Geophysical Research Abstracts
Vol. 13, EGU2011-8603, 2011
EGU General Assembly 2011

NPGO index and Cross-Shore Dynamics Variability of the Southern California Current Ecosystem

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The California Current System (CCS) is one major Eastern Boundary Upwelling System of the world ocean and one of the most ever studied. The associated ecosystem has been shown to be constrained by the low frequency variability of the CCS, e.g. Pacific Decadal Oscillation (PDO), El Niño Southern Oscillation (ENSO) and North Pacific Gyre Oscillation (NPGO), and by a high-frequency mesoscale dynamics driven by the California Current. Observations in the southern CCS (CalCOFI) have revealed regime shifts, unexplained to date, in the cross-shore structure of ocean biological variables. Furthermore, recent studies have shown that low frequency cross-shore transport variability is driven by the NPGO, which is correlated with upwelling-driven alongshore winds: the positive (negative) phase of the NPGO is associated with strong (weak) alongshore winds, hence a high (low) upwelling efficiency. In this context, we investigate with a numerical approach the role of the different NPGO phases on the ecosystem cross-shore structure. We coupled ROMS (Regional Oceanic Modeling System), a three-dimensional physical model, with NEMURO (the North Pacific Ecosystem Model for Understanding Regional Oceanography), which includes several size-classes of plankton variables: small and large phytoplanktons, small, large and predatory zooplanktons. We use embedded models with a parent grid configured at 15km resolution over the North East Pacific domain and a child grid centred on the southern part of the CCS at 5km resolution, which allows reproduction of eddy dynamics. Positive and negative phases of the NPGO are simulated with satellite-derived (QuickSCAT) wind observations from 2001 and 2005, respectively. Dynamics of modelled physical variables and differences in sumulated upwelling efficiency between years 2001 and 2005 are characterized and validated. Then, the spatial structuration of the ecosystem is described, especially with dominance of large and small plankton species in the coastal and offshore areas, respectively. Biological patterns are expected to be variable in relation with the NPGO index through contrasted efficiency in eddy transport and Ekman transport. In particular, the eddy dynamics is confirmed to play an important role in the variability of cross-shore gradient. Lastly, we study the ecosystem response to NPGO positive and negative phases in terms of seasonal variability of the system, by characterizing the emergence and respective dominance of the different planktonic species.