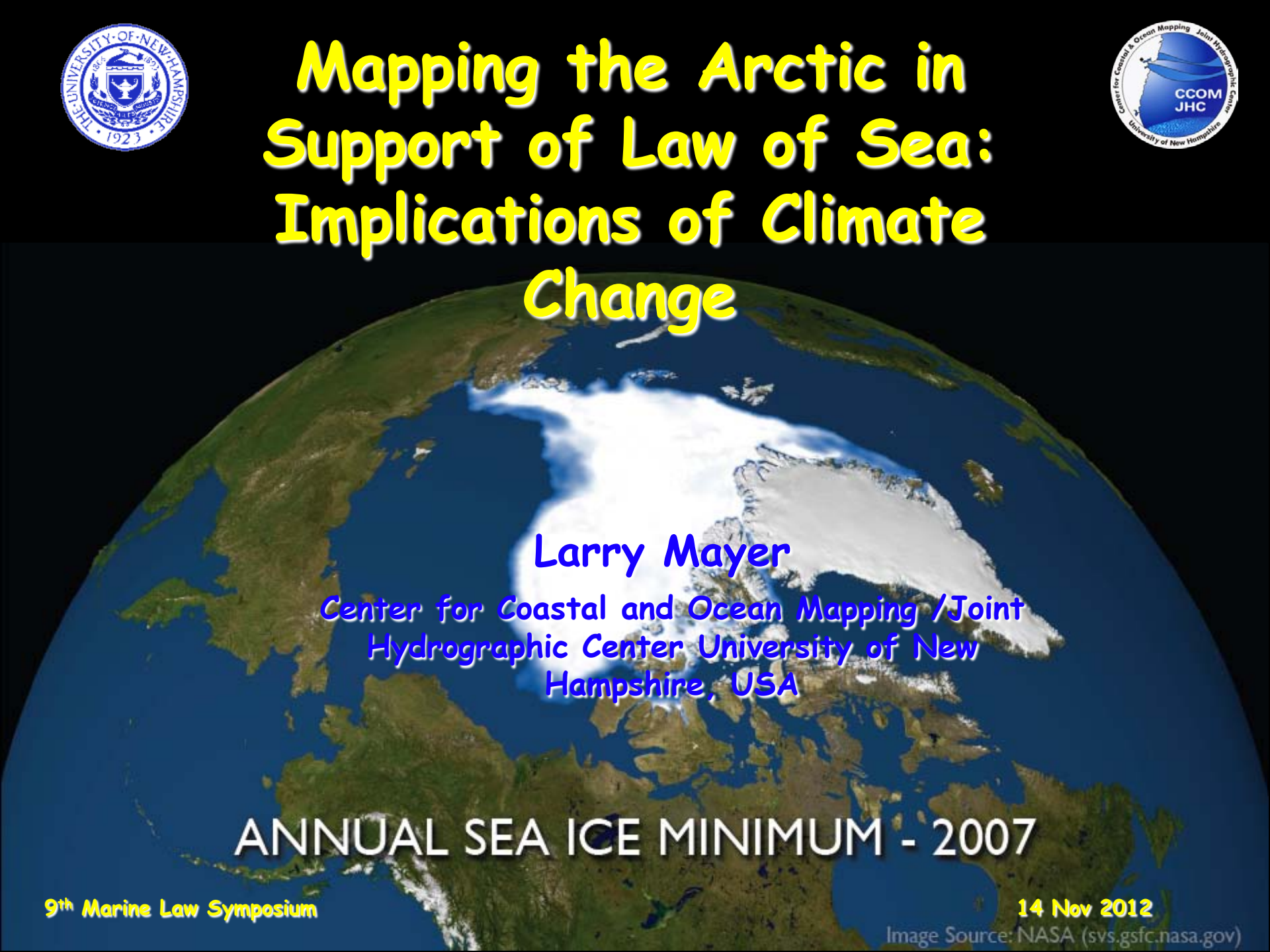
Mapping the Arctic in Support of Law of Sea: Implications of Climate Change

Larry Mayer

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

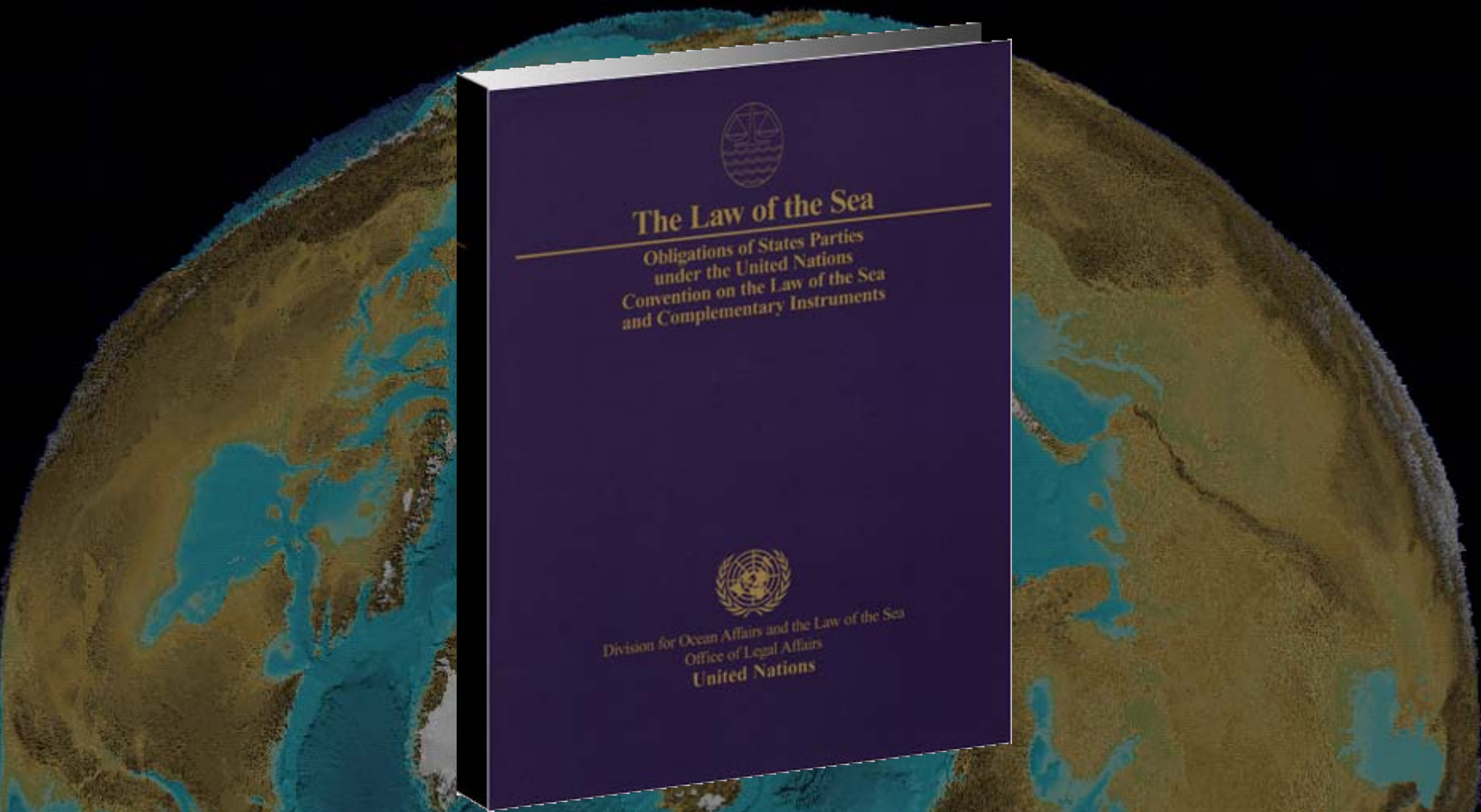


9th Marine Law Symposium

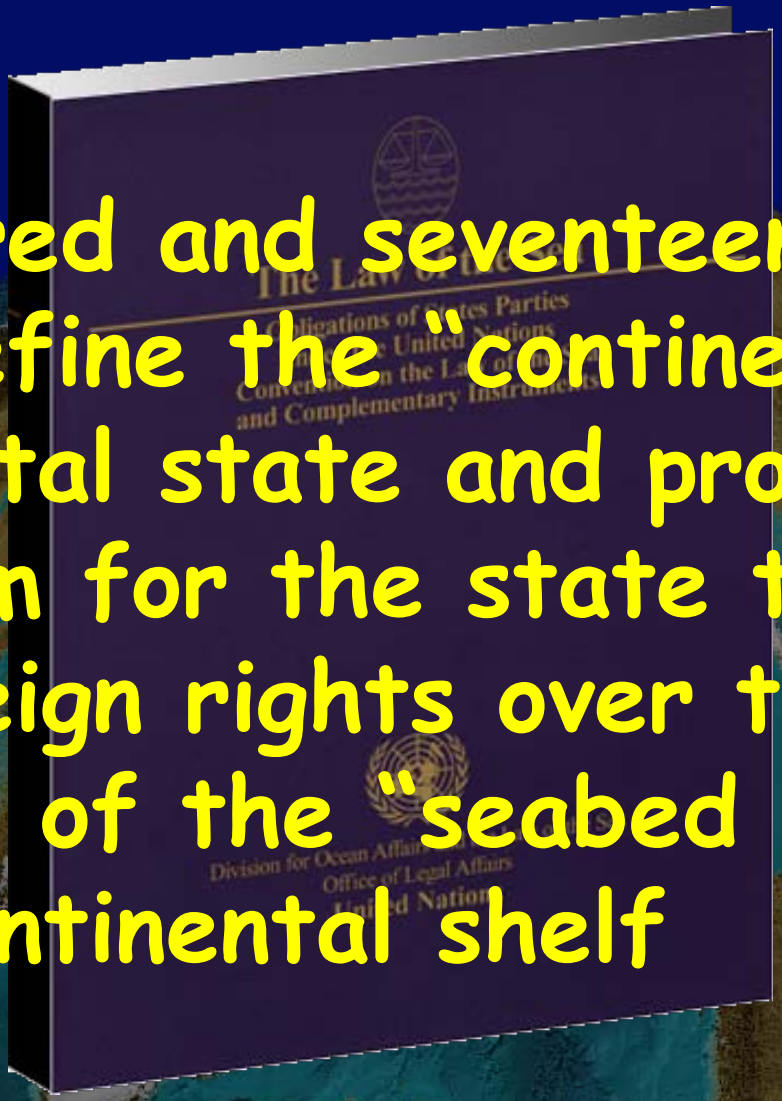
14 Nov 2012

Image Source: NASA (svs.gsfc.nasa.gov)

THE CONVENTION ON THE LAW OF THE SEA



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

UNCLOS Article 76

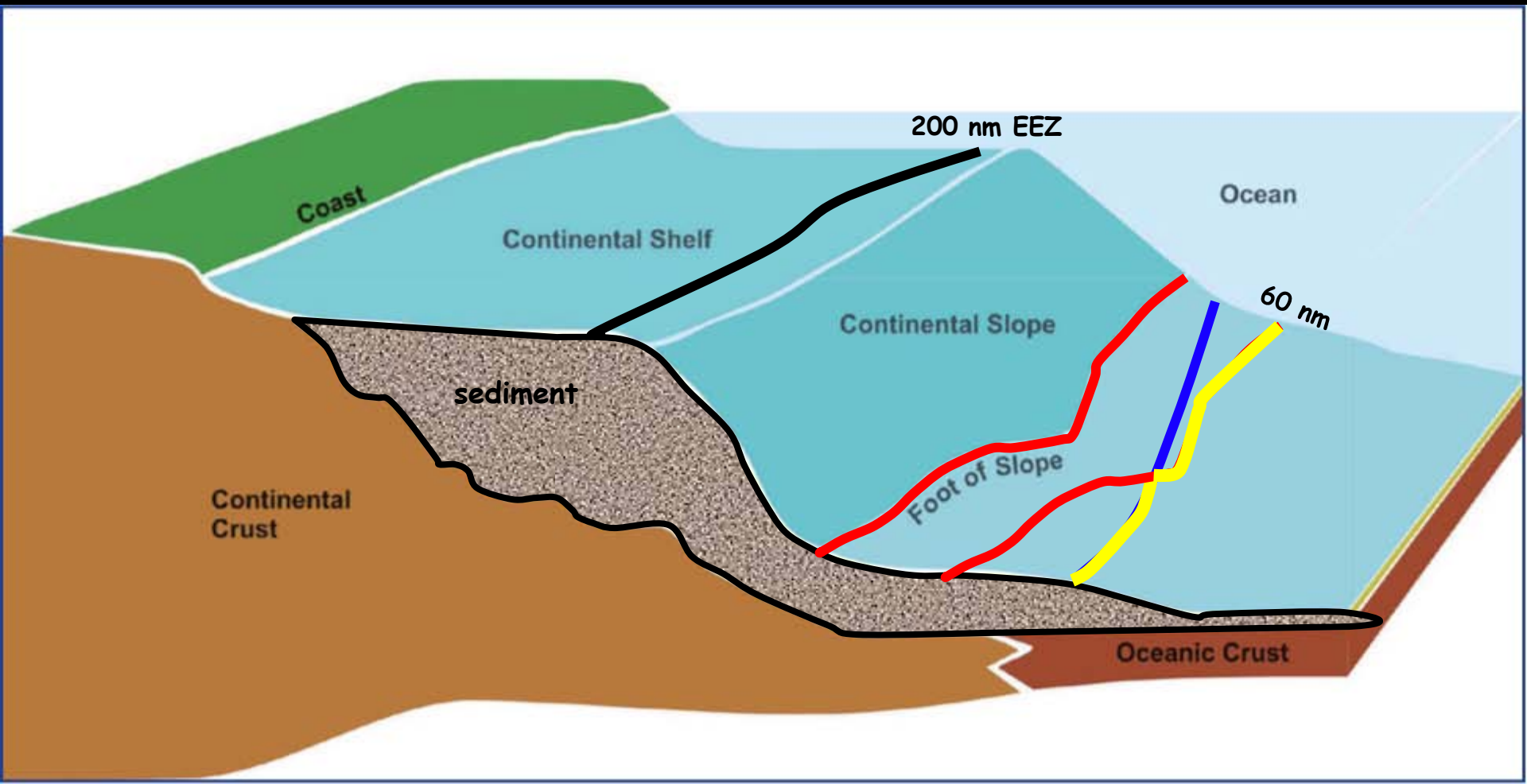
- A coastal state can extend its continental shelf beyond 200 nm from its baselines (entitling it to sovereign rights over the resources of the seafloor and subsurface) if certain morphological characteristics are met – these are determined by:
  - depth and shape of the seafloor (FOS and 2500m contour)
  - the thickness of the underlying sediments (1% line)
  - distances from the territorial sea baselines (350 nm line)

Need to map the seafloor

Formulae Lines:

Foot of Slope + 60 nmi – bathy

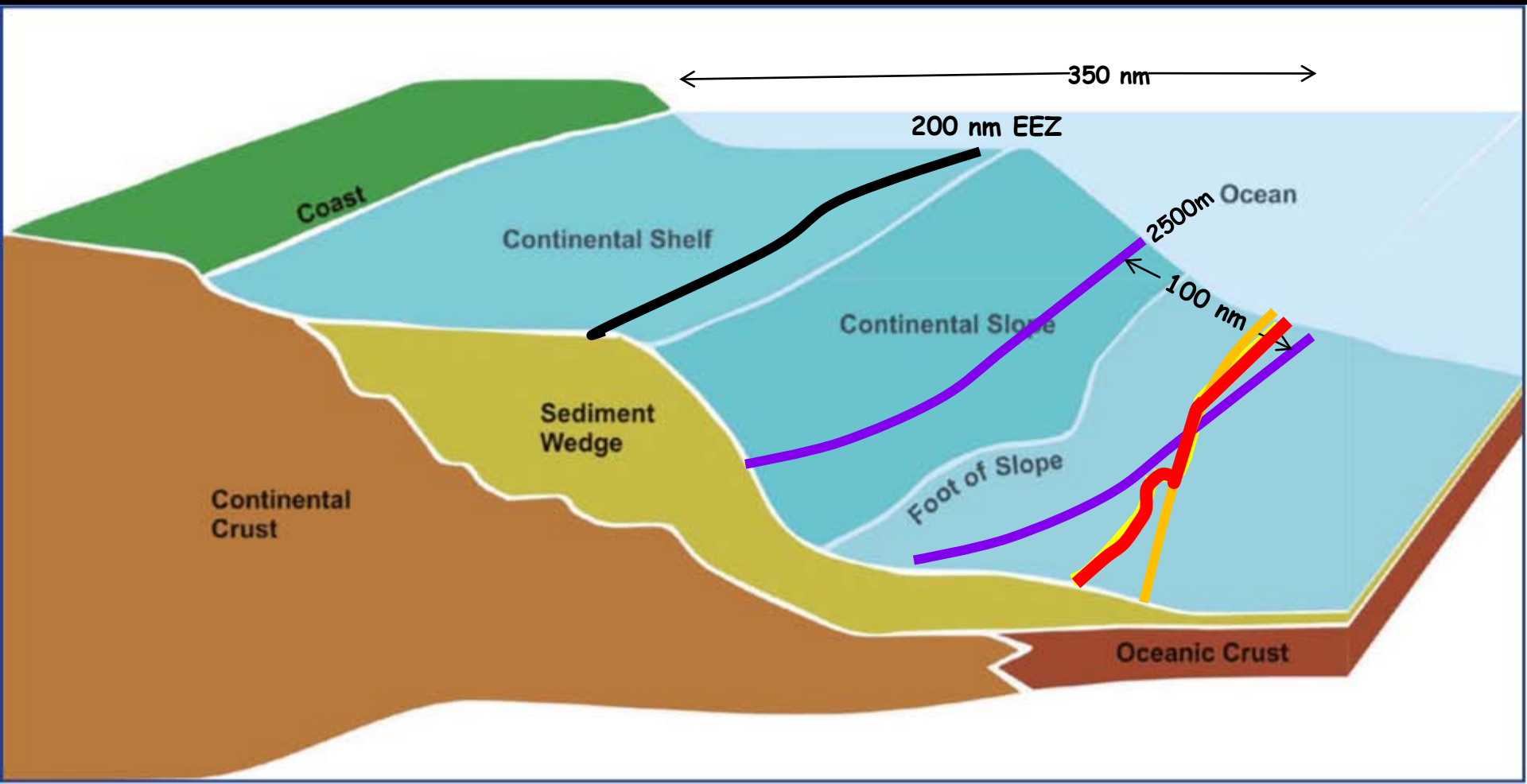
Gardiner line – **sediment thickness less than 1% of distance back to FOS** – seismic and bathy



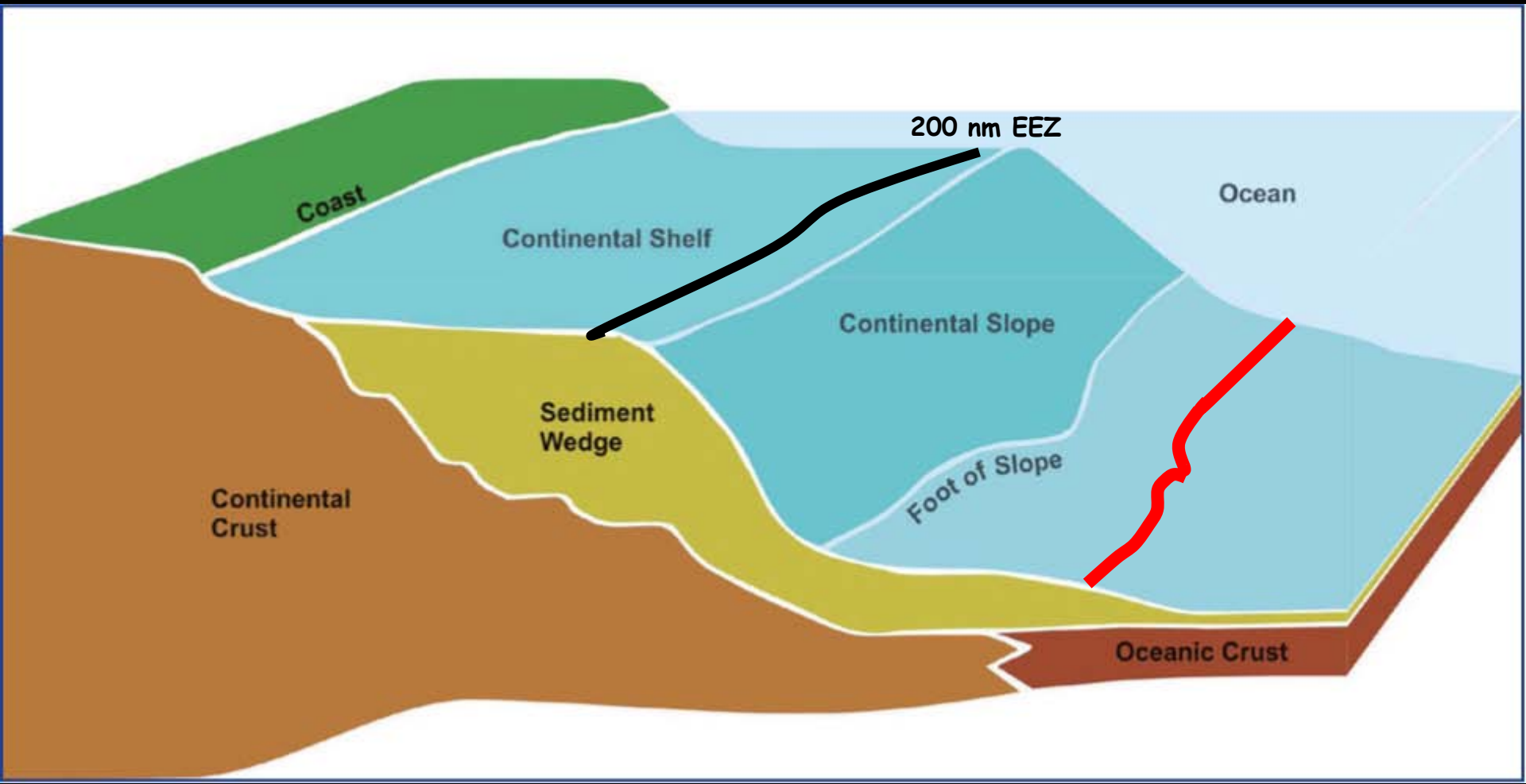
Limit Lines:

