Exploration Under Ice with new Polar AUV

Neil Bose, Principle

Peter King, AUV Facility coordinator

Australian Maritime College

pdking@utas.edu.au

18 October 2017

Under-Ice Exploration and Research

- How the oceans melt Antarctic ice shelves, and quantifying present and future Antarctic Ice Sheet mass loss and its contribution to sea-level rise?

- What are controls on marine life, from pelagic microbes to benthic communities?

- What is the contribution of the Antarctic Ice Sheet to sea level since the Last Glacial Maximum (~20,000 years ago)?

(Antarctic Gateway Partnership)

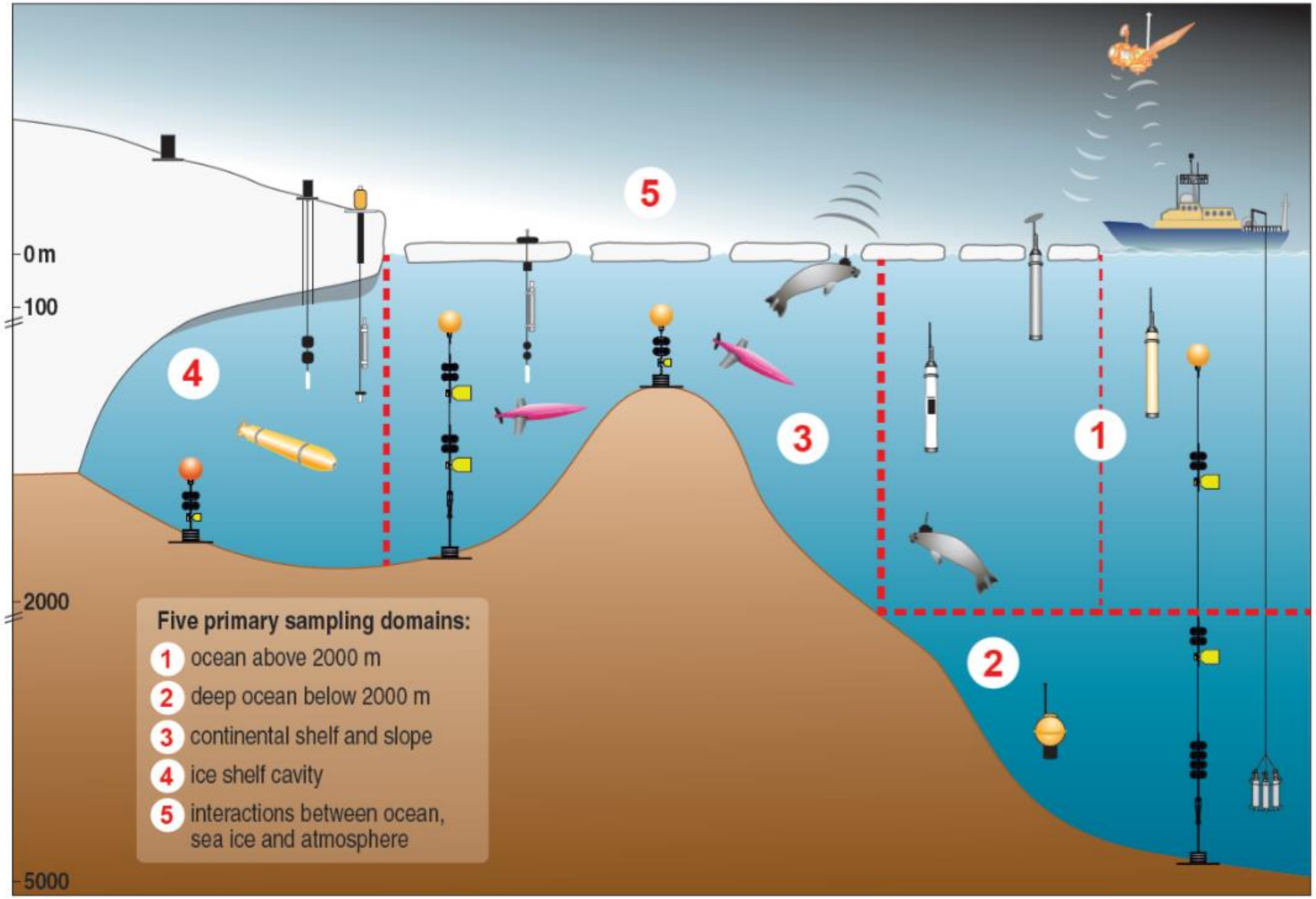


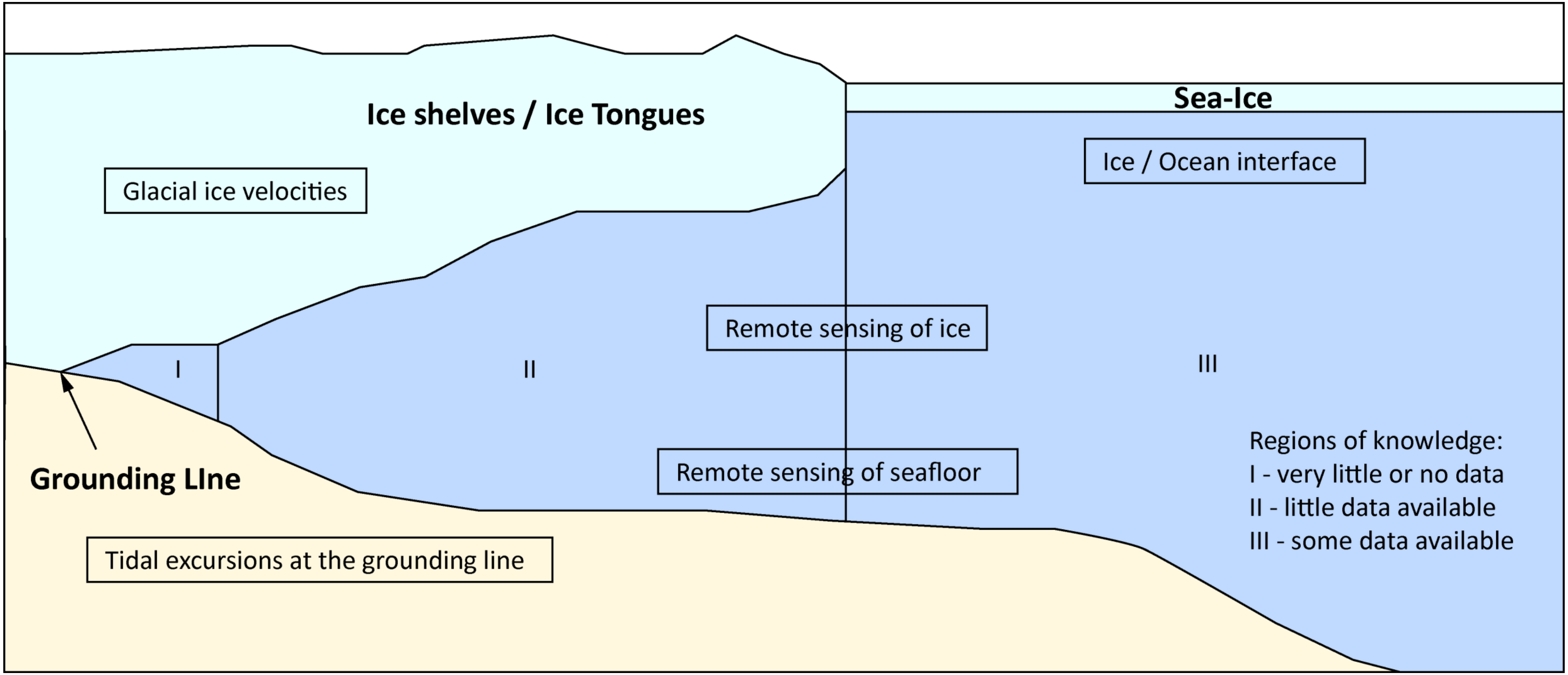
Figure 15: The high latitude Southern Ocean and Antarctic margin includes several physical environments, each with distinct characteristics that mean a different mix of platforms is appropriate in each case. See the Tables below for a summary and explanation of the observing strategy in each domain..

