

The Climate-Energy Challenge to Our Heritage Buildings

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September 25 2009





















CLIMATE

Positive feedbacks appear to be developing enormous force

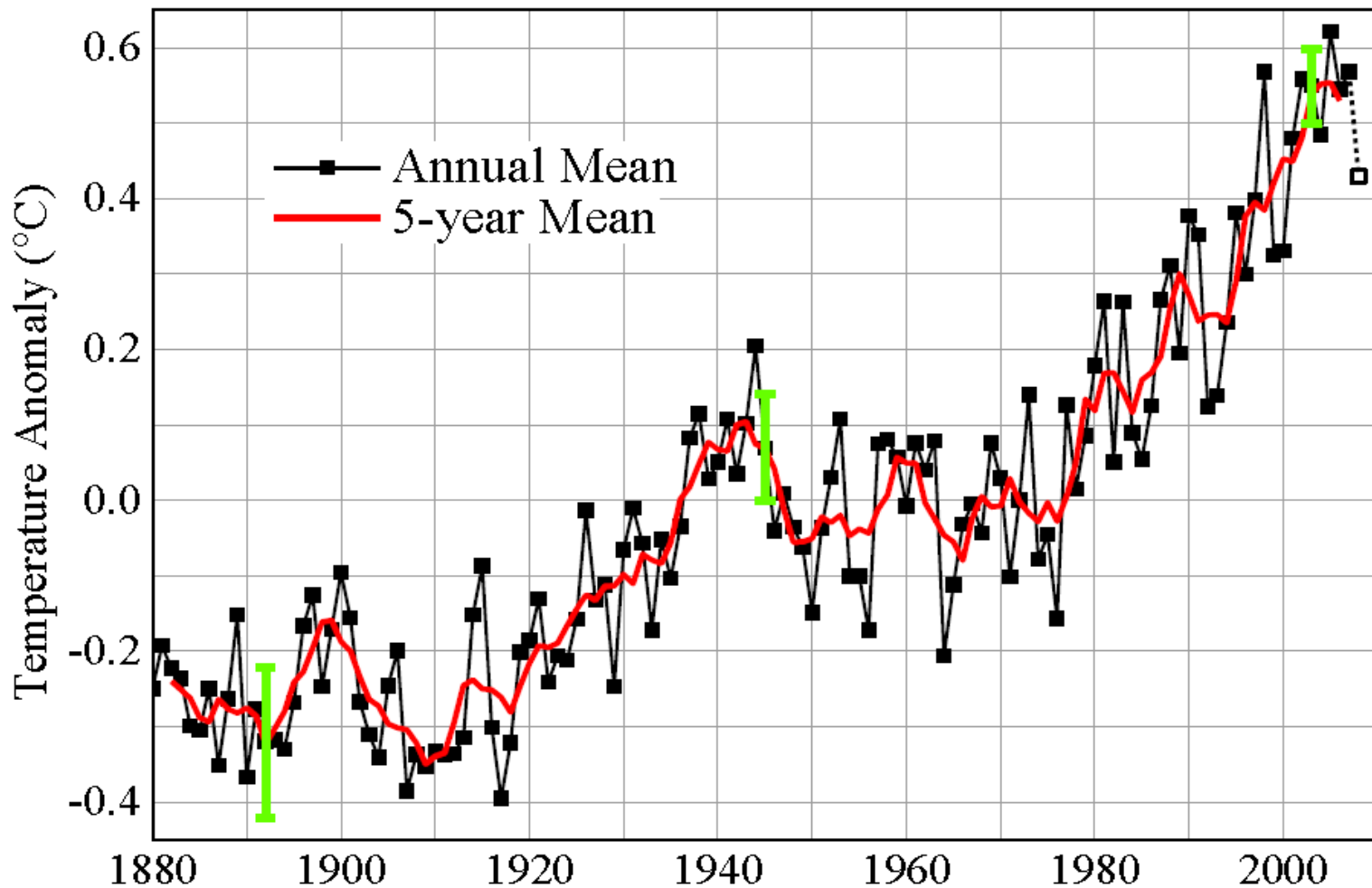
Changes in the Arctic appear to be occurring far faster than expected

“Palaeoclimate data show that the Earth’s climate is remarkably sensitive to global forcings. **Positive feedbacks predominate. This allows the entire planet to be whipsawed between climate states.** . . . Recent greenhouse gas emissions place the Earth perilously close to dramatic climate change that could run out of our control, with great dangers for humans and other creatures.”

Hansen et al, *Phil. Trans. R. Soc. A* (2007).

