



Challenges of Collecting Data for Article 76 in Ice Covered Waters of the Arctic

5th ABLOS Conference

Monaco

October 16, 2008

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|---------------------|---|---------|
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Outline



- Requirements UNCLOS
- Challenges
 - Remoteness
 - Weather
 - Existing Data
 - Survey Seasons
 - Ice
 - Costs
- Operational Experience
- Future Plans and Conclusions

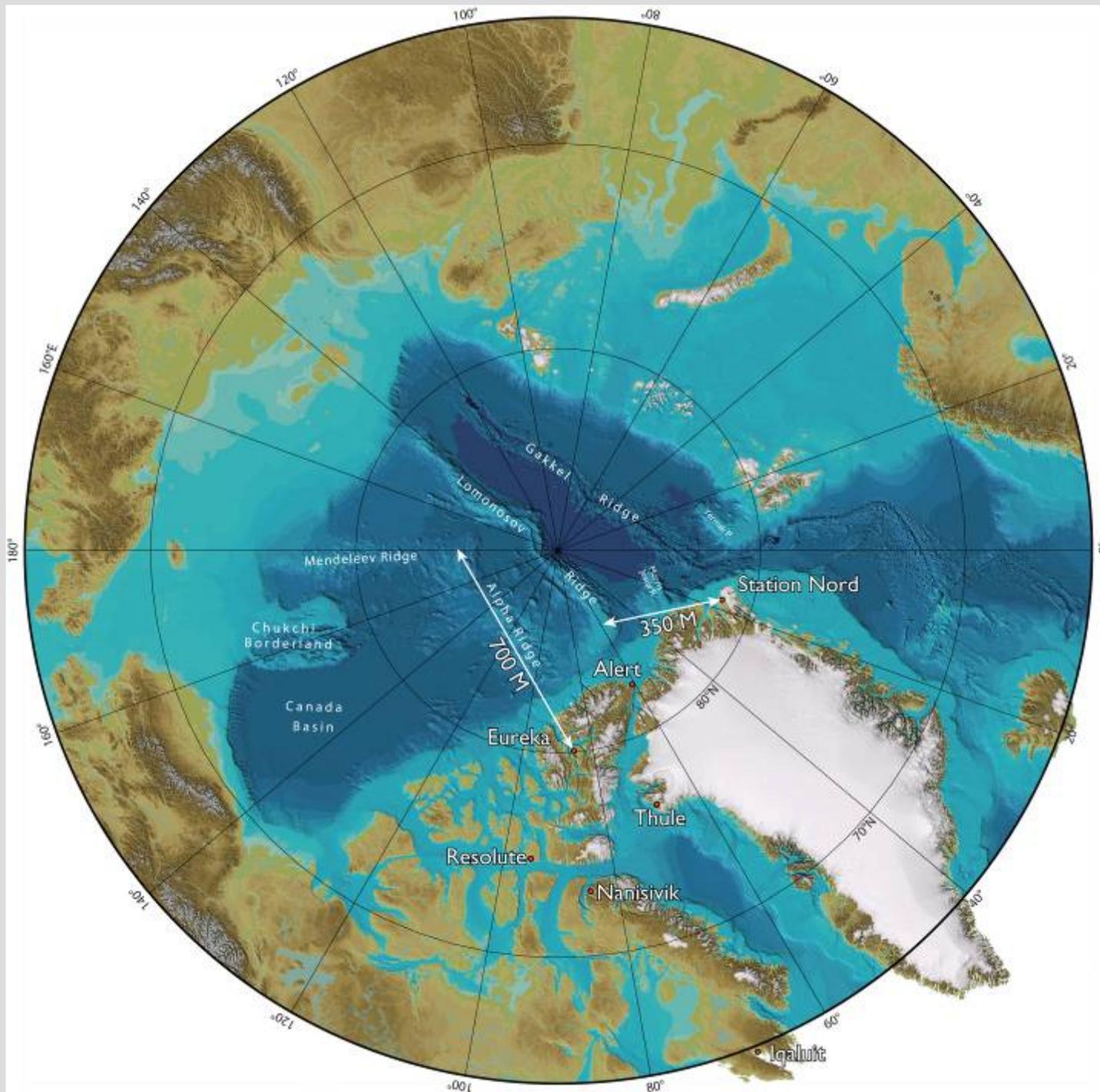
CLCS guidelines



- Ice-covered waters mentioned in 4.2.3 (bathymetry) and 8.2.19 (sediment thickness)
- 60 M maximum spacing requirement for acquisition of seismic data in 8.2.20 and 8.2.21



Remoteness



*IBCAO
Version 2.23*

Weather



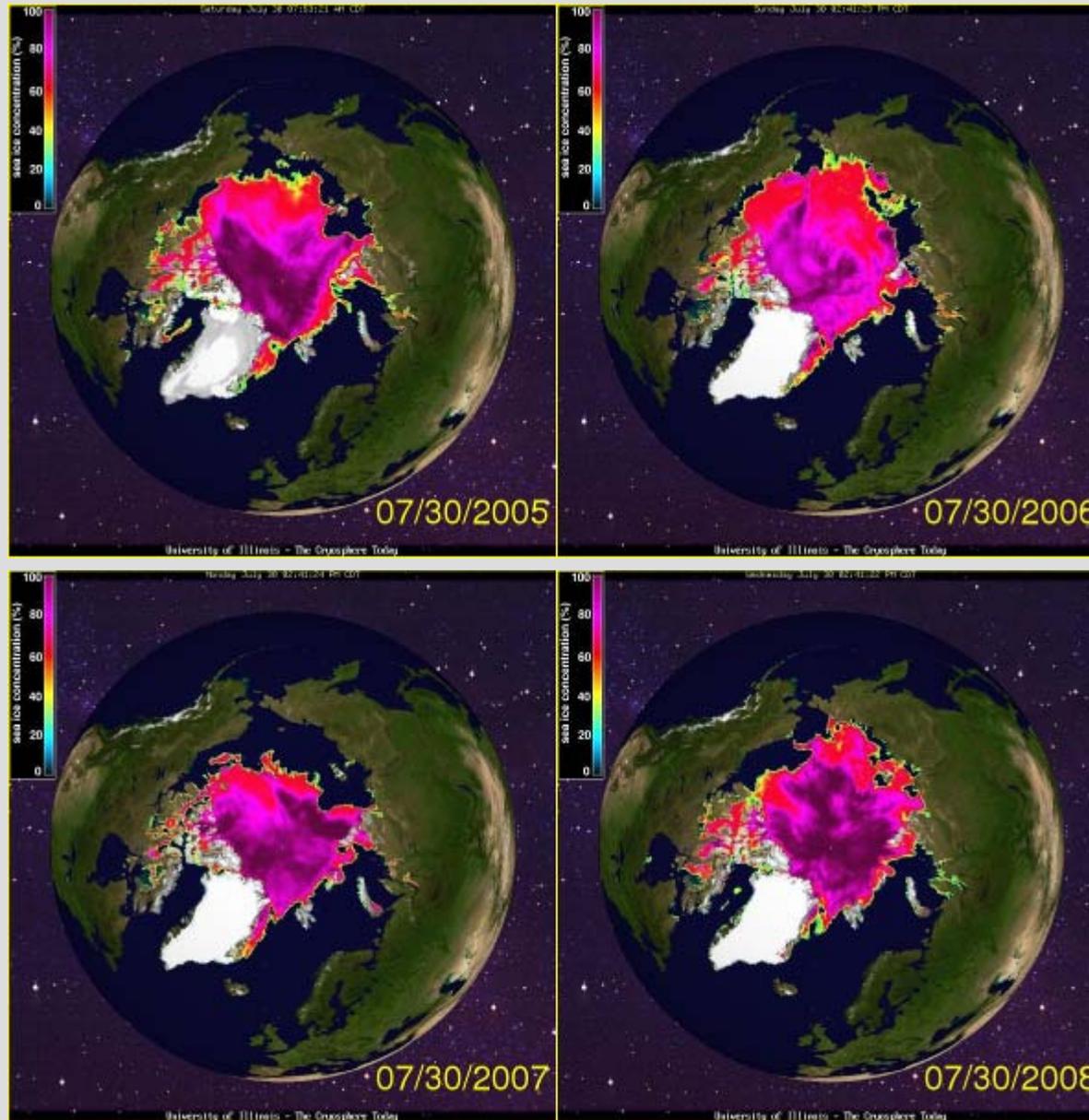
- Average Temperature - Alert
 - March - 32.4° C
 - April - 24.4° C
 - May - 11.8° C
 - June - 0.8° C
 - July 3.2° C
 - Aug 0.8° C
 - Sep - 9.2° C
 - Oct - 19.4° C
- Hours Daylight
 - Zero – October 15 to February 25
 - 24 hours April 7 – to September 5

