DEFENCE R&D DÉFENSE

The Application of AUVs in Support of the Canadian UNCLOS Submission

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Defence Research and Development Canada

Recherche et développement pour la défense Canada

Canada

Presentation Overview

- Cornerstone Background
- Technical Challenges and Solutions
- Arctic Field Operation 2010
- Few results and Summary

Project Cornerstone Overview

Objective:

To use Autonomous underwater vehicles (AUVs) to collect high quality bathymetric data , in particular between the 2500 m contour line and the "foot of the slope", in ice covered waters in the Arctic

Benefits:

- Provide risk mitigation against poor weather and poor ice conditions
- Provide an improved UNCLOS submission

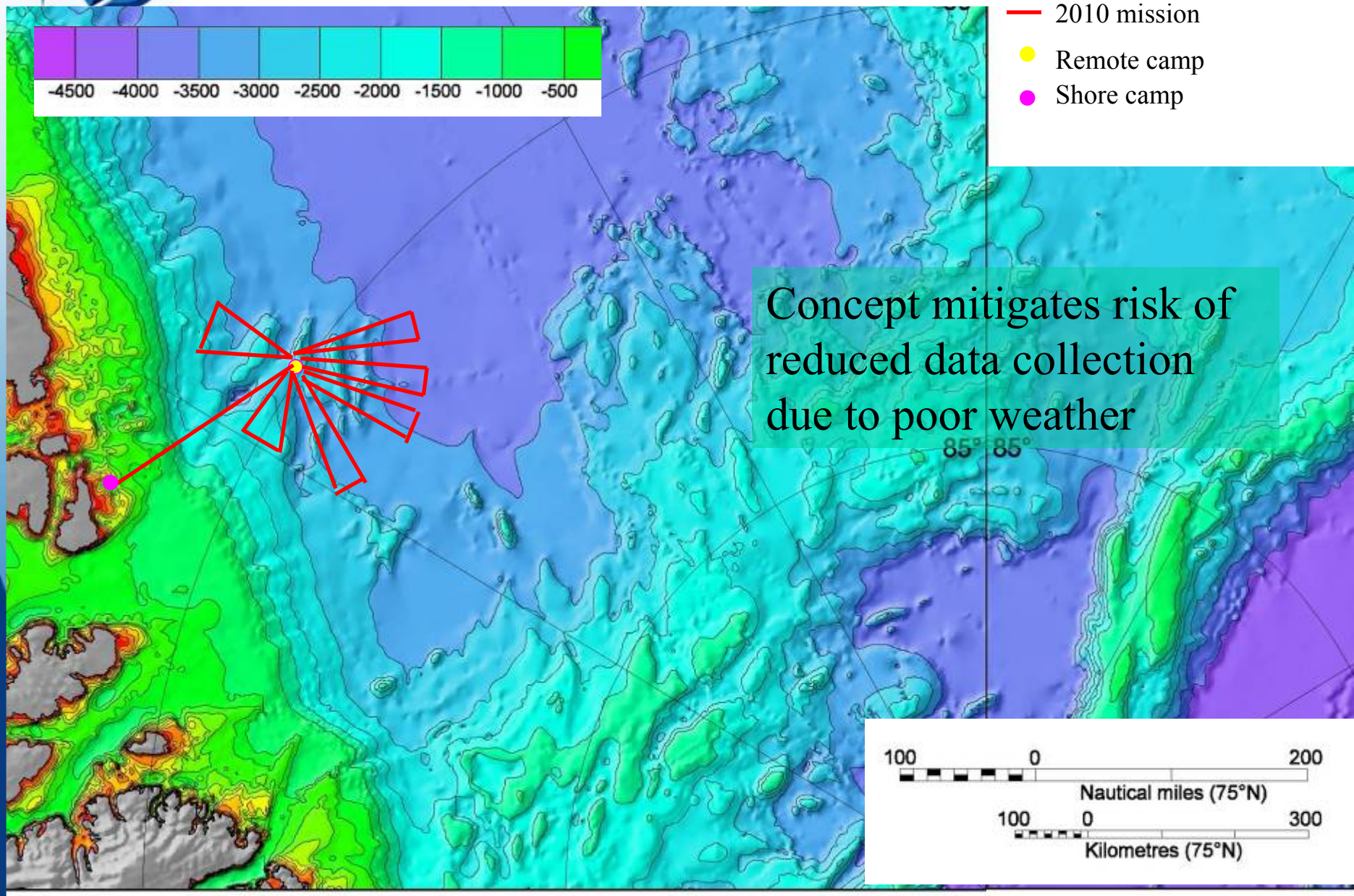
Project Execution:

Interdepartment MOU between DRDC, NRCan, and DFO

Project Timeline

- ADM Steering Committee Approval — Jun 2008
- AUV Contract Award — Nov 2008
- IMOU Signed — Feb 2009
- Preliminary Arctic Trial — Mar / Apr 2009
- AUV Factory Acceptance Testing — Aug 2009
- AUV Sea Acceptance Testing — Sept / Oct 2009
- Engineering Trials — Nov 2009 – Feb 2010
- Arctic Trial 2010 — Mar / Apr 2010
- Arctic Trial 2011 — Mar / Apr 2011
- Option to extend for another season (2012)

AUV Concept for Collecting Bathymetry

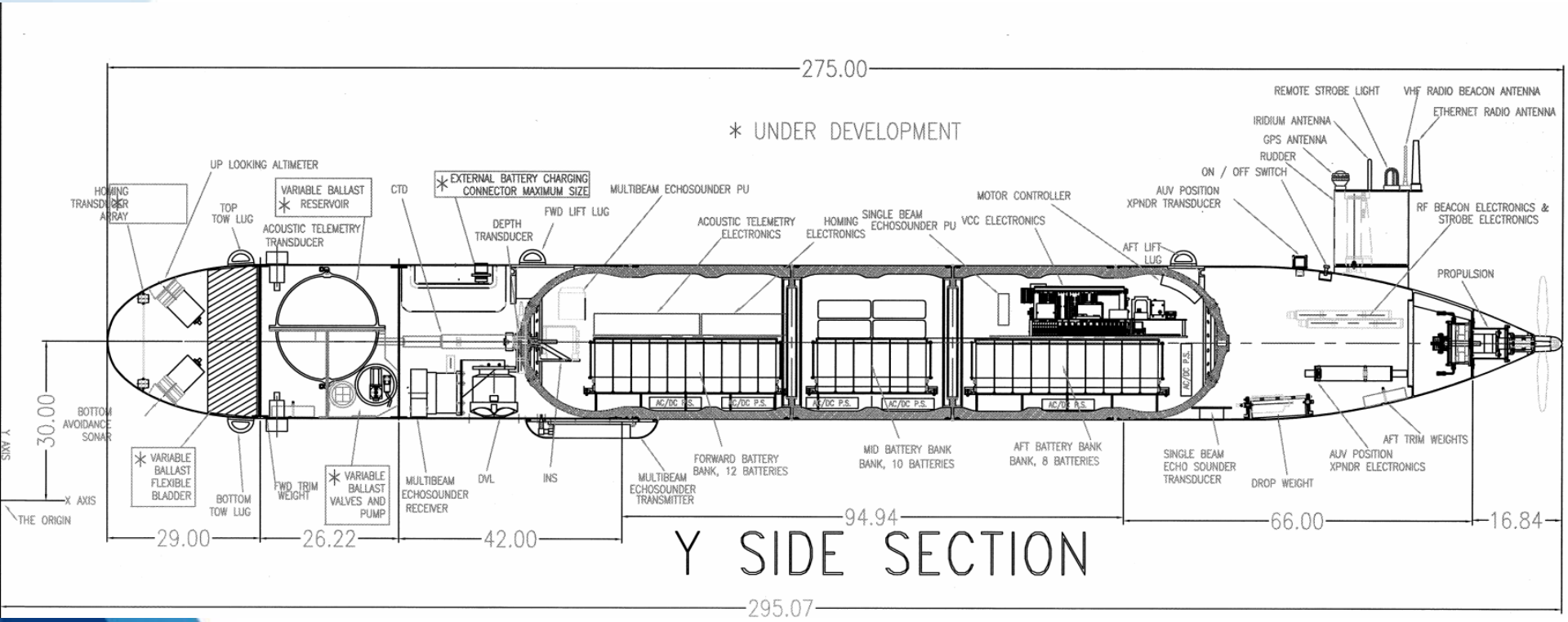


Concept mitigates risk of reduced data collection due to poor weather

AUV Overview

- Length 7m, Weight 1800kg
- Max Speed 5knots (2.5m/s), Survey Speed 3knots (1.5m/s)
- Propulsion: single thruster, 2 bladed propeller
- Endurance of >400km, 3 days
- Deep diving to 5000m
- Modular design
- Bathymetric data collection:
  - single beam echo sounder (Knudsen)
  - multibeam echo sounder (EM2000)