SOOS: Seeing Below The ice, 2014

Challenges: Environmental Uncertainty

- Shape of the ice
- Dynamics of ice
- Extent of the cavity
- Shape of the seafloor

Challenges: Environmental Uncertainty

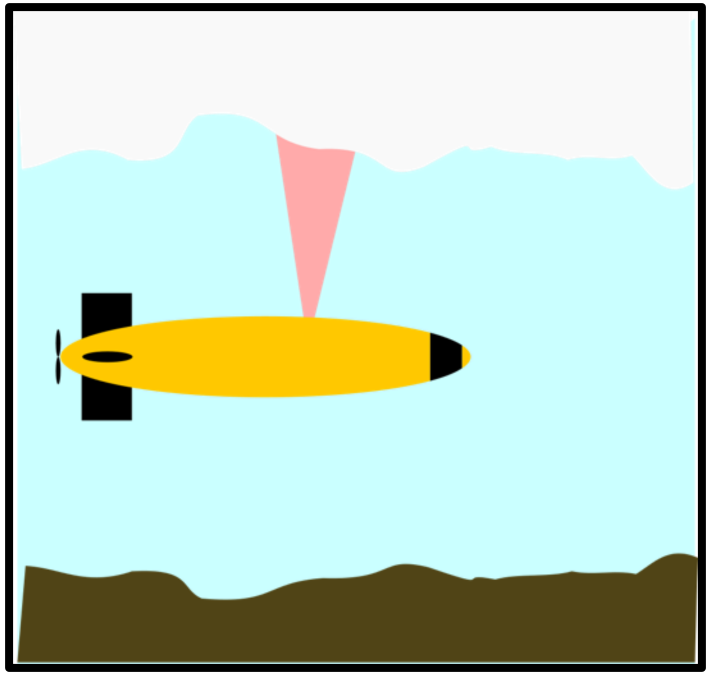


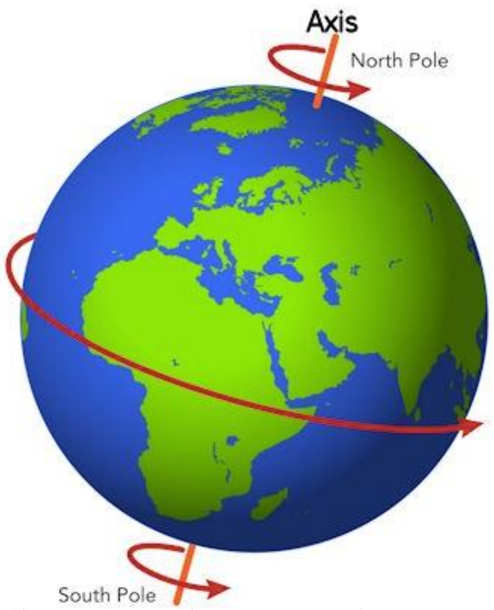
Solutions: Environmental Uncertainty

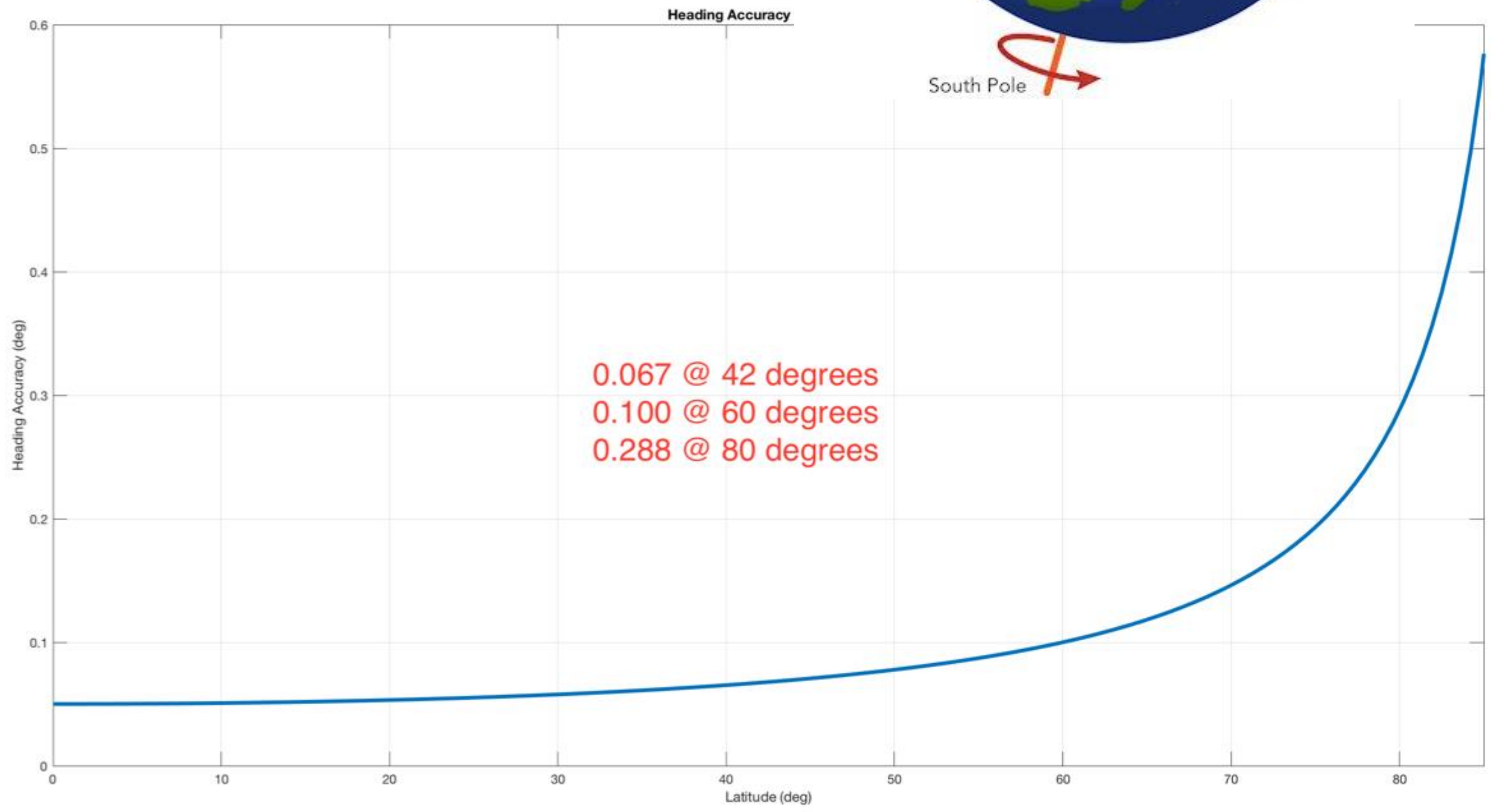
- Smarter AUVs
  - Adaptive missions
  - Decision making
- Improved communications/infrastructure
- Planning
  - Iterative approaches
  - Simulation

Challenges: Navigation

- Heading
- Speed
- Infrastructure







Challenges: Navigation

- Best case scenario is 0.1% of distance travelled
  - 2.5m/s x 1hour X 0.001 = 10m per hour (240m in 24hr)

- Worse case is 12%
  - 1,100m per hour (26.4km)

- Real case example is 1.6% *
  - 144m per hour (3.4km)

* McEwen et al, Performance of an AUV navigation system at Arctic Latitudes. Journal of Oceanic Engineering, 2005.