Survey Seasons

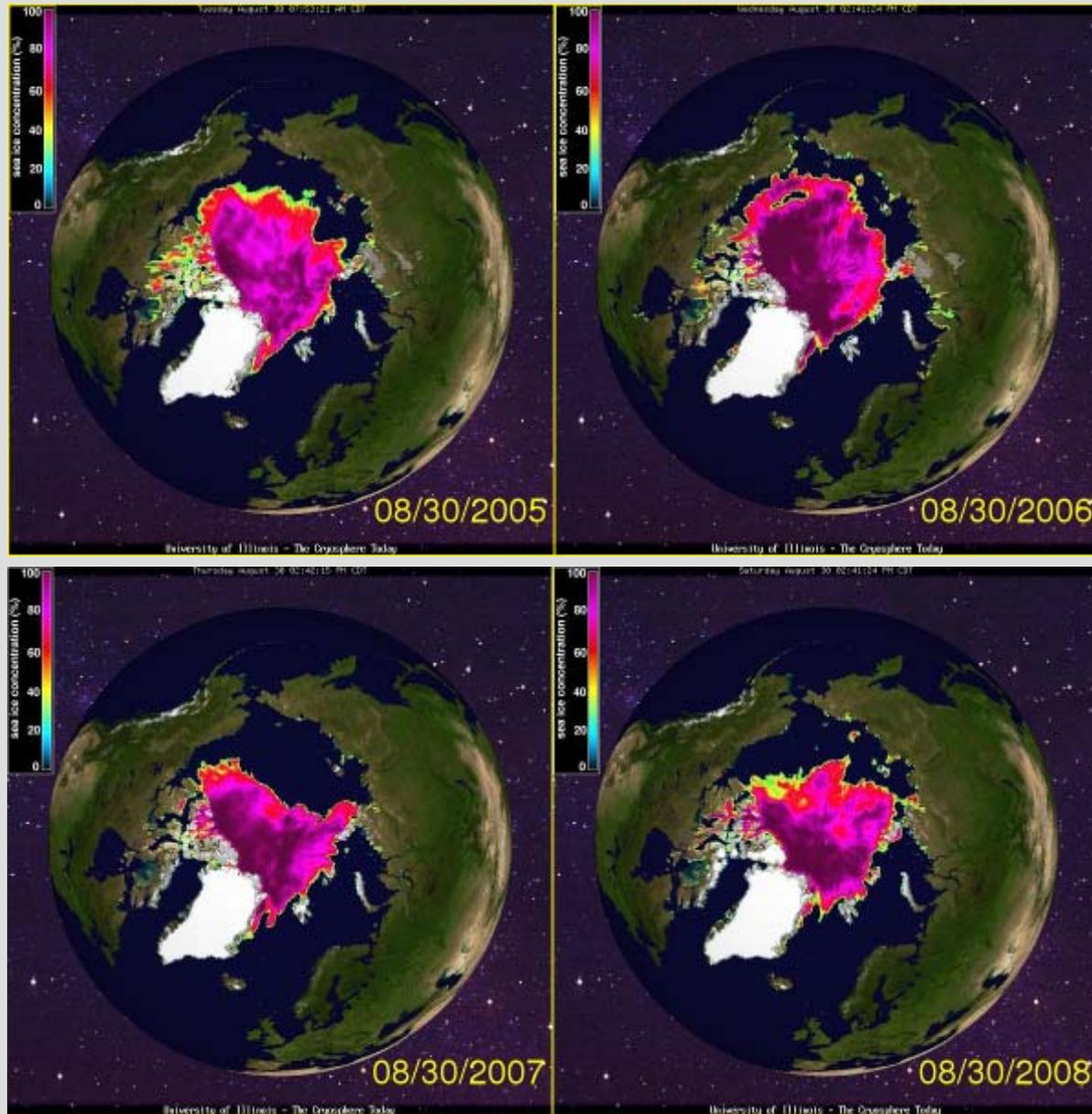


- Winter
 - March and April
 - Daylight Returns
 - Stable Ice conditions
 - Cold and Clear Weather
- Summer
 - August and September
 - Maximum Ice Melt

