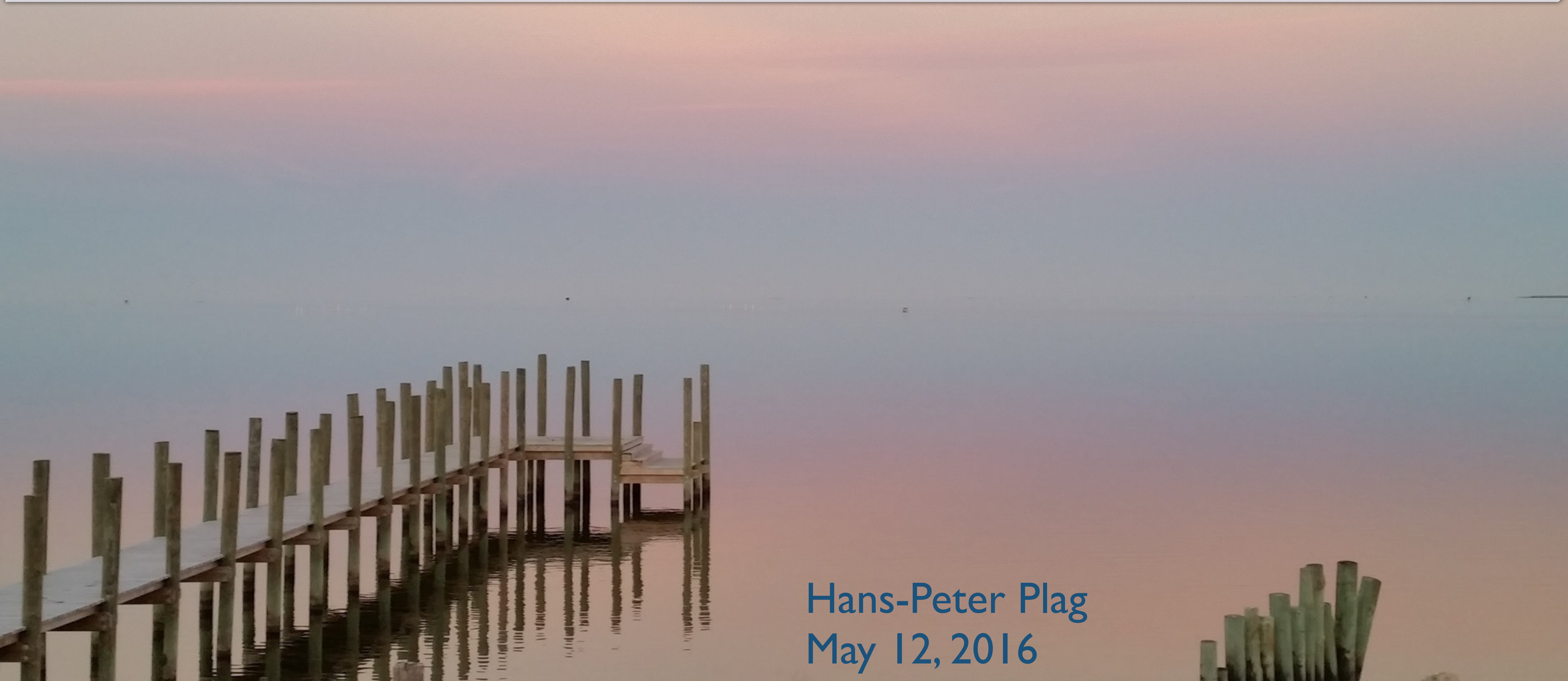
Oluwakemi Izomo

Global and Climate Change and Sea Level Rise: Understanding and Meeting the Challenge From Local to Global Levels



Hans-Peter Plag

May 12, 2016

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"Managing Risk Through Process and Organizational Innovation"

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Focus on:

- *risk management*
- *asset management*
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Are we prepared, or even considering, global emergencies?

Griggs et al., 2013

Plag and Jules-Plag, 2013

The system:
the Earth’s life-support system, in which humanity is a component, and on which humanity depends;

Plag and Jules-Plag, 2013

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"Managing (Global) Risk Through Process and Organizational Innovation"

Plag and Jules-Plag, 2013

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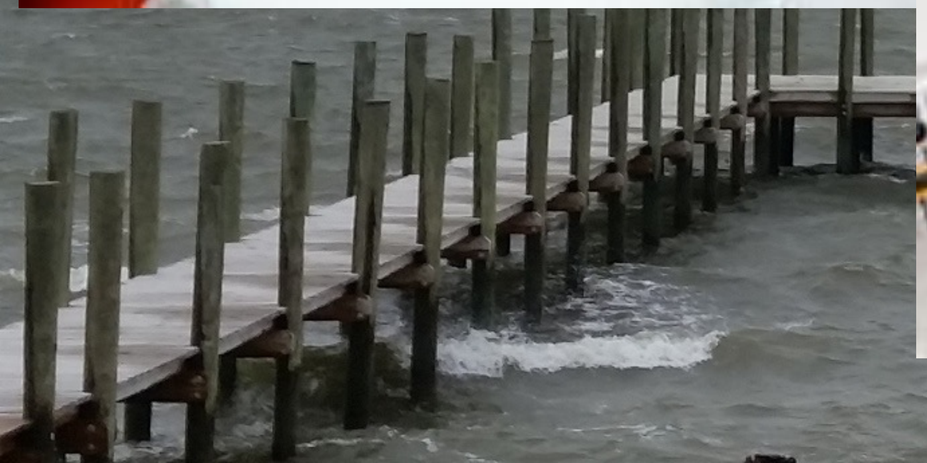
OLD DOMINION UNIVERSITY



Global and Climate Change and Sea Level Rise: Understanding and Meeting the Challenge From Local to Global Levels

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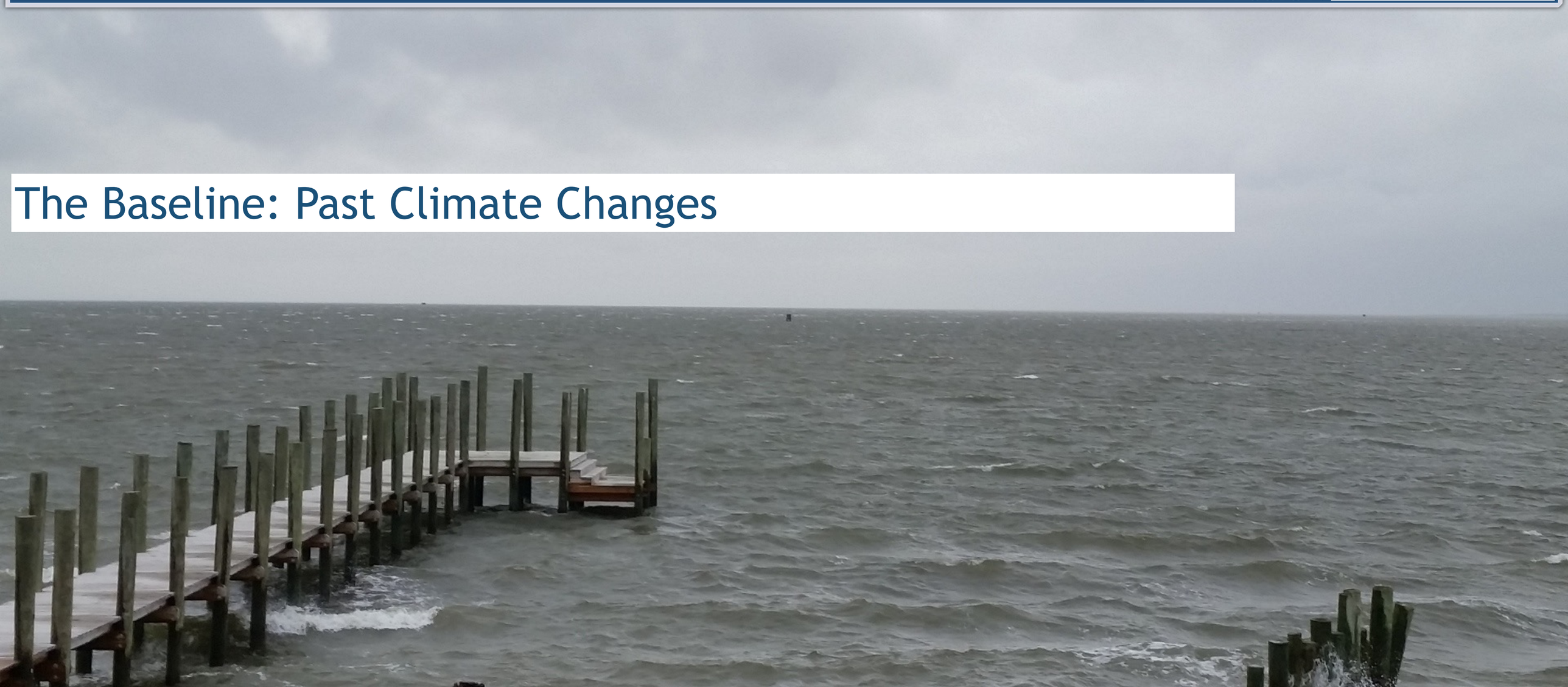
The Baseline: Past Climate Changes



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The Diagnosis: Leaving the “Safe Operating Space”

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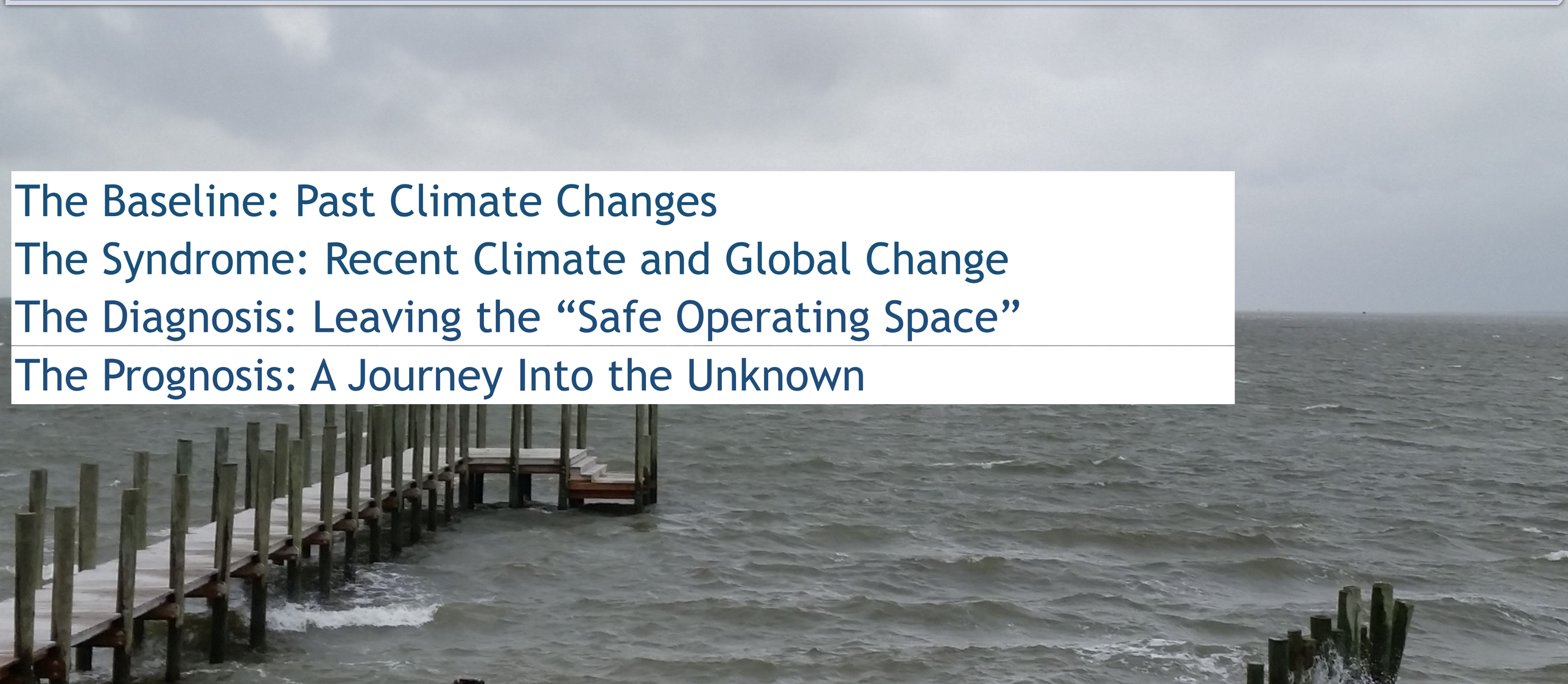

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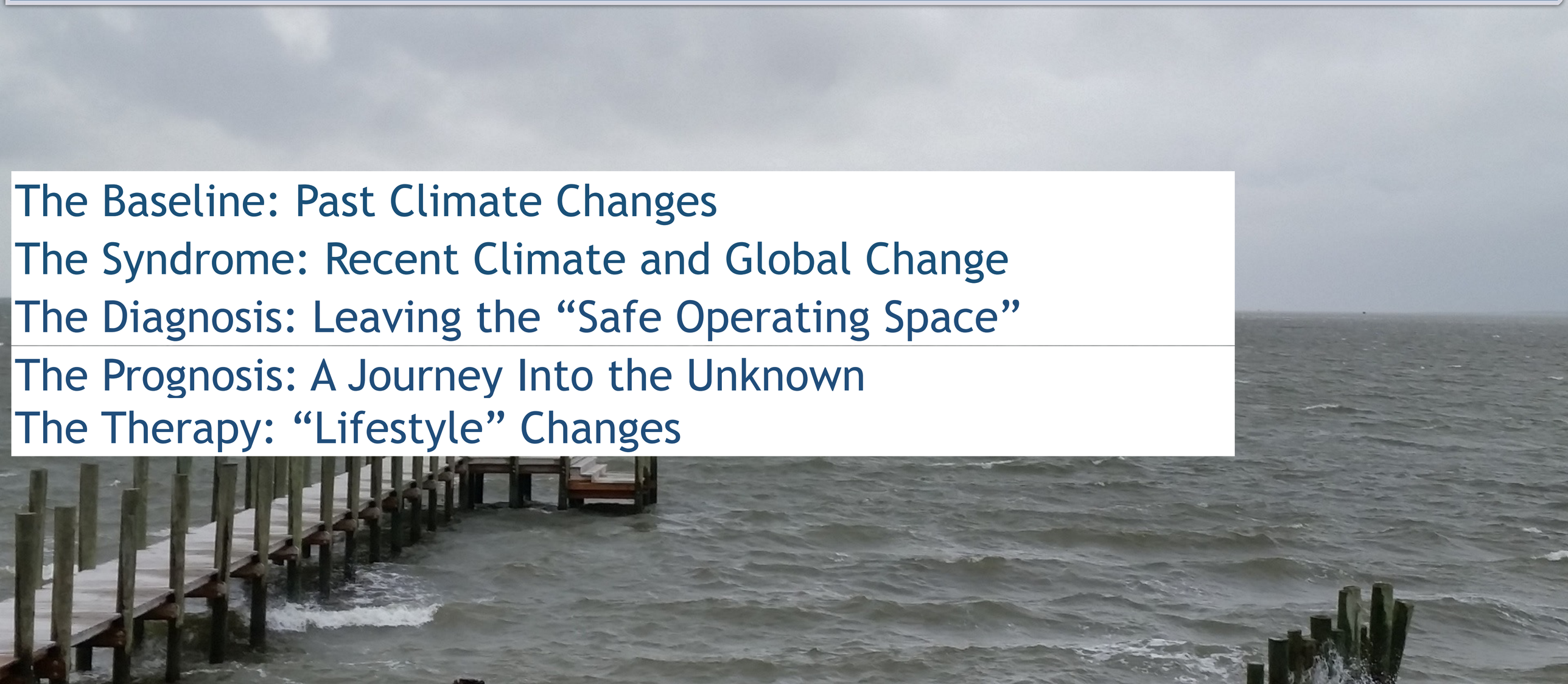

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The Baseline: Past Climate Variability

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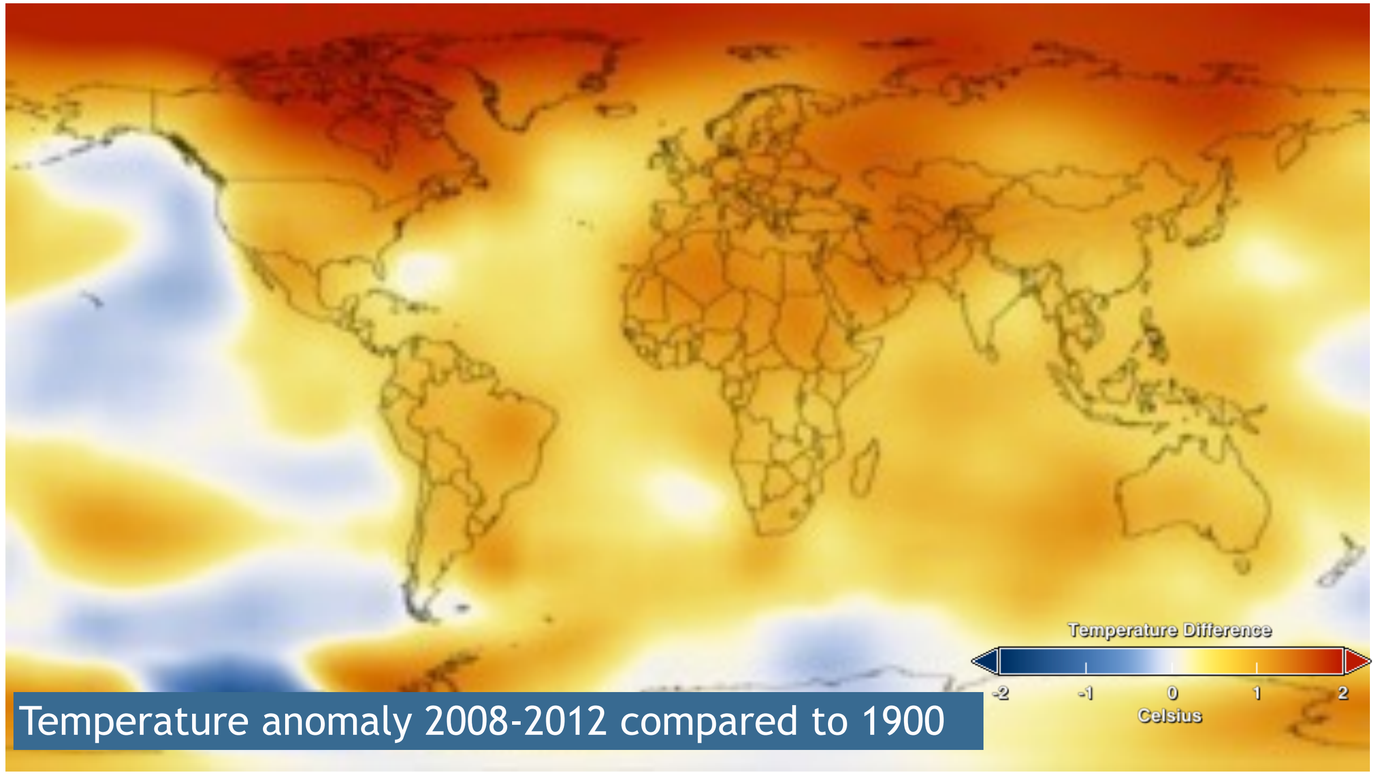

Temperature anomaly 2008-2012 compared to 1900

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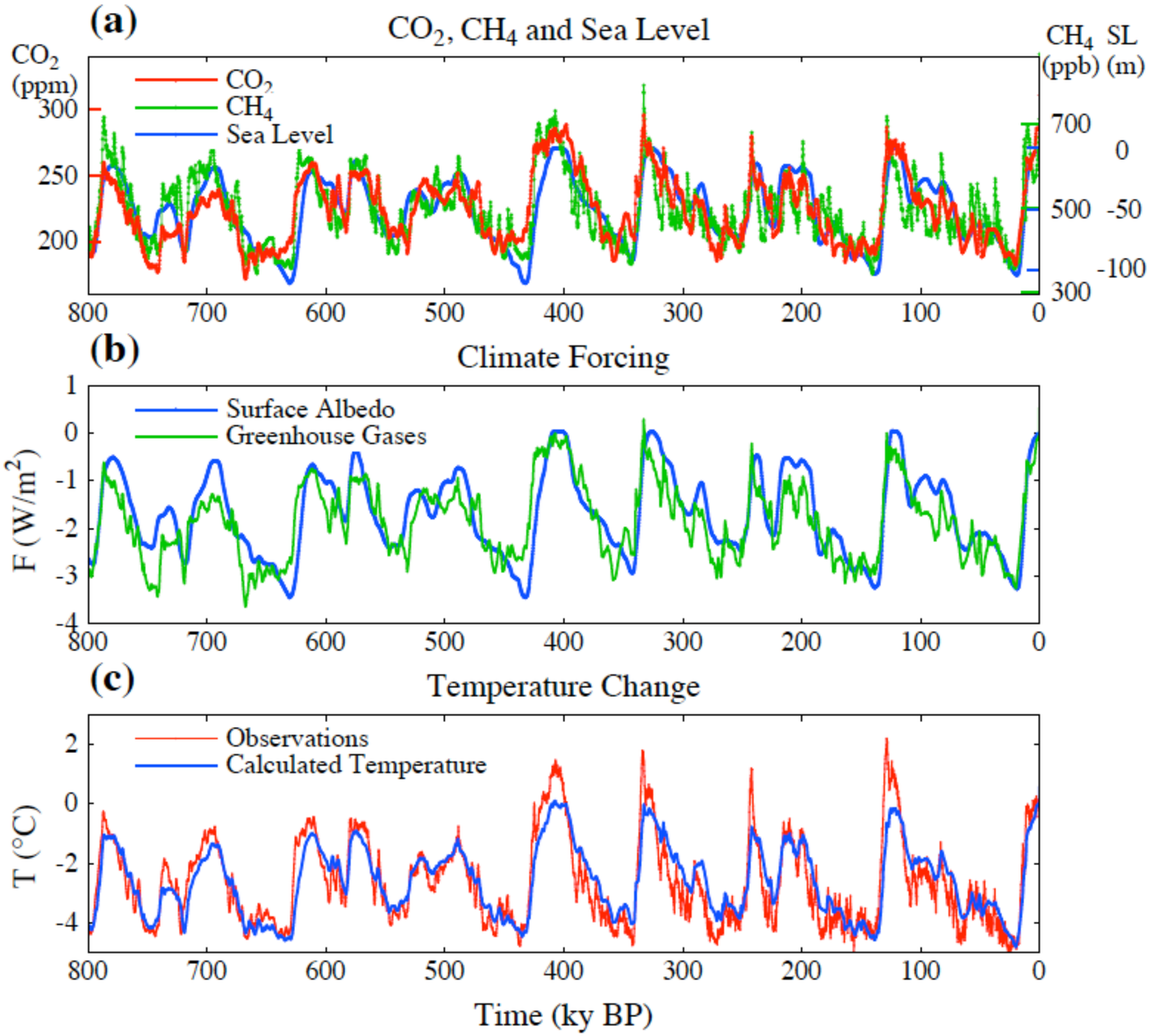
Climate can change a lot over time.



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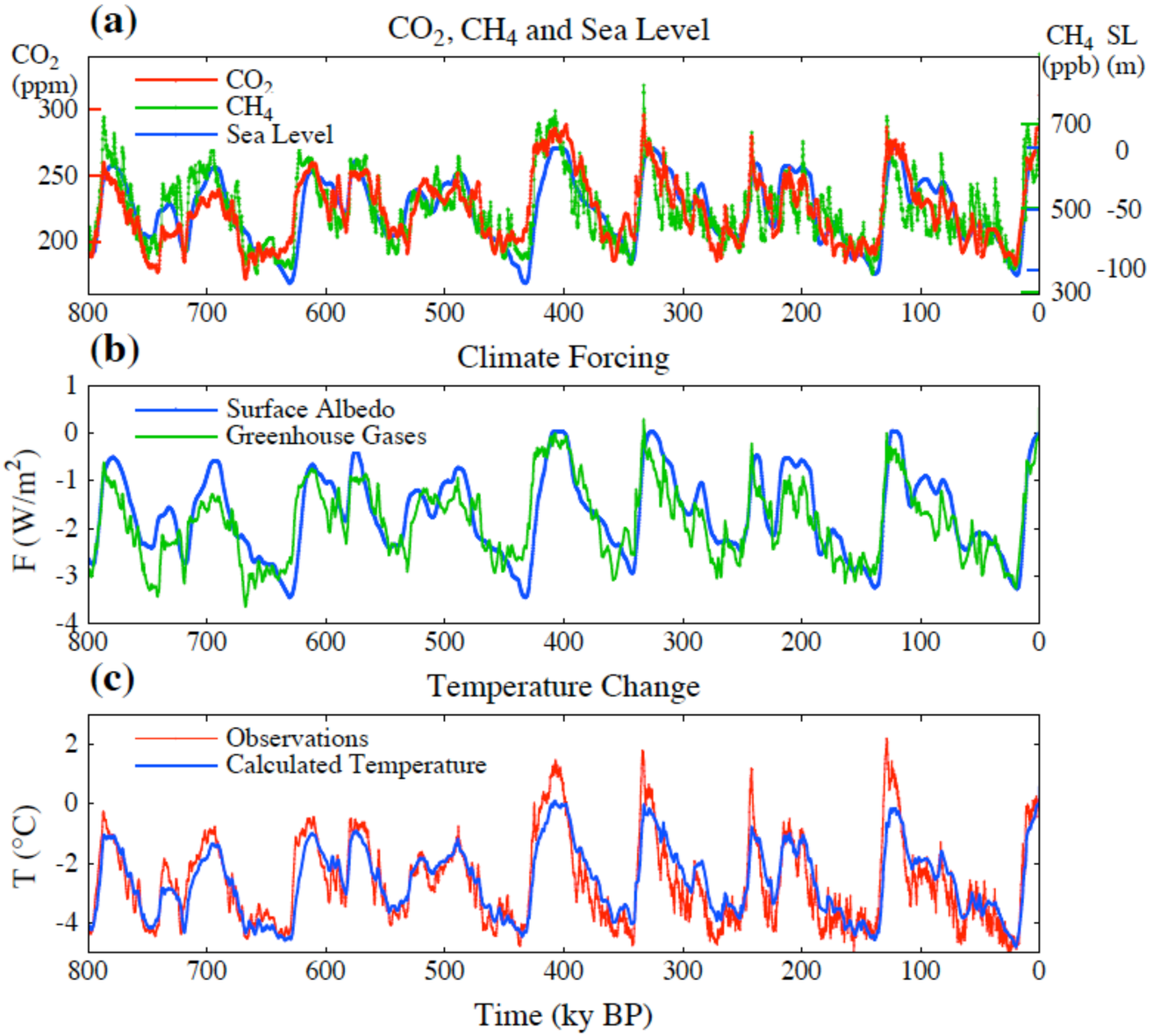

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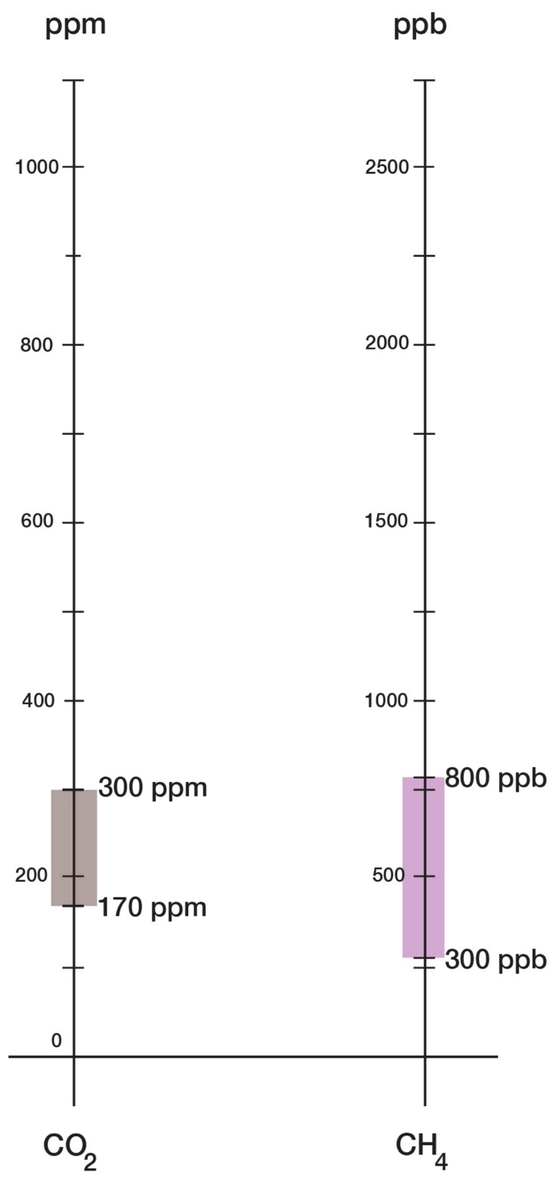
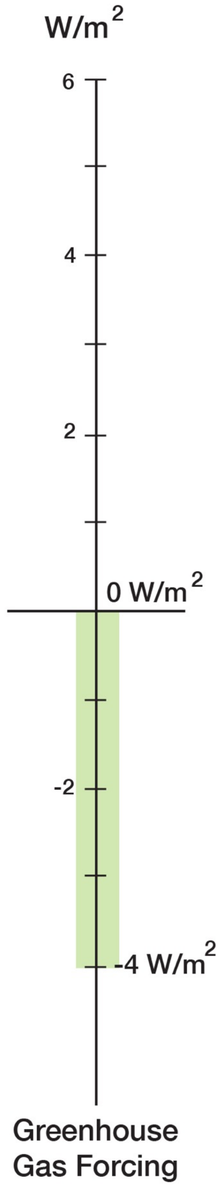
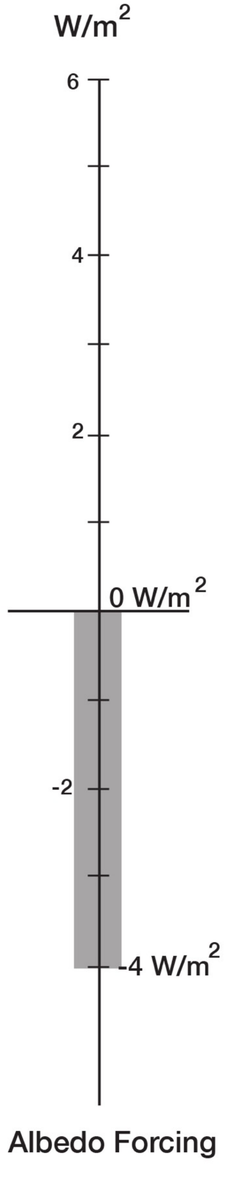
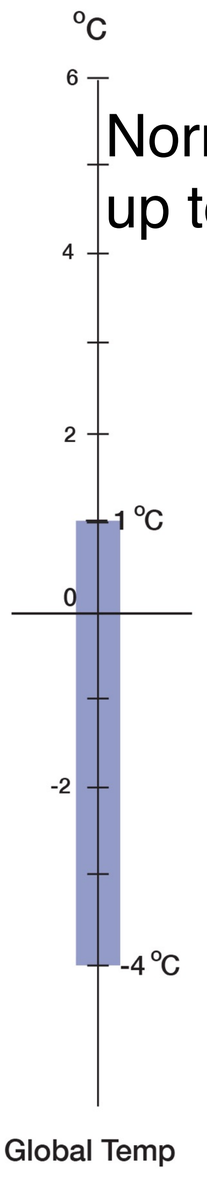
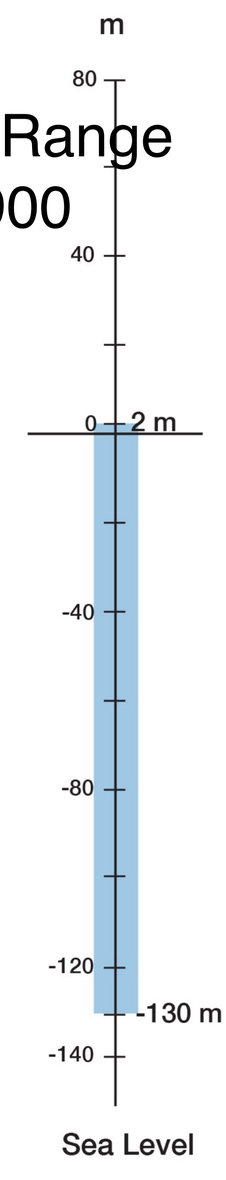


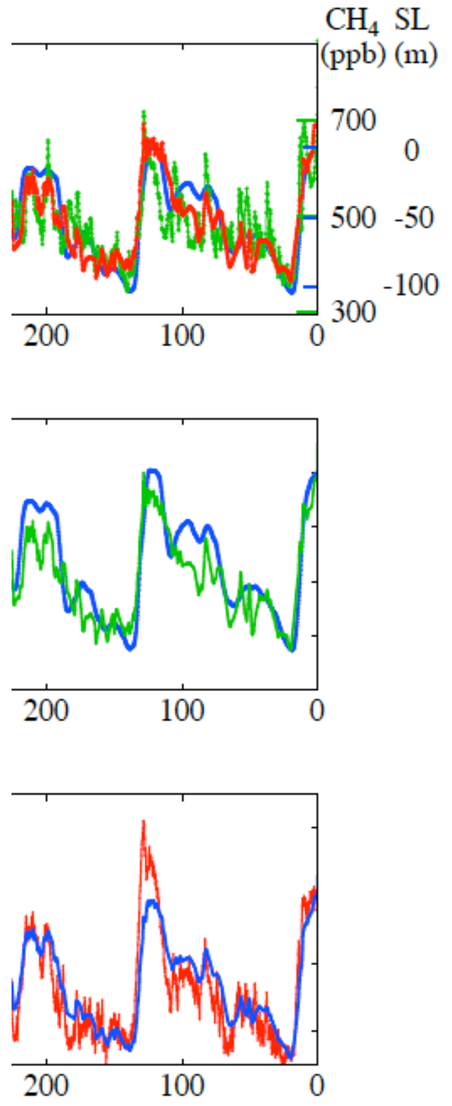






Normal Range up to 1900





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Long-term (centuries to millennia) correlations:

- 130 ppm CO
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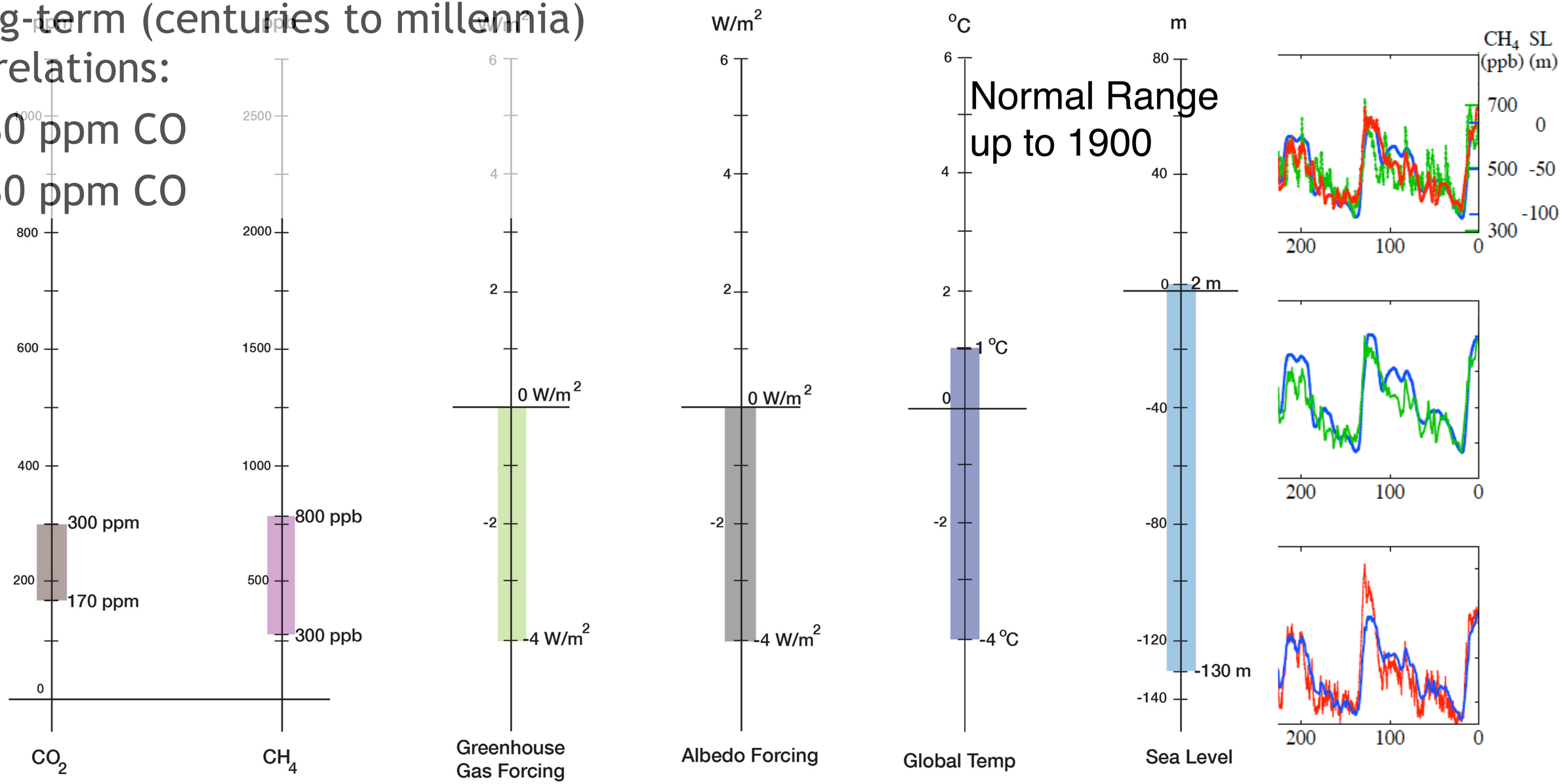

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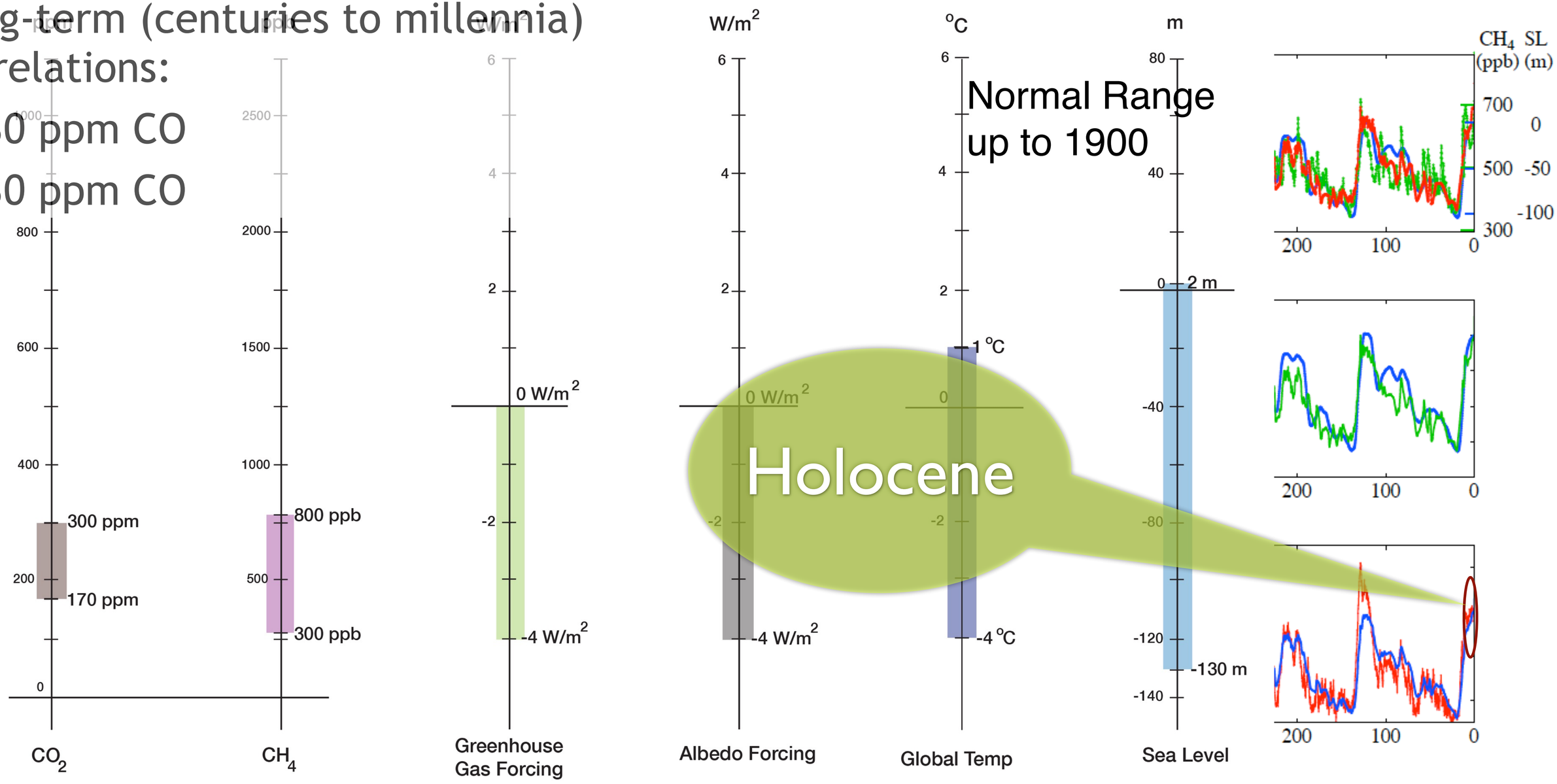

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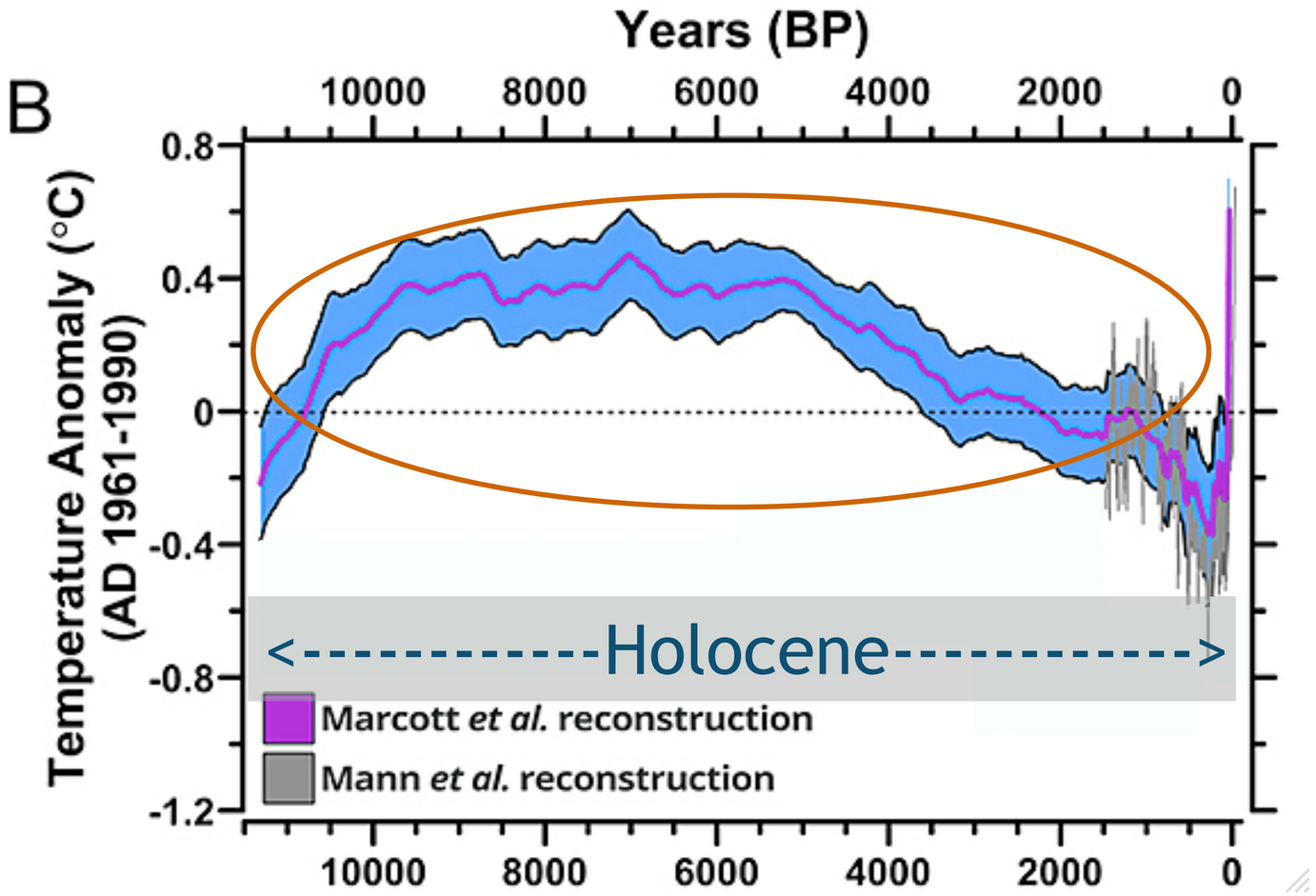
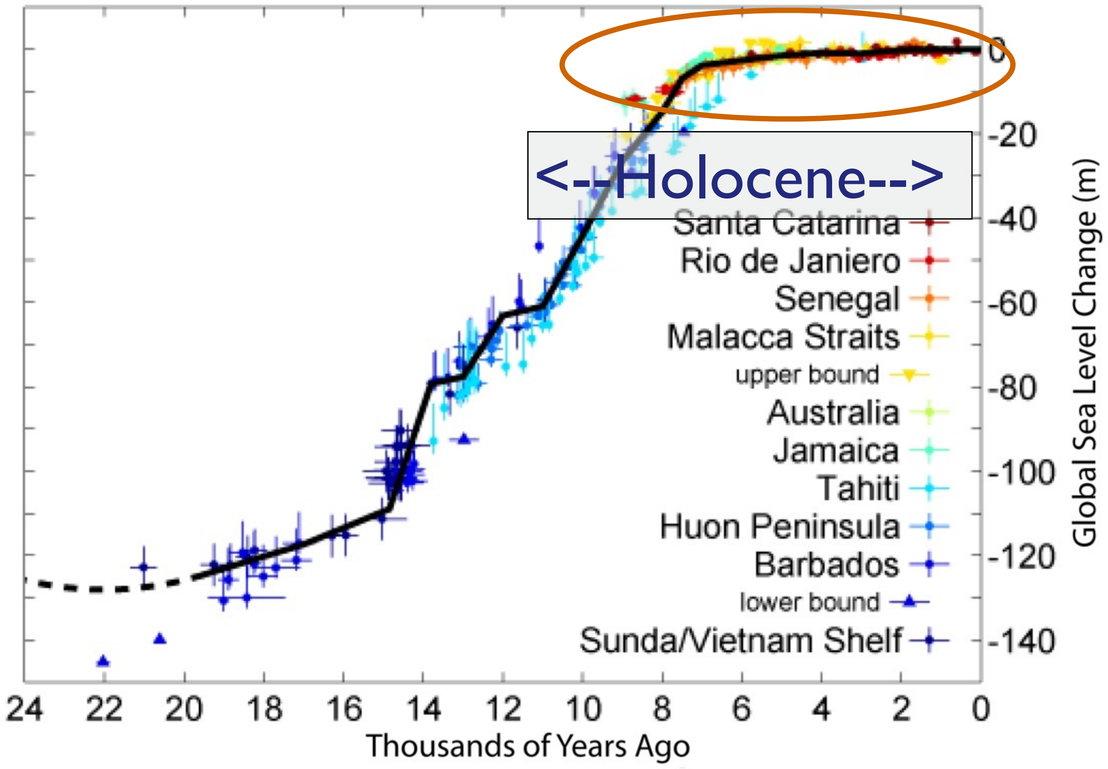
Global Temperature Changes



Marcott et al., 2013

Global Sea Level Changes



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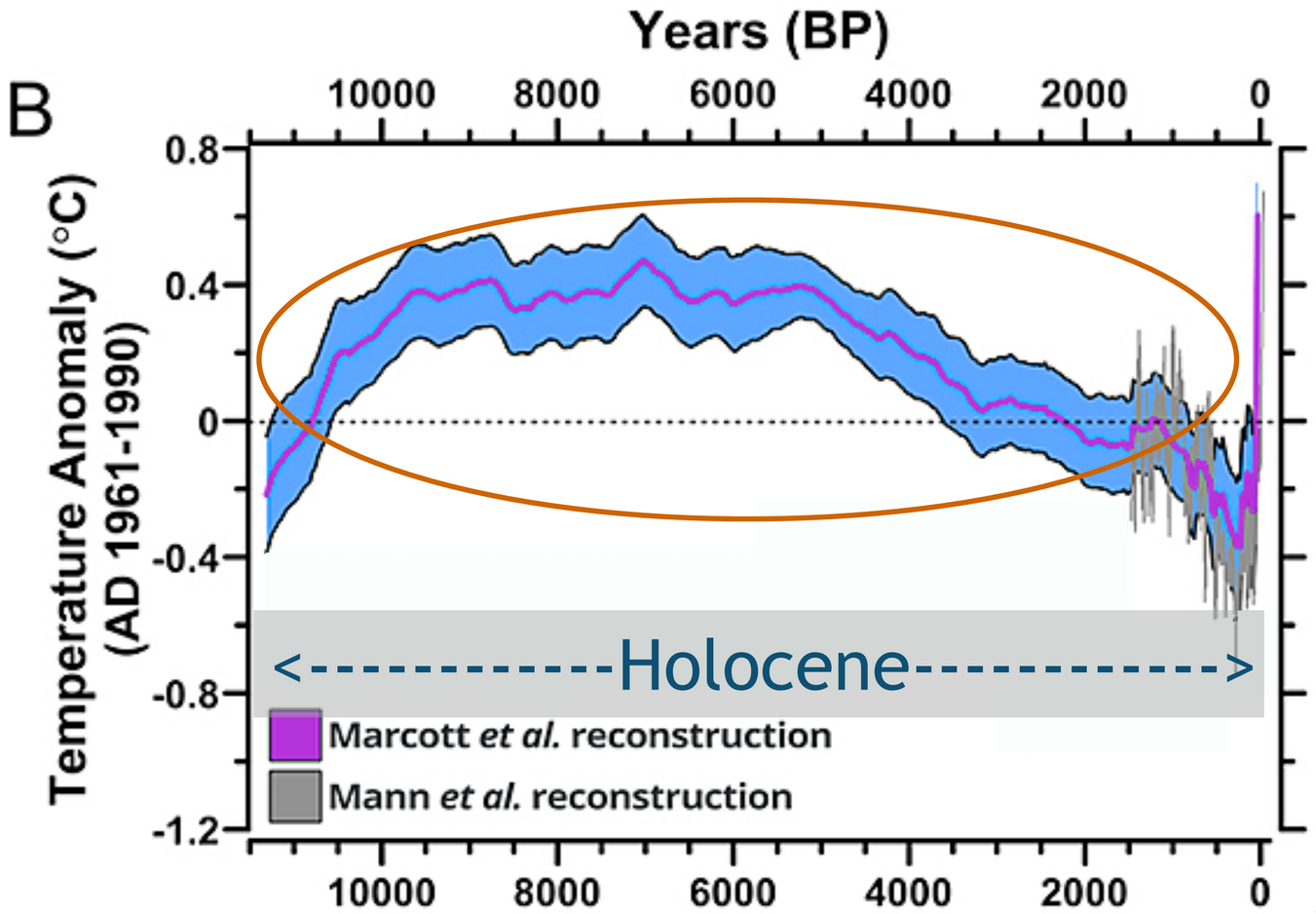

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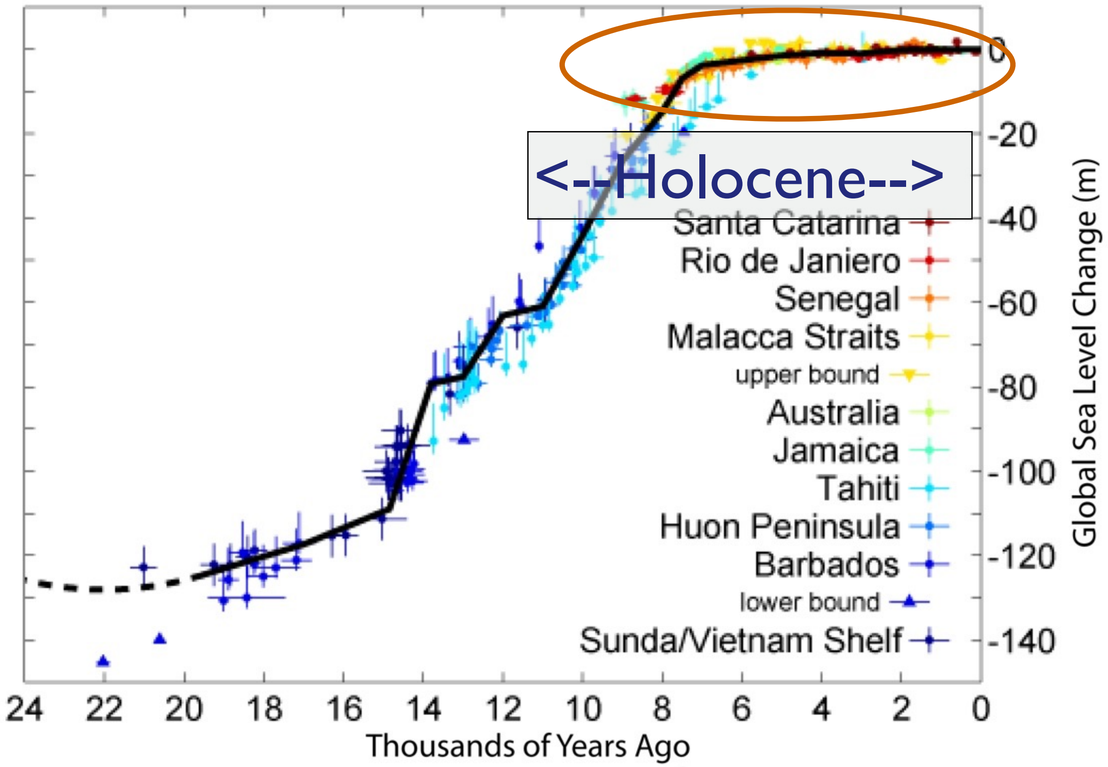

The Baseline for Civilization:
During the Holocene, climate, global temperature, and sea level were exceptionally stable; a perfect condition for the development of civilization.