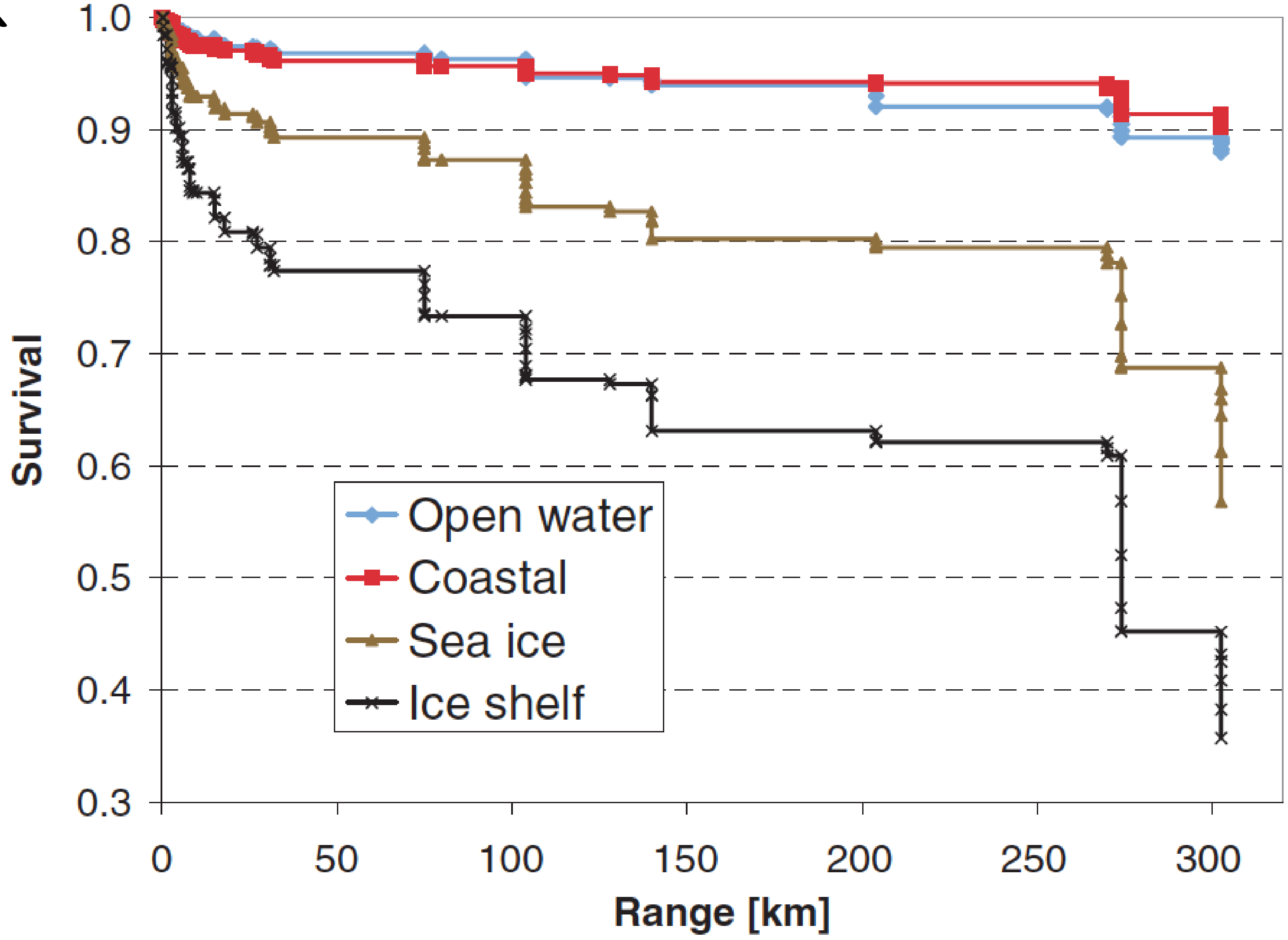
Solutions: Navigation

- Infrastructure
  - Long-range communications (fiber?)
  - Homing

- Smarter AUVs
  - Improved navigation
  - Sensor feedback for error bounding (TAN, SLAM)
  - Relative navigation
    - Path Following
    - Visual homing

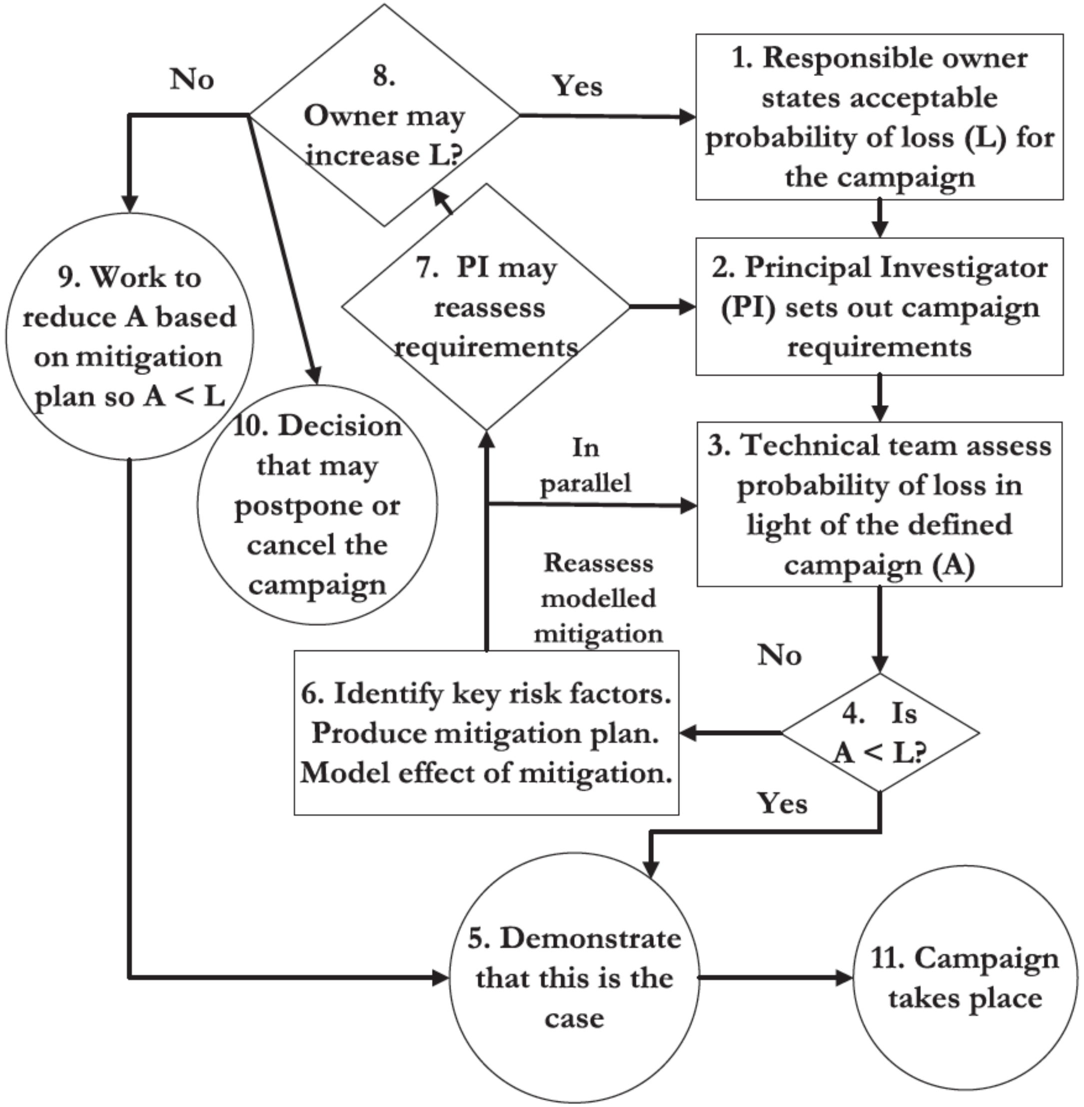
Challenges: Risk

- Beneath the ice, nearly any fault can become fatal



Brito et al, Risk Analysis for AUV operations in extreme environments. Risk analysis, 2010

Solutions: Risk

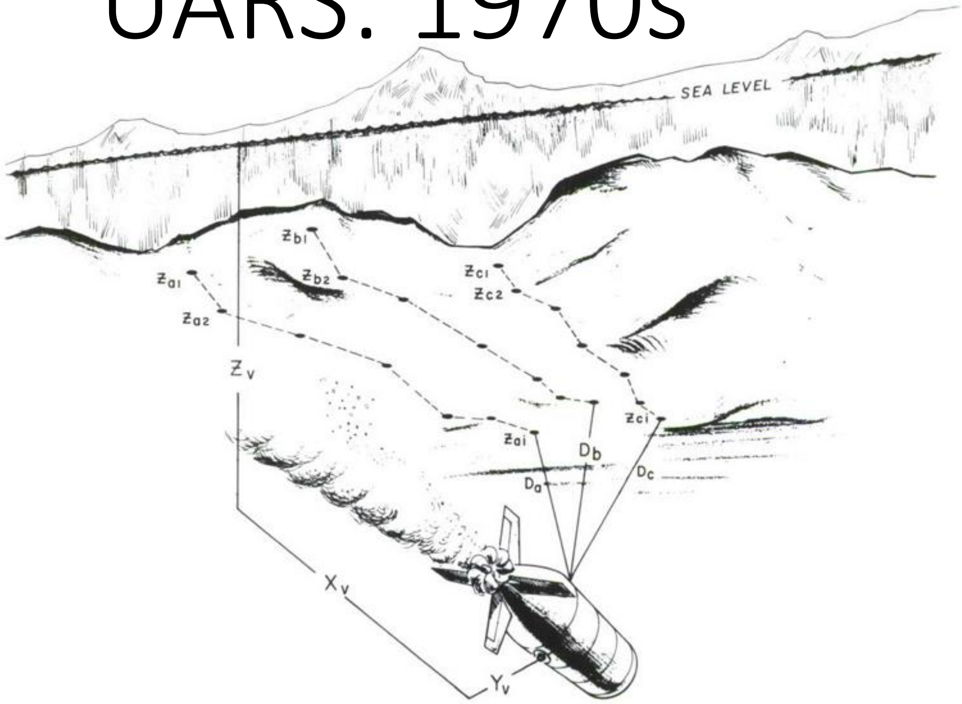


- Better understanding
- Better models
- Risk centric approaches (Brito et al)
- Better Planning