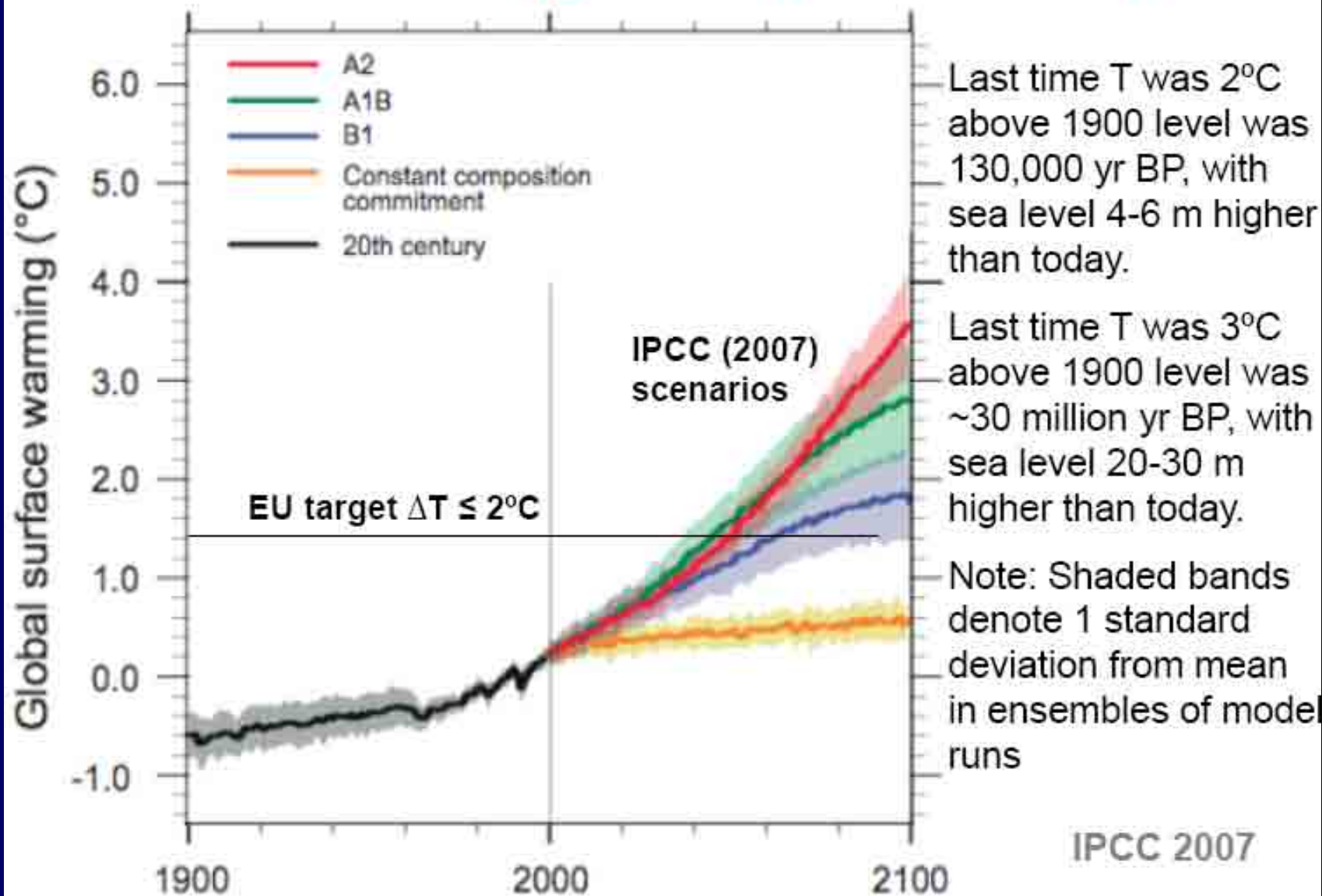


Global Land-Ocean Temperature Index



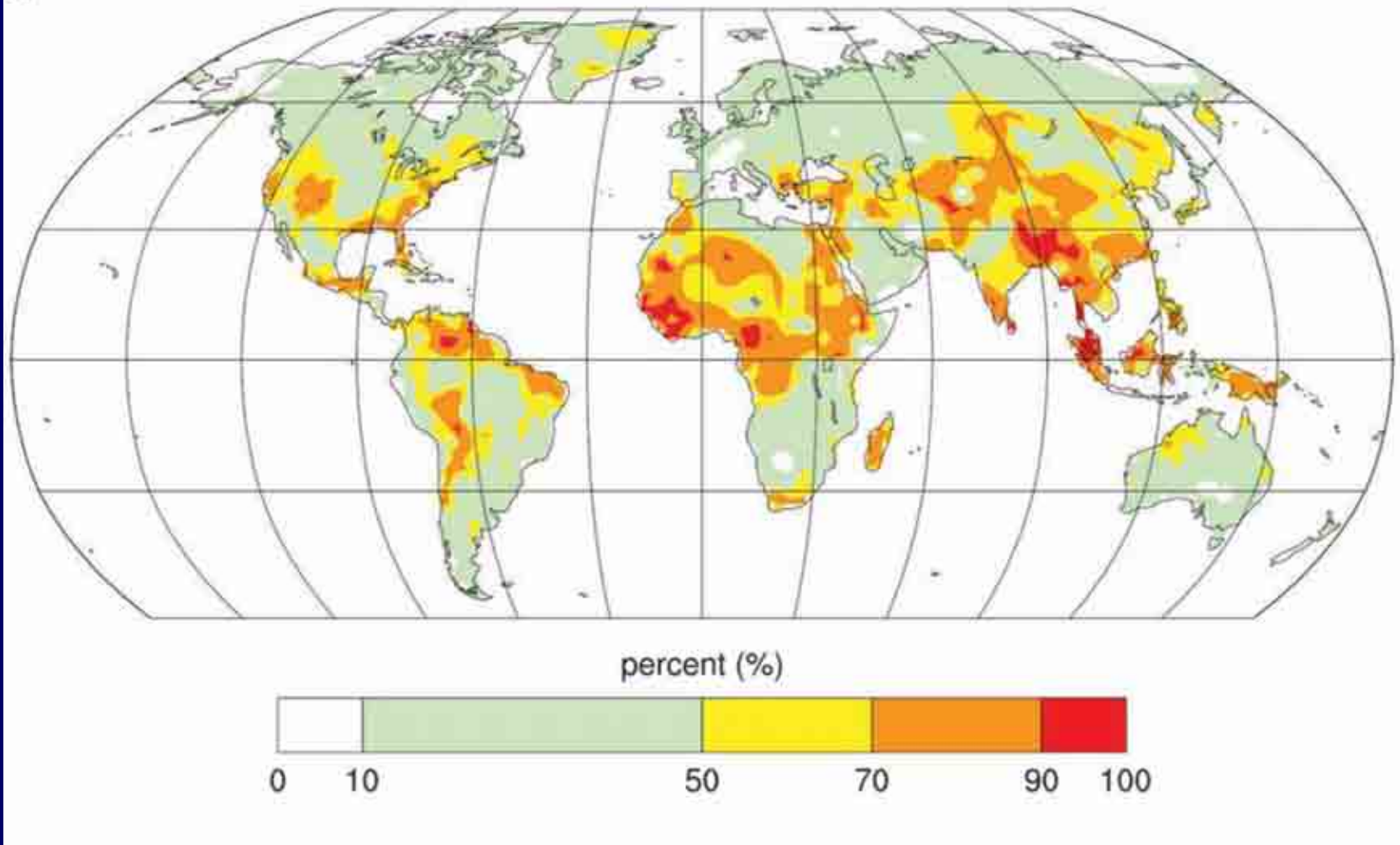
GISS analysis of global surface temperature; 2008 point is 11-month mean.

Under BAU much bigger disruption is coming



A

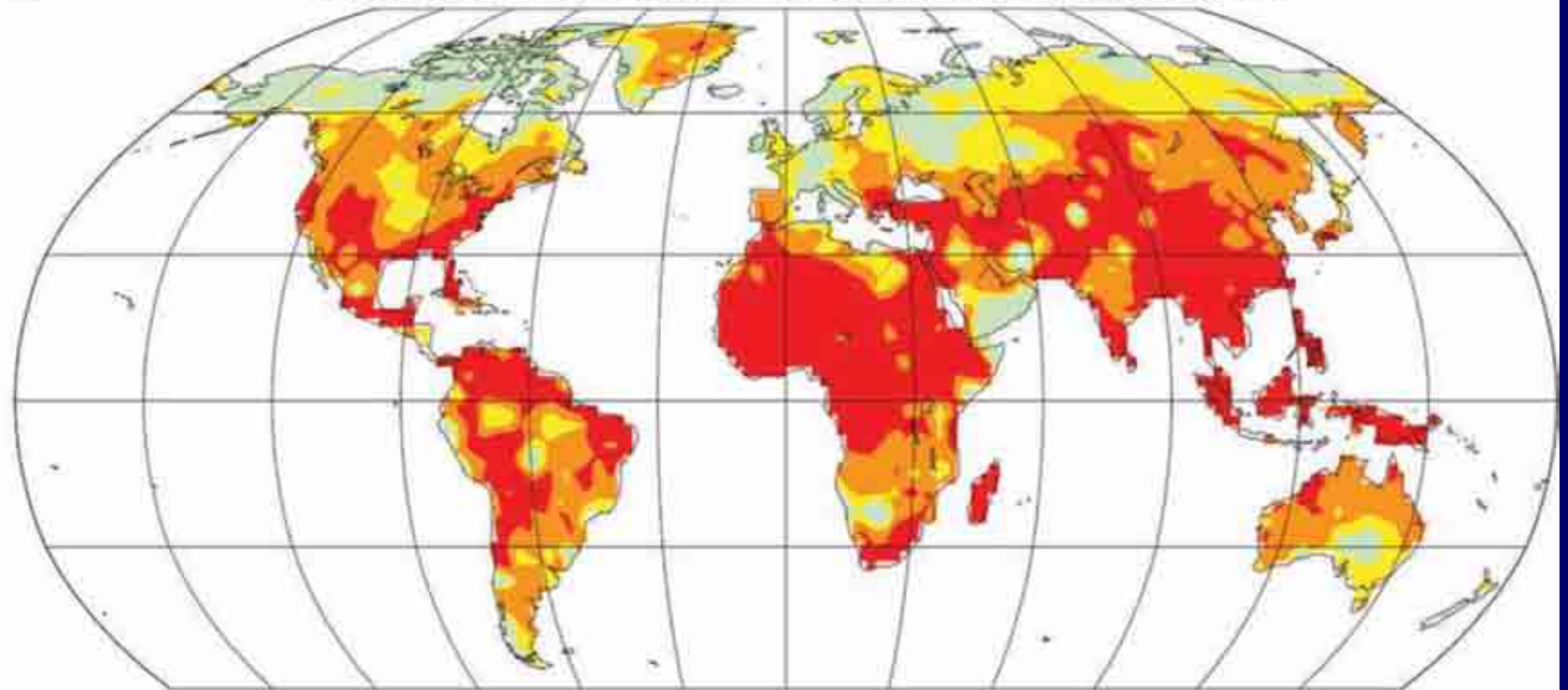
Summers in 2040-2060 Warmer than Warmest on Record



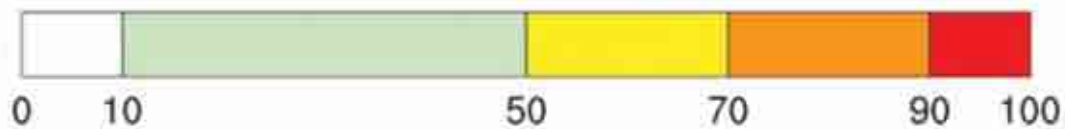
Battisti and Naylor, "Historical warnings of future food insecurity with unprecedented seasonal heat."
Science (9 January 2009): 240-44

