# Climate Change
# The Global Picture

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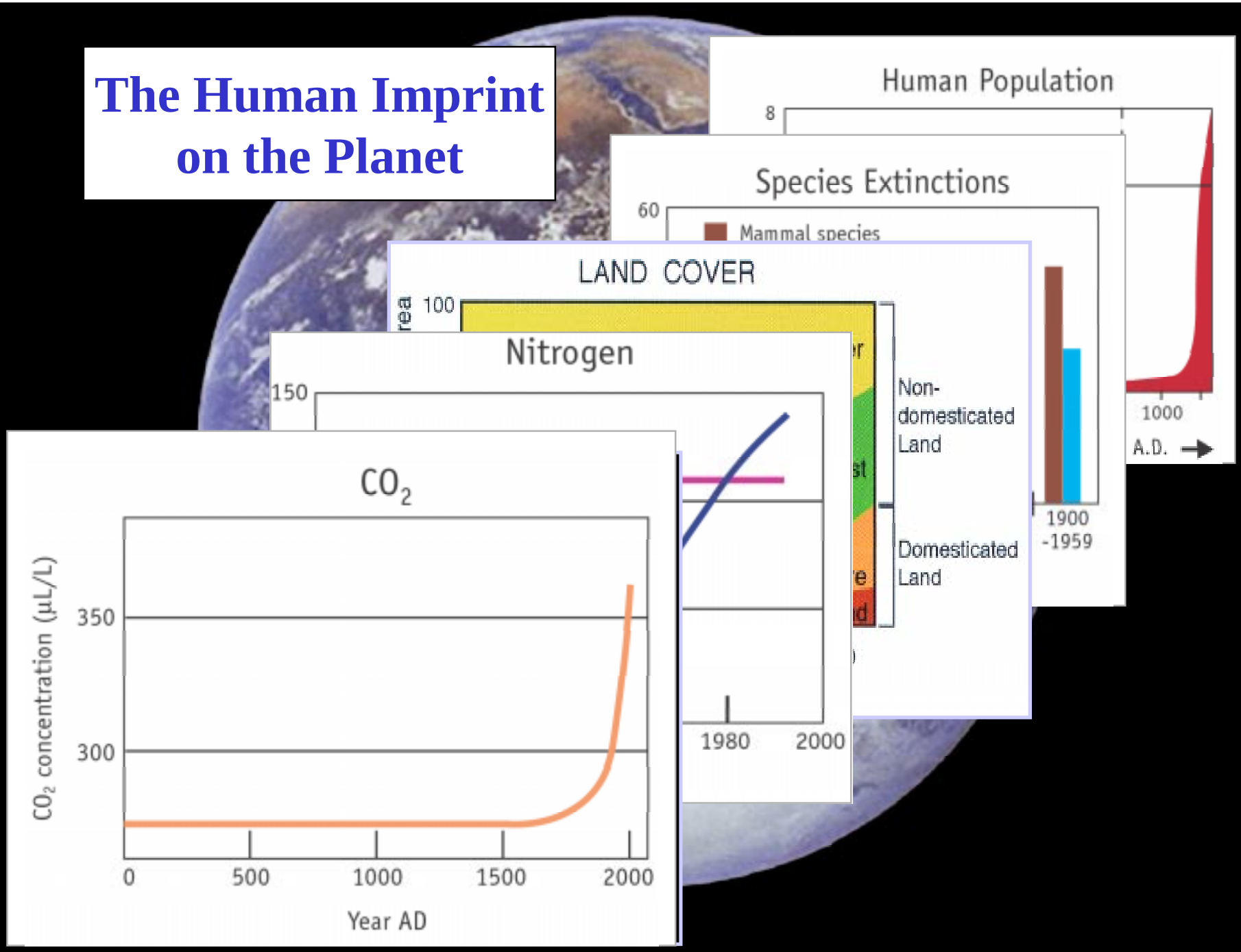
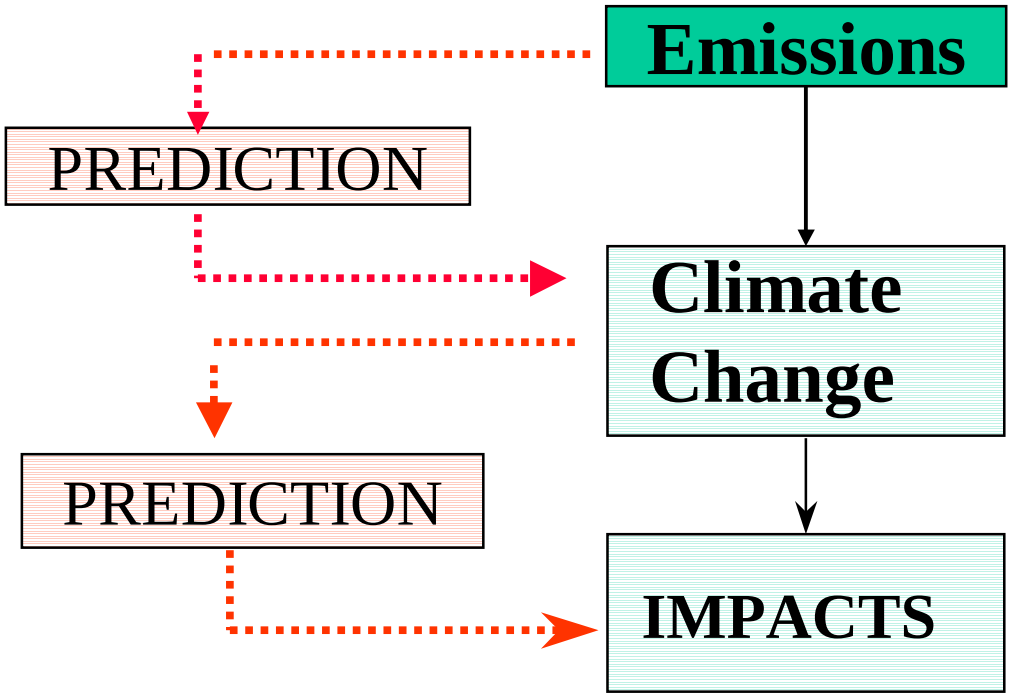
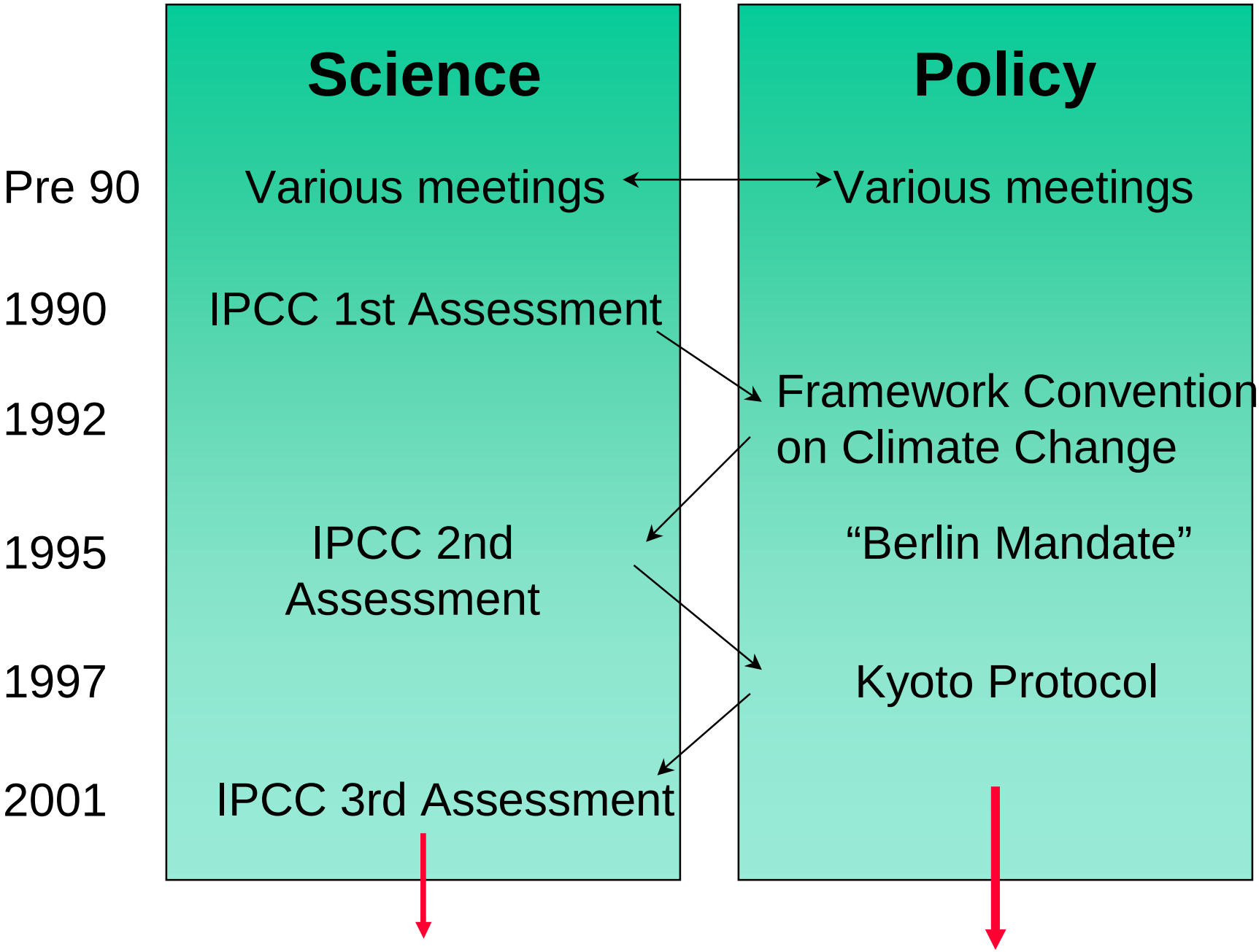
Presentation to the Workshop on
“Risk Management Approach to Climate Change”
Barbados, 11-13 Dec., 2001

# The Human Imprint on the Planet



# Understanding climate change
# Relating the human imprint back to impacts on humans and ecosystems.




Science
Policy
Pre 90
Various meetings
Various meetings
1990
IPCC 1st Assessment
1992
Framework Convention
on Climate Change
1995
IPCC 2nd
Assessment
“Berlin Mandate”
1997
Kyoto Protocol
2001
IPCC 3rd Assessment

# UN Framework Convention on Climate Change

- **Article 2**

**“ … stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.**

**Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure food production is not threatened and to enable economic development to proceed in a sustainable manner.”**

