Interdisciplinary observations of the under-ice environment using a remotely operated vehicle

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1 Summary

1) Physical, biological, and chemical parameters have been observed year-round to characterize sea-ice and ocean properties
2) The integrated datasets allow for a better understanding of physical and biological linkages in the sea ice and the upper ocean

2 Data and survey overview

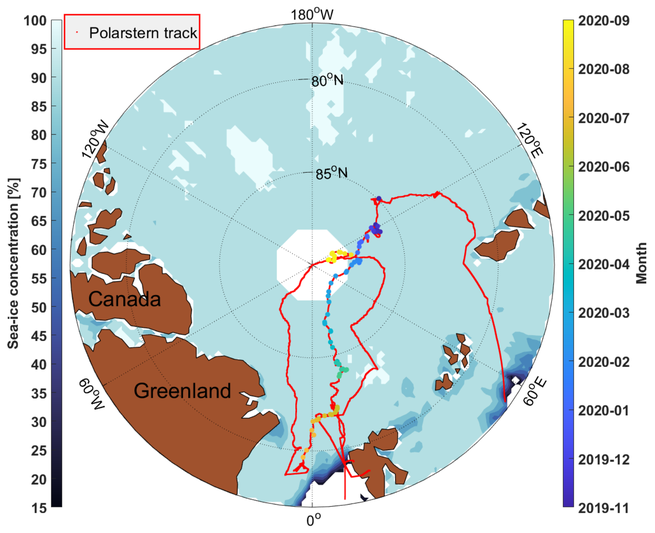

Figure 1. *ROV surveys: Coloured points illustrate the position of Polarstern at the start of the surveys. The background is the mean sea-ice concentration from the OSI-SAF (Interim) Climate Data Record for March 2020 (Hendricks et al., 2021).*

More than 80 scientific surveys covering various regions and sea-ice and surface conditions

- **Under-ice topography**
- **(Bio-) Optics**
- Zooplankton nets
- Hydrography
- Video & photography
- Instrument deployment, inspection, maintenance

