IPCC Working Group I Fourth Assessment Report

Expert Review Comments on First-Order Draft

Chapter 1

The following compilation of review comments and author responses is supplied by the Working Group I Technical Support Unit as a record of the process used to prepare the Working Group I report. These comments and responses are not to be edited and/ or re-distributed in part or in full to others.

Please note that under IPCC procedures authors are required to take account of all substantive review comments in both review rounds. Thus responses to individual comments may be influenced by comments from other reviewers.

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1-1	A	0:0	0:0	I find this chapter and Chapter 6 lack balance in the limited space they give to an extensive and increasingly relevant literature on climate history from the ancient past, and especially that through Cenozoic times (last 65 million years). Both paleogeography from sea floor magnetic anomalies and temperature history from oxygen isotopic measurements of shells in deep-sea sediments were well enough known by the late 1970's for a comprehensive account of the history of the planet's oceans and climate. This is well summarised in the last few chapters of Jim Kennett's "Marine Geology" 1982. As IPPC TAR has already noted, atmospheric CO2 levels have already exceeded those of the last 400,000 years (now the last 800,000 years in "Eight glacial cycles from an Antarctic ice core" Augustin et al. Nature (London), vol.429, no.6992, pp.623-628, 2004) and have likely exceeded any in the last 20 million years (now better established in "Marked decline in atmospheric carbon dioxide concentrations during the Paleogene" Pagani et al., Science, vol.309, no.5734, pp.600-603, 2005). Surely these observations require is to look beyond the Quaternary for understanding the changes expected in the next few decades. IPCC projections for CO2 and temperature by the end of this century (doubling and 1.4-5.8degC) could well reach levels last seen on earth before the first big Antarctic ice sheet formed 34 million years ago ("Comparison of longterm greenhouse projections with the geologic record" Crowley, T J; Kim, K, Geophysical Research Letters, vol.22, no.8, pp.933-936, 1995). Indeed the formation of this ice sheet is now seen to be largely a consequence of declining CO2 levels ("Rapid Cenozoic glaciation of Antarctica induced by declining atmospheric CO2" DeConto, R M; Pollard, D, Nature, vol.421, 245-249, 2003; "Cooling a continent" Barrett, P J, Nature, vol.421, 221-223, 2003). Some claim that knowledge of earth's pre-Quaternary climate (ie climate more than 2 million years ago) is not useful because the geography has changed too much. This is not so. The movement of continents has been tracked in detail for the last 150 million years from sea floor records, so that geographies over this time at least can be reconstructed with a high degree of confidence on the scale of current GCMs (see for example "Mesozoic and Cenozoic Plate Reconstructions" by C.R. Scotese and W.W. Sager (Editors). Elsevier, Amsterdam, 410pp, 1989, but field much advanced since then). As an example of improved understanding of past environmental change that is relevant to the near future, Naish et al. (in "Orbitally induced oscillations in the East Antarctic ice sheet at the Oligocene/Miocene boundary" 2001, Nature, 419, 719-723, 2001) describe a sedimentary record from the Antarctic margin that shows how the Antarctic ice sheet was fluctuating on both 100,000 and 40,000 year time scales and causing changes of ~50 m in global sea level just 24 million years ago, when CO2 levels were likely not much more	Noted. Space restrictions were severe and prevent such detailed treatments.

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				than todays. The deadline has now arrived, and I regret not having found the time required to made a more substantial contribution to the current draft. I will do some further drafting over the next week, though I realise there is little chance of its consideration. This has been a great learning experience, and causes me to see the importance of early involvement in the next assessment (due out in 2013?). In the next few years the relevance of Cenozoic climate history for both perspective and understanding both global and regional climate processes is likely to become even more obvious. [Peter Barrett]	
1-2	A	0:0	0:0	Great job - it may be useful when talking about past work to refer to where in the rest of the document updated information can be found. i.e. refer to chapter 8 in section 1.4, chapter 3 for 1.5.1, chapter 6 for 1.5.2 etc… [Piers Forster]	Accepted. References to AR4 Chapters will be included as appropriate in Chapter 1.
1-3	A	0:0		I am glad that the historical overview clearly recognises the past en also very present problems with unphysical corrections necessary to obtain a realistic climate state in state of the art models i.e. section 1.5.9 page 22 line 42 to page 23 line 38 on flux adjustments and tuning of radiative parameters. The inclusion of a whole section (1.5.8 page 21 line 8 and further) on cloud modelling and climate sensitivity and the large uncertainties in that area is also a very much welcomed element. Some worry remains however concerning the discrepant statements that climate is a large system that comprises of many nonlinear dynamical subsystems that are coupled by many feedbacks which makes it hard to test hypothesis in an "experiment like" fashion, while on the other hand it seems to implicitly be assumed that models provide correct results and prognoses of climate are indeed possible despite serious uncertainties about magnitude and sometimes sign of mechanisms. [Florens De Wit]	Noted. Compliments appreciated, but we reject the assertion that "it seems to implicitly be assumed that models provide correct results."
1-4	A	0:0		I found this chapter to be a nice summary of the history and the present day understanding of global warming issues, and thus, I have just a few minor suggestions. [Michael Alexander Alexander]	Noted. Thanks.
1-5	A	0:0		This chapter is an excellent summary of the history of climate and climate change research, and sets the context well for subsequent chapters. It is a welcome addition to the series of IPCC reports. The "tutorial" on the scientific method and what is and what is not science is valuable. I am sure it is written with the alarming trend in the U.S. toward non-science or politically based science in mind. The example of "global cooling"	Noted. Thanks.

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				theories in the 1970s and how the scientific method eventually sorted it out is quite interesting and useful---as a student at the University of Wisconsin in the late 1960s and early 1970s and a friend of Reid Bryson I remember these arguments very well! [Richard Anthes]	
1-6	A	0:0		This is a concise but highly informative overview of the meteorological and oceanographic aspects of climate change. The major shortcoming is that it almost completely ignores biospheric aspects of climate change - there is only one brief mention (page 1-23 lines 37-38, as if this were a new and esoteric aspect of the issue. However, there is a rich history of research in this field, much of it from the International Geosphere-Biosphere Programme but also from elsewhere. There is a section on the cryosphere, but the biosphere is at least as important as the cryosphere, both as a source of feedbacks and drivers of climate change and also as an indicator of climate change. While biogeochemical processes obviously have their own chapter for the first time, I strongly feel that in Chapter 1 there should also be a section on a historical overview of biospheric topics of equal prominance to the cryosphere section. [Richard Betts]	Noted. Space restrictions were severe and prevent such detailed treatments. We chose to present some areas in more depth rather than to cover more areas more shallowly.
1-7	A	0:0		Good and self-contained overview of history of climate change science. Congratulations! [Manola Brunet]	Noted. Thanks.
1-8	A	0:0		Add Polar Oceans descriptions under 1.5 [Zhaoqian Dong]	Noted. Space restrictions were severe and prevent such detailed treatments.
1-9	A	0:0		I think that there is much stated and unstated underlying this chapter that is illogical. The mere fact of growth in a research field does not mean that it is important or getting closer to the truth. It could mean that there is a herd instinct. The mere fact that there are more apers does not mean we are closer to the truth. There are many many terrible papers being published in the last decade - partly it seems because the explosion of papers dampens their scrutiny. The increase in the number of pages per paper could be an increase in knowledge or it could be that figures are easier (and cheaper) to produce and that with global data and global models, "coffee-table" science is published at the loss of quantitative analysis. I think the authors should seriously consider what points they are trying to make in this chapter (which I think have to do with historical development and growth in confidence in predictions as observations and models become more comprehensive and include more processes), and omit some of the fuzzy reasoning. I have not yet looked at later chapters but I know there is some divergence in models and also in model quality and I think that this chapter is too broad-brushed in speaking of model improvements. [Anne Douglass]	Noted. Growth in papers published has been de-emphasized, and the figure illustrating it has been removed.
1-10	A	0:0		I really enjoy reading this chapter. The content helps the reader to locate himself in a	Noted. Thanks.

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				historic context that is necessary to understand the unintentional environmental impacts due to climatic change. It was really missing in the previous reports. [NADIA GAMBOA]	
1-11	A	0:0		It is a very good idea to start the report with a chapter on climate change science since the AR4 will not be used only by researchers but also students and general public interested in the field. [Savitri GARIVAIT]	Noted. Thanks.
1-12	A	0:0		The chapter also introduces essential basics for policy makers. However, cautions should be put on consistency with other chapters focusing on the same topics or themes. [Savitri GARIVAIT]	Noted. After the SOD, we will devote more attention to the relationship between Chapter 1 and other chapters.
1-13	A	0:0		Ch 1 is an excellent background document - realistic, comprehensive and honest. There is one missing area that I think needs addressing. That is the subject of dimming and rebrightening of solar radiation at ground level that has been widely observed over the last half century. Its significance in relation to areosols, clouds and evaporation could benefit from discussion. [Roger Gifford]	Noted, but the topic has been largely developed post-TAR and so will be treated in other AR4 chapters.
1-14	A	0:0		I think that the technical terms like forcing agent, radiation forcing, GWP will be included in a glossary. It would also be good to make the link between RF and GWP. [G. H. Sabin GUENDEHOU]	Accepted, and the AR4 glossary does treat these terms.
1-15	A	0:0		The addition of this chapter is quite necessary for readers to understand the whole progress of climate assessment report since it provides an introductory description to historical context for the remainder of the report. This chapter also points out the key accomplishments and challenges in studies on climate and climate change. The chapter is well constructed and also well documented in the history of IPCC Reports. [Xueliang Guo]	Noted. Thanks.
1-16	A	0:0		This chapter is well written and has a good coverage [Per Holmlund]	Noted. Thanks.
1-17	A	0:0		Works quite well and looks in good shape. It does however need a concluding section. [Brian Hoskins]	Noted. Thanks. Agreed. Text has been edited.
1-18	A	0:0		This chapter is well written and provides a useful, interesting, and readable overview of some of the history of climate change science. I have relatively few significant comments. In general, it would help to have forward references to the relevant sections in later chapters that provide the latest assessment of some of the climate issues discussed in your examples, even if this is just a mention of the most relevant chapter or chapters. [David Karoly]	Accepted. References to other AR4 Chapters will be included as appropriate in Chapter 1.
1-19	A	0:0		I am sure that there must be some rationale for the ordering of the examples in section 1.5	Accepted. Material has been re-

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				but it was not obvious to me. In particular, I recommend moving much earlier the last two examples, 1.5.11 and 1.5.12 on the greenhouse effect and human sources of greenhouse gases. These might come as the first two examples, but they should definitely come before any discussion of greenhouse gases and radiative forcing (1.5.5) and before detection and attribution (1.5.10). [David Karoly]	ordered.
1-20	A	0:0		This chapter is important, informative and interesting to read. It puts in perspective the whole exercize. Suggested corrections are minor (lack real overview of the progress in paleoclimatic science..). Only important point, which is missing also in chapter 5, the missing evaluation of effects of technical changes [Laurent LABEYRIE]	Noted. We are unclear what is meant by "missing evaluation of effects of technical changes."
1-21	A	0:0		Overall, the idea of adding this type of chapter to the IPCC WG 1 report seems a positive step. The ordering of the issues addressed in section 1.5, however, seems a bit strange, with, for example, the Greenhouse Effect coming very late in the list even though it is really fundamental. It is also not clear how or where the questions sections will be fit into the chapter--and, in fact, there seems to be some duplicaiton among them (e.g., Question 1.1 and 1.3 cover similar issues) and with some of the various sections of 1.5. I would hope that the authors would work to do a general streamlining as they move to their next draft. [Michael MacCracken]	Accepted. Material has been re-ordered. Questions (FAQs) have been extensively revised.
1-22	A	0:0		I am concerned that, for a report covering a topic of such intense public interest, the discussion of uncertainties isquite academic. While the technical chapters are indeed intended for a scientific audience, this one in particular seems to me likely to be read by generalists, and there are quite a number of places in the chapter (mentioned later in specific comments) where the tone and phraisng indicates such greeat uncertainty that one might wonder if we know anything at all. It was, in my experience, not being careful enough about this issue that caused the significant controversy about detection-attribution in the SAR--basically, the particular chapter used jargon from statistics instead of making explicitly clear what was meant by the phrases--and that got transferred to the public domain and misused. The phrasing in this chapter--and indeed in the whole assessment--needs to be very explicit about what is meant and avoid jargon. [Michael MacCracken]	Accepted. Uncertainties topic is now treated extensively throughout AR4, both in Chapter 1 and elsewhere, and consistent usage throughout AR4 is stressed.
1-23	A	0:0		A key issue that ABSOLTUELY MUST be much better covewred is to define what is meant by the word "uncertainty" and to describe the efforts of the IPCC over the years to develop a lexicon to express scientific findings to a more general audience. This has been the casue of much of the controversy in the past and absolutely has to be explained. Thus, it needs to be said that scientists (in the physical sciences, at least--this is not the way it is	Accepted. Uncertainties topic is treated extensively in AR4, both in Chapter 1 and elsewhere, and consistent usage throughout AR4 is stressed.

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				done in all of IPCC expertise) is to seek two-sigma significance (so like 20-1 odds) before really formulating a finding--at that point, there certainly remains uncertainty, but such high odds (or likelihood) are far above what is typical in the other expert fields of IPCC (WG II and III) and in how the business community, the environmental community, and the general public run their activities and live their lives. It really needs to be explained that the 2-sigma criterion is based on a value judgment by the physical sciences community because we are building the proverbial "pyramid of knowledge" and do not want to (often) be wrong. This is well and good, but whether this is the standard to use for making judgments about the growing risk of climate change is a separate question. So, I very strongly encourage the authors to be more forthright and comprehensive on this issue of uncertainties and level of confidence, and to explain the history of IPCC's recognition and dealing with this issue trhough the development of the lexicon--and in each of the sections of 1.5, the authors should be using a consistent (and clearly defined) lexicon to explain themselves--e.g, to go from the balance of evidence on attribution in the SAR to the most of the change over last 50 years statement in the TAR. It is true that these statemeetns generally appeared in the Summary for Policymakers, but that is also part of the history of the subject--indicating how the scientific findings were conveyed--that has to be covered in this chapter (following a general explanation of the issue). [Michael MacCracken]	
1-24	A	0:0		Opening Comment: I prefer not to provide an anonomous review. For me, an open and accountable process requires a two-way process of communication between the Reviewer and the authors, particularly so between the Reviewer and the Coordinating Lead Authors, and probably the Review Editors. In my view, this open process empowers a better final report. Because this reviewing the Draft WG! Draft Report(1644 single-spaced pages!) is such a collossal task, I will send in my review comments chapter by chapter. This will allow the early-chapter authors to make alterations that should prove to be useful to the authors of the later chapters, as well as to maintain my patience and sanity. [Jerry Mahlman]	Noted. Following IPCC procedures, we respond to all reviewer comments.
1-25	A	0:0		This is a very well written, and a very well considered, chapter. Indeed, it could provide invaluable knowledge and perspective for a graduate student or postdoc interested in a possible career in climate-change science. However, for the intended readershipof this IPCC Working Group 1 Fourth Assessment report, this Chapter produces more of a barriier to the motivated reader/policymaker/citizen/teacher/planner, than as a pathway the the very important new conclusions of this Fourth Assessment Report of IPCC. I thus recommend a far shorter Introduction and retrospective piece that is designed to orient the reader to comprehend the historical background of previous climate science that sets the stage for laying out the 2006 FAR conclusions and insights on the human-induced	Noted, but this reviewer's views are anomalous, in that many other reviewers prefer the general approach that we have taken, and we cannot satisfy this reviewer and all the others as well.

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				climate change that is the very basis for the existence of this Report. This very important and insightful retrospective on "how we got here" would be an invaluable reference basis for the motivated reader who came in late(graduate students, career switchers, and science historians? (Note to Headquarters: I am writing this in the same tiny type as that of the 1644 single-spaced pages in this WG1 First Order Draft. The punishment fits the crime!) [Jerry Mahlman]	
1-26	A	0:0		A drastically reduced introductory Chapter 1 would then serve as a simple and straightforward stabilizing context to guide the reader much more directly to the FAR's invaluable and insightful new conclusions and their guidance for policymakers, the greater scienfific community, technologists, citizens, students, and educators. Such an approach would drastically reduce the jarring discontinuity between the current Introduction and the FAR's very strong and well grounded new scientific findings, indeed the very essence of why these IPCC Reports are so invaluable. Such a highly refocussed Chapter 1 could set the stage for Chapter 2, which starts out with a significant number of the new quantitative conclusions that substantally advances the quantitative sciences' case for why human-induced climate warming is such a major challenge for the planet, now and centuries from now. I thus conclude that the great quantitative detail that lies within the "old" Chaper 1 would be appropriately moved to an Appendix, or even a separate IPCC or WMO publication. I believe that this altered status would solve the "awkward opening of FAR WG1" problem. This "old" Chapter 1 essay is eloquently written and very well grounded scientifically; indeed, it could be readily converted intoa book or a monograph that has a separate, but complementary status from the upcoming FAR. [Jerry Mahlman]	Noted, but this reviewer's views are anomalous, in that many other reviewers prefer the general approach that we have taken, and we cannot satisfy this reviewer and all the others as well.
1-27	A	0:0		Somewhere in this FAR, it seems now to be compelingly relevant for all of us climate scientists(and IPCC itself) to produce an IPCC perspective on the very loud, but scientifically inept, "contrarians science" phenomenon. In my recent experience, it has been clear that the "science" of those who are naysaying mainstream science has become increasingly inept, scientifically dishonest, extremely loud, and militantly ascientific, given the robust nature of FAR and its predecessors, and relative to the quirky, and often lampoonable "contrarians' climate science". In retrospect, it seems quite odd that our collective responses from the climate-science community have been diluted greatly, and diminished by the actions of the press to provide "balanced reporting", and in the process, creating widespread confusion among those whose education in such matters consitsts mainly from reading newspaper accounts that are backed by editors who are demanding "balance in reporting". Indeed, the climate science writers from the press declare themselves as discouraged and isolated by the demands for a platform for "contrarian science" I realize that this is a major demand upon IPCC, but a non-response, or at tepid	Noted, and several LAs agree that they would like to see IPCC take on the contrarians directly, but a short chapter on progress in climate science in historical context cannot accommodate this large task.

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				response, from IPCC actually acts to undermine its very own basis for existence. The contrarians' case leaves huge room for exposing their incorrect, misguided, and politically tinged claims. I thus assert that it is time for IPCC to speak to the contrarian's bizarre claims directly, with point-by-point examinations of their loud, but eminently falsifable claims. If the IPCC has the courage to face this problem directly, I am very sure that IPCC will receive strong support for this from the mainstream climate-science community. At the minimum, we need a genuine dialog amongst ourselves to evaluate how this FAR should respond, not IF we should respond. In my opinion, the first person you should contact would be Richard Somerville. He has been on the front lines, and he is calm, deliberate, kmnowledgable and eloquent; indeed, look at the masterful writing in this now "old draft" of Chapter 1. At the minimum, this should no longer be a "taboo subject" among the leading scientists whose work has empowered this draft WG1 FAR report. [Jerry Mahlman]	
1-28	A	0:0		Laudatory comment. It is impressive how few typos and grammer errors there are in this text. My only problem is differentiating between "British" and "Americanese" in much of the text. It seems that there is a very quiet "cultural war" going on. The Americans like clarifying commas, while the British seem to think that commas should be outlawed. I found it challenging many times trying to decipher a sentence with introductory clauses that went on, comma less, for as much as two lines. If I grumpily add in commas to find meaning in a sentence, please correct my corrections, or forgive me! [Jerry Mahlman]	Noted. We follow IPCC usage guidance but strive for maximum intelligibility and clarity.
1-29	A	0:0		I estimate that the chapter is currently about 33% over its target length. The balance across subsections seems about right to me, but I would suggest that careful revision could shorten most sections. [Martin Manning]	Accepted. Every effort will be made to meet the length limit in the next draft.
1-30	A	0:0		This chapter is considerably improved since the ZOD and is very readable with an interesting perspective on climate change that is new for the IPCC. In particular the authors are to be congratulated on achieving a sense of the development in understanding - not just in techniques. However, I am disappointed that the authors have chosen to drop the issue of uncertainty. The strengthened focus on development of understanding would provide a great platform to differentiate between confidence in the science and probabilistic estimates of likelihood of change or 2-sigma errors on individual numbers. [Martin Manning]	Accepted, in principle, within length limitations. Uncertainties topic is treated extensively throughout AR4, both in Chapter 1 and elsewhere, and consistent usage throughout AR4 is stressed.
1-31	A	0:0		For entire Chapter 1, because there is a inhomogeneity concerning the conclusions for each paragraph, I suggest that all paragraphs to have conclusions or a summary of the methods/models in a hierarchical form.	Rejected. Forcing each section into a common format would detract from readability and constrain the chapter

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				[CONSTANTIN MARES]	unnecessarily.
1-32	A	0:0		I don't think that the IPCC report should start with Figure 1.1. An increase in the number of papers published is not necessarily an increase in knowledge. Also, JGR is not the only journal which addresses IPCC topics. Figure 1.1 "pats" the atmospheric research community on the back - readers outside the research community may react in an adverse manner to this Figure. I feel it is appropriate to discuss in the text the increase in publications, but not to start the IPCC report with this Figure. [Steven Massie]	Accepted. Growth in papers published has been de-emphasized, and the figure illustrating it has been removed.
1-33	A	0:0		The Chapter 1 Figures are generally very poor quality; given our capabilities with Computer Graphics, an IPCC report should not use such shoddy graphics. [Lourdes Maurice]	Accepted. Figures in this draft were preliminary placeholders, and high-quality figures are being prepared for the next draft.
1-34	A	0:0		The use of italics is excessive. The message of importance generally associated with italics is not coming across. [Lourdes Maurice]	Noted. Text has been edited.
1-35	A	0:0		The chapter ends in an abrupt manner and lacks a clear, unifying summary. Suggest including such a summary, highlighting the main points of the discussion. [Lourdes Maurice]	Noted. Text has been edited.
1-36	A	0:0		This is an excellent introduction - a terrific primer on the science and history of climate change research and will really help many readers. My comments are generally minor and often about style, rather than content. [Neville Nicholls]	Noted, with appreciation.
1-37	A	0:0		Chapter 1 should give a historical overview of climate change science, with particular emphasis on the how it has developed after we realised the global temperature was increasing and that the potential consequences of such a change could be devastating for life on earth. This happened in the seventies and the early eighties when the role of CO2 in the atmosphere became clear and semi-robust model estimates of global temperatures associated with this process began to be published. As the chapter stands now it does not sufficiently explain how this change came about. Rather, it introduces a number of individual scientific disciplines that are related directly or indirectly to climate change, but it fails to show that it was the integration of these disciplines that facilitated a proper understanding of climate change. A rewriting of the introduction could solve this problem. Chapter 1 follows the same structure as the other chapters, starting off with an executive summary. This works fine for chapters that present data and hardcore science, allowing	Noted. Executive Summary is being extensively revised. The suggestion that the focus of the chapter should have been on recent developments has to be rejected, with exceptions. It would have been possible to concentrate on the topics suggested by the reviewer, in particular the developments in the 1970s and 1980s. However, this emphasis would not have provided the broader context needed by non-specialist readers coming to AR4 without a deeper background in climate

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				the most important results to be listed up-front. This is not the case for chapter 1. The executive summary is confusing and faltering. The introduction should tell a story which can be grasped by both layman and scientists. In fact, it is not before sub-section 1.5 that the reader is presented with interesting and stimulating text that is related the science part of it (1.1 should be deleted and 1.4 should either be incorporated into sections 1.5.7-9, or be given a 1.5-section of its own). I find this strange because the development of climate change science is a very exciting story. In the paper "Climatic Change: Are we on the brink of a Pronounced Global Warming", published in Science in 1975, Wallace S. Broecker shows with great clarity what scientists should look for, and the public expect, in the coming decades (it is not even mentioned in ch1). Six years later Hanson et al. followed up with another key paper "Climate Impact of Increasing Atmospheric Carbon Dioxide" where they documented that the global temperature had increased and that CO2 played a major role in forcing that change. Common for both of these papers, and crucial to their findings, is that they combined knowledge from different scientific communities - from monitoring, modelling and paleoclimate. Why not use these papers as a starting point for the introduction. What made them special? How did other scientist react to those papers? How did they shape the further development of climate change science? After Hanson et al. published their paper climate change became very much politicised, and it affected the further progress of climate change science in profound ways. In fact, it split up scientific communities into fractions (why were we so slow to accept the idea of human forcing?) and it probably influenced funding as well. Considering the recent request from US Senator Barton and the harassment of Mike Mann and co-workers (and the TAR) I think this point is well worth considering for ch1, and it would certainly fit in an introduction. Finally, a critical development of paleoclimate was the transition towards the use of quantitative data, which should be mentioned in section 1.5.2. [Øyvind Paasche]	science. The LAs do not share the reviewer's opinion about the relative importance of the Broecker and Hansen papers mentioned, nor do they agree with the reviewer's final points about politicization.
1-38	A	0:0		The description of different forcing mechanisms is biased. Cloud and aerosol related mechanisms are described very well, but the description of solar forcing is rather poor. A lot of recent publications are missing. [Eugene Rozanov]	Noted. Text has been edited. Post-TAR work is not the subject of this chapter.
1-39	A	0:0		I particulary checked compliance wiht the "Guidance Notes for Lead Authors of the IPCC Fourth Assessment Report on Addressing Uncertainties". "Uncertainty" is not a topic in most of the sections. If it shows up, it is mostly used in a rather vague form, not making any use of the "Guidance Notes". An exception is section 1.5.5 "Greenhouse Gases, Aerosols, and Radiative Forcing", details below. [Robert Sausen]	Accepted, in principle, within length limitations. Uncertainties topic is treated extensively throughout AR4, both in Chapter 1 and elsewhere, and consistent usage throughout AR4 is stressed.

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1-40	A	0:0		The chapter is rather inhomogenoeus, some sections are more the explanation of a phenomenon than a historical overview. The latter the reader expects from the chapter title and the introduction (1.1). [Robert Sausen]	Noted. Text has been edited.
1-41	A	0:0		Not evry reader is aware of abrivations used. They should be provide in full length when occuring for the first time. [Robert Sausen]	Noted. Text has been edited.
1-42	A	0:0		The sections are really excellent as written but don't do justice to the carbon science on the gas that is after all responsible for ~50% of the problem, and by doing so, also miminizes the contribution of the carbon greats (too many of which are no longer with us) Revelle, Keeling, Siegenthaler, Sarmiento, Fung, Wofsy, Prentice, and the like relative to their more physical and chemical collegues in this historical review (not that policymkers may care, but I do). [David Schimel]	Noted. The relative balance of topics considered is not easy to reach agreement on. We cannot cover every topic. Length limits are severe. We chose to present some areas in more depth rather than to cover more areas more shallowly.
1-43	A	0:0		According to the guidelines for reviewers positive and critical comments should be outlined here. It deserves merit to include an historical overview of climate change science in the IPCC WGI report. It shows not only that "recent decades have seen an explosive growth of knowledge" about the climate system but also that a new scientific specialty emerged in connection with the political issue of controlling anthropogenic effects on earth's climate. Probably—and that is the main point of this review—the climate change sciences are one of the precursors for some fundamental changes in recent sciences. The huge organizational efforts to monitor the earth system, new modes of data distribution (IPCC DDC, WDC), the periodical production of assessment reports, and the connected enlargement of peer review procedures speak to that fact. The chapter shows the importance of the effective organization of scientific work within this field. [Falk Schützenmeister]	Noted, with appreciation.
1-44	A	0:0		Unfortunately it is not always clear to which end this chapter was written. It seems indecisive between the two poles of outline the history of climate science as a success story of establishment new forms of scientific work and the normative claim of traditional scientific values. Sometimes these two goals seem conflicting in this chapter. On one hand, there is the advancement of scientific theories and work methods. In climate change questions of complexity, uncertainty and the epistemic role of simulation play a more important role than in the reductionist methodology of classical physics or chemistry. New approaches were developed to deal with these questions. On other hand, these advancements are denied by referring to a very classical view of scientific work (Popper). This review focuses on the points, which highlight the innovation of climate research, and contests its epistemological standpoint a little.	Noted. Text has been edited.

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				[Falk Schützenmeister]	
1-45	A	0:0		Surely, for the IPCC it is important to take a standpoint on these issues. The reviewed chapter rejects implicitly and courageous some extensive interpretations about changes in the climate research by the political and social sciences. Of course the climate change research is good science backed by a set of norms and it is very important to highlight this fact to gain the appropriate acceptance in the political process of decision-making. Furthermore, new norms appeared in the history of climate research to defend science against interested demands. Regrettably, this merit of climate research and especially the IPCC is not mentioned in this chapter as it could. Especially the discussions within the SAR chapter 8 controversies and Robert Watsons White Paper dealing with the problems of interested reviews are speaking to this fact (cf. Agrawala 1998). [Falk Schützenmeister]	Noted. We have chosen to emphasize the history of the science rather than the history of the IPCC.
1-46	A	0:0		The advances outlined above could be shown with the procedures dealing with uncertainties of scientific knowledge as well. Unfortunately this section—named in the first outline of the [Falk Schützenmeister]	Noted, and text has been revised. Uncertainties topic is treated extensively throughout AR4, both in Chapter 1 and elsewhere, and consistent usage throughout AR4 is stressed.
1-47	A	0:0		Cited literature Agrawala, S. (1998) 'Structural and Process History of the Intergovernmental Panel on Climate Change.' Climatic Change 39, 621-642. Kitcher, P. (1989) Scientific Explanation. Minneapolis Laudan, L. (1977) Progress and Its Problems. Towards a Theory of Scientific Growth. Berkeley u.a. Lakatos, I. (1978) The methodology of scientific research programmes. Cambridge, MA. [Falk Schützenmeister]	Noted, but we are severely space-constrained and cannot provide extensive bibliographical material.
1-48	A	0:0		The chapter was a pleasure to read and accomplishes its goals highly successfully. [Dian Seidel]	Noted with thanks.
1-49	A	0:0		The chapter as a whole mainly credits individual scientists with major advances. While this is largely justified, the role of institutions should also be recognized and noted. One obvious place to do this would be in Section 1.5.12, in the discussion of the "Keeling curve" (Fig. 1.3). Although Keeling was the pioneer of these observations, he was funded by government agencies and the curve continues today largely due to NOAA support of the the Mauna Loa observatory and the observation program. By acknowledging the role of governments (or other institutions) in research, particularly monitoring research or other activities too complex, prolonged, or expensive for a single research team to undertake, the AR4 would be communicating the importance of adequate funding of those	Noted, and C. D. Keeling's autobiographical paper (1998) is cited and provides these details. The LAs have been sensitive to avoid the appearance of special pleading for research funding.

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				agencies in the future. [Dian Seidel]	
1-50	A	0:0		Please write down more long history with showing the uncertainty. It means following two things. 1) Peoples like to know the reason of the ice age coming, 2) Long ago CO2 concentration was really high, in that age what the Earth temperature was. These comments have to writ down in the first history pages. [Akira Sekiya]	Noted. Causes of ice ages and paleoclimatic time variation of atmospheric carbon dioxide are well covered in textbooks and other reference material cited.
1-51	A	0:0		Although the Chapter as a whole provides a good review of progress in climate change science, it concentrates too much on GCM developments to the exclusion of other significant areas. The most important of these is the recent progress made in downscaling of GCMs to overcome problems of grid size, which are not meaningfully discussed in the Chapter. Regional Climate Models and Statistical Downscaling approaches have seen considerable advances since FAR and will underpin most of the impact analyses of interest to policymakers. A fairly substantial section dealing with these developments is surely necessary in the Chapter, perhaps at the expense of some of the GCM methodological details. [John Sweeney]	Noted, and downscaling is covered elsewhere in AR4. Much progress has been made since the TAR, the publication of which is the stopping point for Chapter 1.
1-52	A	0:0		1) I helped out a lot on Question 1.3 of this chapter. Should I be on the CA list? [Kevin Trenberth]	Yes. Accepted. Thanks.
1-53	A	0:0		General comments: This is an interesting chapter but surprising for what it does include and what it leaves out. It is not an introduction to AR4 or to the report. Somehow I would like to see it serve that role a little more than it does. Isn't the purpose of the history so that it can set the stage for this report? I believe this chapter needs to forge that connection much more than it does. Indeed in a couple of places, the chapter refers to a host of papers in post TAR times whereas it would be much better to refer to the appropriate AR4 chapters that deal with the topic in more detail. [Kevin Trenberth]	Accepted. Text has been edited.
1-54	A	0:0		General Comments (continued): It is titled "historical overview of climate change science" but it is not. For instance it never mentions the development of the WCRP in 1980 or the first or second climate change conferences, or events like FGGE. It does not deal with ozone assessments. Then when it does deal with IPCC, which seems especially relevant, it make no mention whatsoever of the IPCC process. The number of people involved, the openness, the review procedures, the appointment of review editors (the Santer fiasco), the line by line	Noted. Text has been edited. However, we have chosen to emphasize the history of the science rather than the history of the IPCC.

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				(word by word) approval of the SPM and how problematic (and political) that has become as governments get involved, and so on, are not well known and I find that these are surprising omissions. Even under the IPCC discussion a major 200 pp special report in 1992 "Climate Change 1992" is not even mentioned. [Kevin Trenberth]	
1-55	A	0:0		General Comments (continued): Then in section 1.5 it provides "examples of research progress in historical context" but there is not a clear understanding of why these examples were chosen and not some others. Thus surface temperature is chosen (perhaps obviously so), but atmospheric circulation is not, yet there is a wonderful and rich history of measurements of sea level pressure and sea level pressure charts, and assessments of the mass of the atmosphere (reviewed for instance in Trenberth, K. E., 1981: Seasonal variations in global sea level pressure and the total mass of the atmosphere. J. Geophys. Res., 86, 5238–5246.) and this seems as much as or more relevant than some other topics. [Kevin Trenberth]	Noted. The relative balance of topics considered is not easy to reach agreement on. We cannot cover every topic. Length limits are severe. We chose to present some areas in more depth rather than to cover more areas more shallowly.
1-56	A	0:0		The chapter is clear and well written. [Philippe Tulkens]	Noted with thanks.
1-57	A	0:0		This historical overview is a new feature in IPCC reports, it is informative and useful [Philippe Tulkens]	Noted with thanks.
1-58	A	0:0		I do not understand why chapter 1.4 (model evolution) is not included in chapter 1.5 (examples of research progress). [Heinz Wanner]	Noted. Text has been edited.
1-59	A	1:0	4:	This first chapter (pages 1-4) discusses the importance of scientists building upon the work of others, and acknowledging previous work: "Therefore intellectual honesty and professional ethics require that a scientist acknowledge the work of predecessors and colleagues." I agree with this, but it appears that this report could be more careful in acknowledging relevant work that occurred before 2000—the overwhelming number of references are to papers that have appeared in the past five years. I will give three specific examples later in my review. [Richard Anthes]	We have had to be highly selective in choosing references because of space limitations. The reviewer is not correct, in that of the more than 250 references in the FOD, only a few were in the past five years. Our cut-off date was the TAR (2001). Nevertheless, we will take this comment into account.
1-60	A	1:0	4:	It is good to review the three previous IPCC reports, and to see that they present a consistent, though evolving, summary of our understanding of climate change. [Richard Anthes]	Noted, with thanks.
1-61	A	1:0	4:	Please be sure to update the Keeling curve with the very latest data before the report is published. [Richard Anthes]	Accepted.

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1-62	A	1:0		I commend the authors for the excellent writing style and for the fascinating narration. The ordering of the sub sections in 1.5 can be improved. The sub section 1.5.11 should be upfront as 1.5.1 and 1.5.12 should be inserted after 1.5.6. . I feel, by discussing surface tempearture without including a section on atmospheric temperature, they are making a strategic mistake by the apperance that they are avoiding a major controversy in differential temperature trends between troposphere and surface. [Veerabhadran Ramanathan]	Accepted in principle, and the text has been revised and sections reordered.
1-63	A	1:0		I have included comments on several chapters below. I commend the authors for the excellent writing style and for the fascinating narration. The ordering of the sub sections in 1.5 can be improved. The sub section 1.5.11 should be upfront as 1.5.1 and 1.5.12 should be inserted after 1.5.6. . I feel, by discussing surface tempearture without including a section on atmospheric temperature, they are making a strategic mistake by the apperance that they are avoiding a major controversy in differential temperature trends between troposphere and surface. [Veerabhadran Ramanathan]	This is a repeat of the previous comment (1-62).
1-64	A	1:1	1:47	This seems like an excellent idea to lead off with a historical perspective chapter. [Andrew Lacis]	Noted with thanks.
1-65	A	1:9	1:9	Miles Allen -> Myles Allen [Reto Knutti]	Accepted.
1-66	A	1:9	1:10	One specific paragraph is missing on assessing effects of technological changes with time on measurements, errors or drifts, ways they are taken care of. The example of the water bucket is just an extreme case [Laurent LABEYRIE]	Noted. Text has been edited.
1-67	A	1:10	5:15	Past environments may also be considered as experimental settings for changes in boundary conditions, eg. Sensitivity of ice sheets, water cycle, biosphere to changes in heat distribution (through insolation), perturbation of THC by fresh water input, constraints on natural changes of atmospheric CO2, CH4 [Laurent LABEYRIE]	Noted. Text has been edited.
1-68	A	1:11	1:	It may be worth explicitly acknowledging and referring to (some of) Croll's pioneering works: Croll, J., 1864: On the physical cause of the change of climate during glacial epochs. Philosophical Magazine, 28, 121-137. Croll, J., 1867: On the eccentricity of the earth's orbit, and its physical relations to the glacial epoch. Philosophical Magazine, 33, 119-131. Croll, J., 1867: On the change of obliquity of the ecliptic; its influence on the climate of the polar regions and the level of the sea. Philosophical Magazine, 33, 426-445. Croll, J., 1875: Climate and time in their geological relations: A theory of secular changes of the Earth's climate. Daldy, Isbister & Co. [Ian Simmonds]	Noted. In fact, Croll is mentioned and his 1890 paper is cited. We do not have space for a more extensive bibliography.

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1-69	A	1:43	21:54	Ch 1 p 1-21 lines 43-54. Needs to reflect measurement uncertainties and role of IN subject to different modes of incorporation into clouds and into supercooled drops. Existing parameterization can be most misleading. [John Hallett]	Noted, but space limitations prevent a fuller explanation.
1-70	A	2:0	3:	This section concludes with major uncertainties and lists cloud feedback. Many in the community would include the aerosol-cloud interactions as another major source of uncertainty for it introduces a large uncertainty on the radiative forcing. Should this section say some thing about feedbacks with the biotic component of the climate system as a potential unknown? [Veerabhadran Ramanathan]	Accepted. Text has been edited.
1-71	A	2:0	3:	This section concludes with major uncertainties and lists cloud feedback. Many in the community would include the aerosol-cloud interactions as another major source of uncertainty for it introduces a large uncertainty on the radiative forcing. Should this section say some thing about feedbacks with the biotic component of the climate system as a potential unknown? [Veerabhadran Ramanathan]	This is a repeat of the previous comment (1-70).
1-72	A	2:1		Section Executive Summary: The executive summary highlights some striking new developments in science connected with the climate research, e.g. the difference between the "search for simple and general laws" and the specific methods to deal with complexity, the meaning of computer simulation, the emergence of earth system simulation as a fundamental new approach, or the prominent role of IPCC within this field. Unfortunately, the conclusion (lines 45-47) downplays the meaning of these developments a little. [Falk Schützenmeister]	Noted. The Executive Summary has been revised.
1-73	A	2:3	2:7	The use of the word "ancient" in line 4 and the phrase "several centuries old" do not seem to match well--"ancient to most readers means the time generally 2000-5000 years ago, or so. Perhaps the confusion arises due to the ill-defined word "subject" in line 4. [Michael MacCracken]	Accepted.
1-74	A	2:3	2:3	Delete climate and: title is only on climate change [Michael Manton]	Rejected. Studying climate is a necessary prerequisite for studying climate change.
1-75	A	2:4	2:4	Roots are not ancient [Michael Manton]	Accepted.
1-76	A	2:4	2:4	Omit sentence beginning "However…" The second sentence is much too soon to be introducing qualifications. [John Sweeney]	Accepted. Text has been edited.
1-77	A	2:6	2:7	It is a bit of a stretch to claim three centuries of awareness of greenhouse gases	Noted. Text has been edited.