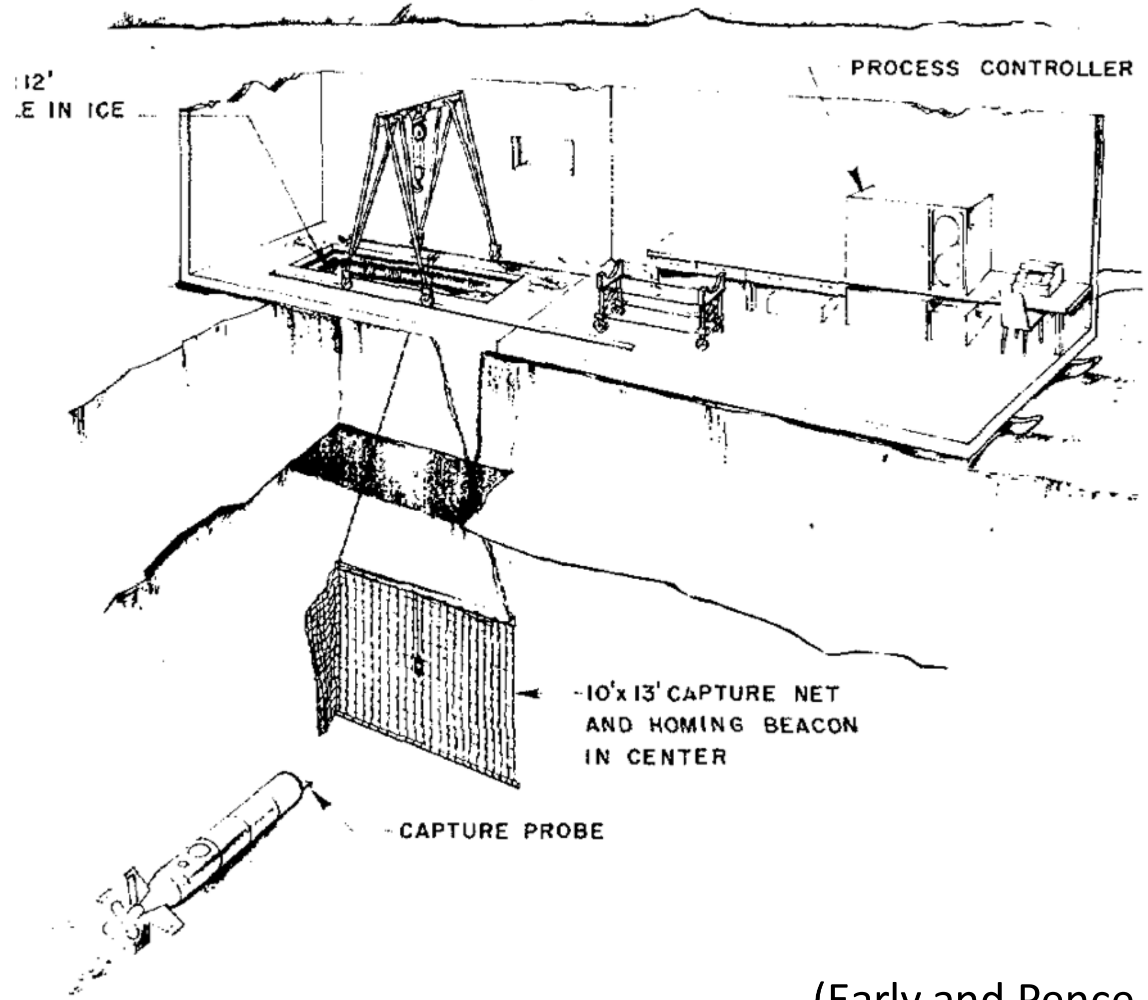
Brito et al, Risk Analysis for AUV operations in extreme environments. Risk analysis, 2010

A brief history of under-ice AUVs

UARS: 1970s

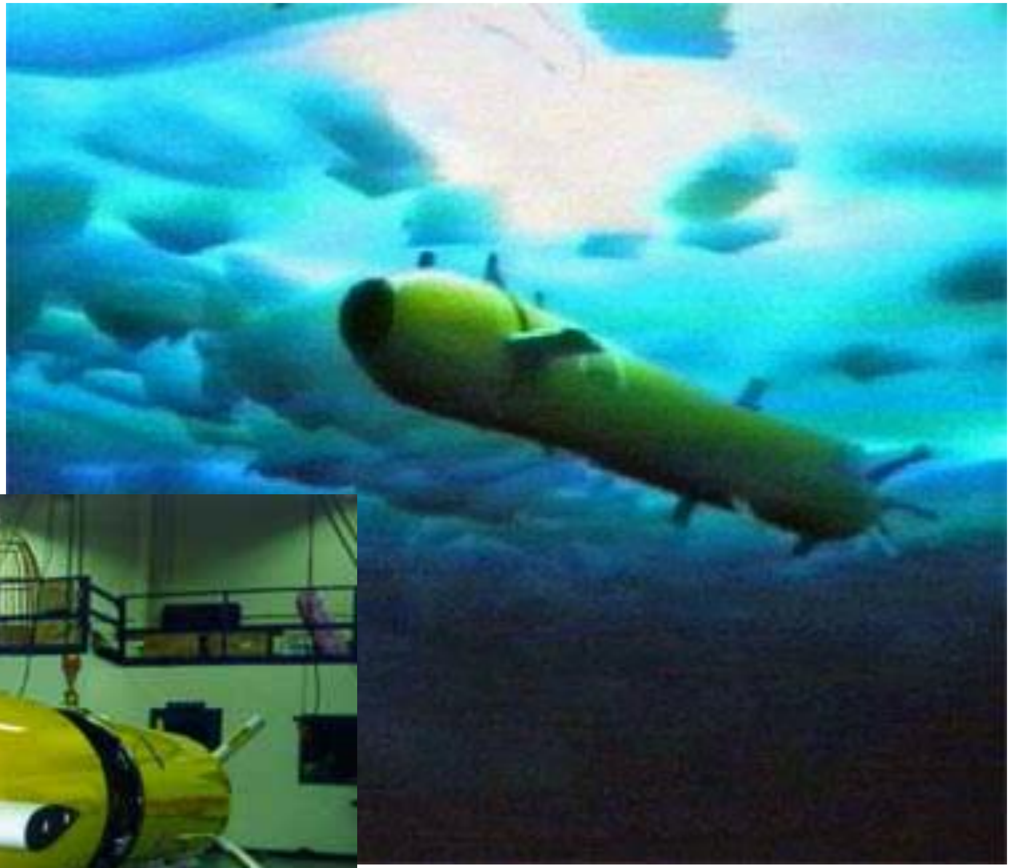


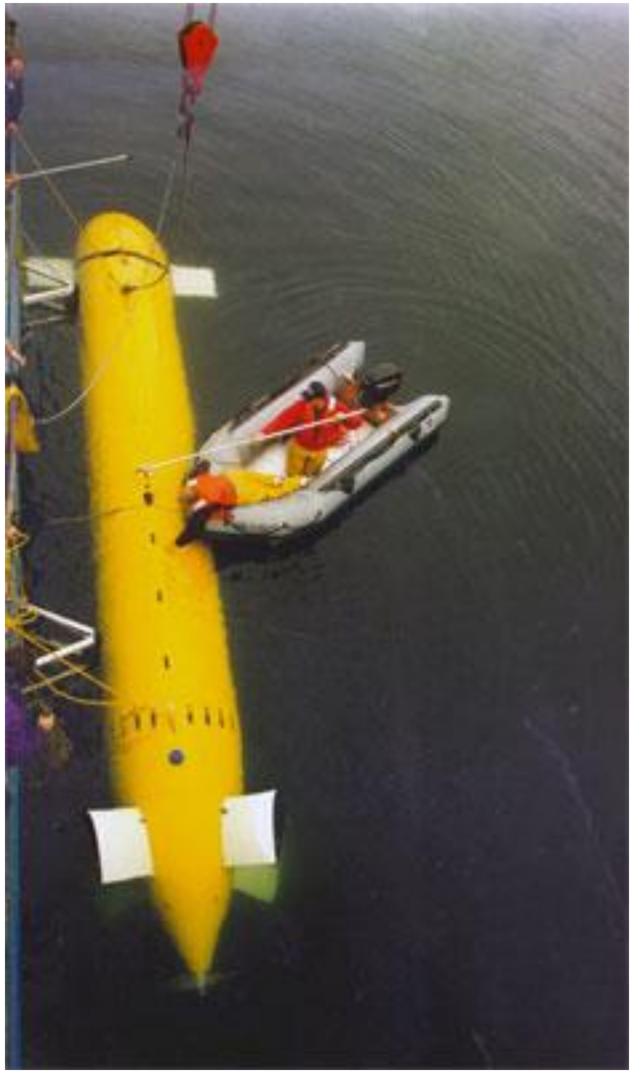
(Francois and Nodland 1972)

