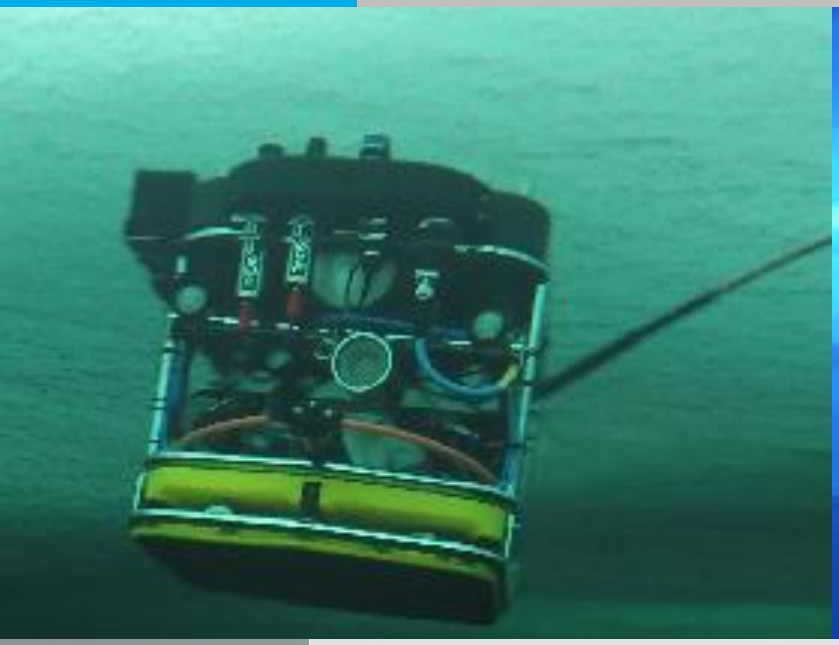
ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

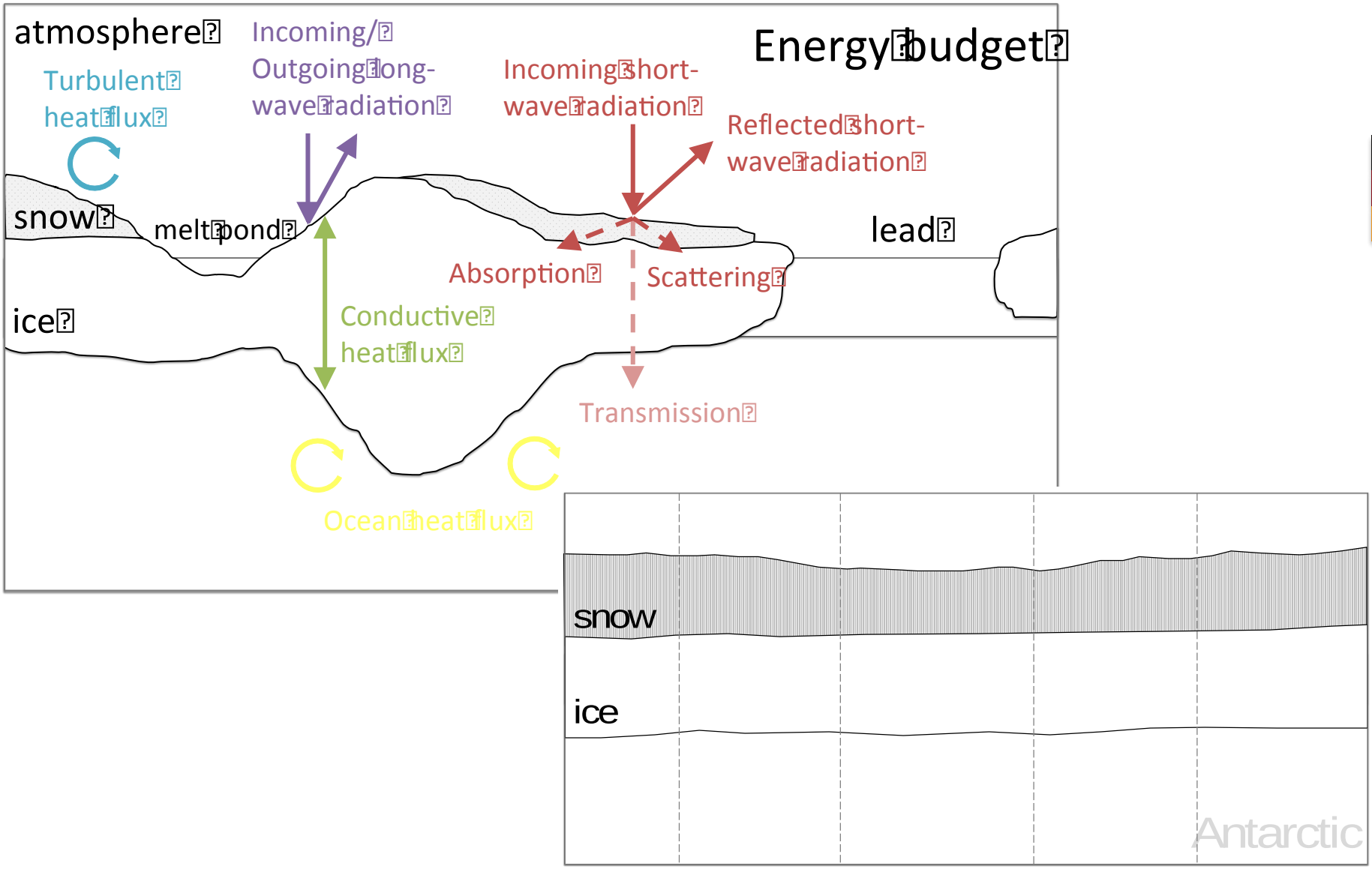
Stefanie Arndt, Klaus M. Meiners, Robert Ricker, Thomas Krumpen, Marcel Nicolaus, Christian Katlein, Benjamin Rabe, Martin Schiller, Daniel Scholz



