The Arctic as a warning system

for the entire planet

Maria Sand maria.sand@cicero.oslo.no

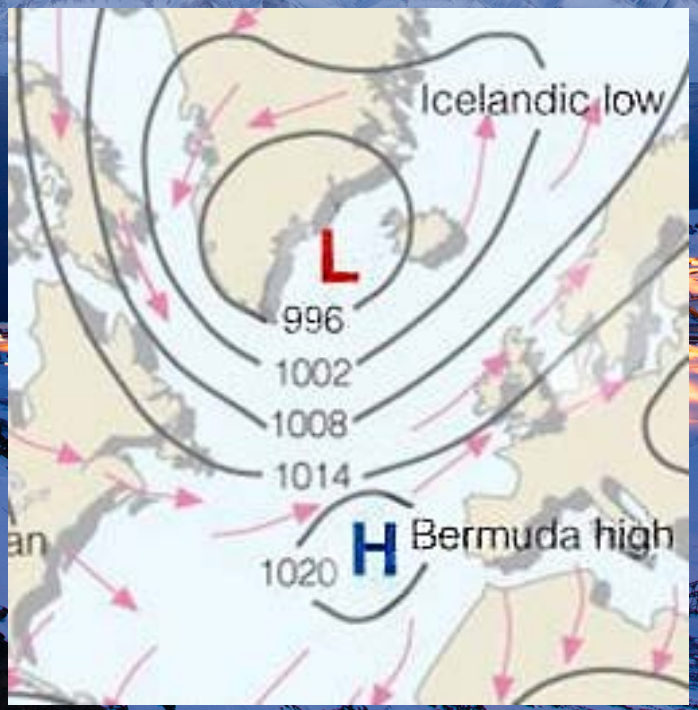
°CICERO Senter for klimaforskning Center for International Climate and Environmental Research - Oslo www.cicero.uio.no


PERSR
ASIAE
PARS
OCEANUS SCYTHICUS
Mare Sin
OCEANUS SEPTEN
TRIONALIS
SEP:
TENTRIO
NALIVM
Terrarum de:
scriptio.

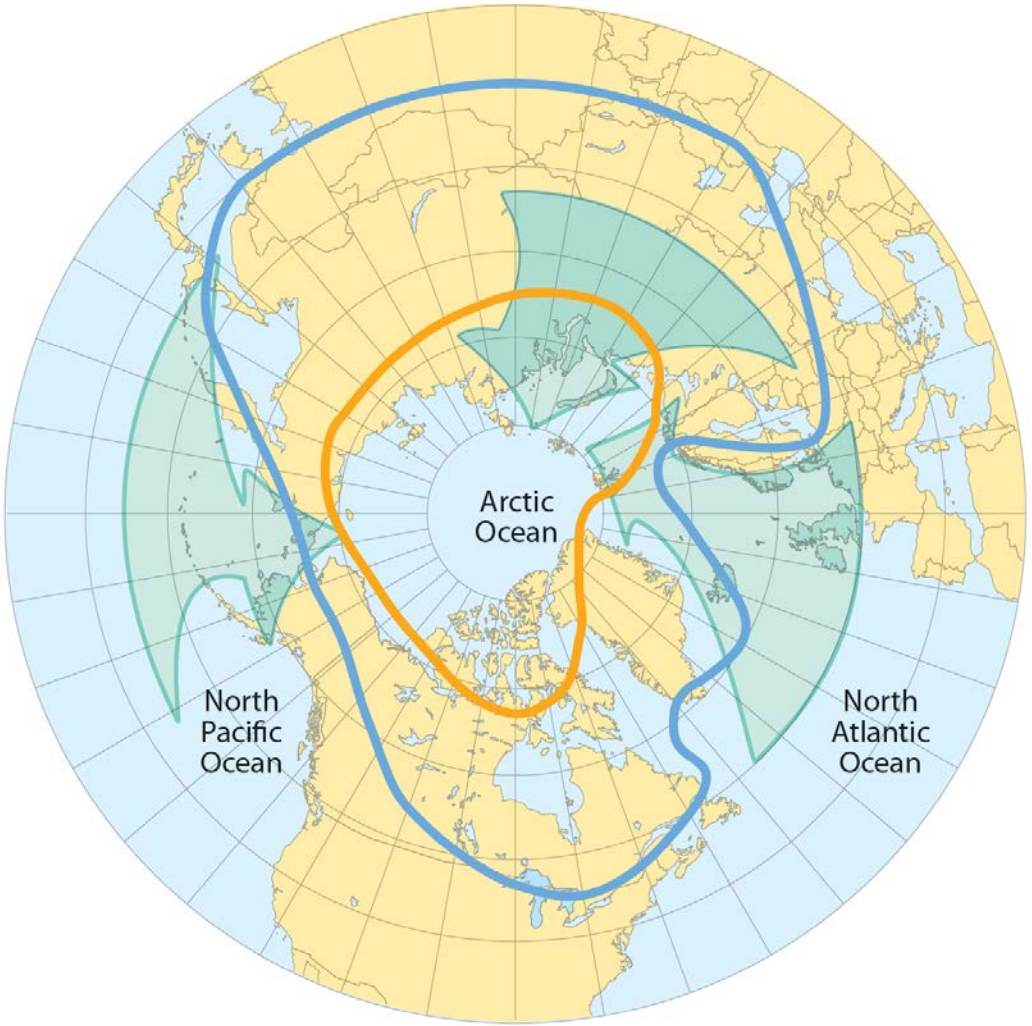
Willem Barentsz discovered Bjørnøya and Svalbard in i 1596

Arctic tundra climate on Svalbard with maritim influence

Midnight sun: 20. April to 23. Au
Dark season: 26. October to 15. February



Pollution from mid latitudes is transported into the Arctic



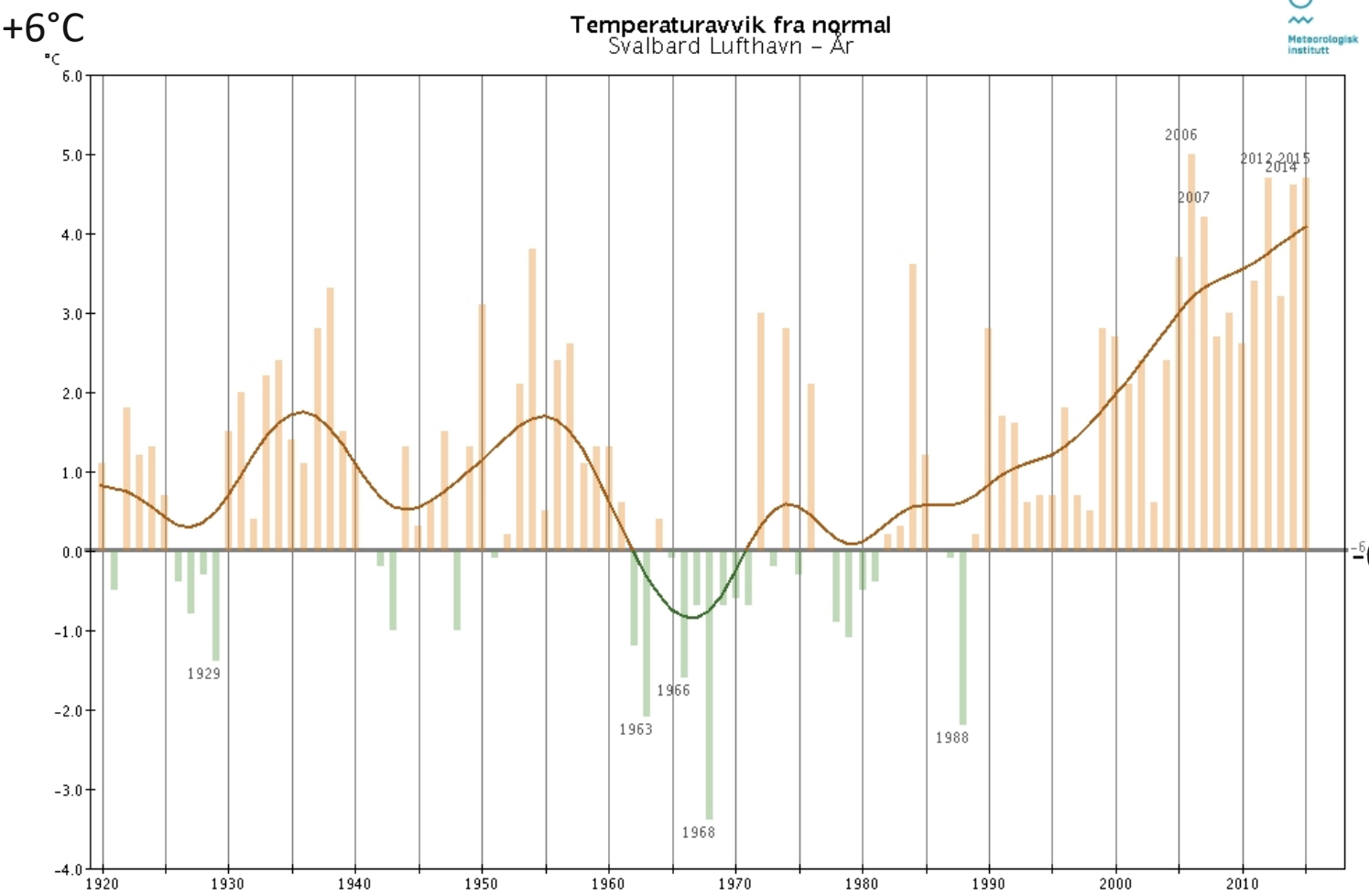
Arctic Front Winter

Arctic Front Summer

Major south to north air transport routes into the Arctic

The weather station at Svalbard airport has been measuring temperatures since 1912

+6°C



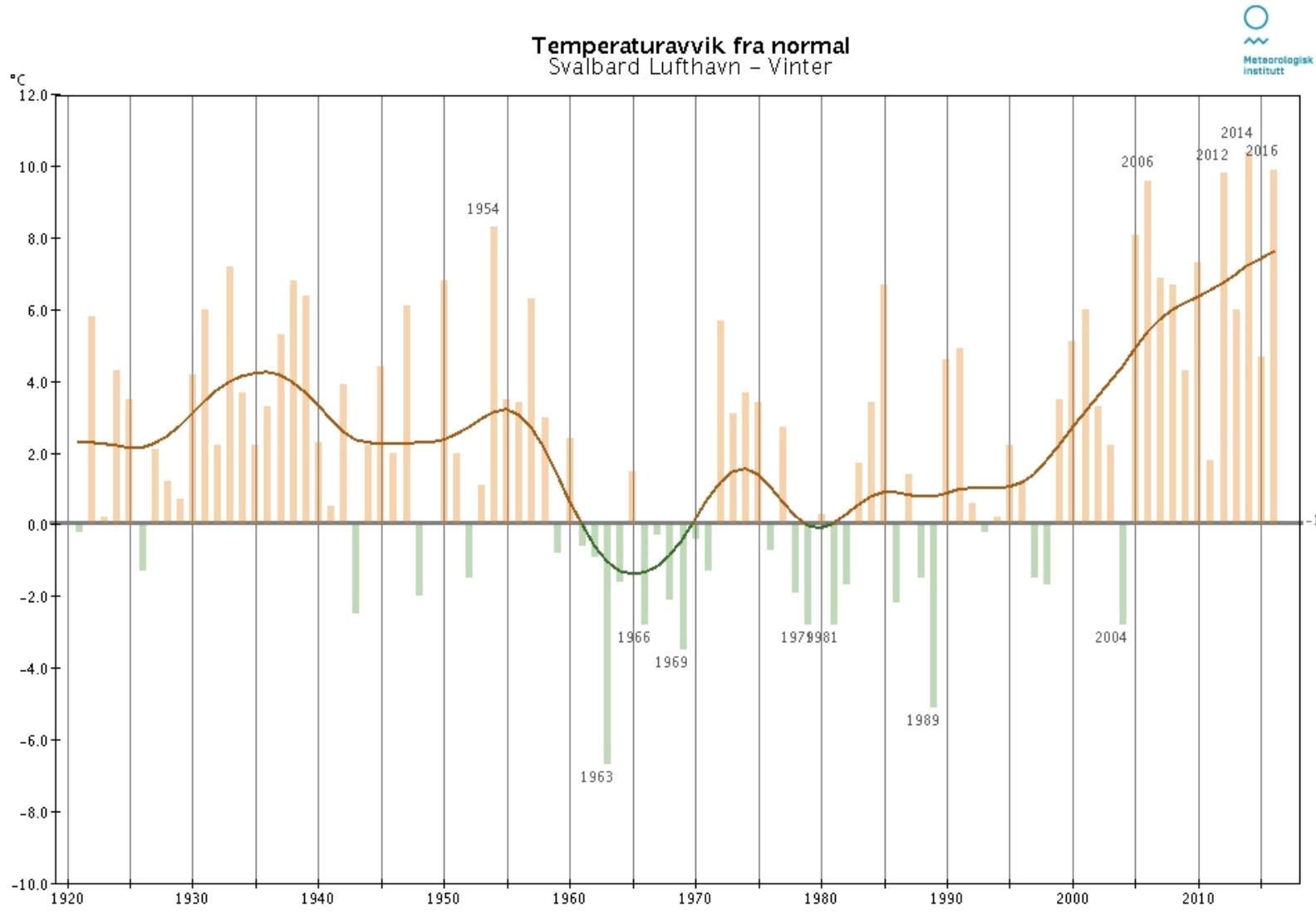
-6.7°C

Last 50 years: increase **3.2 degrees**, trend = **0.65 degrees per decade**.

1920

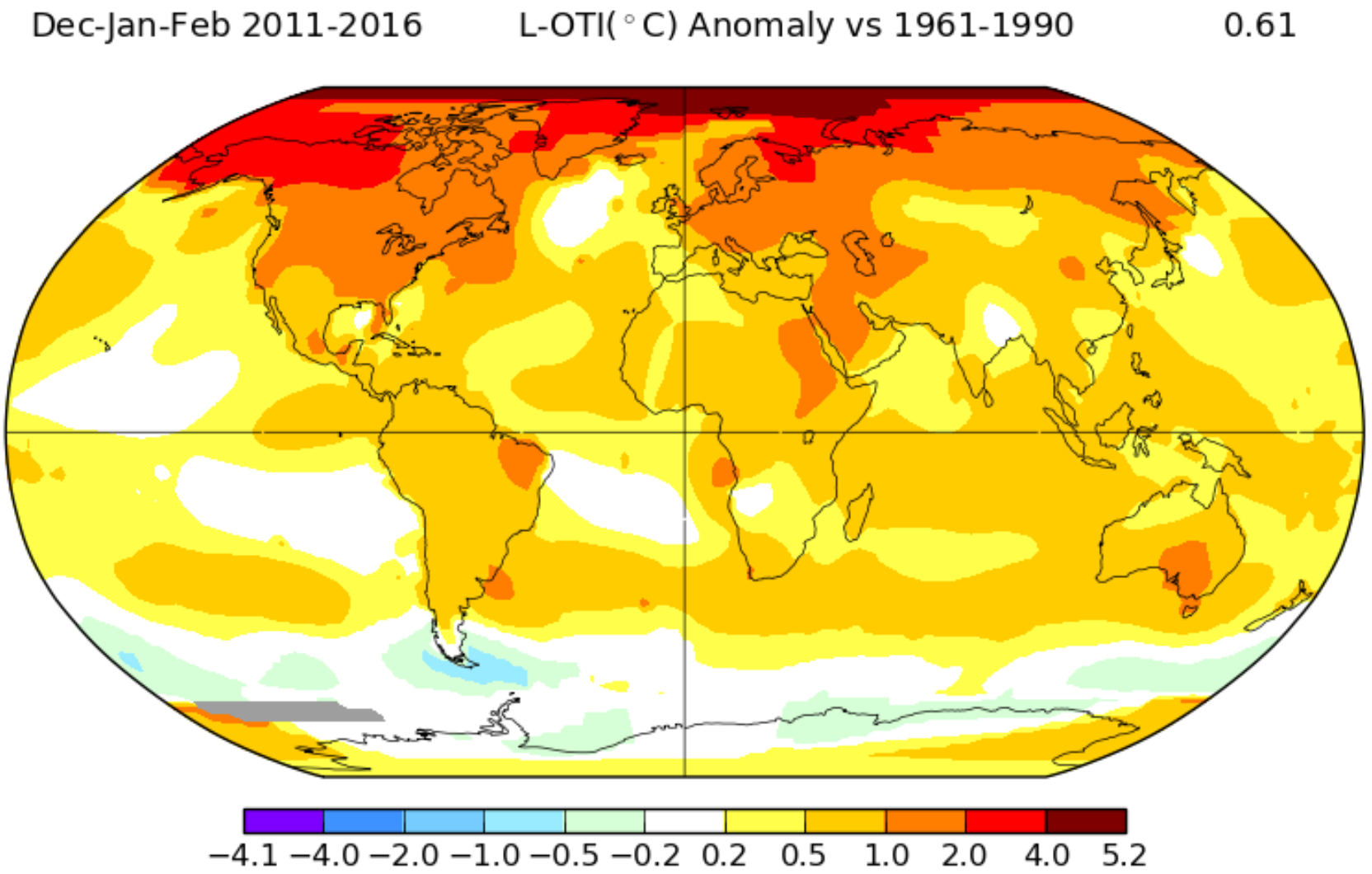
The temperature increase at Svalbard is highest during the winter season
The variability is large due to the strong influence of the sea-ice

