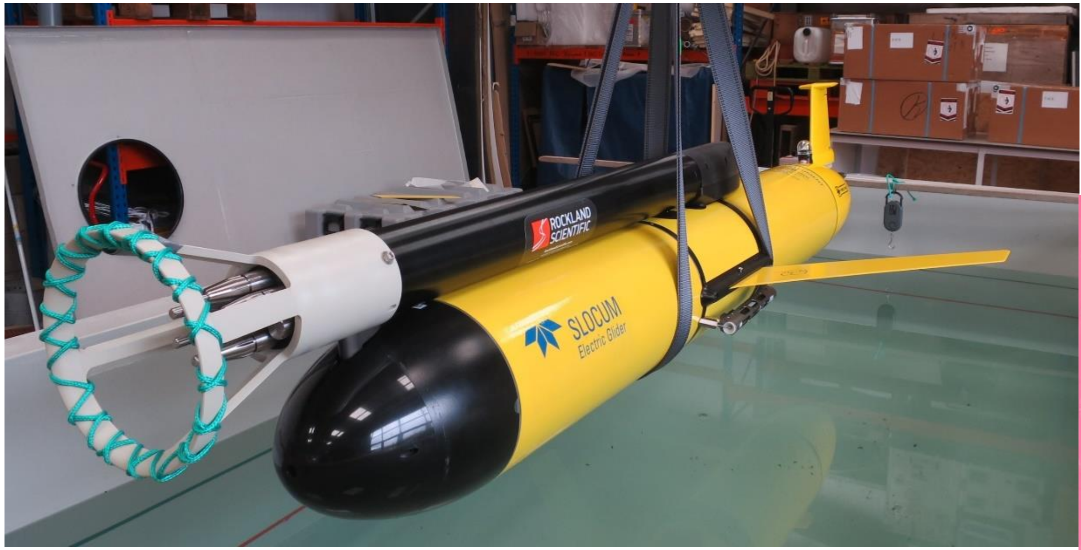
This work is a part of COMPASS (Climate-relevant Ocean Measurements and Processes on the Antarctic continental Shelf and Slope), funded by the European Research Council under the European Union's Horizon 2020 research and innovation programme (grant agreement n° 741120).

In recent years the UEA glider group worked with Kongsberg Maritime (now Hydroid) and Rockland Scientific Inc. (RSI) to develop and test an integrated microstructure system which could be mounted on Seagliders (figure 1). Existing RSI microstructure packages such as the MicroRider could not be used on Seagliders because of a geometry mismatch with the shape of the Seaglider's hull that made mounting difficult, and because the size of those packages added an unacceptable drag. We also required a more sophisticated software interface so that the RSI system could be controlled by the standard Seaglider scientific logger payload control software.



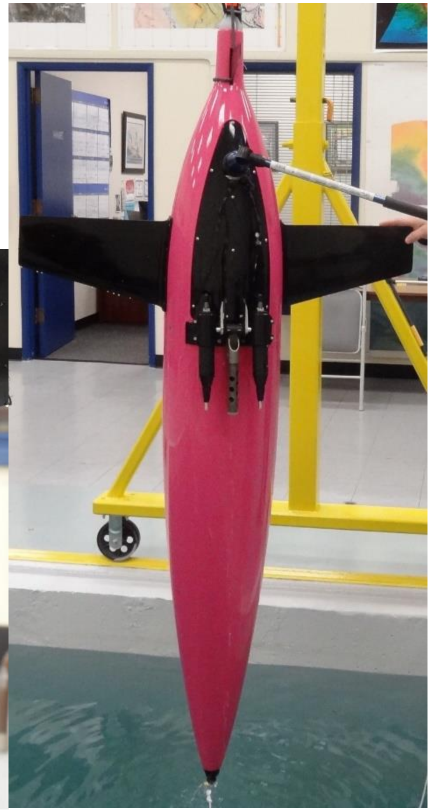


Figure 1: Mounting microstructure sensors.
Above, Slocum glider with MicroRider.
Right, Seaglider with MicroPods.

Since the initial sea trials in 2015, UEA microstructure Seagliders have been deployed on missions in the Bay of Bengal, the Faroe Shetland Channel, east of the Bahamas, the Weddell Sea, and east of Barbados (figure 2).

