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Contrasting biogeochemical responses of ENSO induced upwelling variability in the Humboldt Current System

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The Humboldt Current System (HCS) is one of the most productive ecosystems in the world. This high productivity is supported by a large input of nutrients from the subsurface layers to the surface due to year-round upwelling. However, upwelling also supplies waters with low pH and low aragonite saturation state potentially affecting many organisms, especially those that calcify. The influence, extent and source of upwelled water vary substantially on interannual timescales in association with the El Niño/Southern Oscillation (ENSO) phenomenon, generating natural contrasting responses on the biogeochemistry of this system. Here we analyze these responses using an eddy resolving, basin-scale ocean model that covers the whole Pacific Ocean with high resolution (4 km) on the west coast of South America. We performed a simulation of the last 30 years (hindcast simulation) that allows us to investigate the influence of at least eight El Niño episodes and eight La Niña episodes on productivity variations and changes in oxygen concentration and aragonite saturation state. An absolute change in surface omega aragonite of almost 2 units, as well as an absolute change of the aragonite saturation depth of $\sim$200 m result from the change of an El Niño phase to a La Niña phase. This variability is on the same order of magnitude as the projected change in the aragonite saturation state in a centennial timescale. During La Niña events, a lower aragonite saturation state values and reduced oxygen concentration in the surface layer are a direct consequence of enhanced upwelling and increased net primary productivity. The opposite is true during El Niño events, where high values of omega aragonite occur in concordance with extraordinarily low net primary productivity values.