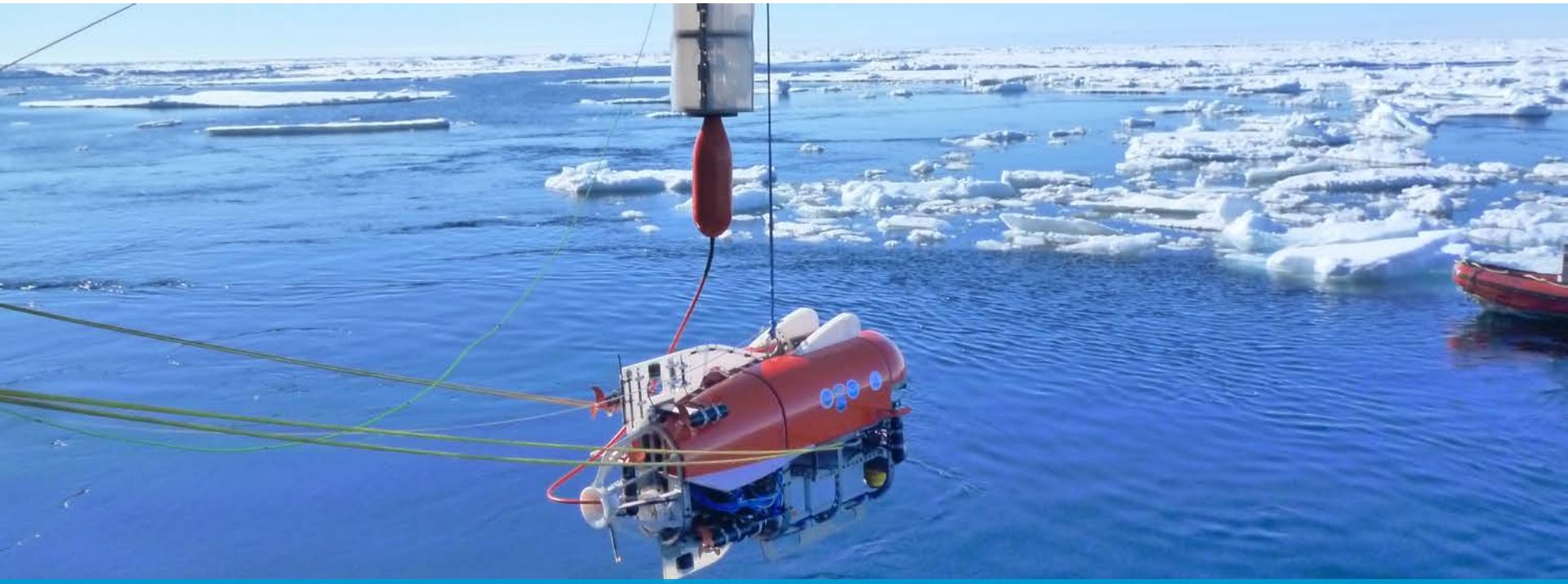
Christian Katlein
S. Arndt, H. J. Belter, M. Schiller , M. Nicolaus

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG



Remotely Operated Vehicles under sea ice – Experiences from five years of polar operations

Contributions by:

