

A Call to Action: Understanding Climate Risk

Mario Molina

University of California, San Diego

Mario Molina Center for Strategic Studies in
Energy and the Environment

Member, El Colegio Nacional

The Economic and Financial Risks of a Changing Climate



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WHAT WE KNOW:

THE REALITY, RISKS AND RESPONSE TO CLIMATE CHANGE



The AAAS Climate Science Panel



The AAAS Climate Science Panel

Mario Molina (Chair)

University of California, San Diego and Scripps Institution of Oceanography

James McCarthy (Co-chair)

Harvard University

Diana Wall (Co-chair)

Colorado State University

Richard Alley

Pennsylvania State University

Kim Cobb

Georgia Institute of Technology

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Stanford University

Kerry Emanuel

Massachusetts Institute of Technology

Howard Frumkin

University of Washington

Katharine Hayhoe

Texas Tech University

Camille Parmesan

University of Texas, Austin and University of Plymouth, UK

Marshall Shepherd

University of Georgia

WHAT WE KNOW

THE REALITY, RISKS AND RESPONSE TO CLIMATE CHANGE

- Based on well-established evidence, about **97% of climate scientists** have concluded that human-caused climate change is happening here and now.
- We are **at risk** of pushing our climate system toward **abrupt, unpredictable, and potentially irreversible changes** with highly damaging impacts.
- The **sooner we act, the lower the risk and cost**. And there is much we can do.

Scientific Evidence

Are scientists convinced?

- There's a consensus of scientists because there's a consensus of evidence.
- Not only is there a vast difference in the number of convinced vs. unconvinced scientists there is also a considerable gap in expertise between the two groups.

YES
97%

Of climate scientist think climate change is significantly due to human activity

NO
3%

Of climate scientist do not think climate change is significantly due to human activity



Sources: Anderegg et al, **Expert credibility in climate change**, *PNAS*, 107(27), 2010
Doran PT and Zimmerman MK, **Examining the scientific consensus on climate change**, *Eos Trans AGU*, 90:22–23, 2009. <http://thinkprogress.org/romm/issue/>

Media Coverage

Does reporting reflect the consensus?

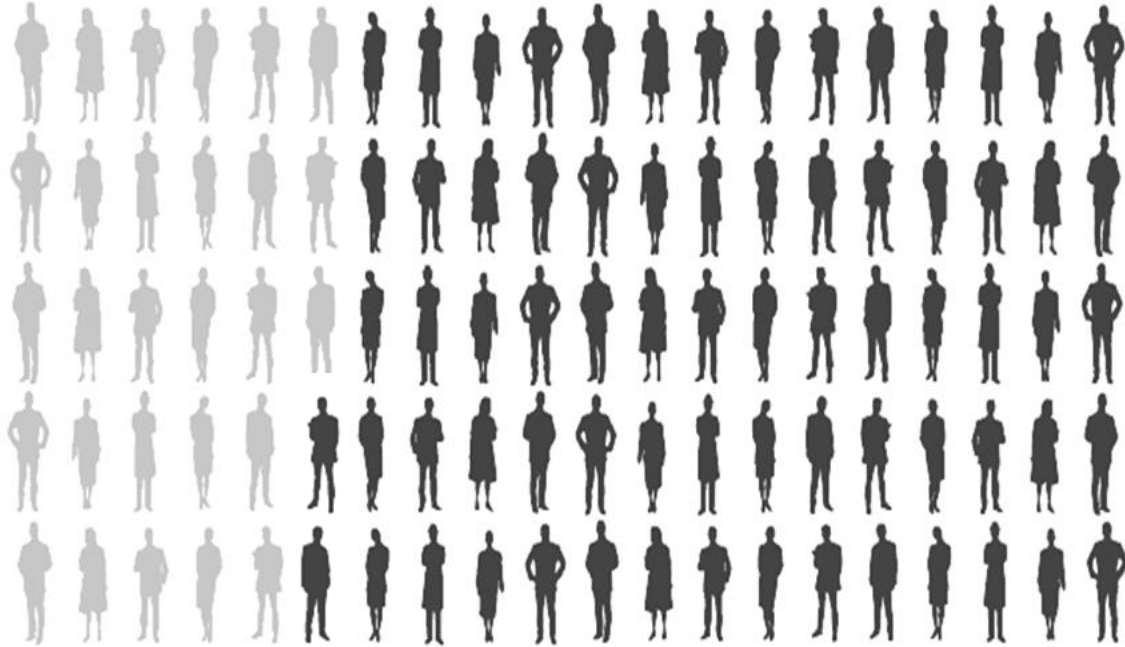
- Media coverage misrepresents scientific understanding of man-made climate change.
- Because of the institutionalized journalistic norm of balanced reporting, US television news coverage has perpetrated an informational bias by significantly diverging from the consensus view in climate science that humans contribute to climate change.

