Observing infrastructure FRAM: Year-round multidisciplinary and multi-platform observations of global change effects on Arctic ecosystems

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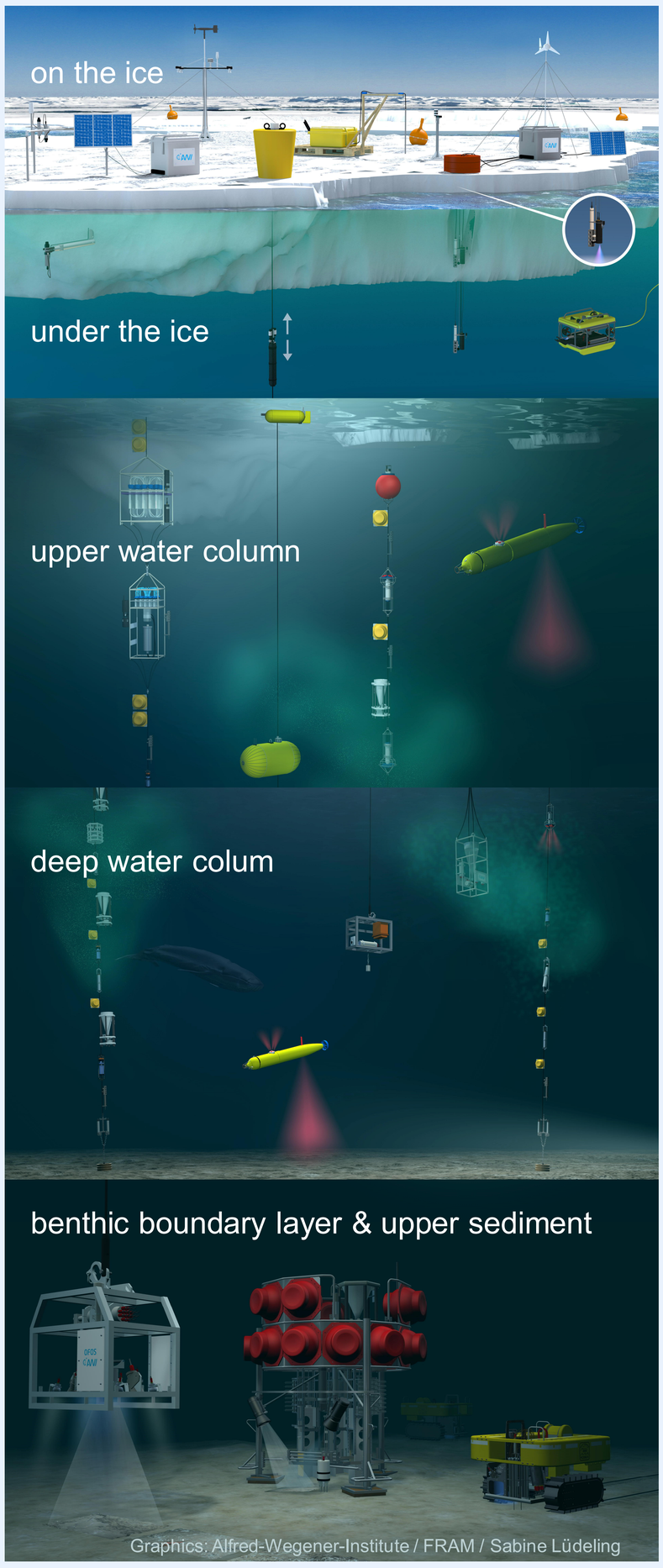
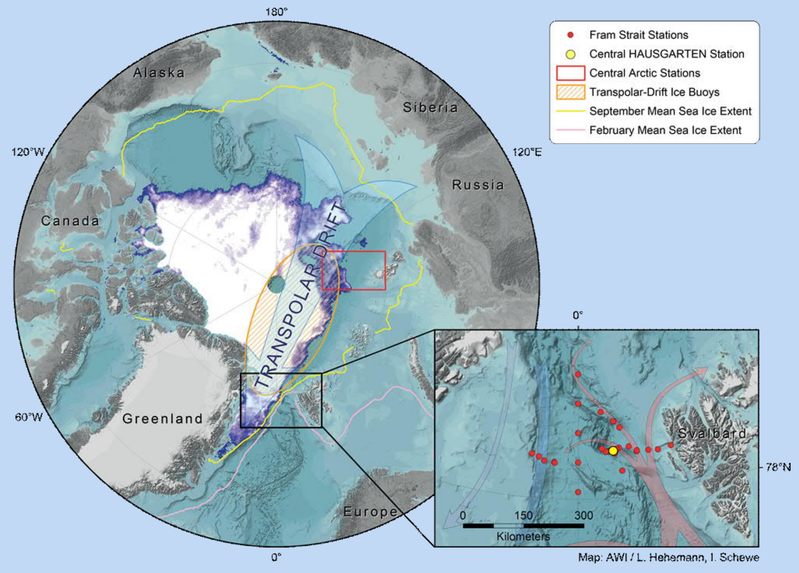
The FRAM infrastructure

The FRAM ('FRontiers in Arctic Marine Monitoring') Ocean Observing System (OOS) uses a multi-platform approach for year-round multidisciplinary observations in harsh and partly ice-covered Arctic regions. The core of the infrastructure is operated at a station network across Fram Strait and the Central Arctic Ocean (see map). The implementation of the distributed infrastructure started in 2014 and is currently being finalized. Installations extend from the sea ice to the seafloor (see below illustrations). Year-round measurements and sampling relies on state of the art automated platforms, including static (e.g., moorings, moored profilers, benthic installations, ice-tethered instruments) as well as mobile components (e.g., under-ice ROV, AUV, benthic crawlers). In-situ observations are combined with regular research vessel campaigns and complemented with remote sensing data.