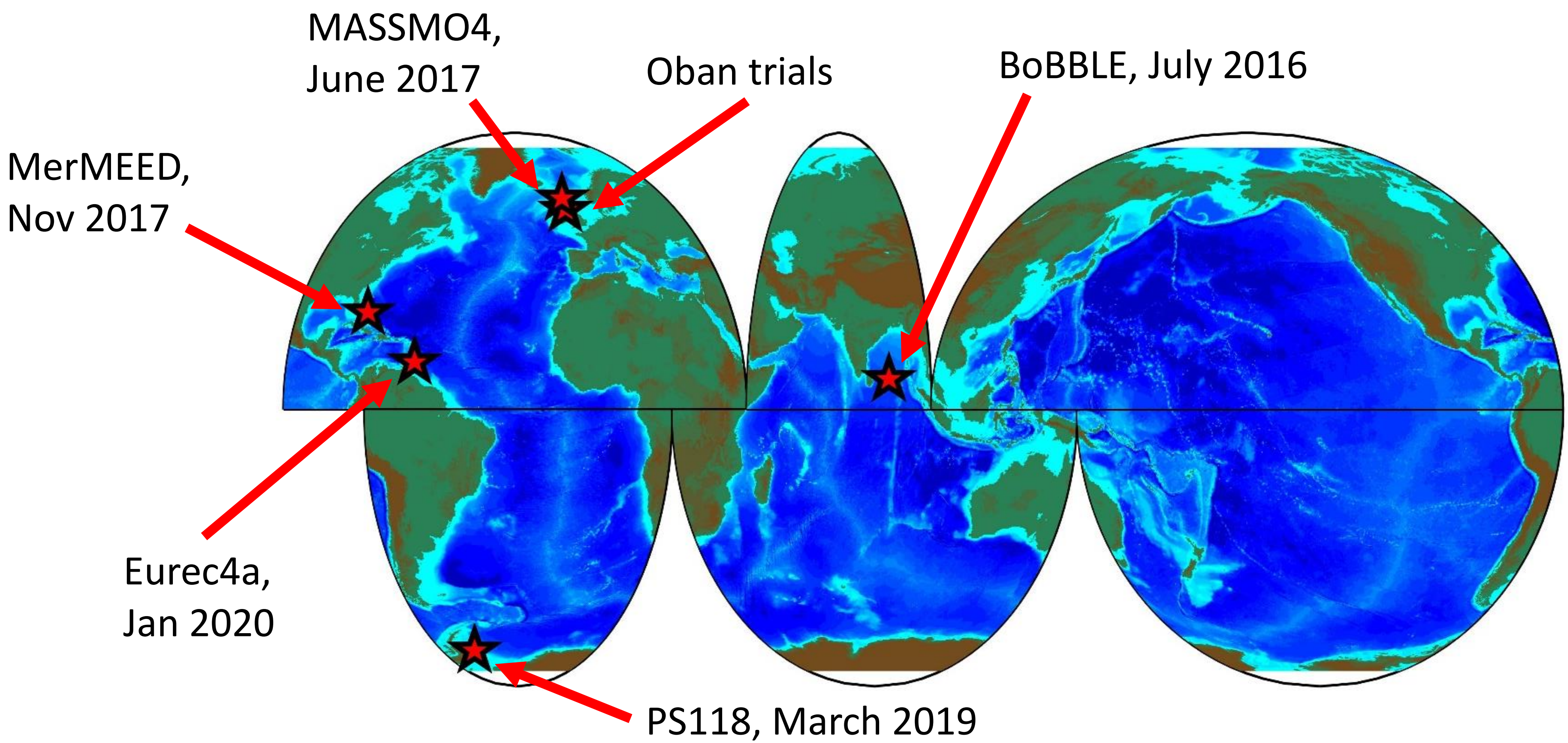


Figure 2: UEA Microstructure Missions

BoBBLE – Bay of Bengal Boundary Layer Experiment – July 2016

162 microstructure profiles were collected over 11 days. Initial processing appeared to show large differences in dissipation between descents and ascents – which is a problem, because dissipation in the ocean does not depend on which direction a glider happens to be travelling! But improvements in the glider flight model estimates of speed in the direction of travel, using the UEA Seaglider processing toolbox, have led to improvements in dissipation estimates (figures 3 and 4).

