

# Risks and consequences, timescales and uncertainties

Martin Manning

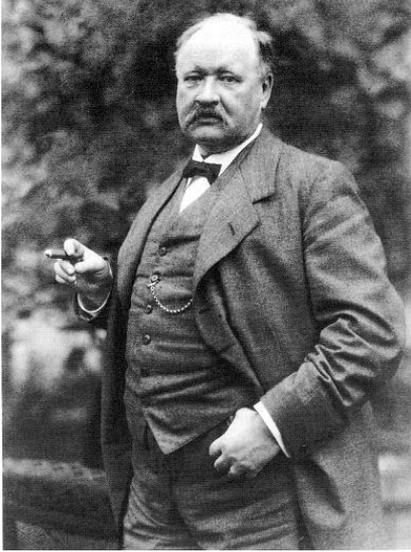
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# Key points

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- Scientists have learned a lot about climate change
- But science keeps seeing ‘surprises’ as well – and more risks can become serious
- We need to remember the ‘precautionary principle’ that was agreed in 1992
- This should lead to a collective approach for risk management.

# Recognising the importance of CO<sub>2</sub> – but then a first ‘surprise’



Svante Arrhenius (Nobel prize winner)  
in 1906:

... “any doubling of the percentage of  
carbon dioxide in the air would raise the  
temperature of the Earth’s surface by 4°C.”

That was amazingly correct for someone who did not  
have computers to do the climate modelling work.

But Arrhenius and his colleagues thought that this would  
take a thousand years to happen because the CO<sub>2</sub>  
coming from fossil fuels would mainly just be dissolved  
into the oceans.

# Oops: it's going to warm up much sooner



Then in the 1950s ...

Roger Revelle in California discovers that CO<sub>2</sub> is not very soluble in the ocean.



Athol Rafter in DSIR, NZ, finds that carbon in the atmosphere was getting much “older” — due to fossil fuel burning meaning an increase in CO<sub>2</sub> .

The Otago Daily Times, Wednesday, January 23, 1957.—Page 5.

## *Polar Ice Caps May Melt With Industrialisation*

The effect of industrialisation could cause the future des-

Otago Daily Times cite Rafter in a conference at Dunedin during the International Geophysical Year in 1957

# So do we know how much warming?

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In the early 1960s two estimates of the warming for a doubling of atmospheric CO<sub>2</sub> were 2°C and 4°C – so it was concluded that it would be somewhere in the range 1.5°C to 4.5°C.

Forty years later (2007) some who are trying to combine information from many sources say the best estimate would be 3°C and it's likely to be within 2°C to 4.5°C.

But others still point out that it depends on what happens to the forests and ice sheets as a result of the warming and then how far into the future do you want to know the answer.

Should we just watch this space ....

**... or recognise that the warming will be significant.**

# Local changes are more important than the global average

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The warming that is expected in New Zealand is smaller than the global average – but ...

This warming is larger relative to our summer to winter variations than is the case for most countries in the Northern Hemisphere.

Studies of the metabolic effects of warmer temperatures on a range of biological systems show that those in the tropics are more sensitive than those in the mid latitudes of the Northern Hemisphere because they have evolved in a less variable climate.<sup>1</sup>

<sup>1</sup>Dillon et al, Nature, 2010

# Another Oops: There are actually quite a lot of other greenhouse gases

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In the 1970s quite a number other greenhouse gases were discovered.

And then there is a cooling effect due to sulphate aerosols coming from combustion and vehicles.

So there is much more uncertainty for quantifying all the processes.

**... but the warming can still be significant.**

# And some of them are destroying the ozone layer

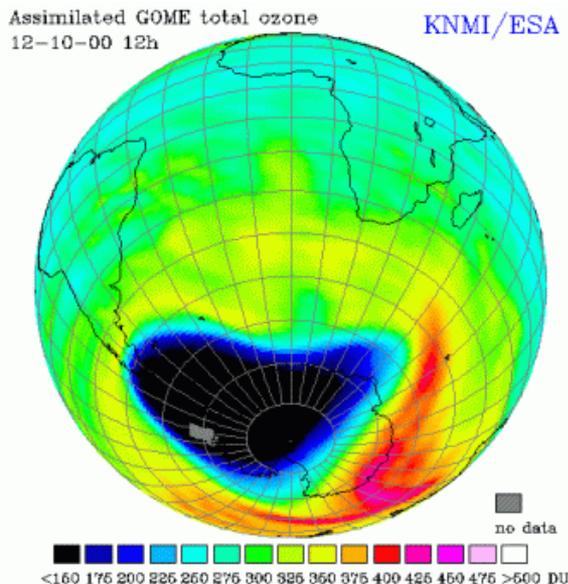
In the 1920s, Thomas Midgely invents CFCs for refrigeration and shows these are perfectly safe if you accidentally breathed them into your lungs.

Then in 1974 Sherry Rowland and Mario Molina discover CFCs are starting to destroy the ozone layer and so will increase skin cancers.

This deserves the Nobel prize in chemistry, but ...

Then in 1985 comes the **surprise** ... over much of Antarctica most of the ozone layer is getting wiped out in spring time by CFCs.

So pollutants emitted in the Northern Hemisphere can have more impact on the other side of the world.



# **We save the ozone layer but shift the load on our environment**

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So we replace the CFCs with some other greenhouse gases that will be removed in the lower atmosphere and that increases our reliance on some other chemistry that we don't fully understand yet.

Every day most of the removal of our forcing effect on the climate system is coming from complex atmospheric chemistry in the troposphere.

We have discovered that this chemical removal of gases seems to be more widespread than expected, but large forest fires in Indonesia were also seen to cause significant reductions in it right down into the Antarctic.

# Sea level rise estimates have changed

Sea level rise by year 2100

Early estimates included contributions from loss of ice sheets.

Little direct evidence for that happening, so IPCC estimates were predominantly just for thermal expansion of the ocean.

