The IPCC WG1 Fourth Assessment (2007) and Thoughts on Assessments and Policy

Susan Solomon

1. Introduction and background
2. IPCC process
3. Key findings of AR4 SPM
4. What makes an assessment count?
5. A few words about stratospheric ozone assessments
6. Discussion

IPCC WG1

IPCC (1995):

"Balance of evidence suggests discernible human influence"

IPCC (2001):

"Most of global warming of past 50 years *likely* (odds 2 out of 3) due to human activities"

IPCC (2007):

"Warming is unequivocal"

and

"Most of global warming of past 50 years *very likely* (odds 9 out of 10) due to human increases in greenhouse gases"

IPCC (2013): ??????

Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.

Intergovernmental Panel on Climate Change

Governments require information on climate change for negotiations

The IPCC formed in 1988 under auspices of the United Nations

Function is to provide assessments of the science of climate change

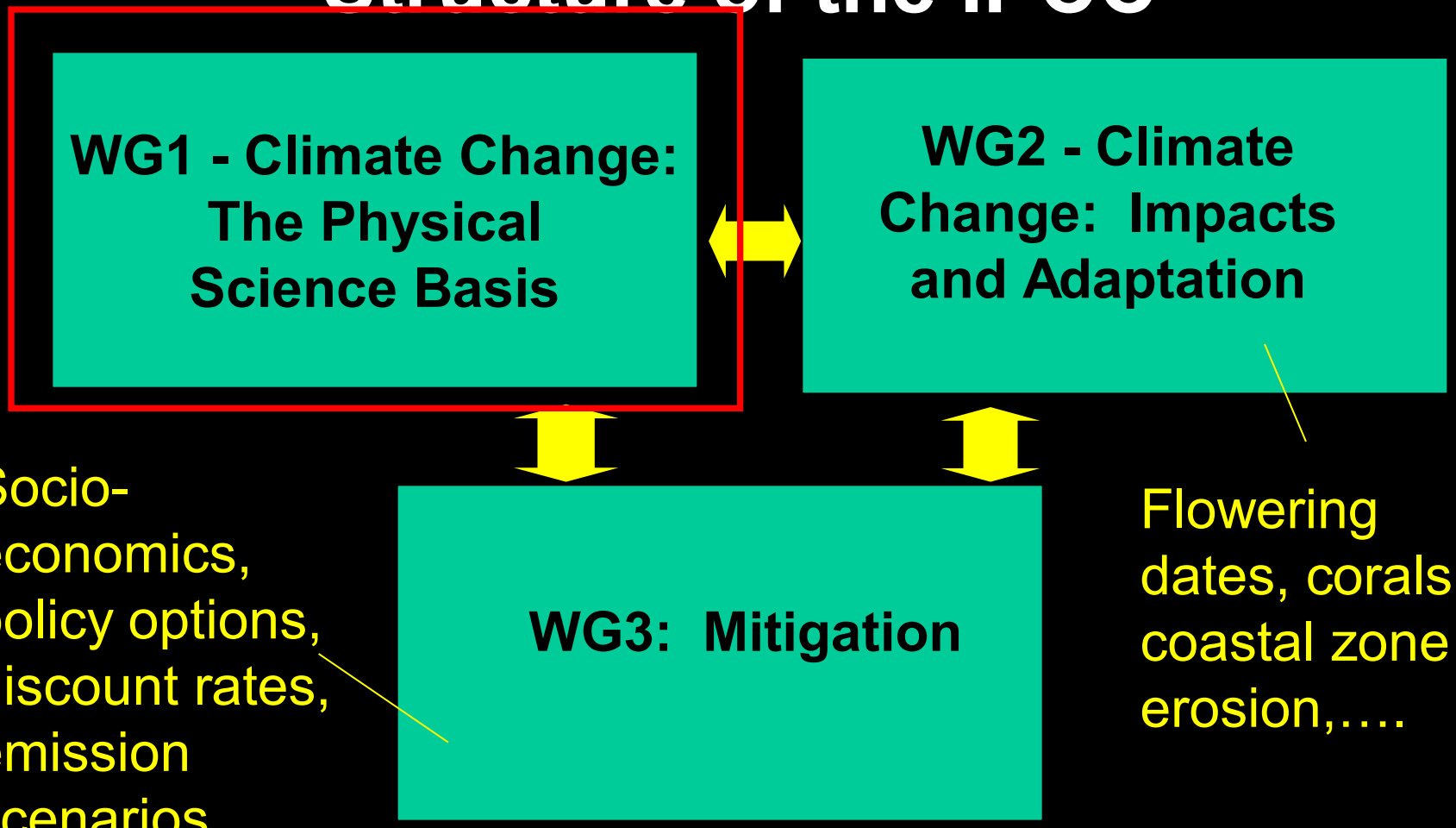
Photograph of IPCC meeting removed due to copyright restrictions.

Scientific community contributes widely and on a voluntary basis

75% of the authors in WG1 IPCC (2007) did not work on WG1 IPCC (2001)

Substance of IPCC WG1 report in the hands of scientists

Structure of the IPCC



Three different working groups with quite distinct scientific purviews and required expertise. Note: IPCC assesses research but it doesn't do research.

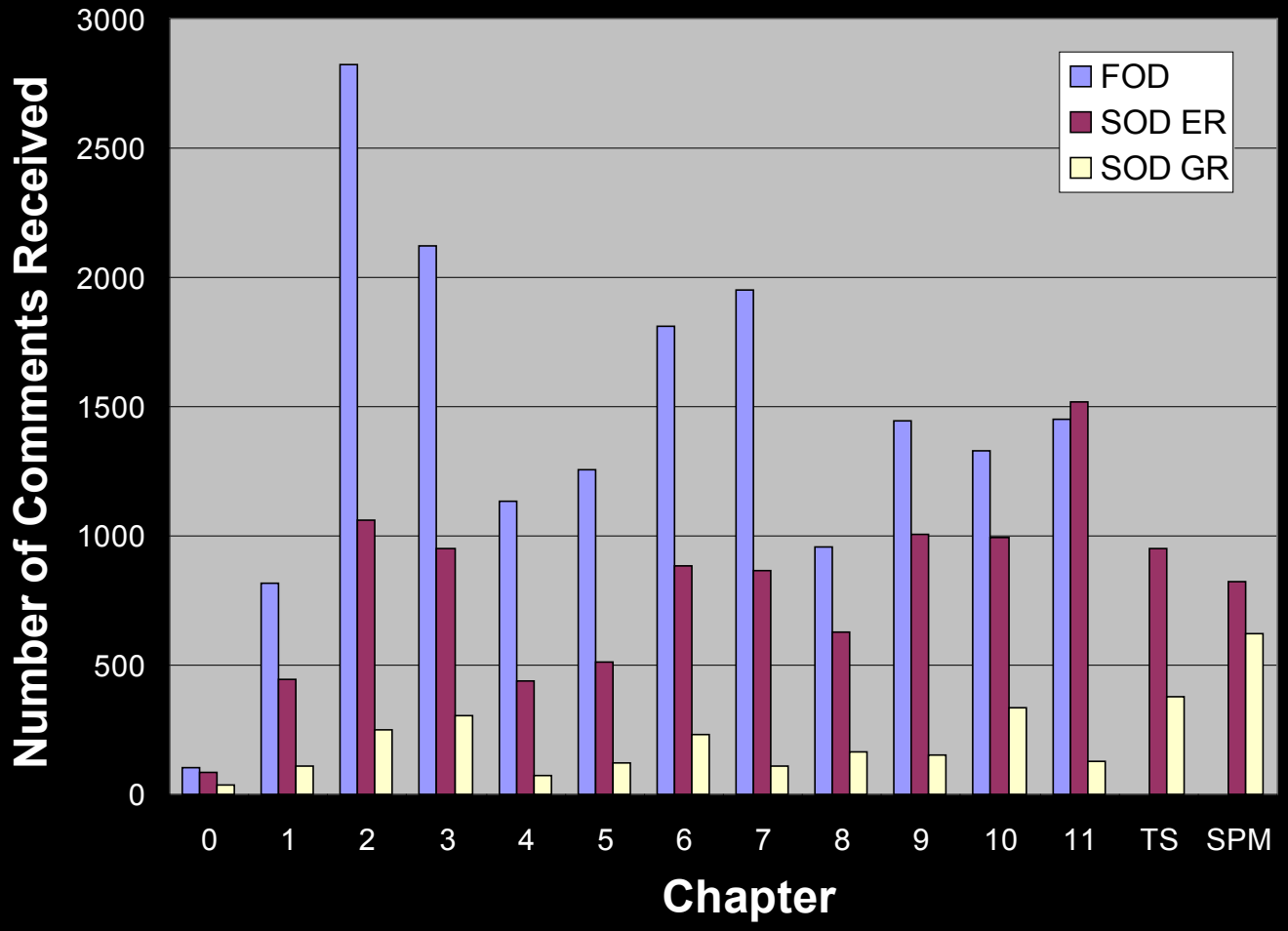
Preparation and Review of the WG1 AR4

- Each report is an assessment of the state of understanding based upon peer-reviewed published work. It goes through a demanding process of multiple reviews and revision and re-review:
- Informal ZOD prepared, comments sought from 6-12 outside experts for each chapter (Oct 2004 - Mar 2005).
- Formal first order draft (FOD) reviewed by about 600 reviewers worldwide (Sept -Nov 2005). Open to all reviewers.
- Formal second order draft (SOD) re-reviewed by about 600 experts worldwide and by dozens of governments (April-May 2006).
- Govt comments on revised Summary for Policy Makers only (Oct-Nov 2006); final approval word-by-word and line-by-line in Feb, 2007.