B

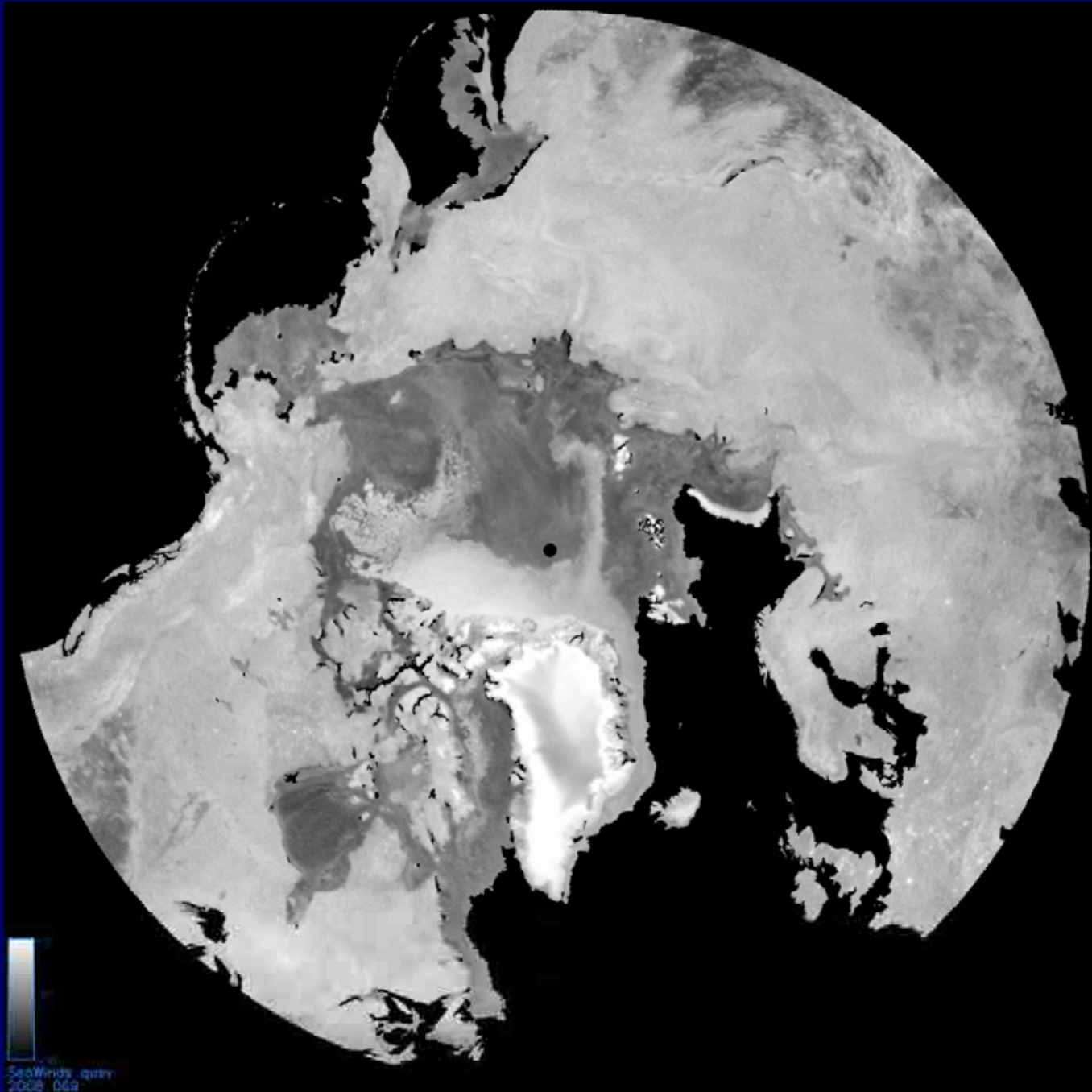
Summers in 2080-2100 Warmer than Warmest on Record



percent (%)

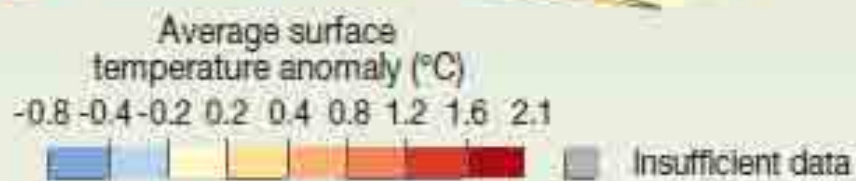
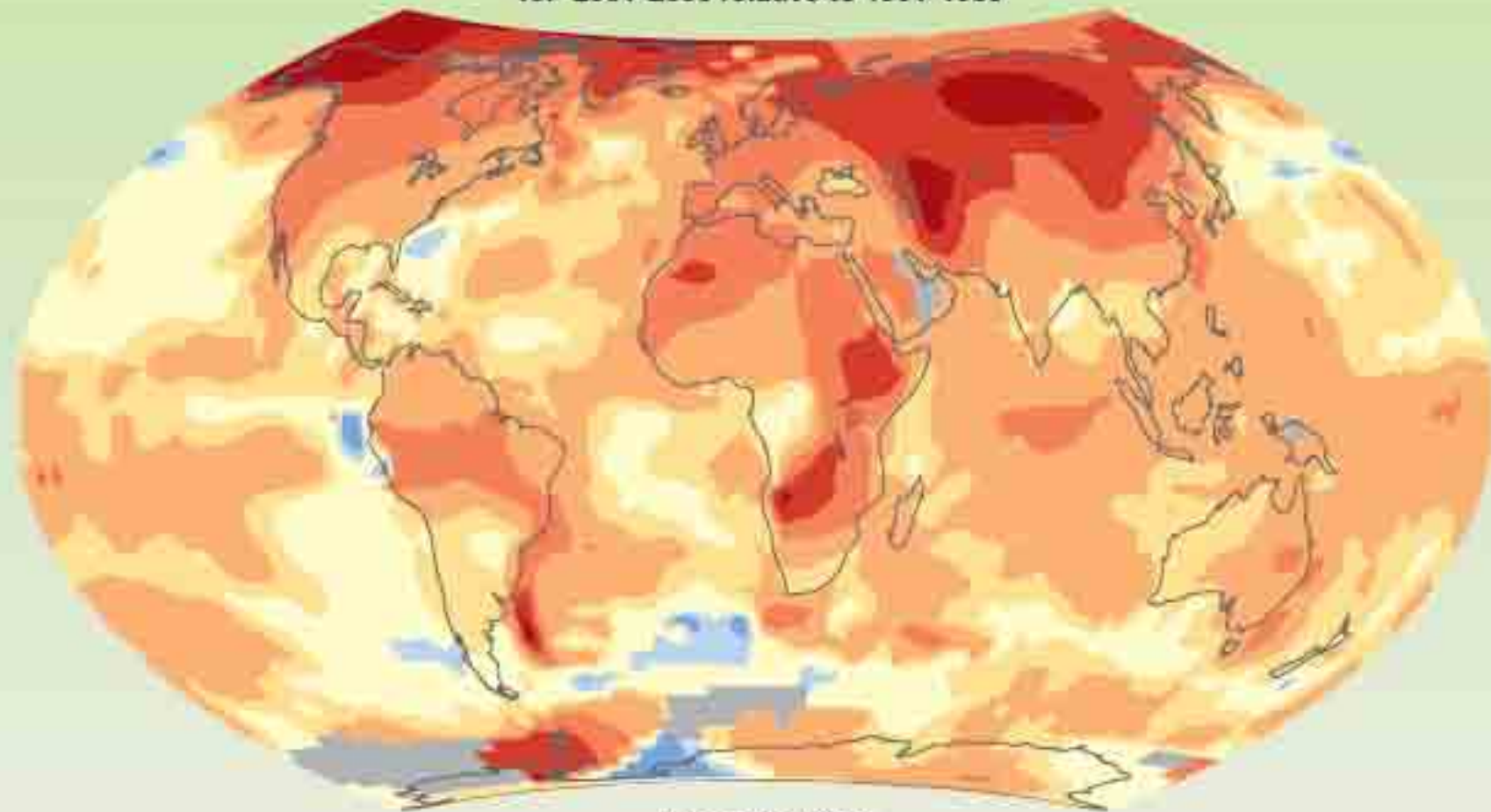


Battisti and Naylor, "Historical warnings of future food insecurity with unprecedented seasonal heat."
Science (9 January 2009): 240-44



