

**“In Visibility of Climate Change” –
a Dialogue between Natural and Social Sciences,
PIK, 19 November 2013**

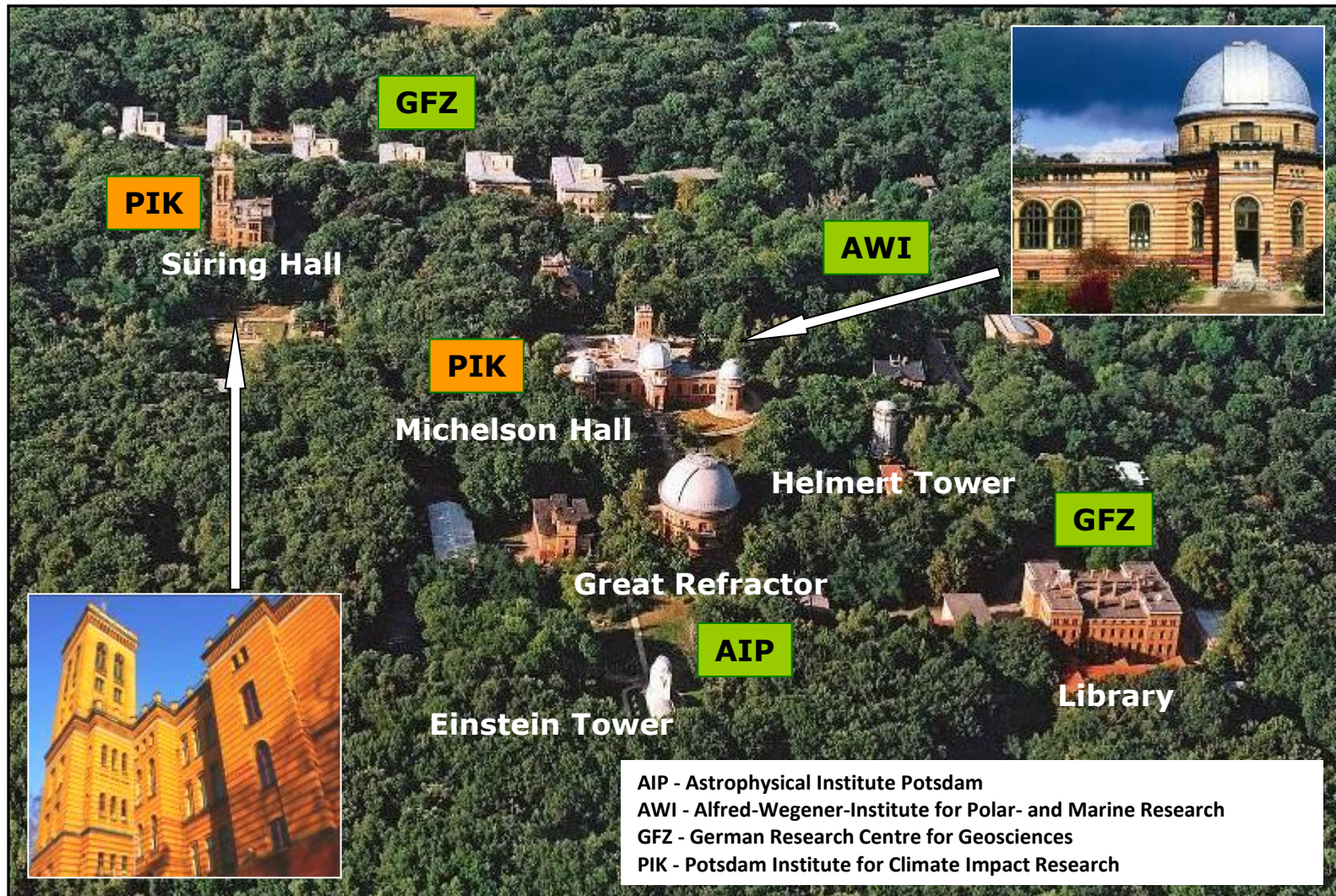
The Potsdam Institute, Climate Change and the Co-Production of Evidence

Hans Joachim Schellnhuber



Part I

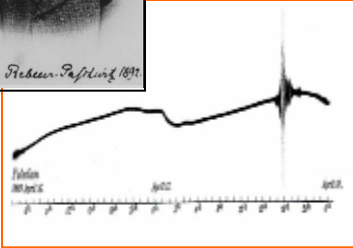
Telegraph Hill: Location



Telegraph Hill: Scientific Breakthroughs



Ernst von Rebeur-Paschwitz
1861-1895



1889 First Record of
Teleseismic Earthquake

Albert Einstein
1879-1955



1832/33 Opto-
Mechanical
Telegraph Line
Station No. 4
Potsdam

First Solution of Einstein's Equations



Secular Station Potsdam



Reinhard Süring
1866-1950



Karl Schwarzschild
1873-1916

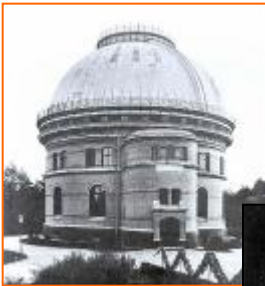


Friedrich Robert Helmert
1843-1917



1870-1950 Potsdam Datum Point
Helmert Tower

1904 Interstellar Matter
Large Refractor



Johannes Hartmann
1865-1936



1881 Michelson Experiment



Albert Abraham Michelson, 1852-1931

Karl Schwarzschild: Pioneer of Climate System Research



Radiative transfer in planetary atmospheres

$$\frac{d}{d\tau_\nu^*} L(\tau_\nu, \Theta, \nu) = -\frac{1}{\cos \Theta} [L(\tau_\nu^*, \Theta, \nu) - B(\nu, T(\tau_\nu^*))]$$

<http://www.odec.ca/projects/2007/joch7c2/images/Schwarzschild.jpg>



Sciencephotolibrary, C009/1251, Retrieved:
http://www.sciencephoto.com/image/428404/530wm/C0091251-Karl_Schwarzschild,_German_astronomer-SPL.jpg

PIK: Research Structure



Research Domain 1: Earth System Analysis

Co-Chairs:
Stefan Rahmstorf &
Wolfgang Lucht



Research Domain 2: Climate Impacts and Vulnerabilities

Co-Chairs:
F.-W. Gerstengarbe &
Hermann Lotze-Campen



Research Domain 3: Sustainable Solutions

Co-Chairs:
Ottmar Edenhofer &
Anders Levermann



Research Domain 4: Transdisciplinary Concepts and Methods

Co-Chairs:
Helga Weisz &
Jürgen Kurths

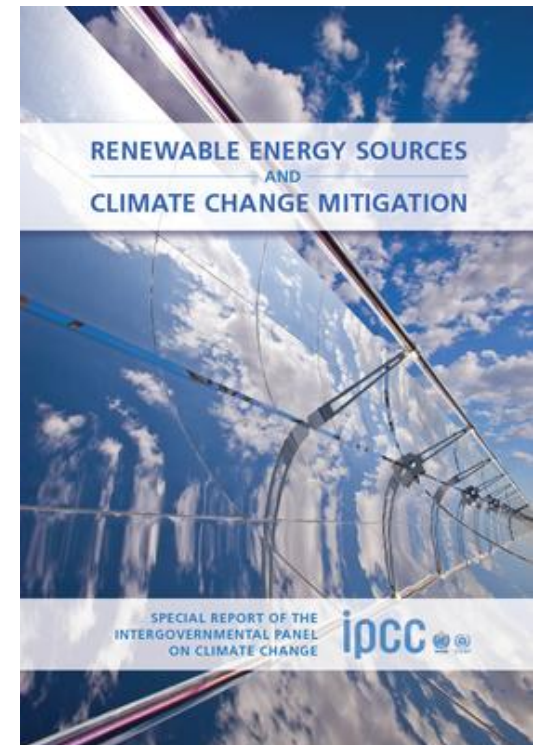
Intergovernmental Panel on Climate Change (IPCC)



Ottmar Edenhofer and
Christopher Field



Ramon Pichs Madruga (Cuba),
Ottmar Edenhofer und Birama Diarra
(Youba Sokona)



IPCC Special Report on Renewable
Energy Sources and Climate
Change Mitigation (SRREN), 2011

Scientific Policy Advice

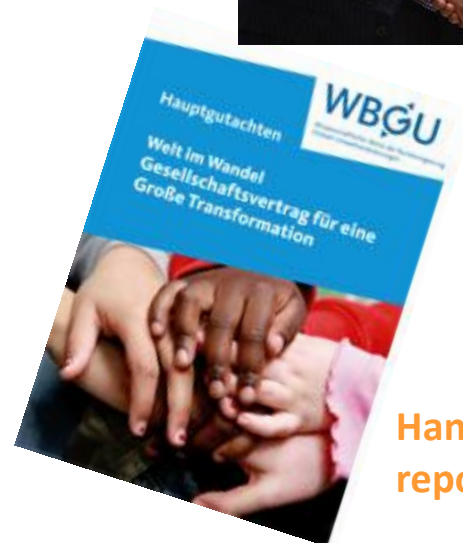


Advice to German Government



Advice to Federal State of Brandenburg

Contributions to debate on „Energiewende“
in Germany



Handing over WBGU flagship
report, 2011



Turn Down the Heat

Why a 4°C Warmer World
Must be Avoided



THE WORLD BANK

November 2012

A Report for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics

Authors:

Hans Joachim Schellnhuber, William Hare, Olivia Serdeczny, Sophie Adams, Dim Coumou, Katja Frieler, Maria Martin, Ilona M. Otto, Mahé Perrette, Alexander Robinson, Marcia Rocha, Michiel Schaeffer, Jacob Schewe, Xiaoxi Wang, and Lila Warszawski

The Potsdam Symposium Series: Global Sustainability – A Nobel Cause 2007



ATHENA



GAIA

GLOBAL SUSTAINABILITY – A NOBEL CAUSE
1ST INTERDISCIPLINARY SYMPOSIUM

8–10 OCTOBER 2007, POTSDAM



Potsdam, 8-9 October 2007

ST. JAMES'S PALACE
NOBEL LAUREATE
SYMPOSIUM



London, 26-28 May 2009



Potsdam Memorandum





3rd
Nobel Laureate Symposium
on Global Sustainability
Transforming the World in an Era of Global Change
Stockholm, Sweden, May 16-19 2011

"We cannot afford the luxury of denial. We must respond rationally, equipped with scientific evidence."

"We are the first generation facing the evidence of global change. It therefore falls upon us to change our relationship with the planet, in order to tip the scales towards a sustainable world for future generations."

