
Climate Change and Transition Studies

An Interactive Online Learning Initiative

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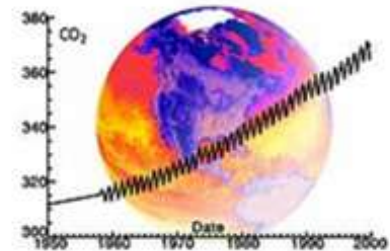
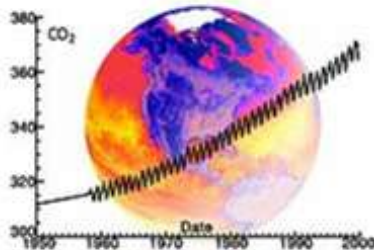
created by

Timothy C. Weiskel

Research Director, *Cambridge Climate Research Associates*

Climate Science for Human Survival

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Session 3

Earth's Changing Climate: Causes and Global Consequences

26 July 2018

In this session we will explore...

- The important question of ***Scale***:

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- The important question of **Scale**:
 - The main or “forcing mechanisms” or “drivers” of Earth’s changing climate in “deep time” and “historical time.”

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- The important question of **Scale**:
 - The main or “forcing mechanisms” or “drivers” of Earth’s changing climate in “deep time” and “historical time.”
- What is the “relevant scale” for humans?
 - (both deep time & historical time are important.) Our climate is influenced by multiple forcing mechanisms but *anthropogenic forcing* has become prominent, and perhaps dominant in recent centuries.

In this session we will explore...

- Why has anthropogenic behavior become a “forcing mechanism” in climate change?

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 - Because of the “energy demands” for fossil fuel consumption across the globe in the past two centuries.

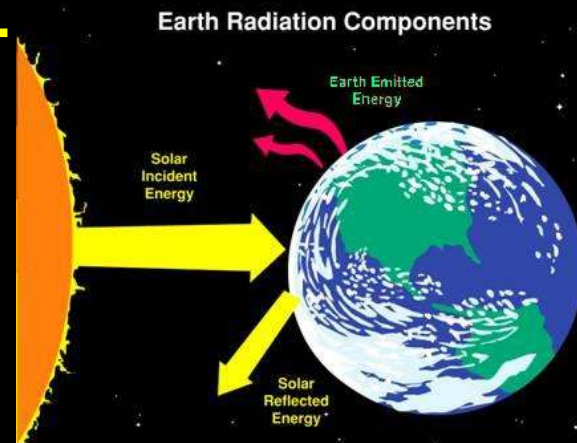
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 - Because of the “energy demands” for fossil fuel consumption across the globe in the past two centuries.

In effect, humans are burning terrestrial carbon (that has taken nature hundreds of millions of years to store in the Earth) in a geological “split second.” This has changed the composition of the atmosphere.

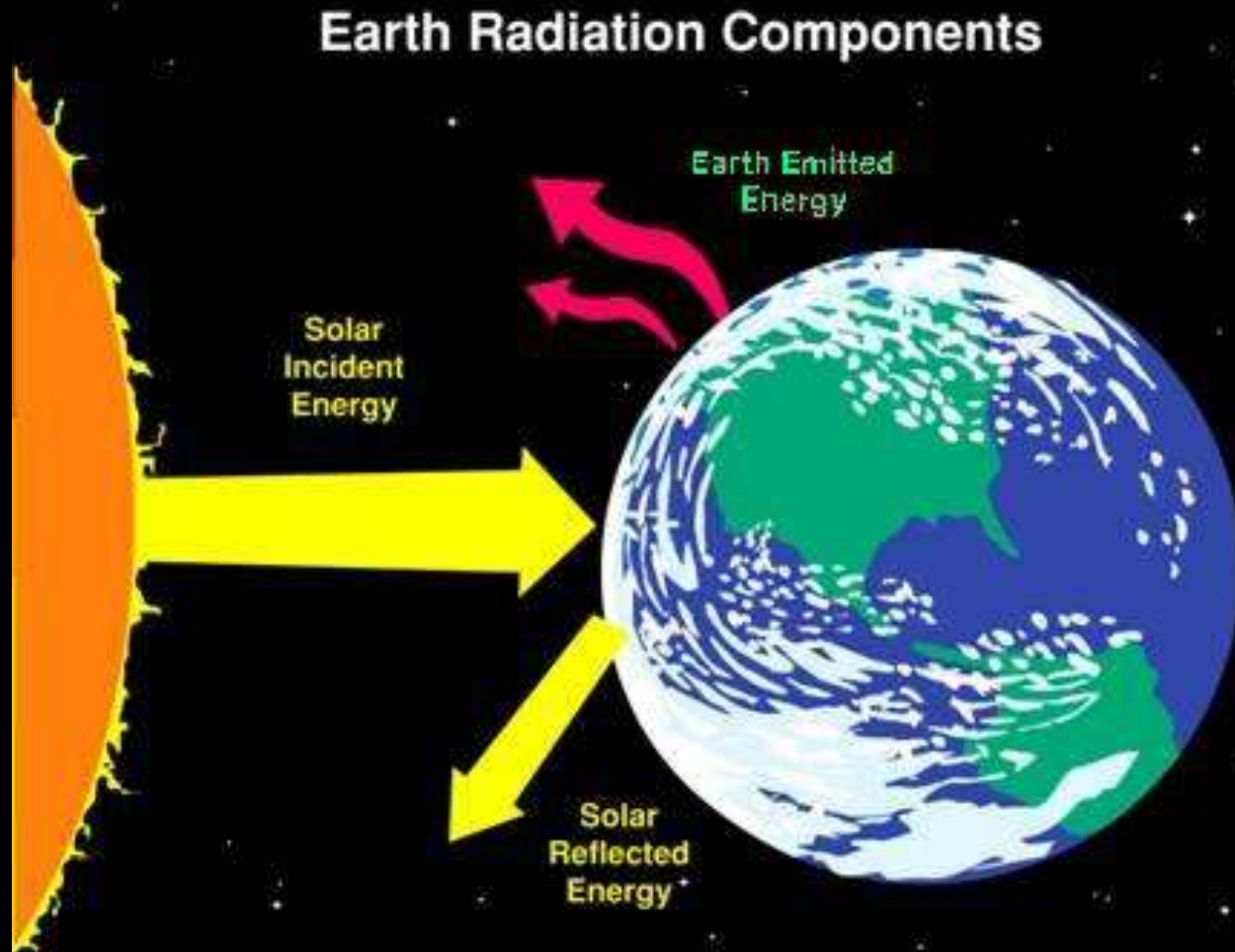
In this session we will explore...

- The changed composition of the atmosphere has changed the “energy budget” of the Earth because the gas CO₂ serves as a “blanket” -- it allows sunlight to pass into the earth but slows the transmission of heat through it to escape to outer space..



What is Earth's "Energy Budget?"

The sunlight that is converted to heat energy at Earth's surface needs to be radiated back into space to keep the "energy budget" in balance. Green house gases (GHG) inhibit the radiation of heat back into space and Earth warms up.



To understand humanity's current problem,
let's look at the ultimate source of the
electrical energy in *just one city*: New York...



<https://environmentaljusticetv.wordpress.com/2018/07/26/treasures-of-the-earth-power-nova-pbs/>

Total current dependence of industrial societies on burning of fossil fuels... (instead of what other sources?)



<https://environmentaljusticetv.wordpress.com/2018/07/26/treasures-of-the-earth-power-nova-pbs/>

Two important and related
phenomenon developed over
roughly the same time
period

- 1) The growth of industrialization with an increasing use of fossilized fuel.

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AND

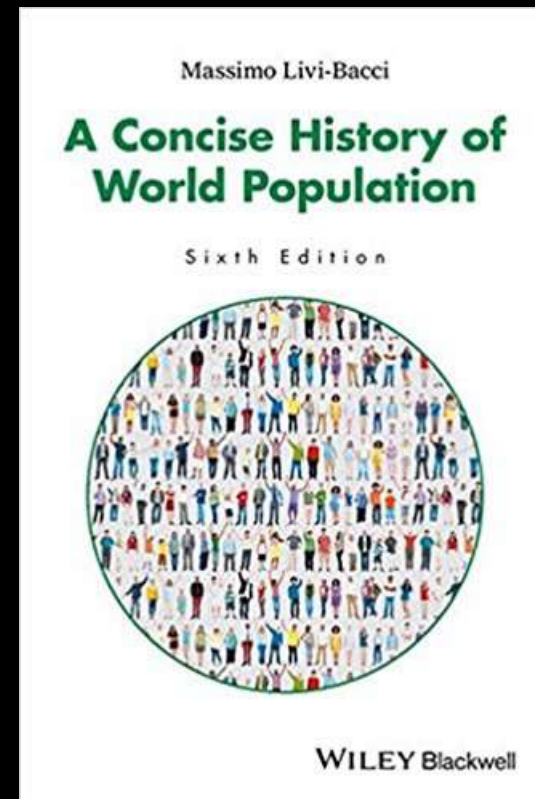
2) The growth of human populations
around the world.

What have been human's population dynamics?

