Modern Climate Change:
A Symptom of a Human-Caused High-Energy Pulse

(Virtual) Lecture Series at the
Christ and St. Luke's Episcopal Church, Norfolk
May 2020

May 3: Part 1: The Baseline
May 10: Part 2: The Syndrome and Diagnosis
May 17: Part 3: The Prognosis and Therapy

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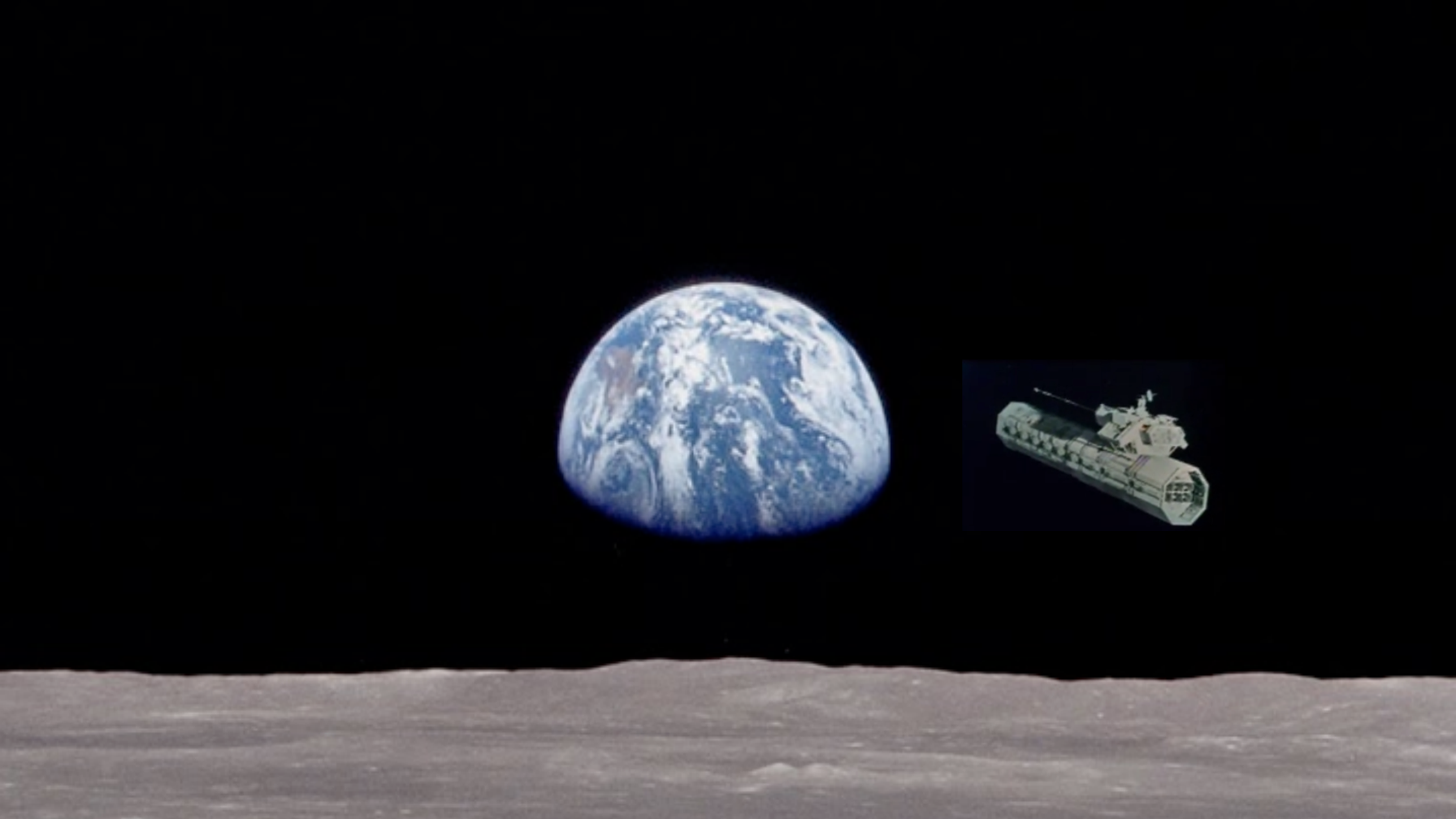
Old Dominion University
Norfolk, VA, USA



Physiology of the Planetary Life-Support System: Homeostasis

Global Essential Variable: Energy Imbalance: Incoming Energy minus Outgoing Energy

“Healthy Life-Support System”:
Earth’s Energy Imbalance (EEI) due to photosynthesis on the order of 10^{-10} to 10^{-9}

Imbalance today: 300-320 TW, i.e., on the order of $3x10^{-3}$
(e.g., Stephens et al., 2012; Trenberth et al., 2014, Cheng et al., 2016)

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(1) Why did the Earth’s energy imbalance increased so dramatically?
(2) Where, and in what form, is the energy stored, and what are the consequences?

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Contents

Key Points

Baseline

During the Holocene, climate and sea level were exceptionally stable.

The Holocene was a “safe operating space for humanity” allowing the emergence of a dominant species

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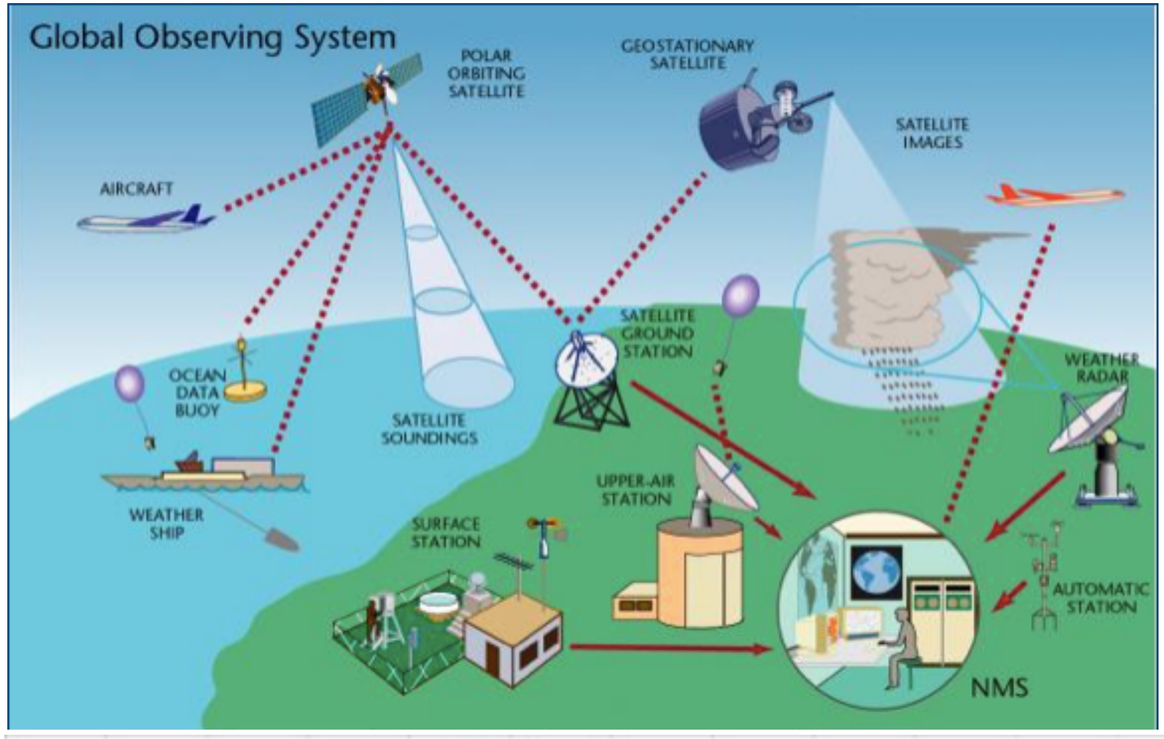
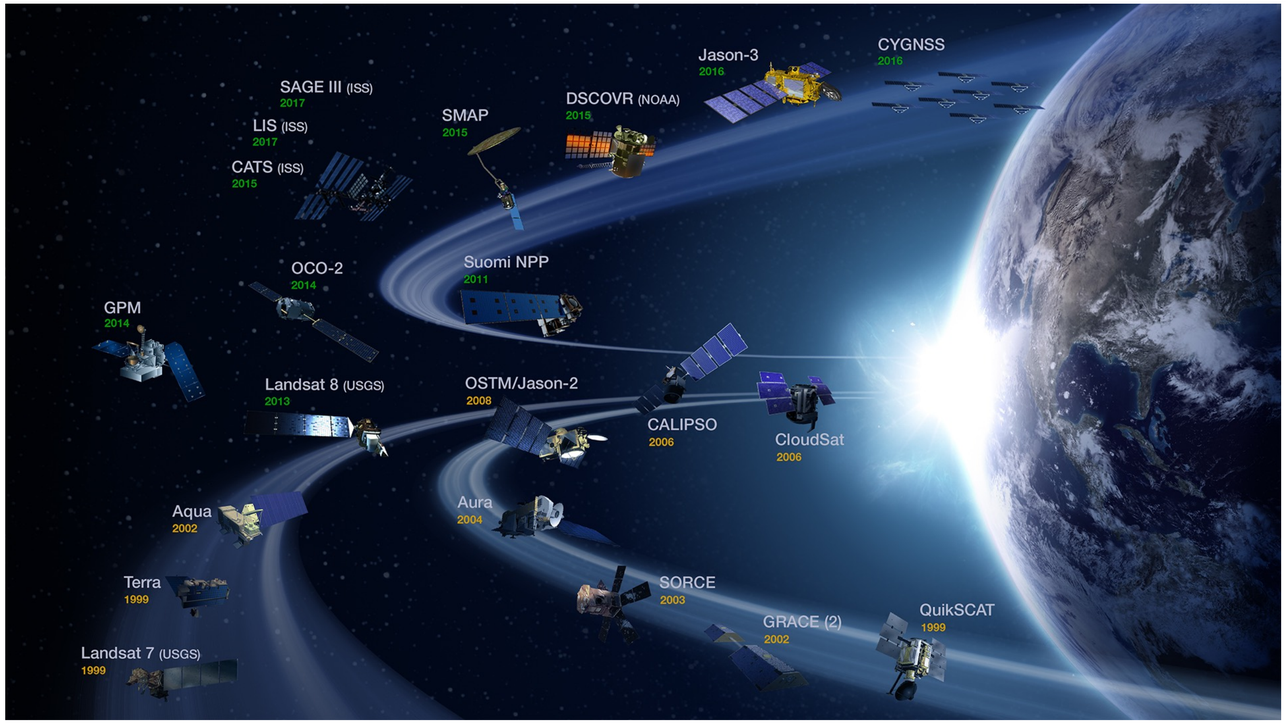
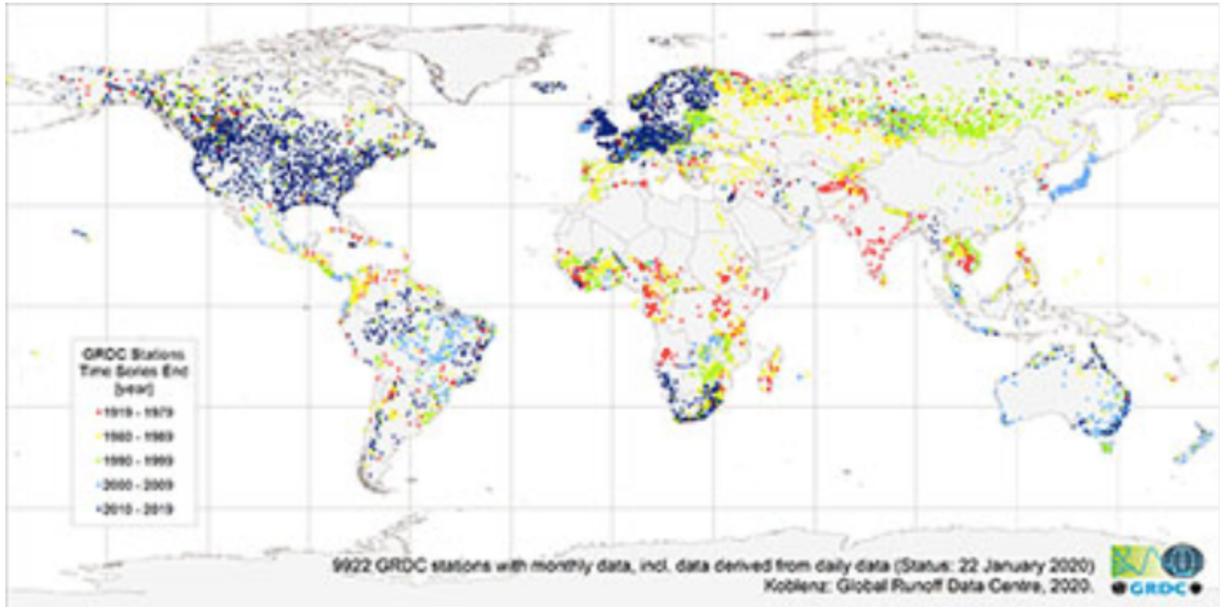
Contents

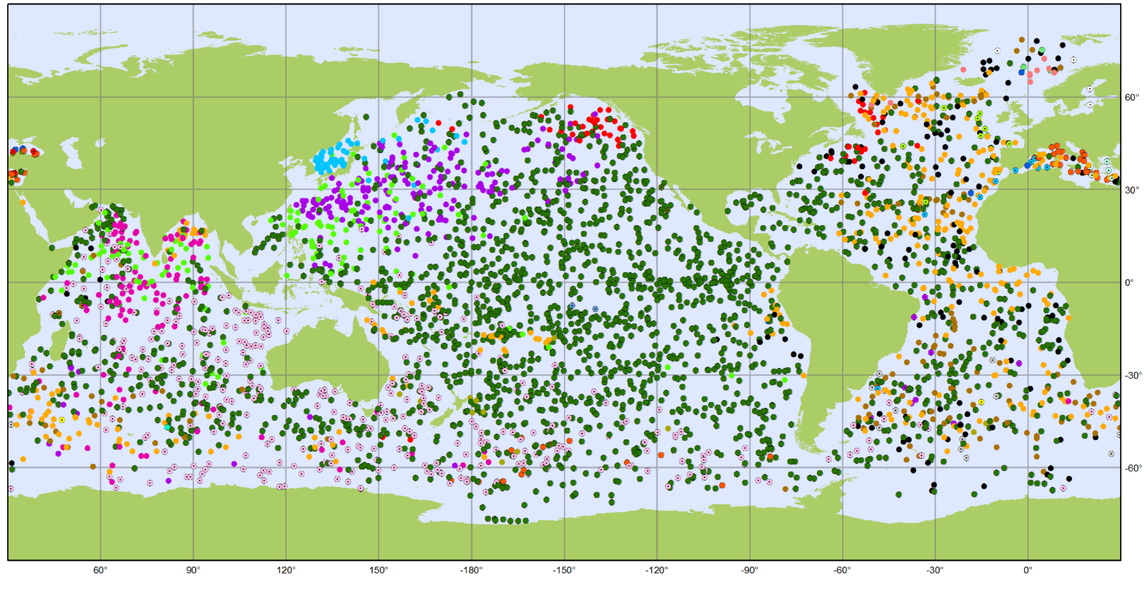
How do we know?

The Syndrome: Modern Climate and Global Change



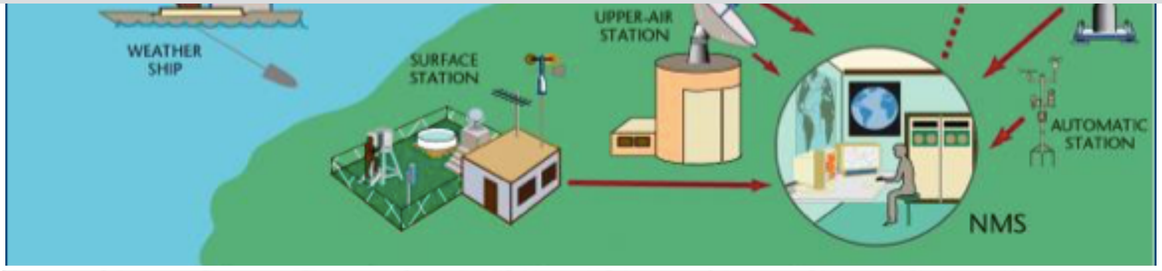


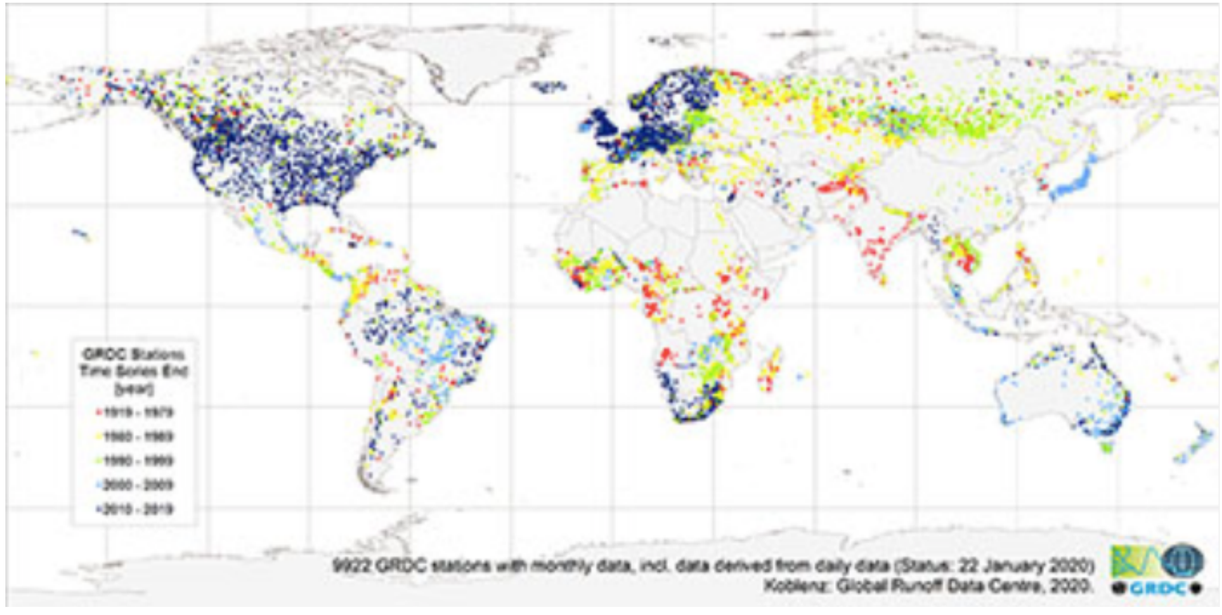


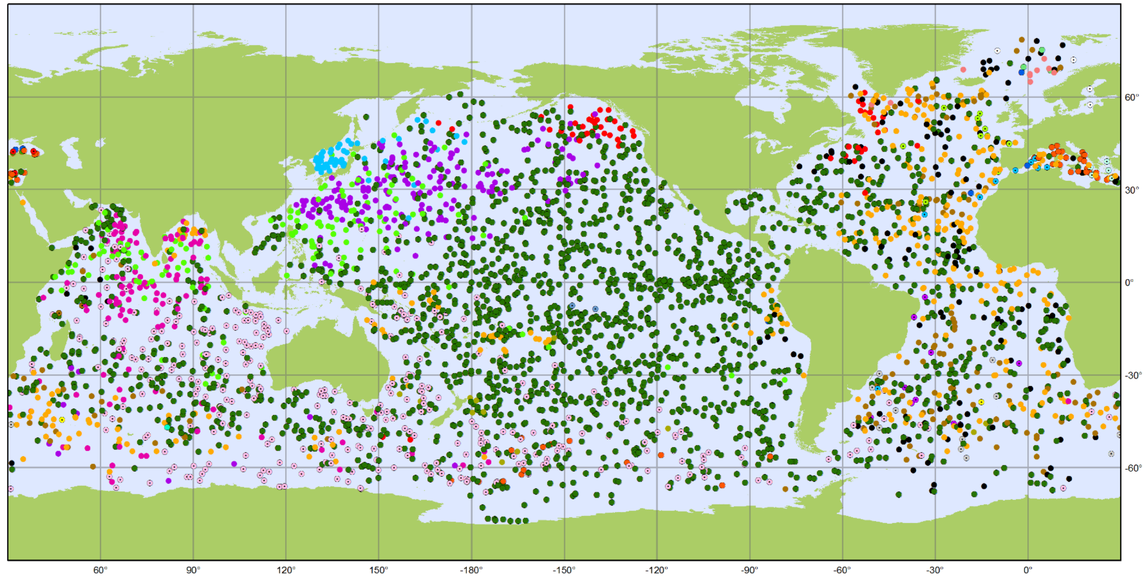


The Syndrome: Modern Climate and Global Change

Humanity has
- an enormous amount of data
- all the knowledge







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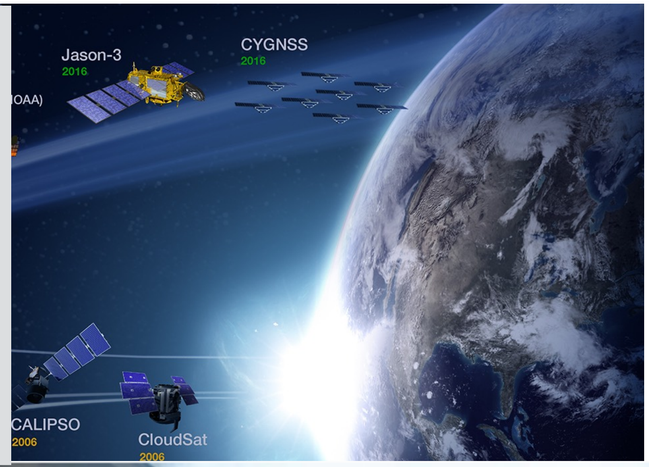
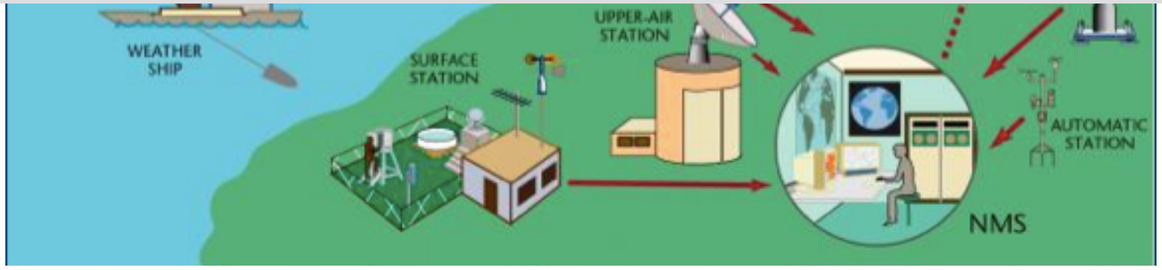
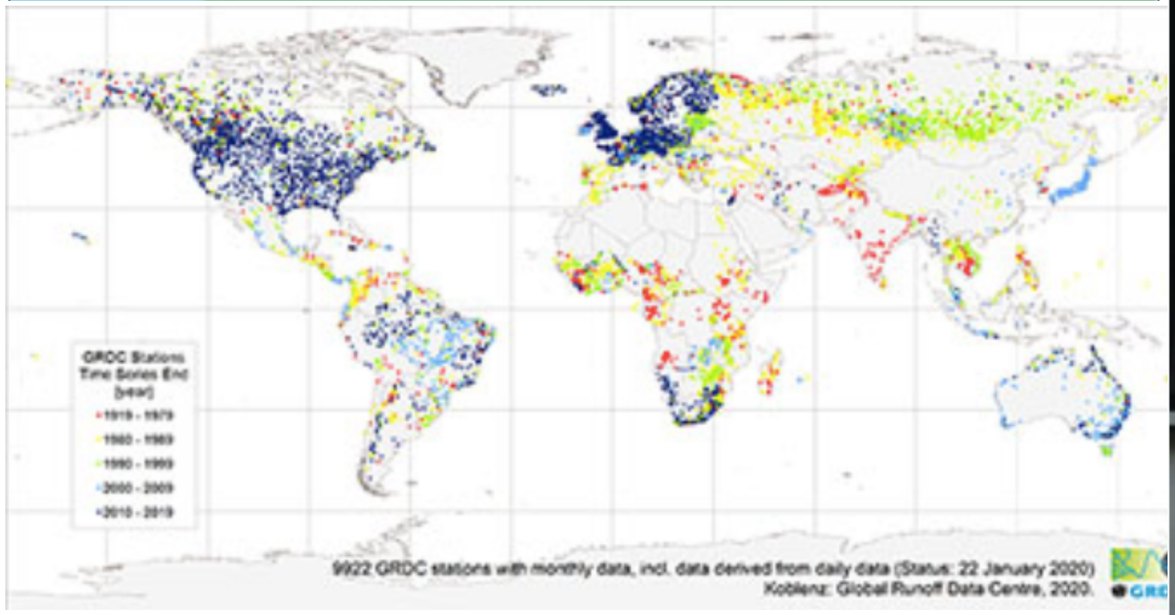
but the knowledge does not turn in power







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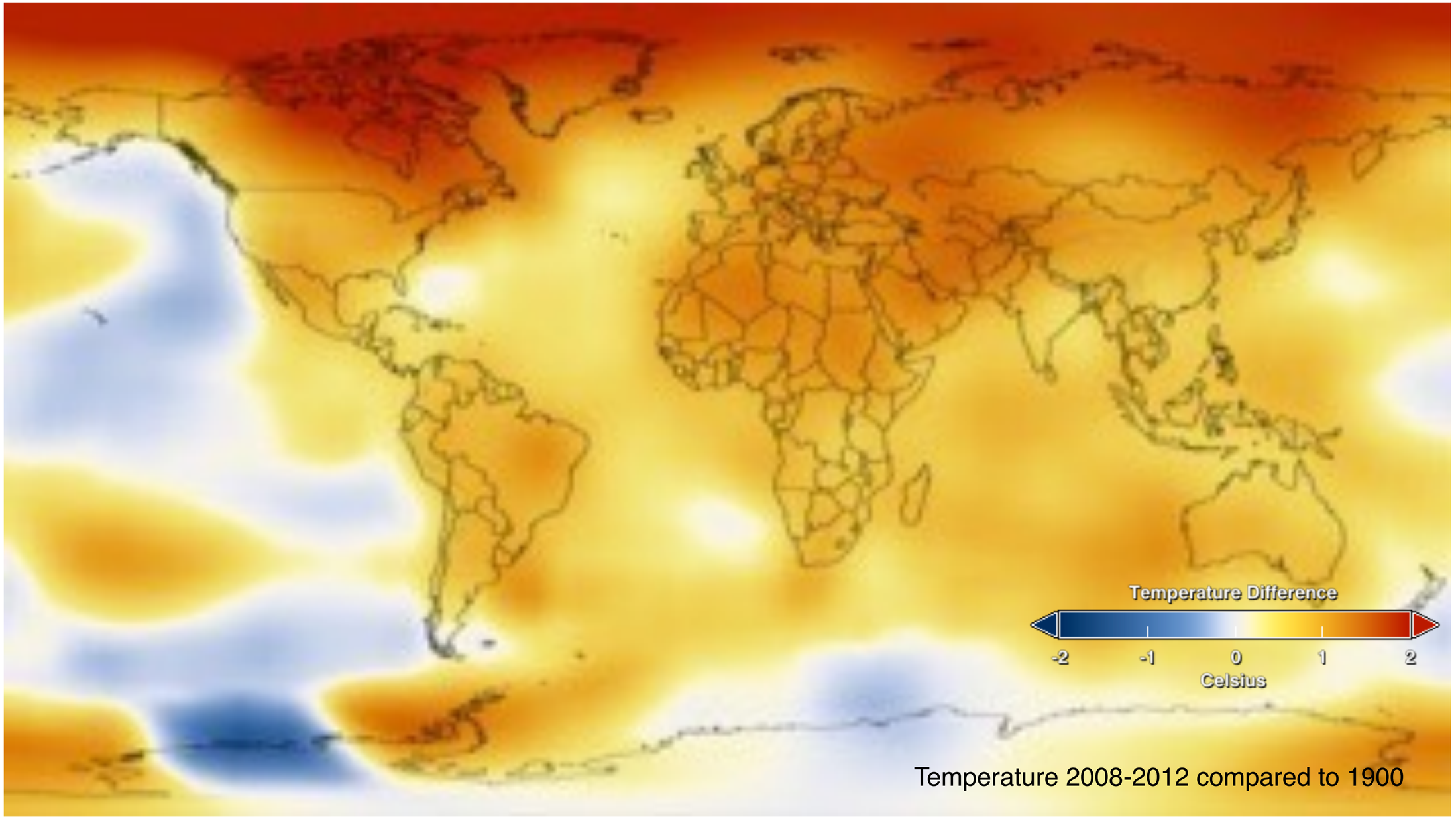

Temperature 2008-2012 compared to 1900

The Syndrome: Modern Climate and Global Change

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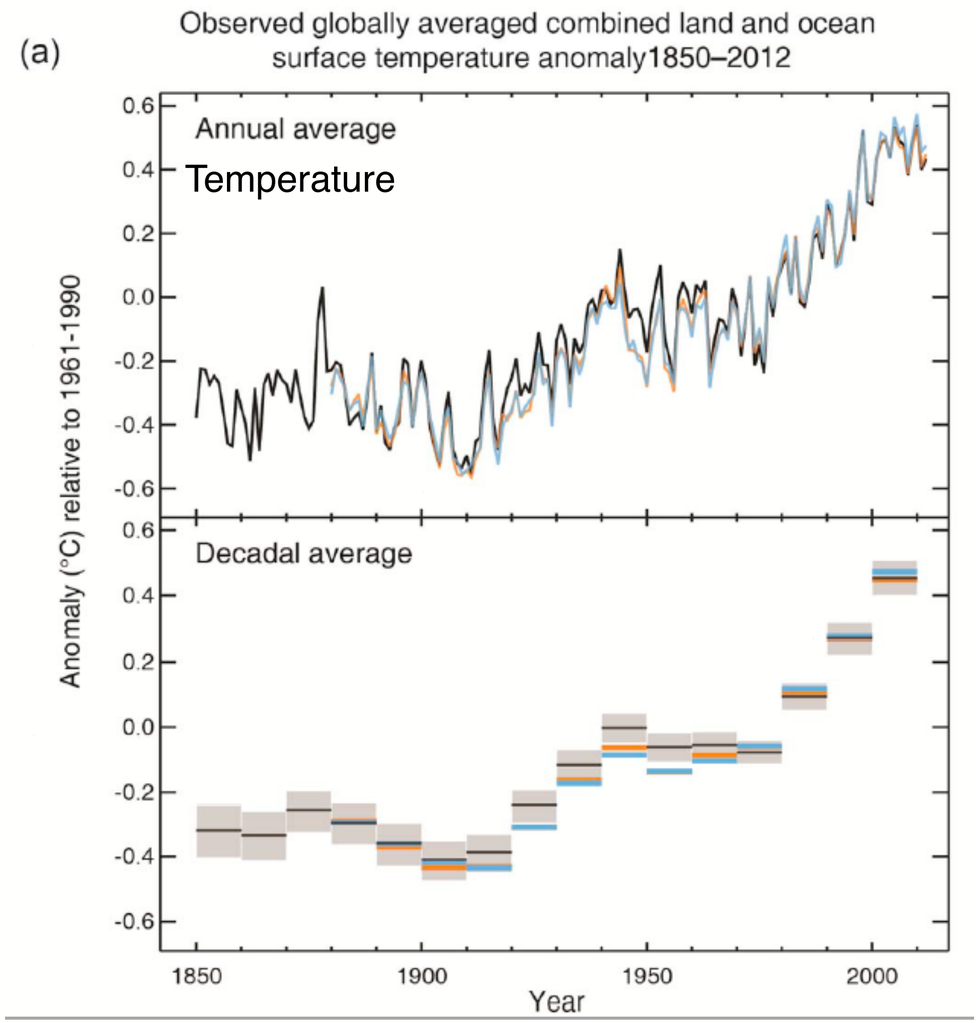

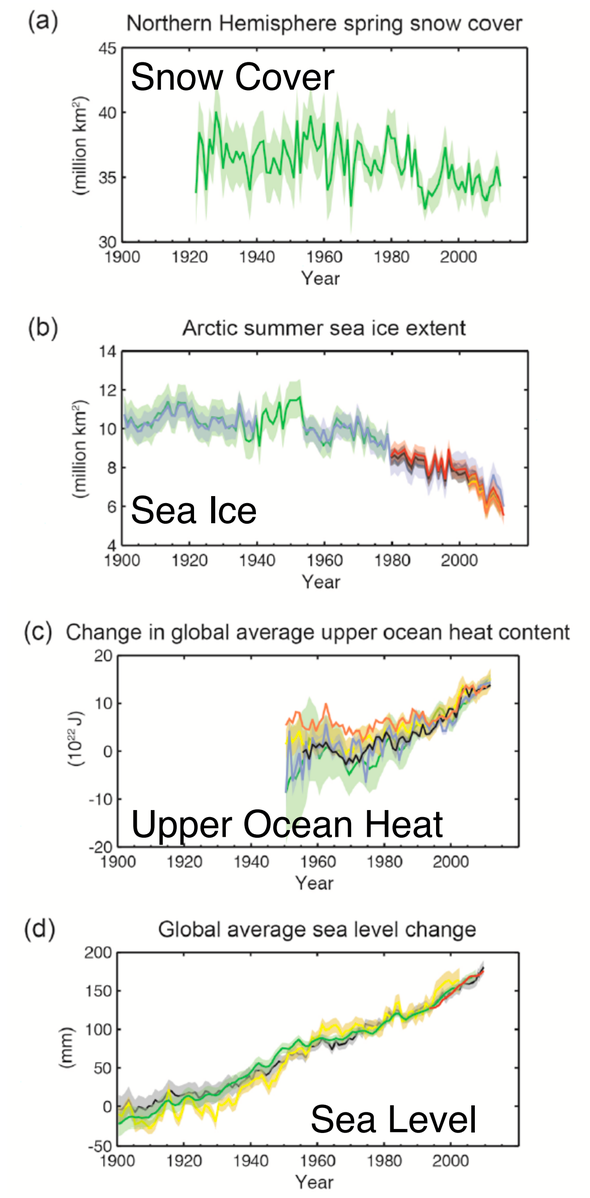

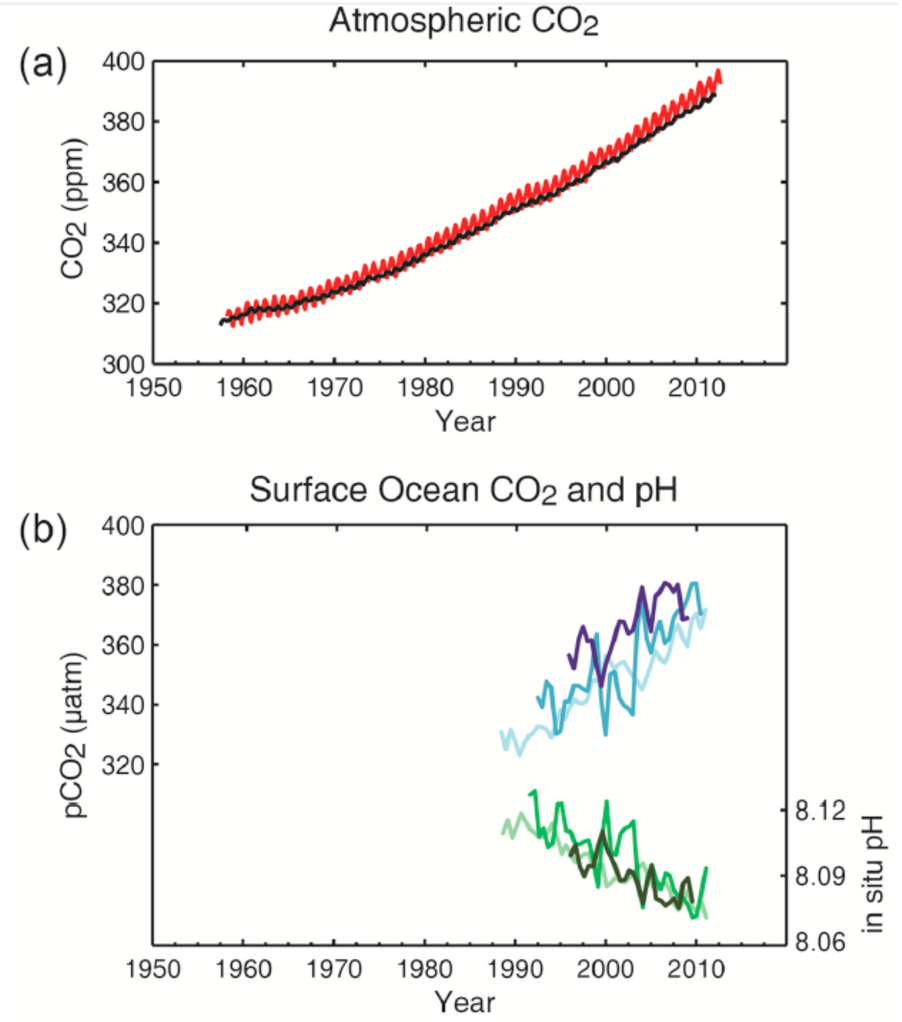

IPCC, 2013

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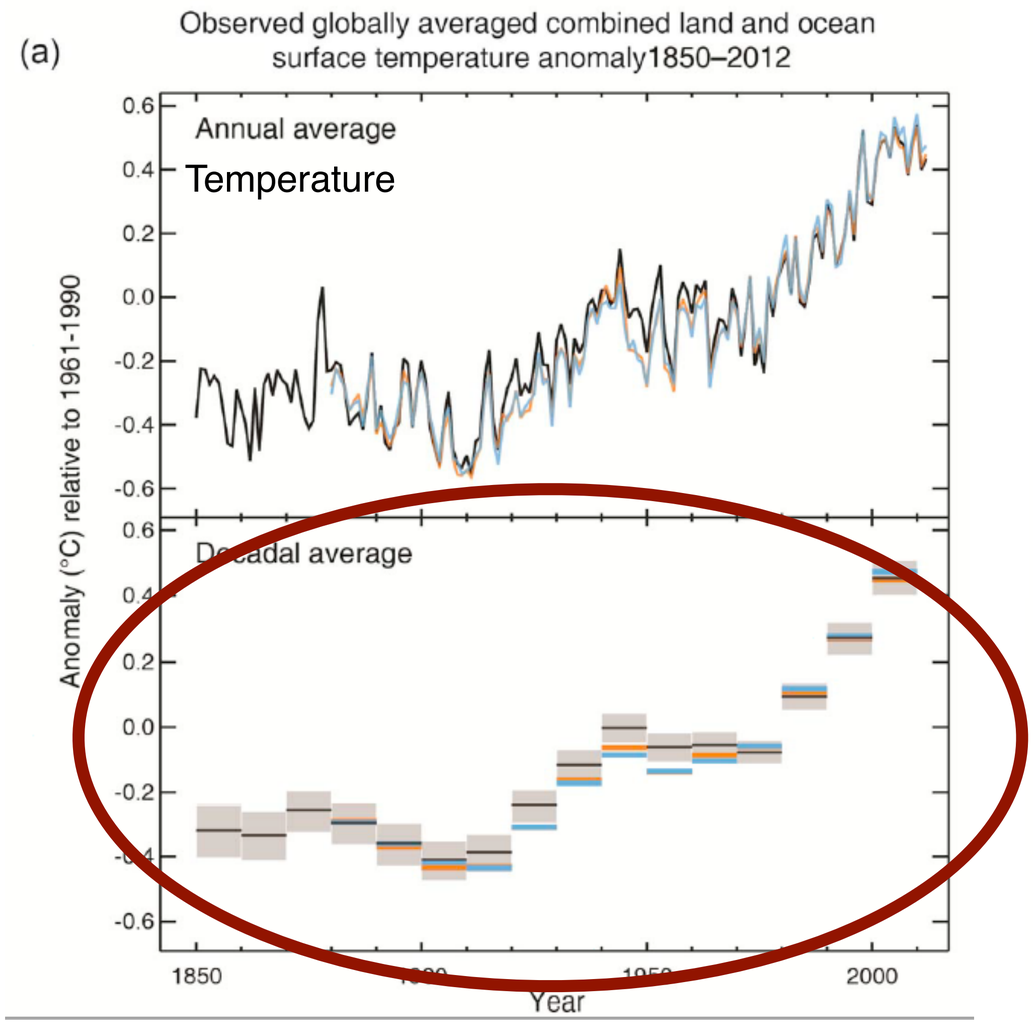