AR5: Sept 2013 Plenary

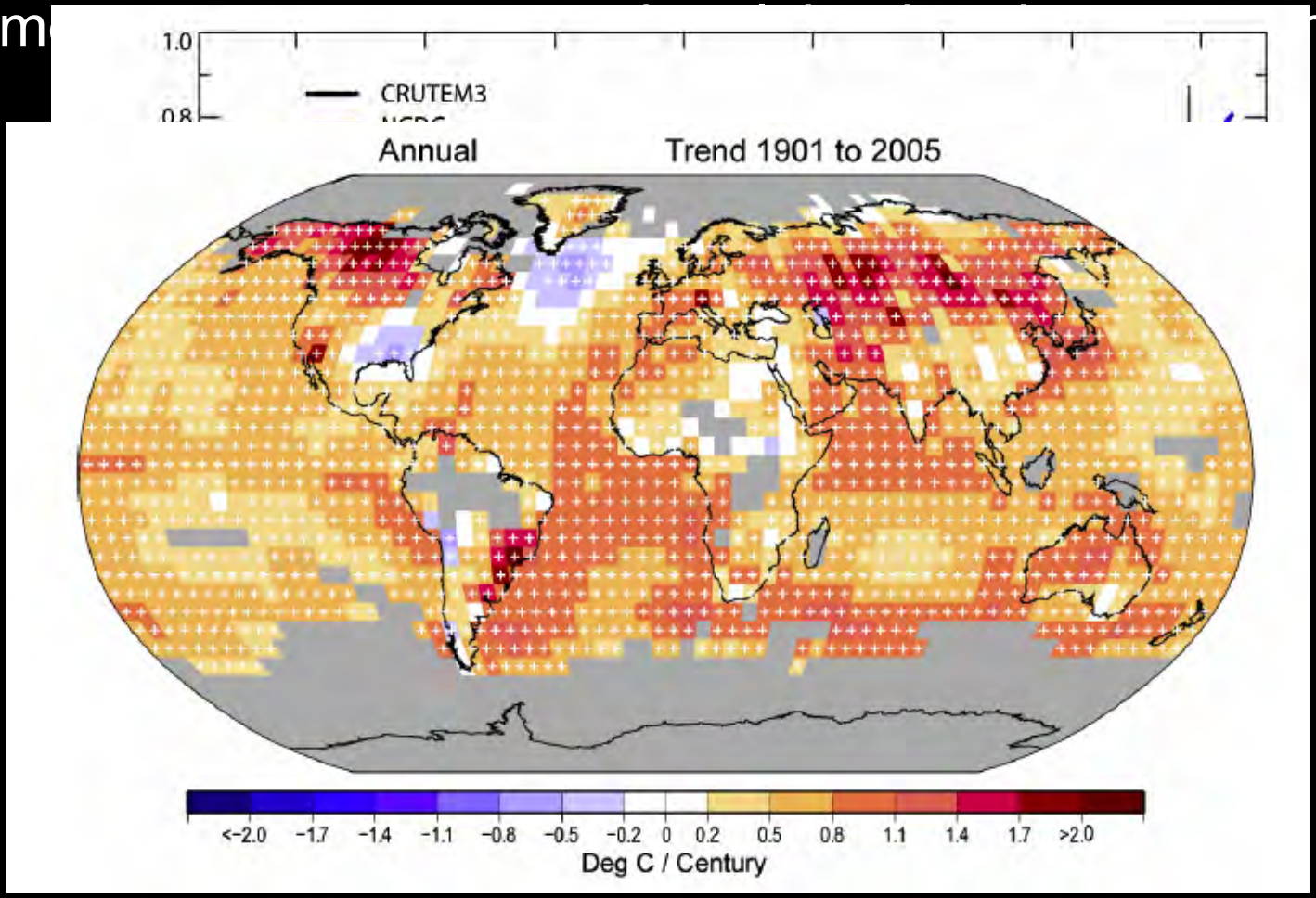
- WG1 received and carefully considered over 30000 comments in total (compare this to a typical scientific paper, normally reviewed by 2-3 experts). The assessment is not the view of any single scientist or few scientists. It reflects a broader process. All of the comments and responses were made available on the internet, and remain available now (via Harvard's archive).

Number of Comments Received on AR4



Final plenary, Paris, 2007

It’s warm ntury ago.



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.
Source: Climate Change 2007: The Physical Science Basis. Chapter 3. Observations: Surface and Atmospheric Climate Change. Figure 3.9. Page 250.

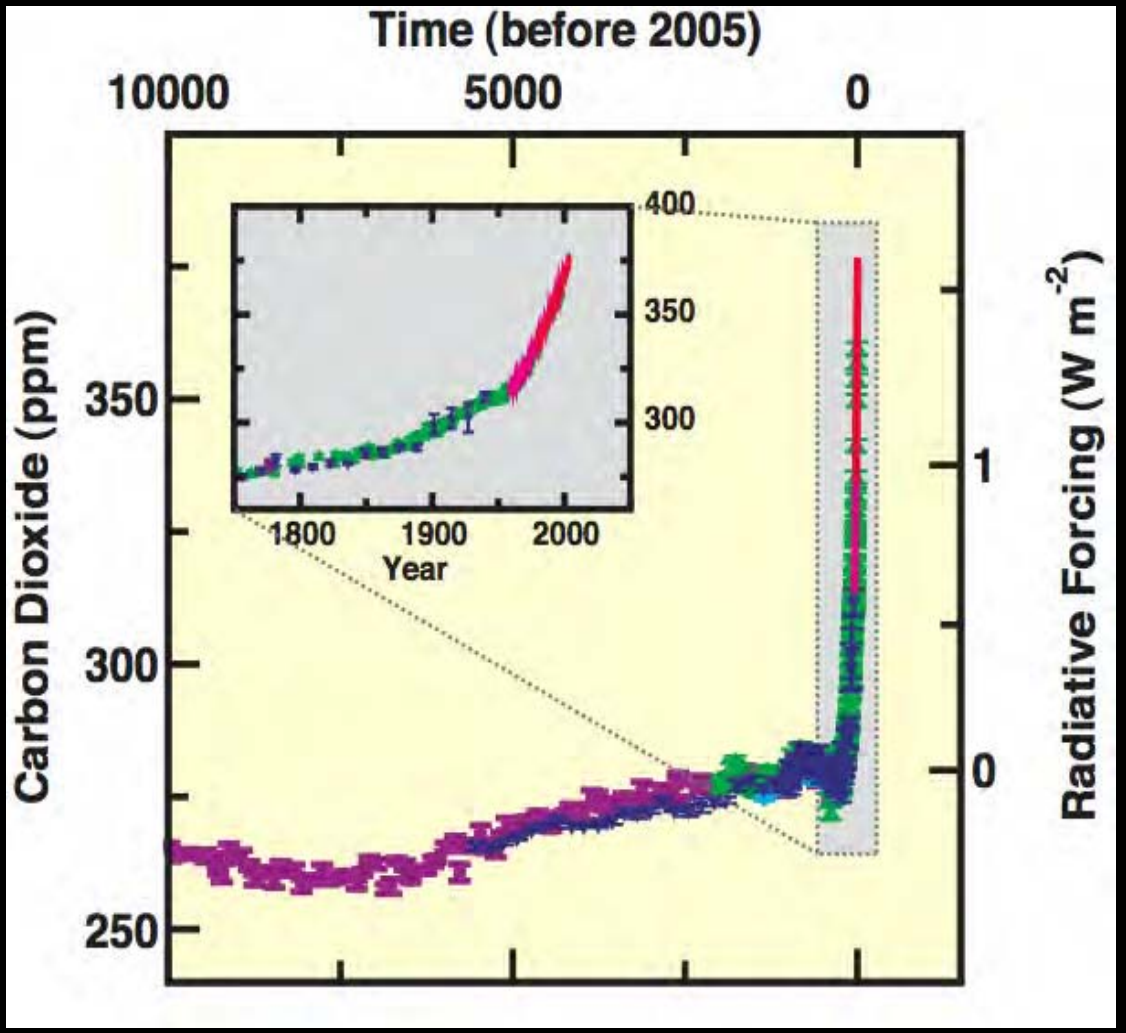
Globally averaged, the planet is about 0.75˚ C warmer than it was in 1860, based upon dozens of high-quality long records using thermometers worldwide, including land and ocean.

Paris plenary: acceleration of rate of warming since 1980? Not accepted.

Human Drivers of Climate Change: Unprecedented

CARBON DIOXIDE

- A critical greenhouse gas
- Dramatic increase in industrial era, forcing climate change
- Higher concentration than for more than 600,000 years



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission. Source: Climate Change 2007: The Physical Science Basis. Summary for Policy Makers. Figure SPM.1. Page 3.

A different world in today s warm Arctic: present and future

Courtesy of NOAA's National Ocean Service. License: CC-BY.

Courtesy of Vladimir Romanovsky. Used with permission.

The Arctic was also warm in the period 1925-1940, but the extent of warmth was not global at that time.

Massive future changes in Arctic sea ice are very likely.

Changes in sea ice don t significantly affect sea level because this ice is already floating. Changes in land ice (glaciers, ice caps, and ice sheets) do affect sea level.

Clear decreases in Arctic sea ice extent.

