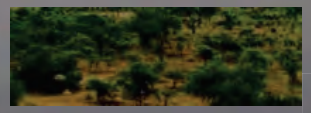
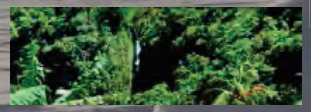
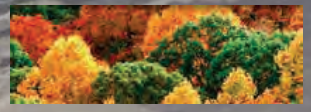
Antarctica for Global Climate

Sea Ice Mass Balance in the Antarctic **SIMBA**)

International Polar Year 2007: **Why was it important**

Role of Sea Ice Arctic and Antarctic

	10^6 km^2 (IPCC, 2001)
 DESERT, SEMI DESERT	27.7
 TROPICAL SAVANNAS, GRASSLANDS	27.6
 TEMPERATE GRASSLANDS, SHRUBLANDS	17.8
 RAINFOREST	17.5
 CONTINENTAL ICE	15.5
 TAÏGA	13.7
 CROPLANDS	13.5
 TEMPERATE FOREST	10.4
 TUNDRA	5.6

Total winter sea ice extent in Antarctica, at ~ 20 million km^2, rivals the extent of the earth's major terrestrial biomes.

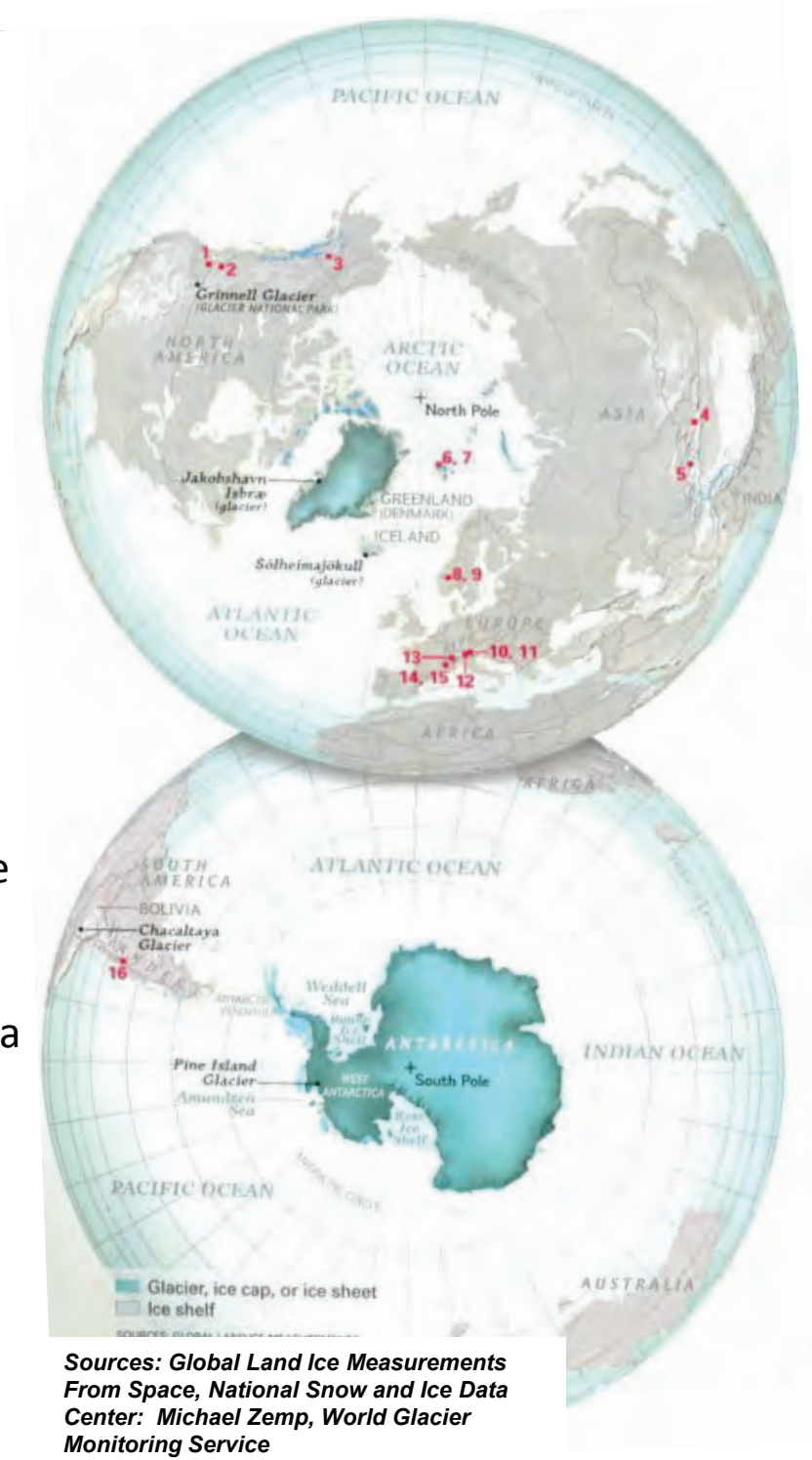
Courtesy of Blake Weissling

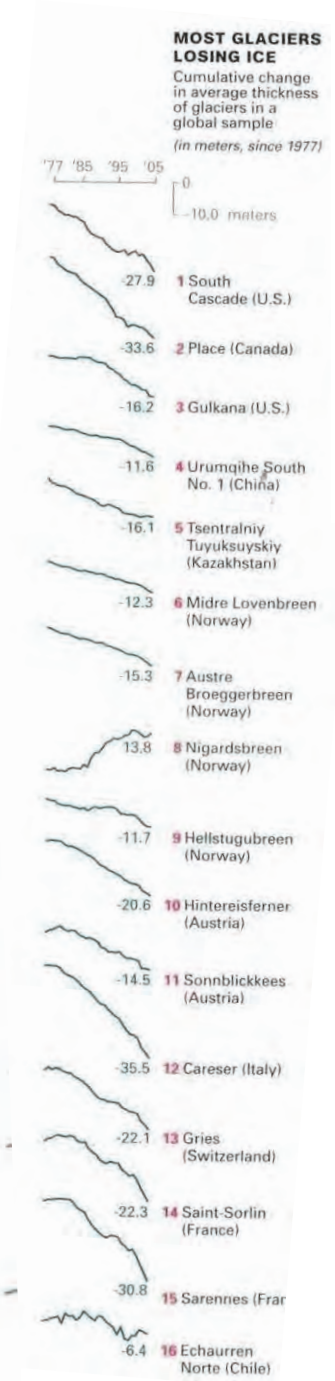
Major Glaciers and Ice Sheets

- For the last 100 years close to 90% of the glaciers in Europe, North America, South America and Asia have retreated. This has resulted in Europe's Glaciers having only 40% of the mass they had 100 years ago.

Glacier Calving Video

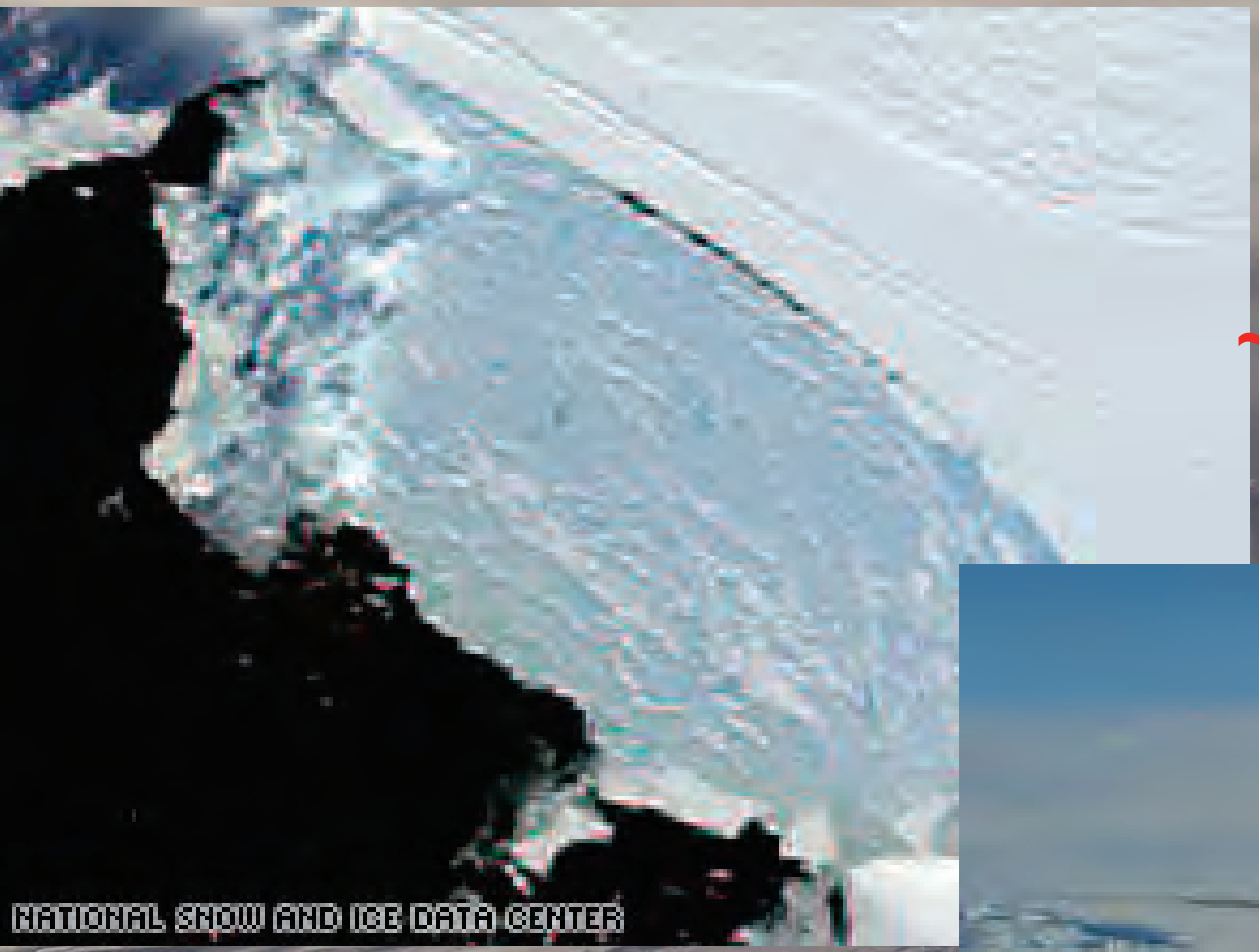
- The continental ice sheets over Greenland and Antarctica account for over 90% of the total fresh water on the earth. Formation and Melting of these and other continental ice sheets (now gone) have been the major factors in sea level change in geologic time.





