BREA Project: Measuring the Thickness and Strength of Hummocked Multi-year Ice
[Agenda item 7.3]

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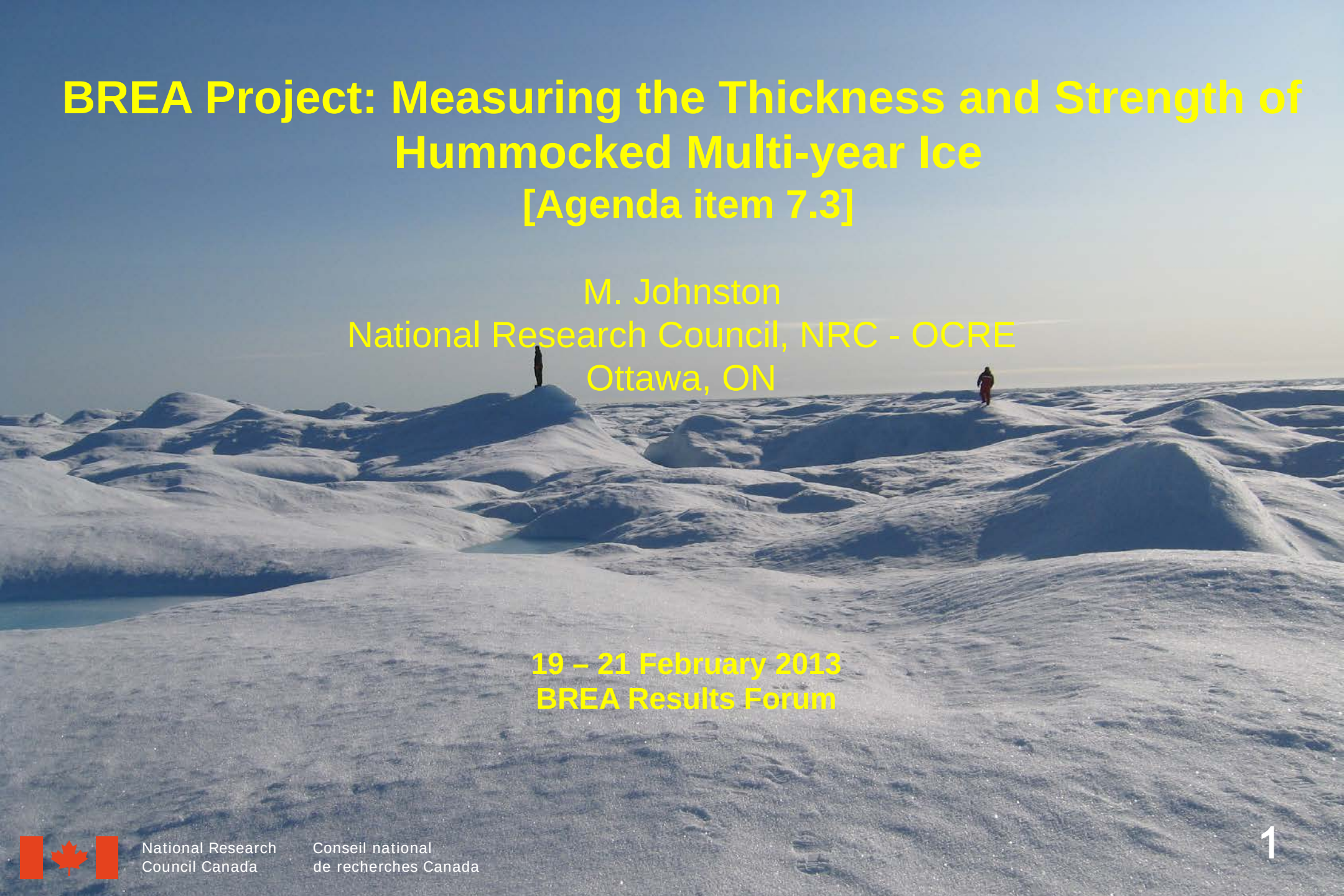
BREA Results Forum



Objectives of this research

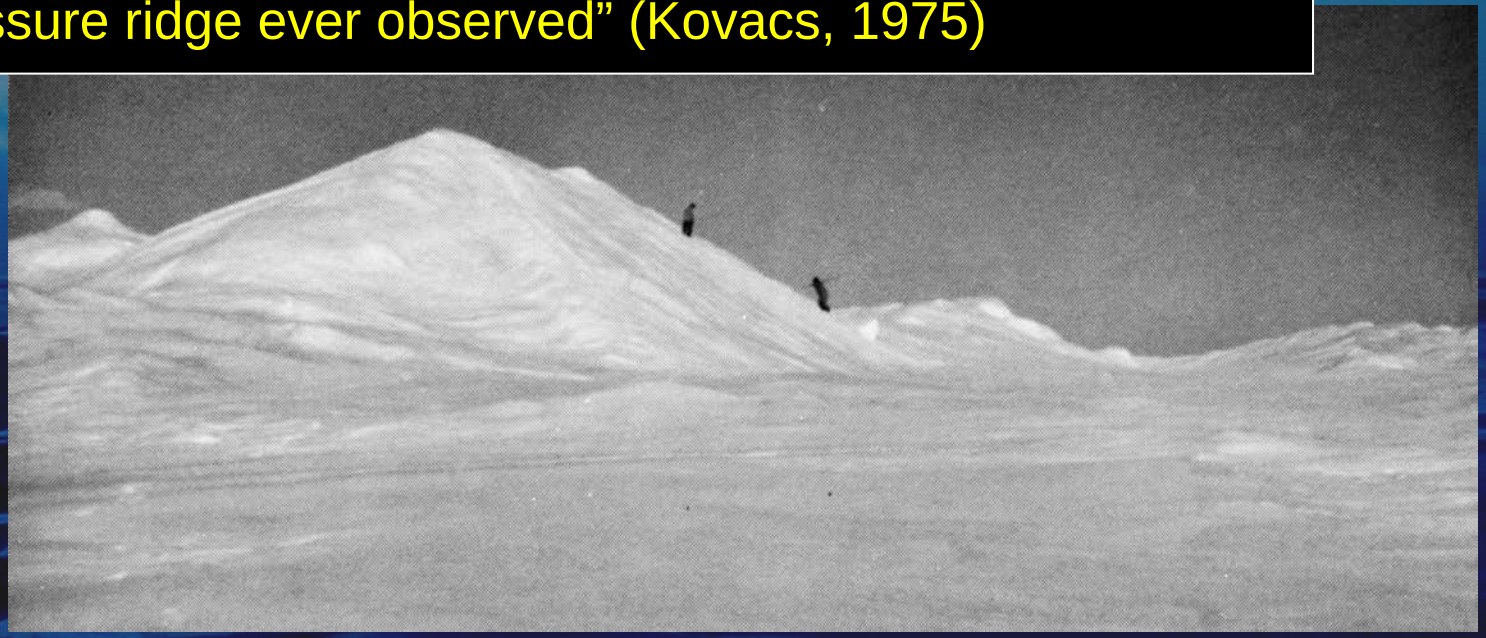
- provide detailed ice thickness measurements to validate results from other BREA projects (D. Barber, C. Haas)
- measure the strength of very thick multi-year ice (MYI) at depths where we have no information