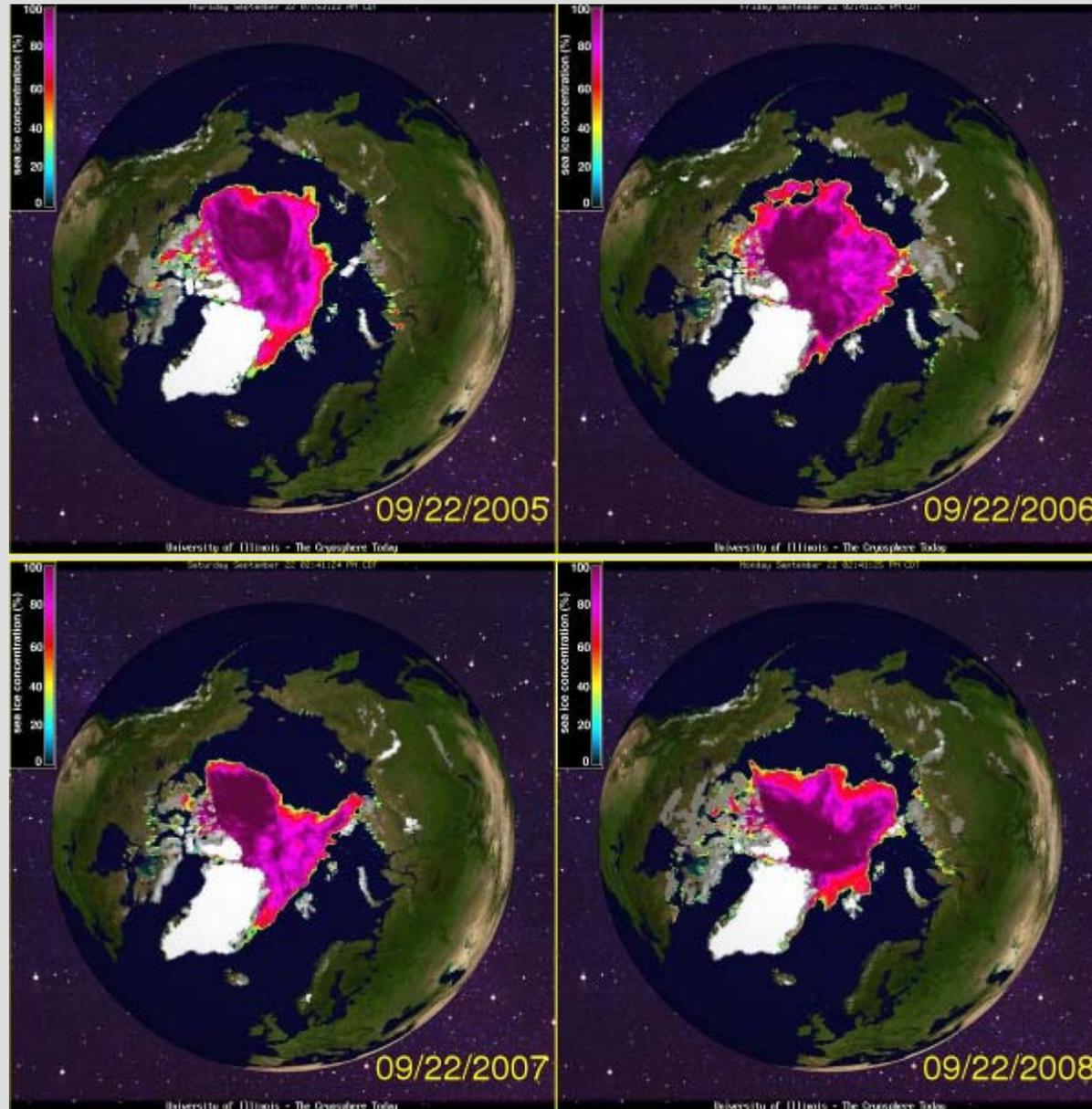
Ice Conditions – July 30



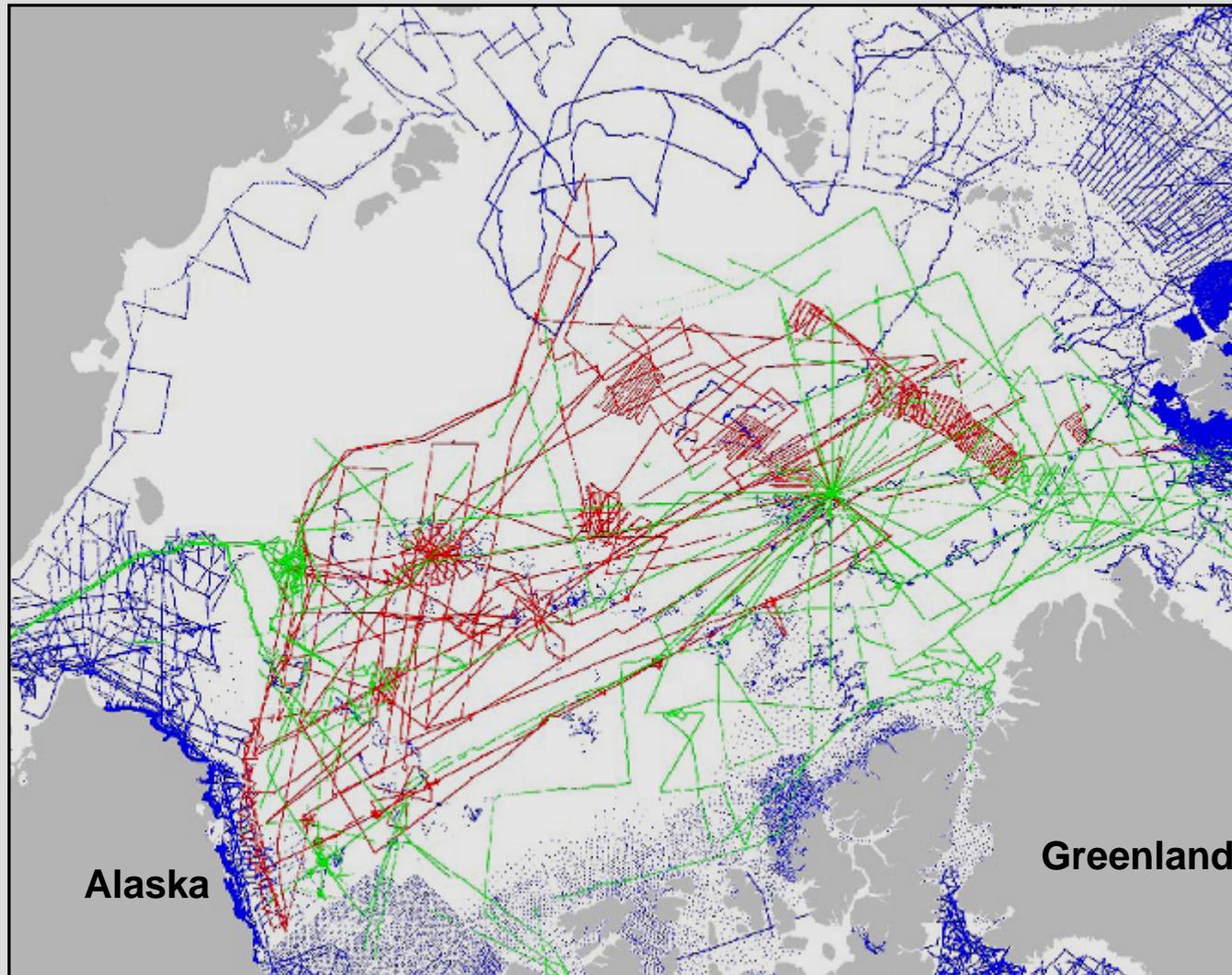
Ice Conditions - August 30



Ice Conditions – September 22



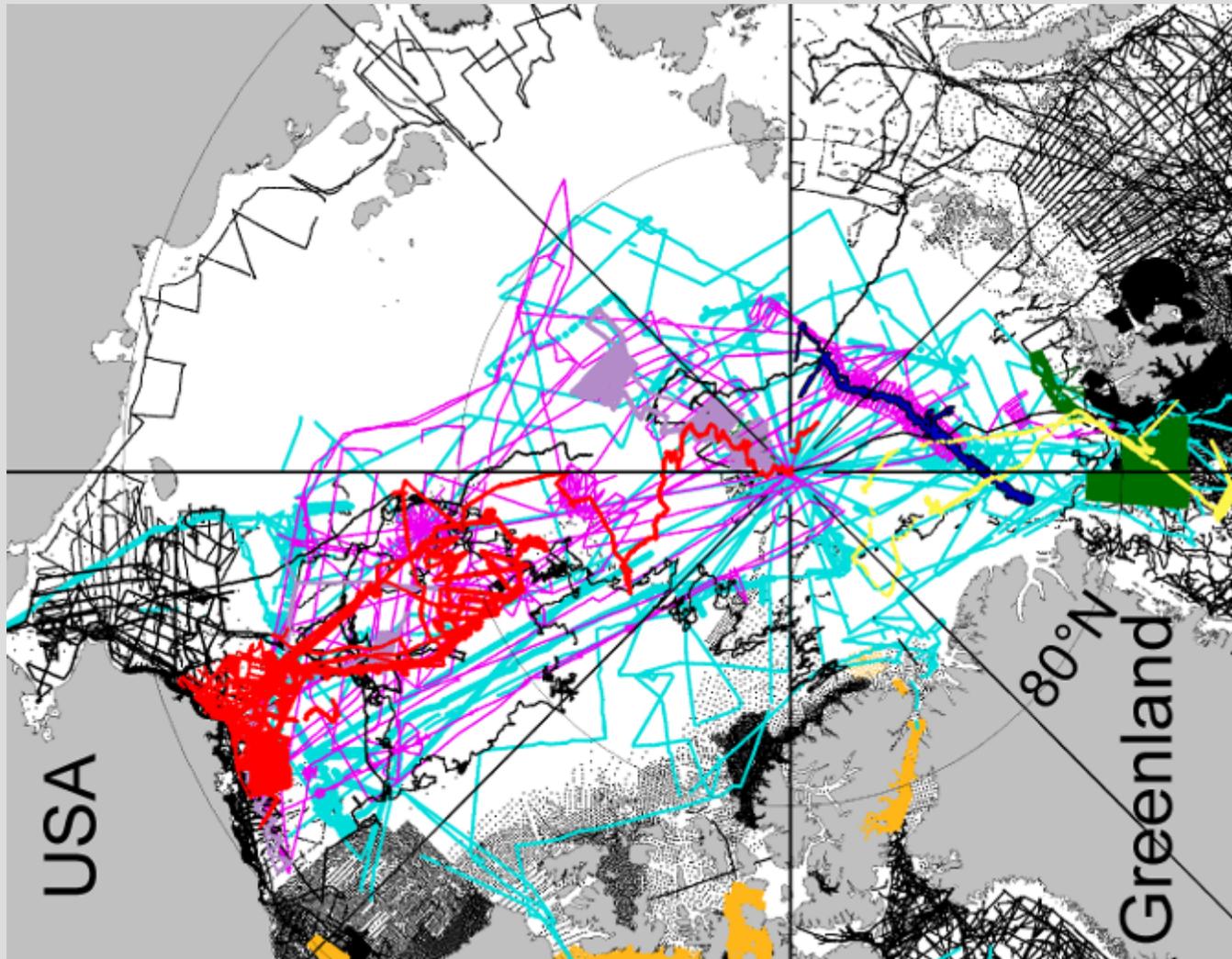
Bathymetric data coverage



IBCAO 2000

blue: spot soundings
green: US & UK nuclear submarines (1958-1992)
red: SCICEX nuclear submarine (1993-1999)

Bathymetric data coverage



IBCAO 2008



Costs



- Icebreakers: \$65000 to \$85000 / Day
- Aircraft: \$1300 to \$12500 / Hour; Minimums 3 - 4 Hr / Day
- Fuel:
 - Diesel \$1.50 - \$2.50 / L
1- 2 Million L per Icebreaker per Summer Survey
 - Jet Fuel Resolute: \$2.50 / L by sea; \$7 / L by air
Eureka: \$3.50 / L by sea; \$8 / L by air
Alert: \$10 / L by air
Ice Camp: \$14 - \$20 / L by air
300,000 - 400,000 L per Winter Survey
- Air freight: \$ 50 per Kg to Resolute by air
\$ 18000 to \$60000 Charter to Ocean
- Canada and Denmark have launched expensive data acquisition programs

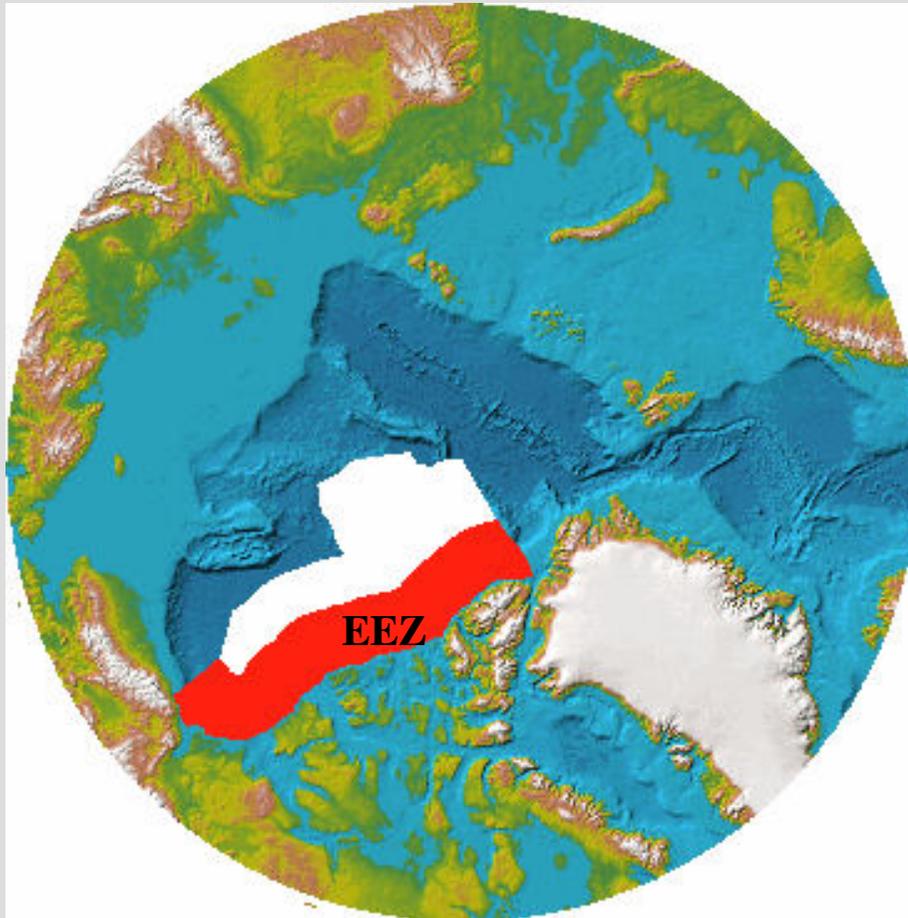
Operational Strategies



Desk Top studies form the basis for data collection strategy:

- On-ice test of appurtenance using refraction seismic experiments
- Eastern part: on ice bathymetry profiles approx. 50 M apart (“ping” rate from 10 km to 2 km)
- Icebreaker surveys in western part and where ice conditions permit for bathymetry and sediment thickness

