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Coastal upwelling systems under changing climate and high CO_2

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Eastern Boundary Current Upwelling Systems (EBUS) are major oceanographic ecosystems that are well known for high productivity and for playing an important role in the marine carbon cycle. EBUS are particularly sensitive to human-induced climate change, such as potential shifts in the distribution and the magnitude of upwelling-favorable winds, as well as ocean acidification from rising atmospheric CO2 concentration. However, neither the biological response to changes in wind forcing nor the extent to which coastal waters might become exposed to undersaturated waters due to a shoaling of the CaCO3 saturation horizon are currently well understood. The fact that local environmental and physical conditions substantially vary from one EBUS to another further complicates the story. To address the vulnerability of different EBUS, we investigate the magnitude and effect of ocean acidification and the impacts of changes in upwelling favorable winds on the productivity by conducting eddy-resolving simulations with the Regional Oceanic Modeling System – ROMS – coupled to a nitrogen based Nutrient-Phytoplankton-Detritus-Zooplankton (NPDZ) biogeochemical model including a representation of the marine carbon cycle for two of the four major EBUS, namely the California and the Canary Current Systems. We examine how potential changes in wind stress will affect the productivity in both upwelling systems and explore past, present and future changes in pH, CaCO3 saturation horizons, and other biogeochemical and ecological processes in response to elevated atmospheric CO2. A particular focus of our analyses is on the rate of change and on the timing when critical thresholds will be passed in the different EBUS.