Global Perspective on Climate Change

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- Lead Author IPCC Reports, 1995, 1998, 2001
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- Author, *Climate Change: Turning Up the Heat* (in press)

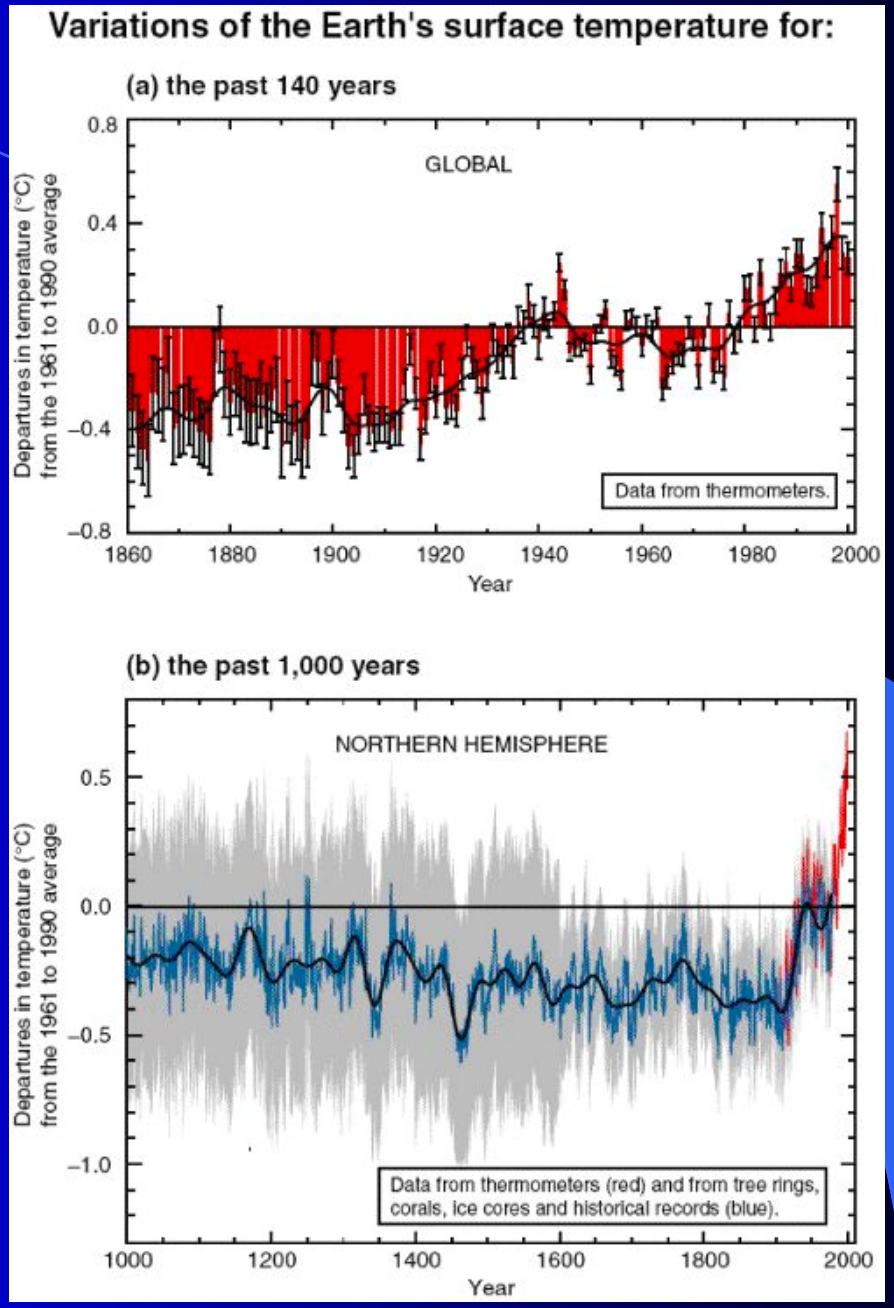
Outline

- Evidence for climate change
- Uncertainty and risk
- Potential global scale impacts
- Mitigation and adaptation are both needed
- The challenge of adaptation

On the Balance of Evidence for Global Warming

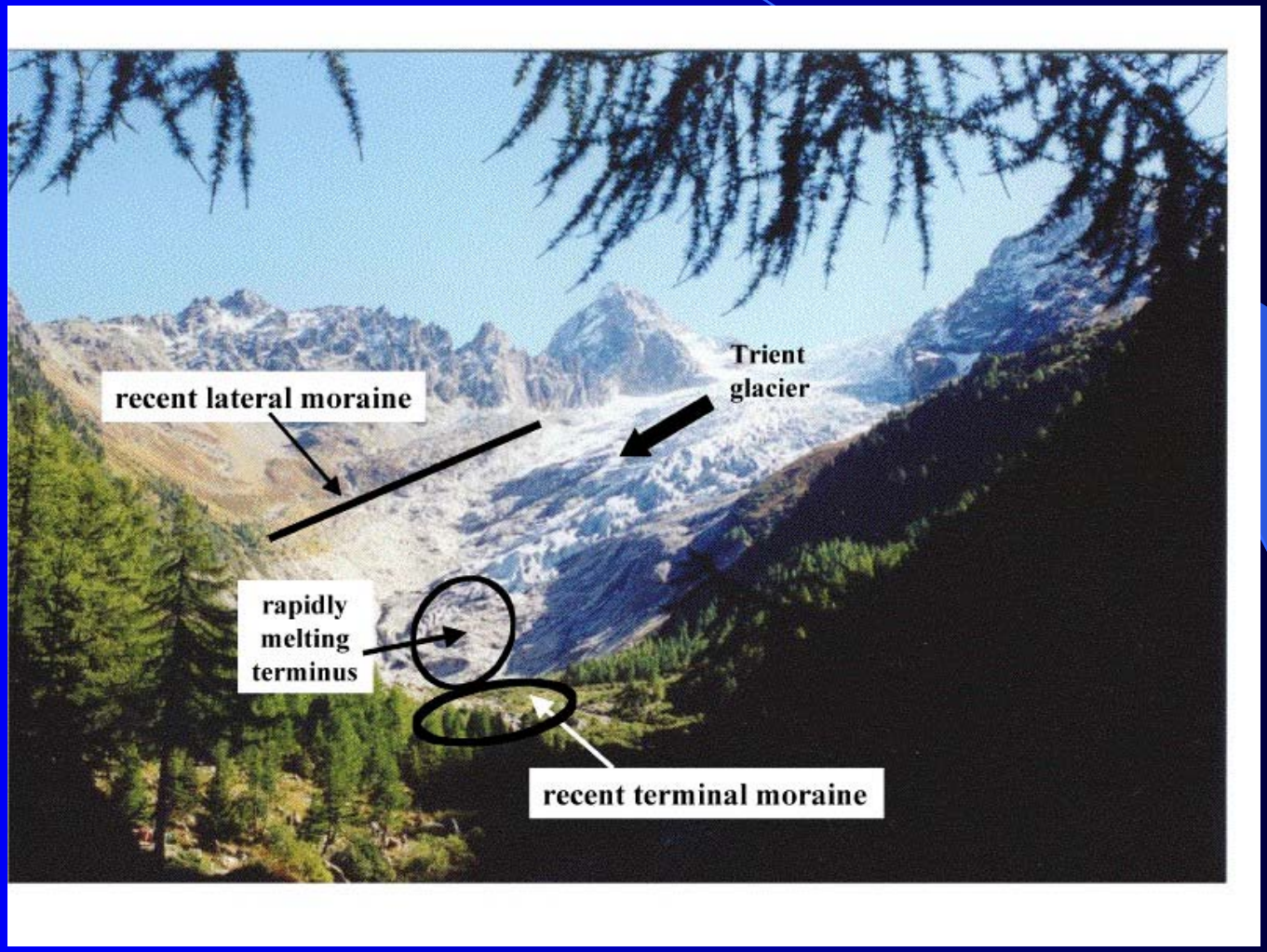
- Land-based temperature record
- Sea-surface temperatures (ships, satellite obs.)
- Bore-hole temperatures
- Most glaciers retreating fast
- Less snow cover (local, satellite obs.)
- Less NH sea ice (satellite obs.)
- Tree-line rising
- Location shifts of birds, fishes and insects (obs. all continents)
- Longer growing seasons (anecdotal, satellite obs.)
- Earlier breakup of river and lake ice