+12°C



-15°C

During the last decades, the Arctic has warmed twice as much as the global mean, mainly due to feedbacks in the system



You can make this plot on your own here: http://data.giss.nasa.gov/gistemp/maps/

Long-term change in summer Arctic air temperatures, as estimated from lake sediments, ice cores and tree rings ('proxy' records)

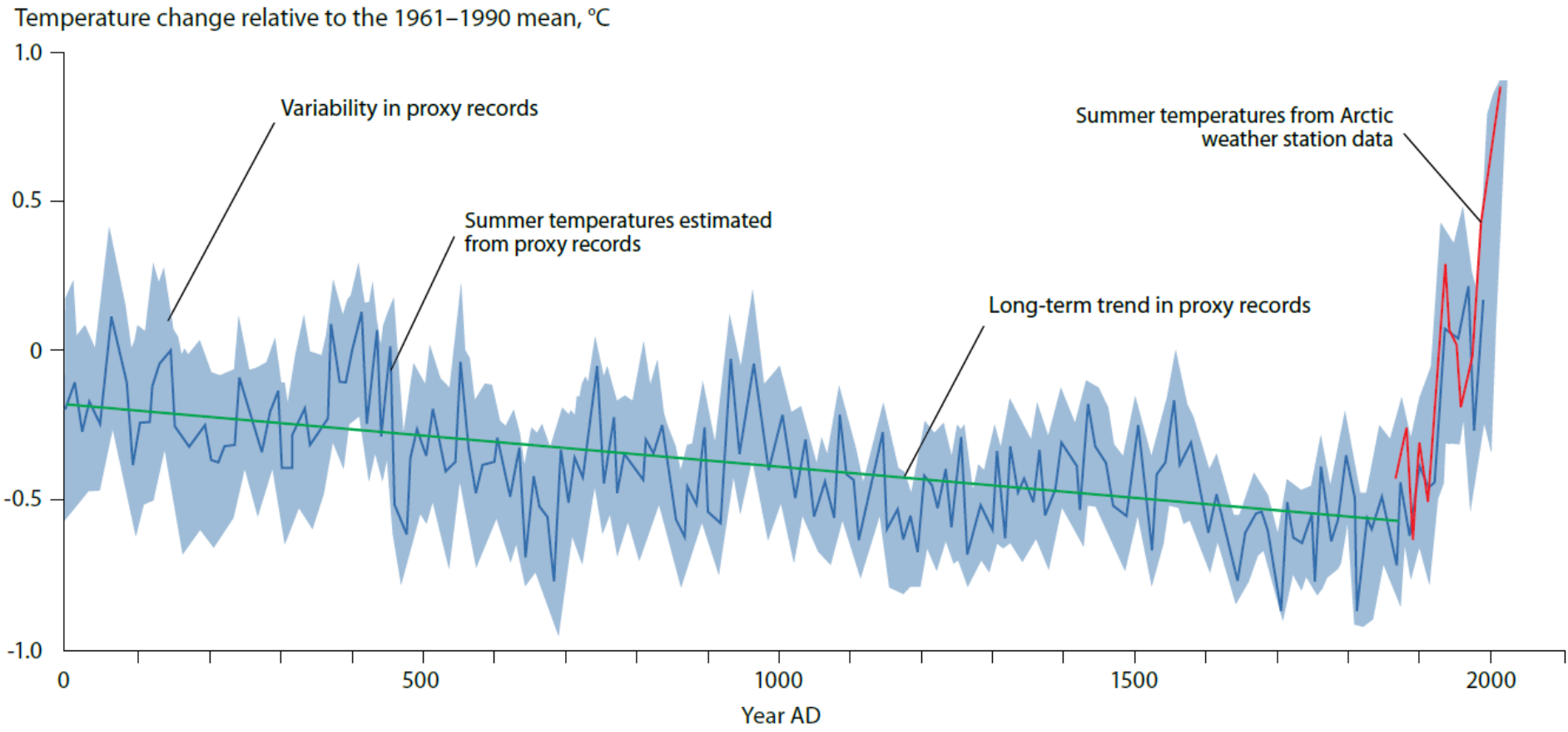
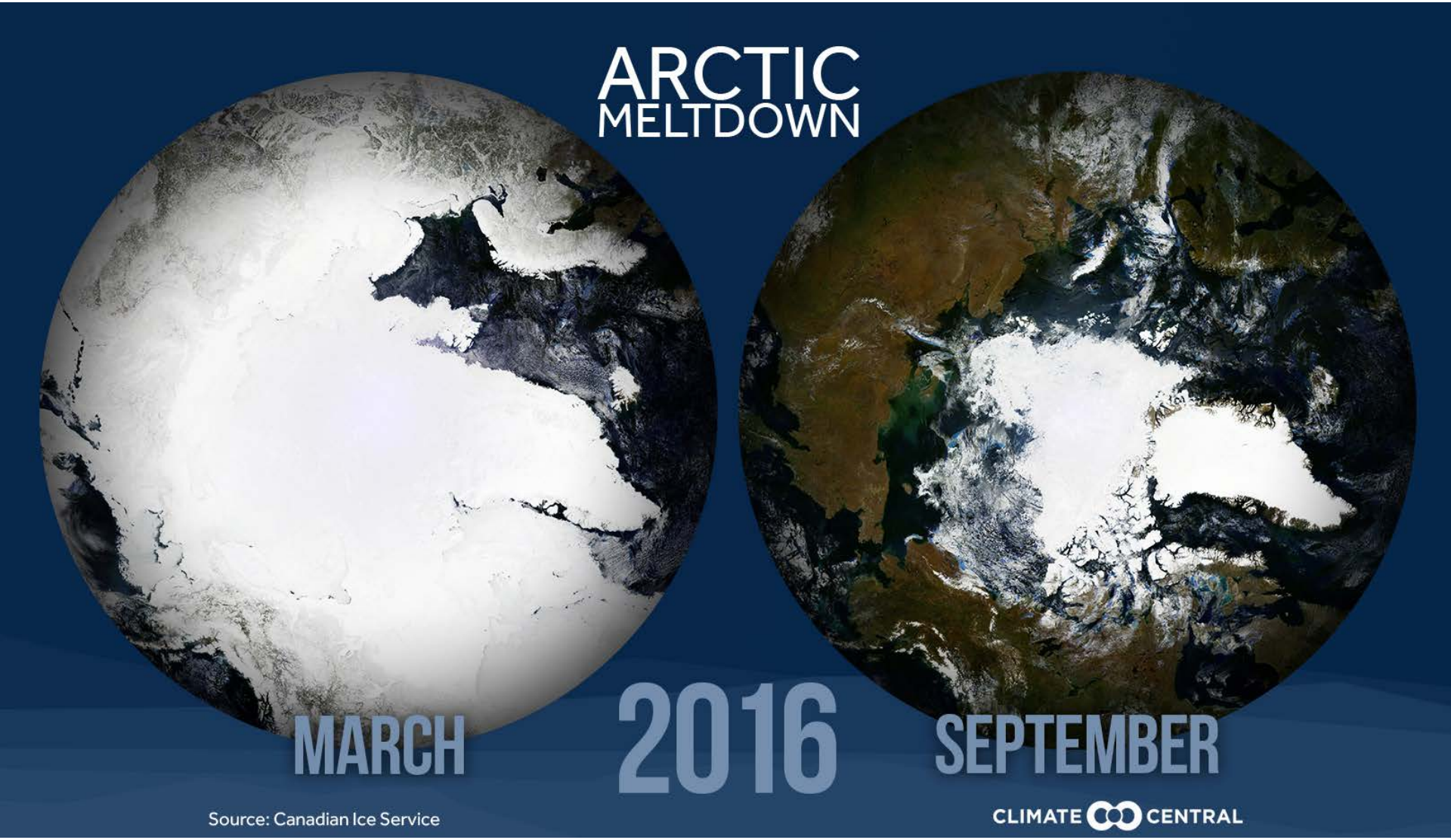
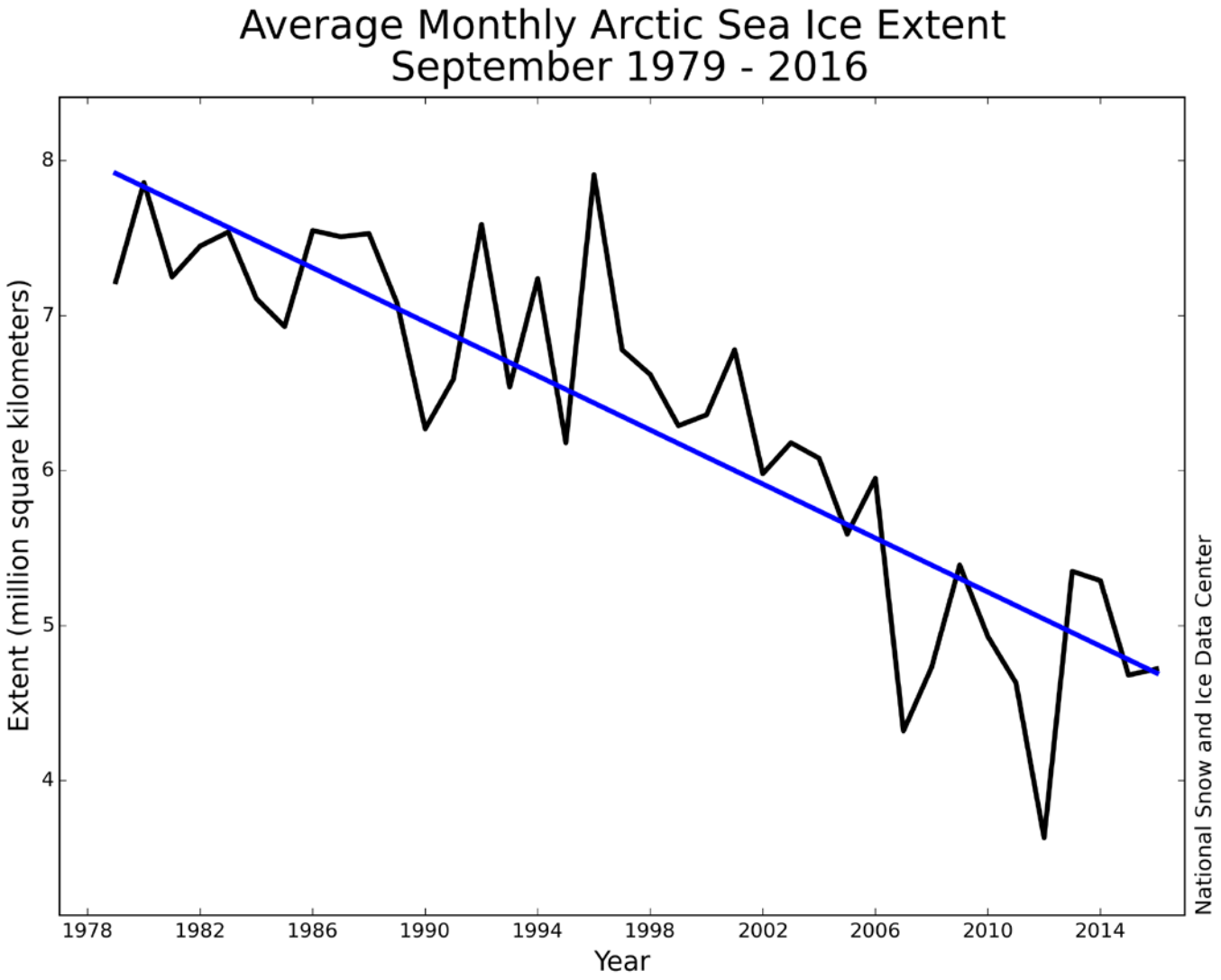


Figure: SWIPA (http://www.amap.no)

The sea ice reaches its minimum thickness and extent in September – is roughly half the size of the winter maximum

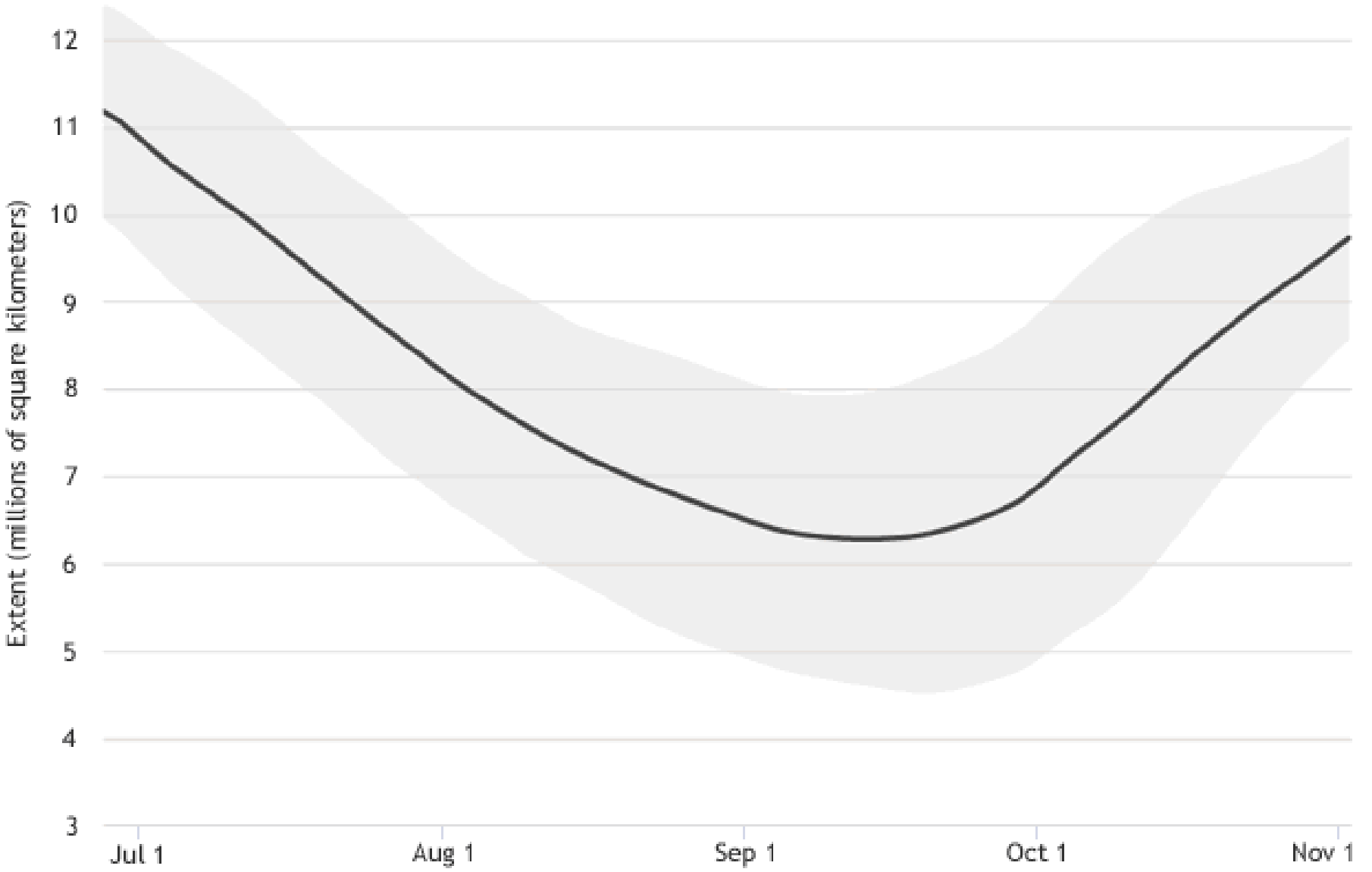


Monthly September ice extent for 1979 to 2016 shows a decline of 13.3% per decade



