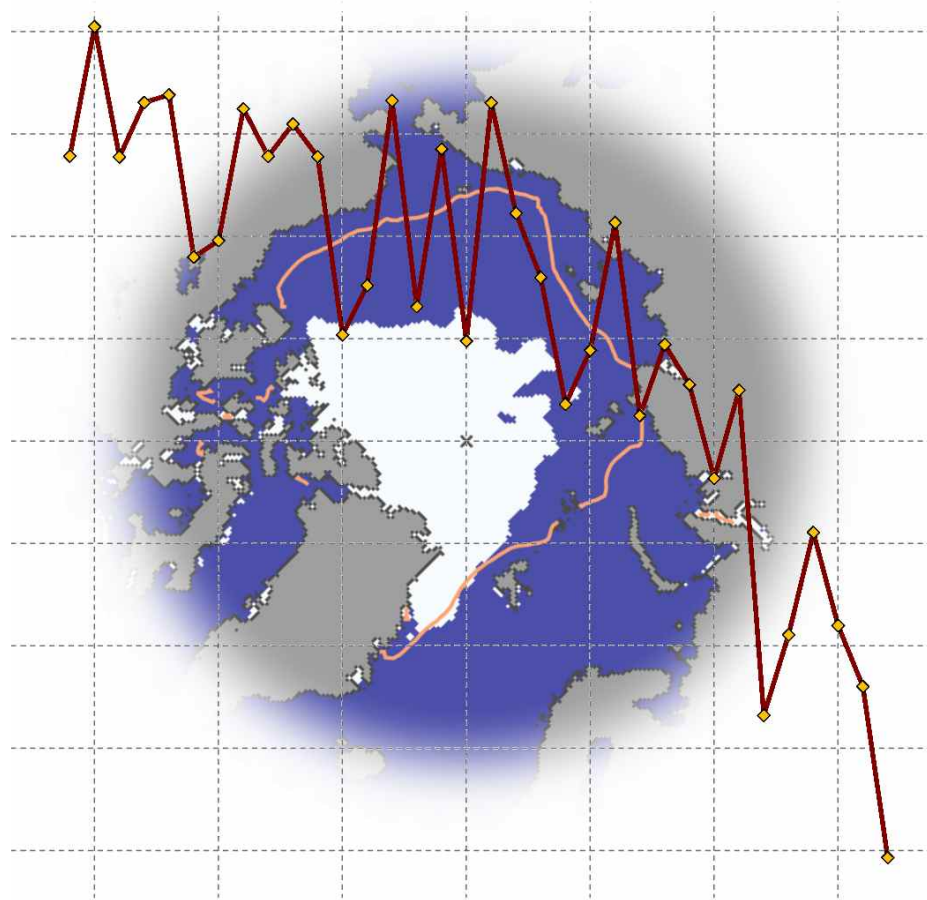


Sea ice and climate change



Andy Mahoney
Geophysical Institute, University of Alaska Fairbanks

SMAP/ICESat-2 Joint Mission Applications Tutorial

Fairbanks, AK

Sep 18-20



Outline

- What is sea ice? (*and what is it not?*)
- Local and global significance of sea ice
- Why is sea ice in the news?
- Importance of measuring sea ice thickness



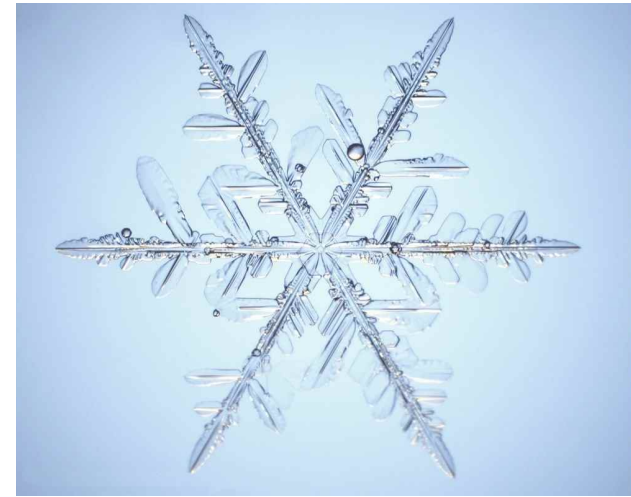
What is sea ice?

- Sea ice is frozen sea water
 - contains liquid brine encapsulated in pockets
- *First year* (seasonal) ice
 - found at periphery of Arctic
 - Level ice up to 2m thick
- *Multiyear* (perennial) ice
 - Occupies central Arctic
 - Level ice up to 4m thick
- Pressure ridges may form up to 40 m thick



Other components of the *cryosphere*

- **Snow**
 - Formed by nucleation in atmosphere
- **Glaciers & ice sheets**
 - Composed of compacted snow
- **Permafrost**
 - Permanently frozen ground
 - (may not contain any ice)
- **River and lake ice**
 - Frozen fresh water
 - (no brine pockets)

