




The Climate Reality Project[®]

**Presented to Climate Reality Santa Clara Chapter
And Guests
February 24, 2020**

A photograph of a conference room. A speaker in a black shirt stands at a podium on the left. A large white projection screen is in the background. In the foreground, the back of a bald man's head is prominent. To the right, a yellow sign on a stand is partially visible. A pink text box is overlaid in the center of the image.

Renewable Energy \$ >> Fossil-Fuel Energy \$
2008



**Climate Crises and the
Need for Arctic Sea Ice Restoration**
Presented by
Gary Latshaw, Ph.D.

STANLEY FARKAS, PH.D, PHILIP RUSSELL, PH.D.

ANTHONY STRAWA, PH.D., STEVE ZORNETZER, PH.D.

SECURETHEFUTURE2100.ORG

RESTORATION OF ARCTIC SEA ICE IS ESSENTIAL TO MITIGATE AGAINST CLIMATE CRISES

- Continued loss of Arctic Sea Ice is **accelerating global warming**.
- Conversely, **ice restoration** will buy time to achieve elimination of greenhouse gas emissions.
- Therefore, restoration of Arctic Sea Ice **is essential**.

ASK

**The Government of the United States
implement a comprehensive, broad,
international program of STRATEGIC
RESEARCH & DEVELOPMENT with the
objective of RESTORING THE
ARCTIC SEA ICE.**

“National Arctic Ice Restoration Initiative” (NAIRI)

ICE RESTORATION IS A
PARALLEL EFFORT TO THE
ELIMINATION OF FOSSIL FUELS

PETER WADHAMS

A FAREWELL TO ICE

A REPORT FROM THE ARCTIC

EXXON: THE ROAD NOT TAKEN

BY NISLA BANERJEE, JOHN H. CUSHMAN JR.
DAVID WASEMYER AND LISA SONG





THAWING PERMAFROST

AIR TRANSPORT

COAL MINING

OIL PRODUCTION

COAL PLANTS

FERTILIZATION

INDUSTRIAL PROCESSES

LAND TRANSPORT

LANDFILLS

HOW WARM IS WARM?

Pulitzer Prizes



The 2016 Pulitzer Prize Finalist in Public Service

Finalist: InsideClimate News

For a probe into a major oil company's decades-long misinformation campaign to muddy the debate over climate change.

Neela Banerjee, Ho H. Cushman Jr., David Hasemyer and Lisa Song

InsideClimate News' **Exxon: The Road Not Taken** series was named a **finalist** on Monday for the Pulitzer Prize for Public Service.

The carbon dioxide content of the atmosphere is[a] concern since it can affect **global climate**. Carbon dioxide and other trace gases ..., etc. absorb part of the infrared rays reradiated by the earth. ...

This phenomenon is referred to as the “greenhouse effect.”

EXXON'S ROLE

- Roger Cohen, Head of Theoretical Science at Exxon Corporation Research Laboratory, September, 1982:

Our “ethical responsibility is to permit the publication of our research in the Scientific Literature. Indeed, to otherwise would be a breach of Exxon’s public position and ethical credo on honesty and integrity.”

- Between 1983 and 1984, at least three peer-reviewed papers in Journal of Atmospheric Sciences and an American Geophysical Union monograph
- Exxon: *The Road Not Taken*, 2020

November 12, 1982

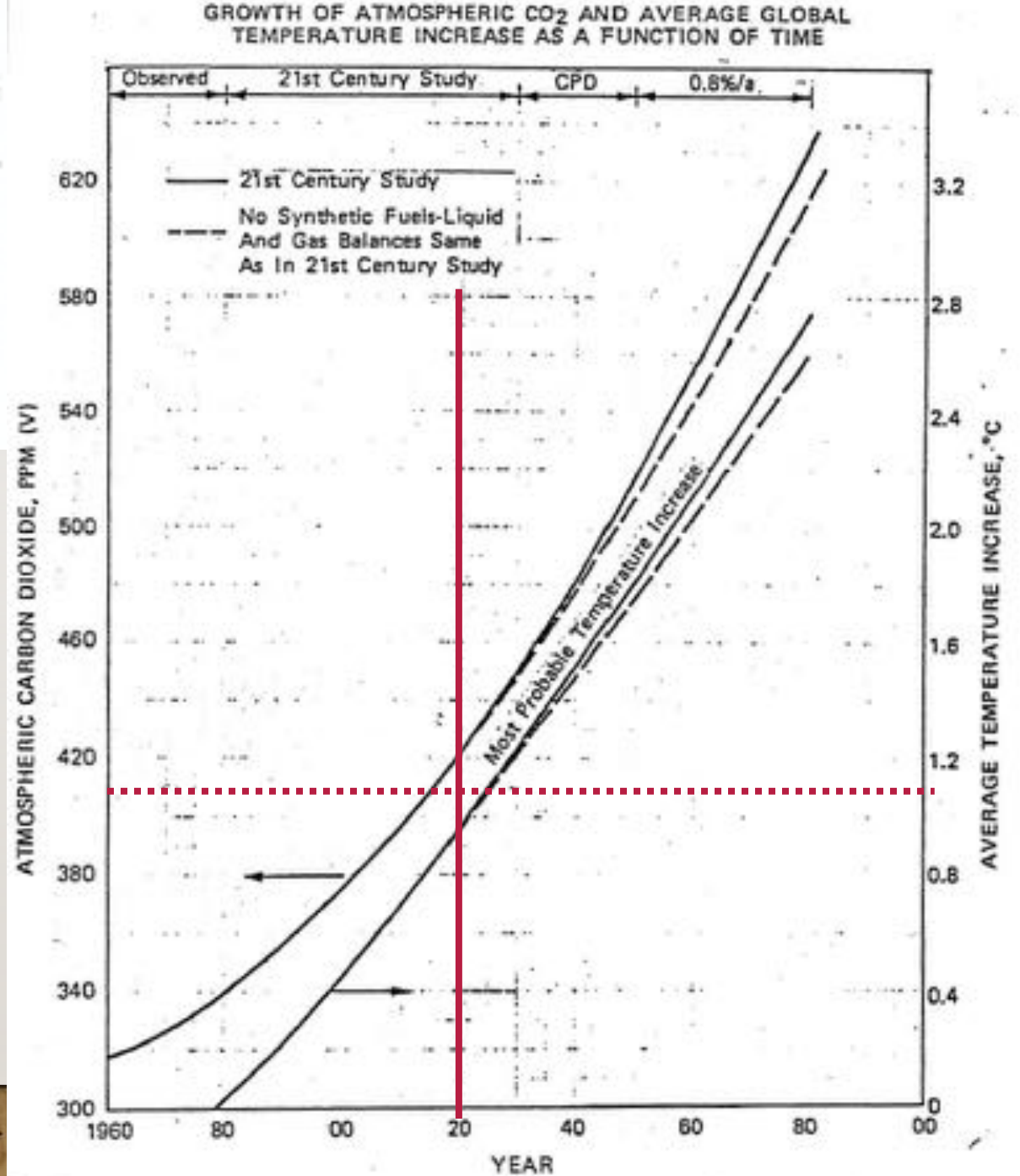
CO₂ "Greenhouse" Effect

82EAP 266

1982 prediction for 2020 was for ~ 412 ppm and 1.1 C

Actual
2019 is 412 ppm and 1.1 C (Hansen)*

*Hansen, et al., *Global Temperature in 2019*, 15 January 2020, Earth Institute, Columbia University, NY, NY



EXXON RESEARCH AND ENGINEERING COMPANY

P.O. BOX 101, FLORHAM PARK, NEW JERSEY 07932

W. B. GLASER
Manager
Environmental Affairs Programs

Case: ENCREXON, N.Y.

November 12, 1982

CO₂ "Greenhouse" Effect

82EAP 266

The increase would not be uniform over the earth's surface with the polar caps likely to see temperature increases on the order of 10 C and the equator little, if any.

EXXON'S RESPONSE

- Cut Research on Climate Change
- Fund: *Global Climate Coalition*, an alliance of some of the world's largest companies seeking to halt government efforts to curb fossil fuel emissions. Exxon used the
 - *American Petroleum Institute*,
 - *right-wing think tanks*,
 - *campaign contributions and*
 - *its own lobbying to push a narrative that climate science was too uncertain to necessitate cuts in fossil-fuel emissions.*
- *Exxon: The Road Not Taken*

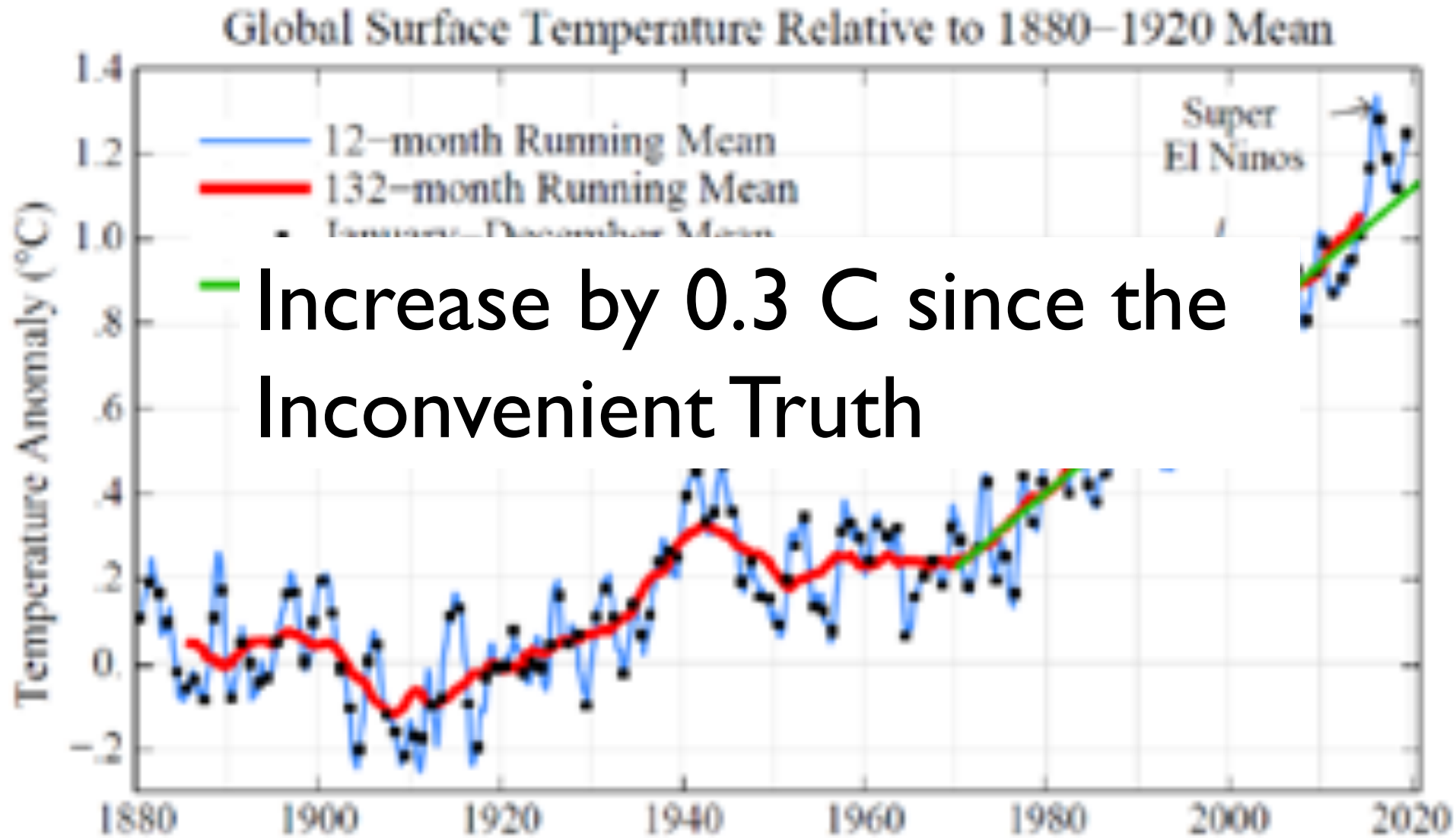


Fig. 1. Global surface temperatures relative to 1880-1920 based on GISTEMP data, which employs GHCN.v4 for meteorological stations, NOAA ERSST.v5 for sea surface temperature, and Antarctic research station data¹.