SeaWinds_qtzy
2008_069

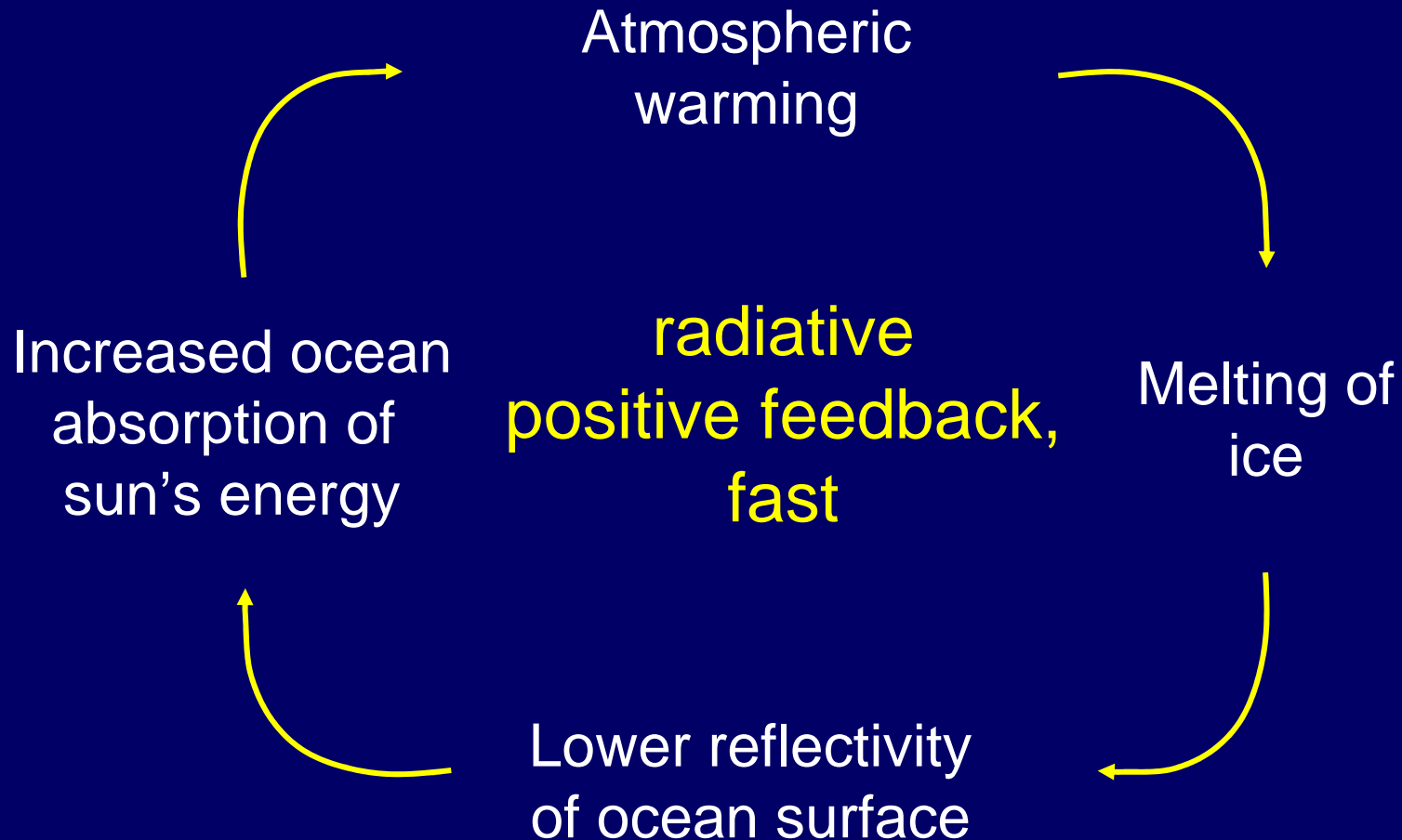
Annual temperatures increases
for 2001-2005 relative to 1951-1980



Source : Hansen, J., et al. *Global Temperature Changes*, *Proc. Natl. Acad. Sci.* 103, 2006.

