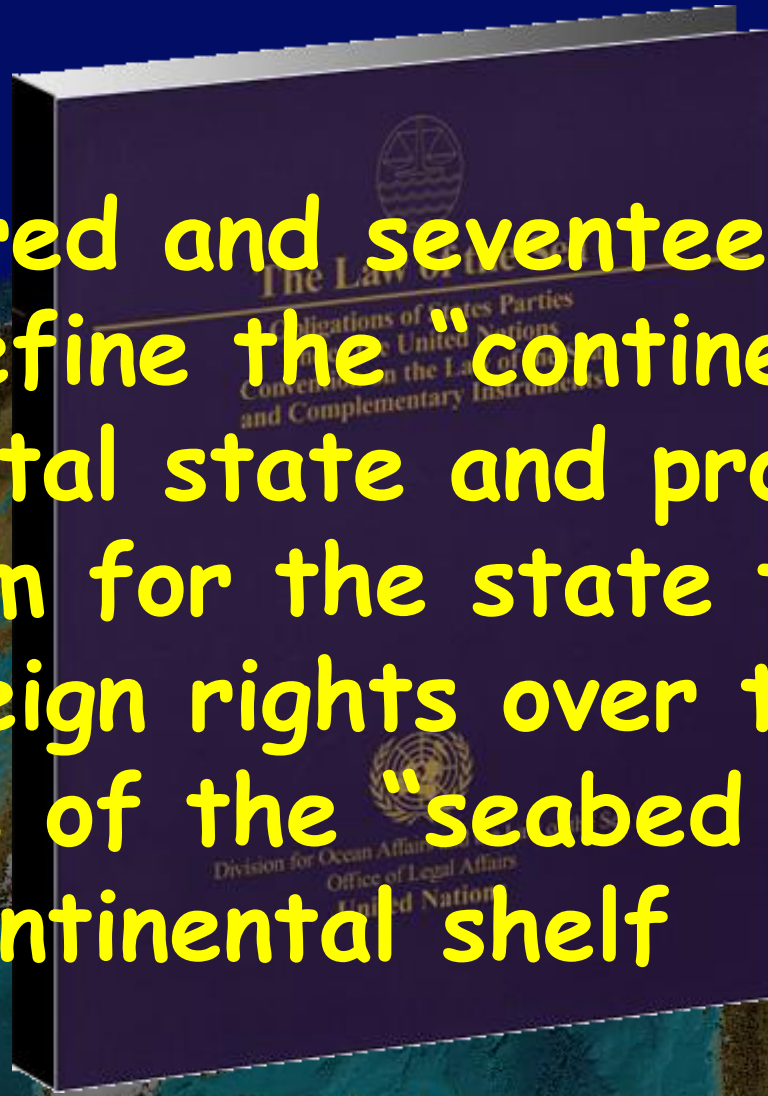


# Eight Seasons of Law of the Sea Mapping and Sampling Activities in the Arctic



# *ARTICLE 76 of UNCLOS*

Six hundred and seventeen words that redefine the “continental shelf” of a coastal state and provide a mechanism for the state to extend its sovereign rights over the resources of the “seabed and subsoil” of the continental shelf







# *Data Required*

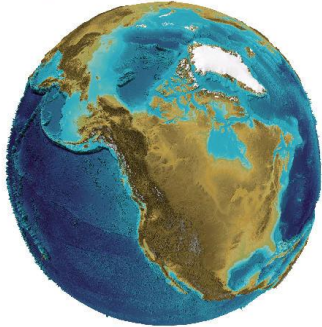
- To establish an extended continental shelf a coastal state must demonstrate that the region is a "natural prolongation" of continental landmass – limits of which are determined by:
  - depth and shape of the seafloor (FOS and 2500m contour)
  - the thickness of the underlying sediments (1% line)
  - distances from territorial sea baselines (350 nm line)

**Need to map the seafloor**

# Desktop Study 2002

The Compilation and Analysis of Data Relevant to a U.S. Claim  
Under United Nations Law of the Sea Article 76:  
A Preliminary Report

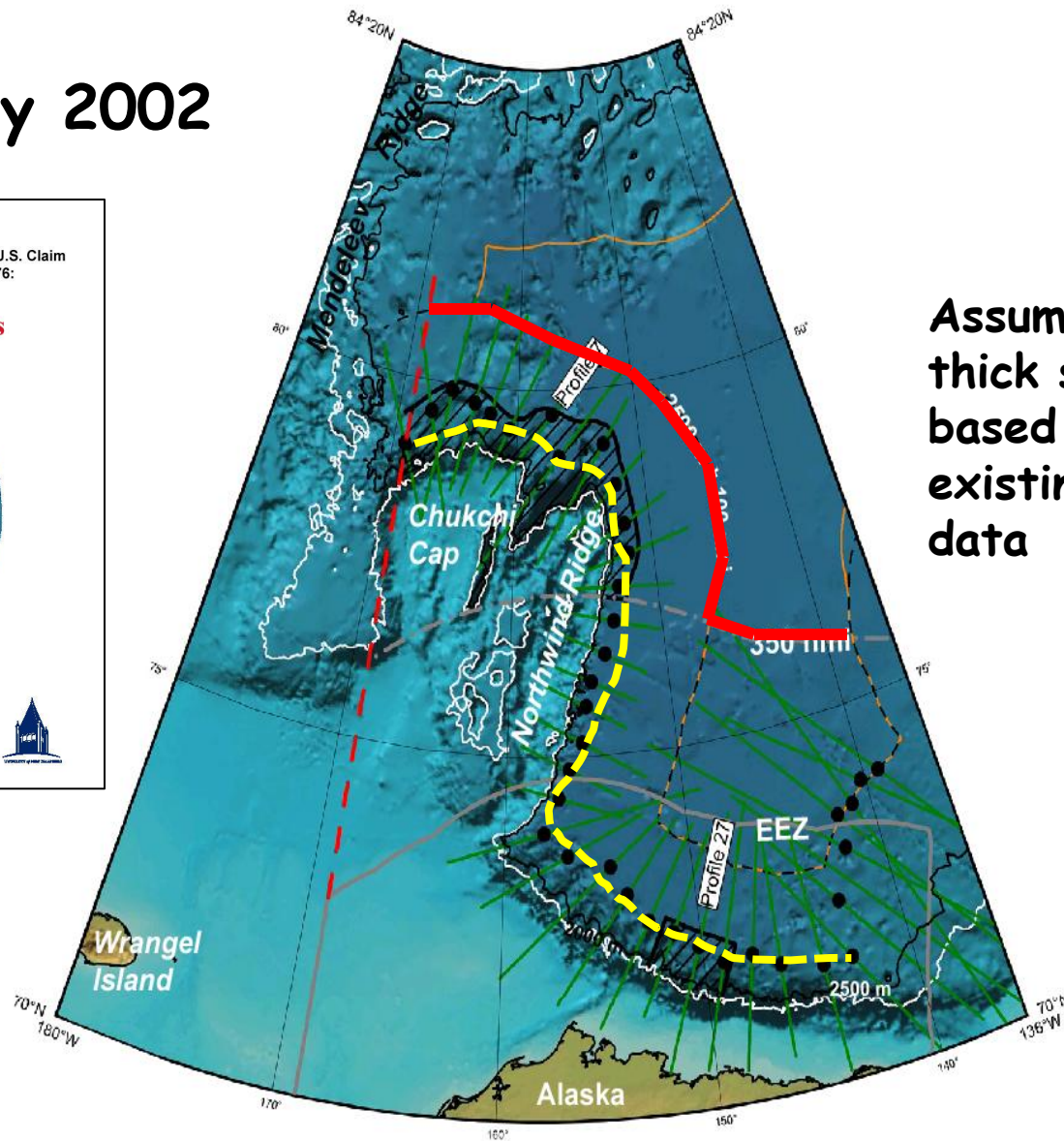
<http://ccom.unh.edu/unclos>



Center for Coastal and Ocean Mapping/Joint Hydrographic Center  
University of New Hampshire

Durham, N.H.  
May, 2002

Larry Mayer, Martin Jakobson and Andrew Armstrong




**Assumed - very  
thick sediment  
based on limited  
existing seismic  
data**

5.10B. Bathymetry from IBCAO in detailed area ARC, drawn bathymetric profiles, and possible locations of the FOS. Labeled profile is shown in figure 5.11. Note that the orange line, which represents the 2500 m + 100 nm, makes use of the 2500 m contour of the Alpha-Mendeleev Ridge as well as the Canadian shelf.



# ECS CRUISES

2003, 2004, 2007,  
2008, 2009, 2010,  
2011, 2012

An aerial photograph of a white and red research vessel, the ECS, navigating through a dense field of sea ice. The ship is viewed from a high angle, showing its deck with various equipment and its superstructure. The ice consists of numerous small, irregular floes surrounding the ship's path.

**MBES** 2003 - 2009 - Seabeam 2112 2x2 deg 12 kHz  
Now - Kongsberg EM122 - 1x1 deg 12 kHz **MBES**  
**Hi-Res Subbottom** - Knudsen 350B Chirp Sonar  
**Dredging**



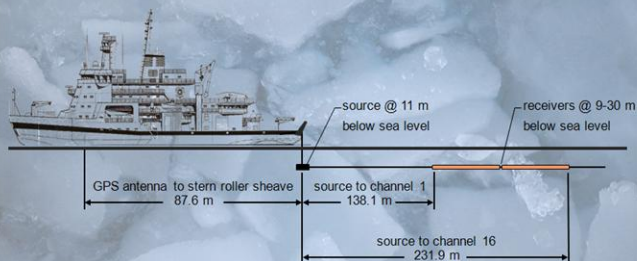
# JOINT PROGRAMS WITH CANADIAN ICEBREAKER *LOUIS S. St. LAURENT*