CRITICAL REGION:THE ARCTIC

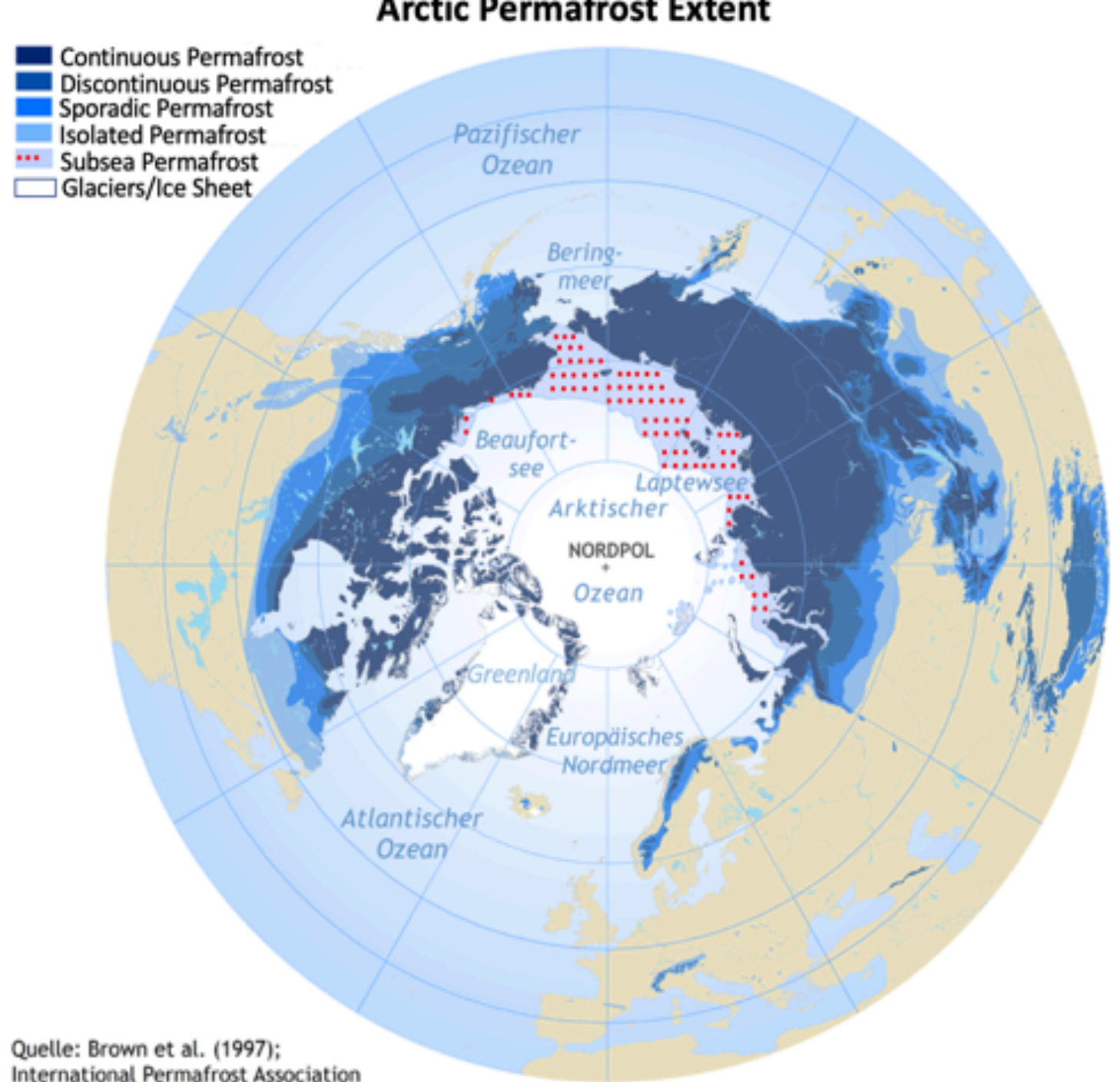
MAP OF ARCTIC REGION

Area of Arctic Sea Ice:

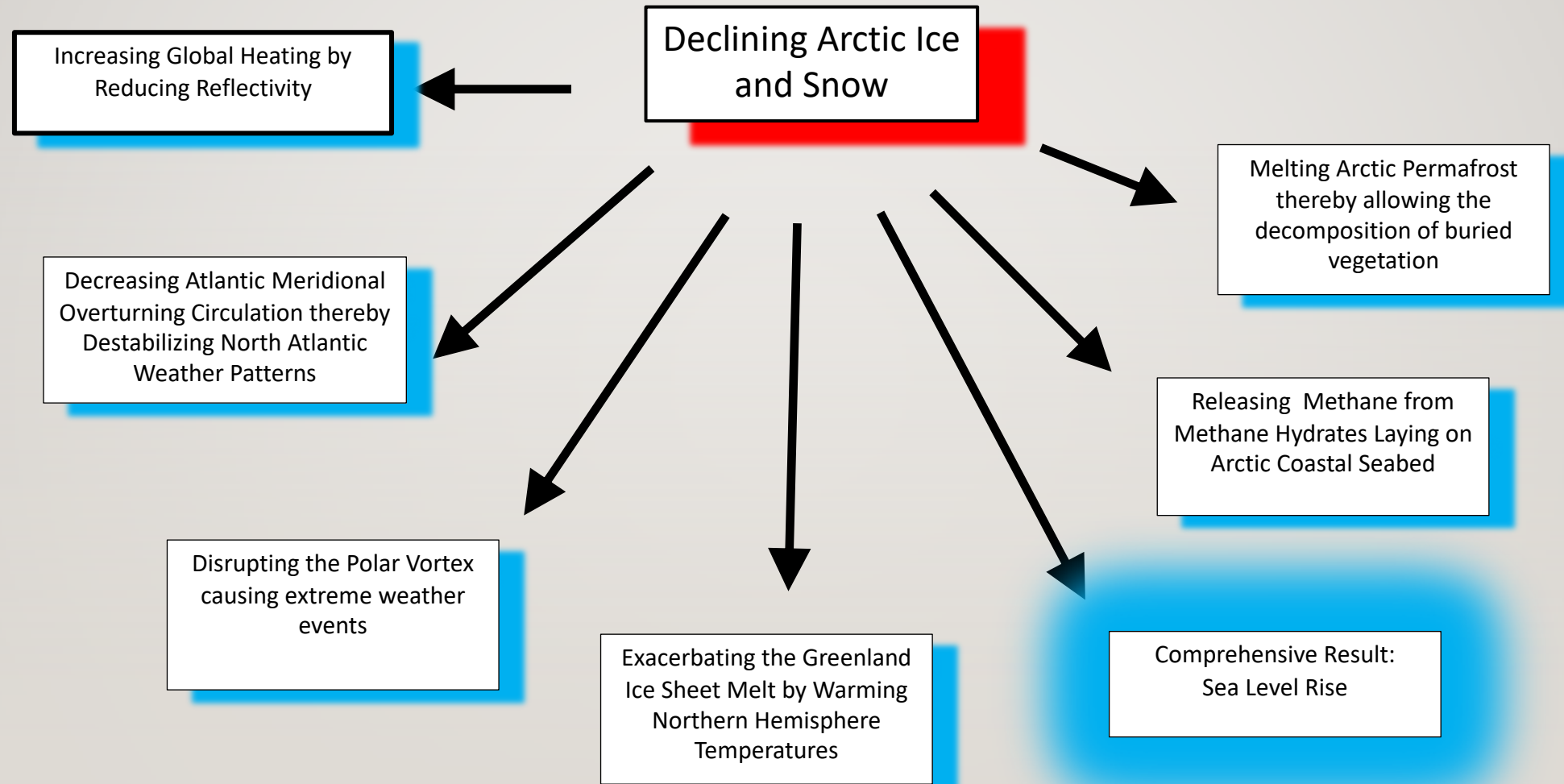
March: ~ 6 million square miles

September ~ 2.6 million square miles

Area of US is 3.8 million square miles



Multiple Earth Systems at Risk from Loss of Arctic Ice



Multiple Earth Systems at Risk from Loss of Arctic Ice

Increasing Global Heating by Reducing Reflectivity

Declining Arctic Ice and Snow

Decreasing Atlantic Meridional Overturning Circulation thereby Destabilizing North Atlantic Weather Patterns

Disrupting the Polar Vortex causing extreme weather events

Exacerbating the Greenland Ice Sheet Melt by Warming Northern Hemisphere Temperatures

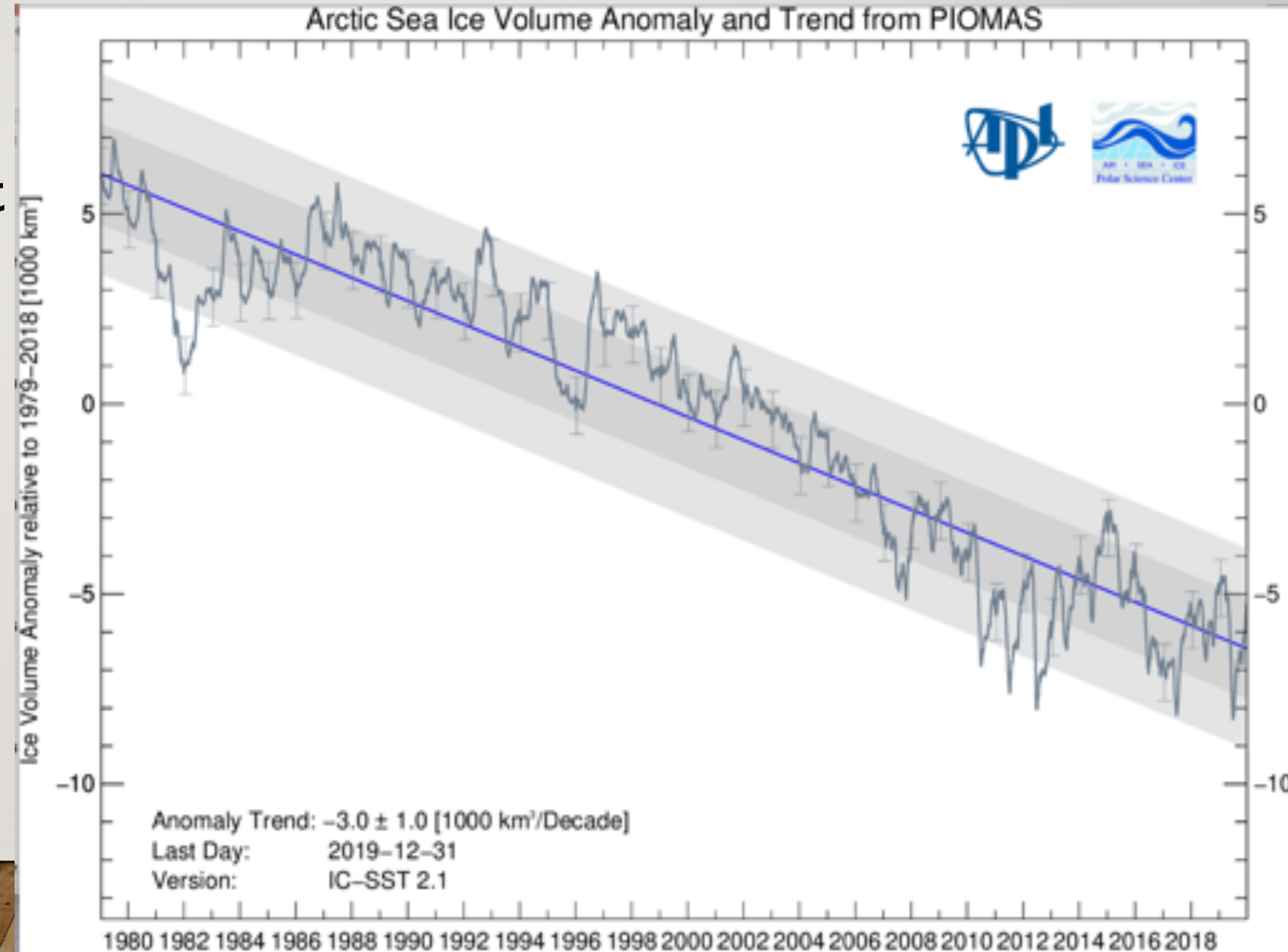
Melting Arctic Permafrost thereby allowing the decomposition of buried vegetation