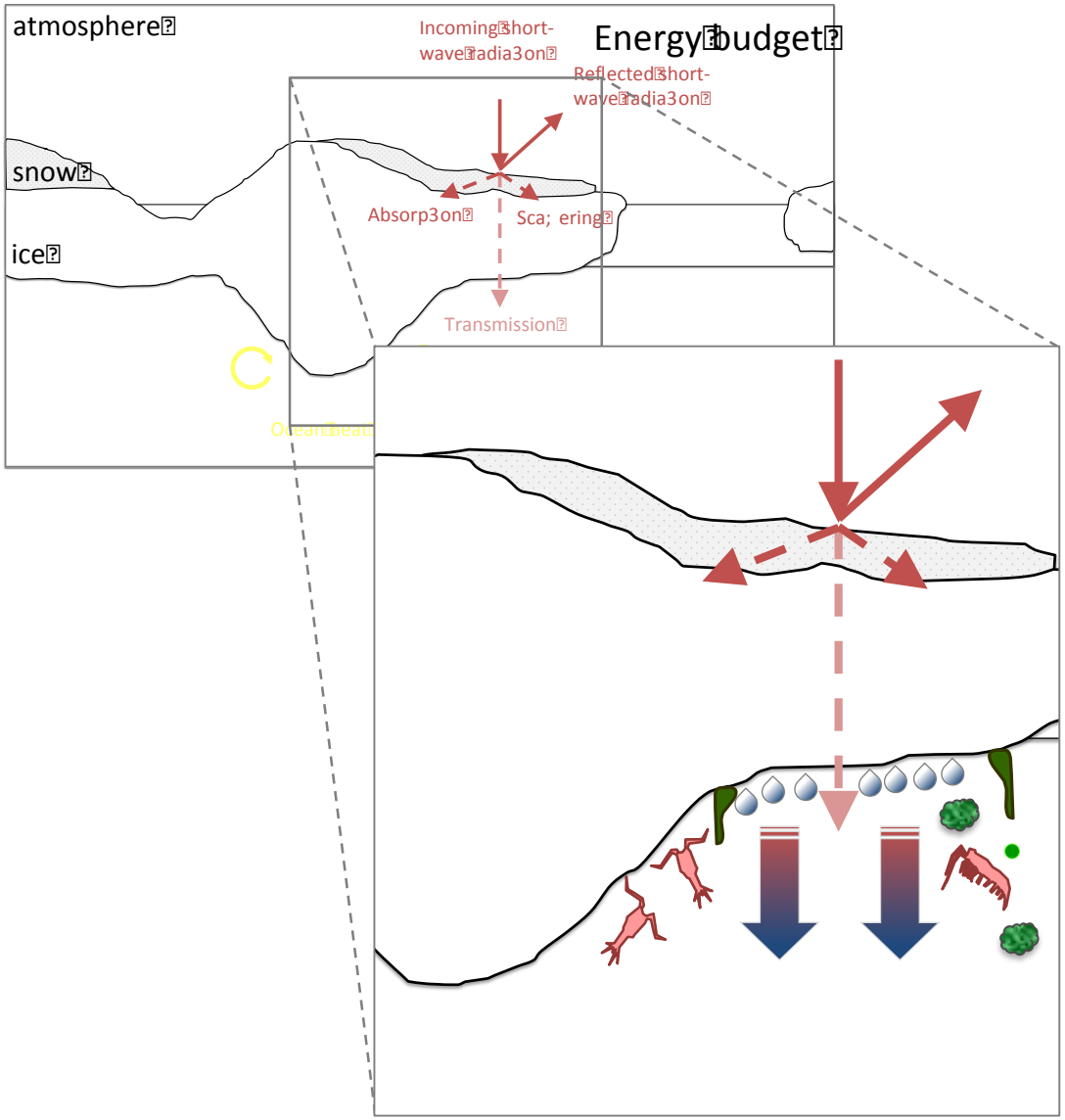
Recent and future studies on Remotely Operated Vehicles – Interdisciplinary research under Arctic and Antarctic sea ice

HELMHOLTZ ASSOCIATION

Surface energy budget



Importance of transmitted heat fluxes



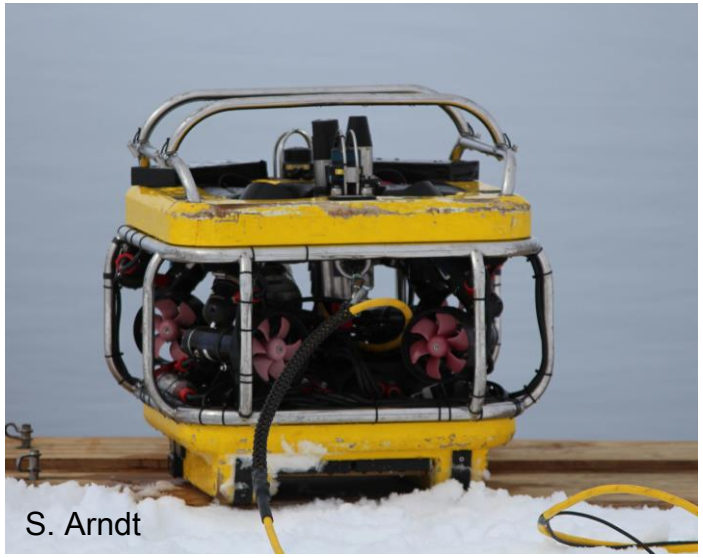
Mass budget of sea ice
bottom melt

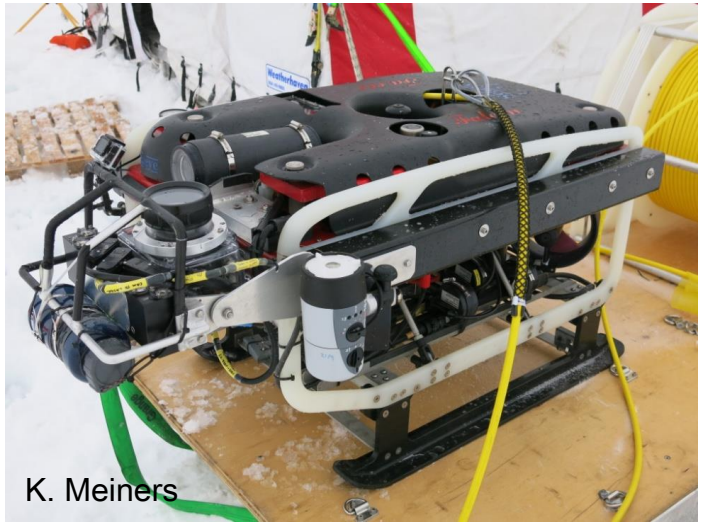
Energy budget of the upper ocean
warming of the upper ocean