And warmer permafrost temperatures, and reductions in area of seasonally frozen ground…

Warming is Unequivocal

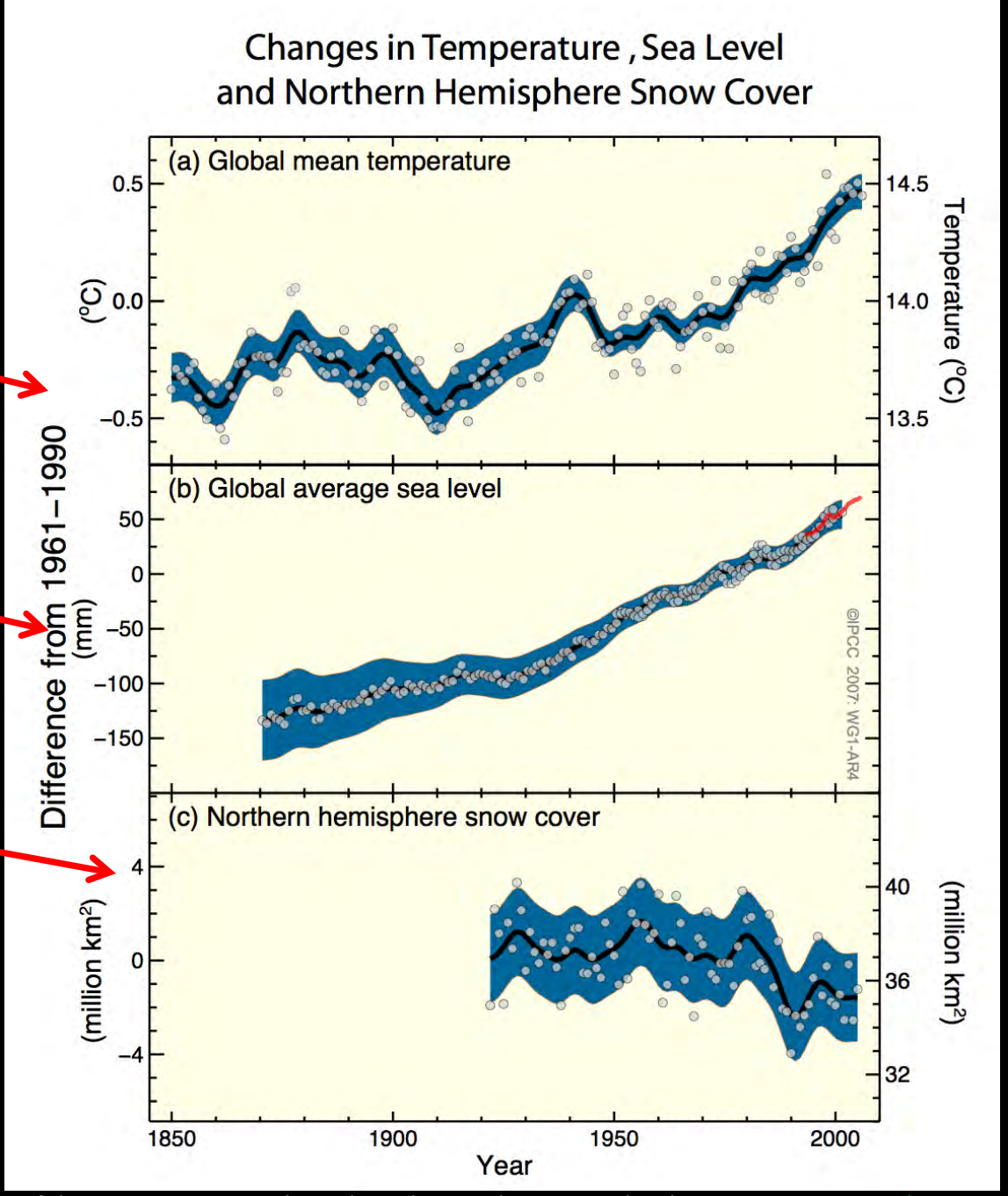
Rising atmospheric temperature

Rising sea level

Reductions in NH snow cover

And oceans...

And upper atmosphere….



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission. From: Climate Change 2007: The Physical Science Basis. Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Figure SPM.3, Cambridge University Press.

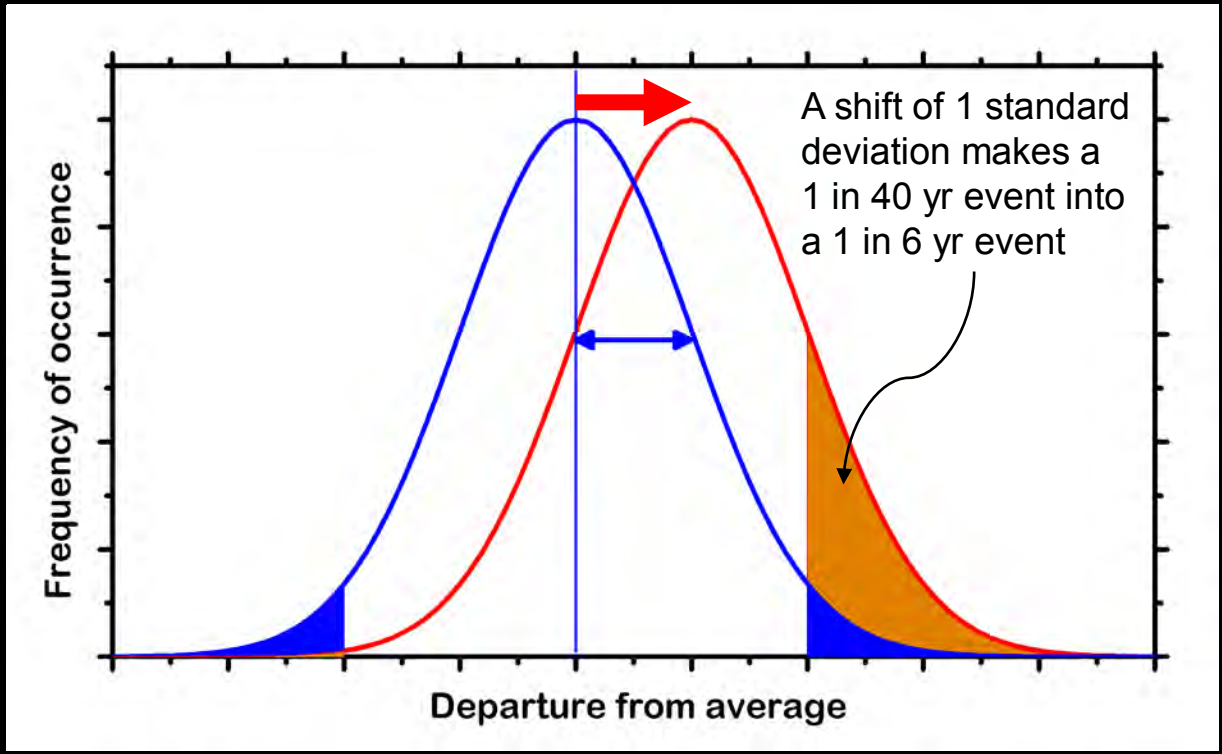
Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (see Figure SPM.3). {3.2, 4.2, 5.5}

Courtesy of the Intergovernmental Panel on Climate Change. Used with permission. Source: Climate Change 2007: The Physical Science Basis. Summary for Policy Makers. Observations: Surface and Atmospheric Climate Change.

Calculus of extremes

The distribution of weather events around the climatic average often follows a ‘bell-shaped’ curve.

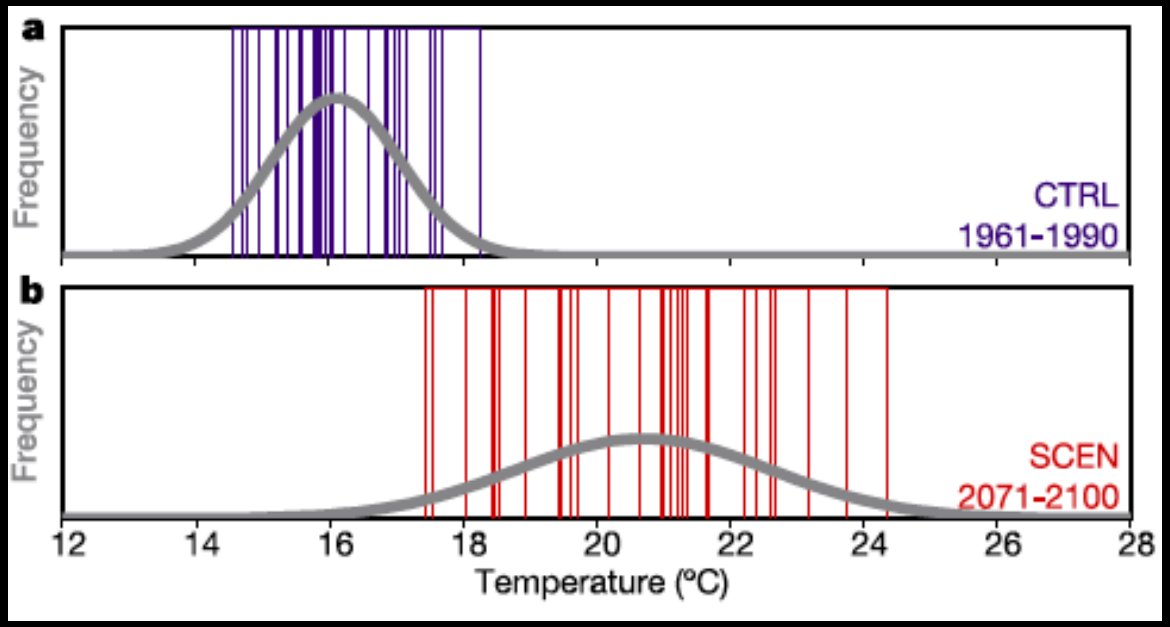
Climate change can involve change in the average, or the spread around the average (standard deviation), or both.