Variations of Earth's Surface Temperature over Last 1,000 Years

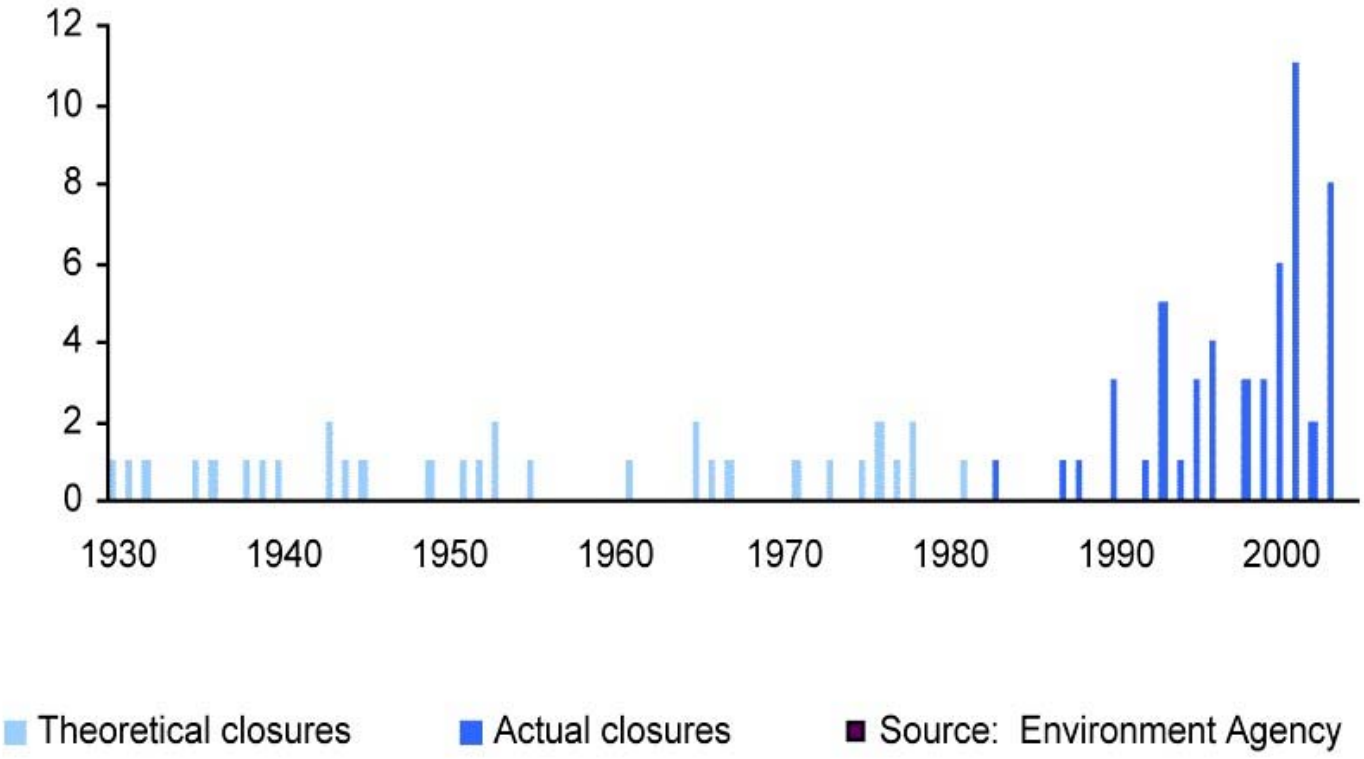


Glaciers retreating rapidly

- e.g., Trient glacier, Switzerland, year 2000

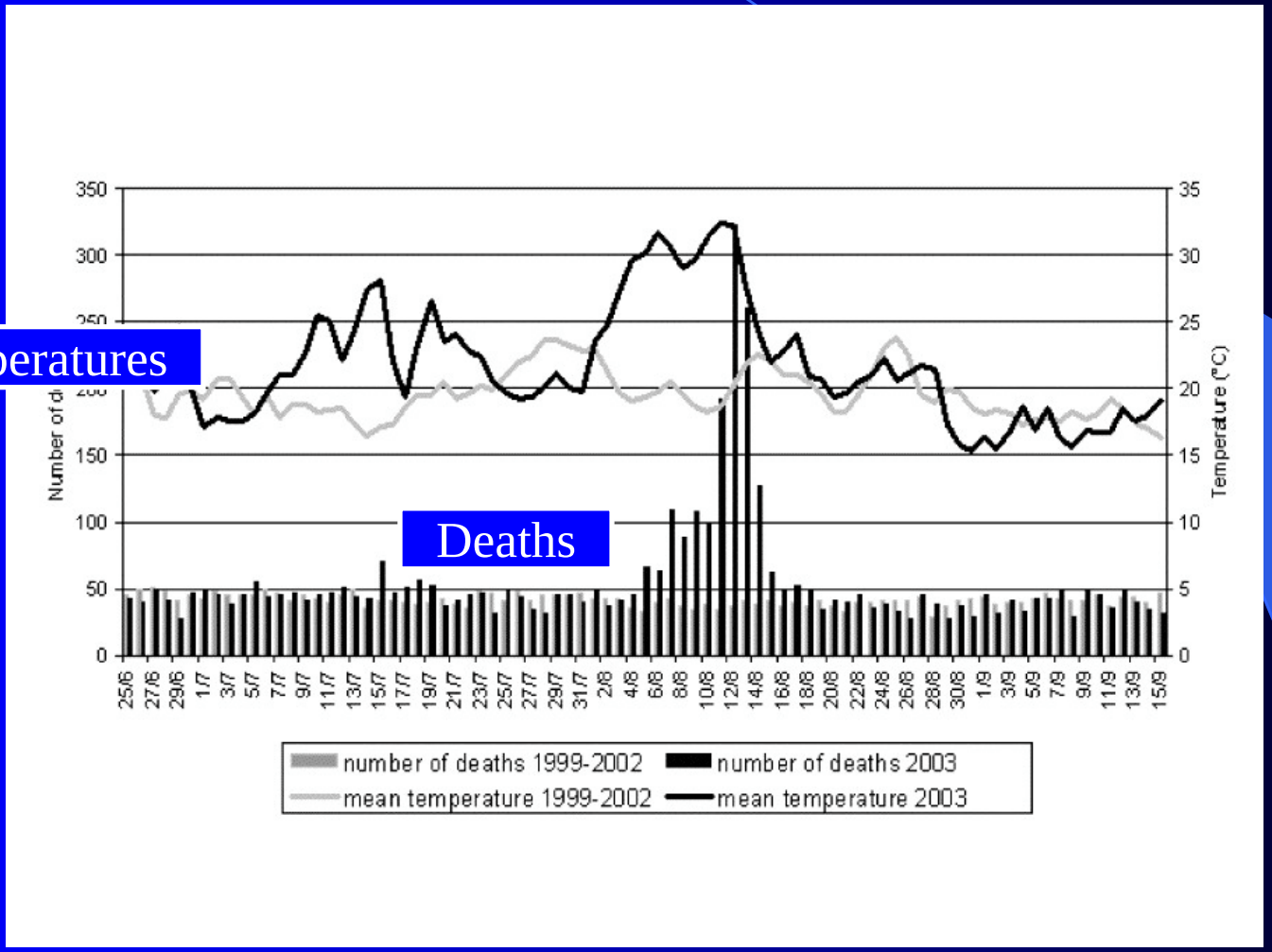