Under-ice ecosystem
changing habitat conditions for ice-associated organisms

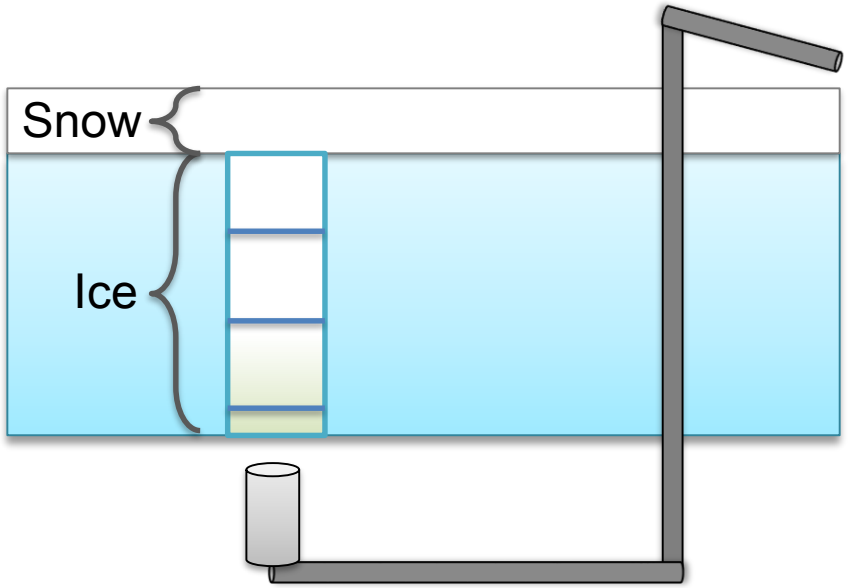
Light transmittance measurements

ROV – Remotely operated vehicles


S. Arndt

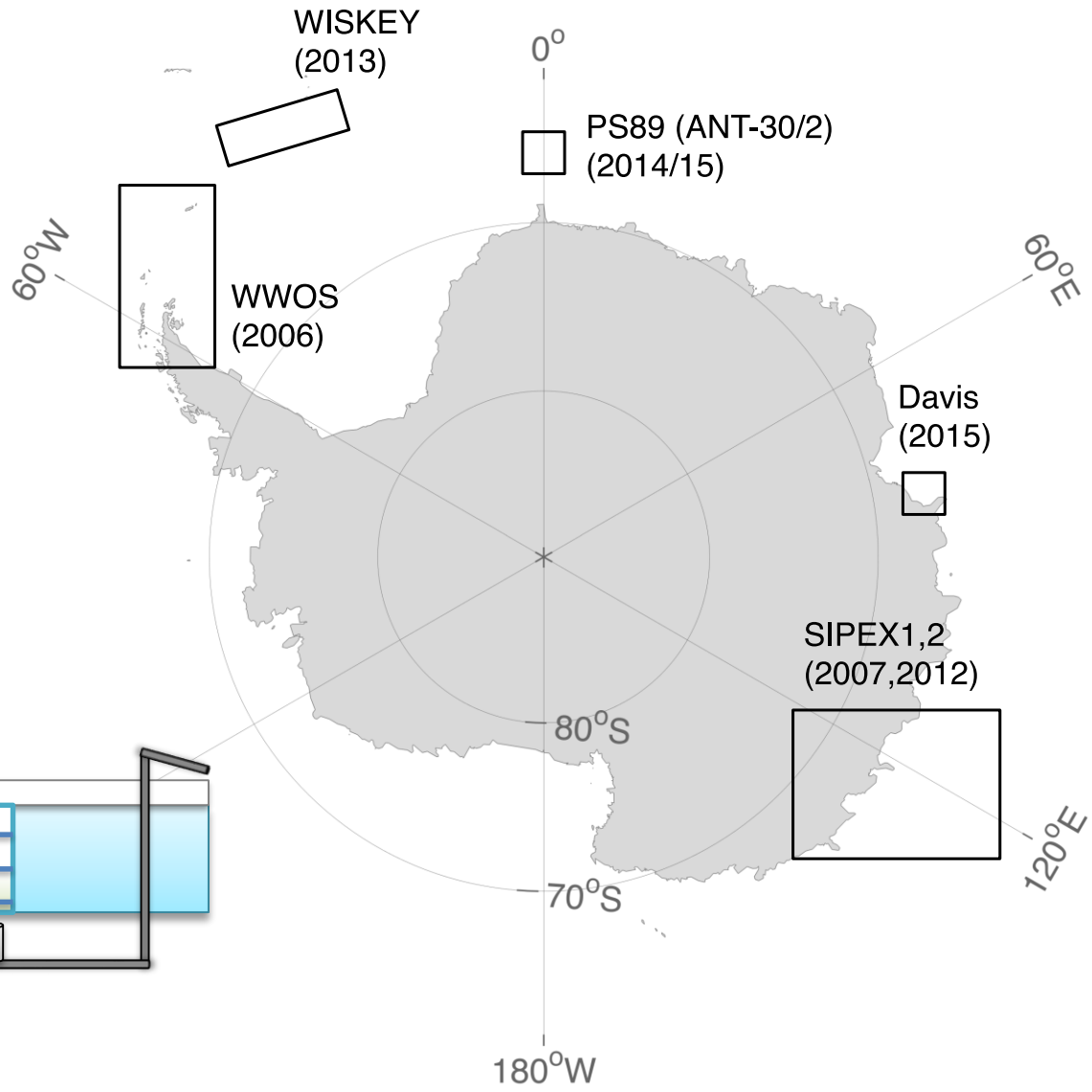

K. Meiners

L-Arm measurements

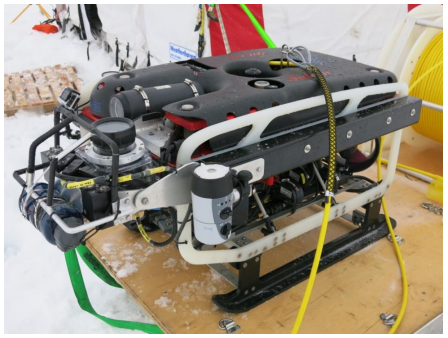


Melbourne-Thomas et al., 2015, adapted

Light transmittance field campaigns

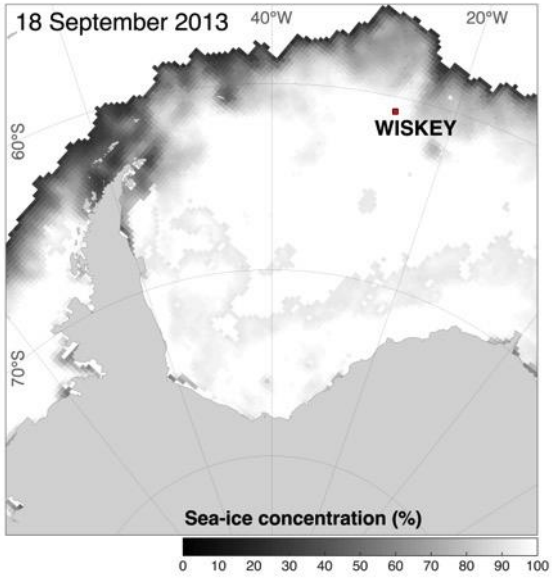


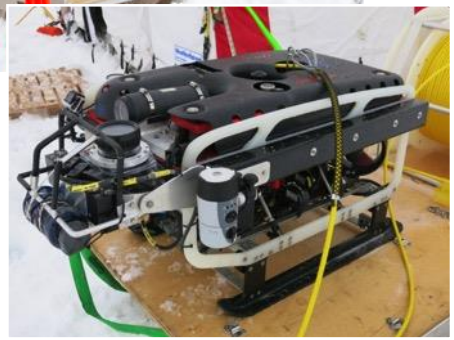
ROV



L-Arm

Study side and measurements





WISKEY

= *Winter study on Sea ice and KEY species*
14 August to 16 October 2013

Measurements:

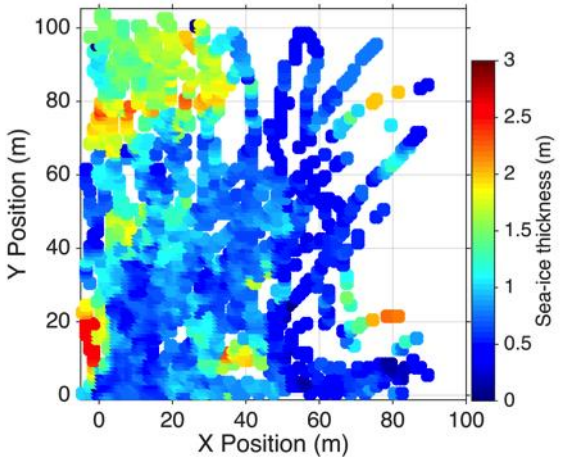
- Spectral solar radiation measurements: Remotely Operated Vehicle (ROV)
- Total sea-ice thickness: Multi-frequency electromagnetic induction (GEM-2)
- Snow depth: Magna Probe

Arndt et al., 2017 (JGR)

Physical properties of the pack ice floe

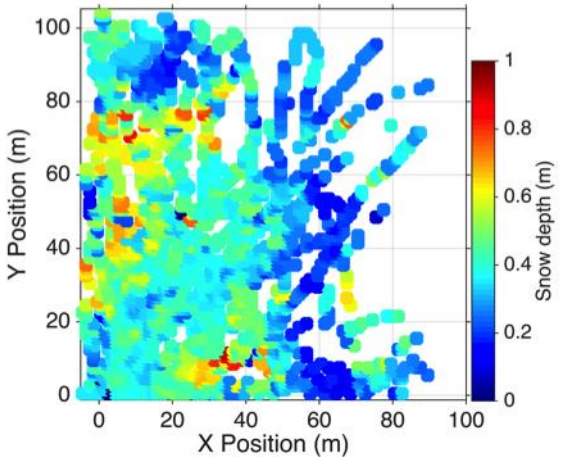
Sea-ice thickness, I:

mean(I) = 0.93 ± 0.45 m



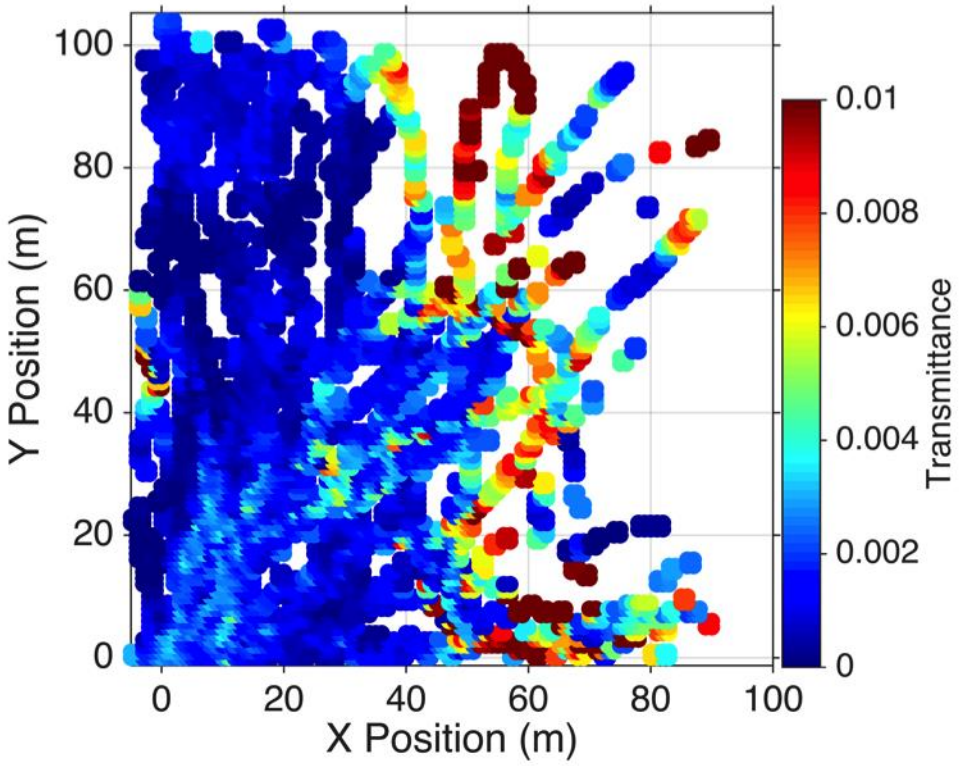
Snow depth, S:

mean(S) = 0.39 ± 0.13 m



Transmittance, T:

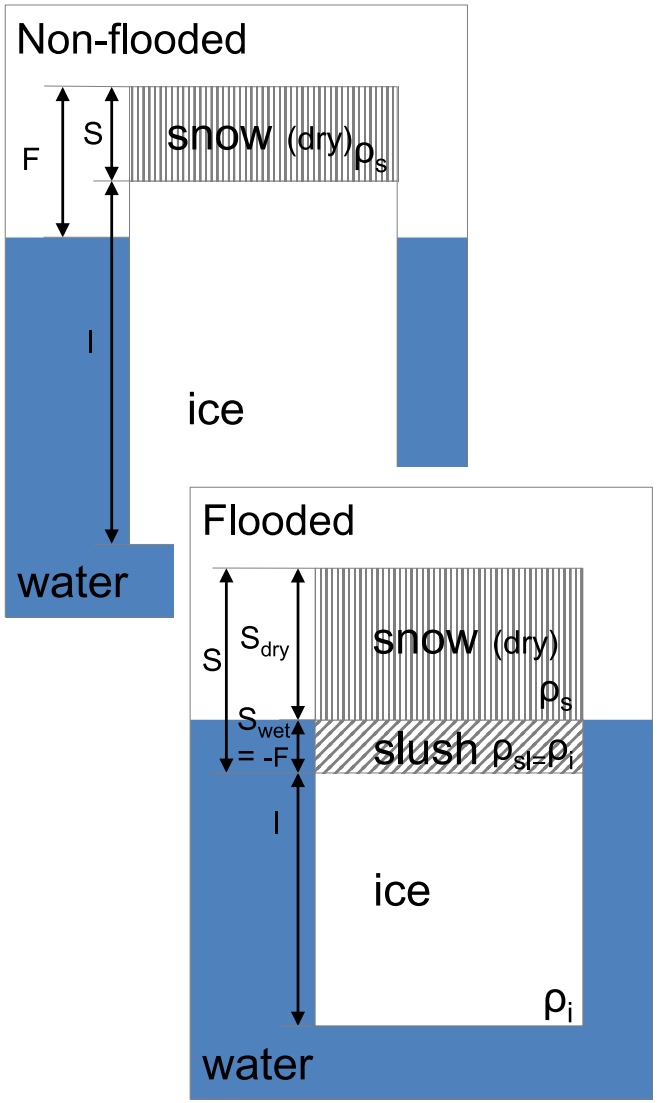
mean(T) = 0.0024 (0.24%)
mode(T) = 0.0008 (0.08%)



Antarctic pack ice transmits less than 0.1% of the incoming solar radiation during early spring

