

**Arctic-Antarctic Seafloor Mapping
Stockholm, Sweden, May 2011**

Important Role of Bathymetry in Polar Sea Ice Formation and Evolution

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Rigor³, and G. Neumann¹**

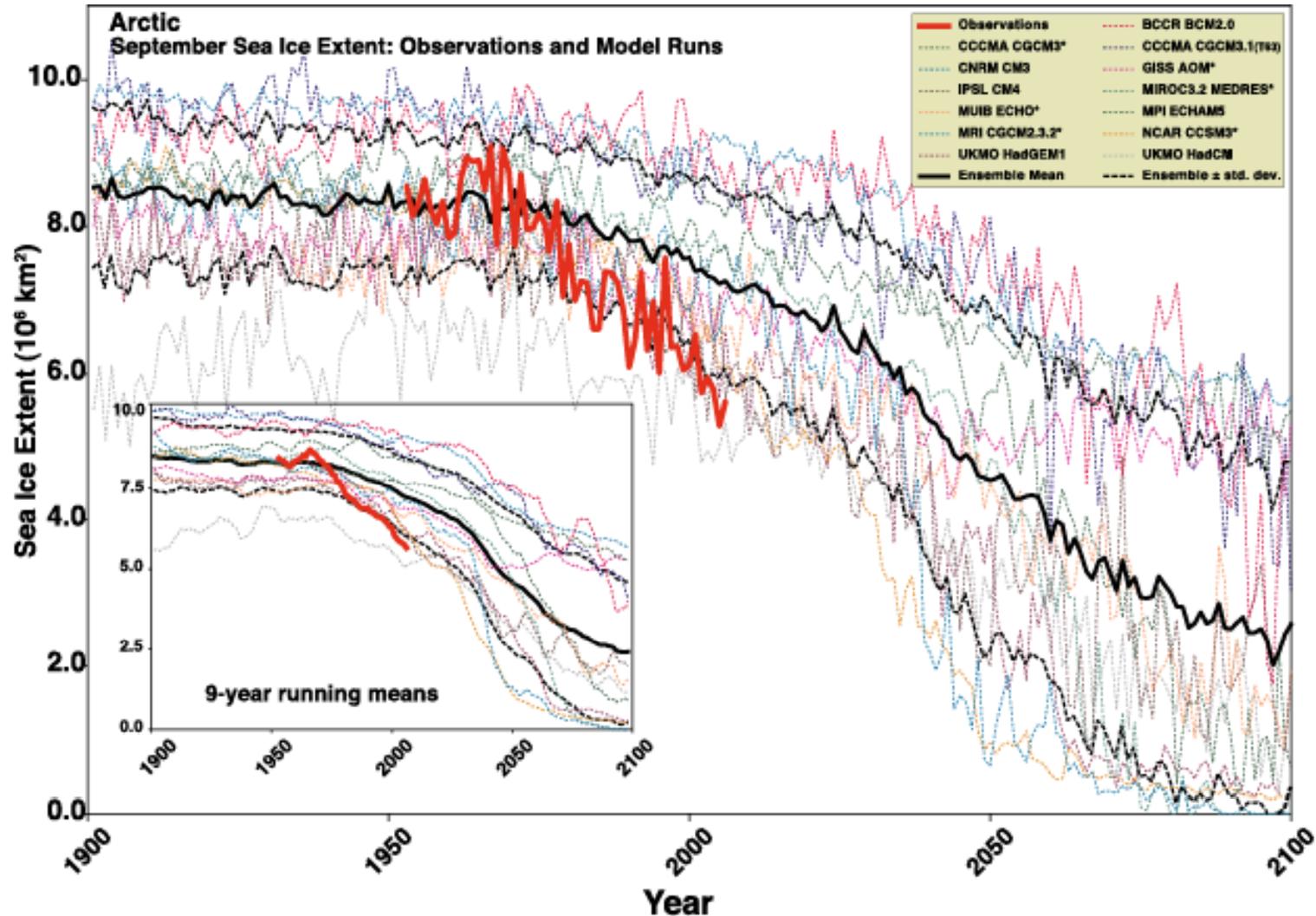
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³Polar Science Center, University of Washington, WA, USA

Rapid Reduction of Sea Ice

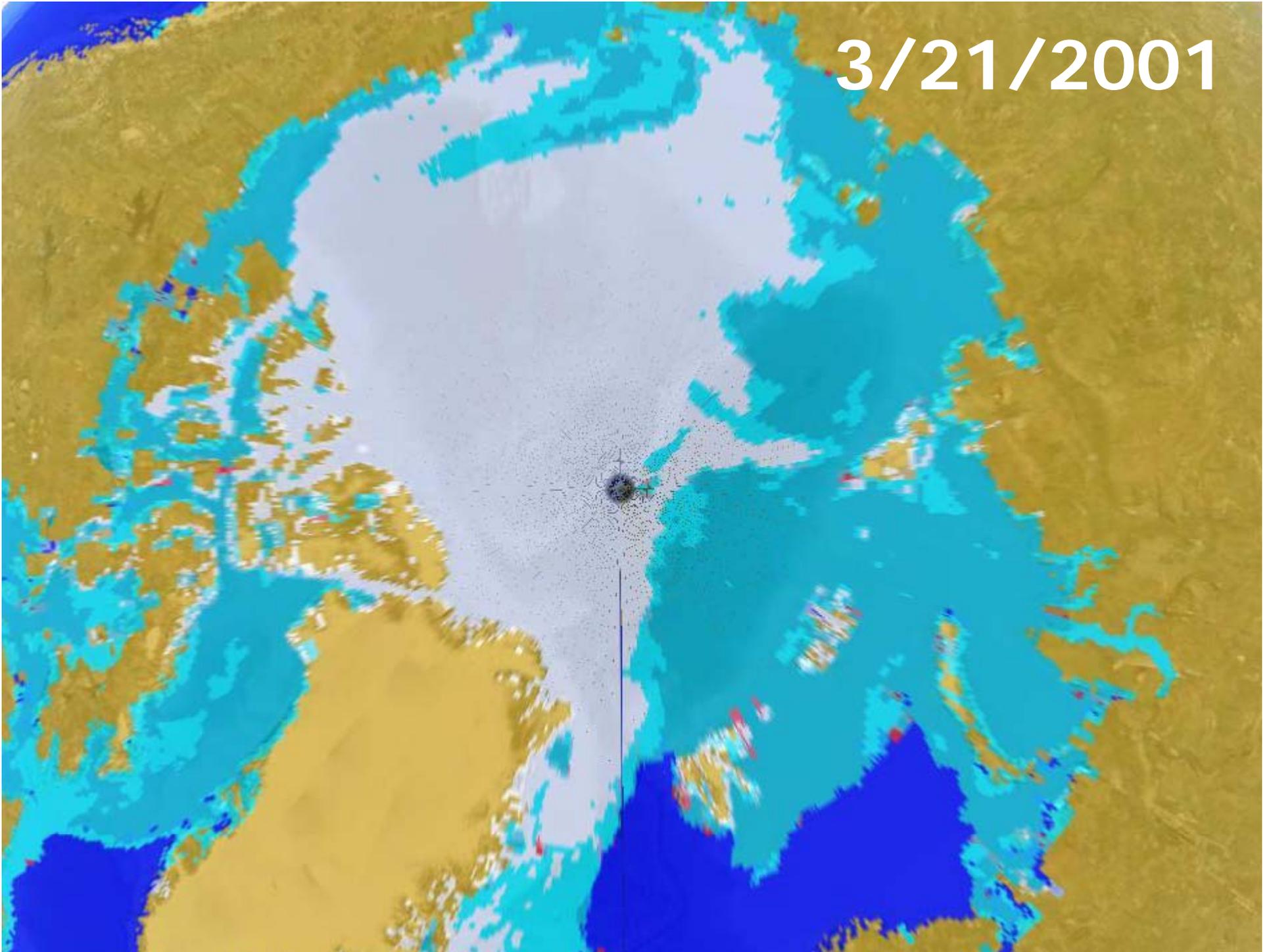
J. Stroeve et al. , Arctic sea ice decline: Faster than forecast, *Geophys. Res. Lett.*, L09501, 2007



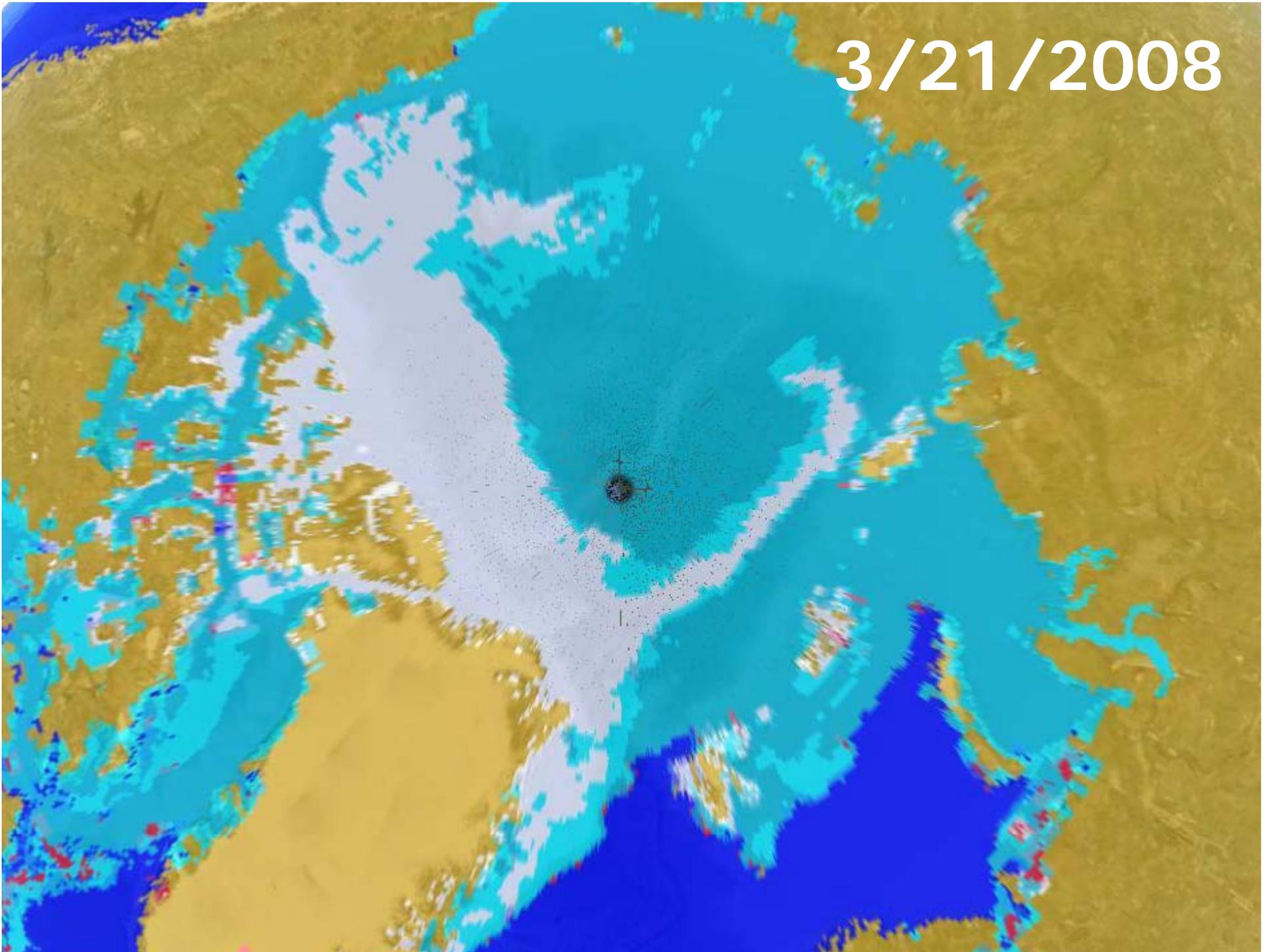
Two Major Ice Classes

- **Perennial sea ice: Surviving at least a summer melt, multi-year age, thick ice, important to ice mass and ice pack stability**
- **Seasonal sea ice: Thinner ice, forming and melting away seasonally**