The Stockholm Memorandum
Tipping the Scales towards Sustainability
18 May 2011

Fourth Nobel Laureates Symposium on Global Sustainability

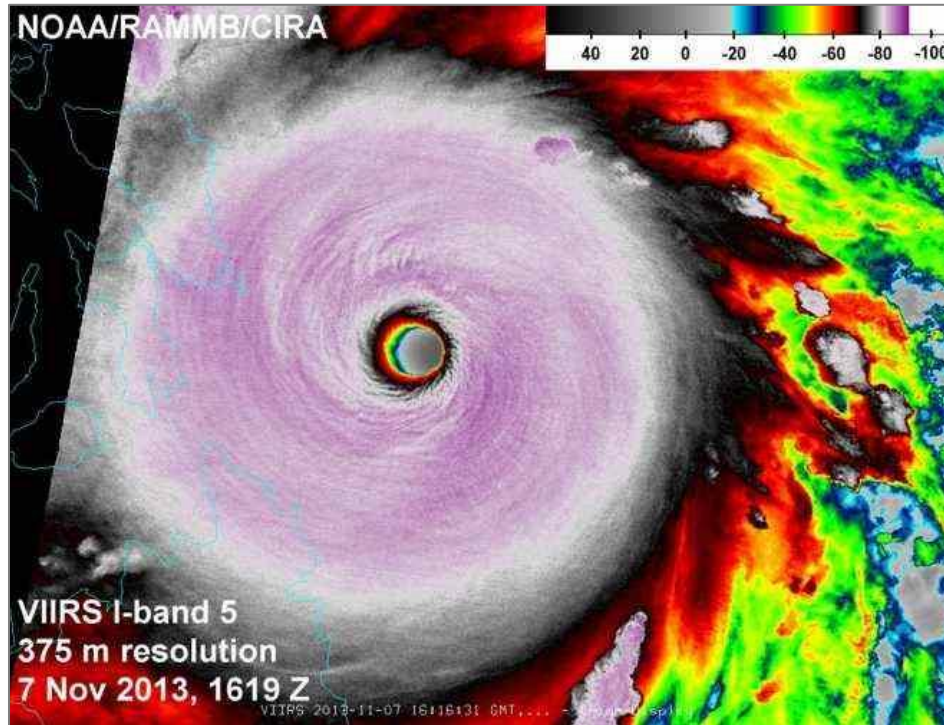
4C: Changing Climate, Changing Cities

8 – 11 October 2014, Hong Kong



Part II

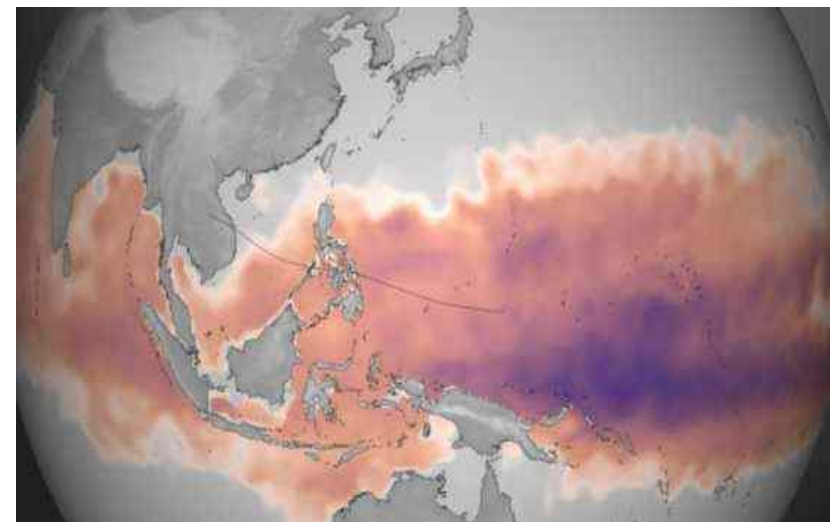
Typhoon Haiyan



- strongest tropical cyclone to make a landfall on record (315km/h*)

*JTWC

Fuelled by warm water (Nov 7, 2013):

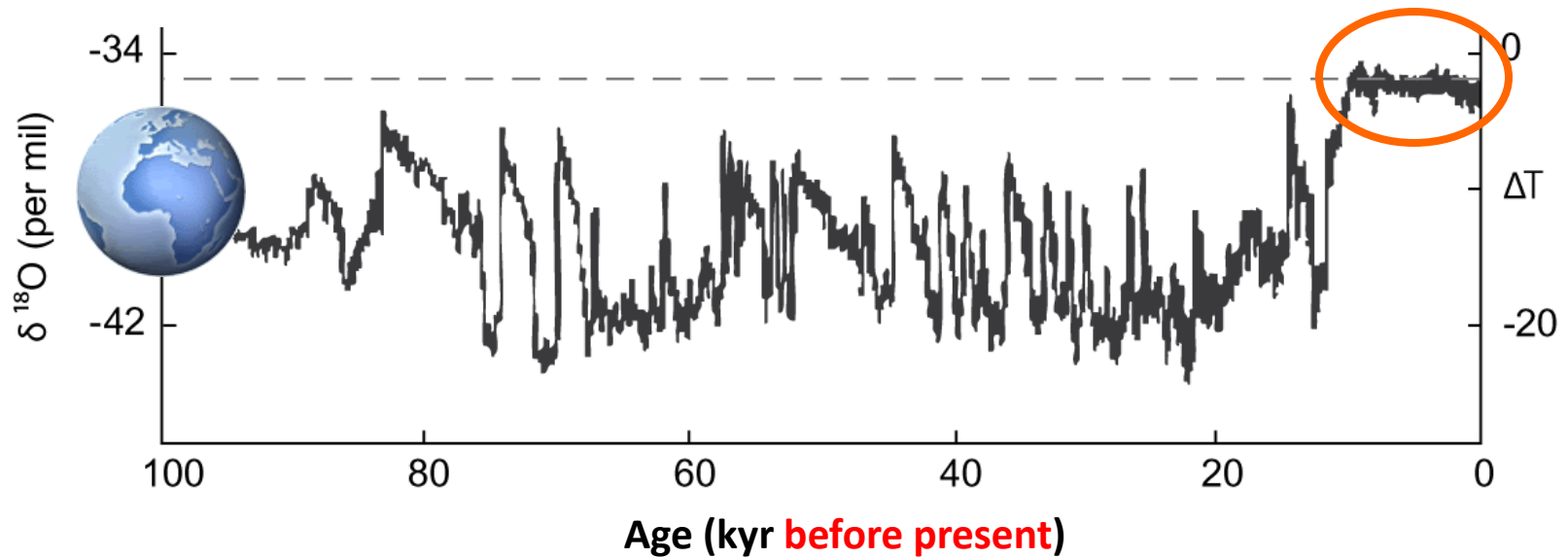


Available energy [kJ/cm²]

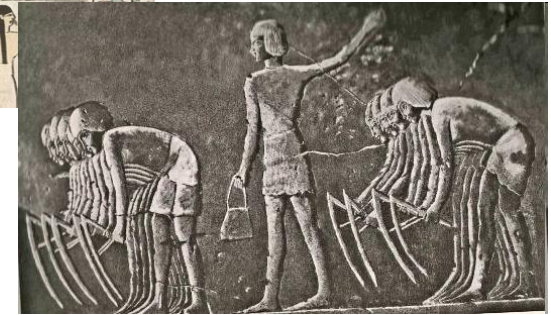
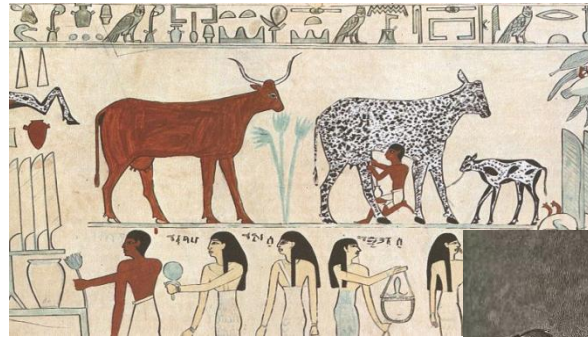


NOAA

Humankind's 11 000 Years of Grace

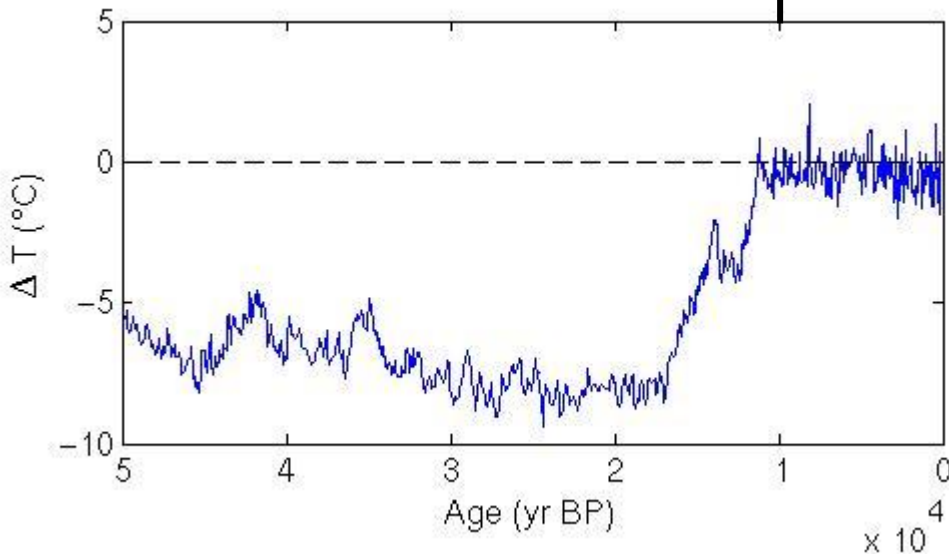


The Blessings of the Holocene



Neolithic Revolution
Starting ~ 10 000 B.C.

