Monitoring under ice phyto- and zooplankton blooms with the Nereid Under Ice remotely operated vehicle

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Introduction

The perennially ice-covered Central Arctic is changing rapidly due the loss of multiyear ice. These changes in the under ice ecosystem can lead to under-ice phytoplankton blooms which may increase grazing and carbon export. However, our knowledge of the interactions between sea ice, sub-ice and under-ice communities is still poor. In July 2014 the Nereid Under Ice remotely operated vehicle (NUI) (Bowen et al. 2014) was used to follow the evolution of a phyto- and zooplankton bloom below 2 m thick multiyear ice.

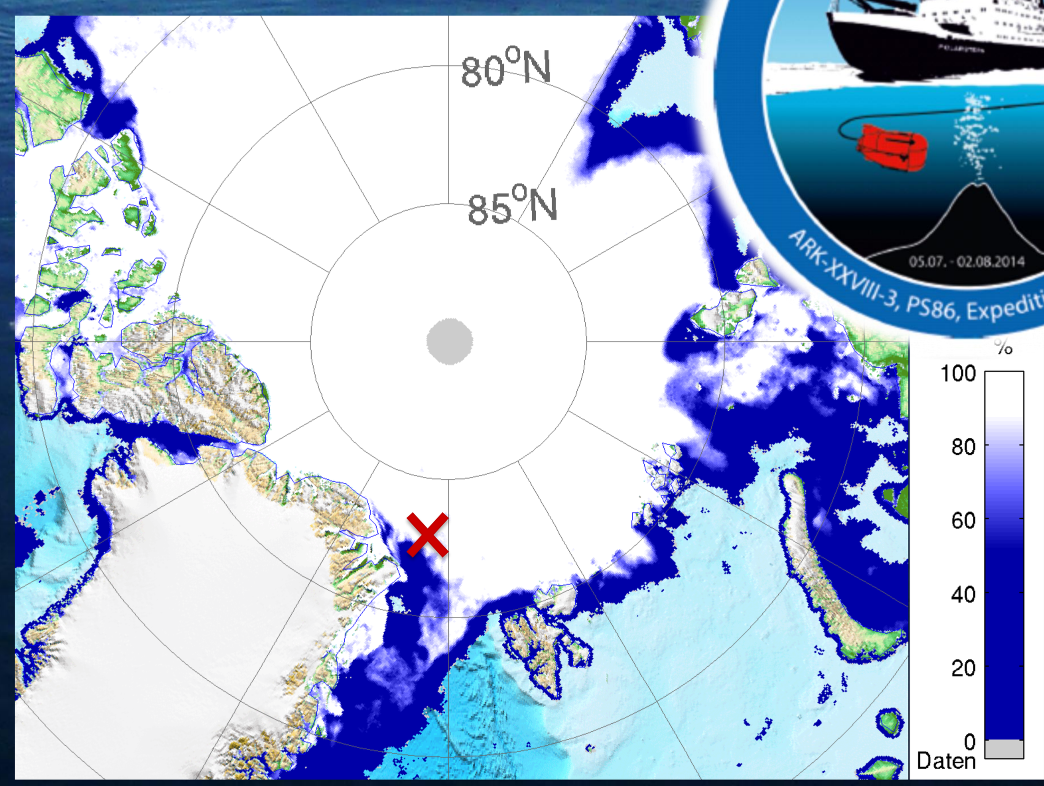


Fig 1. Average sea ice concentration during July 2014. The red cross indicates the study site at 83ºN 6°W north-east of Greenland.

Aims

- Monitor in vivo the evolution of an under ice phyto and zooplankton bloom.
- Identify layers of sinking particles with distinct optical properties.

