

# Climate Change: The Collision of Science, Politics, Economics & Ethics

*Ken Denman*

Canadian Centre for Climate Modelling and Analysis  
Environment Canada  
c/o University of Victoria, BC, Canada

&

Institute of Ocean Sciences, Fisheries and Oceans Canada

Email: [ken.denman@ec.gc.ca](mailto:ken.denman@ec.gc.ca)



Environment  
Canada

Environnement  
Canada



CCCma



U.  
Victoria



Fisheries and Oceans  
Canada

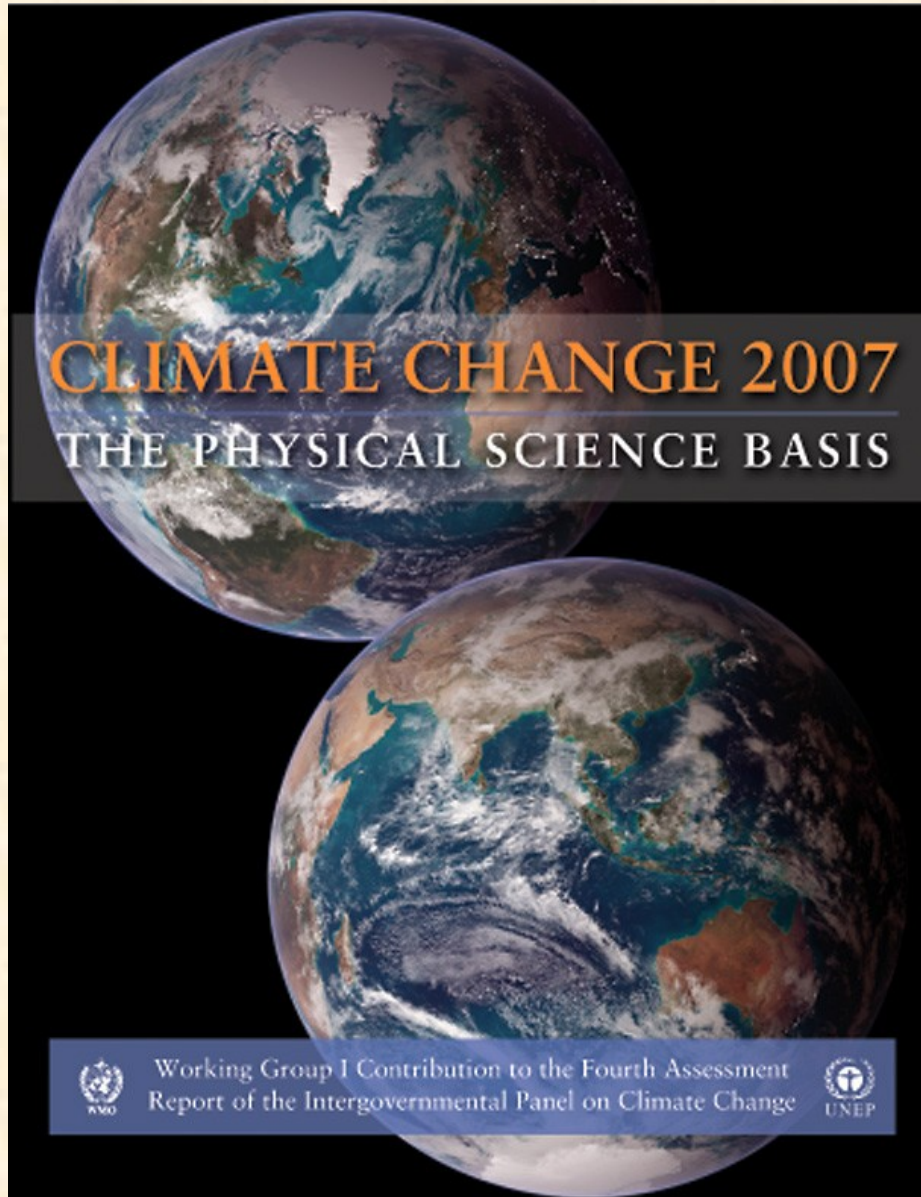
Pêches et Océans  
Canada



# Outline

1. The 2007 IPCC Fourth Assessment Report AR4
  - Process and main conclusions
2. Developments since AR4 - A sense of urgency
3. Progress on post-Kyoto controls on emissions
4. Economics and ethics
  - discounting the future: goods versus lives
  - possibility of extremely rare catastrophic events
5. Scientists and policy - where is the boundary?

# The Working Group I Report

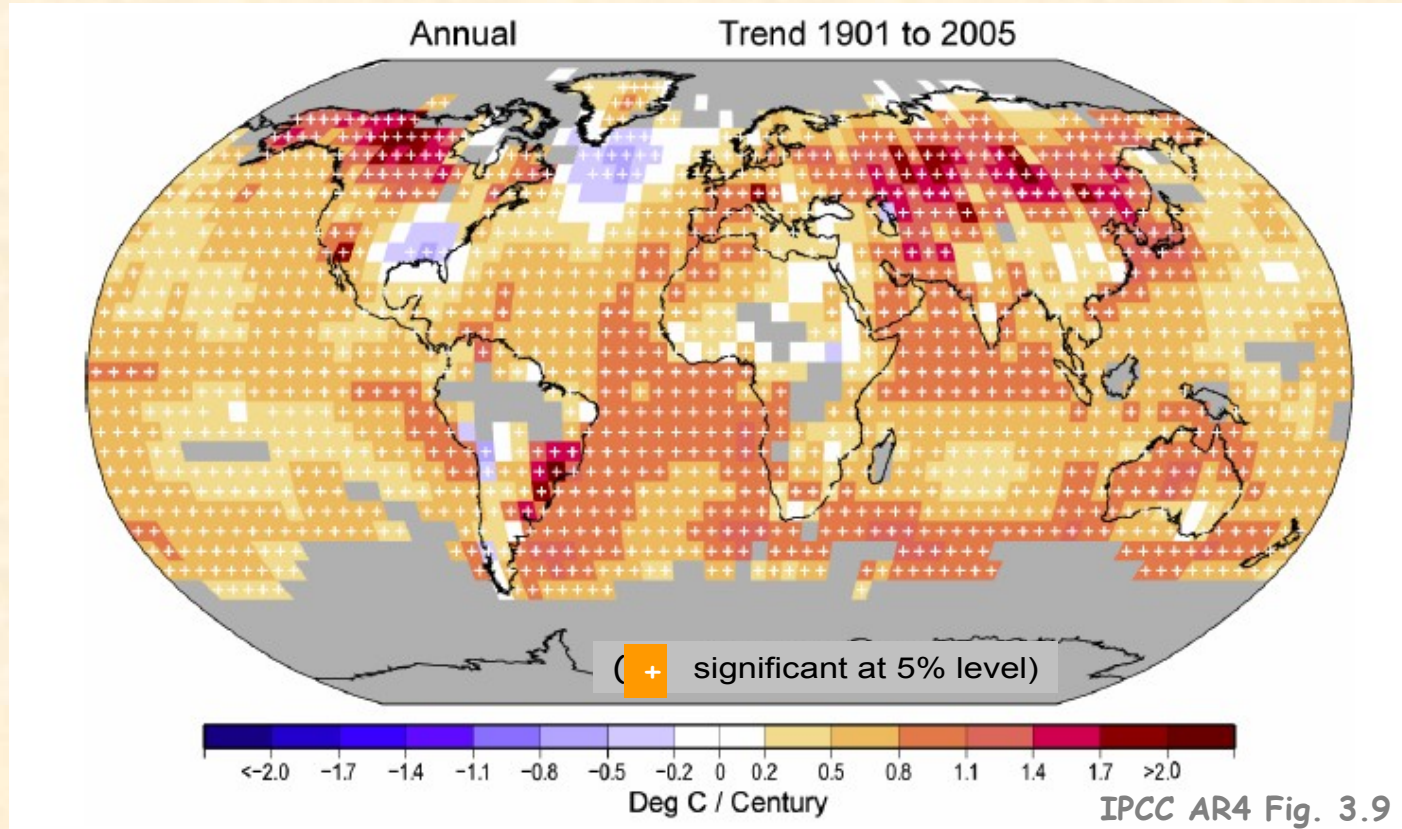


- Started 2004
- Completed February 2007
- 152 Authors
- ~450 contributors
- ~600 expert reviewers
- 30,000+ review comments  
*[~3000 our chapter alone]*

## Contents

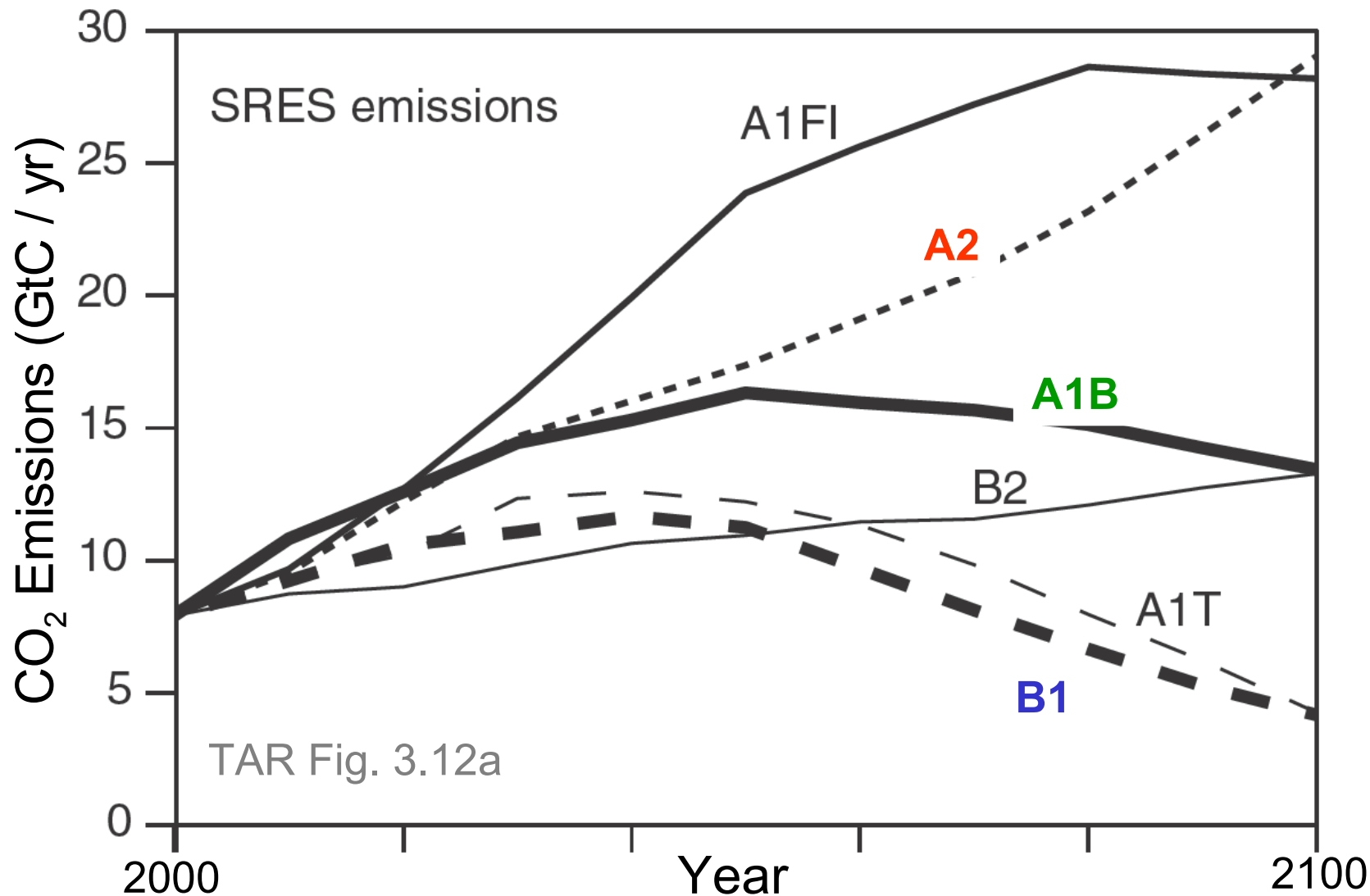
- Summary for Policymakers
- Technical Summary
- 11 Chapters
- Frequently Asked Questions
- ~5000 literature references
- ~1000 pages