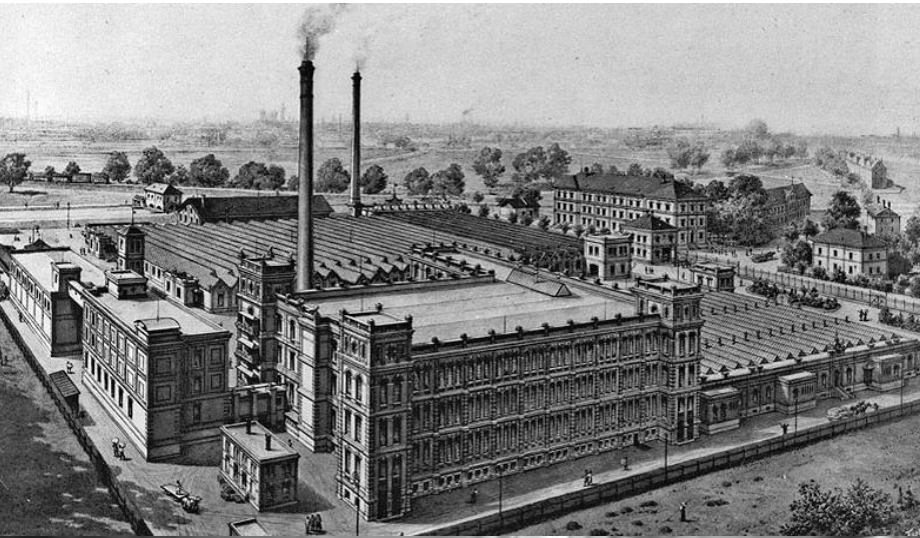
World Population < 1 Million



World Population (2050) ~ 9 Billion

Global Industrialization

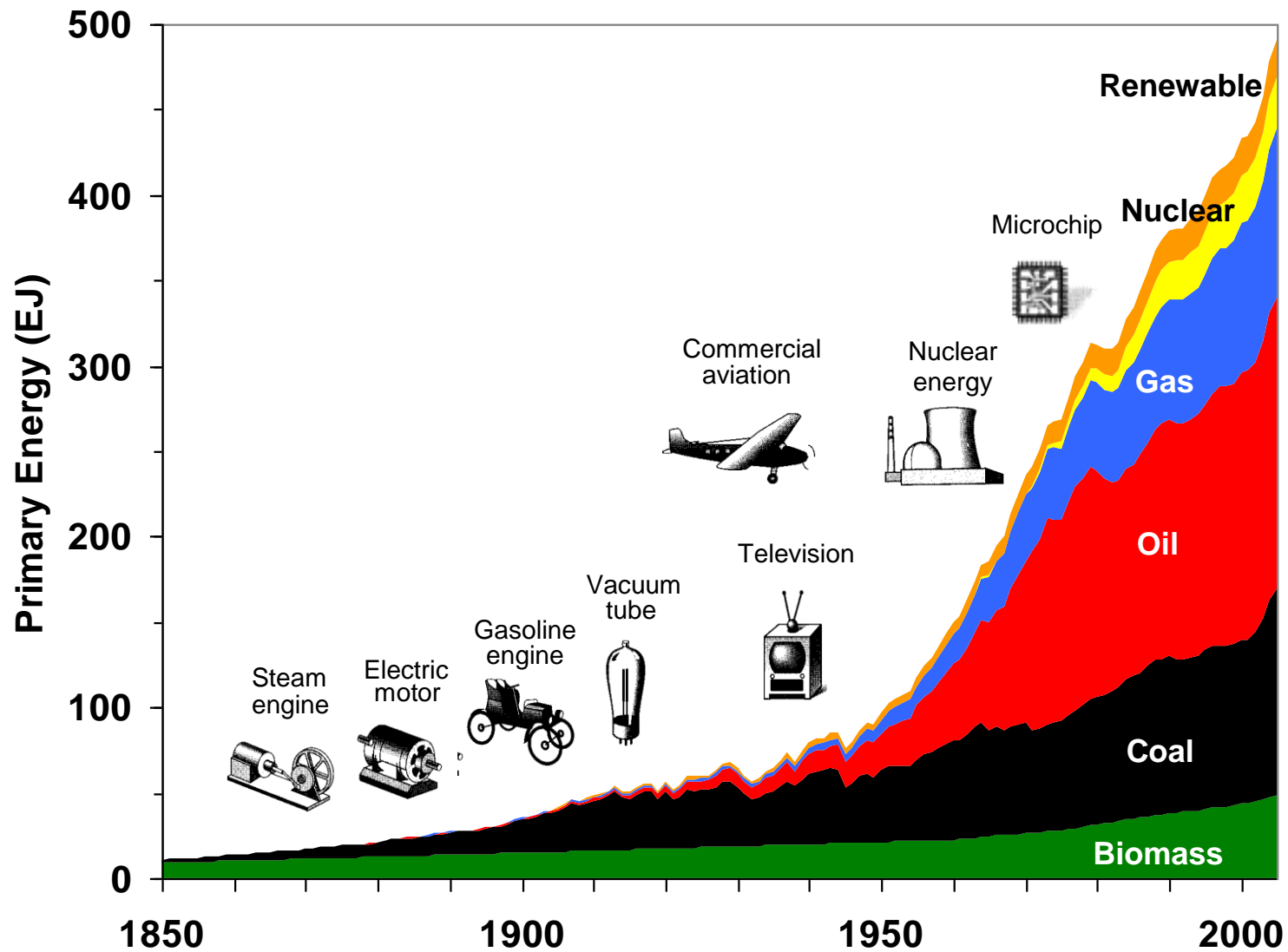
Manchester Capitalism in the 19th Century



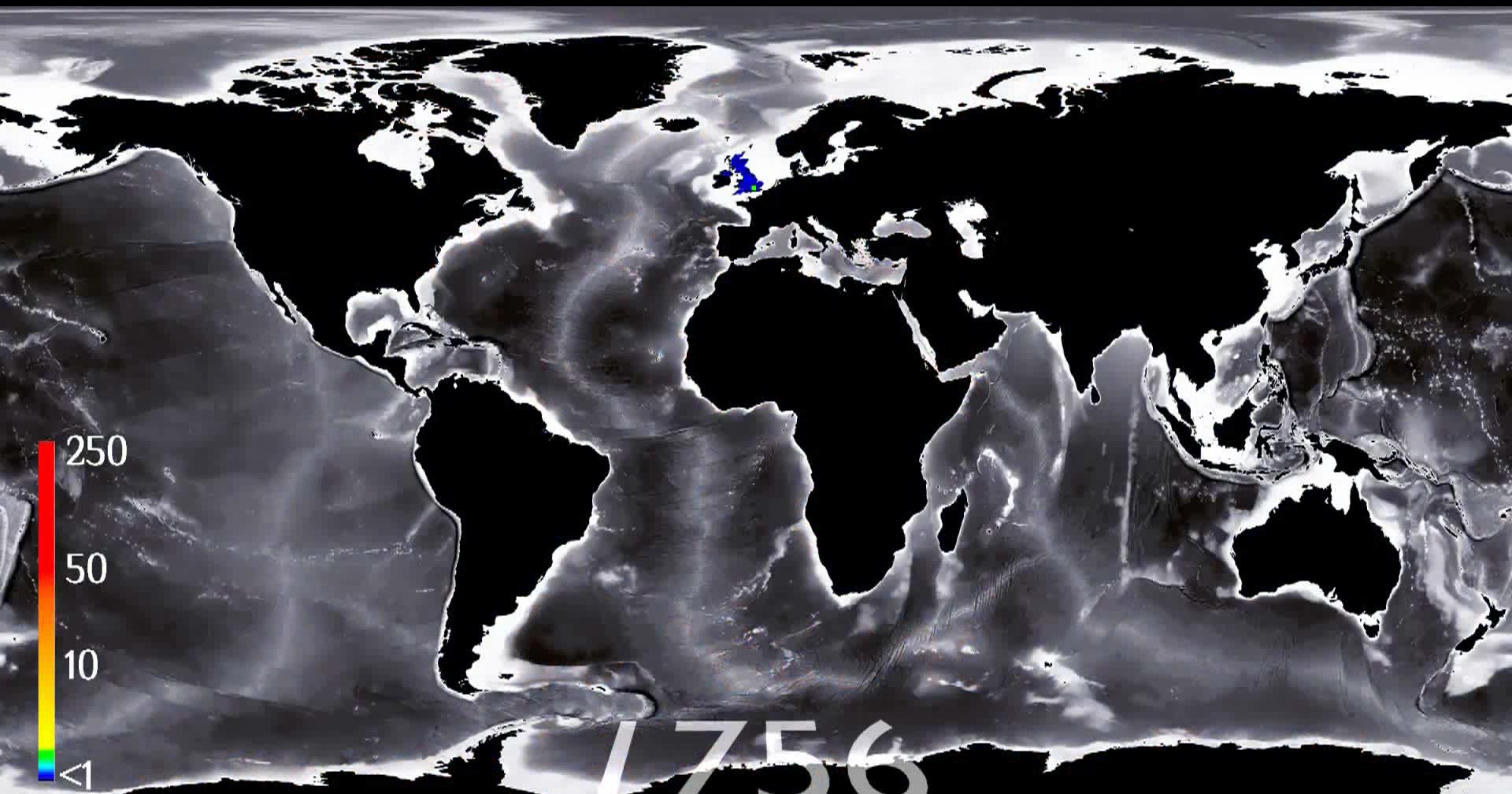
Collapse of a Textile Factory in Bangladesh 2013



World Primary Energy Mix



Source: Nakicenovic (IIASA)