The Baseline: Past Climate Variability

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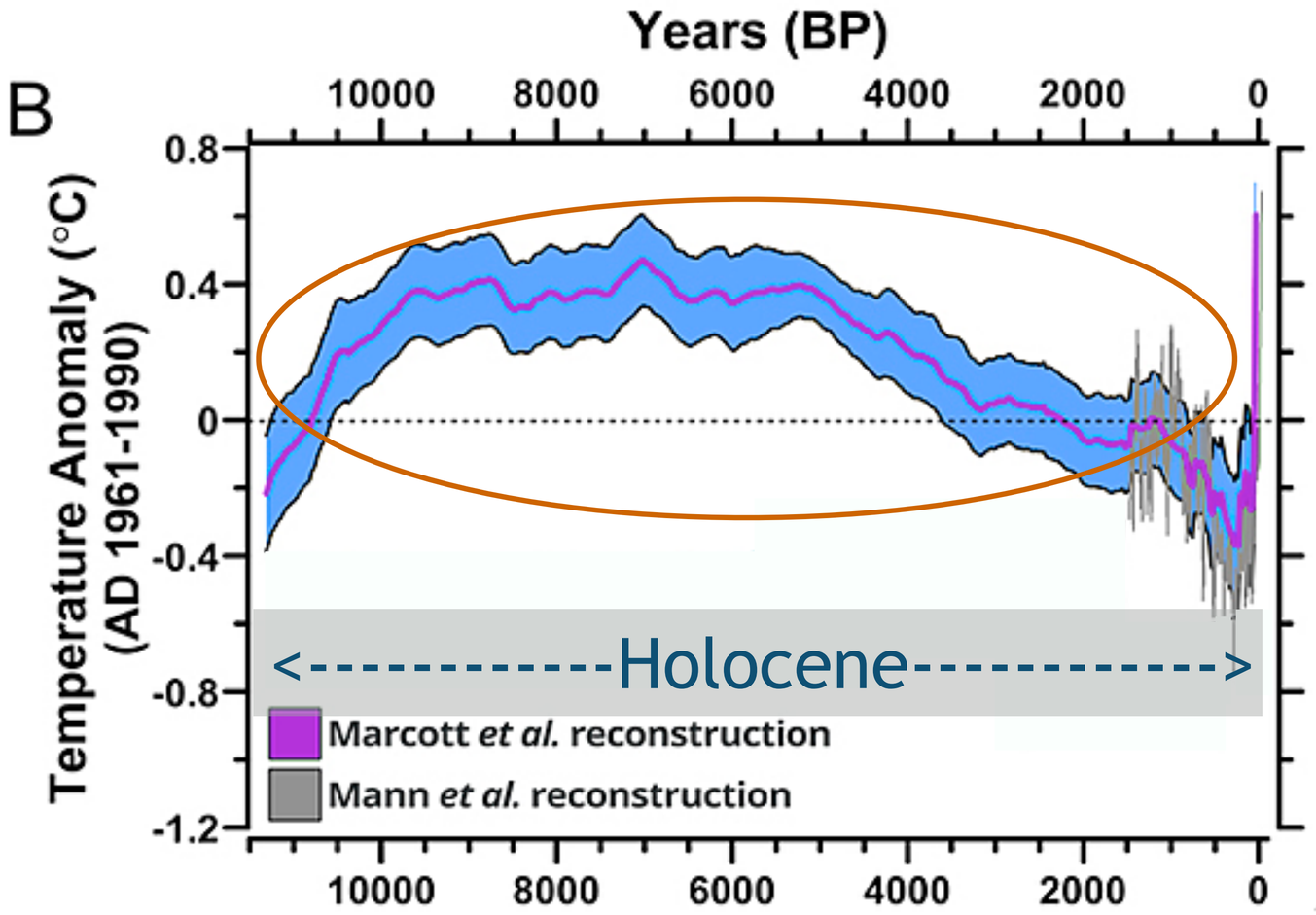

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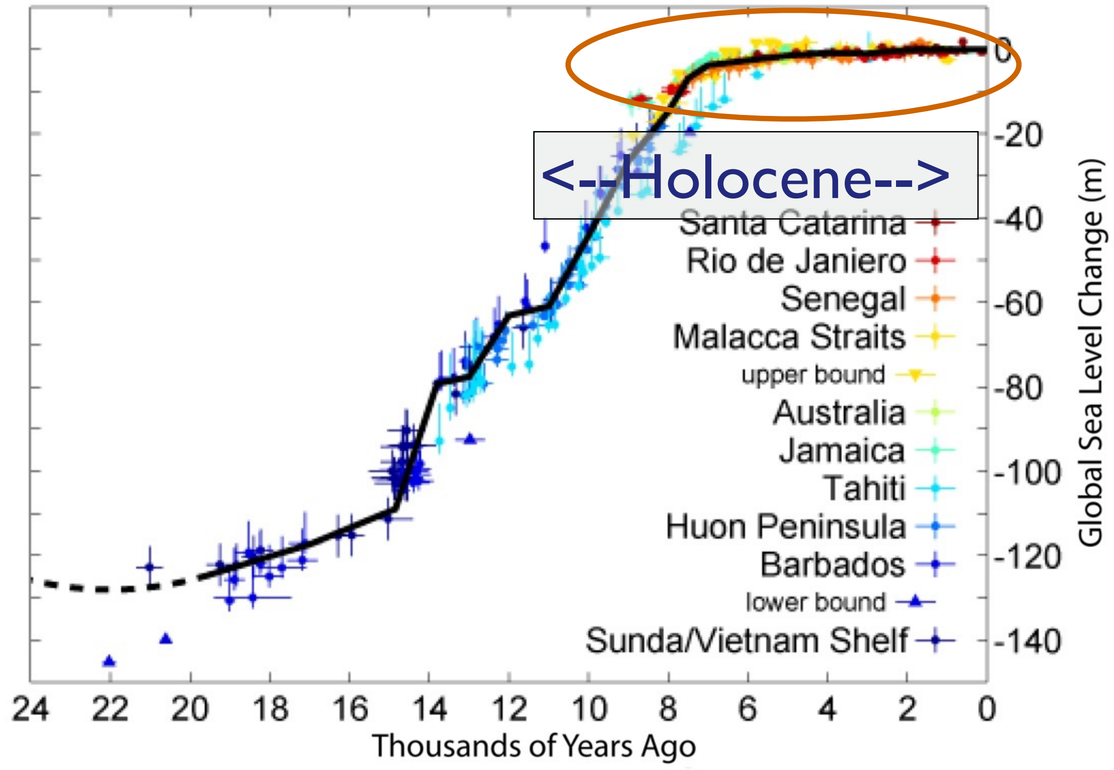

The Holocene was a "safe operating space for humanity"

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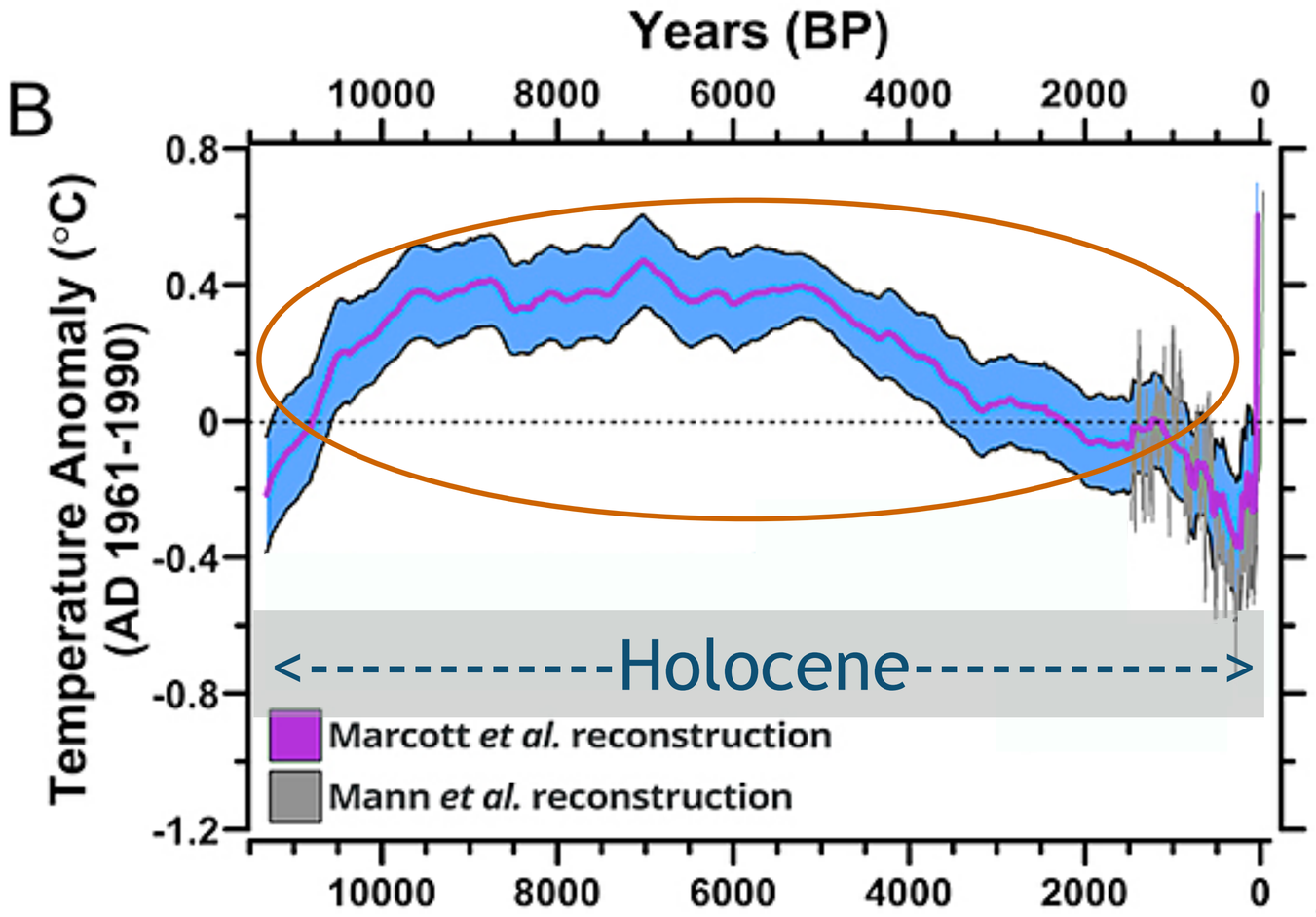

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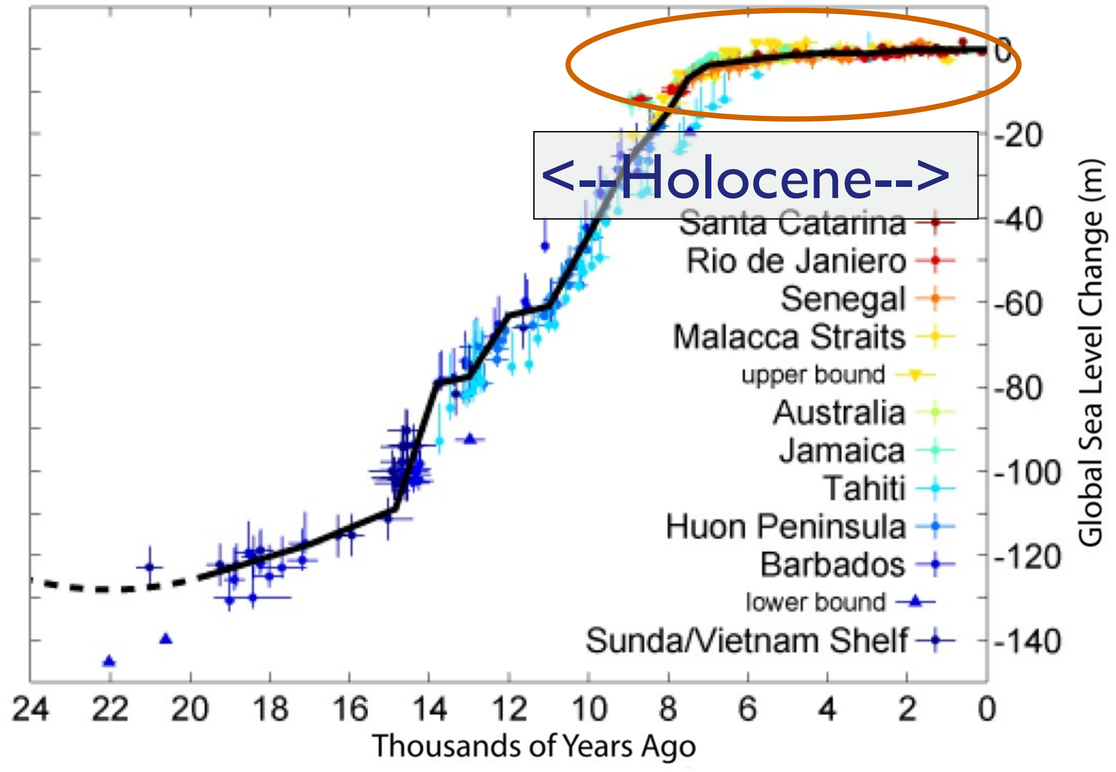

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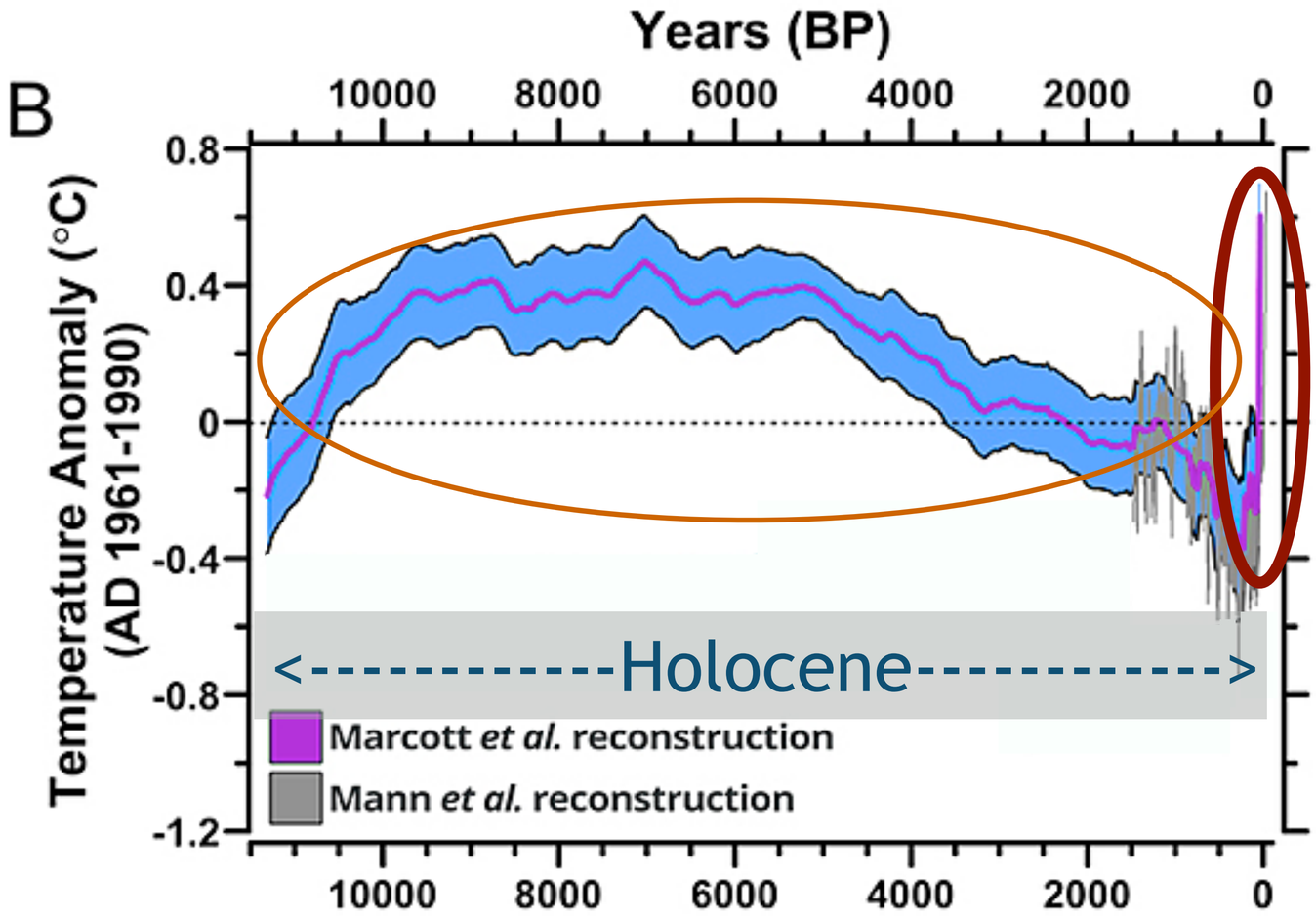

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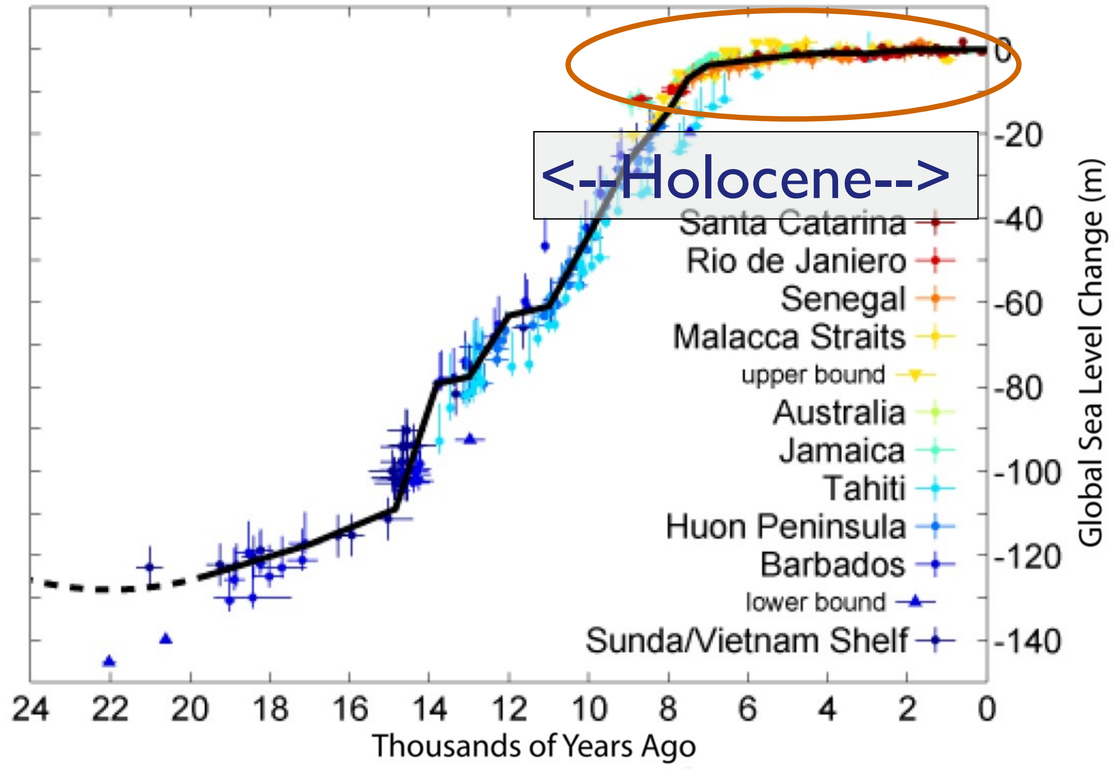

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Key Points

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During the Holocene, climate and sea level were exceptionally stable

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The Syndrome: Recent Climate and Global Change

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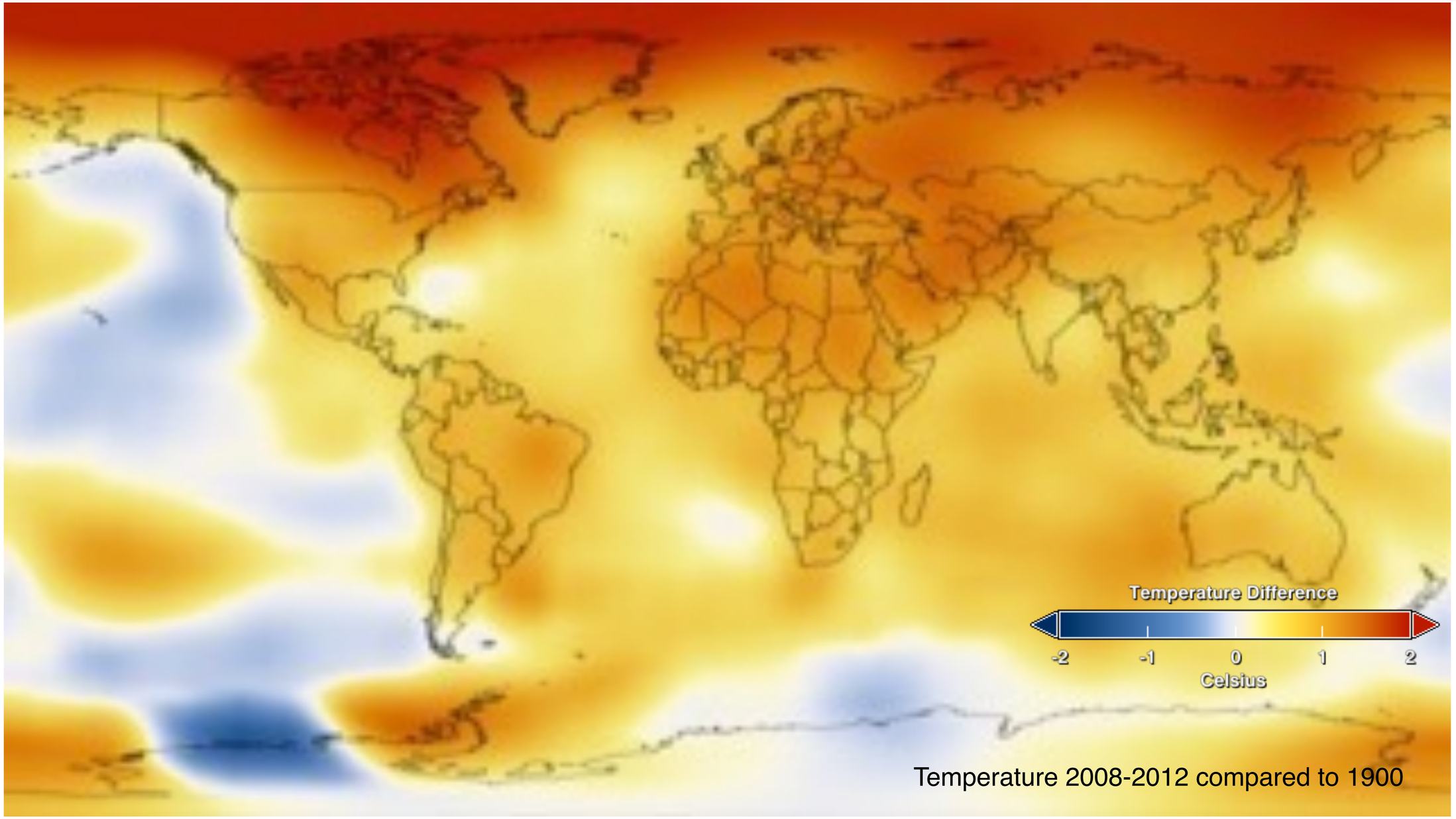

Temperature 2008-2012 compared to 1900

The Syndrome: Recent Climate and Global Change

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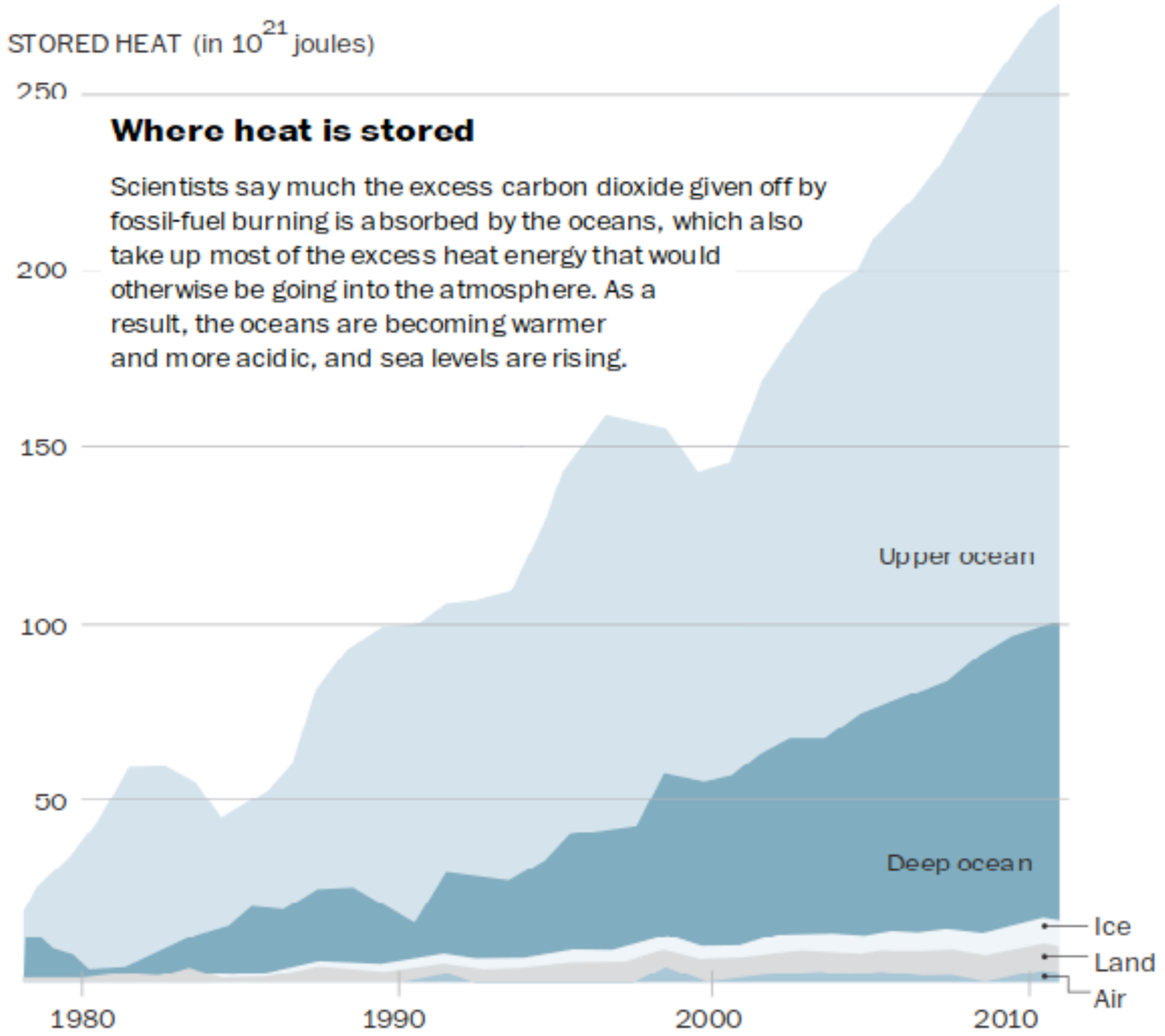
Heat storage:



SOURCE: IPCC Fifth Assessment Synthesis Report. GRAPHIC: Patterson Clark - The Washington Post. Published Nov. 2, 2014.

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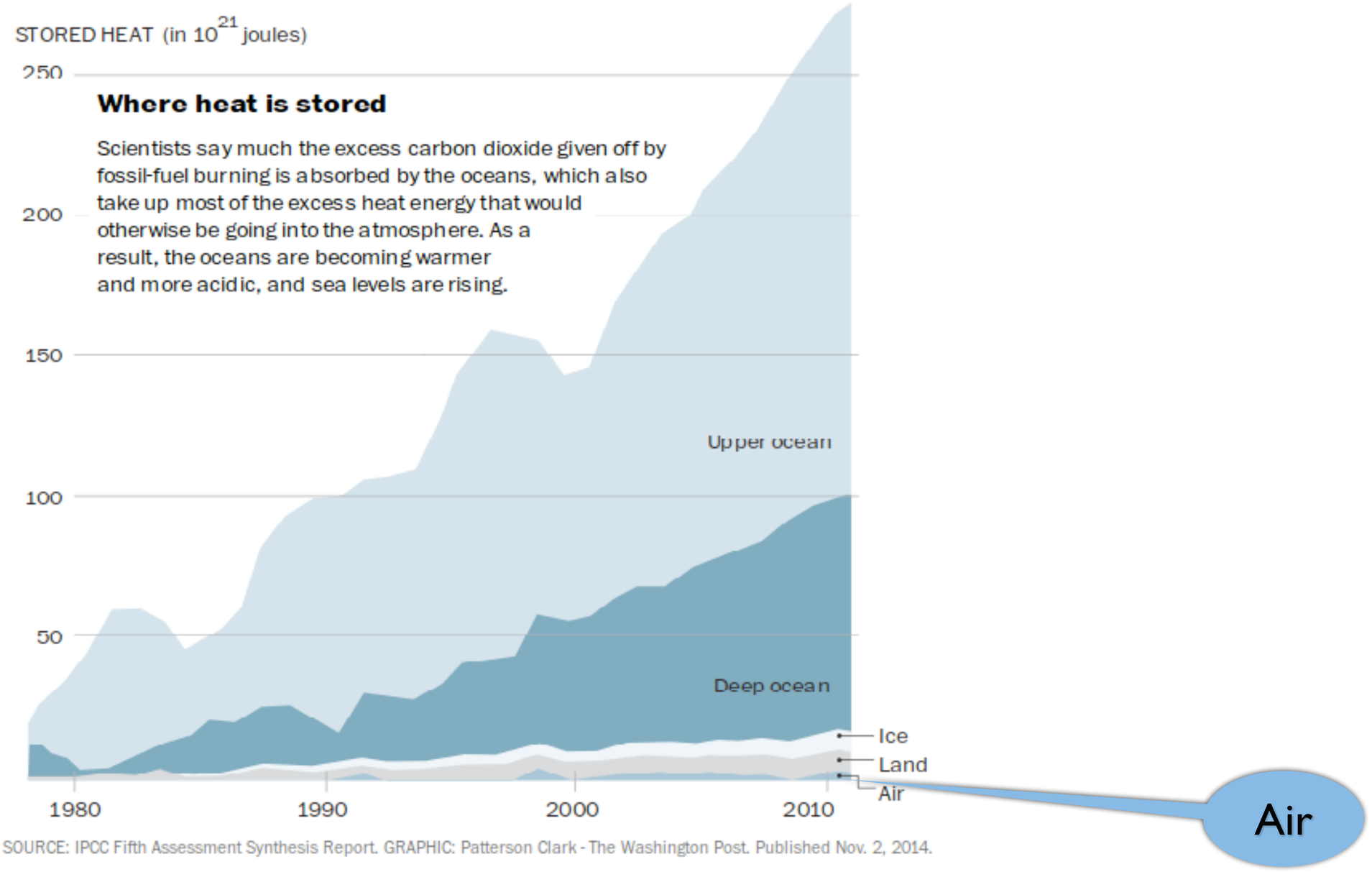

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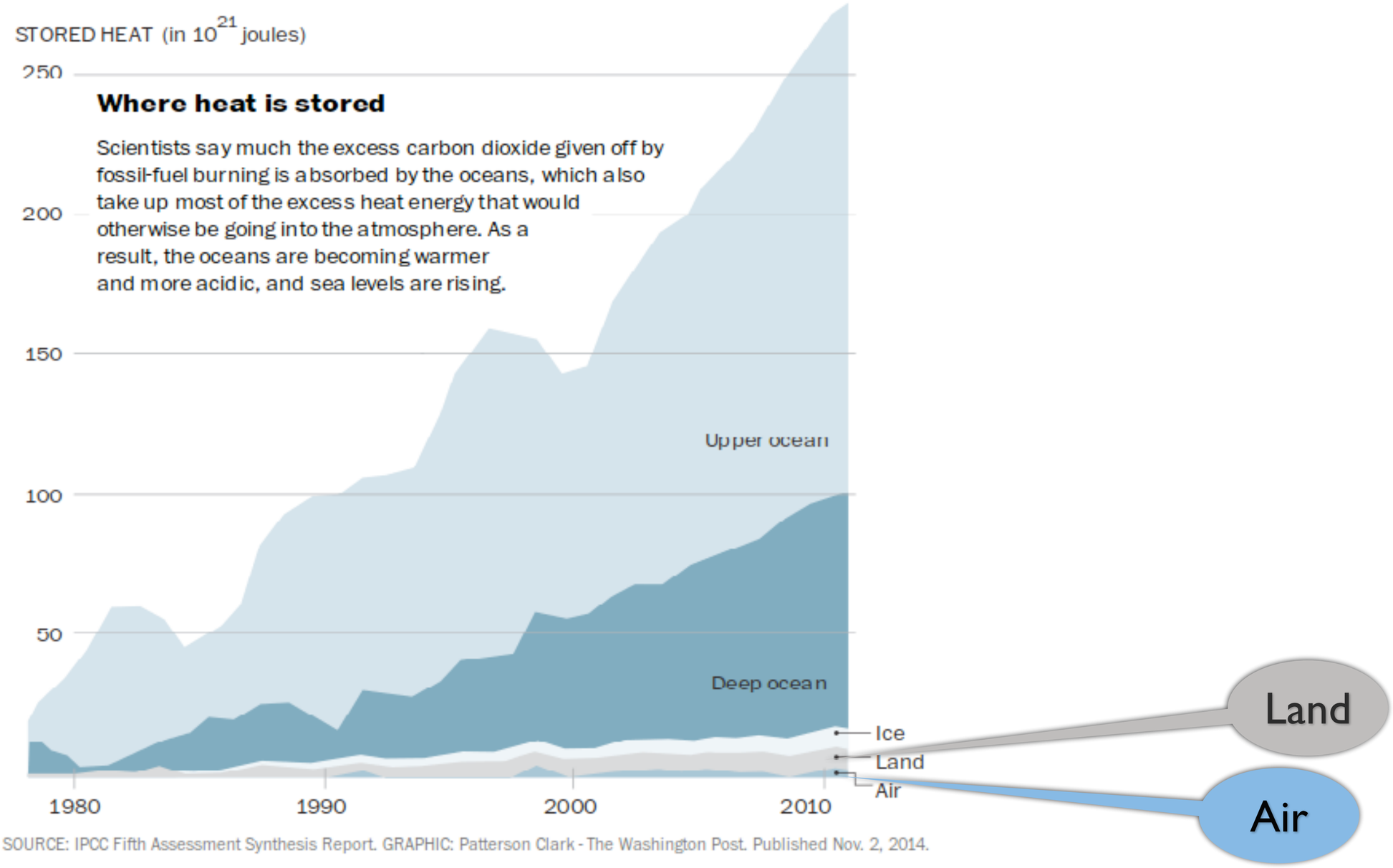

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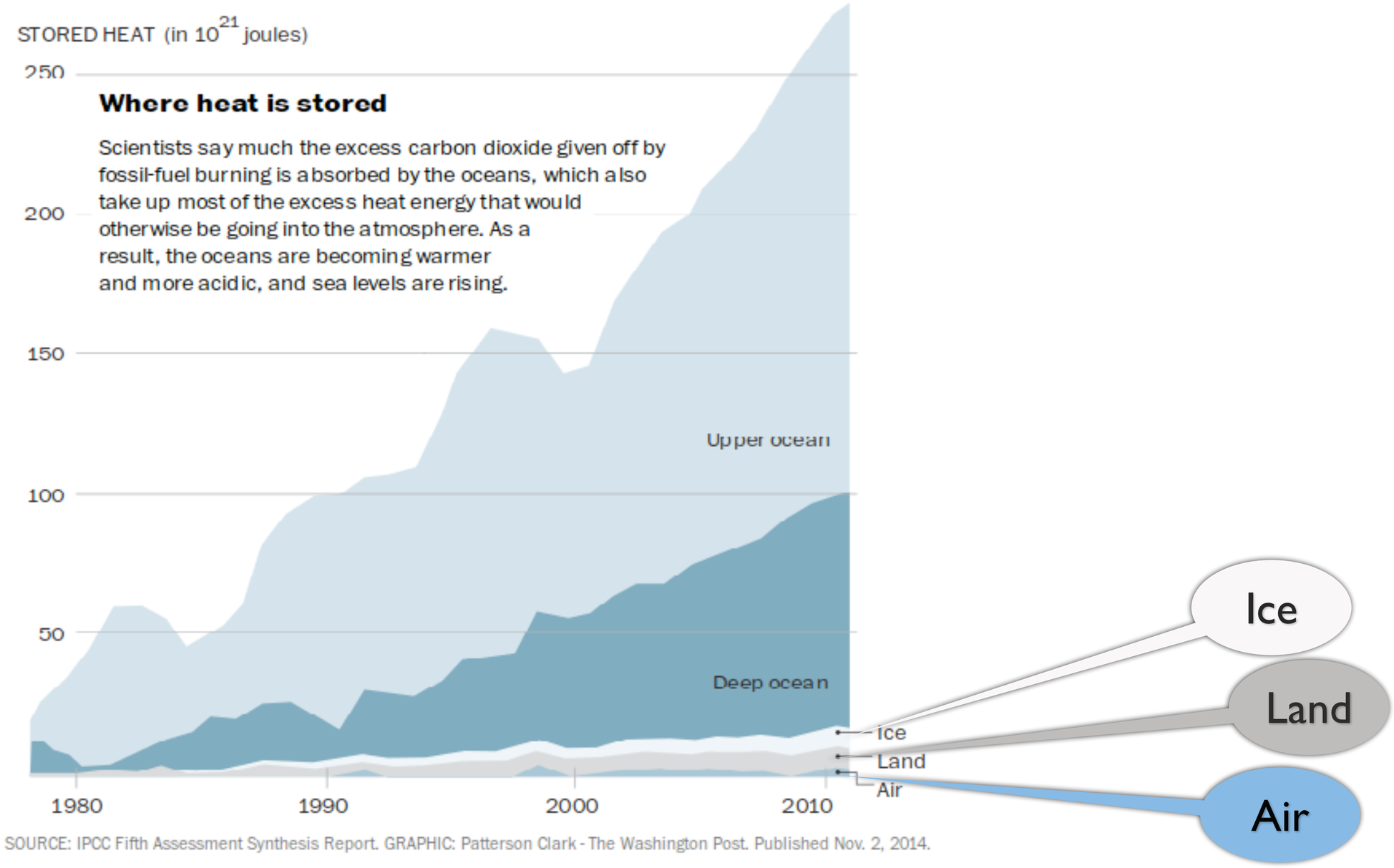

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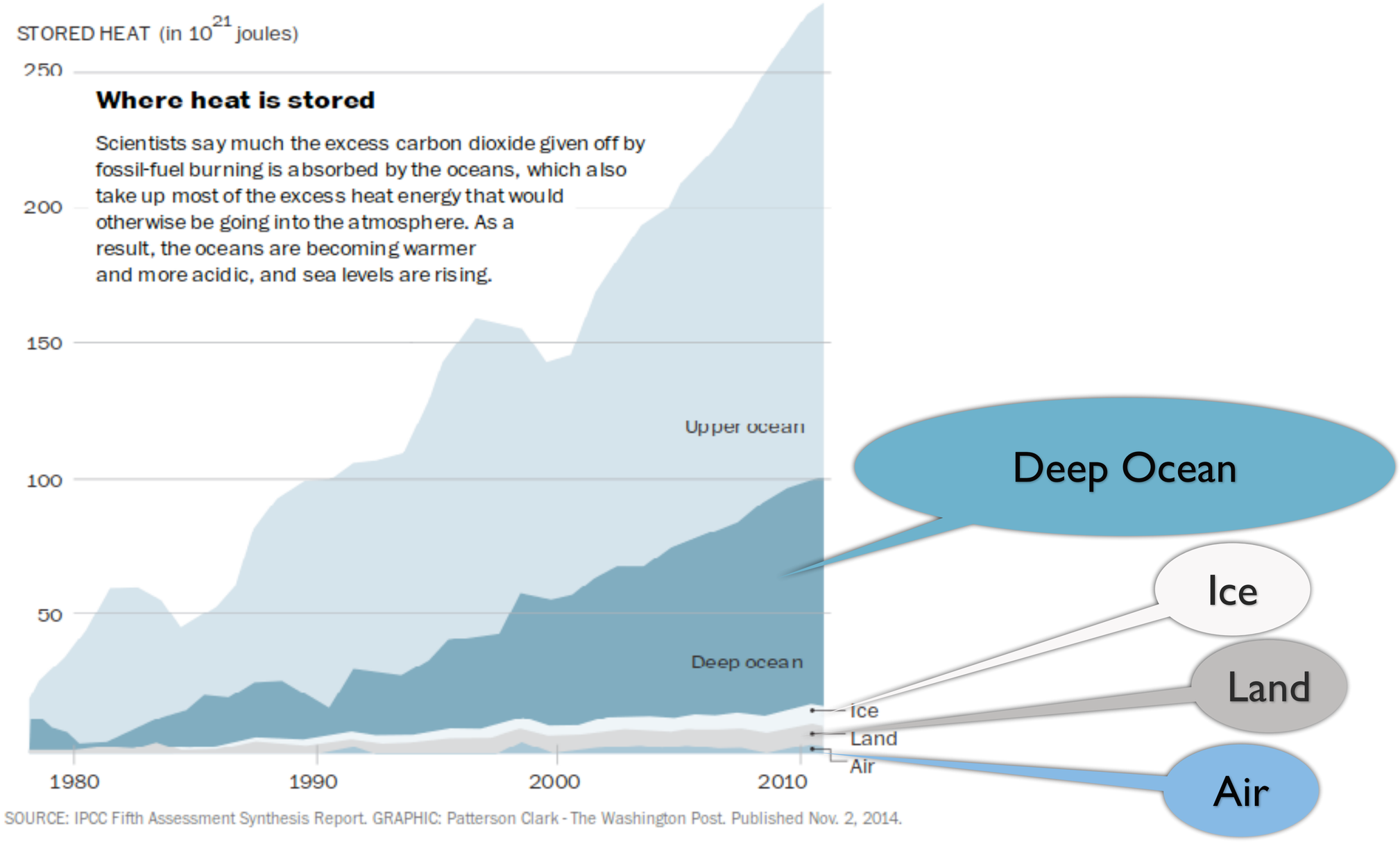

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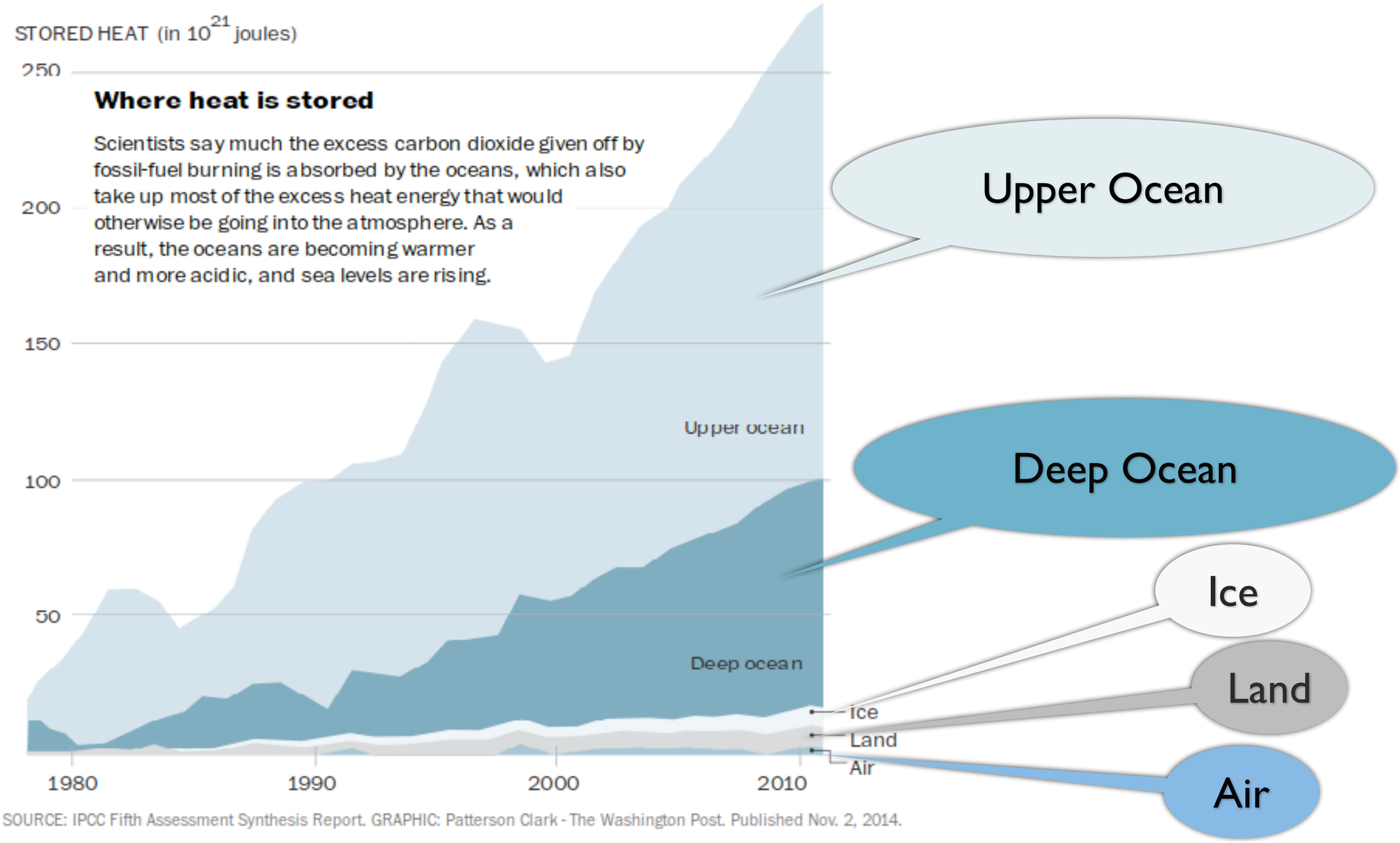

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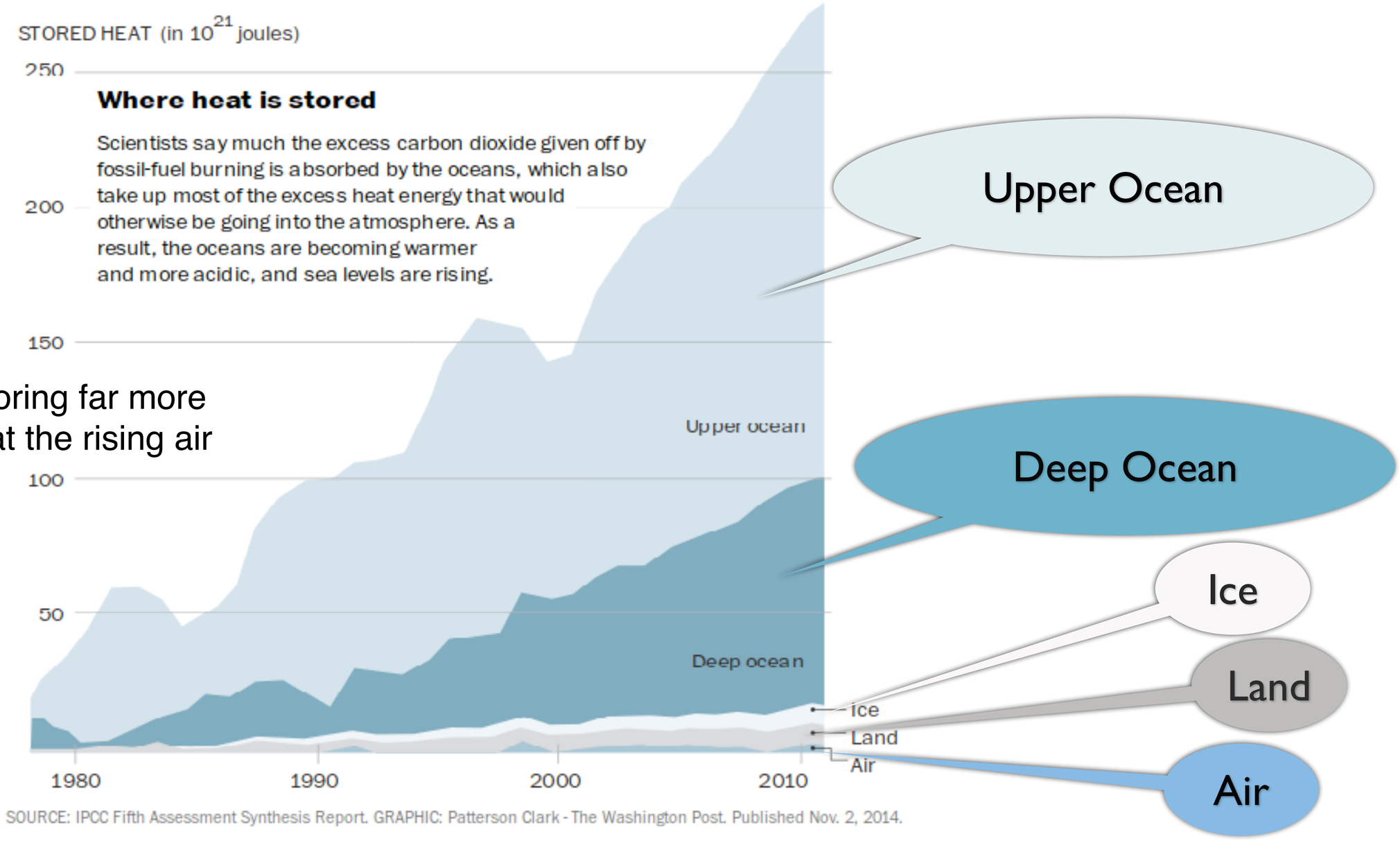