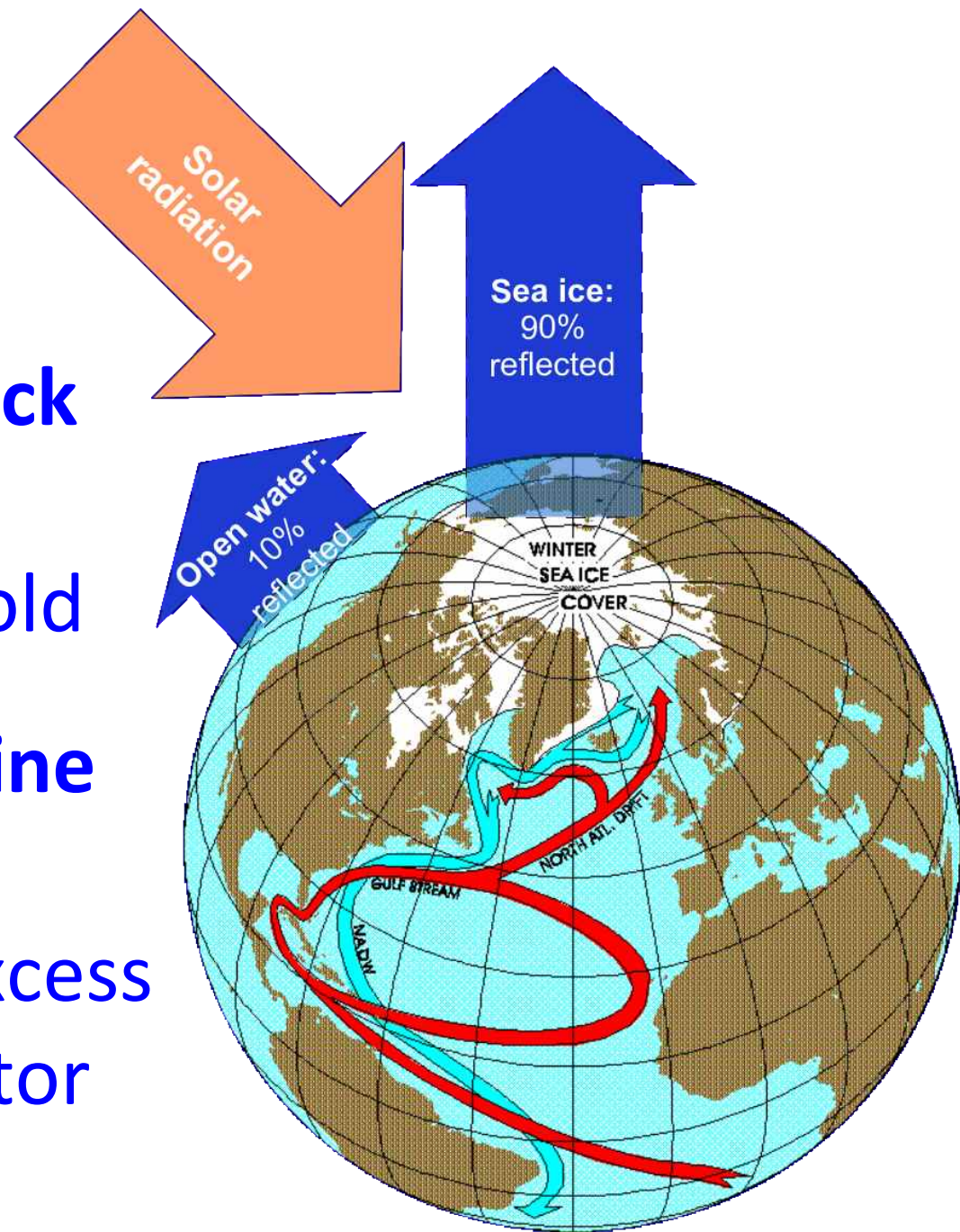


Role of sea ice in climate, ecosystem & society



Regulator Of Earth's Climate

- **Ice-albedo feedback**
 - Helps keep the Polar Regions cold
- **Global thermohaline circulation**
 - Redistributes excess heat from equator



Essential Component Of Polar Ecosystem

- Substrate for primary production
- Habitat for marine mammals



Impact On Human Activities

- Platform for hunting and travelling
- Obstacle for shipping
- Hides submarines
- Mitigates coastal erosion



Scientific importance of sea ice



*Abstracts submitted to the Annals of Glaciology v52(57):
Sea Ice in the Physical and Biogeochemical System*

