Tracking the state and use of coastal ice in Alaska communities through collaborative observations

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J Leavitt, B Adams; ***Barrow***, AK

I Krupnik; ***Smithsonian Institution***, Washington, DC

Sea-ice system services & ice use

- Sea ice provides services & hazards to people from the global to the local scale
- Slow onset
  - Climate regulation
  - Coastal protection
  - Geologic agent
  - Subsistence activities
- Rapid onset
  - Marine & coastal hazard
  - Transportation corridor
  - Platform

C. Nayokpuk, Shishmaref

Masterson

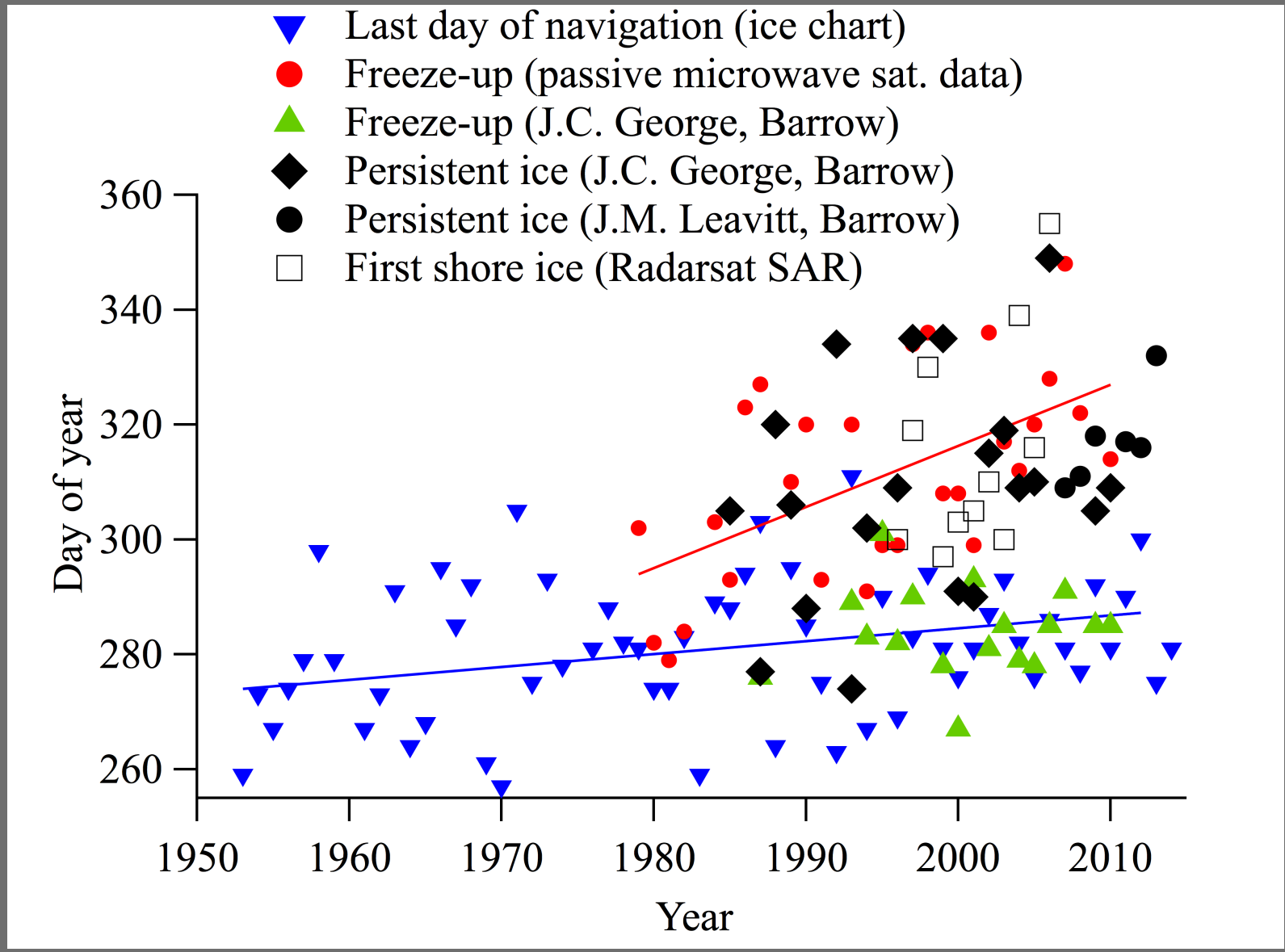
Sea-ice system services & ice use

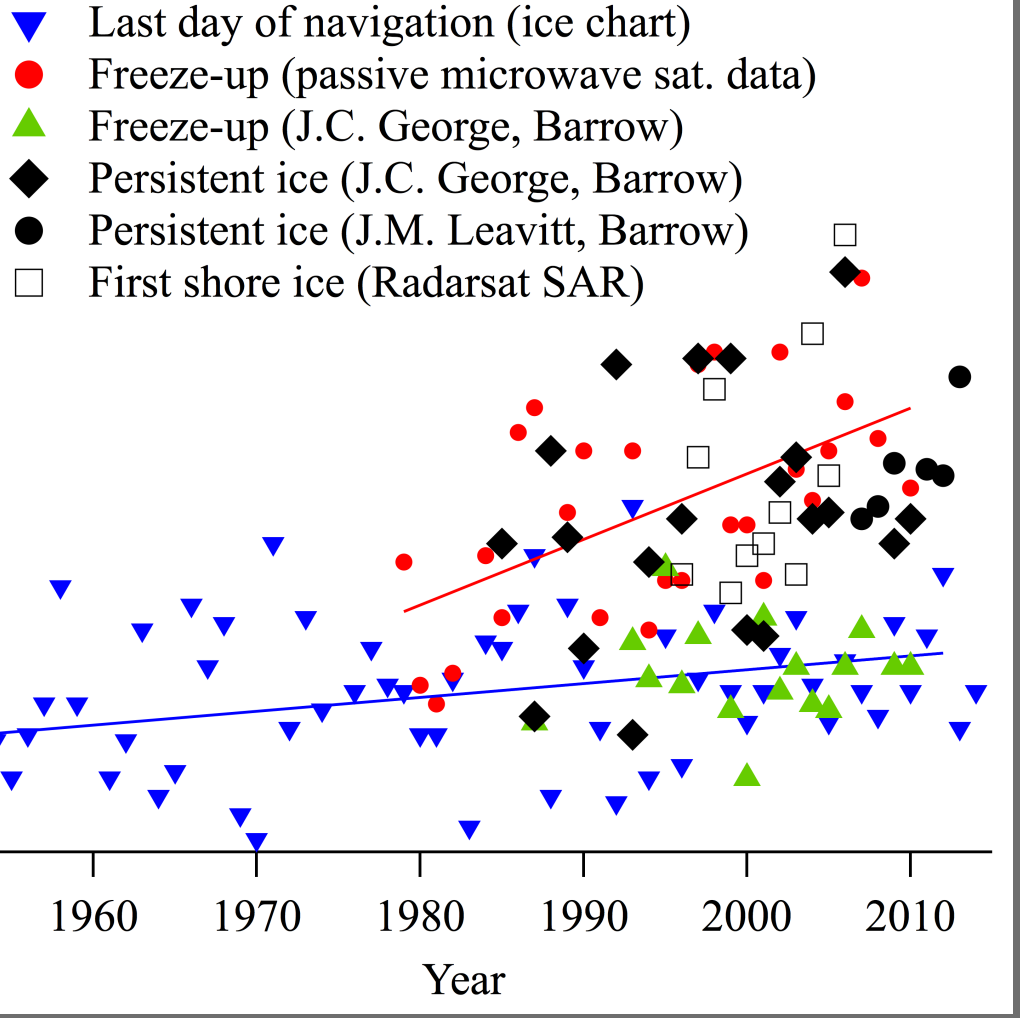
- What sea-ice properties & processes are relevant to key ice users?
- How do these relate to sea-ice mass-balance and climate data variables?
- What is the range of interannual variability and what are longer-term trends in ice use variables?
- Focs on sea-ice use by Alaska coastal communities

