

TOPIC #16

CLIMATE CHANGE: IMPACTS & ISSUES – THE IPCC FINDINGS & WHAT LIES AHEAD

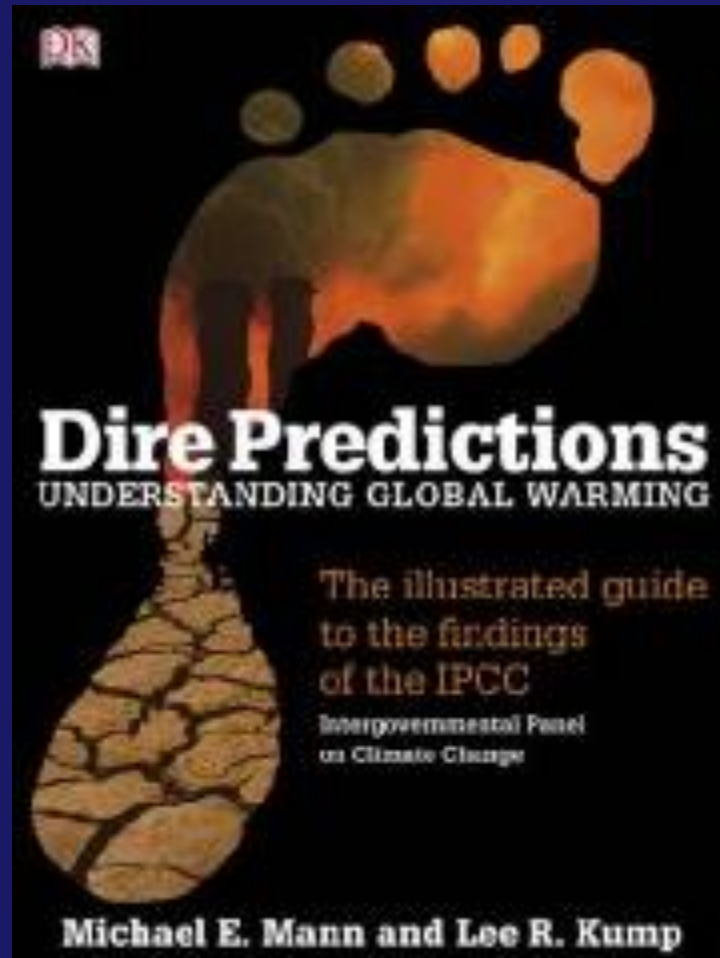
p 95 in Class Notes

There is a paradoxical gulf between the importance of Earth's climate and the level of public interest in it

We're in the middle of a large uncontrolled experiment on the only planet we have.



*- Donald Kennedy
editor-in-chief of the journal Science*



“The Illustrated Guide to
the findings of the IPCC”

The most comprehensive source of information on Global Climate Change -- the IPCC



INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE



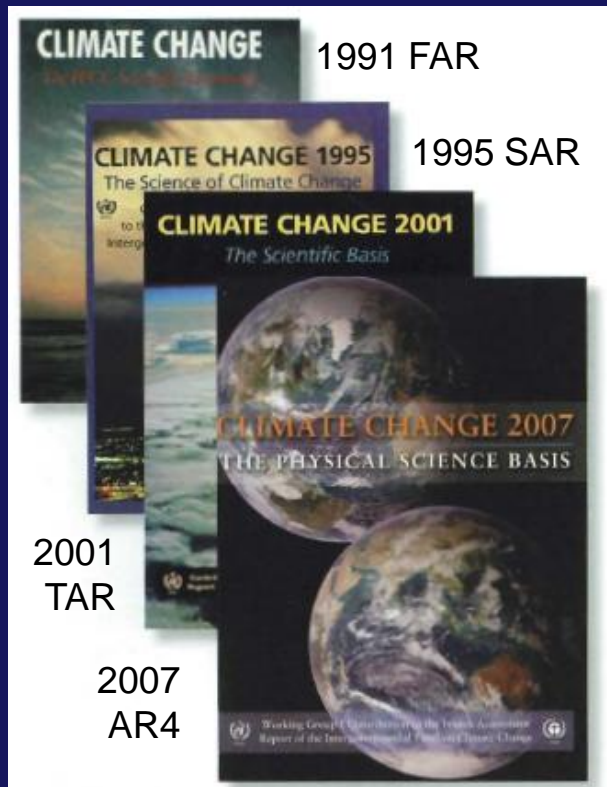
- Established by World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988 as an objective source of information for decision-makers, etc.

“to provide the world with a clear scientific view on the current state of climate change and its potential environmental and socio-economic consequences” (IPCC 2007)

- The IPCC does not conduct any research on its own, nor does it monitor climate related data or parameters.

Began with:

The “First Assessment Report” (FAR) in 1991



Most recent:

“Assessment Report 5” (AR5) in 2013

(parts of it are still coming out)

- Its role is **to assess on a comprehensive, objective, open and transparent basis** the latest **scientific, technical** and **socio-economic** literature produced worldwide relevant to the understanding of:

- the **risk** of human induced climate change

- its **observed and projected impacts** and

- options for **adaptation and mitigation.**

<http://www.ipcc.ch/>

**ASSESSMENT
REPORT 5
(AR5)**

September 2013



Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased

- The **IPCC** is a **scientific body**
- **Thousands of scientists** from all over the world contribute to the work of the IPCC on a voluntary basis.
- **PEER REVIEW** is an essential part of the IPCC process, to ensure an objective and complete assessment of current information.
- **Differing viewpoints** existing within the scientific community are reflected in the IPCC reports.

- The **IPCC** is an **intergovernmental body**, and it is open to all member countries of UN and WMO.
- Because of its scientific and intergovernmental nature, the IPCC embodies a **unique opportunity to provide rigorous and balanced scientific information to decision makers**.
- By endorsing the IPCC reports, **governments acknowledge the authority of their scientific content**.
- The work of the organization is **therefore policy-relevant and yet policy-neutral, never policy-prescriptive**.



**Small, low income, vulnerable people & nations:
They are least responsible,
yet likely to be impacted the most!**

*The IPCC has 3 “working groups,” a Task Force
(and various other subcommittees):*

Working Group I (WGI):

Physical Science of climate and climate change.

Working Group II (WGII):

People & Climate – Impacts, Vulnerability of people and natural systems to climate change, & Adaptation options)

Working Group III (WGIII):

Mitigation - options for limiting GHG emissions

Plus: A Task Force that oversees
the National Greenhouse Gas Inventories Program

... And **SPECIAL REPORTS:**

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

Report

- [Summary for Policymakers](#)
- [Generic Presentation](#)
- [Fact Sheet](#)

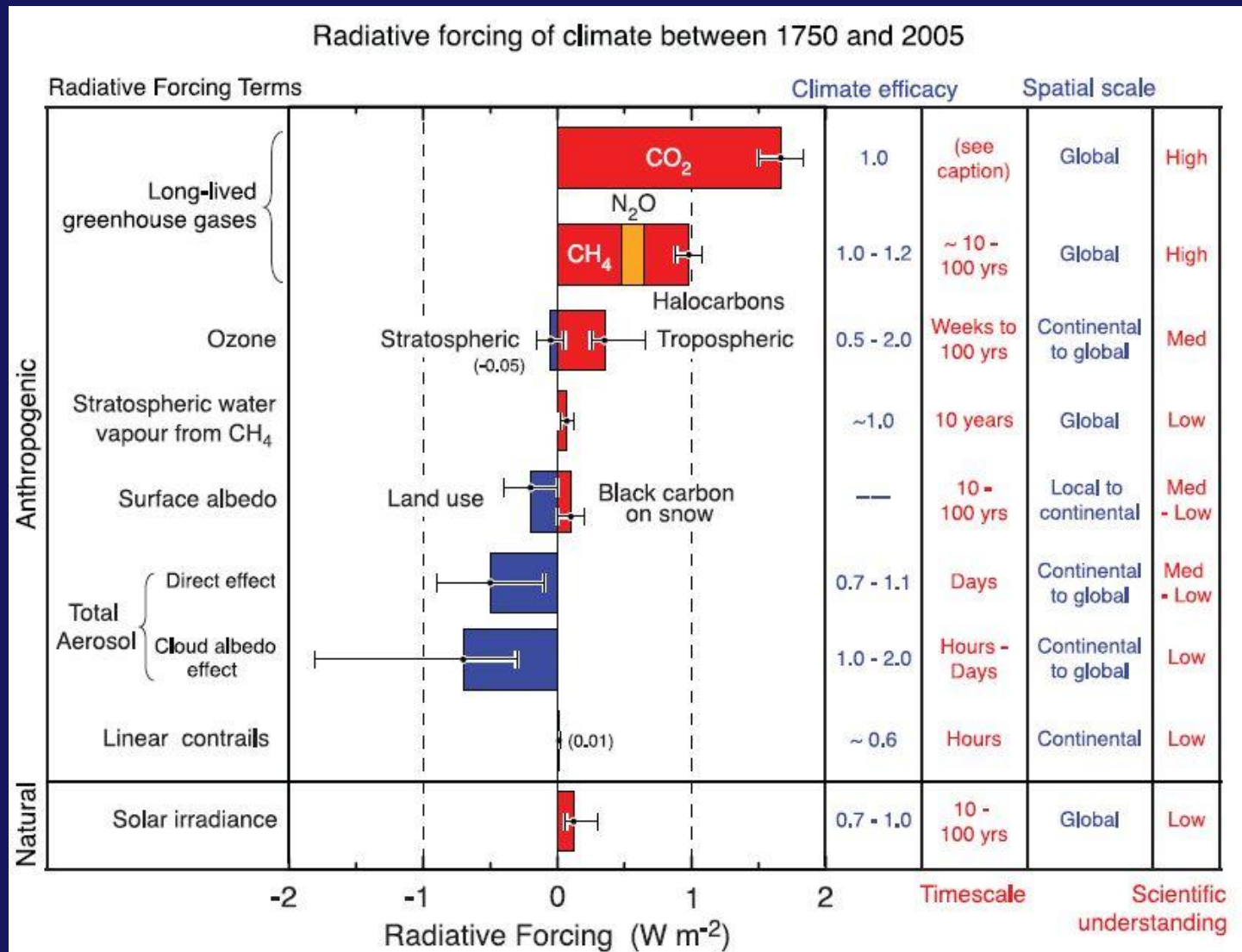
Report Press SREX Website

What was NEW in the most recent reports:

Estimates of confidence in the report's results / conclusions:

- **virtually certain** (greater than 99% chance that a result is true)
- **very likely** (90-99% chance);
- **likely** (66-90% chance);
- **medium likelihood** (33-66% chance);
- **unlikely** (10-33% chance);
- **very unlikely** (1-10% chance);
- **exceptionally unlikely** (less than 1% chance).

