Motivation

Diapycnal diffusivity plays an important role in the ventilation of the Eastern Tropical North Atlantic (ETNA) Oxygen Minimum Zone (OMZ). Studies by Fischer et al. (2013), Banyte et al. (2012) and the synthesis by Brandt et al. (2015) found that diapycnal mixing contributes up to 20%, locally up to 30%, to the oxygen supply in the OMZ.

Tracer Release Experiments

For the first time, two Tracer Release Experiments (TREs) within the same area at different depths were realized: the Guinea Upwelling Tracer Release Experiment (GUTRE) initiated in 2008 in the oxycline at 320 m depth, and the Oxygen Supply Tracer Release Experiment (OSTRE) initiated in 2012 in the core of the OMZ at 410 m depth. Repeated measurements of the tracer (SF$_6$) allow the quantification of diapycnal and isopycnal dispersion from direct observations.

GUTRE tracer was detected during two of the OSTRE surveys which allowed to estimate diapycnal diffusivity from GUTRE over a time period of seven years.

Diapycnal diffusivity

The mean diapycnal diffusivity was found to be $(1.06 \pm 0.24) \times 10^{-5}$ m$^2$ s$^{-1}$ in the OMZ core during OSTRE.

The result is consistent with the diapycnal diffusivity estimates from GUTRE in the oxycline, as well as with microstructure measurements in the OMZ region. This demonstrate that the diapycnal diffusivity does not vary significantly in the OMZ within the depth range of 200-600 m and does not change in time.

For both experiments no significant vertical displacements of the tracer peak larger than 5 m per year were observed over the entire time period of both TREs.

Enhanced mixing

The diapycnal diffusivity estimates from both TREs are about five times higher than expected from the Garrett and Munk reference (background) internal wave field. Vertical shear spectra from ship ADCP data showed elevated internal wave energy levels in the seamount vicinity. Both tracer patches covered increasingly overlapping areas with time and thus spatially integrated increasingly similar fields of local diffusivity, as well as a different local stratification counteracted the influence of roughness on diffusivity.

Mean diapycnal diffusivity coefficients for OSTRE (blue), GUTRE (magenta), and estimates from microstructure measurements (black). Boxes are giving the uncertainty ranges.

Diapycnal diffusivity coefficients for GUTRE (white diamonds) and OSTRE (black dots). The mean coefficients are marked with horizontal lines.

Normalized mean tracer concentration profiles for GUTRE (a) and OSTRE (b).

Mean tracer profiles during OSTRE-III 2014 (left) and OSTRE-IV 2015 (right) from raw data (dots) for OSTRE (solid line) and GUTRE (dashed line).