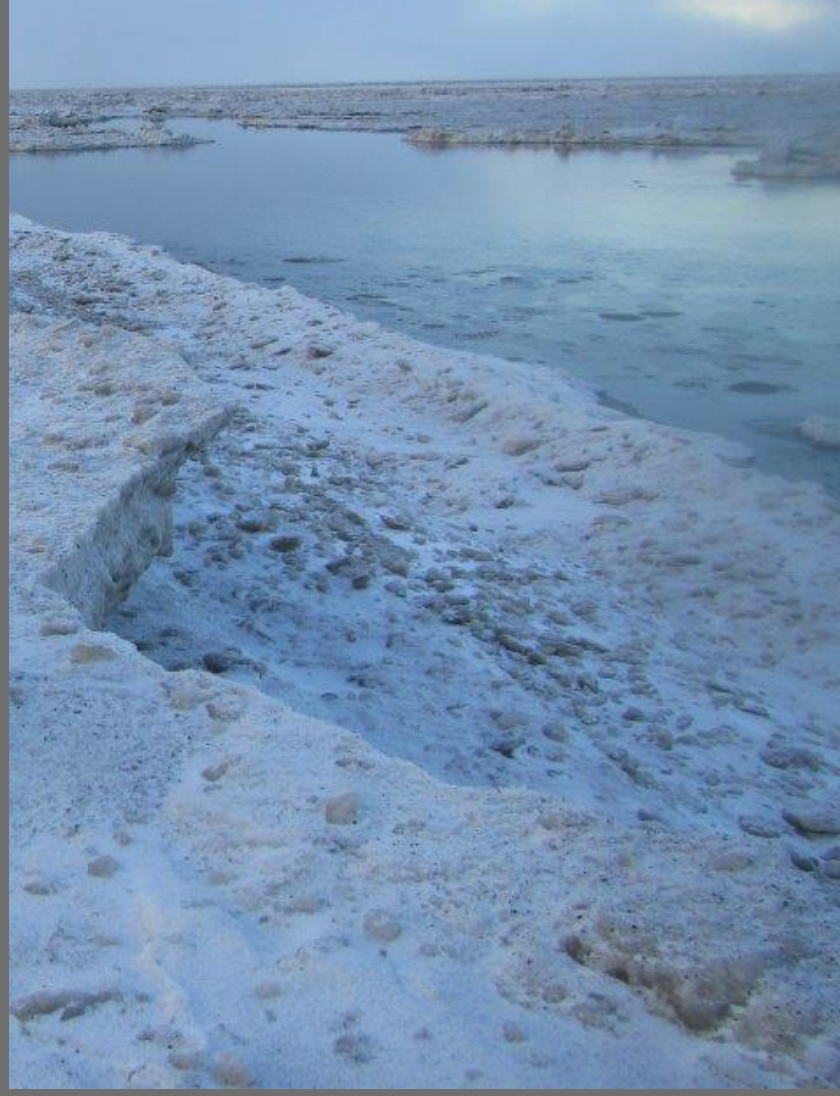
C. Nayokpuk, Shishmaref

Masterson

Freeze-up & first persistent ice – Barrow region



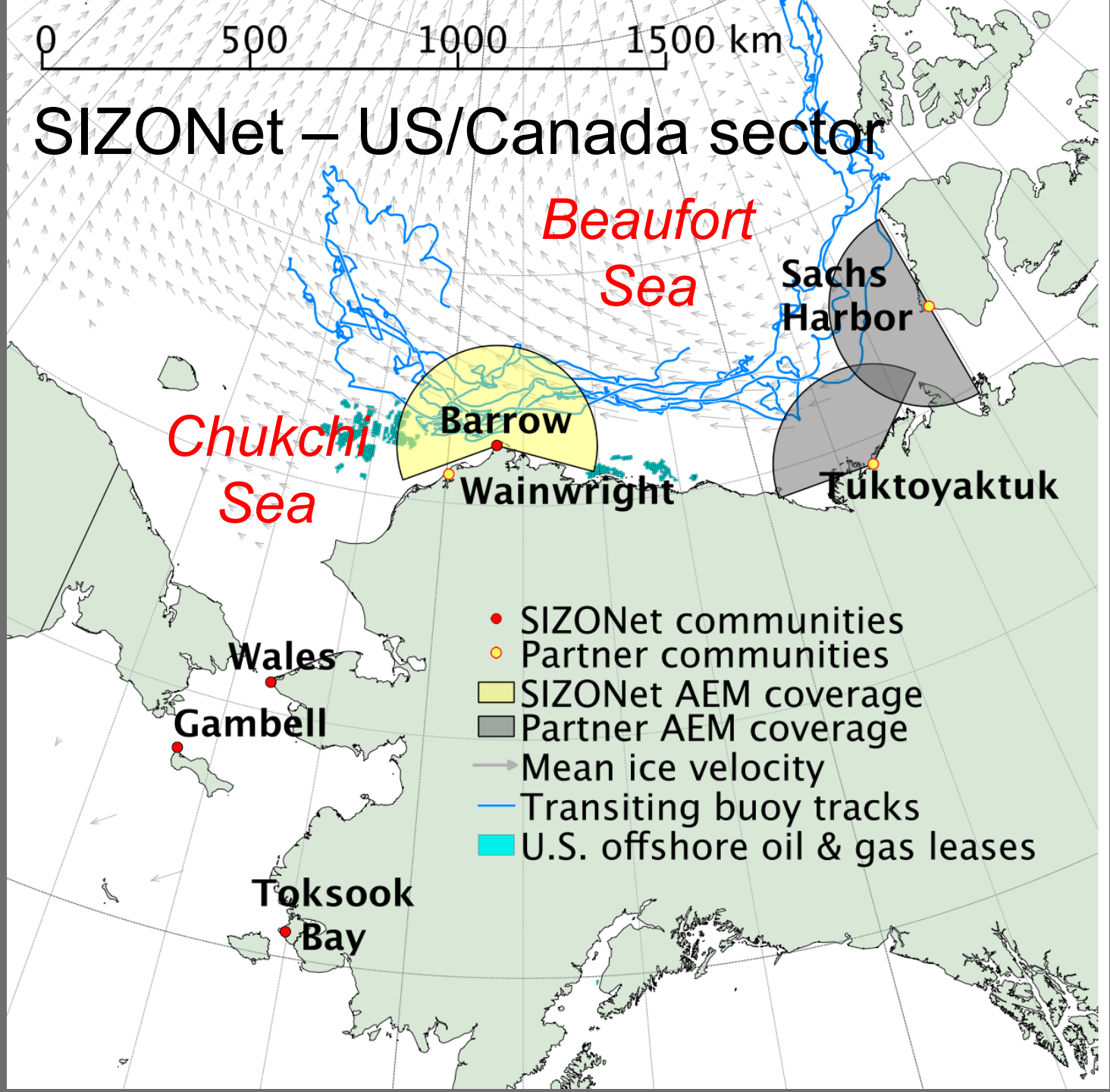




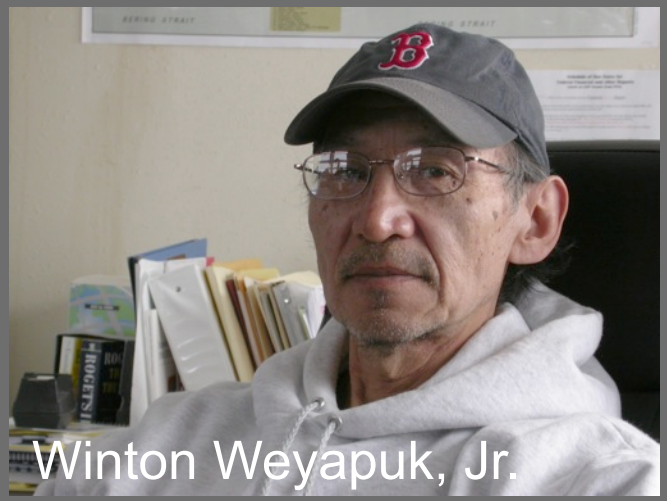
Billy Adams, Barrow, 26 Oct 2015:

• There is a 4-6 foot berm of frozen slush that has been made naturally as the Point is always a place where many things land to; […] new ice and waves have just [accumulated] slush there.

• Brown slush and young ice mixed that is what is coming in now from the north and east. At about 1 mile there is whiter clean ice that we can see further out.


0 500 1000 1500 km
SIZONet – US/Canada sector
Beaufort Sea
Chukchi Sea
Barrow
Wainwright
Sachs Harbor
Tuktoyaktuk
Wales
Gambell
Toksook Bay
SIZONet communities
Partner communities
SIZONet AEM coverage
Partner AEM coverage
Mean ice velocity
Transiting buoy tracks
U.S. offshore oil & gas leases

Key collaborators & partners


Winton Weyapuk, Jr.


