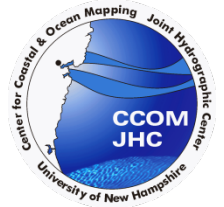


## GEBCO-Related High Arctic Activities - Summer 2011

John K. Hall

Geological Survey of Israel (Retired)





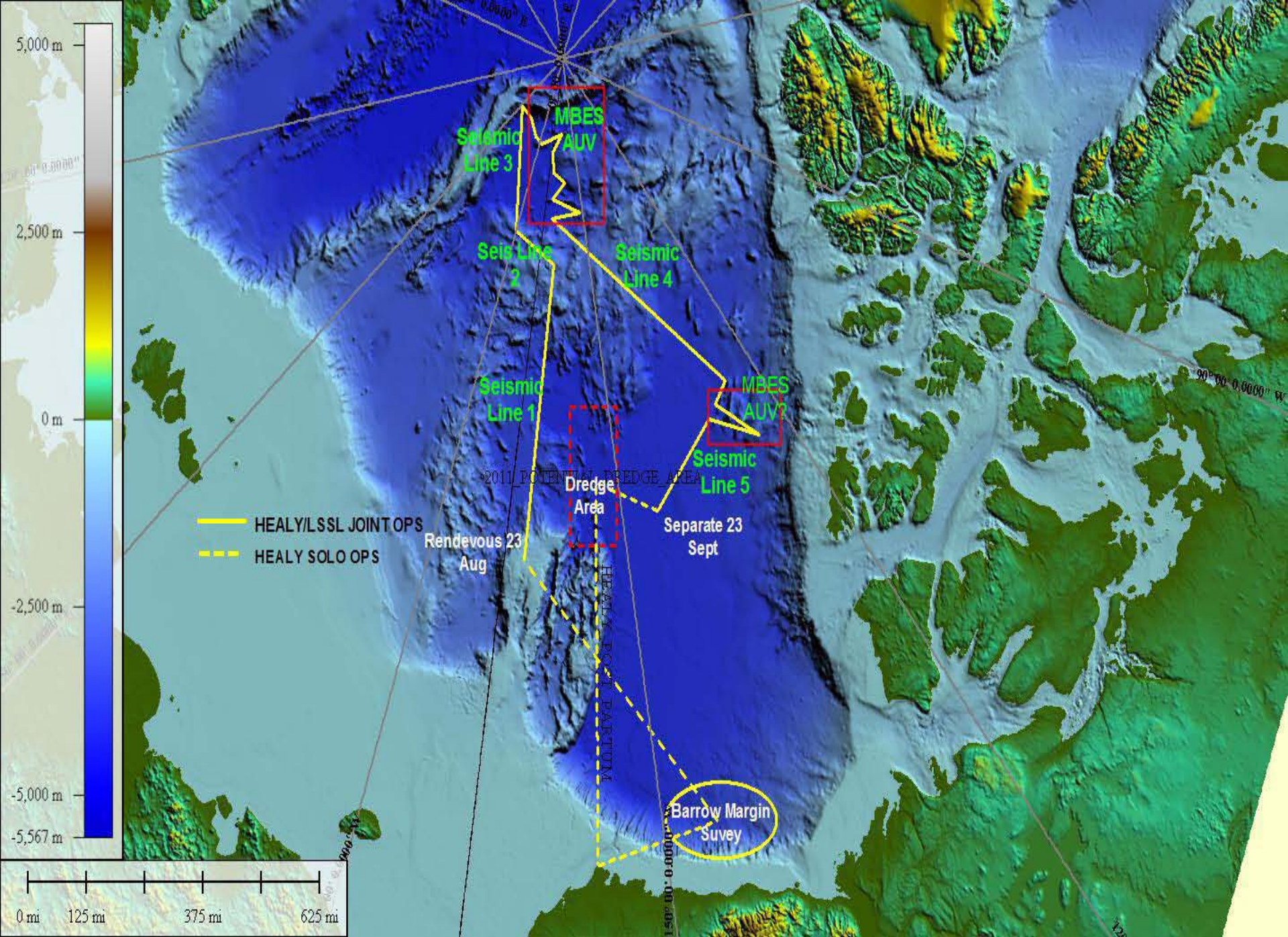
# HEALY-1102

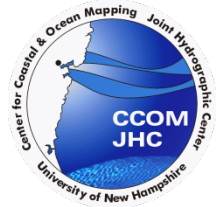
## Law of the Sea

### and why we are here









# HEALY-1102

## What we've done



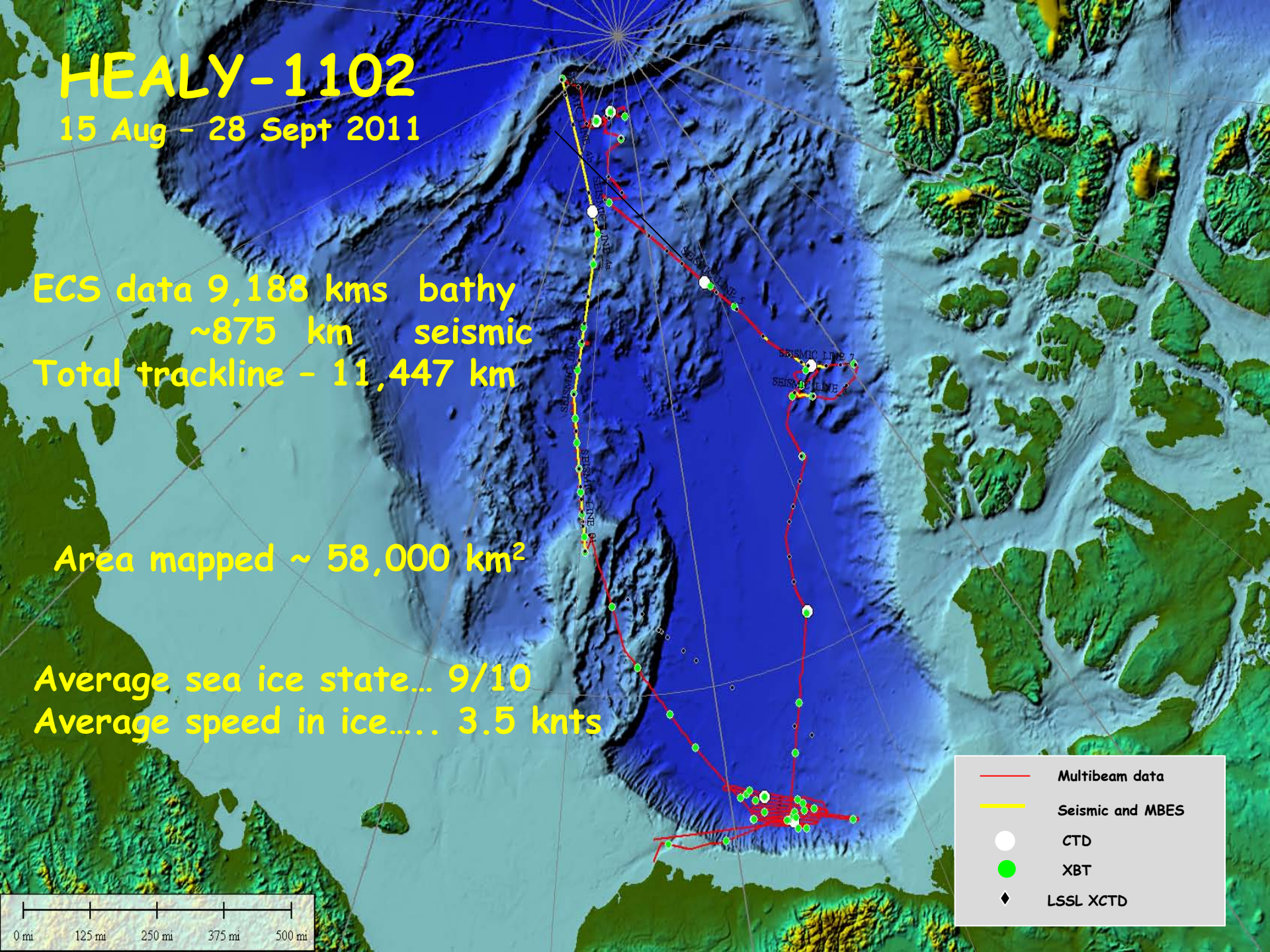
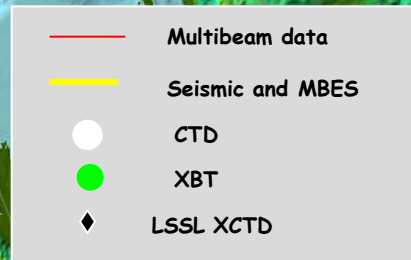
# HEALY-1102

15 Aug - 28 Sept 2011

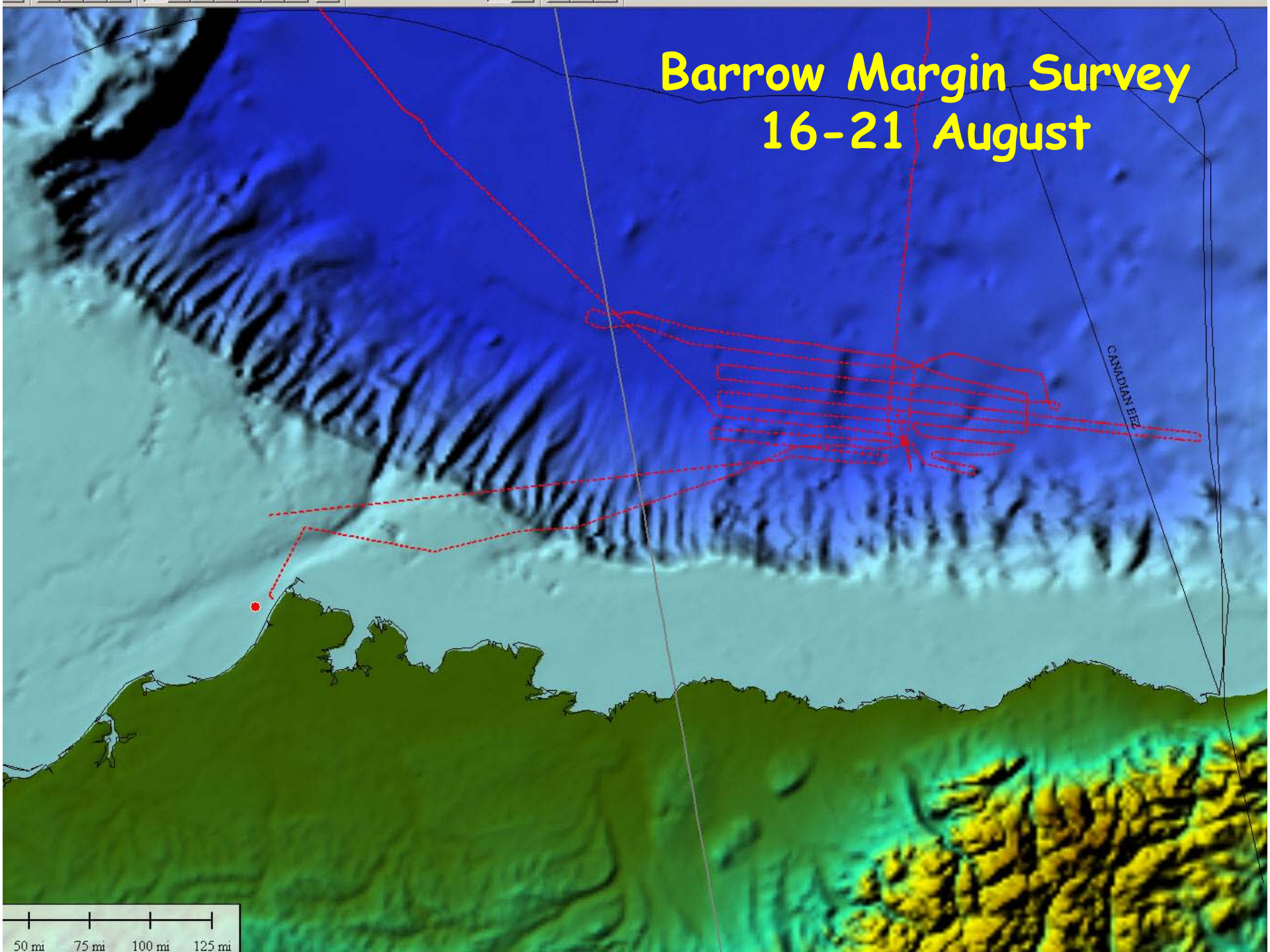
ECS data 9,188 kms bathy  
~875 km seismic  
Total trackline - 11,447 km

Area mapped ~ 58,000 km<sup>2</sup>

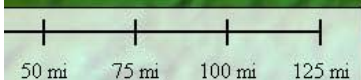
Average sea ice state... 9/10  
Average speed in ice..... 3.5 knts