2008  
2009  
2010  
2011





# Seismic data collected in two-ship operations by GSC on CCGS LOUIS S. ST. LAURENT



From David Mosher





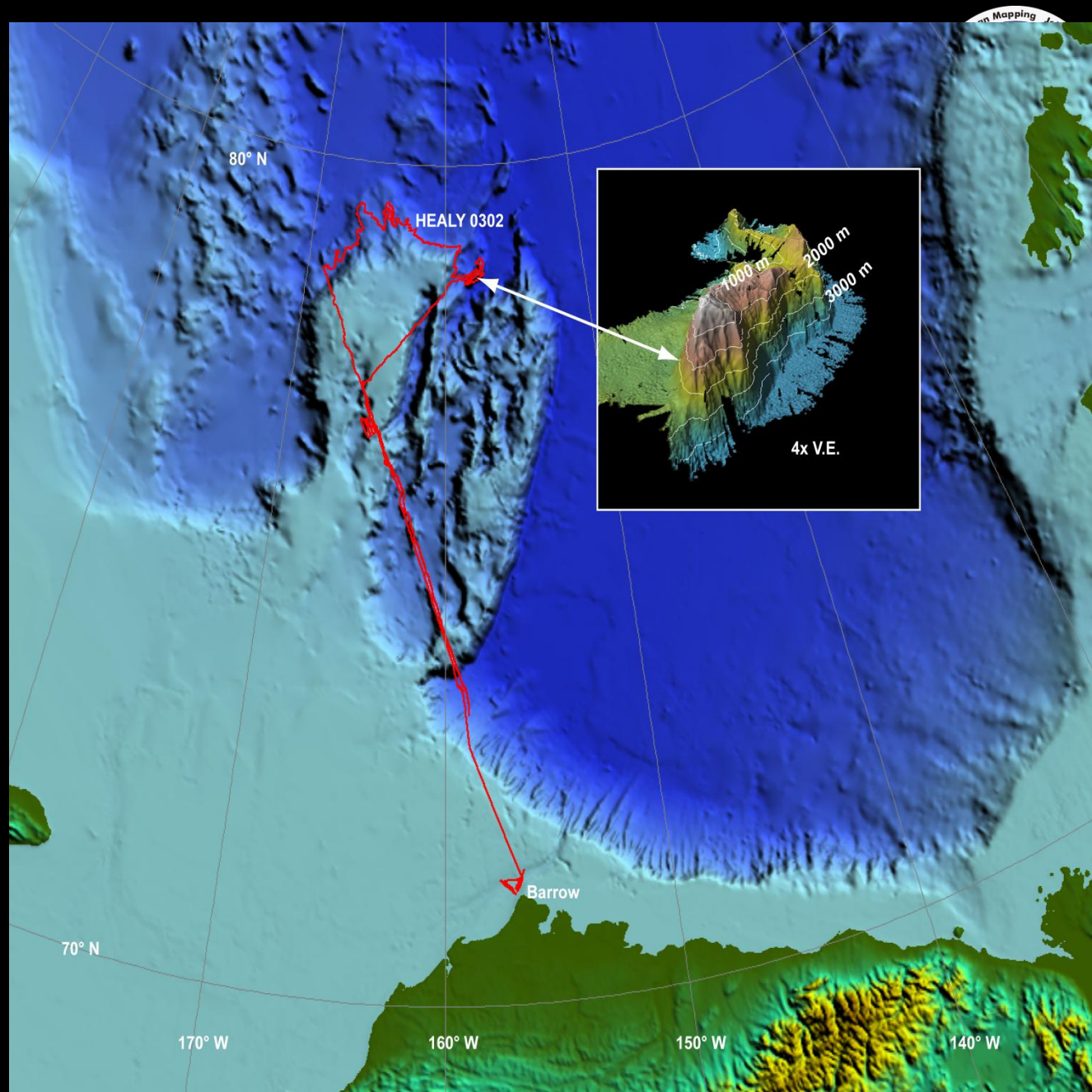


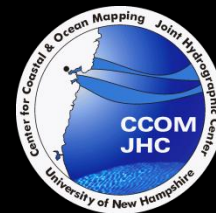
From David Mosher



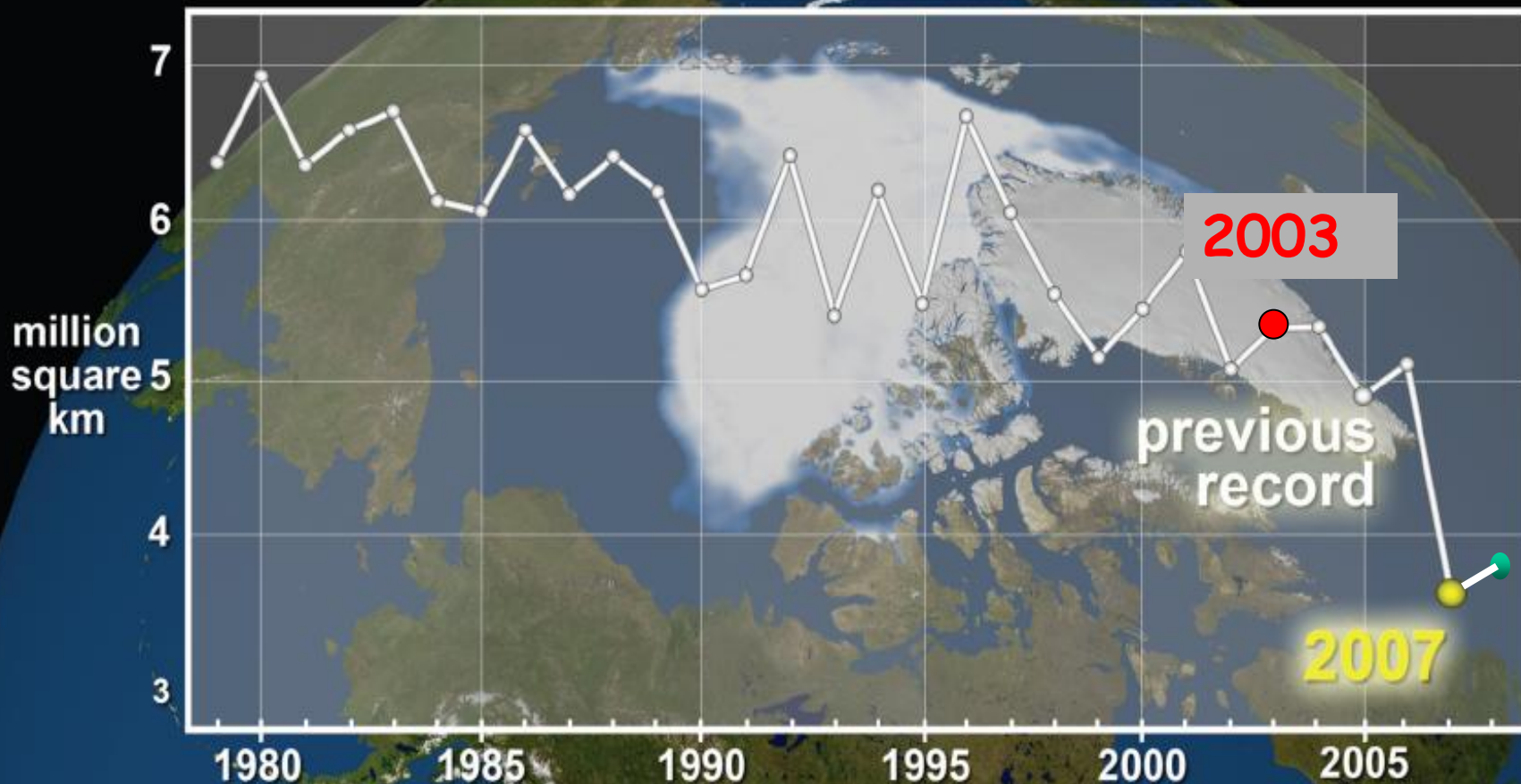


**Healy 03-02**  
**~3000 km of**  
**multibeam**  
**sonar**  
**bathymetry**  
**1-11 Sept 03**  
**8/10 ice**





## Annual Sea Ice Minimum

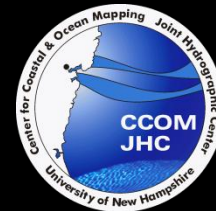




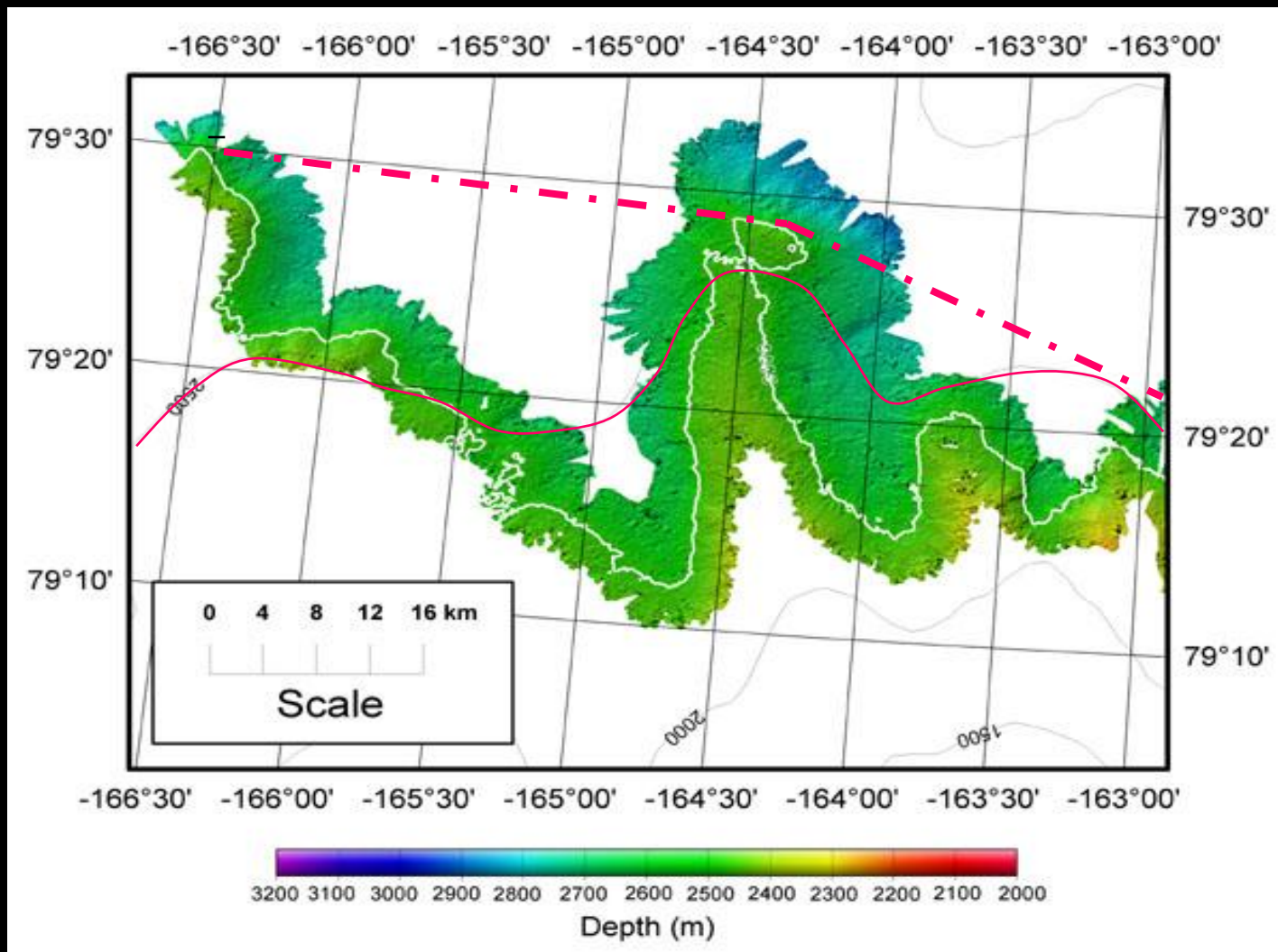
typical ice conditions  
2003  
8/10 “cheesy” ice