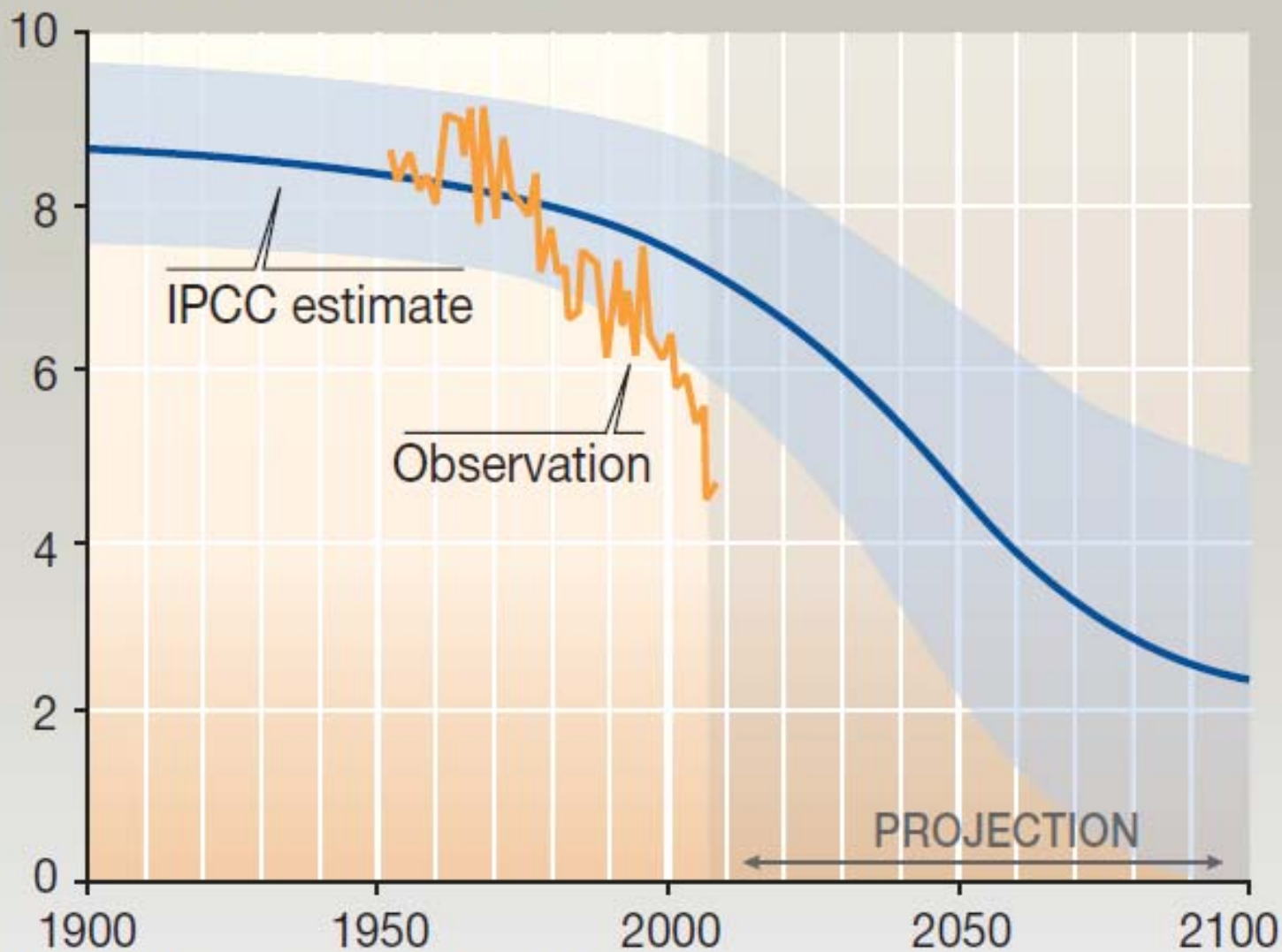
More rapid warming at poles

One reason: Ice-albedo feedback



Minimum arctic summer sea ice extent

Million square kilometres



Source : Stroeve et al., 2007, updated

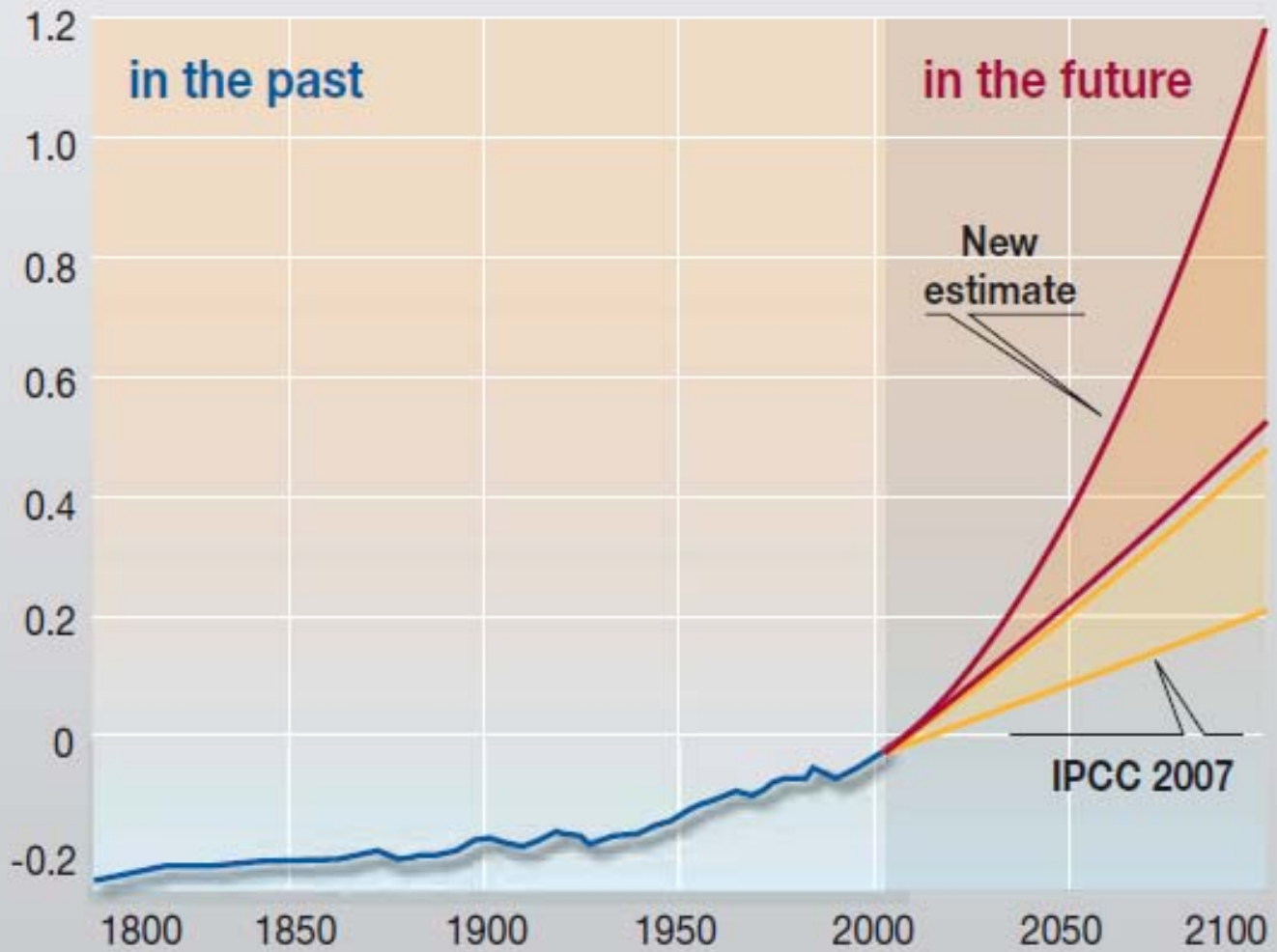
Mass balance of the Greenland Ice Sheet

Gigatonnes per year

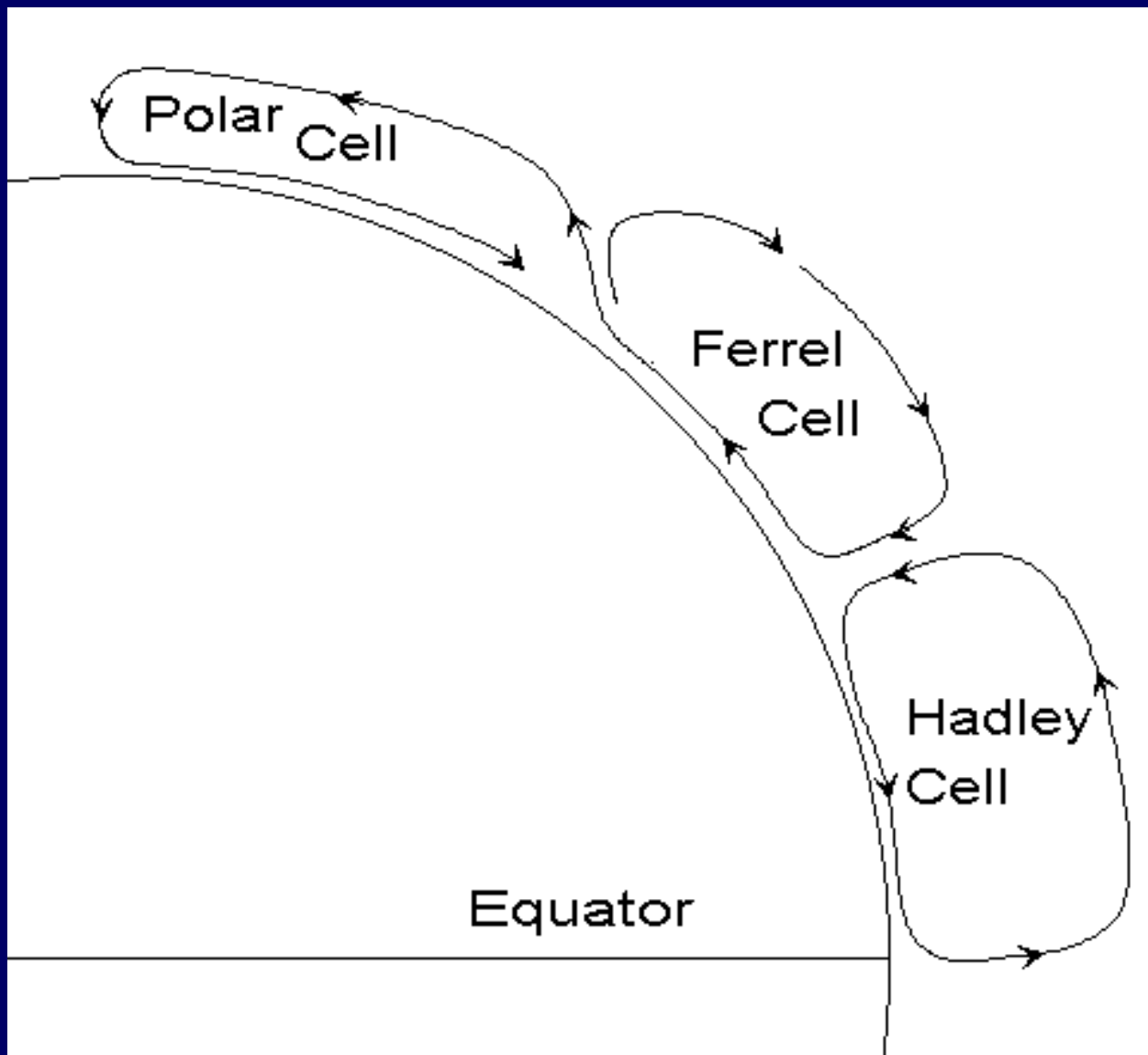


Global sea level

Metres



Source: Cazenave and Llovel, 2009.