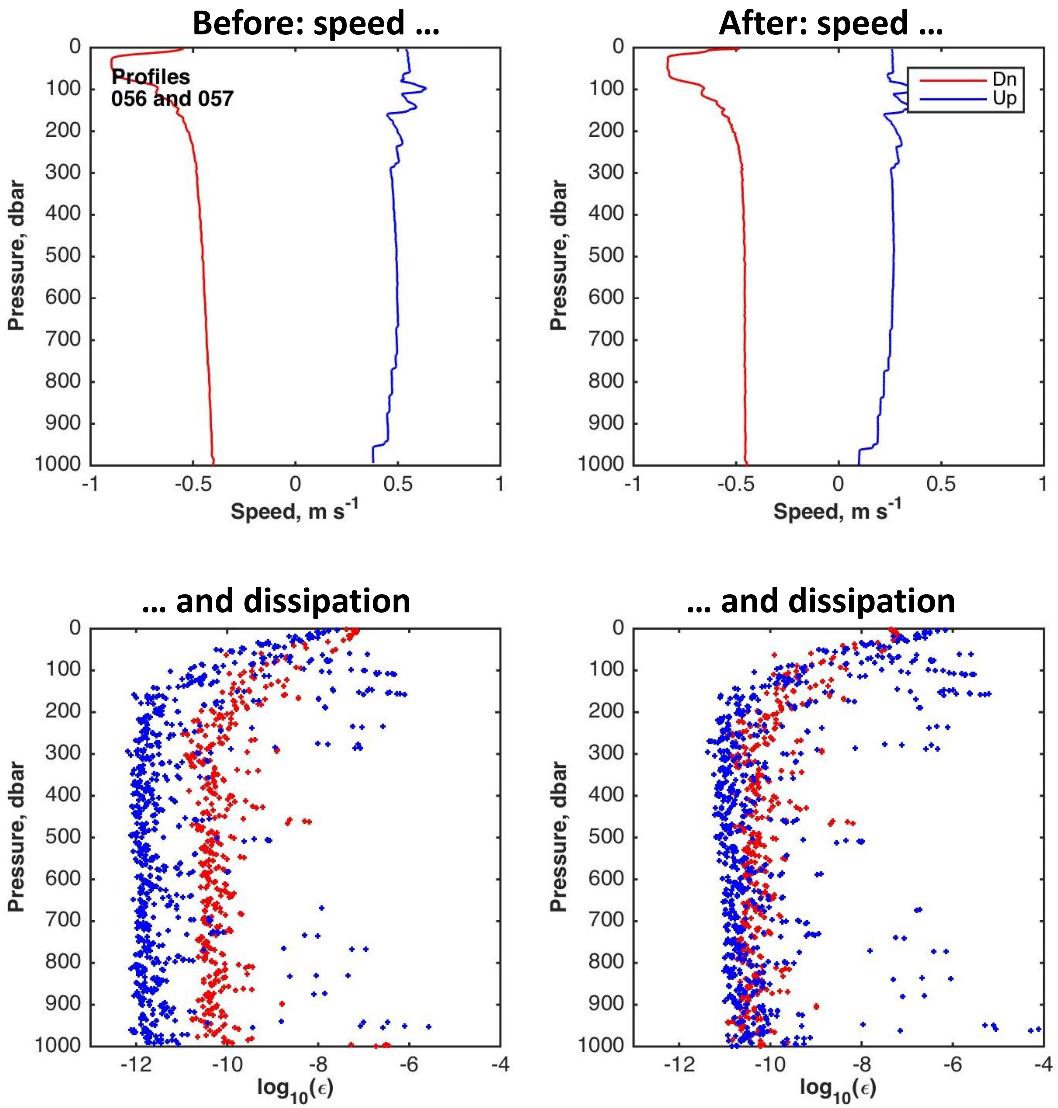


Figure 3: Example pair of profiles showing effect of improvements in the flight model. Descent (red) and ascent (blue) show systematic difference in dissipation when using the uncorrected flight model estimates of speed. After the speed is corrected using the UEA Seaglider processing toolbox, the difference in dissipation between the descent and ascent is largely eliminated.

Note also that the speed of ascent is slower than speed of descent, once the flight model has been corrected. This will lead to a greater number of estimates of dissipation during the ascents.