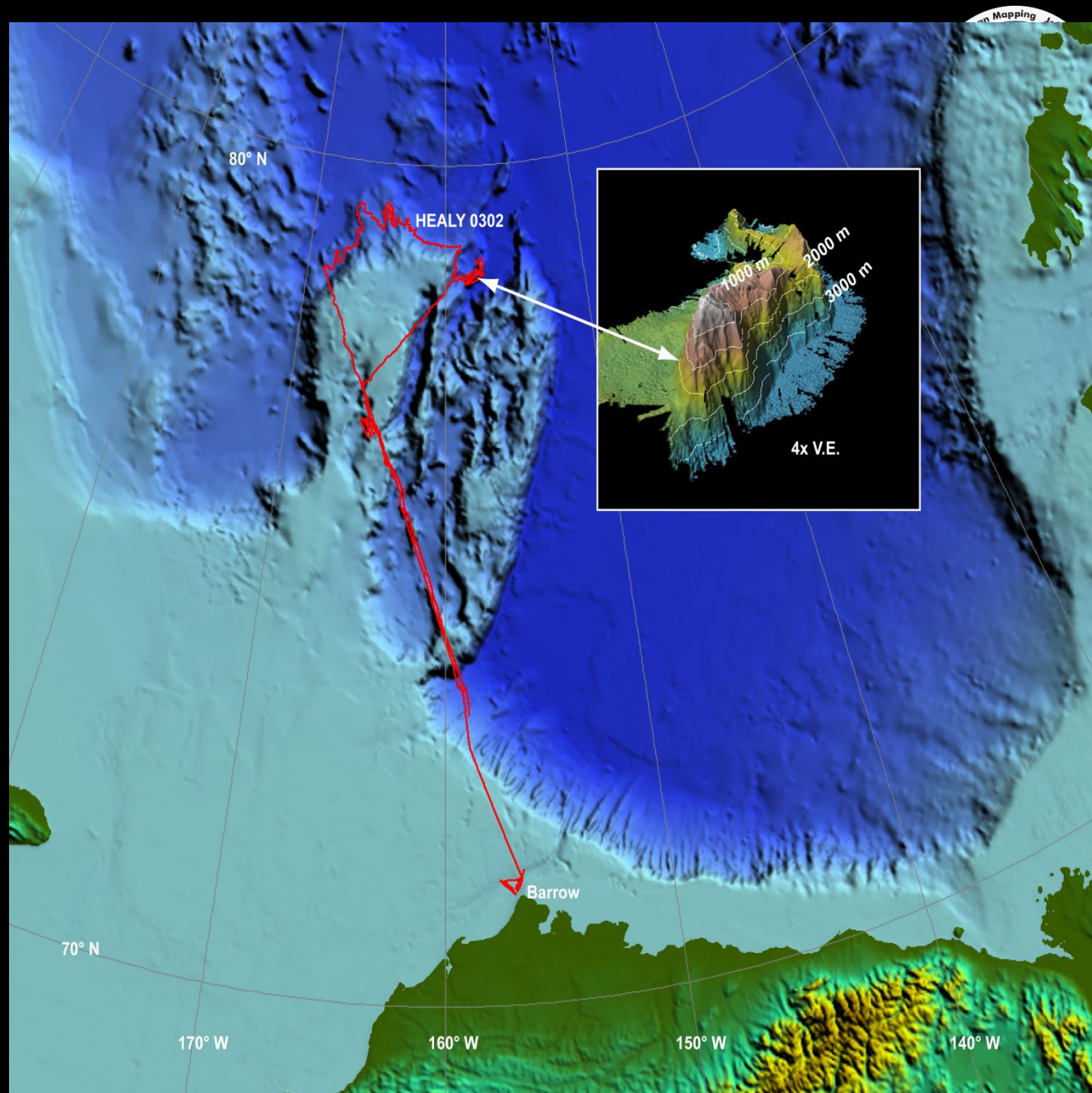
# Redefinition of the 2500 m contour





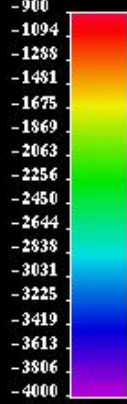


**Healy 03-02**  
**~3000 km of**  
**multibeam**  
**sonar**  
**bathymetry**  
**1-11 Sept 03**  
**8/10 ice**

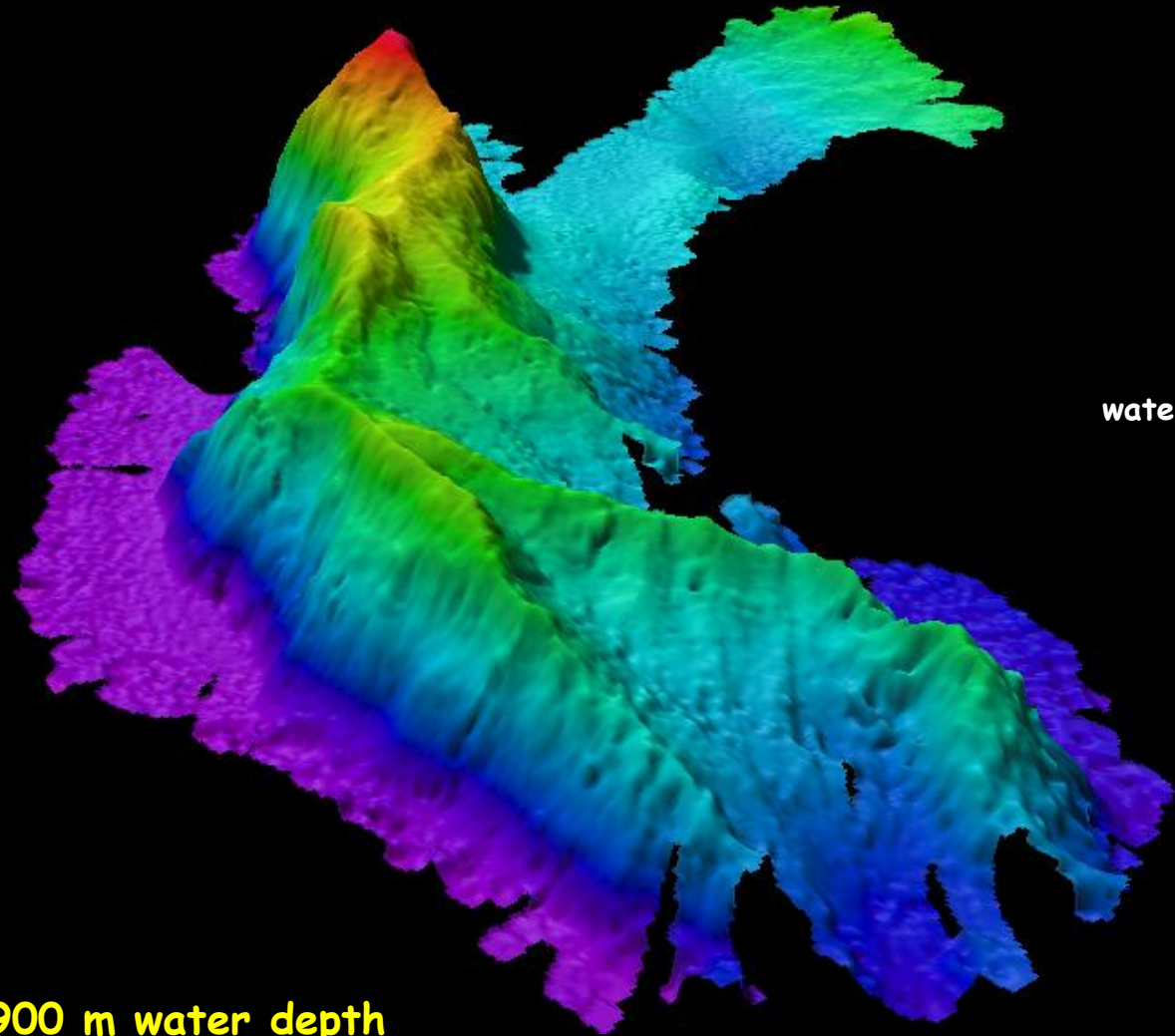




# Healy Seamount looking S, ve=6x



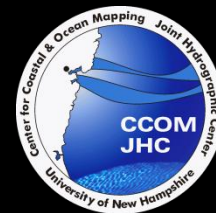
water depth (m)



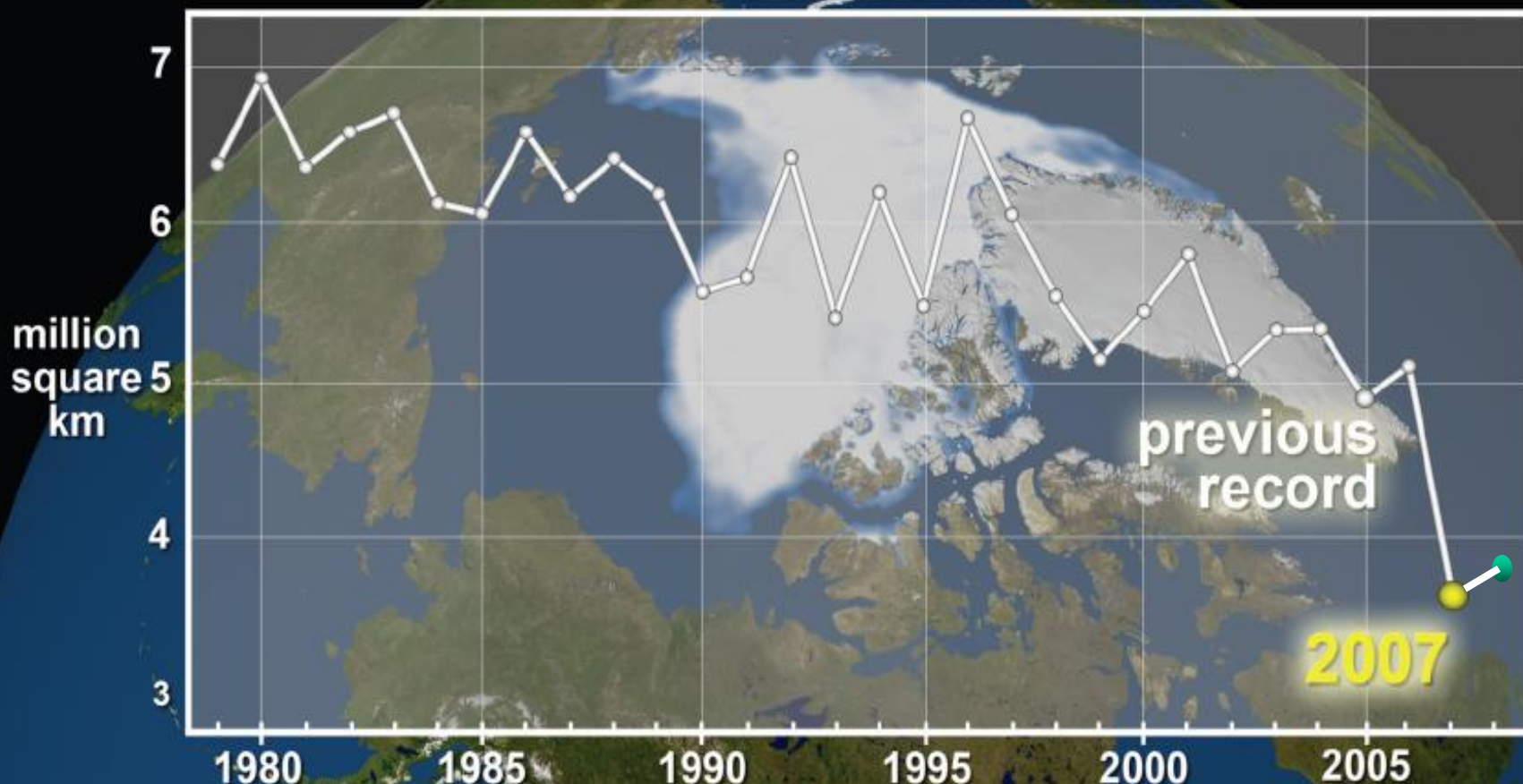
3100 m high, summit at 900 m water depth