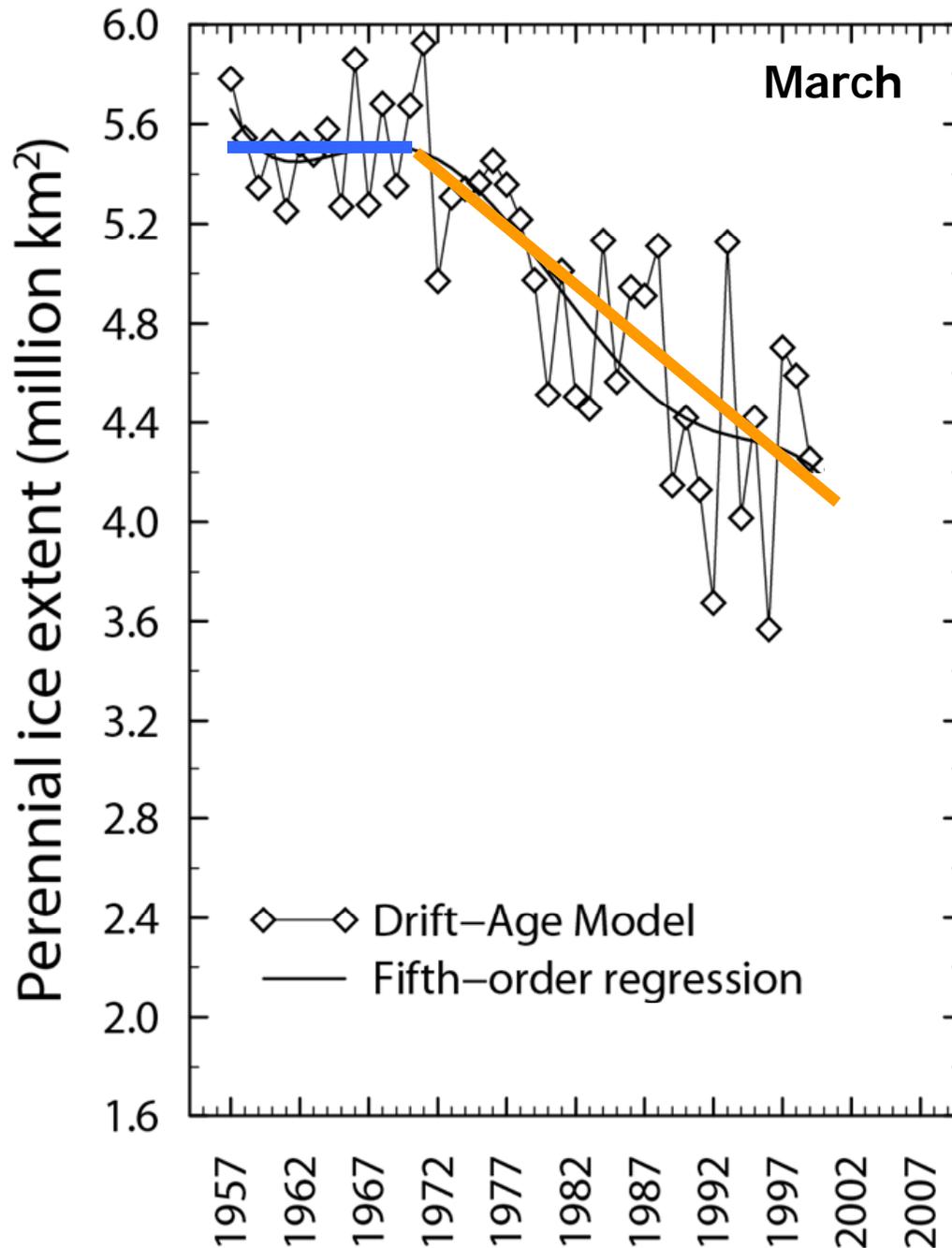
3/21/2001



3/21/2008



Perennial Sea Ice Change 1957-1999



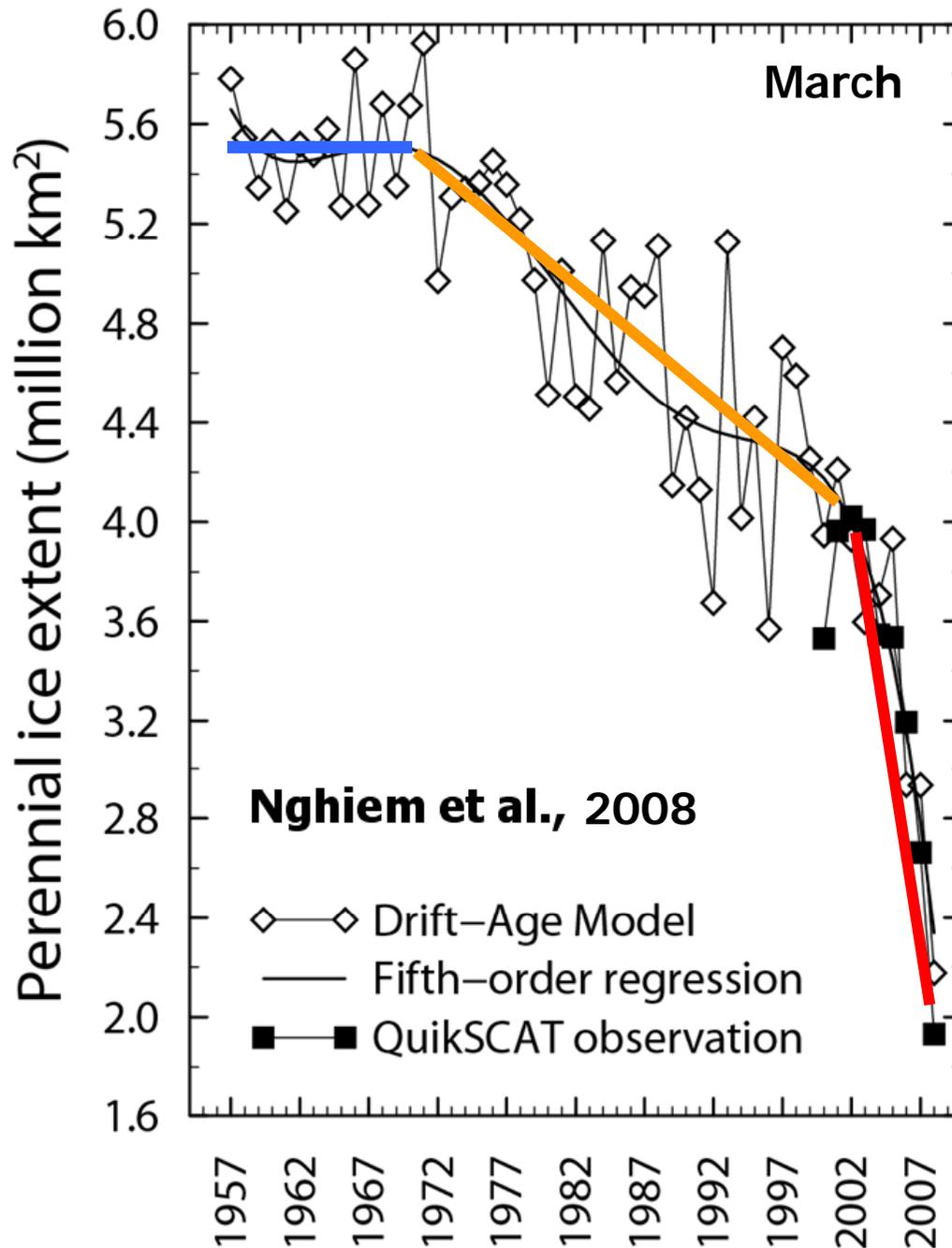
Before 1970:

No discernable trend in March perennial ice extent.

1970-1999:

Decrease of 0.5×10^6 km² per decade in March perennial ice extent as estimated from the Drift-Age model.