AUV Schematic



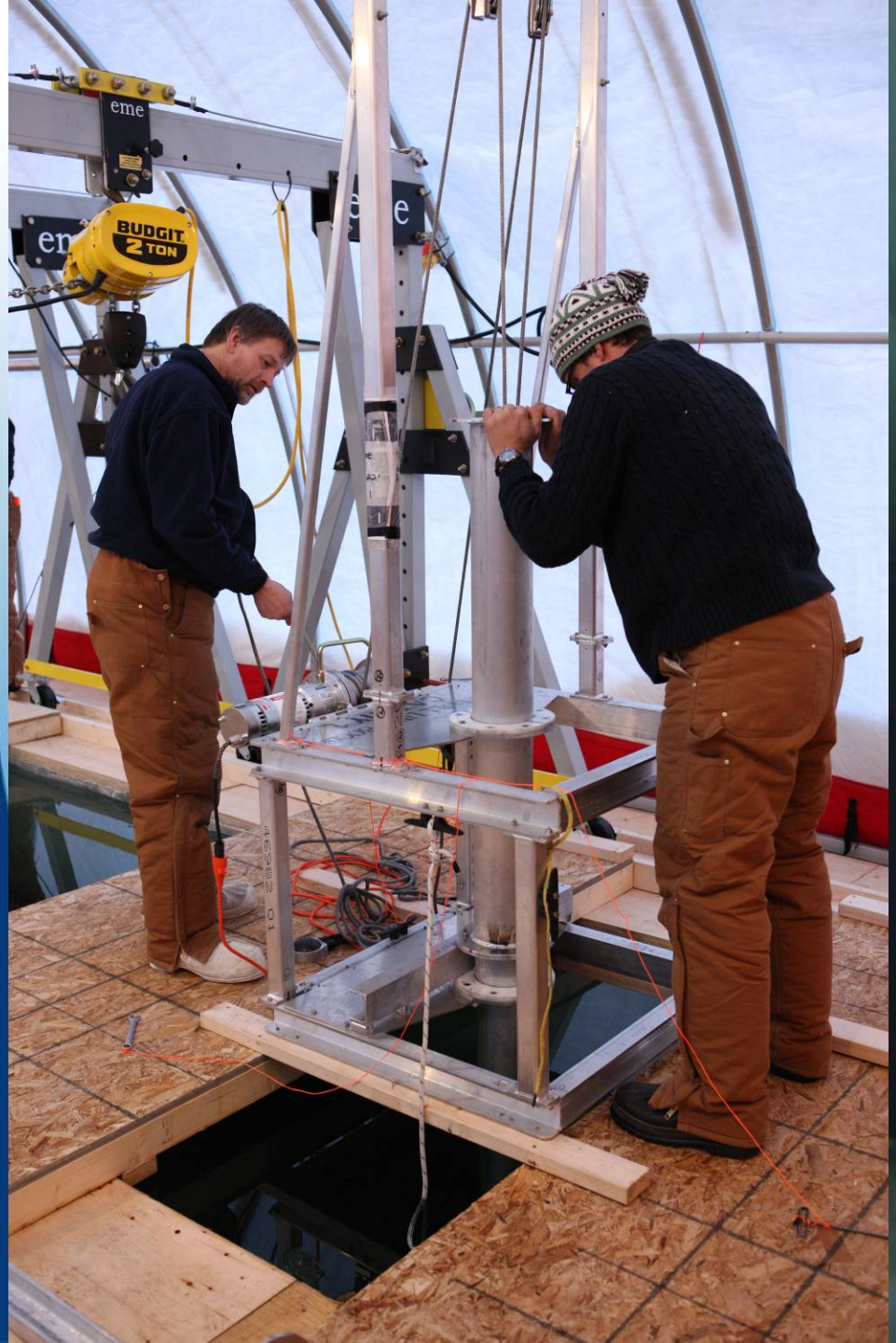
Technical Challenges and Solutions

Variable Ballast System

- The Concept of Operation required the AUV must be able to park under the ice at the end of each mission
- Fault management also required ability to park on the sea bottom
- Developed a variable ballast system
  - Rating of 5000 m
  - Titanium sphere
  - Double pumps

In water Charging

- CONOPS required continuous operations from a remote camp with no facilities to recover the AUV
- Necessitated in-water recharging after each mission
- Developed a novel pole assembly to capture the vehicle and facilitate attaching the charging cable
- Also allows for rotating the vehicle to align the INU if necessary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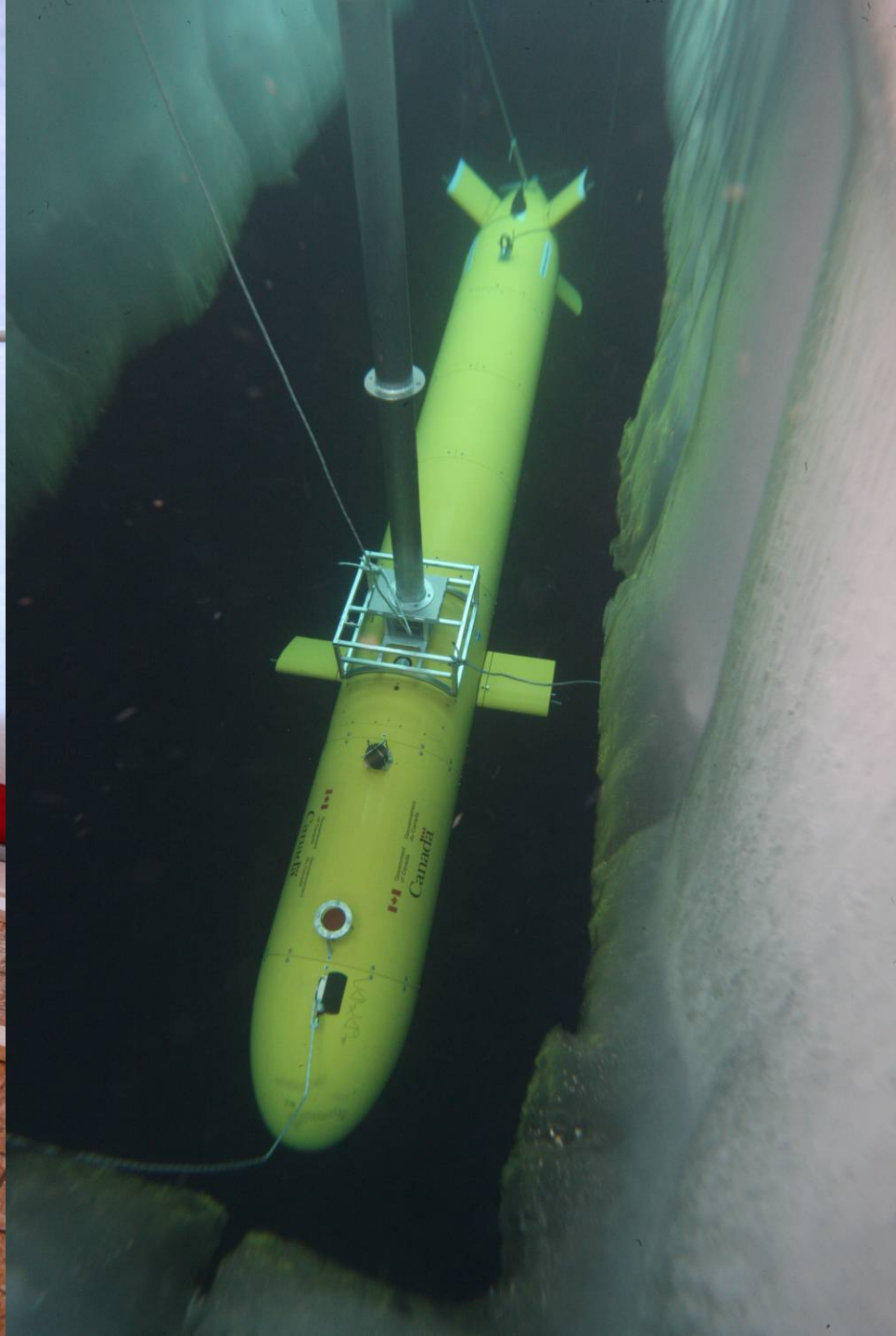
2 TON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Homing