Outline of Talk

- Why is multi-year ice a concern - hummocked ice especially?
- Year 1: Developing tools to probe the thickness of multi-year ice
- Year 2: Field program from Resolute (May 2012)
- Years 2 & 3: Upcoming field program from Sachs Harbour (March – April 2013)
- Challenges encountered during planning stages

“Largest multi-year pressure ridge ever observed” (Kovacs, 1975)

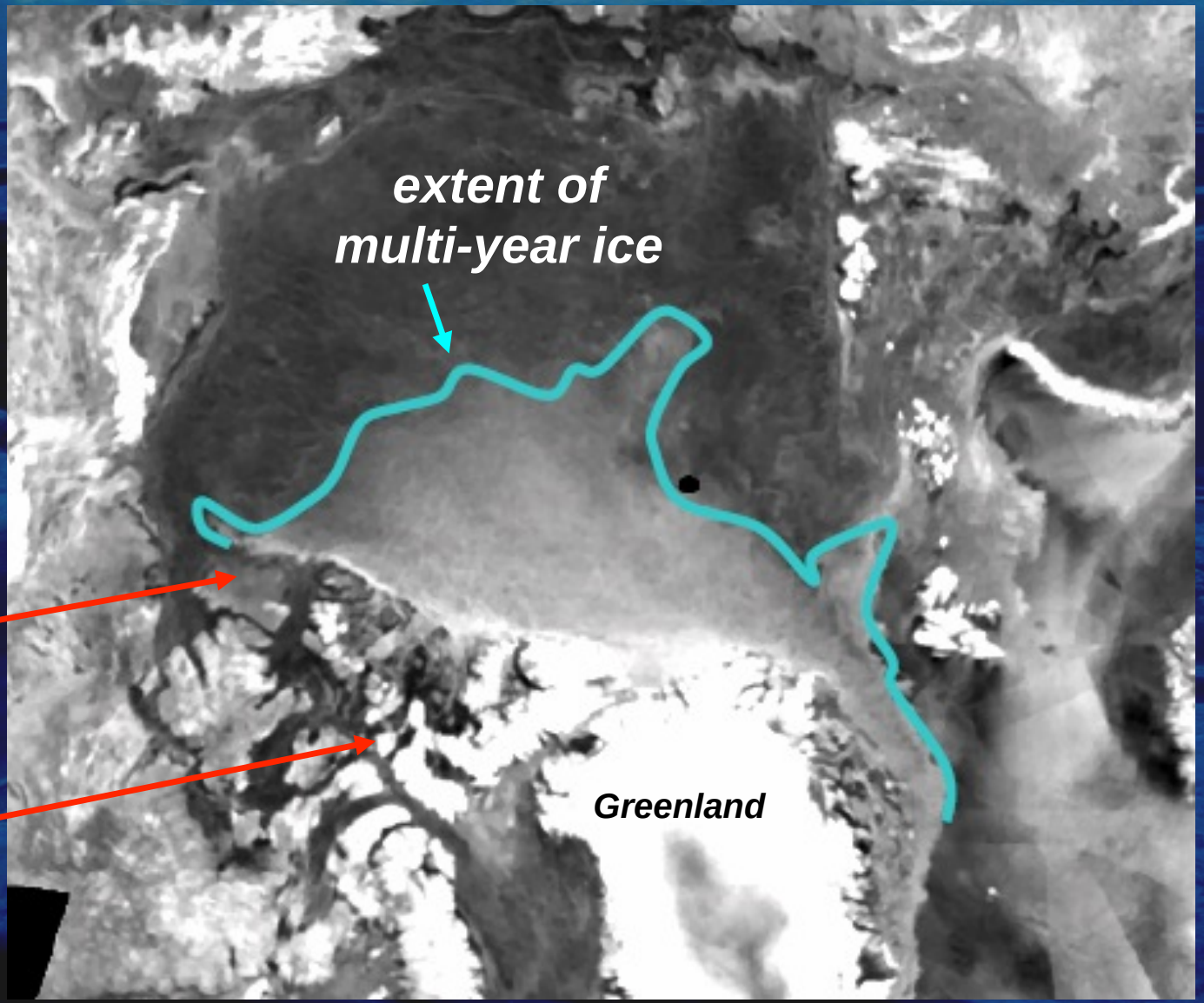
location: west Banks Island
date: spring 1975
ice thickness: 42 m



“A multi-year floe that looks like second-year ice” (ISS, Canadian Ice Service)