US Dept Energy, 1985

IPCC 1990

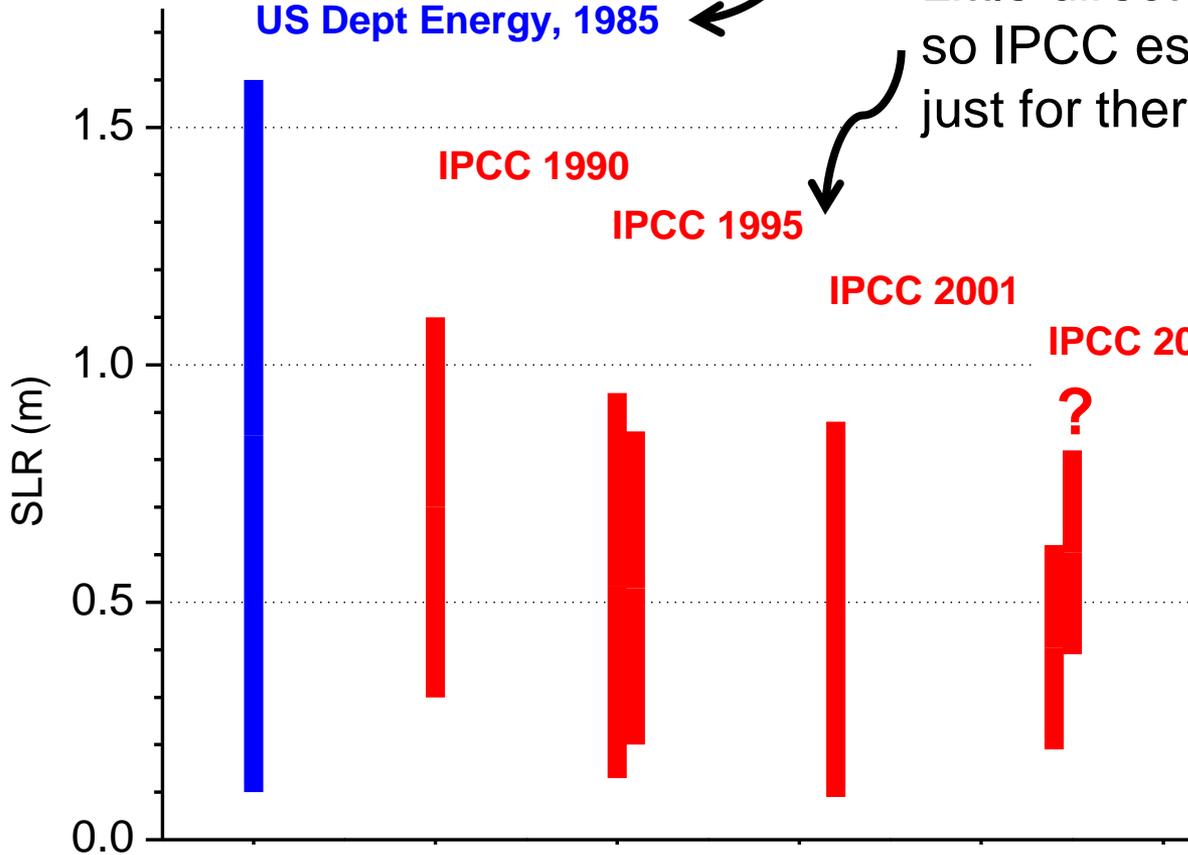
IPCC 1995

IPCC 2001

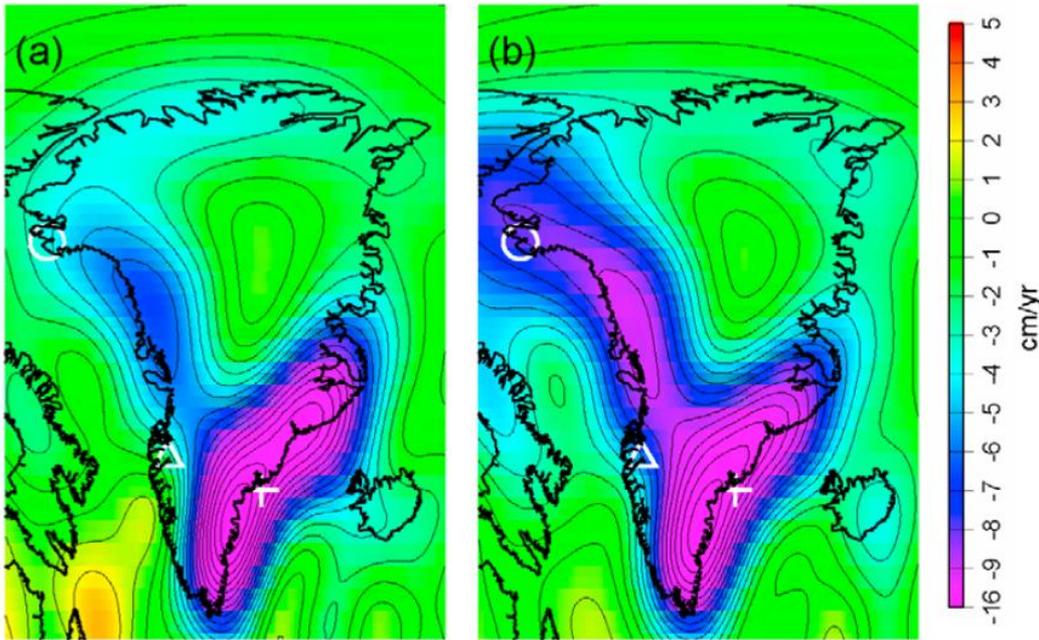
IPCC 2007

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**But in 2007, IPCC had to say that we could not give an upper bound as there was growing evidence for changes in the major ice sheets.**



# Major ice sheets melting faster than expected



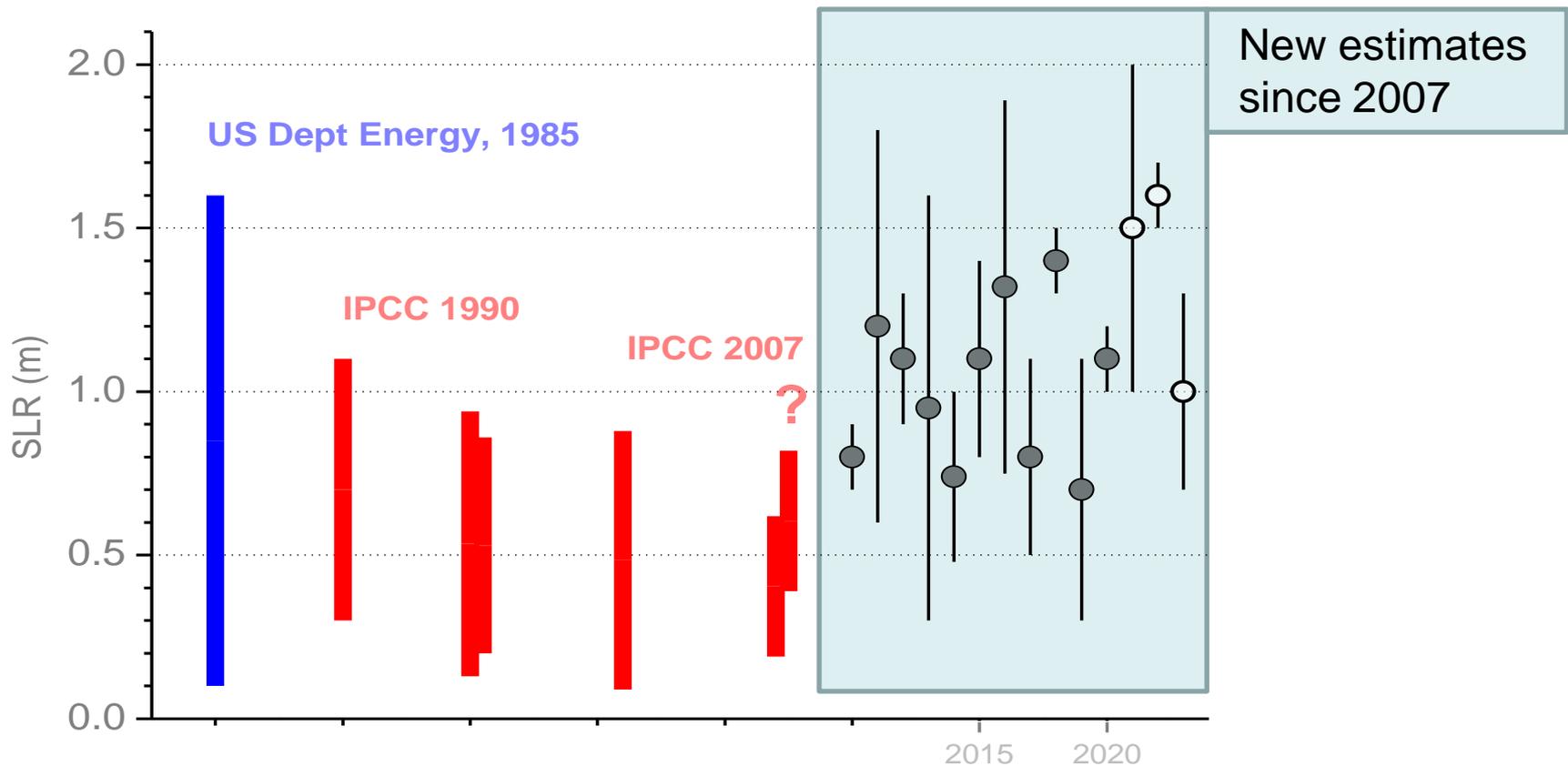
Ice loss rates over Greenland over Feb 2003 to Feb 2007, and then Feb 2003 to Jun 2009.