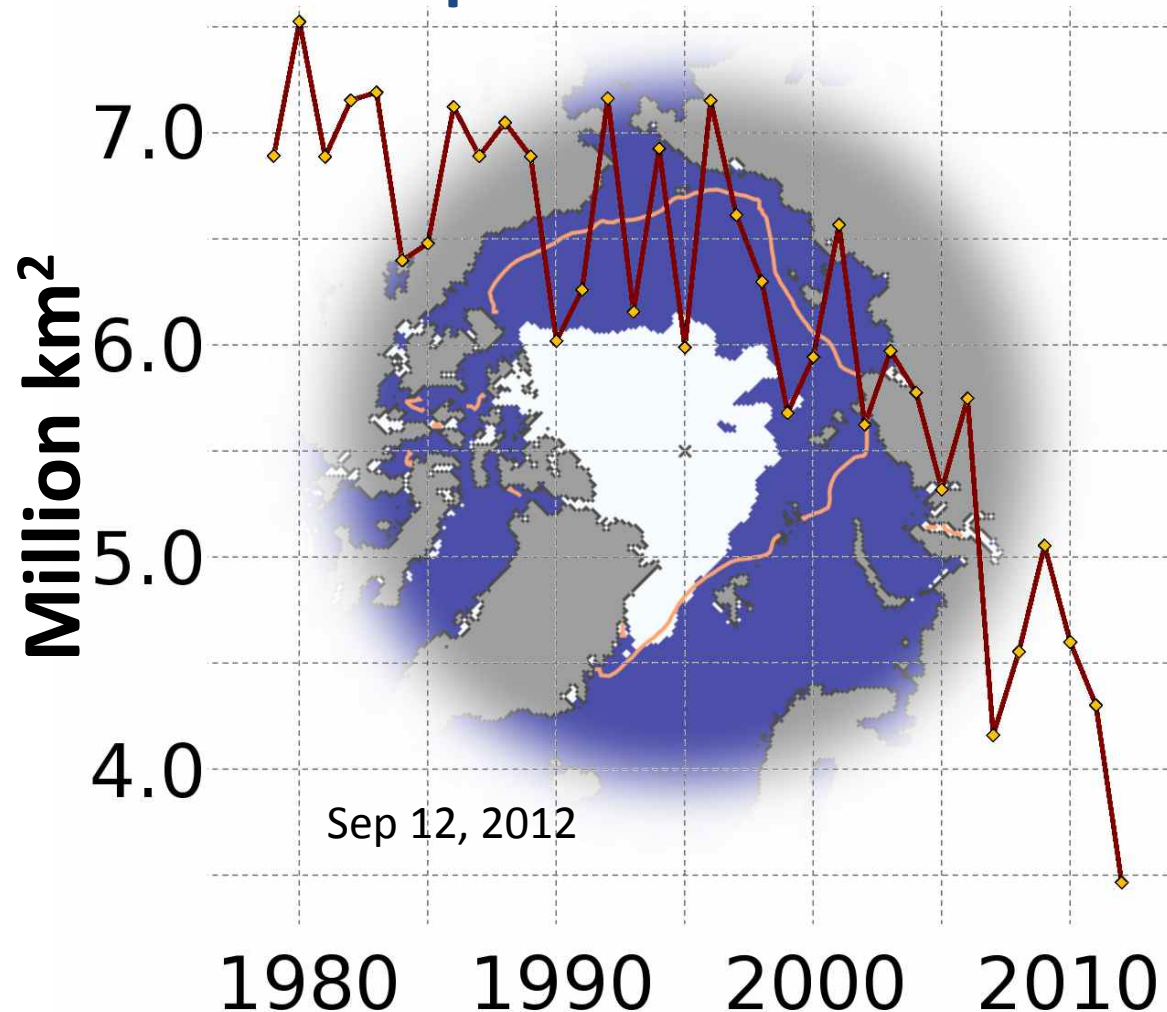
Local importance of sea ice



Contributions from hunters and elders from the communities of Barrow (Alaska), Clyde River (Nunavut) and Qaanaaq (Greenland)


Why is sea ice in the news?

Northern hemisphere minimum sea ice extent




Data from National Snow and Ice Data Center

Why is sea ice in the news?



sea ice



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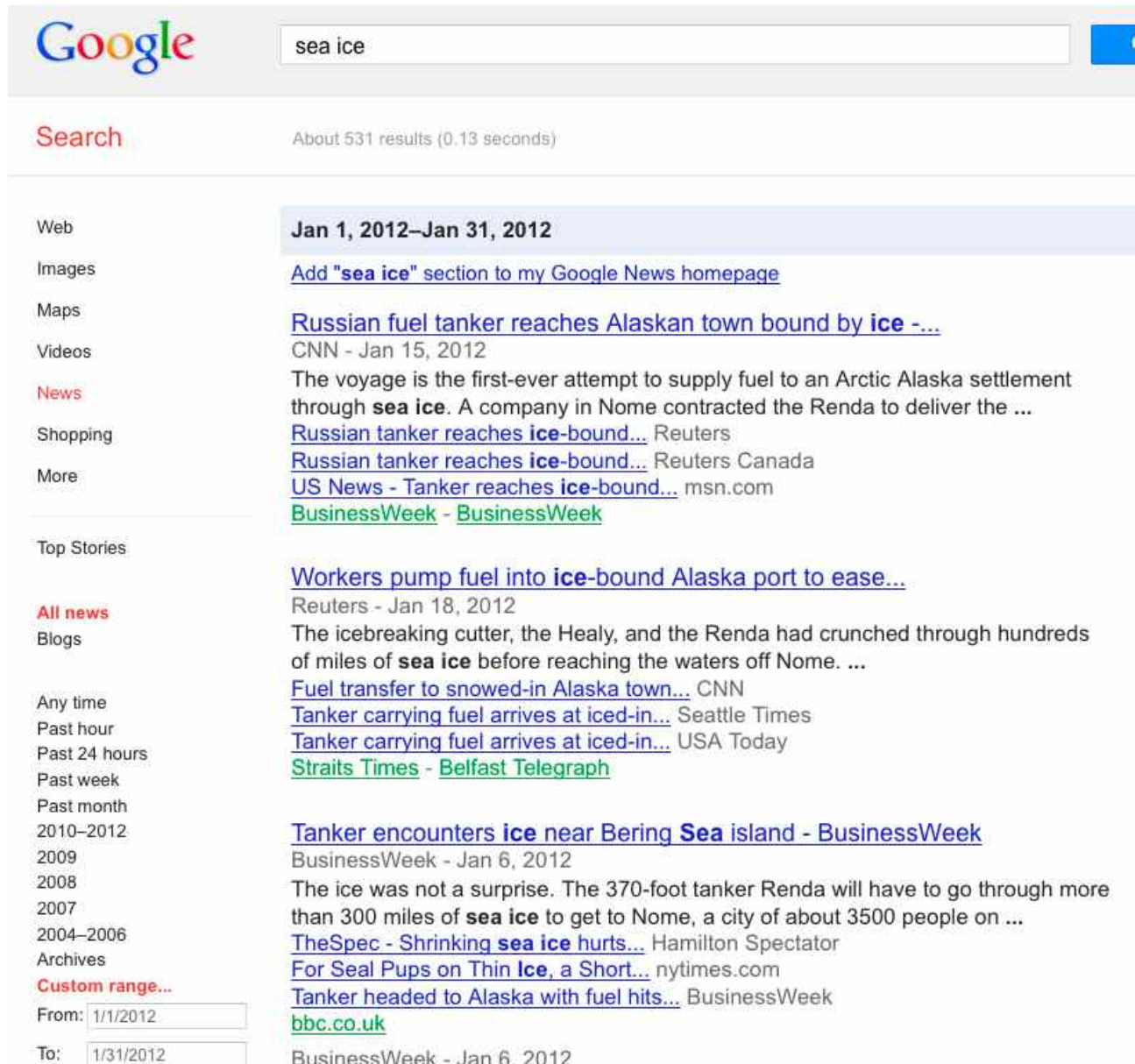
[Arctic sea ice hits record low: live updates and reaction](#)
The Guardian (blog) - 19 hours ago
The older **sea ice**, which is 3m to 4m thick, is becoming increasingly ... The study also provides a detailed history of **sea ice** in the Arctic.
+ [Video: All The Ice Is Melting](#)  Rocketboom
[Record loss of Arctic ice may trigger extreme weather](#) Los Angeles Times
[Arctic Crustaceans Use Deep-Water Migration To Survive Sea Ice ...](#)
PlanetSave.com
[Huffington Post](#) - [Phys.Org](#) - [NBCNews.com](#)
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[Ice still delaying Shell Arctic offshore drilling](#)
CBS News - Sep 11, 2012
ANCHORAGE, Alaska — Moving **ice** may keep a Royal Dutch Shell petroleum drill ship away from a Chukchi **Sea** prospect for several days, ...
[Shell Halts Arctic Drilling Right After It Began](#) New York Times (blog)
[Ice threat halts Shell's drilling in Arctic Ocean after one day](#) Los Angeles Times
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NBCNews.com