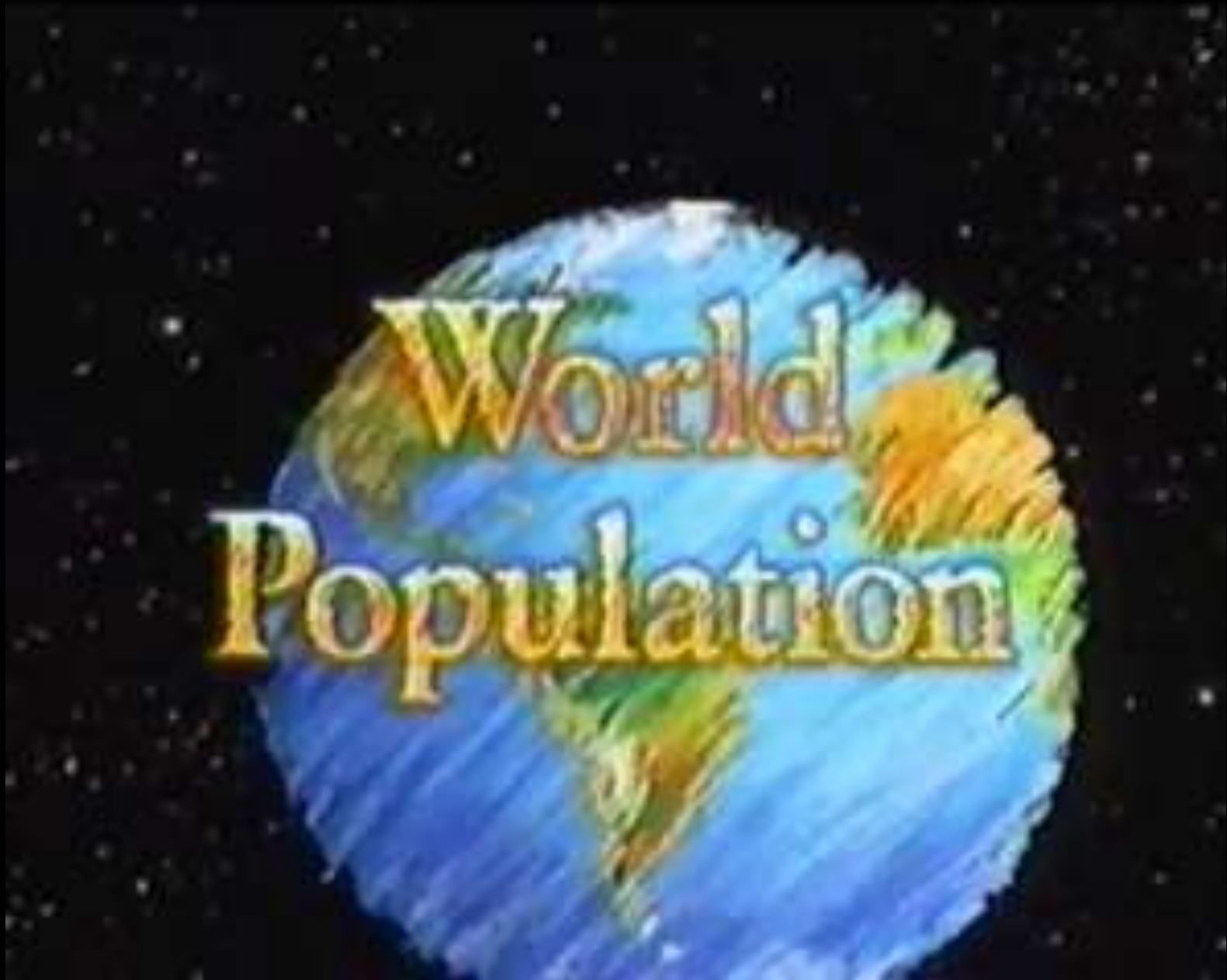
How have human populations evolved over evolutionary and historical time?

Human population history can be studied over long periods of time.

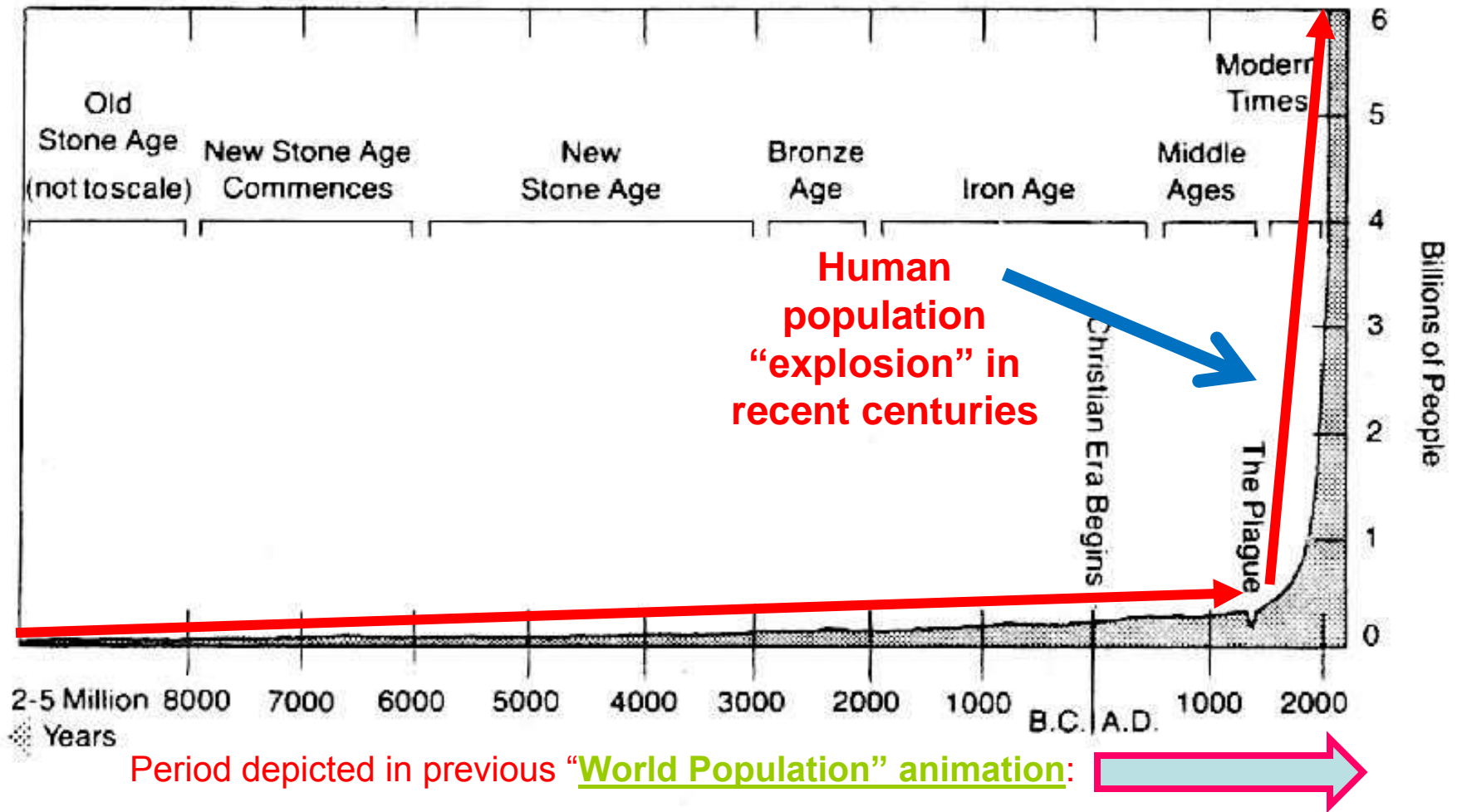
In recent centuries it has “exploded” all over the world.



<https://environmentaljusticetv.wordpress.com/2016/01/31/world-population-on-vimeo/>