2500 m contour+100 nmi – bathy

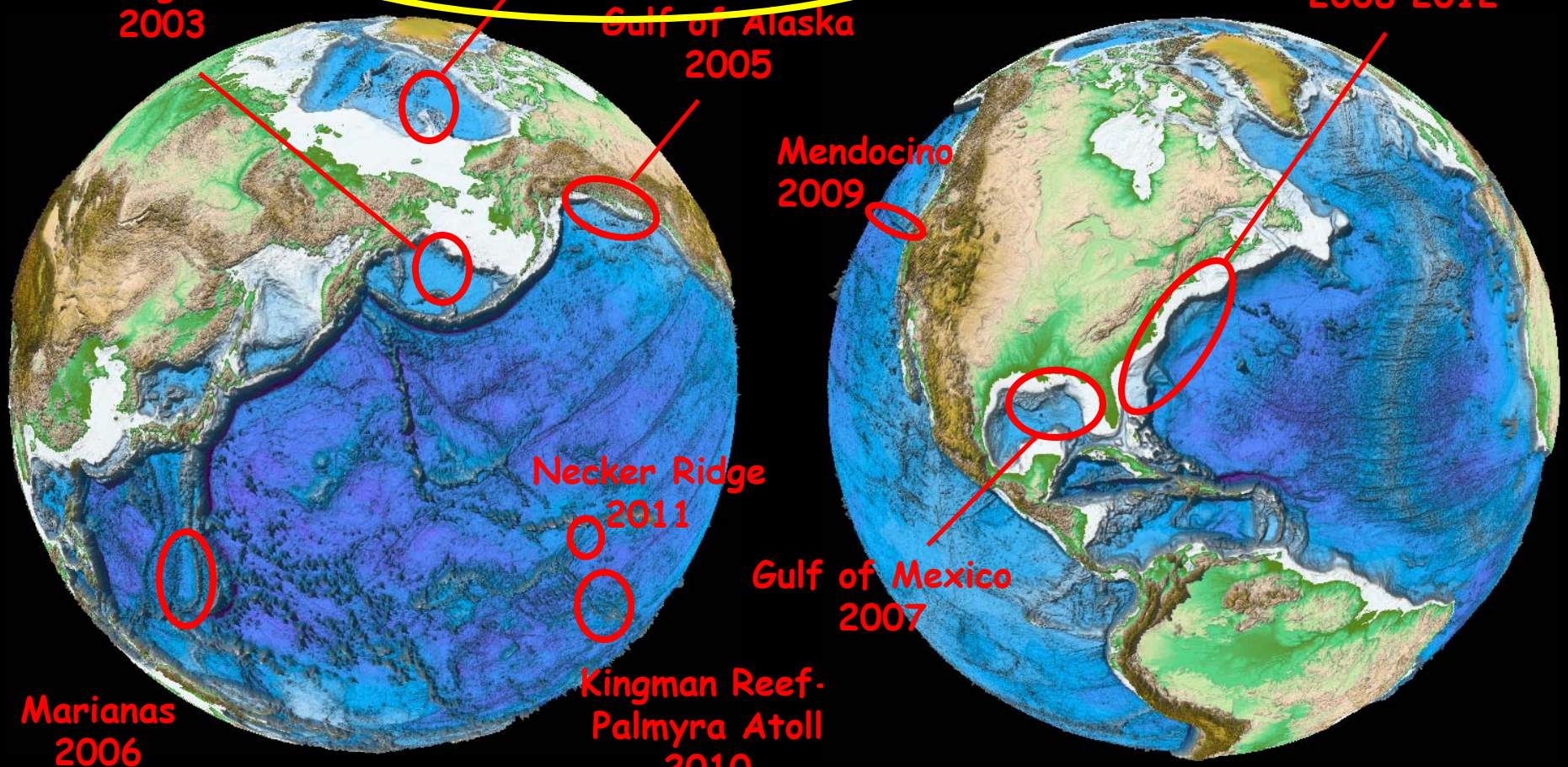
350 nmi from baseline – distance



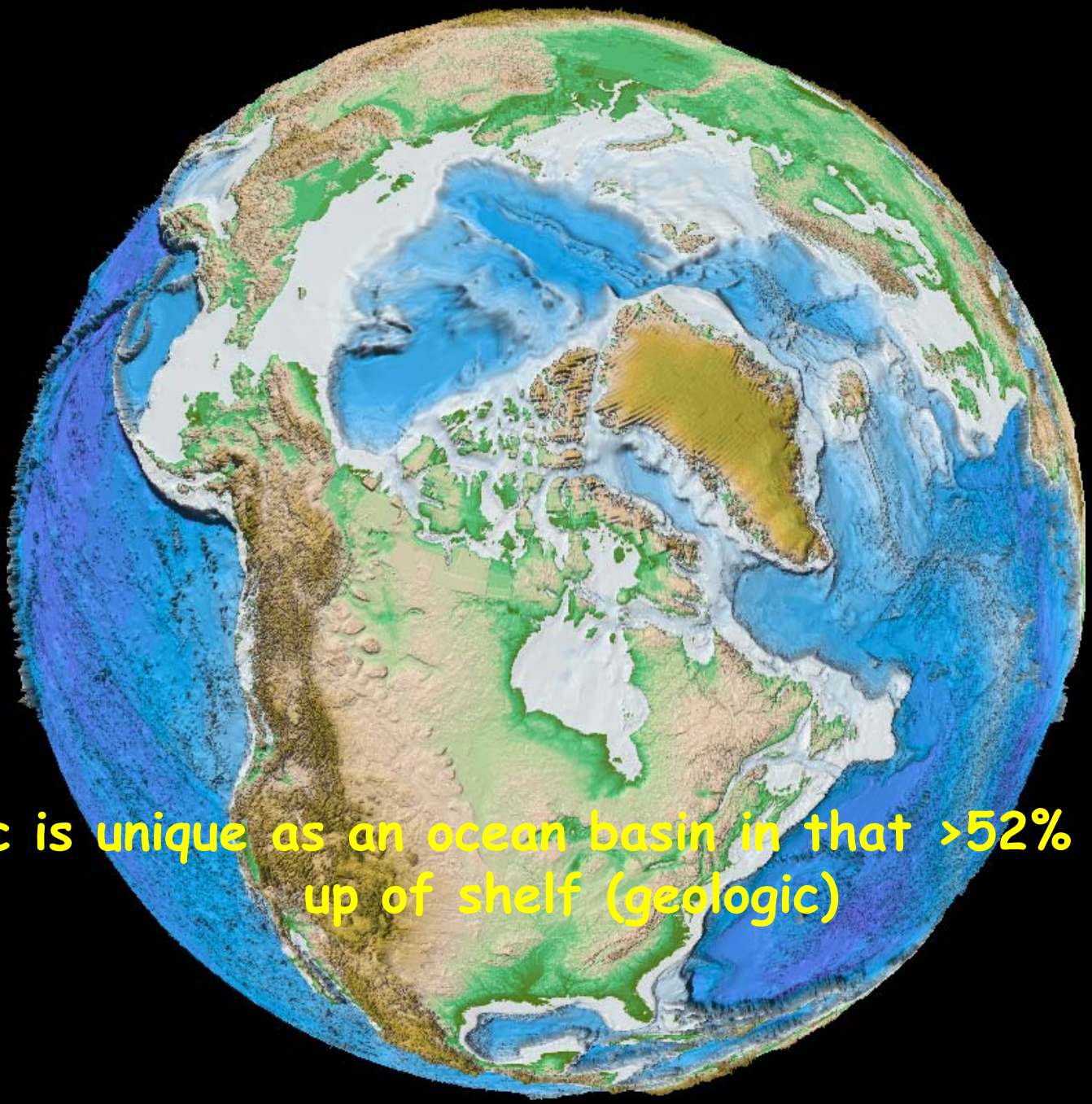
EXTENDED CONTINENTAL SHELF



UNH CCOM-JHC U.S. Law-of-the-Sea Bathymetric Mapping to Date



> 2,070,000 km²

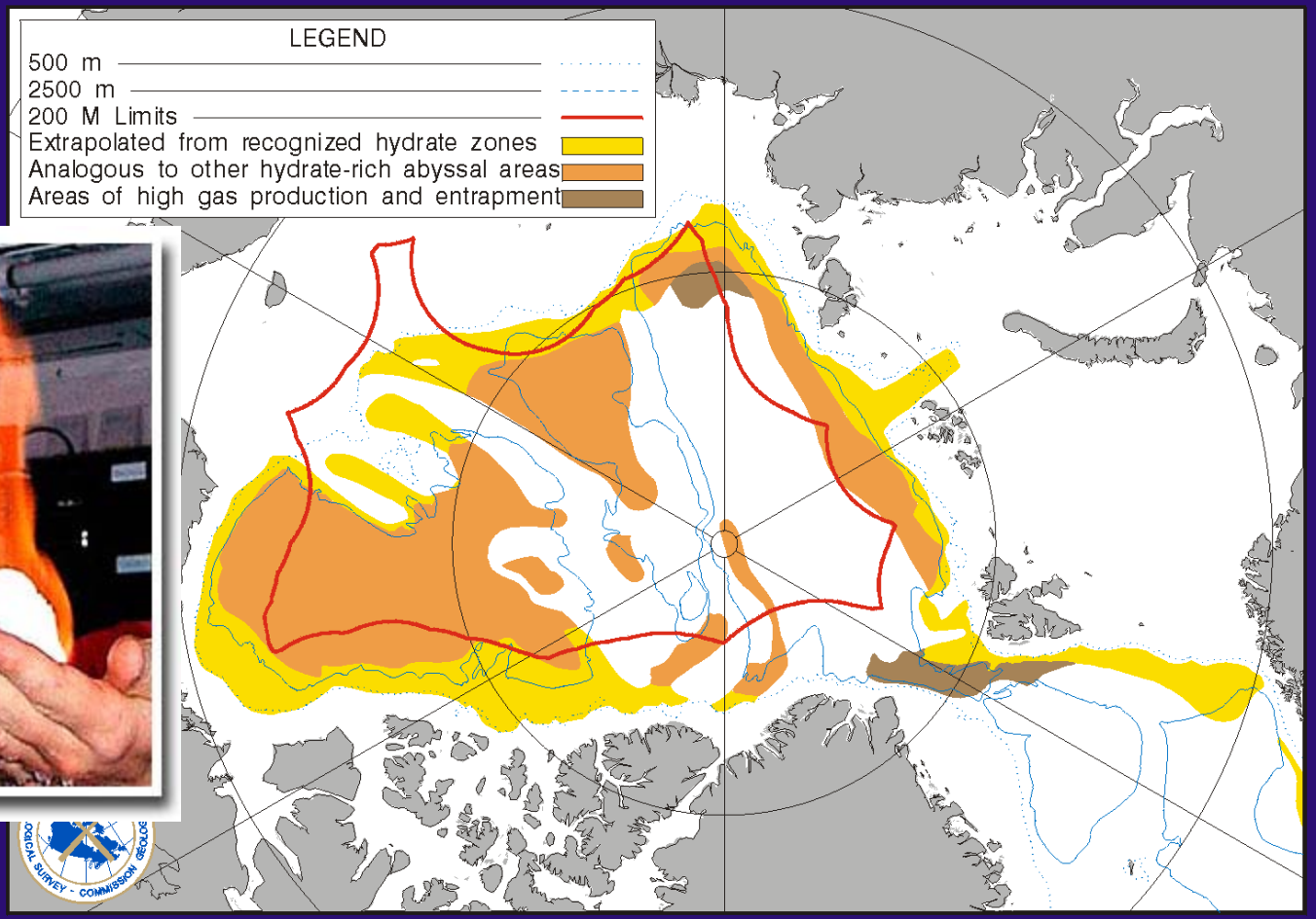


Arctic is unique as an ocean basin in that >52% is made up of shelf (geologic)

Potential for Oil and Gas in the Arctic

USGS (2009) 13% of world's undiscovered oil, 30% undiscovered gas, 20% undiscovered natural gas liquids

HYDRATE LIKELIHOOD AREAS IN THE ARCTIC



Adapted from Max and Lowrie, 1990

DV, RM & GC GSC Atlantic June 1997 (Revised)

Slide courtesy Ron Macnab

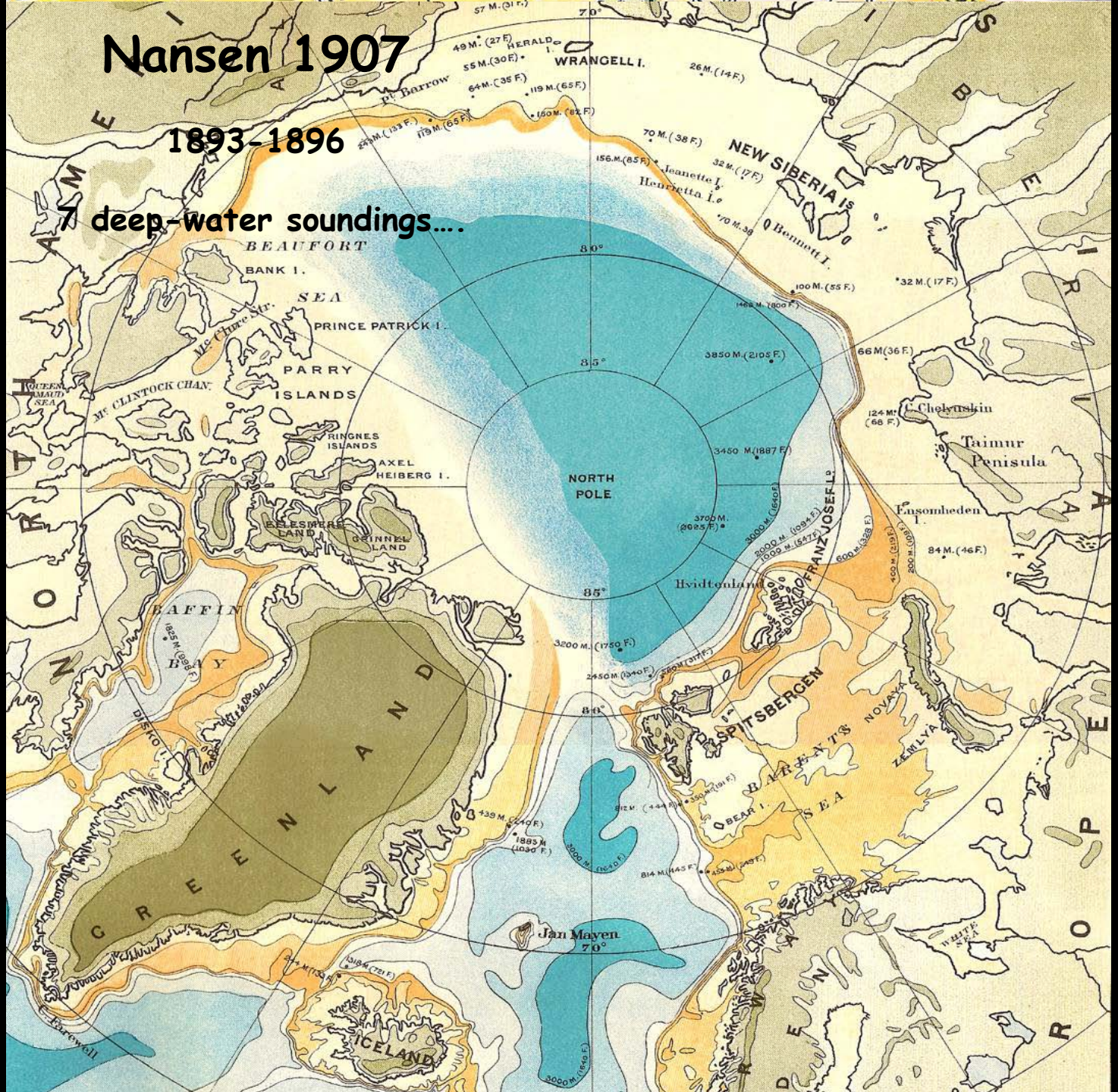
How do we map in this?

Photo from M. Jakobsson

Nansen 1907

1893-1896

7 deep-water soundings….