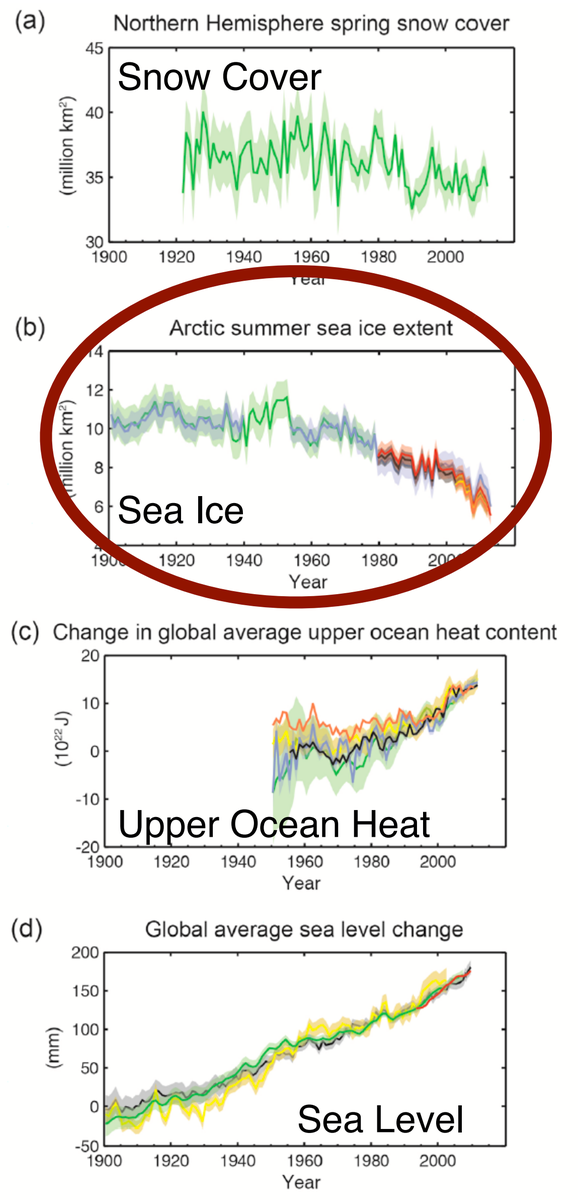

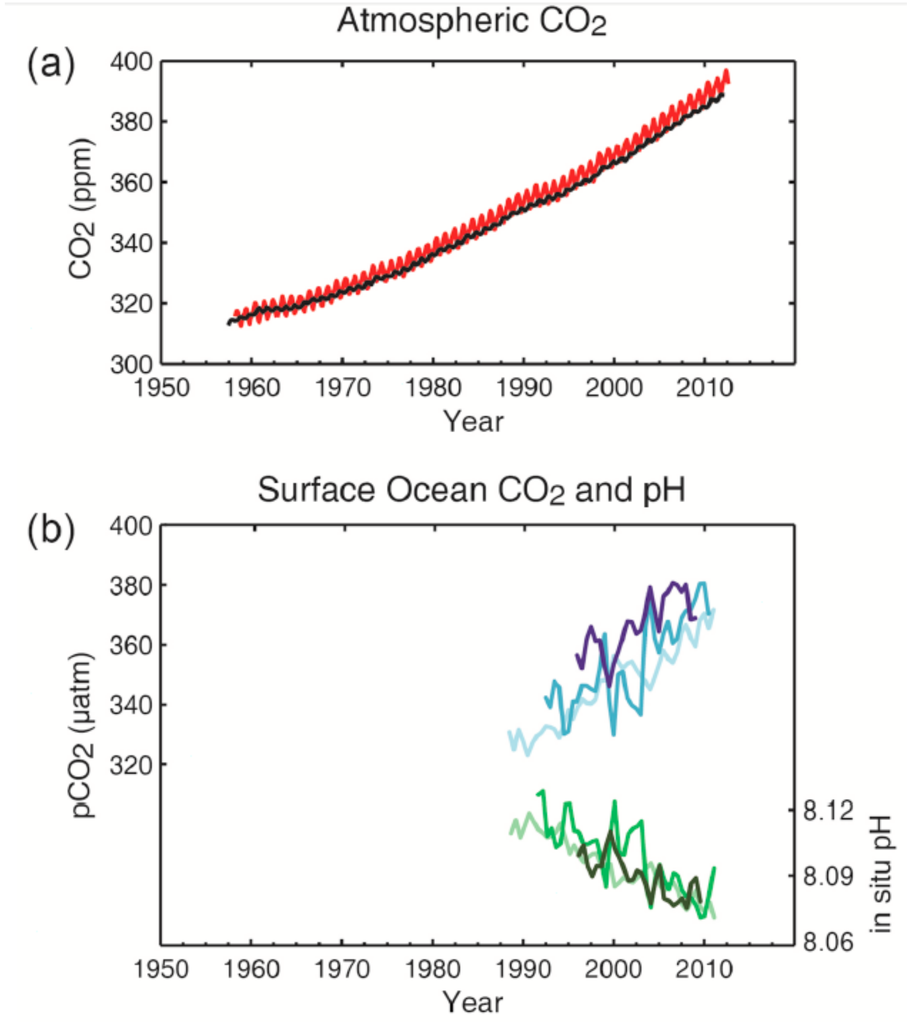

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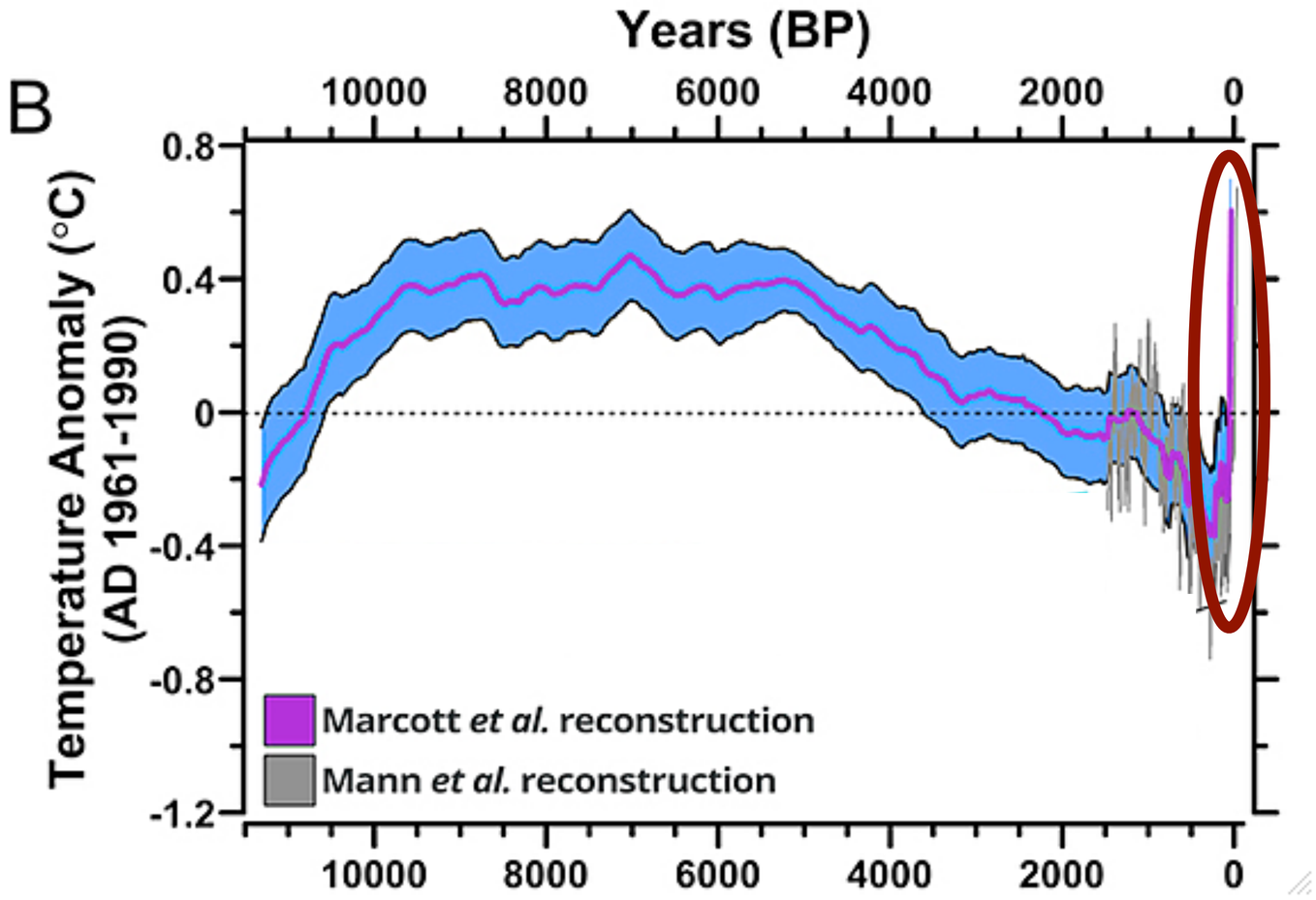
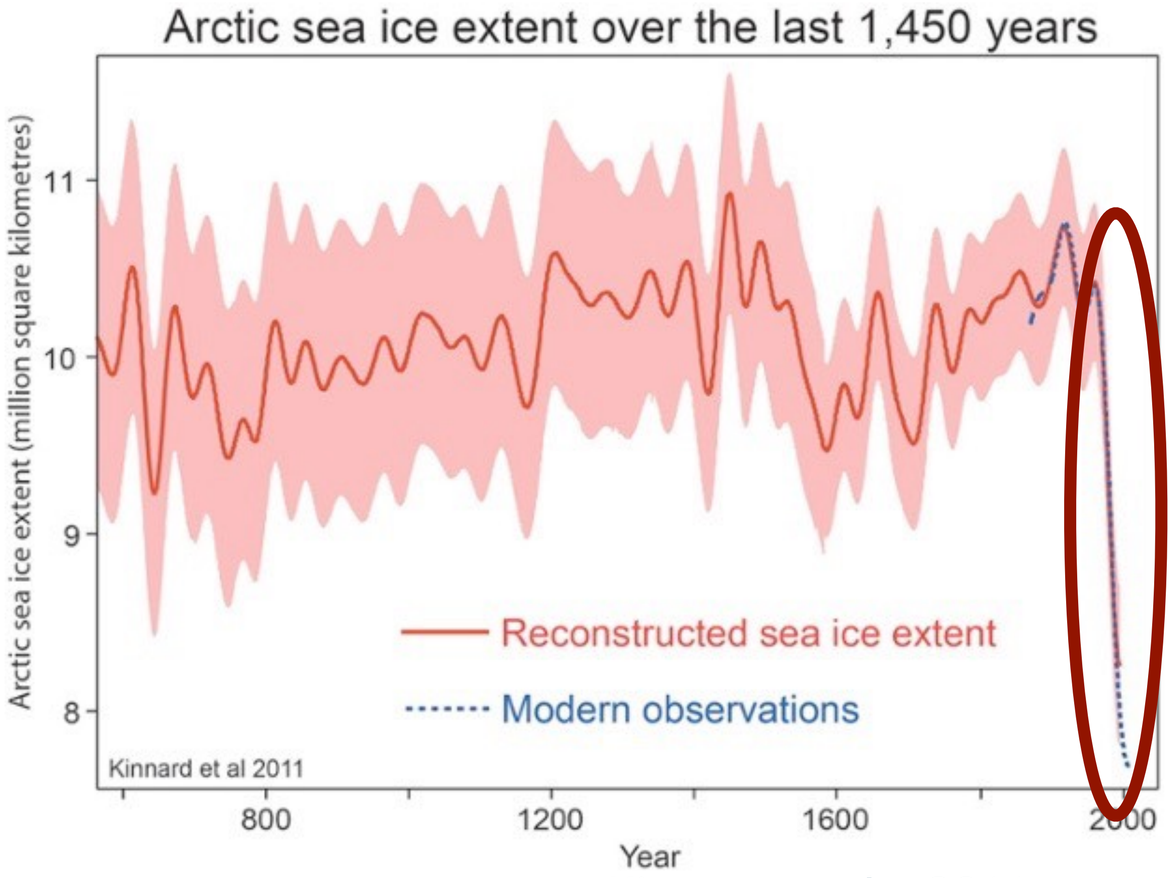


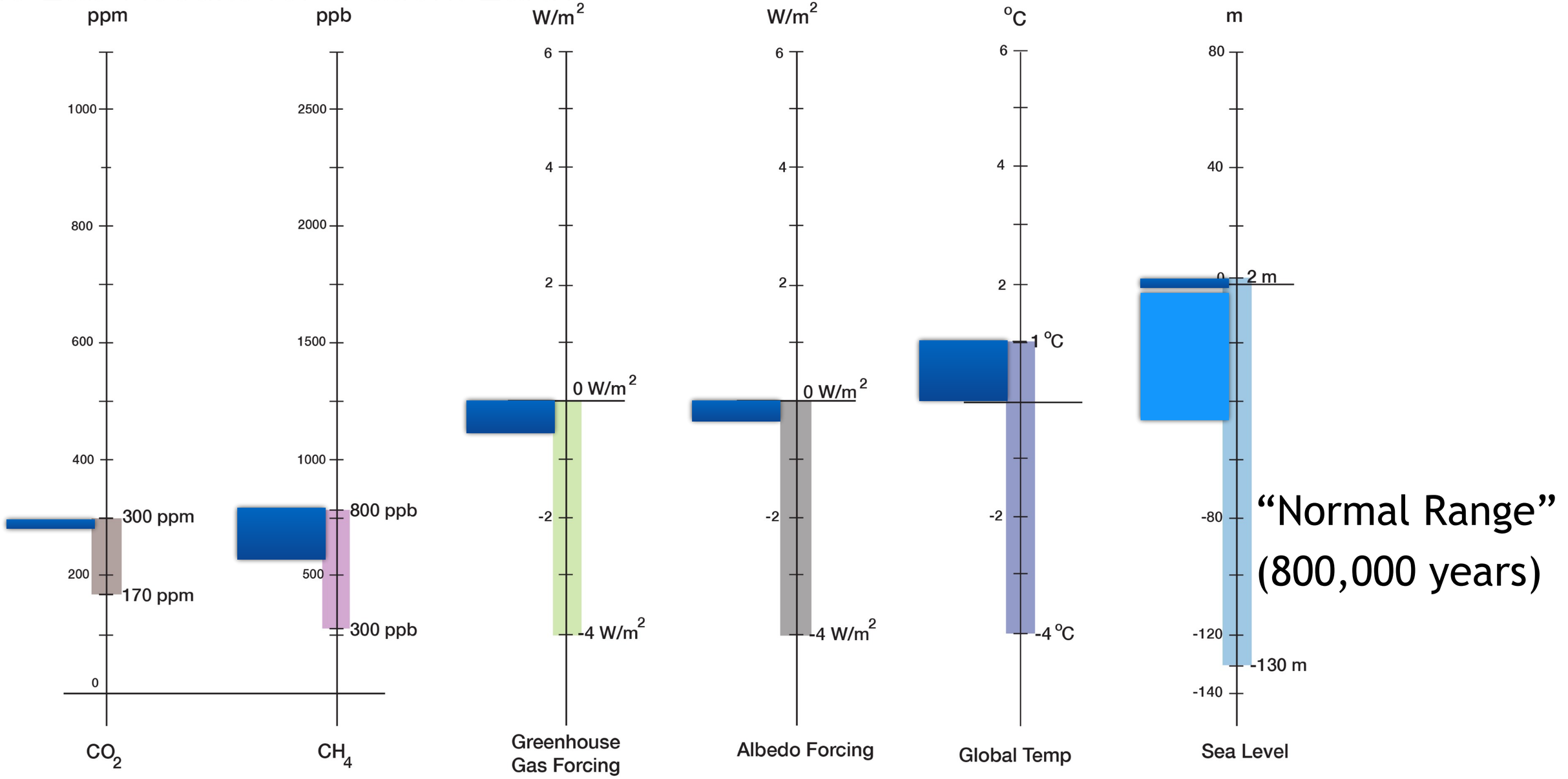
Marcott et al., 2013



Kinnart et al., 2011

The Syndrome: Modern Climate and Global Change

The Lab Results for “Patient Earth”



“Normal Range”
(800,000 years)

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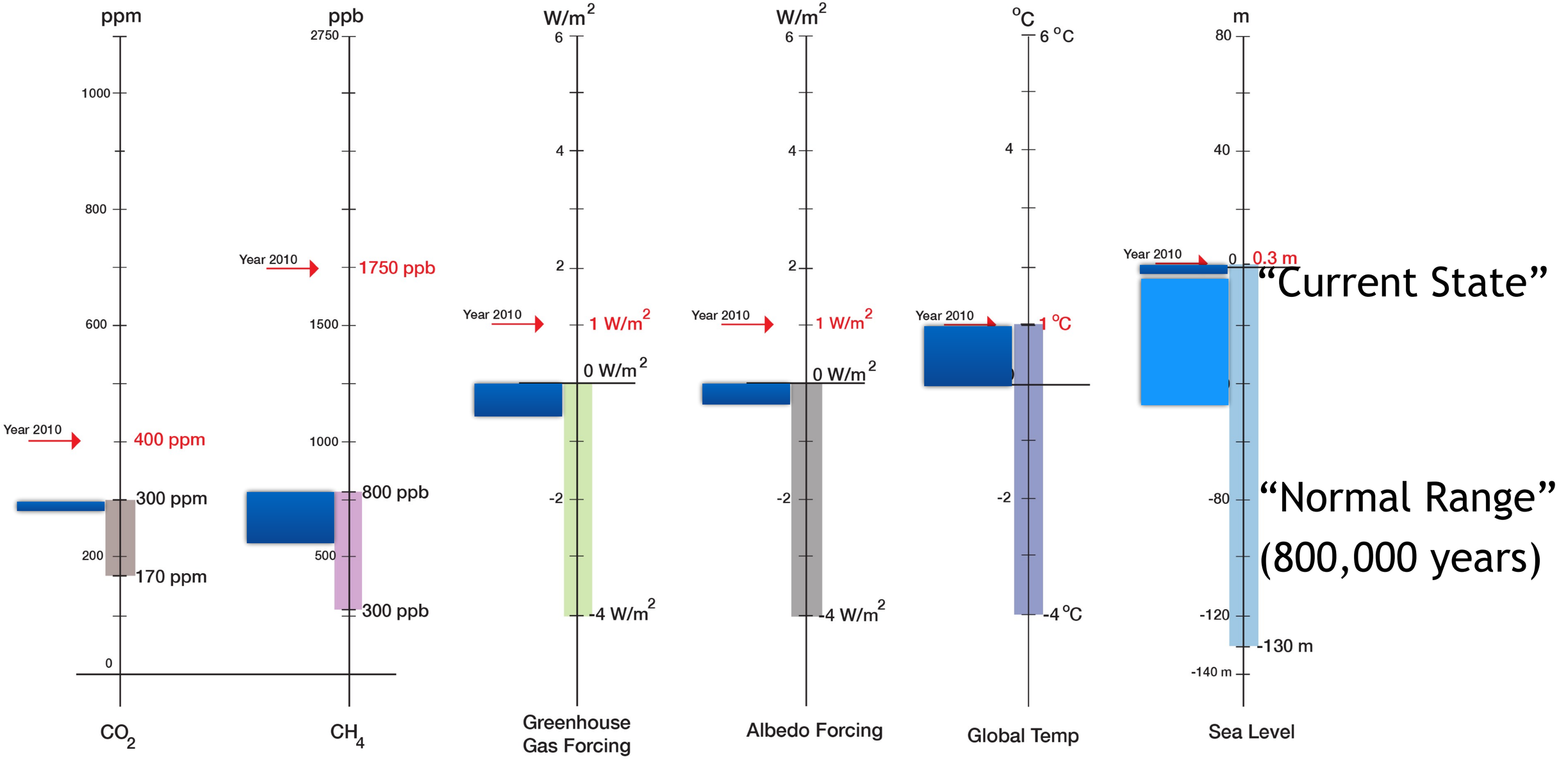
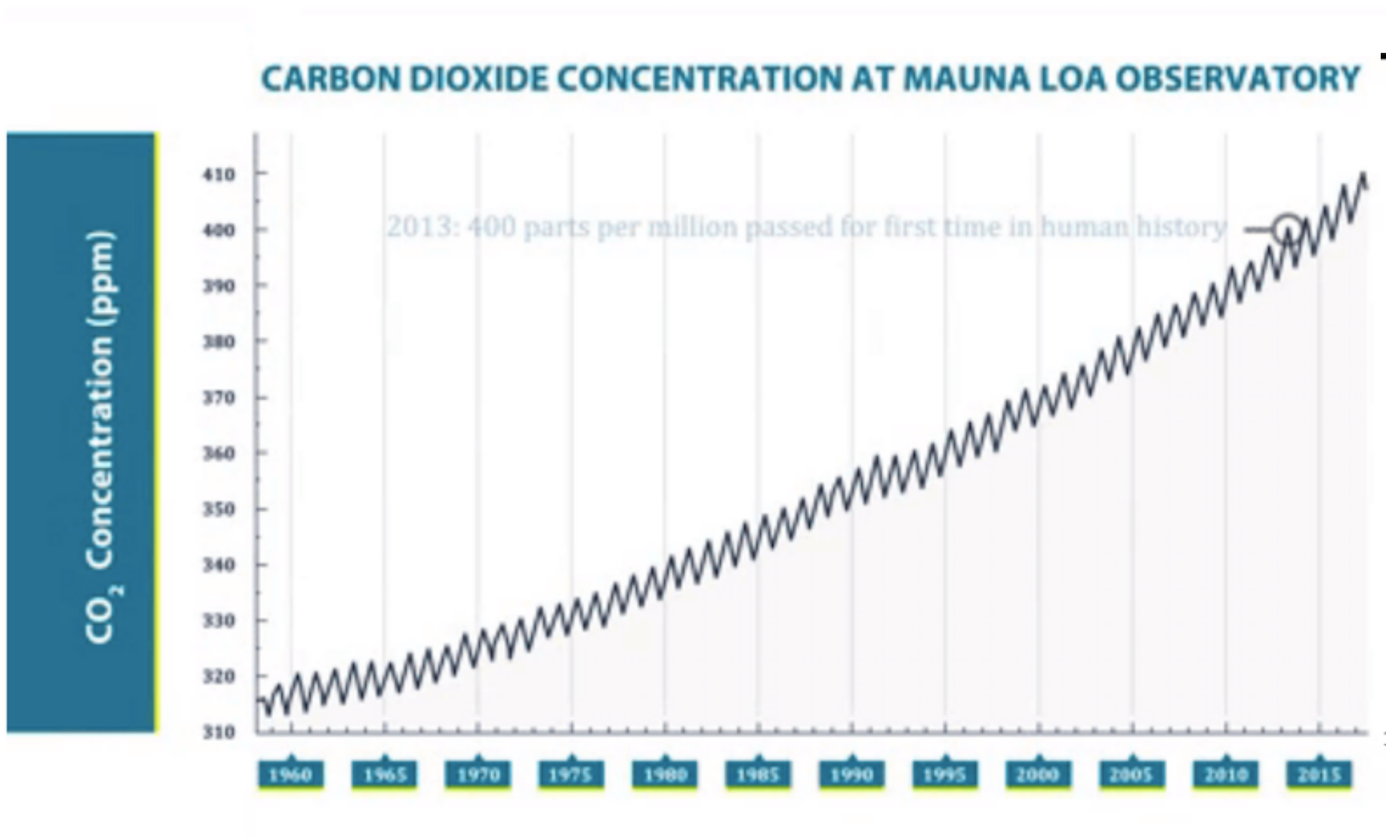
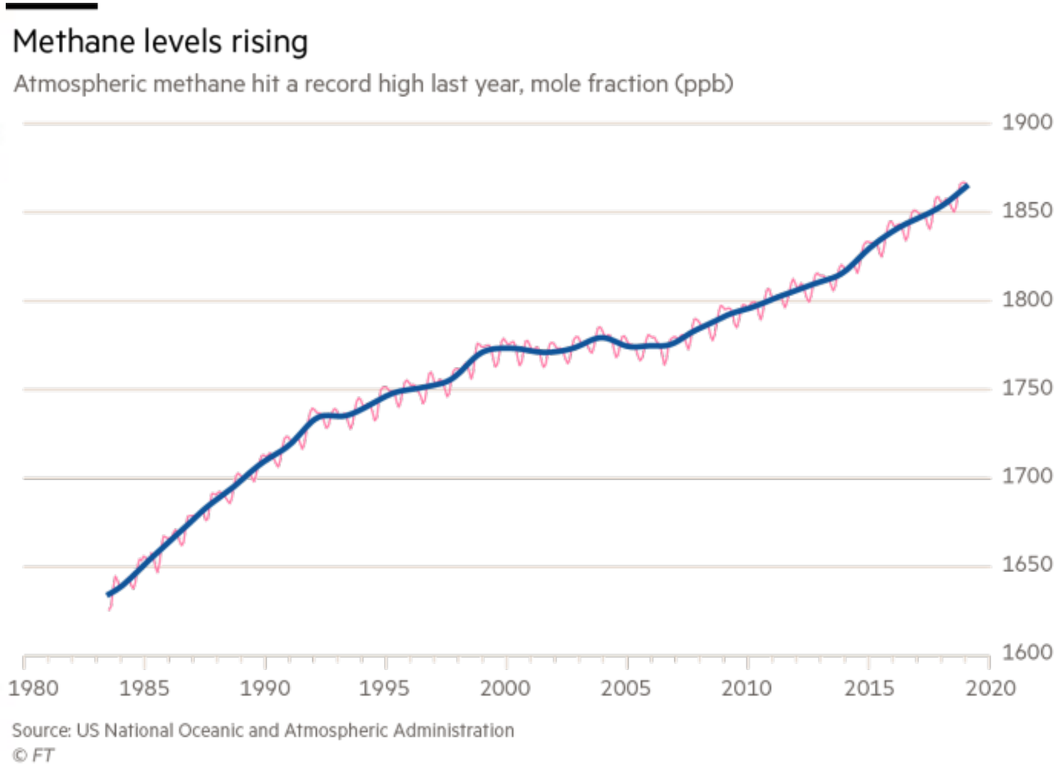


The Syndrome: Modern Climate and Global Change

Greenhouse Gases





The Syndrome: Modern Climate and Global Change

Greenhouse Gases: Example CO_2

- 180 ppm: 20,000 years ago (glacial maximum)
- 270 ppm: 10,000 years ago (transition to agriculture)
- 280 ppm: At the start of industrialization in the 17th Century

} Time since the last glacial maximum

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} Time since the last glacial maximum

- 312 ppm: My Birth
- 320 ppm: Started as carpenter
- 331 ppm: Started at university
- 350 ppm: PhD
- 373 ppm: Married
- 416 ppm: Today (April 2020)

} Time of my life

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My “age” in CO_2 increase: 104 ppm (1.53 ppm/year)
Increase over the last 20,000 before industrialization: 120 ppm (0.006 ppm/year)

The increase in my life-time was 250 times faster than on average during the pre-industrial 20,000 years.

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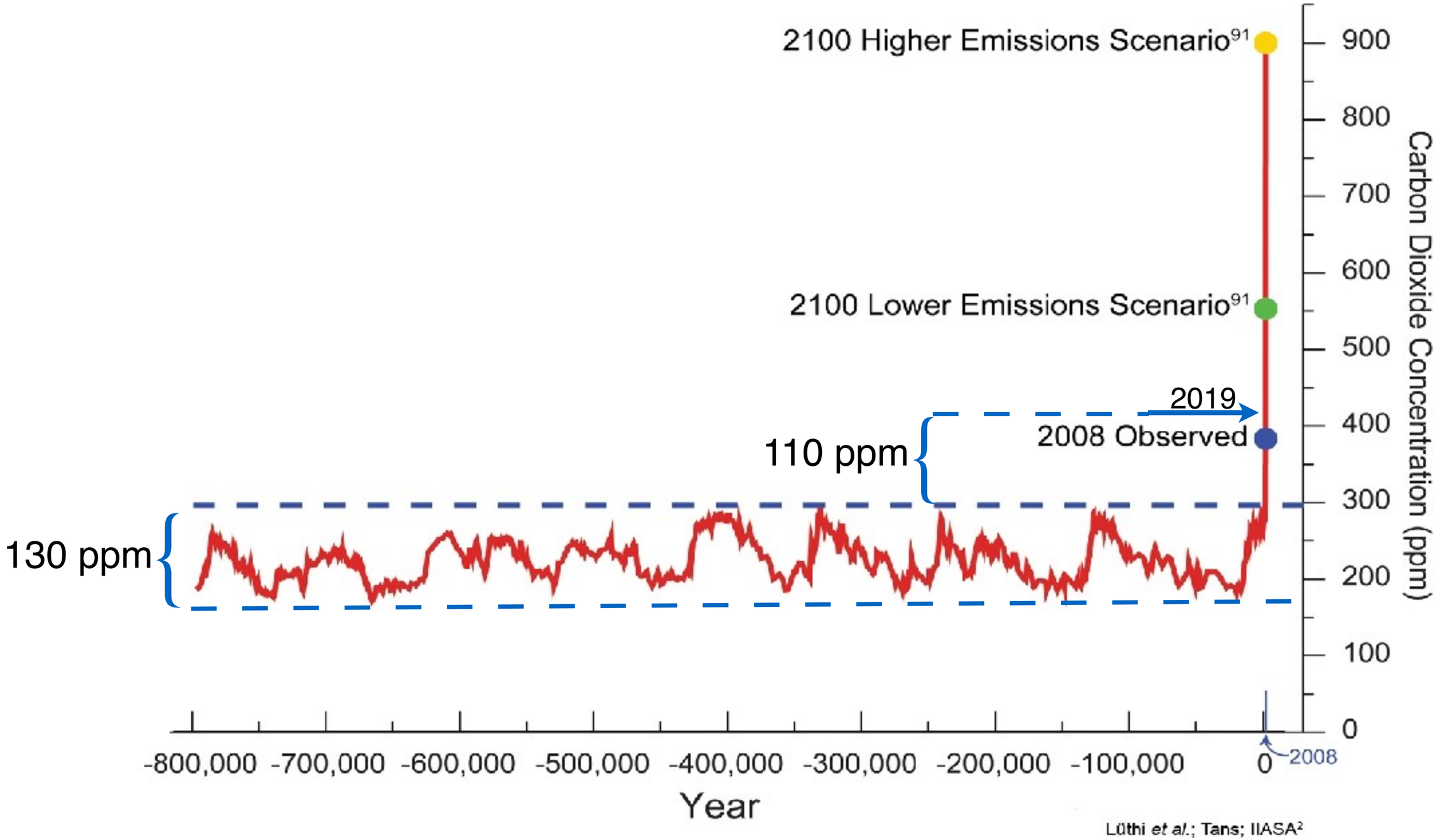

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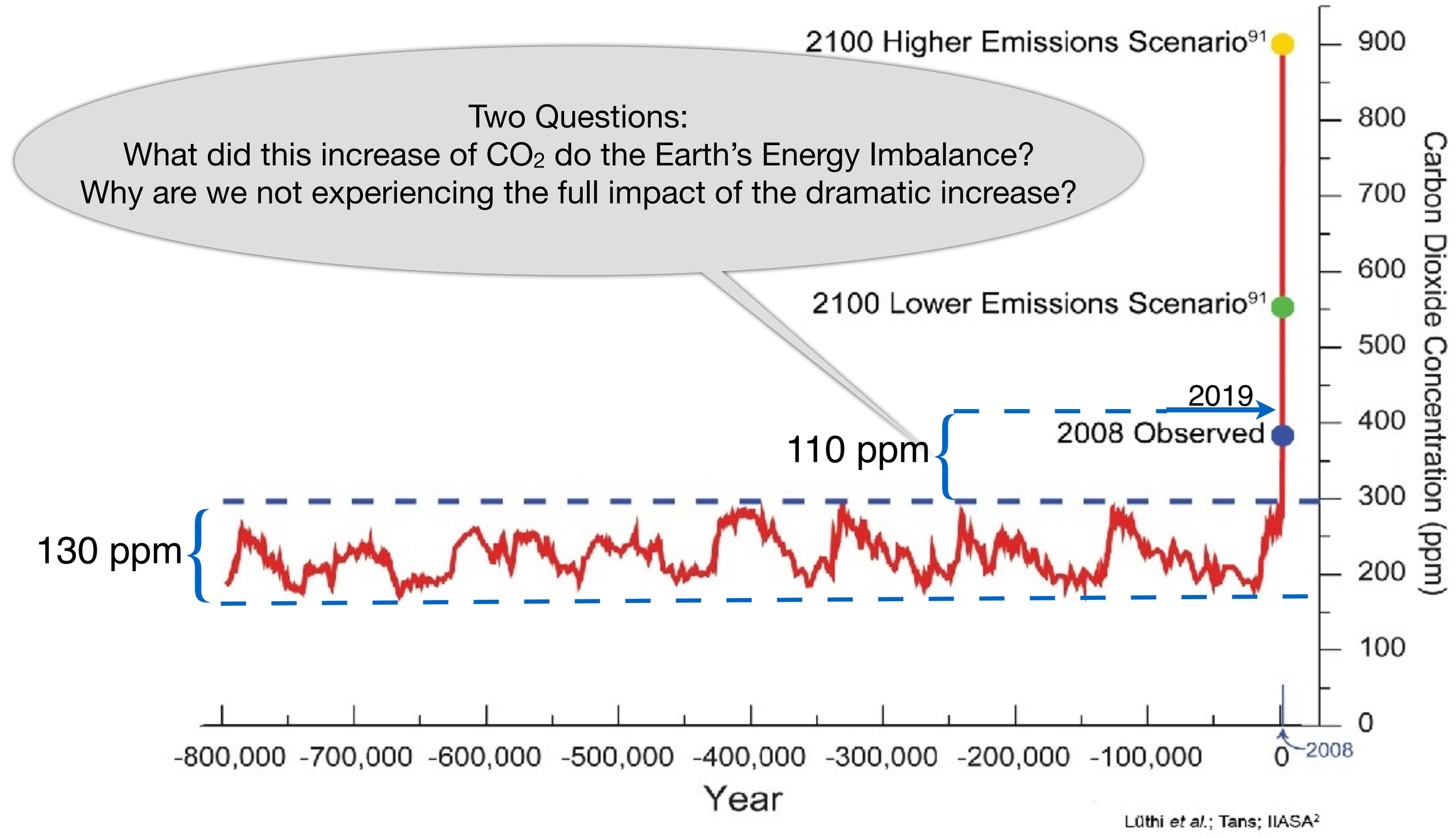

Earth's Energy Imbalance

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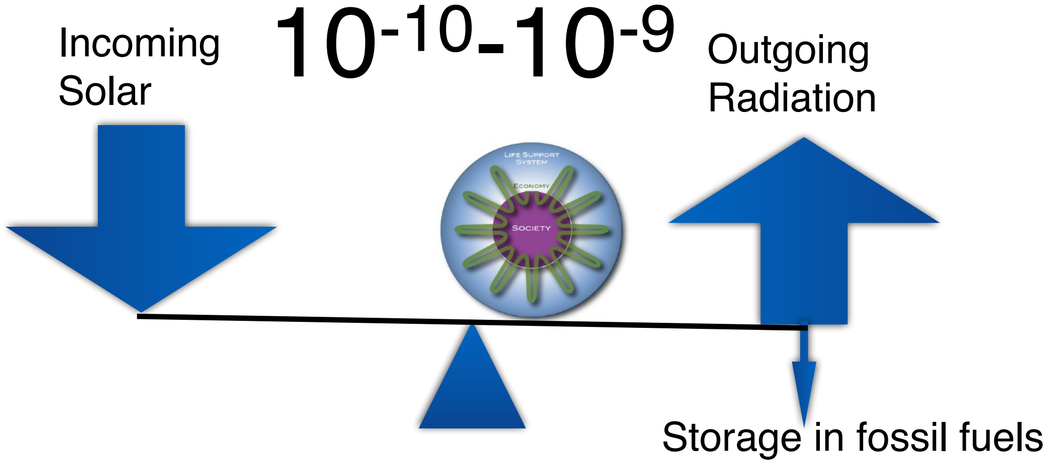

Imbalance on the order of 10^{-10}-10^{-9}

Last 200 Million years

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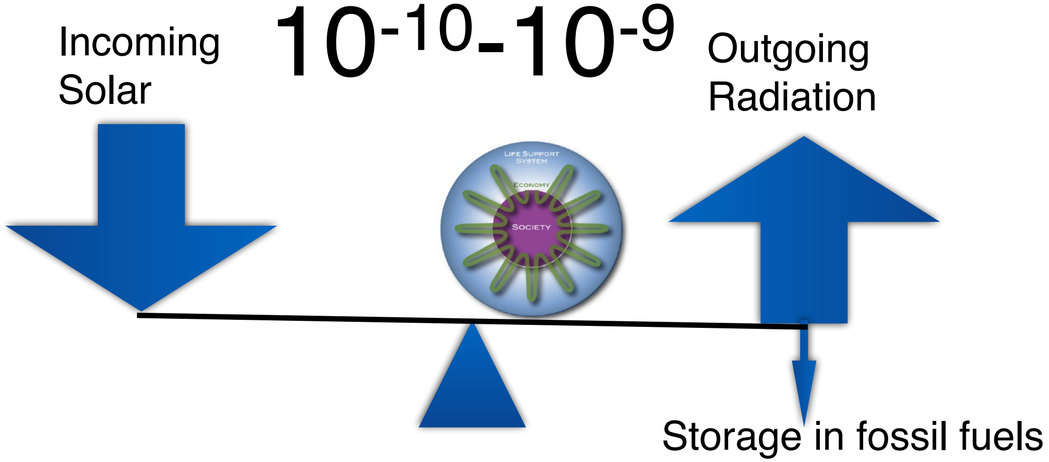

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Total energy storage in 200 Myrs:
Order 100-1000 ZetaJoules

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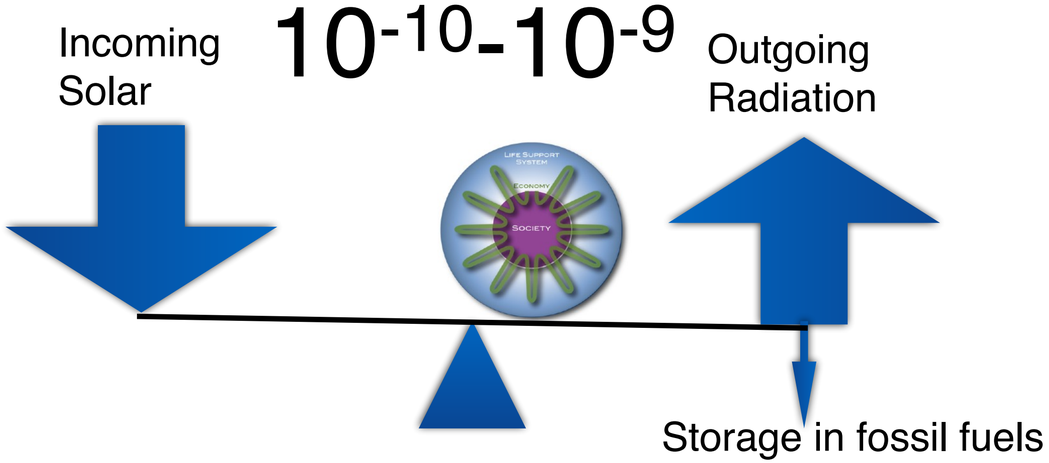

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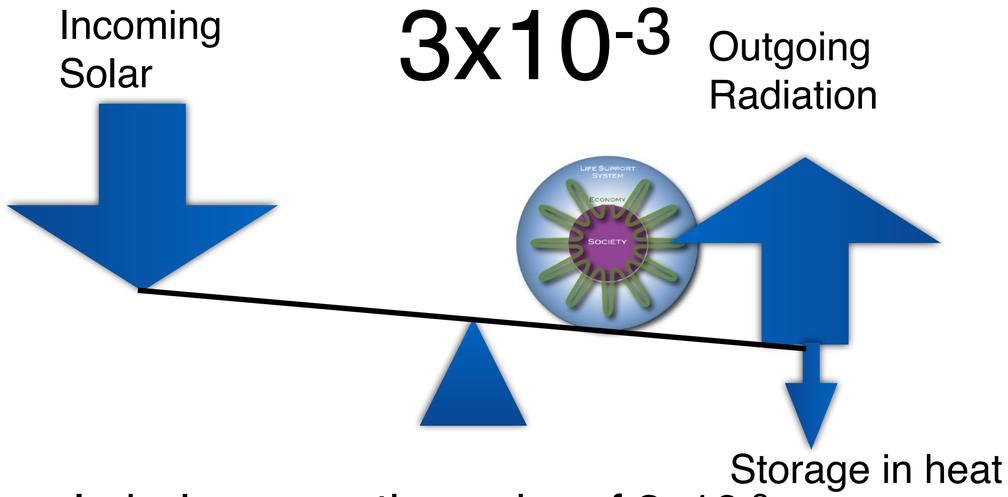


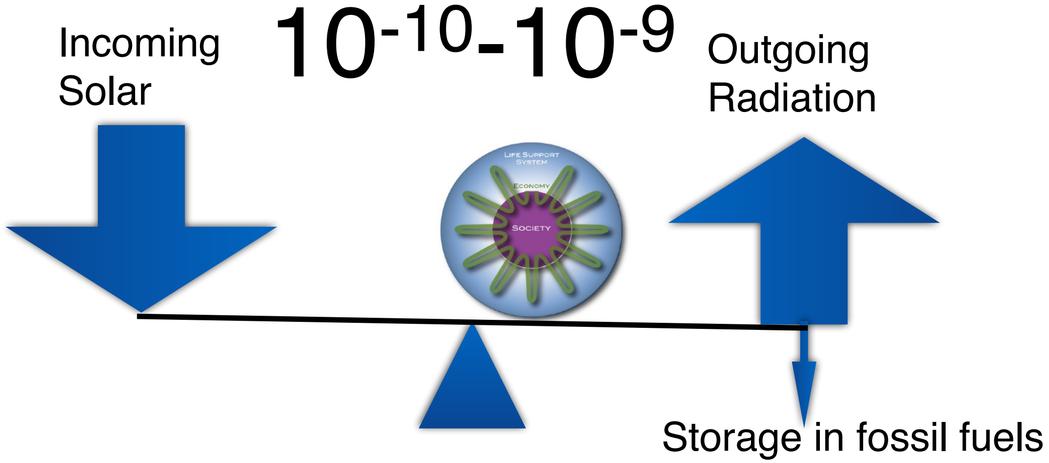
Imbalance on the order of $3x10^{-3}$

Last 70 years

Total energy storage per century:
Order 1000 ZetaJoules

Earth's Energy Imbalance

The Earth's Energy Imbalance increased by a factor of 10^6 to 10^7!