Frequency of Closure of Thames Barrier: Multiple Causation



European Heatwave, 2003

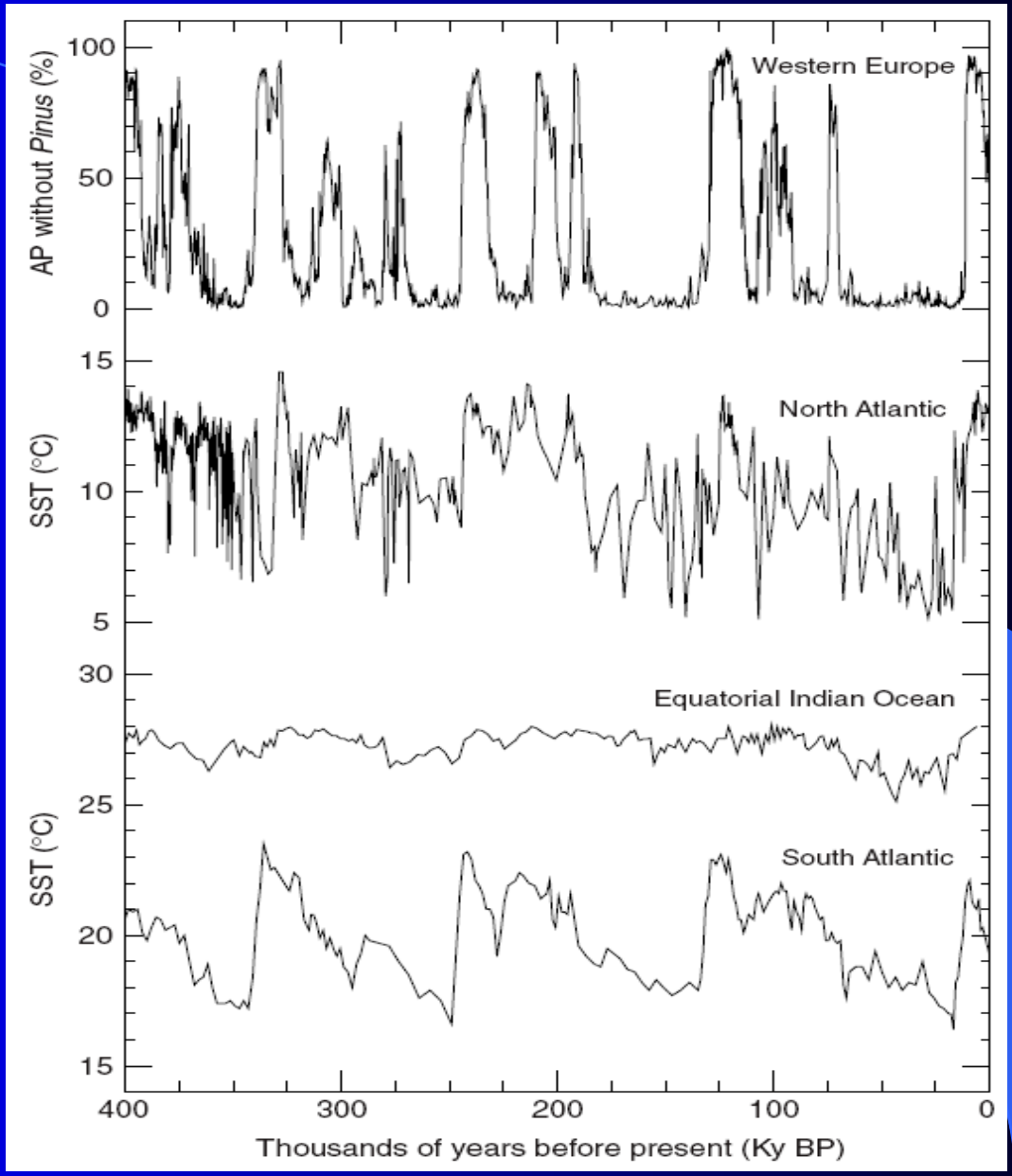
- Number of deaths in Paris during heatwave, July-August 2003