Releasing Methane from Methane Hydrates Laying on Arctic Coastal Seabed

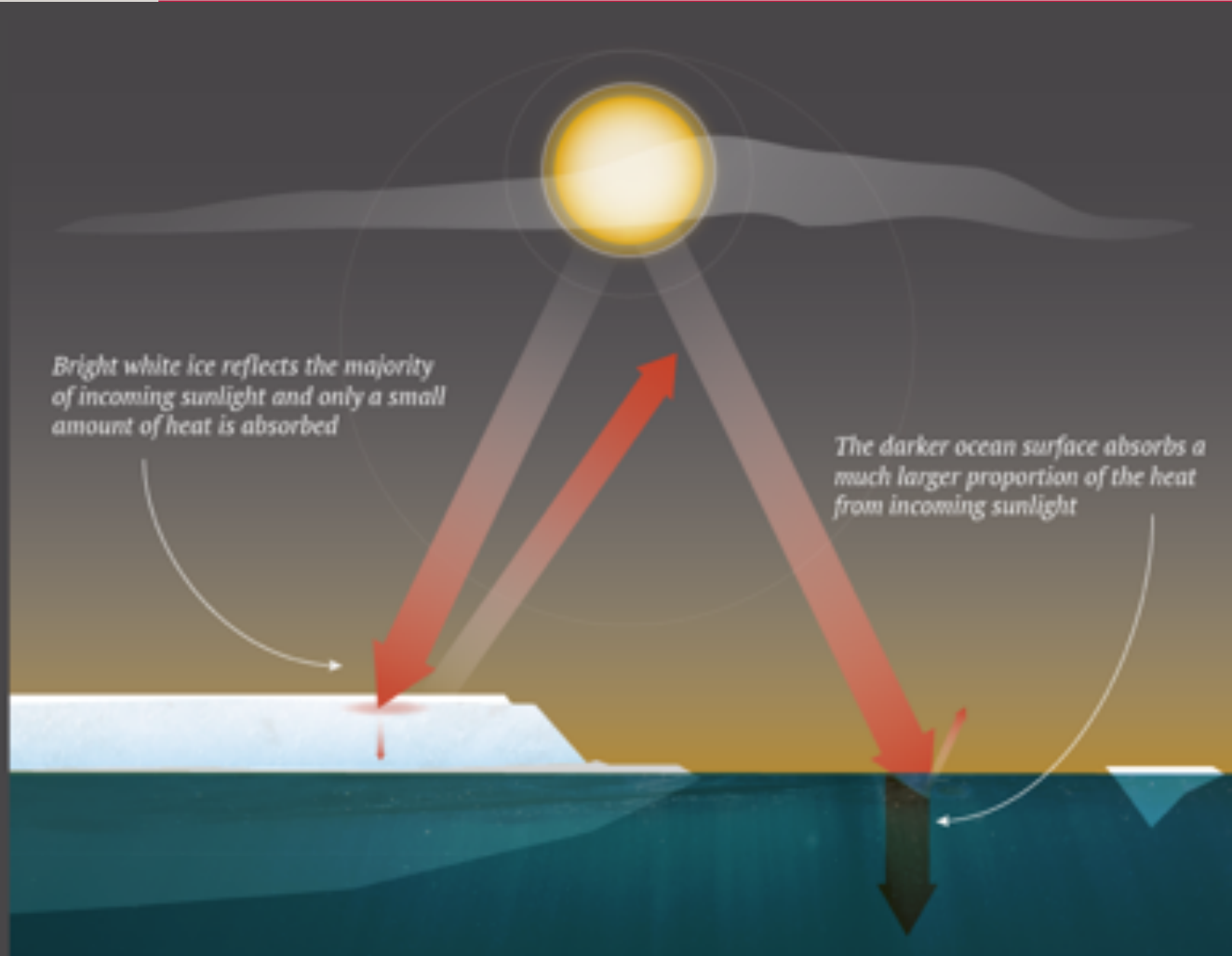
Comprehensive Result: Sea Level Rise

10 years to an Ice-Free Summer Arctic

- 2019 second lowest average sea ice volume since 1979
- **Loss 75%** - half from area decline and half from thickness decline



SUBSTANTIAL EXCESSIVE GLOBAL HEATING

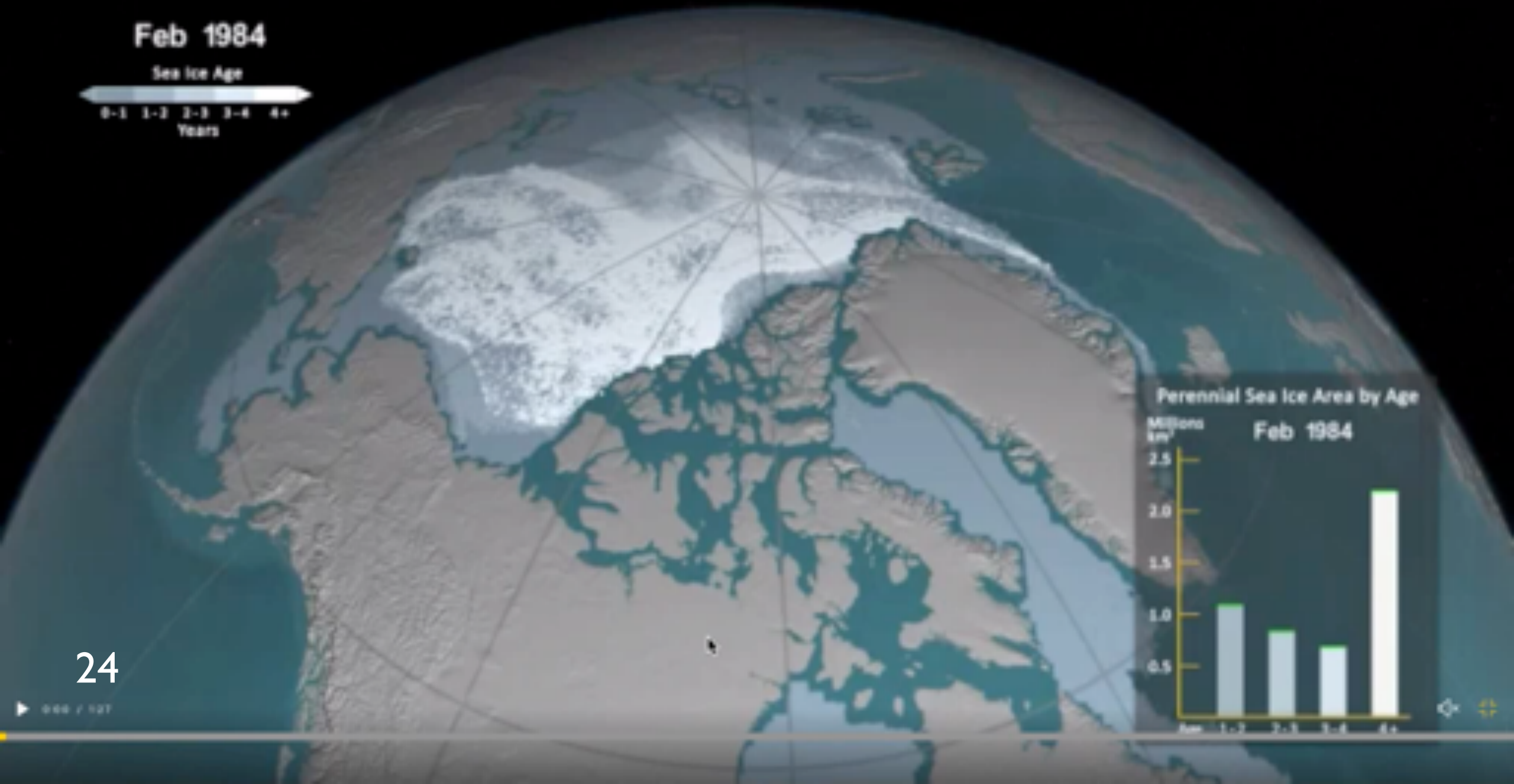
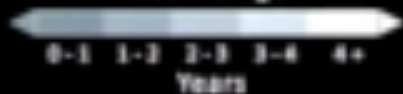


- More Heat Absorption in open ocean and thin ice

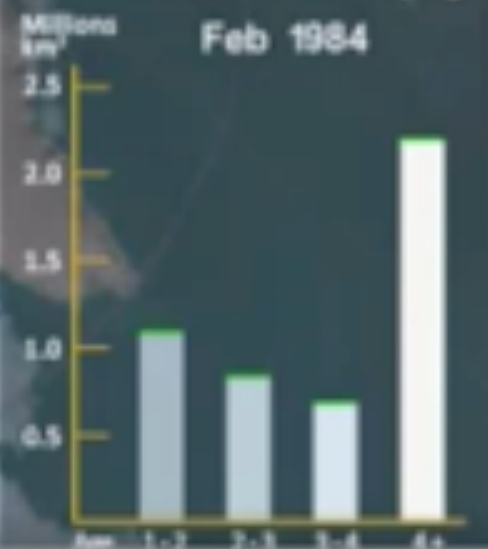


Feb 1984

Sea Ice Age




Perennial Sea Ice Area by Age



24

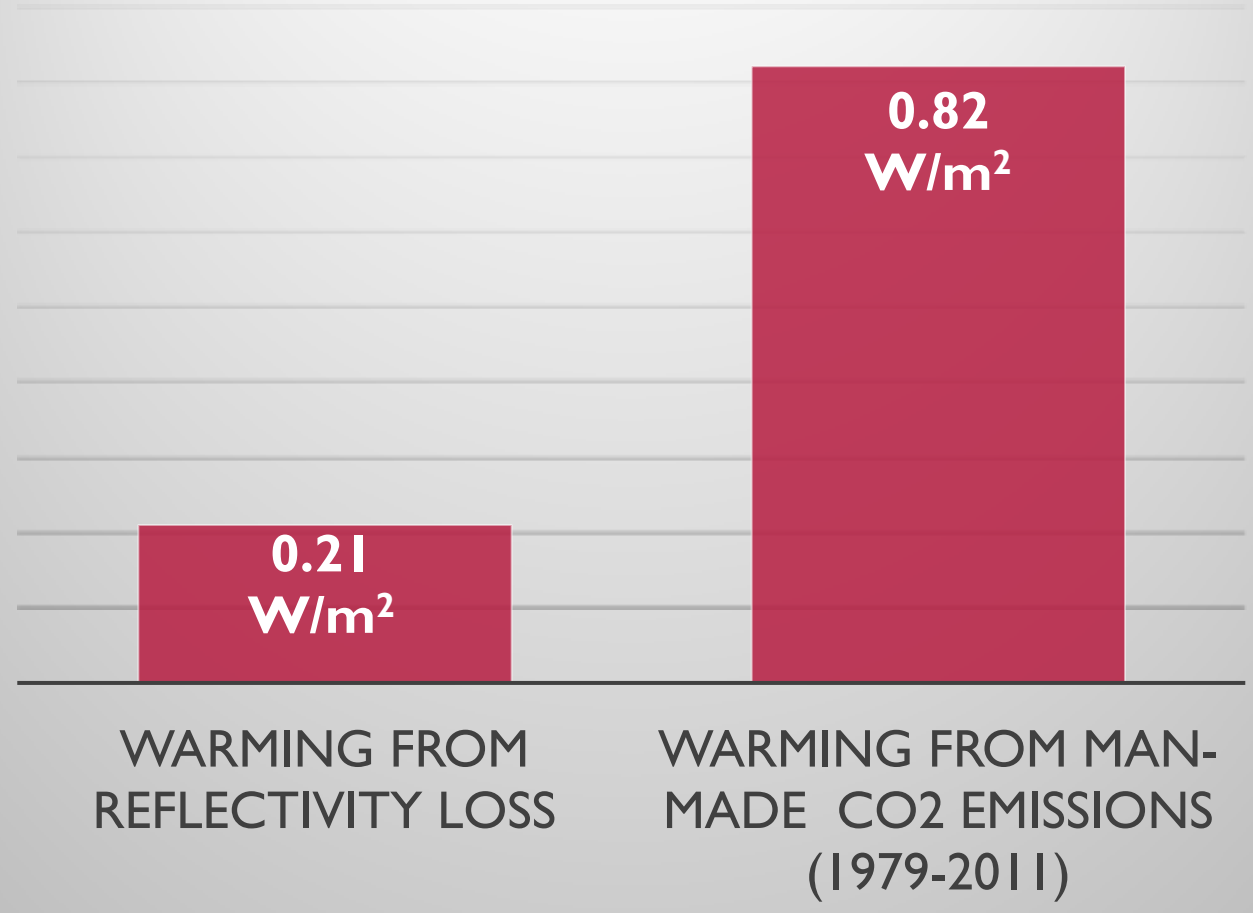


An aerial photograph showing a vast expanse of dark blue water with numerous irregular, light-colored ice floes scattered across the surface. The floes vary in size and shape, some appearing as thin, elongated strips and others as larger, more rounded patches. The overall scene depicts a fragmented and thinning ice cover.

The Arctic's oldest and thickest
sea ice has never been observed
breaking up.

It happened twice in 2018.