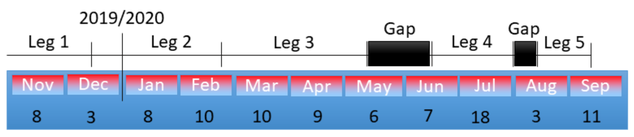

Figure 2: *Number of ROV surveys per leg.*

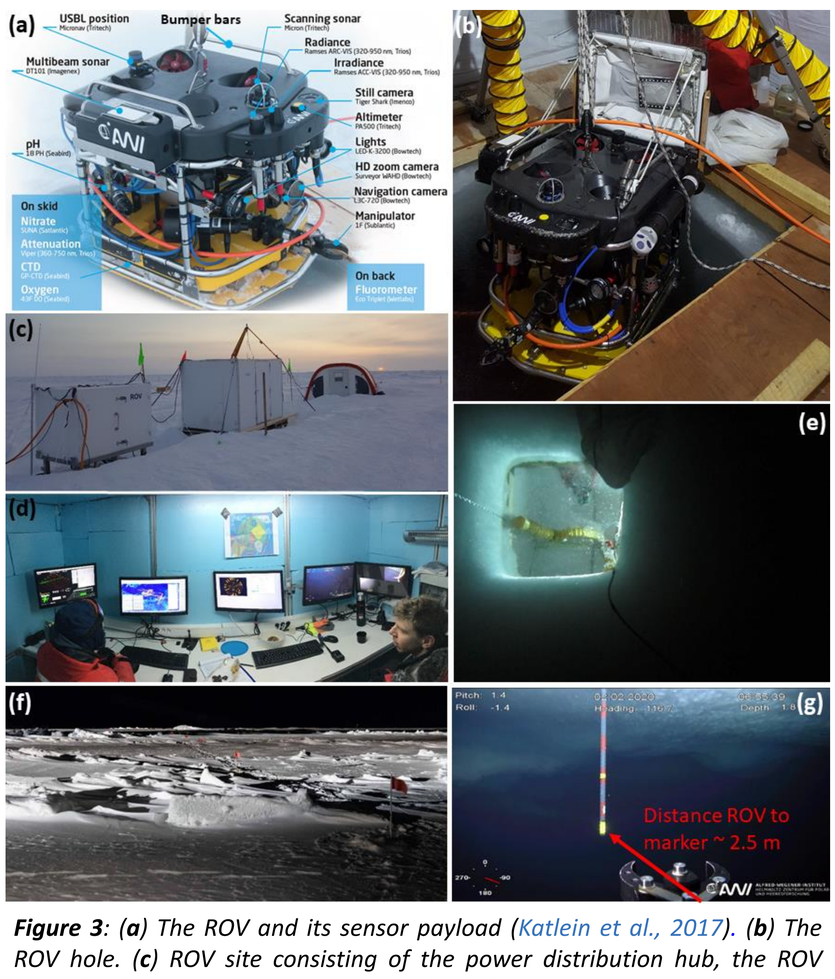

Figure 3*: (**a**) The ROV and its sensor payload (Katlein et al., 2017). (**b**) The ROV hole. (**c**) ROV site consisting of the power distribution hub, the ROV control cabin, and the tent covering the hole. (**d**) Inside of the ROV cabin (Steven Fons, NASA). (**e**) Upward-looking image taken below the ROV hole. (**f**) Photograph of a ROV study area. (**g**) Screenshot of a marker hanging under the ice.*

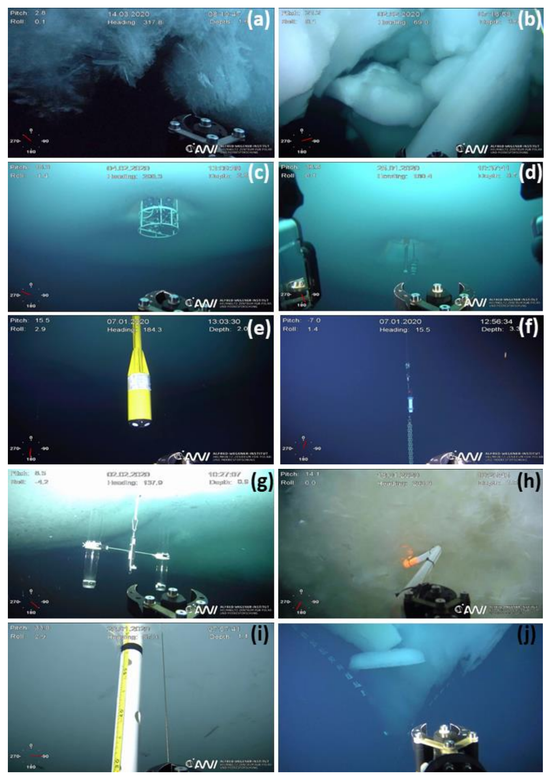

Figure 4*: Screenshot of (**a**) platelet and (**b**) ridged ice, (**c**) observing conductivity, temperature, depth (CTD), and oxygen sensor (**d**) and micro structure sonde casts at Ocean City, (**e**) acoustic doppler current profiler, (**f**) CTD, (**g**) inspecting a sediment trap, (**h**) suction algae sampling, (**i**) reading stakes, and (**j**) inspecting the haul of Polarstern.*

Data set	Sensor set	Data access
Positioning	Long baseline positioning system	
Telemetry	Inertial measurement unit	
Depth	Pressure sensor	
Single-beam sea-ice draft	Altimeter	
Multi-beam sea-ice draft	Multibeam sonar	
Spectral radiation	Radiometer	
Hyperspectral attenuation	Photometer	
Currents	Acoustic doppler current profiler	
Hydrography	Conductivity, temperature, depth, oxygen sensors	
Scattering & fluoresence	Scattering fluorescence sensor	
pH	pH sensor	
Nitrate	Spectrometer	
Videos	Video camera	
Upward-looking images	Still camera	
Attention points		
Quicklook plots		

SCAN ME

Table 1: *Overview of the datasets. A detailed description on the ROV and its sensor payload is provided by Katlein et al., 2017.*

CAUTION:
Not all data is quality-controlled and calibrated to every aspect!