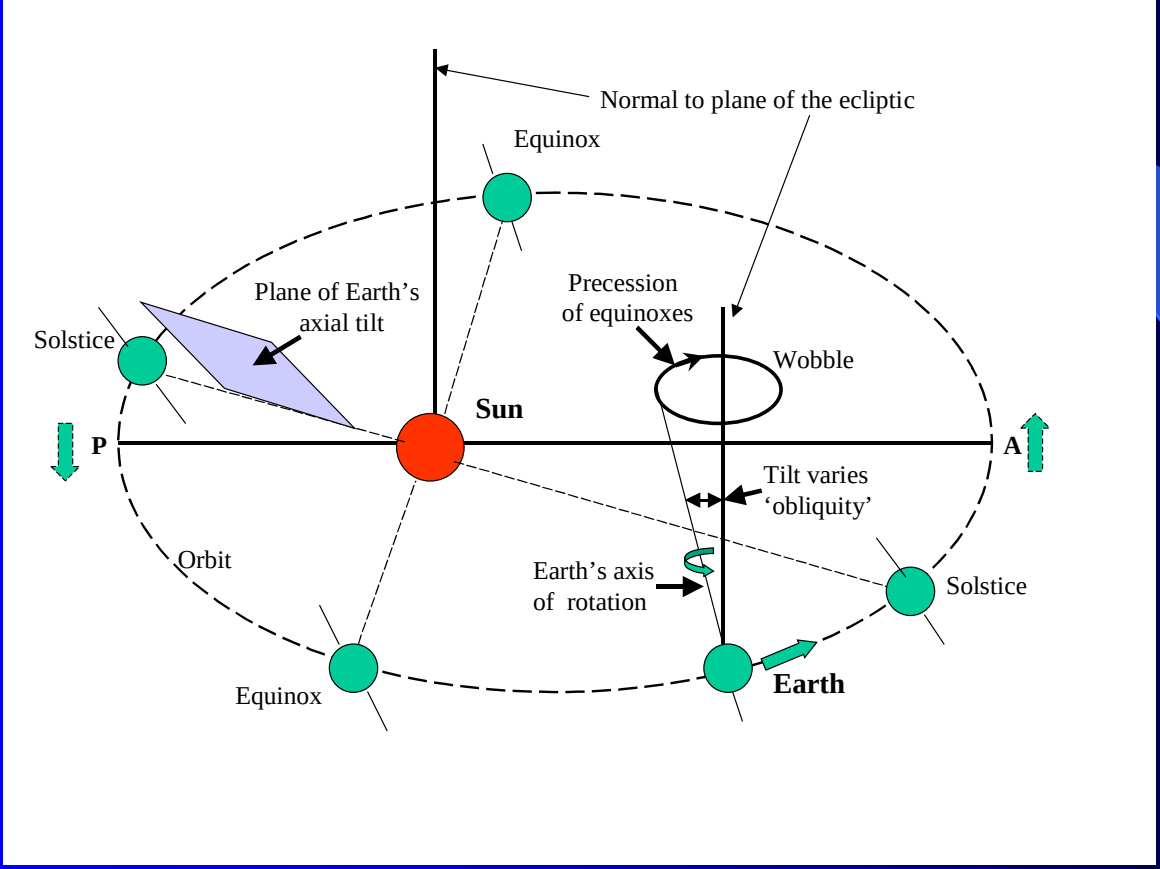
Increases in Disasters 1960s to 1990s

	1960s	1970s	1980s	1990s	**Ratio 1990s/ 1960s**
# Weather-related	16	29	44	72	4.5
# Non-weather	11	18	19	17	1.5
Economic losses	50.8	74.5	118.4	399.0	7.9
Insured losses	6.7	10.8	21.6	91.9	13.6