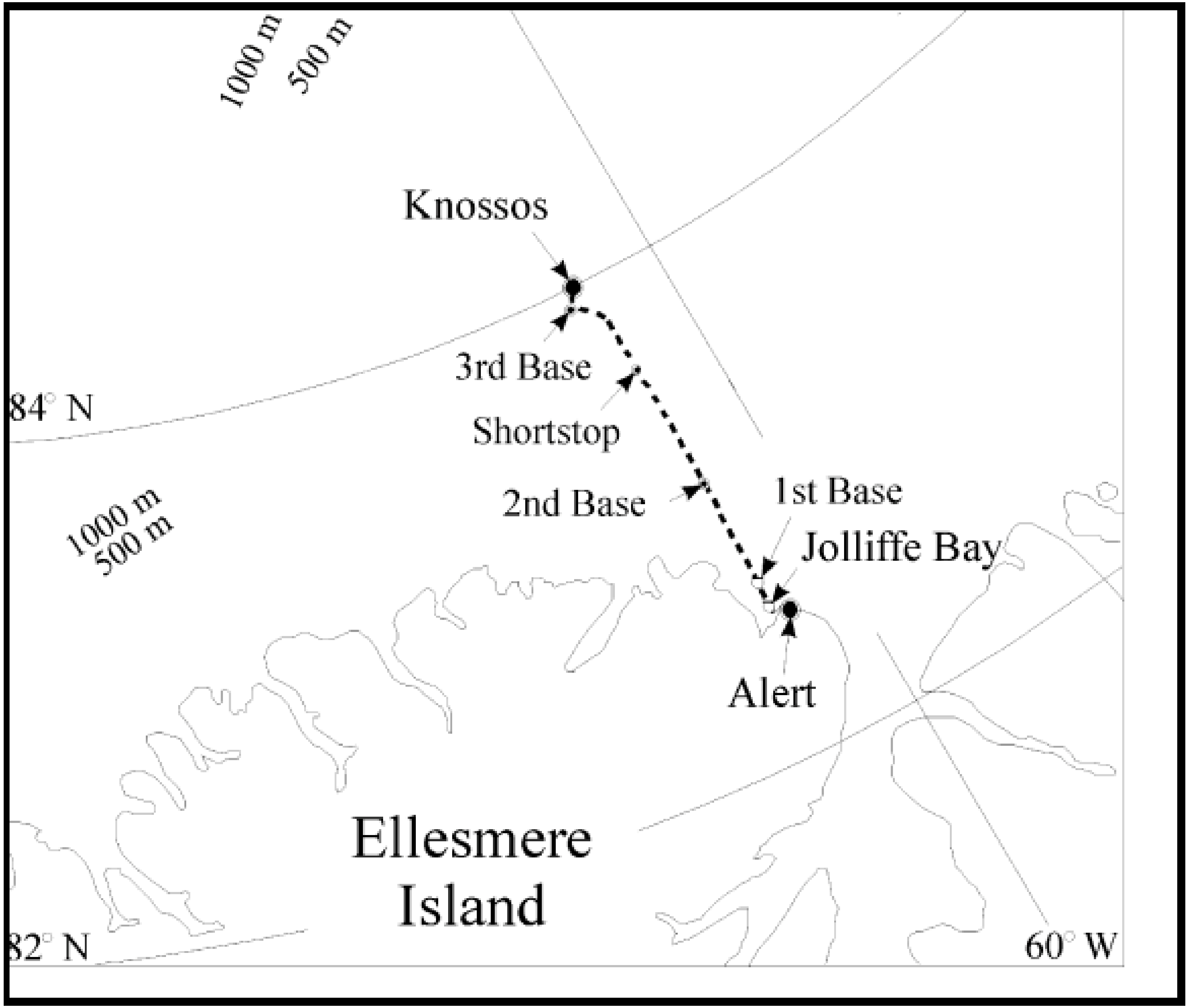


(Early and Pence 1972)

Theseus:1990s

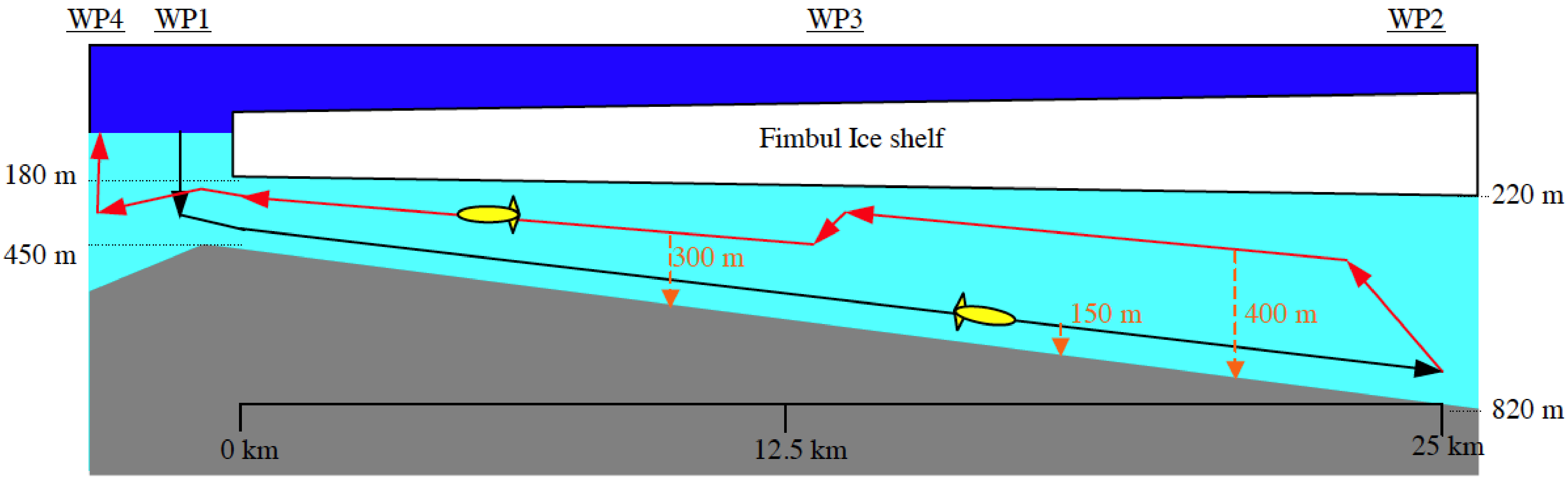





1000 m
500 m
Knossos
3rd Base
84° N
Shortstop
2nd Base
1st Base
1000 m
500 m
Jolliffe Bay
Alert
Ellesmere
Island
82° N
60° W

