Observing ocean conditions in the Fram Strait with a multi-purpose acoustic system and Seagliders

Jenny Ullgren[1¤], Hanne Sagen[1], Agnieszka Beszczynska-Möller [1,2], Wilken-Jon von Appen[3], Katrin Latarius [3]

1) Nansen Environmental and Remote Sensing Center, Bergen, Norway
2) Institute of Oceanology Polish Academy of Sciences (IO-PAS), Sopot, Poland 3) Alfred Wegener Institute, Bremerhaven, Germany

Introduction

The Fram Strait is the gateway through which warm, saline Atlantic water enters the Arctic Ocean and cold, fresh polar water is exported. The exchange is crucial for the Arctic Ocean heat and salt budget. Changes in oceanic heat flux may play a role in the sea ice decline seen in the last decades.

A mooring array has been maintained across the Fram Strait since 1997 by the Alfred Wegener Institute (AWI) and Norwegian Polar Institute (NPI) to monitor volume, heat, and freshwater exchange.

In the project 'Acoustic Technology for Observing the Interior of the Arctic Ocean' (ACOBAR) 2008-2012, the observing system was extended with a multi-purpose acoustic system for thermometry, passive acoustics, and glider navigation. The acoustic monitoring system in the Fram Strait is continued and augmented in the ongoing project 'Arctic Ocean under Melting Ice' (UNDER-ICE).

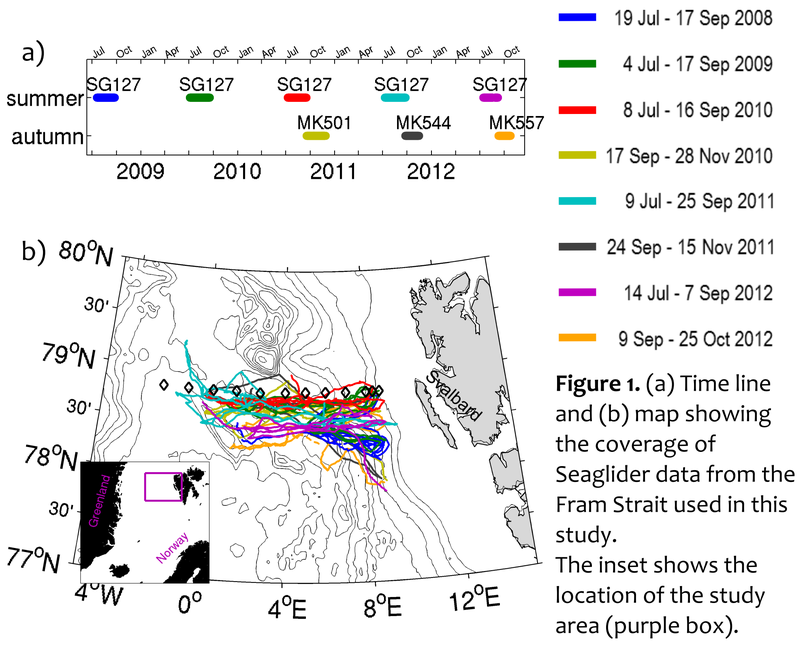
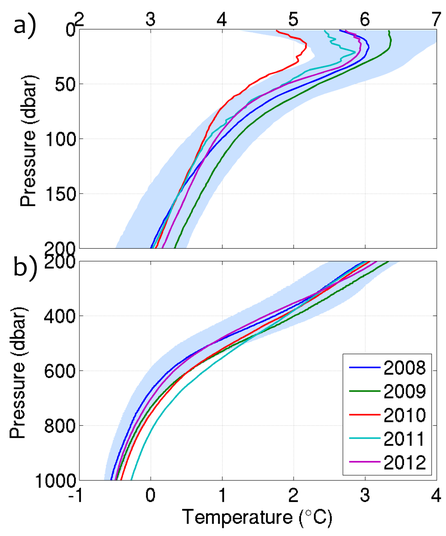


Figure 1. (a) Time line and (b) map showing the coverage of Seaglider data from the Fram Strait used in this study. The inset shows the location of the study area (purple box).

