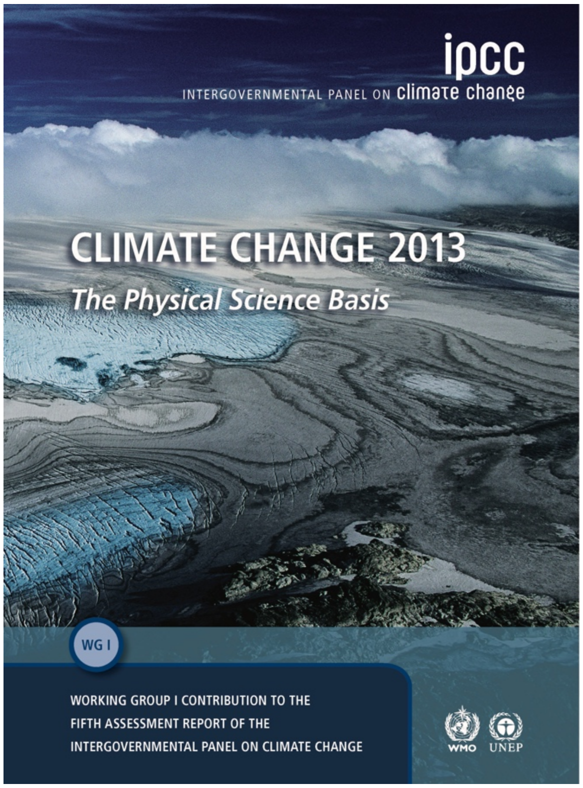

Fig. 1. IPCC Cover: Stocker, Thomas F. and Dahe Qin (eds.). *Climate Change 2013 The Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. Geneva: Intergovernmental Panel on Climate Change (2013), i.

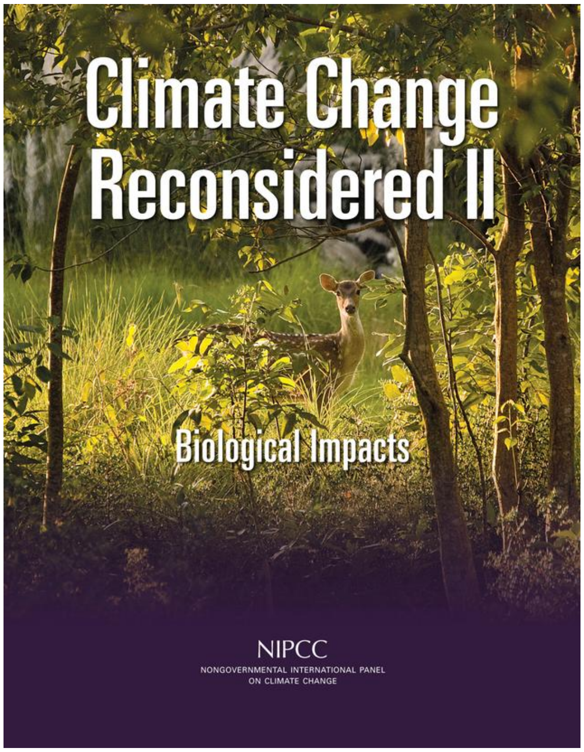

Fig. 2. NIPCC Cover: Idso, Craig D., Robert M. Carter, S. Fred Singer (eds.). *Climate Change Reconsidered II: Physical Science*. Chicago: The Heartland Institute (2013), i.

