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Seaglider Observations of the Seasonal Evolution of the Upper Ocean in the Northeast Atlantic

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As part of the Ocean Surface Mixing Ocean Submesoscale Interaction Study (OSMOSIS), a year-long Seaglider deployment was undertaken at 48.7°N, 16.2°W, in the subpolar Northeast Atlantic 41 km south-east of the Porcupine Abyssal Plain sustained observatory. Two Seagliders at a time were deployed with turnarounds at roughly three month intervals, collecting a total of 8138 profiles to 1000 m of temperature, salinity and biogeochemical variables, plus an estimate of the average current over each dive cycle. The region sampled was approximately 15 km by 15 km. This unique data set has a vertical resolution between 0.5 and 1 m, and an average time interval between profiles of 2.1 hours. Here we present the highlights of the physical observations.

The surface mixed layer reached its maximum depth of 390 m in early February 2013, and the mixed layer depth is highly variable during the winter on timescales of hours to weeks. In July and early August 2013, more than half the profiles show no mixed layer up to the minimum depth reliably observed by the glider (2-3 m). The mixed layer depth is very stable in the summer, then deepens and increases in variability in the autumn. The mixed layer has a significant seasonal cycle in temperature, with a marked warm layer and seasonal thermocline during the summer and early autumn. However, the mixed layer shows less short-term (hours to weeks) temporal variability than the water layers beneath. The temporal variability in temperature generally increases with depth, except that during September and October 2012, a layer of water from just below the mixed layer to approximately 100 m shows increased variability in temperature compared with all other times and depths. In late August to early September 2013, the same increased variability layer seems to be developing, suggesting that this is a seasonal feature.

There is no obvious seasonal cycle in salinity, although there is some evidence of increased temporal variability in summer/autumn compared with winter/spring down to approximately 200 m. This is similar to the increased variability in temperature beneath the mixed layer in summer/autumn, but the signal is weaker in salinity and covers a greater depth range. Below 400 m, the variability in salinity increases with depth, and below approximately 800 m, this is linked to the intermittent appearance of patches of high salinity Mediterranean Water.

The dive-average currents reach a maximum of 38 cm s^{-1}. Currents with speeds >20 cm s^{-1} include flow to the south-east in September and early October 2012, north-eastward veering to south-eastward through late January to mid-February, and north-eastward in August 2013. In late April through May 2013, there is a reversal, with south-westward flow with speeds > 20 cm s^{-1}. At other times, the currents are weaker (<15 cm s^{-1}) and the direction varies more rapidly, with the weakest currents (< 10 cm s^{-1}) in July 2013. We discuss the relationships between the dive-average currents and the variability in temperature and salinity.