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The Earth system is storing far more heat (energy) than what the rising air temperature indicates

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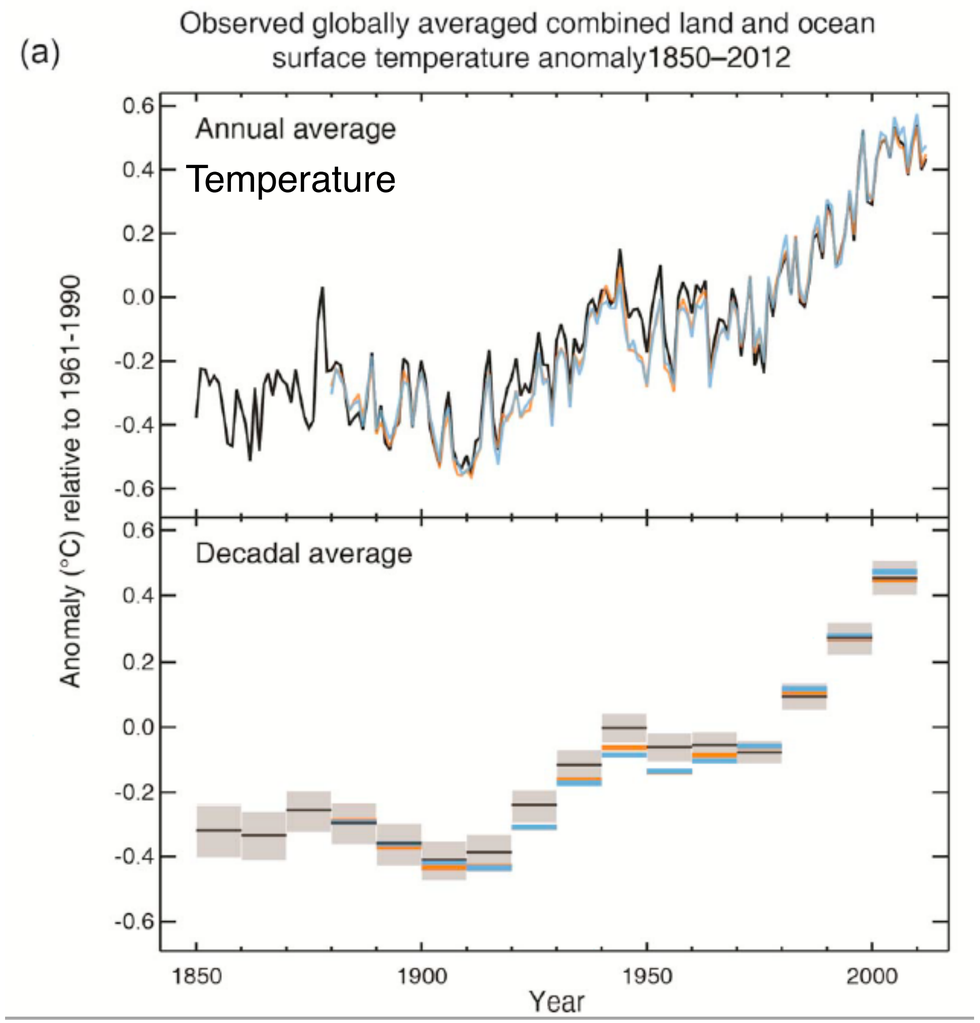

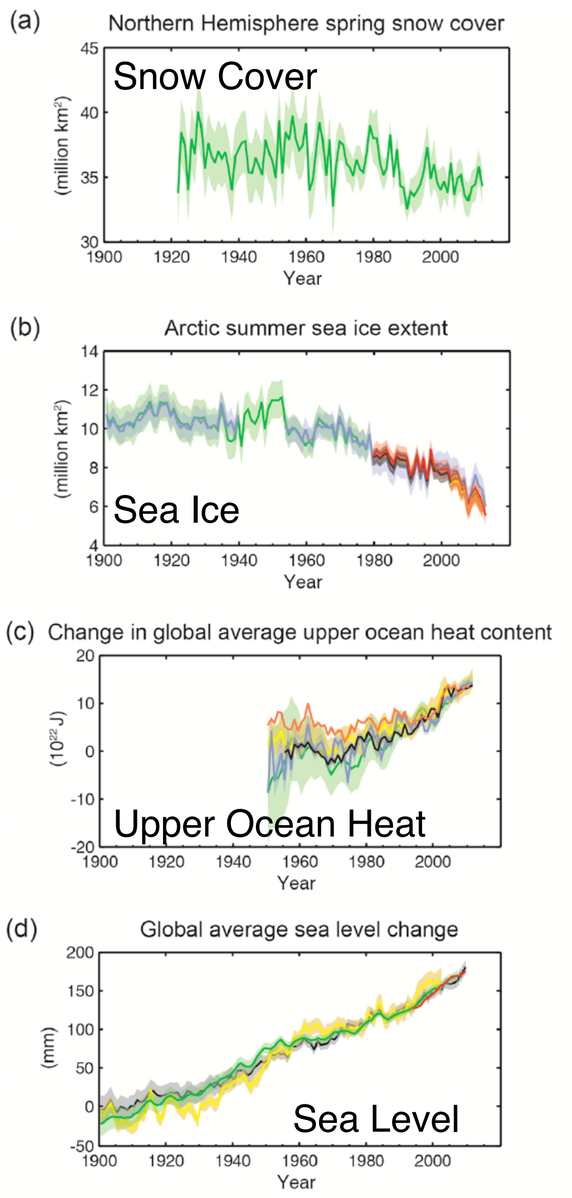

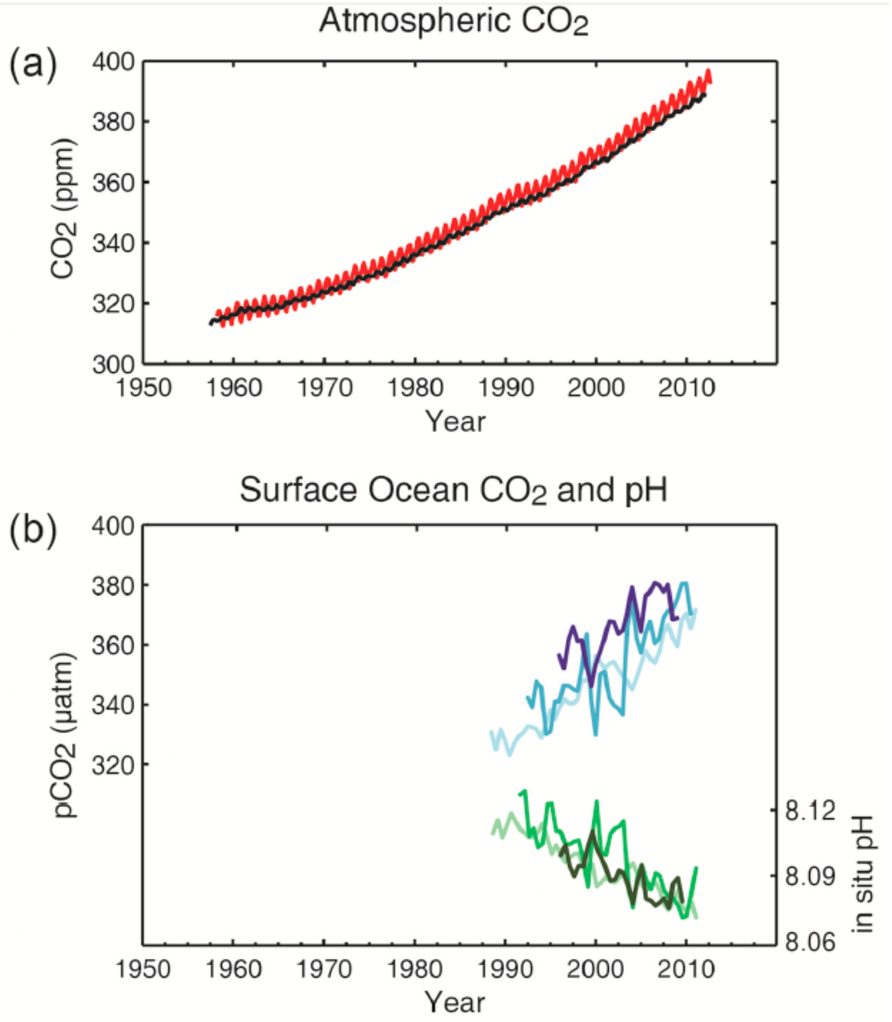

IPCC, 2013

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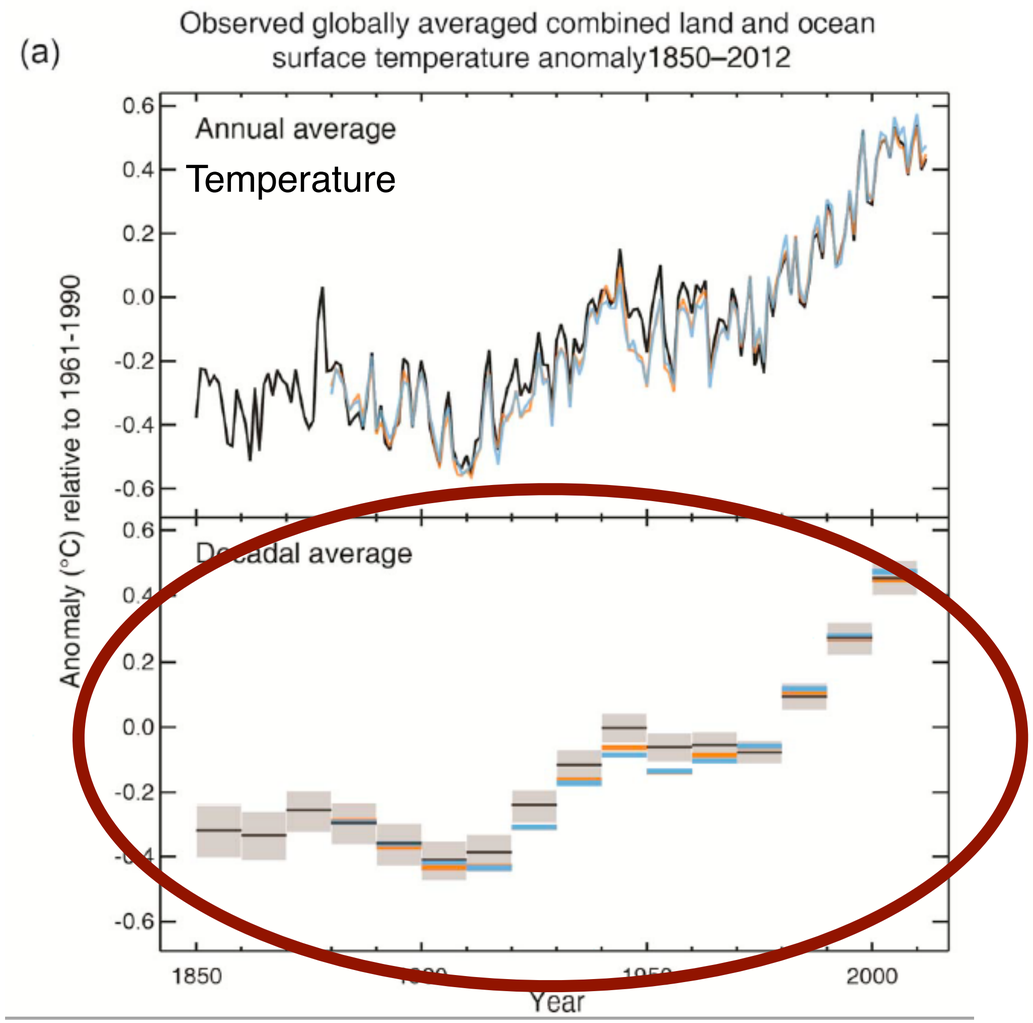

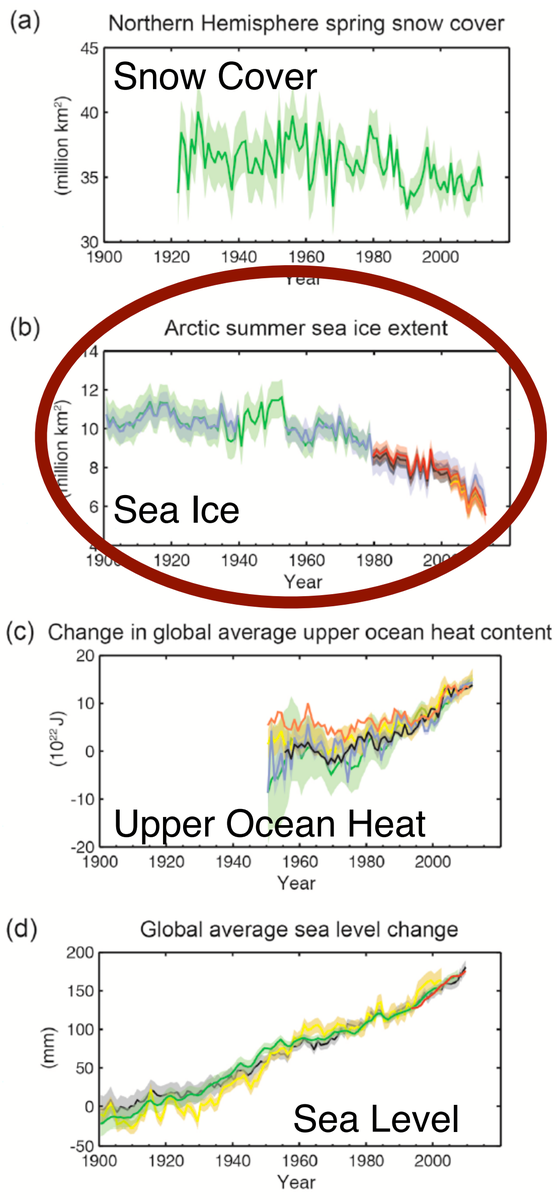

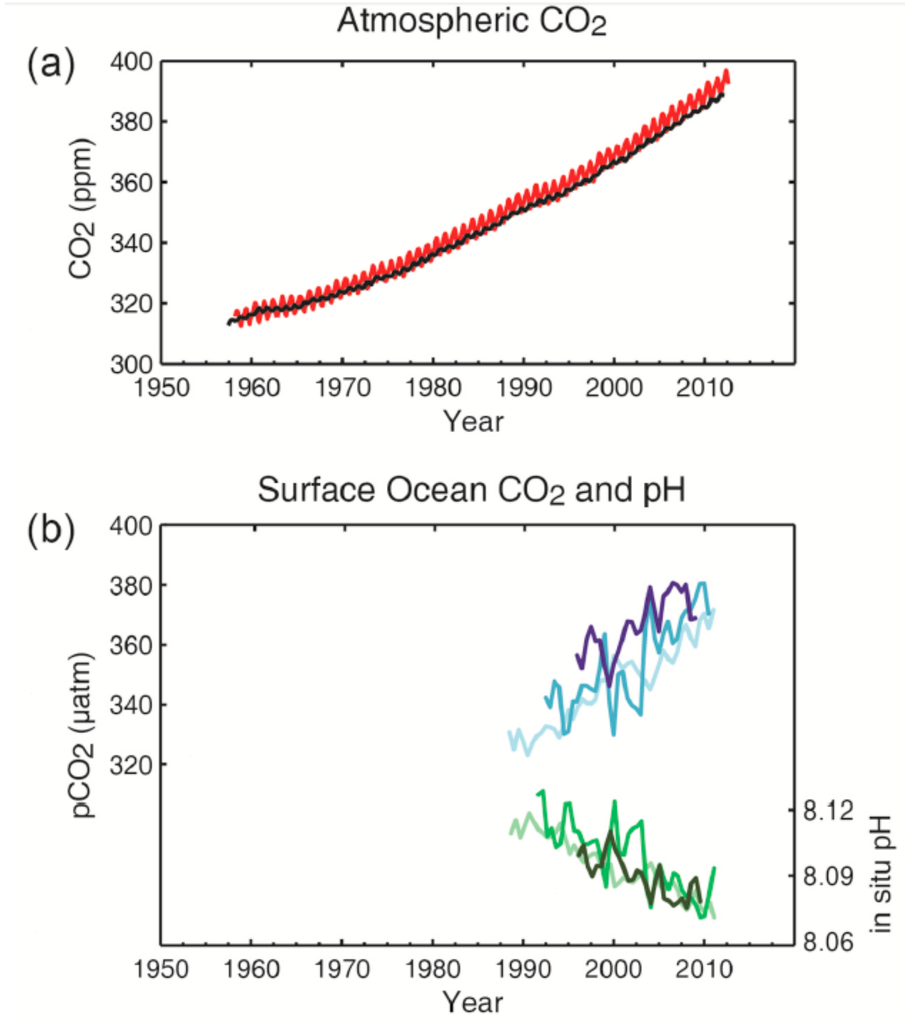

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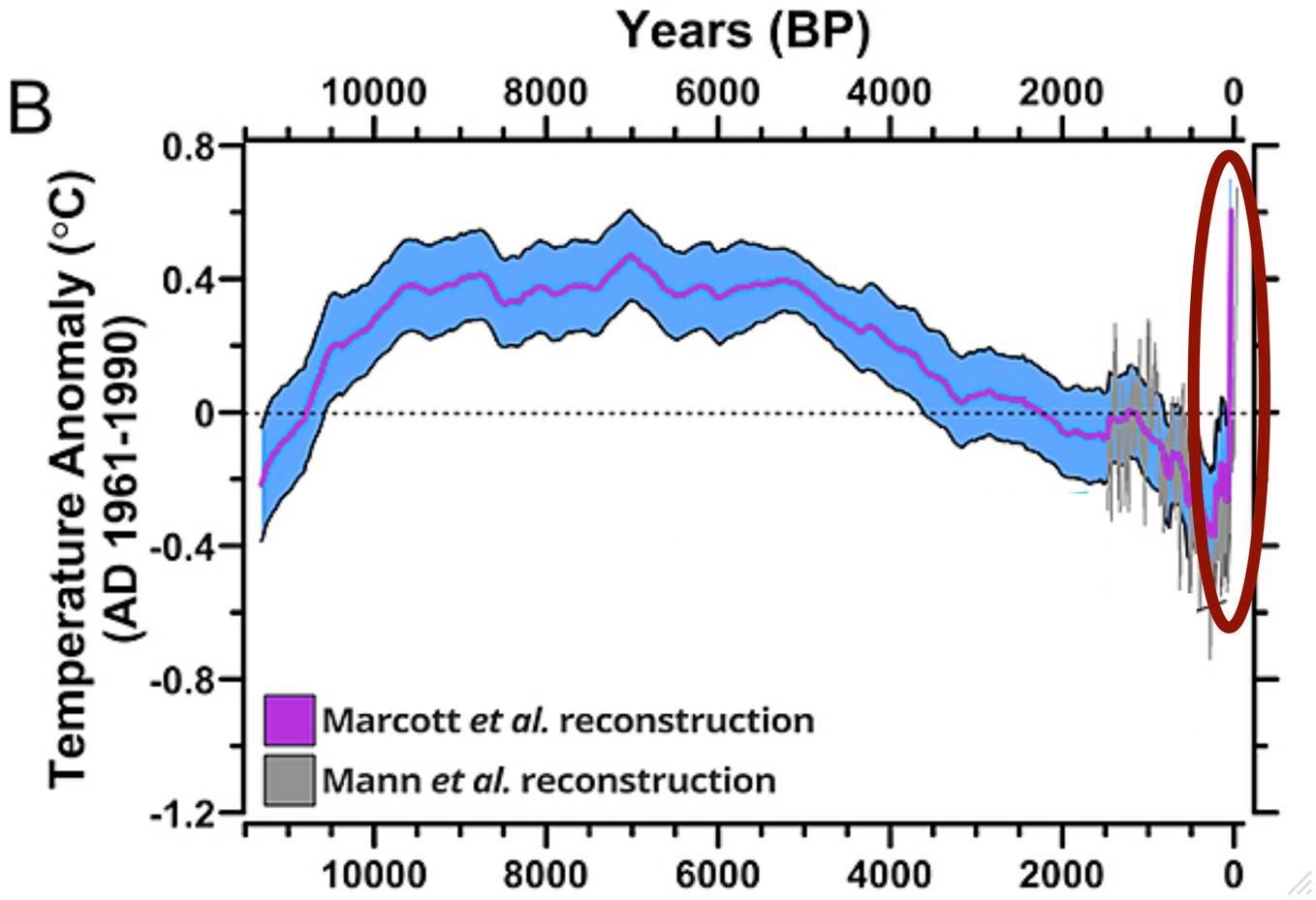
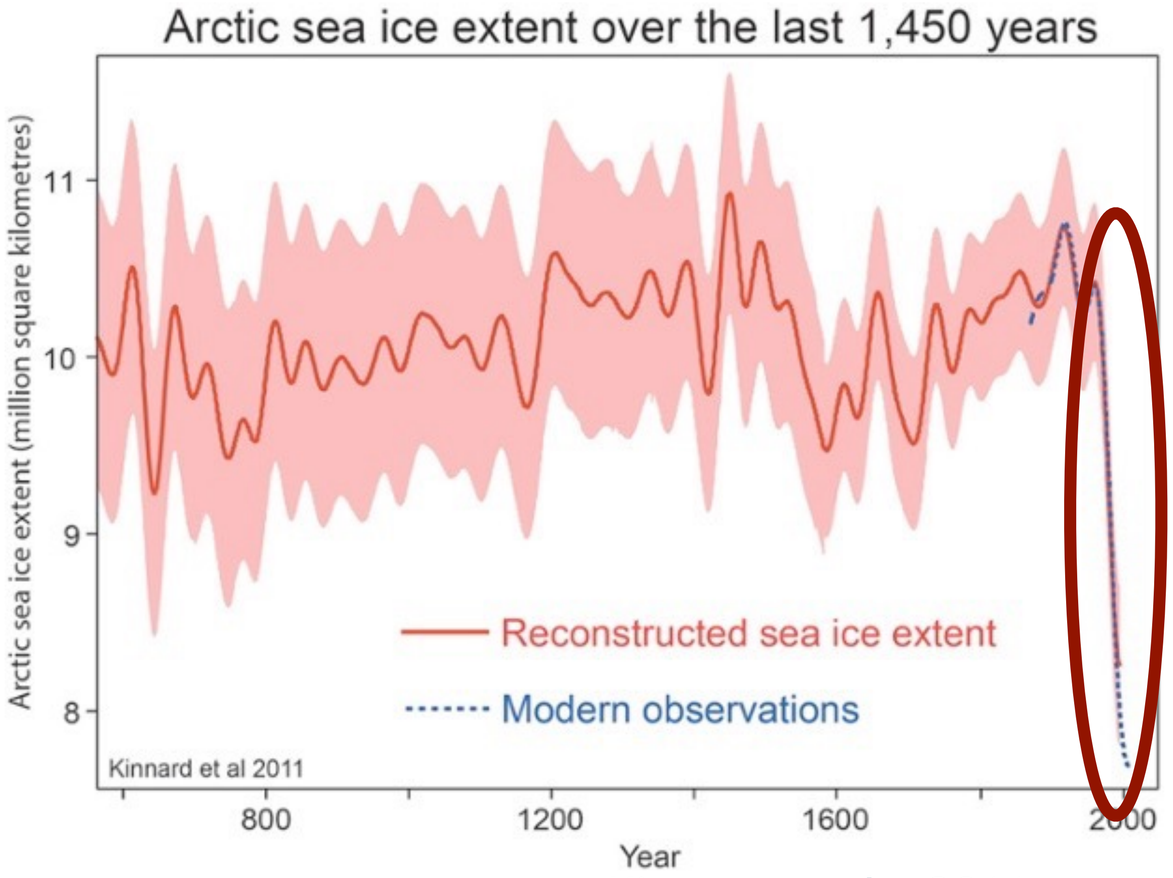


Marcott et al., 2013



Kinnart et al., 2011

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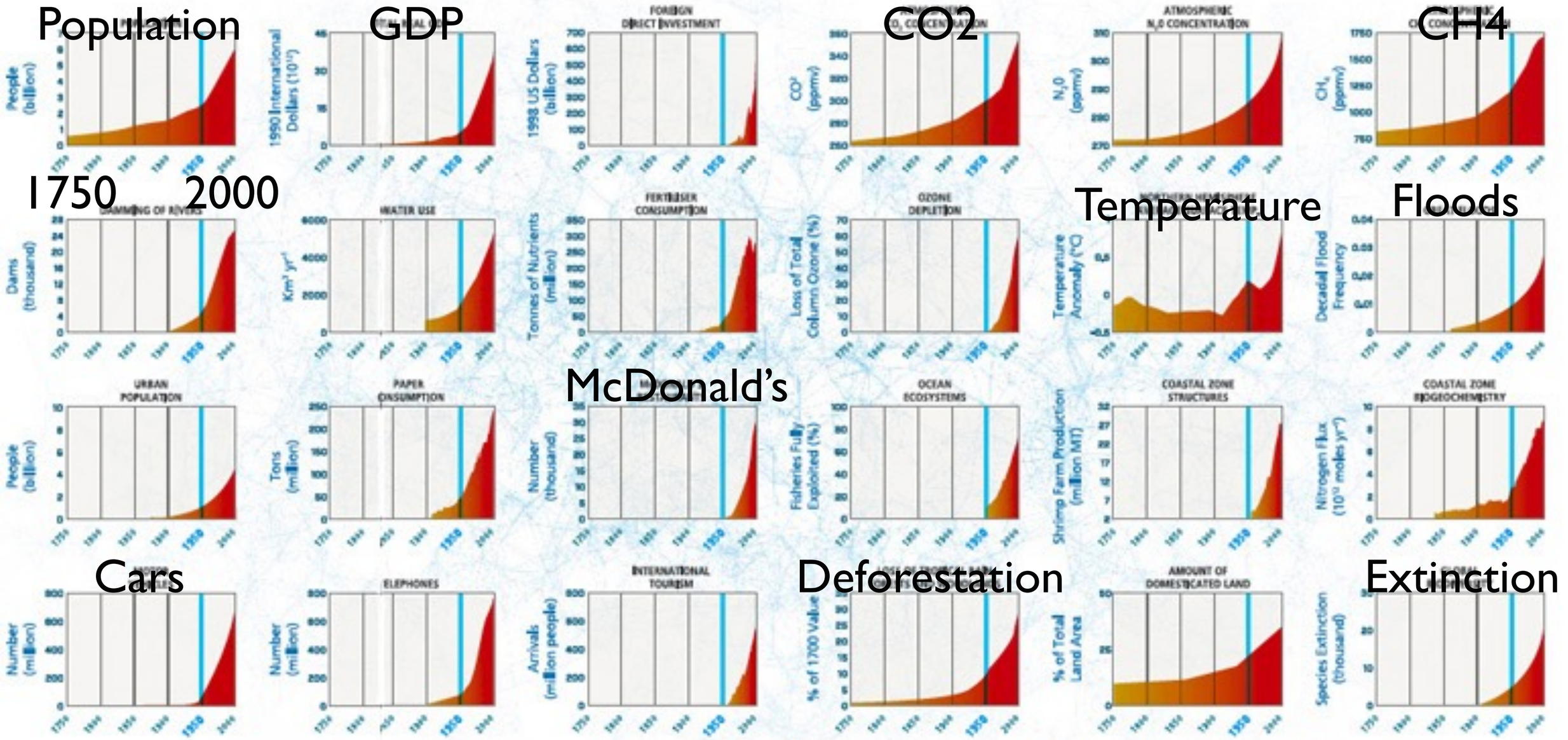

Figure 1. An enterprise to reckon with. Human nanipulation of their environment began in earnest during the Industrial Revolution and accelerated markedly after the 1950s, as IGBP's Great Acceleration graphs show. Modified after Steffen W *et al.* (2004).

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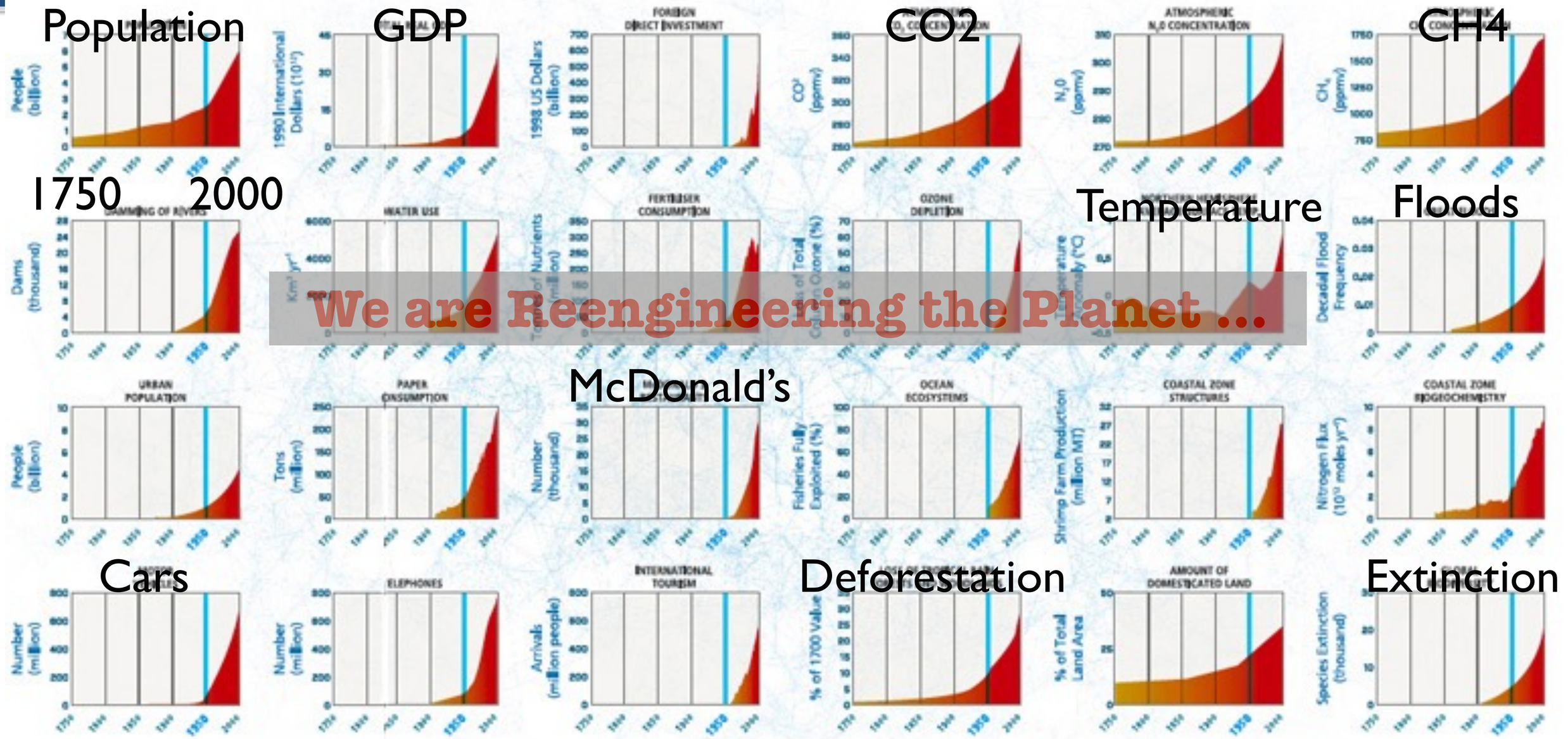

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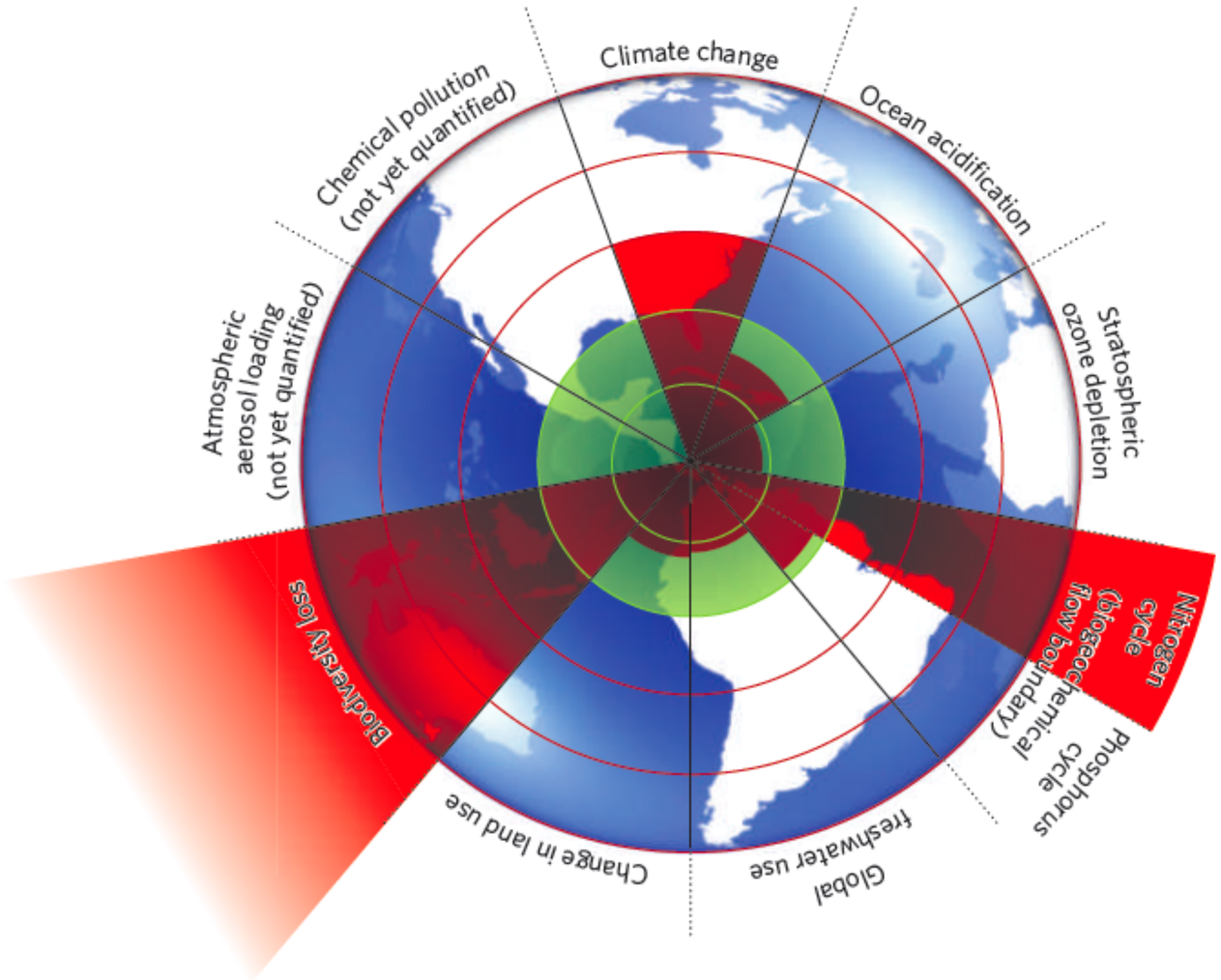

Figure 1 | Beyond the boundary. The inner green shading represents the proposed safe operating space for nine planetary systems. The red wedges represent an estimate of the current position for each variable. The boundaries in three systems (rate of biodiversity loss, climate change and human interference with the nitrogen cycle), have already been exceeded.

We are moving out of the Holocene and the "safe operating space for humanity" (Rockstroem et al., 2009):

Climate Change (***)

Ocean acidification (**)

Stratospheric ozone depletion (*)

Nitrogen (******) and Phosphorous cycles (**)

Global freshwater (*)

Change in land use (*)

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Atmospheric aerosols (?)

Chemical pollution (?)

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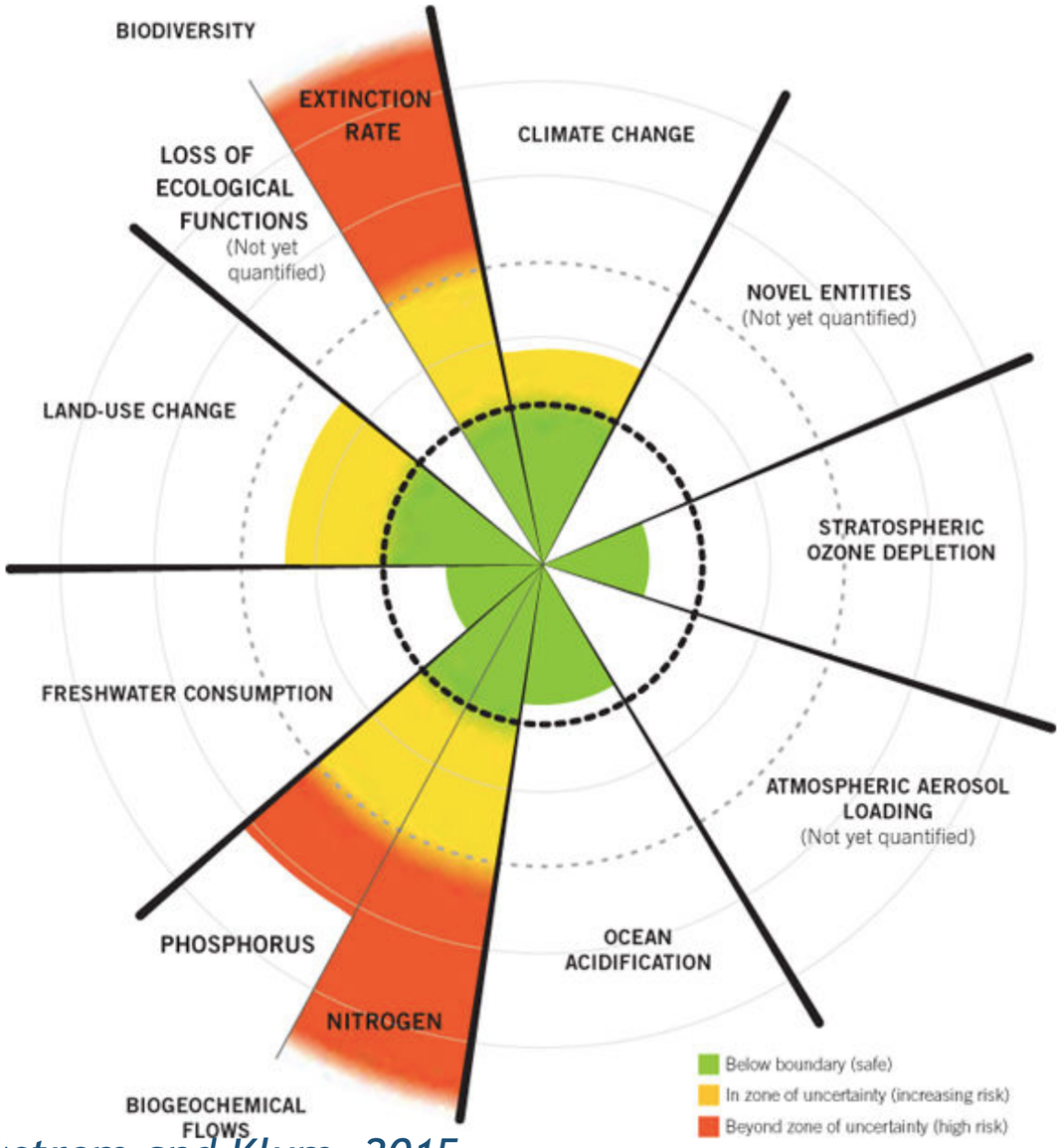

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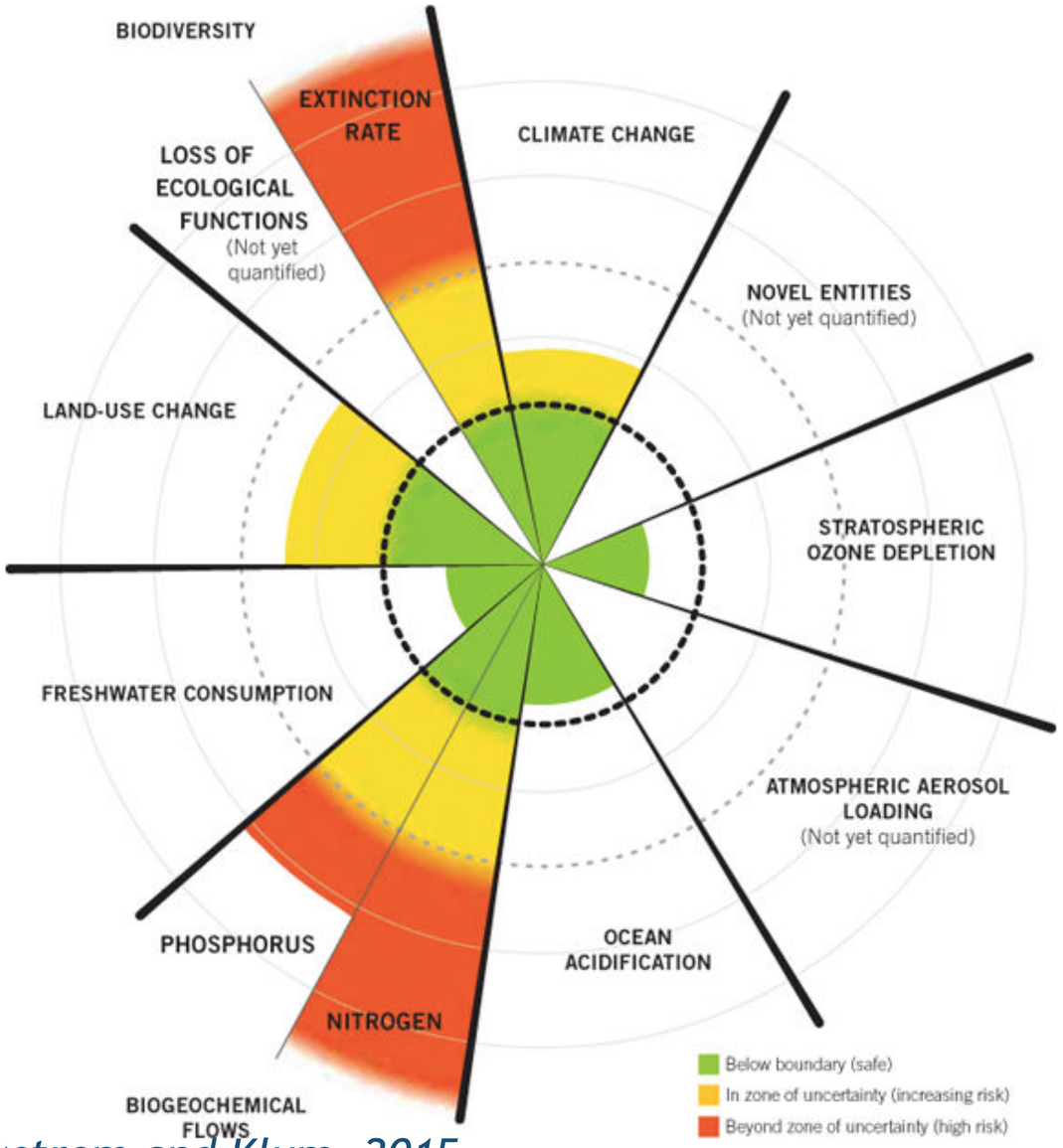

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Climate change and sea level rise are symptoms, not the cause, not the "sickness."

Key Points

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The Diagnosis: Leaving the “Safe Operating Space”

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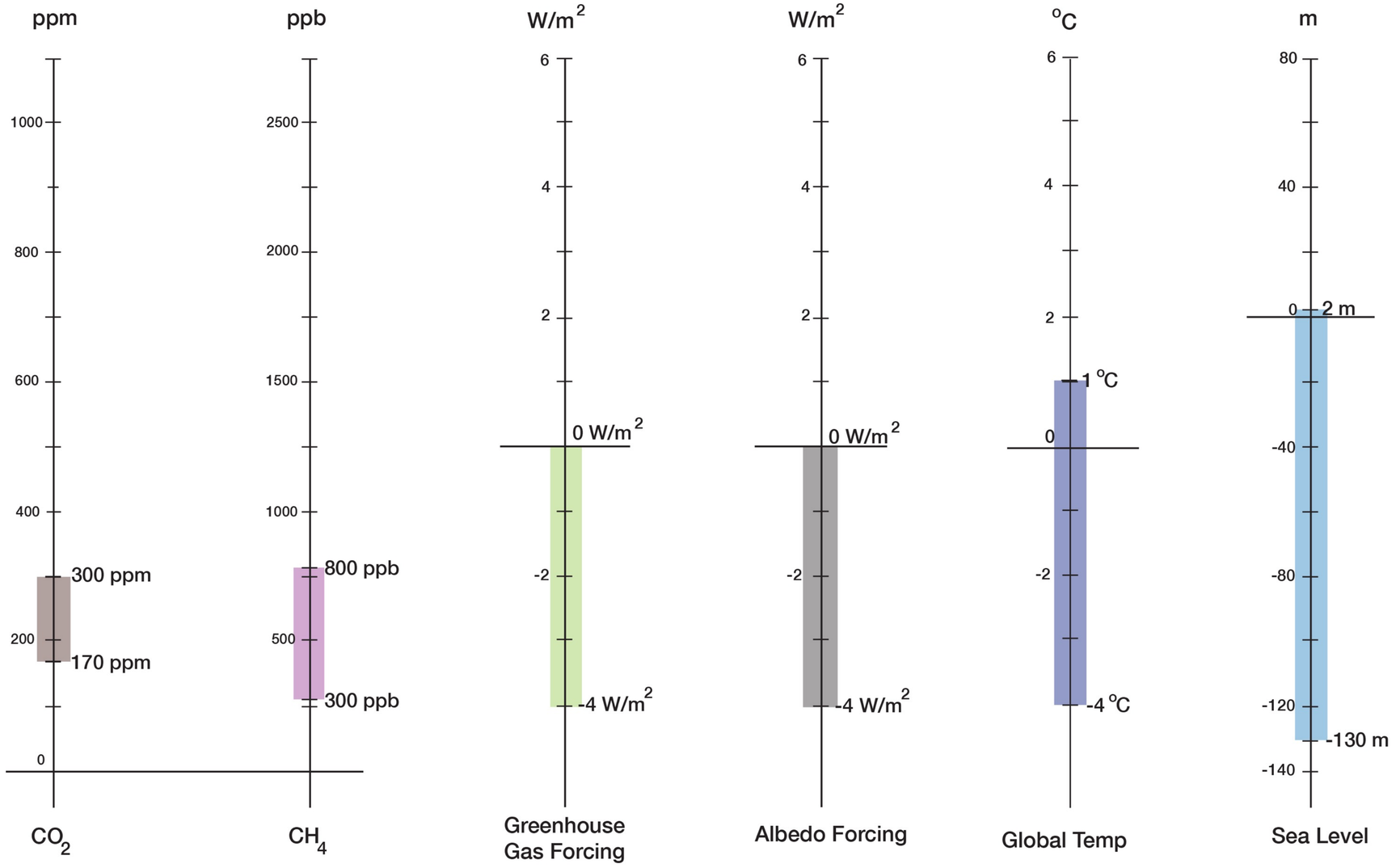
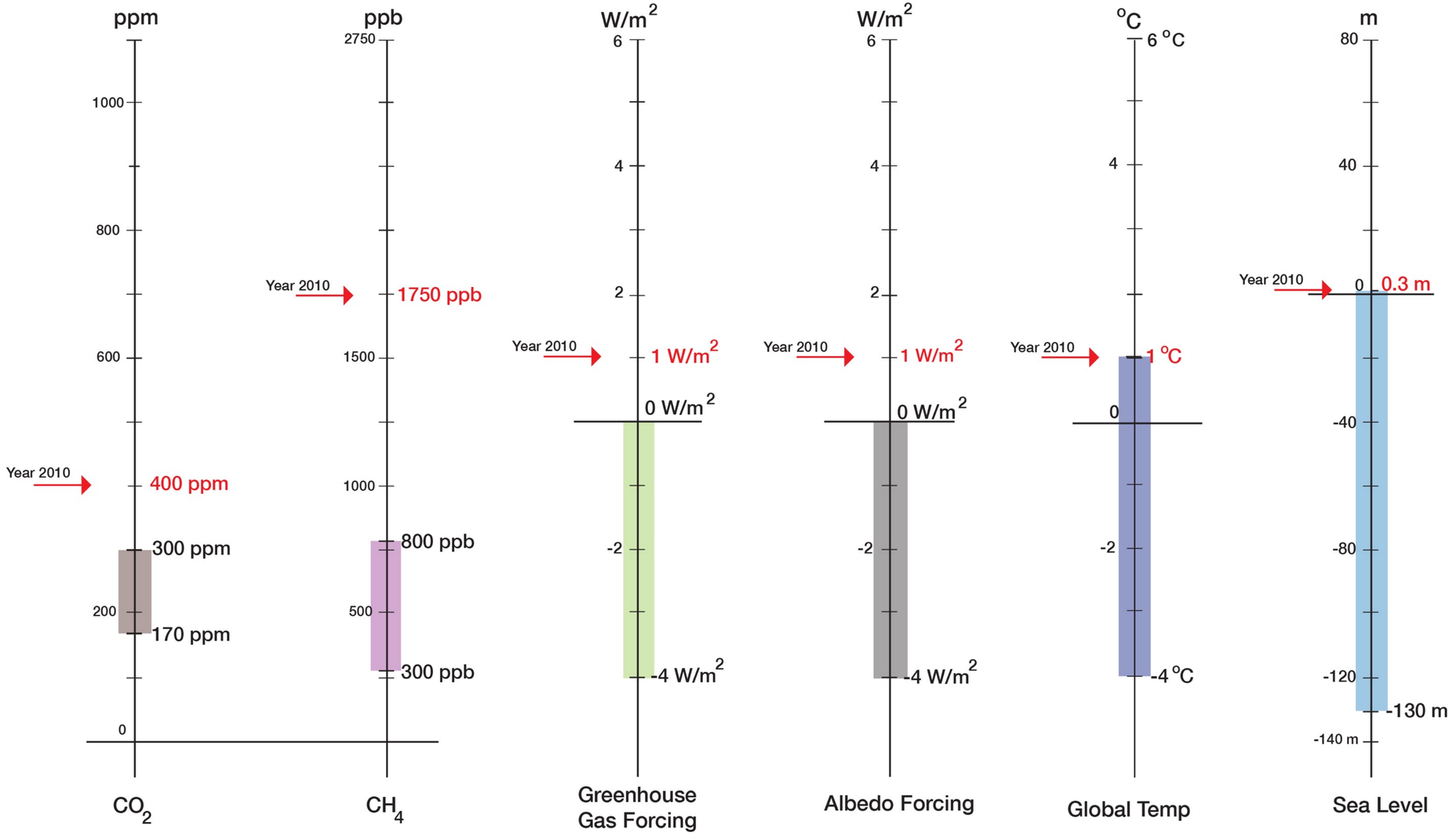


"Normal Range"
(800,000 years)

The Diagnosis: Leaving the "Safe Operating Space"



