Glider observations of oceanic conditions in the Fram Strait, 2008-2012

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

* jenny.ullgren@nersc.no

EGU General Assembly 2015, Vienna - OS 1.2 - Y218

Introduction

The inflow of warm, saline Atlantic water and outflow of cold, fresh polar water through the Fram Strait are crucial for the Arctic Ocean heat and salt budget. Changes in oceanic heat flux may play a role in the sea ice decline over 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).

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 of Figure 1).

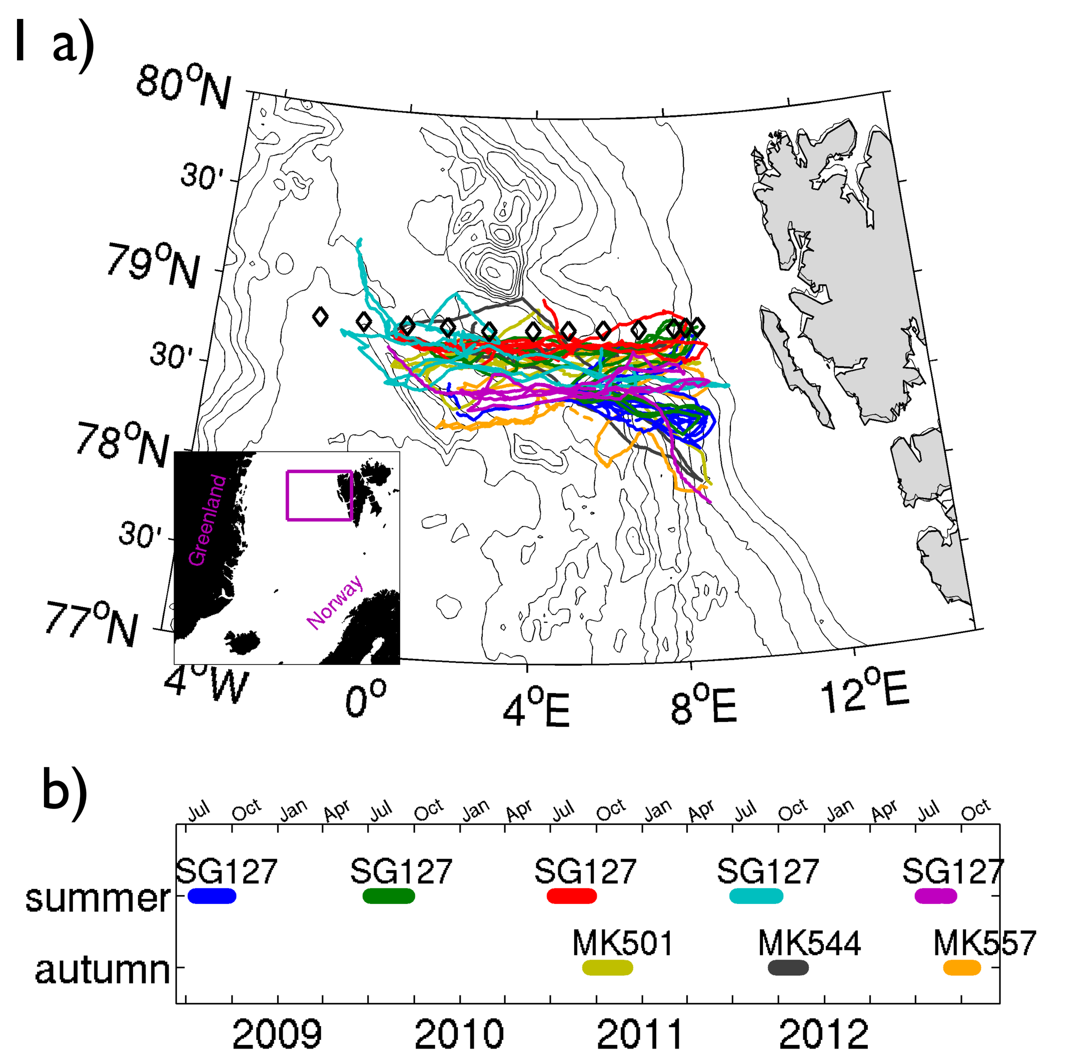


Figure 1. (a) Map and (b) time line showing the coverage of Seaglider data from the Fram Strait used in this study. The inset shows the location of the study area (purple box).