More accurate assessment of magnitude of individual RADIATIVE FORCINGS :



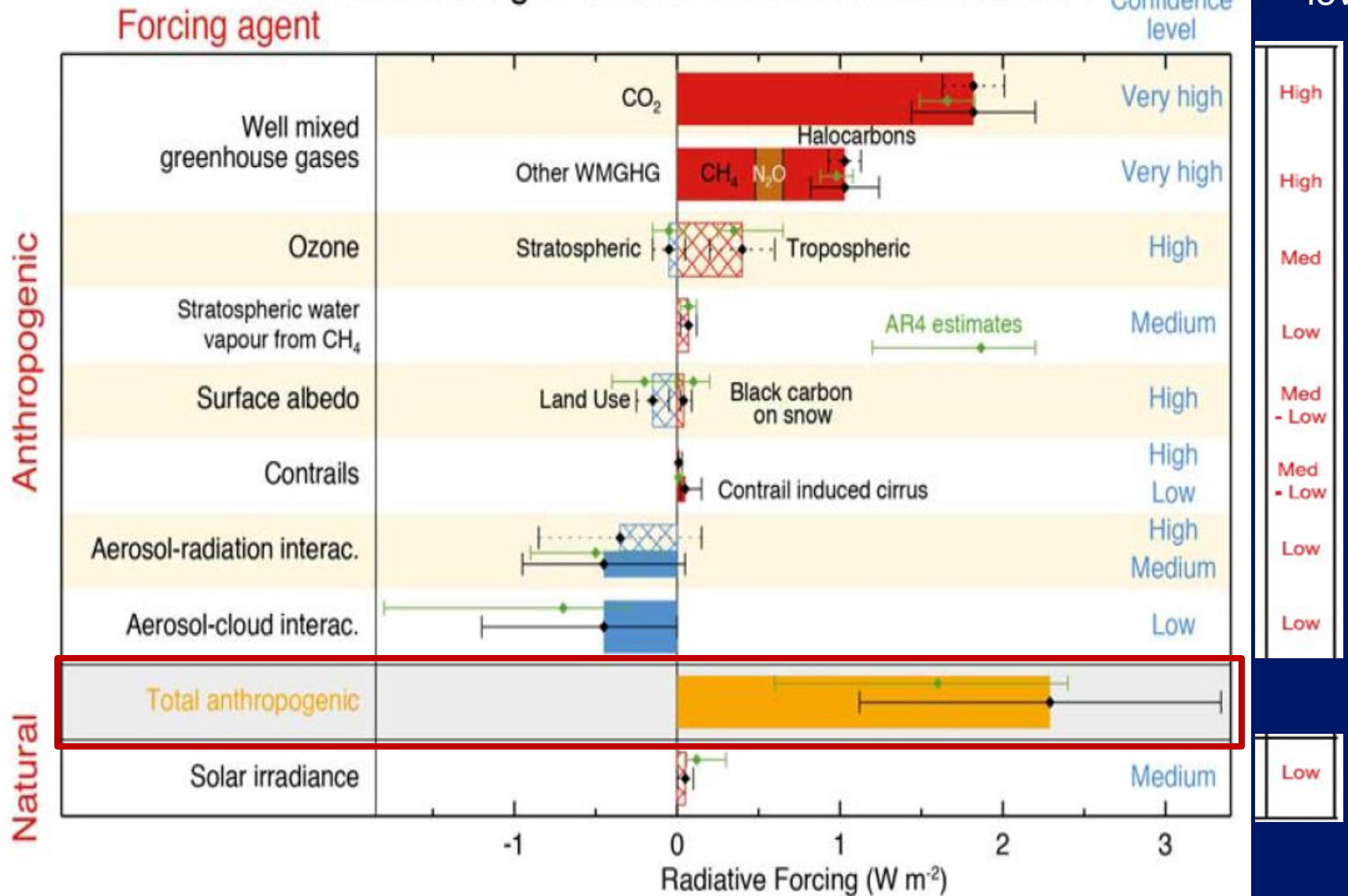
SOURCE: IPCC 2007 WG-1 Synthesis Report Summary for Policymakers

review

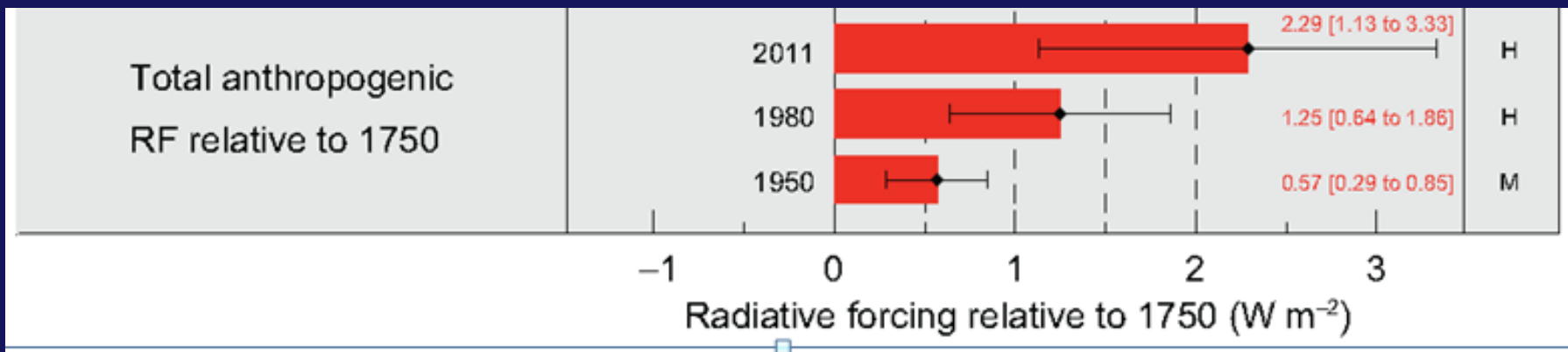
IPCC REPORTS 2007 vs 2013

2007
levels

Radiative forcing of climate between 1750 and 2011



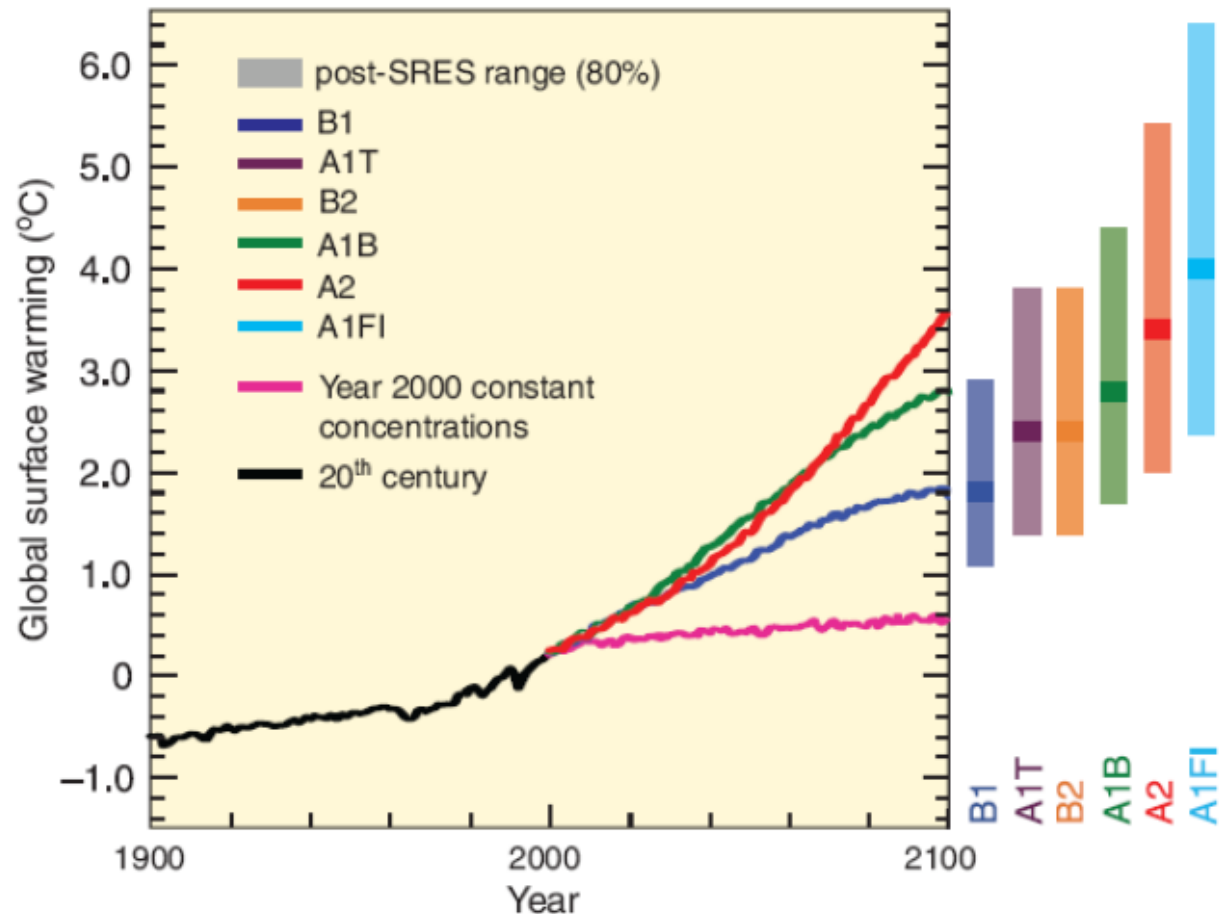
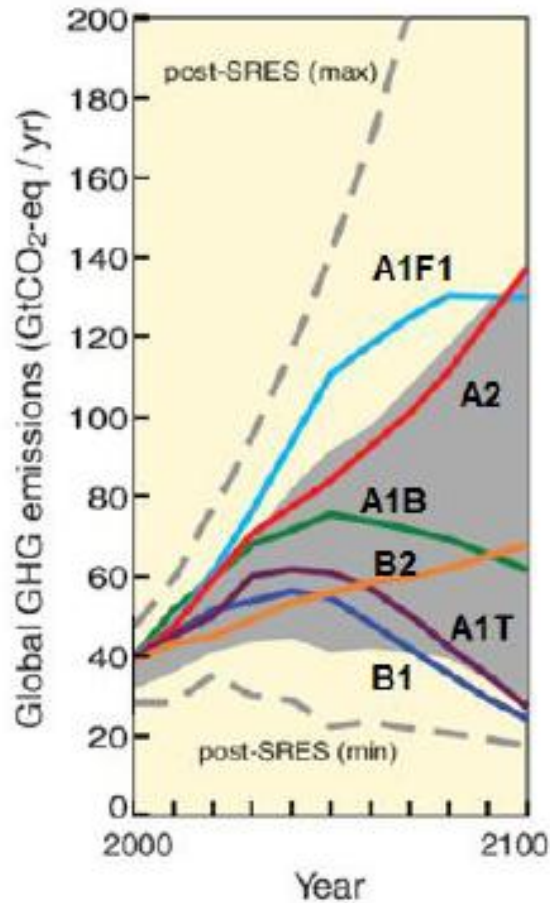
NEW: A time comparison of
**TOTAL ANTHROPOGENIC
FORCING!**



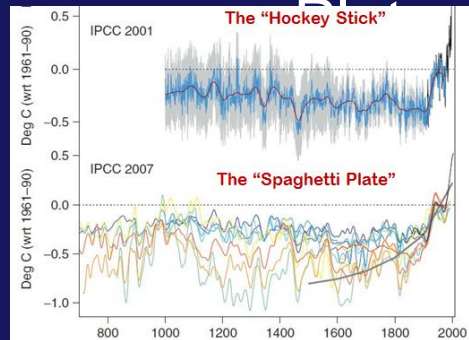
Projections of Climate Change based on **state-of-the-art computer model results** and **revised SCENARIOS**:

Projected Climate Change for Different Scenarios of GHG Emissions

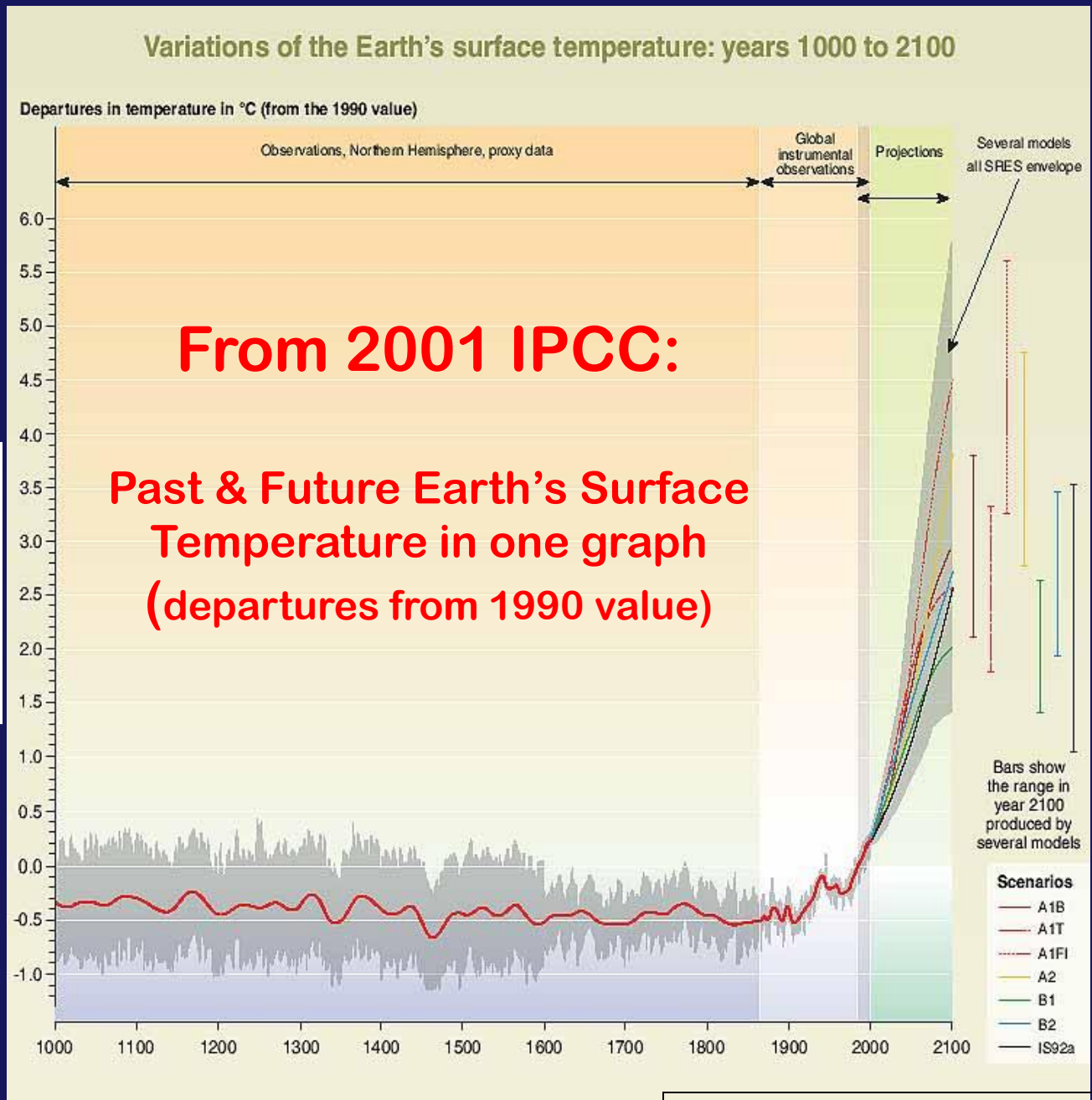
Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies) and projections of surface temperatures



Continually
improving
“Hockey
Stick”
(from 2001 Third
Assessment)
→ Spaghetti



**GLOBAL
SURFACE
TEMPERATURE
CHANGE
(° C)
(compared to
1990 value)**



From Self test 8

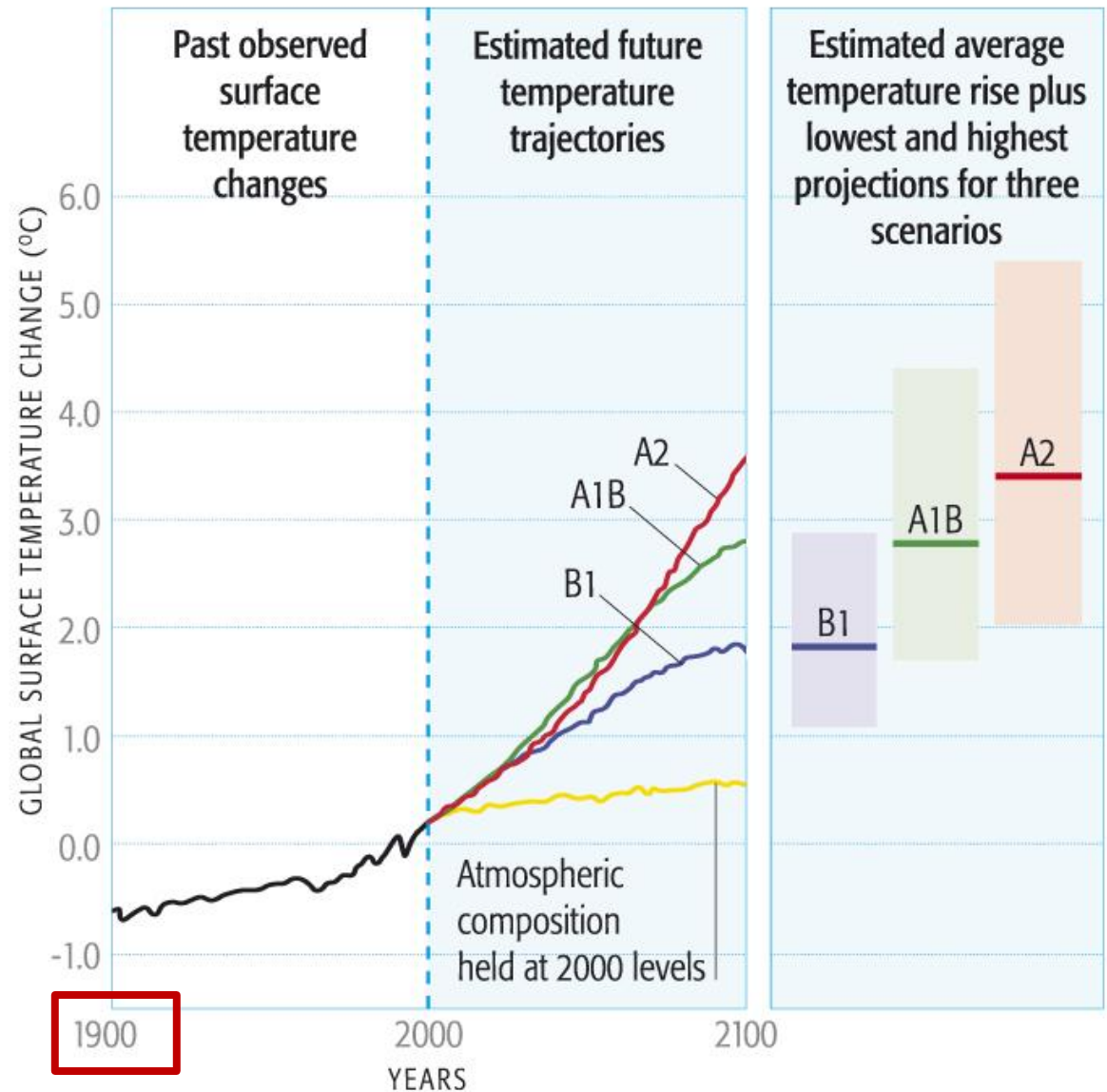
Updated version in AR4:

2007 IPCC FOURTH ASSESSMENT REPORT

GLOBAL SURFACE TEMPERATURE CHANGE (°C)

Compared to 1980-1999 period

POSSIBLE PATHS OF FUTURE GLOBAL WARMING



Starts in 1900

© 2009 Pearson Education, Inc.

From *Dire Predictions* (p 20)

RANGE OF POSSIBLE TRAJECTORIES FOR FUTURE CLIMATE CHANGE

CO₂ in ATMOSPHERE
(due to emissions)

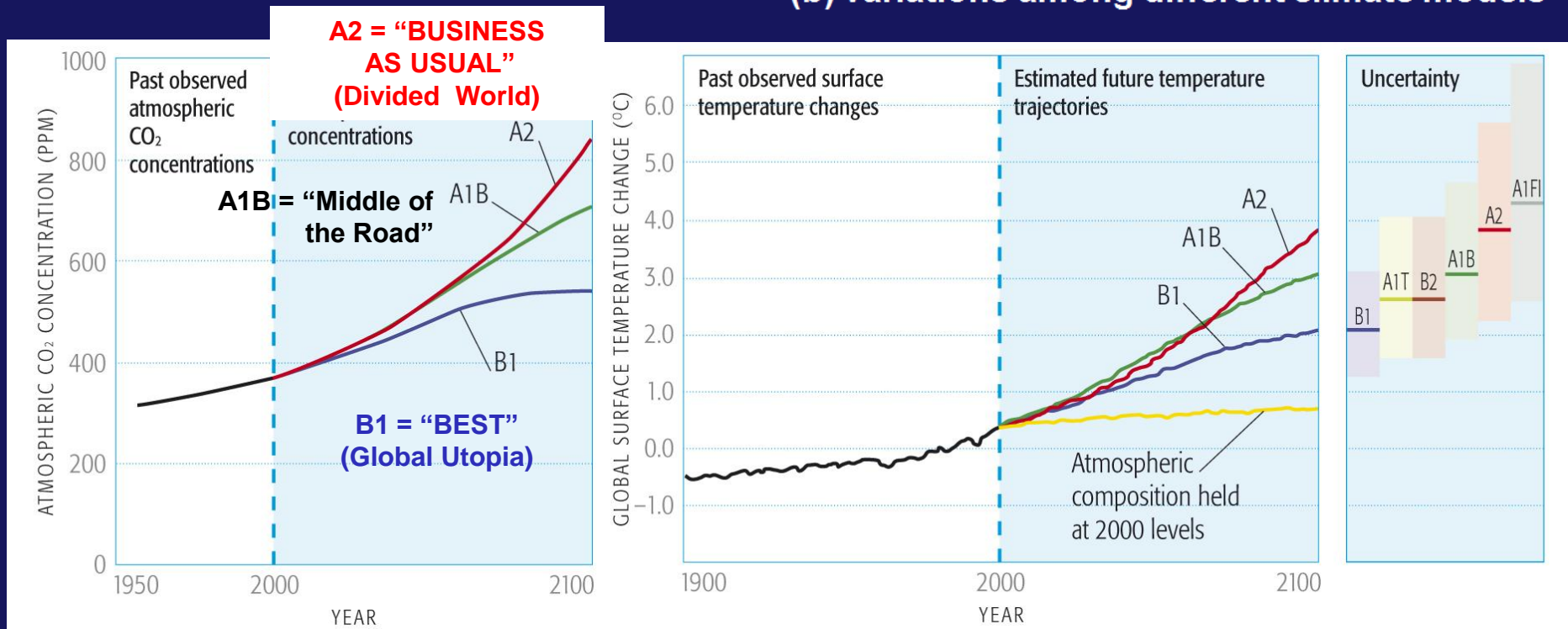


RESULTING WARMING:
TEMPERATURE INCREASE



Spread of results due to:

- (a) which future emission scenario used
- (b) variations among different climate models