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				contributing to a possible climate warming effect is several centuries old. I think it was Arrhenius who actually made a public case of it, in just a bit over century and a decade ago. [Jerry Mahlman]	
1-78	A	2:6	2:7	The sentence "The realization that Earth's climate might be sensitive to the atmospheric concentrations of gases that contribute to the greenhouse effect is several centuries old." requires a reference. The references are cited later on page 24, Section 1.5.11; however, they should also be cited here (or at least make a reference that details are found in Section 1.5.11). [Lourdes Maurice]	Noted. Text has been edited.
1-79	A	2:10		Replace "an explosive growth", which implies an uncontrolled increase, with "a remarkable growth" [Vincent Gray]	Accepted. Text has been edited.
1-80	A	2:10		Insert "greatly increased" between "with" and "numbers" [Vincent Gray]	Accepted. Text has been edited.
1-81	A	2:11	2:11	should read: "… quasi-exponentially …" [Stephan Lingner]	Accepted. Text has been edited.
1-82	A	2:11	2:11	Exponential growth is not unique to climate research; why highlight it? [Michael Manton]	Accepted. Text has been edited.
1-83	A	2:11		Delete "increasing exponentially with time" A fixed mathematical function is inappropriate. [Vincent Gray]	Accepted. Text has been edited.
1-84	A	2:13	2:13	Modern communications are also worth mentioning [Michael Manton]	Accepted. Text has been edited.
1-85	A	2:13	2:13	Suggest inserting "recent" or "modern" before "revolutionary. [Lourdes Maurice]	Accepted. Text has been edited.
1-86	A	2:15	2:15	In the late 1950s ....(This awareness was culminated in the late 1950s with the commitment to begin measuring CO2 as part of the IGY.) [Jerry Mahlman]	Accepted. Text has been edited.
1-87	A	2:16	2:16	"the obtaining" needs to be rephrased [Jón Egill Kristjánsson]	Accepted. Text has been edited.
1-88	A	2:17	2:18	replace "..was conducting a unique and inadvertent large-scale experiment.." with "..was unwittingly conducting a unique large scale experiment.." [Peter Barrett]	Accepted. Text has been edited.
1-89	A	2:17	2:17	Delete the words "in the near future" from this sentence. See the next sentence which indicates "until substantial time has passed."	Accepted. Text has been edited.

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				[Howard Feldman]	
1-90	A	2:21	2:48	In these paragraphs, we have observations of the climate system as a "foundation" of our science, then models as a "second pillar". I am not sure what the first pillar is here. [Robert KANDEL]	Accepted. Text has been edited.
1-91	A	2:21	2:48	Furthermore, there is mention only on line 28 in this executive summary of the extremely important role of paleoclimatic research, which provides empirical knowledge of climates differing strongly from the present, and so provides severe tests of the competence of climate models, tests which they are beginning to pass. [Robert KANDEL]	Accepted. Text has been edited.
1-92	A	2:21	2:24	I propose : Three important developments date from the 1950s: (1) systematic and accurate measurements of atmospheric carbon dioxide concentration began; (2) radio-isotope dating came of age, providng reliable dating of past climates, indeed with 1950 as the "present" in B.P.; and (3) attempts to simulate the atmospheric general circulation numerically laid the foundations for today's comprehensive models of the climate system. [Robert KANDEL]	Noted. Text has been edited.
1-93	A	2:22	2:24	replace with "concentration began, along with the earliest attempts to simulate the atmospheric general circulation numerically, which laid the foundations for today's comprehensive models of the climate system." [Peter Barrett]	Noted, but the resulting suggested long sentence impedes readability without contributing significantly to clarifying the intended meaning.
1-94	A	2:22	2:24	1950s is incorrect for first attempts to numerically model atmospheric circulation. L.F. Richardson published his book on the topic in 1922. Ref: Weather prediction by numerical process. London: Cambridge University Press, 1922. [Chuck Hakkarinen]	Rejected. The text says "atmospheric general circulation." This is a well-defined technical term, not the same as Richardson's weather prediction.
1-95	A	2:26	2:33	Perhaps should also mention that data are not forthcoming from many parts of the globe: ie some progress but not enough [Michael Manton]	Noted. Text has been edited.
1-96	A	2:26	2:26	One could quibble with the idea that "observations … are the foundation of our science", since the whole IPCC enterprise is motivated by the theory of global warming due to increasing greenhouse gases. I'd suggest changing "the foundation" to "a foundation". [Dian Seidel]	Accepted. Text has been edited.
1-97	A	2:27		Insert after "chapter" "and throughout this Report" [Vincent Gray]	Noted. Text has been edited.
1-98	A	2:27		It would seem appropriate to say "this report" rather than just "this chapter" [Martin Manning]	Noted. Text has been edited.
1-99	A	2:30	2:33	"Over the last decade global land-surface sets have been able to increase the number of stations substantially". Is untrue.There has been a substantial reduction in the number of	Noted. Text has been edited.

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				stations since 1980. see T C Peterson and R S Vose 1997 "An Overview of the Global Historical Climatology Network Temperature Database" Bulletin of the Royal Meteorological Society Vol 78, pages 2837-2849. There has been a particularly large reduction in the former Soviet Union. Delete from "decade" on line 30 to "not" on line 33 and replace with "substantial reductions in numbers of stations, and in their reliability, since 1980, have affected accuracy of recent figures". [Vincent Gray]	
1-100	A	2:30	2:31	The phrasing implies that the number of surface stations is rising, when I gather what is meant is that work to included records from a greater number of past observational data sets is what is being done. Phrasing should instead be something like "…have been able to make use of observations from a substantially larger number of station records going back to even before the 20th century." [Michael MacCracken]	Noted. Text has been edited.
1-101	A	2:30	2:31	The sentence "Over the last decade, global land-surface data sets have been able to increase the number of stations substantially." is unclear. [Lourdes Maurice]	Noted. Text has been edited.
1-102	A	2:31	1:33	Could you please provide and cite a few examples of such new time series? Please try to equalize them with the ones in Chapter 6. [Carlo Casty]	Noted. Text has been edited.
1-103	A	2:31		However, during the 21st century, there are significant reductions in the number of reporting surface and upper air stations. The current text gives a misleading impression that all stations are continuing to report and access to surface observational data is not a problem. Tom Peterson (one of your LAs) or the GCOS office could provide information on the recent declines in operationally reporting climate observing stations, both surface and upper air. [David Karoly]	Noted. Text has been edited.
1-104	A	2:32	2:32	Suggest changing to read "able to be used to demonstrate" as it is interprestation of the results that yields the finding. [Michael MacCracken]	Noted. Text has been edited.
1-105	A	2:35	2:40	They should include the role of satellites in obtaining the cloud radiative forcing from the Earth radiation budget experiment and thus settling decades old issue of whether clouds have a net radiative cooling or warming effect on the planet (Ramanathan et al, Science,1989). The ERBE data on cloud radiative forcing is one of the major tools for validating climate models and enable the Cess et al study referred to later. Ramanathan, V., R. D. Cess, E. F. Harrison, P. Minnis, B. R. Barkstrom, E. Ahmad, and D. Hartmann, 1989: Cloud-Radiative Forcing and Climate: Results from the Earth Radiation Budget Experiment. Science, 243: 57-63.	Noted. The assertion is correct, but there is a level of detail that is inappropriate for the overview of highlights in an Executive Summary. In any case, the Executive Summary has subsequently been extensively revised from that appearing in the FOD.

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				[Veerabhadran Ramanathan]	
1-106	A	2:35	2:40	They should include the role of satellites in obtaining the cloud radiative forcing from the Earth radiation budget experiment and thus settling decades old issue of whether clouds have a net radiative cooling or warming effect on the planet (Ramanathan et al, Science,1989). The ERBE data on cloud radiative forcing is one of the major tools for validating climate models and enable the Cess et al study referred to later. Ramanathan, V., R. D. Cess, E. F. Harrison, P. Minnis, B. R. Barkstrom, E. Ahmad, and D. Hartmann, 1989: Cloud-Radiative Forcing and Climate: Results from the Earth Radiation Budget Experiment. Science, 243: 57-63. [Veerabhadran Ramanathan]	This repeats the previous comment (1-105).
1-107	A	2:36	2:37	Suggest changing to read "For example, combining satellite observations with extensive in situ measurments has provided a global data set at a variety of wavelengths, detailing a rich variety of information detailing cloud height …" [Michael MacCracken]	Noted. Text has been edited.
1-108	A	2:36	2:38	While this statement is true for research on climate processes, for climate change purposes the main contributions of satellites have come from soundings and AMVs, for reanalysis. Why not choose a better example than clouds? [Michael Manton]	Noted. Text has been edited.
1-109	A	2:37	2:37	"at a variety of wavelengths" may be too technical for this chapter and could easily be deleted [Dian Seidel]	Noted. Text has been edited.
1-110	A	2:40		Please add "but only if continuity is improved and assured." There are major outstanding issues with regard to satellite data and how it can be made into climate data records. In fact it is not possible to "monitor" climate from space at present. [Kevin Trenberth]	Noted. Text has been edited.
1-111	A	2:41	2:48	I propose: In situ and remote sensing observations of recent and present climate constitute one of the three pillars sustaining our science. Quantitative data on climates of the remote past constitute a second family of observations, and the extremely important results acquired at an accelerating rate over the past five decades continue to revolutionize our understanding of how climate can vary. Computer models constitute a third pillar, making possible projections of future climates in a way consistent with our understanding of present and past. [Robert KANDEL]	Noted. Text has been edited.
1-112	A	2:42	2:43	A general comment on "style". What is meant by "pillar sustaining our science". Who are "we"? The text as written may prove difficult to translate correctly into other	Noted. Text has been edited.

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				languages. The text in general should be written in the third person. Alternate wording could be "Computer models also serve a major supporting role in climate science." [Chuck Hakkarinen]	
1-113	A	2:45	2:46	Delete the words "remarkable" and "absolutely" from this sentence. Hyperbole of this type is inappropriate for an IPCC report. One can also argue that the terms are incorrect. While climate models have had a large measure of success, every IPCC report on the subject, including this one, contains a long list of their limitations and shortcomings. [Lenny Bernstein]	Noted. Text has been edited.
1-114	A	2:45	2:46	The remarkable success of climate simulation models, "unexpected as recently as 50 years ago" - well in the computing age 50 years ago is a lifetime ago. What is this supposed to mean? [Anne Douglass]	Noted. Text has been edited.
1-115	A	2:45	2:48	Delete the sentence beginning "The remarkable..." 1. While climate models have improved, the report describes many areas such as clouds which have limited their success. 2. The success of the models has not led to the new discipline of numerical experimentation. Scientists conducted these experiments even with more primitive models. [Howard Feldman]	Noted. Text has been edited.
1-116	A	2:45		Replace "Remarkable success" with "usefulness" No model has yet succeeded in predicting a future climate change and until one does they cannot be considered particularly "successful" [Vincent Gray]	Noted. Text has been edited.
1-117	A	2:47	2:48	The last bit of that phrase with the adjective "fortunately" may be unclear. The meaning of that section of the phrase could be clarified [Philippe Tulkens]	Noted. Text has been edited.
1-118	A	2:50	2:50	Suggest changing to read "The rapid development and verification of more and more …" [Michael MacCracken]	Noted. Text has been edited.
1-119	A	2:50	2:51	The development of more and more models has not provided increased confidence. The confidence has come from the systematic intercomparison of models (under the auspices of WCRP). [Michael Manton]	Noted. Text has been edited.
1-120	A	2:51		Add after "system" "but, so far, no reliable future climate prediction" [Vincent Gray]	Noted. Text has been edited.
1-121	A	2:53	2:53	How can the science be both young and ancient? [Michael Manton]	Accepted. Text has been edited.
1-122	A	2:54	2:54	It is much safer scientifically to use the phrase "model projections", simply because the	Accepted. Text has been edited.

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				climate system lacks predictability in the initial-value sense that we use for weather forecasts or even ENSO forecasts. In practice, we are projecting a statistically different state, which can have important new manifestations. [Jerry Mahlman]	
1-123	A	2:54	2:54	Models are not trustworthy, but we hope modellers are [Michael Manton]	Accepted. Text has been edited.
1-124	A	2:54	2:54	The use of the words "trustworthiness and reliability" does not capture the ultimate intent, to increase accuracy/reduce uncertainty. Suggest using the latter words (accuracy/reducing uncertainty) instead. [Lourdes Maurice]	Noted. Text has been edited.
1-125	A	2:55	2:55	complement: "… research, although residual uncertainty will remain." [Stephan Lingner]	Noted. Text has been edited.
1-126	A	2:55		Add at end "but, so far, not yet achieved" [Vincent Gray]	Noted. Text has been edited.
1-127	A	3:1	3:2	Please do not use the word "extremely". Furthermore, it seems to me that the many citations are not very recent at all, examples will be presented later. [Carlo Casty]	Accepted. Text has been edited.
1-128	A	3:1	3:2	Using the phrase "extremely recent" to refer to the "last few decades" suggests a geological rather than an IPCC perspective on time. An example that might be siad to be "extremely recnt" would be cloud aerosol effects. [Michael MacCracken]	Accepted. Text has been edited.
1-129	A	3:1	3:2	For much of science, the last few decades is not recent [Michael Manton]	Accepted. Text has been edited.
1-130	A	3:1		In the context of the report as a whole the term "extremely recent" would probably be read as something like since the TAR whereas the authors seem to have a much longer time scale in mind - perhaps this language should be modified. [Martin Manning]	Accepted. Text has been edited.
1-131	A	3:2	3:2	"developed" must be replaced by e.g., 'made' [Jón Egill Kristjánsson]	Accepted. Text has been edited.
1-132	A	3:4	3:6	I am not sure that we have achieved a successful transition to fully coupled models; there remains a lot of drift in most cases. The stopping of drift remains an art. [Michael Manton]	Accepted. Text has been edited.
1-133	A	3:7	3:8	Truly complete earth system models will need to include ecological systems, economic and societal systems. Current models are including chemical and biogeochemical components. [Michael Manton]	Accepted. Text has been edited.

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1-134	A	3:10	3:13	This phrasing of these sentences is one of the places in this chapter that seems to me to convey a much greater uncertainty than really exists--almost suggesting that we know nothing (i.e., "we still lack an adequate understanding") about "clouds, croyosphere and the oceans." The real problem here is that the authors are making a value judgment by using the word "adequate"--adequate for what purpose? For scientists, we rearely understand anything adequately, but for public policy decisions regarding getting started in mitigation, we very likely have more than adequate understanding. Indeed, we have a pretty good sense of the bounds of the roles that these systems can play--indeed, uncertainties about these factors are indeed what are used to really define the IPCC range of climate sensitivities. What needs to happen in this chapter is to scrub the inappropriate inclusion of value-laden words such as "adequate"--the scientific community should not be making such judgments, but should instead indicate the ranges that we do generate. [Michael MacCracken]	Accepted. Text has been edited.
1-135	A	3:13	3:13	Unstated here is the mega-challenge on how to properly initialize the complete climate system in our models. Many tricks are employed that produce an equilibrated state, but not necessarily comfortably close to that of the real climate system, present or future. [Jerry Mahlman]	Noted. Text has been edited.
1-136	A	3:13	3:13	The gaps in knowledge on clouds, cryosphere and ocean processes are mentioned but the remainder of the executive summary refers to clouds processes only. It would be logical to add one sentence for each of the two other processes listed on line 13 [Philippe Tulkens]	Accepted. Text has been edited.
1-137	A	3:15	3:15	Again, think about the wording. The word "gaps" tends to imly we know nothing about something--a better word choice would be "limitations" [Michael MacCracken]	Accepted. Text has been edited.
1-138	A	3:17	3:18	I would very much suggest trying to not use the word "uncertainty" esepcially as it has not really been defined and can mean so many different things to different people--and can imply we know nothing. I would suggest changing the wording to "... accounts for much of the range that exists in our ability to specify the sensitivity of climate to changes in greenhouse gas concentrations, and to project the climate of future decades." Not only should the word "uncertainty" be much less used (and defined if it is used), but use of the word "predict" needs to be done very cautiously. IPCC has carefully used "project" rather than predict because our prognostications are conditional, being dependent on what the emissions are. The chapter also needs to explain this--and how the words "predict" and "project" differ and should be used. [Michael MacCracken]	Accepted. Text has been edited.
1-139	A	3:18	3:21	The sentence "Although much demonstrable progress has occurred, and in spite of a large	Noted. Text has been edited.

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				and coordinated set of model and observational studies, the uncertainty range of future climate predictions associated with cloud feedbacks has not been reduced thus far." is inconsistent at best, or at worst points to a lack of utility in the research. Has the "demonstrable progress" had no impact whatsoever in reducing uncertainty? What is the outlook for reducing these uncertainties in the near future? [Lourdes Maurice]	
1-140	A	3:18	3:18	Add: ... climate to green house gas AND PARTICLE LOAD changes .... [Sabine Wurzler]	Noted. Text has been edited.
1-141	A	3:19	3:21	Have there really been large and coordinated studies focused on cloud feedbacks and sensitivity? The first real international focus on sensitivity came with WG1 of the AR4; ie probably too late for the AR4. [Michael Manton]	This is arguable. For example, the Cess & Potter and Cess et al. model comparisons might be considered to fall in this category of research.
1-142	A	3:20	3:20	Replace "predictions" by "projections"--and I would also suggest changing "uncertainty" to "the contribution to the"--and it might well help to indicate that the uncertainties regarding our understanding of the physical system contribute about 50% to the range of the projections of the IPCC--the other half being due to the range of plausible emissions. This really does need to be covered. [Michael MacCracken]	Accepted. Text has been edited.
1-143	A	3:23	3:24	Complexity of the system . . . Imposes definite limitations on our capacity to predict it. FOREVER? [Anne Douglass]	Accepted. Text has been edited. Forever is indeed a long time.
1-144	A	3:23	3:24	On line 23, delete the word "extreme"--it really is overstating things in terms of projecting the global scale changes--just look at the IPCC results for the next several decades and see how little difference there is. And on line 24 change "predict it" to "project changes." I would also add that this listing says nothing about the uncertainties caused by not knowing what the future emissions will be--so the societal-energy side--and this is really an important factor. Again, if you will explain the difference between prediction and projection, that would really help. [Michael MacCracken]	Accepted. Text has been edited.
1-145	A	3:23	3:24	Complexity implies multiple interactions. But it's chaos from non-linearities which impose the main limit on prediction. [Michael Manton]	Rejected. This is by no means clear for climate, although it is central to predictability theory for explaining limits on weather prediction.
1-146	A	3:26	3:26	replace "determination" by "description" [Stephan Lingner]	Noted. Text has been edited.
1-147	A	3:26	3:28	This text is again really making it seem as if we know much less that we do--at least in	Noted. Text has been edited.

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				general terms (and comparing to Chapter 6 and their much more definitive view of Earth history). The "instabilities" have limits, and the changes are not really instabilities in the sense of a gyroscope just falling over, etc.--there are a range of possible conditions that are pretty well bounded. The inherent chaotic aspects are also pretty limited as far as we really know--what has happened in Earth history may be unexplained, but that does not mean that this is all chaotic, only that we do not yet understand what the forcing mechanisms and processes might be for at least some of the events. One can call the Dansgaard-Oeschger events chaotic--but if they are due to the release of freshwater from glacial melt ponds that have built up die to the particulr geography, etc., we understand them and they are not going to occur in the same way for a warmer world, etc. In addition, regarding abrupt change, as Chapter 6 makes clearer, it is not at all clear that there were such large abrupt changes in global average temeprature as this wording (and the Greenland record) might at first imply--there may well be relatively abrupt changes in atmospheric and oceanic circulations, and so many regions may get what feels like an abrupt change in condition--but is this the same sort of thing as an abrupt global shift in temperature. What all htis is pointing out is that this chapter really needs to do more up front to define what it means--what does change mean, what about shift, what is global and what is regional, etc. And to conclude with the indication that the paloecloimatic evidence is unambiguous seems a significant overstatment, especailly how our knowledge of the present climate is said to be so uncertain. [Michael MacCracken]	
1-148	A	3:27	3:28	We always have to be very careful when we discuss "abrupt climate change". Typically, such "abrupt"climate changes take decades to centuries to millenia, e.g. thermohaline circulation slowdown/collapse(50-100 years), West Antarctic ice sheet collapse(500-1000years) ; Arctic summer sea ice melting roughly a century or so). [Jerry Mahlman]	The point is well taken, although much faster changes than those cited by the reviewer are now known to occur. We will alter the text to clarify the concept of abrupt climate change.
1-149	A	3:30	3:30	Science in general does not require international collaboration. Rutherford said (something like) he could do nuclear physics in Antarctica. It's the global nature of climate science that drives international collaboration. [Michael Manton]	Accepted. Text has been edited.
1-150	A	3:33	3:34	It is a little unfair to only mention IPCC, esp in relation to model intercomparisons. [Michael Manton]	Accepted. Text has been edited.
1-151	A	3:36	3:43	Given all the discussion that has gone on about detection and attribution, this paragraph is much too brief (and the later text is as well). This issue has been at the forefront of much of the controversy over the IPCC reports, and it deserves more discussion. [Michael MacCracken]	Accepted. Text has been edited. However, we have strict length limits and cannot include all topics that "deserve discussion."
1-152	A	3:37	3:37	Delete "compelling". It is quite subjective -- others may have felt that the qualitative case	Accepted. Text has been edited.

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				was far less than compelling. [Howard Feldman]	
1-153	A	3:37	3:43	The summary of assessments could be better: FAR was the first authorative summary of climate change science, SAR noted balance of evidence for anthropogenic climate change, TAR highlight paleoclimate data, and AR4 is expected to highlight impacts and vulnerabilities. [Michael Manton]	Noted. Text has been edited. We recognize that any such brief characterization cannot possibly do justice to an IPCC Assessment Report.
1-154	A	3:41	3:42	"understandings" should be replaced by 'the understanding' [Jón Egill Kristjánsson]	Accepted. Text has been edited.
1-155	A	3:41	3:43	Suggest mentioning that early models were artificially "flux adjusted" and only in the TAR are some coupled models run without such devices. [Kevin Trenberth]	Noted. Text has been edited. Any such brief characterization cannot possibly do justice to an IPCC Assessment Report.
1-156	A	3:45	3:47	Please delete the whole subsection, it includes no additional information. [Carlo Casty]	Rejected. The authors do not agree, but in any case, the Executve Summary has been extensively revised.
1-157	A	3:45	3:47	It is proposed to include reference to those areas with dramatic advances as well as to those areas with unsolved issues and seemingly untraceable issues. [Klaus Radunsky]	Accepted.
1-158	A	3:46	3:47	The phrase "unsolved and seemingly intractable remaining issues" seems again an overstatement--in virtually all of the situations, at least the ones that really matter beyond their real scientific interest, there are reasonably clear bounds to what could be the case and how much the climate can change--after all, life has geenrally persisted quite well, especially over the last thousands of years. So, I would recommend much more careful wording or this sentence, like quite a few ohters, will be taken out of context. [Michael MacCracken]	Noted and arguable, but in any case, the Executve Summary has been extensively revised.
1-159	A	3:47		"possibly" nstead of "seemingly" might be better here - "seemingly" suggests we have already decided that some of the problems will never be solved. [Neville Nicholls]	Accepted.
1-160	A	3:47		"possibly" nstead of "seemingly" might be better here - "seemingly" suggests we have already decided that some of the problems will never be solved. [Neville Nicholls]	This comment duplicates the previous one (1-159).
1-161	A	4:0		Figure 1.3 should have a reference and possibly a location [Piers Forster]	Accepted.
1-162	A	4:1	5:	While I appreciate the spirit of the discussion in preparing the community for dissent amongs climate scientists, it is overly negative in its examples, particularly in singling out	Noted. Text has been edited. The Bryson case exemplifies the self-

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				the Bryson example. Why not then bring out some positive examples where the predictions have been proven, such as the arctic amplification of surface warming (by Budyko, Manabe and others) accompanying the global warming of the last few decades? [Veerabhadran Ramanathan]	correcting characteristic of science. In the revised text, research successes are given more prominence.
1-163	A	4:1	5:	While I appreciate the spirit of the discussion in preparing the community for dissent amongs climate scientists, it is overly negative in its examples, particularly in singling out the Bryson example. Why not then bring out some positive examples where the predictions have been proven, such as the arctic amplification of surface warming (by Budyko, Manabe and others) accompanying the global warming of the last few decades? [Veerabhadran Ramanathan]	This comment duplicates the previous one (1-162).
1-164	A	4:3	4:4	Delete first two sentences. Why emphasise a past deficiency? Moreover the concept is not new to science. [Michael Manton]	Noted. "Deficiency" is the reviewer's term, one which the authors would not use, nor is it implied by the text..
1-165	A	4:3		As witten in the text:"The concept of this chapter is new", this is very helpful to readers to understand the whole report in a short time. [Shigeki Kobayashi]	Noted, with thanks.
1-166	A	4:6		Replace "IPCC Mission" with "IPCC responsibility". The IPCC is not a religious organisation attempting to convert the ignorant, but a scientific organisation placing facts before the public so that they can decide. This whole chapter should be less of an advocate and more of a scientific summary. [Vincent Gray]	Noted. Text has been edited.
1-167	A	4:7	4:9	It is not strictly true that this chapter "stops" with TAR. In the chapter body for example Soden et al. 2002 is highlighted on page 5 and A-train missions on page 22. I suggest either relaxing this requirement or keeping to it [Piers Forster]	Noted. In the next draft, we shall eliminate virtually all references to post-TAR research, referrin g the reader to later chapters in AR4.
1-168	A	4:7	4:7	Suggest changing "scientific evolution" to "iadvances in scientific understanding"--staying away from a rather red-flag word in the US. [Michael MacCracken]	Noted, with a certain sadness. The authors trust that readers will realize the intended definition of "evolution," or will consult a dictionary if necessary.
1-169	A	4:11	4:12	Replace "all share the underlying messages" with "show". The IPCC is not promulgating "messages" but scientific eveidence [Vincent Gray]	Accepted. Text has been edited.
1-170	A	4:12	4:12	The suggestion that the science is "becoming more complex" seems to imply that it is becoming less understandable, when in fact the opposite is generally the case. In actuality, climate change science is "becoming more comprehensive" and more detailed, if you want, but we are gaining a lot more insights into how the sytem works, some bounds on its behavior, and are developing some predictive capabilities--so I think the phrase "more	Accepted. Text has been edited.

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				complex" gives a serious misimpression. [Michael MacCracken]	
1-171	A	4:14	4:14	I would suggest changing "mankind" to "humankind" as the problems affect everyone--all humanity. [Michael MacCracken]	Accepted. Text has been edited.
1-172	A	4:14	4:14	(Article 1) error grammar; correction: profoundly important to [Gerold Wefer]	Accepted. Text has been edited.
1-173	A	4:16		At end of opening section, I urge mention of something like: Ironically, therefore, uncertainties typically have not decreased precisely because new knowledge has exposed new complexity as fast as other uncertainties have been reduced. And so we end up knowing a lot more about what we don't know. [Kevin Trenberth]	Accepted. Text has been edited.
1-174	A	4:17	4:50	This section is a really good read and useful. However, maybe it should be toned down just a little? It very much describes the scientific ideal. In reality incorrect theories can hang around too long, peer review can occasionally be a battle against the establishment, new papers fail to cite/account for previous work, and results and methods are not always clearly laid out enough to be repeatable. [Piers Forster]	Accepted.
1-175	A	4:17	4:17	complement: "… Earth Science Research" [Stephan Lingner]	Rejected. Science and research are somewhat redundant and we want the focus to be on science and the scientific method as lay readers would never have heard of a "research method".
1-176	A	4:17	4:17	Overall Chapter 1 is a fine addition to the WG1 document. The discussion about the science method in "natural sciences" will be (unfortunately) news to some of the readership. Compliments to the authors for the clarity of presentation. It will work as intended to inform non-experts of the how's and why's many climate science "opinions" fit against the body of good science. [Thomas Vonder Haar]	Noted with thanks.
1-177	A	4:17		Section 1.2. The discussion of the nature of science fails to bring out that often times "scientific consensus" is an impediment to new ideas, and indeed progress. This point is potentially very important to policy makers seeking to take action. The difficulties of introducing a "paradigm shift" have been well documented (See Thomas Kuhn, Nature of Scientific Revolutions, for example) and should be acknowledged in this discussion. [Lourdes Maurice]	Accepted.
1-178	A	4:17		Section 1.2: This section is problematic because it intermingles epistemic and normative questions. It is important to outline the normative base for doing good science in a	Rejected. While the comment has merit, trying to explain this topic fully

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				complicated field like climate science is. But the reference to Popper (1934) completely ignores 70 years of discussion in the philosophy, sociology of science, and science policy studies. This critic does not speak to a radical constructivist or postmodern views. There are still others—e.g. naturalist—positions (e.g. Laudan 1977, Kitcher 1989). It was shown that falsification is logically impossible because it requires true observation sentences. But they cannot exist if sentences can be falsificated only (Lakatos 1979). By the way this does not affect the norm to change scientific knowledge sentences by experience and observations. Both, the provided epistemology and the indirect from Hawkins cited Einstein anecdote are not convincing reasons for the importance of the presented normative frame of good science. [Falk Schützenmeister]	for the readership that we have in mind would take far too much space and distract readers from the central message. As we did not state that the results had to be falsifiable (we only said that some philosophers of science say that), it is not necessary to give a complete technical counter-balancing argument. Also, note comment 1-179 below.
1-179	A	4:19	4:25	Bravo for citing Popper, a necessary antidote to "validation", whether of model results or satellite data products. [Robert KANDEL]	Noted with thanks. Please also note that the above comment disagrees.
1-180	A	4:19	4:25	This paragraph gives a rather old-fashioned view of what science is. I am not a philosopher of science, but I suspect that such people would have strong dis-agreements with the point of view expressed here. I would nto start with a paragraph that would likely be controversial, ie I wouldnt even try to define what science is. The remainder of this section is OK - I just worry about the first paragraph. [Neville Nicholls]	Accepted in part, with thanks. We have changed the first paragraph. But we do largely retain the perspective that this reviewer characterizes as a fairly old-fashioned view of science.
1-181	A	4:19	4:38	These paragraphs are to common. It is not clear what is the implication. The authors emphasized the importance of self-correcting, however unpublished and "in preparation" papers are widely used throughout the report. [Eugene Rozanov]	Rejected. In-preparation papers cited by other chapters of AR4 follow IPCC guidelines and are not necessarily inconsistent in the sense treated here.
1-182	A	4:20	4:20	Instead of "only" to I suggest "generally" [CONSTANTIN MARES]	Accepted in part: "only" is removed but no other adverb added.
1-183	A	4:21	4:23	Delete "some" from this sentence. It implies that there are other approaches to scientific truth, which is not correct. Unless a statement can be tested and proven false, it is an article of faith, not science. [Lenny Bernstein]	Rejected: Generally the authors might agree with this comment, but comment 1-178 shows that this isn't quite true.
1-184	A	4:21	4:21	replace "objectively" by "trans-subjectively" [Stephan Lingner]	Rejected: trans-subjectively may be technically more accurate but our target audience would not understand it.
1-185	A	4:22	4:25	I think more explanation is needed here. First, I would change "statement" to be "statement or method" especially as a key issue is the validity of applying models. Second, I think this issue of necessarily being suject to testing and falsification needs to be expanded upon in the context that we are dealing with, or one might make no	Accepted in part. The change of "statement" to "statement or method" is not appropriate language, but the point will be clarified. The general point and

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				projections at all. It is fine to follow Popper in some situations, but then one might never cross the street--that is, there needs to be an indication that one tests certain approaches and understandings and then makes some projections with them--and that while they can certainly turn out to be false, they would be the most reliable approach available for tyirng to learn something about the future and impacts we might be having. It would help to explain, for example, that the Earth system operates based on certain principles/conservation laws that are well tested, and that what we are doing in many cases is applying them--and we do test to see how they work and to improve them, and that these tests help to give us a certain degree of confidence in results--or a range of possible results, etc. This is all just too abstractly presented here--in a report that is about a very proactical and serious issue, Much greater care and nuance is needed. [Michael MacCracken]	emphasis will be incorporated in the text.
1-186	A	4:24	4:25	replace with '..research findings to careful scrutiny by their peers, and to disclose fully the methods and data they use, so that their results can be checked through replication by other scientists." [Peter Barrett]	Accepted.
1-187	A	4:27	4:31	delete paragraph [Stephan Lingner]	Rejected. However, the paragraph is question will be shortened and combined with another.
1-188	A	4:28	4:28	Suggest replacing "Opinion" with "belief or opinion" to make sure that that aspect is also covered. [Michael MacCracken]	Accepted.
1-189	A	4:29	4:30	Reference to Hawking unneeded: original cite to Einstein enough [William Connolley]	Accepted.
1-190	A	4:30	4:30	Reference to Hawking is inappropriate. If there is a need to do anything other than quote Einstein directly, source should be an appropriate science historian or biographer, not a cosmologist etc, not matter how high his profile. [Ian Enting]	Rejected. The reference to Hawking is now just a normal citation. In searching for a more appropriate citation, we found a Time magazine article on Einstein as the Person of the Century (December 31,1999). The history of relativity section which contained this quote was written by Hawking. He may not be a biographer, but he is a subject matter expert. Also, the source of the quote is of only minor importance compared to the quotation itself.

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1-191	A	4:33	4:37	This is all too abstract and not adjusted for the climate change problem and is not nuanced against some of the criticisms that "The Skeptics" (much less Michael Crichton in his book) put forth. What IPCC is doing in making projections out 100 years ahead would seem improper given the requriements here as with models we have not made a clean 100 year "prediction"--in fact it would take 100 years to see if we were right. To test models, we are necessarily going back and testing them against past events and often doing so iteratively as we learn more and improve specifications of boundary conditions, etc. A purist would say this is not a "prediction"--but this is how things must be done if we are to have any hope of gaining insight about the future. Also, it is not explained until much later what the difference is between weather and climate and that what we are predicitng (or projecting) are the statistics of the change and not the detailed results--something clearly "The Skeptics" do not understand--for example, Michael Crichton wants a 10 year forecast that gets, near as one can tell, the monthly anomalies right each year at every measuring station, and Pat Michaels wants the GCM simulations that start in 1860 (or earlier) to be simulating the running 10-year anomalies through the 20th century (which really requires 100+ year predictions of the timing of El Nino events, etc. This section of the chapter really needs to be much less abstract about all of this and really address is considerably more detail the criticisms being flung at the IPCC--not specifically citing them, but explaining what we are doing in real terms and why the testing of models against past events and their basis on fundamental conservations laws (and empirical relationships) and then therir use for making projections (not 100 year predictions) is all valid. [It would also help to explain that what the public needs is not a 100-year weather forecast--but indications of the most likely types of changes, etc.]. With respect to some specific changes in wording, I would suggest that the sentence beginning with "Scientific theories .." be changed--theories are ways of explaining information and providing insights. It is not their value that is at issue--but the adequacy of how they are formulated. And get into the issue of testing on past events, etc. And the last phrase is also overstated--we often leaarn a lot by unsuccessful predictions--they might demonstrate incompleteness of an aspect of it, the need for reformulation, applicable only under some bounds [after all, most physics classes still rely on Newton], etc. But the phrasing here sort of implies that the "greenhouse theory" might be subject to abandonment, etc.--much too loose. [Michael MacCracken]	Accepted.
1-192	A	4:36	4:36	should read: "… that the underlying theory …" [Stephan Lingner]	Accepted.
1-193	A	4:39	4:50	Though interesting, this section adds very little to the Chapter and does not provide any information on the attributes of science. [Lourdes Maurice]	Rejected. The cumulative nature of science is part of how it differs from many other aspects of human life.

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1-194	A	4:47	4:47	should read: " … and the professional ethos …" [Stephan Lingner]	Accepted.
1-195	A	4:53	4:56	Queries need to be in the same form and amenable to a "no" response deserving less credence. The last half of the last query is framed the wrong way round. Suggest replacing lines 54 and 55 to "..other scientists?" with the following."Has it appeared in the peer-reviewed literature? Has it been reported in the context in which it was published?" [Peter Barrett]	Rejected, as our readers are unlikely to understand what "has it been reported in the context in which it was published?" means.
1-196	A	4:54	4:55	"or ignore …" is inconsistent with the following if-clause. [Stephan Lingner]	Accepted.
1-197	A	5:1	5:2	This passage is an admission that "earth science" does not agree with the principles expounded on page 1_4, so we can never be confident of the results [Vincent Gray]	Rejected. This comment is wrong.
1-198	A	5:1	5:42	This whole page tries to make excuses why we are unable to predict climate change, but tries to pretend that we can. [Vincent Gray]	Rejected. This comment is wrong.
1-199	A	5:1	5:15	The auhors describe something that could be considered as being comparable to the outer façade of some building or structure. But they totally neglect to mention the fact that this building has an exceptionally solid foundation and a remarkably strong supporting framework. [Andrew Lacis]	Accepted.
1-200	A	5:1	5:15	Of all scientific endeavors of mankind, climate science is the most interdisciplinary of them all. It makes use of several centuries worth of detailed laboratory measurements and ground breaking developments in theoretical physics and mathematics to formulate the climate problem in terms of fundamentaly verified equations of motion, fluid dynamics, thermodynamics, and radiative transfer. Advances in applied mathematics have made it possible to perform finite difference analyses of the evolution of atmospheric and ocean circulation in a way that conserves mass, energy, momentum, and vorticity. Climate science relies heavily on the disciplines of chemistry and biology for modeling the chemistry of key atmospheric gases such as ozone and methane, the formation and evolution of atmospheric aerosols, and the overall operation of the global carbon cycle and ocean chemistry. Astronomy and astrophysics provide the basis for the Milankovitch theory of ice ages and understanding for the steady increase in solar luminosity over geological time scales. [Andrew Lacis]	Accepted.
1-201	A	5:1	5:15	Nuclear physics provides the fundamental basis for radioactive isotope tracer studies, geological time dating, and isotope ratio analyses of geophysical processes. Geology is intimately involved in establishing the historical record of climate change over all time	Accepted.

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				scales and in the study of physical processes that drive climate change. Sophisticated electronics, computerization, and rocket science make it possible to conduct unprecidented measurements of the Earth, its atmosphere, and cryosphere at virtually all wavelengths of the spectrum. Even the study of classical literature, searching for the mention of unusual lunar eclipses and failed grape harvests, has provided important information for dating and assessing the effects of large volcanic eruptions during classical times (Stothers, 2002). It is in light of this impressive background that scientific questions regarding climate science experiments are posed, tested, analyzed, and answered, even if the climate change problem is a once in a lifetime experiment in which we happen to be both a contributing cause and an interested observer. [Andrew Lacis]	
1-202	A	5:1	5:15	This paragraph emphasizes, that "testing hypothesis empirically is still the key to Earth sciences" and it provides new methods to do so. Especially the meaning of quasi-experimental design like the Pinatubo eruption is very interesting. [Falk Schützenmeister]	Noted.
1-203	A	5:3	5:3	delete "system-scale experiments ," [Stephan Lingner]	Rejected. It is the whole system-scale that is of concern, though this may be reworded in the revised text.
1-204	A	5:5		Insert between " 2004)" and "Nevertheless" This means that future predictions based on earth sciences are always uncertain." [Vincent Gray]	Rejected, as it would imply an erroneous emphasis. That is, it may be technically true, but what the reader would be likely to understand would not be true.
1-205	A	5:9	5:10	Without really having explained and justified models as an approach, this sentence seems to assume that they are accepted by all as a proven tool. This is really not the case--indeed, whether models are valid is a key issue. So, as noted earlier, there needs to be discissuion of how we have come to accept models as a tool, why they are needed (essentailly the only option for so complex a system), how they are tested and can be usefully and acceptably applied, etc. [Michael MacCracken]	Partially accepted: The sentence that caused the concern has been changed enough to reduce if not eliminate the concern. Partially rejected. Adding an entire section devoted to explaining models would be too long and distract from the central points of the section.
1-206	A	5:17	5:32	I feel that the discussion here may be misleading (and perhaps the next para too), since it gives a greater weight to "cooling" than is deserved; at the time, there was uncertainty as to warming/cooling; this para appears to imply that cooling was the dominant idea, but corrected. That is wrong. Mason (B. J. Mason, QJRMS, 1976, p 473 (Symons Memorial Lecture); partial quote available from http://www.wmconnolley.org.uk/sci/iceage/mason.1976.html) could be cited as evidence that scientists then were well aware of the dangers of extrapolating trends.	Accepted.