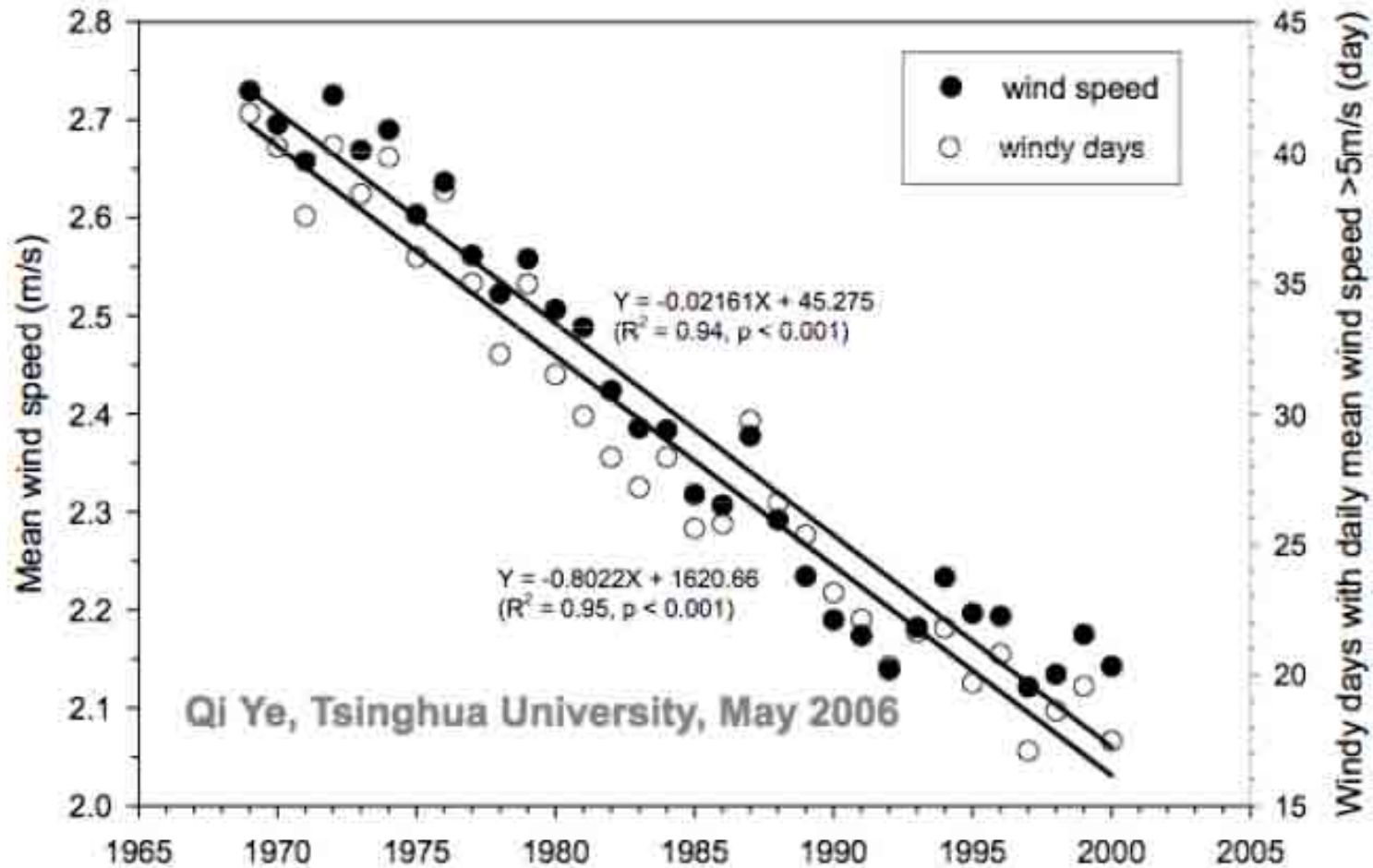
VULNERABILITY OF THE GLOBAL FOOD SYSTEM

China requires about 450 million tons of grain each year

World grain trade is about 200 million tons

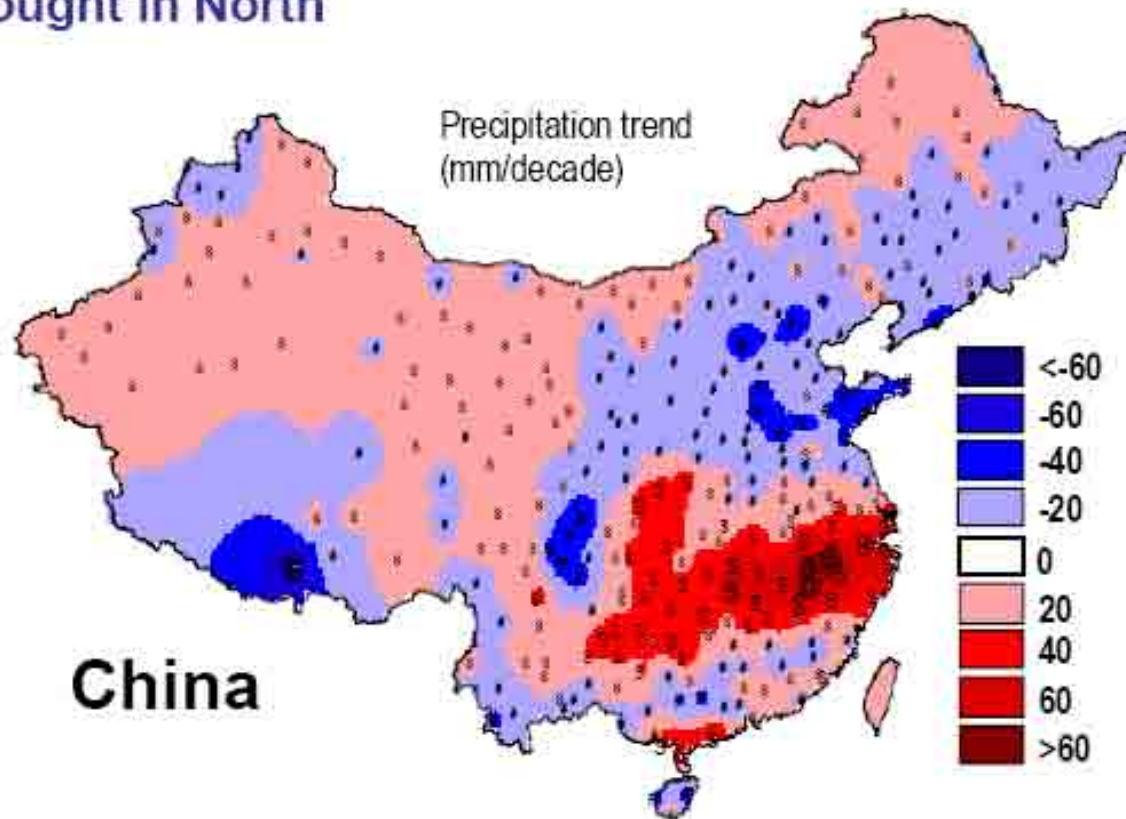
An intervention by China on world grain markets for only 20 percent of its needs would absorb 50 percent of grain on world markets

WEAKENING OF EAST ASIAN MONSOON



The observations match model predictions, by Chinese researchers, for greenhouse-gas-driven disruption .

Weakening monsoon means less moisture flow South to North, producing increased flooding in South, drought in North



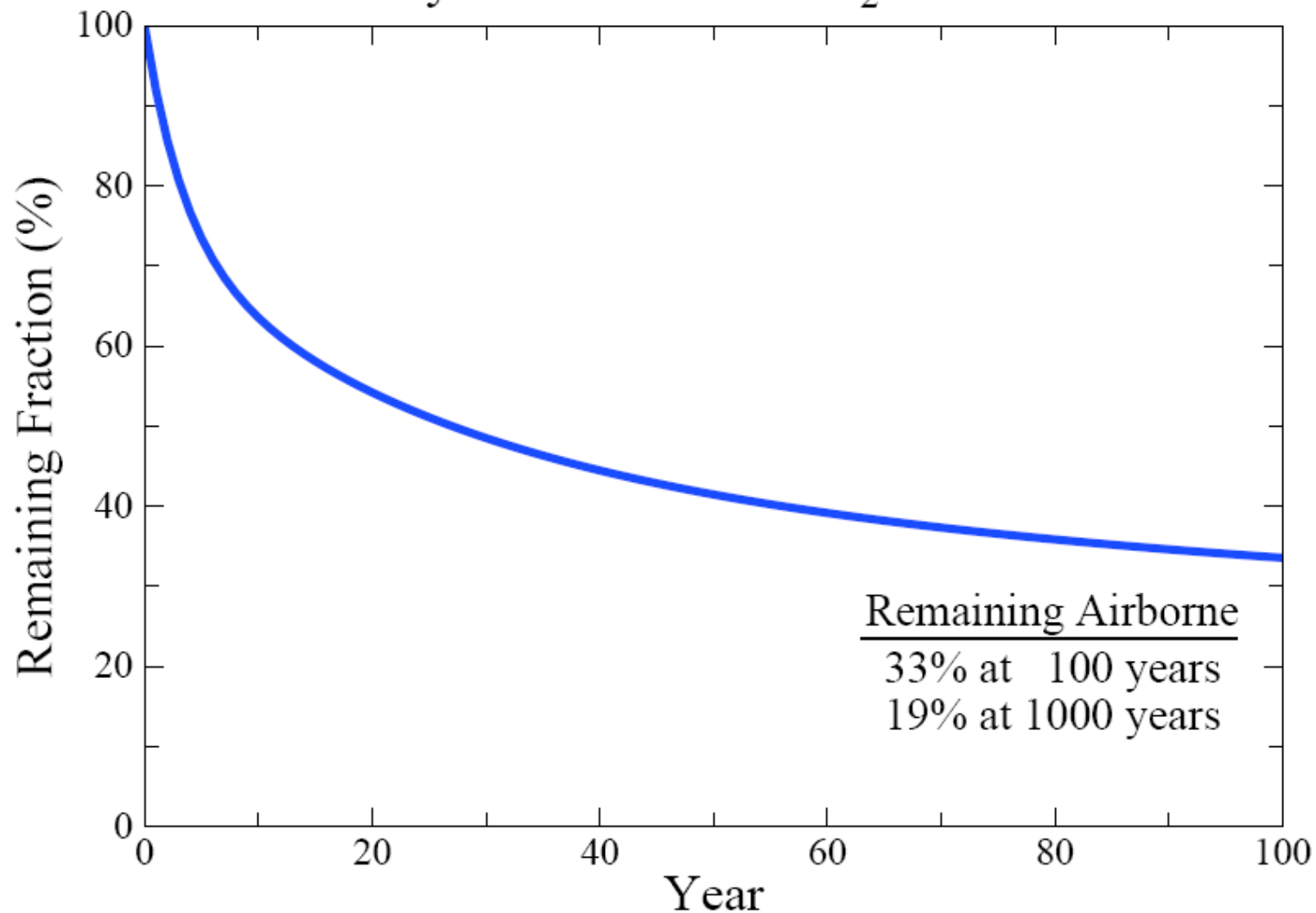
Qi Ye, Tsinghua University, May 2006

“ [We show] that to hold climate constant at a given global temperature requires near zero future carbon emissions. . . . As a consequence, any future anthropogenic emissions will commit the climate system to warming that is essentially irreversible on centennial timescales.”