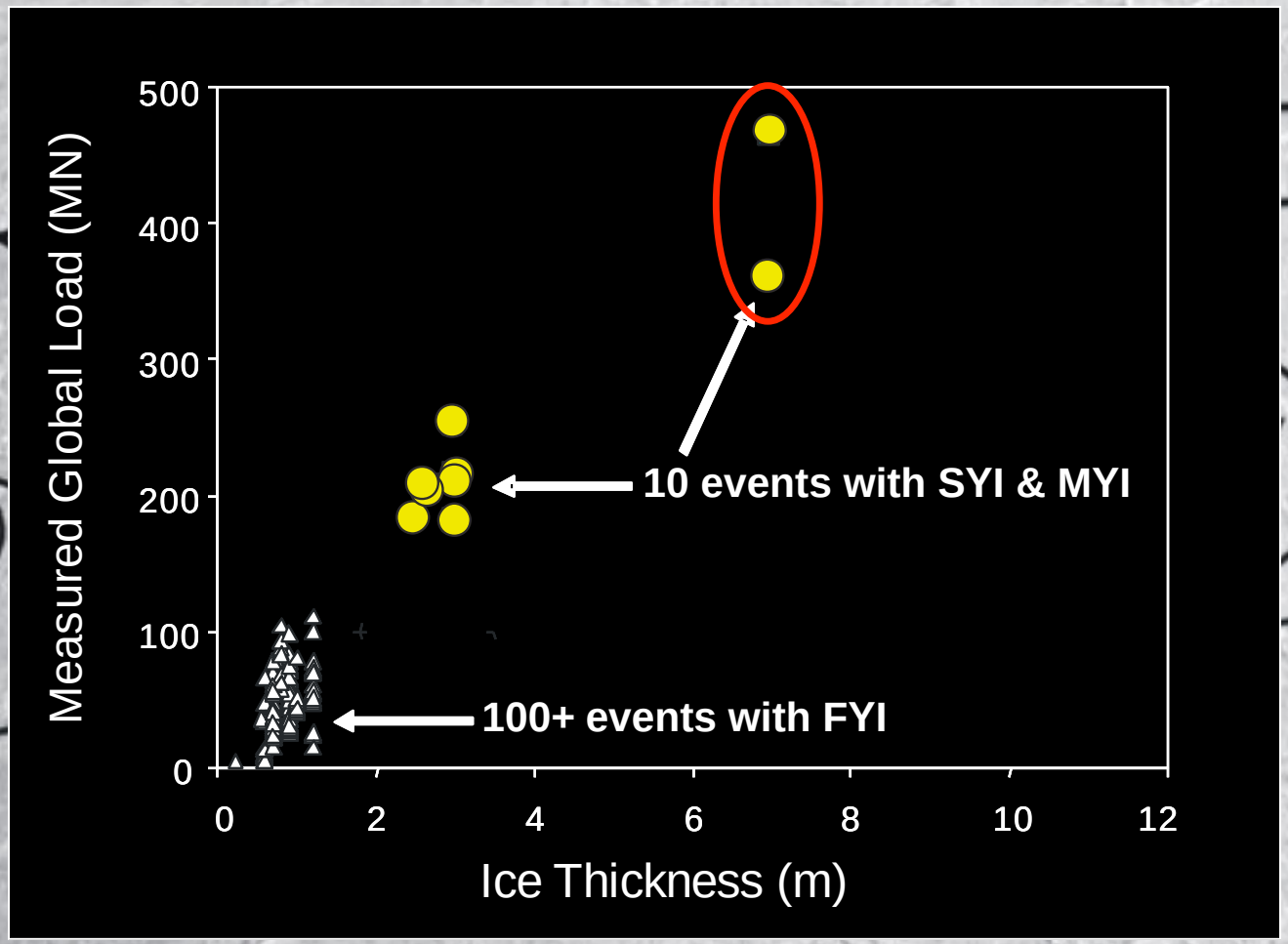
location: Beaufort Sea
date: summer 2002
ice thickness: 0.5 to 2 m

January 2013: Extent of multi-year ice as seen from the north pole



ASCAT image courtesy of T. Wohlleben, Canadian Ice Service

The most reliable data on the forces caused by thick MYI comes from the exploration structure ‘Molikpaq’ (1985/86)



There are only 10 events for which we know the forces that thick MYI causes on an offshore structure

Those 10 events provide a basis for ISO Codes (International Standards Organization) which engineers use to calculate the forces that can be expected on new structures

Force calculations are most accurate when we know the **ICE THICKNESS, ICE STRENGTH & FLOE SIZE**

Accurate information ➡ Well-designed structures

We know very little about the thickness & strength of MYI:
the work is grueling & requires very specialized equipment

M. Johnston

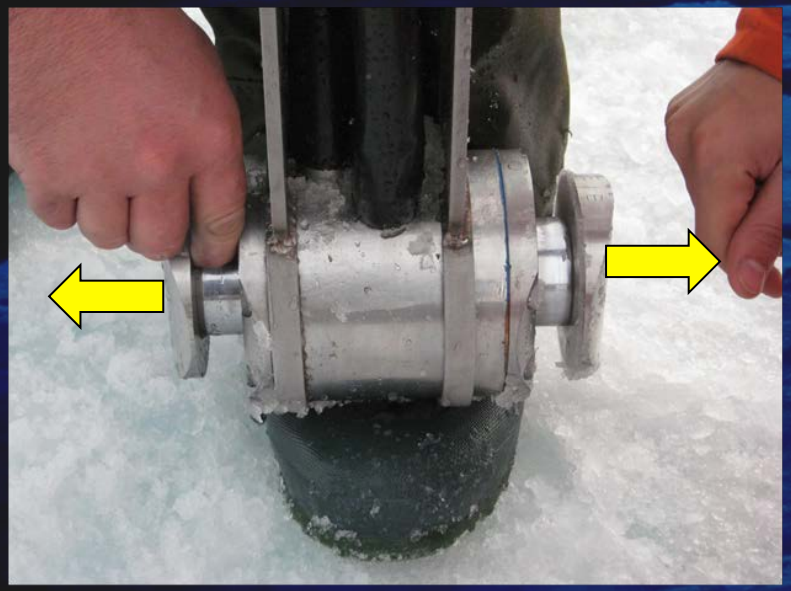
What we measure:

- air temperature
- snow thickness
- ice thickness
- ice freeboard
- ice salinity (from ice cores)
- ice temperature (from ice cores)
- ice strength
- drift of floe from GPS

Let's talk about STRENGTH!