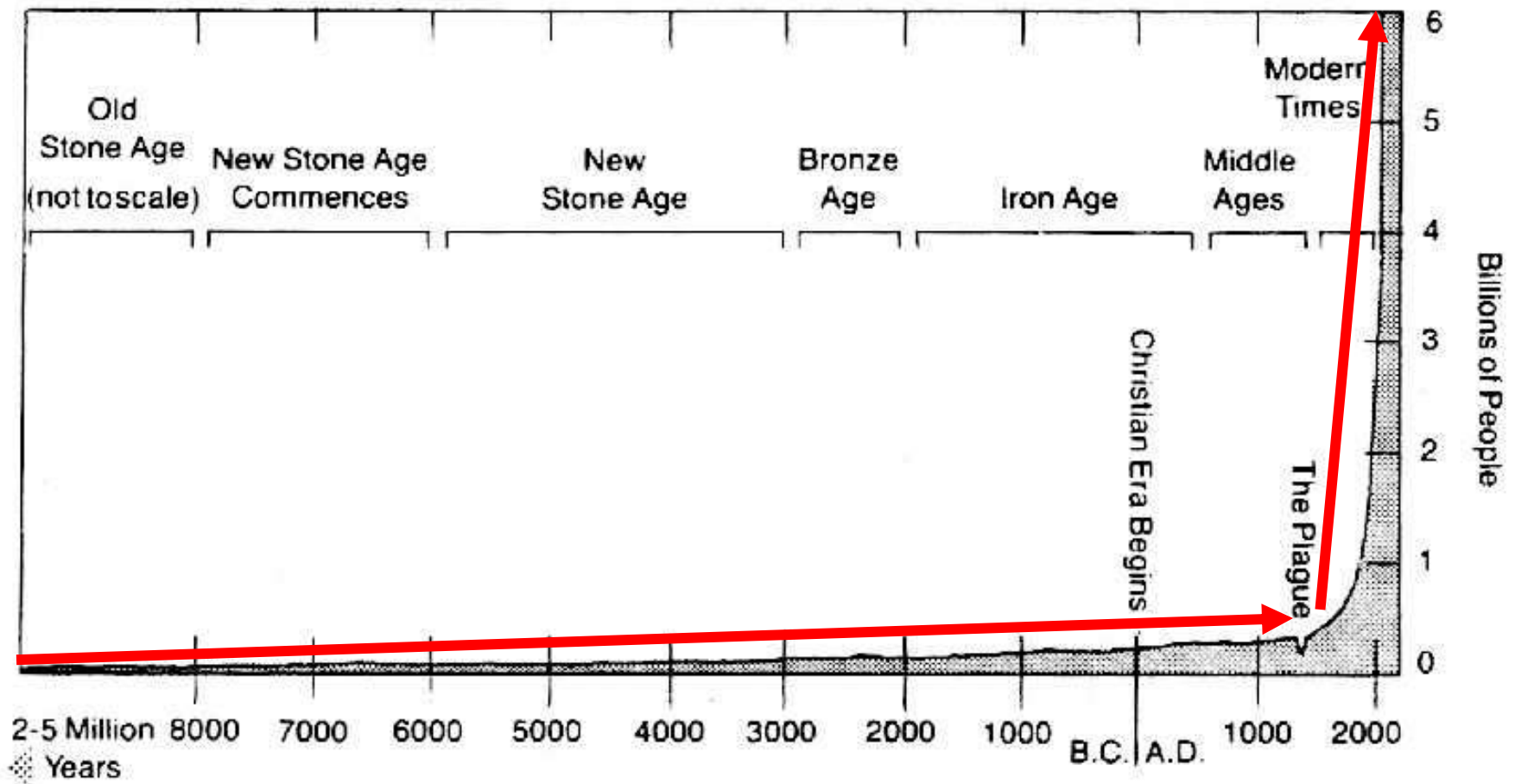


World Population Growth Through History



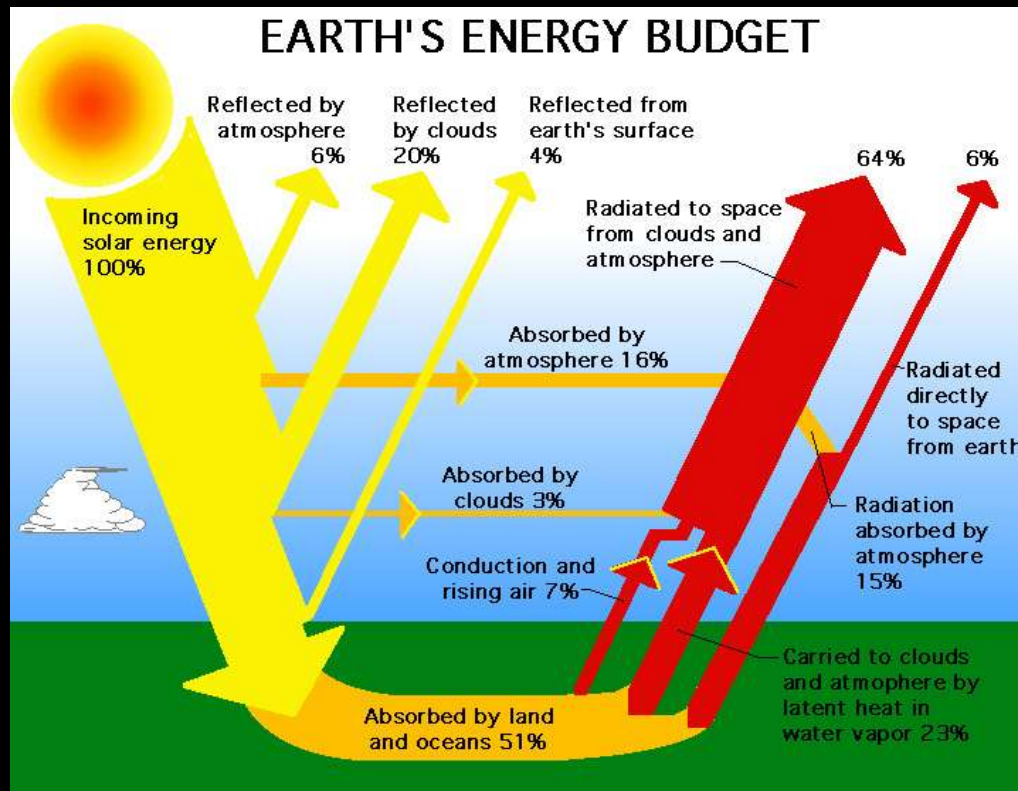
Despite our treasured sense of exceptionalism we are in fact acting as a species in an ecosystem in a very patterned and depressingly predictable manner.

World Population Growth Through History



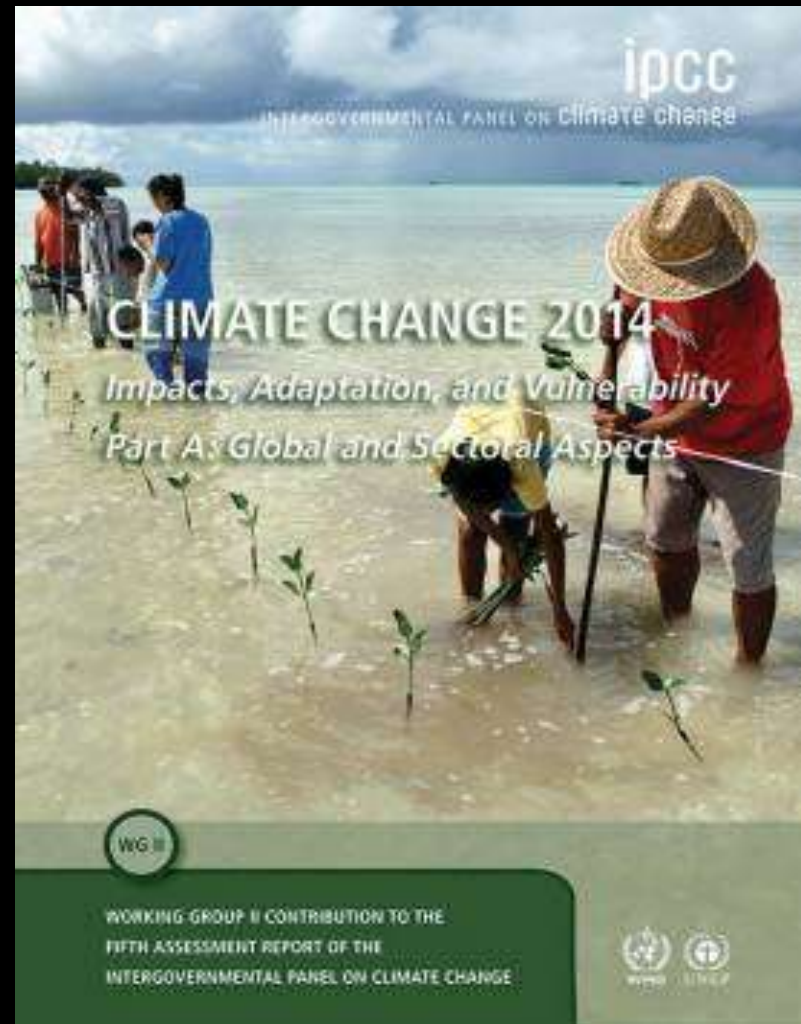
Despite our treasured sense of exceptionalism we are in fact acting as a species in an ecosystem in a very patterned and depressingly predictable manner.

Human population growth **AND** the increased use *per capita* of fossilized carbon has led to the change in the composition of the atmosphere. This has, in turn, changed the Earth's energy budget. An increased amount of sunlight – converted to heat energy at the Earth's surface – is not being radiated back into space as quickly as the green-house-gases increase their “thermal blanket” effect in the atmosphere.



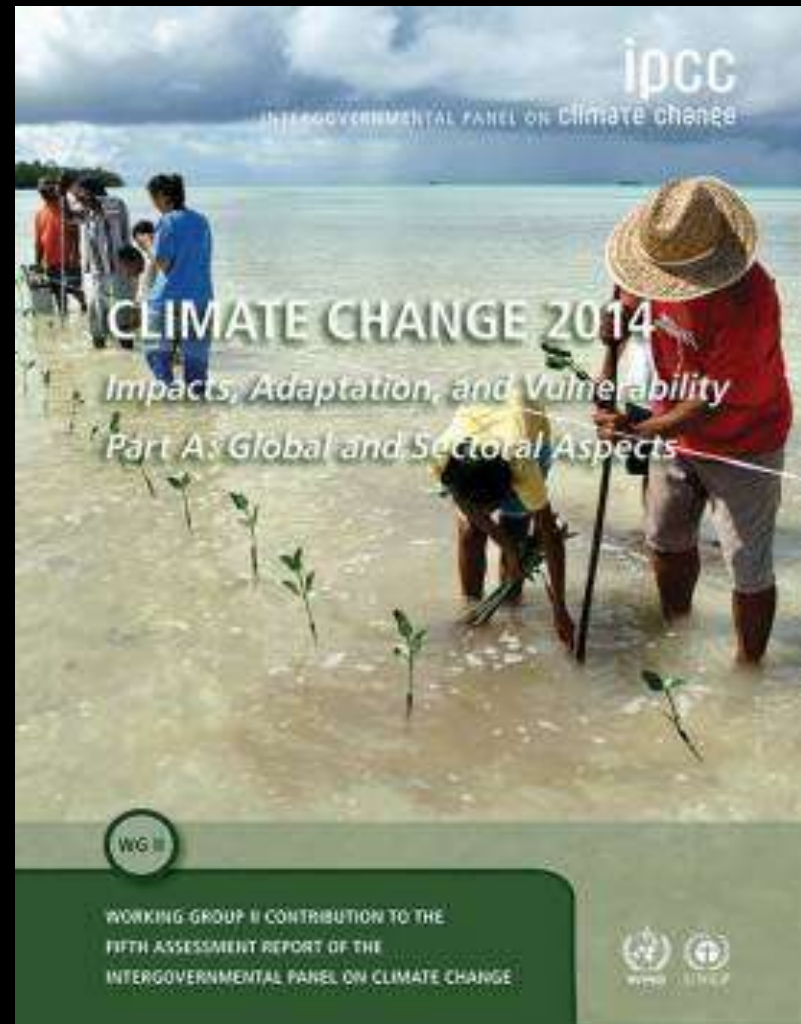
What are the major consequences of changing Earth's energy budget?

Briefly put, changing the energy budget changes the global climate....



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Largest peer-reviewed study in human history!
... the [2014 IPC](#)
[Assessment Report](#)



What are the major consequences of changing Earth's energy budget?



Largest peer-reviewed
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Some of the important physical manifestations of Earth's changing climate

- Earth's surface is warming

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- “Positive Feedbacks” in an ecosystem are *very dangerous* since they lead to “run-away,” self-reinforcing syndromes.
- Stable ecosystems are dominated by “negative feedback” mechanisms.

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- Changes in the masses of continental ice and sea ice are leading to measurable and potentially unstable phenomena, including
 - The rise of sea-level world wide and
 - The potential change of ocean currents, wind patterns over ocean currents and the interaction of the tropics and the poles as well as the evolution of global atmospheric circulation – with more frequent & severe extreme weather events.

Let's consider each of these four physical phenomena in turn

- 1 Changes in the climate of the north and south pole.
- 2 Changes in global sea-level
- 3 Changes in the circulation of ocean currents
- 4 Changes in the frequency, impact and duration of “severe weather” events – are there new patterns emerging?