- AUV must return to a drifting ice camp that was moving at up to 10 km/day!
  - For a 3 day mission, this is a total drift of 30 km
- Developed a custom 7 element hydrophone array that is mounted in the nose of the AUV
- Deploy a custom built 1300 hz, >190 db sound source at the ice hole
- Using specialized software on the AUV, the bearing angle from the AUV to the ice camp is calculated
- Homing at ranges greater than 50 km

Engineering Trial Highlights
Nov/Dec 2009, Jan/Feb 2010

Nov / Dec 2009 CFMETR, Nanoose, BC

- Trial Objectives: Workup of both vehicles, including full endurance mission; Evaluation and testing of homing and position systems and navigation system
- Trial Outcomes:
  - Good initial results from homing system
  - Approximately 2/3 of trial time was lost, mainly due to weather; as a result engineering trials were extended into Jan/Feb 2010

Jan / Feb 2010 Indian Arm, Vancouver Area, BC

- Trial Objectives: Evaluation and testing of homing and position systems and execution of full endurance missions; Final in water testing prior to Arctic trial
- Trial Outcomes:
  - Homing and position systems tested and evaluated
  - Two full endurance missions and one extended mission were completed

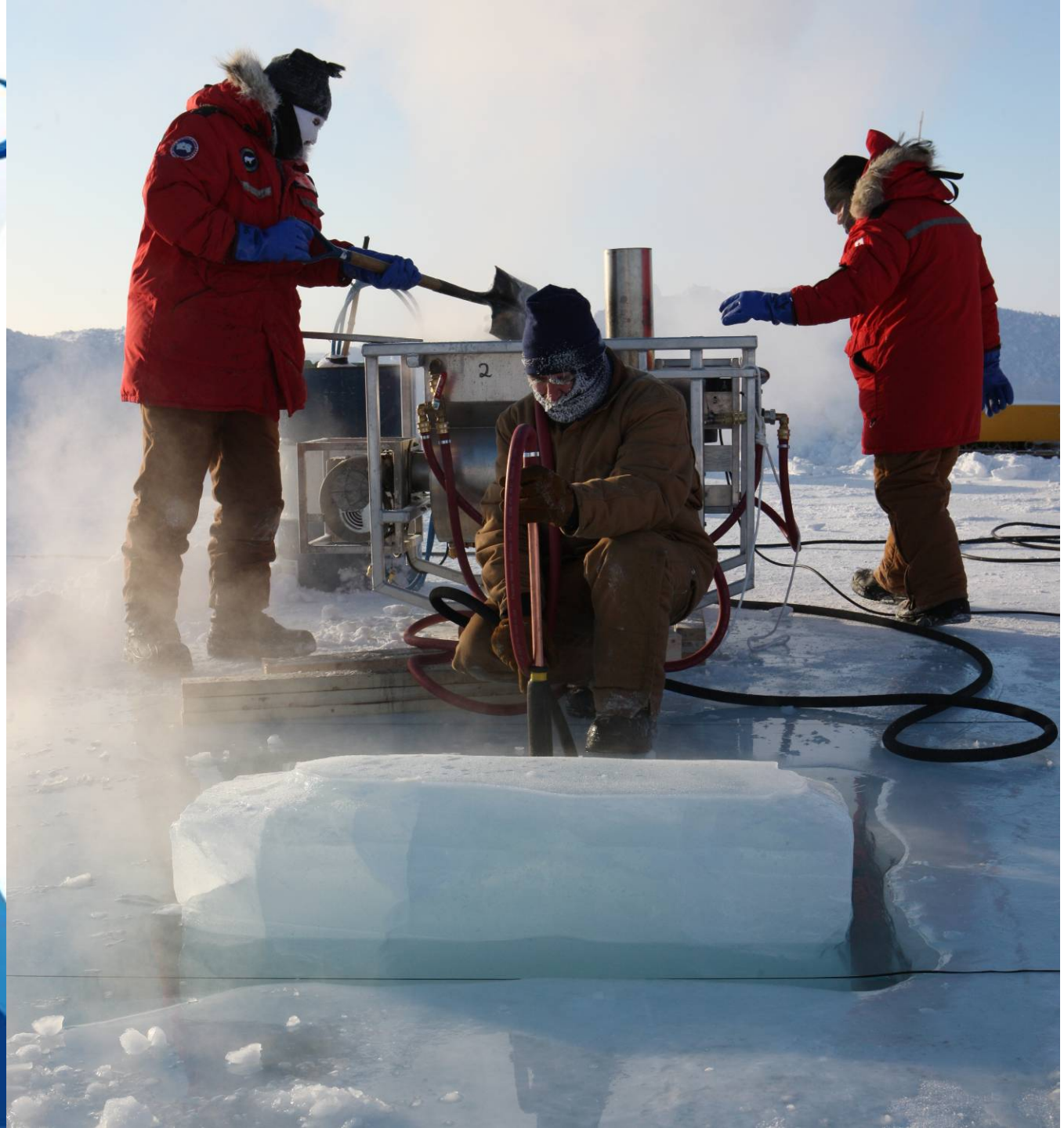

Cornerstone Ice Camp
Floe6
Borden Ice Camp
Resolute Bay
Arctic Operation 2010
Image IBCAO
© 2010 Google
© 2010 Tele Atlas
Image © 2010 TerraMetrics
72°48'01.40" N 102°02'27.15" W elev 0 m
Eye alt 2656.71 km
©2009 Google


FIRST AIR
C-FNVK


Buffalo


DC-3
Kenn Borek Air Ltd.