How do we measure the ice strength?

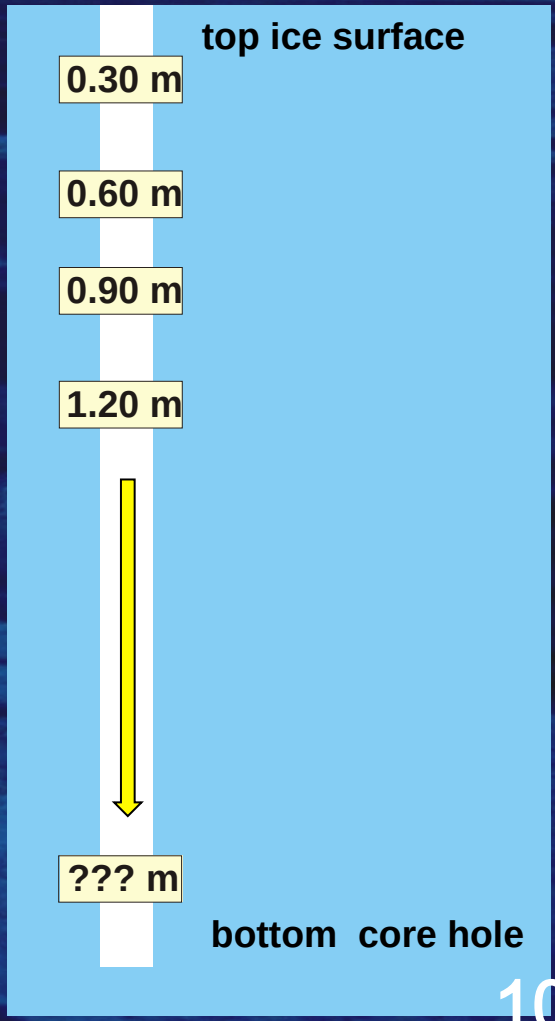
NRC borehole indentor is used to measure the strength of the hole that ice cores come from



NRC borehole indentor has two faces that each penetrate the ice by 25 mm (1 inch)

as the indentors penetrate the ice, the pressure increases to a maximum of 69MPa (10,000 psi)

strength tests
are done at 30 cm depths, until the bottom of the hole is reached

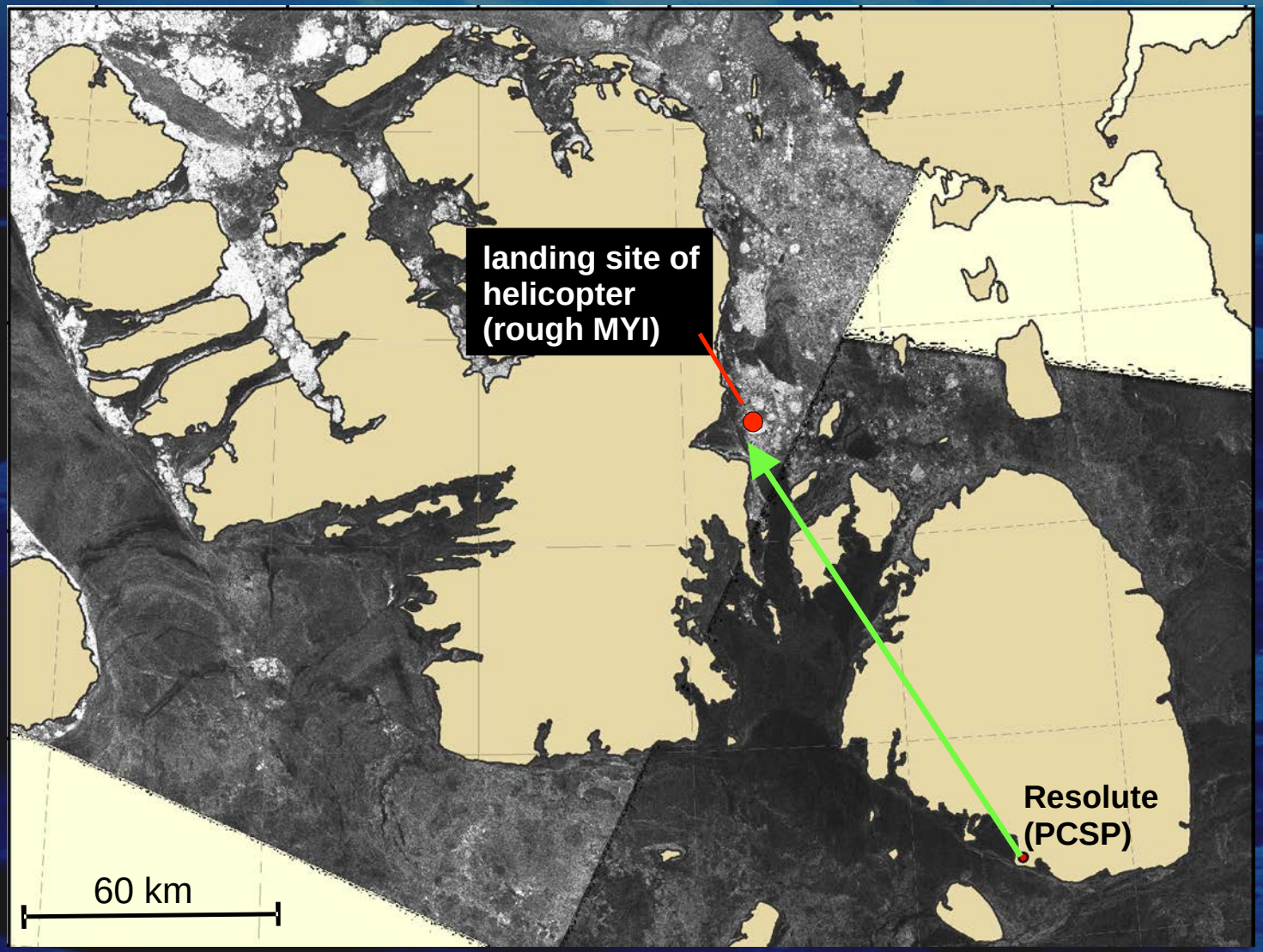


Yr-1 (Phase 1): Design and fabricate “lightweight” frame to lower & lift our 125kg (250 lb) equipment to an ice depth of 12 m