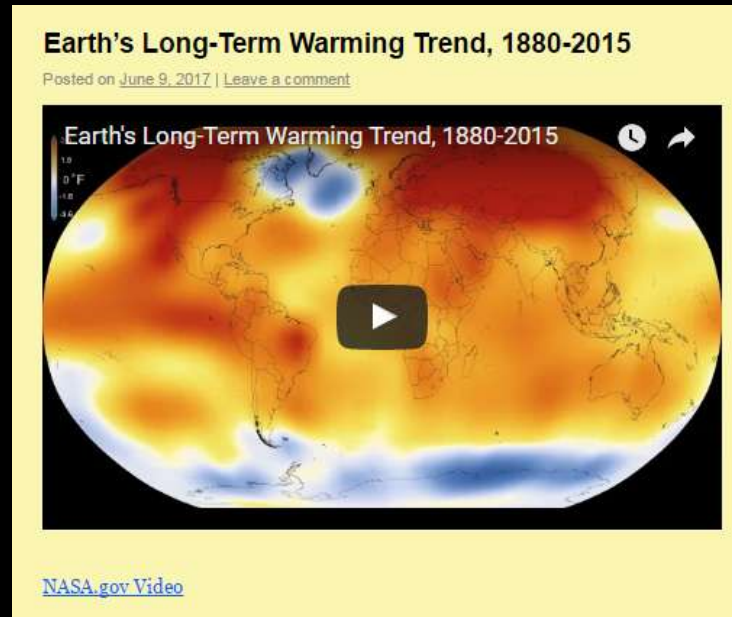
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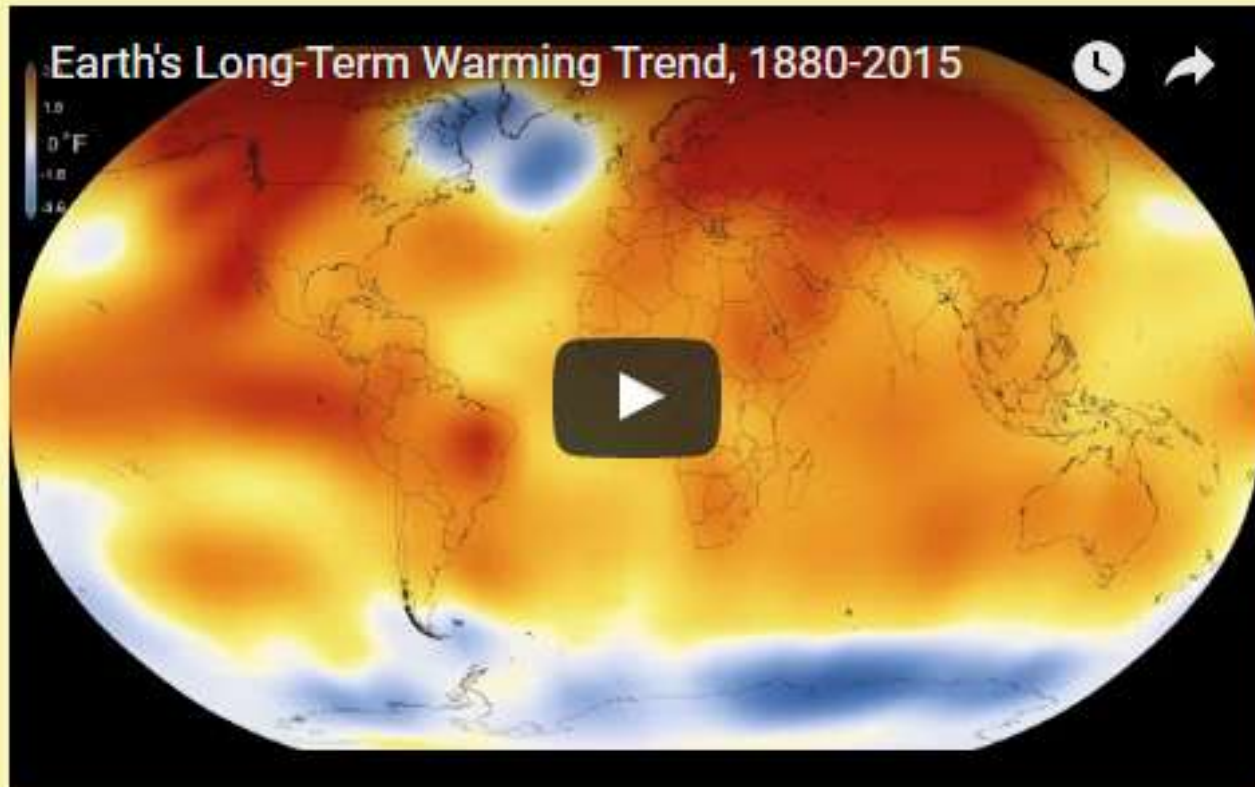
- Changes in the climate of the north and south pole.....

Do you remember our first day's map of surface temperature over time?



Earth's Long-Term Warming Trend, 1880-2015

Posted on [June 9, 2017](#) | [Leave a comment](#)



[NASA.gov Video](#)

<https://environmentaljusticetv.wordpress.com/2017/06/09/154-earth-s-long-term-warming-trend-1880-2015/>



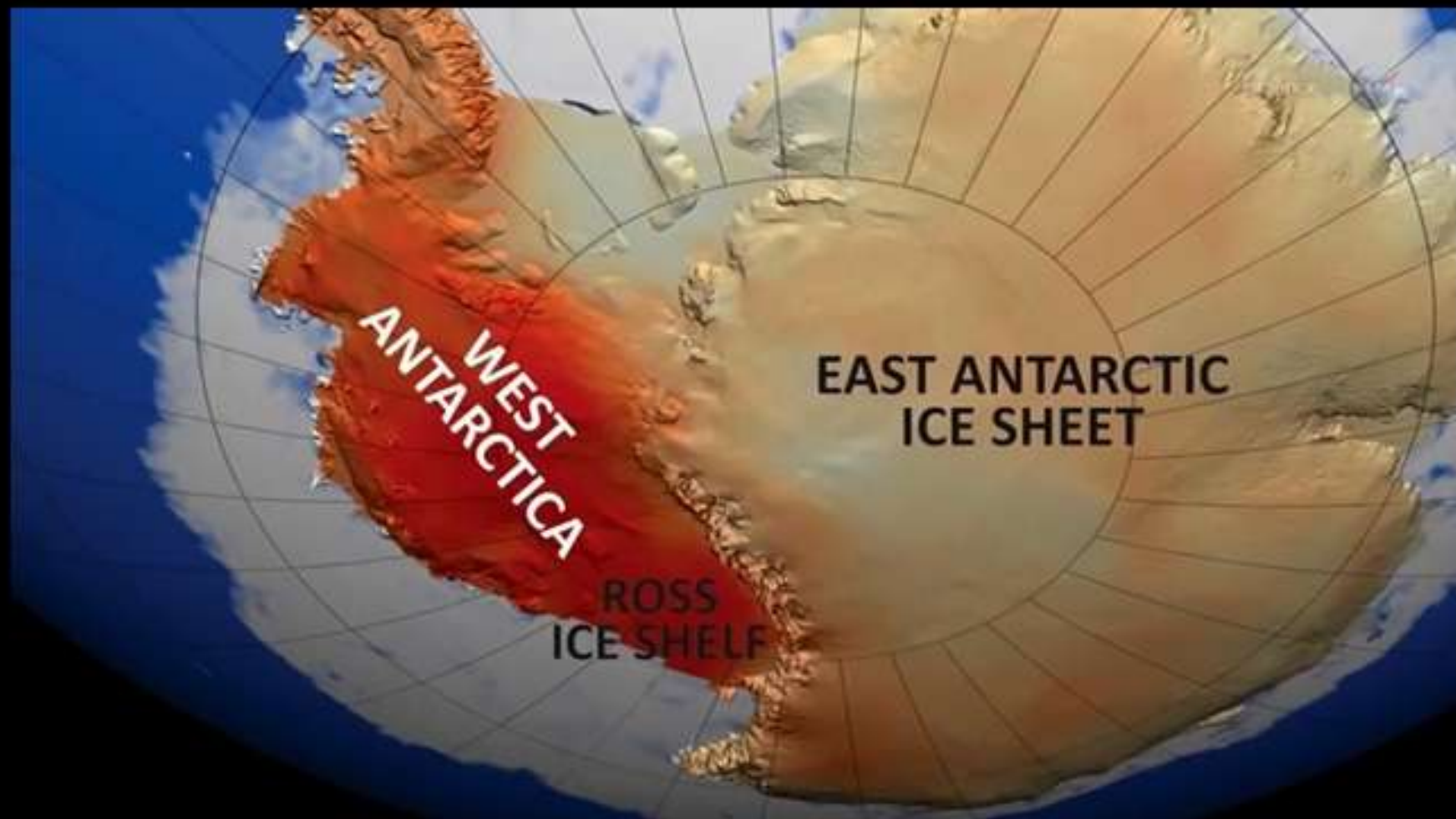
ERIC RIGNOT

University of California, Irvine & NASA, Jet Propulsion Laboratory

SCIENCE@NASA

The Hidden Meltdown of Greenland

<https://environmentaljusticetv.wordpress.com/2017/07/12/sciencecasts-the-hidden-meltdown-of-greenland/>



SCIENCE@NASA

No Turning Back: West Antarctic Glaciers in Irreversible Decline

<https://environmentaljusticetv.wordpress.com/2017/07/12/sciencecasts-no-turning-back-west-antarctic-glaciers-in-irreversible-decline/>



There is an enormous “positive feedback” problem with the thawing of arctic permafrost – (frozen mud).

Positive Feed-back...

SCIENCE@NASA

The “Sleeping Giant” in Arctic Permafrost

<https://environmentaljusticetv.wordpress.com/2017/07/12/sciencecasts-the-sleeping-giant-in-arctic-permafrost/>



<https://environmentaljusticetv.wordpress.com/2017/05/26/permafrost-the-tipping-time-bomb-3/>

2. What will added water and ice do to global sea-levels?



<https://environmentaljusticetv.wordpress.com/2014/05/29/earth-under-water-worldwide-flooding-sea-level-rise-slr/>

Miami, Florida



<https://environmentaljusticetv.wordpress.com/2014/05/29/earth-under-water-worldwide-flooding-sea-level-rise-slr/>



“There are cities you can save and cities that you can’t save...”



“There are cities you can save and cities that you can’t save...”

Which cities can be “saved?”



“There are cities you can save and cities that you can’t save...”

Which cities CANNOT (will not) be saved?

Consider the fate of California...



<https://environmentaljusticetv.wordpress.com/2014/05/29/earth-under-water-worldwide-flooding-sea-level-rise-slr/>

Consider the Mediterranean...



<https://environmentaljusticetv.wordpress.com/2014/05/29/earth-under-water-worldwide-flooding-sea-level-rise-slr/>

Are You "Climate Ready" Boston?

(& New York? Philadelphia? Baltimore? Washington?...+
London? Hong Kong? Lagos? Cairo?, ...etc?)




MOOSENEE Sunday, 12 February 2017

WIND GUST FORECAST (MPH) | MONDAY 12:00PM

STORM FORCE GUSTS 65-75 MPH
20-25' SEA - NOON H.TIDE

BHS beacon hill seminars

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CLIMATE READY BOSTON

UMASS BOSTON

Climate Change and Sea Level Rise Projections for Boston

The Boston Research Advisory Group Report

JUNE 1, 2016

City of Boston Mayor Martin J. Walsh Green Ribbon Commission

CLIMATE READY BOSTON | CLIMATEREADY.BOSTON.COV | #CLIMATEREADYBOSTON

Earth's Changing Climate: What is Causing It? What Will It Mean for You?