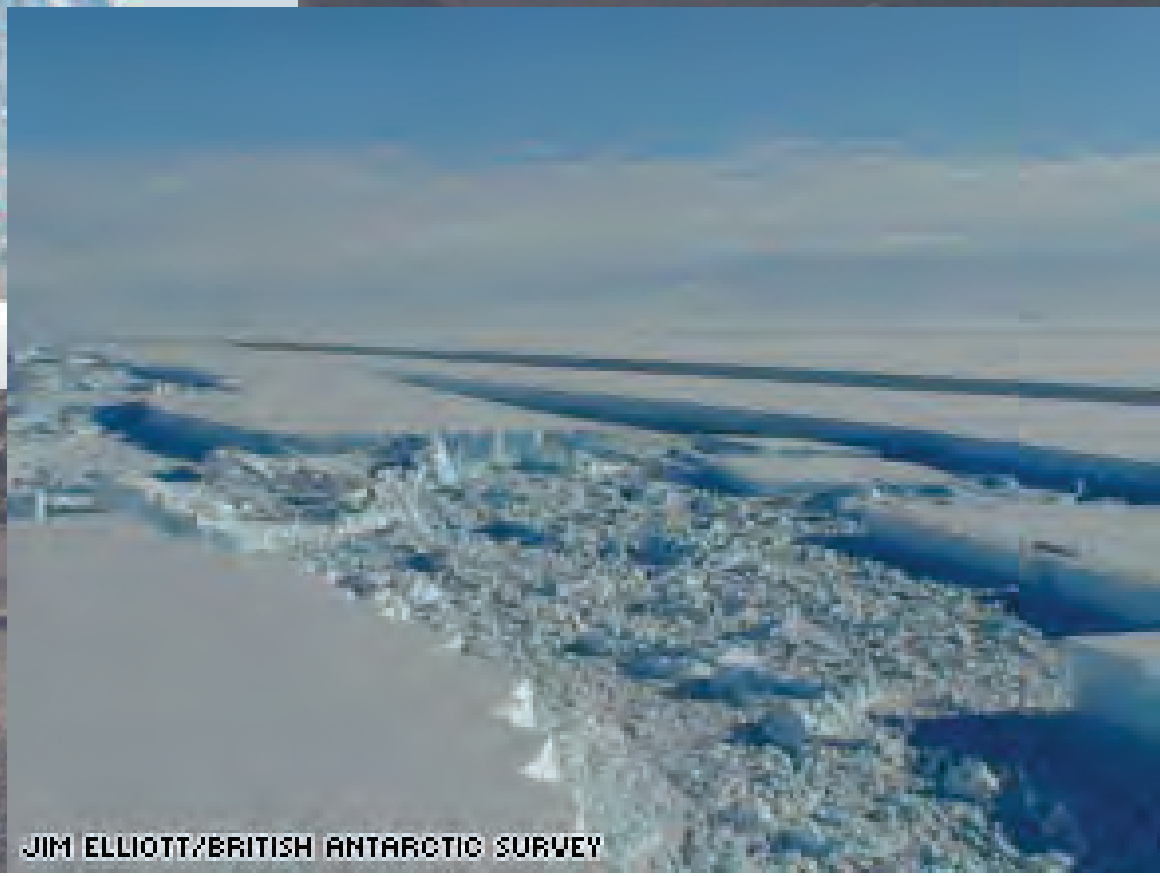
Sources: Global Land Ice Measurements From Space, National Snow and Ice Data Center: Michael Zemp, World Glacier Monitoring Service
NGM Maps, National Geographic Magazine

Wilkins Ice Shelf - 2008



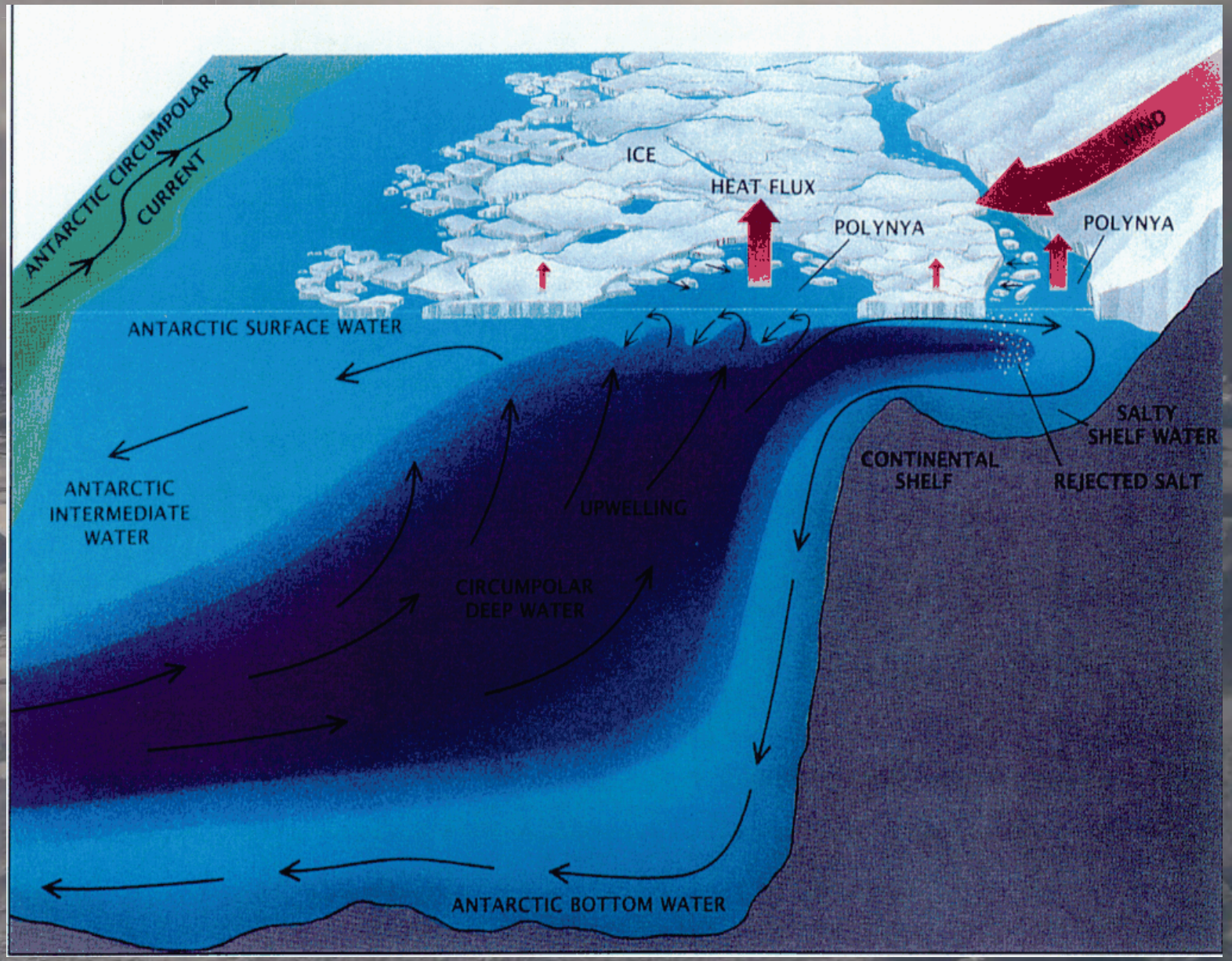
220 mi^2

~7x the size of Manhattan



Sea Ice – Significance to Global Climate

- Ice-Albedo feedback
- Controls ocean heat flux
- Dampens waves and momentum transfer
- Brine rejection drives ocean thermohaline circulation
- Melting provides fresh water influx