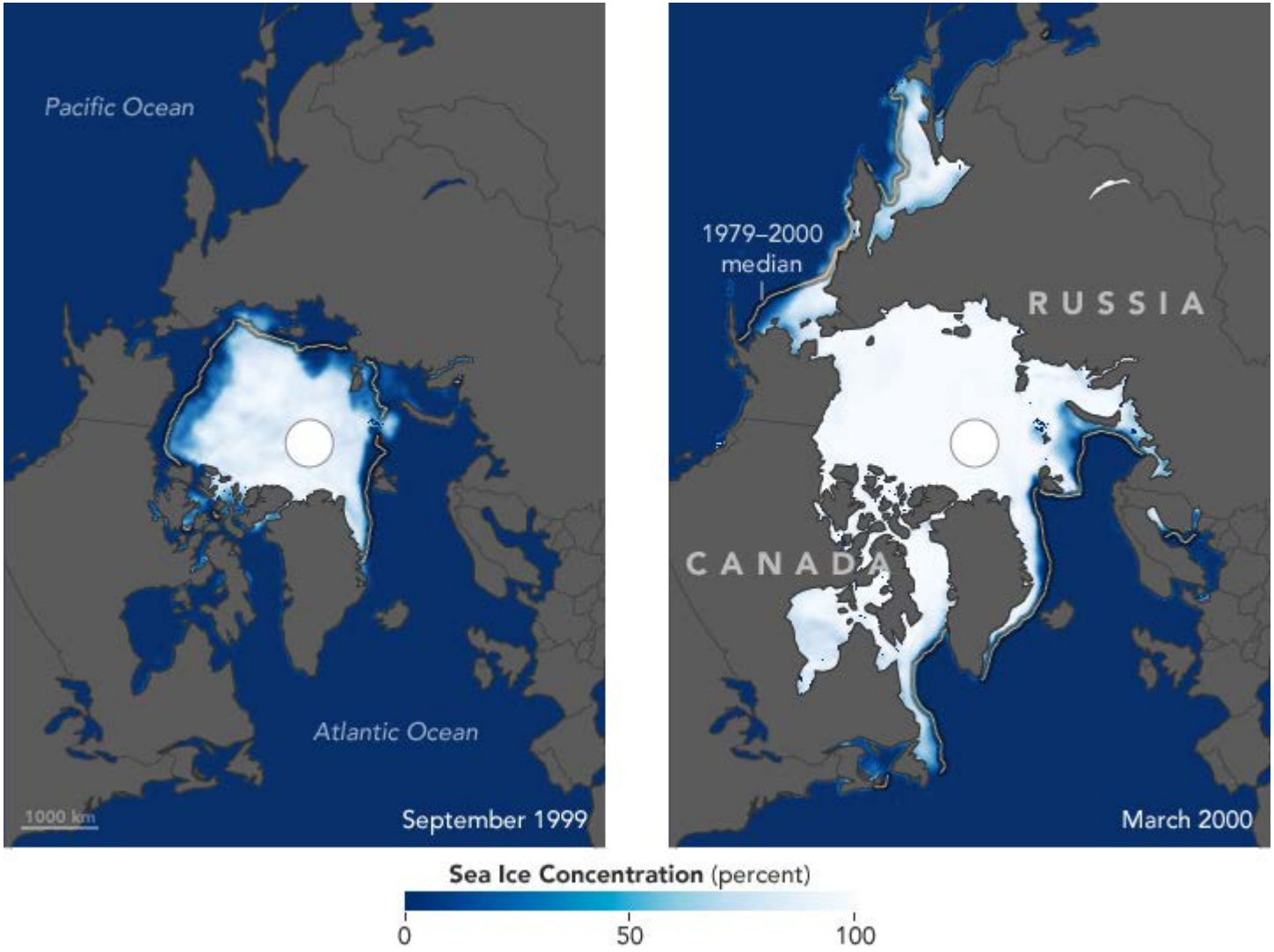
Credit: National Snow and Ice Data Center

Sea-ice extent 1979-2016



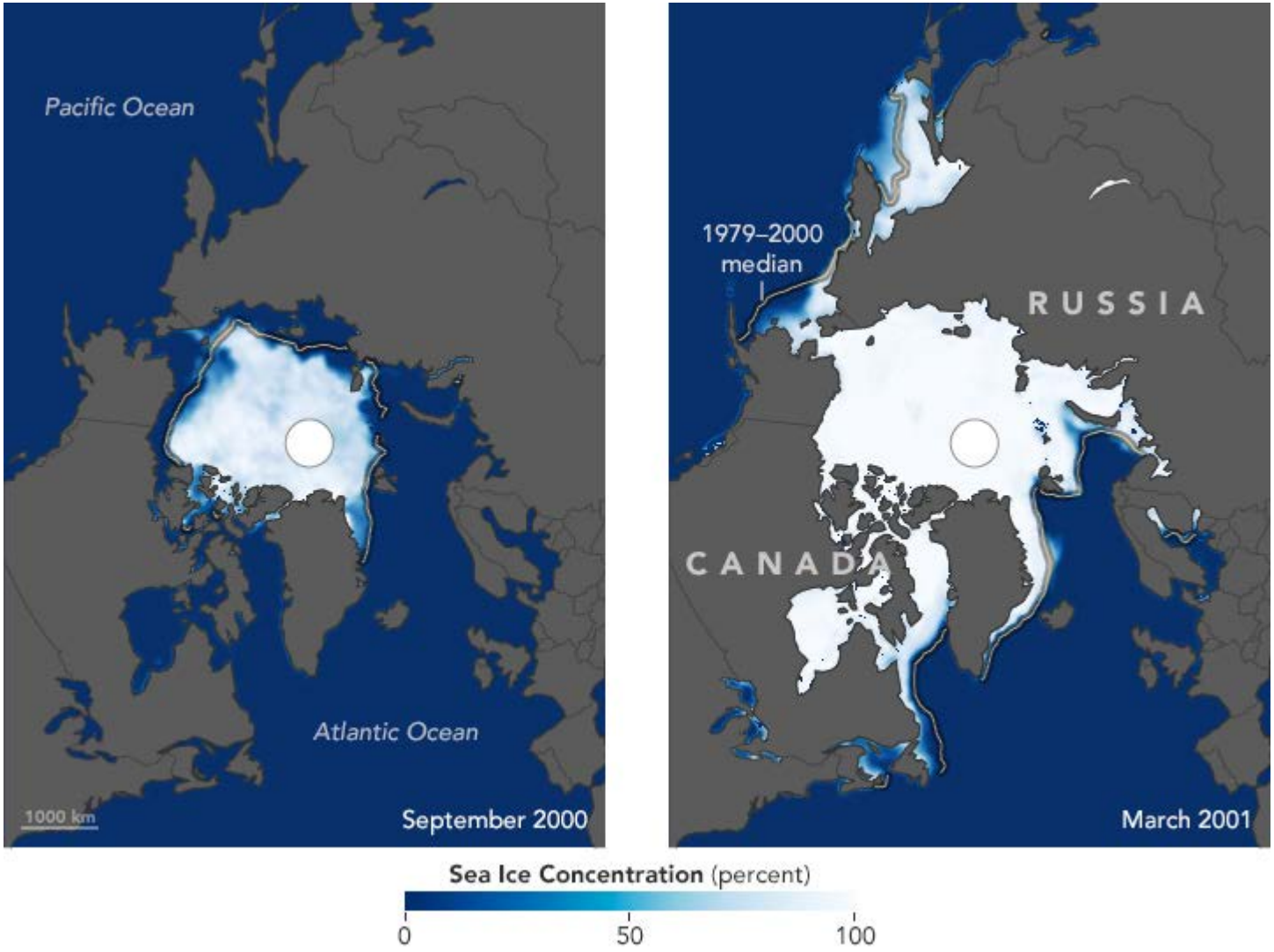
by Climate.gov, adapted from NSIDC's Charctic (http://nsidc.org/arcticseaicenews/charctic-interactive-sea-ice-graph/)

