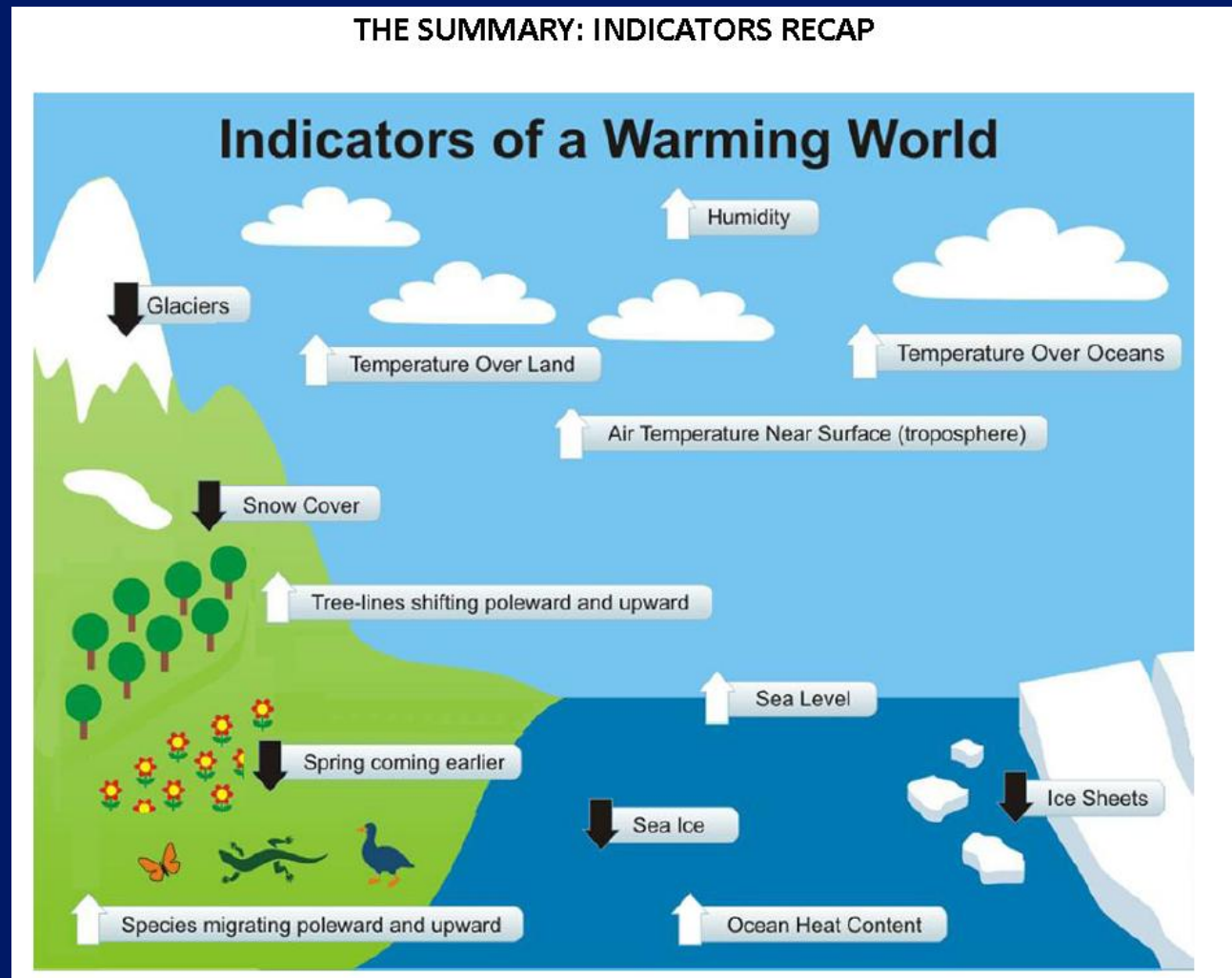


We started out by reviewing the various indicators of a warming world – which we have already discussed this diagram . . . but now a report has summarized even more for the United States specifically (next slide) →



Environmental
Protection Agency
(EPA) report:



Climate Change Indicators in the United States



2010

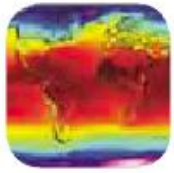


www.epa.gov/climatechange/indicators.html

EPA SUMMARY OF KEY FINDINGS

Atmosphere

Oceans / Hydrosphere



U.S. and Global temperatures increasing



Heat wave frequency up



Some indication of drought increase



U.S. and Global precipitation increasing; some areas (e.g. Southwest) decreasing



More heavy precipitation events



Intensity (but not frequency) of tropical storms has increased



Stored ocean heat has increased



Sea surface temperatures have increased, but significant spatial and temporal variation



Average sea level has increased, with regional variations



Ocean has become more acid, associated with increased dissolved CO₂

EPA SUMMARY OF KEY FINDINGS (cont.)

Cryosphere



Extent of Arctic sea ice has decreased



Glacial melting has accelerated over last decade



Lake ice in northern US is freezing later and thawing earlier



Snow cover has decreased in N. America, but variable



Snowpack and depth has decreased in many areas, esp. western US

Biosphere



Heat-related deaths, but trends difficult to determine



Length of growing season has increased in lower 48 states



Plant hardiness zones have shifted northward, w/ higher winter temps



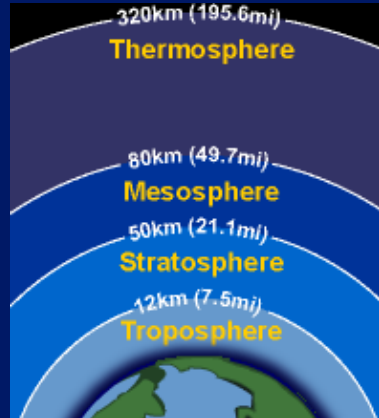
Some species leafing and blooming earlier



Bird species have shifted wintering grounds northward

10 Indicators of a Human Fingerprint on Climate Change

Source: NOAA's 2009 State of the Climate Report



[evidence of enhanced greenhouse effect from radiation & temperature observations at various levels in the atmosphere]

Shrinking thermosphere

Less heat escaping to space

Cooling stratosphere

The Greenhouse Signature

Cooling In the Stratosphere

Warming In the Troposphere

Rising tropopause

Less oxygen in the air

[evidence from atmospheric composition measurements]

30 billion tonnes of CO₂ per year

More fossil fuel carbon in the air

[evidence from carbon isotopes]

Nights warming faster than days

[evidence from surface temperature measurements]

More heat returning to Earth

More fossil fuel carbon in coral

[evidence from carbon isotopes]