# The World Has Warmed But Not Evenly



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

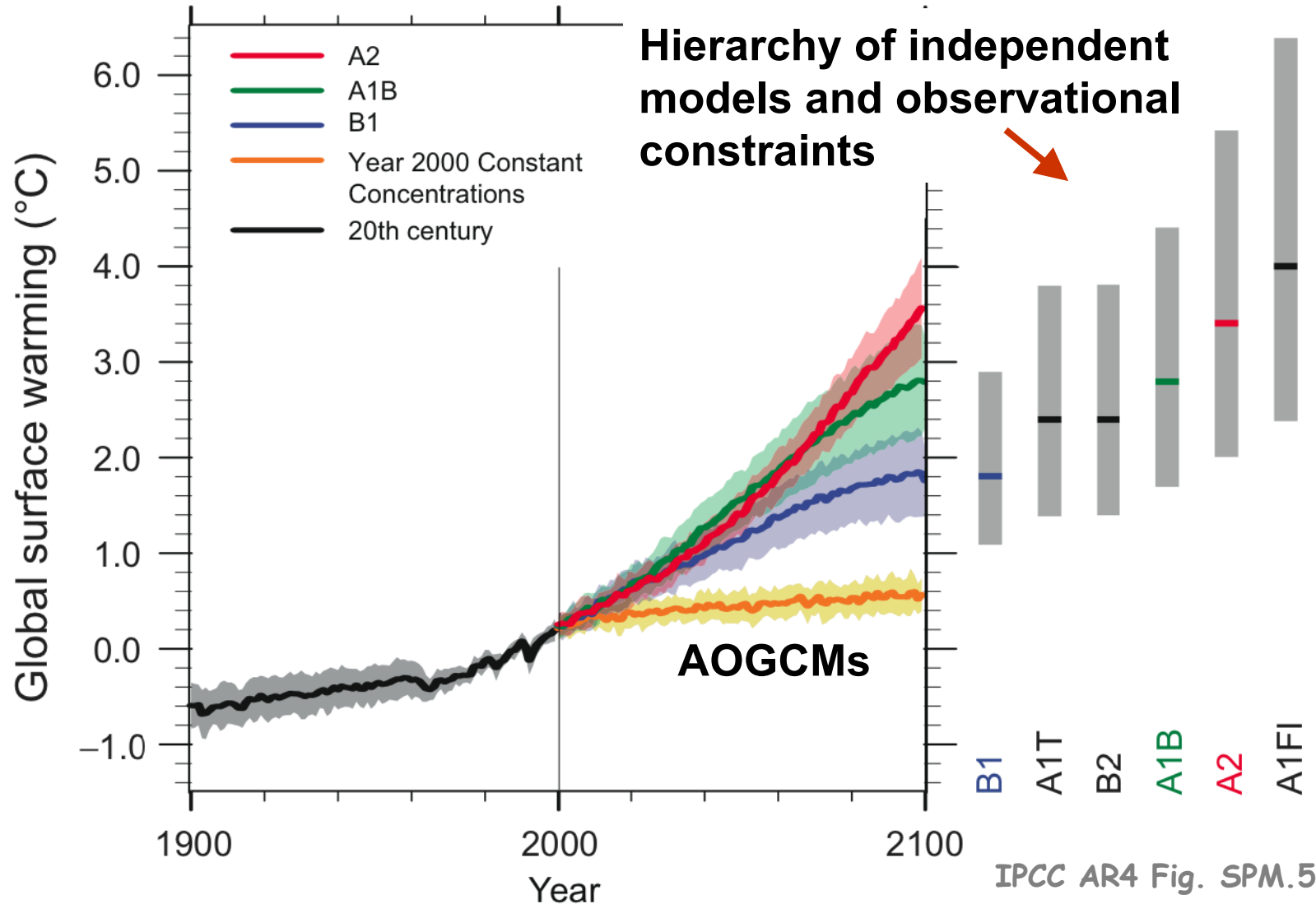
# The Future: SRES Scenarios



Economists and social scientists must forecast:  
population growth, human behaviour and response to change

# Projected Surface Warming to 2100 (relative to 1980-1999 mean)

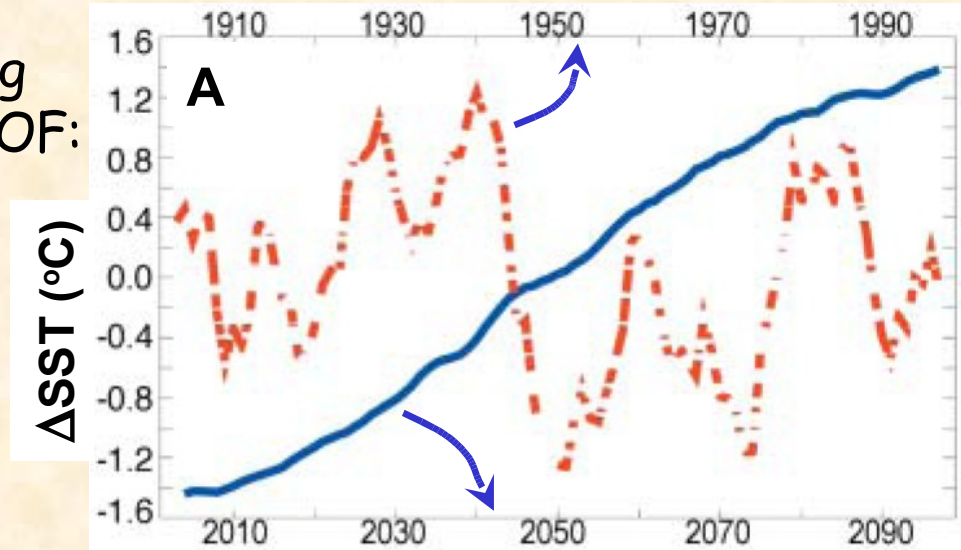
Multi-model Averages and Assessed Ranges for Surface Warming



# But Observed Decadal Variability Is Large

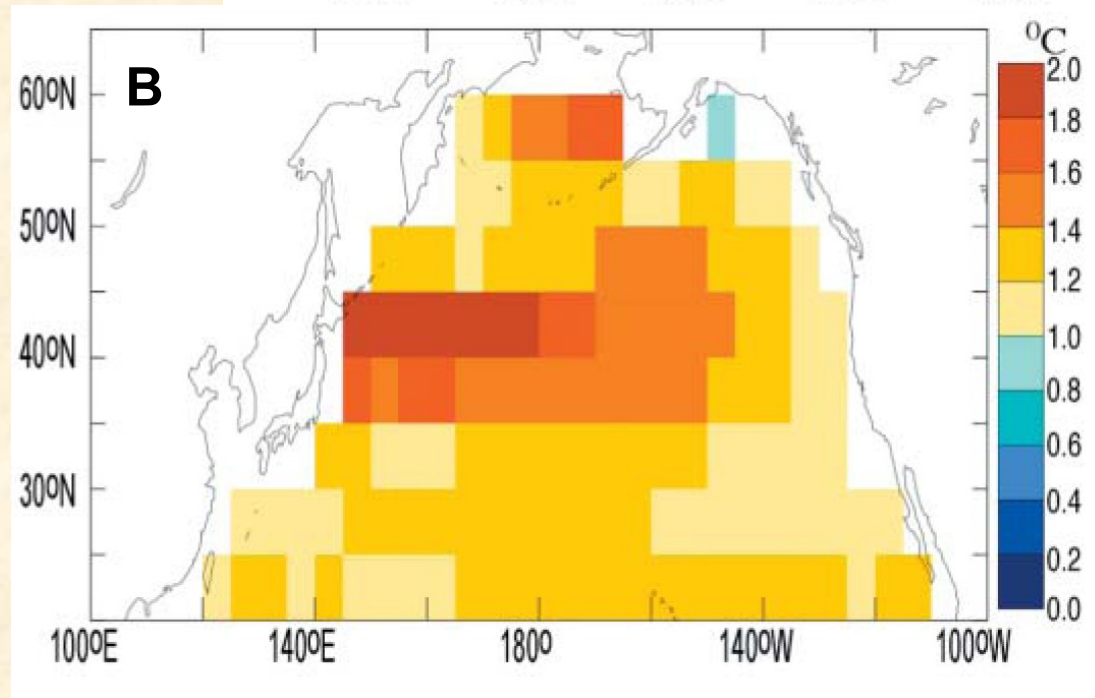
Spatial pattern of projected warming similar to that of the PDO first EOF:

- A. SST anomaly (November - March), first EOF (i.e. PDO), for 1901-1999 (from Hadley Centre SST analysis) & Ensemble mean of SST first EOF, for A1B SRES scenario, 2002-2099 (10 IPCC-AR4 models from PCMDI site)