After Gordon and Comiso, 1988

Ice albedo feedback

Melting

+

+

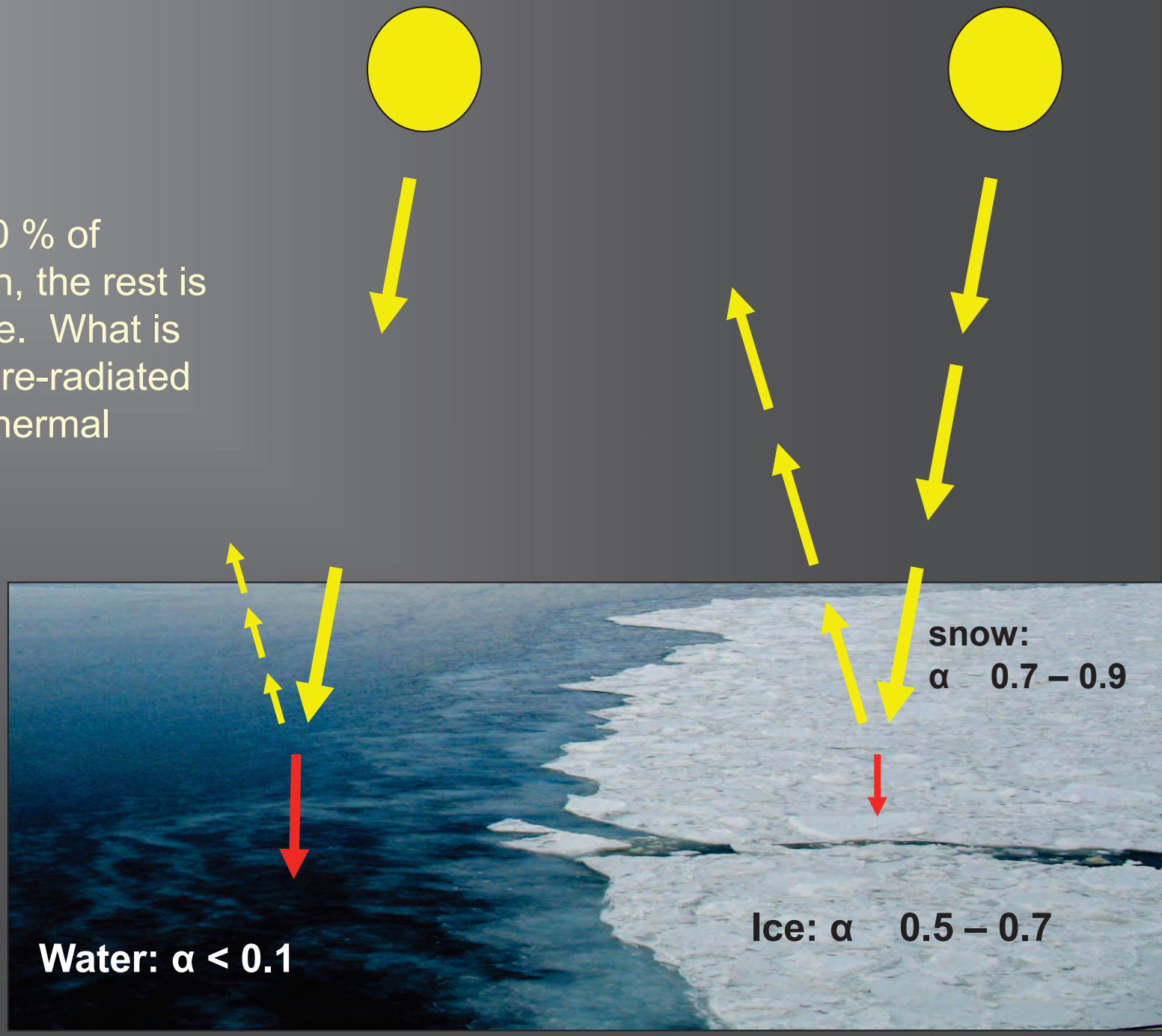
Lower albedo

Absorbed sunlight

+

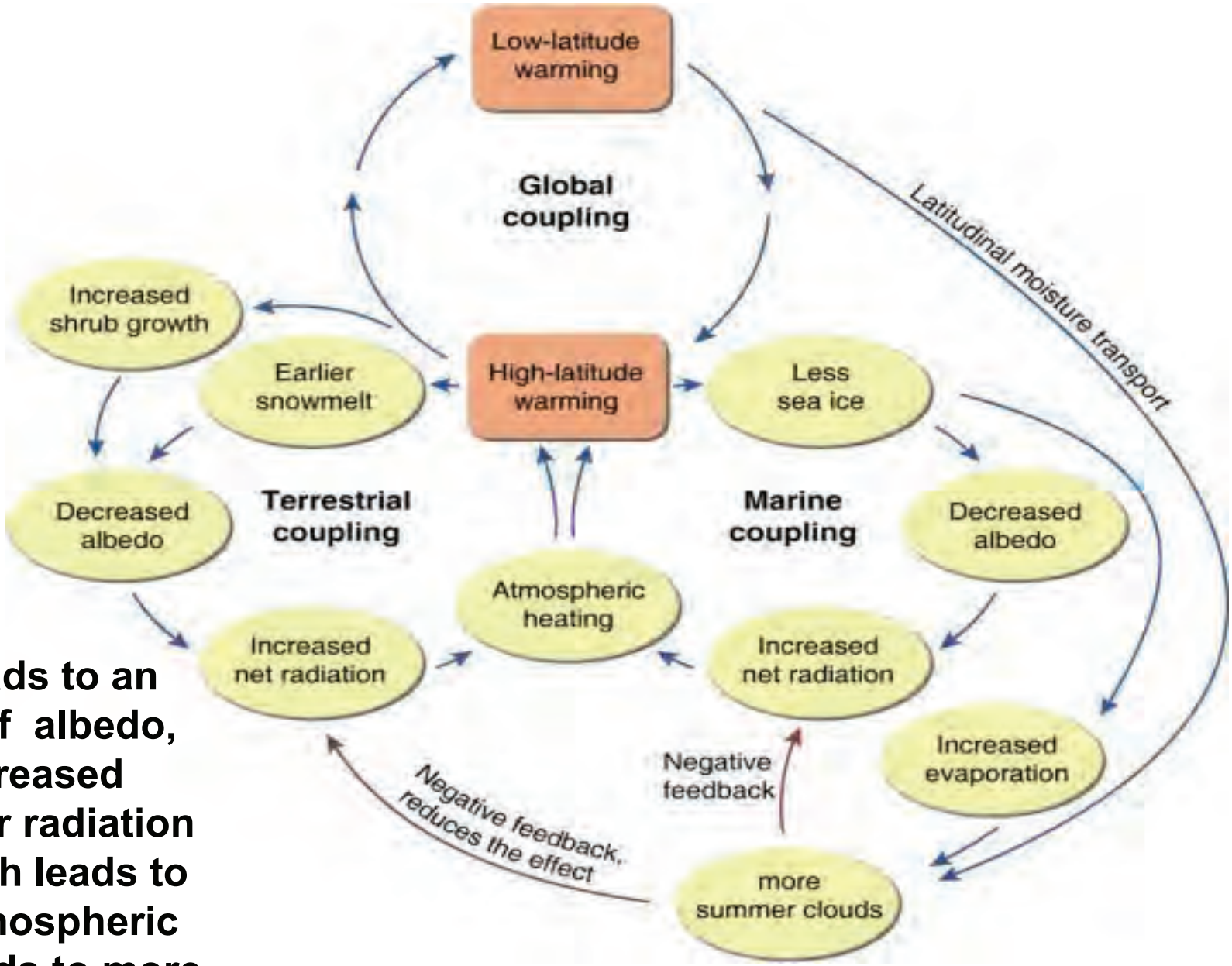
Albedo change

Sea ice reflects 50 – 90 % of incoming solar radiation, the rest is absorbed by the sea ice. What is absorbed is eventually re-radiated to the atmosphere as thermal radiation.



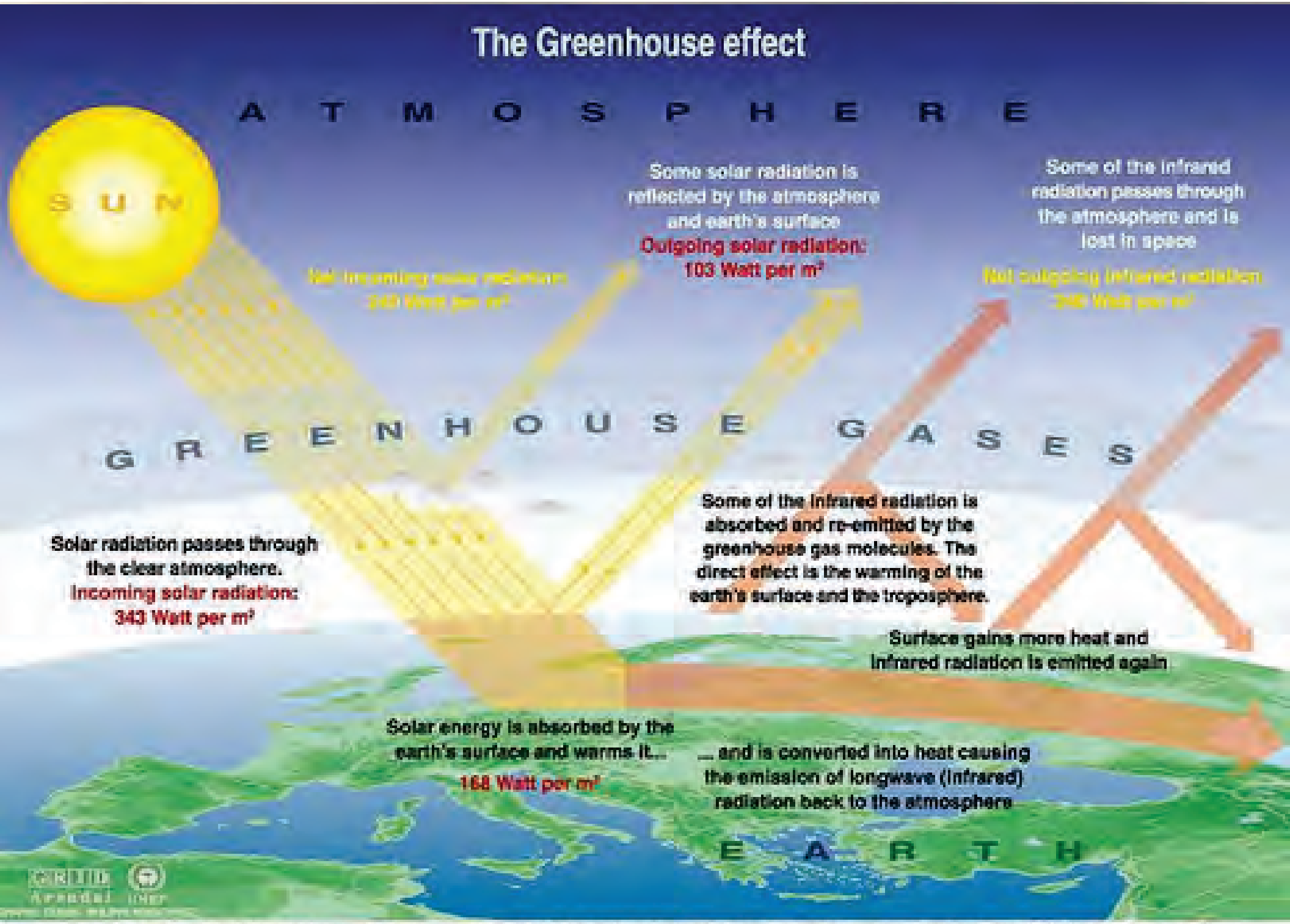
Courtesy of Blake Weissling

What's the Problem?



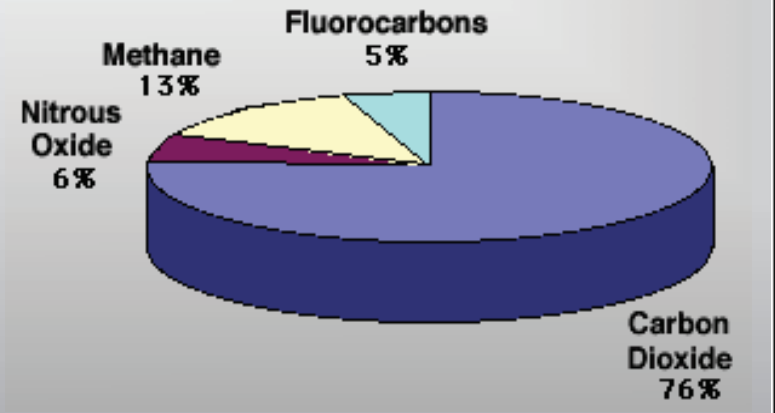
Loss of sea ice leads to an overall decrease of albedo, which leads to increased absorption of solar radiation by sea water, which leads to an increase in atmospheric heating, which leads to more loss of sea ice.