A shift in the distribution of temperatures has a much larger relative effect at the extremes than near the mean.

Extremes will increase

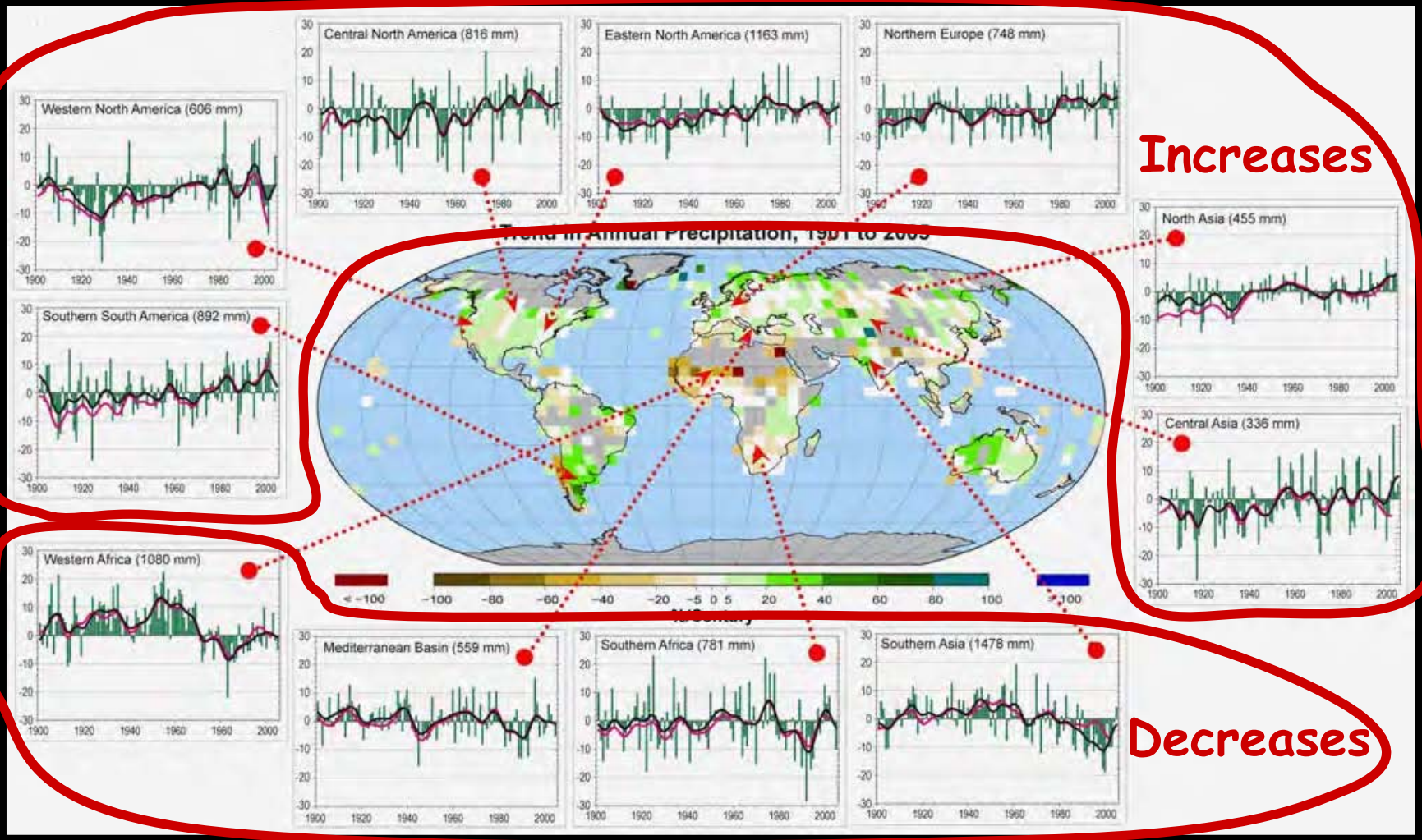
- Risk of 2003 type heat wave doubled in Europe due to current level of greenhouse gases (single study).
- Extreme summer temperatures become at least 20 times more frequent by end of century (average for 3 scenarios and for multiple models).



From Schar et al. [Nature, 2004], see also Stott et al. [Nature, 2006]. Europe will have many summers like 2003 in the 21st century. It will be a different Europe.

Source: Schär, Christoph, Pier Luigi Vidale, et al. "The Role of Increasing Temperature Variability in European Summer Heatwaves." *Nature* 427, no. 6972 (2004): 332-6.

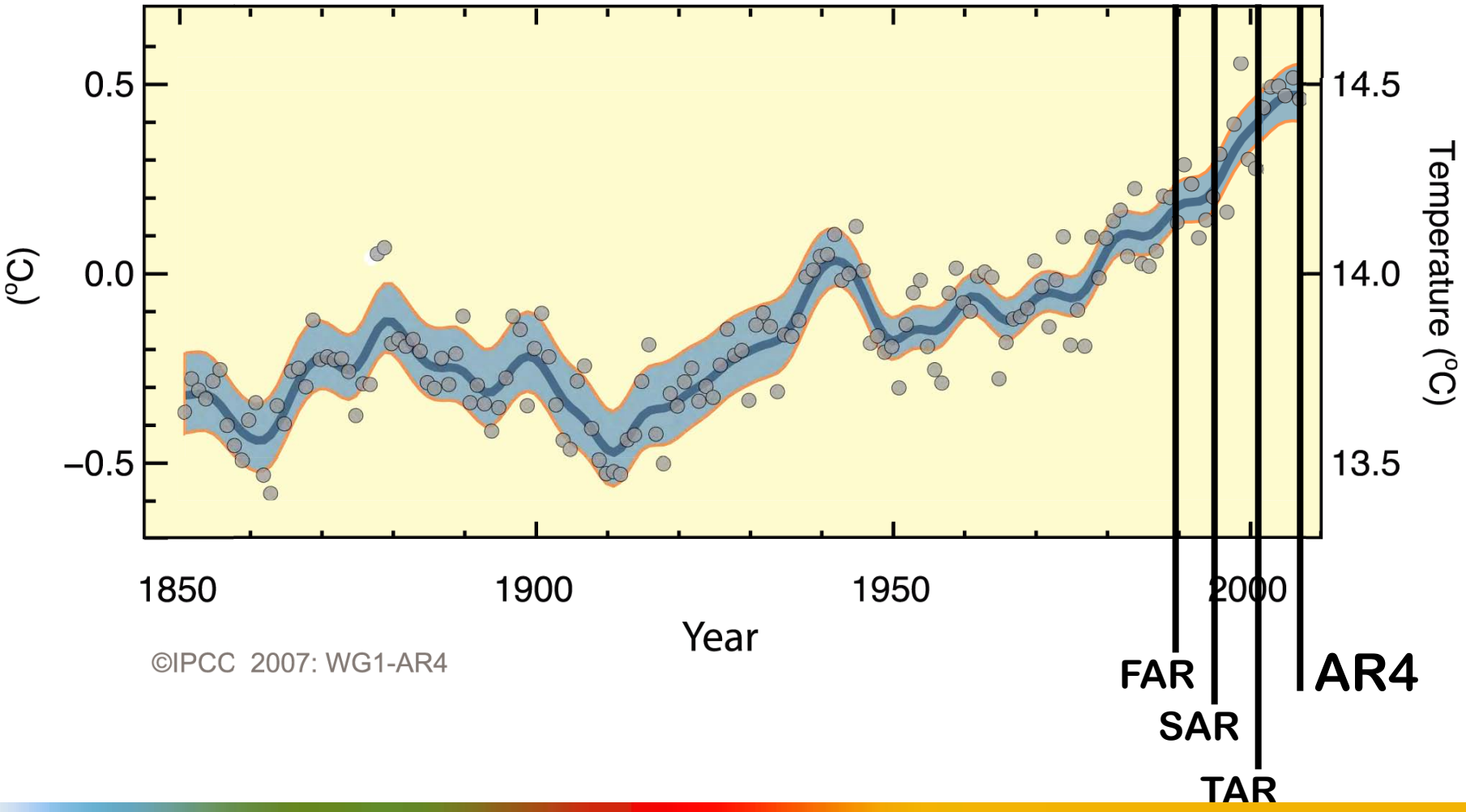
Land precipitation is changing significantly over broad areas



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.
Source: Climate Change 2007: The Physical Science Basis. Chapter 3. Observations: Surface and Atmospheric Climate Change. Figure 3.14. Page 257.

Smoothed annual anomalies for precipitation (%) over land from 1900 to 2005; other regions are dominated by variability.