C-GKBC
Kenn Borek Air Ltd.
Twin Otter

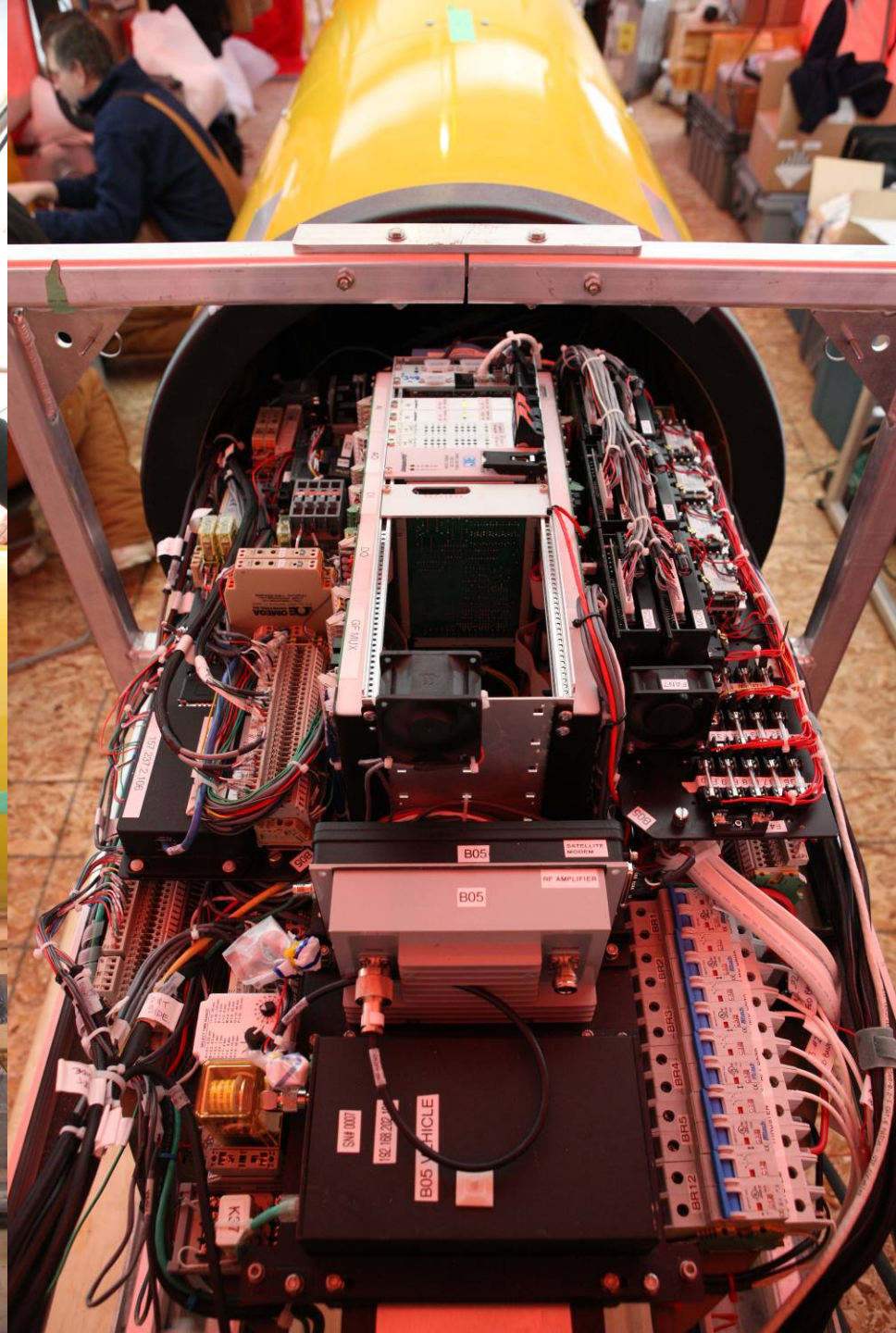


la défense Canada


305
BOF


Bobcat


B05
B05
B05


B05
SATELLITE MODEM
B05
RF AMPLIFIER
B05 VEHICLE
SM 1001
BR1
BR2
BR3
BR4
BR5