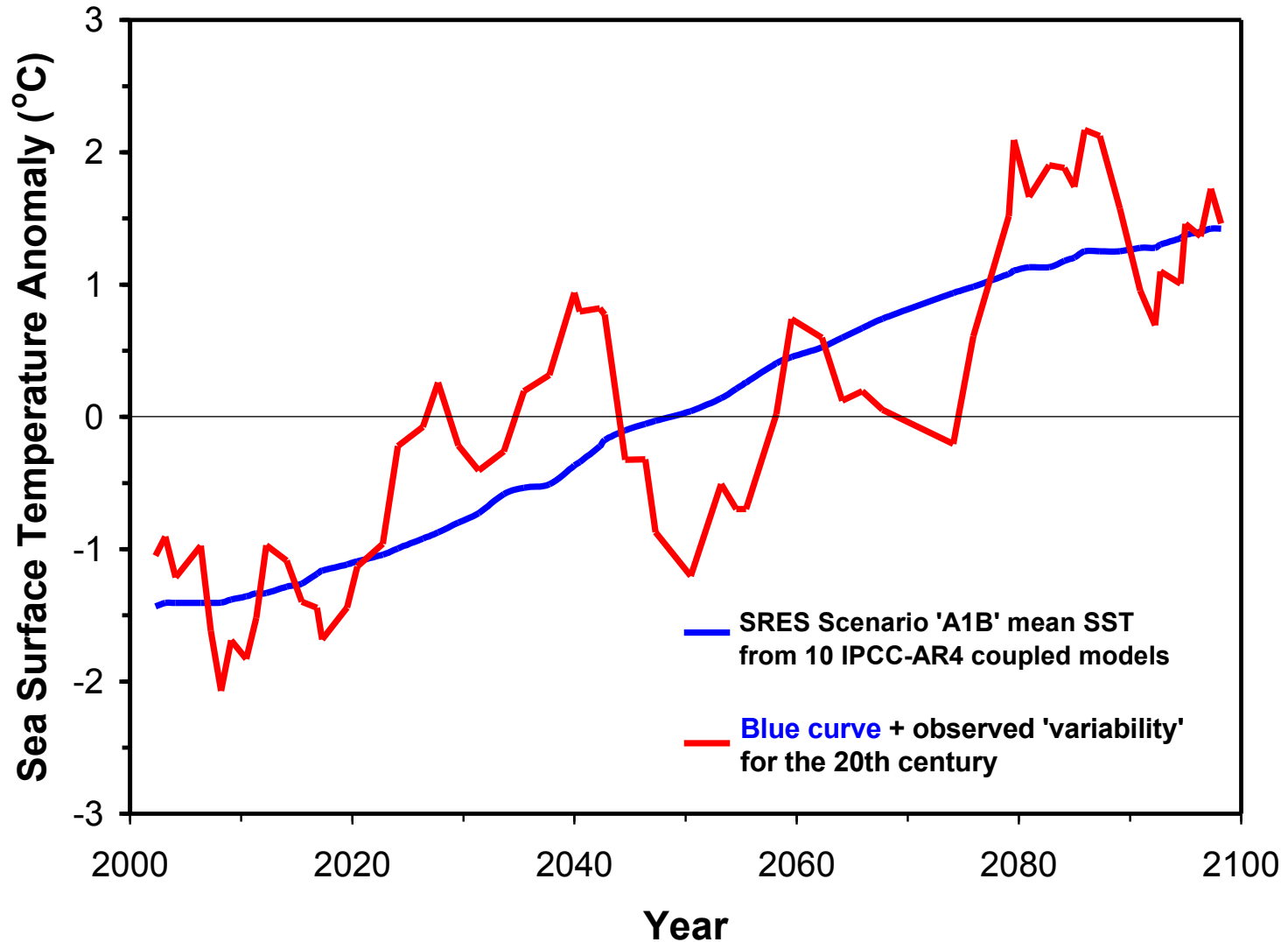


- B. Projected model average decadal winter mean SST (2040-2049), relative to 1980-1999 pattern from the Hadley Centre data

*Jim Overland and Muyin Wang  
2007, EOS/AGU 88(16)*



# Natural Variability Can Reverse Warming Trend for a Decade or More





# Science Informs Policy

## IPCC produces Scientific Assessments

- must be *'policy neutral'*, NOT *'policy prescriptive'*
- all 40+ Future Scenarios are to be assessed equally

## UNFCCC develops Policy instruments

- in the 1995 IPCC Second Assessment Report we said: *"The balance of evidence suggests a discernible human influence on global climate"*
- basically this statement gave governments the confidence to proceed to negotiate the *Kyoto Protocol* for controlling greenhouse gas emissions

# Will Stronger Science Lead to Stronger Policy???

In IPCC AR4 we state that

*"Warming of the climate system is **unequivocal**,  
as is now evident from observations ... "*

**&**

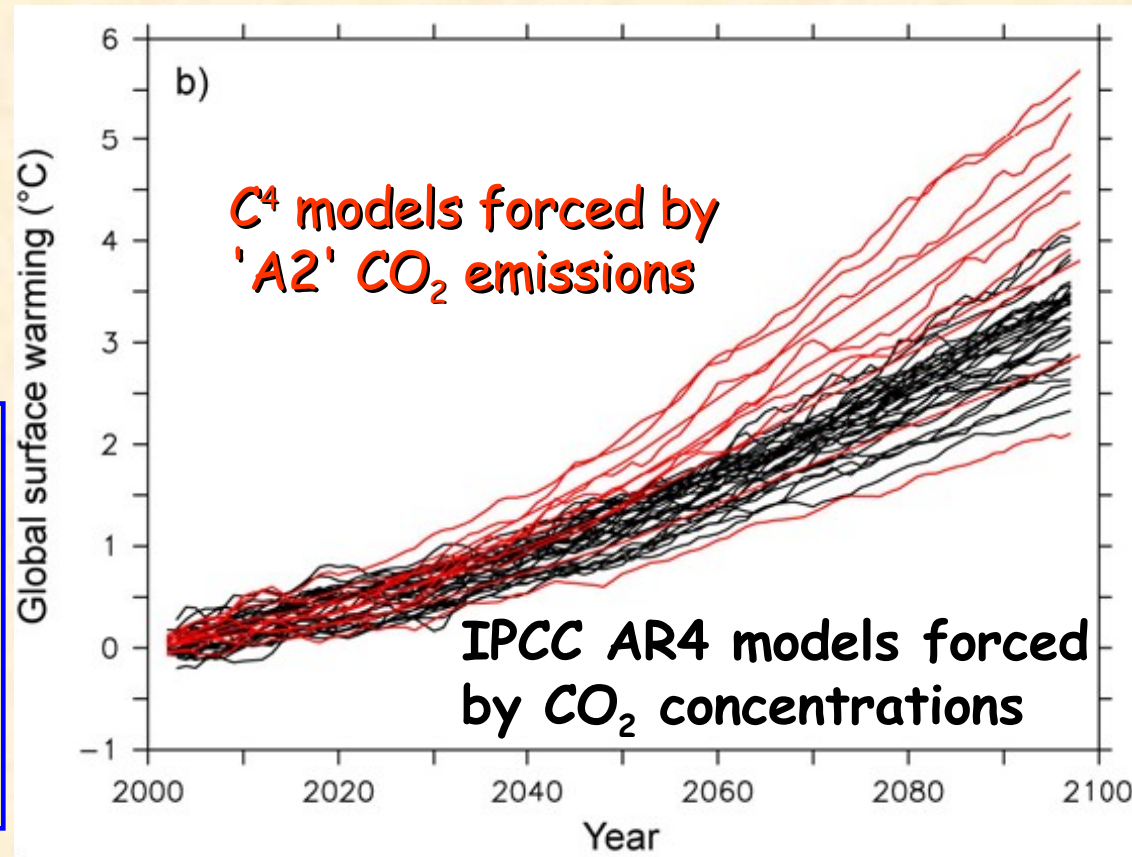
*"Most of the observed increase in globally averaged  
temperatures since the mid-20<sup>th</sup> century is  
**very likely** (>90% certainty) due to the observed  
increase in anthropogenic greenhouse gas  
concentrations"*

**Emerging issues:**

# Coupled Carbon Cycle Climate "C<sup>4</sup>" models forecast an additional ~1°C warming added to the 'official' IPCC AR4 projections for 2100

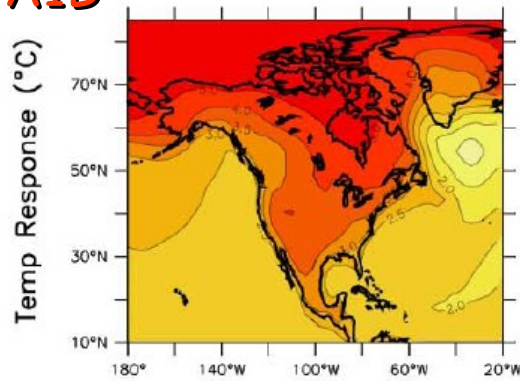
*A 'positive feedback' between the carbon cycle and climate change*

*Greater reductions in CO<sub>2</sub> emissions would be needed to achieve the same CO<sub>2</sub> conc. stabilization level*