Atmospheric Temperatures: On The Rise

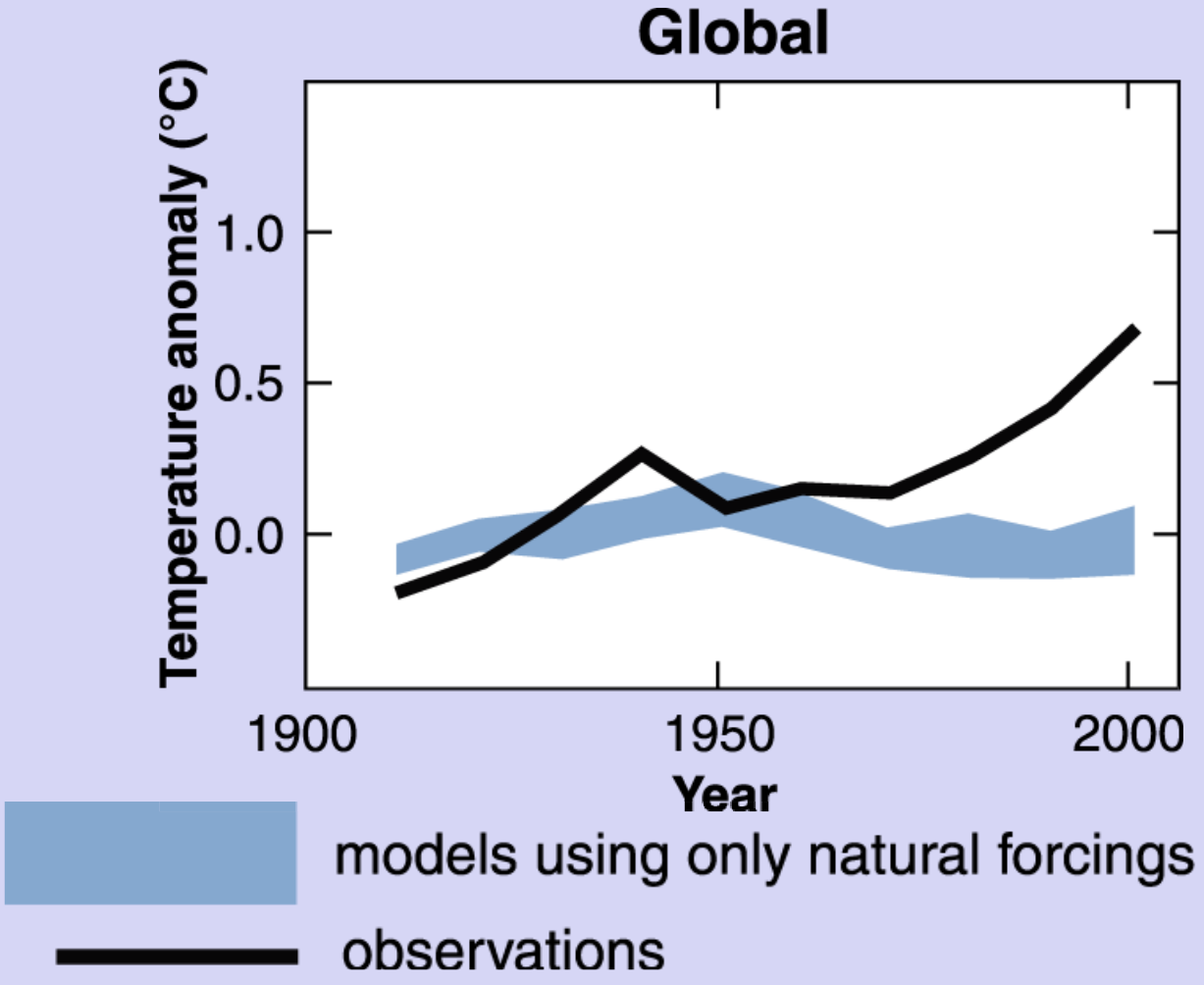


IPCC - WGI

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (see Figure SPM.3). {3.2, 4.2, 5.5}

Courtesy of the Intergovernmental Panel on Climate Change. Used with permission. Source: Climate Change 2007: The Physical Science Basis. Summary for Policy Makers. Figure SPM.4. Page 11.

Are Humans Responsible?



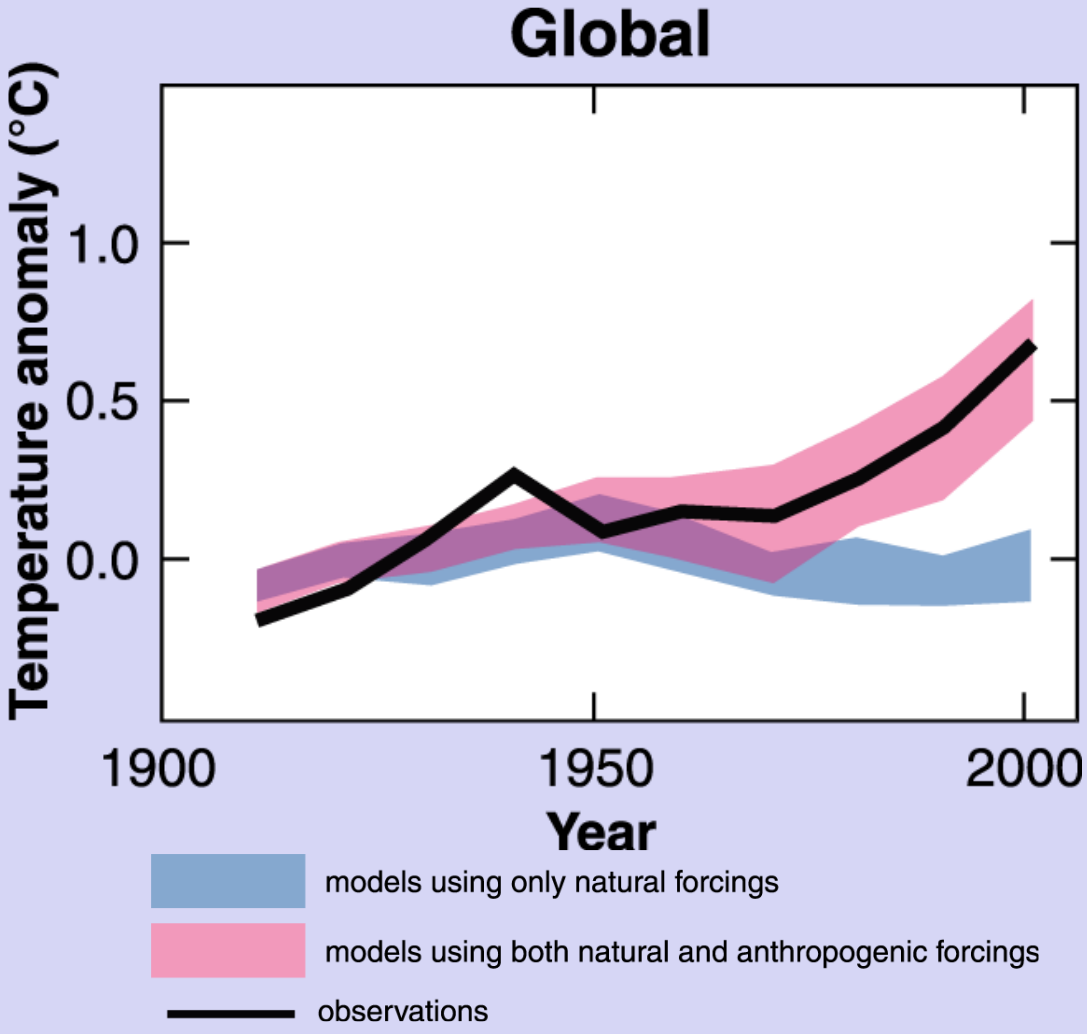
Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.
Source: Climate Change 2007: The Physical Science Basis. Summary for Policy Makers. Figure SPM.4. Page 11.

Are Humans Responsible?

IPCC (1995):
Balance of evidence suggests discernible human influence

IPCC (2001):
Most of warming of past 50 years (odds 2 out of 3) due to human activities

IPCC (2007):
Most of warming (odds 9 out of 10) due to greenhouse gases

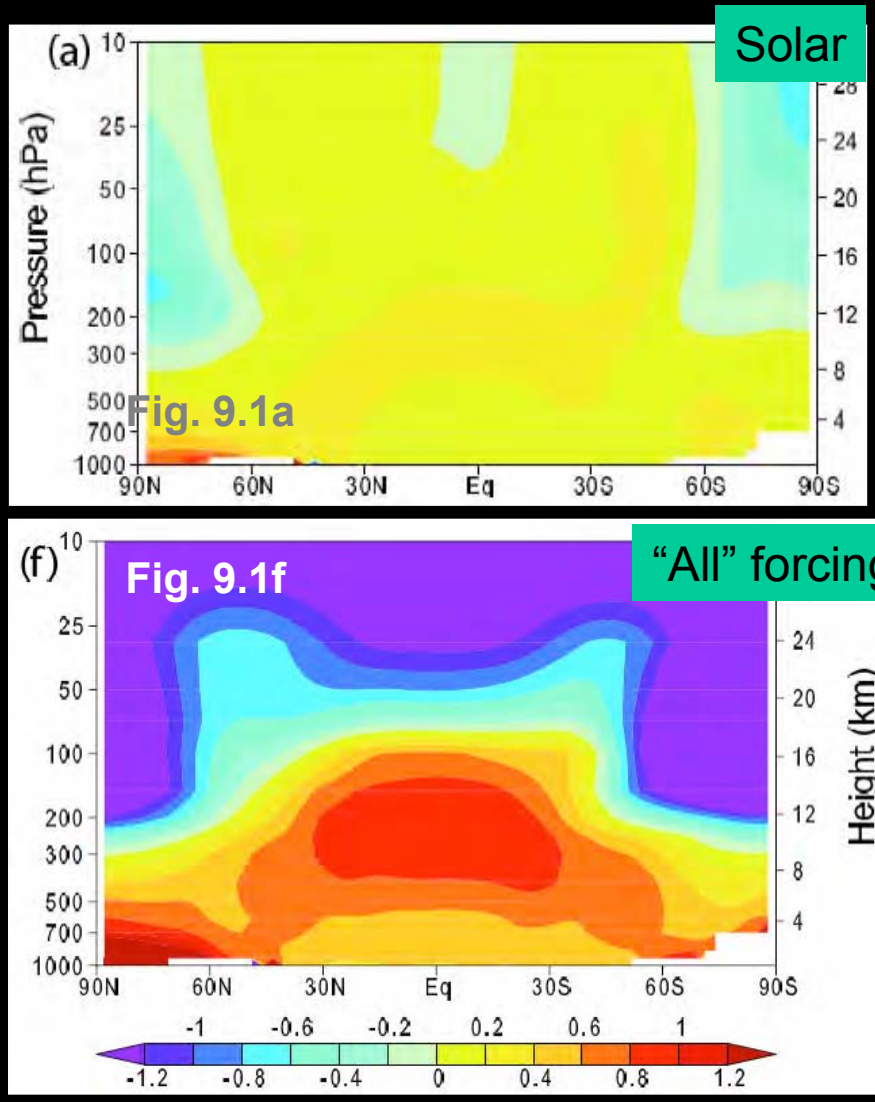


IPCC - WGI

Solar forcing cannot explain observed change

Attribution studies

- Separate time-space patterns of response.
- Solar response has very different behavior to GHG. For example, the upper atmosphere would be expected to be much warmer if solar irradiance were the cause of current climate change.