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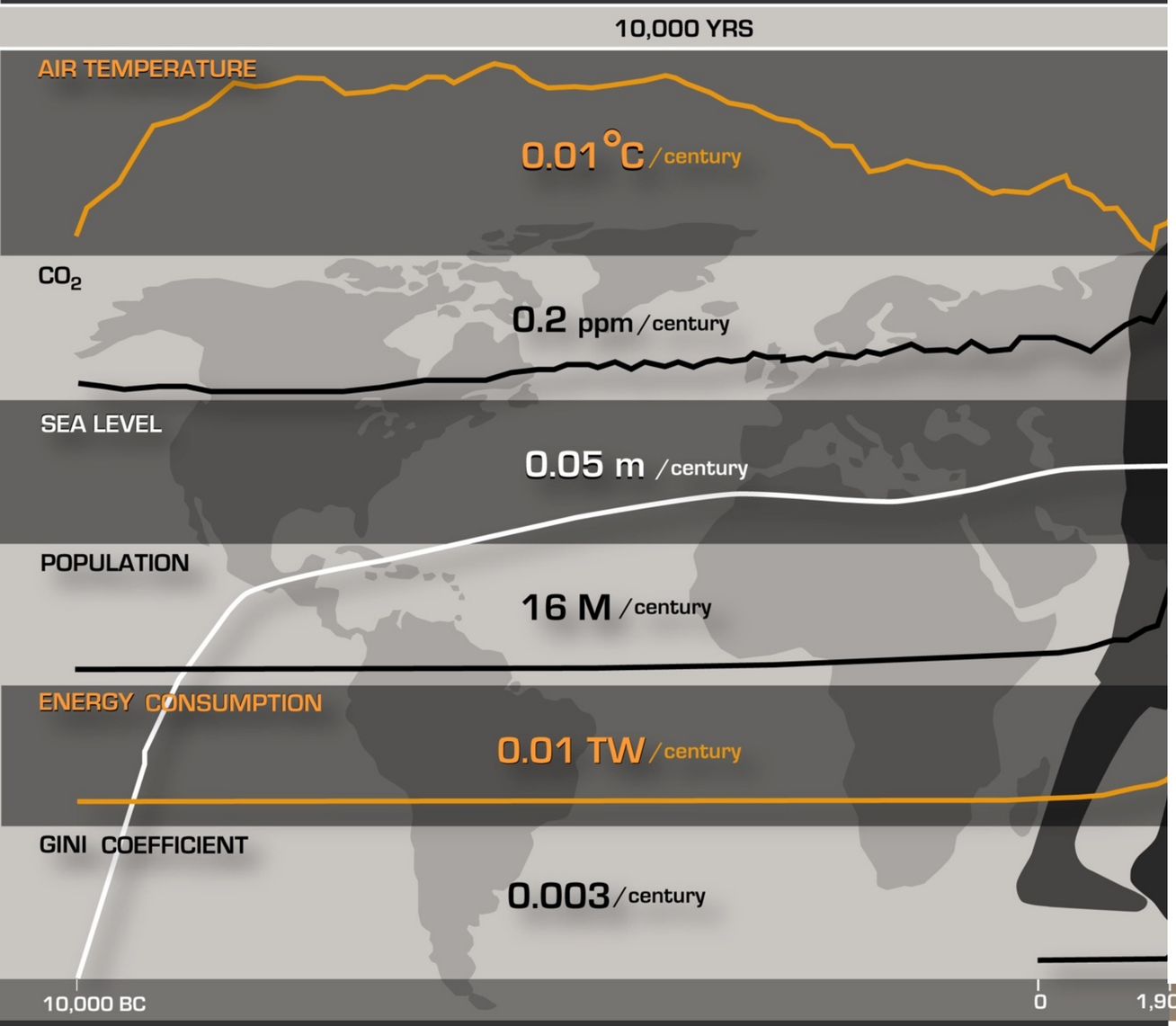
Humanity's Journey

The Evolution of Key Environmental Factors



Stability

Humanity's Journey

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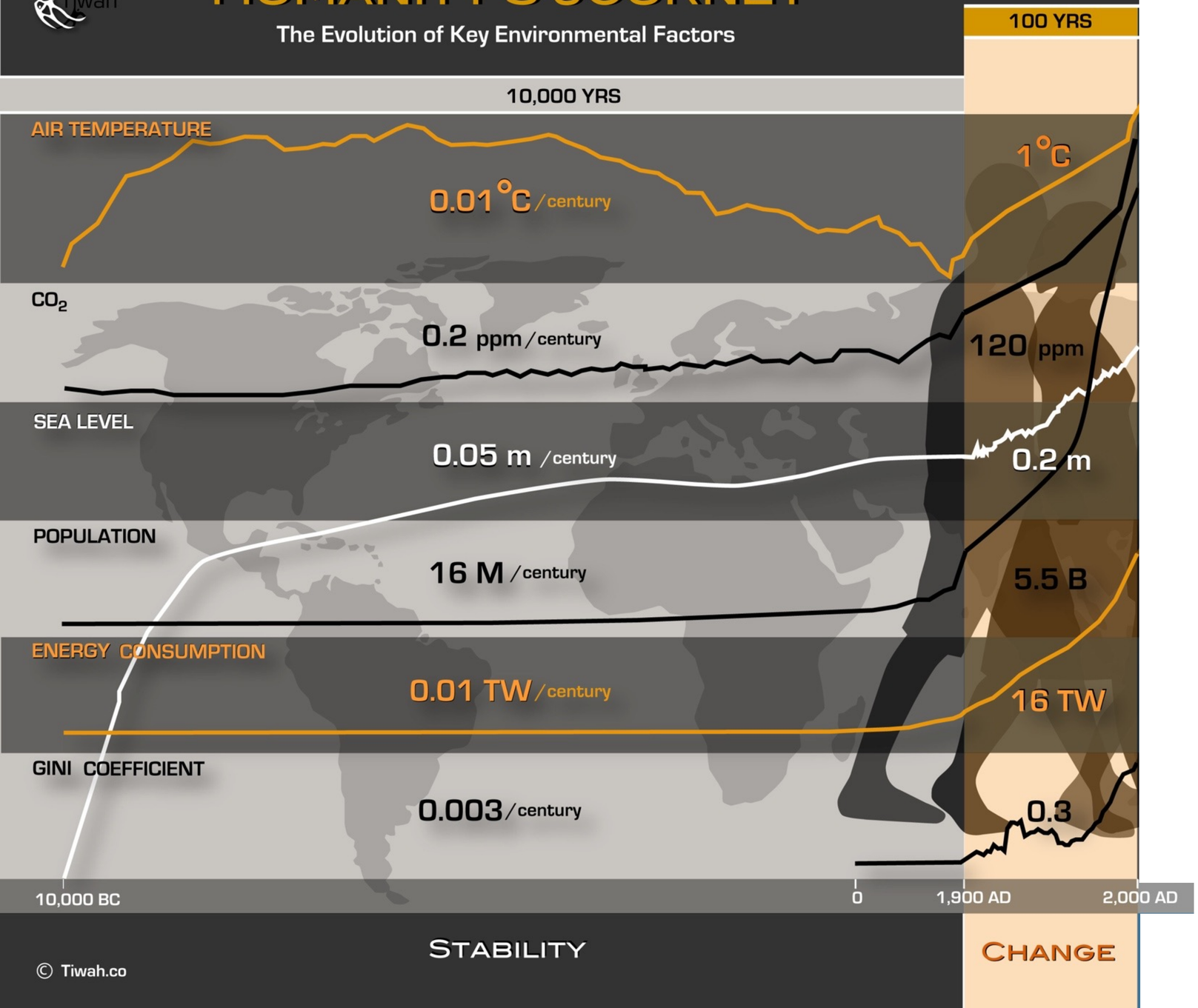

Stability

Change

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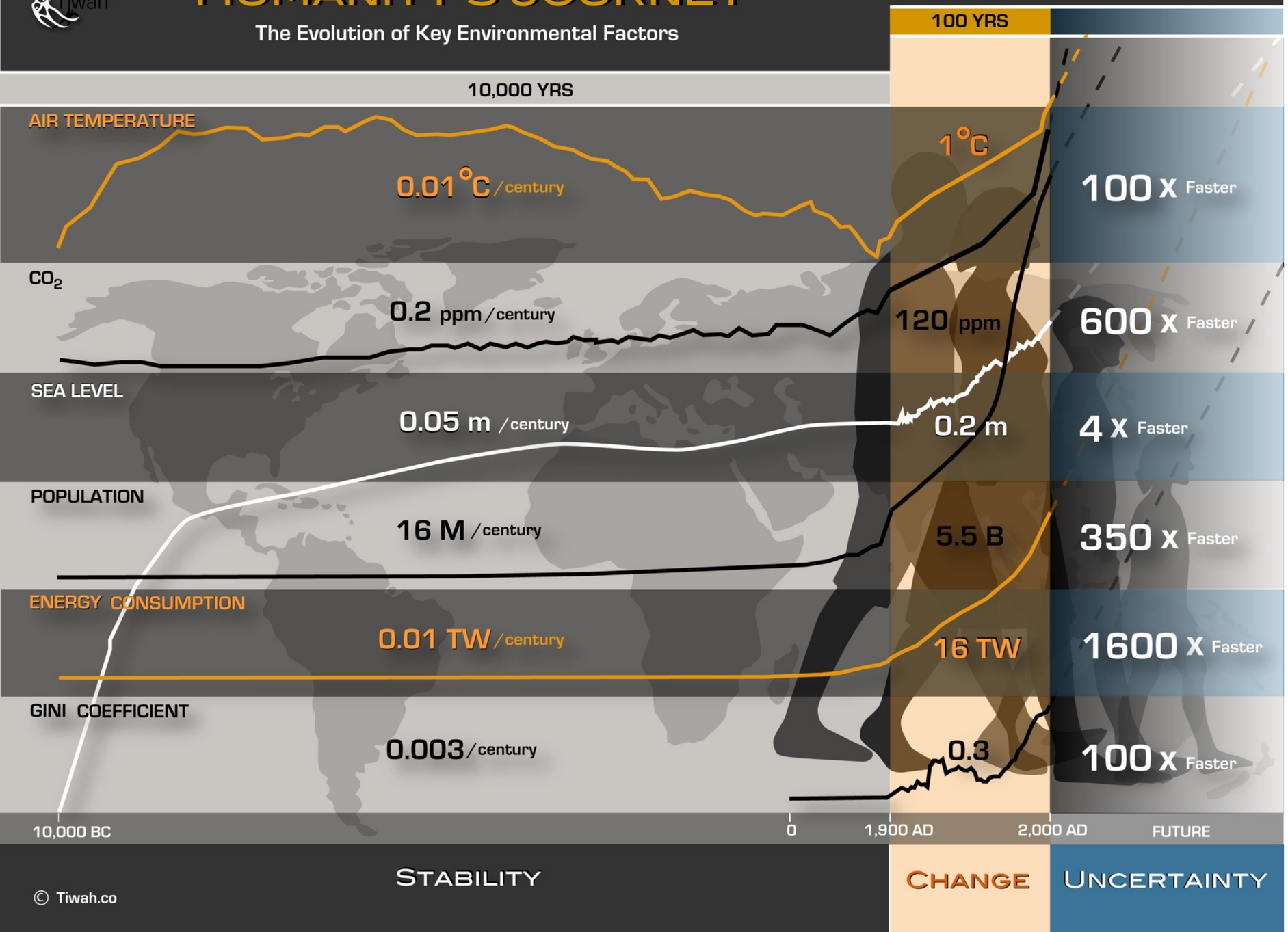

Stability | Change | Uncertainty

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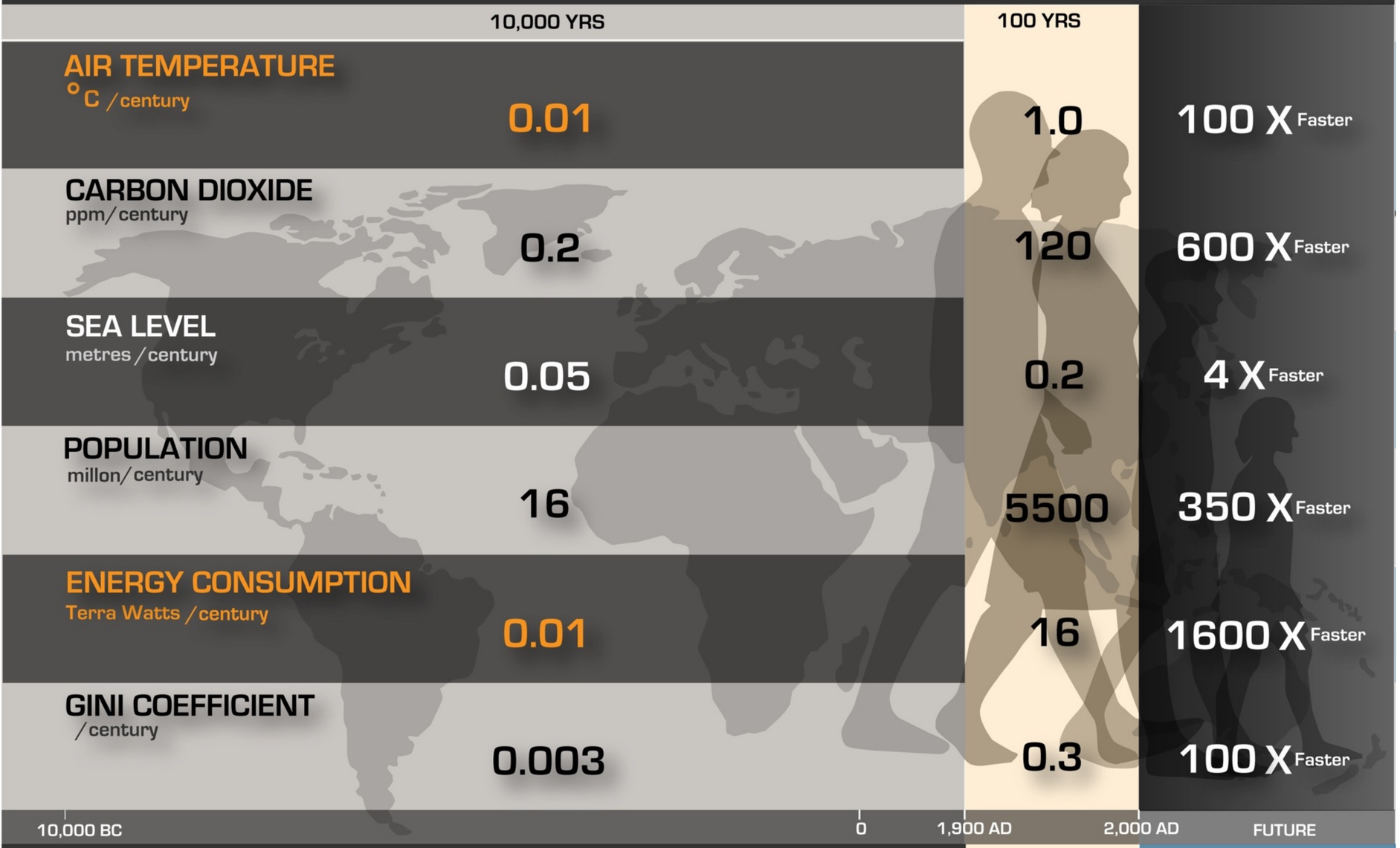

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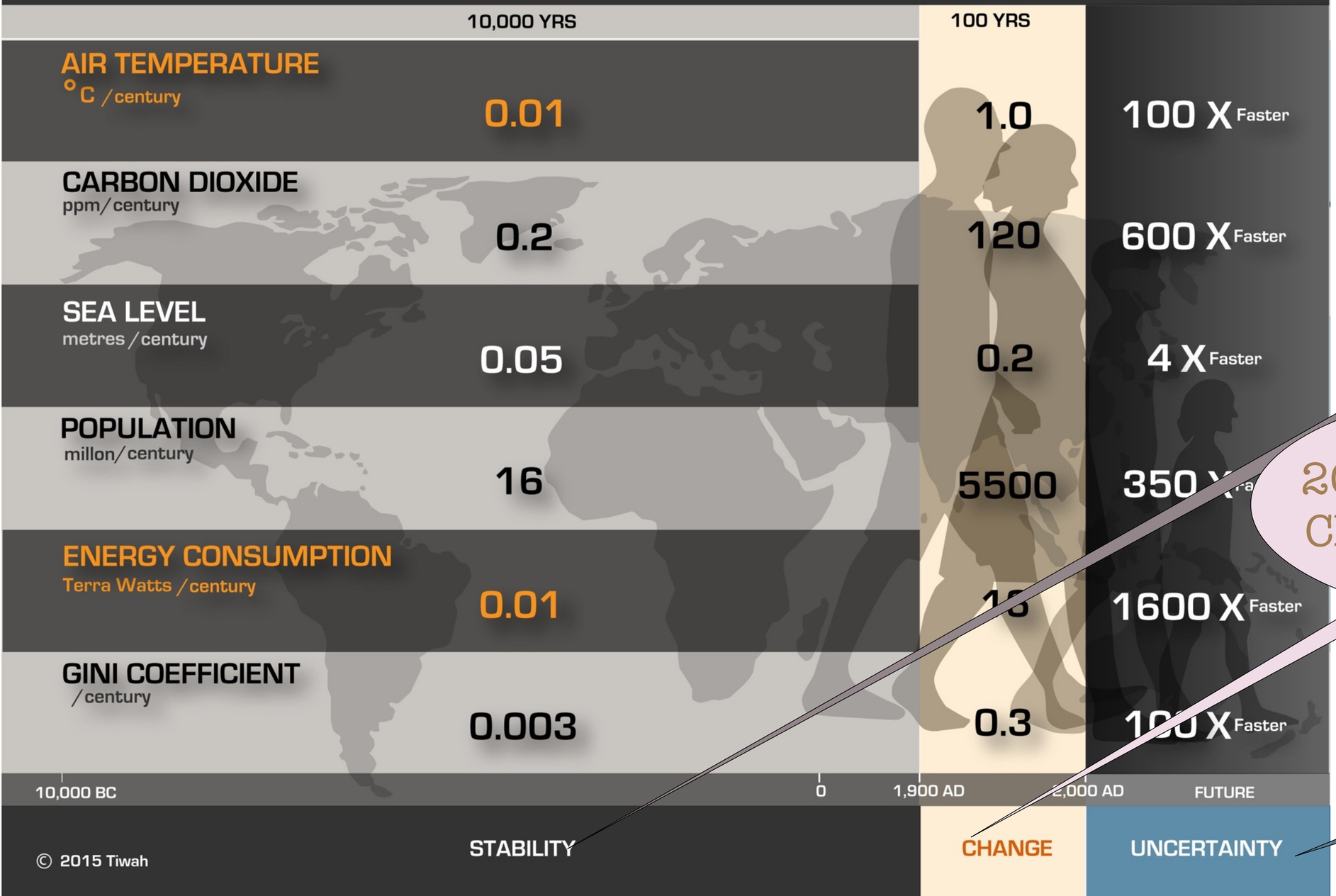
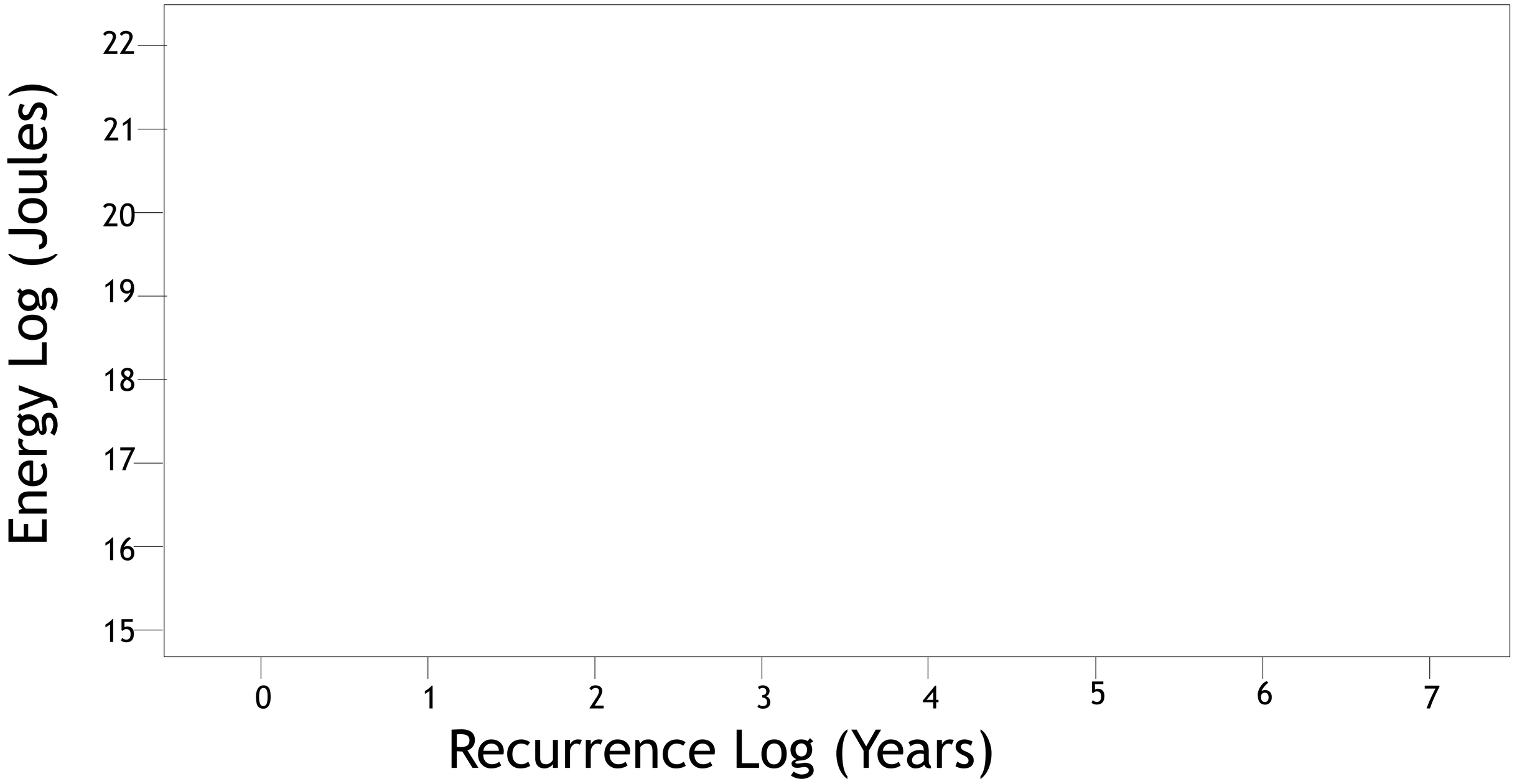


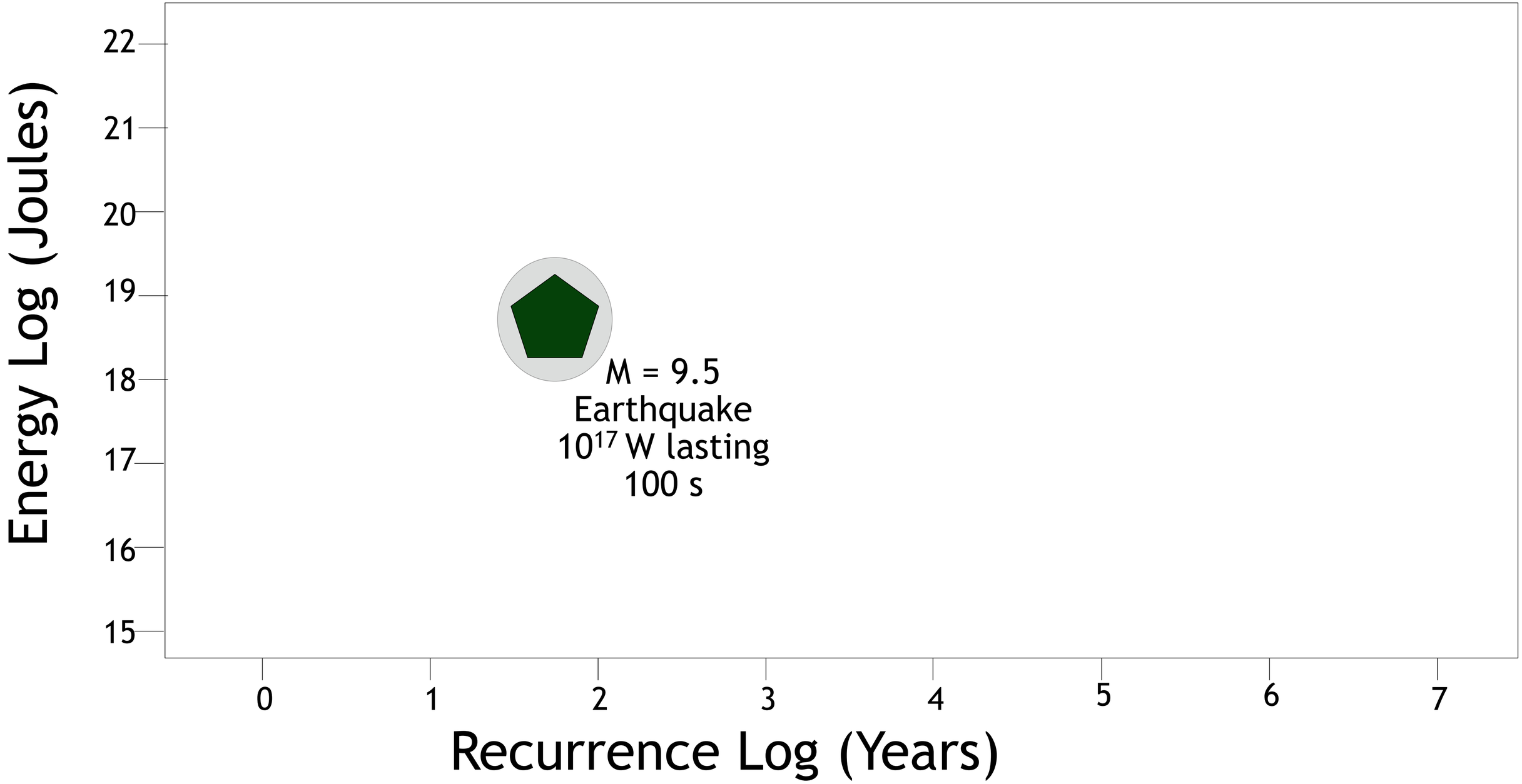
Holocene: Stability

20th and 21st Century: Change, disequilibrium

Future: Uncertainty


Energy Log (Joules)
22
21
20
19
18
17
16
15
0
1
2
3
4
5
6
7
Recurrence Log (Years)

Energy associated with natural hazards:



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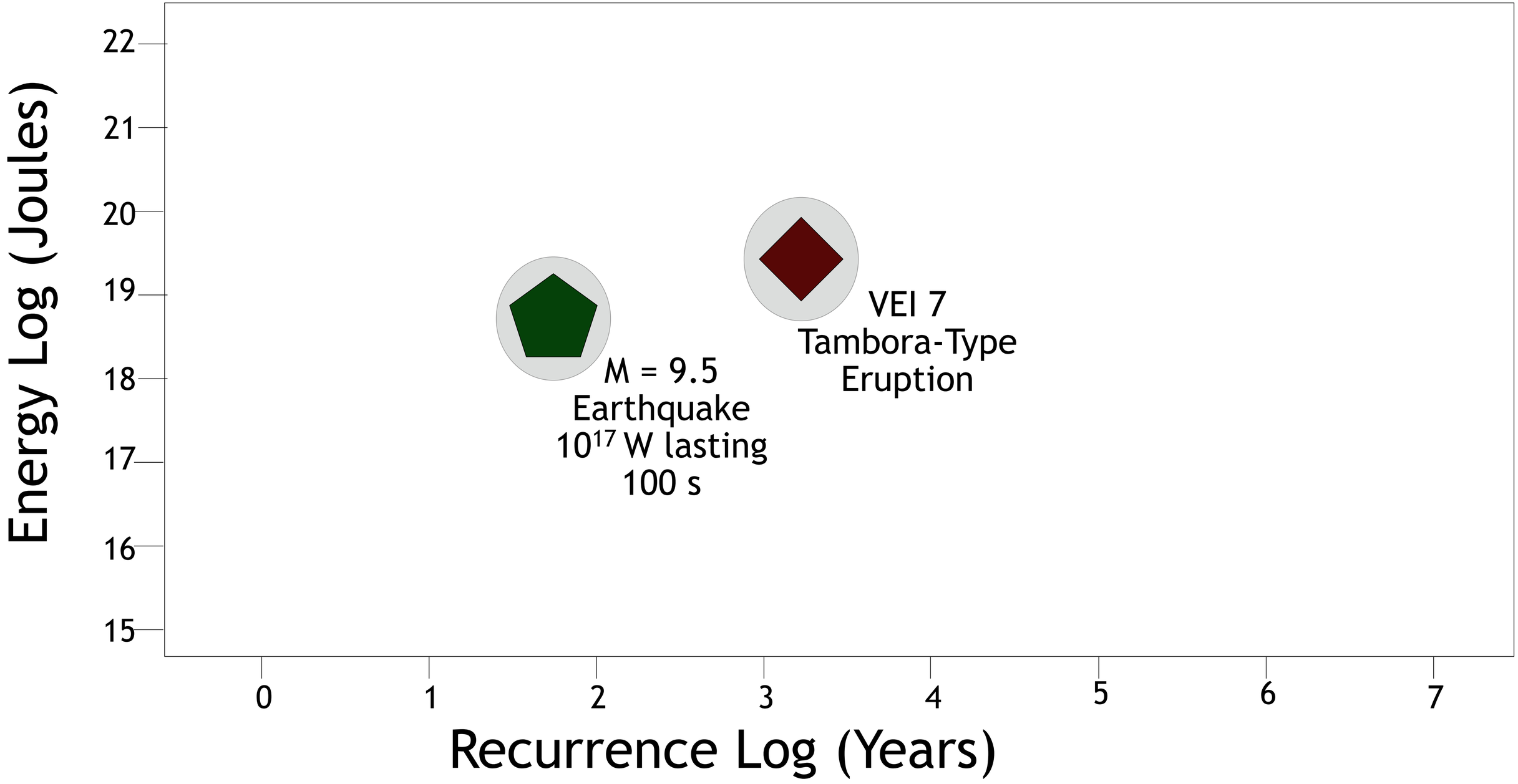

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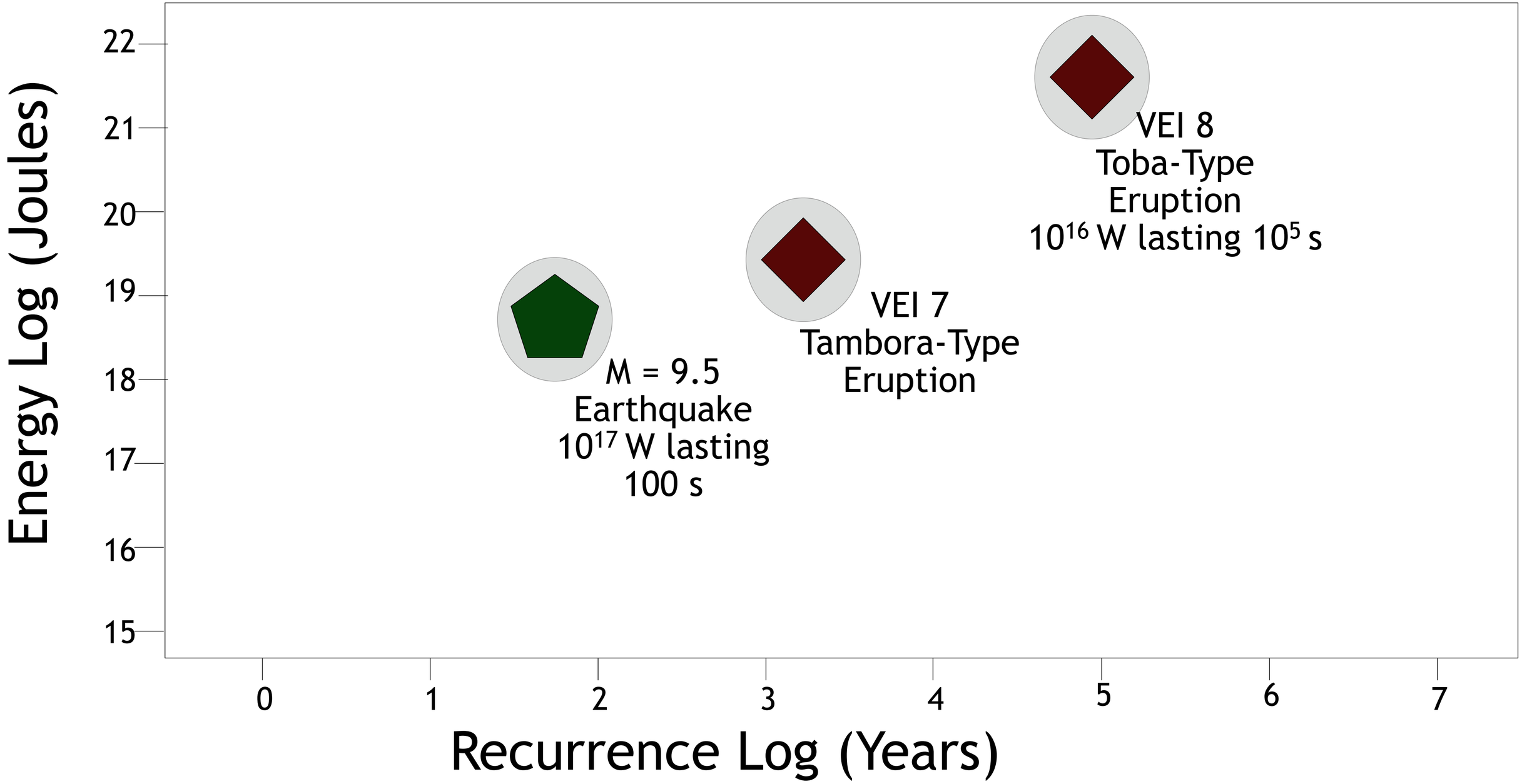

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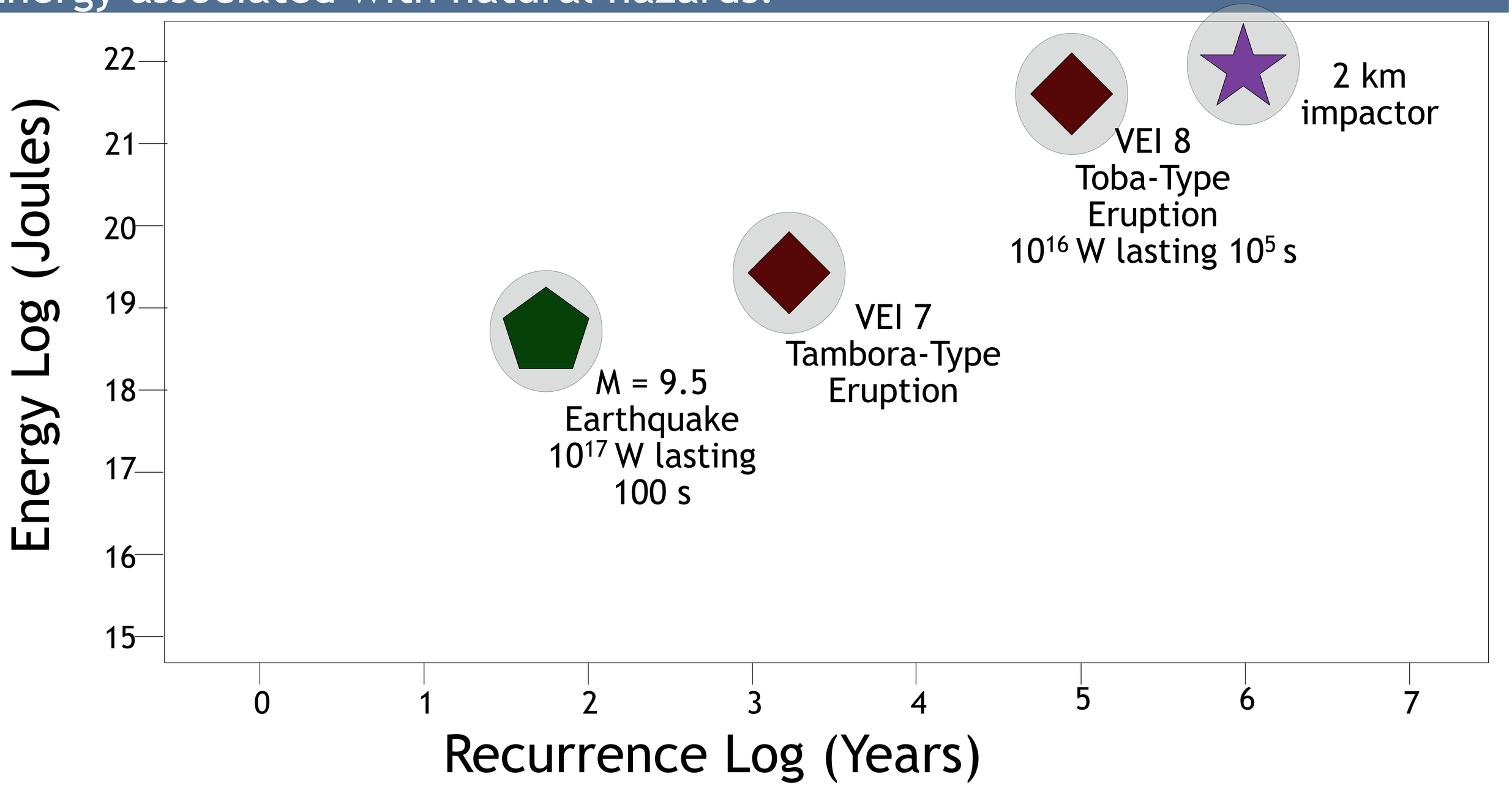

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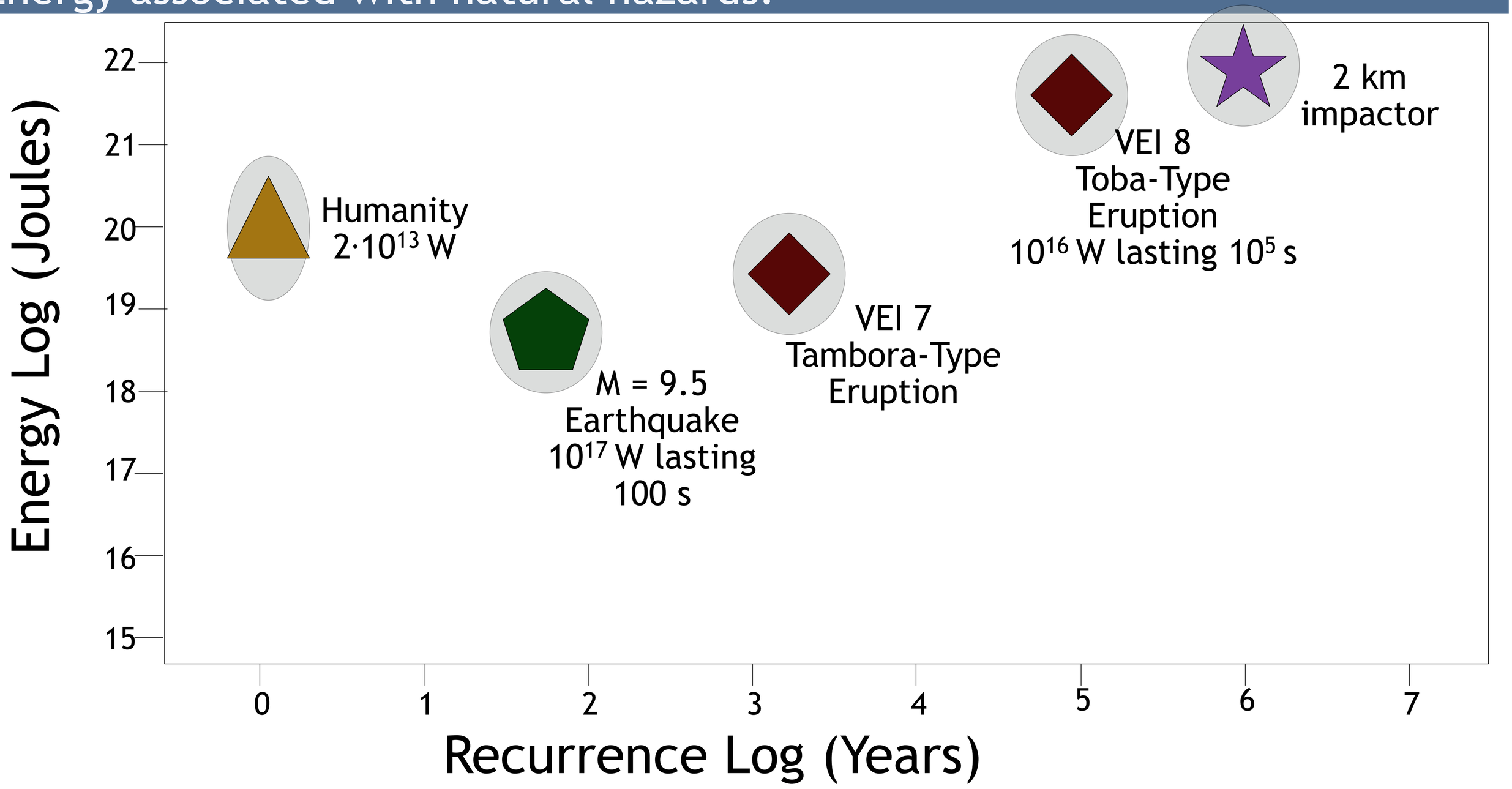

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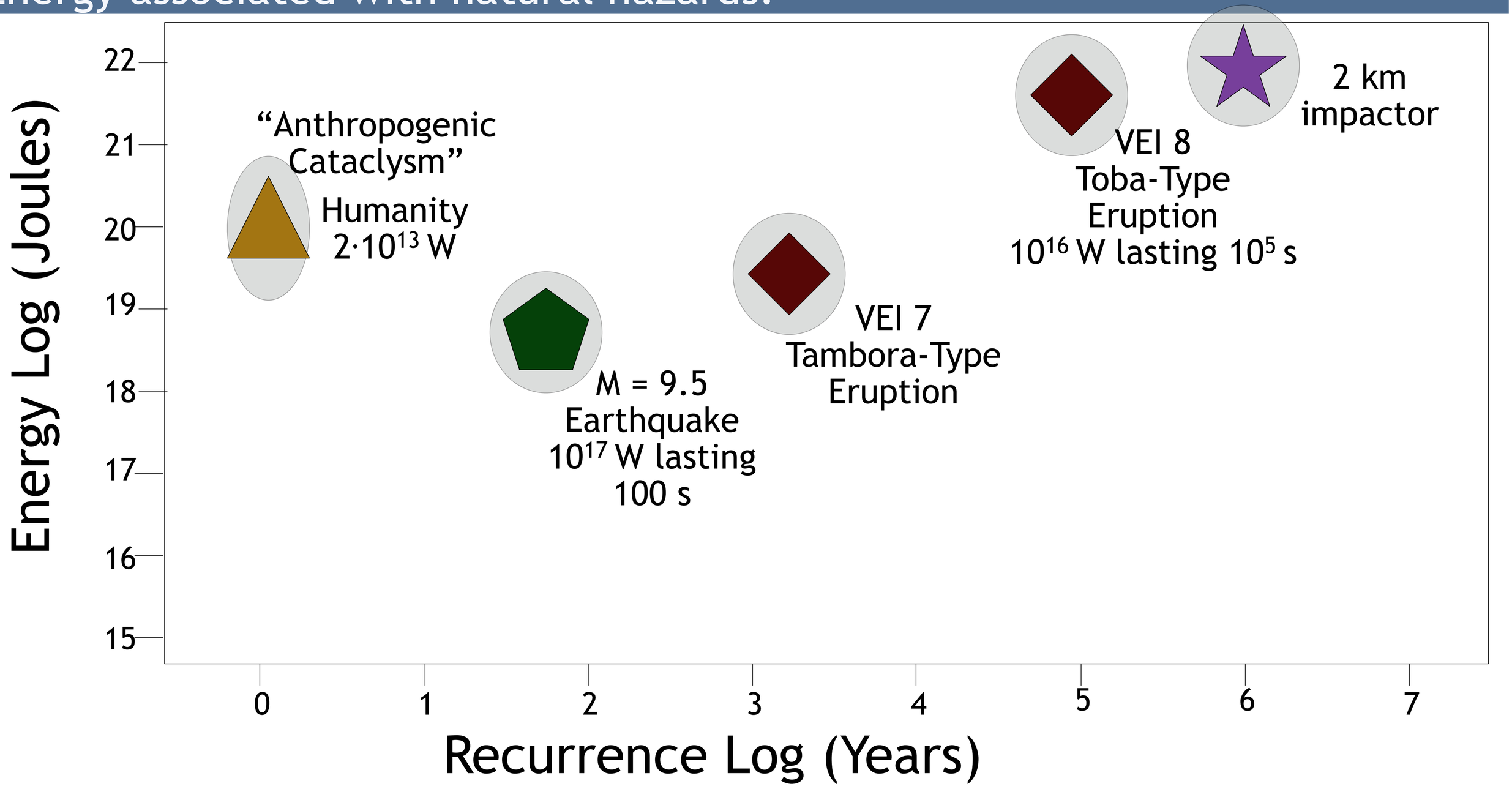

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The system is already now outside the “normal range” and in the dynamic transition into the Post-Holocene; we have increasing disequilibrium

The Prognosis: A Journey Into the Unknown

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Four Questions:

- What are the implications for sustainability?
- How should we present the prognosis?
- How solid is our knowledge of current and future trends?
- What should we be worried about?

SUSTAINABILITY:

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How difficult is it to keep a system within the sustainable range?

It depends...