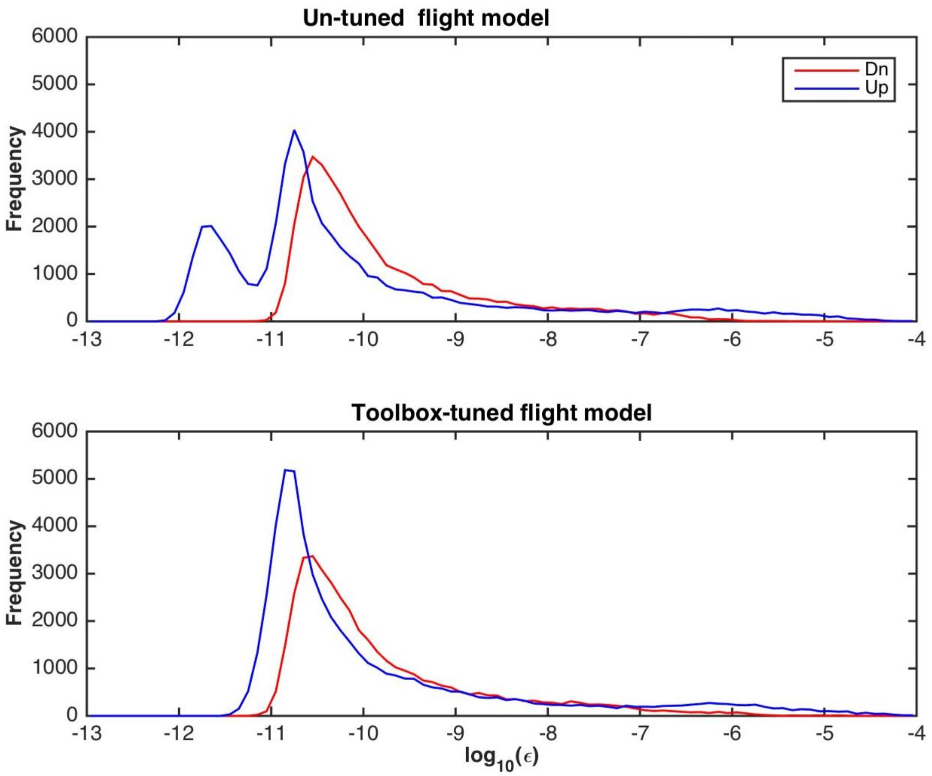


Figure 4: Histograms of all dissipation estimates during descents (red) and ascents (blue), before (top) and after (bottom) the flight model corrections. After correction the shape of the histograms, and range of dissipations, is considerably more consistent between descent and ascent.

The larger number of dissipation estimates during ascents is simply because of the slower speed during ascents.

The uncorrected speeds resulted in an apparent bimodal distribution of dissipation estimates collected during glider ascents (figure 4, top panel). This is particularly unrealistic, so it is promising that this feature is removed by the corrections to the flight model.

Comparison with microstructure estimates from a VMP250 deployed during the same cruise (though some miles away) show a similar pattern, though dissipation estimates from the glider are lower on average (figure 5).