BR12


WLL 5500 LB
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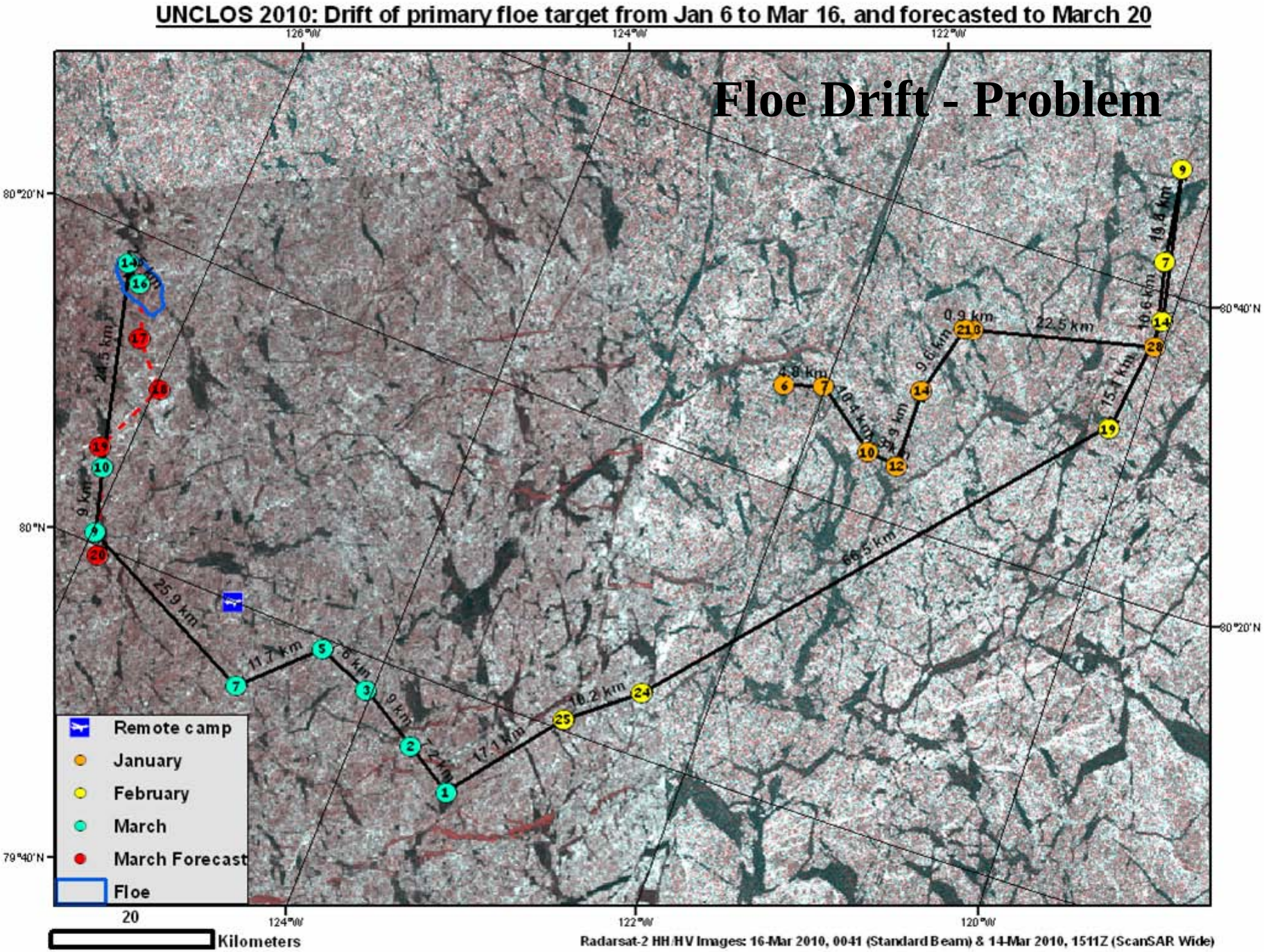
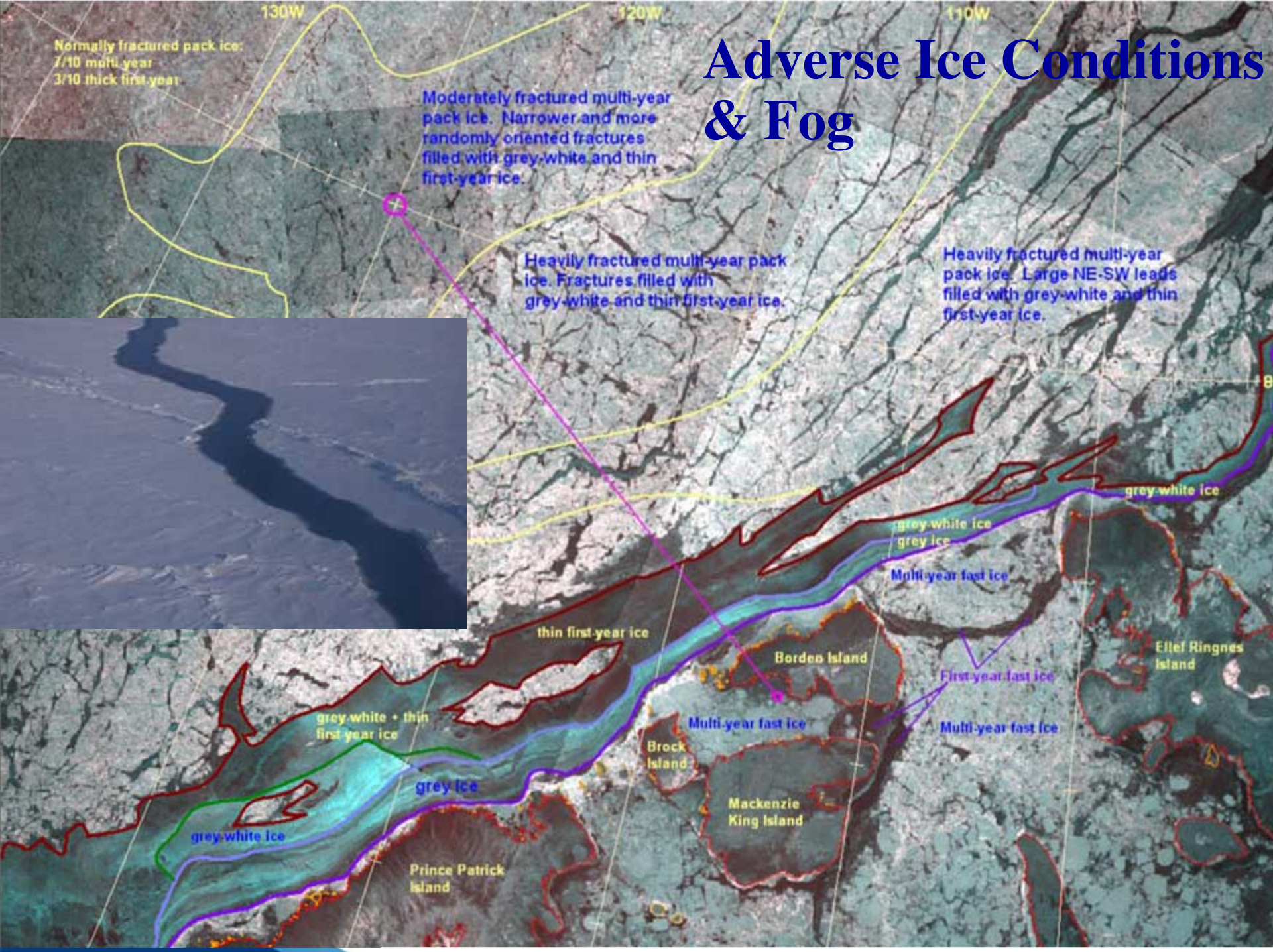
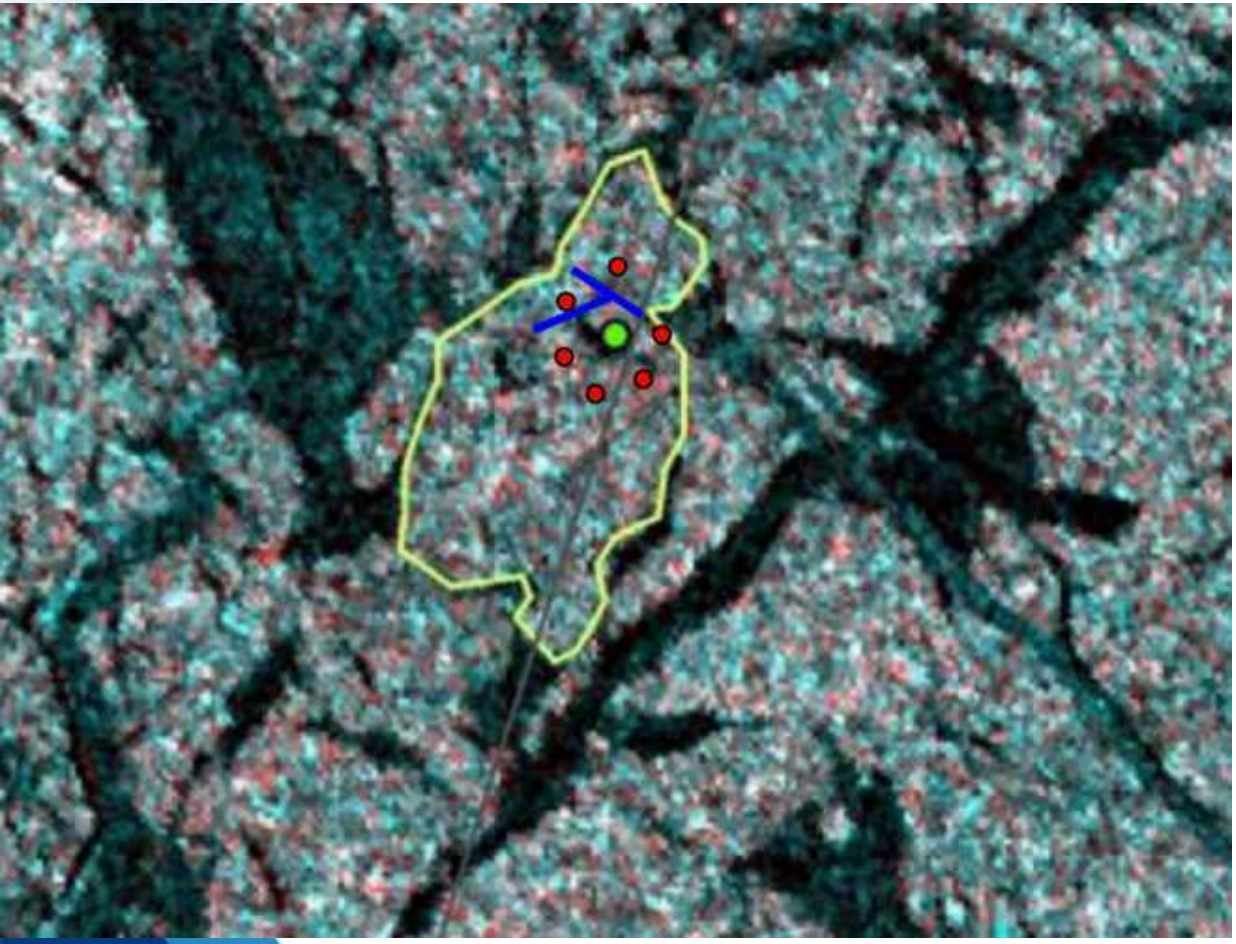
Floe Drift - Problem