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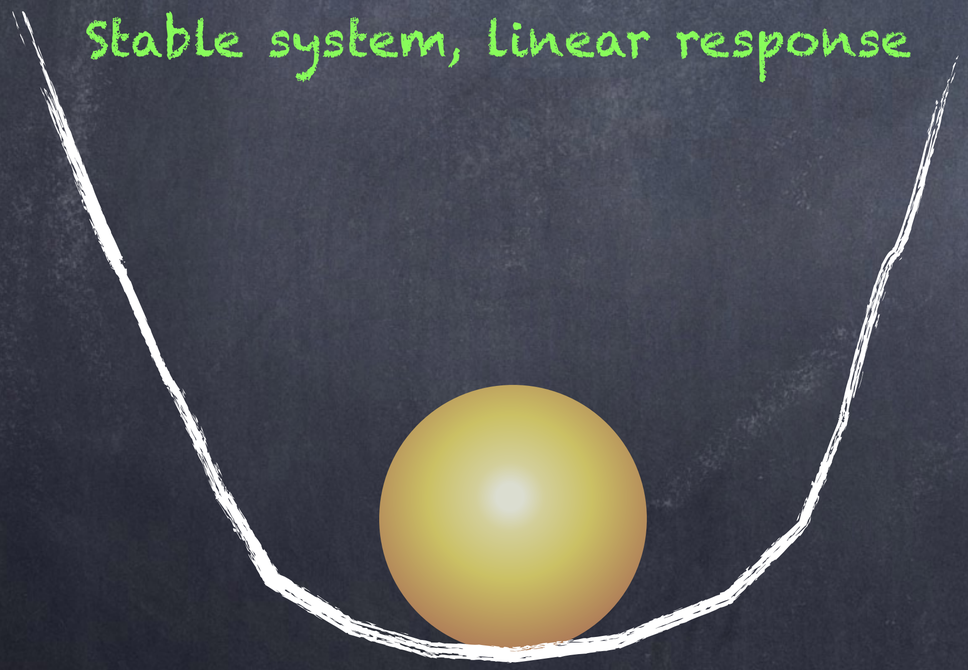
Stable system, linear response



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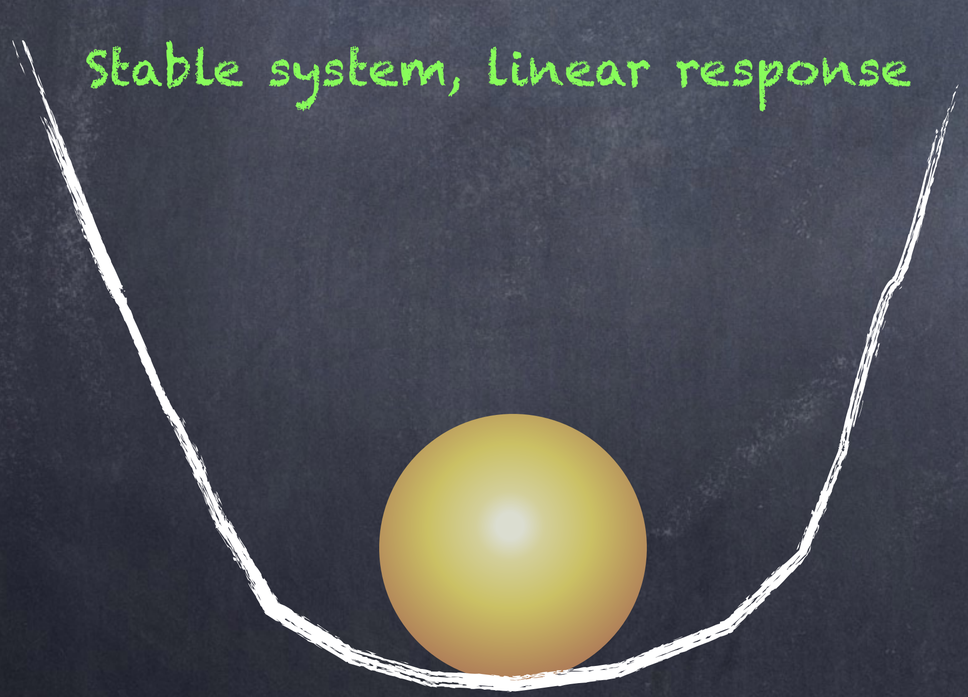

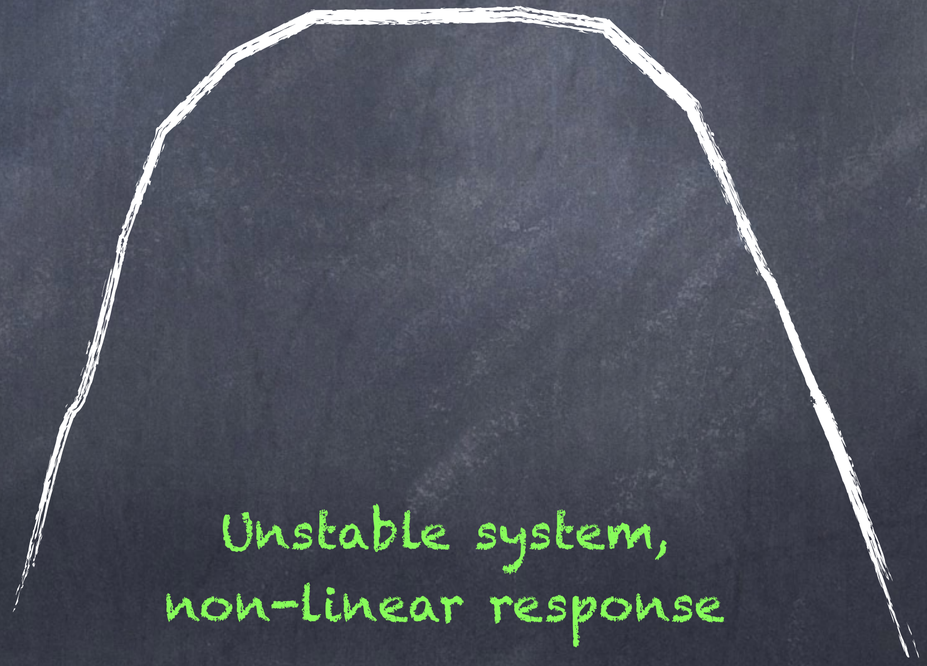

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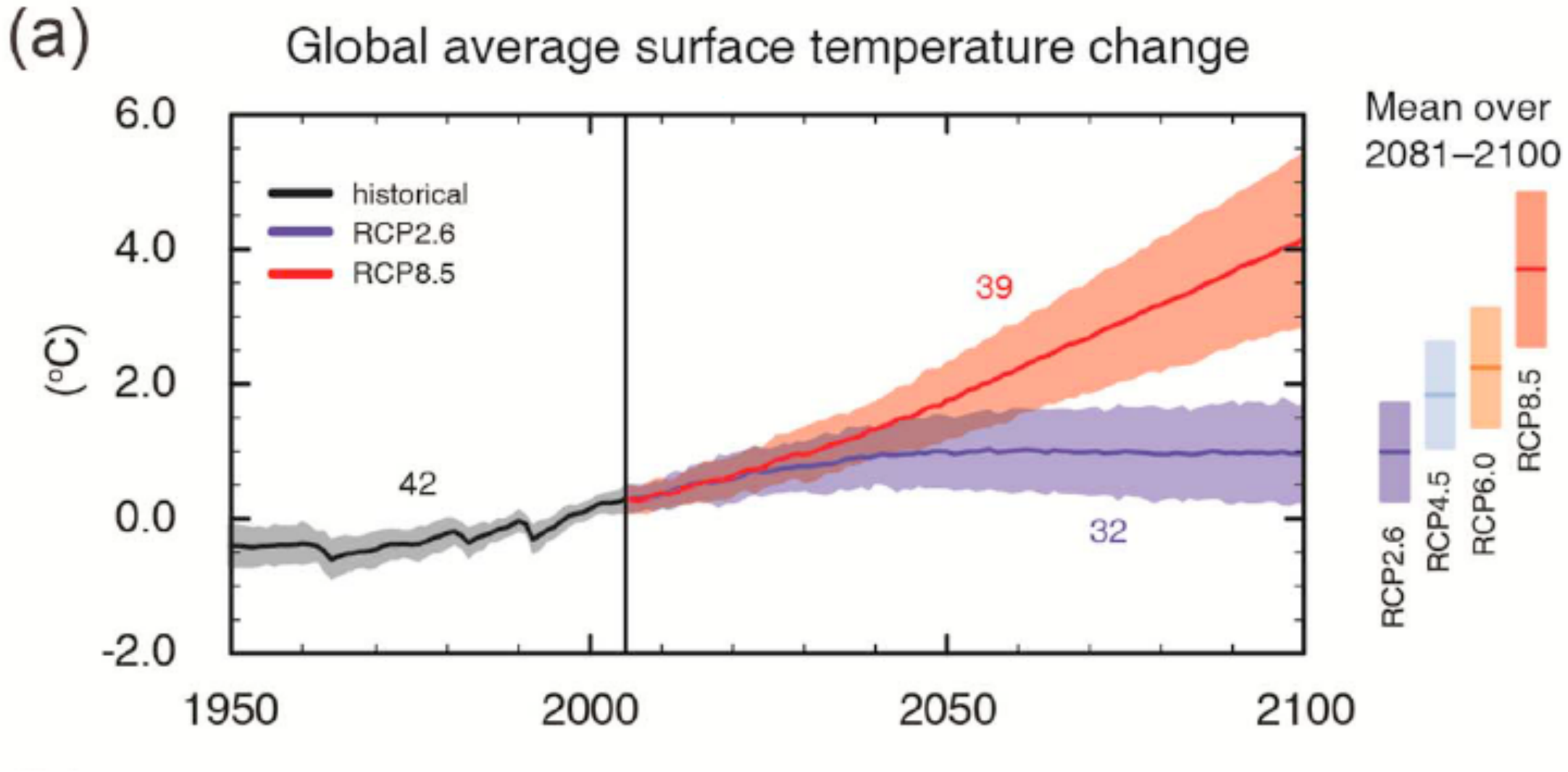
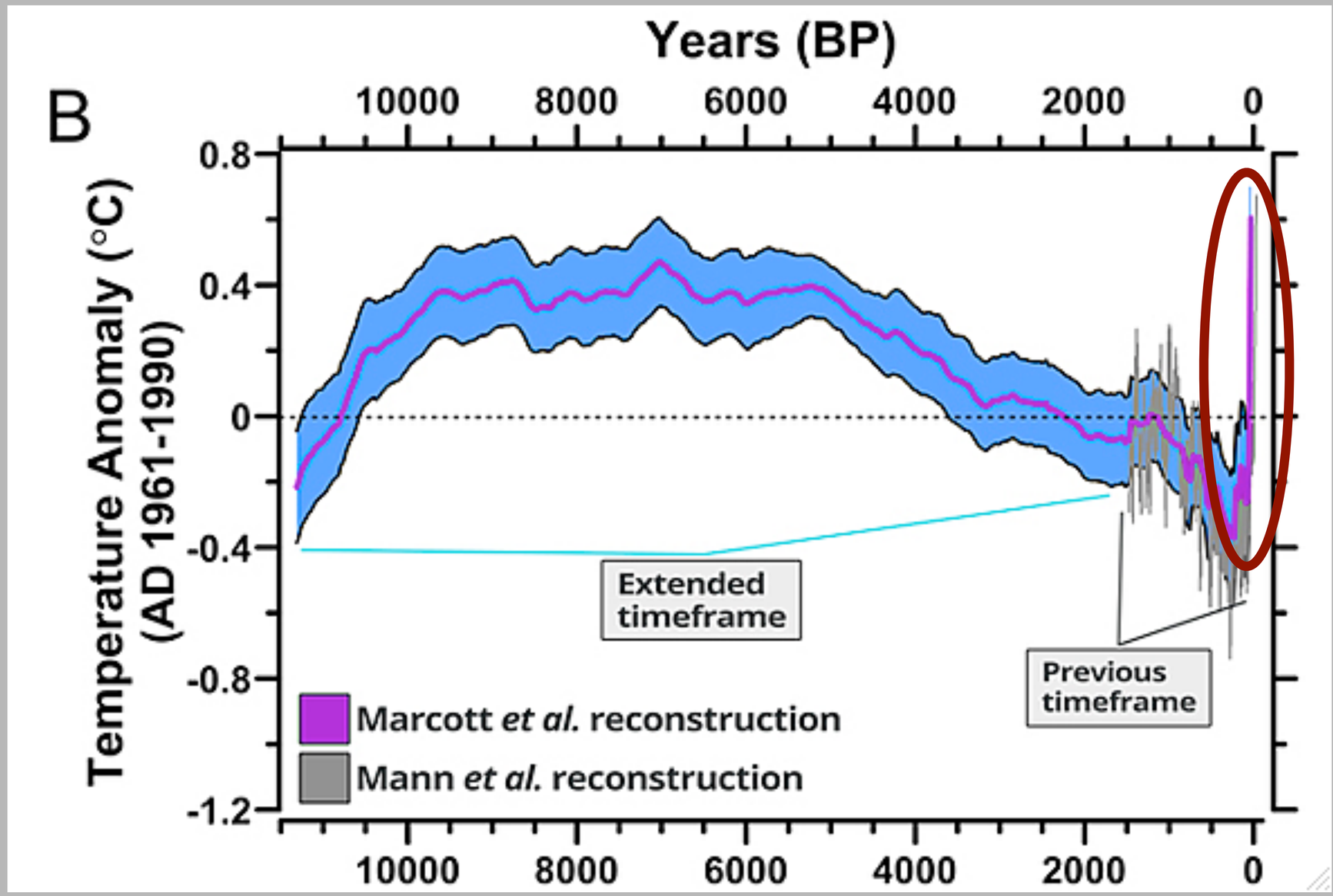


IPCC, 2013

The Prognosis: A Journey Into the Unknown



Marcott et al., 2013

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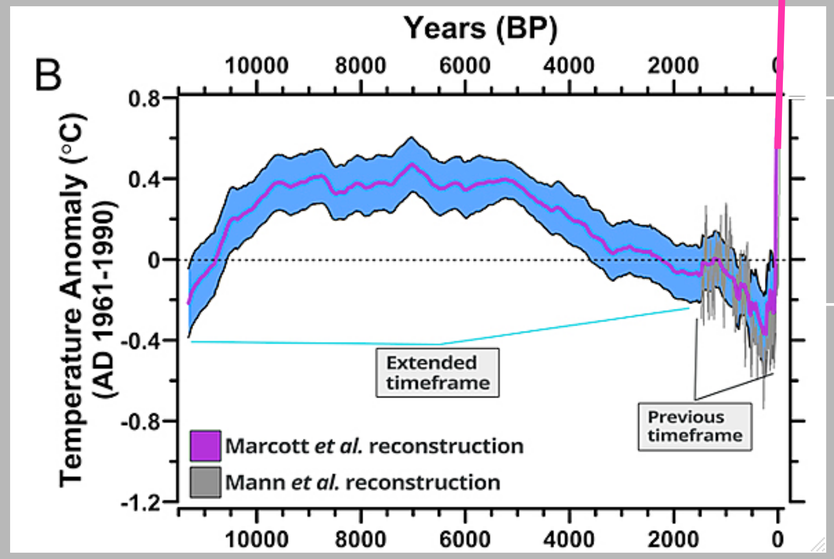
4

3

2

1°C

IPCC Assessment:
Very Likely by 2100



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4

<--Post-Holocene

3

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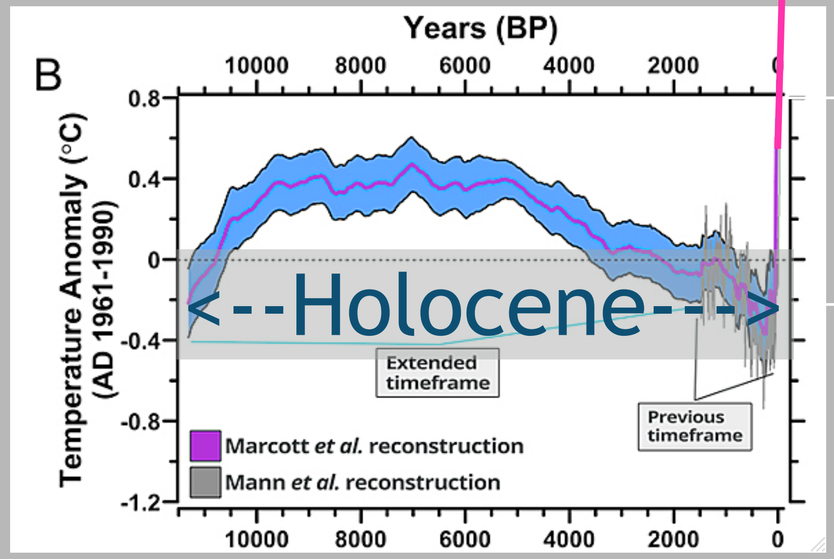
1°C



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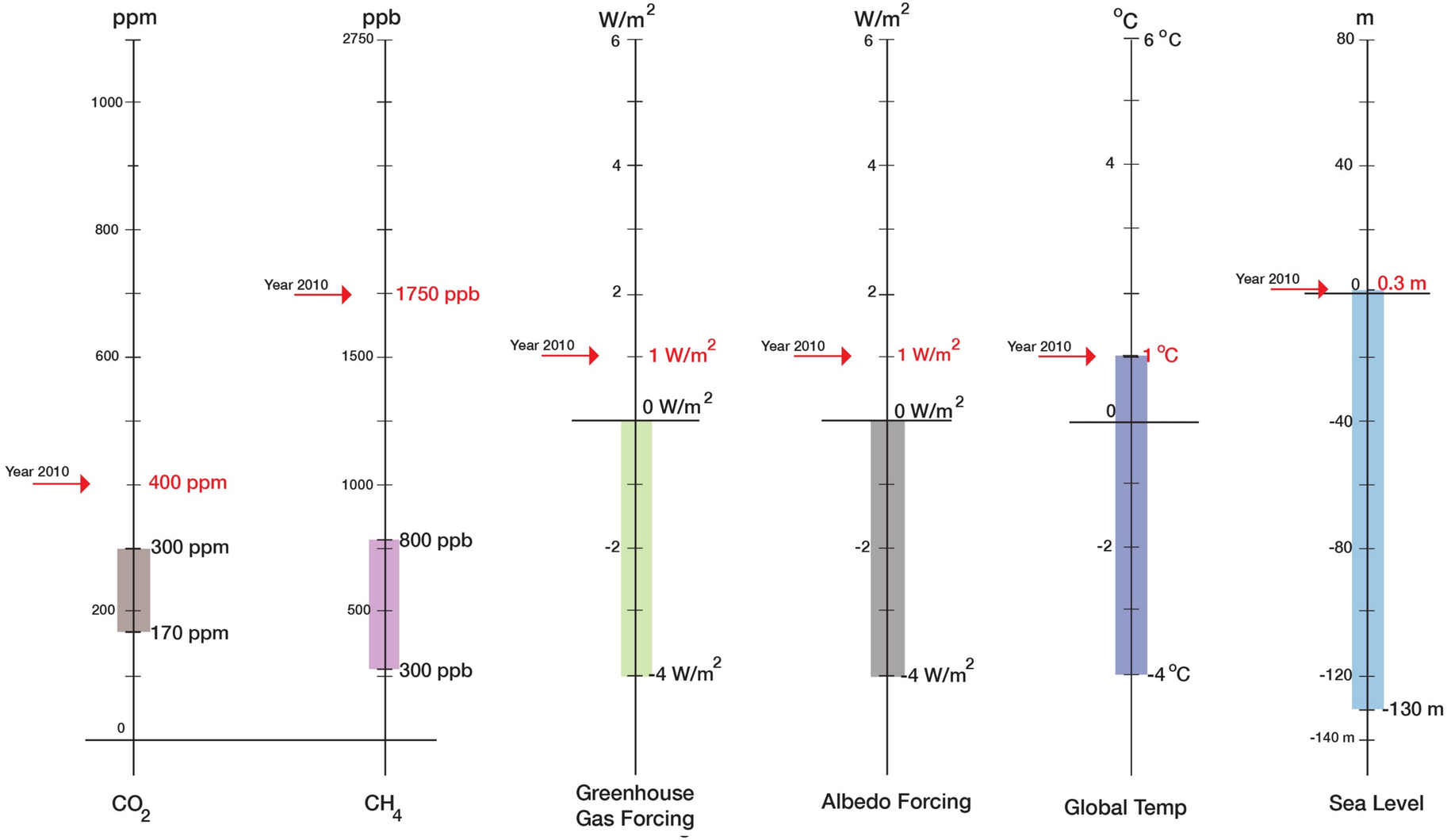
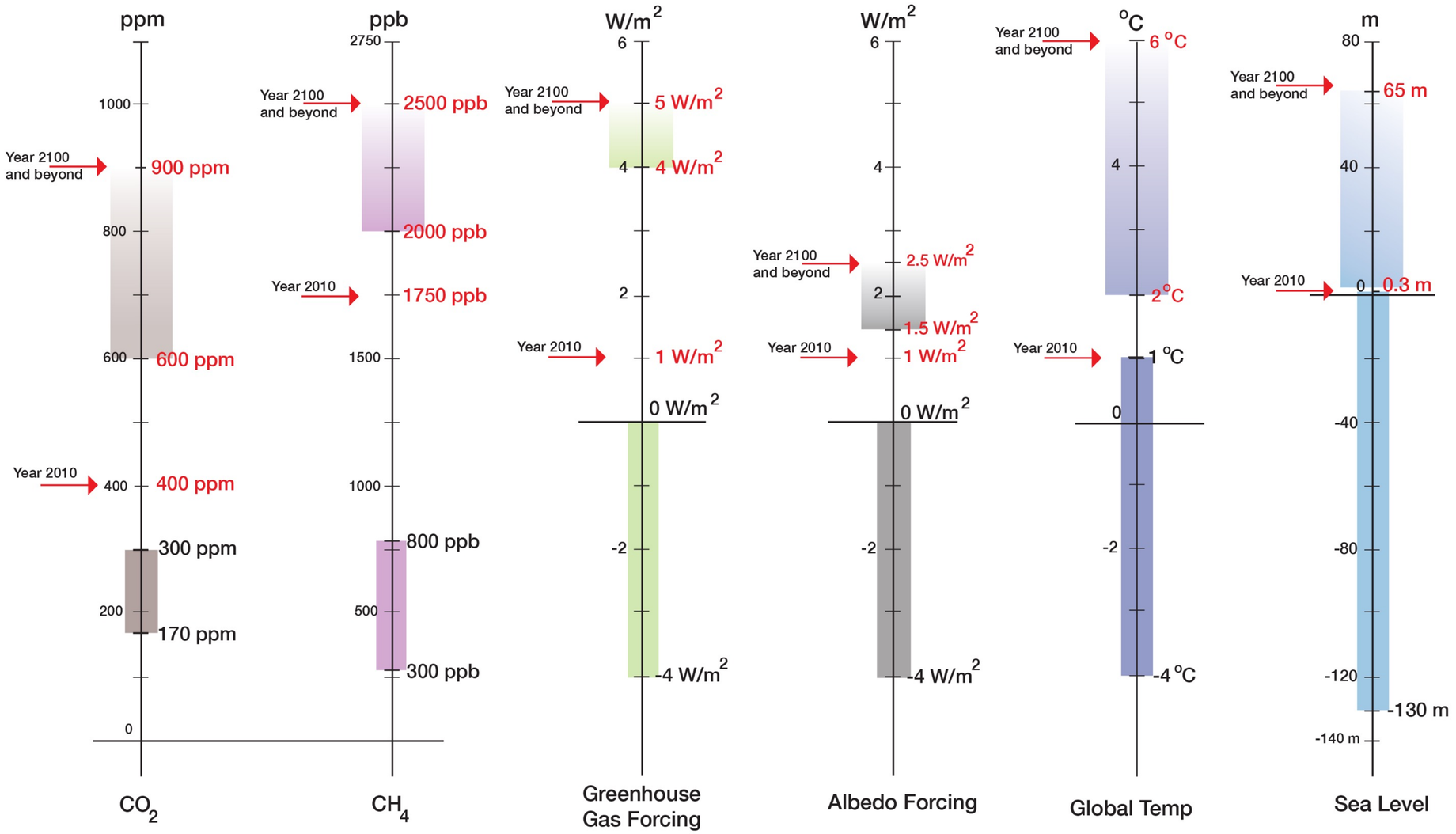


"Current State"

"Normal Range"
(800,000 years)

The Prognosis: A Journey Into the Unknown



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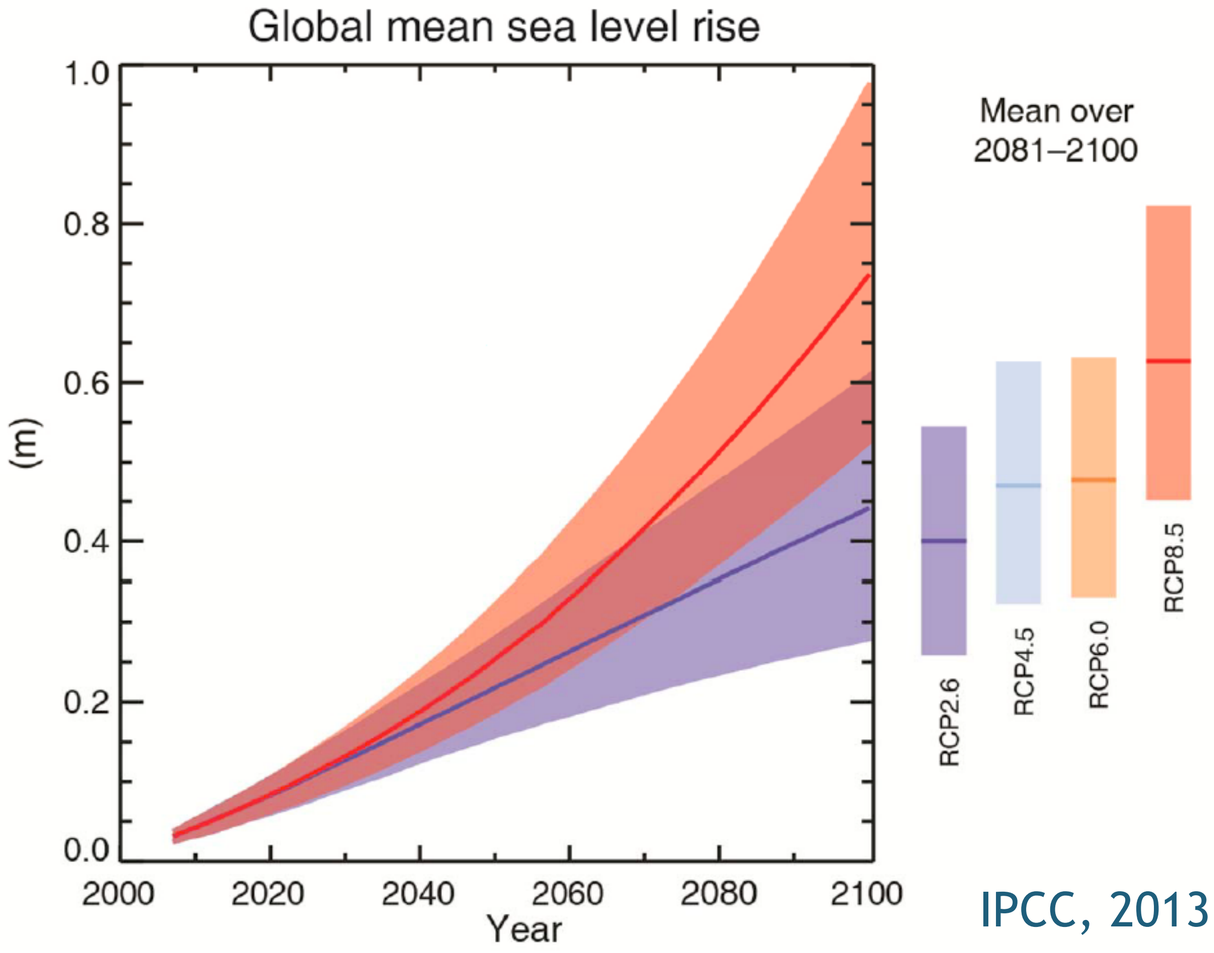

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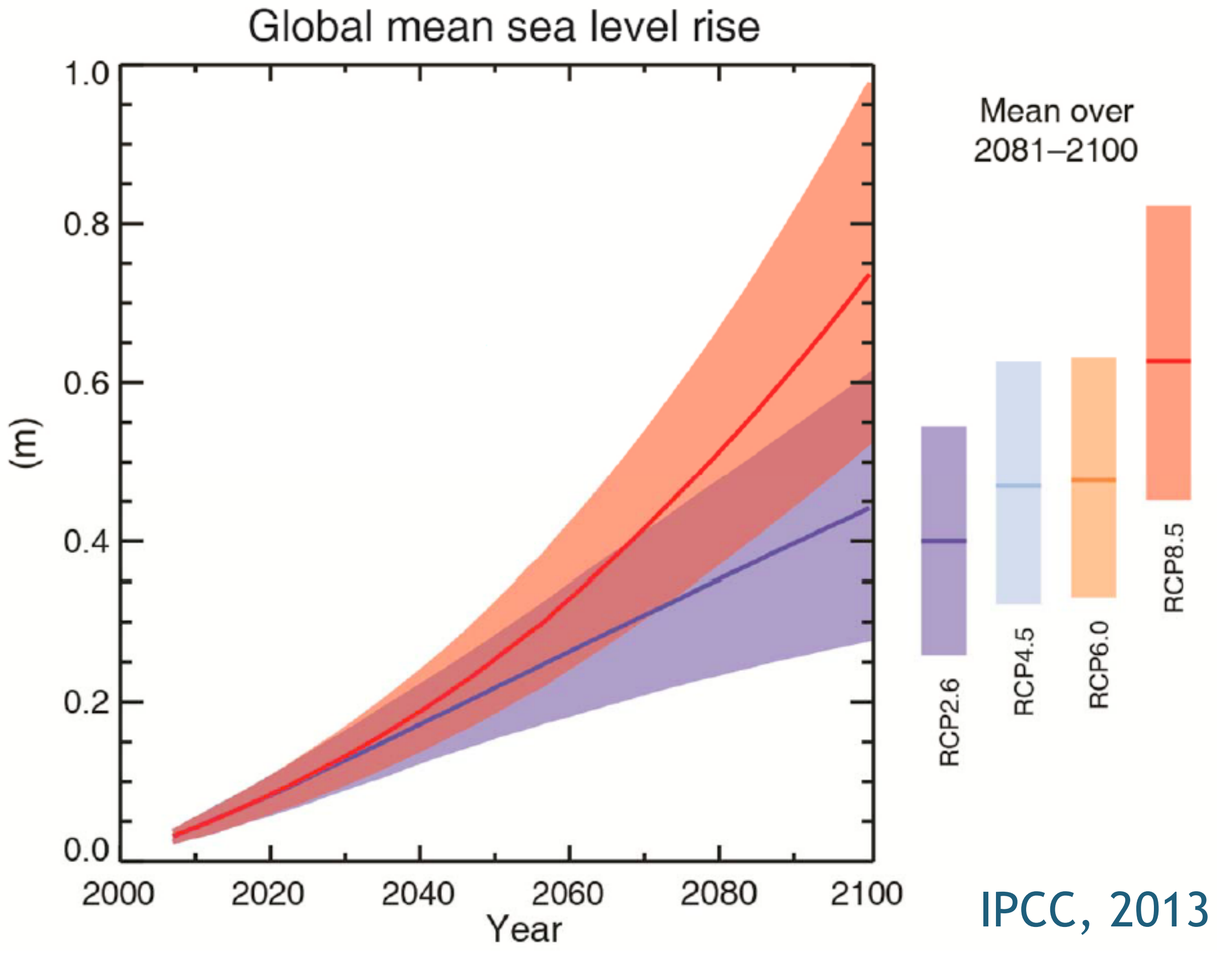
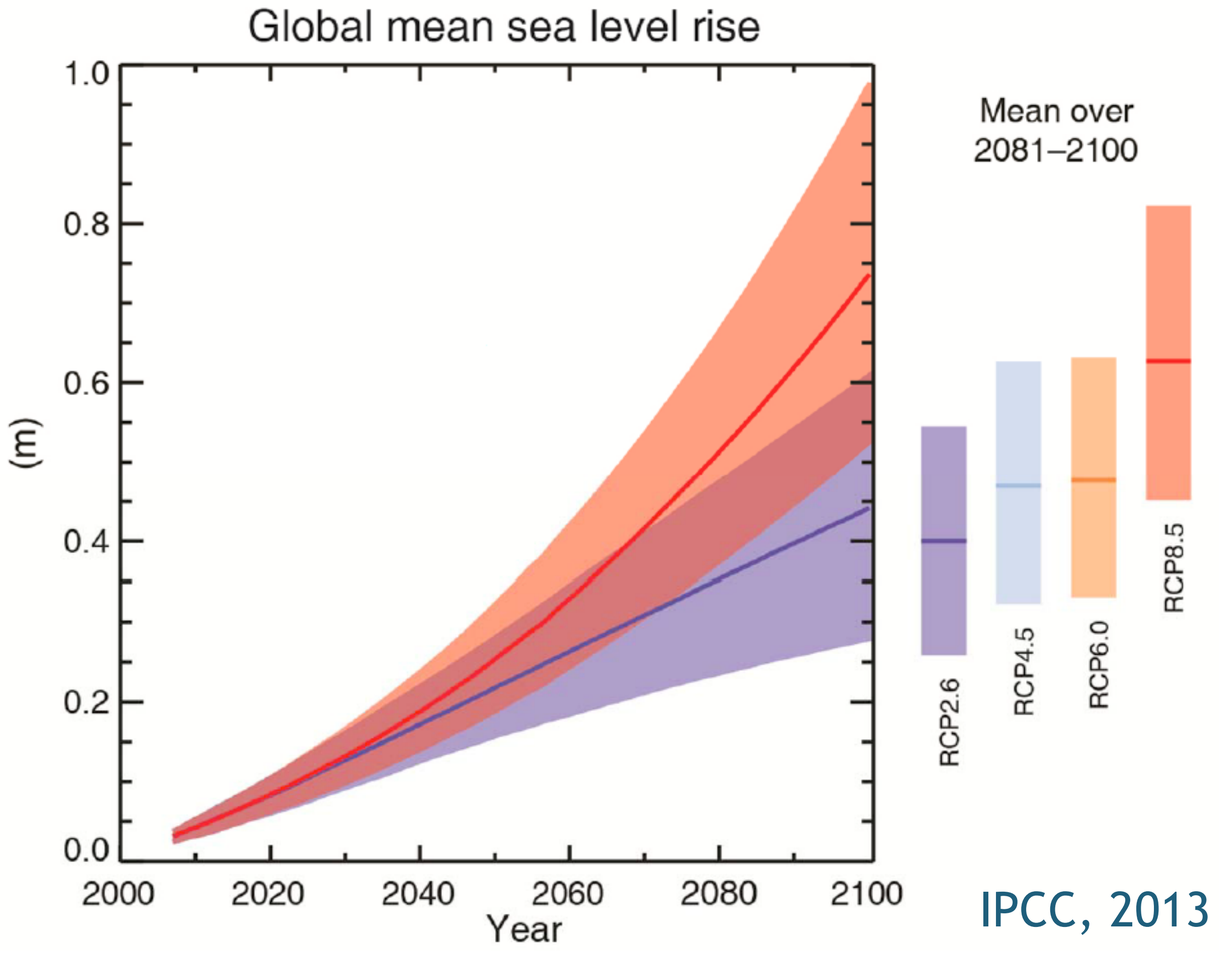


IPCC, 2013

Note: No accelerated contribution from Greenland and Antarctic ice sheets considered

The Prognosis: A Journey Into the Unknown



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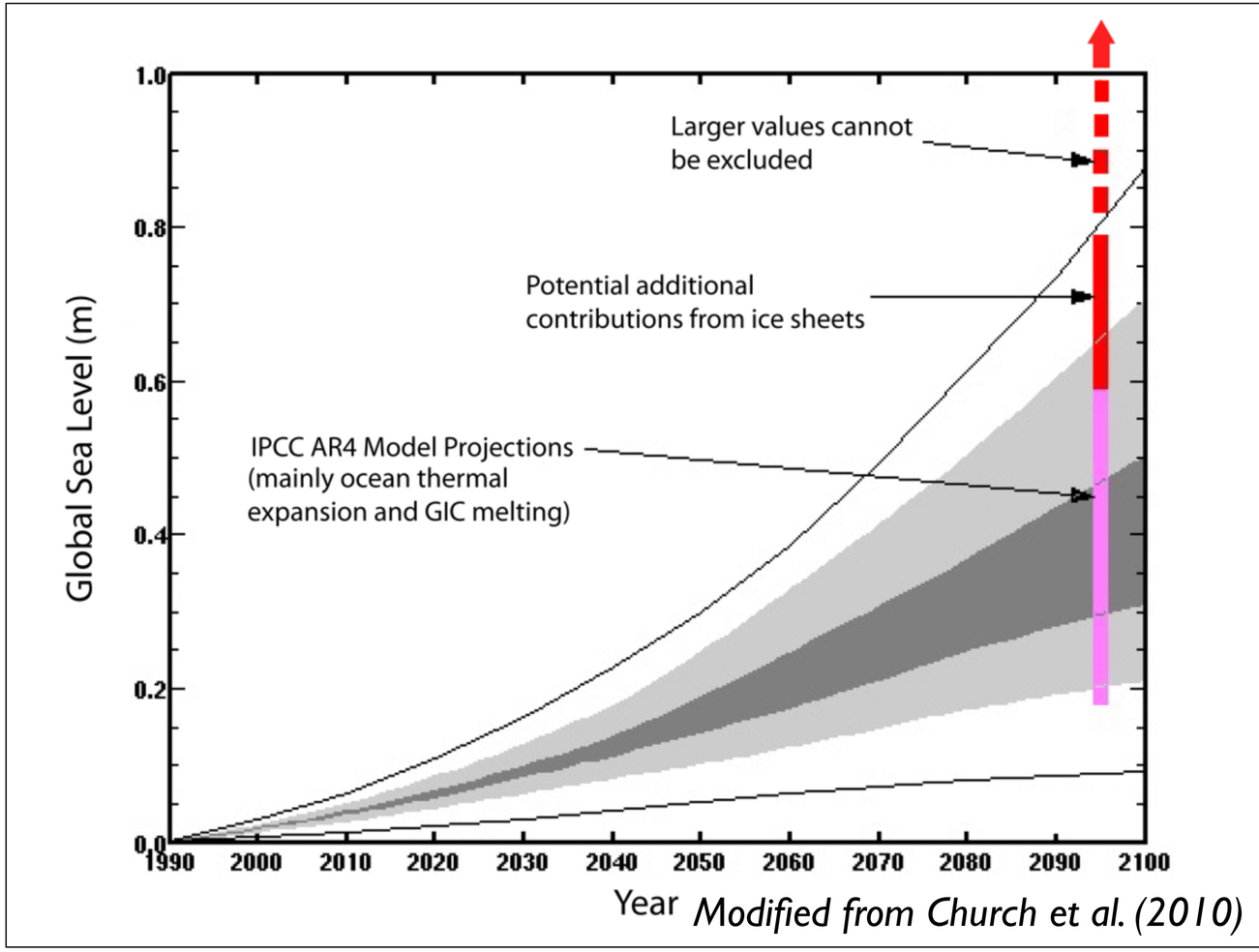

Modified from Church et al. (2010)

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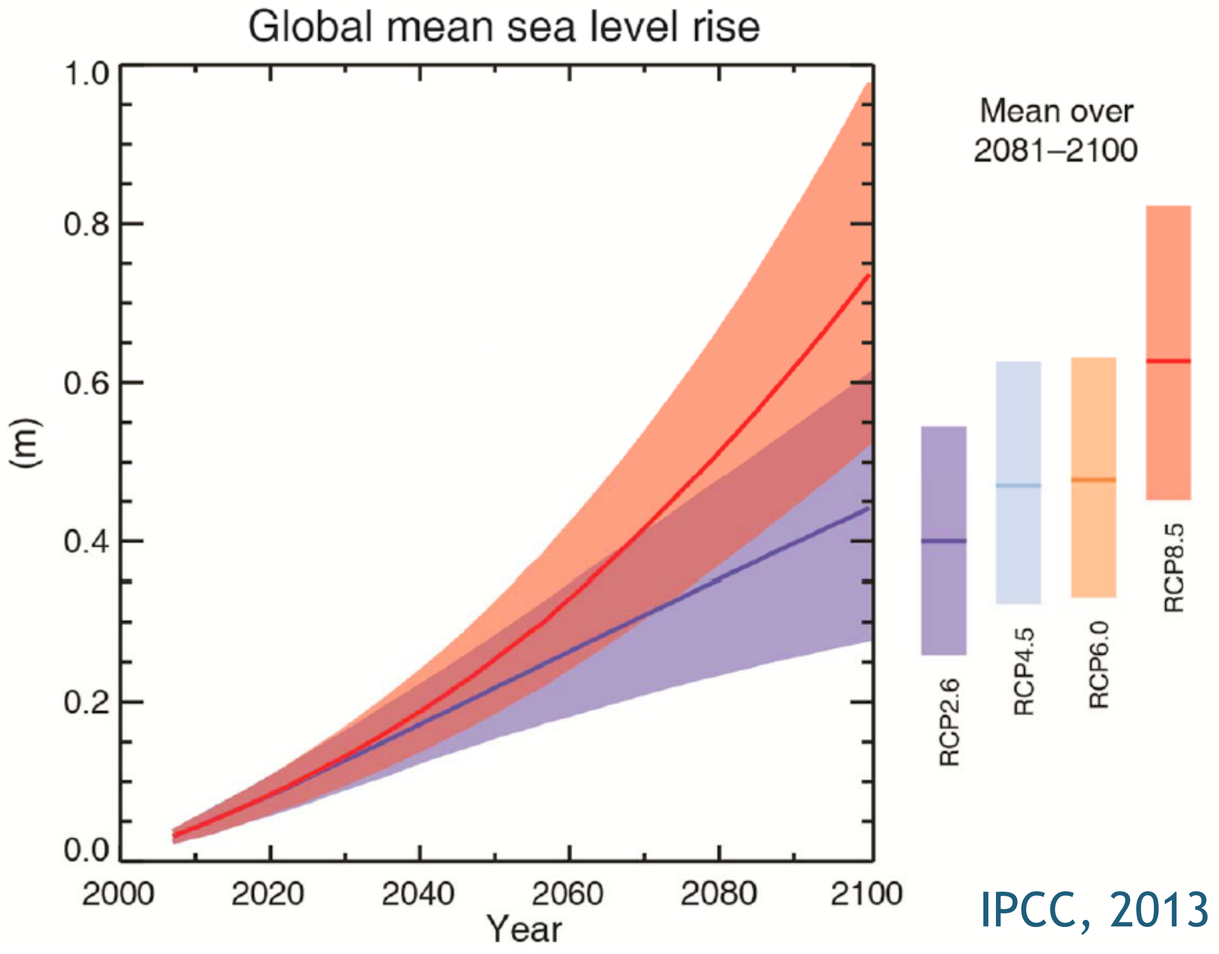

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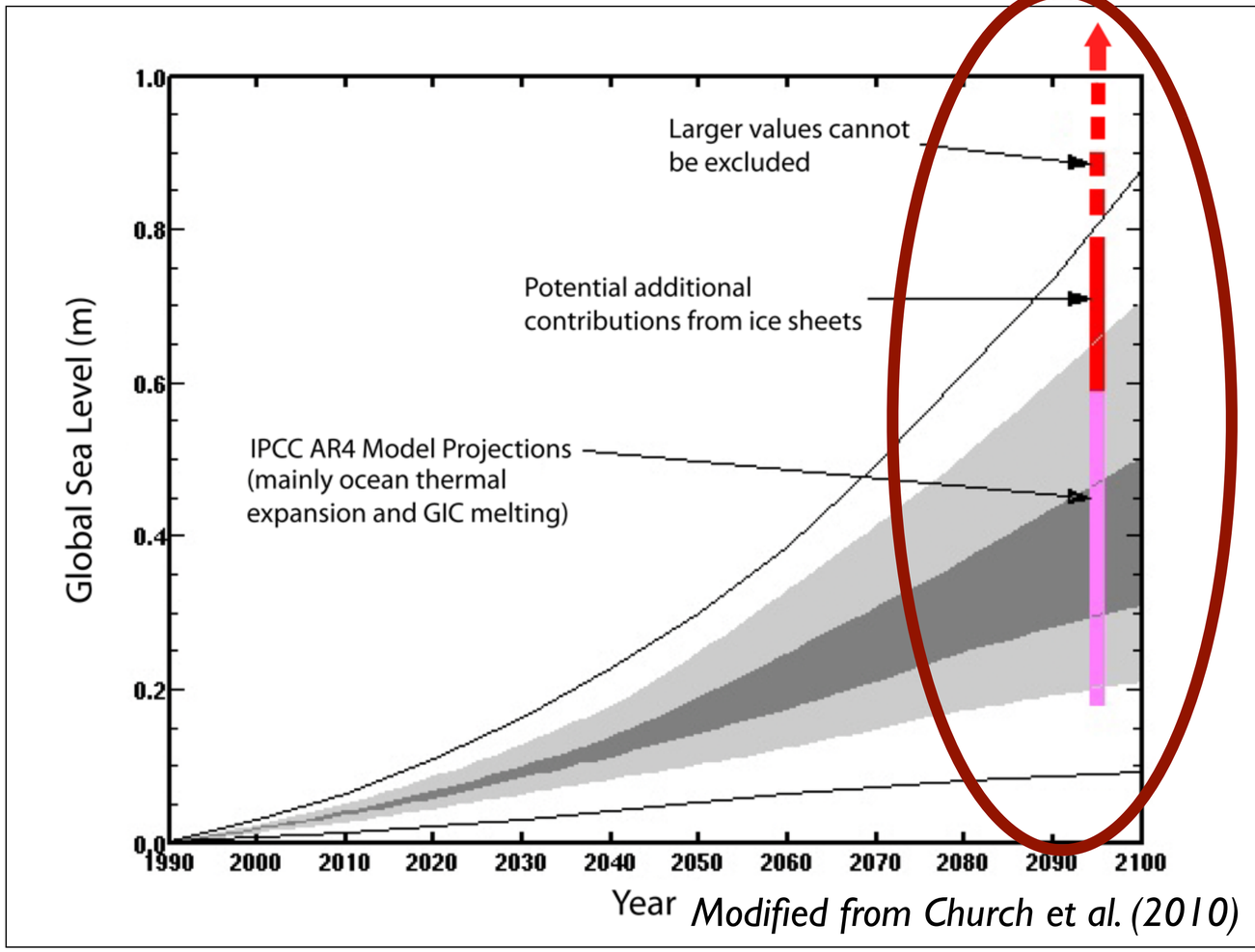

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The Prognosis: A Journey Into the Unknown

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The Prognosis: A Journey Into the Unknown

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Example sea level rise

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Antarctica: minor contribution

Main contribution: steric changes

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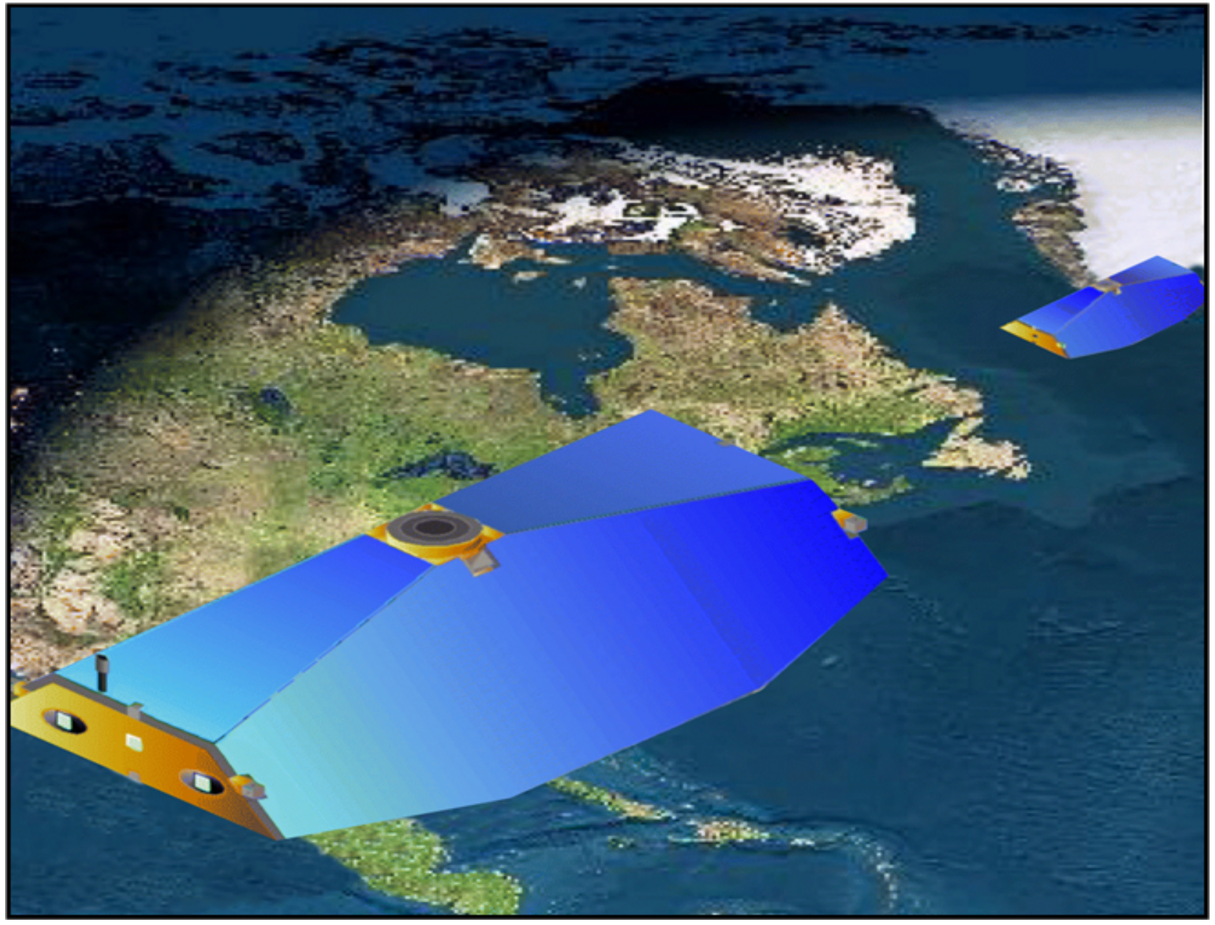

Gravity Recovery and Climate Experiment (GRACE)

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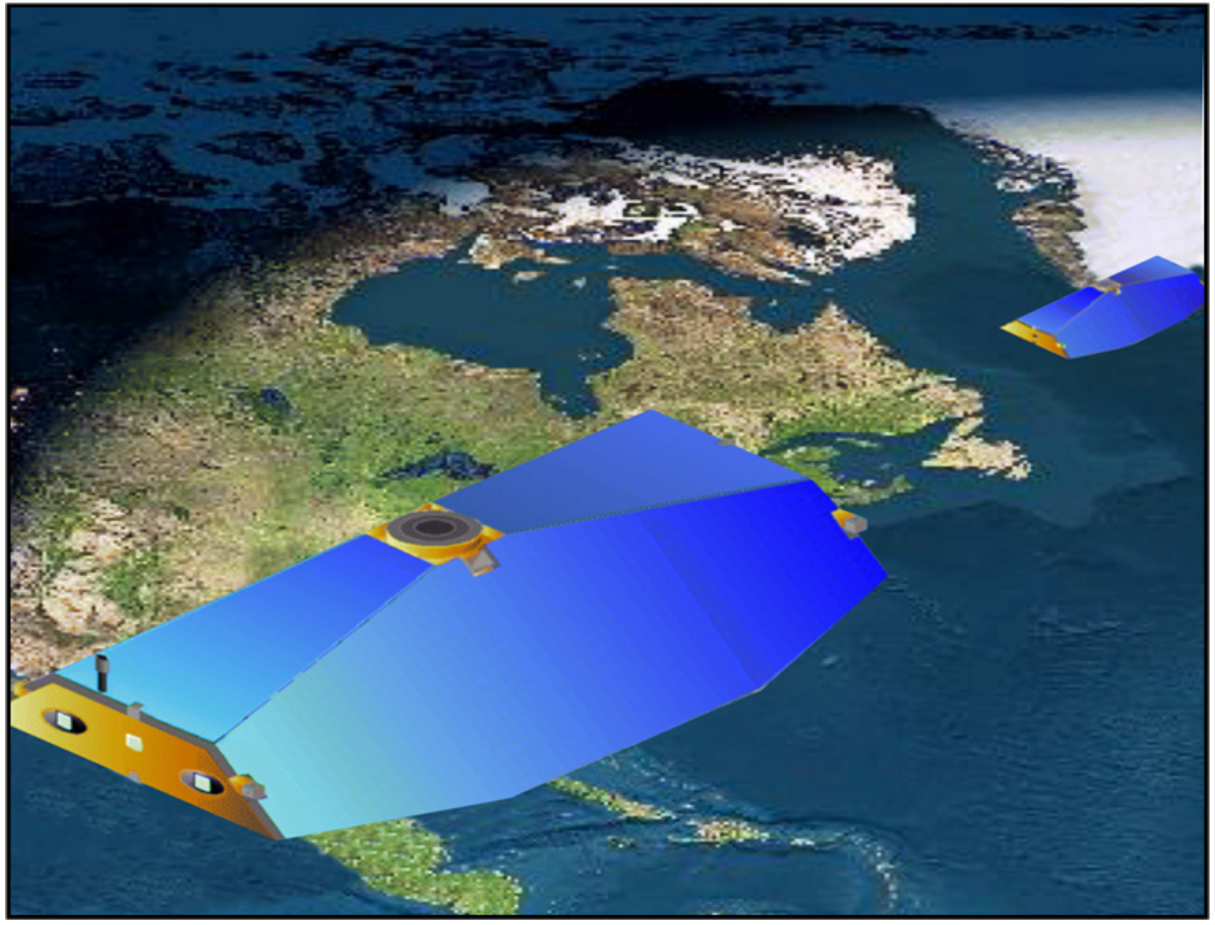

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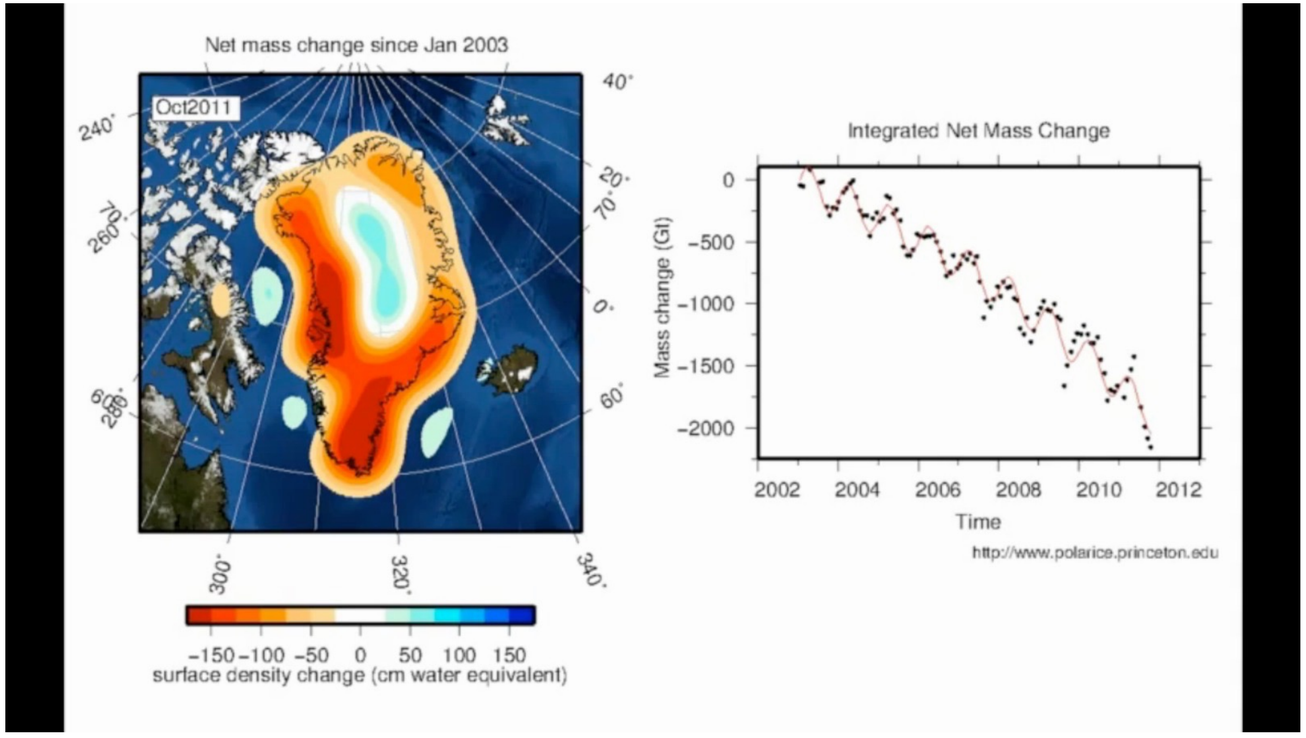

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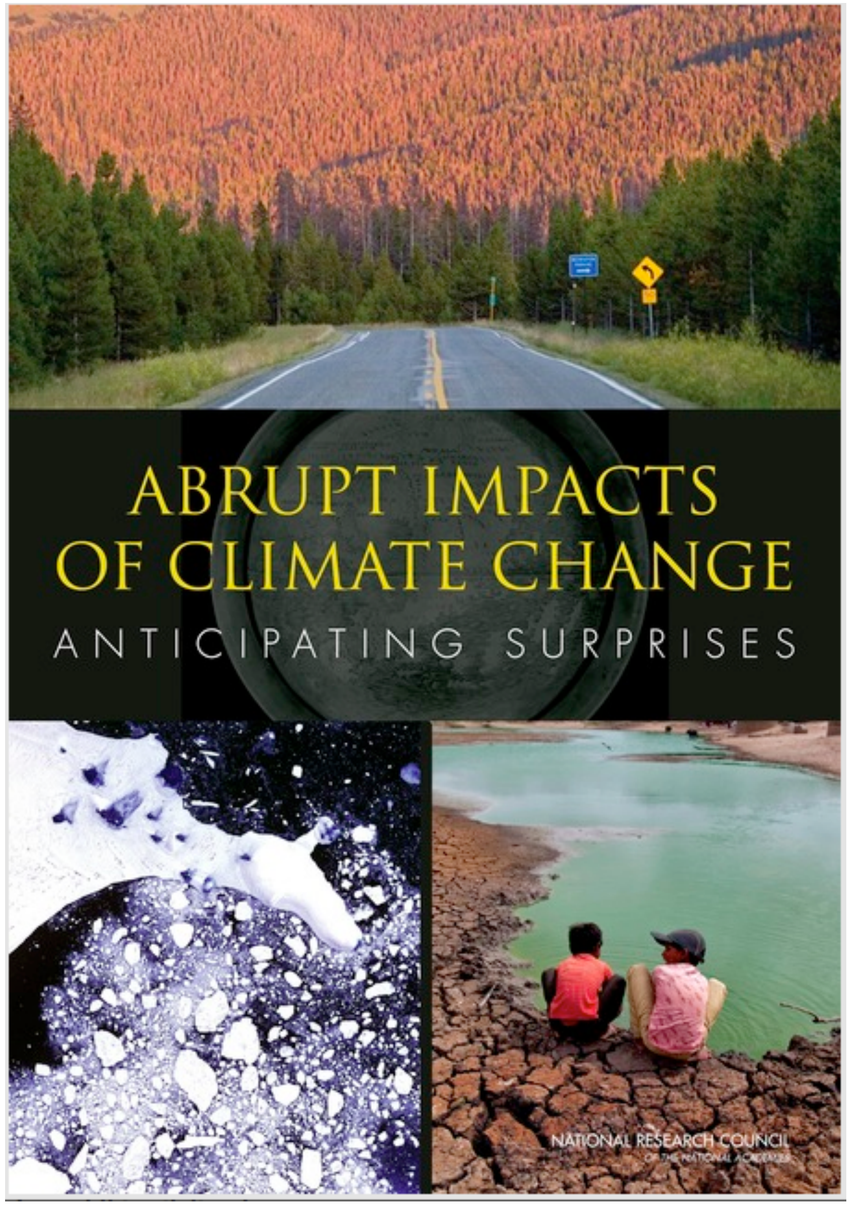
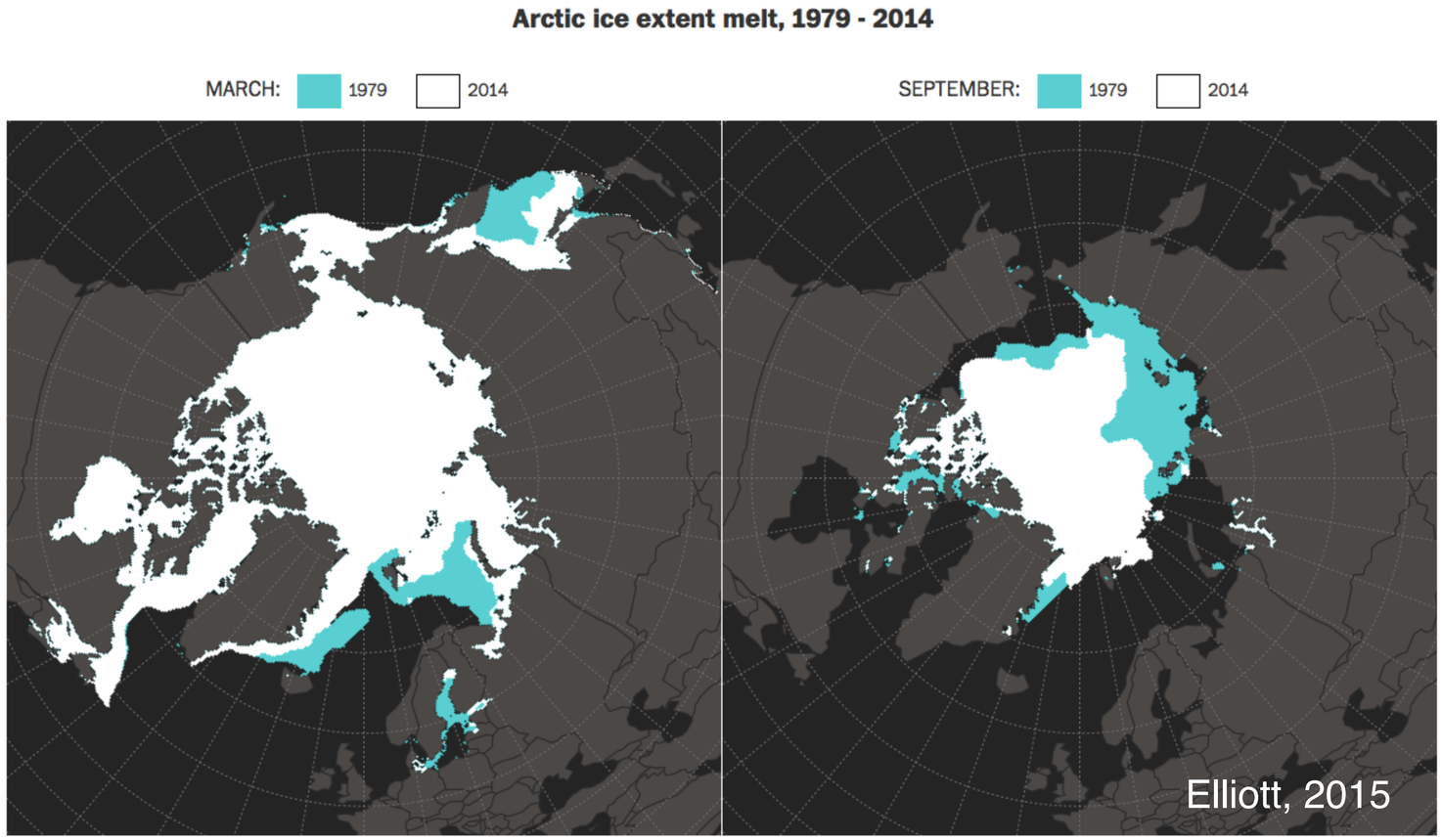


National Research Council in 2013:

There is the potential for surprises and new extremes ...

