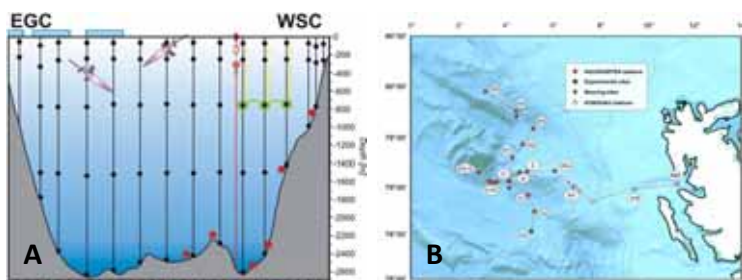


FRAM: a multidisciplinary observatory in the North Atlantic - Arctic Ocean transition zone

Felix Janssen, Thomas Soltwedel, Ingo Schewe, Ursula Schauer, Antje Boetius, and the FRAM Team
Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Bremerhaven, Germany

Observatory and site essentials

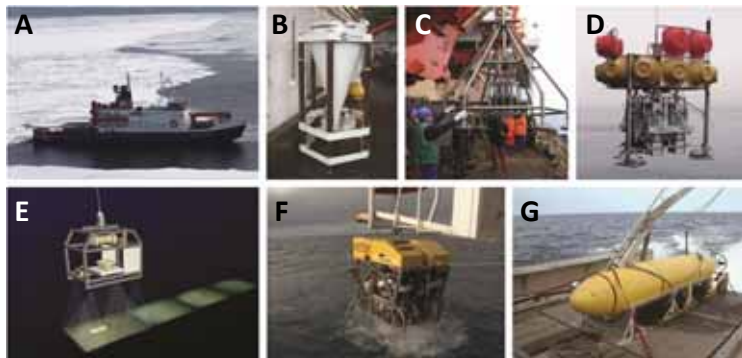
Physical oceanography and ecosystem observations in Fram Strait are carried out since approx. 15 years. The site represents the only polar open-ocean long-term observatory and a key site of the EMSO-Network. Climate variability has a strong impact on environmental conditions in the area – including sea ice retreat as well as heat and freshwater exchange between the Arctic and the North Atlantic. Multidisciplinary time-series observations in this dynamic environment allow to assess how natural and man-made changes in ocean dynamics and climatic conditions affect polar ecosystems.



A Key to physical oceanography studies is the cross-strait mooring array at 78°50'N. B Ecosystem observations are centered at the station network 'HAUSGARTEN' forming a latitudinal and longitudinal transect. Both observatory components are operated in close collaboration with Norwegian colleagues.

Variables and instrumentation

Key observatory components are long term moorings and benthic platforms as well as annual research vessel missions for sampling, surveys, *in situ* measurements, and experiments. Ship campaigns include regular deployments of landers, AUVs, and ROVs. Apart from oceanographic variables, investigations cover primary productivity, particle fluxes, biogeochemistry, and biodiversity. Observations include the pelagic zone, the benthic boundary layer, the sediment water interface, and the seafloor.



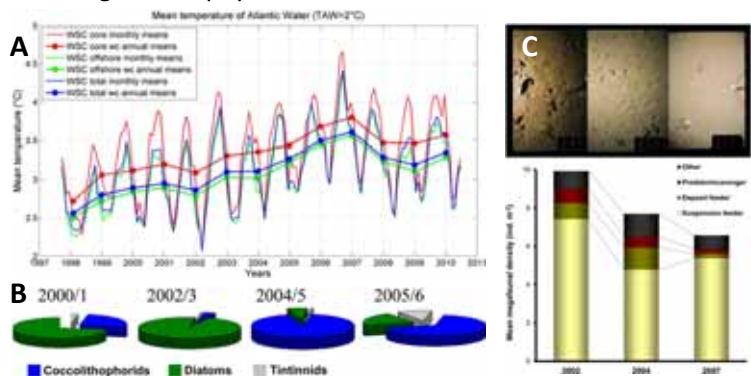
Some examples of instruments used for ecosystem observations. A R/V Polarstern at the ice edge, B Particle trap, C Multiple Corer, D Lander / benthic observatory, E Seafloor imaging system OFOS, F ROV Victor, G AUV Bluefin (Images: T. Riehl, T. Soltwedel, N. Lochthofen, M. Bergmann / AWI).

References and further reading

Beszczynska-Moeller, A., et al (2012) Variability in Atlantic water temperature and transport at the entrance to the Arctic Ocean, 1997–2010. – ICES Journal of Marine Science, doi:10.1093/icesjms/fss056.
Bauerfeind, E., et al. (2009) Particle sedimentation patterns in the eastern Fram Strait during 2000–2005: Results from the Arctic long-term observatory HAUSGARTEN, Deep-Sea Res. I 56: 1471–1487.
Bergmann M. et al. (2011) The interannual variability of megafaunal assemblages in the Arctic deep sea: Preliminary results from the HAUSGARTEN observatory (79°N), Deep-Sea Res. I 58: 711–723.
Soltwedel, T. et al. (2005) HAUSGARTEN: Multidisciplinary Investigations at a Deep-Sea, Long-Term Observatory in the Arctic Ocean, Oceanography 18: 46-61.
Soltwedel, T. et al. (2013): FRAM - Frontiers in Arctic marine Monitoring: Permanent Observations in a Gateway to the Arctic Ocean, OCEANS - Bergen, 2013 MTS/IEEE. doi: 10.1109/OCEANS-Bergen.2013.6608008

Observed ecosystem changes

Variations in environmental conditions in Fram Strait are reflected in ecosystem changes throughout the water column. Strong Atlantic influence with warming waters from 2004 onward results in changes of the entire ecosystem including particle fluxes and community composition from micro-organisms to megafauna. This holistic ecosystem perspective is facilitated by the chosen multidisciplinary approach with sustained observations of biological and physical variables from surface to seafloor.



Exemplary ecosystem time series results. A: Temperature increase in Atlantic waters at up to 400m water depth (Beszczynska-Moeller et al. 2012), B: Changes in biogenic particle composition in traps (Bauerfeind et al. 2009), C: Example benthic images and changes in Megafauna assemblages (Bergmann et al. 2011).

FRAM observatory infrastructure

The FRAM observatory (FRontiers in Arctic marine Monitoring) will build on existing observation activities in Fram Strait and the Arctic Ocean. FRAM is currently under negotiation for national funding. It will include novel instrumentation, e.g., profiling moorings, ice-tethered platforms, gliders, and benthic crawlers. This will allow for year-round observations and near real time data access. FRAM will extend observations over larger areas and encompass the upper-most / under-ice water layer.



Artist's vision of FRAM: a multi-component, multi-disciplinary observatory for year-round observations of physical, chemical, and biological ecosystem components (Sabine Lüdeling, www.medieningenieure.de).

Schauer, U. et al. (2008) Variation of measured heat flow through the Fram Strait between 1997 and 2006. Arctic-Subarctic Ocean Fluxes: Defining the Role of the Northern Seas in Climate, Springer, Dordrecht: 65-85
Rabe, B. et al. (2009) Freshwater components and transports in the Fram Strait - recent observations and changes since the late 1990s. Ocean Science 5: 219-233.