Hendricks et al. (2021): *Product user guide & algorithm specification: Awi cryosat-2 sea ice thickness (version 2.4)*
Katlein et al. (2017): *A new remotely operated sensor platform for interdisciplinary observations under sea ice*
Neckel et al. (2022): Helicopter-borne rgb orthomosaics and photogrammetric digital elevation models from the mosaic expedition

3 Data examples

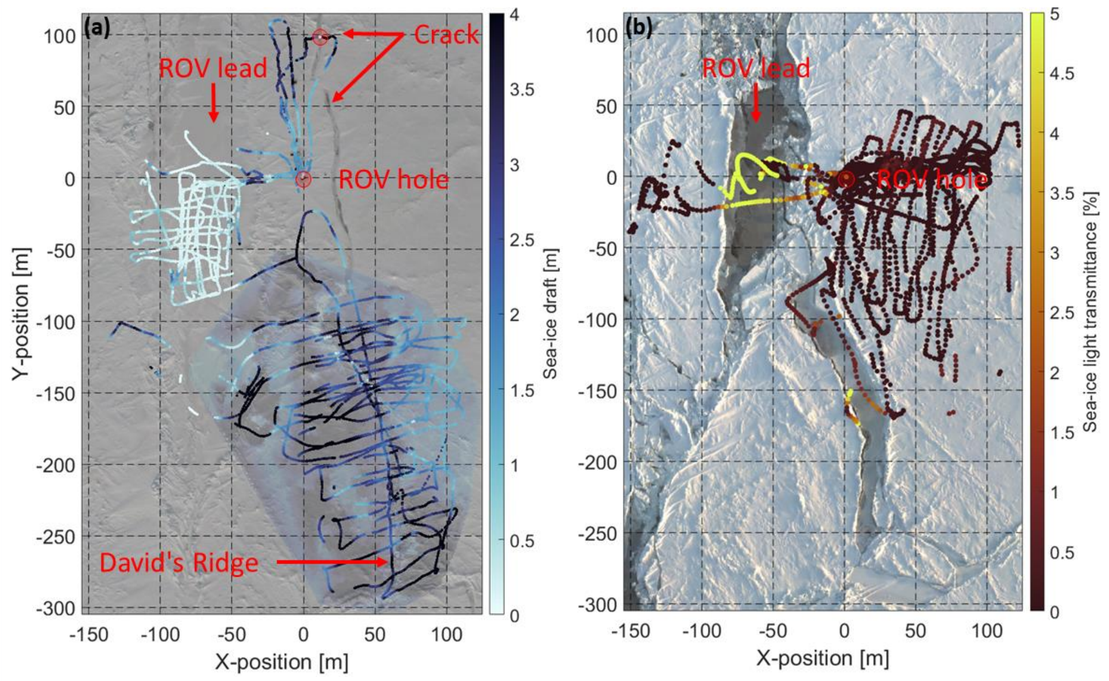

Figure 5*: ROV measurements from below the ice including (**a**) sea-ice draft of a refreezing lead as derived from both the altimeter (scatters) and the multibeam (meshgrid) and (**b**) sea-ice light transmittance. The background images are orthomosaics showing the surface of the ice (Neckel et al., 2022).*

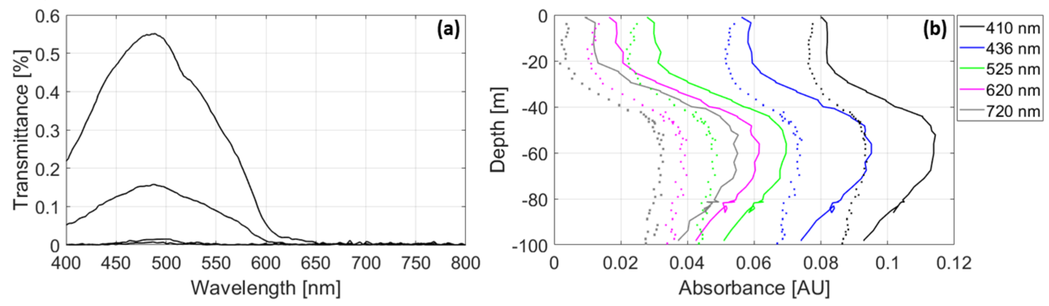

Figure 6*: The underice light conditions. (**a**) Sea-ice transmittance spectra as obtained by normalizing under-ice with surface radiation. (**b**) Depth profiles of absorbance at different wavelengths as obtained by the photometer.*