YES
28%

Of news coverage depicts human contribution to warming as significant

NO
72%

Of news coverage includes a skeptic view point or denies man-made warming



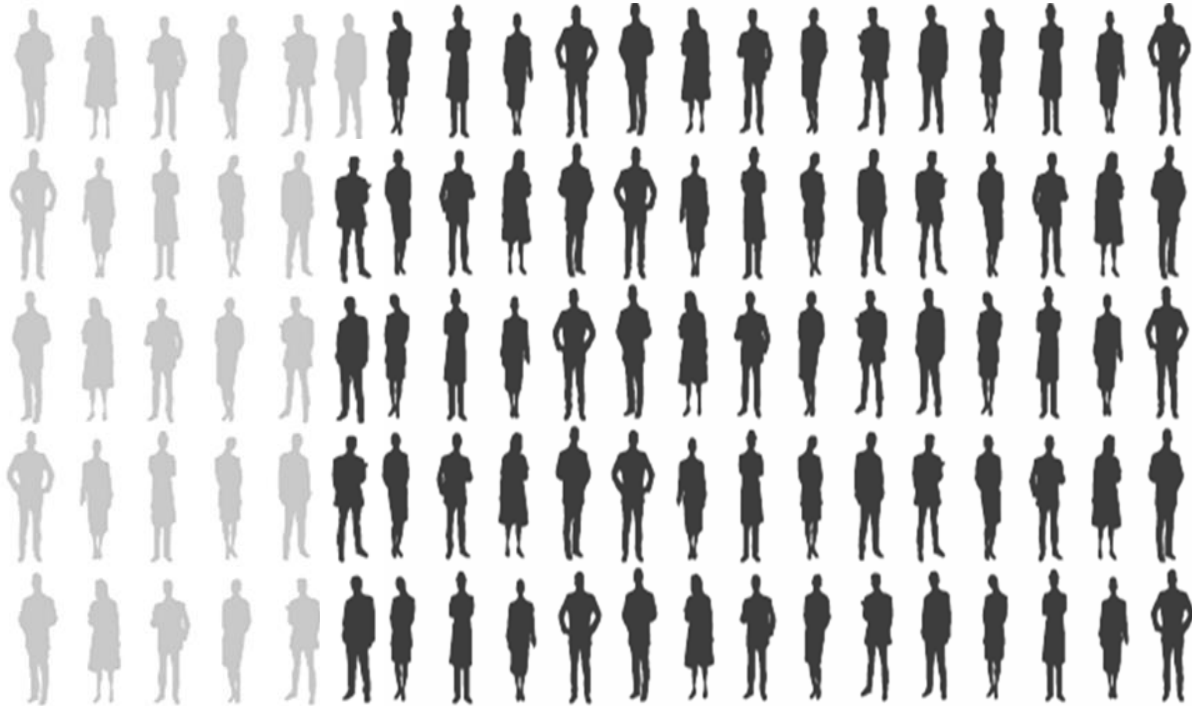
Public Perception

Is the public convinced?

- Media coverage of climate change is not “balanced” and is affecting public opinion throughout the world

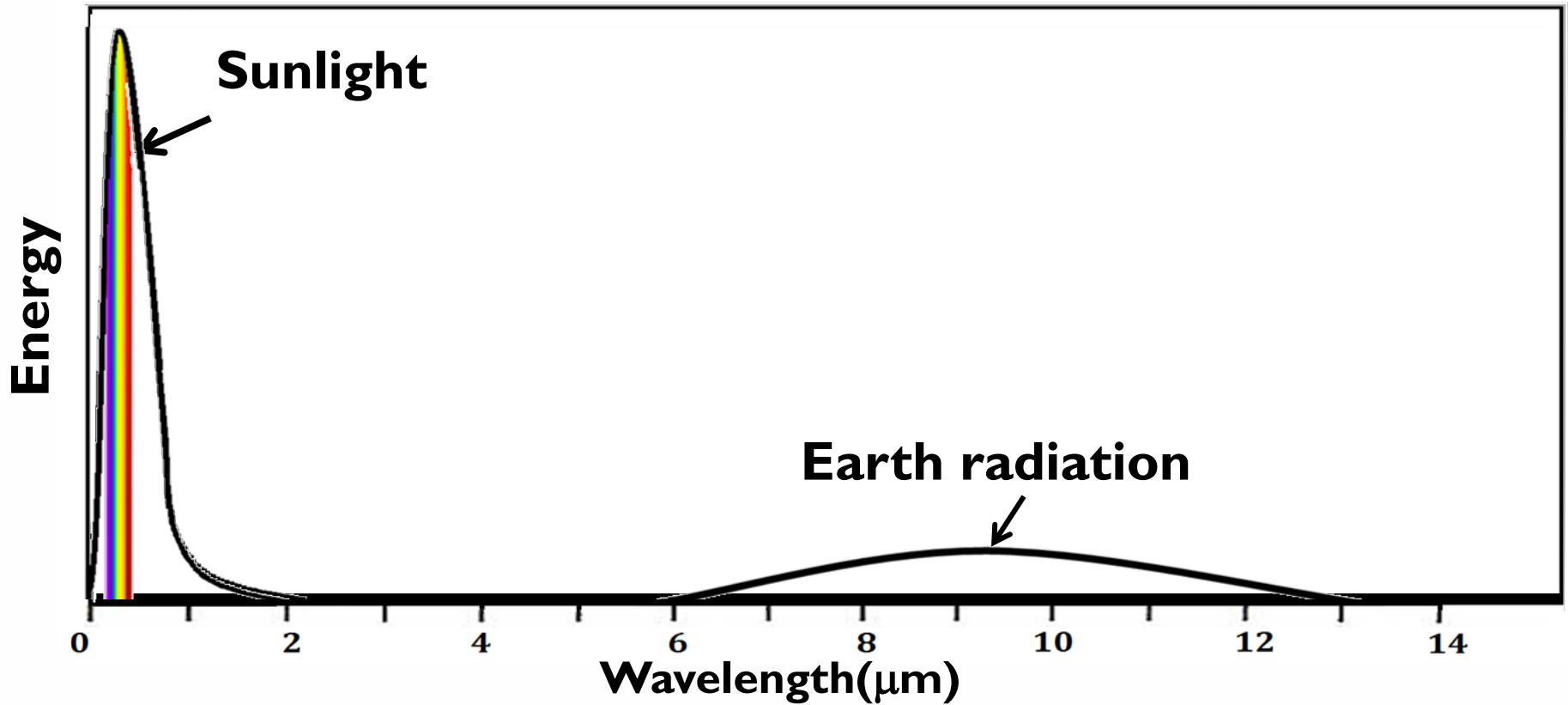
YES
26% Of people believe climate change is happening and humans are causing it