TOPIC #15

CLIMATE CHANGE: IMPACTS & ISSUES –

Part I

THE IPCC FINDINGS

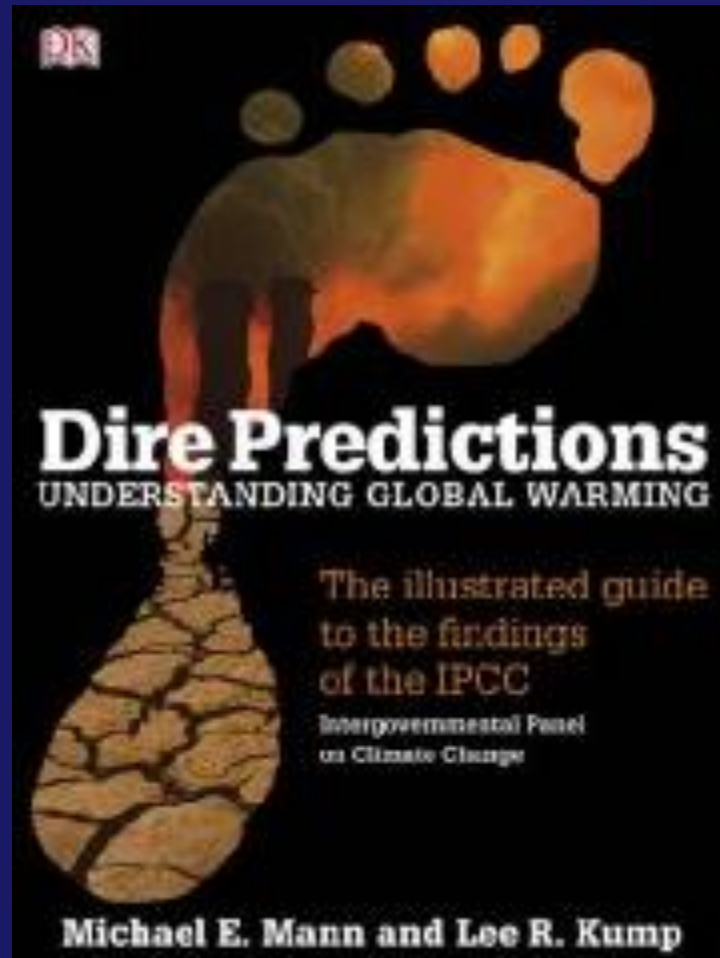
pp 89 in Class Notes

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



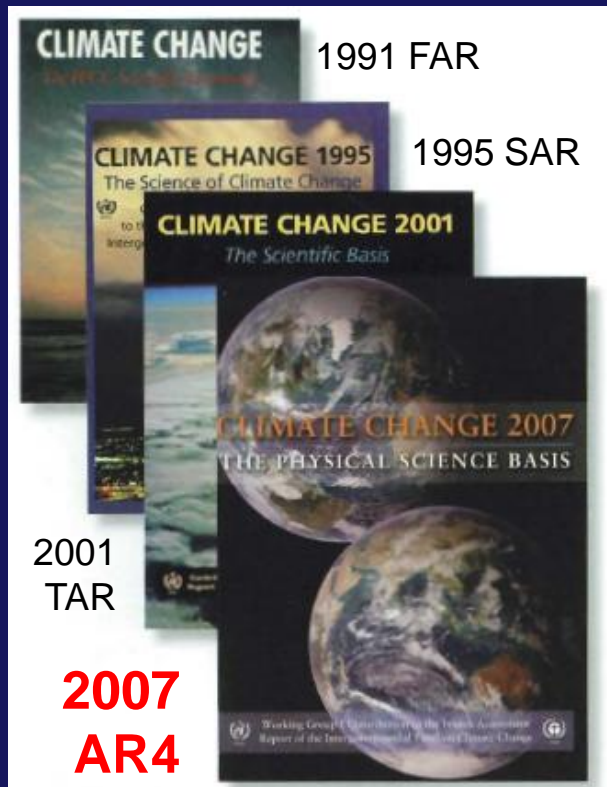
- Established by World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) in 1988 as an objective source of information for decision-makers, etc.

“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 4”
(AR4) in 2007
(now working on AR5)**

- 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.**

- 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

The **Fourth Assessment Report (AR4)** was released in 2007, and it consists of four volumes: the three IPCC Working Groups (WGs) Reports and a Synthesis Report (SYR)



© The Nobel Foundation

IPCC honoured with the
2007 Nobel Peace Prize

The AR4 Synthesis Report

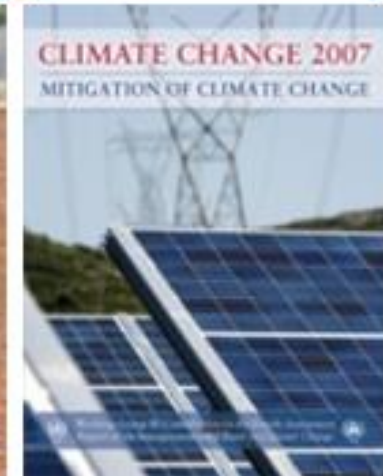
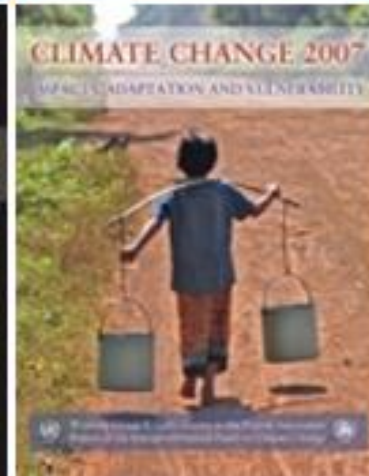
WG I
The Physical Science Basis

WG II
Impacts, Adaptation and Vulnerability

WG III
Mitigation of Climate Change

Climate Change 2007:
Synthesis Report

Summary for Policymakers



An Assessment of the Intergovernmental Panel on Climate Change

This summary approved in detail at IPCC Plenary XXVII (Bali, Indonesia, 12-17 November 2007), represents the formally agreed statement of the IPCC concerning key findings and uncertainties contained in the Working Group contributions to the Fourth Assessment Report.

Based on a draft prepared by:

Larry Birrell, Peter Bosch, Osvaldo Canziani, Zhenlin Chan, Renato Christ, Ogunlade Deck, William Hare, Saleemul Hameed, David Karoly, Vladimir Kattsov, Zbigniew Kundzewicz, Jian Li, Ulrike Lohmann, Martin Manabe, Toshi Matsuno, Bahareh Moravej, Bert Metz, Montuul Mirza, Neville Nicholls, Leonard Ntsoa, Rajendra Pachauri, Juan Palisot, Martin Parry, Dasha Qin, Nijavalli Ravindranath, Andy Reisinger, Jitwan Rian, Keywan Riahi, Cynthia Rosenzweig, Marika Rusticucci, Stephen Schneider, Yubei Sokona, Susan Solomon, Peter Stott, Howard Strubbe, Toshi Sugiyama, Rob Swart, Dennis Tignor, Colleen Vogel, Gary Yohe

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

... And **SPECIAL REPORTS:** BREAKING NEWS: just out last Friday, Nov 18!!

ipcc
INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

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

WORKING GROUPS I-II
Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)

ipcc
INTERGOVERNMENTAL PANEL ON climate change
WMO UNEP

Get Fact Sheet Overview Report Contributors Press & Events IPCC Process Background

Special Report

Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)

SREX OVERVIEW

PLAY

SUMMARY FOR POLICYMAKERS
PDF - 29 pages - 8MB

FULL SREX REPORT
Available February 2012

Read the [Press Release](#) and see [Generic Presentation](#)