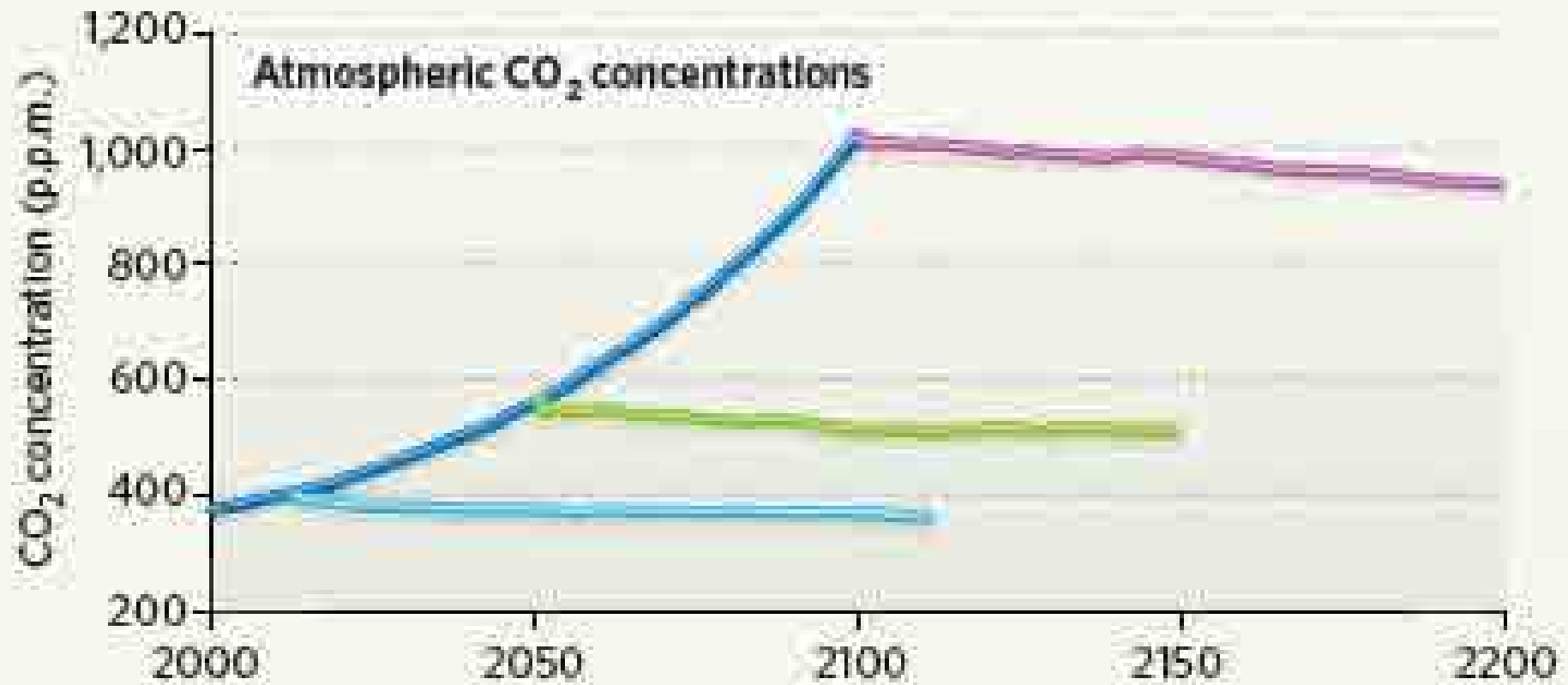
Matthews, H. D., and K. Caldeira (2008), “Stabilizing climate requires near-zero emissions,” *Geophys. Res. Lett.*

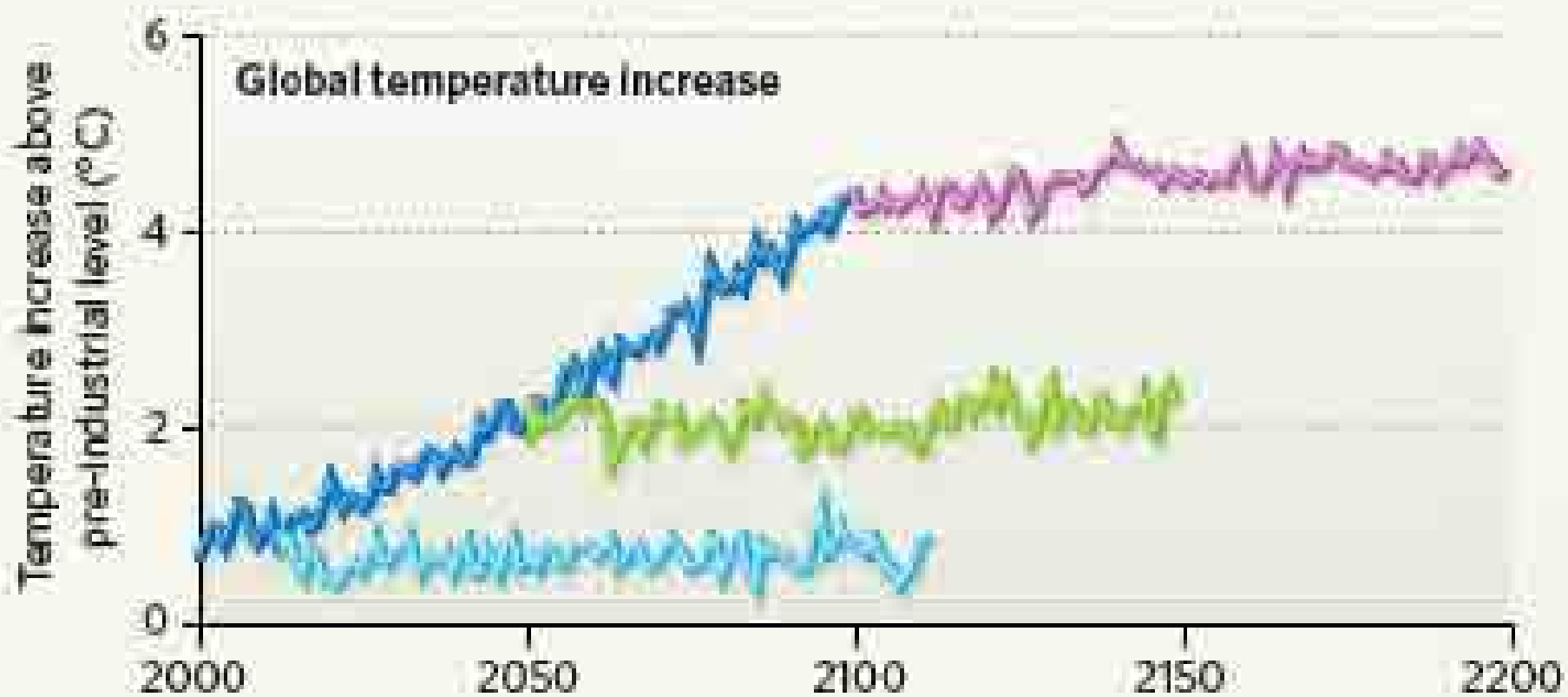


Decay of Fossil Fuel CO₂ Emission



Hansen, *Atmos. Chem. Phys.* 7 (2007): 2287-2312.