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				[William Connolley]	
1-207	A	5:17	5:21	Another reason that cooling was being projected was because the new satellite data suggested that Northern Hemisphere snow cover was increasing from year to year (see paper by Kukla). It turned out that the area of increase was, as I recall, Tibet, and the snow cover was thin, and a few years later melted--showing the problems of extrapolating from a short observational record, especially from a new instrument (a lesson that needs to be mentioned somewhere near here as it most certainly has applied to the experience regarding the Microwave Sounding Unit and tropospheric versus surface temeprature trends). [Michael MacCracken]	Rejected. Too tangential to include.
1-208	A	5:17	5:43	The quoted example does little to embellish the arguments preceding and could be omitted. Initial reading of the example casts doubts more on the authors (Bryson and Dittberner) lack of clarity in their original publication than the merits of the scientific methodology nbeing exemplified. The two paragraphs could be omitted without any adverse effects on the integrity of the points being made. [John Sweeney]	Noted, but partially rejected. We couldn't find a better example but we did shorten the section dramatically, which partially addresses the reviewer's concern.
1-209	A	5:17		As there is no general consensus about the causes of the warming, in the context of this chapter (Historical Overview) it would be interesting (necessary?), to better explain: - the causes of the cooling at the light of present knowledge and modeling - a part of Bryson & Dittberner, the explanations for the cooling given by the scientists at the time. [WALTER DRAGONI]	Rejected. The authors agree that sucha discussion would be interesting and informative, but it would not be essential in the sense of being helpful to the topic being discussed. We must be mindful of length limitations.
1-210	A	5:19		After the sentences ending in the word "decade": It was not yet recognized that climate change could be characterized by variations that differed systematically on a world wide scale (Pittock, 1978). Add to reference list: Pittock, A. B., A critical look at long term sun-weather relationships, Rev. of Geophys and Space Phys. 16, 400-420, 1978. [Joan Feynman]	Rejected. This is a very good suggestion, but this section has been shortened with less emphasis on global cooling, so this additional reference would be counter productive.
1-211	A	5:20	5:21	Insert "it has to be admitted that, so far, there is no model; capable of reliable predictions of future climate [Vincent Gray]	Rejected. This would be misleading to include. We have taken pains to convey an accurate impression of model strengths and also of shortcomings.
1-212	A	5:21	5:22	Suggest change wording to "For example, results from a model … surface temepratures were (mis)interpreted to indicate that a doubling …" It is results from models that matter and are interpreted--not the models themselves--and the distinction can be important. [Michael MacCracken]	Rejected. This is a good suggestion that did not make it into the chapter, because the section was dramatically shortened and reworded.
1-213	A	5:21	5:32	The highlighting of Bryson and Dittberner may be a useful illustration of the self-	Accepted for the first part. The second

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				correcting nature of science, but the text should be reduced. Moreover, another example could be the MIT study from the same era which essentially gave an accurate prediction of the impact of greenhouse warming over the last 25 years of the 20th century. [Michael Manton]	part is not added as we now plan a figure that will touch on that topic.
1-214	A	5:25	5:26	replace with "made it clear that increasing CO2 would lead to a decrease in hemispheric surface temperature which "would be directly counter to all known scientific evidence about the direct effect of CO2.." [Peter Barrett]	Rejected. A good suggestion, but this part of the text has been dramatically shortened.
1-215	A	5:27	5:28	Suggest rewording to say "in the model, they said, was found to be due to the influences on the modeled temperature of small particles (aerosols), which were produced …" [Michael MacCracken]	Rejected. A good suggestion, but this part of the text has been dramatically shortened.
1-216	A	5:29	5:30	"residence time of tropospheric aerosols is extremely short compared to CO2.... [Jerry Mahlman]	Accepted.
1-217	A	5:33	6:8	All these lines seem to me unnecessary and out of the real issue. I suggest deleting them or strong shortening. [WALTER DRAGONI]	Partly accepted. Large parts of this have been removed. But the first part about the self-correcting nature is retained, because it is a central feature of science.
1-218	A	5:34	5:35	Suggest moving the phrase "for many reasons" to before "a classic illustration" [Michael MacCracken]	Rejected as "for many reasons" has been removed from the text.
1-219	A	5:41	5:41	replace "do justice to" by "satisfy" [Stephan Lingner]	Rejected. It is a good suggestion, but this sentence has been removed from the text.
1-220	A	5:42	5:42	replace "nuanced" with "well-qualified" [Peter Barrett]	Rejected. It is a good suggestion, but this sentence has been removed from the text.
1-221	A	5:44	6:20	Progress in science is not necessarily measured by numbers of published pages [Vincent Gray]	Rejected. While technically true, the comment would lead to an erroneous message as science does progress with publication of additional papers.
1-222	A	5:44	6:8	There is too much emphasis on growth in publications. It has occurred in many fields. Moreover, there is growing concern about the quality of publications, so just advertising quantity may be opening up a can of worms. [Michael Manton]	Accepted: the emphasis has been reduced, but the topic is still mentioned.
1-223	A	5:44	6:9	This section although interesting could be shortened a bit by summarizing the idea [Philippe Tulkens]	Accepted.

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1-224	A	5:48	5:56	Increased words and illustrations are not necessarily a measure of progress in a field, the example of cold fusion required increased words to discredit progress in a field. These lines can be deleted. [Robert Molinari]	Rejected. One can find technical points to provide a counter-example, but in general more scientists and more papers do come from more research.
1-225	A	5:49	6:9	Selectively naming a few journals in this section is rather arbitrary and smacks a bit of the authors' personal preferences. Many other major journals also could have been quantified in the manner chosen and perhaps it is best to omit specific references. After all, just because the average length of papers has doubled it does not mean that the science has progressed. Other factors may be at work. [John Sweeney]	Accepted.
1-226	A	5:53		I think that figure 1.1 is redundact, since the information provided in the text illustrates the point adequately, so, I suggest deleting the figure. [Ricardo García-Herrera]	Accepted.
1-227	A	5:54	5:56	delete 1,5 sentences from "a phenonemon ..." on. [Stephan Lingner]	Accepted.
1-228	A	5:55	5:56	I am not sure but it seems the authors are too optimistic about progress in climate science. To support the statement it would be necessary to compare the growth in climate science with some other sciences, like computer science, physics or genetics. It well could be that the described growth in climate science is small in comparison with other sciences. [Eugene Rozanov]	Rejected. The important point is not that the growth of climate science may be small compared to some other fields (such as medical science); climate research is definitely progressing.
1-229	A	6:1	6:1	Figure 1.1? - not clear where the Kiehl & Trenberth figure will be placed in the text -- is there an updated version of this 1997 figure available? Or have none of the numerical estimates in the fluxes changed since then? [Chuck Hakkarinen]	Noted, but the figure has been dropped.
1-230	A	6:3	6:8	Same comment as for previous line. [Robert Molinari]	Rejected for the same reasons as his previous comment.
1-231	A	6:5	6:7	Need to change to past tense--line 5, change "finds" to "found" and line 7 "notes" to "noted" and "contains" to "contained" [Michael MacCracken]	Accepted.
1-232	A	6:10	1:10	Sorry, some research articles push the field backwards. I could cite examples . . . Nice thought though. [Anne Douglass]	Rejected. One can obviously find counter-examples, but in general more scientists and more papers do reflect more research progress.
1-233	A	6:10	6:20	The claim in line 10 that every new research article incrementally increases knowledge is dangerous without due recognition of the loss of knowledge with time. This comes from two sources - increasing complexity as knowledge expands, limiting the ability of	Rejected. The incremental increase aspect has been significantly toned down, but we will not add a section on

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				scientists and society to utilise new knowledge, and the loss of experience in applying new knowledge as the older generation of scientists passes on. I would prefer to see emphasis placed on improved knowledge and understanding from more comprehensive databases and more sophisticated (and realistic) modelling. [Peter Barrett]	losses as older scientists retire. Their papers live on, in general. In general, Earth science and related knowledge increases with time, even if there are occasional setbacks in specific areas.
1-234	A	6:10	6:13	Saying that our knowledge has grown because the number of published articles has grown has the relationship backwards. Published articles are, or should be, a reflection of the growth of knowledge. Knowledge can be shared in many ways, but given the size and complexity of the scientific community, publication is the best method. [Lenny Bernstein]	Accepted.
1-235	A	6:10	6:10	delete whole line [Stephan Lingner]	Rejected. The cumulative nature of science is a crucial aspect of science.
1-236	A	6:10	6:10	This sentence is much too optimistic, many new research articles can actually impede progress causing researchers to debunk erroneous results. [Robert Molinari]	Accepted. Wording has been changed somewhat to reflect this point.
1-237	A	6:20	6:20	Figure 1.1 should be inserted here, not figure 1.2 [Philippe Tulkens]	Noted. Text has been revised and both figures dropped.
1-238	A	6:21	6:21	It is here that one might interject some insight of the role of "contrarian science" and why it has been ignored(to date, more or less) by the IPCC. Contrarianism is part of the history of IPCC, even though we would prefer that it simply disappear in the light of compelling scientific evidence. That will not happen for some time. Perhaps now is time that we all deal with this "ascieintific" challenge in a far more straightforward way than we have to date [Jerry Mahlman]	Noted – we do not feel that we can treat the large topic of contrarian science directly, but we have have referred to how 'science' is done. We agree that contrarianism deserves more attention, but we judge that this space-constrained chapter is not the best place to do it.
1-239	A	6:21		Prior to the current 1.3, shouldn't there be a section on the setting for the IPCC and especially the WCRP and the World Climate Conferences? [Kevin Trenberth]	Rejected. Such a section would be possible but is beyond our page limits.
1-240	A	6:22	7:36	Recall the double review process to which every IPCC report is subnitted : this process contributes greatly to the confidence attached to IPCC statements. [Michel Petit]	Noted, and we agree that this is important and expect it will be included in the AR4 introductory material.
1-241	A	6:24	6:34	Some mention needs to be made of the fact that the mandate of the IPCC came from the UN General Assembly. The IPCC has always been tied to the political process. It was created because policymakers needed a source of scientific and technical information, not becasue the scientific community needed it. [Lenny Bernstein]	Noted, but the founding of the IPCC by the WMO and UNEP is a familiar story. We have consistently chosen to make this chapter a history of the science rather than of the IPCC.
1-242	A	6:24		Section 1.3. the discussion fails to acknowledge any drawbacks in the IPCC process. The	Rejected. The process of building a

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				IPCC has achieved tremendous progress. However, the process of consensus and Government approval generally leads to a "lowest common denominator' product. Also, the timelines are such that products are often dated almost before they are published. For example, although the Aviation and the Global Atmosphere report quoted was published in 1999, the process is such that the final product was based on early to mid-1990s research. Given the scientific advances in the last decade, many of the findings are now dated. However, in the absence of a new consensus report, the 1999 report continues to exert substantial influence, even though arguably its relevance is diminishing. Making these points will provide important context for policy makers. [Lourdes Maurice]	consensus is important, because otherwise we are left with a large range of seemingly random results in the published literature. The idea that the report cited relied on outdated results is factually incorrect. We do not agree with the reviewer's "lowest common denominator" charge, and we will stress that an assessment is not at all the same as an imposed consensus.
1-243	A	6:24		Section 1.3: This section describes the role of the IPCC for the political process of climate change negations and for the development of science. Beside the limited mandate of the IPCC it had big effects inspiring new research. [Falk Schützenmeister]	Noted. This and previous text has been revised slightly to take account of this point.
1-244	A	6:36	6:36	'not meant to' carry out new research -- this is problematic The issue is that it could (legitimately in English) be interpreted as 'meant not to'.... This can create difficulties with politically-motivated attempts to discredit the IPCC by embroiling it and its authors in disputes over what constitutes new research. We went through this 10 years ago with carbon cycle calculations for the IPCC special report on radiative forcing. The answer we got is that the IPCC could (in our case under WMO resolution EC-XLIV) conduct (i.e. call for) research and so we didn't need to worry about over-stepping ill-defined bounds. Words like 'does not generally carry out' seem safer. [Ian Enting]	Accepted. Agreed, done.
1-245	A	6:36	6:36	Replace data by variables [Michael Manton]	Rejected, data = quantitative results that are accepted by the scientific community. "Variables" means something different.
1-246	A	6:43	6:43	For consistency throughout the complete report, check in WGII and WGIII draft reports if a brief history is also given [Philippe Tulkens]	Noted, but not relevant, since this is primarily WGI history.
1-247	A	6:51	6:51	The First Assessment Report also included reports from WG II and WG III. While this chapter correctly is focused on the history of WG I, it needs to recognize that the IPCC's other two WGs have progressed along parallel paths. [Lenny Bernstein]	Accepted, and we have added WGI, with thanks.
1-248	A	6:53	6:53	FAR not compelling for some. Replace "compelling" with "powerful" [Peter Barrett]	Rejected. We considered 'powerful' but felt it was too strong, so we chose 'persuasive' as best choice. There will

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					always be people for whom some results are not compelling.
1-249	A	6:54	6:54	since the statement is that "most conclusions from the FAR remain valid today", why not present examples of conclusions that are still valid, as well as conclusions that are no longer valid. If all conclusions from FAR are still valid, then change wording from"most" to "all". [Chuck Hakkarinen]	See previous section for evidence that 'most' results are still valid. Among the more important results, it is not easy to find an invalid example. We are still seeking optimal language here.
1-250	A	6:54		Are any of the FAR conclusions no longer considered valid? An example or two of these might be interesting to include here. [Neville Nicholls]	Noted, and we will continual to look for invalid FAR conclusions.
1-251	A	6:56	6:56	"increasing the atmospheric concentrations of … CFC" Isn't this one conclusion from the FAR that is no longer valid, due to compliance with the Montreal Protocol? [Dian Seidel]	Noted, but this error was lack of prescience on human choices, not on known science, will look for the latter.
1-252	A	6:56		Insert after " N20 " However, methane concentrations appear currently to be falling" [Vincent Gray]	Rejected, incorrect statement.
1-253	A	6:57	7:1	The Intergovernmental Negotiating Committee (INC) was established before the FAR was finalized. A more correct statement would be that the FAR played an important part in INC negotiations. [Lenny Bernstein]	Accepted. Yes, done, thanks.
1-254	A	7:0		Section 1.4. Why is this a separate section rather than one of the sections in 1.5 and perhaps even merged with the other model histories? [Kevin Trenberth]	Accepted. Done, merged with other examples.
1-255	A	7:0		(1.4) A mention somewhere near here of how increased computing capabilities and more complex models help reduce the uncertainty of model output would be helpful. [Thomas Vonder Haar]	Accepted. A new figure has been added to show the increased resolution of models due to increased computing power.
1-256	A	7:2	7:2	should read: ".. policy framework and legal base for adressing .." [Stephan Lingner]	Accepted. Done, thanks
1-257	A	7:4		What about the 1992 IPCC special report "Climate Change 1992"? That is a major omission, especially given all the space assigned to other special reports such as the aviation one. [Kevin Trenberth]	Accepted. Yes, this is now noted here.
1-258	A	7:5	7:12	This was a very big step, and well deserves to receive attention here. See also, lns25-34. [Jerry Mahlman]	Noted, thanks
1-259	A	7:8	7:11	This sentence is confused - needs re-drafting. [Neville Nicholls]	Done.

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1-260	A	7:25	7:34	This was a very big step, and well deserves to receive attention here. [Jerry Mahlman]	Noted, thanks.
1-261	A	7:33		Actually it seems to me that the last sentence is weaker than the first two (lines 28 - 30), as it states simply that "same of these changes (are) attributable to human acuities" and on this everybody agrees. In my opinion this softening of the attribution should be underlined. [WALTER DRAGONI]	Noted. However, almost everyone else viewed this as a strengthening of the 'attribution' part. We will consider rewording.
1-262	A	7:35		I think there ought to be a section here on the IPCC process and timelines. [Kevin Trenberth]	Noted. We will consider adding it to an expanded paragraph on AR4.
1-263	A	7:38	7:38	Not all climate scenarios depend on numerical models, analog scearo [David Easterling]	Accepted. See response to (1-264).
1-264	A	7:40	7:40	Since this is the first use of the word scenarios, definitions of both scenarios in general, and climate scenarios in specific, should be provided, either in the text or in a footnote. It is important to remind readers that scenarios are not predictions. [Lenny Bernstein]	Accepted. We will clarify and may refer to Glossary
1-265	A	7:40	7:40	Climate scenarios do not rely on anything but imagination. Change sentence to "Climate scenarios may be characterized using numerical models." [Howard Feldman]	Noted. See response to (1-264).
1-266	A	7:40	7:52	Somewhere in this section I think Hansen/GISS deserve pioneer status along with GFDL [Piers Forster]	Noted. It is very difficult to perform this kind of selection well. We wil try.
1-267	A	7:40		Section 1.4 lacks any clear conclusions and themes. Suggest at the very least trying to answer "what is the cost-benefit" of moving between hierarchy of models. [Lourdes Maurice]	Noted. Text has been edited.
1-268	A	7:41	7:42	megaflops and teraflops will be meaningless terms to most readers without further definition and context. Why not instead say something about how the computational power (speed?) of computers used in climate modeling have increased by a factor of X over the past Y years, since the first IPCC report was prepared. [Chuck Hakkarinen]	Accepted. Text will be altered to reflect this excellent suggestion. Clarification of terms such as flops, mega and tera will be made and consistent usage will be enforced.
1-269	A	7:41	7:42	From Mega to Tera represents a multilication by one million, not by one billion [Michel Petit]	See response to (1-268).
1-270	A	7:41	7:42	Flops aren't commonly known to be 'floating point operations per second' so should be defined. [Dian Seidel]	See response to (1-268).
1-271	A	7:42	7:42	replace "billion" with "million" [Stefan Brönnimann]	See response to (1-268).

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1-272	A	7:42	7:43	Please change "one billion" to "a factor of one billion". [Carlo Casty]	See response to (1-268).
1-273	A	7:42	7:42	Typo: should be ".. one million (not billion) in three decades" (since Teraflop/Megaflop=1e6) [Mikhail Danilin]	See response to (1-268).
1-274	A	7:42	7:42	"million" in place of "billion" (from Megaflops to Teraflops) [MARCOS S. P. GOMES]	See response to (1-268).
1-275	A	7:42	7:42	There may well be a mix-up between British and American usage here, but going from megaflops to Teraflops is for those of us in the US going from 10 to the sixth to 10 to the twelfth, which is not "one billion" but "one million". [Michael MacCracken]	See response to (1-268).
1-276	A	7:44	7:45	The sentence "The models…over time" could be deleted (carries no information) [Michel Petit]	Noted. Text has been edited.
1-277	A	7:51	7:51	Please explain "transient" in simple words. [Carlo Casty]	Noted. Text has been edited.
1-278	A	7:51	7:51	To many people, the word "transient" means something goes up and then down--is there only for a short while. While this has become the usage of the climate modeling community to indicate that they are doing a time-dependent experiment, the word 'transient" can easily be misinterpreted, and should either be defined or not used. In the case here, it would be much better to say "time-dependent (transient)" [Michael MacCracken]	Noted. Text has been edited. We shall clarify the definition and may also refer to a Glossary entry here.
1-279	A	7:57		It should be known to everybody that no model in any discipline is a perfect simulation of the reality nor it will be in the future. It is not clear to me if such obvious statement is for the layman or if it is a self consolatory statement for the model-builders (who for sure know the approximate nature of the models). I would delete the entire sentence or simply say that even if the models do not simulate climatic reality very well, they help to build scenarios and strategies. [WALTER DRAGONI]	Noted. Text has been edited. We continue to strive for language that accurately reflects the present status of models in the senses referred to here, including their weaknesses, strengths, and the ways in which they can best be used. It is well to keep in mind that all science is incomplete, yet useful.
1-280	A	8:1	8:4	The phrasing on line 1 seems to imply that we cannot get a reasonably well-defined, if still approximate, answer until we have actually resolved all space and time scales (from nucleation to global, and microseconds to millennia?), whereas this is clearly not the case. Again, we need to indicate that we have gotten plausible bounds on the issue. I am all for finer resolution, and in fact the evidence seems to indicate that this helps to resolve some of the systematic differences that appear in model results, but it has not at all really changed estimates of the global climate sensitivity. The, on line 4, the statement that "our understanding of many such process is still notably incomplete" again implies we	Noted. See response to (1-279).

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				probably have no business asying anything at all, when we actually have established reasonable bounds (albeit, still with some uncertainty); the problem here is that the statement is clearly true if designing a fundamental research program, but is not helpful nor accurate if implying to the IPCC decisionmakers that understanding is so weak that we cannot say anything. So, again, more nuanced wording should be used. [Michael MacCracken]	
1-281	A	8:1	8:9	Unfortunately, simple models can have severe limitations, physically, while intermediate models are limited in what problems they can properly address, and global "complete" climate models can be difficult to analyze and to execute due to limited computational resources relative to the scope of the challenges to be addressed. Cloud resolving global models remains a daunting challenge, but with promise in regional sub-scale models, all of which still have formidable modelling challenges. [Jerry Mahlman]	Noted. See response to (1-279).
1-282	A	8:2	8:2	I suggest to replace : "is partly" with "generally" (Please note, Lorenz,1963) [CONSTANTIN MARES]	Noted. Text has been edited.
1-283	A	8:3	8:3	This use of the phrase "abrupt climate change" needs to have some prior explanation to really be understood--and I actually do not think the phrase should be so glibly used (it would help, for example, to define "abrupt"). There can certainly be shifts in the circulation pattern over days to months, and these can persist, but the global average temeprature is hard to change so quickly due to the thermal inertia created by the oceans. Do recall that there has been a movie that fro9ze the world in a few days (and so did the initial nuclear winter paper)--both neglected the heat capacity of the oceans--one for dramatic reasons, the other was a serious scientific mistake. So, this chapter should be explaining what we understand is possible--significant shifts in the circulation that significantly and abruptly change the weather conditions in a region--and that the persistence of these altered conditions is later called a climate shift, or even abrupt change--but global average temeprature changes much less rapidly. [Michael MacCracken]	Noted. See response to (1-148). The concept of abrupt climate change, and the use of a clear and consistent definition, has emerged as a critically important point for Chapter 1 and indeed for all of AR4. We shall strive for optimal language in this context.
1-284	A	8:6	8:6	A better description is needed about the hirearchy of models, what they can and cannot be used for, and what they can and cannot show. This phrasing seems unduly leaning toward such simplified models--yes, they can help in understading and exploring concepts, etc.--but the global models really do provide a much more stringent test for the processes have to work under a much greater variety of conditions and they also (at least attmept to) include the more subtle teleconnection influences. Saying that all types of models have their place is fine--overstating what simple models can do is not, however, justified. To find space for a box on modeling, what I would suggest is combining the answers of questions 1-1 and 1-3 and using the extra question to explain what a model is and what it	Noted. See response to (1-279).

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				can be used for--while this may get done later, if models are going to be discussed here, such a box is needed early on about the model hierarchy. [Michael MacCracken]	
1-285	A	8:23	8:32	The section should begin with the most well known example of simple models: the radiative-convective equilibrium models which have contributed much to our understanding of lapse rate and water vapor feedbackls and climate sensitivity.. After all most GCMs are now converging to the RC sensitivity of 2 to 2.5 K for doubling of CO2. [Veerabhadran Ramanathan]	Noted. See response to (1-279).
1-286	A	8:23	8:32	The section should begin with the most well known example of simple models: the radiative-convective equilibrium models which have contributed much to our understanding of lapse rate and water vapor feedbackls and climate sensitivity.. After all most GCMs are now converging to the RC sensitivity of 2 to 2.5 K for doubling of CO2. [Veerabhadran Ramanathan]	Noted. See response to (1-279).
1-287	A	8:28	8:30	Does the term 'box models' adequately describe the 2-D zonally averaged ocean models used to examine THC dynamics for the TAR? [R Allyn Clarke]	Noted.
1-288	A	8:34	8:40	This paragraph may well be fine in a theoretical sense, but it really fails to indicate that there are bounds on such nonlinear behavior--and the types of climate change we will be talking about virtually certainly go well beyond these limits (certainly for global average temeprature--and soon for continental scale, etc.). So, I do not think this should be the concluding paragraph of the section--it really is hardly relevant to the issue the IPCC assessment is looking at--certainly not in such a major sense. [Michael MacCracken]	Accepted. The paragraph in question has been moved to alter the emphasis that might be inferred from its location atthe end of the section.
1-289	A	8:34	8:40	This is a bit dramatic. Actually, the discussion on deterministic chaos should have started back when the text referred to "clilmate forecasts", which doesn't really exist in global warming research, simply because they are actually probabilistic "projections". [Jerry Mahlman]	Accepted. See response to (1-288).
1-290	A	8:34	8:40	This paragraph looks like not complete, some conclusion is missing. [Eugene Rozanov]	Accepted. See response to (1-288).
1-291	A	8:35	8:39	nonlinear behavior … at all time scales – Is this statement true? In models at long time scales (long than 10 years), most responses look very linear to the forcing changes. See Ramaswamy and Chen 1996 or Haywood et al. 1997. [Ronald Stouffer]	Accepted. See response to (1-288).
1-292	A	8:40		Add "As a result we never achieve a wholly reliable predictive model." [Vincent Gray]	Noted. See response to (1-288).
1-293	A	8:41		How come the atmospheric concentration of methane is falling?	Noted. This comment seems

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				[Vincent Gray]	misplaced, as line 8:41 is blank.
1-294	A	8:42		I did not see a logical ordering in the subsections of this section and would suggest that they be re-arranged to follow some blend of chronological order and causal connections. My suggested ordering would be 1.5.(2, 1, 6, 5, 11, 3, 4, 7, 8, 9, 10, 12), with 1.5.11 seeming to be the subsection furthest from its logical position. [Martin Manning]	Accepted. This material has been extensively re-ordered.
1-295	A	8:42		Section 1.5: The authors should re-think the order of the sub-sections. E.g., I would have expected the sub-sections on greenhouse gases before "radiative forcing". [Robert Sausen]	Accepted. This material has been extensively re-ordered.
1-296	A	8:47	8:47	It would be good to have some explanation why globally averaged surface temperature is important. [David Easterling]	Accepted.
1-297	A	8:47		Section 1.5.1: It is a very important point to connect the development of earth observation to the development of organizational networks like the IMO/WMO and measurement networks (GCOS). Consequently the paragraph concludes: "…, century-scale global temperature time series would not have been possible without the conscientious work of individuals and organizations worldwide quantifying and documenting their local environment." With the climate research the meaning of research organizations for modern science became more obvious. [Falk Schützenmeister]	Accepted. Though modified somewhat.
1-298	A	8:49	8:53	The late 1600s also saw the first scientific journals. Weather observations were published in these journals from the very beginning (e.g., John Wallis, in Philosophical Transactions, Vol. 1 (1665), p. 167). Data exchange is an important topic. [Stefan Brönnimann]	Accepted.
1-299	A	8:49	8:49	Please check: Fahrenheit invented the thermometer 1714, after Torricelli invented the barometer 1643, as from my knowledge. [Stephan Lingner]	Rejected: Fahrenheit invented the mercury thermometer (Galileo invented the thermometer around 1593), which was a significant advance. Torricelli and the barometer do not fit into a section on global temperatures.
1-300	A	8:50	8:51	Consider inserting "The Industrial Revolution provided a major stimulus to the growth of the observational network principally as a result of concerns for public water supplies and sanitation in the rapidly growing cities on the coalfields of Europe." [John Sweeney]	Rejected: In many parts of the world, agriculture was the major stimulus to growth of observational networks, particularly in the European colonies.
1-301	A	8:55	8:55	Please replace : " Buijs" with " Buys" [CONSTANTIN MARES]	Acepted.

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1-302	A	9:0		Section 1.5.1. Suggest showing a figure of the evolution of observing networks in some way. For instance: Trenberth, K. E., J. R. Christy and J. W. Hurrell, 1992: Monitoring global monthly mean surface temperatures. J. Climate, 5, 1405–1423. features a map of the location of ship observations from COADS, see p 1420. [Kevin Trenberth]	Rejected: Not a bad idea but not good enough for the extra space required.
1-303	A	9:8	9:9	The name of the german scientist is "Dove" and not "Döve". [Heinz Wanner]	Accepted.
1-304	A	9:17	9:17	I could not understand the inclusion of the Large Eddy Simulation approach (LES) within the classification of "process oriented models". The use of LES, as an approach for solving turbulent flows (by filtering the smaller flow scales form the larger ones, and solving the transient flow for the large scales and applying a simplified model solution for the small flow scales) has increased in the last few years, but its mention here seems a bit out of context. Maybe the authors could rephrase the sentence? [MARCOS S. P. GOMES]	Noted. This point is misplaced – it is not part of page 9:17 in Chapter 1.
1-305	A	9:41	9:41	"a former student of Willett's," Is the genitiv "s" OK? [Robert Sausen]	Accepted.
1-306	A	9:43	9:45	"Good agreement" needs to be quantified with respect to the use of these data-sets in present day studies. [Robert Molinari]	Accepted: First, the good agreement does not need to be further described here, because it is a result quoted from an article. However, we may include a figure showing the early time series which will help quantify the good agreement.
1-307	A	9:47	9:52	Unless the quality of the different Russian approach relative to the previously described approaches can be given (I.e., any they suitable for present day research) this paragraph should be deleted. [Robert Molinari]	Reject: Adding the ocean was a major advance whether the approach was initially flawed or not, just as adding the ocean to models was an advancement, even though not all the early attempts improved the results.
1-308	A	9:56	9:56	replace "Advancements" with "Advances" [Peter Barrett]	Accepted.
1-309	A	9:57	10:1	It seems more adequate to me first quoting the earliest analysis of Jones et al. (1986) and then that of Hansen and Lebedeff (1987) than quote them in alphabetical order. Moreover, I propose to also quote the work of Vinnikov et al. (1990): Vinnikov, K.Ya., Groisman, P.Ya. and Lugina, K.M., 1990: Empirical data on contemporary global climate changes (temperature and precipitation). J. Climate 3, 662 677.) after quoting the Hansen and	Rejected: The order of quoting isn't alphabetical but rather is designed to lead from Jones' homogeneity advancement directly into the following paragraph discussing homogeneity

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				Lebedeff work. [Manola Brunet]	advancement. Vinnikov et al. did good work but did not make significant new contributions/developments to global temperature time series analyses, as they mainly continued the work of Budyko.
1-310	A	10:1		Make the loss of active stations in remote areas of Russia since the political transformation an issue. [Stephan Lingner]	Mainly rejected though partly accepted. The topic of the problem with recent data is mentioned. But Russia is not singled out. It may well be that most of the problem was due to data exchange rather than stations being closed. We would also have to comment on other countries such as the Democratic Republic of Congo where civil war has devastated observations. Also, if we specifically mention the loss of these remote stations we need to add a section on the rise of remote stations such as Canada putting one station in each 5x5 degree grid box across the whole country which is instrumenting previously vacant northern areas – and all these stations are becoming GCOS Surface Network stations. If we did all this it would be too long and detract from the general message.
1-311	A	10:2		Delete "rigorously" [Vincent Gray]	Rejected: rigorously accurately describes how the data were homogeneity-adjusted.
1-312	A	10:4	10:5	Add "However, it has to be admitted that the rigorous homogeneity adjustment procedures available in the United Staes are rarely fully applicable to many other countries. It also has to be pointed out that the numbers of meteorological stations has fallen drmatically over the past twenty years (Peterson and Vose 1997 Bull Royal Meteorological Society Vol 78, pages 2837-2849 [Vincent Gray]	Rejected in part and accepted in part: The first part is rejected as the Peterson and Vose article cited deals with global data not US (and was published in BAMS) and homogeneity reviews indicate that many different methodologies work well. The second

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					point is accepted, that the network has declined in recent years due to poor real-time data exchange, and this will be commented on in a general way.
1-313	A	10:5	10:10	A reference to the paper by Parker (2004) would bring the discussion of urban biases more up to date. [John Caesar]	Rejected: Papers after TAR are not to be cited in this chapter.
1-314	A	10:5	10:10	Should also cite Parker (Nature 2005) and Peterson (J Clim? 2003?) [William Connolley]	Rejected: Papers after TAR are not to be cited in this chapter.
1-315	A	10:5		I would mention some other reference to the Urban Heat Island effects, and add some comments about the measurement devices affected by that (in many countries many meteorological stations are located in urban areas or airports, so that for those areas there are some problems): Lin XC, Yu SQ (2005): Interdecadal changes of temperature in the Beijing region and its heat island effect. CHINESE JOURNAL OF GEOPHYSICS-CHINESE EDITION 48 (1): 39-45 JAN 2005. Zhang JY, Dong WJ, Wu LY, Wei JF, Chen PY, Lee DK (2005): Impact of land use changes on surface warming in China . ADVANCES IN ATMOSPHERIC SCIENCES 22 (3): 343-348 MAY 2005 Chung U, Choi J, Yun JI (2004): Urbanization effect on the observed change in mean monthly temperatures between 1951-1980 and 1971-2000 in Korea. CLIMATIC CHANGE 66 (1-2): 127-136 SEP 2004. There is also the neglected problem of the definition of average daily temperature: until a few decades ago, at least in some countries, it was considered to be the average between the maximum and the minimum daily temperature, while today is computed as the average out of 48 or more daily measurement. How that impacts the trend analysis? Some clarification should be given (probably the increasing temperature trends appear to be less steep then they actually are). [WALTER DRAGONI]	Rejected: All papers cited are too recent to be included. Papers after TAR are not to be cited in this chapter. In addition, the description in the chapter about rigorous assessments of UHI, that is assessments that take the homogeneity of the data into account and cover large areas, is still accurate.
1-316	A	10:6	10:10	Sentence long and meaning obscure. Needs to be split into 2 or 3 sentences. [Peter Barrett]	Accepted.
1-317	A	10:6		Using "currently" suggests that work to ensure that urban heating does not contaminate the temperature rcord is a very recent activity. In fact it has been considered for many years. I suggest deleting this word. [Neville Nicholls]	Accepted: Rephrased to make it clear that the description applies until the TAR.
1-318	A	10:10	10:10	Please, consider adding after Peterson et al. 1999 these other more recent contributions:	Rejected: Papers are too recent. Papers

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				Peterson, 2003; Parker, 2004; Petersona and Owen, 2005) References: Peterson, T.C., 2003: Assessment of urban versus rural in situ surface temperatures in the contiguous United States: no difference found. J. Climate, 16, 2941–2959. Parker, D.E., 2004: Large-scale warming is not urban. Nature, 432, 290–290. Peterson, T.C. and T.W. Owen, 2005: Urban heat island assessment: Metadata are important. J. Climate, 18, 2637–2646. [Manola Brunet]	after TAR are not to be cited in this chapter. But the section will point ahead to other chapters in AR4.
1-319	A	10:10	10:12	Add "This belief has been challenged by McKitrick and Michaels (2004, Climate Research. Vol 20, pages 159-173) who carried out a statistical study of a range of individual stations, as well as the IPCC gridded data and found a significant influence of a many of socio-economic factors such as income, gross domestic product, growth rates, coal usage and data quality on the supposedly "corrected" figures. A particularly startling discovery was the deterioration of Russian data after1989, with multiple missing monthly figures, suggesting that the data should be rejected altogether [Vincent Gray]	Rejected: (A) The paper is too recent. Papers after TAR are not to be cited in this chapter. (B) Analysis linking economic output vs temperature change really indicates that midlatitudes are warming faster than the tropics, which is caused by factors other than economic factors.
1-320	A	10:28	10:36	It might be worth pointing out that buoys now provide more measurements of SSTs than do ships of opportunity (and that this is a very recent phenomenon). [Neville Nicholls]	Rejected: Too recent. Developments after TAR are not to be cited in this chapter.
1-321	A	10:29	10:29	'advance' rather than 'advancement' (advancement is generally used with an explicit object, e.g 'advancement of knowledge' 'personal career advancement' etc.) [Ian Enting]	Accepted.
1-322	A	10:31		This should mention the Global Weather Experiment (FGGE) which initially set up the drifting buoys, and TOGA (WCRP) for the moored buoys. [Kevin Trenberth]	Rejected: Describing individual experiments like FGGE is too detailed for this overview.
1-323	A	10:34	10:36	The problem of non-stationarity in SST fields should be acknowledged when using post-satellite fields to fill in pre-satellite fields. [Robert Molinari]	Rejected: This is too detailed for our broad overview.
1-324	A	10:35	10:36	are the past satellite thermometry artefacts due to poor orbital calibrations an issue in this context? [Stephan Lingner]	Rejected: No, they are not because the satellite data were anchored to the in situ data and just used for gradients in the fields. However, this sentence is being dramatically changed due to post-TAR referencing.
1-325	A	10:40	10:42	Being stricter and reckoning the pioneering work of Climatic Research Unit (CRU) in this field, I think you should quote first the group so-called by this chapter's authors like UK Met-Office-University of East Anglia, renaming it like appear in Chap 3: CRU-UKMO; and then those of NASA and NOAA.	Rejected. This is a good suggestion but the section has been removed and replaced with a forward-looking statement (such as see Chapter 3 for

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				[Manola Brunet]	more current information).
1-326	A	10:42	10:43	Consider modify the sentence as follow: Their results agree very well despite using different databases of station temperatures, different approaches to homogeneity testing and different techniques of combining the basic data (Jones, 2001). Reference added: Jones, P. D., 2001, Instrumental temperature change in the context of the last 1000 years. In Detecting and Modelling Regional Climate Change, edited by M. Brunet and D. López, pp. 55-68, Springer-Verlag, Berlin. [Manola Brunet]	Rejected. This is a good suggestion but the whole sentence and most of the paragraph in question has been removed.
1-327	A	10:50	10:57	This paragraph can be deleted as those acknowledged probably will not read this report. [Robert Molinari]	Rejected. It is more than a thank you; it is an acknowledgements of a world-wide effort by individuals.
1-328	A	10:50	10:57	This is a very nice gesture. On the whole, the chapter is very generous in recognizing the community activity that is climate science. [Dian Seidel]	Noted. Thank you.
1-329	A	10:51	10:54	Mankind owes a great debt" is awkward wording and perhaps difficult to translate. Why not say "The dedicated work of individual weather observers remains a very important component of the world's weather observation system, even as automation of the process continues to expand. [Chuck Hakkarinen]	Accepted. The awkward wording will be reworded, although not exactly in the way the comment suggests
1-330	A	10:51		Perhaps use "humankind" instead of "mankind." [Richard Anthes]	Accepted, in that mankind has been replaced. But rather than mankind or humankind (as suggested) it is now "climate science".
1-331	A	11:0		Nothing on ice sheet instability, links with THC, Heinrich events? CLIMAP and the LGM? Very generally, the part on paleo misses most of the major paleocean work, and is strongly biased towards ice records [Laurent LABEYRIE]	Noted, but much of this material will be in the Chapter 6. Papers after TAR are not to be cited in this chapter. We do point ahead to later chapters in AR4.
1-332	A	11:1	11:1	This is a major comment: The authors wisely state that Section 1.5 presents "a restricted set of topics … chosen for their relevance and importance to the IPCC mission". Furthermore, they state that this accounnts emphasizes on areas where there are still gaps. I am missing a section on the history observation of upper-level temerature and stratosheric ozone (following Section 1.5.1 on global surface temperature observations). Given the weight of the topic of upper-level temperature in the recent debate (Nature 429 (2004), 55, Science 309 (2005), 1548, Science 309 (2005), 1556, Science 309 (2005), 1551) as well as in IPCC-AR4, a subsection on this topic in Chapter 1 is a must. One could mention early attempts to establisch operational upper-level measurements in the early 20th century by means of kites, pilot balloons, later aircraft and radiosonde (see	Noted, but we cannot expand here. Papers after TAR are not to be cited in this chapter. Many of the references quoted in this comment are post—TAR, and the upper atmosphere was one of the many topics not reviewed here.

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				Brönnimann, S., G. P. Compo, P. D. Sardeshmukh, R. Jenne, and A. Sterin (2005) New approaches for extending the 20th century climate record. Eos, 86, 2-7.) One could mention Scherhag's first climatology of the stratosphere (Scherhag, R. (1948) Neue Methoden der Wetteranalyse und Wetterprognose. Springer, Berlin.) and his later work on the data side (Berlin stratospheric data). Then the improvement of the network during IGY and the work by J. K. Angell in the 1960s and later. Then the satellite data should be mentioned. Even though the satellites are featured in the Executive Summary as one of the two major advances in the history of climate science, they are hardly mentioned in the rest of the chapter. Also, the current efforts to re-evaluate historical radiosonde data (Brönnimann, S. (2003) A historical upper air data set for the 1939-1944 period. Int. J. Climatol. 23, 769-791.) and establish large globale data sets (Durre, I., R. S. Vose, D. B. Wuertz (2005) Overview of the Integrated Global Radiosonde Archive (submitted)) should be mentioned. Concerning stratospheric ozone, Dobson's first network could be mentioned as well as the improved and enlarged network after IGY. And, of course, the satellite data. Satellite images of the ozone hole have become the probably most prominent icon for atmospheric and climate change. A history chapter should also address this. [Stefan Brönnimann]	
1-333	A	11:1	15:	Surprisingly missing is the rather recent insight that a relatively small Milankovitch radiative forcing of, say, -1W/M2 can produce an ice age of as much as -6C cooling, suggesting an extraordinarily large climate sensitivity when given roughly 10-20Kyears to allow the positive feedbacks to occur. To me, this is a generally ignored punchline that gives us an important perspective on the presence of postive feedbacks in the climate system that could be still operative over future millenia. This section is very interesting, well written, and informative. To me, however, it still should be part of a separable tutorial, not an introduction to a quadrennial assesment of the changing state of earth's climate. See my opening suggestions on how this welll written, and insightful, essay can be more productively utilized than is the case in the present WG1 draft. [Jerry Mahlman]	Noted, and an interesting point, but we cannot start with new tutorial essays at this point, with limited space.
1-334	A	11:1	16:	This discussion is interesting and informative, but is an example of why the length of this context-setting Chapter 1 does not help to set up Chapter 2 in the way that it needs to be as the introductory chapter of an IPCC report. I promise to not bring this up again! [Jerry Mahlman]	Noted. This is an inter-chapter issue that needs to be further considered.
1-335	A	11:1		I think that section 1.5.2 is unbalanced when dealing with past climate observations. Most of this part deals with paleoclimatic sources, such as icecores or corals, with a marginal reference to the abundant new achievements from documentary sources, which are only barely mentioned in l 1-4 of p13. This is even more striking, since chapter 6 is completely	Noted. A good point. We have not expanded to a new section, but rather have tried to insert documentary evidence where we can.