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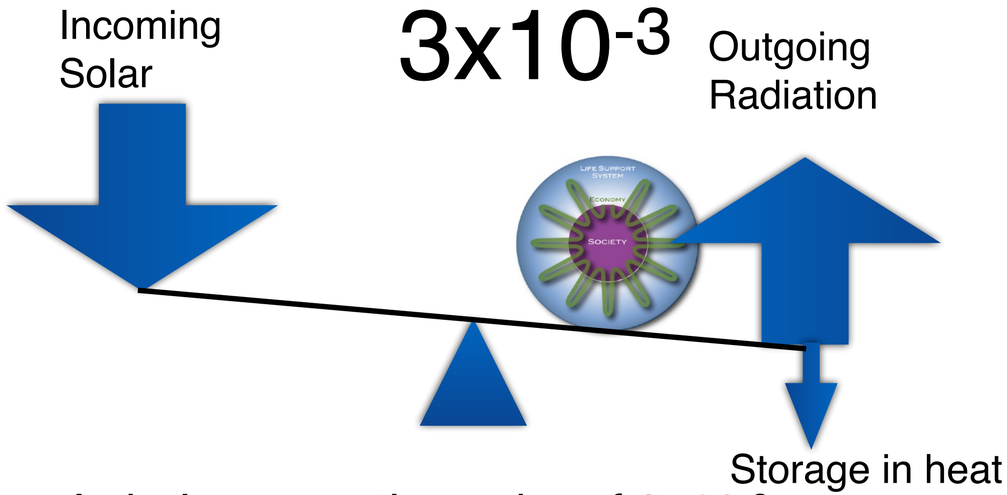

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Earth's Energy Imbalance

- Long-term due to photosynthesis: 10-100 MegaWatt
- Today: 300-320 TeraWatt

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

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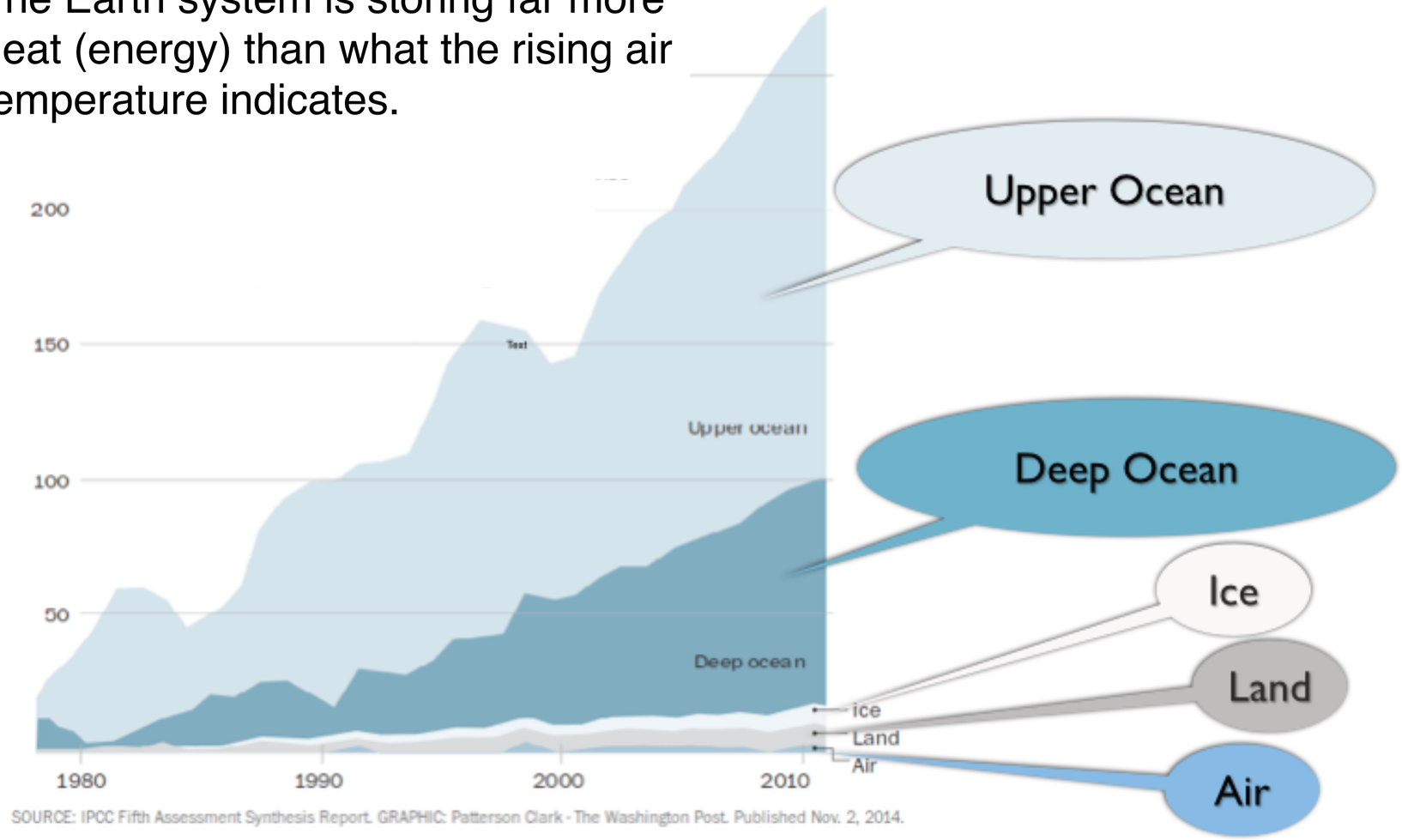

SOURCE: IPCC Fifth Assessment Synthesis Report. GRAPHIC: Patterson Clark - The Washington Post. Published Nov. 2, 2014.

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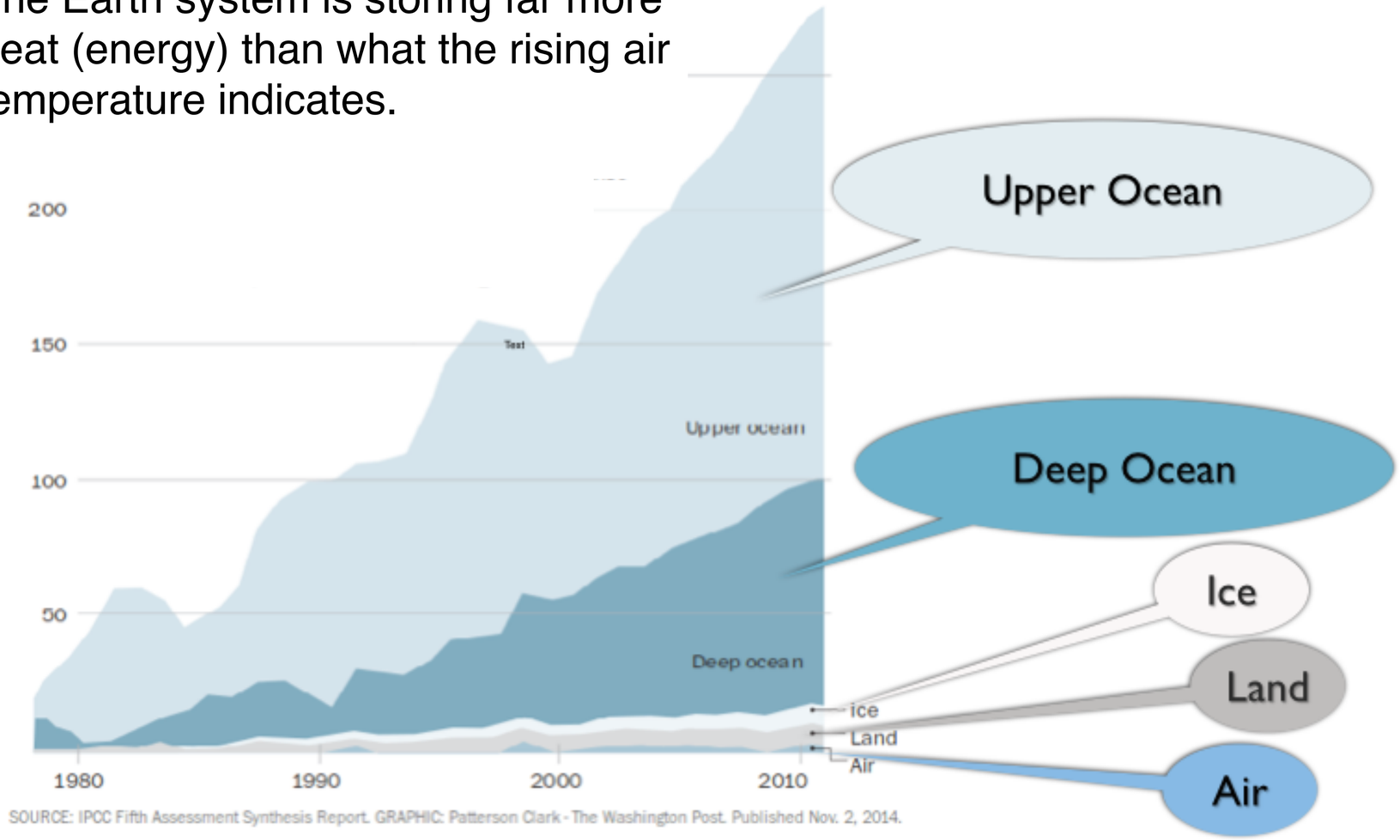

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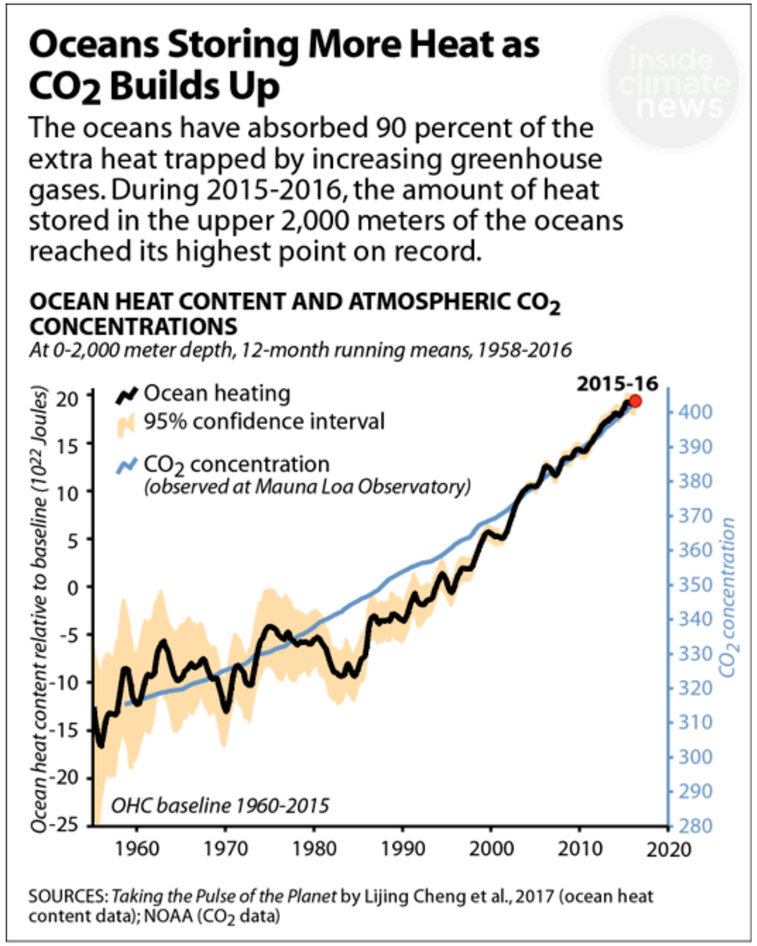

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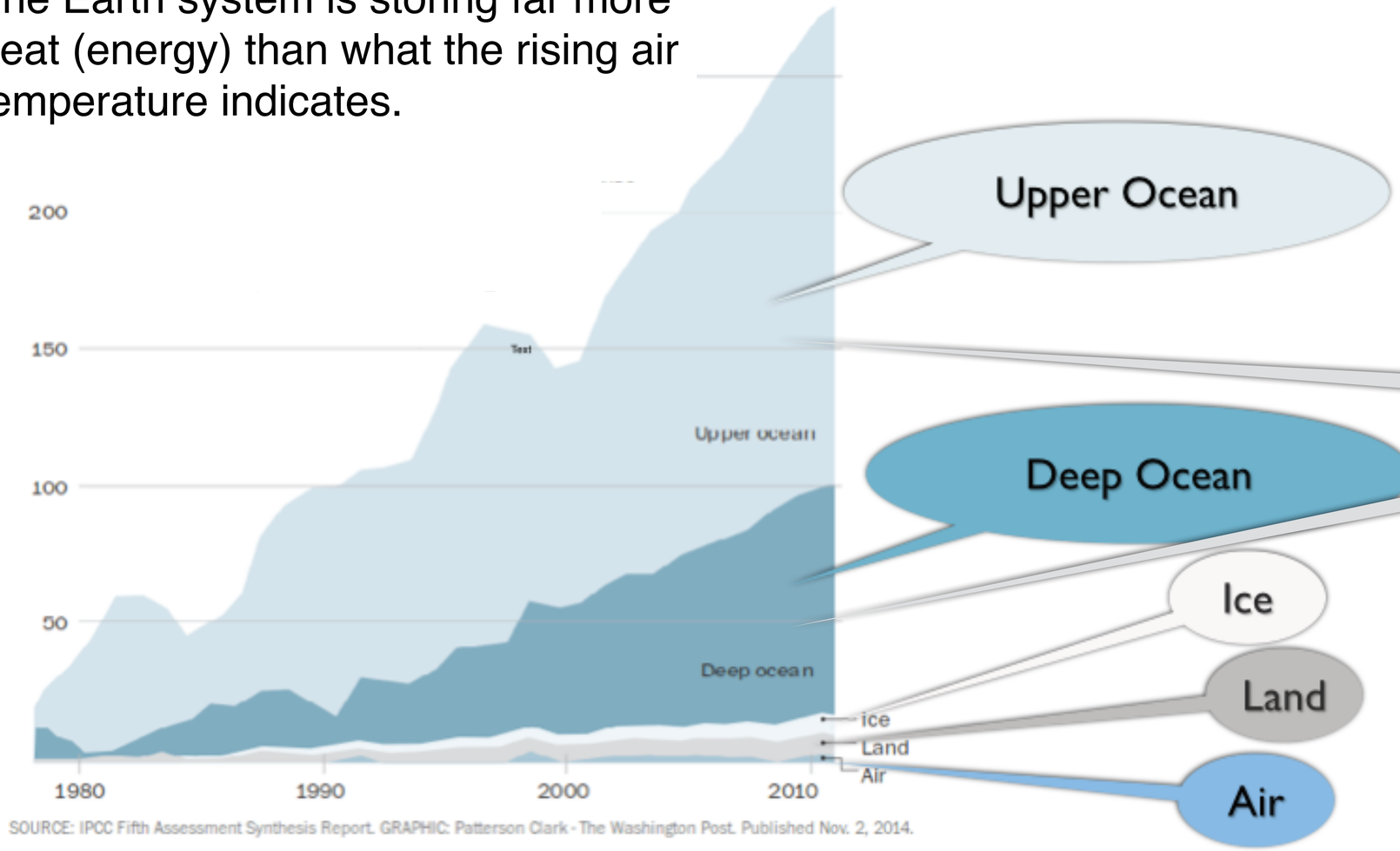

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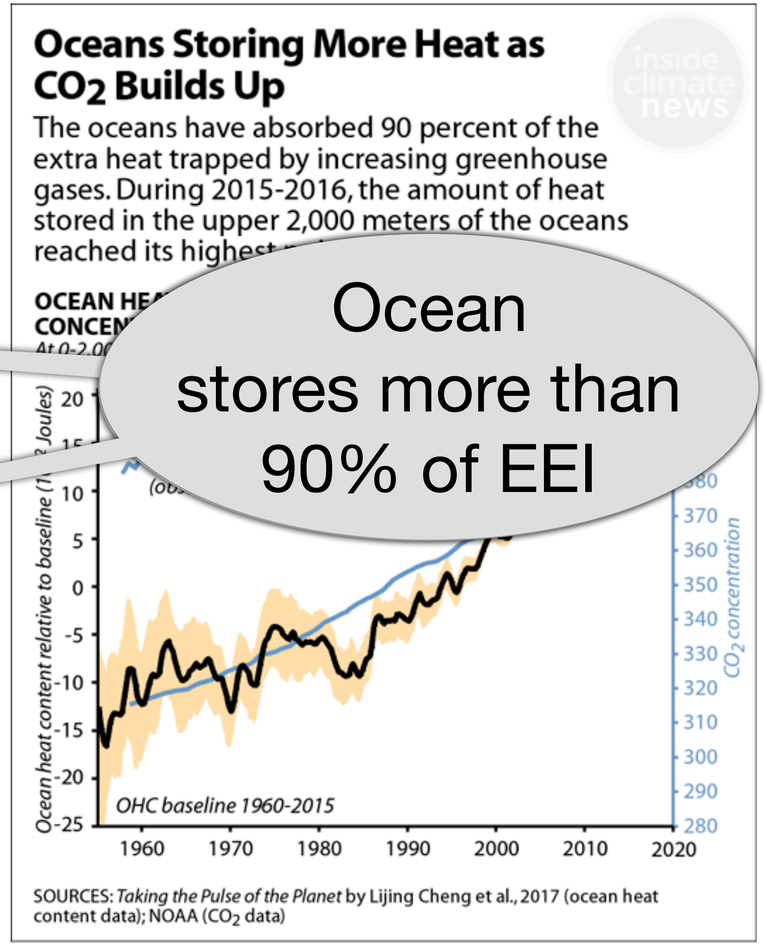

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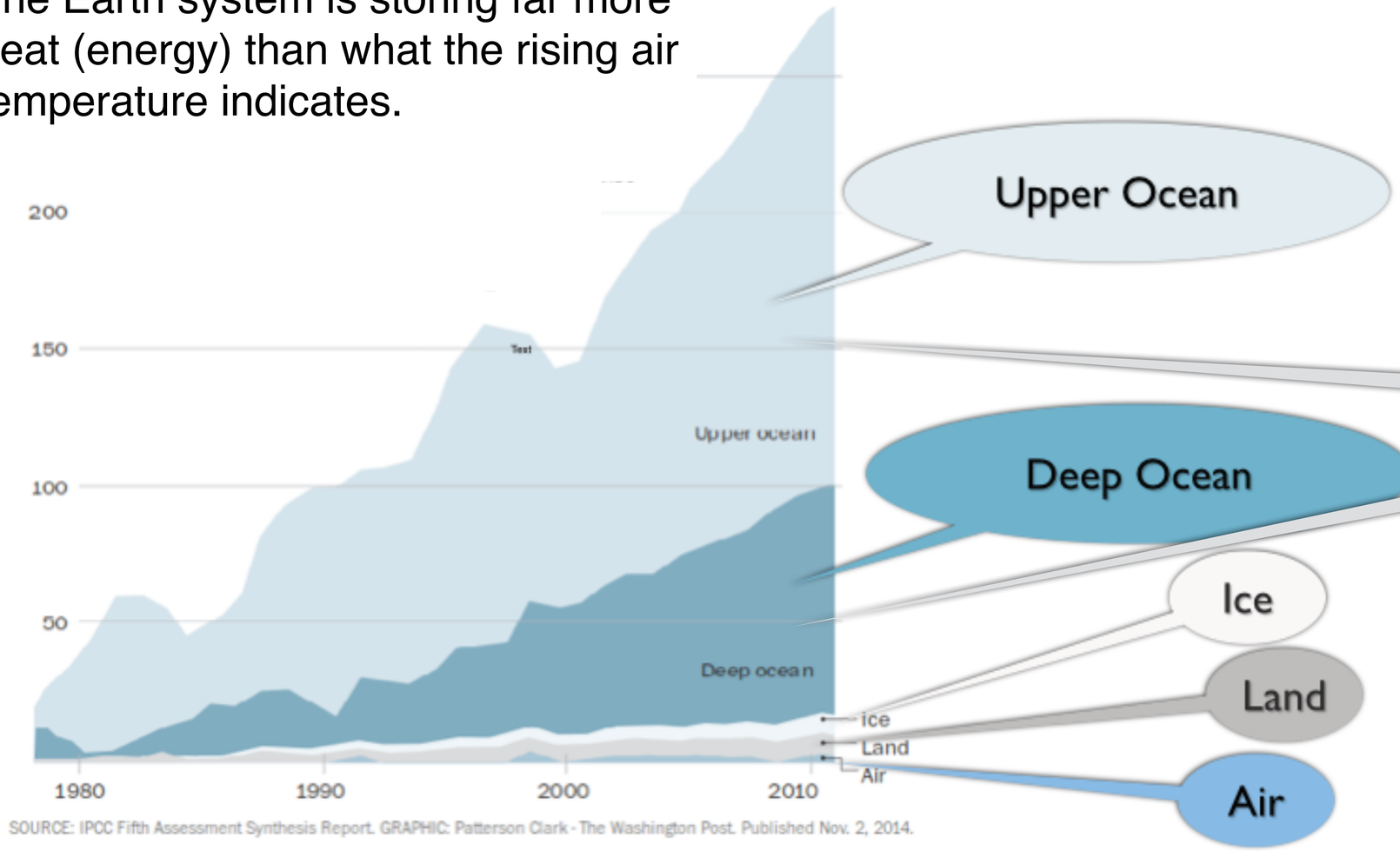

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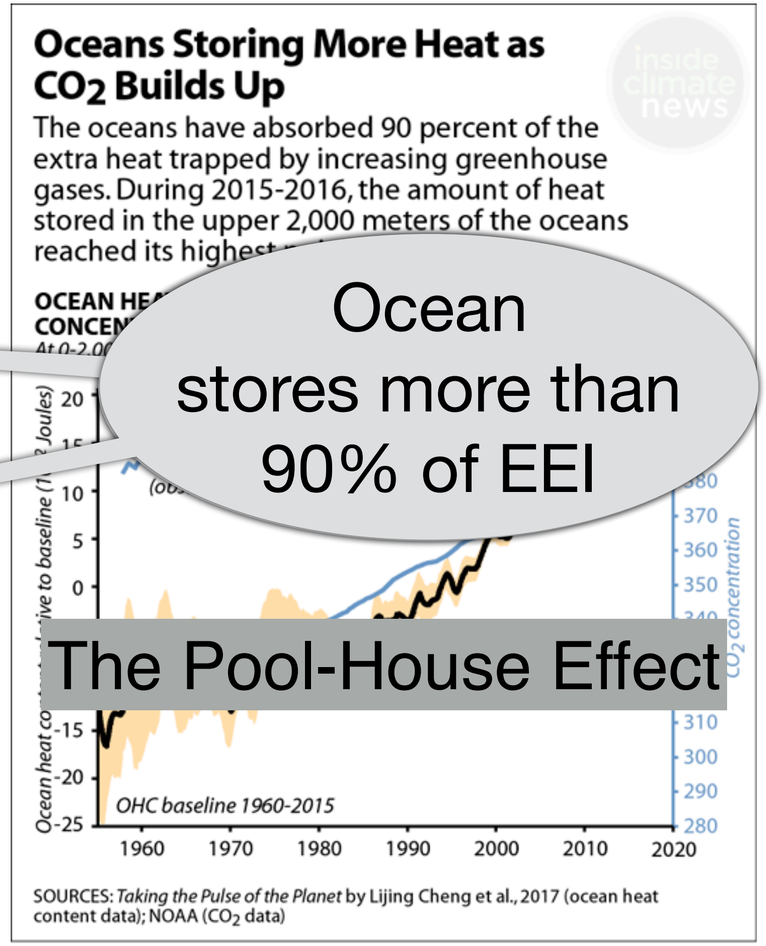

SOURCES: *Taking the Pulse of the Planet* by Lijing Cheng et al., 2017 (ocean heat content data); NOAA (CO_2 data)

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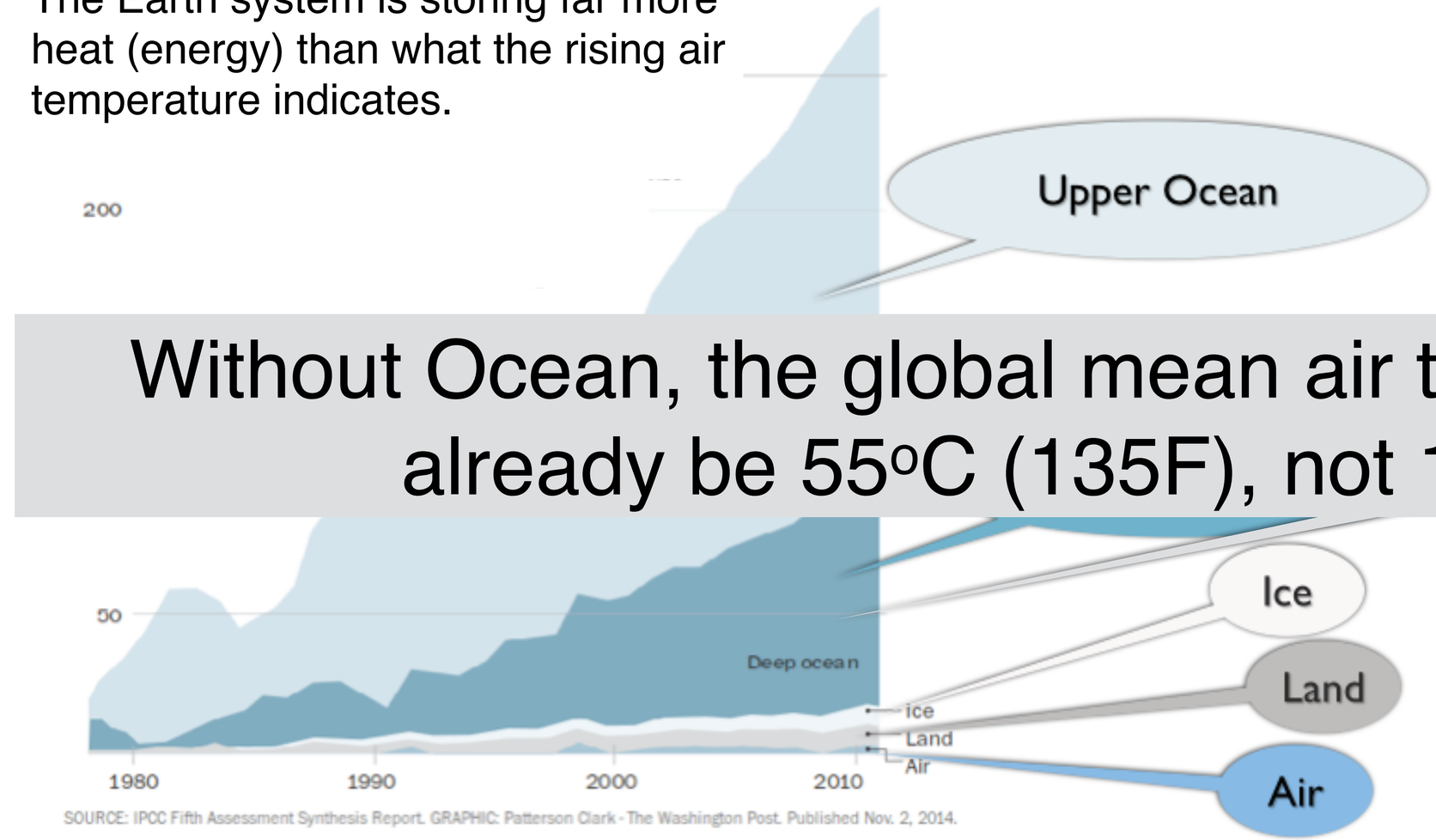
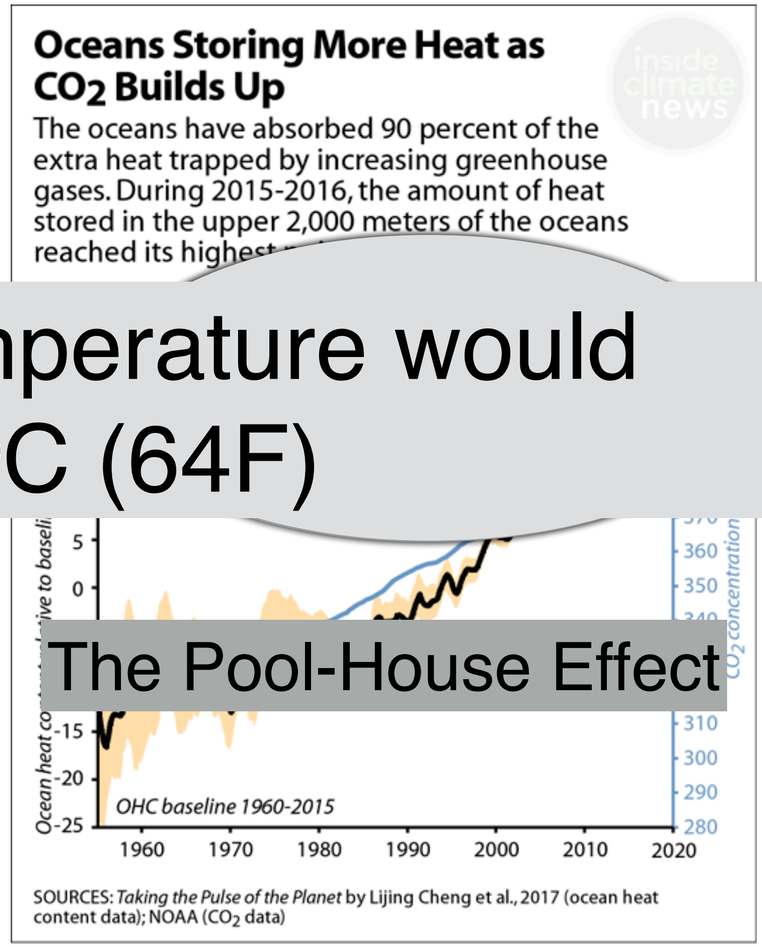


Without Ocean, the global mean air temperature would already be 55°C (135F), not 18°C (64F)



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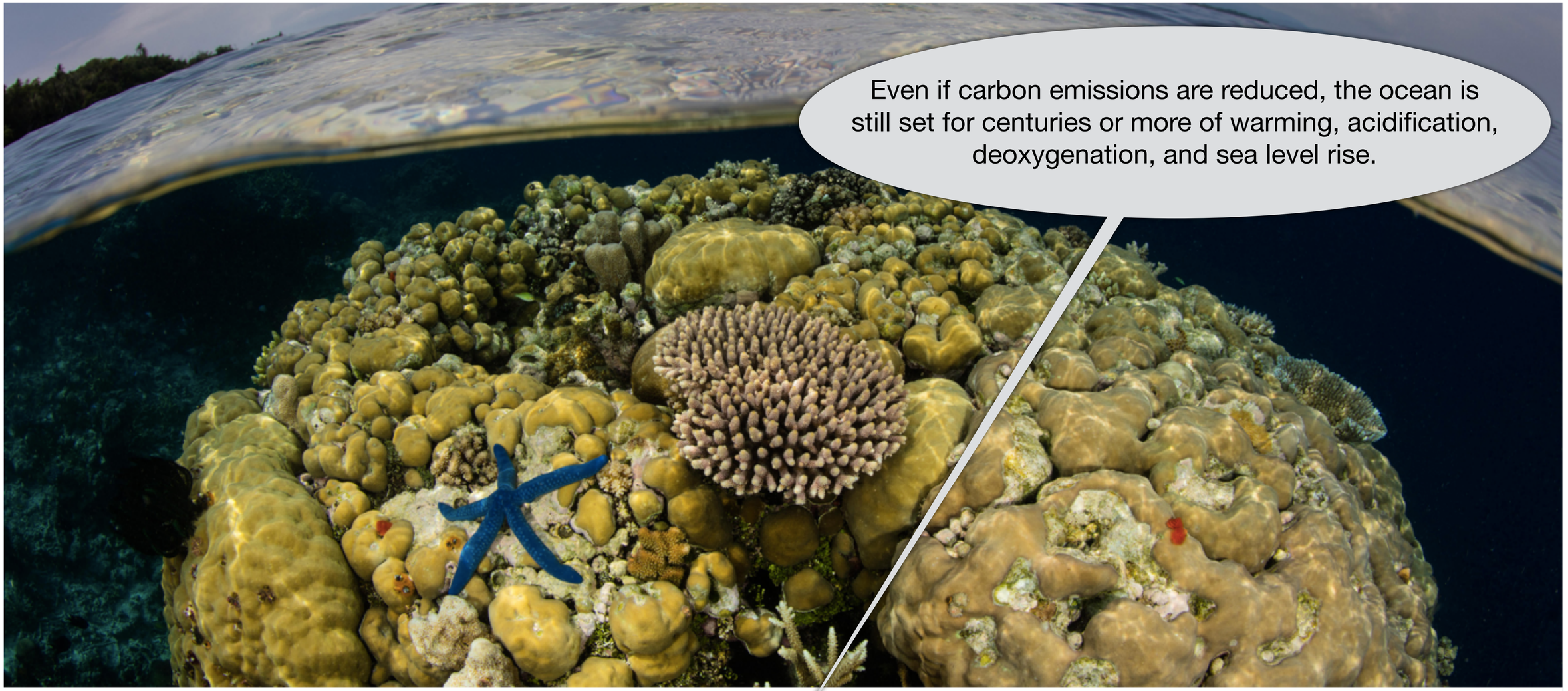
Even if carbon emissions are reduced, the ocean is still set for centuries or more of warming, acidification, deoxygenation, and sea level rise. Photo by Ethan Daniels/Alamy Stock Photo

When It Comes to Climate Change, the Ocean Never Forgets

The Syndrome: Modern Climate and Global Change



Even if carbon emissions are reduced, the ocean is still set for centuries or more of warming, acidification, deoxygenation, and sea level rise. Photo by Ethan Daniels/Alamy Stock Photo

When It Comes to Climate Change, the Ocean Never Forgets

What about Modern Global Change?

The Syndrome: Modern Climate and Global Change

Planetary Physiology

Earth: Life-Support System for many species

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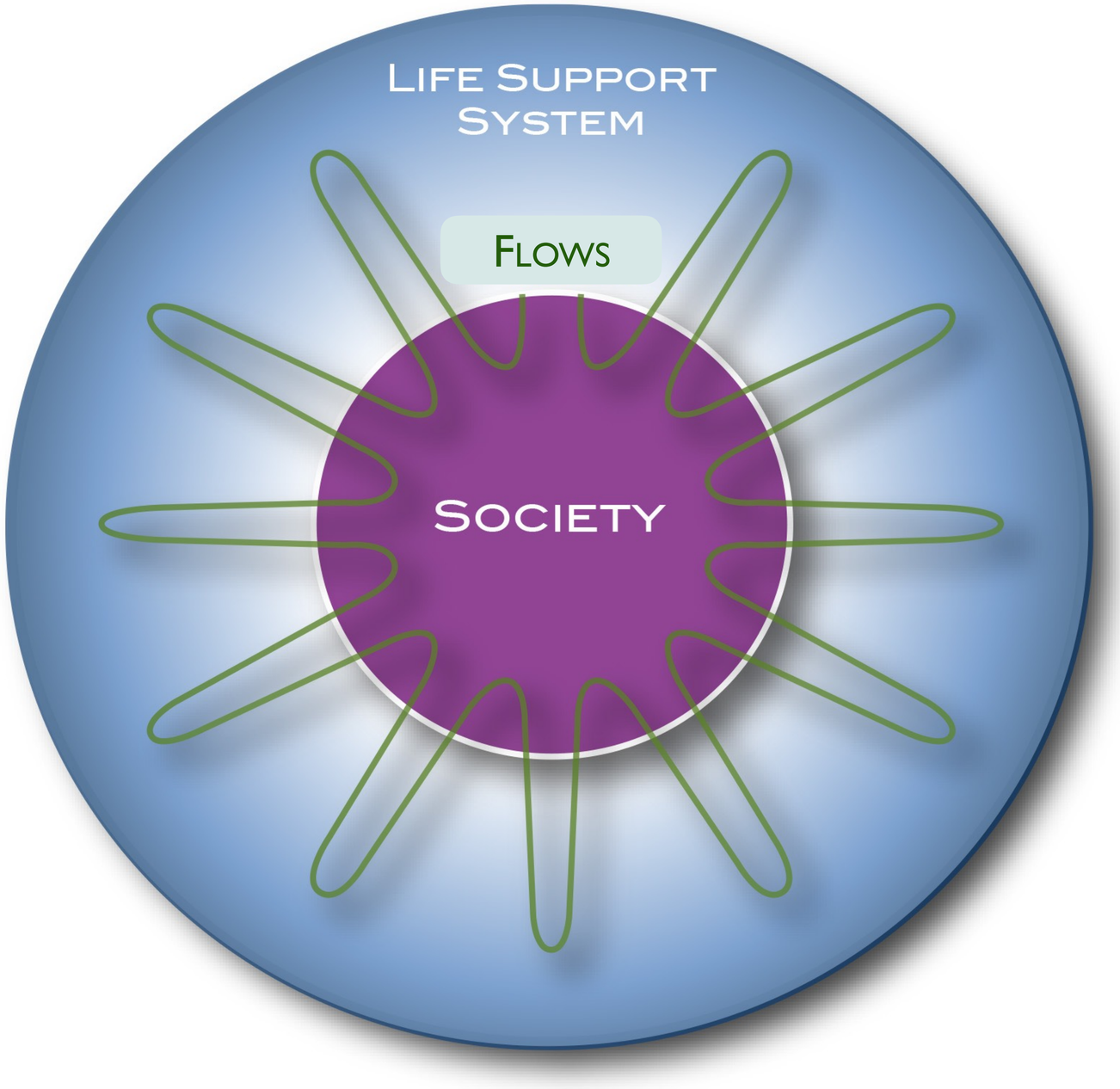
Planetary Physiology

Earth: Life-Support System for many species

Everything is about Flows



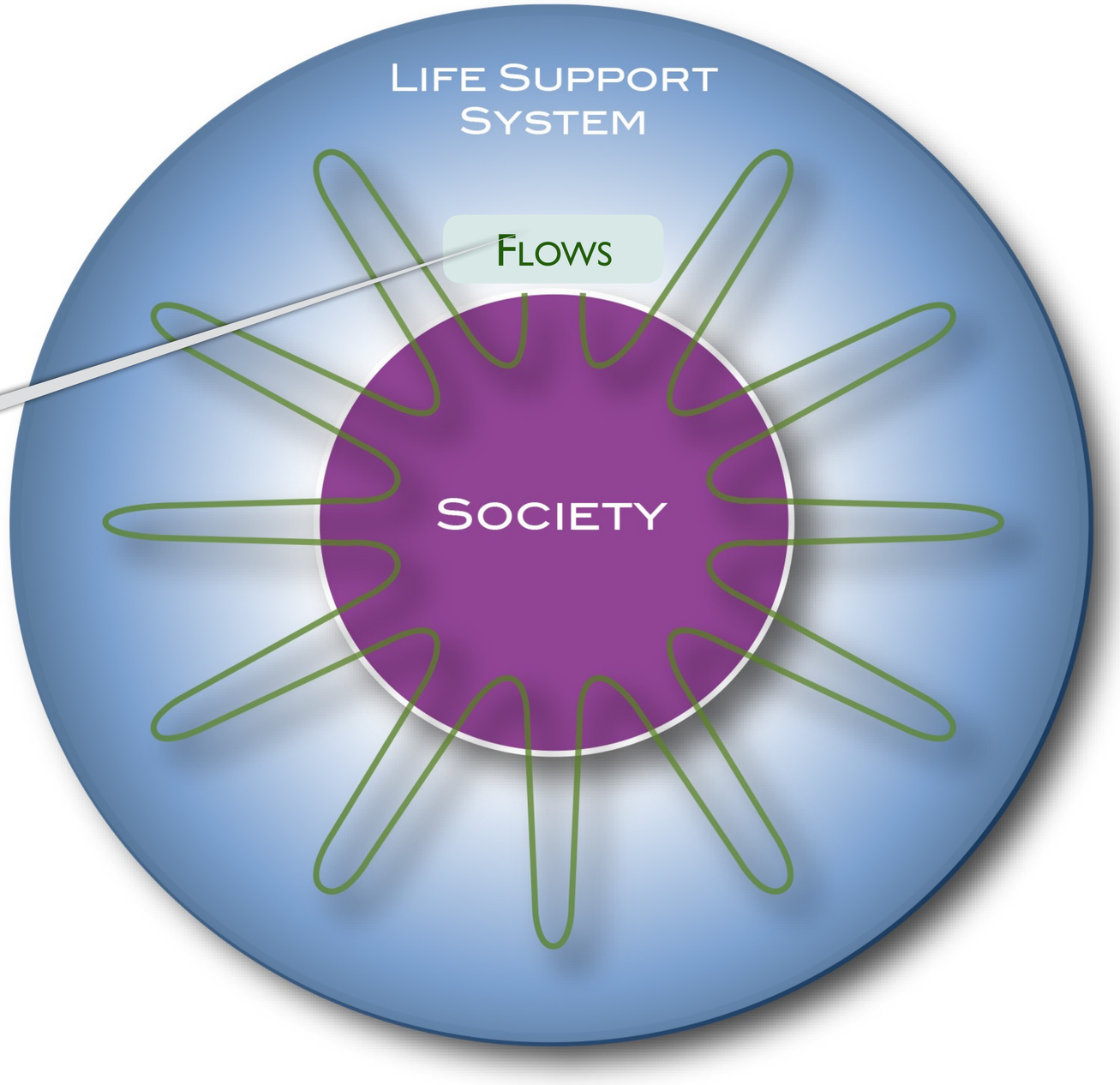
The Syndrome: Modern Climate and Global Change

Planetary Physiology

Earth: Life-Support System for many species

Everything is about Flows

Limitations in the flows between a community and its life-support system limit the growth of the community