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

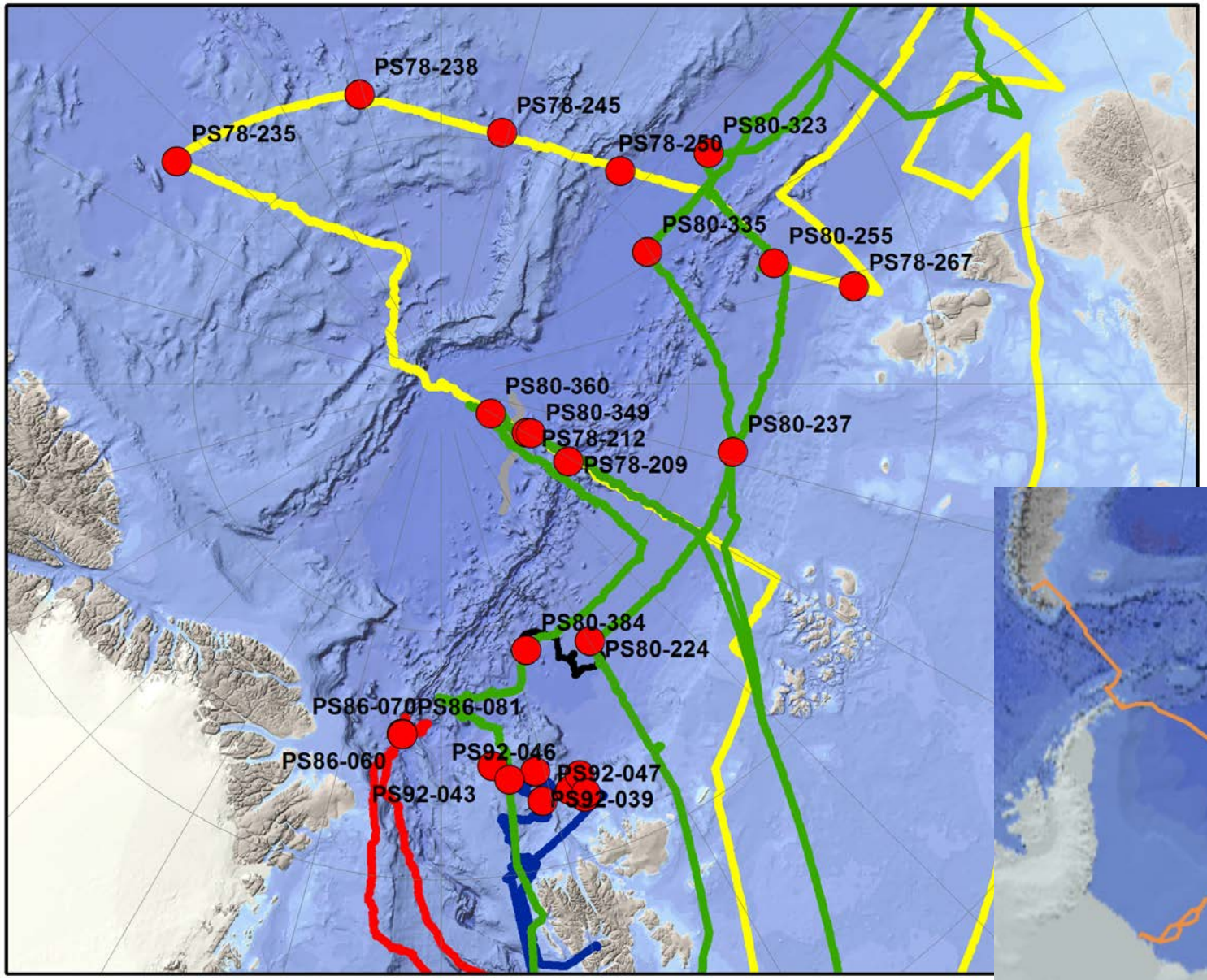
JOHNS HOPKINS WHITING SCHOOL of ENGINEERING

POLMAR

HELMHOLTZ GEMEINSCHAFT

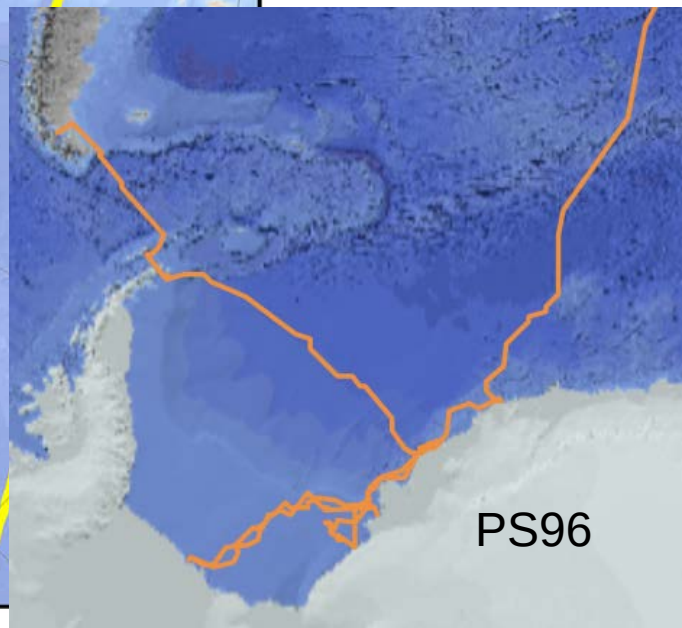
Typical sea ice sampling vs. ROV

Expeditions (4 Arctic + 1 Antarctic)



upcoming:

- Sep/Oct 2016
  Karasik seamnt.
- Jun/July 2017
  5 week drift
- Dec 2017
  Weddell Sea



Observation class ROV


Ocean Modules V8

Photo: SAAB SeaEye

Weight: 60 kg
Range: 200 m
Operators: 2-3

- operated from the ice
- high maneuverability
- limited payload

SAAB SeaEye Falcon (AAD)

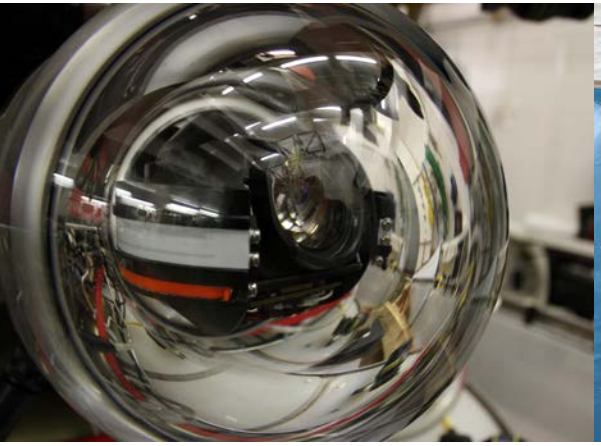
Nereid Under-Ice (NUI)