250

50

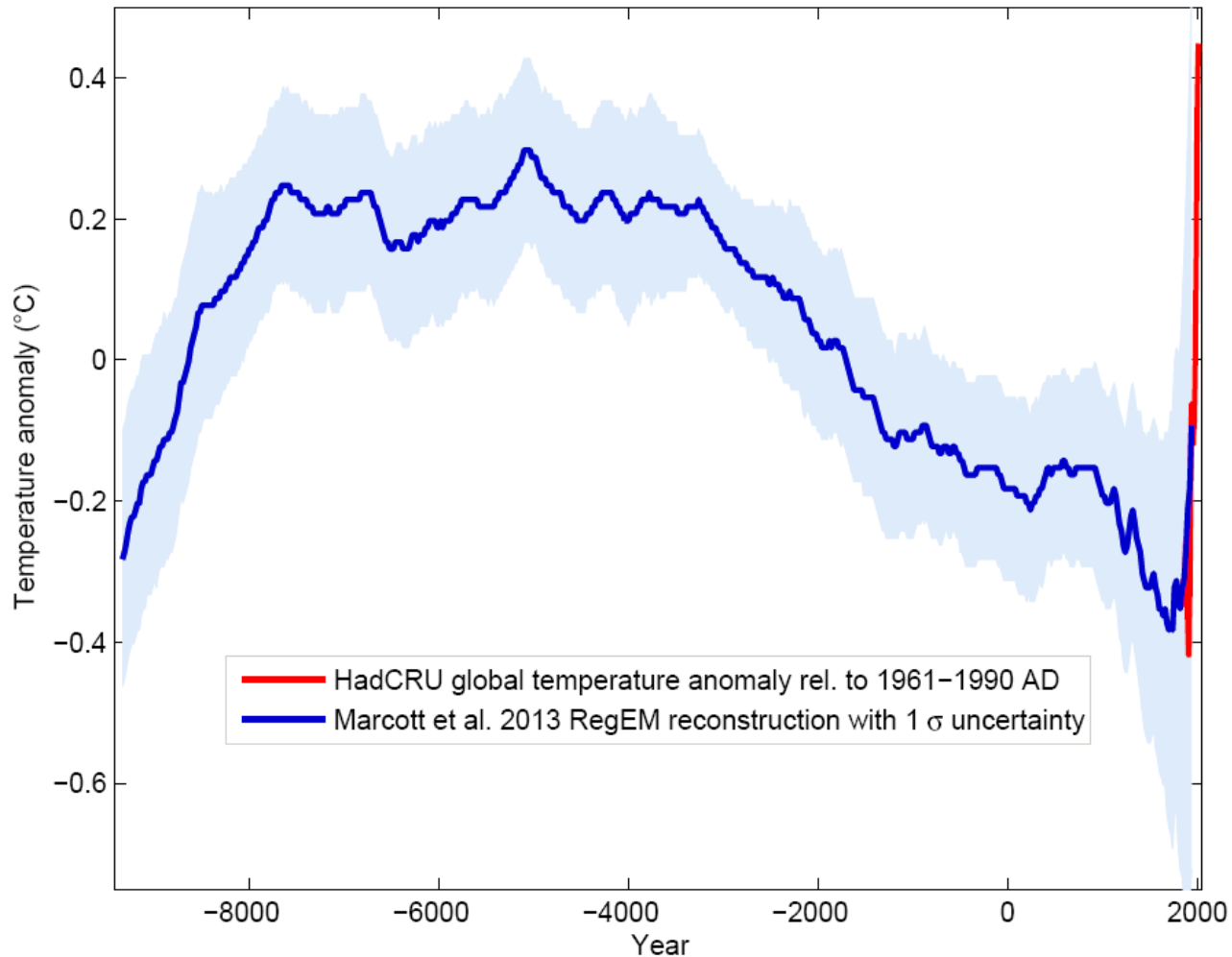
10

<1

Tg CO₂ per 1° grid
square per year

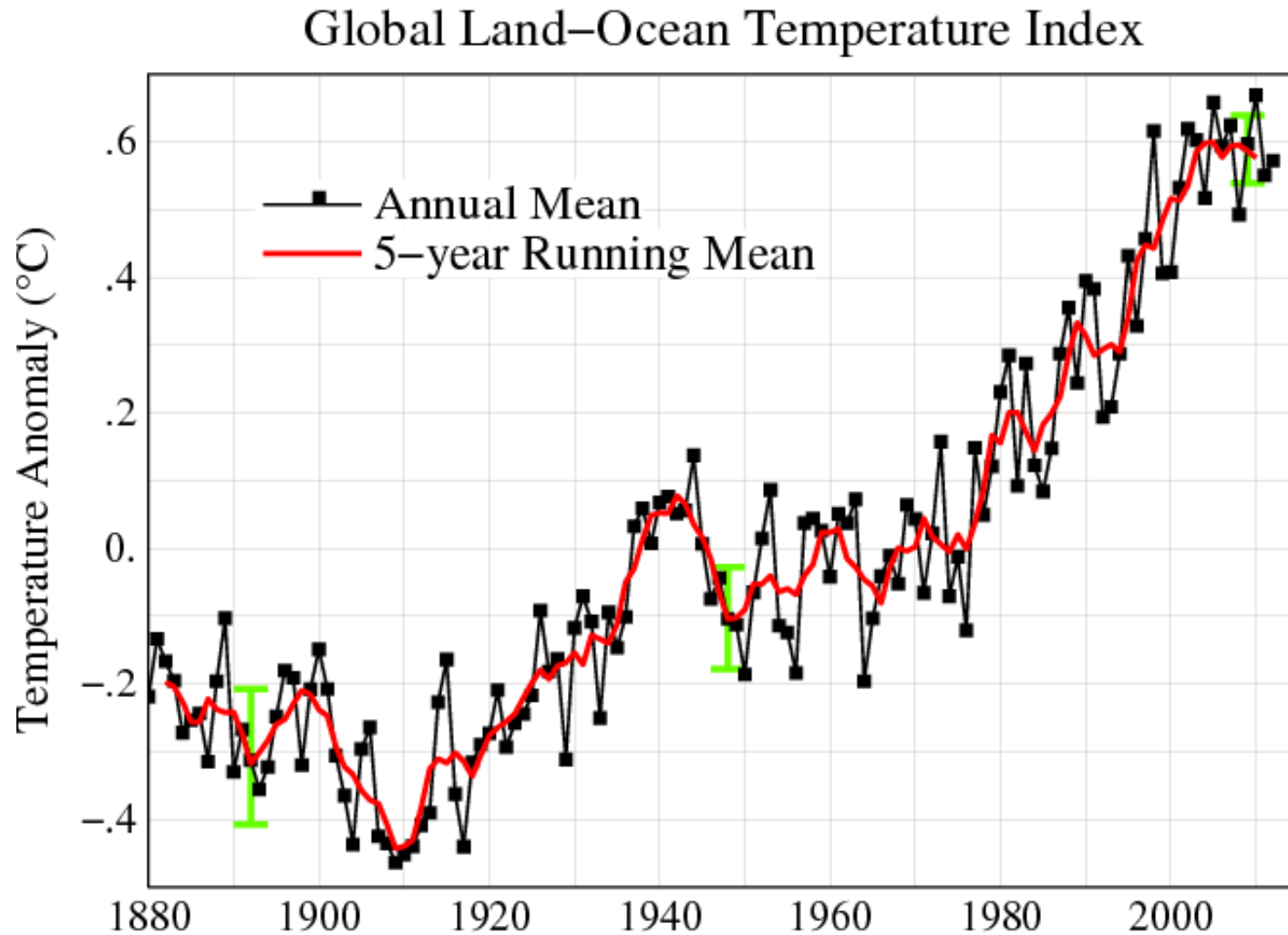
1756

First Global Reconstruction of Temperature for the Past 11 300 Years



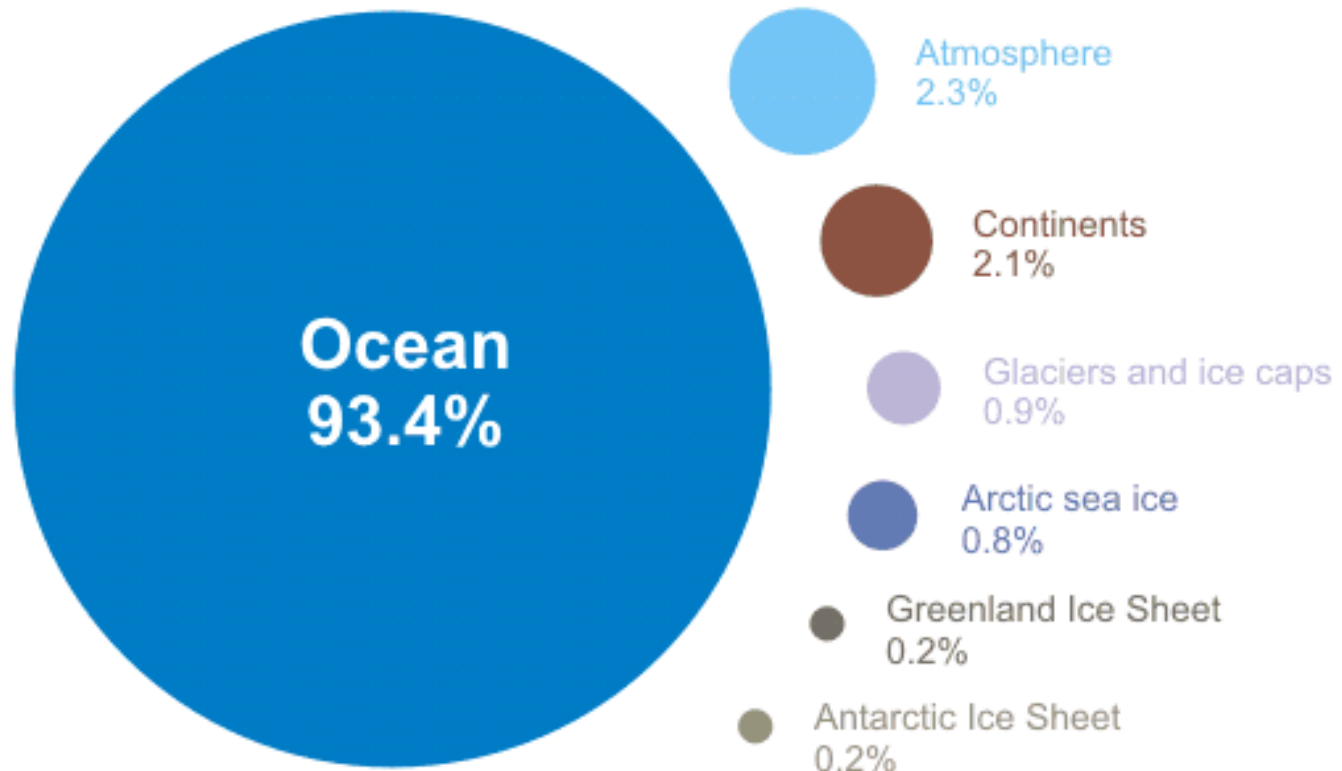
Marcott et al. Science 2013

Is Global Warming Taking A Break Now?



Source NASA GISS

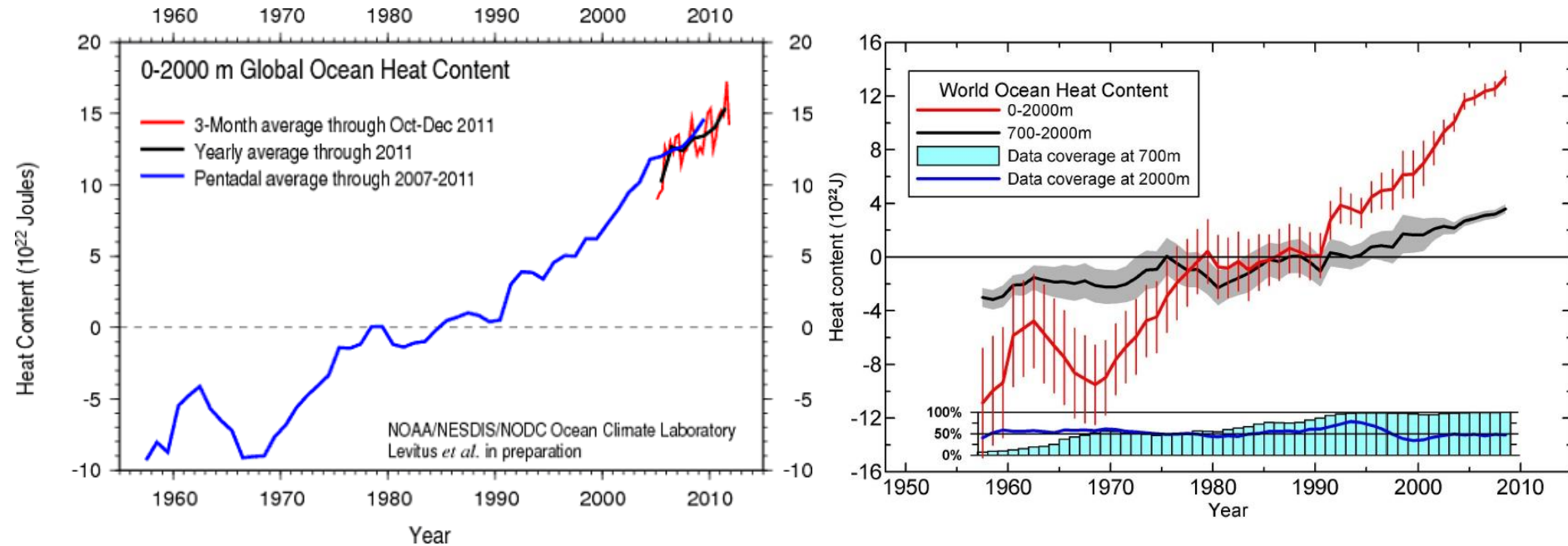
Where is Global Warming Going?



Components of global warming
for the period 1993 to 2003
(based on data from IPCC AR4)

Illustration by John Cook from
www.skepticalsciences.com

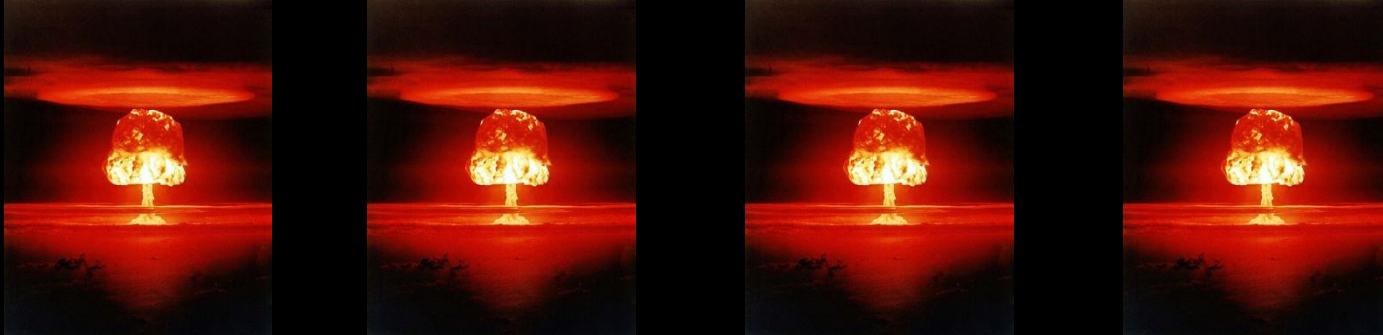
Global Ocean Heat Content



"We have estimated an increase of 24×10^{22} J representing a volume mean warming of 0.09°C of the 0-2000m layer of the World Ocean. **If this heat were instantly transferred to the lower 10 km of the global atmosphere it would result in a volume mean warming of this atmospheric layer by approximately 36°C (65°F)."**