NO
74% Of people are not convinced or deny humans are causing climate change





Earth's Energy Balance



$$\text{Energy density} = \frac{2\pi h \nu^3/c^2}{e^{h\nu/kT} - 1}$$

Planck's distribution law

$$E = h \nu$$

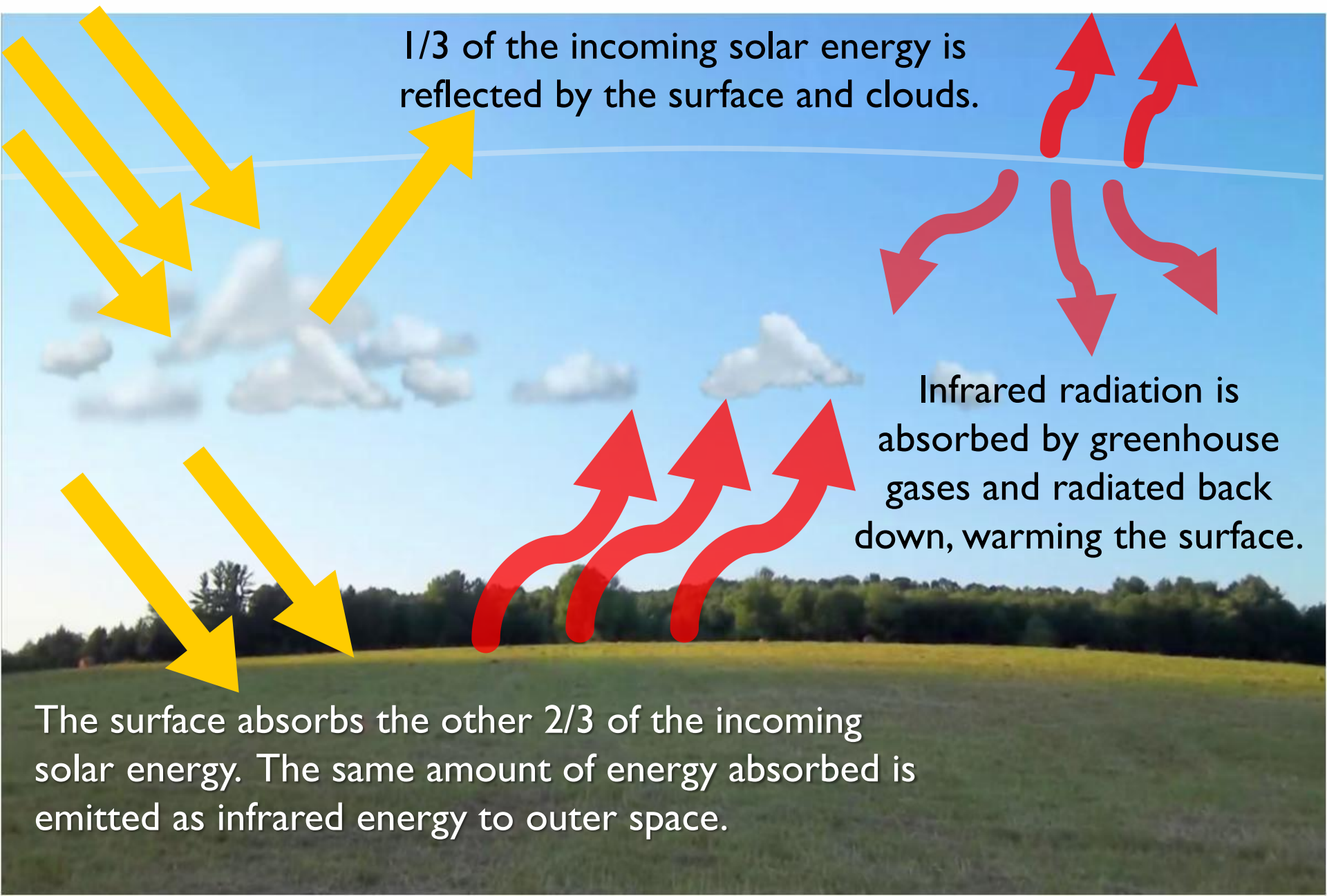
Einstein's Photoelectric effect

Earth's Greenhouse Effect

1/3 of the incoming solar energy is reflected by the surface and clouds.

Infrared radiation is absorbed by greenhouse gases and radiated back down, warming the surface.

The surface absorbs the other 2/3 of the incoming solar energy. The same amount of energy absorbed is emitted as infrared energy to outer space.

