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Equatorial deep jets in the Atlantic Ocean

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Vertically alternating deep zonal jets of short vertical wavelength were discovered in the equatorial oceans more than 35 years ago. These jets that are observed to be coherent across the equatorial basins are characterized by vertically alternating eastward and westward currents lying within 1° of the equator, with amplitudes of 0.1-0.2 ms-1 and vertical wavelengths between 300 and 700 m. In the Atlantic, equatorial deep jets oscillate with a period of about 4.5 years, while their energy propagates upward. The 4.5 year signal can be seen in sea surface temperature as well as atmospheric data (e.g. surface wind and rainfall) indicating the significance of the deep jets for climate. Here we analyse velocity data from more than 7 years of moored observations at the equator, 23°W as well as shipboard hydrographic and current observations along the 23°W repeat section. Our focus is on intermediate depth levels (300-700 m), where the deep jets are superimposed on a mean flow composed of the westward flowing Equatorial Intermediate Current centred on the equator and the eastward Southern and Northern Intermediate Countercurrents located at 2°S and 2°N, respectively. The large zonal oxygen gradient from the well ventilated western boundary toward low-oxygen values near the eastern boundary makes the meridional oxygen distribution in the central equatorial Atlantic sensitive to zonal flow variations in time and latitude. We compare the observed meridional structures of the mean and anomalous oxygen and zonal velocity distributions as well as their temporal evolution with results of an advection-diffusion model driven by a prescribed velocity field, restoring to high oxygen values at the western boundary, and otherwise constant oxygen consumption. The prescribed velocity field is composed of a high order baroclinic vertical normal mode aimed at representing the 4.5-year cycle and a mean velocity field resembling the observed mean zonal current structure. Similarities between observed and simulated tracer distribution are used to discuss the equatorial deep jet's nature in the light of normal mode oscillations and their role in the ventilation of the equatorial Atlantic at intermediate depths.