Lead Line and Sounding Machine

Between 1900 and 1940 ~ 2000 lead line measurements in the Arctic

Special Publication No. 143

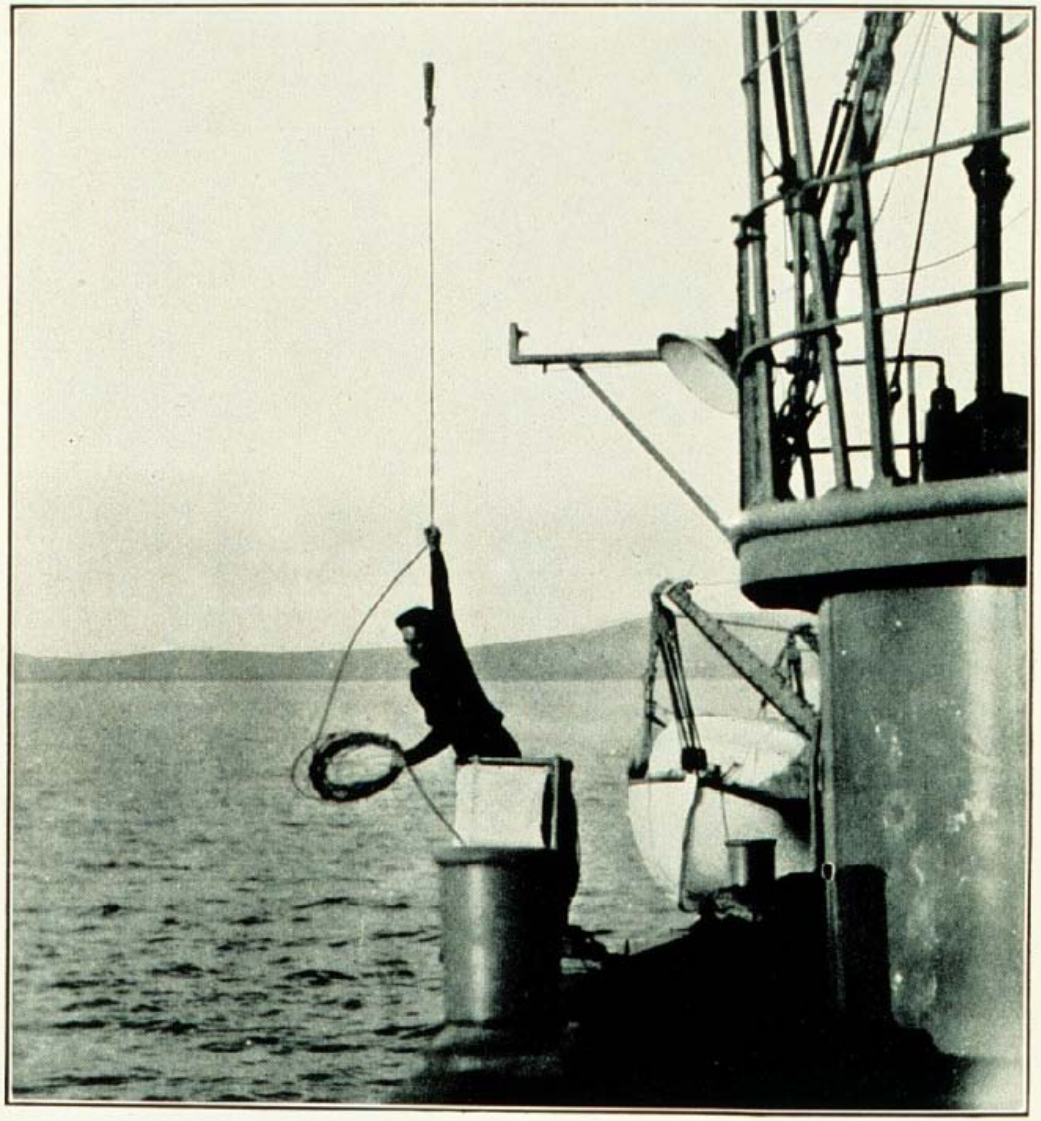
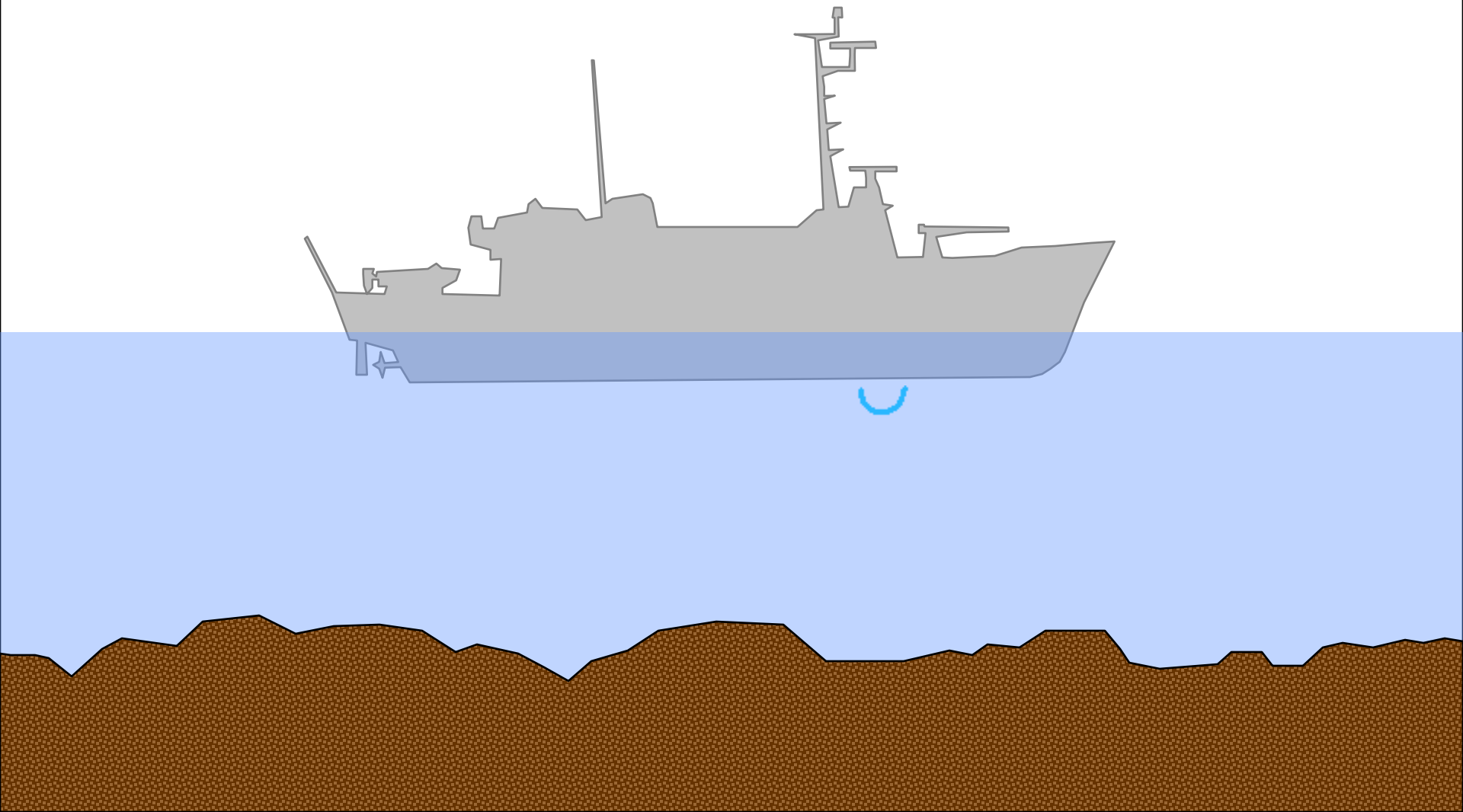