And ...

Loss of this ice modifies the Earth's gravitational field so is expected to lead to more sea level rise on the other side of the world – e.g. in New Zealand.

So the Southern Hemisphere seems to come out worse again.

# Oops: sea level rise estimates are higher



Summary of recent peer reviewed scientific papers on estimates of SLR by 2100. Solid dots are projections for this century, open dots are from analogies with the last time the Earth warmed up.

# How does NZ deal with new issues



Pauanui, NZ

New Zealand has a large amount of coastline, and many of our towns and cities are on low lying land.

We also have several of our main transport corridors on low lying land, and we tend to increase this area of potential vulnerability.

Scientists talk of 'mal-adaptation'.

Others should wonder if we have really planned for our future.

The expected trend towards more extreme storm events will combine with sea level rise to mean that some coastal impacts will come sooner and penetrate further inland.



**So do we know everything that  
will happen now?**

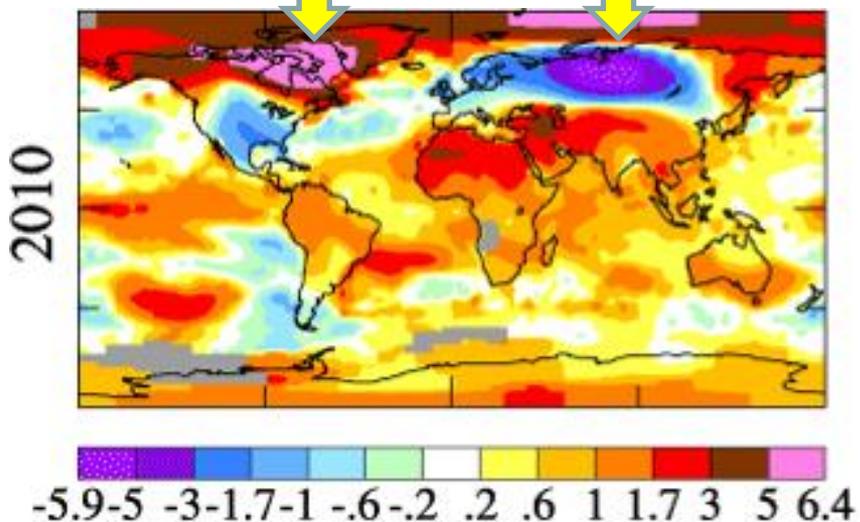
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# Oops: did we tell you that climate change means extreme cold events in some places?



Much colder than normal

Much warmer than normal



Temperature anomaly (°C) for Dec-Jan-Feb 2010, relative to 1951-1980 average

"An important result of our simulations is that a decrease of the wintertime sea ice cover in the Barents and Kara seas does not always result in *a priori* expected warming over the adjacent continental areas. A robust cooling may also be associated with the sea ice reduction within a certain range, which can be important in perspective of global climate change.

Petoukhov & Semenov, JGR, 2010.

Their paper was submitted in November 2009, this type of event happened in early 2010, and the paper was published afterwards.

# Oops: looks like extreme rainfall is coming sooner than we thought

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“Here we show that human-induced increases in greenhouse gases have contributed to the observed intensification of heavy precipitation events found over approximately two-thirds of data-covered parts of Northern Hemisphere land areas.

“Changes in extreme precipitation projected by models, and thus the impacts of future changes in extreme precipitation, may be underestimated because models seem to underestimate the observed increase in heavy precipitation with warming.

*Min et al, “Human contribution to more-intense precipitation extremes”. Nature, 2011.*

# Hmmm – Perhaps floods and fires have got linked together now?

Drought and widespread fires in Russia at the same time as record breaking flooding down the Indus valley in Pakistan and near-record flooding across much of China is raising the question of correlations between extreme events.

Extremes like this have been expected to become more frequent, for some time - but some climate scientists are now concerned about the likely connections between them.



# Can scientists attribute these events to anthropogenic climate change

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At a meeting of climate scientists covering extreme events in August 2010, Kevin Trenberth gave a detailed explanation of potential connections between:

- Arctic ice sheet loss,
- warming of the Indian Ocean,
- blocking of weather patterns over much of Asia,
- record droughts in Russia,
- record floods in Pakistan, and
- extreme flooding across much of China.

Do we need to wait for that to be resolved before we adapt to more widespread extreme events?

# More in January 2011



Then in late-December 2010 and January 2011  
Sri Lanka:– heaviest rains for about 100 years,  
300,000 displaced.



Philippines:– by Jan 25 four weeks of sustained  
rain over a third of the country's provinces, 1.9  
million people affected.



Brazil:– by Jan 14 over 600 dead and this their  
deadliest natural disaster on record.

# Australia in January 2011



And then there were the Queensland floods at the same time.

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Queensland floods can be attributed to the strong La Nina conditions that started in mid-2010.

Some have argued that the Brazil flooding was due to very warm conditions in the Atlantic ocean.

Trenberth's explanation for the wide pattern of extreme events in the Northern Hemisphere does not seem to apply to the Southern Hemisphere.

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The last few years have seen even broader patterns of extreme events than have been shown here, and include persistent droughts.

Is this a new aspect of climate change?

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here

# And impacts in one country can propagate

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In 2010 a research paper suggested that effective globalization of water resources through a growing dependence on international trade for agriculture leaves fewer options for coping with exceptional droughts and crop failure – and so global trade can reduce our resilience to climate impacts.

*See: D’Odorico et al, GRL, July 2010*

....and this was then seen after the serious Russian drought later that year, when Vladimir Putin banned exports of grain.

There was a rapid and large increase in global prices for grain that were linked with food riots in Mozambique.

*The Observer, 5 Sep 2010*

**We better think about the  
major risks a bit more**

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# Scientists did say that ‘surprises’ can happen

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“Future unexpected, large and rapid climate system changes (as have occurred in the past) are, by their nature, difficult to predict. This implies that future climate changes may also involve "surprises". In particular, these arise from the nonlinear nature of the climate system. When rapidly forced, nonlinear systems are especially subject to unexpected behaviour.

The Summary for Policymakers in the IPCC Second Assessment Report, 1995.

And these words were put together by Steve Schneider with some help from Martin Manning.