Sea-ice extend



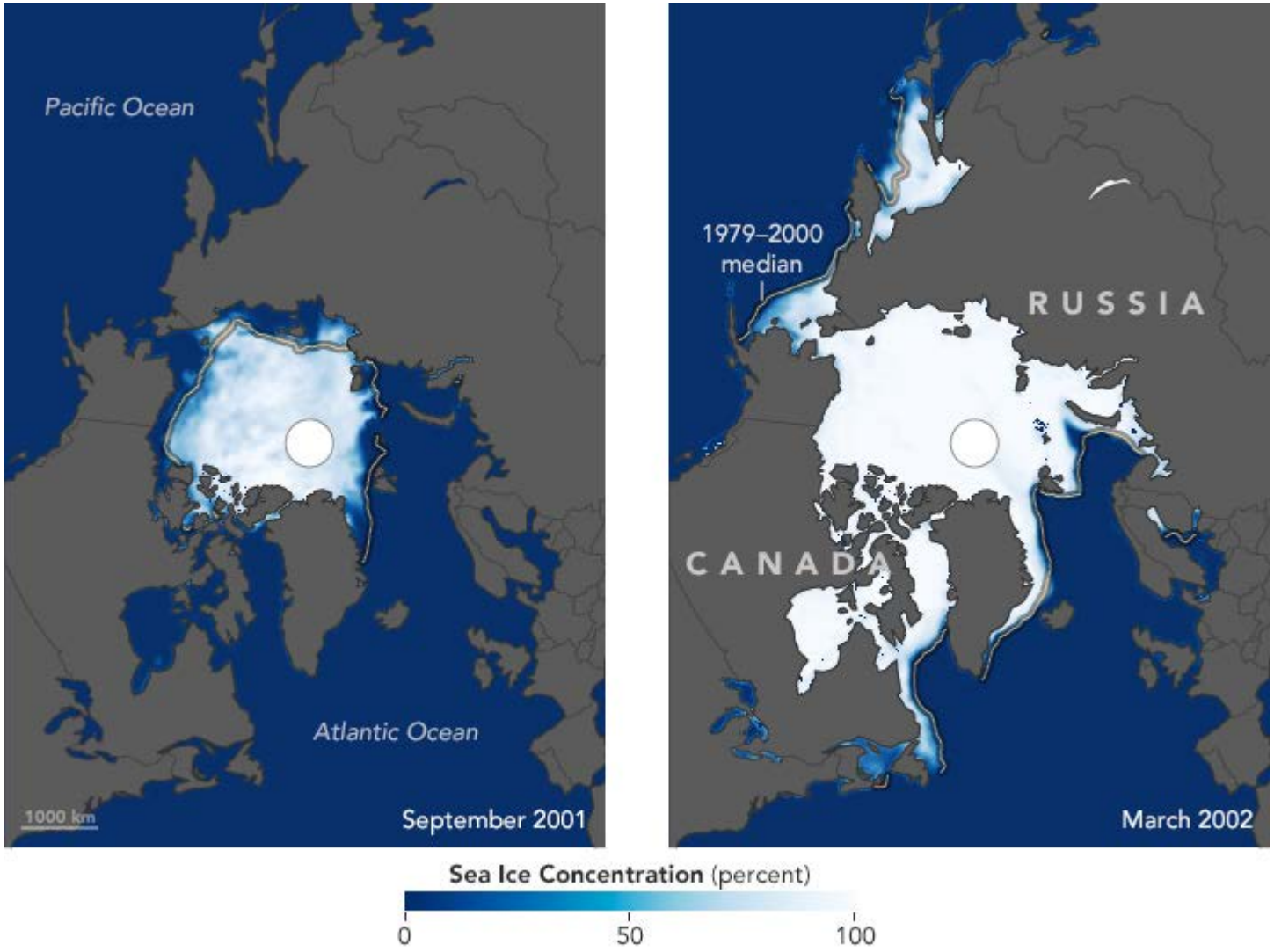
Yellow line: average 1979-2000

Sea-ice extend



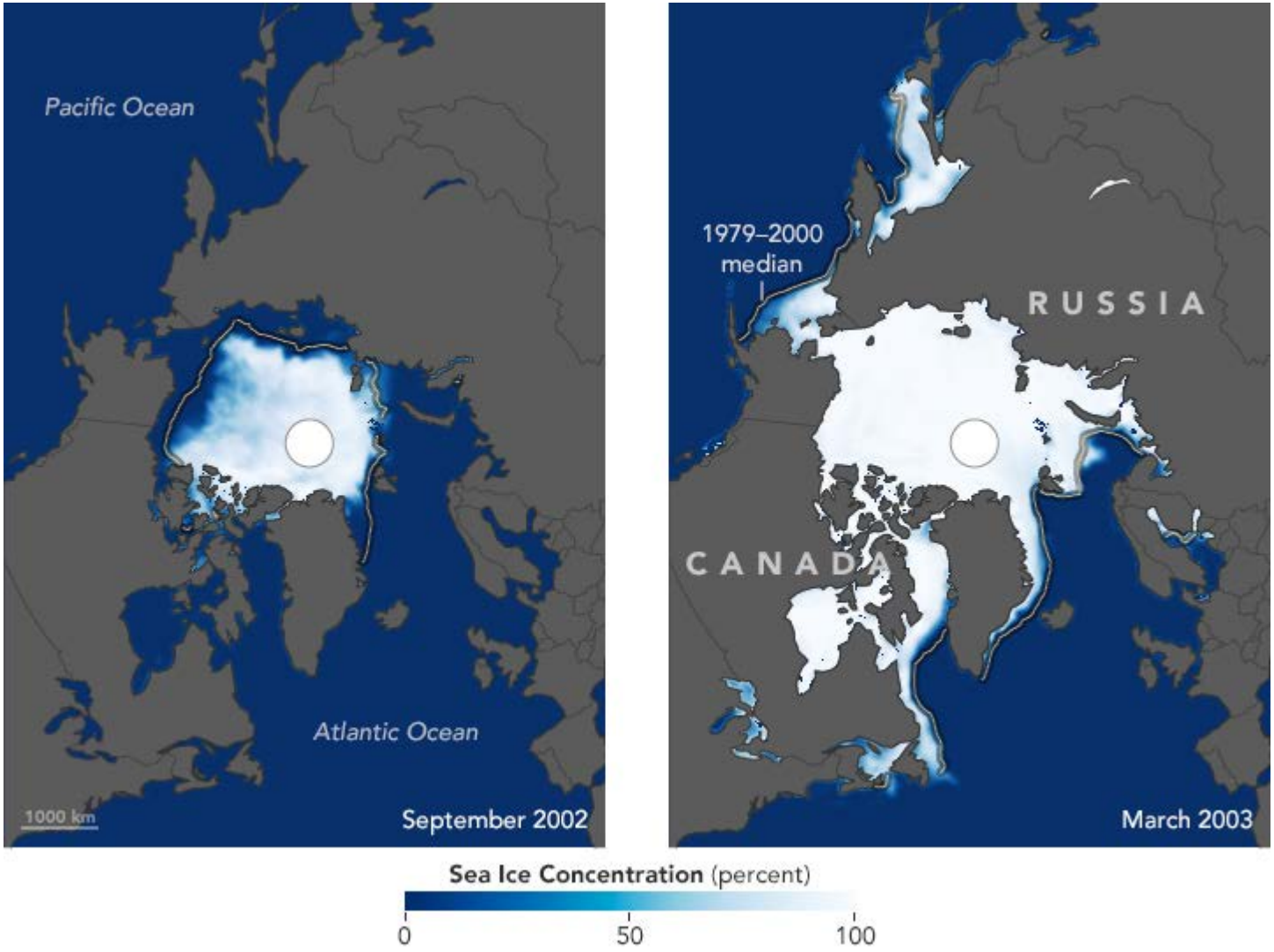
Yellow line: average 1979-2000

Sea-ice extend



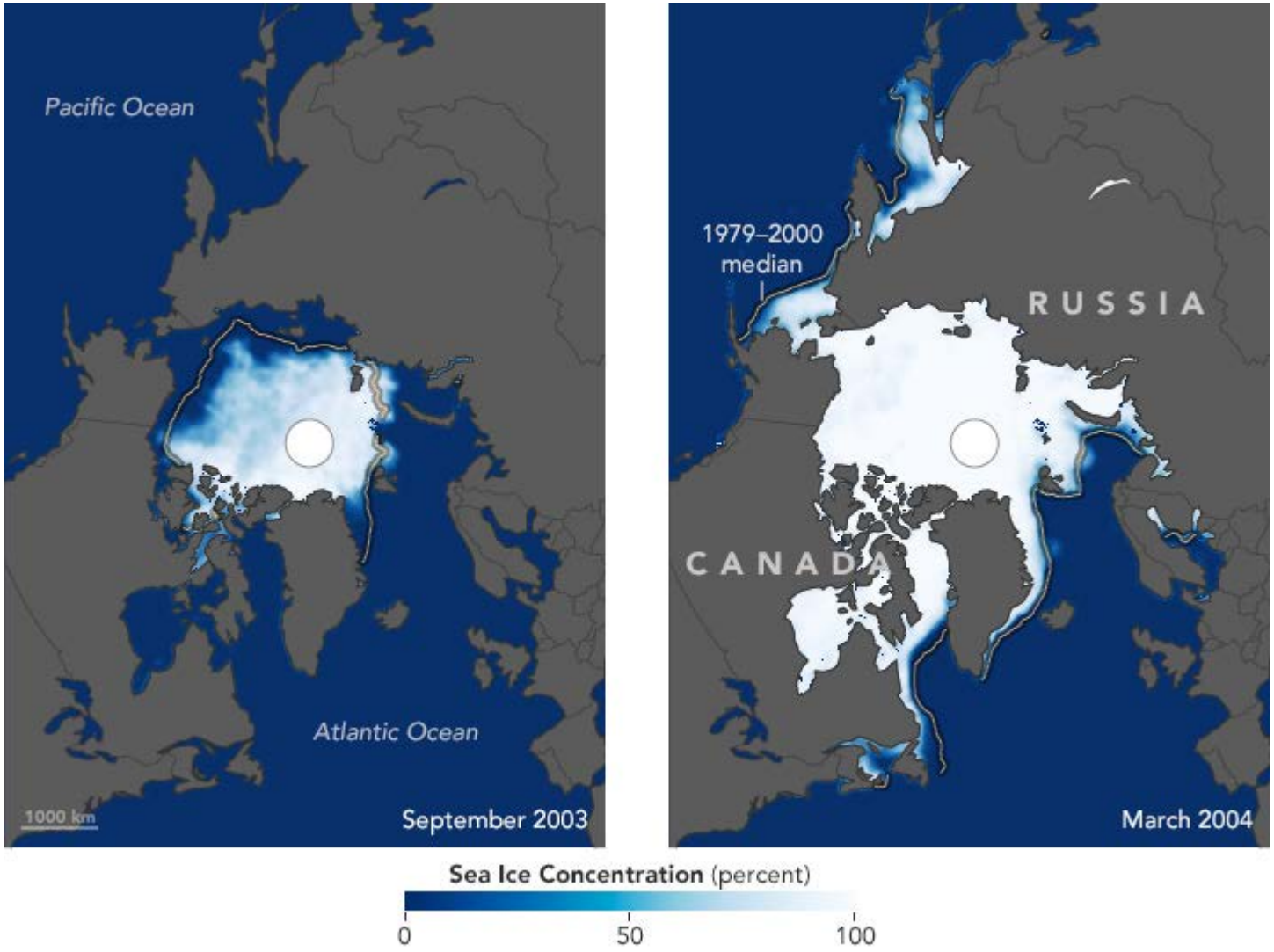
Yellow line: average 1979-2000

Sea-ice extend



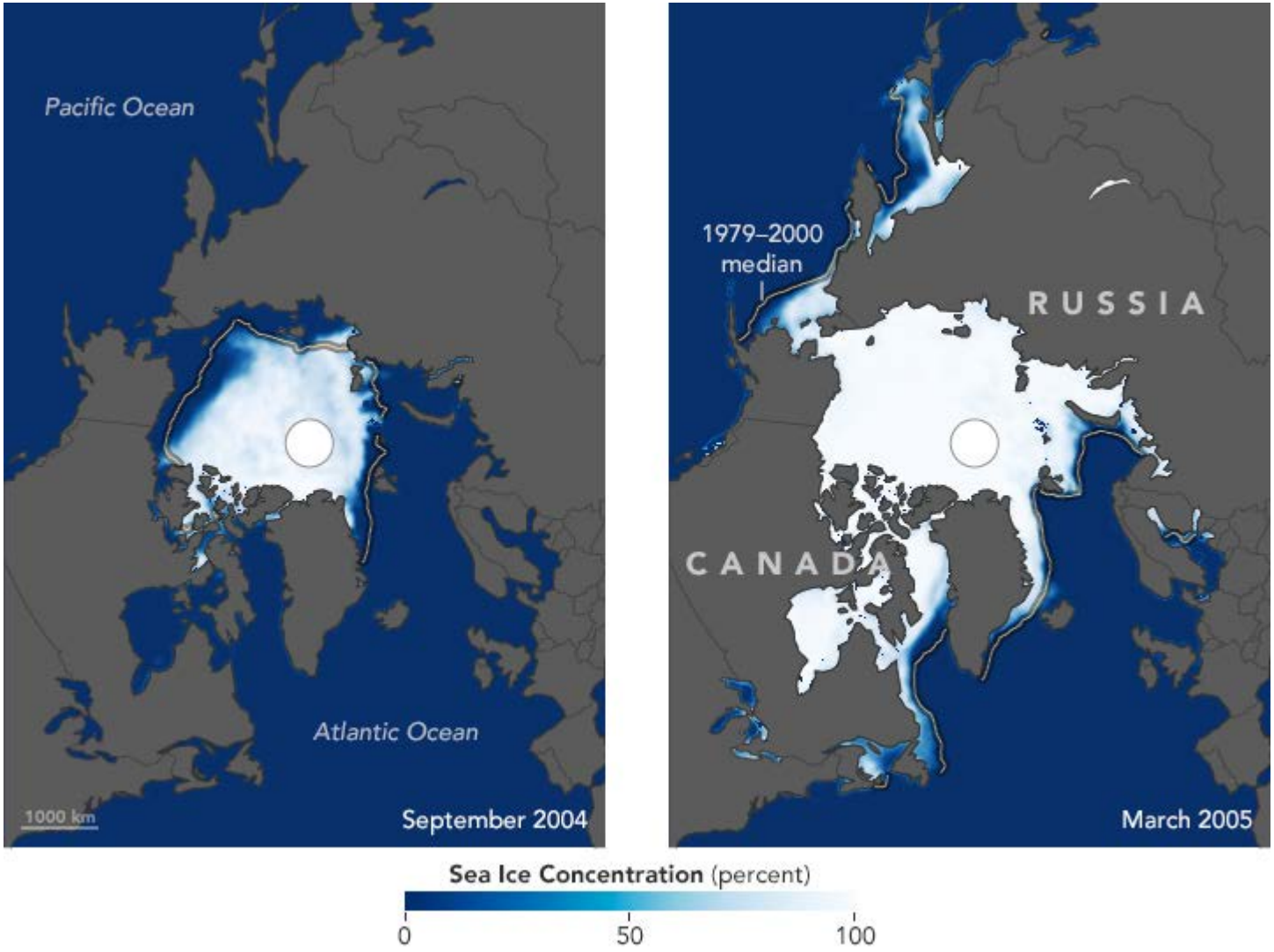
Yellow line: average 1979-2000

Sea-ice extend



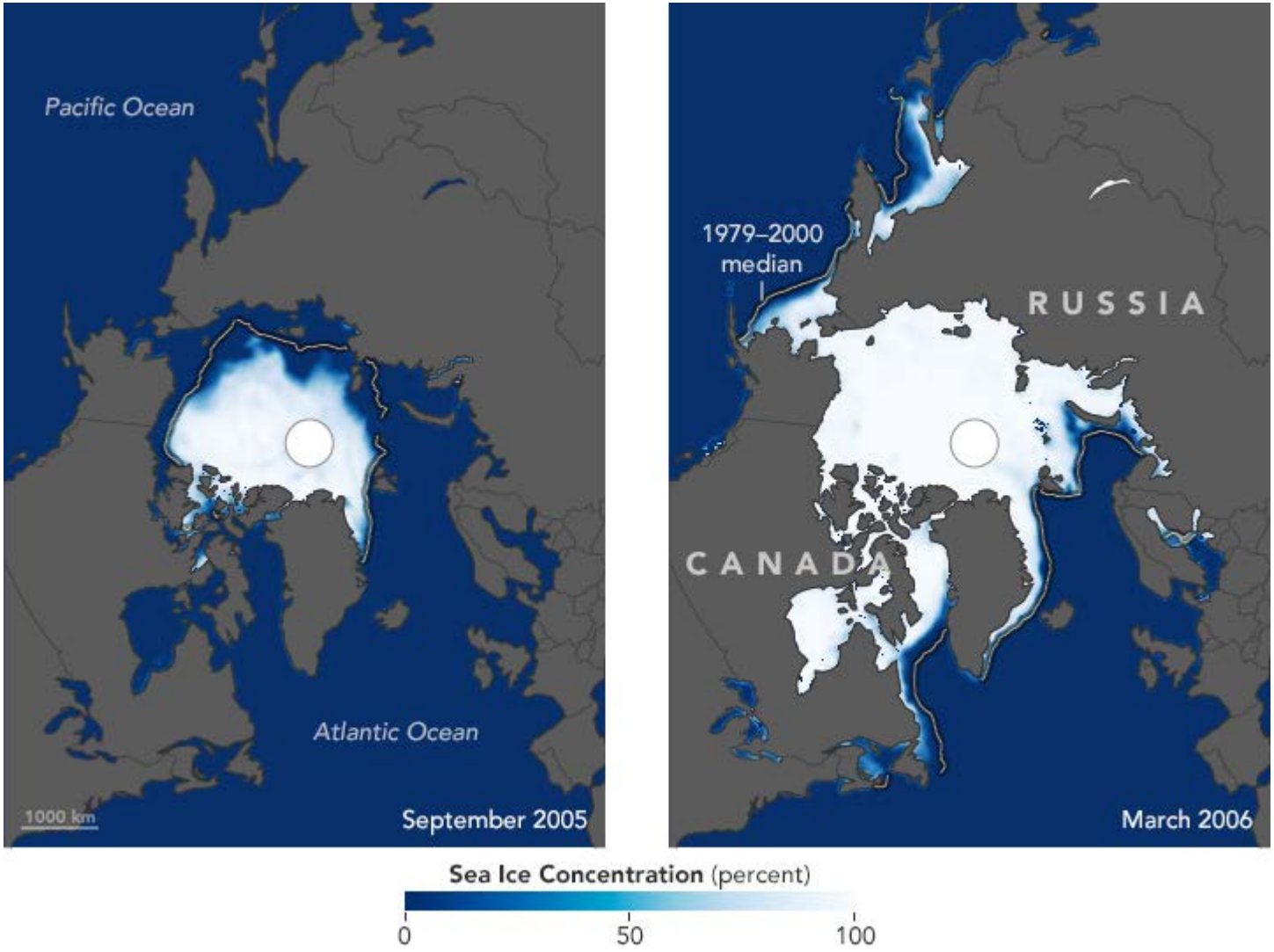
Yellow line: average 1979-2000

Sea-ice extend



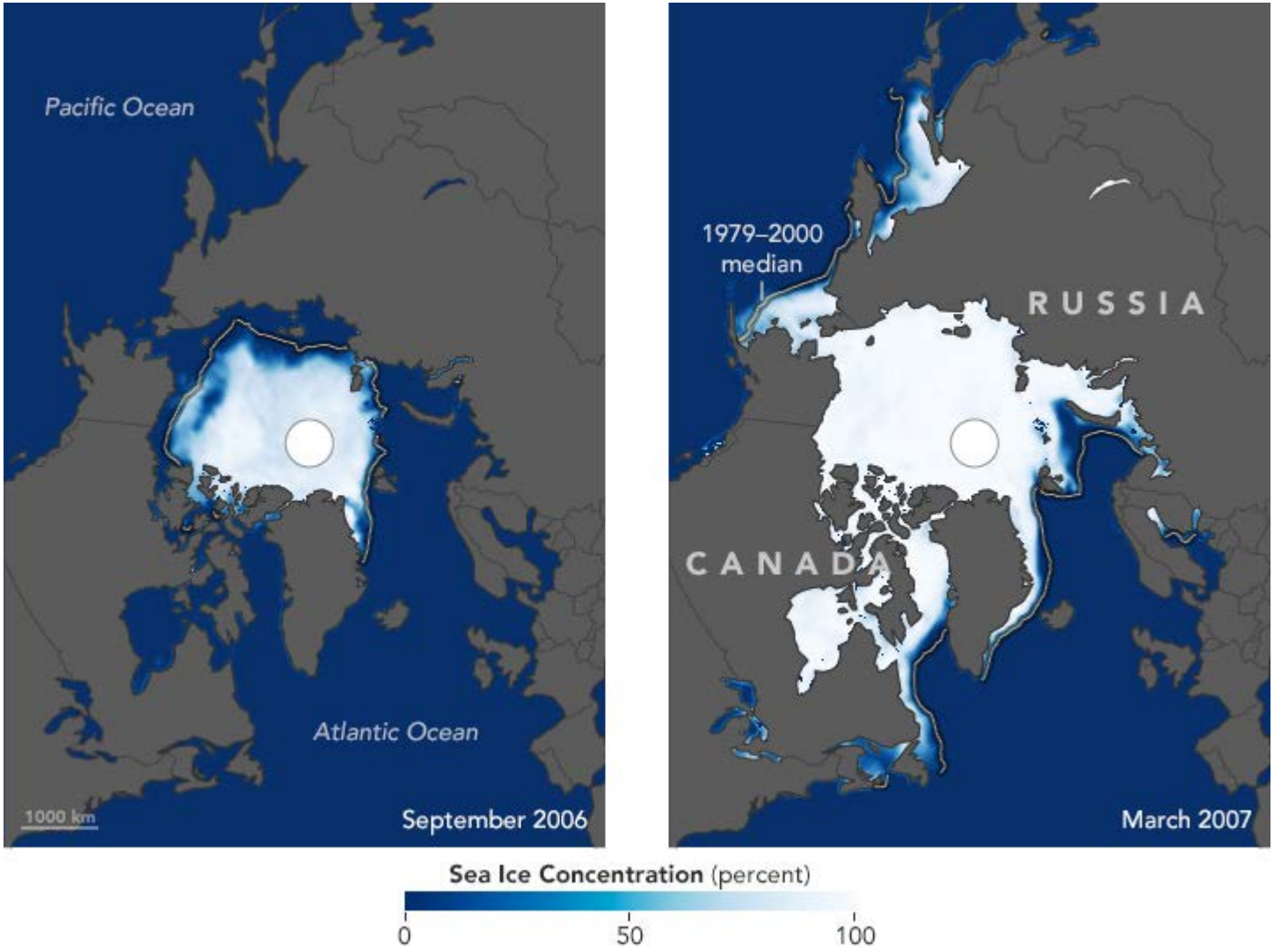
Yellow line: average 1979-2000

Sea-ice extend



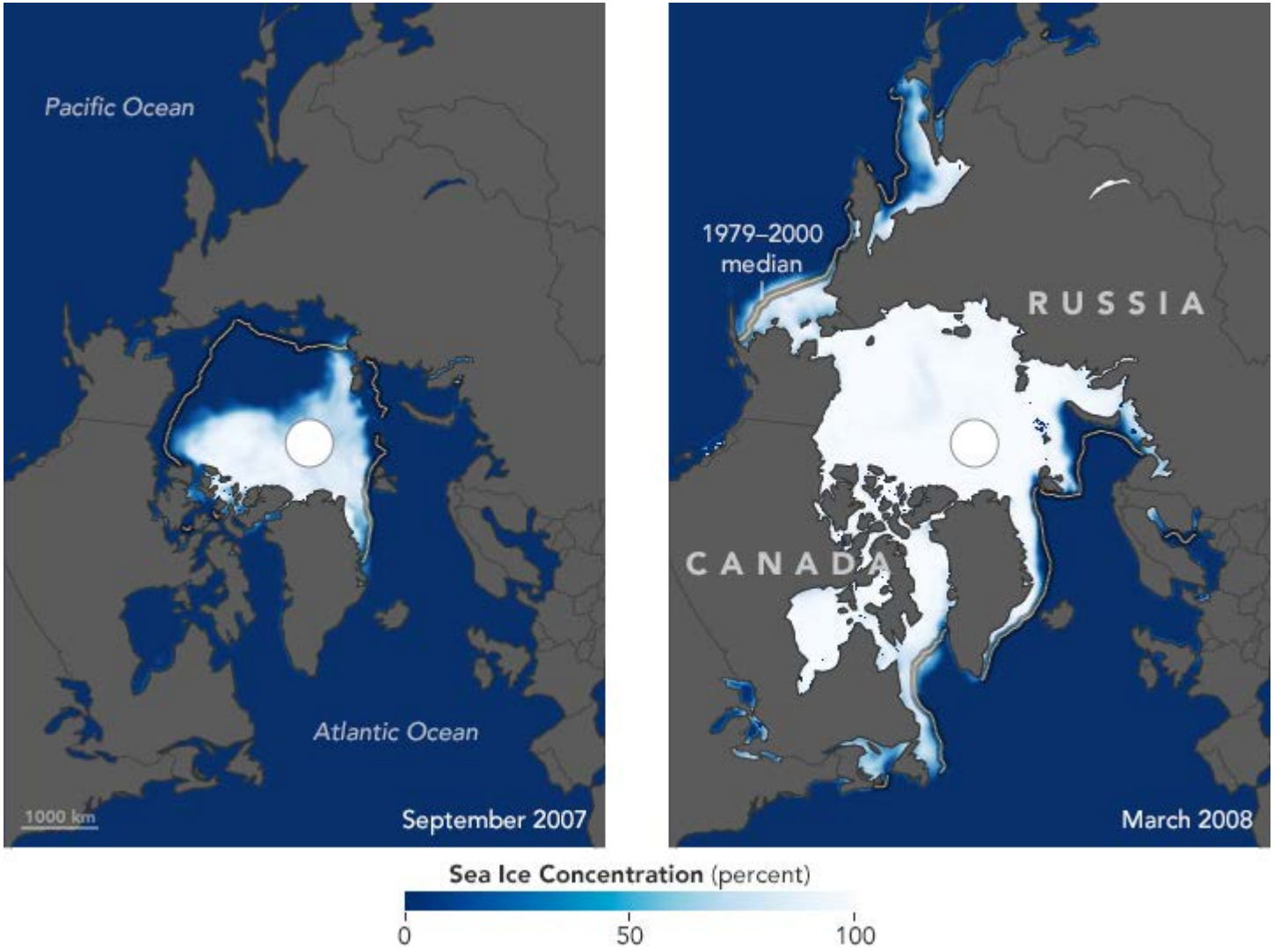
Yellow line: average 1979-2000