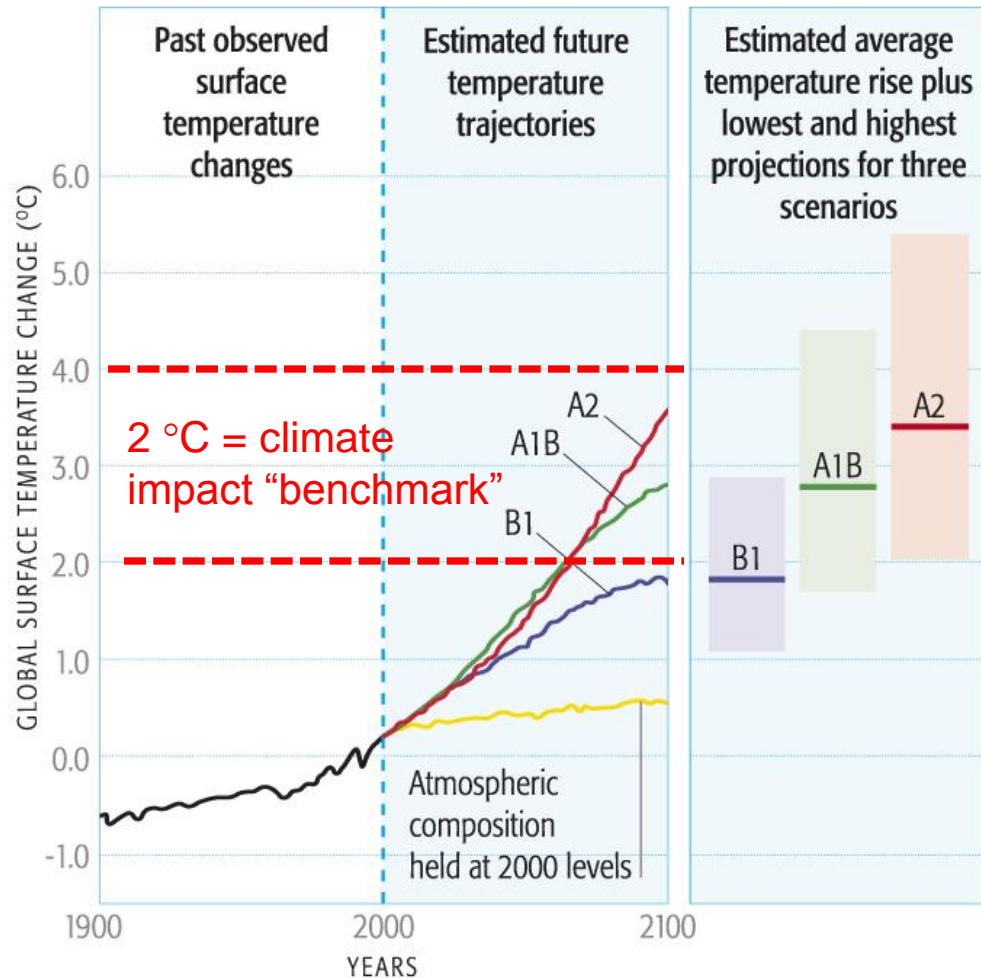


2007 REPORT

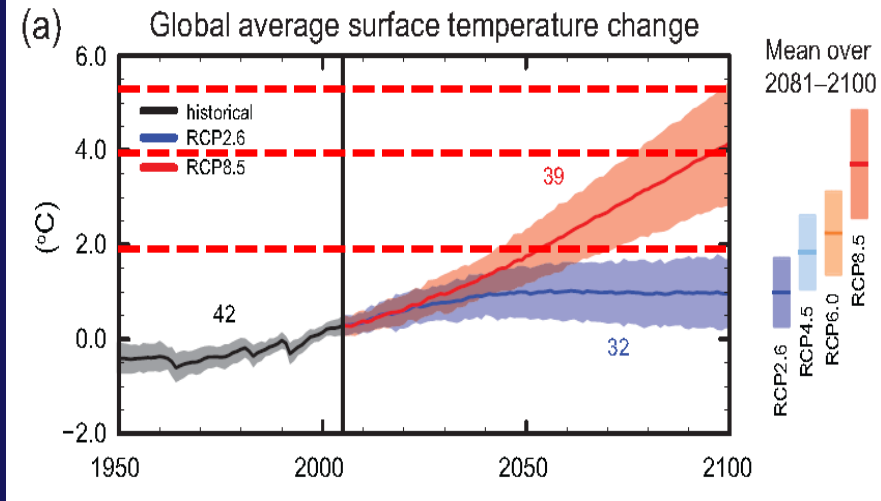
2013 REPORT

Future Temperature Change Projections:

POSSIBLE PATHS OF FUTURE GLOBAL WARMING



© 2009 Pearson Education, Inc.

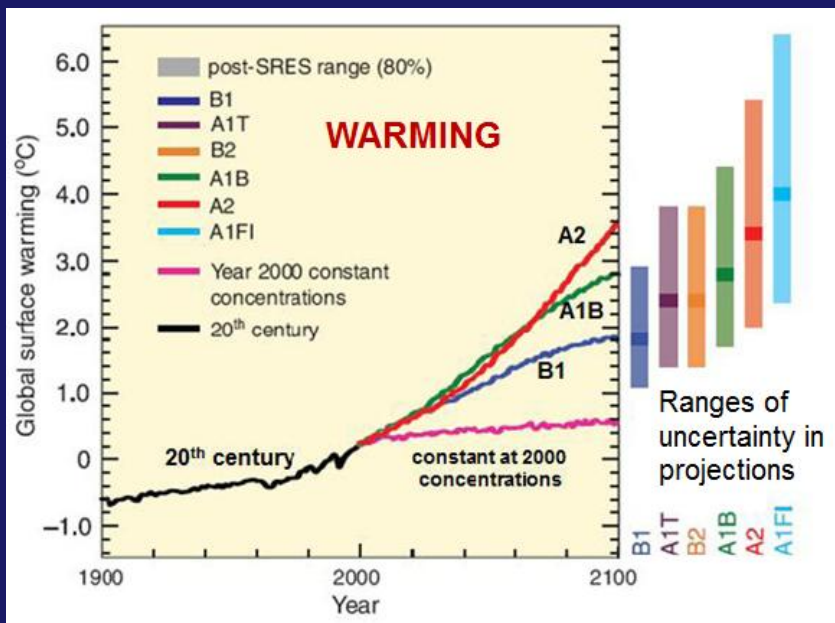


Representative Concentration Pathways (RCPs)

RCPs = future scenarios identified by their approximate total radiative forcing in year 2100 relative to 1750

GLOBAL SURFACE TEMPERATURE CHANGE (° C)

From *Dire Predictions* (p 20)



The TABLE below shows the computer model estimates of temperature change for each of the scenarios on ← this graph

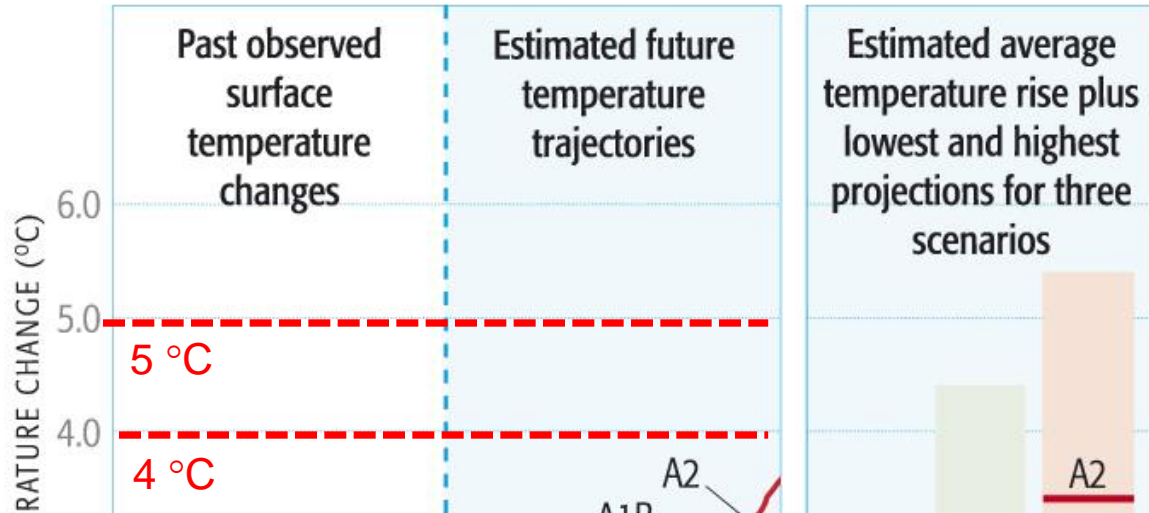
Table SPM.1. Projected global average surface warming and sea level rise at the end of the 21st century. {Table 3.1}

Case	Temperature change (°C at 2090-2099 relative to 1980-1999) ^{a, d}		Sea level rise (m at 2090-2099 relative to 1980-1999)
	Best estimate	Likely range	Model-based range excluding future rapid dynamical changes in ice flow
Constant year 2000 concentrations ^b	0.6	0.3 – 0.9	Not available
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

We are already on a path that is close to the A2 scenario or WORSE!!

← This is much faster than was expected when the 2007 IPCC first came out!

POSSIBLE PATHS OF FUTURE GLOBAL WARMING



The I-2D LESSON 4 ONLINE TUTORIAL

has an excellent section that will help you understand these graphs!

“This means that we will have no choice but to adapt to a change in climate”

- even if our mitigation actions place us on a low emissions pathway (such as B1) or . . .
- even if emissions are stopped entirely (which would be impossible)

↑
GLOBAL
SURFACE
TEMPERATURE
CHANGE
(° C)

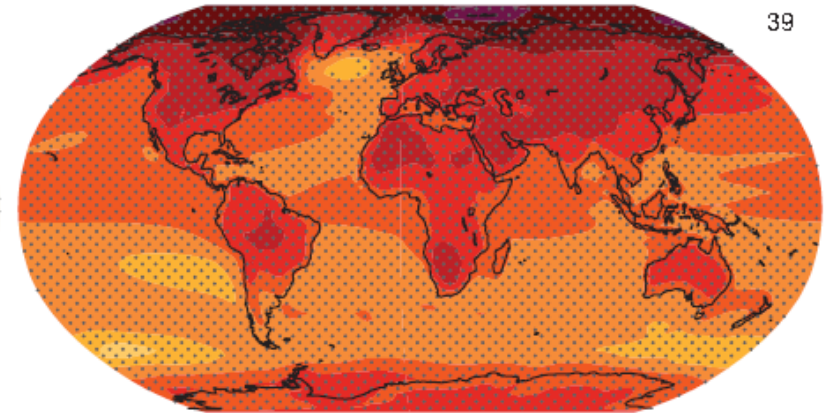
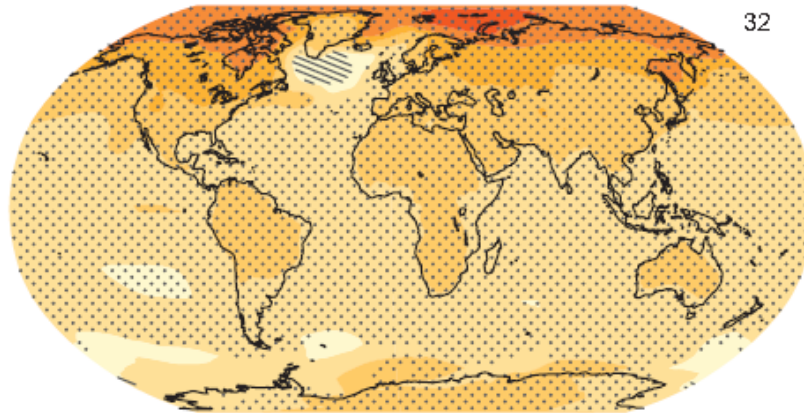
Two FUTURE SCENARIOS FROM THE 2013 REPORT:

very low forcing level

very high greenhouse gas emissions

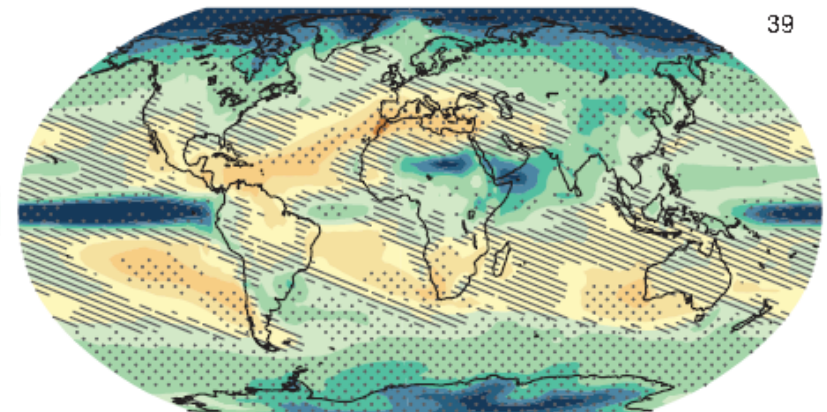
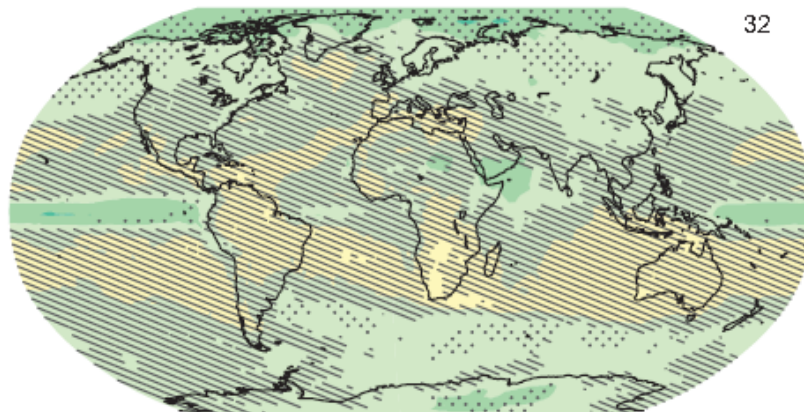
(a)

Change in average surface temperature (1986–2005 to 2081–2100)



(b)

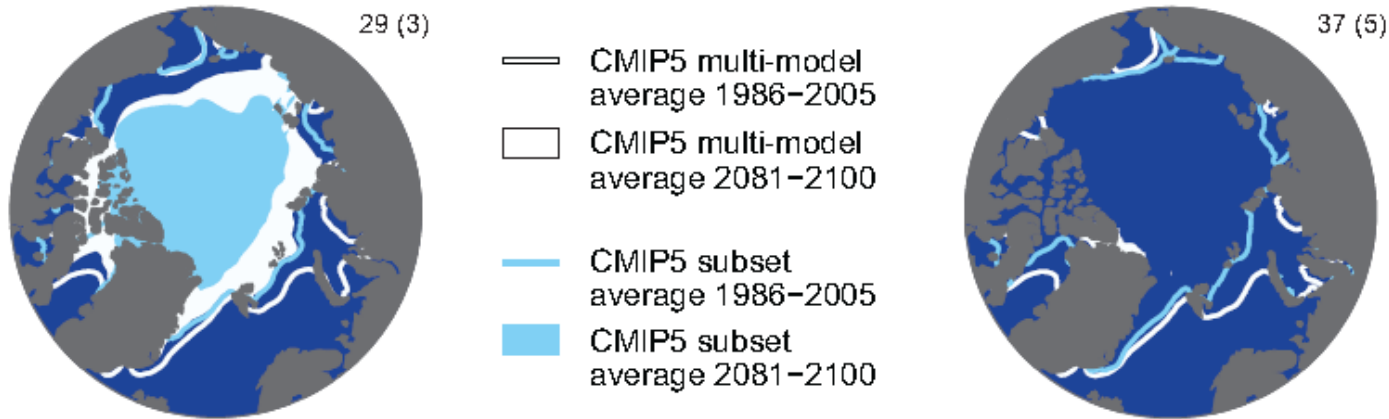
Change in average precipitation (1986–2005 to 2081–2100)



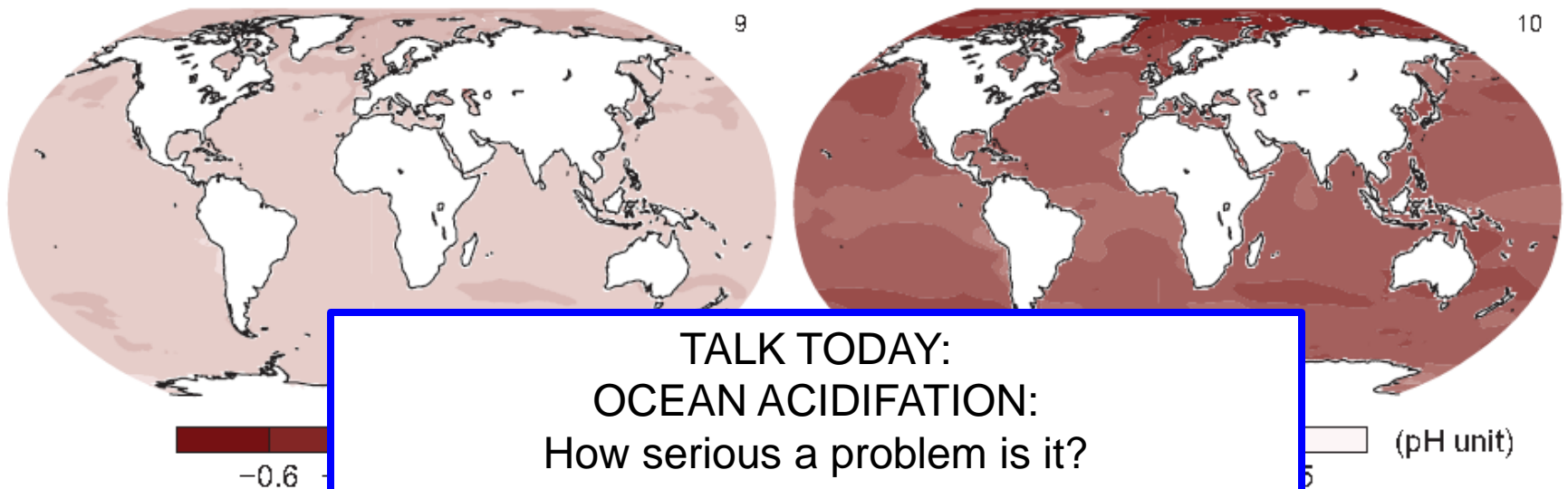
very low forcing level

very high greenhouse gas emissions

(c) Northern Hemisphere September sea ice extent (average 2081–2100)



(d) Change in ocean surface pH (1986–2005 to 2081–2100)



TALK TODAY:
OCEAN ACIDIFICATION:
How serious a problem is it?

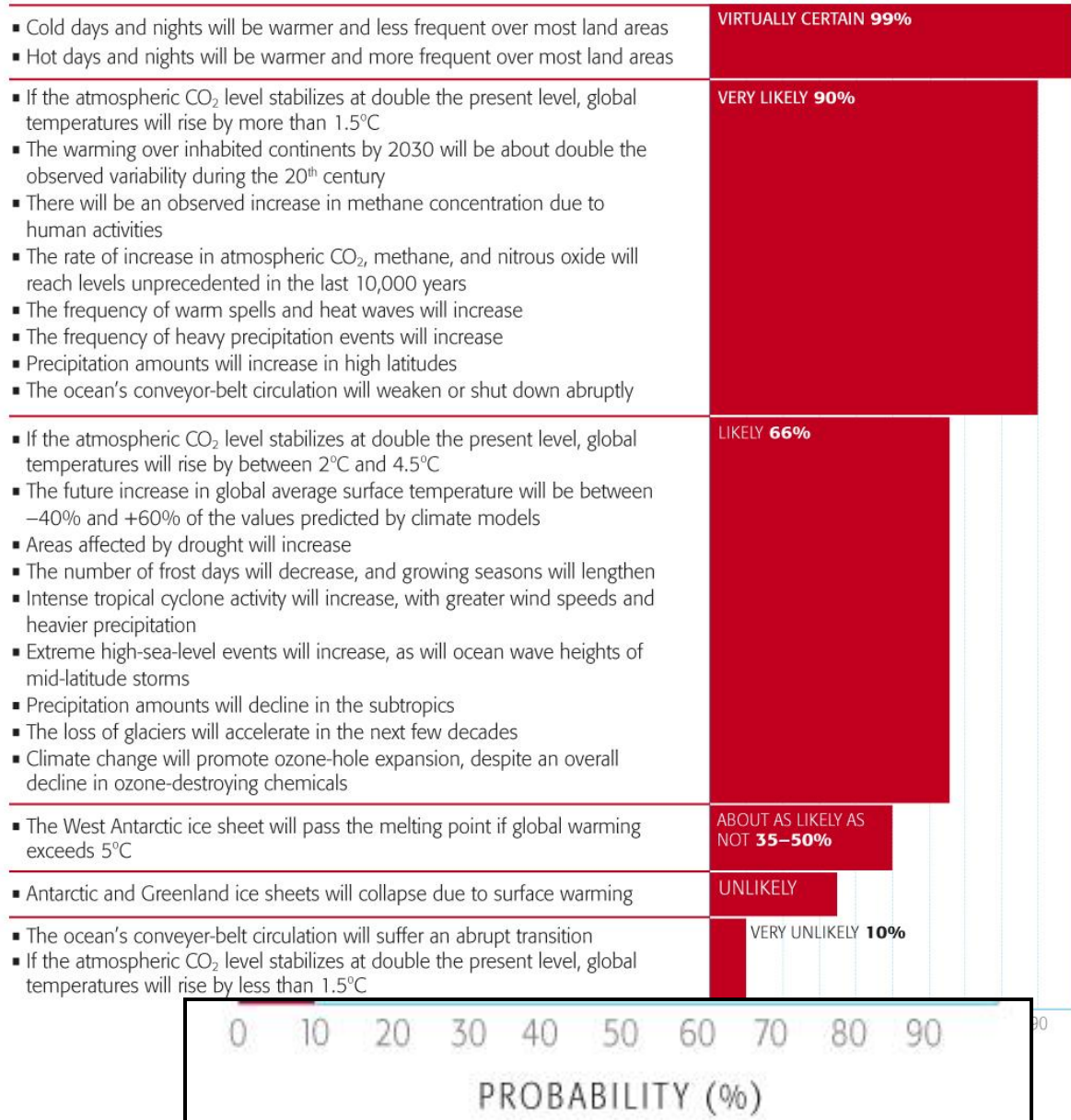
Dec 3 (TODAY) @ 5 pm in Soc Sci room 100

The DIRE PREDICTIONS based on the science summarized by the 2007 IPCC



(with **certainty / likelihood** assigned to each projected future impact)

IPCC PROJECTIONS FOR THE 21ST CENTURY



From Dire Predictions (p 21)

IPCC PROJECTIONS FOR THE 21ST CENTURY

VIRTUALLY CERTAIN 99%

- Cold days and nights will be warmer and less frequent over most land areas
- Hot days and nights will be warmer and more frequent over most land areas

VIRTUALLY CERTAIN 99%

0 10 20 30 40 50 60 70 80 90

PROBABILITY (%)

- Over most land areas:

HOT DAYS & NIGHTS will be WARMER;
and MORE FREQUENT



Recurrence Interval = measure of frequency

An event happening “once in 50 years”
in the future, might happen “once in 10 years”
(or have a “1 in 10” chance of occurring in any year)