Mesoscale variability

Glider section data show mesoscale features with vertical isopycnal displacements of sometimes more than 300 m over less than 20 km (see Figure 5). Currents are variable and recirculation occurs west of the West Spitsbergen Current core (Figure 6). The glider missions took place in the seasons with the lowest level of Eddy Kinetic Energy (EKE) measured by the moorings (Figure 7). Even higher levels of mesoscale variability might be expected in the Fram Strait during the winter season.

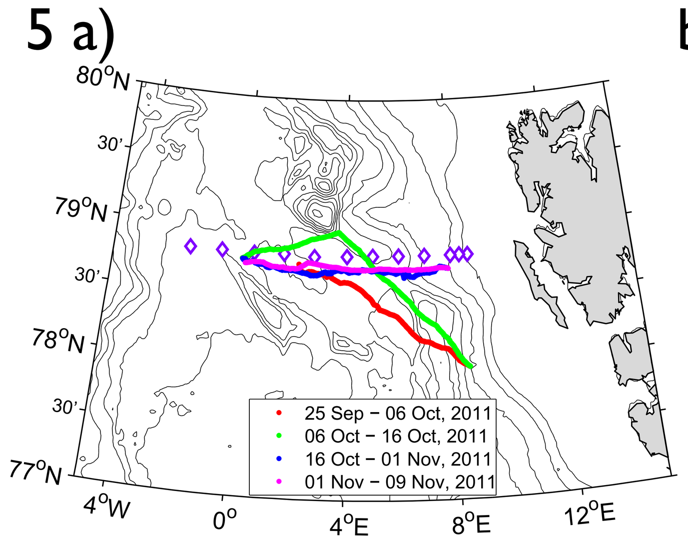
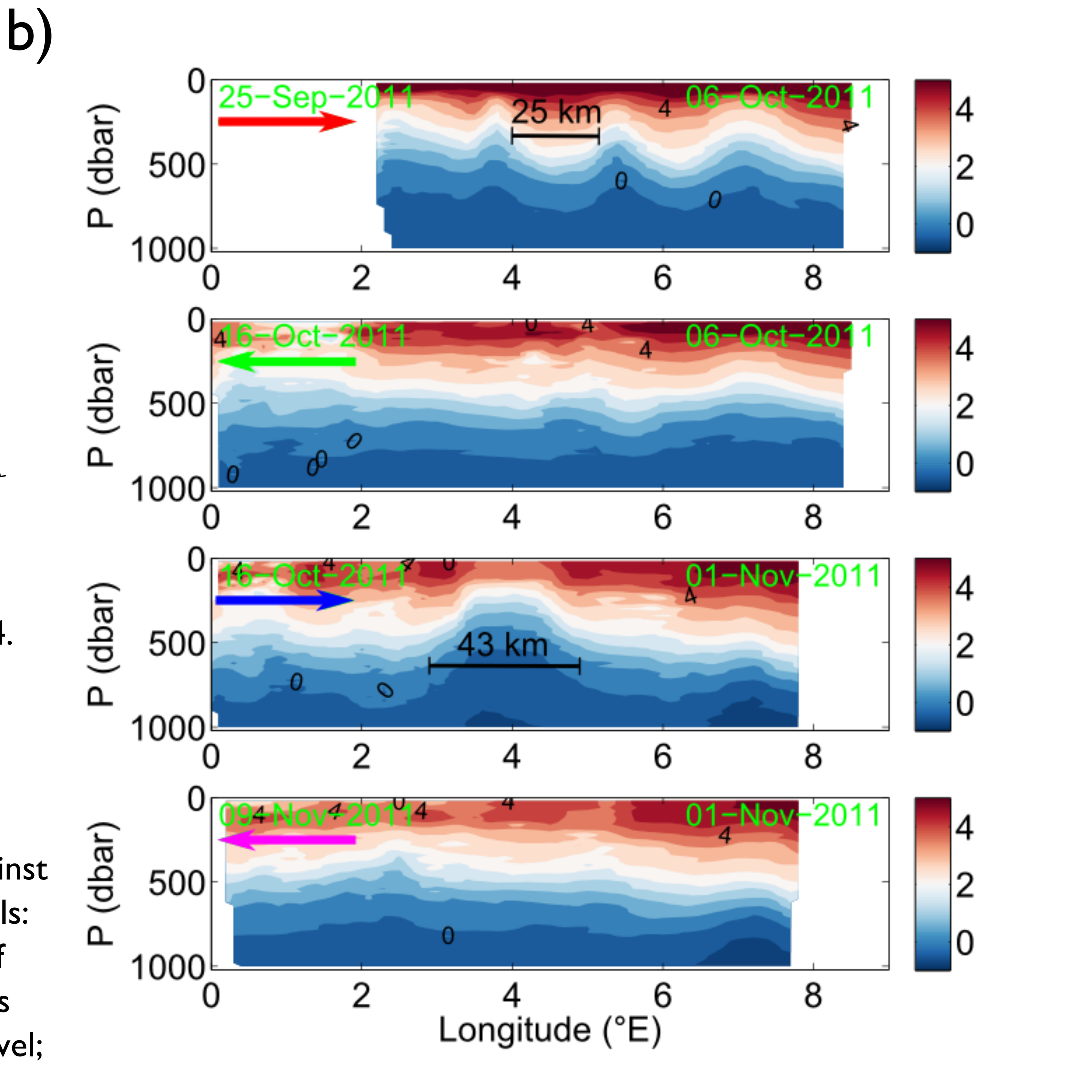