Sea-ice extend



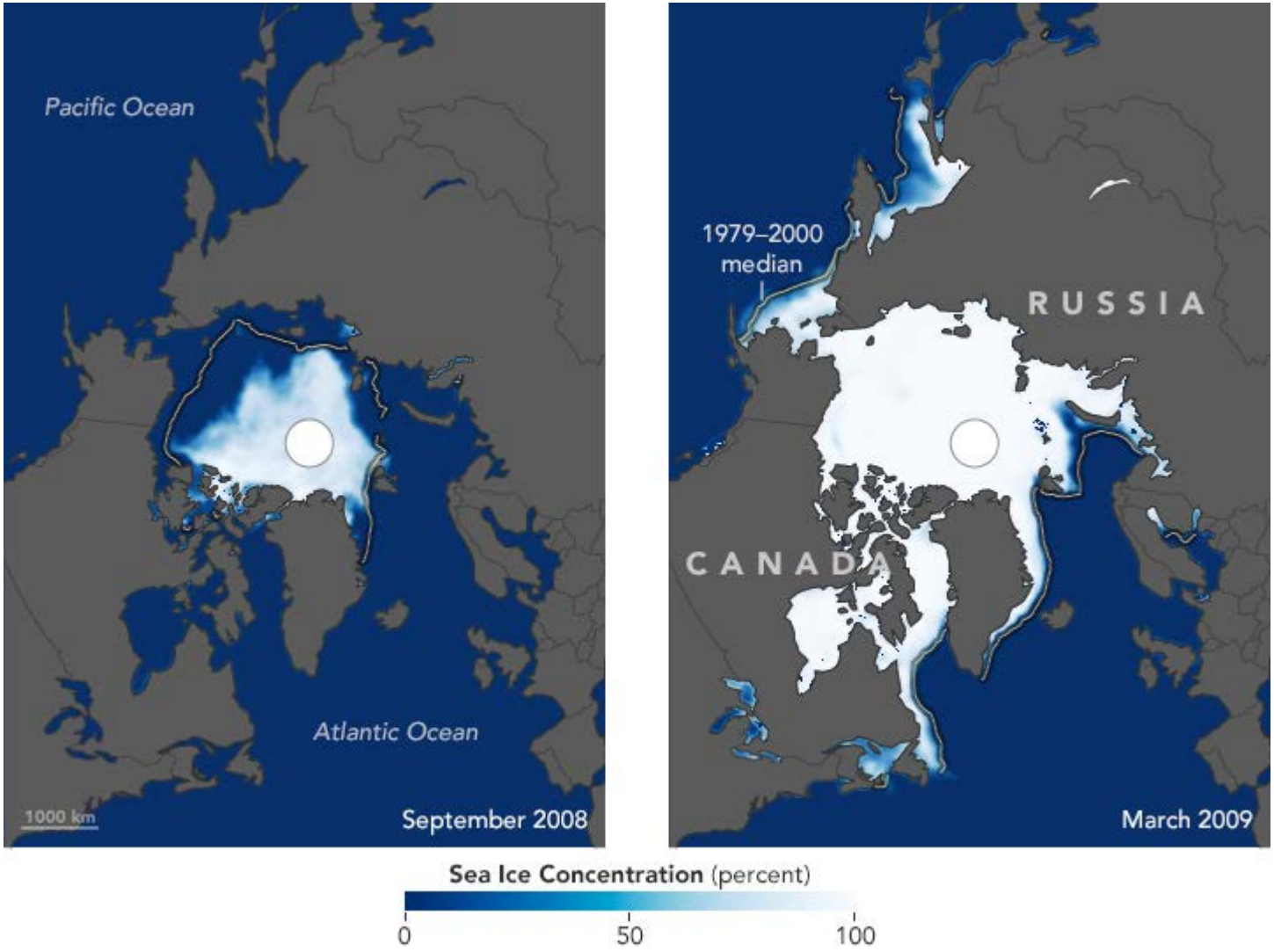
Yellow line: average 1979-2000

Sea-ice extend



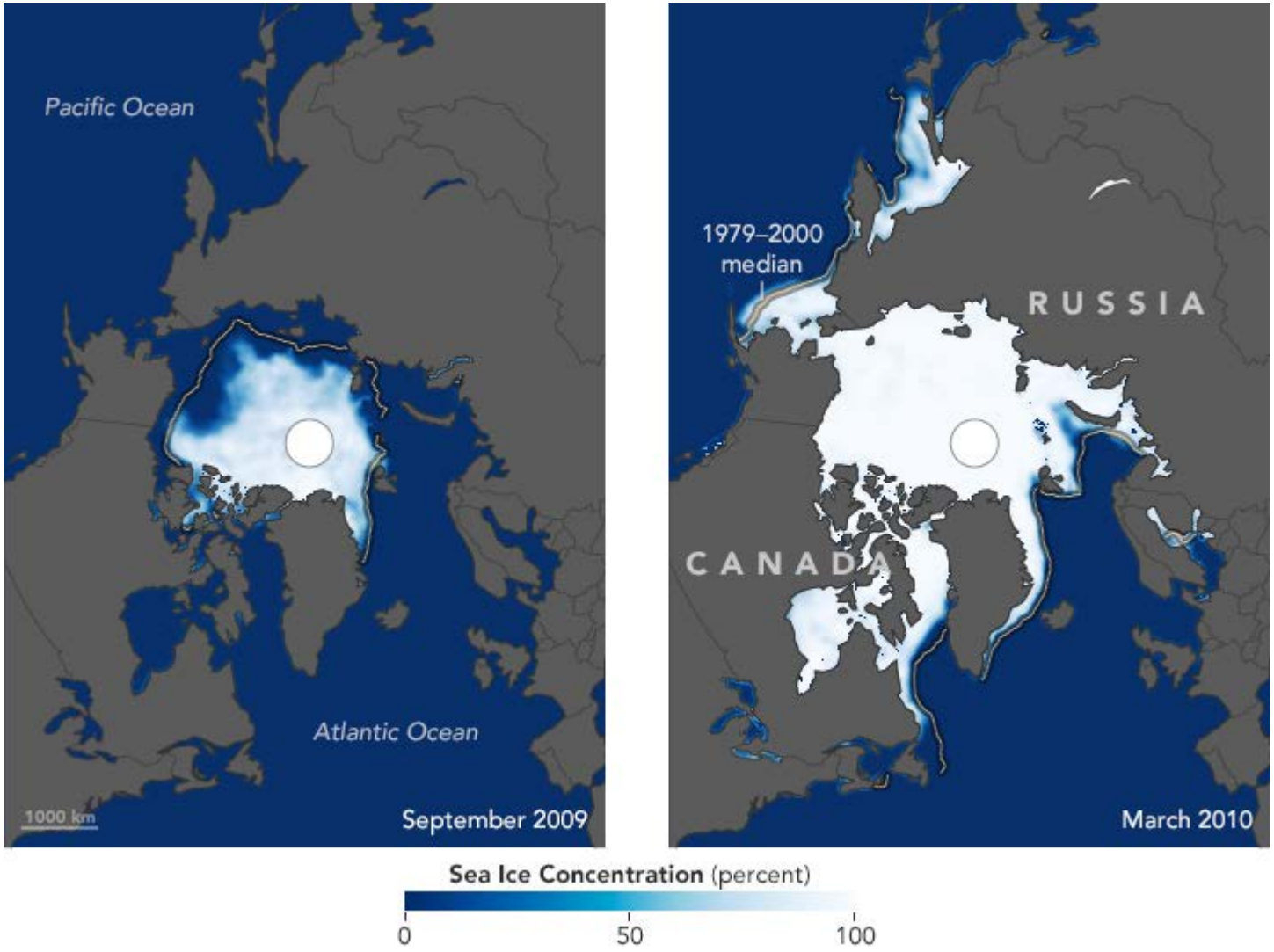
Yellow line: average 1979-2000

Sea-ice extend



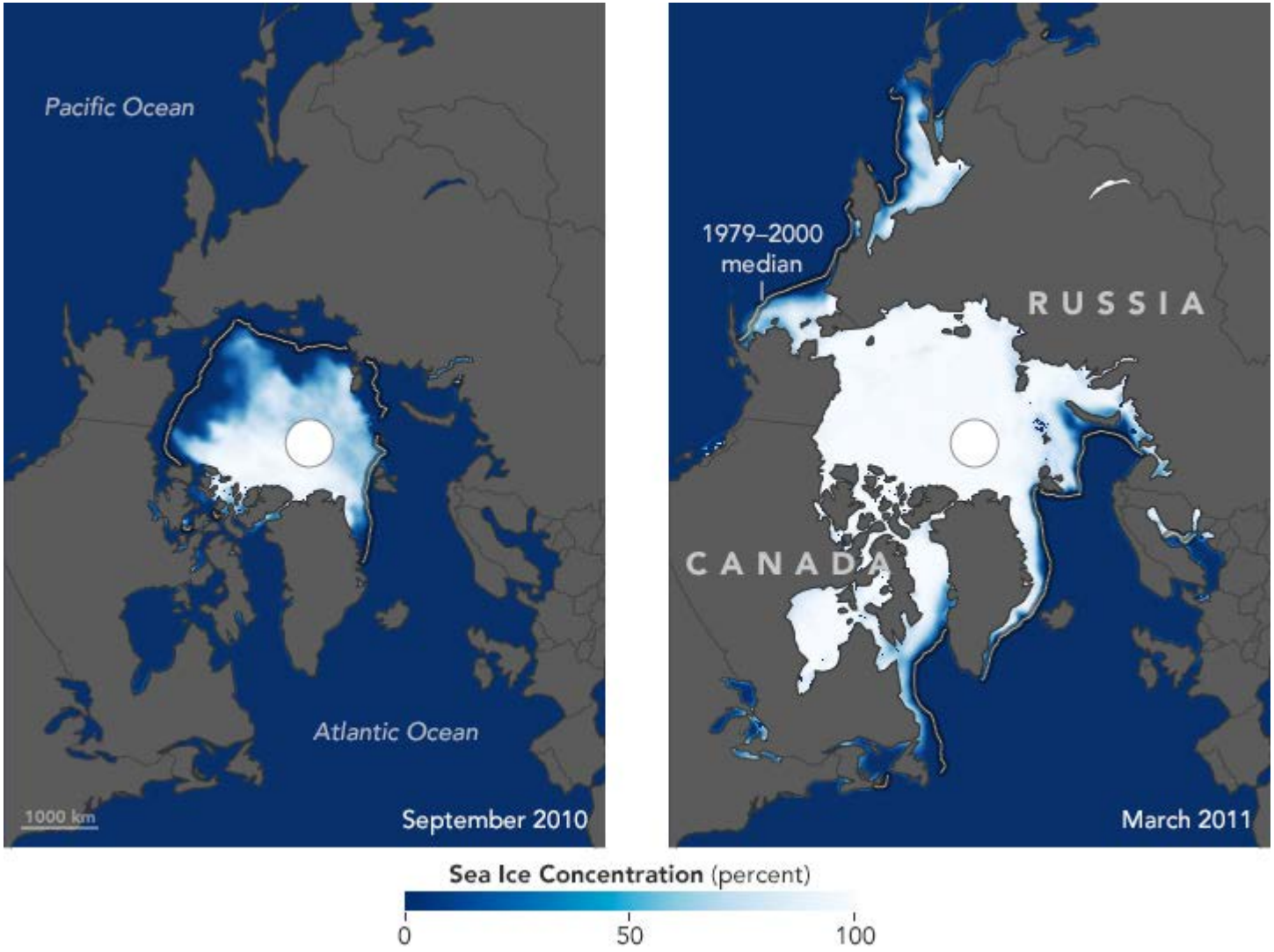
Yellow line: average 1979-2000

Sea-ice extend



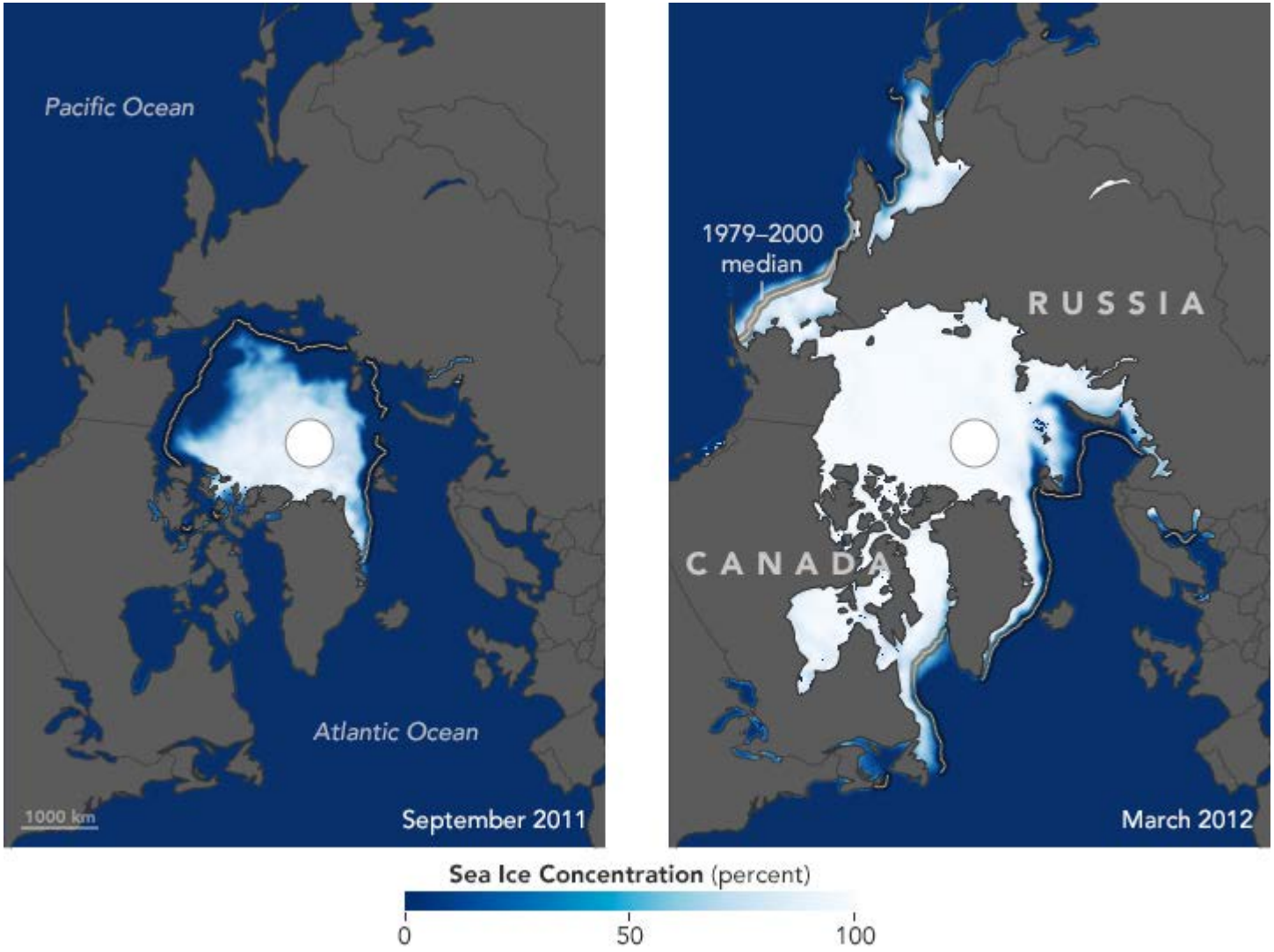
Yellow line: average 1979-2000

Sea-ice extend



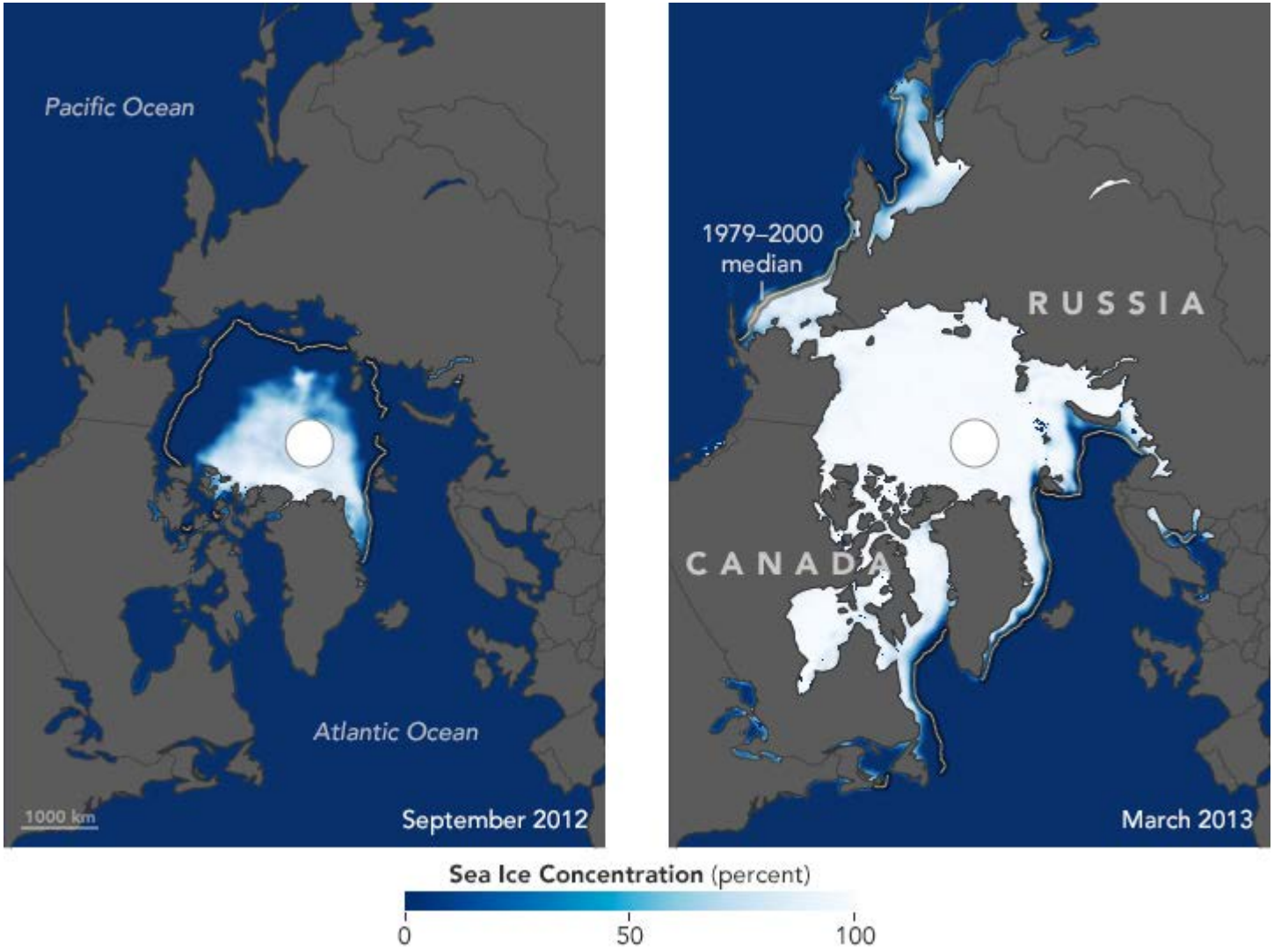
Yellow line: average 1979-2000

Sea-ice extend



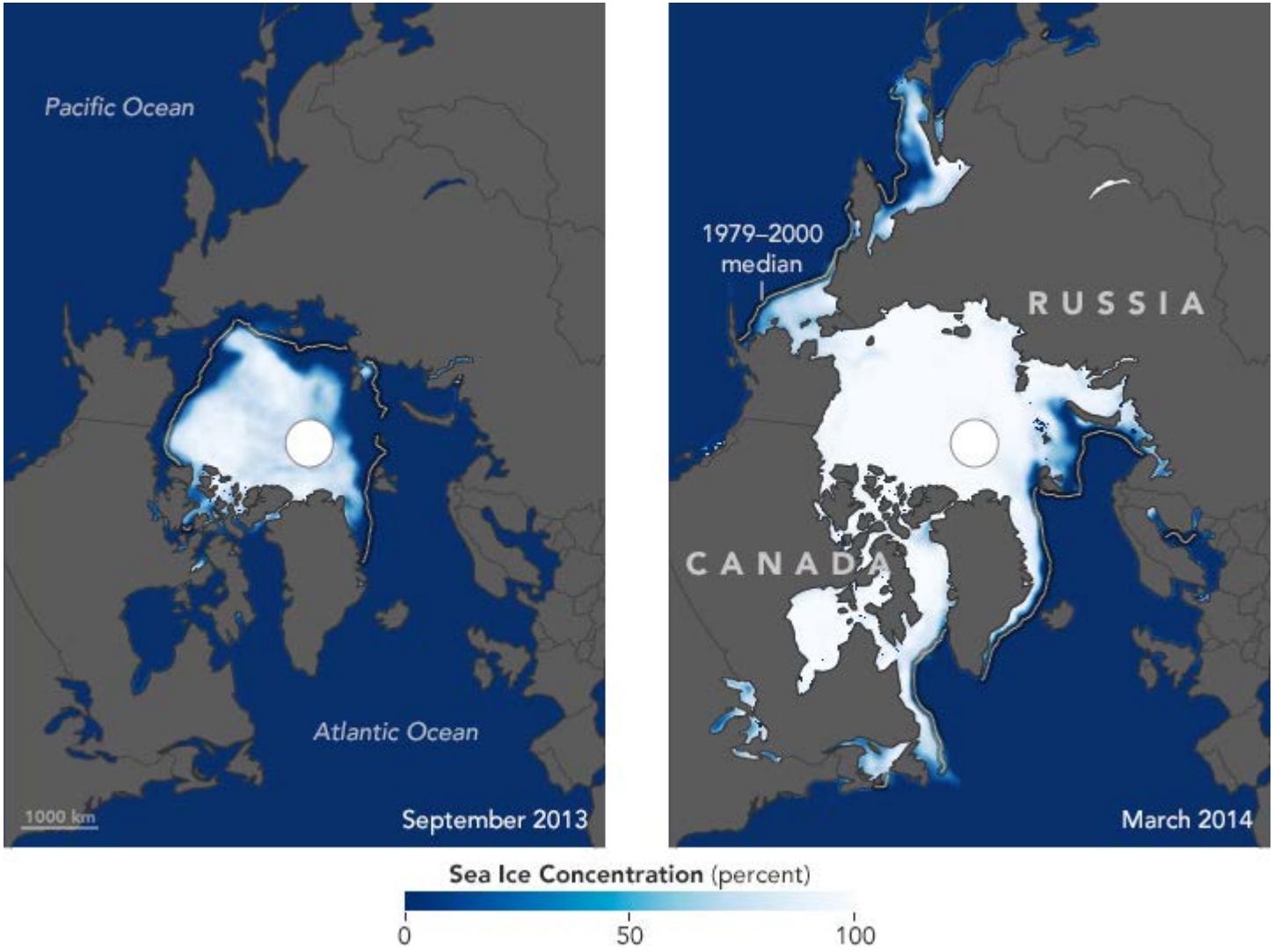
Yellow line: average 1979-2000

Sea-ice extend



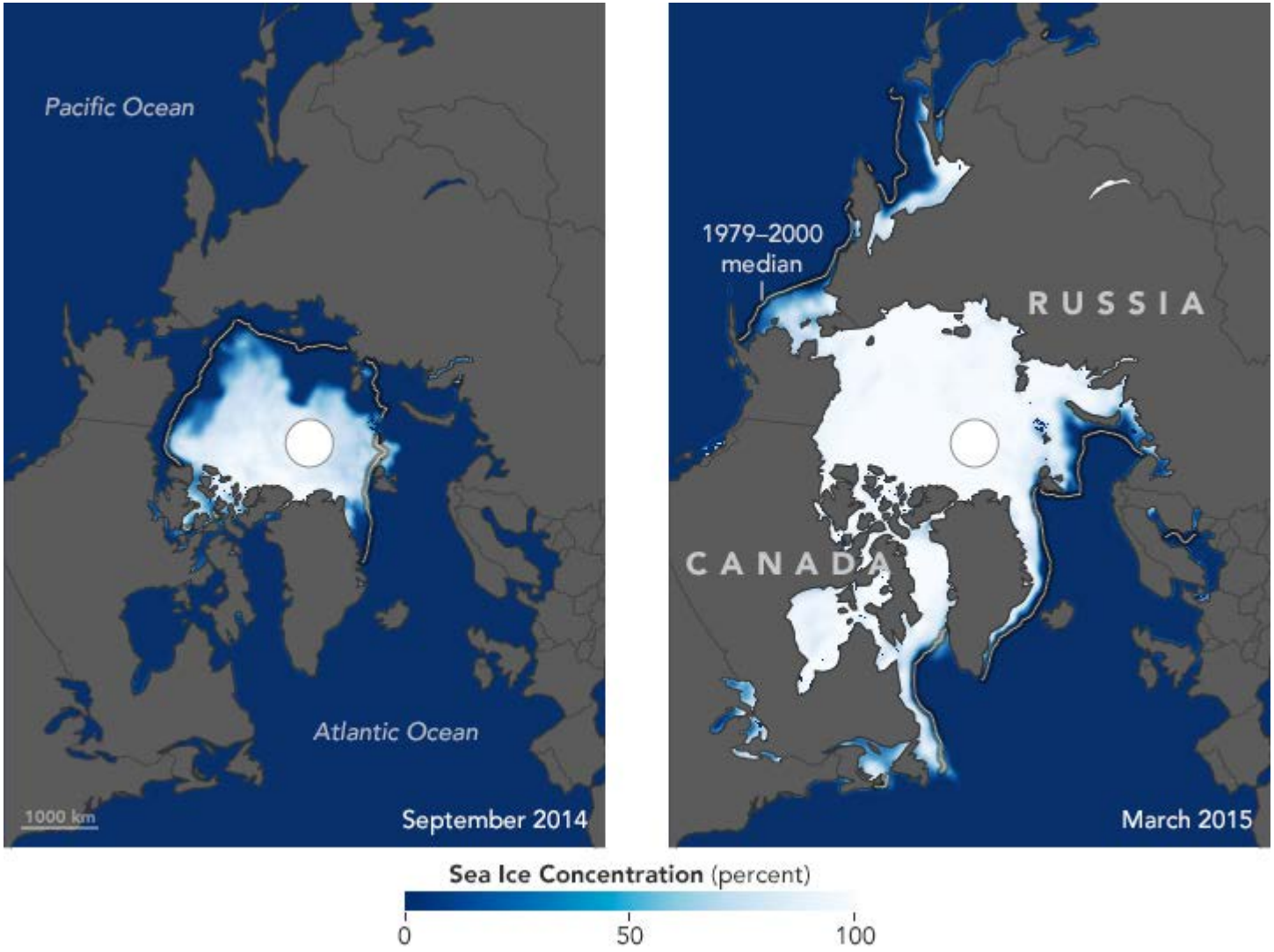
