

Antarctica and the ice-covered ocean are much more relevant to South Africa *than you think!*

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Polar regions are the cooling systems of the Earth: most susceptible elements of the climate system

- They have the largest difference between seasons (*large seasonal cycle*)
- Continental *ice sheets* store the largest reservoir of water on land
- *Sea ice* regulates the exchanges of heat between the ocean and the atmosphere (*sea ice-albedo feedback*)
- They are sensitive to the *type of precipitation*, snow vs. rain
- They host one of the *shortest food web* on the Earth
- ***Polar amplification of anthropogenic global change (warming)***

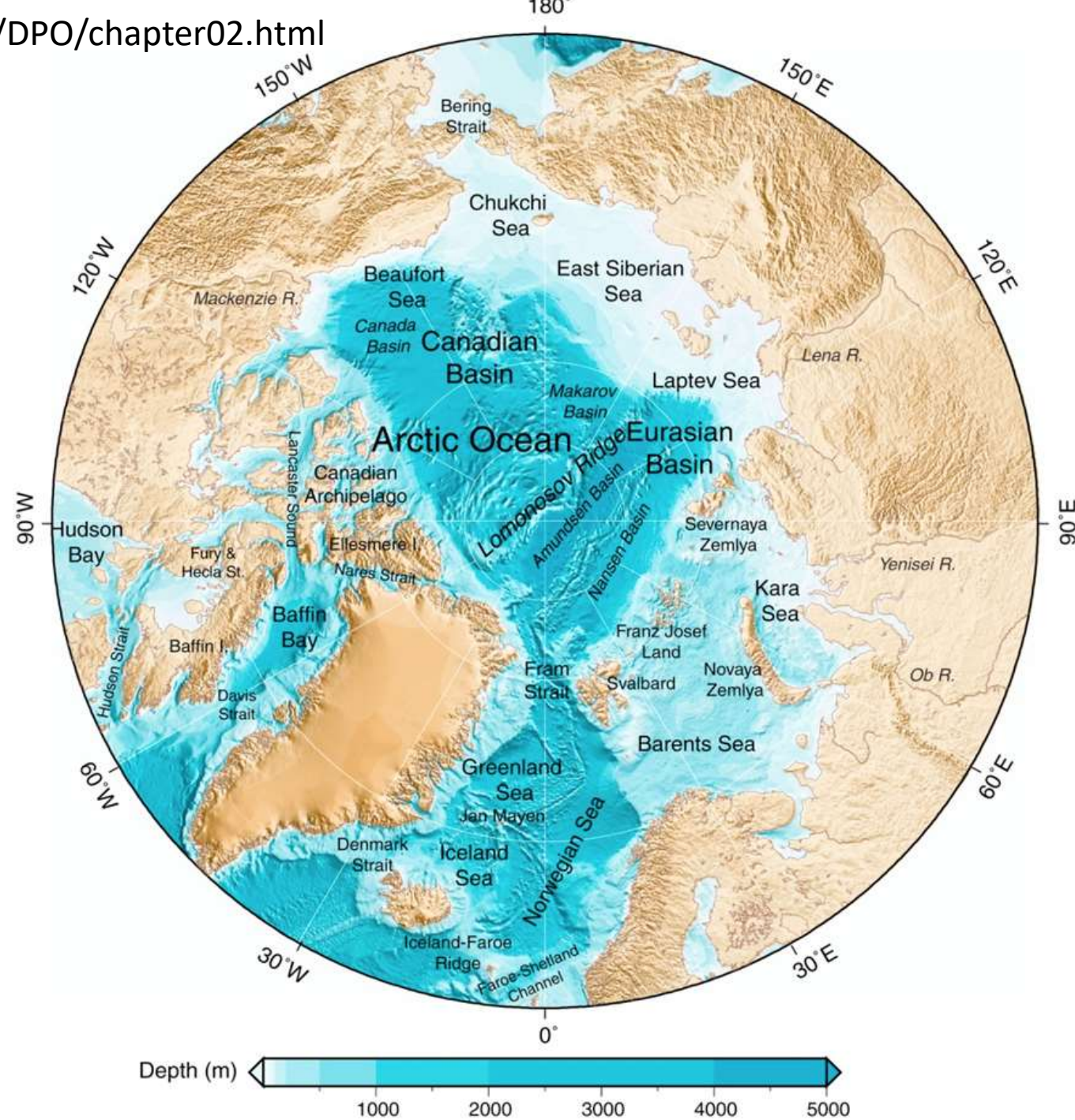




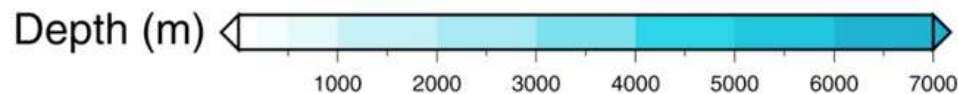
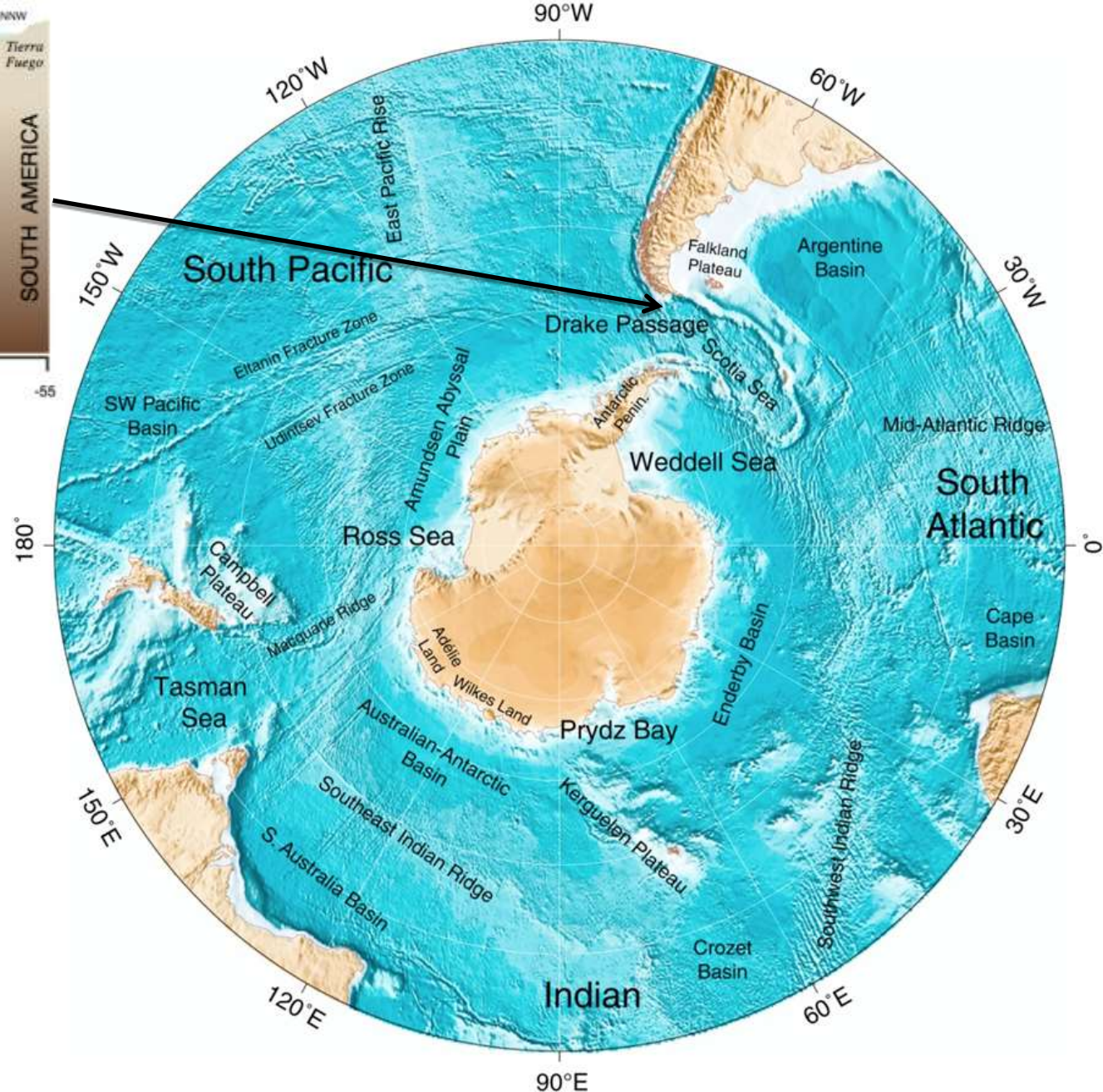
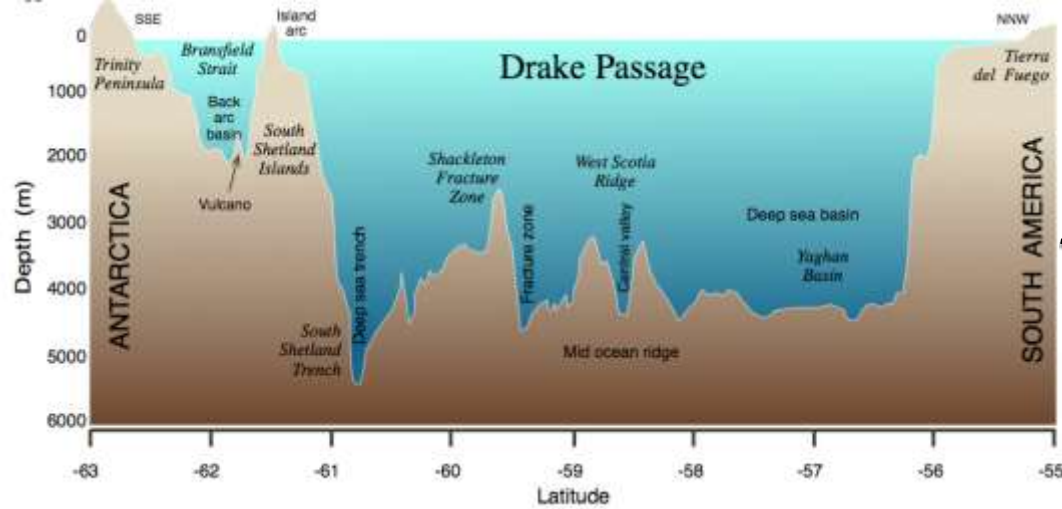
The geography of the polar oceans

The Arctic and Antarctic oceans are geographically opposite and are responding differently to global change





The geography of the Arctic Ocean



The geography of the Southern Ocean and Antarctica

The Southern Ocean is not an official name recognised by international treaties. The names of the sub-basins are also not official, apart from the Weddell and Ross Seas.