# UNFCCC

**Article 4:**

**(g) Scientific, technological, technical, socio- economic and other research; systematic observation; data archives**

**(h) Full, open and prompt exchange of information**

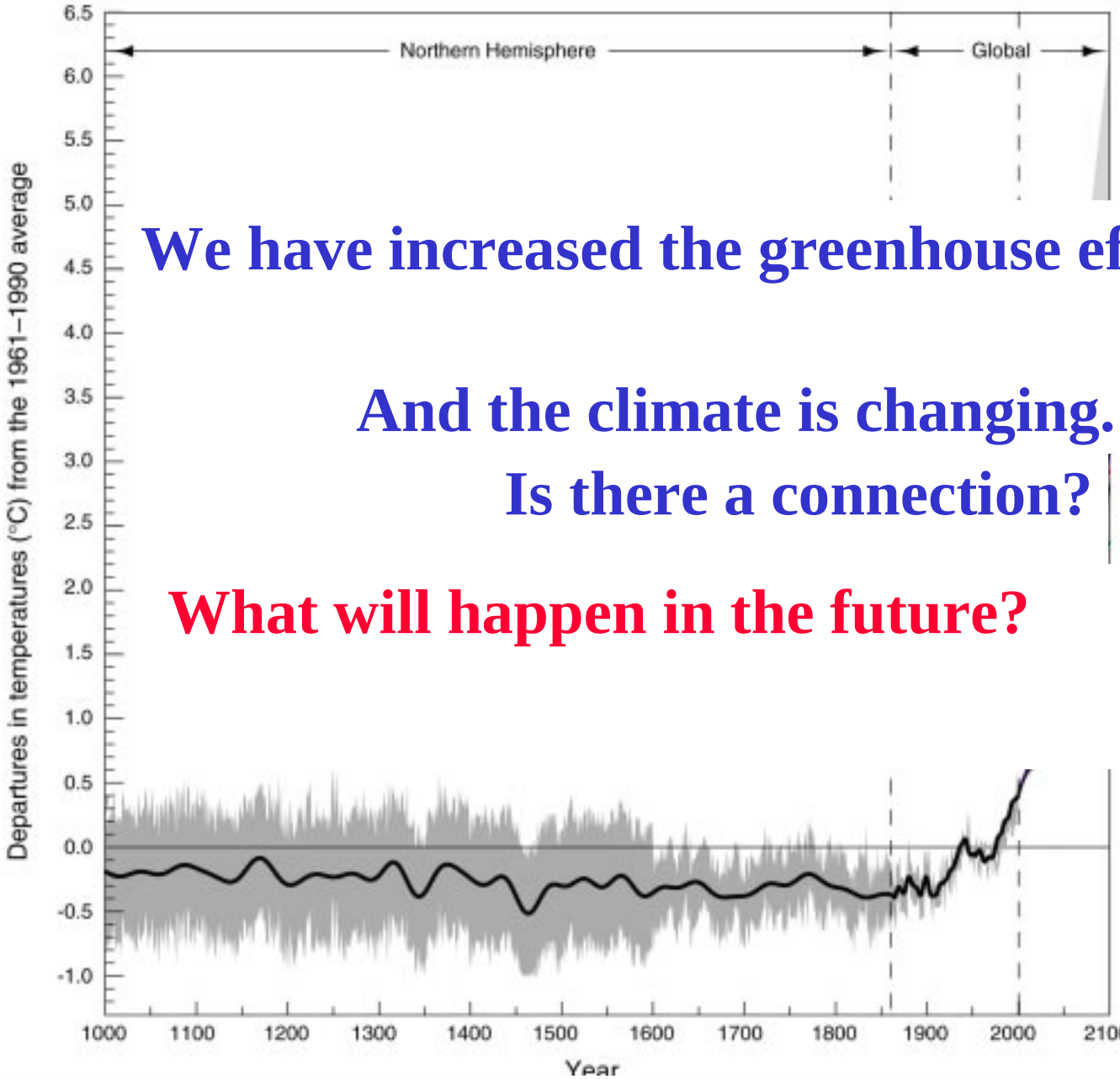
**(I) Education, training and public awareness**

**Article 5:**

**Research and systematic observations**

**Article 6:**

**Education, training and public awareness**



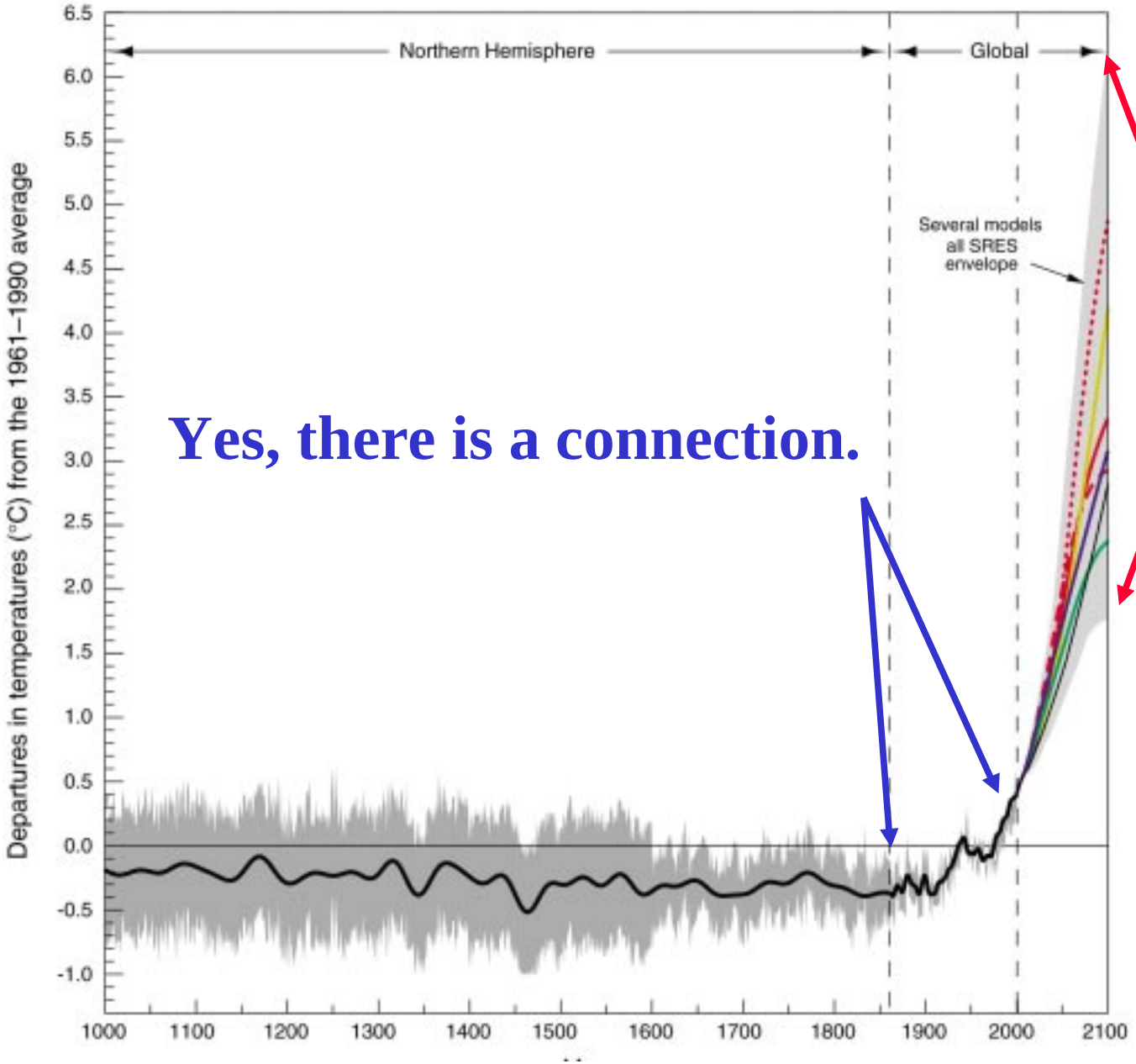

**We have increased the greenhouse effect**

**And the climate is changing.**

**Is there a connection?**

**What will happen in the future?**

Source:
IPCC 2001




**Yes, there is a connection.**

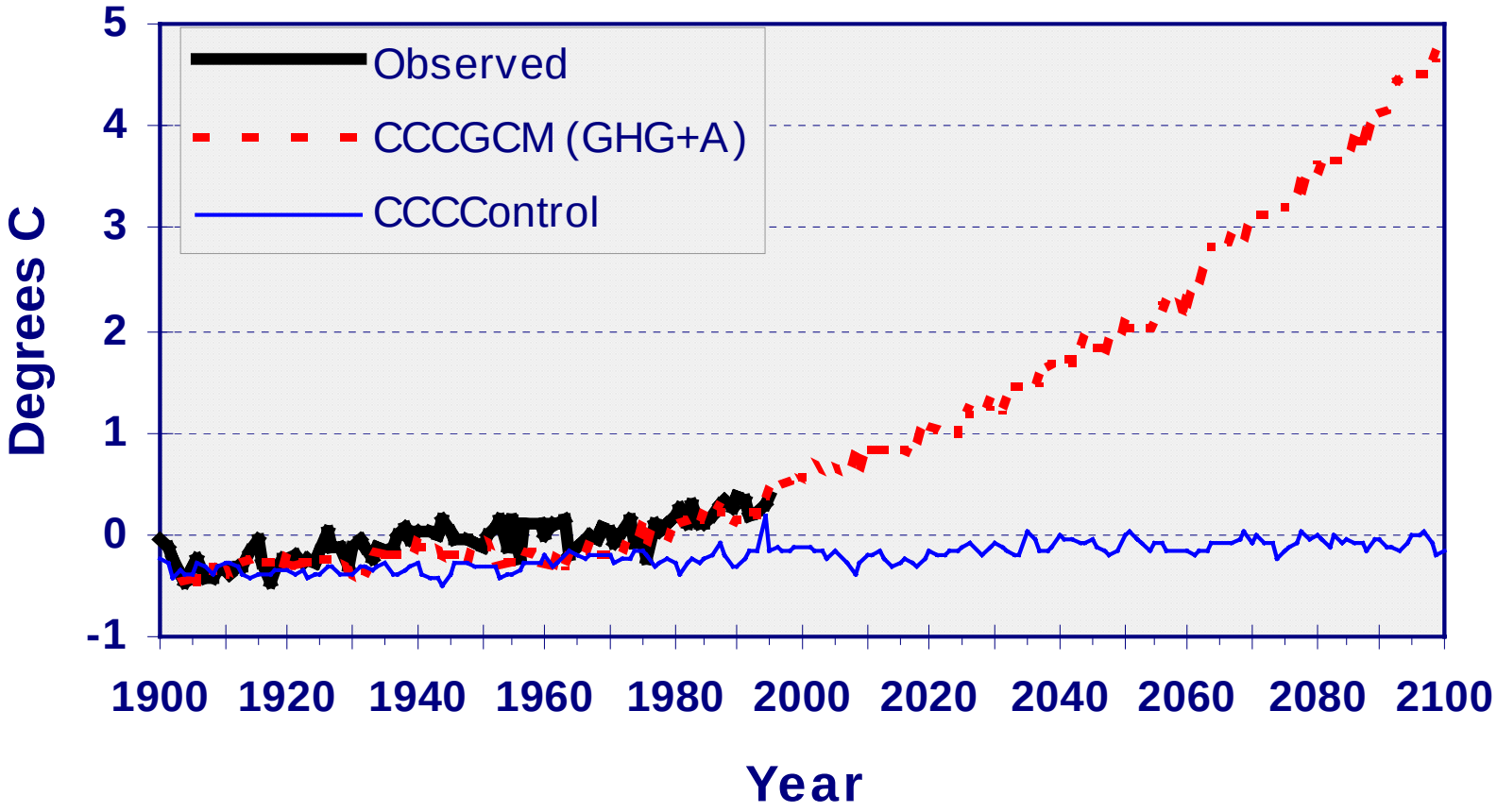
**And it will change more in the future.**