- Worldwide Scientific Collaboration -

220 AUTHORS

62 COUNTRIES

18784 REVIEW COMMENTS

Website

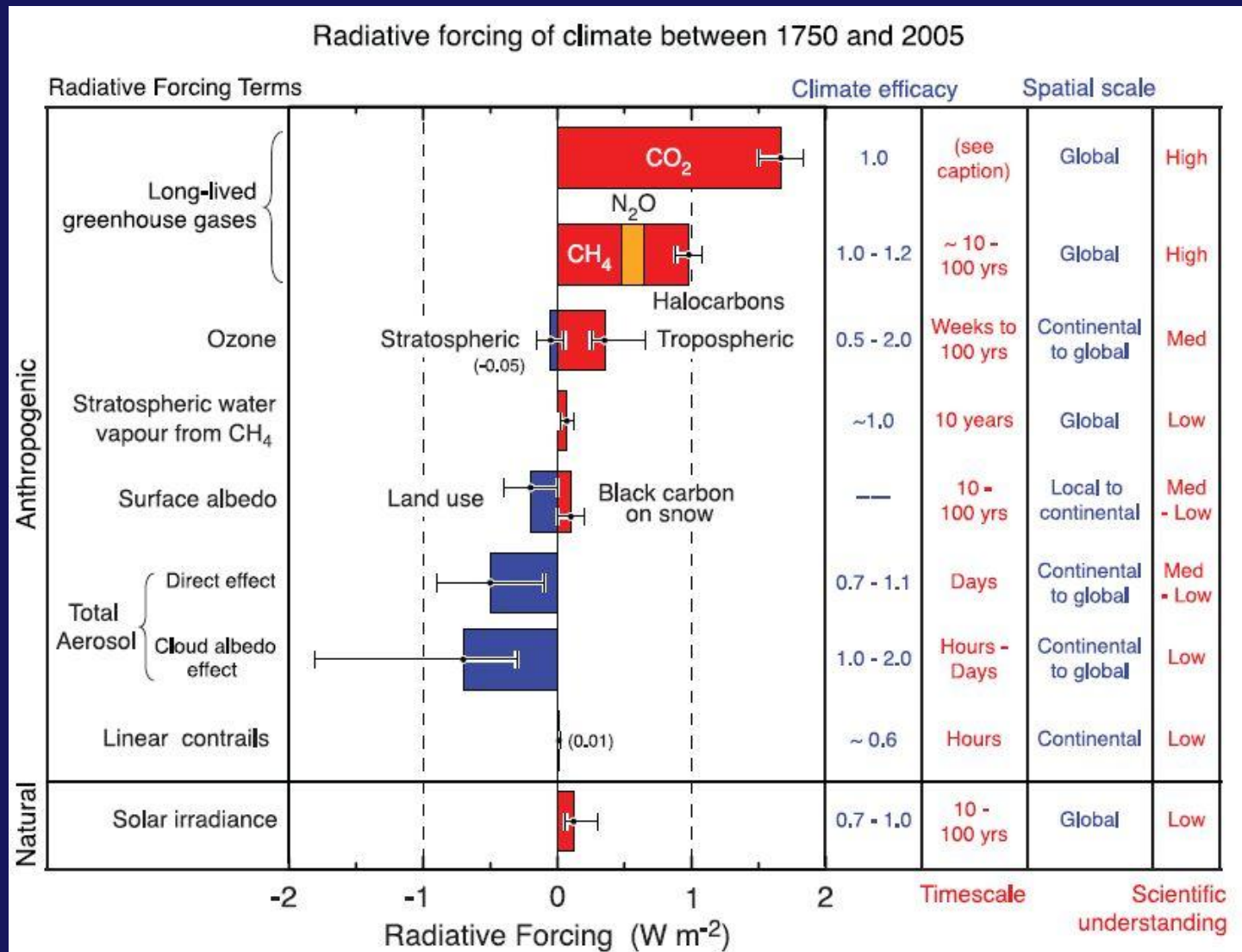
REPORT WEBSITE: <http://www.ipcc-wg2.gov/SREX/>

What was NEW in the most recent IPCC report:

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 :



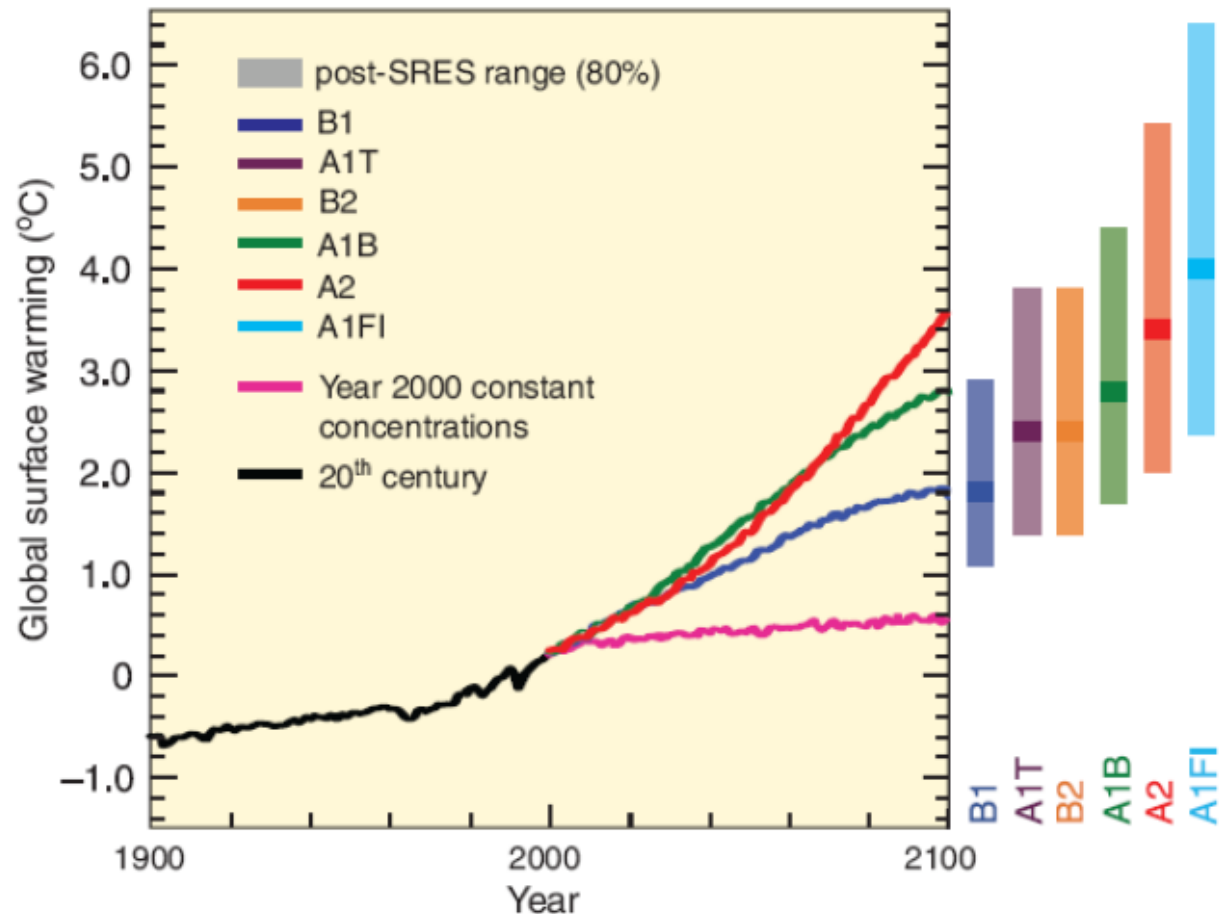
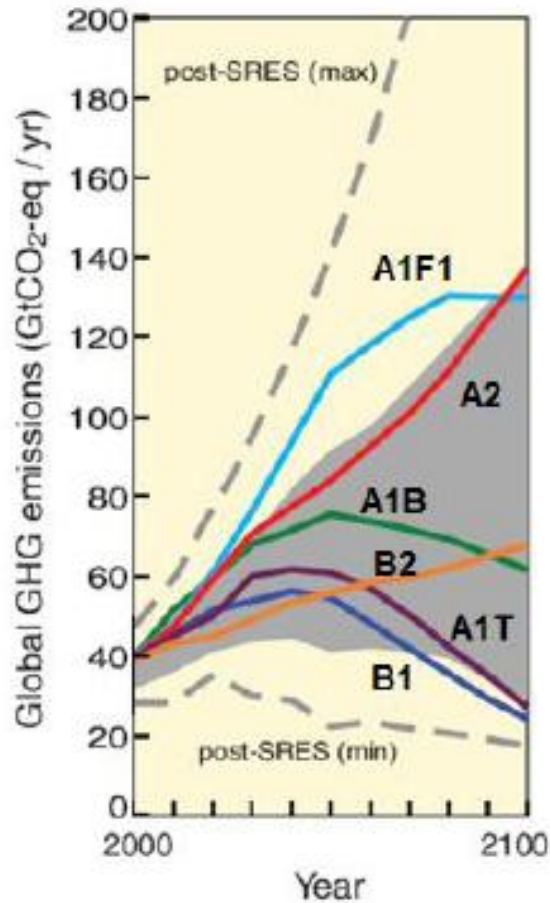
SOURCE: IPCC 2007 WG-1 Synthesis Report Summary for Policymakers