# Barrow Margin Survey 16-21 August

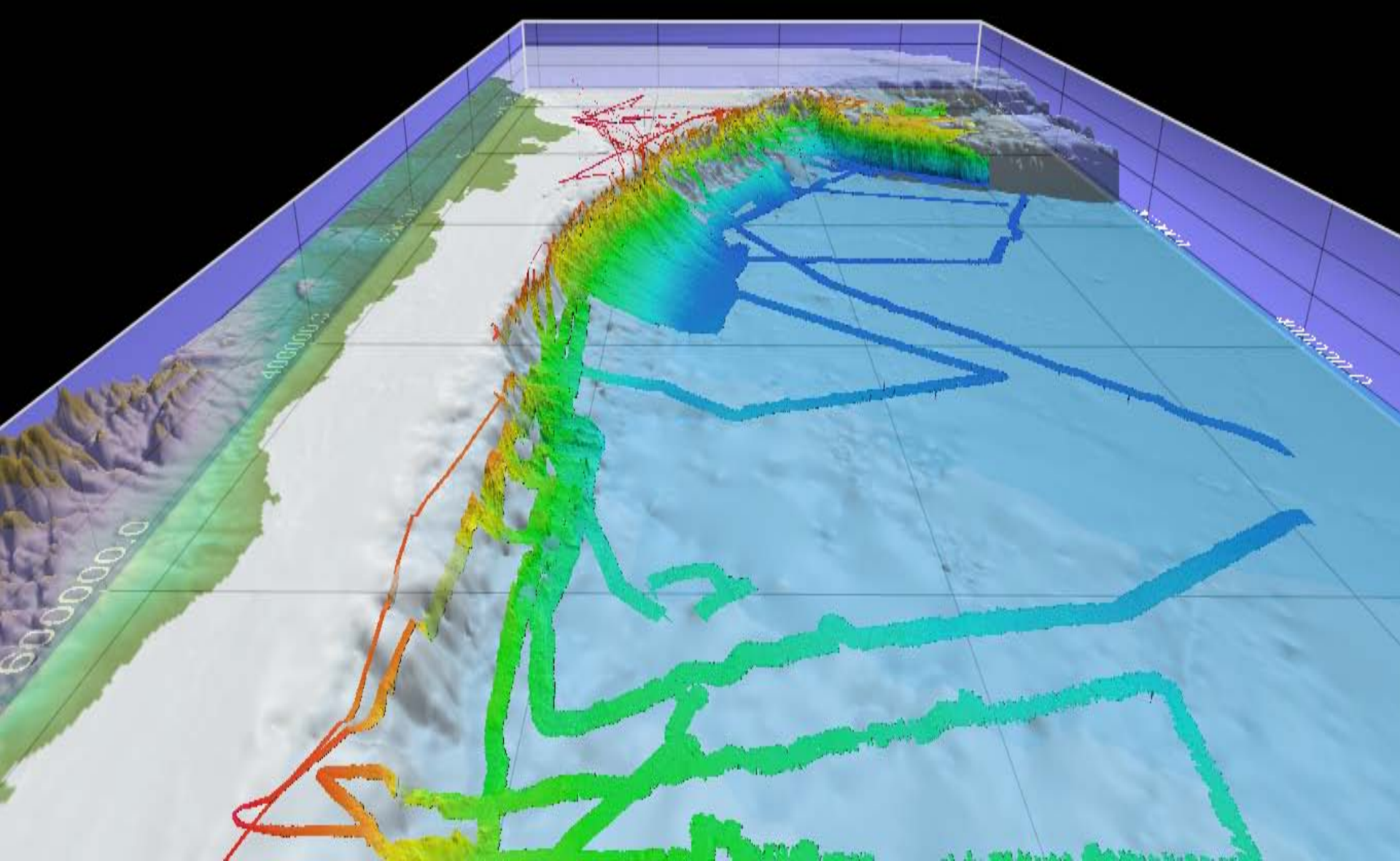


CANADIAN EEZ



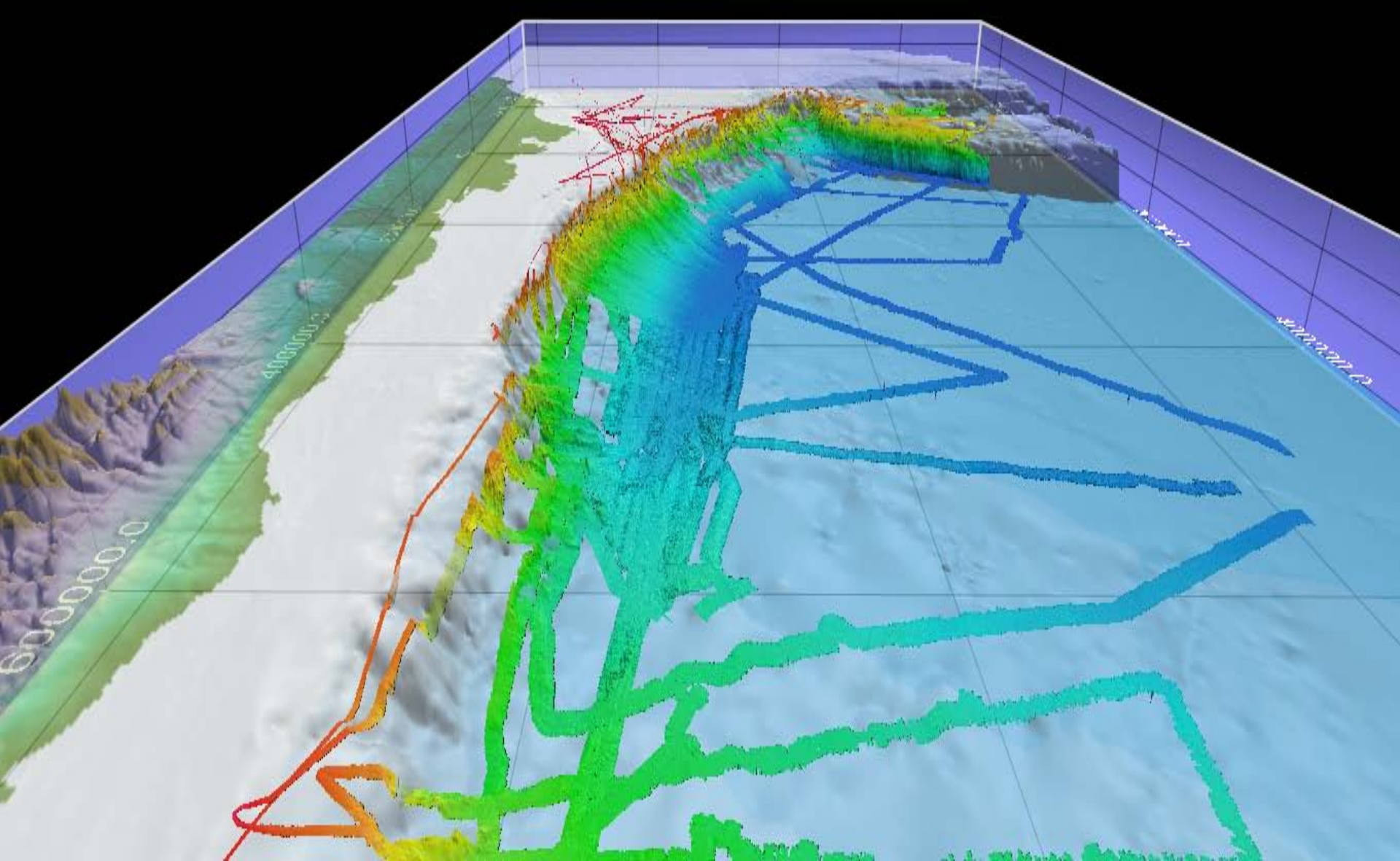


# Before HLY-2011



# 16 - 21 August 2011

~ 7500 sq nm

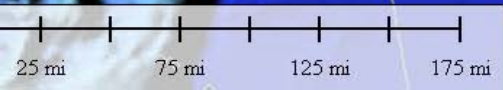


Rendezvous 23 August

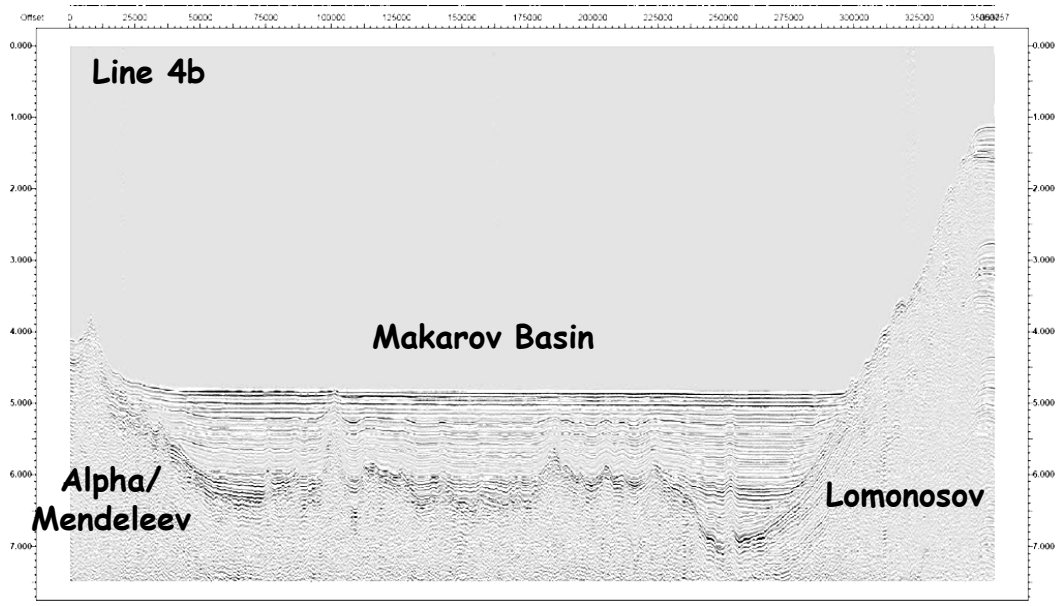
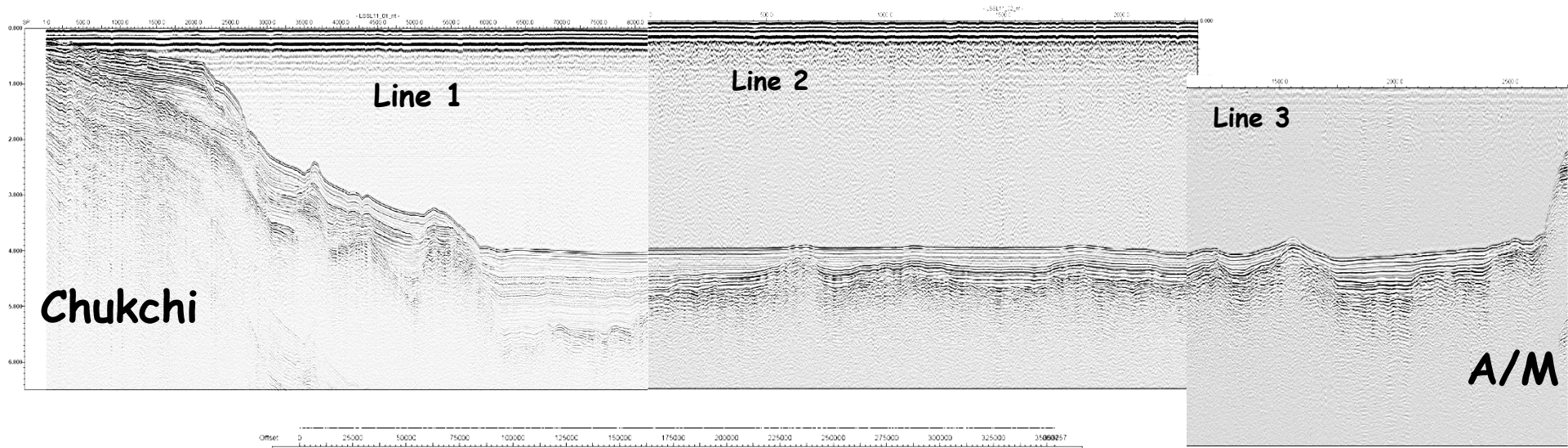




20 SEPT

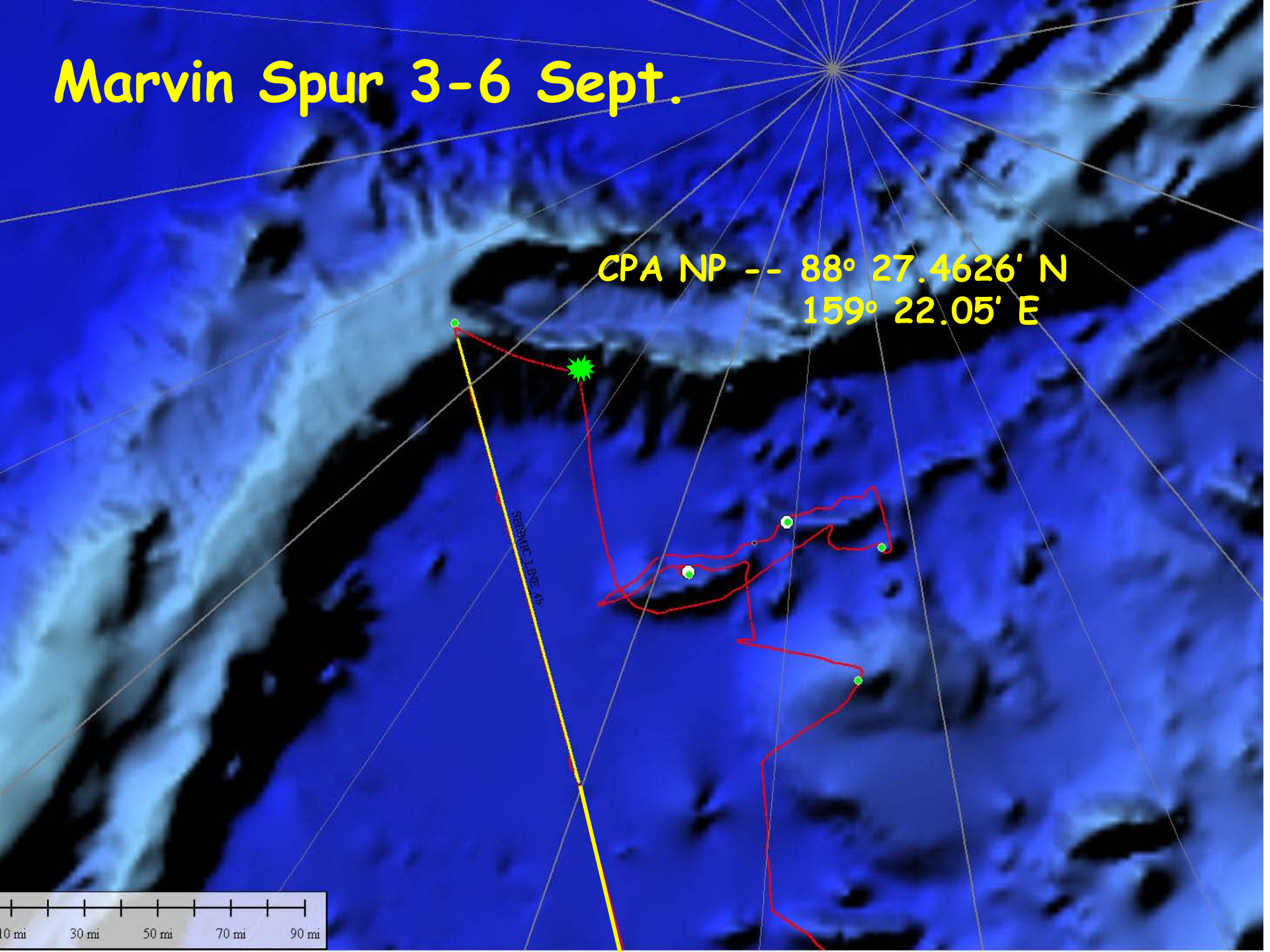
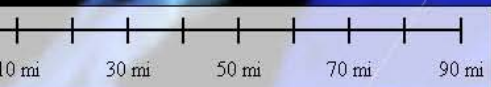