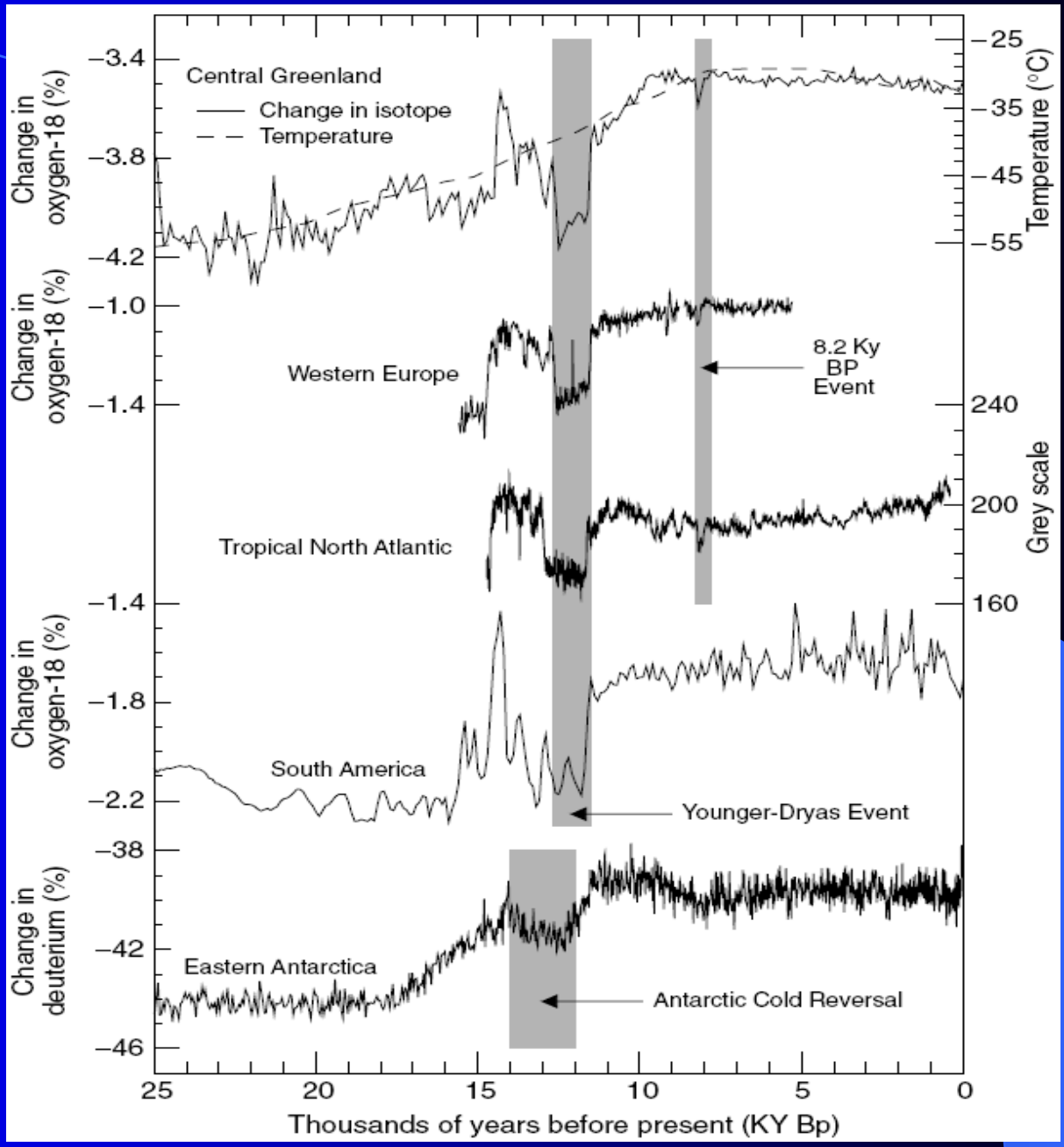
Paleo-record of last 400,000 years



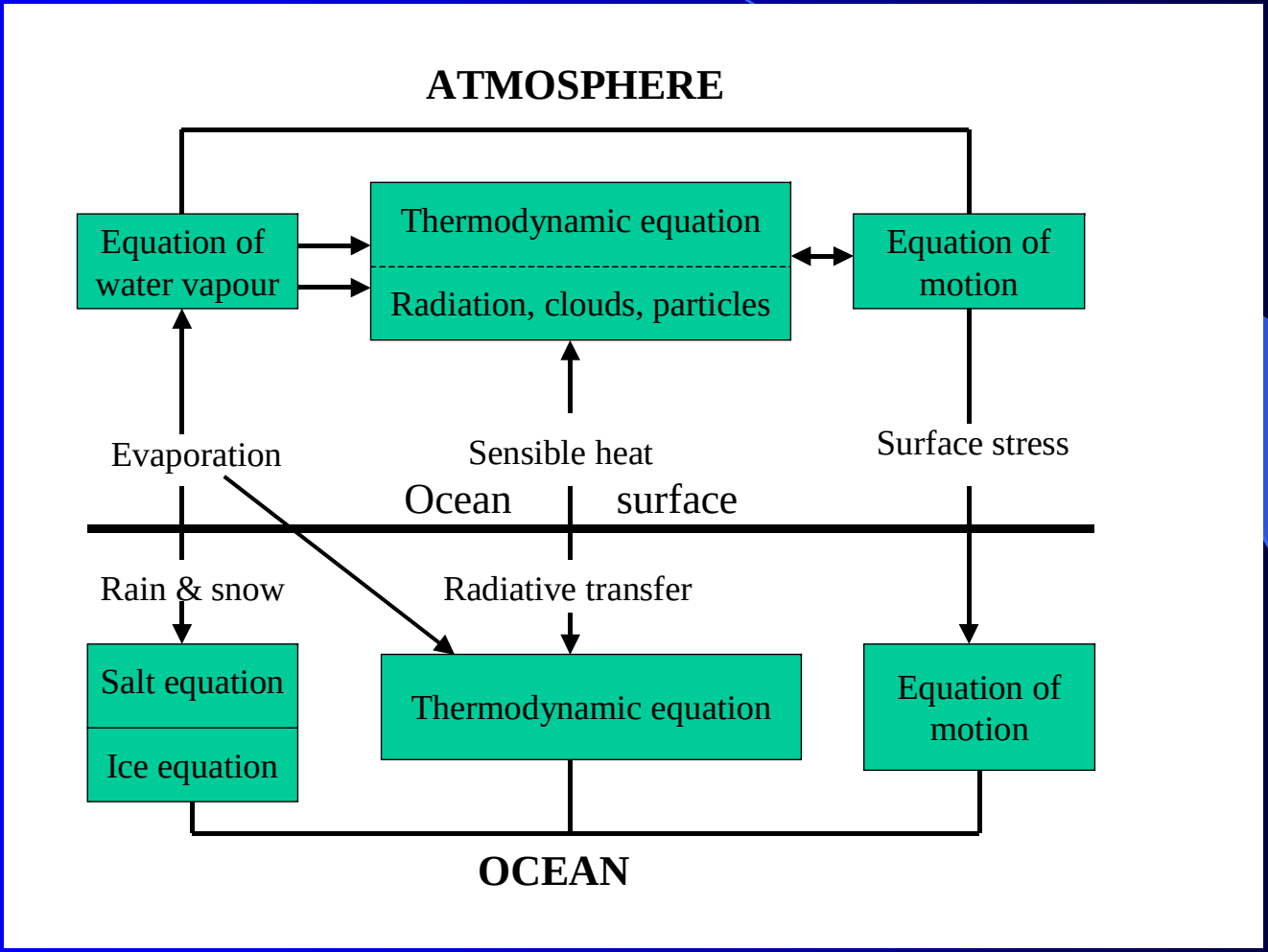
Orbital Variations of Earth Explain Periodicities in Climate