Yellow line: average 1979-2000

Sea-ice extend



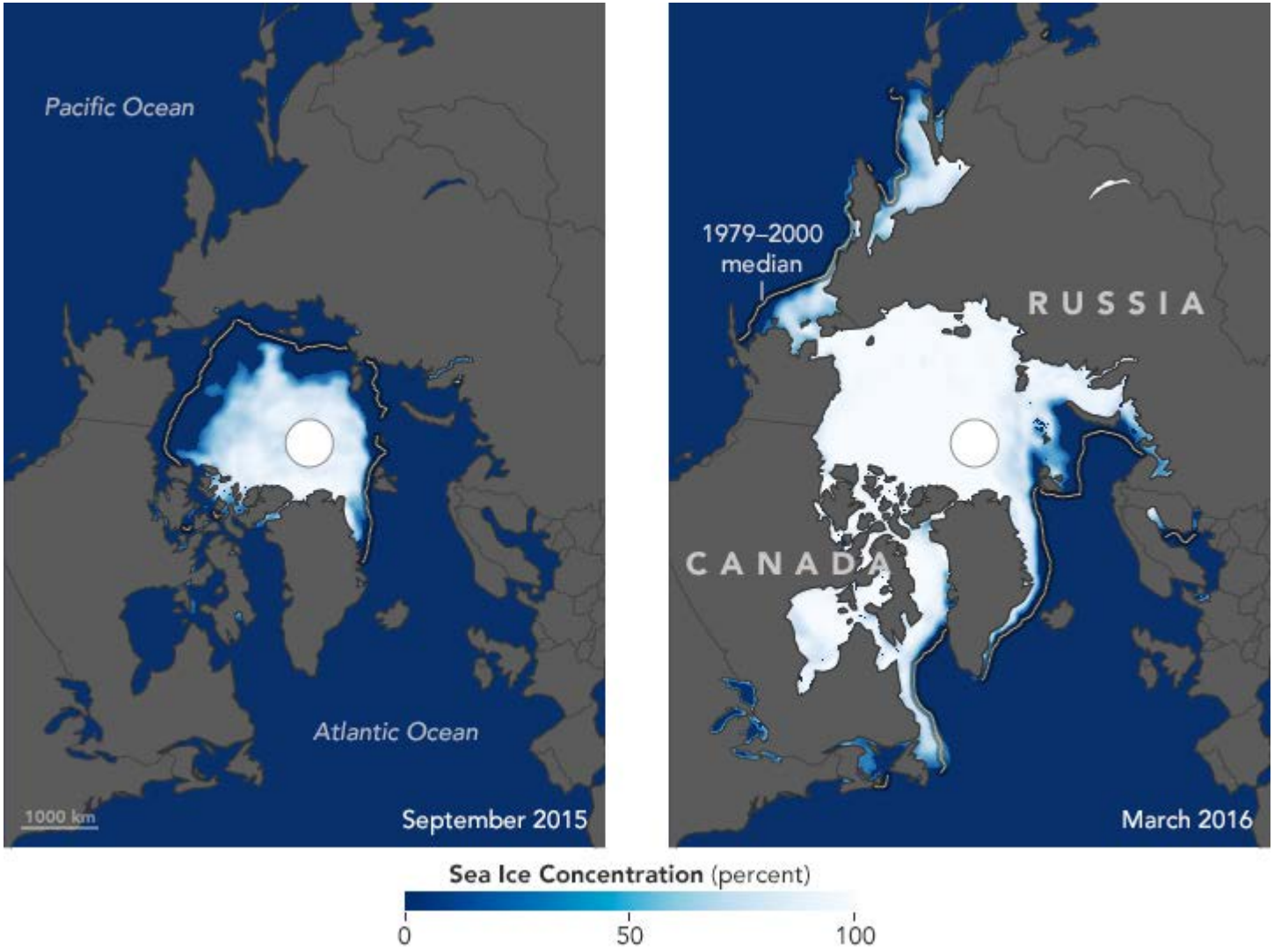
Yellow line: average 1979-2000

Sea-ice extend



Yellow line: average 1979-2000

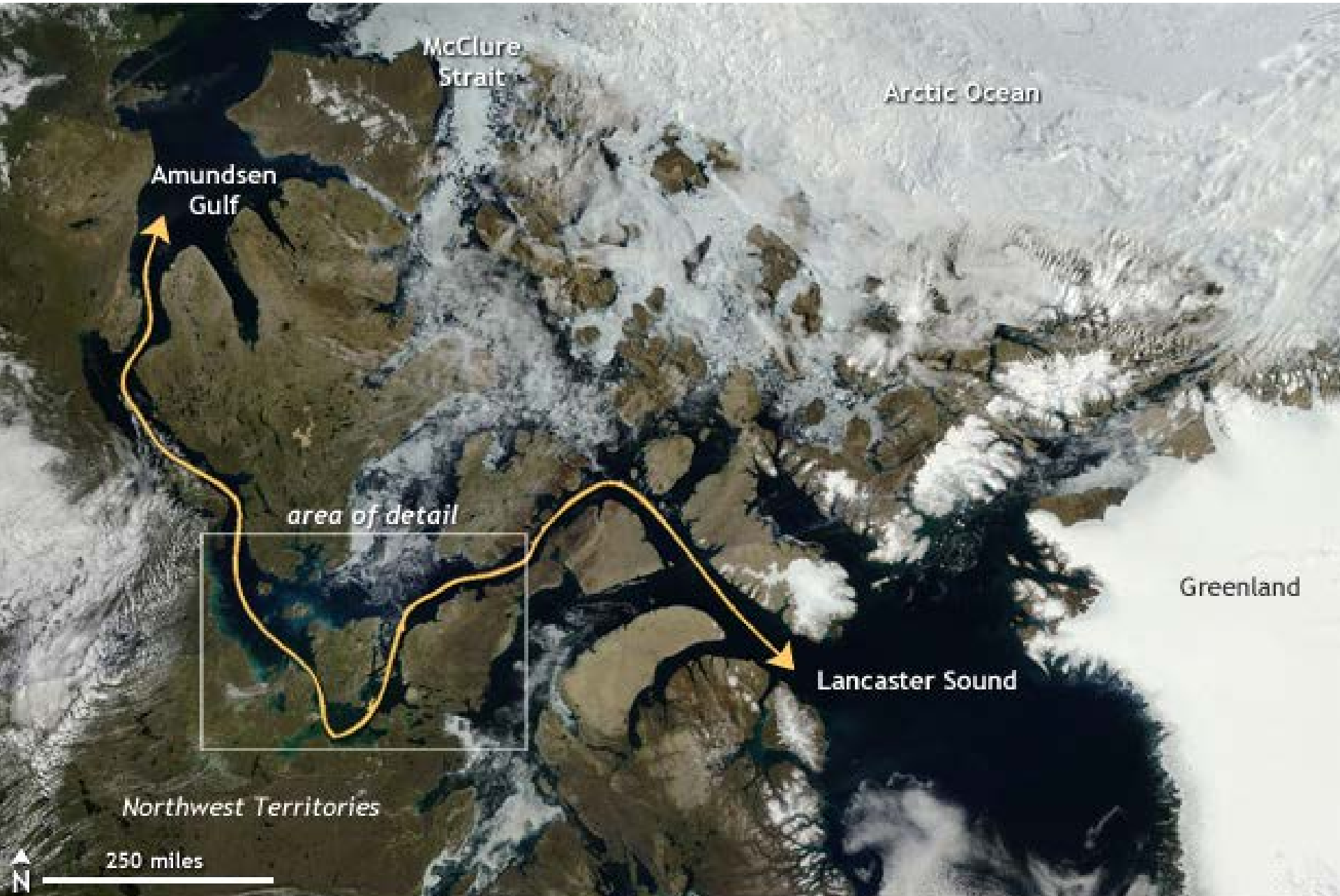
Sea-ice extend



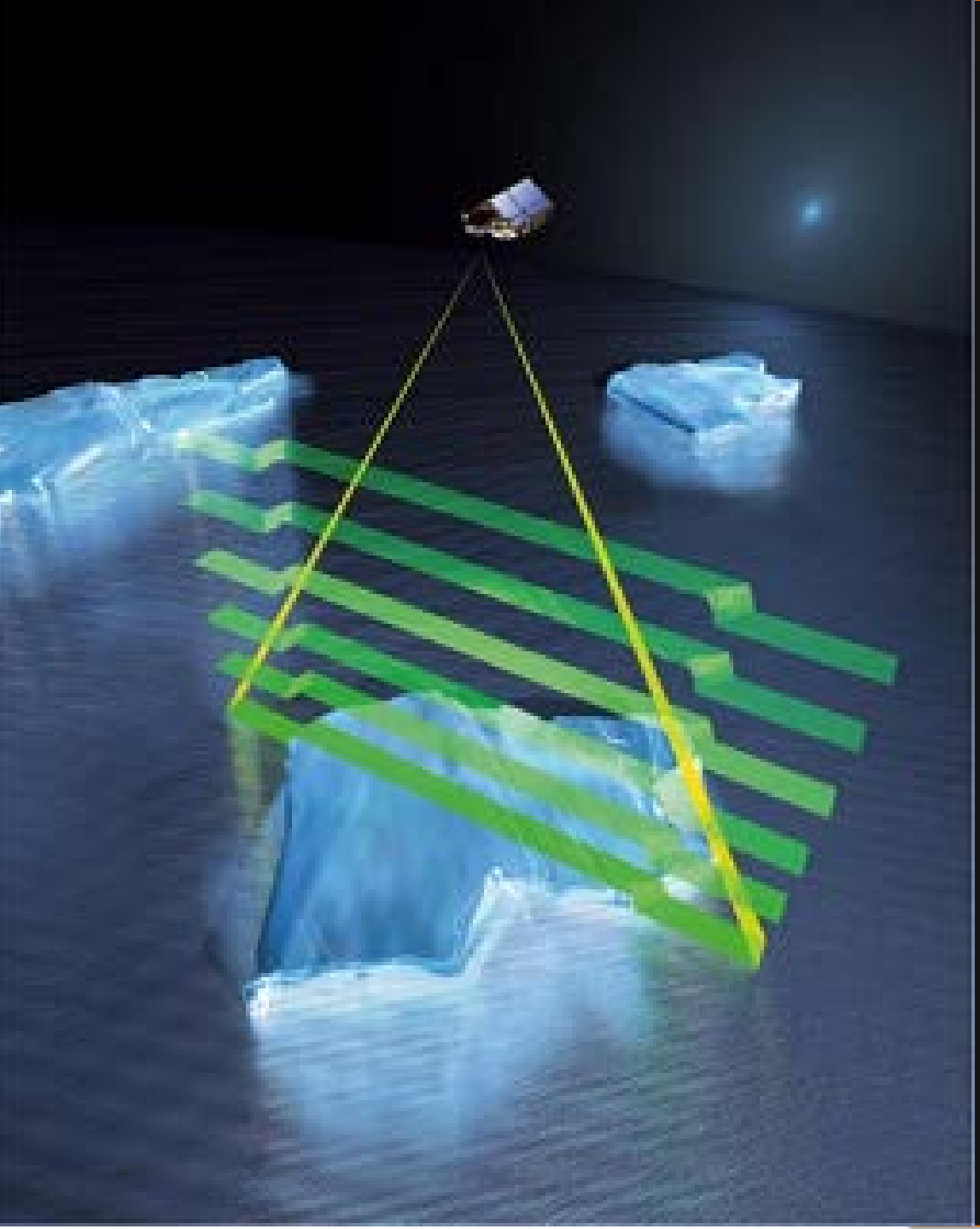
Yellow line: average 1979-2000

http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice.php?all=y

Northwest Passage clear of ice again in 2016



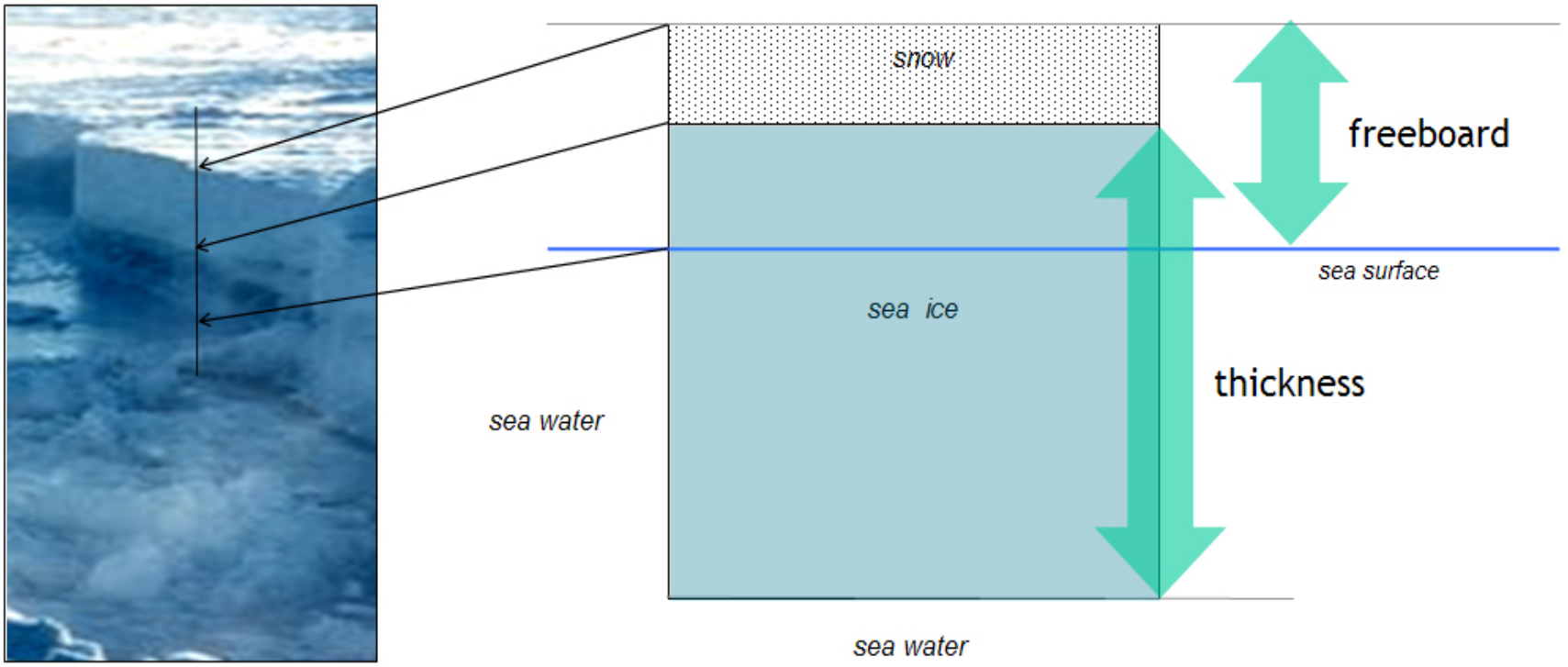
Not only the sea-ice extend, but also the thickness is decreasing

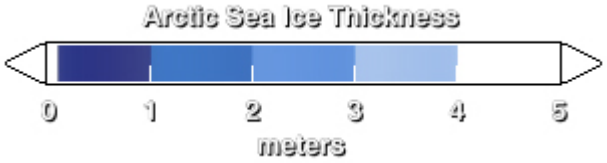


ESA's CryoSat-2 satellite measuring sea ice freeboard

(Image courtesy ESA)