Already happening: Disappearance of late-summer Arctic sea ice



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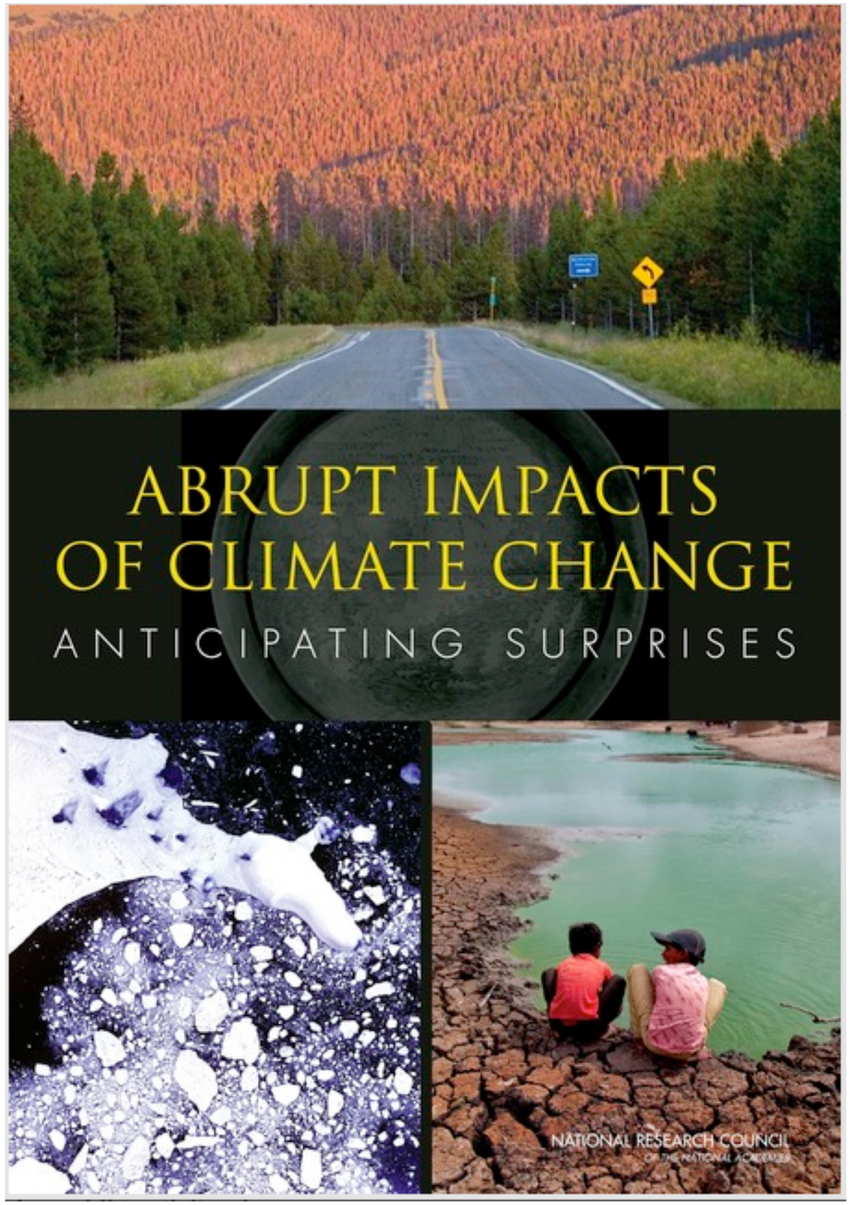

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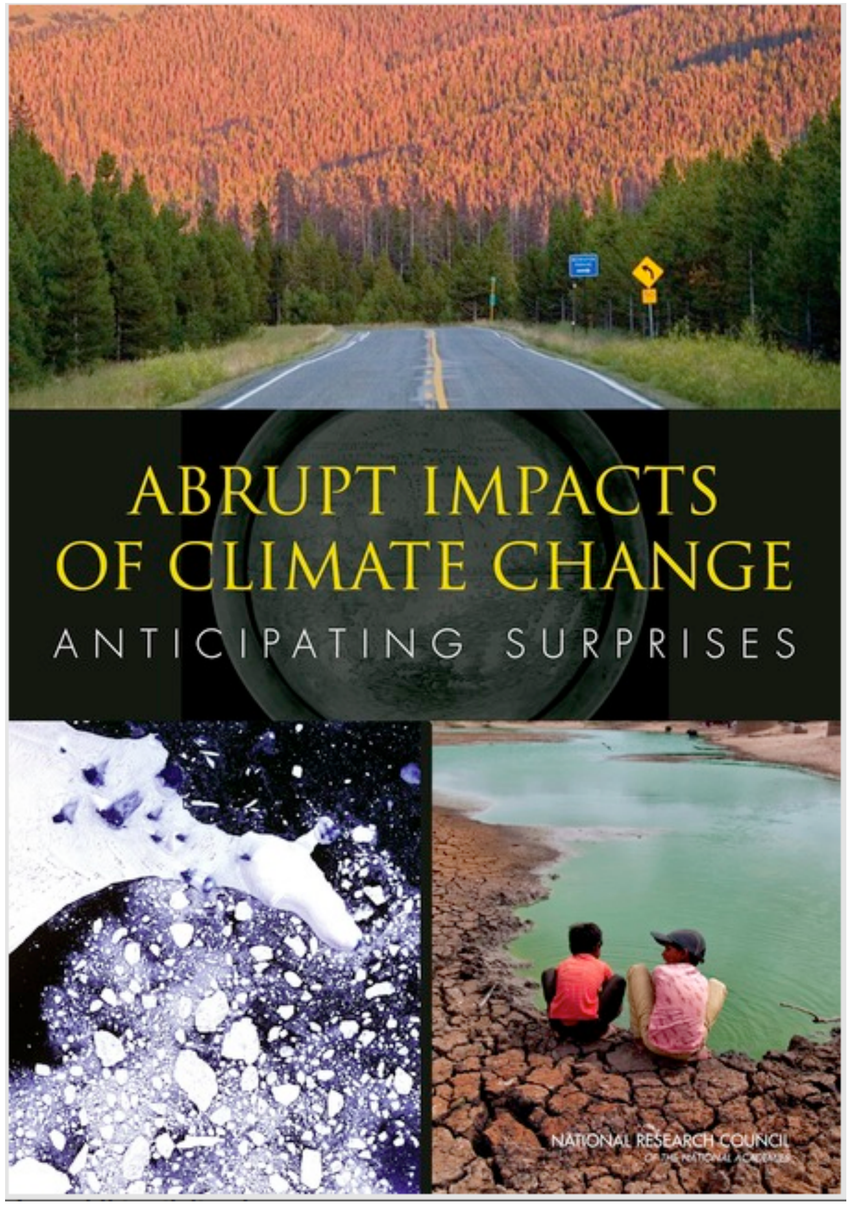

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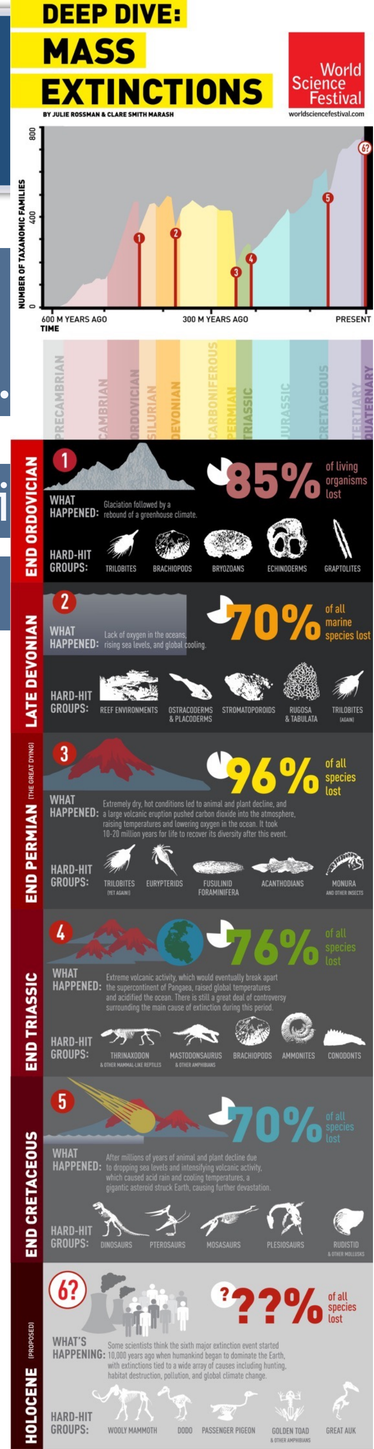
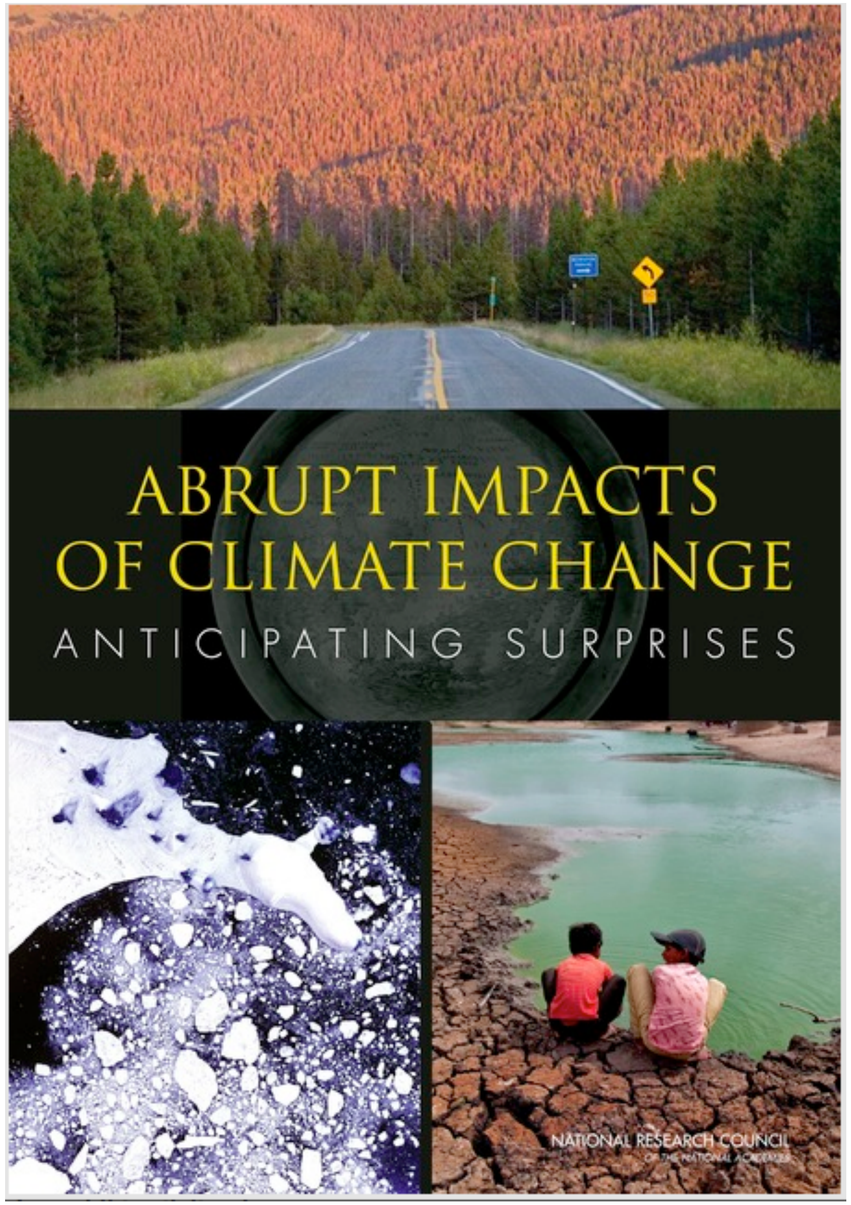


Rossman&Marash (2014)

The Prognosis: A Journey Into the Unknown



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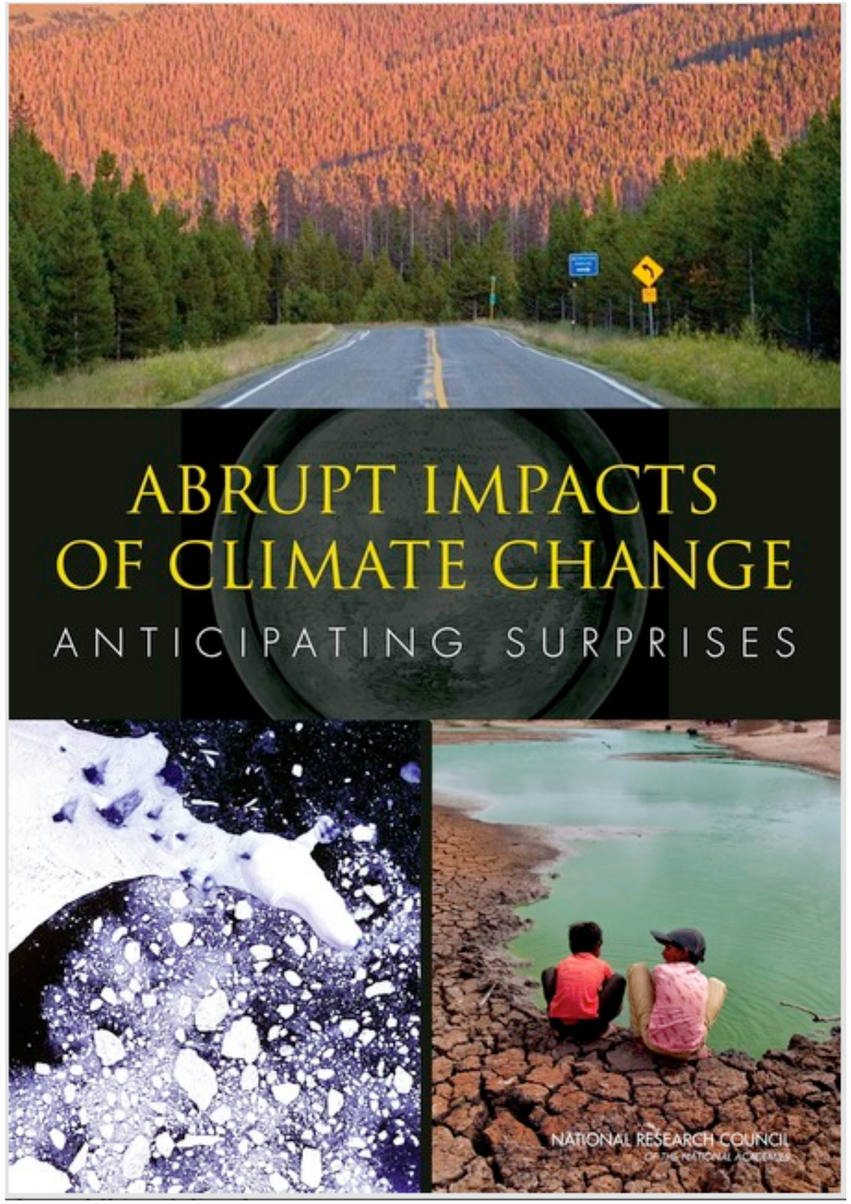

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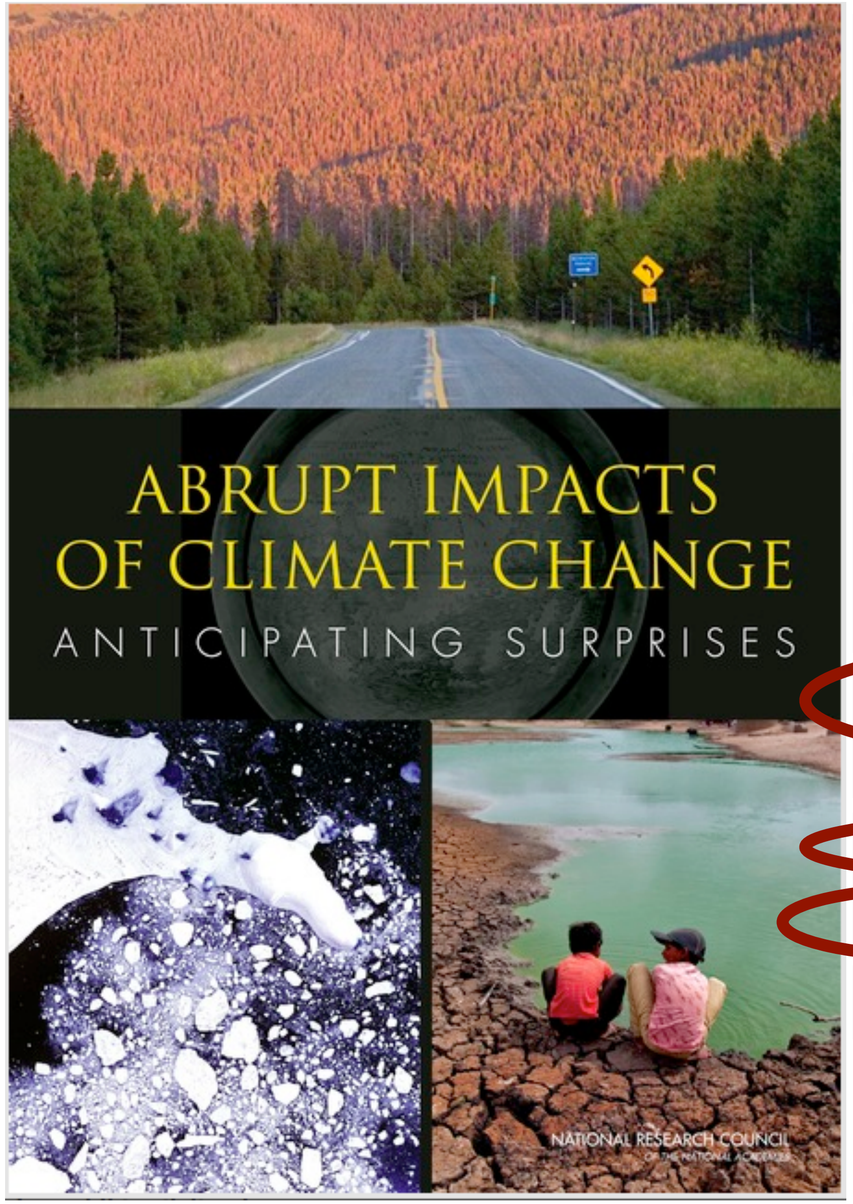
Most likely (low-probability) rapid impact: ocean acidification

The Prognosis: A Journey Into the Unknown



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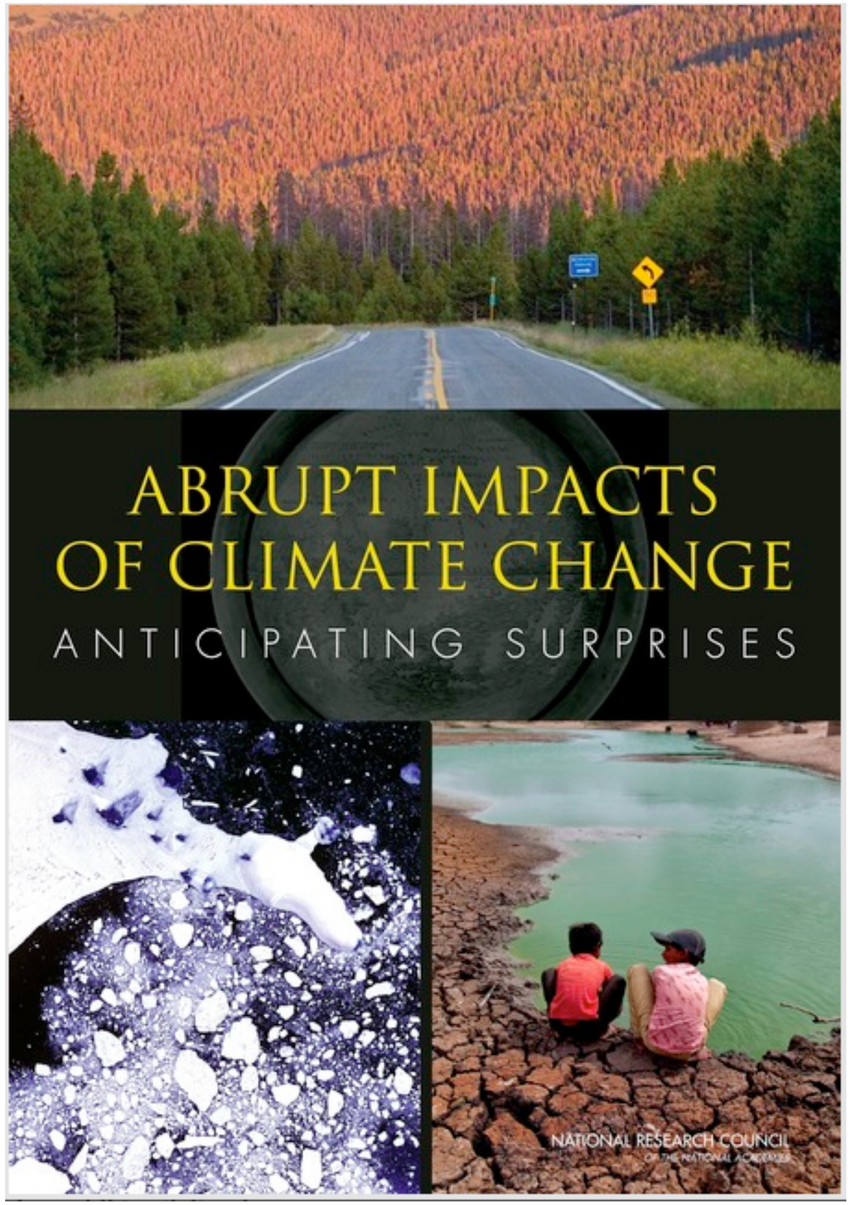

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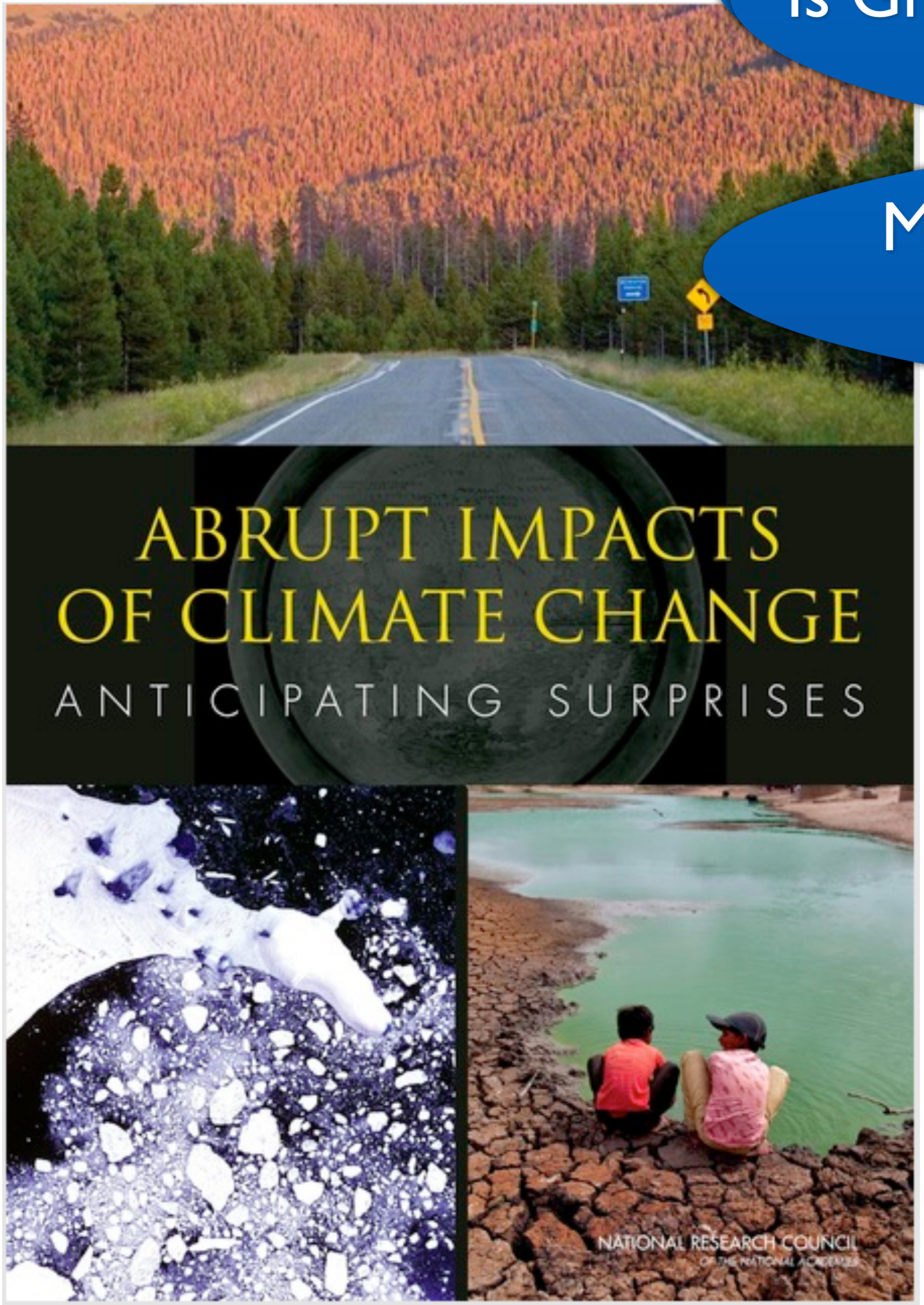
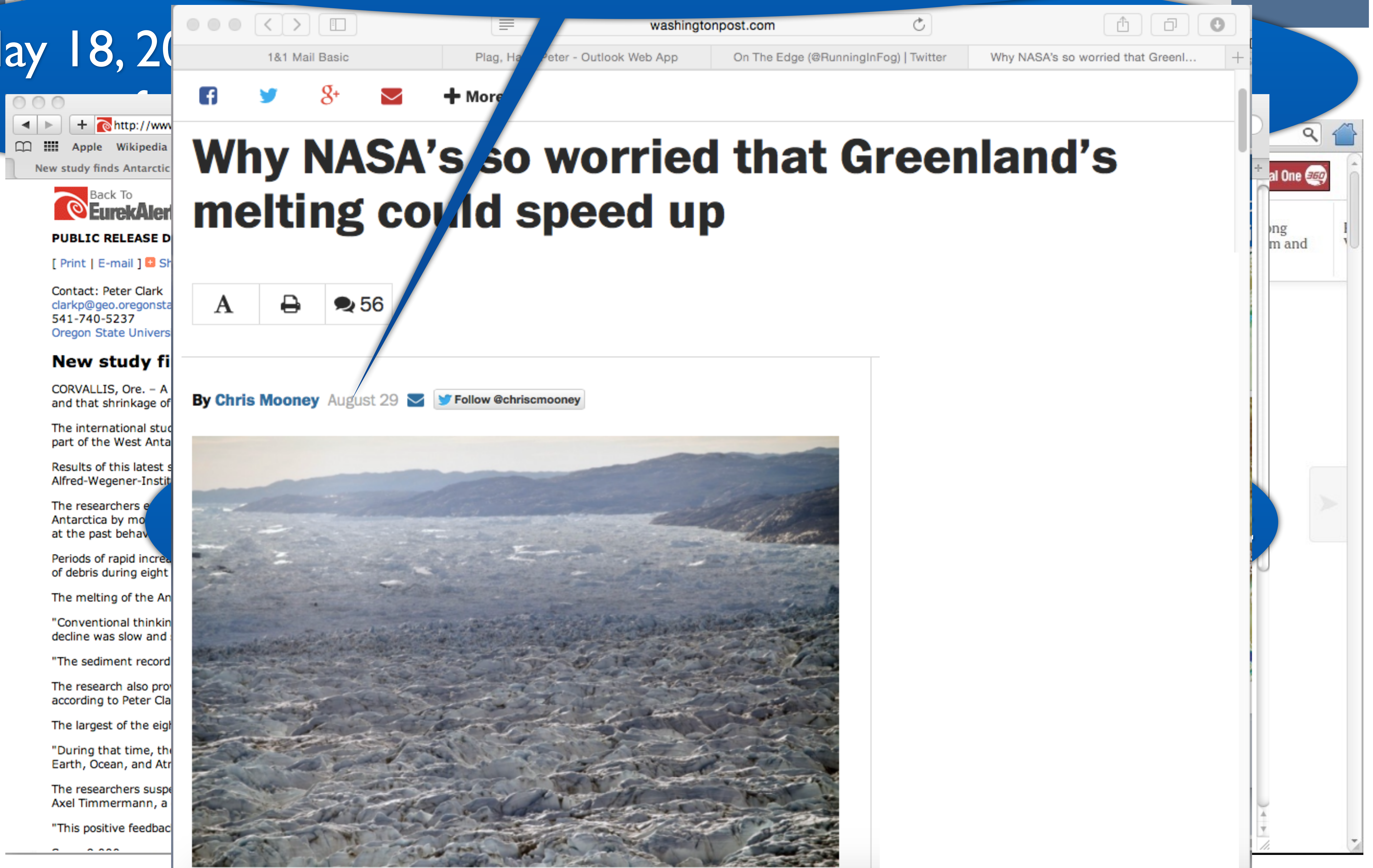
The Prognosis: A Je

August 29, 2015: "The critical question thus becomes: Is Greenland likely to lose even more ice than it's currently losing per year — and could Antarctica do the same?"

May 18, 20





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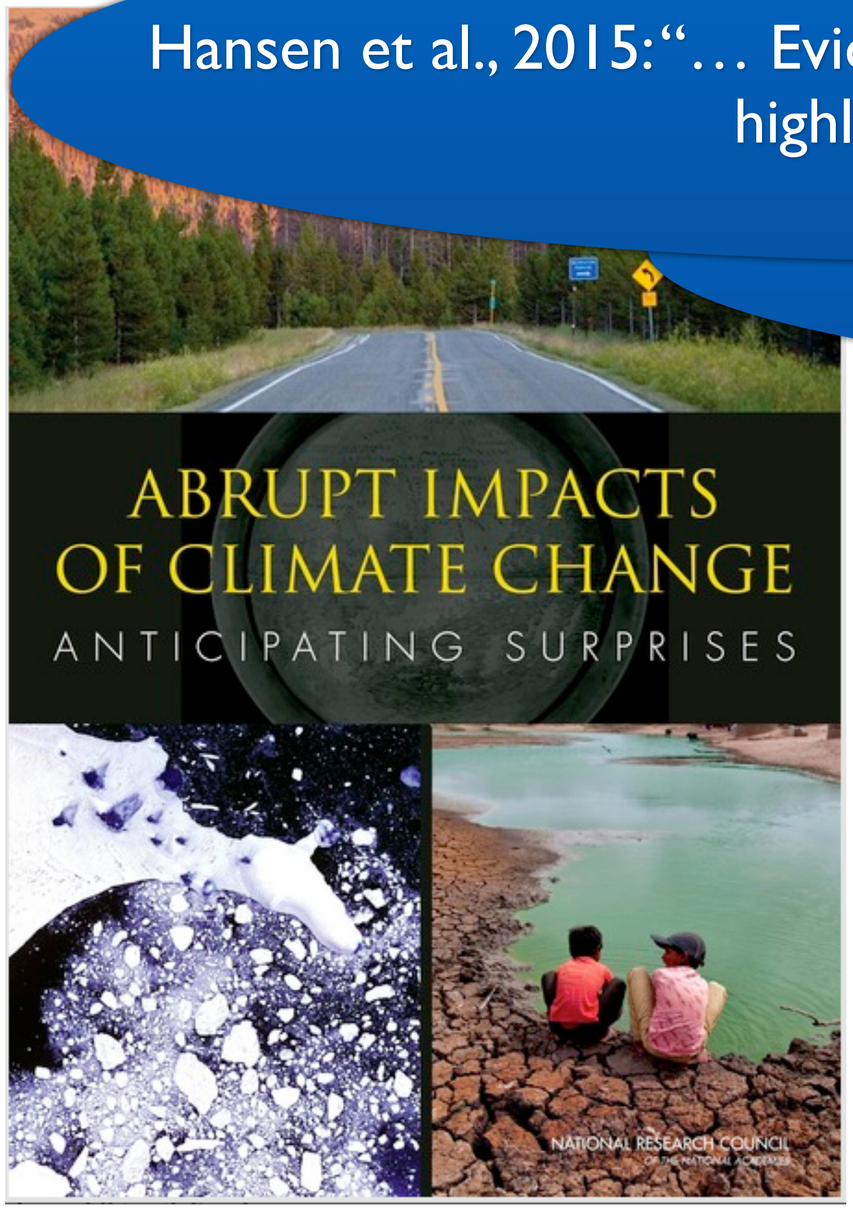
The Prognosis: A Jo… 2015: "The critical question thus becomes:

Hansen et al., 2015: "… Evidence … that 2°C global warming is highly dangerous."



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Atmos. Chem. Phys. Discuss., 15, 20059-20179, 2015
www.atmos-chem-phys-discuss.net/15/20059/2015/
doi:10.5194/acpd-15-20059-2015

Research Article 23 Jul 2015

Ice melt, sea level rise and superstorms: evidence from paleoclimate data, climate modeling, and modern observations that 2 °C global warming is highly dangerous

Review Status
This discussion paper is under review for the journal Atmospheric Chemistry and Physics (ACP).

J. Hansen[1], M. Sato[1], P. Hearty[2], R. Ruedy[3,4], M. Kelley[3,4], V. Masson-Delmotte[5], G. Russell[4], G. Tselioudis[4], J. Cao[6], E. Rignot[7,8], I. Velicogna[7,8], E. Kandiano[9], K. von Schuckmann[10], P. Kharecha[1,4], A. N. Legrande[4], M. Bauer[11], and K.-W. Lo[3,4]

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[4]NASA Goddard Institute for Space Studies, 2880 Broadway, New York, NY 10025, USA
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[6]Key Lab of Aerosol Chemistry & Physics, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710075, China
[7]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, 91109, USA
[8]Department of Earth System Science, University of California, Irvine, California, 92697, USA
[9]GEOMAR, Helmholtz Centre for Ocean Research, Wischhofstrasse 1–3, Kiel 24148, Germany
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[11]Department of Applied Physics and Applied Mathematics, Columbia University, New York, NY, 10027, USA

Received: 11 Jun 2015 – Accepted: 09 Jul 2015 – Published: 23 Jul 2015

Abstract. There is evidence of ice melt, sea level rise to +5–9 m, and extreme storms in the prior interglacial period that was less than 1 °C warmer than today. Human-made climate forcing is stronger and more rapid than paleo forcings, but much can be learned by combining insights from

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Discussion Paper
- Supplement (2719 KB)

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The Prognosis: A Journey Into the Unknown

The Washington Post

Energy and Environment

Scientists find more reasons that Greenland will melt faster

By Chris Mooney April 30

Photograph of Torsukatat Avannarleq, a tidewater glacier in West Greenland, with 2 visible sediment plumes at its terminus. These plumes are made up of

The Washington Post

Energy and Environment

Dominoes fall: Vanishing Arctic ice shifts jet stream, which melts Greenland glaciers

By Chelsea Harvey May 2

Iceberg, with Mount Dundas in the background, Qaasuitsup, west Greenland, Denmark. (Photo by DeAgostini/Getty Images)

The Prognosis: A Journey Into the Unknown

How solid is our knowledge?

Example sea level rise

Accepted knowledge in 2000:

Greenland: no significant contribution to sea level rise

Antarctica: minor contribution

Main contribution: steric changes

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Antarctica: West Antarctic ice sheet (WAIS) will contribute 4.5 m

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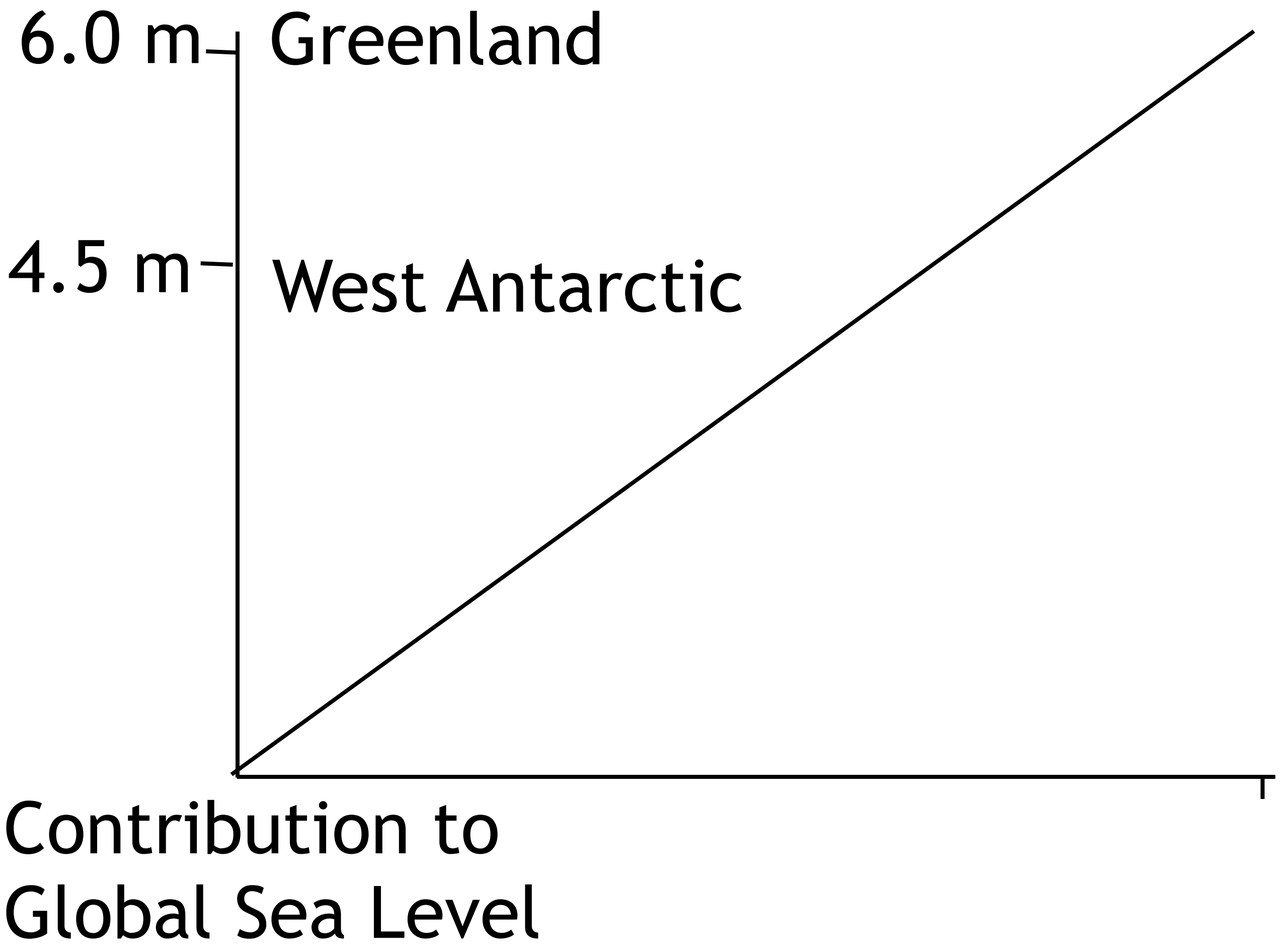

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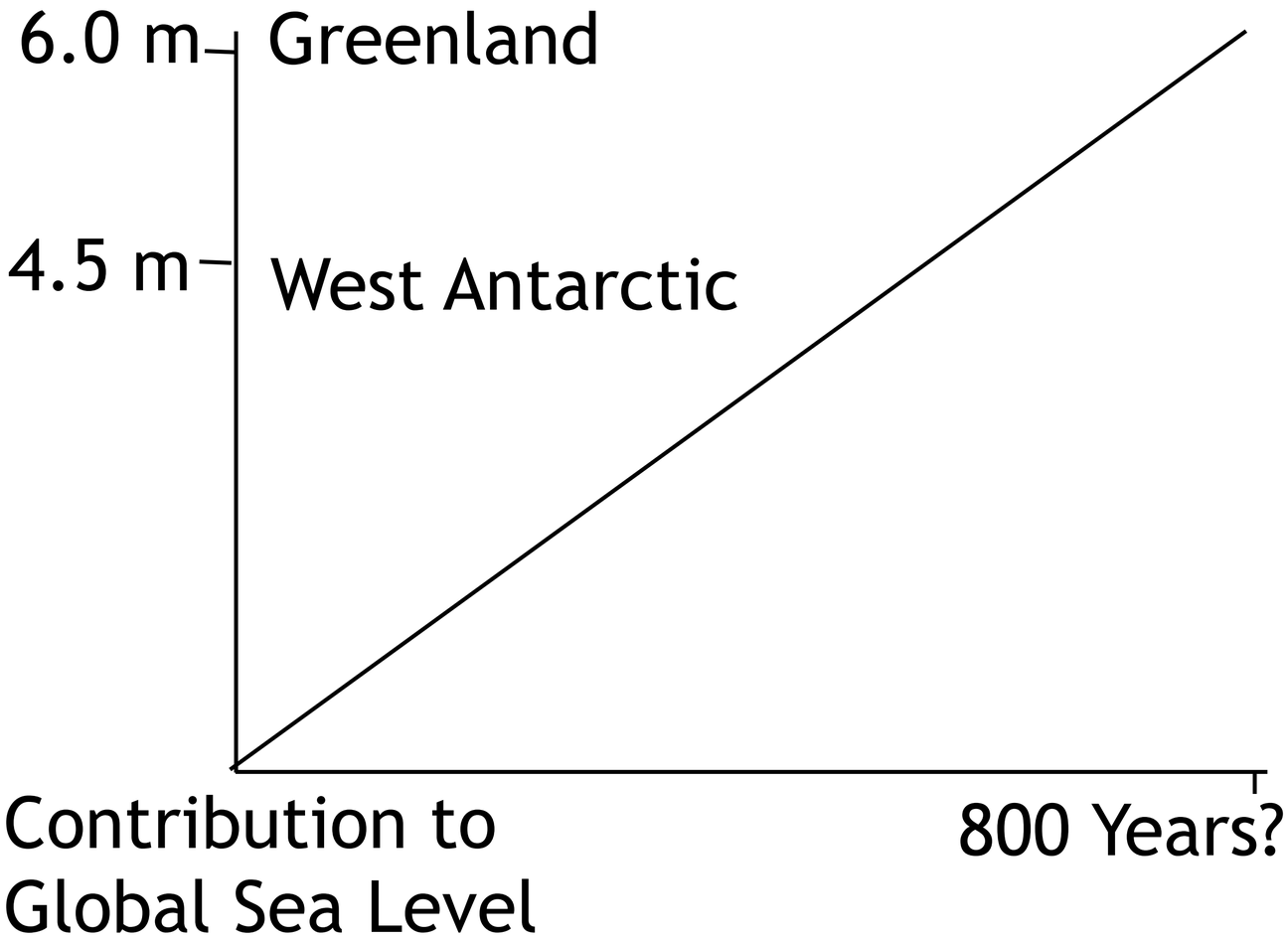

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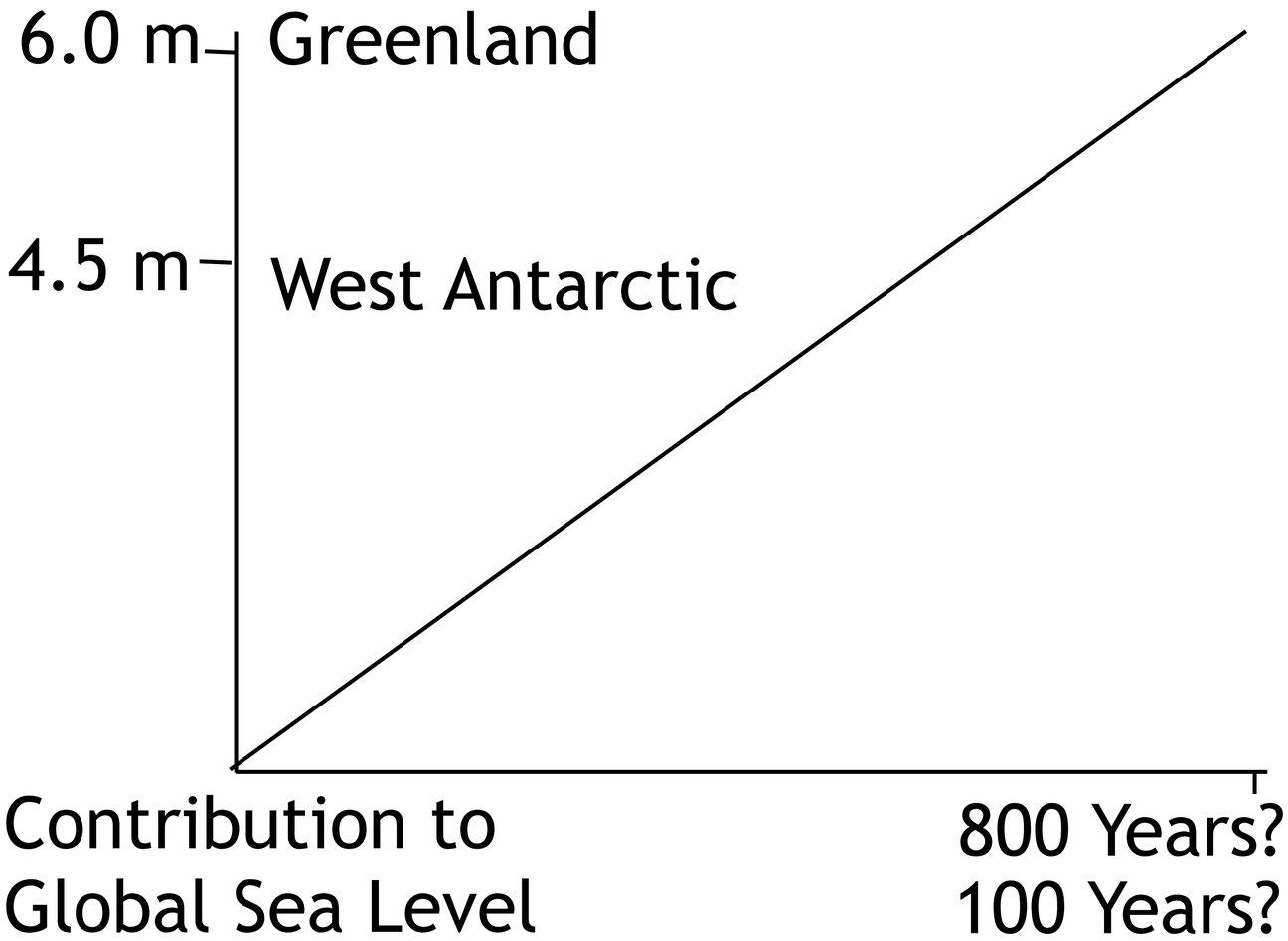

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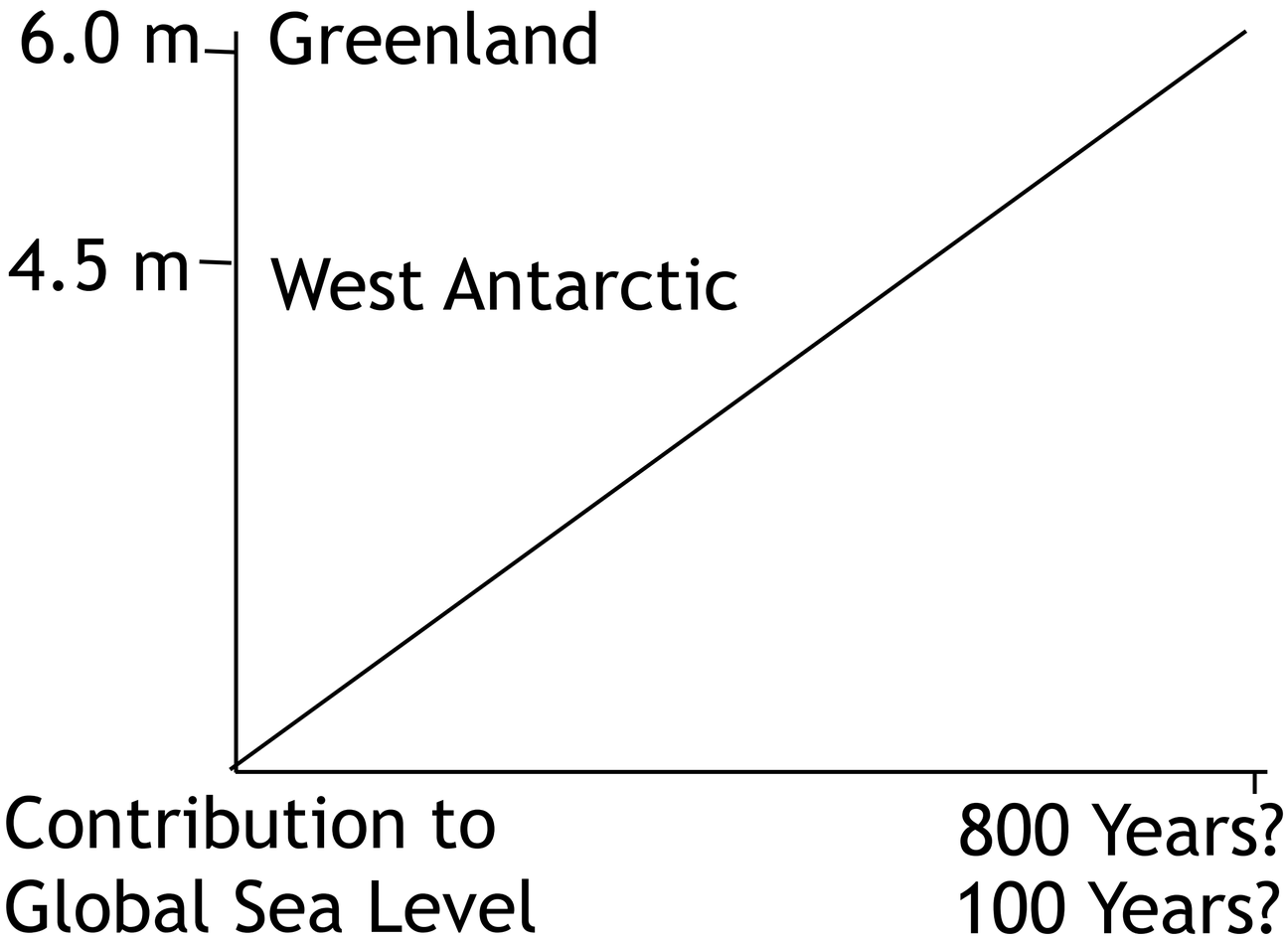

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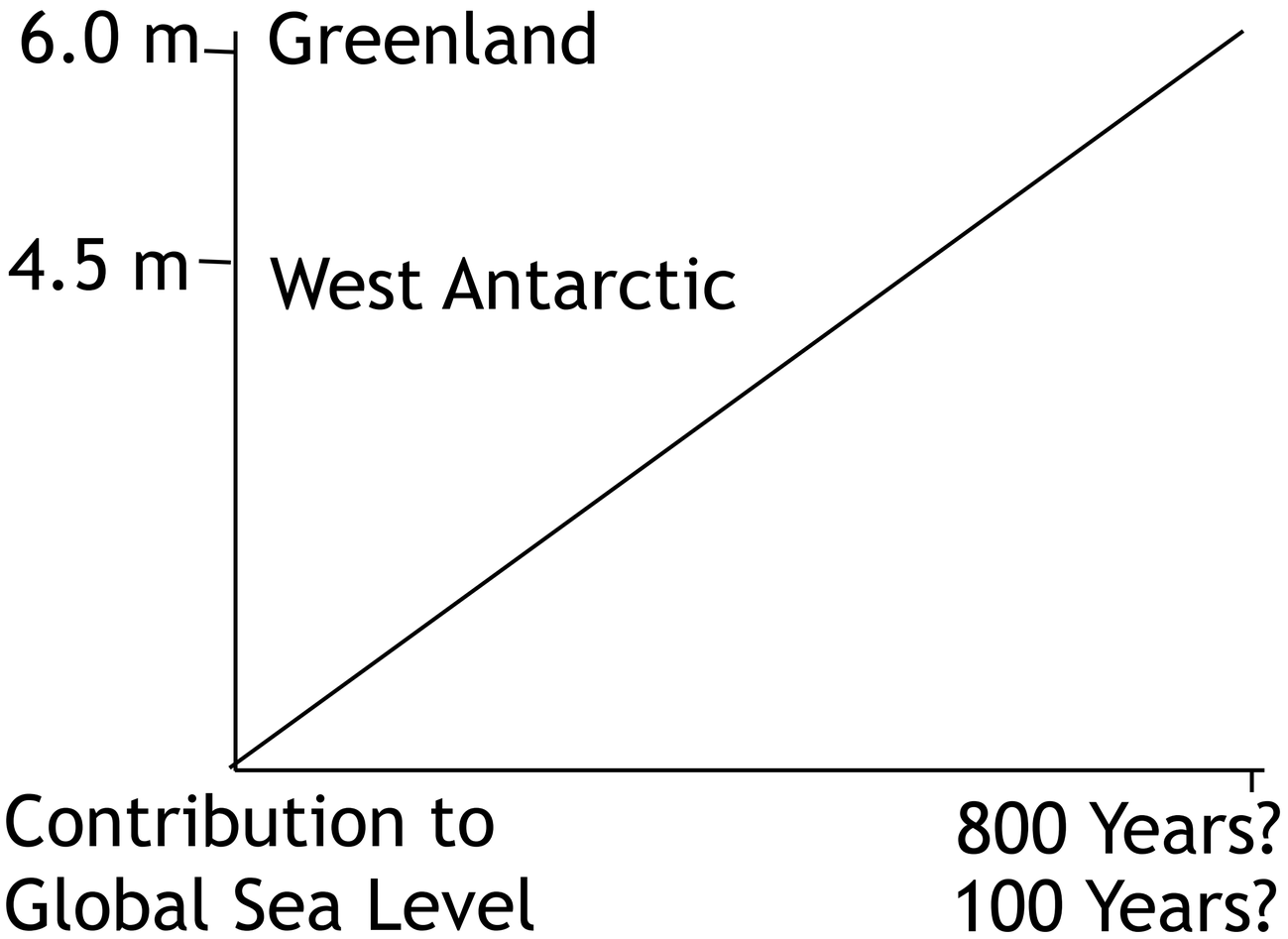

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What should we be worried about?

