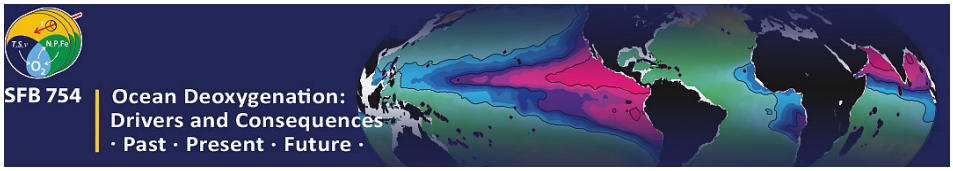

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Impact of non-linear internal waves on the cross slope circulation in the Peruvian upwelling region.

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Non-linear internal waves (NLIWs) are a prominent feature on the continental slope and shelfs of all major upwelling regions. They are known to enhance diapycnal mixing and associated nutrient fluxes, thereby fueling biogeochemical cycles. Additionally, they cause elevated near-bottom velocity variability which affects sedimentation rates and benthic distribution of biota. NLIWs are also capable of transporting mass through Stokes drift and are thus potentially contributing to cross-shelf exchange. During a measurement program at 11°S off Peru in austral summer 2013, particularly elevated onshore-propagating NLIWs were observed in velocity records from moorings and landers as well as hydrographic and turbulence profiles collected by research vessels and autonomous platforms. The generation and cross-slope evolution of NLIWs along 11°S is investigated using a fully nonlinear two-dimensional very high-resolution model (8m horizontally, 0.25m vertically) with observed topography that is forced with a cross-shore barotropic tide having amplitudes taken from the moored velocity records. Many features of the simulations are consistent with the collected data set. A first vertical mode baroclinic tide forms at a water depth of about 500m due to tidal beams of small vertical extend that originate from a critical continental slope section between 800 and 600m depth. While the baroclinic tide propagates into shallow waters, amplitude dispersions generates trains of NLIWs at a water depth of about 300m, having near N frequencies. Particle displacements due to NLIWs determined from the observations and from solutions to the Dubreil-Jacotin-Long model giving NLIW phase speeds yield an onshore transport of 0.3m^2/s in shallow waters. This onshore transport exceeds offshore Ekman transport averaged to 0.18m^2/s from direct wind measurements during the observational period. Distributions of diapycnal mixing due to tide-topography interaction and upwelling patterns due to divergent cross-shore flow are discussed. Finally, we offer an alternative explanation for the observed cold near-shore surface temperatures relative to warmer surface temperatures offshore and provide reasoning for sulfidic events that frequently occur off Peru inshore of the 150m-isobaths during austral summer.

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