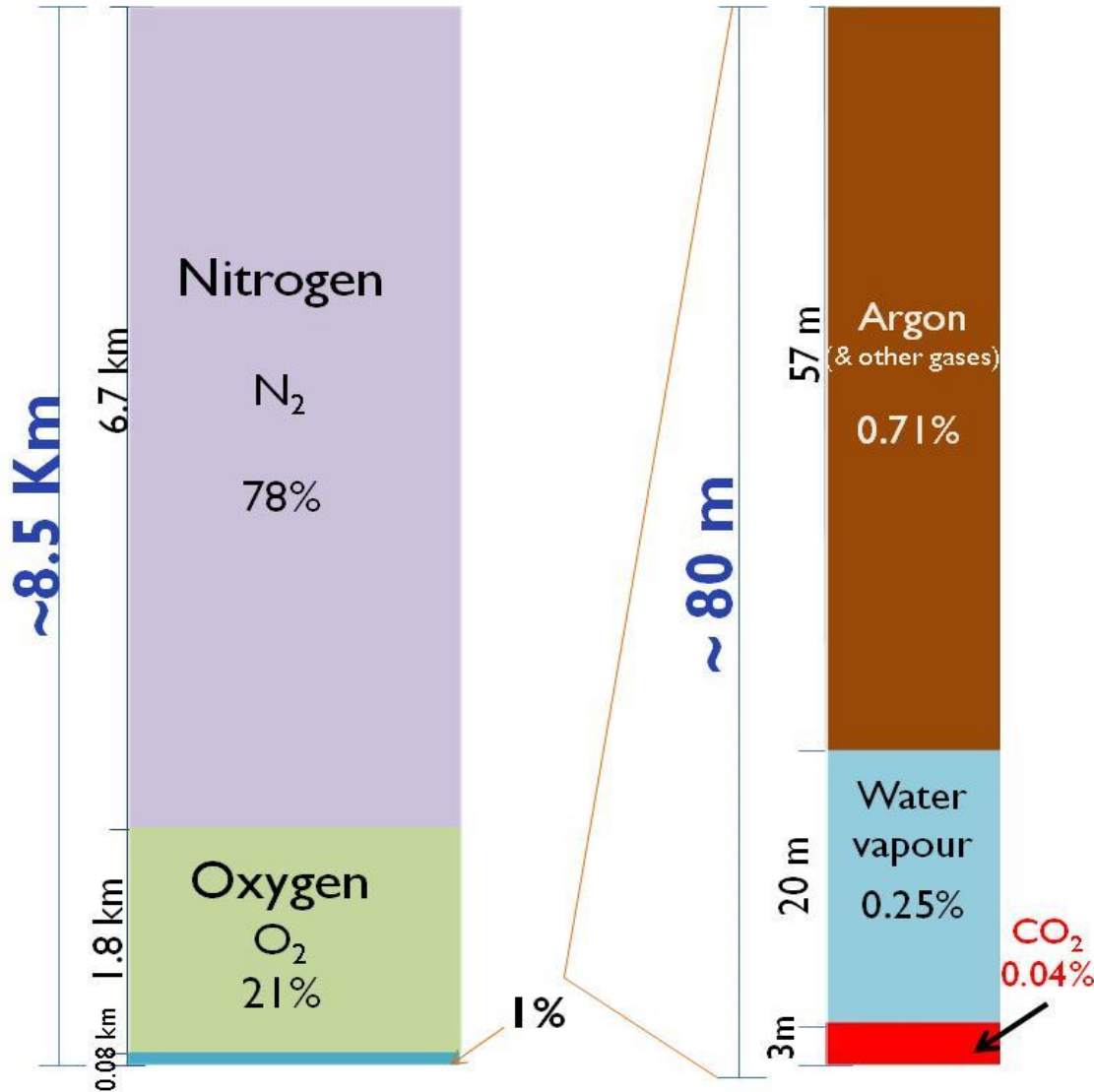


Composition of the Earth's Atmosphere

Earth's atmosphere

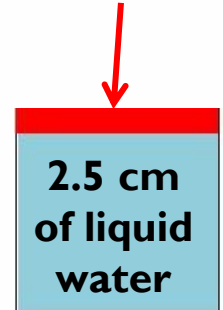
1% of the atmosphere

(Height of Mount Everest) (Height of 23-floor building)

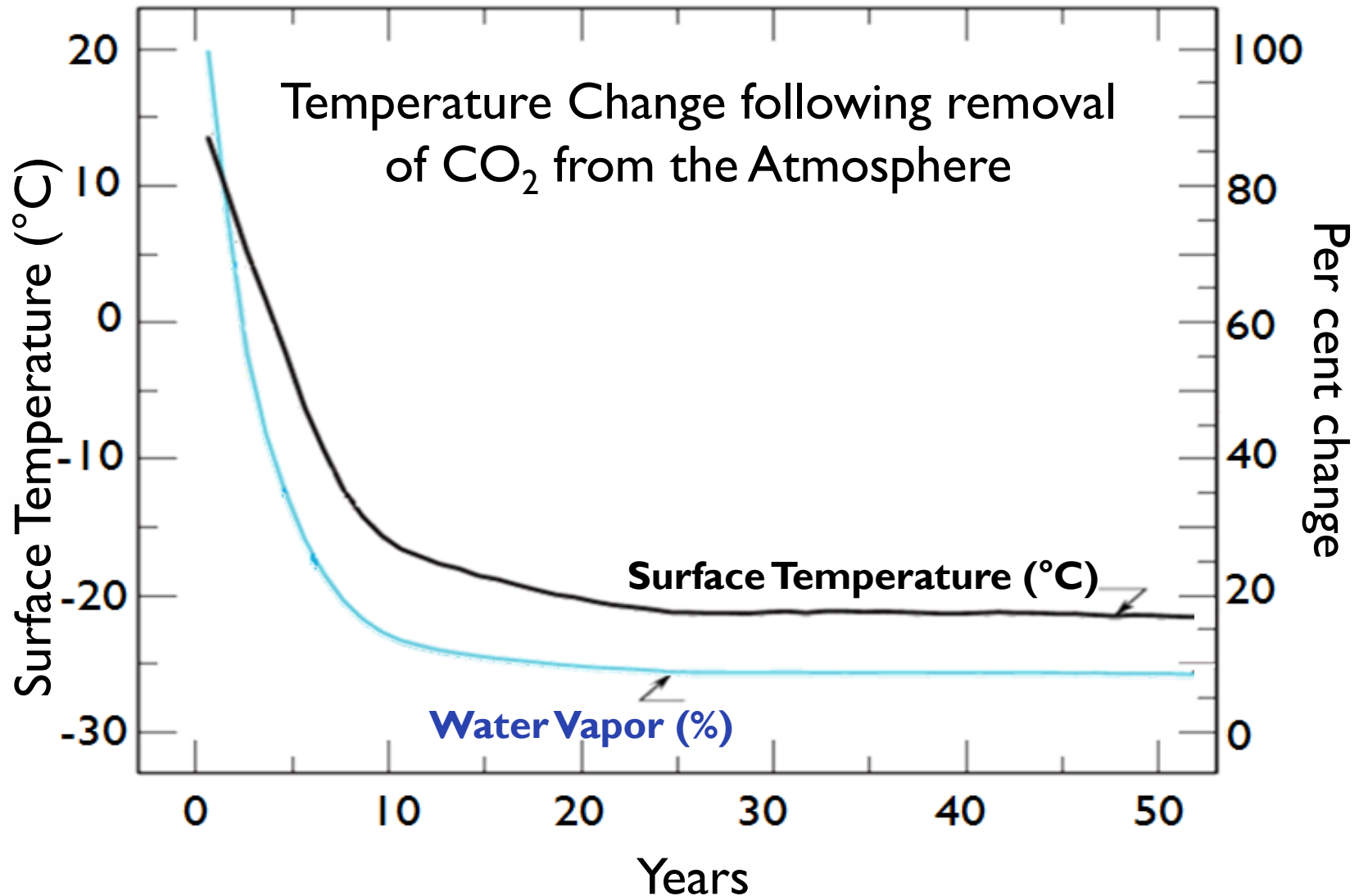


Climate control

~4 mm of solid CO₂ (dry ice)