<http://ecoethics.net/2014-ENVRE120/20170212-EV&N-237-Link.html>

Low-lying agricultural areas are even more vulnerable than cities....



<https://environmentaljusticetv.wordpress.com/2014/05/29/earth-under-water-worldwide-flooding-sea-level-rise-slr/>

But the “post-Columbian” city will be hard hit all over the world because it is on the sea coast.

The World After Sea-Level Rise

Posted on [July 12, 2017](#) | [Leave a comment](#)



<https://environmentaljusticetv.wordpress.com/2017/07/12/the-world-after-sea-level-rise/>

Study suggests buried internet infrastructure at risk as sea levels rise

Posted on [July 19, 2018](#) | [Leave a comment](#) | [Edit](#)



Wall Street (and therefore the world's financial institutions) are vulnerable to any interruption of their electronic communications.

Similar vulnerability is potentially possible in Hong Kong, London, Miami, Seattle, etc.

Lights Out: Climate Change Risk to Internet Infrastructure

Ramakrishnan Durairajan[†], Carol Barford^{*}, Paul Barford^{*}

[†]University of Oregon, ^{*}University of Wisconsin - Madison

ABSTRACT

In this paper we consider the risks to Internet infrastructure in the US due to sea level rise. Our study is based on sea level incursion projections from the National Oceanic and Atmospheric Administration (NOAA) [12] and Internet infrastructure deployment data from Internet Atlas [24]. We align the data formats and assess risks in terms of the amount and type of infrastructure that will be under water in different time intervals over the next 100 years. We find that 4,067 miles of fiber conduit will be under water and 1,101 nodes (e.g., points of presence and colocation centers) will be surrounded by water in the next 15 years. We further

1 INTRODUCTION

Climate change is perhaps the most significant problem facing humanity. The dramatic rise in greenhouse gas concentrations in the atmosphere over the past 100 years is causing changes in weather patterns including increased likelihood of severe storms as well as rapid rise in sea levels due to melting polar ice caps and thermal expansion of seawater [27]. These phenomena have important implications for the planet and the effects are already being felt in many areas [36].

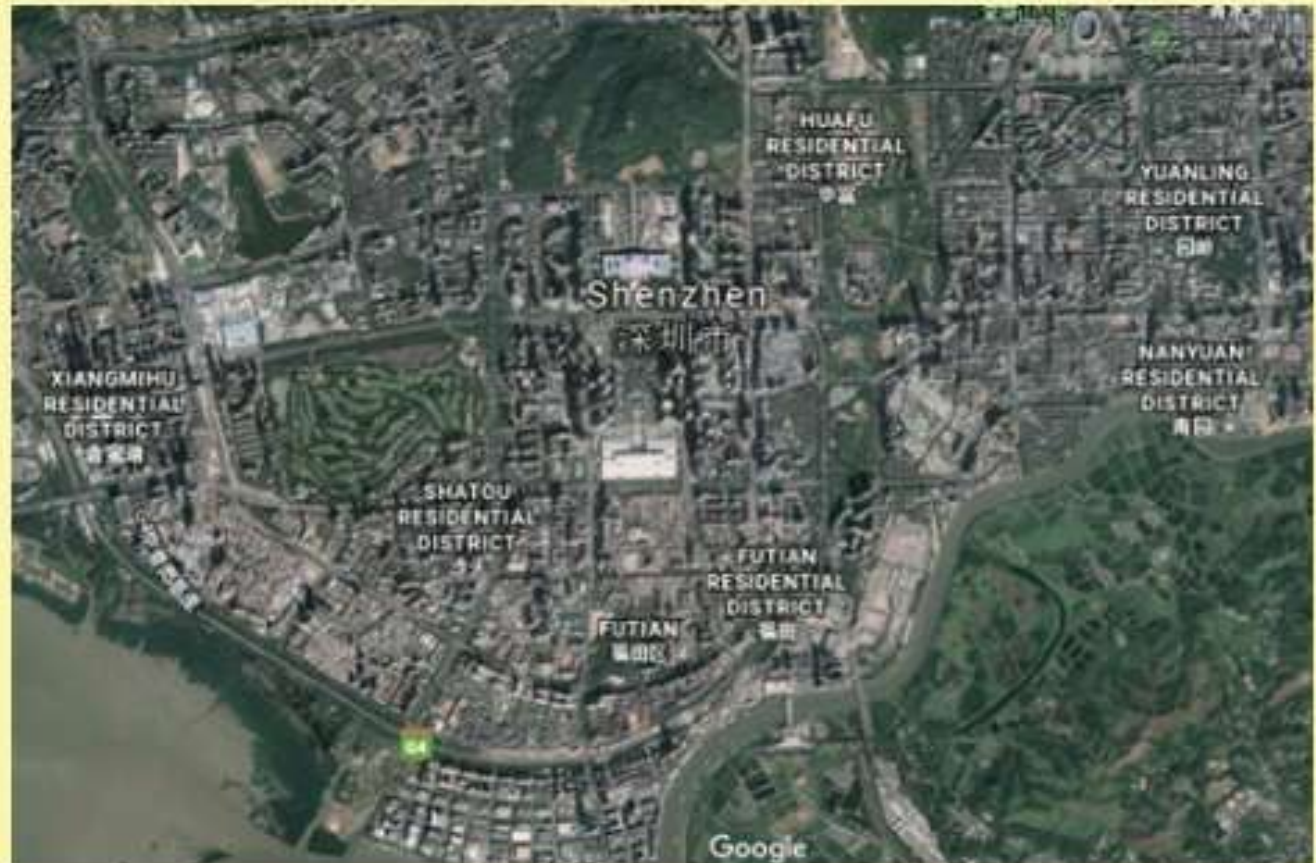
To understand and prepare for the impacts of climate change, a number of models have been developed to project average sea level rise. The models are based on a variety of

Researchers can use the Google Earth/ Web application to explore climate vulnerable areas around the world.

Climate Change & Sea-Level Rise – Some Vulnerable Areas in China – a tool to explore selected regions through Google Earth

Posted on [July 18, 2018](#) | [Leave a comment](#) | [Edit](#)

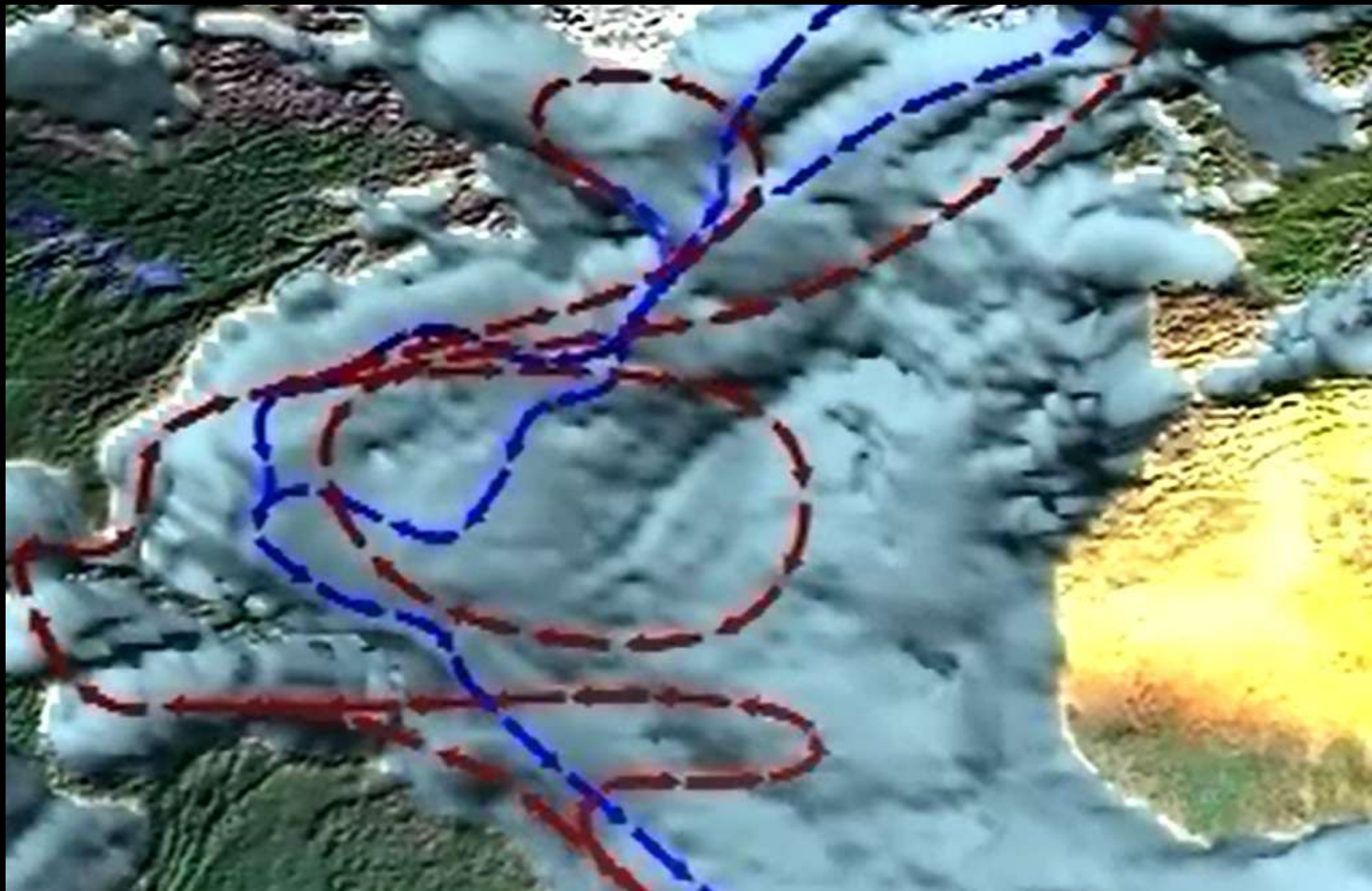
Shenzhen



...beyond questions of sea-level change...
we should consider the...