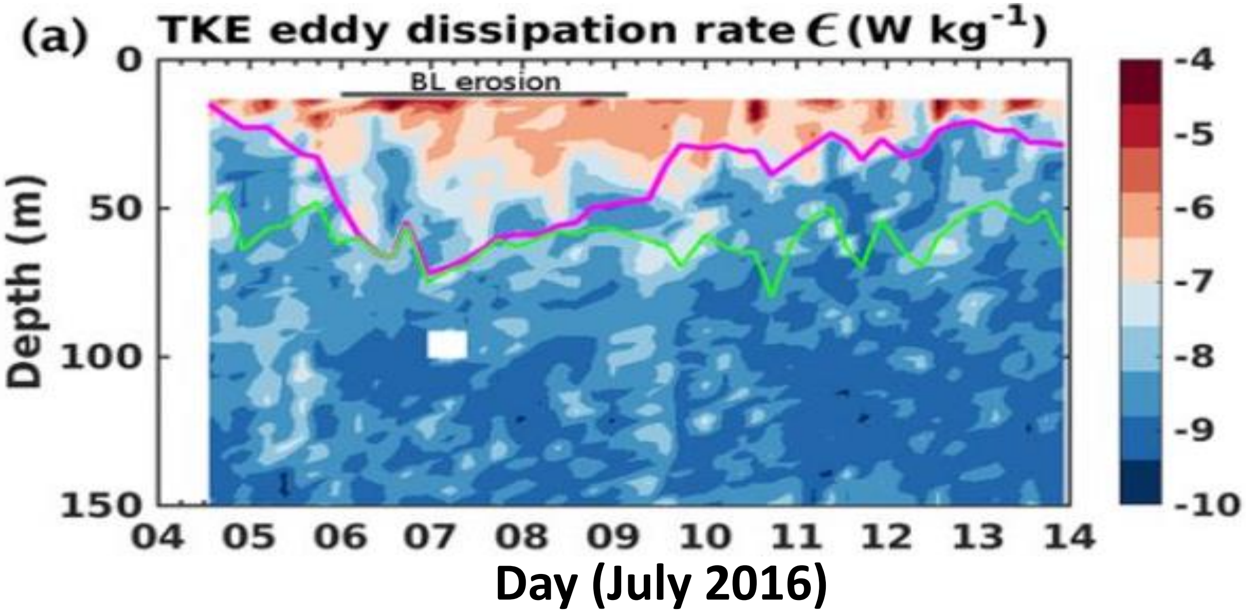
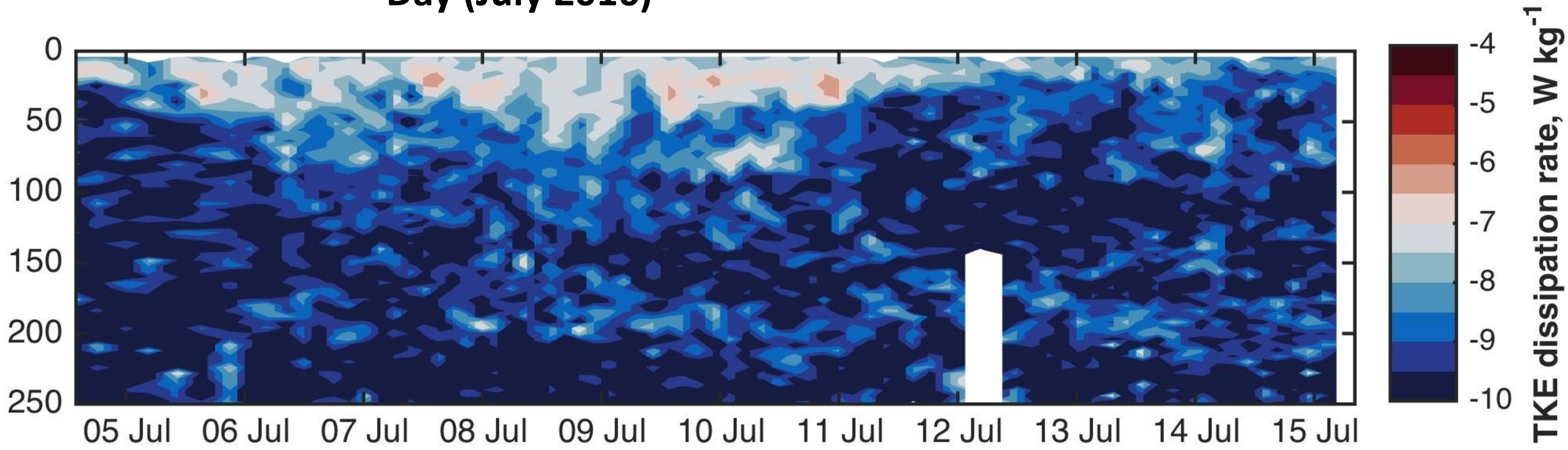


Figure 5: Dissipation rates measured during BoBBLE by the VMP250 (left) and the glider (below).

The VMP250 figure is taken from George et al., 2019, JPO. DOI: 10.1175/JPO-D-18-0204.1



The next two missions suffered from technical difficulties:

MASSMO4 – Faroe Shetland Channel – June 2017

- Power supply issue caused massive spikes in shear measurements – also affected glider.
- Microstructure switched off and glider recovered.
- Datalogger subsequently repaired by RSI.

MerMEED – Bahamas – November 2017

- Glider had problems, kept rebooting, had to be recovered. (First mission with a scicon Seaglider.)
- Glider subsequently repaired by Kongsberg and datalogger upgraded by RSI.