45 km long x 15 km wide





## Annual Sea Ice Minimum

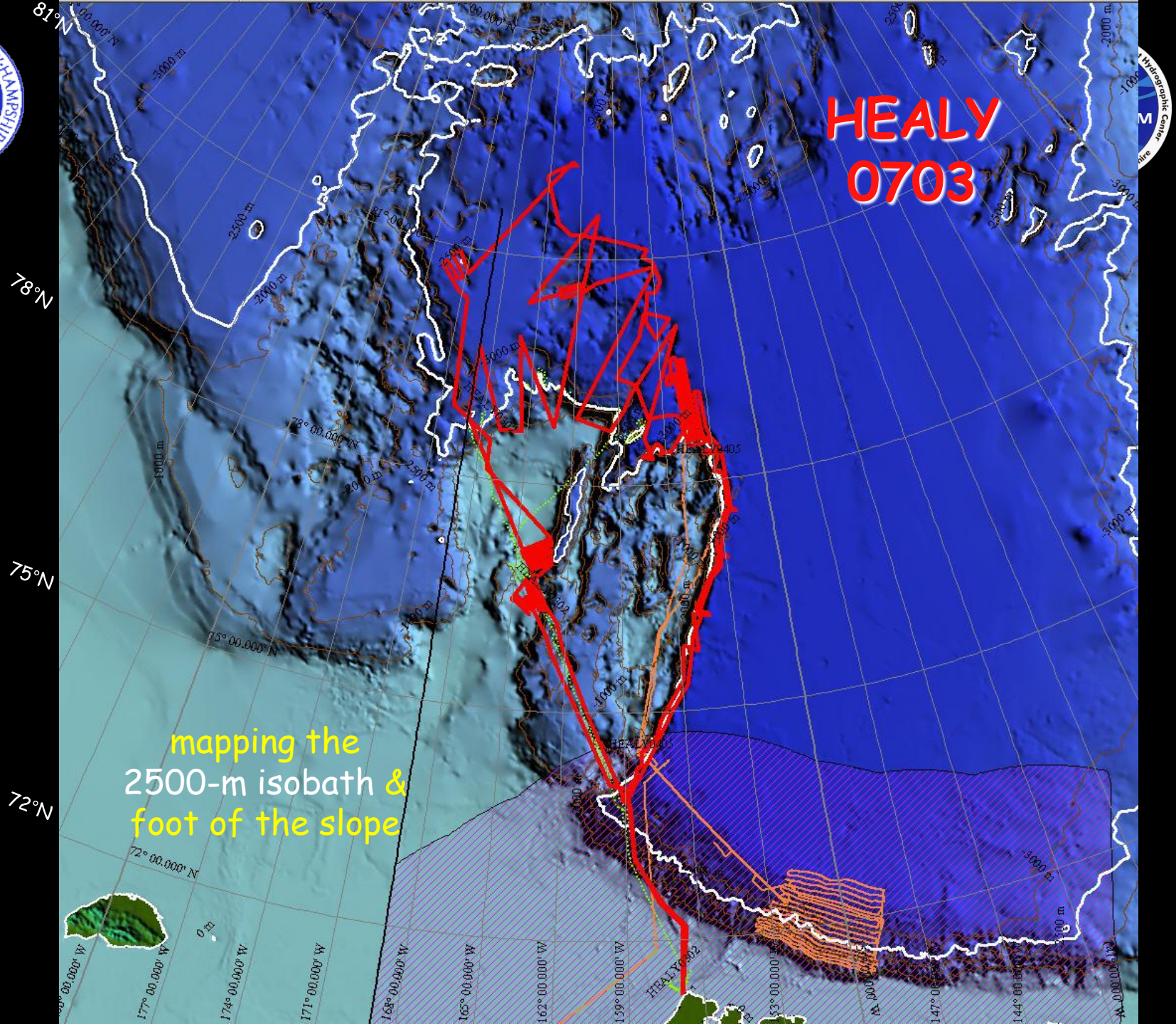










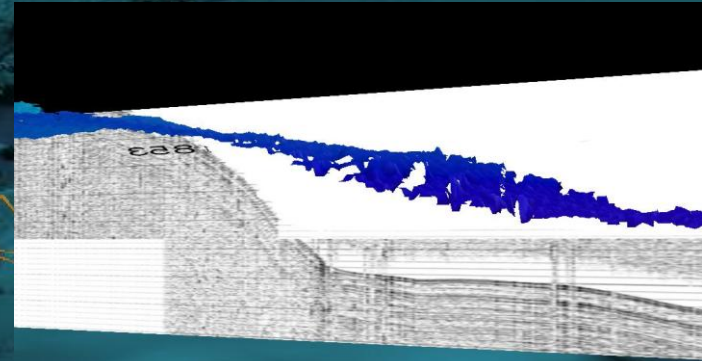


mapping the  
2500-m isobath &  
foot of the slope

HEALY  
0703



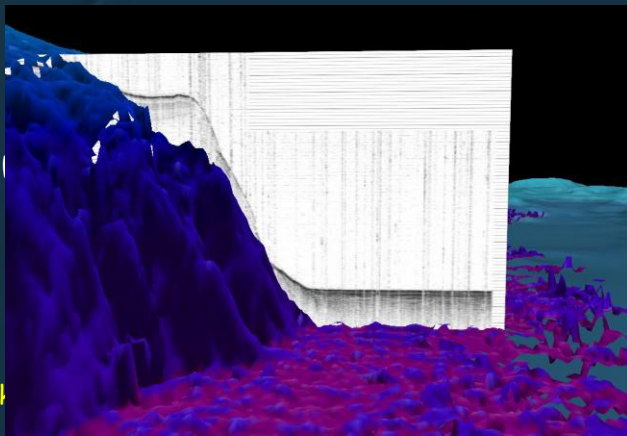
*Healy 03-02, 04-05, 07-03*



Where we thought FOS was

Where we now think it is

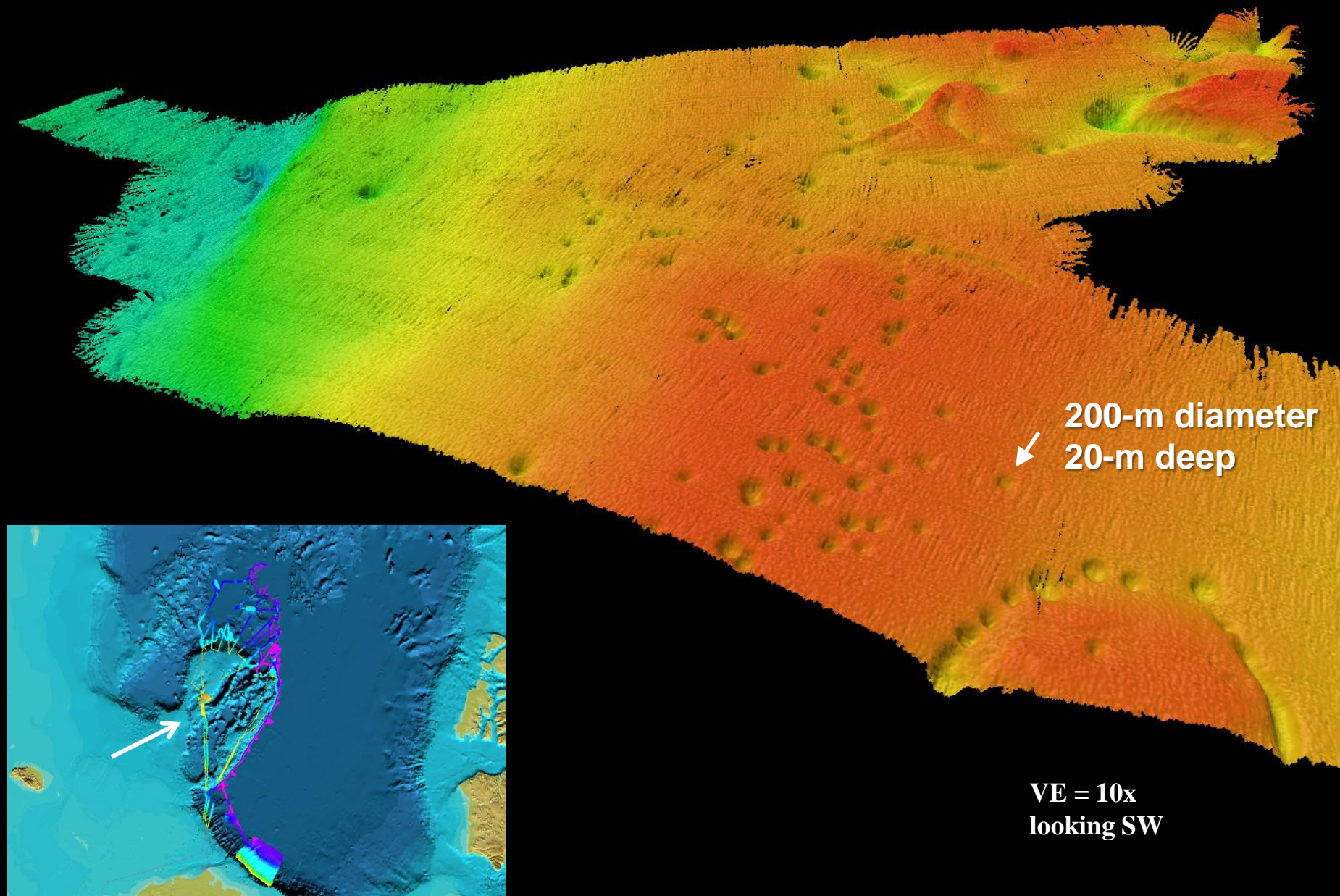
2007 res



perspective view look

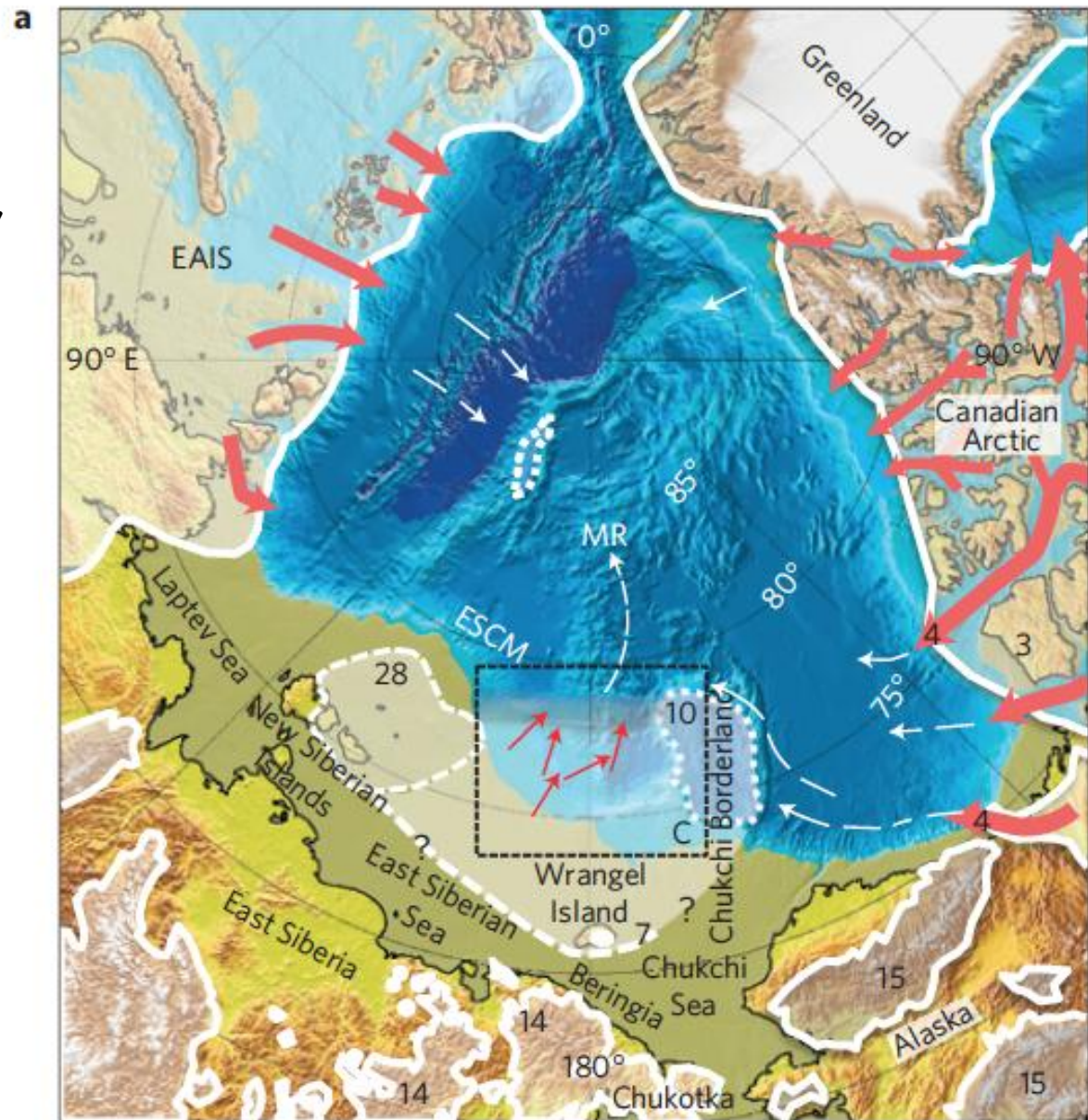


# central Chukchi Plateau pockmarks





Niessen et al,  
2013





# HEALY 1102

USCGC Healy

CCGS Louis S. St-Laurent





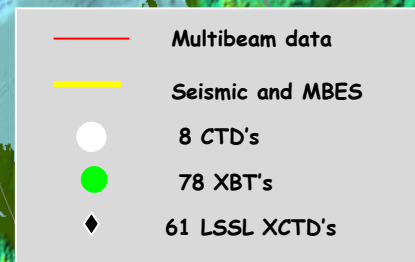
# HEALY-1102

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>

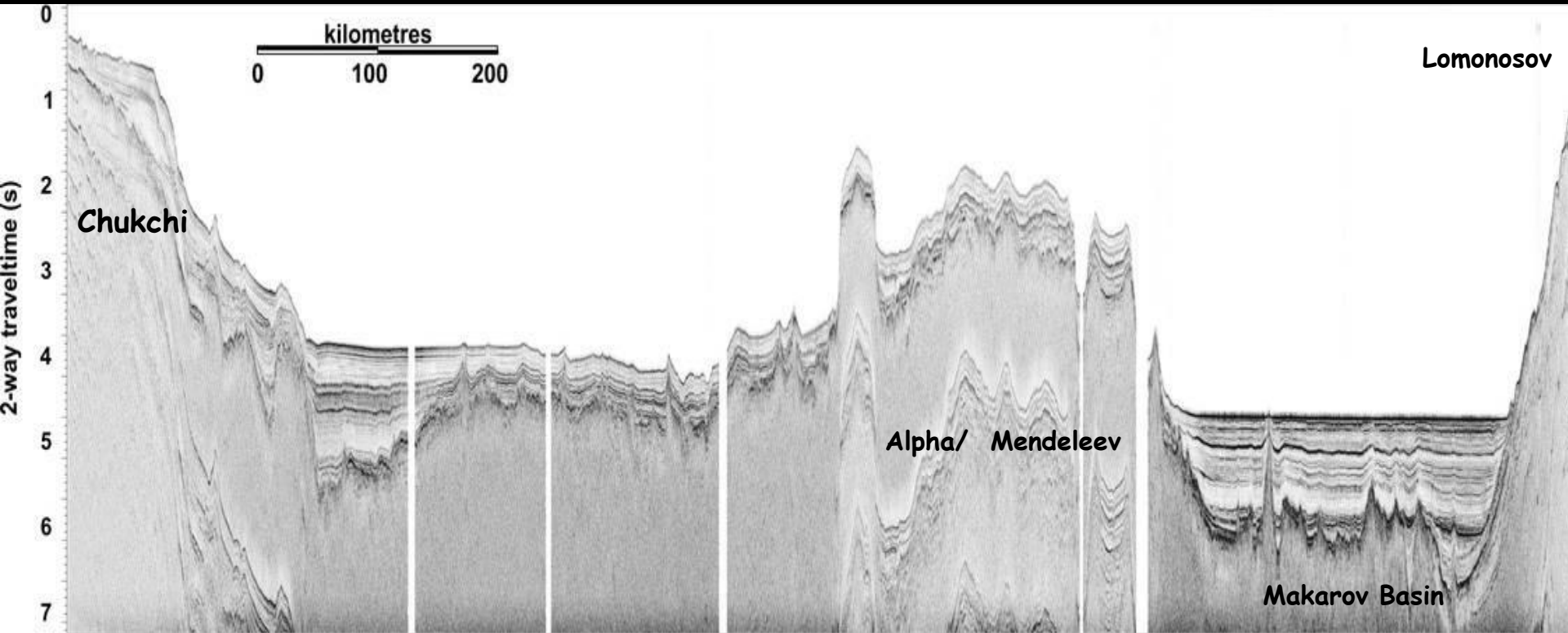
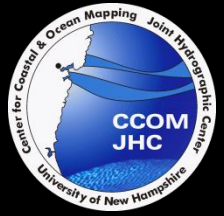
Average sea ice state... 9/10  
Average speed in ice.... 3.5 knts