Arctic Ocean – Canada

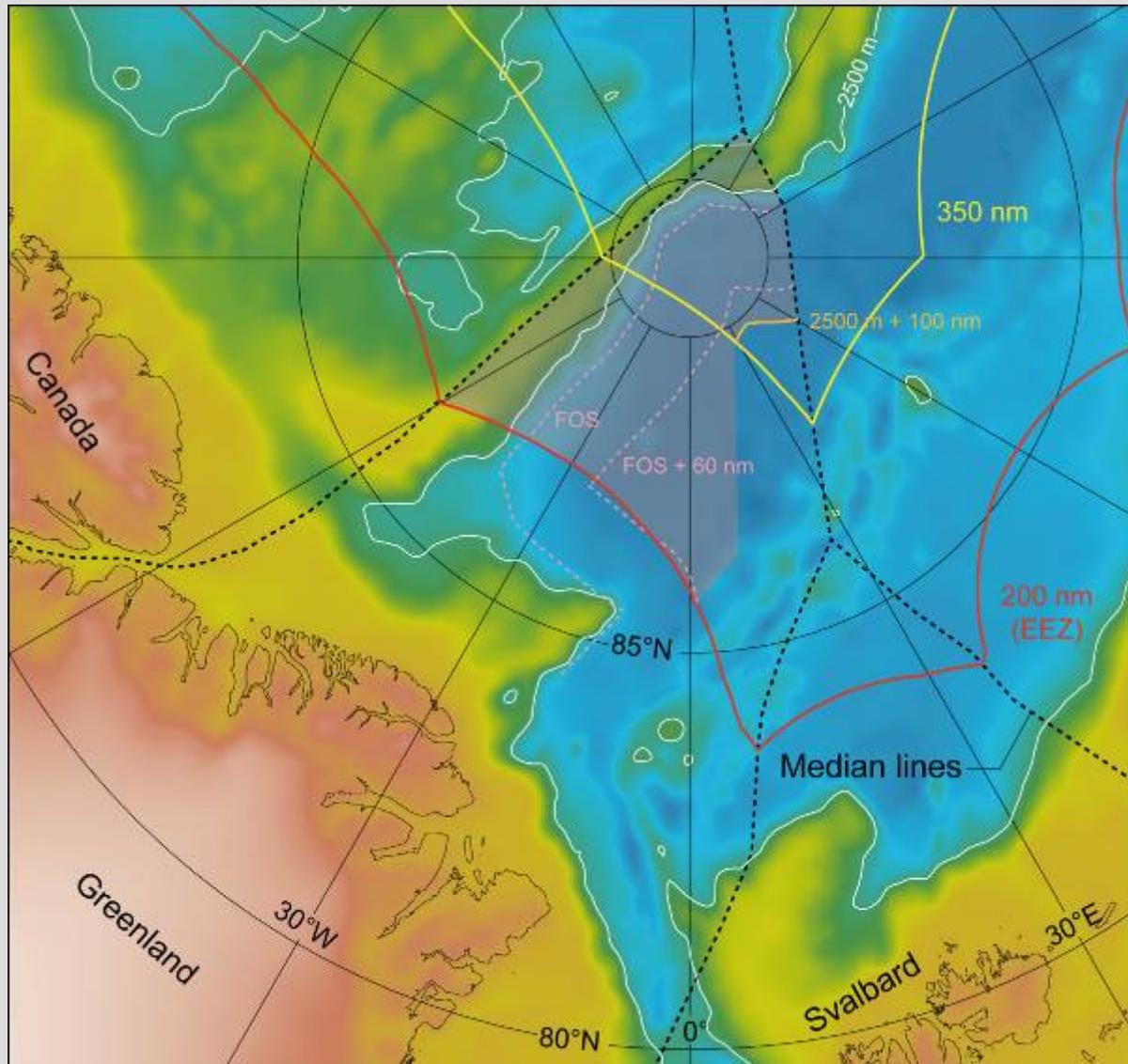


The white zone, or part of it, could be Canada's extended continental shelf under Article 76

Complicated seafloor geology and difficult data collection

- Eastern Arctic (start in 2006)
- Western Arctic (start in 2006)
- Possible overlaps with USA, Russia and Denmark: need negotiations
- Program requires at least 5 field seasons of data collection
- Concerns: weather and ice conditions/icebreaker capability

Arctic Ocean – Greenland



Possible eCS
area north of
Greenland
based on desk
top study

Logistical challenges



- No commercial survey vessels can operate in this region of the Arctic Ocean
- Only a few Polar Class icebreakers are available
- “SCICEX” US submarines have been decommissioned, UUV concept to be developed
- Specialized ice strengthened bathymetry and seismic equipment for icebreaker surveys has to be develop
- Former experience and equipment used in the 80´ties for on-ice surveys have aged
- Establishment of ice camps on more unstable sea ice
- Sharing of knowledge and cost through cooperation between Canada and Greenland/Denmark

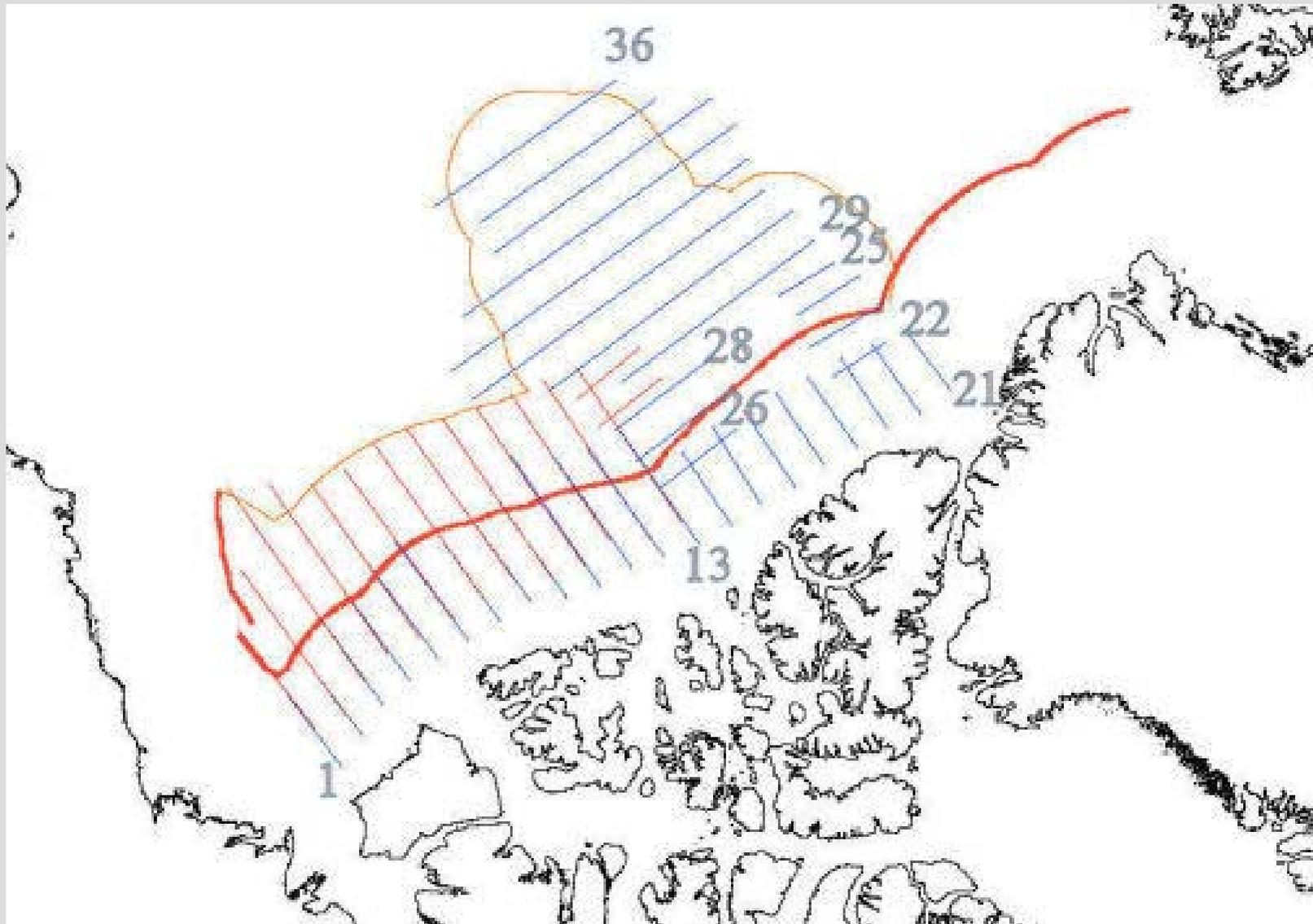
Operational Experience



Strategy

- Western Arctic (from North America perspective)
 - Icebreaker Surveys
 - Sediment Thickness
 - Bathymetry (Foot of Slope)
- Eastern Arctic
 - Ice Camps
 - Tests of Appurtenance (Alpha & Lomonosov)
 - Bathymetry (Foot of Slope and 2500 m isobath)
 - Sediment Thickness
 - Aero Gravity and Magnetics
- North of Greenland
 - Icebreakers
 - Ice Camp
 - Aero Gravity and Magnetics

Ideal Plan – 50 M line spacing



Western Arctic



- Multibeam Test 2005
- Seismic System Test – 2006
- Seismic and Bathymetric Survey – 2007
 - 7800 Km Single Beam bathymetric data
 - 3000 Km Seismic data
- Seismic and Bathymetric Survey – 2008
 - CCGS Louis S. St-Laurent / USCGC Healy
 - 2800 Km Seismic data
 - X km Single and Multi Beam bathymetric data
- Plan – Work Towards East to Limit of Icebreaker Capability

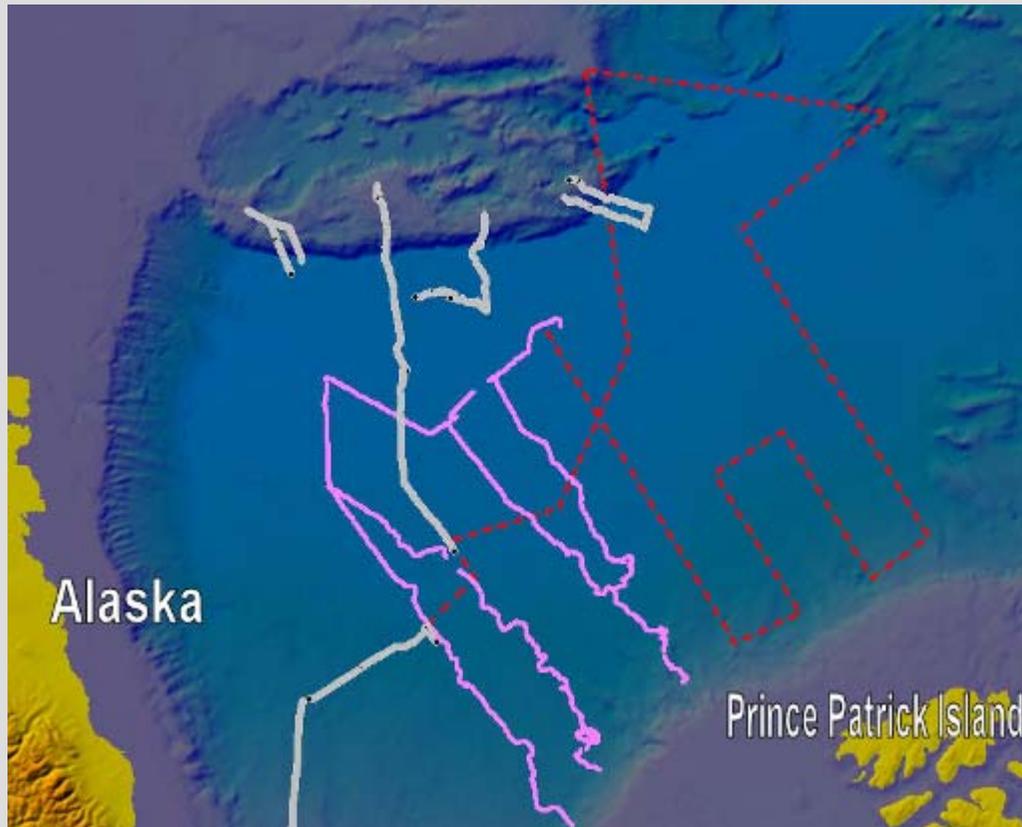
Deploying Air gun array (weight: 4400 pounds)



