



Numerical study on the upwelling system in the Arafura Sea and its relation to ENSO

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The Arafura Sea is located in the eastern part of the Indonesian archipelago. It is a relatively shallow water basin (less than 200 m) which undergoes monsoonal winds and is also affected by the Banda Sea circulation. Previous studies suggest that the upwelling (downwelling) occurs during the southeast (northwest) monsoon in northern hemisphere summer (winter). Consequently, the phytoplankton bloom takes place during the southeast monsoon, especially at the southern coast of Papua (northwestern Arafura Sea). In order to understand the physical mechanisms that lead to upwelling in this region, the 3-D baroclinic numerical model HAMSOM (HAMBurg Shelf Ocean Model) was employed. To investigate the ENSO-related inter-annual variability of the impact of the monsoon on upwelling patterns, the model ran for 25 years (1990-2014). HAMSOM is forced by NCEP/NCAR meteorological fields and uses boundary conditions for tides (13 tidal constituents), river discharge, temperature, and salinity. The results are compared with MODIS-Terra SST data and vertical temperature profiles retrieved from CTD measurements in 2012. The model is able to reproduce the CTD temperature profiles reasonably well, with an average correlation and RMSE of 0.99 and 0.76°C, respectively. During the southeast monsoon, a westward surface current near the southern coast of Papua is generated. The model results reveal that this westward current, which forms along with a vertical upward motion (upwelling), is active from May through September. The zonal vertical distribution shows that the maximum upward velocity is found between 50-100 meters depth. The results indicate that the duration of upwelling is shorter in La Niña than in El Niño years. During La Niña years, the onset of the upwelling occurs in May and at it ends in August, whereas during El Niño years, the upwelling period lasts from April until November. In addition, the upwelling strength is also modulated by ENSO events: During La Niña (El Niño) years the upwelling is weakened (reinforced). This is represented by the simulated SST (Sea Surface Temperature) and vertical velocity anomalies in 86 m depth, which are correlated negatively (positively) and positively (negatively) with the NINO 3.4 index (Southern Oscillation Index), i.e. -0.458 (0.505) and 0.349 (-0.507), respectively. Overall, the results indicate that the upwelling in the Arafura Sea is enhanced (reduced) in both strength and duration during El Niño (La Niña) years.