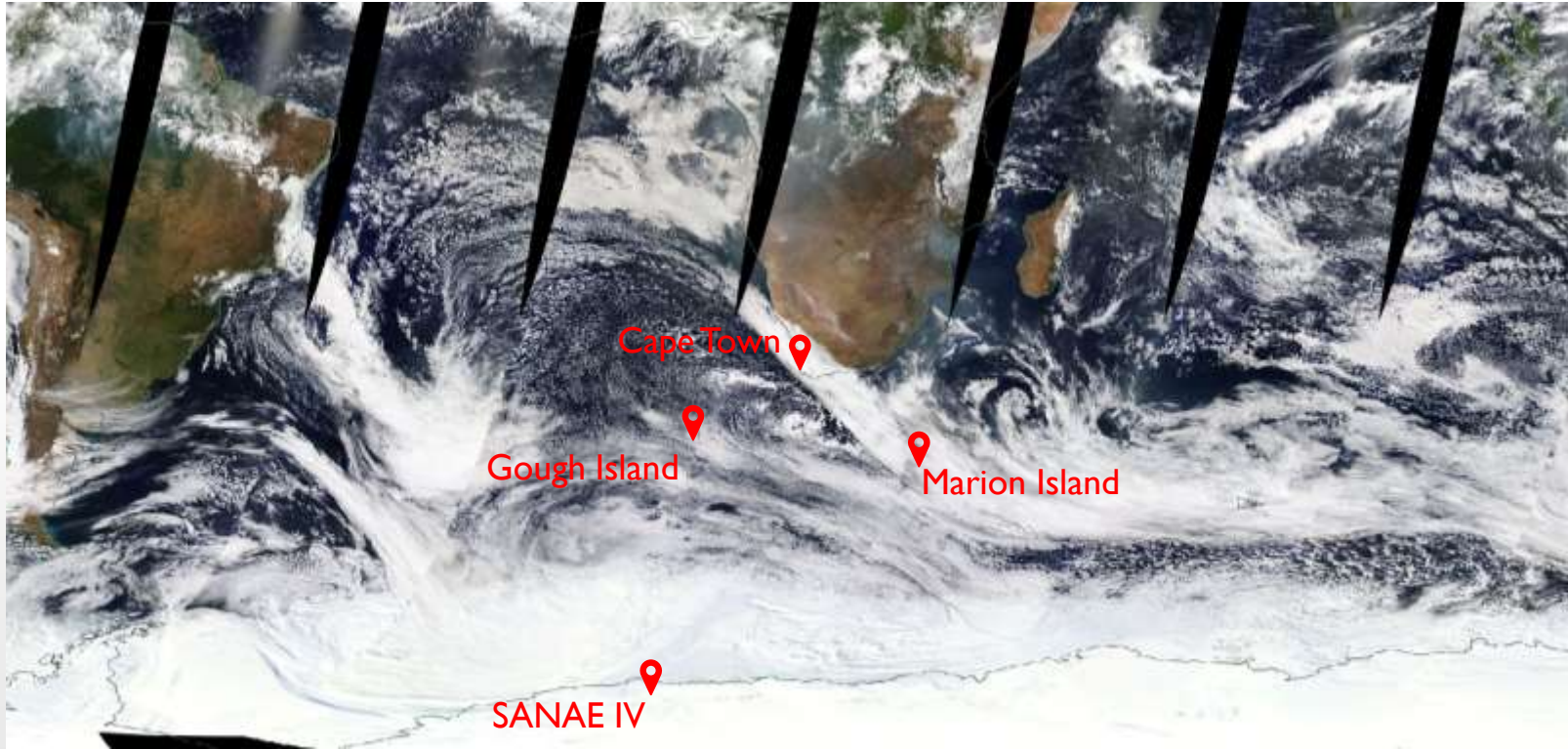
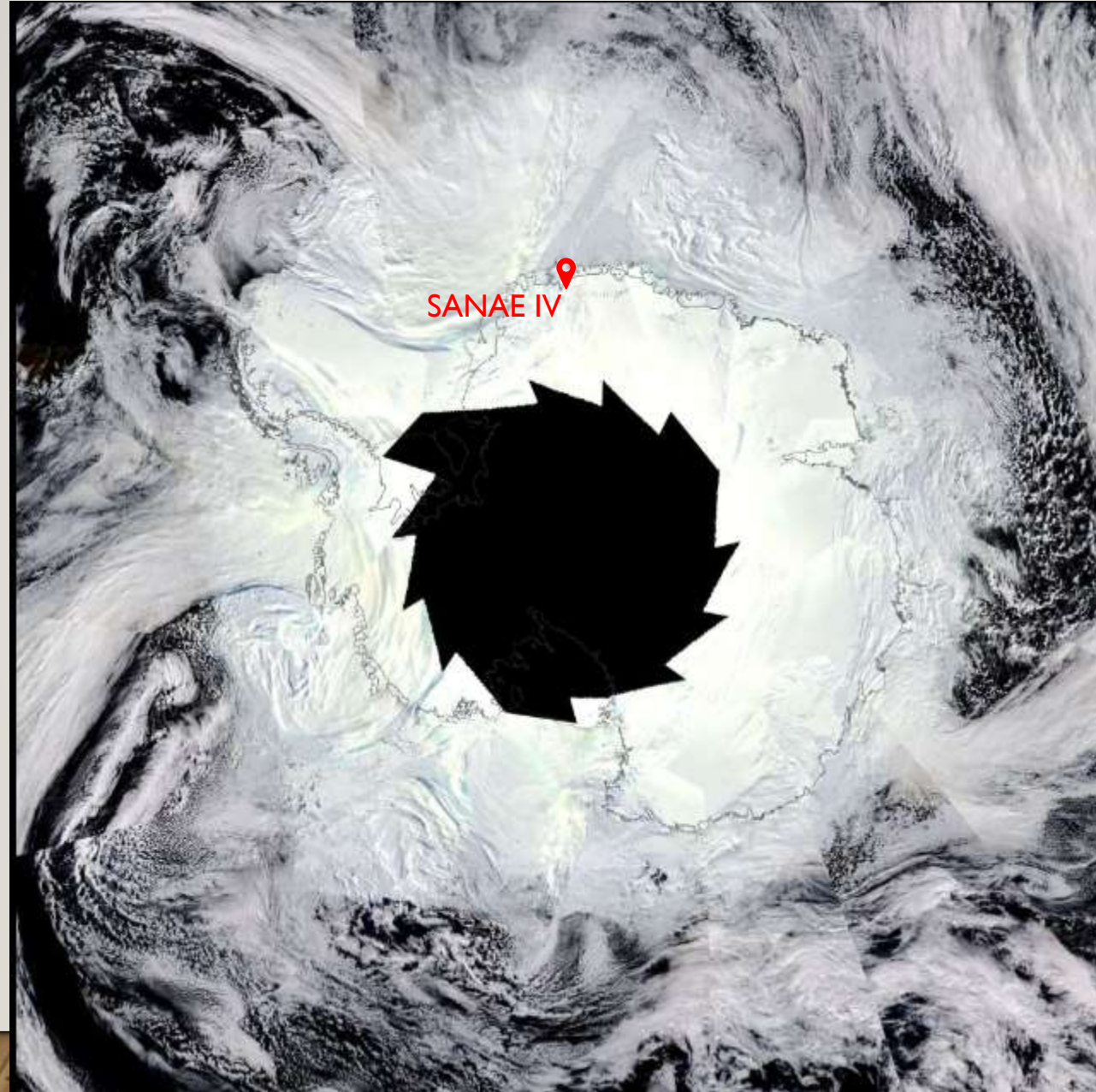
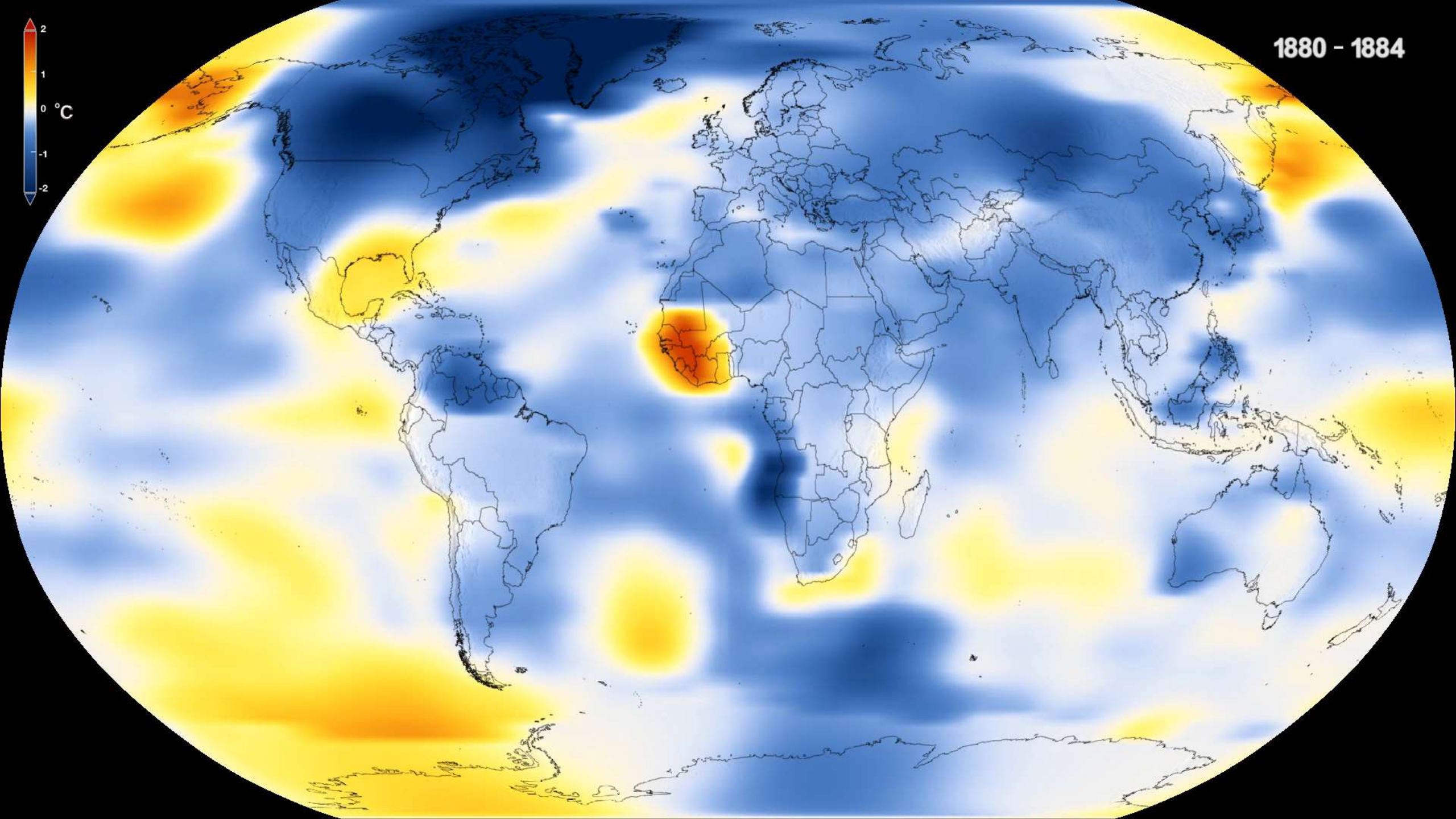


Image from NASA Worldview / Public domain (Terra MODIS, 2018-09-05)

Projections are deceptive!