Using the airgun array on CCGS Louis S. St-Laurent



2008 Plan



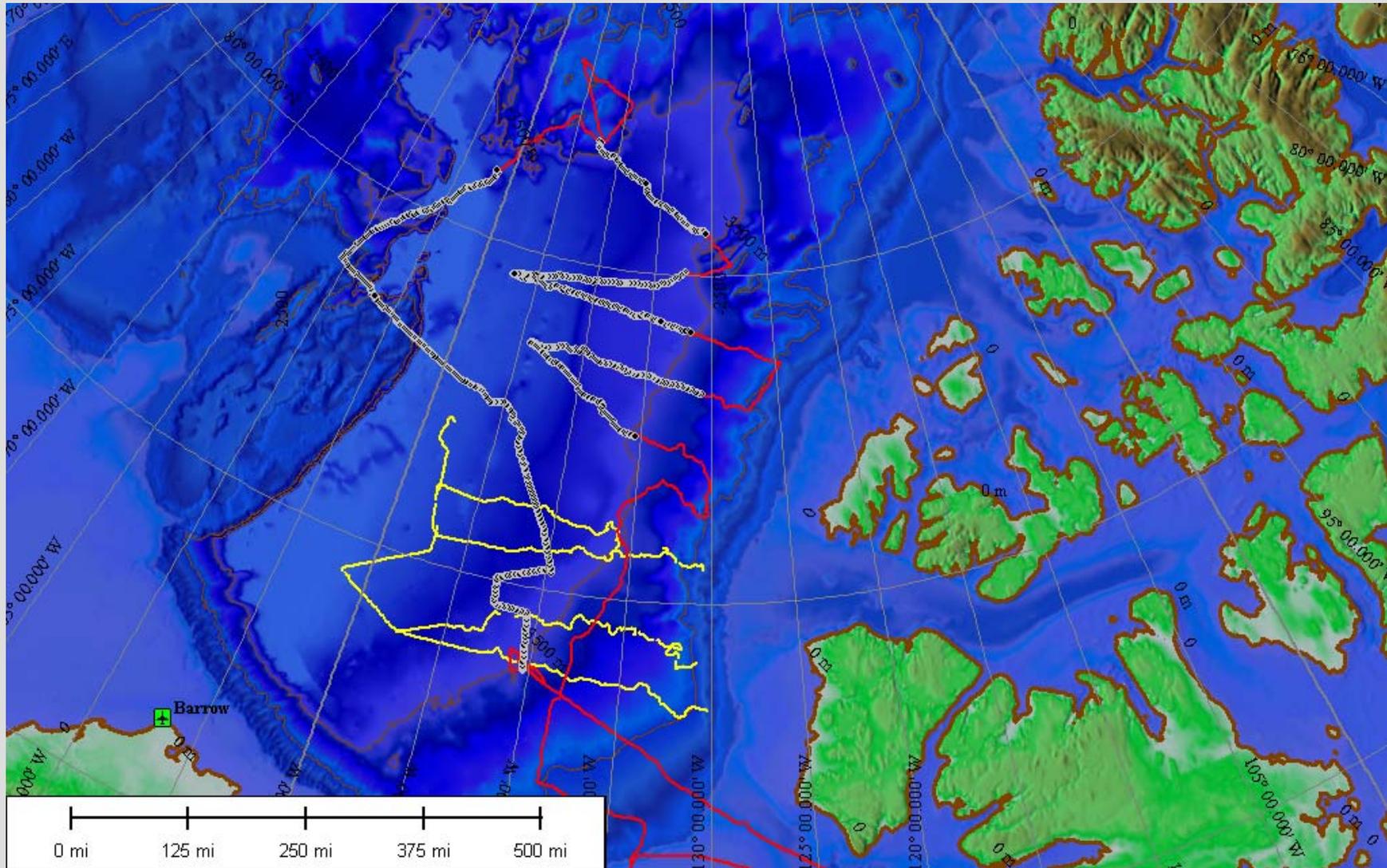
CCGS Louis S. St-Laurent



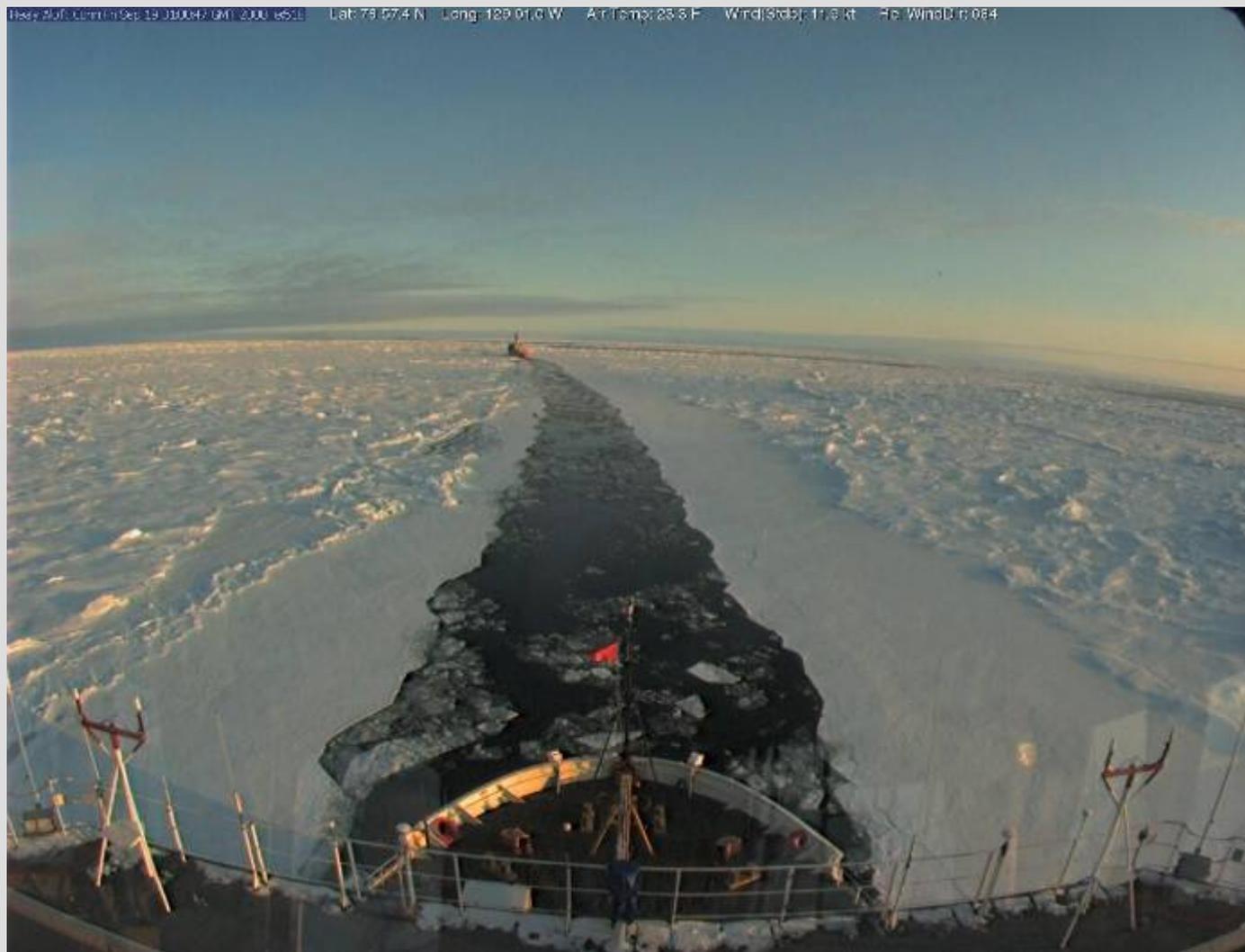
USCGC Healy



2008 Plan - achieved



Web-cam on *Healy*



Louis S. St. Laurent
breaking ice

Healy
acquisition of
multibeam data

Beaufort Sea
September 2008

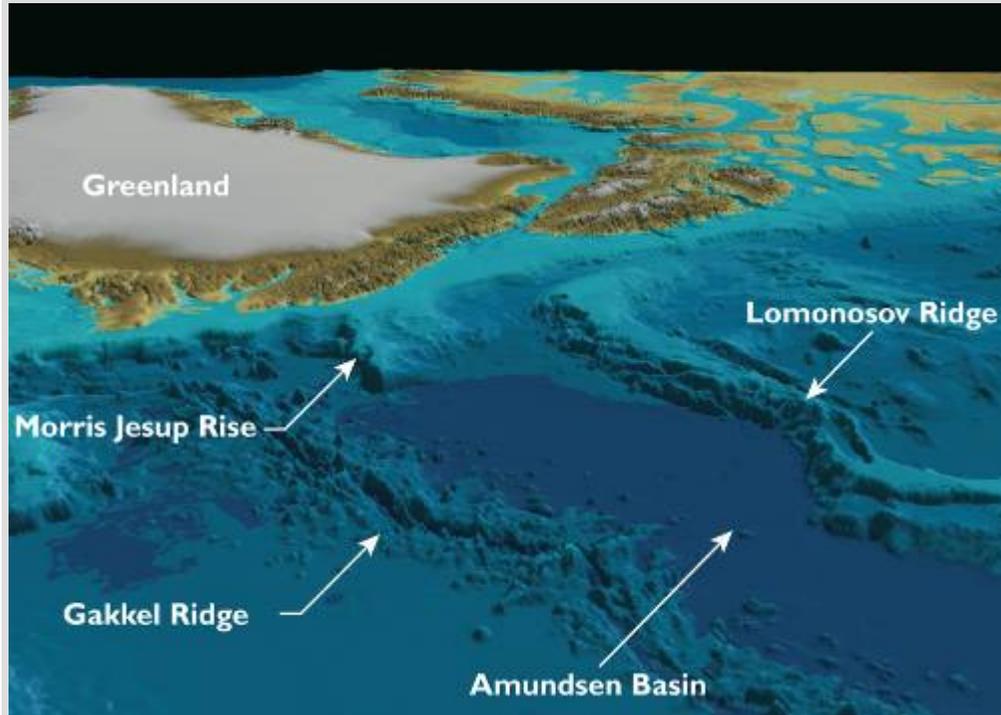


Eastern Arctic



- Lomonosov Test of Appurtenance – 2006
- Bathymetric Survey – Spring 2007
- Seismic & Bathy Survey – LOMROG 2007
- Alpha Ridge Test of Appurtenance – 2008
- Planned:
 - Bathy North Ellesmere Island and Greenland – Spring 2009
 - Bathy and Seismic Lomonosov – Summer '09 and '11
 - Use of UUV's (?)