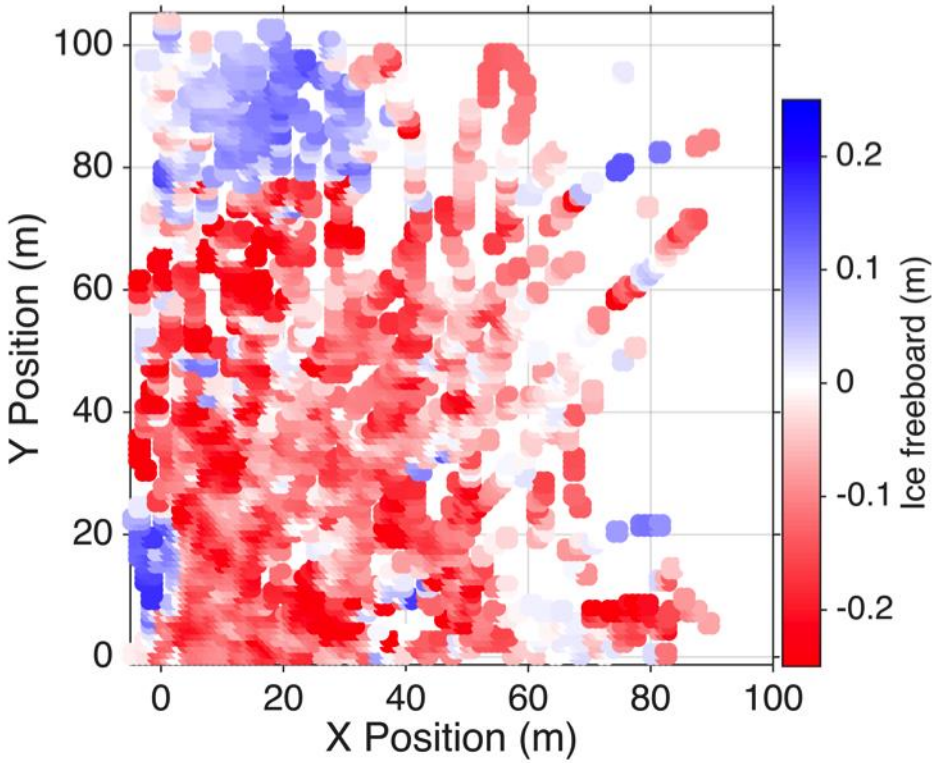
HELMHOLTZ ASSOCIATION

Physical properties of the pack ice floe



Ice freeboard, F:

mean(F) = -0.08 ± 0.10 m



Spectral optical properties

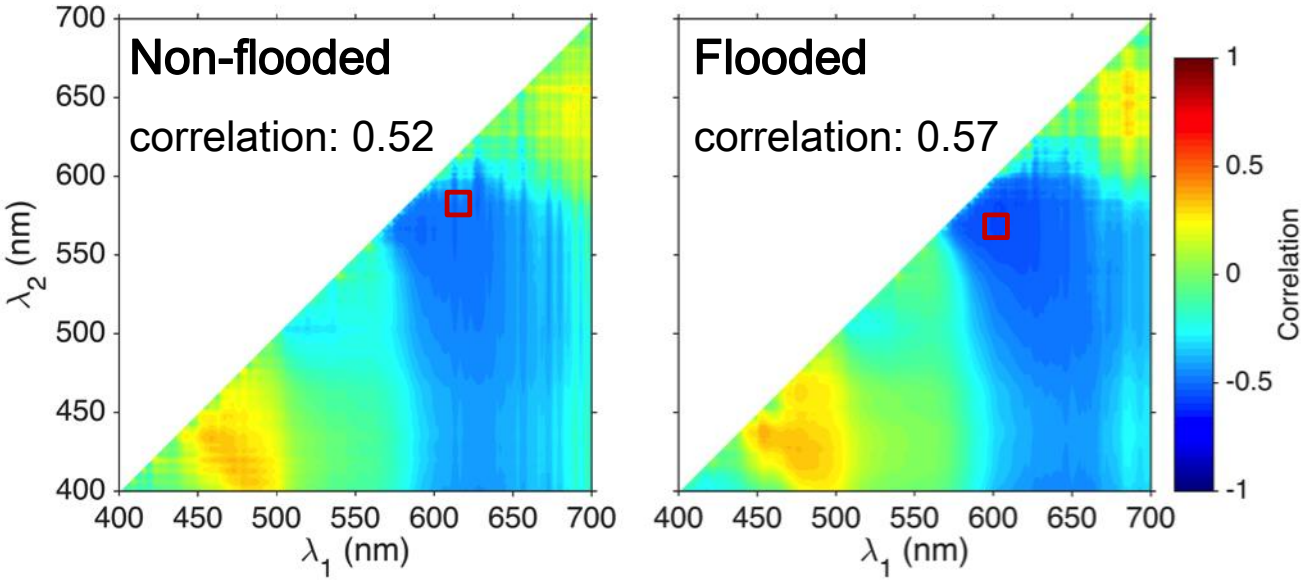
Normalized difference indices (NDI) of under-ice irradiance spectra:

$$NDI = \frac{E_d(\lambda_1) - E_d(\lambda_2)}{E_d(\lambda_1) + E_d(\lambda_2)}$$

λ_1, λ_2: wavelength pairs

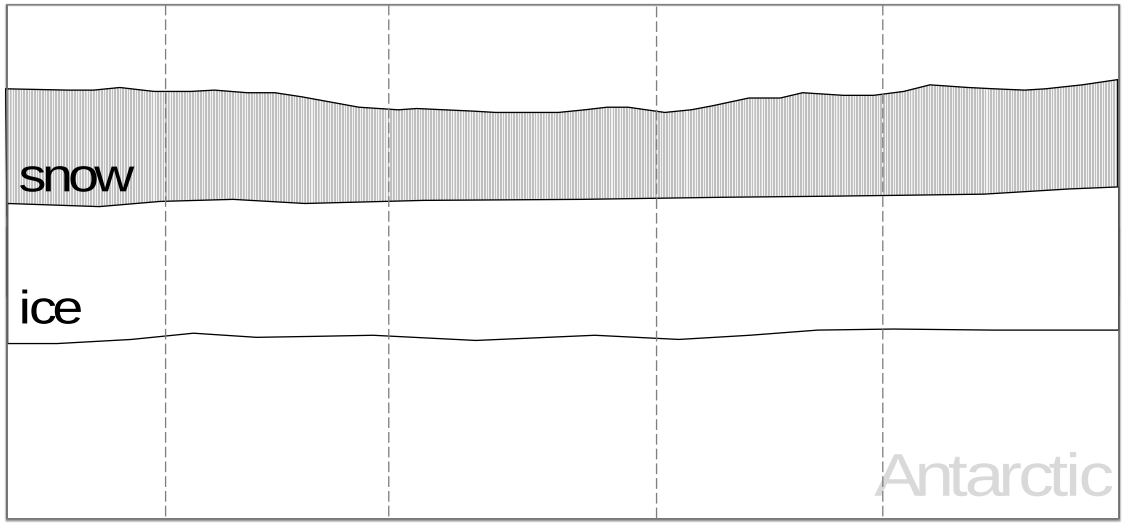
(Mundy et al., 2007)