1880 - 1884





Exploring Antarctic sea ice



SCALE WIN22

Winter 2022 expedition on board the SA Agulhas II

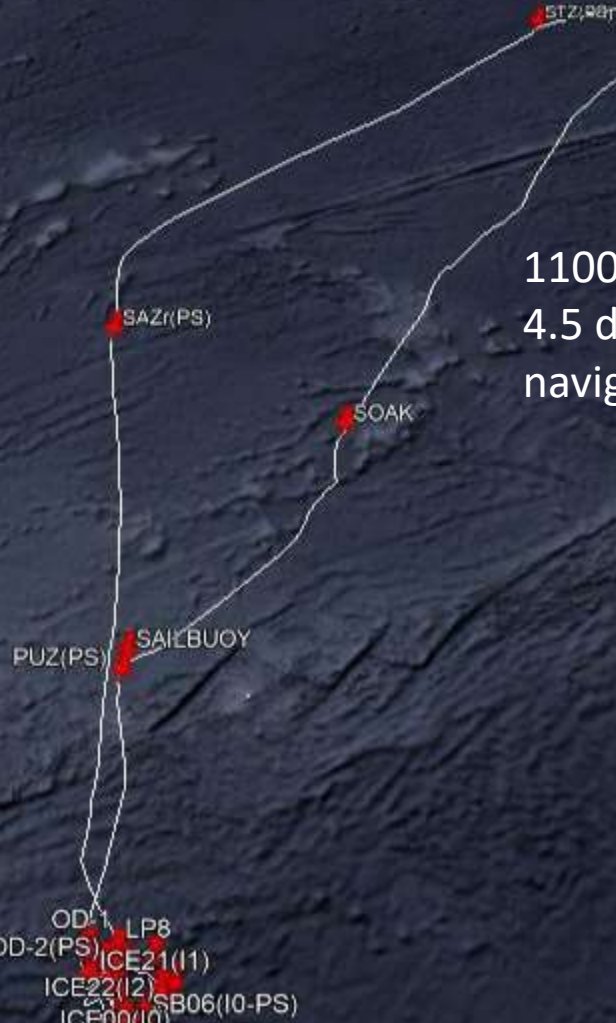
Legend

 Stations

Departure: 12/07 00:17

Return: 31/07 01:58

1100 nm @10.9 knots
4.5 days of stormy
navigation



Google Earth

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus



S. A. AGULHAS II







🕒 7/3/2017 1:43 am 🔍 🗺️
7/4/2017 4:14 am
7/4/2017 7/5/2017

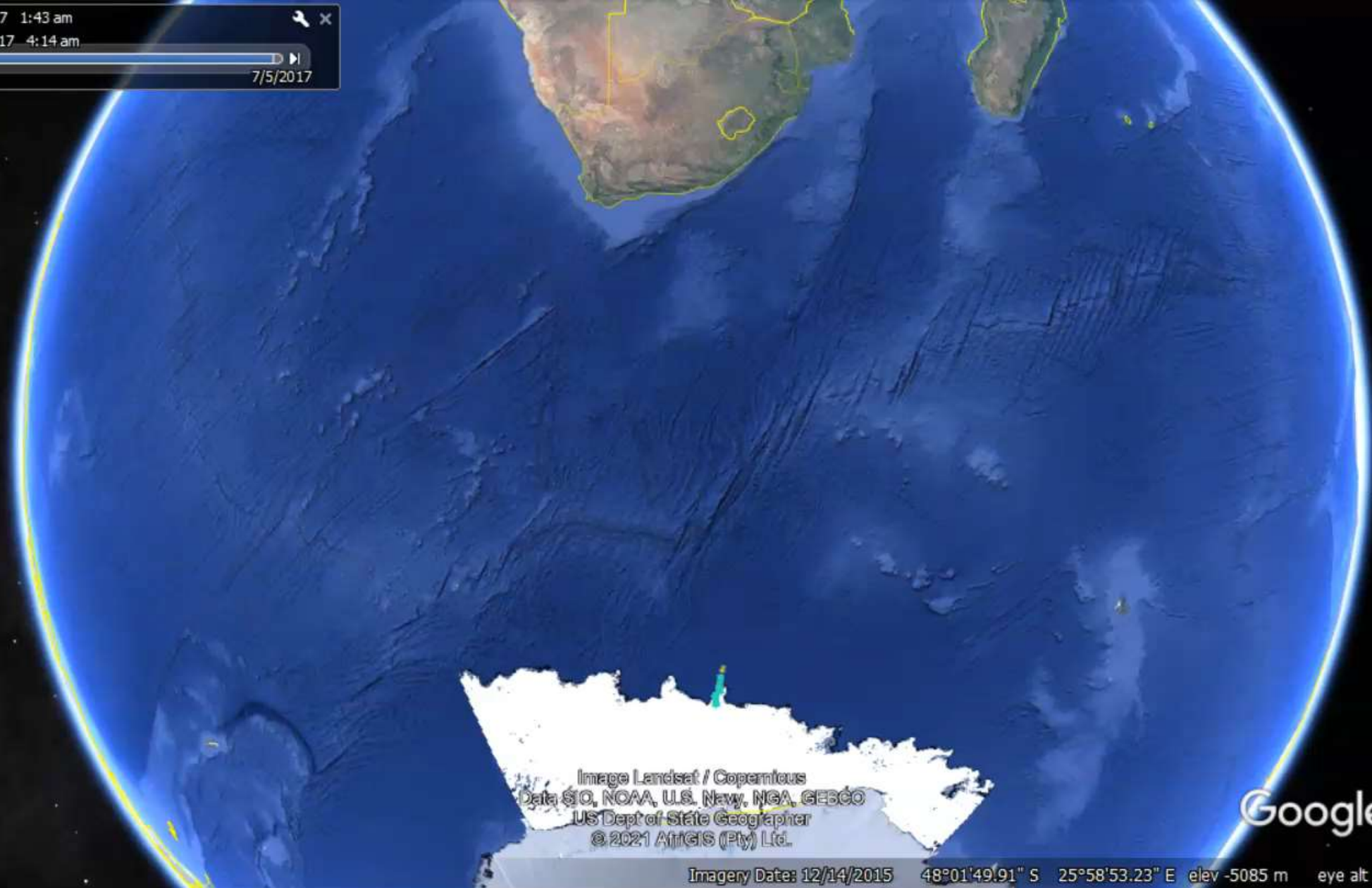
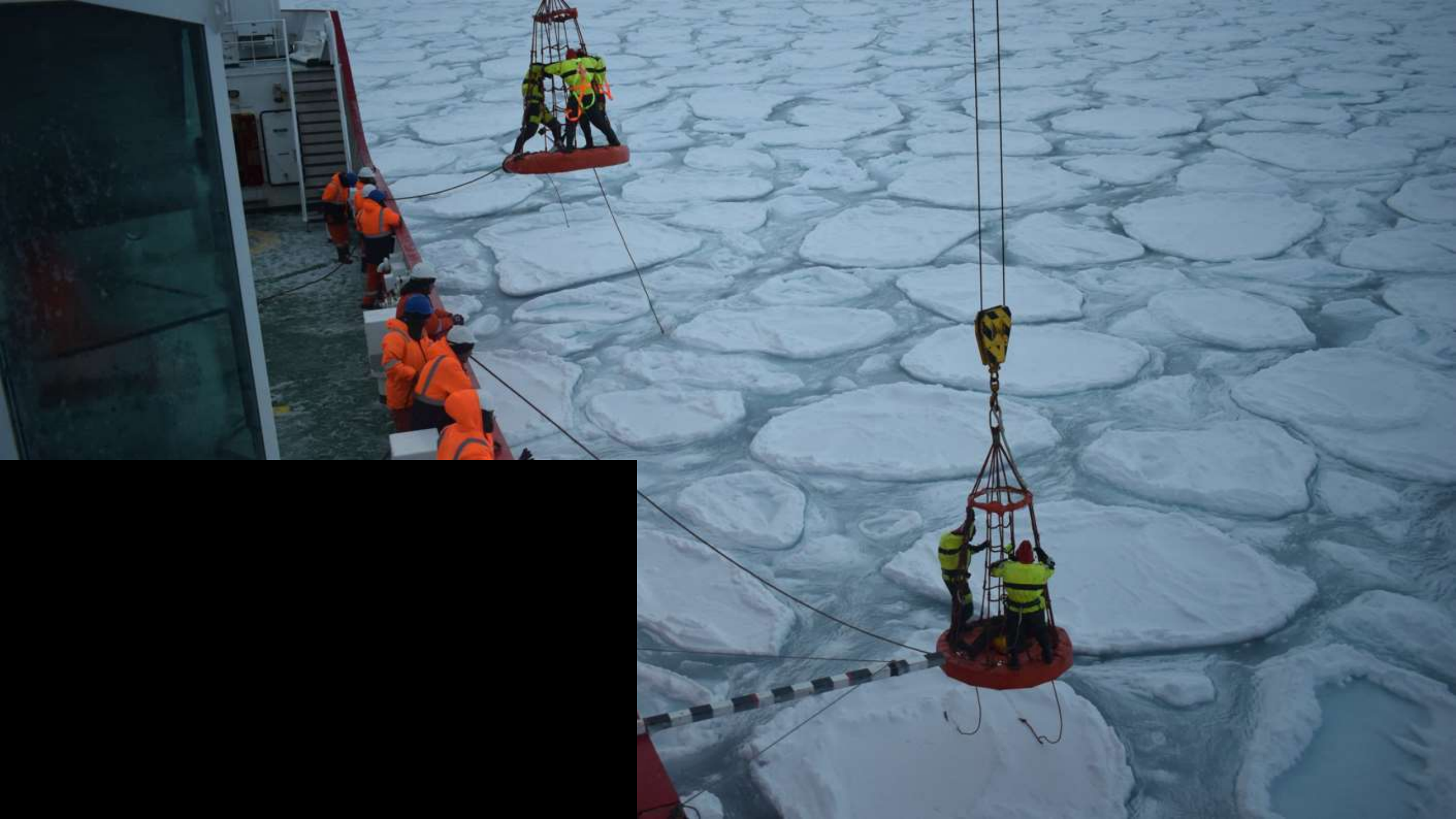


Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
US Dept of State Geographer
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Google Earth

Imagery Date: 12/14/2015 48°01'49.91" S 25°58'53.23" E elev -5085 m eye alt 8578.68 km

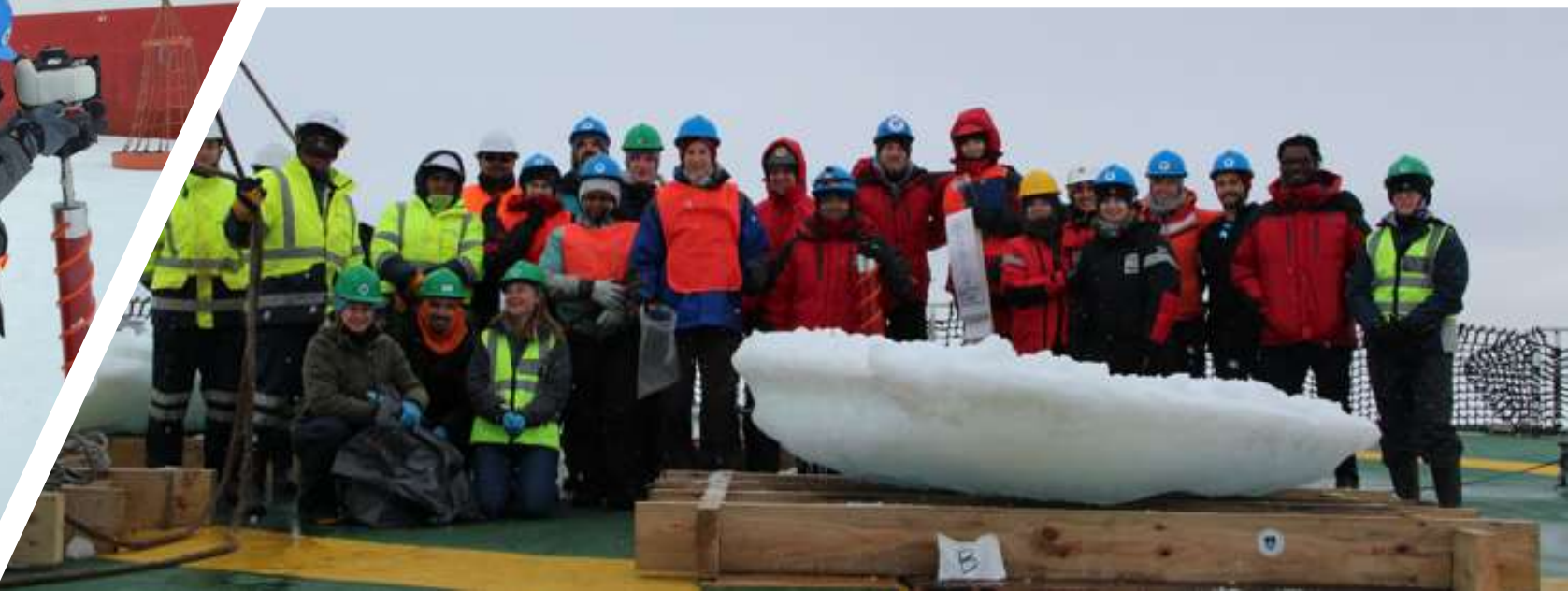




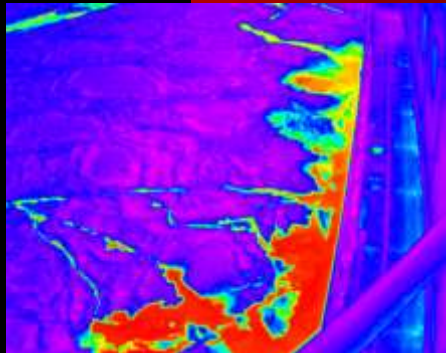
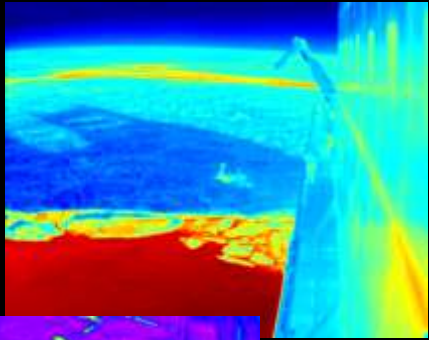
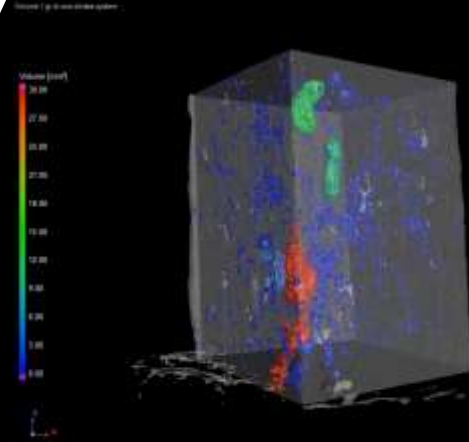








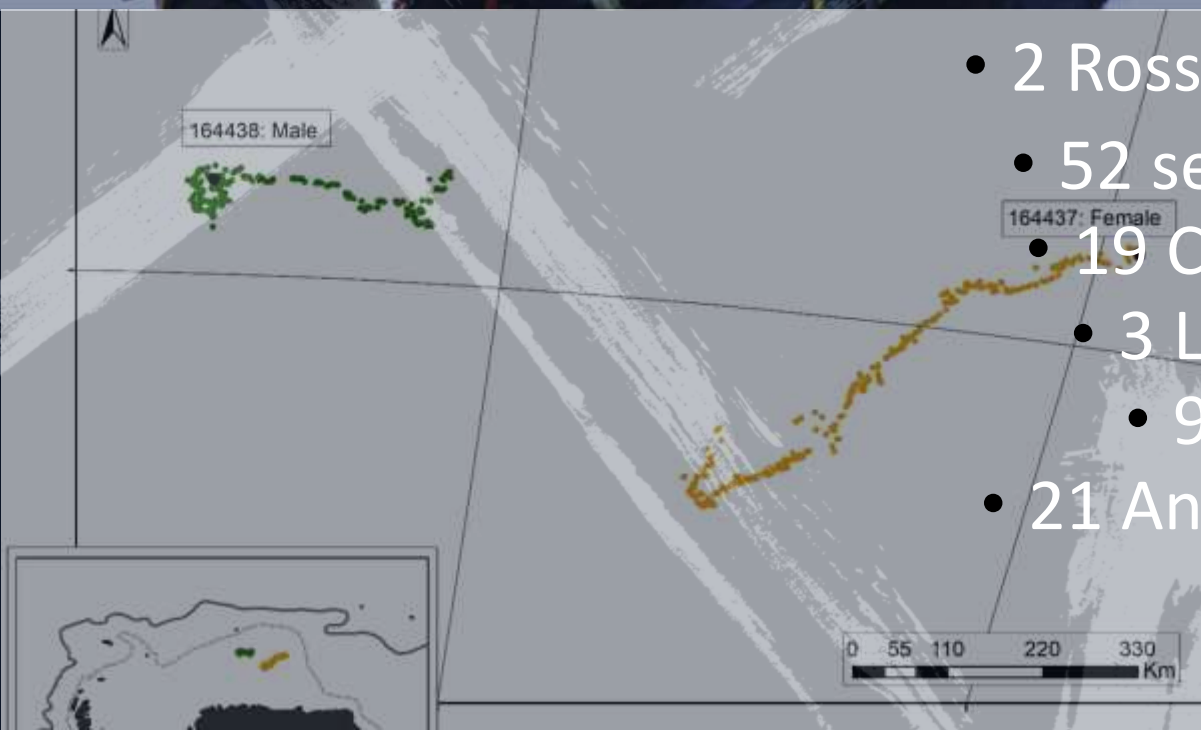






Number of seals tagged

- 2 Ross Seals tagged
- 52 seals spotted
- 19 Crabeater seals
- 3 Leopard seals
- 9 Ross seals
- 21 Antarctic Fur seals