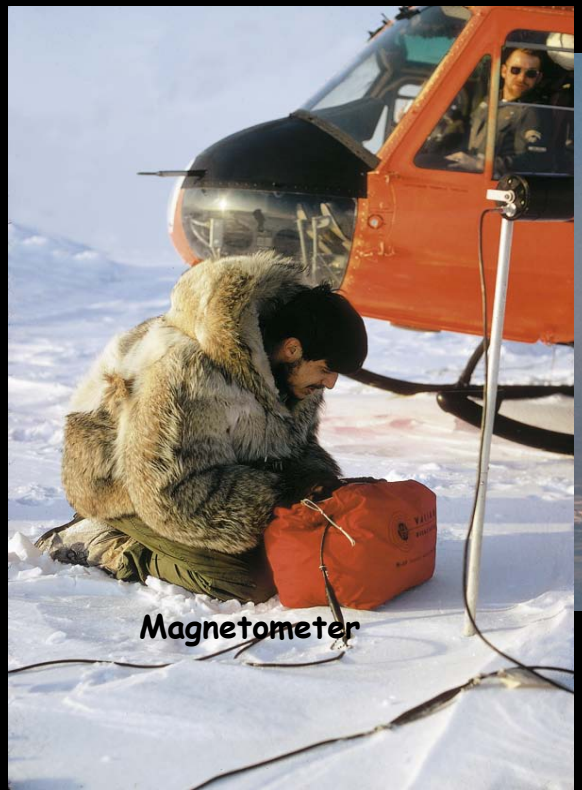
FIG. 10.—HEAVING THE LEAD

Single Beam Echo Sounder



Airborne Measurements and Point Soundings

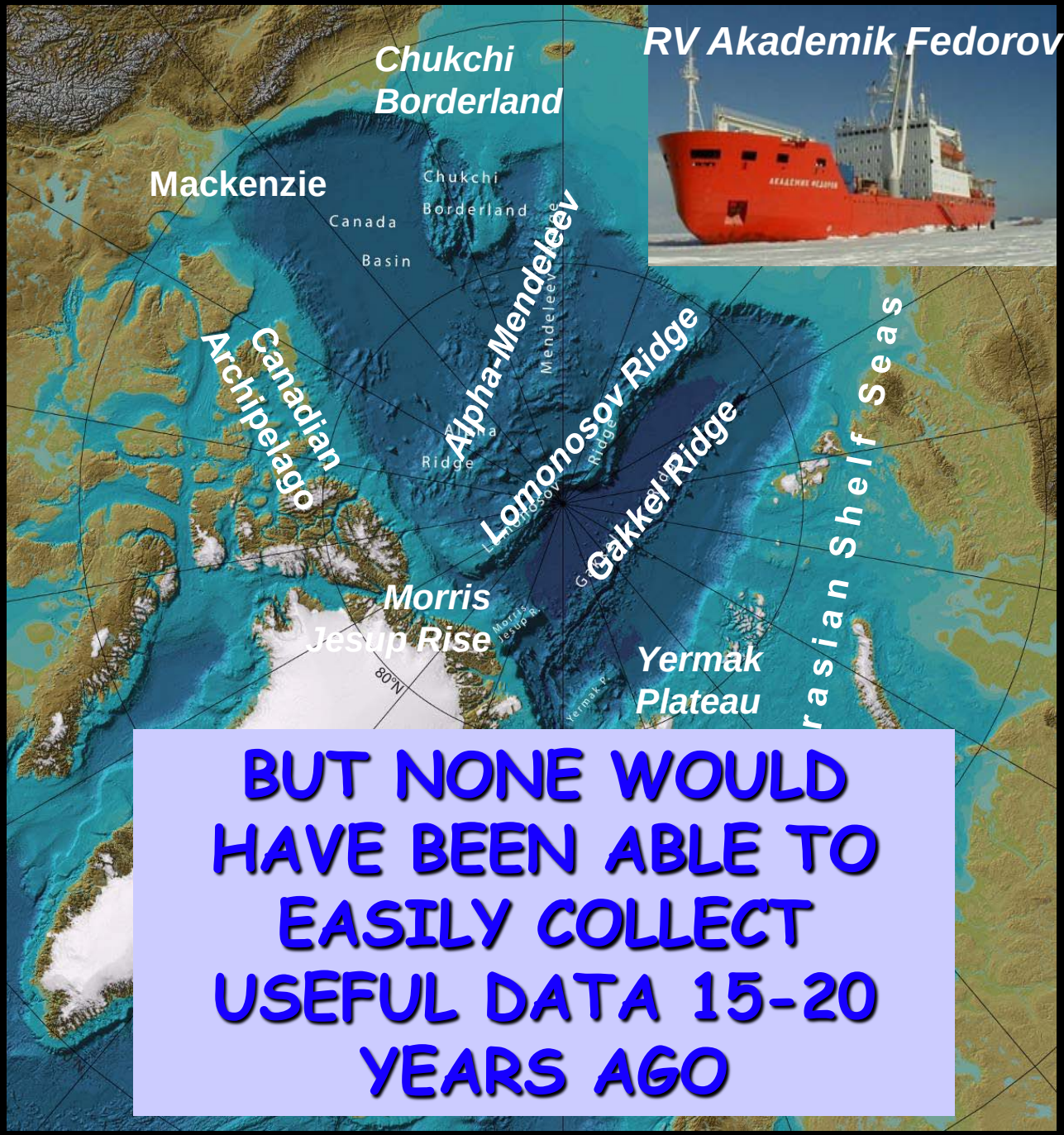

Gravity Measurement


Magnetometer


Depth Sounding

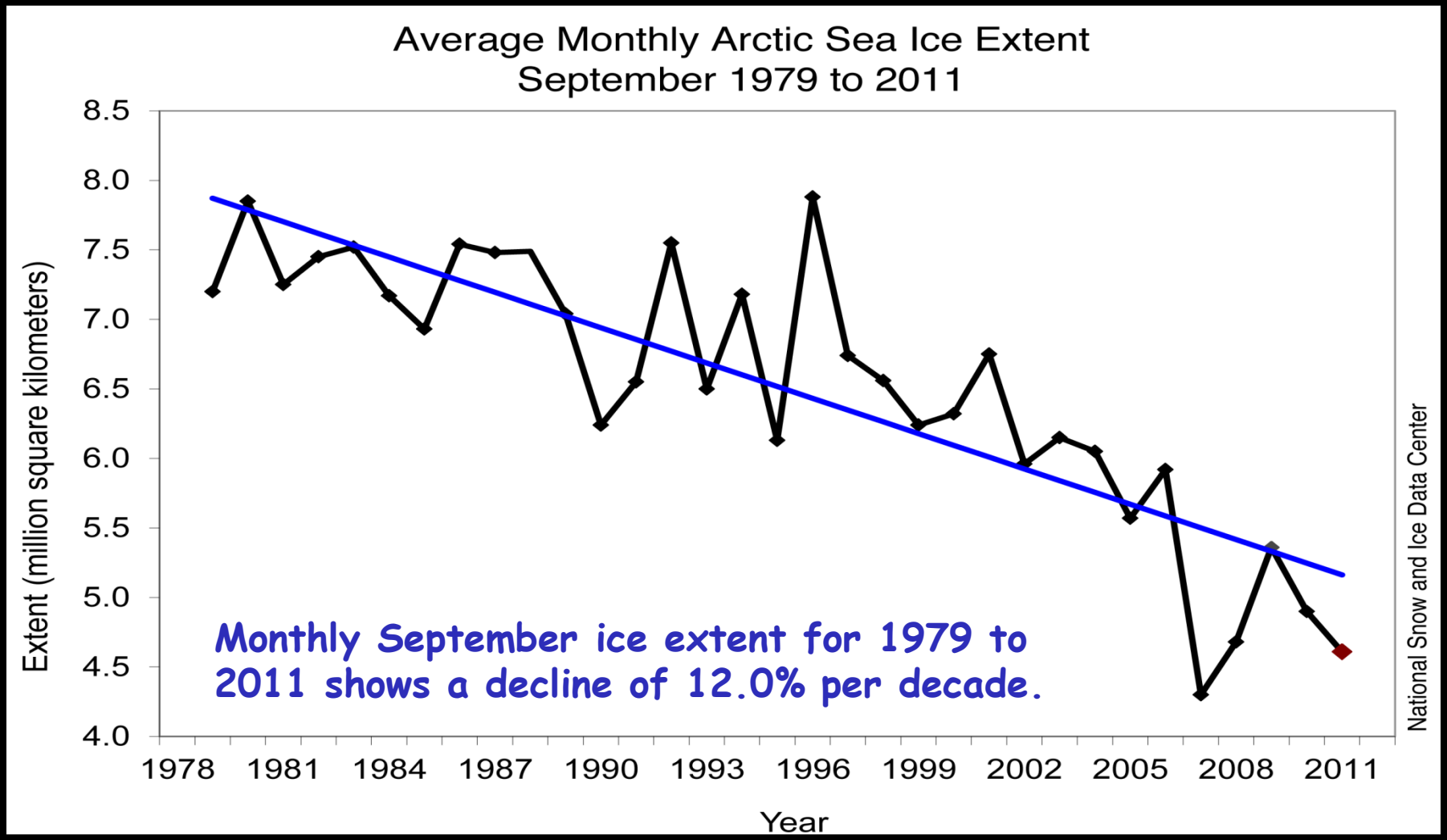

Multibeam
Echo Sounder

Multibeam mapping



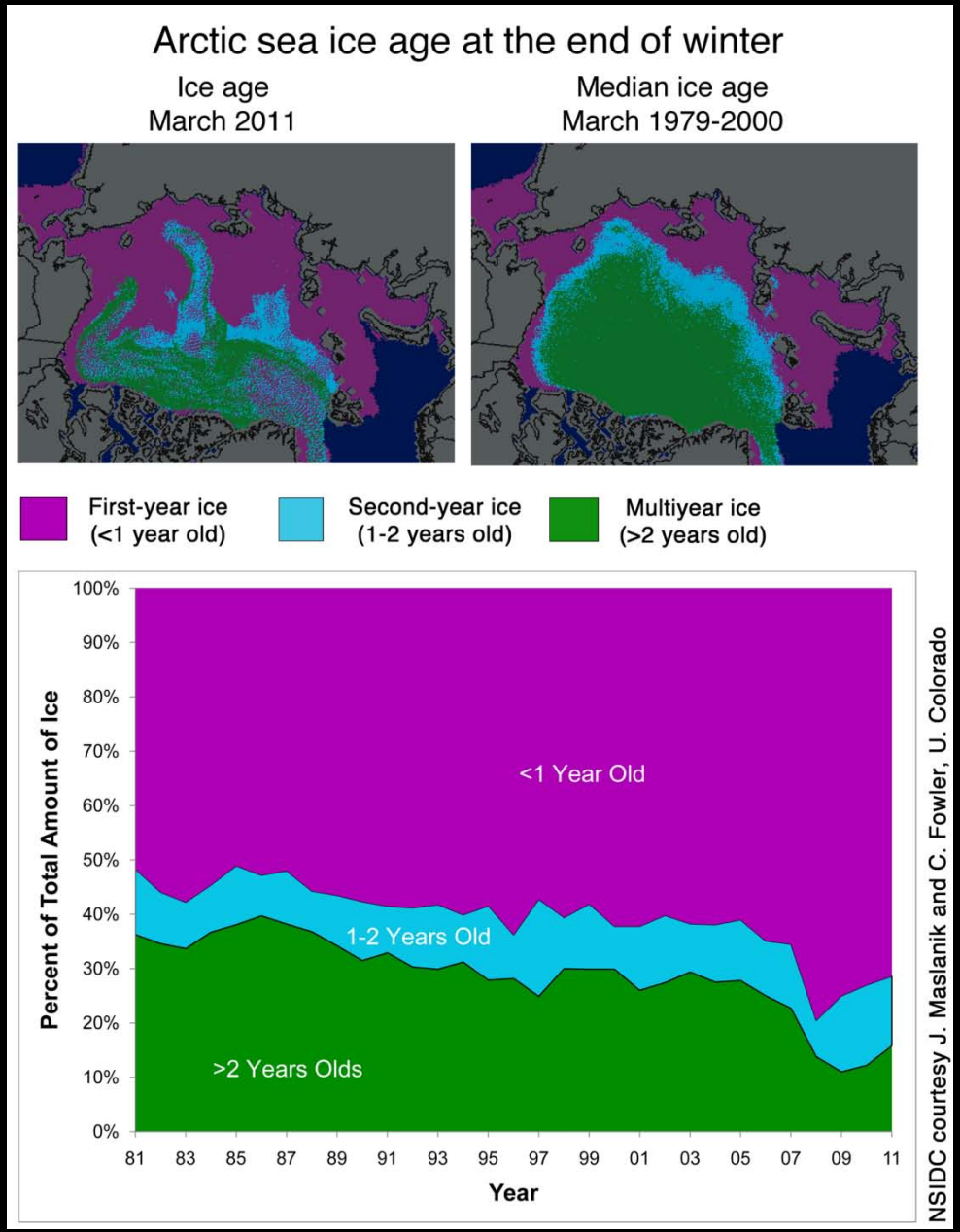
BUT NONE WOULD HAVE BEEN ABLE TO EASILY COLLECT USEFUL DATA 15-20 YEARS AGO

Minimum Ice Extent



National Snow and Ice Data Center

AGE OF SEA ICE



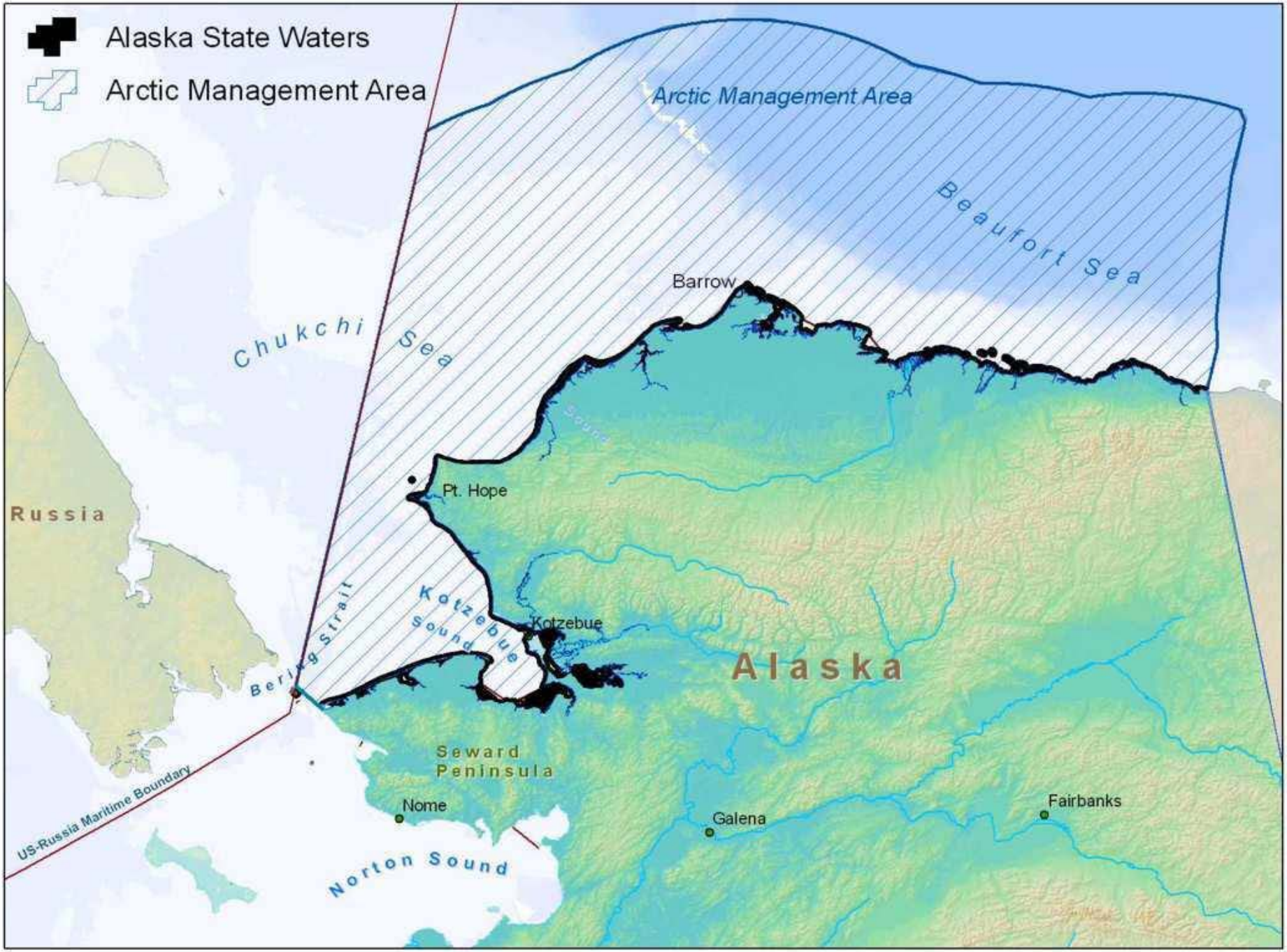
1980-2000
~30% > 2
years old

2009 <
10% > 2
years old

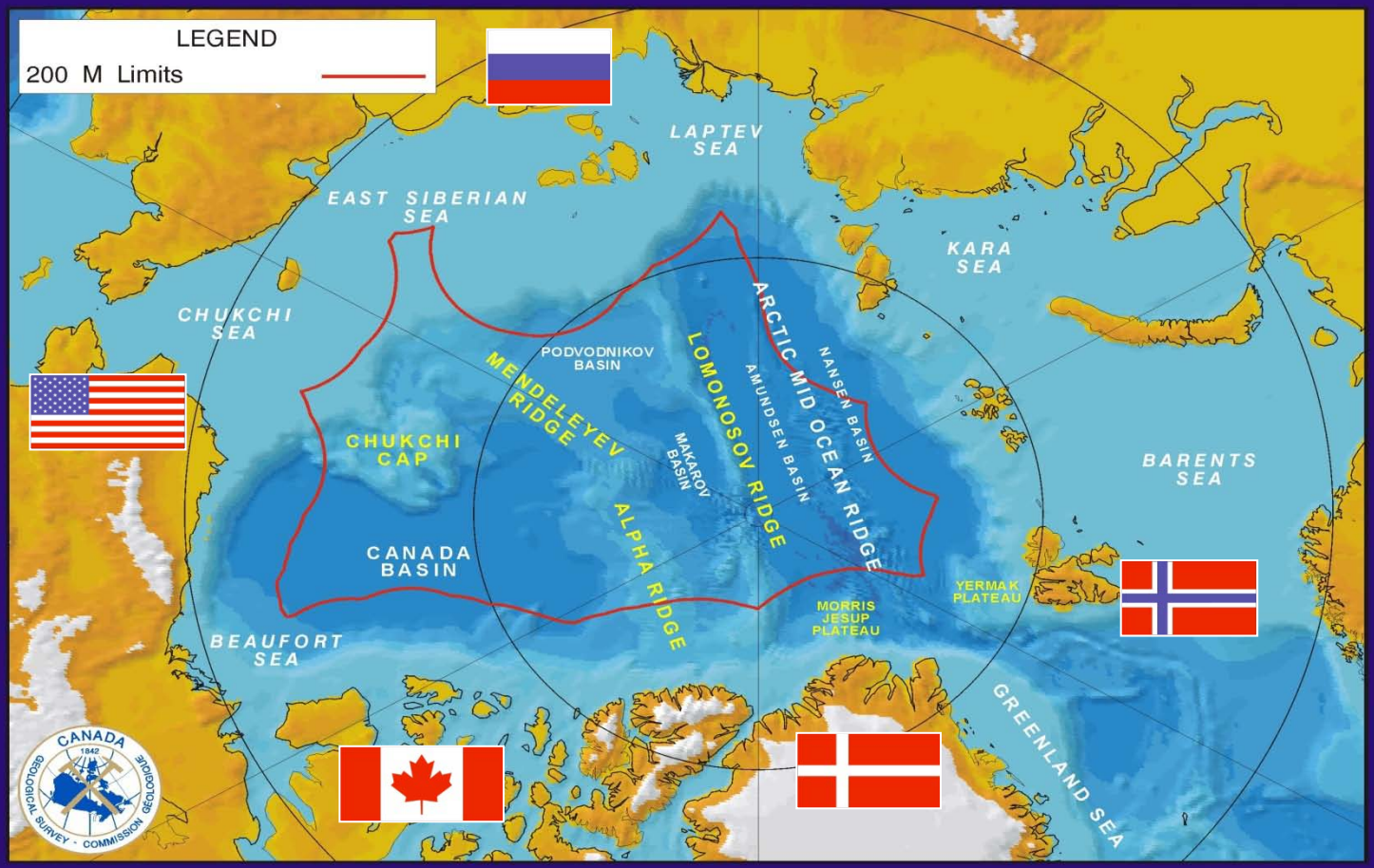
National Snow and Ice Data Center

Impact of Ice-Free Arctic Summer on Marine Transport

Source: UPEP GRID Arendal


Alaska State Waters
Arctic Management Area
Arctic Management Area
Beaufort Sea
Chukchi Sea
Barrow
Pt. Hope
Kotzebue Sound
Kotzebue
Bering Strait
Russia
Alaska
Seward Peninsula
Nome
Galena
Fairbanks
Norton Sound
US-Russia Maritime Boundary

Five nations having potential extended shelves

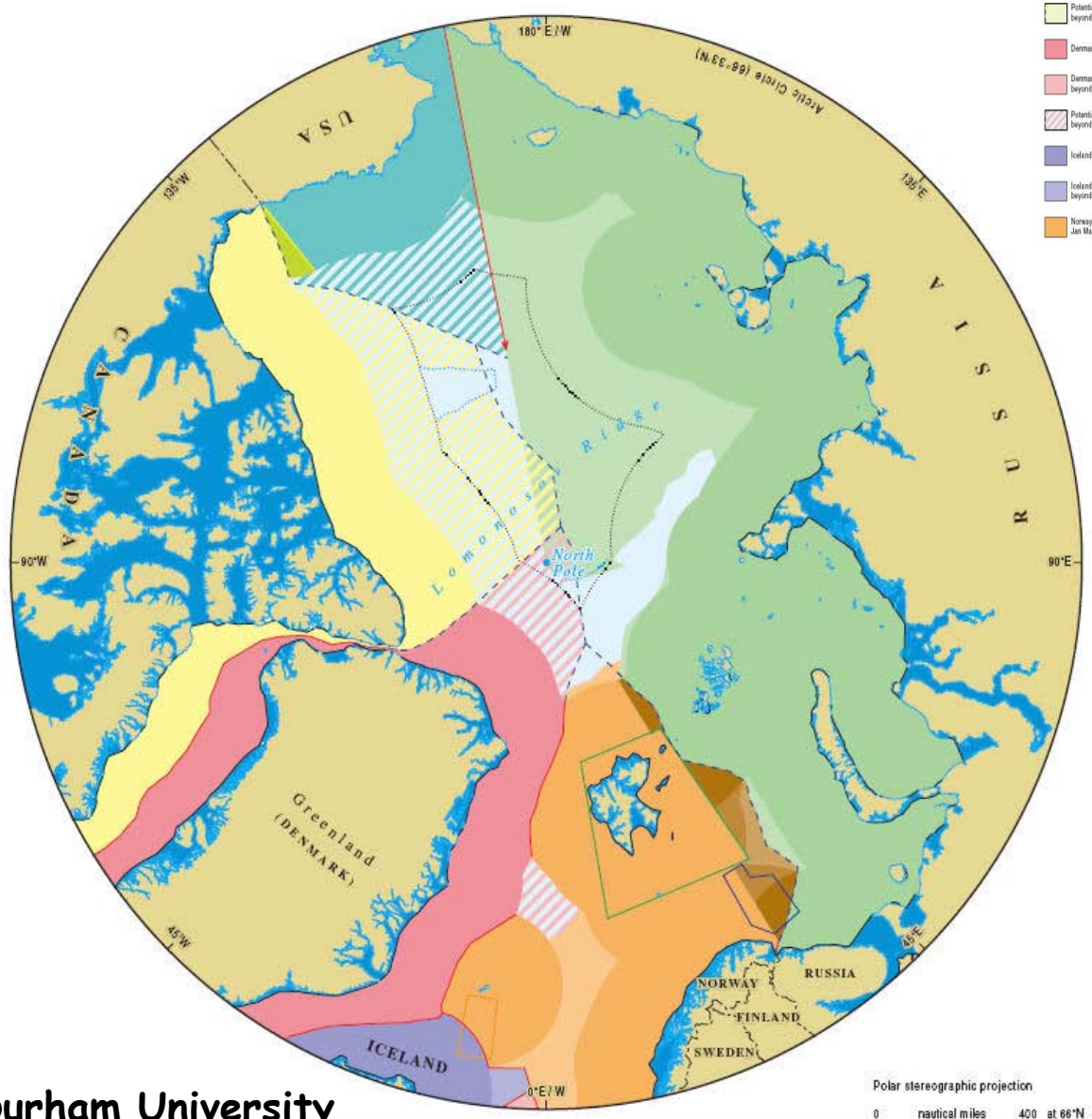


From Ron McNab

IBRU International Boundaries Research Unit

Durham University

Maritime jurisdiction and boundaries in the Arctic region



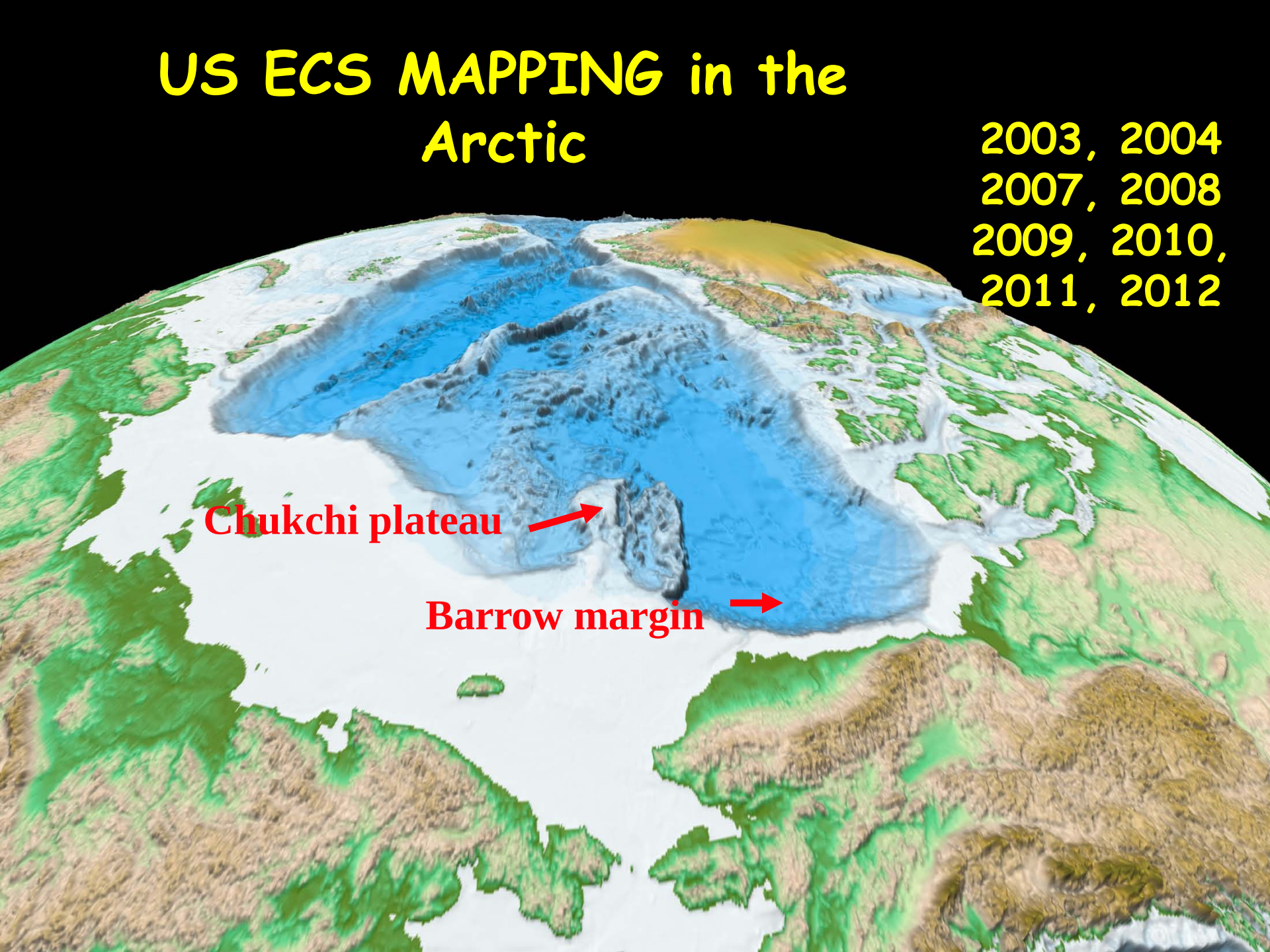
Internal waters
Canada territorial sea and EEZ
Potential Canada continental shelf beyond 200 nm (note 1)
Denmark territorial sea and EEZ
Denmark claimed continental shelf beyond 200 nm (note 2)
Potential Denmark continental shelf beyond 200 nm (note 1)
Iceland EEZ
Iceland claimed continental shelf beyond 200 nm (note 2)
Norway territorial sea and EEZ / Fishery zone Jan Mayen) / Fishery protection zone (Svalbard)
Norway claimed continental shelf beyond 200 nm (note 3)
Russia territorial sea and EEZ
Russia claimed continental shelf beyond 200 nm (note 4)
Overlapping Norway / Russia EEZ (note 5)
Overlapping Norway EEZ / Russia claimed continental shelf beyond 200 nm (note 5)
Overlapping Norway / Russia claimed continental shelf beyond 200 nm (note 5)
USA territorial sea and EEZ
Potential USA continental shelf beyond 200 nm (note 1)
Overlapping Canada / USA EEZ (note 6)
Straight baselines
Agreed boundary
Median line
350 nm from baselines
100 nm from 2500 m isobath (beyond 350 nm from baselines)
Svalbard treaty area (note 7)
Iceland - Norway joint zone (note 5)
Norway - Russia 'Grey Area' (agreed fishing regime)
Canada EEZ boundary claim (note 6)
Eastern Special Area (note 8)

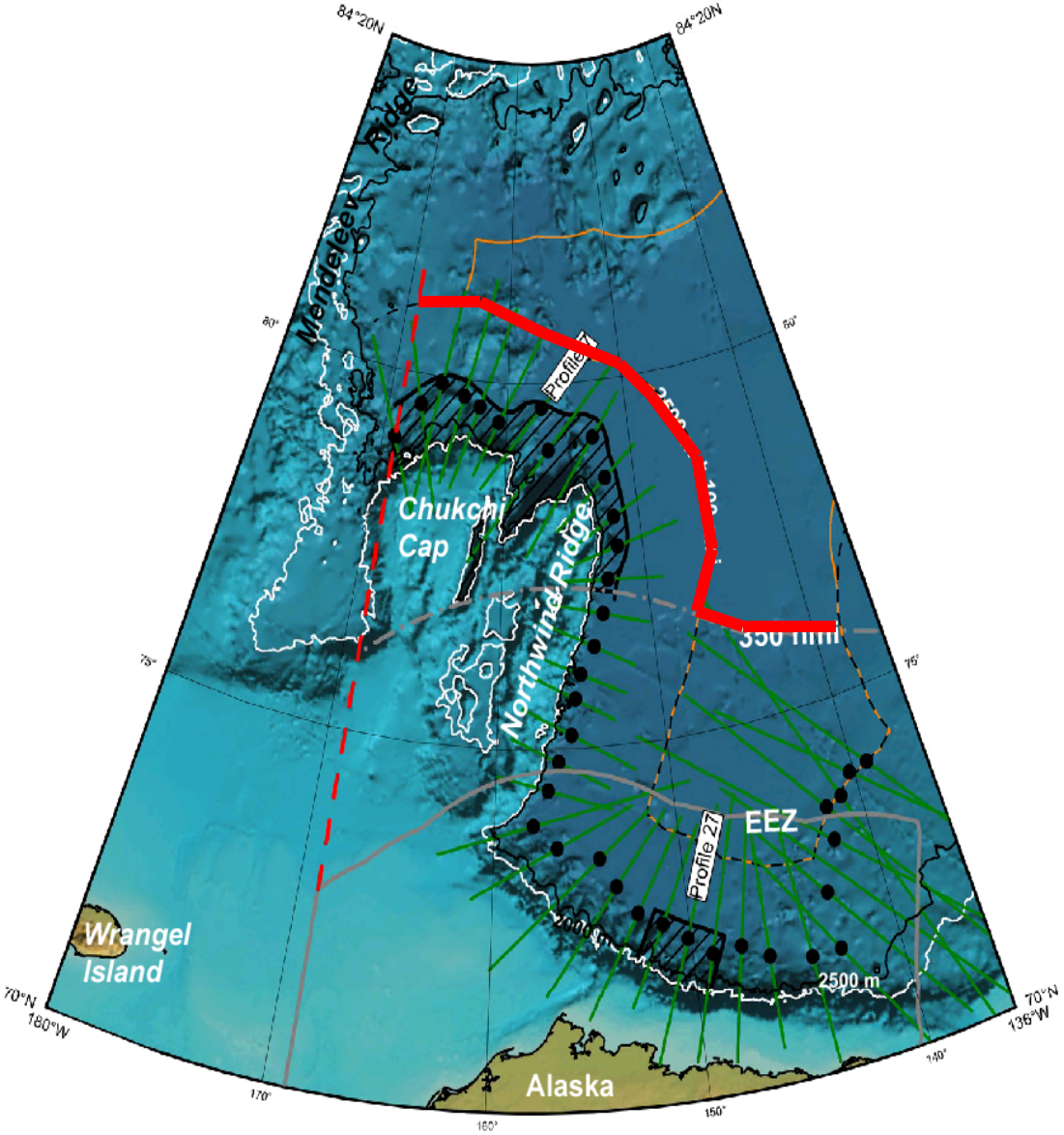
www.durham.ac.uk/ibru

From Durham University

US ECS MAPPING in the Arctic

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



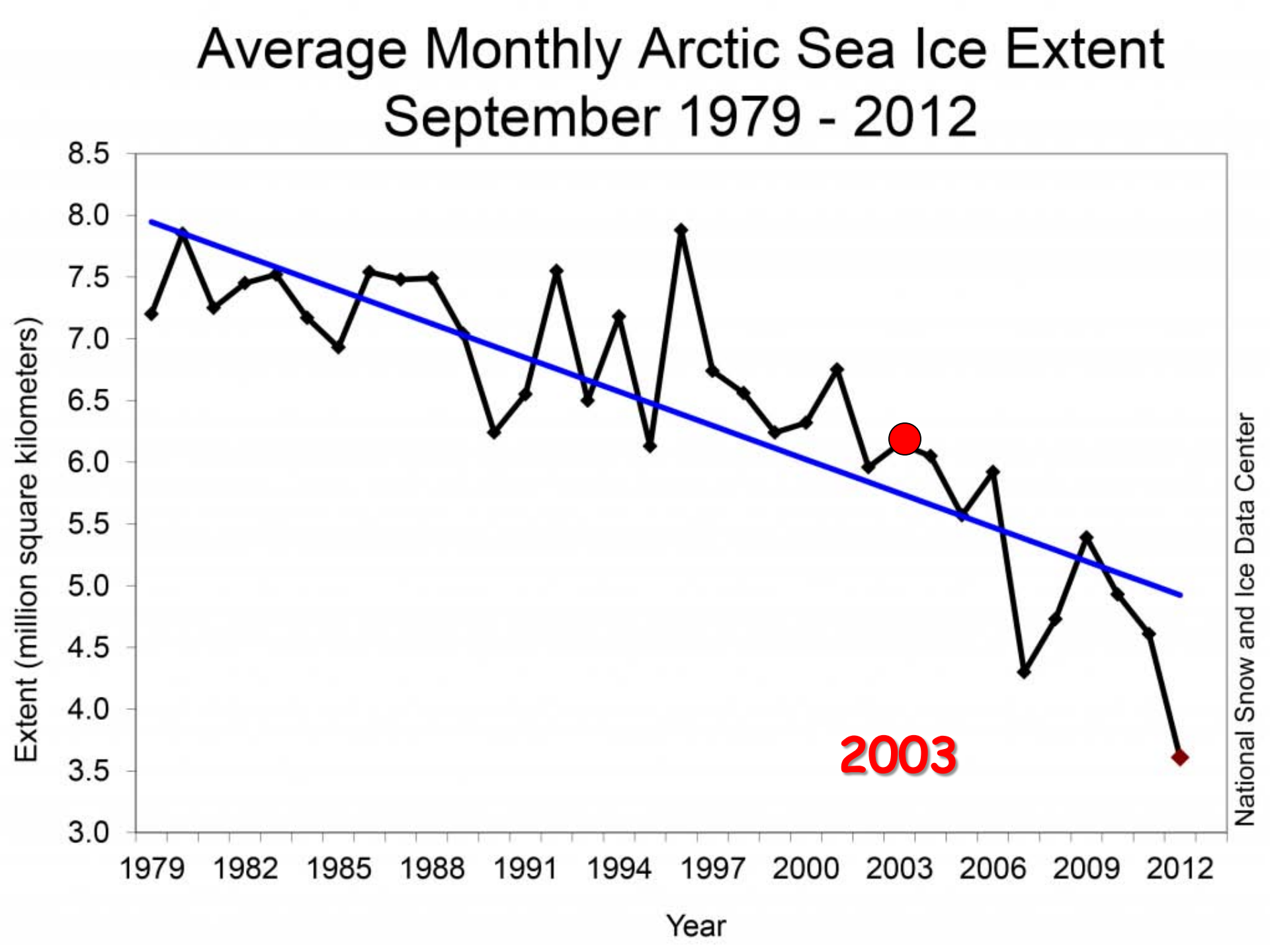


5.10B. Bathymetry from IBCAO in detailed area ARC, drawn bathymetric profiles, and possible locations of the FOS. Labeled profile is shown in figure 5.11. Note that the orange line, which represents the 2500 m + 100 nm, makes use of the 2500 m contour of the Alpha-Mendeleev Ridge as well as the Canadian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