Joe Leavitt

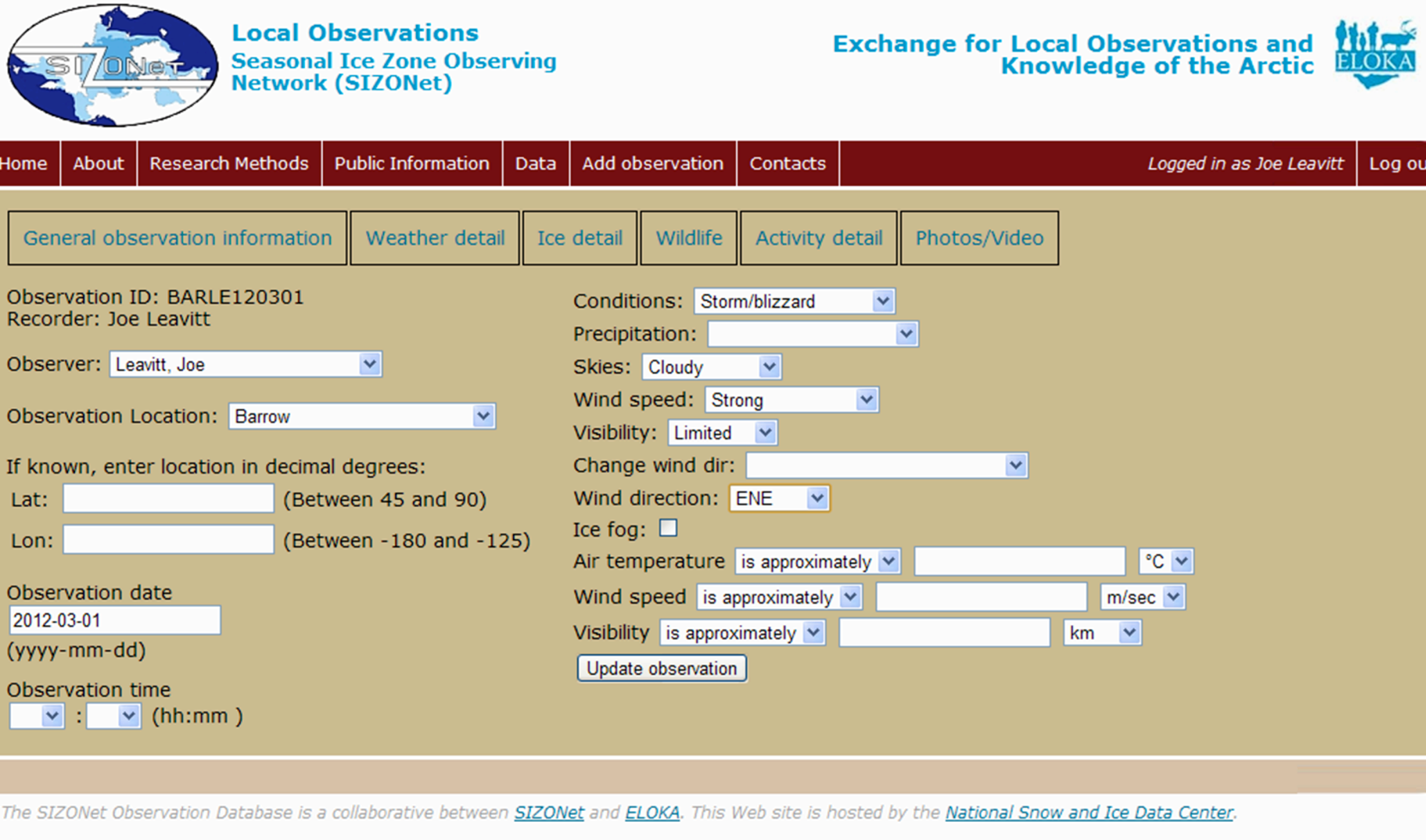

Billy Adams

- North Slope Borough, Barrow Whaling Captains Association, Eskimo Walrus Commission, Calista Elders Council
- AK Native Tribal Health Consortium
- ELOKA, ARCUS

- W. Weyapuk, Jr. (Wales)
- J. Leavitt, B. Adams (Barrow)
- S. John (Toksook Bay)
- P. & L. Apangalook Sr. (Gambell)

- NOAA & National Weather Service

A database for community-based ice observations through ELOKA support

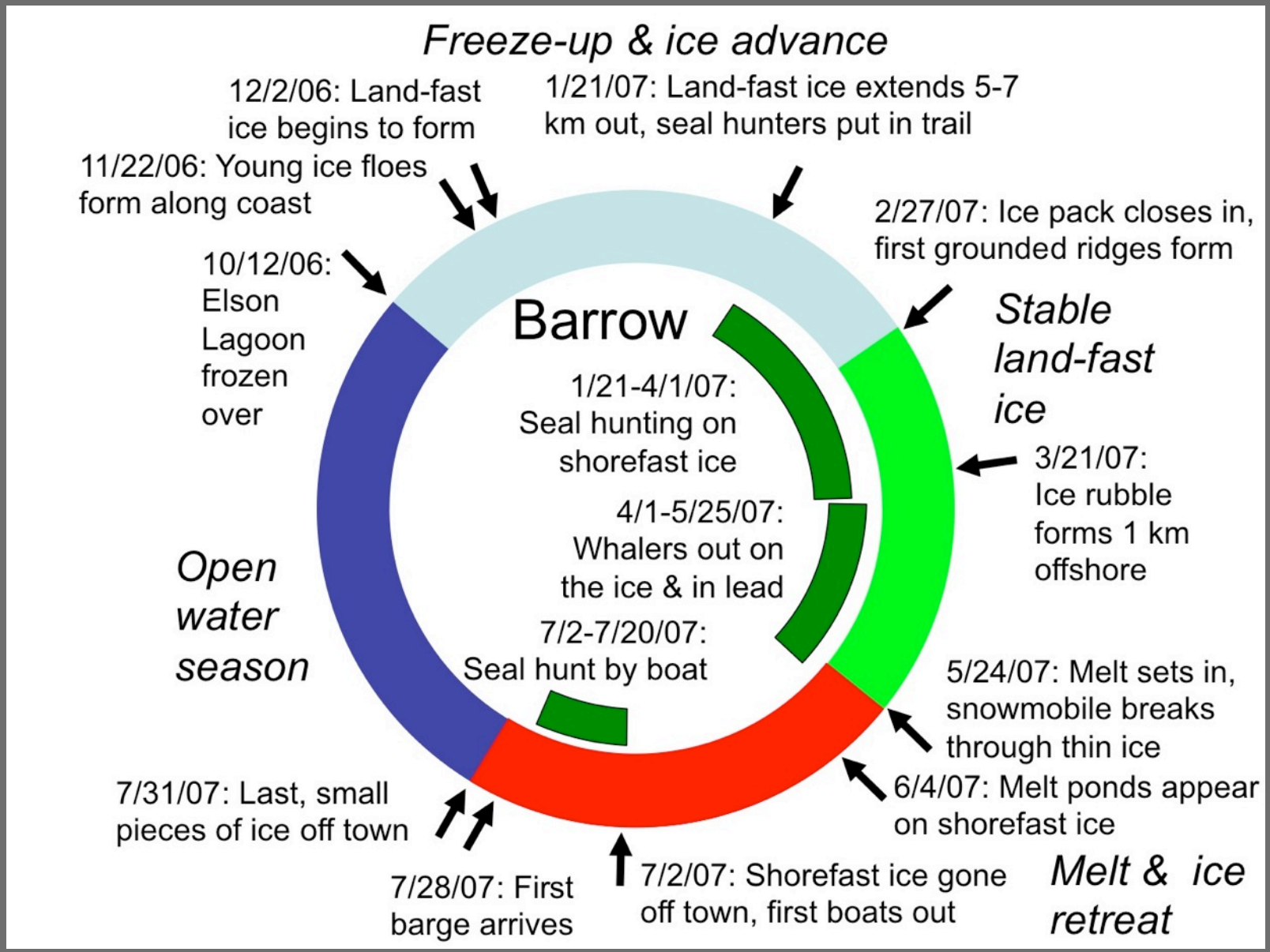


Access database at: https://eloka-arctic.org/sizonet

Status of database & associated projects

- >5000 observations from five core communities (Barrow, Wales, Shishmaref, Toksook Bay, Kwigillingok) from 2006 through 2015
- Additional observations from Shishmaref, Nome, Shaktoolik and other communities
- Wales Sea Ice Dictionary
- Sea Ice for Walrus Outlook (with NWS, EWC, ARCUS)
- USFWS W-AK LCC: Ice-coastal interaction during freeze-up 2012-14 (with ANTHC)
- ELOKA Phase 3: Build-out of database & archive for community use in education

Seasonal sea-ice cycle at Barrow
J. Leavitt, 2006/07



From unstructured observations to protocols

- Early observations unstructured with focus on ice use, hazards, ice-associated wildlife
- Development of data-base categories/fields
- Review by contributors & community members
- Development of specific protocols focusing on fall freeze-up for W-AK-LCC

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Fall Freeze Up Log Sheet

Western Alaska LCC

It is important to understand the details of how sea ice is changing along Alaska's shorelines, and how this change affects the coastline and coastal communities. In a small pilot project, we want to learn more about how ice, waves and wind interact with the coast during freeze-up. In particular, we are interested in observations in your community of how nearshore ice protects or damages the coast and impacts other activities in your area. The time period we are interested in is from the very first appearance of ice nearshore until the ice is stable and thick enough to travel on. This log sheet may be helpful in recording such observations. Also, we are interested in photos of some of the ice features or the potential impacts of storms, waves and ice on the coast.