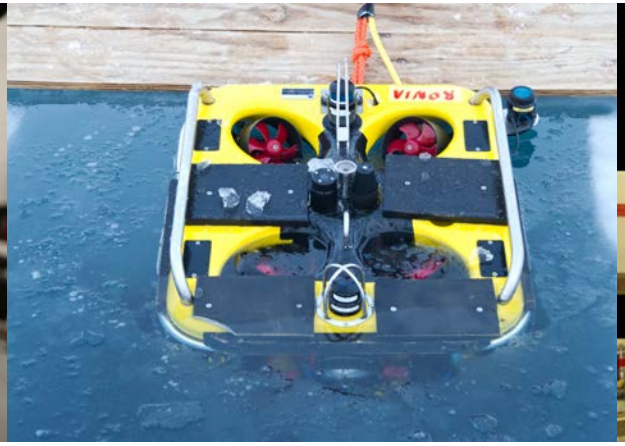
- Light-fiber tether
- Piloted / autonomous
- Multiple sensors:
  - Radiometers → light
  - Multibeam sonar → ice topography
  - …

WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930

Interdisciplinary sensor suite

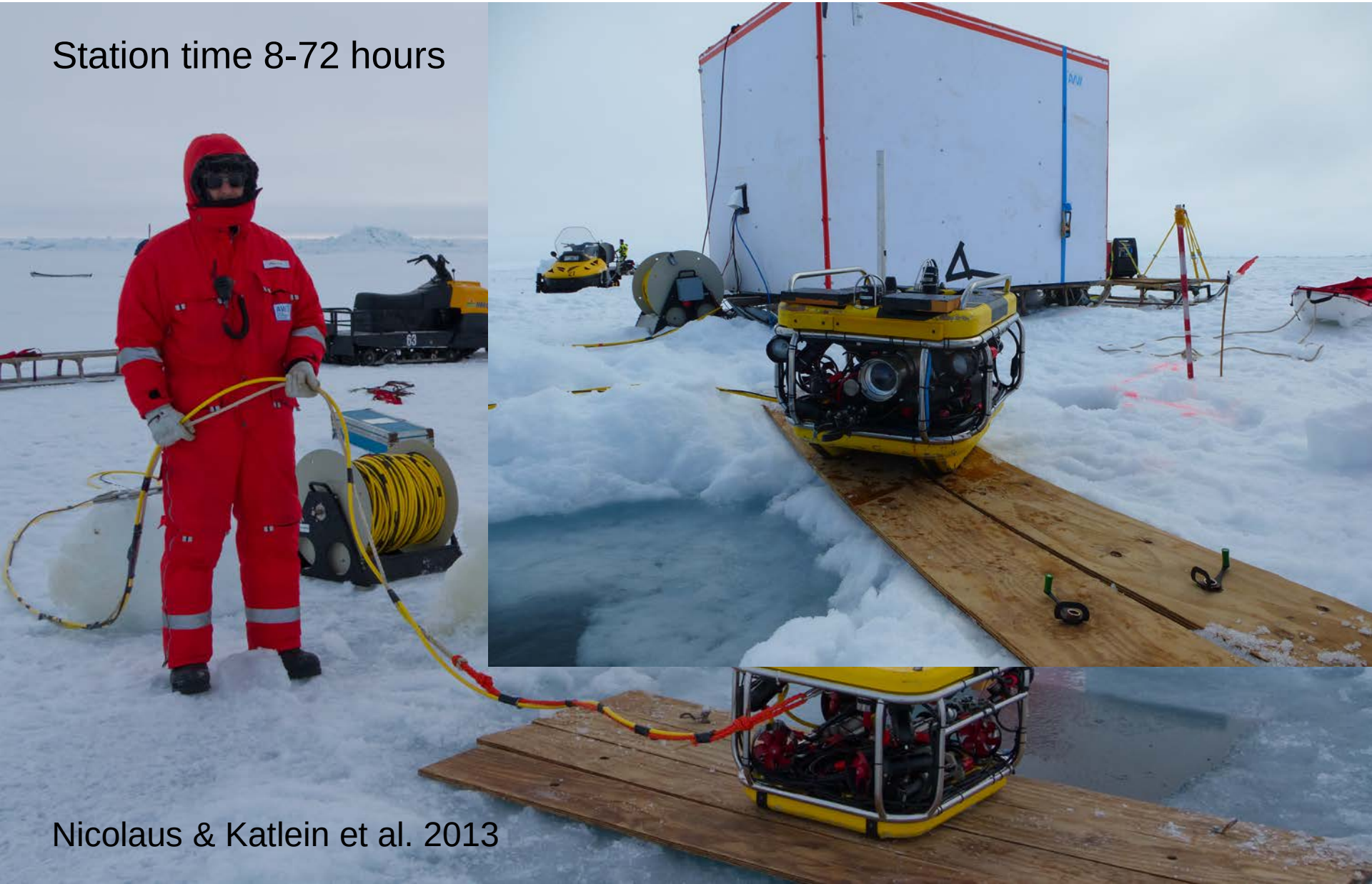
- Sonars (Imaging/Altimeter/ Multibeam)
- Cameras (HD/ upward looking)
- Light sensors
- CTD / Fluorometers