National Geographic

Why is sea ice in the news?



The image is a screenshot of a Google search results page for the query "sea ice". The search bar at the top shows "sea ice" and indicates "About 531 results (0.13 seconds)". The left sidebar contains navigation links: Web, Images, Maps, Videos, News (highlighted in red), Shopping, More, Top Stories, All news (highlighted in red), Blogs, Any time, Past hour, Past 24 hours, Past week, Past month, 2010-2012, 2009, 2008, 2007, 2004-2006, Archives, Custom range... (highlighted in red), From: 1/1/2012, and To: 1/31/2012. The main content area displays a date filter for "Jan 1, 2012-Jan 31, 2012" and a link to "Add 'sea ice' section to my Google News homepage". Below this, several news snippets are listed, each with a headline, source, and date. The snippets are: "Russian fuel tanker reaches Alaskan town bound by ice -..." from CNN (Jan 15, 2012) about a voyage to supply fuel to an Arctic Alaska settlement; "Russian tanker reaches ice-bound..." from Reuters and Reuters Canada; "US News - Tanker reaches ice-bound..." from msn.com; "BusinessWeek - BusinessWeek"; "Workers pump fuel into ice-bound Alaska port to ease..." from Reuters (Jan 18, 2012) about icebreakers Healy and Renda; "Fuel transfer to snowed-in Alaska town..." from CNN; "Tanker carrying fuel arrives at iced-in..." from Seattle Times and USA Today; "Straits Times - Belfast Telegraph"; "Tanker encounters ice near Bering Sea island - BusinessWeek" from BusinessWeek (Jan 6, 2012) about the 370-foot tanker Renda; "TheSpec - Shrinking sea ice hurts..." from Hamilton Spectator; "For Seal Pups on Thin Ice, a Short..." from nytimes.com; "Tanker headed to Alaska with fuel hits..." from BusinessWeek; and "bbc.co.uk" from BusinessWeek (Jan 6, 2012).