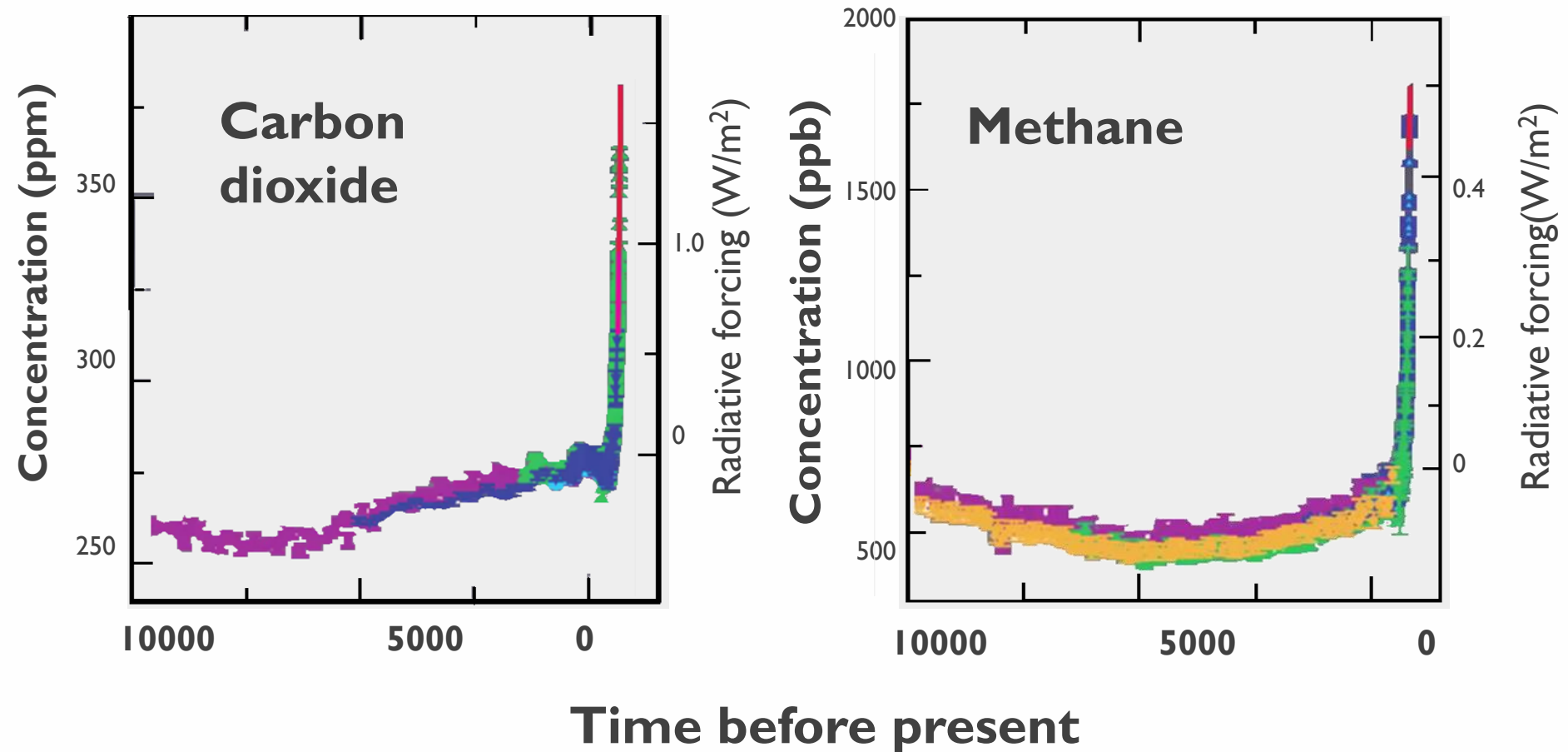


CO₂: Earth's Climate Thermostat



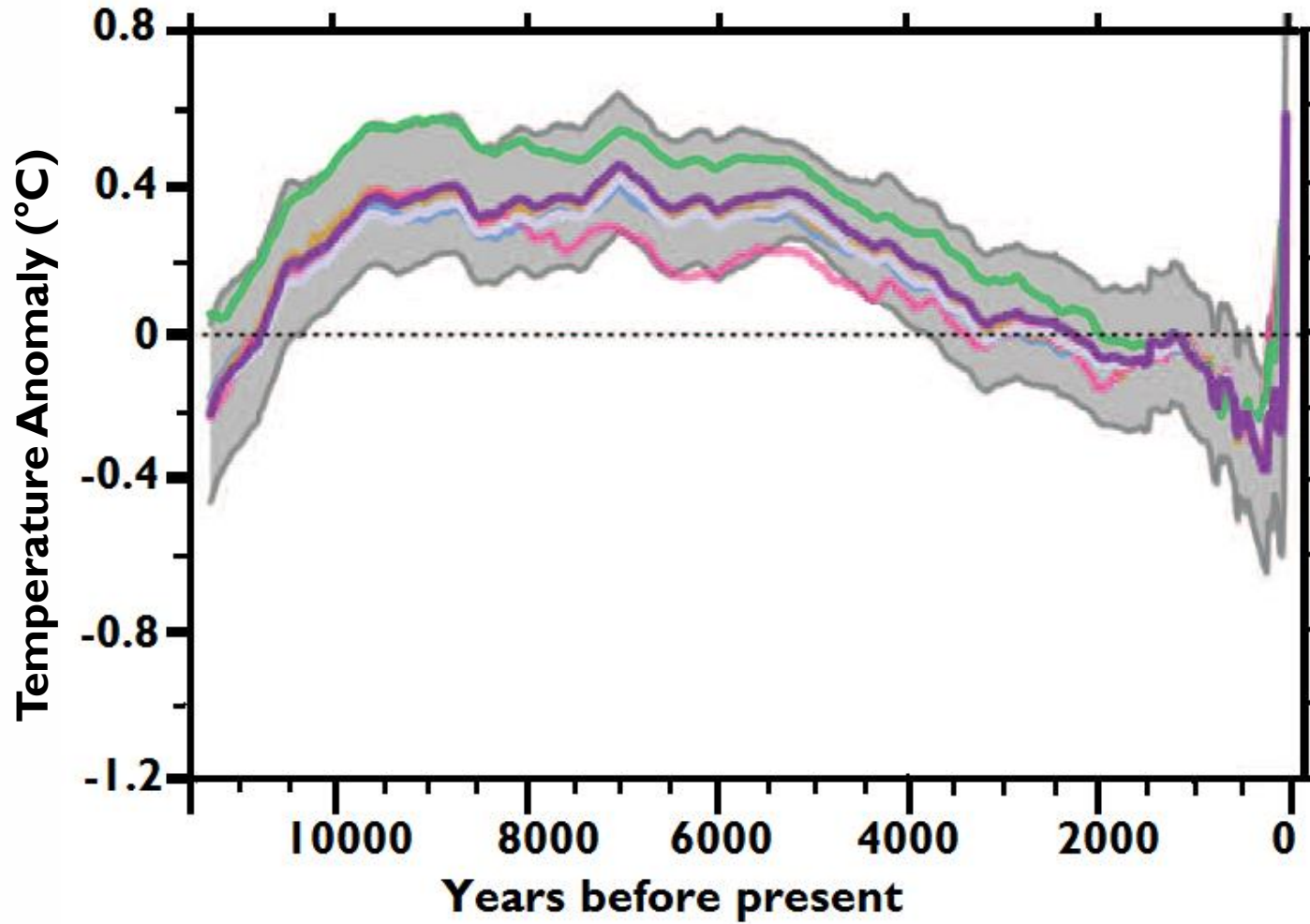
Source: Lacis et al, *Atmospheric CO₂: Principal control knob governing Earth's temperature*, *Science*, **330**, 2010.