Source:
IPCC 2001

## Dr. Robert Watson – Chair IPCC to CoP6

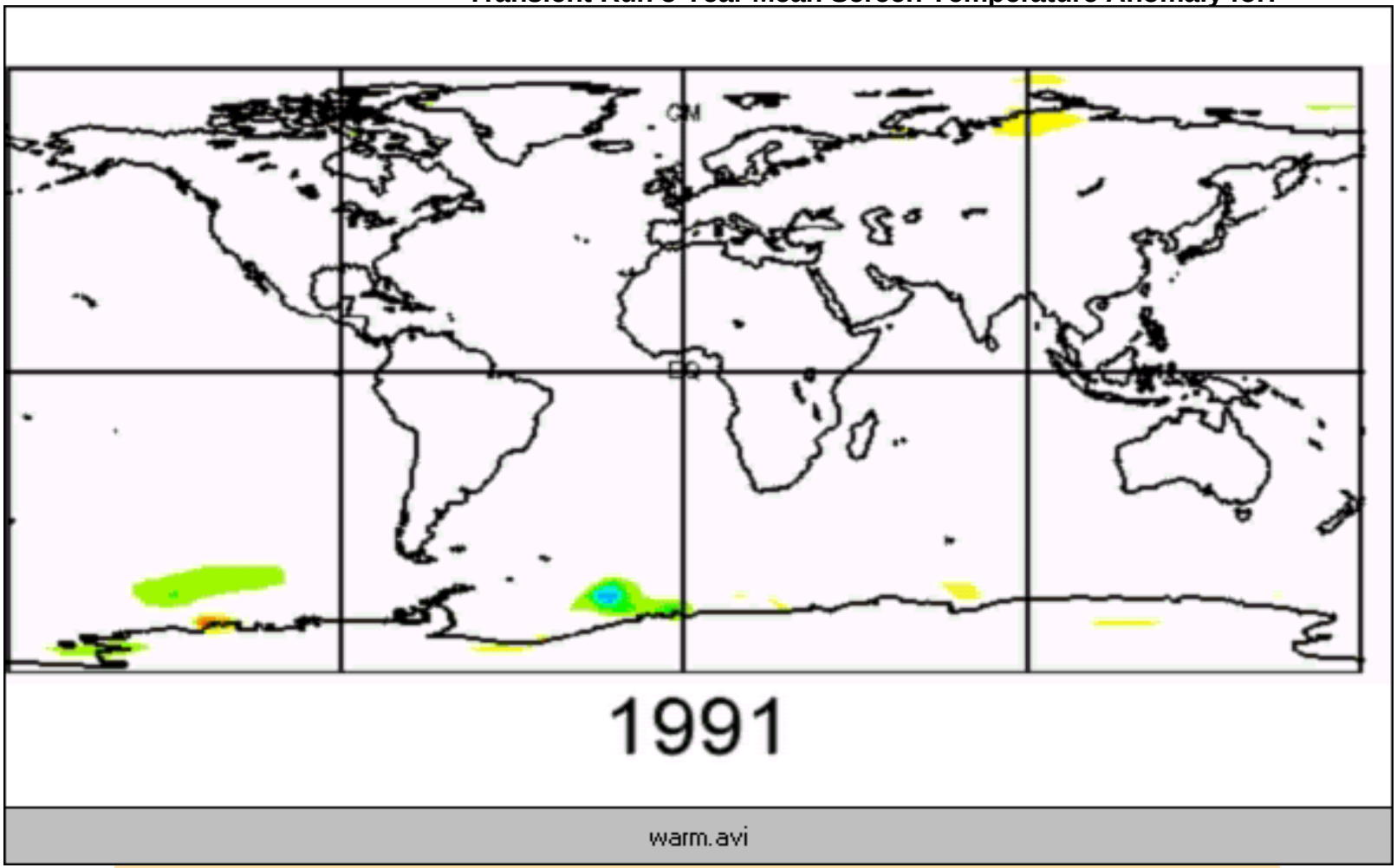
- *The overwhelming majority of scientific experts, whilst recognizing that scientific uncertainties exist, nonetheless believe that human-induced climate change is inevitable.*
- *"One of the major challenges facing humankind is to provide an equitable standard of living for this and future generations: adequate food, water and energy, safe shelter and a healthy environment (e.g., clean air and water). Unfortunately, human-induced climate change, as well as other global environmental issues such as land degradation, loss of biological diversity and stratospheric ozone depletion, threatens our ability to meet these basic human needs.*

# As the greenhouse gas concentration increases, how will global mean temperature (and other climate characteristics) change?

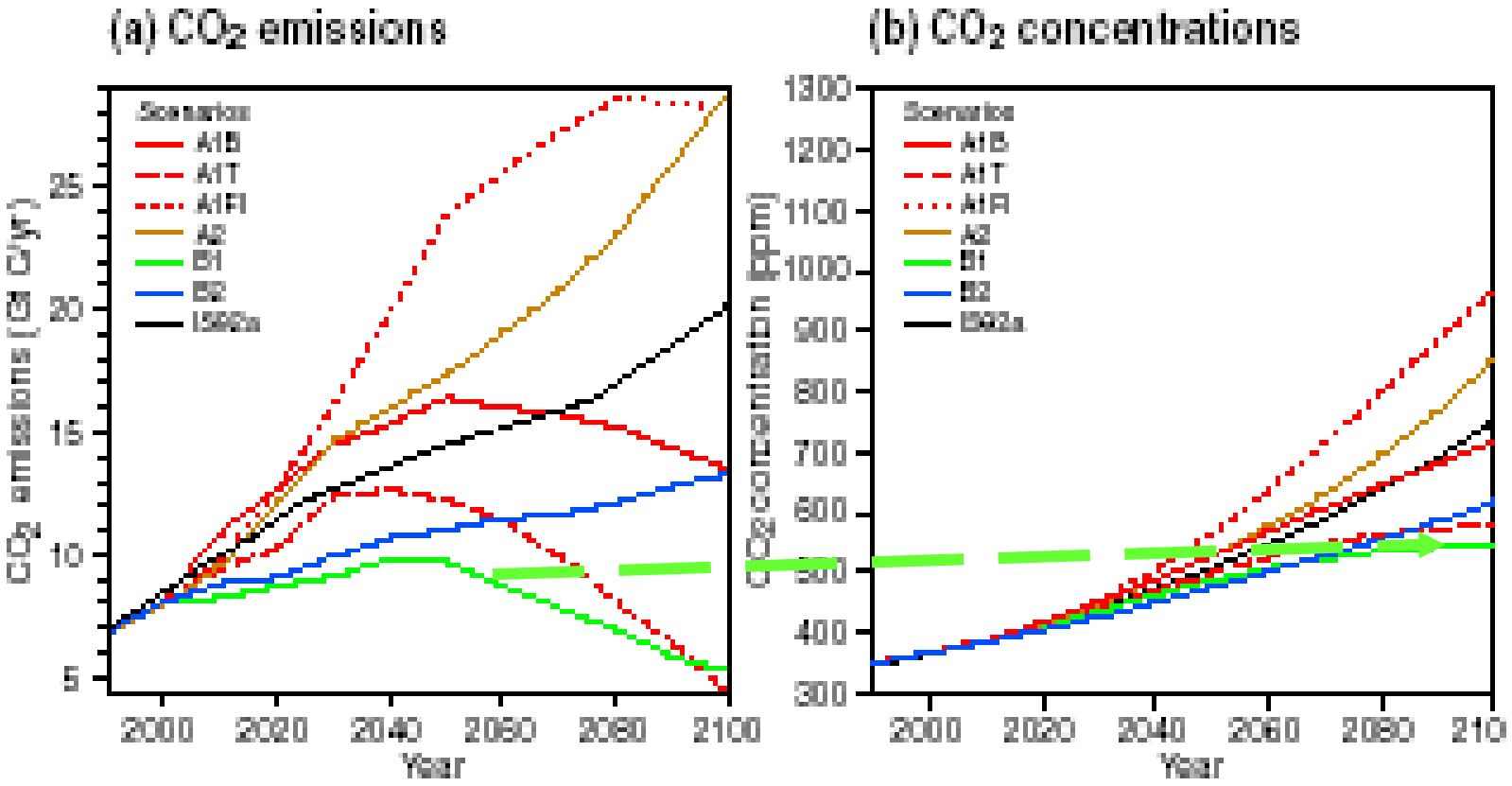


# There will be variations spatially as the globe warms

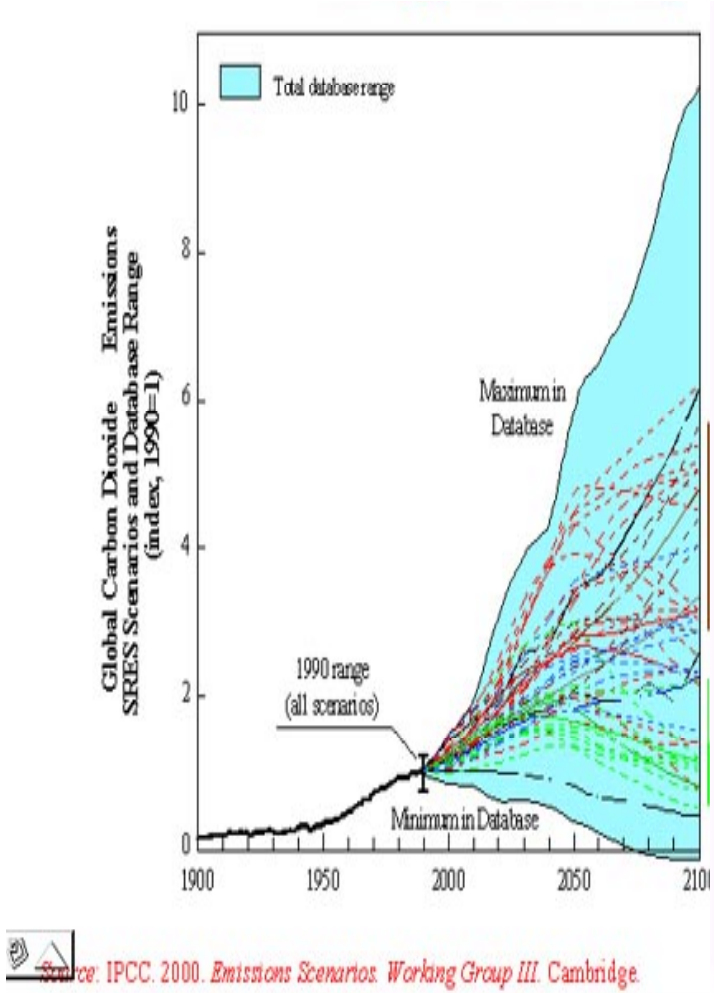
**Transient Run 5 Year Mean Screen Temperature Anomaly for:**

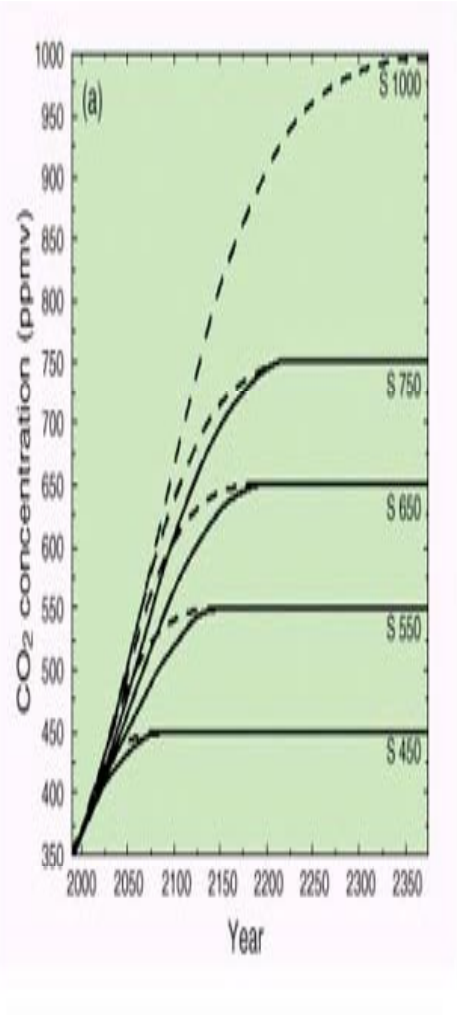


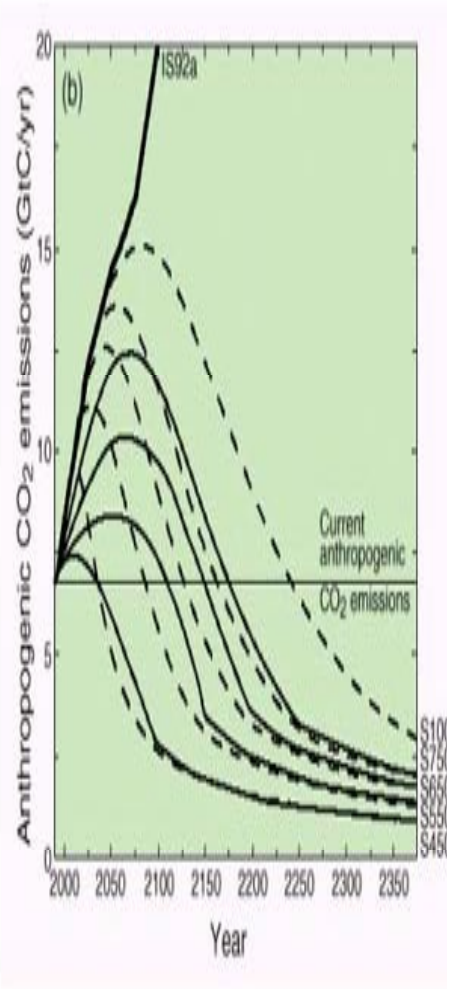
# Relations between emissions and concentrations