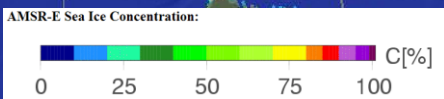
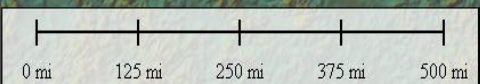
# LSSL Monitor Records



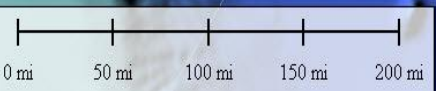


★ 6 Sept 2011

Advanced Microwave Scattering Radiometer  
Spreen et al 2007







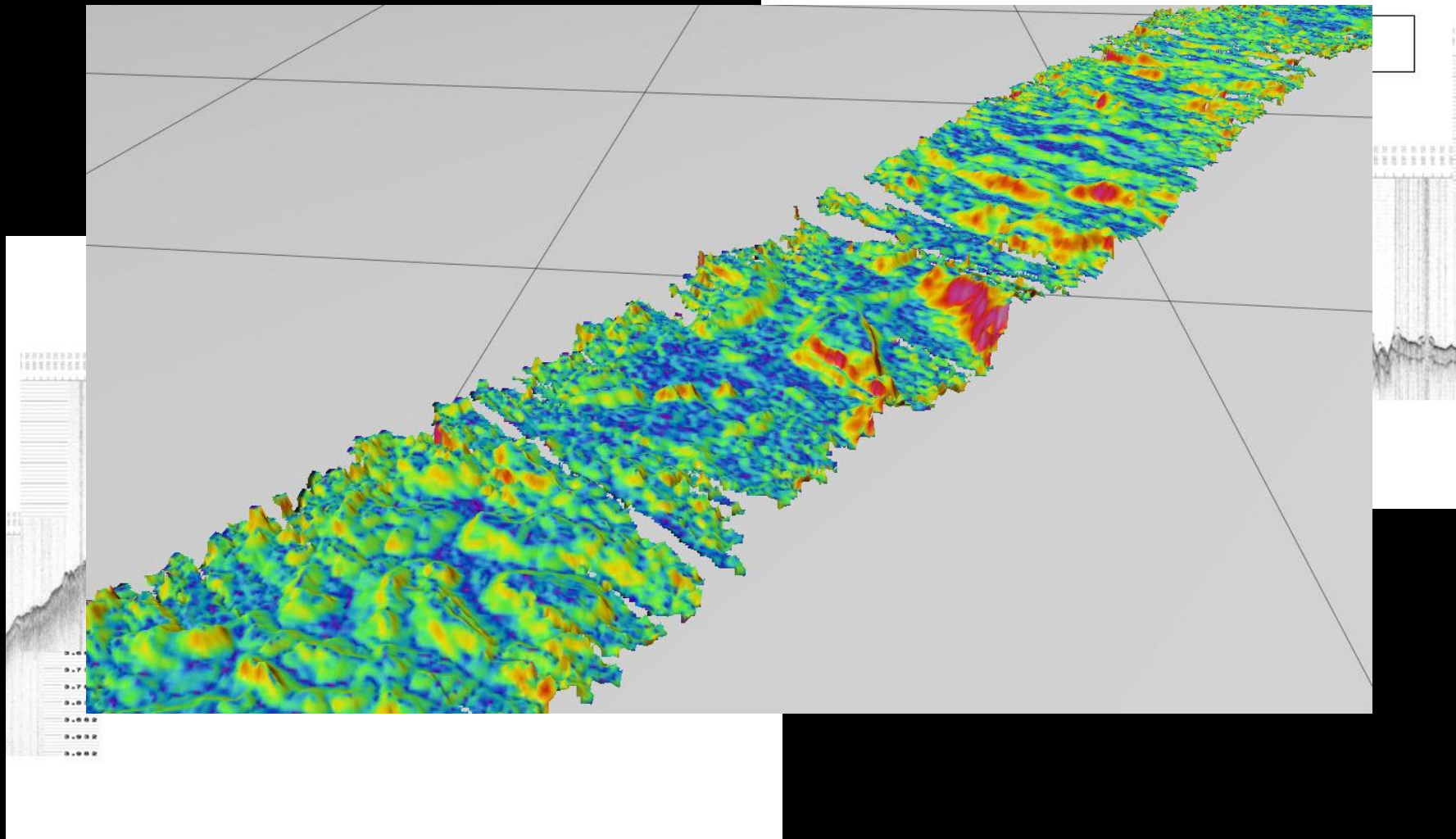
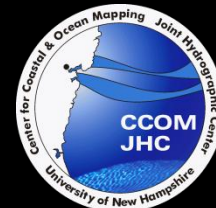
SEISMIC LINE 2

SEISMIC LINE 3





# Hyperbolic Echoes on Alpha/Mendeleev Ridge





# HEALY 1202

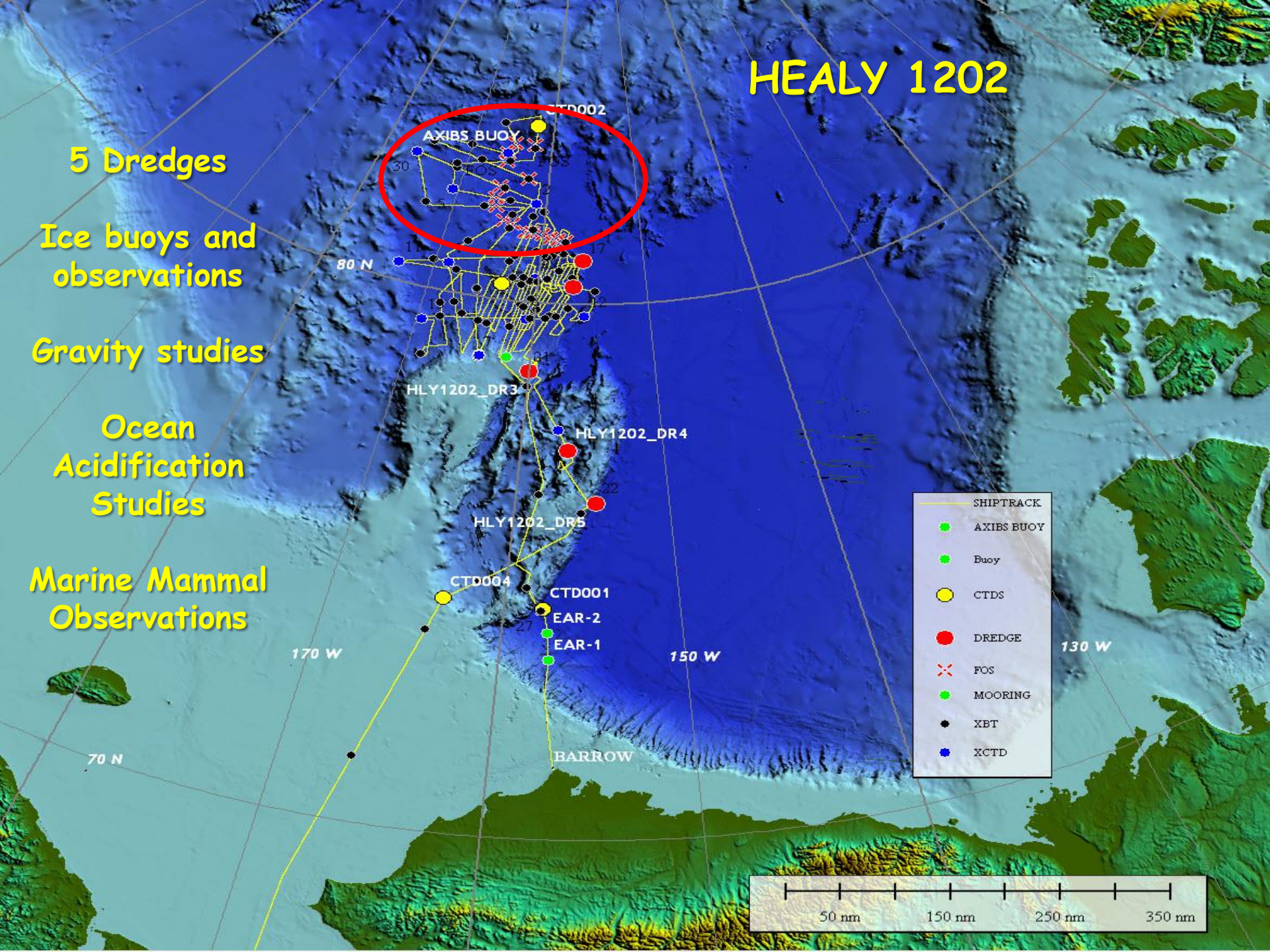
5 Dredges

Ice buoys and  
observations

Gravity studies

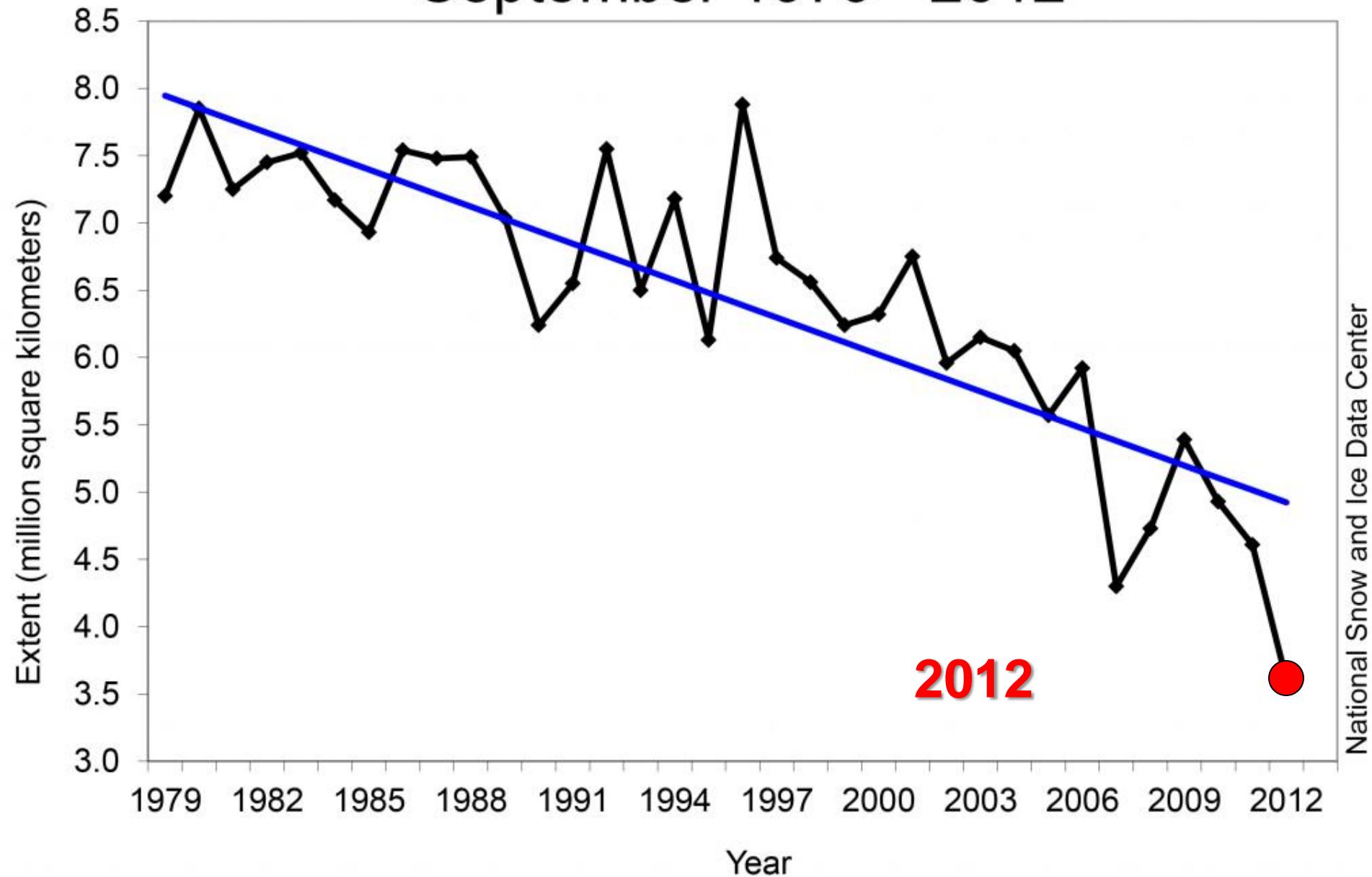
Ocean  
Acidification  
Studies

Marine Mammal  
Observations





# Average Monthly Arctic Sea Ice Extent September 1979 - 2012





Long/Lat.: -156.072055 W, 80.293353 N  
2007 (9-6-2007)