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				focused on paleoclimate. So, in order to produce a more balanced section, I suggest to include the following text in line 50 of p12 [Ricardo García-Herrera]	
1-336	A	11:1		In the recent decades documentary sources have provided new evidences on climate variability during the preinstrumental period. These sources comprise all non-instrumental man-made data on past weather and climate as well as early instrumental observations laid down prior to the creation of continuous meteorological networks. Non-instrumental evidence is subdivided into descriptive documentary data (includes all kind of direct observations about weather, e.g. reports from chronicles, daily weather reports, travel diaries, ship logbooks, etc.) and documentary proxy data (comprise phenomena dependent on the weather which may reflect the beginning of agricultural activities, the time of freezing and opening up of waterways, religious ceremonies in favor of ending meteorological stress etc. The height of floods or low water tables was often chiseled on rocks or buildings. Descriptive evidence has a good dating control and high temporal resolution (often down to the individual day). The reports distinguish meteorological elements and - taken together - they cover all months and seasons. On the other hand descriptive evidence is discontinuous and biased by the perception of the observer. The methods of analysis involves collocating a substantial amount of quality controlled descriptive and proxy evidence for a given region. Long series of documentary proxy data are calibrated against instrumental measurements. The spatial and logical comparison and cross-checking of the entire body of evidence collocated for a given month or season allows assessment of a climatic tendency which is in form of an intensity index for temperature and/or precipitation. [Ricardo García-Herrera]	Noted. Papers after TAR are not to be cited in this chapter. This comment has too many post-TAR refs. Again, we will try to include some aspect of this. We note that this discussion in a short form with some of the same refs occurs in 13:1-4
1-337	A	11:1		Documentary evidence is the main source for the analysis of natural disasters and their impact upon past societies. Thus, analysis of man-made data enables an investigation of the relationship between variations in climate and the frequency and severity of extreme events - a major source of societal concern in light of global warming. Therefore reconstructions based on documentary data play an important role in the greenhouse debate. Documentary evidence is generally limited to regions with long written traditions, such as Europe (e.g., Pfister, 1992, 1998; Pfister et al. 1999; Brázdil et al. 2004 and references therein; Chuine et al. 2004; Jones and Mann, 2004; Guiot et al. 2005), eastern Asia and Japan (Wang and Zhao 1981; Zhang and Crowley 1989; Song 1998, 2000; Mikami, 1999; Wang et al. 2001; Yang et al. 2002; Qian et al. 2002, 2003; Ge et al. 2003), North America (Bradley and Jones 1995; Druckenbrod et al., 2003; Overland and Wood 2003),	Noted. See response to (1-336).

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				South America (Quinn and Neal 1992; Ortlieb 2000; Prieto et al 1999, 2000, 2004). Further, records from Spanish galleons crossing the Pacific Ocean during the 16th-18th centuries provide a description of secular changes in the wind circulation (García et al, 2001). The systematic abstraction of logbooks has made available a new database with daily wind observations over the Atlantic and Indian Oceans for the period 1750-1850 (García-Herrera et al 2005a; Jones and Salmon 2005). The existence of possible secular variations in the occurrence of Atlantic hurricanes in the 16th-18th centuries is also suggested from records obtained from the same sources (García-Herrera et al 2005). Documentary data have been proven to be of much importance for monthly to seasonal NAO and sea level pressure (e.g. Luterbacher et al. 2002ab) as well as large-scale temperature field reconstructions (e.g. Mann et al. 1998, 2000; Pauling et al. 2003; Luterbacher et al. 2004; Guiot et al. 2005). [Ricardo García-Herrera]	
1-338	A	11:1		References: Bradley, R. S., and P. D. Jones (Eds.) 1995: ‚Climate Since A.D. 1500', 706 pp., Routledge, New York. Brázdil, R., Pfister, C., Wanner, H., von Storch, H., and Luterbacher, J., 2004: Historical climatology in Europe – The State of the Art, Clim. Change, in press. Chuine, I., P. Yiou, N. Viovy, B. Seguin, V. Daux, and E. Le Roy Ladurie, 2004: Grape Harvest Dates and Temperature Variations in Eastern France since 1370, Nature, in press. Druckenbrod, D., M. E. Mann, D. W. Stahle, M. K. Cleaveland, M. D. Therrell, and H. H. Shugart, 2003: Late 18th century precipitation reconstructions from James Madison's Montpelier Plantation. Bull. Am. Meteorol. Soc., 84, 57–71. García, R.R., H. Díaz, R. García Herrera, J. Eischeid, M.R. Prieto, E. Hernández, L. Gimeno, F. Rubio and A.M. Bascary, 2001: Atmospheric circulation changes in the tropical Pacific inferred from the voyages of the Manila galleons in the 16th–18th centuries'. Bull. Am. Met. Soc., 82, 2435-2455. García-Herrera, R., Können, G.P., Wheeler, D., Prieto, M.R., Jones P.D., and Koek, F.B.: 2005a: 'CLIWOC: A climatological database for the world's oceans 1750-1854', Clim. Change, in press. Garcia-Herrera R., L. Gimeno, P. Ribera and E. Hernandez, 2005b: 'New records of Atlantic hurricanes from Spanish documentary sources'. J. Geophys. Res., in press). Ge Q., Zheng J., Fang X., Man Z., Zhang X., Zhang P. and Wang W-C., 2003: Winter half-year temperature reconstruction for the middle and lower reaches of the Yellow River and Yangtze River, China, during the past 2000 years. The Holocene, 13, 933-940. Guiot J, Nicault A, Rathgeber C, Edouard JL, Guibal F, Pichard G and Till C, 2005: Reconstruction of western Europe summer temperature using tree ring and historical	Noted. See response to (1-336).

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				documentary series. The Holocene, in press. Jones, P.D. and M. I. Salmon, 2005, 'Preliminary reconstructions of the North Atlantic Oscillation and the Southern Oscillation index from wind strength measures taken during the CLIWOC period', Clim. Change, in press. Jones, P.D., Mann, M.E., 2004: Climate Over Past Millennia, Reviews Geophys., 42, RG2002, doi: 10.1029/2003RG000143. Luterbacher, J., Xoplaki, E., Dietrich, D., Jones, P.D., Davies, T.D., Portis, D., Gonzalez-Rouco, J.F., von Storch, H., Gyalistras, D., Casty, C., and Wanner, H., 2002: Extending North Atlantic Oscillation Reconstructions Back to 1500. Atmos. Sci. Lett., 2, 114-124 (DOI:10.1006/asle.2001.0044). Luterbacher, J., Xoplaki, E., Dietrich, D., Rickli, R., Jacobeit, J., Beck, C., Gyalistras, D., Schmutz, C., and Wanner, H., 2002: Reconstruction of Sea Level Pressure fields over the Eastern North Atlantic and Europe back to 1500. Clim. Dyn., 18, 545-561. Luterbacher, J., Dietrich, D., Xoplaki, E., Grosjean, M., and Wanner, H., 2004: European seasonal and annual temperature variability, trends, and extremes since 1500, Science, 303, 1499-1503 (DOI:10.1126/science.1093877). Mann, M. E., R. S. Bradley, and M. K. Hughes, 1998: Globalscale temperature patterns and climate forcing over the past six centuries, Nature. 392, 779–787. Mann, M. E., E. Gille, J. Overpeck, W. Gross, R. S. Bradley, F. T. Keimig, and M. K. Hughes (2000), Global temperature patterns in past centuries: An interactive presentation, Earth Interact., 4-4, 1-29. Mikami, T. 1999: Quantitative reconstruction in Japan based on historical documents, Bull. Natl. Mus. Jpn. Hist., 81, 41–50. Ortlieb, L. 2000: The documentary historical record of El Nino events in Peru: An update of the Quinn record (sixteenth through nineteenth centuries), in El Nino and the Southern Oscillation: Multiscale Variability and Its Impacts on Natural Ecosystems and Society, edited by H. F. Diaz and V. Markgraf, pp. 207–295, Cambridge Univ. Press, New York. Overland, J. E., and K. Wood, 2003: Accounts from 19th century Canadian Arctic explorers' logs reflect present climate conditions. Eos Trans. AGU, 84, 410-412. Qian W-H, Zhu Y-F., 2002: Little Ice Age climate near Beijing, China, inferred from historical and stalagmite records. Quat. Res., 57, 109–119. Qian, W. , Q. Hu, Y. Zhu, and D.-K. Lee, 2003: Centennial-scale dry-wet variations in East Asia. Clim. Dyn, 21, 77–89. Quinn, W. H., and V. T. Neal, 1992: The historical record of El Nino events, in Climate Since A.D. 1500, edited by R. S. Bradley and P. D. Jones, pp. 623–648, Routledge, New York. Pauling, A., Luterbacher, J., and Wanner, H., 2003: Evaluation of Proxies for European and North Atlantic Temperature Field Reconstructions, Geophys. Res. Lett., 30 (15), 1787	

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				(DOI 10.1029/2003GL017589). Pfister, C.: 1992, 'Monthly temperature and precipitation patterns in Central Europe from 1525 to the present. A methodology for quantifying man-made evidence on weather and climate', in Bradley, R. S. and Jones, P. D. (eds.), Climate Since A.D. 1500, Routledge, London and New York, pp. 118–142. Pfister C., Brázdil R, Glaser R., (Guest editors) 1999: Climatic Variability in Sixteenth Century Europe and its Social Dimension. Special Volume of „Climatic Change" 1/43. (also published by Kluwer, Dordrecht). Pfister, C., Luterbacher, J., Schwarz-Zanetti, G., and Wegmann, M., 1998: Winter air temperature variations in western Europe during the Early and High Middle Ages (AD 750-1300). The Holocene, 8, 535-552. Prieto, M. R., Herrera, R., and Dussel, P., 2000: Archival Evidence for Some Aspects of Historical Climate Variability in Argentina and Bolivia during the 17th and 18th Centuries, in Volkheimer, W. and Smolka, P. (eds.), Southern Hemisphere Paleo and Neoclimates, Springer-Verlag, Berlin-Heidelberg. Prieto, M. R. and Herrera, R., 1999: Austral Climate and Glaciers in the 16th Century through the Observations of the Spanish Navigators', Quaternary of South America and Antarctic Peninsula, A. A. Balkema/Rotterdam/Brookfield, Vol. 11, pp. 153–179. Prieto, M. R.,, R. García-Herrera, E. Hernandez Martin, 2004: Early records of icebergs in the south Atlantic ocean from spanish documentary sources. Clim. Change, 66, 29-48. Song, J., 1998: Changes in dryness/wetness in China during the last 529 years. Int. J. Climatol., 18, 1345-1355. Song, J., 2000: Reconstruction of the southern oscillation from dryness/wetness in China for the last 500 years. Int. J. Climatol., 20: 1003-1016. Yang, B., Braeuning, A., Johnson, K.R., and Yafeng, S., 2002: General characteristics of temperature variation in China during the last two millennia. Geophys. Res. Lett., 10.1029/2001GL014485 Wang, S.-W., and Z.-C. Zhao, 1981: Droughts and floods in China, 1470–1979, in Climate and History, edited by T. M. L. Wigley, M. J. Ingram, and G. Farmer, pp. 271–288, Cambridge Univ. Press, New York. Wang, S.-W., D. Gong, and J. Zhu, 2001: Twentieth-century climatic warming in China in the context of the Holocene. The Holocene, 11, 313–321. Zhang, J., and T. J. Crowley, 1989: Historical climate records in China and reconstruction of past climates, J. Clim., 2, 833–849. [Ricardo García-Herrera]	
1-339	A	11:2		I appeciate the work that went into this paleo section, and its a nice start. However, it might help to circulate this paleo section among interested chap 6 LA's (we could assign a	Accepted. Yes, we have enlisted Raynaud in the revisions.

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				small team, perhaps) to make the section fit more with the development that has led to the AR4 chap 6. For example, the development of the science around orbital dynamics and abrupt change is richer than indicated. It would be good to put more highligh on "warm climate" abrupt change - going beyond MOC to droughts, etc., plus what the Alley et al. US NRC study has added. The multi-proxy section is in need of work, and it seems appropriate to mention the big, and expanding roles of paleo with respect to model evaluation and biosphere/biogeochemical dynamics. Also, not useful to use terms like "Mid-Holcene optimum" [Jonathan Overpeck]	
1-340	A	11:4	11:4	The history of climate paleoclimate research should include the 18th century debates (e.g., Mann (Abbé) (1790) Ueber die allmählichen Veränderungen der Temperatur und des Bodens in verschiedenen Climaten, nebst Untersuchungen über die Ursachen dieser Veränderungen. Historia et Commentationes AcademiaeTheodoro-Palatinat. Vol. 6, Physicum Mannheimii, pp. 82-111, Williamson H (1771) An attempt to account for the change of climate, which has been observed in the Middle Colonies in North-America. Trans. Amer. Phil. Soc. 1.). [Stefan Brönnimann]	Noted. This is a nice point, but we cannot be so comprehensive in this brief overview.
1-341	A	11:13	11:20	An extremely inadequate description of palaeoclimatic research, which has developed as stated in the 19th and 20th centuries within geology and can be found in many textbooks. There is a huge literature that should be acknowledged if briefly on the ice ages of the Late Precambrian and the Carboniferous-Early Permian, and global late reconstructions based on the distribution of sedimentary strata that are climate indicators (glacial deposits, coal, red beds, evaporites) eg. "Climatically controlled sediments, the geomagnetic field, and trade wind belts in Phanerozoic time" Drewry, G E; Ramsay, A T S; Smith, A Gilbert, Journal of Geology, vol.82, no.5, pp.531-553, 1974. Distribution plotted on Lambert equal-area maps; see also Bibliography. [Peter Barrett]	Noted, but we had to choose a brief overview of the critical paleo work affecting current IPCC work. See chapter 6 for more detail.
1-342	A	11:14	11:14	Replace "vegetal" by "plant" [John Sweeney]	Accepted. Yes, done
1-343	A	11:16	11:20	How much warmer and colder? A figure could be placed here, after the text, indicating these temperature variations, or at least some numbers could be presented [MARCOS S. P. GOMES]	Noted. These are difficult to quantify, depends on where and how averaged. Cannot do so here.
1-344	A	11:16	11:16	insert "several" after "last". [John Sweeney]	Accepted. Yes, thanks
1-345	A	11:16	11:20	The distinction in geological terms between eras and periods requires to be tightened up here. The conventional descriptor for the era commencing about 600M BP is the "Palaeozoic era". There is no convention of describing the Tertiary or Quaternary as an	Accepted. Yes, thanks again

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				'era' and the sentence should refer to Tertiary Period and Quaternary Period. Alternately the Tertiary and Quaternary could be described as part of the "Cenozoic" era. [John Sweeney]	
1-346	A	11:18	11:19	It is my understanding that the names of geological epochs should be capitalized, to "Tertiary" and "Quaternary"--these are proper nouns and not adjectives (I.e., we are not dealing with a tertiary process). This comment applies generally (and practice needs to be coonsistent with chapter 6). [Michael MacCracken]	Accepted. Done, see above
1-347	A	11:21		There ought to be a paragraph describing the challenge of using proxy data to get information about climate variables; perhaps mentioning del O18 etc. [Kevin Trenberth]	Yes, but where? Declined
1-348	A	11:22		I don't think "history" can "accelerate", although I know what you mean. Perhaps the "pace" instead of "history"? [Neville Nicholls]	Yes. Accepted.
1-349	A	11:26		I am not certain this Emiliani 1955 is the best reference for deep water temperature changes. You may have refered to my 1987 paper (Labeyrie, L.D., J.C. Duplessy, and P.L. Blanc, Variations in mode of formation and temperature of oceanic deep waters over the past 125,000 years, Nature, 327, 477-482, 1987) [Laurent LABEYRIE]	Noted, but not included.
1-350	A	11:28		Why focus on Emiliani again. What about Shackleton? [Laurent LABEYRIE]	Yes, need ref. Accepted.
1-351	A	11:39	11:39	I suppose the correct ref. to the 400 kyr Vostok record of temperature and GHG is Petit, Nature 99 [Reto Knutti]	Yes. Accepted.
1-352	A	11:39	11:42	This sentence is misleading and should deleted :the astronomical forcing much more likely affects the energy balance, hence the temperature than directly changes the atmosphere composition.. The observed correlation between paleo-temperatures and CO2 paleo-concentrations proves that a temperature increase induces a concentration increase, not the reverse. [Michel Petit]	Accepted. Yes, but there are proposals that the insolation change directly affects ocean biology and CO2. Will reword to try to avoid the mistaken causal link.
1-353	A	11:41	11:41	Delete "unambiguously". These ice cores demonstrate correlations but not causality. [Howard Feldman]	Accepted.
1-354	A	11:47	11:47	What does "the dominance of the longer time scales in the spectral record" mean? I did not understand the consence. [Carlo Casty]	Noted, have revised and shortened.
1-355	A	11:47	11:47	Suggest changing wording from "spectral record" to "spectral analyses of the geological	Noted, have revised

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				record"--the record is not spectral. [Michael MacCracken]	
1-356	A	11:49	11:57	In this discussion of abrupt changes, there is really no discussion (at least early on) of the spatial scale of what is happening. When "a few degrees" is mentioned, there is no spatial domain indicated--On Greenland, there may well be an abrupt change of over 10 C due to a change in atmospehric circulation, for the North Atlantic, the change is less and over a longer time, and for the globe, again, smaller and longer. So, space and time need to be addressed together. [Michael MacCracken]	Accepted.Yes, have modified with 'regionally'
1-357	A	12:1	12:20	This implies that we know that these various "abrupt climate changes" were rapid(without defining "rapid" here). Later in this section, "rapid" climate change at regional scales is of order decades to centuries. To all non-practicioners, a century seems to be very "unrapid". I think that it is better to leave these terms with the paleoclimate community. They do not translate well to the people in the here and now when people talk about, e.g., "rapid, century-scale summer Arctic ice melting". [Jerry Mahlman]	Accepted. Yes, have eliminated 'rapid' from this discussion entirely as it is used in two meanings.
1-358	A	12:5	12:5	unforced' implies the abrupt events in the glacial are caused by internal processes only. Of course they are not anthropogenically forced, but there are hypothesis that they might be forced by solar variations, and some even believe in asteroids or other orbital forcing. Suggest change 'unforced' to 'not anthropogenically forced' [Reto Knutti]	Noted, rewritten.
1-359	A	12:5	12:6	How is it known, seemingly without any uncertainty, that these changes were "unforced"--and what does "unforced" mean. This phrasing seems to imply that we could at present have such a sudden shift or jump (words I prefer to change)--and there is no evidence during warm periods that this could happen--seemingly suggesting that what occurred was somehow related to something that happened due to the presence of glacial ice--something that we will not be facing in the future (I guess one could argue that all of Greenland could form meltwater and then suddenly burst forth over the ocean--but very low likelihood). If the text is going to discuss the possibility of such abrupt changes, then rather than going back to glacial times, it should be using the Holocene record to draw from, not applying a quite possibly irrelevant feedback. Alternatively, the conclusion being drawn should not be that we are uncertain about future climate because of this possibility, but that the system is capabable of being changed quite drmatically if there is significant forcing (internal it may be, but would presumably also apply to external as well). [Michael MacCracken]	Noted, rewritten.
1-360	A	12:8	12:9	I suggest to introduce at references for abrupt climate change : "Rahmstorf, S, 2001:	Noted, but not necessary

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				Abrupt Climate Change. In : Encyclopedia of Ocean Sciences[J.Steele, S. Thorpe, and K. Turekian (eds)]. Vol.1, Academic Press, London, pp. 1-6." [CONSTANTIN MARES]	
1-361	A	12:11	12:20	Loess should be added as another paleoclimate proxy. In fact, together with Wallace Broecker, Tungsheng Liu was awarded the 2002 Tyler Prize for Environmental Achievement for his contribution in developing ways to measure global climate patterns by studying loess. [Jilan Su]	Noted. This does not fit here, we are talking about proxies for current observables.
1-362	A	12:11	12:11	Replace "observables" by "observations" [John Sweeney]	Accepted. Fixed with better wording
1-363	A	12:20		This line should include reference to the solar/climate correlations, such as those of Bond et al (Bond, Gerard, Bernd Kromer, Juerg Beer, Raimund Muscheler, Michael N. Evans, William Showers, Sharon Hoffmann, Rusty Lotti-Bond, Irka Hajdas, Georges Bonani, 2001, Persistent Solar Influence on North Atlantic Climate During the Holocene: Science, Vol. 294, Issue 5549, 2130-2136.) They show D-O events correlated with solar activity proxies. Note also that in Chapter 6, this report identifies orbital perturbations correlate with large time scale climate change events. Inview of the extensive new literature on solar climate connections, it is incumbent on the IPCC to acknowledge this area of current research and the uncertainty it brings to conclusions of dominating greenhouse effects. [Lee C. Gerhard]	Noted. This does not fit here, we are talking about proxies for current observables. Yes, we agree, but this is up to Chapter 6.
1-364	A	12:20		No, just an hypothesis at that time. [Laurent LABEYRIE]	Noted. Yes, but wording is OK
1-365	A	12:22	12:23	It seems quite inconcsitent to me to be saying that these "abrupt changes" are "well-documented" given the limits to our understanding about them--in a paleoclimatic reference frame, perhaps well-documented, but not compared to present changes. I would also prefer, on line 22, to see the phrase "abrupt jumps" and on lines 22-23 "abrupt regime shifts" rather than calling these all changes--myintent being not to confuse the reader with respect to the global changes that IPCC does talk about. [Michael MacCracken]	Noted. Yes, have dropped the prefix, not necessary.
1-366	A	12:25	12:25	delete "period" [Rolf Philipona]	Yes. Accepted.
1-367	A	12:28	12:28	Suggest "humanity's" or "societiey's" instead of "man's"--or maybe just "human" [Michael MacCracken]	Yes. Accepted.
1-368	A	12:31	1:49	There is some tension between the paragraphs within this lines. The first says that past climate systems will not be faithfully repeated in the future. The second is rather optimistic about what can learned from historical data. The possibility of link climate change between the two hemispheres should be tempered by the warnings in the first	Noted. OK, but suggestions not clear, overall, this part has been revised to shorten.

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				paragraph. [Robert Molinari]	
1-369	A	12:31		Many references about the "demission of the idea that the past could give analogues for the future" should be given. Indeed it seems very hard to rely for the building of future scenarios only on the (contrasting) results of models and dismiss what actually happened to the climate in the past (which in general is not simulated by the models). At least for Italy a few papers show that, in the last few thousands of years and for variations of 1 - 2 C, warm periods corresponded to dry periods, compared to the cool ones, as it happening at present; just for example the following references: Dragoni W. (1998): Some considerations on climatic changes, water resources and water needs in the Italian region south of the 43 N. In "Water, Environment and Society in Times of Climatic Change". Issar A., Brown N. editors. Kluwer, pp. 241 - 271. Issar A. S. (2003): Climate Changes during the Holocene and their Impact on Hydrological Systems. International Hydrology Series, Cambridge University Press, pp.127. (ISBN 0527817269). Franco Ortolani, Silvana Pagliuca (2005): Natural, Rapid and Cyclical Climatic-Environmental Change in the Mediterranean Area and Human Responses During the Last 3000 Years. Final Meeting, Dark Nature - Rapid Natural Change and Human Responses, September 6-10, 2005, Villa Olmo, Como, Italy. http://atlas-conferences.com/cgi-bin/abstract/caqy-41 [WALTER DRAGONI]	Noted, have tried to merge in this reference.
1-370	A	12:31	:40	This stsement of non-uniformitarianism is notlogical, perhaps present climaate changes are not "faithfully" replicated in the past, the cyclic trends are the same, and there is a clear past-present correlation. This smacks a bit of neo-catastrophism, which would be unbecoming to the report. [Lee C. Gerhard]	Yes, this paragraph was awkward and confused. It has been shortened and moved to the end of this section.
1-371	A	12:32	12:32	The word "instabilities" really is misleading here--would be much better to simply say "variations"--we really do not know if these are purely natural or related to some process (seems most likely); it might be appropriate to indicate thet there may be some tipping points that could lead to non-linear behavior, or even mention some hysteresis, but just introdicuting the notion of "instabilities" as if the climate could naturally bounce all over independent of some driving force does not seem to me to be well-established. [Michael MacCracken]	Yes, this paragraph was awkward and confused. It has been shortened and moved to the end of this section.
1-372	A	12:35	12:35	I was there and in on the discussion, and the phrase "largely dismissed" seems misleading to me--the text should really give an explanation and not suggest it was so cavalier. On the one hand, most warmer climate analogs were being pushed by Budyko and were based	Yes, this paragraph was awkward and confused. It has been shortened and moved to the end of this section.

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				on climate changes due to orbital element shifts, which many felt were an inappropriate analog, and to much earlier times when data was then quite limited. On the other hand, there was some use of paleoclimate records, as explained on page 1-13, lines 18-27 of this chapter. I would suggest s changing "largely dismissed" to "were not seen as adequately well-developed or sufficiently similar to the time-dependent change of climate due to increasing concentrationss of greenhouse gases." [Michael MacCracken]	
1-373	A	12:38	12:40	This sentence seems to be implying that the set of porcesses now included may not be adequate for simulating current climate, which is not really a conclusion that can be drawn from the discovery that past climates were affected by isostasy, breakout of meltwater ponds, and so on. While models do need to include these processes to simultate past (generally colder) climates, most models now include the processes relating to warmer climates that need to be treated--at least there is not a "wide range" of relevant processes relevant to simulating 21st century climate that models do not include in some way--or if there are, then this sentence needs to be made more specific and not sound as if we know essentially nothing. [Michael MacCracken]	Yes, this paragraph was awkward and confused. It has been shortened and moved to the end of this section.
1-374	A	12:39		would prefer "provide" instead of "constitute as" [Neville Nicholls]	Yes, this paragraph was awkward and confused. It has been shortened and moved to the end of this section.
1-375	A	12:42	13:36	In general, I am reviewing chapter 2, rather than chapter 1; however, I was very interested to read this chapter. In general, I found the chapter very well written, informative, and helpful. The sole exception is the page of text called out by this comment. I found it much denser reading and having more specialist lingo than the rest of the chapter. I would therefore suggest revising this page of text for increased ease of readability. [Scot Martin]	Yes. The first paragraph is deleted, the remainder is shortened.
1-376	A	12:46	12:46	Change"will" to "should". Nothing in the future is as certain as "will" implies. [Lenny Bernstein]	Paragraph deleted
1-377	A	12:47	12:47	I would suggest changing the phrase "climate changes" to "changes in climate" to be more gramattically correct. It may be fine to say "climate change" to encompass a set of changes in temeprature, winds, etc., but to make this plural seems to be really confusing. [Michael MacCracken]	Paragraph deleted
1-378	A	12:52	12:52	I would suggest changing the wording to "proxy data; such studies continue today." And to what the first word of the next sentence (I.e., "This") refers is not at all clear. [Michael MacCracken]	Yes, this paragraph was rewritten for clarity.
1-379	A	12:54		"dendroclimatology" should be defined or a more recognizable word used in its place. [Michael Alexander Alexander]	Yes, this paragraph was rewritten for clarity.

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1-380	A	12:56	12:56	Suggest changing "could" to "can" [Michael MacCracken]	Yes, this paragraph was rewritten for clarity.
1-381	A	13:1		I suggest to change the term 'historical' by 'documentary', since all the cited references deal with information obtained from documents kept in different archives. In this sense, 'documentary' is more precise. [Ricardo García-Herrera]	Yes.
1-382	A	13:6		Add Loess to the list of proxy data. [Jilan Su]	Yes, but paragraph largely revised.
1-383	A	13:7	13:7	"Slower" than what? [Michael MacCracken]	Dropped.
1-384	A	13:7	13:7	Suggest chaning "comparison or correlation" to comparison and correlation" [Michael MacCracken]	Yes, done
1-385	A	13:12	13:12	Some comment on other forms of proxy data is needed to balance this section. In particular phenological proxies and documentary sources should be mentioned. Something along the following lines might be considered: "Human proxy data has also proven a valuable source of climatic reconstruction for the period before instrumental records became available. In some countries such as Iceland, China and Ireland, ancient manuscripts can provide fragmentary insights into past conditions. While such subjective sources have to be considered very carefully, the sometimes very meticulous recording of blossoming dates, harvest dates, grain prices etc. can supply useful climatic proxies for some areas, as can more direct sources such as ships' logs, early newspapers and weather diaries." [John Sweeney]	Nicely written, done.
1-386	A	13:12		This summary fails, in my view, for not recognizing the huge step forward that Michael Mann et al achieved with his salient 1998 paper. Prior to that time paleo reconstructions were at single sites. Some very loose efforts had been made to consider other records and then grandiose statements were made about global climate change with no consideration of careful dating alignment. For the first time in this Mann et al paper, great care was taken with annually or better resolved time series to make sure that dating lined up and patterns of temperature variability and change could be dealt with, so that true hemispheric values were obtained. This was a major step forward and the real revolution of that paper, and not so much the hockey stick shape that resulted. [Kevin Trenberth]	Yes, have rewritten to emphasize this.
1-387	A	13:13	13:16	Please update these references. There are many new records available than the ones cited here. Please try to equalize them with Chapter 6. [Carlo Casty]	No, see the chapters for this.
1-388	A	13:13	13:16	This little paragraph about multiproxy reconstructions is vague and doesn't seem to fit	Yes, have revised substantially.

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				with the "voice" of the rest of the chapter. [Dian Seidel]	
1-389	A	13:18	13:27	Perhaps a table listing the epochs, periods, etc., and when they occurred should accompany this paragraph. [Michael Alexander Alexander]	We will try to reduce the use of epochs and periods to avoid the space.
1-390	A	13:18	13:27	This paragraph is a very general statement and I suggest to move it to the introduction of chapter 6 (paleoclimate) and delete it from this chapter. [Ricardo García-Herrera]	Has been shortened greatly.
1-391	A	13:18	13:36	I think you could high-light that some recent paleo reconstructions have focussed on annually-resolved data, to try to provide more temporal information (eg Mann et al). [Neville Nicholls]	Yes, have done so.
1-392	A	13:18	13:27	Suggest giving date ranges for the various geologic epochs. [Dian Seidel]	Will drop most of these.
1-393	A	13:21	13:21	"Mid-Holocene [Rolf Philipona]	Dropped.
1-394	A	13:22	13:22	Uncritical use of "MWP" and "LIA" is inappropriate, since the various xAR reports have usualy noted their uncertain globality. [William Connolley]	Dropped.
1-395	A	13:22	13:22	I think the IPCC, and this chapter, need to be quite careful about implying that the "Medieval warm period" and "Little Ice Age" were as distinct and clear as the "Younger Dryas". It really seems that the two former periods were quite regional and/or were spread over time. I would much prefer to see these periods identified primarily by the time periods rahter than, expecially in the case of these two ones, to include the outcome in the name. Chapter 6 seems much more circumspect on this. I am also struck that in this sentence these various times are provided as an incication of "cliamte variability" and not of "cliamte change." It would really help to have the chapter define what is meant by cliamte change and climate varaibility, etc. [Michael MacCracken]	Yes. Changed, let Chapter 6 review paleoclimate in general.
1-396	A	13:29	13:36	comment to the paragraph: hint for the debate is lacking [Hartmut Grassl]	The Mann debate is primarily post-TAR and we leave to Chapter 6.
1-397	A	13:29	13:35	This paragraph suggests that the TAR based the conclusions about mean surface temperature variations over the last millenium solely (or mainly) on the multi-proxy reconstructions of Mann et al (1999). That is incorrect and plays into the hands of some sceptics who argue that there are errors in that reconstruction. I suggest you refer to some of the other references of temeprature reconstructions for the last millenium used in the TAR.	Yes, need to do so.

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				[David Karoly]	
1-398	A	13:29	13:36	Undiscussed here is the vitrolic right-wing attack on Mann and his colleagues for daring to show relatively small warming from AD 1000 to 1900, with strong warming thereafter. Even right wing Congressmen are attacking him at the present time. [Jerry Mahlman]	The Mann debate is primarily post-TAR and we leave to Chapter 6.
1-399	A	13:29	13:36	The paleo estimates of surface temperature are generally at best hemispheric. The lack of southern hemisphere data should be noted. [Michael Manton]	This is noted .
1-400	A	13:29	:36	This work by Mann et al. has been criticised in peer reviewed journals ["Corrections to the Mann et al (1998) Proxy Data Base and Northern Hemisphere Average Temperature Series"Energy and Environment 14(6) 751-772. ; "The M&M Critique of the MBH98 Northern Hemisphere Climate Index: Update and Implications Energy and Environment 16(1)69-100; and "Hockey Sticks, Principle Components and Spurious Significance" Geophysical Research Letters, Vol 32(3), Feb 12 2005;]. Though Mann et al have responded to the criticism (most notably online at their weblog realclimate.org), it should be noted that to date they have not provided all the data and methods necessary to fully replicate their work, making the result questionable in a quite fundamental scientific sense as also noted in the draft: "Science may be stimulated by argument and debate, but it advances only through formulating hypotheses clearly and testing them objectively. This testing is the key to science. In fact, some philosophers of science insist that to be genuinely scientific, a statement must be susceptible to testing that could potentially show it to be false (Popper, 1934). Therefore, scientists are required to submit their research findings to the severe scrutiny of review by their peers and to disclose fully the methods and data which they use so that other scientists may attempt to replicate their results."(my emphasis) [Chapter 1, page 4, lines 20 -25] This requirement has clearly been violated by Mann et al. Note that this is an independent issue from the correctness of their methods and use of data, which may be resolved independently. I also do not see the need to defend an individual paper as part of an assessment even if that paper's results played a prominent role in a previous assessment. The nature of climate science is that, as in any devellopping science, insight can change at any time so one should not be surprised that problems turn up with at least one of the publications used to support an assessment. The point of a new report is to provide a new assessment, even if that just means updating the references (so to speak). My advice is to remove the discussion of the Mann et al issue, preferably supplemented by a short section outlining the issue and a clear admission that the result published in	The Mann debate is primarily post-TAR and we leave to Chapter 6.

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				TAR has been subject to a materials complaint and further criticism in peer reviewed literature, followed by a citation of the relevant works. The minimal action I would like to ask is an addition after line 36 of the following: "This result has been subject to criticism concerning replication issues and disclosure of data and methods [cite abovementioned papers here]. The discussion on the validity of the methods used and results aquired is still ongoing.". [Florens De Wit]	
1-401	A	13:29		Here the authors should clearly state that the temperature reconstruction of Mann et al., 1999 (the so called hockey stick) is not an absolute truth, as it is questioned by some authors and some findings. For example: Essex C & McKitrick R. (2002): Taken by storm. Key Porter Books. Martinez-Cortizas, A., Pontevedra-Pombal, X., Garcia-Rodeja, E., Novoa-Muñoz, J.C. and Shotyk, W. 1999. Mercury in a Spanish peat bog: Archive of climate change and atmospheric metal deposition. Science 284: 939-942. [WALTER DRAGONI]	The Mann debate is primarily post-TAR and we leave to Chapter 6.
1-402	A	13:29	:36	Macintyre and McKittrick replicated the Mann et al results; the issue is not replication, but whether the statisitical devices used are appropriate. Theysuggest that Mann et al did not use valid statistical manipulations and that their work is suspect, and that has not yet been addressed inthe published literature that I have read. A denigrating statement that Mc andMc 's work is of no consequence owing to a new replication is not germane. [Lee C. Gerhard]	The Mann debate is primarily post-TAR and we leave to Chapter 6.
1-403	A	13:29		Insert "annual" before "global temperatures". [Kevin Trenberth]	Yes, it may not survive rewrite.
1-404	A	13:34	13:36	Given the controversy over the Mann et al. report, it is important to also mention here that this study was generally confirmed by the work of others. [Michael MacCracken]	The Mann debate is primarily post-TAR and we leave to Chapter 6. But TAR used others
1-405	A	13:36	13:38	Add at end. "S.McIntyre and R.McKitrick (2003,"Corrections to the Mann et al (1998) proxy data base and Northern Hemispheric Average Temperature series", Energy and Environement Vol 14 pages 751-767, and 2005 "Hockey Sticks, principal components, and spurious significance", Geophysical Research Letters 2005 Vol 32 L03710, doi:10.1029/2004GL021750) have identified several errors in the papers of Mann et al., and shown that the corrected temperature values in the early 15th century exceed any values in the 20th century. Also W. Soon and S. Baliunas (2003, "Proxy Climate and Environmental Changes of the past 1000 Years", Climate Research, Vol 23, pages 89-110 and W. Soon, S. Baliunas, C. Idso, S. Idso, and D. R. Legates 2003 "Reconstructing Climatic and Environmental Changes of the Past 1000 Years : A Reappraisal", Energy and Environment Vol 14, pages 233-296). have shown that proxy measurements before	No, not here. This is late science and needs to be reviewed in Chapter 6

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				1500 are insufficiently representative to provide a fair average; but generally support the existence of a medieval warm period warmer than the 20th Century [Vincent Gray]	
1-406	A	13:38		It would be nice to highlight how our understanding of ice sheet dynamics and sea level have changed over IPCC time. I sense there is a revolution starting to take place with the recognition of "dynamic instability" and the roles various processes might play in speeding up ice sheet response to climate. Obs like ice shelf collapse and ice acceleration are starting to get mainstream attention. One way to do it would be to go back to Mercer's idea in the late 70's that the WAIS might be unstable, and then chronicle the focus on his hypothesis and move of the ice sheet community to thinking "no way" "WAIS is a rock," and back again to the worry that this might not be true (as higlighted now in chaps 4 and 6, and hopefully - soon - other chaps as well. Great story - very relevant and new for AR4 [Jonathan Overpeck]	Accepted. Text will be modified and pointers will be made to future chapters. Yes it would be nice, but not here.
1-407	A	13:38		During the Qing Dynasty, China had extensive records of snow fall. This needs to be referred to in "Section 1.5.3 Cryospheric Topics". [Jilan Su]	Accepted. Text added. But we could only find a post-tar reference (Zhang et al 2004), so this is not added.
1-408	A	13:42		Insert after "climate", "or expand in a cooling climate". [Vincent Gray]	Accepted. Text added.
1-409	A	13:42		Full stop after the second "climate" and a capital "H" for "however" [Vincent Gray]	Accepted.
1-410	A	13:42		Replace "increase" with "changes in". [Vincent Gray]	Accepted.
1-411	A	13:42		Change "precipitation" to "snowfall". [Kevin Trenberth]	Rejected. Precipitation includes snowfall.
1-412	A	13:43	13:43	The phrase "in at least some locations" needs to be added to the end of the sentence as this would not occur everywhere. [Michael MacCracken]	Taken into account. Text modified.
1-413	A	13:43	13:43	Consider inserting: ", and changes in the frequency of key circulation types," after "cycle". [John Sweeney]	Taken into account Statement made more general.
1-414	A	13:43		Replace "strengthened" with "altered". Delete "may counter this effect" and put a full stop after "cycle". [Vincent Gray]	Rejected. Text loses meaning (no verb). However, text is modified.
1-415	A	13:43		Change "strengthened hydrological cycle" – which depend on aerosols not being present to achieve – to "increased water vapour" which occurs robustly with warming regardless of aerosols.	Taken into account. Statement made more general.

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				[Kevin Trenberth]	
1-416	A	13:49	13:49	The mass balance study of Storglaciären was initiated in the spring 1946. The hydrological year 1945/46 is thus the first year of the record. [Per Holmlund]	Accepted
1-417	A	13:50		Point out that many more glaciers have their length routinely monitored? [Neville Nicholls]	Beyond the scope. We only show examples.
1-418	A	14:1	14:22	Why is this material here? It is not paralleled elsewhere. If the climate system components are to be introduced along with their character it should be done for all components, not just the cryosphere. [Kevin Trenberth]	Rejected. Throughout the chapter we have chosen to present examples of development within the field of climate. Here the history revolves around monitoring and feedback effects.
1-419	A	14:7	14:7	As far as I know CRYSAT did not make it to space. Apart from this minor comment, future satellites should not be part of an historical overview. [Robert Sausen]	Accepted.
1-420	A	14:7	14:7	The reference to Cryosat should be updated since the launch failed and the satellite was destroyed on October 10, 2005 [Philippe Tulkens]	Accepted.
1-421	A	14:13	14:13	Ocean releases CO2 as sea ice retreats? Really? [William Connolley]	Taken into account. Statement made more general.
1-422	A	14:15	14:	'latter' means the last of two. 'later' should be replaced by 'last' here [Ian Simmonds]	Accepted.
1-423	A	14:17		In addition, the carbonaceous material in the previously frozen ground may be subject to microbial activity and aerobic or anaerobic decomposition, releasing more CO2 and CH4. [David Karoly]	Taken into account. Statement is very general.
1-424	A	14:22		Insert "consequent" before "greenhouse gas releases"? [Neville Nicholls]	Accepted.
1-425	A	14:24		The mechanism doesn't have a longer history - just our study of it. [Neville Nicholls]	Accepted.
1-426	A	14:25		comment to the data "0.8": 0.8 is too high [Hartmut Grassl]	Accepted. Statement is made more general.
1-427	A	14:27	14:27	Change "earth" to "Earth" [Michael MacCracken]	Accepted.
1-428	A	14:31	14:35	This paragraph raises the obvious question of whether SHEBA succeeded in better defining ice-albedo feedback, but doesn't answer the question. [Dian Seidel]	Accepted. Text is removed.
1-429	A	14:37	14:38	should read: "importance and ecological vulnerability"	Accepted

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				[Stephan Lingner]	
1-430	A	14:37	14:44	This summary paragraph seems to me to be focused too much on achieving what might be called full understanding rather than sufficient understanding. The phrase "many physical processes (of which only a few are discussed above) are still not well understood, quantified, or represented in the climate models." This statement seems to me to be seriously overstated, at least in terms of processes that are controlling the large scale/global response, and this phrase will surely be taken way out of context and used to serioulsy challenge the IPCC results. It needs to be made much clearer that uncertainties can work both ways and such a vague statement about which processes are being referred to should not be allowed to stand. Given how well the models are doing in simulating the seasonal cycle and other test situations, this paragraph, and this sentence, see way out of line. [Michael MacCracken]	Taken into account. Text is modified.
1-431	A	14:37	14:44	A if not the major cryospheric issue is the future behaviour of the polar ice sheets. This has been controversial for at least 15 years, and is in need for focused international action. [Michael Manton]	Taken into account. Text is added.
1-432	A	14:50		If not in a separate section, at least a brief mention of the wonderful history of estimating mass and sea level pressure (see Trenberth 1981) is warranted here: Mascart 1892 for first mass estimate, Buchan 1869 for first global SLP map, used by Ferrell 1877 etc. [Kevin Trenberth]	Taken into account. Text is meant to be brief and incomplete (only examples).
1-433	A	14:51	14:51	Suggest changing "whereas" to "and" as these are complementary findings. [Michael MacCracken]	Accepted.
1-434	A	14:51		and" instead of "whereas [Neville Nicholls]	Accepted.
1-435	A	14:56	14:56	Please introduce for " Teisserenc de Bort and Richard Assmann) the year and also give them at the references. [CONSTANTIN MARES]	Accepted.
1-436	A	14:56	14:56	Richard Assmann": The correct spellingof the family name is "Aßmann [Robert Sausen]	Accepted.
1-437	A	14:56	14:57	Richard Aßmann discovered the stratosphere already at the end of the 19th century (1894-1897), before de Bort did (see: http://saekular.pik-potsdam.de/de/allgemein/ballonfahrt_de.htm and references provided there). You should also mention Süring and Berson, who made the first ballon flight into the stratosphere (~ 10500 m) in an open balloon in 1901. [Robert Sausen]	Accepted. But both deserve credit for their individual contributions.
1-438	A	14:57	15:2	Not sure who was recognizing a meridional overturning circulation prior to 1805 (more	Taken into account. Reference added.