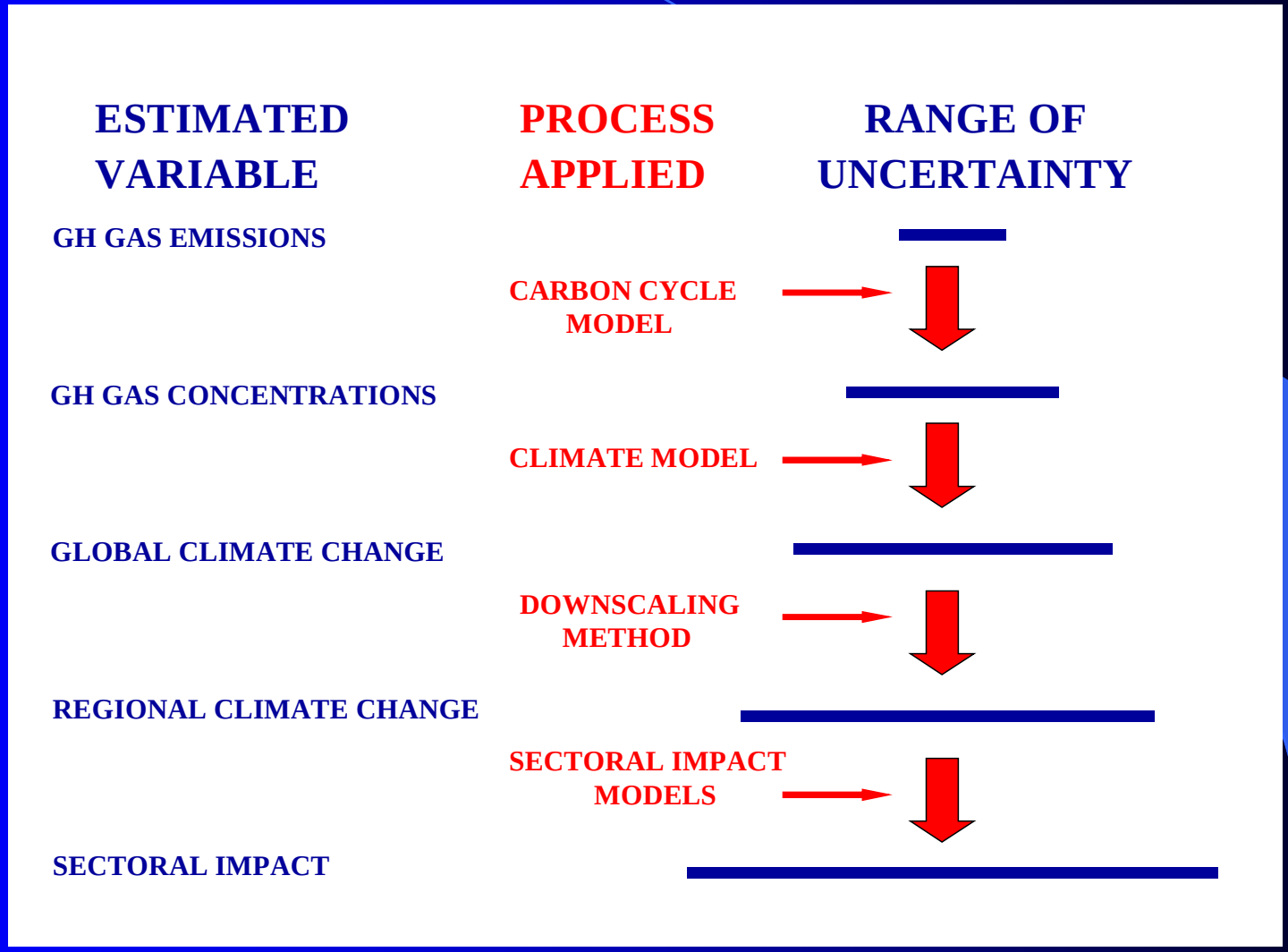
Paleo-record of the last 25,000 years



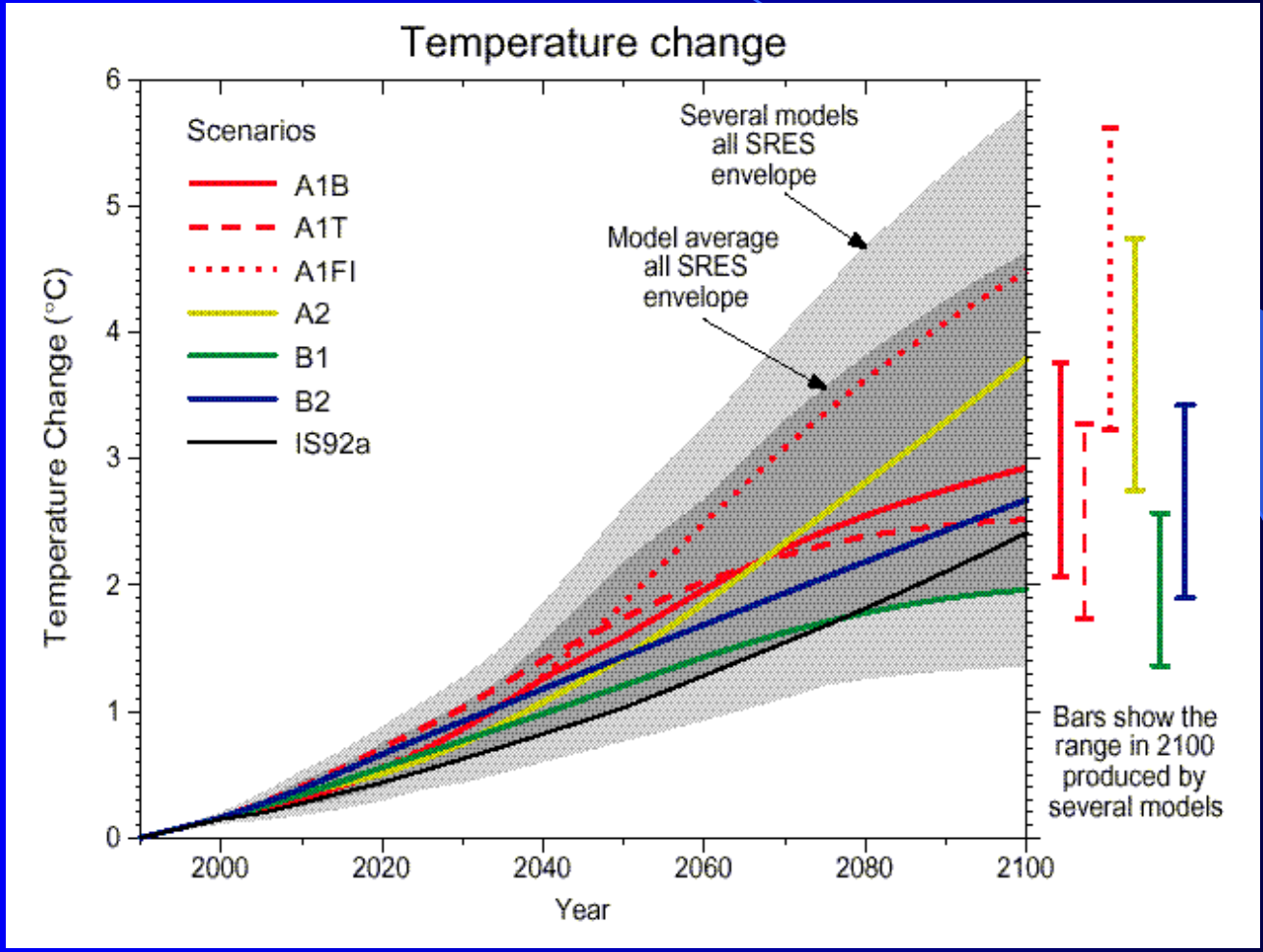
Internal Components of Climate Models



Cascade of Uncertainty



Global temperature projections



Warmings for Various Emissions Scenarios

Scenario	warming at 2100	at 2350	at equilibrium
SRES B1	1.4-2.6	n/a	n/a
SRES B2	1.9-3.5	n/a	n/a
SRES A1T	1.8-3.3	n/a	n/a
SRES A2	2.8-4.8	n/a	n/a
SRES A1F1	3.2-5.8	n/a	n/a
WRE 450	1.2-2.3	1.4-3.0	1.5-3.9
WRE 550	1.6-2.9	1.9-4.0	1.9-5.2
WRE 650	1.8-3.2	2.2-4.7	2.3-6.3
WRE 750	1.9-3.4	2.6-5.4	2.7-7.1
WRE 1000	2.0-3.5	3.2-6.6	3.5-8.7

