Important Role of Bathymetry in Polar Sea Ice Formation and Evolution

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Rapid Reduction of Sea Ice

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
Before 1970:
No discernable trend in March perennial ice extent.

1970-1999:
Decrease of $0.5 \times 10^6$ km$^2$ per decade in March perennial ice extent as estimated from the Drift-Age model.
2000-2008: Decrease of $1.5 \times 10^6$ km$^2$ 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 TD\(^1\) carrying ice out of Arctic via Fram Strait

Warm Atlantic water effectively melted ice in Greenland Sea

Nghiem et al. GRL, 2007
The Polar Express in 2005

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

Dipole anomaly

Nghiem/9
Animation of sea ice
20 frames per second
Acceleration of Transpolar Drift
TARA Expedition - Gone With the Wind
Gascard et al., Eos, Vol. 89, No. 3, 2008
Bathymetric Control of Water Masses

Nghiem et al., JGR, 2005
Bathymetric Control of Sea Ice

Nghiem, Van Woert, Neumann, JGR, 2005
Bathymetric Control of Sea Ice

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

Kamchatka
Anadyr
Aleutian N. Slope
Alaskan Stream

2008-03-12

Sea-ice backscatter (dB)
ETOP05 bathymetry (meter)

Nghiem/18
Bathymetric Control of Sea Ice
Summary

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