Perennial Sea Ice Change 1957-2008



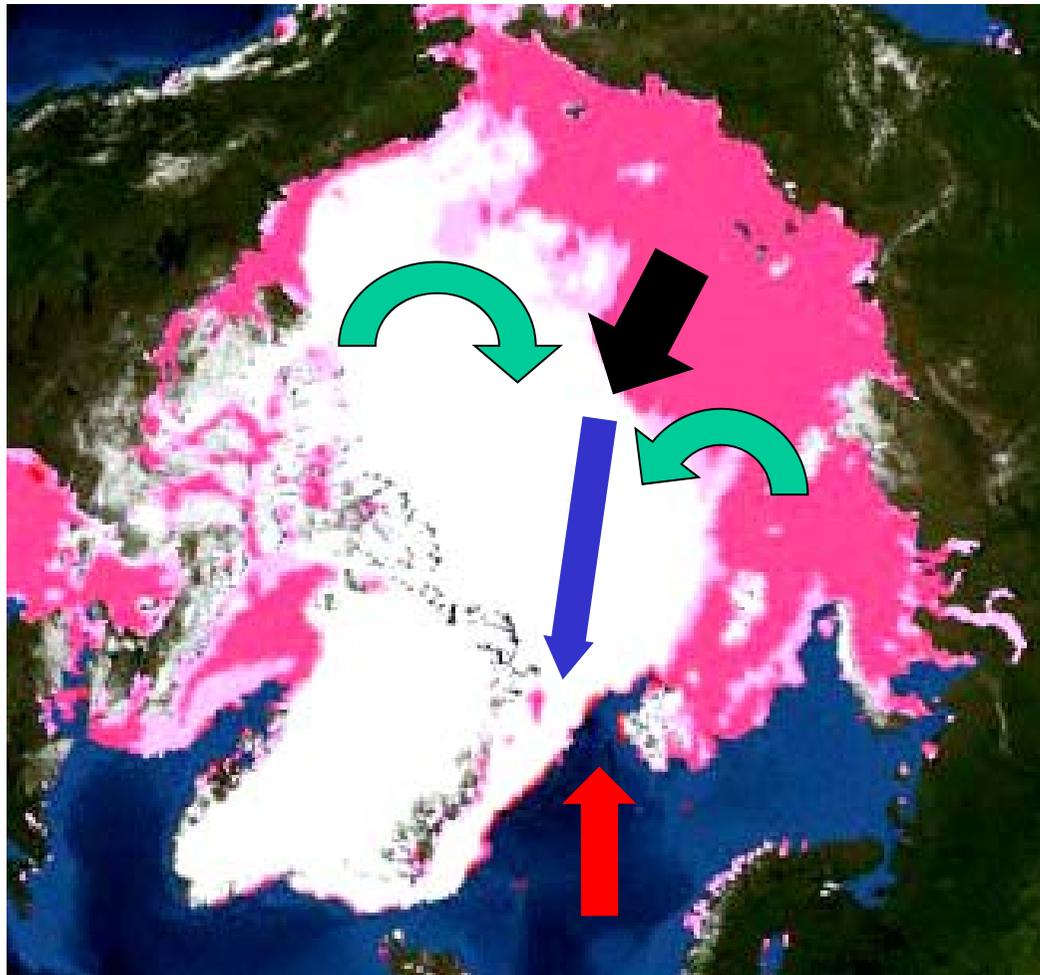
2000-2008:

Decrease of 1.5×10^6 km² per decade in March perennial ice extent as measured from QuikSCAT data and estimated from the Drift-Age model.

TRIPLE THE LOSS RATE
in the previous three decades

'The Polar Express'

Ice loss mechanism in any season (not just summer)



Ice compression from East to West Arctic

Ice compression into Transpolar Drift (TD)

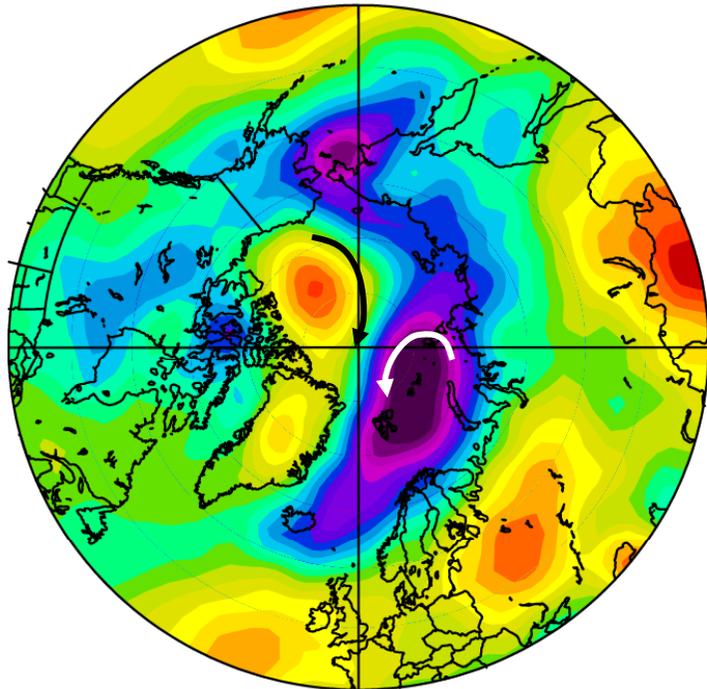
Acceleration of TD¹ carrying ice out of Arctic via Fram Strait

Warm Atlantic water effectively melted ice in Greenland Sea

The Polar Express in 2005

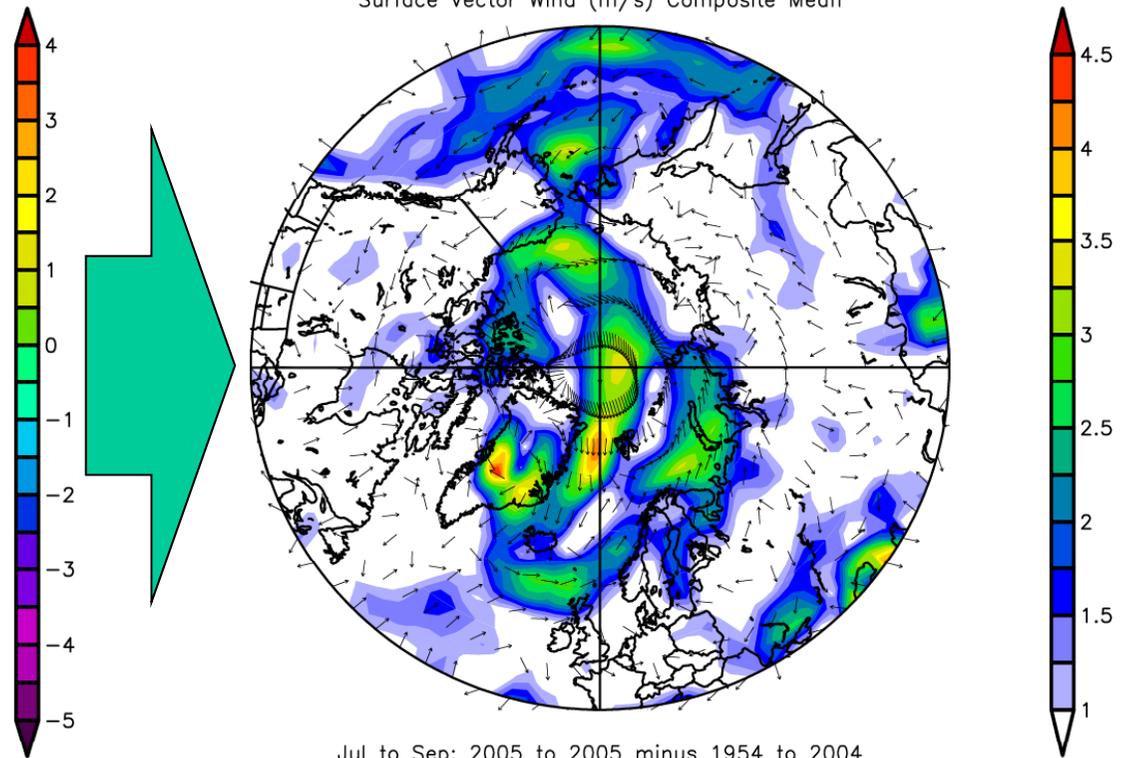
Barents-Sea low and Canadian-Basin high anomalies set up anomalous winds over Fram Basin and Greenland Sea

NCEP/NCAR Reanalysis
Surface Pressure (mb) Composite Mean



Jul to Sep: 2005 to 2005 minus 1954 to 2004

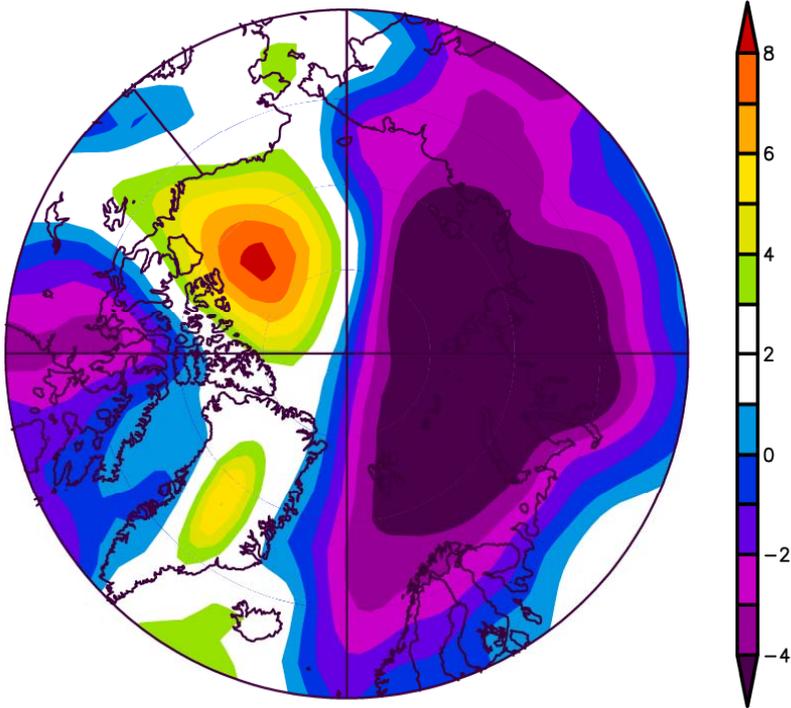
NCEP/NCAR Reanalysis
Surface Vector Wind (m/s) Composite Mean



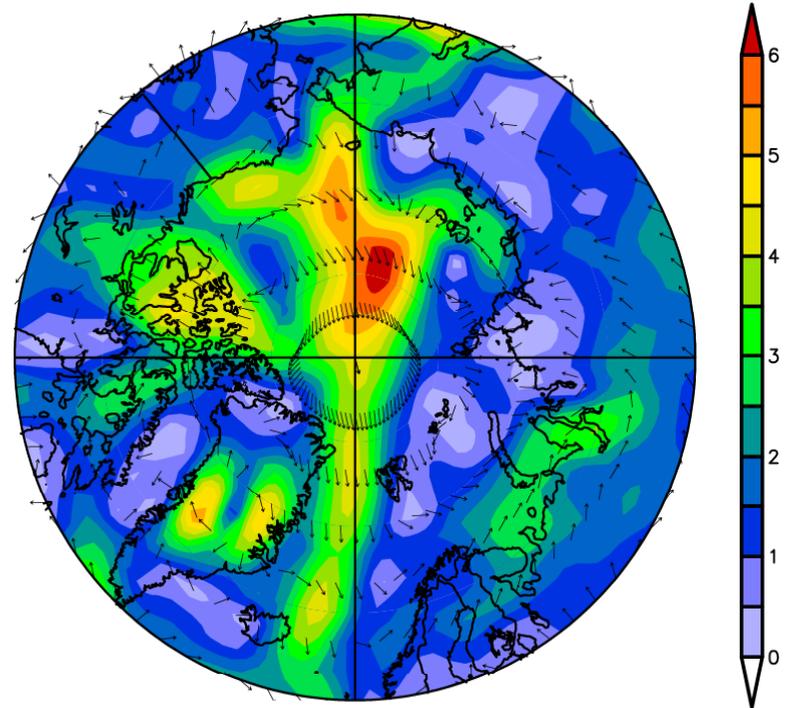
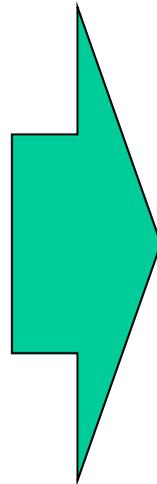
Jul to Sep: 2005 to 2005 minus 1954 to 2004