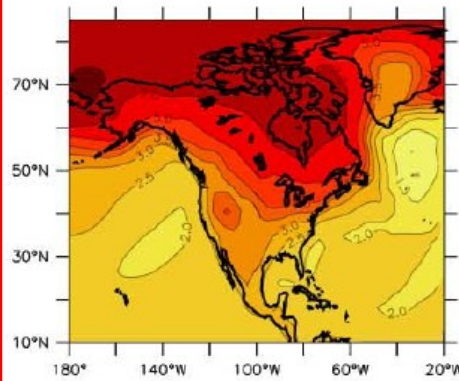


**A1B**

Annual

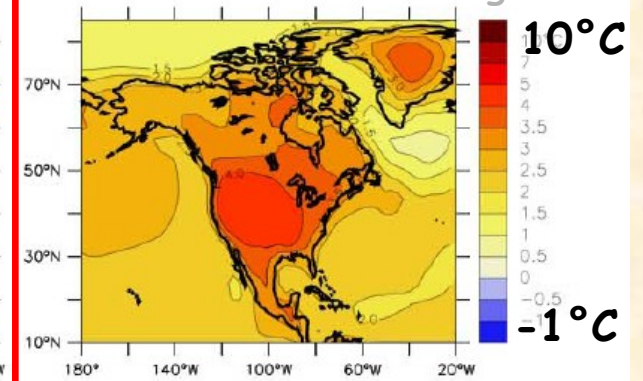


DJF



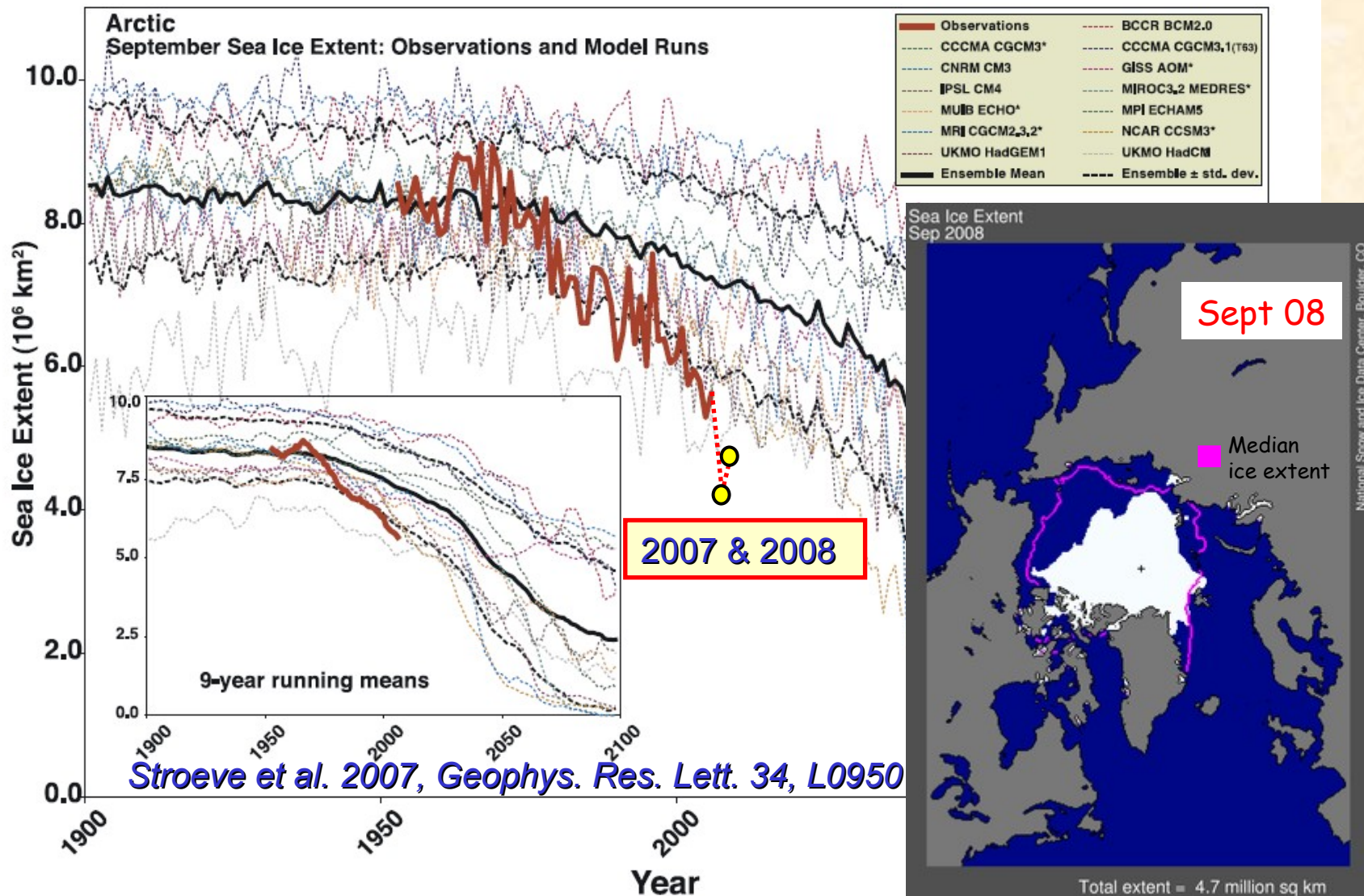
JJA

AR4 Fig. 11.12



**Projections of Winter Warming  
in the Arctic Are Already Huge**

# The Minimum Annual Extent of Arctic Sea Ice Is Decreasing Faster Than All Model Projections



# The Greenland Ice Sheet Contains 6 to 7 m of Sea Level Rise When Melted

*"Current models suggest ... that the surface mass balance becomes negative at a global average warming (relative to pre-industrial values) in excess of 1.9 to 4.6°C."*

*"The corresponding future temperatures in Greenland are comparable to those inferred for the last interglacial period 125,000 years ago, when paleoclimatic information suggests reductions of polar land ice extent and 4 to 6 m of sea level rise."*

[AR4 Working Group I Summary for Policy Makers]

Estimates for disappearance of the ice sheet  
range from 3000 years to 300 yrs  
(depending on the scenario we 'choose' to follow)

# The Total Mass Balance (TMB) Deficit of the Greenland Ice Sheet Has Increased 3X During the 11 Years 1996-2007

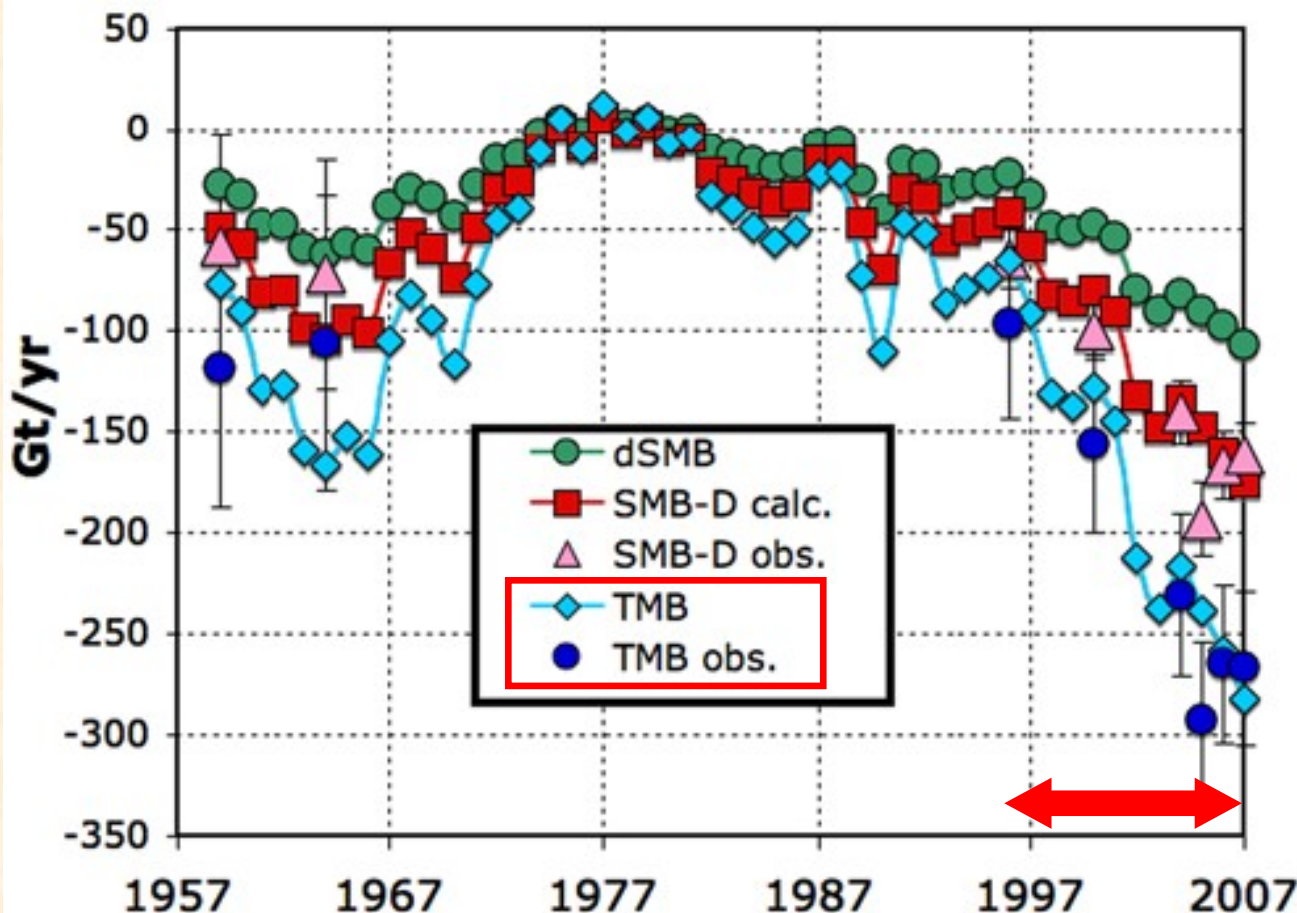
**SMB** -  
Surface Mass Balance

**D** - Ice Discharge

**TMB** -  
Total Mass Balance

$$\text{TMB} = \text{SMB} - \text{D}$$

All in Gt/yr  
i.e. (mass / year)



Rignot et al., *Mass balance of the Greenland ice sheet from 1958 to 2007*,  
*Geophys. Res. Lett.*, 35, L20052, 2008