USCGC *Healy*

Length, Overall =128 meters
Beam = 25 m
Propulsion = Diesel/Electric
Displacement = 16,000 LT
Shaft HP = 30,000 HP
Props = 2 fixed pitch
Cruising Speed = 12 knots.
Max Speed – 17 knts
Fuel Cap = 4.62 M liters
Icebreaking = 1.4 m continuous, 2.44 m backing and ramming
Accommodations = 19 Officer, 12 CPO, 54 enlisted, 35 (+15) scientists

2001-2009 – Seabeam 2112 2x2 deg 12 kHz MBES
Now – Kongsberg EM122 – 1x1 deg 12 kHz MBES

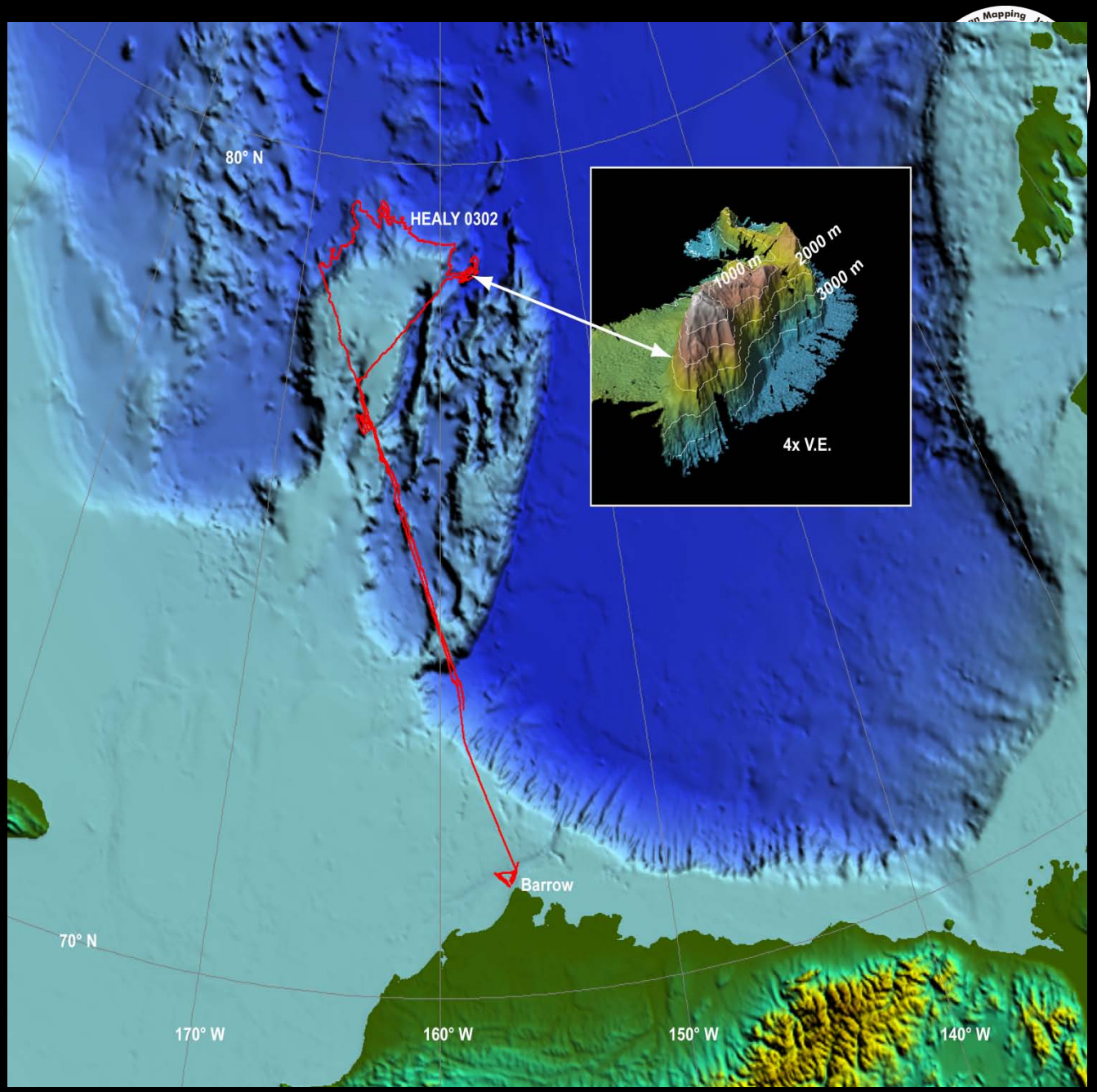

Average Monthly Arctic Sea Ice Extent
September 1979 - 2012
Extent (million square kilometers)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
Year
2003
National Snow and Ice Data Center

Healy 03-02

~3000 km of multibeam sonar bathymetry

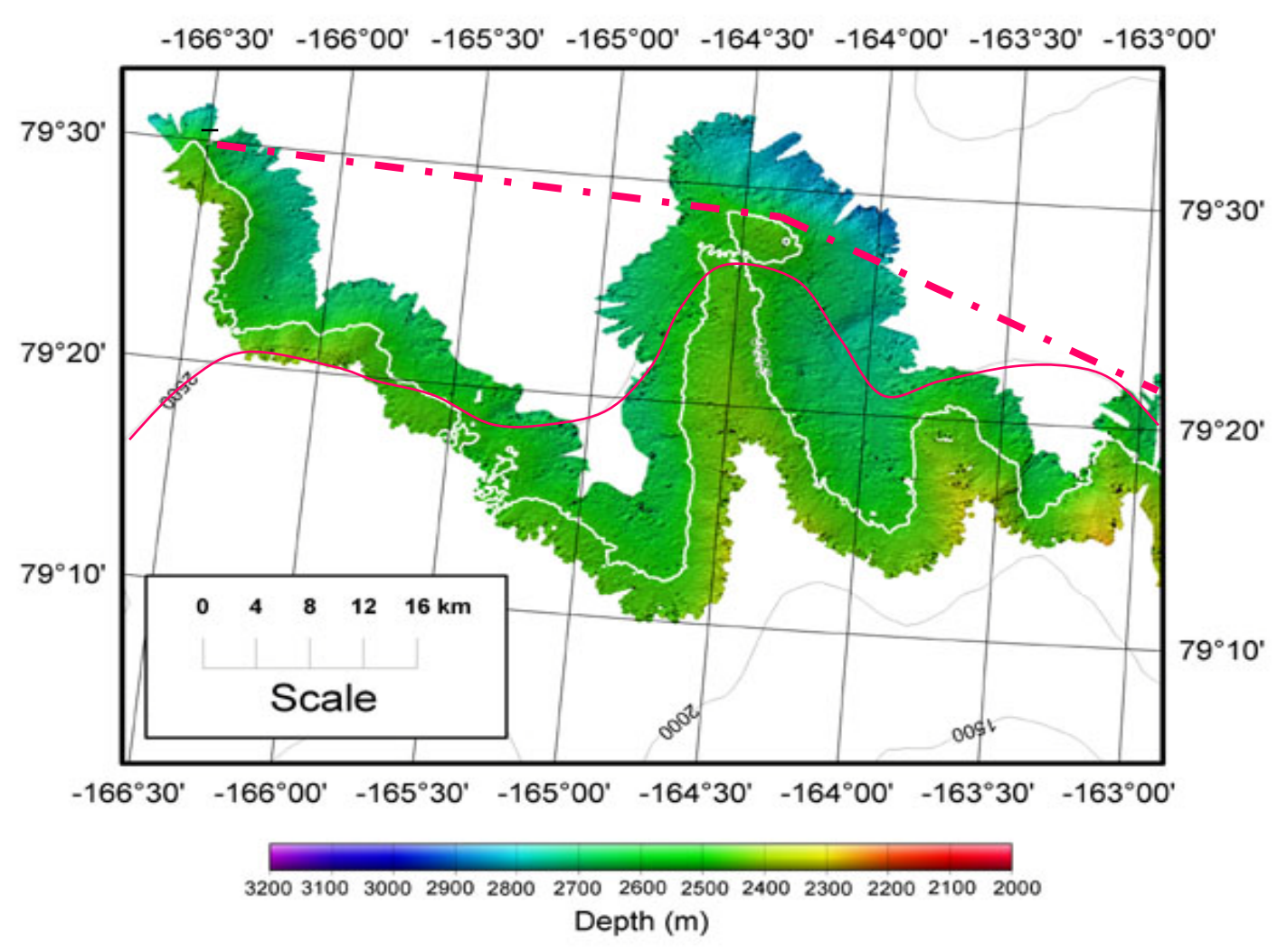
1-11 Sept 03

8/10 ice

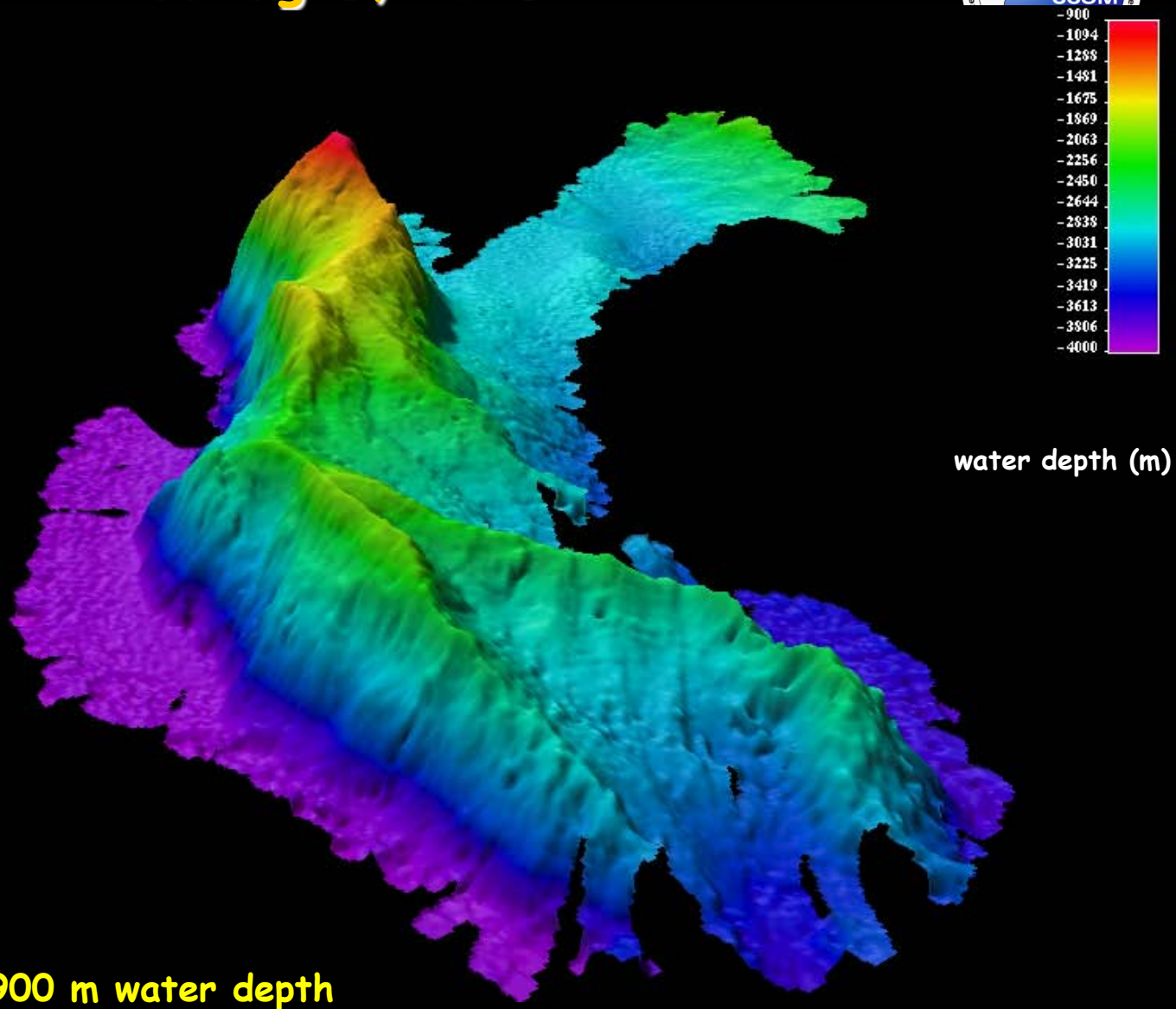



typical ice conditions
2003
8/10 “cheesy” ice

Redefinition of the 2500 m contour

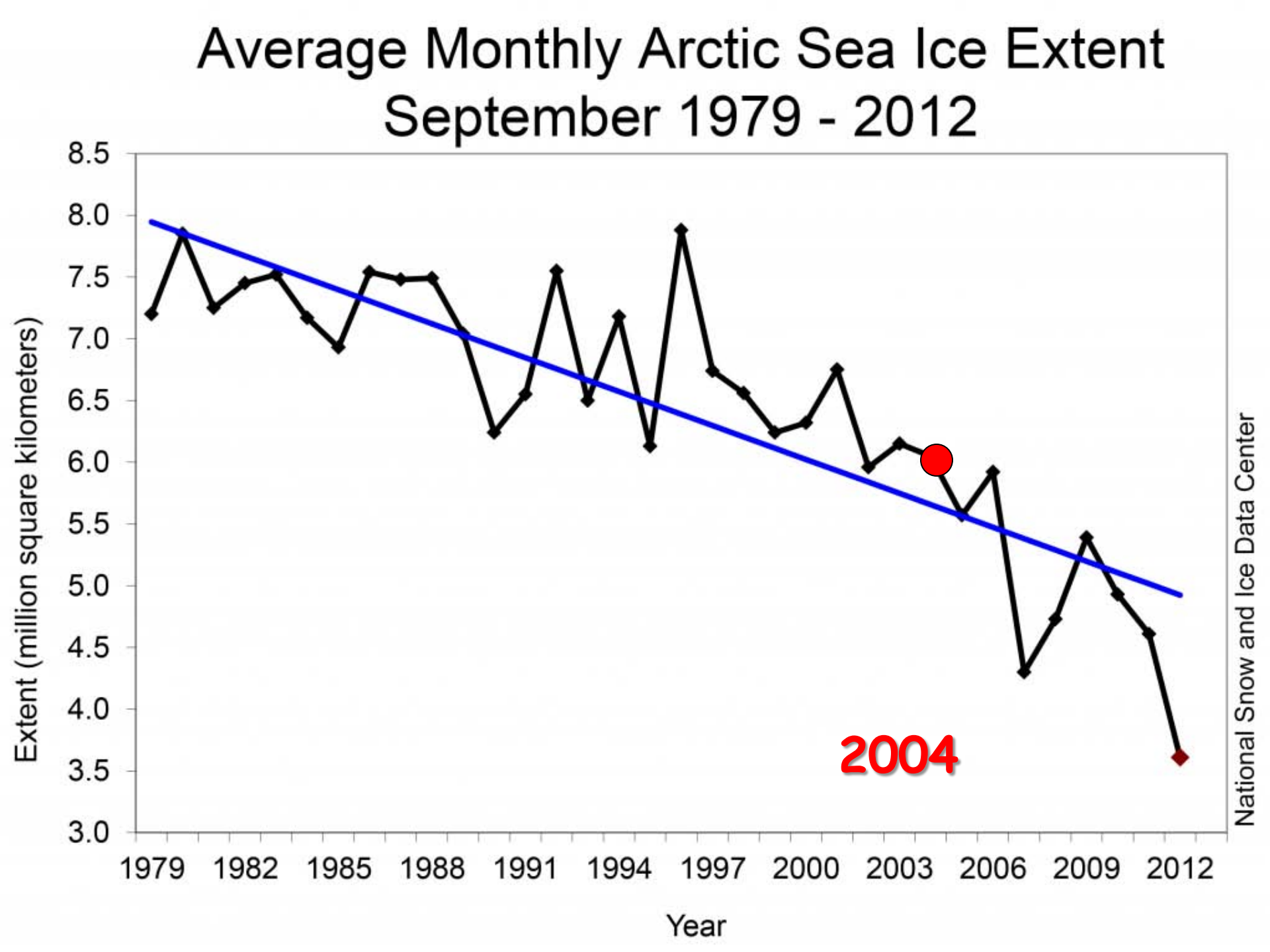


Healy Seamount
looking S, ve=6x



3100 m high, summit at 900 m water depth

45 km long x 15 km wide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4.0
3.5
3.0
1979
1982
1985
1988
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1994
1997
2000
2003
2006
2009
2012
Year
2004
National Snow and Ice Data Center