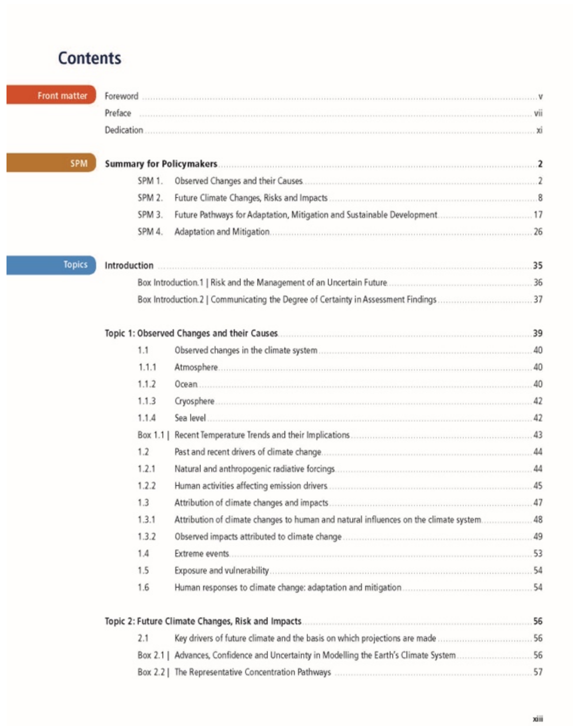

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Fig. 3 IPCC Table of Contents: Rajendra K. Pachauri, Leo A. Meyer (eds.). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* Geneva: Intergovernmental Panel on Climate Change (2014), xiii.

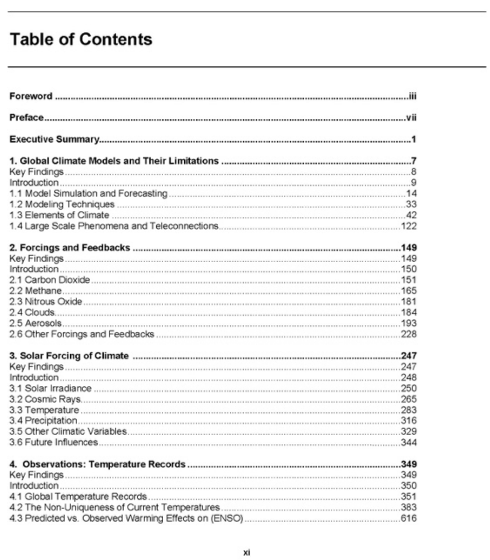

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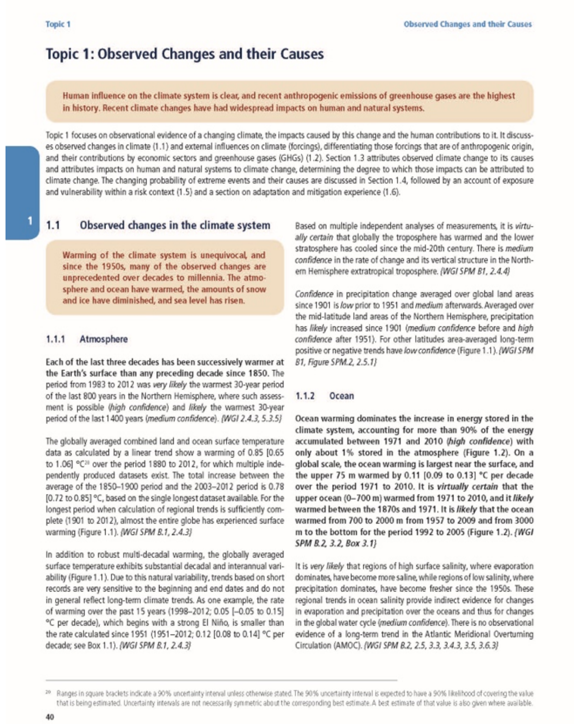
Fig. 4 NIPCC Table of Contents: Idso, Carter, and Singer (eds.). *Climate Change Reconsidered II*, xii.



Topic 1: Observed Changes and their Causes

Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.

Topic 1 focuses on observational evidence of a changing climate, the impacts caused by this change and the human contributions to it. It discusses observed changes in climate (1.1) and external influences on climate (forcings), differentiating those forcings that are of anthropogenic origin, and their contributions by economic sectors and greenhouse gases (GHGs) (1.2). Section 1.3 attributes observed climate change to its causes and attributes impacts on human and natural systems to climate change, determining the degree to which those impacts can be attributed to climate change. The changing probability of extreme events and their causes are discussed in Section 1.4, followed by an account of exposure and vulnerability within a risk context (1.5) and a section on adaptation and mitigation experience (1.6).

1

1.1 Observed changes in the climate system

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.