Number of birds spotted

- 52 different species of birds spotted
- Highlights include:
- Salvin's Albatross (first for the GoodHope Line)
- White-Bellied Storm Petrel
- MacGillivray's Storm Petrel





Number of whales spotted

- 161 hours of observations
- 84 groups sighted, with a total of 272 individuals
- 8 identified species

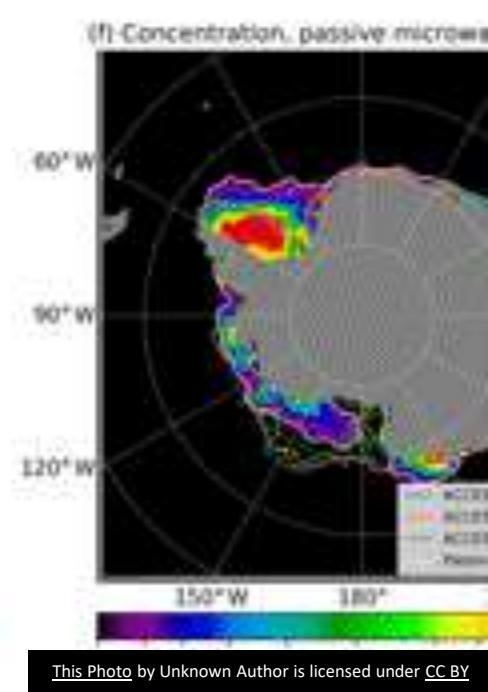
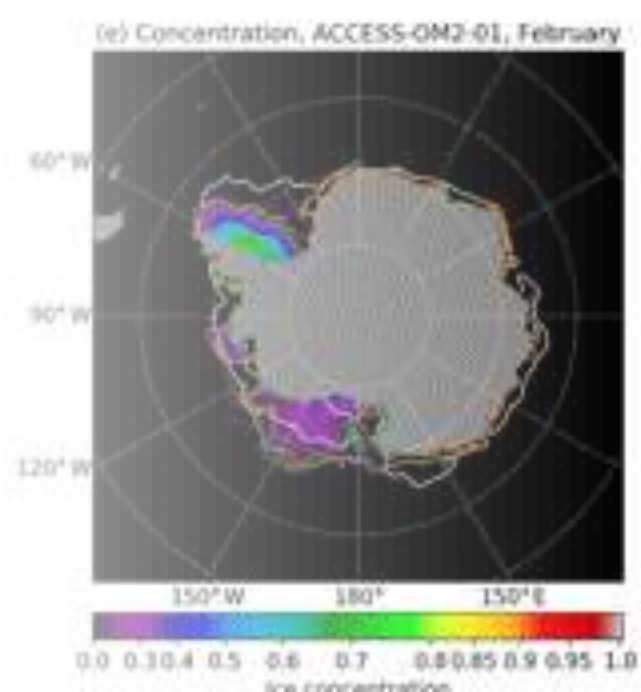
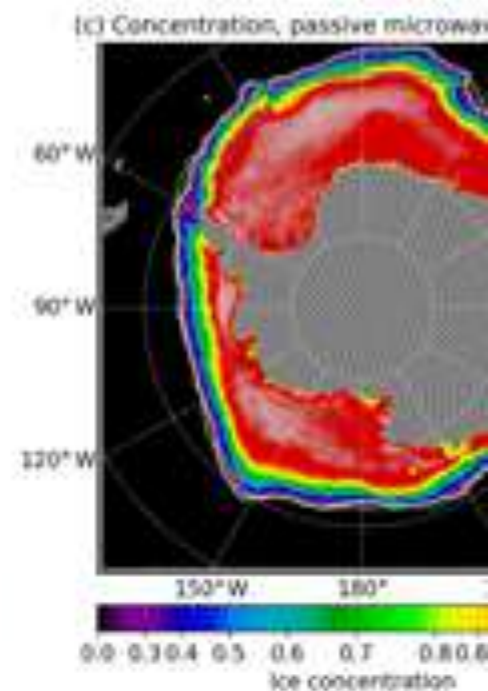
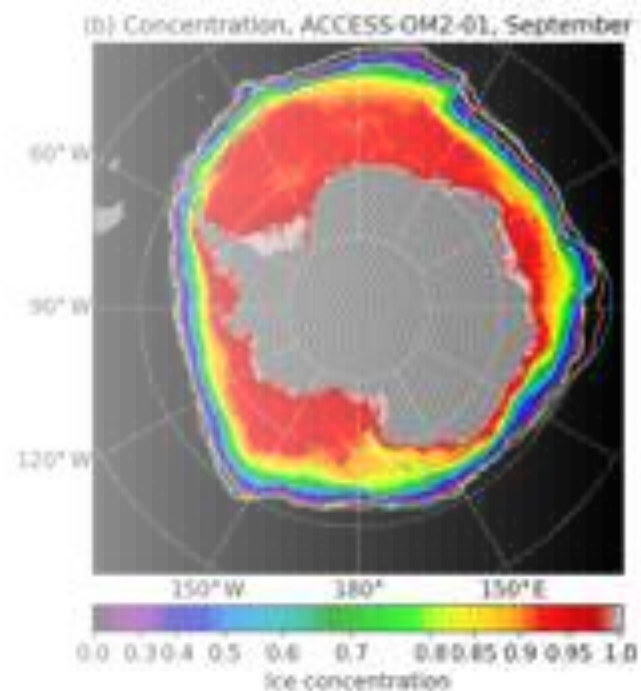
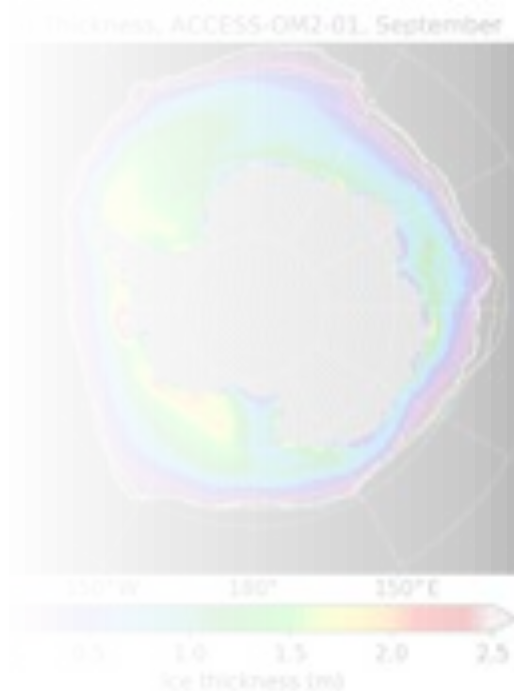




The crew

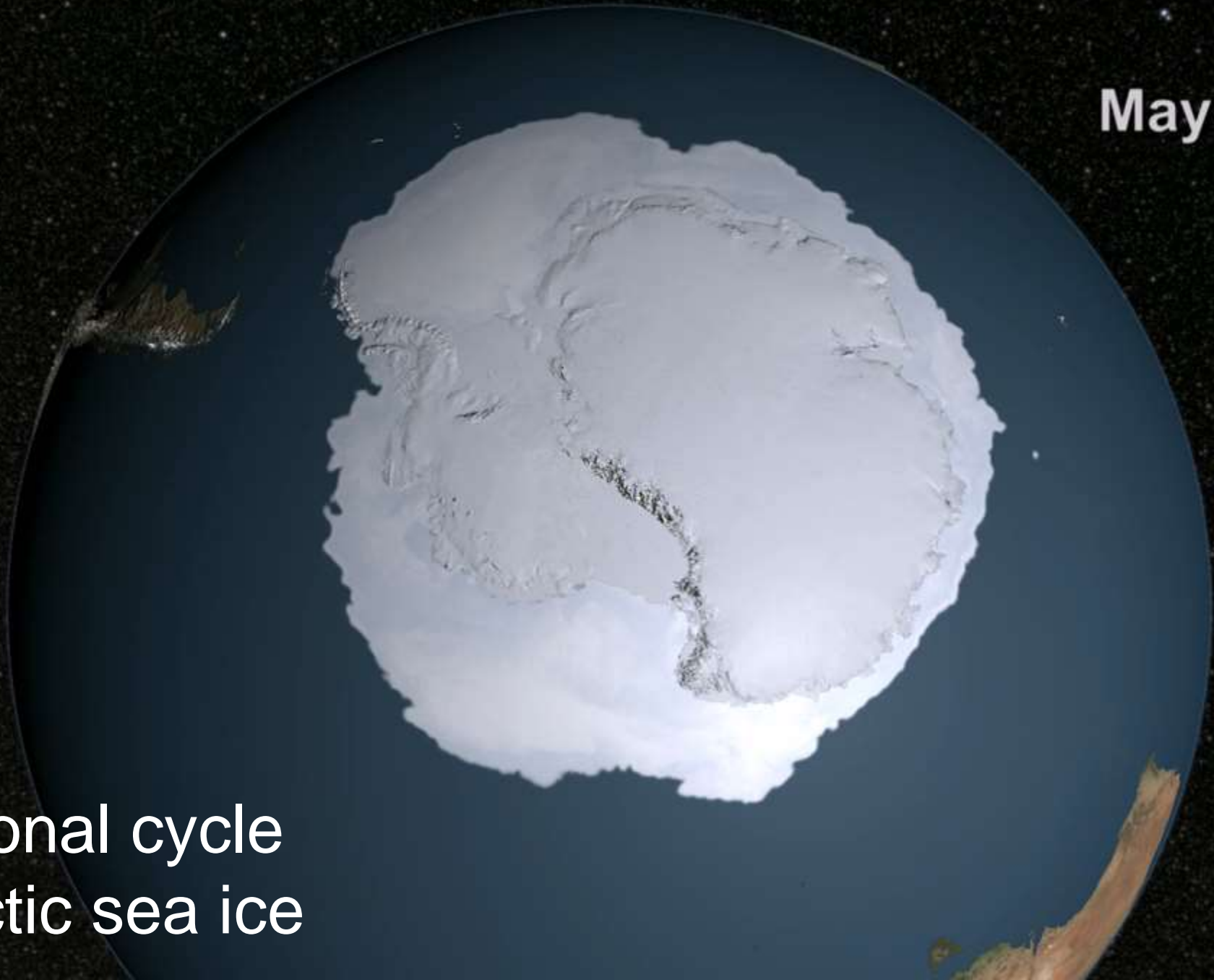


Seasonality, trends and projections of Antarctic climate



May 26, 2009

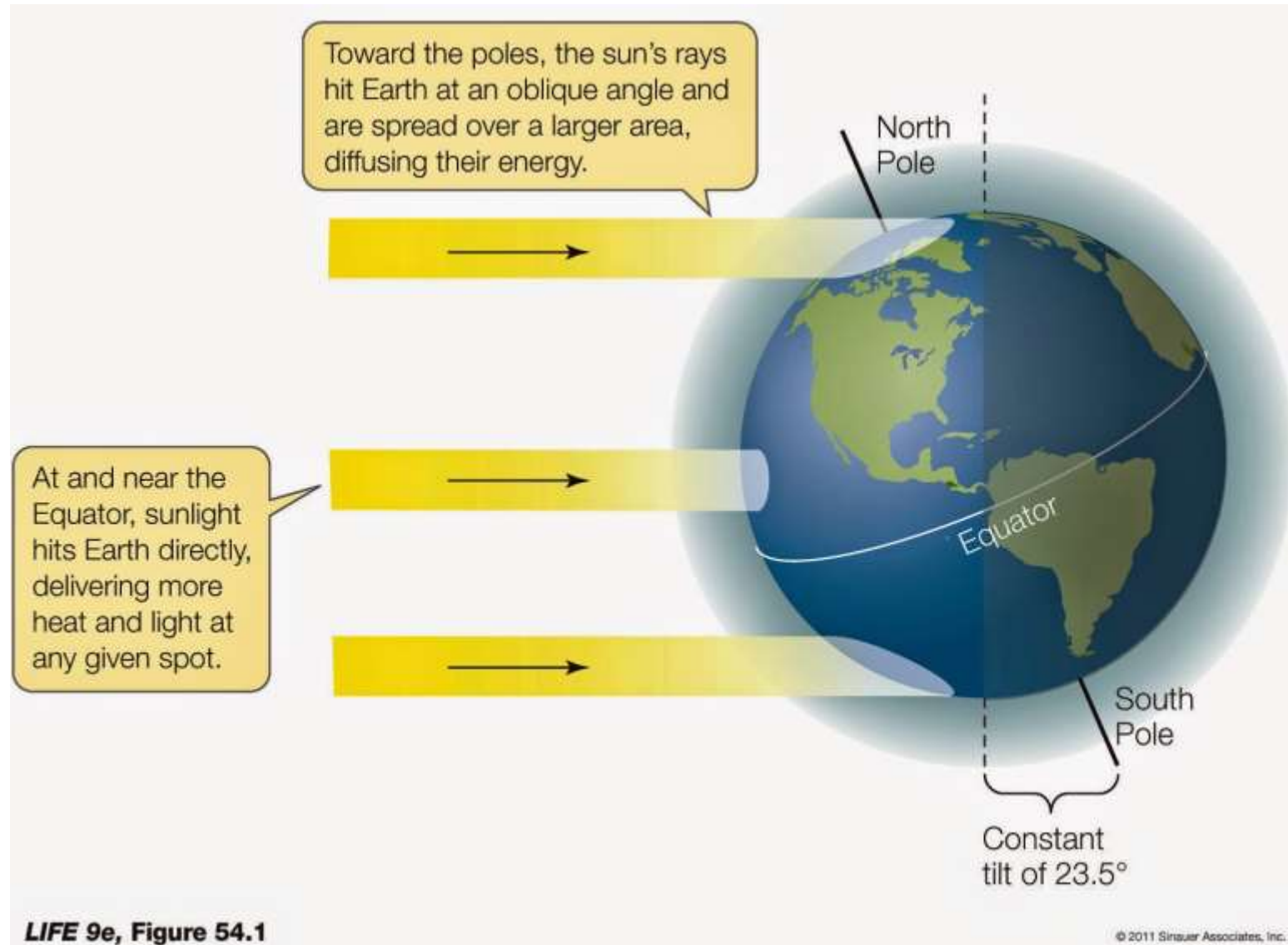
Seasonal cycle
Antarctic sea ice



It all begins with the Sun (and geometry)

The unequal distribution of heat on the tilted Earth generates an imbalance between the equator and the poles.