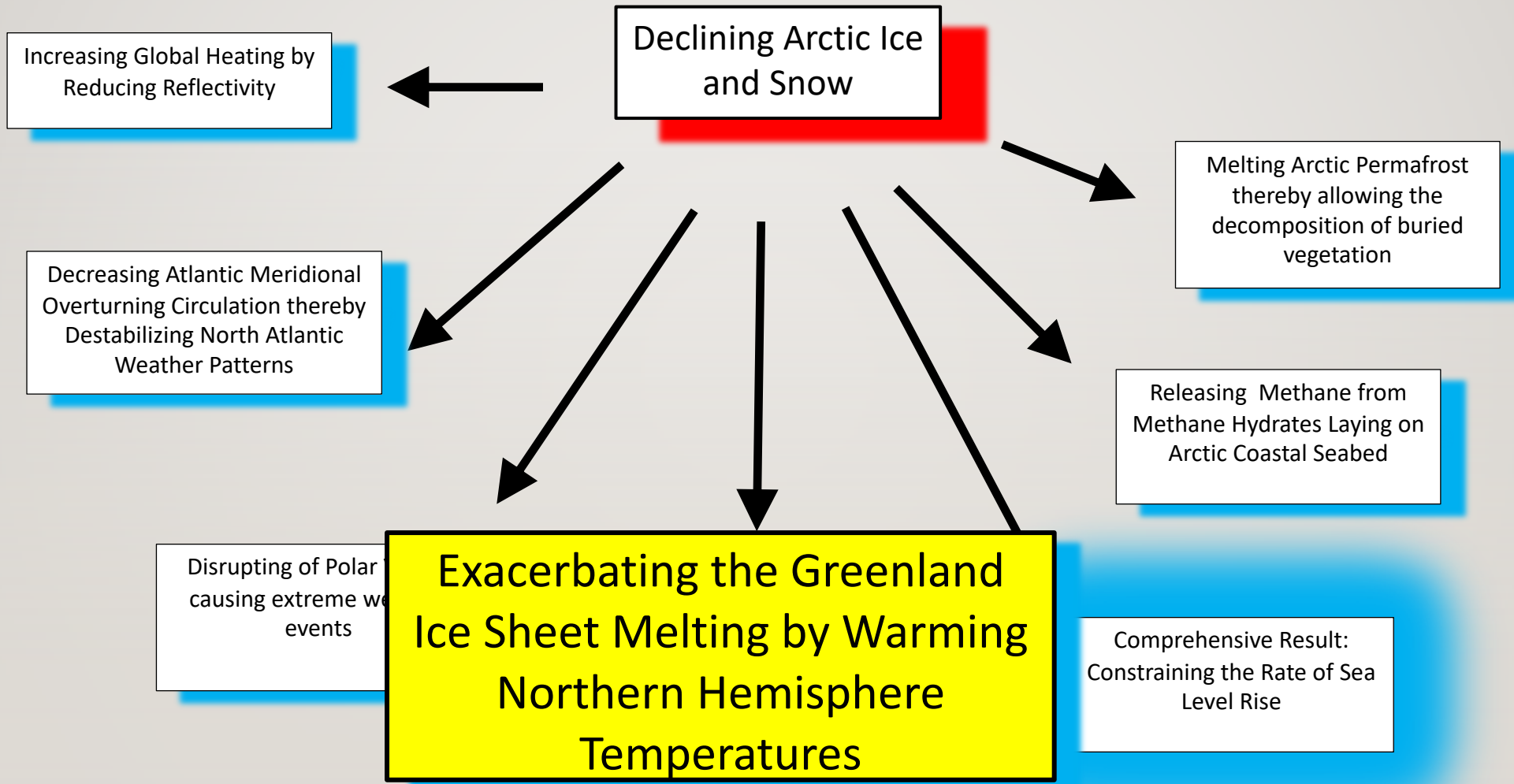
Warming from Loss of Reflective Sea Ice vs. Warming from Extra CO₂ emitted between 1979-2011



- From 1979-2011 the decline in sea ice caused warming equal to **one quarter** of the warming from man-made CO₂ emitting during the same period.
- **Arctic Ice-Free Summer** projections show 0.71 W/m² warming for an Ice-Free Summer
 - **Three times** Warming from Current Loss of Arctic Ice

Reference: Pistone, etal, *Radiative Heating of an Ice-Free Arctic Ocean*, AGU 10.1029/2019GL082914

Multiple Earth Systems at Risk from Loss of Arctic Ice



ICE SHEET, KANGERLUSSUAQ, GREENLAND

Greenland's ice is melting four times faster than originally thought, and more is melting from the permanent ice sheet than from glaciers.

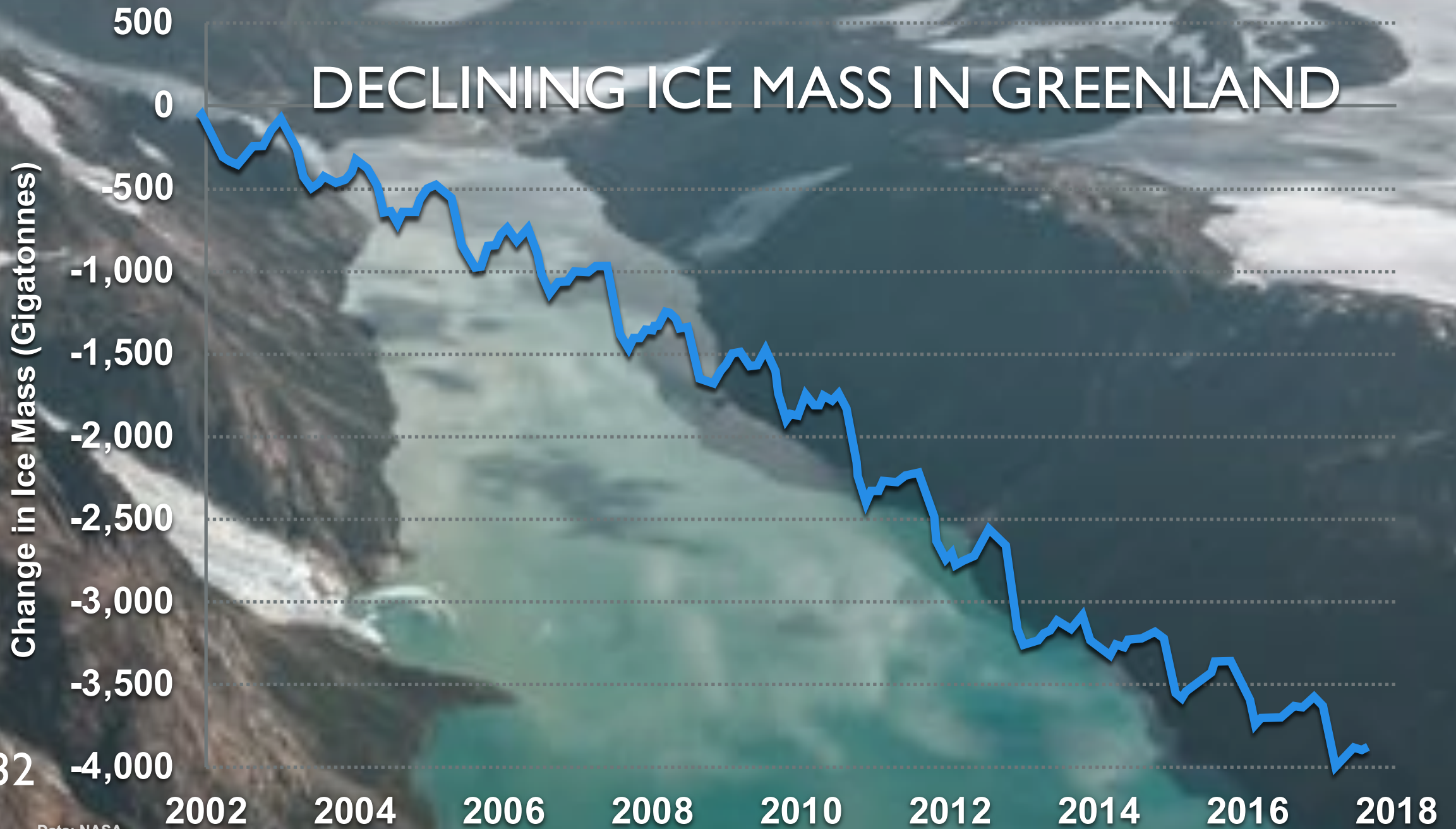
30

FORMATION OF RIVERS IN GREENLAND

- **Greenland's Ice Melt Rate Has Now Accelerated To A Whopping 234 Billion Tons Of Ice Lost Per Year**
- **Forbes, jan 12, 2020**



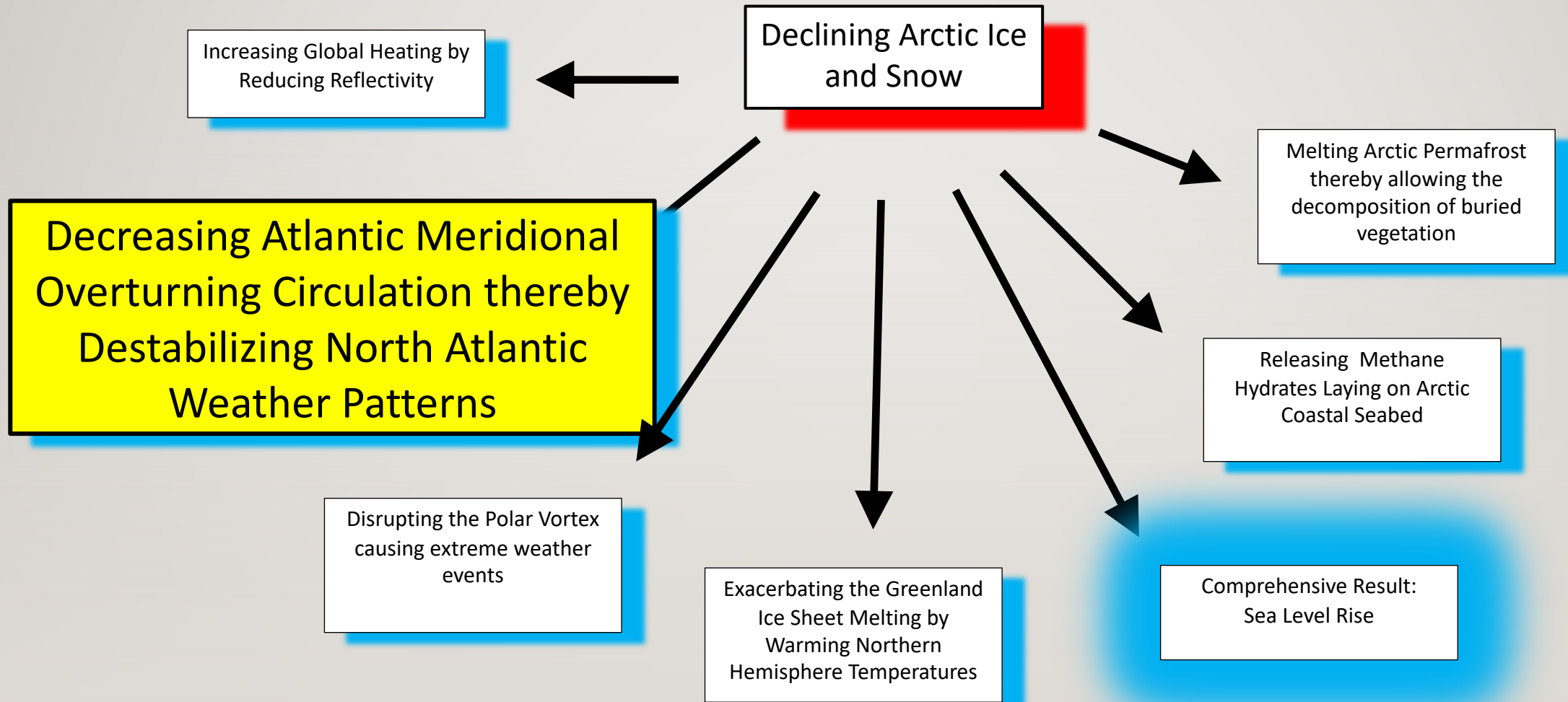
DECLINING ICE MASS IN GREENLAND



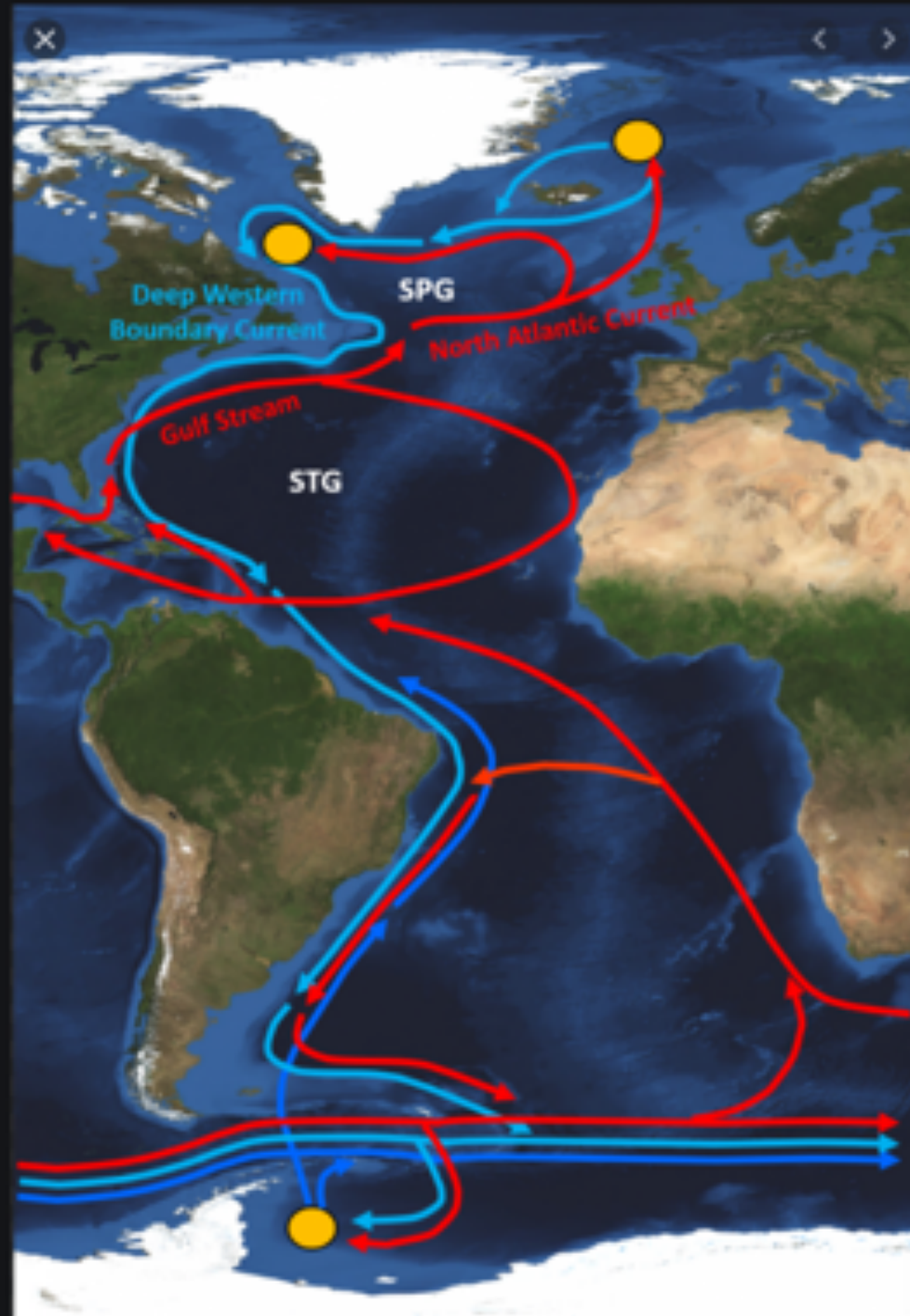
32

Data: NASA
Images courtesy Anders Bjørk, © Natural History Museum of Denmark/Tholstrup (2013) and Danish Geodata Agency (1935)