Adverse Ice Conditions & Fog



Remote Camp Floe Satellite Image



Green line – floe outline

Red dots – modems

Green dot – camp

Blue lines – open leads

Dark areas – thin ice or open water


FRAGILE
TOP
DO NOT
FREEZE
REMOTE
CONSOLE

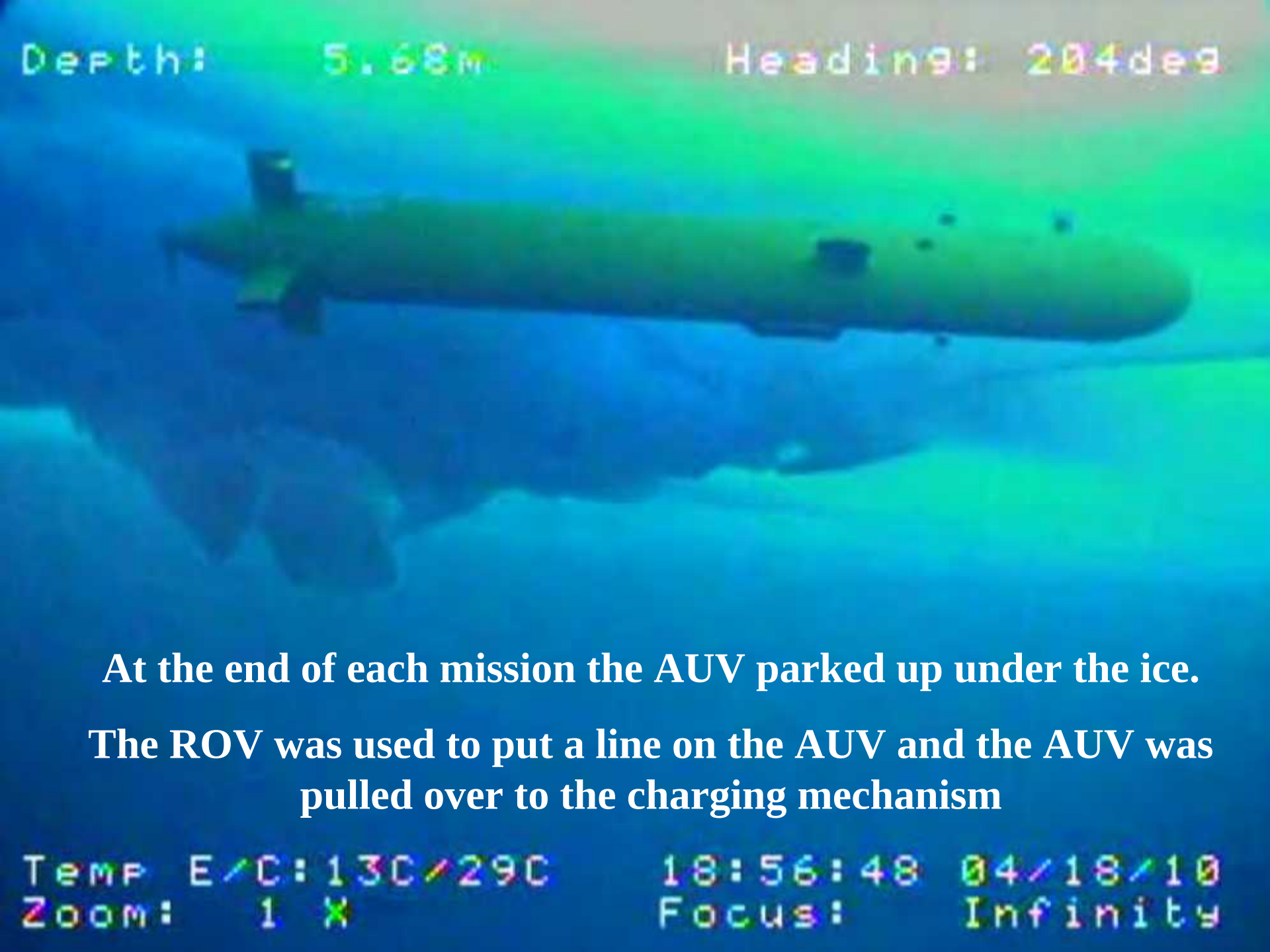

WLL 5500 LB
WLL 5500 LB
eme
eme
eme
eme

And then we waited.

And waited.

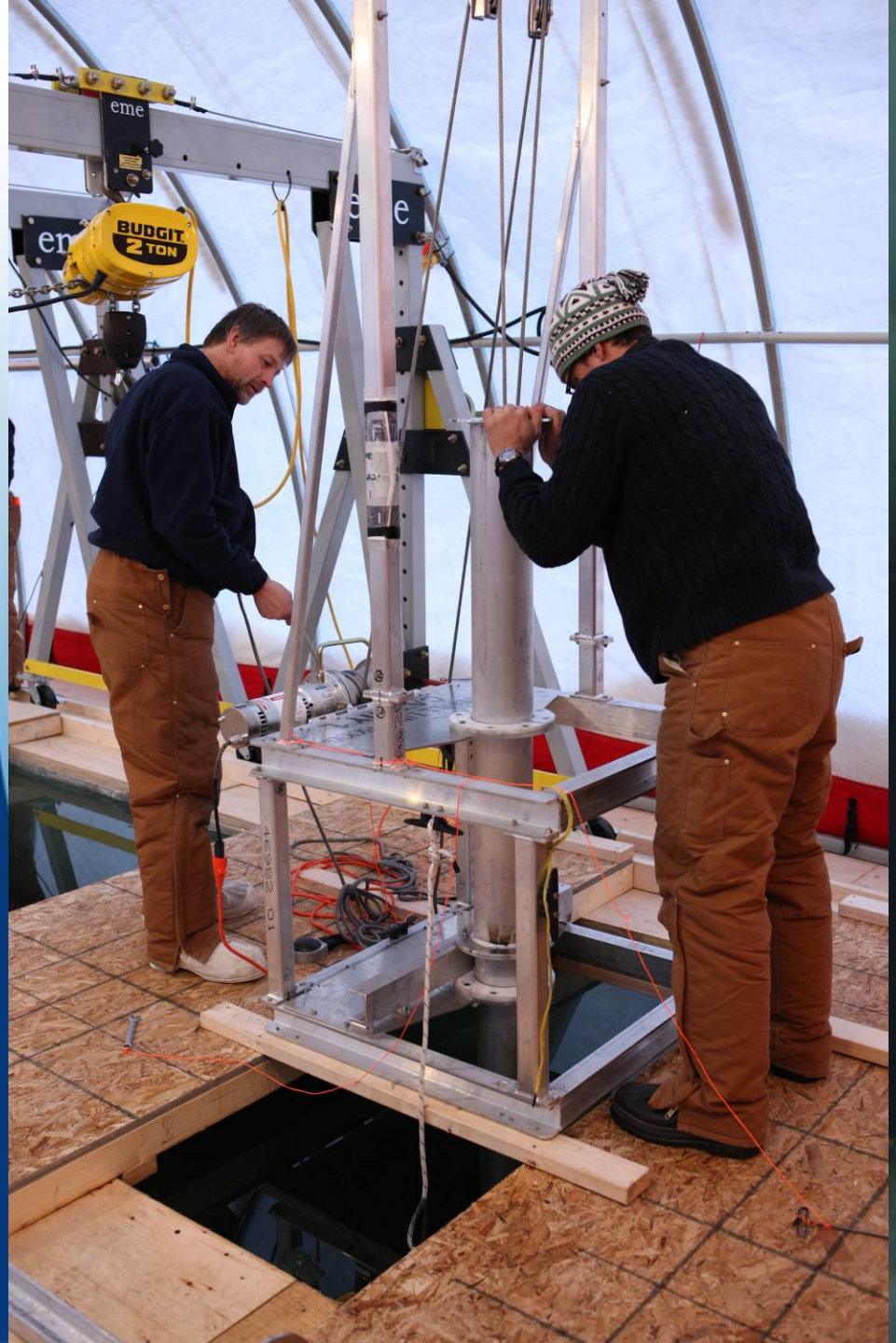
And waited.

For 3 days!!!!



At the end of each mission the AUV parked up under the ice.