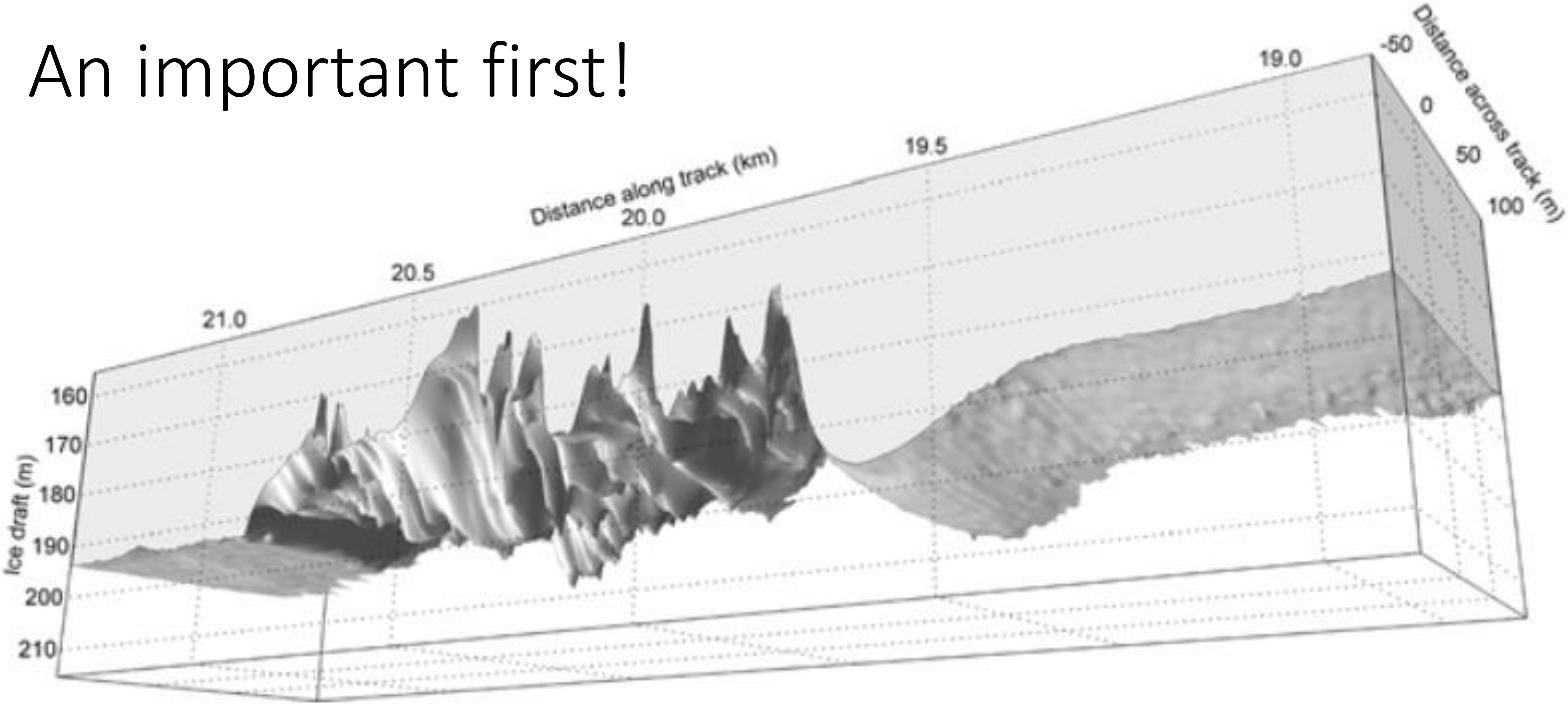
Autosub2: 2000s

A major first!



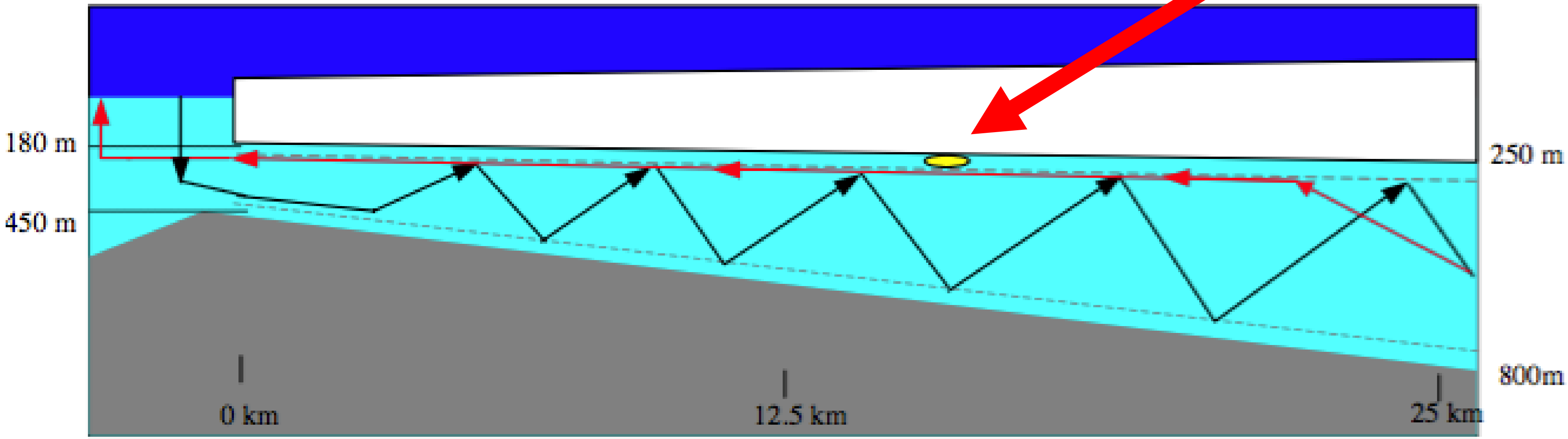
(jcr97)

An important first!



(Dowdeswell et al 2008)

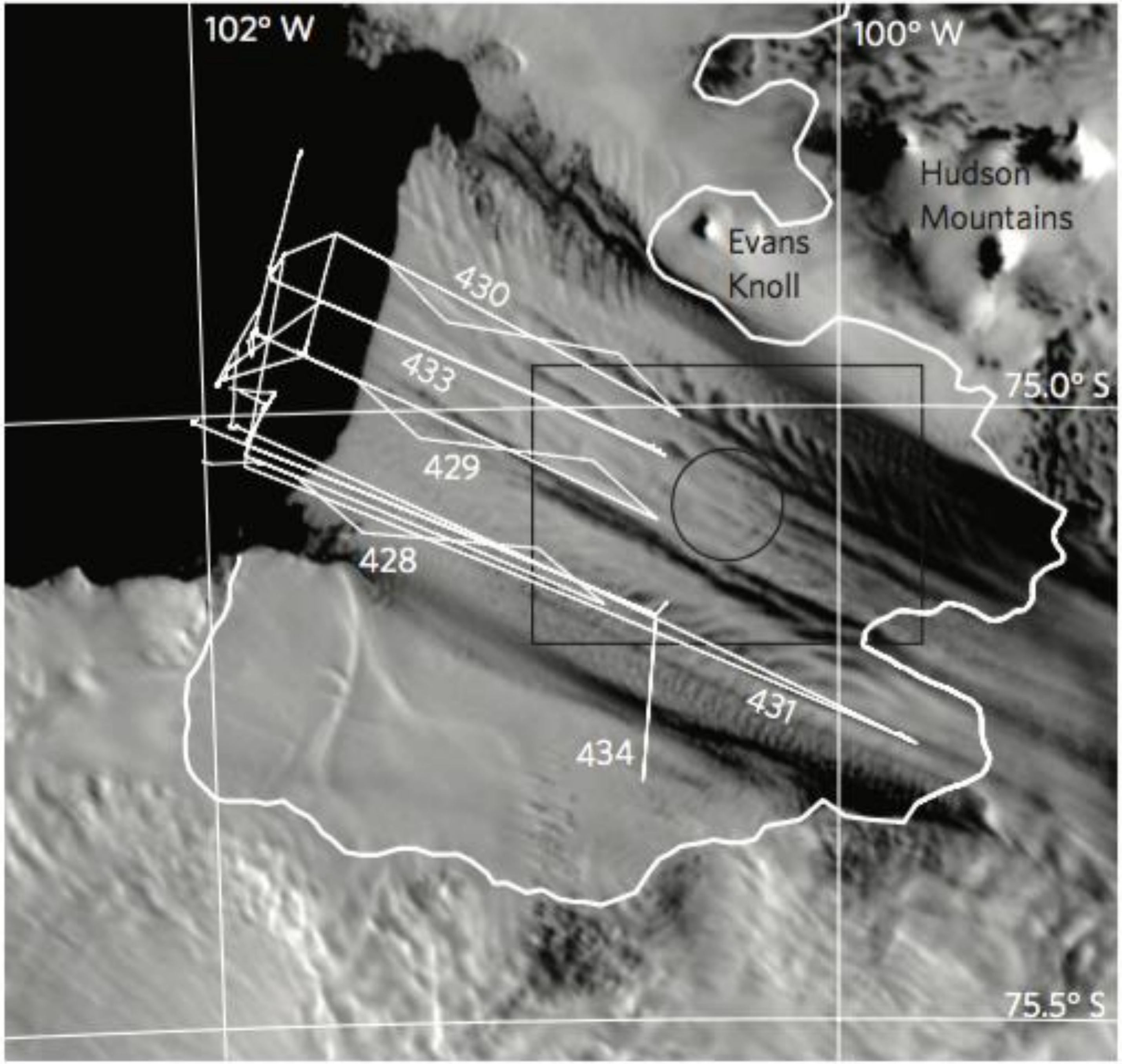
An unfortunate first



383	16/2/2005 07:34	-	Plan to profile in between 80 m off the seafloor to 80 m off the ice shelf, then turn and run reciprocal track, swathing the underside of the ice shelf at 80 m range.	Autosub lost 14km under the ice shelf. Presumed floating. Emergency beacon had dropped, and was transmitting at 1 minute interval, indicating "abort" state.