Multiple Earth Systems at Risk from Loss of Arctic Ice



- Atlantic Meridional Overturning Circulation (AMOC)
- 10-15% slow down



MANHATTAN, NEW YORK

Superstorm Sandy caused damage to Jamaica, Cuba, Haiti, the Dominican Republic, the Bahamas, and US Mid-Atlantic and Northeastern States

SLOWING OF AMOC IS EXPECTED TO CAUSE RELATIVE SEA LEVEL RISE ALONG US EAST COAST



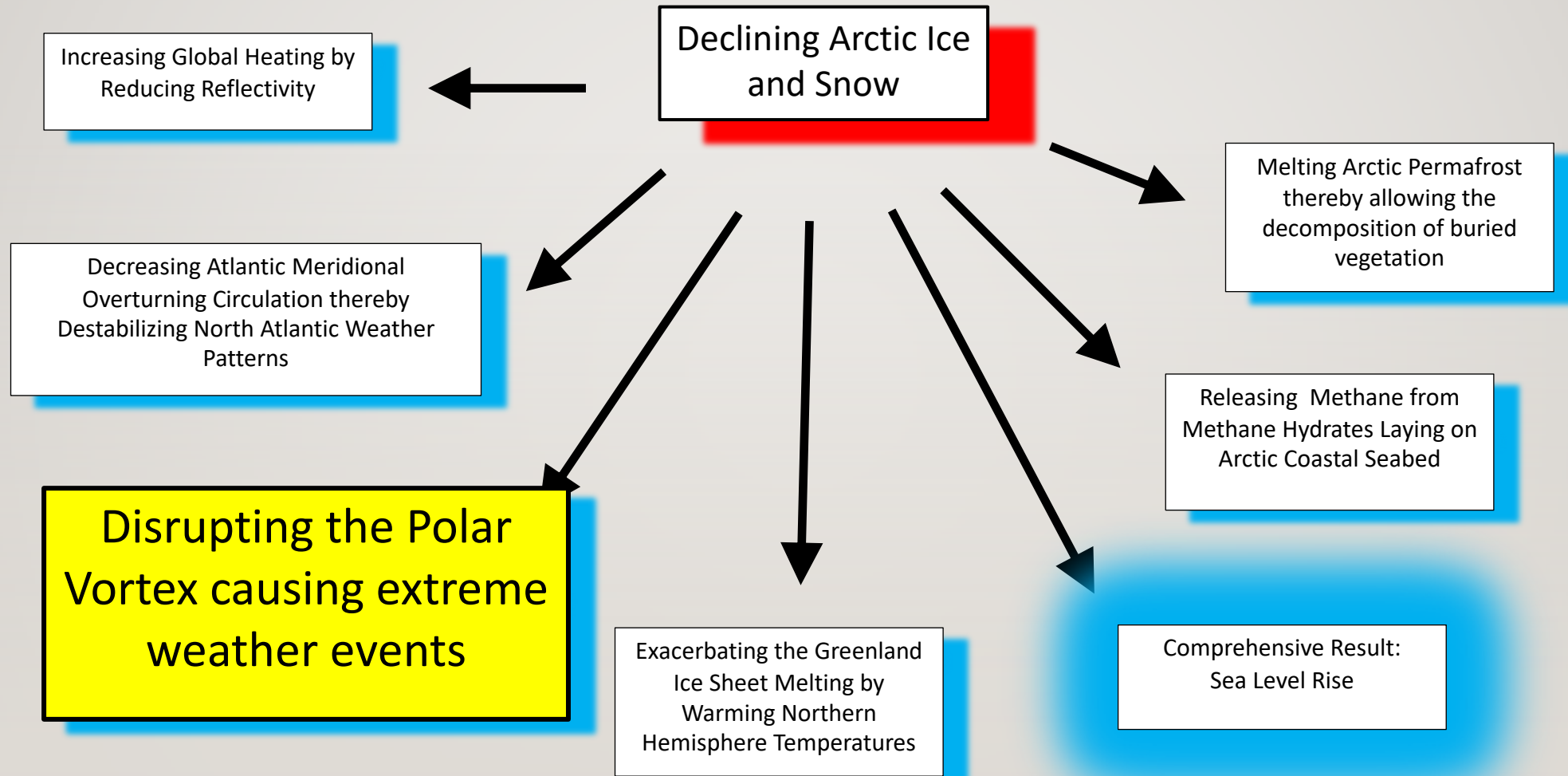
Rising Seas Are Flooding Norfolk Naval Base, and There's No Plan to Fix It

The giant naval base in Virginia is under threat by rising seas and sinking land, but little is being done to hold back the tides.

By Nicholas Kusnetz

OCT 25, 2017

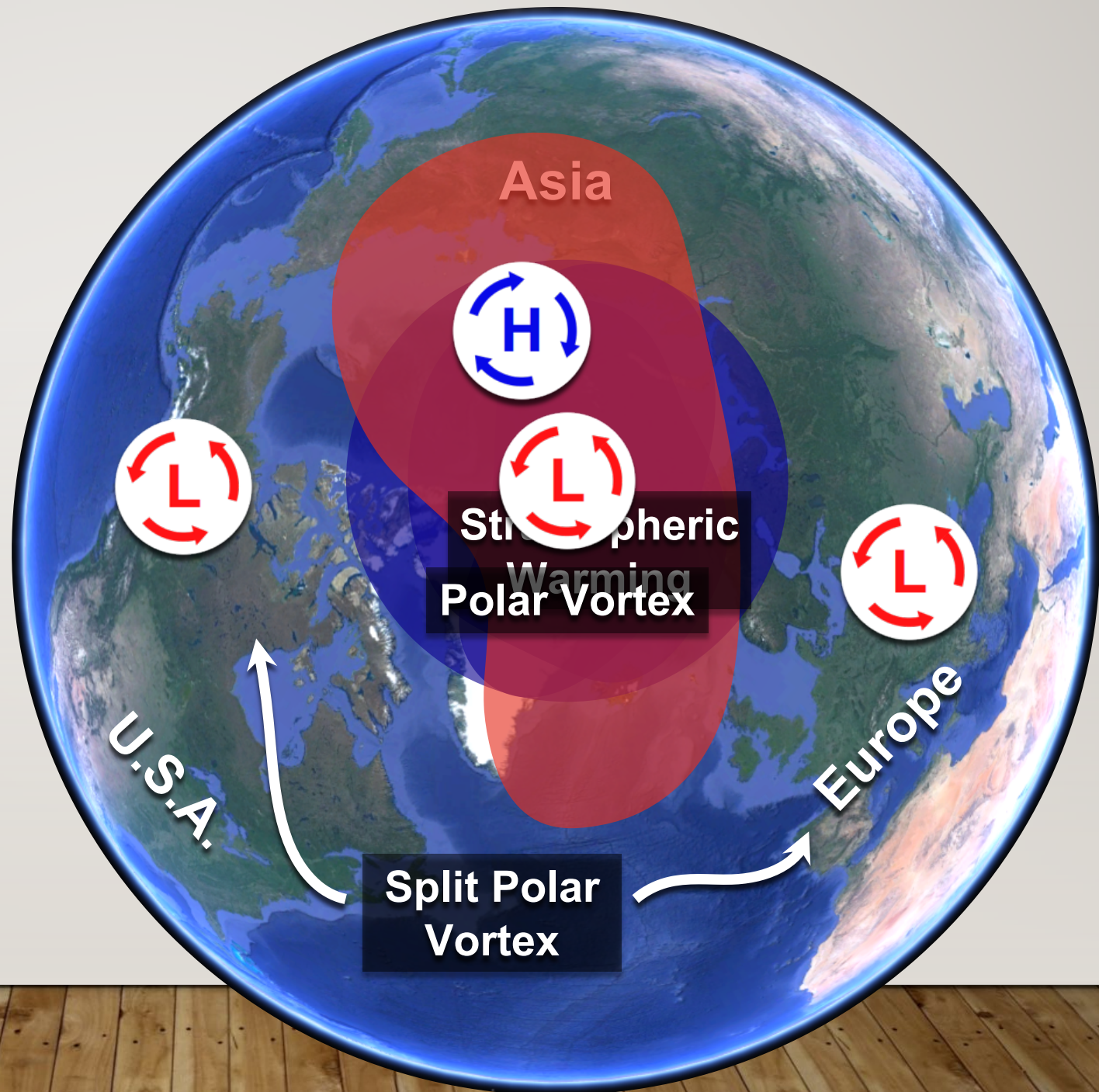
Multiple Earth Systems at Risk from Loss of Arctic Ice





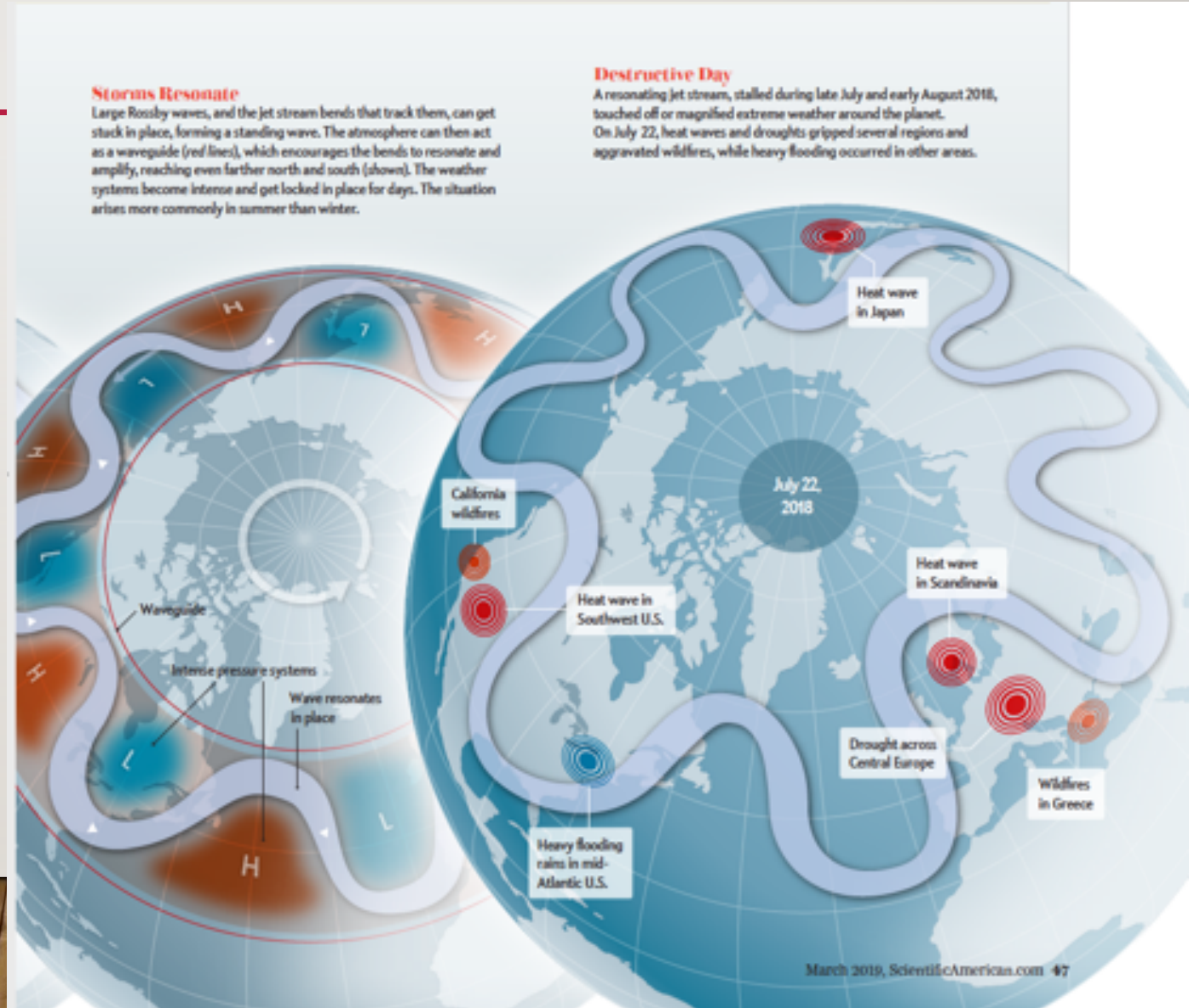
Temperature
Difference
Reduced as
1982 Exxon
Analysis
Expected

In mid-February 2018, the Polar Vortex split in two, bringing bitter cold to parts of North America and Europe, and record warmth to the Arctic.

