Eddy-induced upwelling off Cape São Tomé (22◦ S, Brazil) : A numerical modeling study

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The regional ocean off southeast Brazil (20 S – 28 S) is known as a current-eddy-upwelling region. The proximity of the Cape São Tomé (CST) meander to the coast and its near stationary growth suggests the possibility of background eddy-induced upwelling which intensifies the prevalent coastal upwelling due to wind and topography effects.

The coastal upwelling off CST and Cabo Frio(CF) has been intensively studied for its relevance to ocean productivity and, therefore, to the local economy. In terms of water masses, the upwelling signal is marked by the penetration and the surfacing of the South Atlantic Central Water (SACW) into the inner shelfregion. Most of the upwelling studies along the Brazilian coast have focused on wind [Lorenzzetti et. al, 1988; Castelão & Barth, 2006]. Castro & Miranda (1998) summarized the quasi-seasonal upwelling scenario as a consequence of the persistence of southeasterly winds during the summer. These winds represent the western branch of the South Atlantic Subtropical High. Due to the continental margin orientation, the surface Ekman layer transport is oceanward and SACW thus moves inshore as in a classical coastal upwelling picture.

In the vicinity of the shelf break and in the oceanic area, the Brazil Current (BC) and Intermediate Western Boundary Current (IWBC) system exhibits intense meso-escale activity, which are commonly associated with unstably-growing cyclonic meanders [Mascarenhas et. al, 1971; Garfield, 1990]. The literature refers to CST and CF as sites of recurrent eddy formation. There is little information on the periodicity of such features even though there is evidence of their being part of a meso-scale vorticity wave train [Silveira et. al, 2004; Calado et. al, 2006]. Moreover, the most unstable waves are likely to be quasi stationary, with both CF and CSF meanders growing in amplitude oceanward with virtually negligible phase speeds when compared to the surface BC velocities. Using thermal satellite imagery, the meander growth can be easily tracked via advection of a Coastal Water (CW) plume by the vortical structure toward the open ocean.

In this work, with the help of a numerical simulation, shows the evidence that eddy-induced upwelling in the absence of wind is possible in this region. The simulation was conducted with a regional configuration of the 3-D Princeton Ocean Model with initial field provided by a feature-based implementation of the BC and Eddies, blended with climatology based on Calado et. al, 2008 implementation.