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Does mesoscale matters in decadal changes observed in the northern Canary upwelling system?

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The Western Iberia constitutes the northern limb of the Canary Current Upwelling System, one of the four Eastern Boundary Upwelling Systems of the world ocean. The strong dynamic link between the atmosphere and the ocean makes these systems highly sensitive to global change, ideal to monitor and investigate its effects. In order to investigate decadal changes of the mesoscale patterns in the Northern Canary upwelling system (off Western Iberia), the field of the satellite-derived sea surface temperature (SST) trends was built at the pixel scale (4x4 km) for the period 1985-2007, based on the monthly mean data from the Advanced Very High Resolution Radiometer (AVHRR) on board NOAA series satellites, provided by the NASA Physical Oceanography Distributed Active Archive Center (PO.DAAC) at the Jet Propulsion Laboratory. The time series were limited to the nighttime passes to avoid the solar heating effect and a suite of procedures were followed to guarantee that the temperature trends were not biased towards the seasonally more abundant summer data, when the sky is considerably clear. A robust linear fit was applied to each individual pixel, crossing along the time the same pixel in all the processed monthly mean AVHRR SST images from 1985 until 2007. The field of the SST trends was created upon the slopes of the linear fits applied to each pixel. Monthly mean SST time series from the one degree enhanced International Comprehensive Ocean-Atmosphere Data Set (ICOADS) and from near-shore measurements collected on a daily basis by the Portuguese Meteorological Office (IM) are also used to compare the results and extend the analysis back until 1960.
A generalized warming trend is detected in the coastal waters off Western Iberia during the last decades, no matter which data set we analyse. However, significant spatial differences in the warming rates are observed in the satellite-derived SST trends. Remarkably, off the southern part of the Western Iberia the known upwelling pattern is clearly reflected in the warming field. There, the coastal upwelled waters show a weak warming trend when compared with the offshore waters. If we assume that the SST contrast between coastal and offshore waters is a proxy for the upwelling intensity, then this fact suggests the enhancement of the upwelling regime off SW Iberia since 1985. Although the seasonal nature of the upwelling in the region, the strengthening must be significant since it leaves a coherent imprint in the annual warming field. An analysis done on a monthly basis reveals that the central months of the classical upwelling season (July to September) are the responsible for this coherent mesoscale structure observed in the warming field off SW Iberia. The same conclusions are not clear for the mesoscale structure further north, where no significant differences are observed between the coastal and offshore warming rates.
To investigate if our results, obtained for the period with satellite coverage (1985-2007), could be extended or not until 1960, we computed an upwelling index as the SST difference between coastal and offshore ICOADS SST. The analysis revealed that the trends are different whether we consider the whole time series or only the period investigated with the satellite imagery. We can suppose a relatively unchanged upwelling regime if we consider the period 1960-2005, but a rapid increase of intensity if we consider the period from 1985 onwards, particularly in the most southern regions, in agreement with the satellite imagery analysis.
Our present results point out that mesoscale activity can account for larger changes in local SST than global average trends. In Eastern Boundary Upwelling Systems, where mesoscale structures play a major role in the description of the upwelling regime, to rely on sparse spatial observations to hypothesize about the decadal behaviour of the upwelling intensity at the basin scale may be questionable.