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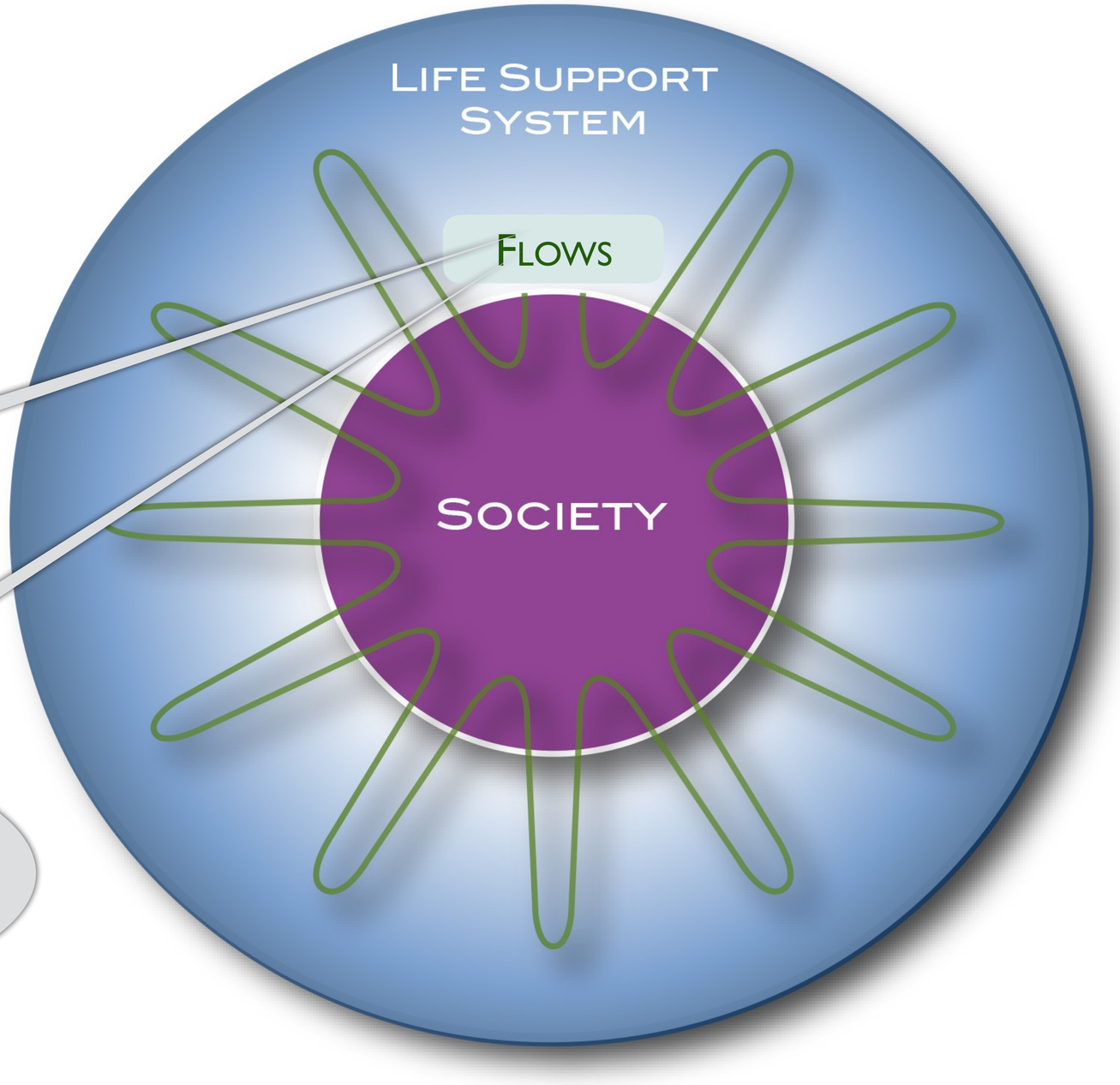

Limitations in the flows between a community and its life-support system limit the growth of the community

For Homo sapiens, the flows are regulated by ethical, social, and - recently - economic rules

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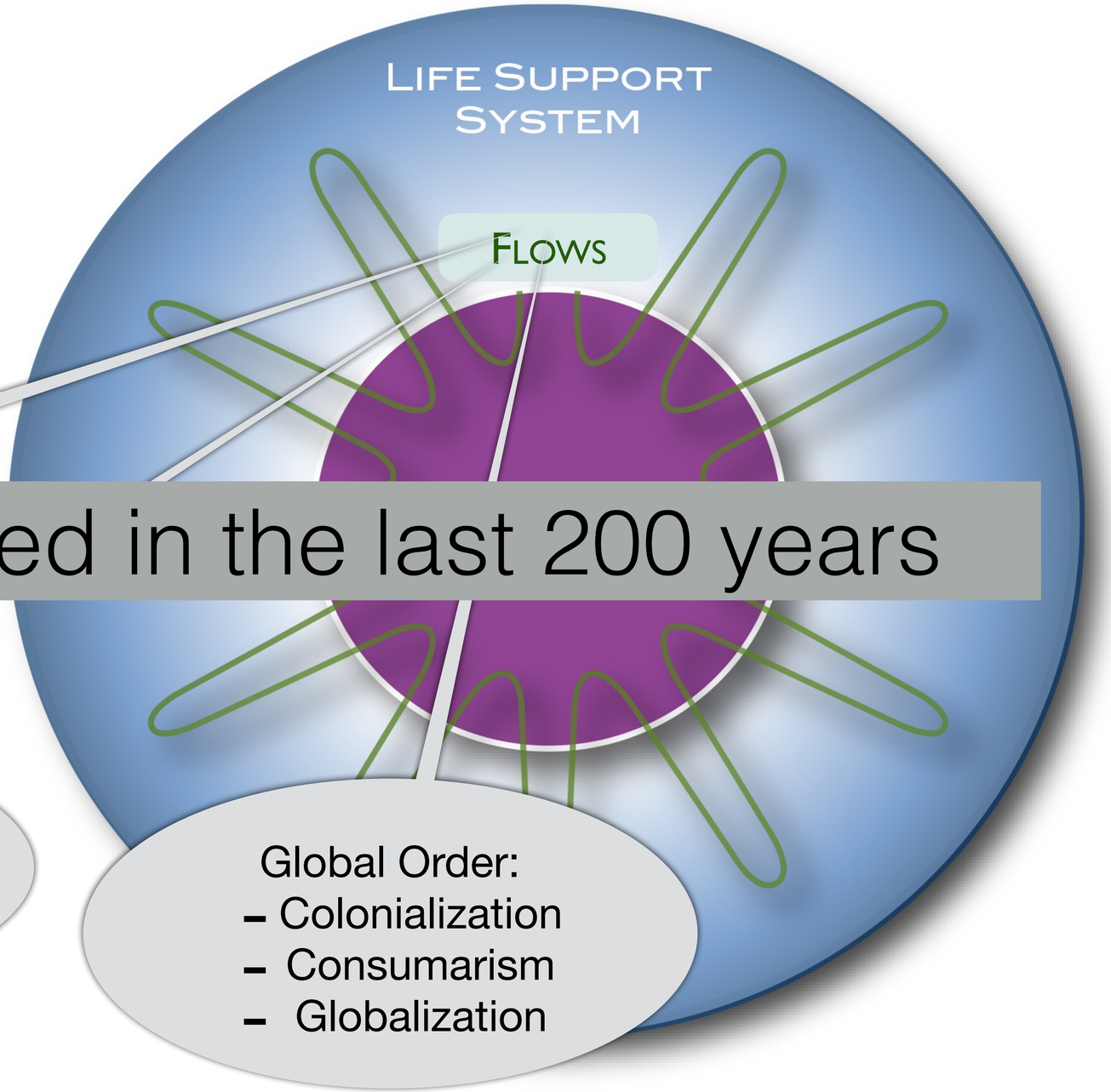
Earth: Life-Support System for many species

Everything is about Flows



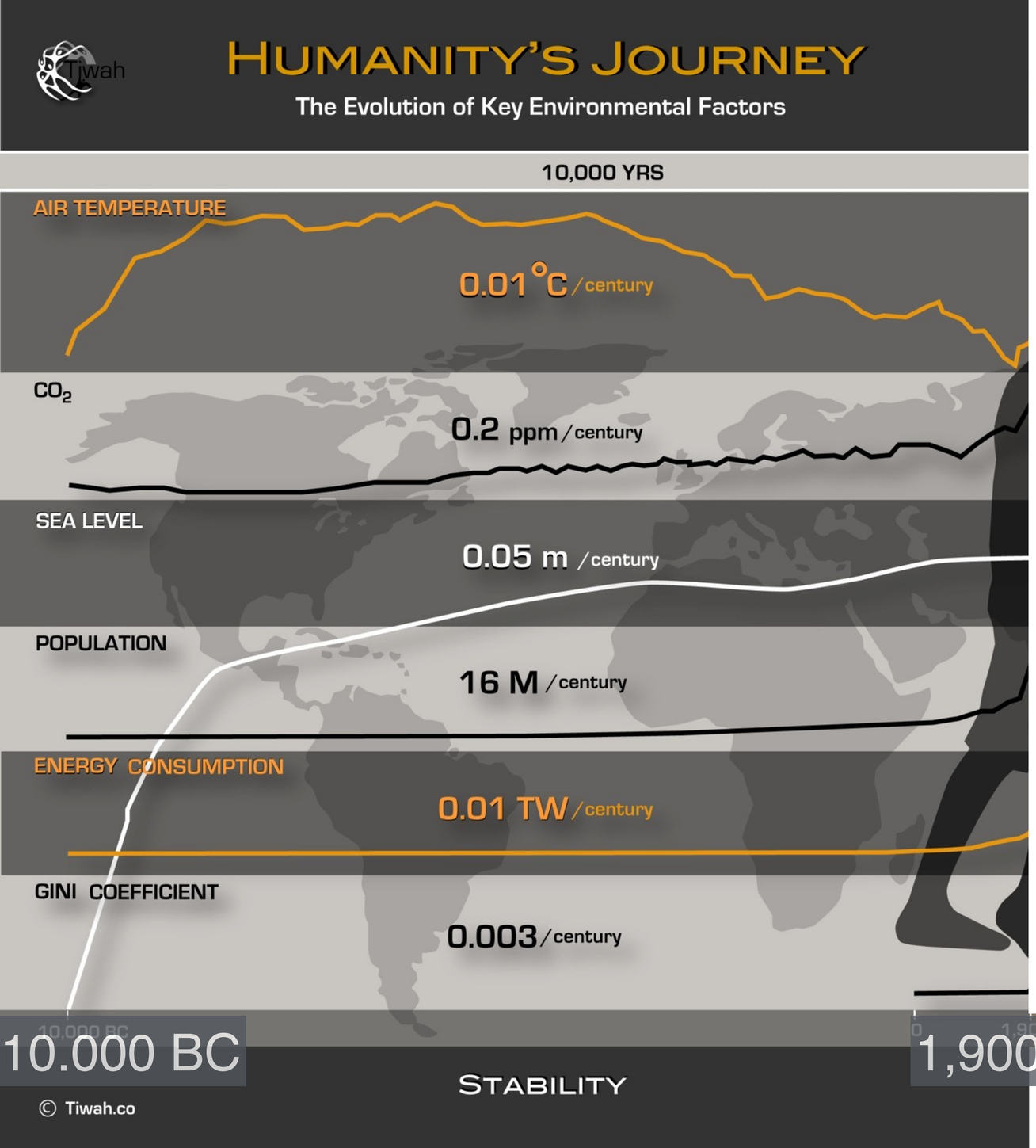
community

For Homo sapiens, the flows are regulated by ethical, social, and - recently - economic rules

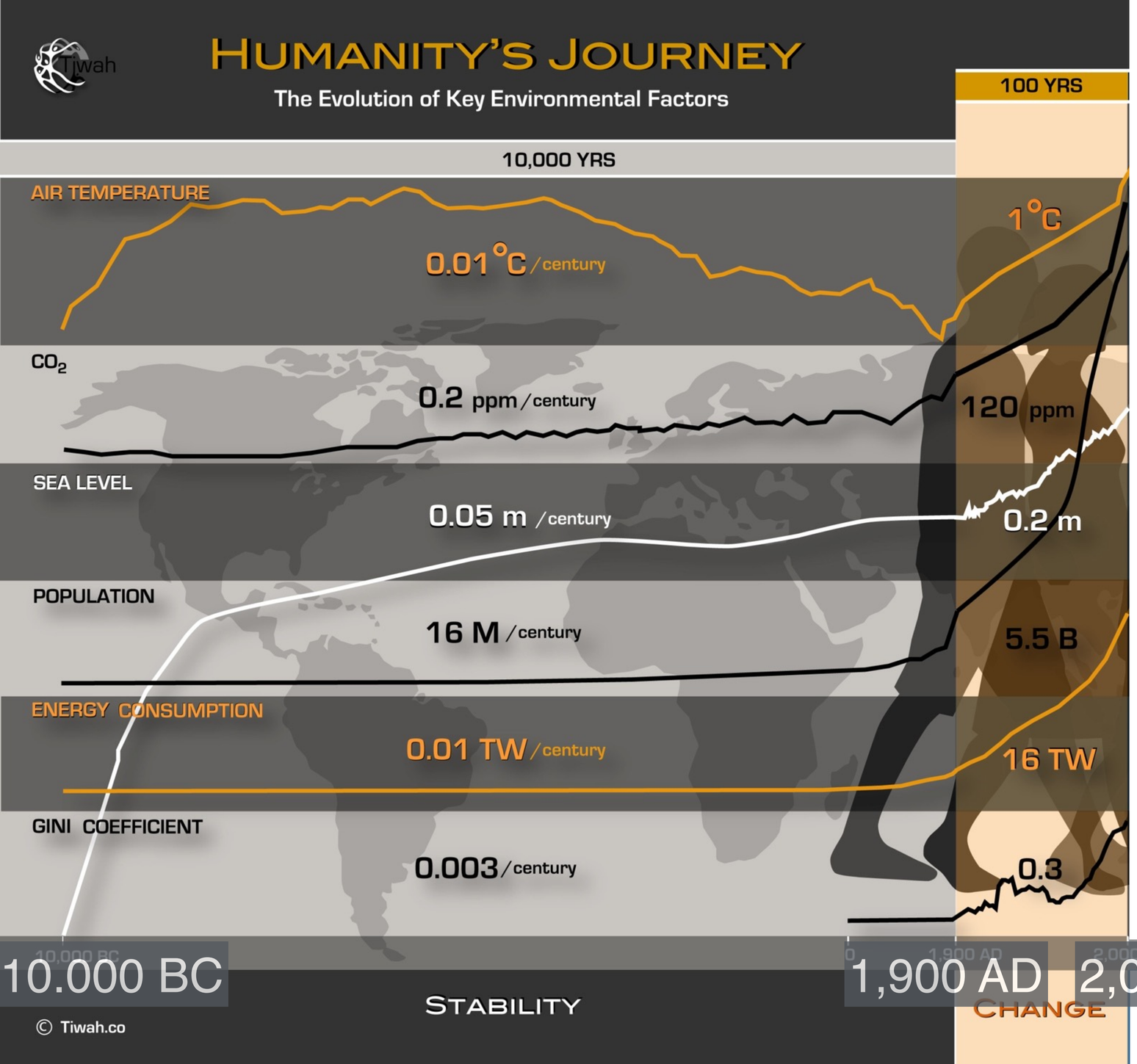
Global Order:
- Colonialization
- Consumarism
- Globalization

Flows have accelerated in the last 200 years

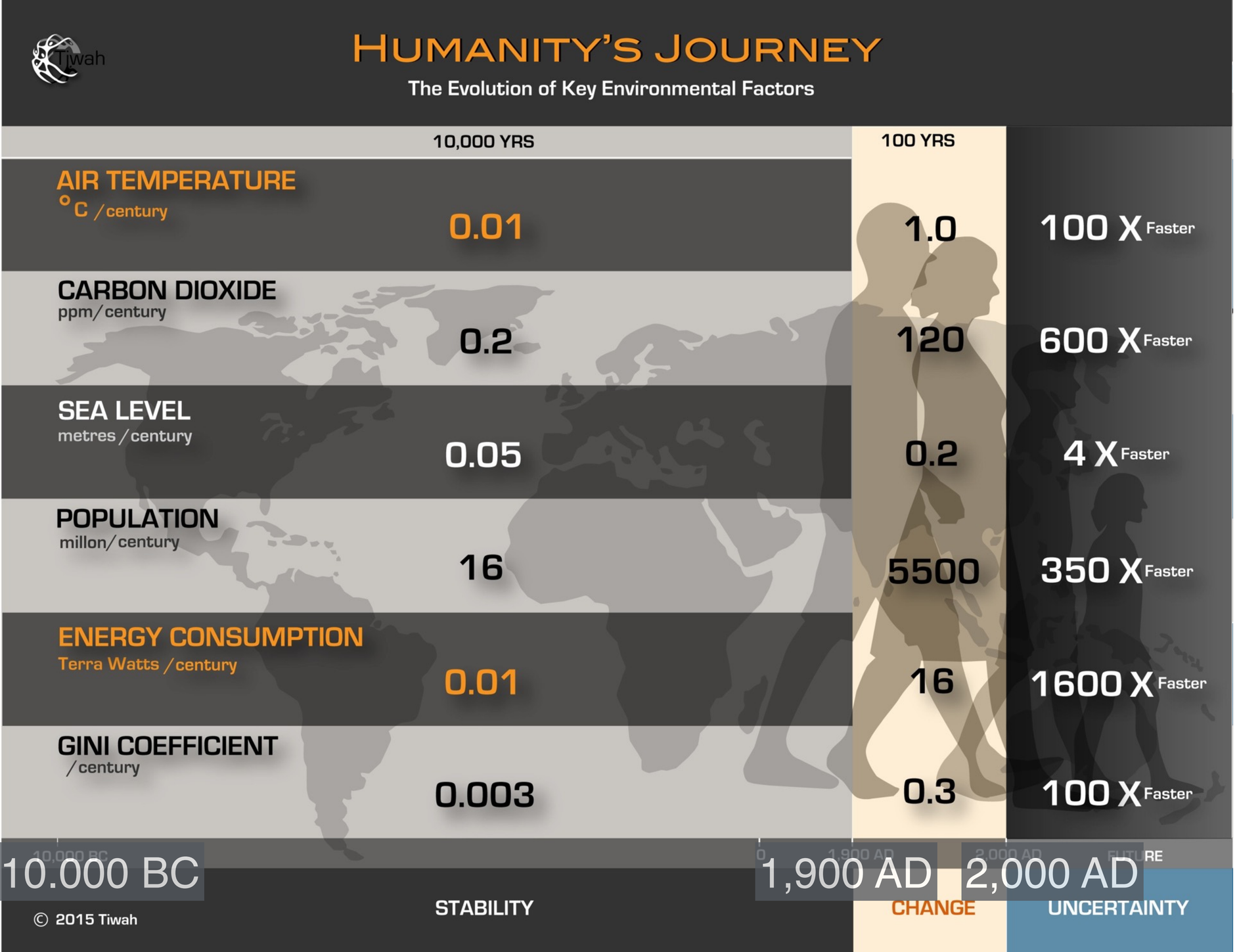
Plag, 2016


Tiwah
HUMANITY'S JOURNEY
The Evolution of Key Environmental Factors
10,000 YRS
AIR TEMPERATURE
0.01 °C /century
CO2
0.2 ppm /century
SEA LEVEL
0.05 m /century
POPULATION
16 M /century
ENERGY CONSUMPTION
0.01 TW /century
GINI COEFFICIENT
0.003 /century
10,000 BC
1,900 AD
STABILITY
© Tiwah.co

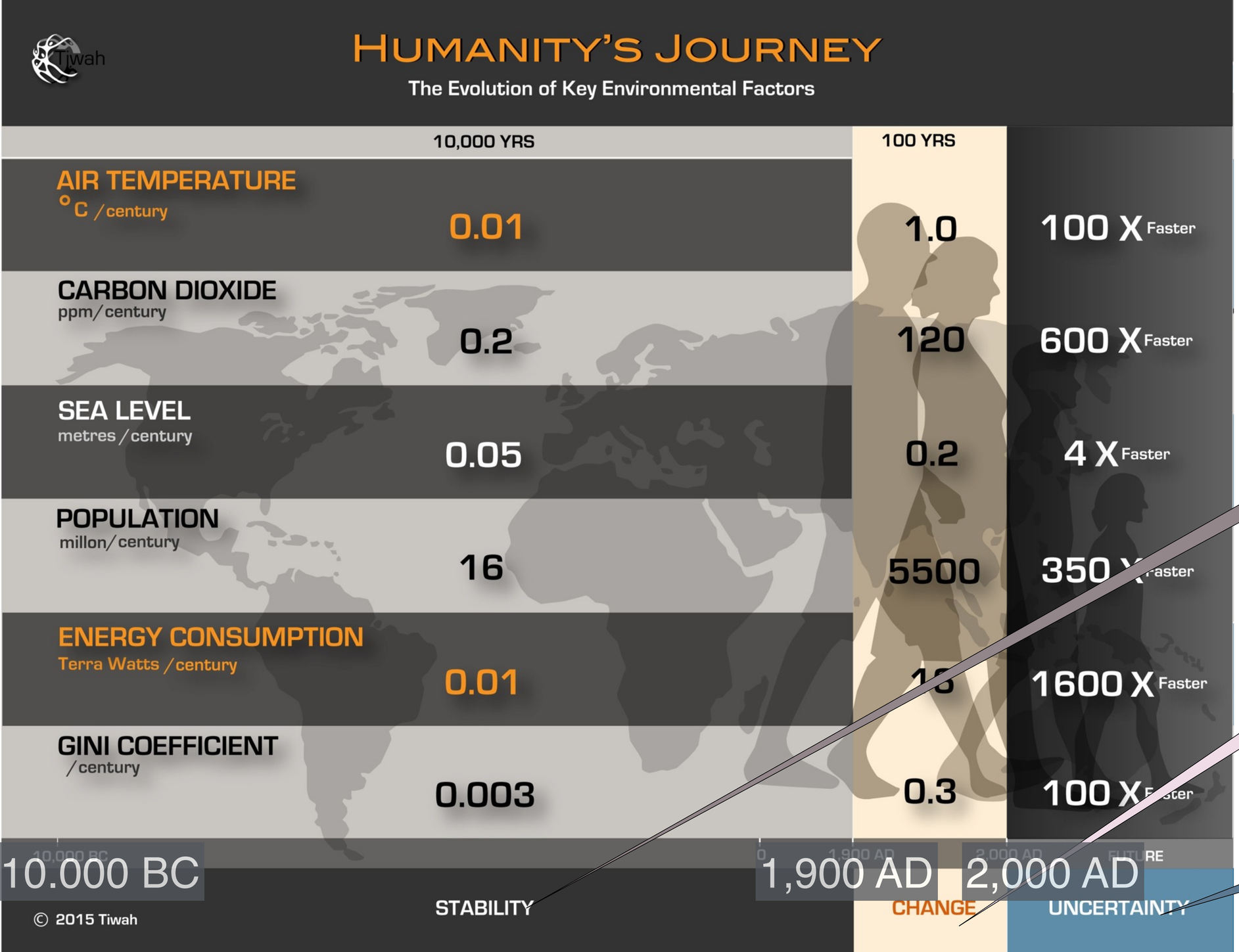
Plag, 2016


Tiwah
HUMANITY'S JOURNEY
The Evolution of Key Environmental Factors
100 YRS
10,000 YRS
AIR TEMPERATURE
0.01 °C /century
1 °C
CO2
0.2 ppm /century
120 ppm
SEA LEVEL
0.05 m /century
0.2 m
POPULATION
16 M /century
5.5 B
ENERGY CONSUMPTION
0.01 TW /century
16 TW
GINI COEFFICIENT
0.003 /century
0.3
10,000 BC
0
1,900 AD
2,000 AD
STABILITY
CHANGE
© Tiwah.co

Plag, 2016


Tiwah
HUMANITY'S JOURNEY
The Evolution of Key Environmental Factors
10,000 YRS
100 YRS
AIR TEMPERATURE
°C /century
0.01
1.0
100 X Faster
CARBON DIOXIDE
ppm/century
0.2
120
600 X Faster
SEA LEVEL
metres /century
0.05
0.2
4 X Faster
POPULATION
millon/century
16
5500
350 X Faster
ENERGY CONSUMPTION
Terra Watts /century
0.01
16
1600 X Faster
GINI COEFFICIENT
/century
0.003
0.3
100 X Faster
10,000 BC
0
1,900 AD
2,000 AD
FUTURE
10.000 BC
1,900 AD
2,000 AD
STABILITY
CHANGE
UNCERTAINTY
© 2015 Tiwah

Plag, 2016



Holocene: Stability

20th and 21st Century: Change, imbalance

Future: Uncertainty

Plag, 2016

Homo sapiens and Earth

Human environment
300 million tons of humans and
700 million tons of domesticated animals

400 million domesticated dogs
600 million domesticated cats
1.5 billion cows
20 billion chicken

81% of Earth's surface changed significantly by humans

Earth's Energy Imbalance increased by roughly 10,000,000 times above pre-human values

Non-Human environment
100 million tons of wild animals (more than 2 kg)

200,000 wolfs
40,000 lions
900,000 African buffalo
50 million penguins

5% of Earth surface still untouched

Modern climate change is a symptom in the syndrome of Modern Global Change, not the cause.

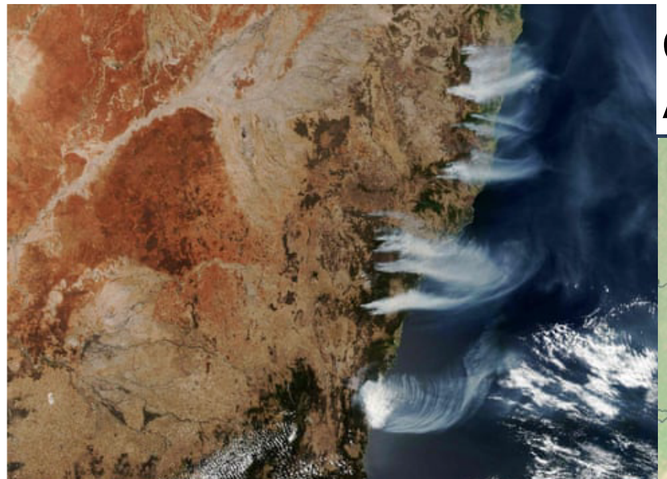
The Syndrome: Modern Climate and Global Change

Modern climate change is a symptom in the syndrome of Modern Global Change, not the cause.

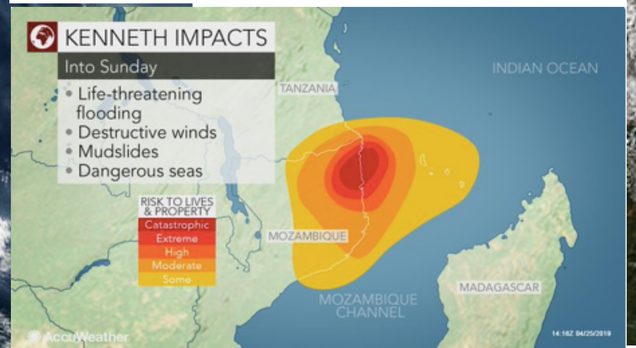
However, modern climate change is increasingly causing cascading changes, thus extending the syndrome of modern global change

Extreme weather-related disasters

Hurricane Dorian
September 1, 2019



Cyclone Kenneth,
April 22, 2019



Cyclone Idai,
March 15, 2019

Extreme weather-related disasters

Hurricane Dorian
September 1, 2019

Cyclone Idai,
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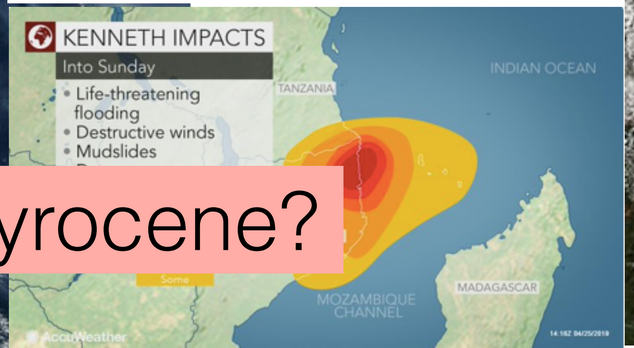
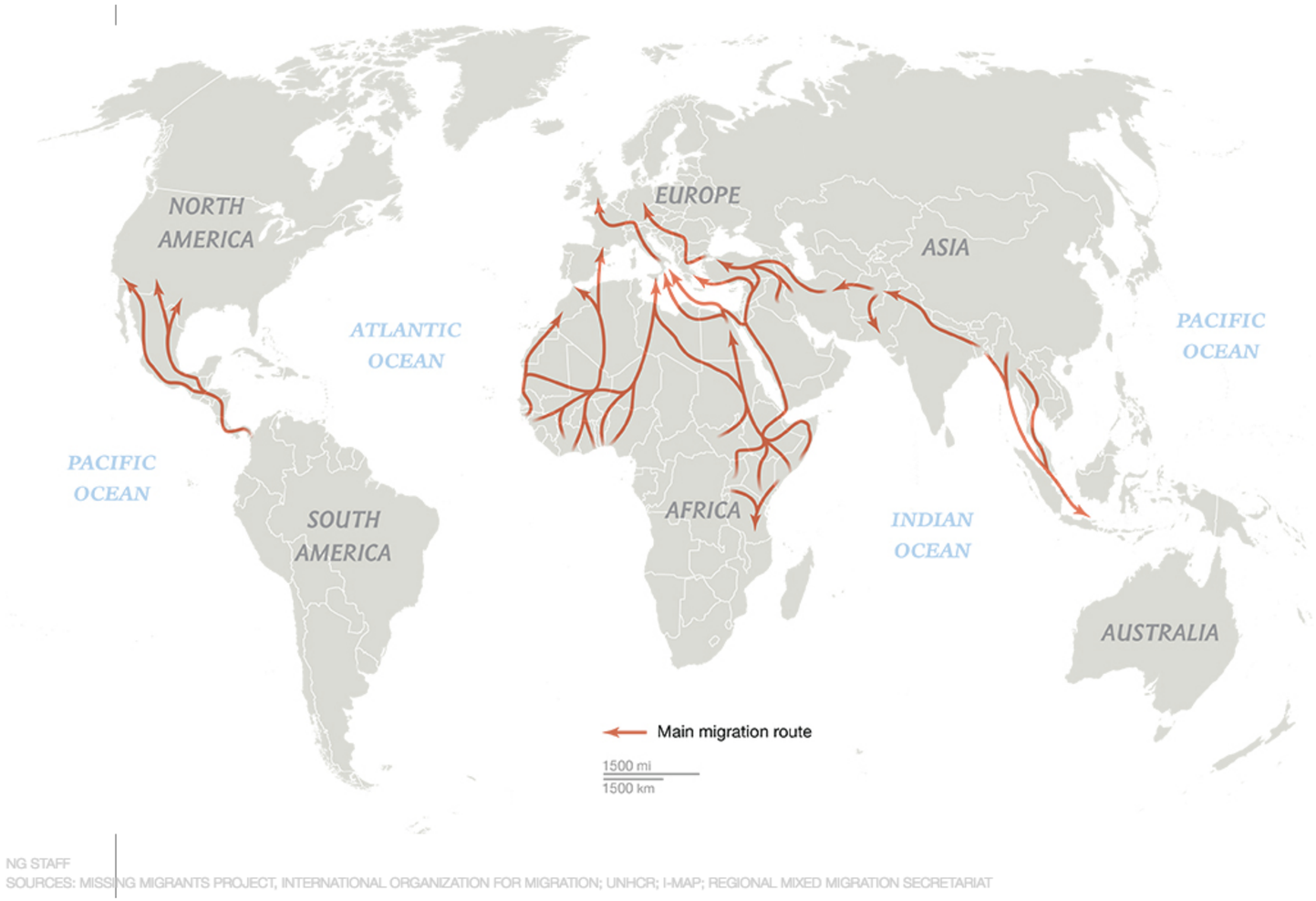
April 22, 2019

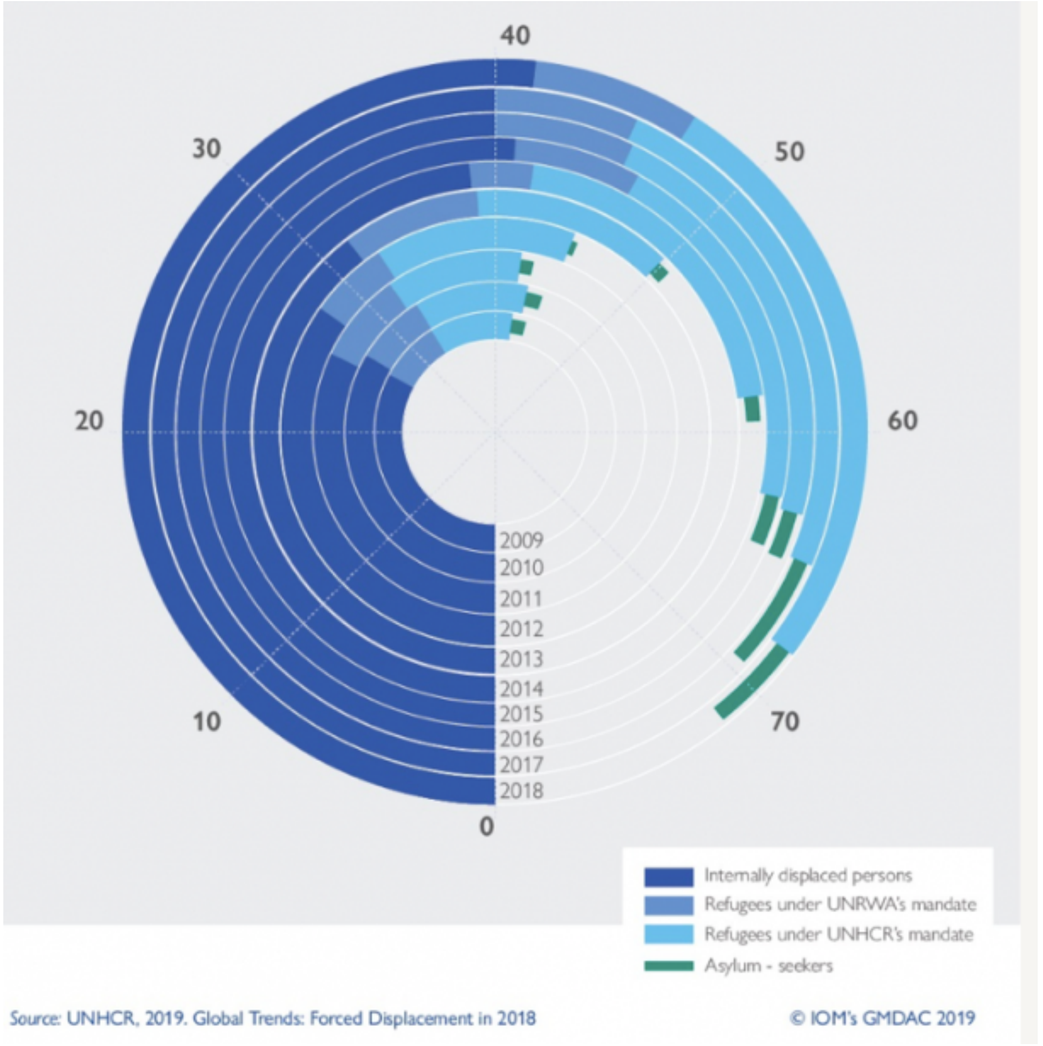


Anthropocene or Pyrocene?

Migration Causing Massive Harm



NG STAFF
SOURCES: MISSING MIGRANTS PROJECT, INTERNATIONAL ORGANIZATION FOR MIGRATION; UNHCR; I-MAP; REGIONAL MIXED MIGRATION SECRETARIAT



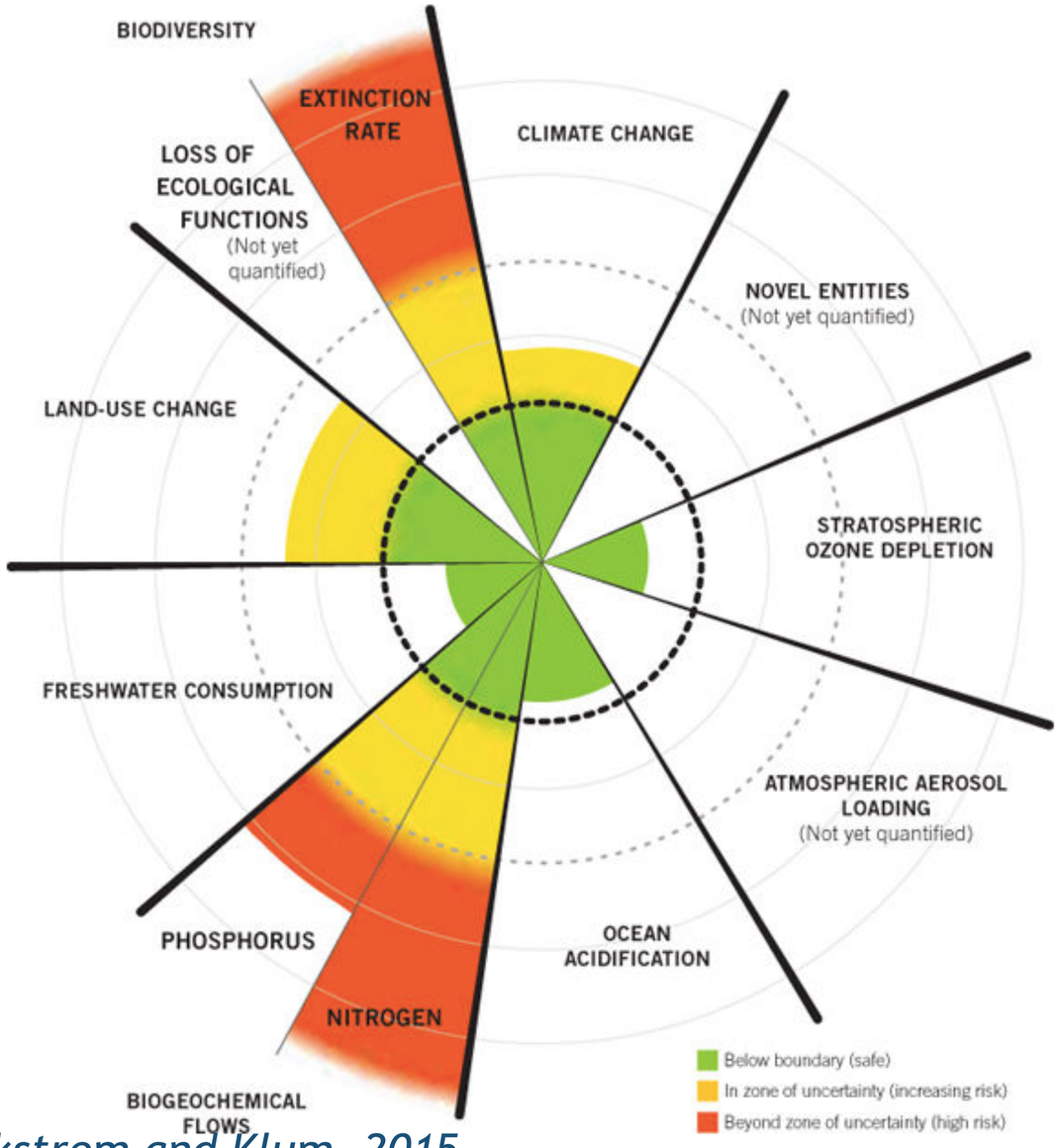
Source: UNHCR, 2019. Global Trends: Forced Displacement in 2018

© IOM's GMDAC 2019

The Syndrome: Modern Climate and Global Change

The Syndrome: Modern Climate and Global Change

The Holocene was a “safe operating space for humanity”



Rockstrom and Klum, 2015

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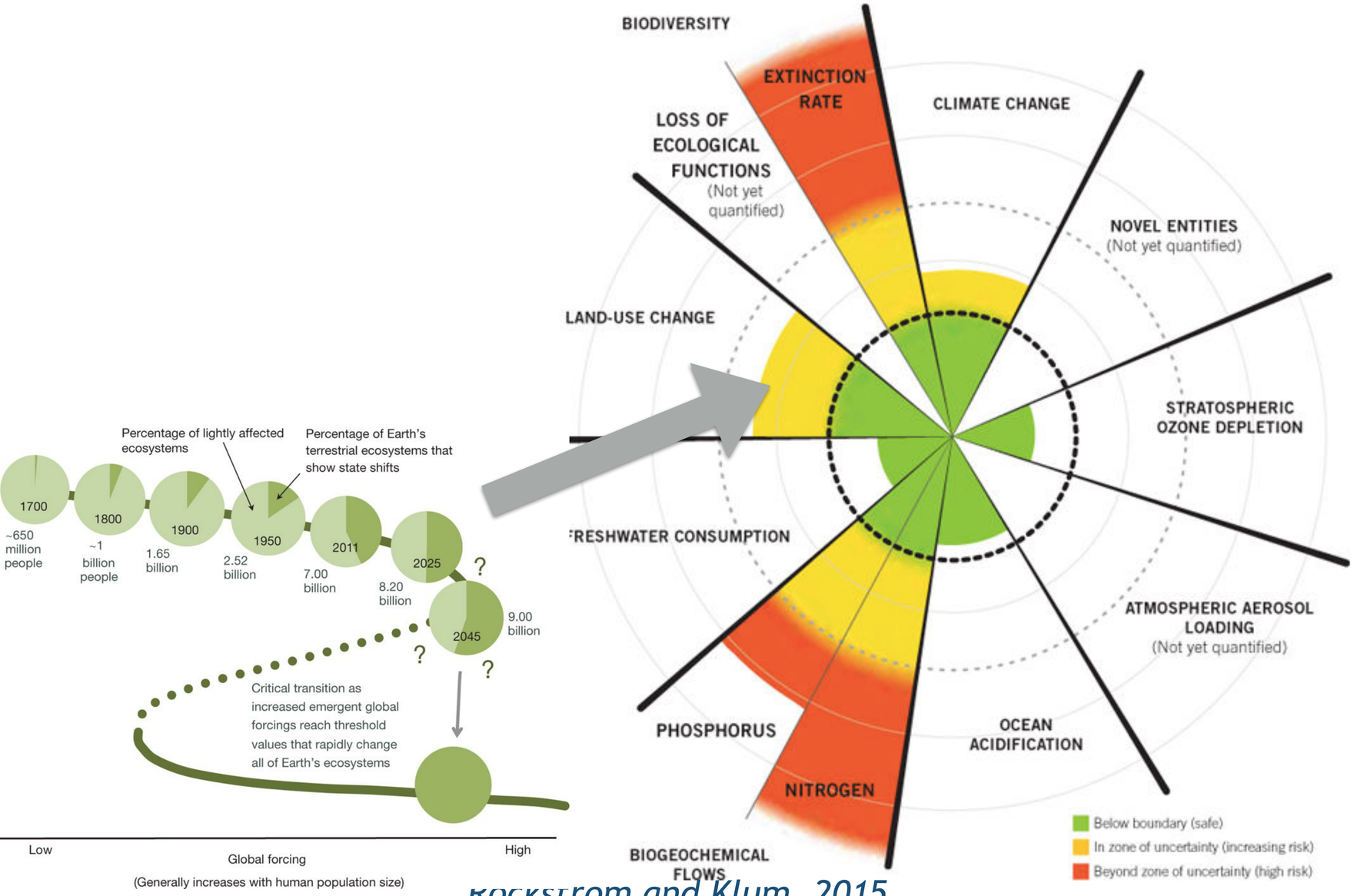