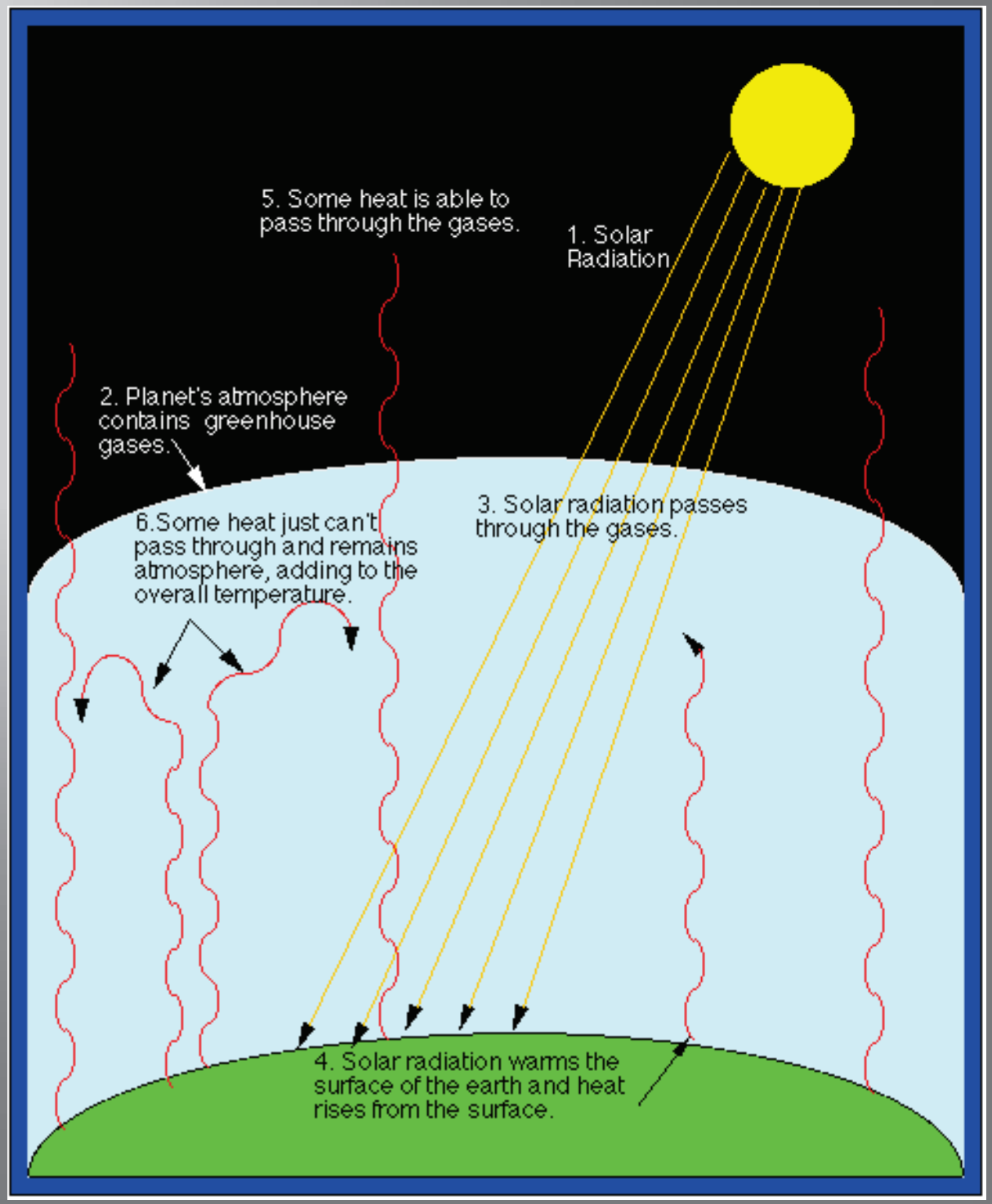
The Greenhouse effect

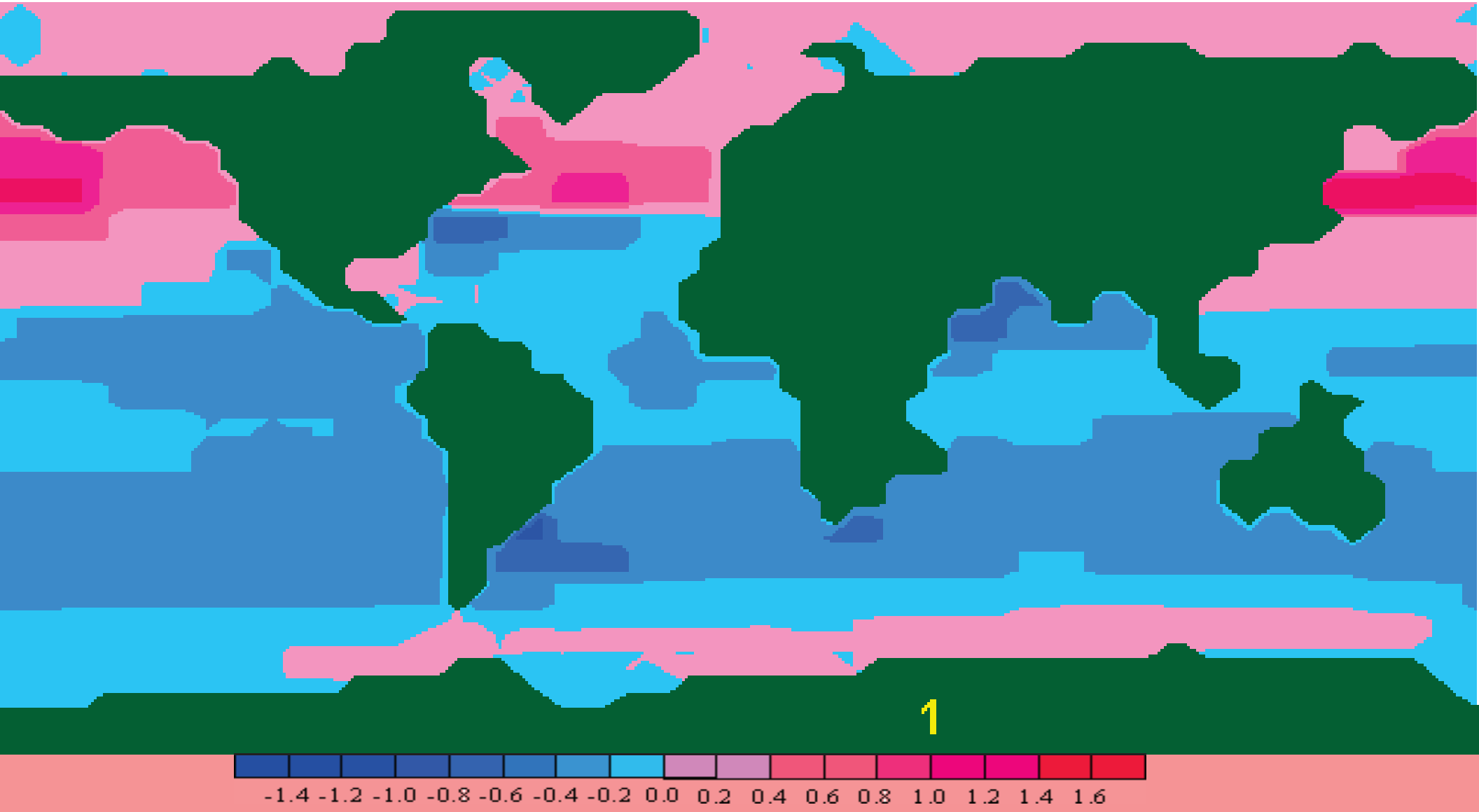


Sources: Okanagan university college in Canada, Department of geography; University of Oxford, school of geography; United States Environmental Protection Agency (EPA), Washington; Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996

Greenhouse Gases



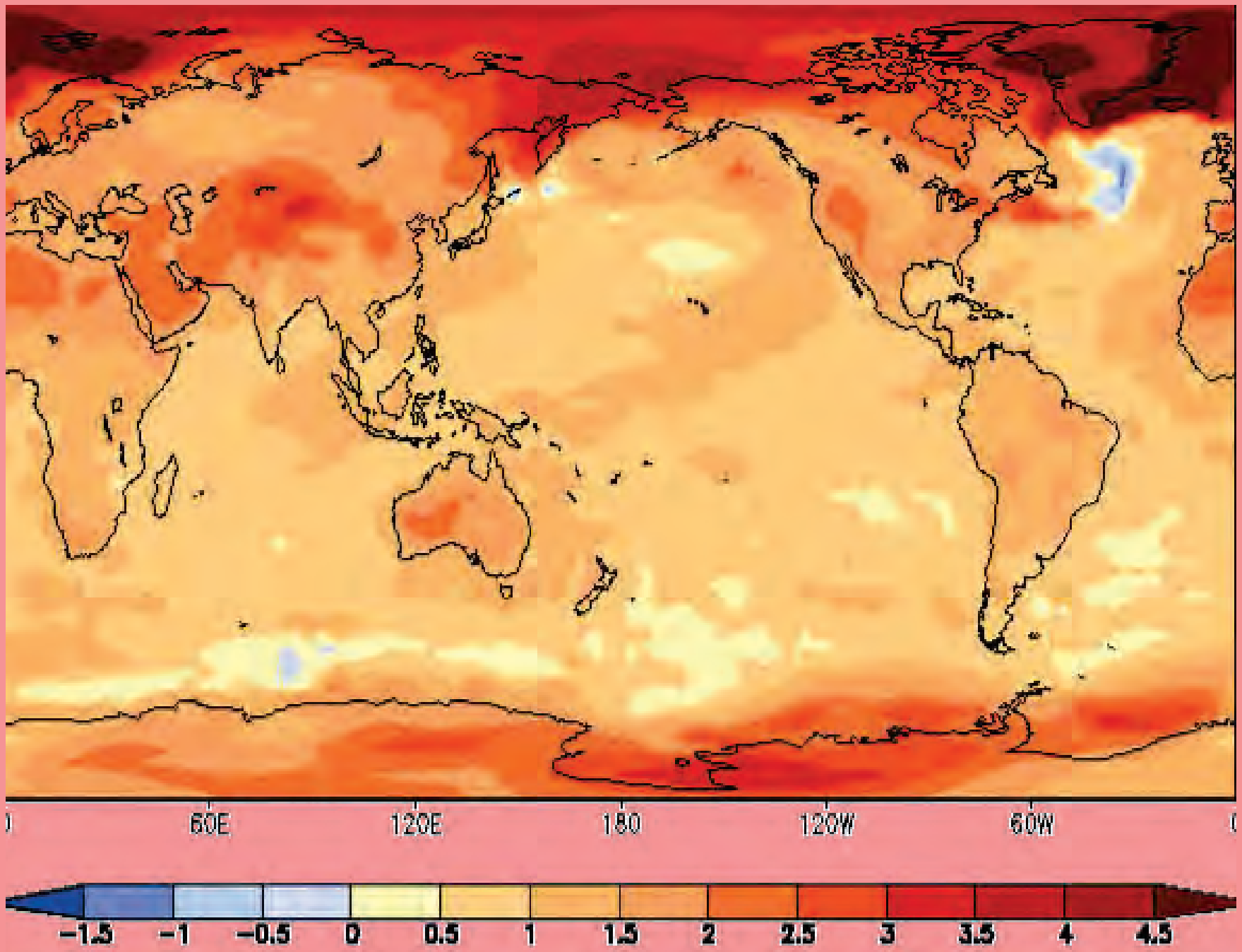




Partly depending on temperature of the surface water, the oceans can be a source or a sink of CO^2. Generally, cold waters absorb and warm waters emit.

The Southern Ocean, the body of water that surrounds Antarctica, is the single largest sink of CO^2 on the planet.

Temperature Prediction for 2xCO2

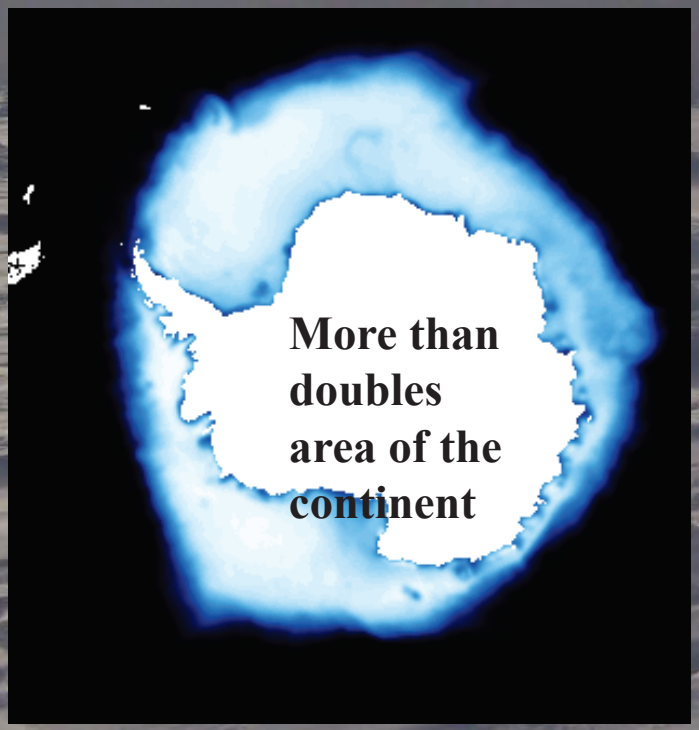


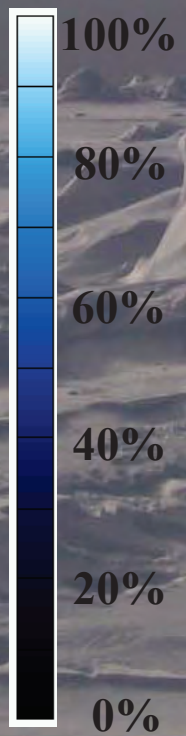
What's the role of sea ice in a global climate perspective?

Every autumn the ocean freezes over,

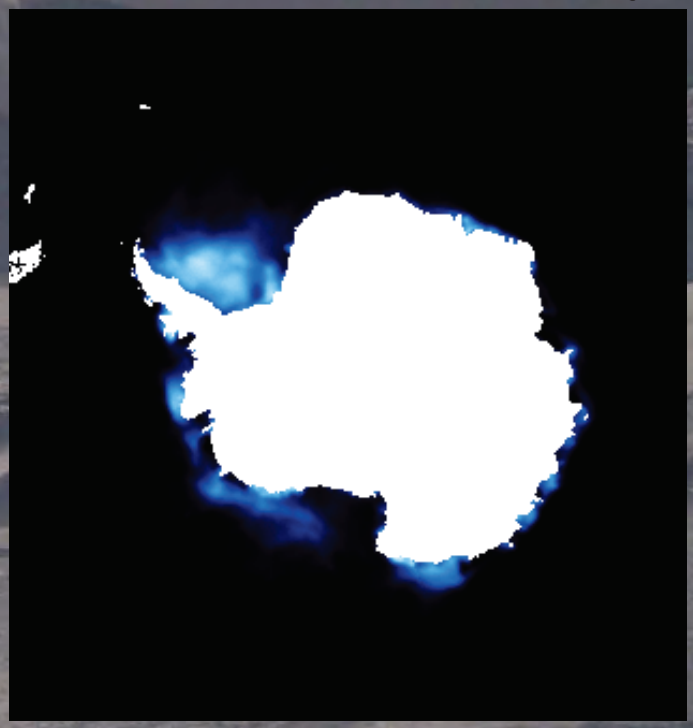
every Summer the sea ice melts.