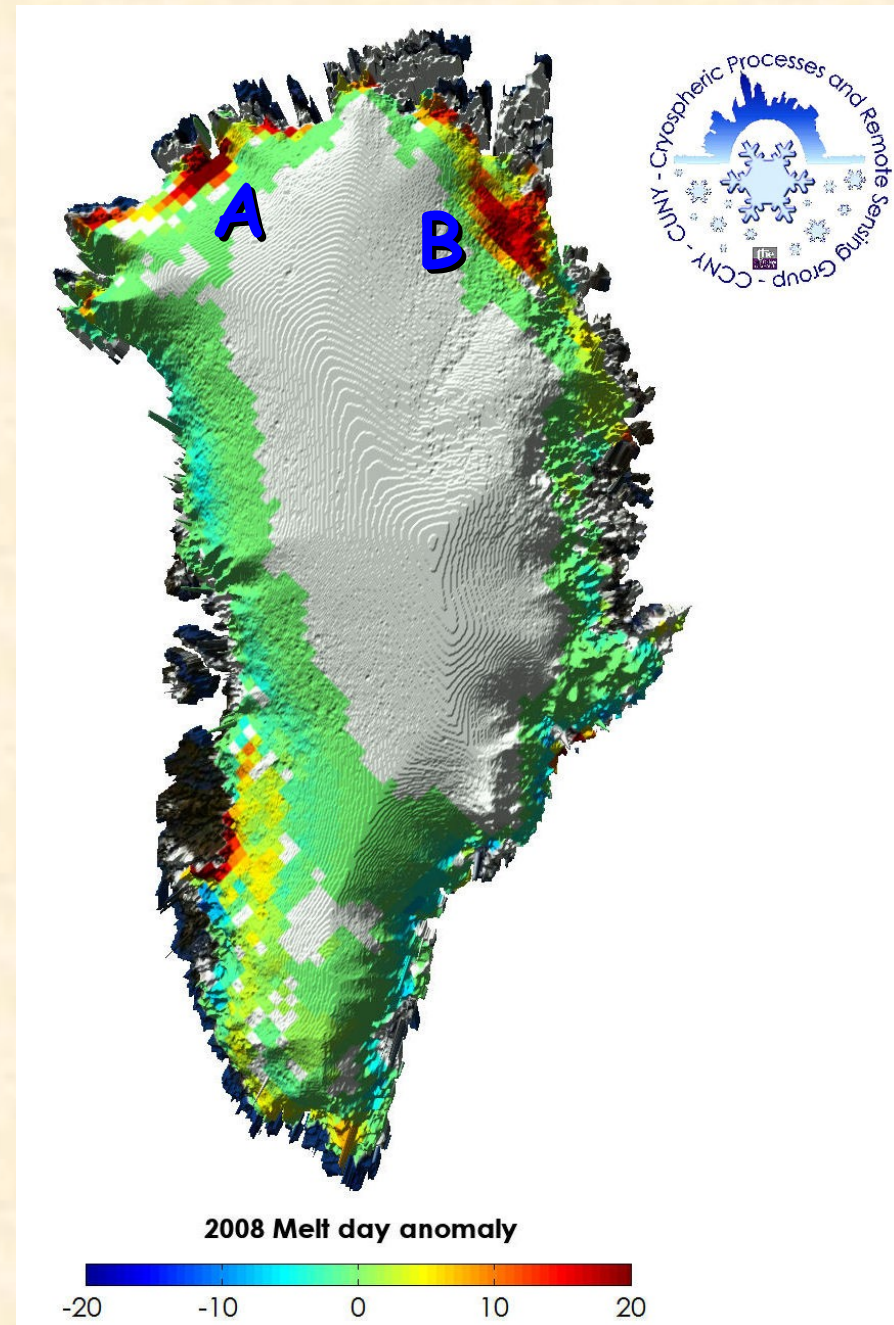
# Number of Melting Days

minus  
the 1979-2007 Average

Record number of melting days in areas **A** and **B**

*(from the Special Sensor Microwave Imager SSM/I)*

*Tedesco, M. Extreme snowmelt in Northern Greenland during summer 2008, AGU EOS, 89, 7 Oct. 2008*





# Future CO<sub>2</sub> Emissions Scenarios

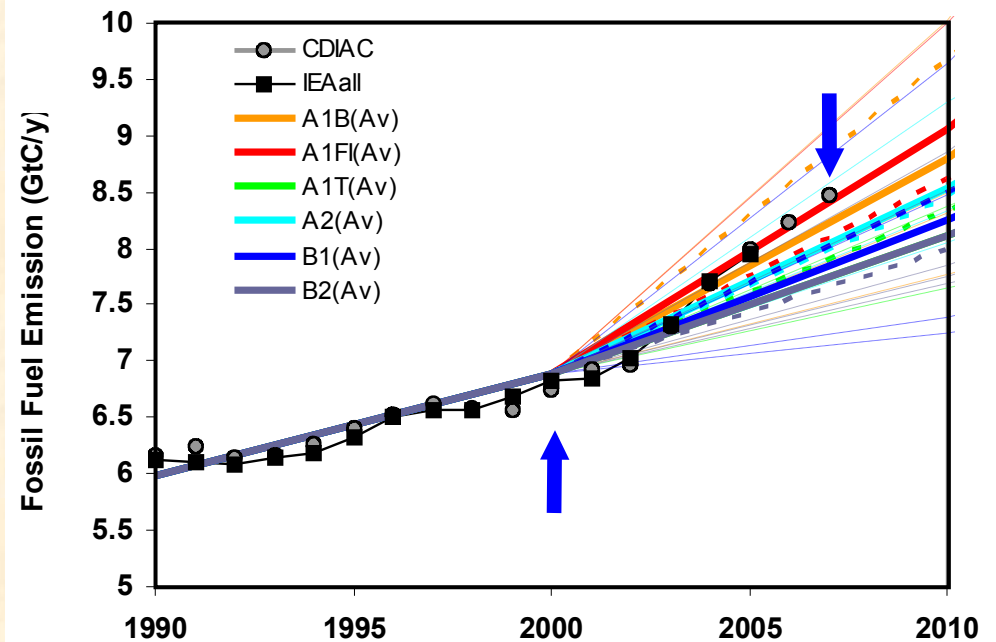
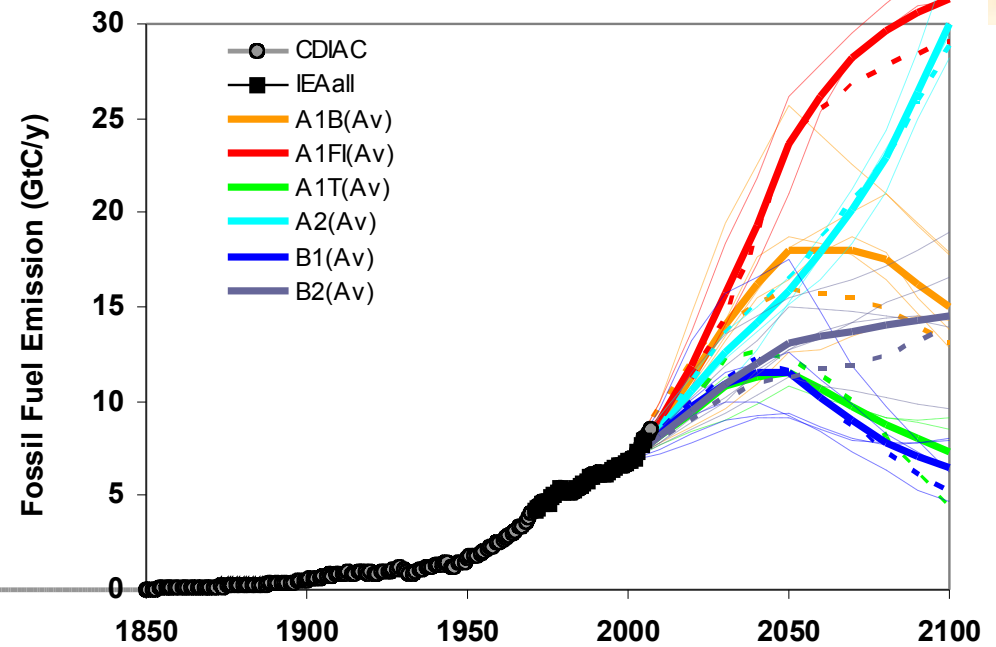
[from Raupach et al.,  
US. Proc. Natl Acad Sci  
Vol. 104, 12 June 2007]#

Observed rate of increase  
(3.5 % /year) for 2000-07  
is ~4 times that in 1990s

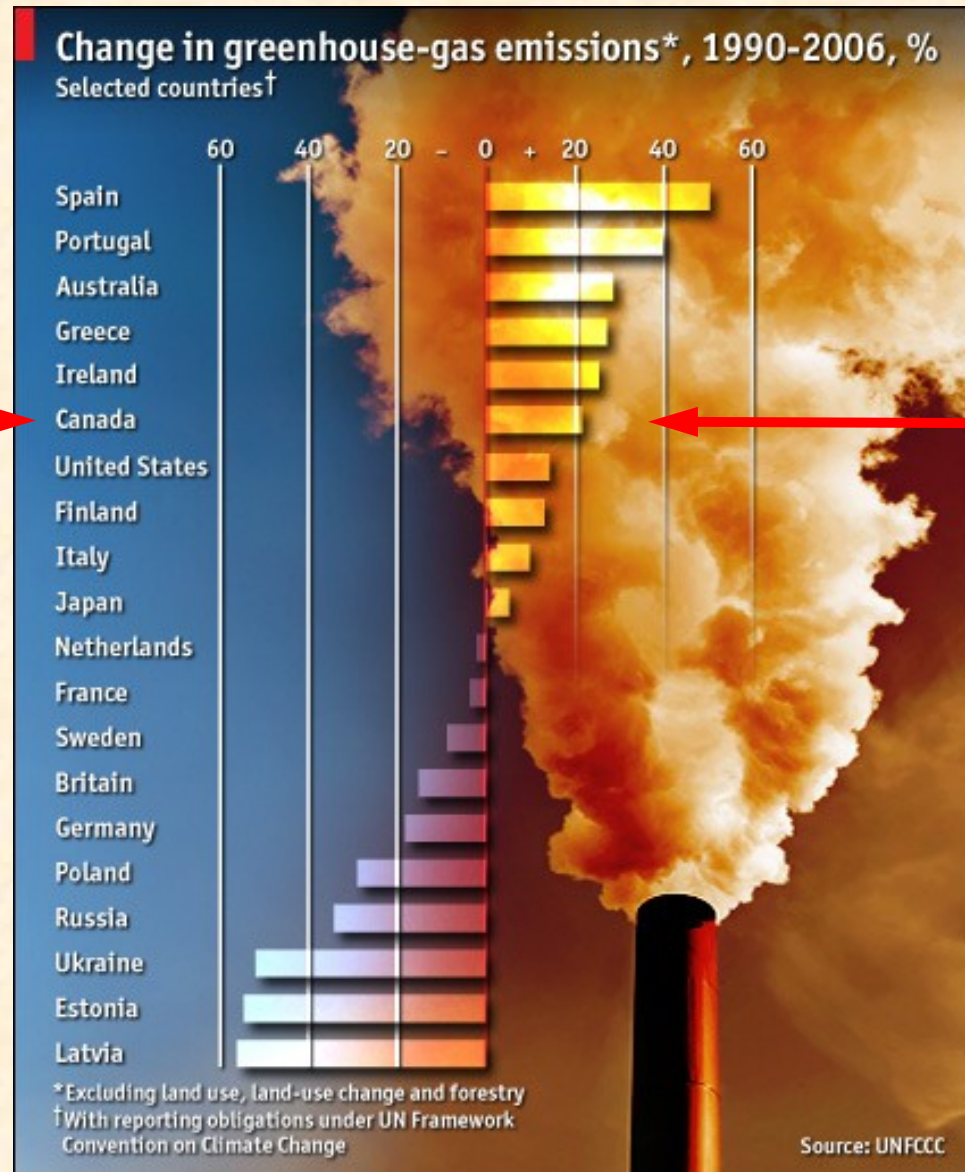
2004 Carbon emissions per  
person:

Globe	(Canada)
~1.2 tonnes/year	( ~5.5)
= 4 tonnes CO <sub>2</sub> /year	( ~20)

# Updated from the Global Carbon  
Project website, Oct. 2008



# How Are Canadians Doing So Far?



'[www.economist.com](http://www.economist.com)'  
November, 2008

# December 2007 FCCC Conference of the Parties 'CoP-13' in Bali

1. Over 10,000 participants from 180 countries
2. **Objective:** To work towards a post Kyoto Protocol agreement on emissions reductions, adaptation measures, etc.
3. A group of over 100 scientists, including me, signed a '**Bali Declaration**' which was presented at the Conference

*"... Based on current scientific understanding, this requires that global greenhouse gas emissions need to be reduced by at least 50% below their 1990 levels by the year 2050. In the long run, greenhouse gas concentrations need to be stabilised at a level well below 450 ppm (parts per million; measured in CO<sub>2</sub>-equivalent concentration). In order to stay below 2°C, global emissions must peak and decline in the next 10 to 15 years, so there is no time to lose."*

[<http://www.ccrcc.unsw.edu.au/news/2007/Bali.html>]

# And What Came Out of CoP-13 In Bali?

## 1. 'The Bali Roadmap' [<http://unfccc.int>]

An agreement to negotiate and meet again at CoP-14 in Poznań in 2008 and reach an agreement at CoP-15 in Copenhagen in 2009.

## 2. The progress made in Poznań, Poland in December 2008 was not encouraging:

*'Déja-vu' all over again*

# What Other Drivers Are Influencing Our Actions on Climate Change Besides Science?

# Economics Studies of the Costs / Benefits of Dealing with Climate Change Must Assign \$\$\$ to Ethical Values

Re: criticism of the 2006 700-page review of the costs of climate change by Sir Nicholas Stern, former vice president of the World Bank, who advocates strong action to mitigate the degree of climate change:

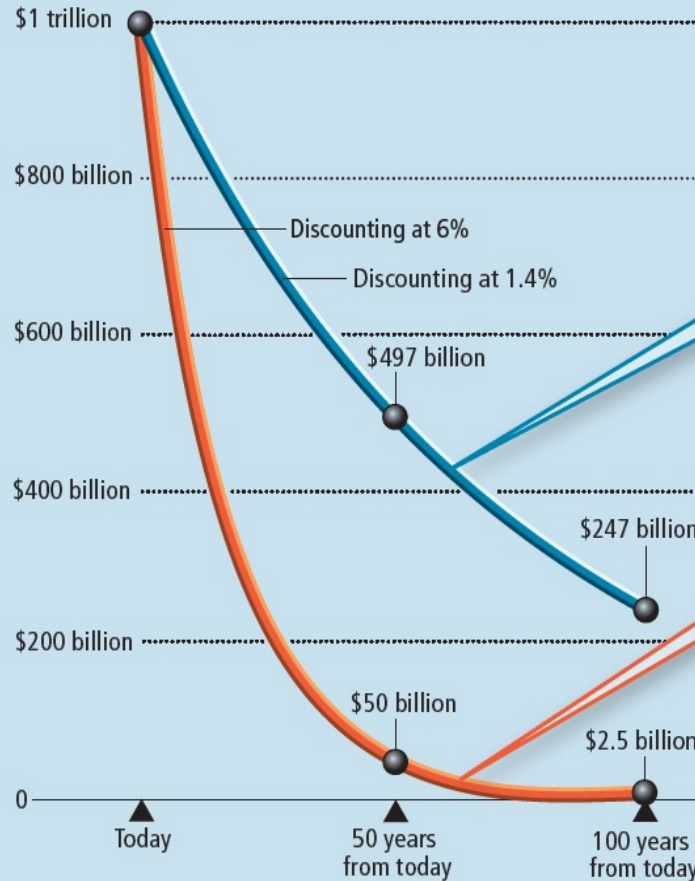
*"The contentious issue is the size of the 'pure-time' discount rate, which determines how much the welfare of current generations is valued compared with future, as yet non-existent generations."*

[Nature, 445, 8 Feb 07, p.582]

# How 'Discounting' Works

## HOW DISCOUNTING EVALUATES FUTURE GOODS

The graph shows how the value economists assign today to receiving goods worth \$1 trillion in the future depends both on the discount rate and on how far into the future the trillion dollars' worth of goods will be received.



How much should we sacrifice today to improve the lives of future people richer than we are?

Nicholas Stern's 1.4 percent discount rate places a relatively high value on the well-being of future generations. A trillion dollars' worth of goods received in 100 years is valued at \$247 billion today. In fact, Stern argues, the world needs to begin investing 1 percent of its total production, or about \$500 billion today, on efforts to reduce greenhouse gases.

William Nordhaus's 6 percent discount rate places far less value than Stern's rate does on the well-being of future generations. A trillion dollars' worth of goods in 100 years is valued at only \$2.5 billion today, hardly enough to justify the costs of greatly reducing greenhouse gases.

Which is worse, the death of a child in 2108 or the death of a child today?

John Broome, 'The Ethics of Climate Change', *Scientific American*, June 2008

# What About Extremely Rare Severe Events?

Martin Weitzman, Harvard Economist, states that Stern may have got it right for the wrong reasons.

He argues that Integrated Assessment Models assume 'thin-tailed' Gaussian/normal probability distributions

They miss extremely improbable catastrophic events, which are characterized by 'fat-tailed' distributions where neither the probability nor the extent of damage and economic costs can be estimated

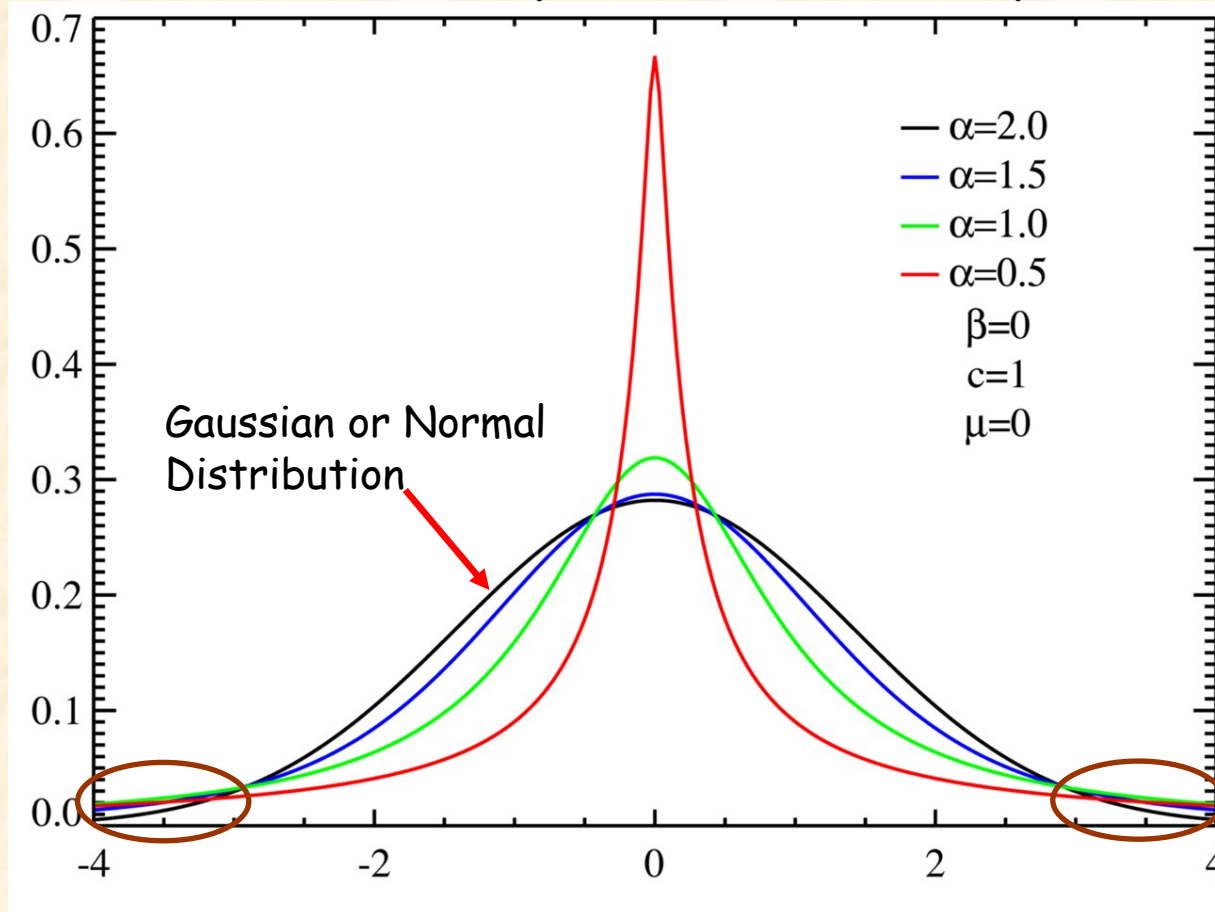
Examples:

- *Collapse and non-recovery of the Northern Cod stocks*
- *Hurricane Katrina destroying New Orleans*
- *The current economic meltdown*