# LSSL Monitor Records

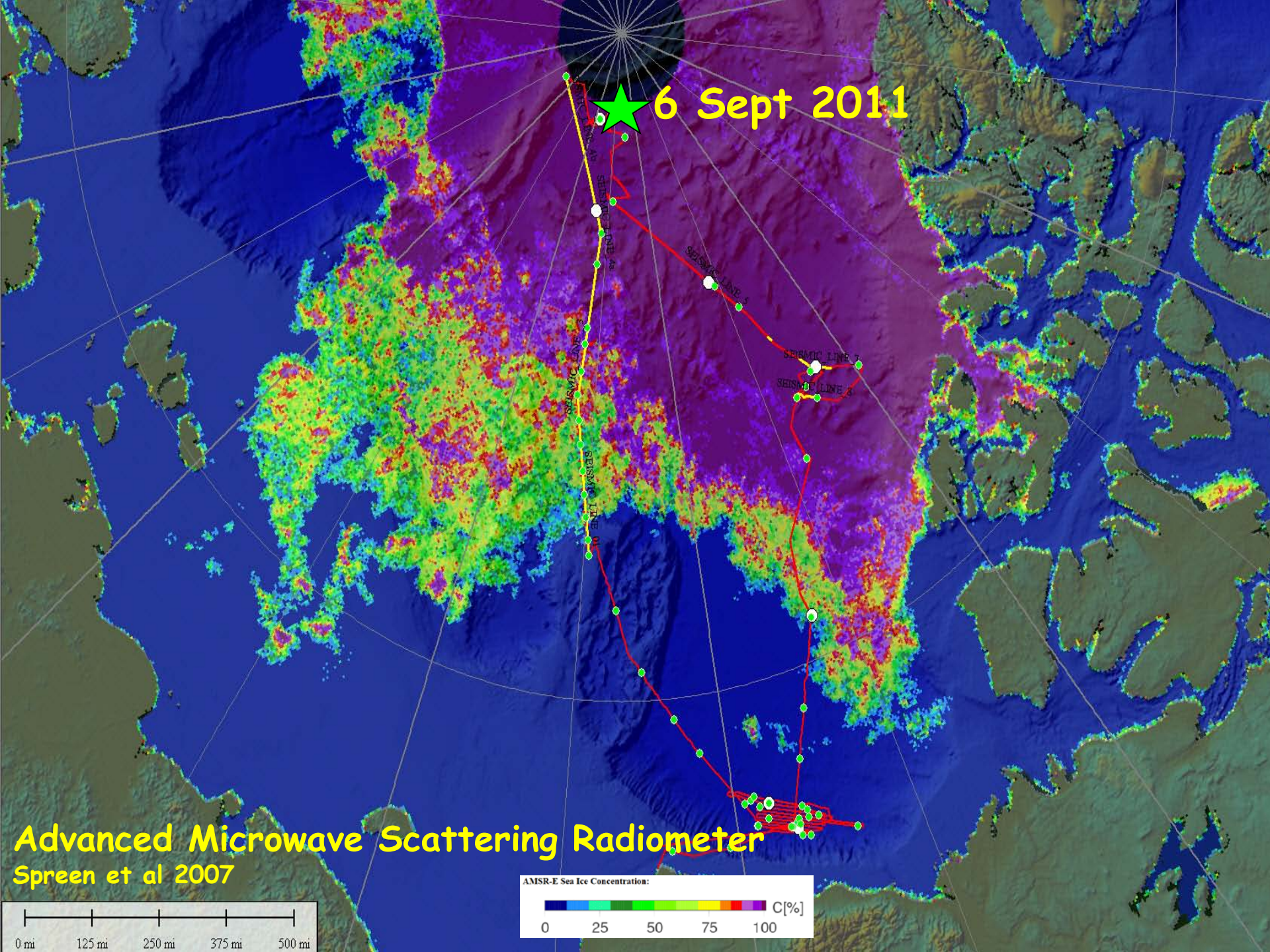


# Marvin Spur 3-6 Sept.

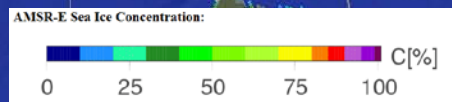
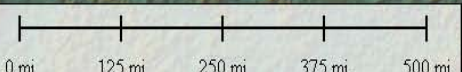
CPA NP --  $88^{\circ} 27.4626' N$   
 $159^{\circ} 22.05' E$



★ 6 Sept 2011



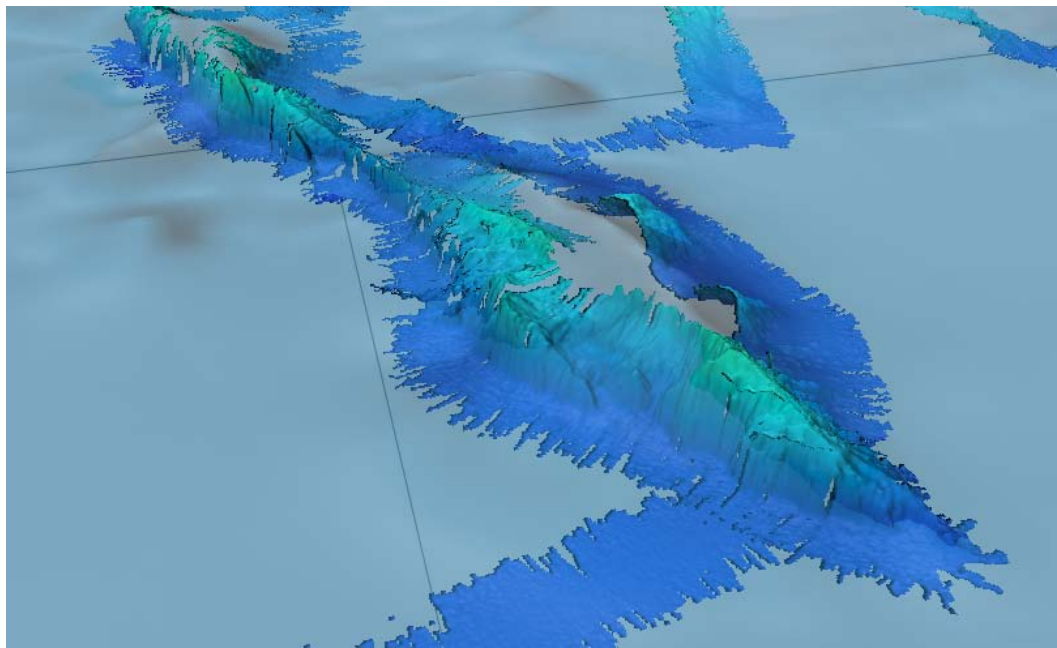
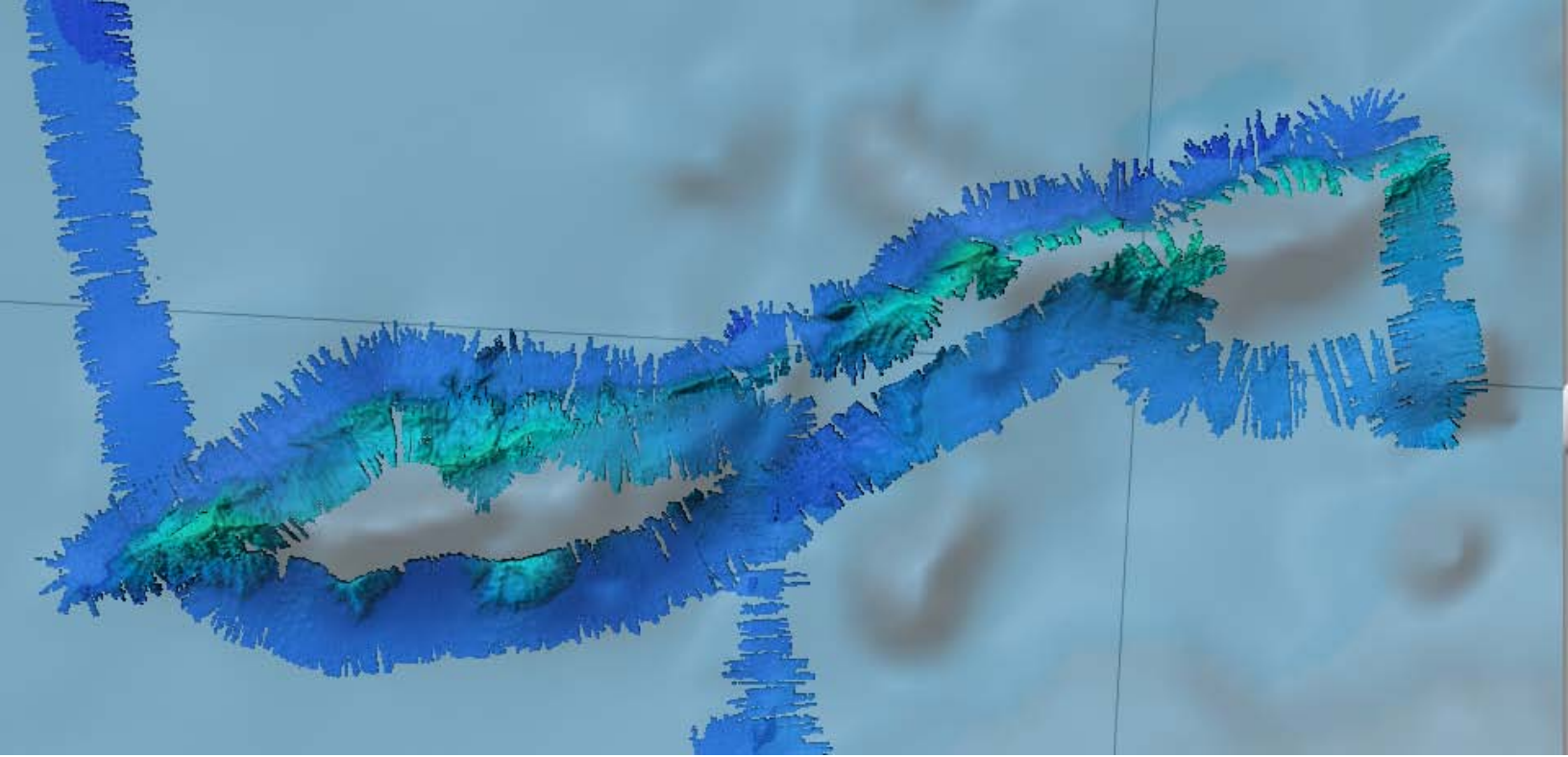
Advanced Microwave Scattering Radiometer  
Spreen et al 2007





# LSSL AUV LAUNCH







3 Sept 2011



http://mapserver.healy.polar.science.net/

Healy Map Surfer

Healy Map Surfer

Longitude: -179.99 to 179.86 Latitude: 78.98 to 86.69 Scale: 1931573

SHOW LEGEN  
Refresh Map  
Load All Layers

## Ship Tracks

- Healy (CURRENT)
- IBCAO
- Underway Date
- Homezone
- Safety
- Sea Surface Temp
- Apparent Day Visibility

## Waypoints

- Healy Stop/Waypoint
- Moorings
- AMP Buoy
- ANCO Buoy
- USAF Time Series Pt
- NOAA Buoy 48087
- HLY1102 Pt
- HLY1102 CTD/087s
- Ships

## Remotely Sensed/Radar

## Remotely Sensed/Visible

## Remotely Sensed/Derived

- Daily SST\_Moored
- SST\_Satellite/MSR2002
- Chlorophyll\_a/SeaWiFS

## Radar Layers

- LACong Dht
- Countries
- Bath/Trop
- Bath/Contours
- IBCAO 2008
- BOBST Healt
- Russian Arct 01115
- SOOEX
- Oden Multibeam
- Canadian Multibeam
- Misc Multibeam
- NGDC Multibeam
- Healy Multibeam
- Realtime Multibeam
- Oden Gasflow
- Alaska/Canada Cities
- Rivers/Lakes
- NOAA Net (Charts)
- Weather/Bering Sea
- LANGSAT 2000



Ship Position at 2011/09/10 15:23:40 - Long: 137.9232 W. Lat: 83.53755 N (Easting: 201176.29 Northing: -624861.80)

"IBCAO" depth: 2425 m. Multibeam depths(Archive/Current/Centerbeam): NA / NA / NA m

SOG: 0.4 COG: 51.6 Heading: 84.76 Water Temp: -1.473 Sal: 27.992 Floor: 0.17 Wirecut1: NA Wirecut2: NA

Almanac: 09/10 21:05Z local noon, 09/11 07:21Z Sunset, 09/11 09:05Z local midnight, 09/11 10:54Z Sunrise