Maximum: September





Minimum: February



Extent: ~20 million sq km

Extent: ~3 million sq km

Graphics courtesy of Dr. Sharon Stammerjohn

SIMBA

SEA ICE Mass Balance in the Antarctic

September 26 we arrived at Ice Station Belgica

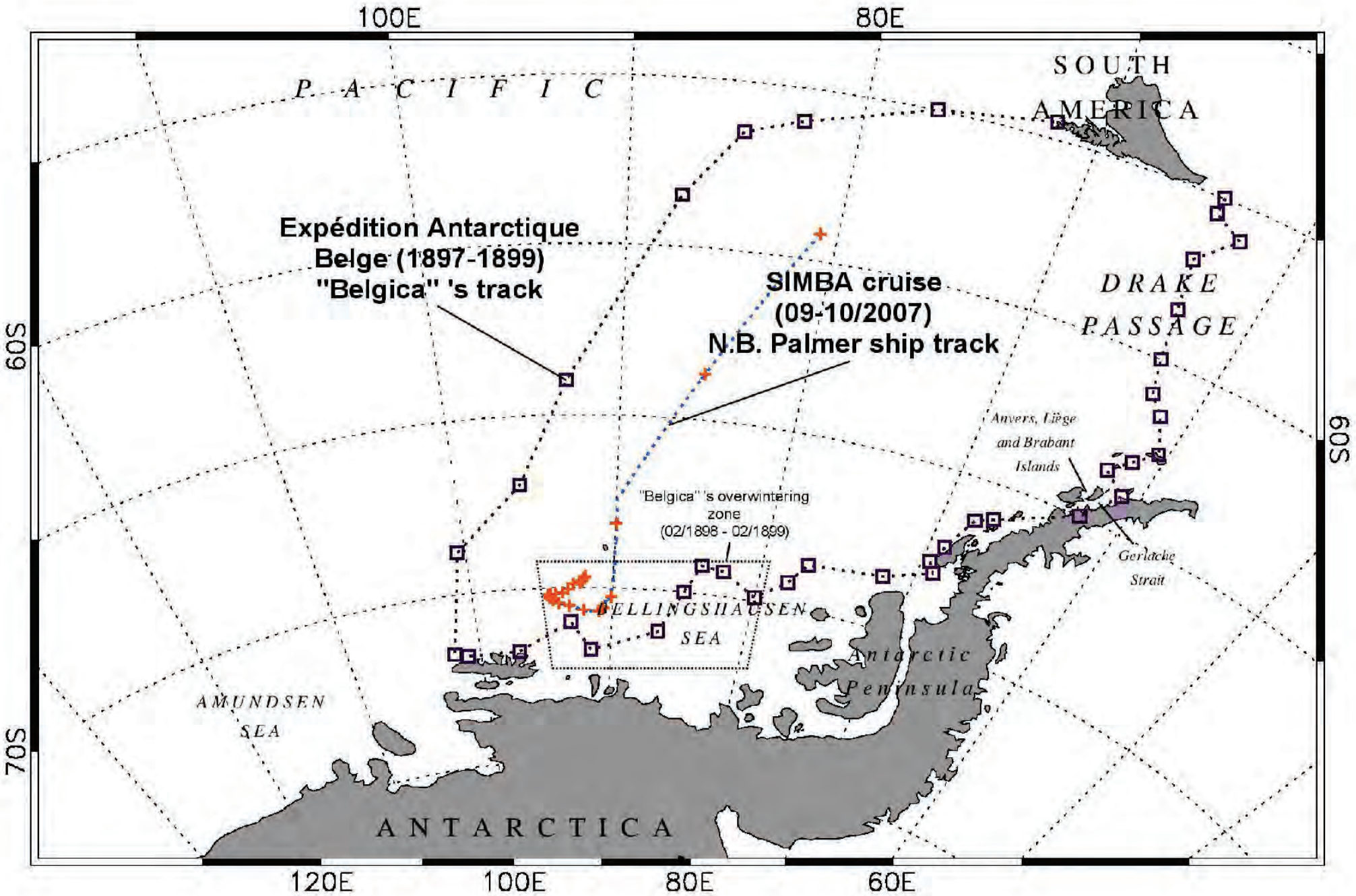
Latitude 71 South Longitude 90 West

25 days after first departing Punta Arenas

No human has ventured into this region in wintertime since the first Belgica expedition arrived in 1898

Note: they got trapped in the ice for 18 months!

Courtesy of Blake Weissling



Courtesy of Martin VanCoppenelle

SIMBA

Baseline data from which to monitor future change in Antarctic sea ice:

- Geophysical processes (snow & ice thickness and extent, physical properties, heat flux, energy balance)
- Biogeochemical processes (biological habitats, DMS production, trace metals, CO_2 Flux)
- Satellite Remote Sensing (validating tools for long-term monitoring of sea ice / climate systems)

En Route to Final Ice Camp:

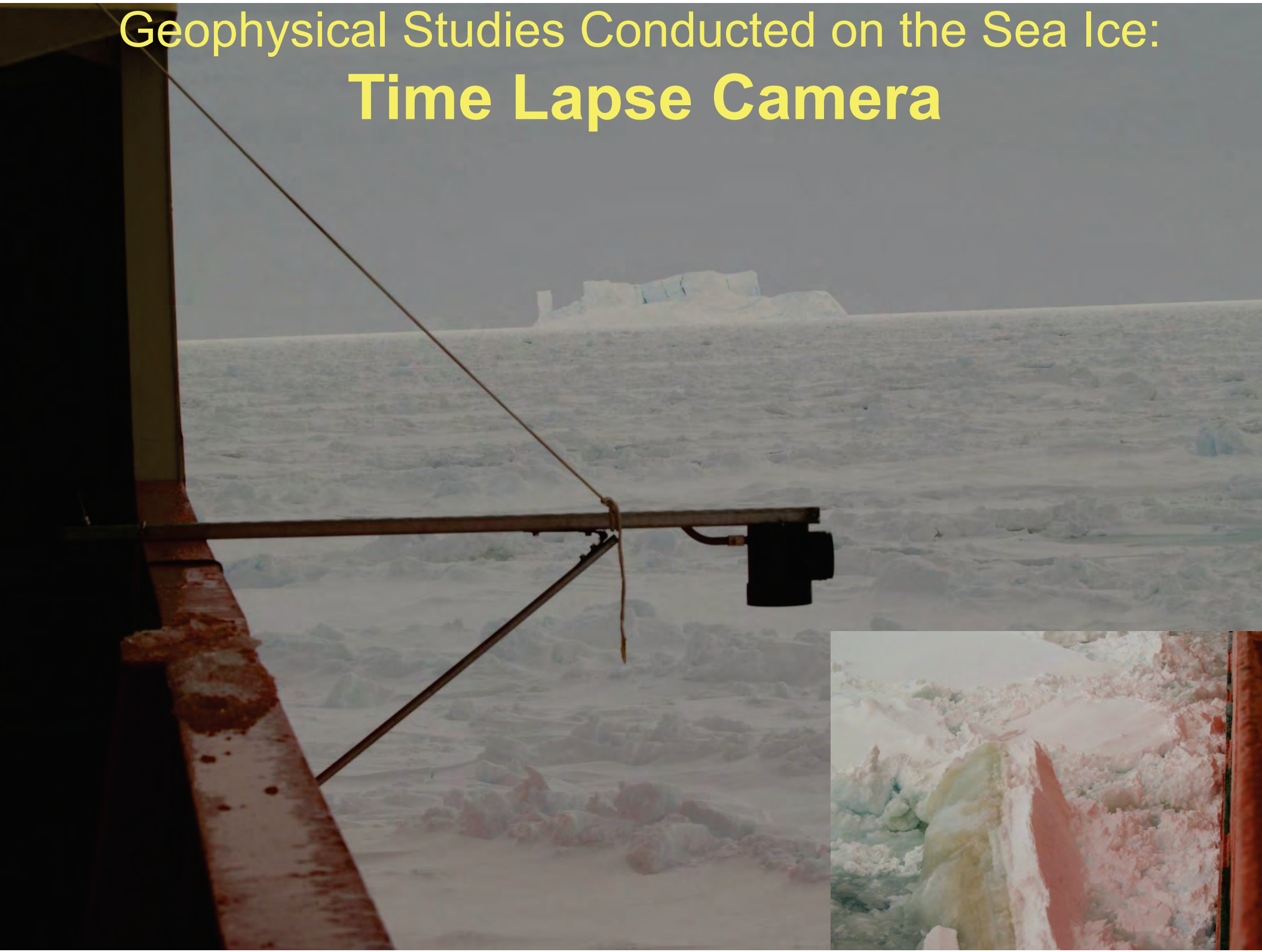
Ice Observations

En Route to Final Ice Camp:

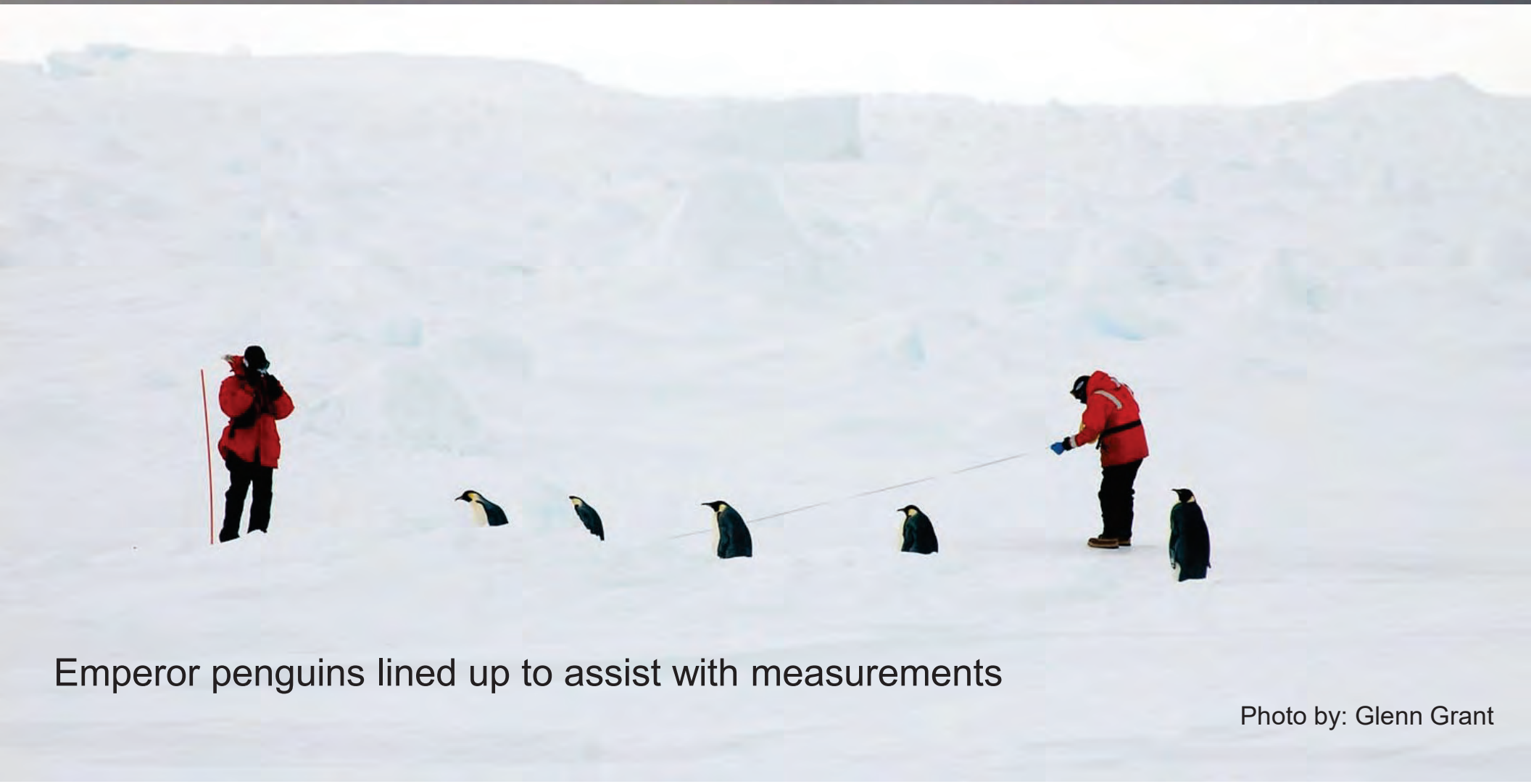
Ice Observations

Geophysical Studies Conducted on the Sea Ice:

Time Lapse Camera

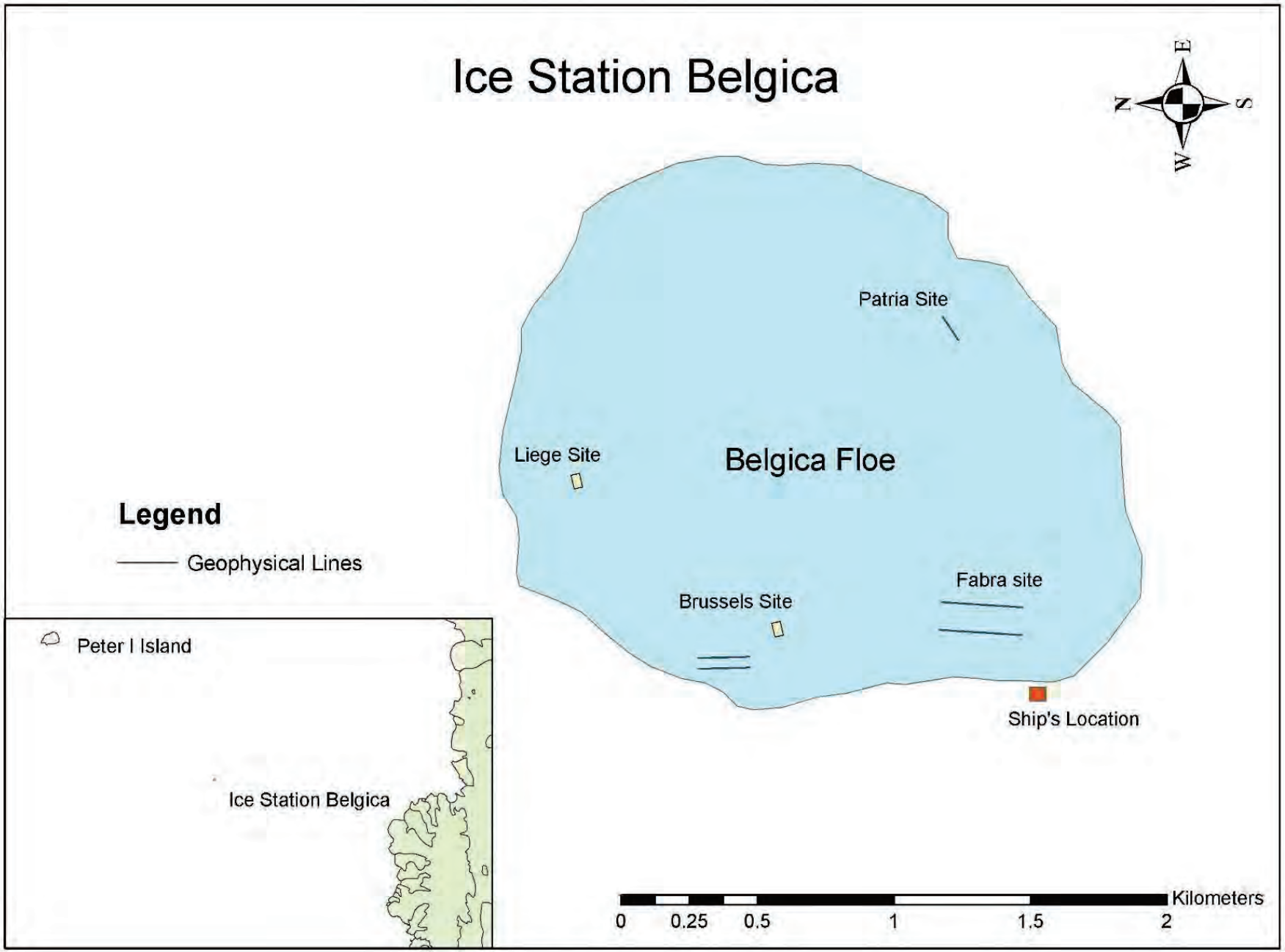


SIMBA Geophysical Assessment

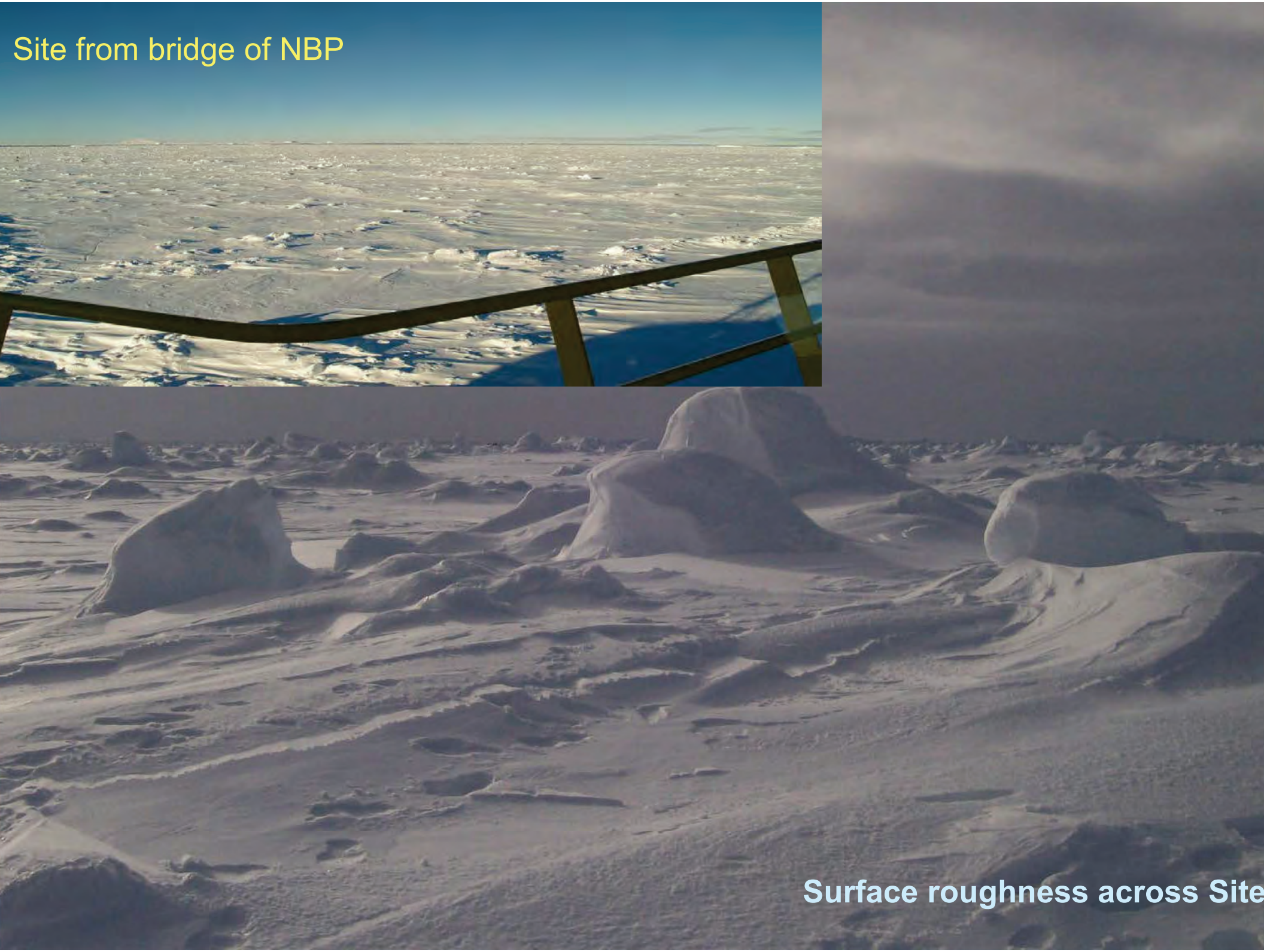


Emperor penguins lined up to assist with measurements

Photo by: Glenn Grant



Courtesy of Blake Weissling and Mike Lewis


Site from bridge of NBP
Surface roughness across Site

Getting started

Geophysical Studies Conducted on the Sea Ice:

Snow Depth and Ice Thickness

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Snow Depth and Ice Thickness

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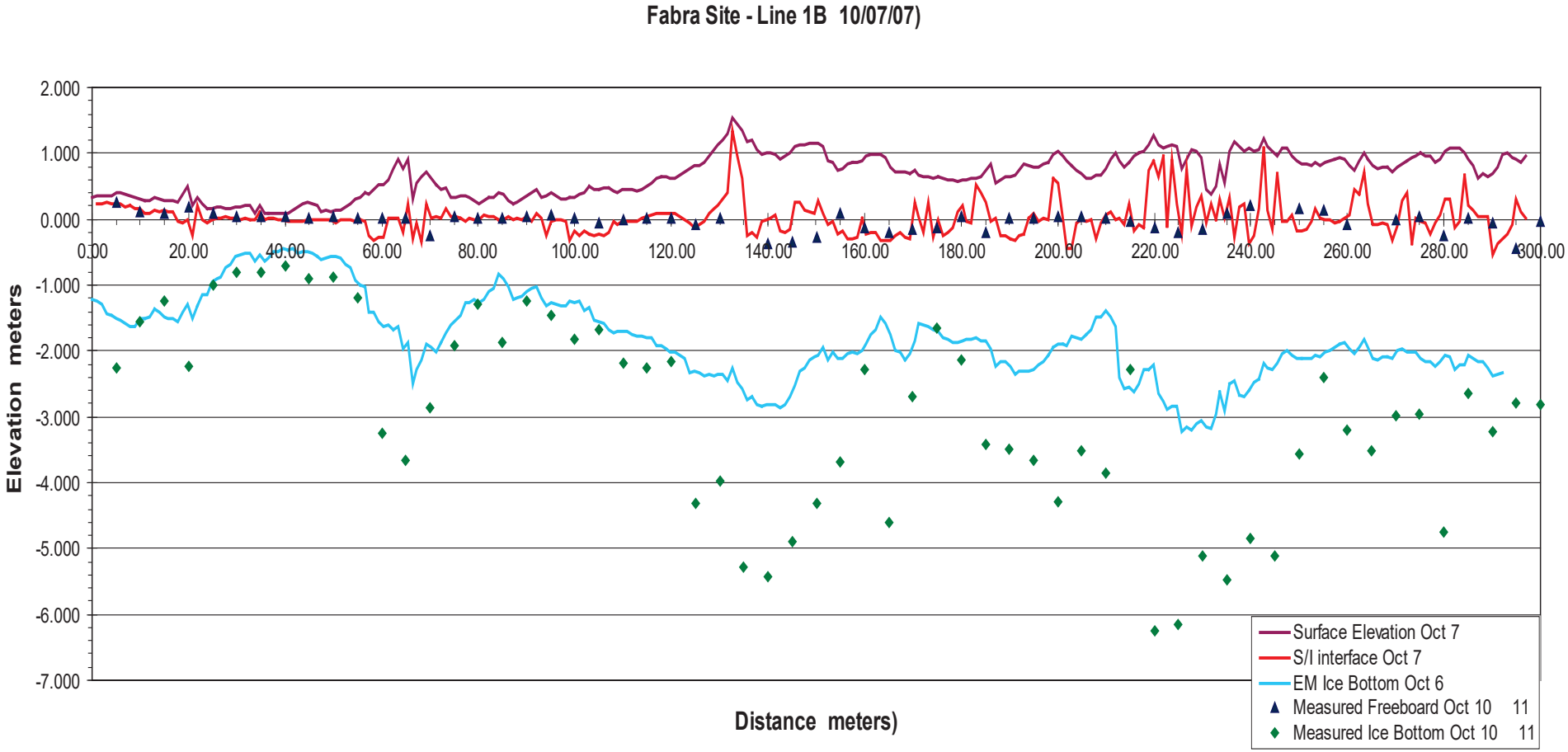
Snow Depth and Ice Thickness