The excess of heat at the equator is redistributed to the poles through the atmosphere and the ocean, driving the changes in surface temperature, the wind and ocean circulations, and ultimately the seasons.

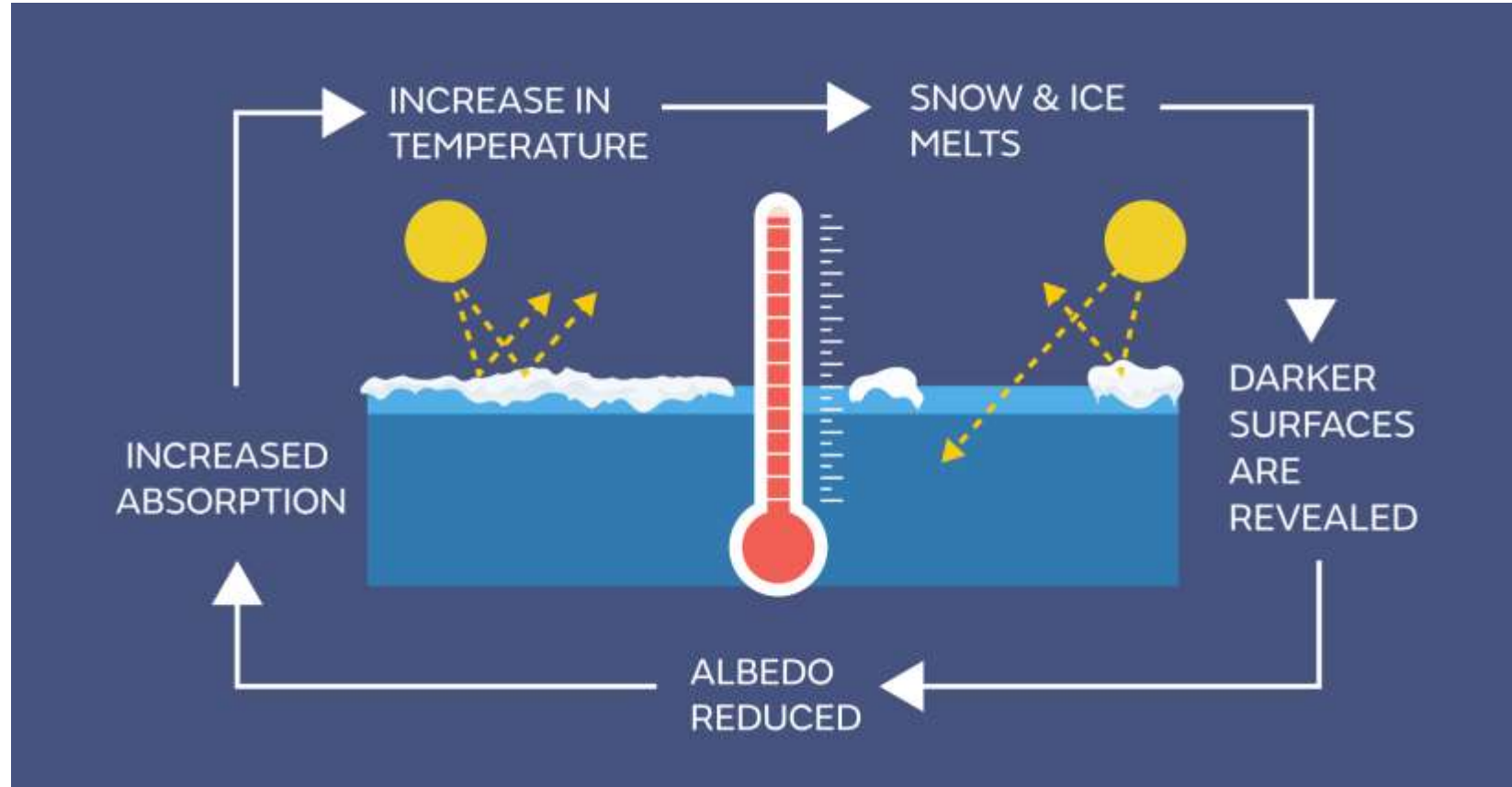


Good to know: "Climate" comes from a Greek word that means "inclination"



Sea ice – albedo feedback

- Albedo is the reflectance of surfaces to incoming light: if light is not reflected, it is absorbed, and heat accumulates
- Snow and ice have the highest albedo. The ocean is dark and has a much lower albedo
- This is called “positive feedback”. The change reinforces the process



<https://www.metoffice.gov.uk/research/climate/cryosphere-oceans/sea-ice/index>

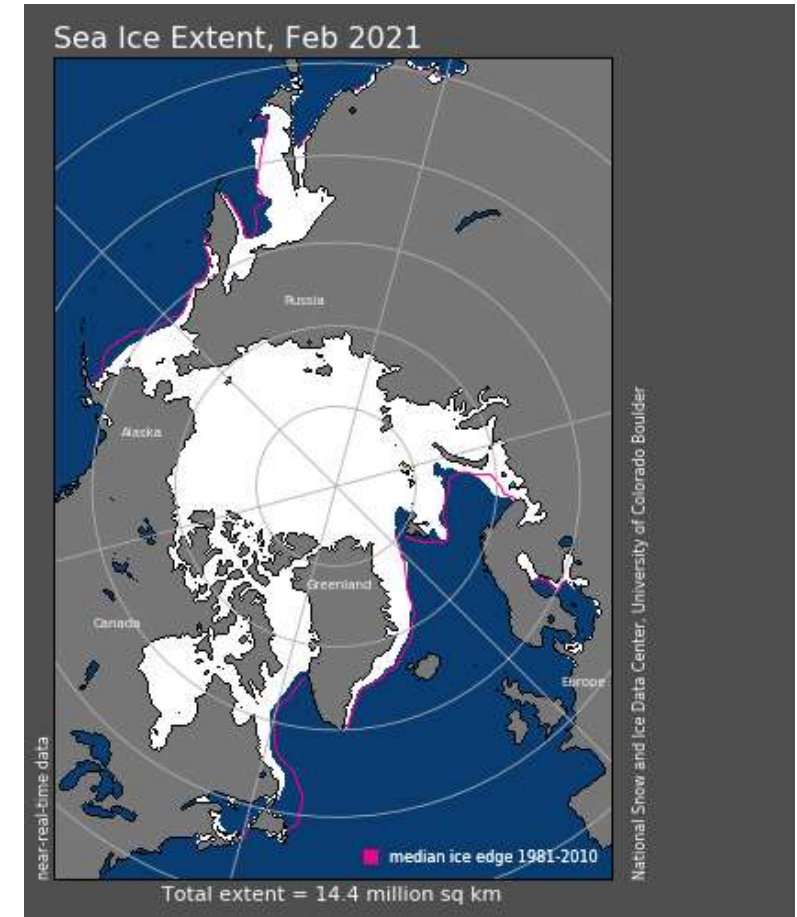
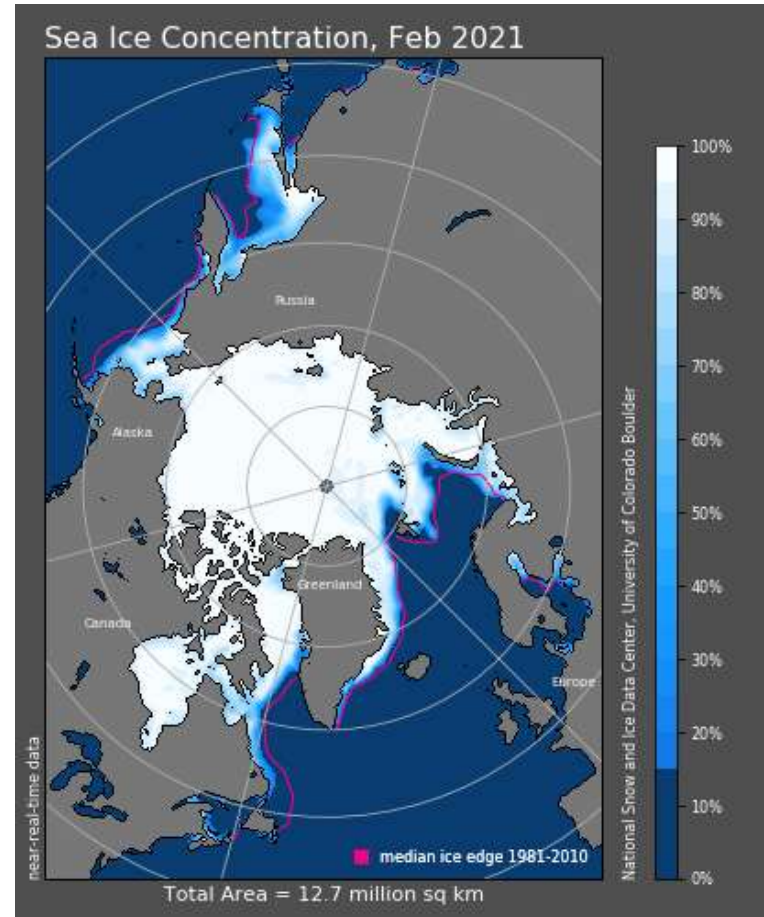
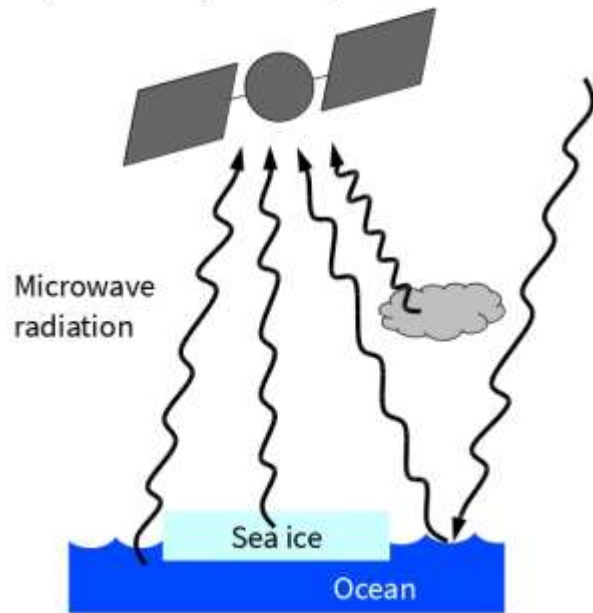
Important to know: The type of precipitation affects ice albedo. More rain than snow will further increase the melting rate



Measuring sea ice seasonality

Measuring microwave brightness temperatures with passive sensors

The satellite measures microwave radiation emitted by the surface (ocean and sea ice), emitted by the atmosphere, and emitted by space and reflected by the surface. The total radiation is expressed as brightness temperature.