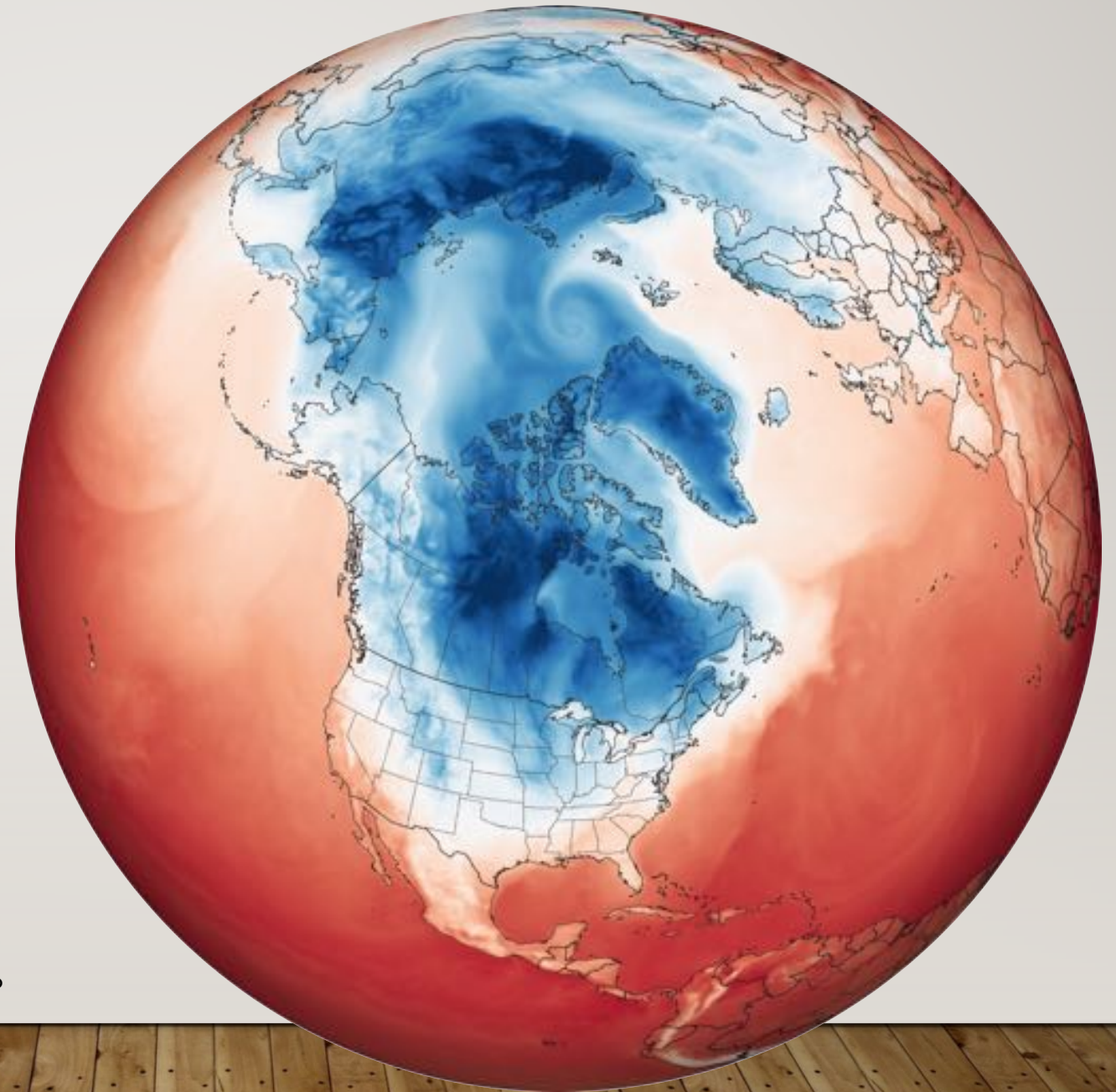


WANDERING POLAR JET STREAM

- More severe weather
- Unpredictable Weather complicating agriculture
- More Melting



JANUARY 29, 2019



Air Temperature at 2 Meters (°F)



≤ -40° -4° 32° 68° ≥ 100°

The temperature at the North Pole was **28° C (50° F) hotter than normal** on February 25, 2018.



NORTHWEST GREENLAND

- June 13, 2019

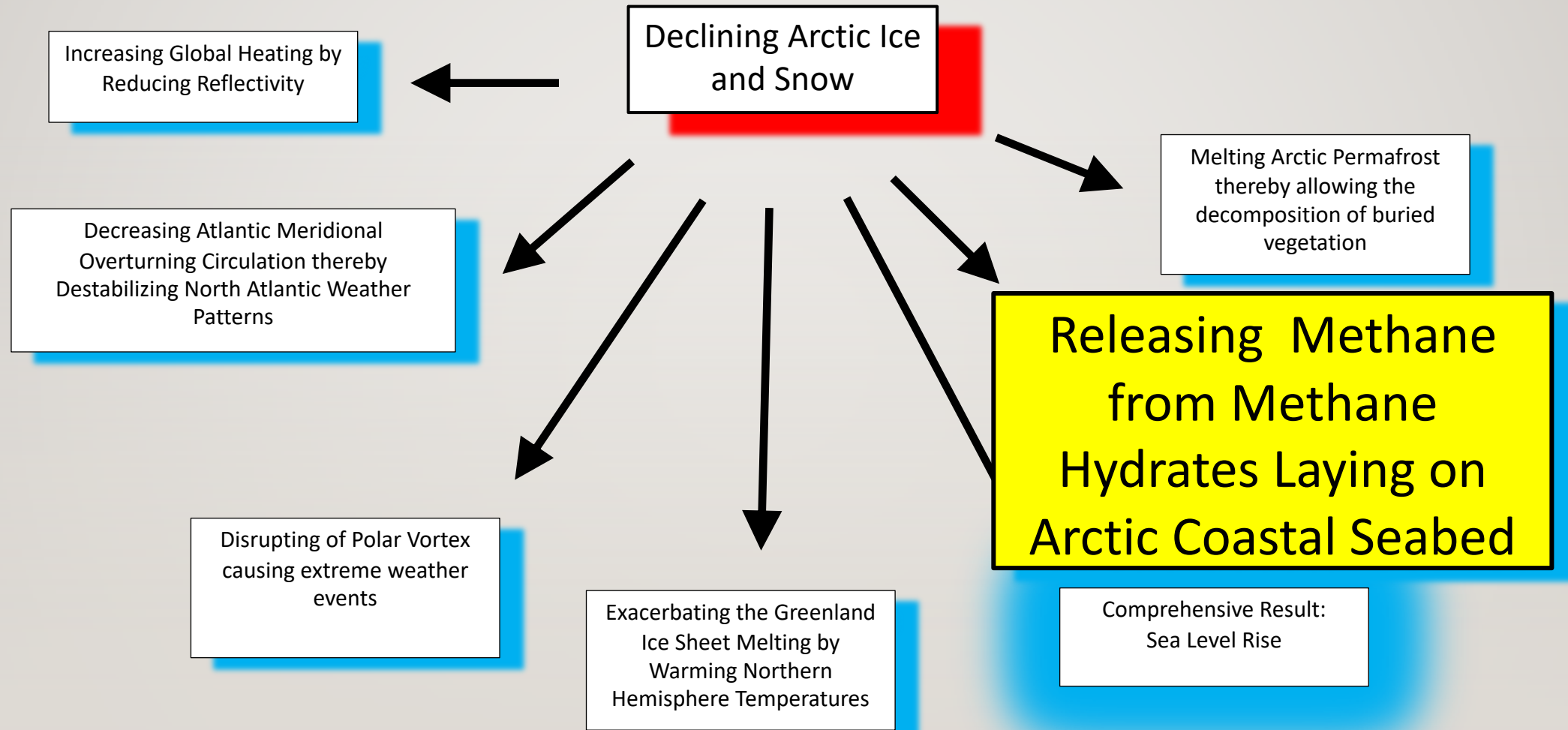


ROME, ITALY

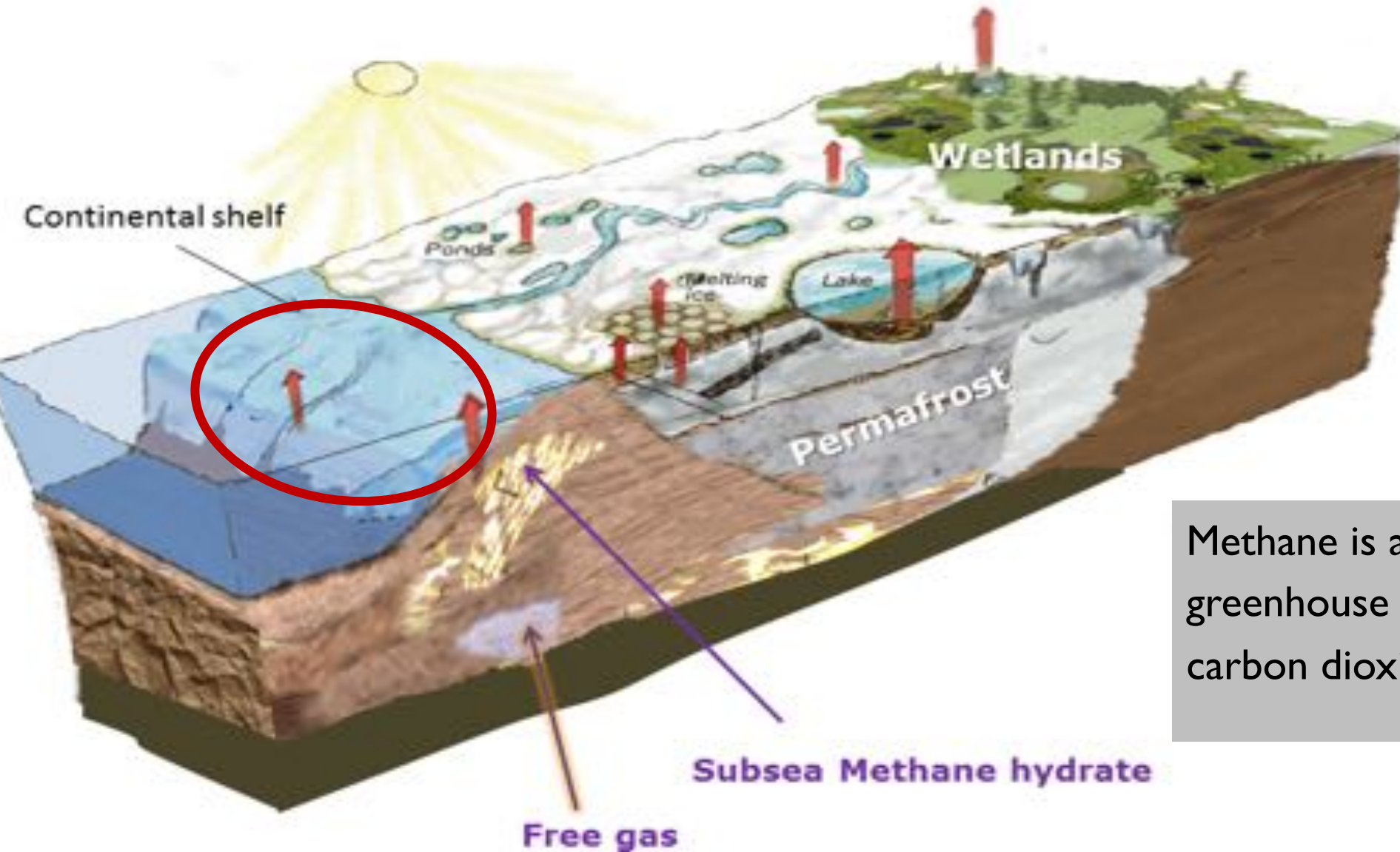
• February 26, 2018



Multiple Earth Systems at Risk from Loss of Arctic Ice



Arctic sources of methane



Methane is a very powerful greenhouse gas - ~80 times that of carbon dioxide over a 20-year period