Eastern Arctic: Natural prolongation of submarine ridges/elevations



Collaboration with Denmark

- MOU with Denmark (June 2005) for joint surveying in area north of Greenland / Ellesmere Island
- Saves Canada & Denmark \$ 1.5 million
- Other advantages: joint data collection and interpretation

Project LORITA – March 2006

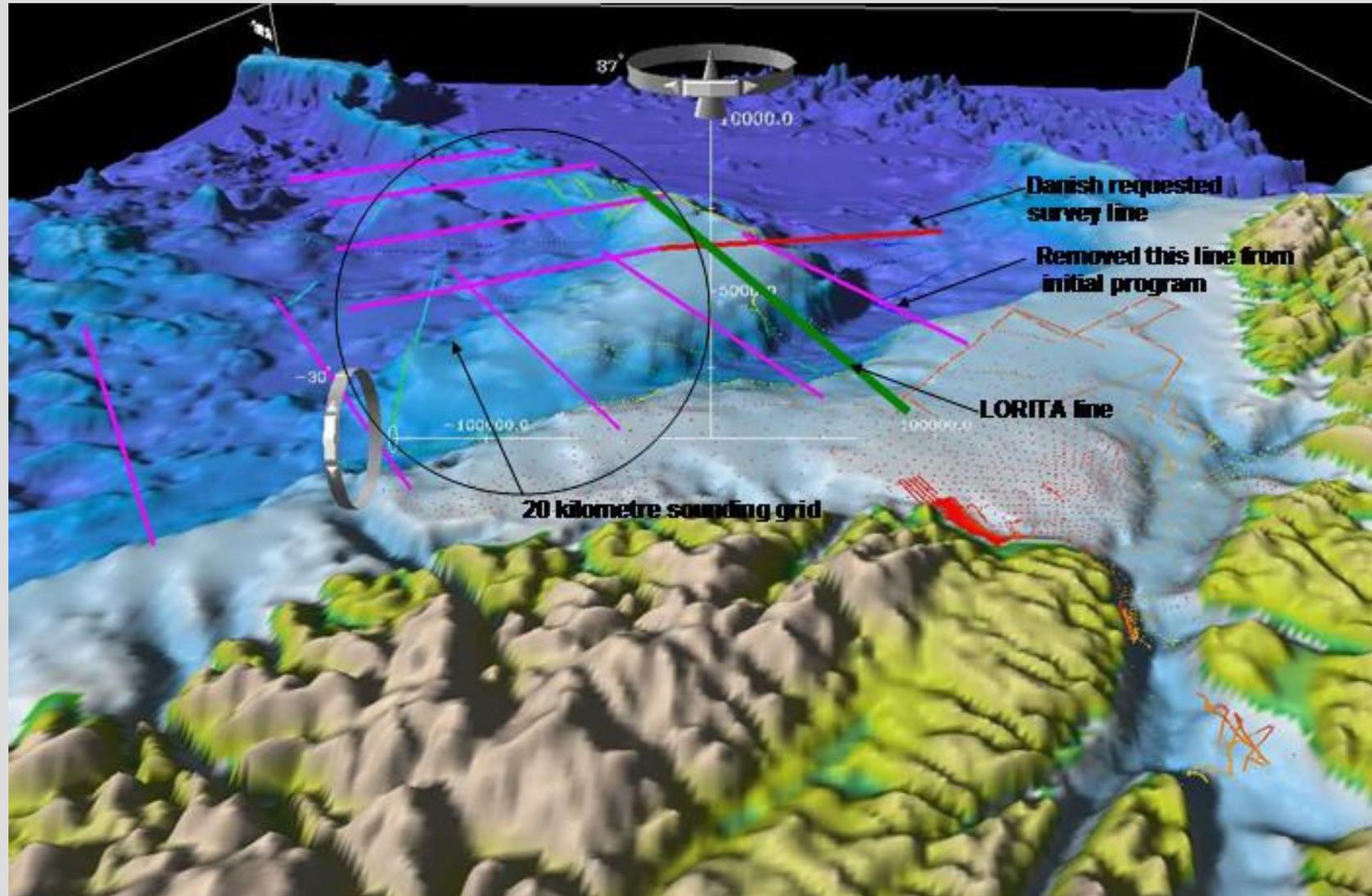
(Lomonosov Ridge Test of Appurtenance)