Results

1. Temporal evolution of the phytoplankton biomass below the ice.

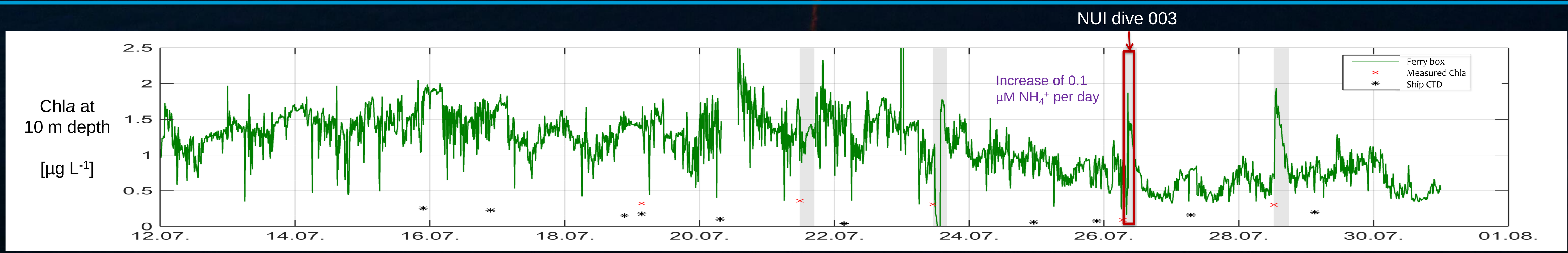


Fig 2. Chl*a* fluorescence measured at 10 m depth during the entire cruise (green line). The four NUI dives are marked in grey. Discrete measurements of Chla with the ships CTD fluorometer (black stars) and Chla measured with acetone extraction (red crosses).

Turbidity | Sea-ice algal aggregates | Copepods | Ctenophores | Appendicularia

Fig. 3. Images extracted from the videos of the NUI real time color HD video camera showing the different plankton groups observed below the ice. With the images from the upward looking camera the distribution of sub-ice algal aggregates could be assessed (Katlein 2014).

Conclusions

- NUI produced high quality *in vivo* observations of the undisturbed under-ice ecosystem showing advantages compared to ship-based measurements.
- Video footage obtained with NUI directly below the ice showed the development of algal mats at the bottom of the ice floe and a succession of zooplankton blooms presumably causing a decline of the phytoplankton bloom.
- Polar copepods, ctenophores and appendicularia could be identified forming dense biomasses underneath the ice.
- Layers of sinking particles with different optical properties were detected in the mixed layer (upper 6-15 m) which could not be observed using a ship-deployed CTD.