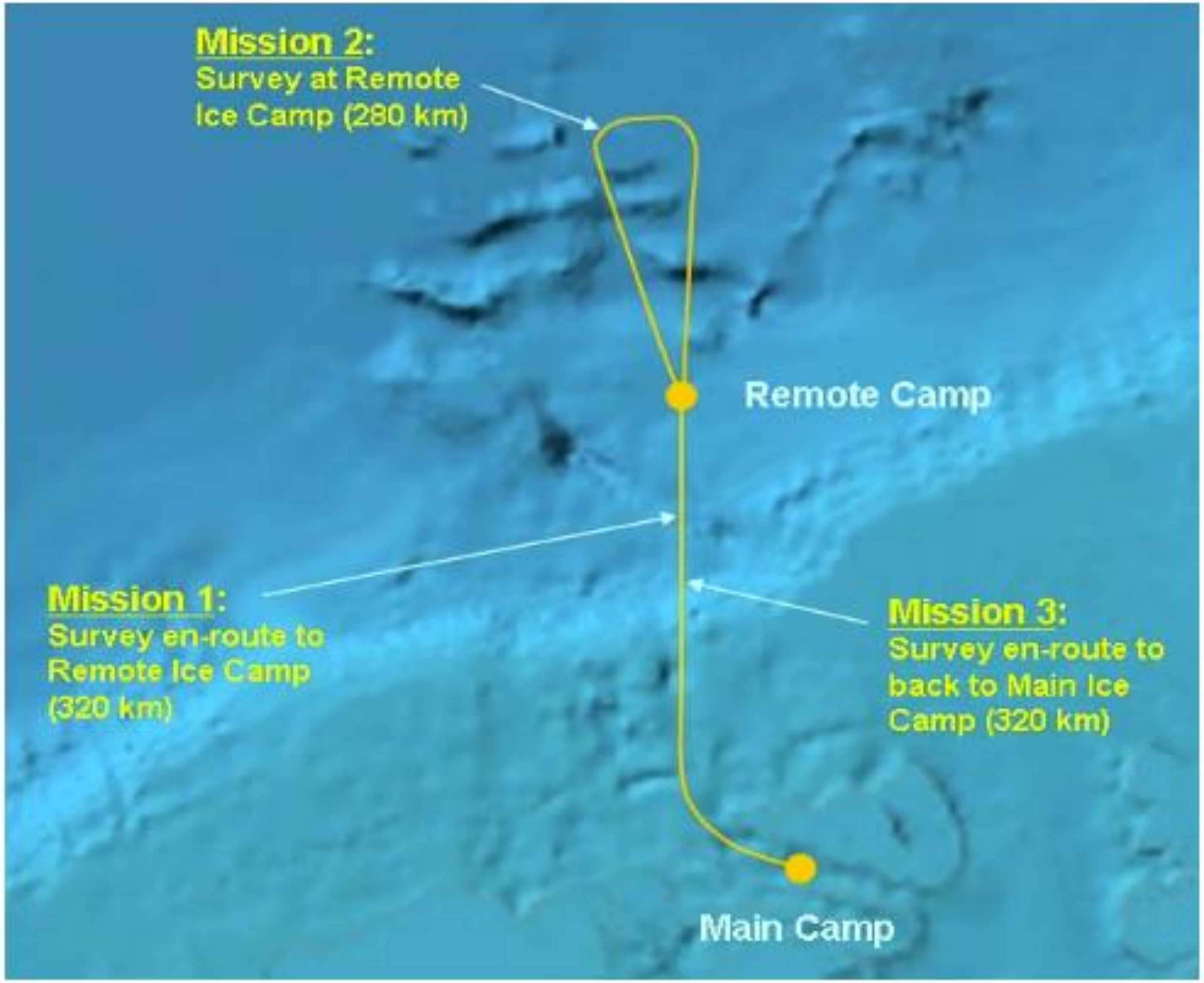
(JCR97)

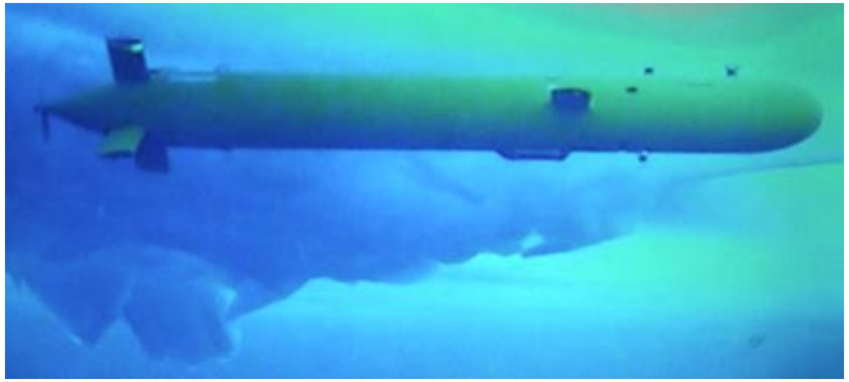
Autosub3

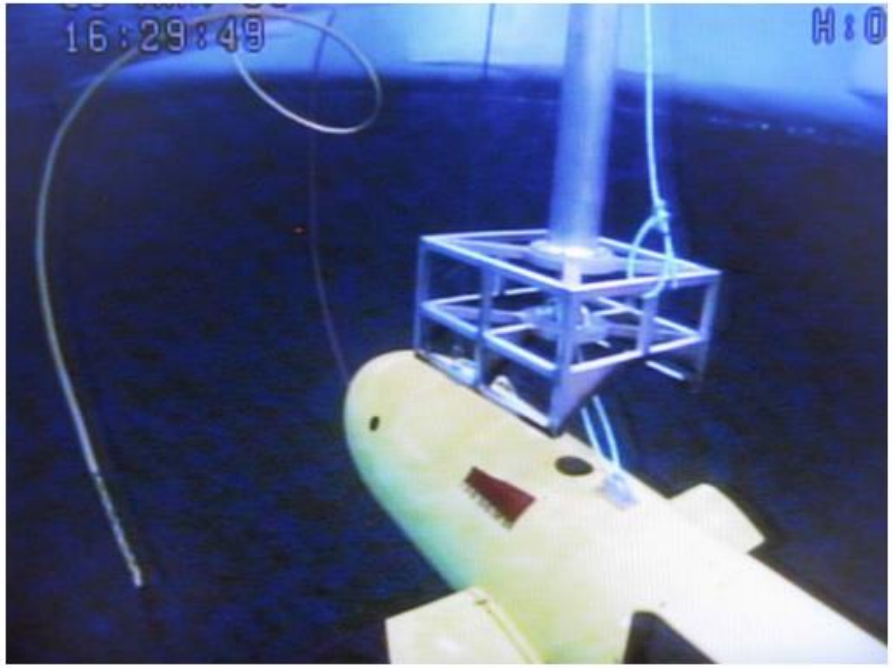


(Jenkins et al 2010)

And the record goes to …







(Kaminski et al 2010)

Antarctic Gateway Partnership Project

- Special Research Initiative of the Australian Research Council
- Build further polar research capability in Tasmania
- A Key objective being

  "Developing an innovative, next-generation, polar AUV to acquire high resolution data under sea ice and ice shelves"