review

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

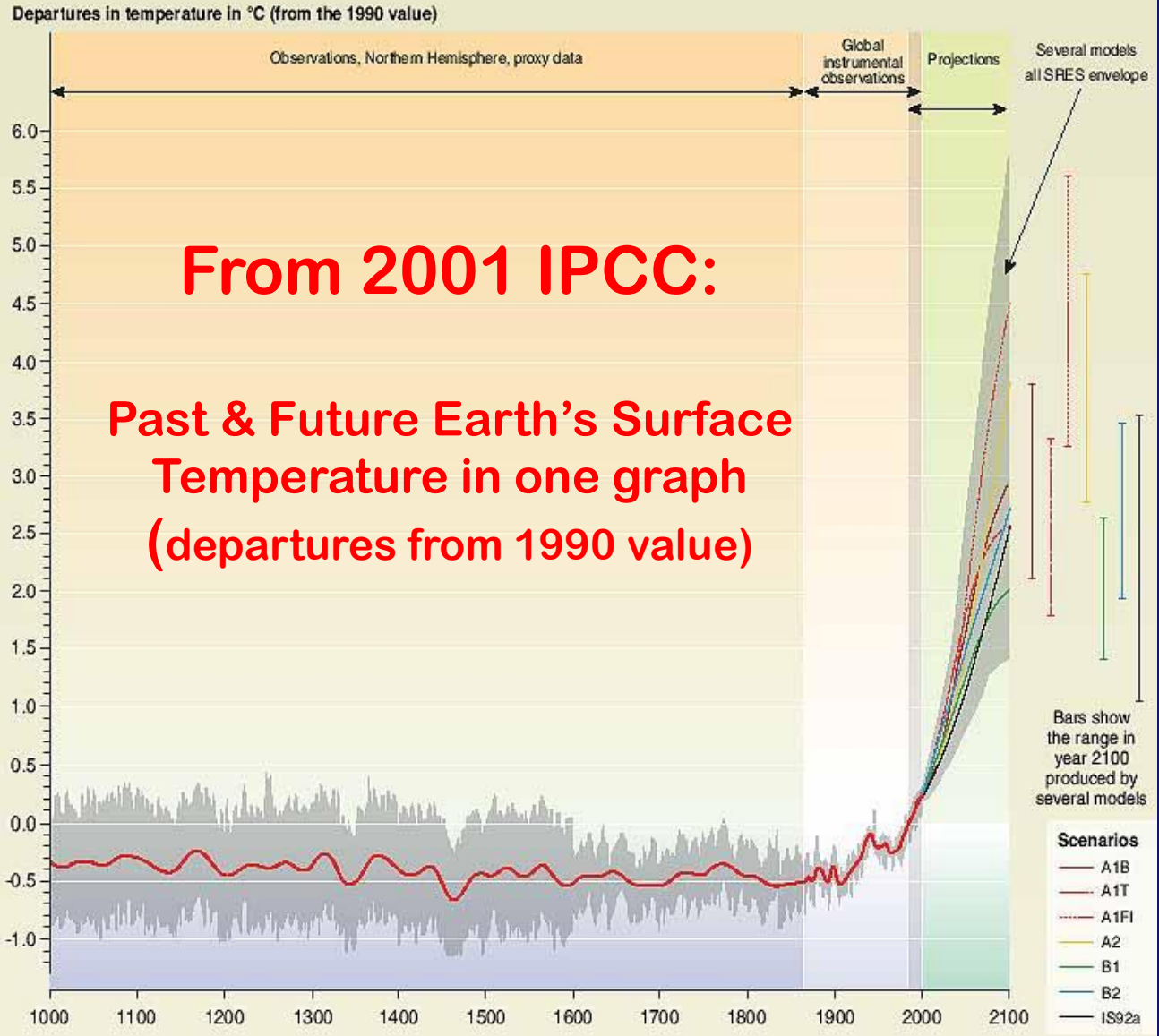
Projected Climate Change for Different Scenarios of GHG Emissions

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



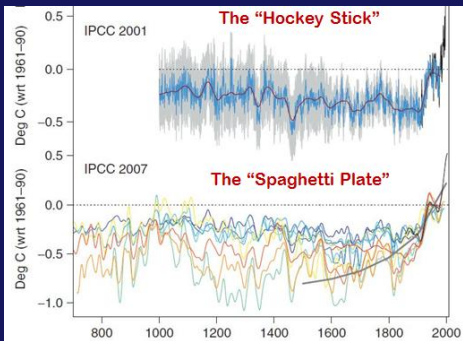
Improved
 “Hockey
 Stick”
 (from 2001 Third
 Assessment)
 → Spaghetti
 Plate

Variations of the Earth's surface temperature: years 1000 to 2100



From 2001 IPCC:

**Past & Future Earth's Surface
 Temperature in one graph
 (departures from 1990 value)**



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

From Self test 8

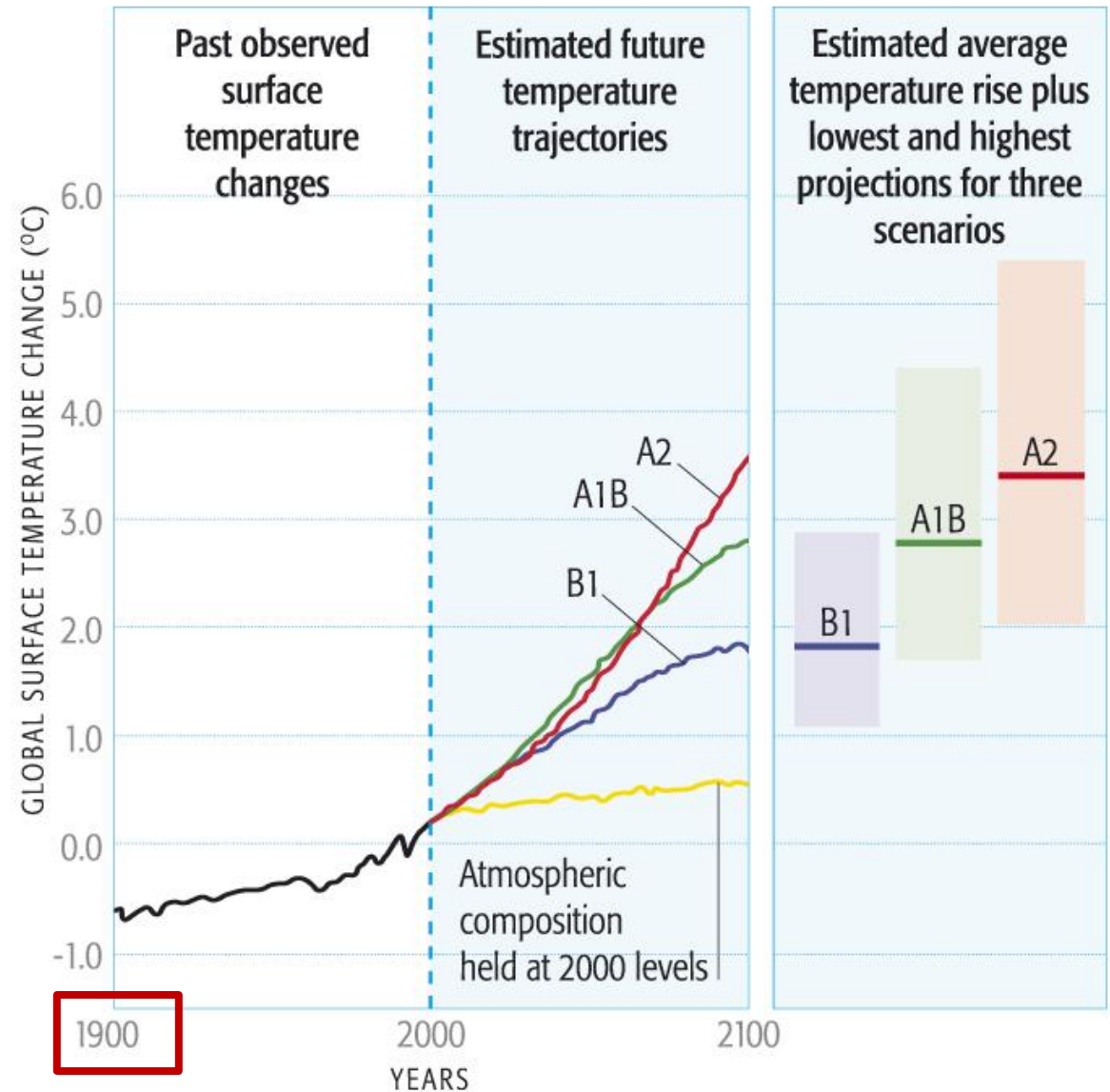
Updated version in AR4:

2007 IPCC FOURTH ASSESSMENT REPORT

**GLOBAL
SURFACE
TEMPERATURE
CHANGE
(° C)**

**Compared to
1980-1999
period**

POSSIBLE PATHS OF FUTURE GLOBAL WARMING

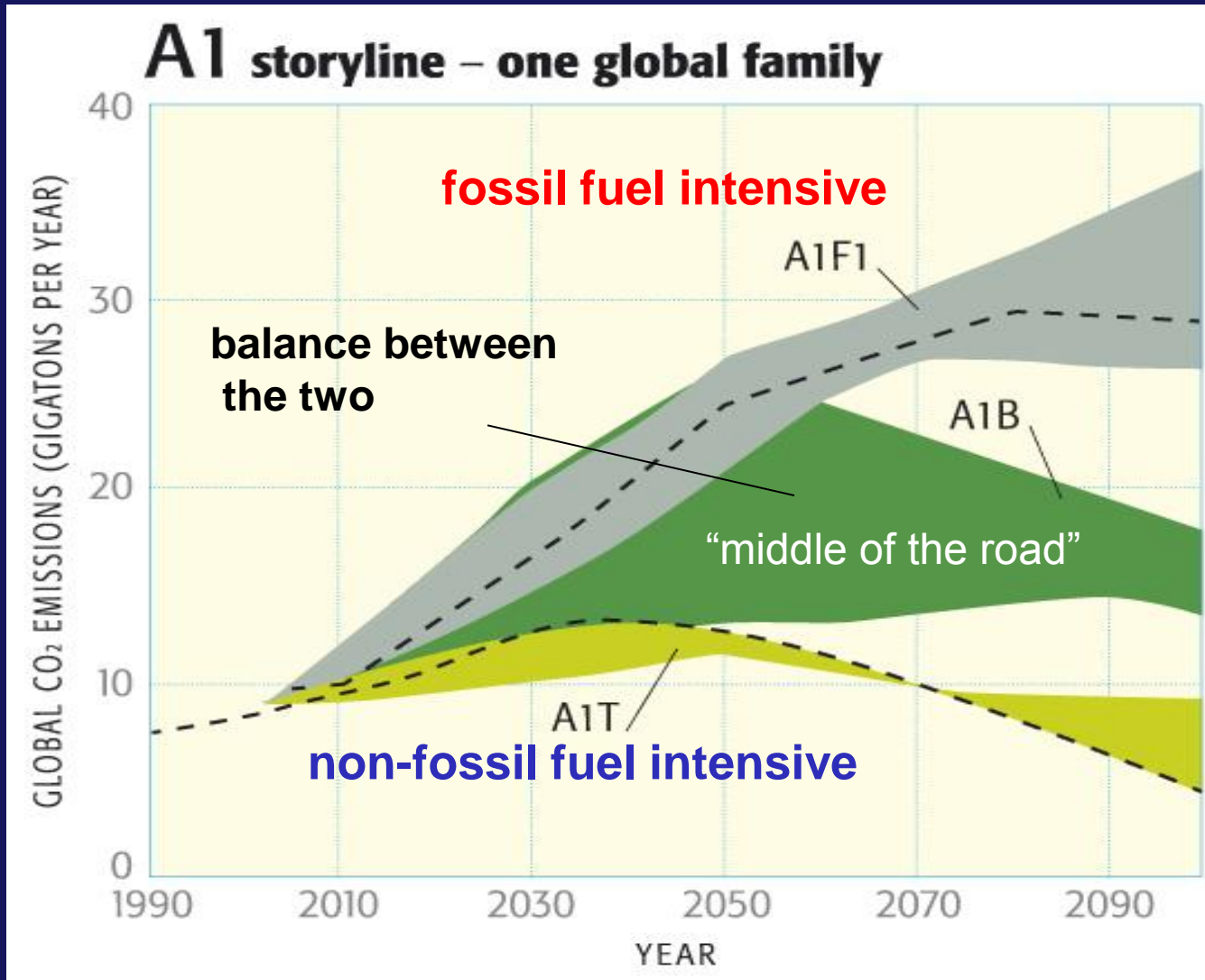


Starts in 1900

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From *Dire Predictions* (p 20)

Possible CO₂ emissions scenarios, or “storylines”



A1 STORY:
Assume these things happen . . .