# . . .stabilization of greenhouse gas concentrations in the atmosphere



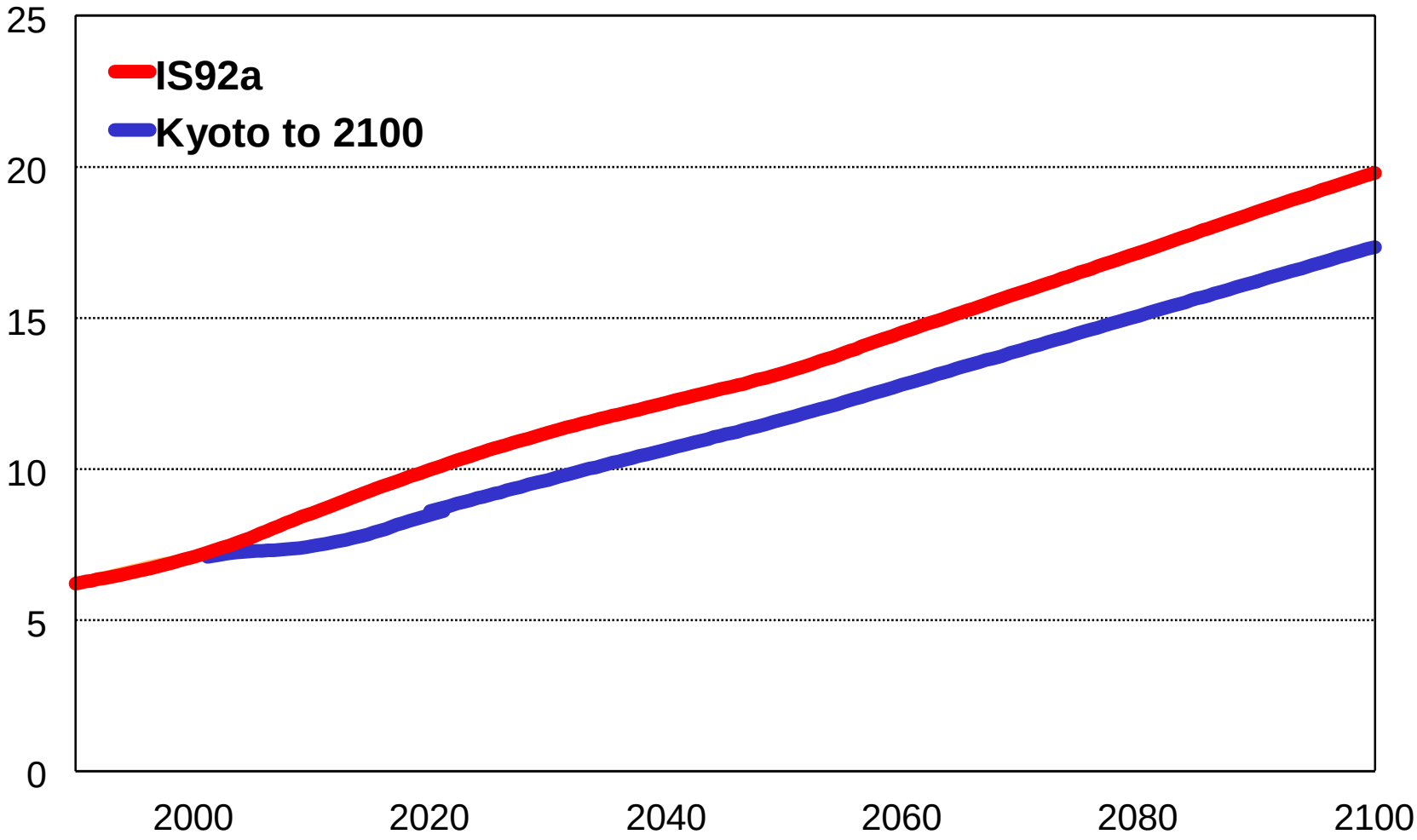



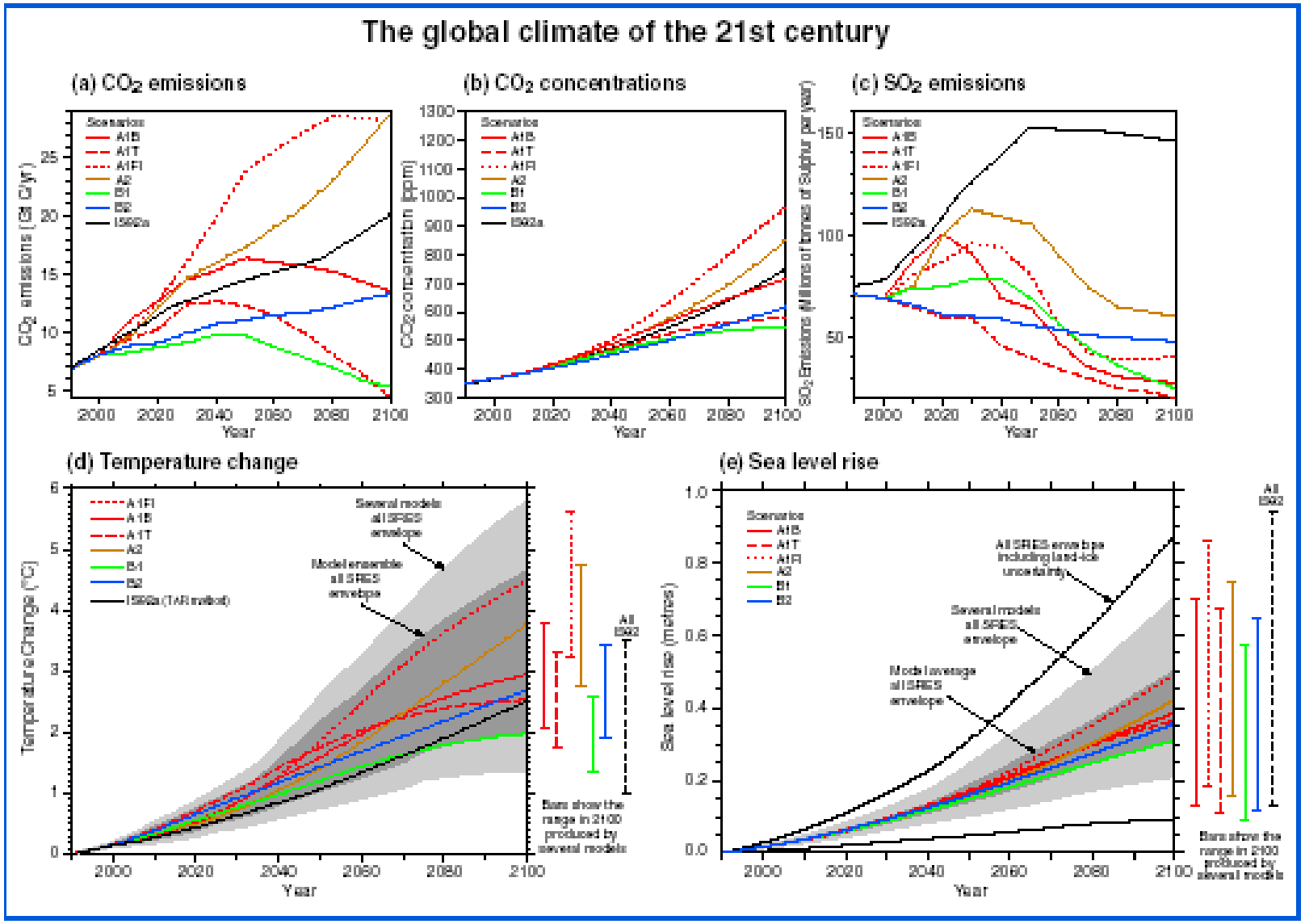




Source: IPCC. 2000. *Emissions Scenarios. Working Group III.* Cambridge.

# GLOBAL $CO_2$ EMISSIONS

## Kyoto Scenarios vs IS92a




The global climate of the 21st century
(a) CO2 emissions
CO2 emissions (Gt C/yr)
Year
Scenarios
A1B
A1T
A1FI
A2
B1
B2
IS92a
(b) CO2 concentrations
CO2 concentration (ppm)
Year
(c) SO2 emissions
SO2 Emissions (Millions of tonnes of Sulphur per year)
Year
(d) Temperature change
Temperature Change (°C)
Year
A1FI
A1B
A1T
A2
B1
B2
IS92a (TAR method)
Several models all SRES envelope
Model ensemble all SRES envelope
All IS92
Bars show the range in 2100 produced by several models
(e) Sea level rise
Sea level rise (metres)
Year
All SRES envelope including land-ice uncertainty
Several models all SRES envelope
Model average all SRES envelope
All IS92
Bars show the range in 2100 produced by several models

# Need to consider Disaster Management Approaches

- RECOVERY
- **ANTICIPATE through Forecasts and warnings**
  - advise people about impending events and advise on response strategy

  examples: tsunami, hurricane; seasonal drought; climate change
    - tsunami - 10 minutes**
      - run for cover
    - hurricane in next few days**
      - Prepare for evacuation; implement emergency responses

**MITIGATION - ADAPTATION**

- adopt standards, codes, practices that protect people, infrastructure, economy, etc., from "reasonable" extremes

examples: building codes; agricultural practices;

- increased likelihood of hurricanes, coastal storm surges; seasonal drought**
  - modify codes and practices; prepare response strategies