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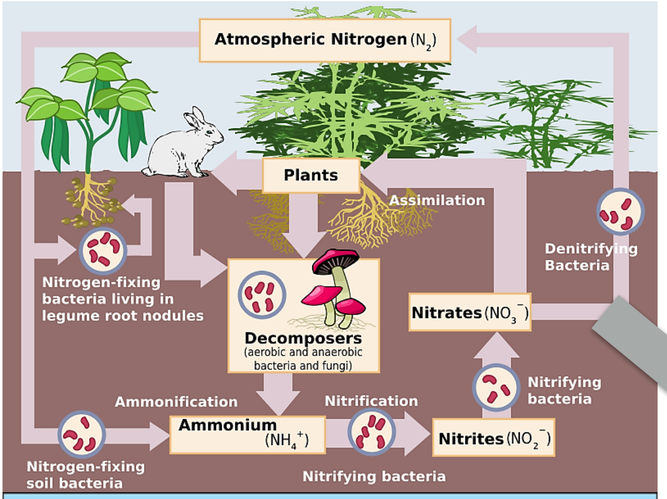

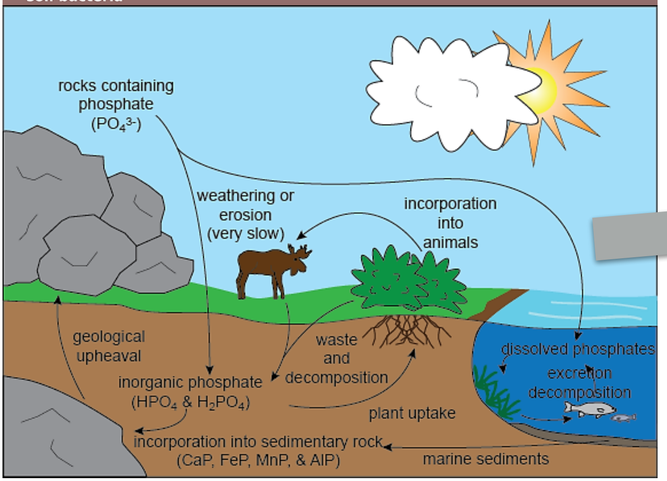

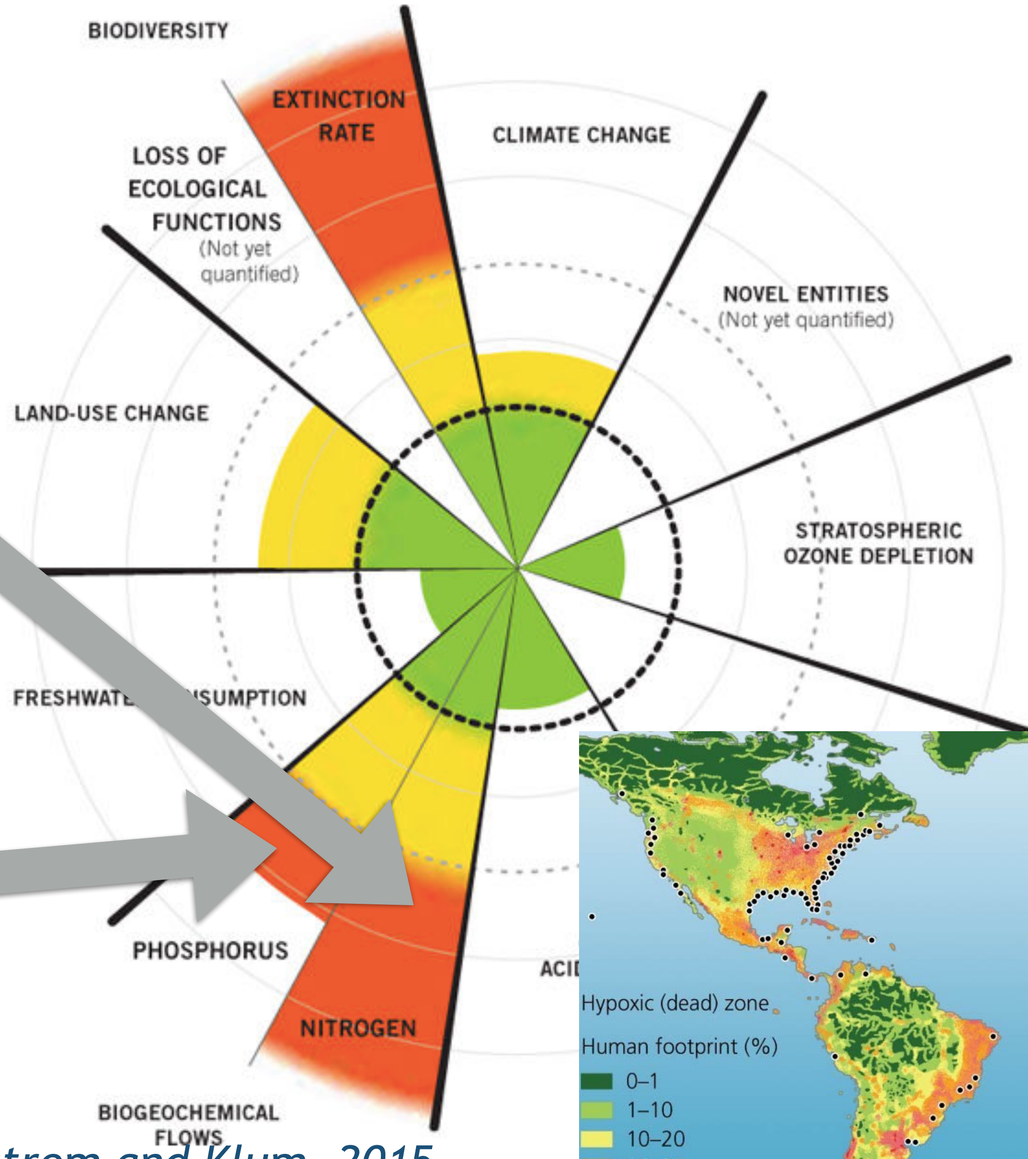

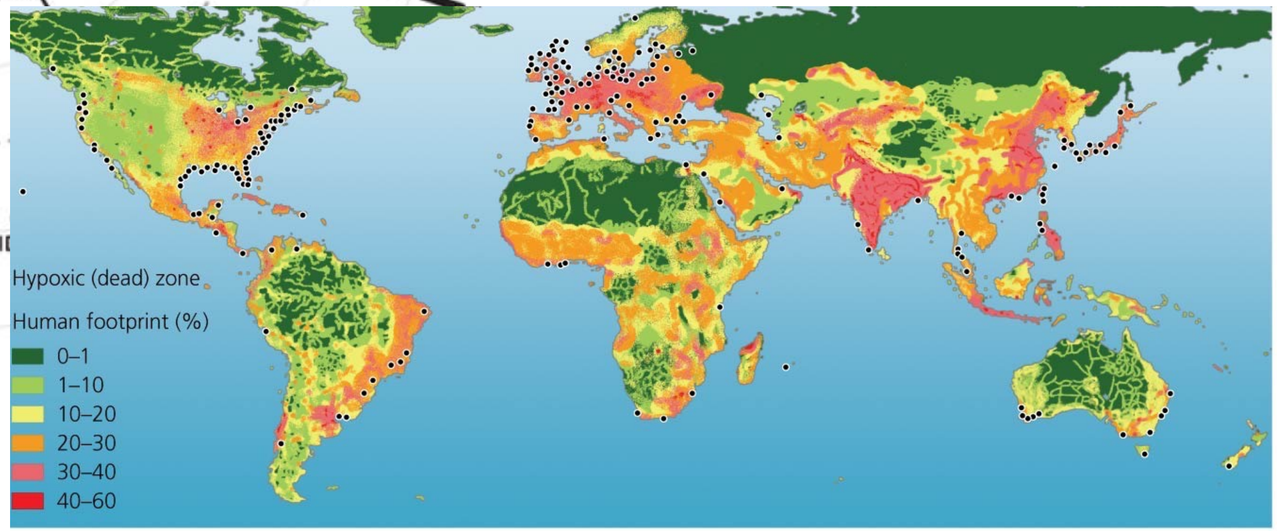

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The Syndrome: Modern Climate and Global Change

The Holocene was a “safe operating space for humanity”

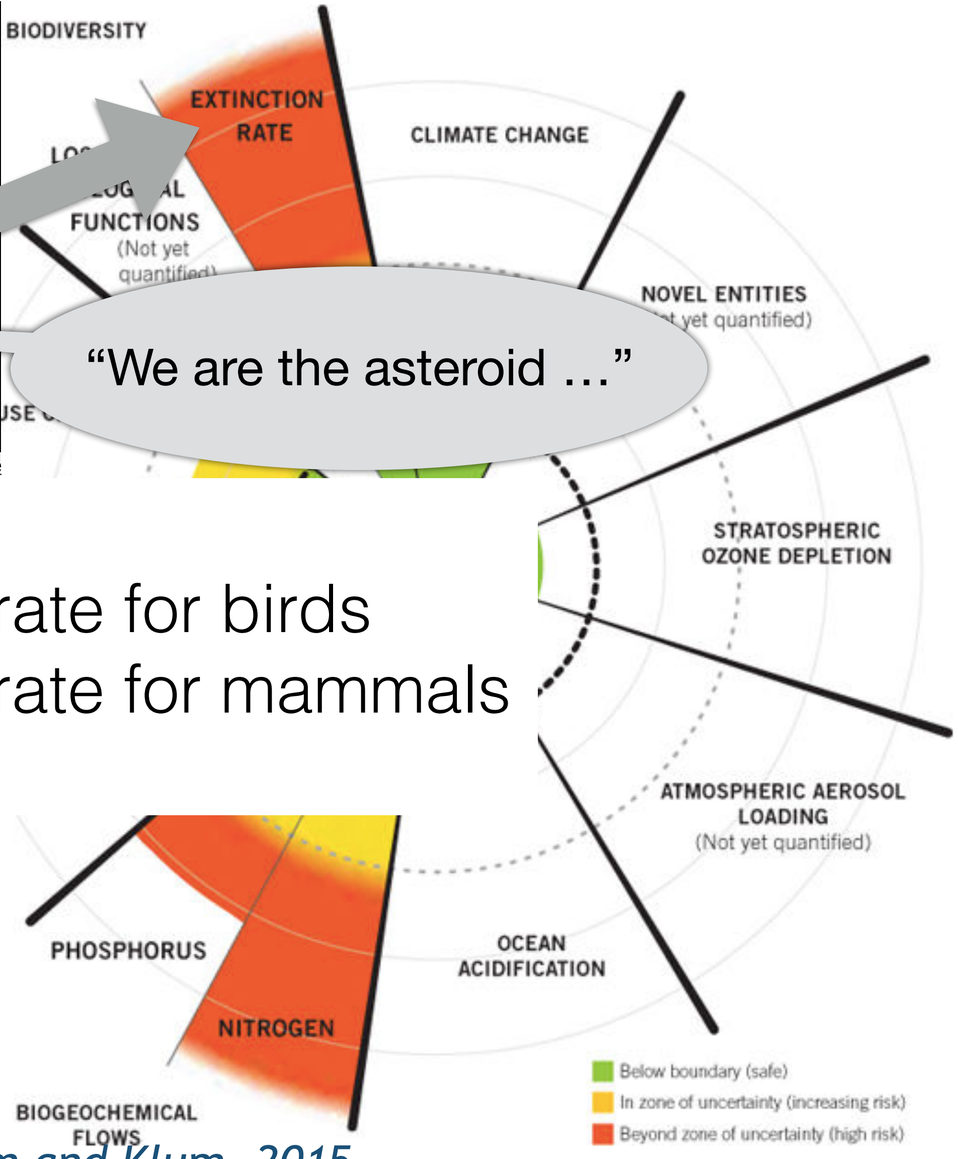
https://www.youtube.com/watch?v=gPq9YAg9mfc&feature=youtu.be

“We are the asteroid …”

Current extinction rates:

300 times background rate for birds

80,000 times background rate for mammals



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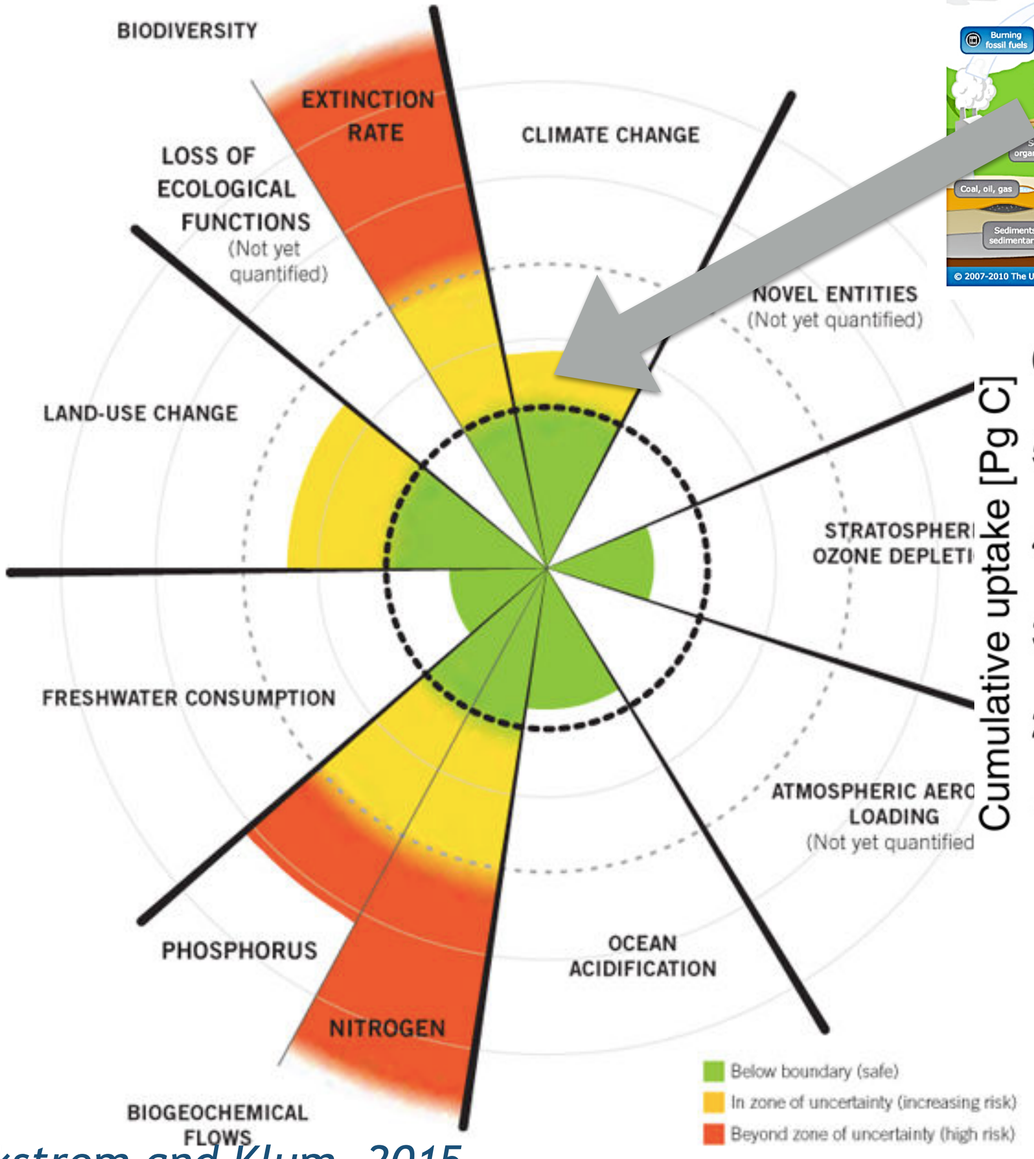

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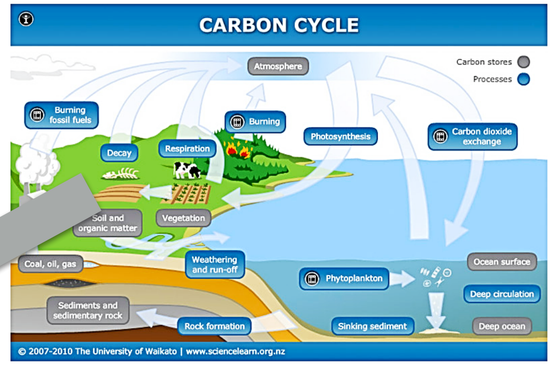

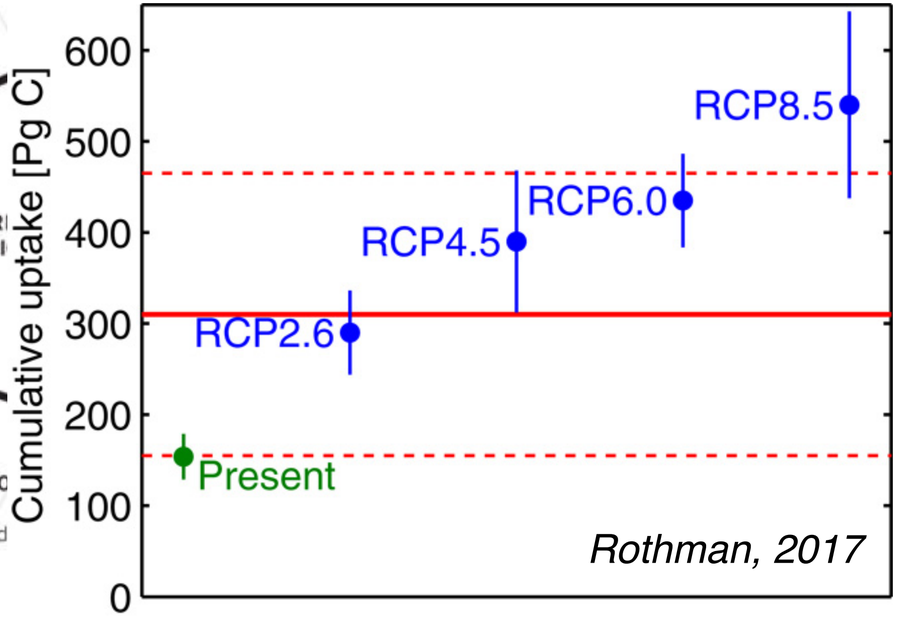

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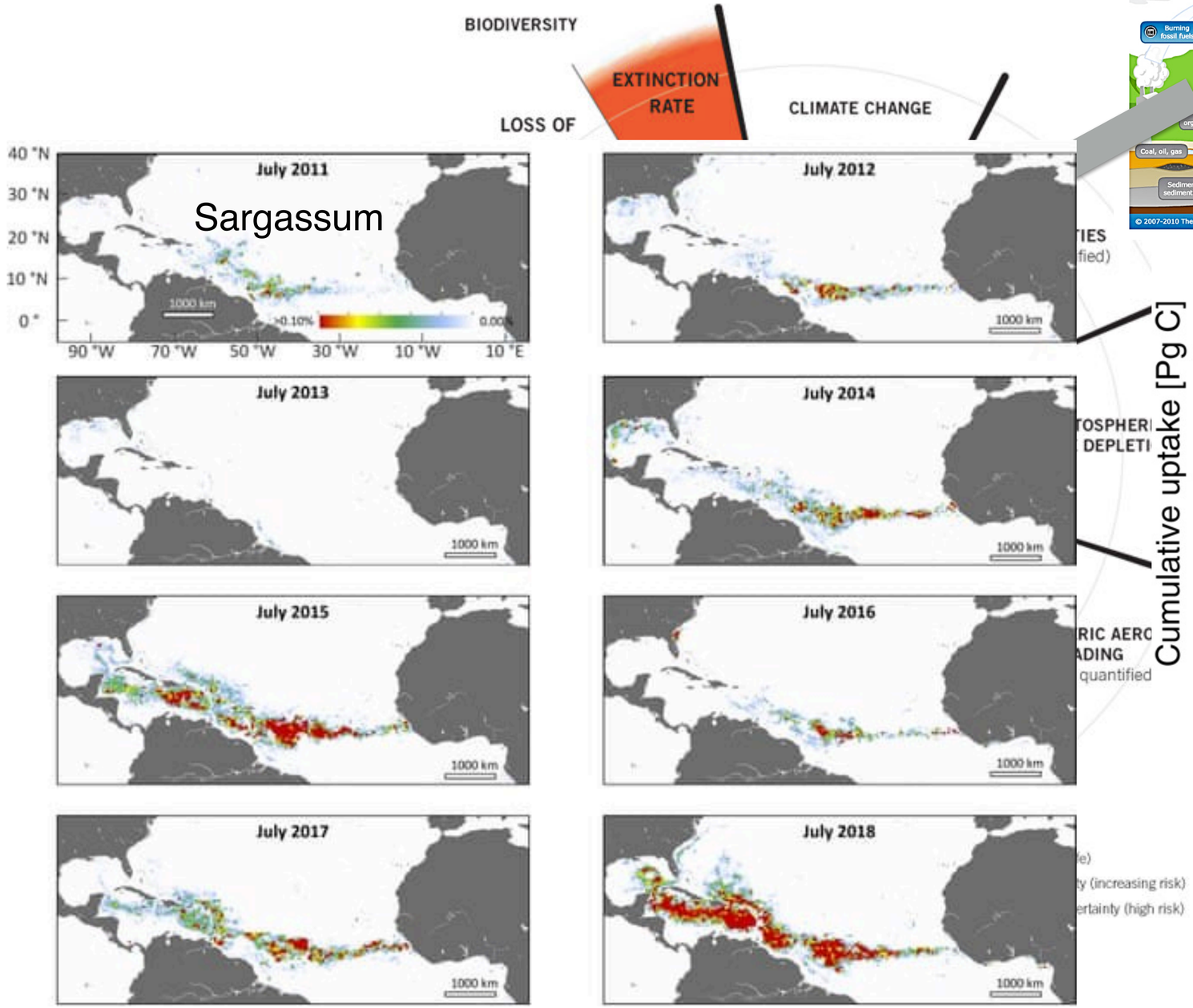

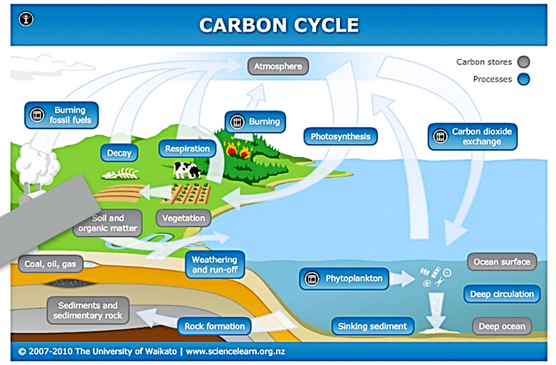

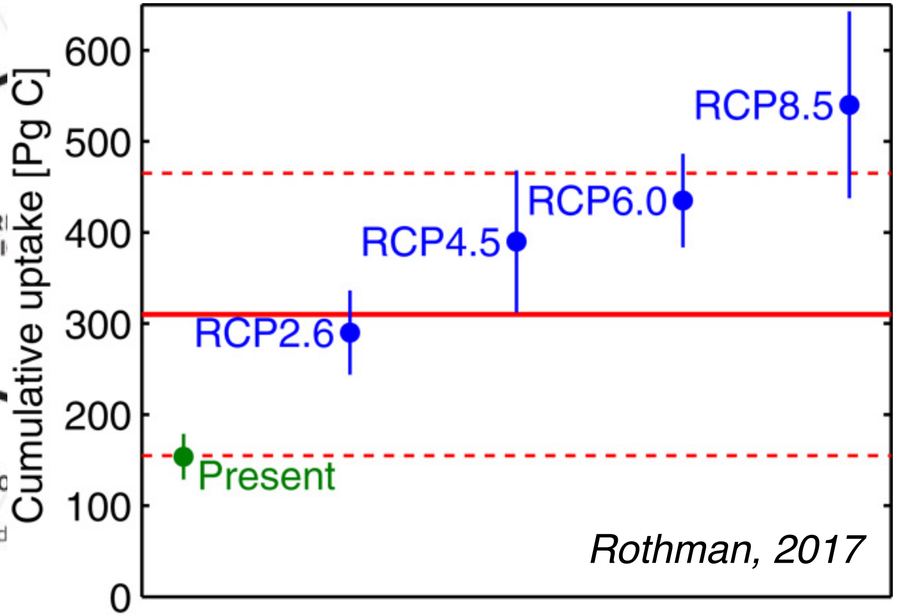

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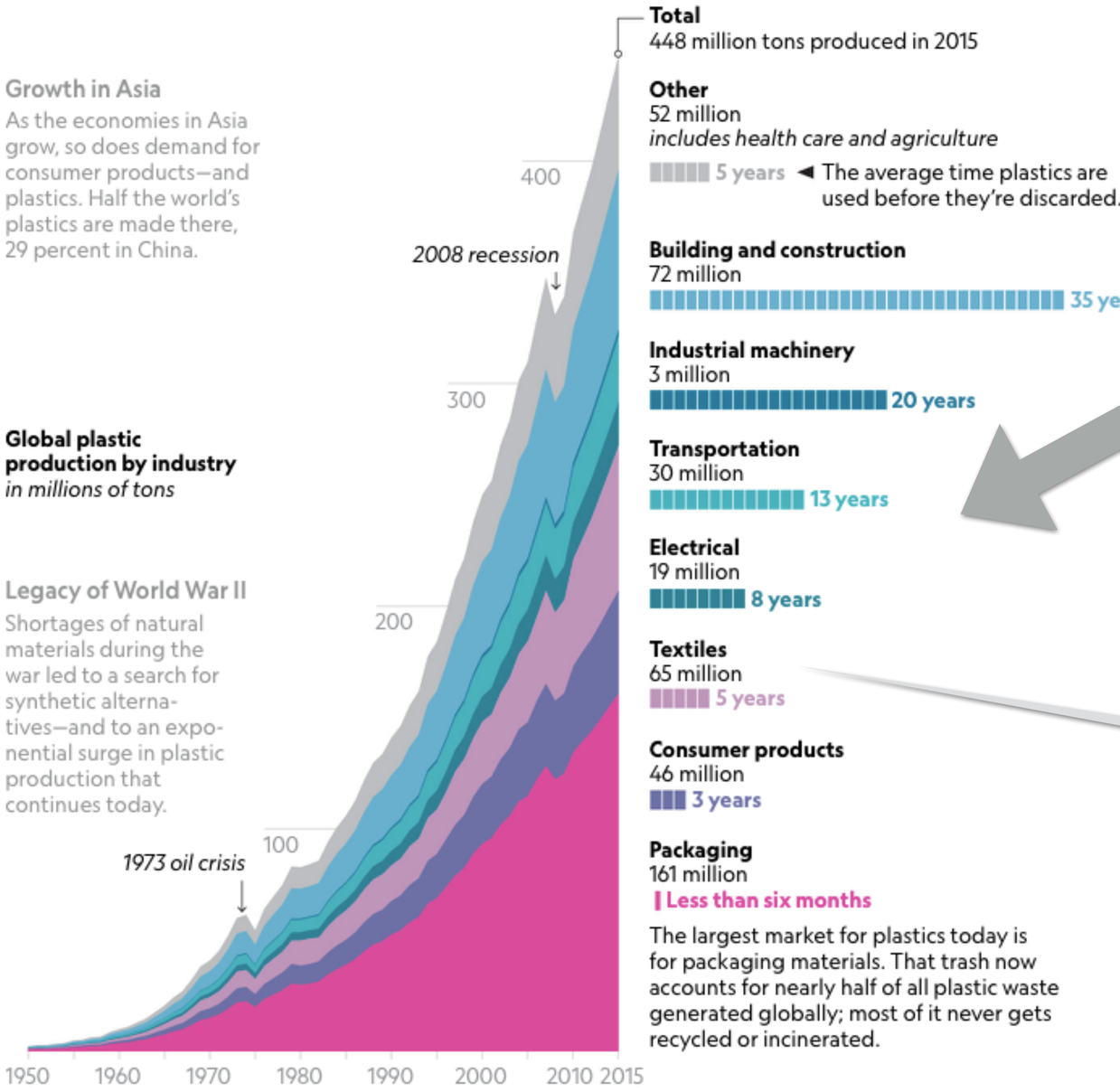
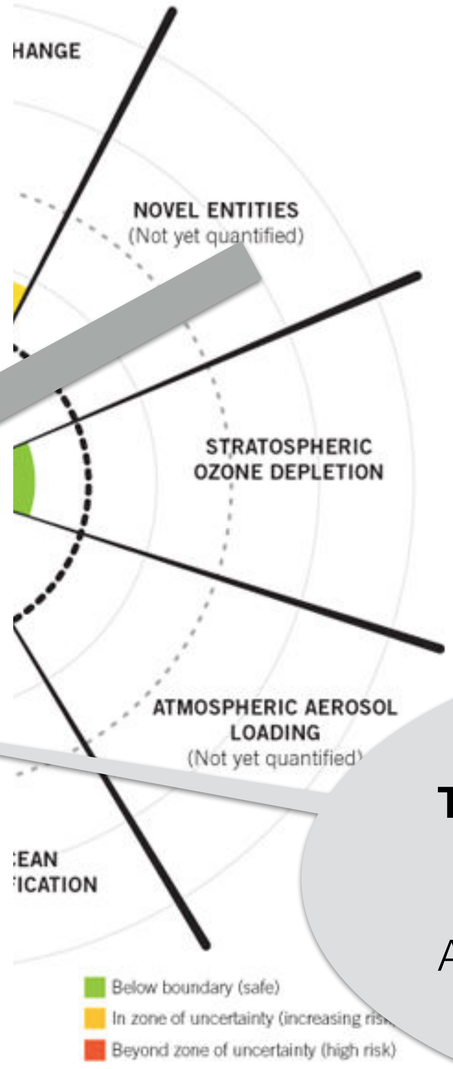




The urgent challenge of plastics

448 Million tons in 2015

Average use time: 5 years

Average lifetime: 1000-5000 years

Key Points

Baseline

During the Holocene, climate and sea level were exceptionally stable.

The Holocene was a “safe operating space for humanity” allowing the emergence of a dominant species

Syndrome

During the last few hundred years, humanity has made large and rapid planetary changes, accelerated existing and introduced new flows in the planetary physiology.

The system is outside the “normal range” and in the dynamic transition into the Post-Holocene.

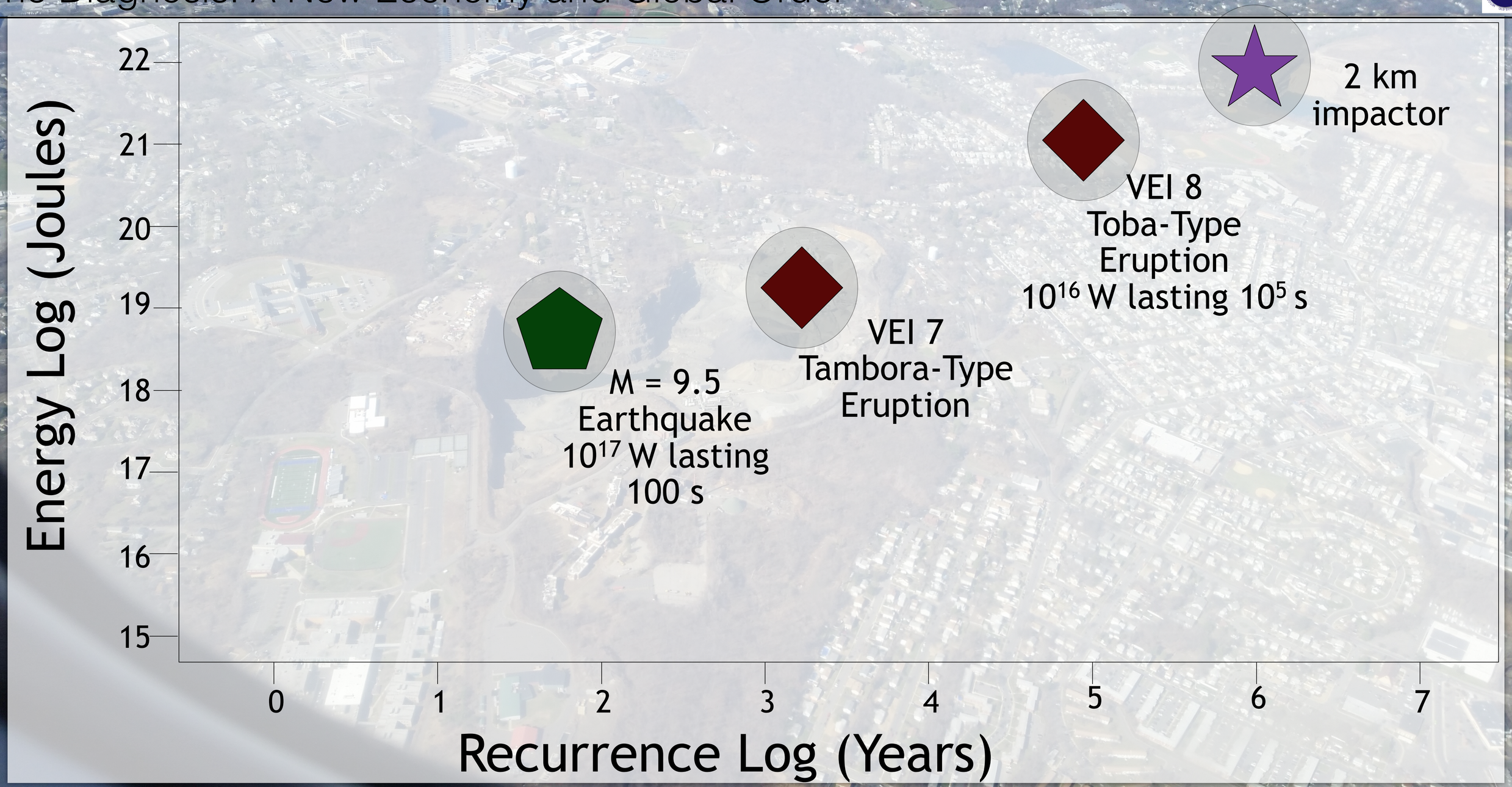
Modern Climate Change:
A Symptom of a Human-Caused High-Energy Pulse

Contents

- The Baseline: Past Climate Changes
- The Syndrome: Modern Climate and Global Change
- The Diagnosis: A new Economy and Global Order
- The Prognosis: Leaving the “Safe Operating Space” and into the Unknown
- The Therapy: A new Ethics, Economy, and Global Governance

The Diagnosis: A New Economy and Global Order

The Diagnosis: A New Economy and Global Order



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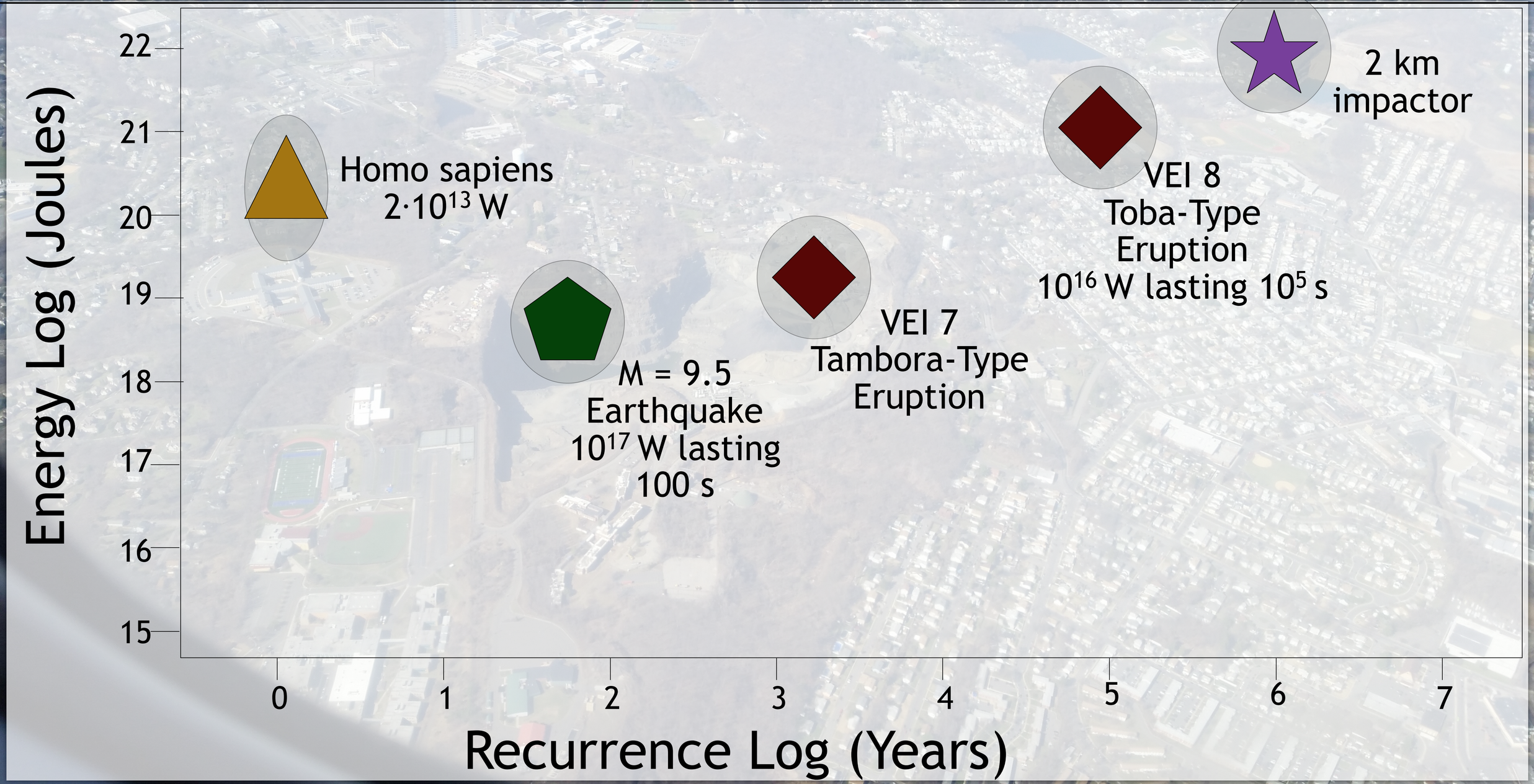