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				than two centuries ago). I had thought that the earliest deep ocean temperature observations were made in the mid 19th century and the idea of high latitude sources of these waters dates from the second half of the 19th. [R Allyn Clarke]	
1-439	A	15:1	15:4	The important point about ocean variability is put too obliquely. I think the importance of the THC has been recognised since its 'discovery'. [Michael Manton]	Noted. Text is modified.
1-440	A	15:8	15:9	The sentence begins "One key technological accomplishment …" but does doesn't go on to say what that accomplishment was. [Michael Alexander Alexander]	Accepted
1-441	A	15:8	15:8	I would suggest changing "variable" to "dynamic"--the average temeprature, etc., does not change much--what is meant, I am imagining, is that the waters move. And I am not at all sure that the word "highly" is correct unless some context is used to indicate what this means; I would suggest saying "quite dynamic". [Michael MacCracken]	Accepted
1-442	A	15:8	15:9	The sentence referring to the "Aries experiment" is meaningless unless explained--I have no idea what is being referred to here. [Michael MacCracken]	Accepted
1-443	A	15:12		Please note that "as much as half of the poleward heat transport" was quite wrong; see Trenberth and Caron 2001 J Climate (max is about 17% in tropics). Trenberth, K. E., and J. M. Caron, 2001: Estimates of meridional atmosphere and ocean heat transports. J. Climate, 14, 3433–3443. [Kevin Trenberth]	Accepted. text modified.
1-444	A	15:13	15:13	The phrase "state estimation" is jargon that is hard, at best, to figure out. [Michael MacCracken]	Accepted. Text modified.
1-445	A	15:13	15:13	The term "state estimation" will be lost on many readers. [Dian Seidel]	Accepted. Text modified.
1-446	A	15:19	15:19	Citations should not include first names, even for seminal papers.This precedent should not be established here. [John Sweeney]	Accepted
1-447	A	15:20	15:21	The statement "… the approximately equal division of atmosphere-ocean heat transport …" should have the qualifier that the approximately equal division of atmosphere-ocean heat transport occurs in the tropics (30°S-30°N) [Michael Alexander Alexander]	Accepted. Text modified.
1-448	A	15:24	15:24	I would suggest changing "was" to "appeared to be" as we really do not have much proof of this--we suspect it to be the case.	Taken into account. Text modified.

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				[Michael MacCracken]	
1-449	A	15:29	15:40	Please do not mix the terms "MOC" and "THC". [Carlo Casty]	Accepted
1-450	A	15:29	15:40	Should comment that modern aogcms don't show this collapse [William Connolley]	Taken into account. Statement is made more general.
1-451	A	15:31	15:34	The fact that the Sutton and Allen results can also be explained by wind forcing and not only MOC variability should be noted. [Robert Molinari]	Taken into account. Text modified.
1-452	A	15:35		More complex, parts become more saline [Laurent LABEYRIE]	Accepted. Text modified.
1-453	A	15:36	15:36	I would suggest modifying the phrasing so this reads "raising the possibilty that ocean conditions may be approaching the point where the circulation could flip into Stommel's other stable regime." [Michael MacCracken]	Taken into account. Text modified.
1-454	A	15:45	15:47	Walker actually built on earlier (late 19th century) work that had shown the existence of this see-saw. He did not discover it, especially as late as 1928. [Neville Nicholls]	Accepted.
1-455	A	16:0	18:	Section 1.5.5 is mostly a review of earlier IPCC assessments. I would rather prefer some authentic references. For example, Lelieveld and Crutzen (Lelieveld, J. and P.J. Crutzen, Indirect chemical effects of methane on climate warming, Nature 355, 339-342, 1992) were the first to calculate the indirect climate effects of methane in the troposphere and stratosphere with a coupled chemistry-climate model. This included the feedback of methane on its own lifetime, being earlier than Prather (1994) as indicated om p. 17, l. 56. These calculations of the RF and GWP of methane by Lelieveld and Crutzen (1992) are still valid, including the AR4 (chapter 2). [Jos Lelieveld]	Wrong location. Noted, but rejected as this paper follows others such as Isaksen and Hov, 1987 in noting that significant CH4 changes will change OH and the CH4 lifetime – it misses the key recognition that the time scale of CH4 perturbations is lengthened by 40% because of this. In that sense the GWP derived here is no longer valide as it did not include the correct time scale.
1-456	A	16:1		I am pretty sure that the first real seasonal-interannual ENSO forecasts were accomplished by Mark Cane and Steve Zebiak. I do, however, see yourBarnett, et al., reference that disagrees with my single attribution to Cane and Zebiak. You win, I think. [Jerry Mahlman]	Accepted
1-457	A	16:2		Insert "often" before "rises significantly". [Neville Nicholls]	Accepted
1-458	A	16:6	16:6	Why not reference the following (1986/87) study(ies) directly rather than or in addition to the Barnett 1988 review?	Accepted

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				Cane, M. A., S. C. Dolan, and S. E. Zebiak, 1986: Experimental forecasts of the El Niño. Nature, 321, 827-832. Zebiak, S., E. and M. A. Cane, 1987: A model El Nino-Southern Oscillation. Mon. Wea. Rev., 115, 2262-2278. [Michael Alexander Alexander]	
1-459	A	16:6	16:6	Suggest rephrasing this to read "the first experimental ENSO forecasts were made" as these were experimental and not really official. [Michael MacCracken]	Accepted
1-460	A	16:12	16:12	The TAR is quoted here, perhaps the exact reference and page can be provided with [Philippe Tulkens]	Accepted
1-461	A	16:21	16:25	The 1924 paper by Defant (Defant, A. (1924) Die Schwankungen der atmosphärischen Zirkulation über dem Nordatlantischen Ozean im 25-jährigen Zeitraum 1881-1905. Geogr. Ann. 6, 13-41.) should be mentioned along with Exner and Walker when talking about NAO. [Stefan Brönnimann]	Accepted, but we chose to mention the names without the bibliographic references.
1-462	A	16:27	16:44	The text makes the point that the atmsopeheric and ocean circulations can vary and that varaitions in one location can affect other locations by teleconnections. What seems to be problematic is that the discussion focuses only on natural processes that might do this, and not on various human-induced processes that may well be contributing, including regional changes in land cover and particularly latitudinal and regional contrasts between positive greenhouse gas forcing and negative sulfate aerosol forrcing. While these suggestions are still rather speculative, there are certainly indications that such changes can have regional or larger conseqeunces (e.g., the model experiments on Amazon deforestation, land cover change in the Sahel, etc.), so the text should be levaing this possibility open. There has been intensive looking at the changes in hemispheric and global temeprature over the 20th century--and findings that the changes are not linear due to the changing balancing and counterbalancing of the GHG and sulfate forcings, yet quite a number of analysts (e.g., those saying they are seeking a greenhouse signal in the hurricane record) keep looking for a linear trend and assert that all ups and downs in NAO, etc. are purely natural when they have not even considered the possibiliity that human forcings may have had an influence on the atmospheric and/or ocean circulations (and do note that the contrast of GHG positive forcing and sulfate negative forcing is largest just where the NAO variations are centered--over the North Atlantic). So, I would urge that a phrase be added to the end of the sentence on line 34 to the effect, "model simulations), although it remains to be explored whether the contrasting and time varying forcing due to greenhouse gases and sulfate aerosols may have also had an influence, especially during	Accepted. Text could be misunderstood, and is modified.

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				the early to mid-20th century." [Michael MacCracken]	
1-463	A	16:33	16:33	define stochastic [Michael Alexander Alexander]	For glossary.
1-464	A	16:43	16:44	Its not generally agreed upon that changes in MOC impact the NAO, so this (the last) sentence in paragraph should either be dropped or modified to something like "might influence the NAO". [Michael Alexander Alexander]	Accepted
1-465	A	16:43	16:43	questionable; salinity maybe the dominant factor (Lazier, 1995) rather than temperature (Bjerknes 1964) if indeed overturn is involved References for Article 1: Lean et al. 1995: Implications Lara and Villalba 1993: italicize tree name Luterbacher et al. 2000: Maunder Hays et al.: Lower Case? Wang et al. 1976: Title? Wyrtki 1975: Pacific [Gerold Wefer]	Noted. Here we discuss the feedback from ocean to atmosphere (which is independent of salinity), not how to trigger an oceanic collapse. But: text is removed.
1-466	A	16:44		Reference? [Neville Nicholls]	Accepted.
1-467	A	16:45		No mention is made of annular modes??? (See also Chapter 3). [Kevin Trenberth]	Accepted. Text modified
1-468	A	16:46	18:51	This sub-chapter should discuss how the evolution of the radiative forcing evaluations evolved from an AR to the next one, and the consistency of these evolutions with the estimed errors bars. [Michel Petit]	Noted. It does discuss this in terms of how items appeared, but not strict evolution of quantities since many issues changed. The discussion of uncertainty has been moved to the concluding section on IPCC history.
1-469	A	16:46		Section 1.5.5: This section highlights the meaning of the IPCC again. Especially the visionary efforts to drawing many components of the earth system together can be seen as a major influence of the IPCC to earth science as well as the initiation of model-comparison projects or open invitation workshops to several issues. Another success is to define rules about dealing with uncertainty. [Falk Schützenmeister]	Noted, thanks.
1-470	A	16:48	1:51	There was some discussion of these issues in workshops before 1988, even at Stockhom in 1972, and the SMIC report [Robert KANDEL]	This has been revised to reflect that we pick up with the ability to quantify and agrre upon the numbers.

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1-471	A	16:48	16:57	This is very nicely done. [Jerry Mahlman]	Noted
1-472	A	16:48	18:51	Why is section 1.5.11 ("the greenhouse effect") not included in this section? It is very important and should be placed much earlier in the text. [Carlo Casty]	Noted, some change in ordering and sectioning should help
1-473	A	16:53	16:53	Change IPCC to WG I and delete FAR. The FAR consisted of three volumes. This statement refers only to WG I's report. Also change "was visionary" to "made an important contribution." As documented elsewhere in this chapter, the connections referred to in this sentence were understood by the scientific community at the time. WG I created no new insights or theory -- it reported on the then state of knowledge, which was its mandate. [Lenny Bernstein]	Noted and mostly accepted. This opening has been rewritten to correct these mistakes.
1-474	A	16:53	16:53	Delete any adjective about the IPCC. How can an assessment of existing science by visionary? "The FAR noted the importance..." is appropriate. [Michael Manton]	Accepted, revised differently.
1-475	A	16:53		Even though it is accurate, I don't think the IPCC should use self-congratulary terms such as "visionary". [Neville Nicholls]	Accepted, this has been fixed.
1-476	A	16:56	17:38	Change FAR to WG I. The FAR consisted of three volumes. This text refers only to WG I's report. [Lenny Bernstein]	Noted. The FAR as used here for shorthand has been defined as WGI report.
1-477	A	17:1	17:12	This is very nicely done. [Jerry Mahlman]	Noted, thanks
1-478	A	17:1	19:	This is all clearly written and appropriate. However, it does bump squarely into Chapter 2, which discusses very similar things in the early pages of their draft report, and is also very clearly written and appropriatly noted. Obviously, some early cross-chapter communication should save some precious time for the Co-ordinating Lead Authors of Working Groups I and II, depending on how things are re-ordered in the second draft. [Jerry Mahlman]	Noted.
1-479	A	17:4	17:19	The introduction of GWP was an example of a policy-driven indicator, which while useful for policy is fraught scientifically. [Michael Manton]	Noted.
1-480	A	17:5	17:5	I would suggest changing "different emissions" to "the different climatic influences of different gases." And mention also needs to be made that these estimate take account of the differnet biogeochemical cycles and radiative influences. [Michael MacCracken]	Accepted.

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1-481	A	17:8	17:8	I would suggest adding a phrase so this reads "by the concentrations of the highly reactive gases" so it is more generally understandable how this all works. [Michael MacCracken]	Noted, "emissions of highly reactive..."
1-482	A	17:12		Add at end. "It has to be admitted, however, that the atmospheric methane concentration is currently falling. [Vincent Gray]	Rejected. Not relevant here, and not true.
1-483	A	17:14	17:14	Define and explain the concept of radiative forcing [Steven Massie]	Accepted, have tied to give brief definition.
1-484	A	17:14	17:28	This section can do a more accurate job of writing the history on the concept of radiative forcing and the indirect effect of many gases on the global radiative forcing. The phrase' radiative forcing" was introduced for anthropgenic forcing in Ramanathan et al (1985), the sentence after Eq. 7, in P.1559. The fact that many gases can produce indirect effect on global radiative forcing was well established before FAR. I refer the readers to a WMO sponosred study by Ramanathan et al (1997) which has two chapters dedicated to climate-chemistry interactions and documents the magintude of the indirect radaitive forcing. Ramanathan, V., R. J. Cicerone, H. B. Singh and J. T. Kiehl, 1985: Trace Gas Trends and Their Potential Role in Climate Change. J. Geophys. Res. Atmospheres, 90: 5547-5566. Ramanathan, V., L. Callis, R. Cess, J. Hansen, I. Isaksen, W. Kuhn, A. Lacis, F. Luther, J. Mahlman, R. Reck and M. Schlesinger, 1987: Climate-Chemical Interactions and Effects of Changing Atmospheric Trace Gases. Rev. of Geophy., 25: 1441-1482. [Veerabhadran Ramanathan]	Noted, and we will try to get one ref in, BUT this is NOT the history of RF, but how it evolved in the climate assessments. Please note the opening paragraph.
1-485	A	17:14	17:28	This section can do a more accurate job of writing the history on the concept of radiative forcing and the indirect effect of many gases on the global radiative forcing. The phrase' radiative forcing" was introduced for anthropgenic forcing in Ramanathan et al (1985), the sentence after Eq. 7, in P.1559. The fact that many gases can produce indirect effect on global radiative forcing was well established before FAR. I refer the readers to a WMO sponosred study by Ramanathan et al (1997) which has two chapters dedicated to climate-chemistry interactions and documents the magintude of the indirect radaitive forcing. This paper also gives a detailed definition for Radiative forcing, which is still adopted todate. Ramanathan, V., R. J. Cicerone, H. B. Singh and J. T. Kiehl, 1985: Trace Gas Trends and Their Potential Role in Climate Change. J. Geophys. Res. Atmospheres, 90: 5547-5566. Ramanathan, V., L. Callis, R. Cess, J. Hansen, I. Isaksen, W. Kuhn, A. Lacis, F. Luther, J. Mahlman, R. Reck and M. Schlesinger, 1987: Climate-Chemical Interactions and Effects of Changing Atmospheric Trace Gases. Rev. of Geophy., 25: 1441-1482.	Noted, and we will try to get one ref in, BUT this is NOT the history of RF, but how it evolved in the climate assessments. Please note the opening paragraph.

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				[Veerabhadran Ramanathan]	
1-486	A	17:15	17:15	Insert: albedo . . . and the Earth's surface albedo. [Andrew Lacis]	Done, thanks
1-487	A	17:15	17:15	I would suggest changing "agents" to "influences" [Michael MacCracken]	Rejected, too weak, they are the 'agents' of climate change.
1-488	A	17:16	17:17	Substitute "indirect effects" for "indirect effect" [Vincent Gray]	Noted, but this is a quote.
1-489	A	17:36	17:38	"values from the FAR were backed away from" and "somewhat quantitative" are very awkward phrases -- their meaning is not obviously to this reader. [Chuck Hakkarinen]	Yes, have used 'retracted'
1-490	A	17:49	17:49	O2/N2 ratios were not really used until the TAR, not the SAR [Ian Enting]	Accepted.
1-491	A	17:55	17:55	The words "too great" need to be changed to "significant" so that the text is not making a judgment--or it must be explained that this is "too great" for what--being conclusive about the science, giving advice on risks, etc. [Michael MacCracken]	Accepted, just dropped 'too'
1-492	A	18:0		The section on greenhouse gases gives short shrift to carbon cycle research while providing considerable detail on other species. This section needs some additional detail on carbon cycle science or less on hotchemical greenhouse gases. For example, not only were 21 models invited to examine chemical issues in the the TAR, but a similar effort was made on carbon. The cucial information here is that in 1995 a first assessment was done through an international intercomparision of the relationship between emissions of CO2 and ensuing concenteations. The analsysi was done both to calcualte the evolving effect of terrestrial and ocean uptake, as they were understood in the early 1990s and again in the late 1990s for the FAR, and also to calcualte the possible anthropogenic emissions consistent with a series of scenarios of changing concentrations stabilizing CO2 at a range of levels. These analyses form the background to the ongoing discussion of "safe levels" of greenhouse gases, and the geophysics and economics of stabilizing the atmosphere. [David Schimel]	Accepted with limits – revisions made to mention CO2 comparison, but there is limited space on what to cover.
1-493	A	18:0		Continuing that thought, mention might be given to the marine efforts to constrain ocean uptake (parallel with the discussion of research on chemistry) through JGOFS and WOCE, and the effort to understand terrestrial uptake via manipulative experiments, such as Free Air CO2 Enrichment Stuies (FACE) and networks of eddy flux stations that provide direct observations of the respobnse of terretrial exchange to climate (eg Goulden et al 1995 Science , Ciais et al 2005 Science, Braswell et al 2005 Global Change	Rejected. We did not summarize programs in atmospheric chemistry or any other area here. The FACE experiments have yet to have a notable impact on the assessment. No post-TAR science can be cited in Chapter 1.

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				Biology). In addition, the 2000s saw the development of coupled carbon climate models that linked terrestrial and marine carbon process models to coupled AOGCMs. [David Schimel]	
1-494	A	18:1	18:51	I think is too much description in order to put in evidence the aerosols importance. 1/2 from this size might be reduced. [CONSTANTIN MARES]	Yes, we have tried to include the requests to enlarge this section while editing it to be shorter.
1-495	A	18:1		Replace "consensus" with "agreement" [Vincent Gray]	Rejected. the definitions are close and 'agreement' is stronger.
1-496	A	18:4	18:4	"Greenhouse" does not fit here. [Eugene Rozanov]	Accepted
1-497	A	18:4		greenhouse agents ?? This is a strange term to use for aerosols, whose main effect is on solar radiation. Do you mean that aerosols affect climate? If so, another term should be used. [David Karoly]	Accepted – changed to climate forcing agents.
1-498	A	18:9	18:10	Specify what "uncertainty ranges" denote here, 1 sigma?? [Robert Sausen]	Noted – have dropped uncertainty because it is not clear what the range means.
1-499	A	18:11	18:12	maybe "radiative forcing" should be used instead of "climate forcing" here for consistency with rest of chapter and report [Piers Forster]	Done.
1-500	A	18:15	18:19	This section should include the major advancement in our understanding of the anthropgenic aerosol effects due to the field campaigns : INDOEX conducted in 1999 and Ace-Asia in 2001. These two campaigns demonstrated clearly the large reduction in surface solar radiation (negative surface forcing) and a comparably large increase in atmospheric solar heating due to black carbon and organics and thus opened the possibility that aerosol direct forcing, can have a hitherto unsuspected effect on the hydrological cycle in addition to a cooling effect on surface temperatures. Conant et al, JGR 2003 for Ace-Asia. Ramanathan, V., et al., 2001: The Indian Ocean Experiment: An Integrated Assessment of the Climate Forcing and Effects of the Great Indo-Asian Haze. J. Geophys. Res. Atmospheres,106, (D 22), 28,371-28,399. [Veerabhadran Ramanathan]	Noted, but not done. This could have been done, but it belongs in the current chapter since the campaigns noted here did not have impact on RF of the TAR.
1-501	A	18:15	18:19	This section should include the major advancement in our understanding of the anthropgenic aerosol effects due to the field campaigns : INDOEX conducted in 1999 and Ace-Asia in 2001. These two campaigns demonstrated clearly the large reduction in surface solar radiation (negative surface forcing) and a comparably large increase in	Noted, but not done. This could have been done, but it belongs in the current chapter since the campaigns noted here did not have impact on RF of the TAR.

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				atmospheric solar heating due to black carbon and organics and thus opened the possibility that aerosol direct forcing, can have a hitherto unsuspected effect on the hydrological cycle in addition to a cooling effect on surface temperatures. Conant et al, JGR 2003 for Ace-Asia. Ramanathan, V., et al., 2001: The Indian Ocean Experiment: An Integrated Assessment of the Climate Forcing and Effects of the Great Indo-Asian Haze. J. Geophys. Res. Atmospheres,106, (D 22), 28,371-28,399. [Veerabhadran Ramanathan]	
1-502	A	18:18	18:35	Details on aviation report seem a little unnecessary, especially since AR4 does not sectorize(word?) the aviation RF [Piers Forster]	Maybe AR4 should! Will shorten this section and use in final section on history of uncertainty in the IPCC.
1-503	A	18:18	18:18	The name of the country is USA or U.S.A. in an international publication. Avoid a termonology which is internal to the USA. [Robert Sausen]	Done.
1-504	A	18:18	18:35	Why is this here at all? Suggest deleting it: the aviation report is already mentioned lines 14-23 p 1-7 and it is not needed again here, and makes this out of balance. [Kevin Trenberth]	Rejected, but it will be shortened, It is part of the evolution of RF treatment by IPCC
1-505	A	18:22		Replace "a consensus" with " an agreement" [Vincent Gray]	Rejected, the words are near-synonyms, and agreement is stronger.
1-506	A	18:24	18:24	"CH4": it must be CH4 with 4 written as subscript [NADIA GAMBOA]	Yes.
1-507	A	18:24		correct format of "Ch4" [Hartmut Grassl]	Yes.
1-508	A	18:28	18:28	The first phrase of this sentence makes clear why this chapter needs to address the ways in which IPCC has worked on this issue--in particular via developing a lexicon to communicate relative levels of confidence. In addition, it would really help if it were made clearer that due to the nature of the Earth system (we have only one, and only one pass through time),it is inhernetly impossible to apply a number of traditional ways of estimating uncertainty, so a wider range of approaches and considerable judgment must be used instead. Without having a better explaination of the challenge of developing estimates and communicating relative levels of understanding, this sentence is really not helpful in explaining the situation. [Michael MacCracken]	Yes, this is being dropped from here, but moved to final section on IPCC history and use of uncertainty.
1-509	A	18:32	18:35	There is nothing wrong with what is said in these two sentences. However, by combining them in close proximity without appropriate explanation, they further the misinterpretation of the relative impacts of aviation emissions. It is true that RF is a first-	Noted, but rejected. Please NOTE however that this section has been shortened here to focus on the ability to

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				order measure of global mean surface temperature response. It is also true that the special report on aviation provided RF values for the individual components for aviation. However, one cannot take the relative heights from the RF chart and determine the relative contributions to surface temperature change (which is one implication that could be drawn from the two sentences). The RF values shown were apples and oranges -- not comparable. The CO2 reflected the RF of the cumulative CO2 emissions up to that point in time. The contrails were the RF for a typical day (not accumulated). And the different future lifetimes of the impacts were not represented. What would be more valuable are the marginal contributions of the various emissions (integrated into the future) for one new flight. The RF chart for aviation has led to a good deal of misinterpretation (e.g. people saying the climate impact of aircraft per unit CO2 should be mulitiplied by a factor of 2-6 because of the short-lived effects). I understand that it is not your intention in this chapter to go into this level of depth, but to save further misinterpretation, I recommend just dropping these two sentences. [Ian Waitz]	quantify the range of RFs and discussion of additivity and uncertainty moved to the final section on history of IPCC.
1-510	A	18:34	18:34	Suggest inserting "at the time" after estimate to acknowledge the advancements made since the 1999 Aviation report. [Lourdes Maurice]	Accepted, although it is redundant since the chapter is on 'history'.
1-511	A	18:39	18:39	"…but took a sobering step backwards in others". I wonder if the adjective here is appropriate. Apparently, the scientific community did not agree on total radiative forcing estimates. Does that mean that is a step "backwards"? The particular context of the workshop referred to should indicate whether the lack of consensus was sobering or not [Philippe Tulkens]	Accepted. (Some LAs thought the wording was accurate, but it is not necessary here).
1-512	A	18:53	19:48	This sub-chapter should discuss how the evolution of the solar forcing evaluations evolved from an AR to the next one, and the consistency of these evolutions with the estimed errors bars [Michel Petit]	Taken into account.
1-513	A	18:55	19:48	The sun is one "natural" forcing of the climate system. There is no introduction to the effect of volcanic eruptions in the whole text. Volcanoes have to be included somewhere in the manuscript. Otherwise, lines 35-36 (page 19) confuse the reader. [Carlo Casty]	Taken into account. The sequence of the paragraphs and the wording has been changed to increase clarity and brevity.
1-514	A	19:4	19:4	I would encourage adding a phrase at the end of the semtence to say "Eddy, 1976), due to the colder than mormal conditions occurring especially in Europe and the North Atlantic basin." Also, it is important that the views here be made compativle with those in section 1.5.2. [Michael MacCracken]	Rejected. This is very much in debate and post-TAR material
1-515	A	19:13	19:13	I applaud IPCC for captializing "Earth" to indicate the planet, and would urge it also to	Accepted.

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				capitalize "Sun" when referring to our star. It seems strange to capitalize one and not the other. [Michael MacCracken]	
1-516	A	19:18	20:35	This paragraph describes striking how the community of modelers could gain scientific credibility within a very modern form of science. It is not only backed by a special epistemology but mainly in the combination of openness to a community, it's shared values, and in efforts to reach consensual standardization to make models comparable. The organizational precautions to secure scientific standards are mentioned. [Falk Schützenmeister]	Noted. Thanks.
1-517	A	19:21	19:21	It seems awfully surprising that Langley could have been off by so much--was he perhaps referring to the average value for the daylit sky or something--it is just hard to believe he was off by a factor of over 2, and the explanation here seems quite inadequate. [Michael MacCracken]	Noted. There is not enough space in this chapter to discuss the problems with Langley's first measurements in detail
1-518	A	19:23	19:26	It would be helpful here to mention that estimating TSI from a surface measurement require use of an inversion process that accounts for atmospheric effects, and it is through possible errors in this process that one can get a value that is higher than the actual solar output. [Michael MacCracken]	Noted. There is not enough space in this chapter to discuss the problems with Langley's first measurements in detail
1-519	A	19:28	19:48	I would add something about Solar irradiance variability in short wave spectral region. [Eugene Rozanov]	Noted. It is a detail, whose discussion would not increase clarity nor brevity
1-520	A	19:28	:48	Solar activity correlations with documented climate change are numerous in the recent literature (references to follow). It is critical that this report acknowledge the growing volume of solar-climate change correlation and data. There is clearly more research needed here, as the correlations are much better than previous solar intensity changes data would have predicted. [Lee C. Gerhard]	Noted. There is already a list of papers mentioned in this section dealing with this issue. There are nowadays more papers available, but they are post-TAR, and thus cannot be cited in Chapter 1
1-521	A	19:28		Hoyt, D. V., and K.H. Schatten, 1997, The Role of the Sun in Climate Change: Oxford University Press, New York, 279 p. Hu, F. S., D. Kaufman, S. Yoneji, D. Nelson, A. Shemesh, Y. Huang, J. Tian, G. Bond, B. Clegg, and T. Brown, 2003, Cyclic Variation and Solar Forcing of Holocene Climate in the Alaskan Subarctic: Science, v. 301, p. 1890-1893. Labitzke, K, van Loon, H, 1988, Associations between the 11-year solar cycle, the QBO, and the atmosphere: I. The troposphere and stratosphere in the northern hemisphere in winter: Journal of Atmospheric and Terrestrial Physics, v. 50, p. 197-206. Reid, G. C., 1991, Solar total irradiance variation and the global sea surface temperature record: Jounral of Geophysical Research v. 96, p. 2835-2844. Sharma, Mukul, 2002, Variations in solar magnetic activity during the last 200,000 years:	Noted. See above

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				is there a Sun-climate connection?: Earth and Planetary Science Letters, v. 199, p. 459-472. Tsiropoula, G., 2003. Signatures of solar activity variability in meteorological parameters. Journal of Atmospheric and Solar-Terrestrial Physics 65, 469– 482, 2003, online <http://zeus.nascom.nasa.gov/~bfleck/jastp_publ.pdf> Zahn, Rainer, 2002, Milankovitch and Climate: The Orbital Code of Climate Change: JOIDES Journal, v. 28, n. 1, p. 17-22. [Lee C. Gerhard]	
1-522	A	19:32		Should you mention that there are larger fractional changes in the UV wavelengths between solar max and solar min, that lead to variations in ozone amounts in the stratosphere associated with the solar sunspot cycle. These ozone variations due to the solar cycle are not generally included in coupled ocean atmosphere climate models and may enhance the climate response to solar variations. [David Karoly]	Noted. It is a detail, whose discussion would not increase clarity nor brevity. It is also post-TAR
1-523	A	19:43	19:43	What is meant needs to be more clearly stated. Does this phrasing mean that 100-year averages could shift by 0.24%-0.30% from one century to the next (e.g., randomly), or that variations of this magnitude could occur during a century or what, or that there have been cyclic variations this big, that persistent changes are occurring, or what? [Michael MacCracken]	Noted. The wording has been changed to increase clarity.
1-524	A	19:45	19:48	The phrasing here is not clear--how long could/did there changes in surface temeprature last; how long did it take for them to occur, etc.? Were they changes on fluctuations that followed the solar fluctuations, etc.? Was it the fluctuations due to solar changes that were smaller than the 20th century warming, or has there been a shift in solar radiation that could be said to cause some of the shift (rather than the fluctuation) during the 20th century? This all is just not clear enough. And it would be useful here to perhaps indicate what the derived climate sensitivty would be for such a solar change (and time interval)--and that if this is all indeed solar, then the climate sensitivity would seem likely to be larger than the present models are indicating. [Michael MacCracken]	Noted. To answer and discuss all these questions, would exceed all page limits. A lot of it is post-TAR material. The wording has been changed to increase clarity.
1-525	A	19:46	19:48	This seems to be implying that perhaps half the warming of the 20th century can be attributed to changes in solar irradiance. I don't think this matches estimates in Chapter 3. [Neville Nicholls]	Taken into account. The wording has been changed
1-526	A	19:46	19:46	Saying surface temperature do you mean global mean or local. [Eugene Rozanov]	Noted. Both, global and local.
1-527	A	19:47	19:48	Delete "but such changes…" This is the only place in the chapter where the individual forcing function is measured against the full temperature change. [Howard Feldman]	Accepted.

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1-528	A	19:48		Insert between "observed" and "over" "from surface readings" [Vincent Gray]	Taken into account. This particular subordinate close has been deleted (see previous comment).
1-529	A	19:52	19:55	Their is some misunderstanding here. In the 1979 NAS "Charney Report, the 1.5-4.5C global surface warming value estimated was described as a one standard deviation range based on just the GFDL and GISS models for a doubling of CO2. Today, that range now encompasses a two standard deviation range of confidence. I would call that substantially more improved confidence than the casual reader has been perceiving in the popular literature, or in newspapers. [Jerry Mahlman]	Accepted. The wording has been altered to clarify the statement.
1-530	A	19:52	19:52	Replace "U.S. National Academy of Sciences" by "National Academy of Sciences of the USA", "US" is an internal terminology. [Robert Sausen]	Accepted.
1-531	A	19:53	19:53	The phrasing here is really irresponsible and unacceptable, accepting a usage that The Skeptics prefer to make things appear much less well understood than they are. To see this, imagine that the range of estimates had been from 0 to 0.00001 C--then the ratio approach used here would indicate a factor of infinity uncertainty--which is clearly absurd. The proper phrasing would seem to be 3 C plus or minus 50% or plus or minus 1.5--but most definitely NOT 'a factor of three". Also, at the start of the line, it should read "results from two early general circulation models," and for the rest of the sentence should say gave a ragne of 1.5 to 4.5 or an estimate of 3 plus or minus 1.5 or 50%. [Michael MacCracken]	Taken into accout. The wording of this paragraph has been altered to accomodate the concerns of the reviewer.
1-532	A	19:54	19:54	"(…) due to doubled atmospheric carbon dioxide (…)" Does this mean from 280 ppm to 560 ppm ? It could be specified. [Philippe Tulkens]	Rejected. Adding this further details does not improve clarity or brevity.
1-533	A	20:1	20:3	Not clear that any of the Lorentz/chaos stuff has any relevance to climate prediction [William Connolley]	Rejected. The Lorenz/chaos "stuff" has a lot to do with climate prediction (see also next comment).
1-534	A	20:1	20:16	In order to introduce and explain the uncertainty in climate predictions I think would be useful, if not necessary, to explain the difference between, predictions of the first and second kind (:Lorenz 1975, [Lorenz, E.N., 1975 : Climate predictability : The physical basis of climate modeling. WMO, GARP Publ.Series, 16, 132-136]). The first kind is defined as the prediction of the statistical properties of the climate system with a given initial state as if we were dealing with a long-range forecast problem. Predictions of the first kind are initial value problems and, because of the non-linearity and instability of the underline equations, are not predictable indefinitely into the future. On the other hand predictions of the second kind deal with the determination of the response of the climate	Taken into account. This section has been moved and has been reworded.

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				system to changes in the external forcings. These predictions are not concerned directly with the chronological evolution of the climate state, but rather with the long term average of the statistical properties of climate. Predictions of the second kind do not depend on initial conditions; they want to determine how the statistical properties of the climate system (e.g. the annual average global mean temperature, or the expected number of winter storms, or hurricanes, or the average monsoon rainfall…) change as some parameter, CO2 content for example, is altered. Estimates of future climate scenarios as a function of the concentration of atmospheric greenhouse gases (see e.g. Chapter X in IPCC 2001) are typical examples of predictions of the second kind. As far as seasonal predictability is concerned, numerical experiments using prescribed SST to estimate the average impact of (say) El Niño events can again be regarded as predictions of the second kind, while actual seasonal forecasts with coupled ocean-atmosphere models are actually initial-value problems in a complex, multi-scale environment. Therefore uncertainty in climate predictions (of the second kind) arises mainly from model uncertainties/errors. [SUSANNA CORTI]	
1-535	A	20:1	20:4	It is improper to be comparing climate predictions (relating to human-induced changes) to weather forecasts in the way done here--the causes of their differences are quite different and the reasons for their intrinsic uncertainty are quite different (and I should add that the intrinsic uncertainty of climate predictions caused by internal variability appears to be generally bounded, etc.). And saying "it is well known" when general understanding about this point is so limited and often misstated seems particularly inappropriate. Indeed, the Lorenz notion of chaos was really applied to the weatehr and not generally to the climatic state (that is, the long-term average of the weatehr)--and this is improtant because the climate system is much more greatly influenced by changes in the boundary conditions. So, I would recommend a general rewriting of these opening sentences. An explanation should also be given that a perfect prediction and verification is not possible and why this is the case, why ensembles are needed, etc.--and how observations and climate model simulations can differ but stil be consistent as observations are only one manifestation of reality. [Michael MacCracken]	Taken into account. This section has been moved and has been reworded.
1-536	A	20:1	20:2	I recommend changing "because it is well known that climate predictions" to "because climate predictions" since "well known" is only repeating the idea that variability is "no surprise". [Brian Magi]	Accepted.
1-537	A	20:1	20:2	The uncertainty in weather and climate predictions is different in degree. A deterministic weather forecast is scientifically justifiable. [Michael Manton]	Taken into account. This section has been moved and has been reworded

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1-538	A	20:1	20:16	One of the most important factors of uincertainty is not mentioned here, that is the unknown future development of anthropogenic greenhouse gas emissions. They are unpredictable. Therefore emission scenarios are used. The uncertainty discussed in the paragraph applies only to the situation within one selected scenario. [Robert Sausen]	Noted. This point is dealt with in the section an atmospheric chemistry-greenhouse gases
1-539	A	20:1	20:5	Somewhere in this section note difference between weather (chaos) and climate. Climate is much more damped than weather. [Ronald Stouffer]	Taken into account. This section has been moved and has been reworded.
1-540	A	20:8	20:8	Delete 'realistically" unless add an explanation of what is meant--there are limits about what can be expected. [Michael MacCracken]	Taken into account. This section has been moved and has been reworded.
1-541	A	20:10		such as those which generate many cloud sysems.(Satellite pictures reveal many features that organize clouds on very large scales,e.g., synoptic disturbances, jet streams, ITCZ, and widespread areas of marine stratus clouds. ln 24.... climate response to carbon dioxide INCREASES. lns25-57. Very nicely written. [Jerry Mahlman]	Taken into account. This section has been moved and has been reworded.
1-542	A	20:11		not yet include in totally - Will this ever be the case? [Ronald Stouffer]	Taken into account. This section has been moved and has been reworded.
1-543	A	20:12	20:12	The first use of "errors" should be changed to "limitations" and the second usage to "limits"--parameterizations are approximations and these have limits, of course. They may well be in error, but making an approximation is not necessarily an error. [Michael MacCracken]	Taken into account. This section has been moved and has been reworded.
1-544	A	20:18		Insert between "To" and "assess" the words "attempt to" [Vincent Gray]	Rejected. The intention is to assess, not to attempt.
1-545	A	20:19	20:20	The word "favored" is not really appropriate. I would suggest saying something like "worked to achieve an increase in the number and range of simulations being carried out in order to more fully explore the factors affecting the accuracy of the simulations." [Michael MacCracken]	Accepted.
1-546	A	20:23	20:24	The wording should be changed to read "differences among model simulations in their representation of cloud feedback, and how consequent effects on atmospheric radiation resulted in different model response to dobuling of the CO2 concentration." [Michael MacCracken]	Accepted.
1-547	A	20:24		term "disagreement" (?) [Hartmut Grassl]	Taken into accout. The wording has been changed following comment 546.
1-548	A	20:26	20:26	Change "reaction" to "reactions" [Michael MacCracken]	Accepted.

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1-549	A	20:28	20:28	Change "propose" to "undertake" [Michael MacCracken]	Accepted.
1-550	A	20:28	20:42	The order of these two paragraphs is wrong: AMIP comes before CMIP. [Kevin Trenberth]	Rejected. The first paragraph describes the idea of MIP's in general and mentiones AMIP and CMIP in the chronologically right order, the second one elaborates on AMIP as an example.
1-551	A	20:29	20:29	Many readers to not know what a GCM is. [Robert Sausen]	Noted. The term GCM is described in the Glossary. The term GCM is spelled out now, as it is used for the frst time.
1-552	A	20:29	20:29	"GCM" was mentioned for the first time, and should be spelled out. [Jin-Yi Yu]	Noted. The term GCM is described in the Glossary. The term GCM is spelled out now, as it is used for the frst time.
1-553	A	20:34	20:34	Explain what the "Taylor diagram" is [Steven Massie]	Rejected. The Taylor diagram is described in the Glossary
1-554	A	20:40	20:42	The last sentence begins "These results". Do "these results" refer to output from the AMIP runs? If so its not clear how AMIP studies are able to separate the various errors remaining in ocean models or that the atmospheric errors are primarily due to cloud-radiation processes for that matter. [Michael Alexander Alexander]	Taken into account. The wording has been changed to increase clarity.
1-555	A	20:41	20:41	"coupled GCM". You implicitly think of a atmosphere-ocean GCM, other scientists might think of an Atmosphere GCM coupled to a chemistry module. Better use "AOGCM". [Robert Sausen]	Accepted.
1-556	A	20:44	20:49	Please do not use the term "Monte Carlo". Use "ensemble" instead. Monte Carlo is a statistical term for permutation test statistics. Why cite Palmer (2000) when the first studies using ensembles where already performed in 1994 and 1995 by Cubasch et al. and Barnett? [Carlo Casty]	Accepted.
1-557	A	20:44	20:49	This paragraph does not really say very much--not giving much indicationof what the result was of undertaking these activities. [Michael MacCracken]	Taken into account. A sentence has been added to cover this point.
1-558	A	20:44	20:49	In addition to ensemble simulations with a single model, the "multi model" esembles (Palmer et al. 2004, BAMS) designed to overcome model uncertainities is another new development in climate model prediction. The multi-model ensemble method is discussed in Chapter 8. [Jin-Yi Yu]	Noted. This paper ist post-TAR and will be discussed in the appropriate chapter.