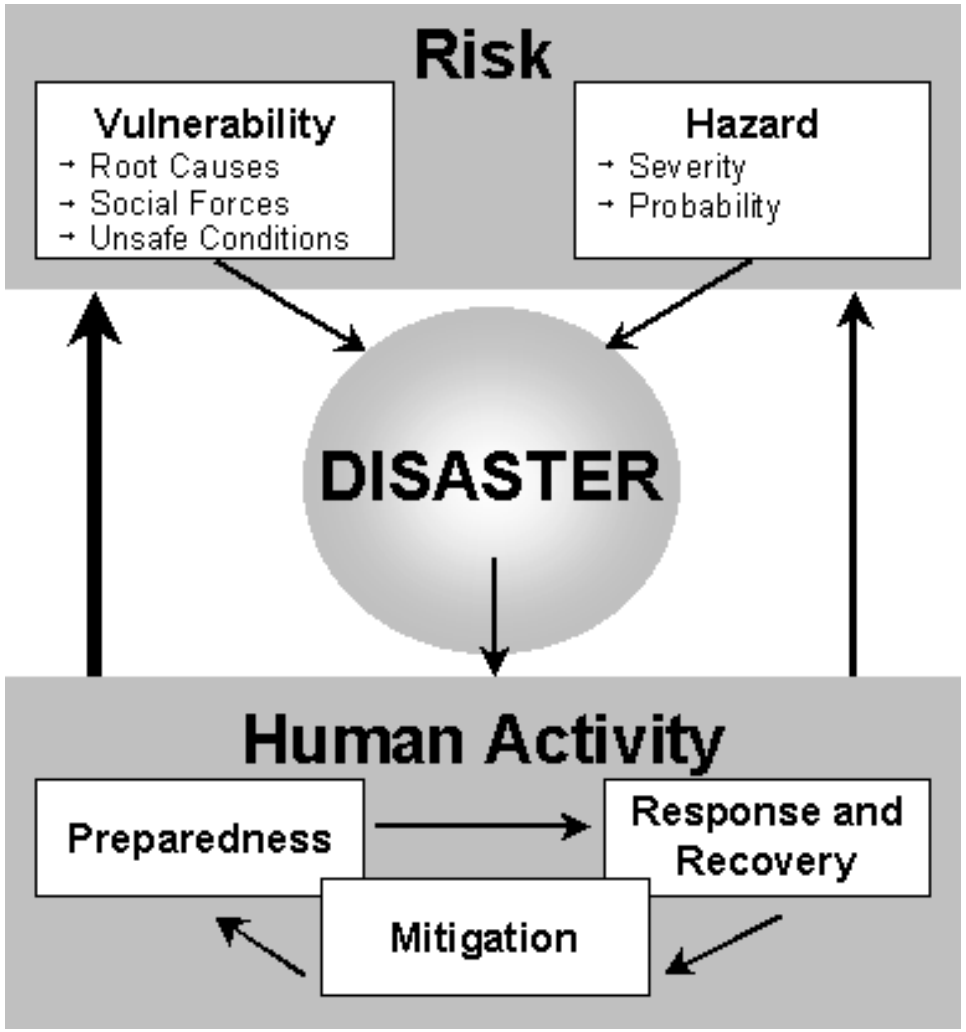
**Prevention**

**** Predictions –**

**how to maximize the value/benefits of the prediction?**

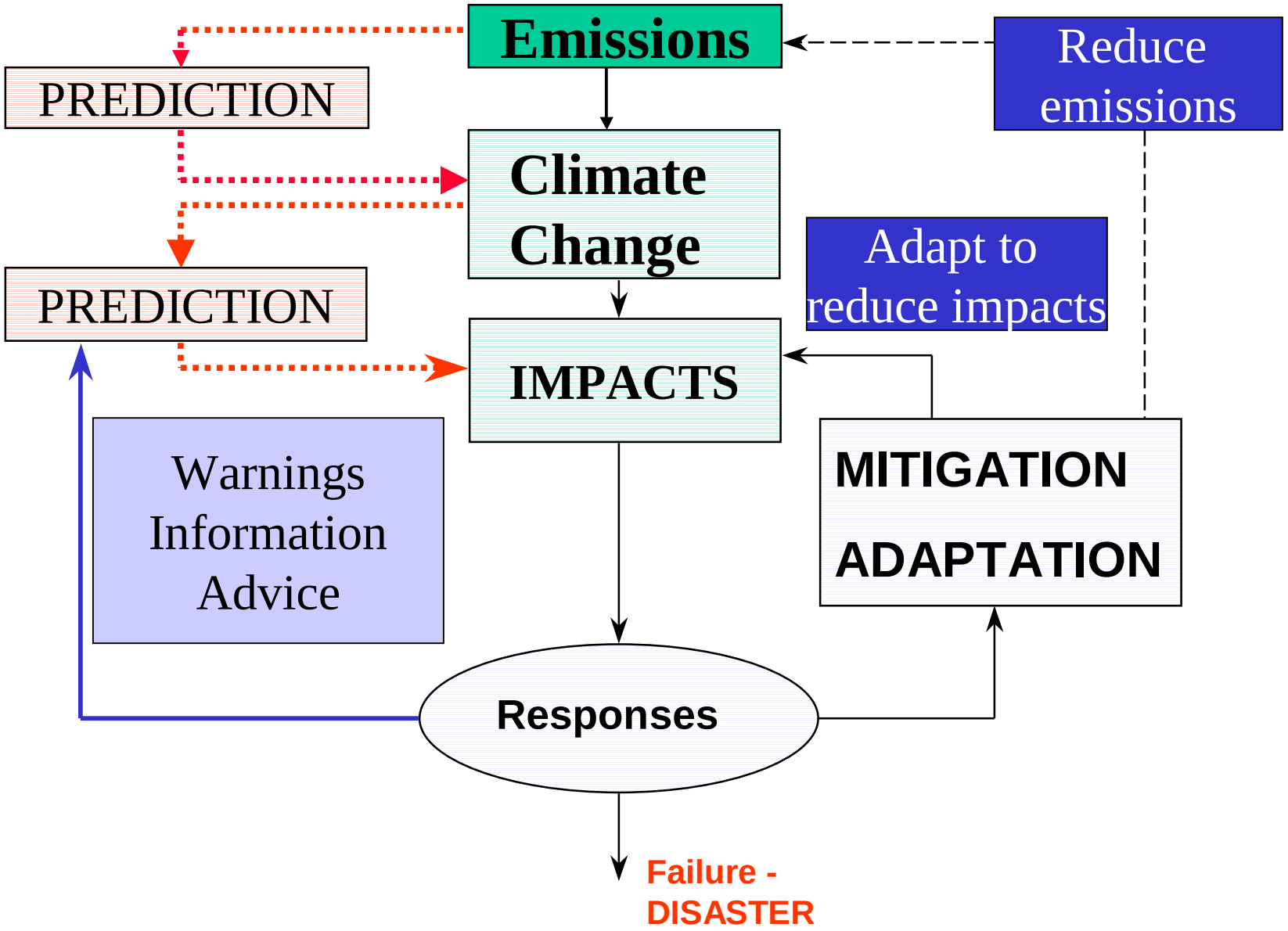
# Climate Variability and Change

**Reduce vulnerability by planning, adaptation and warnings**




**Hazards will continue to occur**

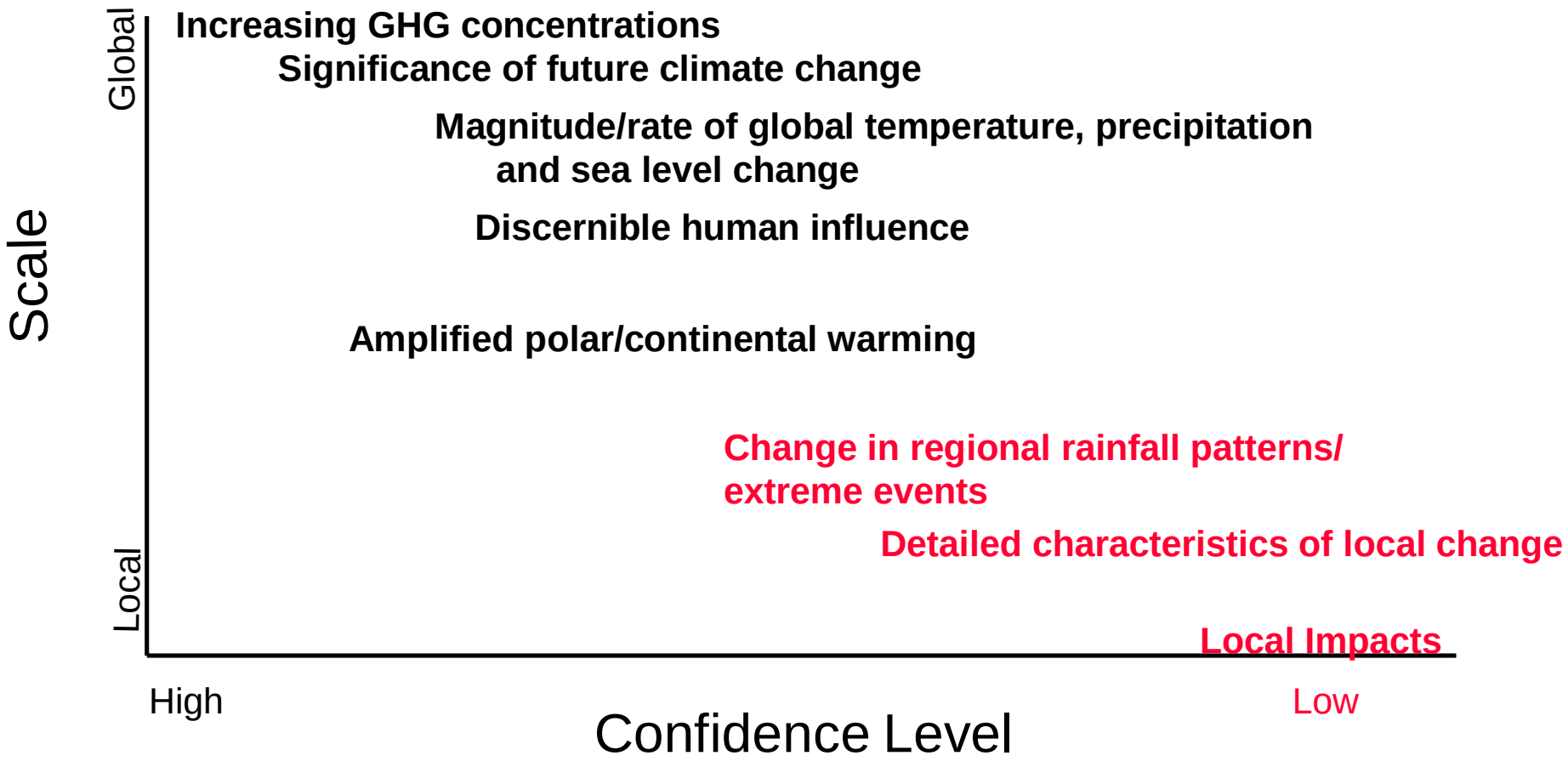
# Responding to Climate Change



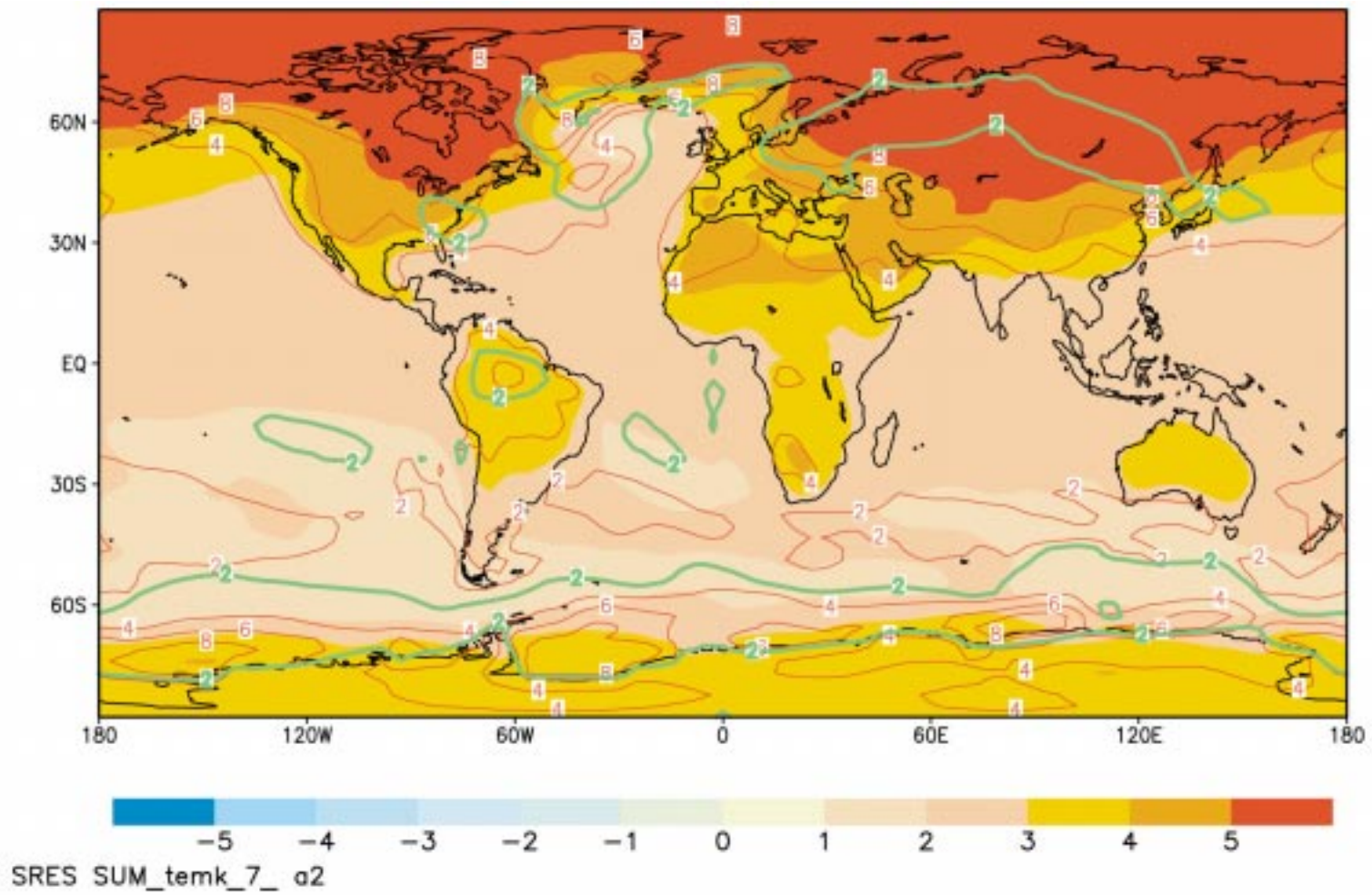
# Risk Management for climate change

- Predictions of climate change are uncertain
  - account for:
    - extreme events that are less likely
    - less extreme events that are more likely
  - probabilistic approach
- Need to reduce vulnerability
  - understanding of natural, social, engineering, health sciences