Your name:
Where was observation made (village and specific location):

Observation	Date	Description (and guidance on additional helpful information)	
First signs of ice on the ocean			Is slush or grease ice visible in the ocean?
First signs of other types of ice			What type of ice (floe ice, old ice)? Where did it come from?
First appearance of ice attached to the shore			How far out does the shorefast ice extend?
Ice berm formed (ice wall protecting shore along beach)			How did the berm form and how long did it stay in place?
Sea ice with mud or sand (dirty ice)			Where is the mud in the ice? Where did the ice come from?
Ice push event (ice driven onto the shore)			
Ice pressure ridges forming (floating or grounded)			
Strong ice movement and fracturing			
Unusually large waves, currents or coastal flooding			
Ice is stable enough to walk on for first time			
		Additional observations – please record on back of this sheet	

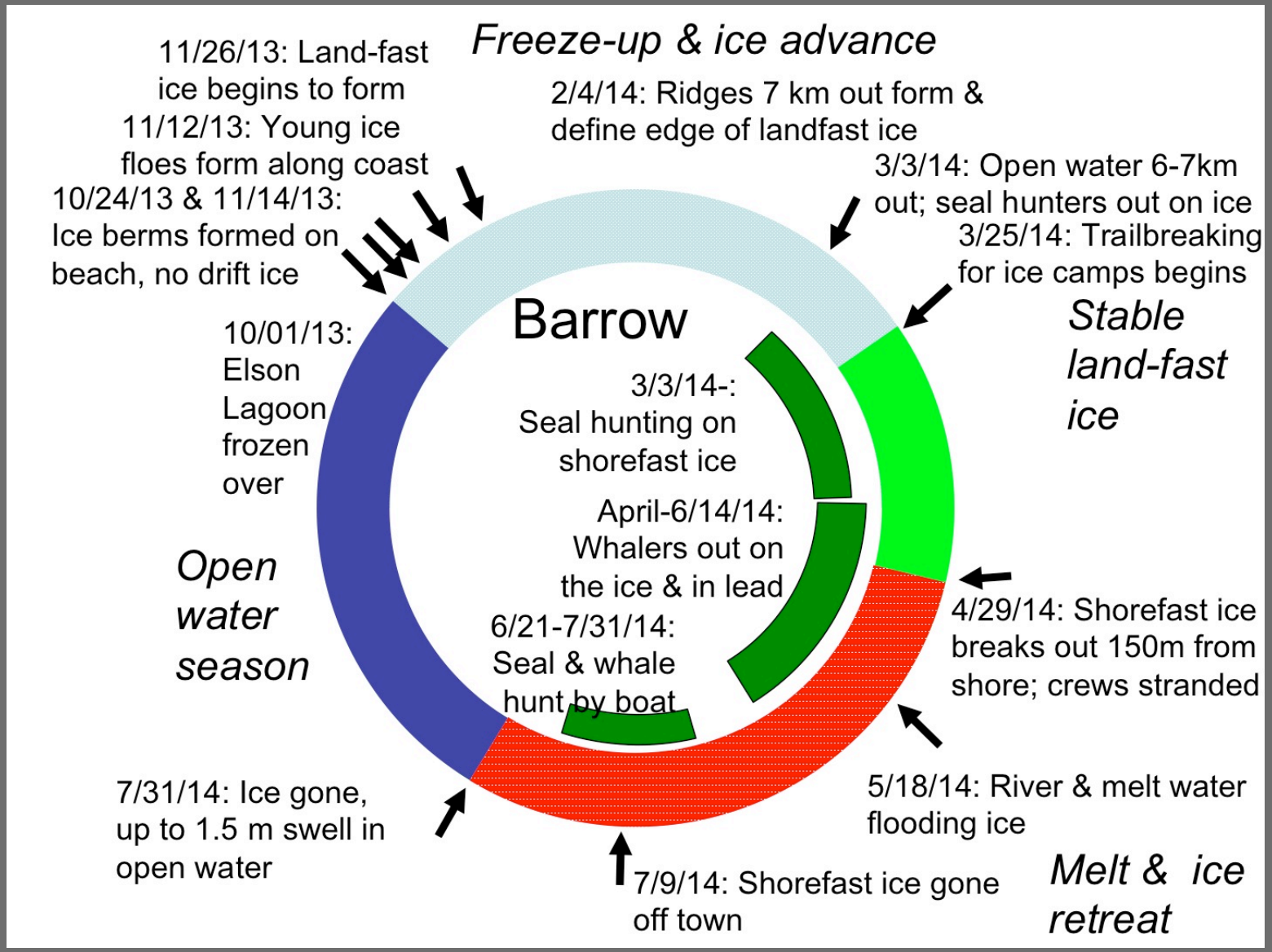
Please include the Native name in Yupik or Inupiaq if that adds to the description.

We want to learn what is important to people in your community about the ice and ocean. Please include anything else you observed about coastal ice that is interesting or important to you. You can use the reverse side of this page or additional pages.

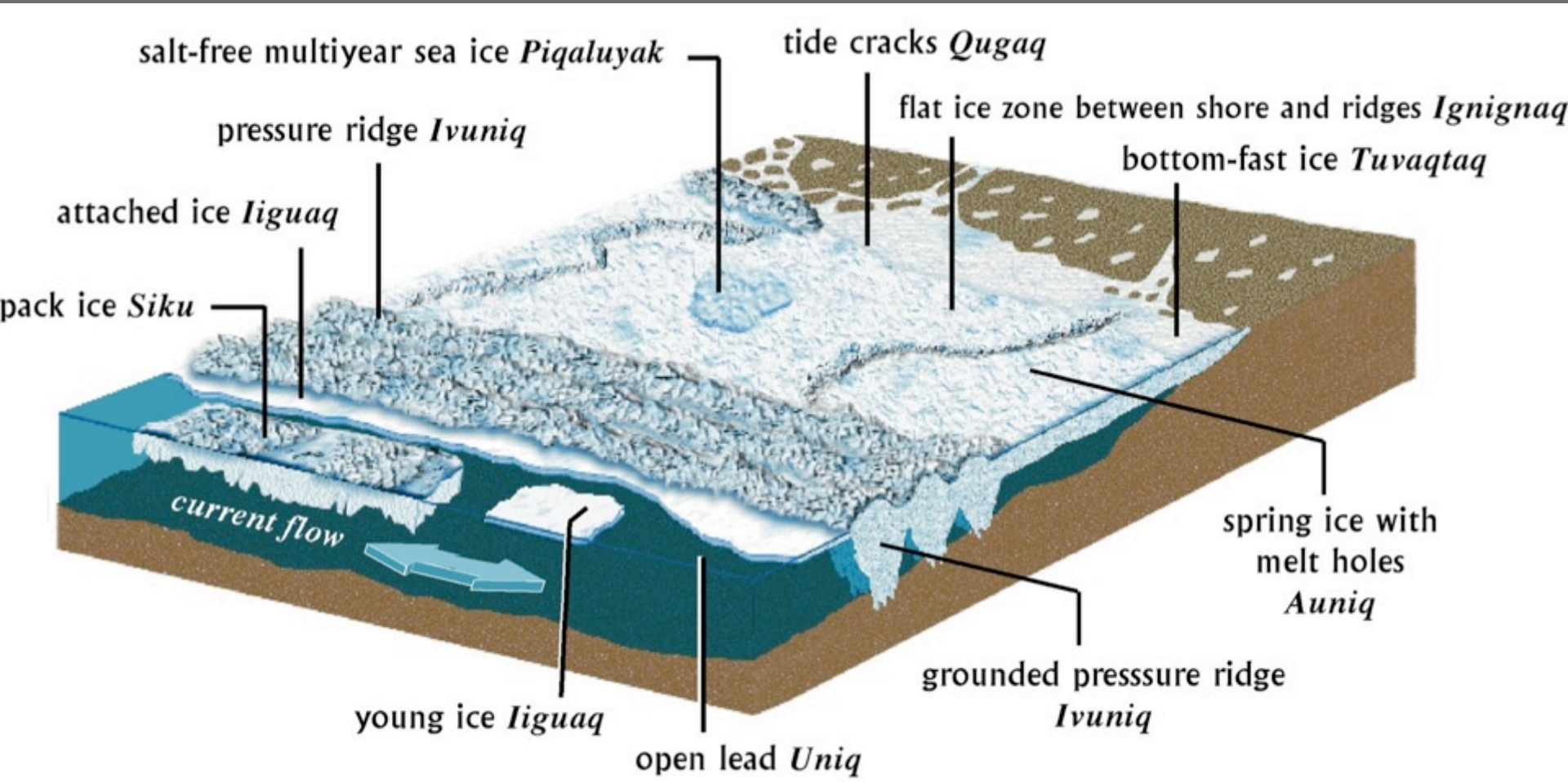
Once freeze-up is over, please mail this page to Ms. Mette Kaufman who is part of our project at the University of Alaska Fairbanks (contact information below, you can also call by phone). Quyana, Quyanaqpak and Quyanaghhalek! Thank you for your help.