- On ice experiment

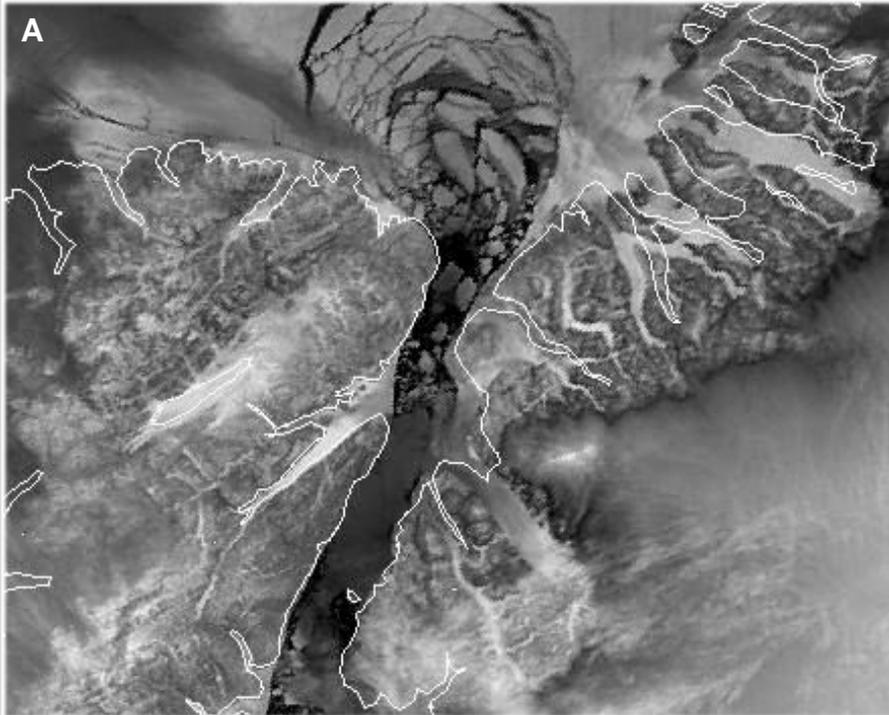


LORITA –
Refraction
seismic
experiment
on sea ice

CHS Bathymetry Plan in March – April 2007

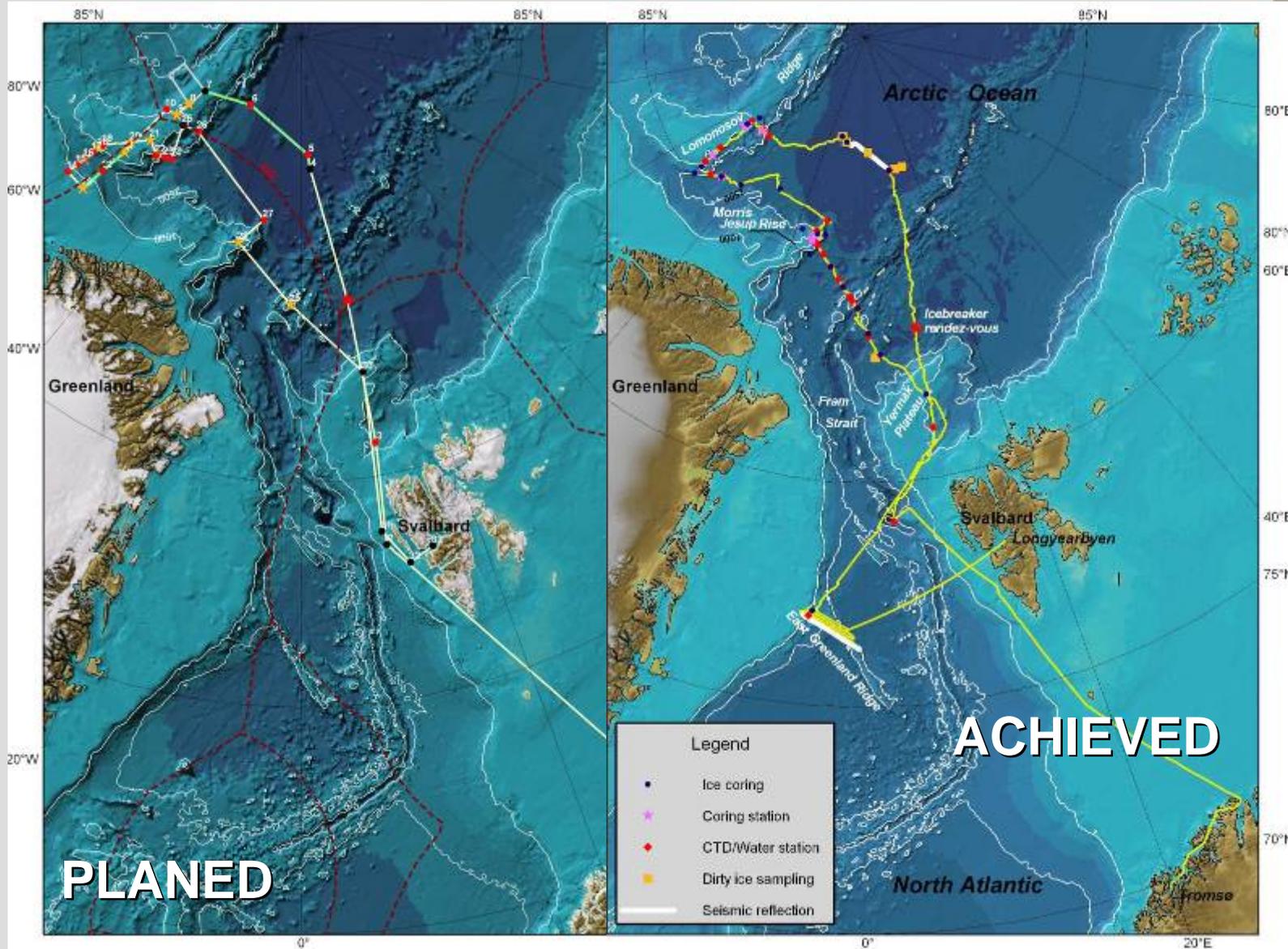


CHS Bathy Plan in March – April 2007

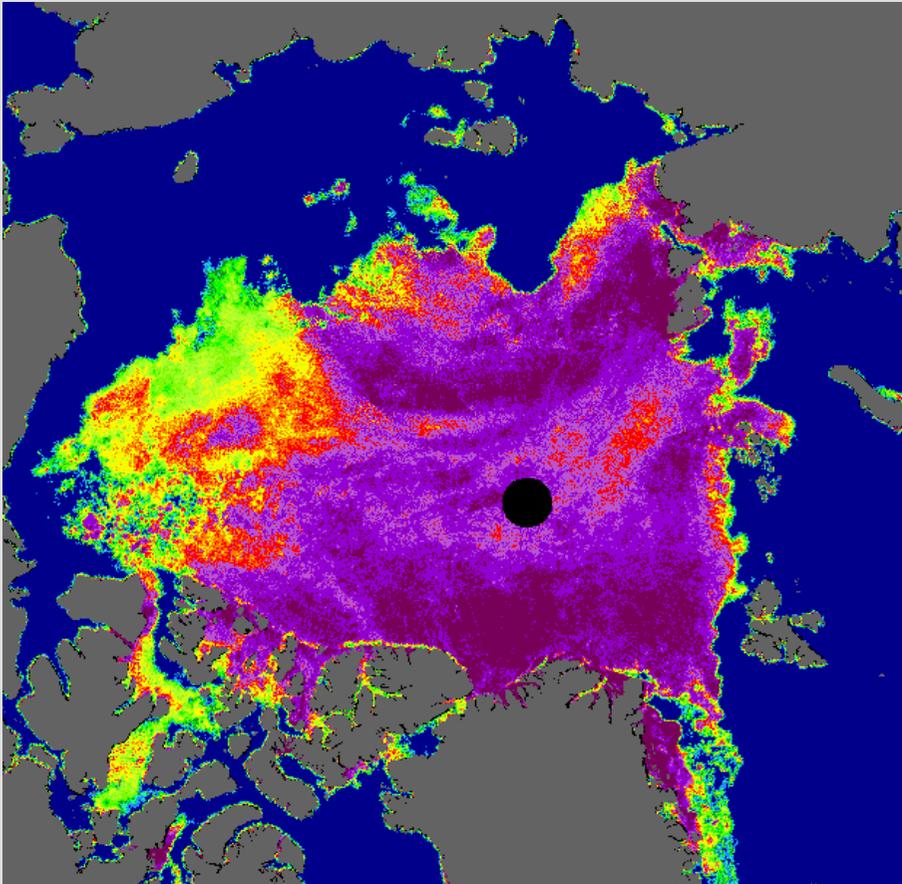


A – drainage of sea ice from the Lincoln Sea trough the Nares Strait. **B** – Helicopters with no horizon in spring of 2007 – data acquisition not possible..

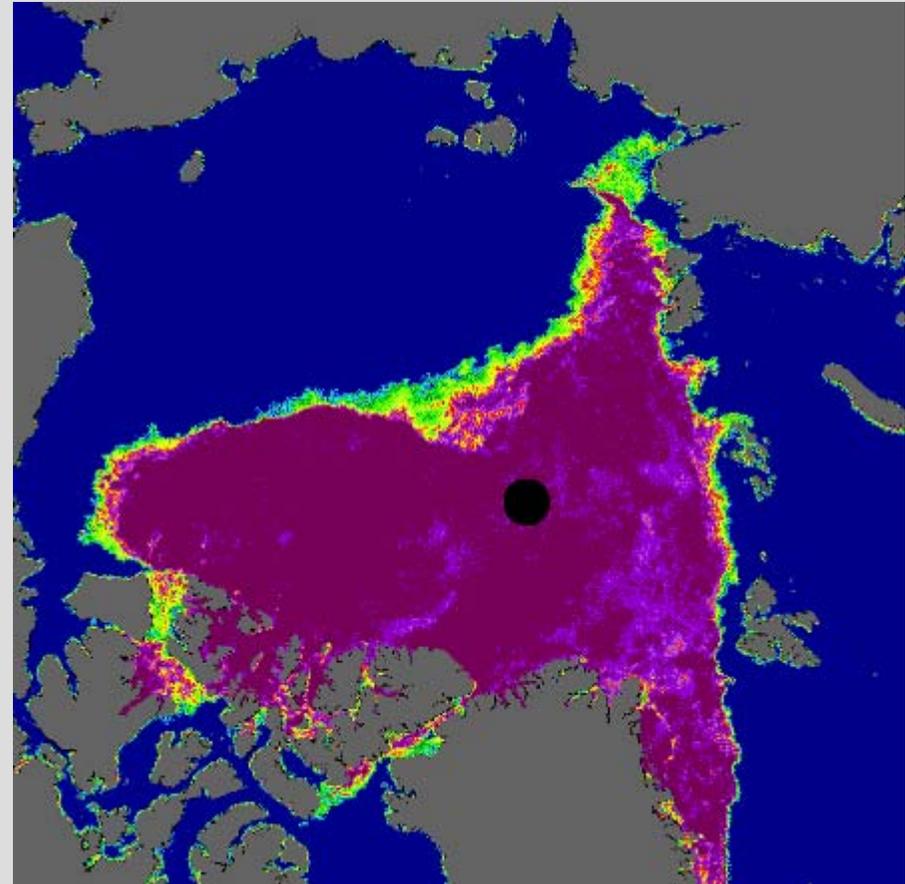
LOMROG: August-September 2007



LOMROG: Ice conditions



August 1, 2007



September 30, 2007

LOMROG: Seismic equipment



Airgun

Seismic streamer



Winch

Recording container

LOMROG: Ice Escort – *50 Let Pobedy and Oden*



LOMROG: Ice Escort – *50 Let Pobedy and Oden*

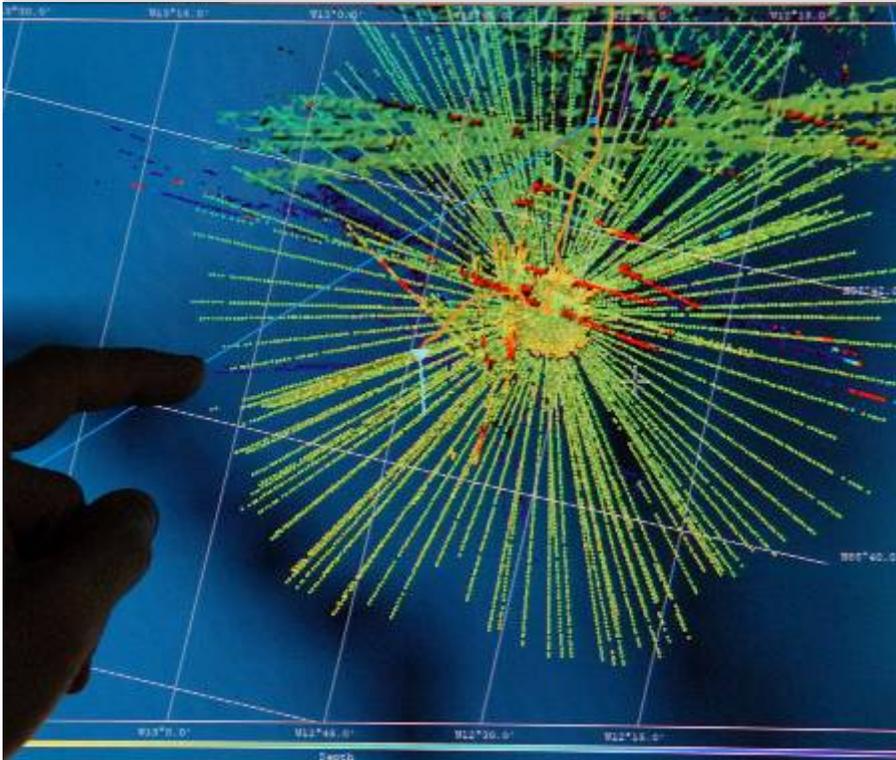


LOMROG: The Occasional Snag

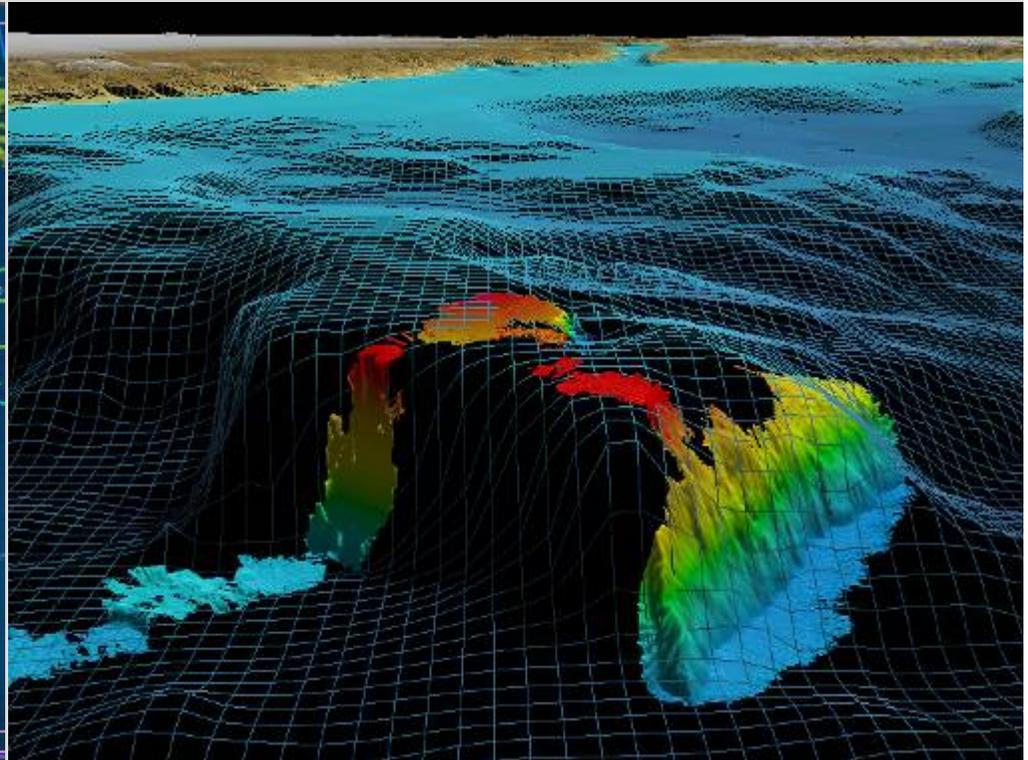


Seismic
streamer
caught in
heavy sea ice

LOMROG: Multi beam acquisition



"Pirouette surveying"