# Knowledge of the Climate System



# Ensemble of temperature responses (C) at 2100 under scenario A2




**Cubasch et al, IPCC, 2001**

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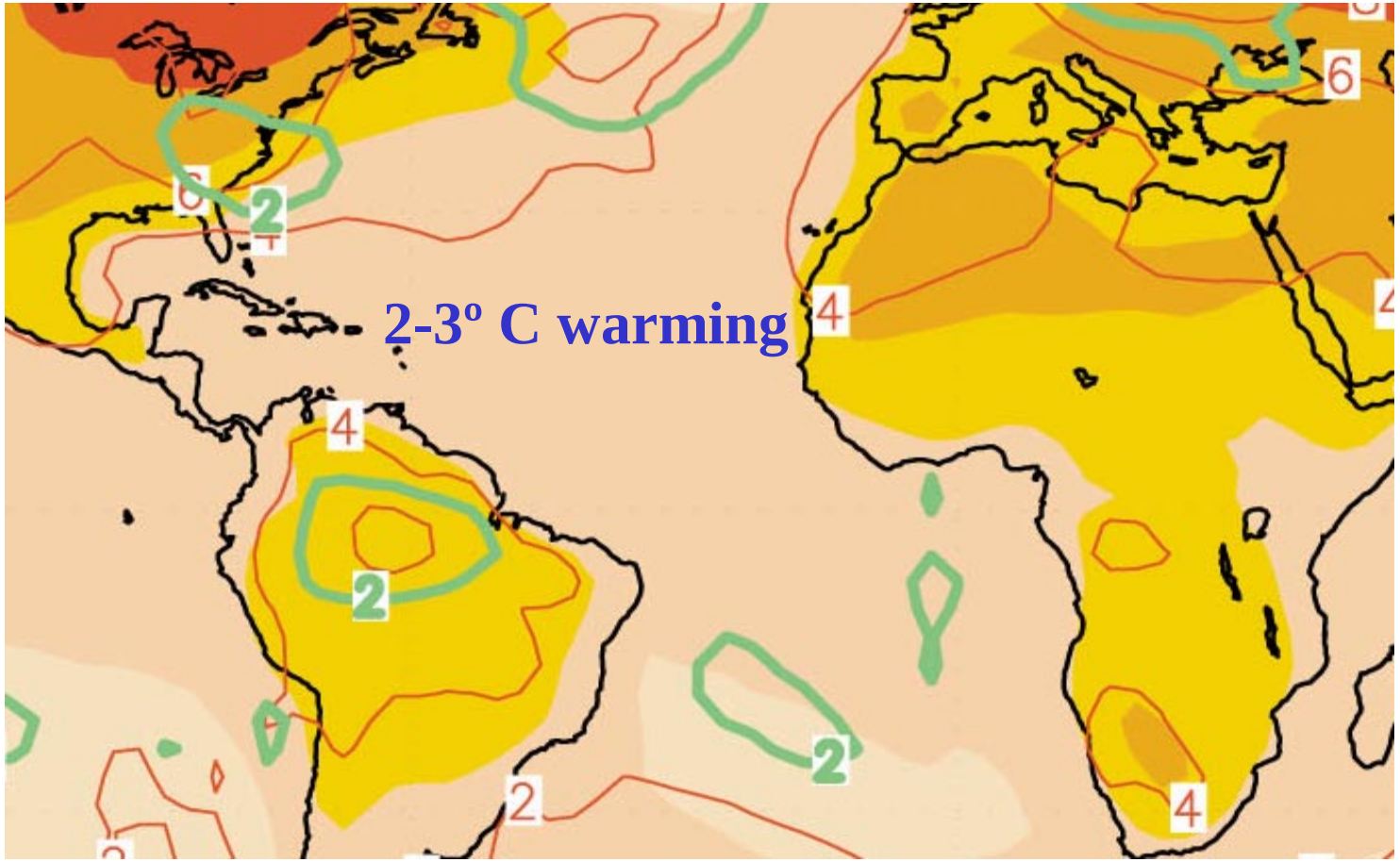
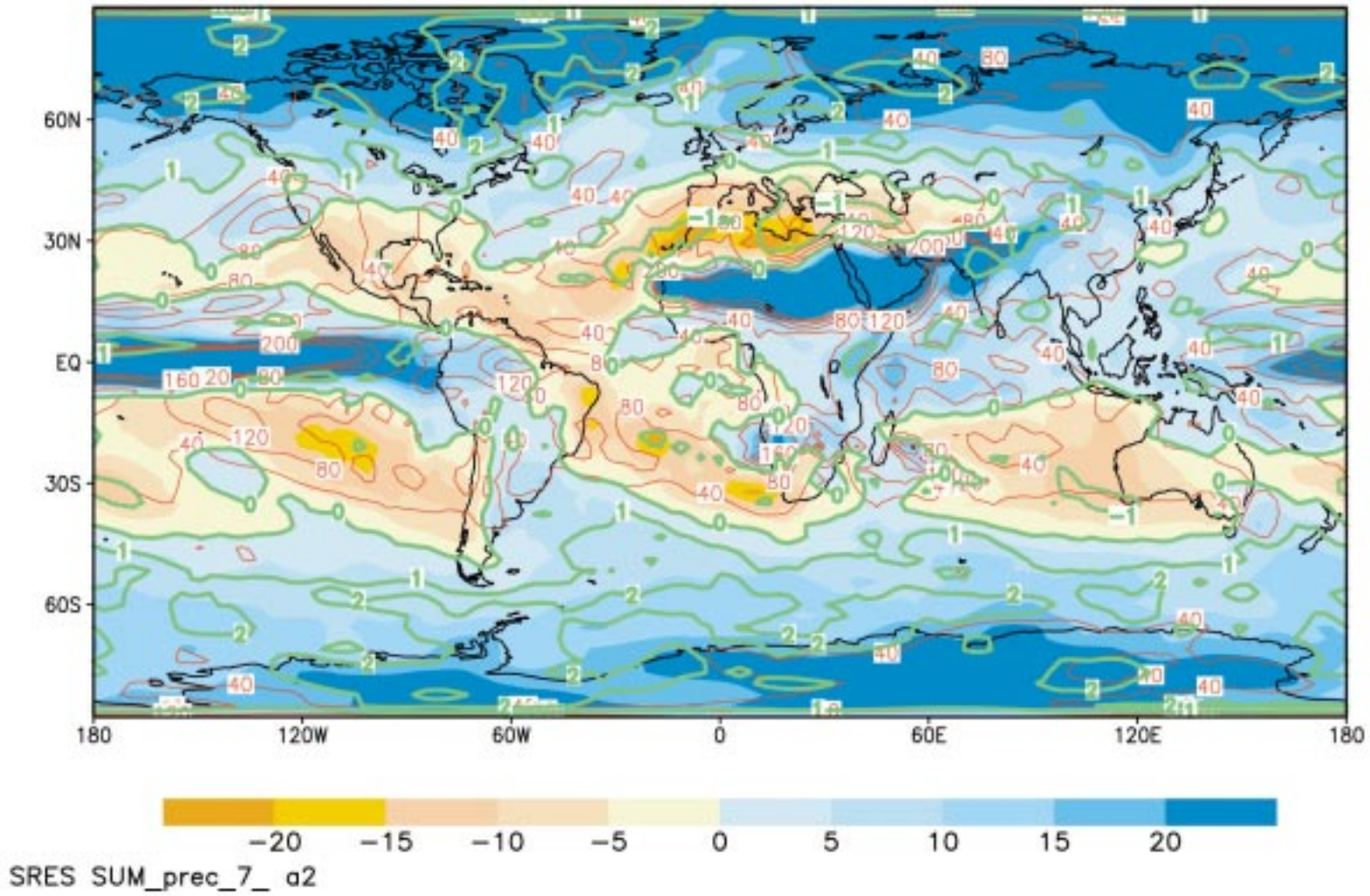



**Cubasch et al, IPCC, 2001**

# Ensemble of precipitation responses (%) at 2100 under scenario A2




**Cubasch et al, IPCC, 2001**

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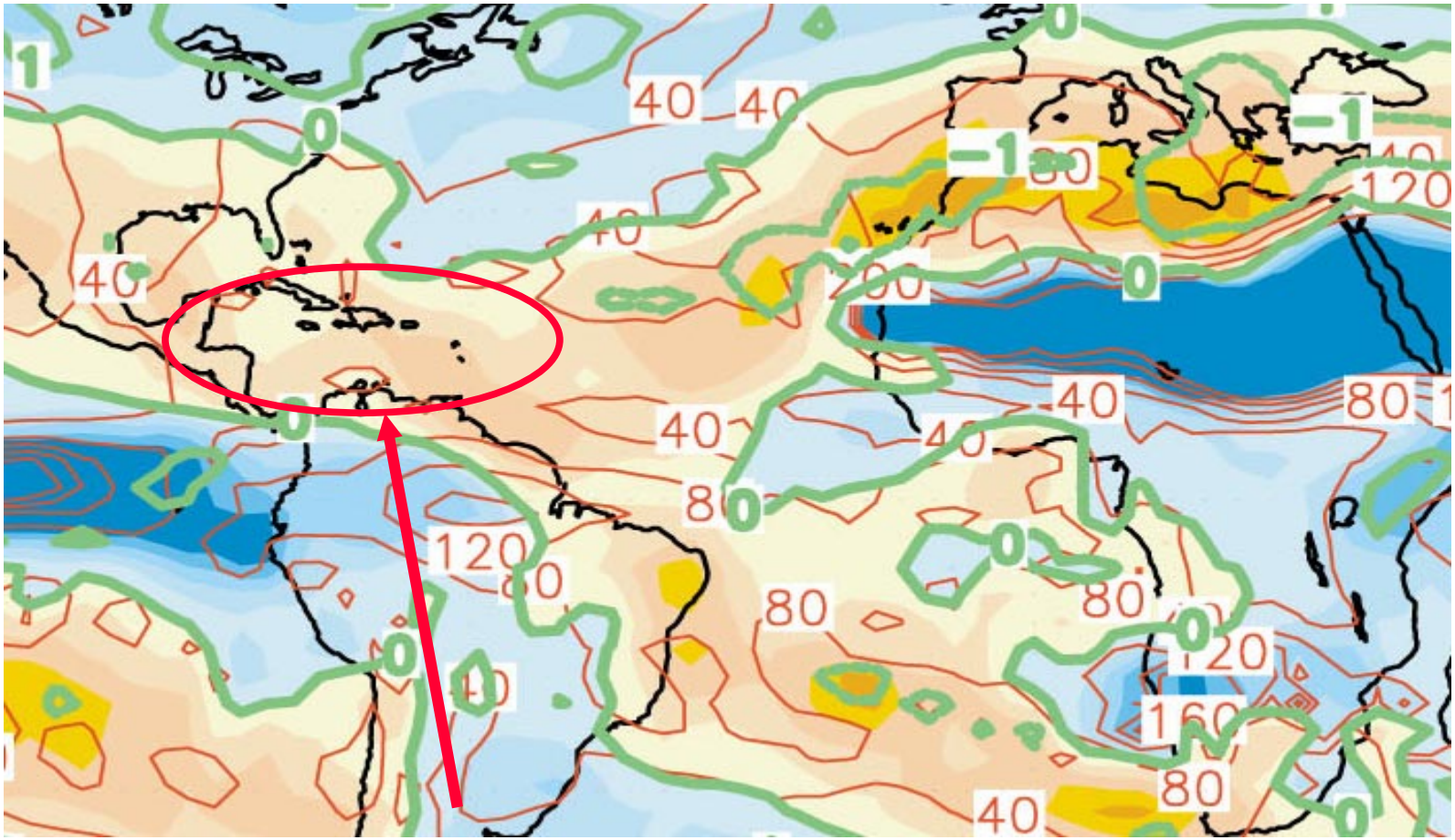