Figure 5. Repeated sections from the autumn mission in 2011 with glider MK544. a) Map of autumn 2011 transects. Purple diamonds mark the locations of moorings in the 78° 50'N array.



b) 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 a).

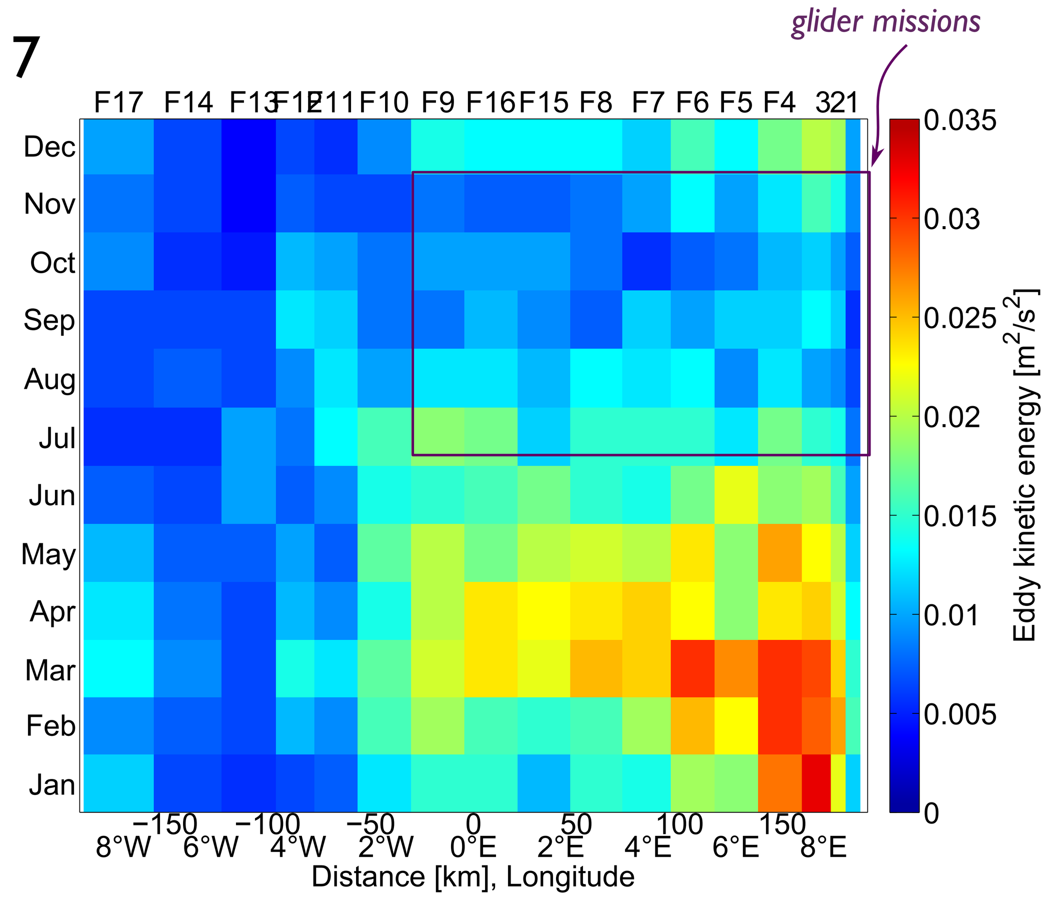


Figure 7 (by Wilken-Jon von Appen) Monthly averages of EKE from moored instruments at a nominal depth of ~75 m, computed by removing 3-month low pass filtered data.