Coring equipment

Strength equipment

Yr-2 (Phase 2): 4 days of testing equipment on MYI, Resolute May 2012



Radarsat image courtesy of Canadian Ice Service

Day 1:
- transport equipment to floe
- strength of MYI at hole #1

Day 2:
- temperature & salinity of MYI at hole #1

Day 3:
- temperature, salinity & strength at hole #2

Day 4:
- ice thickness at 20 holes
- remove all equipment

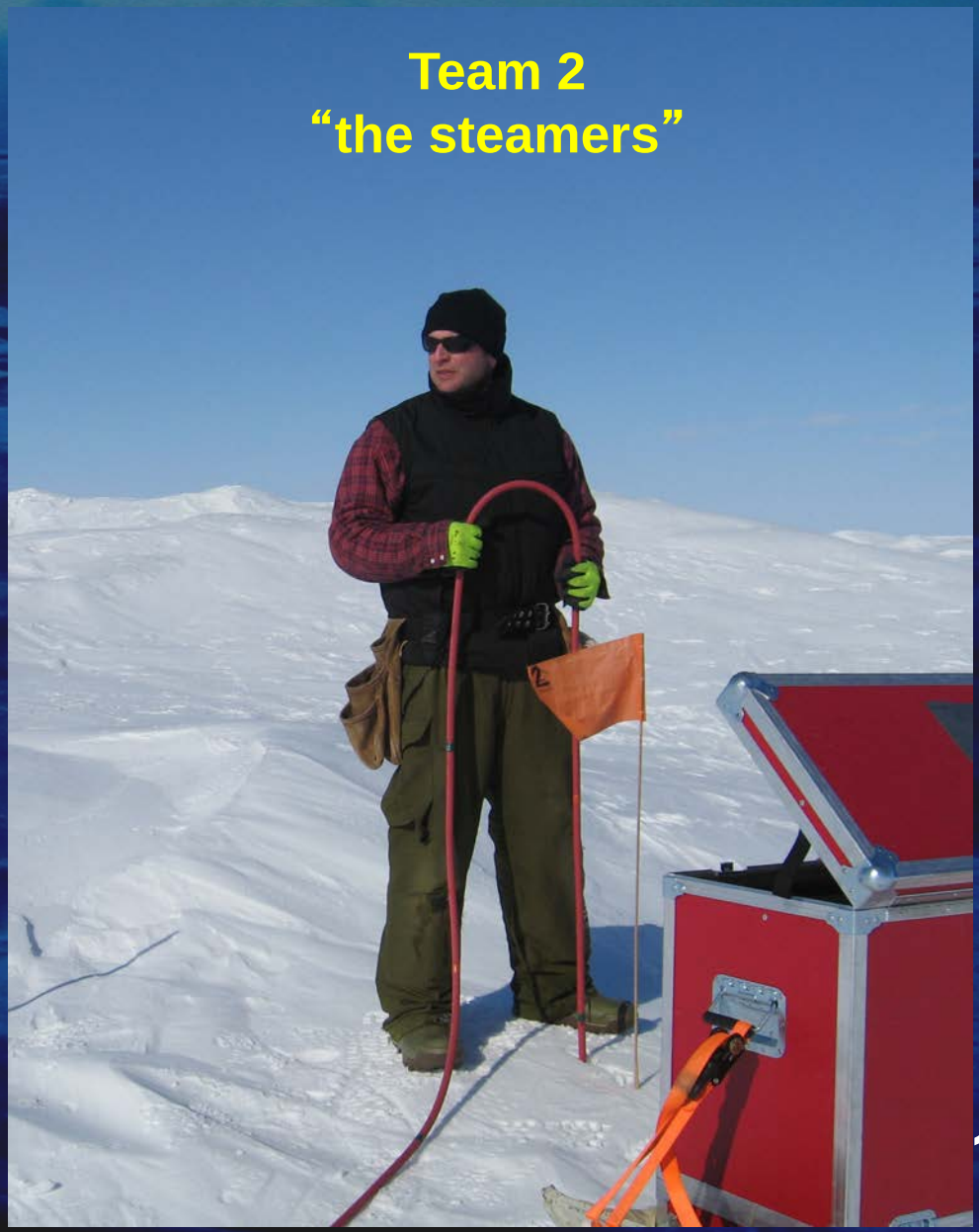
Moving 4 people & 1000 kg (2000 lbs) of equipment to the ice:

- ✓ Twin Otter to move equipment from Resolute to VERY smooth ice near MYI floe
- ✓ helicopter (206L) to move 4 people from Resolute to MYI floe
- ✓ helicopter to ferry equipment from smooth ice to hummocked MYI (in 3 trips)