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.
Source: Climate Change 2007: The Physical Science Basis. Chapter 9: Understanding and Attributing Climate Change. Figure 3.9. Page 675.

Final approved language

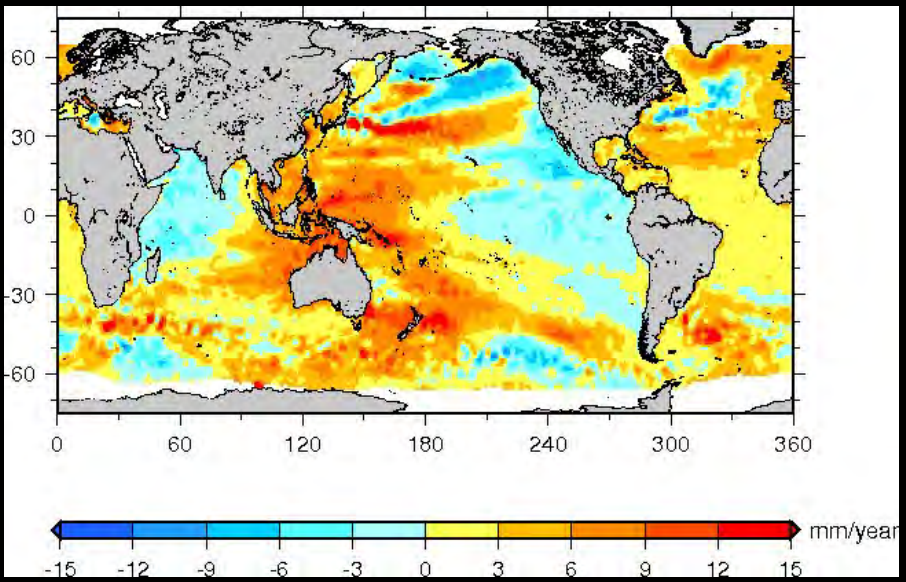
Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations.[12] This is an advance since the TAR's conclusion that "most of the observed warming over the last 50 years is *likely* to have been due to the increase in greenhouse gas concentrations". Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns (see Figure SPM.4 and Table SPM.2). {9.4, 9.5}

Both global ocean and global atmosphere warmed

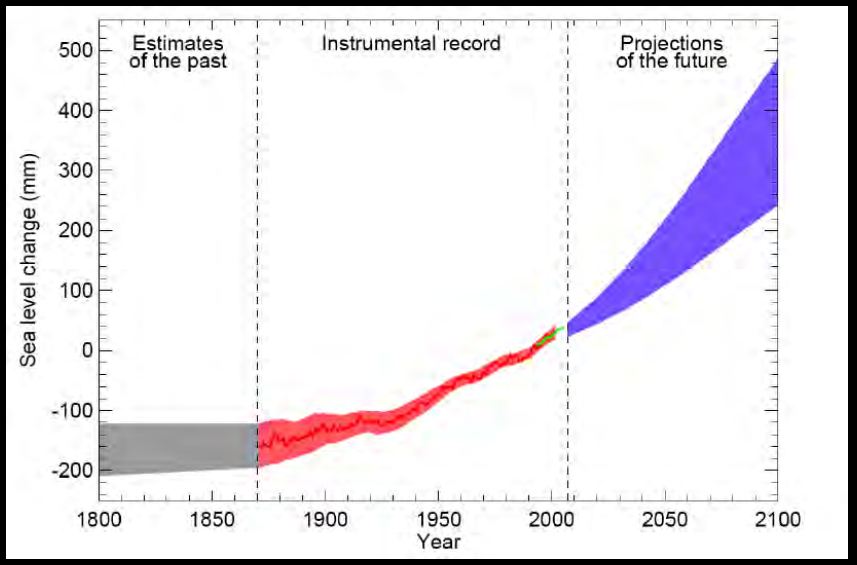
Warming took place at a time when natural forcing (sun+volcanoes) acted to cool

[12] Consideration of remaining uncertainty is based on current methodologies.

What else happens in a hotter world?



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.
Source: Climate Change 2007: The Physical Science Basis. Chapter 5: Observations: Oceanic Climate Change and Sea Level. Figure 5.15A. Page 412.



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.
Source: Climate Change 2007: The Physical Science Basis. Chapter 5: Observations: Oceanic Climate Change and Sea Level. Figure FAQ 5.1. Page 409.

Observations of sea level rise from satellites, 1993-2003.

The global average for the 20th century was about 6 inches (0.17m), mostly from expansion of the hot ocean and glacier melt. Also, the balance between melting and snowfall on Greenland gives current ice loss…

Future changes by 2100 could be up to 1.5 feet (0.5 m), and up to 3 feet (1 meter) just from these processes within about 2-3 centuries, depending on how much GHGs are emitted.

But what about other processes? Rapid ice flow?

Sea level rise and the ice sheets

- Accelerated ice sheet discharge observed - and not in current models. How much SLR?
- Uncertainty issues: some glaciological studies suggest that ice sheet discharge is transient and will stop.
- Note: Mass balance is important too. More snow expected at high latitudes in a future world.

A tough job in AR5, as it was in AR4.

Courtesy of Roger Braithwaite. Used with permission.

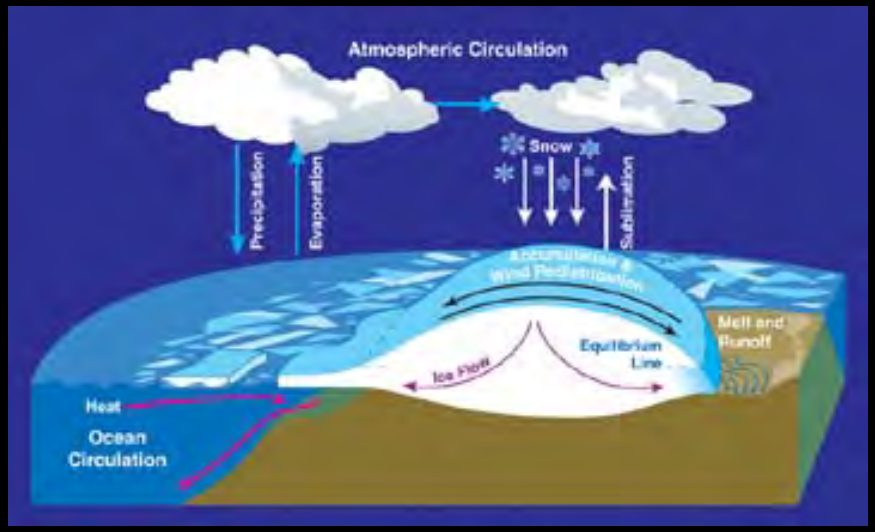
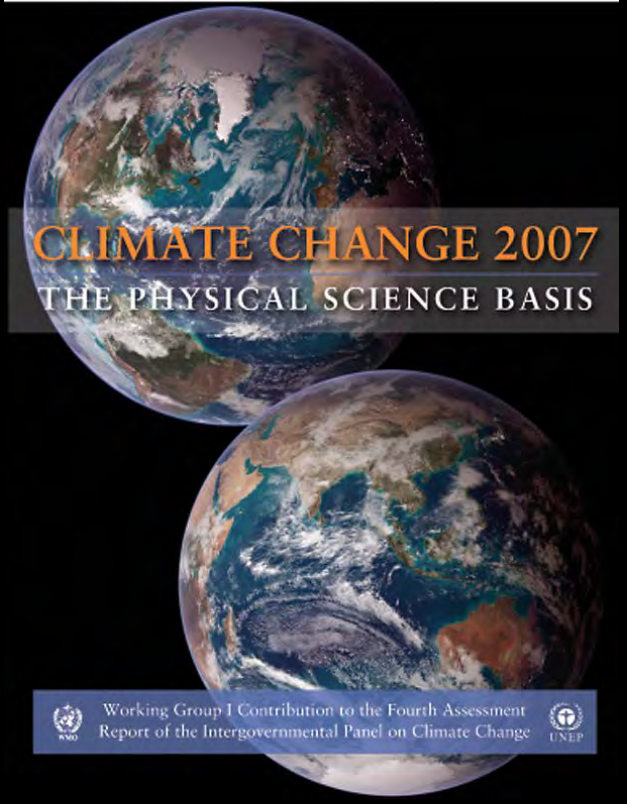


Image is by NASA and is in the public domain.


TSU WG I
Susan SOLOMON
Co-chair WG 1
Dahe QIN
Co-chair WG 1



Courtesy of the Intergovernmental Panel on Climate Change. Used with permission.