Google

sea ice

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Jan 1, 2012-Jan 31, 2012

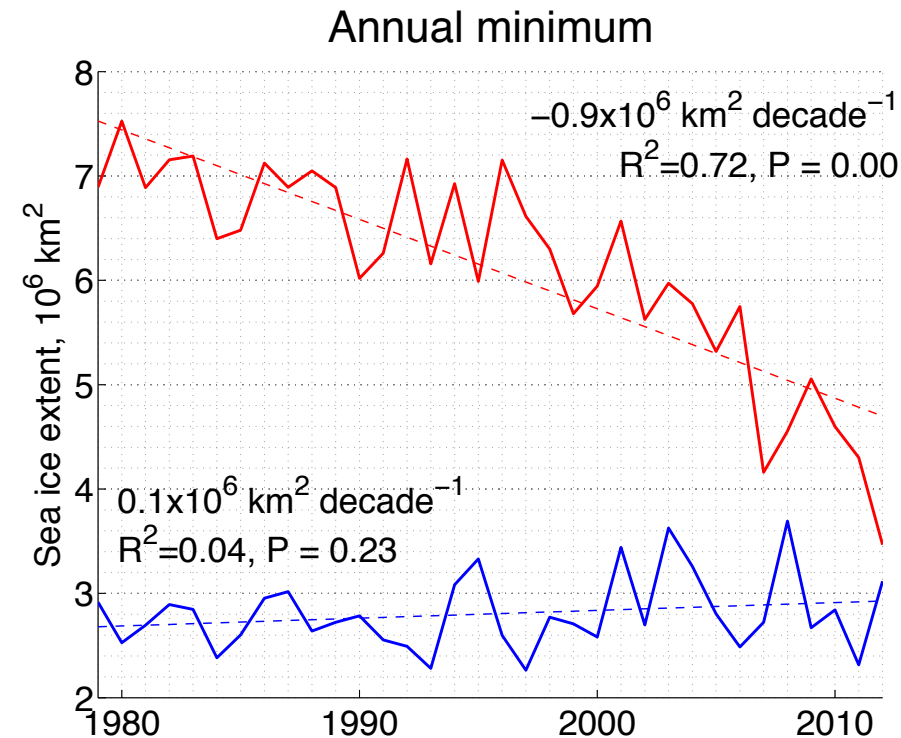
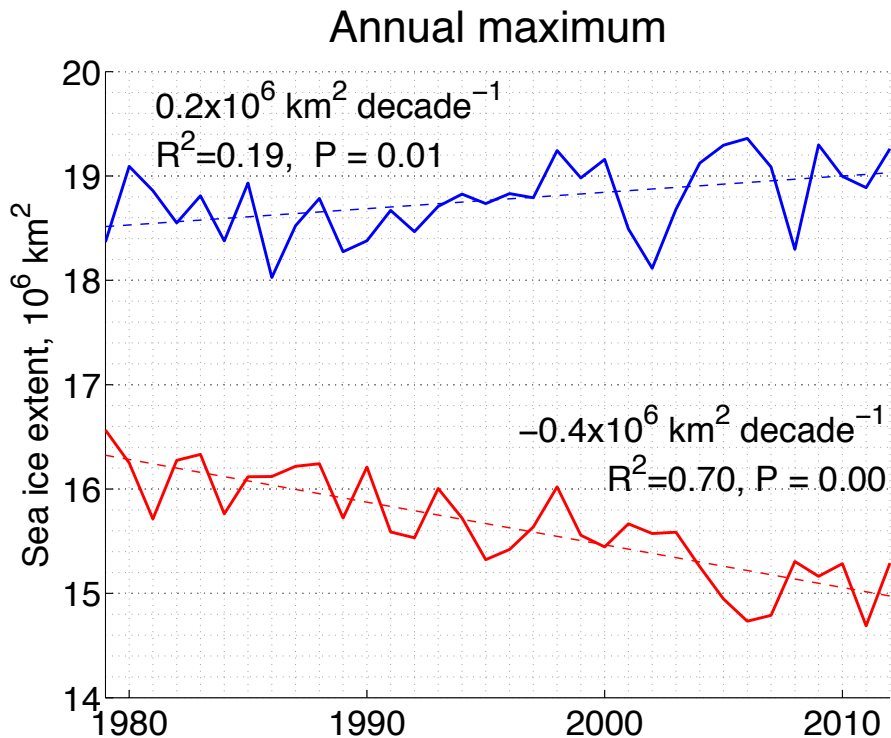
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[Russian fuel tanker reaches Alaskan town bound by ice -...](#)
CNN - Jan 15, 2012
The voyage is the first-ever attempt to supply fuel to an Arctic Alaska settlement through **sea ice**. A company in Nome contracted the Renda to deliver the ...
[Russian tanker reaches ice-bound...](#) Reuters
[Russian tanker reaches ice-bound...](#) Reuters Canada
[US News - Tanker reaches ice-bound...](#) msn.com
[BusinessWeek](#) - [BusinessWeek](#)

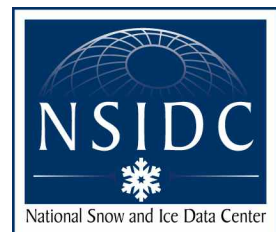
[Workers pump fuel into ice-bound Alaska port to ease...](#)
Reuters - Jan 18, 2012
The icebreaking cutter, the Healy, and the Renda had crunched through hundreds of miles of **sea ice** before reaching the waters off Nome. ...
[Fuel transfer to snowed-in Alaska town...](#) CNN
[Tanker carrying fuel arrives at iced-in...](#) Seattle Times
[Tanker carrying fuel arrives at iced-in...](#) USA Today
[Straits Times](#) - [Belfast Telegraph](#)

[Tanker encounters ice near Bering Sea island - BusinessWeek](#)
BusinessWeek - Jan 6, 2012
The ice was not a surprise. The 370-foot tanker Renda will have to go through more than 300 miles of **sea ice** to get to Nome, a city of about 3500 people on ...
[TheSpec - Shrinking sea ice hurts...](#) Hamilton Spectator
[For Seal Pups on Thin Ice, a Short...](#) nytimes.com
[Tanker headed to Alaska with fuel hits...](#) BusinessWeek
[bbc.co.uk](#)
BusinessWeek - Jan 6, 2012