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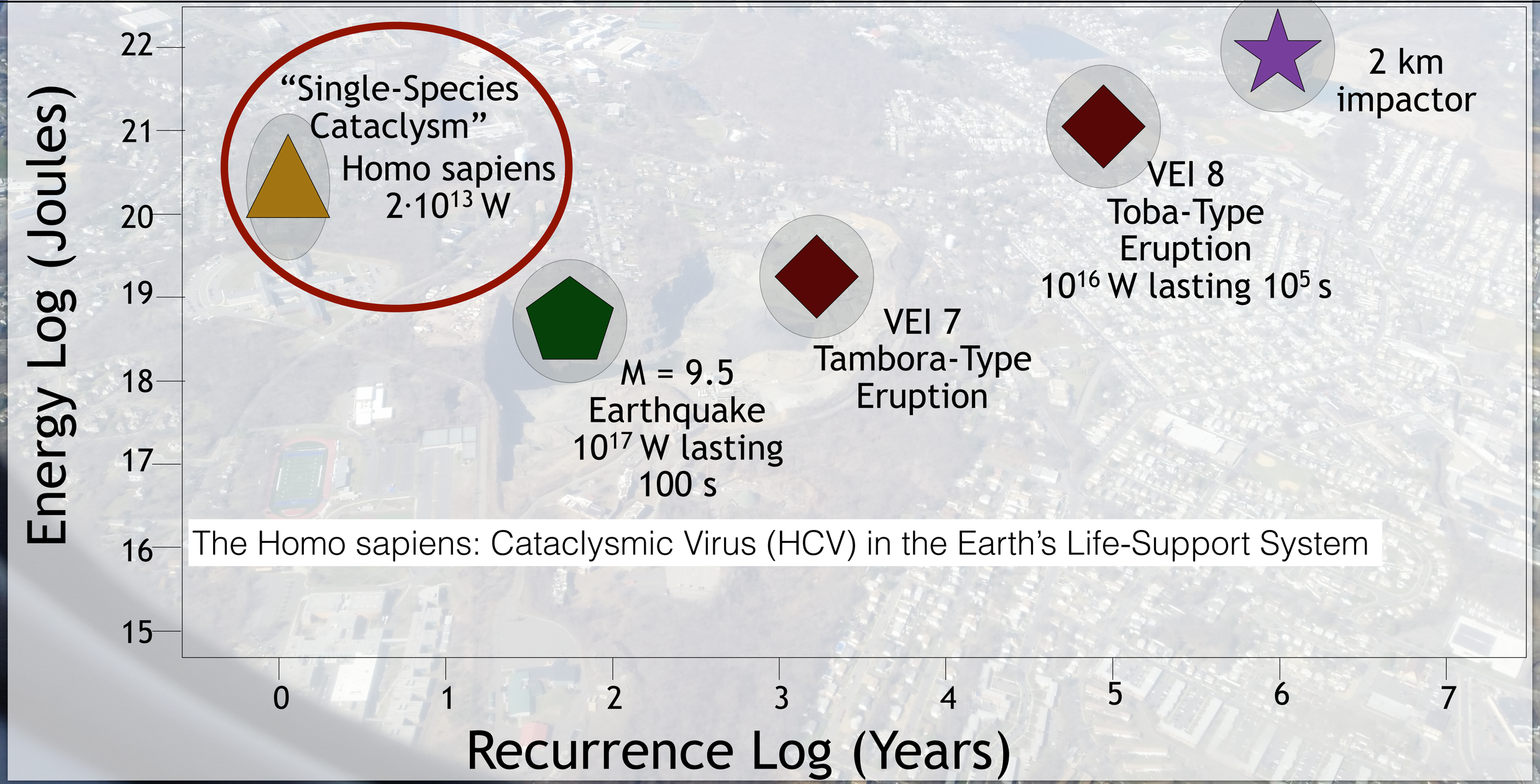
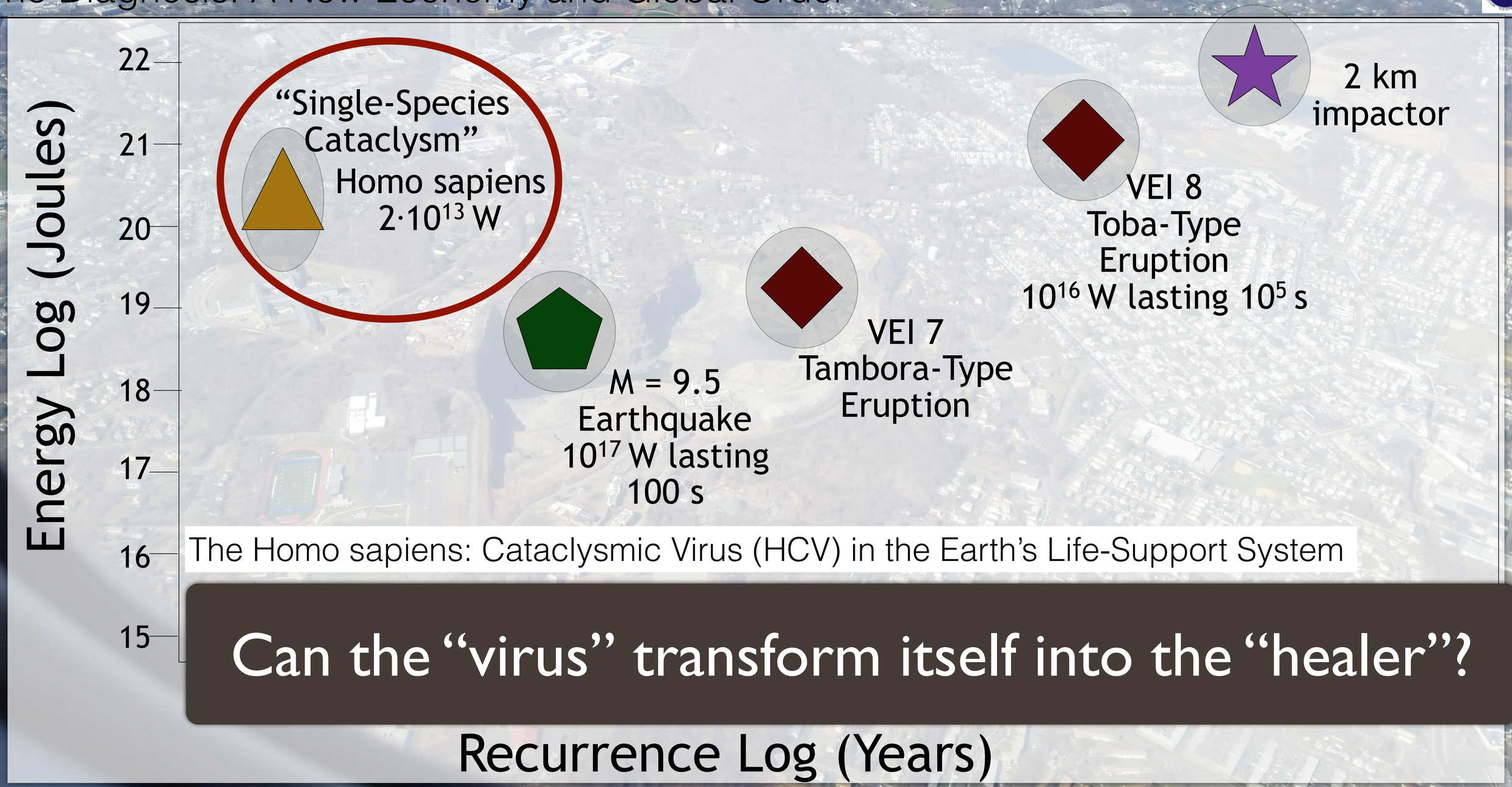
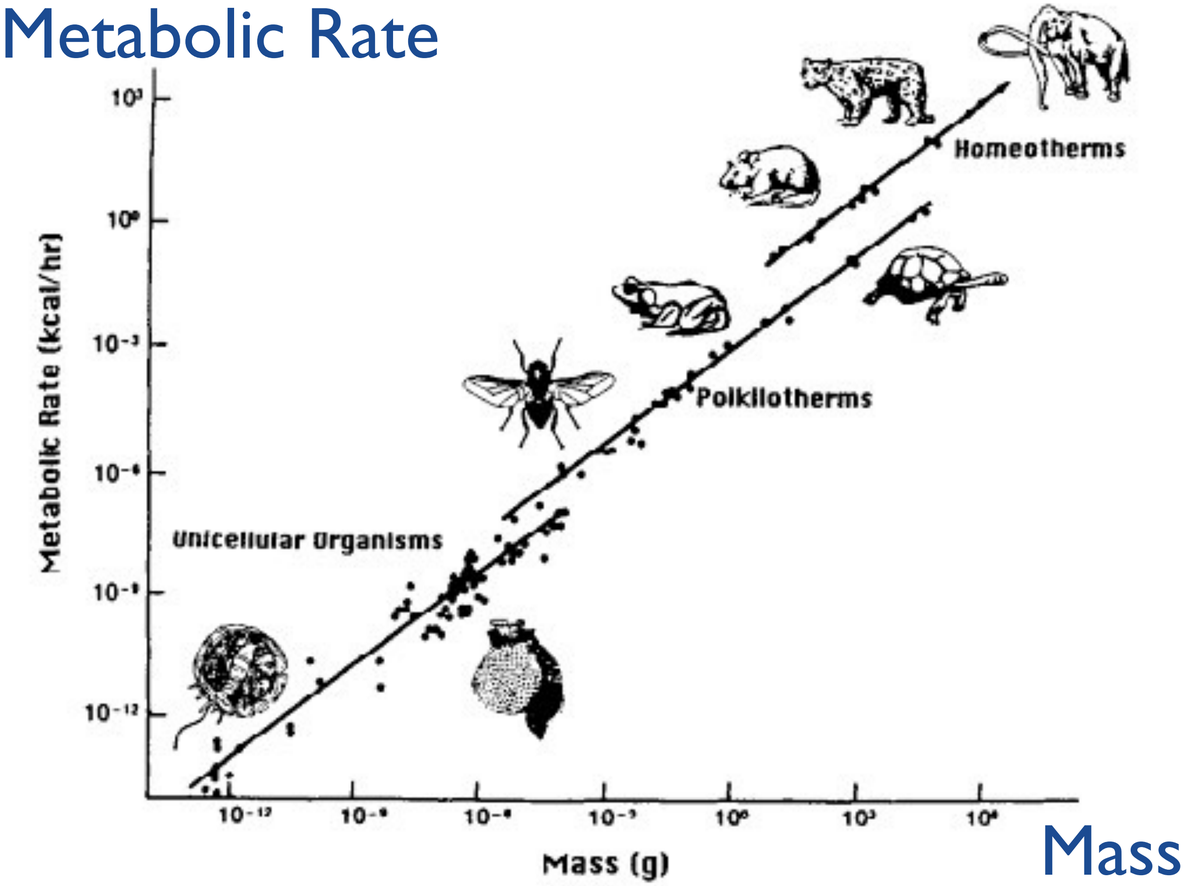



Energy Log (Joules)
22
21
20
19
18
17
16
15
"Single-Species Cataclysm"
Homo sapiens
$2 \cdot 10^{13}$ W
M = 9.5
Earthquake
10^{17} W lasting
100 s
VEI 7
Tambora-Type
Eruption
VEI 8
Toba-Type
Eruption
10^{16} W lasting 10^{5} s
2 km
impactor
The Homo sapiens: Cataclysmic Virus (HCV) in the Earth's Life-Support System
Can the "virus" transform itself into the "healer"?
Recurrence Log (Years)

Out of Scale

Scaling law for metabolic rate:
$Y = Y_0 * M^{(3/4)}$

Metabolic Rate



Mass

Out of Scale

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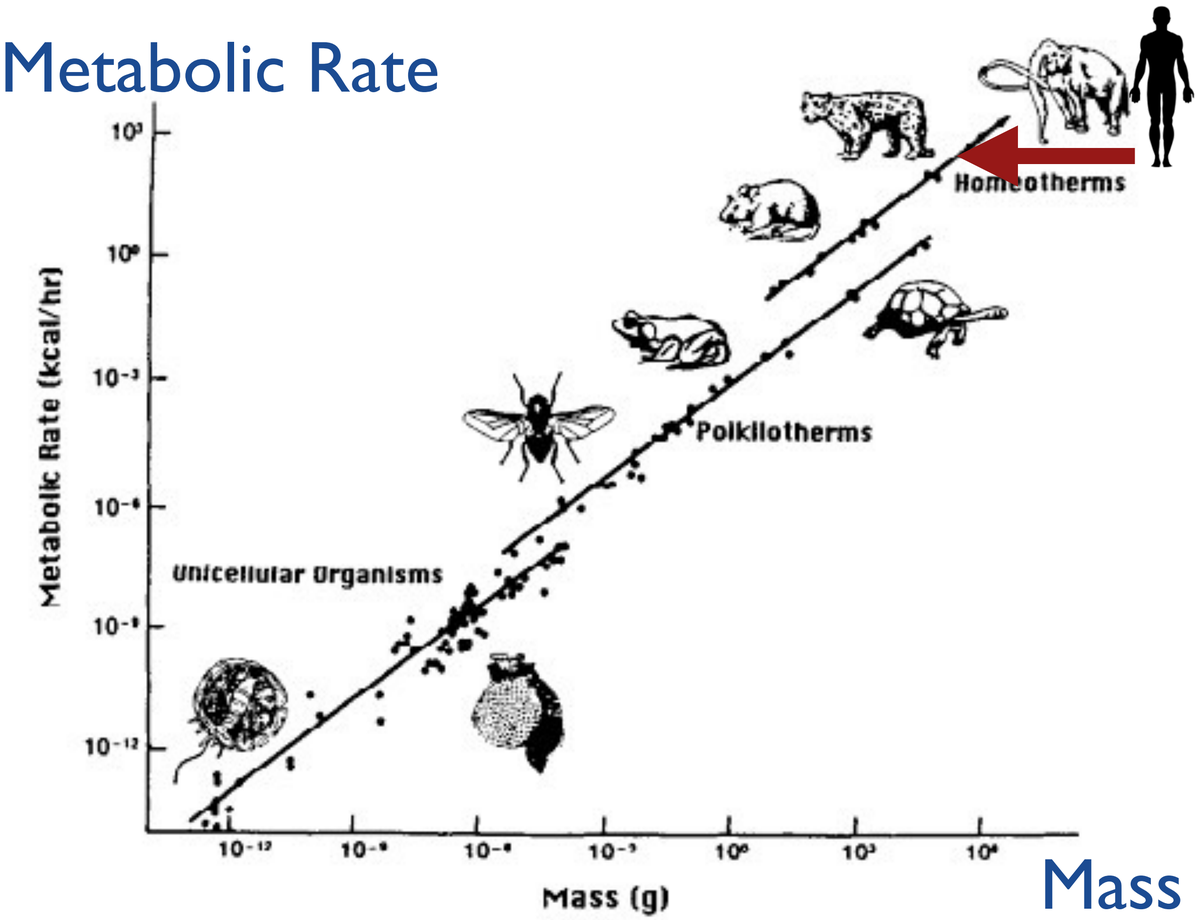
human: Y = 50 -100 Watt

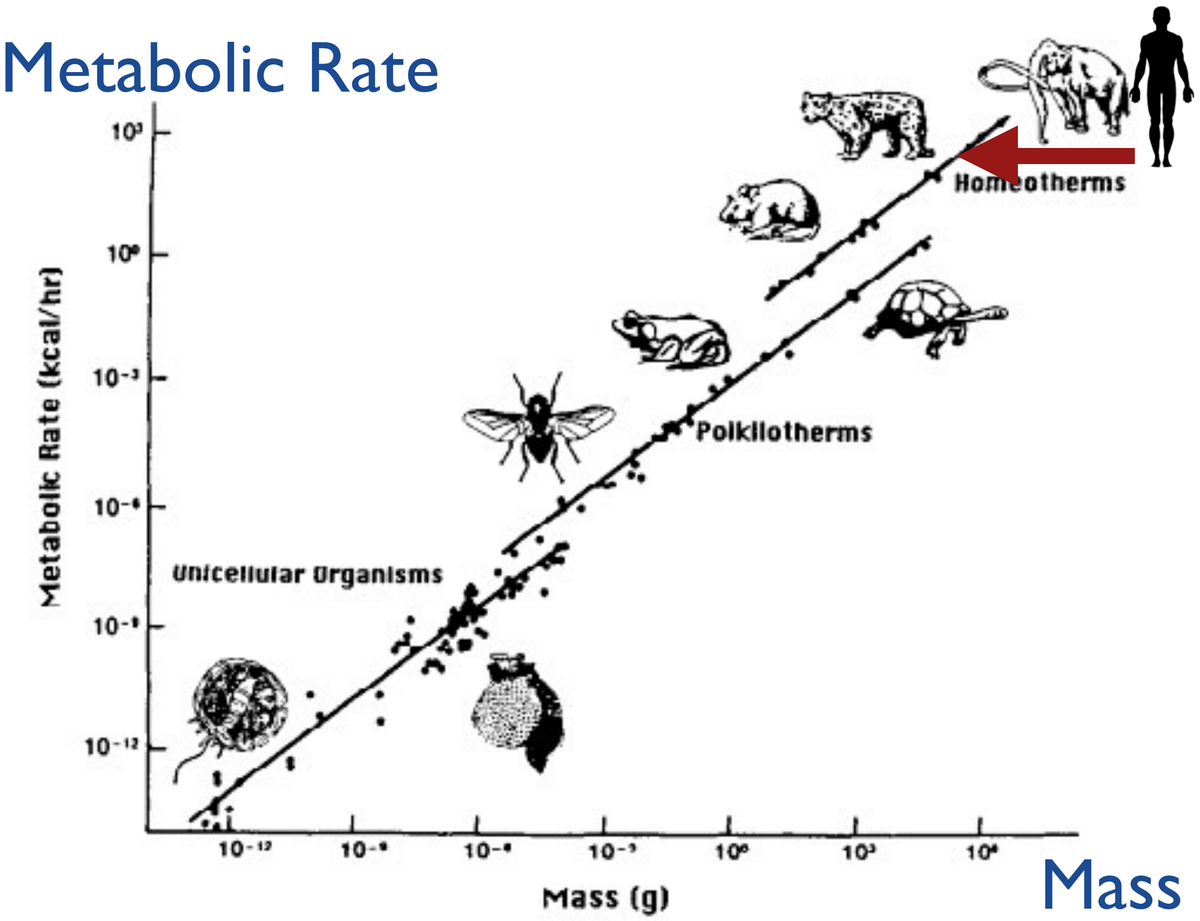
Metabolic Rate



Mass

Out of Scale

Metabolic Rate



Mass

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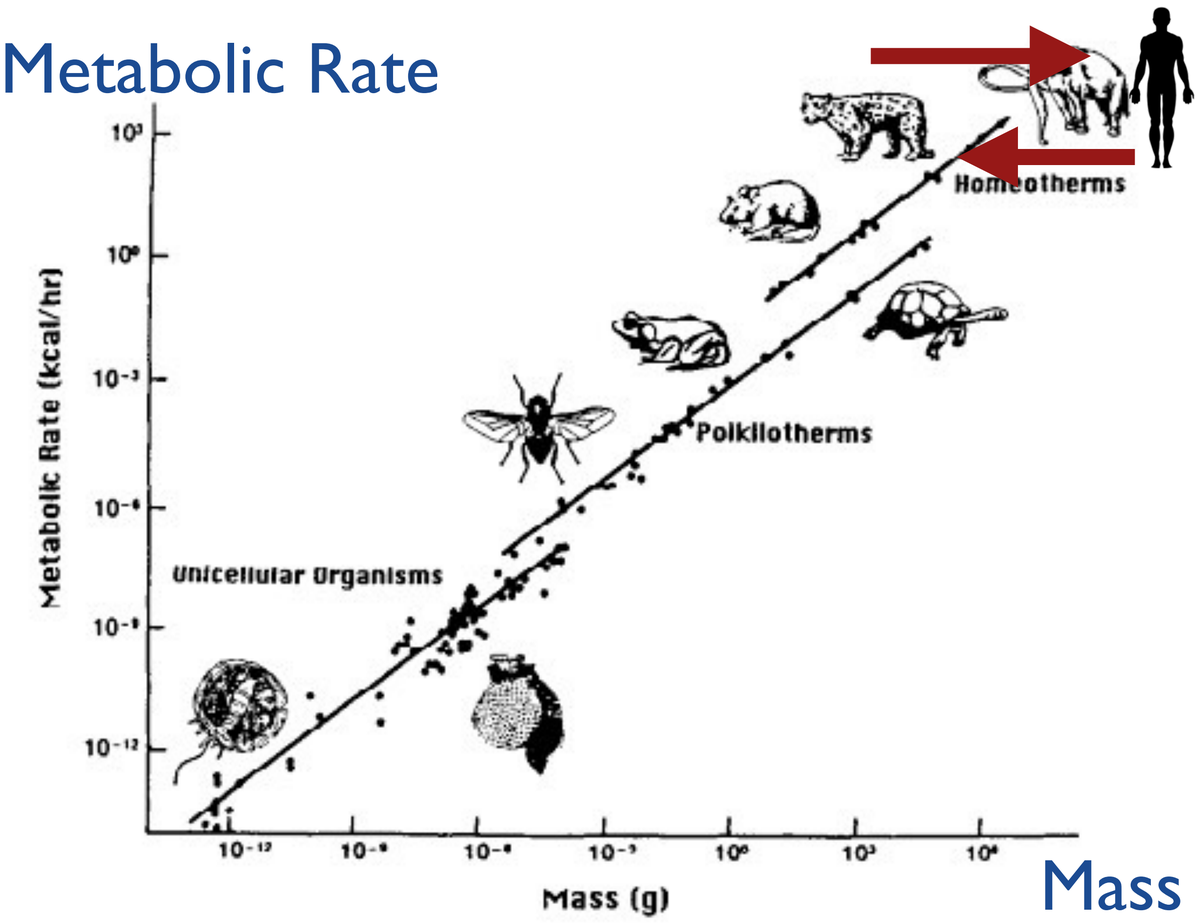
Extended metabolic rate:
$Y_E = Y + C_E$
(C_E: total energy consumption)

Out of Scale

Metabolic Rate



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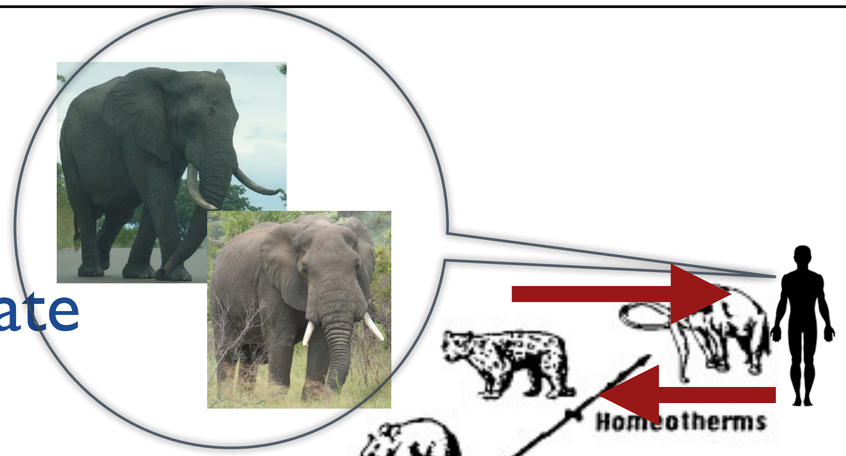
Energy consumption per capita:
Global Average: Y_E = 2,835 Watt
M = 10 metric tons

The Diagnosis: A New Economy and Global Order

Out of Scale



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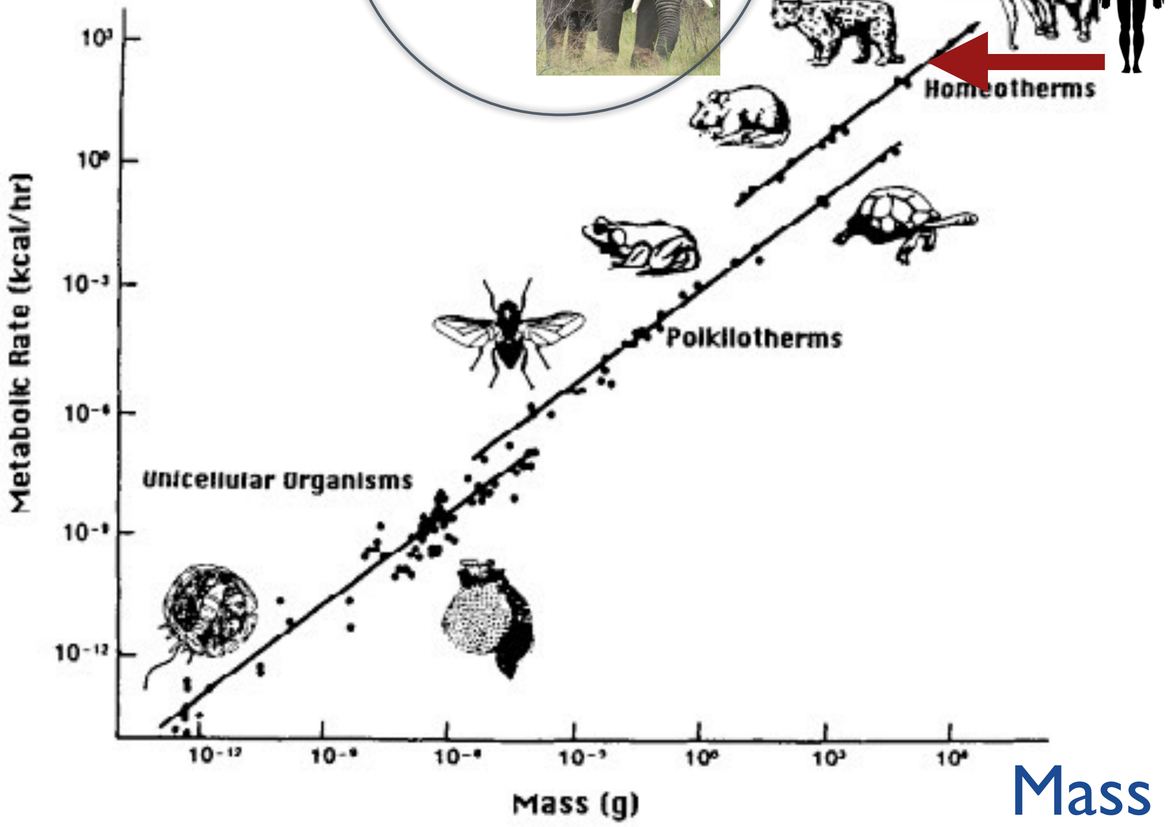

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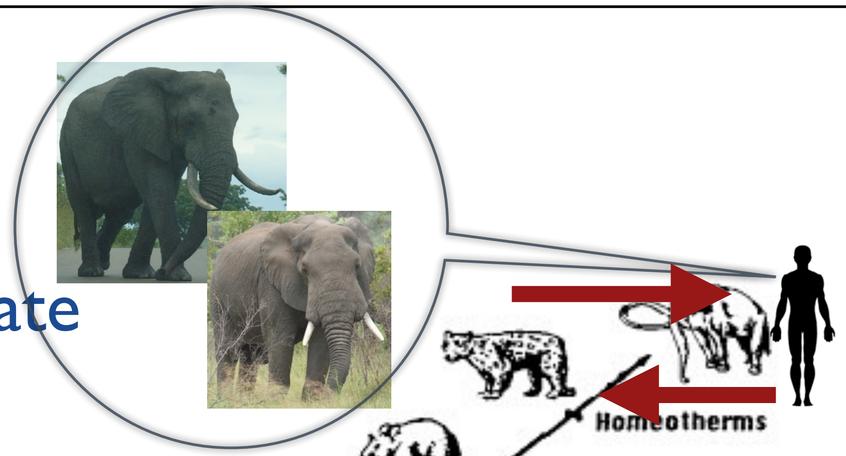
Humanity has an extended metabolic rate equivalent to 14 Billion elephants (2.7 Billion for the U.S. alone)

The Diagnosis: A New Economy and Global Order

Out of Scale



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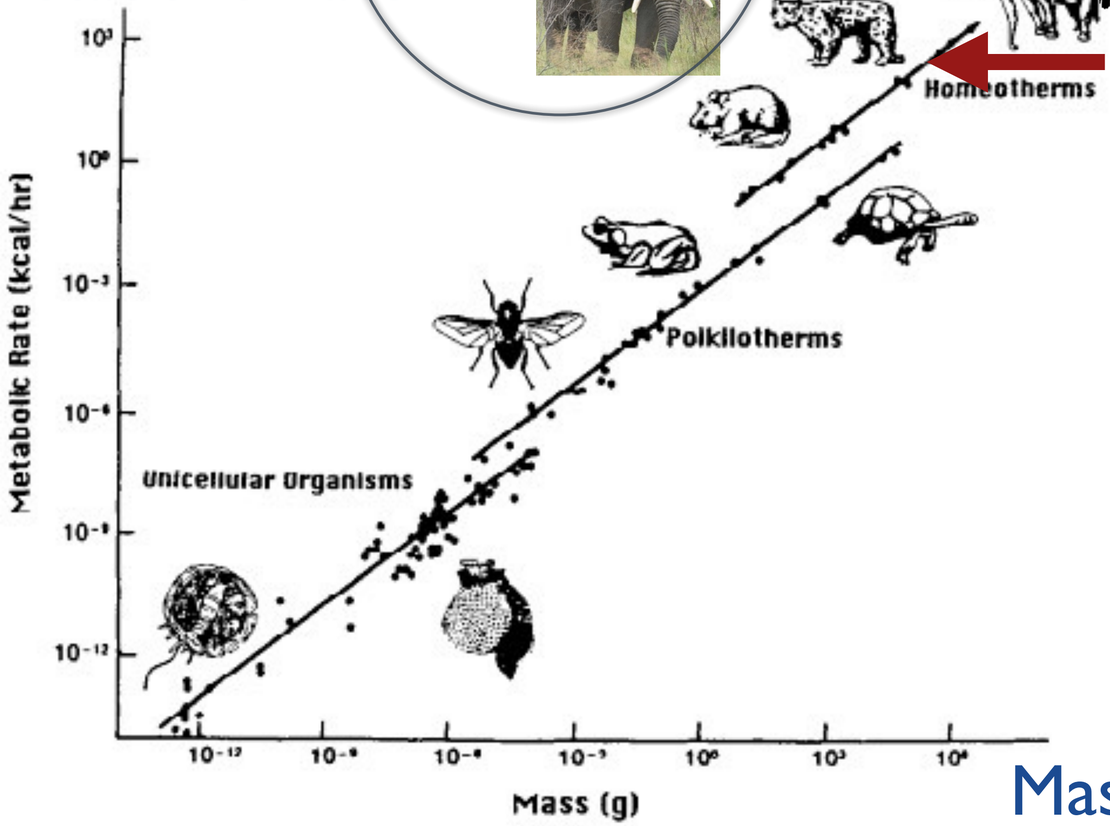

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human: Y = 50 -100 Watt

14 Billion elephants: a heavy "load' for Earth

The Diagnosis: Leaving the “Safe Operating Space”

Breaking Scaling Laws

How could Homo sapiens “break” the scaling law?

The Diagnosis: Leaving the “Safe Operating Space”

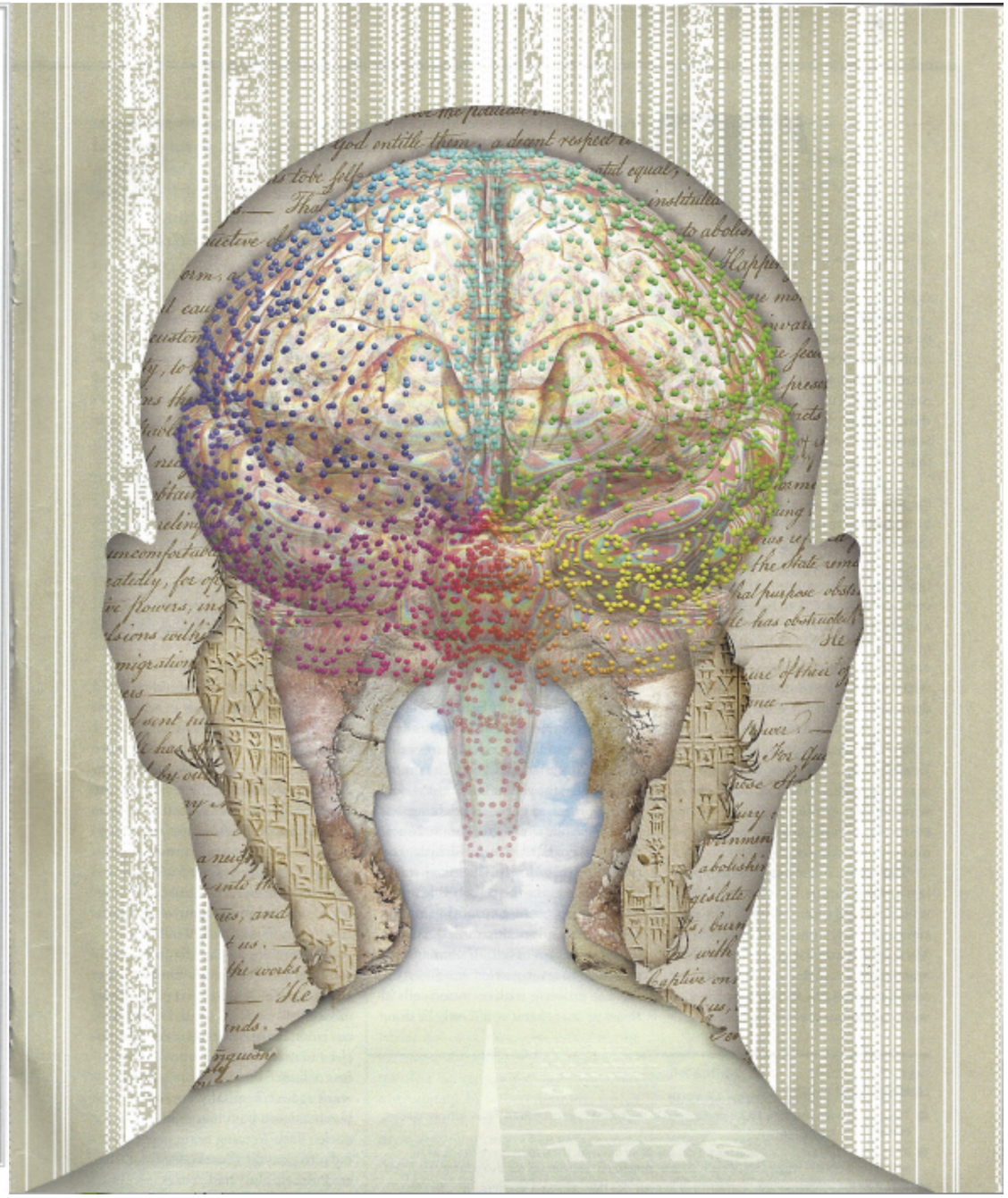
Breaking Scaling Laws

The Remarkable *(But Not Extraordinary)* Human Brain

A novel technique for counting neurons is changing our appraisal of just how special the human brain really is

By Suzana Herculano-Houzel

ILLUSTRATION BY JEAN FRANÇOIS PODEVIN

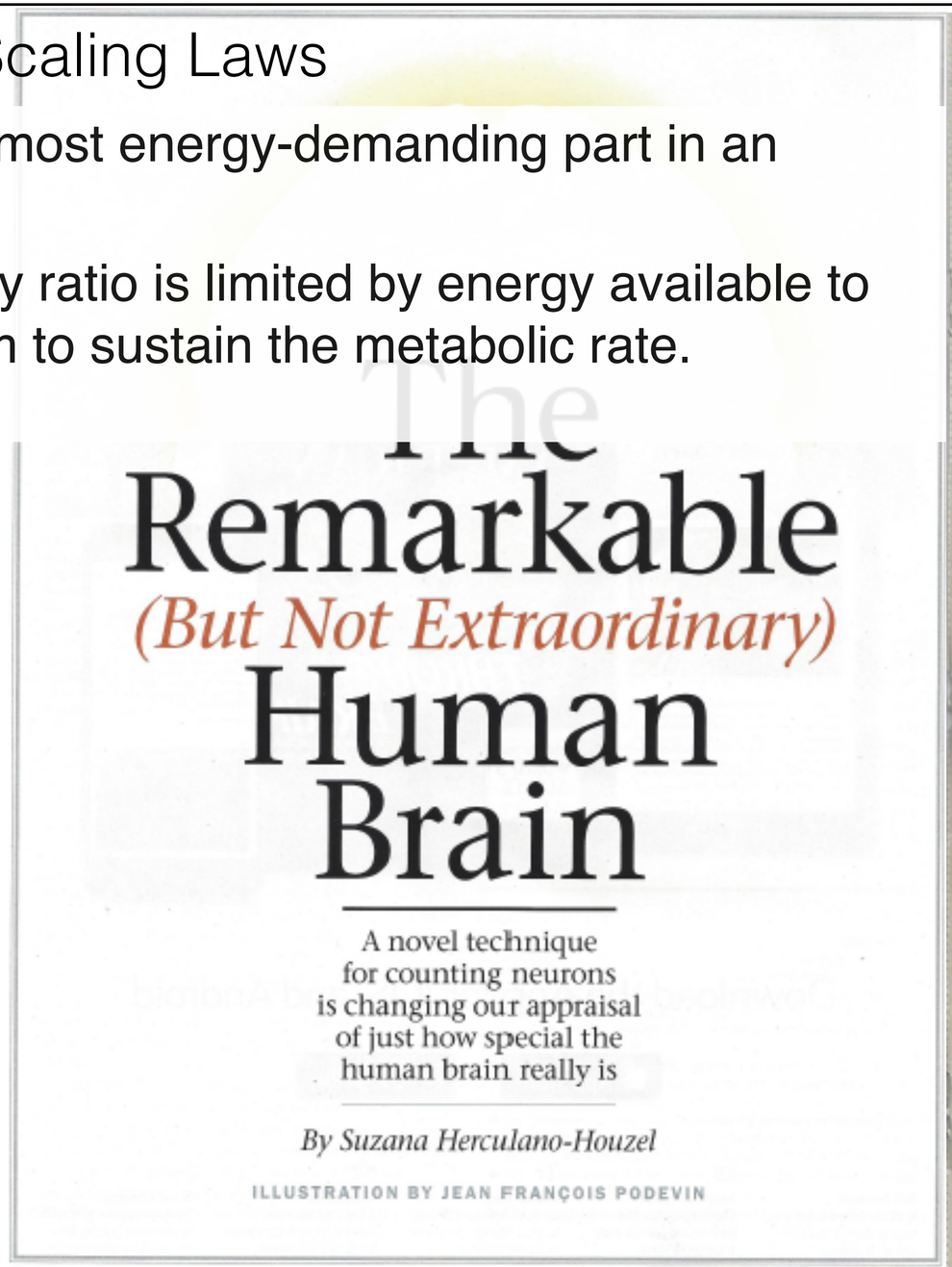


The Diagnosis: Leaving the “Safe Operating Space”

Breaking Scaling Laws

Brain is the most energy-demanding part in an organism.

Brain to body ratio is limited by energy available to the organism to sustain the metabolic rate.



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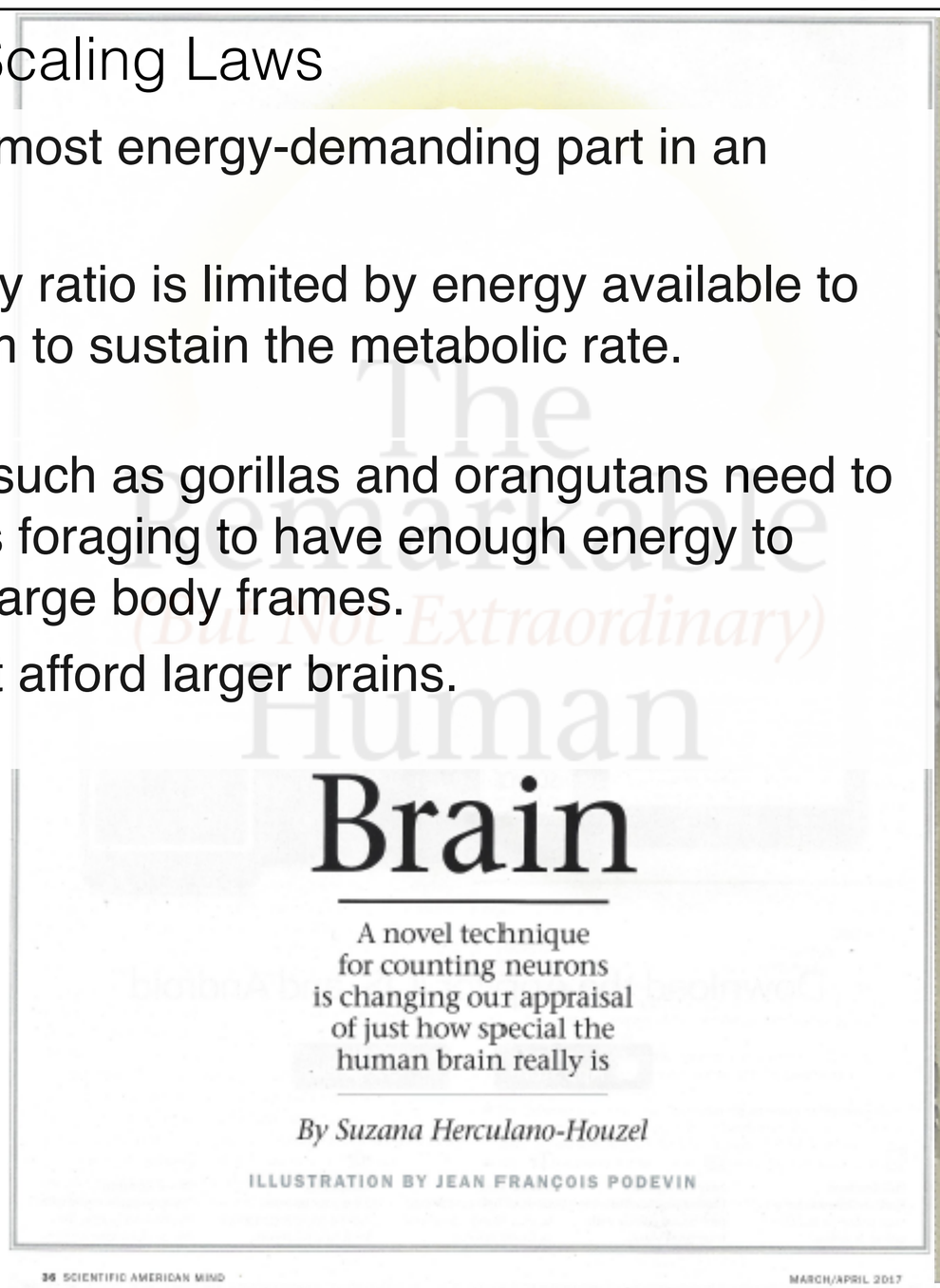
Great apes such as gorillas and orangutans need to spend hours foraging to have enough energy to sustain the large body frames.

They cannot afford larger brains.



Brain

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ILLUSTRATION BY JEAN FRANÇOIS PODEVIN

36 SCIENTIFIC AMERICAN MIND MARCH/APRIL 2017

The Diagnosis: Leaving the “Safe Operating Space”

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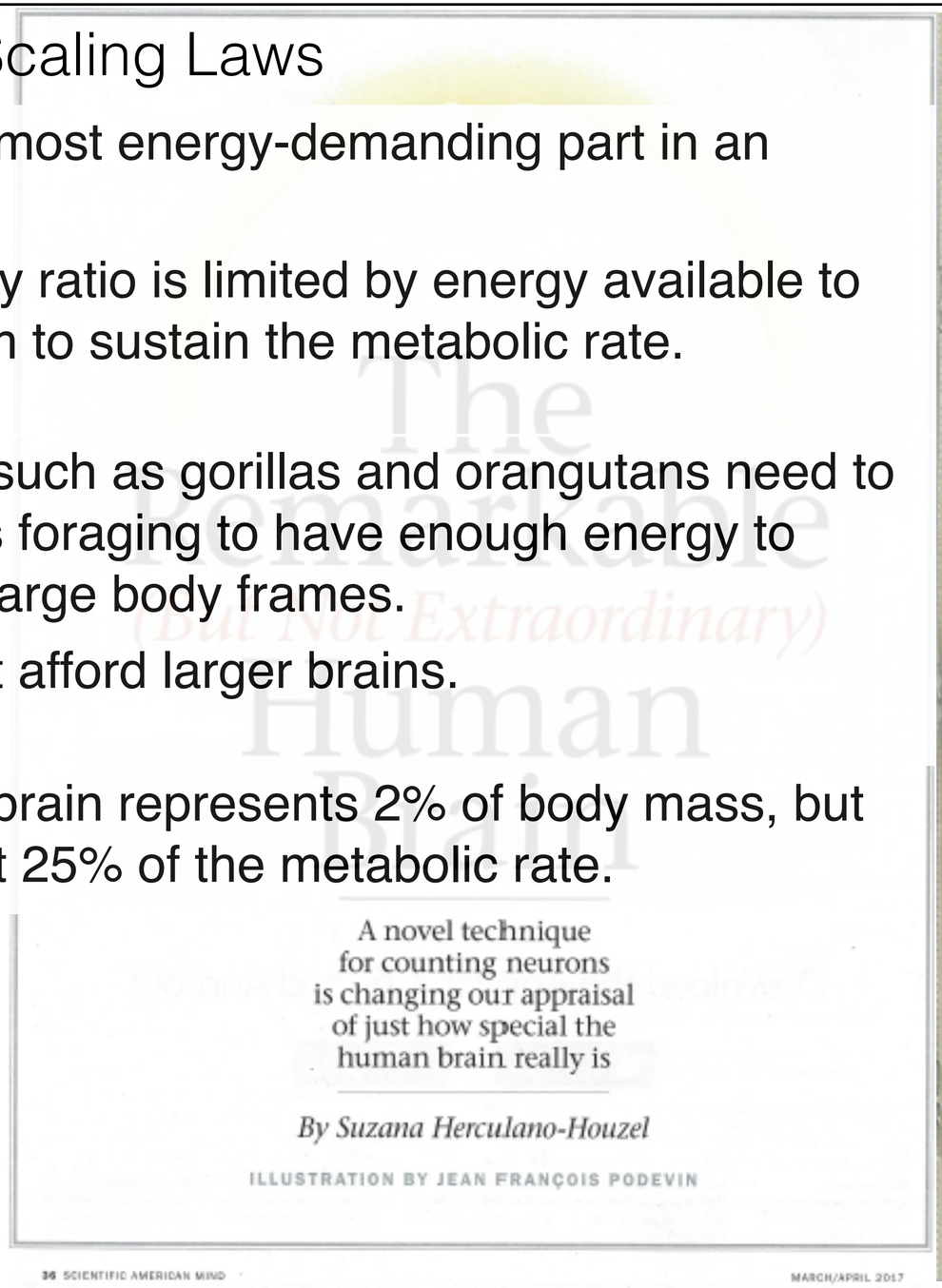
The human brain represents 2% of body mass, but it uses about 25% of the metabolic rate.