Atmospheric Concentrations: CO₂ and CH₄ for the past 10,000 years



Source: WGI - AR4, IPCC 2007

Global Mean Surface Temperature in the last 11,000 years



Source: Marcott, S. et al., A Reconstruction of Regional and Global Temperature for the Past 11,300 Years. *Science* 339, 1198 (2013)

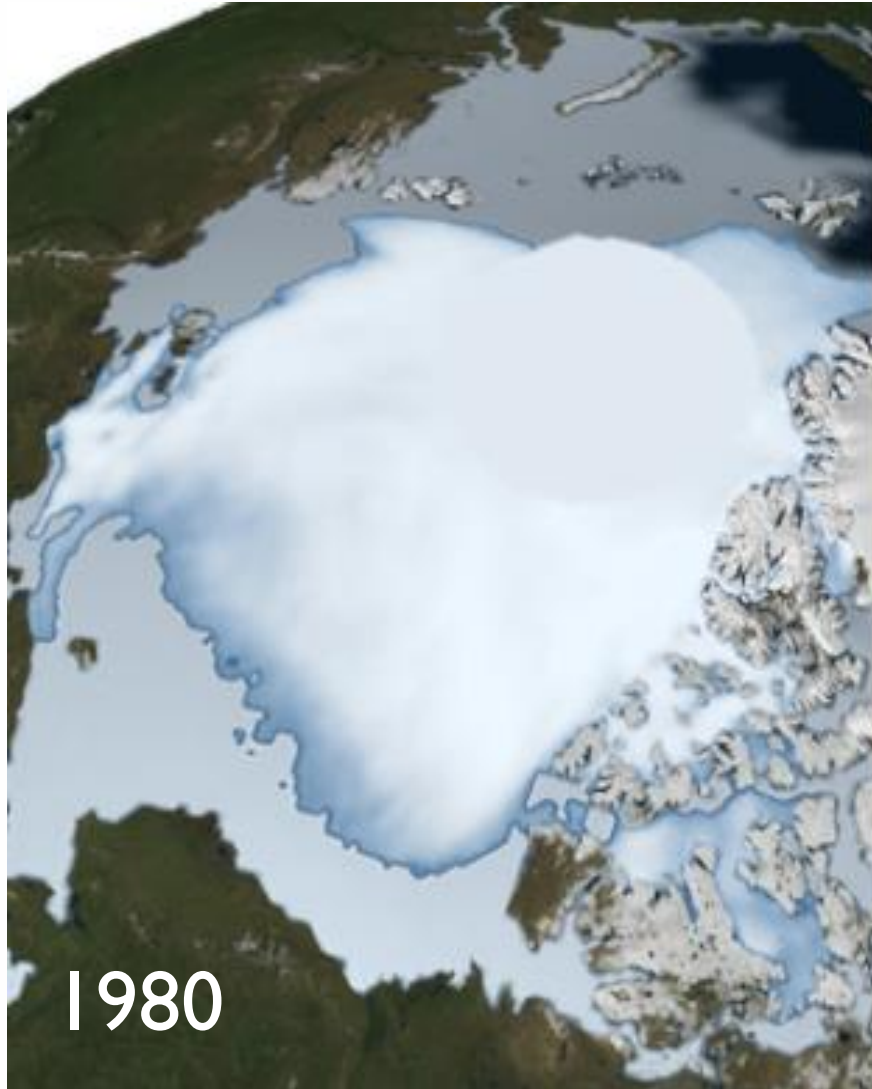


Intergovernmental Panel on Climate Change

- **Established by the UN and World Meteorological Organization in 1988**
- **Role of the IPCC: to assess the scientific, technical, and socio-economic information relevant for the understanding of the risks of human-induced climate change**
- **Assessments based on published and peer-reviewed literature**



Arctic Sea Ice



Floods

Bangladesh -2012

139 fatalities

More than 5 million affected

360,000 houses damaged

50,778 people evacuated to 246 shelters

North India –June 2013

More than 1,000 fatalities

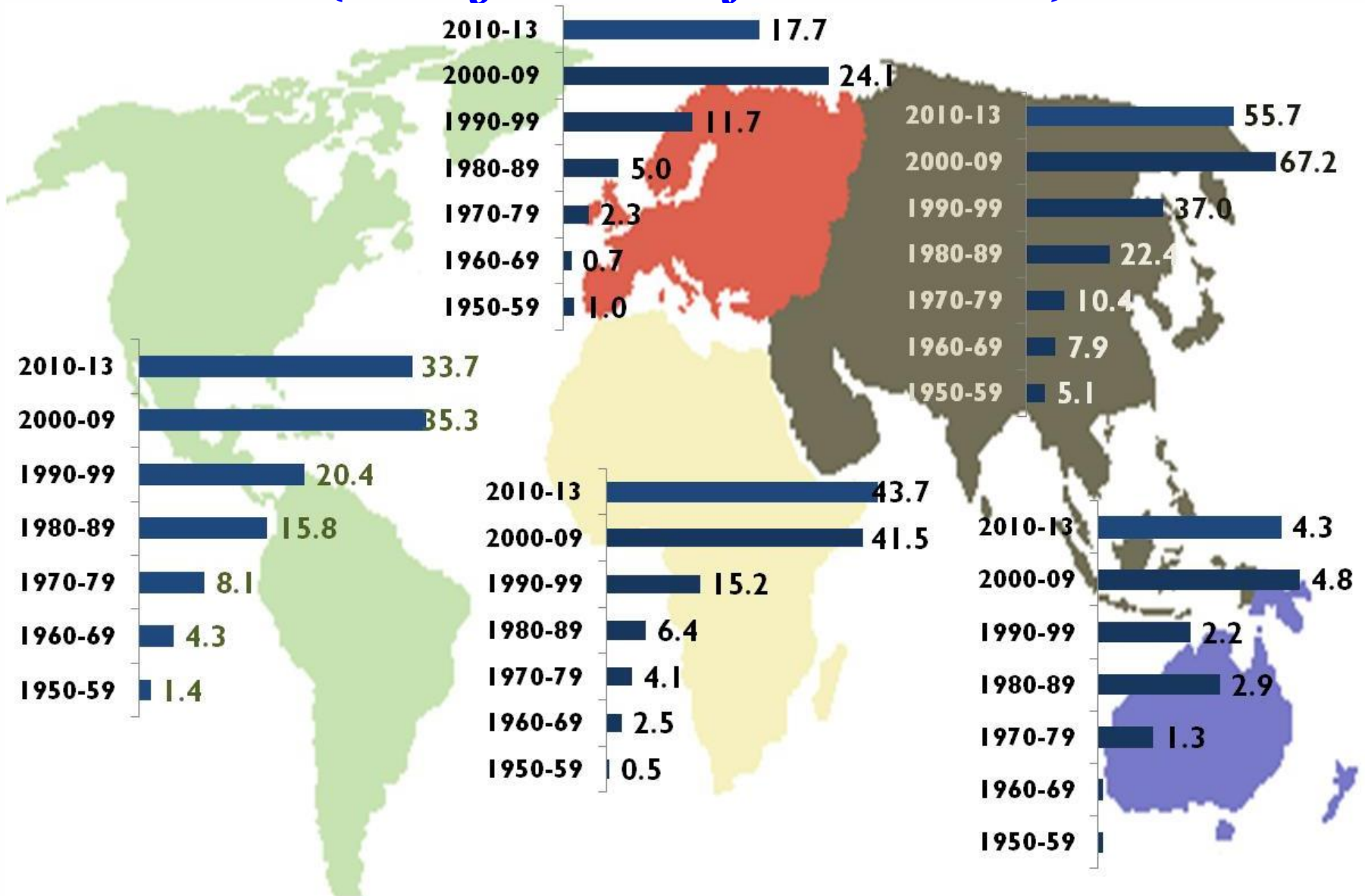
Over 70,000 people were stuck because of damaged or blocked roads