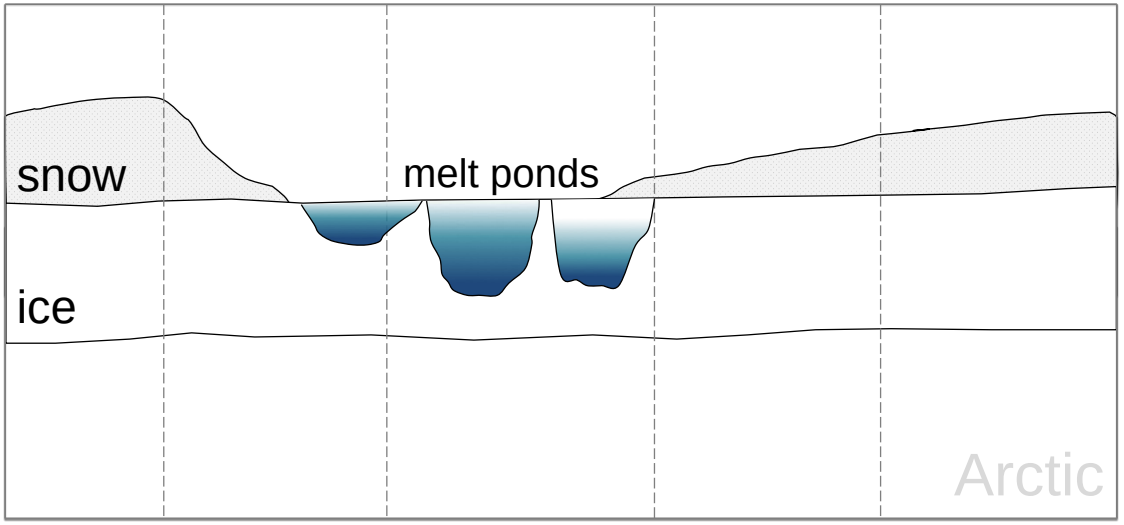
Correlation surfaces of normalized difference indices (NDI) for snow depth



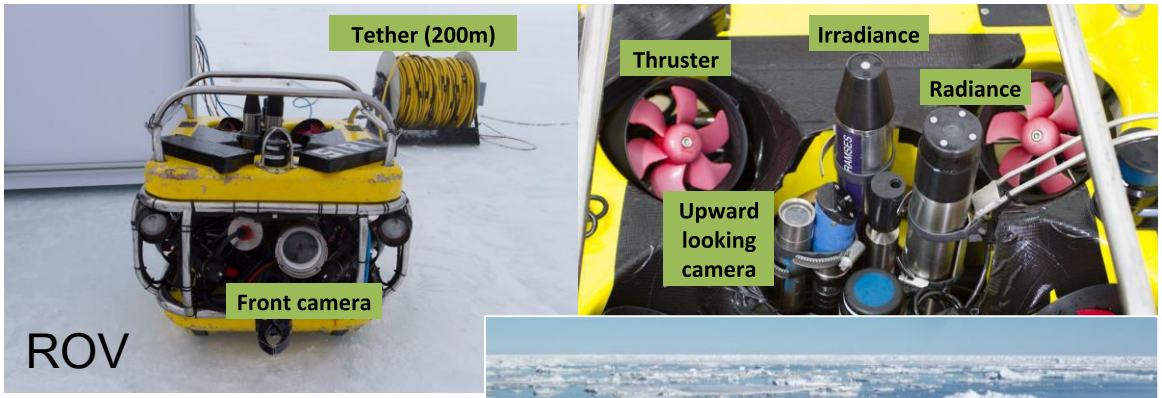
The heterogeneous snow on Antarctic pack ice obscures a direct correlation between the under-ice light field and snow depth

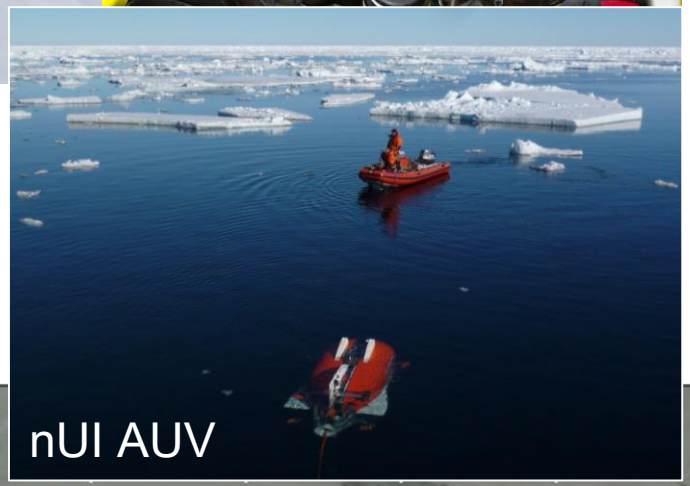
Comparison with Arctic studies





Comparison with Arctic studies

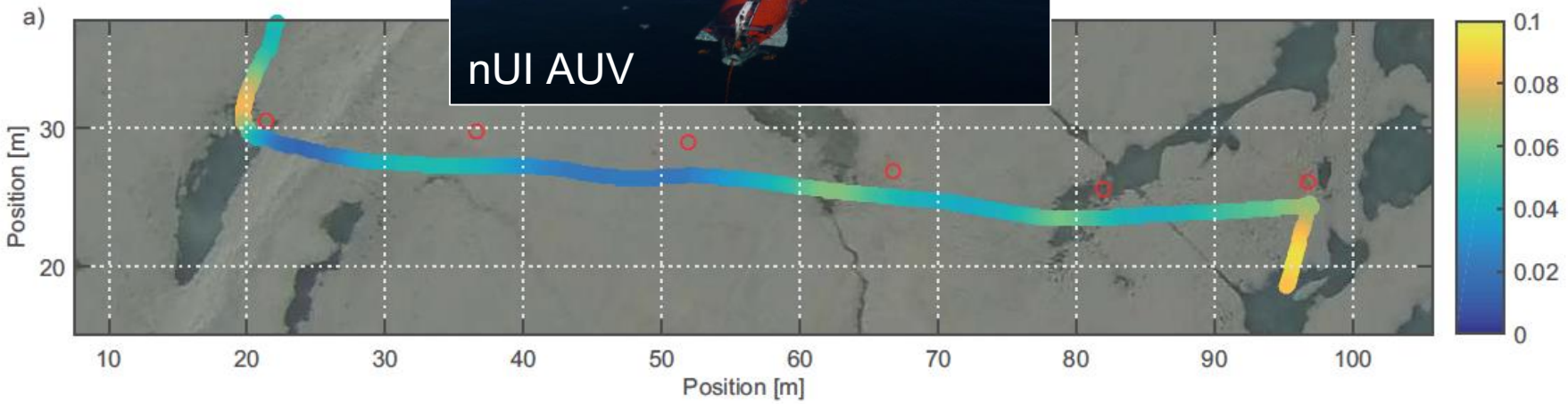




5 ROV campaigns
1 AUV campaign
(since 2011)

Optical properties highly correlated with sea-ice surface properties (e.g. melt ponds)

Light transmittance significant higher (summer FYI: 0.09, summer MYI: 0.05)