# Society should take over from science when it comes to risk management



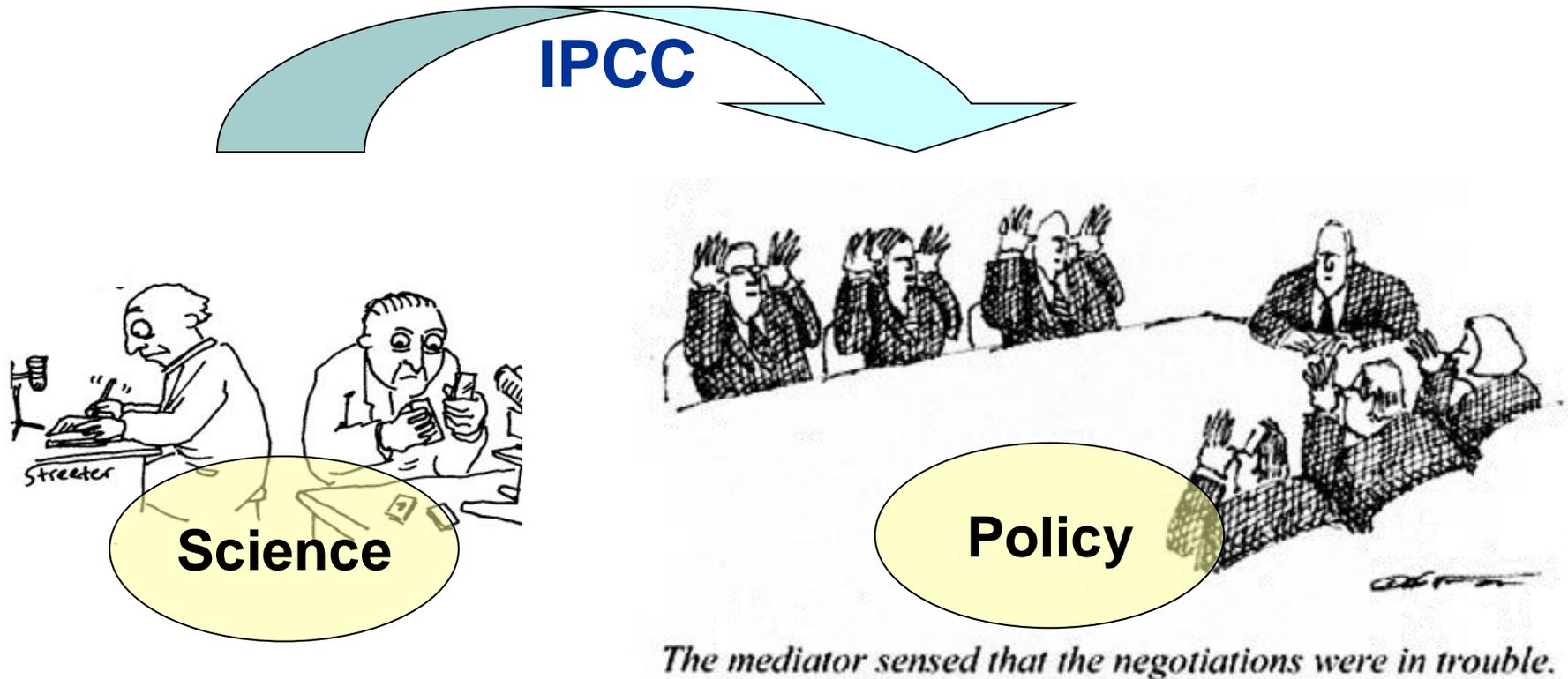
Scientists usually want to be sure of what they know, and understand the limits for what they don't know, before they say it.

So do we wait till the science is sure or do we follow the ...

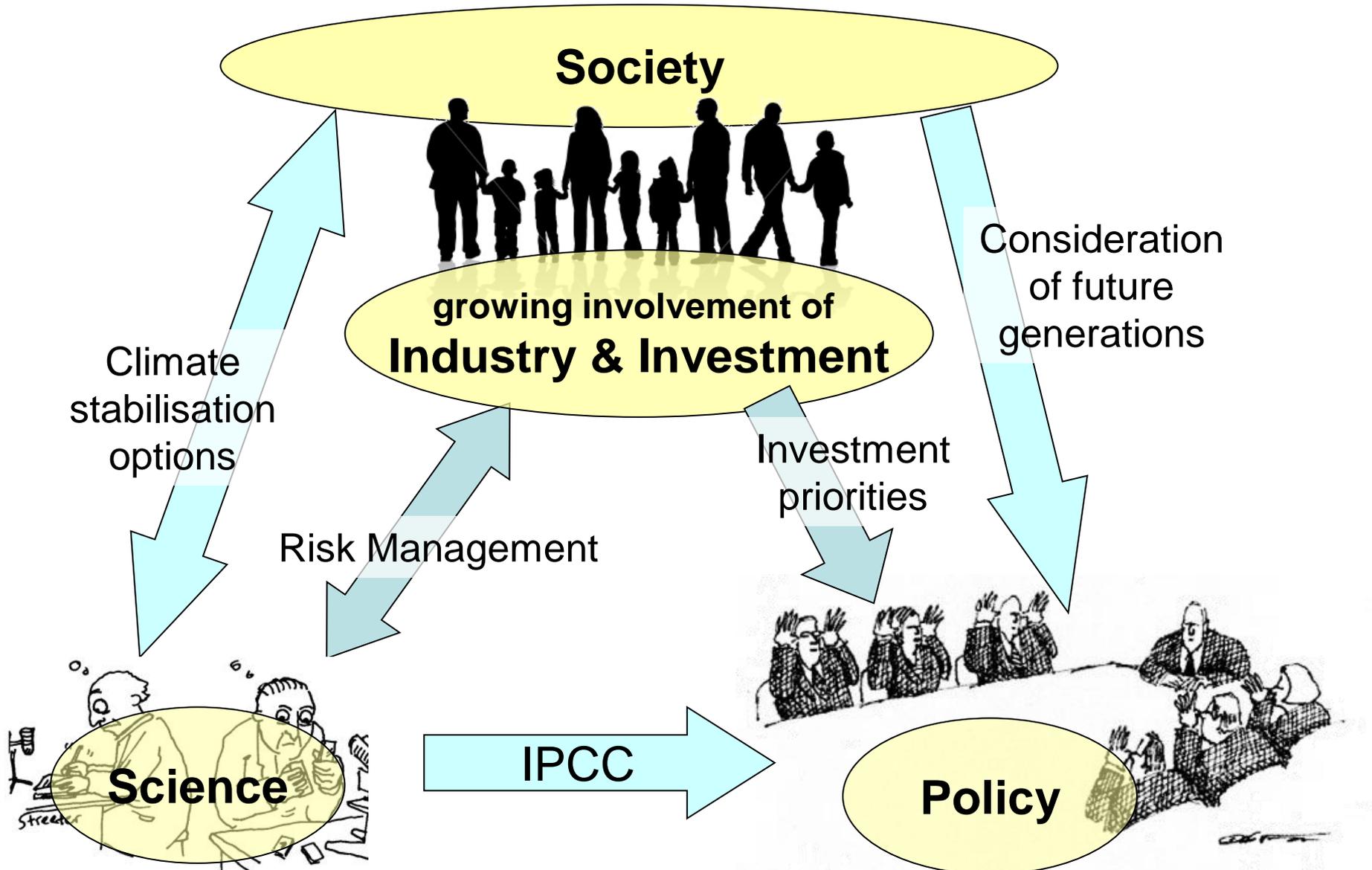
***The United Nations Precautionary Principle agreed by all governments in 1992 which said ...***