Dipole anomaly

The Polar Express in 2007

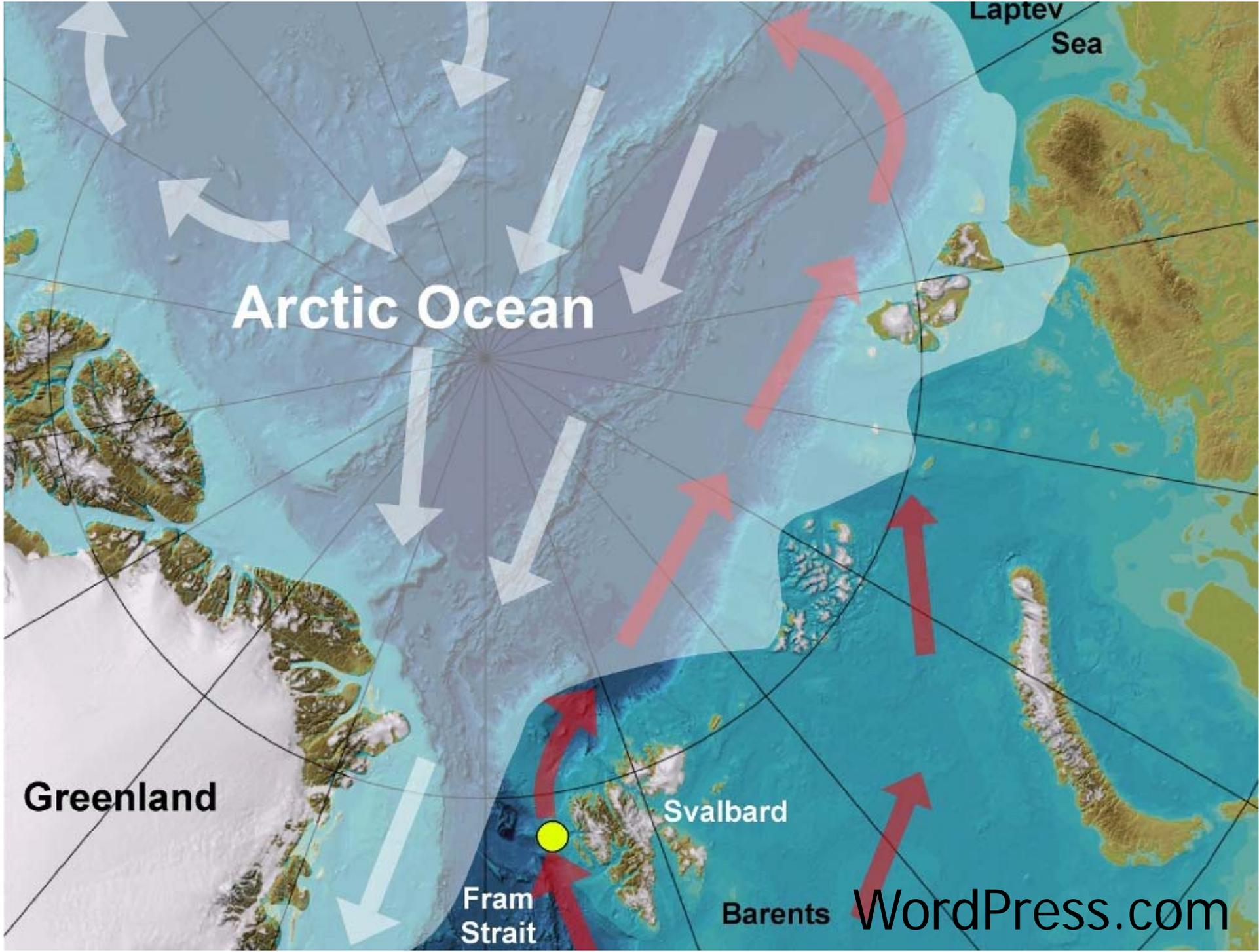


Aug: 2007 to 2007 minus 1950 to 2006



Aug: 2007 to 2007 minus 1950 to 2006

Dipole anomaly





Animation
of sea ice
20 frames
per second

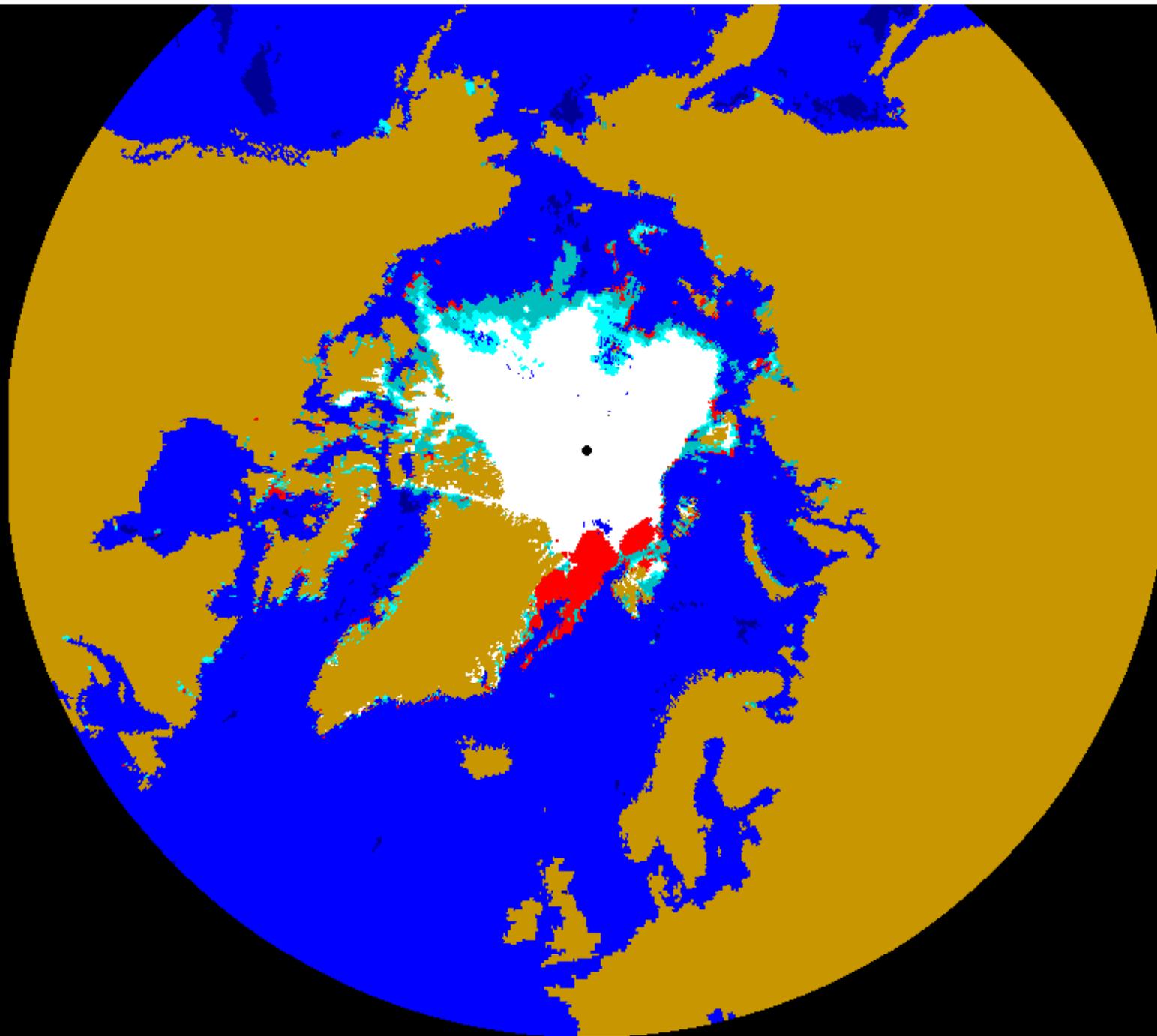
**SEA ICE
CLASSES**

Seasonal