Essential Climate Variables: derived from satellite sea ice concentration (SIC) sea ice extent SIE (area where SIC \geq 15%) and sea ice area SIA (actual coverage) SIE \geq SIA (14.4 vs 12.7 million km² in the example)

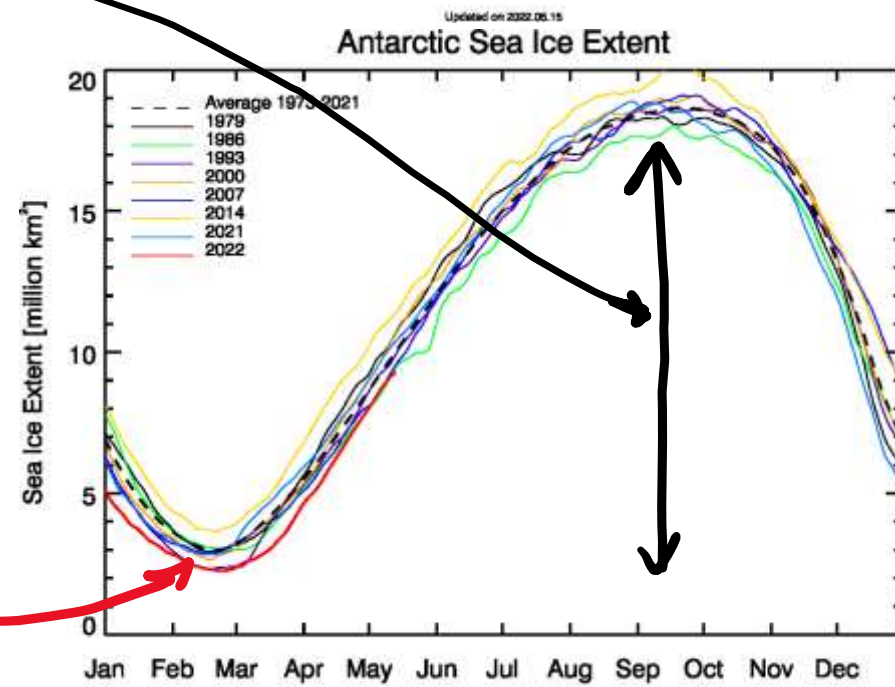
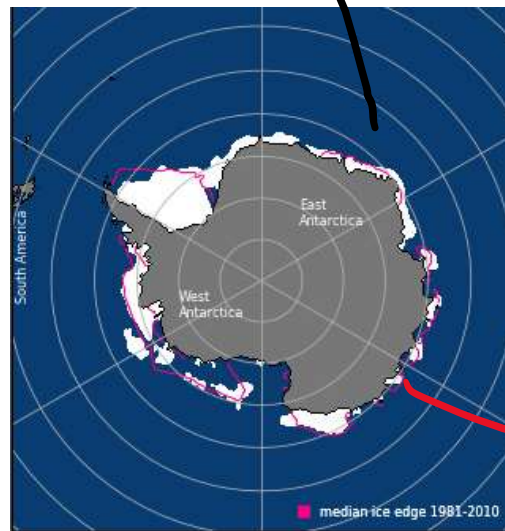
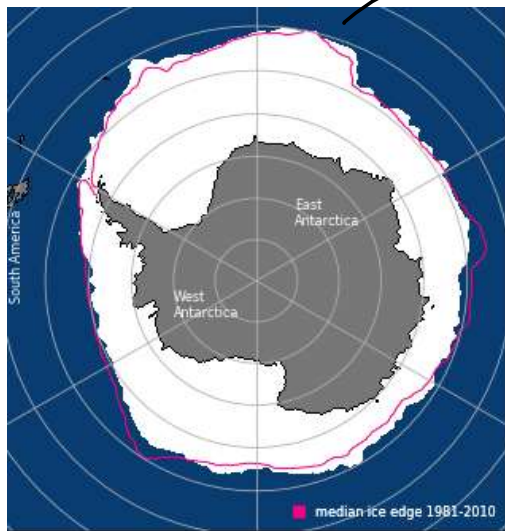
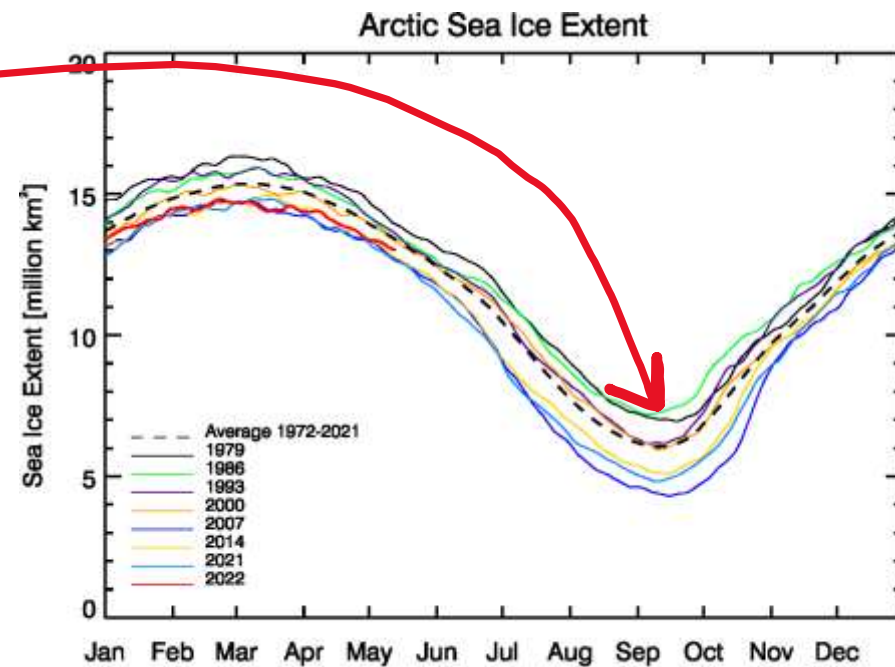




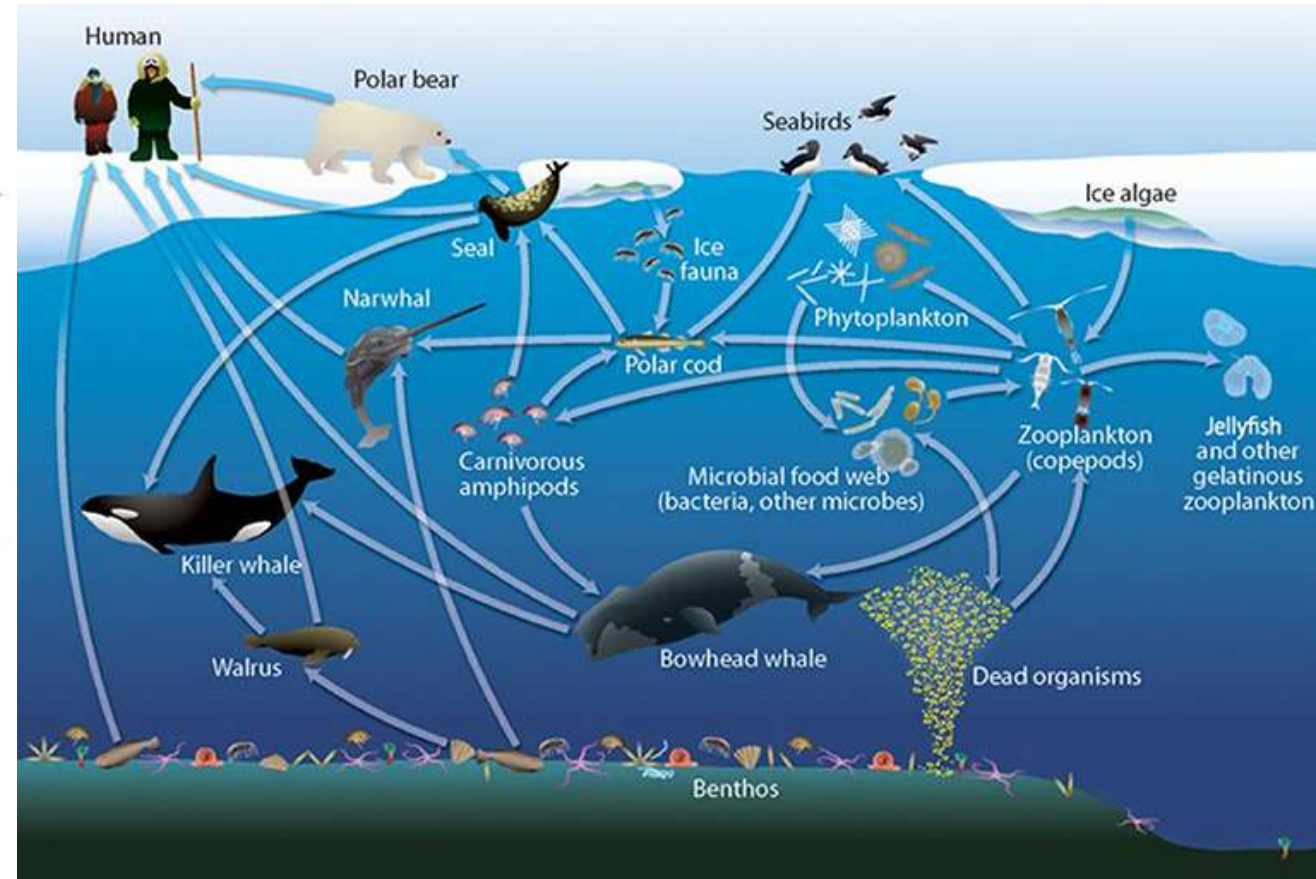
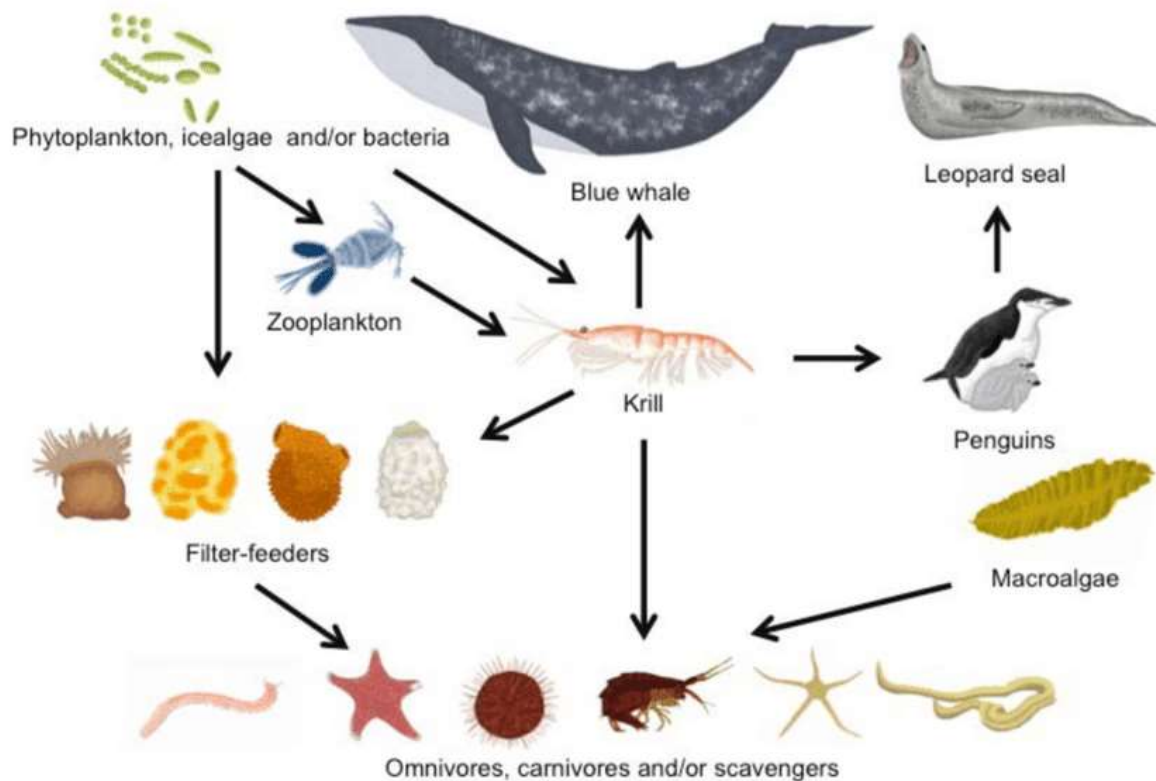
PERENNIAL

Scientists call it
Multi-Year Ice (MYI)

SEASONAL



Antarctic and Arctic food webs



Important to know:

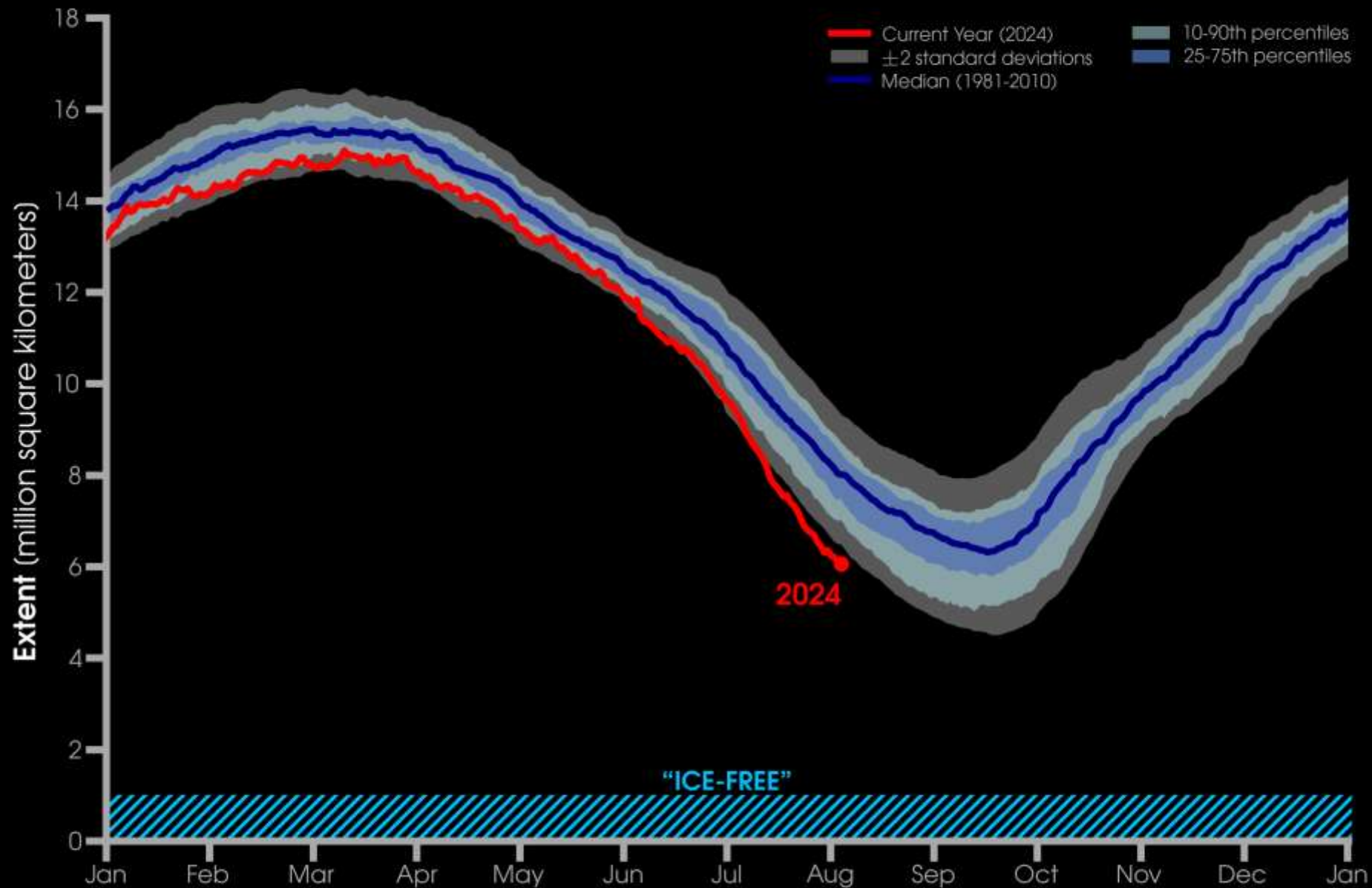
Food web diagrams are simplified views of the ecological relationships between organisms and the environment





Sea ice trends

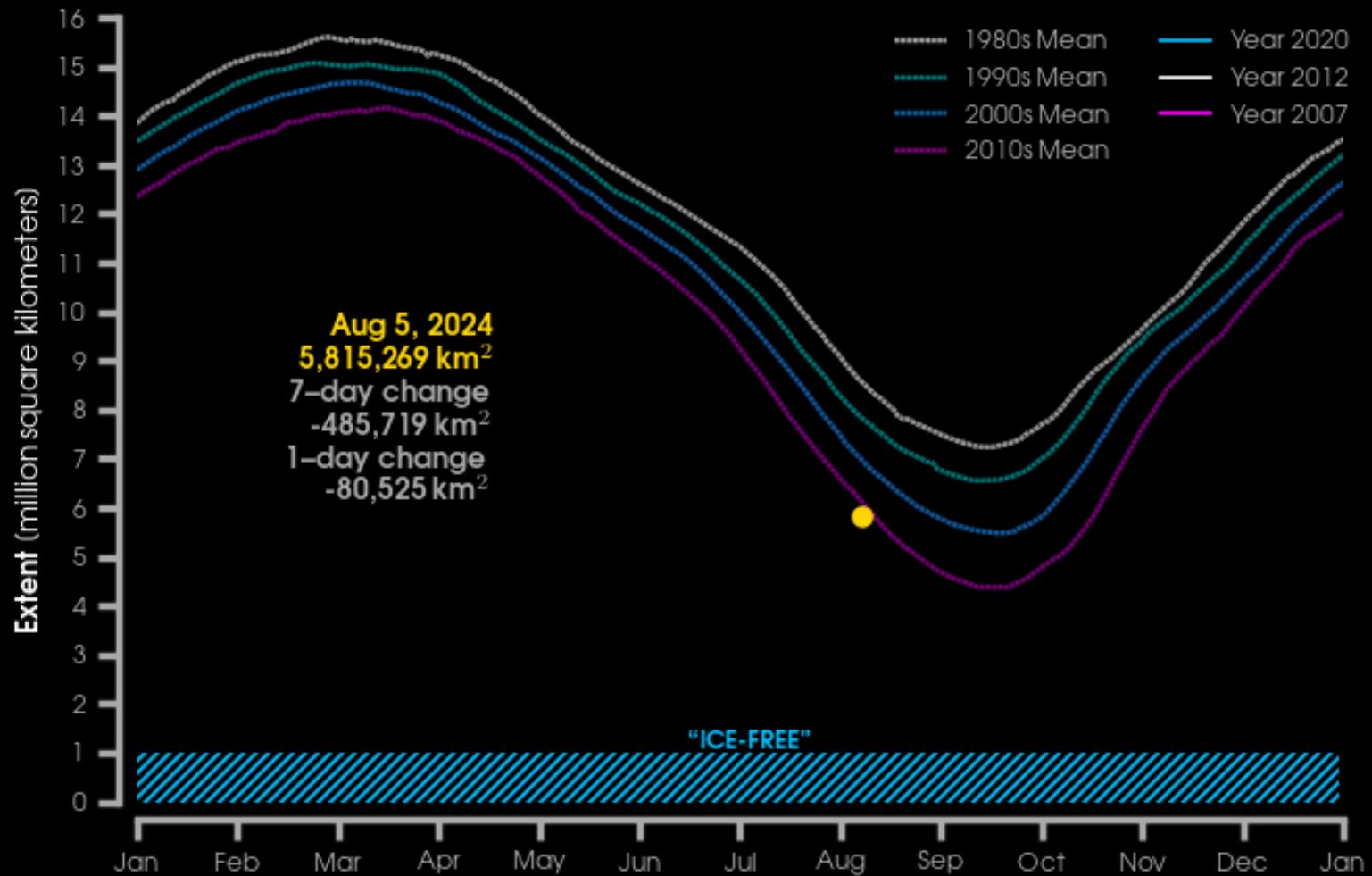
ARCTIC SEA ICE



DATA: National Snow & Ice Data Center, Boulder CO (Sea Ice Index v3; 1979-2024*)
SOURCE: <ftp://sidads.colorado.edu/DATASETS/NOAA/G02135/>

GRAPHIC: Zachary Labe (@ZLabe)

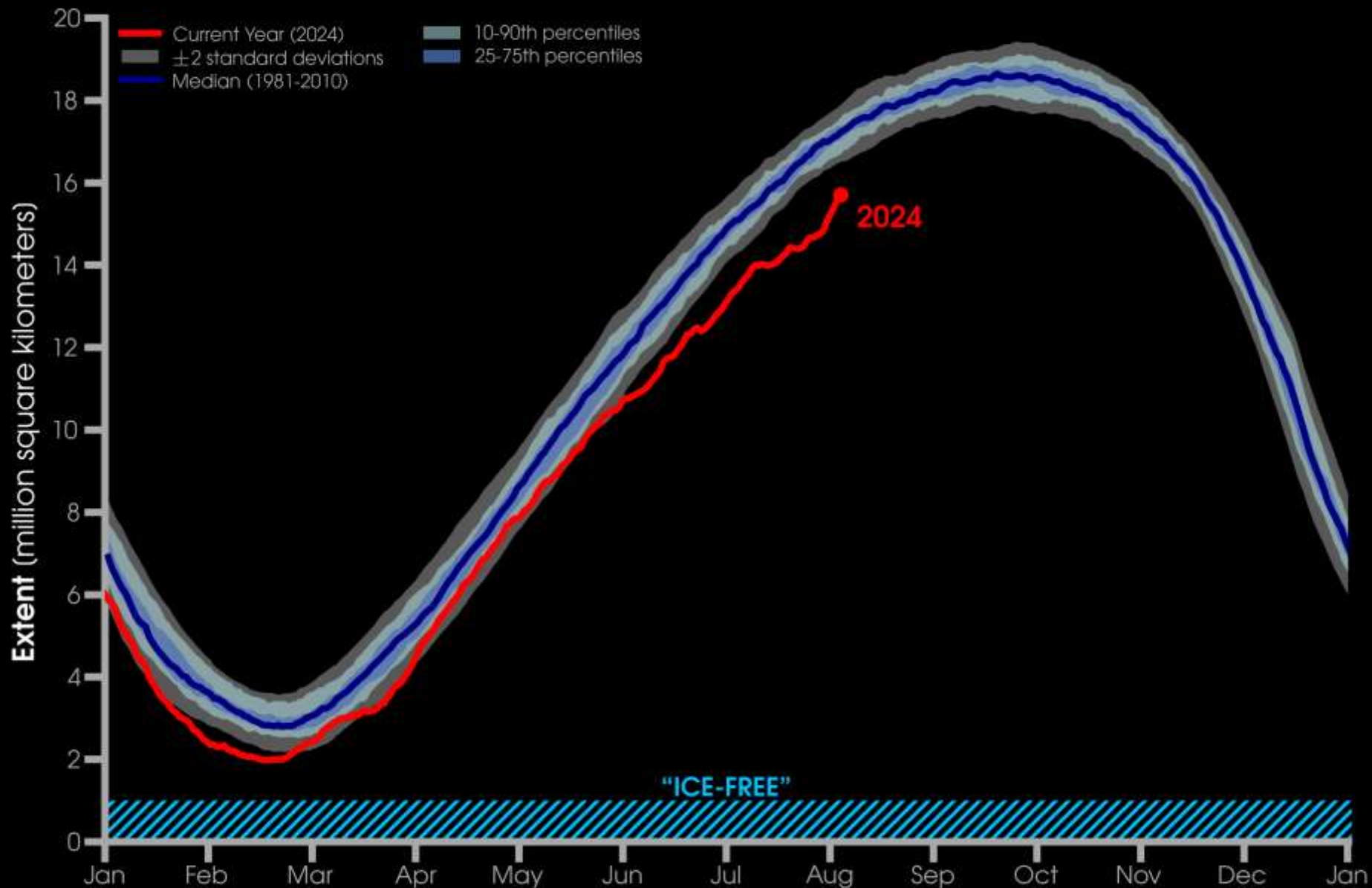
ARCTIC SEA ICE



DATA: JAXA 2002-2024* (Arctic Data archive System, NIPR)
SOURCE: <https://ads.nipr.ac.jp/Mshop/Mshop-extent.html>