Here we show hydrographic data from Seaglider missions run by the AWI as part of ACOBAR. Gliders followed a quasi-zonal transect just south of the mooring array at 78° 50'N, profiling to 1000 m. Five missions were completed in summer and three in autumn - for dates, see legend above (Figure 1).

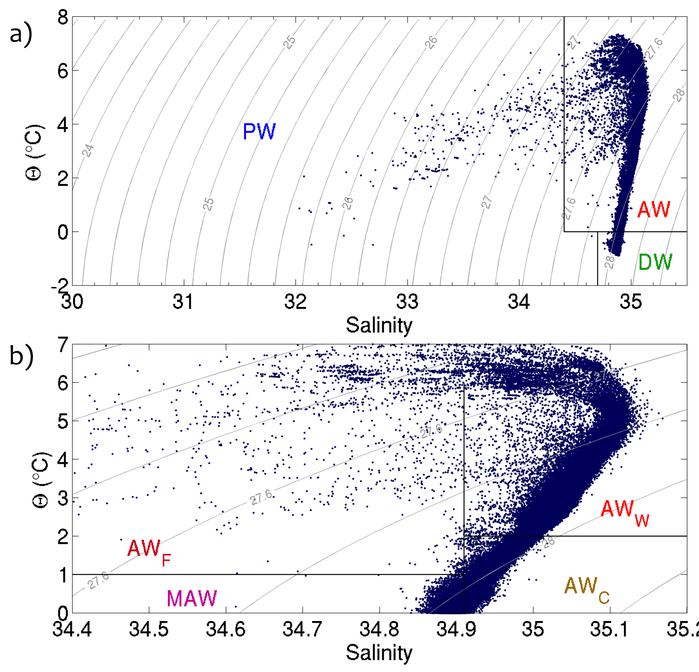
Year-to-year comparison (summer)



Differences between mean temperature profiles were small compared to the variability within each mission. In 2010 and 2011, temperatures seem high at depth and low in the upper layer. The difference might, however, be due to different sampling locations rather than changes in oceanographic conditions.

Figure 5. Mean temperature profiles from the summer glider missions (SG127, see Fig. 1a). The shaded area shows ±1 standard deviation for 2008. Note different scale for upper 200 m (a).

Hydrography



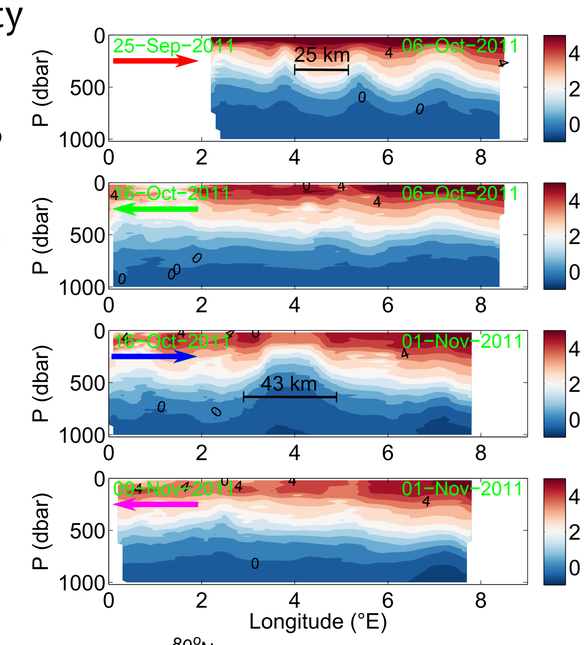
PW	Polar Water
AW	Atlantic Water
DW	Deep Water
AW_W	warm AW
AW_C	cold AW
AW_F	fresh AW
MAW	Modified AW

Figure 2. θ-S diagram from the 2008 summer mission, for the (a) entire θ-S range of the upper 1000 m, and (b) Atlantic Water range. Water masses listed above; definitions from Schlichtholz and Houssais, 2002. Grey lines are isopycnals with reference pressure 0 dbar.