**R...**

Flange: 500  
Phase: 9

Max Limits: 2000-2500m

AutoPhase On

Max. Depth Limit: 4500

Min. Depth Limit: 500

Close

**LF**

Div/Gb: 2220

Gain: 200

Agc

Power: 4

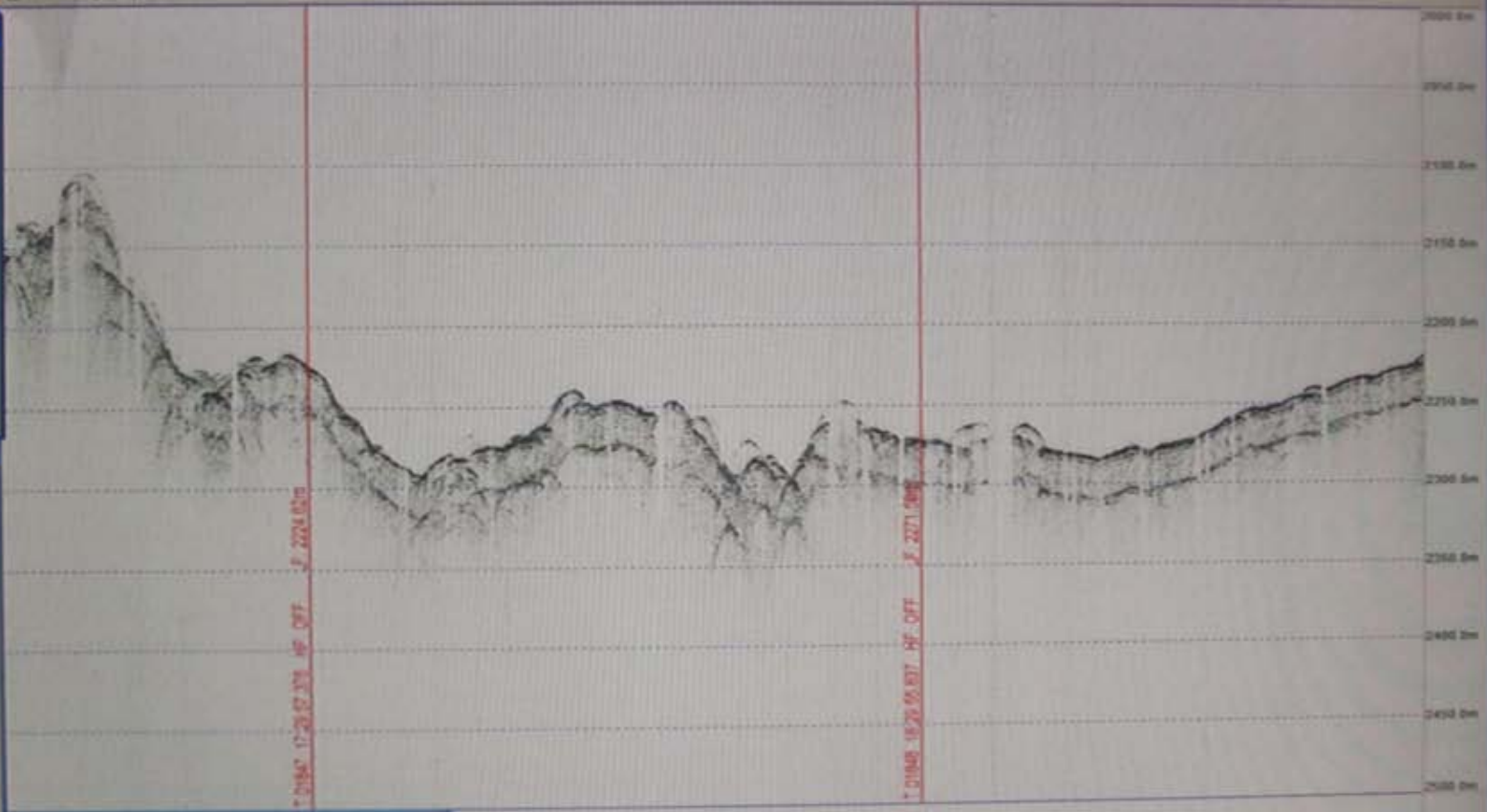
Pulse Type: 24 no chop

Processing Gain: 1

Tx Blvd: 8.0

Sensitivity: 45

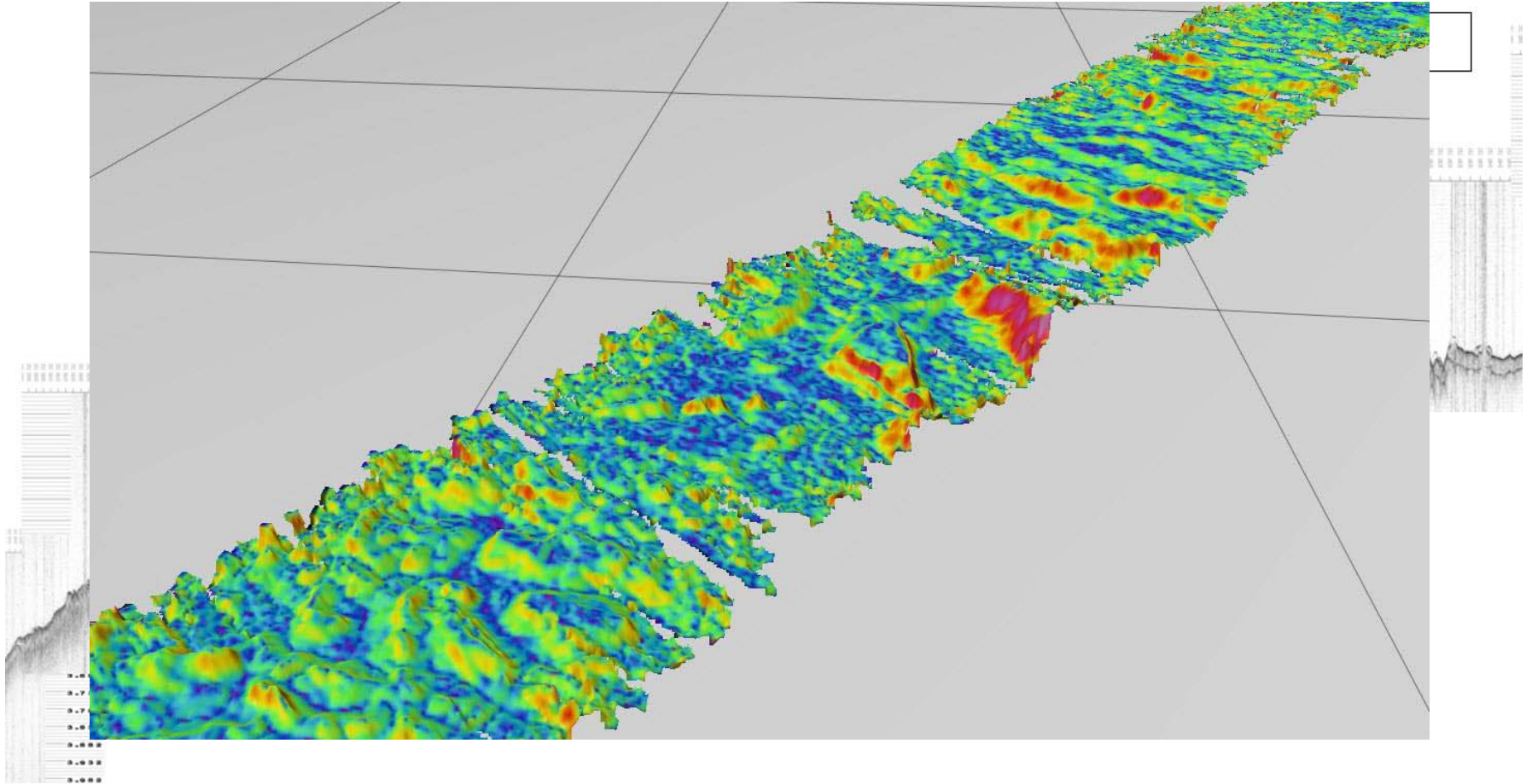
Close



HF: OFF n/a  
LF: 2220 m -52 dB

M 50m deeper than MB

# Hyperbolic Echoes on Alpha/Mendeleev Ridge



# Sever Spur

12 Sept

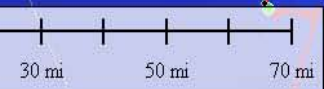
SEISMIC LINE 7

2 seismic lines

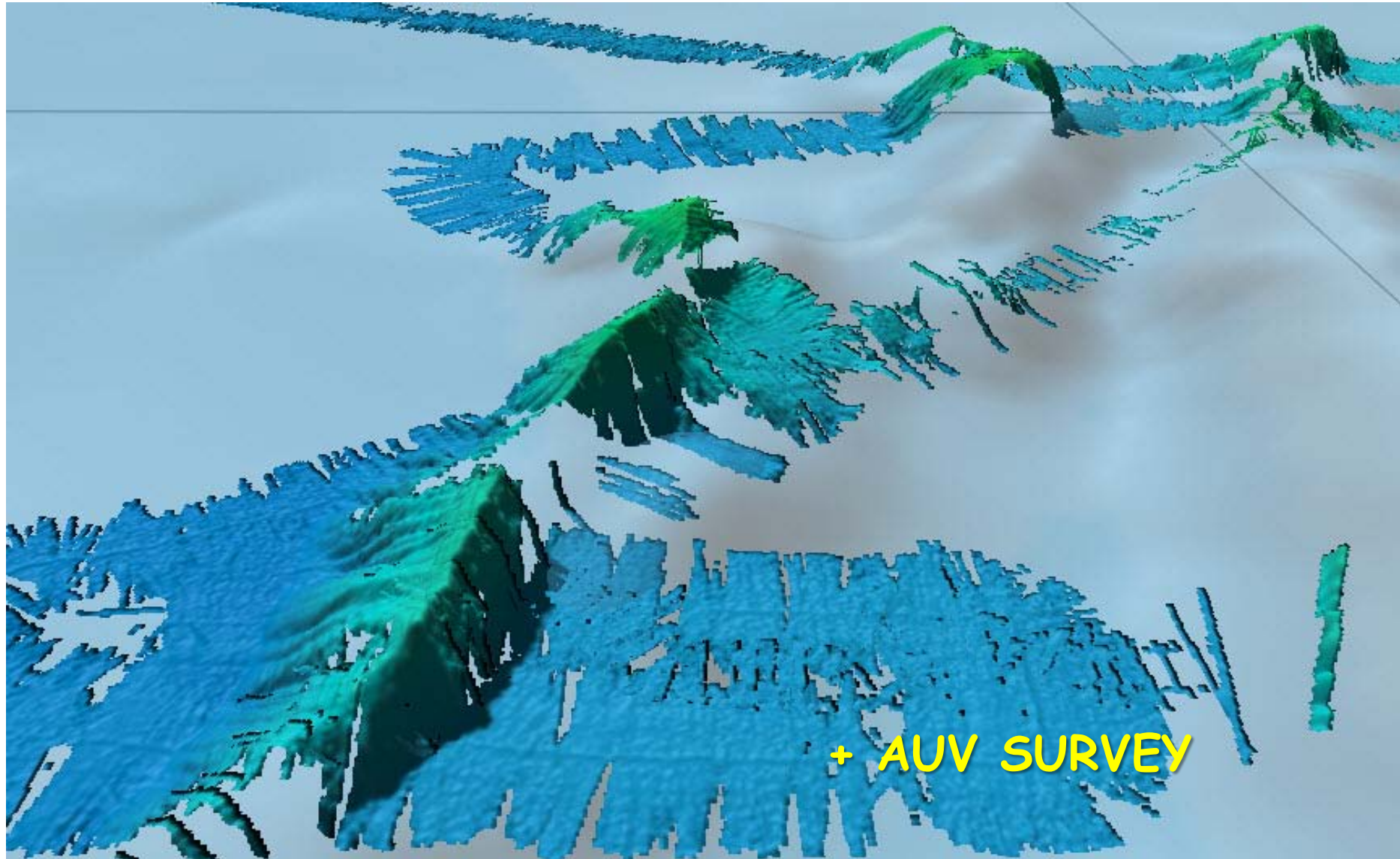
AUV deployment

18 Sept

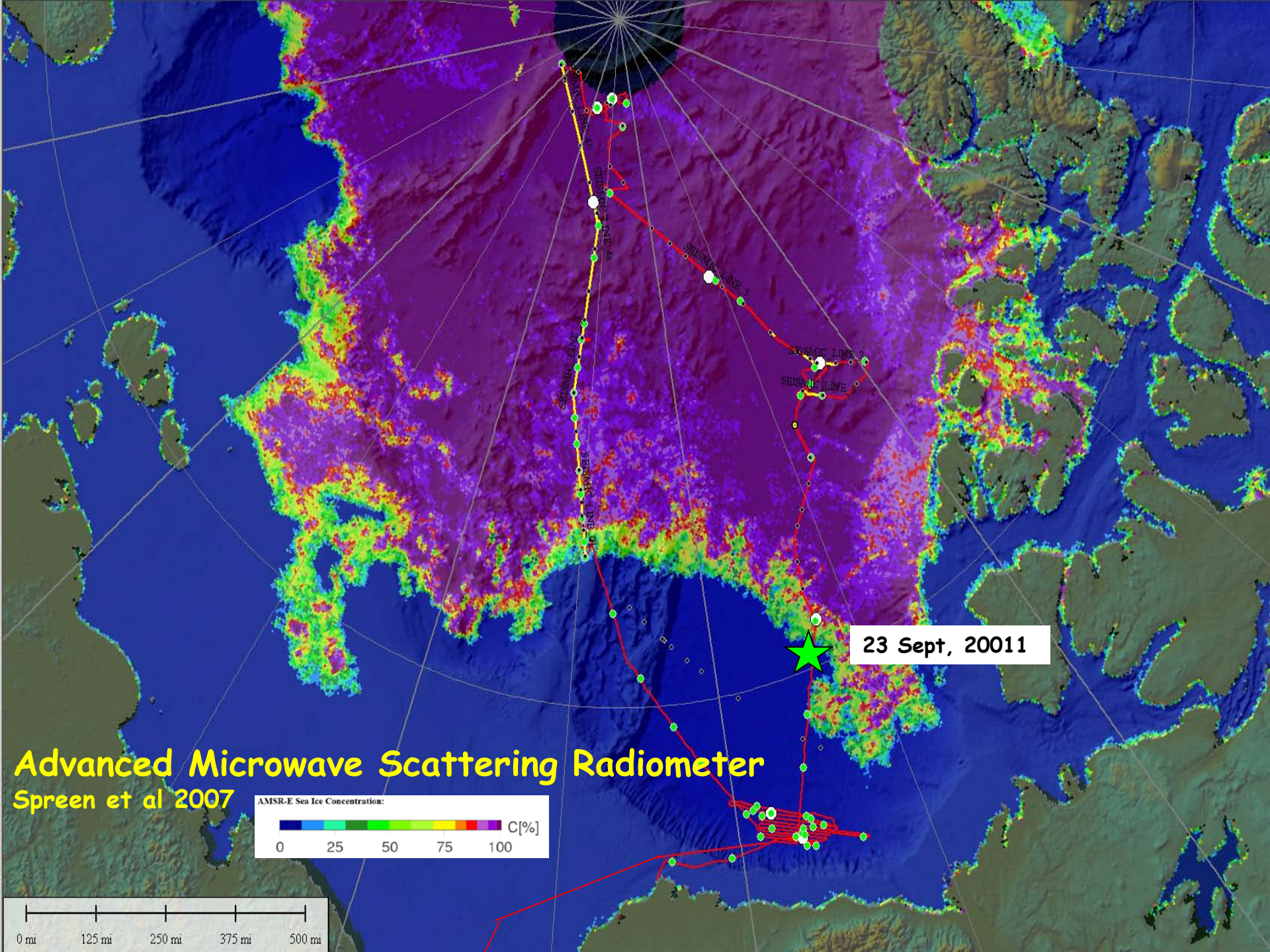
SEISMIC LINE



# Sever Spur

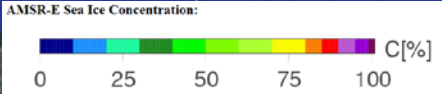




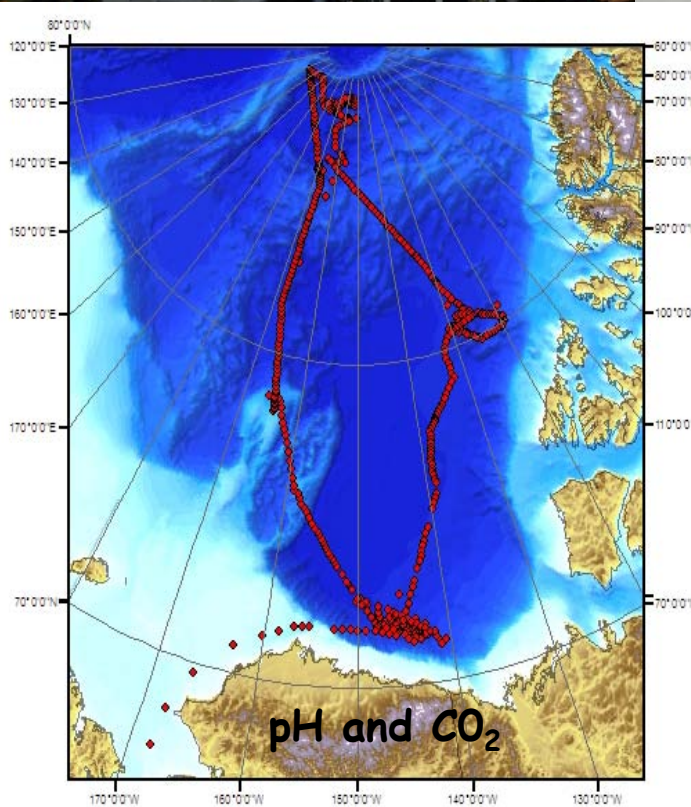
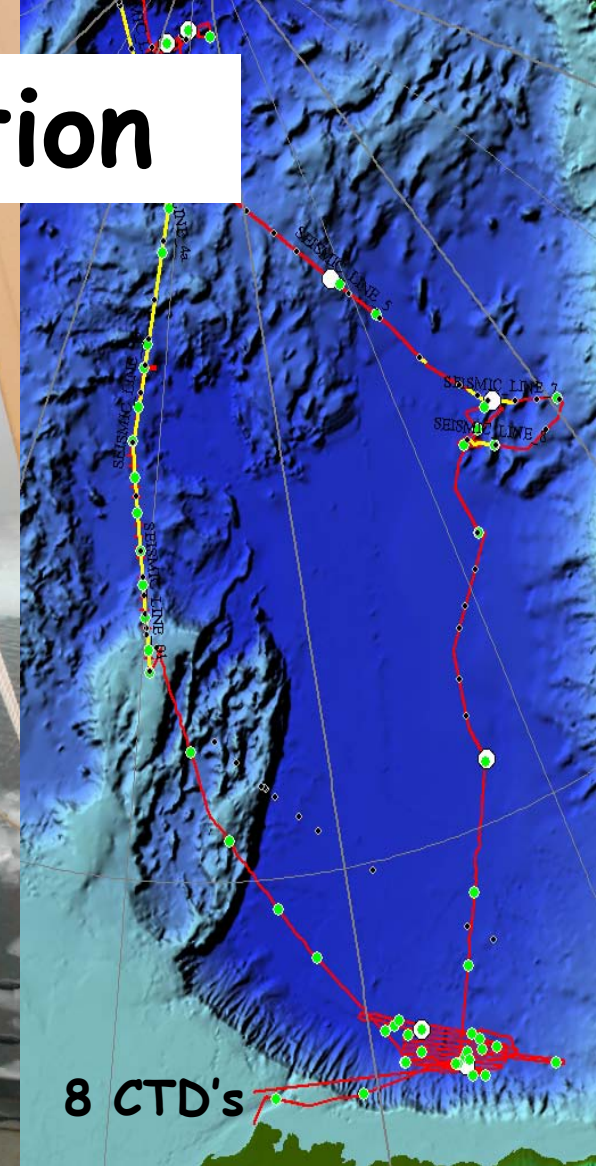
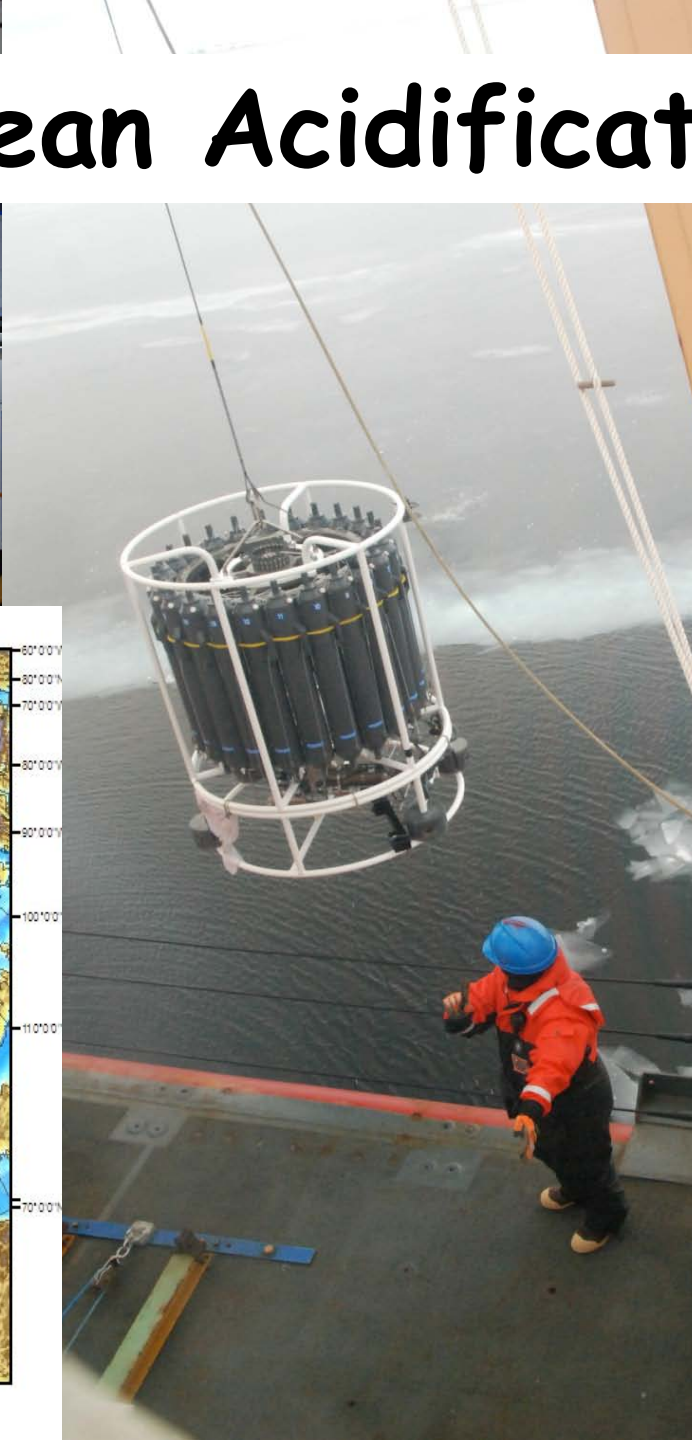
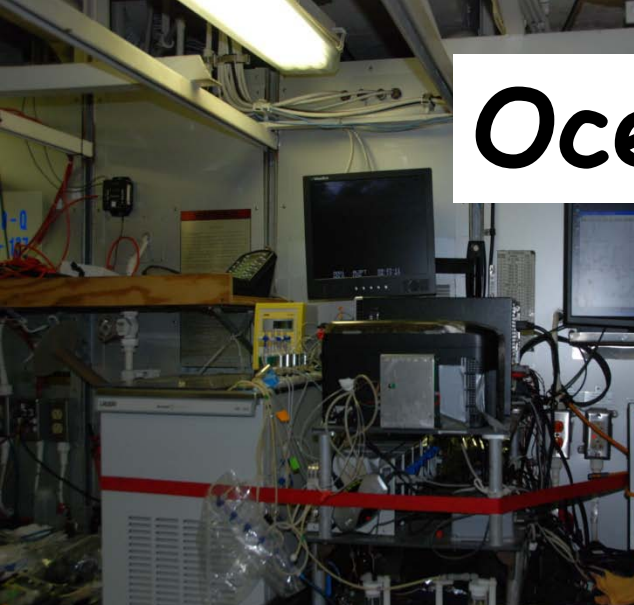


23 Sept, 2011

Advanced Microwave Scattering Radiometer  
Spreen et al 2007