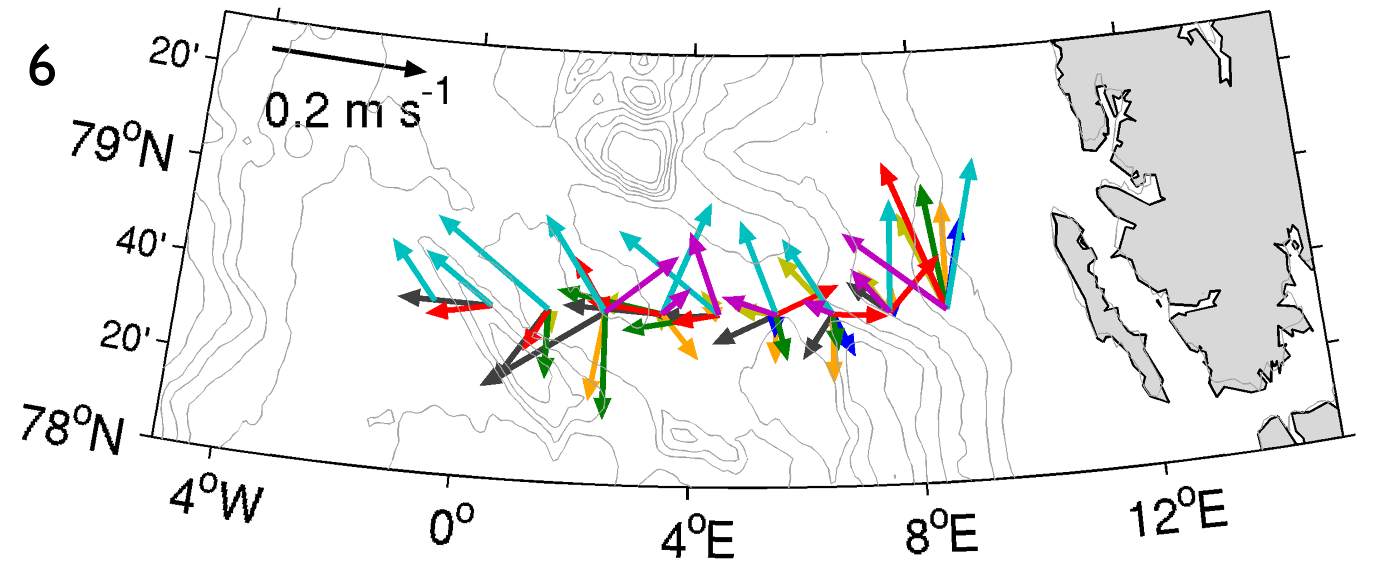


Figure 6. Depth average current vectors from the eight Seaglider missions (colours as in Fig. 1). Current velocities from each mission have been averaged over 1° longitude bins. Dives shallower than 400 m, and bins with less than 15 dives, are excluded.