Deployment (floe)

Station time 8-72 hours



Nicolaus & Katlein et al. 2013


Control cabin (650 kg)
Skidoo


Crane


heated


Helicopter

Deployment (ship)

- Easy logistics
- Maintain ice free hole for operation
  → strong currents
- Danger by Ship Propeller

- **Necessary for large platforms**

Video

Complications under sea ice

- **Investigated Objects above Vehicle**
- **Obstacles are above Vehicle**
- **Surfacing only possible in one location**

- **Sea Ice Drifts (@ ~0.5kn)!**

Paradigm shif in vehicle operation

- tether trim (slightly heavy)
- vehicle trim (slightly sinking)
- navigation acoustics (toroidal geometry)
- ice relative navigation
  (no geographic coordinates for floe surveys)
- during summer no lights necessary

- contingency plan (sink & pull)

Pole problem

- no stable magnetic north in the vicinity of the pole
- Arctic only
- affects vehicle stabilization

- standard compass: >5000nT

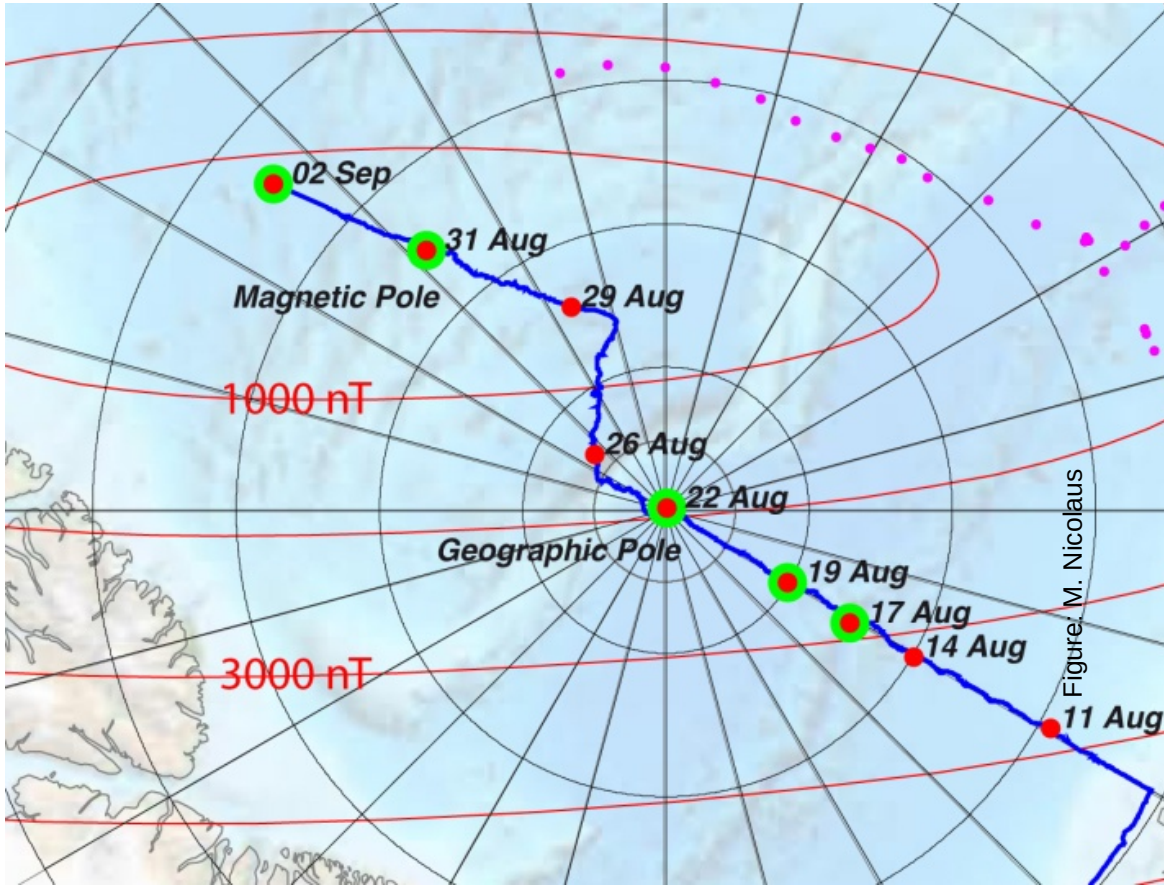
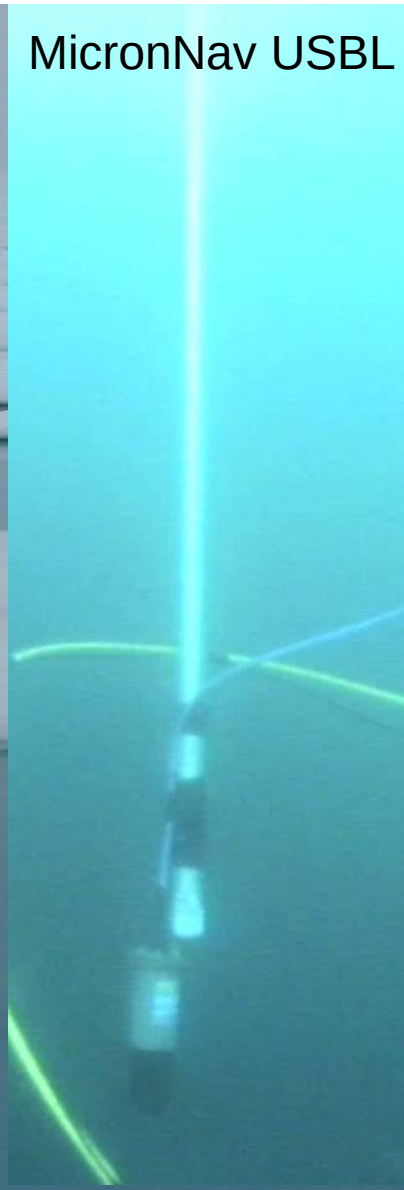