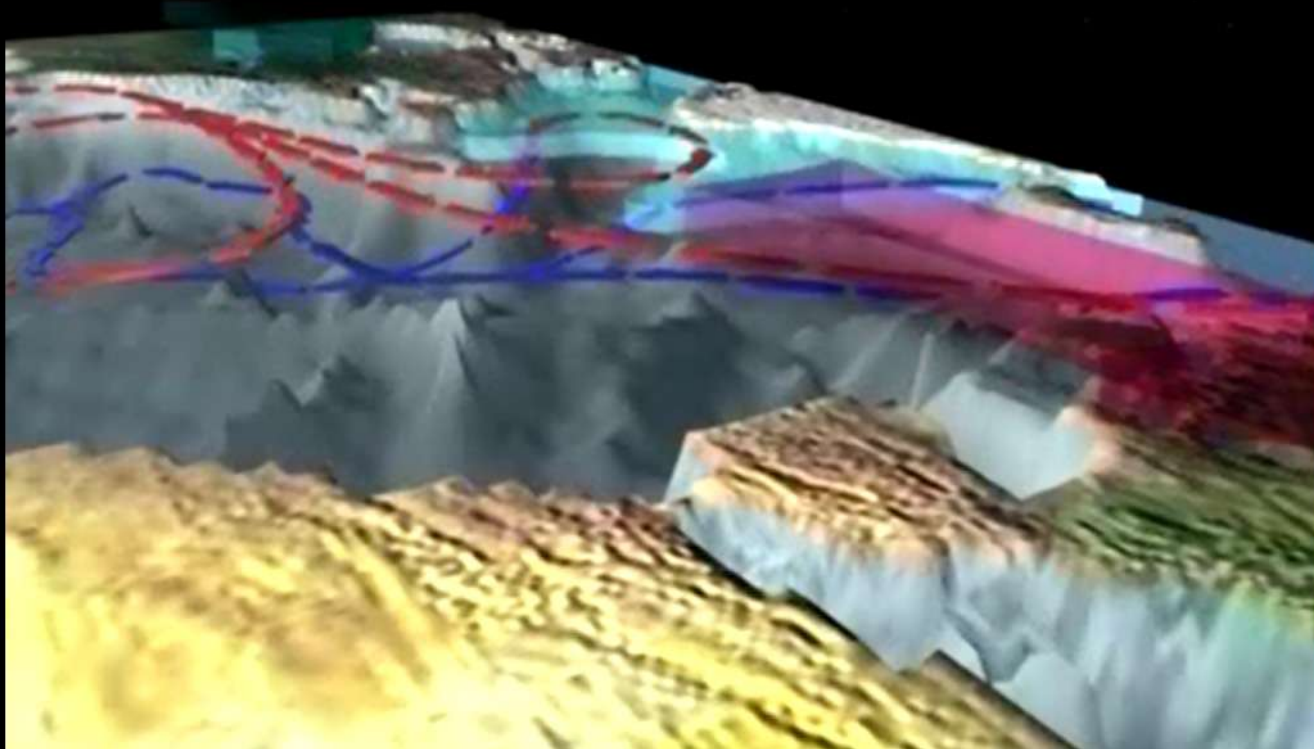
3. Potential Changes in Ocean Currents

What about ocean currents and ocean-atmosphere-land interactions?

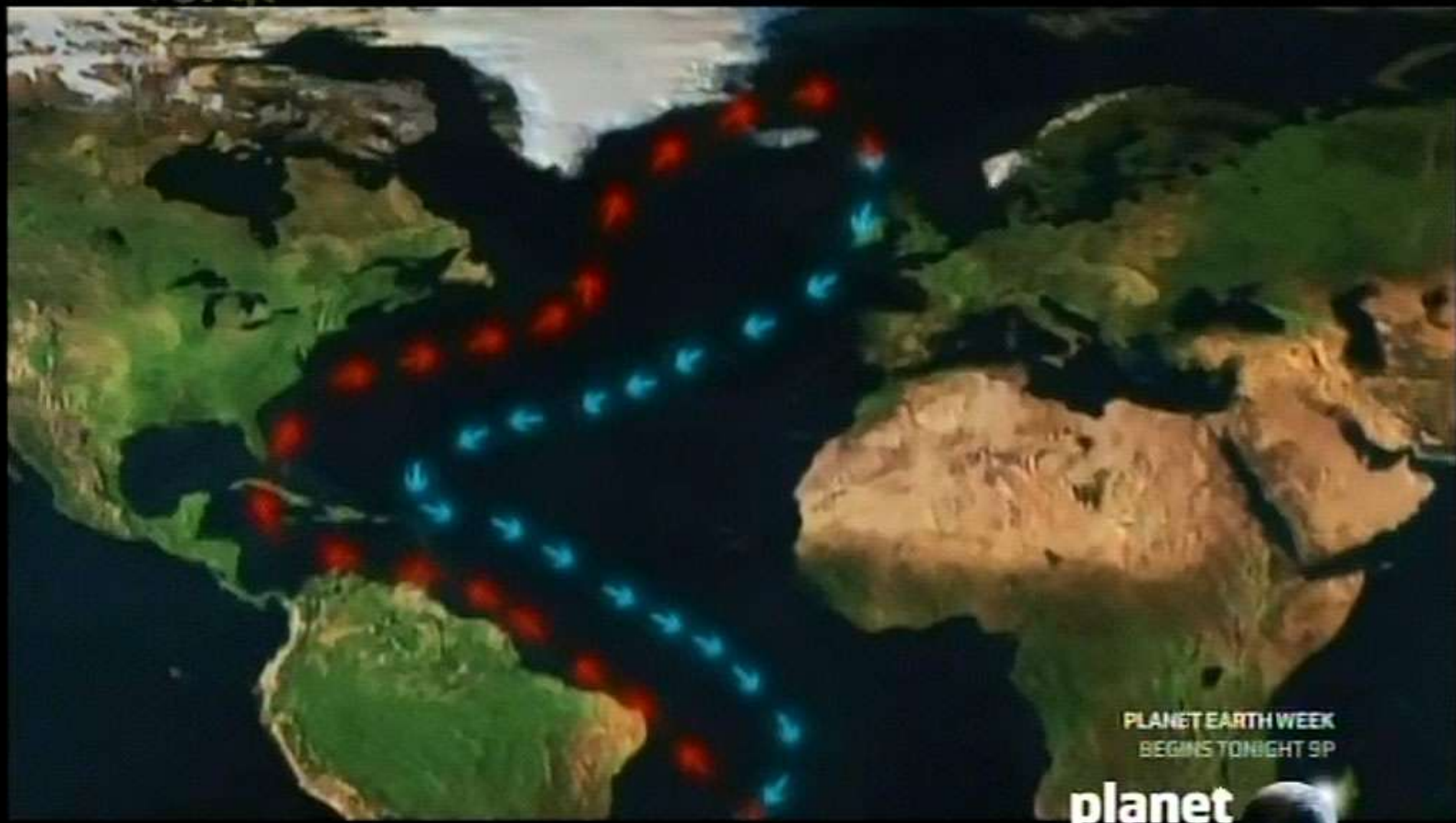


What might Greenland melting do to the North Atlantic “Thermo-Haline Circulation” (THC) system?

The melt water from Greenland’s glaciers might be disrupting the THC system, causing drought in the Mediterranean and wetter, colder weather further north in Europe.



The circulation of warm waters from the tropics toward the poles determines the “weather” over much of Earth. Any changes in this circulation can lead to abrupt changes in weather over time – ie. climate. The Asian monsoons need to be studied in addition to **the north Atlantic THC system.**



Paleo-climatologists (climate archeologists) are now finding evidence for an abrupt change in ancient climate leading to the simultaneous collapse of ancient Egypt and Mesopotamia – *perhaps related to a shift in the Atlantic THC system*



<https://environmentaljusticetv.wordpress.com/2014/07/08/why-ancient-egypt-fell-2/>

The archaeology of collapse...



<https://environmentaljusticetv.wordpress.com/2014/07/08/why-ancient-egypt-fell-2/>

Yale archaeologist studying the sudden collapse of the ancient Akkadian civilization in northern Syria due apparently to an abrupt change of climate.



<https://environmentaljusticetv.wordpress.com/2014/07/08/why-ancient-egypt-fell-2/>

One of the world's leading experts on interpreting ocean sediment core samples



<https://environmentaljusticetv.wordpress.com/2014/07/08/why-ancient-egypt-fell-2/>

In short, the study of the collapse of ancient civilizations may teach us a great deal about “**abrupt climate change**” – well before the atmospheric carbon burden added by industrial civilization in recent centuries.



This is ongoing research. Professor Weiss convened a conference in October 2017 to examine climate-related ancient societal collapse

Humanities/Humanity Faculty Workshop, Whitney Humanities Center,
Harvey Weiss, organizer

Collapse! What Collapse?

Societal adaptations to abrupt climate changes before global warming.

A workshop at Yale October 20-22, 2017.

Sponsors:

Richard Burger, Dept. Anthropology

Michael Dove, Dept. Anthropology and FES

Joseph Manning, Depts. History and Classics

Robert Mendelsohn, FES and Dept. Economics

Harvey Weiss, Environmental Studies and FES

<https://environmentaljusticetv.wordpress.com/2017/07/12/collapse-what-collapse-societal-adaptations-to-abrupt-climate-changes-before-global-warming-a-workshop-at-yale-october-20-22-2017/>

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Welcome to the Meghalayan Age – a new phase in history – BBC News

Posted on July 20, 2018 | [Leave a comment](#) | [Edit](#)

Eonothem / Eon	Erathem / Era	System / Period	Series / Epoch	Stage / Age	GSSP	numerical age (Ma)
		Quaternary	Holocene	Meghalayan	✓	present
				Northgrippian	✓	0.0042
				Greenlandian	✓	0.0082
			Pleistocene	Upper		0.0117
				Middle		0.126
				Calabrian	✓	0.781
				Gelasian	✓	1.80
				Piacenzian	✓	2.58
			Pliocene	Zanclean	✓	3.60
					✓	5.33
					✓	7.2

<https://environmentaljusticetv.wordpress.com/2018/07/20/welcome-to-the-meghalayan-age-a-new-phase-in-history-bbc-news-2/>

4. What about changes in *weather*? What can we expect in a changed climate?

The global circulation of air and water are driven by the differences between hot and cold regions.

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As the tropics heat up, the northern and southern movement of air and water masses may increase in speed.

What about changes in *weather*? What can we expect in a changed climate?

The global circulation of air and water are driven by the differences between hot and cold regions.

As the tropics heat up, the northern and southern movement of air and water masses may increase in speed.

Hot air holds more water → ? So the northern movement of tropical air masses may contain more water moving faster ? [Further research on extreme weather needed.]

Ongoing anecdotal evidence of weather extremes....

- Dry, hot western United States and Canada with severe forest fires.
- Severe forest fires in Portugal, Greece
- Severe floods in China

Etc., etc.