Hydrography

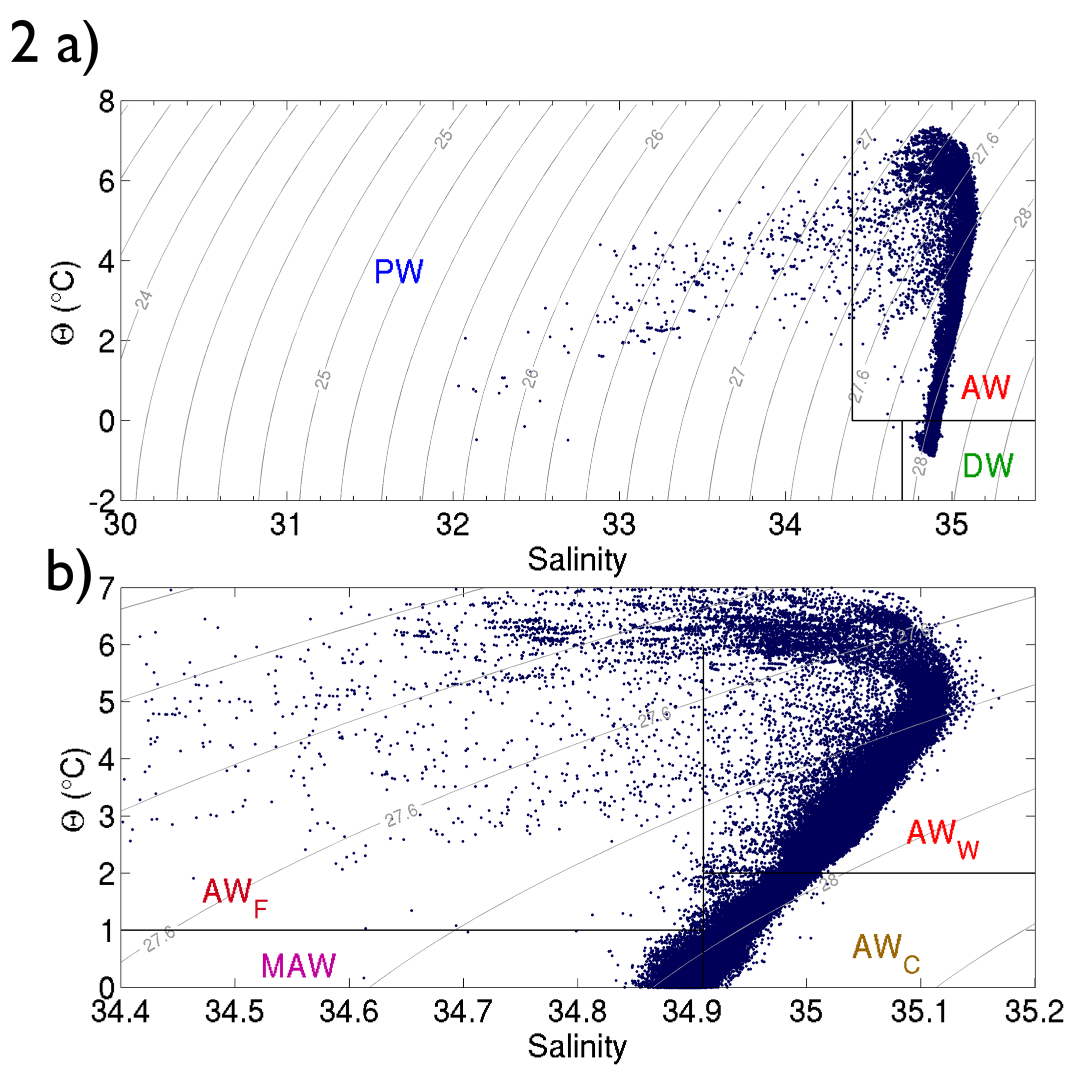


Figure 2. θ-S diagram from the 2008 summer mission, for the (a) entire θ-S range of the upper 1000 m, and (b) Atlantic Water range. Water masses listed to the right; definitions from [1]. Grey lines are isopycnals with reference pressure 0 dbar.

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

Long-term time series from moorings have shown a temperature peak in 2007 [1]. The Atlantic Water in the upper layer during the summer 2008 glider mission was