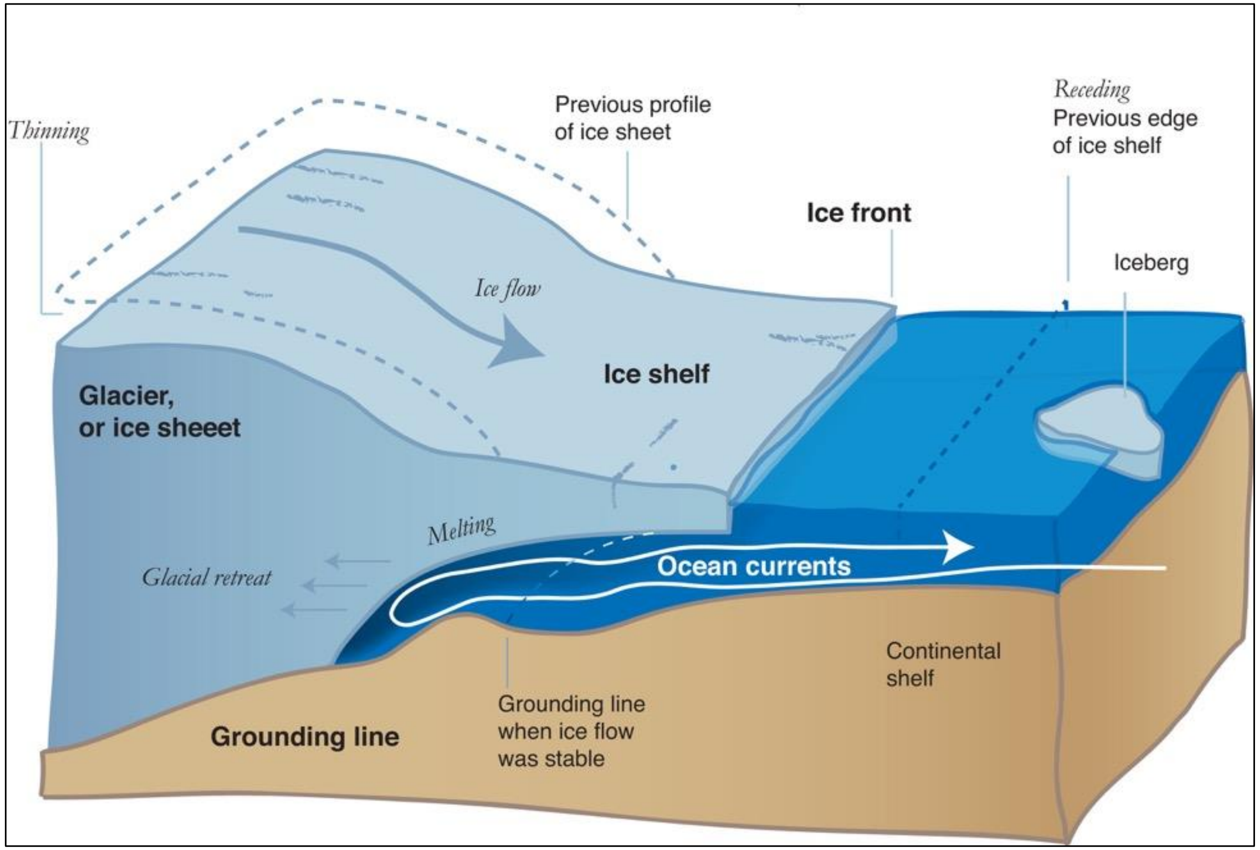
Australian Government
Australian Research Council

UNIVERSITY of TASMANIA AUSTRALIA

CSIRO

Australian Government
Department of the Environment and Energy
Australian Antarctic Division

Polar AUV Requirements

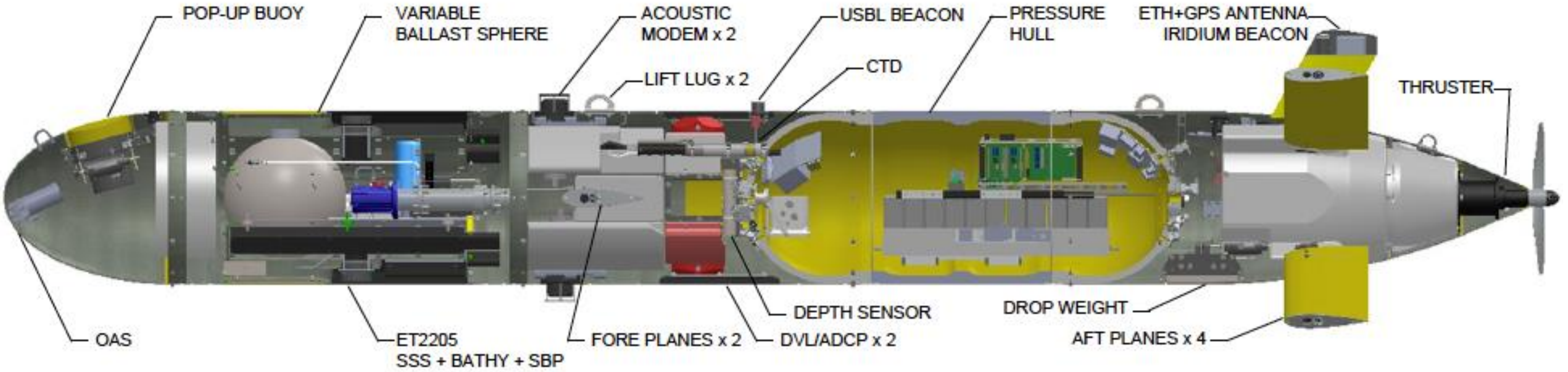


- Endurance of > 100km
- Flexible payload
  - Orientation + Additional payload modules
  - Advanced payloads
- Ice tracking and avoidance
- Landing/Parking capability
  - Seabed/under-ice
- Open architecture

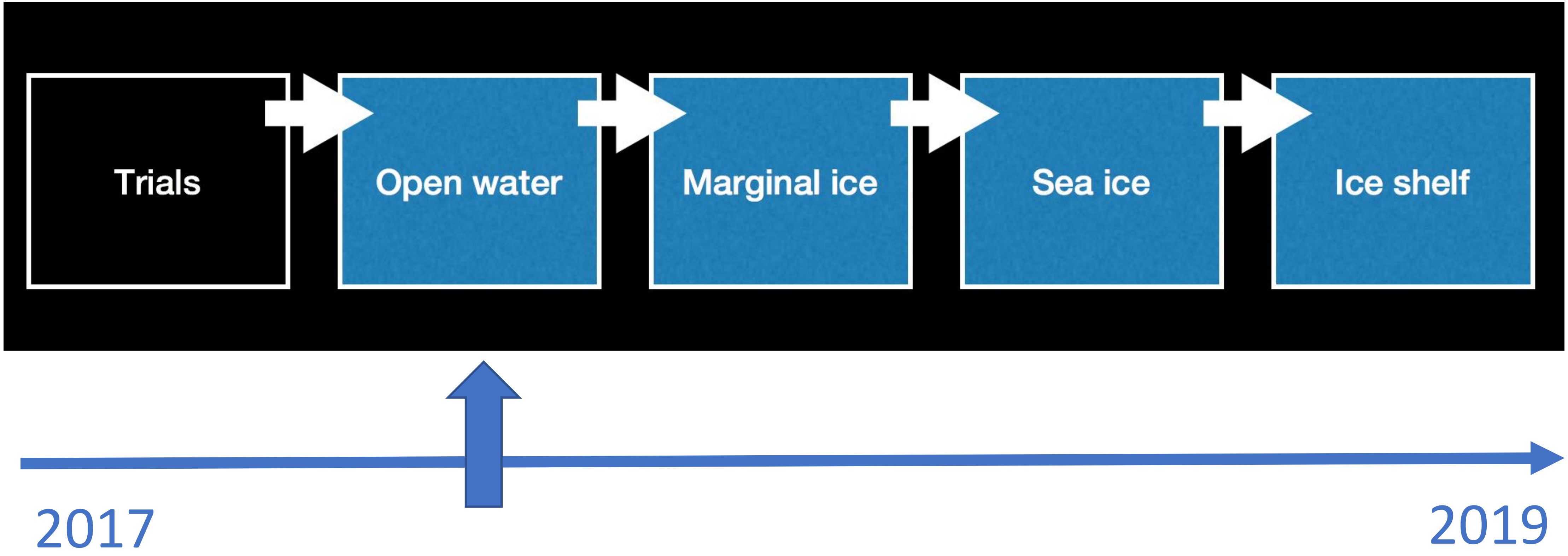
nupiri muka – eye of the sea

- Open tender awarded to International Submarine Engineering

ISE Explorer AUV



Progress



Questions?