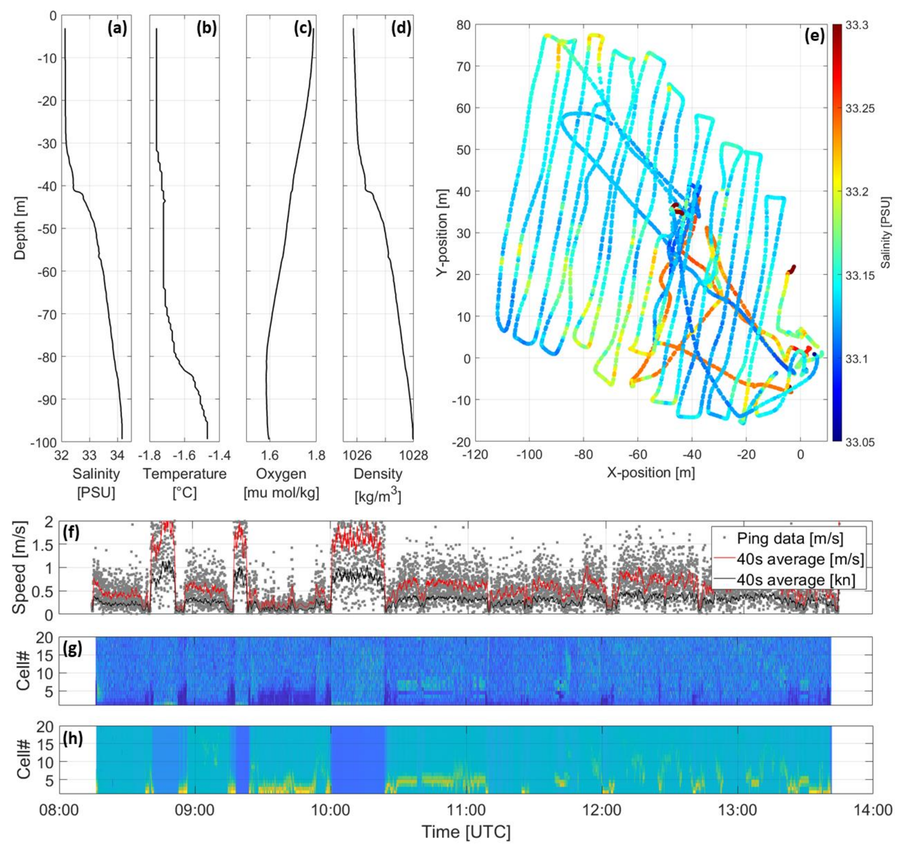

Figure 7*: Hydrographic data and currents describe the ocean state underneath the sea ice. Depth profiles of (**a**) salinity, (**b**) temperature, (**c**) oxygen, (**d**) density. (**e**) Local variability of salinity. (**f**) Speed through the water together with (**g**) currents and (**h**) backscatter in each cell.*

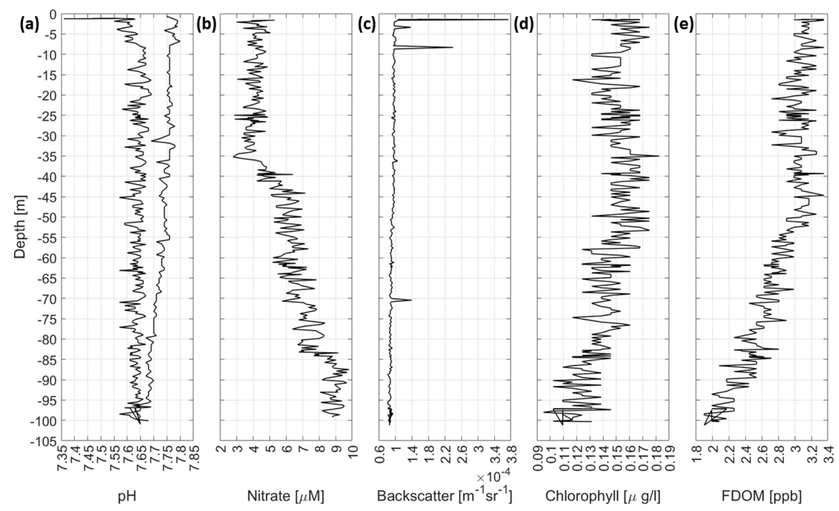

Figure 8*: Variability of biological parameters in the water column. Depth profiles of (**a**) pH values, (**b**) nitrate, (**c**) backscatter, (**d**) chlorophyll a, and (**e**)* fluorescent dissolved organic matter (FDOM).

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