Tracking a newly predominant ice type
SIZONet observations of FY ice thickness north of AK

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Photo: David Ball, NRL
A seasonally dominated Arctic Ocean

Sea ice age
- 1st year
- 2nd year
- 3rd year
- 4th year
- 5th year
- older

Data courtesy of Jim Maslanik
U. Colorado
Early ice catches the early snowfall?
Barrow ice mass balance station (MBS)

1999-2004
Manual observations (stake farm)
• “Hot-wire” ice thickness gauges
• Snow depth stakes
• Internally-logging in-ice thermistor string

2005-present
Automated mass balance station
• Acoustic measurements of snow depth, ice thickness and water depth
• In-ice thermistor string
• Air and water temperature
• Data transmitted to shore station by VHF link
Barrow ice mass balance station (MBS)
12 seasons of FY ice growth

Diamonds show max thickness in last 3 weeks of May
Annual maximum FY ice thickness

Trend: -1 cm yr\(^{-1}\)  
\(R^2: 0.11\)
Possible drivers of thinning FY ice

Freezing Degree Days

- Significant trend toward fewer FDDs
Possible drivers of thinning FY ice

Date of “freeze-up”

- “Freeze-up” not easily defined
- Landfast ice forming later
Possible drivers of thinning FY ice

- No significant trend in snow depth
Possible drivers of thinning FY ice

Ice thickness vs Date of “freeze-up”

+1 day of delayed fast ice formation ≈ -1cm ice thickness
Possible drivers of thinning FY ice

Ice thickness vs Snow depth

**End-of-year snow depth**
- **Slope**: -3.50
- **$R^2$**: 0.19, **$P$**: 0.16

**Season-mean snow depth**
- **Slope**: 53.21
- **$R^2$**: 0.00, **$P$**: 0.90
Possible drivers of thinning FY ice

Ice thickness/FDD vs Freezing degree days

- Normalized ice thickness, $10^{-4}$ m per degree-day
- +1 cm of snow $\sim$ -1.7 cm of ice growth
  
  *(In a “typical” 4200-FDD winter)*
Early ice catches the early snowfall?
Airborne electromagnetic (AEM) surveys

Photo: David Ball, Naval Research Lab.
9 years of Barrow AEM campaigns
PDFs of AEM ice + snow thickness

Diamonds show modal thickness in FY range

- Secondary mode indicates level multiyear (MY) ice thickness
- only clearly evident in 2007

No separation of modes
Comparison of MBS and AEM ice thicknesses

MBS and AEM show similar interannual variability
Particularly since 2010

Trend: -1 cm yr$^{-1}$
$R^2$: 0.11
Comparison of MBS and AEM ice thicknesses

Evidence of similar variability in eastern Beaufort Sea

Annual maximum FY ice thickness at Barrow, Alaska

MBS
EM31/drilling
AEM
Eastern Beaufort

Trend: -1 cm yr$^{-1}$

$R^2$: 0.11

Data from Christian Haas, York University
Deformed ice thickness

Hanna Shoal generates the thickest ice in the Chukchi Sea

- importance as late-summer habitat for walrus
- significant hazard for maritime activities
- recurs every year, but forming later in season
Summary

First-year sea ice north of Alaska is thinning

- *largely driven by shorter, warmer winters*
- *delayed freeze-up not offset by thinner snow*

Impacts on marine mammal habitat and ice-related hazards unclear

- *significant source regions of thick, deformed ice still present*

*Coordinated observations of seasonal ice zone critical for understanding the transitioning Arctic Ocean*