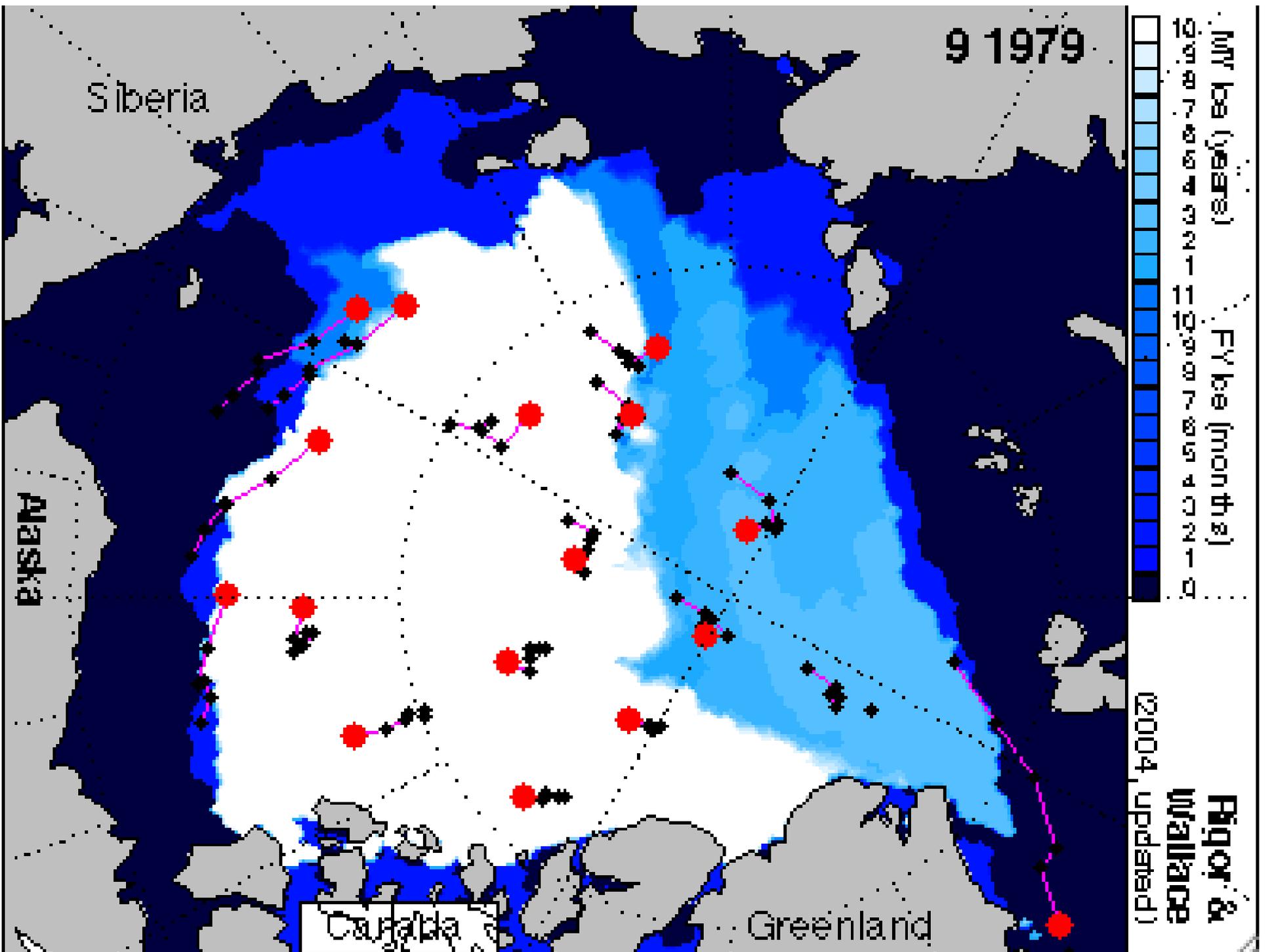
Mixed ice

Perennial

Melt



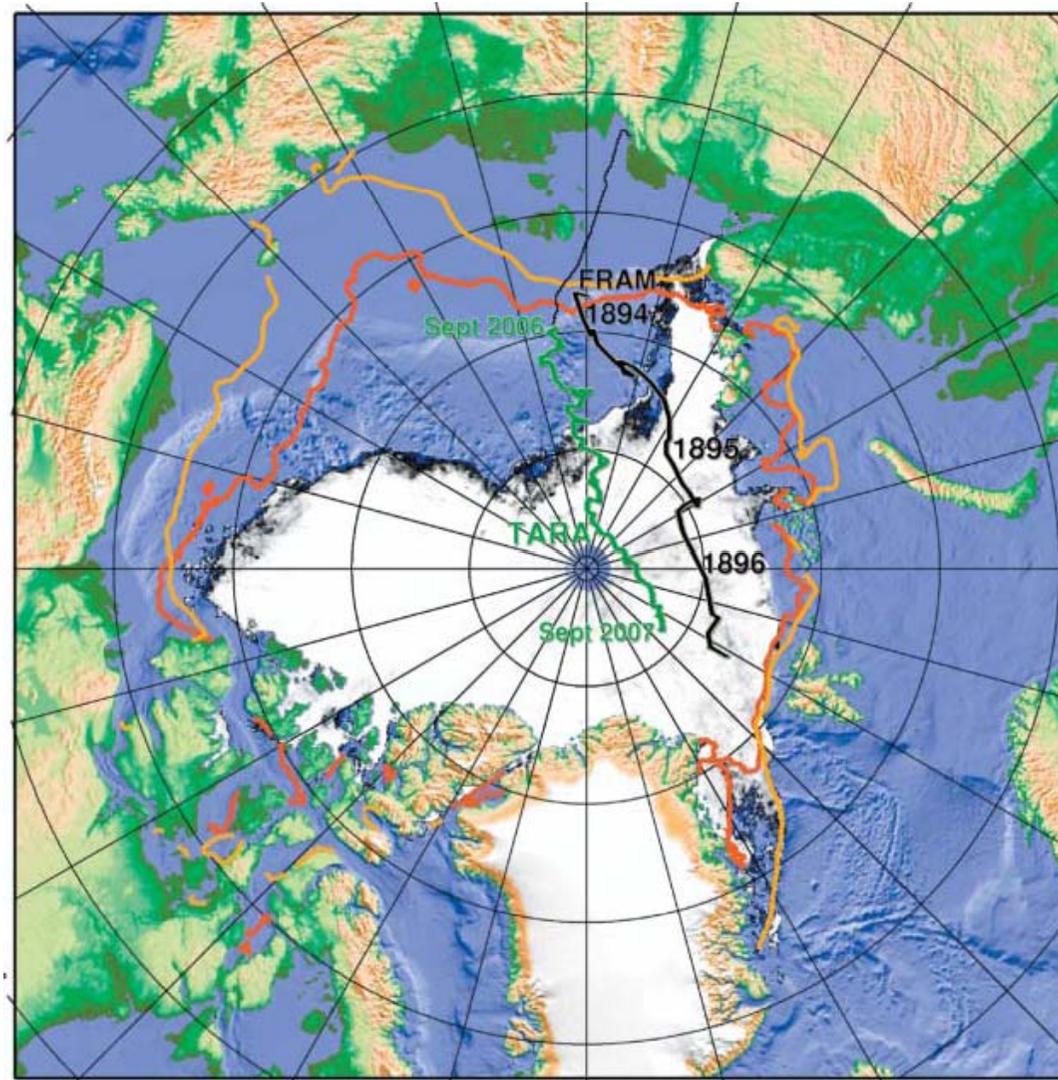
2008-09-12



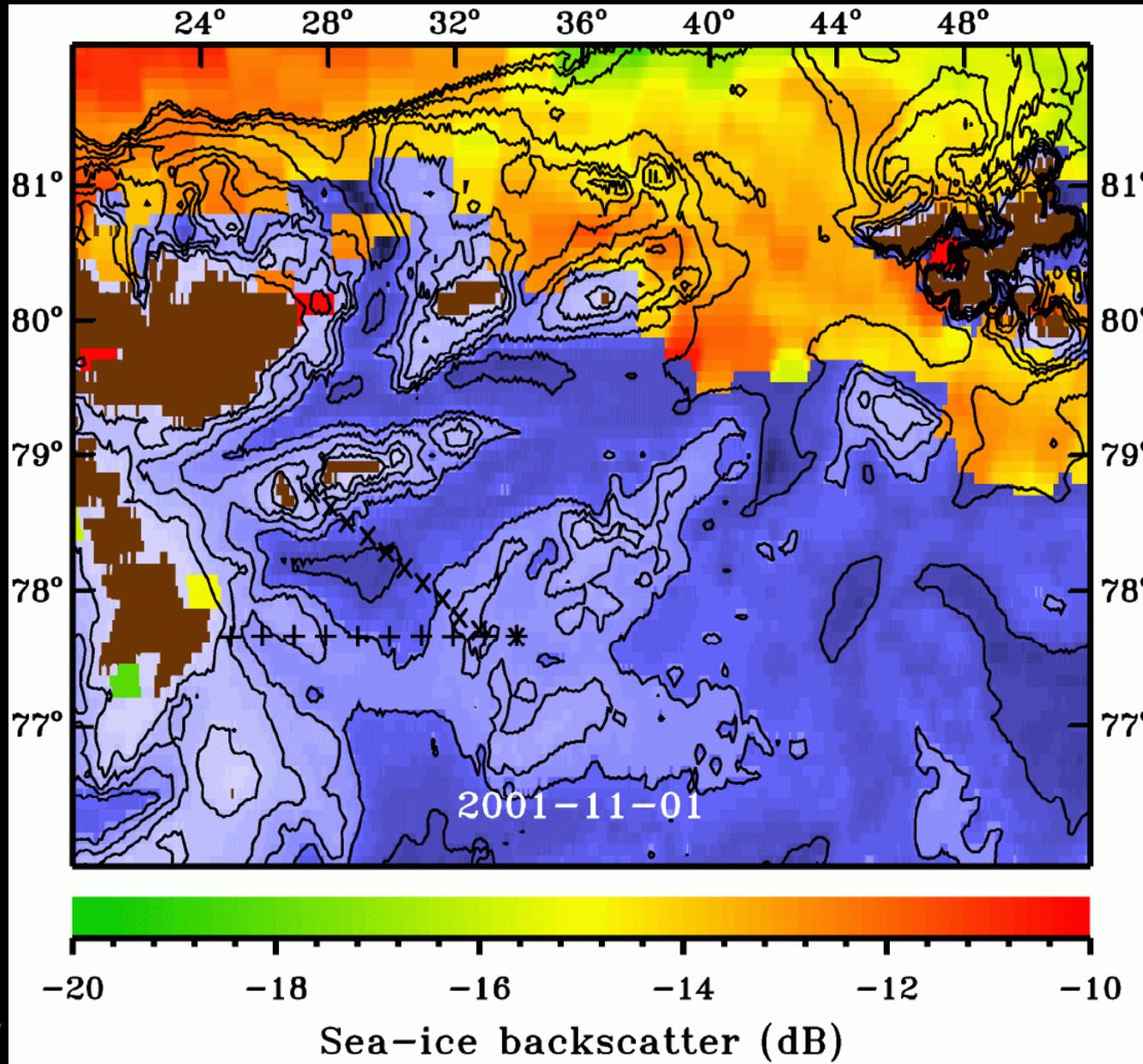
Acceleration of Transpolar Drift

TARA Expedition - Gone With the Wind

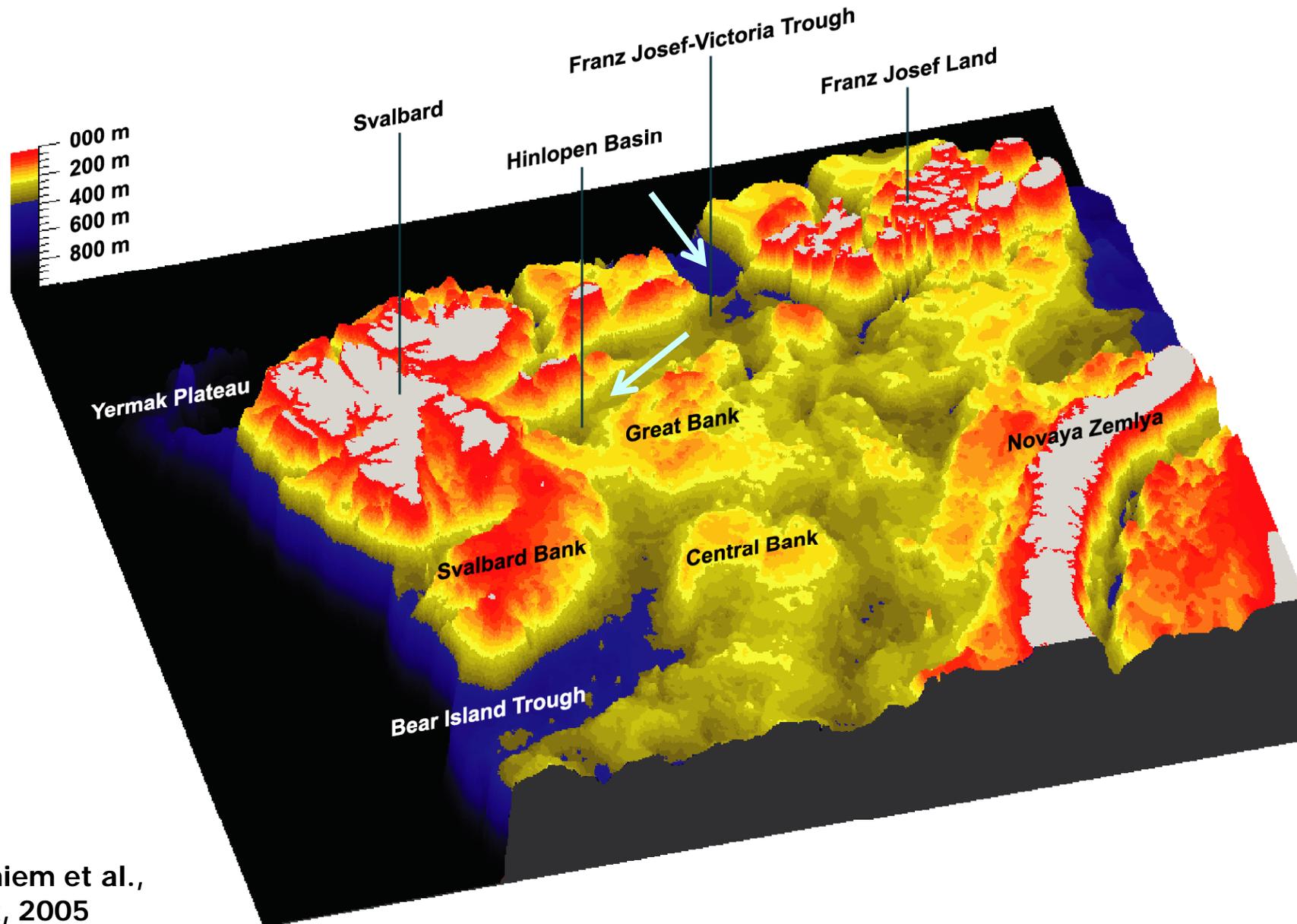
Gascard et al., Eos, Vol. 89, No. 3, 2008