*“Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”*

# The IPCC communicates between science and the international policy process



# We now need a broader framework ...



*The mediator sensed that the negotiations were in trouble.*28

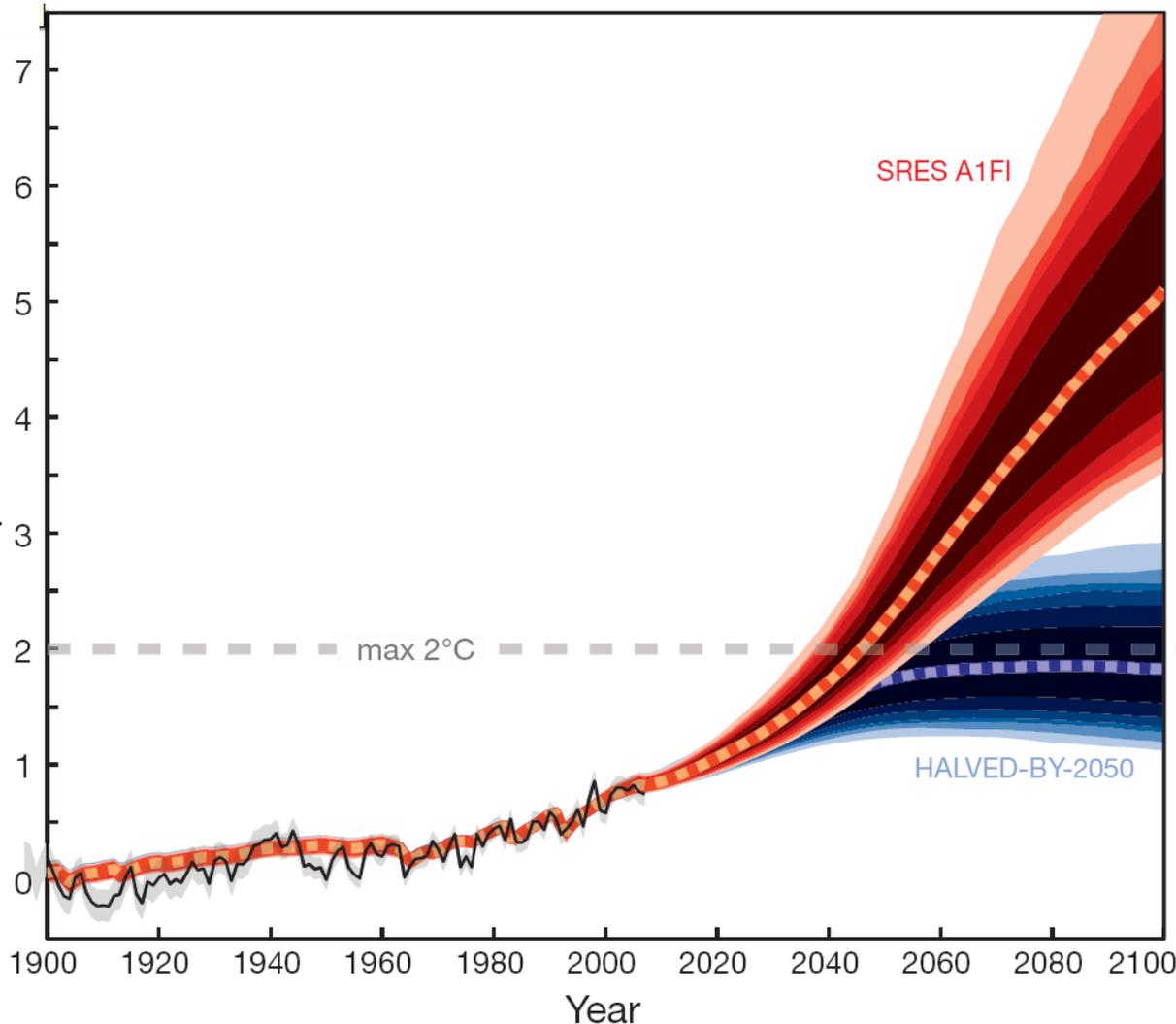
# Summary

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# The Y-Junction depends on views?



Politics has to be based on winning the next election

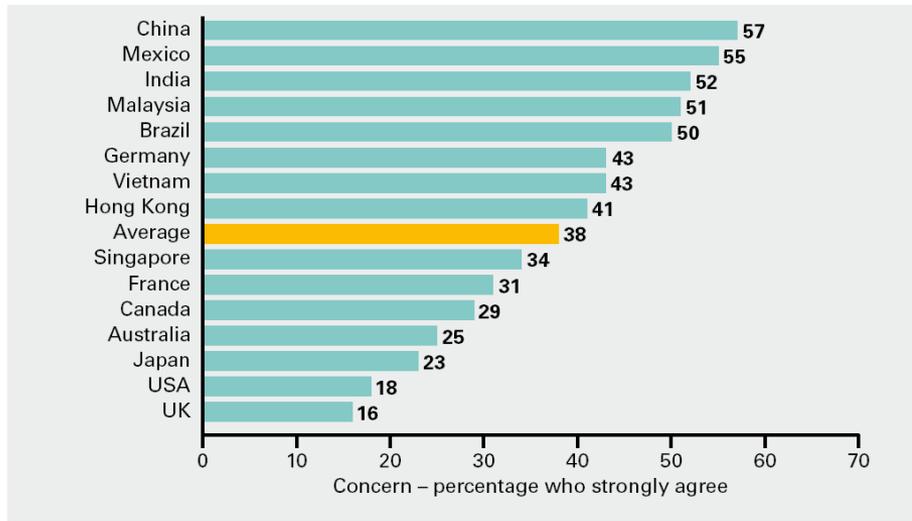
Our children can look after themselves

Perhaps in 10 years time we can start to do something

We want security for long term investments

We will be judged by what we pass on to future generations

# Public perceptions seem different in developing countries and some rapid shifts in energy sources



**Figure 4. Concern 2010.** Climate change and how we respond to it are among the biggest issues I worry about today. 6+7 on a scale from 1-7 where 1 means 'strongly disagree' and 7 means 'strongly agree'.

The Honkong Shanghai Banking corporation has been finding consistently that people in developing countries are more concerned about climate change than those in developed countries.