Figure: M. Nicolaus

Navigation solutions

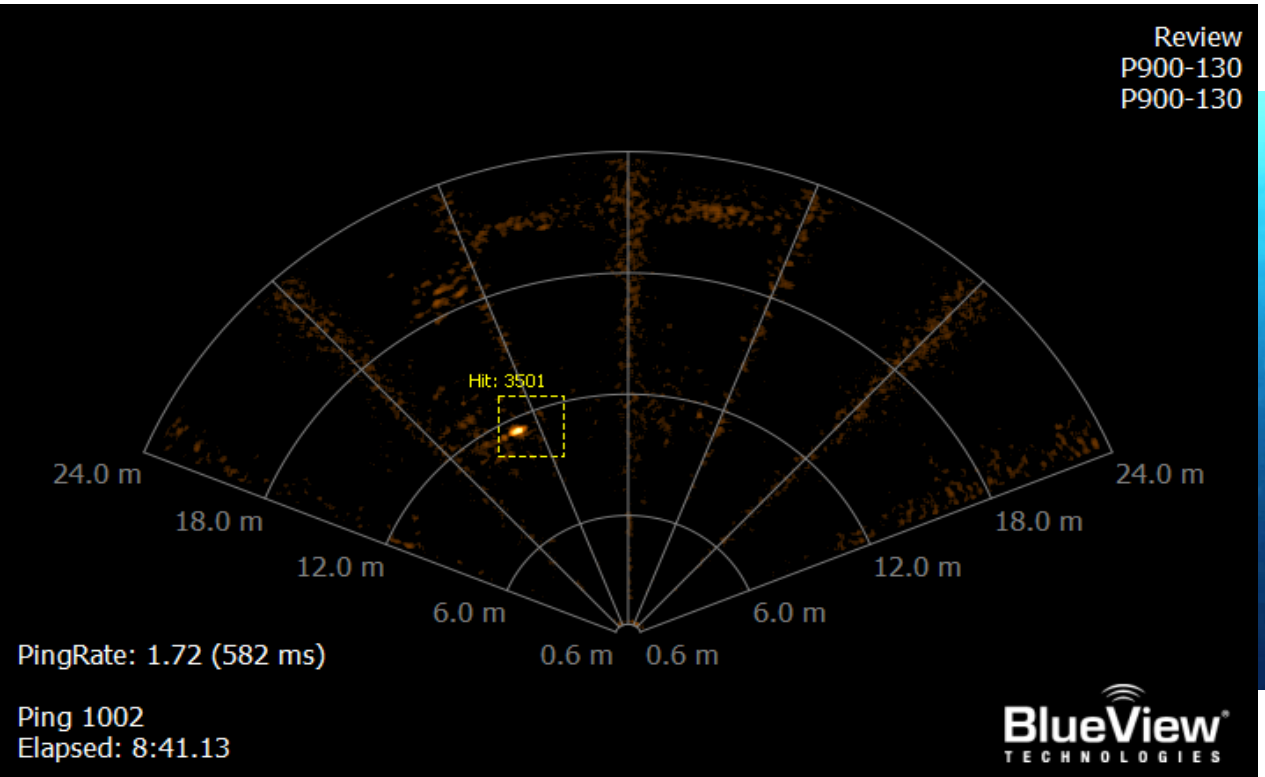
- Marker Sticks
- Acoustic Positioning
  - USBL
  - LBL
- Dead Reckoning
  - Inertial Navigation (INS)
  - Up DVL (‚Bottom track‘)