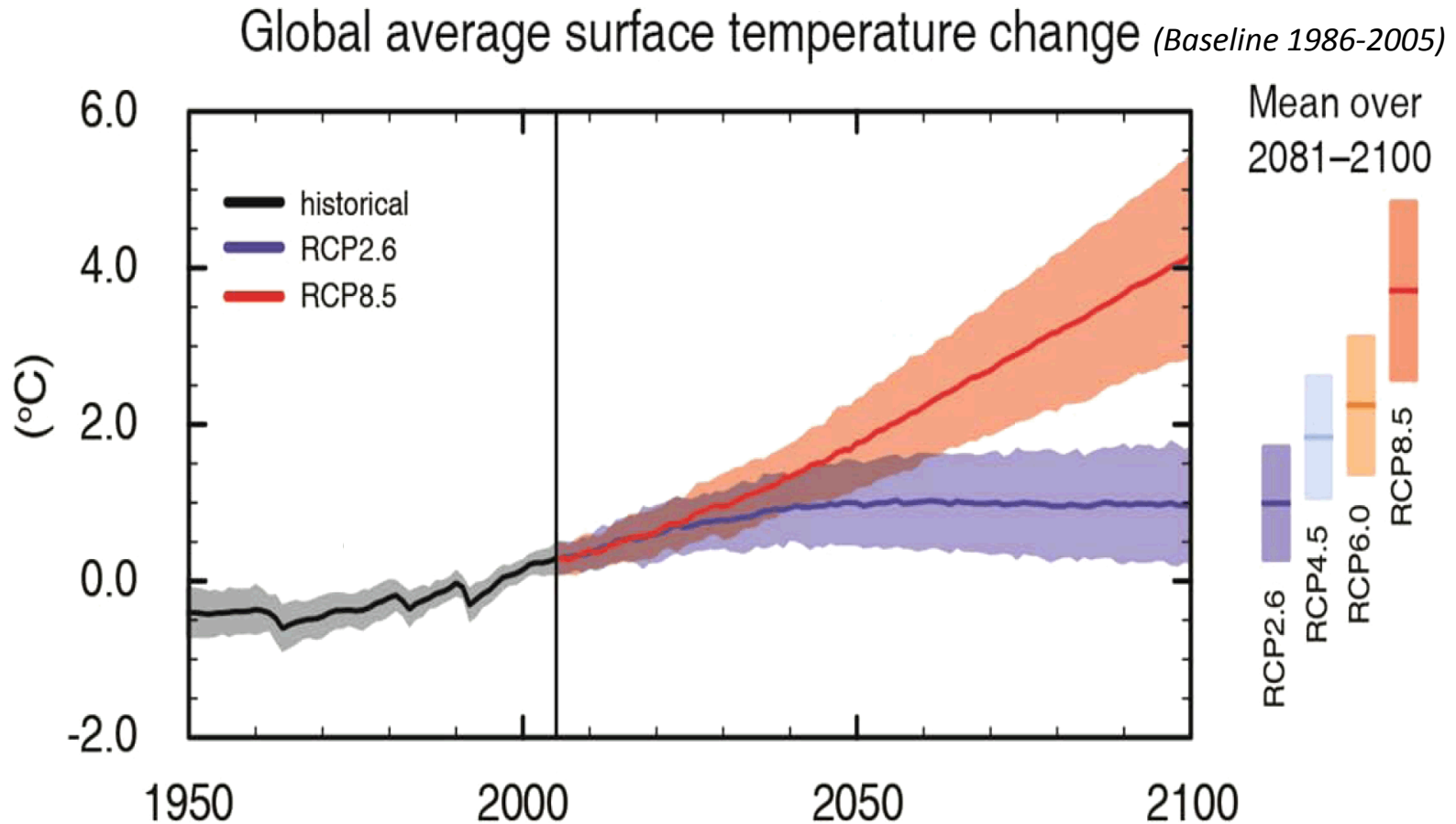
**Additional greenhouse effect through anthropogenic
emissions produces net energy import
equivalent to**

4 Hiroshima-Bomb explosions per second

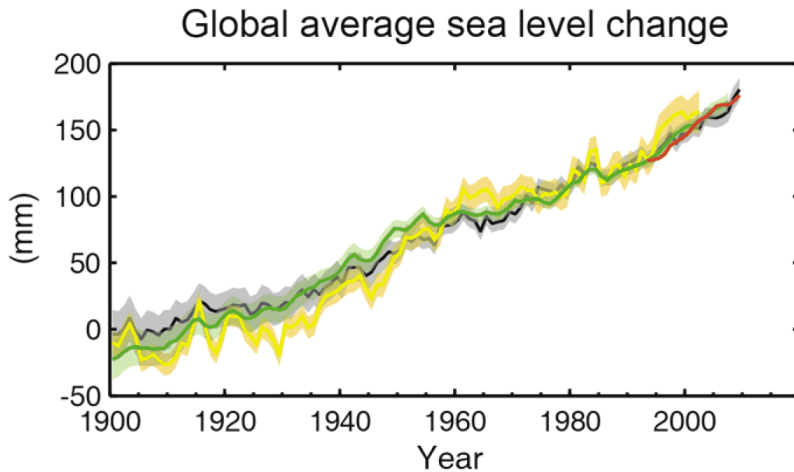


**This corresponds to approximately 125 Million
Hiroshima-Bomb explosions per year!**

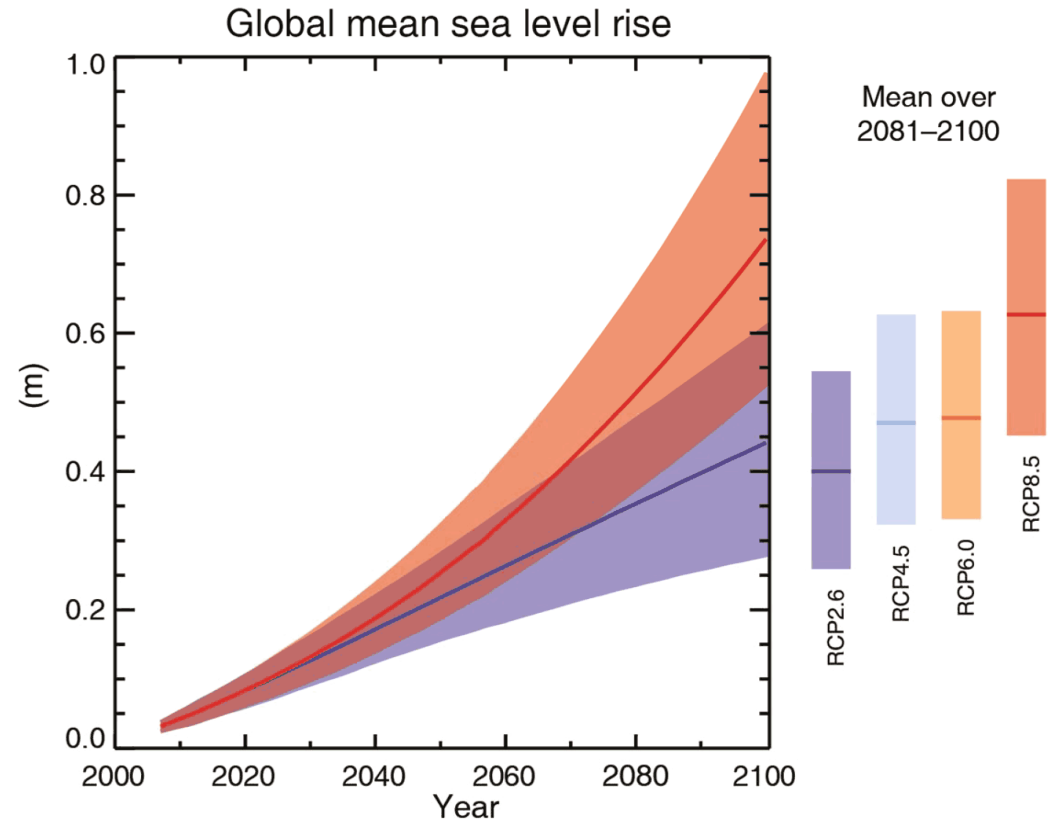
IPCC AR 5: Temperature Projections



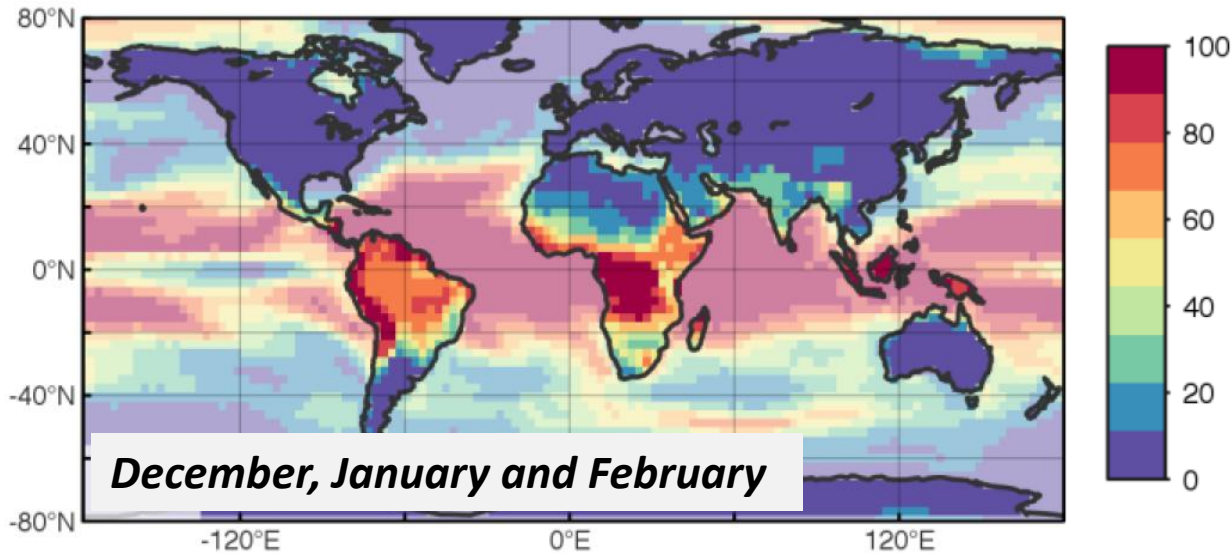
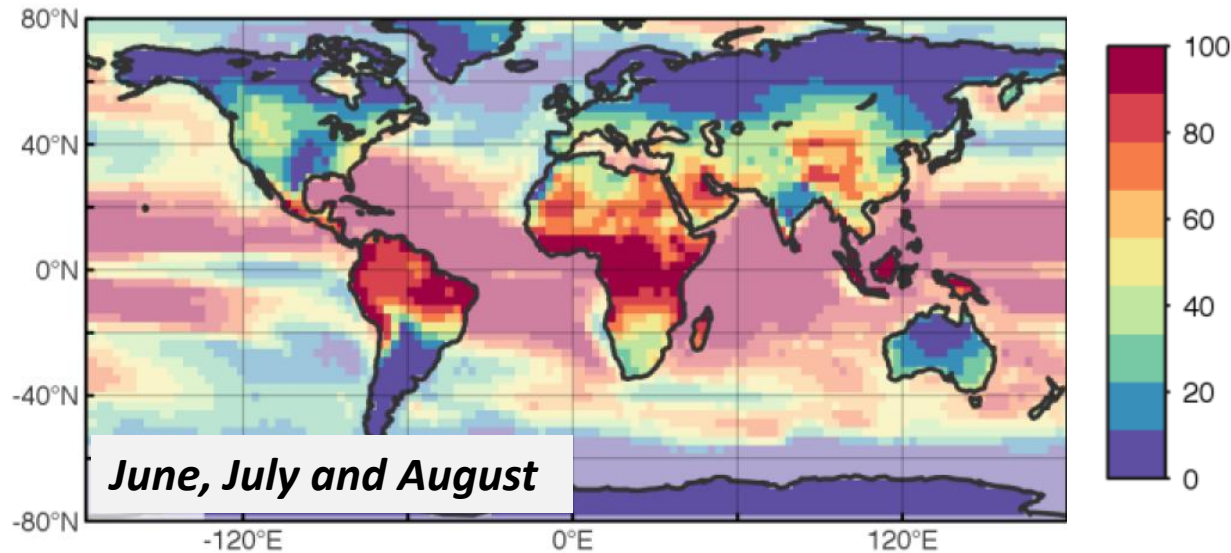
IPCC AR 5: 2013 Update on Sea Level Rise



The rate of sea level rise since the mid-19th century **has been larger than the mean rate during the previous two millennia (high confidence)**. Over the period 1901–2010, global mean sea level rose by 0.19 [0.17 to 0.21] m.