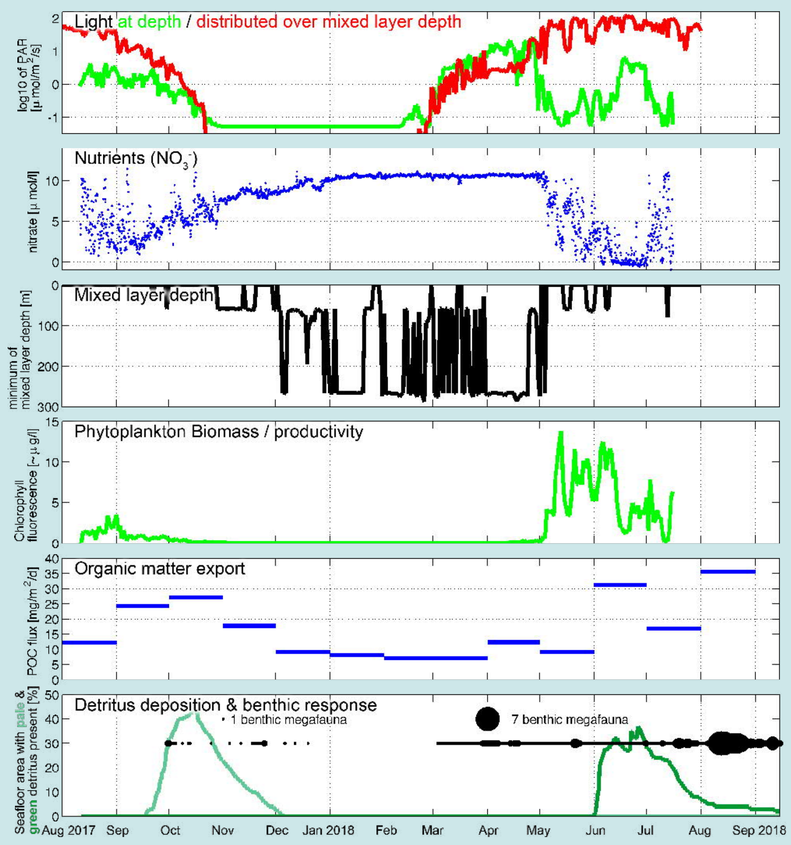
Scientific background and focus

FRAM aims to observe the ecosystem response to climate change-related impacts that are particularly severe in the Arctic ('Arctic amplification'). The current observing program builds on a legacy of ~20 years of time-series observations at the LTER Observatory HAUSGARTEN in Fram Strait, an oceanographic mooring array at ~79° N, as well as autonomous observations in the central Arctic basins. Addressing most GOOS EOVs, FRAM quantifies drivers of change (warming, decreasing sea ice extent, freshening, acidification) as well as effects on biological communities (microbes to large, vocalizing mammals) and biogeochemical processes (primary productivity in surface waters and sea ice, particle export and attenuation, remineralization at the seafloor, and water column oxygenation).



Recent findings

The first multidisciplinary FRAM time-series are becoming available for holistic ecosystem studies at high temporal resolution. An example is shown below.



Observations at the central HAUSGARTEN station HG IV (yellow dot in map) show strong seasonality in primary production, export fluxes, and deposition and use of organic matter pulses at the seafloor. Although nutrients are available throughout spring, a significant increase in surface water productivity is only observed approx. two months after the end of the polar night at the time that a shallow mixed layer evolved. At least one more month passes until significant quantities of detritus appear in bottom-near sediment traps and start forming detritus patches at the seafloor. With short delay, increased presence of benthic mega-fauna reveals utilization of the food pulse by epibenthic fauna. A comparison to the previous year, when the region was ice-covered in spring, indicates a strong influence of ice conditions on the magnitude and timing of primary production and the export of organic matter to the deep sea (data not shown).

Conclusions

The FRAM OOS is largely implemented and allows year-round multidisciplinary observations from surface / sea ice to seafloor. This proves a powerful approach to comprehensively address complex phenomena that may involve physics, biogeochemistry, as well as biology, depict a strong seasonality, and take place throughout the water column (e.g., the efficiency of the biological carbon pump). Comparing years with contrasting physical conditions (e.g., ice cover) provides insights into the ecosystem response to a changing Arctic climate and helps predicting the future of the Arctic Ocean.

Acknowledgements

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Further reading

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