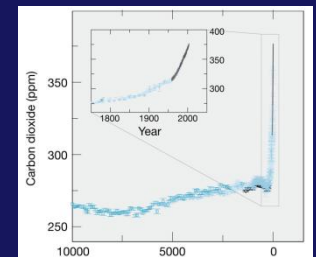
IPCC PROJECTIONS FOR THE 21ST CENTURY

VERY LIKELY 90%

- If the atmospheric CO₂ level stabilizes at double the present level, global temperatures will rise by more than 1.5°C
- The warming over inhabited continents by 2030 will be about double the observed variability during the 20th century
- There will be an observed increase in methane concentration due to human activities
- The rate of increase in atmospheric CO₂, methane, and nitrous oxide will reach levels unprecedented in the last 10,000 years
- The frequency of warm spells and heat waves will increase
- The frequency of heavy precipitation events will increase
- Precipitation amounts will increase in high latitudes
- The ocean's conveyor-belt circulation will weaken or shut down abruptly

VERY LIKELY 90%

- the **RATE** of increase of **GHG's** will be **UNPRECEDENTED** in past 10,000 yrs
- Frequency of **HEAVY PRECIPITATION EVENTS** will INCREASE



IPCC PROJECTIONS FOR THE 21ST CENTURY

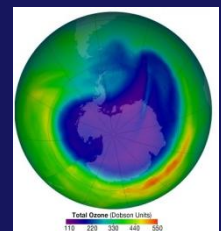
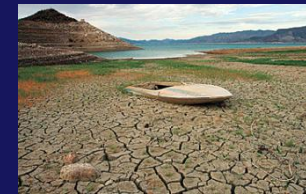
LIKELY 66%

- If the atmospheric CO₂ level stabilizes at double the present level, global temperatures will rise by between 2°C and 4.5°C
- The future increase in global average surface temperature will be between -40% and +60% of the values predicted by climate models
- Areas affected by drought will increase
- The number of frost days will decrease, and growing seasons will lengthen
- Intense tropical cyclone activity will increase, with greater wind speeds and heavier precipitation
- Extreme high-sea-level events will increase, as will ocean wave heights of mid-latitude storms
- Precipitation amounts will decline in the subtropics
- The loss of glaciers will accelerate in the next few decades
- Climate change will promote ozone-hole expansion, despite an overall decline in ozone-destroying chemicals

LIKELY 66%



- Extreme **HIGH SEA LEVEL** events will increase
- **SUBTROPICS** (that's us!) will experience **PRECIPITATION DECLINE**
- Stratospheric cooling → **ozone hole persistence** even **WITH** ban of CFC's!



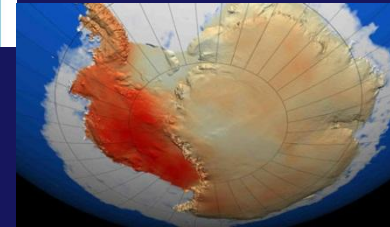
IPCC PROJECTIONS FOR THE 21ST CENTURY

AS LIKELY AS NOT 35 - 50%

- The West Antarctic ice sheet will pass the melting point if global warming exceeds 5°C

ABOUT AS LIKELY AS
NOT 35-50%

- **W. ANTARCTIC ICE SHEET MELTING** (if Temp > 5° C)



UNLIKELY 35%

- Antarctic and Greenland ice sheets will collapse due to surface warming

UNLIKELY

- **ANTARCTIC & GREENLAND ICE SHEETS COLLAPSE**

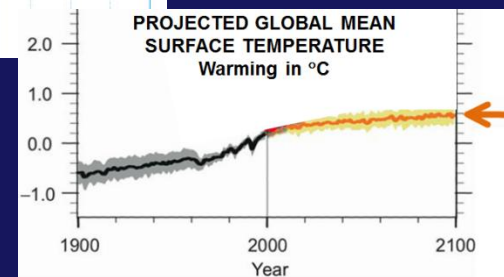


VERY UNLIKELY 10%

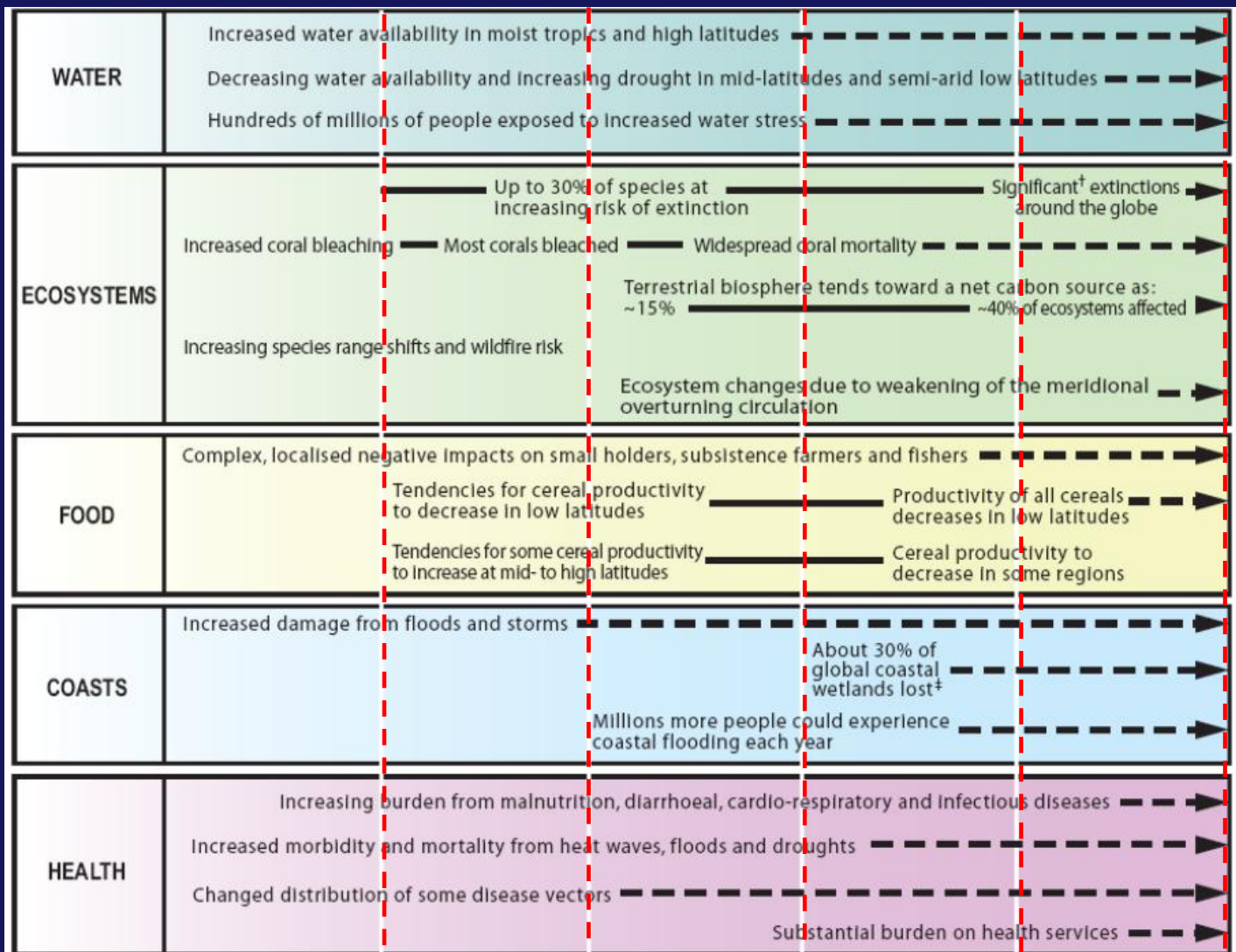
- The ocean's conveyer-belt circulation will suffer an abrupt transition
- If the atmospheric CO₂ level stabilizes at double the present level, global temperatures will rise by less than 1.5°C

VERY UNLIKELY 10%

- **GLOBAL TEMPERATURES** will rise by LESS than 1.5° C (if CO₂ stabilizes at 2x)

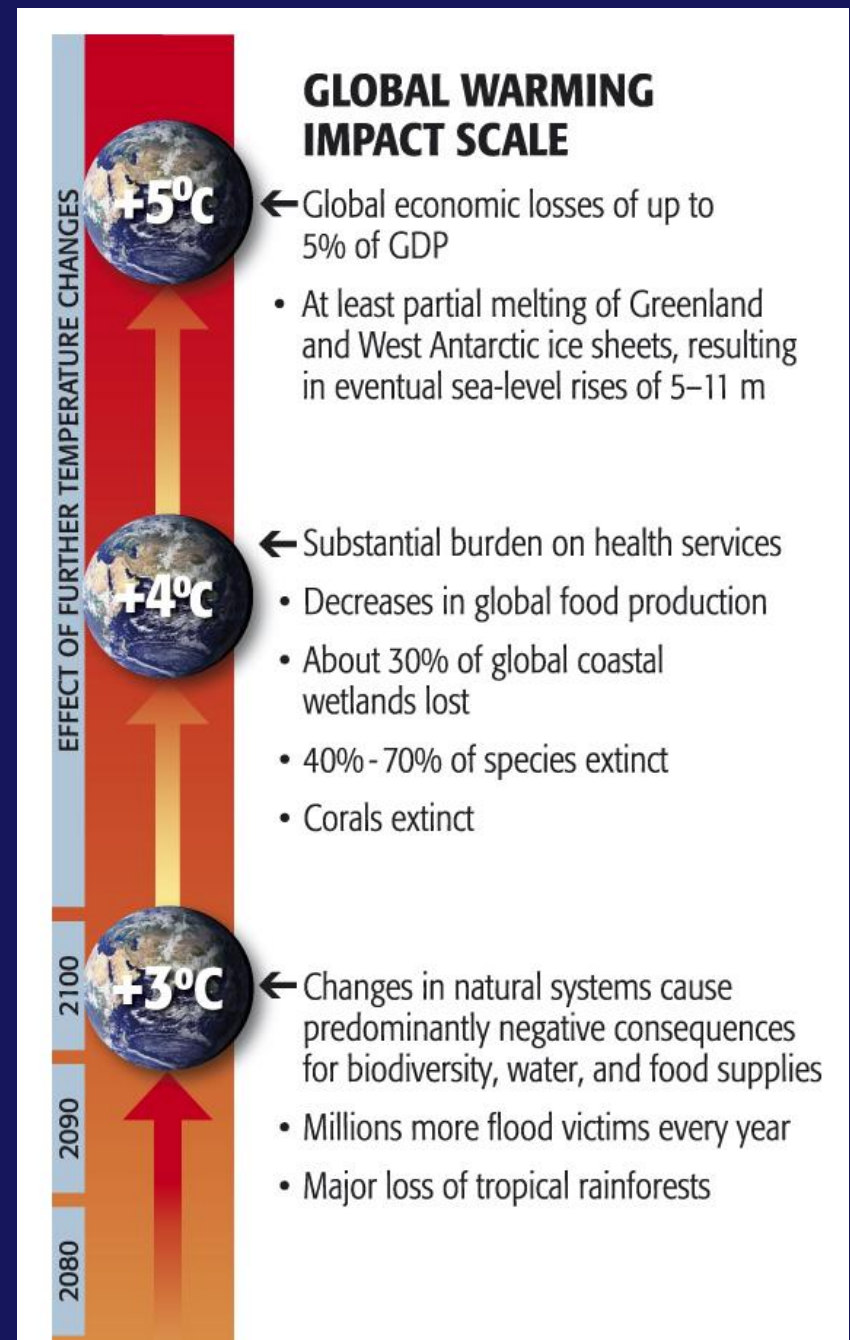
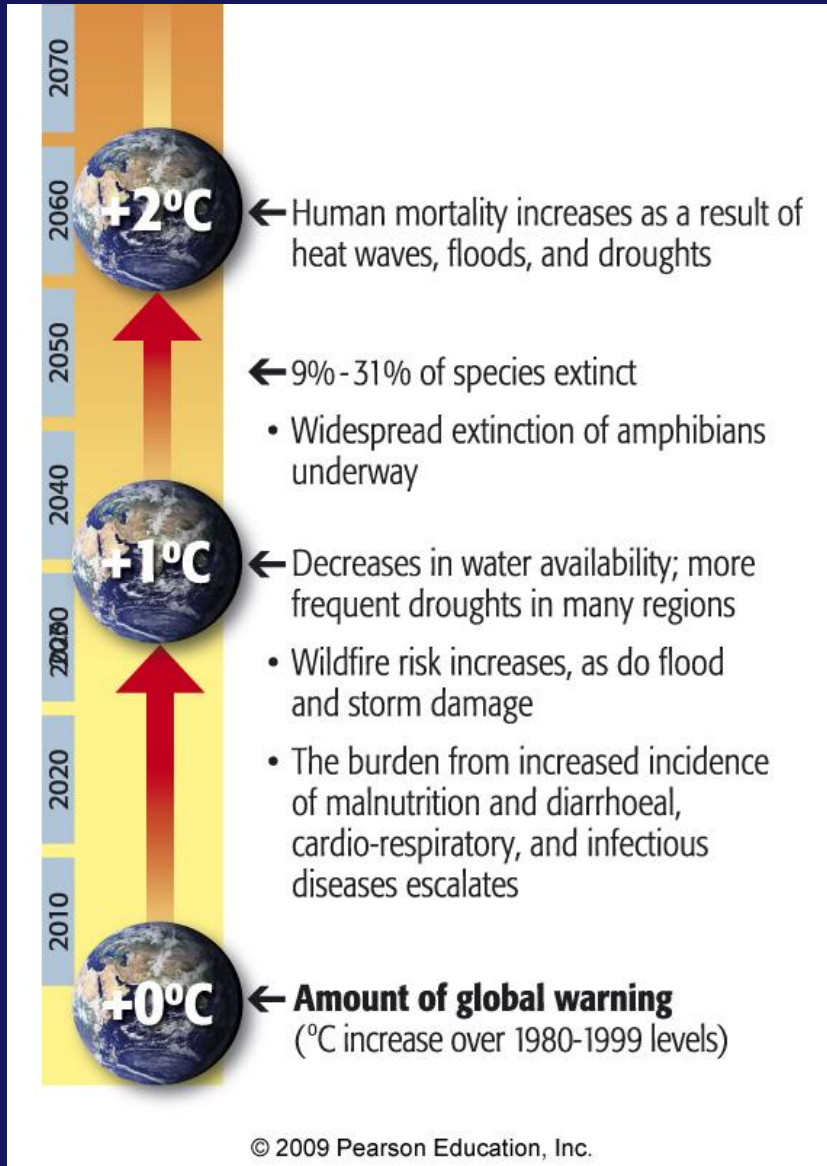