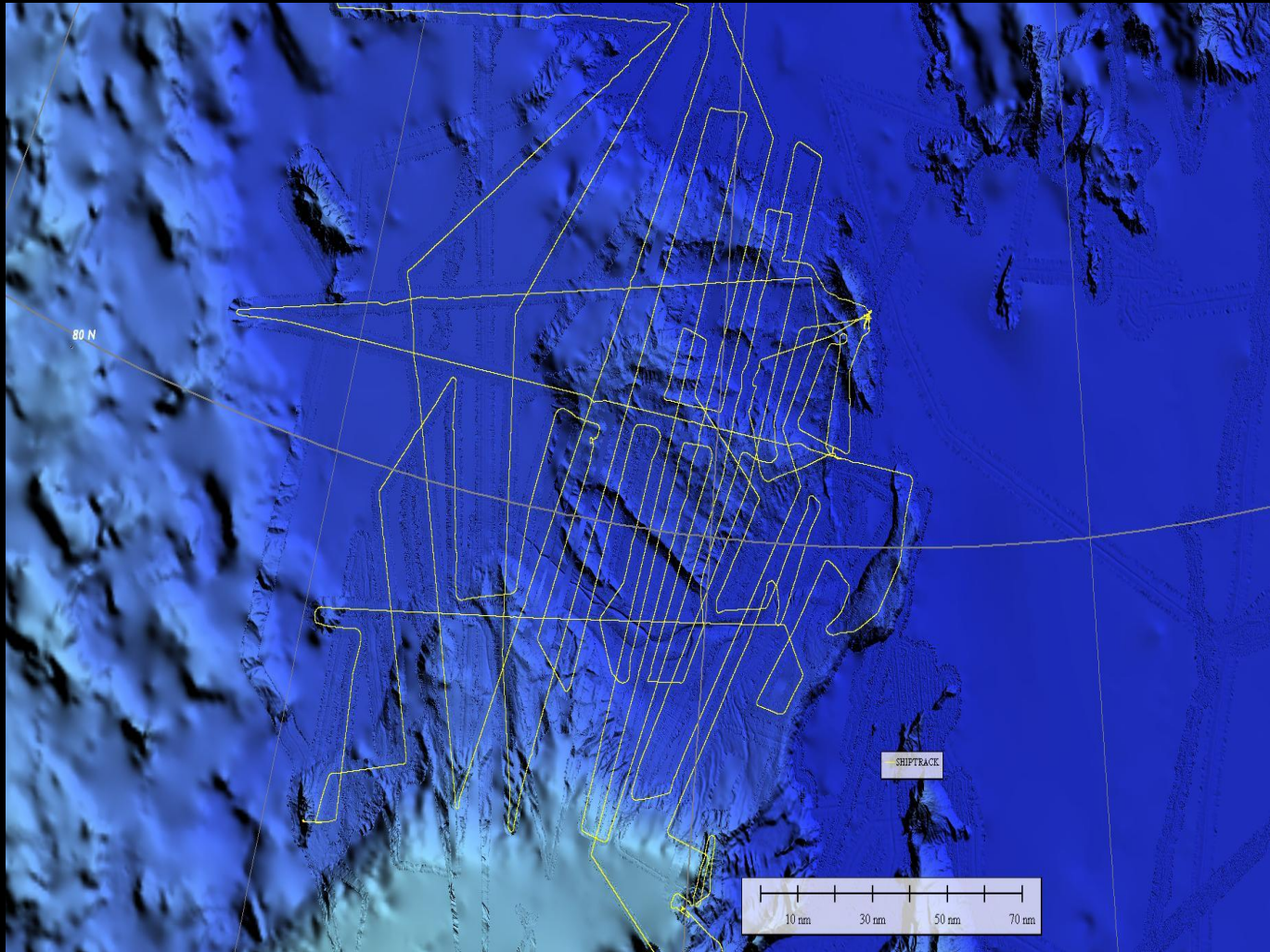
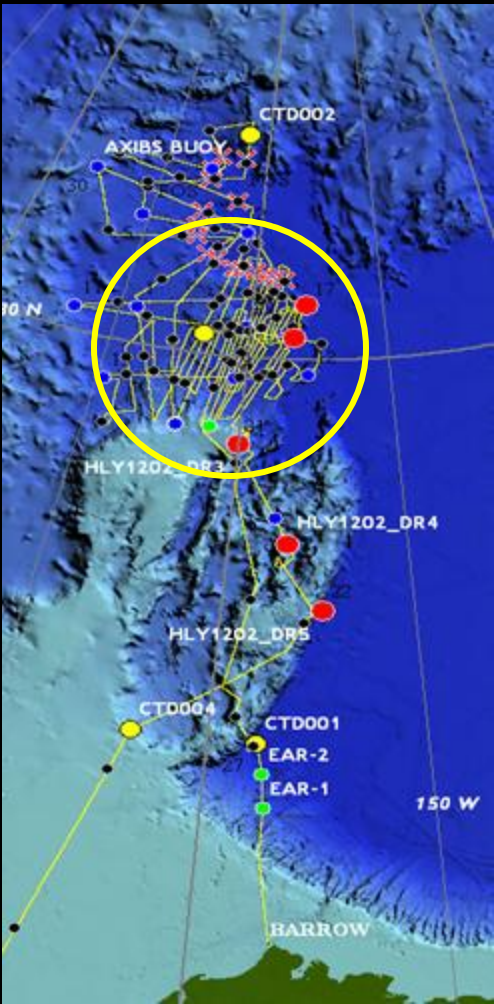




Long/Lat.: -156.072055 W, 80.293353 N  
2012 (9-12-2012)

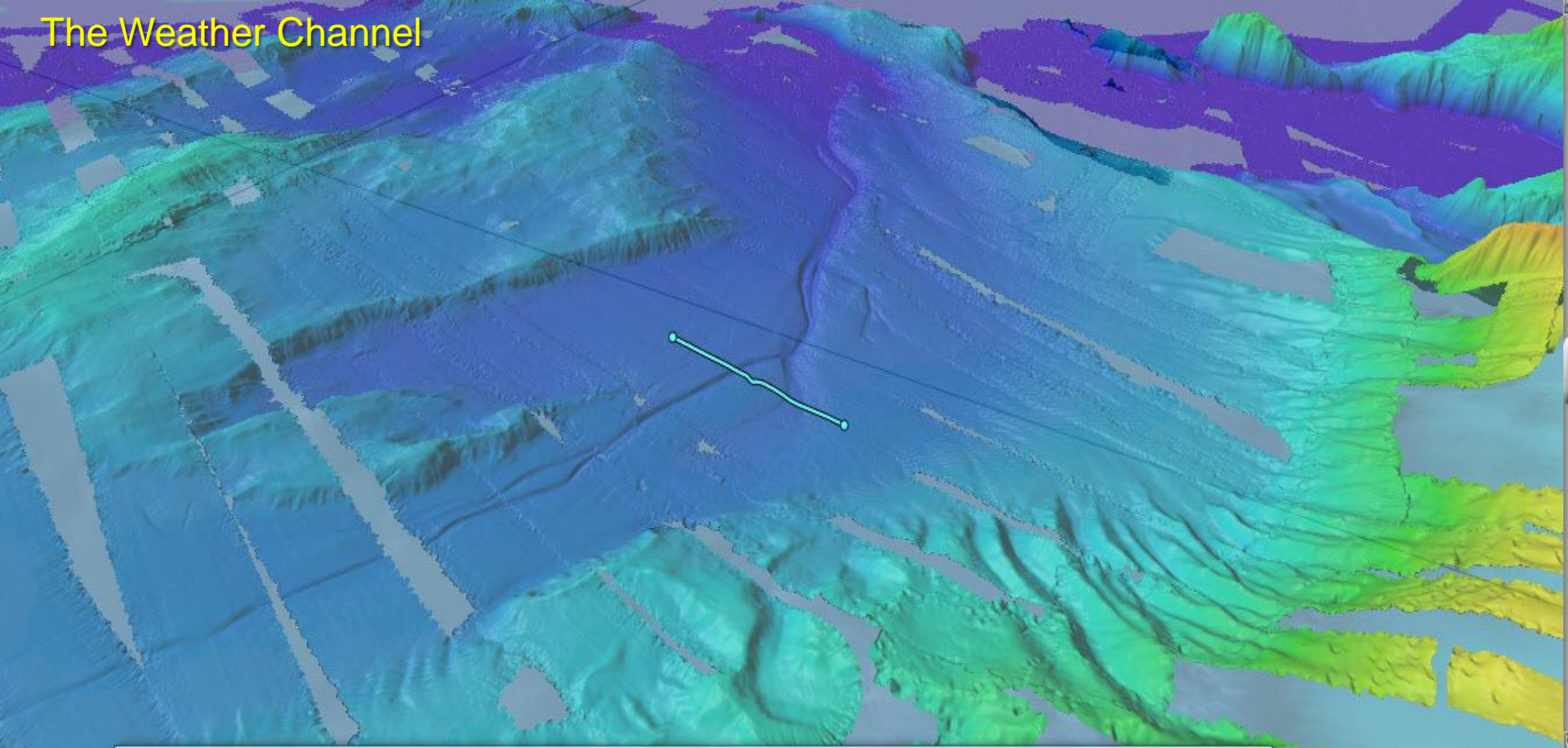




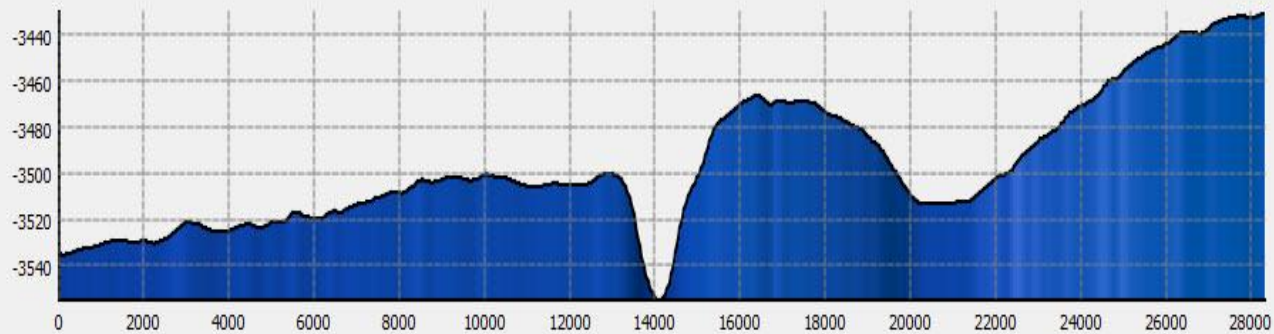




# The Weather Channel



Profiling



Create Profiler Object

Tools

V-Scale:

41.48

Lock

2D Distance:

28303.19

Surface Distance:

28309.27

Slope:

0.000

Close



Area mapped..... ~420,000 km<sup>2</sup>

operations..... 219 days

transits..... 44 days

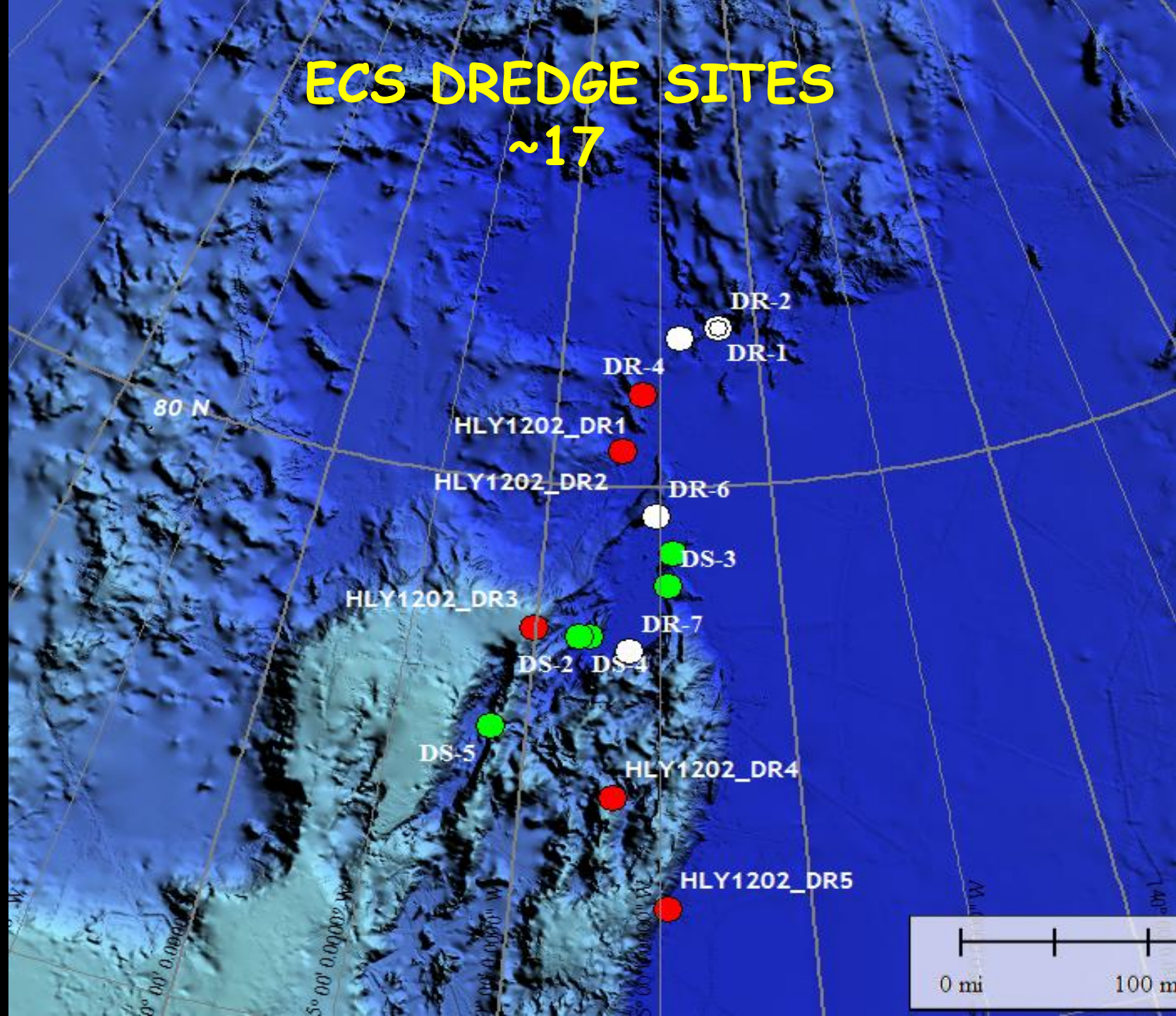
average speed (in ice)..... 4 kts

average sea-ice state..... 8-9/10

US ECS Arctic Mapping 2003, 2004, 2007, 2008, 2009, 2010, 2011, 2012



# ECS DREDGE SITES ~17





# ANCILLARY PROGRAMS

## METOC PROGRAM

### U.S. Navy

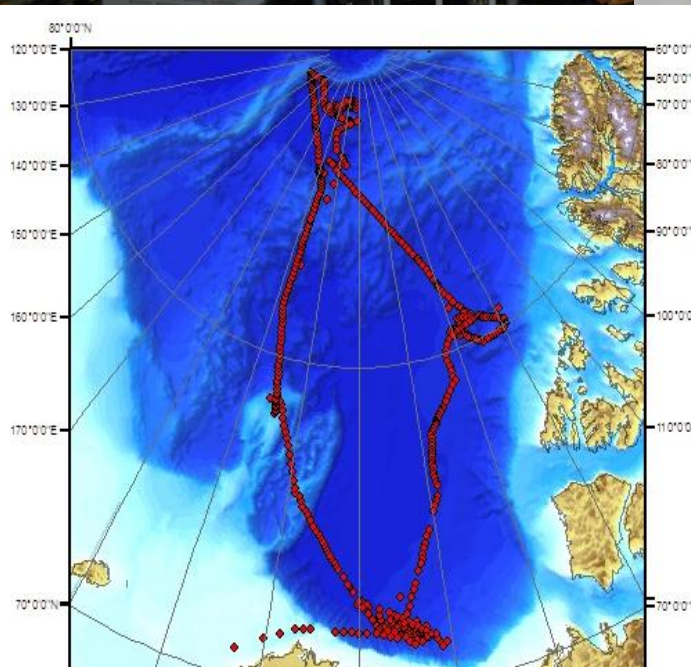


47 RAWINSONDE  
deployments xmitted  
to FNMOC





# Ocean Acidification USGS

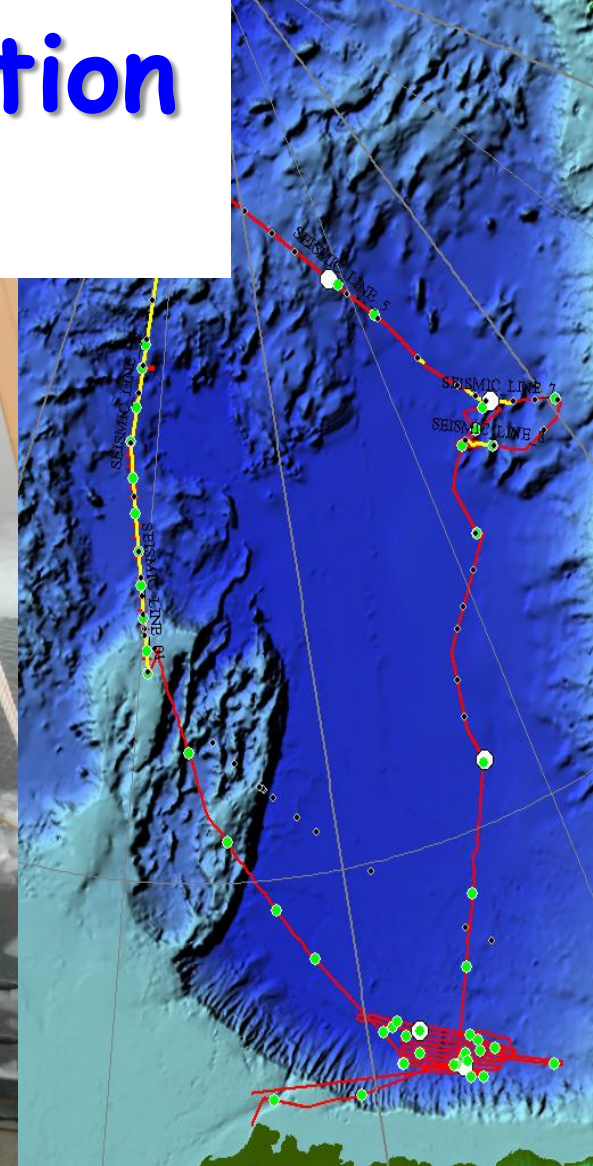


515 pH and 350 CO<sub>3</sub>  
discrete samples



8 CTD's

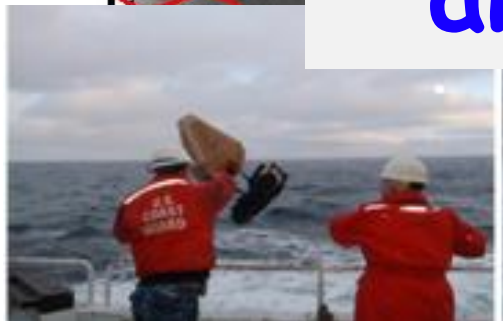
9000 continuous  
measurements of pH,  
CO<sub>2</sub> and TCO<sub>2</sub>



Spectrophotometer



# ICE OBSERVATIONS and BUOYS - NIC



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

OPEN WATER

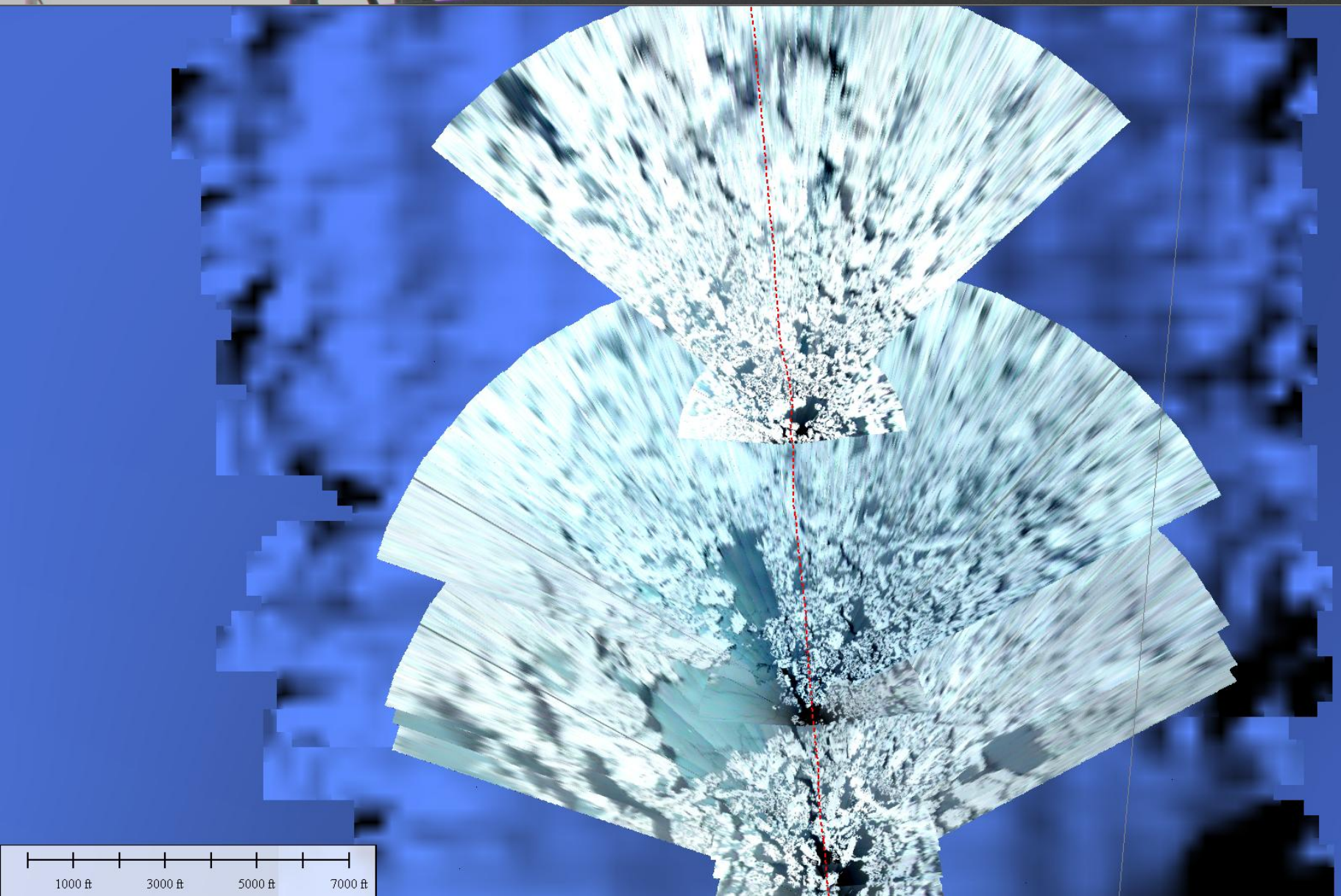
1- UpTempO buoy  
8- Surface Velocity  
Program Drifters  
2 - AXIB's