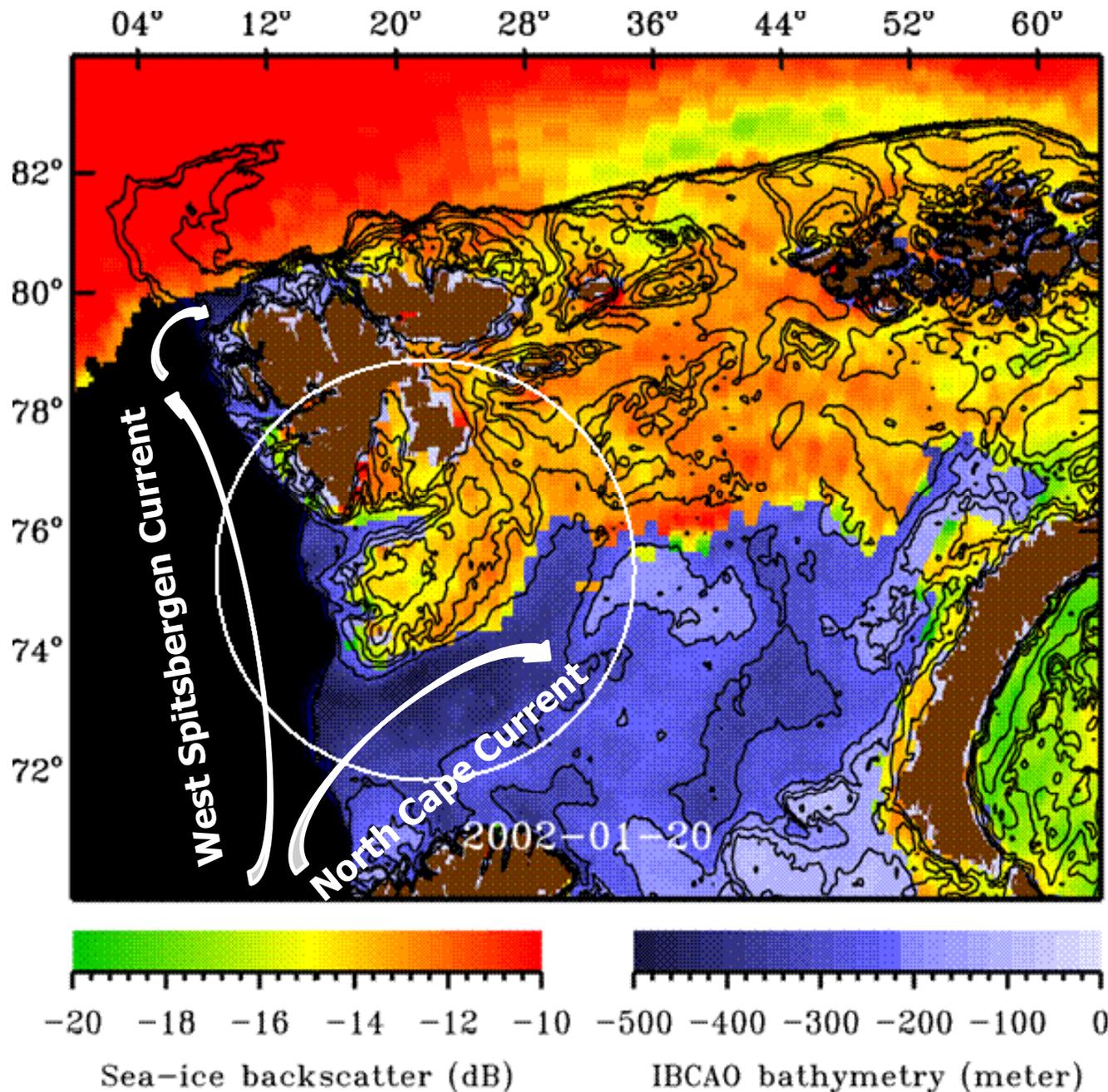
Svalbard Sea-Ice Barrier Formation



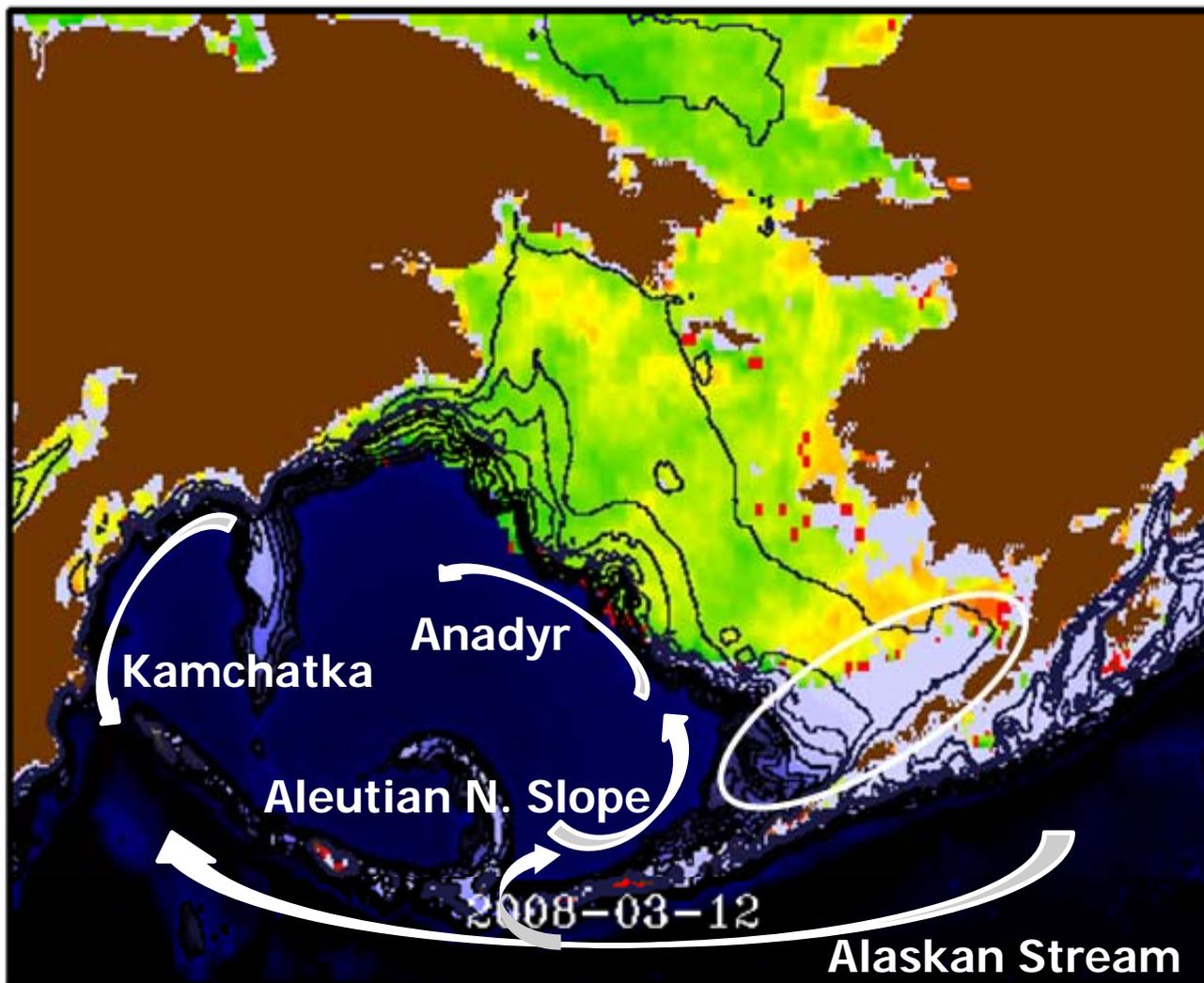
Bathymetric Control of Water Masses



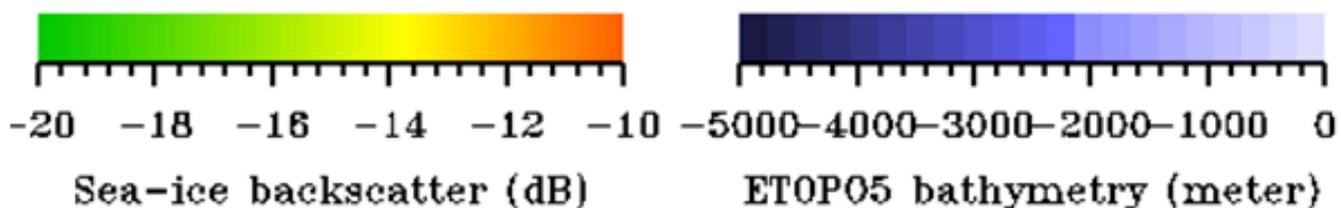
Nghiem et al.,
JGR, 2005

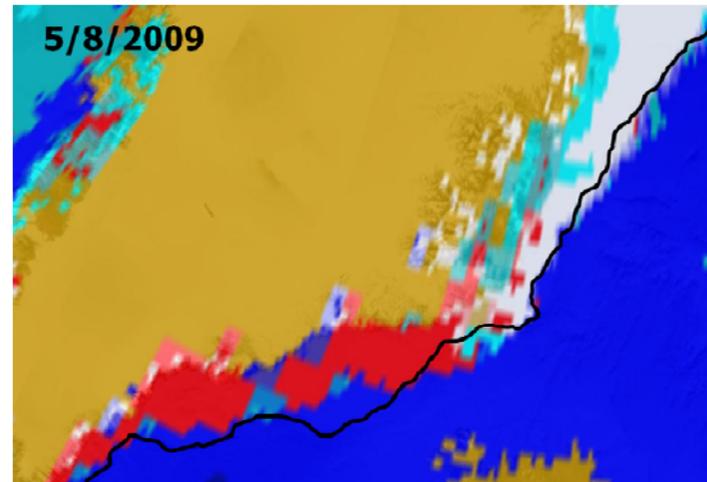
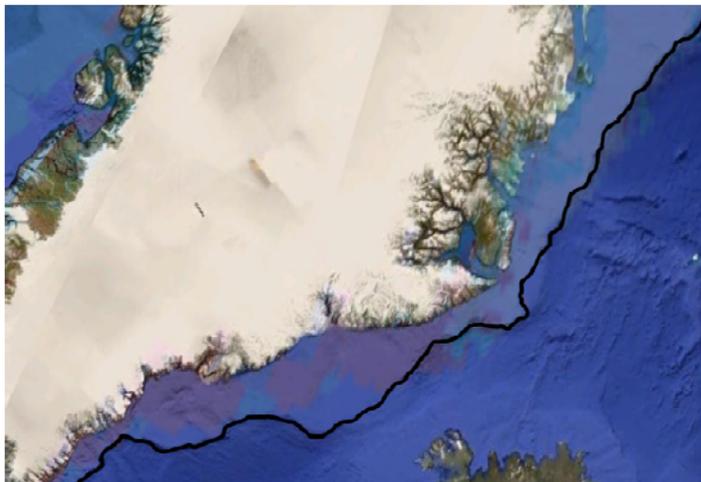
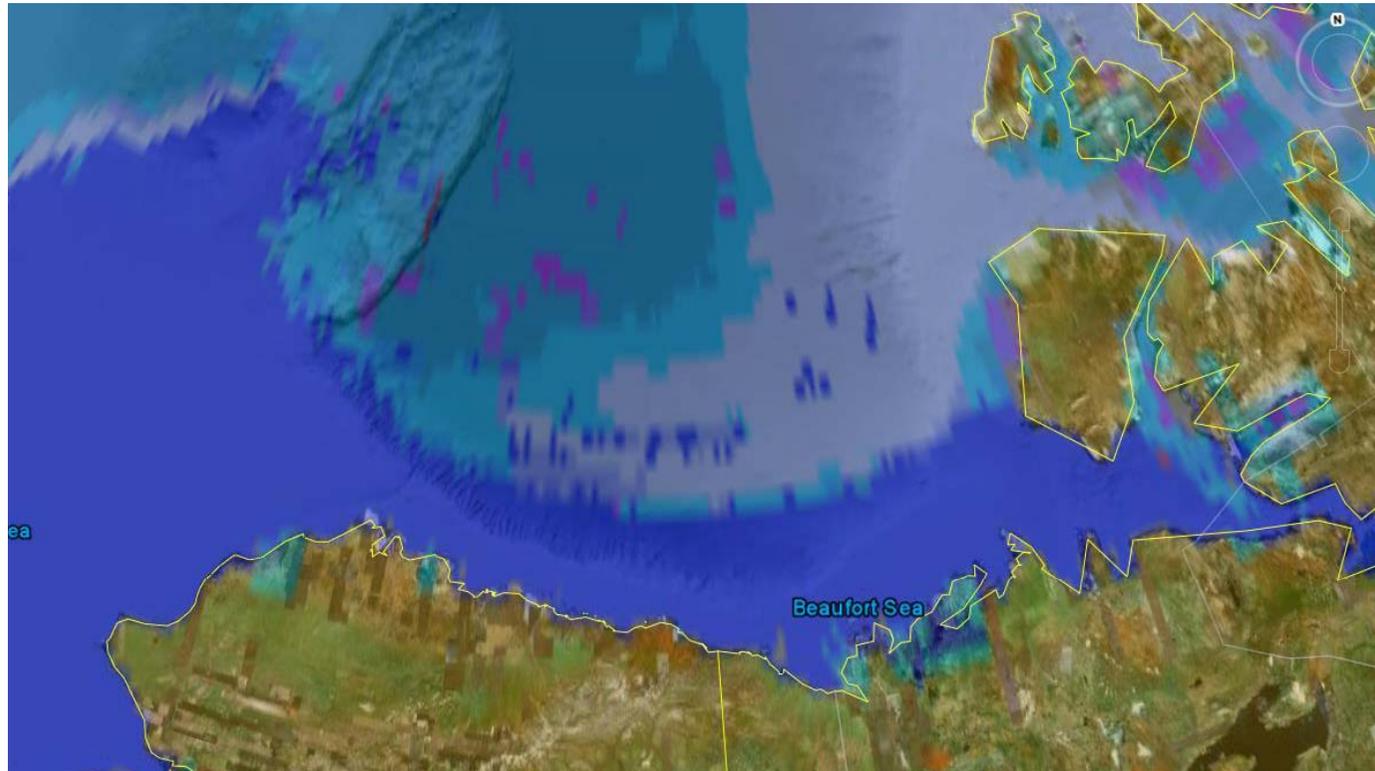