Geophysical Studies Conducted on the Sea Ice:

Snow Depth and Ice Thickness – EM 31

Concurrent measuring of ice thickness to compare with in situ measurements

Typical Profile of Snow Depth and Ice Thickness



Courtesy of Mike Lewis

Geophysical Studies Conducted on the Sea Ice:

Snow Pits

Geophysical Studies Conducted on the Sea Ice:
Resistivity

Various Teams Required to Each Job

Biogeophysical Studies Conducted on the Sea Ice:

Ice Coring

Biogeophysical Studies Conducted on the Sea Ice:

Ice Coring

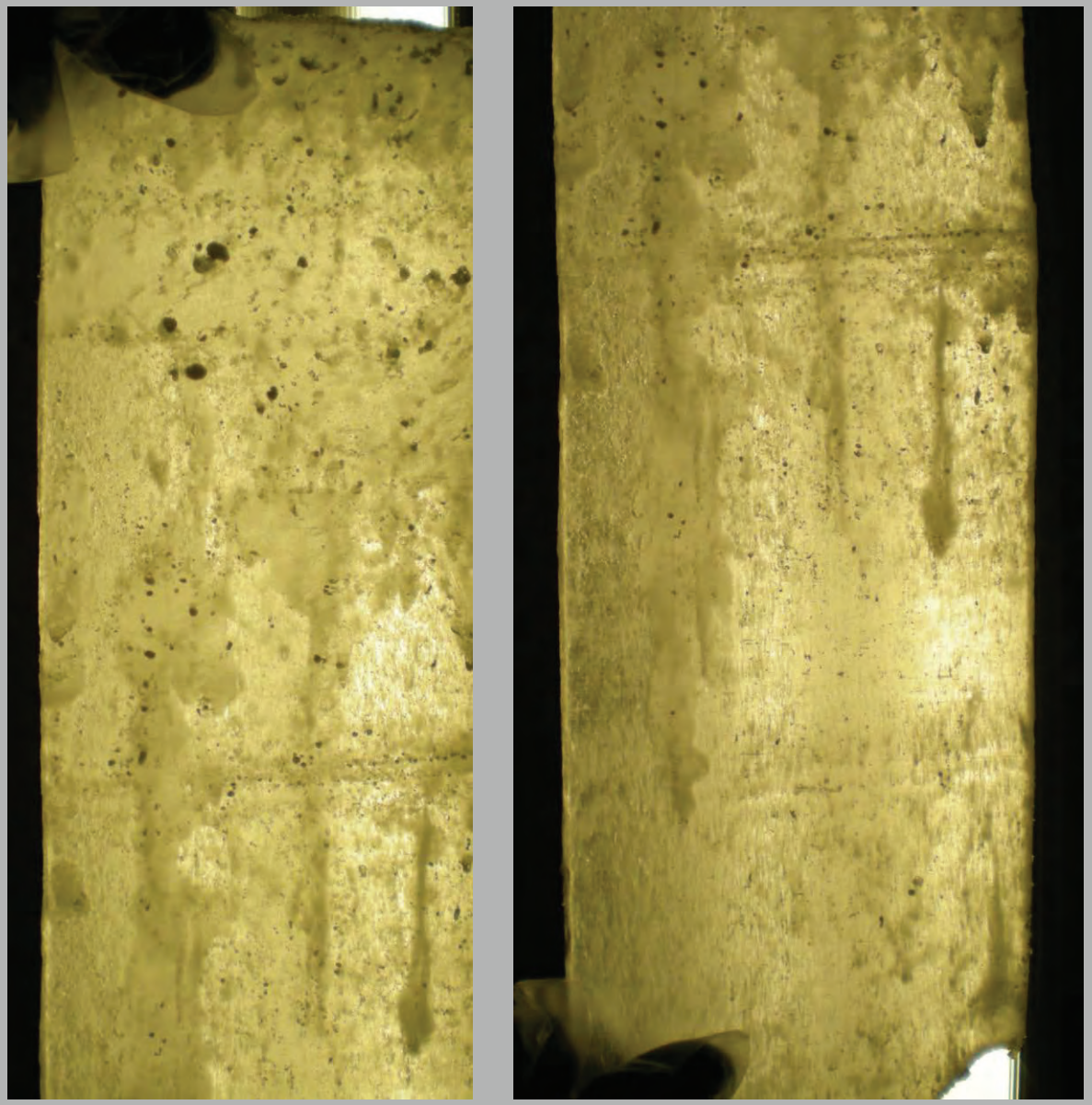


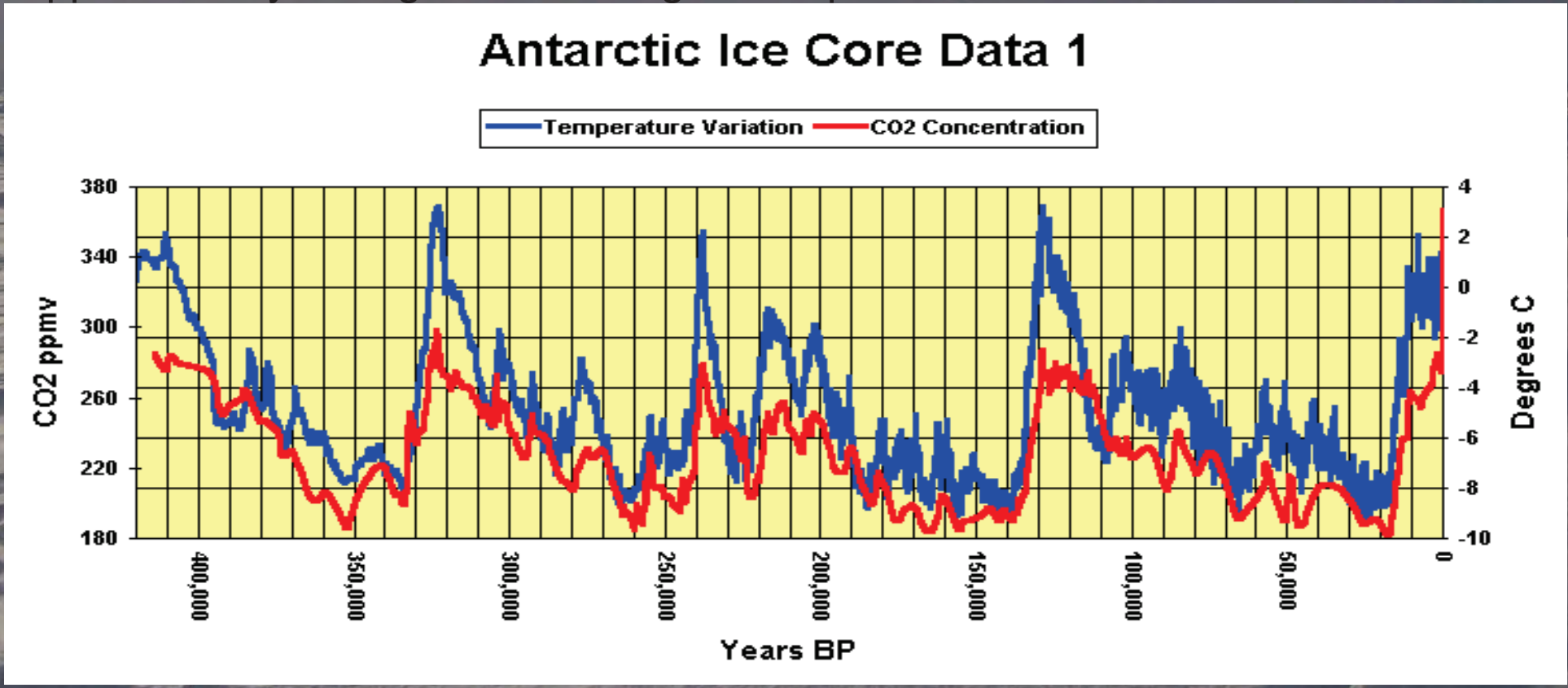
Figure 8 : 1 cm-thick section of the Brusels 4 core clearly showing the descending refrozen brine tubes. Fingers for scale.

Native Animals Tend to be Curious

Current Trends

• The amount of CO2 in the atmosphere affects our planet's temperature. With concentrations of CO2 currently at 383 ppm, the planet is now approximately 0.8 °C warmer than pre-industrial levels.