# Ocean Acidification



# ICE OBSERVATIONS and BUOYS

- 1- UpTempO buoy
- 8- Surface Velocity Program Drifters
- 2 - AXIB's

0-3/10ths  
10-20% Old ice  
remainder Thick 1st year ice  
and new ice

9-10/10ths  
70-100% Old ice  
remainder Thick 1st year ice

OPEN WATER

160°00'W

74°00'N

130°00'W

10 NM

MDA 2011

78°00'N

76°00'N

130°00'W



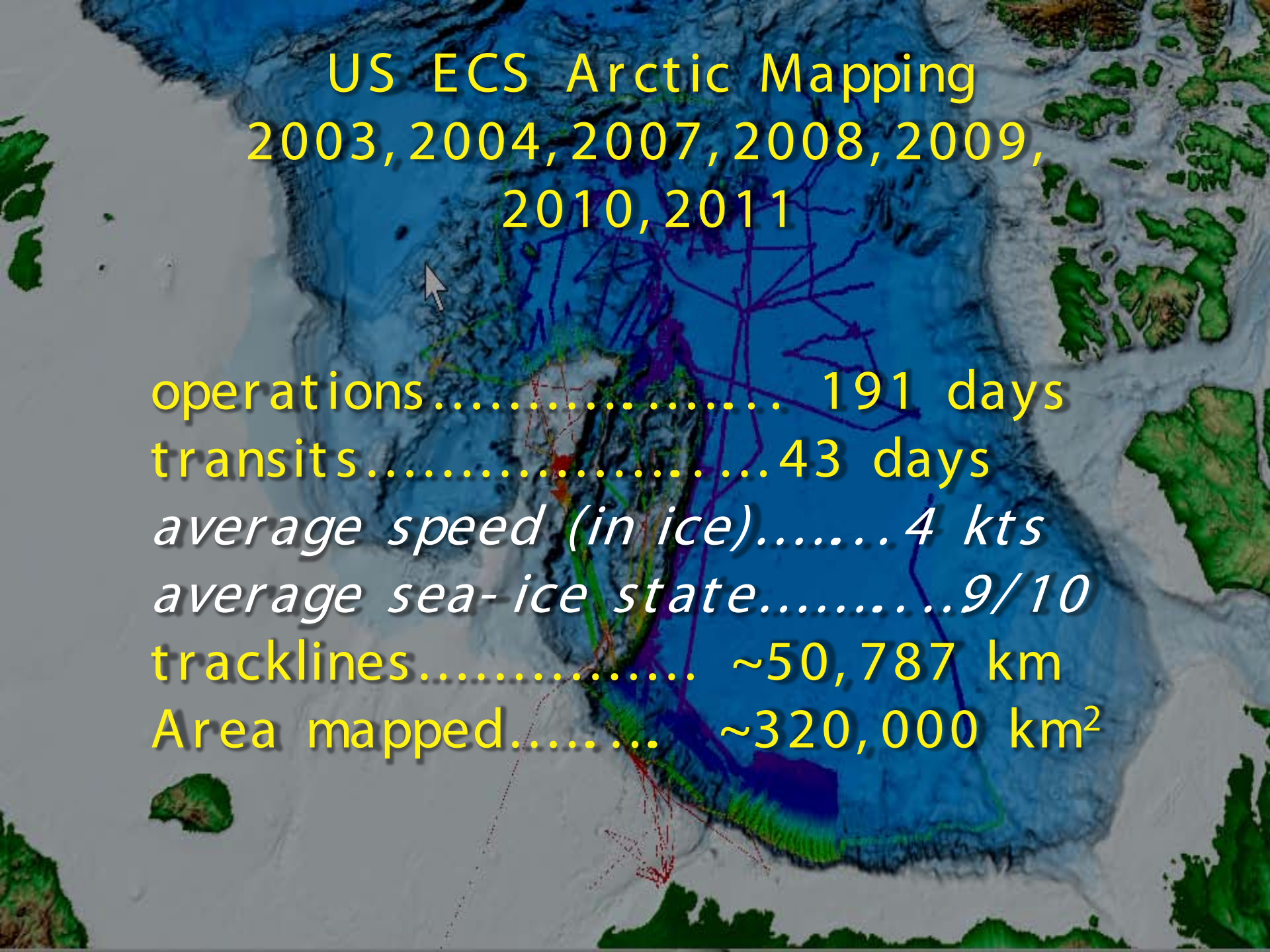


UAS OPS on LSSL



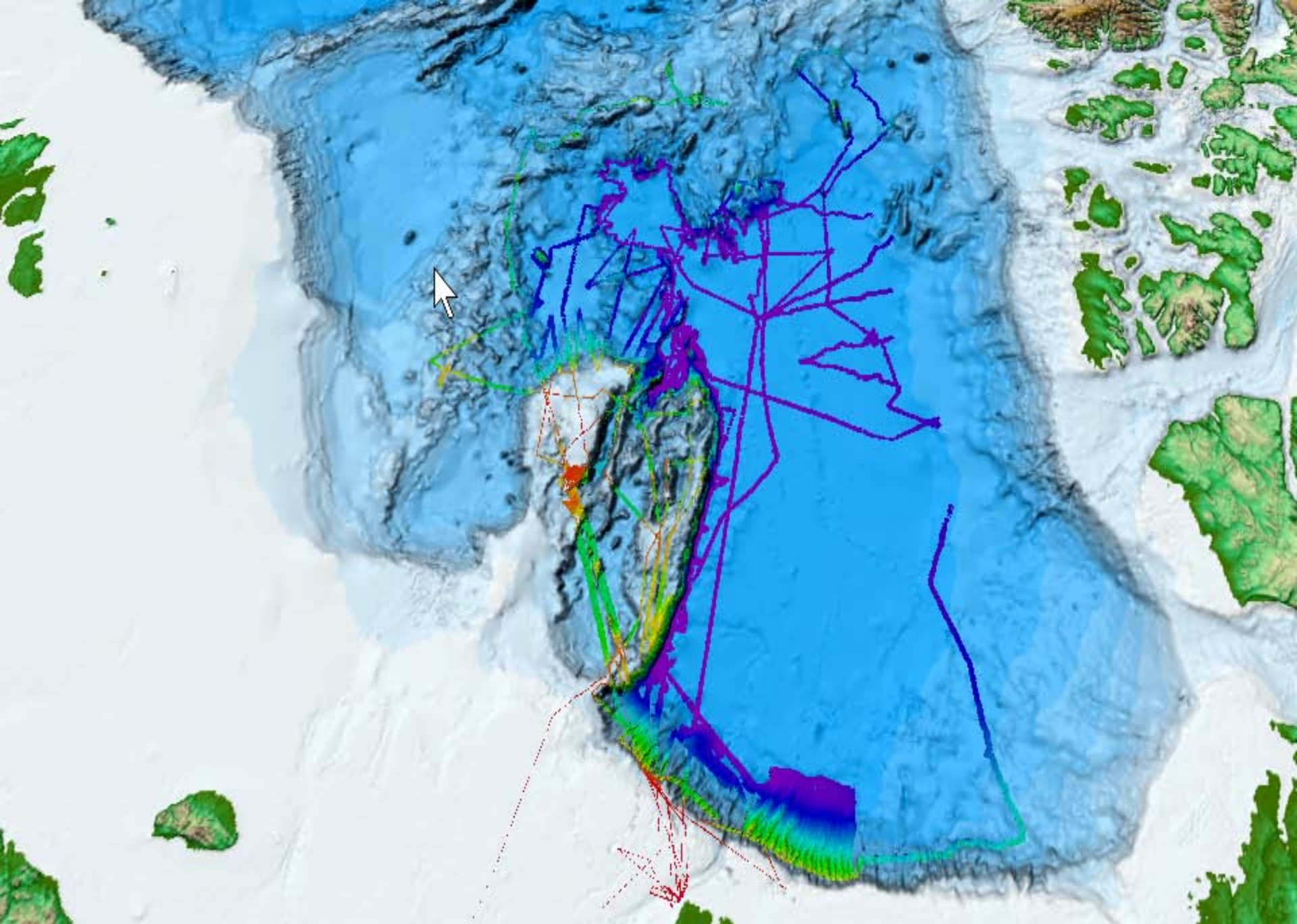
HEALY 1102  
15 Aug - 28 Sept 2011

operations..... 44 days  
transits.....8 days  
*average speed (in ice)..... 3.5 kts*  
*average sea-ice state.....9/10*  
tracklines..(ECS)..... 9,188 km  
total trackline..... 11,447 km  
Area mapped..... 57,817 km<sup>2</sup>



US ECS Arctic Mapping  
2003, 2004, 2007, 2008, 2009,  
2010, 2011

operations..... 191 days  
transits.....43 days  
*average speed (in ice)..... 4 kts*  
*average sea-ice state.....9/10*  
tracklines..... ~50,787 km  
Area mapped..... ~320,000 km<sup>2</sup>