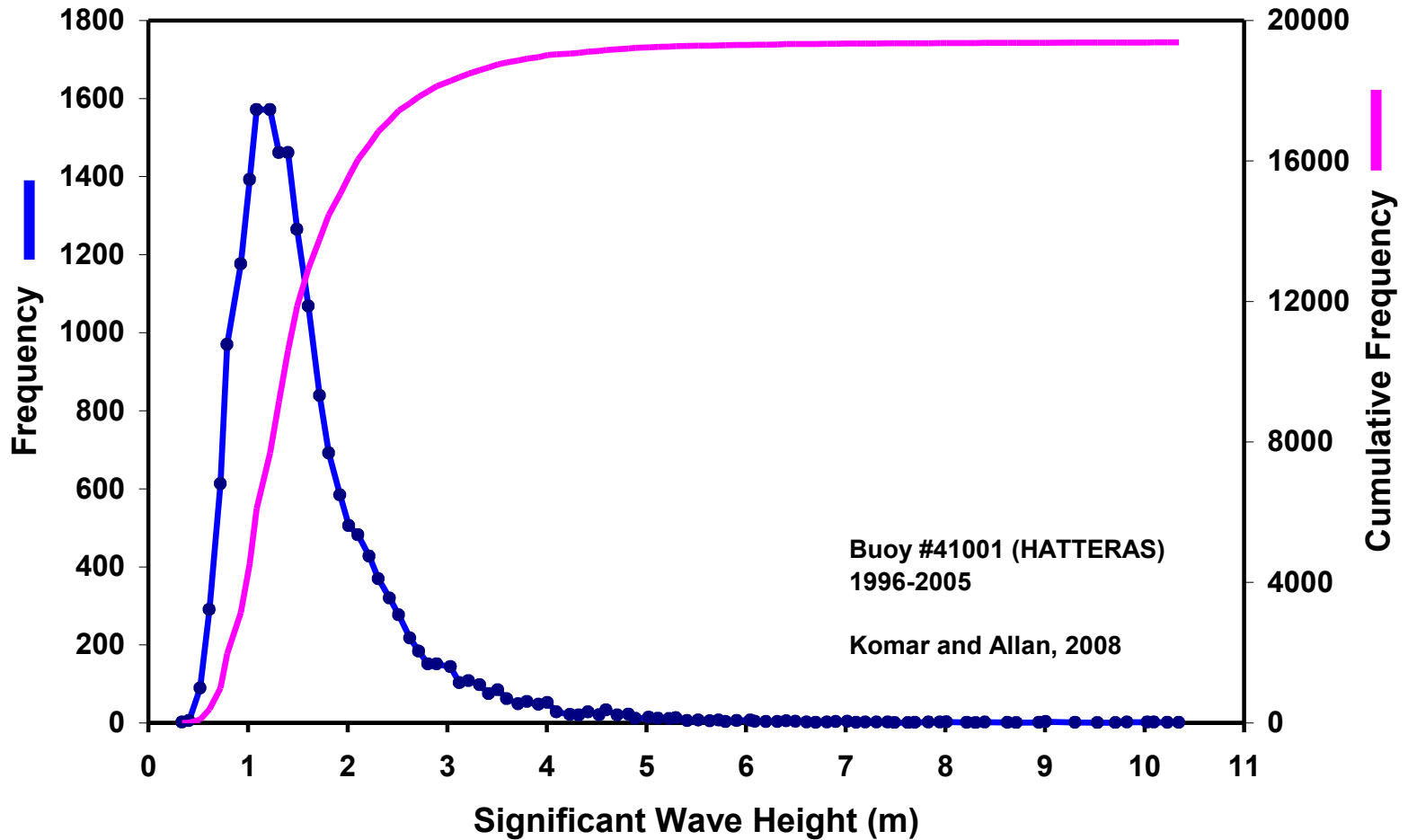
# Fat- or Heavy-tailed distributions

Levi - Stable Distributions, Wikipedia: 'Fat-' or 'Heavy-tailed distributions'

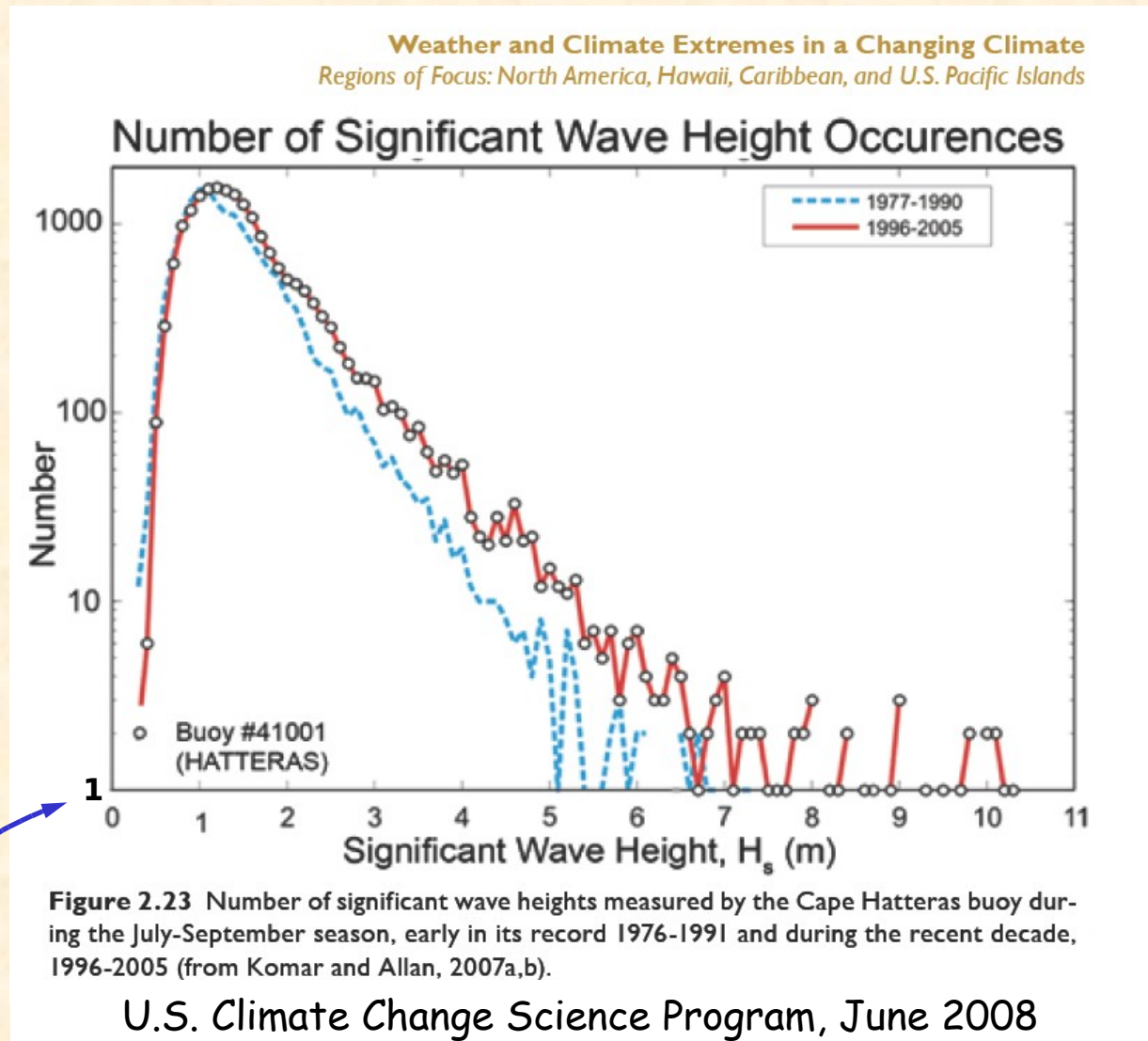


Geophysical phenomena are often asymmetrical  
with a one-sided 'long' or 'heavy' tail away from zero

# Even With Large Number of Observations, the Long Tail For Wave Heights > 6m Not Obvious



# Log-Scale Shows Long Tail of Rare Events



Komar, P. and J. Allan, 2008. *J. Coastal Res.* 24, 479-488.

# 2003 European Heat Wave

Europe:

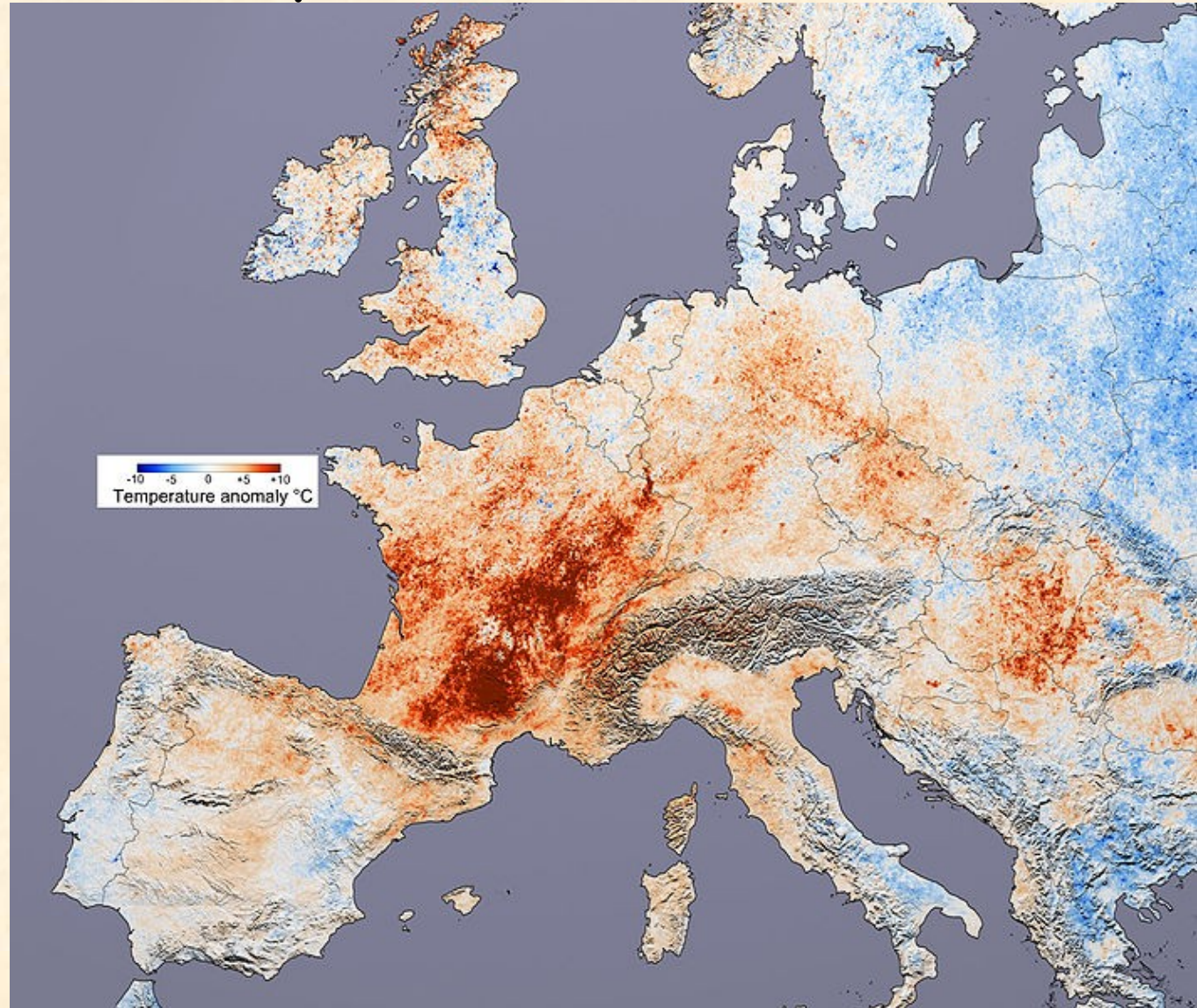
~35,000 deaths

France:

