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Seasonal variations of tidally generated internal waves in the eastern boundary upwelling system off Angola

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The eastern boundary upwelling system of the South Atlantic Ocean is one of the most productive marine ecosystems. It is separated by the Angola-Benguela frontal zone at about 16°S into a permanent wind-driven upwelling system to the south and a tropical upwelling system to the north. Here we study the seasonal upwelling at 11°S using shipboard hydrographic and current data, microstructure data as well as temporally high-resolution moored velocity data acquired during several field experiments since July 2013. Additionally we use hydrographic data taken in the frame of the Norwegian Nansen Programme during biannual cruises covering the main downwelling and upwelling seasons over more than 20 years. The seasonal upwelling is strongly influenced by the propagation of semiannual coastally trapped waves leading to a dynamical change in the stratification at the shelf. Local wind forcing plays only a minor role in driving the near-coastal upwelling. Moored velocity observations at the shelf break at about 500 m water depth show a seasonal enhancement of internal wave energy near the buoyancy frequency during the main upwelling system. An on-shore propagation of internal waves as observed during the field campaigns implies enhanced mixing on the shelf, which is in general agreement with sparse microstructure measurements. To better understand the processes at work, a 2-D very high-resolution non-hydrostatic model is applied to simulate the generation of internal waves at the shelf break by a barotropic tidal flow and their onshore propagation. Simulations performed using mean observed stratifications of the main upwelling and downwelling seasons show significant differences in the onshore propagation of internal waves induced by both differences in slope criticality and near surface stratification.