90,000 people from hundreds of villages and towns hit by the floods have been rescued



Floods 1950-2013

(average number of annual events)



Source: The international disaster data base. Center for Research on Epidemiology of Disasters. 2013.



environment360

Opinion, Analysis, Reporting & Debate

YALE ENVIRONMENT 360

02 JUN 2011: **OPINION**

Forum: Is Extreme Weather Linked to Global Warming?

*In the past year, the world has seen a large number of extreme weather events, from the Russian heat wave last summer, to the severe flooding in Pakistan, to the recent tornadoes in the U.S. In a **Yale Environment 360** forum, a panel of experts weighs in on whether the wild weather may be tied to increasing global temperatures.*

Did climate change contribute to Hurricane Sandy?

**The answer is:
*probably yes.***

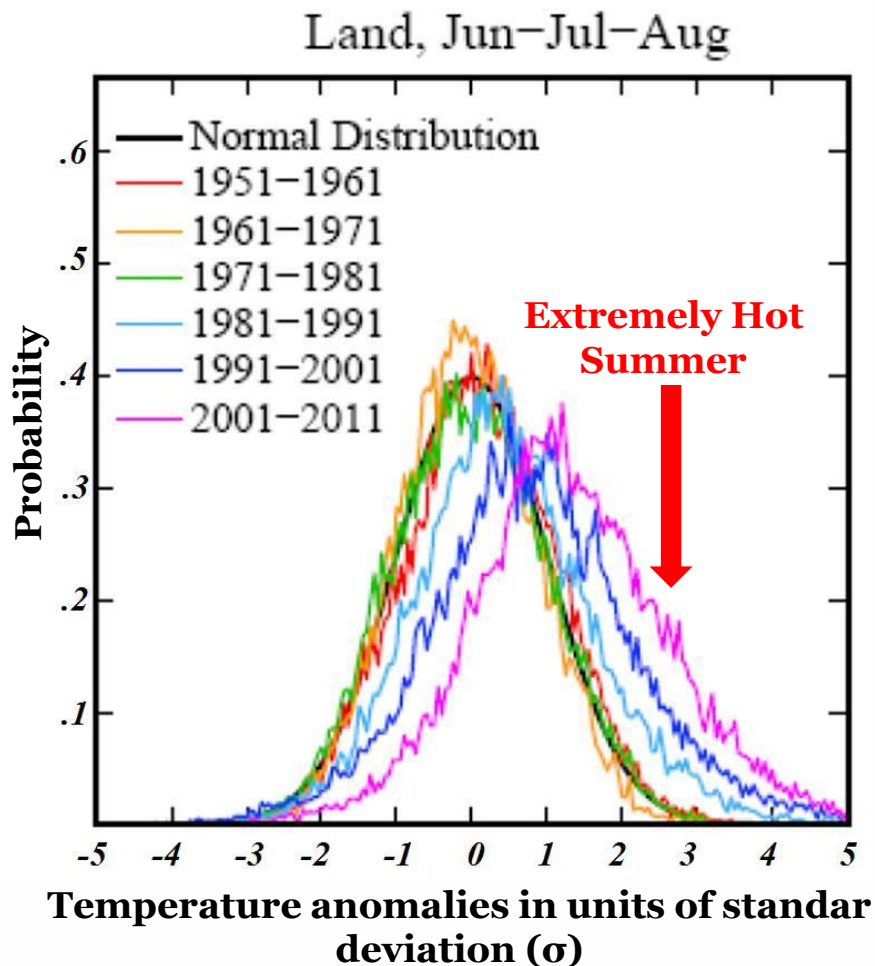


A warming climate puts more energy into storms, including hurricanes, loading them with more rainfall and the stronger winds pushing more of a storm surge.

Overall, climate change has stacked the deck so that this kind of event happens more frequently.

Source: R. Corell, J. Masters and K. Trenberth, POLITICO, Nov. 5, 2012.

Temperature Anomaly Distribution in the North Hemisphere



- **Statistical analysis of measured temperatures from 1951 to 2011**

1σ = “Hot” summer

2σ = “Very Hot” summer

3σ = “Extremely Hot” summer

- **The probability of an extreme heat wave has increase by about 40 times in the last 50 years.**

Recent examples of summer temperature anomalies exceeding $+3\sigma$ include the heat wave and drought in Oklahoma, Texas and Mexico in 2011.