Northern vs Southern hemisphere

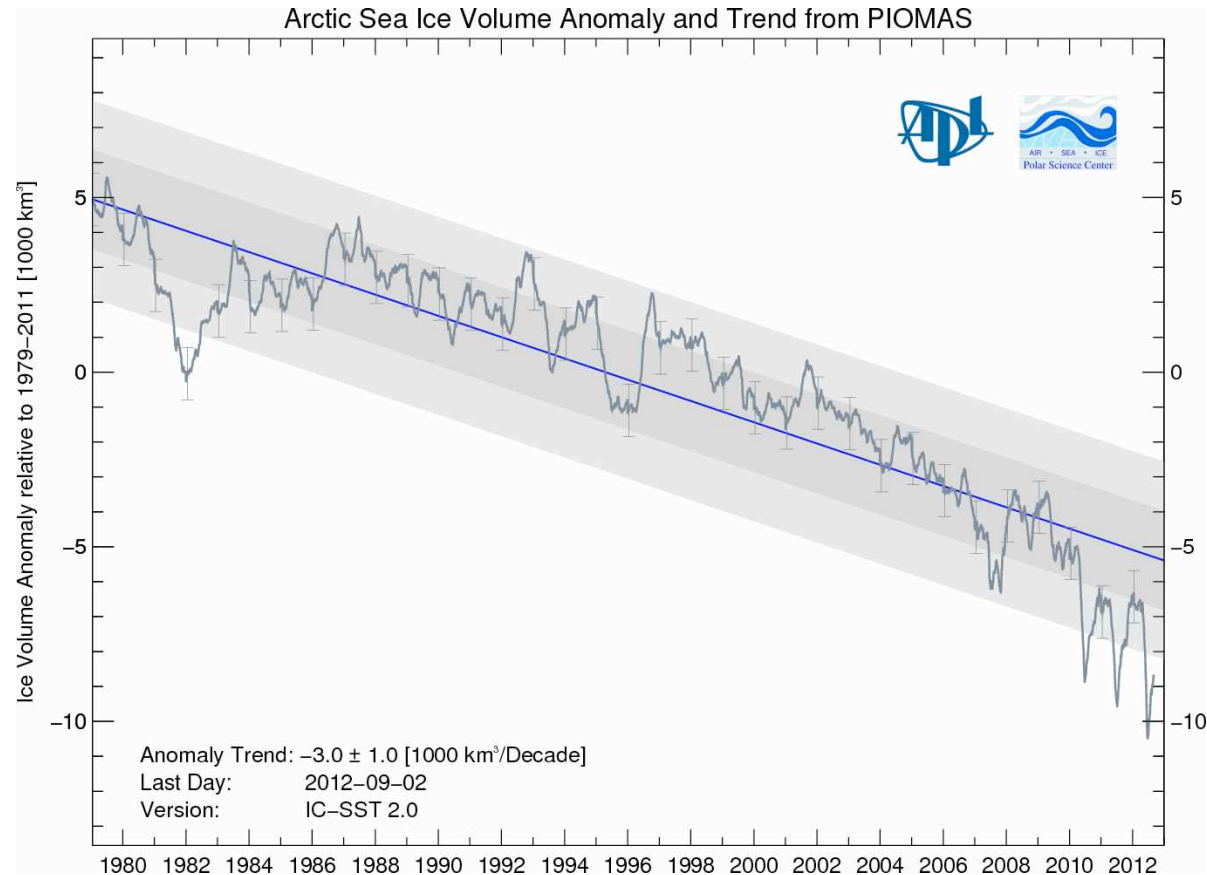


Data from National Snow and Ice Data Center



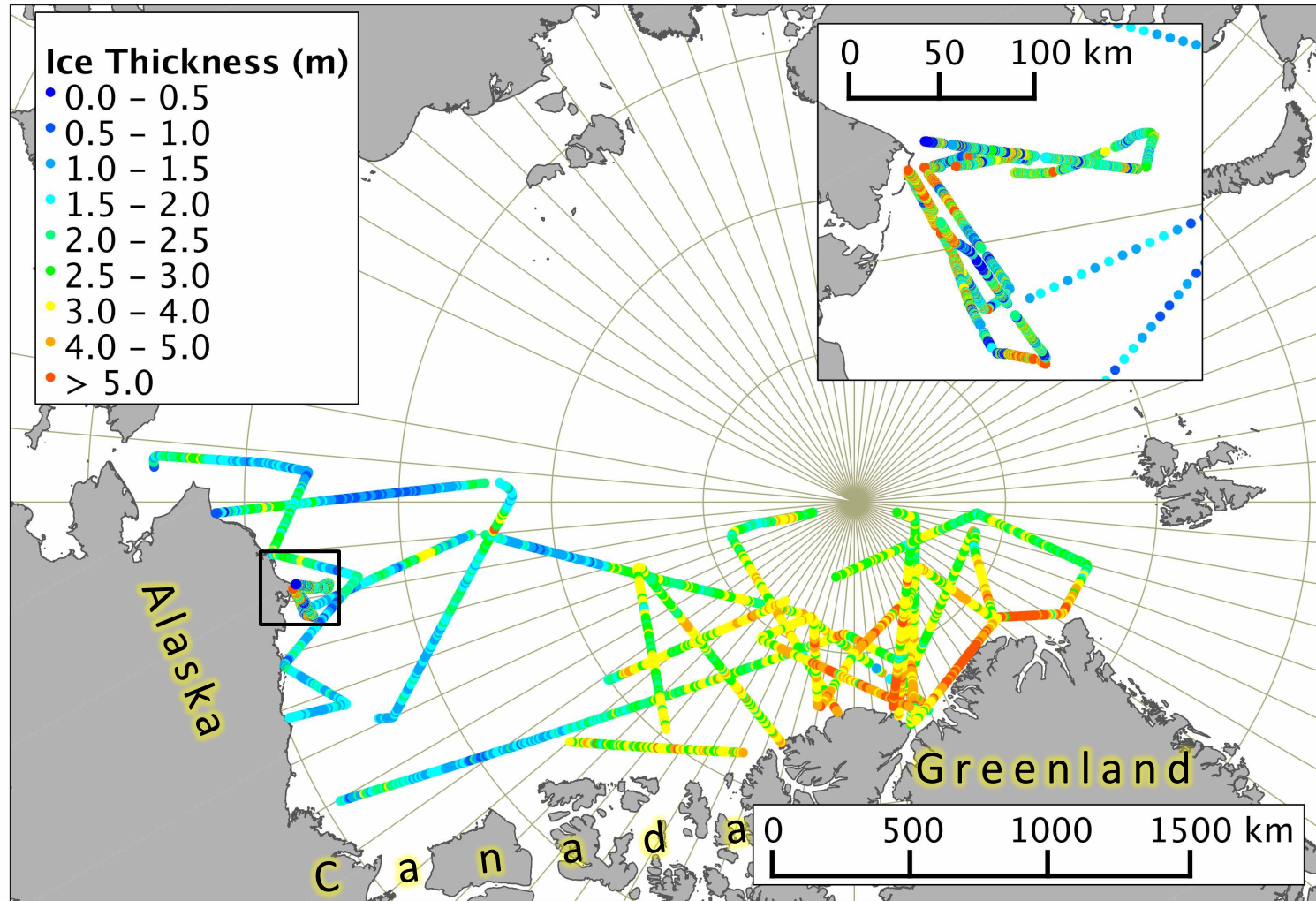
Sea ice extent only part of the story

- Arctic sea ice volume has been decreasing steadily for several years
- This year's rapid loss of ice largely attributed to loss of thickest ice floes in previous years