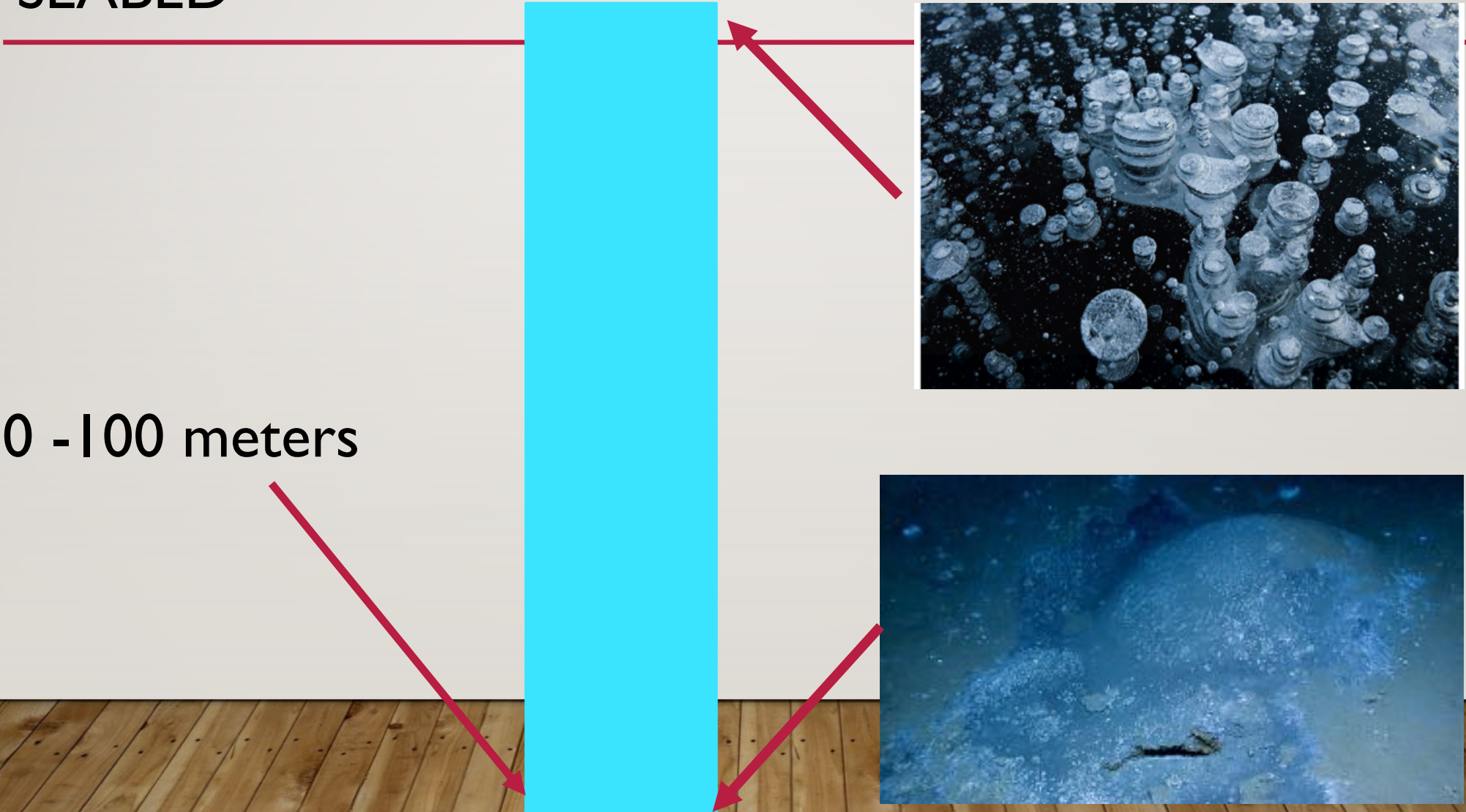
47

Yentay R

SINCE 2005 RUSSIAN ARCTIC SHELF WATERS HAVE BEEN ICE-FREE

- Sunlight is penetrating the surface and warming the temperatures to above freezing
- Measurements from Laptev Sea confirm methane release

METHANE RELEASES FROM SHALLOW ARCTIC SEABED



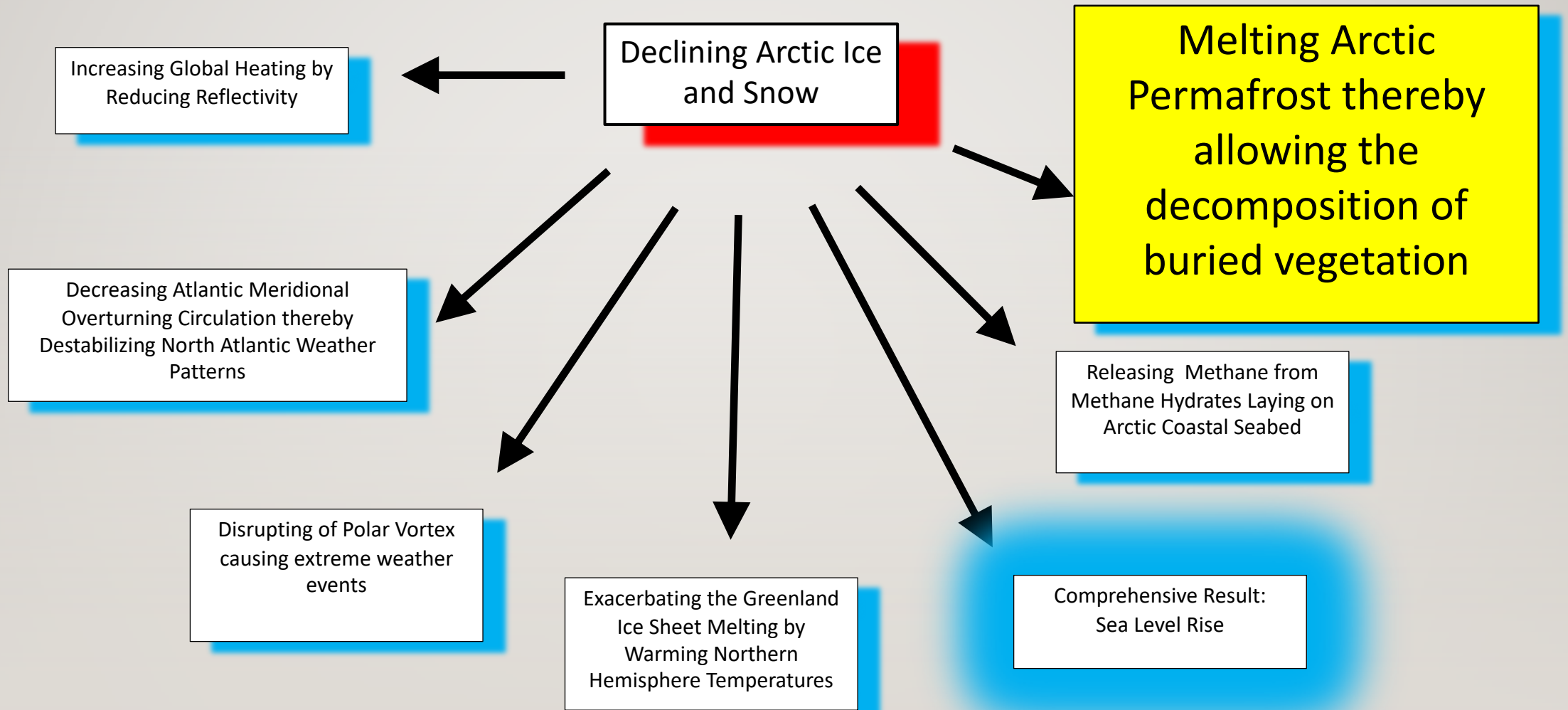
Depth 50 - 100 meters



THREAT FROM DETERIORATING CONTINENTAL SHELF

- Potential of 50 Gt Release of Methane Resulting in a 0.6° C increase in global temperatures
- 400 Gt Estimated Stored on Continental Shelf

Multiple Earth Systems at Risk from Loss of Arctic Ice



Unexpected future boost of methane possible from Arctic permafrost



Thermokarst lakes provide a mechanism that releases large amounts of buried and dissolved methane.

"We don't have to wait 200 or 300 years to get these large releases of permafrost carbon. Within my lifetime, my children's lifetime, it should be ramping up. It's already happening but it's not happening at a really fast rate right now, but within a few decades, it should peak."

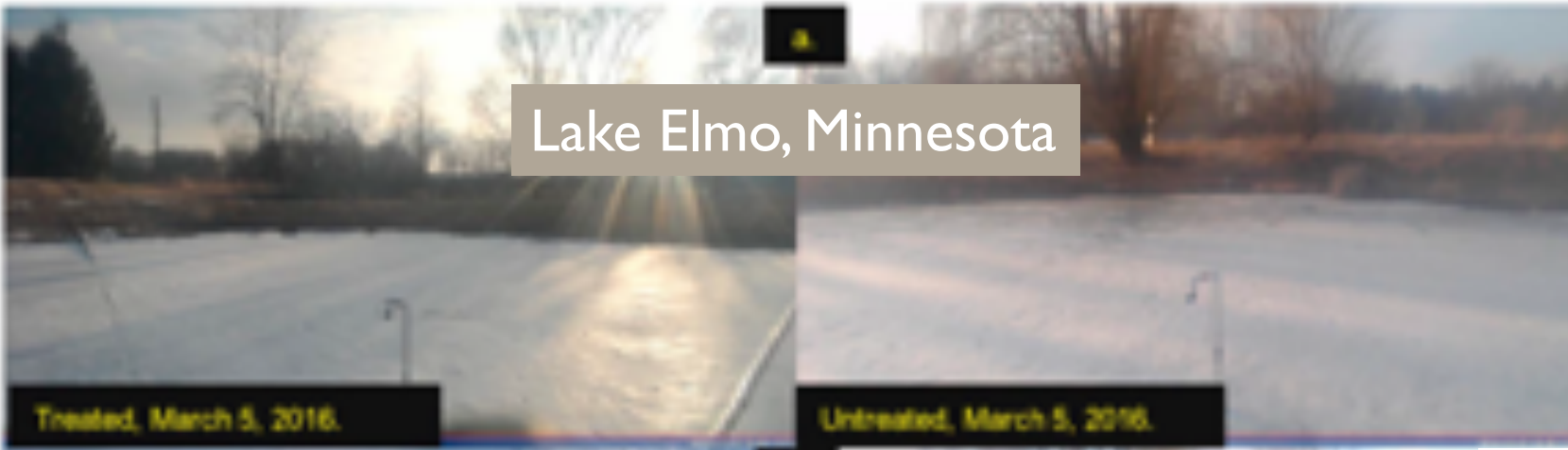
Katy Walter Anthony at the University of Alaska



PROMISING METHODS TO “RESTORE” THE ARCTIC (NOT EXHAUSTIVE LIST)

PETITION AVAILABLE TO SUPPORT GOVERNMENT INITIATIVE

Lake Elmo, Minnesota



Treated, March 5, 2016.

Untreated, March 5, 2016.



Treated, March 8, 2016.

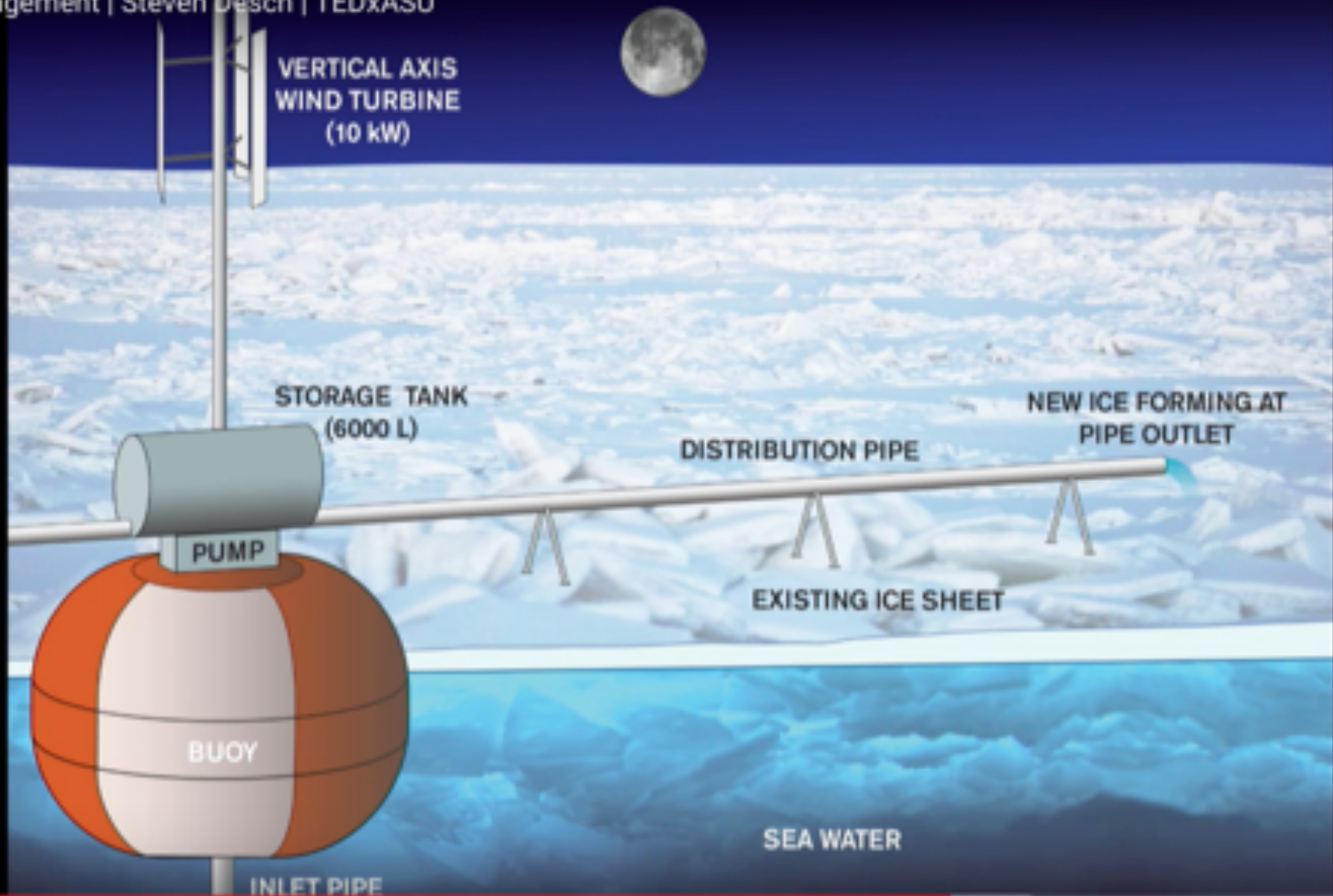
Untreated, March 8, 2016.