Katlein et al., 2015

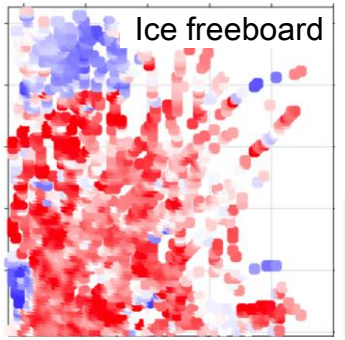
Conclusions

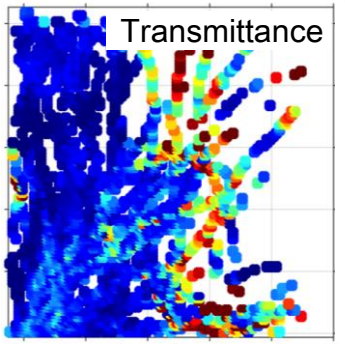
Antarctic pack ice transmits less than 0.1% of the incoming solar radiation during early spring

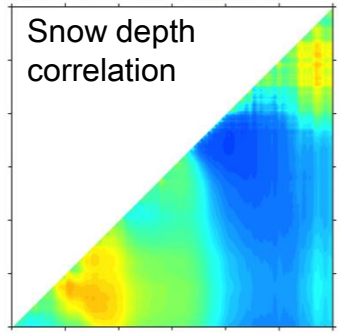
Ice freeboard and related flooding at the snow/ice interface dominates the spatial variability of the under-ice light regime

Limitation in the use of snow-NDI prevents estimating light transmission from snow depth and vice versa

In contrast to Arctic sea ice, the dependency of light transmittance of Antarctic sea ice on its surface properties is more obscure





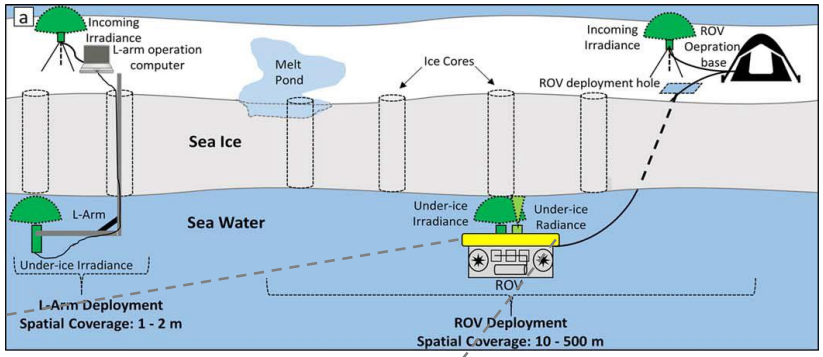


Arndt et al., 2017 (JGR)

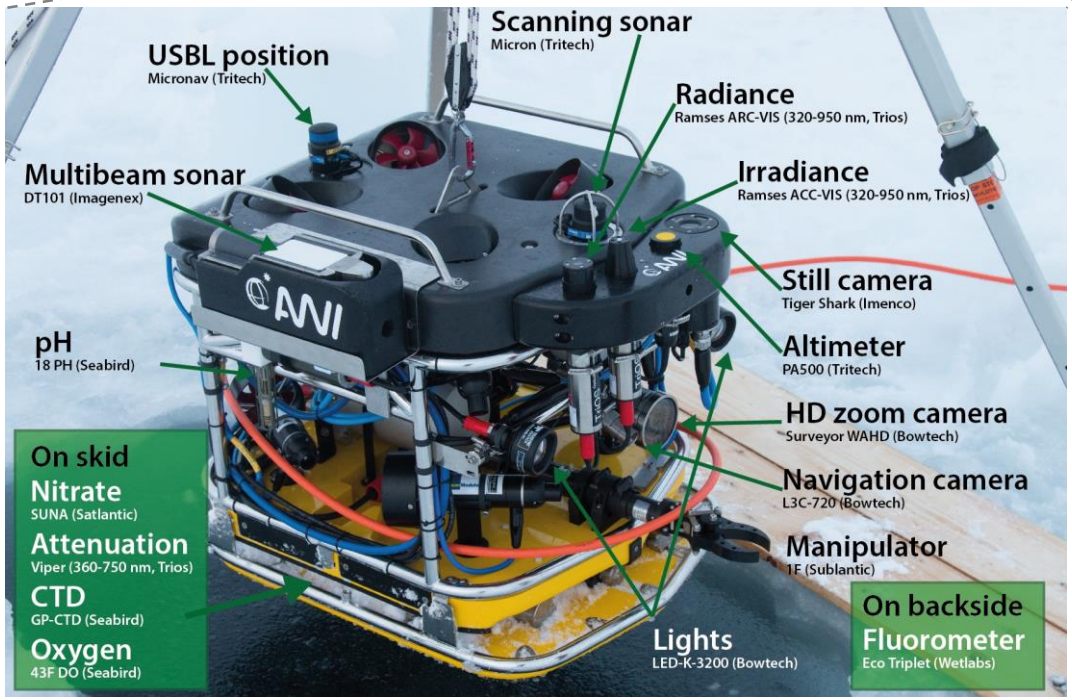
Outlook – Our new research platform

New interdisciplinary platform

- Operated from an ice floe
- Complex, interdisciplinary sensor suite
- Planned extensions (e.g. zooplankton)