Photo from M. Jakobsson

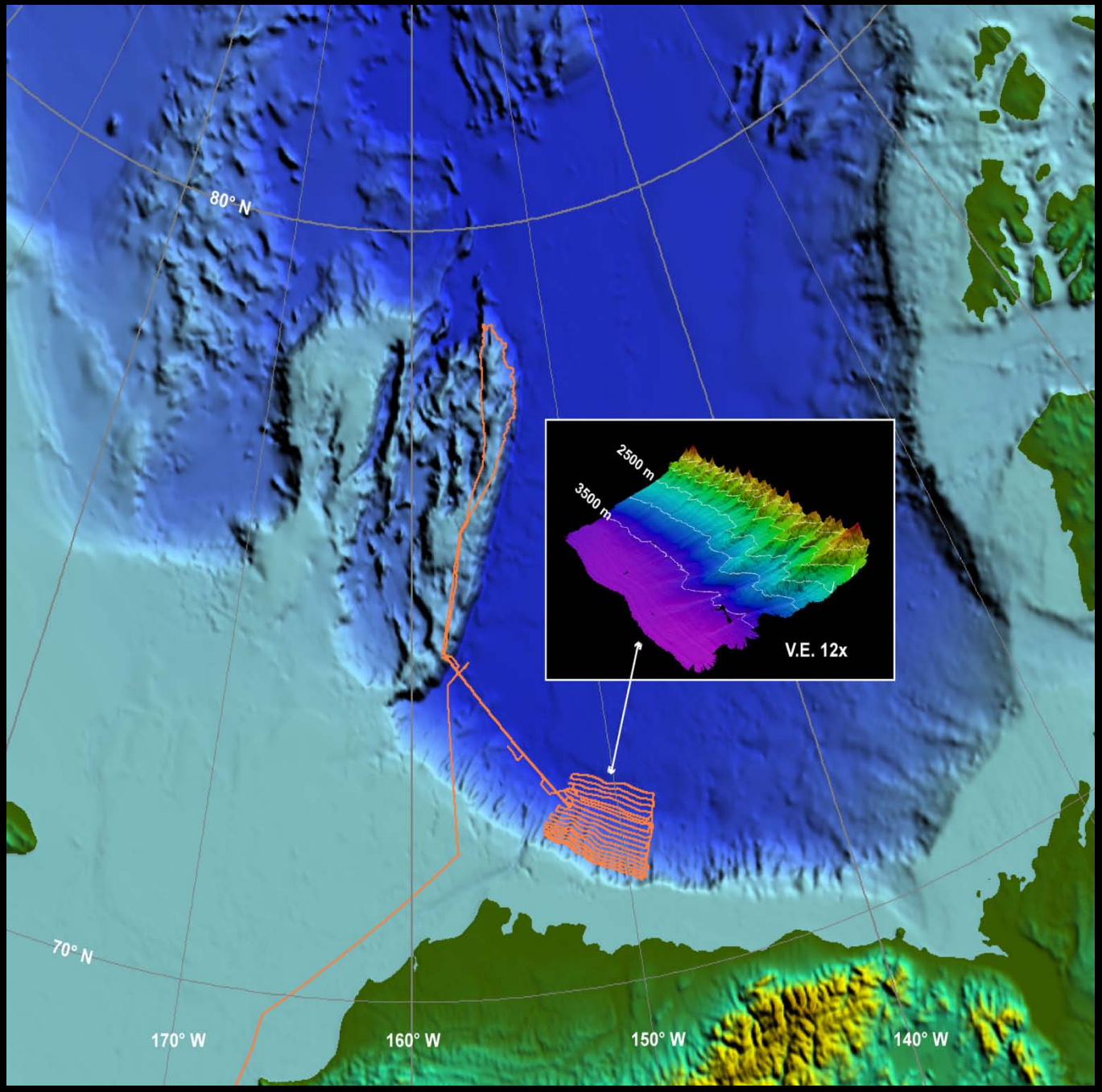
HEALY 04-05 TRACK

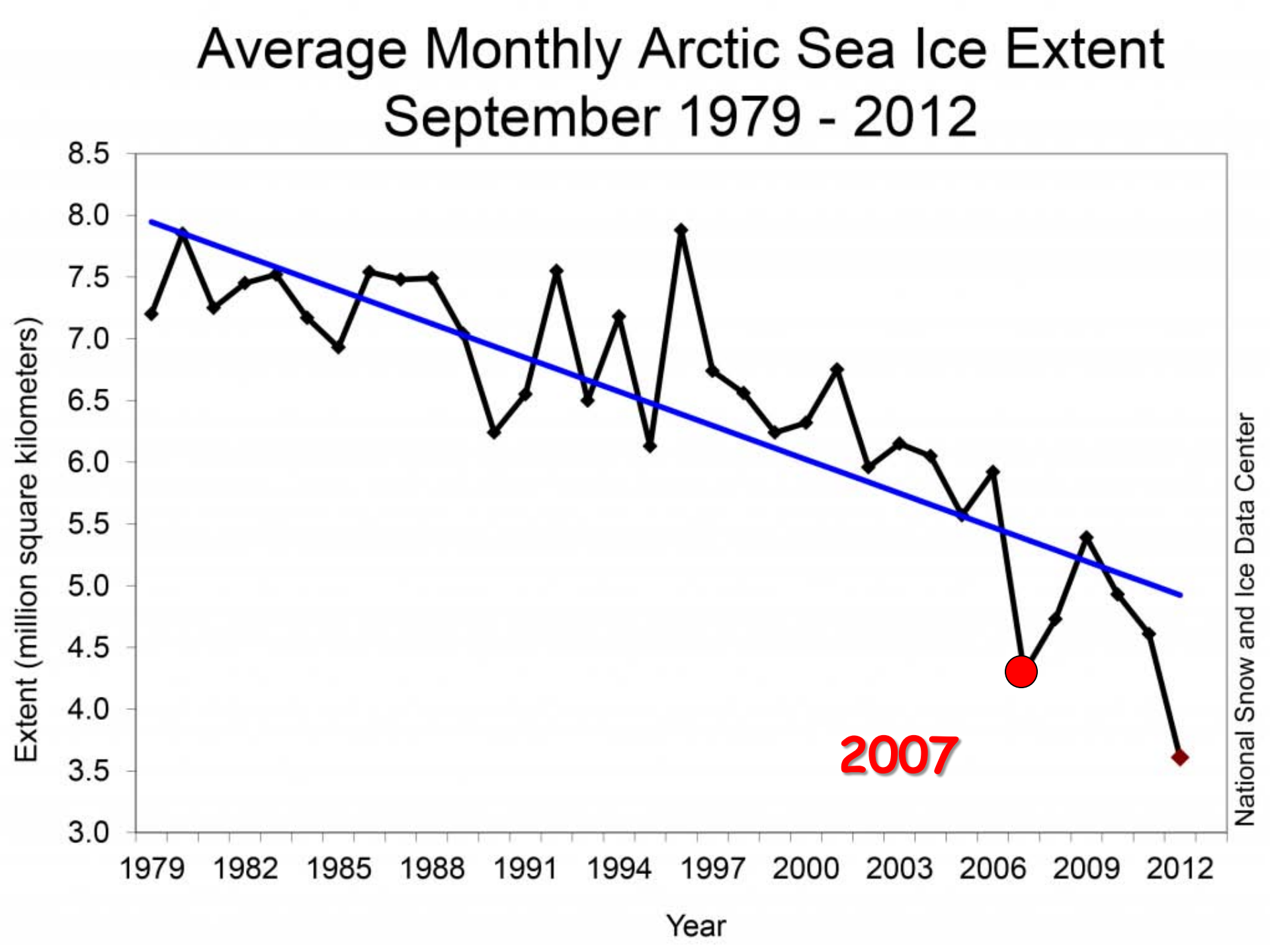
6-26 Oct. 2004

6700 line km

"Ratchet Surveying"

"Pirouette Surveying"

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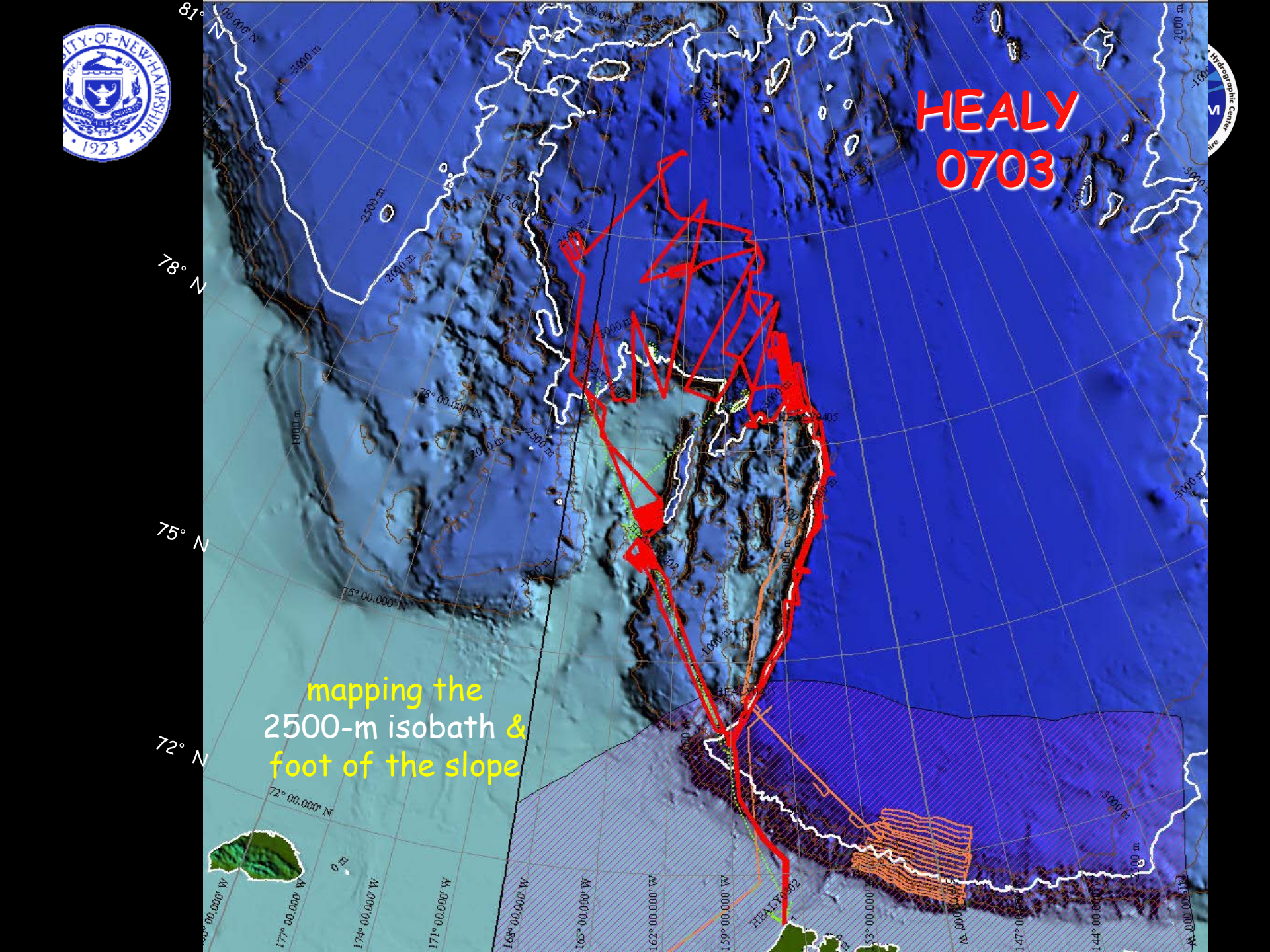
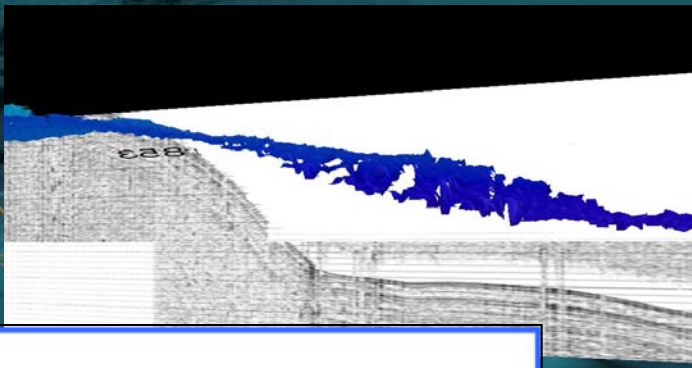
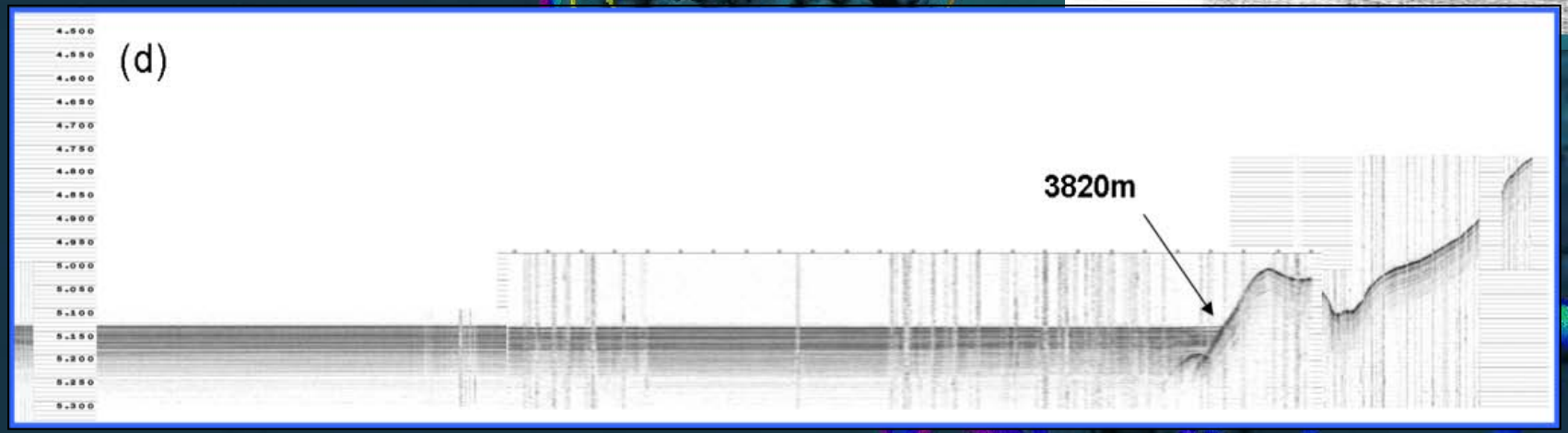
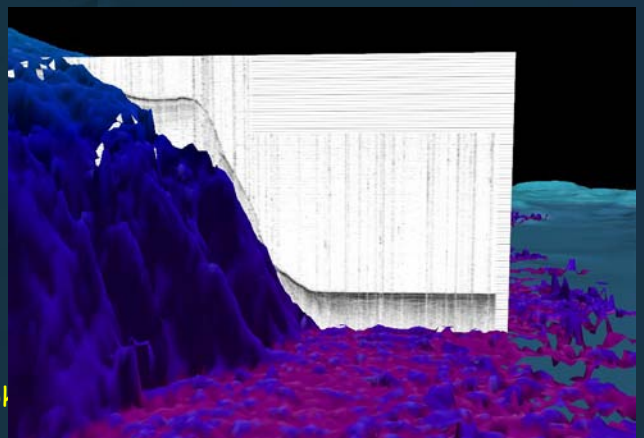
2012
Year
2007
National Snow and Ice Data Center


HEALY
0703
mapping the
2500-m isobath &
foot of the slope
81° N
78° N
75° N
72° N

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



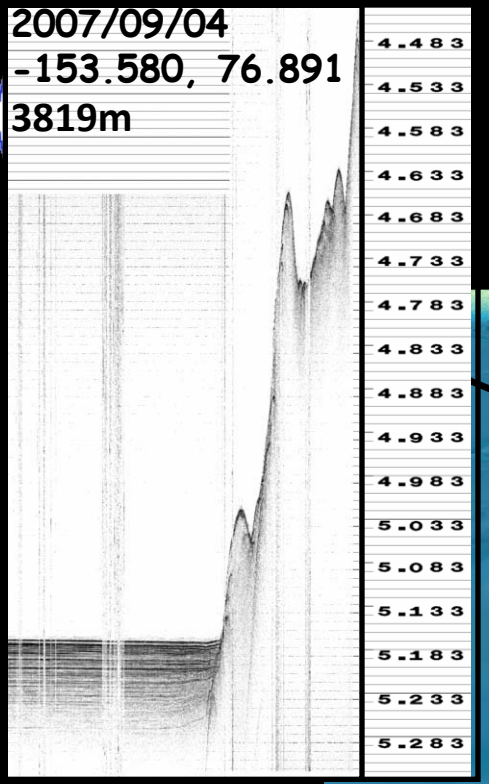


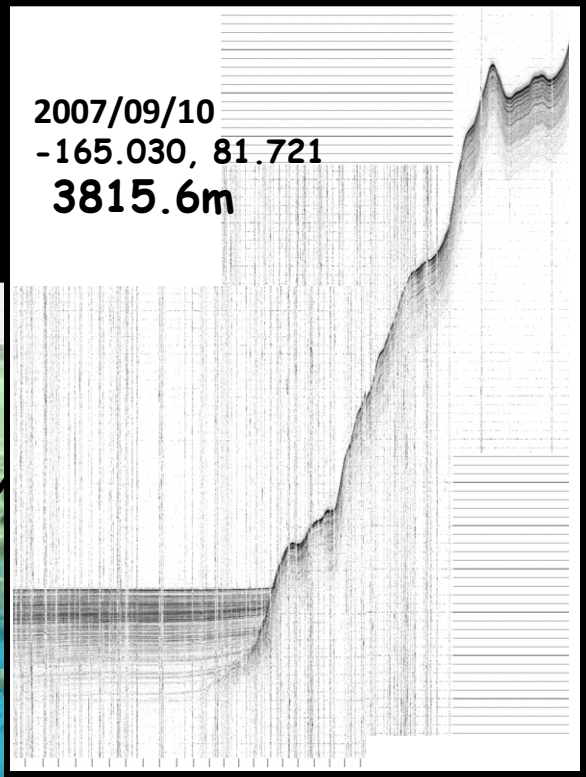


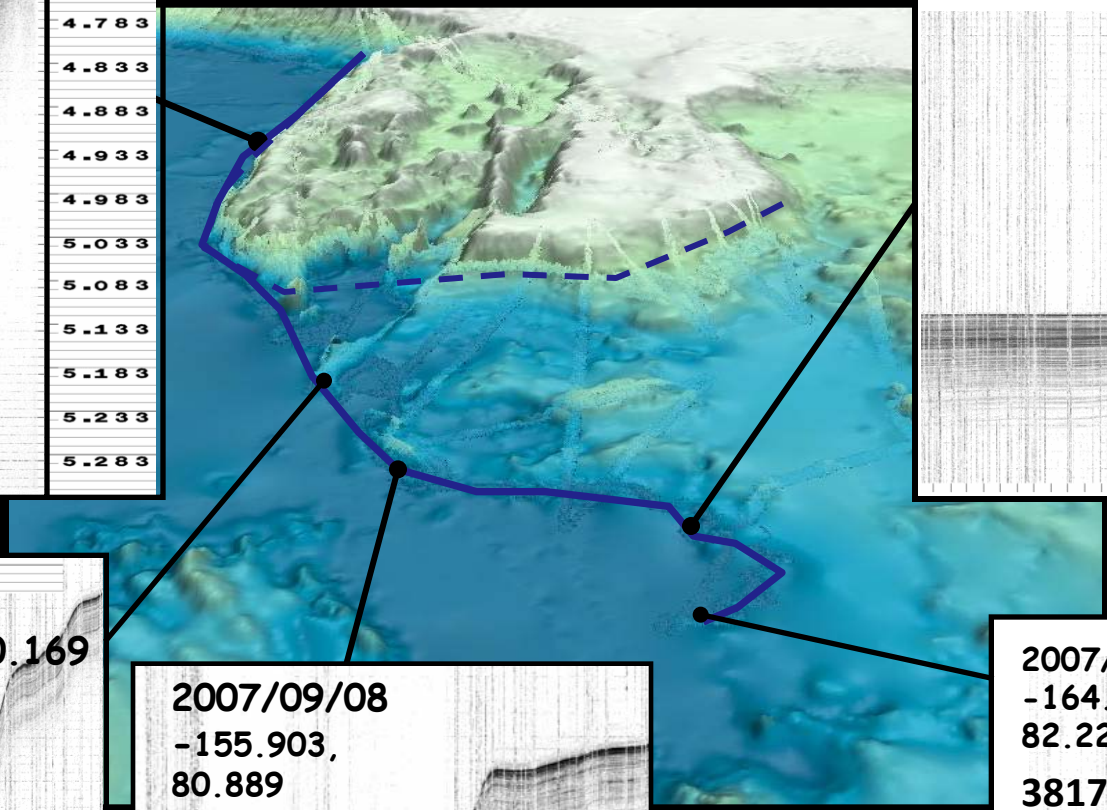
Where we now think it is

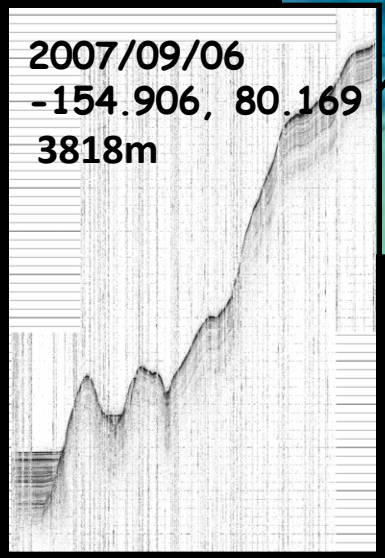
perspective view look

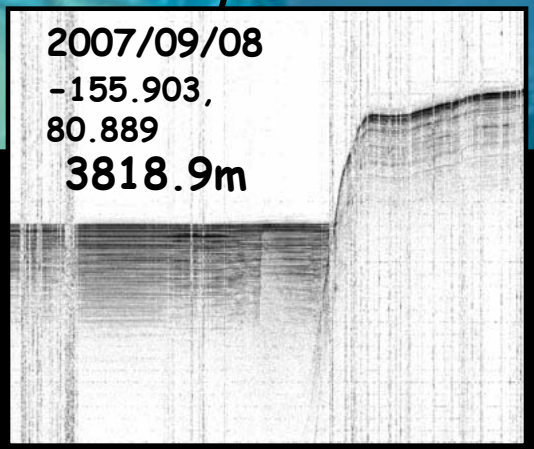
The "Foot of the Slope"