Treated, March 9, 2016.

Untreated, March 9, 2016.

From publication at
ice911.org
*Increasing Arctic Sea Ice
Albedo Using Localized
Reversible Geoengineering*
AGU100
Downloaded October 2019



STEVE DESCH, ETAL

- Wind power pump bringing 10 kg/second water to the surface
- 6-meter blades
- 10 million pumps

- Result: 1-meter thick ice with 10 pumps per square kilometer

PROPOSED NAIRI RESEARCH FOCUS AREAS

- **Field Work to Better Understand:**
 - Physics and Chemistry and Biology of the Arctic
 - Influence of Sea Ice on Atmospheric Circulation and Jet Stream
 - Influence of Sea Ice on Ocean Currents
- **Modeling Efforts to Better Understand:**
 - Implications of Arctic Ice Depletion on Weather Patterns, Ocean Circulation
 - Benefits and Risks of Potential Remediation Schemes



Multidisciplinary drifting Observatory for the Study of Arctic Climate

FEATURES | 18 November 2019 | 8:00

Inside MOSAiC: How a year-long Arctic expedition is helping climate science



Scientific focus areas

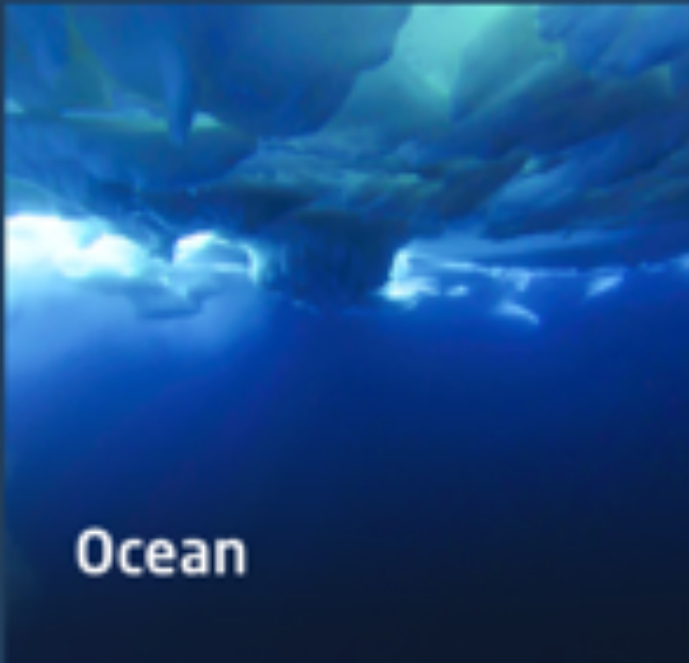
MOSAIC's complex interdisciplinary science approach based on main scientific focus areas.



Atmosphere



Sea ice



Ocean



Biogeochemistry



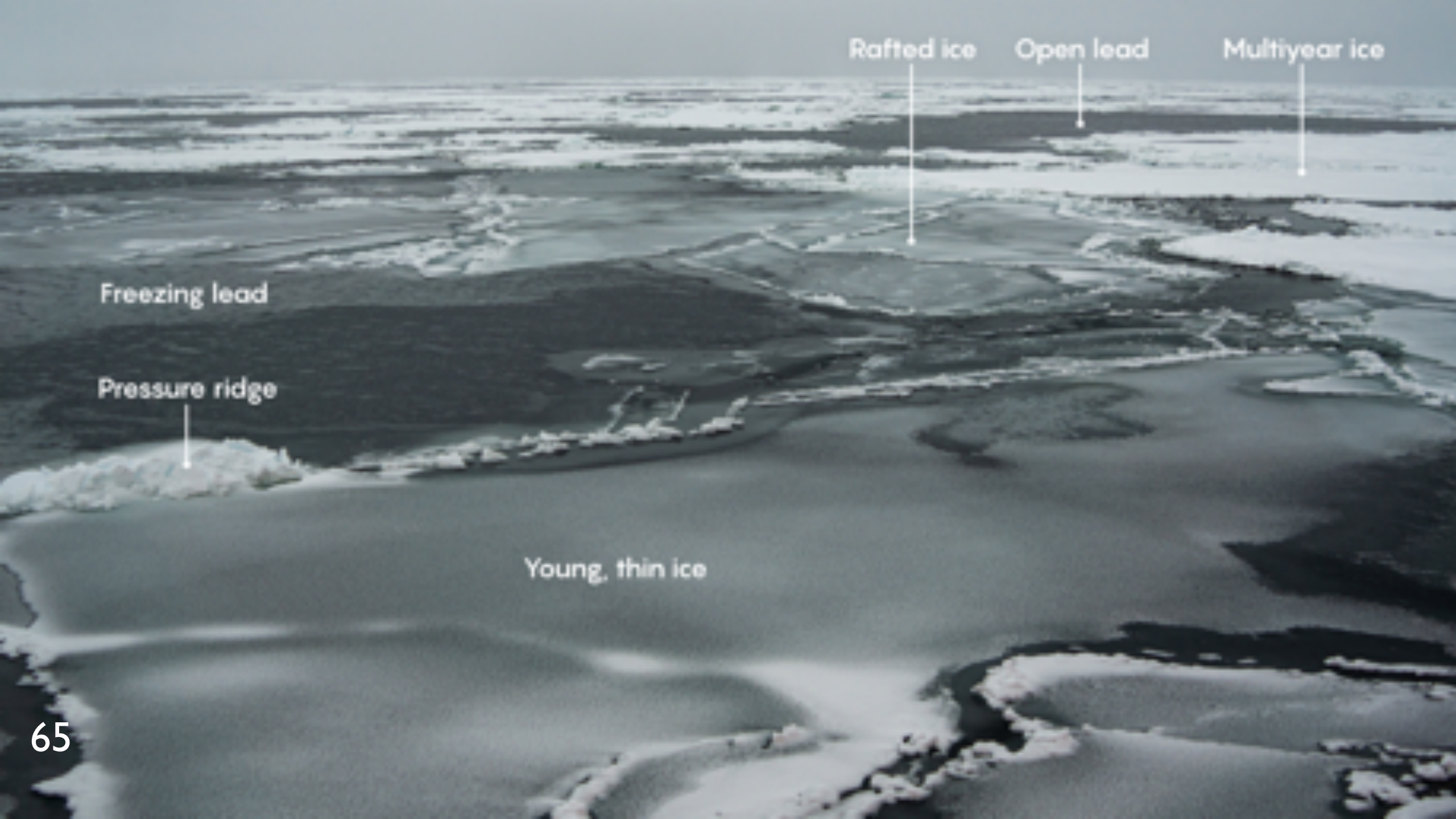
Ecosystem



**Polarstern assisted by
Akademik Fedorov**

The German icebreaker Polarstern is moored to a piece of ice that scientists hope to drift with and study for the next year.
Ravenna Koenig for NPR





Rafted ice

Open lead

Multiyear ice

Freezing lead

Pressure ridge

Young, thin ice



Scientist Jessie Creamean moves a portable aerosol sampler out onto the ice to test it in the cold conditions.

Ravenna Koenig for NPR

THE COST OF CARBON

- *Political Instability*
- *Floods & Mudslides*
- *Wildfires*
- *Drought*
- *Storm Damage*
- *Ocean Acidification*
- *Infrastructure Loss*
- *Climate Refugees*



- *Species Extinction*
- *Melting Glaciers*
- *Famine*
- *Water Scarcity*
- *Ecosystem Loss*
- *Our Way of Life*
- *Infectious Diseases*
- *Sea Level Rise*

... And much, much more
“The #1 Threat to the
Global Economy”

November 12, 1982

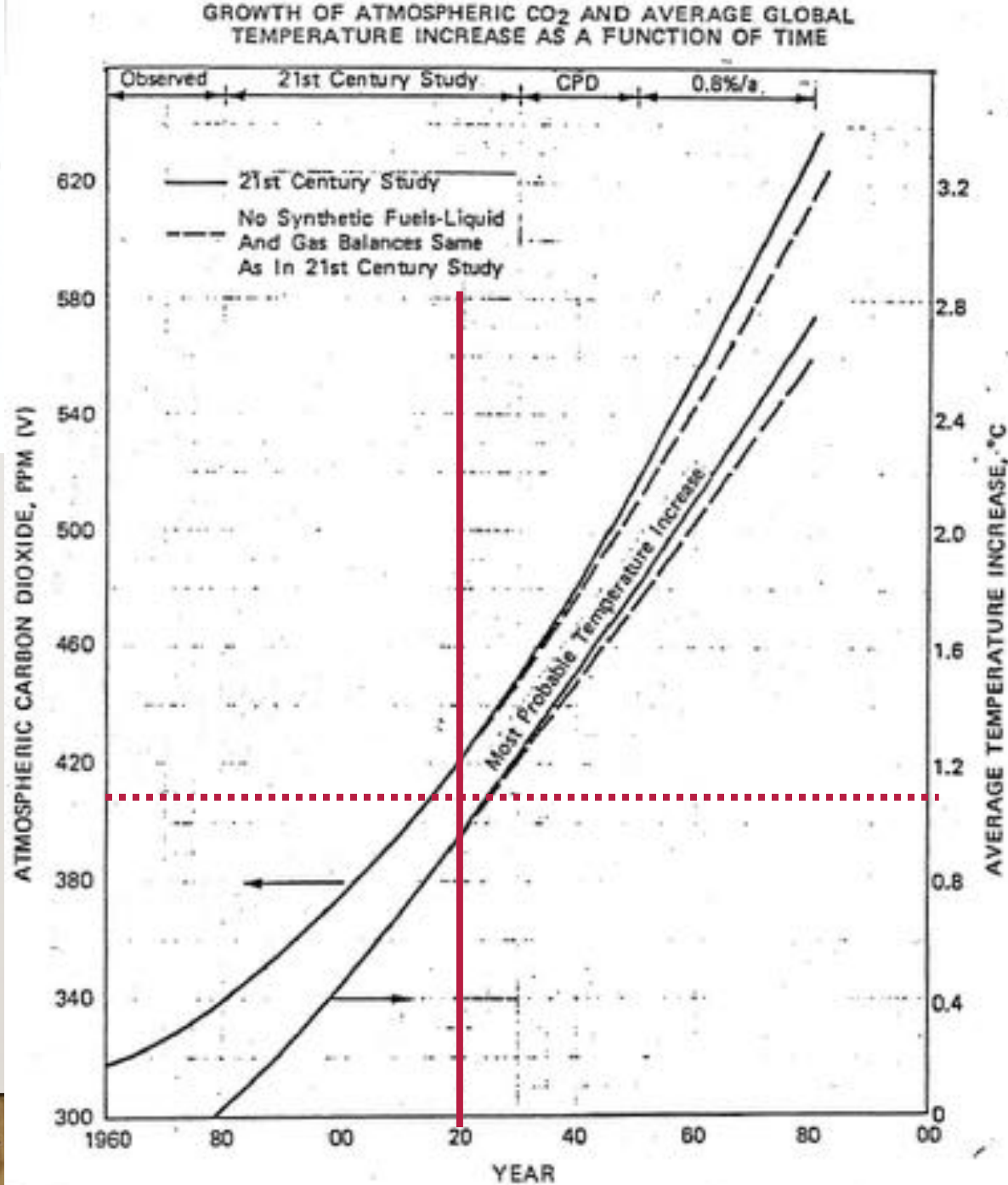
CO₂ "Greenhouse" Effect

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Actual
2020 is 412 ppm and 1.1 C (Hansen)*

*Hansen, et al., *Global Temperature in 2019*, 15 January 2020, Earth Institute, Columbia University, NY, NY



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What will they say about us some day?

SECURETHEFUTURE2100.ORG

A group with ranging fields of expertise with objective of providing **elected officials and their staffs with unbiased judgements** on issues related to climate change.

Stanley Farkas, Ph.D, Philip Russell, Ph.D.

Anthony Strawa, Ph.D., Steve Zornetzer, Ph.D.