Examples of IMPACTS associated with global average annual temperature change (relative to 1980-1999 average temperature)



1°C 2°C 3°C 4°C 5°C

GLOBAL WARMING IMPACT SCALE



So what do we do about all of these impacts???

ADAPTATION & MITIGATION SOLUTIONS

**POLICIES & POSSIBLE ACTIONS
to SLOW
GLOBAL WARMING . . .
& ADAPT to the warming we
can't prevent!**

**“ A world civilization able
to envision God and the afterlife,
to embark on the colonization of space,
will surely find the way
to save the integrity of this magnificent planet
and the life it harbors because quite simply
it's the right thing to do,
and ennobling to our species.”**

-E. O. Wilson



**MITIGATION
VS
ADAPTATION ?**

MITIGATION

Mitigation: intervention to reduce anthropogenic
Forcing on the climate system through:

(a) strategies to
reduce GHG **emissions**



(b) strategies to
enhance GHG **sinks**




planting trees

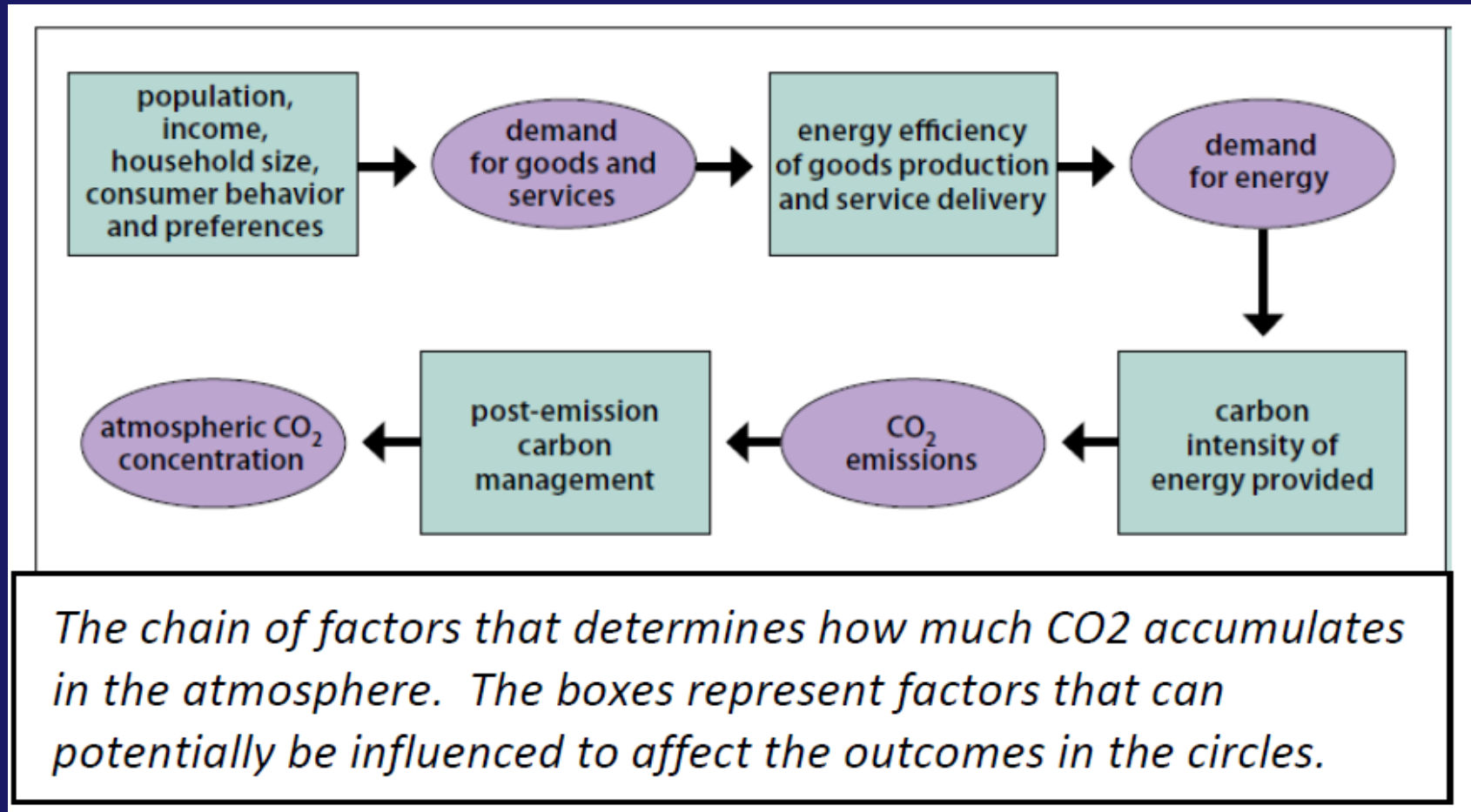
EXAMPLE OF MITIGATION PROCESS

PROBLEM FACTORS!

= factors that lead to increasing accumulation of CO₂ in atmosphere

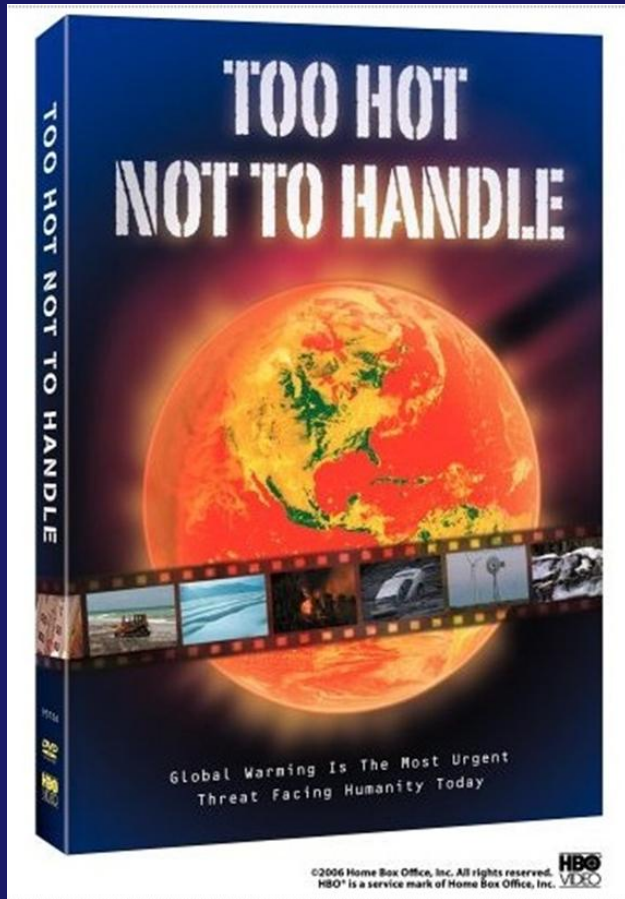
SOLUTION FACTORS!

= factors that HUMANS can adjust to influence the :  factors



Several **MITIGATION SOLUTIONS** were described in:

“Let a thousand flowers bloom”.



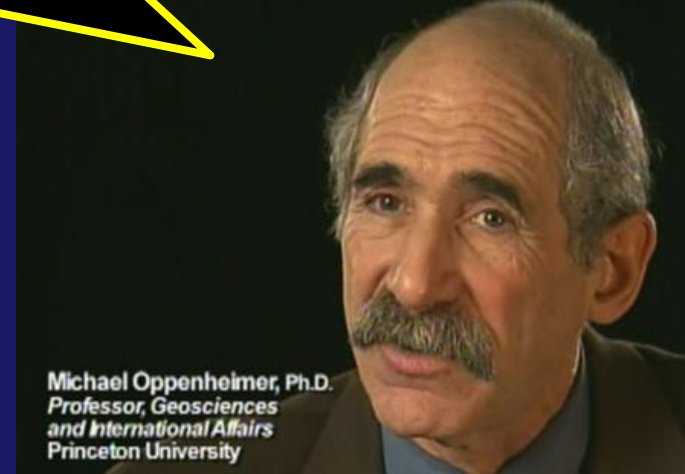
SOLAR

BIOFUELS WIND

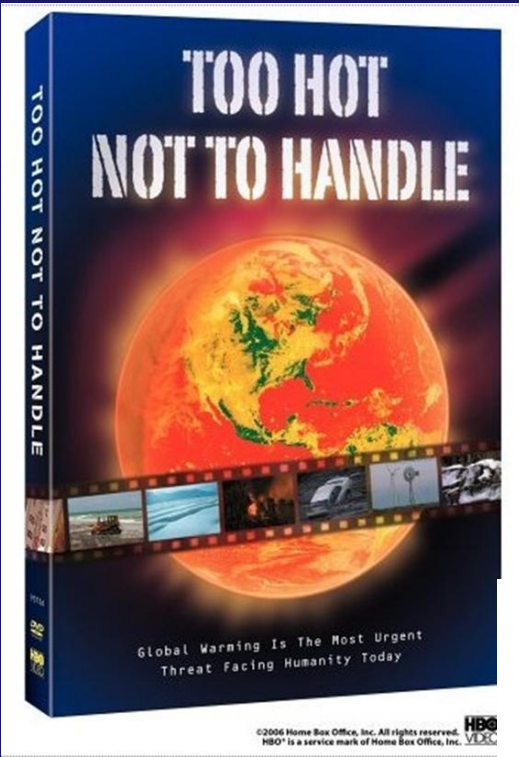
SUSTAINABLE COMMUNITIES

(Portland, Oregon example)

Michael Oppenheimer, Ph.D.
Professor, Geosciences
and International Affairs
Princeton University



FILM FOLLOW UP....