The Atlantic Water in the upper layer during the summer 2008 glider mission appears rather warm and saline compared to some earlier studies (1984 data; Schlichtholz and Houssais, 2002), in agreement with more recent CTD observations (2009-2010 data; Pavlov et al., 2015).

Mesoscale variability

Eddies are common in the Fram Strait. The high mesoscale variability leads to uncertainty in long-term flux estimates.
Glider section data (Figure 3) show mesoscale features with vertical isopycnal displacements of sometimes more than 300 m over less than 20 km.
This is remarkable considering that the glider missions took place during the seasons with the lowest level of Eddy Kinetic Energy (EKE) measured by the moorings (Figure 4).



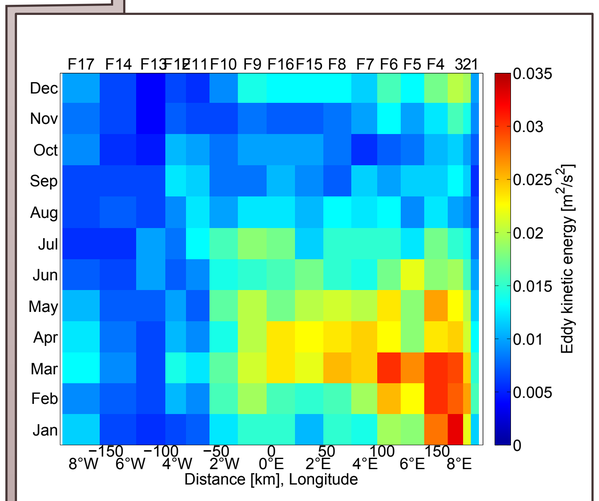


Figure 4 (by Wilken-Jon von Appen) Monthly averages of EKE from moored instruments at a nominal depth of ~75 m, computed by removing 3-month low pass filtered data.

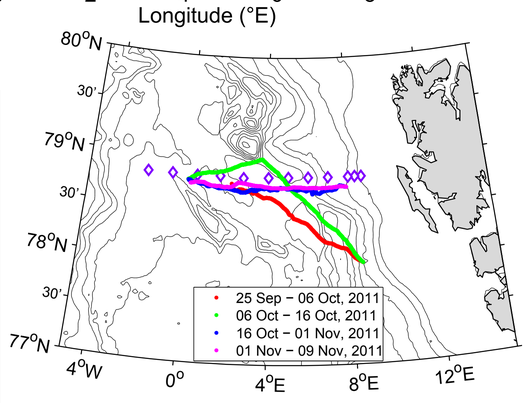


Figure 3. Repeated sections from the autumn mission in 2011 with glider MK544. a) Temperature contours, plotted against longitude. Green labels: start and end dates of each transect. Arrows show direction of travel; arrow colour corresponds to the track shown in b).
b) Map of autumn 2011 transects. Purple diamonds mark the locations of moorings in the 78° 50'N array.

Acknowledgements

UNDER-ICE is supported by the Research Council of Norway and GDF SUEZ E&P Norge. Field work is supported by the Norwegian Coast Guard and the University of Bergen. We thank the crews of the K.V. Svalbard, R. V. Håkon Mosby, and R. V. Polarstern.

Please note that results presented here are preliminary. Careful post-processing of glider data is underway.

References

Schlichtholz and Houssais (2002) An overview of the θ - S correlations in Fram Strait based on the MIZEX 84 data. Oceanologia, 44 (2), 243-272.
Pavlov et al. (2015) Contrasting optical properties of surface waters across the Fram Strait and its potential biological implications. J. Mar. Syst. 143, 62-72.

Summary

Mesoscale eddies and meanders play an important role in the Fram Strait current system. Data from repeated Seaglider missions complement mooring measurements and provide improved statistics of the variability.

Ocean Outlook, Bergen, Norway, 19-20 February, 2015. ¤ jenny.ullgren@nersc.no