Measuring the sea-ice thickness





°CICERO Senter for klimaforskning www.cicero.uio.no
Center for International Climate and Environmental Research - Oslo

Arctic sea-ice is getting younger and therefore more fragile

In **1987**: - **57%** > 5 years old
- **25%** > 9 years old

When they returned to the Arctic again in **2007**:
- **7%** > 5 years old
- the ice that was at least 9 years old had **vanished**

Maslanik, et al. 2007. A younger, thinner Arctic ice cover: Increased potential for rapid, extensive sea-ice loss. *GRL*.

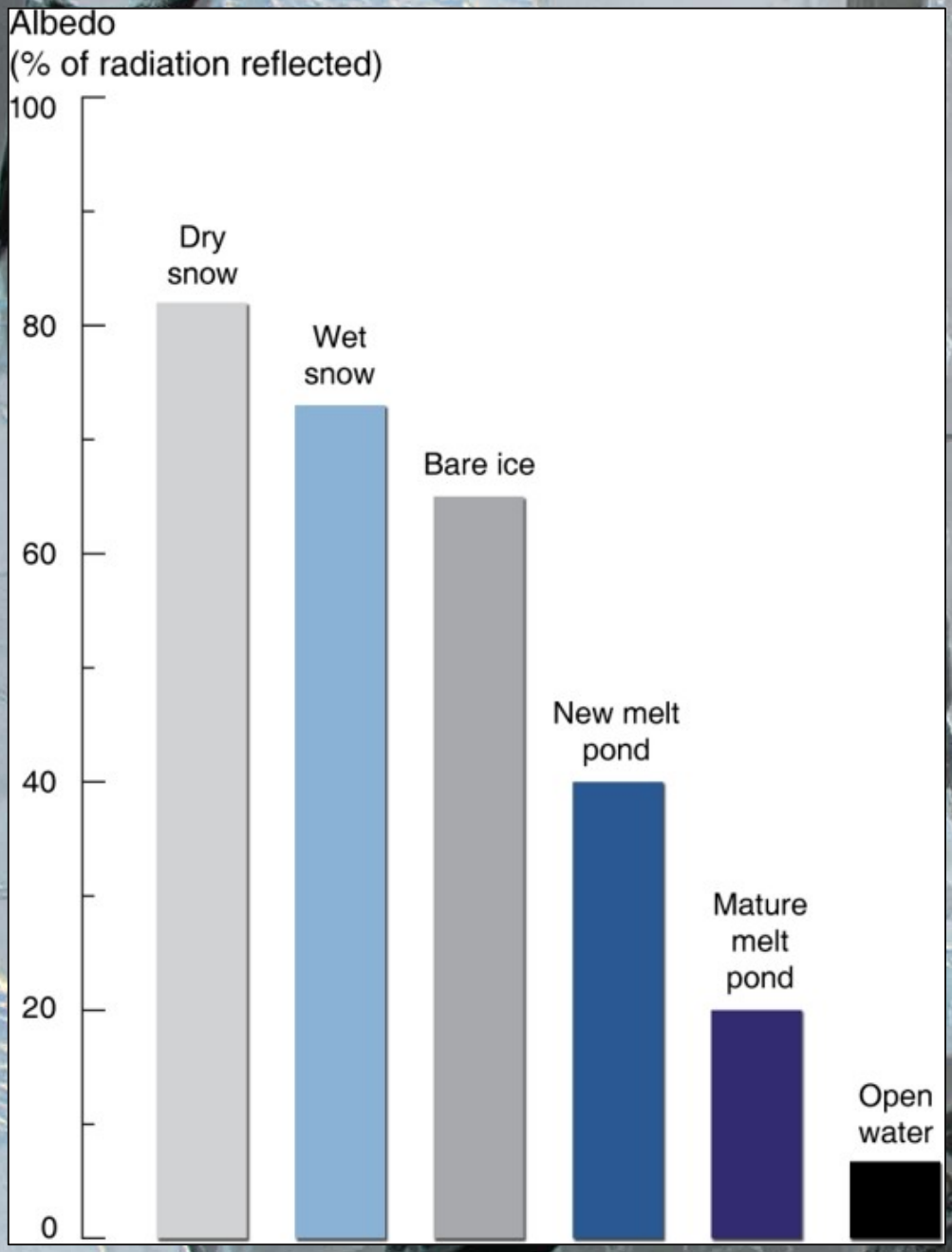
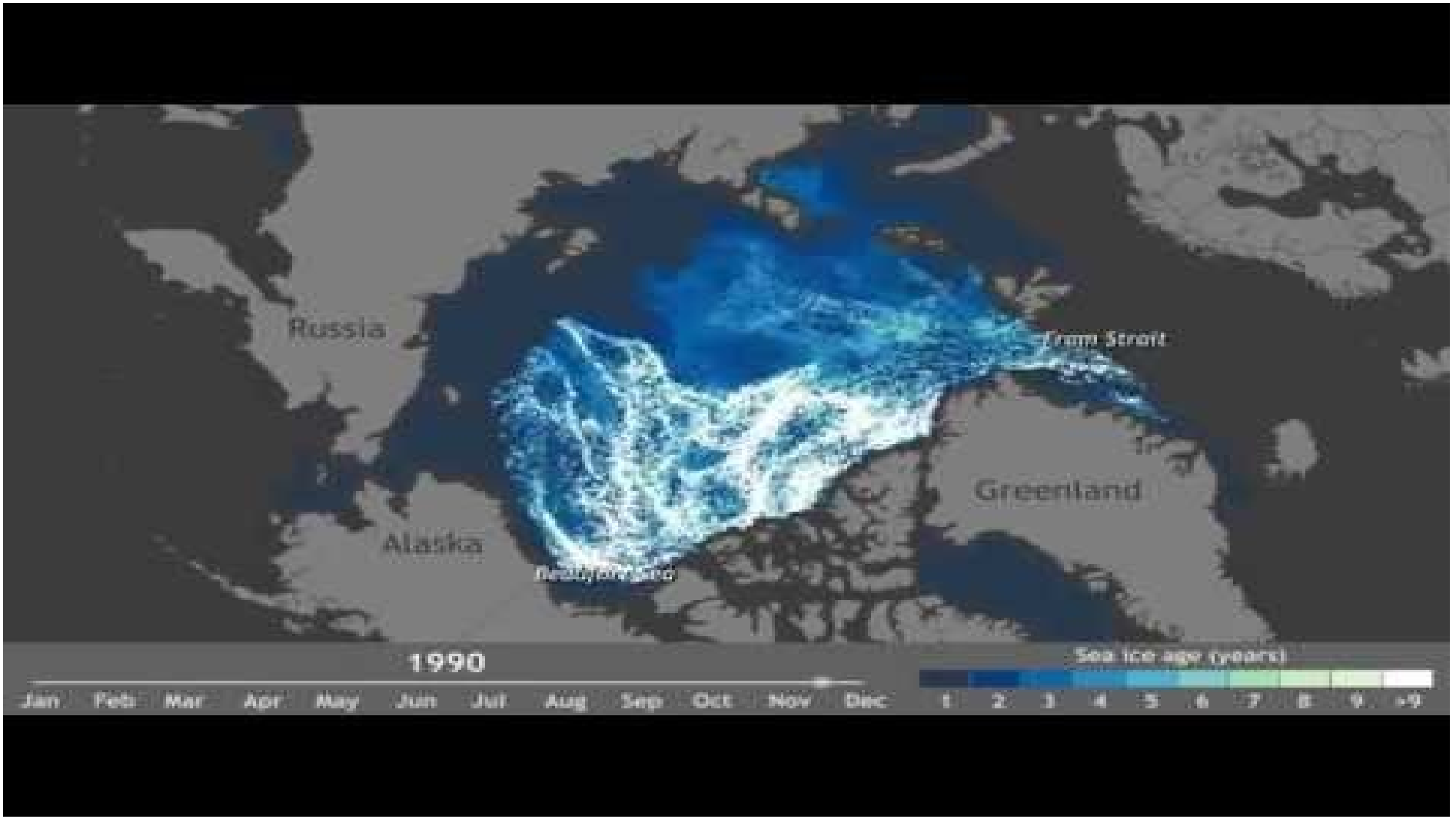