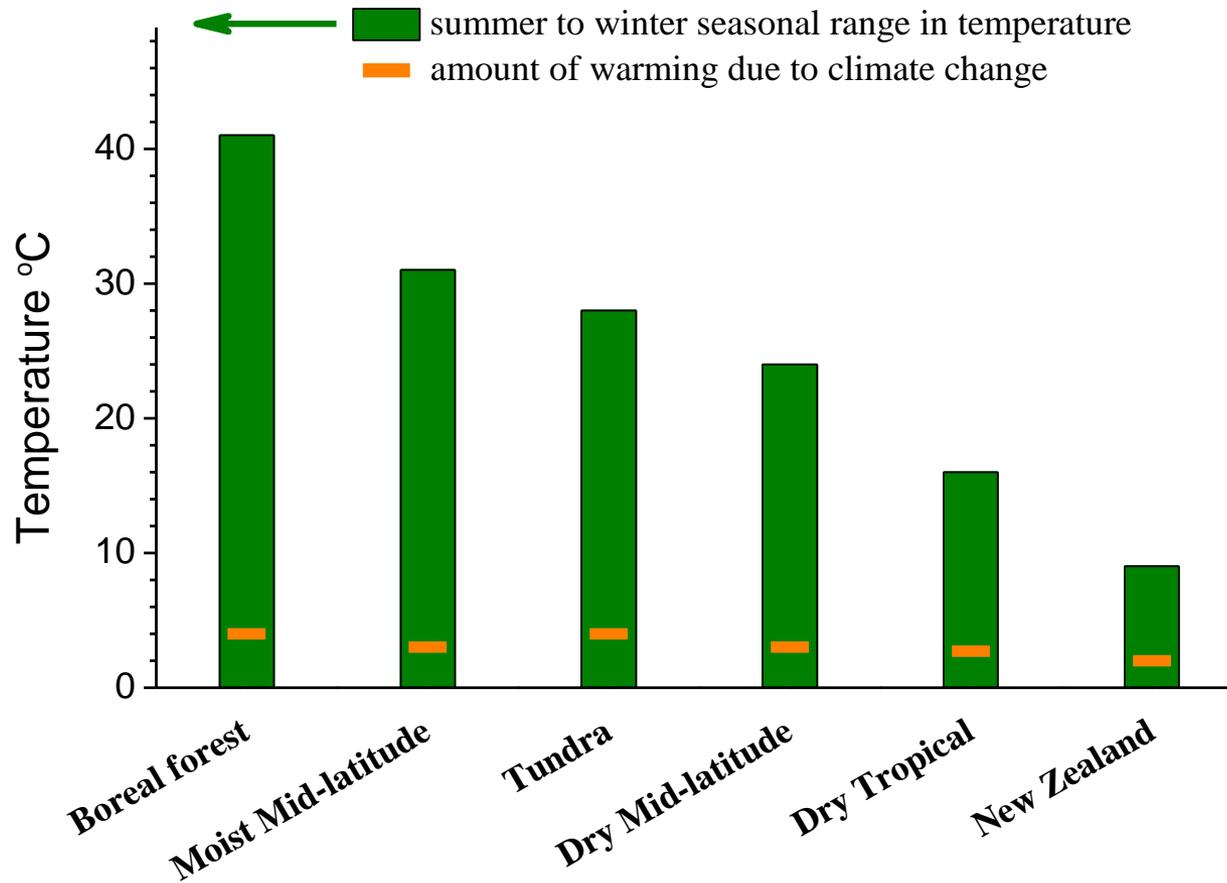
(By the way this corporation has its head office in London!)

Despite its smaller GDP, China has been investing more than the USA in renewable energy since 2009.

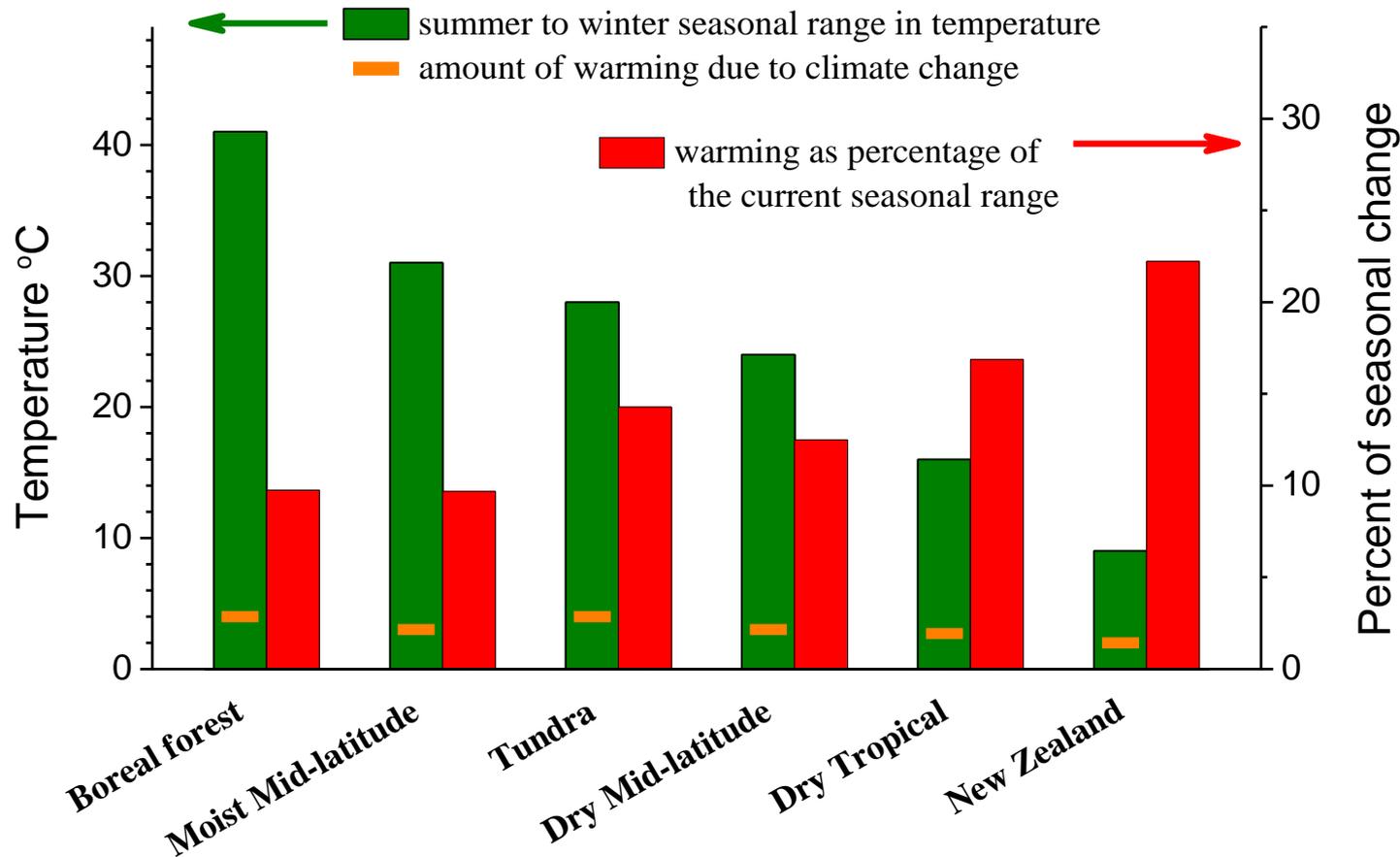
China has most of the world's solar water heating and is moving rapidly on wind power and solar photovoltaics.

However, despite the 2008 recession, renewables accounted for 60% of new installations in the EU and 50% in the USA.

# Warming versus what we are used to



# Warming versus what we are used to



Impacts depend on sensitivity to change

# We are still learning what the effects may be

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“Global metabolic impacts of recent climate warming”,  
Dillon et al, Nature 2010, 467:704.

Points out that the impacts of warming on the biosphere depend on its physiology and the metabolic rate which determines its energy needs.