(Draft) Rules of Successful Assessment

1) **The product must be designed (and proven) to be useful….for <u>both</u> the stakeholders and the science community that produces it**

2) **There must be a clear demarcation of roles and procedures between the stakeholder/Governments and the scientists who produce the report. Independence is required.**

3) **The report must go through several staged and different rounds of careful review by a very broad range of experts and stakeholders.**

4) Scientific judgment must be the guiding force and final arbiter in the content and in responses to the review process. Authors must have "author"-ity.

5) The author teams must have adequate time. Never rush an assessment.

3) The report goes through several staged and different rounds of review

…there is a big difference between having just one review and having several of these different types. The IPCC system of developing a zero-order draft, informal review, first order draft, broad expert review, second order draft subject to a Government review means that the structure and content of the report is determined by scientists. The timing of the review involving governments (stakeholders) is key.

6) The assessment conclusions must be fully grounded in well-documented literature.

7) Stakeholder inputs must be provided in open yet formal forums (e.g., the IPCC plenary).

8) Clear science leadership must be provided by the chairs and lead author team, who are internationally known and respected scientists.

.

Rules for an IPCC co-chair to live by:

1) **…..the assessment doesn't drive the research (organizations like WCRP and IGBP should and do).**

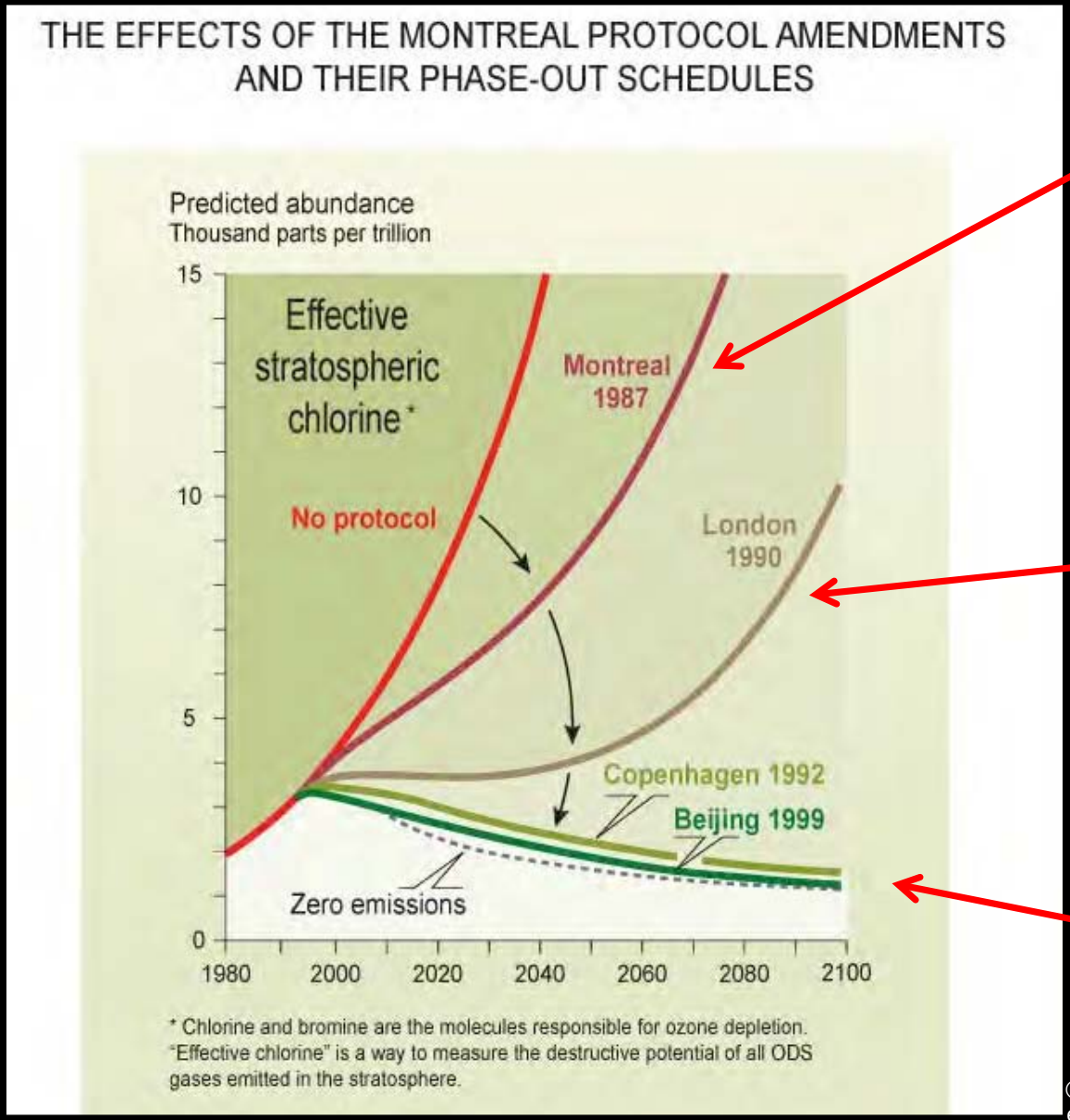
2) **…..force no consensus before its time.**

3) **…...policy-relevant but not policy-prescriptive assessment can be achieved because the best science is always highly self-critical and highly objective. Rely on the scientific culture and ethic (which works well when it operates objectively within its own standards) and communicate this clearly to authors, governments, and others. We are here to seek understanding, and only understanding.**

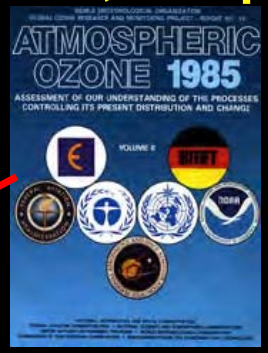
Uphold these rules for assessment vigorously.

Photograph by Tambako the Jaguar on flickr. CC-BY.

What is an Assessment? Science input to policy decisions, and built an epistemic community of scientists, technical experts, and policymakers



Courtesy of Emmanuelle Bournay, UNEP/GRID-Arendal. Used with permission.

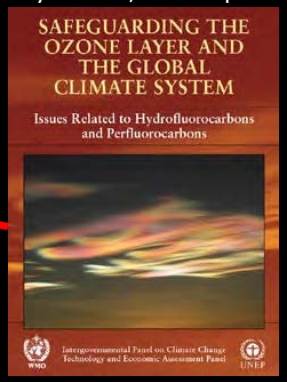


Ozone hole discovered

Figure by NOAA; in the public domain.

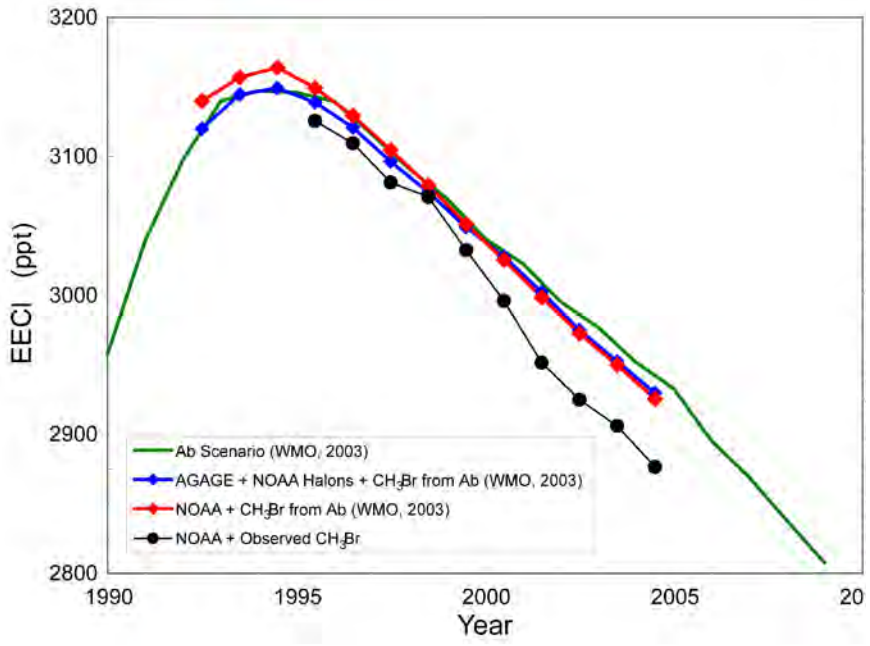
Ozone hole explained; also depletion in mid-lats

Figure by NOAA; in the public domain.



HCFC accelerated phaseout; climate coupling

Some Key Science Inputs



The Protocol Is Working: OD Changes

Table 8-6. Comparison of scenarios and hypothetical cases[a]: the year when EESC drops below the 1980 value for both midlatitude and polar vortex cases, and integrated EESC differences (midlatitude case) relative to the baseline (A1) scenario. Note that the polar recovery times have not been given in previous Assessments; interpretation of any comparison between these numbers and recovery times given in previous Assessments requires an understanding of the large role played by the different transport times from the troposphere to the stratospheric midlatitude and polar vortex regions.