The ROV was used to put a line on the AUV and the AUV was pulled over to the charging mechanism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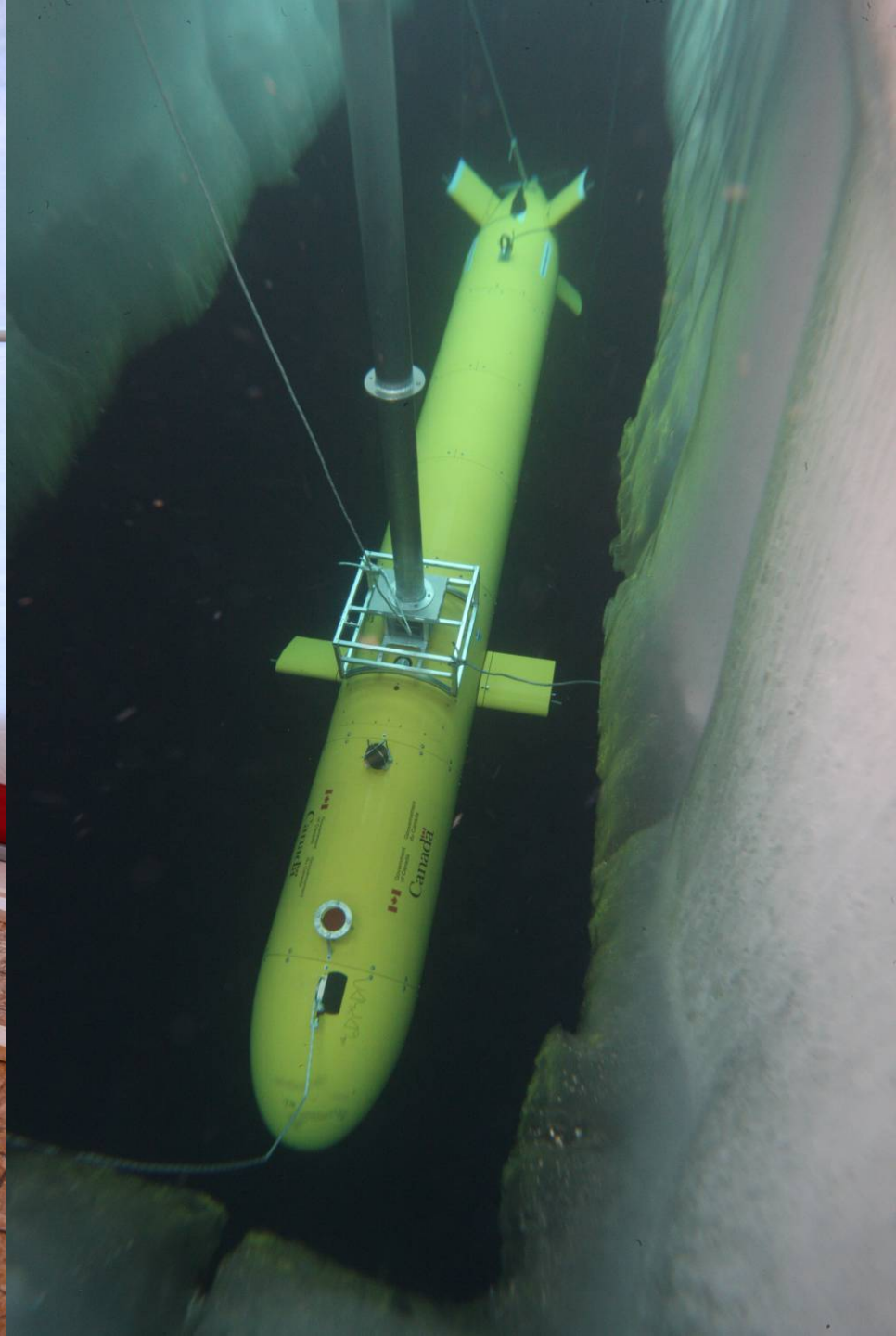
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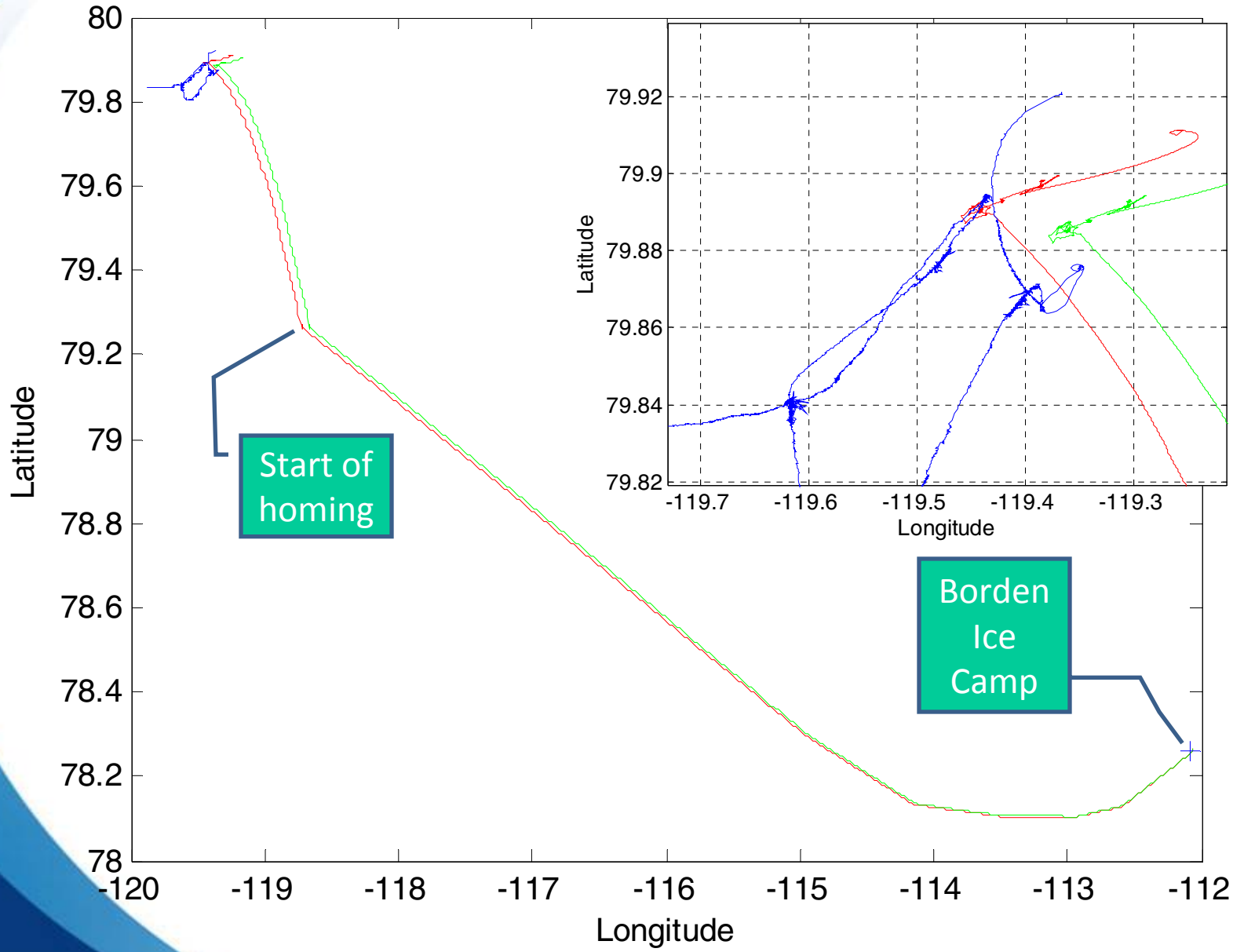
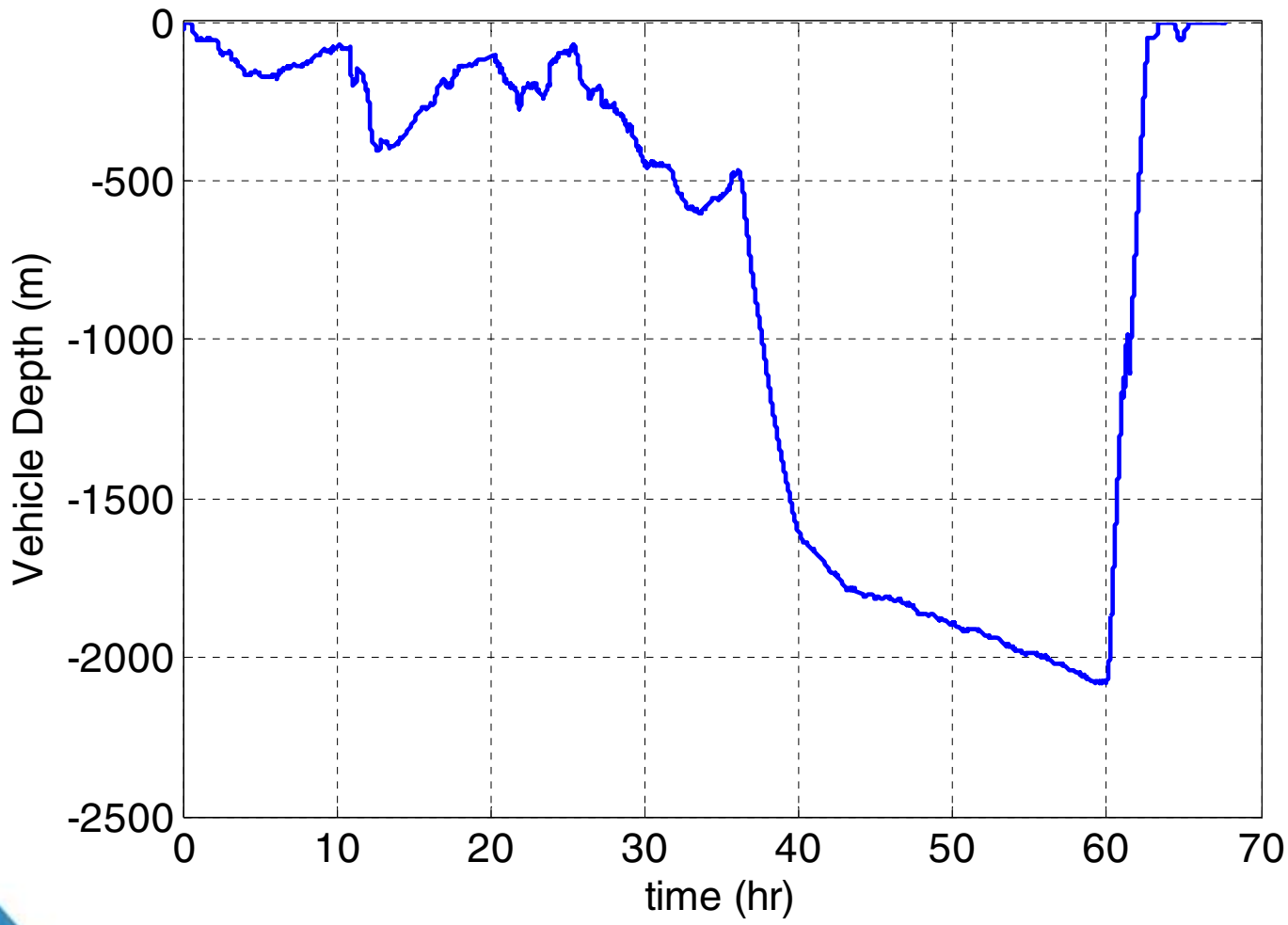
Transit to the Remote Camp