ENERGY

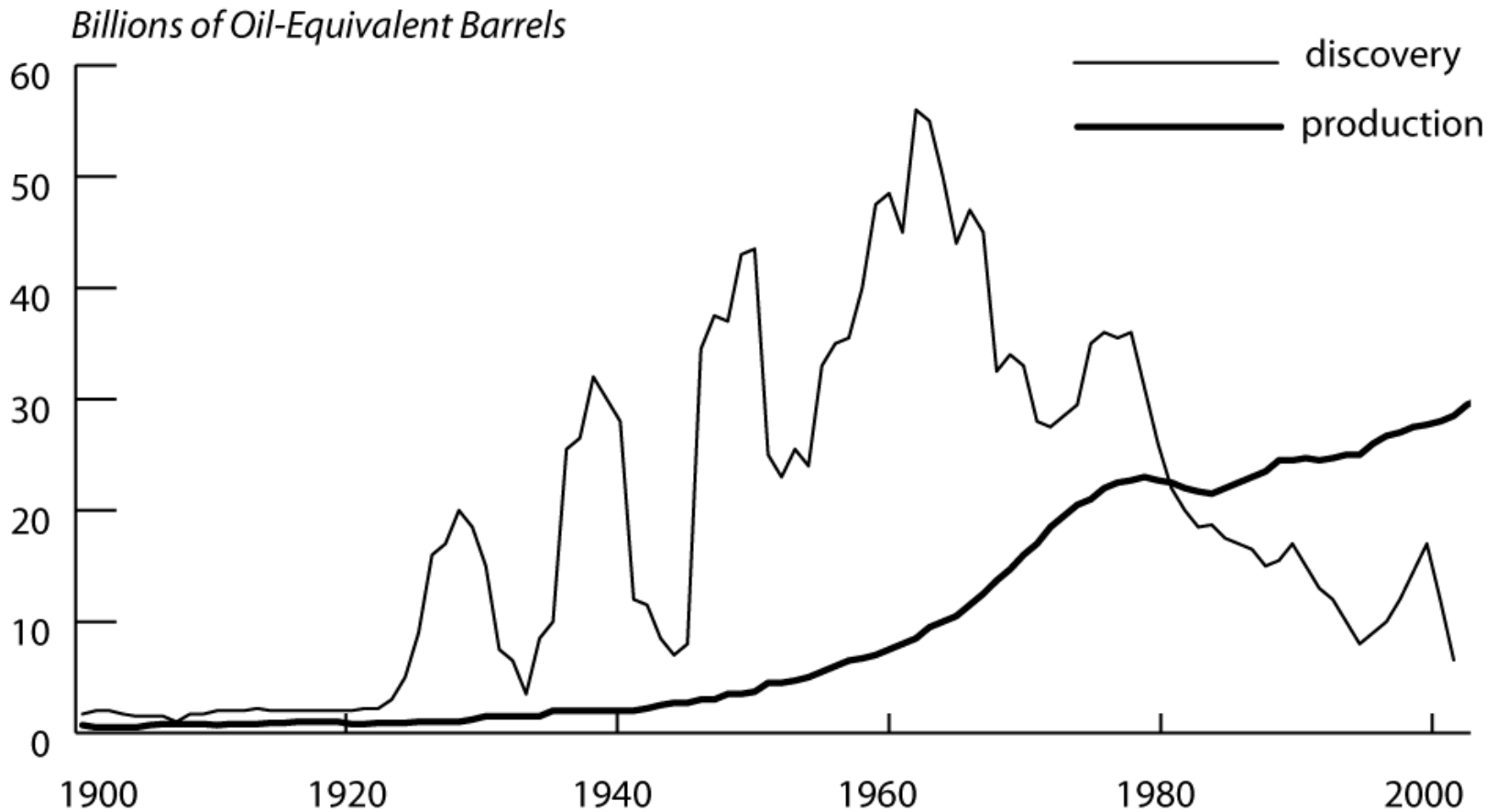
We are probably near peak
global output of conventional oil

Energy costs will continue to rise
relative to other costs in coming
years





Global oil discovery peaked in the early 1960s



Source: Harry Longwell, "The Future of the Oil and Gas Industry: Past Approaches, New Challenges," *World Energy* 5 3 (2002): 100-4, and Colin Campbell, personal correspondence.

Producing energy costs energy

This principle is best understood through the concept of

Energy Return on Investment (EROI)

We're shifting from a world of abundant high-EROI energy to one of scarce, mixed-EROI energy

Just at the time

We need vast additional amounts of cheap energy to solve our increasingly difficult problems

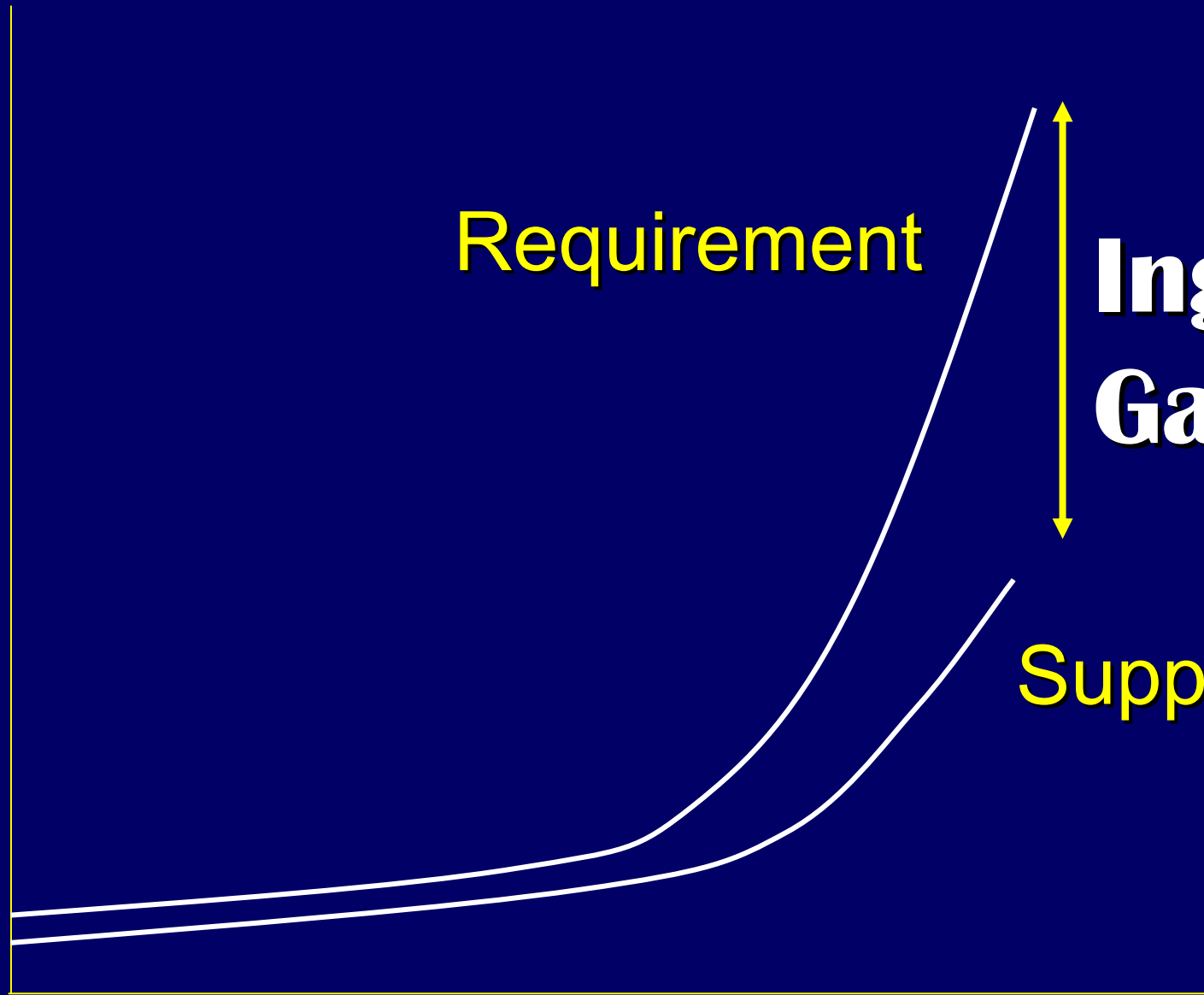
In this new
world, what
should we do?

Requirement

Ingenuity
Gap

Supply

Time



Two types of ingenuity

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graph TD; A[Two types of ingenuity] --> B[Social]; A --> C[Technical]
```

Social

Technical

The ingenuity supply chain

Brains

Science

Markets

Politics