What's made the the B.C. wildfires so severe?

Posted on [July 12, 2017](#) | [Leave a comment](#)



<https://environmentaljusticetv.wordpress.com/2017/07/12/whats-made-the-the-b-c-wildfires-so-severe/>

Firefighters battle wildfires across the West

Posted on [July 12, 2017](#) | [Leave a comment](#)



Transition Studies

<https://environmentaljusticetv.wordpress.com/2017/07/12/firefighters-battle-wildfires-across-the-west/>

Heavy rains bring record flooding to Central, Southern China

Posted on [July 11, 2017](#) | [Leave a comment](#) | [Edit](#)



<https://environmentaljusticetv.wordpress.com/2017/07/11/heavy-rains-bring-record-flooding-to-central-southern-china/>

BBC news on China flood already damaged \$1.33 billion government property

Posted on [July 11, 2017](#) | [Leave a comment](#) | [Edit](#)



<https://environmentaljusticetv.wordpress.com/2017/07/11/bbc-news-on-china-flood-already-damaged-1-33-billion-government-property/>

After Wildfire Greek's Athens hit by Torrential Rains

Posted on [July 26, 2018](#) | [Leave a comment](#)



Footage shows damage from heavy rainstorm in NW China

Posted on [July 26, 2018](#) | [Leave a comment](#)



Catastrophic Flood in Japan scene. July 2018

Posted on [July 26, 2018](#) | [Leave a comment](#)



Flood in China 2018 |It can destroy city within minutes

Posted on [July 26, 2018](#) | [Leave a comment](#)



Weather is NOT climate...

Please remember, weather is NOT climate. Extreme weather events may be isolated and consider “anomalies.”

BUT, if *over time* (years & decades) and *over large regions* (Western U.S. or Coastal China) there is a pattern of a new range of events, then we must examine if there is a fundamental shift in climate occurring.

Even though patterns of climate change may not yet be fully understood, humanity still needs immediately to learn how to adjust to the impact of short-term severe weather events occurring around the globe.

Research suggests that extreme weather “events” – like regional heatwaves – have been linked to human driven climate change.

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NEWS

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Climate change driven by humans made heatwave 'twice as likely'

By Matt McGrath
Environment correspondent

🕒 27 July 2018 📄

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UK heatwave



GETTY IMAGES

The current UK heat wave has dried out some reservoirs

If incidents of extreme weather events become a pattern and provide evidence of climate change over time, humanity will have to develop permanent social, economic and political institutions to accommodate the

Human cost of climate change...

Already the number of refugees is historically very high...

The number of people now living in refugee camps is the largest since WWII. Equivalent to the size of the population of England or Italy

Posted on June 19, 2017 | [Leave a comment](#) | [Edit](#)

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UN Refugee agency: Record 65.6 million people displaced worldwide

2 hours ago World

Europe migrant crisis



A record 65.6 million people are either refugees, asylum seekers or internally displaced across the globe, the UN refugee agency said.

<https://environmentaljusticetv.wordpress.com/2017/06/19/un-refugee-agency-record-65-6-million-people-displaced-worldwide-bbc-news/>

World Refugee Day At record 65M UN calls for more action

Posted on [June 21, 2017](#) | [Leave a comment](#) | [Edit](#)



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Waves of Migrants, Rising Seas:

Floods, Droughts and the Global Climate Challenge
to the Nation-State and International Community

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Philippines hit by massive typhoon

Typhoon Koppu slams into the northern Philippines with at least one person confirmed dead and tens of thousands forced to evacuate.

47 minutes ago Asia

- Flood warnings issued
- Typhoon Koppu makes landfall
- 'I've battened down hatches'



Waves of Migrants, Rising Seas:

Floods, Droughts and the Global Climate Challenge to the Nation-State and International Community



Severe weather conditions -- driven by climate change -- are straining the capacity of political systems across the world.



Which Countries Already Have Climate Change Refugees?

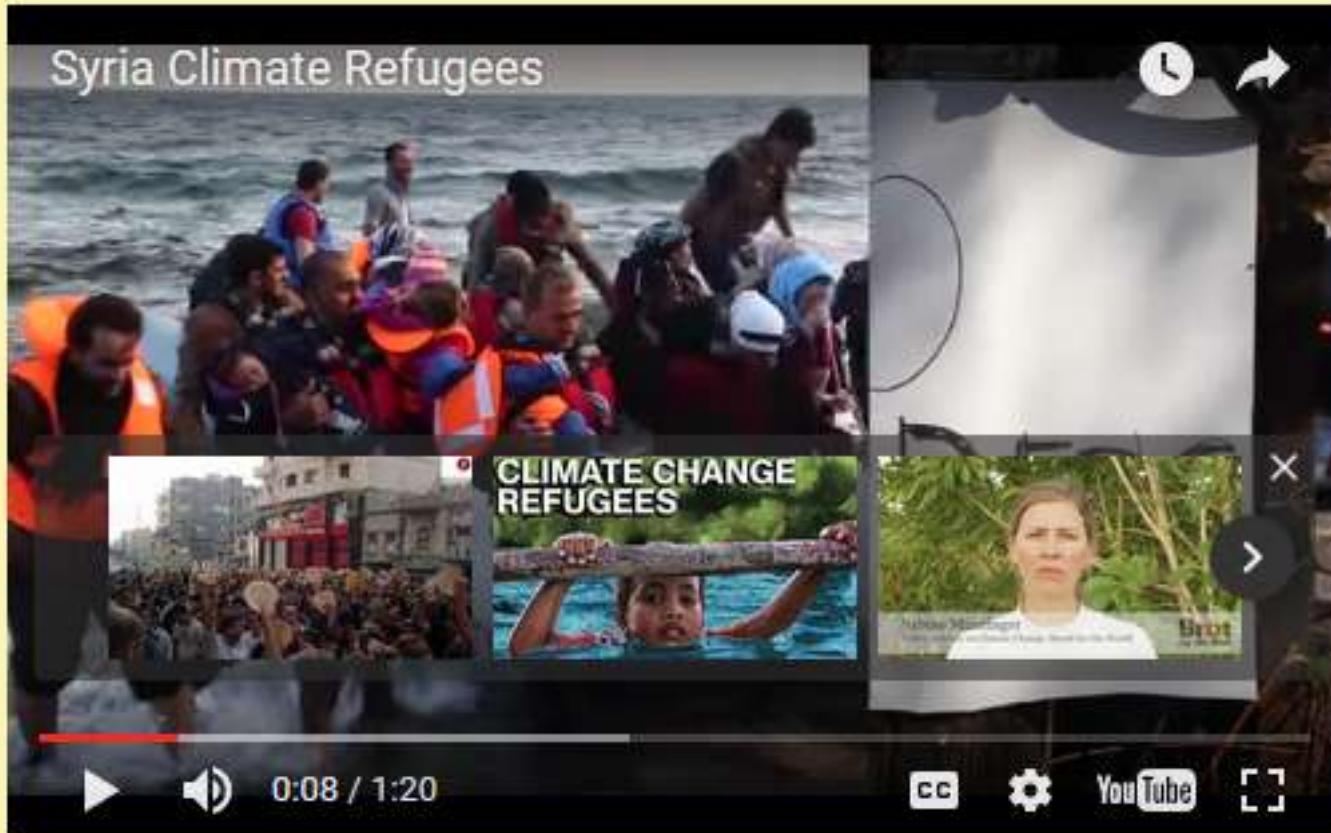
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<https://environmentaljusticetv.wordpress.com/2017/07/12/which-countries-already-have-climate-change-refugees/>

Syria Climate Refugees

Posted on [December 17, 2015](#) | [Leave a comment](#) | [Edit](#)



<https://environmentaljusticetv.wordpress.com/2015/12/17/syria-climate-refugees/>

Public Health Implications

water-borne diseases

Cholera infects 300,000 people in Yemen

Posted on July 10, 2017 | [Leave a comment](#) | [Edit](#)



<https://environmentaljusticetv.wordpress.com/2017/07/10/cholera-infects-300000-people-in-yemen/>

Public Health Implications vector-borne diseases

Climate Change Might Increase Risk Of Malaria

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Public Health Implications vector-borne diseases

Climate Change Might Increase Risk Of Malaria

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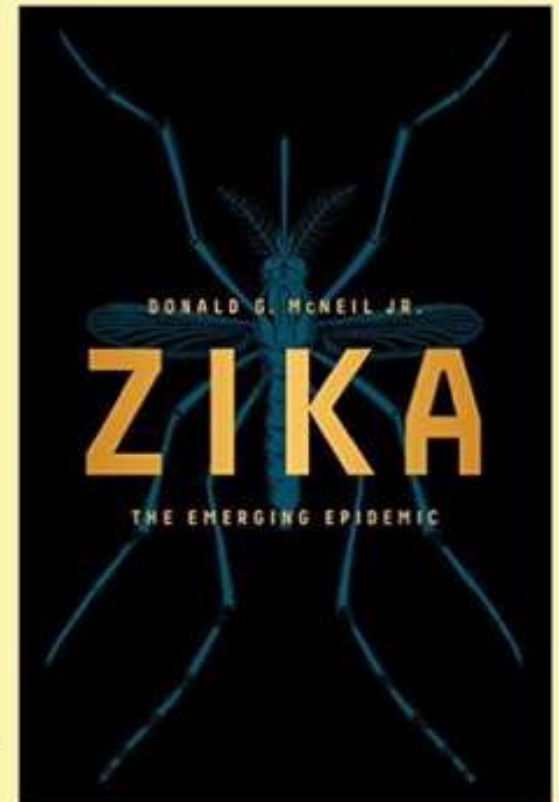


Zika: The Emerging Epidemic

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A gripping narrative about the origins and spread of the Zika virus by *New York Times* science reporter Donald G. McNeil Jr.

Until recently, Zika—once considered a mild disease—was hardly a cause for global panic. But as early as August 2015, doctors in northeast Brazil began to notice a trend: many mothers who had recently experienced symptoms of the Zika virus were giving birth to babies with microcephaly, a serious disorder characterized by unusually small heads and brain damage.



Public Health Implications

the “species-jump” of diseases from wild or domestic species to human populations

Avian Flu

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Climate Change: Health and Disease Threats | The Forum at HSPH

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Climate Change and National Security in the 2014 Quadrennial Defense Review

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THE CENTER FOR CLIMATE & SECURITY
EXPLORING THE SECURITY RISKS OF CLIMATE CHANGE



The U.S. military consider climate change a
“threat multiplier.”