NUI dives on the 26 July 2014

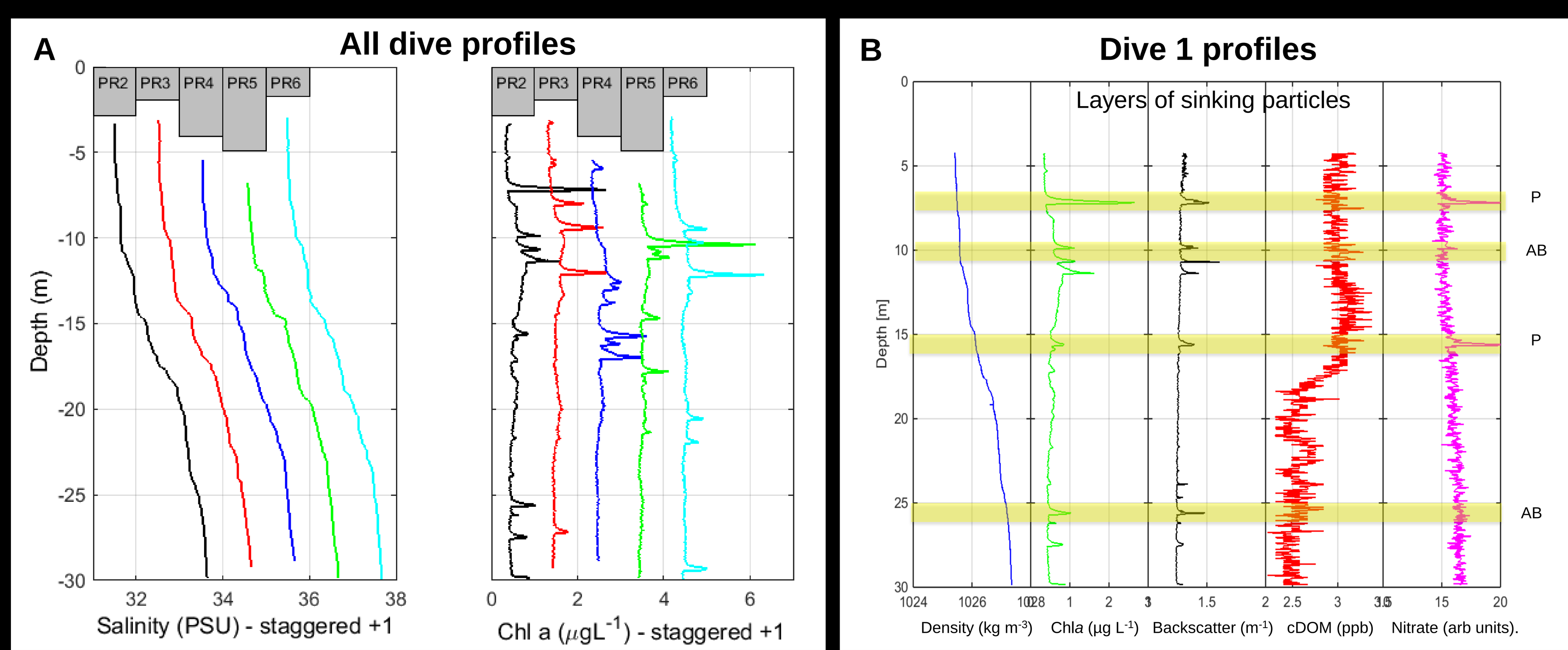
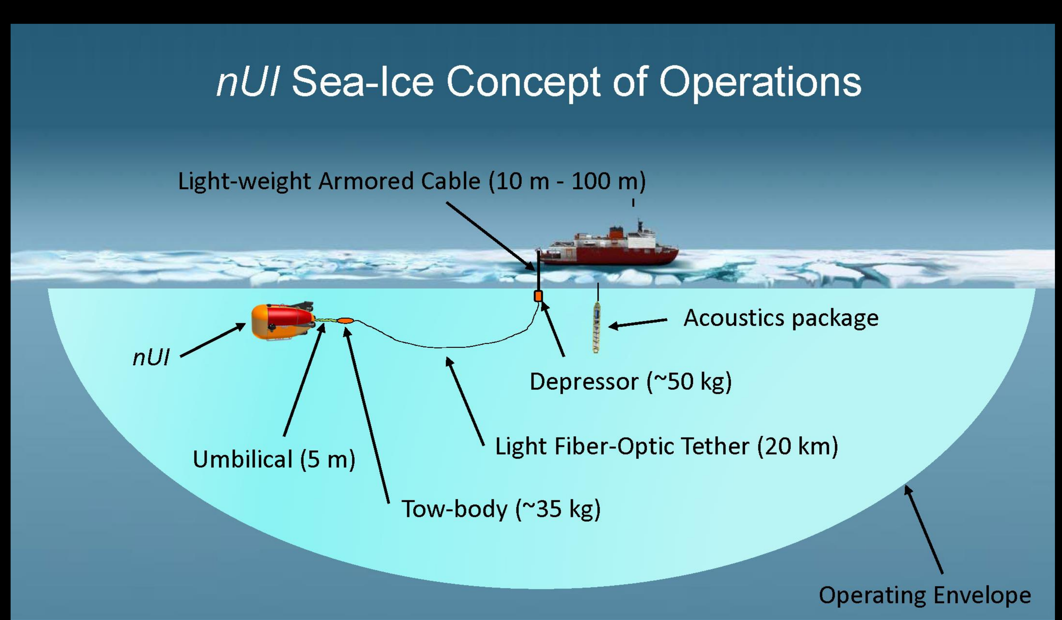


Fig 3. (A) All salinity and Chla vertical profiles on 26 July below the ice. (B) Example of density, Chl*a*, backscatter at 700 nm (total particle concentration), cDOM and nitrate vertical profiles during dive 1 on 26 July. Layers of sinking particles (Laney *et al*. 2014) are marked in yellow. P= Particles, AB= Autotrophic biomass. Chl*a* and nitrate are not calibrated. Measured nitrate concentrations were around 2 µM below the ice.

Specifications



Nereid Under Ice ROV

- Range: 40 km
- Weight: 1800 kg
- Communication: Tether Fiber optic
- Acoustic: multibeam
- Chemical/Physical sensors: SBE 25plus Sealogger CTD
- Biological sensors: Fluorometer-Scattering-CDOM Sensor ECO FLbb-CD and Submersible Ultraviolet Nitrate Analyzer.

- Complementary measurements on board Polarstern:
  Ships Seabird CTD with fluorometer.
  Ferry Box: Fluorescence, pCO2, pH, oxygen, turbidity, T & S.

References

Bowen, AD et al. 2014. Design of Nereid-UI: A Remotely Operated Underwater Vehicle for Oceanographic Access Under Ice. IEEE-MTS Oceans.
Katlein et al 2014 Distribution of algal aggregates under summer sea ice in the Central Arctic , Polar Biology . doi: 10.1007/s00300-014-1634-3
Laney S R et al. 2014 Assesing algal biomass and bio-optical distributions in perennially ice-covered polar ocean ecosystems. Polar Science 8:73-85

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