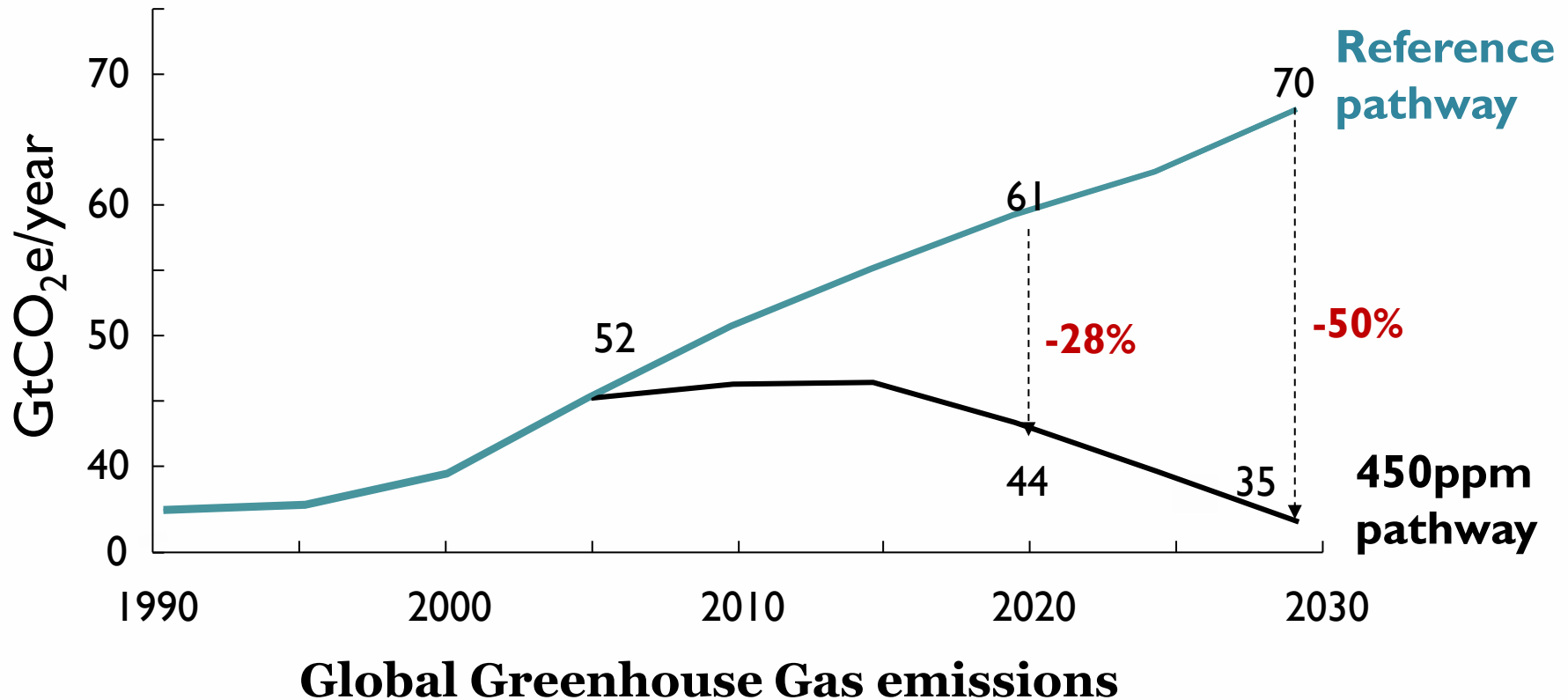
The Copenhagen Accord

The Conference of the Parties takes note of the Copenhagen Accord of 18 December 2009.

- **The Heads of State, Heads of Government, Ministers, and other heads ... have agreed on this Copenhagen Accord which is operational immediately.**
- **We underline that climate change is one of the greatest challenges of our time.**
- **We agree that deep cuts in global emissions are required**

... to reduce global emissions to hold the increase in global temperature below 2 degrees Celsius ...

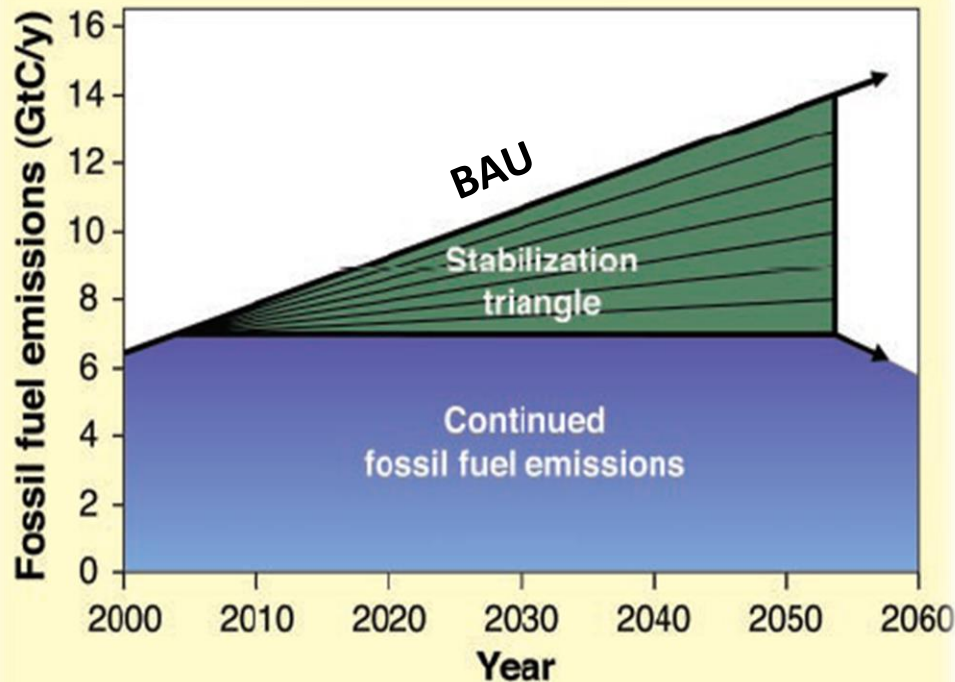
450 ppm Pathway: $< 2^{\circ}\text{C}$ Temperature Increase



Source: McKinsey Global GHG Abatement Cost Curve v2.0; Den Elzen, M.G.J. and M. Meinshausen, 2006: Multi-gas emission pathways for meeting the EU 2°C climate target; IEA World Economic Outlook 2007; Project Catalyst analysis

Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies

S. Pacala & R. Socolow



- *Improved fuel economy*
- *More efficient buildings*
- *Improved power plant efficiency*
- *Substituting natural gas for coal*
- *Carbon capture and storage*
- *Nuclear fission*
- *Wind electricity*
- *Solar energy*
- *Biofuels*
- *Forest management*

Wind energy



Solar thermal energy



New generation of nuclear power plants



Value of a Climate Policy Under Uncertainty

No Policy

What would we buy with STABILIZATION of CO₂ at 550 ppm?

A NEW WHEEL with lower odds of EXTREMES