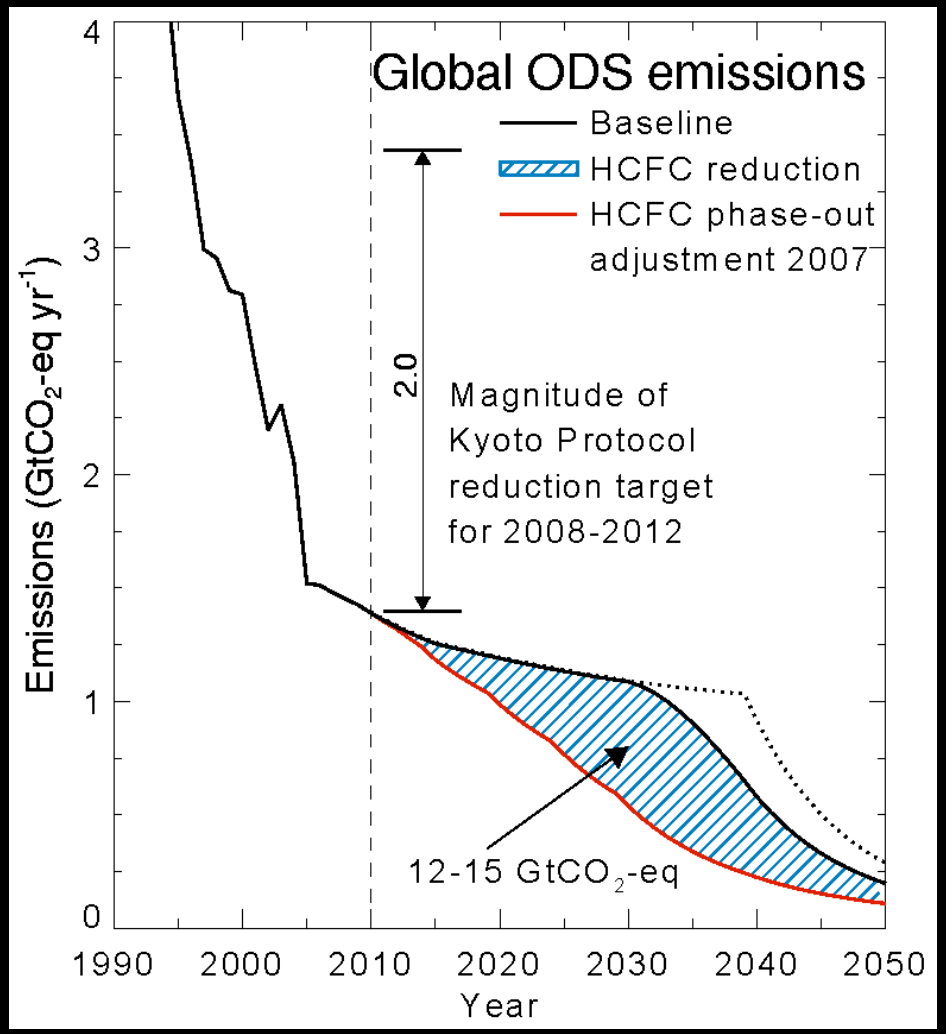
Scenario and Cases	Percent Difference in integrated EESC relative to baseline scenario for the midlatitude case		Year (x) when EESC is expected to drop below 1980 value	
	Midlatitude			Antarctic vortex[b]
	$\int_{1980}^{x} EESC\,dt$	$\int_{2007}^{x} EESC\,dt$		
Scenarios				
A1: Baseline scenario			2048.9	2065.1
Cases[a] of zero production from 2007 onward of:				
P0: All ODSs	−8.0	−17.1	2043.1	2060.3
CFCs	−0.1	−0.3	2048.8	2065.0
Halons	−0.2	−0.5	2048.8	2065.1
HCFCs	−5.5	−11.8	2044.4	2062.2
Anthropogenic CH_3Br	−2.4	−5.1	2047.9	2063.7
Cases[a] of zero emissions from 2007 onward of:				
E0: All ODSs	−19.4	−41.7	2034.0	2049.9
CFCs	−5.3	−11.5	2045.0	2060.3
CH_3CCl_3	−0.1	−0.2	2048.9	2065.1
Halons	−6.7	−14.4	2045.6	2061.9
HCFCs	−7.3	−15.7	2043.7	2061.8
CCl_4	−1.3	−2.9	2048.5	2064.9
Anthropogenic CH_3Br	−2.4	−5.1	2047.9	2063.7
Cases[a] of full recovery of the 2007 banks of:				
B0: All ODS	−12.9	−27.8	2040.8	2056.7
CFCs	−5.2	−11.3	2045.1	2060.4
Halons	−6.7	−14.3	2045.7	2062.0
HCFCs	−1.9	−4.1	2048.4	2064.8
CH_3Br sensitivity:				
Same as A1, but CH_3Br anthropogenic emissions set to 20% in 1992[c]	3.1	6.6	2050.6	2067.7
Same as A1, but zero QPS production from 2015 onward	−1.5	−3.2	2047.9	2063.7
Same as A1, but critical-use exemptions continued at 2006 level	1.9	4.0-4.7	2050.1	2067.0

[a] Importance of ozone-depleting substances for future EESC were calculated in the hypothetical "cases" by setting production or emission to zero in 2007 and subsequent years or the bank of the ODS to zero in the year 2007 alone. These cases are not mutually exclusive, and separate effects of elimination of production, emissions, and banks are not additive.

[b] This metric specifically for Antarctic polar vortex ozone depletion has not been shown in any previous ozone Assessment.

[c] In the baseline scenario, this fraction was assumed to be 30% in 1992, with a corresponding emission fraction of 0.88 of production. In this alternative scenario, an anthropogenic fraction was assumed to be 20%, with an emission fraction of 0.56 of production. In both scenarios, the total historic emission was derived from atmospheric observations and a lifetime of 0.7 years.

Montreal Sep 2007 adjustment: HCFC early phase-out



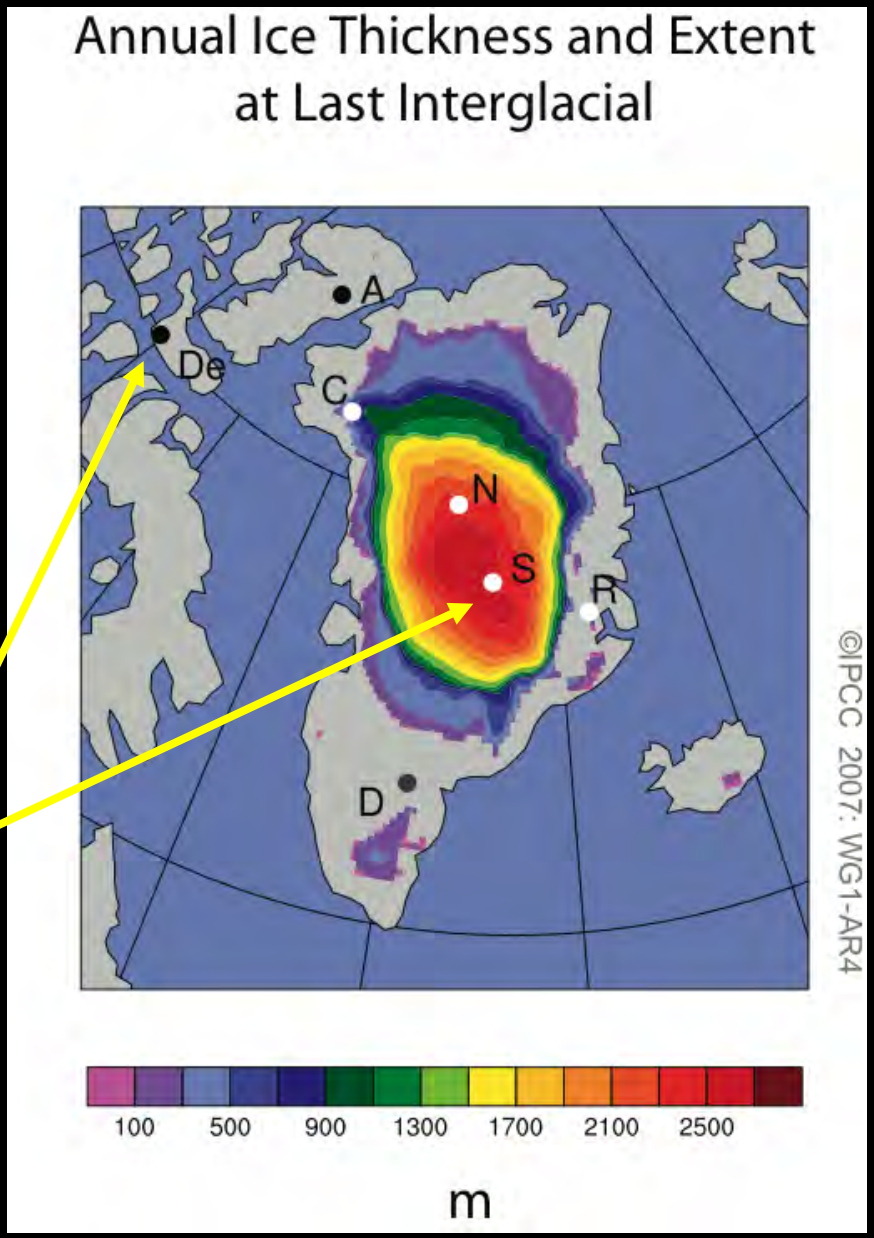
Reduction in emissions:

- HCFCs 'transition' speedup, reducing production & use in <u>developing</u> countries.
- 12-15 $GtCO_2$-eq potential reduction (6-7.5 'Kyoto-eq years').
- Realizing the potential depends on technology and science: needs development and testing of new, improved substitute chemicals (e.g., molecules like 2,3,3,3-tetrafluoropropene ($CF_3CF=CH_2$), proposed for mobile air conditioning units).

Past Change in The Greenland Ice Sheet

The last time polar regions were significantly warmer (by 3-5˚ C) than present for an extended period (about 125,000 years ago), reductions in polar ice volume led to 4 to 6 m of sea level rise.

White and black dots show drill sites where ice older than 125,000 years is and is not found. Significant but not complete melt over millennia….slow melt? Or rapid ice flow?



ESD.864 / 12.844J Modeling and Assessment for Policy
Spring 2013