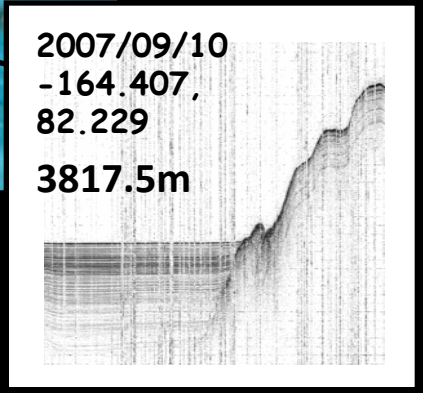






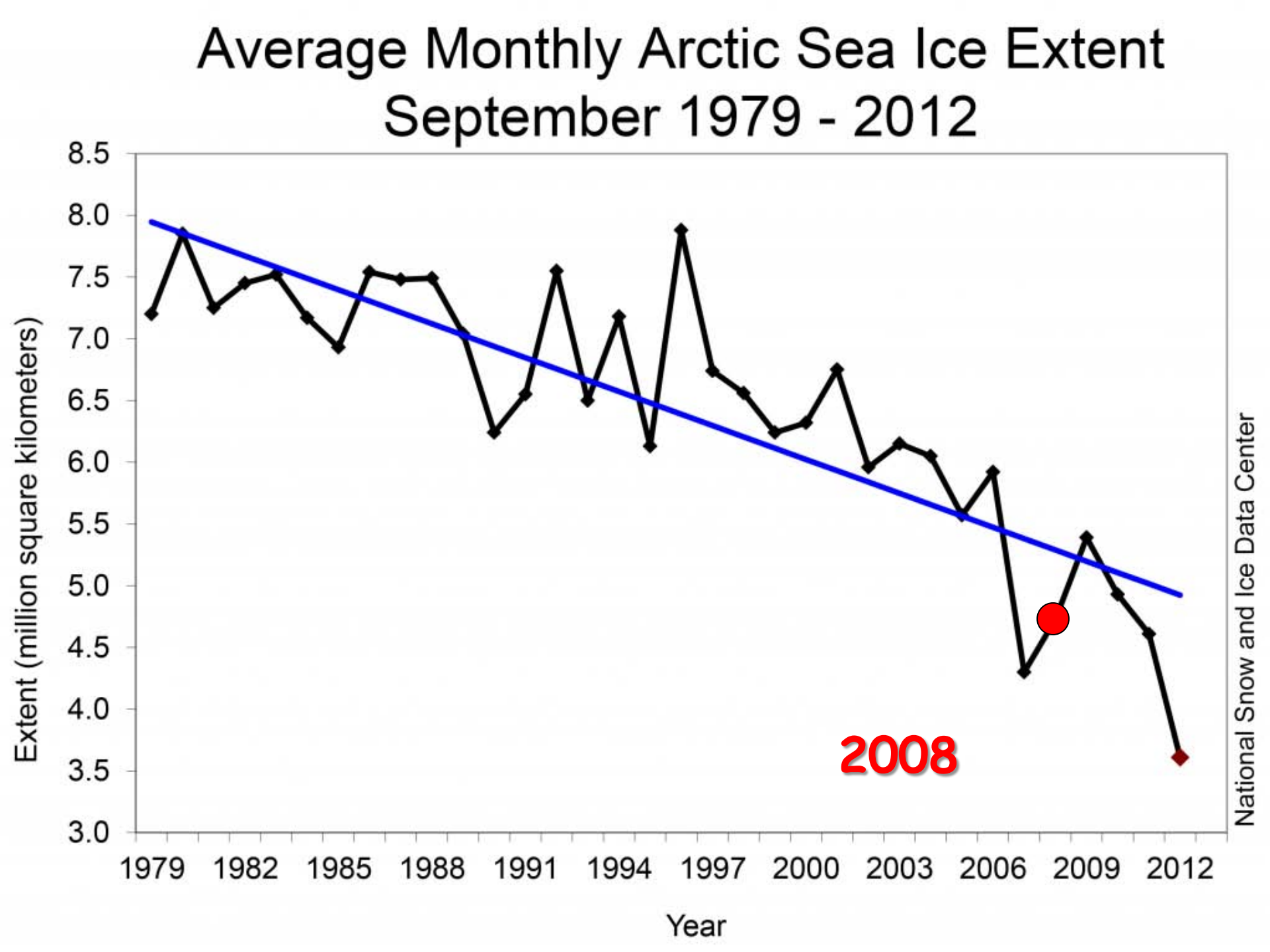






(From Brumley, 2009)

2008-2011– JOINT CANADIAN/U.S. PROGRAMS – FOCUS ON SEISMIC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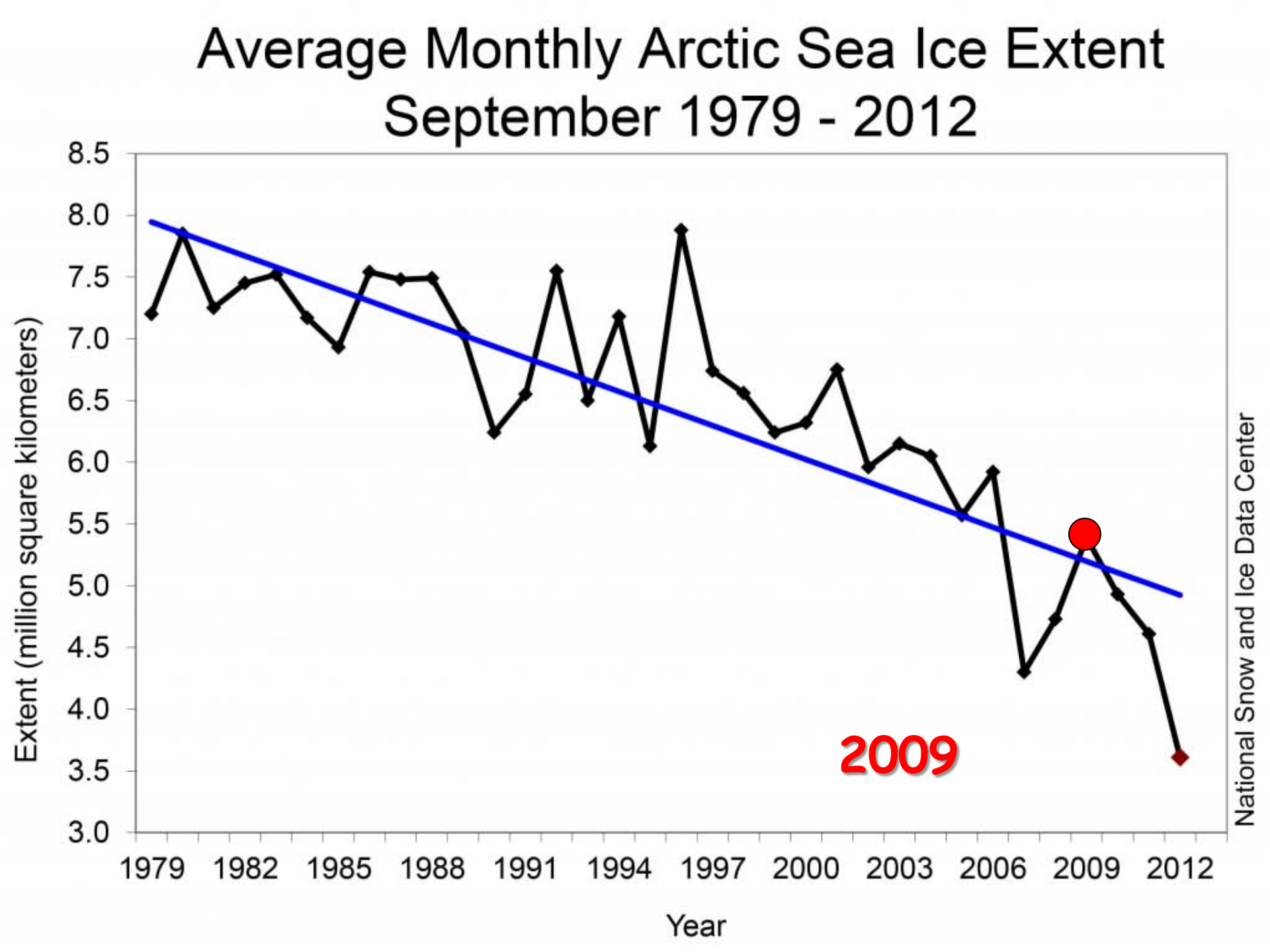
National Snow and Ice Data Center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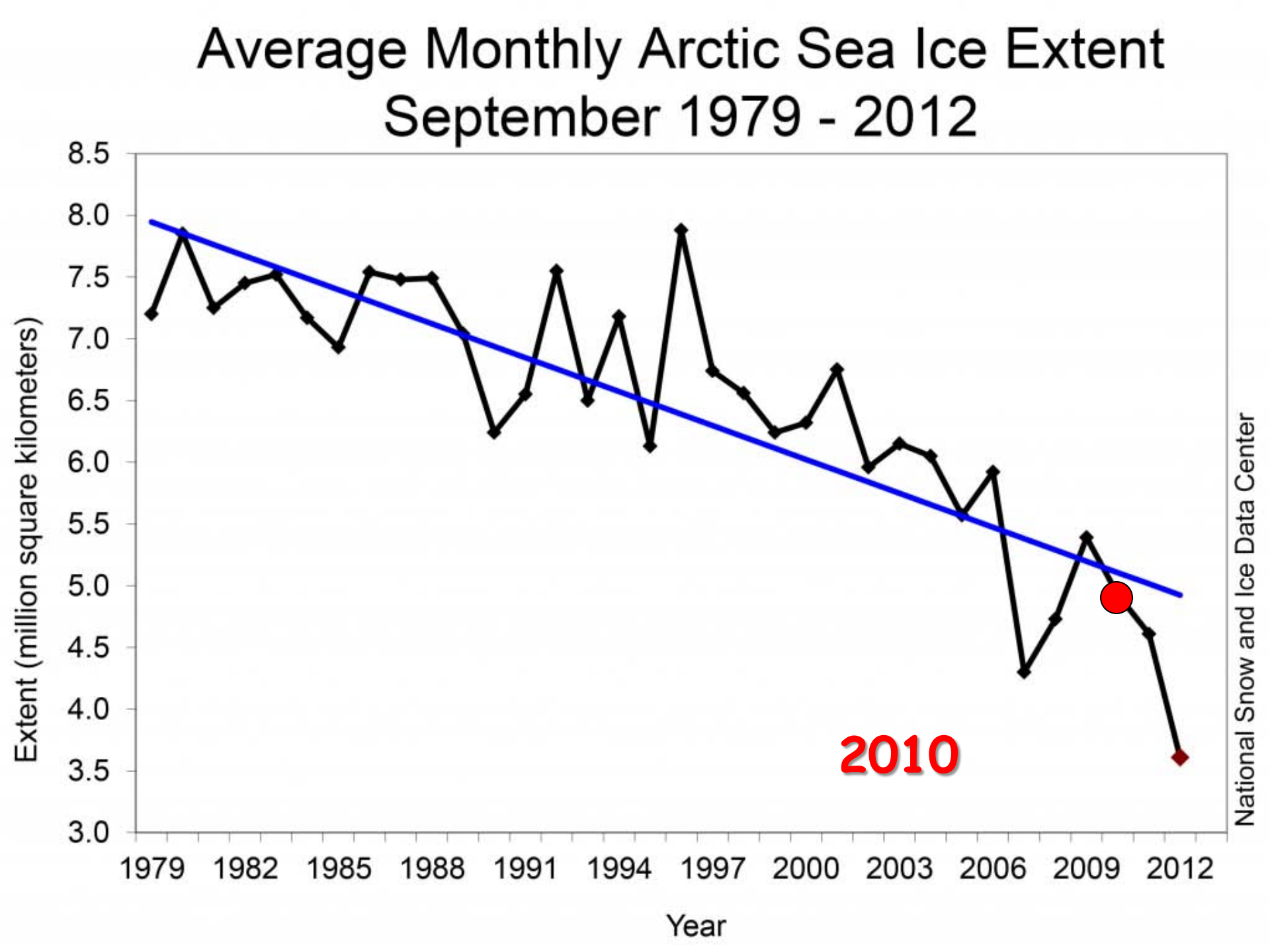
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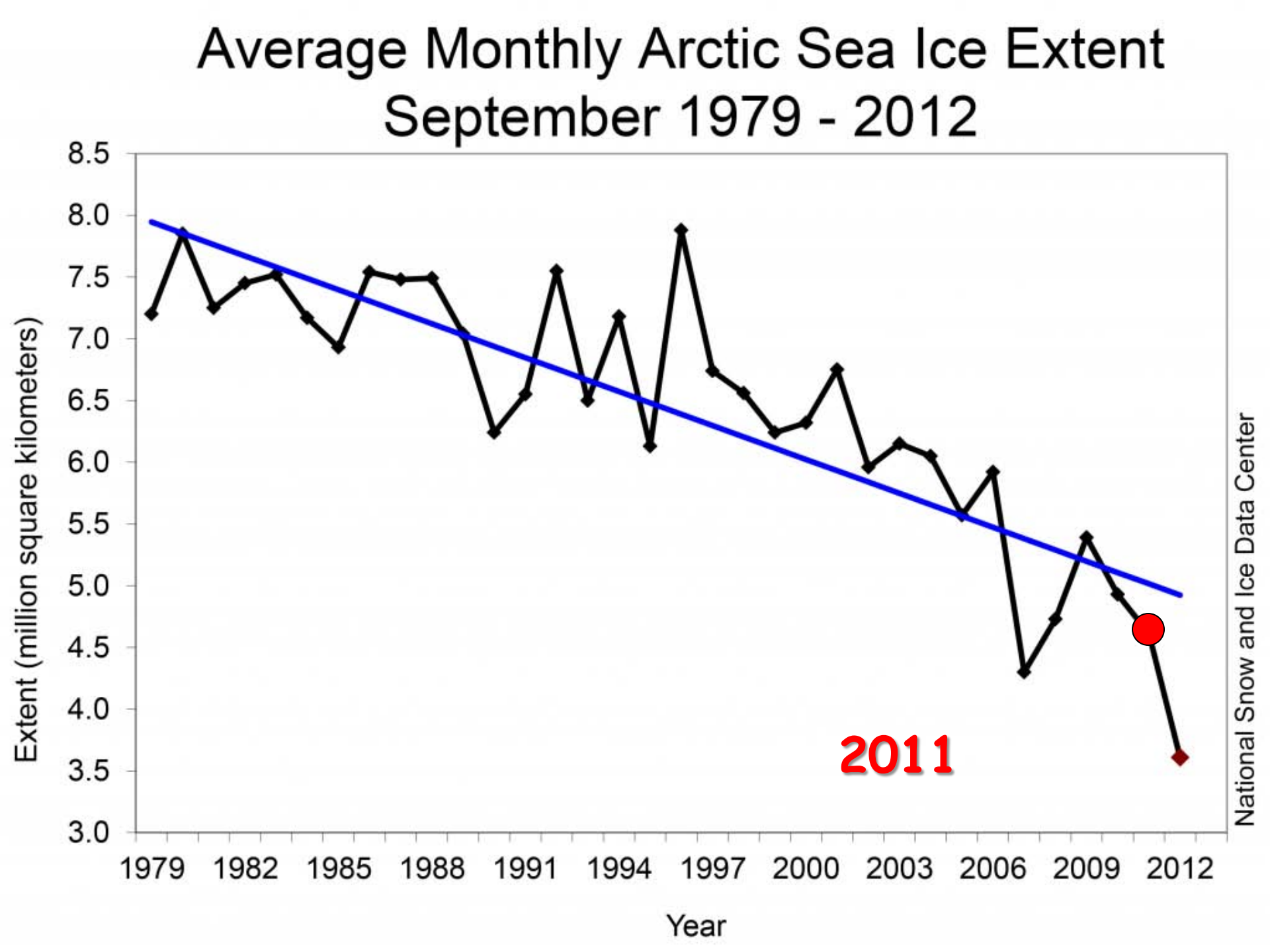
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2003
2006
2009
2012
Year
2011
National Snow and Ice Data Center