In August 2018 we carried out successful trials in Oban of the repaired glider and both upgraded microstructure systems.

PS118 – Weddell Sea – March 2019

Last year's deployment in the Weddell Sea allowed comparison between Seaglider estimates of dissipation and those from an established microstructure profiler (MSS90). 24 profiles were collected by the glider over 3 days, and 11 MSS profiles (figure 6). Dissipation estimates measured by the Seaglider system varied between 10^{-10} and 10^{-5} W kg^{-1}, with higher values generally closer to the surface. Those observed by the MSS were similar at depth but slightly higher in the top 200 m (figure 7). Further work will aim to understand these differences.

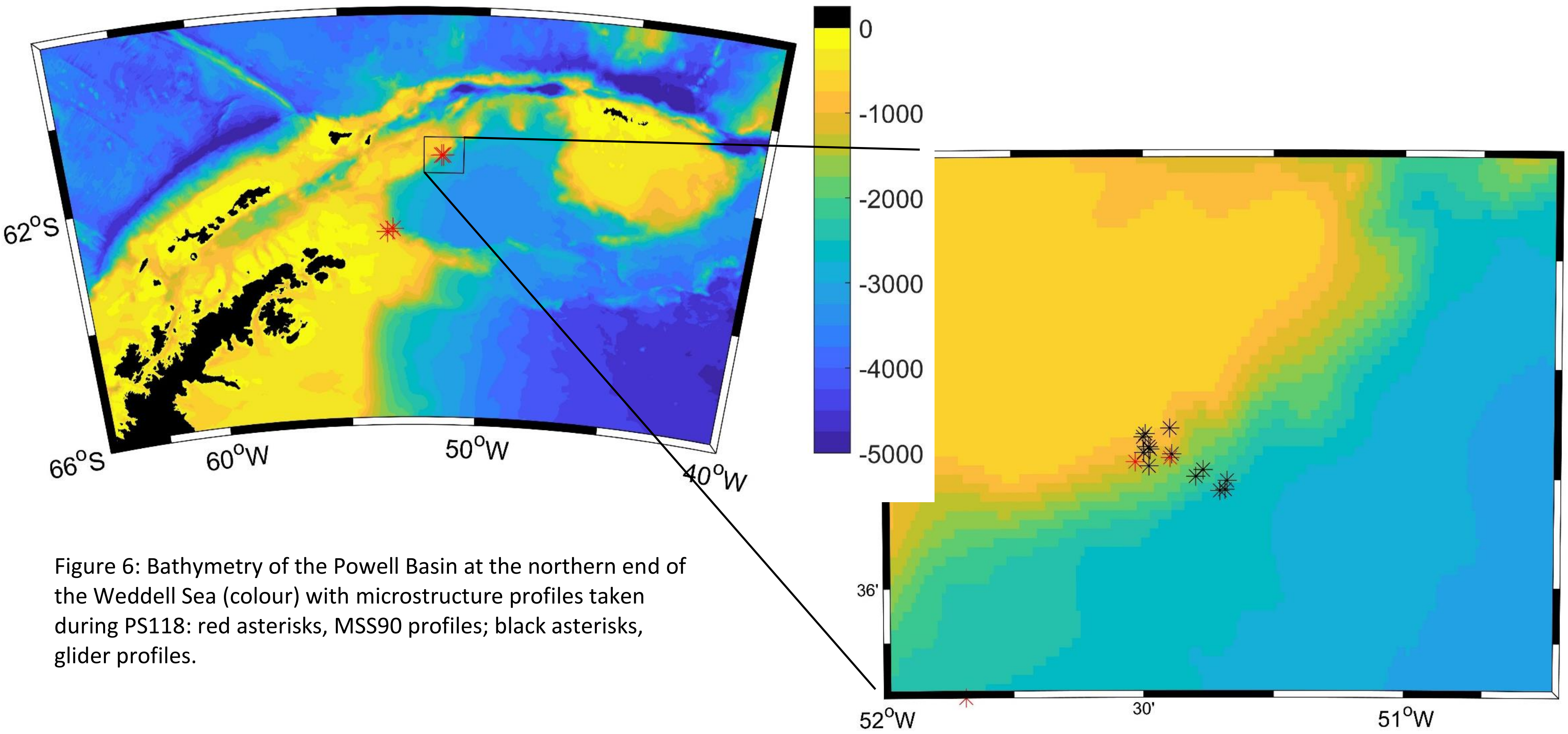


Figure 6: Bathymetry of the Powell Basin at the northern end of the Weddell Sea (colour) with microstructure profiles taken during PS118: red asterisks, MSS90 profiles; black asterisks, glider profiles.