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





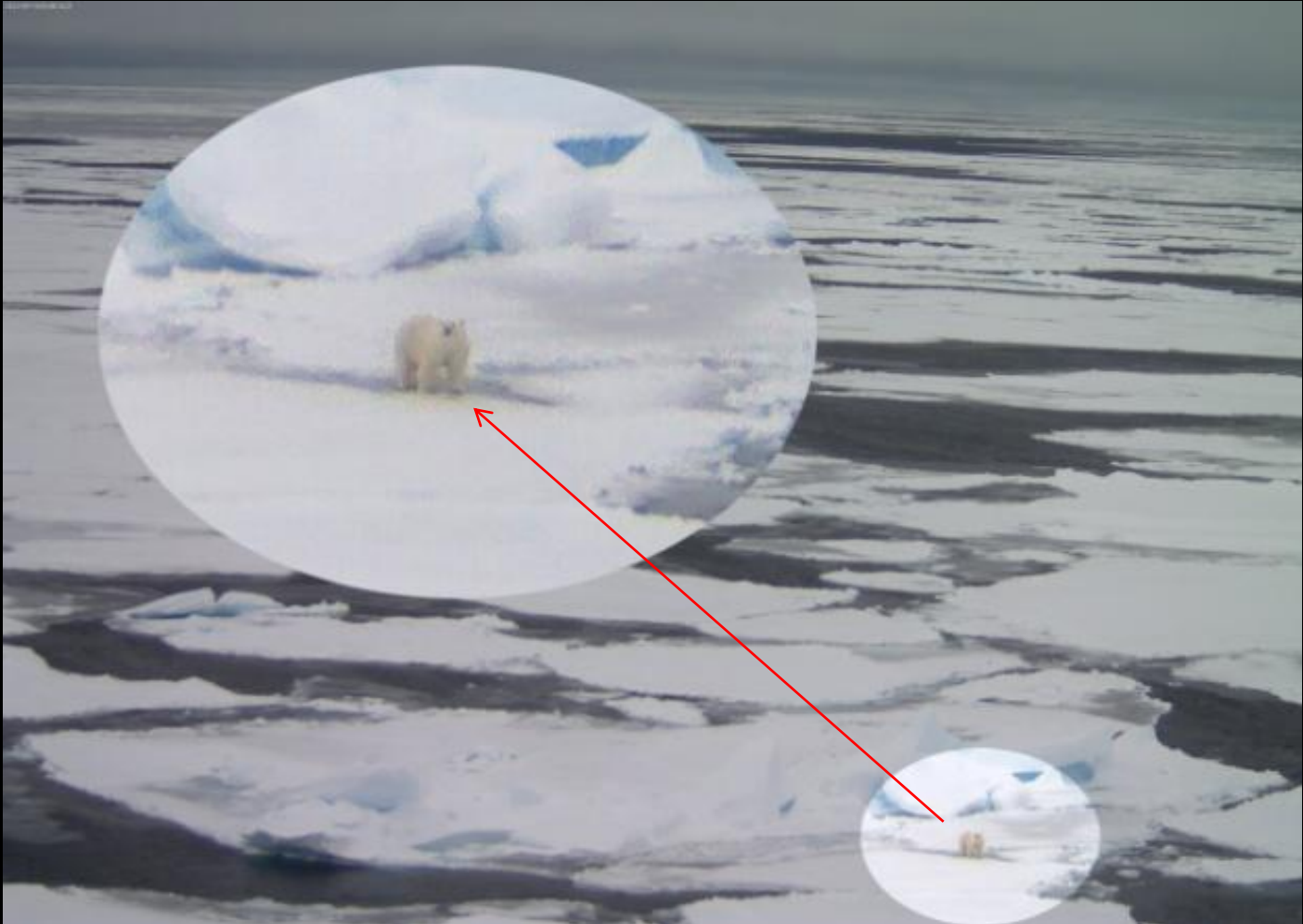
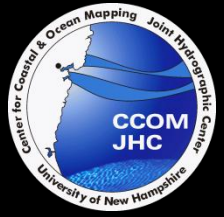
# GeoCamera CCOM-UNH







# More than ice



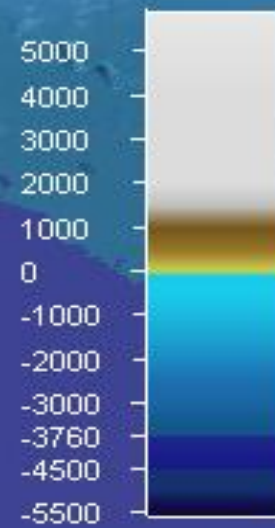




**UAS OPS on LSSL  
 U.S. Air Force**

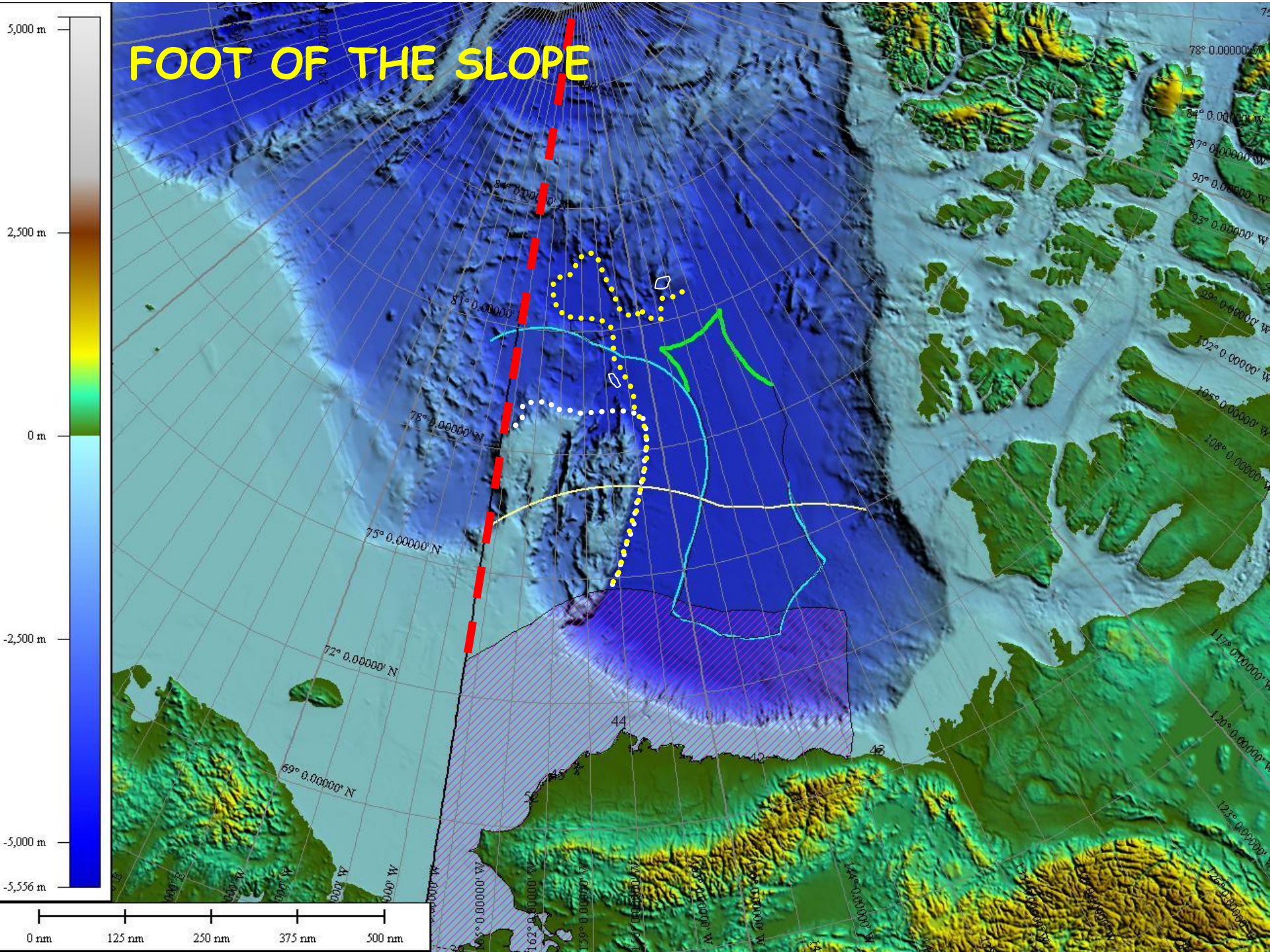


IBCAO Ver 3

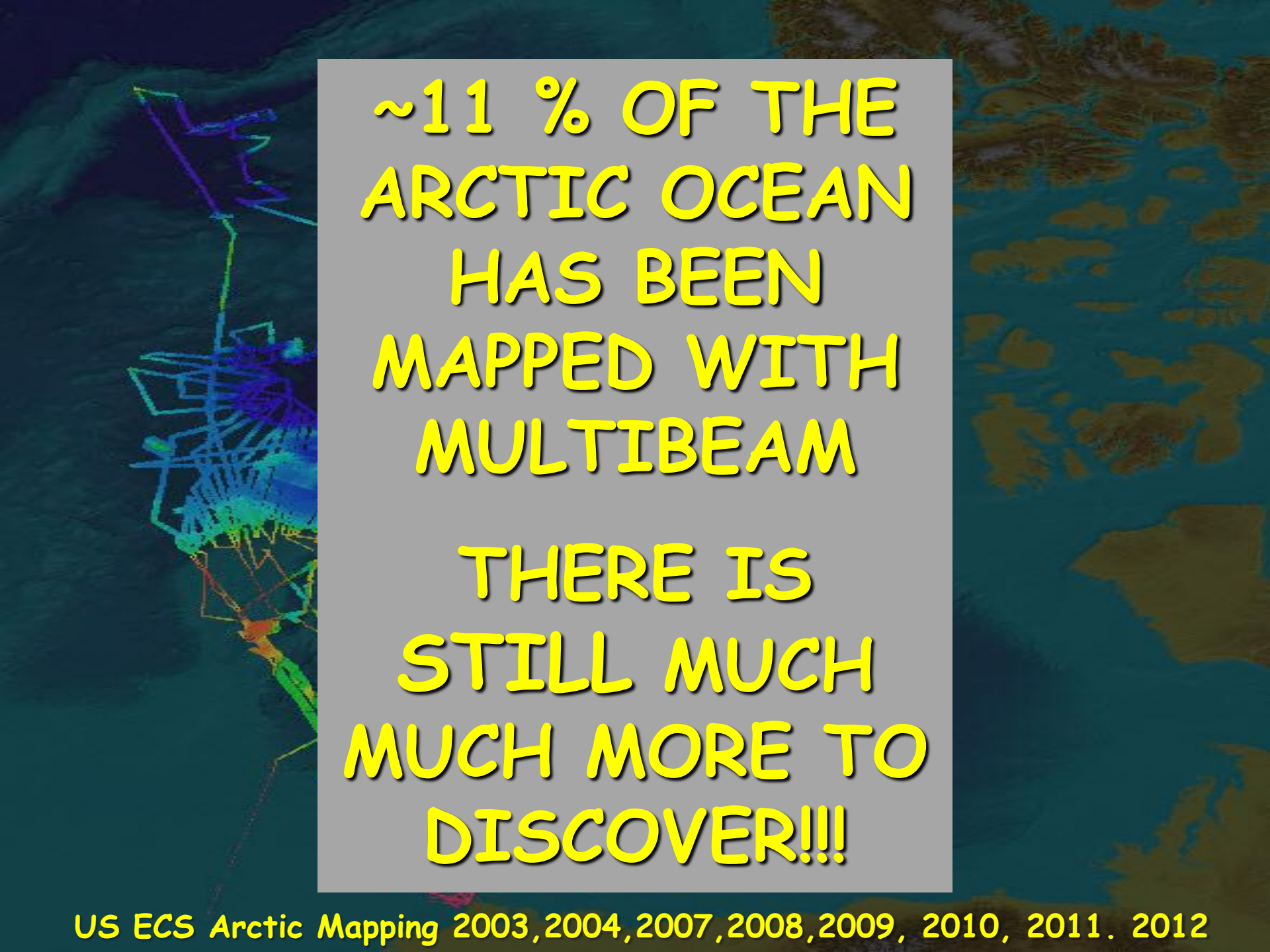




FOOT OF THE SLOPE





The background of the slide is a map of the Arctic Ocean. Overlaid on the map are numerous colored lines (purple, blue, green, yellow, red) representing multibeam sonar mapping tracks. These tracks are concentrated in the central and eastern parts of the Arctic Ocean, showing a complex pattern of survey lines. The text is centered on a light gray rectangular background.

**~11 % OF THE  
ARCTIC OCEAN  
HAS BEEN  
MAPPED WITH  
MULTIBEAM**

**THERE IS  
STILL MUCH  
MUCH MORE TO  
DISCOVER!!!**



# SWERUS-C3 2014