US ECS Arctic Mapping 2003, 2004, 2007, 2008, 2009, 2010



Coast Guard  
Guard ctiere

LOUIS S. ST-LAURENT

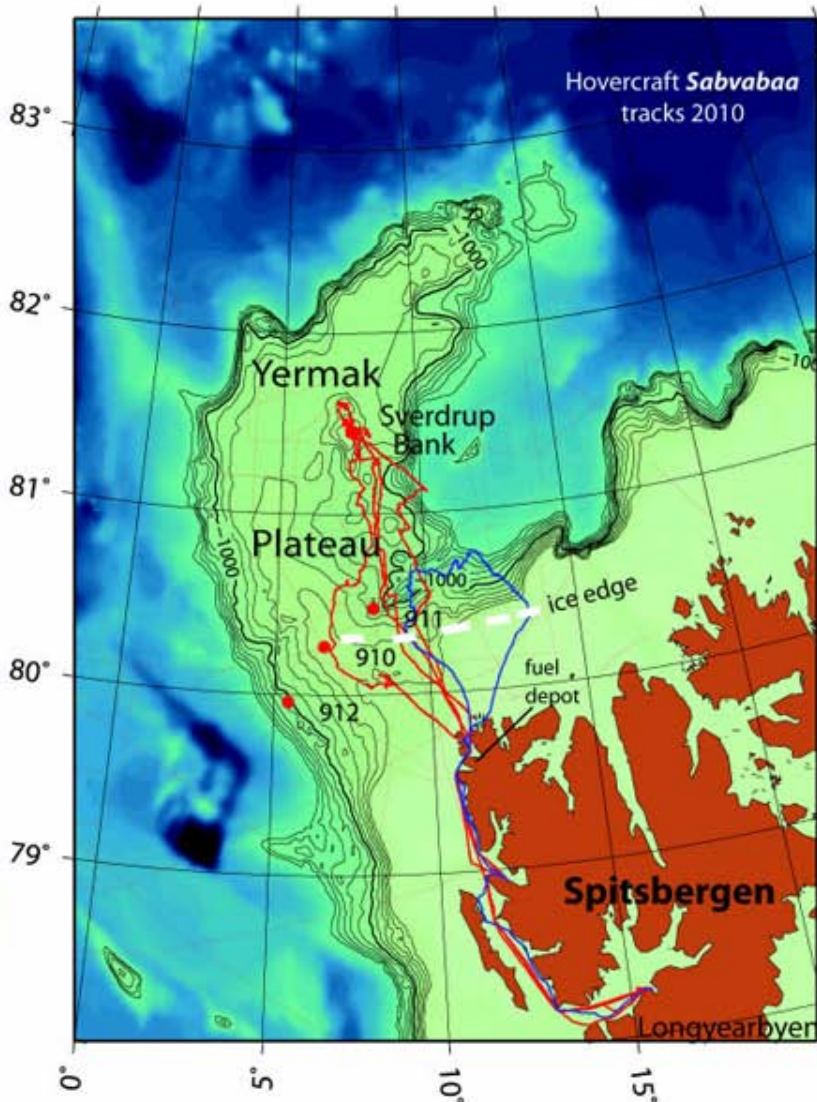
Canada







**R/H SABVABAA - In the Eastern Arctic**



Scientific activities	2008	2009	2010
Ice thickness measurements	200 km	30 km	0 km
Ice cores	3	2	0
CTD stations	10	57	0
Seismic reflection (in drift mode)	10 km	35 km	35 km
Sediment cores	2	0	0
Rock dredges (successful)	0	5 (3)	11 (7)

Hovercraft operations	2008	2009	2010
Total number of trips Longyearbyen to north of 80 N	5	5	3
Total milage	3.300 nm	3.100 nm	2.075 nm
Total distance over sea ice	80 nm	80 nm	540 nm
Distance north from the ice edge	7 nm	15 nm	90 nm
Longest trip without refuelling	504 nm	724 nm	675 nm
Fuel consumption at economy speed	60 l/hr.	60 l/hr.	60 l/hr.
Economy speed with full payload	16-28 knop	16-28 knop	16-28 knop
Average payload at departure Longyearbyen	3.2 ton	3.2 ton	3.2 ton

2011 - 30 dredges, CSP, seismic buoys, E/S buoys tested.

By now, we have logged 1.700 n.m. driving north of the ice edge. This is equivalent to 3x the great circle distance from the ice edge north of Svalbard to the North Pole. Ice conditions this year were the best we have had and we were able to average over 7 knots over several 10's of nautical miles. With the rocks we recovered from the sea bed earlier and now from as far as 82 N, we are able to deliver what we promised and have had support from the Norwegian Petroleum Directorate for 3 seasons now.

We are slowly getting acceptance for the notion that hovercraft is a useful alternative platform for science in the Arctic Ocean as the Germans have come and asked us to join their icebreaker expedition into the central Arctic Ocean in 2014. The craft continues to impress me with respect to traversing difficult ice. Damage to skirt segments is minimal, but safety links are regularly consumed. Have junked only 4-5 segments so far.



DL1519AP





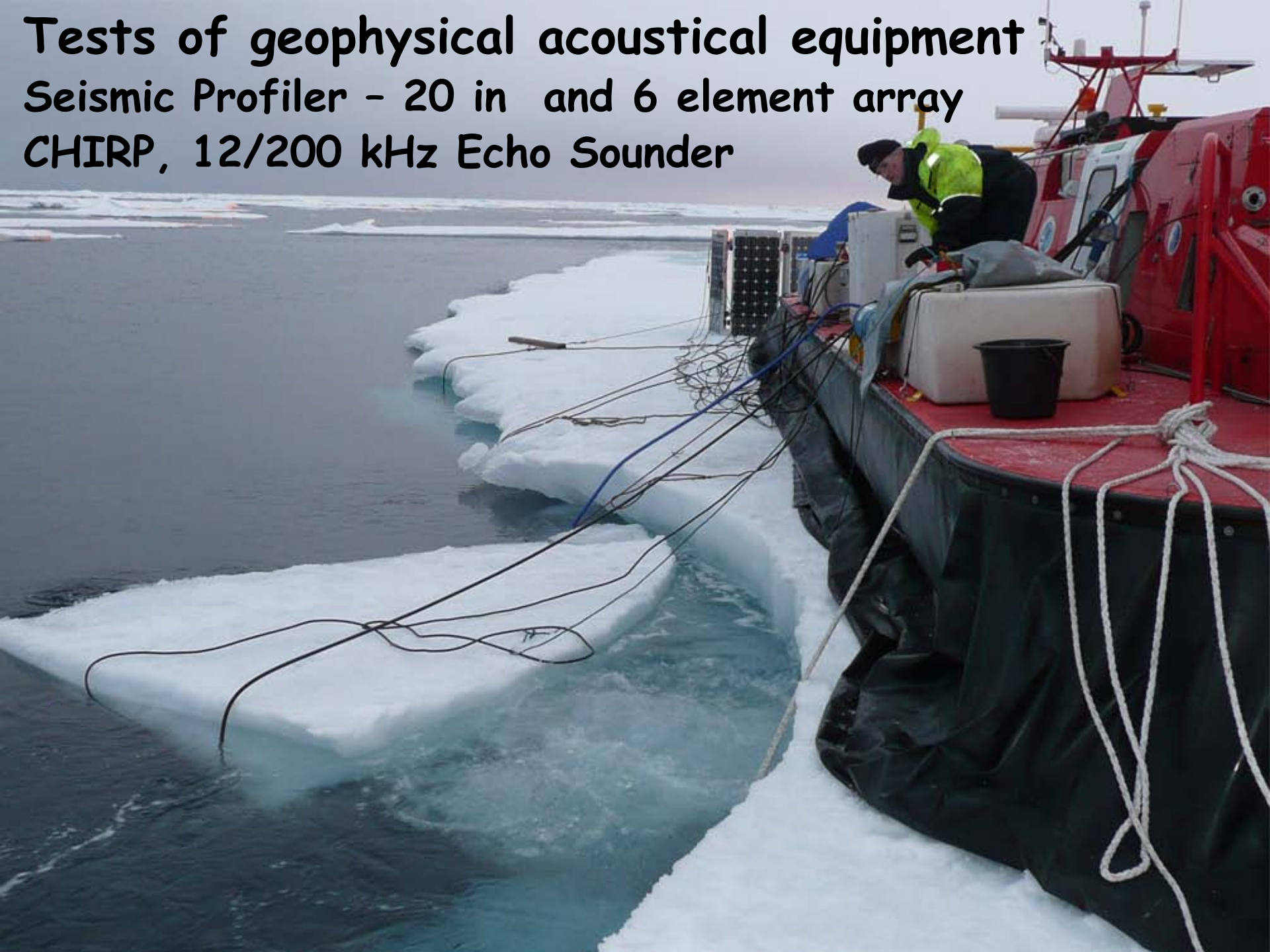


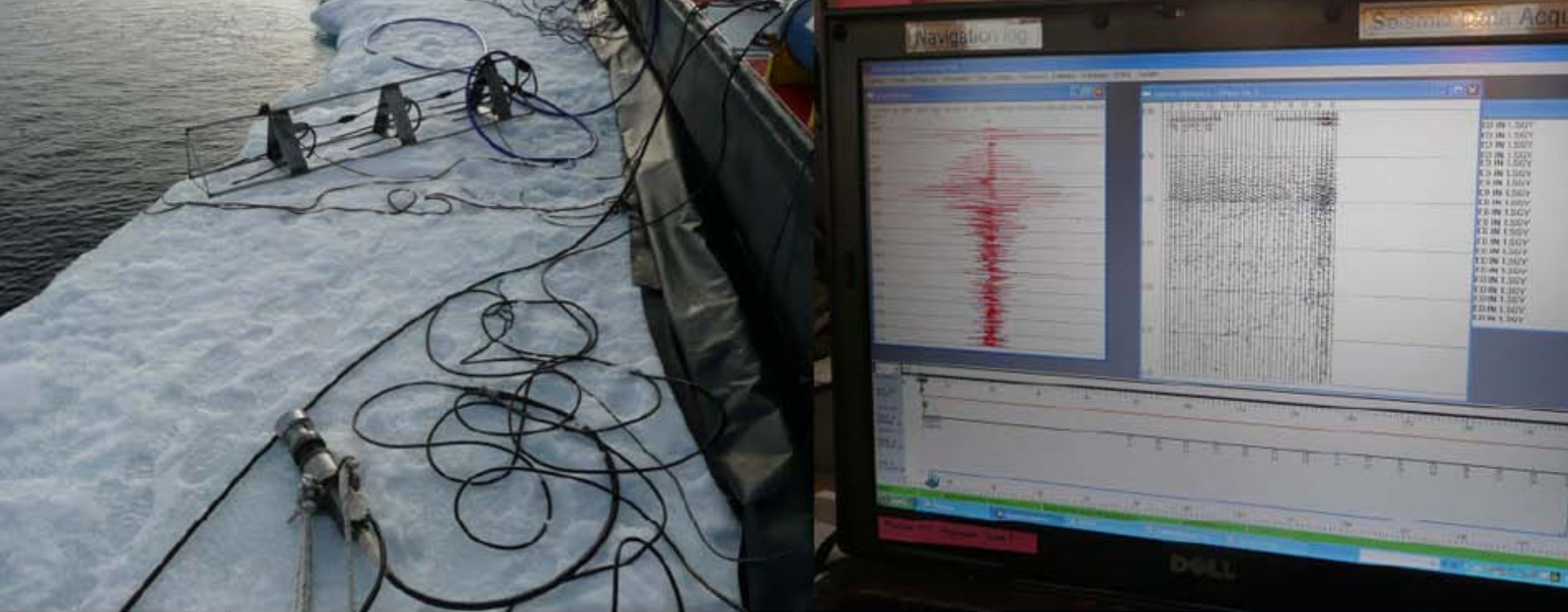


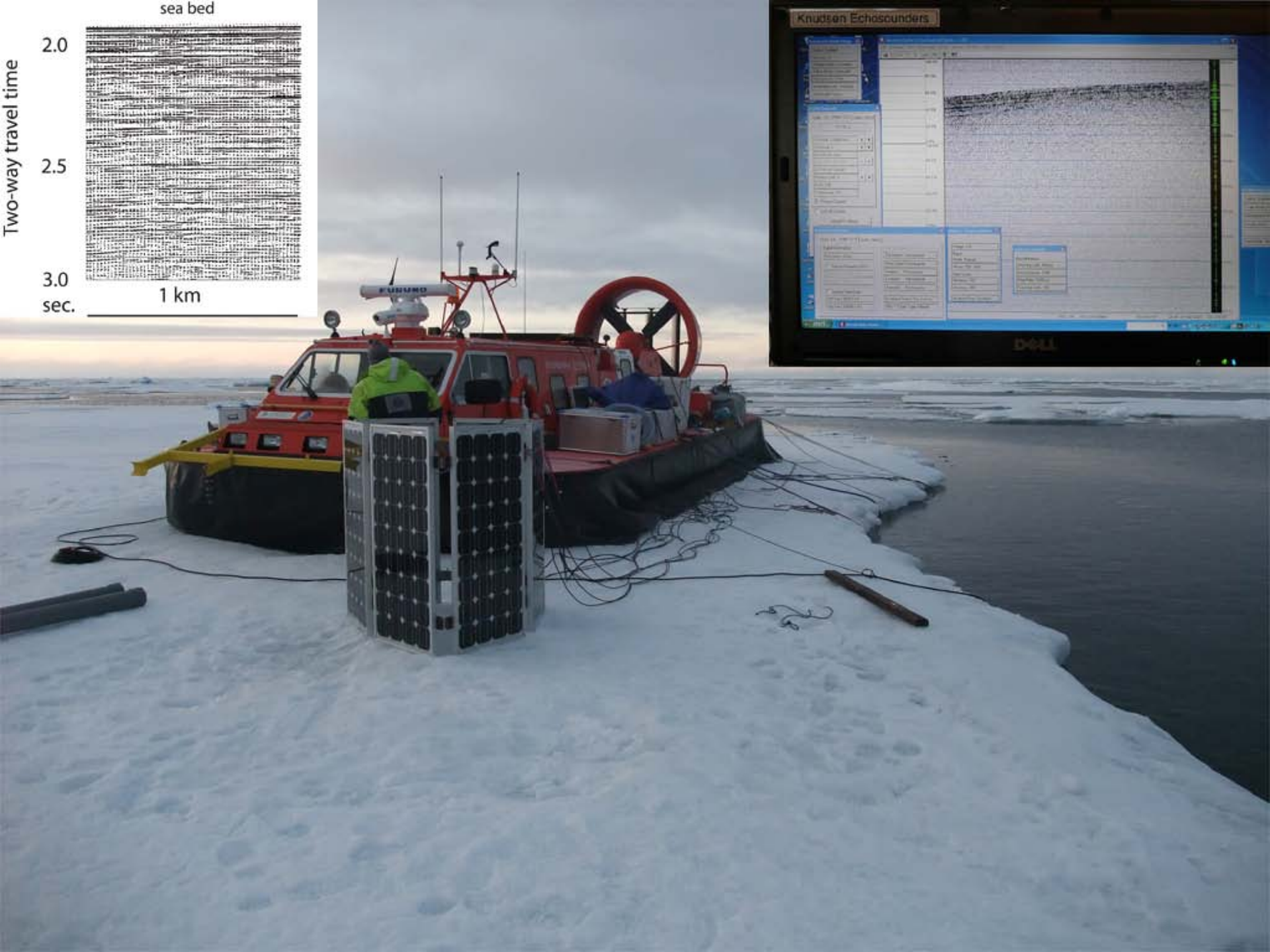


# Tests of geophysical acoustical equipment

Seismic Profiler - 20 in and 6 element array  
CHIRP, 12/200 kHz Echo Sounder



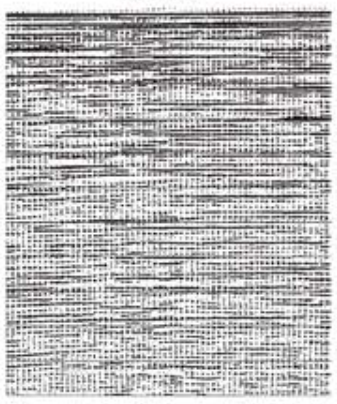




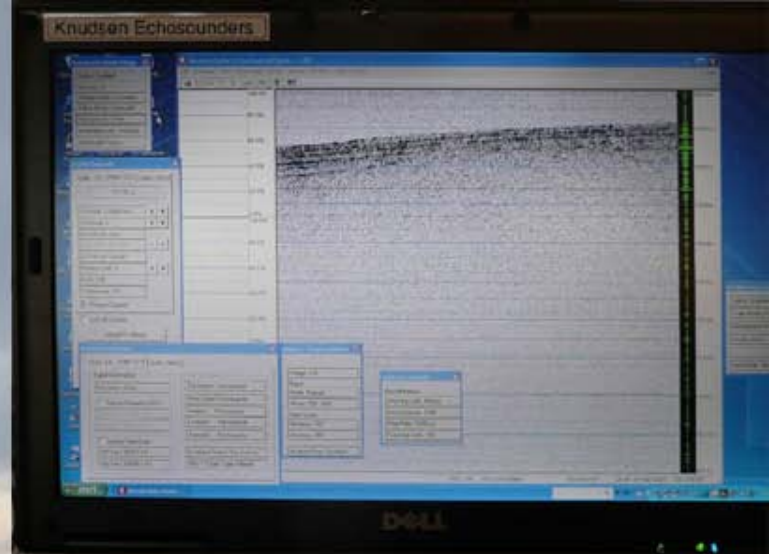
sea bed

Two-way travel time

2.0  
2.5  
3.0  
sec.



