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Characterization and impact of "dead-zone" eddies in the tropical Northeast Atlantic Ocean

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Localized open-ocean low–oxygen dead-zones in the tropical Northeast 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 shows that eddies with low oxygen concentrations at 50-150 m depths can be found in surprisingly high numbers and in a large area (from about 5°N to 20°N, from the shelf at the eastern boundary to 30°W). Minimum oxygen concentrations of about 9 μmol/kg in CEs and close to anoxic concentrations (< 1 μmol/kg) in ACMEs were observed. In total, 495 profiles with oxygen concentrations below the minimum background concentration of 40 μmol/kg could be associated with 27 independent "dead-zone" eddies (10 CEs; 17 ACMEs). The low oxygen concentration right beneath the mixed layer has been attributed to the combination of high productivity in the surface waters of the eddies and the isolation of the eddies' cores. Indeed eddies of both types feature a cold sea surface temperature anomaly and enhanced chlorophyll concentrations in their center. The oxygen minimum is located in the eddy core beneath the mixed layer at around 80 m depth. The mean oxygen anomaly between 50 to 150 m depth for CEs (ACMEs) is -49 (-81) μmol/kg. 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. North of 12°N, eddies of both types carry anomalously low salinity water of South Atlantic Central Water origin from the eastern boundary upwelling region into the open ocean. This points to an eddy generation near the eastern boundary. A conservative estimate yields that around 5 dead-zone eddies (4 CEs; 1 ACME) per year entering the area north of 12°N between the Cap Verde Islands and 19°W. The associated contribution to the oxygen budget of the shallow oxygen minimum zone in that area is about -10.3 (-3.0) μmol/kg/yr for CEs (ACMEs). The consumption within these eddies represents an essential part of the total consumption in the open tropical Northeast Atlantic Ocean and might be partly responsible for the formation of the shallow oxygen minimum zone.