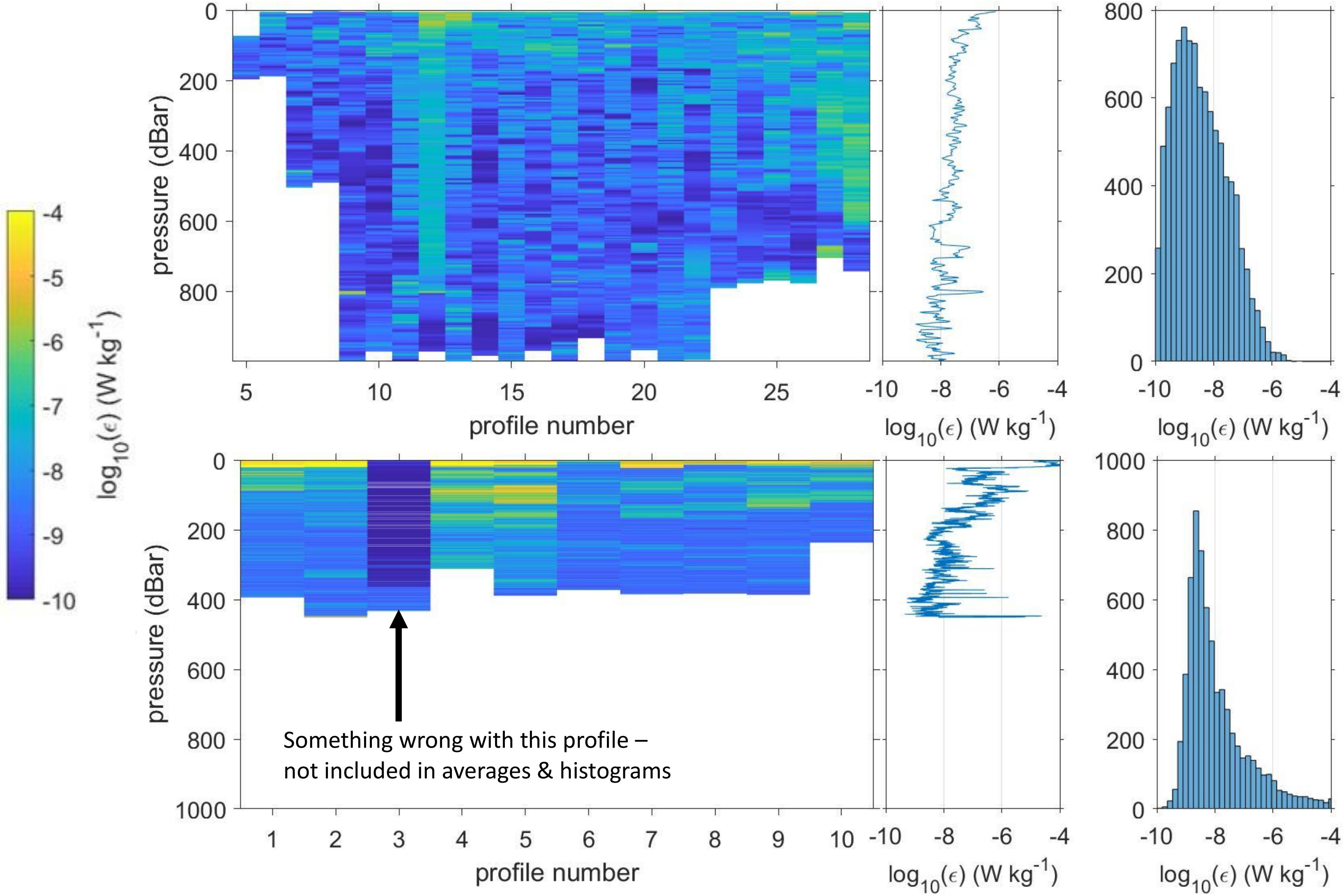


Figure 7: Dissipation estimates from the glider (top) and MSS90 (bottom). Second column shows the average over all profiles, and the third column shows histograms of all dissipation estimates. Note that these histograms are over the entire depth range, so we expect more estimates of low disspation from the glider (which went deeper).