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1-559	A	21:1	21:6	The text here should really be expanded to indicate what was accomplished and included in the TAR--and how these studies overall led to an increase in the confidence that can be placed in the model results. As the whole section presently reads, it seems as if a certtain number of words were allowed, and a lot was done on the lead up to all of the intercomparison studies, and then there was not any space to cover what is really important--namely what was accopmlished by all of these efforts. [Michael MacCracken]	Taken into account. The wording has been changed to deal with the concern of the reviewer. It has to be stressed that the majority of ensemble simulations were done after the TAR.
1-560	A	21:4	21:34	comprehensive climate model studies are STILL exceptionally demanding on computer.... lns24-34. This is a nice discussion on the daunting problem of quantifying cloud-radiation feedback, not so specifically discussed in the Radiative Forcing Chapter 2. [Jerry Mahlman]	Noted. Thanks.
1-561	A	21:8		Section 1.5.8: This is no historical overview. [Robert Sausen]	Taken into account. Text has been edited. This section has been extensively rewritten.
1-562	A	21:10	21:34	Please insert the most important references on this topic. There are no references at all. [Carlo Casty]	Taken into account. Text has been edited. This section has been extensively rewritten.
1-563	A	21:20	21:20	The sentence "Comparisons of models to observational data clearly show that, on the average, the representation of clouds in climate models is much more realistic now than only a few years ago." is too vague. What does "on the average" and "more realistic now" exactly mean? Can this statement be quantified? And is the representation of clouds good enough, or is more research required? This is vaguely touched upon later. The report should provide policy makers with a clear recommendation on whether the representation of clouds is good enough for decision making or the uncertainties are high enough that the data does not provide any quantitative information suitable for action. [Lourdes Maurice]	Taken into account. Text has been edited. This section has been extensively rewritten.
1-564	A	21:21	21:21	Change “Indian Ocean” to “Indian Monsoon” or “Indian Precipitation”. [Michael Alexander Alexander]	Noted. Commment appears misplaced.
1-565	A	21:21	21:21	It is not clear what "on the average" means--is this an average across models or what? [Michael MacCracken]	Accepted. Text has been edited.
1-566	A	21:22		but clouds in models are still not very good at all, e.g. Dai, A., and K. E. Trenberth, 2004: The diurnal cycle and its depiction in the Community Climate System Model. J. Climate, 17, 930-951. [Kevin Trenberth]	Noted. Post-TAR reference cannot be includedin Chapter 1.
1-567	A	21:24	21:25	I would suggest rewording this to say "… however, uncertianties in how cloud amount and vertical distribution will change as the climate changes still constitute the main model-related cause of the range in estimates of future climate change." Again,	Noted. Text has been edited.

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				"uncertainties" is a problematic word unless more fully explained--it would be better to indicate that htis is the main cause of the resulting range (other than the different emission scenarios). [Michael MacCracken]	
1-568	A	21:25	21:25	Explain what is meant by the phrase "amplitude of climate projection" [Steven Massie]	Accepted. Text has been edited.
1-569	A	21:29	21:30	In accord with the theme of the chapter about science discovery and replication of results, you might wish to note at this point that the first satellite measurements of the Earth's Radiation Budget from the 1960's were published by Vonder Haar and Suomi in Science, 1699; JAS, 1971. They found a lower planetary albedo than had been estimated and therefore a warmer and darker plant with greater energy transport required by the Earth-Atmosphere System between Tropical and Polar Regions. In the 1980's, the Earth Radiation Budget Experiment (ERBE), consisting of 3 satellites, also measured the same basic Earth Radiation Budget values for the planet. Thus, the early results were confirmed by new sensors with even greater spatial and temporal coverage. [Thomas Vonder Haar]	Accepted. Text has been edited.
1-570	A	21:30	21:30	"1%" of what? Is the albedo changed by 0.01 or by 0.003? [Robert Sausen]	Accepted. Text has been edited.
1-571	A	21:30		Replace "blackbody" with "black-body" [Vincent Gray]	Accepted. Text has been edited.
1-572	A	21:31	21:33	This sentence is comparing apples and oranges as the CO2 induced fording of 4 watts per square meter is applied at the tropopause--and feedbacks (such as water vapor) give a much larger value for the change in flux at the surface due to a CO2 doubling. In fact, the whole comparison is a bit confusing here--an increase of 1% in the albedo would change the troopause flux by about 3.4 watts per square meter, and then with feedbacks would lead to a larger change in flux at the surface as feedbacks amplify the warming. The more I look at the comparisons here, the more confused I am, in that for solar one has to also account for atmospheric absorption, etc. And I have alwasy thought that clouds account for more than two-thirds of the planetary albedo--despite the numbers in the figure with Question1-1 which I think must be off as the surface albedo in that figure comes out about 15%, which seems too high given all the ocean areas. [Michael MacCracken]	Noted. Text has been edited.
1-573	A	21:35	21:35	Perhaps the first quantitatve analysis of cloud feedbacks and climate sensitivity is the study by Hansen et al. (1984). Manabe and Wetherald (1975) had obtained a 2C global warming for doubled CO2, while the new GISS results obtained 4C. Both models had comparable physics and radiation treatments, so it was puzzling that the results were so	Accepted. Text has been edited.

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				different. The key differences were the use of fixed clouds in the GFDL model versus computed clouds in the GISS model, and little sea ice in the GFDL model versus a more complete sea ice field in the GISS model. The feedback magnification in the GISS GCM due to a decrease in low clouds, an increase in cirrus, and the melting of sea ice, was sufficient to account for the factor of 2 difference in climate sensitivity between the two GCMs. Hansen et al. also showed that the relative strengths of water vapor, cloud, and snow-ice albedo feedbacks could be quantified by means of 1D model calculations, and that the different feedbacks do not combine linearly and must instead be combined in a multiplicative fashion. [Andrew Lacis]	
1-574	A	21:43	21:54	Again, the references cited here are rather old. I do not know if there are recent insights on this problem. [Carlo Casty]	Noted. This is a chapter on history, not an attempt to bring everything up to date, which is done in later chapters.
1-575	A	21:44	21:44	Again, it is improper to talk about there being "a factor of three in the range of the model sensitivity"--one does not divide the maximum by the minimum. The range is 50%--and efforts to make it sound as large as a factor of three are really inappropriate. [Michael MacCracken]	Taken into account. Text has been edited.
1-576	A	21:46	21:54	It would be appropriate to mention here that observations impose some constraints on what the climate sensitivity can be--even though we surely can come up with parameterizations of various types that give any number we want. That is, it would be virtually impossible to explain the paleoclimate of the Earth with a climate sensitivity of less than about 1.5 C, and were it more than about 4.5 C, Earth history would be much more variable than it is. So, there needs to be mention of the observational constriants. If one wants to really get into trouble on all of this, of course, what to point out would be that, using the IPCC paradigm of relating change in flux at the tropopause to surface temeprature change, orbital element varioations cause virtually no change of flux totaled over the Earth over a year, yet eventually result in an ice age, so the sensitivity must be enormous or the IPCC approach must be flwaed--but that is a subject for separate discussion (perhaps in chapter 6). [Michael MacCracken]	Noted. This is a chapter on history, not an attempt to bring everything up to date, which is done in later chapters. Nevertheless, text has been edited taking these comments into account.
1-577	A	21:53	21:54	Why compare models with models and not with observations? [Kevin Trenberth]	Taken into account. Text has been edited.
1-578	A	22:1	22:40	Highlight role of tropical low clouds in climate sensitivity? [Ronald Stouffer]	Taken into account. Text has been edited.
1-579	A	22:2		ISCCP is not consistent: it has major errors and inhomogeneities (see chapter 3). You should also mention Steve Warren's ground based climatology for clouds here. [Kevin Trenberth]	Taken into account. Text has been edited.

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1-580	A	22:8	22:26	Please indicate when these satellites where launched and when these programmes took place. It would be very nice to sort them chronologically. [Carlo Casty]	Noted. We are space-constrained here, and many missions are involved.
1-581	A	22:8	22:40	. ... ,these data alone have not yet provided ... lns 8-40. I suspect that this paragraph is too optimistic. We need to have far better observations of clouds and their radiative properties above, within, and below the clouds in many different regimes in be able to "tease out" the roles of clouds in the still-elusive cloud-radiative feedback quantification. I fear that the problem is considerably more formidable than many observational and modeling scientists are willing to admit. I suspect that we may end out "backdooring" our way to better understanding of just what controls the quantification of the still-elusive cloud-radiaton feedback physics that will pin down the actual climate sensitivity. [Jerry Mahlman]	Taken into account. Text has been edited. We are summarizing history here, rather than speculating about future developments or needs for research progress. Some of these considerations may be more appropriate for subsequent chapters in AR4.
1-582	A	22:12		Say what is meant by "resolution," i.e. spectral resolution. [Richard Anthes]	Accepted.
1-583	A	22:21	22:26	Is there no ESA programme? [Robert Sausen]	Taken into account. Text has been edited.
1-584	A	22:22	22:22	Replace "U.S." by "U.S.A" [Robert Sausen]	Accepted.
1-585	A	22:25	22:26	... Convective systems (E.G., TOGA-CORE; Webster and Lukas, 1992), or stratocumulus (E.G., ASTEX) [Sabine Wurzler]	Accepted.
1-586	A	22:28	22:35	I suggest adding a reference to the CAPT technique, which runs climate models in numerical weather prediction mode to allow exact comparisons with observations. The best reference I know of is: Phillips, T.J., G.L. Potter, D.L. Williamson, R.T. Cederwall, J.S. Boyle, M. Fiorino, J.J. Hnilo, J.G. Olson, S. Xie, and J.J. Yio, "Evaluating Parameterizations in General Circulation Models: Climate Simulation Meets Weather Prediction", Bulletin of the American Meteorological Society (BAMS), pp1903-1915, December 2004. [Philip Cameron-Smith]	Rejected. These are post-TAR references, and Chapter 1 is a history that stops at TAR.
1-587	A	22:28	22:29	I did not understand the first sentence. It is rather long and complicated. [Carlo Casty]	Noted. Text has been edited.
1-588	A	22:28	22:40	These two paragraphs are out of place and should be deleted. [Kevin Trenberth]	Noted. Text has been edited.
1-589	A	22:35	22:35	Add: Furthermore the combined efforts of laboratory experiments and rather detailed cloud modelling have advanced the representation of aerosol cloud interactions and thus their effects on climate (e.g., Diehl and Wurzler, 2004, Lohmann and Diehl, 2005).	Rejected. These are post-TAR references, and Chapter 1 is a history that stops at TAR.

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				References: Diehl, K., and S. Wurzler, 2004: A freezing module for heterogeneous drop freezing in immersion mode. J. Atmos. Sci., 61, No 15, 2063-2073; Lohmann, U., and K. Diehl, 2005: Sensitivity studies of the importance of dust ice nuclei for the indirect aerosol effect on stratiform mixed phase clouds. J. Atmos. Sci. in press [Sabine Wurzler]	
1-590	A	22:37	22:40	Chapters 8/ 9 and Colman's work etc I think says that uncertainty in water vapour feedback is just as important (smaller uncertainty but in a large +ve feedback), so maybe the emphasis on clouds should be toned down? [Piers Forster]	Noted. This is an important cross-chapter issue that we will look into further, keeping in mind that Chapter 1 is a history that stops at the TAR.
1-591	A	22:37	22:40	This would be another place where paleoclimatic approaches to constraining the range of climate sensitivity could be mentioned. In this way, one could make clearer that, while we do not have the cloud effect pinned down, it must be constrained somewhat. [Michael MacCracken]	Taken into account. Text has been edited.
1-592	A	22:37	22:40	Can the authors offer an estimate on when application of the scientific tools to tackle cloud feedback processes might actually lead to decreasing uncertainties associated with cloud feedback when predicting climate change? [Lourdes Maurice]	Noted. We are summarizing history here, rather than speculating about future developments or needs for research progress. Some of these considerations may be more appropriate for subsequent chapters in AR4.
1-593	A	22:38	22:39	Awkward sentence; change from "If this uncertainty has not yet been reduced, nevertheless it is certainly true that recent years" to "Although this uncertainty has not yet been reduced, recent years" [Brian Magi]	Accepted.
1-594	A	22:45	22:47	Here coupled ocean-atmosphere models are claimed to eb the greatest advance in modelling; on the previous page it was cloud feedbacks. [Neville Nicholls]	Accepted. Text has been edited.
1-595	A	22:45		In most other sections a reference is given to a survey where more information can be found. I urge one be given here such as. Trenberth, K. E., Editor, 1992: Climate System Modeling. Cambridge University Press, 788pp. [Kevin Trenberth]	Accepted.
1-596	A	22:47	22:48	The slab models predicted lots of warming in the southern oceans; aogcms don't [William Connolley]	Taken into account. The wording has been changed..
1-597	A	22:47	22:47	Suggest deleting "it is fair to recognize that" as unnecessary. [Michael MacCracken]	Taken into account. The wording has been changed.
1-598	A	22:48	22:48	replace 'mean' by 'equilibrium' Overall, this paragraph doesn't capture the essence that	Taken into account. The wording has

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				equilibrium climate is what slab models can be (and were) expected to do. [Ian Enting]	been changed.
1-599	A	22:49	22:49	The use of the words "a first step" really do understate how much we know and how far we have come--they imply we are far from having a useful result for policymakers, which is not the case. It may well be that to really pindown all the scientific details, if this can ever be done to a gnat's eyelash, we are at the first stage, but this assessment is for a much different audience. [Michael MacCracken]	Taken into account. The wording has been changed.
1-600	A	23:1	23:2	It seems to me that there needs to be a sentence added to this paragraph saying something about the overall progress in ocean modeling, and that each of these issues has been dealt with; in particular with regard to the third point, the issue here is not to create such a feedback, but to get the processes well enough represented that significant imbalances do not arise, as such salinity imbalances would be an indication of shortcoming of process representations. In a larger sense, however, there certainly are feedbacks that limit salinity accumulations--namely the water becomes denser and initiates convection or spreading or bottom water formation, etc.--so, why is it seemingly implied that there is nothing that can counterbalance salinity buildups? [Michael MacCracken]	Rejected. This is highly debatable. It might well be argued that the more significant progress in ocean modelling came after the TAR when the computing resources became sufficient to calculated all the effects mentioned in the review.
1-601	A	23:1		Add "direct" between "there is no" and "stabilizing feedback". Density will damp the salinity anomaly if big enough. [Ronald Stouffer]	Accepted.
1-602	A	23:4	23:6	I did not understand this sentence. What is the connection between the details of cloud feedbacks and mean simulated climate? [Carlo Casty]	Taken into account. The wording has been changed.
1-603	A	23:12	23:18	Flux-corrections are not 'arbitrary'. what is going on is the (not arbitrary) assumption that a perturbation of the time history can be calculated plausibly even of the model has a drift. [Ian Enting]	Accepted.
1-604	A	23:12	23:13	In this sentence, for clarity, I would suggest deleting "has" and adding at the end "into early simulations" [Michael MacCracken]	Accepted.
1-605	A	23:12	23:38	This problem, and its claimed solution, still lurks, even though empirical fixes have been supplied that provides better looking results. There is concern, however, that we still do not know how to initialize the climate system, with the ocean and all its heat capacity remaining a lurking challenge. Integrating coupled models for a few thousand years "solves" that problem, but almost assuredly attains an equilibrated state that is somewhat different than today's climate system, even if initialized with "observed data". The discussions on diagnostic "fingerprints" are nicely done.	Noted. No action required.

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				[Jerry Mahlman]	
1-606	A	23:12	23:24	flux correction - The community has agreed to call these adjustments - flux adjustments. Change wording. [Ronald Stouffer]	Taken into account. The wording has been changed.
1-607	A	23:12	23:24	It is astonishing that not a single NCAR model is referred to, given the leadership role in using non-flux adjusted models. The summary material on this in my book would be useful as a reference here. [Kevin Trenberth]	Taken into account. The NCAR model has now been mentioned.
1-608	A	23:13		(about line 13.) In flux adjusted models, the real reason is the need for a realistic state, or else the feedbacks are apt to be wrong. [Kevin Trenberth]	Noted. The sentence already now mentioned this fact.
1-609	A	23:15	23:16	There needs to be some clarification here. I would suggest saying "… counteracting shortcomings in model representation of the oceans (in terms of both grid resolution and physical processes) that led to drift in time and unrealistic patterns in the model's simulated base state as compared to observations." Just two additional notes about this--the observational data base at the time this was all being done was not all that good either, and the real ocean is not in equilibrium with the atmospehre either, so actually forcing the model back to observations does not necessarily mean that the ultimate simulation is better (thus using the phrase "realistic climatic state" is really inappropriate--especially because the observed state is, in fact, just one member of what is likely an ensemble of possible conditions for the oceans, it would be better to say "observed conditons.". And further, what really matters in calculating climate change is the sensitivity of the model, and it has not really been shown that making this correction has a large effect on the climate sensitivity (it of course has some effect). [Michael MacCracken]	Noted. The words suggested by the reviewer do not add to clarity (a lot is still under discussion) nor brevity.
1-610	A	23:20	23:21	Use "TAR" instead of Third Assessment Report. [Carlo Casty]	Accepted.
1-611	A	23:20	23:20	Use TAR acronym? [Piers Forster]	Accepted.
1-612	A	23:24	23:24	Is the use of the word "many" really appropriate--it is my impression that most of the major modeling centers are no longer using a flux correction. [Michael MacCracken]	Taken into account. The wording has been changed.
1-613	A	23:33	23:34	This discussion of "ad hoc" tuning is really inadequate. First, it needs to be made clear that parameterizations are approximations to the very complex reality and necessarily include some parameters that can be roughly estimated, but often cannot be observed (e.g., the average drag coefficient over a grid square, etc.) and so tuning a parameter within realistic limits (generally established indirectly by observations--such as the	Taken into account. The wording has been changed.

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				vertical wind profile) is a quite reasonable and necessary thing to do. It also needs to be noted that such tuning (of a parameter or relationship) is typically done for a relatively controlled situation (e.g., for an area where a field experiment has been conducted or intense observations gathered) and then is expected to work in all locations and seasons without local adjustment--so there is not local tuning. It seems to me, therefore, that referring this as "ad hoc tuning" is pejorative and seriously misleading. A much more nuanced explanation of this is needed here so it is clearer that there are virtually always physically based constraints that allow the parameter to be estimated. For a legal analogy, think about direct evidence versus circumstantial evidence--the latter can often be very convincing. [Michael MacCracken]	
1-614	A	23:37	23:37	The model used by Cox et al (2000) was actually flux-adjusted - although based on HadCM3, the study used a lower-resolution version of the ocean model which did require flux adjustments. [Richard Betts]	Taken into account. The wording has been changed.
1-615	A	23:40	:51	This "definition" of attribution requires that one has complete knowledge of the climate system and this should be noted explicitly. Therefore I propose to add a statement after line 51 to the effect: "Since this definition of attribution assumes a (near) complete knowledge of the system, and previous sections have outlined some areas where this completeness is lacking, any attribution however extensive and well documented should clearly be viewed as preliminary to a reasonable degree. They are attributions to the best of knowledge at a certain point in time, and in view of uncertainties in knowledge, model development and computational capabilities." [Florens De Wit]	Noted. Line 45 comprehensivley expresses the concern of the reviewer. A more extensive statement, as suggested by the reviewer does not enhance clarity, creates redundancy and takes up space.
1-616	A	23:40		Detection and attribution of what? It is implicit that it is attribution of anthropogenic climate change, but I think that you should state that in the title or the first sentence. [David Karoly]	Accepted. The wording has been changed.
1-617	A	23:40		Section 1.5.10: This is only partly a historic overview. [Robert Sausen]	Noted. The section has been altered to improve clarity.
1-618	A	23:40		Section 1.5.10 should be preceded by a substantial section on regional climate models and downscaling. These are two areas where major advances have been made in recent years. No review of progress is complete without a section on these aspects. It is somewhat astonishing to find in a progress/review chapter on this topic that the word "downscaling" does not appear. Neither does "RCM". Acute difficulties exist for policymakers (whom the IPCC ultimately serve) in utilising GCM output. If the IPCC is to have a function into	Noted. This is a general comment which has gone astray. Generally speaking, the regional models have not contributed substantially in this sense to the IPCC reports through TAR. The recent developments in this field are

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				the future it must be relevant to the needs of policymakers.Yet the chapter does not recognise at any point the important contribution made by regional models and statistical downscaling techniques in adding value to gcm output. This should be rectified in the next draft. [John Sweeney]	covered in chapter 11.
1-619	A	23:42	23:44	The second sentence needs reworking. I would suggest revising it to say"Detection refers to the process of demonstrating that observed conditions over one period are significantly dfferent (in a statistically valid sense) than for another prior state." The problem that I have with the present version of the sentence is that we do not know what "natural (internal) climate variability" is--all our instrumental records are from times when there have been human influences, and both the instrumental and preceding records include natural external variability (solar, volcanic) for which we only have direct evidence of the magnitude. Thus, as stated, the task is really impossible to accomplish--unless one relies on models for natural variabiility, but one has no real way of verifying that they are estimating this variability correctly as there is no uncontaminated data base. So, at least phrase this task so that it can be accomplished. [Michael MacCracken]	Noted. These are the definitions of the TAR. The concerns of the reviewer are dealt with in the next paragraph, where the limitations of the observations are discussed. To mix it with the definitions would not increase clarity or brevity.
1-620	A	23:42	23:44	This definition is slightly different to the definition used in chapter 9 which is slightly different to that of the TAR [Neville Nicholls]	Accepted. The wording has been change to correspond to the one in the TAR.
1-621	A	23:44		Insert between "variability" and "Attribution", " (a process which, so far, has never been achieved") [Vincent Gray]	Rejected. We are dealing here with the definitions, not yet with possible results.
1-622	A	23:45	23:47	I would suggest inserting the phrase "at a minimum" after "would require" for it is not at all clear that controlled experiments would be sufficient. It would then make sense to insert the word "thus" after "change is" on line 47. [Michael MacCracken]	Rejected. The suggested wording does not make sense: If "at a minimum" is "our climate system" what is then the maximum? The Universe? What experiments would make it sufficient? Uncontrolled ones?
1-623	A	23:47		Insert between "understood" and "to", "by the IPCC" [Vincent Gray]	Rejected. This definition si not limited to the IPCC alone.
1-624	A	23:48	23:48	The word "should" should be avoided--replace with "is calculated to" [Michael MacCracken]	Accepted.
1-625	A	23:53	23:54	I would suggest being a bit more precise in wording, so on line 53, replace "runs" with "simulations" and on line 54 say "in the atmospheric CO2 concentration" [Michael MacCracken]	Accepted.
1-626	A	23:53		This applies only to validated models that pass tests.	Noted. The comments hints to a detail,

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				[Kevin Trenberth]	the mentioning of which does not increase clarity or brevity.
1-627	A	23:57	23:57	After "records, I would suggest adding the phrase ", and a lack of understanding of the full range and effects of the various and ongoing external influences." It is not just the length of the record that is the problem. [Michael MacCracken]	Accepted.
1-628	A	23:57	24:4	It may be worth noting that attribution studies up to and including those in TAR did not include land use change, which is becoming increasing recognised as a significant forcing (at least at regional scales). [Richard Betts]	Noted. The comments hints to a detail, the mentioning of which does not increase clarity or brevity.
1-629	A	24:6	24:11	Historical facts are inaccurate here; the statements imply the earliest work was by Wigley and Roper (1990) and that too with global average temperatures. I refer the authors to a paper in Science by Madden and Ramanathan (1980) which used the most homoegeneous surface temperature records in the northern hemisphere in conjunction with a simple climate model for detection of global warming trends and concluded that the warming shoud rise above the background noise and be detectable by 2000! It also recommended that an attribution should include several variables inclding spectral shift in outgoing radiation flux. Madden, R. A. and V. Ramanathan, 1980: Detecting Climate Change Due to Increasing CO2 in the Atmosphere. Science, 209: 763-768. [Veerabhadran Ramanathan]	Taken into account. The appropriate paragraph has been reworded.
1-630	A	24:6	24:11	Historical facts are inaccurate here; the statements imply the earliest work was by Wigley and Roper (1990) and that too with global average temperatures. I refer the authors to a paper in Science by Madden and Ramanathan (1980) which used the most homoegeneous surface temperature records in the northern hemisphere in conjunction with a simple climate model for detection of global warming trends and concluded that the warming shoud rise above the background noise and be detectable by 2000! It also recommended that an attribution should include several variables inclding spectral shift in outgoing radiation flux. Madden, R. A. and V. Ramanathan, 1980: Detecting Climate Change Due to Increasing CO2 in the Atmosphere. Science, 209: 763-768. [Veerabhadran Ramanathan]	See above. This comment repeats (1-629).
1-631	A	24:7	24:7	Regarding the phrase "global-mean changes in the Earth's surface temeperature, " it really is important to be clear when talking about the record being looked at, for there are those who keep wondering how we meausre the average temperature of the Earth. Thus, I would suggest saying "global average of changes in local average-annual surface temperature for locations spread across the Earth." Now, I know this is a long and	Noted. The definition of the Earth's surface temperature can be found in the Glossary. A new definition would not increase clarity or brevity.

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				complicated way to say this, so perhaps use the present phrasing, but somewhere explain what this term means. [Michael MacCracken]	
1-632	A	24:7	24:8	Suggesting that some of the "earliest" work was by Wigley and Raper fails to recognize much earlier work by Callendar, Mitchell, Bryson, and others (e.g., the word "fingerprint" was first used in the early 1980s and there was an entire DOE state-of-the-art assessment report on the detection (and attribution, though not in the report's title) issue published in 1985. Alternative phrasing is needed if the discussion is going to start with Wigley and Raper. [Michael MacCracken]	Taken into account. The appropriate paragraph has been reworded.
1-633	A	24:12	24:12	I think it is really important that this section go over in more detail the various expressions of findings in the IPCC reports on this issue. In particular, the phrasing about detection and attribution in the SAR needs to be discussed, making clear how the technical chapter focused on rigorous statistical analyses (and unfortunately sometimes used statistical jargon) and how the phrases in the Summaries for Policymakers are consistent with the chapters after accounting for the switch made form a pure statistical perspective to the relative likelihood perspective that has been the way the SPMs communicate findings to decision makers. Right now, all this important material and advancing in understanding (such as the Santer et al. paper and approach used in the SAR) are neglected--just where one thinks they should be covered assuming IPCC still stands behind them (and I believe they do). [Michael MacCracken]	Taken into account. The appropriate paragraph has been reworded.
1-634	A	24:20	24:20	I would suggest changing "and time" to be "season, and history over the 20th century" as there are really two time scales involved. [Michael MacCracken]	Accepted.
1-635	A	24:22	24:28	This paragraph just has too much important information locked up in it as compared to other sections of the chapter. As indicated above regarding the SAR, the phrasing and conclusions of the TAR need to be explained and it made clear on what they were based (why the statements were stronger) and that the findings remain valid. It might well be useful to make the point that natural forcings over the last 50 years likely exerted a cooling influence, so that the statement that most of the warming over the past 50 years is likely due to human activities may actually be an understatement. [Michael MacCracken]	Taken into account. The appropriate paragraph has been reworded.
1-636	A	24:22	24:28	These references here are mostly post-TAR and are not yet history, and not appropriate in this chapter. It should refer to AR4 instead. [Kevin Trenberth]	Accepted. Post-TAR references have been removed.
1-637	A	24:24	24:24	Add the reference: Santer, B.D., F. Wehner, T.M.L. Wigley, R.Sausen, G.A. Meehl, K.E.	Rejected. This is a post-TAR reference.

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				Taylor, C. Ammann, J. Arblaster, W.M. Washington, and J.S. Boyle, W. Brüggemann, 2003: Contributions of Anthropogenic and Natural Forcing to Recent Tropopause Height Changes. Science 301, 479-483. [Robert Sausen]	
1-638	A	24:26	24:26	Add the reference: 63. Sausen, R., and B.D. Santer, 2003: Use of Changes in Tropopause Height to Detect Human Influences on Climate, Meteorol. Z. 12, 131-136. [Robert Sausen]	Rejected. This is a post-TAR reference.
1-639	A	24:27		I would delete "best" [Neville Nicholls]	Rejected. To delete "best" would convey a wrong message.
1-640	A	24:30	26:32	Sections 1.5.11 and 1.5.12 are the foundation of climate change theory and typically considered "what we know" about the topic. They should therefore be moved to sections 1.5.1 and 1.5.2. [Robert Molinari]	Yes, sections re-ordered, different sectioning.
1-641	A	24:30		reconsider arrangement of this section (see 1.5.5) [Stephan Lingner]	Yes, sections re-ordered, different sectioning.
1-642	A	24:32	24:46	Arguing that the realization that the Earth's climate might be sensitive to the atmospheric concentration of gases is several centuries old because of Mariotte's (1681) and Saussure's (1760) observations of the greenhouse effect for glass is incorrect. The first realization of the atmospheric greenhouse effect was not until Fourier's work in 1824, which makes the concept less than two centuries old. The Executive Summary Pg. 2, line 7, also need to be changed. [Lenny Bernstein]	Yes, fixed, thanks.
1-643	A	24:32	26:32	Maybe these sections should be the first two in Section 1.5? [Piers Forster]	Yes, sections re-ordered, different sectioning.
1-644	A	24:32	26:	These sections should me moved to earlier sections as mentioned in my introductory comment. [Veerabhadran Ramanathan]	Yes, sections re-ordered, different sectioning.
1-645	A	24:32	26:	These sections should me moved to earlier sections as mentioned in my introductory comment. [Veerabhadran Ramanathan]	Yes, sections re-ordered, different sectioning.
1-646	A	24:38	24:38	I assume that the word "planes" should be "panes" [Michael MacCracken]	Yes, thanks.
1-647	A	24:48	24:52	Somewhere it seems worth mentioning the basic physics that the greenhouse gases are those with 3 or more atoms, because the IR-modes are the low energy bending modes of molecules (i.e. modes that don't exist in O2 or N2) [Ian Enting]	Yes, done in different rewrite

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1-648	A	24:51	24:56	A reference to this pioneering work by Arrhenius is: Arrhenius, S., 1896: On the influence of carbonic acid in the air upon the temperature of the ground. The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science 41: 237-276. [Per Holmlund]	No, we are using the Fleming reference as the overview of history and not repeating all the old references contained in it.
1-649	A	24:54	24:56	This is a bit much self-congratulation (as a community) since the cause-effect relations between CO2 and glacial cycles are still problematic. [Ian Enting]	Yes, this important caveat is now noted! CO2 likely follows and amplifies climate response.
1-650	A	25:2	25:2	To avoid confusion about what models really are, I would think that what Callendar did should be referred to as a "set of equations" or something--or else one should really correct the text on 1-24 line 7 about some of the earliest modeling work. [Michael MacCracken]	Accepted, thanks.
1-651	A	25:8	25:10	A good reference to Ahlmann is: Ahlmann, H. W:son., 1953: Glacier Variations and Climate Fluctuations. Bowman Memorial Lectures, 3rd. Series. The American Geographical Society, New York, 51 p. [Per Holmlund]	Note, but we have chosen to refer to the historical review of Fleming (1998).
1-652	A	25:8	25:6	My suggestion is to introduce in the references : Ahlmann (1947) and Plass (1956) [CONSTANTIN MARES]	Note, but we have chosen to refer to the historical review of Fleming (1998).
1-653	A	25:9		It should say "and wrongly believed …" [Kevin Trenberth]	Accepted, thanks.
1-654	A	25:10	25:10	It is my recollection that what Plass used was really a radiation model and not a climate model--is it not agreed that the Manabe-Wetherald model in 1967 was the first real climate model (i.e., that included radiation and convection and got surface temperature about right)? So, I would change the word "cliamte" to "radiation" to indicate that the scope of the physics being represented was a good deal narrower than is included in a climate model. [Michael MacCracken]	Agreed, will drop 'climate' from model.
1-655	A	25:16	25:19	Is this interpretation of the Revelle and Seuss paper correct? Or is it simply a case that CO2 uptake by the oceans is a "slow" process, so that the rate of input to the atmosphere today exceeds the rate of uptake by the ocean. Only when the emissions are "stabilized" will the ocean uptake "catch up". My guess is that the "catch-up" time is about 400 years, based on carbon uptake models by Wigley and other scientists in that field. [Chuck Hakkarinen]	Yes, this has been substantially rewritten, keeping the basic idea.
1-656	A	25:16	25:19	A better explanation needs to be included here about how this was all resolved. This is necessary because some Russian scientists (e.g., frequently cited by Kondratyev) continue to push this explanation. So, this text needs to say that while mixing of CO2 can occur rapidly into the upper well-mixed layer of the ocean, the mixing time with the deep ocean is many centuries and for that reason, the atmospheric concentration can build up	Yes, we have carried out a major revision along the lines described.

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				substantially, and will go down only slowly. Additional complexities relating to carbon chemistry and biogeochemisty could also be referred to, as well as that warming may slow the rate of bottom water formation and thus the transport of some of the excess carbon to the deep ocean. [Michael MacCracken]	
1-657	A	25:19	25:19	My suggestion is to replace " steady state" with " steadily state" [CONSTANTIN MARES]	Rejected, wrong wording.
1-658	A	25:21	25:32	Perhaps the current issues concerning the indirect effect of aerosols should be mentioned in this paragraph e.g. see: Ramanathan, V., P. J. Crutzen, J. T. Kiehl and D. Rosenfeld, 2001: Aerosols, Climate and ?The Hydrological Cycle. Science, 294, 2119-2124. [Michael Alexander Alexander]	No, this is too recent a reference.
1-659	A	25:21	25:32	Please take note that Charles David Keeling died of a heart attack recently. [Jerry Mahlman]	Noted, sad, but we do not list deaths in IPCC assessment reports.
1-660	A	25:25	25:32	The discussion of aerosol effects should be made into a separate paragraph. In addition, a bit more needs to be said about recognition of aerosol effects as they7 go back considerably further than indicated in this paragraph. That aerosols might be cooling the climate was suggested, as I recall, in the early 1960s--in particular as soon as Mitchell's paper found that the world was not continuing to warm as Callendar had suggested. There was talk of the "human volcano," work by Bryson, etc.--and this all led to suggestions that we would head more toward cooling than warming (forgetting that the lifetime of particles is days to weeks and of the excess concentration of GHGs centuries and more). So, what is here is really quite insufficient from a history of the science perspective. [Michael MacCracken]	Separate paragraph, yes, but in terms of impact on the science community, these are the dominant papers.
1-661	A	25:34	25:34	Use of the word fingerprint could be confusing, given the section above on attribution. Something like 'the accumulation of atmospheric greenhouse gases' may be more accurate if less appealing. [Michael Manton]	Noted, but it describes a much better evidence of the fingerprint.
1-662	A	25:34	25:34	The title is misleading. "fingerprint" is used in IPCC report with a somewhat different meaning. it is more the the anthropogenic part [Robert Sausen]	Actually, it is a more accurate English usage here.
1-663	A	25:34		Section 1.5.12: This is no historical overview. [Robert Sausen]	Noted, see re-sectioning of these examples.
1-664	A	25:34		Section 1.5.12. The human Fingerprint on Greenhouse Gases. The section clearly rules out the natural processes as single cause for the buildup of GHG concentration in the atmosphere. This is in line with previous IPCC reports. However, it could be interesting to have in this section some further explanation on why natural bio-geochemical fluctuations are believed not to explain the observed shift from 280 ppm to 375 ppm in atmospheric	Yes, we have added language on isotopes and oxygen that also point to fossil fuel carbon.

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				carbon dioxide concentration. Over past periods, natural variations of the order of 100 ppm (from 180 to 280 ppm) occurred over geological times. The explanation given would describe why in the present case, the order of magnitude of natural variations do not match with the trends in GHG concentrations measurements. [Philippe Tulkens]	
1-665	A	25:42	25:44	The last sentence of the paragraph should be amended to say "Not only does the Keeling curve illustrate the human-induced influence on the mean CO2 concentration, but the precision of the curve is so accurate that it is also sufficient to detect a long-term intensification in the seasonal cycle of the biosphere." Both types of result need to be indicated--and when possible, the word "change" should be replaced by a word indicating the sign of the change (so "intensification"). [Michael MacCracken]	Accepted, fixed in a slightly different manner.
1-666	A	25:43	25:44	This seems to be a pretty significant conclusion on how the Keeling CO2 record can be used -- it should be supported with some reference citations. [Chuck Hakkarinen]	Supported with additional data on O2 and 13-CO2 and pointing to AR4 sections.
1-667	A	25:46	25:46	This version of the Keeling curve seems quite coarse in its resolution. Higher resolution versions show a clear, sharp drawdown of atmospheric concentrations during Northern Hemisphere summer, and a smoother, more gradual increase in concentration over time in other seasons. Using a higher resolution figure here (available from the NOAA CMDL folks, I'm sure) could help address my comment #8, along with some citations. [Chuck Hakkarinen]	Figure dropped.
1-668	A	25:48	26:2	Comparison of the atmospheric increase of carbon content with the fossil fuel consumption is a further fingerprint. Isotopic compsition of the atmospheric carbon is one more [Michel Petit]	Yes, thanks, this has been added (also O2/N2).
1-669	A	25:49	25:50	The second part of the sentence should be altered to say "…gases is also helpful in making clear that the observed rise since the start of the Industrial Revolution is due to human influences and not due to a natural cycle." [Michael MacCracken]	Noted, this has be rewritten.
1-670	A	25:52	25:55	It would help to rewrite the sentence to read "The initial measurements demonstrated that CO2 abundances were significantly lower during the las ice age than over the 10,000 years of the Holocene (Neftel et al., 1982), and that the CO2 concentration rose roughly exponentially from a pre-industial value of about 280 ppmv to about 370 ppmv at the end of the 20th century (Neftel et al., 1985; Etheridge et al., 1996). Furthermore, variations in the CO2 concentration during the Holocene have not exceeded about 20 ppmv (Indermuhle et al., 1999)." Suggesting that the variations during the Holocene were all "natural" would seem premature, especially as Ruddiman has offered explanations for	Yes, thanks, have taken your wording.

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				some of them that tie in with human activities (or their cessation due to plague, etc.). [Michael MacCracken]	
1-671	A	25:53		comment to data "280 ppm" (?) [Hartmut Grassl]	Noted, but not sure what is meant.
1-672	A	26:0		The man text ends abruptly. It would be tempting and not very helpful to finish with a motherhood statement, but perhaps something in the way of a summary might be nice. [Neville Nicholls]	Yes, we have added final sentence.
1-673	A	26:0		The chapter ends very abruptly. Wouldn't some summary paragraph be useful? [Dian Seidel]	Yes, we have added final sentence.
1-674	A	26:1	26:2	I would suggest including mention of the isotopic stdies that confirm that the recent rise is due to huamn activities. [Michael MacCracken]	Yes, done.
1-675	A	26:1	26:2	You might point out why measurements of radiocarbon C-14 in CO2 provides a definitive tag on the fossil fuel origin of much of the CO2 currently in the atmosphere. [Jerry Mahlman]	14CO2 is difficult beause of bomb 14C. We did add note on 13-CO2.
1-676	A	26:1	26:1	"modern times" wrong wording. I guess you mean not only the recent few years. [Robert Sausen]	Yes, fixed by revisions.
1-677	A	26:2	26:2	Change from "emissions of from fossil fuel consumption." to "emissions from fossil fuel consumption." [Brian Magi]	Yes, thanks.
1-678	A	26:2	26:2	Remove "of" before "from". [Lourdes Maurice]	Yes, thanks.
1-679	A	26:2	26:2	omit "of" [John Sweeney]	Yes, thanks.
1-680	A	26:2		emissions from of fossil": drop "of [Hartmut Grassl]	Yes, thanks.
1-681	A	26:2		Add at end "although a quantitative relationship between the two remains elusive" [Vincent Gray]	Noted, this incorrect section revised.
1-682	A	26:9	26:9	Adjust to say "The rate of increase of N2O …" [Michael MacCracken]	Yes, thanks.
1-683	A	26:9		correct "the rate in increase" to "rate of increase" [Hartmut Grassl]	Yes, thanks.
1-684	A	26:9		delete "rate in" [David Karoly]	Yes, thanks.
1-685	A	26:13	26:13	Change to say "over the last two centuries"	Yes, fixed by revisions.