Contact: Mette Kaufman, Geophysical Institute, University of Alaska Fairbanks
PO Box 757320, 903 Koyukuk Drive, Fairbanks, AK 99775-7320.
mrkaufman@alaska.edu ph (907) 474-5431, fax (907) 474-7290

Seasonal sea-ice cycle at Barrow
J. Leavitt, 2013/14



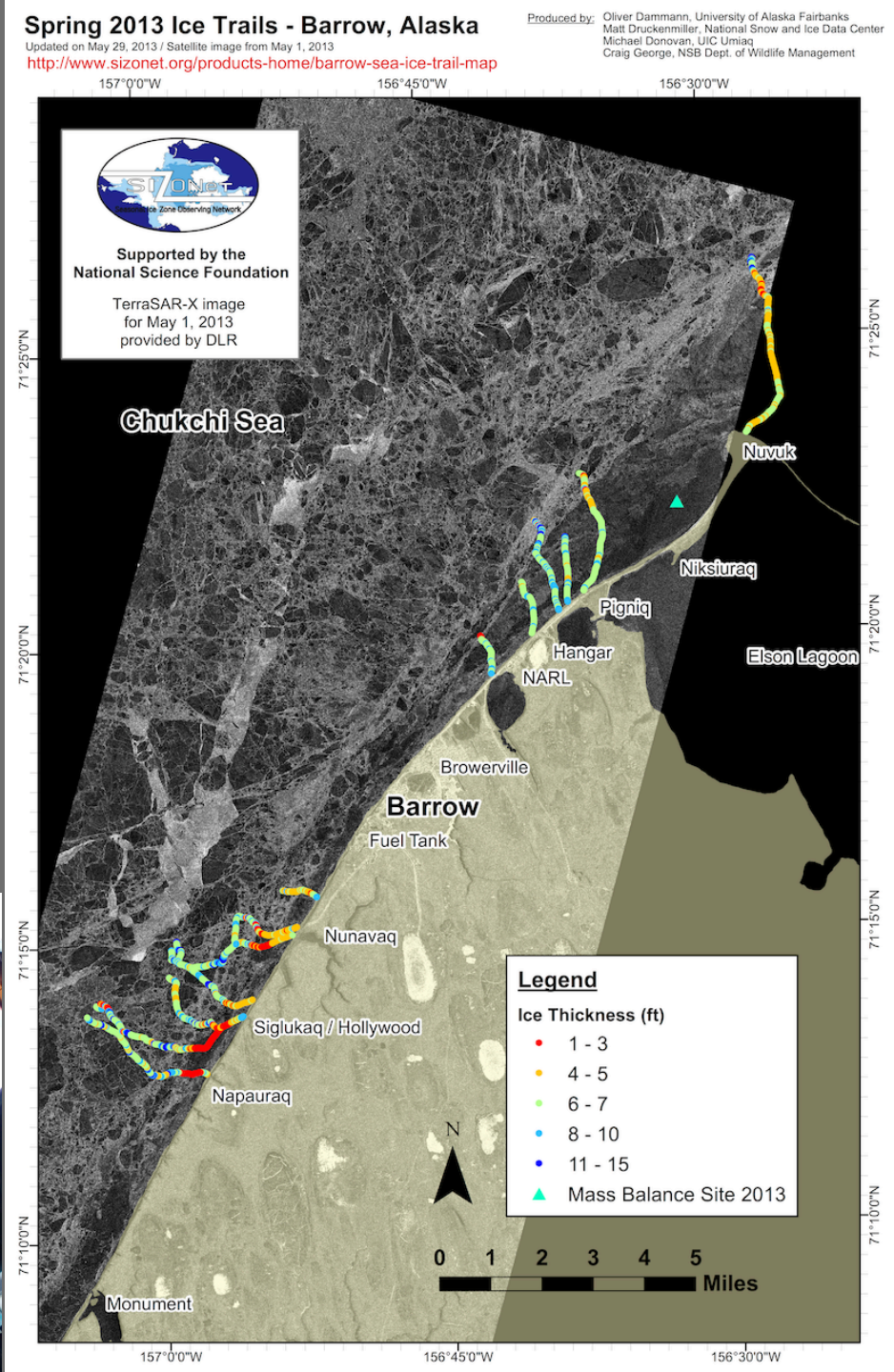
Use of shorefast ice as platform

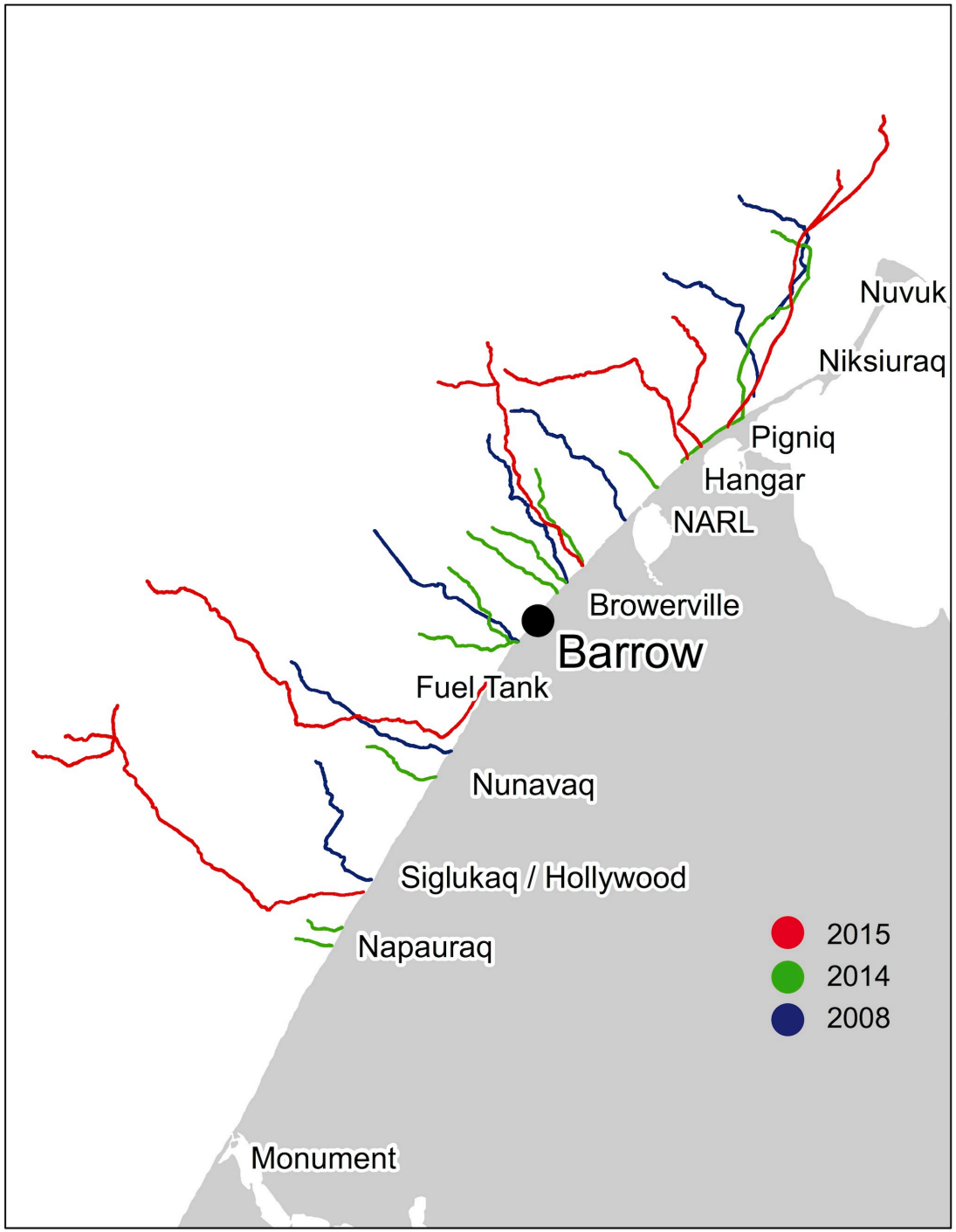


George et al., 2004

Information product

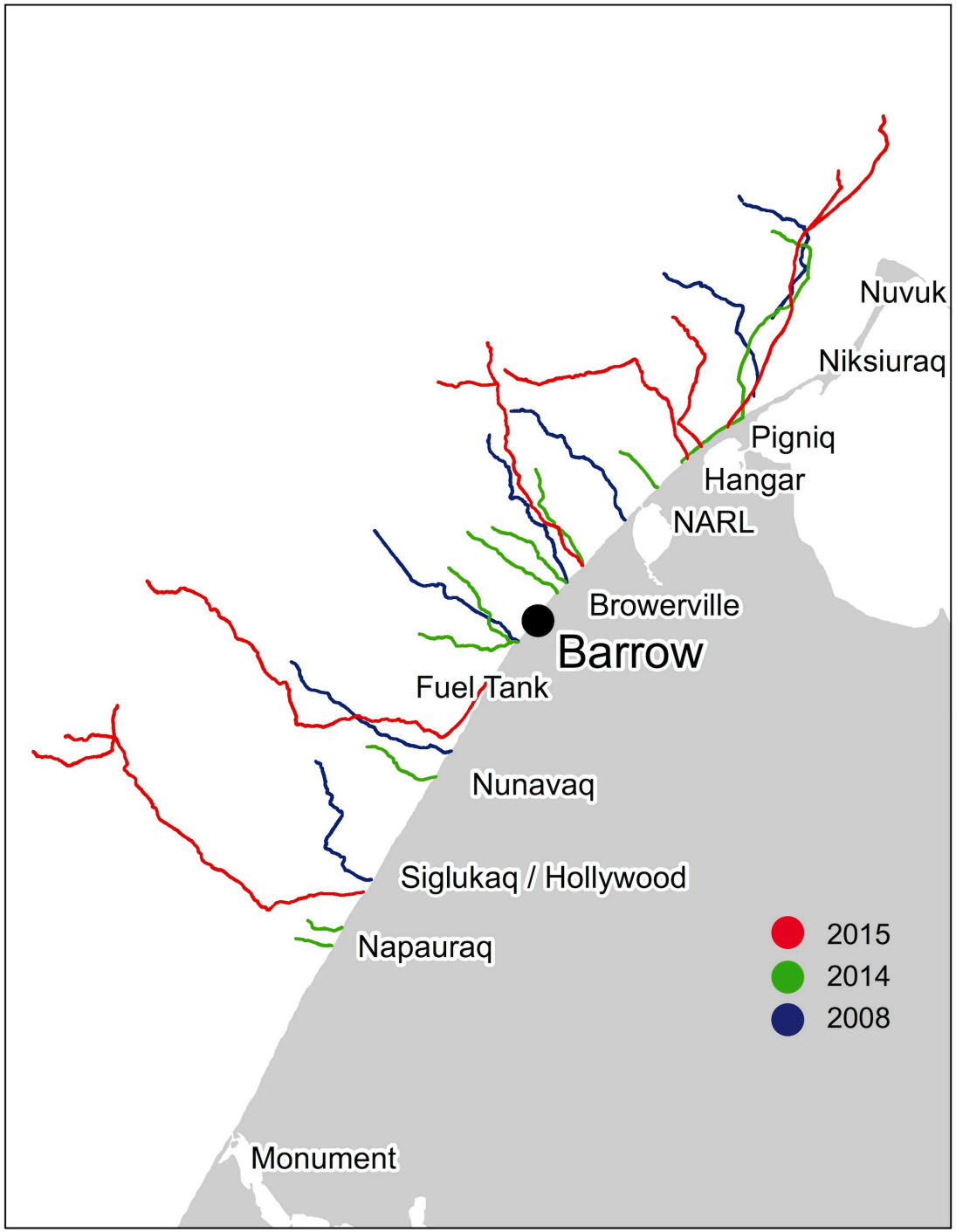
- Information product for community of Barrow
- Trail thickness surveys: Grad students Dammann & Druckenmiller, NSB-DWM, BWCA
- Local observer logs & hunter interviews





Variability

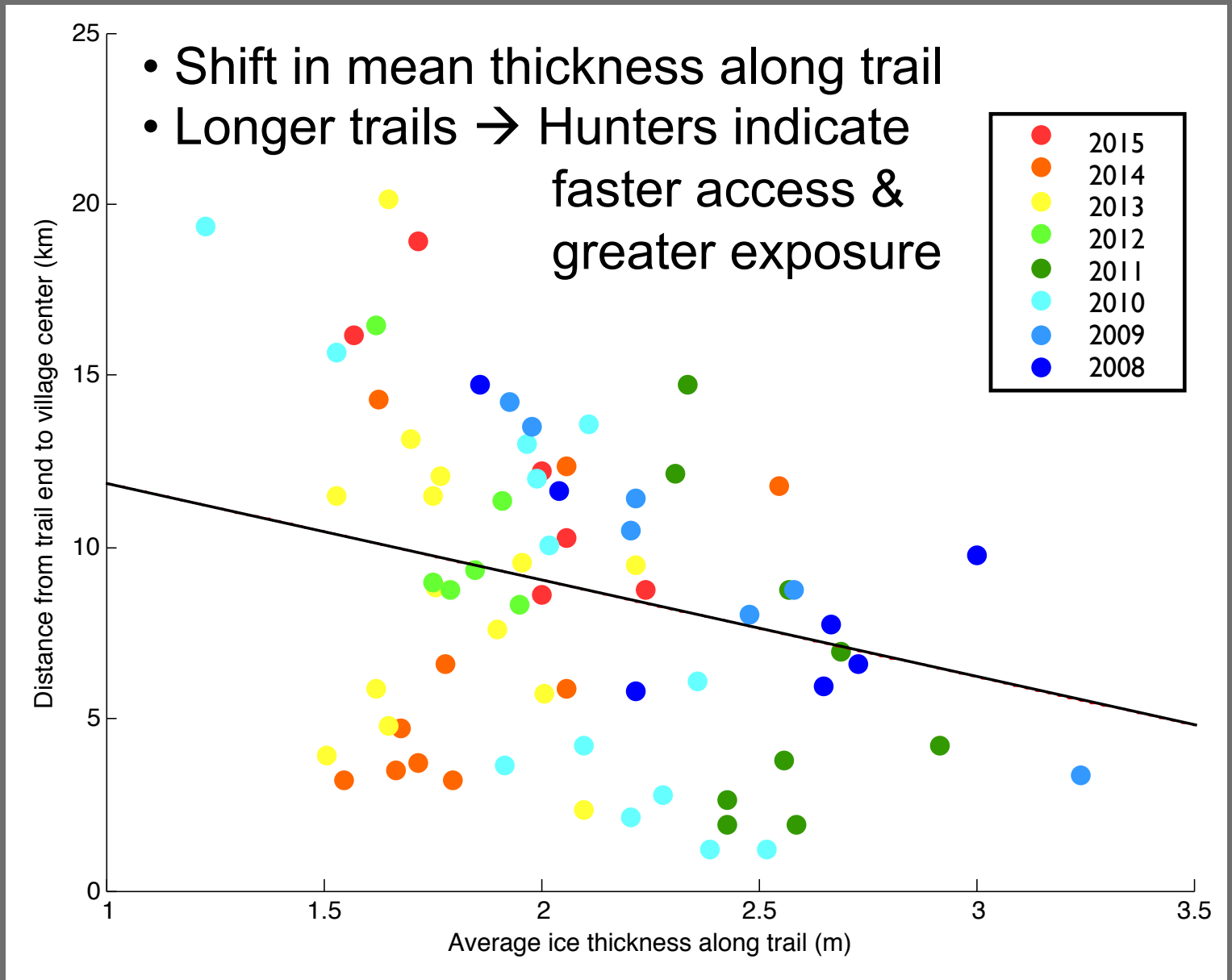
- 2008: MY ice helps stabilize shorefast ice
- 2014: Lack of MY ice & lack of grounded ridges in combination with currents & pack ice interaction drive major break-out
- 2015: Lack of MY & modest grounding and wide extent increase risk to hunters



Key variables

- Areal fraction & location of grounded pressure ridges (pack-ice interaction, currents/wind forcing; MY ice fraction)
- Ungrounding of grounded pressure ridges (atm. circ., ocean heat flux) & offshore stress components
- Ice roughness
- “Thin” ice distribution

Trends & key conclusions (2006-2015)