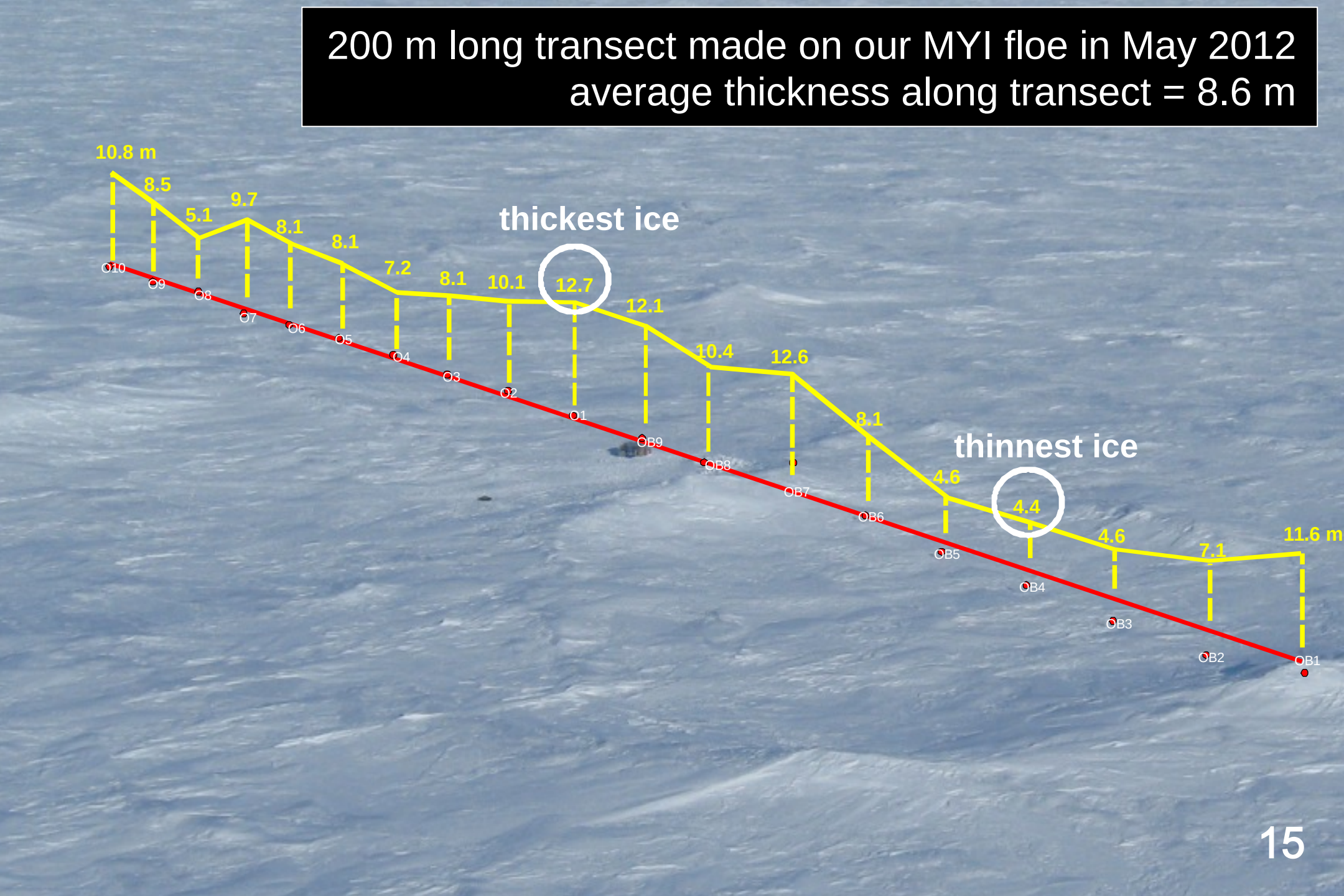
How do we measure the ice thickness?

Team 1
“the drillers”

Team 2
“the steamers”

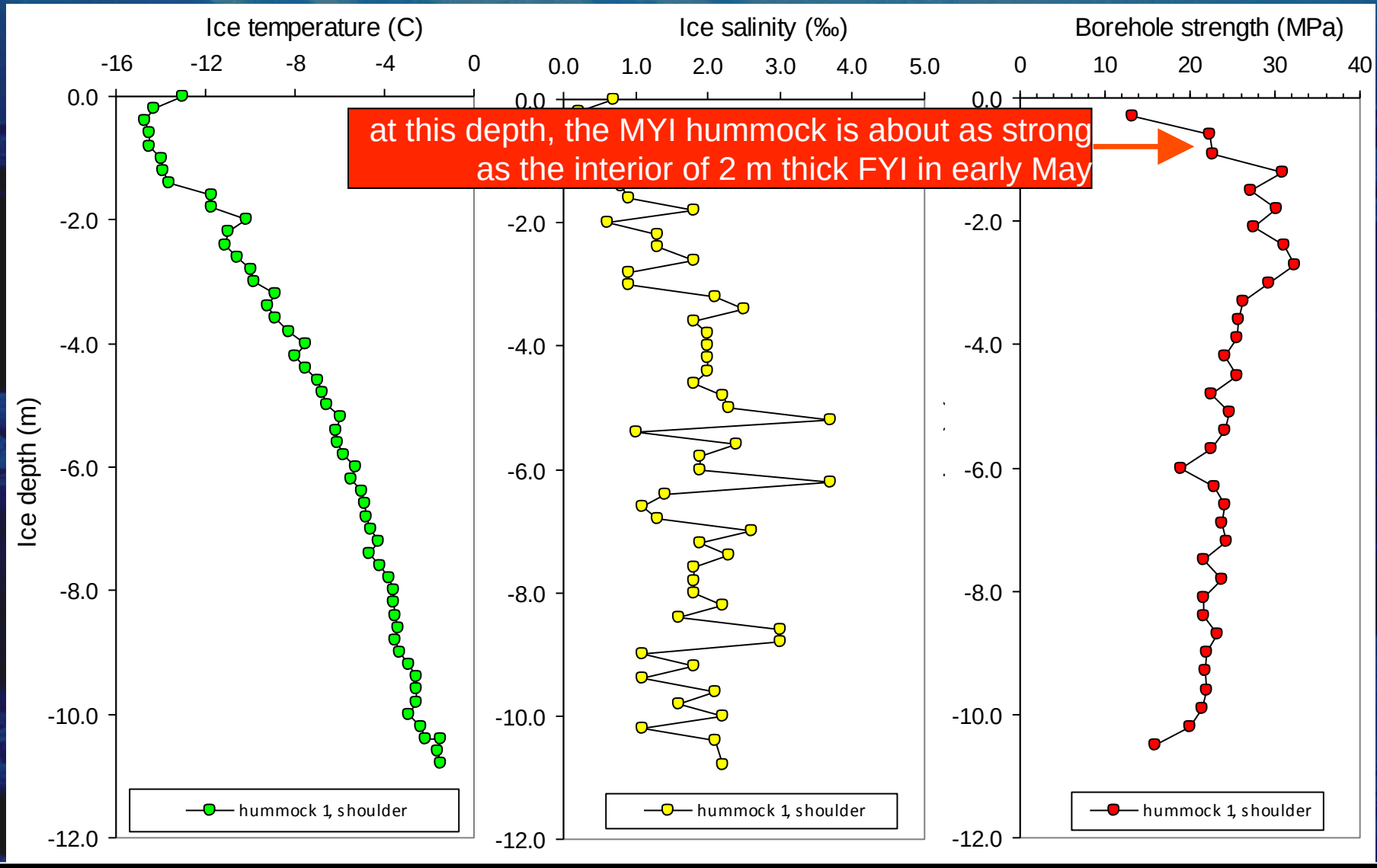


200 m long transect made on our MYI floe in May 2012
average thickness along transect = 8.6 m