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				[Michael MacCracken]	
1-686	A	26:21		These references are post TAR and instead the reference should be to AR4 chapters. [Kevin Trenberth]	Yes.
1-687	A	26:23	26:24	The first sentence needs to be broken in two and altered so industry is not blamed for emitting all the halocarbons. I would suggest wording as follows: "Several synthetic halocarbons (CFCs, HCFCs, PFCs, halons, SF6) are potent greenhouse gases. The chemical industry has been producing these gases since about 1930, and they have been leaking into the atmosphere since that time from refrigeratiors, air conditioners, industrial sites, fire extinguishers, and many other generally important uses." [Michael MacCracken]	Yes, have accepted most of these suggestions.
1-688	A	26:26	26:26	Make insertion to say "reflecting the latitudinal distribution of anthorpogenic sources." [Michael MacCracken]	Accepted, thanks.
1-689	A	26:26	26:28	This statement is not technically correct as not "all of the synthetic halocarbons" were controlled by the Montreal Protocol, and so the concentrations of some of them are continiuing to increase--some more rapidly than before due to their increased use as substitutes for others of them. [Michael MacCracken]	Yes, fixed by revisions.
1-690	A	26:30	26:32	I would suggest rewording part of this sentence to say "…well-mixed greenhouse gases over the last half-million years (Petit et al., 1999), and now know that today's abundances are greater than ever occurred during at least this period. [Michael MacCracken]	Yes, fixed by revisions
1-691	A	27:1	36:46	Please make sure that all references have the same style. [Carlo Casty]	Accepted.
1-692	A	27:3	36:46	The References need to be edited into a common format [Vincent Gray]	Accepted.
1-693	A	27:33	27:33	CO2 must be written with 2 as subscript. [NADIA GAMBOA]	Accepted.
1-694	A	28:13	28:13	CO2 must be written with 2 as subscript. [NADIA GAMBOA]	Accepted.
1-695	A	28:30	28:30	… Nature, vol 348, page 22 [Rolf Philipona]	Accepted.
1-696	A	29:36	29:36	CO2 must be written with 2 as subscript. [NADIA GAMBOA]	Accepted.
1-697	A	29:45	29:45	"N2O...CH4 and CO2": it must be written N2O with 2 as subscript; CH4 with 4 as subscript and CO2 with 2 as subscript. [NADIA GAMBOA]	Accepted.

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1-698	A	29:45	29:45	N2O must be written with 2 as subscript. [NADIA GAMBOA]	Accepted.
1-699	A	33:1	33:1	CO2 must be written with 2 as subscript. [NADIA GAMBOA]	Accepted.
1-700	A	33:11		Insert Reference " McIntyre, S., and R. McKitrick, Corrections to the Mann et al. (1998) proxy data base and Northern Hemispheric average temperature series. 2003. Energy and Environment 14 751-771" [Vincent Gray]	No post-TAR references are allowed in Chapter 1, a history up to the TAR.
1-701	A	33:11		Insert Reference "McIntyre. S and R. McKitrick, Hockey sticks. Principle components, and spurious significance. 2005. Geophys Research Letters 32 L03710, doi.10.1029/2004GL021750" [Vincent Gray]	No post-TAR references are allowed in Chapter 1, a history up to the TAR.
1-702	A	33:11		Insert Reference "McKitrick, R and Michaels, P.J. 2004, A test of corrections for extraneous signals in gridded surface temperature data. Climate Research, 26, 159-173" [Vincent Gray]	No post-TAR references are allowed in Chapter 1, a history up to the TAR.
1-703	A	33:19	33:19	It is not necessary to underline the ISBN number. [NADIA GAMBOA]	Noted.
1-704	A	34:1		Insert Reference "Peterson, T. C., and R.S.Vose, 1997, An overview of the Global Historical Climatology Network temperature data base Quarterly Journal Meteorological Society 78 2837-2849." [Vincent Gray]	Noted.
1-705	A	35:31	35:31	N2O must be written with 2 as subscript. [NADIA GAMBOA]	Accepted.
1-706	A	35:31		Insert Reference "Soon, W., and S. Baliunas. 2003. Proxy climate and environmental changes of the past 1000 years. Climate Research. 23, 89-110" [Vincent Gray]	No post-TAR references are allowed in Chapter 1, a history up to the TAR.
1-707	A	35:31		Insert Reference "Soon, W., Baliunas,. S., Idso, C, Idso, S, and Legates, D. "Reconstructing climatic and environmental changes of the past 1000 years : a reappraisal 2003. Energy and Environment 14, 233-296Z" [Vincent Gray]	No post-TAR references are allowed in Chapter 1, a history up to the TAR.
1-708	A	36:13	36:13	After "Hansen", insert "Greenhouse effects due to man-made perturbations of trace gases." [Chiu-Ying LAM]	Noted.
1-709	A	37:0		Q 1.1 This description fails to describe the climate system and its components and their role properly. It is remiss in not adequately addressing the role of water. In the figure 1 of Q	Taken into account. Question 1.1 has been extensively rewritten.

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				1, in fact most loss of energy from the surface is from evapotranspiration (78 units) vs 66 for radiation. So why isn't the water cycle highlighted here? Water is the air conditioner of the planet. You might like to see Chapter 1 of the SAR (which I wrote). [Kevin Trenberth]	
1-710	A	37:1	37:49	Why are the GHG not included? This could help refer to question 1.3. The figure is very old (1997). Is it possible to update the figure? [Carlo Casty]	Taken into account. Question 1.1 has been extensively rewritten.
1-711	A	37:1	37:50	does this Q need to briefly define "climate"? [Piers Forster]	Taken into account. Question 1.1 has been extensively rewritten.
1-712	A	37:1	37:49	This explanation would be enhanced by explicit recognition that the poleward transport of energy by the atmosphere and oceans that is necessary to achieve global radiation budget is highly variable between seasons and on longer time scales. Temperatures over middle and high latitudes respond to the magnitude of energy transport, such as during El Nino events when middle latitude temperatures tend to be warmer, especially during winter. [WILLIAM KININMONTH]	Taken into account. Question 1.1 has been extensively rewritten.
1-713	A	37:1	37:42	I suggest to reduce this description with 1/3 from actual size, and in the same time might be developed some description about "Biosphere" as an important component of the climate system. [CONSTANTIN MARES]	Taken into account. Question 1.1 has been extensively rewritten.
1-714	A	37:1	41:17	The question and answer format is very good. However, it requires a brief introduction to provide context. This comment also applies to all chapters. [Lourdes Maurice]	Taken into account. Question 1.1 has been extensively rewritten.
1-715	A	37:1		Questions 1.1-1.3 I believe this section containing questions are not appropriate for a report of this nature. These are questions more appropriate to a text book on climatology and detract from the substance of the main report. It is in my opinion not the function of the Report to provide an educational primer of this nature and consideration should be given to removing this section and any similar sections whcih occur in other chapters. [John Sweeney]	Noted, but IPCC, not the authors of this chapter, decided to include FAQs in the Fourth Assessment Report.
1-716	A	37:1		Q.1.1 We suggest a revised opening paragraph. The question is a general one but the answer becomes very specific, ie clouds, right away. Suggest following more general approach similar to that in 6.1 ln 11-17, ie. 'Our global climate is determined by the radiation balance of the planet (Question 1.1). There are three fundamental ways to change the radiation balance and hence cause a climate change: (1) changing the incoming solar radiation (e.g., by changes in the Earth's orbit or in the sun itself), (2) changing the fraction of solar radiation that is reflected (this fraction is called the albedo – it can be changed e.g., by changes in cloud cover, aerosols or land cover), and (3) altering the long-wave back-radiation (e.g., by changes in the greenhouse gas concentration). In	Accepted. Question 1.1 has been extensively rewritten.

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				addition, local climate also depends on how heat is distributed by winds and ocean currents. All of these factors have played a role in past climate changes.' [David & David Wratt & Fahey]	
1-717	A	37:4	37:4	I would include the Sun emission among the factors that either do not change or change very slowly [Alcide di Sarra]	Taken into account. Question 1.1 has been extensively rewritten.
1-718	A	37:9	37:9	To make clear that these are tendencies and not expected changes in temperature, I would suggest rewording to say "… both creating a cooling influence by reflecting sunlight and a warming influence by increasing the greenhouse effect." [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten.
1-719	A	37:11	37:11	To make this more technically correct, change to say "… greatly impacted by local and even regional surface characterisitcs and by atmospheric and oceanic circulations …" [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten.
1-720	A	37:16	37:20	This all would make much more sense if it had been explained that weather forecasting is an initial value problem and long-term climate is controlled by the boundary conditions. Thus, it really matters to get precise observations to improve weatehr forecasts, but, contrary to what the current head of NOAA has sometimes implied, getting a perfect set of observations about the current state of the atmosphere will not significantly reduce the range of estimates of long-term climate change. [Michael MacCracken]	Noted. We have treated this topic in FAQ 1.2.
1-721	A	37:21	37:21	Rather "sulfate containing gases" then "small particles" [Eugene Rozanov]	Accepted. Question 1.1 has been extensively rewritten.
1-722	A	37:22	37:22	To help the reader understand, I suggest changing the end of sentence to read "these aerosols typically influence the climate for about a year or two before falling into the tropsphere and being removed by precipitation." [Michael MacCracken]	Accepted. Question 1.1 has been extensively rewritten.
1-723	A	37:23	37:23	To help the reader understand the magnitude of the effect, I would suggest changing the last part of the sentence to read "can cause a drop in mean global surface temeprature of order half a degree that can last for months or even years." [Michael MacCracken]	Accepted. Question 1.1 has been extensively rewritten.
1-724	A	37:25	37:36	Comment: In Chapter 1 I miss the dispute on the age of the Earth that went on until the twentieth century. In 1862 Lord Kelvin made the first numerical calculation of Earth's age based on observed vertical temperature profiles and he arrived at about 100 million years. As an anti-evolutionist he used his arguments to show that Darwin's ideas were wrong. At that time it was of course unknown that radioactive decay keeps re-supplying heat. So, internal heat sources of the Earth play a role in its cooling rate on geological time scales. Now the question arises whether nowadays these internal heat source of the Earth can be	Noted. Question 1.1 has been extensively rewritten. Because of space limitations, we had to be very selctive in choosing illustrative examples and concluded that this was beyond the scope of the chapter.

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				neglected. There should be a sentence added to, for instance, Question 1.1 on page 1-37, to state that this internal heat source can be neglected. This to exclude the option that recent changes in internal radioactive decay processes might cause the observed temperature rise in the last decades. [henk.debruin@wur.nl de Bruin]	
1-725	A	37:25	37:26	This last analogy is really confusing and in some sense seems to make the oppoiste point that seems to be intended--in fact this whole discussion of the significance of Lorenz for weather versus climate needs to be improved. [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten. For this topic, please se FAQ 1.2.
1-726	A	37:27	37:27	Capitalize "earth" [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten.
1-727	A	37:29	37:29	Change opening words of sentence to "Clouds radiate energy both out to space and back to the surface and elsewhere in the atmosphere." [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten.
1-728	A	37:29	37:29	Given what is being said here, it would be better to change the word "day" to "hour" as the divergence is quite limited for limited periods. [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten. For this topic, please see FAQ 1.2.
1-729	A	37:32	37:33	I am confused here--what does "recent" mean? And total GHG direct forcing is equal to about 1% change in solar constant, not one half of one percent. From the rest of the sentence, it almost sounds as if this is meant to be referring to how much the Earth system is out of balance--and if this is the case, a better explanation is needed. [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten.
1-730	A	37:32		expression: "one half of one percent" (?) [Hartmut Grassl]	Taken into account. Question 1.1 has been extensively rewritten.
1-731	A	37:33	37:33	It is confusing to say 'earth" here as this normally means the whole system--switch to say "land" [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten.
1-732	A	37:34		Add "approximate" at the beginning [Vincent Gray]	Taken into account. Question 1.1 has been extensively rewritten.
1-733	A	37:35	37:35	This is another example of implying that the climate determines the weather. Change "an El Nino climate to" to read "a warming of sea surface temperature" [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten. For this topic, please see FAQ 1.2.
1-734	A	37:37	37:37	lower zenith angle? Or higher in the sky? [Piers Forster]	Taken into account. Question 1.1 has been extensively rewritten.
1-735	A	37:37	37:37	At the start of the line, change to read "where sunlight strikes the atmosphere at a lower angle." In the second part of the wentence, it is not clear what "this" is referring to. And in	Taken into account. Question 1.1 has been extensively rewritten.

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				line 38, make "circulation" plural--they are not the same. [Michael MacCracken]	
1-736	A	37:42	37:42	The phrasing here makes it seem as if the atmosphere can directly change the 'salinity of the sea." It would help to explain that this can happen through evaporation and precipitation processes. [Michael MacCracken]	Accepted. Question 1.1 has been extensively rewritten.
1-737	A	37:42	37:43	Change "earth-atmosphere-ocean" to "atmosphere-land-ocean-biosphere-cryosphere" or something similar. [Michael MacCracken]	Accepted in FAQ 1.2.
1-738	A	37:43	37:44	Replace "most famously" by "especially the intensity of" and change last phrase to read "caused by clouds and greenhouse gases" [Michael MacCracken]	Accepted in FAQ 1.2.
1-739	A	37:45	37:45	Change "gases" to gas concentrations" [Michael MacCracken]	Accepted in FAQ 1.2.
1-740	A	37:46	37:47	First, I would suggest changing "are complex climate" to "finer scale" and adding "occur" to the end of the sentence; everything is complex--that is not a useful adjective here. Second, it almost seems here as if climate is creating the weather (or climate phenomena are). It is important to be very careful to make clear that it is the weather that is real--and climate is a mathematical construct we make from that--so really just a mental construct. One might say that the lan-sea distribution, the seasonal cycle of solar radiation, and atmospheric and oceanic processes combine to lead to the weeather that occurs, and when this is suitably averaged and analyzed, one finds recurrences of the weather that we call the monsoons, etc.--but we should not really be saying that the climate creates the weather (see further comments on this regarding Question 1.2). [Michael MacCracken]	Taken into account. Question 1.1 has been extensively rewritten.
1-741	A	37:46	37:46	Change "averages" to "changes in averages" [Michael MacCracken]	This concern has been addressed by rewording the relevant parts of FAQ 1.2.
1-742	A	37:47	37:48	This is a bit of a strange comparison--one really wants to talk about how things are changed, for example, by HIV/AIDS, so say the "dates of death of specific people cannot be predicted, but the changes in the statistics of life expectancy for a large population can be projected more reliably because they will change more slowly." [Michael MacCracken]	Rejected. This section has been reworded in FAQ 1.2 but definitely not the way the reviewer recommends..
1-743	A	37:50	37:50	Scientists have not just recognized this "in recent years"--it goes back certainly 40-50 years and arguably over 100 years. [Michael MacCracken]	Good point, this part of FAQ 1.2 has been modified accordingly..

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1-744	A	37:51	37:51	Change "can be due" to "results from" [Michael MacCracken]	Accepted in FAQ 1.2.
1-745	A	37:53	37:54	Another one of these confused sentences. A correct way of saying this would be "As the factors influencing the Earth's energy balance change, the statistics of the weather that results change, and this change in the statistics of the weather is what we call a variation or, if it persists, achange in the climate." [Michael MacCracken]	Rejected. The relevant part of FAQ 1.2 has been rewritten but definitely not the way the reviewer recommends because that isn't the point we wished to make.
1-746	A	37:54	37:56	This sentence has things exactly reversed. It changes in boundary conditioons (like the CO2 concentrations) cause the weather to be different, then the average temeprature will be different, and we call this a change in the climate. Keep remembering that "climate" is a mental construct--it is not real--weather is real. [Michael MacCracken]	Rejected in FAQ 1.2 because the point we are making is quite different than the point the reviewer wants us to make. The reviewer wants us to say that changes in weather cause changes in climate and that point has already been made. The point we are trying to make is that if the climate warms it doesn't mean that each type of weather will be a half a degree warmer but the mix of weather conditions may change.
1-747	A	38:0		Q 1.2. I wrote a short book jointly with others to address the whole issue of this question. Please see: Trenberth, K. E., K. Miller, L. Mearns, and S. Rhodes, 2000: Effects of Changing Climate on Weather and Human Activities. Understanding Global Change: Earth Science and Human Impacts Series, Global Change Instruction Program, UCAR. University Science Books. 46 pp. Weather patterns and storm tracks are systematic and storms play a key role in the climate system. Lines 28-37 fail to address the fundamental role of instabilities in the atmosphere as part of the climate system. I disagree with part of lines 3 to 12 on the relationship between weather and climate. An alternative way of viewing this is to say that weather corresponds to the primarily atmospheric phenomena associated with instabilities (such as convective and baroclinic), while systematic interactions of the atmosphere with other parts of the climate system control the climate, which varies on all time scales (the diurnal cycle is a climate phenomenon). [Kevin Trenberth]	Accepted in part. The comment is wrong when it says that weather is primarily atmospheric phenomena associated with instability. A meteorologist/weather enthusiast might say during a dry period in a desert that there is no weather. But our target audience would think that in such conditions the weather was hot and sunny. This FAQ will not try to change that fundamental perception. The part about instability of weather important to climate has been incorporated. In this FAQ, we need to summarize weather and climate change in limited space.
1-748	A	38:1	38:1	It seems more logical to me to have this be the third question rather than the second (or combine the first and third ones) [Michael MacCracken]	Taken into account. The FAQs have been extensively rewritten.

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1-749	A	38:1		Question 1.2. What is the relationship between climate change and weather? There is no factual mistake in the answer. However, I subjectively have the feeling that the question should be addressed in a more conventional way despite the difficulties in defining all elements. Can the IPCC avoid defining the climate, climate change and weather in a formal way? Once each term is defined, their relationships could be described and the relevant examples given. Skipping the first step might not be appropriate. For your information, Roger A. Pielke's weblog discusses the matter (http://climatesci.atmos.colostate.edu/?cat=2) . The IPCC text could clarify this point. [Philippe Tulkens]	Rejected. The FAQs have been extensively rewritten. The comment, "no factual mistake" is noted with appreciation. We have consulted many sources in answering this question, including the weblog cited. The IPCC cannot avoid defining terms like climate change.
1-750	A	38:3	38:12	This paragraph seems to me quite confusing, implying that the climate creates the weatehr, when instead it is conditions that create the weather and that we then average to get the climate. I can start to offer some corrections, but more work may be needed. On line 4, change "description" to "measures of the weather" and delete "of weather". For opening phrase of sentence beginning on line 6, change to read "Climate change is an indication that there have been changes in the weather". Delete the sentence starting "To understand ...". In the next sentence, the phrase "that determine what weather may occur" is wrong, it seems to me, especially if the "atmosphere" is included in the list. It might be better to say that "The term climate is commonly used to encompass a description of the boundary conditions that influence the time-averaged weather, including the amounts of sea and glacial ice, the state of the biosphere, and, depending on the context, ocean surface temepratures and soil mositure of the ground." The last sentence then really confuses things by talking about climate covering a period of three months, which would not be the time-average used to get at climate change. There needs to be much more care taken in defining weather and cliamte and what influences what. [Michael MacCracken]	Accepted.
1-751	A	38:3		I found this rather unsatisfactory. The total effect of the weather is a vital part of climate, e.g. the heat transport by midlatitude waether systems. Ths distinction between weather and climate given is simplistic. The specificity of the prediction changes continuously with the time and space under consideration, with probabilities underlying predictions in all cases. [Brian Hoskins]	Accepted.
1-752	A	38:4		Q1.2: See comment above on opening paragraph. Suggest a 'softer start' to achieve a simple answer. For example, would reconsider simplifying or omitting 'as the statistical description in terms of the mean and variability of relevant quantities of weather over a period of time' in the opening sentence. Another example of complexity is ln 35, 'El Nino climate event', which should be defined/explained. [David & David Wratt & Fahey]	Accepted.

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1-753	A	38:10	38:10	Please introduce besides the other components of the climate system and lithosphere. [CONSTANTIN MARES]	Rejected: Adding more material would unduly lengthen the necessarily short answer. The lithosphere is shown in the figure associated with this FAQ.
1-754	A	38:25	38:26	While the golf ball example is graphic, it is also misleading. The flight of a golfball is not chaotic, but defined by very well determined laws of physics. If it were chaotic, how could golf professionals show the accuracy they do? Your example should be drawn from another chaotic system. [Lenny Bernstein]	Accepted.
1-755	A	38:46		It is not that averages are more predictable but rather that forced variations (through the boundary conditions to the atmosphere) have some predictability. [Kevin Trenberth]	Accepted.
1-756	A	38:50	38:50	The phrase "In recent years" here understates the work of the IPCC and collaborating scientists. I think this should read "In recent decades". [Brian Magi]	Accepted.
1-757	A	38:53		Insert between "in" and "land", "urbanisation, energy consumption and" [Vincent Gray]	Rejected: We say land use: that covers urbanization.
1-758	A	40:1	40:57	"Natural" Greenhouse Effect? Is there any other kind? A more physically based explanation of this fundamental physical process would be helpful. There is no need to even suggest that there might be some other form of greenhouse effect that is somehow unnatural or harmful or mysterious. Atmospheric physics does not really care whether a given CO2 molecule was "naturally" exhaled by some endangered ring-tailed lemur or "artificially" injected into the atmosphere from a gas guzzling SUV. In either case, that particular CO2 molecule is not going to contribute much to the atmospheric greenhouse effect until it works its way to higher altitudes in the atmosphere where the temperature is significantly colder than the surface temperature. At that point the CO2 molecule will start making a radiative contribution to the atmospheric greenhouse effect, irrespective of its original pedigree. The same considerations apply to any other GHG molecule that happens to get injected into the atmosphere. [Andrew Lacis]	Accepted. The FAQs have been extensively rewritten.
1-759	A	40:1	40:57	Everything in the universe that has a definable temperature, everything from outer space debri at near absolute zero in temperature to stellar interiors at over a 100 million degrees K, emits radiation at the maximum allowable rate as prescribed by the Planck function. For solid surfaces, this thermal emission is proportional to T**4 as given by the Stefan-Boltzmann law. (The human body has a temperature of about 310 K and total surface area of about 2 m2. It therefore emits thermal energy at the rate of about 500 W/m2, which is equivalent to ten 100 Watt light bulbs! That is the rate at which we would freeze	Taken into account. The FAQs have been extensively rewritten.

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				to death if we were suddenly exposed to an outer space environment. Fortunately, our surrounding environment is at a similar temperature from which we absorb a similar amount of thermal energy, so that our thermal energy balance can be maintained at a relatively comfortable level.) Tenuous substances, such as gases, also emit radiation according to the Planck law, but the thermal emission can occur only at those wavelengths at which the gas absorbs, and in proportion to the absosrptivity of the gas at those wavelengths. [Andrew Lacis]	
1-760	A	40:1	40:57	In terms of its practical impact, the atmospheric greenhouse effect works the same way that thermal insulation around a hot steam pipe reduces the rate of heat energy escape from the+G20 steam pipe. The only significant difference is that thermal insulation restricts energy transport carried by conduction, while absorbing gases in the atmosphere restrict energy transport by radiation (air is a good insulator, so conductive energy transport in the atmosphere is negligible). However, because of the fluid nature of the atmosphere, heat energy can also be transported by convective means, which happens when atmospheric temperature gradients become too large. A necessary condition for greenhouse operation is that a significant fraction of the absorbed solar energy occurs at the ground, as is the case for Earth. In the process of transporting the absorbed solar energy out to space, a monotonic temperature gradient is established within the atmosphere. This is because layers near the top of the atmosphere can not be supplied with as much thermal energy from neighboring layers as layers within the deeper atmosphere. [Andrew Lacis]	Taken into account. The FAQs have been extensively rewritten.
1-761	A	40:1	40:57	For global energy balance, the layers at the top of the atmosphere, from which energy gets radiated out to space, must maintain an effective temperature that is capable of radiating away the absorbed solar energy. As a result of the atmospheric temperature gradient, temperatures at ground surface and at the bottom of the atmosphere will become warmer than the effective radiating temperature of the top atmospheric layers. The temperature difference between the surface temperature and the effective radiating temperature is a measure of the strength of the atmospheric greenhouse effect. For the Earth, which reflects about 30% of the incident solar radiation, the effective radiating temperature has be about 255 K (or -18C). Since the global mean surface temperature of the Earth is approximately 288 K, the greenhouse strength of the Earth's atmosphere is about 33 K. [Andrew Lacis]	Taken into account. The FAQs have been extensively rewritten.
1-762	A	40:1	40:57	The strength of the atmospheric greenhouse effect is determined by the thermal opacity of the atmosphere. Competitive energy transport by convection acts to diminish the atmosphere's greenhouse efficiency. (If it were not for convection, the surface temperature	Taken into account. The FAQs have been extensively rewritten.

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				of the Earth would be some 20C warmer than it actually is.) To a lesser extent, the stratospheric absorption of solar radiation by ozone also tends to diminish the efficiency of the Earth's greenhouse effect. For comparison, our neighboring planets Mars and Venus also possess a greenhouse effect. Mars, with a tenuous atmosphere that is about 1% as dense as the Earht's, has a global mean temperature of about 220 K. Even though Mars has far more CO2 in its atmosphere than the Earth, its greenhouse strenght is only about 3 K. Venus, on the other hand, has a very dense atmosphere about a 100 times more massive than the Earth's that is composed almost entirely of CO2. The greenhouse effect of the Venusian atmosphere exceeds 500 K, so that the surface temperature of Venus is near 740 K, and that is hot enough to melt lead. [Andrew Lacis]	
1-763	A	40:1		Q1.3: Suggest simplifying opening paragraph by omitting concept of 'transparent' and 'opaque' in describing a gas. [David & David Wratt & Fahey]	Taken into account. The FAQs have been extensively rewritten.
1-764	A	40:3	40:3	Change to read "The Earth has a natural greenhouse effect that results from the presence of clouds, and from radiatively active gases (notably including water vapour, carbon dioxide, ozone, methane and nitrous oxide) and aerosols that are present in very small amounts. [Michael MacCracken]	Taken into account. The FAQs have been extensively rewritten.
1-765	A	40:4		change the word position of "methane" (2) and "nitrous" (1) [Hartmut Grassl]	Taken into account. The FAQs have been extensively rewritten.
1-766	A	40:5	40:7	It woul likely be more helpful to the reader if this read "fairly opaque (I.e., highly absorbing) of the outgoing radiant (heat) energy emitted by the surface, low clouds, and atmospheric greenhouse gases." Also, replace 'a large amount of" by "about half of the incident" and change "our planet" to "the surface" [Michael MacCracken]	Taken into account. The FAQs have been extensively rewritten.
1-767	A	40:9		Suggest defining the concept of 'water vapour feedback' here [David & David Wratt & Fahey]	Taken into account. The FAQs have been extensively rewritten.
1-768	A	40:13		would be -19" add: "would be about -19 [Hartmut Grassl]	Taken into account. The FAQs have been extensively rewritten.
1-769	A	40:13		Insert "about" between "be" and "-19" and add Reference for this calculation [Vincent Gray]	Taken into account. The FAQs have been extensively rewritten. We don't use references in the FAQs.
1-770	A	40:16	40:16	It is really strange to have both Figure 1.1 and Figure 1.3 realting to the questions as they show similar information. In fact, I would urge replacing Question 1.3, figure 1 by the related figure appearing in the US National Assessment, in which the width of the arrows is proportional to the flux, so one could use this instead of figure 1 for both Questions 1.1	Taken into account. The FAQs have been extensively rewritten. We have revised the figures. We chose not to use arrow widths to indicate flux sizes,

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				and 1.3. [Michael MacCracken]	however.
1-771	A	40:24	40:25	"clouds increase the average temperature" (?) [Hartmut Grassl]	Taken into account. The FAQs have been extensively rewritten. We now discuss cloud effects in FAQ 1.3.
1-772	A	40:26	40:28	It would be good if IPCC did not make the mistake of suggesting that the natural greenhouse effect and greenhouses work the same way--the reason a greenhouse is warm is that the glass restricts the convective loss, not the heat loss (unless the glass has a low conductivity). [Michael MacCracken]	Accepted. The FAQs have been extensively rewritten.
1-773	A	40:26	40:28	The comment that a greenhouse made of glass "…restricts infrared energy from leaving" contradicts lines 29-31 of Question 2.1 (page 93 of Chapter 2). Those lines state "… the walls of a true greenhouse pass both solar and infrared radiation. An actual greenhouse warms by trapping air within its boundaries so as not to lose the warming from solar radiation to the surrounding air". We think the Q2.3 statement is the correct one (but one of us was the author for Q2.3!). [David & David Wratt & Fahey]	Taken into account. The FAQs have been extensively rewritten.
1-774	A	40:30	40:38	Please tell the reader, which fraction of the composition of the atmosphere are related to GHG (in %) like it is done for O2 and NO2. [Carlo Casty]	Accepted. The FAQs have been extensively rewritten.
1-775	A	40:30	40:32	It is true that nitrogen and oxygen are basically non-absorbing, and thus don't contribute directly to the greenhouse effect. But they do provide the atmospheric framework for the greenhouse gases to operate in. If all of the atmospheric water vapor and CO2 were simply laying on the ground, there would not be much of a greenhouse contribution from these gases. [Andrew Lacis]	Noted.
1-776	A	40:32	40:33	The text claims that molecules of two atoms do not absorb or re-emit significant amounts of infrared radiation. I believe this statement is incorrect. HCl, CO, and NO, for example, absorb and emit infrared radiation. The key physical concept is not how many atoms there are but, rather, if there is a change in the dipole moment of the molecule during a vibration. Symmetric two-atom molecules like O2 and N2 do not have changes in the dipole moment during vibration and therefore do not interact with infrared radiation. [Scot Martin]	Taken into account. The FAQs have been extensively rewritten.
1-777	A	40:32		of only one (?) or two atoms [Hartmut Grassl]	Taken into account. The FAQs have been extensively rewritten.
1-778	A	40:35	40:38	It should be pointed out in the text that the greenhouse effect due to water vapour varies with the latitudinal variation in concentration within the atmospheric boundary layer.	Taken into account. This is too much detail for an FAQ, in our opinion.

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				Saturation vapour pressure varies nearly exponentially with temperature and so the water vapour contribution to the greenhouse effect is much greater over warm tropical waters than over polar ice in winter. [WILLIAM KININMONTH]	
1-779	A	40:36	40:38	It needs to be mentioned that these are the percentage distributions for the current climate--and they will change as the climate changes. [Michael MacCracken]	Accepted. The FAQs have been extensively rewritten.
1-780	A	40:42		Suggest changing to 'equilibrium temperature' [David & David Wratt & Fahey]	Taken into account. The FAQs have been extensively rewritten.
1-781	A	40:46		"Earth-atmosphere system" (?) [Hartmut Grassl]	Taken into account. The FAQs have been extensively rewritten.
1-782	A	40:50	41:4	What is the role of the oceans? [Carlo Casty]	Rejected because discussing the ocean's role in the atmospheric greenhouse effect would not provide much useful information given the amount of space it would require.
1-783	A	40:54	40:55	This percentage change is applicable near the surface--high in the troposphere, the number is greater, and this needs to be mentioned to make clear why the change in water vapor in the upper troposphere is so important. [Michael MacCracken]	Taken into account. The FAQs have been extensively rewritten.
1-784	A	40:57	41:1	It should be pointed out, for balance, that it is necessary to warm the underlying surface before the atmosphere will warm. The thermal capacity of the ocean mixed layer and the additional exchange of heat and latent energy to the overlying atmosphere with increasing sea surface temperature therefore provides a moderating influence on the actual warming of the atmosphere by the anthropogenic greenhouse effect. [WILLIAM KININMONTH]	Rejected. While it is true that the heat storage capacity of the ocean provides a moderating influence on warming, that point is not directly relevant to the greenhouse effect which is the subject of the FAQ.
1-785	A	41:2		I worry that we are relying a lot on this "implies" here - I would be happier if we didn't include this discussion of (possible) observed changes in water vapour. I don't think the last few paragraphs of this question/answer are really essential. [Neville Nicholls]	Taken into account. The FAQs have been extensively rewritten.
1-786	A	41:11	41:12	This doubling is true only when the water vapour feedback is included in isolation. I would say "The water vapour feedback acting alone…" [Piers Forster]	Taken into account. The FAQs have been extensively rewritten.
1-787	A	41:14	41:17	Please delete this paragraph. [Carlo Casty]	Taken into account. The FAQs have been extensively rewritten.
1-788	A	41:18		Add a question 1.4 What is the relationship between the IR absorption lines and the	Noted. This may be too advanced a

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				radiative forcing ? [Michel Petit]	concept for an FAQ, in our opinion.
1-789	A	41:37		Insert "about" between (H2O) and "60%" and add Reference for this calculation [Vincent Gray]	Accepted, but we don't use references in the FAQs.
1-790	A	43:0		Figure 1.1 is a catchy picture. However, this pic is not sound. The peer-review process might have changed between 1980, 1990, and 2001 (although I see thgis should not be the case). This comment is just to say that I find the picture catchy but not so serious. [Paolo Cherubini]	Accepted. All Chapter 1 FOD figures are changed or dropped.
1-791	A	43:0		Figure 1.1: I find it a very intriguing picture and do not want to have it out of the report, however, this may also document that publication pressure has increased accordingly, leading to quantitatively more, but not necessarily qualitatively better publications. A note in this direction wouldn't hurt in the last paragraph of page 1.5. [Martin Wild]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-792	A	43:1	44:14	Why pick the year 2001? 2000 is about the same size and would look "smoother" [Andrew Lacis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-793	A	44:0		Fig. 1.2 Capitalize "m" in "model" in heading. Add period to caption. [Melinda Marquis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-794	A	44:1	44:8	Is there an update of this Figure with the models included into FAR? [Carlo Casty]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-795	A	44:1	44:8	This figure is totally ineffective. Omit, or replace it with something better. [Andrew Lacis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-796	A	44:1		Figure 1.2. Could this figure be updated for AR4 ? The actual figure is taken from TAR. [Philippe Tulkens]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-797	A	44:2	44:4	Figure 1.2 -- Why is there a question mark regarding the features of climate models in the early 2000s? As we are ending 2005, and the 4AR will not be published until 2007, these should be known. Also, future should attempt at a further reaching prediction. [Lourdes Maurice]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-798	A	44:2	44:4	Figure 1.2 -- Along with the increasing complexity, could an assessment of improvements in uncertainty be included in this figure? [Lourdes Maurice]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-799	A	45:0		Fig. 1.3 Better to move plot heading to caption only. [Melinda Marquis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-800	A	45:0		Would it be possible to complement the figure with the most recent years data, in order to avoid nasty speculations ?	Taken into account. All Chapter 1 FOD figures are changed or dropped.

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				[Michel Petit]	
1-801	A	45:1	45:9	The plotted curve looks unnecessarily fuzzy. Is the size of the points meant convey some level of uncertainty in the data? [Andrew Lacis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-802	A	45:5	45:7	Please add a sentence that explains the biological seasonal cycle in simple words. [Carlo Casty]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-803	A	45:5	45:5	should read: "carbon dioxide obviously due to …" [Stephan Lingner]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-804	A	46:0		Q.1.1 Fig. 1 Can not use scanned figure in final draft, will need original. Are all #s in figure W m-2? If so, caption should say so. [Melinda Marquis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-805	A	46:0		Question 1.1, Figure 1: the Figure is taken from the TAR. However, we believe that several of these fundamental numbers given on this figure are not very realistic and might need revision: There is evidence that the longwave back radiation is 20 Wm-2 higher than given in this Figure: Wild et al. 2001, J. Climate, 14, 3227-3239, estimated the longwave back radiation to be close to 344 Wm-2, based on a combination of models and direct observations at the surface which were not available at the time of the first publication of Figure 1.1. The value of 324 Wm-2 given in that Figures lies also outside the range of the values calculated by the various GCMs participating in the IPCC AR4 control experiments, which we determined to range form 333 to 351 Wm-2. On the other hand, we believe that the atmospheric shortwave absorption (67 Wm-2) is underestimated in the Figure, resulting in a surface absorption value which is too high (168Wm-2).We estimated the absorption at the surface to be considerably lower, around 154 Wm-2 (Wild et al. 1998, Climate Dynamics, 14, 853-86, Wild 2005, Geophys. Res. Lett, 32, doi:10.1029/2005GL022421). In a recent study (Wild et al 2005, J. Geophys. Res. (in press), we estimated a clear sky atmospheric absorption (71Wm-2) which is already higher than the all sky value given in this Figure (67 Wm-2), and clouds are likely to increase this value further. In Wild et al. 1998 and Wild 2005 we estimated the most realistic value for solar energy absorbed by the (all sky) atmosphere to be close to 81 Wm-2, in close agreement with recent estimates obtained in other groups (e.g. V. Ramanathan, personnal communication). [Martin Wild]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-806	A	46:1	46:7	This figure is rather old, please update if possible.	Taken into account. All Chapter 1

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				[Carlo Casty]	FOD figures are changed or dropped.
1-807	A	46:1		Question 1.1, figure 1. The figures given are from 1997, a check should be made to see if these figures are still valid [Philippe Tulkens]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-808	A	47:0		I'd add the sentence "Enhancement of extreme events" [Tiziano Colombo]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-809	A	47:1	47:6	The quality of the figure is not very good. [Carlo Casty]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-810	A	47:1	47:8	The figure might look better in color [Andrew Lacis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-811	A	47:1	47:8	Question 1.2, Figure 1:This is definitly not the best figure for explaining the relationship between weather and climate [Robert Sausen]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-812	A	47:6		Q.1.2 Fig. 1 Can not use scanned figure in final draft, will need original. Add period to caption. [Melinda Marquis]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-813	A	48:0		With the purpose of clarity I'd add "Solar radiation short wave passes through the clear atmosphere" [Tiziano Colombo]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-814	A	48:0		The greenhouse effect of clouds is missing from this figure. [Jón Egill Kristjánsson]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-815	A	48:0		According to Kiehl and Trenberth (1997: BAMS), clouds are responsible for 20% of the natural greenhouse effect. I suggest inserting the words 'and clouds' after "greenhouse gas molecules" in the text on the right of the figure. [Jón Egill Kristjánsson]	Taken into account. All Chapter 1 FOD figures are changed or dropped.
1-1	A	2:15	2:15	Replace "a few prescient scientists" with "some scientists" because this is supposed to be a report (not a self-aggrandising document). [Richard S Courtney]	Accepted.
1-2	A	2:17	2:17	Replace "humanity was conducting" with "humanity may have been conducting" because their "perception" had yet to be assessed: indeed, there was insufficient data to assess it. [Richard S Courtney]	Accepted.
1-3	A	2:23	2:23	Replace "today's comprehensive models of the climate system" with "today's models of the climate system" because no comprehensive model of the climate system has been developed to date (e.g. models have insufficient spatial resolution to model clouds). Indeed, Page 1-3 Lines 7 and 8 admits the models do not include "the chemical and biogenic components of the climate system" and Page 1-3 Lines 11 and 12 says "we still	Accepted.

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				lack an adequate physical understanding of key components of the climate system and their mutual interactions" (e.g. "aspects of the clouds, the cryosphere and the oceans") which makes the models much less than "comprehensive". This is succinctly stated on Page 1-20 of the draft where it says, "The models are not completely comprehensive …". [Richard S Courtney]	
1-4	A	2:44	2:44	Replace "to reproduce" with "to emulate" because the models do not "reproduce" anything. [Richard S Courtney]	Accepted.
1-5	A	2:45	2:48	Replace all of from "The remarkable success .." to "… fortunately impossible on the actual Earth." with "Despite the limitations of these models, their use permits investigation of potential climate behaviours many of which are fortunately impossible on the actual Earth." This replacement is needed because the statements in Lines 45 to 48 in the draft grossly overstate the abilities of existing models and ignore the failures of existing models to emulate real climate in terms of, for example, spatial distributions of precipitation and temperature. Indeed, these statements conflict with Page 1-2 Lines 52 to 55 of the draft: why bother to "increase the trustworthiness and reliability of model predictions" if the models are sufficiently good that scientists can use them to "learn" how a modified Earth climate would behave? [Richard S Courtney]	Taken into account. Text has been edited.
1-6	A	2:50	2:51	Replace the sentence "The rapid development of … understanding of the climate system" with "The rapid development of increasingly sophisticated climate models permits testing of our understandings of climate and climate behaviours." because the models are – and can only be – formulations of existing understandings. They can be used 1. to test those understandings against empirical data, 2. to explore the limitations of those understandings against empirical data, 3. and to assess the possible behaviours of the climate system according to those understandings but that is very different from "contributing significantly to our understanding of the climate system". The models are not the real world. They are merely simplified descriptions of part of the real world, and the climate system is the part of the real world they attempt to emulate. [Richard S Courtney]	Taken into account. Text may be modified after further consideration. Testing and exploring and assessing as described in the reviewer's three numbered points can clearly help contribute to increasing one's understanding, however, and so the authors regard the present text as satisfactory.
1-7	A	3:24	2:24	Delete the word "fully" because it is at best ambiguous and at worst misleading. [Richard S Courtney]	Accepted.