Conclusions

- Modal shorefast ice thickness variable, no significant trend
- Shift in mean ice thickness along trails
- **Ice stability & access to shorefast ice decreasing**
- **Shifts in seasonality of sea ice reduce ice & game access windows**
- Important local scale processes: Shoreline protection (ice berms), ice hazards (currents)

- ELOKA database as a resource for other community efforts
- SIWO & NOAA/NWS cooperative observer model
- Combination of observers & instrumentation/remote sensing to track changing ice state & use
- Ice safety & trafficability: Trafficability model to synthesize Indigenous experts' knowledge and remote sensing data

Data at: eloka-arctic.org/sizonet
jukebox.uaf.edu/site7/seaice (Project Jukebox)
www.sizonet.org, seaice.alaska.edu/gi, aoncadis.org

Relevant publications:

- Druckenmiller & al./Eicken/Kapsch & al./Krupnik & al. (2010) SIKU book, Springer
- Eicken et al. (2012) Sea Ice for Walrus Outlook. IPY Monograph.
- Krupnik et al. (2012) Wales Sea Ice Dictionary
- Druckenmiller et al. (2013) Ice trails. Sea Ice special issue, Polar Geogr.
- Eicken et al. (2014) Ice observations. ELOKA special issue, Polar Geogr.
- Deemer (2015) M.S. thesis, UAF
- Eerkes-Medrano et al. (submitted) Arctic