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BALLISTIC MISSILE DEFENSE REVIEW



2014 Quadrennial Defense Review

Executive Summary Translated:
Español / Russian / Arabic
Chinese / Français

VIDEO

The Quadrennial Defense Review (QDR) is a legislatively-mandated review of Department of Defense strategy and priorities. The QDR will set a long-term course for DOD as it assesses the threats and challenges that the nation faces and re-balances DOD's strategies, capabilities, and forces to address today's conflicts and tomorrow's threats.

TOP STORIES

Budget, Strategy Dominate Dempsey's Facebook Town Hall

In the second town hall meeting he has conducted on his Facebook page, the chairman of the Joint Chiefs of Staff fielded questions from around the world that focused largely on the Defense Department's fiscal year 2015 budget request and its correlation with U.S. military strategy. [Story](#)

Air Force Undersecretary: Budget Uncertainty Worries Airmen

Air Force personnel are worried about budgetary uncertainty, and service leaders pledge to be transparent about priorities and programs available as the service moves forward, Air Force Undersecretary Eric Fanning said. [Story](#)

2014 QDR Presumes Future Includes More Risk, Less Money

QDR 2014

TOP STORIES

- Panel Calls for More Force Structure Changes
- Cybersecurity Seizes More Attention, Budget Dollars
- Review Strikes Right Balance for Military, Admiral Says

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ROLLOUT BRIEFINGS

- DOD News Briefing with Secretary Gates and Adm. Mullen from the Pentagon
- DOD News Briefing with Undersecretary Fanning and Vice Adm. Stanley

PRESS RELEASES

President Trump, Military Split on Climate Change

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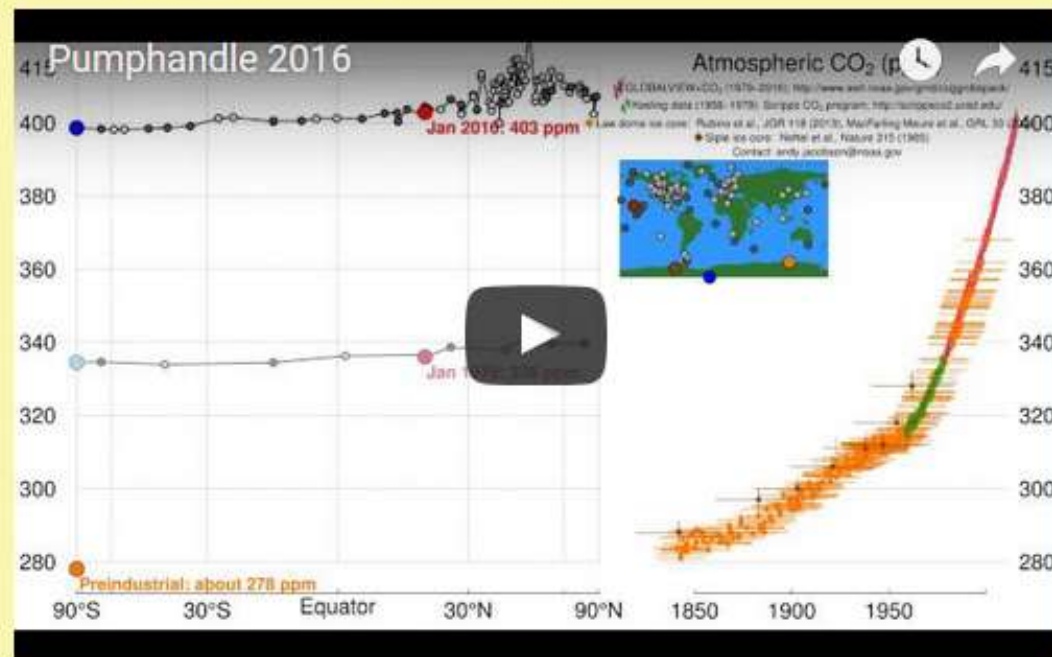
[VOA News](#)

<https://environmentaljusticetv.wordpress.com/2017/02/02/president-trump-military-split-on-climate-change/>

Remember to monitor the long-term trends...in climate measures

Pumphandle 2016

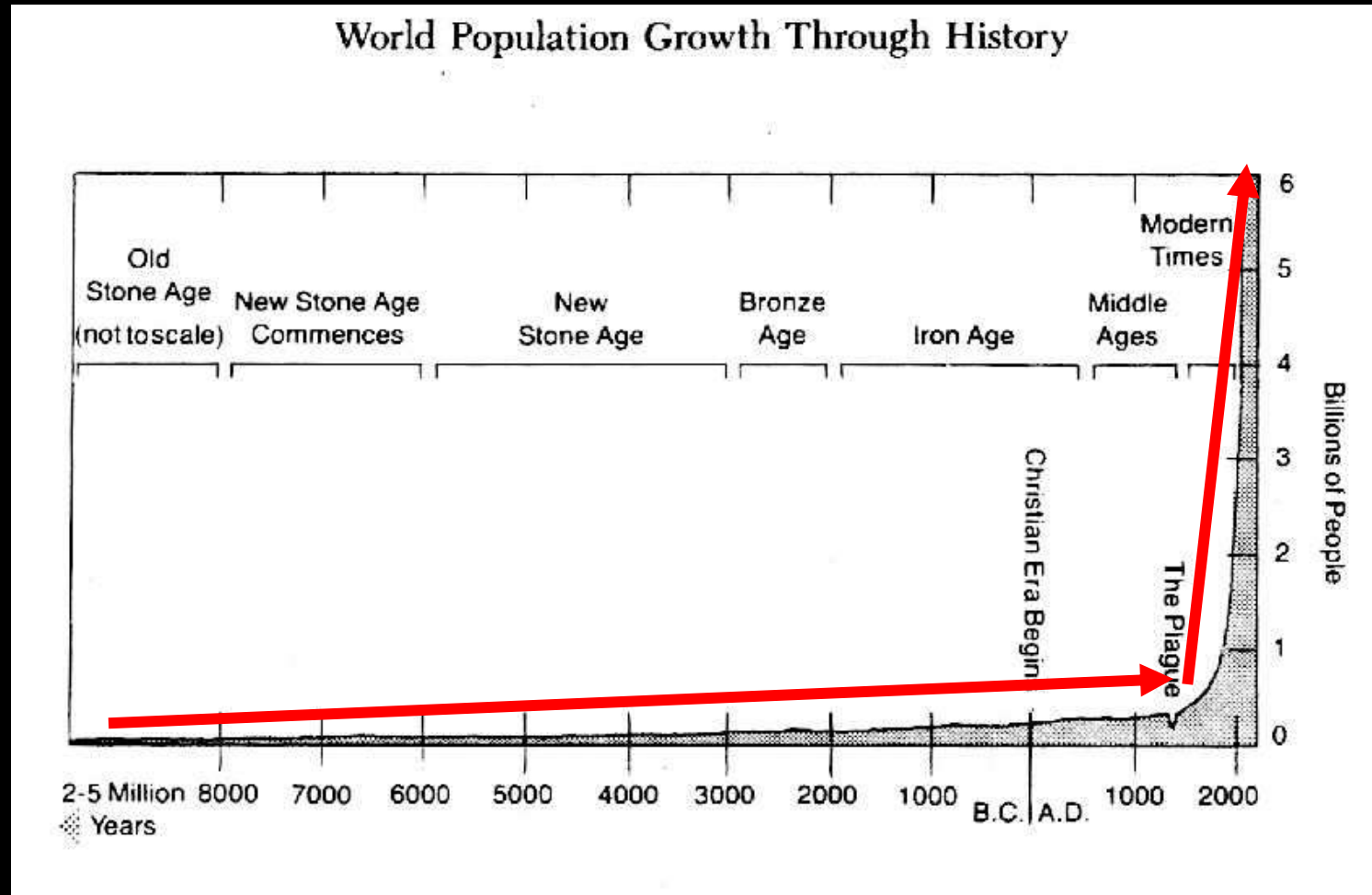
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[CarbonTracker](#)

<https://environmentaljusticetv.wordpress.com/2017/06/01/pumphandle-2016-3/>

Remember to monitor the long-term trends...in climate measures and human behavior...



Despite our treasured sense of exceptionalism we are in fact acting as a species in an ecosystem in a very patterned and depressingly predictable manner.

We urgently need a new kind of
citizen-science alliance around
the world to work together
to devise a transition
to a sustainable
future.

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It's not complicated, really...

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We are now a fossil-fuel driven civilization.

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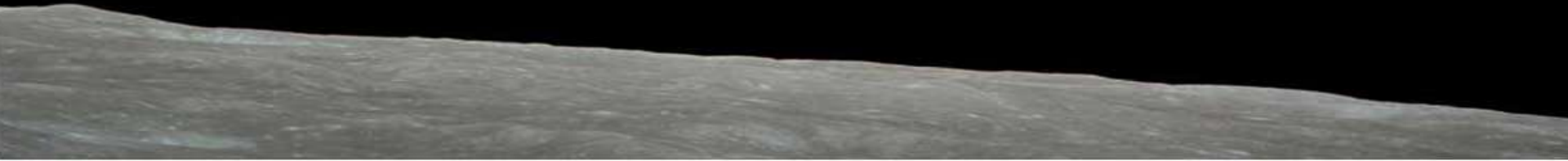
This will require a major **transition**.

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Transition Studies are crucial for
human survival.

This is because...

There is no “Planet B.”



This is because...

There is no “Planet B.”

We only have one Earth.



This is because...

There is no “Planet B.”

We only have one Earth.

We only get one chance.



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Climate Change and Transition Studies

An Interactive Online Learning Initiative

Designed for IvyMind Consulting, LLC
as a project of the

Young Scholars' Online Learning Initiative

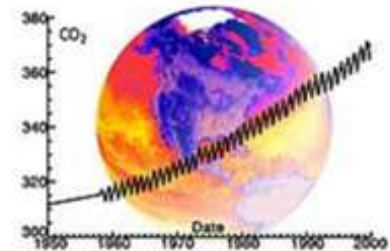
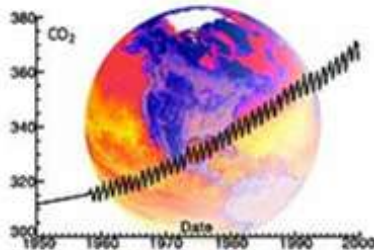
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Timothy C. Weiskel

Research Director, *Cambridge Climate Research Associates*

Climate Science for Human Survival

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Session 3

Earth's Changing Climate: Causes and Global Consequences

26 July 2018