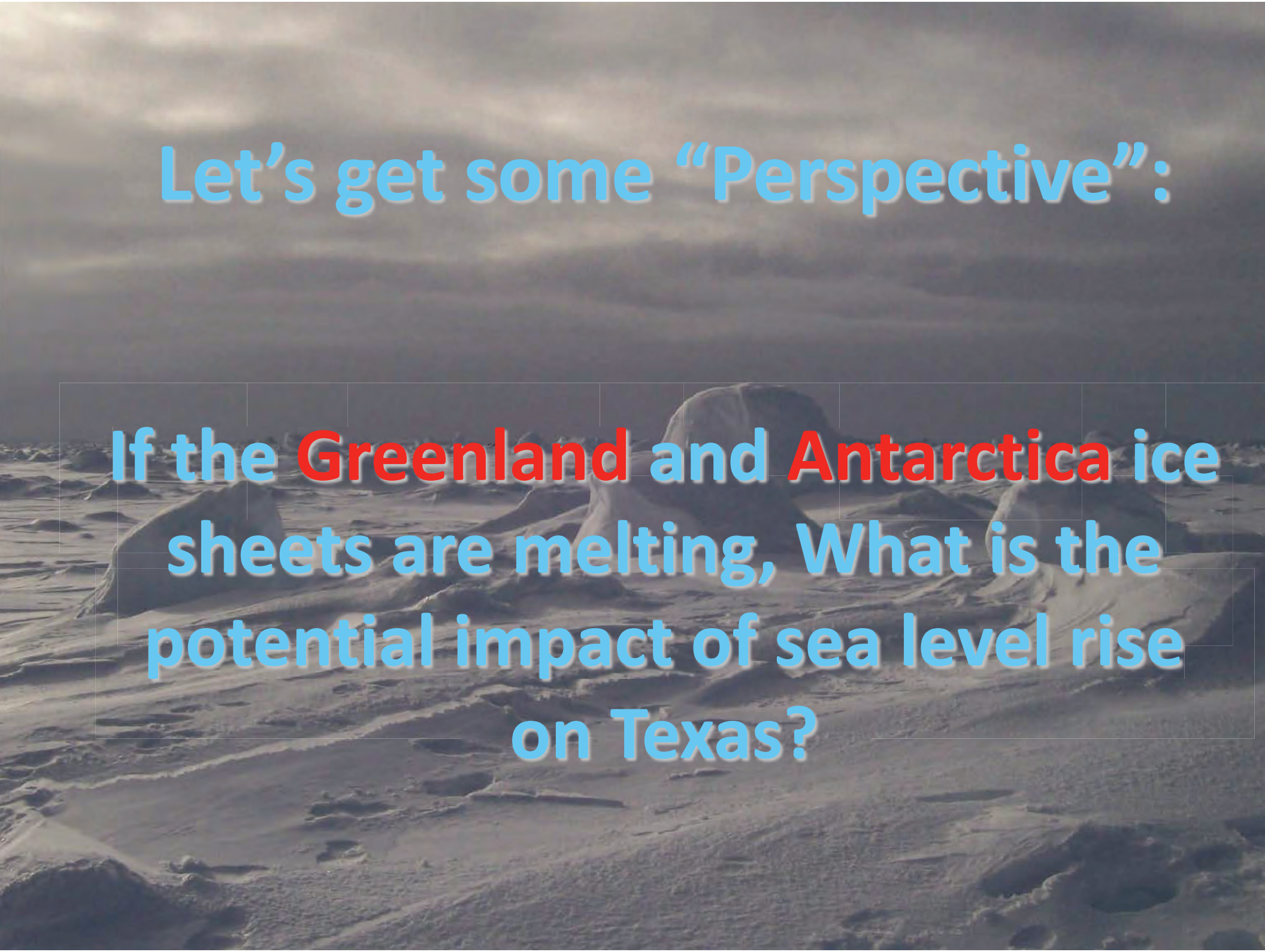
• Scientists are now forewarning that, at approximately 450 ppm CO2 in the atmosphere, we will trigger potentially irreversible glacial melt and sea level rise "out of humanity's control". Concentrations of 450 ppm corresponds to approximately 2 °C global warming above pre-industrial levels



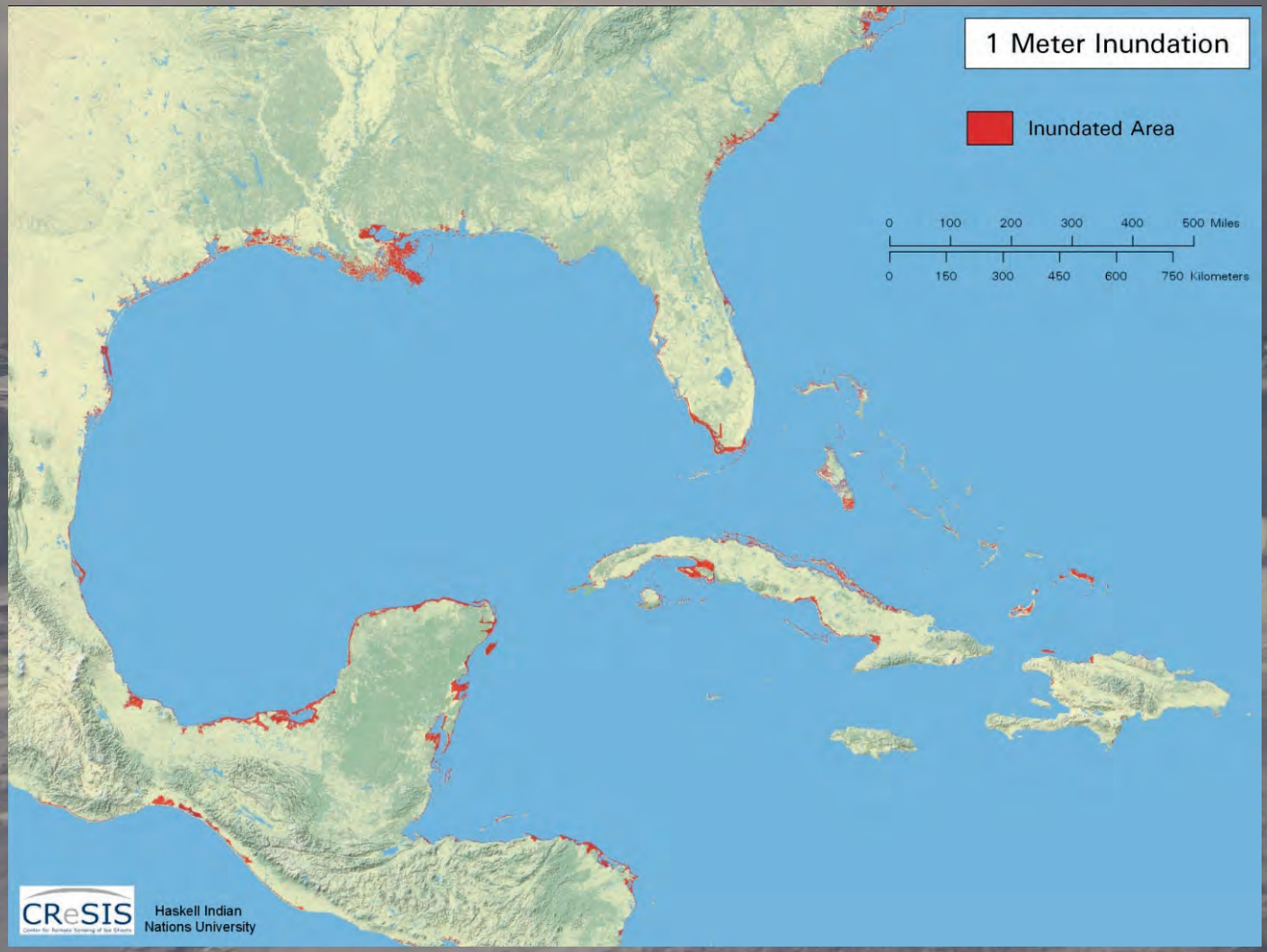
http://cdiac.esd.ornl.gov/trends/co2/vostok.htm

Sea Level Rise with Ice Sheet Melting

- Based on the new rate of sea level rise, the projected increase in sea level by 2100 is now over 1m (>3 ft) rather than 2 ft. The surprising melting of the Greenland and Antarctic Ice Sheets observed recently is also leading to some estimates of 2m increase in sea level, or greater by 2100 (so the 1m rise would take place much sooner).


Let's get some "Perspective":
If the Greenland and Antarctica ice sheets are melting, What is the potential impact of sea level rise on Texas?

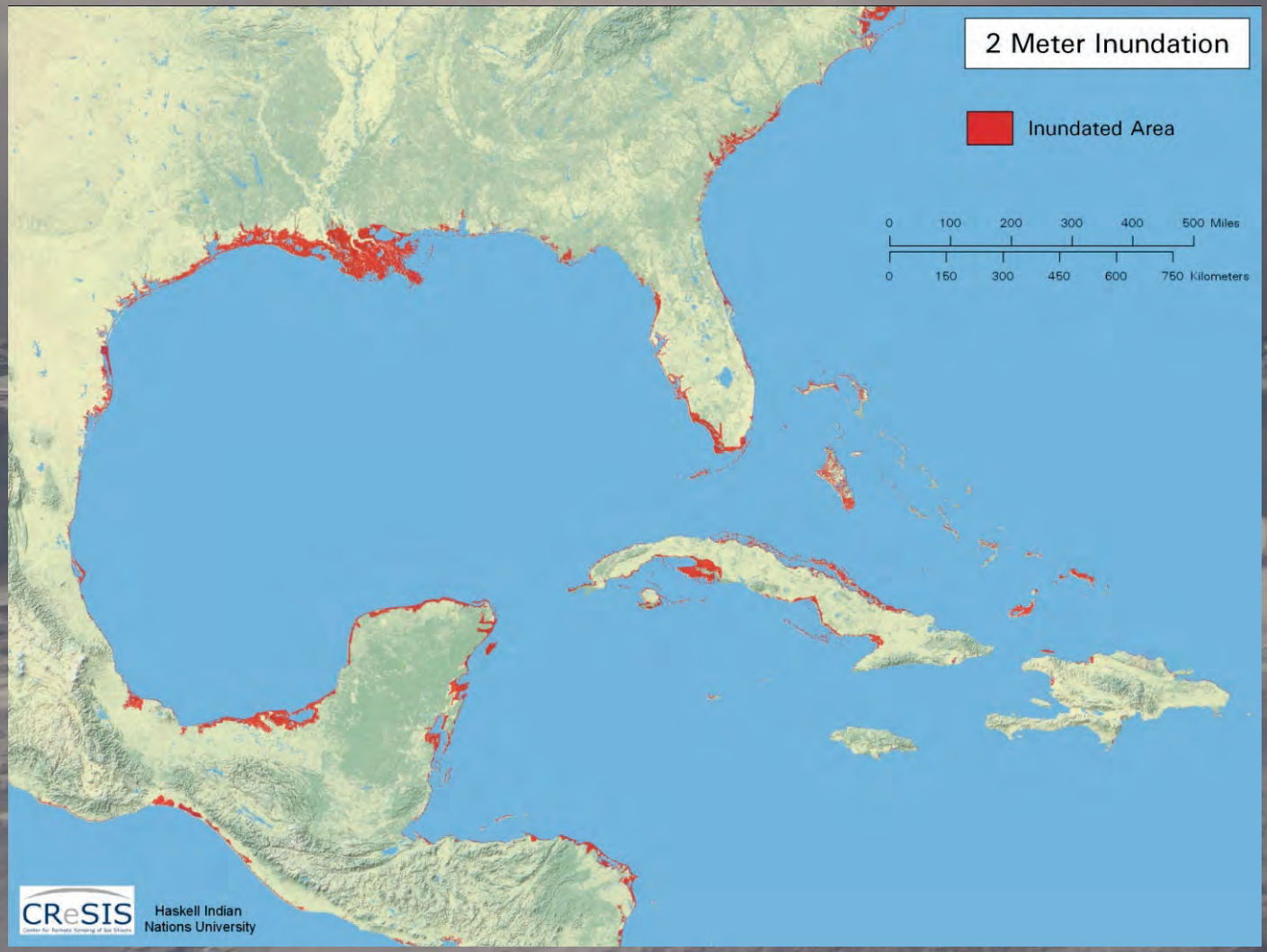
Coastline Change from 1m Rise



“Names on the 1m Face”

- Texas Places that will be under water in 2100
- Port Arthur, Port Isabel, Port Mansfield, Sabine Pass, Sabine, Orange, Lake Charles, La
- South Padre Island, Padre Is Natl Seashore, half of Galveston Island, Matagorda Island (and some mainland coastlines)

Coastline Change from 2m Rise



“Names on the 2m Face”

- Texas Places that will be under water with 2m Sea Level Rise (perhaps by 2100)
- Beaumont, Galveston, Texas City, Port Lavaca, Port Aransas, Rockport, Aransas Pass, Shore Acres, La Porte, Bay Oaks,Clear Lake Shores-SeaBrook and,

- New Orleans Louisiana

Credits

Thanks:

UTSA:

Stephen F. Ackley, Blake Weissling, Mike Lewis, Burcu Cicek, and Hongjie Xie.

ULB:

Jean-Louis Tison and Martin VanCoppenelle

Photo Credits:

Penny Wagner, Mike Lewis, Stephen F. Ackley, and Jean-Louis Tison