**5 to 15% decrease in precipitation (dominated by summer decrease)**

**Cubasch et al, IPCC, 2001**

# Dr. Robert Watson – Chair IPCC to CoP6

- *The overwhelming majority of scientific experts, whilst recognizing that scientific uncertainties exist, nonetheless believe that human-induced climate change is inevitable. Indeed, during the last few years, many parts of the world have suffered major heat waves, floods, droughts, fires and extreme weather events leading to significant economic losses and loss of life. While individual events cannot be directly linked to human-induced climate change, the frequency and magnitude of these types of events are predicted to increase in warmer world.*

# Measures of Certainty

- IPCC Working Group 1 (Science) adopted:
  - Virtually certain >99% chance result is true
  - Very Likely 90-99%
  - Likely 66-90%
  - Medium likelihood 33-66%
  - Unlikely 10-33%
  - Very unlikely 1-10%
- IPCC Working Group 2 (Impacts,…) adopted a similar approach

# IPCC –Quantification of % of Change

| Confidence in observed changes (latter half of the 20th century) | Changes in Phenomenon | Confidence in projected changes (during the 21st century) |
|---|---|---|
| Likely | **Higher maximum temperatures and more hot days over nearly all land areas** | Very likely |
| Very likely | **Higher minimum temperatures, fewer cold days and frost days over nearly all land areas** | Very likely |
| Very likely | **Reduced diurnal temperature range over most land areas** | Very likely |
| Likely, over many areas | **Increase of heat index[8] over land areas** | Very likely, over most areas |
| Likely, over many Northern Hemisphere mid- to high latitude land areas | **More intense precipitation events[b]** | Very likely, over many areas |
| Likely, in a few areas | **Increased summer continental drying and associated risk of drought** | Likely, over most mid-latitude continental interiors (Lack of consistent projections in other areas) |
| Not observed in the few analyses available | **Increase in tropical cyclone peak wind intensities[c]** | Likely, over some areas |
| Insufficient data for assessment | **Increase in tropical cyclone mean and peak precipitation intensities[c]** | Likely, over some areas |

# Tropical Cyclones

- "In Conclusion, there is some evidence that regional frequencies of tropical cyclones may change but none that their location will change. There is also evidence that the peak intensity may increase by 5% to 10% and precipitation rates may increase by 20% to 30%. There is need for much more work in this area to provide robust results."

  – IPCC 2001

# Climate Change and People

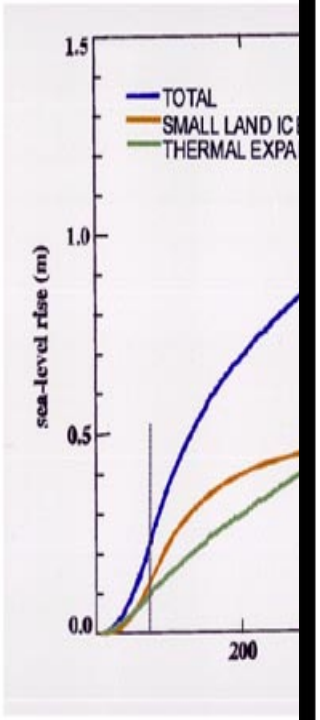
- "The most widespread direct risk to human settlements from climate change is flooding and landslides, driven by projected increases in rainfall intensity, and in coastal areas, sea-level rise" (IPCC – TAR)
- "It (climate change) could even threaten survival in small island States and in low-lying coastal, arid and semi-arid areas" (Ministerial Declaration – 2nd WCC)

# Sea level rise is a big concern.

**Figure 13: Sea**

**Thermal ex**

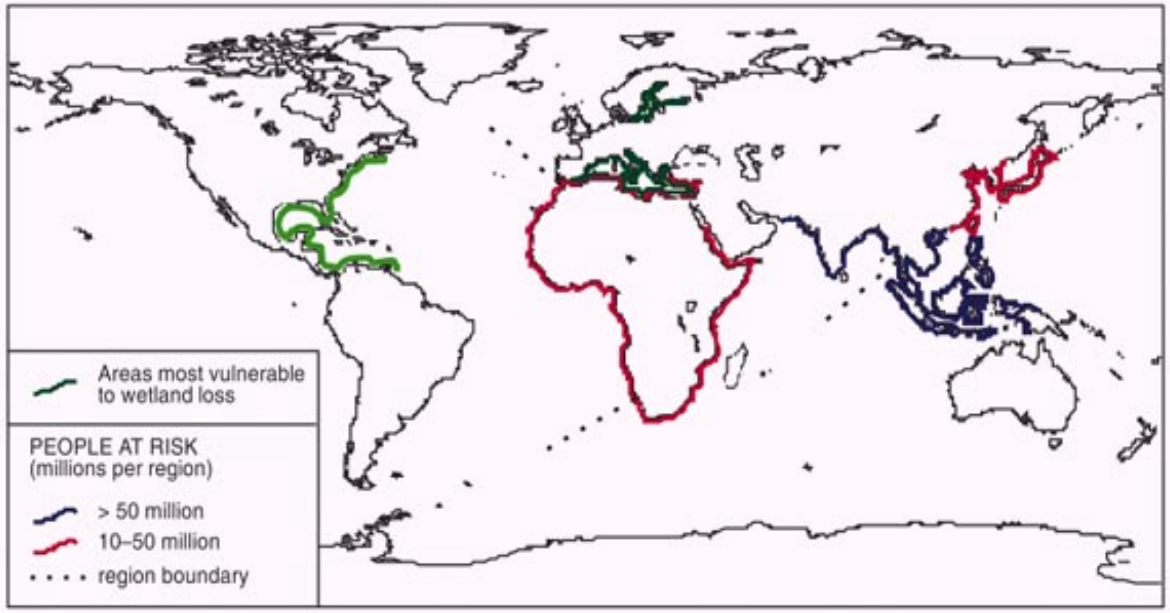
**after an initial 1%**




The Met Office. Hadley Centre for Clim

**Figure 18: People at Risk from a 44 cm sea-level rise by the 2080s**

**Assuming 1990s Level of Flood Protection**




*Source:* R. Nicholls, Middlesex University in the U.K. Meteorological Office. 1997. *Climate Change and Its Impacts: A Global Perspective.*

# Sea Level Rise

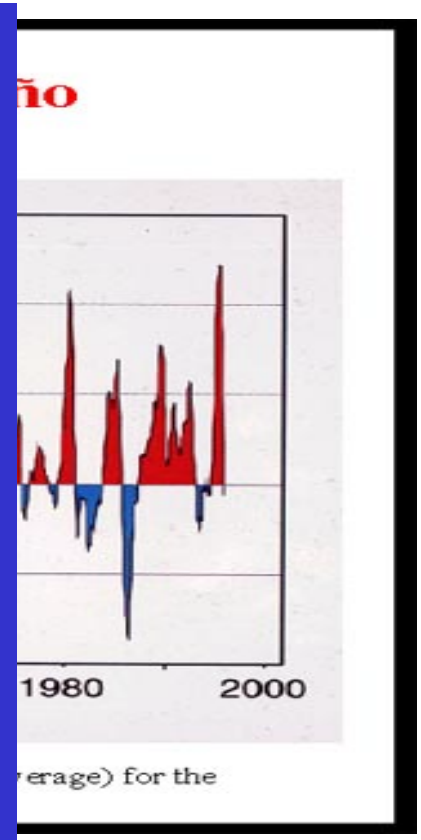
- Past century
  - 1.0 to 2.0 mm/y 0.15m/100y
- By 2100
  - 0.09 to 0.88 m (for full range of scenarios)
  - Thermal expansion 0.11 to 0.43 m
  - Glaciers 0.01 to 0.23 m
  - Greenland -0.02 to 0.09 m
  - Antarctica -0.17 to 0.02 m
  - Very unlikely that West Antarctic Ice sheet would slide into ocean in 21$^{st}$ century
  - Over next 1000 y, likely 3 m rise due to Greenland

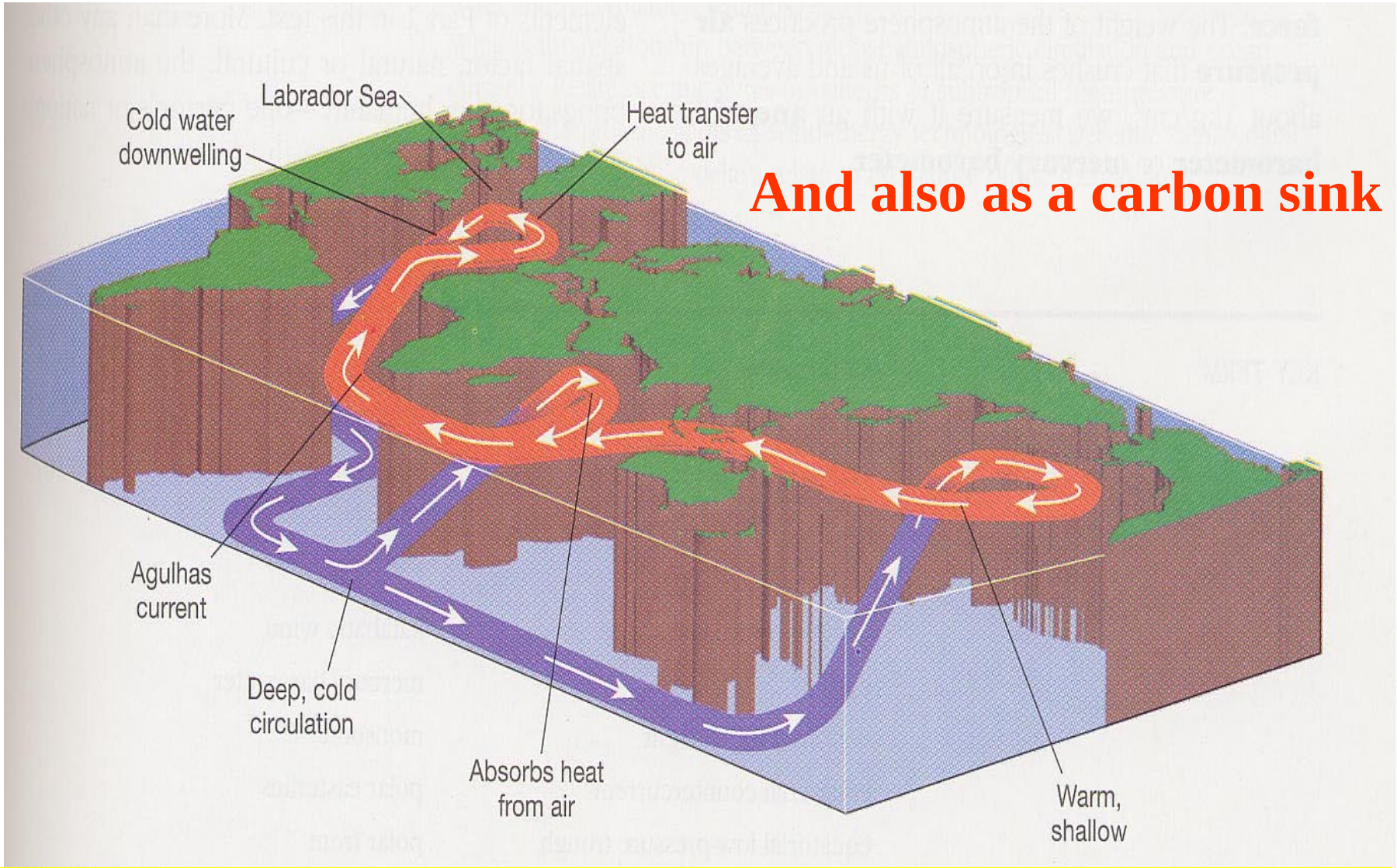
# Sea level rise and Storm Surges

- non-linear interactions of waves, water depth, bottom topography, …cannot use linear addition
- Example
  - Kingston Jamaica
    - local level about 10 cm above global level
    - For 37 cm local sea level rise
    - Storm surge model
    - Increase in surge (compared to present)
    - median over area was 48 cm – with range from 23 to 68 cm
      - Watson, Johnson (2001)