3D-view of the multi beam mapped Morris Jesup Rise north of Greenland

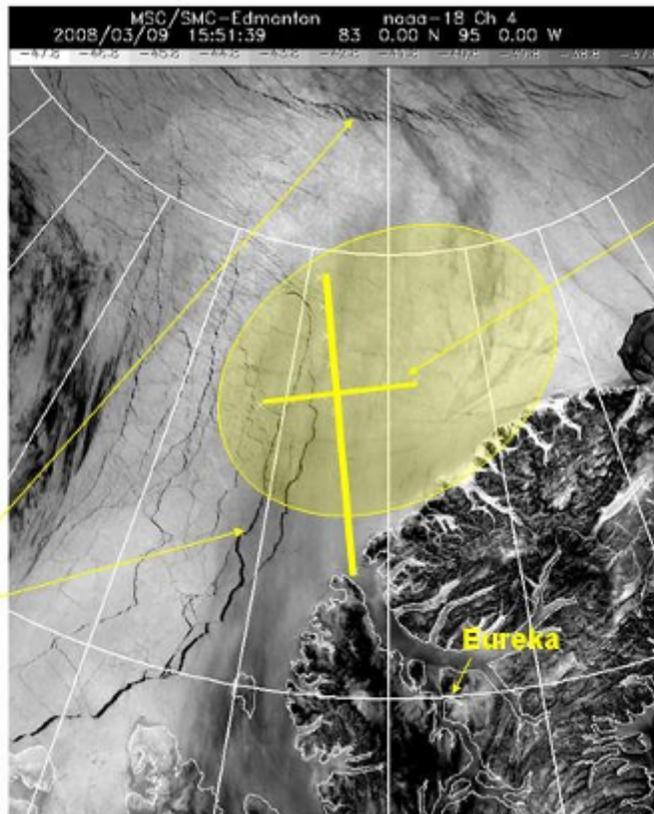
ARTA in 2008:

Alpha Ridge Test of Appurtenance



- Staged from Eureka
- Fuel & Gear into Eureka by Icebreaker
- Ice Camp - ideally 200 NM offshore
 - (need 3500-4000 foot ice runway – Not Found)
- 5 Helicopters
- 1-2 Twin Otters
- DC-3 and Buffalo for Camp in / out
- Two refraction seismic lines – LORITA concept
- Bathymetric profiles ~ 50 M apart

ARTA in 2008: Planned and revised survey area



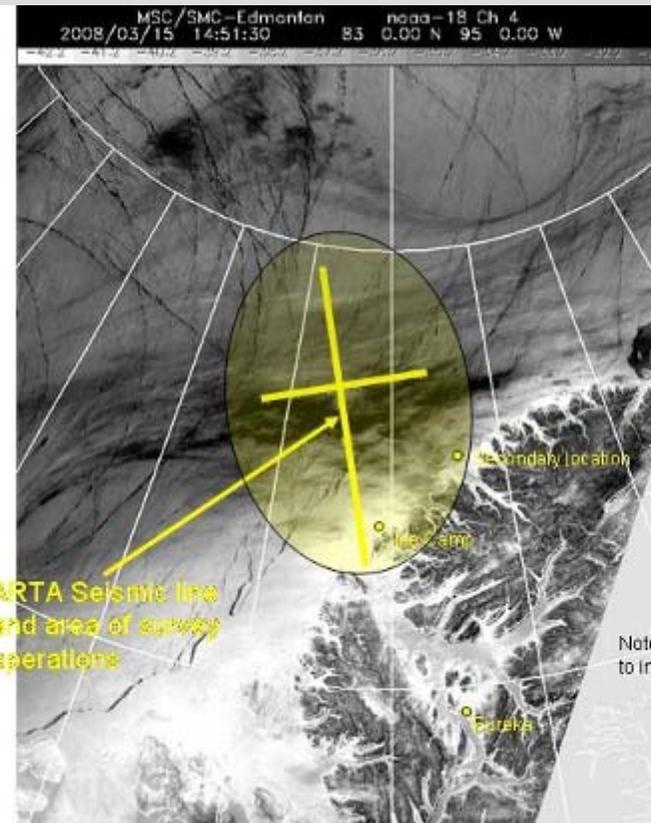
Notes: ice fractures west and north of survey area

Eureka

Survey area and Seismic line

Open water north of Alert

Alert



ARTA Seismic line and area of survey operations

Notes: Fractured ice continues to infiltrate the area of operation

Alert

Secondary location

Ice camp

Eureka

March 9

March 15

ARTA in 2008: Ice conditions



ARTA in 2008: Camp and runway

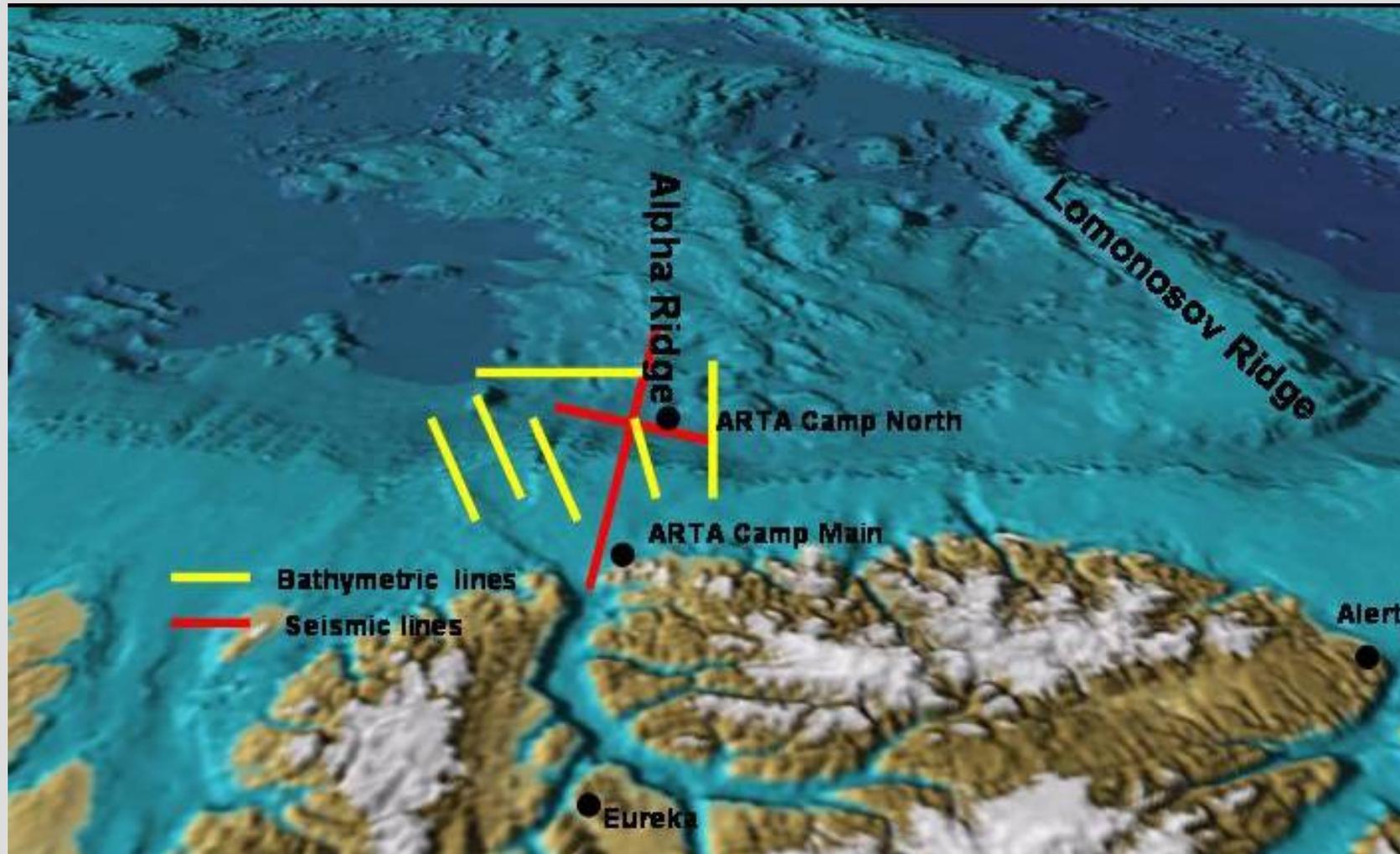


*Photos of landfast
ice and camp with
900 meter ice
runway at entrance
of Nansen Sound.*

ARTA in 2008: Sounding and Gravity Measurements



ARTA in 2008: Acquired data



Conclusions



- Risk of Losing a Season due to Remoteness, changing ice conditions and weather are high.
- Straight Lines and Continuous Profiles are a challenge especially in 10/10 ice.
- Existing Data supplemented by space and airborne Gravity and ground-truthed where practical will be important.
- Possible use of new technology – UUV.
- Opportunity for Cooperation & Joint Projects.



THANKS!