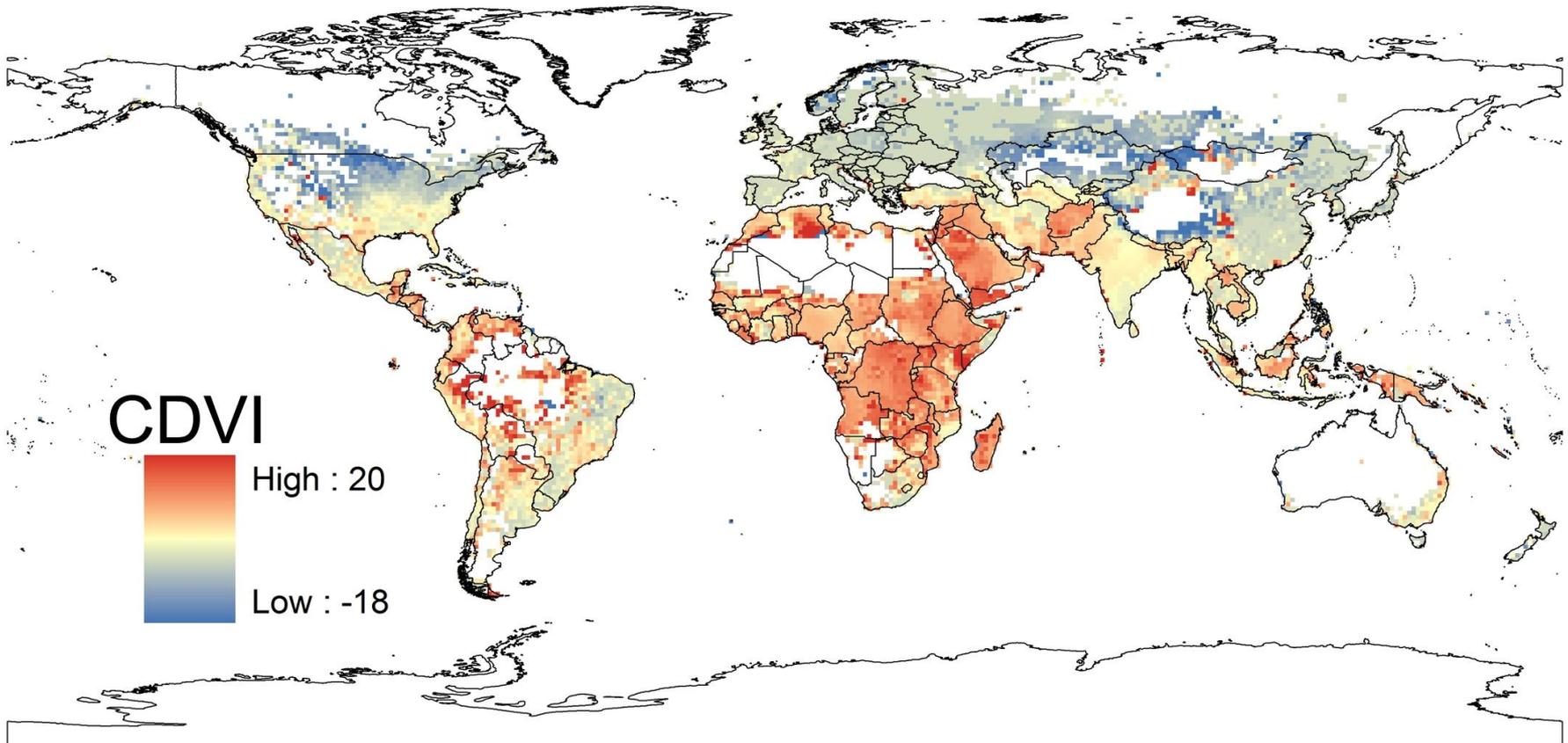
Even though warming has been less in the tropics, this work shows that the impact on metabolic rate has been equivalent in magnitude to that in the north temperate-zone regions, and far greater than in the Arctic.

It concludes that because of temperature's nonlinear effects on metabolism, tropical organisms, which constitute much of Earth's biodiversity, are likely to be profoundly affected by climate warming.

# Human Vulnerability to Climate Change

A Global climate–demography vulnerability index (CDVI).

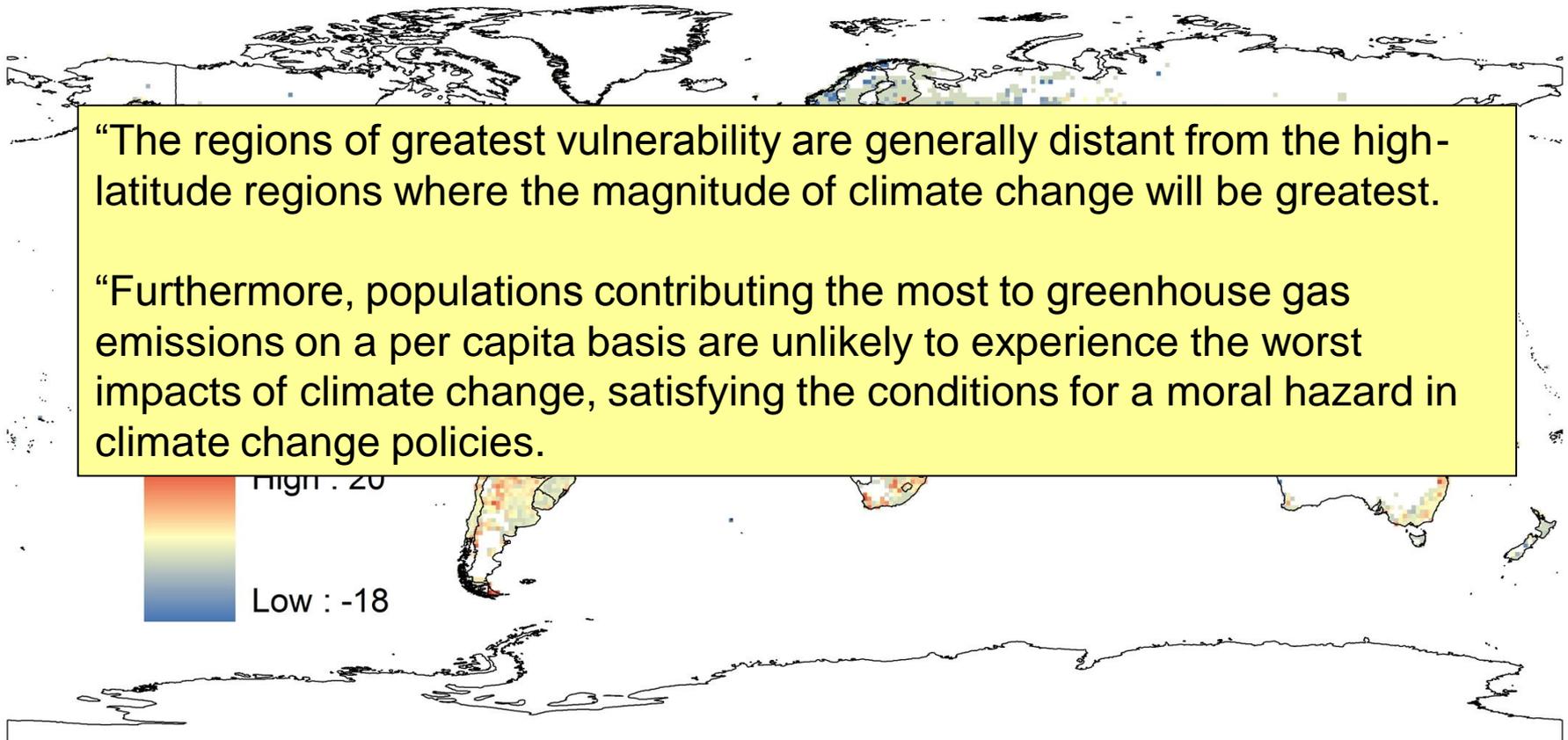
Blue regions are where population growth is below, and red areas where it is above, what is consistent with climate change.