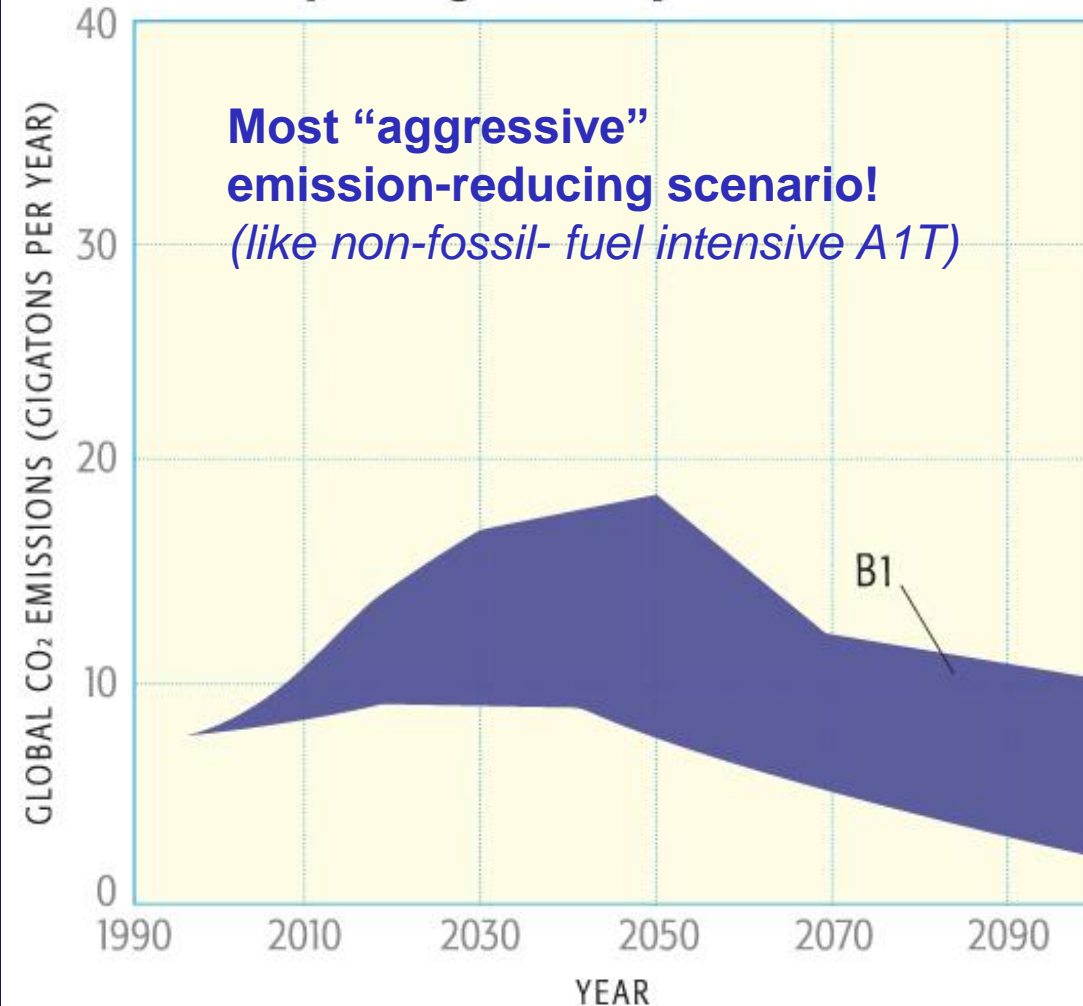
- Regional income differences reduced
- Rapid economic growth
- Peak population in mid 21st century, then declining
- Rapid intro of new more efficient technology

B1 STORY:
Assume these things happen . . .

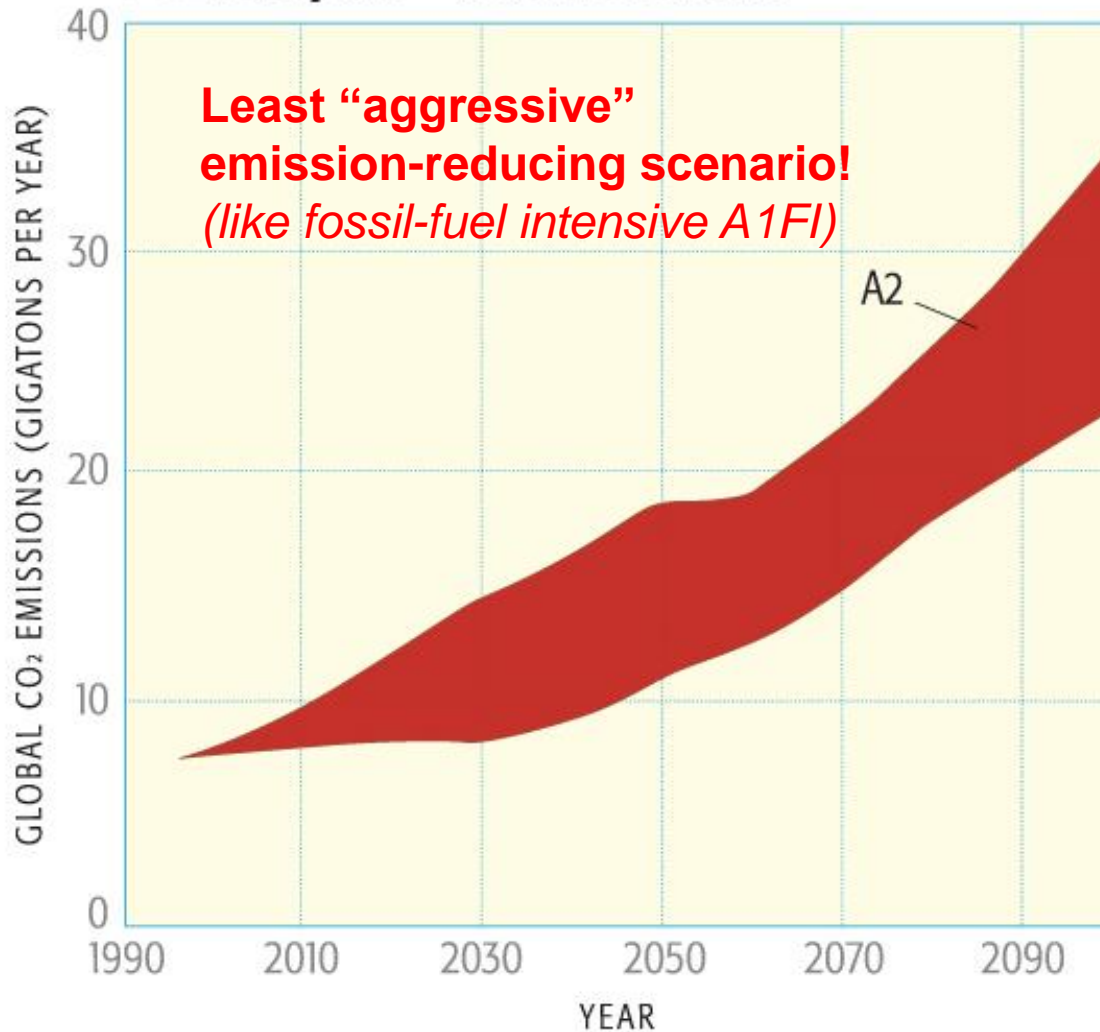
- Emphasis on GLOBAL solutions to sustainability & environmental protection
- Rapid change to information & service economy
- Peak population in mid-21st century, then declining
- Less intense demand for materials
- Intro of clean and efficient energy technologies