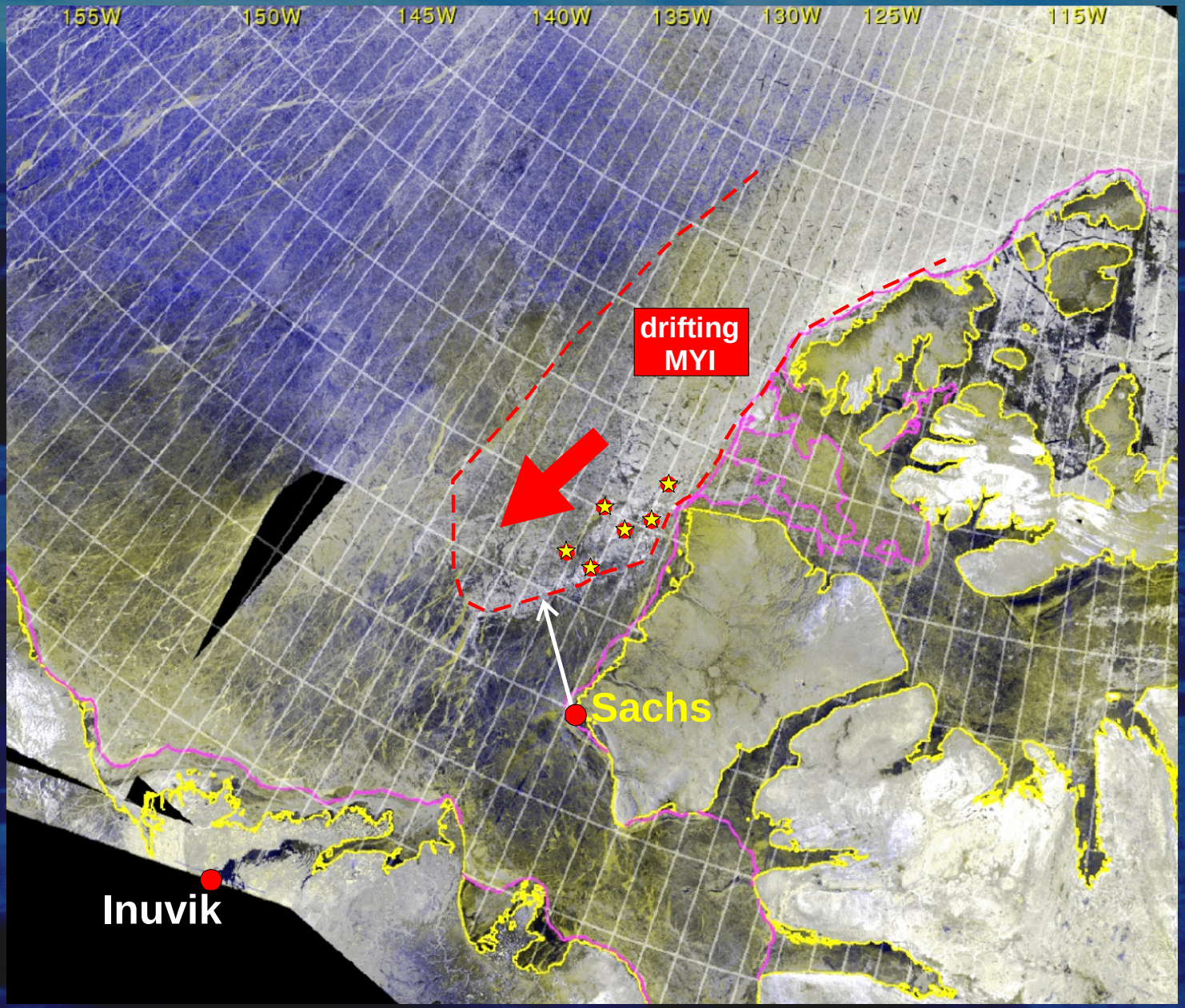
Measuring the temperature, salinity & strength on our MYI hummock

Temperature, salinity & strength of our MYI hummock, May 2012



salinity & strength indicate that this MYI hummock is not very old

Yr-2/Yr-3 (Phase 3): We will sample 6+ MYI floes from Sachs Harbour



Radarsat mosaic courtesy of Canadian Ice Service

Some of the challenges that needed to be overcome

RED TAPE!

Obtain additional funding when cost of 2013 program increases from $300k to $1M

Contracting helicopter for operations (Canadian Helicopters)

Barging 100 drums of fuel into Sachs (NTCL)

Permits needed to proceed (scientific & to store helicopter fuel)

Ground transport 2000 kg (4000 lbs) equipment from Ottawa to Inuvik (PREP Services)

Charter DC-3 to move equipment, groceries, personnel from Inuvik to Sachs (Aklak Air)

Safety: two firearms needed on ice at all times (SHHTC, Discovery Mining Services)

Lodging (Kuptana's) and groceries (Discovery Mining Services) for field party of 9