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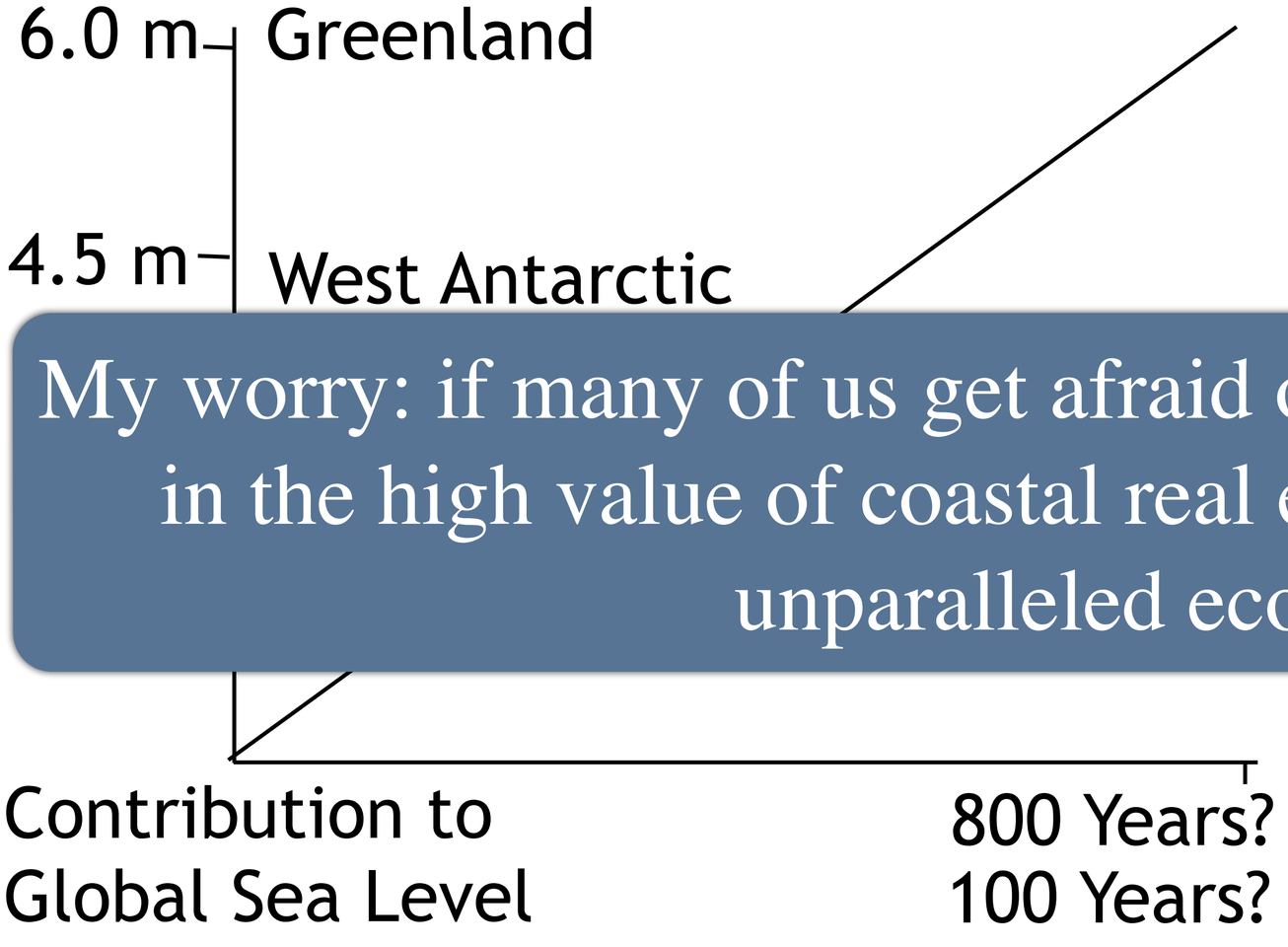

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My worry: if many of us get afraid of sea level rise and stop believing in the high value of coastal real estate, we will see a global and unparalleled economic bubble

How worried should we be?

What should we be worried about?

The Prognosis: A Journey into the Unknown

The Prognosis: A Journey into the Unknown

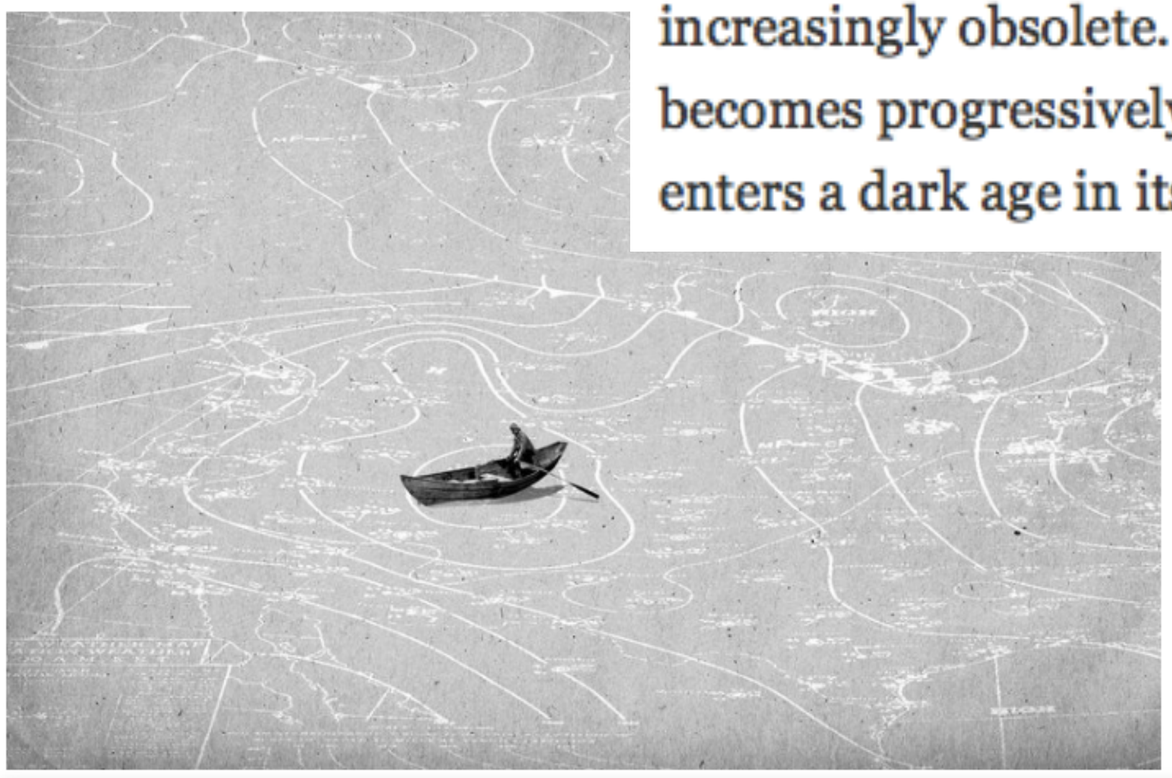
HOME SEARCH

The New York Times

The Opinion Pages | OP-ED CONTRIBUTOR

A New Dark Age Looms

By WILLIAM B. GAIL APRIL 19, 2016



Boulder, Colo. — IMAGINE a future in which humanity's accumulated wisdom about Earth — our vast experience with weather trends, fish spawning and migration patterns, plant pollination and much more — turns increasingly obsolete. As each decade passes, knowledge of Earth's past becomes progressively less effective as a guide to the future. Civilization enters a dark age in its practical understanding of our planet.

The Prognosis: A Journey Into the Unknown

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Crossing thresholds could lead to systemic changes …

The Prognosis: A Journey Into the Unknown

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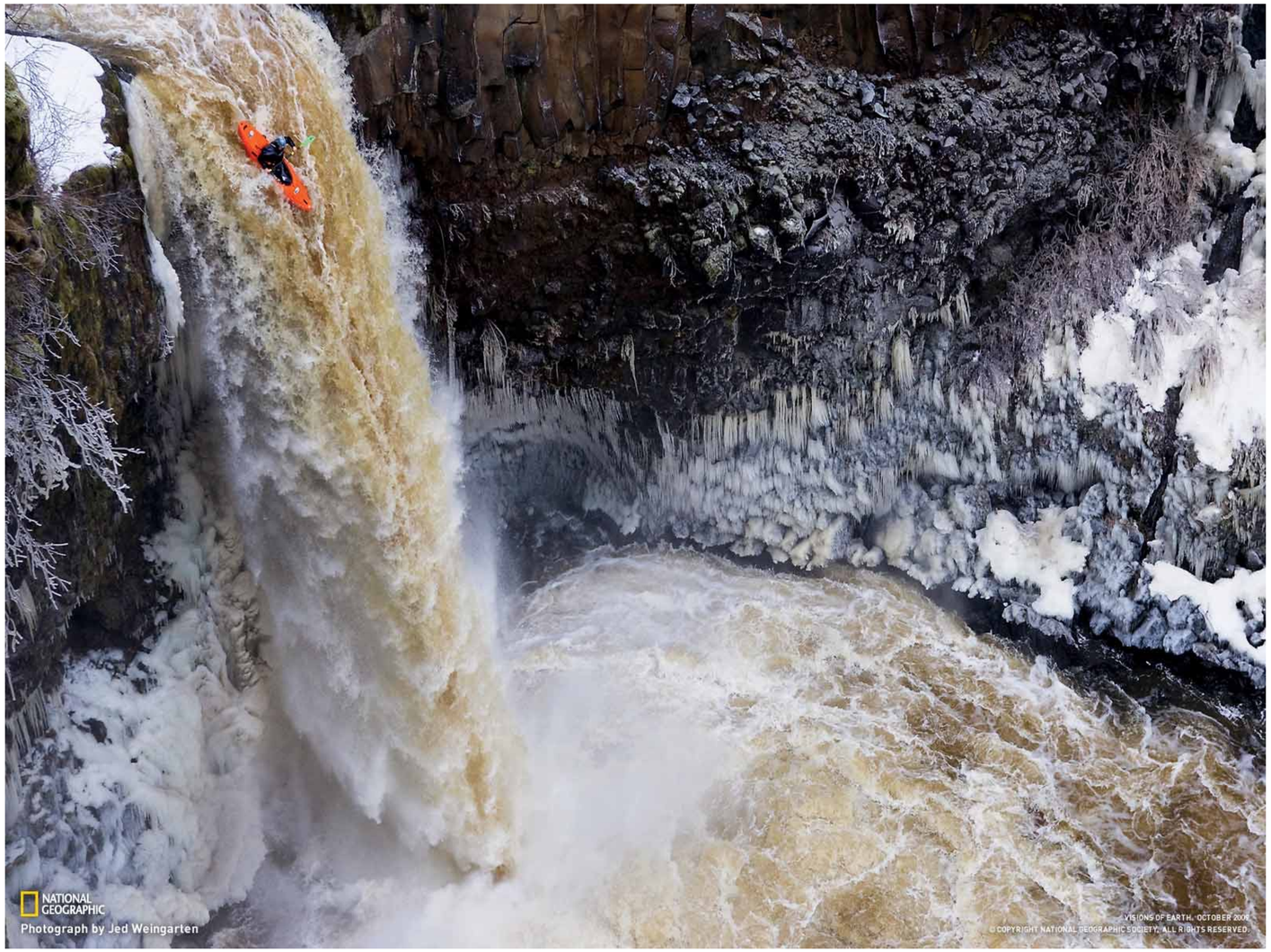
Understanding thresholds

The threshold is not where the boat goes over the edge, it is far up the river, when the people in the boat lose the option to get to the shore



The Prognosis: A Journey Into the Unknown

Crossing thresholds could lead to systemic changes …

Understanding thresholds

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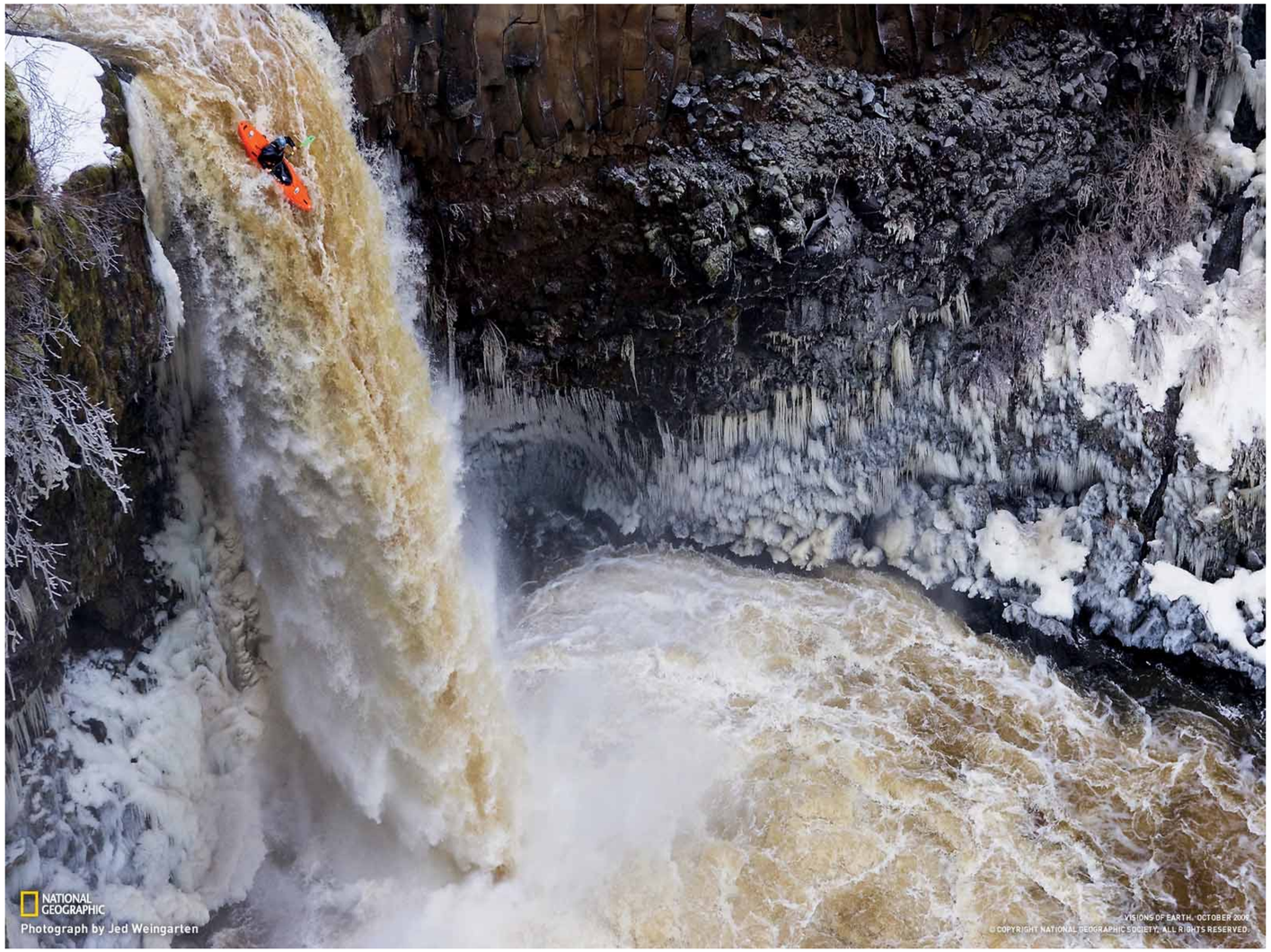
On a big, unknown river, don't go into the middle, stay close to the shore

Jim White



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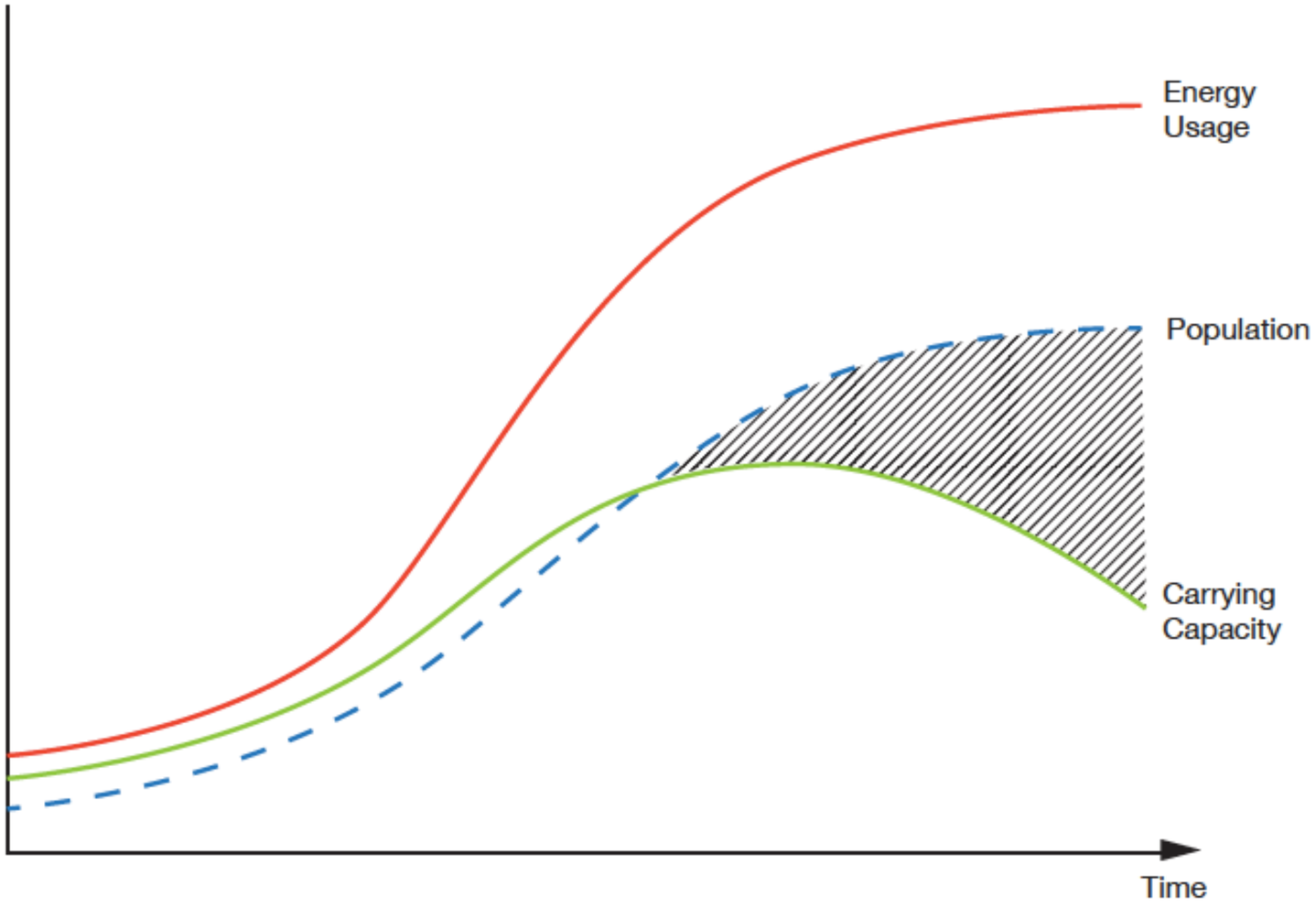

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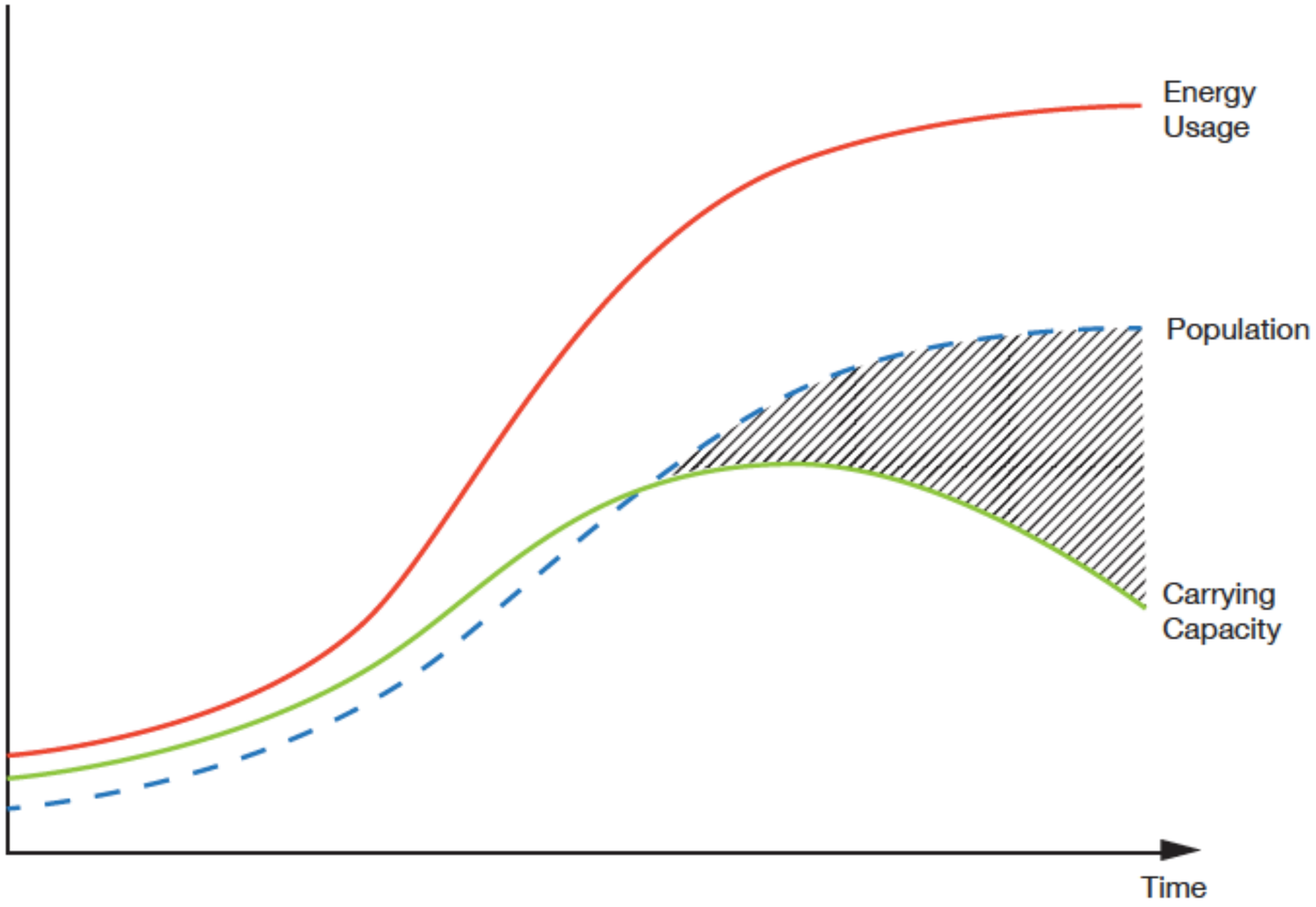

Carrying Capacity = function of: Arable Land, Nitrogen, Phosphorous, Climate, Water, Biodiversity, Land Use, Energy, Degradation, Technology, …

$CC = f(A, N, P, C, W, B, L, E, D, T, \ldots)$

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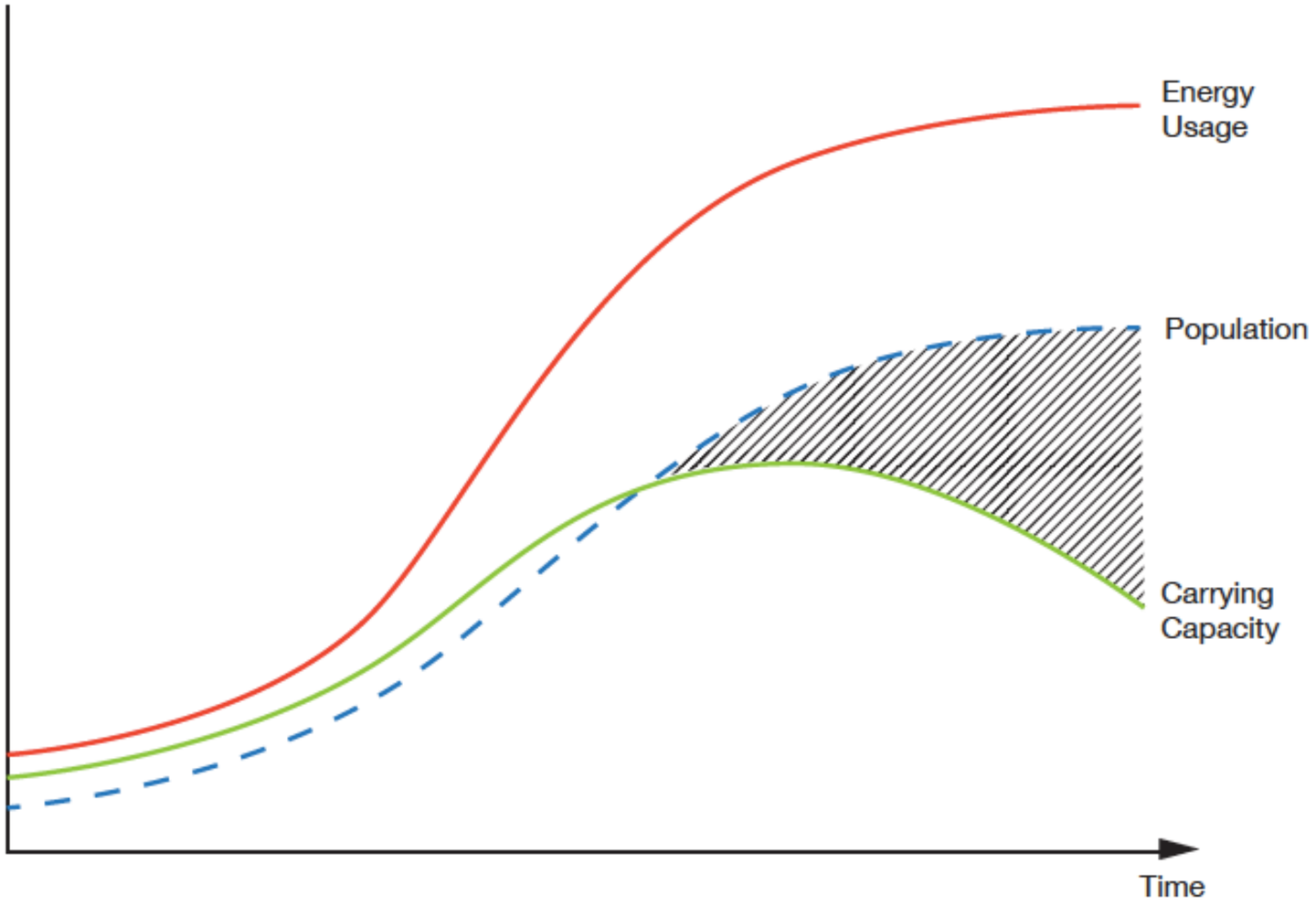

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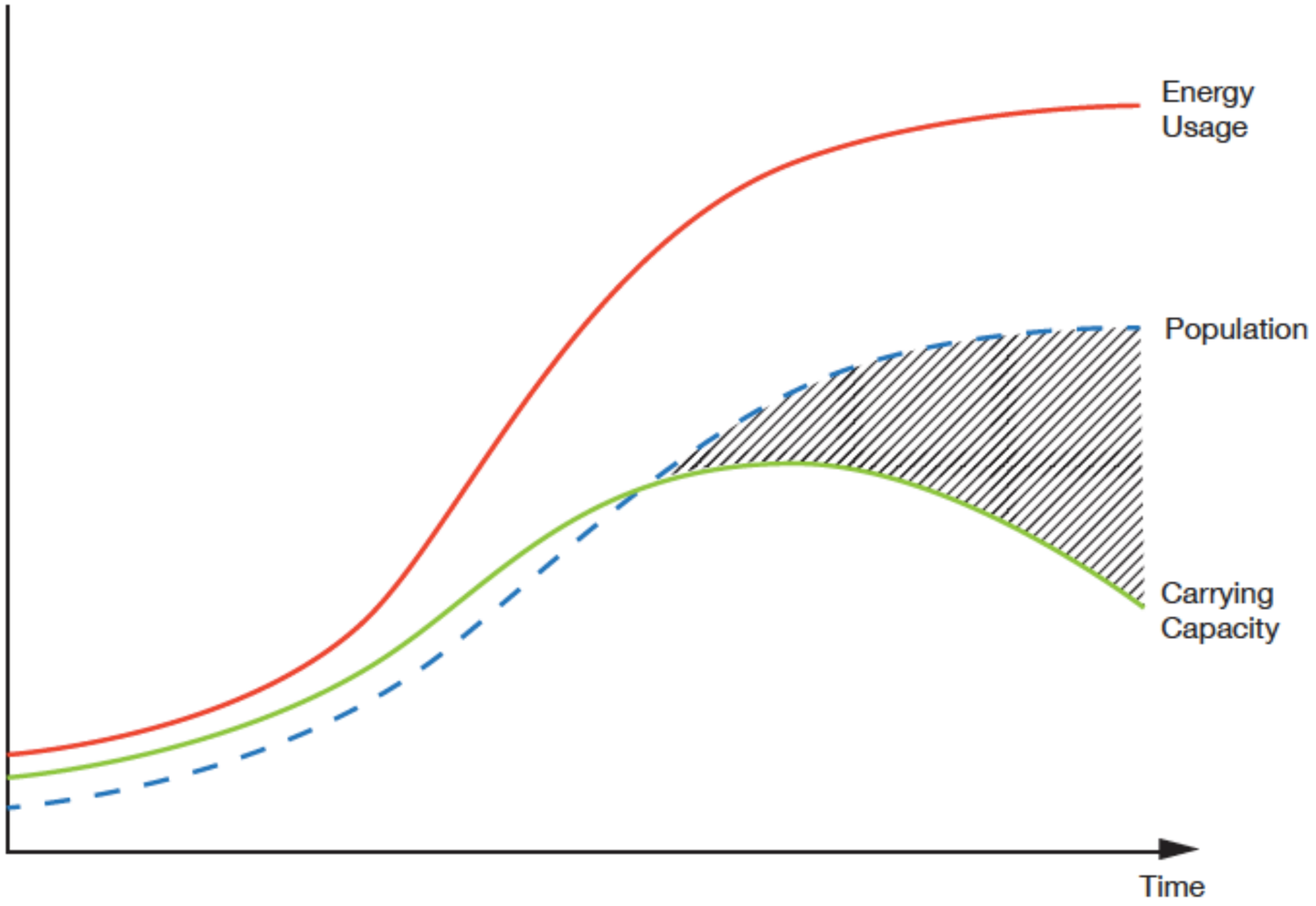

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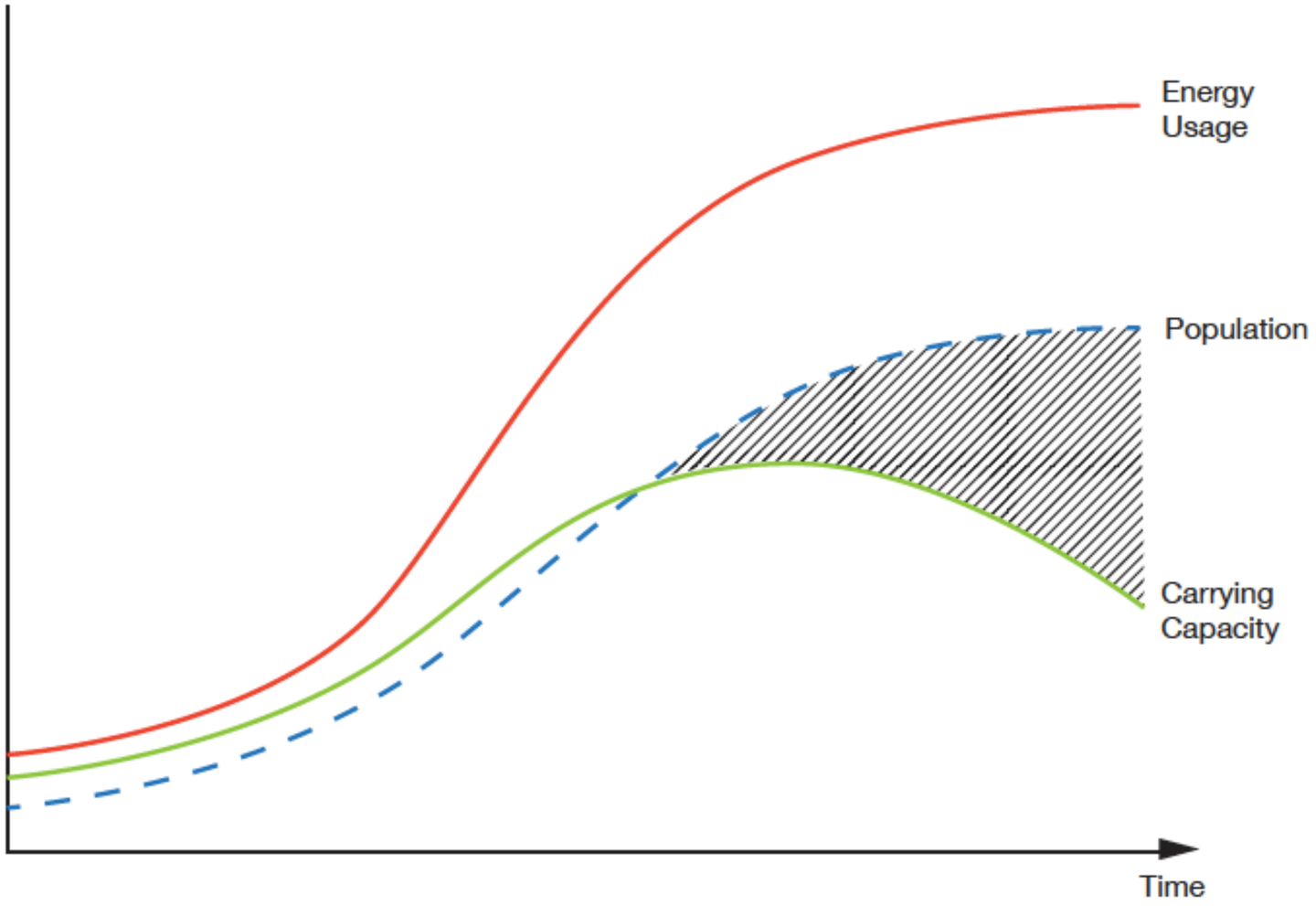

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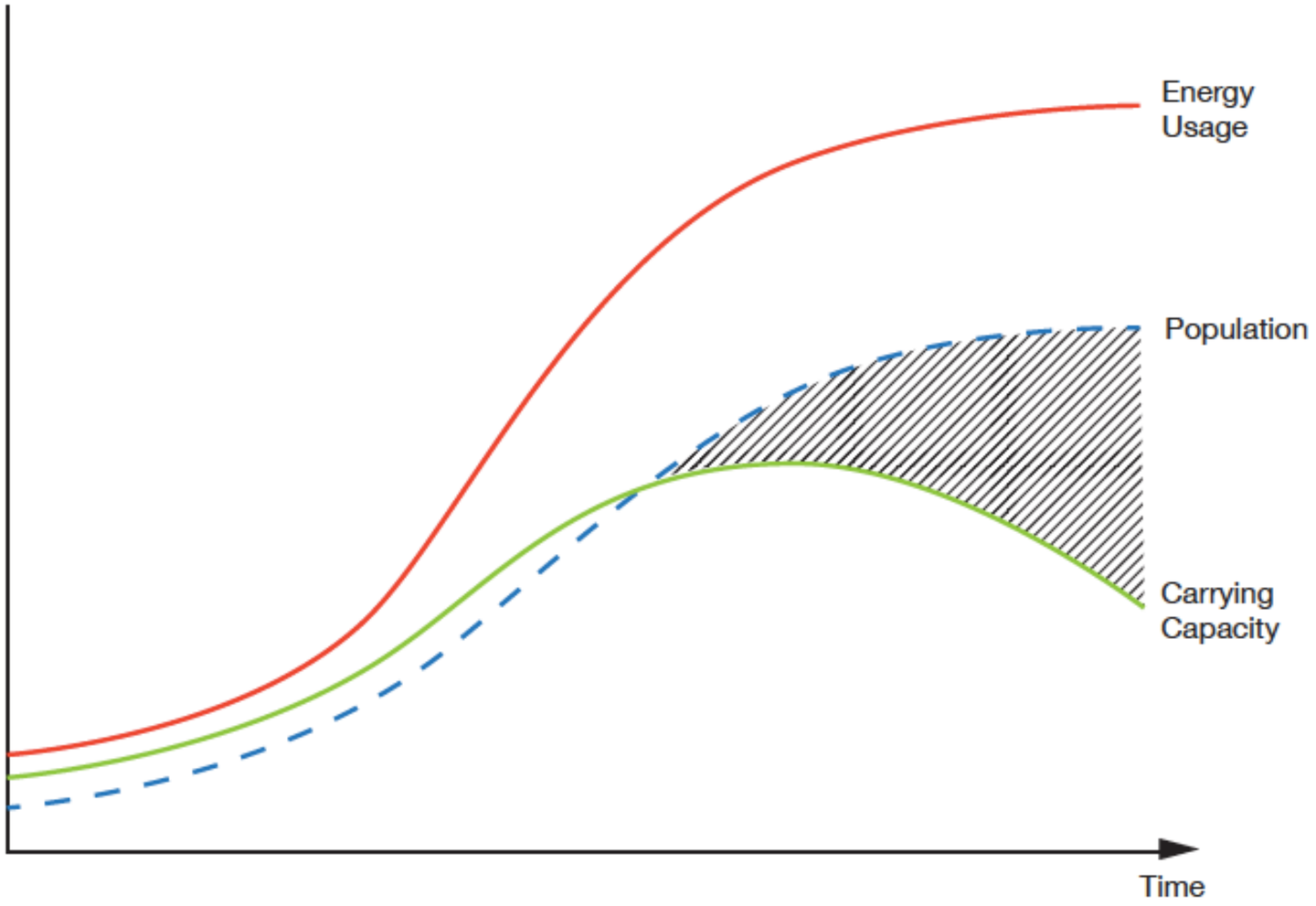

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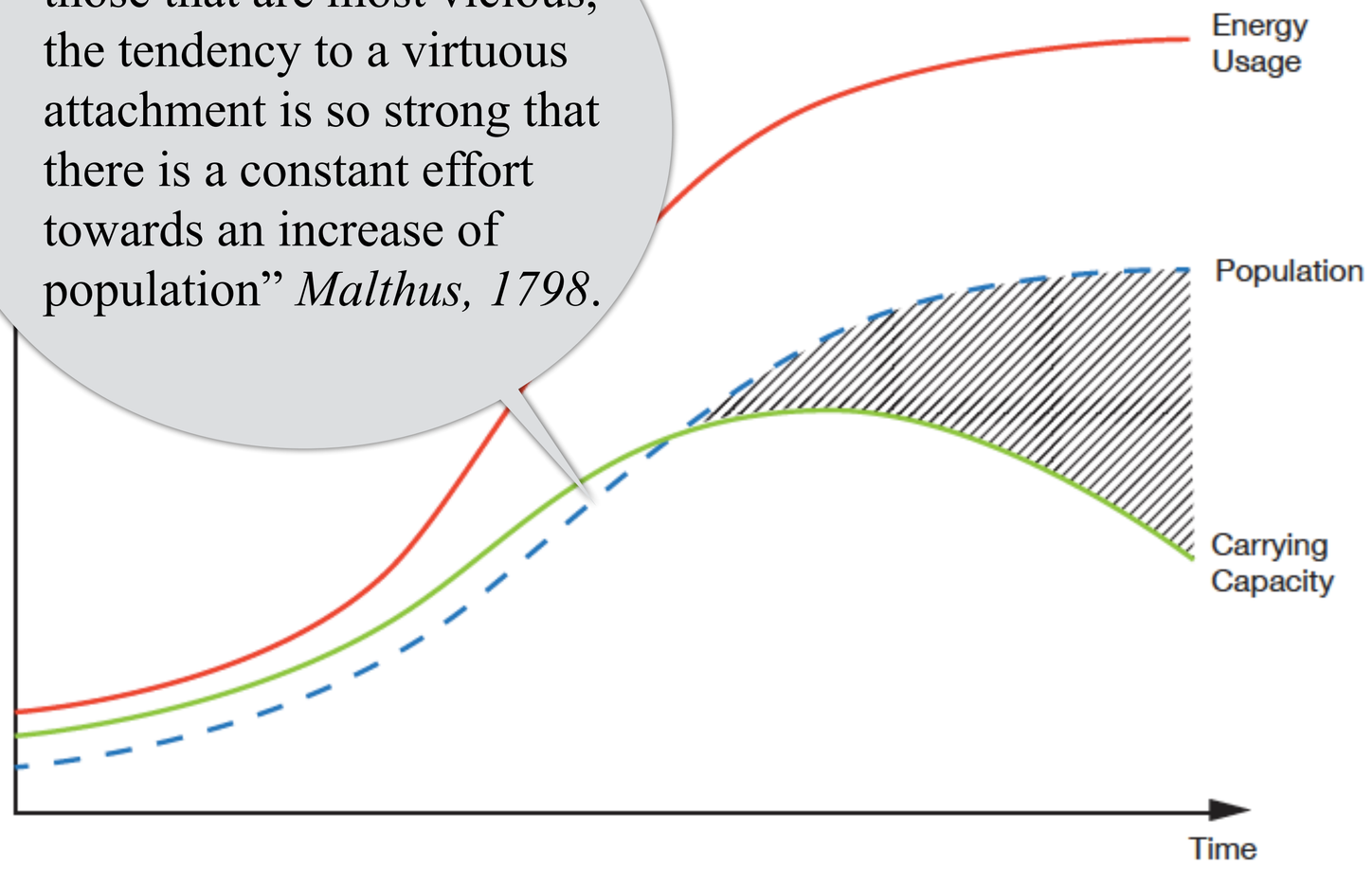
The Prognosis: A Journey into the Unknown

"Yet in all societies, even those that are most vicious, the tendency to a virtuous attachment is so strong that there is a constant effort towards an increase of population" *Malthus, 1798*.



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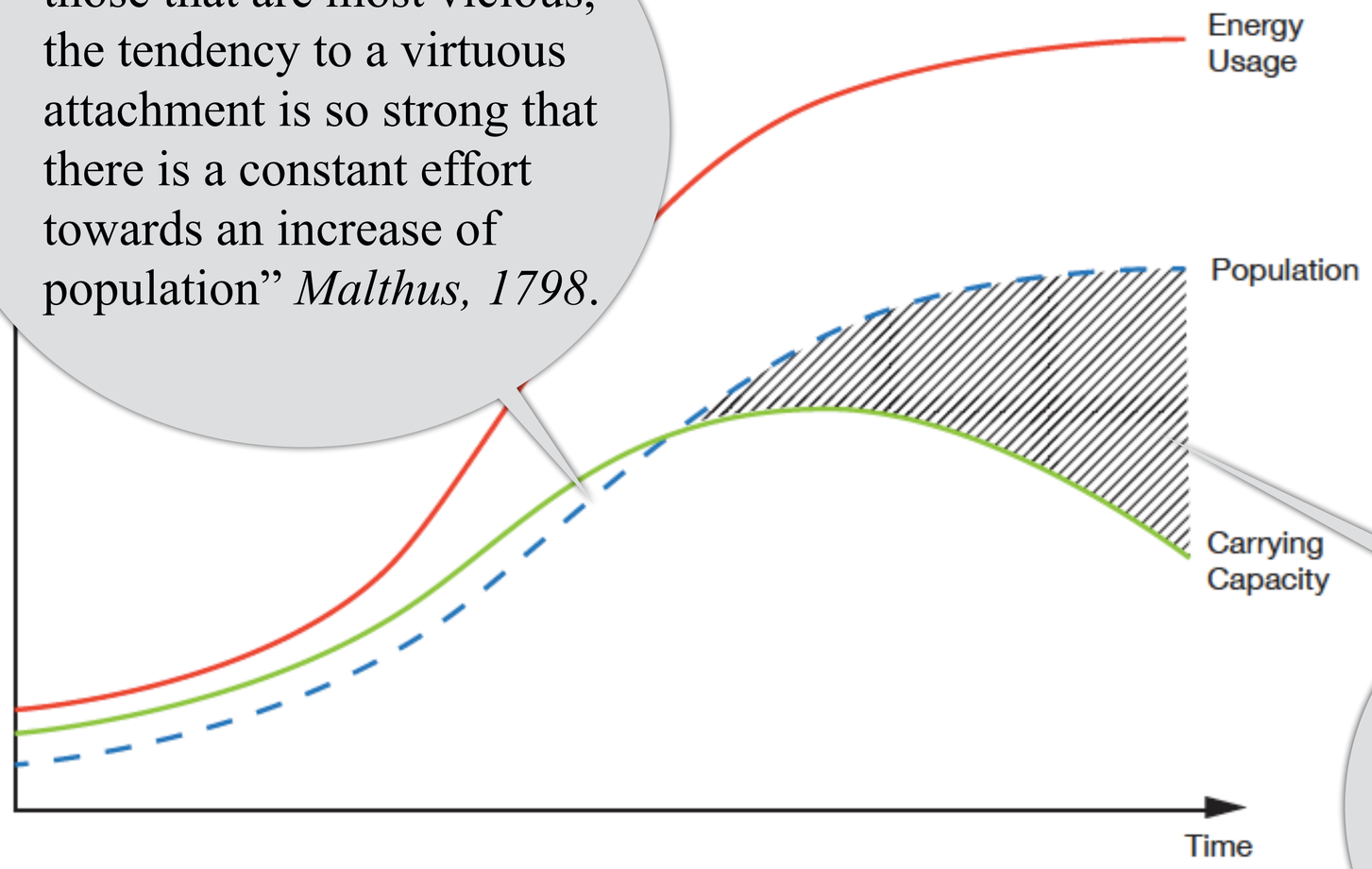

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"That the increase of population is necessarily limited by the means of subsistence, That population does invariably increase when the means of subsistence increase, and, That the superior power of population is repressed, and the actual population kept equal to the means of subsistence, **by misery and vice**."