Nghiem,
Van Woert,
Neumann,
JGR, 2005

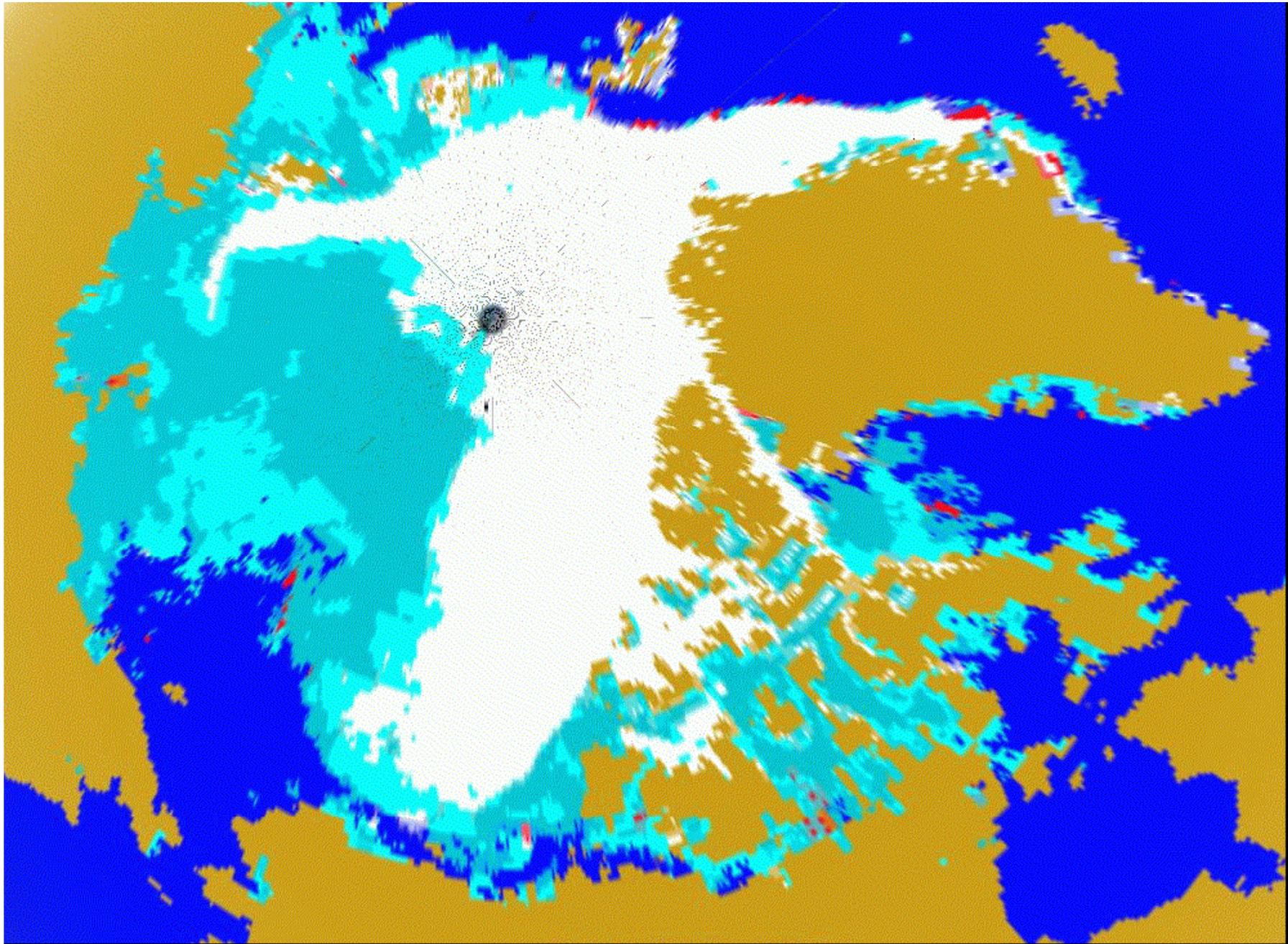


Sea ice:
Green-orange
Melt on ice:
Red
Ocean:
Blue shades





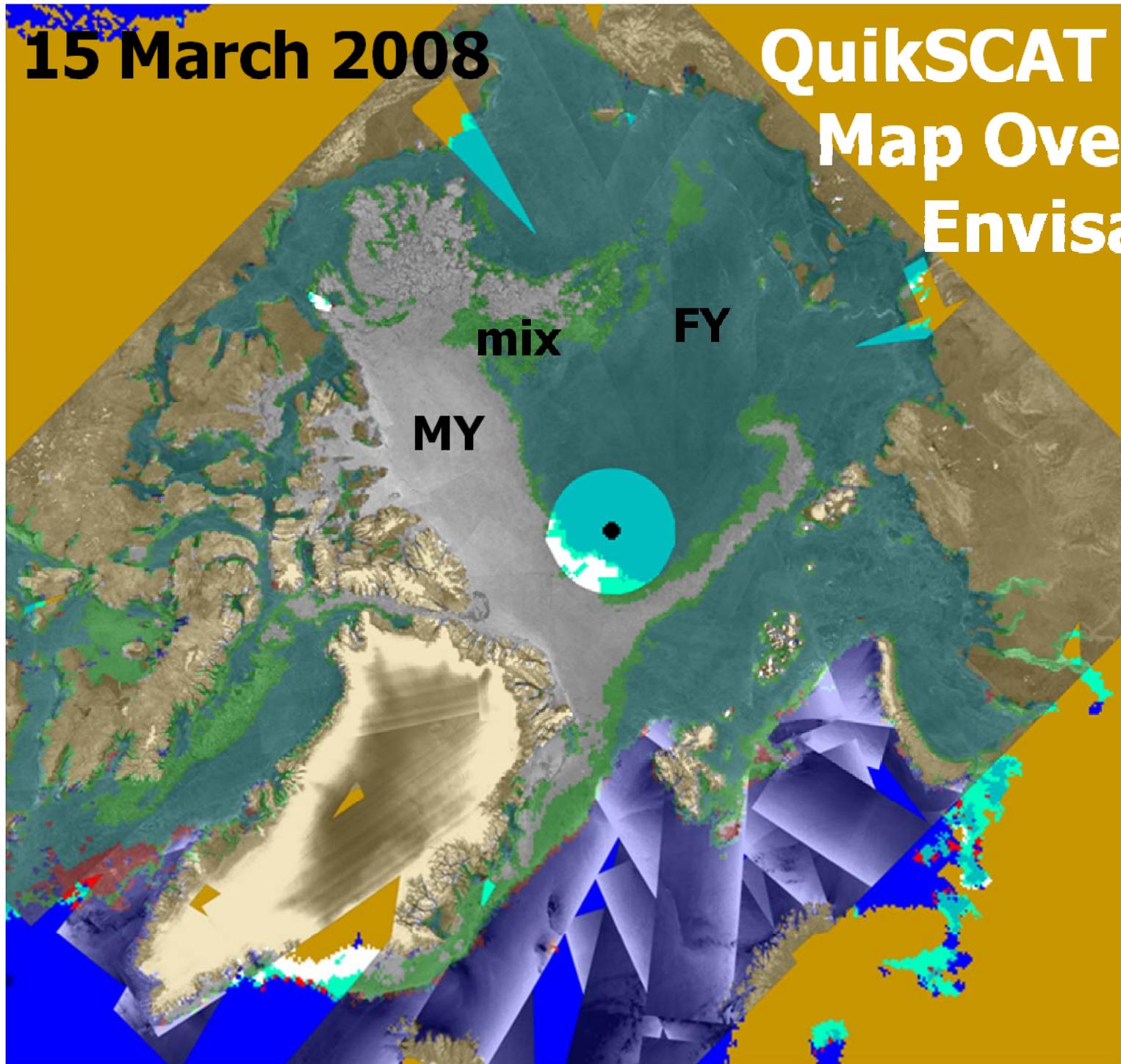
Large-Scale Arctic Ocean Basin



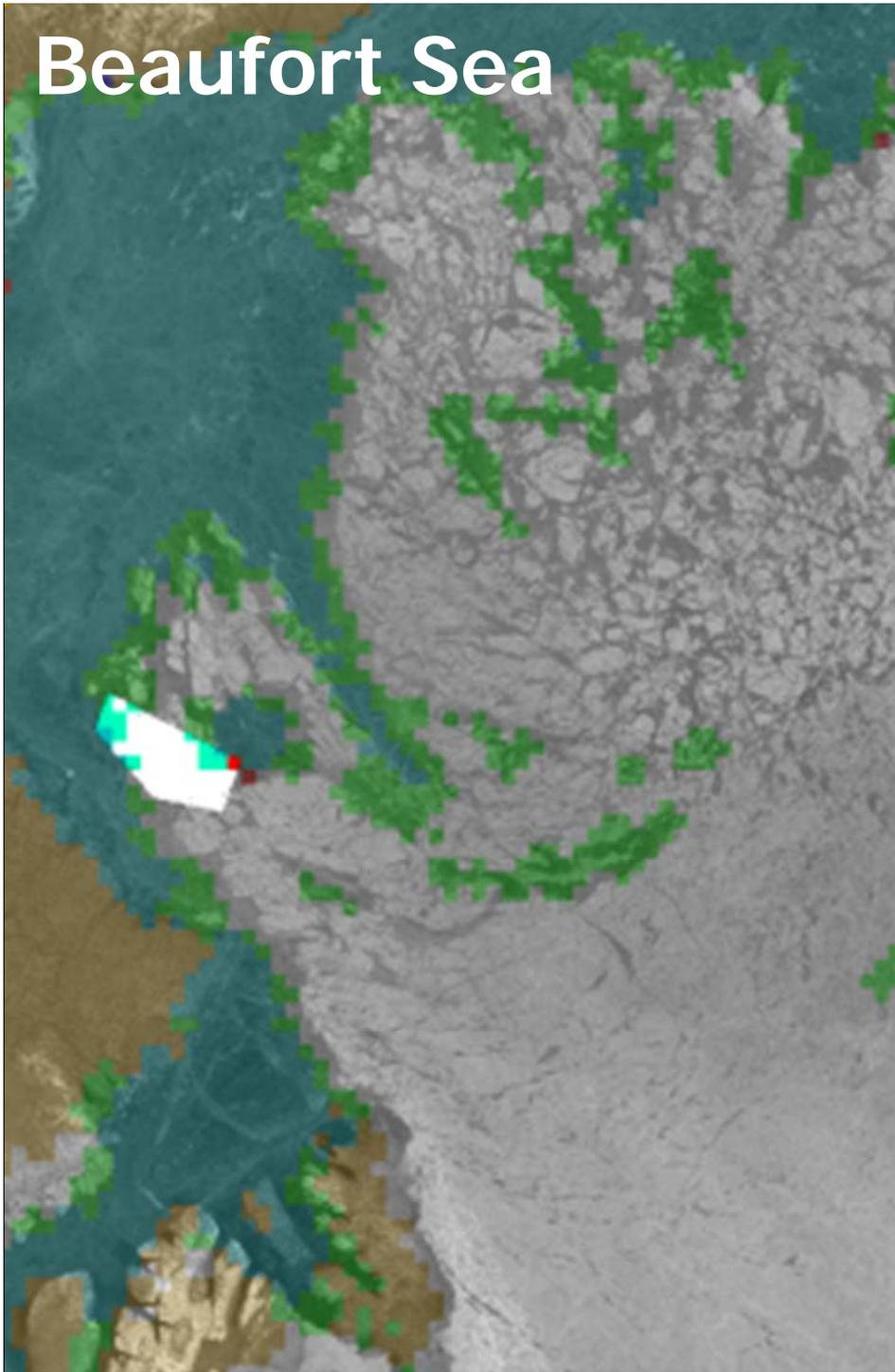
15 March 2008

QuikSCAT Sea Ice Map Overlaid on Envisat ASAR Image

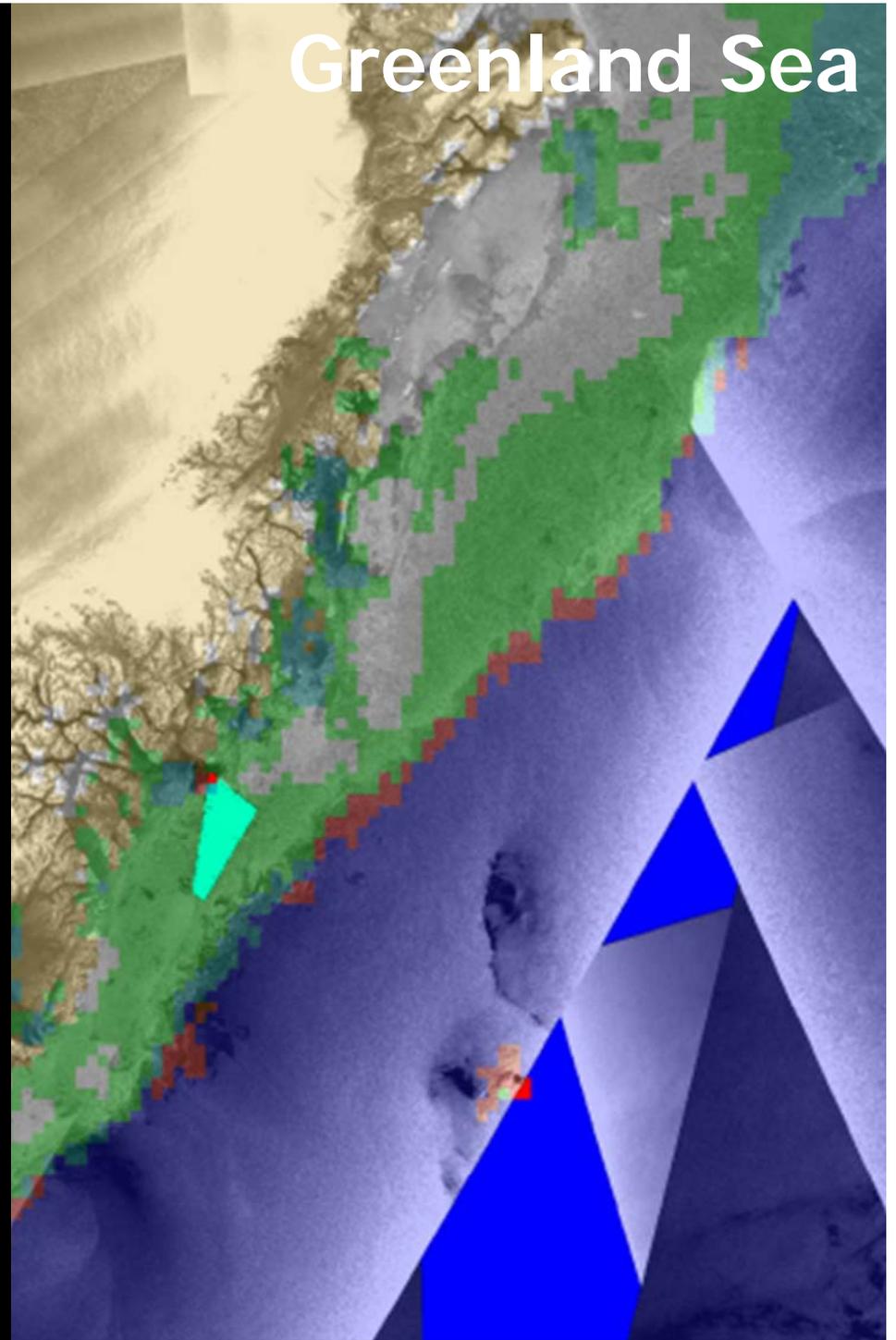
**QuikSCAT -
Envisat GMM
composite
sea ice image
product by
the National
Ice Center**



Beaufort Sea



Greenland Sea



1. Bathymetry affects sea ice reduction process
2. Bathymetry governs water mass distribution and thus controls sea ice formation
3. Composite sea ice mapping products from multiple satellite datasets can be useful.

Bathymetry data need to have:

1. Include seafloor features and not truncated at a given latitude
2. Accuracy in the peripheral seas for a better understanding of sea ice in the MIZ
3. Inclusion of detailed measurements along coastal regions