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# August 2003 Heat Wave in Europe

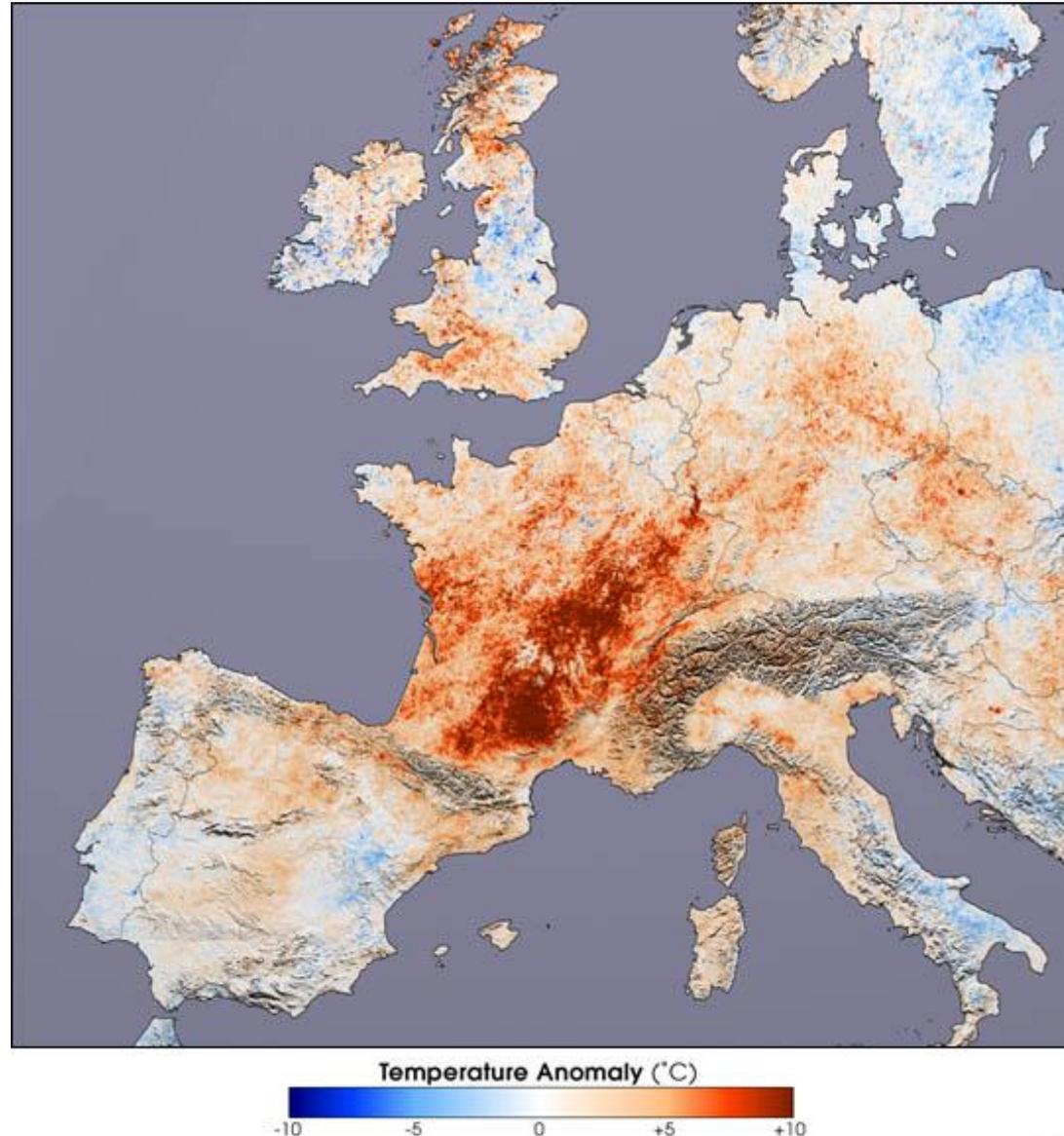
A wide area temperature anomaly of about 3°C

Was more than 7°C warmer than usual in some places

About 30,000 premature deaths

Unprecedented drop in crop yields

This is now twice as likely as it was 50 years ago due to global warming.



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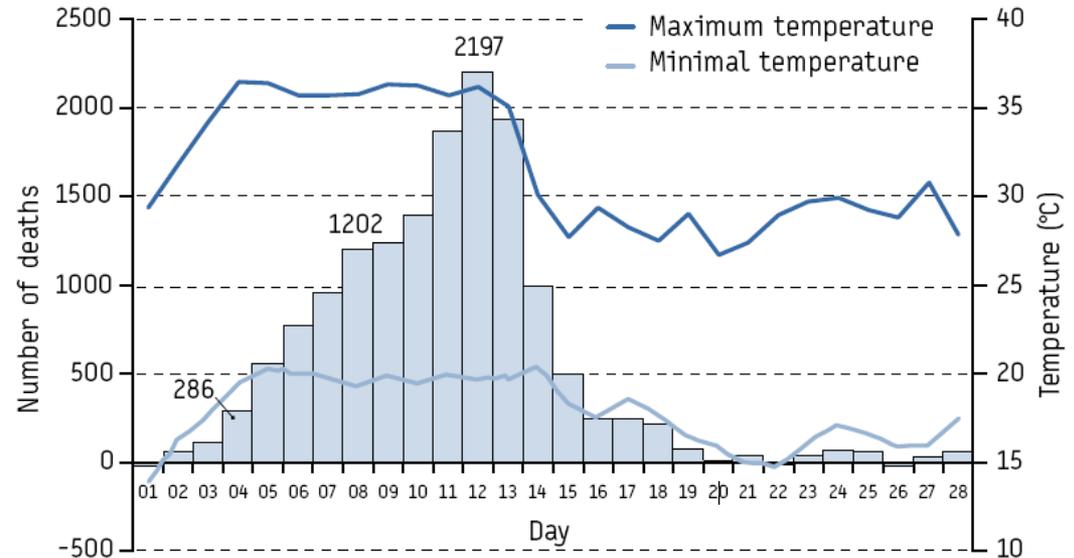
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Daily excess of deaths during August 2003 and minimal and maximal daily temperatures [1], France



	Death toll
France	14,082
Germany	7,000
Spain	4,200
Italy	4,000
UK	2,045
Netherlands	1,400
Portugal	1,300

# Growing evidence for a lack of planning to adapt



In New Orleans, major planning for hurricanes, after Hurricane Betsy occurred in 1965, was never completed. Hurricane Katrina in 2005 was more extreme, and also revealed structural inertia in planning.

- 'The greatest overall disaster in U.S. history at a time of unprecedented U.S. wealth and power
- 'Creating community resilience takes time and longer than anticipated
- 'Surprises should be expected & anticipation was insufficient
- 'Despite 290 years of effort, overall vulnerability to hurricanes has grown