Figure: Hugo Ahlenius, UNEP/GRID-Arendal


Russia
Fram Strait
Greenland
Alaska
1990
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Sea ice age (years)
1 2 3 4 5 6 7 8 9 >9

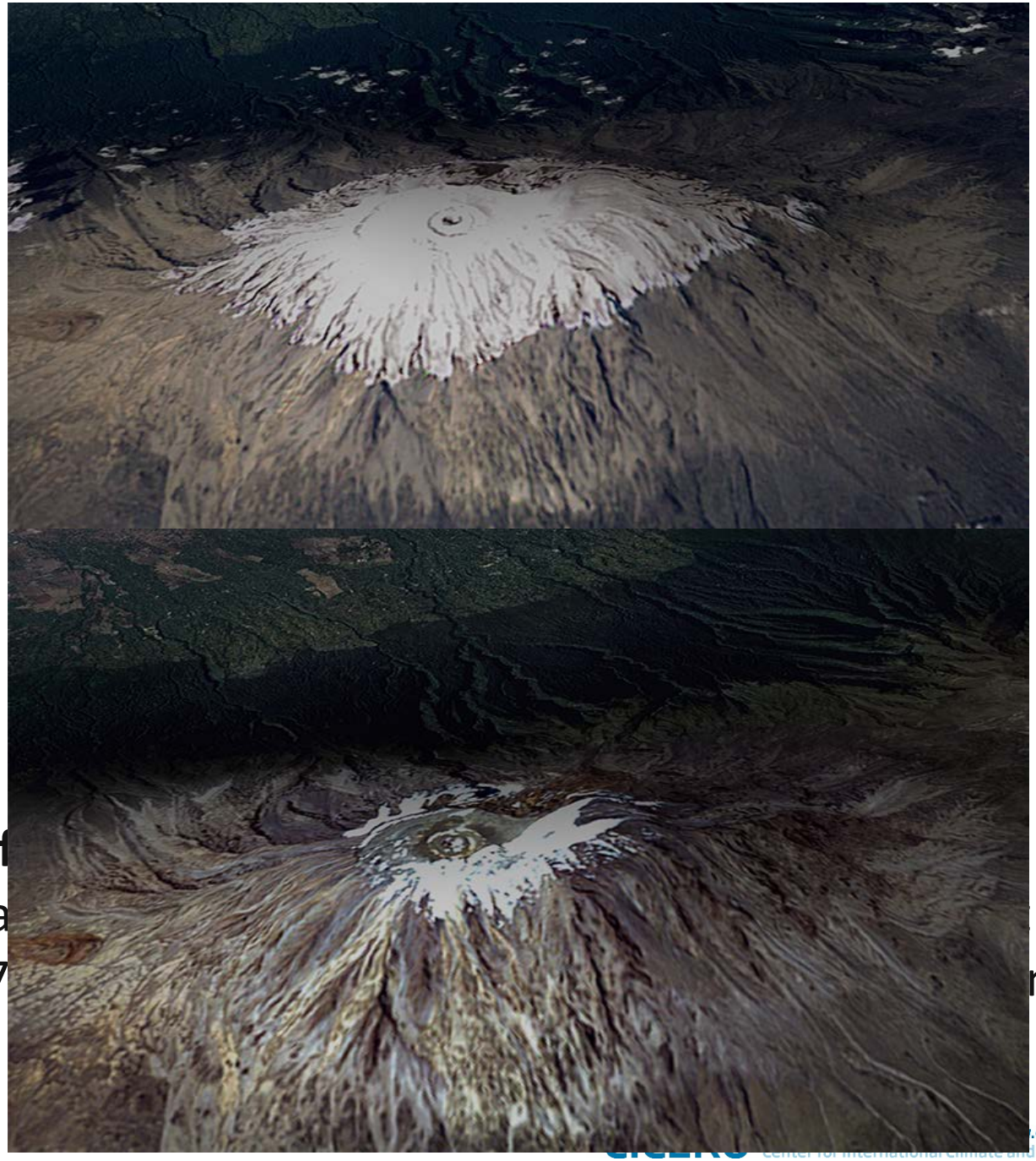
Muir Glacier, Alaska: August 13, 1941 and August 31, 2004

NASA CLIMATE 365

climate365.tumblr.com | go.nasa.gov/climate365

Alaska Ra

Photograp d by Bruce F. Molnia on

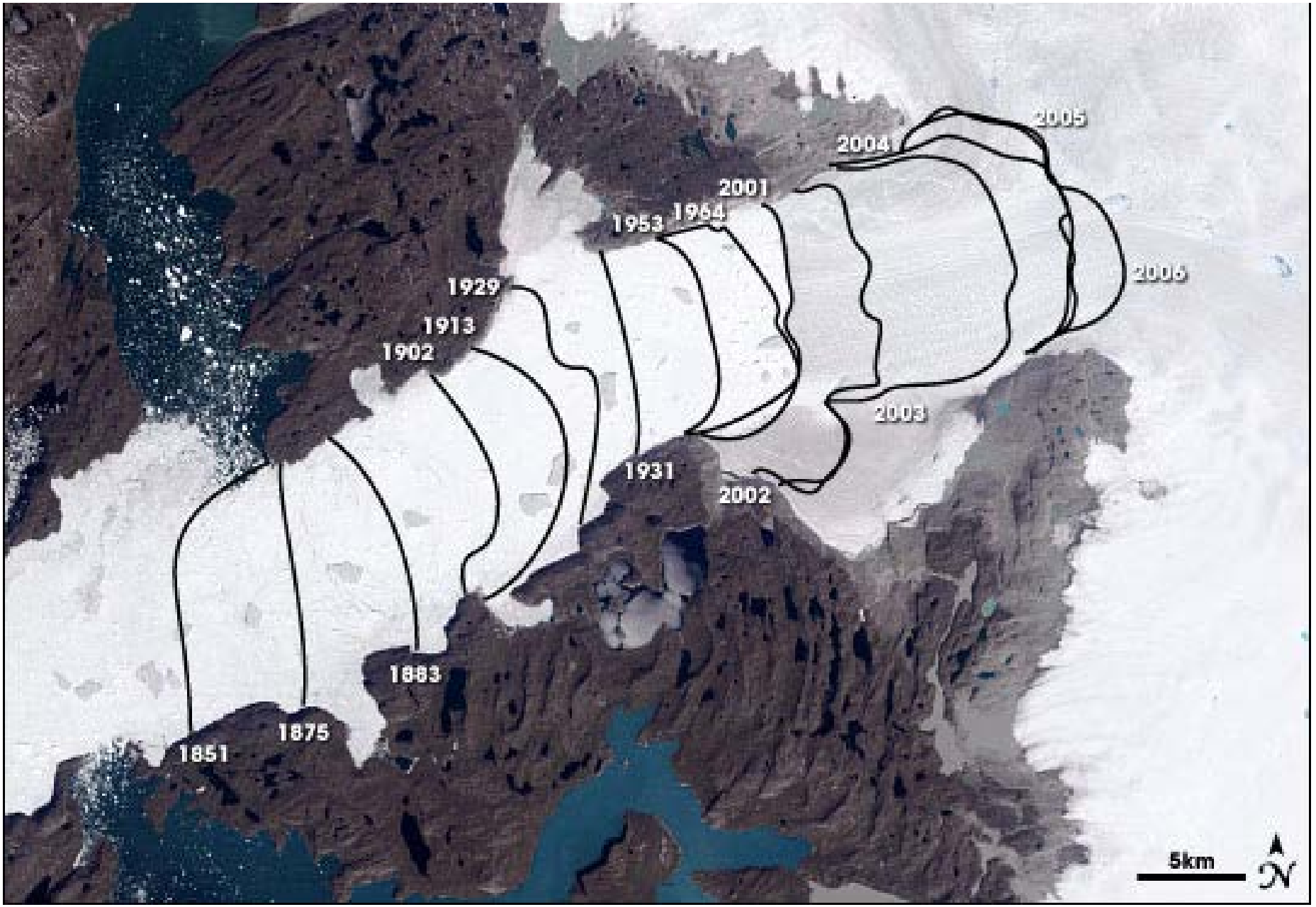


African Rif

Top view a satellite

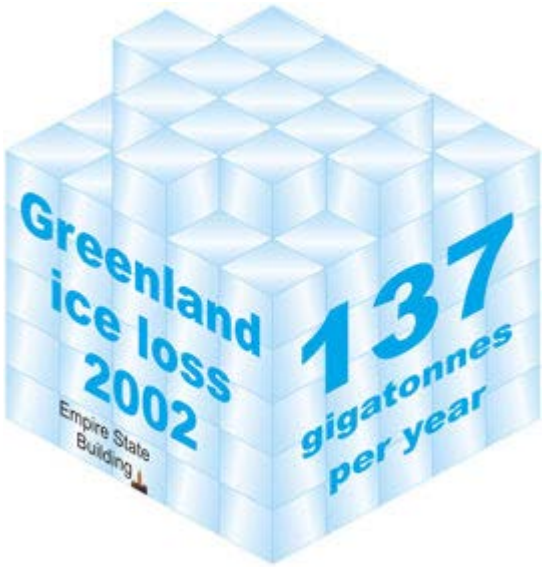
on Feb. 17 m).

Greenland ice loss that has accelerated in the past few years

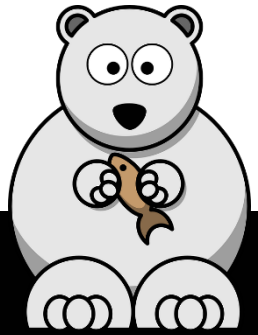


NASA's Operation IceBridge monitors the Greenland ice melt

How much ice are Greenland loosing?



ANTARCTIC



ARCTIC

The world we avoided

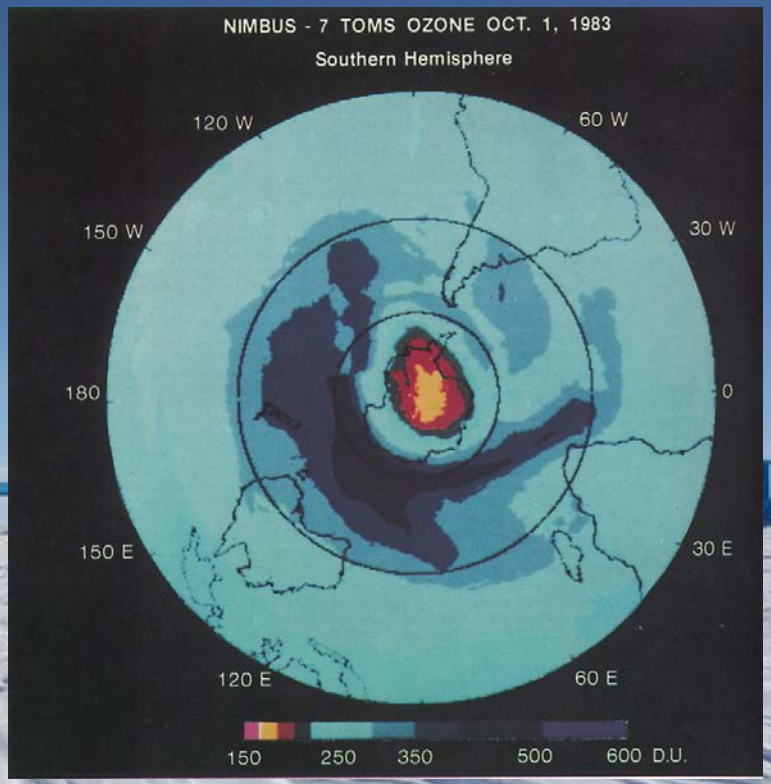
... by saving the ozone layer

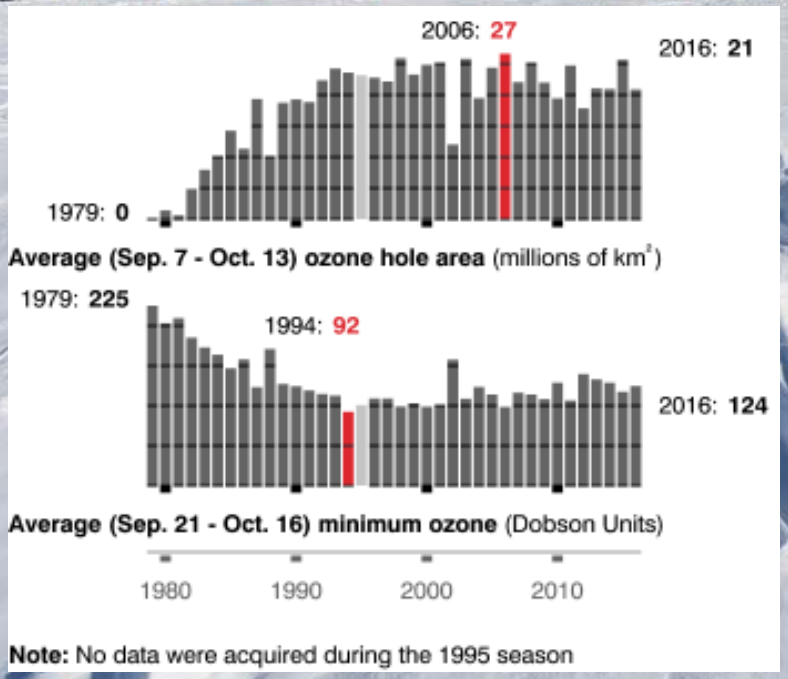
And why the Montreal agreement was such a success!

The year is 2065.

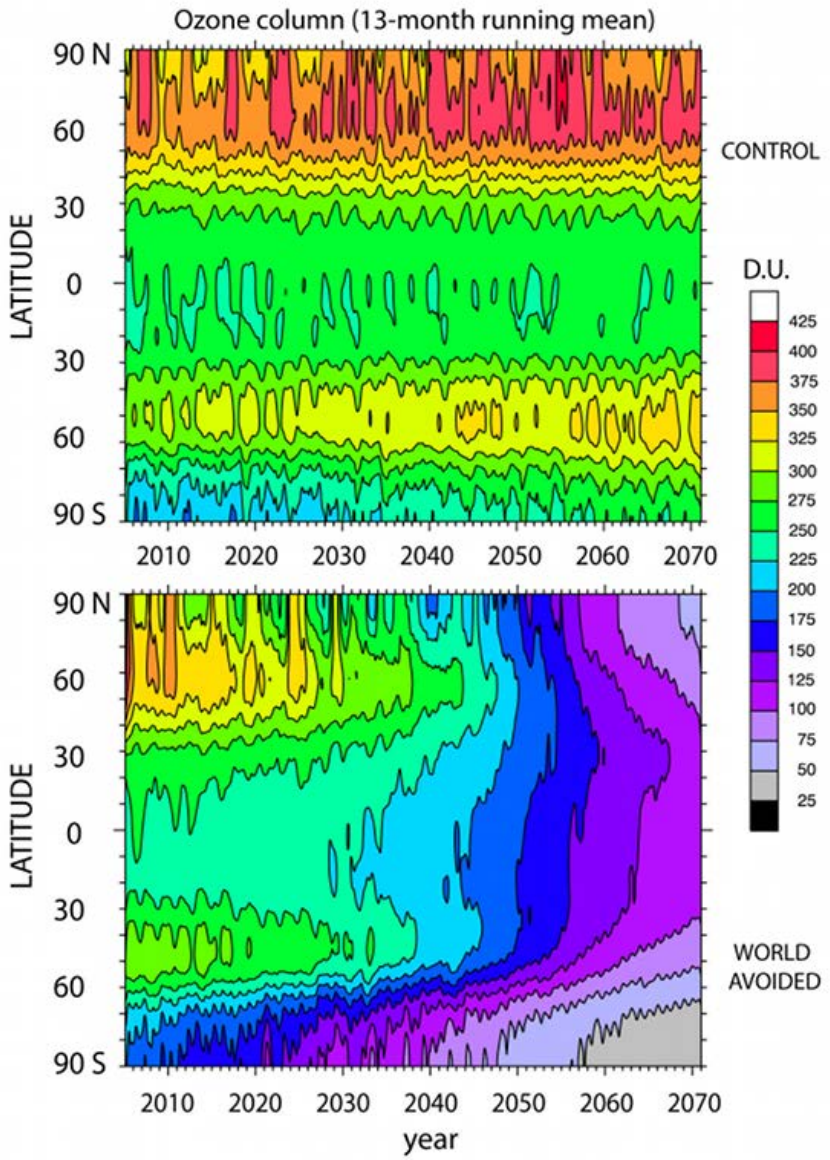
Nearly two-thirds of Earth's ozone is gone—not just over the poles, but everywhere…

The disovery of the ‘ozone hole’ in Antarctica – is now slowly start to recover to its pre-1980s levels





The ozone layer would have collapsed globally by 2050



Control simulation with phase-out of ozone-depleting substanses

'The world avoided' simulation without the Montreal Protocol

Garcia et al. 2012, JGR