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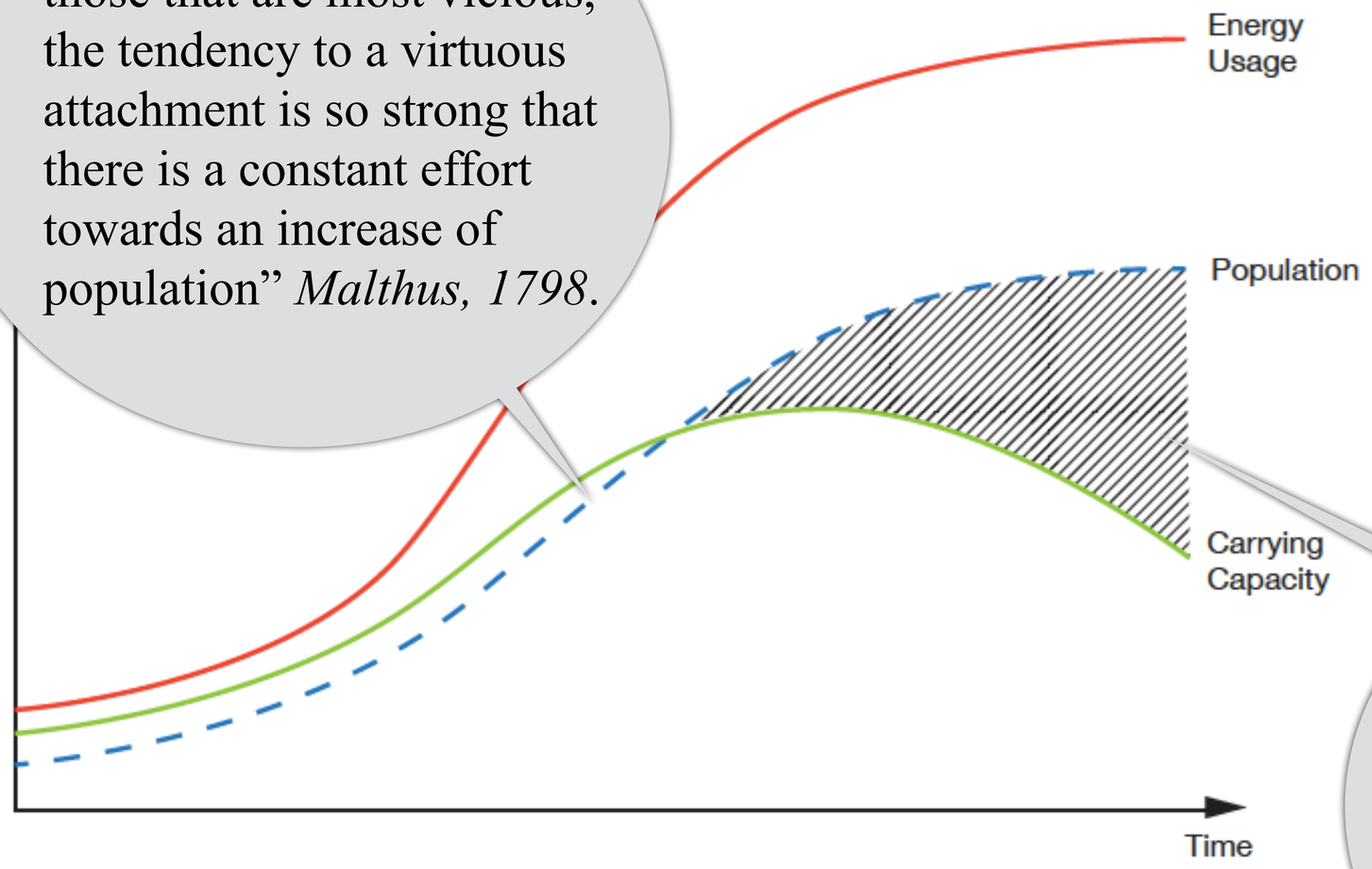

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Lovelock: Carrying Capacity will be down to 1 Billion in 2050

Key Points

During the Holocene, climate and sea level were exceptionally stable

The Holocene was a “safe operating space for humanity”

During the last hundred years, we have introduced rapid and large changes

The system is already now outside the “normal range” and in the transition to the Post-Holocene

Key Points

During the Holocene, climate and sea level were exceptionally stable

The Holocene was a “safe operating space for humanity”

During the last hundred years, we have introduced rapid and large changes

The system is already now outside the “normal range” and in the transition to the Post-Holocene

Our knowledge is changing very fast; existing knowledge becomes invalid

We may not know all environmental, social and economic thresholds

There is a potential for surprises; we should prepare for global emergencies

The Therapy: “Lifestyle”Changes

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Decision Making:

The Therapy: “Lifestyle”Changes

Decision Making:

Half full or half empty?

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Glass of knowledge

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Decision Making Under Uncertainty (DMUU)

Focus on what we don’t know

Glass of knowledge

The Therapy: “Lifestyle”Changes

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Half full or half empty?

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Using what we know to develop foresight:

Decision Making Under Foreseeability (DMUF)

The Therapy: “Lifestyle”Changes

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Decision Making Under Uncertainty (DMUU):
Planning and preparing for a (somewhat) predictable future

The Therapy: “Lifestyle”Changes

Decision Making Under Uncertainty (DMUU): Planning and preparing for a (somewhat) predictable future

- Choose a range of plausible trajectories (for droughts, heat waves, sea level rise, extreme events, ...)
- Determine the range of risks to be reduced based on these trajectories and vulnerabilities
- Adapt land use, building codes, protective measures accordingly

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Knowing the “worst case” and facilitating adaptation to unpredictable future:

- understanding the vulnerabilities and comprehensively assessing the risks
- including the worst cases (food, water, heat waves, droughts, storms, sicknesses, social unrest, wars, ...)
- having early warning (for extreme events and rapid impacts)

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How do we assess, and plan for, events that have never happened?

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Knowing the paradigms our decision making is based on …

The Therapy: “Lifestyle”Changes

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Decision Making Under Foreseeability (DMUF): *Having Foresight*

Abrupt changes are happening (e.g., Arctic sea ice, biodiversity); more likely to come

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Abrupt sea level rise could (slowly) develop into a global disaster

Paradigm shift to overcome normalcy bias:
Instead of “Sea level is stable” (last 6,000 years)
assume “Sea level is variable!”

The Therapy: “Lifestyle”Changes

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To cope with a moving coast line, we need, for example:

- Adaptive infrastructure moving with the coast line;
- Redefine/manage real estate property in the coastal zone;
- Redistribute risk between individuals, communities, states and the country;
- Learn to utilize the benefits of the coastal zone while reduce the risks.

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Learning from experience:

- Trade-off between recovering fast and taking time to reassess the situation;
- In solving present problems, consider the long-term perspective.

The Therapy: “Lifestyle”Changes

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“Sustainable Development is a development that meets the needs of the presence while safeguarding Earth’s life support systems, on which the welfare of current and future generations depends.” (Griggs et al., 2013)

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Economy is the link between humanity and Earth’s life-support system

The Therapy: “Lifestyle”Changes

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Economy is the link between humanity and Earth’s life-support system

Our current economy is **against** humanity: An economy that meets our needs by burning fossil fuels and destroying Earth’s life-support system is like a doctor who practices medicine by killing the patients.

The Therapy: “Lifestyle”Changes

“Sustainable Development is a development that meets the needs of the presence while safeguarding Earth’s life support systems, on which the welfare of current and future generations depends.” (Griggs et al., 2013)

Economy is the link between humanity and Earth’s life-support system

Our current economy is **against** humanity:
An economy that meets our needs by burning fossil fuels and destroying Earth’s life-support system is like a doctor who practices me

Our economic model is at war with life on Earth. We can’t change the laws of nature, but we can change our broken economy.

Naomi Klein, 2013

The Therapy: “Lifestyle”Changes

ON THE EDGE

Safeguarding Our Life Support System

OVERCOMING THE “IMMUTABLE TRUTH” OF GROWTH BEING NECESSARY FOR A THRIVING ECONOMY

Prof. Hans-Peter Plag, PhD
Mitigation and Adaptation Research Institute
Old Dominion University
Norfolk, Va.
www.mari.odu.edu

IN EARLIER COLUMNS, I MADE REFERENCE TO a new definition for sustainable development: a development that meets our needs while safeguarding the Earth’s life support system on which we and all future generations depend. Safeguarding our life support system (LSS) seems logical and to be something we all should be eager and able to agree upon.

The Therapy: “Lifestyle”Changes

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The Therapy: “Lifestyle”Changes

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Malignant skin cancer of the planet *Plag, 2010*

The Therapy: “Lifestyle”Changes

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Anthropogenic Cataclysmic Virus (ACV) *Plag, 2015*

The Therapy: “Lifestyle”Changes

Malignant skin cancer of the planet *Plag, 2010*

Anthropogenic Cataclysmic Virus (ACV) *Plag, 2015*

Can the “virus” transform itself into the “healer”?

Key Points

During the Holocene, climate and sea level were exceptionally stable

The Holocene was a “safe operating space for humanity”

During the last hundred years, we have introduced rapid and large changes

The system is already now outside the “normal range” and in the transition to the Post-Holocene

Our knowledge is changing very fast; existing knowledge becomes invalid

We may not know all environmental, social and economic thresholds

There is a potential for surprises; we should prepare for global emergencies

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Paradigm shifts may be required; for example: instead of “Growth is necessary” assume “Growth is an addiction that we need to overcome.”

"No problem can be solved with the same consciousness that created it."

Albert Einstein

"It is difficult to get a man to understand something when his job depends on not understanding it"

Upton Sinclair

The Therapy: “Lifestyle”Changes

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Are we selecting the leaders who can guide us through the transition from virus to healer?

The Therapy: “Lifestyle”Changes

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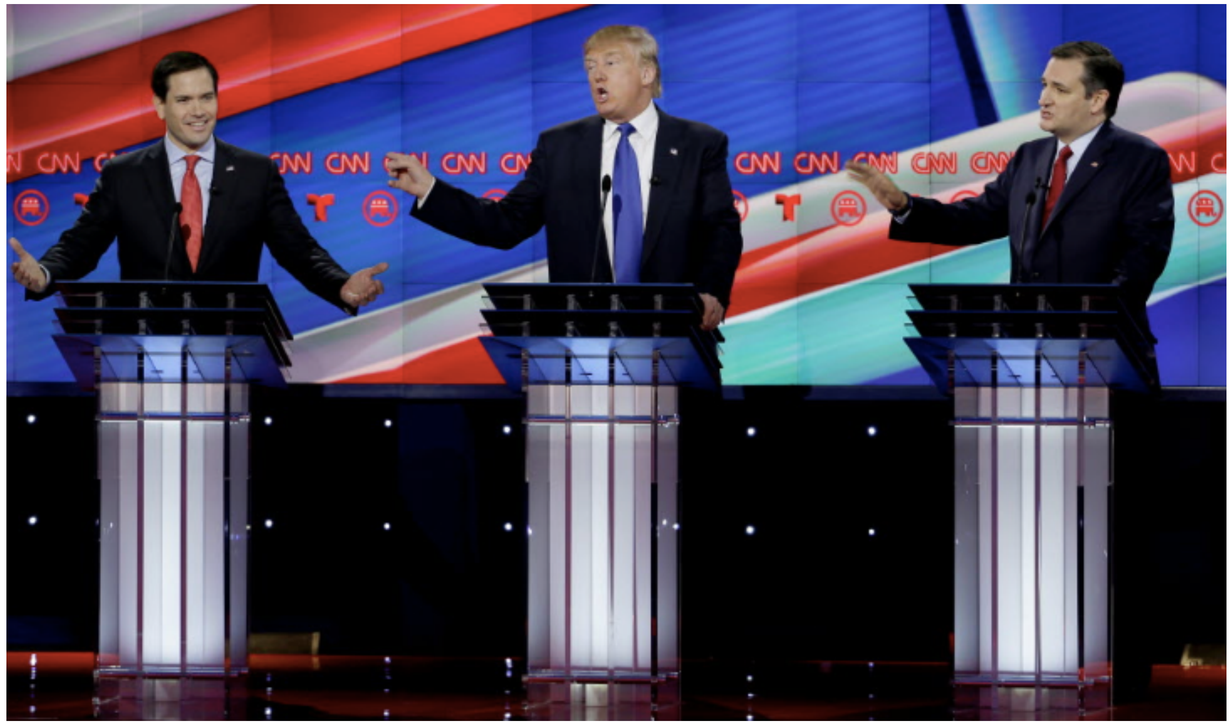

The Diagnosis: Leaving the “Safe Operating Space”

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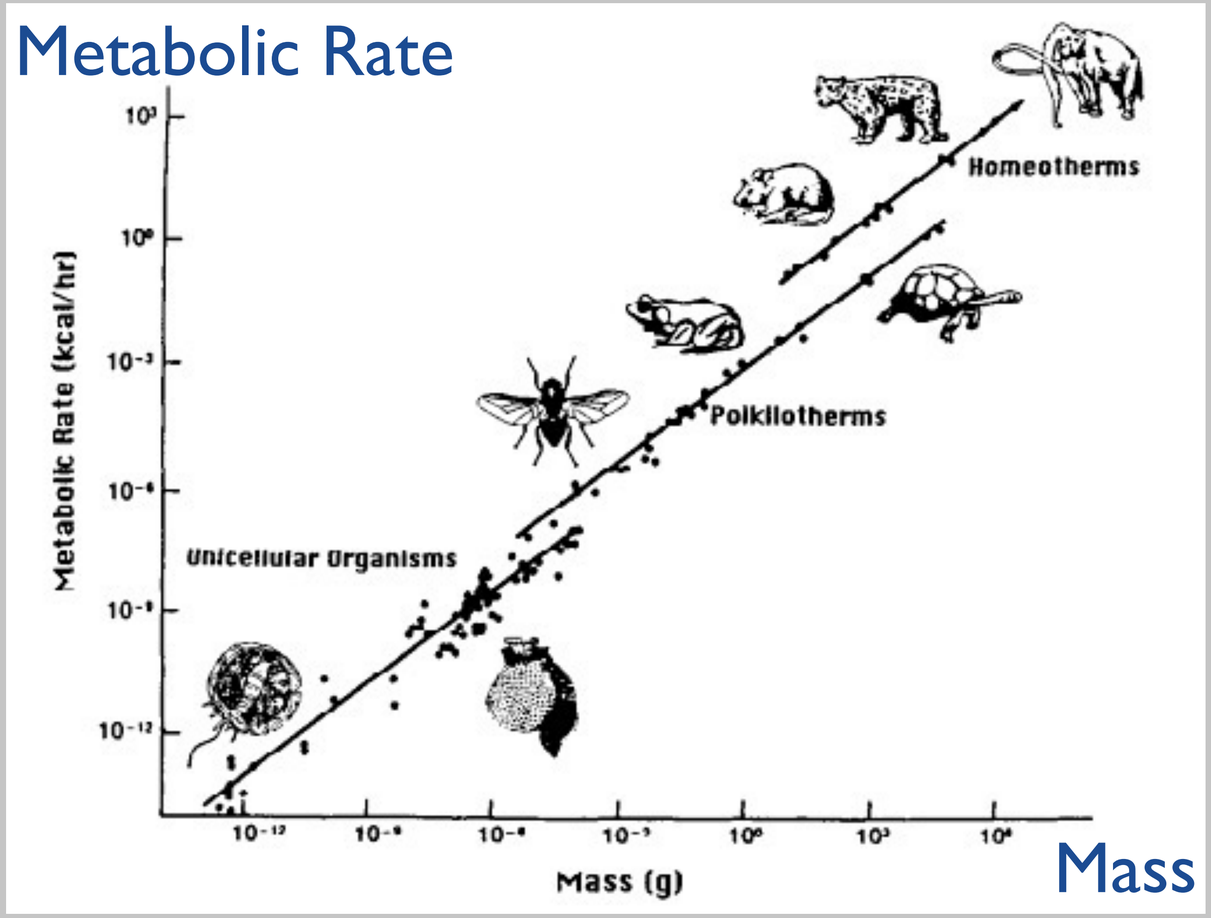
Being out of scale



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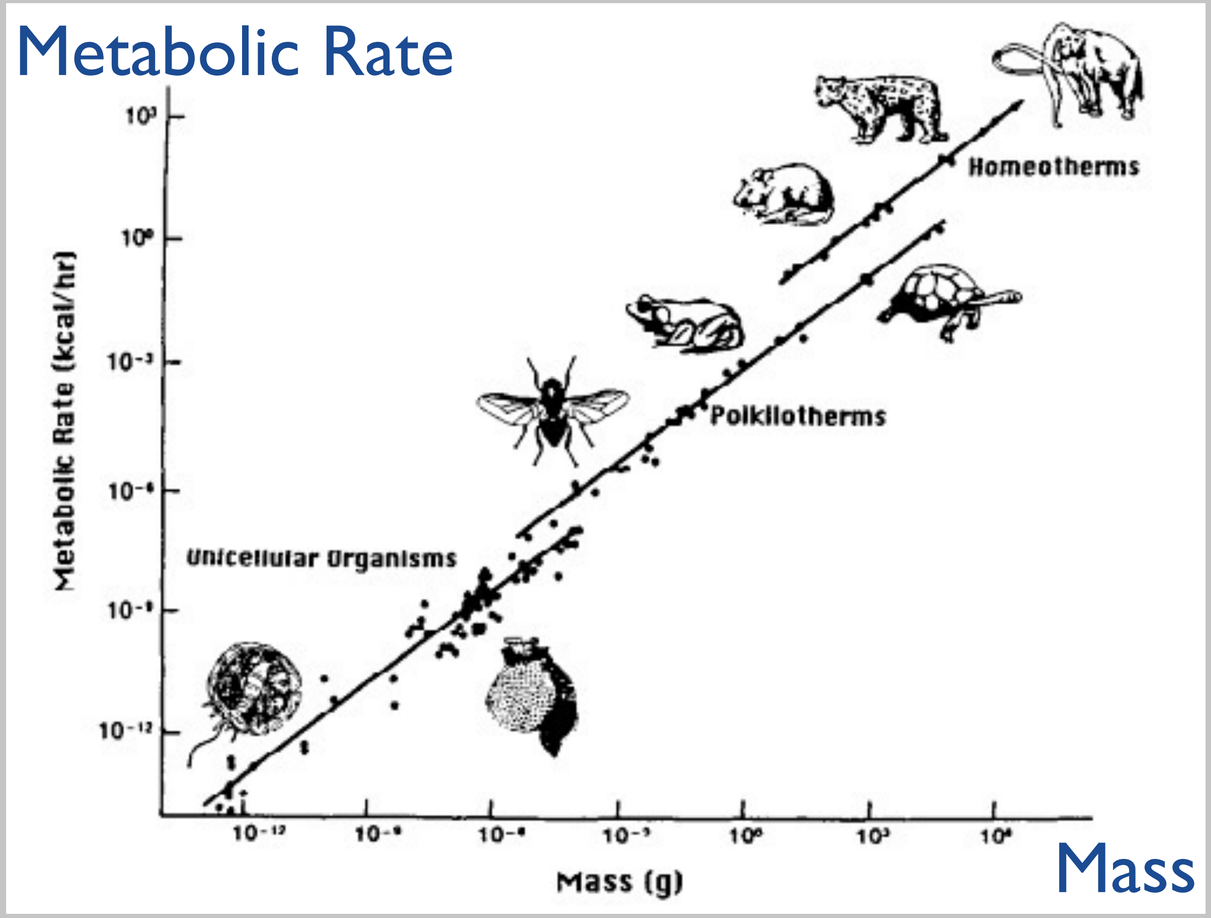

Scaling law for metabolic rate:

$Y = Y_0 * M^{(3/4)}$

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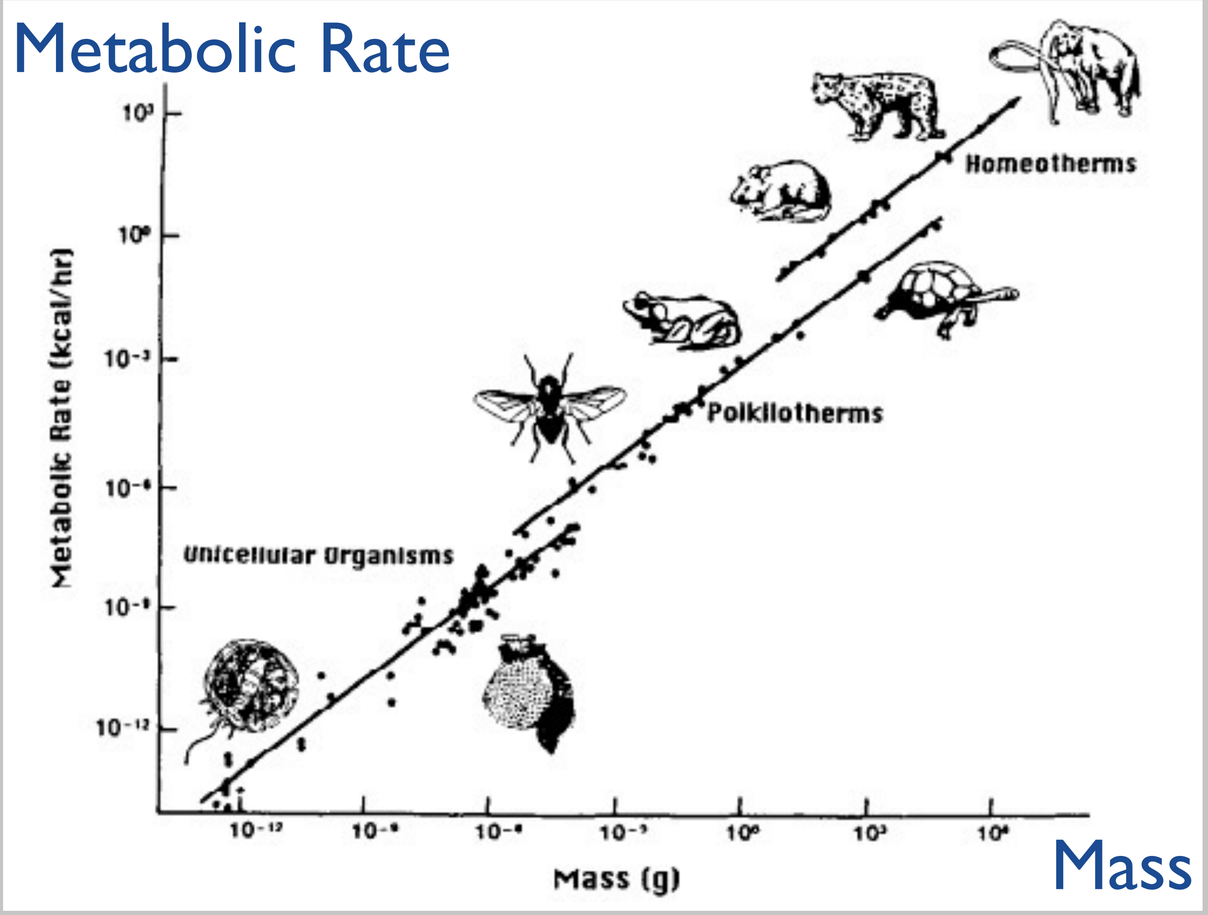

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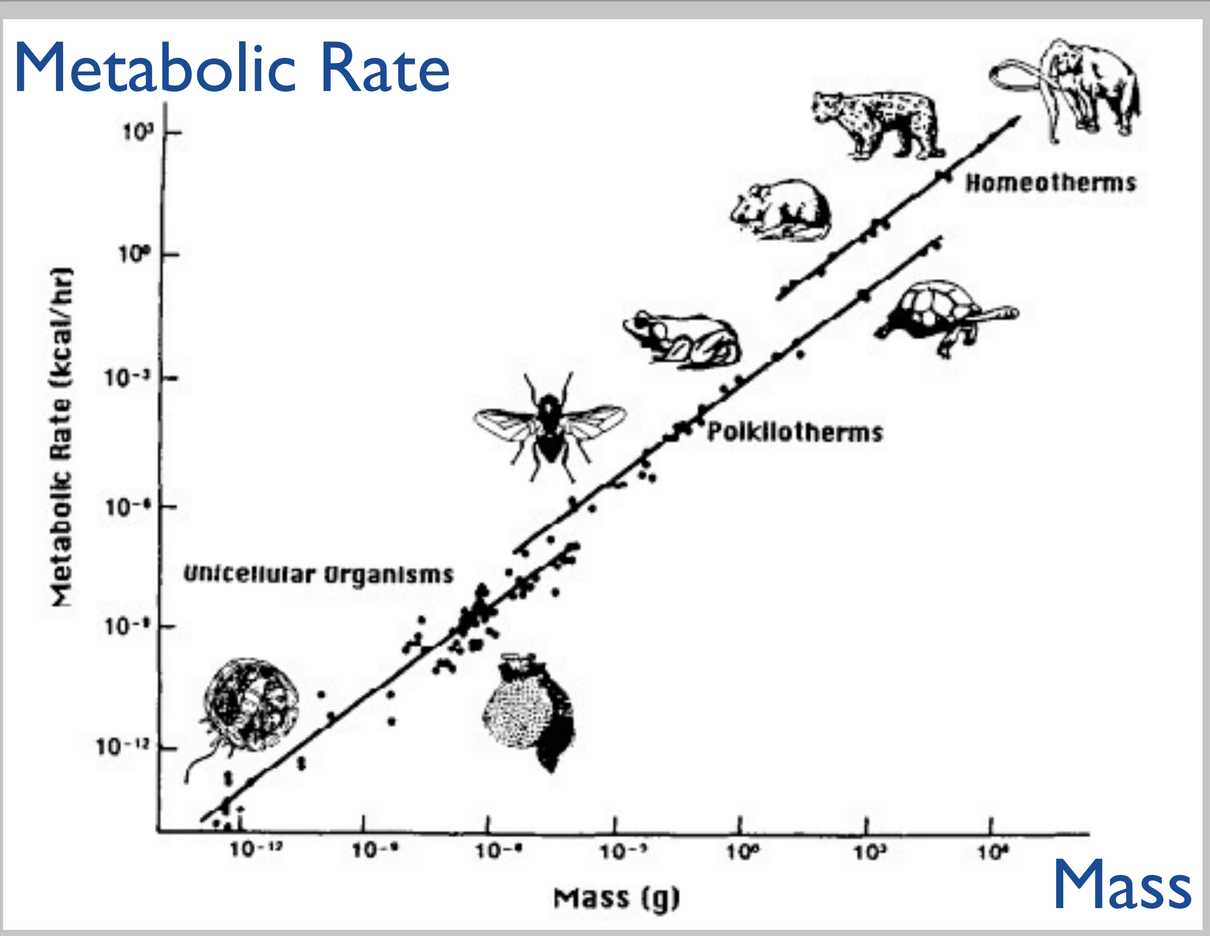

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$Y_E = Y + C_E$
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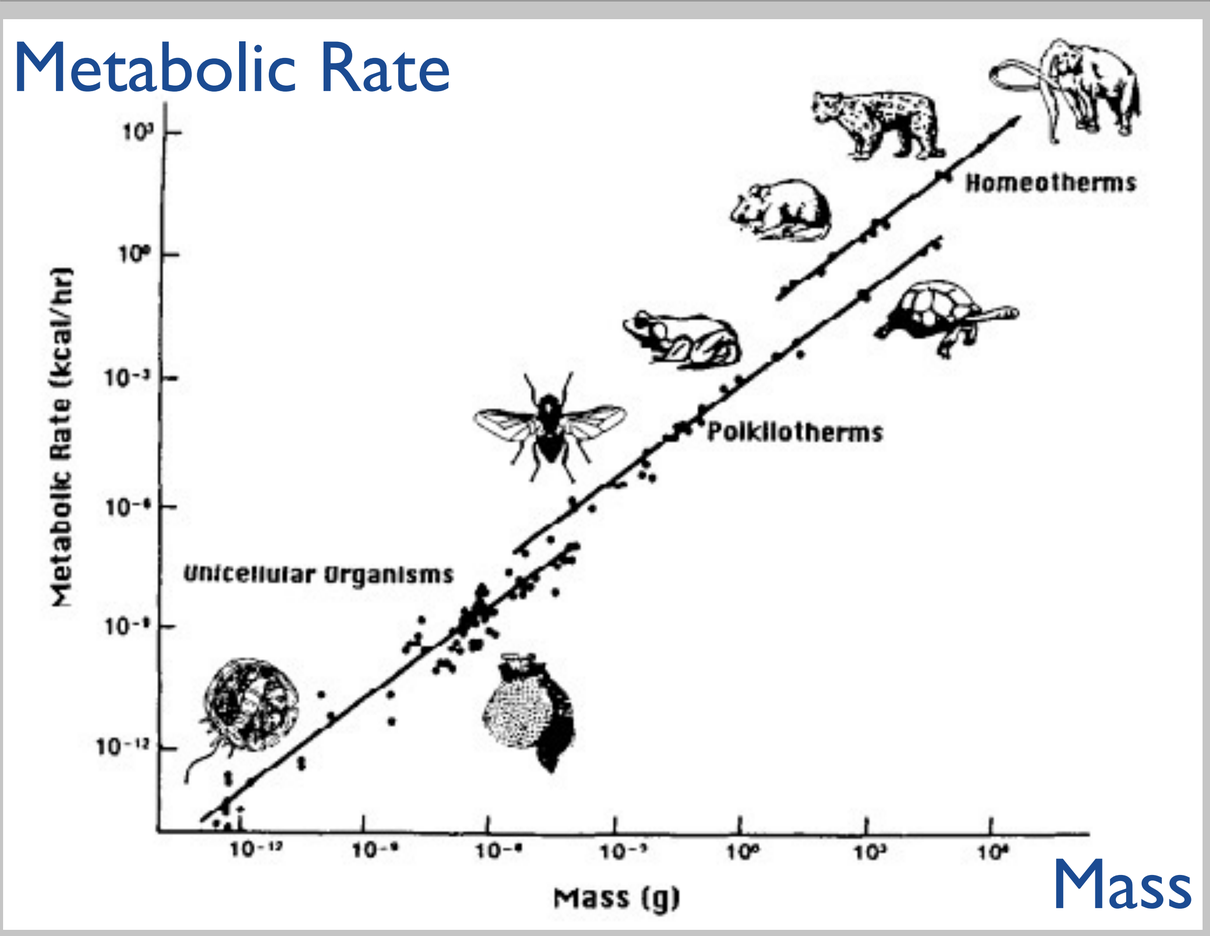

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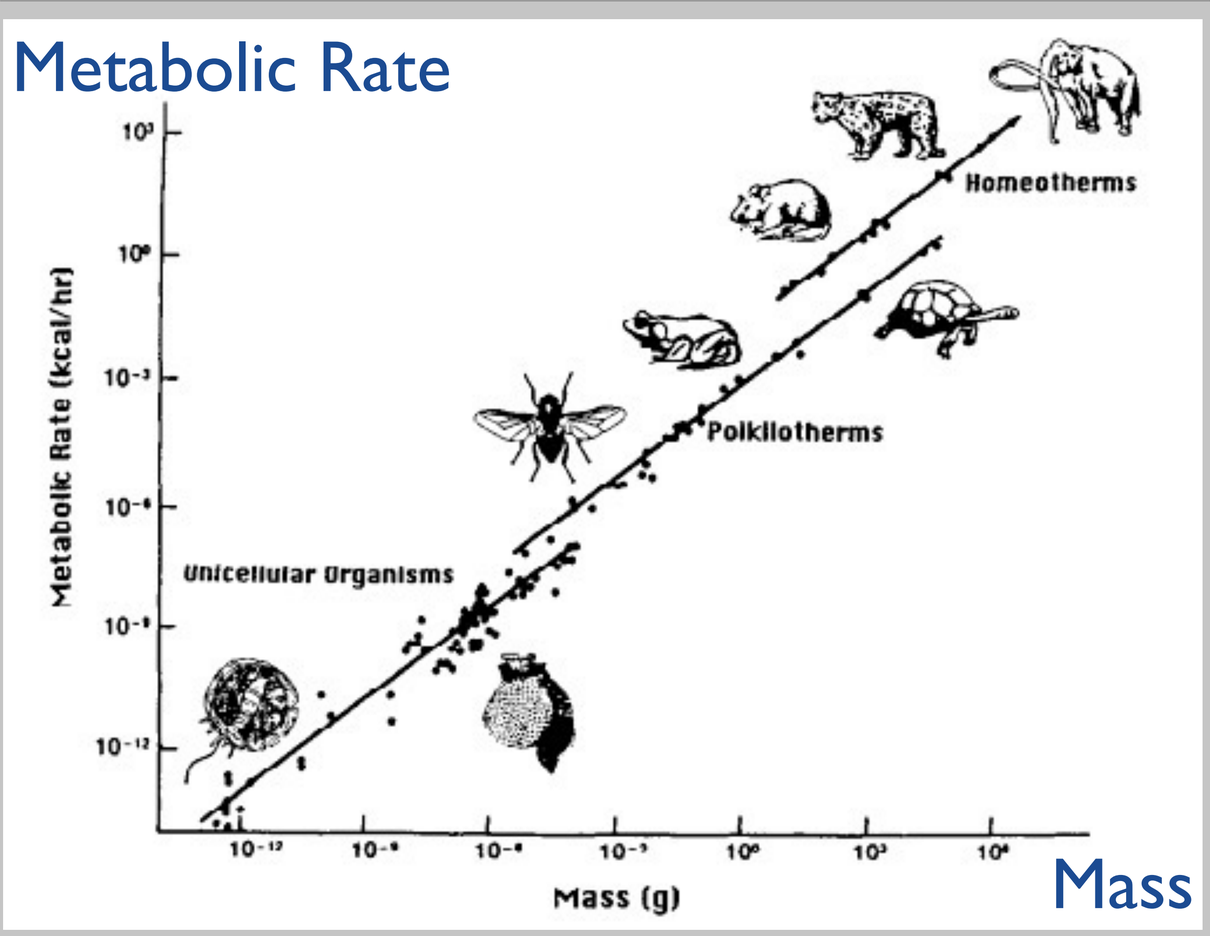

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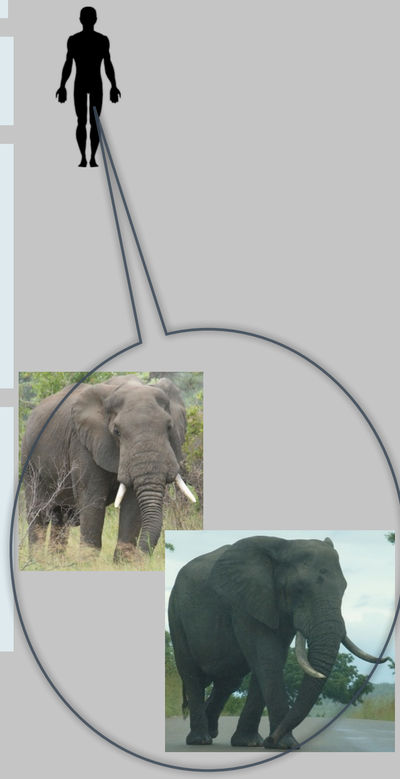

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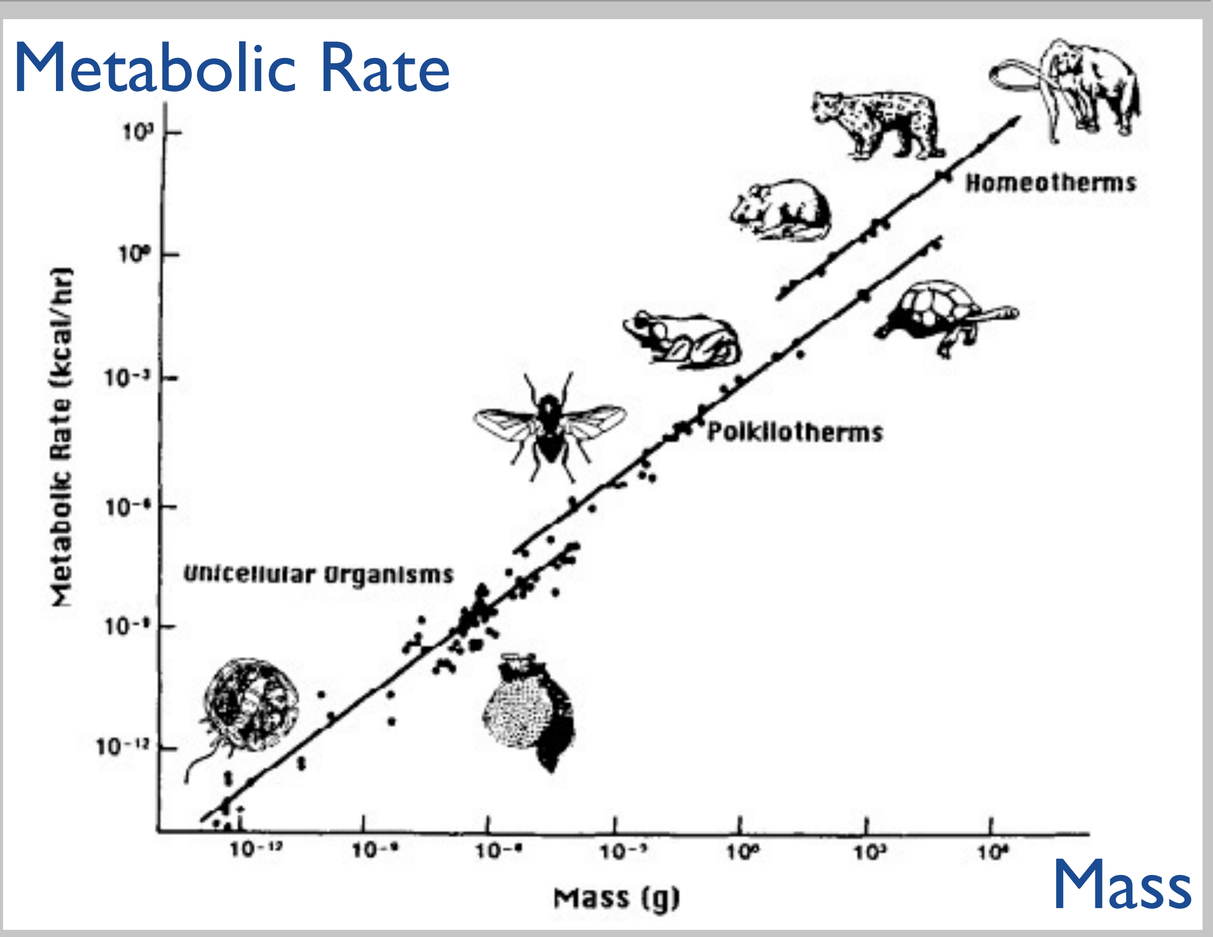

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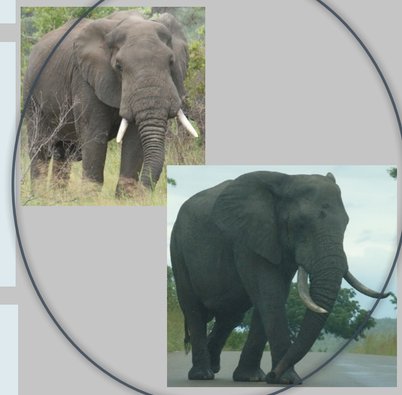

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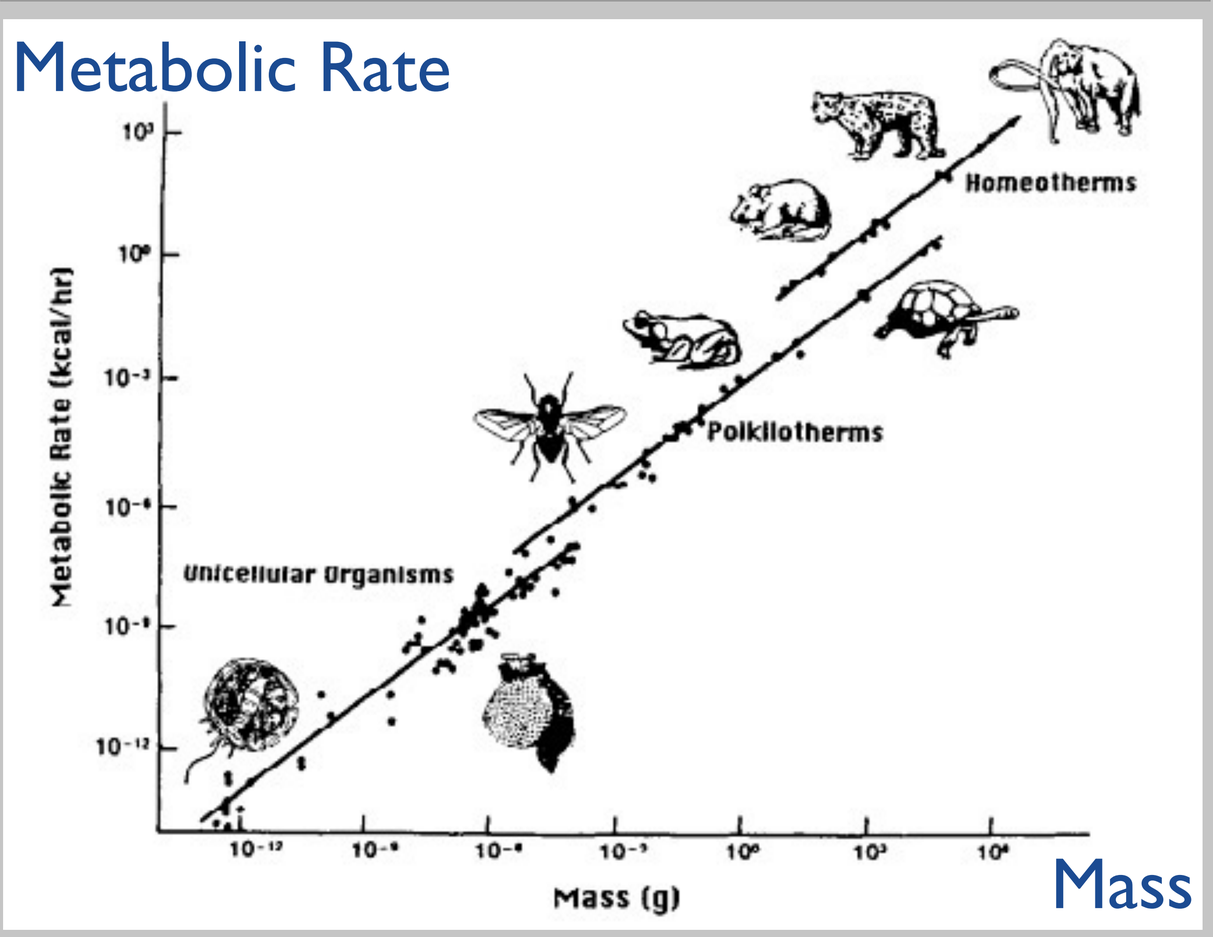

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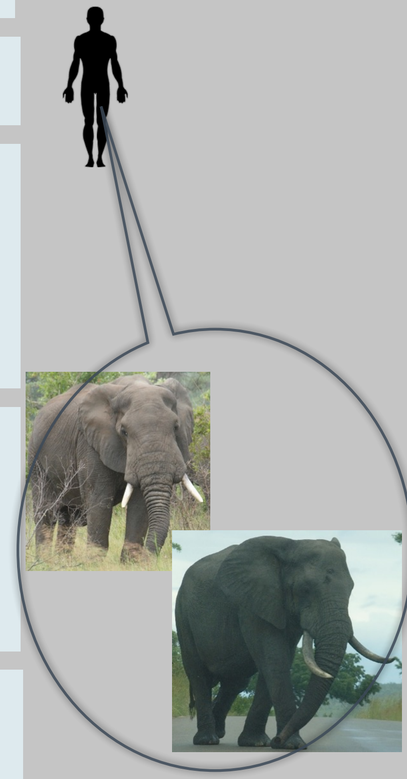

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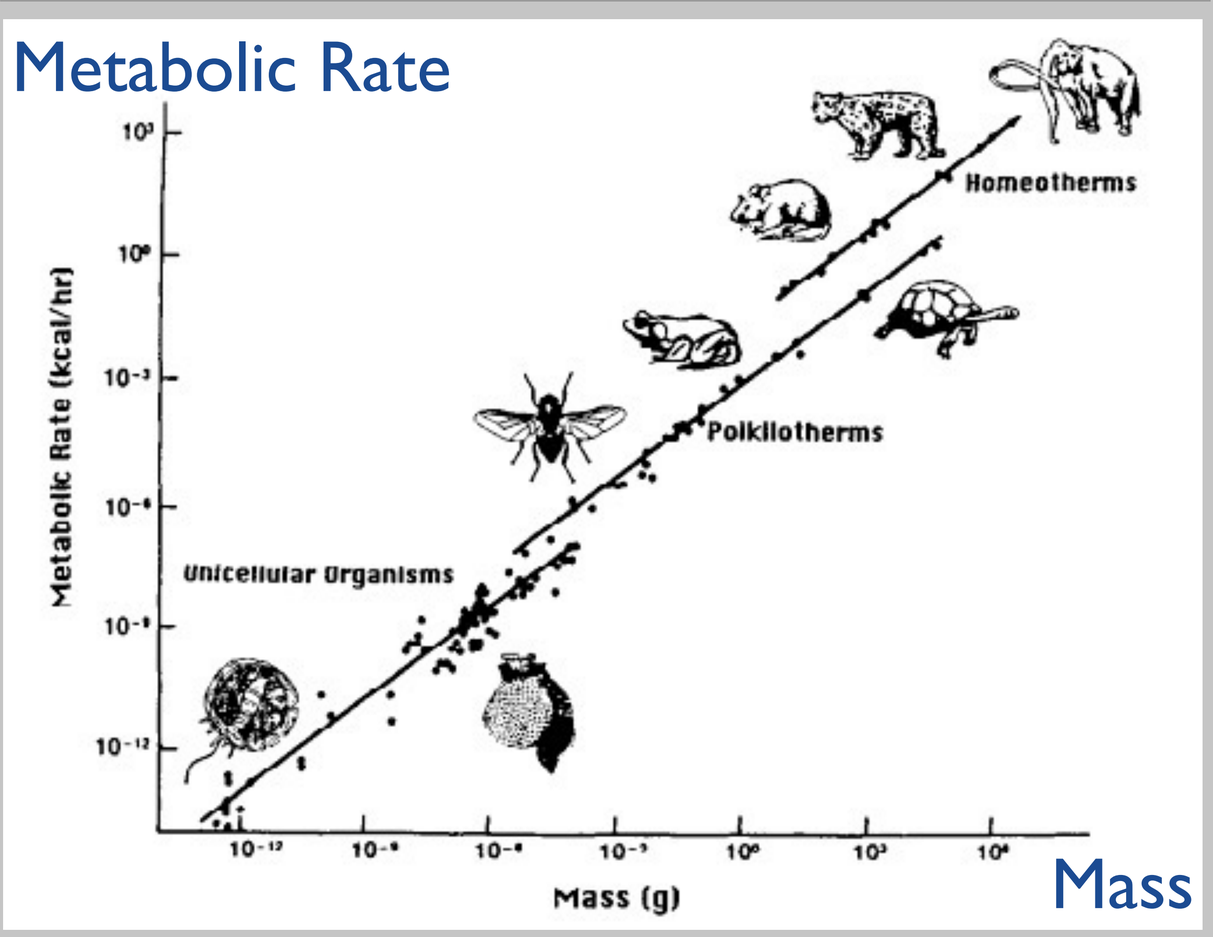

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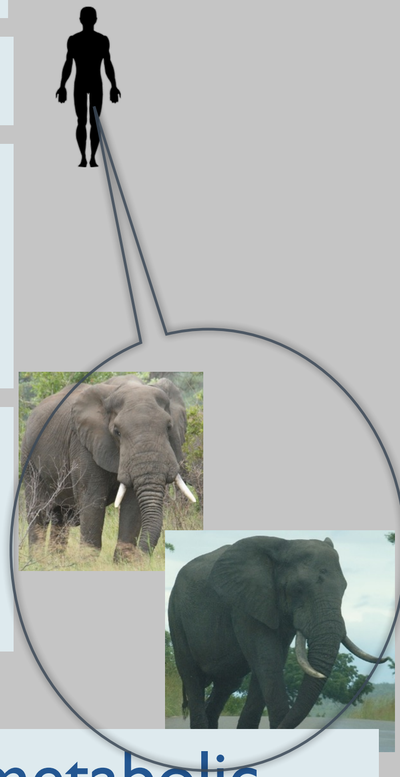

Humanity has an extended metabolic rate equivalent to 14 Billion elephants (2.7 Billion for the U.S. alone)

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14 Billion elephants: a heavy "load' for Earth

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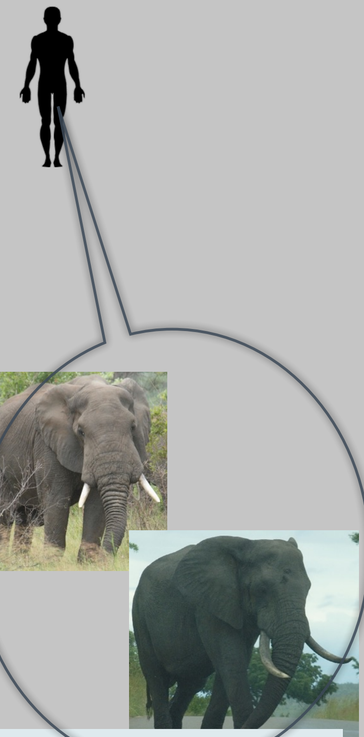

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The Therapy: “Lifestyle”Changes

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Transition to an Economy for Humanity

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Transition to an Economy for Humanity

Making safeguarding the Earth’s life-support system an inherent part of economy

- Depart from a consumption-driven economy
- Limiting globalization:
  - stopping the export of pollution;
  - reducing inequality, injustice;
  - attributing pollution to the consumers
  - localizing of production (in particular, food)
- Enabling de-growth of population, resource usage

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The Therapy: “Lifestyle”Changes

… or being stupid?

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The Therapy: “Lifestyle”Changes

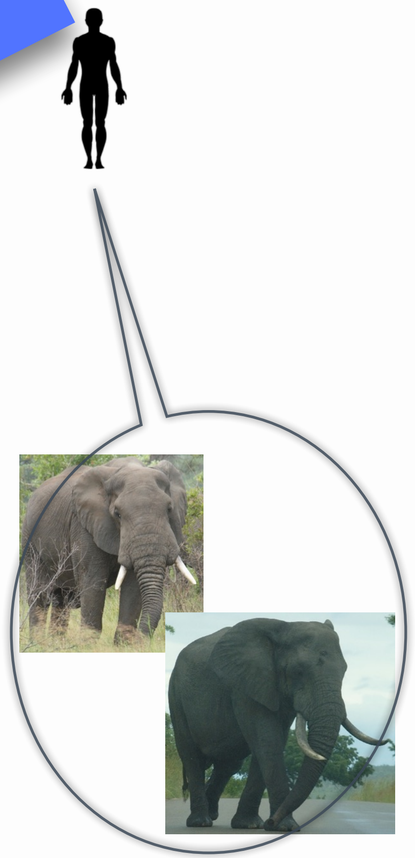
A growth-addicted humanity is heading for the equivalent of >30 billion elephants

IGNORANCE IN ACTION

SOCIAL & POLITICAL INERTIA

RISK BASED PLANNING

SCIENTIFIC INQUIRY AND PROJECTION



30 billion elephants: a load too heavy for Earth?