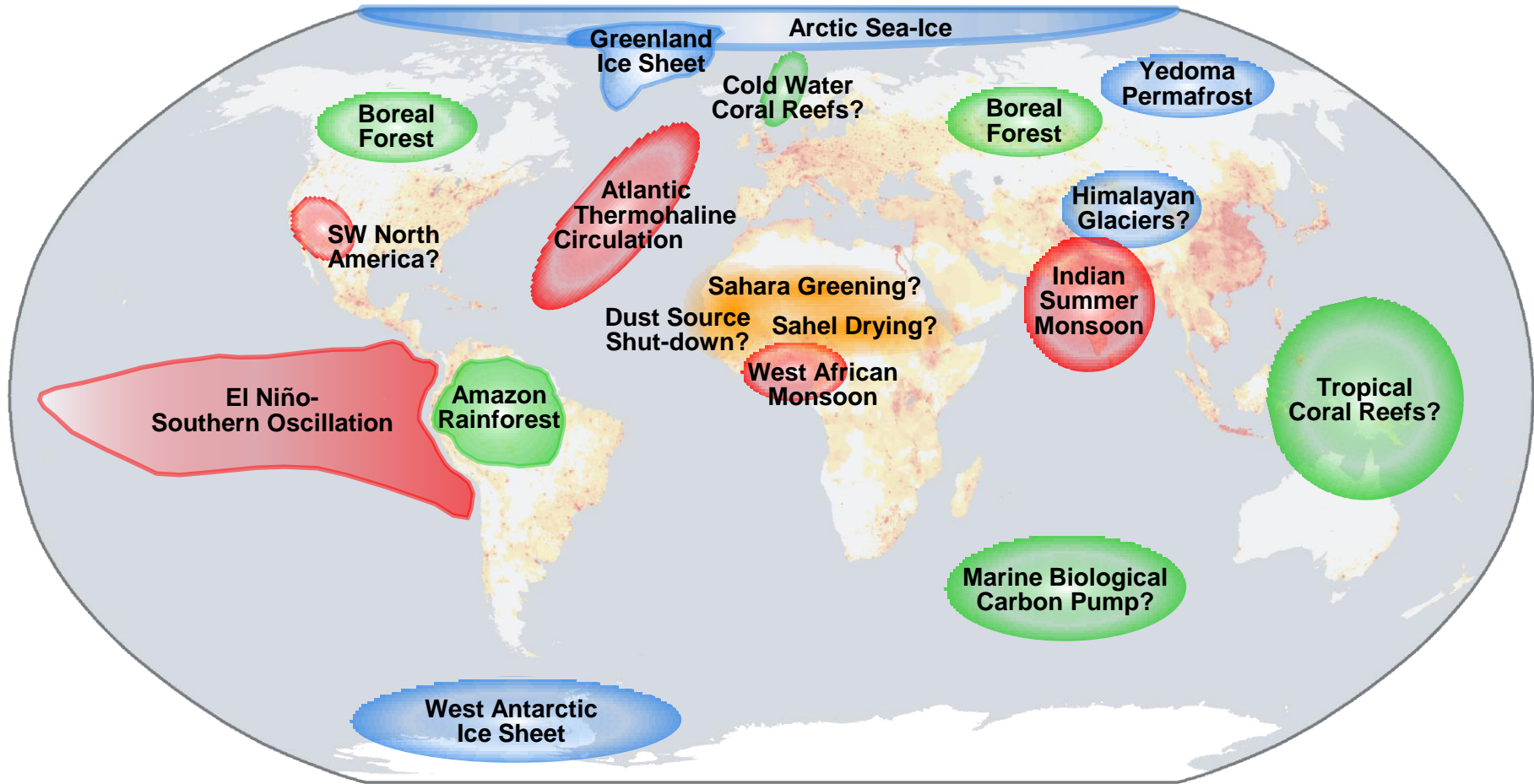
Frequency of Significantly Warmer Months



Multimodel mean of the percentage of months during 2080-2100 that are warmer than 5-sigma relative to the present-day climatology

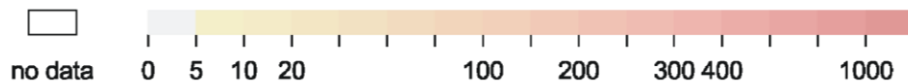
Source: Schellnhuber et al., 2012
Turn Down the Heat – Why a 4°C Warmer World Must be Avoided

Updated Map of Tipping Elements in the Earth System



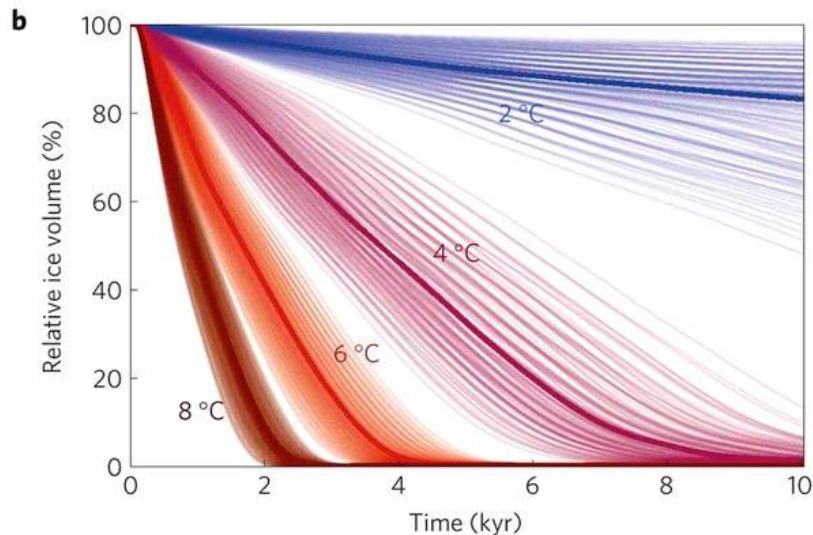
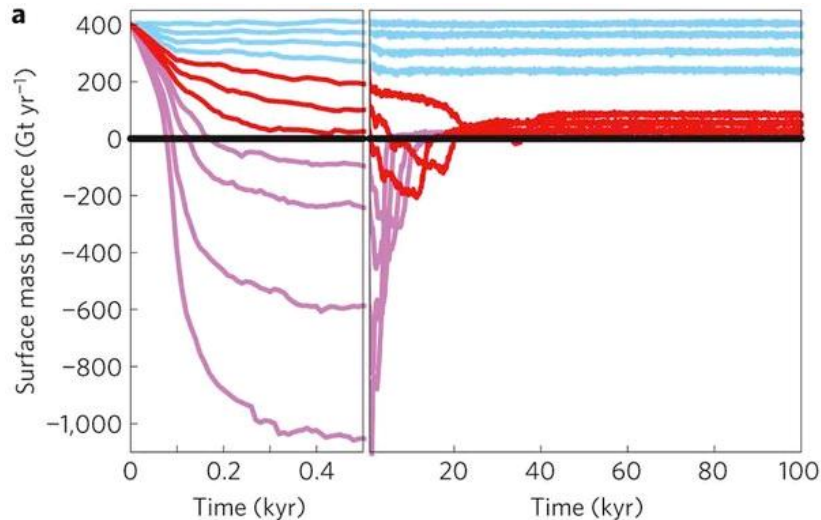
- Melting
- Circulation change
- Biome loss

Population Density [persons per km²]

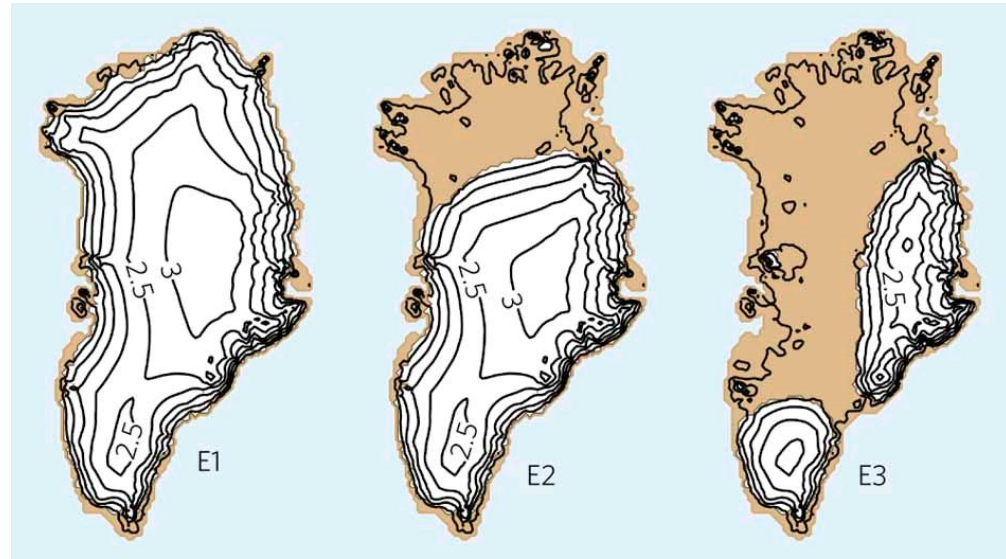


Source: PIK, after Lenton et al., 2008

Irreversible Loss of Greenland Ice-Sheet Could Start with 1.6°C Temperature Rise



Transient GIS evolution.



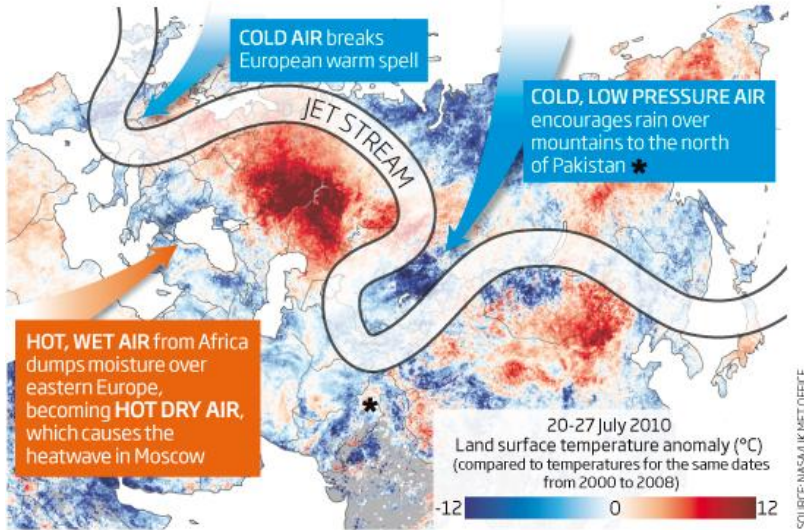
Equilibrium states of the GIS.