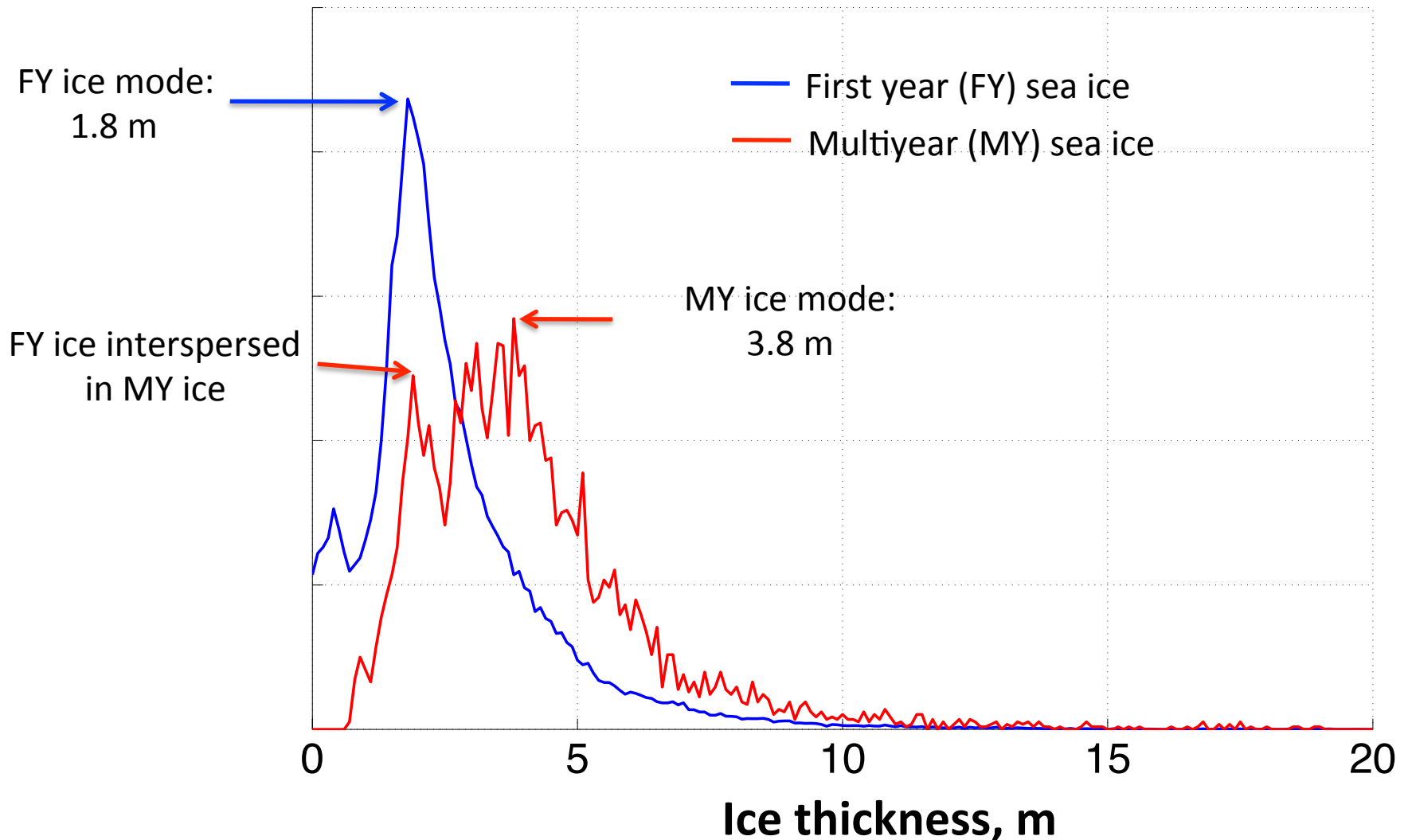
Ice thickness observations

Operation Ice Bridge and SIZONet Airborne ice thickness measurements



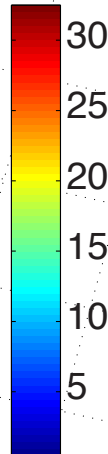
Ice thickness observations

SIZONet ice+snow thickness distributions
Western Beaufort Sea, April 2012



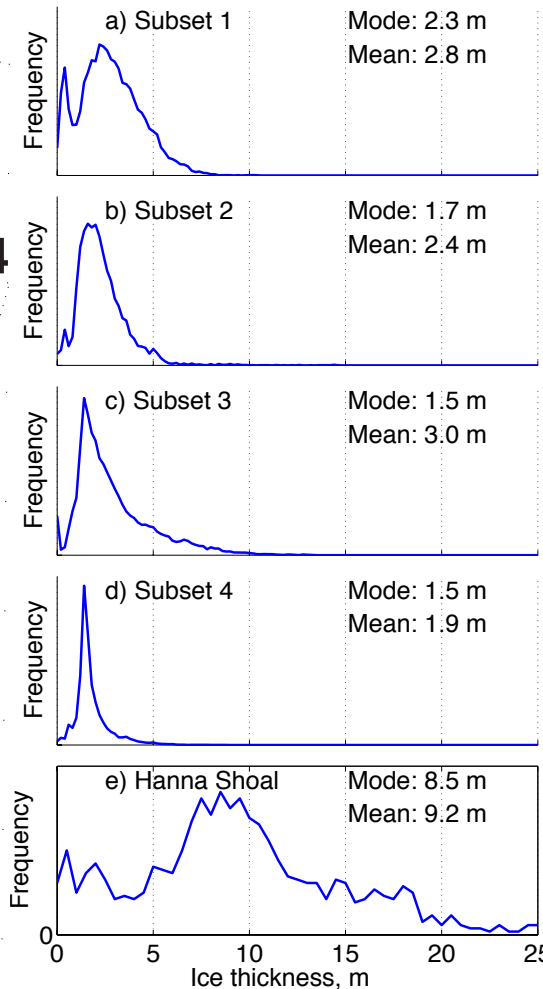
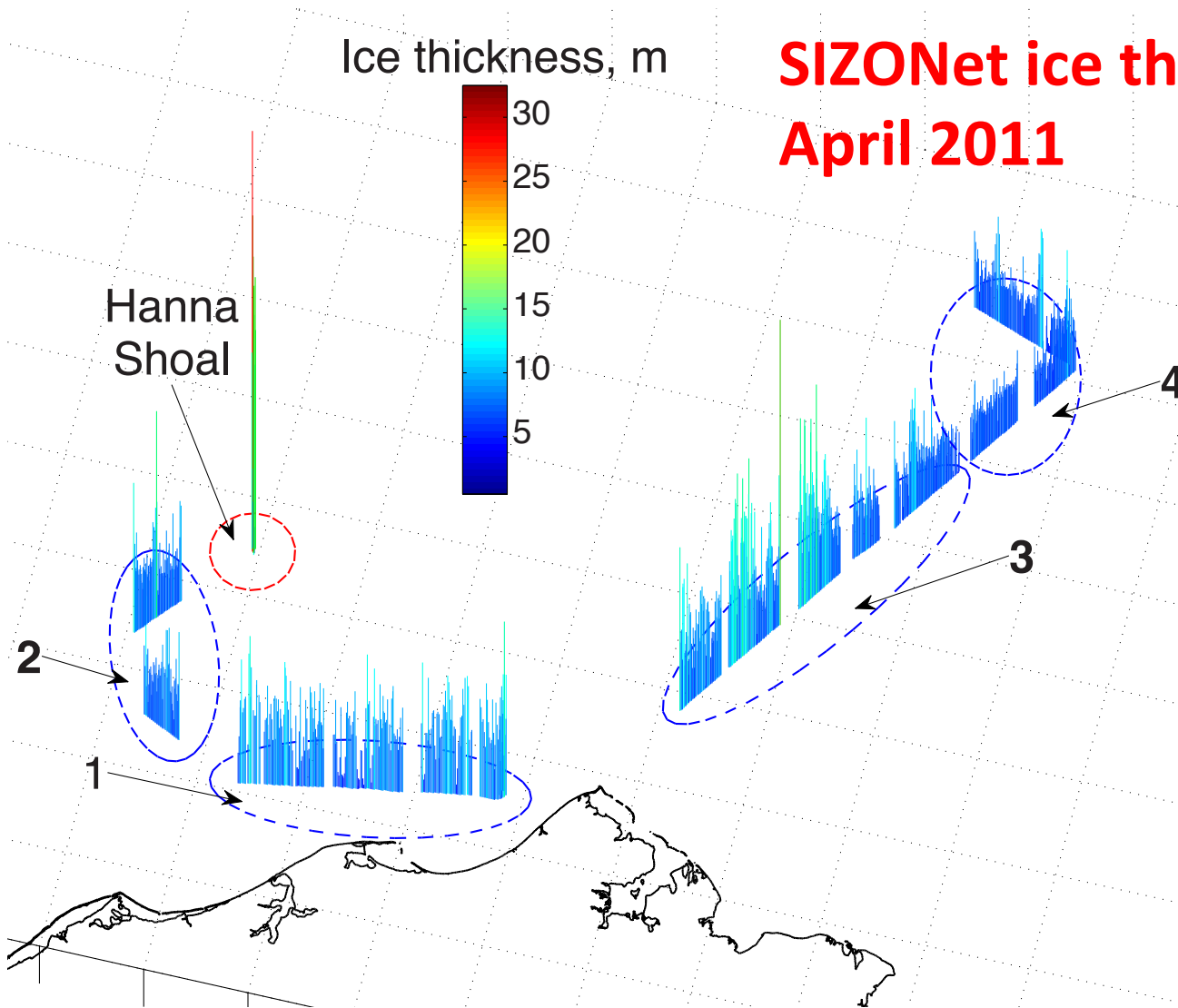
Regional variability can be large

Ice thickness, m



SIZONet ice thickness flights
April 2011

Hanna Shoal



Summary

Arctic sea ice extent is in rapid decline

- **Faster than predicted**

Global, continuous ice thickness

observations are key to understanding these changes:

- **Improving scientific knowledge**
 - *Long-term forecasting and climate models*
- **Increasing maritime operations in Arctic**
 - *short-term operational forecasts and regional variability*
- **Community adaption to change**
 - *Reducing uncertainty for local and regional planning*