MicronNav USBL

Co-Location with surface

- Detect Marker Sticks in Imaging Sonar
- combine with Vehicle navigation (DR/LBL/USBL) → ice relative coordinates



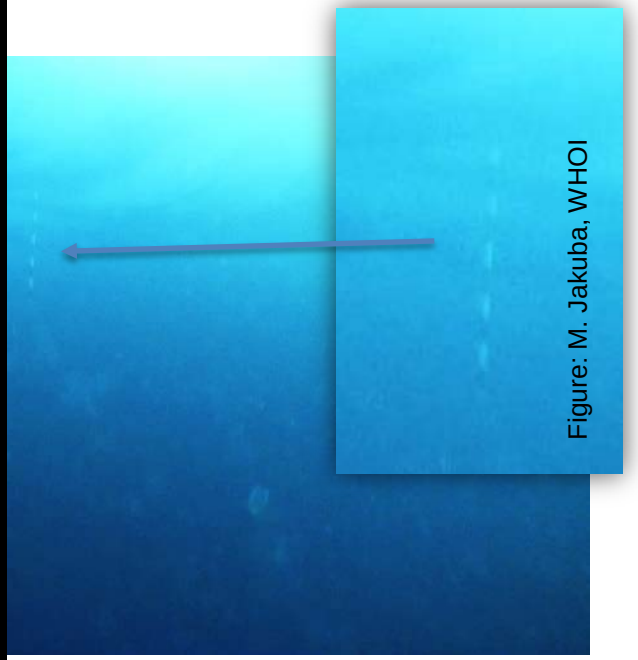
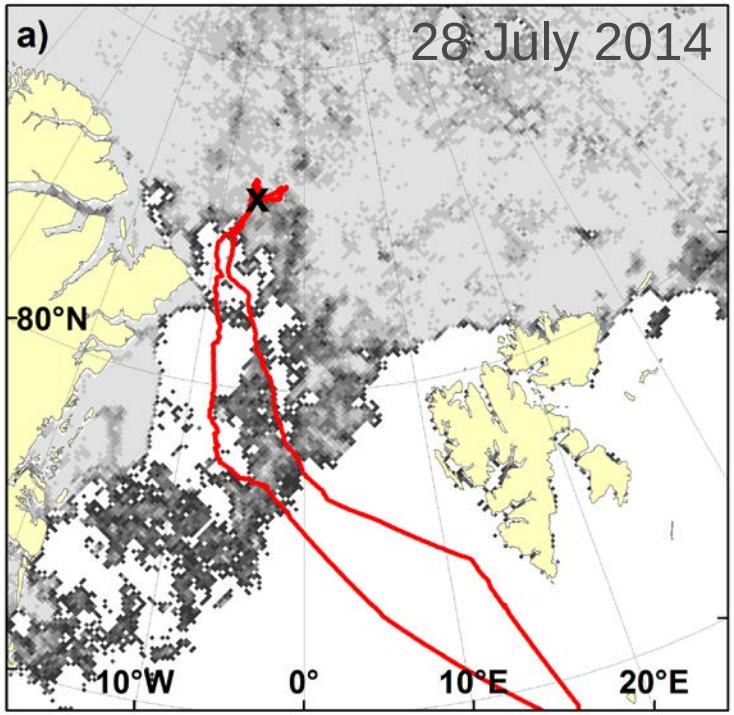