rather warm and saline compared to some earlier studies (1984 data) [2]. This is in agreement with more recent CTD observations (2009-2010 data) [3].

Year-to-year comparison (summer)

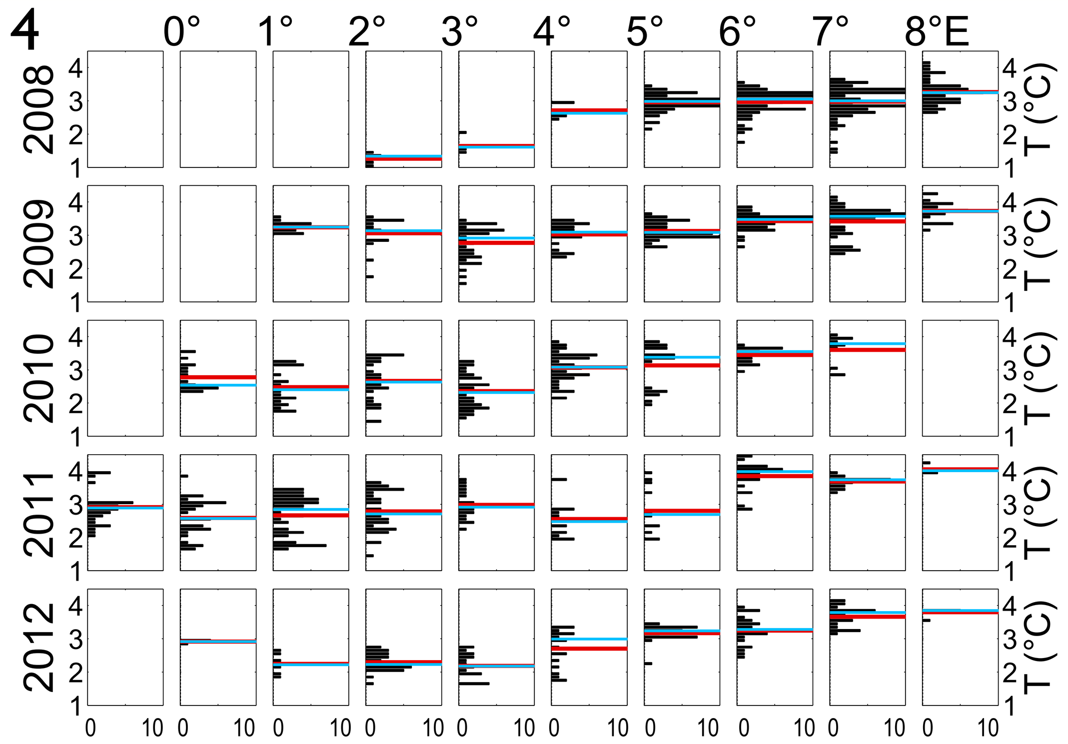


Figure 4. Histograms of upper layer temperatures in 1° longitude bands. Temperatures are averages over the top 500 m of each profile. Columns: longitude bands (label on top). Rows: years (label on left). Red lines show the mean, and blue lines the median, for each longitude/mission bin.

