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Does impact climate change the Peruvian upwelling system?

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The Peruvian upwelling system (PUS) is the most productive marine ecosystem among the Eastern Boundary upwelling Systems (EBUS). The trade wind system of the South Pacific drives a nearly continuous upwelling which is subjected to variations on a wide range of times scales. The intensity and variability of upwelling control crucially the nutrient supply to the euphotic surface layer and thus, the overall productivity of the system.

Using long-term wind data (1950-2019) and SST data from ERA5, the upwelling components were analyzed to obtain information about decadal trends in the mean state and their variability. The HYCOM model data (GOFS 3.1 expt_53.X) for the period of 1994-2015 is also analyzed to estimate the Ekman transport in the coastal area and Ekman pumping due to wind stress curl.
Besides the strong annual cycle, the wind forcing is dominated by interannual and interdecadal oscillation. The interannual fluctuations with a period of 2-5 years are related to the known events of El Niño and La Niña. The wind anomaly shows a good correlation with Oceanic Niño Index (ONI). Interdecadal variation of wind depicts a period of 15-20 years with negative anomaly for 1950-1976, slightly positive for 1977-1982, negative for 1983-1996, and strong positive anomaly for 1996-2014. These long-term variations can be attributed to the Interdecadal Pacific Oscillations (IPO). The spatial distribution of wind stress along the Peruvian coast depicts a local maximum in the Lima-Marcona area (12º-15.4º S) decreasing sharply southward and gradually northward. The wind stress anomaly and SST anomaly are highly correlated in the coastal area. The alongshore wind stress reveals a positive trend in either negative or positive phases of IPO. Moreover, there are two sharp shifts during 1996 and 2015. These can be related somehow to climate warming and climate shifts which are already addressed by various authors.

Additionally, the characteristics of the circulation in the coastal belt off Peru are derived from HYCOM outputs. Ekman transport and Ekman pumping from both wind data and model output are in good agreement. The water masses distribution shows annual as well as inter-annual variations mainly due to El Niño and La Niña events that apply to the mixed layer depth too.