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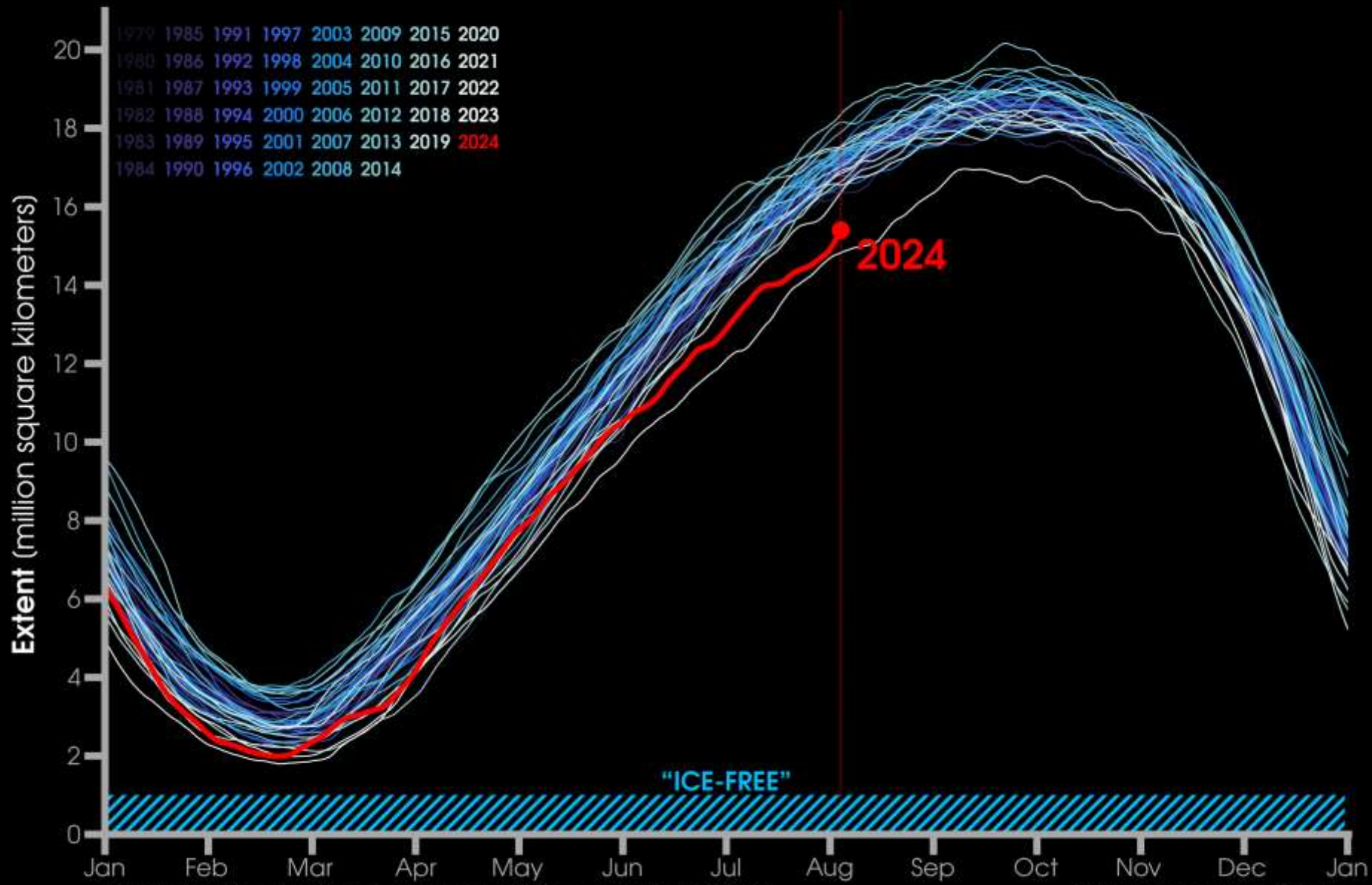
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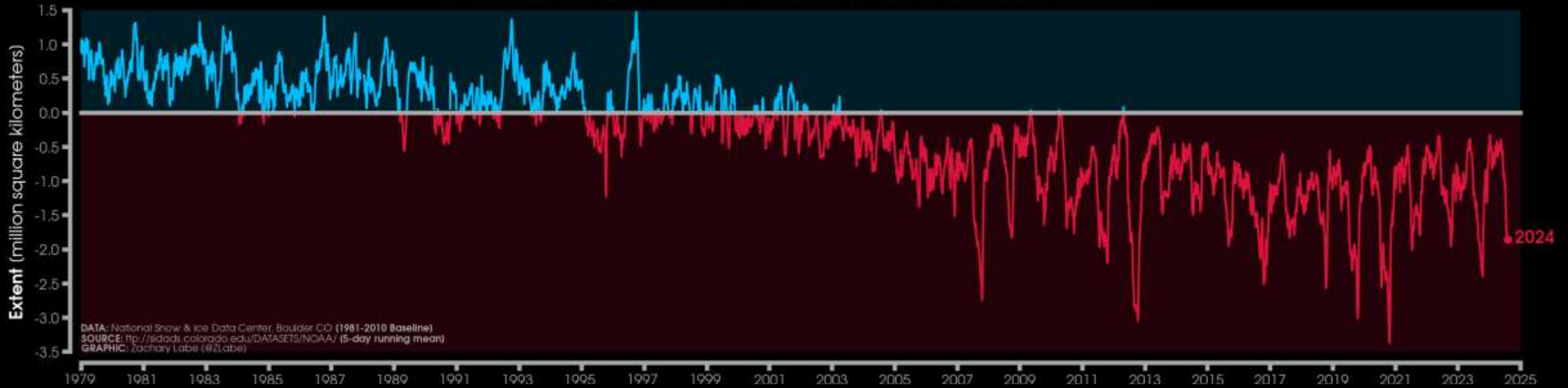
ANTARCTIC SEA ICE



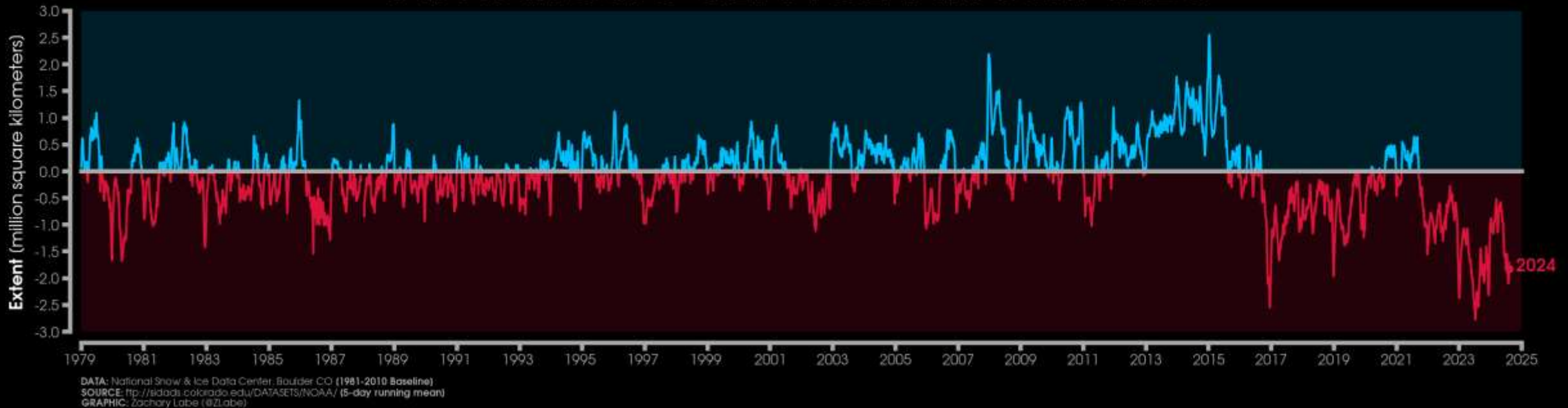
DATA: National Snow & Ice Data Center, Boulder CO (Sea Ice Index v3; 1979-2024*)
SOURCE: <ftp://sidads.colorado.edu/DATASETS/NOAA/> (5-day running mean)

GRAPHIC: Zachary Labe (@ZLabe)

ARCTIC SEA ICE ANOMALIES



ANTARCTIC SEA ICE ANOMALIES





Ice sheet trends

Antarctic ice sheet mass change

Combined satellite observations and models of surface mass balance show a **loss of $2,720 \pm 1,390$ billion tonnes of ice between 1992 and 2017**, which corresponds to an increase in mean sea level of 7.6 ± 3.9 millimetres (The IMBIE team; Nature, 2018).

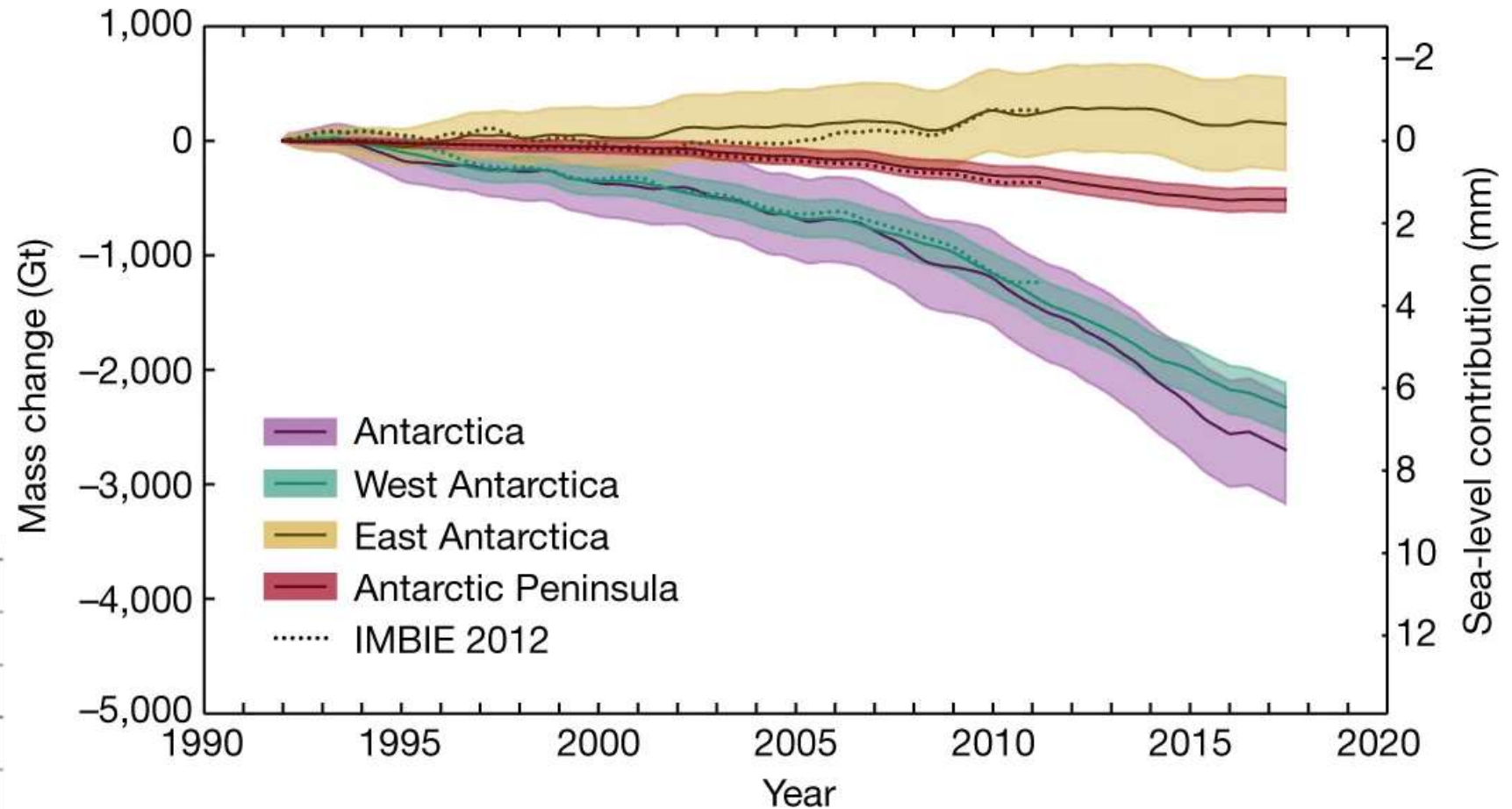
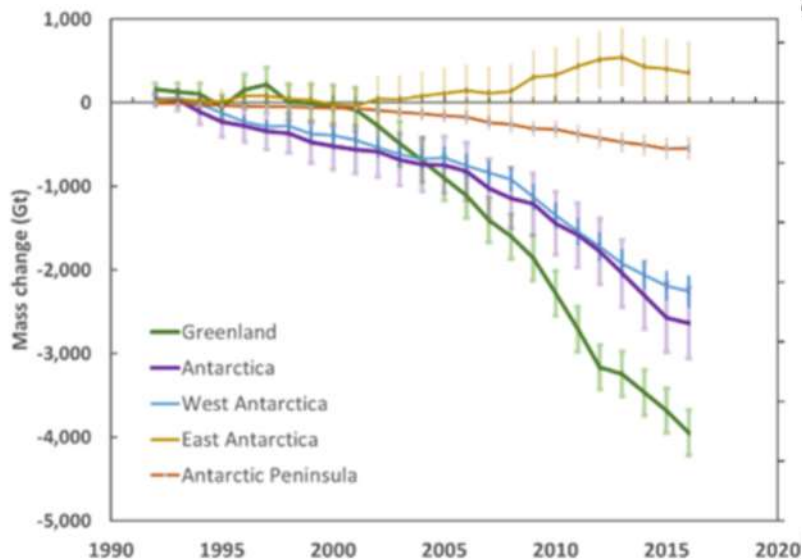


Figure 3.7 from the IPCC Special Report Ocean and Cryosphere. *Greenland has lost ~3.3% volume, the disequilibrium with the 2000-19 climate yields a SLR commitment of 274 ± 68 mm (Box et al., 2022)*

— A future “without” polar ice?

- *Understand and explain the difference between forecasts and projections*
- *Make a clear distinction between continental ice sheets and sea ice*
- In the Arctic we have high confidence that there will be no more perennial ice-covered ocean. Scientists are now forecasting “when” we expect to have an ice-free Arctic in summer
- In the Antarctic, anthropogenic warming is likely to surpass natural variability of Antarctic sea ice in the future (it’s happening right now).
- This will impact the trajectory of prevailing winds with increased chances of more extreme cold/wet vs warm/dry conditions in Southern Africa
- We are seeing the impacts on increased phytoplankton blooms in the Southern Ocean and changes in reproductive patterns of baleen whales





An opportunity for the new generations of South Africans

Creating polar awareness. Local knowledge for adaptation to changes

Resource: Ocean Literacy Toolkit

- UNESCO partnered with EU AtlantECO project to **develop an inclusive ocean literacy toolkit** for AtlantECO partnering countries which will share various **ocean principles, knowledges & cultures**.
- Expand & **improve ocean literacy rates** across the Atlantic region.
- Aims to support teachers with ready-to-use resources to teach and present the Atlantic features to students considering a multidisciplinary approach.
- OL Toolkit focuses on various topics of The Atlantic Region:
 - Arts, History, Geography
 - Gender, Culture
 - Sustainable Blue Economy
 - Biodiversity, Ocean microbiome, Sustainability
 - Ocean innovation, exploration & discoveries
 - Case Studies
- Stay tuned to the AtlantECO Project website at <https://www.atlanteco.eu/> and Online Webinar for the Launch



For more information - Contact Us



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This inter-faculty Centre is hosted in the UCT Department of Biological Sciences. The Management Team is based at the MARiS Centre on Level 4, John Day Building, University of Cape Town, Upper Campus, Rondebosch, Cape Town.