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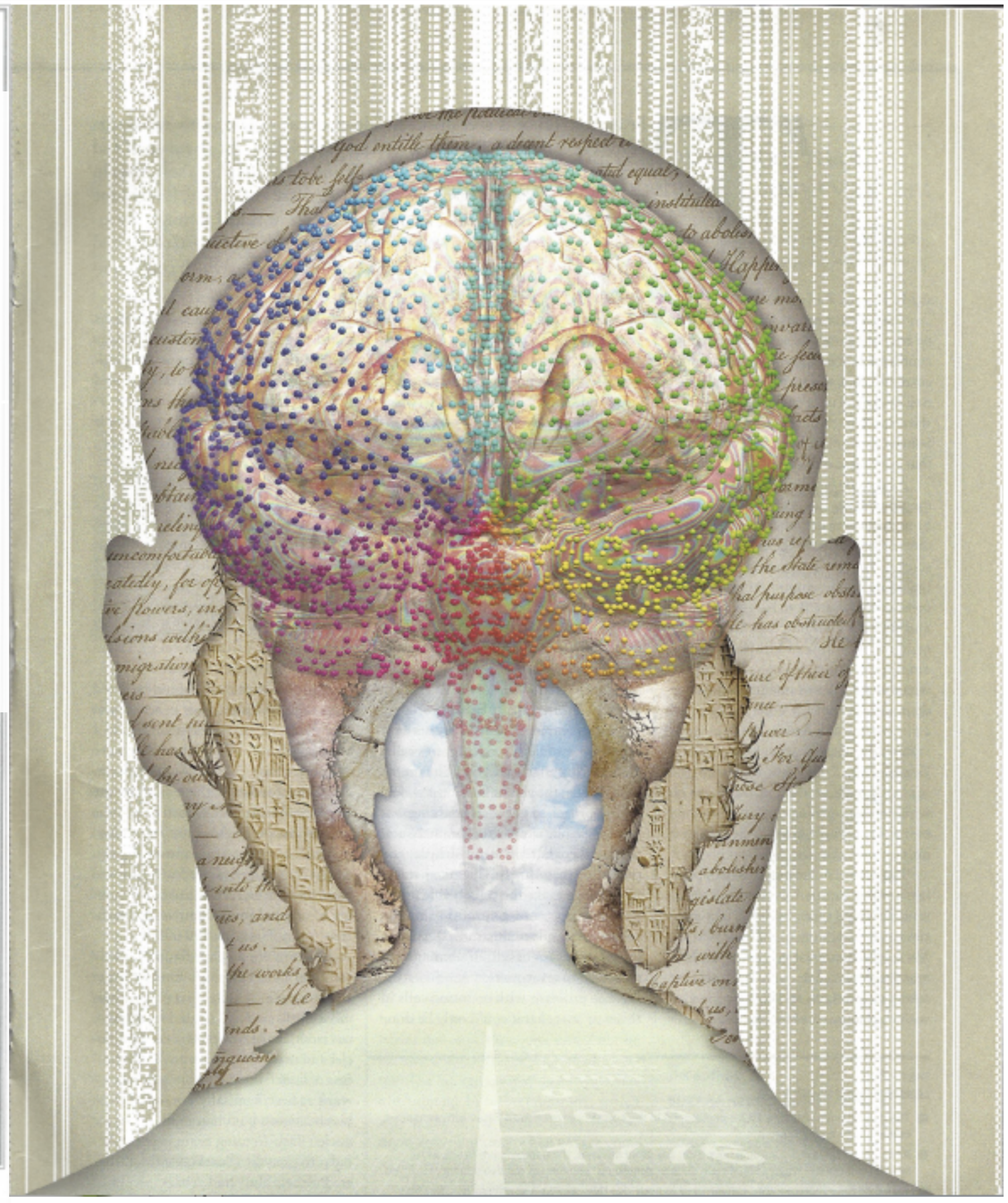
By Suzana Herculano-Houzel

ILLUSTRATION BY JEAN FRANÇOIS PODEVIN



The Diagnosis: Leaving the “Safe Operating Space”

Breaking Scaling Laws

Brain is the most energy-demanding part in an organism.

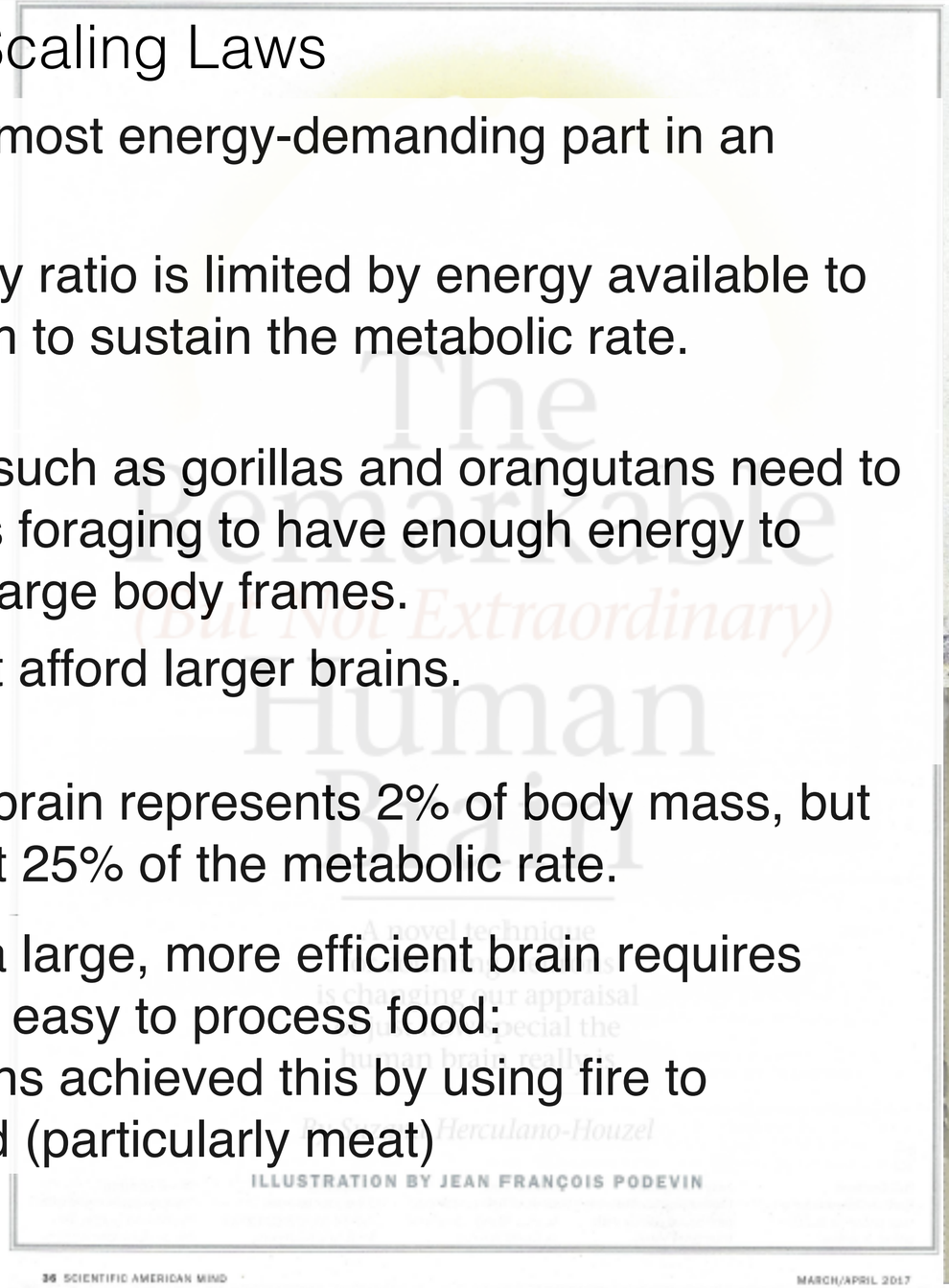
Brain to body ratio is limited by energy available to the organism to sustain the metabolic rate.

Great apes such as gorillas and orangutans need to spend hours foraging to have enough energy to sustain the large body frames.

They cannot afford larger brains.

The human brain represents 2% of body mass, but it uses about 25% of the metabolic rate.

Supporting a large, more efficient brain requires high-energy, easy to process food:
Homo sapiens achieved this by using fire to process food (particularly meat)



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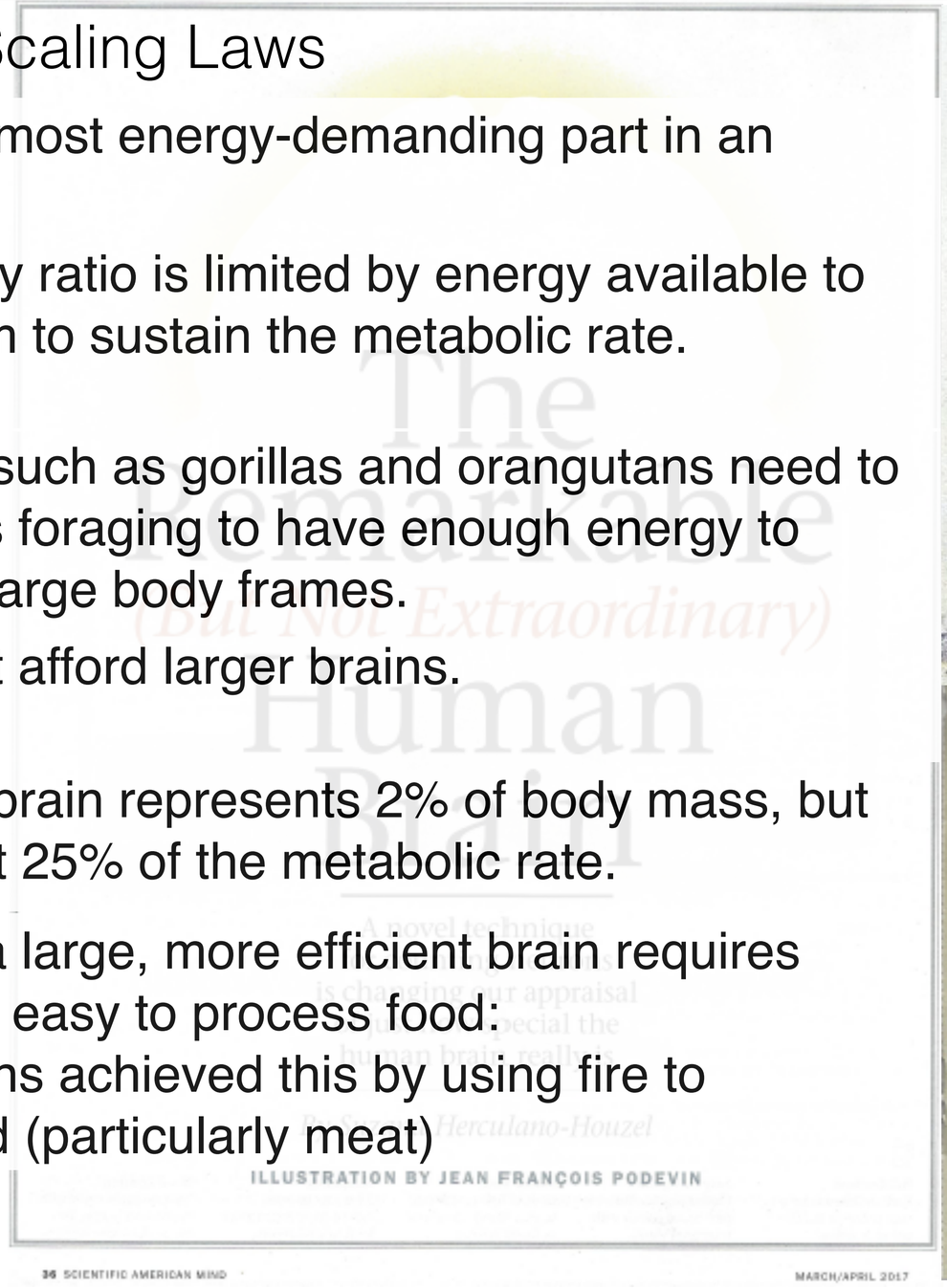
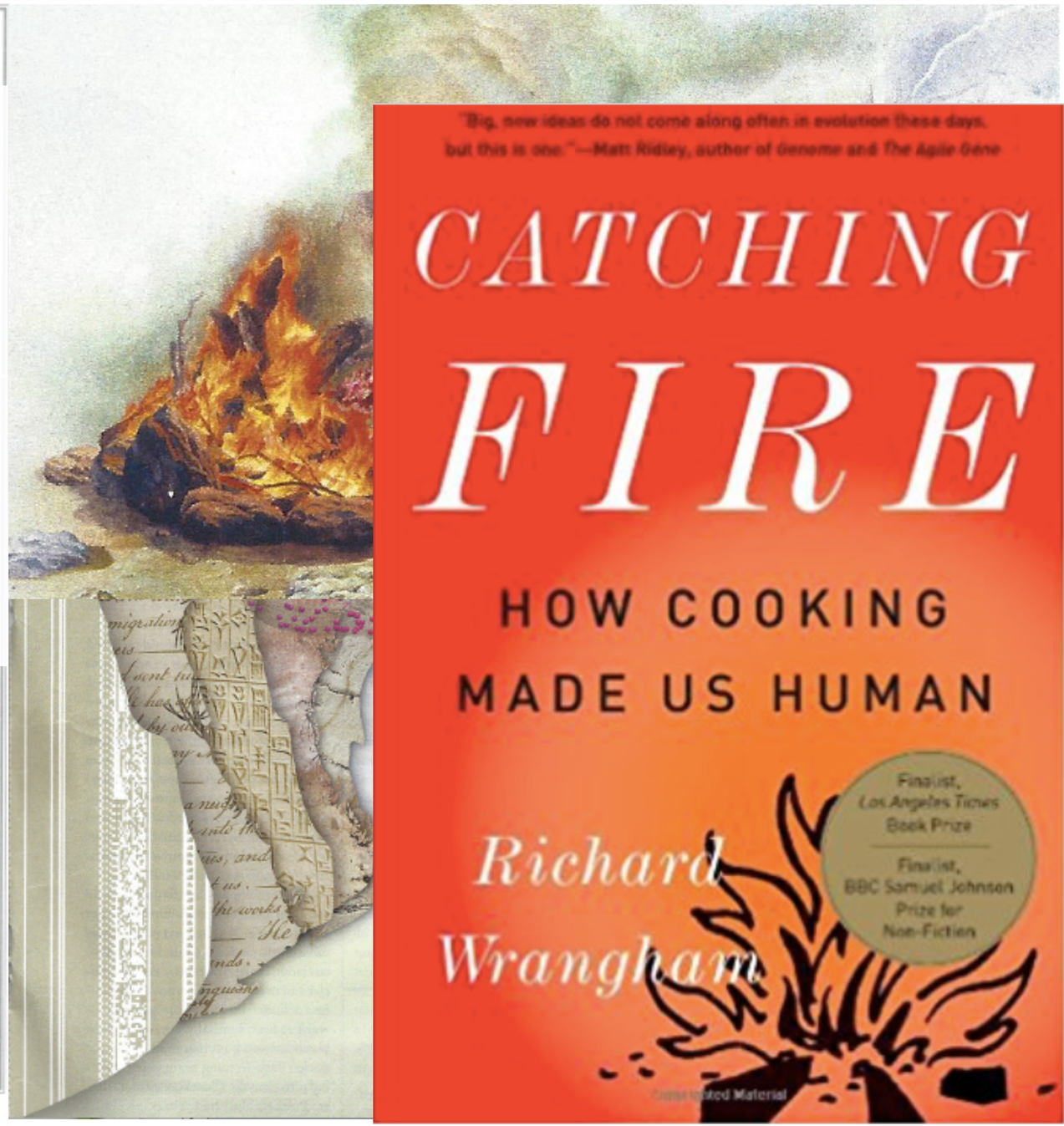
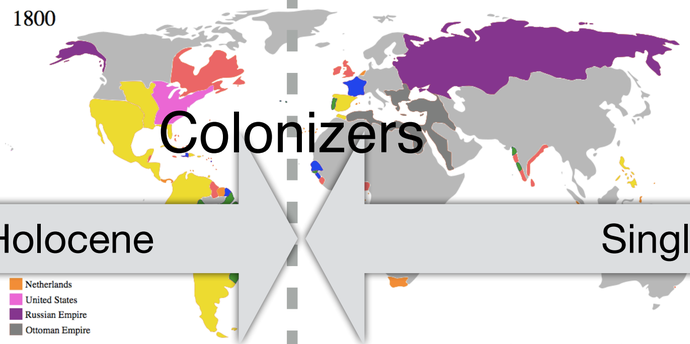




The Diagnosis: A New Economy and Global Order

Homo sapiens

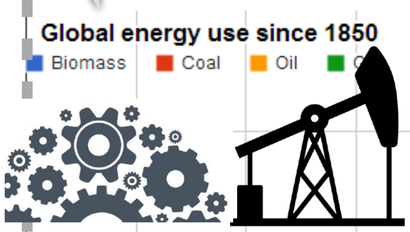


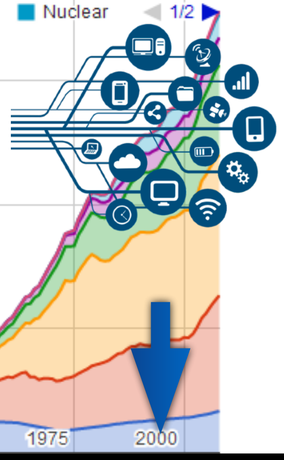
Colonizers

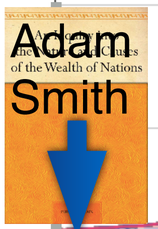
Holocene

Single-Species Dominance

Post-Holocene







10^6 10^5 10^4 10^3 Years BP 10^2 10^1 10^0 2000 10^1 10^2 Years 10^3

Population →

4 M 50 M 1.6 B 5.3 B 6.0 B 6.9 B 12 B? ?

Total energy use → <10^{-6} TW <10^{-3} TW 0.5 TW 10.0 TW 12.8 TW 16.5 TW >100.0 TW?

The Diagnosis: A New Economy and Global Order

Hom

Increasing food efficiency and reducing time needed to process food

Colonizers

Holocene

Single-Species Dominance

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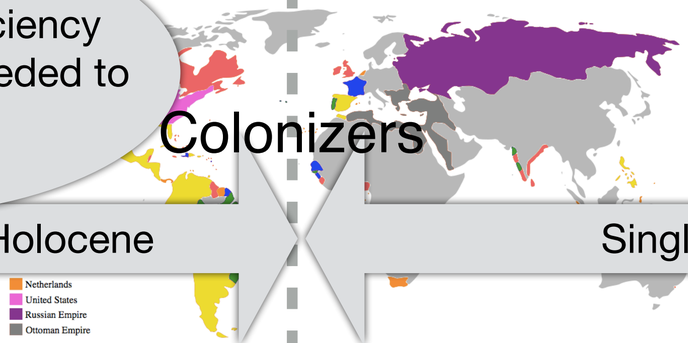

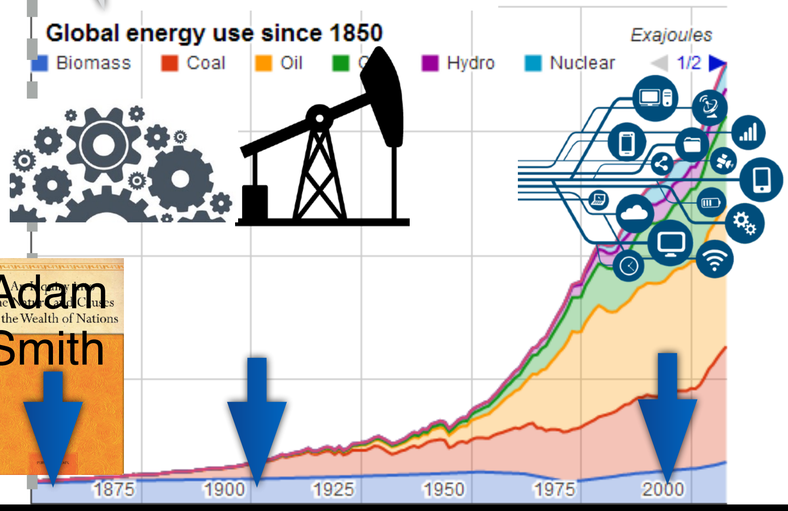

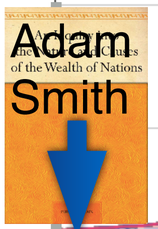

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Increasing food efficiency and reducing time needed to process food

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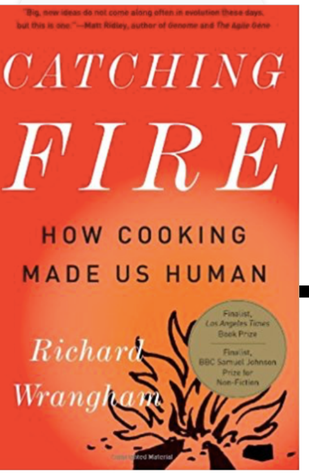
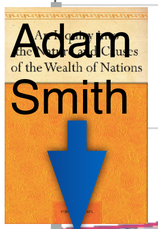
Holocene

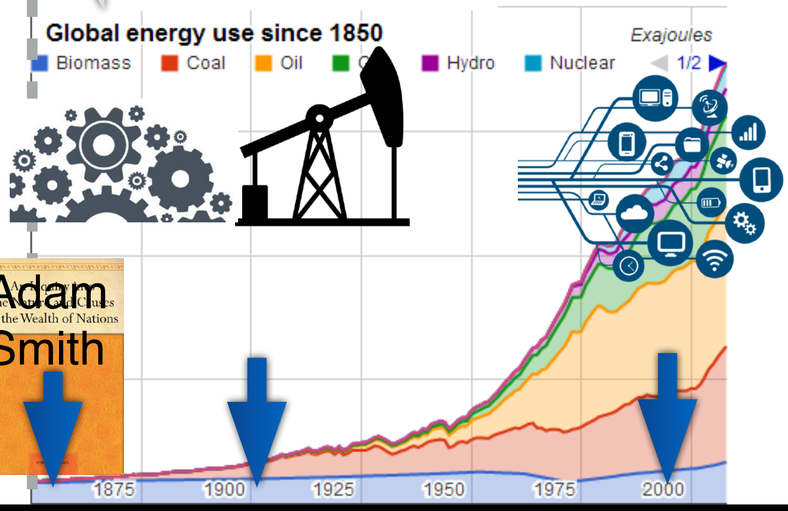
Single-Species Dominance

Post-Holocene

Netherlands
United States
Russian Empire
Ottoman Empire







10^5 10^4 10^3 10^2 10^1 10^0 10^1 10^2 10^3

Years BP — 2000 — Years

Population →

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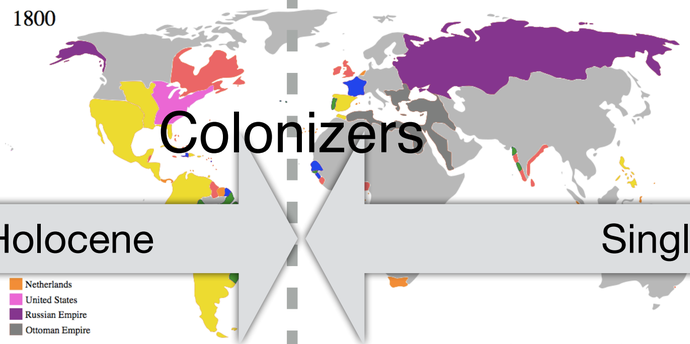
The Diagnosis: A New Economy and Global Order

Homo sapiens



Colonizers

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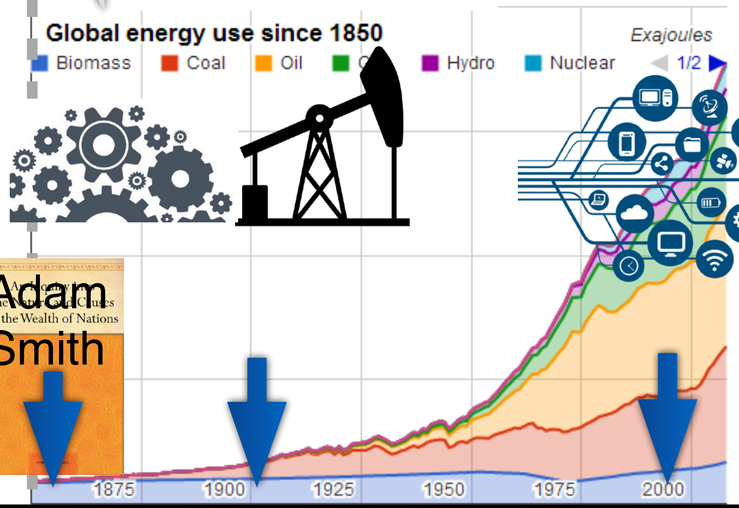
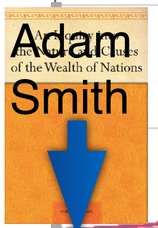




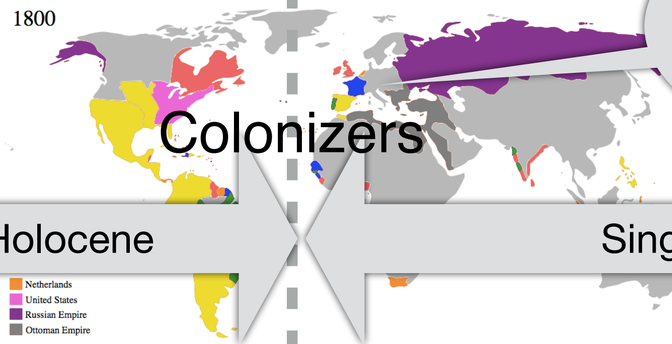
10^{4} 10^{3} Years BP 10^{2} 10^{1} 10^{0} 2000 10^{1} 10^{2} Years 10^{3}

Reducing time needed to obtain food

	4 M	50 M	1.6 B	5.3 B	6.0 B	6.9 B	12 B?	?
Total energy use →	<10^{-6} TW	<10^{-3} TW	0.5 TW	10.0 TW	12.8 TW	16.5 TW	>100.0 TW?	

The Diagnosis: A New Economy and Global Order

Homo sapiens



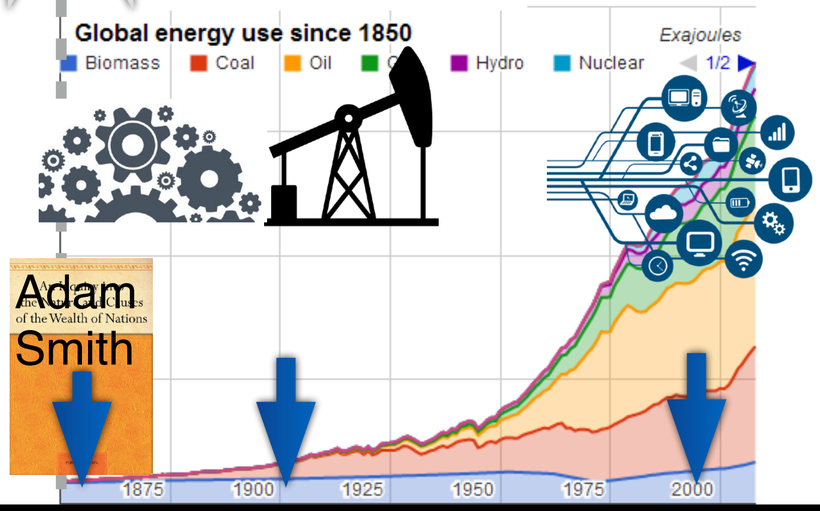
Colonizers

Increasing access to material resources

Holocene

Single-Species Dominance

Post-Holocene



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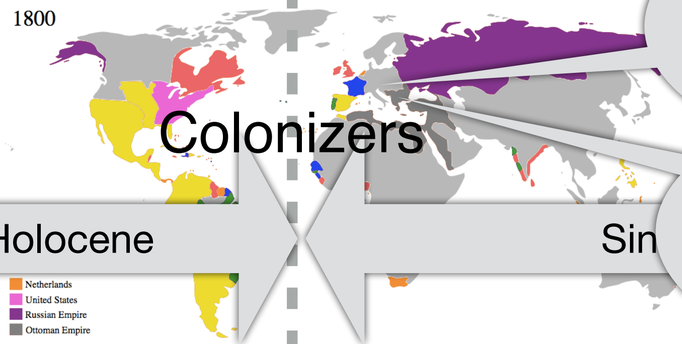


Colonizers

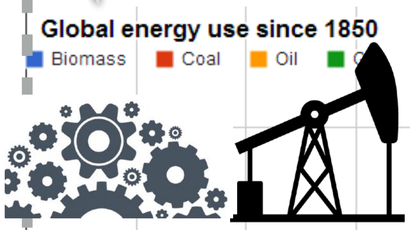
Increasing access to material resources

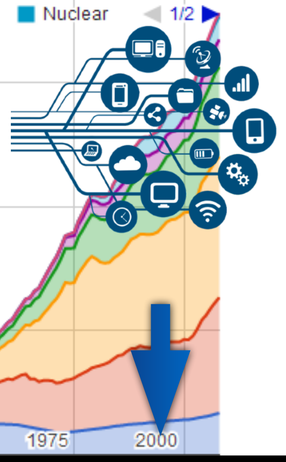
Mainly a (light-skinned) subspecies from Europe

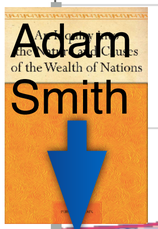
Holocene

Sin

Post-Holocene







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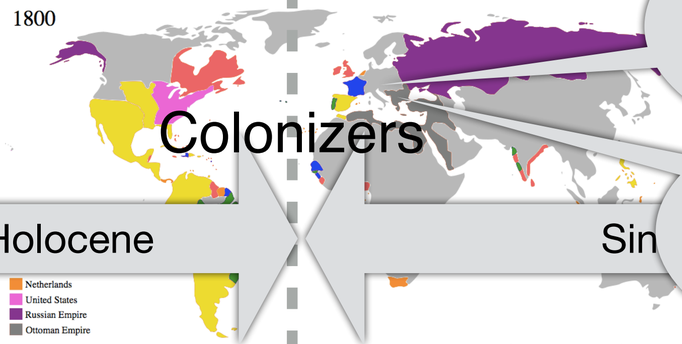

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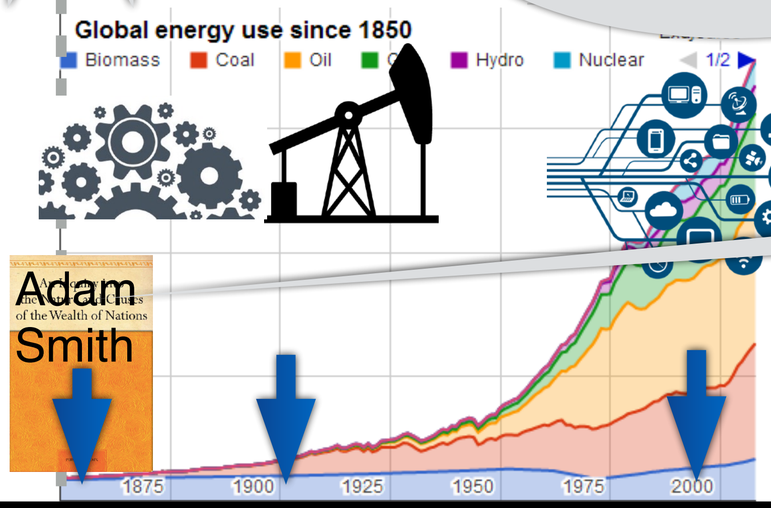

Overcoming extreme poverty:
Goal of economy is to create "human wealth"

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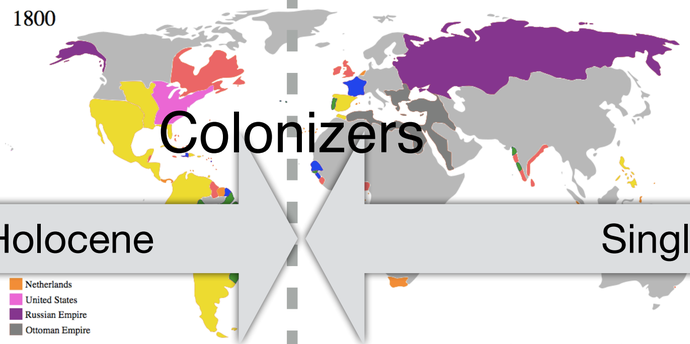


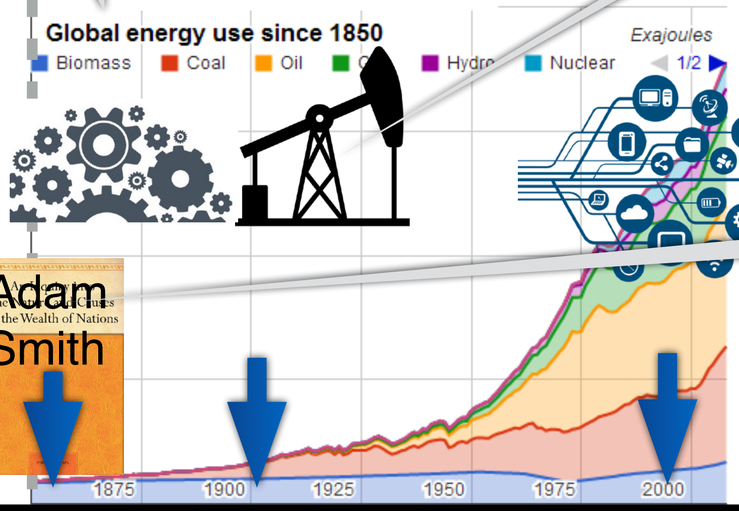
Colonizers

Holocene

Single-Species Dominance

Post-Holocene

Easy access to seemingly infinite energy combined with technology



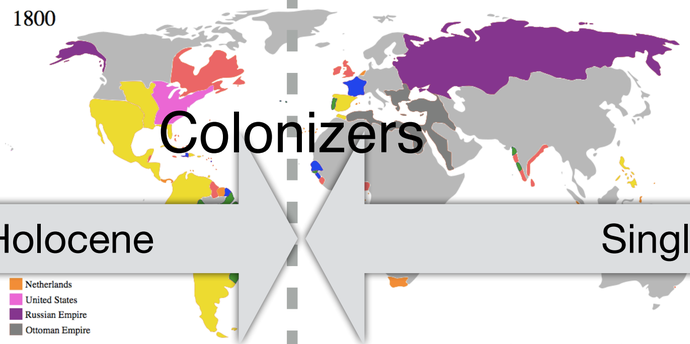
Adam Smith

Overcoming extreme poverty:
Goal of economy is to create "human wealth"

10^6	10^5	10^4	10^3	10^2	10^1	10^0	10^1	10^2	10^3
			Years BP			2000		Years	
Population →		4 M	50 M	1.6 B	5.3 B	6.0 B	6.9 B	12 B?	?
Total energy use →		$<10^{-6}$ TW	$<10^{-3}$ TW	0.5 TW	10.0 TW	12.8 TW	16.5 TW	>100.0 TW?	

The Diagnosis: A New Economy and Global Order

Homo sapiens



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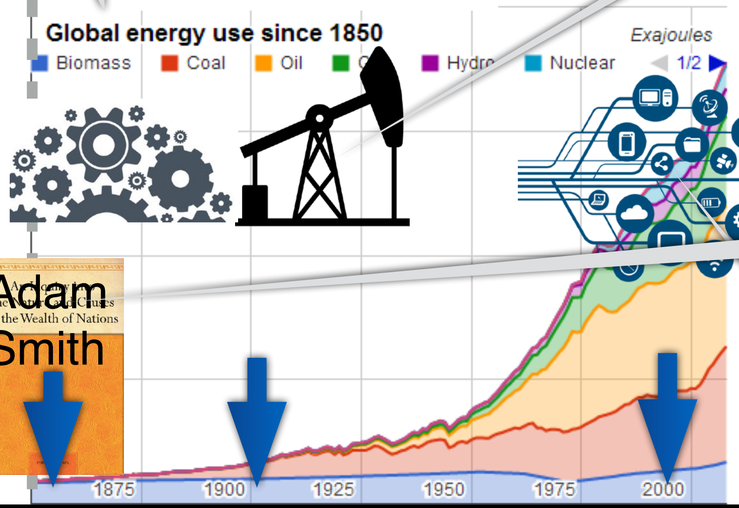

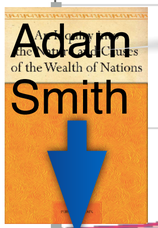

Easy access to seemingly infinite energy combined with technology

Overcoming extreme poverty:
Goal of economy is to create "human wealth"

Technology and access to fossil fuels facilitate economic growth

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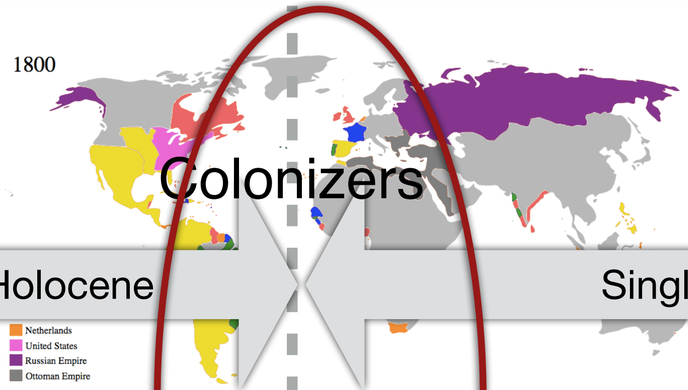

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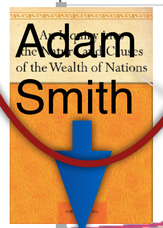

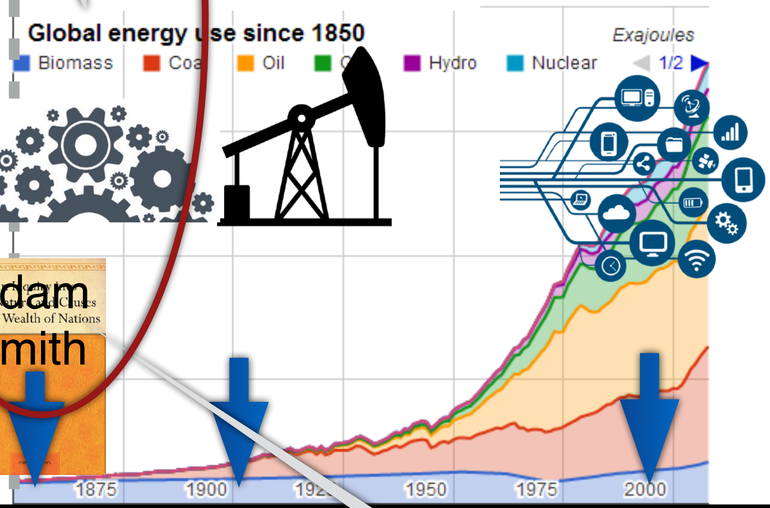

10^6 10^5 10^4 10^3 Years BP 10^2 10^1 10^0 10^1 10^2 10^3 Years

Accumulate, accumulate, …

Population →

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The Diagnosis: A New Economy and Global Order

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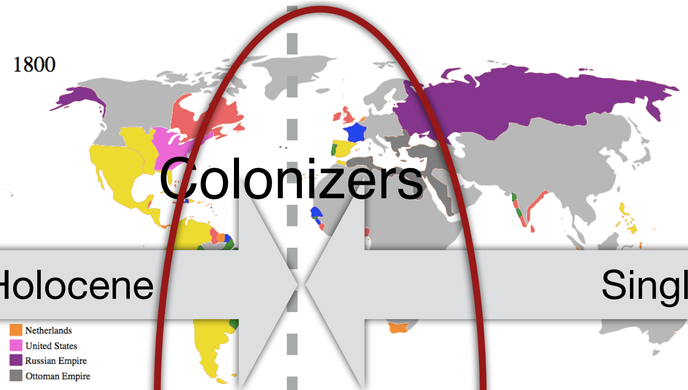

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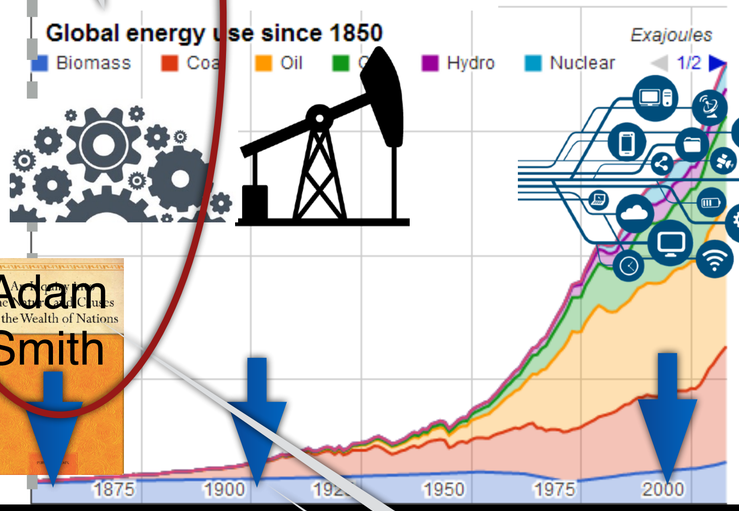
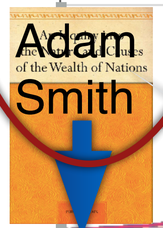




10^6 10^5 10^4 10^3 10^2 10^1 10^0 10^1 10^2 10^3

Years BP

Years

Population →

4 M 50 M 1.6 B 5.3 B 12 B? ?

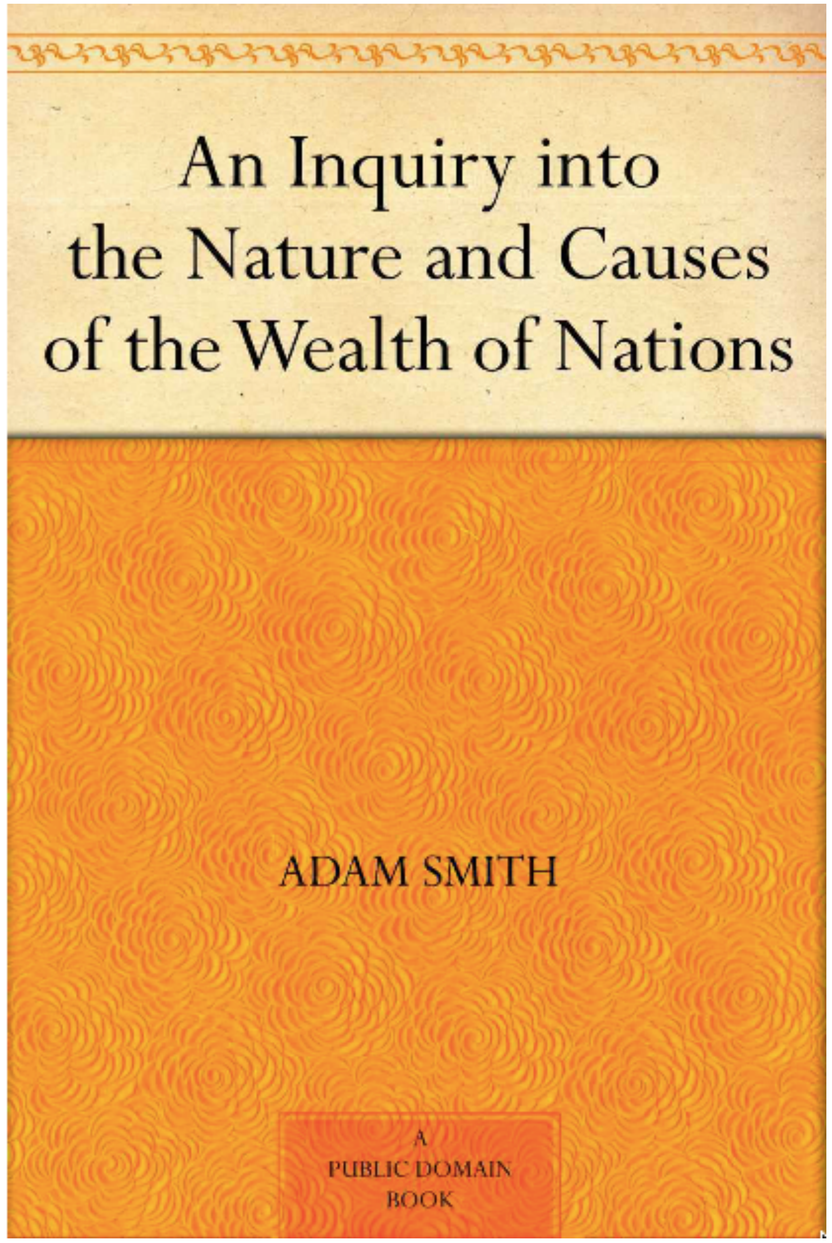
Accumulate, accumulate, …

Consume, consume, …

Total energy use → <10^{-6} TW <10^{-3} TW 0.5 TW 10.0 TW >100.0 TW?