HEALY- 1102

15 Aug – 28 Sept 2011

ECS data 9,188 km bathy

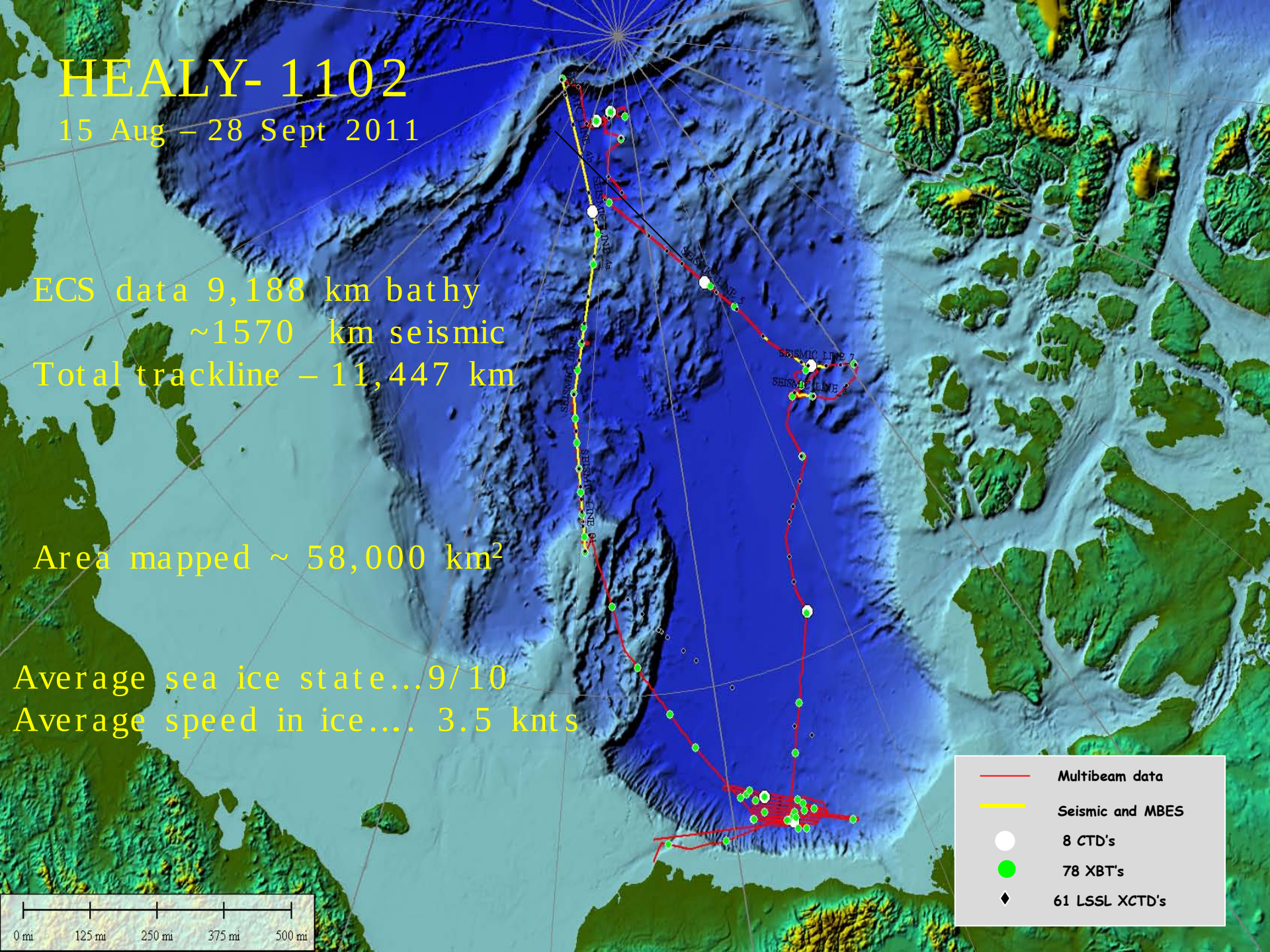
~1570 km seismic

Total trackline – 11,447 km

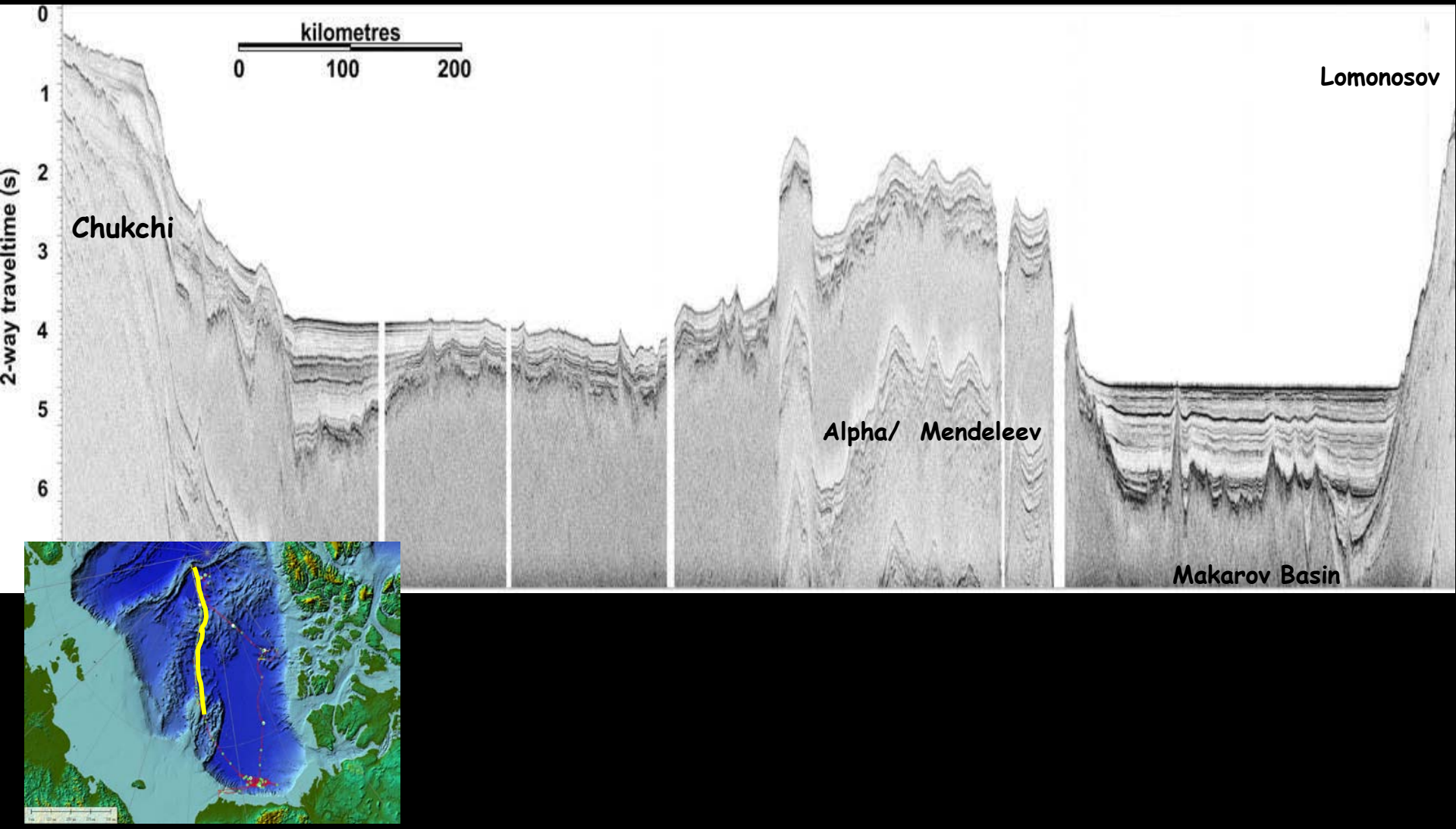
Area mapped ~ 58,000 km^2

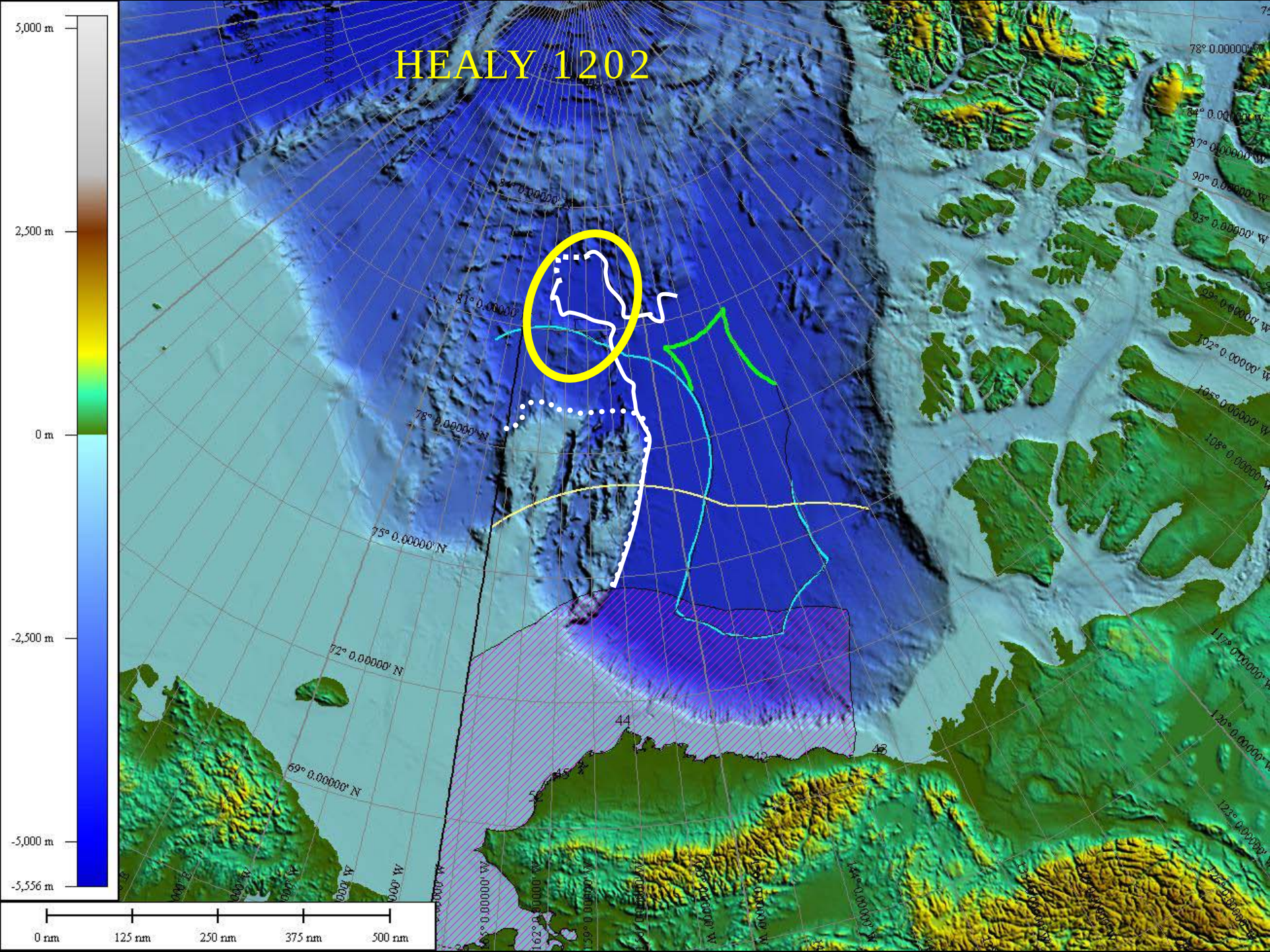
Average sea ice state...9/10

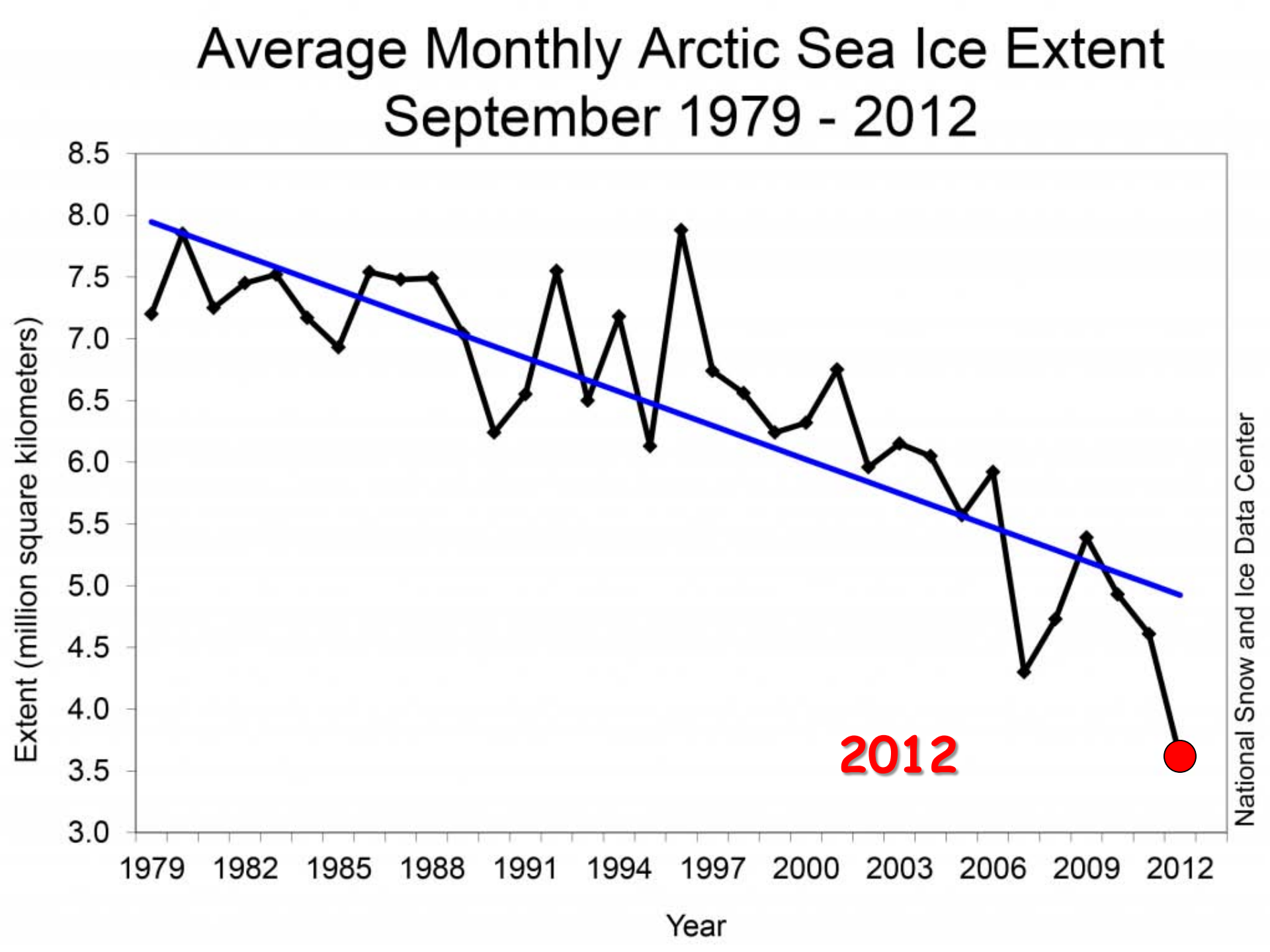
Average speed in ice.... 3.5 knts



LSSL Monitor Records




HEALY 1202
5,000 m
2,500 m
0 m
-2,500 m
-5,000 m
-5,556 m
0 nm
125 nm
250 nm
375 nm
500 nm


Average Monthly Arctic Sea Ice Extent
September 1979 - 2012
Extent (million square kilometers)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
Year
2012
National Snow and Ice Data Center

Long/Lat.: -156.072055 W, 80.293353 N

2007 (9-6-2007)

Long/Lat.: -156.072055 W, 80.293353 N

2012 (9-12-2012)

HEALY 1202 DREDGE SITES

80 N

HLY1202_DR1

volcanoclastic?

HLY1202_DR2

coral

altered basalt

metasediment

HLY1202_DR3

schist

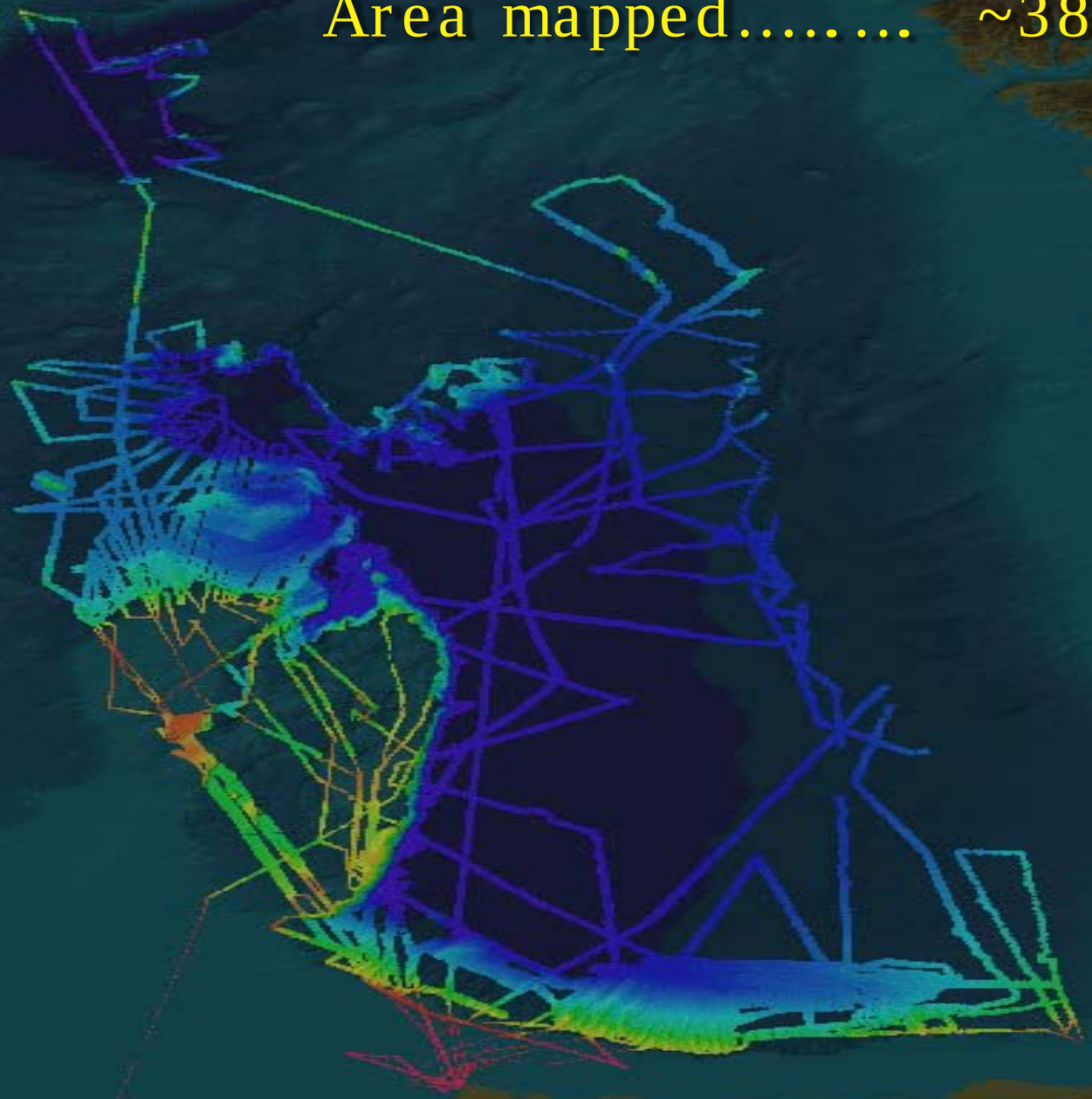
HLY1202_DR4

schist

HLY1202_

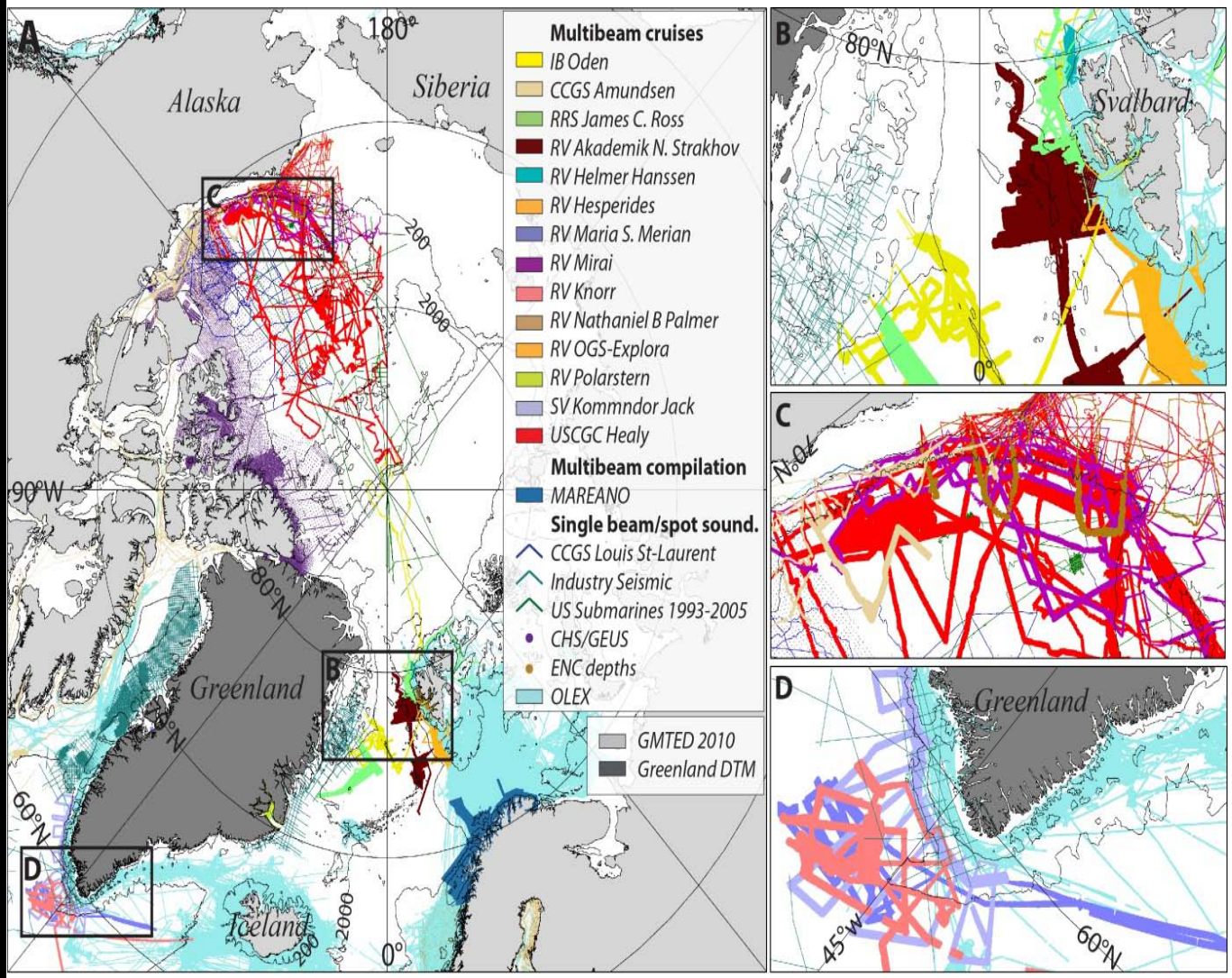
0 nm 25 nm 50 nm 75 nm 125 nm

Area mapped..... ~389,000 km^2

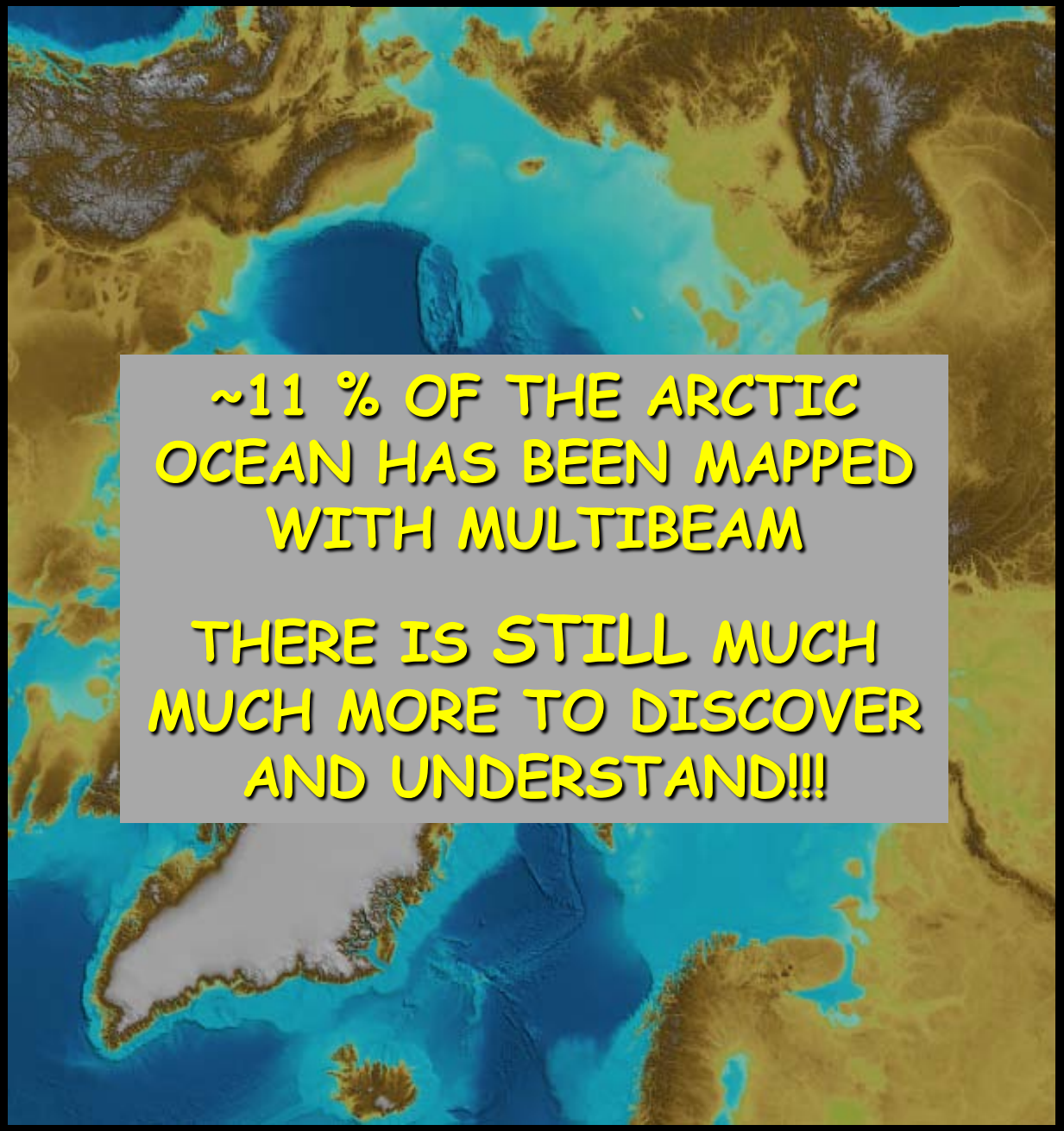


US ECS Arctic Mapping 2003,2004,2007,2008,2009, 2010, 2011. 2012

SINCE IBCAO 2008



IBCAO VER 3.0



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

THERE IS STILL MUCH MUCH MORE TO DISCOVER AND UNDERSTAND!!!