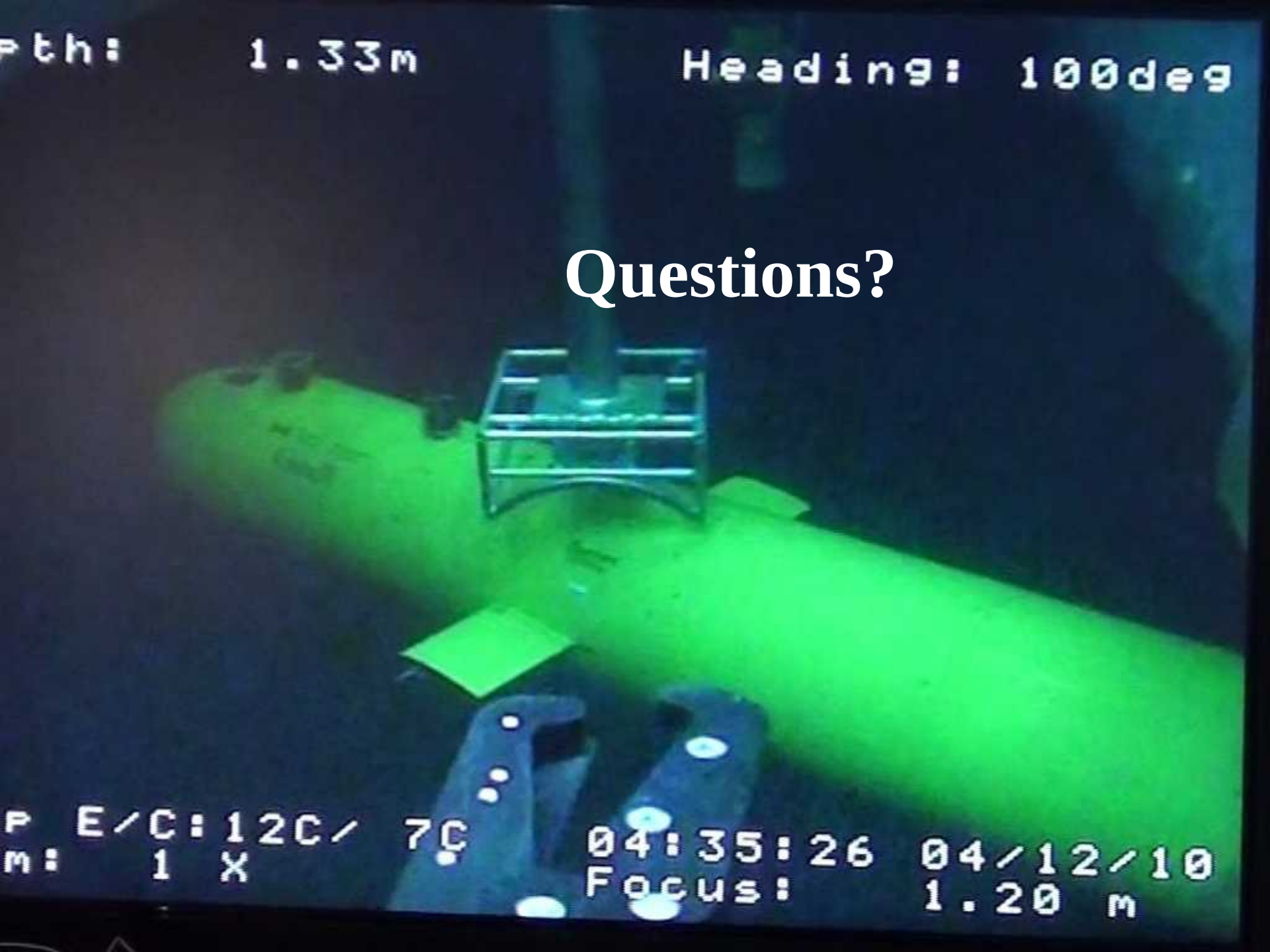


Vehicle Depth during transit to Remote Camp



How did it all end?

- We completed 3 long missions.
- Vehicle traveled over 1000 km!
- Vehicle was at times 3 km under water!
- And we didn’t break anything ….


pth: 1.33m
Heading: 100deg
p E/C:12C/ 7C
m: 1 X
04:35:26 04/12/10
Focus: 1.20 m

Questions?