1 km



# Some scenes from Summer 2009-2010-and-2011 activities



A CTD lowering through a seal's breathing hole

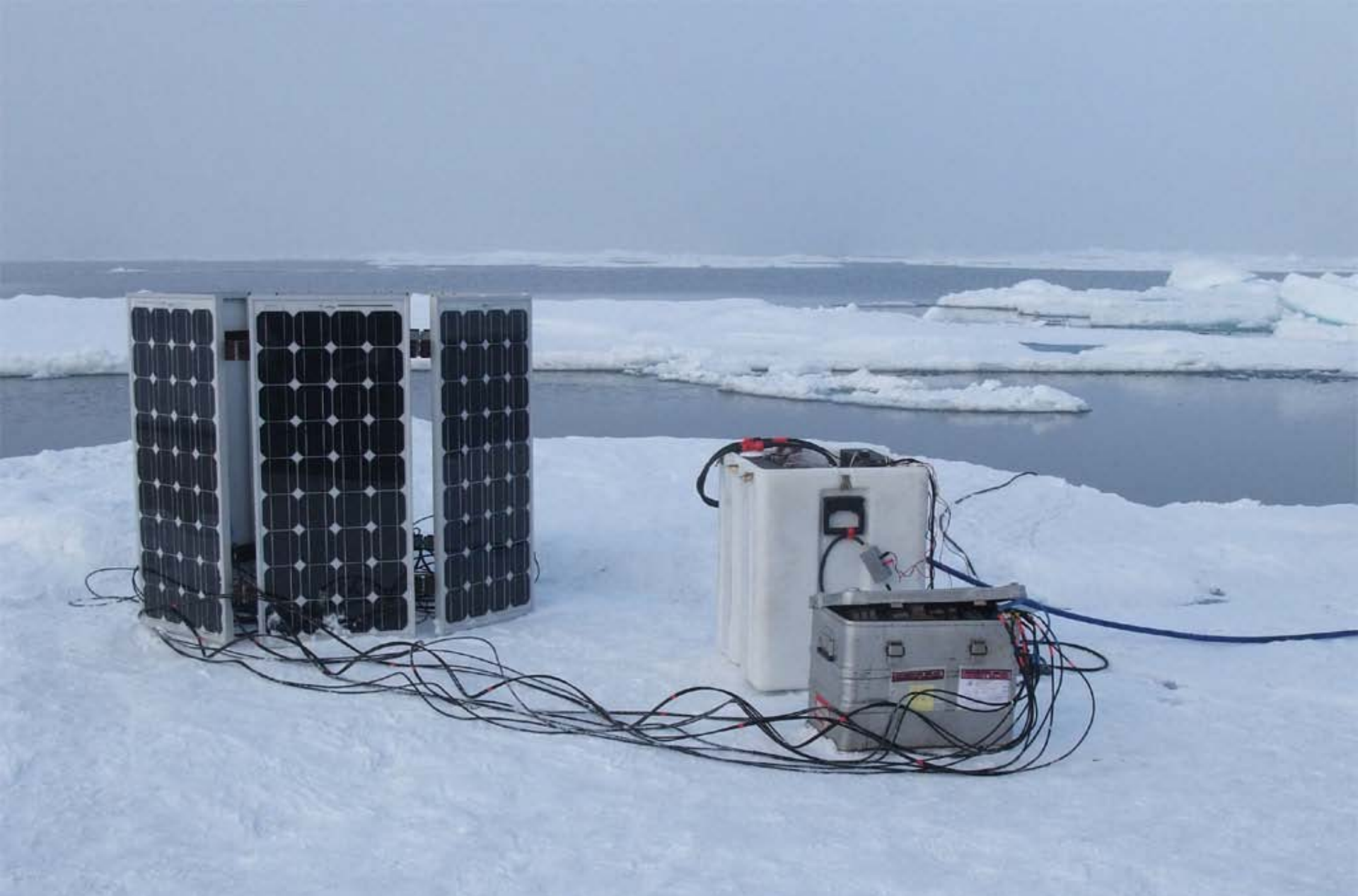


R/H SABVA





The Aagaard ADCP Current Profiler being set up for measurements while the crew sleeps



More tests of one of our two autonomous drifting seismic profiling buoys



# Hydro

INTERNATIONAL

**Autonomous Drifting Echosounding Buoys**

**New Approaches Supporting Hydrographical Education**

**Adaptive Bathymetric System**

Drifting echo-sounding buoys will soon provide bathymetric control in inaccessible areas of the ocean. The SSPARR (SeaFloor Soundings in Polar and Remote Regions) buoy project holds great promise for providing very low-budget bathymetry. Initial deployment may be by hovercraft in the Arctic Ocean.

By Dr. John K. Hall, marine geophysicist, Geological Survey of Canada (GSC), Ottawa, Ontario, Canada

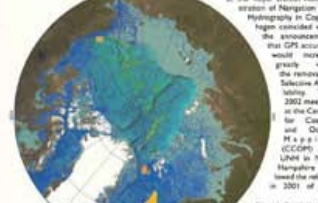
## Autonomous Drifting Echo-sounding Buoys

An emerging new concept in low-budget hydrography is the introduction of relatively inexpensive drifting buoys equipped with echo sounders. For over twenty years, as a member of GEMCO's Sub-Commision for Digital Bathymetry (SDCB), I have published notes in which soundings might be obtained using vessels of opportunity. But problems of navigation, maintenance, monitoring, system testing and changing operating modes is usually a strain. While some mid-ocean soundings certainly

resulted, most efforts probably came to naught. However, the millennium brought with it the availability of high-accuracy GPS technology, which, along with satellite data transmission via the Iridium system, and robust digital acquisition of the first bottom ping

### Origins at GEMCO

The SSPARR (SeaFloor Soundings in Polar and Remote Regions) project had its beginning during the annual GEMCO meetings (General Bathymetric Chart of the Ocean) between 2000 and 2001. The 2000 meeting at the Royal Danish Academy of Sciences and Letters in Copenhagen was the first meeting of the SSPARR. Hydrography in the Arctic region was highlighted with the announcement that GPS accuracy would increase greatly with the arrival of the Selective Availability. The 2001 meeting at the Center for Coastal and Oceanic Technology at UNH in New Hampshire followed the same theme. The 2002 meeting at the Center for Coastal and Oceanic Technology at UNH in New Hampshire followed the same theme. The 2003 meeting at the Center for Coastal and Oceanic Technology at UNH in New Hampshire followed the same theme.



This idea before SSPARR came from GEMCO which in 2001 released its first high-resolution global bathymetric and topographic grid with Selective Availability. The 2002 meeting at the Center for Coastal and Oceanic Technology at UNH in New Hampshire followed the same theme. The 2003 meeting at the Center for Coastal and Oceanic Technology at UNH in New Hampshire followed the same theme.

Figure 1: Distribution of drift soundings in the Arctic Ocean summer season on the USCGC Healy (USCGC 3501) and USCGC Spencer (USCGC 3502) in 2001. USCGC Healy (USCGC 3501) and USCGC Spencer (USCGC 3502) in 2001. USCGC Healy (USCGC 3501) and USCGC Spencer (USCGC 3502) in 2001.

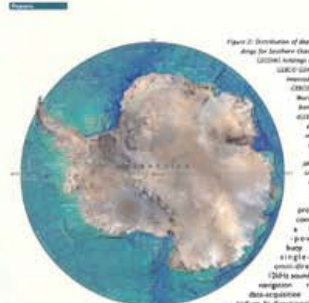


Figure 2: Distribution of drift soundings for SeaFloor Soundings in Polar and Remote Regions (SSPARR) on the USCGC Healy (USCGC 3501) and USCGC Spencer (USCGC 3502) in 2001.

Three areas in the world appear to have extremely sparse sounding coverage. These are the central Arctic Ocean (Figure 2), the south-eastern Pacific, and the Arctic Ocean (Figure 1). While the GEMCO SCDB chairman has noted that the south-eastern Pacific coverage is similar to the US east coast, the Arctic Ocean coverage is sparse. The Arctic Ocean coverage is sparse. The Arctic Ocean coverage is sparse.

The beauty of the concept is the availability of a buoy able to measure depth to 1,500m. It could be programmed to make soundings depending on the state of the sea. By using global grids, which now exist down to 0.1 degree and 0.1 degree, a 2004 could even target density when large deviations exist. The buoy could be used to measure depth to 1,500m. It could be programmed to make soundings depending on the state of the sea. By using global grids, which now exist down to 0.1 degree and 0.1 degree, a 2004 could even target density when large deviations exist.

Figure 3: Typical Arctic Basin bathymetry. The design and development program of the buoy has been discussed by Anderson (2004) and Anderson et al. (2003, 2005). The development program of the buoy has been discussed by Anderson (2004) and Anderson et al. (2003, 2005). The development program of the buoy has been discussed by Anderson (2004) and Anderson et al. (2003, 2005).

Some information on the drift of ice or surface currents as indicated by the same-stamped GPS buoys.

Arctic Application In the Arctic Ocean buoy deployment could be done from icebreakers, aircraft landings, or submarines surfacing, none of which are efficient in 2004. Figure 4 shows the location of the buoy in the Arctic Ocean. The buoy is located in the Arctic Ocean. The buoy is located in the Arctic Ocean.

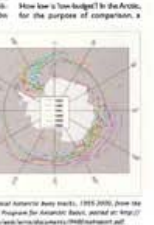


Figure 4: Typical Arctic Basin bathymetry. The design and development program of the buoy has been discussed by Anderson (2004) and Anderson et al. (2003, 2005). The development program of the buoy has been discussed by Anderson (2004) and Anderson et al. (2003, 2005).

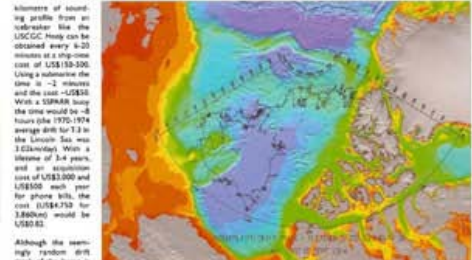
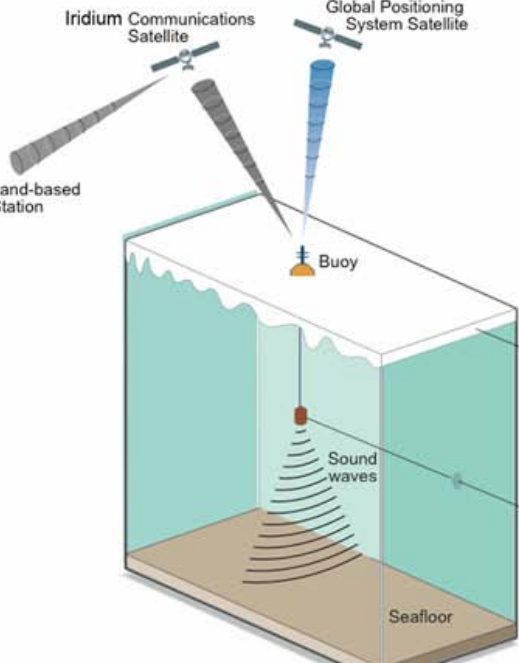


Figure 4: Distribution of drift soundings in the Arctic Ocean summer season on the USCGC Healy (USCGC 3501) and USCGC Spencer (USCGC 3502) in 2001.

kilometers of sounding profiles from an underwater glider like the USCGC Healy can be obtained every 8-20 minutes at a step-size cost of US\$150-200. Using a submarine the cost is 1-2 million and the cost US\$150. With a SSPARR buoy the cost would be 1-2 million and the cost US\$150. With a SSPARR buoy the cost would be 1-2 million and the cost US\$150. With a SSPARR buoy the cost would be 1-2 million and the cost US\$150.



Schematic courtesy Dale Chayes, LDEO

## SeaFloor Sounding in Polar and Remote Regions (SSPARR) Concept

Fulfills need for sea floor depth measurements in areas not visited by ships, such as:

- Arctic Ocean
- Southern Ocean
- Southern Pacific and Indian Oceans

NSF funded prototype SSPARR buoy is an expendable device, deployable in open ocean or ice with target 5 year lifespan. Modular components can be integrated with other buoys. Expandable to use as an aid to navigation for under-ice vehicles.

**Details:**  
**OD 4 inches**  
**E/S 12 kHz**  
**Capability 5000 m**  
**Weight 40 kg**  
**Lifetime: 4 years**  
**Cost: \$3,000 (?)**

**Christian Michelsen Research AS, Bergen**

**SyQwest, Inc.**

# EchoBox™ Hydrographic Echo Sounder

NAL  
RESEARCH  
CORPORATION

Iridium Satellite Tracker  
Model A3LA-TSS



Summer 2009 tests will use a SyQwest EchoBox configured to use a 3.5 kHz transducer to obtain 4000 m bathymetry, Maybe a drifting subbottom profiler?