Synchronicity of Extreme Events

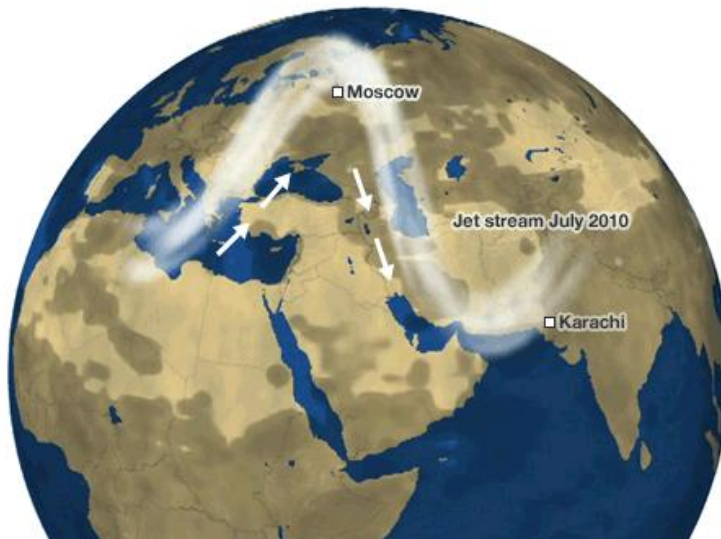
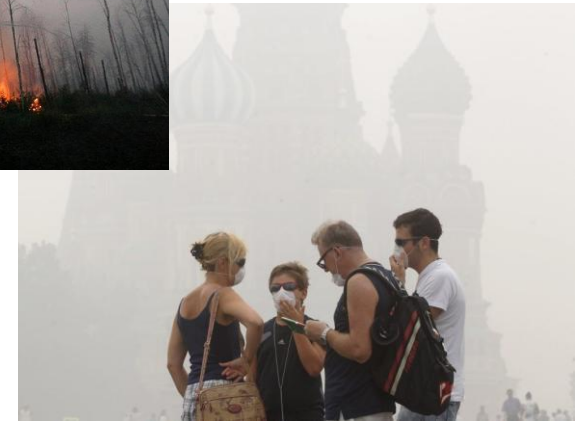
Holding pattern

©NewScientist

In the second half of July, a blocking event froze the meanders of the jet stream over Europe and Asia. The pattern led to extreme weather across the continents



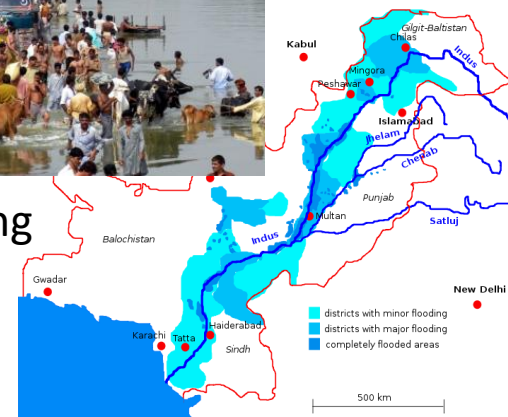
Russian Heat Wave



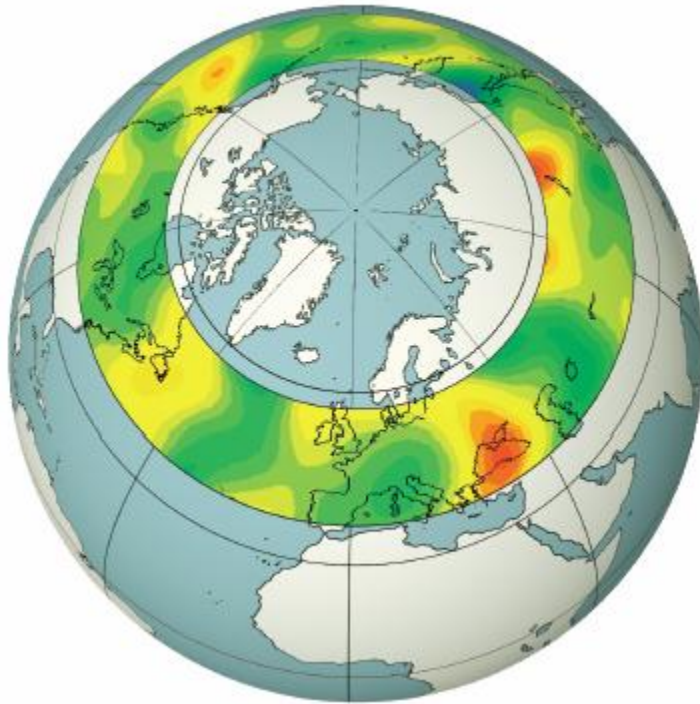
Source: bbc.co.uk



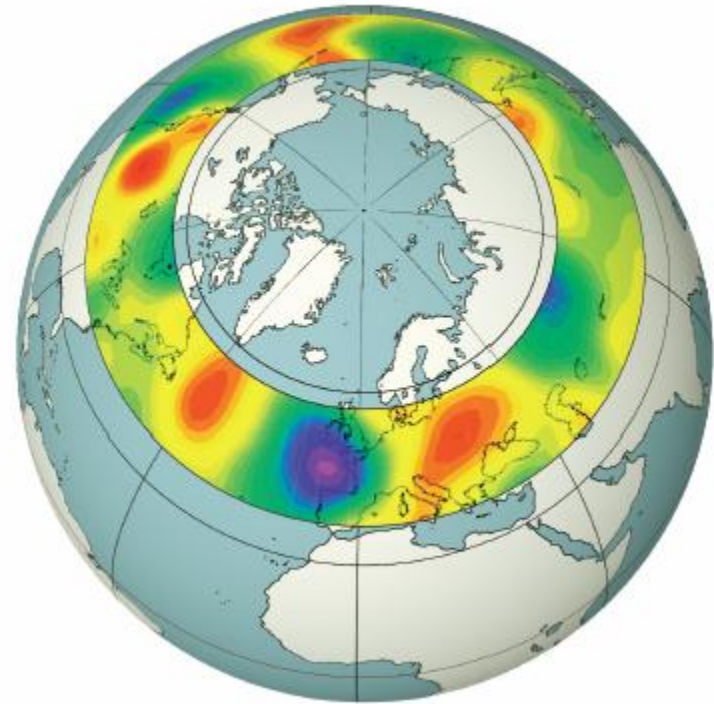
Pakistan Flooding



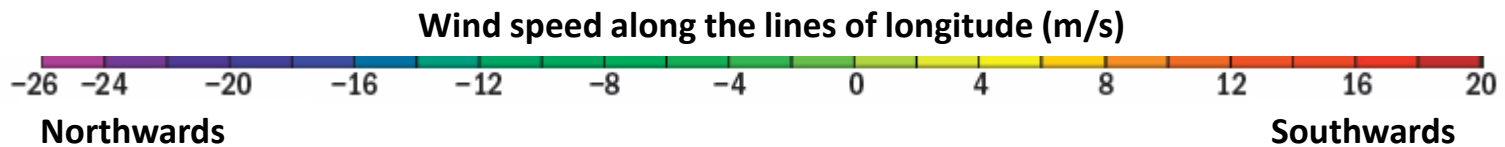
Quasi-Resonance of Planetary Waves



Normal: July 1980



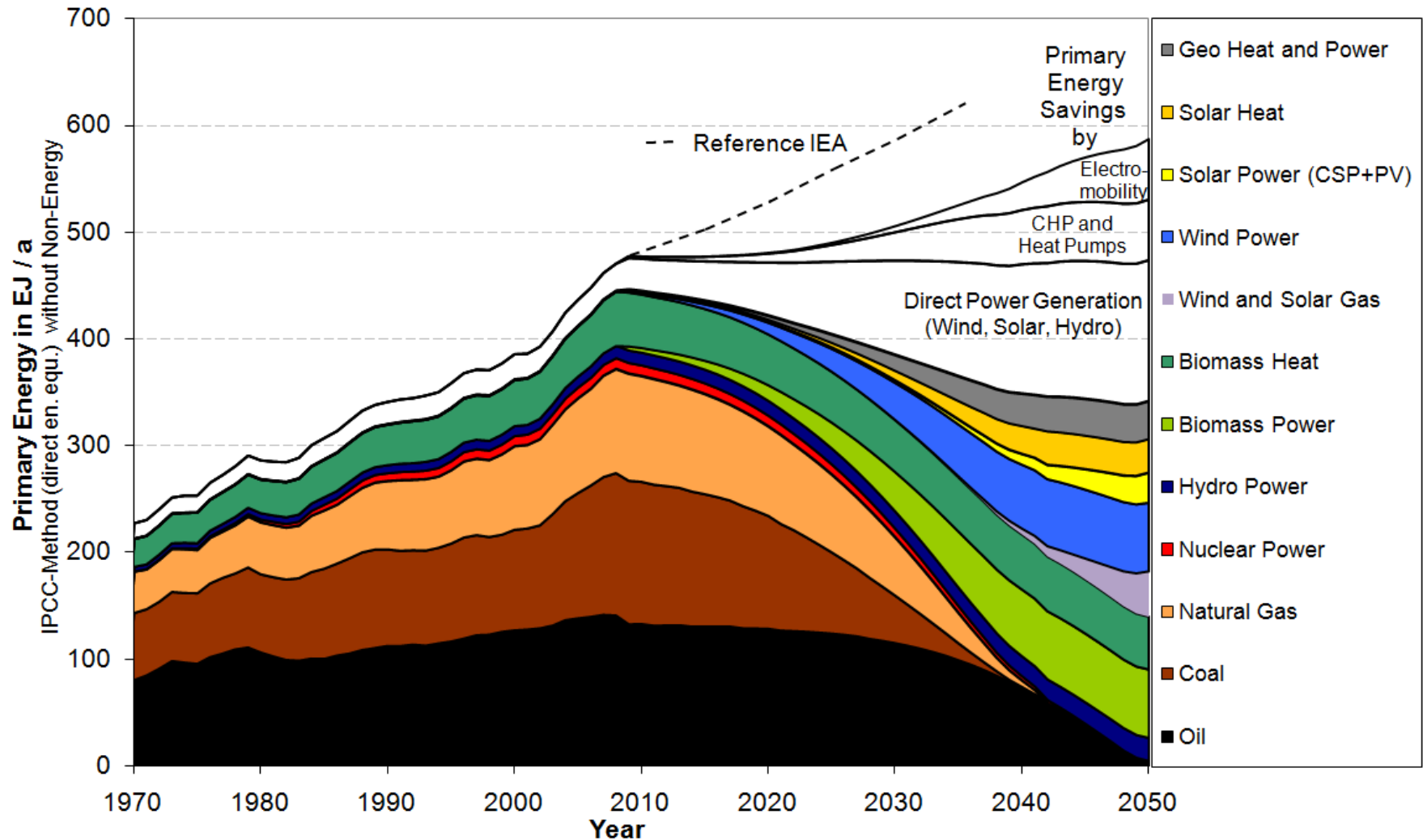
Extreme: May 2013



Stationarity is Dead !?