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1-8	A	3:36	3:36	Replace "the international community of scientists" with "an international community of scientists" because not all past and present scientists were involved. [Richard S Courtney]	Rejected. This appears to be a narrow technical point that decreases the flow of the language and adds no useful information. The involvement of "all past and present scientists" is in no way a necessary condition to justify the use of the term "community."
1-9	A	3:37	3:37	Delete the word "compelling" because it is an opinion that is not shared by many (including me). [Richard S Courtney]	Taken into account. The text may be modified after further consideration but authors consider present text accurate.
1-10	A	3:41	3:41	Delete the word "major" because it is an opinion that is not shared by many (including me). [Richard S Courtney]	Taken into account. The text may be modified after further consideration, but authors consider present text accurate.
1-11	A	4:6	4:6	An insertion, reference or footnote is required here to explain "the IPCC mission" that is stated in Page 1-6 Section 1.3 Lines 24 to 27. [Richard S Courtney]	Accepted.
1-12	A	4:50	4:50	Replace "the international community of scientists" with "an international community of scientists" because not all past and present scientists were involved. [Richard S Courtney]	Rejected. This appears to be a narrow technical point that decreases the flow of the language and adds no useful information. The involvement of "all past and present scientists" is in no way a necessary condition to justify the use of the term "community."
1-13	A	4:54	4:54	Delete "Did it appear in the peer reviewed literature?" because this is not relevant to the scientific worth of a publication; for example, Einstein's papers on relativity were not peer reviewed before their publication in Nature, and the Wright brothers' seminal work on aviation was not peer reviewed prior to its publication in a journal on bee-keeping. The scientific worth of information is shown by its ability to be replicated and to withstand attempts to disprove it. It is not shown by peer review of information prior to its publication (n.b. this is demonstrated by the IPCC's error in the TAR where the now discredited work of Mann et al. was reported because it had been peer reviewed). [Richard S Courtney]	Rejected: Peer-review is a central part of the practice of modern science, one that is is in no way invalidated by its inevitable imperfections. As a matter of historical accuracy, Einstein's papers on relativity appeared in Annalen der Physik, not in Nature, and Mann's work has subsequently been clarified and improved but is not regarded as "discredited" by experts on the subject.
1-14	A	4:55	4:56	Replace the sentence "If the answer to these questions is no … until it is tested and validated." with "In science, no assertion is given credence until it has been independently tested and validated." because the sentence in the draft is simply wrong	Rejected because this recommended change just isn't factually correct.

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				(except for charlatans). [Richard S Courtney]	
1-15	A	5:3	5:3	Before the sentence beginning "This is an important consideration …" insert the additional sentence, "This is similar to the disciplines of astronomy and cosmology that cannot conduct experiments on entire planets, solar systems, galaxies or the cosmos." because the paragraph in the draft wrongly suggests that Earth Science is significantly different in nature from all other physical sciences. [Richard S Courtney]	Accepted, and a change of similar nature will be made.
1-16	A	5:11	5:11	Append to the end of the sentence ending ".. on the actual Earth" the clause "but it should always be remembered that the model is not a perfect and complete emulation of the real Earth so the indicated effects of all such modifications have very high uncertainty." because the sentence in the draft is grossly misleading. [Richard S Courtney]	Rejected. The very high uncertainty recommendation isn't correct, or at least isn't always correct, and the remaining part is not necessary.
1-17	A	5:15	5:15	Append to the end of the sentence ending ".. the current climate models"" the clause "according to Soden et al." because the quotation is an incorrect statement: the quotation should say, "results were consistent with the water vapour feedback used in current climate models". [Richard S Courtney]	Taken into account. Referencing the quote to Soden et al. isn't necessary as the beginning of the sentence makes it clear it is from Soden et al.
1-18	A	5:35	5:35	Before the sentence beginning "The scientists involved …" insert the additional sentence, "And it demonstrates that existing views of future climate behaviour can be overturned by additional information and different understandings." because – without the suggested additional sentence – the paragraph in the draft is a polemical opinion and not an explanation. [Richard S Courtney]	Rejected. Adding this clause would improperly bias the reader into thinking that everything may be overturned at any moment. Even technically accurate caveats, if over-emphasized, provide a very misleading sense.
1-19	A	5:35	5:42	Delete everything in the paragraph from "This example also illustrates …" to "nuanced conclusions of the scientists involved." because it asserts that some interpretations of a conclusion in a scientific paper are more valid than others, but only the conclusion is valid (not interpretations of it). Any interpretation of a scientific conclusion is merely hypothesis that requires testing. Indeed, the quotation from Bryson and Dittberner (1976) cited in the draft is accurate, and it is correct to report it verbatim. It is not proper to assert that some interpretations of its meaning are correct and others are not without further evidence to test the accuracy of those interpretations. This is true for all conclusions published in all scientific papers. [Richard S Courtney]	Rejected. Making this change misses much of the point of the example and the explanation the reviewer provides is simply not correct.
1-20	A	6:17	6:17	Delete the word "well" because it is an irrelevant – and self aggrandising – opinion. [Richard S Courtney]	Accepted.
1-21	A	6:53	6:53	Replace "… made a compelling, but not quantitative, case …" with "… made a	Rejected, because this is an opinion that

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				qualitative, but not quantitative, case …" because the statement in the draft is an unjustified opinion that is not shared by many (including me). [Richard S Courtney]	is shared by most experts on climate change science, in the opinion of the authors.
1-22	A	6:54	6:54	Replace the phrase "the climate system" with "the global climate system" because the FAR did not discuss local anthropogenic climate changes (e.g. from UHI, forest clearance, etc.). [Richard S Courtney]	Rejected, because the climate system is obviously global by definition in this context.
1-23	A	6:56	6:56	Delete "CO2" because it is not true that the peer-reviewed and published evidence still supports the assertion that human activities are substantially increasing the CO2 in the atmosphere. The annual pulse of anthropogenic CO2 into the atmosphere should relate to the annual increase of CO2 in the atmosphere if one is causal of the other, but their variations greatly differ from year to year. (ref. Rorsch A, Thoenes D and Courtney RS, (E&E v10 no2 (2005)). Also, the annual increase to CO2 in the atmosphere is the residual of the seasonal changes to CO2 in the atmosphere, and the Northern Hemisphere seasonal changes (decrease and increase) each year are approximately an order of magnitude greater than both the total annual increase and the total annual anthropogenic emission. (Rorsch et al. (2005)). Rorsch et al. conclude; "This paper has considered the flows of CO2 in and out of the atmosphere. It used the disturbance of the natural cycle by current anthropogenic CO2 emission to investigate the cause(s) of alteration to atmospheric CO2 concentration. The considerations of this paper start from the suggestion that the relatively large increase of CO2 concentration in the atmosphere in the twentieth century (some 30%) is likely to have been caused by the increased mean temperature that preceded it. The main cause is possibly desorption from the oceans with an observed time lag of half a century. However, it cannot be excluded that the production rate from other sources, such as microbiological activity, among others, could have increased. " etc. [Richard S Courtney]	Rejected. Aside from the restriction that Chapter 1 is a historical chapter that is not concerned with publications post-TAR, the Rorsch et al. (2005) paper fails to make a convincing case. There has long been overwhelming evidence, such as from isotopic composition, for the anthropogenic origin of the observed increase in atmospheric carbon dioxide concentration.
1-24	A	6:56	6:56	After the quotation from the FAR insert, "However, it is now clear that anthropogenic emissions of CO2 are an insignificant contribution to the observed increase to atmospheric CO2 concentration." (Rorsch A, Thoenes D and Courtney RS, (E&E v10 no2 (2005)). [Richard S Courtney]	Rejected. See response to comment (1-23).
1-25	A	7:9	7:9	Replace "continues" with "continued" because the grammatical error is misleading. [Richard S Courtney]	Accepted; this was fixed with a more extensive rewrite.

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1-26	A	8:21	8:21	After "feasible computationally" for completeness and clarity add the sentence, "However, caution has to be taken when using information from one type of model as input to another type of model because the absence from a model of a climate mechanism (e.g. storms may be emulated in a regional model but not in a global model with lower spatial resolution) may distort the emulation of other climate mechanisms." [Richard S Courtney]	Taken into account. Text may be modified after further consideration. However, the suggested wording does not add significant new information, in the opinion of the authors. Caution is part of interpreting model results, for this and many other obvious reasons.
1-27	A	10:3	10:3	For accuracy and completeness, after "; Peterson et al. 1998)" it is important to add the following: "However, climate is the integral of weather over a period of at least 30 years. So, if global climate is warming (or cooling) then the average global air temperature must have trended up (or down for cooling) over a period of 30 years. In this case, only a linear trend has meaning because a minimum time scale is being assessed and a linear trend is a single data point. The Jones et al. and GHCN data sets of mean global temperature show very different linear trends when compared over 30 year periods (including the most recent 30 years when they differ by 40%). These data sets are compiled from the same source data and, therefore, these differences demonstrate that the methods used to compile the global mean temperatures can – in at least one of these data sets they do – introduce spurious trends to mean global temperature data with time." [Richard S Courtney]	Rejected because the suggested addition simpy isn't correct.
1-28	A	10:10	10:10	For accuracy and completeness, after "; Peterson et al. 1999)" it is very important to add: "However, many other studies indicate that the urban heat island effect is a substantial contributor to the apparent warming trend in these data sets. For example, Kalnay and Ming determine that land-use change and urbanisation account for a significant portion of the surface temperature increase of the last century. They determine an effect that is at least twice as great as has been previously estimated for the United States (Kalnay and Cai (2003)) (ref. Kalnay E, and M Cai, Nature, vol. 423, 528–531 (2003)). And Brandsma et al. have demonstrated that urban heat island biases in surface temperature data are not confined to cities but may spread to surrounding rural locations thus causing urban heat island effects much larger in magnitude than was previously thought (Brandsma et al. (2003)). (ref. Brandsma, T., G. P. Konnen, and H. R. A. Wessels, 2003. International Journal of Climatology, vol. 23, 829–845 (2003)) [Richard S Courtney]	Rejected. References cited are post TAR. It is also wrong in that all large-scale pre-TAR (and post-TAR that we know of) UHI (urban heat island) analysis using homogeneity-adjusted data do not find a significant UHI bias. Analyses without data being adjusted for changes in observing practices are a different issue.
1-29	A	10:17	10:17	For accuracy and completeness, after "continues to grow." it is important to add: "However, SST data has yet to be obtained for the great bulk of the oceans for most of the	Rejected because it isn't accurate.

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				twentieth century." [Richard S Courtney]	
1-30	A	10:42	10:43	The sentence saying, "Their results agree … and spatial averaging techniques." is factually not correct and should be replaced with the following: "Their results agree in that they show similar periods of global temperature rise and fall with time. However, climate is the integral of weather over a period of at least 30 years. So, if global climate is warming (or cooling) then the average global air temperature must have trended up (or down for cooling) over a period of 30 years. In this case, only a linear trend has meaning because a minimum time scale is being assessed and a linear trend is a single data point. The Jones et al. and NOAA data sets of mean global temperature show very different linear trends when compared over 30 year periods (including the most recent 30 years when they differ by 40%). These data sets are complied from the same source data and, therefore, these differences demonstrate that the methods used to compile the global mean temperatures can – in at least one of these data sets they do – introduce spurious trends to mean global temperature data with time." [Richard S Courtney]	Rejected. The use of a 30 year period is arbitrary, and the results clearly speak for themselves.
1-31	A	10:57	10:57	For accuracy and completeness, after "their local environment." Add "However, it has to be acknowledged that integrating data obtained from equipment that no longer exists and was used by persons who are no longer alive is likely to include errors and differences that cannot now be determined." [Richard S Courtney]	Rejected as it isn't correct. Equipment can be reassessed, e. g., by building historical shelters (see Brunet et al., 2006, International Journal of Climatology).
1-32	A	11:42	11:42	After ".., changes" add "because the atmospheric carbon dioxide concentration followed the temperature changes by centuries (implying that the temperature changes were causing the changes to the carbon dioxide concentration)." because the sentence in the draft is misleading. [Richard S Courtney]	Yes, noted, and this sentence has been revised to reflect CO2 as feedback.
1-33	A	12:8	12:8	Replace the word "demonstrated" with "suggested" or possibly "indicated" because the word in the draft is factually incorrect. [Richard S Courtney]	Agreed, the sentence is awkard and is now reworded.
1-34	A	12:33	12:33	Replace the phrase "the scientific attitude" with "the attitude of many scientists" because it is untrue and arrogant to assert that it is not scientific to retain a view because some scientists (perhaps a majority) change their view in the absence of indisputable and definitive evidence. [Richard S Courtney]	Noted. This paragraph has been rewritten and the wording dropped.
1-35	A	12:46	12:46	Replace the phrase "where it will become possible" with "where it may be possible" because any anticipated achievement is merely a hope until it is achieved.	Noted, and changed to simply "is possible" since that reflects the current

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				[Richard S Courtney]	status.
1-36	A	13:36	13:36	For accuracy and completeness, after "(IPCC, 2001a)" it is very, very important to add: "However, since the TAR several studies have provided doubt to that work of Mann et al.. Many studies provide data that conflict with the findings of that work of Mann et al. (e.g. Beltrami et al) (ref. Beltrami et al "Long-term tracking of climate change by underground temperatures", Geophysical Research Letters v.12 (2005)). In 2005 McIntyre and McKitrick published two papers that together provide a complete refutation of that work of Mann et al. (ref. McIntyre S & McKitrick R, Energy & Environment, v 16, no.1 (2005)) (2005), Geophysical Research Letters Vol. 32, No. 3, (2005)). But, perhaps the most important of their studies of that work of Mann et al. was their publication in 2003 (ref. McIntyre S & McKitrick R, Energy & Environment, v 24, pp 751-771 (2003)) that showed it is not possible to replicate the work of Mann et al. There are several reasons for the inability to replicate this work of Mann et al.; not least that Mann refuses to reveal his source codes. The inability to replicate this work of Mann et al. means it has no scientific worth: i.e. this work of Mann et al. is anecdote of similar kind to a report of a ghost sighting. Hence, the IPCC now apologises for including it in the TAR. The IPCC will now disregard this work of Mann et al. and recommends that all others should also disregard it until it can be – and has been – independently replicated." [Richard S Courtney]	Noted, but rejected. Firstly, we disagree with the overall tone and viewpoint of the statements made in this comment, because there are many subsequent studies that have confirmed the essential results of the Mann et al. work; and secondly, and more importantly, this chapter leaves such modern issues to the later chapters. Chapter 1 is a historical overview, and the history being assessed stops at the TAR. Post-TAR developments, including the topic under discussion here, are the province of other chapters of AR4.
1-37	A	14:18	14:18	Replace "temperature will in turn increase" with "temperature is likely to increase in turn" because the statement is the draft is (a very reasonable) hypothesis stated as fact, and the statement cannot be known as fact until it happens (unless a crystal ball is used). [Richard S Courtney]	Accepted.
1-38	A	14:44	14:44	To avoid being completely misleading, after "progress." it is important to add: "This research has great importance because present understandings as exemplified by climate models suggest the polar regions should be warming at between 2 and 3 times the global average warming rate, but the Antarctic continent continues to cool except for one small region and the Arctic region (North of 65o latitude) has warmed in pace with rest of the globe (Polyakov et al, 2002)." [Richard S Courtney]	Rejected. The assertions are not correct.
1-39	A	16:33	16:33	To avoid being misleading, replace "as evidenced" with "this understanding is evidenced". [Richard S Courtney]	Accepted.
1-40	A	16:57	16:57	To avoid a factual error, it is important to replace "the main conclusions" with "some of the main conclusions".	Rejected. The text is correct; it does not say "all".

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				[Richard S Courtney]	
1-41	A	17:2	17:2	Delete "CO2" because it is not true that the peer-reviewed and published evidence still supports the assertion that human activities are substantially increasing the CO2 in the atmosphere. The annual pulse of anthropogenic CO2 into the atmosphere should relate to the annual increase of CO2 in the atmosphere if one is causal of the other, but their variations greatly differ from year to year. (ref. Rorsch A, Thoenes D and Courtney RS, (E&E v10 no2 (2005)). [Richard S Courtney]	Rejected. See response to comment (1-23).
1-42	A	17:5	17:5	After the "… comparing different emissions" insert, "However, it is now clear that anthropogenic emissions of CO2 are an insignificant contribution to the observed increase to atmospheric CO2 concentration." (Rorsch A, Thoenes D and Courtney RS, (E&E v10 no2 (2005)). [Richard S Courtney]	Rejected. See response to comment (1-23).
1-43	A	17:13	17:13	For accuracy, it is very, very important to insert the following additional paragraphs. "Since the TAR, peer reviewed reconsideration of the evidence has shown that human activities are not making a substantial or significant contribution to increasing CO2 in the atmosphere. The annual pulse of anthropogenic CO2 into the atmosphere should relate to the annual increase of CO2 in the atmosphere if one is causal of the other, but their variations greatly differ from year to year. (ref. Rorsch A, Thoenes D and Courtney RS, (E&E v10 no2 (2005)). Also, the annual increase to CO2 in the atmosphere is the residual of the seasonal changes to CO2 in the atmosphere, and the Northern Hemisphere seasonal changes (decrease and increase) each year are approximately an order of magnitude greater than both the total annual increase and the total annual anthropogenic emission. (Rorsch et al. (2005)). Rorsch et al. conclude; "This paper has considered the flows of CO2 in and out of the atmosphere. It used the disturbance of the natural cycle by current anthropogenic CO2 emission to investigate the cause(s) of alteration to atmospheric CO2 concentration. The considerations of this paper start from the suggestion that the relatively large increase of CO2 concentration in the atmosphere in the twentieth century (some 30%) is likely to have been caused by the increased mean temperature that preceded it. The main cause is possibly desorption from the oceans with an observed time lag of half a century. However, it cannot be excluded that the production rate from other sources, such as microbiological activity, among others, could have increased. ""	Rejected. See response to comment (1-23).

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				[Richard S Courtney]	
1-44	A	19:22	19:23	Delete the clause, ", and mathematical errors … this overestimate." or cite the mathematical errors because the statement in the draft is an assertion of prejudice and not fact. [Richard S Courtney]	Accepted. Text has been edited to reflect the fact that we do not attempt to assess the causes of the errors in Langley's work.
1-45	A	19:48	19:48	For accuracy and completeness, after "the twentieth century." add "This indicates that the changes in solar irradiance are not the major cause of the temperature changes in the twentieth century unless those changes can induce unknown feedbacks in the climate system. However, the effects of solar flares on the atmosphere (e.g. on cloud nucleation) are not known and, therefore, more research to investigate the effects of solar behaviour on climate is needed before the magnitude of the solar effects on climate can be stated with any certainty." [Richard S Courtney]	Taken into account. The wording has been changed.
1-46	A	19:56	19:56	For accuracy, between "wisdom" and "at least" insert "among climate modellers" because most scientists do not agree that anything is indicated by the average of two model results from models that are not validated for prediction of those results: average ignorance is not "wisdom". [Richard S Courtney]	Rejected. It was a far wider scientific community than simply climate modellers which accepted this result.
1-47	A	20:2	20:3	Replace the clauses "because … variety of factors." with "because each model contains different assumptions – known as parametrisations – concerning, for example, the processes of evapouration, precipitation and convection to that used in any other model. Also, the climate system includes deterministic chaos." because the clauses in the draft are untrue and grossly misleading. [Richard S Courtney]	Taken into account. The wording has been changed.
1-48	A	20:18	20:18	Replace "the scientific community" with "the climate modelling community" because the climate modellers and those who work with them are a very small part of the scientific community. (It may be useful to consider what Freud would have thought of this misuse of the phrase "the scientific community"). [Richard S Courtney]	Rejected. It was a far wider scientific community than simply climate modellers which accepted this result.
1-49	A	20:34	20:34	For accuracy, replace "added confidence to" with "given some confidence to". [Richard S Courtney]	Rejected. The wording suggested by the reviewer would seem to imply that previously there was no confidence, which is not true.
1-50	A	21:6	21:6	For accuracy and completeness, after "… years to come." it is very important to add, "However, it should always be kept in mind that the models provide results which are only valid to the degree that those results can be validated against empirical data from observation of the real climate system so, for example, all their predictions have great	Rejected. The suggested wording does not add to clarity or brevity.

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				uncertainty for climate effects from elevated atmospheric greenhouse gas concentrations above those measured in reality." [Richard S Courtney]	
1-51	A	21:22	22:25	For accuracy, completeness and to avoid being grossly misleading, after "… only a few years ago." add, "However, the emulation of cloud processes remains very imperfect in all models and must be a focus of work to improve the models." Then delete "In spite of this undeniable progress, however," and delete the phrase "apparent contradiction". (There is no apparent contradiction but there are great differences between the assumptions concerning, for example, cloud processes that are used in the models). [Richard S Courtney]	Noted. Text has been edited.
1-52	A	23:8	23:8	For accuracy, replace "also explain why" with "provide a possible explanation of why" because the assertion in the draft cannot be known to be true until the problem is solved. [Richard S Courtney]	Taken into account. The wording has been changed.
1-53	A	23:18	23:18	For accuracy and completeness, after "…Gates et al., 1996)" it is very important to add, "because this need for flux corrections indicated the models contained significant error(s) and/or omitted significant climate processes." [Richard S Courtney]	Rejected. The suggested wording does not add to clarity or brevity.
1-54	A	23:49	23:50	For accuracy, replace the words "with alternative" with the words "with some suggested alternative" because not all suggested alternatives have been considered (e.g. changes to cloud nucleation by solar flare activity) and some alternatives may not yet have been discovered. [Richard S Courtney]	Rejected. The suggested wording does not add to clarity or brevity.
1-55	A	23:55	23:55	For accuracy, after "… years to centuries" add "according to the understandings of the climate system built into the model" because the model is – and can only be – merely a representation of those understandings and not of the real climate system. [Richard S Courtney]	Rejected. The suggested wording does not add to clarity or brevity.
1-56	A	24:9	24:9	For accuracy, replace the words "could not be explained by natural internal variability" with the words "could not be explained by their model within its limits of natural internal variability" because the study was of the model's indication of climate behaviour and was not of the behaviour of the real climate. (The entire Section 1.5.10 seems to show that its authors have extreme confusion concerning the difference between model emulation and empirical observation of reality: this error is one example of the confusion). [Richard S Courtney]	Rejected. The suggested wording does not add to clarity or brevity.
1-57	A	24:9	24:10	For accuracy, replace the words "could not be explained by natural internal variability" with the words "could not be explained by their model within its limits of natural internal variability" because the study was of the model's indication of climate behaviour and was not of the behaviour of the real climate. (The entire Section 1.5.10 seems to show that its	Rejected. The suggested wording does not add to clarity or brevity.

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				authors have extreme confusion concerning the difference between model emulation and empirical observation of reality: this error is one example of the confusion). [Richard S Courtney]	
1-58	A	24:10	24:11	For accuracy, replace the sentence, "This finding .. Stouffer et al., 1994)." with "Similar studies using variability estimates from more complex coupled ocean-atmosphere general circulation models provided similar results (e.g., Stouffer et al. 1994)." (The entire Section 1.5.10 seems to show that its authors have extreme confusion concerning the difference between model emulation and empirical observation of reality: this error is one example of the confusion). [Richard S Courtney]	Rejected. The suggested wording does not add to clarity or brevity.
1-59	A	24:24	24:24	For accuracy, after, "… natural factors alone" insert "according to the understandings included in the models." because the statement in the draft is factually incorrect without this addition. (The entire Section 1.5.10 seems to show that its authors have extreme confusion concerning the difference between model emulation and empirical observation of reality: this error is one example of the confusion). [Richard S Courtney]	Rejected. The suggested wording does not add to clarity or brevity.
1-60	A	24:27	24:27	For accuracy, replace, "is required in order to best explain the observed changes." with "is one possible explanation for the observed changes." because the statement in the draft is not fact but is an expression of prejudice (i.e. an assertion lacking any supporting evidence that is assumed to be true): the correct statement is that the observed changes show the failure of the models to correctly emulate the real climate without addition of a factor that they do not include. (The entire Section 1.5.10 seems to show that its authors have extreme confusion concerning the difference between model emulation and empirical observation of reality: this error is one example of the confusion and conflates it with a prejudice). [Richard S Courtney]	Rejected. The suggested wording does not add to clarity or brevity.
1-61	A	24:27	24:28	Delete the sentence, "The evidence from this body of work strengthens the scientific case for a discernible influence on global climate" because it is simply not true. The sentence is an assertion that derives from the extreme confusion concerning the difference between model emulation and empirical observation of reality that is repeatedly displayed in this chapter. The models' results are not reality: they are merely the outcome of understandings of reality that are built into the models. Studies of the models' results show the behaviour of the models, and studies of the real climate system show the behaviour of the real climate system. Differences between findings of these studies inform about the models and not the climate system, because the climate system is reality and the results of the model emulations are merely virtual realities. Also, the failure of a virtual reality to match reality without inclusion of an effect in the virtual reality indicates	Rejected. The suggested change does not add to clarity or brevity. Scientists who use models are well aware of the difference between models and reality, and the intelligent use of models together with observations clearly can contribute greatly to climate change detection and attribution issues and has done so in the past. Any further discussion of the topic is post-TAR and will be dealt with in the detection

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				nothing concerning the existence of any particular postulated effect. So, the difference between a model's results and observed reality informs about the model, and this difference is not "evidence" for the existence or otherwise of any postulated effect – for example, anthropogenic global warming – in the real climate system. (If the authors of the chapter cannot grasp this simple point then they should consider the following. Computer models based on fundamental physical laws can very accurately emulate the behaviours of battling spaceships, but this cannot provide any "evidence" for the existence of alien monsters in real space.) [Richard S Courtney]	chapter (9) of AR4.
1-62	A	24:31	24:31	For accuracy and clarity, insert the following sentence as a first paragraph in the Section; "The greenhouse effect of the Earth is the increase to the Earth's surface temperature that results from the presence of the Earth's atmosphere." [Richard S Courtney]	Rejected. The suggested sentence is not clear. "Greenhouse effect" is defined in the Glossary and was defined in the TAR Glossary. See also the response to comment (1-76).
1-63	A	24:32	24:32	For accuracy, replace the words "create a" with "contribute to" because the statement in the draft very wrongly suggests that the radiative contribution to the Earth's greenhouse effect alone "creates" the Earth's greenhouse effect. But the radiative component of Earth's greenhouse effect is not its only component. For example, two other components of the greenhouse effect are its convective and evaporative components, and they would continue to provide the Earth with a greenhouse effect if all gases with radiative properties were removed from the atmosphere. The convective component increases mean global temperature by transfer of heat from the hottest regions to cooler ones. Radiation from the Sun heats the Earth's day side and most heats the equator on the day side. It does not heat the Earth's night side and does not heat the poles in winter. So, air in contact with the day-side surface is (on average) heated by conduction especially near the equator. The heated air rises by convection, and circulation cells move that heat polewards (and nightwards) where the surface is (on average) heated by conduction from the air. But the thermal energy radiated by a surface is proportional to the fourth power of the surface temperature. Hence, the cooling of the day-side especially near the equator (i.e. the hottest surface) much reduces the thermal heat loss from the planet and, therefore, the average temperature of the planet must rise to maintain thermal equilibrium (i.e. [solar heat absorbed by the planet] = [heat radiated from the planet]). The evaporative component of the greenhouse effect works in the same way as the convective component but more efficiently because water absorbs much heat as latent heat when it evapourates. Heat is transported from the hotter surface regions as latent heat of evaporation. Both these mechanisms raise the mean global temperature and reduce the range of surface	Noted. While some of this comment may be relevant to the details of how heat is transported, it is not essential to the history chapter here. Thus we choose not to include it. "Greenhouse effect" is defined in the AR4 Glossary and was defined in the TAR Glossary. See also the response to comment (1-76).

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				temperatures over the planet (e.g. the temperature rises hundreds of degrees within an hour of dawn on the Moon, but nowhere on Earth experiences such large temperature variations and such large temperature differences do not exist between points on the Earth). Both the evaporative and the convective components of the greenhouse effect would continue to operate if water were not a radiative greenhouse gas. And nowhere on Earth has large day to night temperature variations (as on the Moon) which indicates they are at least as important to climate as the radiative component of the greenhouse effect. Also, polar regions are net radiation emitters because they obtain almost all their heat from ocean currents and winds. [Richard S Courtney]	
1-64	A	24:54	24:56	For accuracy, replace the sentence, "This prediction was … the climate changes." with, "This prediction represented a remarkable coincidence because it was later found that CO2 did vary by this amount between glacial and interglacial periods but the CO2 changes followed the temperature changes by centuries and additional forcing is needed to explain the changes." because the sentence in the draft is grossly misleading. [Richard S Courtney]	Accepted. This sentence has been revised in response to this and other reviews.
1-65	A	25:16	25:16	For accuracy, replace , "another puzzle was solved" with "another puzzle seemed to be solved" because this old information does not consider the newer finding that the slow desorption of CO2 from the oceans in a warming world will also have a delay of about 50 years. (ref. Rorsch A, Thoenes D and Courtney RS, (E&E v10 no2 (2005)). [Richard S Courtney]	Rejected. This view is considered very unlikely. See also response to comment (1-23).
1-66	A	25:19	25:19	For accuracy, and completeness, after "what they can absorb in a steady state" add "Similarly, the slow desorption of CO2 from the oceans in a warming world (as at present) has a delay of about 50 years and this provides a complete explanation for all the rise of atmospheric CO2 (of about 30%) throughout the twentieth century." (ref. Rorsch A, Thoenes D and Courtney RS, (E&E v10 no2 (2005)). [Richard S Courtney]	Rejected. This recent paper does not address pre-TAR status. See also response to comment (1-23).
1-67	A	25:30	25:30	For accuracy and completeness, after "… burning of fossil fuels" add "Additionally, it has been found that increases to sulphate aerosols combined with soot particles have a strong warming effect (0.55 Wm-2) greater than that of methane (0.48 Wm-2), and these combined particles are also linked with the burning of fossil fuels (ref. Jacobson MZ, Nature, vol. 409, 695-697 (2000))." [Richard S Courtney]	Rejected. These numbers do not describe sulfate aerosol correctly, and MZJacobson's numbers are on the high side of the community.
1-68	A	25:56	25:56	For accuracy, and completeness, after"… part of a natural cycle." replace "The" with "These results suggest that the"	Noted, fixed in a different way. Cannot repeat "result."

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				[Richard S Courtney]	
1-69	A	26:2	26:2	Delete "and can only be explained by emissions from of fossil fuels." because it is factually not correct: several other explanations exist including, for example, the diffusion of gases from regions of high concentration through sealing firn (the FAR says the ice takes 83 years to seal). [Richard S Courtney]	Rejected. Alternate explanations fail to be consistent with the CO2 isotopic evidence and the observed O2 decline.
1-70	A	26:3	26:3	For completeness and accuracy it is very important to insert the following paragraph, otherwise the Section would be extremely misleading. "The ice core data are not supported by stomata measurements from ancient plants. The leaves of plants adjust the sizes of their stomata with changing atmospheric CO2 concentration and this permits the determination of past atmospheric CO2 concentrations by analysis of leaves preserved, for example, in peat bogs. (e.g. Retallack (2001), Wagner et al. (2004), Kouwenberg et al. (2003)). The disagreement with the ice core data is clearly seen in all published studies of the stomata data. For example, as early as 1999 Wagner reported that studies of birch leaves indicated a rapid rise of atmospheric CO2 concentration from 260 to 327 ppmv (which is similar to the rise in the twentieth century) from late Glacial to Holocene conditions. This ancient rise of 67 ppmv in atmospheric CO2 concentration is indicated by the stomata data at a time when the ice core data indicate only 20 ppmv rise. (refs. Retallack G, Nature vol. 411 287 (2001), Wagener F, et al. Virtual Journal Geobiology, vol.3. Issue 9, Section 2B (2004), Kouenberg et al. American Journal of Botany, 90, pp 610-619 (2003), Wagner F et al. Science vol. 284 p 92 (1999)). [Richard S Courtney]	Rejected. The direct air measurements in the ice cores are far more reliable than the proxies from stomata.
1-71	A	37:35	37:35	For completeness and accuracy, after "… absorbed solar energy." it is very important to insert the following otherwise the answer would be very misleading. "However, it is important to note that this warming may not result in a discernible change to surface temperature. The climate system is complex and a change to any of its parts will induce changes in its other parts. For example, surface warming increases evapouration that cools the surface and may increase cloud cover so may reflect more solar radiation and may result in an increase to precipitation. The challenge for climatology – as exemplified in climate models – is to determine how the entire climate system will respond to induced changes such as altered radiative forcing." [Richard S Courtney]	Taken into account. The text of all the FAQs has been extensively revised. Nevertheless, the conjectures offered in the suggested text, by emphasizing negative feedbacks only, do not represent a balanced view. After all, it is hardly likely that all the uncertainties will be such as to oppose an increase in surface temperature. The revised text takes these issues into account.
1-72	A	38:6	38:6	Replace the statement "Climate change causes changes in weather" with "Persistent change in weather is climate change" because the statement in the draft Answer is	Rejected. Climate is more than just weather. It is also ocean and ice cover

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				factually incorrect: also, the statement in the draft disagrees with the definition of climate and with the explanation of climate that precedes the statement. [Richard S Courtney]	and biosphere interactions, for example. The text of all the FAQs has been extensively revised.
1-73	A	38:11	38:11	Replace the statement "a climate forecast … rainier than normal" with "a climate forecast may indicate that future winters are likely to be rainier than those in recent past decades" because the statement in the draft Answer is factually incorrect: a prediction of 'more-than-usual rain for the next three months' is a long term weather forecast, but a prediction that 'the conditions determining the likely weather in a season' are likely to change is a climate forecast. [Richard S Courtney]	Rejected. A three-month prediction is a climate prediction, not a weather prediction. The limit of predictability of weather is on the order of 2 weeks. The text of all the FAQs has been extensively revised.
1-74	A	38:44	38:44	Replace the phrase "and more tractable" with "and may be a more tractable" because the statement in the draft Answer is an arrogant and presumptive assertion that cannot be demonstrated to be correct until 50 years have elapsed (and the attempt at justification for this assertion utilises a completely inappropriate analogy). [Richard S Courtney]	Rejected. The problem is more tractable because of the different nature of the problem. Forecasting the weather 50 days from now is impossible, so almost anything is more tractable than that. The text of all the FAQs has been extensively revised.
1-75	A	38:53	38:54	Replace the sentence, "As climate changes, … in a probabalistic sense" with "Changes to climate are observed as changes to the weather that occurs because climate is the integral of weather." because the statement in the draft Answer is simply wrong. (This statement in the draft is one of the examples that demonstrate the authors of this draft Answer are very confused about the relationship of weather to climate). [Richard S Courtney]	Rejected. Climate is more than the integral of weather. Climate includes oceans and the cryosphere, for example. The text of all the FAQs has been extensively revised.
1-76	A	40:1	40:1	The start of this draft Answer is so wrong that it beggars belief (it should be given a 'fail' grade if submitted as answer to an assignment by an undergraduate). The following change is the minimum required to raise the start of this draft Answer to an acceptable standard. Replace the phrase, "The Earth has a natural greenhouse effect" with the following: "The greenhouse effect of the Earth is the increase to the Earth's surface temperature that results from the presence of the Earth's atmosphere. This rise in temperature is caused by several effects, notably the radiative, convective and evapourative components. The convective component of the greenhouse effect increases mean global temperature by transfer of heat from the Earth's hottest regions to cooler ones. Radiation from the Sun heats the Earth's day side and most heats the equator on the day side. It does not heat the Earth's night side and does not heat the poles in winter. So, air in contact with the day-side surface is (on average) heated by conduction especially near the equator. The heated air rises by convection, and circulation cells move that heat polewards (and nightwards)	Rejected. "Greenhouse effect" is defined in the AR4 Glossary and was defined in the TAR Glossary. The same is true for "natural greenhouse effect." The definition of greenhouse effect implicit in the suggested text is at variance with both the Glossary and customary scientific usage. The text of all the FAQs has been extensively revised. The new text improves upon several aspects touched on in this comment without redefining terminology or using it inconsistently as is done by the suggested text.

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				where the surface is (on average) heated by conduction from the air. But the thermal energy radiated by a surface is proportional to the fourth power of the surface temperature. Hence, the cooling of the day-side especially near the equator (i.e. the hottest region of the Earth) much reduces the thermal heat loss from the planet and, therefore, the average temperature of the planet must rise to maintain thermal equilibrium (i.e. [solar heat absorbed by the planet] = [heat radiated from the planet]). The evaporative component of the greenhouse effect works in the same way as the convective component but more efficiently because water absorbs much heat as latent heat when it evapourates. Heat is transported from the hotter surface regions as latent heat of evaporation. Both these mechanisms raise the mean global temperature and reduce the range of surface temperatures over the planet (e.g. on the Moon the temperature rises hundreds of degrees within an hour of dawn, but nowhere on Earth experiences such large temperature variations and such large temperature differences do not exist between points on the Earth). Both the evaporative and the convective components of the greenhouse effect would operate if water was not a radiative greenhouse gas and the air contained no greenhouse gases. And the fact that nowhere on Earth has large day to night temperature variations (as on the Moon) indicates these components of the greenhouse effect are at least as important to climate as the radiative component. Also, the polar regions are net radiation emitters because they obtain almost all of their heat from ocean currents and wind. The radiative component of the greenhouse effect is" [Richard S Courtney]	
1-77	A	40:23	40:24	Replace the phrase, "The natural greenhouse effect" with "The natural radiative component of the greenhouse effect" because the statement in the draft Answer is factually incorrect in that it states that the radiative component of the greenhouse effect is the totality of the greenhouse effect and, for example, denies the existence of the convective and evapourative components of the greenhouse effect. [Richard S Courtney]	Rejected for the reasons stated in the response to comment (1-76).
1-78	A	40:47	40:47	Replace the phrase, "a natural greenhouse effect" with "a natural radiative component of the greenhouse effect" because the statement in the draft Answer is factually incorrect in that it states that the radiative component of the greenhouse effect is the totality of the greenhouse effect and, for example, denies the existence of the convective and evapourative components of the greenhouse effect. [Richard S Courtney]	Rejected for the reasons stated in the response to comment (1-76).
1-79	A	40:47	40:48	Replace the phrase, "a natural greenhouse effect" with "a natural radiative component of	Rejected for the reasons stated in the

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				the greenhouse effect" because the statement in the draft Answer is factually incorrect in that it states that the radiative component of the greenhouse effect is the totality of the greenhouse effect and, for example, denies the existence of the convective and evapourative components of the greenhouse effect. [Richard S Courtney]	response to comment (1-76).
1-80	A	40:51	40:51	Replace the phrase, "the natural greenhouse effect" with "the natural radiative component of the greenhouse effect" because the statement in the draft Answer is factually incorrect in that it states that the radiative component of the greenhouse effect is the totality of the greenhouse effect and, for example, denies the existence of the convective and evapourative components of the greenhouse effect. [Richard S Courtney]	Rejected for the reasons stated in the response to comment (1-76).
1-81	A	41:8	41:17	The statements from, "These observations …" to "… in detail." Are inaccurate and grossly misleading so they should be replaced with the following or similar. "The observations are consistent with the hypothesis that the water vapour feedback is positive if the possible effect on cloud cover is ignored. Quantitatively, this positive radiative feedback could be strong enough to double the change in the radiative feedback due to the added carbon dioxide alone. However, the increased moisture in the air at all elevations could be expected to increase cloud cover that reflects solar radiation and thus provide a negative feedback. An increase to reflective cloud cover of less than 2% would provide a greater negative feedback than the effect of a doubling of carbon dioxide with the maximum possible positive radiative feedback from water vapour. But such a small change in cloud cover is not yet capable of being observed. Hence, the net feedback effect of water vapour remains a subject requiring urgent research. These issues are further complicated by our lack of understanding of the processes that govern the behaviours of clouds, including the processes that form clouds. So, in brief, although the physics that govern the radiative component of the greenhouse effect are well understood, the behaviours of the climate system in response to changes of that component remain to be resolved and are the focus of much climate research." [Richard S Courtney]	Rejected. Statements such as "the increased moisture in the air at all elevations could be expected to increase cloud cover" are not founded on established research results and are simply conjecture. The text of all the FAQs has been extensively revised. The new text improves upon several aspects touched on in this comment. It is true that, "the net feedback effect of water vapour remains a subject requiring urgent research," but the discussion in the suggested text conveys neither the present state of scientific understanding of water vapour feedbacks nor the justification for the research urgency.
1-82	A	45:0		Replace the title with, "Figure 1.3. The Keeling curve showing the rise of atmospheric carbon dioxide concentration measured at Mauna Loa, Hawaii" because the draft title is untrue, polemical assertion (the report may intend to be a sales brochure for one very limited scientific opinion but there is no need to be this blatant about it).	Taken into account. Figures and captions are being modified.

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				[Richard S Courtney]	
1-83	A	47:0		In the Figure title, between "of the" and "components" insert "major" because the title implies the diagram is comprehensive and it is not. [Richard S Courtney]	Taken into account. Figures and captions are being modified.
1-84	A	48:0		Replace the notation, "The Greenhouse Effect" with "The Radiative Component of the Greenhouse Effect" because the statement in the draft diagram is factually incorrect in that it states that the radiative component of the greenhouse effect is the totality of the greenhouse effect and, for example, denies the existence of the convective and evapourative components of the greenhouse effect. [Richard S Courtney]	Rejected for the reasons stated in the response to comment (1-76).
1-85	A	48:0		In the Figure title replace the phrase, "the natural greenhouse effect" with "the natural radiative component of the greenhouse effect" because the statement in the draft title is factually incorrect in that it states the radiative component of the greenhouse effect is the total greenhouse effect and, for example, denies the existence of the convective and evapourative components of the greenhouse effect. [Richard S Courtney]	Rejected for the reasons stated in the response to comment (1-76).