Distribution of dissipation estimates look broadly similar, but there are differences, even in the 200-400 m depth range (figure 8) where at first glance they appear most similar. Possibly the MSS90 may be under-reporting low dissipations – it is a physically smaller platform than the glider.

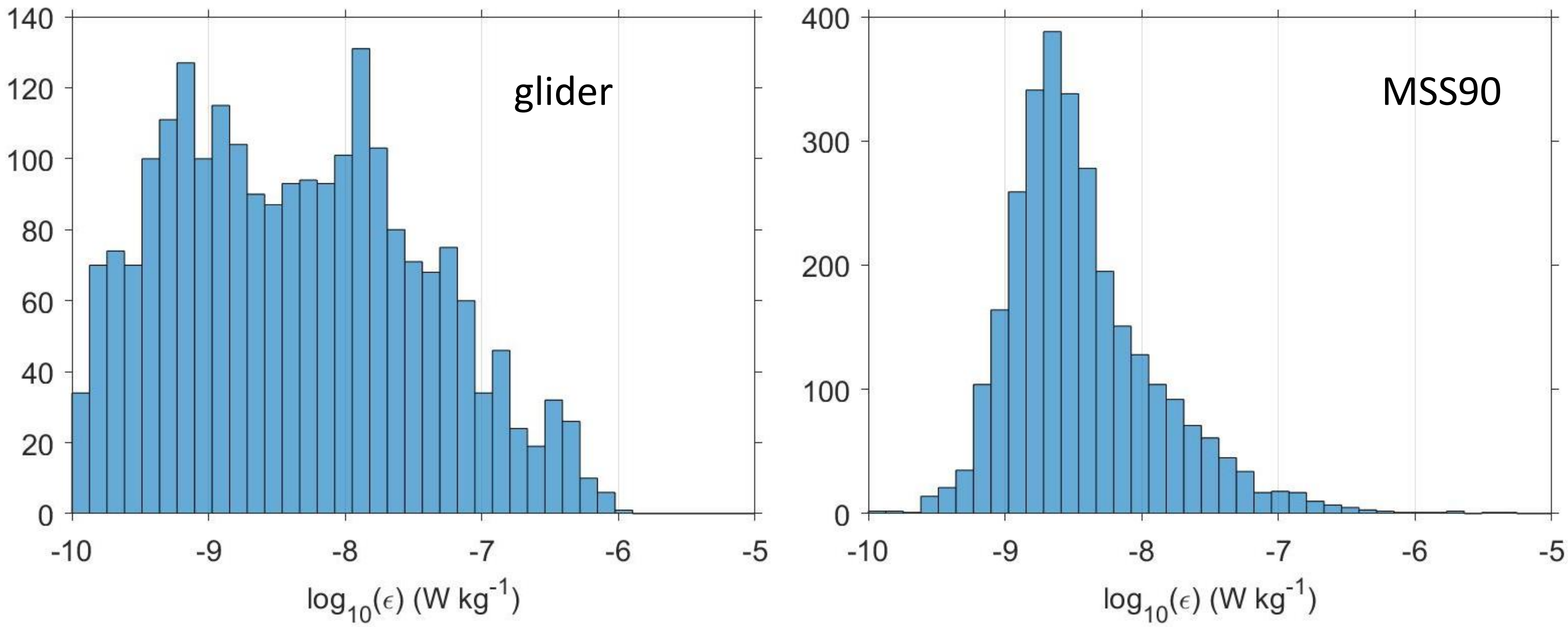


Figure 8: Histogram of dissipation estimates from the glider (left) and MSS90 (right) between 200 and 400 m.

Eurec4a – Jan-Feb 2020 – east of Barbados

162 microstructure profiles collected over 14 days. Data processing is underway now.

Summary

- Seaglider mounted microstructure instruments have measured dissipation with broadly similar patterns and values to those measured by more conventional microstructure platforms
- Early bugs in hardware seem to be ironed out now
- Some more work to be done on flight model regression, despiking, etc
- Eager to discuss with other groups using gliders for microstructure estimates – please contact me at g.damerell@uea.ac.uk