1.1.1 Atmosphere

Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. The period from 1983 to 2012 was *very likely* the warmest 30-year period of the last 800 years in the Northern Hemisphere, where such assessment is possible (*high confidence*) and *likely* the warmest 30-year period of the last 1400 years (*medium confidence*). *{WGI 2.4.3, 5.3.5}*

The globally averaged combined land and ocean surface temperature data as calculated by a linear trend show a warming of 0.85 [0.65 to 1.06] °C[20] over the period 1880 to 2012, for which multiple independently produced datasets exist. The total increase between the average of the 1850–1900 period and the 2003–2012 period is 0.78 [0.72 to 0.85] °C, based on the single longest dataset available. For the longest period when calculation of regional trends is sufficiently complete (1901 to 2012), almost the entire globe has experienced surface warming (Figure 1.1). *{WGI SPM B.1, 2.4.3}*

In addition to robust multi-decadal warming, the globally averaged surface temperature exhibits substantial decadal and interannual variability (Figure 1.1). Due to this natural variability, trends based on short records are very sensitive to the beginning and end dates and do not in general reflect long-term climate trends. As one example, the rate of warming over the past 15 years (1998–2012; 0.05 [–0.05 to 0.15] °C per decade), which begins with a strong El Niño, is smaller than the rate calculated since 1951 (1951–2012; 0.12 [0.08 to 0.14] °C per decade; see Box 1.1). *{WGI SPM B.1, 2.4.3}*

Based on multiple independent analyses of measurements, it is *virtually certain* that globally the troposphere has warmed and the lower stratosphere has cooled since the mid-20th century. There is *medium confidence* in the rate of change and its vertical structure in the Northern Hemisphere extratropical troposphere. *{WGI SPM B1, 2.4.4}*

Confidence in precipitation change averaged over global land areas since 1901 is *low* prior to 1951 and *medium* afterwards. Averaged over the mid-latitude land areas of the Northern Hemisphere, precipitation has *likely* increased since 1901 (*medium confidence* before and *high confidence* after 1951). For other latitudes area-averaged long-term positive or negative trends have *low confidence* (Figure 1.1). *{WGI SPM B1, Figure SPM.2, 2.5.1}*

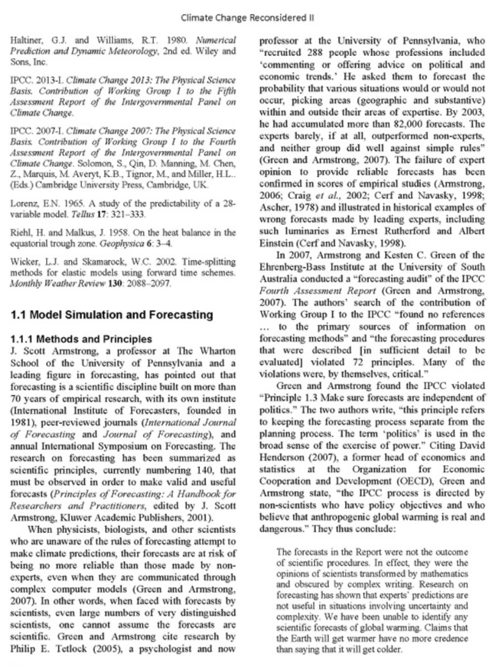
1.1.2 Ocean

Ocean warming dominates the increase in energy stored in the climate system, accounting for more than 90% of the energy accumulated between 1971 and 2010 (*high confidence*) with only about 1% stored in the atmosphere (Figure 1.2). On a global scale, the ocean warming is largest near the surface, and the upper 75 m warmed by 0.11 [0.09 to 0.13] °C per decade over the period 1971 to 2010. It is *virtually certain* that the upper ocean (0–700 m) warmed from 1971 to 2010, and it *likely* warmed between the 1870s and 1971. It is *likely* that the ocean warmed from 700 to 2000 m from 1957 to 2009 and from 3000 m to the bottom for the period 1992 to 2005 (Figure 1.2). *{WGI SPM B.2, 3.2, Box 3.1}*

It is *very likely* that regions of high surface salinity, where evaporation dominates, have become more saline, while regions of low salinity, where precipitation dominates, have become fresher since the 1950s. These regional trends in ocean salinity provide indirect evidence for changes in evaporation and precipitation over the oceans and thus for changes in the global water cycle (*medium confidence*). There is no observational evidence of a long-term trend in the Atlantic Meridional Overturning Circulation (AMOC). *{WGI SPM B.2, 2.5, 3.3, 3.4.3, 3.5, 3.6.3}*

[20] Ranges in square brackets indicate a 90% uncertainty interval unless otherwise stated. The 90% uncertainty interval is expected to have a 90% likelihood of covering the value that is being estimated. Uncertainty intervals are not necessarily symmetric about the corresponding best estimate. A best estimate of that value is also given where available.