14802 deaths

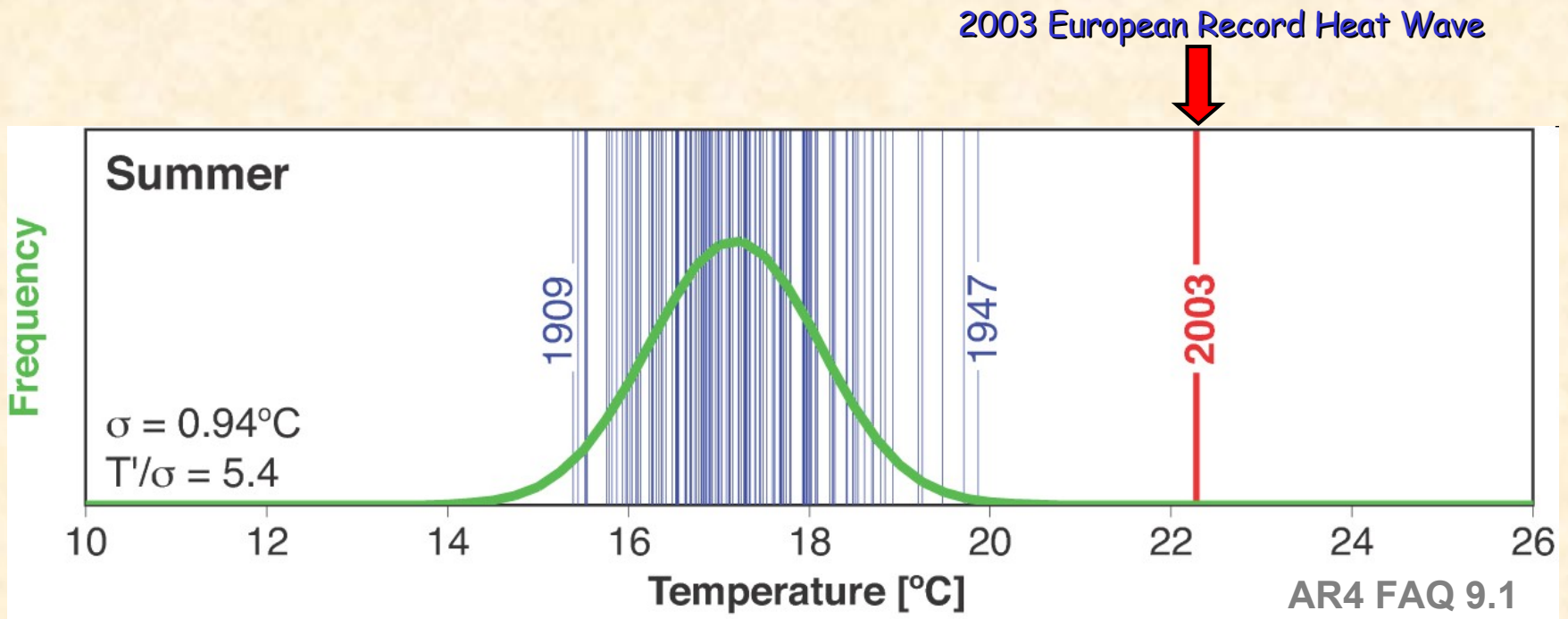
Germany:

~7000 deaths

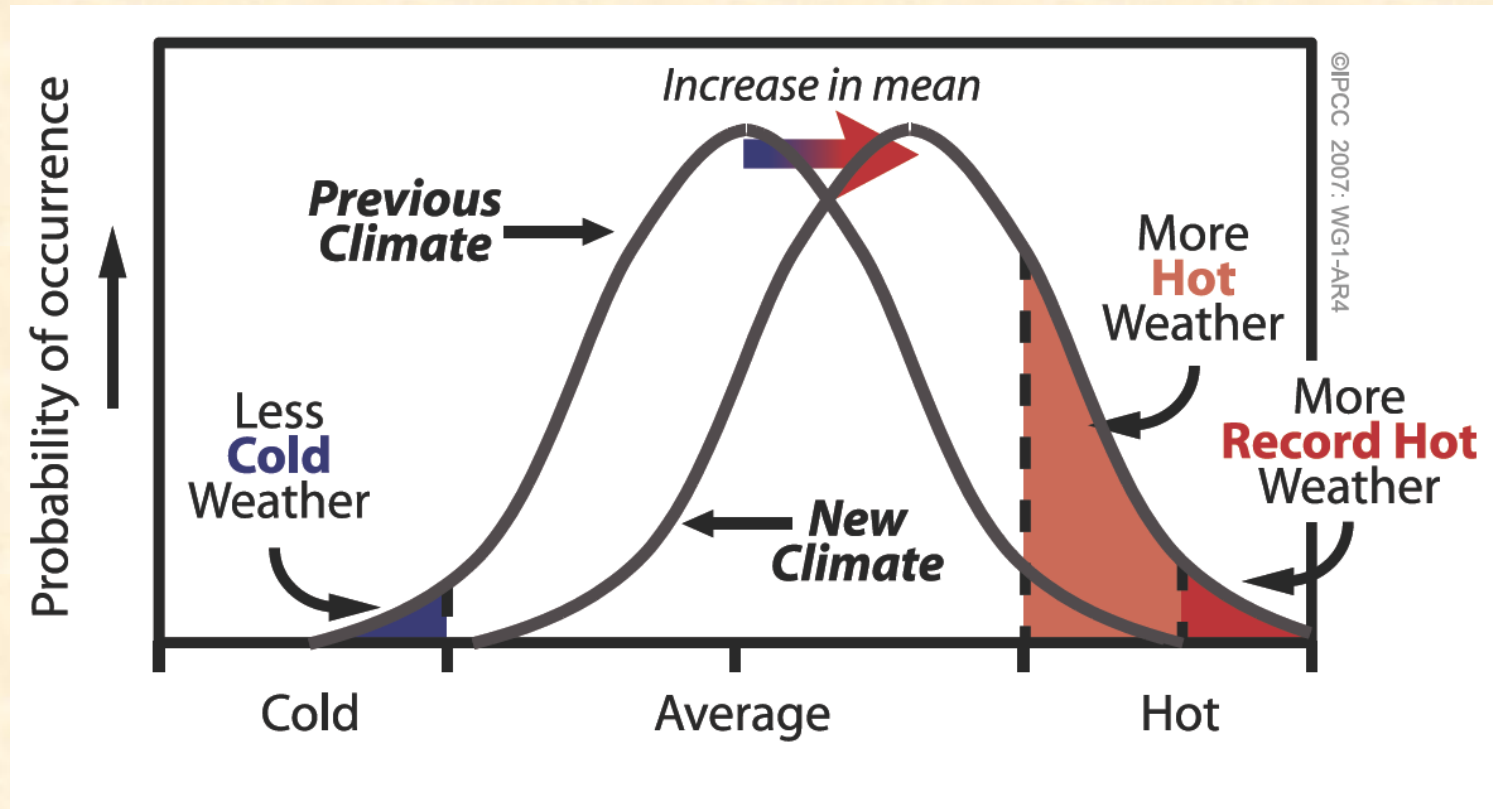


Wikipedia '2003 European Heat Wave'; New Scientist, 10 Oct, 2003

# Distribution of Swiss Summer Surface Temperatures 1864-2003



# Are 'Rare' Events Becoming More Common Because the Distribution Is Shifting?



We think so, but 'proving' this is not easy

# Simulation of Frequency of Hurricane Intensities Now and in a '2xCO<sub>2</sub>' World



*Knutson and Tuleya, 2004, J. Climate, 17, 3477.*

# A Precautionary Principle

Martin Weitzman argues for a "Generalized Precautionary Principle" where we should take actions to avoid climate change that might take us towards these unpredictably rare catastrophies.

[[www.economics.harvard.edu/faculty/weitzman/papers\\_weitzman](http://www.economics.harvard.edu/faculty/weitzman/papers_weitzman)]  
'*On Modeling and Interpreting the Economics of Catastrophic Climate Change*'



# Adopting a Precautionary Principle

Means that if there is a reasonable possibility of a serious negative outcome, then

*The burden of proof is shifted from the 'conservers' to the 'proponents' or 'trustees' - who must demonstrate that actions on a natural system are sustainable - now and into the future.*

# Ethics Without Economics - A Clearer View ?

Margaret Somerville, Medical Ethicist, McGill University

*"Can we reasonably anticipate that future generations would consent to what we both do and don't do now? If not, ethics demand that we change our behaviour."*

*Globe & Mail, 1 May 07*

*i.e. We should act in such a way that we might 'anticipate the consent' of future generations*

# So What Should Scientists Do?

- Acknowledge that other factors influence policy
- Continue to improve our science-based forecasts of the earth system under various future scenarios
- And, especially for proposed emission controls that we hope emerge from CoP-15 in Copenhagen next autumn
- State clearly and repeatedly that for a given level of action (or inaction) on controlling emissions, our best scientific understanding is telling us to expect a given future climate and the related known and **unknown** impacts
- This issue is too important to leave the policymakers to make the decisions of what actions our societies should take ⇒



From the Union of Concerned Scientists website: <http://www.ucsusa.org/publications/>

**Thank You**

# The Concept of 'Sustainability'

[from: 'Our Common Future' - the Brundtland Report  
World Commission on Environment and Development, 1987]

'Sustainable Development' is:

"development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

'The Precautionary Principle' means that the burden of proof is shifting from the 'conservers' to the 'proponents' or 'trustees' - who must demonstrate that actions on a natural system are sustainable - now and into the future.

In 2004 the British newspaper *The Financial Times* listed *Gro Harlem Brundtland* the 4th most influential European for the last 25 years, behind Pope John Paul II, Mikhail Gorbachev and Margaret Thatcher.