Welcome to Brooklyn Pizza Company

Brooklyn has gone Solar! The new panels generate 160,000 kWh of electricity per year. Find out how Brooklyn does its part to mitigate environmental impact.

See the PDF.

NOW 100% SOLAR POWERED!

- 80,000 gal of water saved each year
- 29,700 lbs of CO2 - the biggest contributor to global warming - saved each month
- 160,000 lbs of coal saved each year



Your favorite pizzeria goes solar!

In TUCSON,
on 4th Avenue →

AT UA: INNOVATIVE SOLAR SOLUTION!!

Dr Roger Angel



[Technology](#) [Prototype](#) [Utility Scale](#) [Sustainability](#) [Advantages](#) [About Us](#)



A Solar Revolution

REhnu's technology uses large glass mirrors to focus sunlight onto highly efficient photovoltaic cells. It is designed to produce utility-scale solar electricity at the lowest cost.



<http://www.rehnu.com/>

THE NEXT FRONTIER:



Engineering the Golden Age of Green

More
**MITIGATING
SOLUTIONS**
in our current
film . . .

The Logic Chain to an Effective Global Clean Energy Policy

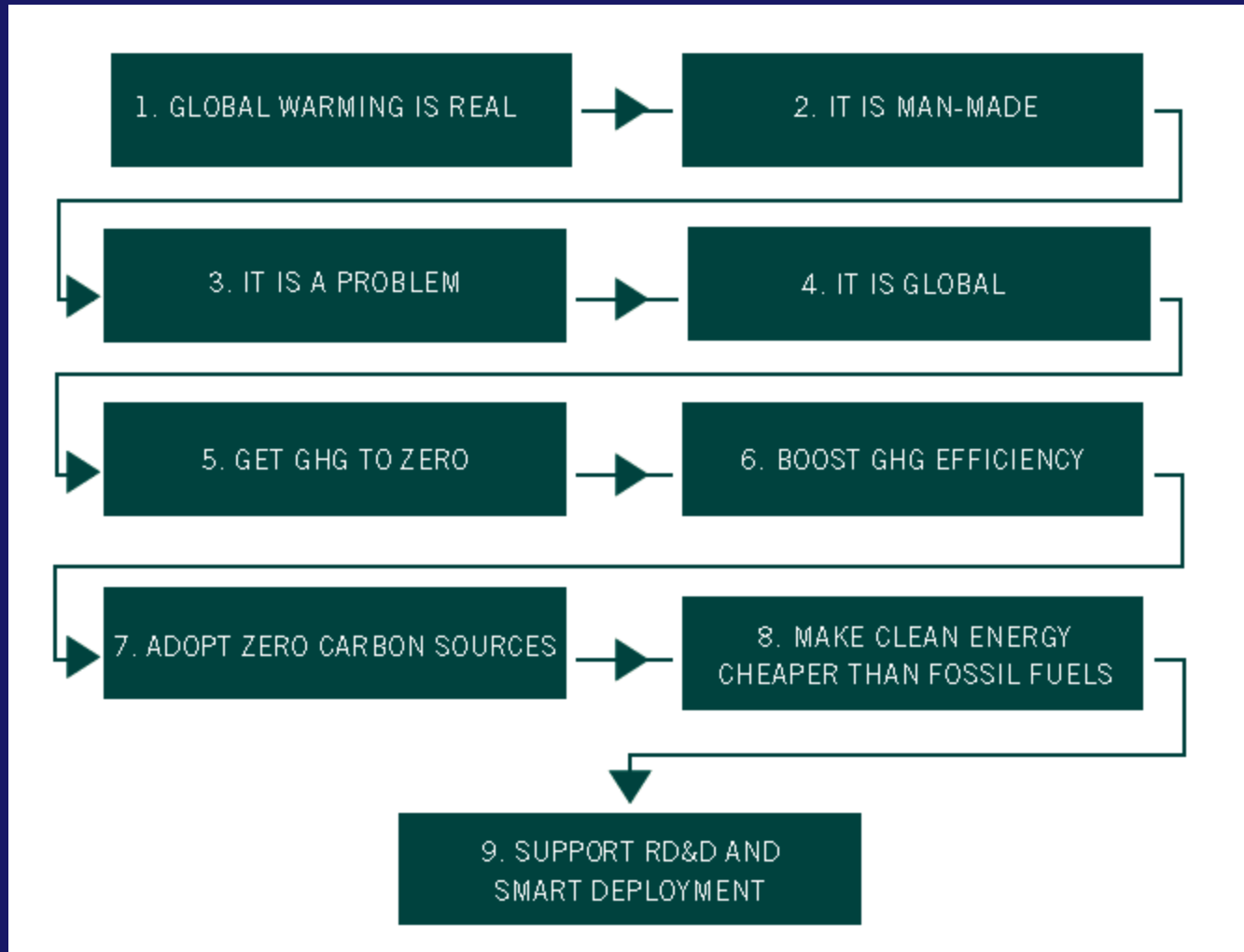


Washington DC Think Tank
(non-profit)

ONLY AN AGGRESSIVE INNOVATION POLICY BASED ON SIGNIFICANTLY
INCREASED SUPPORT FOR RD&D AND SMART DEPLOYMENT WILL
EFFECTIVELY DRIVE ENERGY INNOVATION.

<http://www.itif.org/publications/logic-chain-effective-global-clean-energy-policy>

LOGIC CHAIN



ADAPTATION

ADAPTATION: Adjustments made in response to (or anticipation of) **CLIMATIC IMPACTS** in order to:

(a) Lessen or reduce harm

(b) take advantage of beneficial opportunities



Should this house be rebuilt?



ipcc

INTERGOVERNMENTAL PANEL ON climate change



Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

Report

- [Summary for Policymakers](#)
- [Generic Presentation](#)
- [Fact Sheet](#)

[Report](#)

[Press](#)

[SREX Website](#)



The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

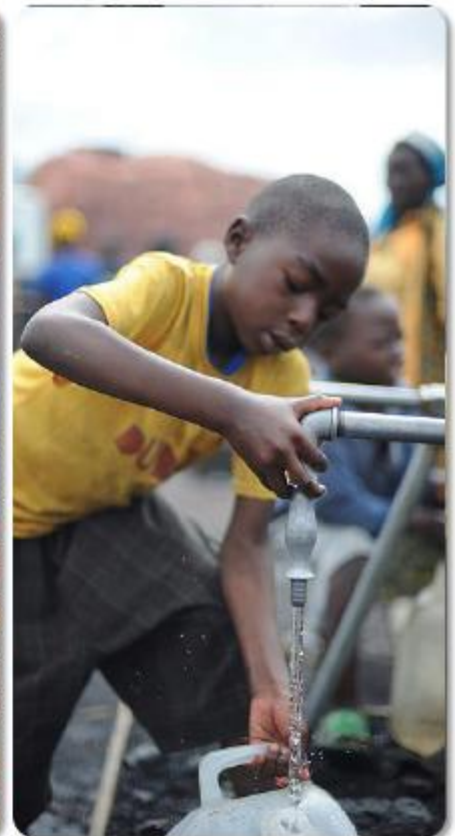
November 2011

ipcc
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

- **Changes in climate vary across regions**
- **Each region has unique vulnerabilities & exposure to hazards**
- **Effective adaptation & risk management must address BOTH exposure & vulnerability of a region**



There are strategies that can help **manage disaster risk now** and also help improve people's livelihoods and well-being



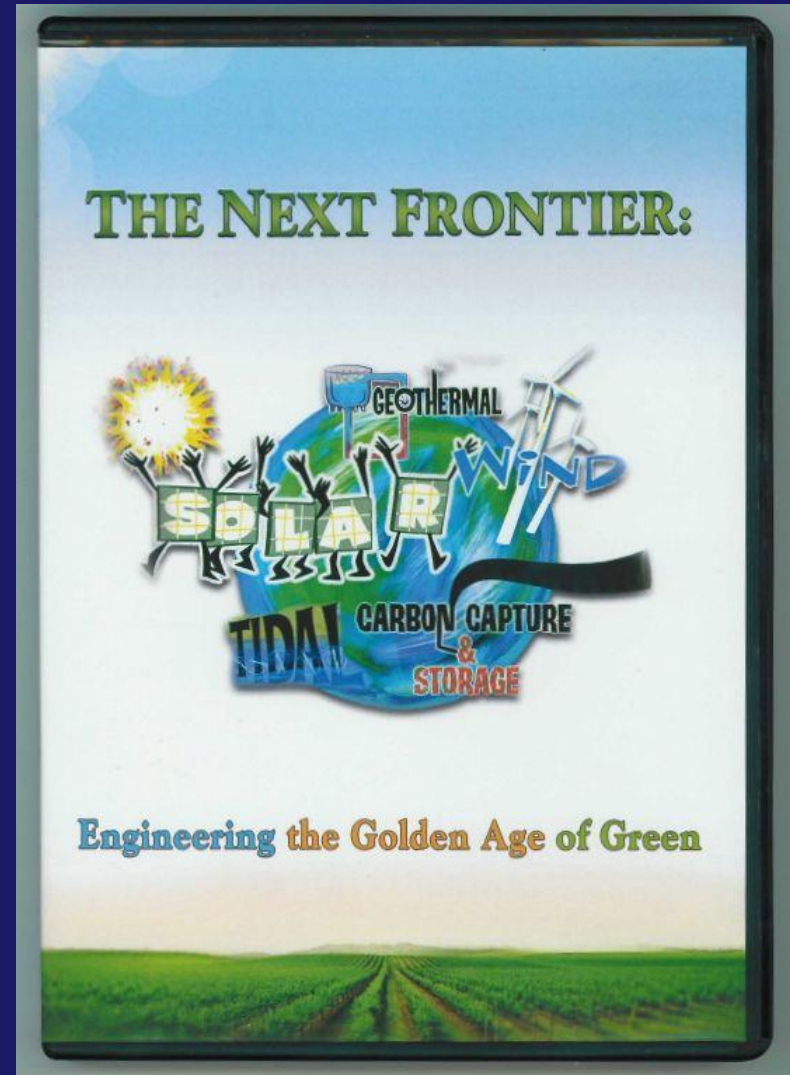
The most effective strategies offer **development benefits** in the relatively near term and **reduce vulnerability** over the longer term

**MITIGATION
VS
ADAPTATION ?**

We need BOTH!

So what other possible
**MITIGATION
SOLUTIONS**
are out there?

Let's finish the film!



**STUDY HARD
FOR TEST # 4 !!**