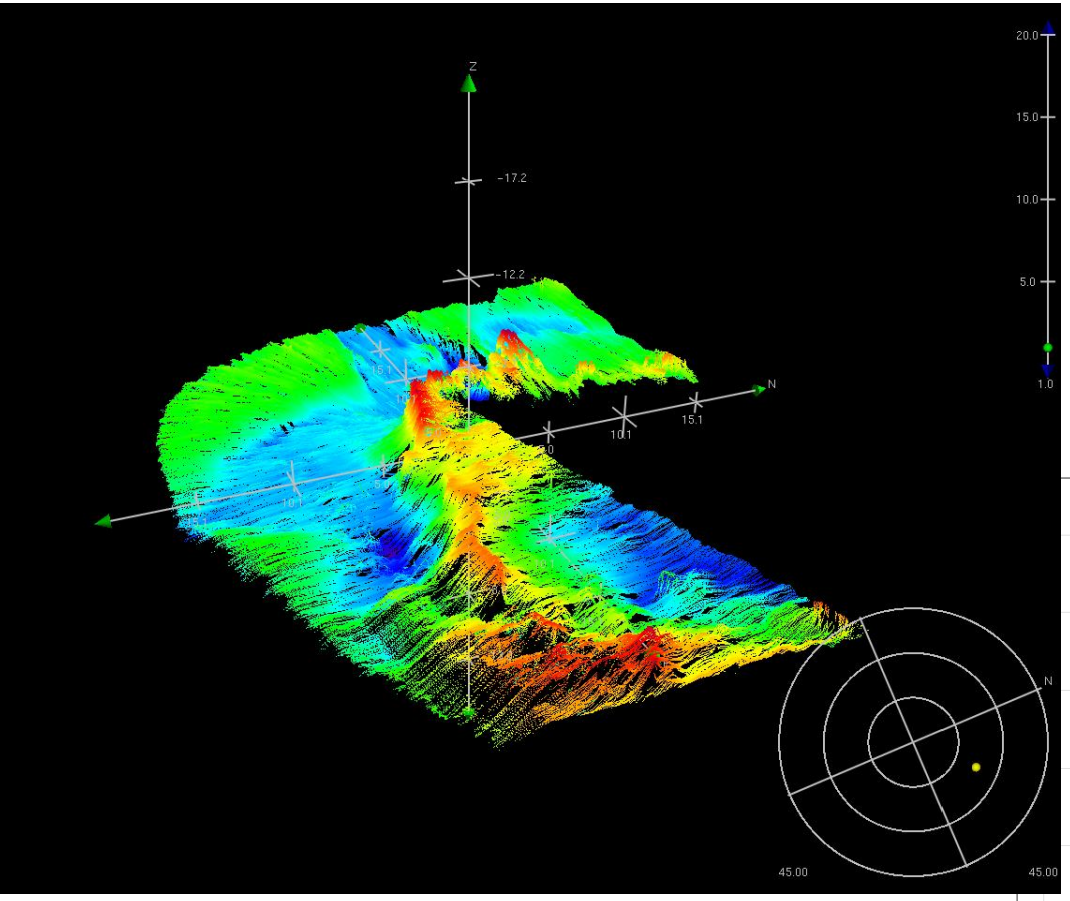


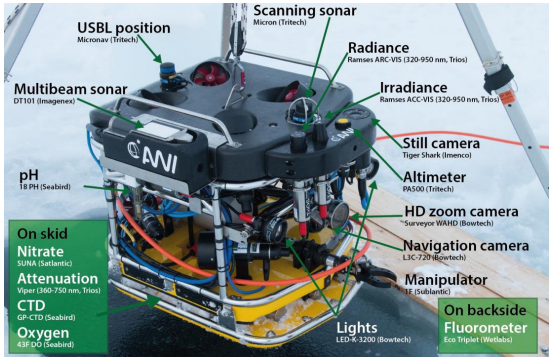
Lange et al., 2016 (JGR)

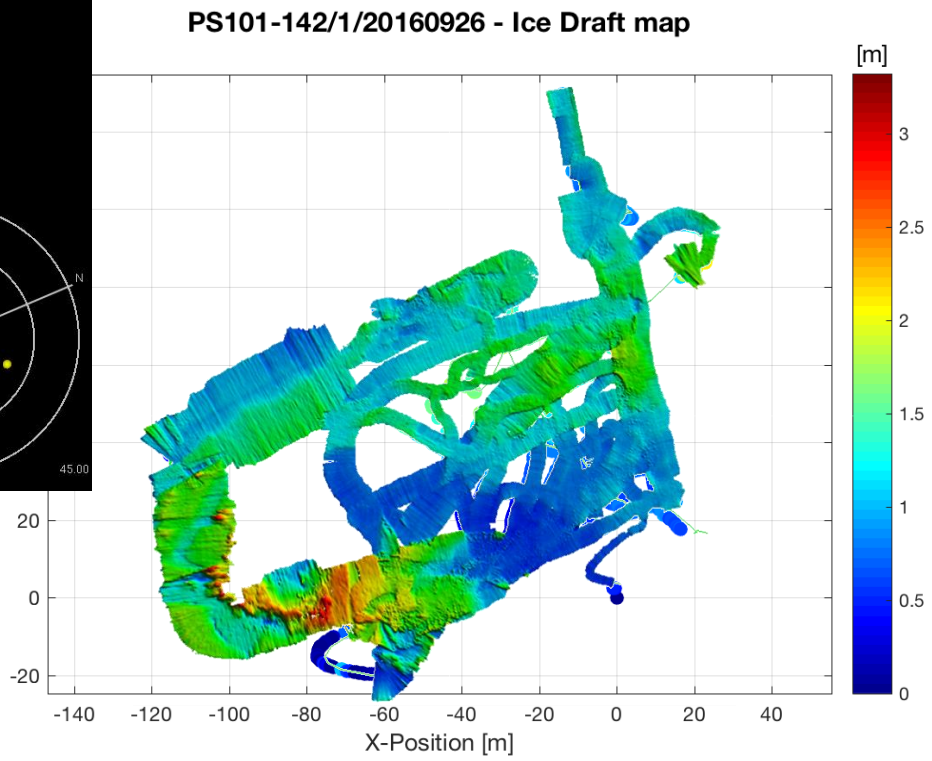


Katlein et al., subm.

Outlook – Our new research platform





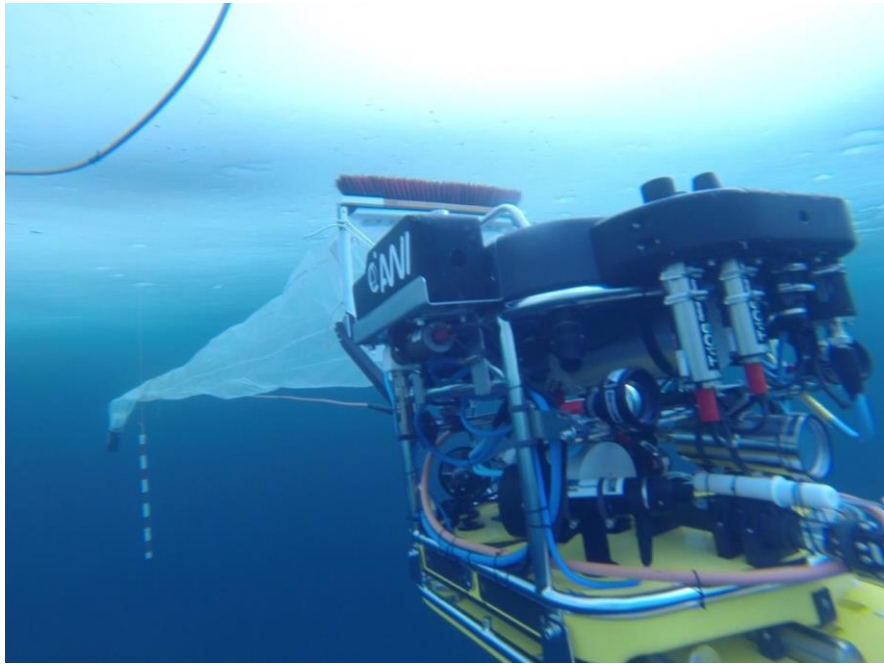


Example for multibeam survey during PS101

HELMHOLTZ ASSOCIATION

Outlook – Data and ongoing work

- Data will be made publicly available on PANGAEA and new AWI data portal (in development)
- Additional payload which is included for the current mission:
  - Water sampling bottle, ADCP (watertrack and under-ice turbulence)
  - Zooplankton camera (ROV-LOKI), Under-ice net (ROV-SUIT)



meereisportal.de

First full-scale science mission during Polarstern cruise just now (PS 106)

Important piece of MOSAiC The International Arctic Drift Expedition