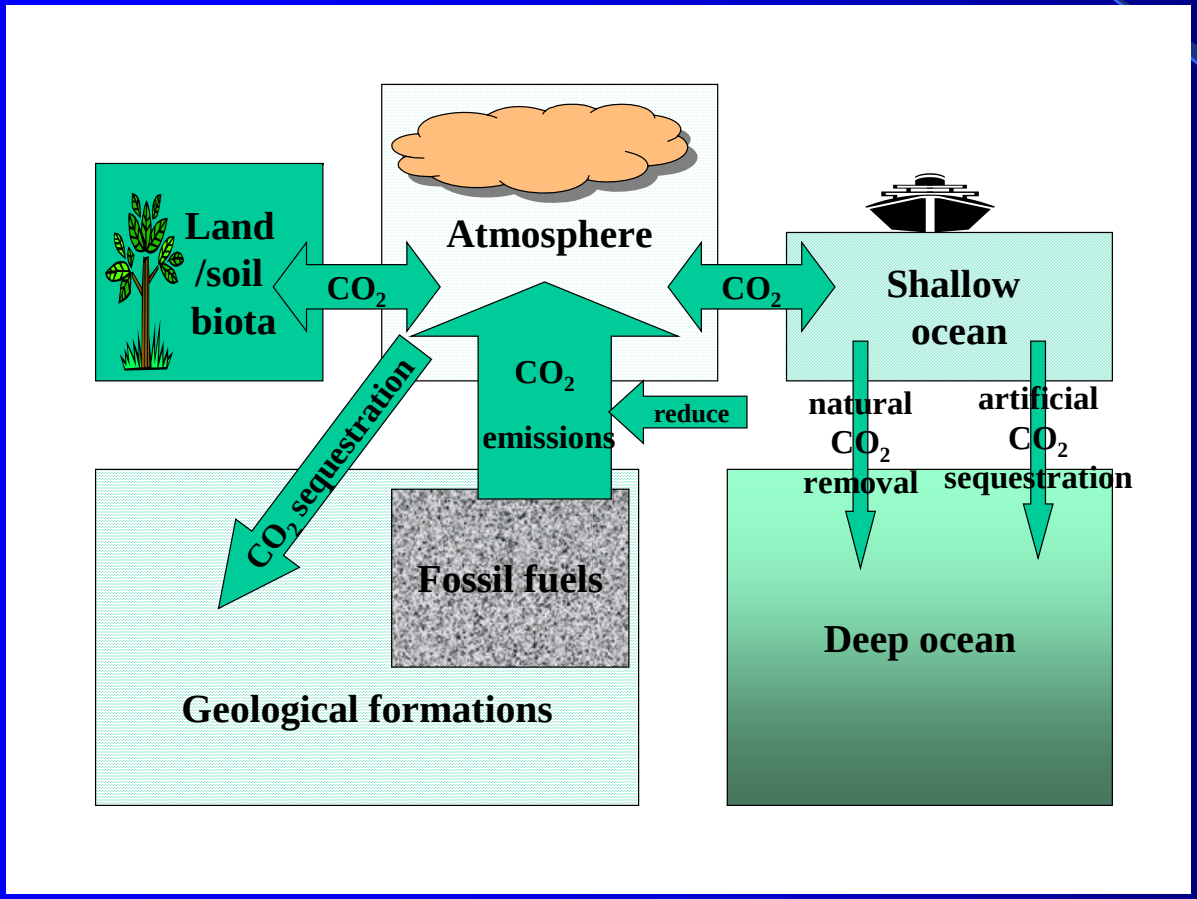
Changes in Extreme Events

Change in phenomena	Likelihood in 21st century
Higher T max, more hot days	Very likely
Higher T min, fewer frosts & cold days	Very likely
Reduced diurnal T range over land	Very likely
Increased heat index affecting comfort	Very likely most areas
More intense precipitation events	Very likely most areas
Increased mid-latitude drought risk	Likely
Increased TC peak winds	Likely, some areas
Increased storm surge, coastal erosion	Very likely
Increased TC mean & peak rainfall	Likely over some areas

Large-scale Discontinuities

Type of event	Cause	Potential impact
Major changes to ocean circulation	Changes to salinity and temperature change stability & overturning	Heat transport north in N. Atlantic greatly reduced, El Nino & East Australian current change
Melting of Greenland and disintegration of West Antarctic Ice Sheet	Surface melting, meltwater lubrication, loss of ice shelves accelerate outflow	Rapid & irreversible sea level rise, up to several metres over few centuries
Accelerated greenhouse gas release leads to more rapid warming	Forests & melting tundra become sources of CO_2 & methane	Greater faster impacts make adaptation more difficult and impacts more severe