Figure: M. Jakuba, WHOI

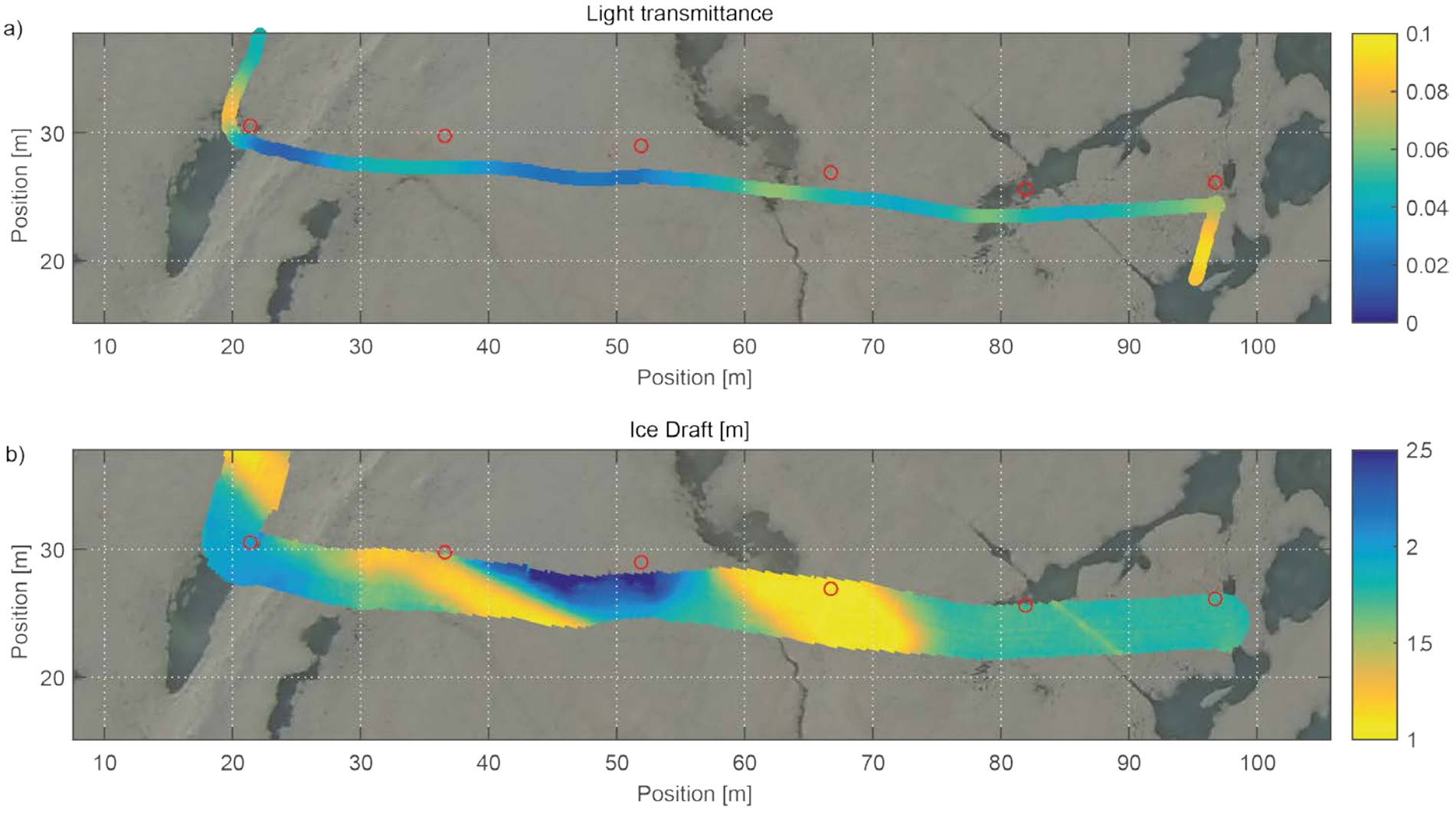
Coordinated survey

Pole survey

- Optics
- Topography
- Drillholes
- Aerial image



Results



Katlein et al. 2015

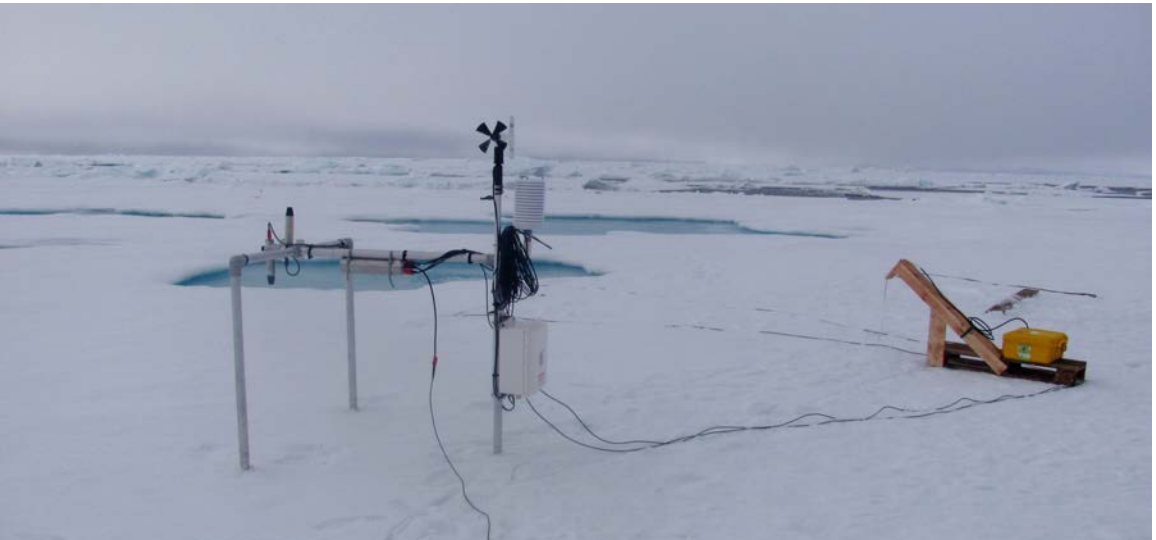
AWI Infrastructure Program FRAM

- NEW observation class vehicle
- rental systems → owned system
- extended payload:
  - multi-beam sonar
  - transmissometer
  - flourometers
  - CTD / O_2
  - Nitrate
  - manipulation & sampling

graphics: OceanModules product brochure

Sensors on buoys

- Investigate seasonal variability:
  - Radiation station (in house)
  - New Ice Mass Balance Buoys (BAS/BRUNCIN)
  - ITBOB (Ice Tethered Bio Optical Buoy - in house)
  - Profiling systems (WHOI-ITP, nke-Provor)