In 2010 our payload was raised by 50% - we carried 2500 liters of diesel - note fuel bladder in addition to the 1500 liters in Vetus tanks



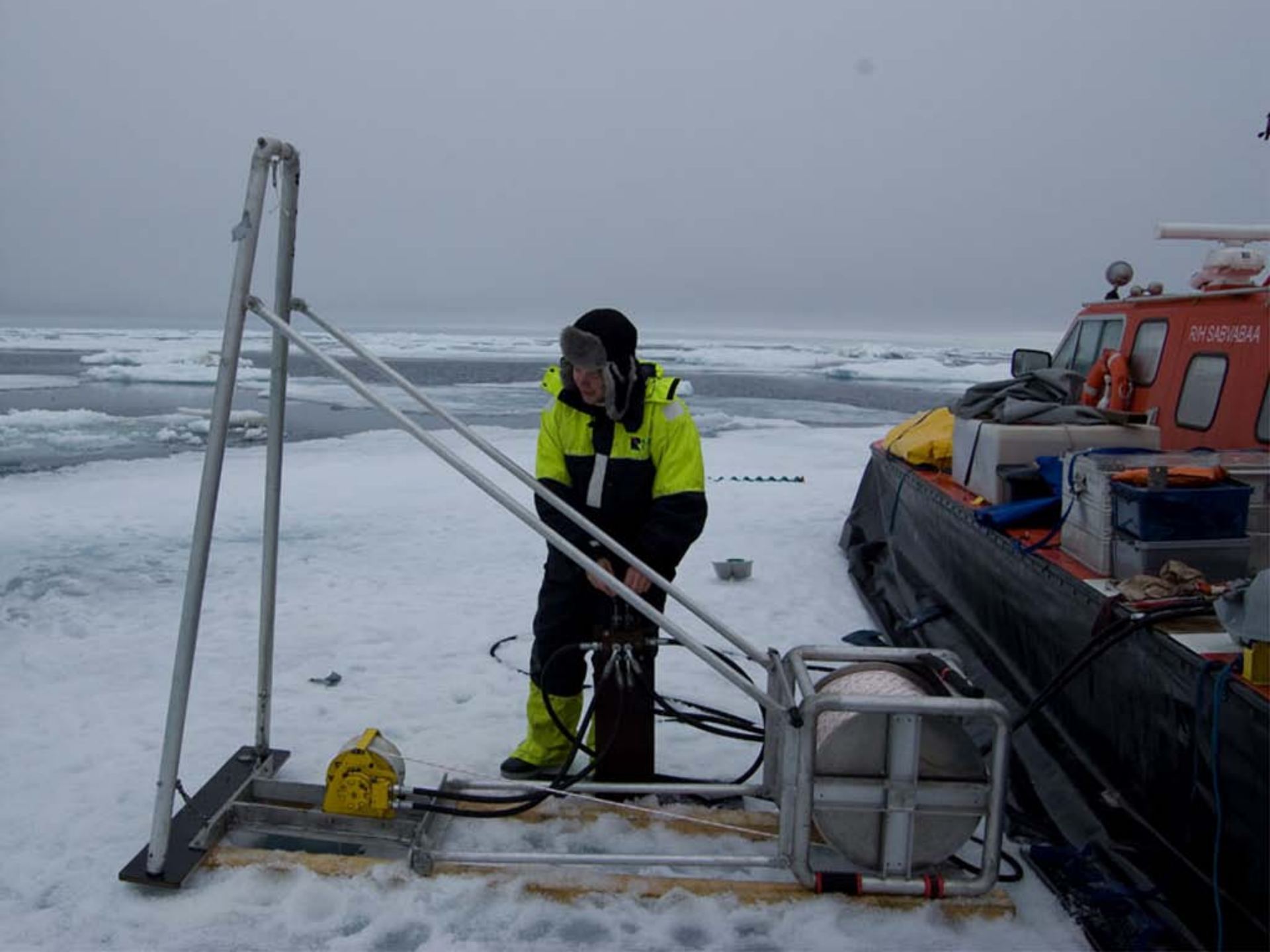


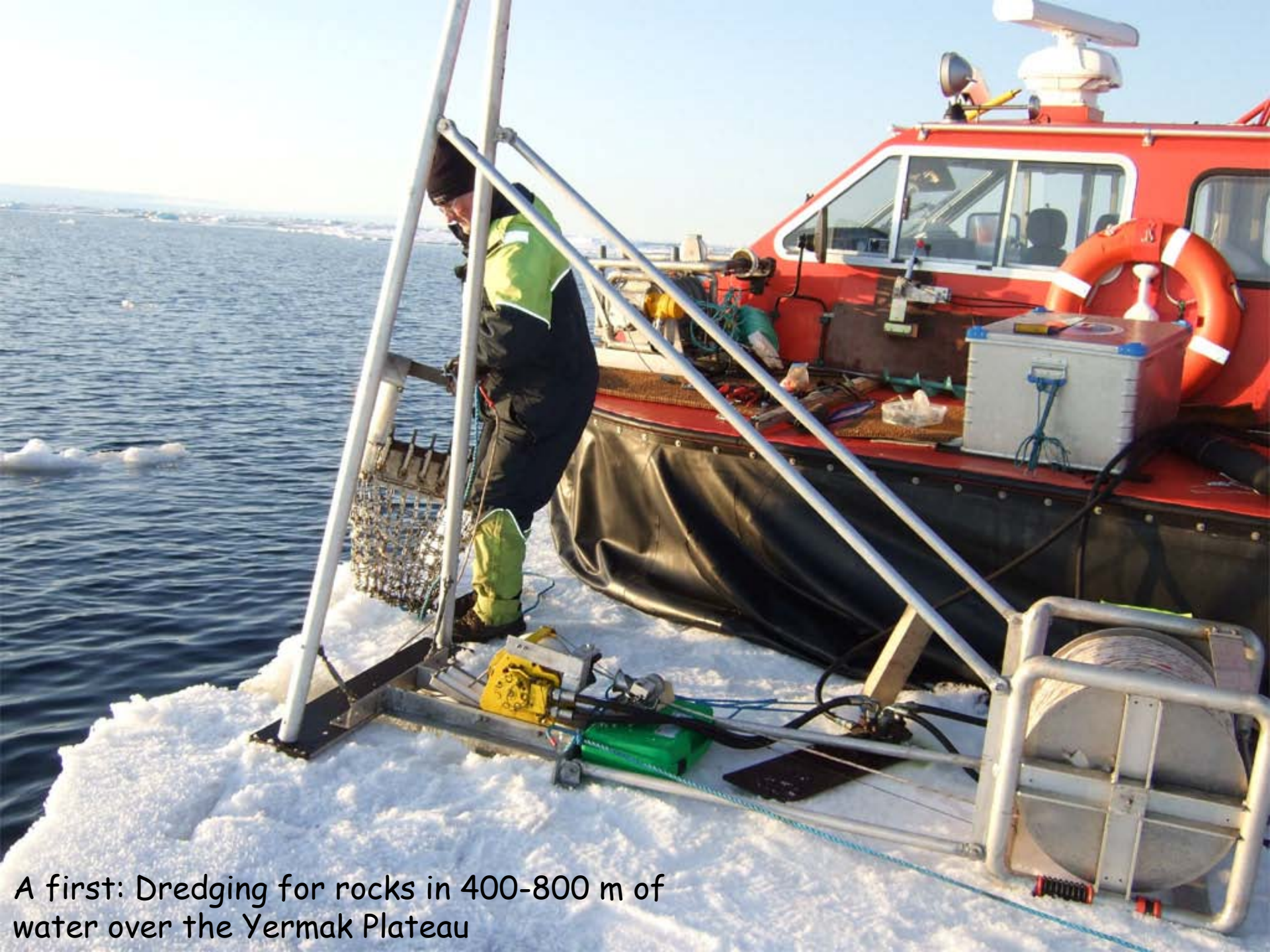




SABVABAA DL1519AB







A first: Dredging for rocks in 400-800 m of water over the Yermak Plateau





Griffon  
Hovercraft











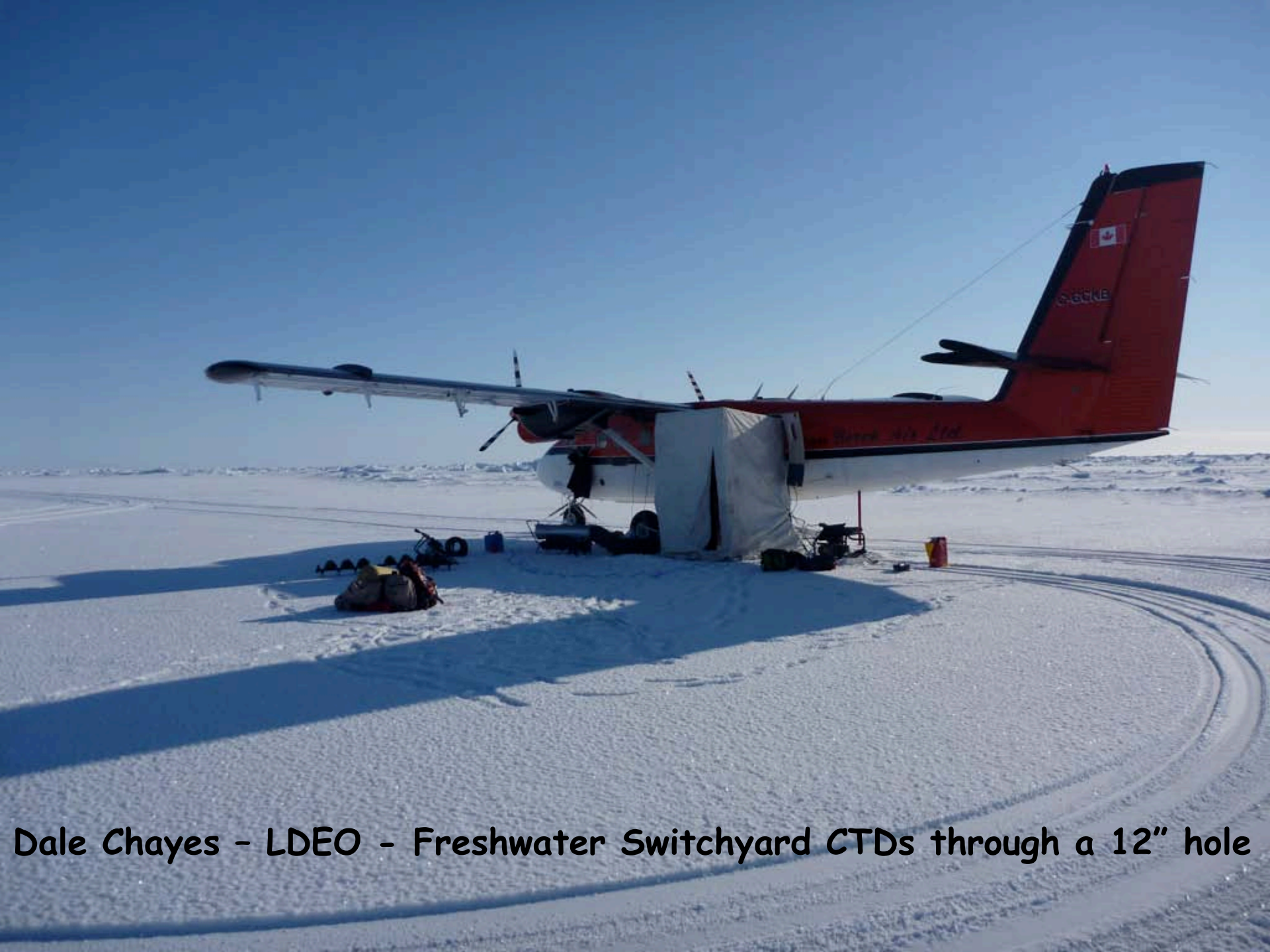
The Hydraulic Winch with Capstan Drive - three turns of kevlar aramid fiber rope





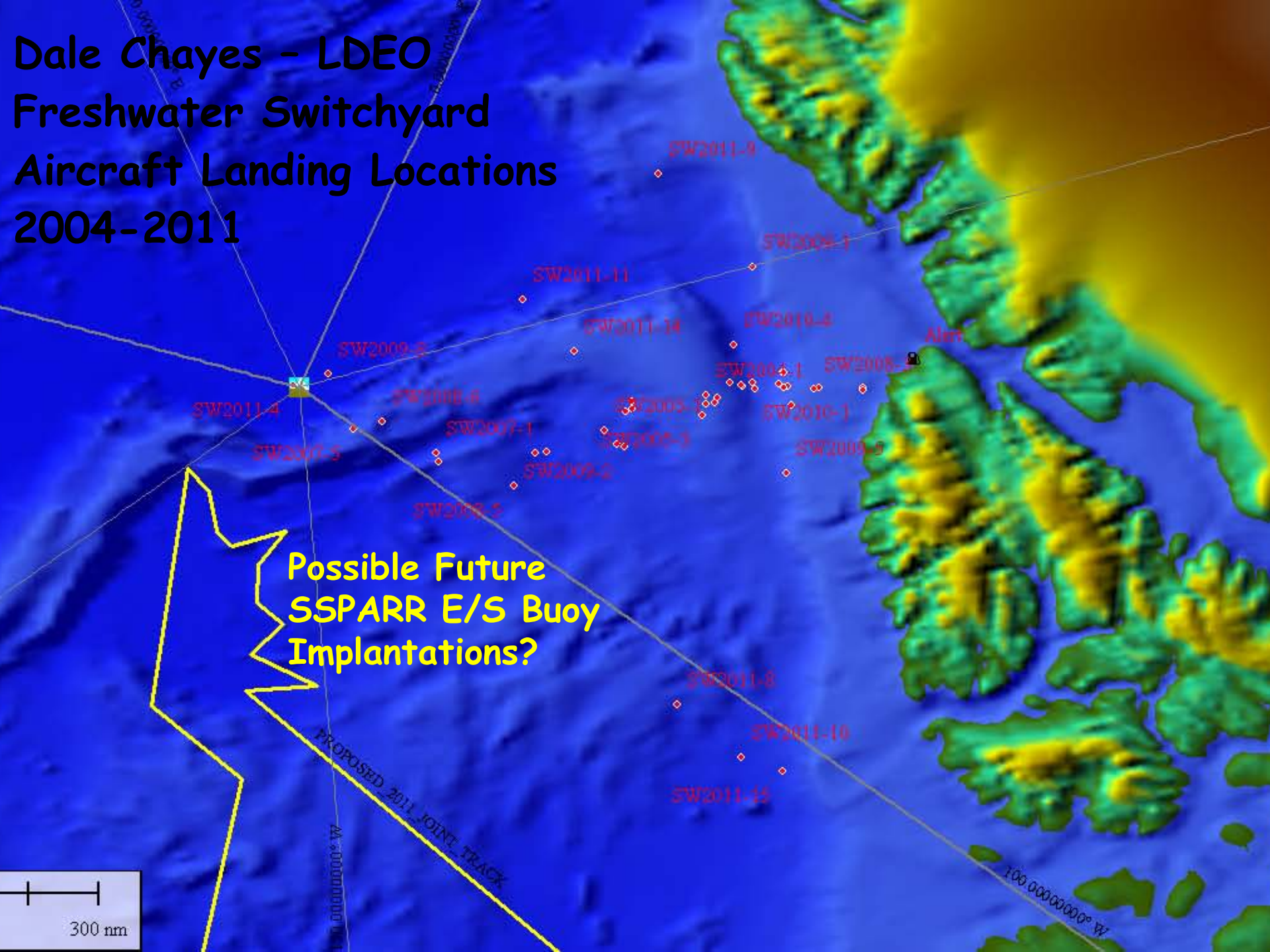






Dale Chayes - LDEO - Freshwater Switchyard CTDs through a 12" hole

**Dale Chayes - LDEO  
Freshwater Switchyard  
Aircraft Landing Locations  
2004-2011**



Thank you for your attention



Photo courtesy Dave Monahan, UNH-CCOM-GEBCO/Nippon