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TITLE: Characterization of ?dead-zone? eddies in the eastern tropical North Atlantic

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ABSTRACT:

Abstract. Localized open-ocean low-oxygen ?dead zones? in the eastern tropical North Atlantic are recently discovered ocean features that can develop in dynamically isolated water masses within cyclonic eddies (CE) and anticyclonic mode-water eddies (ACME). Analysis of a comprehensive oxygen dataset obtained from gliders, moorings, research vessels and Argo floats reveals that ?dead-zone? eddies are found in surprisingly high numbers and in a large area from about 4 to 22° N, from the shelf at the eastern boundary to 38° W. In total, 173 profiles with oxygen concentrations below the minimum background concentration of 40 µmol kg?1 could be associated with 27 independent eddies (10 CEs; 17 ACMEs) over a period of 10 years. Lowest oxygen concentrations in CEs are less than 10 µmol kg?1 while in ACMEs even suboxic (< 1 µmol kg?1) levels are observed. The oxygen minimum in the eddies is located at shallow depth from 50 to 150 m with a mean depth of 80 m. Compared to the surrounding waters, the mean oxygen anomaly in the core depth range (50 and 150 m) for CEs (ACMEs) is ?38 (?79) µmol kg?1. North of 12° N, the oxygen-depleted eddies carry anomalously low-salinity water of South Atlantic origin from the eastern boundary upwelling region into the open ocean. Here water mass properties and satellite eddy tracking both point to an eddy generation near the eastern boundary. In contrast, the oxygen-depleted eddies south of 12° N carry weak hydrographic anomalies in their cores and seem to be generated in the open ocean away from the boundary. In both regions a decrease in oxygen from east to west is identified supporting the en-route creation of the low-oxygen core through a combination of high productivity in the eddy surface waters and an isolation of the eddy cores with respect to lateral oxygen supply. Indeed, eddies of both types feature a cold sea surface temperature anomaly and enhanced chlorophyll concentrations in their center. The low-oxygen core depth in the eddies aligns with the depth of the shallow oxygen minimum zone of the eastern tropical North Atlantic. Averaged over the whole area an oxygen reduction of 7 µmol kg?1 in the depth range of 50 to 150 m (peak reduction is 16 µmol kg?1 at 100 m depth) can be associated with the dispersion of the eddies. Thus the locally increased oxygen consumption within the eddy cores enhances the total oxygen consumption in the open eastern tropical North Atlantic Ocean and seems to be an contributor to the formation of the shallow oxygen minimum zone.

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