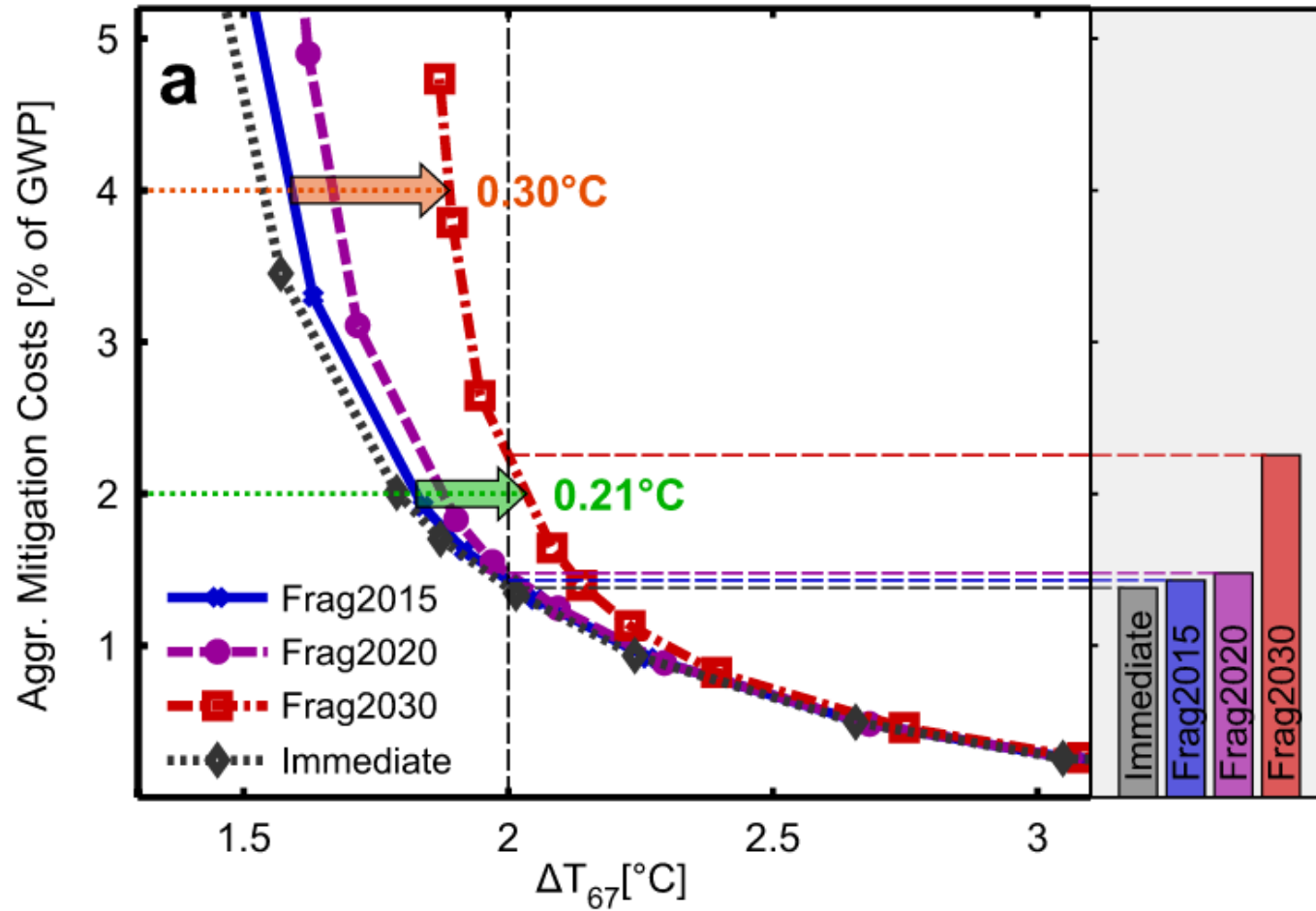
WBGU Vision of Global Energy Revolution Based on Renewables

Development of the primary energy demand between 1970 and 2050



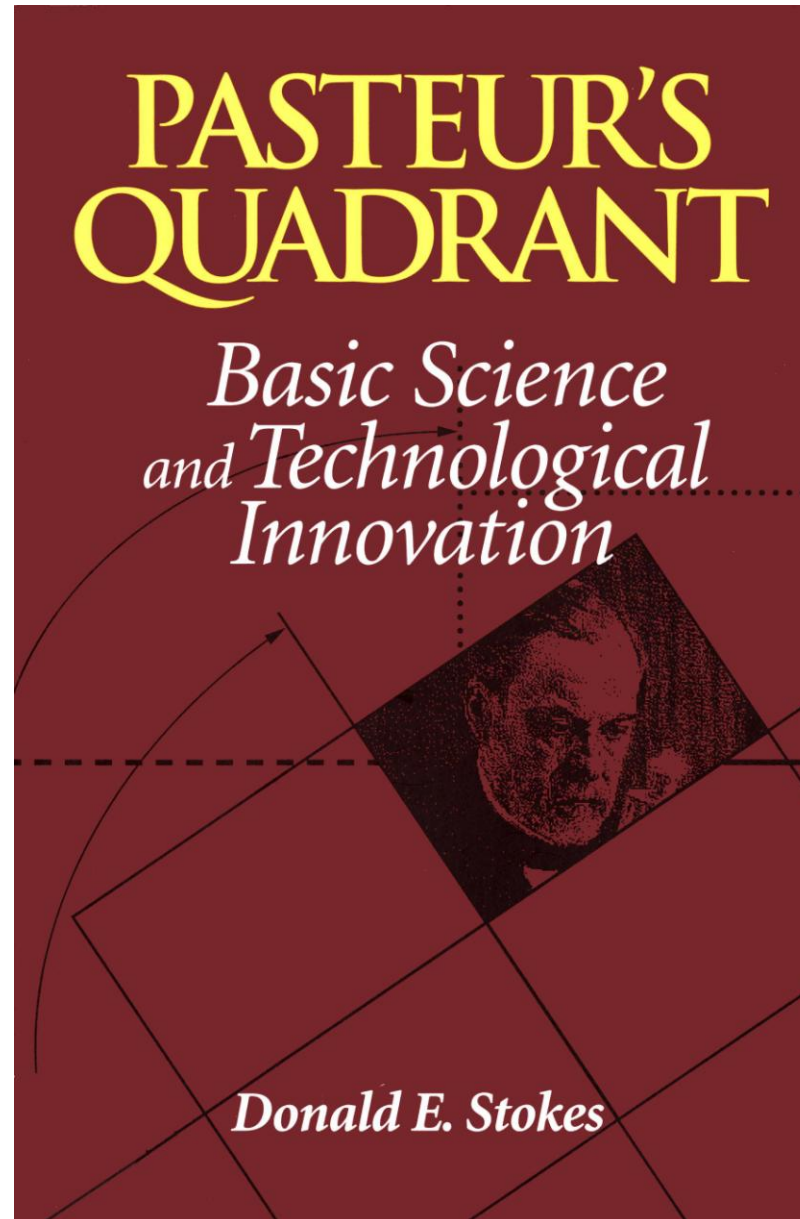
Source: WBGU 2011

Temperature-cost-trade-off curves showing the effect of timing of global comprehensive mitigation action



Source: Luderer et al., Environ. Res. Lett. 2013

Donald Stokes on Basic vs. Applied Research, 1997



V. Bush Report: „Science, The Endless Frontier “

A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945

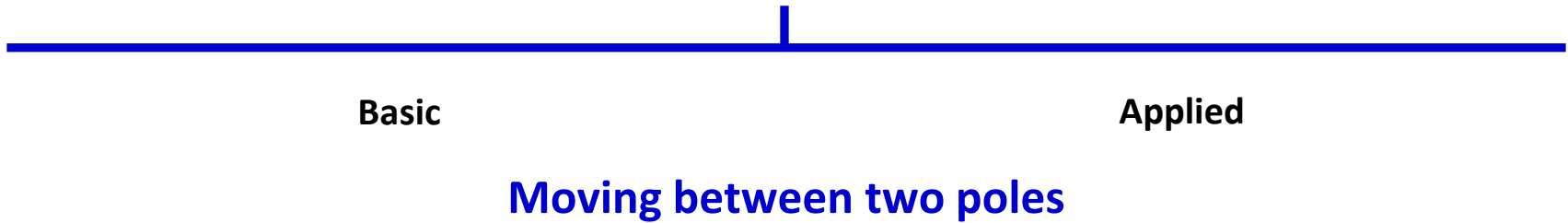
(United States Government Printing Office, Washington: 1945)



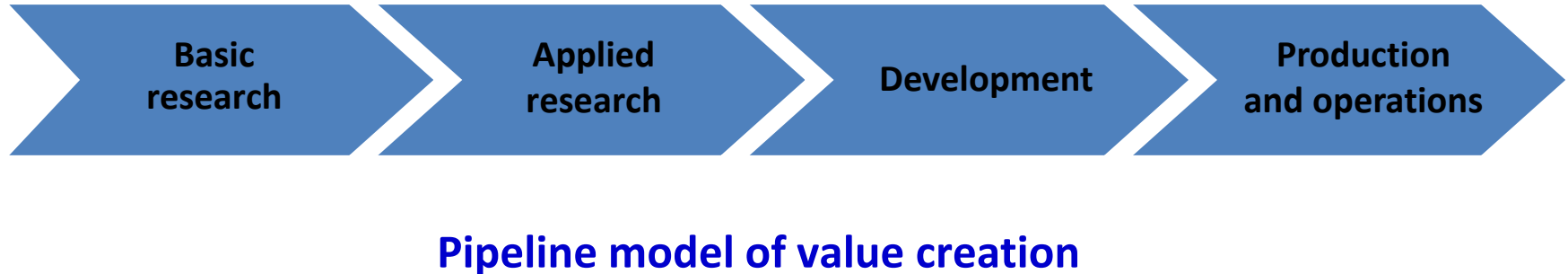
- Delivered on 25 July 1945
- Requested by President Roosevelt on 17 November, 1944
- Bush is counted among the founders of the “military-industrial complex”

The Double-Linear Paradigm

(A)



(B)



Research Characterized by the Motivations that Inspire It

Beyond basic vs applied research:
Science in Stoke's Quadrants

		Considerations of use?	
		No	Yes
Quest for fundamental understanding?	No	Bad research (N. N.)	Applied research (Edison)
	Yes	Basic research (Bohr)	Use-inspired basic research (Pasteur)

Clark W C et al. PNAS 2007;104:1737-1738

PNAS

A portrait of an elderly woman with short, wavy, light-colored hair. She is wearing rectangular-framed glasses and a white turtleneck sweater. Over the sweater, she wears a dark jacket with a prominent red beaded trim along the collar. A necklace with red beads and dark, teardrop-shaped pendants is visible. The background is a dark, textured surface.

[illegible]

Editorial, 2003

Communicated by Susan Hanson, Clark University, Worcester, MA, March 7, 2003 (received for review February 25, 2003)

PNAS

Editorial Board

Sustainability Science

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L'Aquila

A Special Aftershock

Oct. 25, 2012

Joint Statement Regarding the Recent Conviction of Italian Earthquake Scientists

by Ralph J. Cicerone, President, U.S. National Academy of Sciences, and Sir Paul Nurse, President, The Royal Society (U.K.)



The Laws of Nature – and the Laws of Civilization

1st Law of Capitalism:
„Don't kill your customers!“

1st Law of Socialism:
„Don't kill your comrades!“

And, overriding everything else:

1st Law of Humanity:
„Don't kill your children!“