Temperature profiles measured by gliders during all five summer missions were averaged separately for the areas east and west of 5°E (Figure 3), to separate the Atlantic and Polar water domains. The temperature range of the western region is larger (Fig. 3a), in part because it covers a wider area - Figure 4 shows, for each mission, which longitudinal bins contained data. The western region also includes recirculating Atlantic Water in addition to the cooler water from the west.

Differences between mean profiles were rather small compared to the variability within each mission, and may be due to different sampling locations (Figure 4) rather than changing oceanographic conditions.

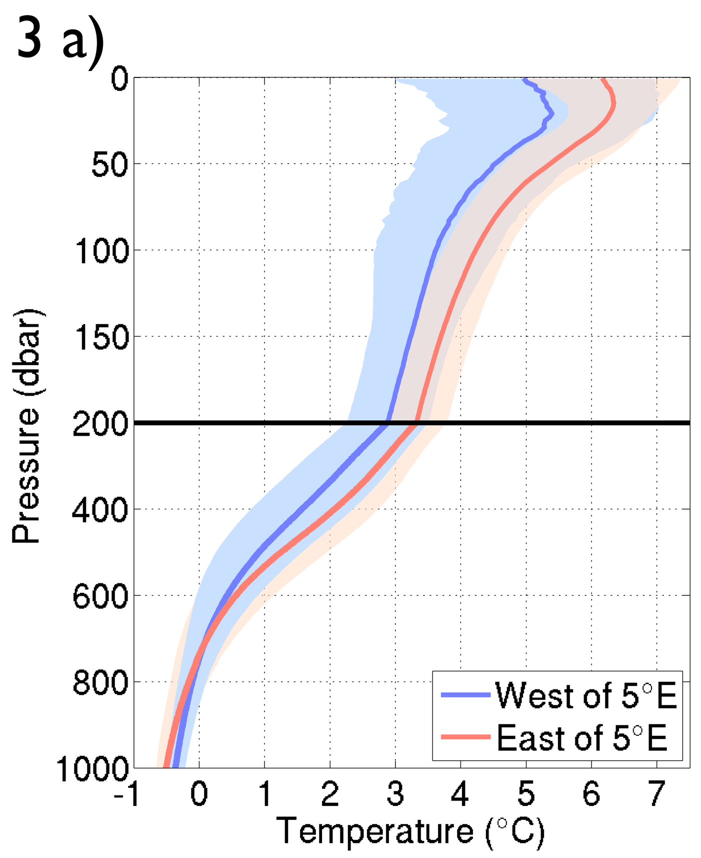
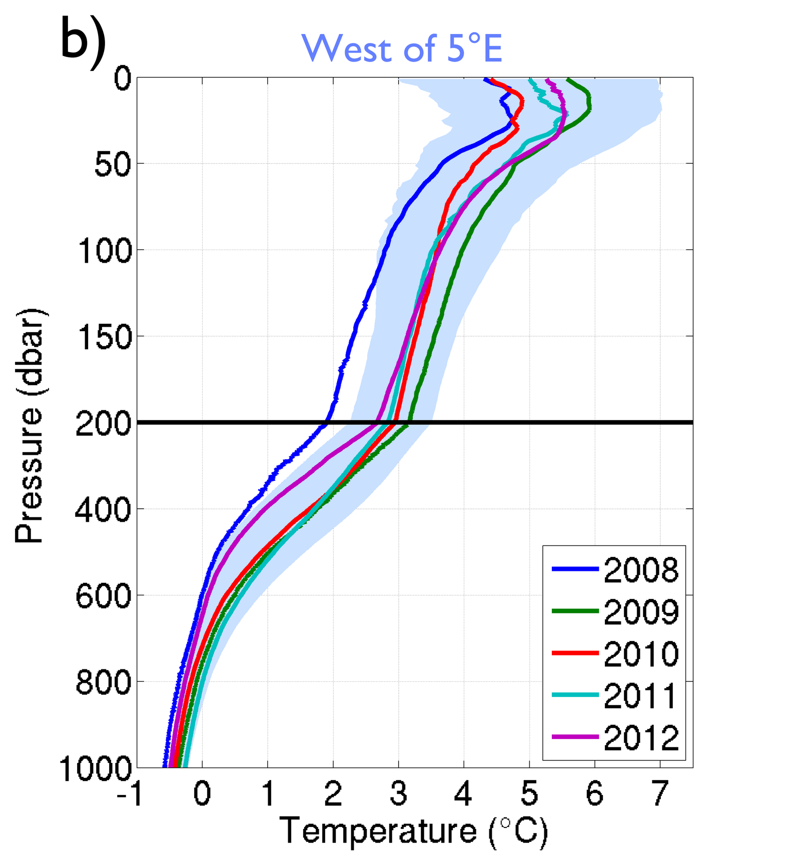
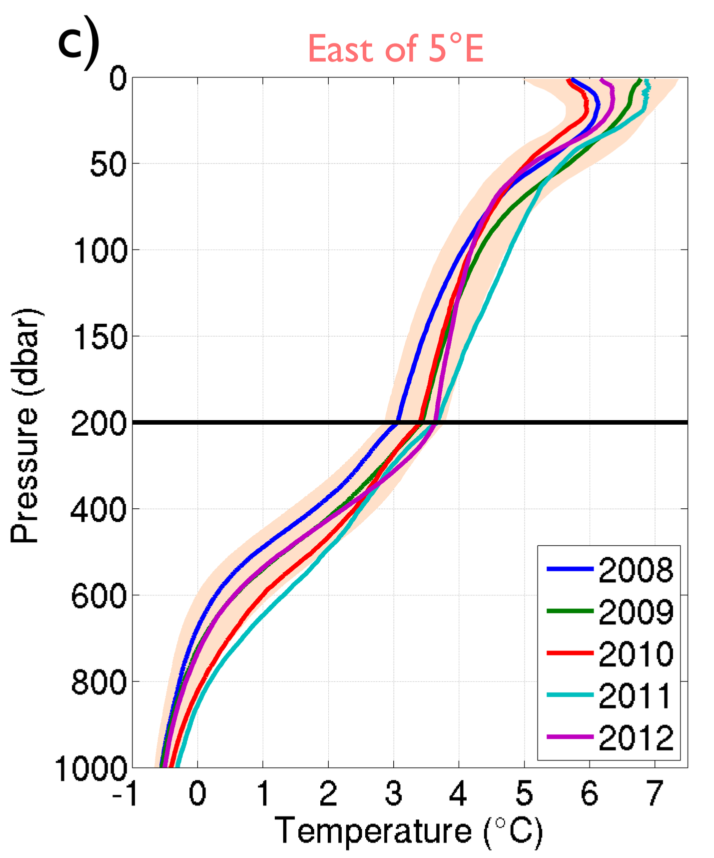


Figure 3 a) Mean temperature profiles from all summer glider missions, east (red) and west (blue) of 5°E. The shaded area shows ±1 standard deviation.



b) Mean temperature profiles west of 5°E for each of the five summer missions, overlaid on the overall mean ±1 st. dev. envelope shown in a. In 2008, few dives were done west of 5°E (cf. Fig. 4).



c) As b but east of 5°E.
Note different vertical scale for upper 200 m in a, b and c; the horizontal black line marks the change in scale.

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

References

[1] Beszczynska-Möller et al., 2012. *ICES J Mar Sci.* 69(5), 852–863.
[2] Schlichtholz and Houssais, 2002. *Oceanologia*, 44 (2), 243-272.
[3] Pavlov et al., 2015. *J Mar Syst.* 143, 62-72.

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.

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.