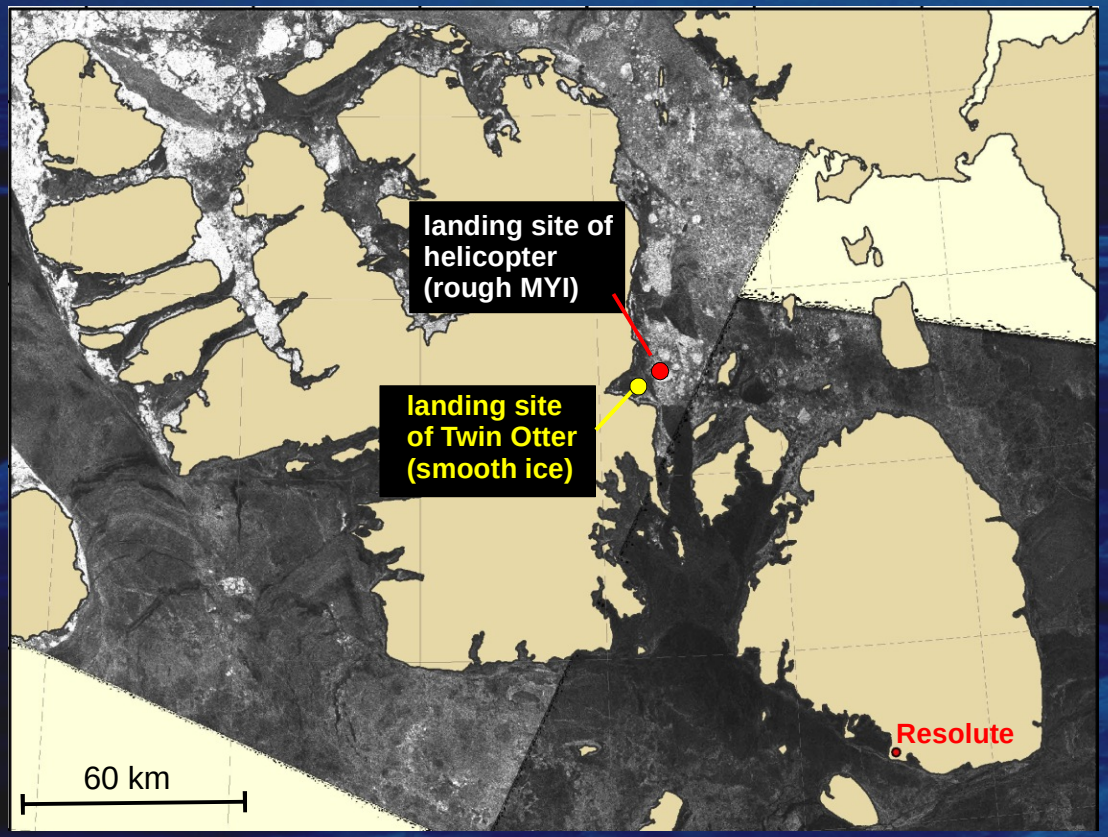
Work space while in Sachs (Parks Canada)

Two snow machines/sleds for certain days (SHHTC)

Three week training program for 3 new technicians to operate equipment (NRC)

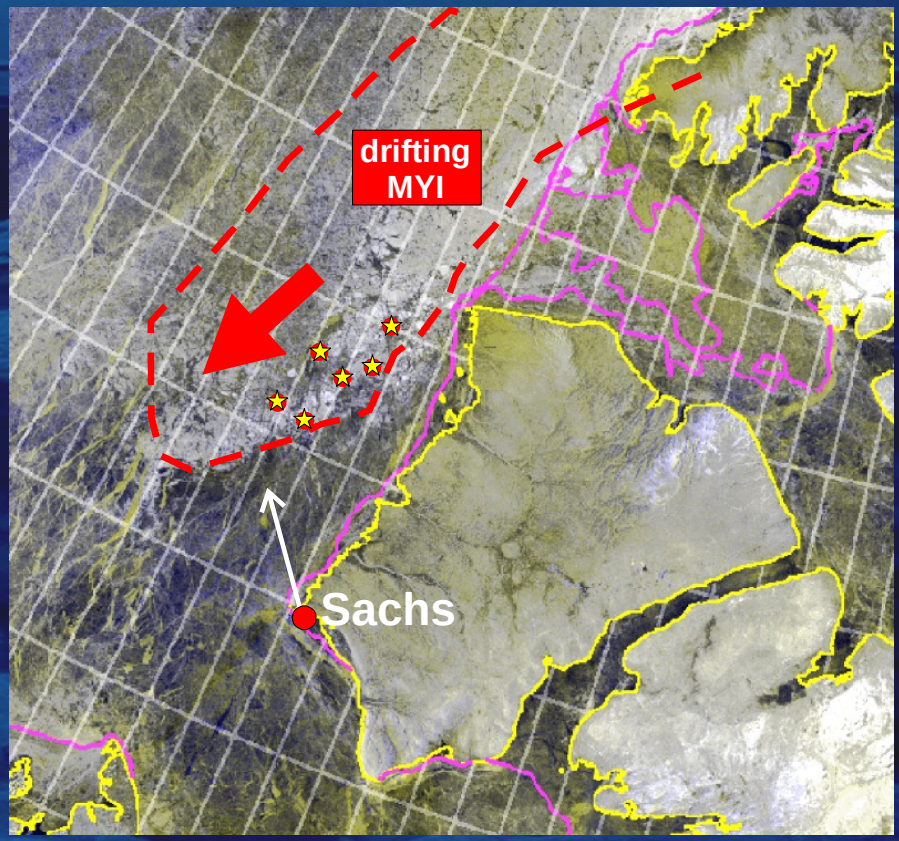
Cost comparison for field programs:

Resolute program, 2012



$200,000
2-week field program

Sachs Harbour program, 2013



$1,000,000+
3-week field program

Acknowledgements

- BREA (Beaufort Regional Environmental Assessment) and PERD (Program of Energy Research and Development) for funding this 4-yr program
- ConocoPhillips and Chevron Oil for saving the 2013 field program!
- Polar Continental Shelf Program (PCSP) for logistical and financial contribution to May 2012 field program
- NRC's Design and Fabrication Services for providing great new equipment!
- NRC for contributing financially to Resolute program and Sachs Harbour program

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- Resolute Hunter's and Trappers Committee
- Nunavut Research Institute & Aurora Research Institute
- Canadian Ice Service
- University of Manitoba, York University for collaborating on this BREA research
- Jackie (Kuptana's), Betty Haogak (SHHTC), Chris Hunt & John Lucas (Parks Canada)

The Team in May 2012