NSF

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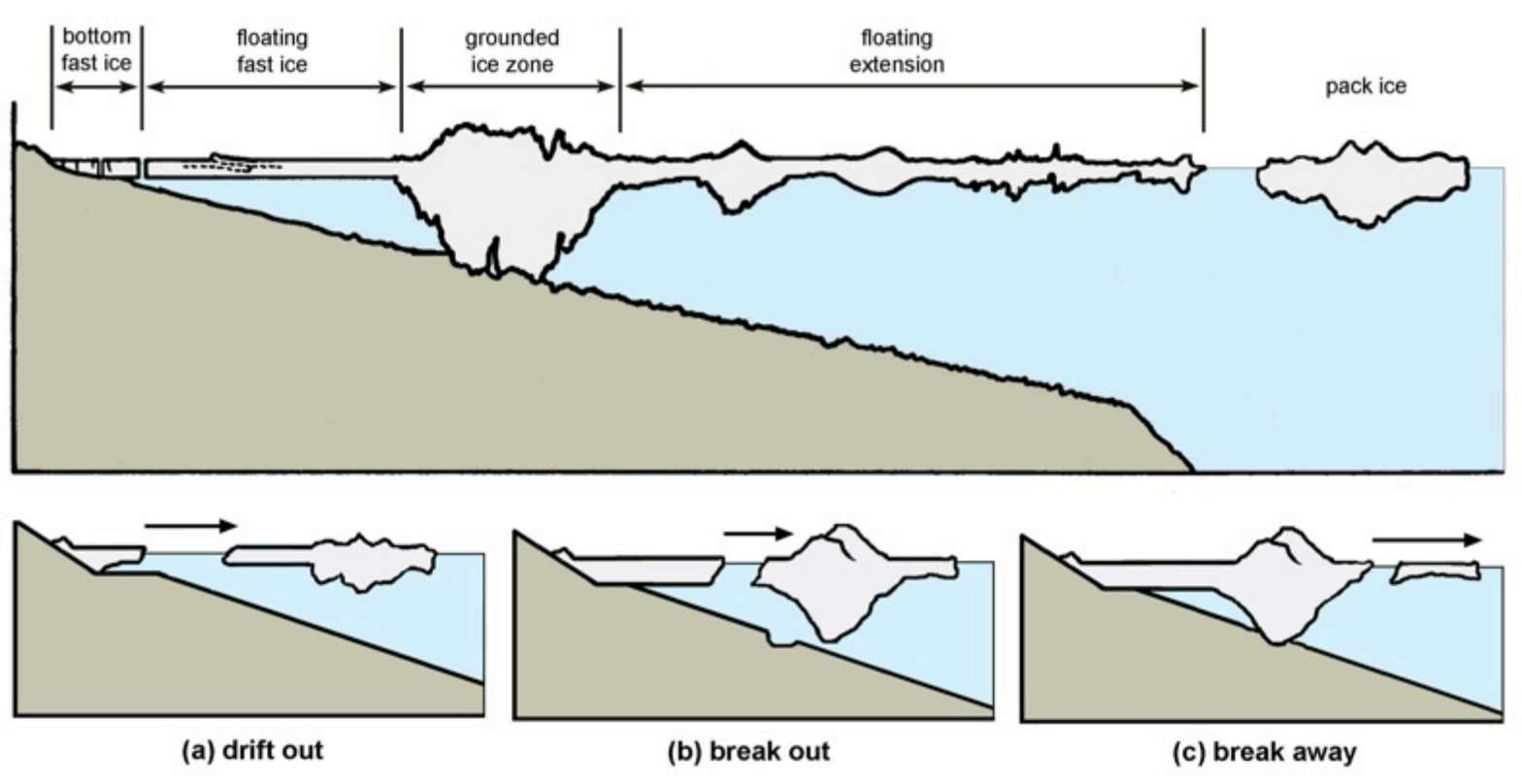
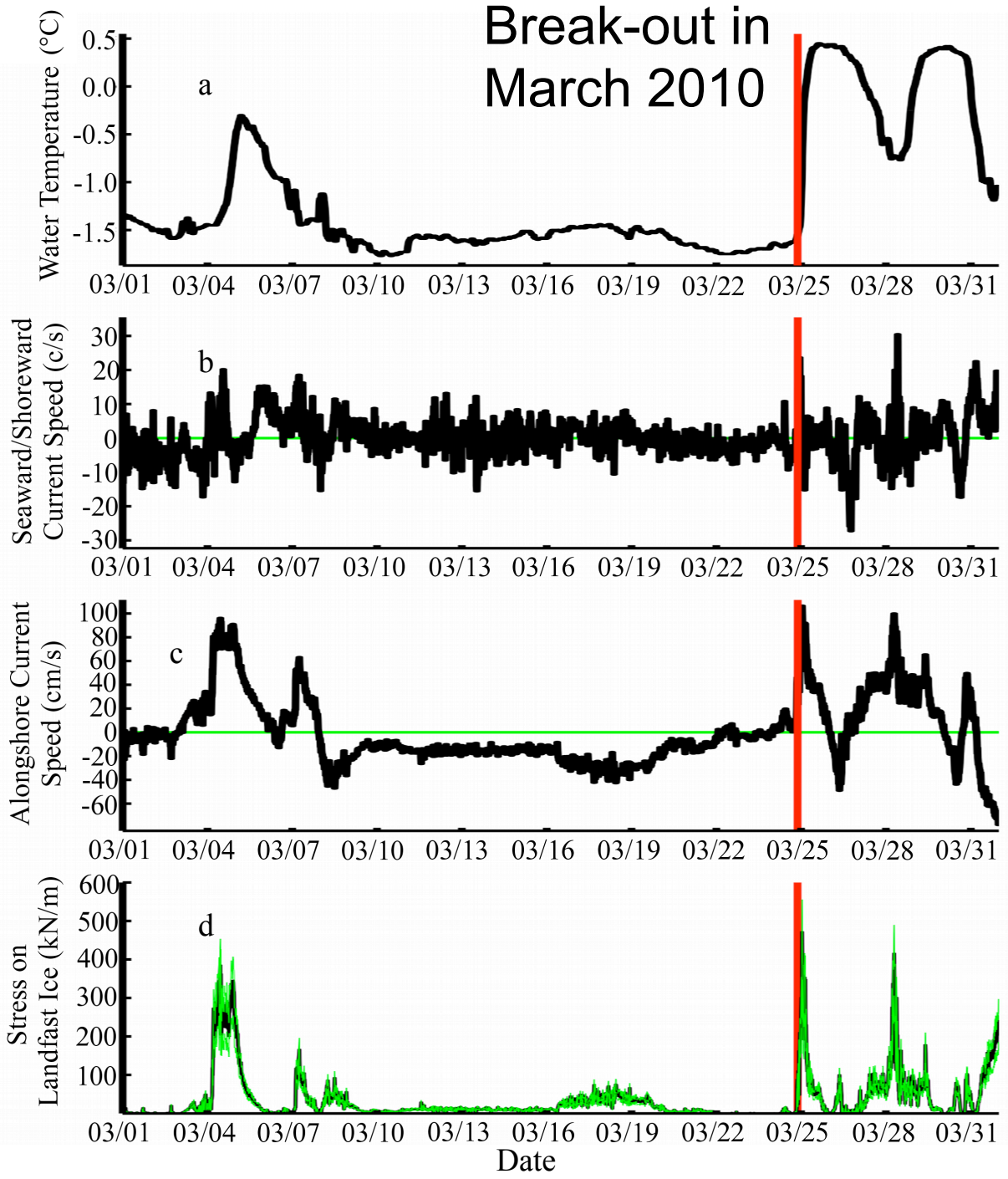
Frameworks for risk assessment