B1 storyline – global utopia

**Most “aggressive”
emission-reducing scenario!**
(like non-fossil-fuel intensive A1T)



A2 storyline – a divided world

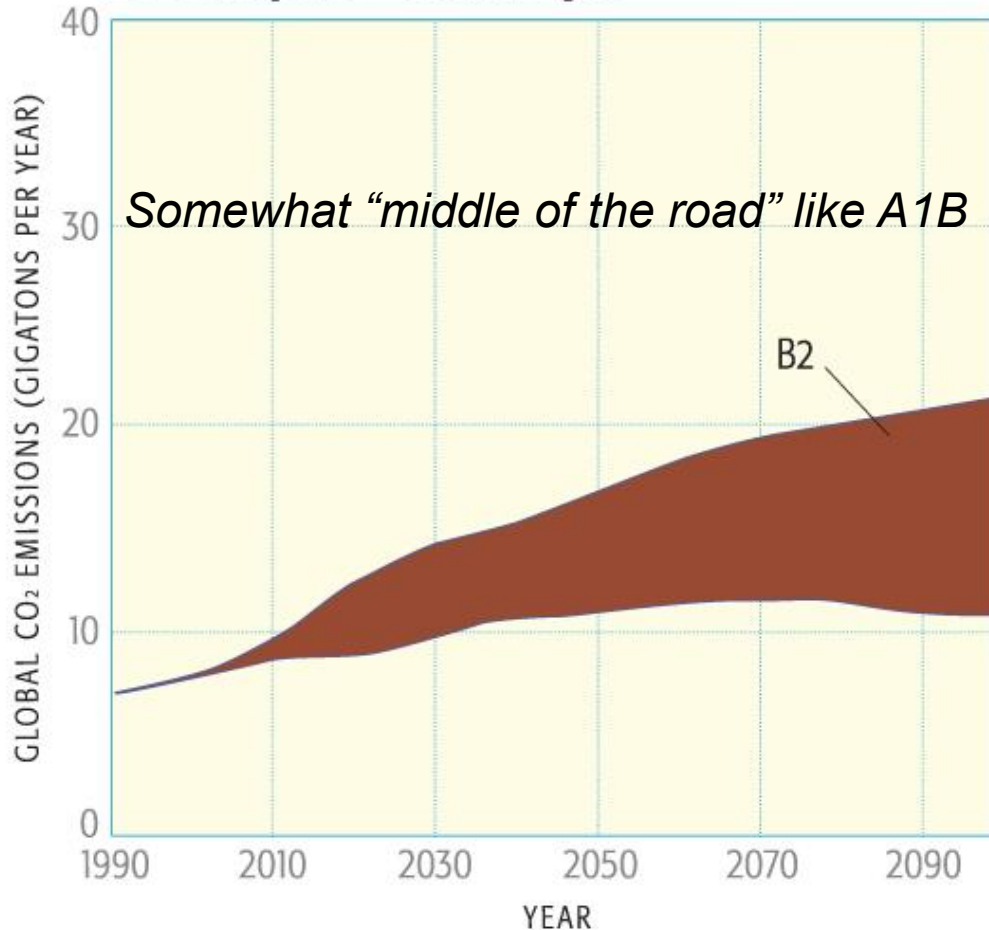


A2 STORY: *Assume these things happen . . .*

- Emphasis on national identities and local/regional (not global) solutions to environmental protection and social equity
- Slow economic growth
- Continuously increasing world population
- Slow technological advancement

POSSIBLE CO₂ EMISSIONS SENARIOS FOR THE FUTURE

B2 storyline – local utopia



B2 STORY: **Assume these things** **happen . . .**

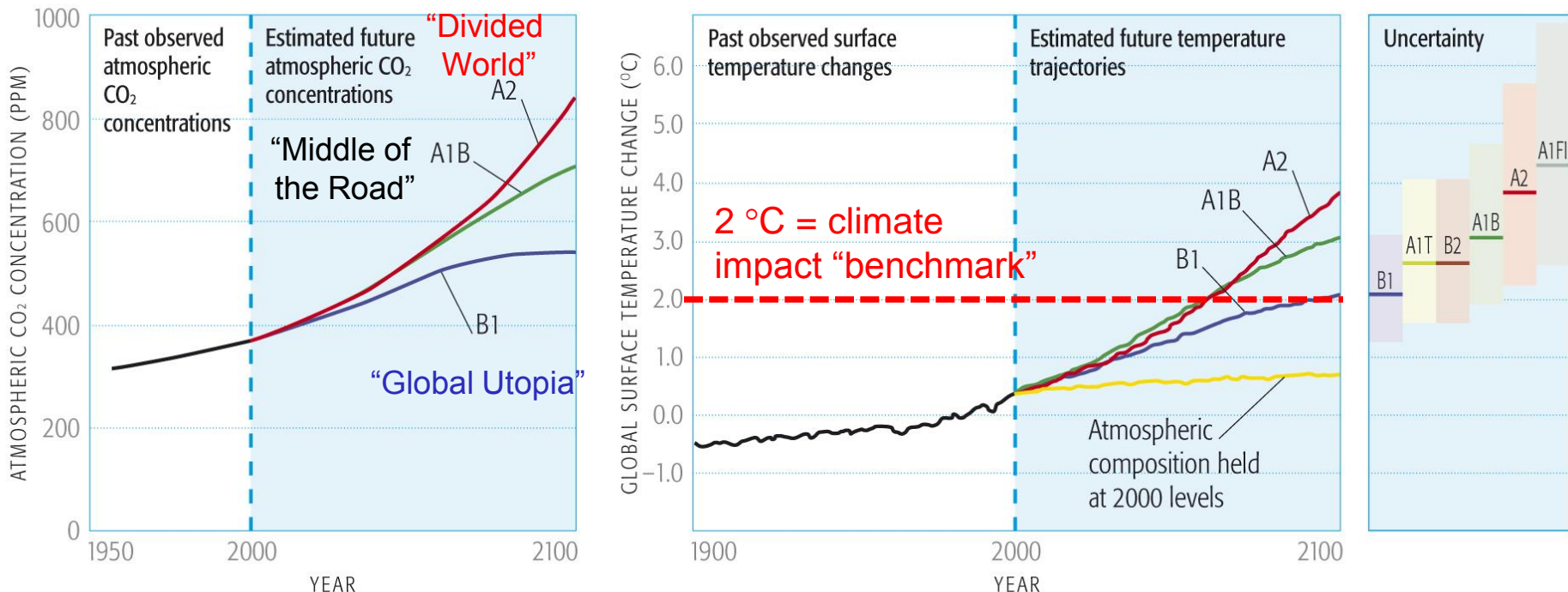
- Emphasis on local and regional (not global) solutions to environmental protection & social equity
- Intermediate economic development
- Continuously increasing world population (but slower than A2)
- Slower development of new energy technologies than B1 and A1

RANGE OF POSSIBLE TRAJECTORIES FOR FUTURE CLIMATE CHANGE

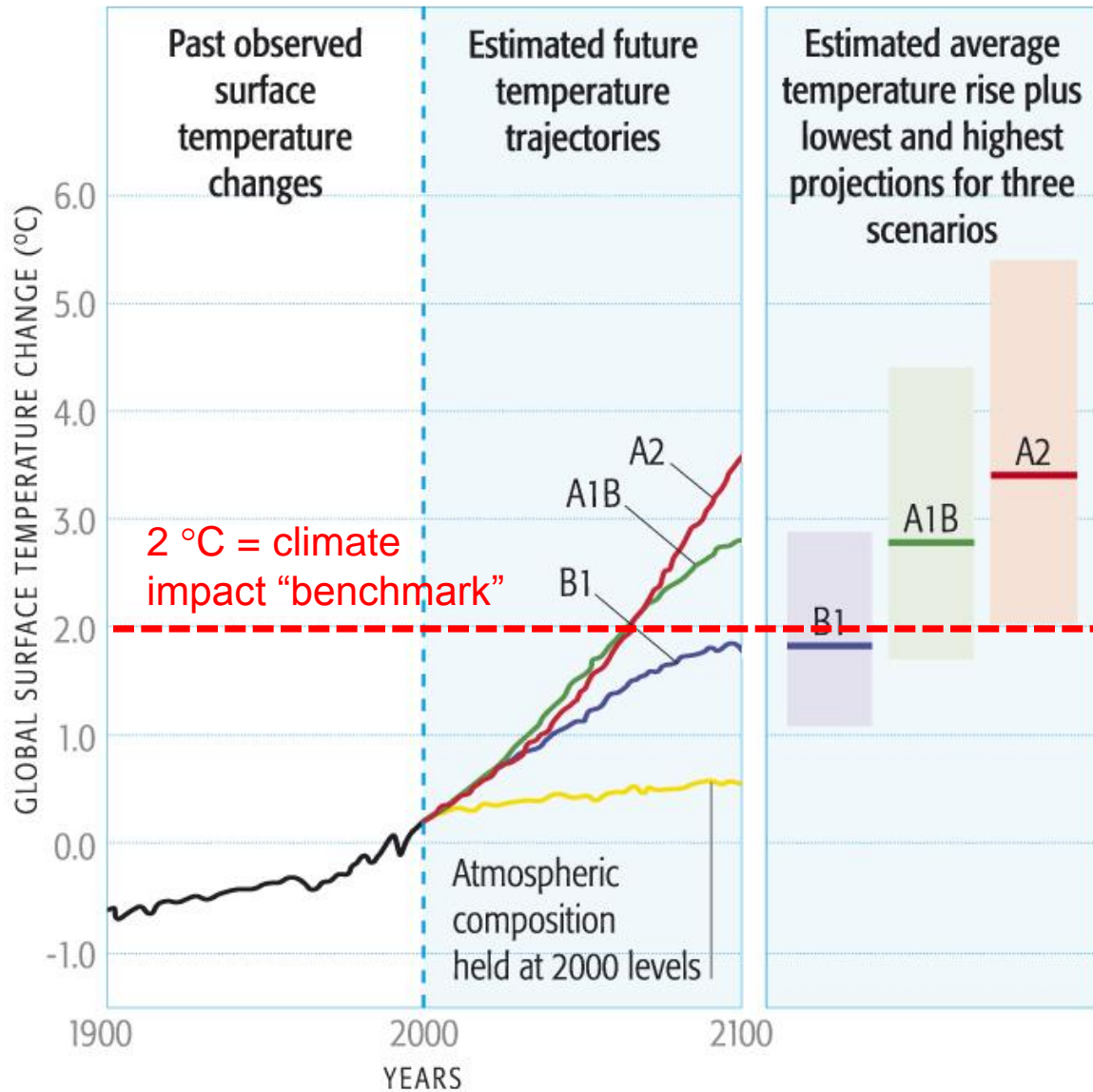
Spread of results due to:

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

ESTIMATED CO₂ AND TEMPERATURE TRAJECTORIES FOR VARIOUS EMISSIONS SCENARIOS



POSSIBLE PATHS OF FUTURE GLOBAL WARMING



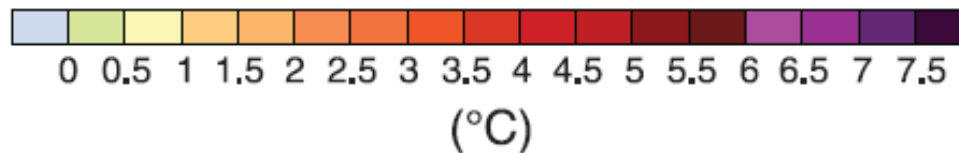
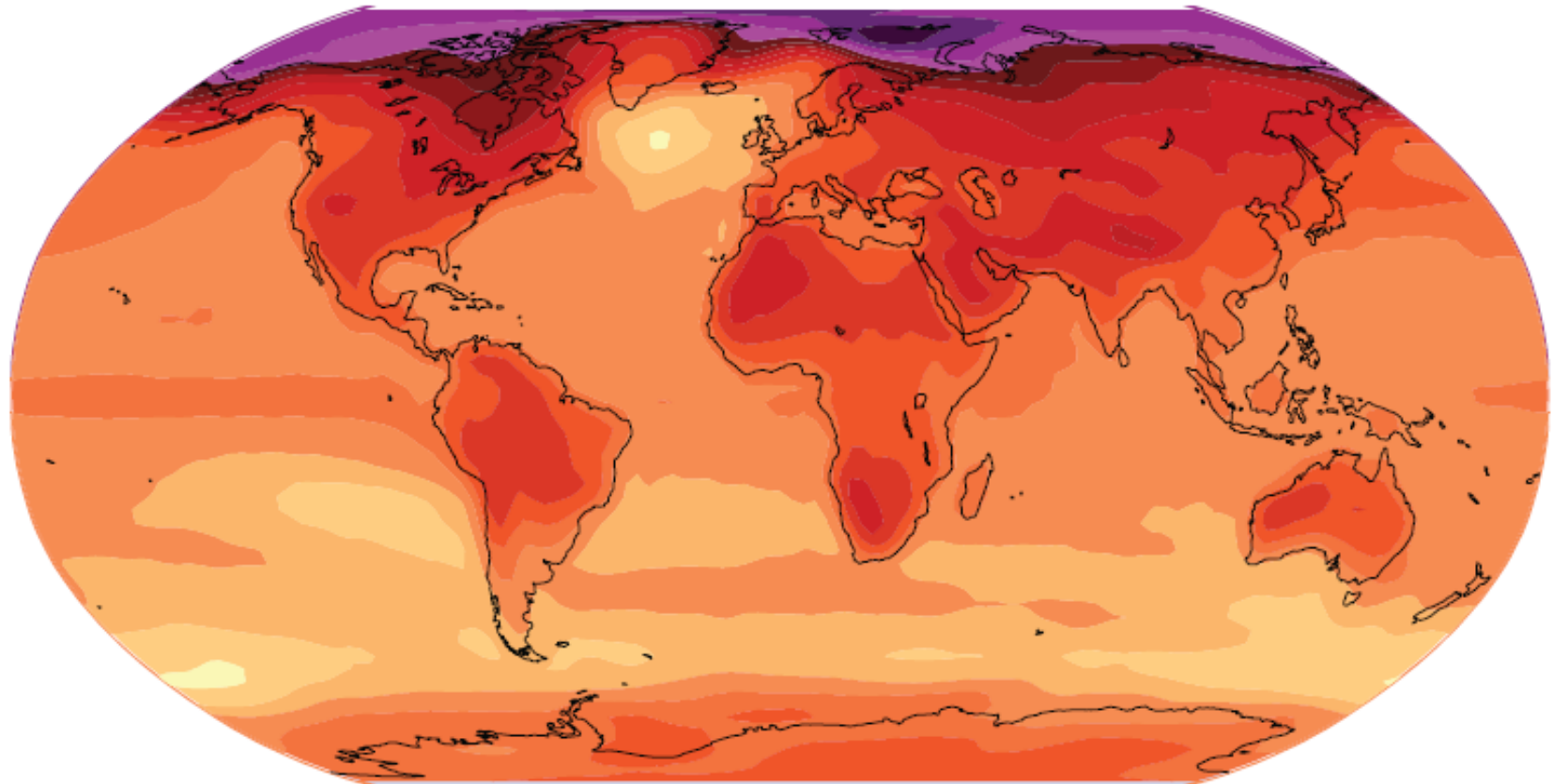
© 2009 Pearson Education, Inc.

GLOBAL
SURFACE
TEMPERA-
TURE
CHANGE
(° C)

From *Dire Predictions* (p 20)

Projected Warming by Late 21st Century (2090-2099) based on the A1B “Middle of the Road” Scenario

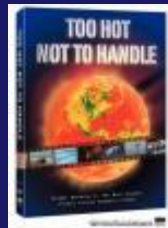
Geographical pattern of surface warming



We also watched another segment of:

TOO HOT NOT TO HANDLE

On Transportation Solutions
(hybrid cars, ethanol & biodiesel)



GETTING READY FOR OUR LAST CLASS:

**I-4 Global Warming Debate Preparation
(last assignment)**

THE QUESTION:

**Should the United States
take aggressive and
immediate action to slow
global warming?**

**(e.g. sign the International
Climate Treaty, reduce or tax
GHG emissions, etc. etc.)**

SEE YOU ON
WEDNESDAY
FOR GLOBAL CHANGE
FILM FESTIVAL FUN!

If you will be gone . . .
See Class Follow Up to
find out how to watch the
same short films!