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Fine- to mesoscale oxygen variability at intermediate depth in the tropical North East Atlantic along 23°W

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The oxygen minimum zone (OMZ) of the tropical North East Atlantic (TNEA) is located in the region between the oxygen rich equatorial band and the Cape Verde Frontal Zone at about 20°N at a depth of 300 – 600 m. Its horizontal extent is predominantly defined by two major current systems: 1) the northern boundary of the OMZ is given by the southward extent of the North Equatorial Current, that transports oxygen rich waters of the northern subtropical gyre, and 2) the southern boundary is given by the extent of the system of mean and variable zonal currents near the equator, in which the eastward flows supply oxygen from the well-ventilated western boundary regime resulting in an equatorial oxygen maximum.

The focus of our study is on the lateral ventilation of the OMZ through its southern boundary. This boundary is given by a maximum of the mean meridional oxygen gradient at about 5°N. In this region energetic mesoscale activity with periods from one to two months is present. The interaction of the mesoscale activity with the mean meridional oxygen gradient gives rise to a rich oxygen variance from finescale to mesoscale (O(1km) – O(100km)).

An intense measurement program along 23°W cutting through the TNEA OMZ has been executed during recent years. Repeat ship sections along the 23°W meridian were performed with standard CTD (conductivity, temperature, depth) and shipboard current measurements. Additionally, high temporal variability of the oxygen and current field was observed with moored optodes and acoustic Doppler current profilers, respectively, along 23°W at the equator, 2°N, 5°N and 8°N. The observed oxygen variability as a function of depth and latitude shows characteristic patterns consisting of an intermediate maximum at the upper boundary of the OMZ, a decay of oxygen variability with depth in the upper OMZ and a second weaker maximum in the lower OMZ. Comparing latitudes shows, that the oxygen variability in the OMZ is strongest at 5°N and weaker at 8°N, 2°N and the equator as well.

To corroborate the observational results, a high-resolution advection-diffusion model was developed to simulate oxygen fluxes being the result of the mesoscale eddy field acting on the mean meridional oxygen gradient. While this model is able to describe the production of oxygen variability on length and time scales of O(1km) and O(1h), respectively, it reproduces several characteristics of the observed oxygen variability pattern.