# El Nino is a natural oscillation with huge impact on humans and ecosystems

**Current projections show little or a small increase in amplitude of El Nino events over the next 100 years. However, … global warming is likely to lead to greater extremes of drying and heavy rainfall and increase the risk of droughts and floods that occur with El Nino events in many regions. (IPCC, 2001)**

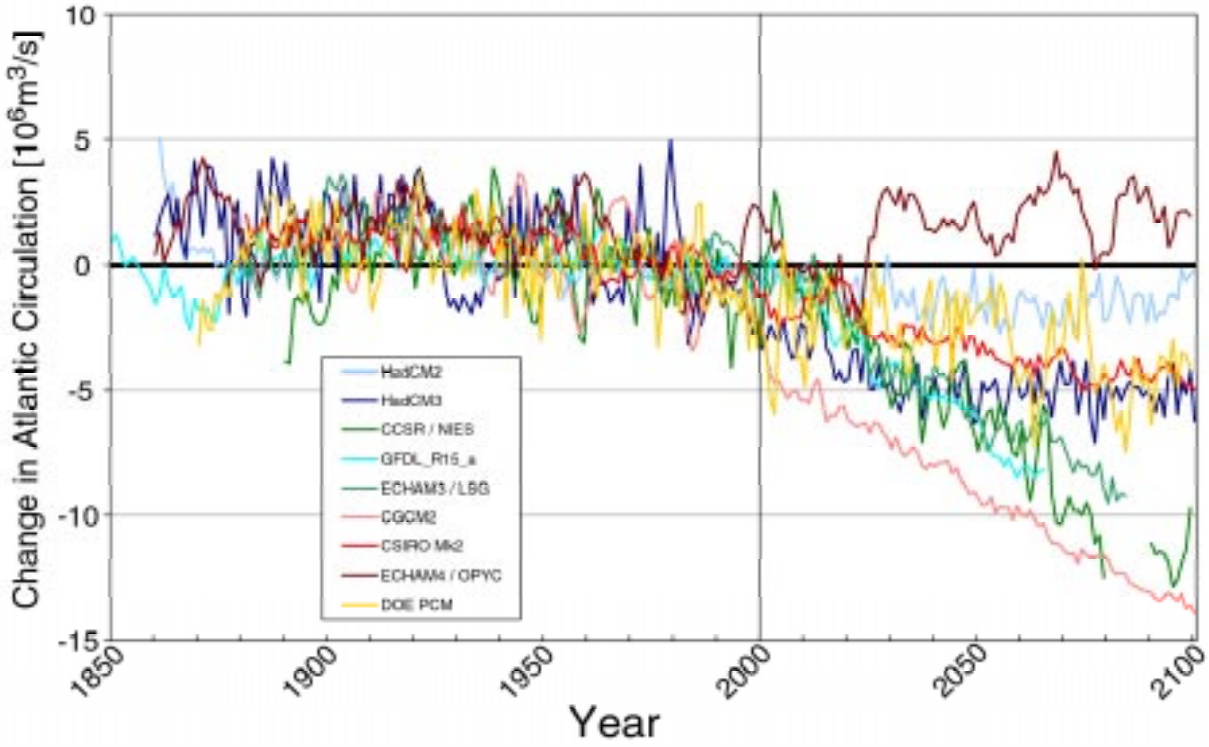





**And also as a carbon sink**

# The Ocean Conveyor Belt is Critical to Climate

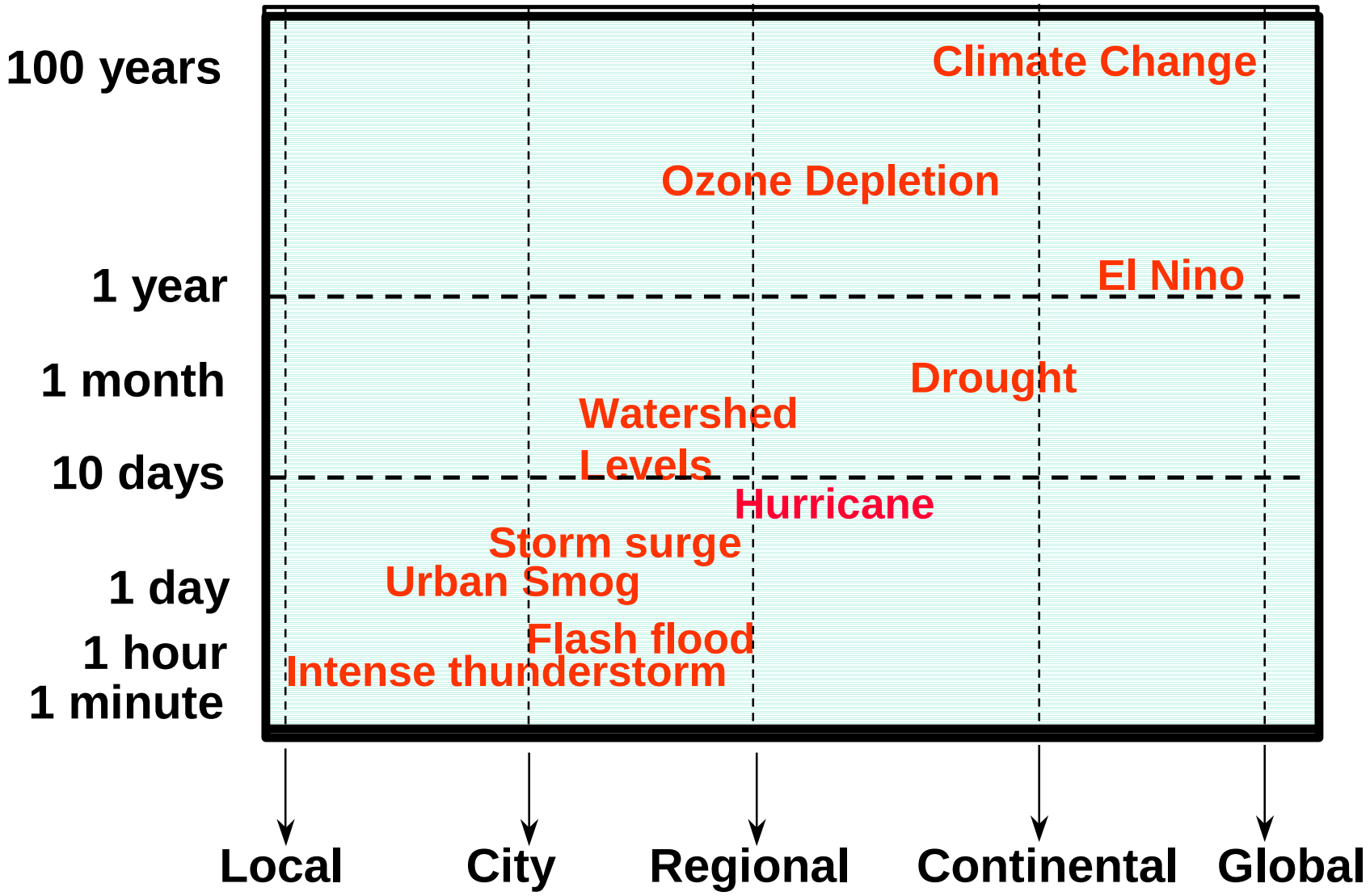
# What is the risk of major change?



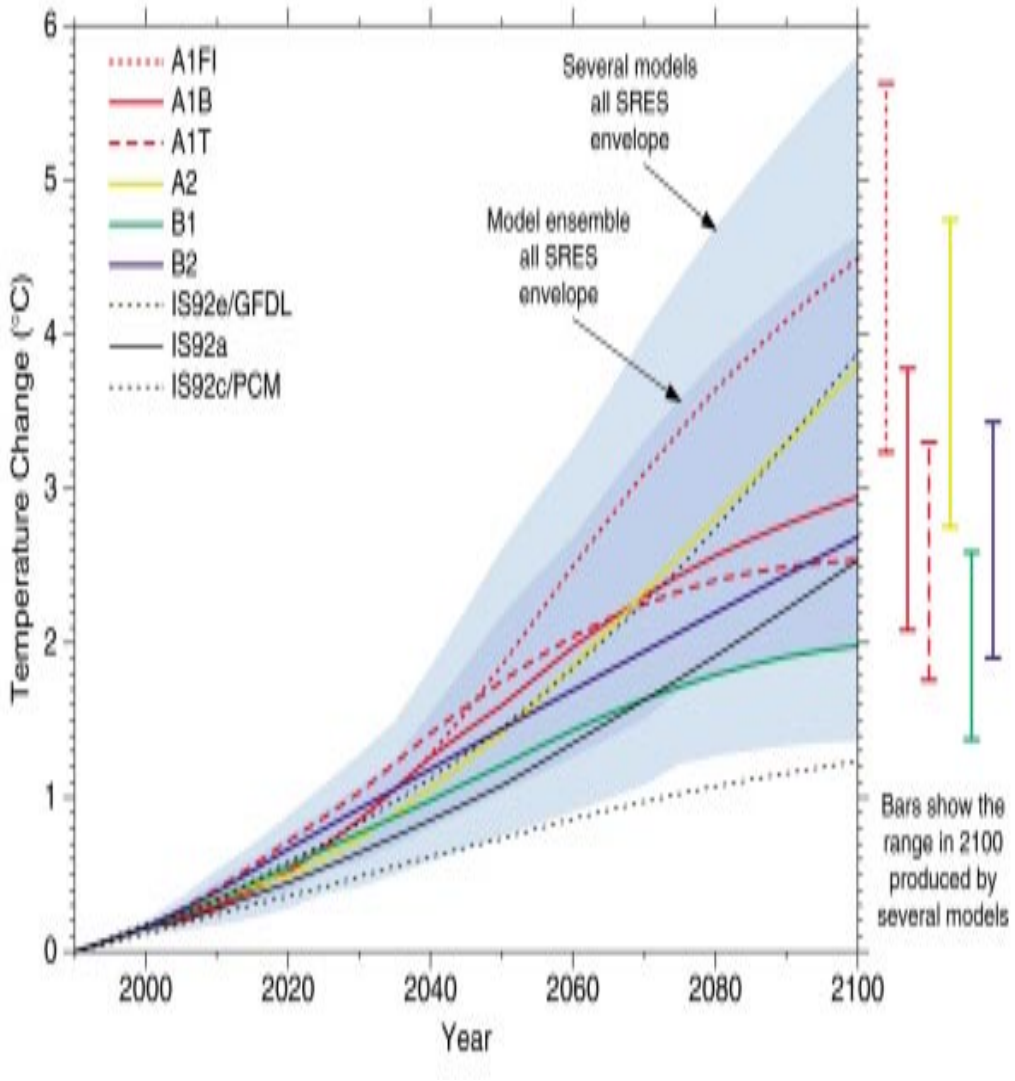

# A FULL SHUT-DOWN CANNOT BE EXCLUDED BEYOND 2100

**Stocker et al, IPCC, 2001**

# Integral to responding to climate variability and change
# A Prediction System– hours – days – seasons - …



# Global mean temperature changes




**Concern mounts**
**-unique, threatened systems**
**-Extreme events**
**-Distribution of impacts**
**-Aggregate impacts**
**-Future large-scale discontinuities**

# Climate change is about children and grandchildren


END