The Nub of the Problem

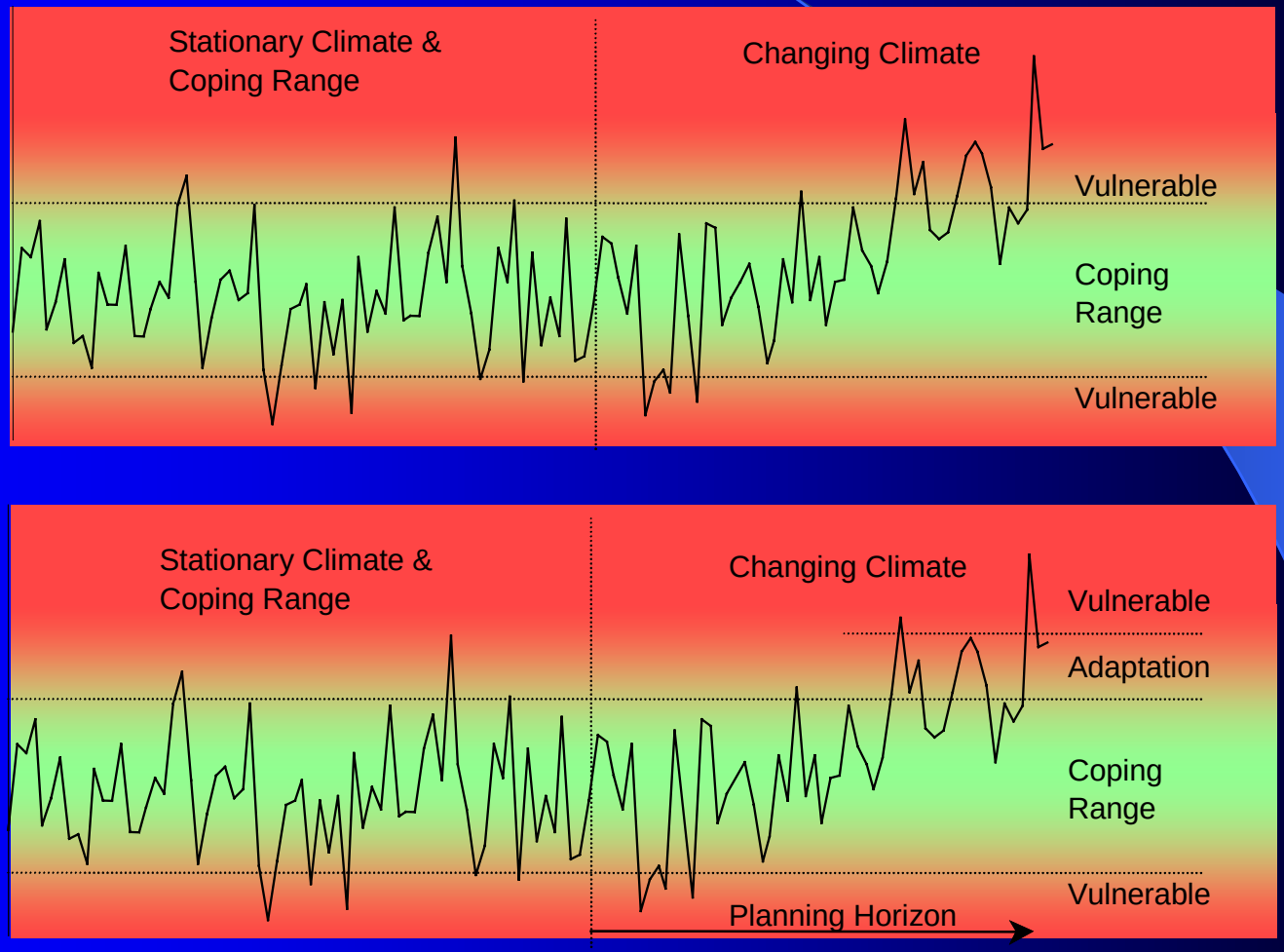


- Huge fossil CO_2 emissions
- CO_2 moves rapidly between atmosphere, biota & upper ocean
- Slow natural sink
- Need to equalise emissions & sinks
- Need reduced emissions & increased sinks

Possibilities for mitigation

- Efficiency & conservation
  - Hybrid petrol/electric or petrol/hydraulic
  - Buildings
  - Public transport, bicycles
- More efficient generators & industry
- Decarbonisation of electricity & fuels
  - Gas for coal & oil
  - Wind, solar, tidal, biomass
  - Carbon capture & storage (artificial sinks)
  - Nuclear power
- Strengthen natural sinks

Adaptation to Reduce Increased Vulnerability

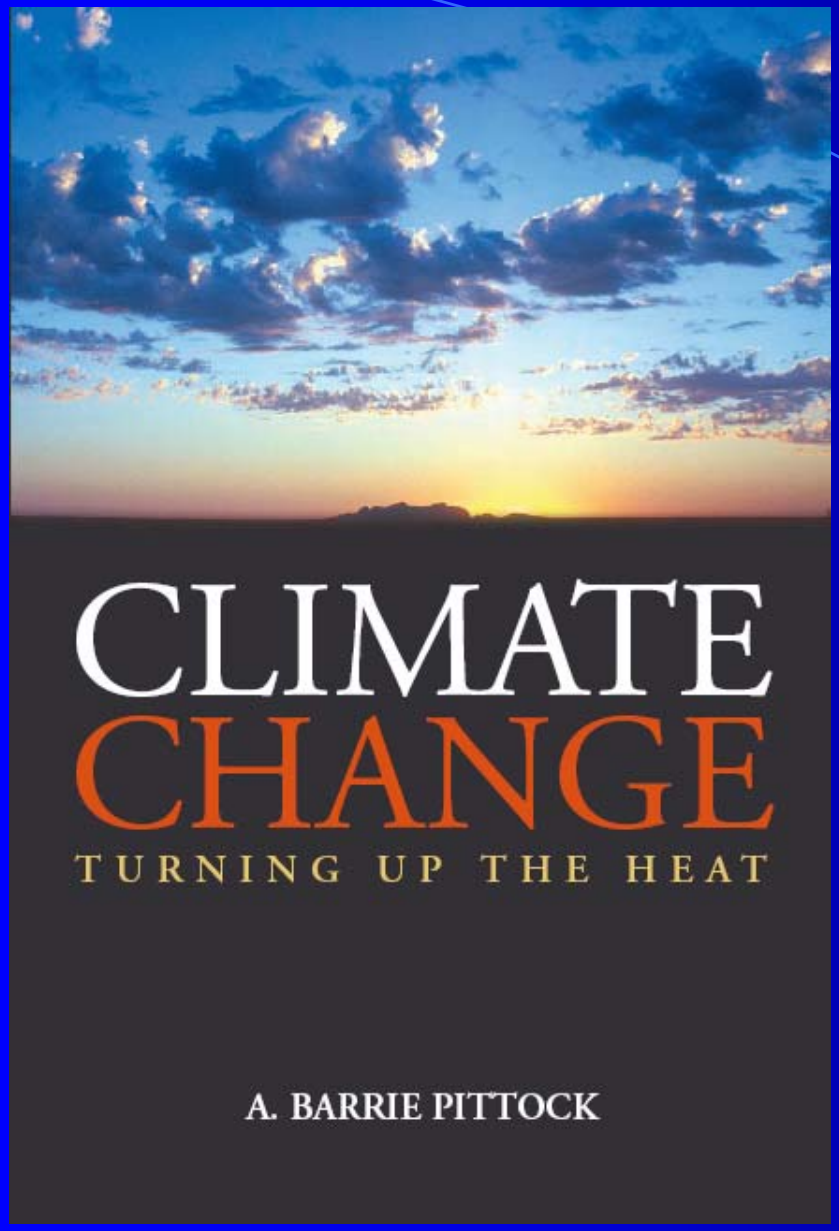


Generic Adaptation Options

Option	Comments or examples
Bear losses	Do nothing. Occurs if do not anticipate, or cannot adapt.
Share losses	Mutual aid, insurance, govt. relief. Still costs community.
Modify threat	Build dams, levees, etc., slow rate of change.
Prevent effects	Change management, irrigate, pest & disease control.
Change use	Switch varieties or crops, change cropping to tourism.
Change location	Move to cooler or wetter region if possible.
Research & development	Requires anticipation and long lead times. Can be slow and costly.
Educate, inform, change behaviour	Helps anticipatory action. Water conservation, fire prevention, change design rules.

Conclusions

- Climate change is happening.
- It is likely to increase.
- Uncertainty inevitable, but risk is certain.
- Without large emissions cuts, global warmings of 3ºC or more likely (>50% probability) by 2100.
- Risk of major global & local impacts.
- Adaptation thus necessary.
- Requires anticipation, will cost, & has limits.



My book, due out October 2005, CSIRO Publications (see handouts)