MOSAiC

·The 2019/20 Arctic drift experiment·

- www.mosaicobservatory.org
- 12 months drift experiment
- RV Polarstern
- Atmosphere, Sea Ice, Ocean, Biology

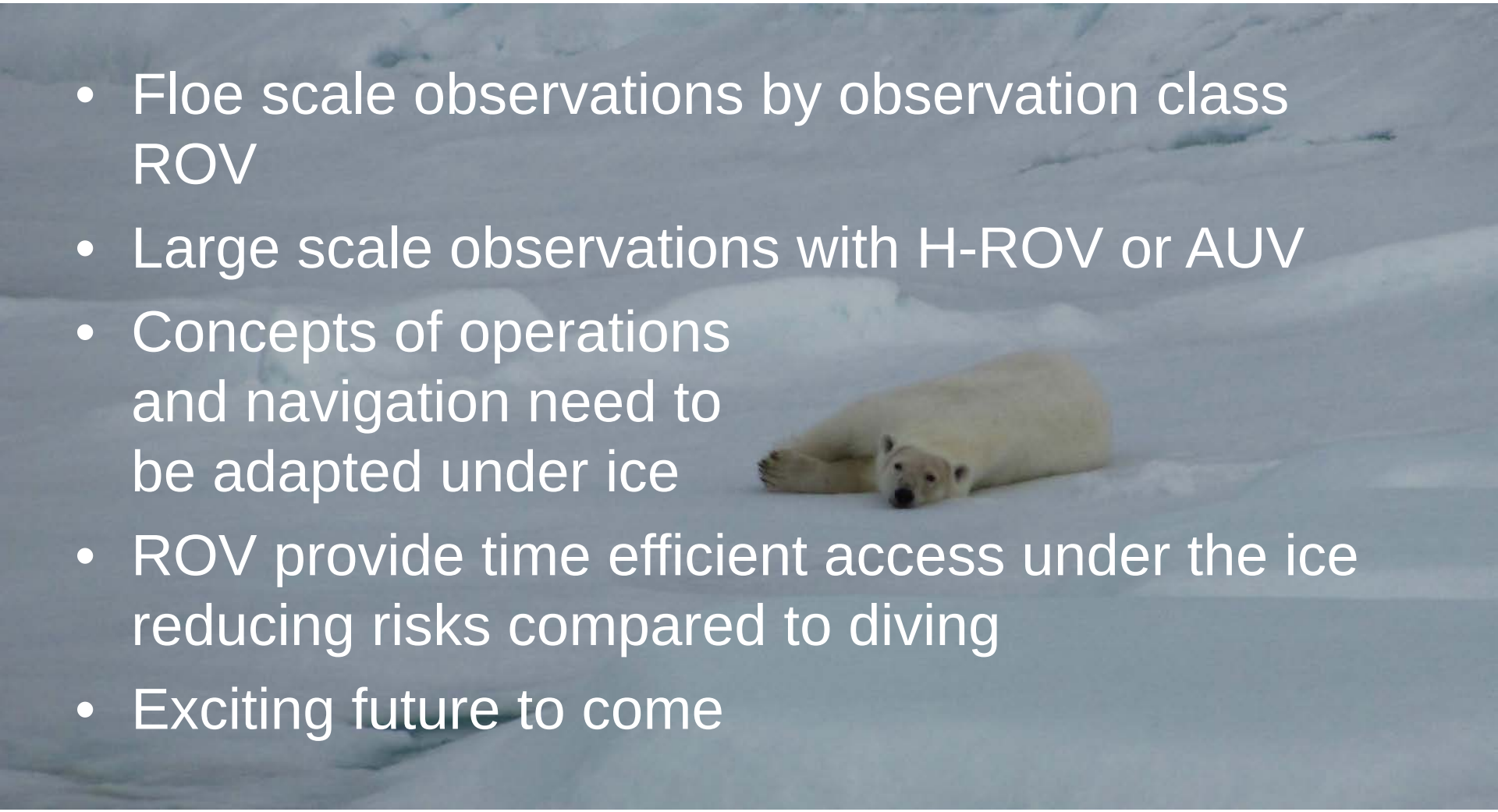
- Science plan & Implementation plan

- **Get involved!**

HELMHOLTZ GEMEINSCHAFT POLMAR

Summary

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG



- Floe scale observations by observation class ROV
- Large scale observations with H-ROV or AUV
- Concepts of operations and navigation need to be adapted under ice
- ROV provide time efficient access under the ice reducing risks compared to diving
- Exciting future to come

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