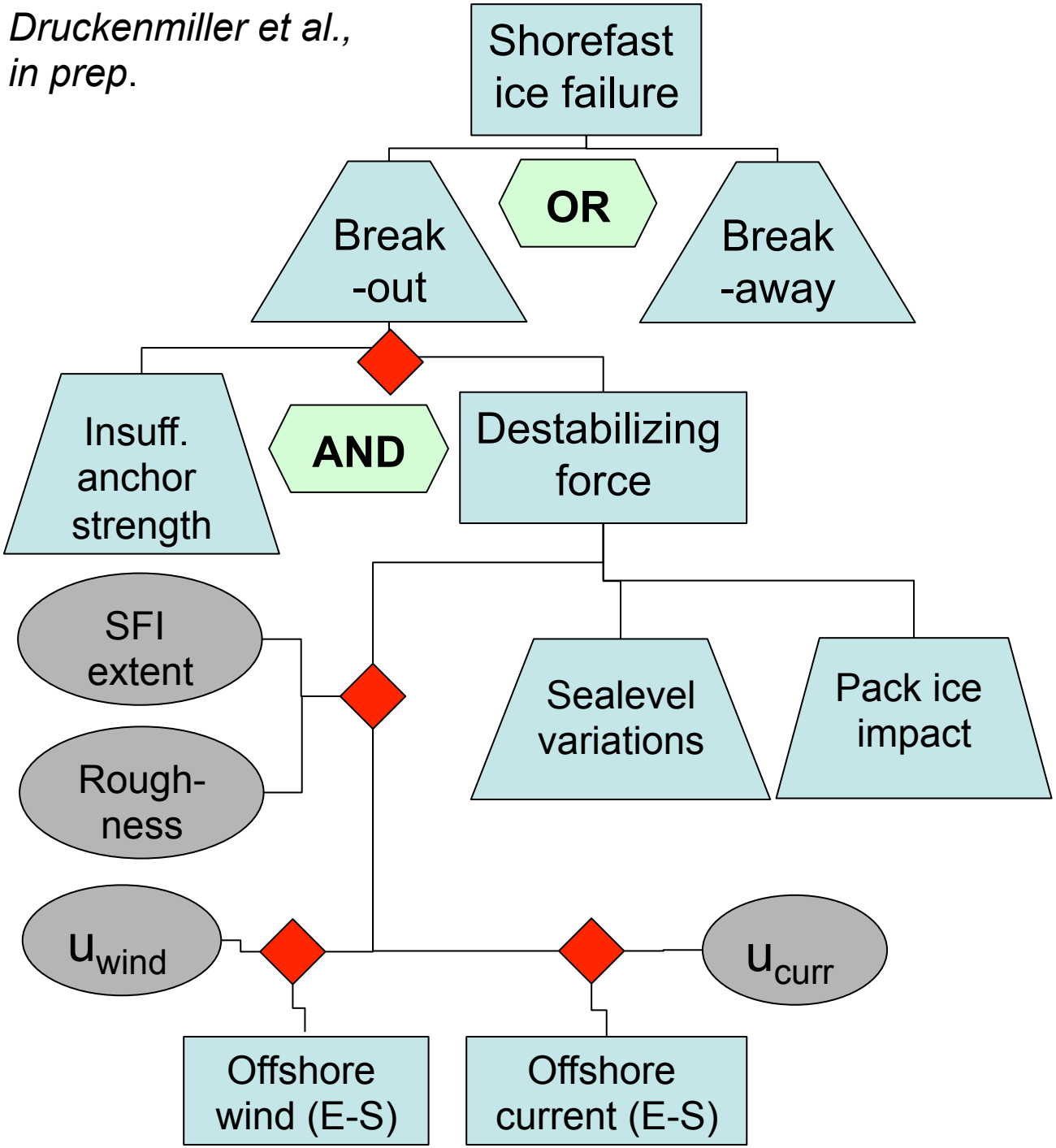
M. Druckenmiller et al., in prep.

- Hazard of landfast ice break-out/away events
- Environment, people & procedures: How to guide operations through integration of observing systems, models, local & indigenous knowledge, and engineering

- Stability determined by grounded ridge density & anchor strength
- Destabilization driven by:
  - Current stress
  - Wind stress
  - Pack-ice shorefast ice interaction
  - Bottom ablation



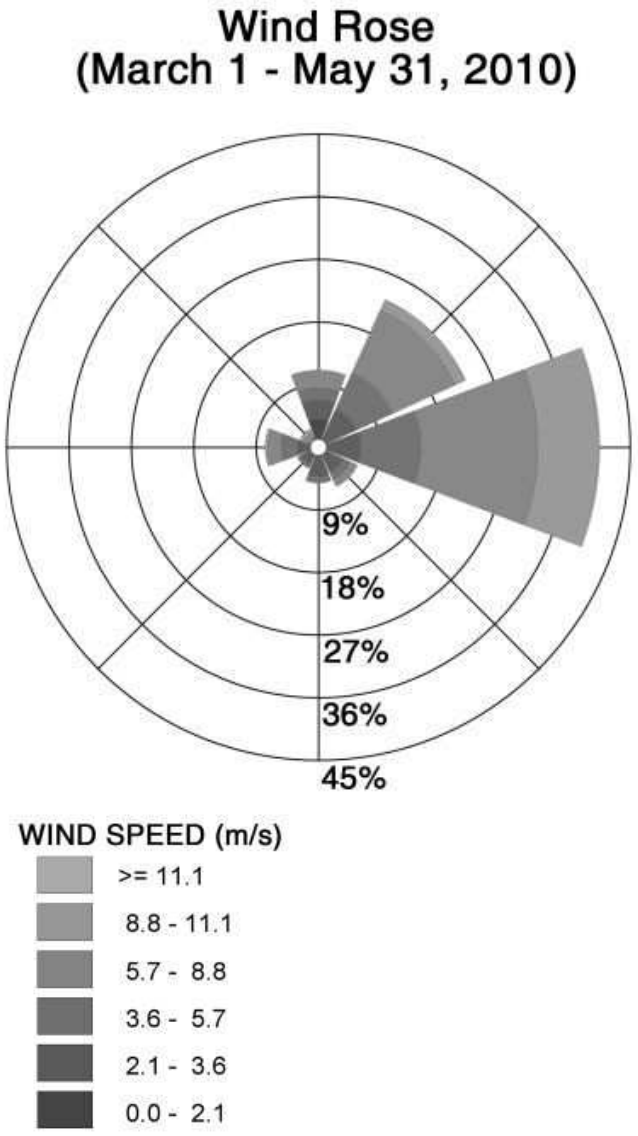
Druckenmiller et al., in prep.

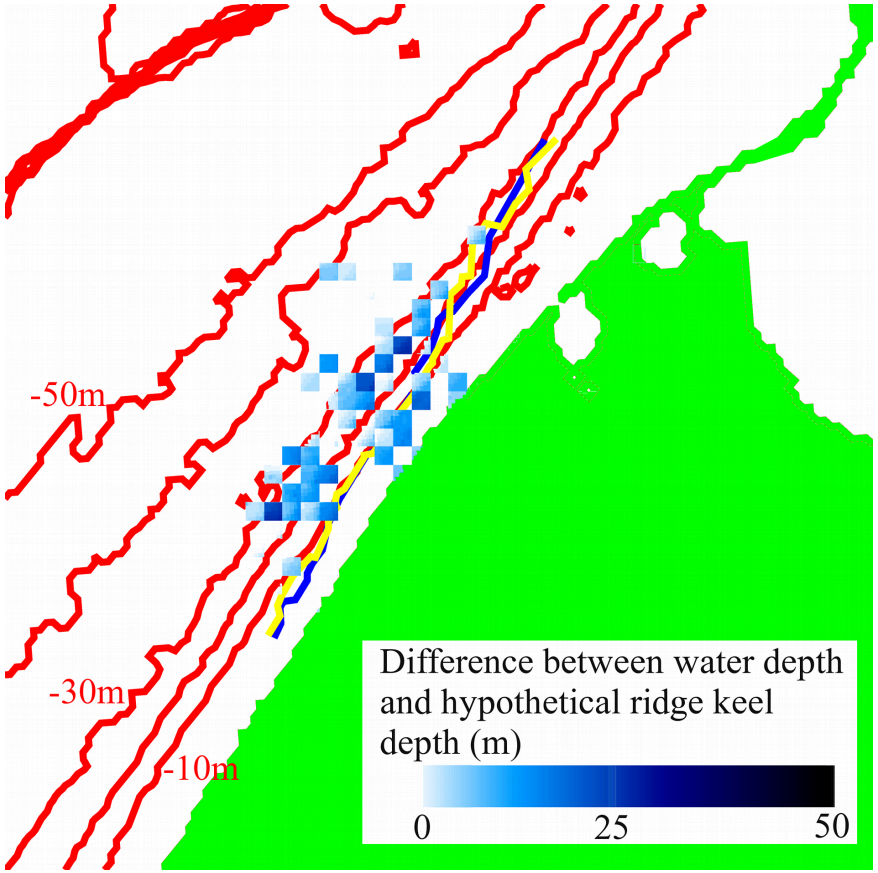


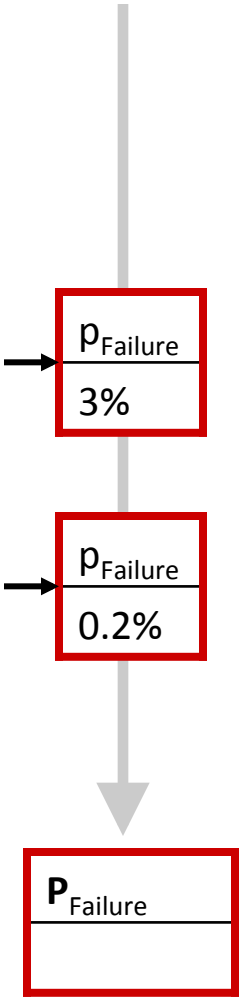
- ***Fault-tree analysis*** as a framework to evaluate hazards (M. Druckenmiller, PhD thesis research)
- Failure criteria based on force balances
- Statistics of met-ocean conditions & ice charac-teristics

Event trees to assess probability & magnitude

Wind Speed Stability Precond. Reliability Prob. of Failure







Druckenmiller et al., in prep.

Druckenmiller et al., in prep.

- ***Fault-tree analysis*** as a framework to evaluate hazards through geophysical data & local or indigenous expertise (ice impact, current strength, veering winds, grounded ridges)