Fig. 5 Example page of IPCC Report: Pachauri and Meyer (eds.). *Climate Change 2014*, 40.



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Riehl, H. and Malkus, J. 1958. On the heat balance in the equatorial trough zone. *Geophysica* **6**: 3–4.

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1.1 Model Simulation and Forecasting

1.1.1 Methods and Principles

J. Scott Armstrong, a professor at The Wharton School of the University of Pennsylvania and a leading figure in forecasting, has pointed out that forecasting is a scientific discipline built on more than 70 years of empirical research, with its own institute (International Institute of Forecasters, founded in 1981), peer-reviewed journals (*International Journal of Forecasting* and *Journal of Forecasting*), and annual International Symposium on Forecasting. The research on forecasting has been summarized as scientific principles, currently numbering 140, that must be observed in order to make valid and useful forecasts (*Principles of Forecasting: A Handbook for Researchers and Practitioners*, edited by J. Scott Armstrong, Kluwer Academic Publishers, 2001).

When physicists, biologists, and other scientists who are unaware of the rules of forecasting attempt to make climate predictions, their forecasts are at risk of being no more reliable than those made by non-experts, even when they are communicated through complex computer models (Green and Armstrong, 2007). In other words, when faced with forecasts by scientists, even large numbers of very distinguished scientists, one cannot assume the forecasts are scientific. Green and Armstrong cite research by Philip E. Tetlock (2005), a psychologist and now professor at the University of Pennsylvania, who "recruited 288 people whose professions included 'commenting or offering advice on political and economic trends.' He asked them to forecast the probability that various situations would or would not occur, picking areas (geographic and substantive) within and outside their areas of expertise. By 2003, he had accumulated more than 82,000 forecasts. The experts barely, if at all, outperformed non-experts, and neither group did well against simple rules" (Green and Armstrong, 2007). The failure of expert opinion to provide reliable forecasts has been confirmed in scores of empirical studies (Armstrong, 2006; Craig *et al.*, 2002; Cerf and Navasky, 1998; Ascher, 1978) and illustrated in historical examples of wrong forecasts made by leading experts, including such luminaries as Ernest Rutherford and Albert Einstein (Cerf and Navasky, 1998).

In 2007, Armstrong and Kesten C. Green of the Ehrenberg-Bass Institute at the University of South Australia conducted a "forecasting audit" of the IPCC *Fourth Assessment Report* (Green and Armstrong, 2007). The authors' search of the contribution of Working Group I to the IPCC "found no references … to the primary sources of information on forecasting methods" and "the forecasting procedures that were described [in sufficient detail to be evaluated] violated 72 principles. Many of the violations were, by themselves, critical."

Green and Armstrong found the IPCC violated "Principle 1.3 Make sure forecasts are independent of politics." The two authors write, "this principle refers to keeping the forecasting process separate from the planning process. The term 'politics' is used in the broad sense of the exercise of power." Citing David Henderson (2007), a former head of economics and statistics at the Organization for Economic Cooperation and Development (OECD), Green and Armstrong state, "the IPCC process is directed by non-scientists who have policy objectives and who believe that anthropogenic global warming is real and dangerous." They thus conclude:

> The forecasts in the Report were not the outcome of scientific procedures. In effect, they were the opinions of scientists transformed by mathematics and obscured by complex writing. Research on forecasting has shown that experts' predictions are not useful in situations involving uncertainty and complexity. We have been unable to identify any scientific forecasts of global warming. Claims that the Earth will get warmer have no more credence than saying that it will get colder.

Fig 6. Example page of NIPCC Report: Idso, Carter, Singer (eds.). *Climate Change Reconsidered II*, 14.