The Diagnosis: A New Economy and Global Order

Role of Mainstream Economic Model



Published in 1776

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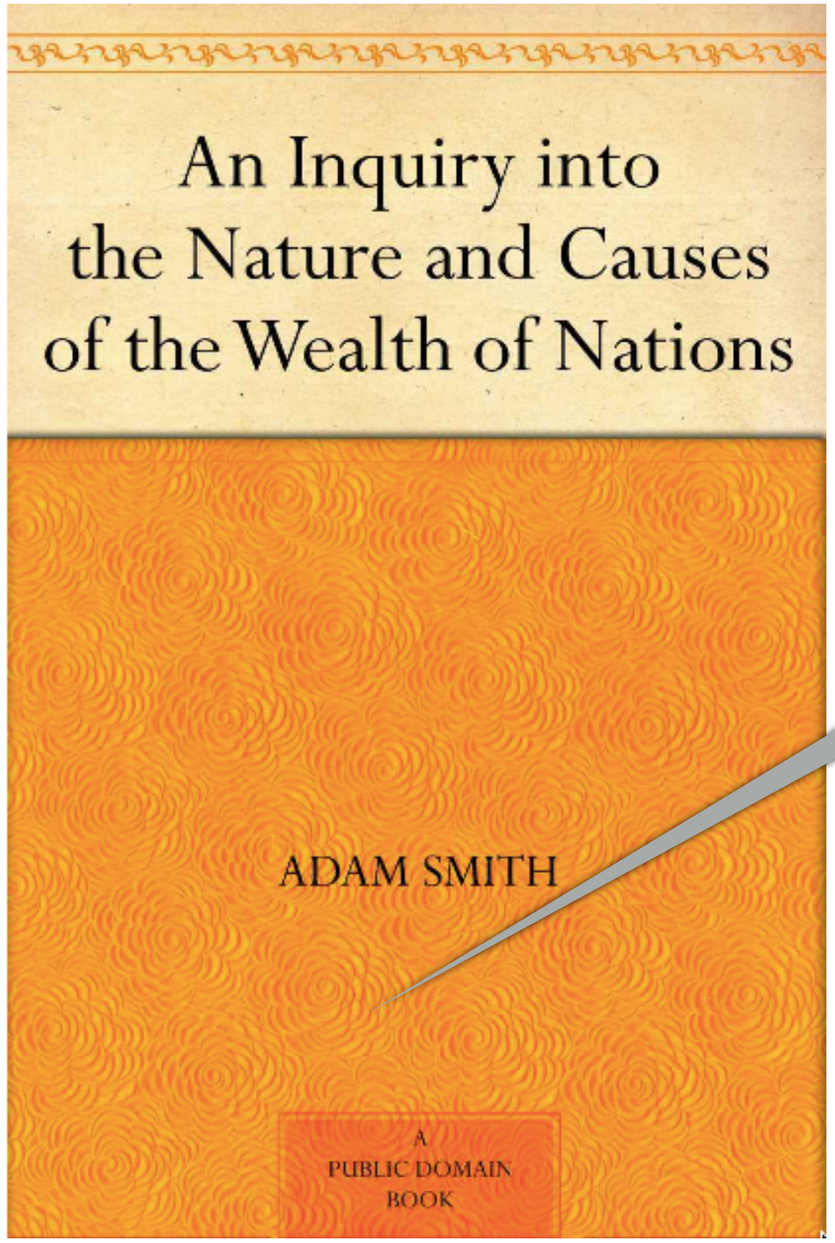
Role of Mainstream Economic Model



Economy: the “invisible hand”

Assumption:
Agents independently seeking their own gain will produce the overall best result for society

Published in 1776

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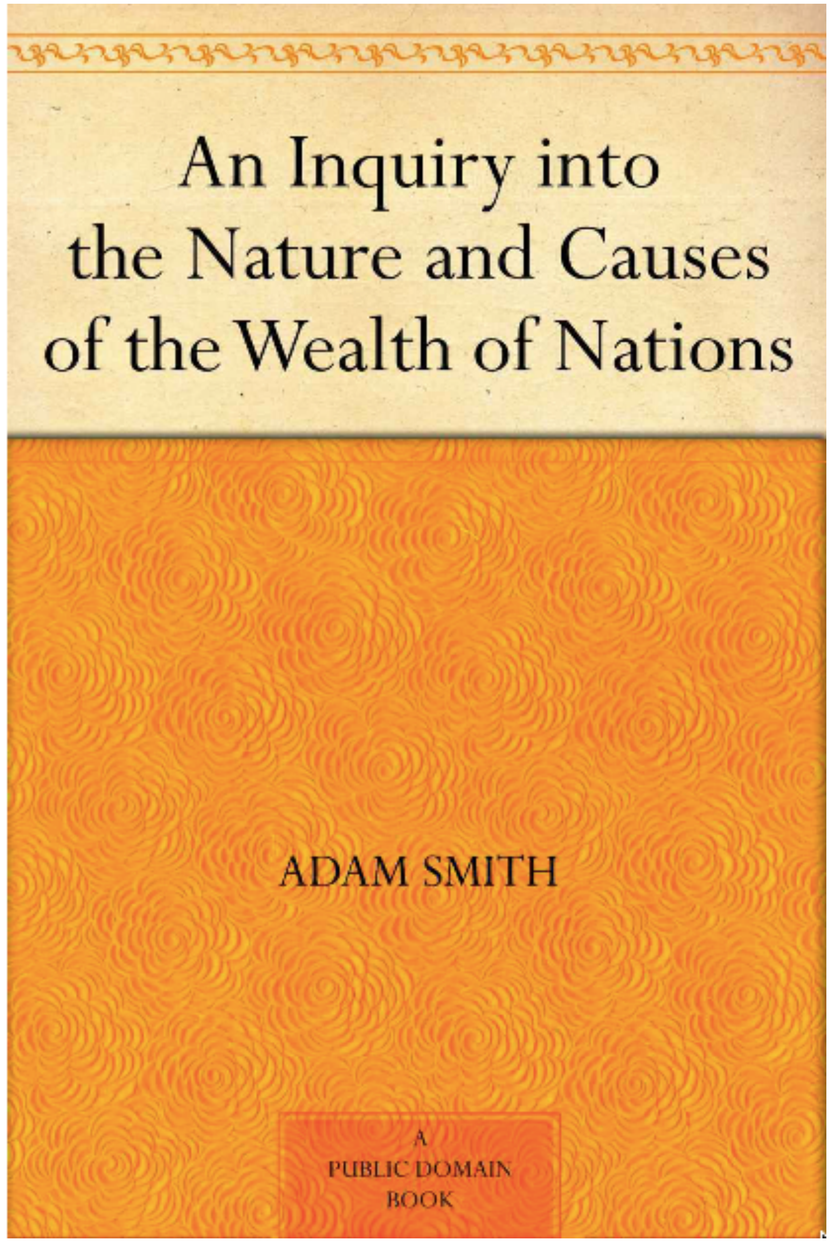
Role of Mainstream Economic Model



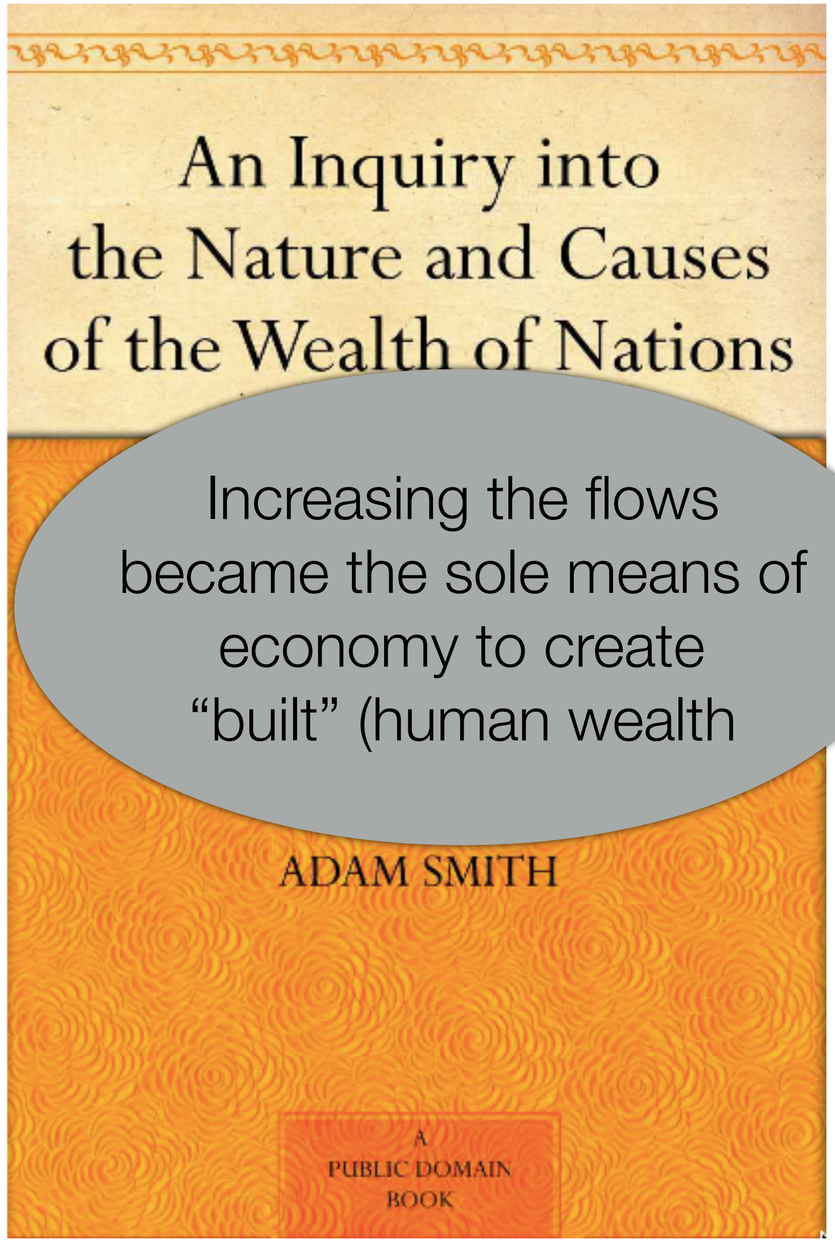
Published in 1776

The current mainstream model of the global **economy is based on a number of assumptions** about the way the world works, what the economy is, and what the economy is for. These assumptions arose in an earlier period, when the world was relatively empty of humans and their artifacts. Built capital was the limiting factor, while natural capital was abundant. It made sense not to worry too much about environmental "externalities," since they could be assumed to be relatively small and ultimately solvable. It also made sense to focus on the growth of the market economy, as measured by gross domestic product (GDP), as a primary means to improve human welfare. And it made sense to think of the economy as only marketed goods and services and to think of the goal as increasing the amount of these that were produced and consumed.

The Worldwatch Institute. State of the World 2013: Is Sustainability Still Possible? (Kindle Locations 2921-2927). Island Press. Kindle Edition.

The Diagnosis: A New Economy and Global Order

Role of Mainstream Economic Model



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Increasing the flows became the sole means of economy to create "built" (human wealth

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Role of Mainstream Economic Model

For almost a century, the **consumption of products has been the dominant paradigm and mindset**.

John Maynard Keynes (*"The General Theory of Employment, Interest and Money"*, 1936):*"I should support at the same time all sorts of policies for increasing the propensity to consume. For it is unlikely that full employment can be maintained, whatever we may do about investment, with the existing propensity to consume."*

Victor Lebow (1955): *"Our enormously productive economy … demands that we make consumption our way of life, that we convert the buying and use of goods into rituals, that we* ***seek our spiritual satisfaction, our ego satisfaction, in consumption*** *… we need* ***things consumed, burned up, replaced and discarded at an ever-accelerating rate****."*

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In 1970, Milton Friedman argued that businesses' sole purpose is to generate profit for shareholders.

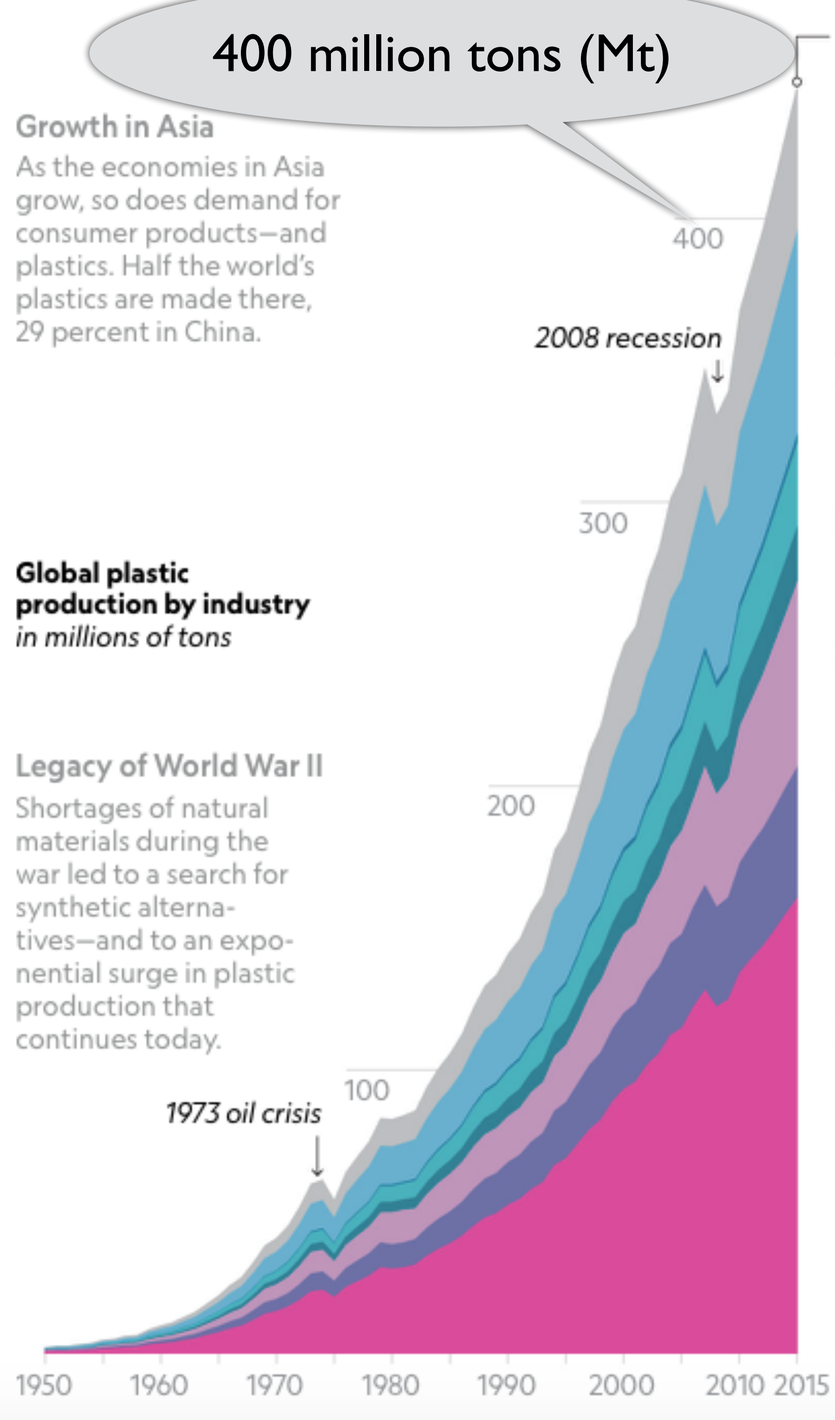
This led to globalization …

The Diagnosis: Le

A LIFETIME OF PLASTIC

The first plastics made from fossil fuels are just over a century old. They came into widespread use after World War II and are found today in everything from cars to medical devices to food packaging. Their useful lifetime varies. Once disposed of, they break down into smaller fragments that linger for centuries.

400 million tons (Mt)



Total
448 million tons produced in 2015

448 Mt in 2015

Other
52 million
includes health care and agriculture
5 years ◄ The average time plastics are used before they're discarded.

Average usetime: 5 years

Building and construction
72 million
35 years

Industrial machinery
3 million
20 years

Transportation
30 million
13 years

Electrical
19 million
8 years

Textiles
65 million
5 years

Consumer products
46 million
3 years

Packaging
161 million
Less than six

Build.+Const.:	72 Mt, 35 yrs
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The largest market for plastics today is for packaging materials. That trash now accounts for nearly half of all plastic waste generated globally; most of it never gets recycled or incinerated.

161Mt < 6 months

JASON TREAT AND RYAN WILLIAMS, NGM STAFF
SOURCE: ROLAND GEYER, UNIVERSITY OF CALIFORNIA, SANTA BARBARA

https://www.nationalgeographic.com/magazine/2018/06/plastic-planet-waste-pollution-trash-crisis/

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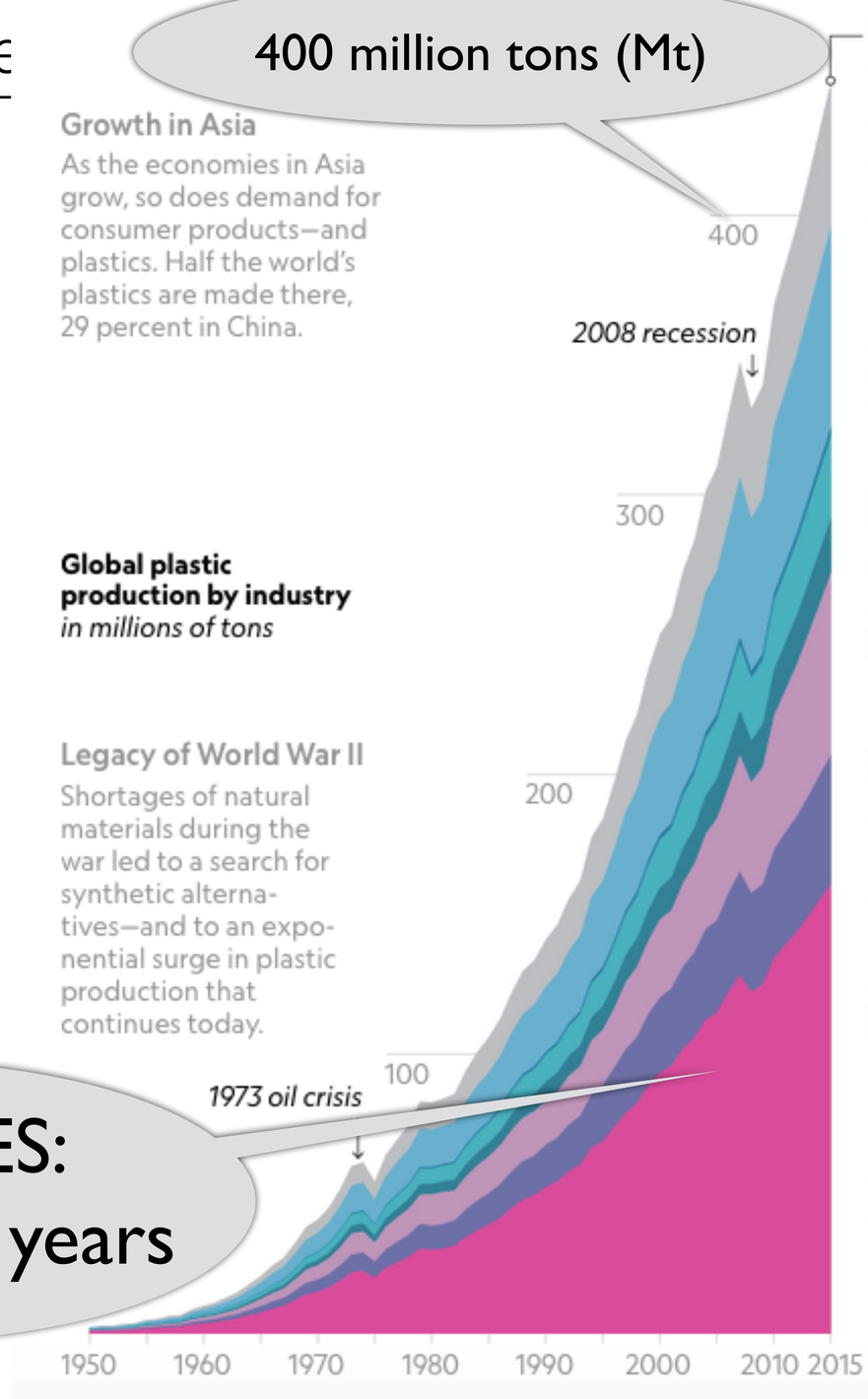

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LIFETIMES: 100 to 5000 years

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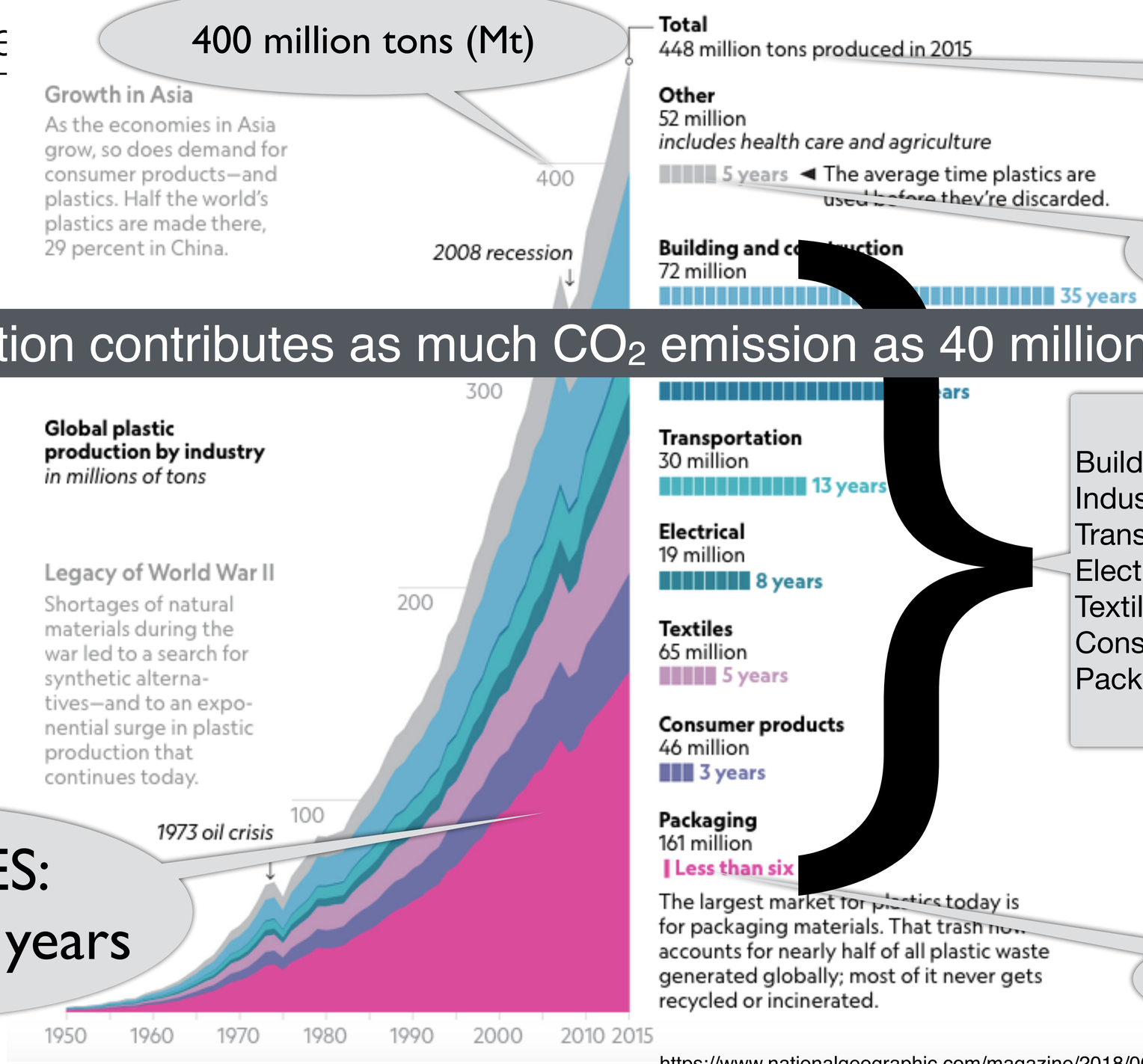
Production contributes as much CO_2 emission as 40 million cars



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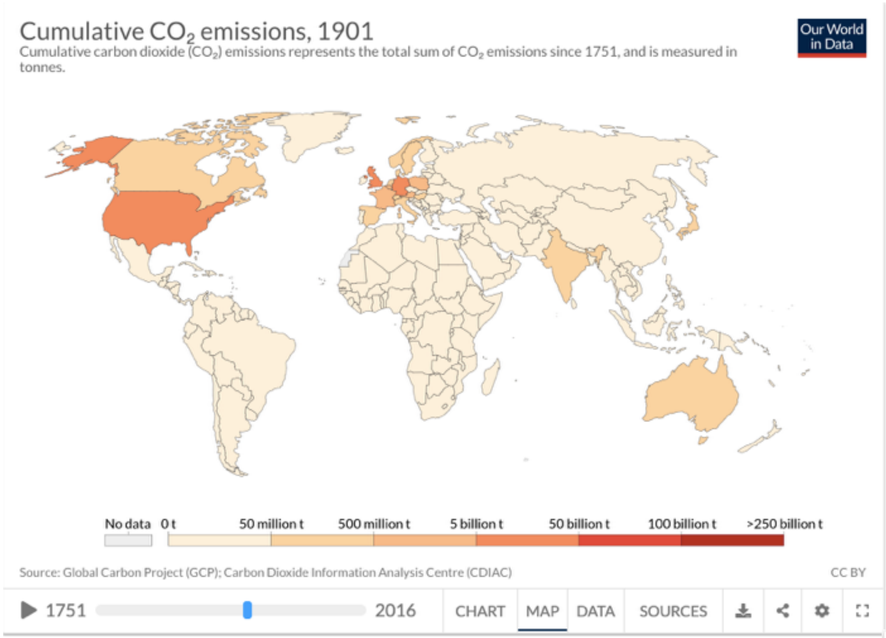
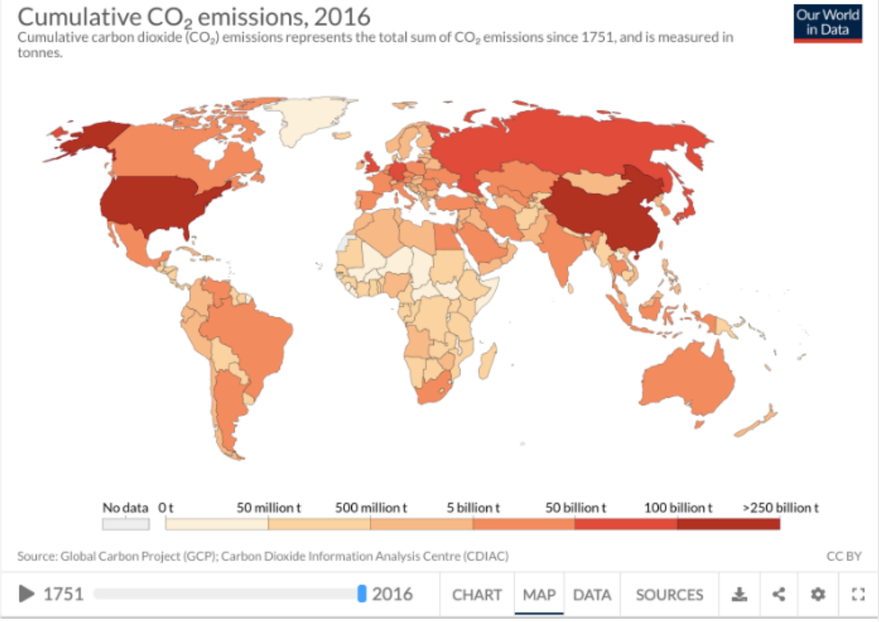
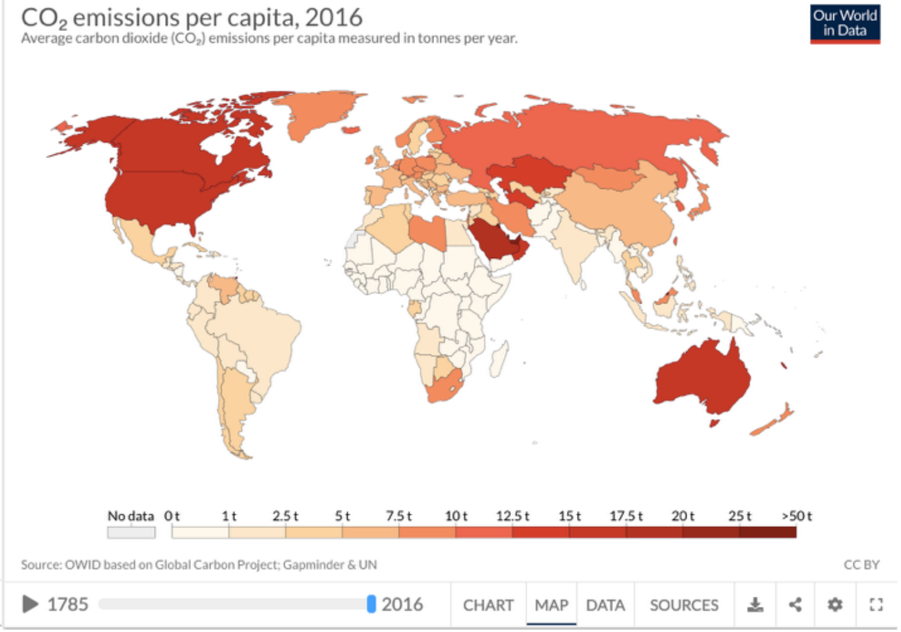
The Diagnosis: A New Economy and Global Order

Inequality of Emissions:
- geographically

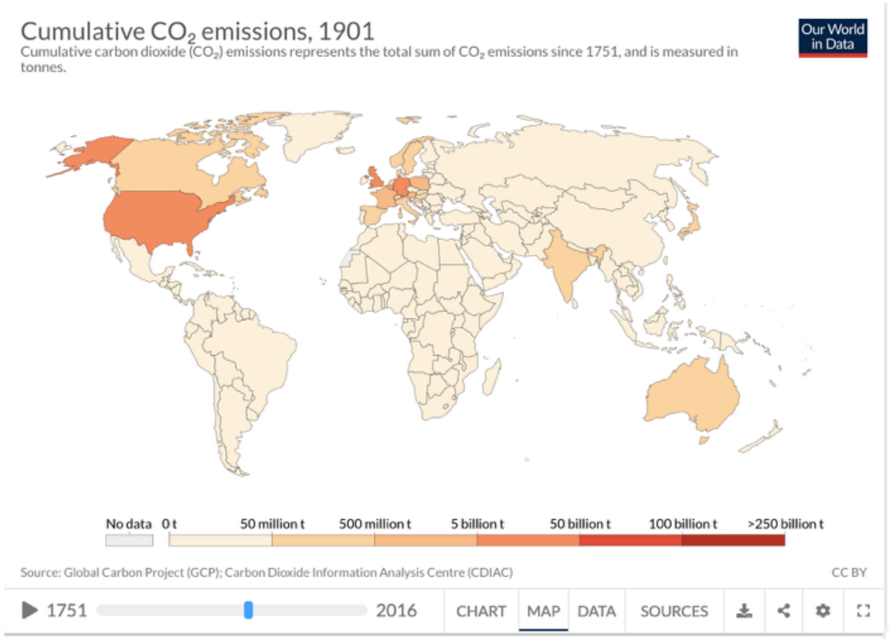


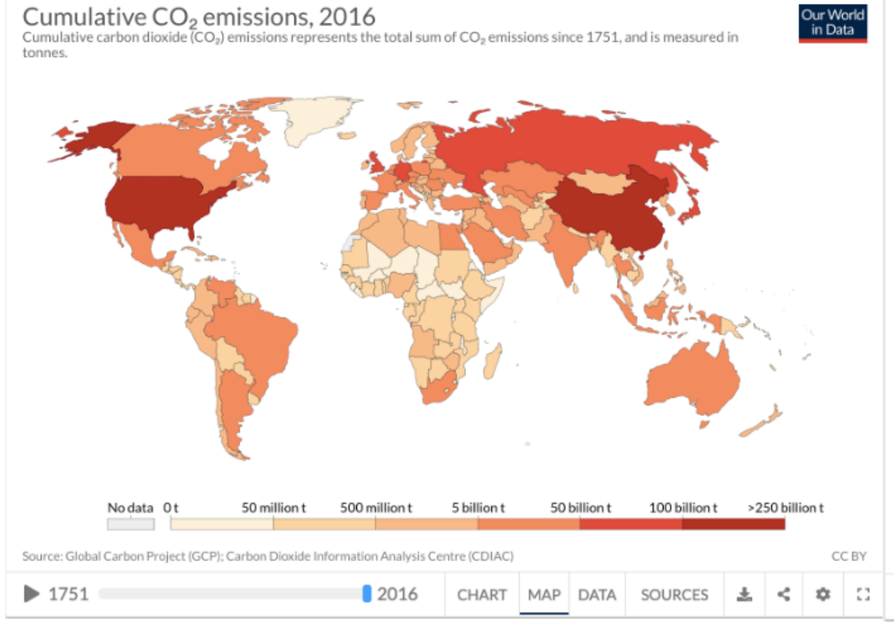




The Diagnosis: A New Economy and Global Order

Inequality of Emissions:
- geographically
- with wealth





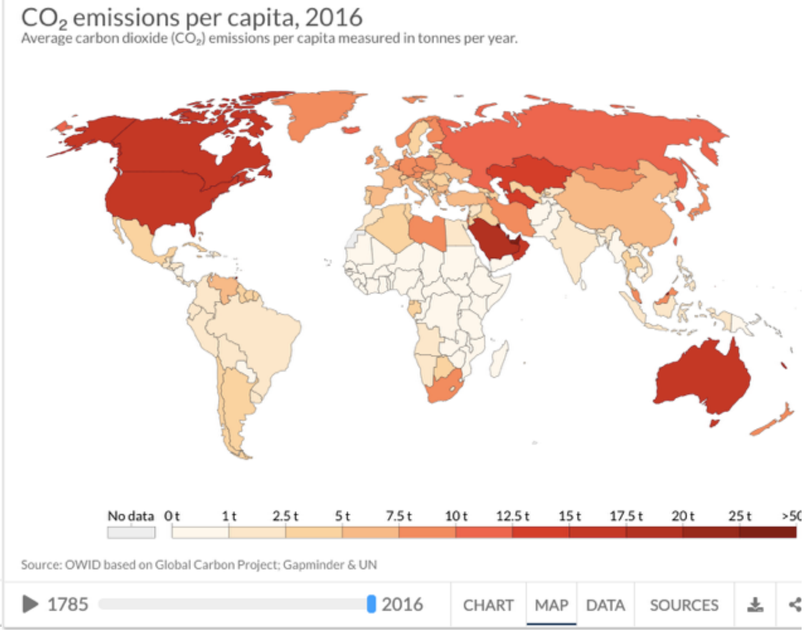


Figure 1: Global income deciles and associated lifestyle consumption emissions

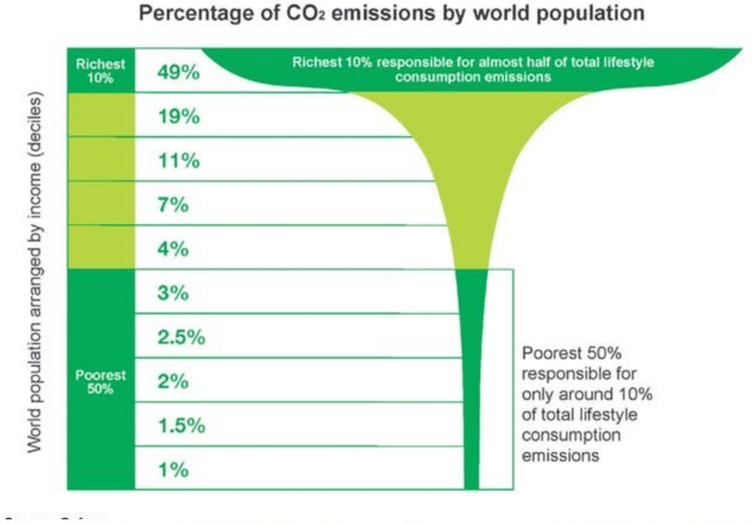
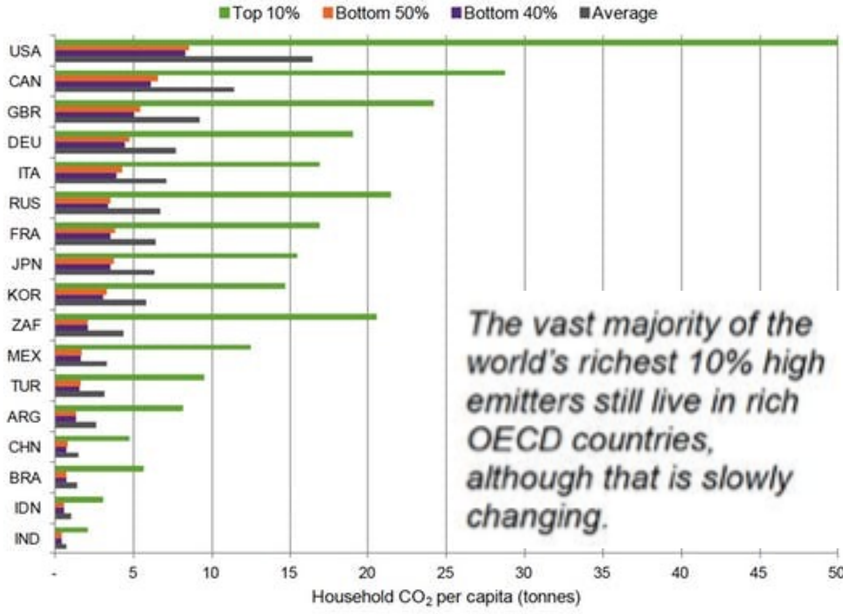


Figure 4: Per capita lifestyle consumption emissions in G20 countries for which data is available



Key Points

Baseline

During the Holocene, climate and sea level were exceptionally stable.

The Holocene was a “safe operating space for humanity” allowing the emergence of a dominant species

Syndrome

During the last few hundred years, humanity has made large and rapid planetary changes, accelerated existing and introduced new flows in the planetary physiology.

The system is outside the “normal range” and in the dynamic transition into the Post-Holocene.

Diagnosis

Easy access to seemingly unlimited energy allowed humans to accelerate flows in the Earth’s life-support system and sustain rapid population growth and increasing demands.

The new mainstream economic model and a changed global order has turned humans into the “Anthropogenic Cataclysmic Virus” (ACV) in the Earth’s life-support system.

Modern Climate Change:
A Symptom of a Human-Caused High-Energy Pulse

Contents