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Interannual to decadal variability within and across the major Eastern Boundary Upwelling Systems

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Detecting the drivers of the major Eastern Boundary Upwelling Systems (EBUS) is essential to understand its present variability and its past and future changes.
We present a statistical analysis of a long-term ocean hindcast from 1958 to 2015 with the global ORCA025 configuration (25 km of horizontal resolution) of NEMO general circulation model. The simulation is forced by a high resolution (25 km of resolution) product that we obtain through a statistical downscaling of the high resolution QuikSCAT winds with the large-scale wind structures from a newly available bias-corrected surface-atmospheric dataset based on the Japanese 55-year atmospheric reanalysis (JRA-55). Moreover, we introduce an ensemble of passive tracers, which are released at the subsurface (150m—300m) at each EBUS from coast to 50 Km offshore. The statistics of passive tracer concentration at surface, which correspond to upwelled coastal water masses and ocean tracers (e.g. nutrients), allowed us to study the large-scale drivers of upwelling variability and trends. The simulation is found to reproduce well the seasonal cycle of upwelling intensity over all EBUS areas, with a maximum in boreal summer in the Northern Hemisphere Systems and in boreal winter in the Southern Hemisphere Systems. The common atmospheric pattern favouring upwelling (e.g., equatorward wind/wind stress, wind stress curl, and heat fluxes), with some differences in terms of their contribution, explains the low-frequency modulations of the seasonal cycle. In particular, Benguela Upwelling System and Canary Upwelling System show long-term trends driven by wind forcing and heat fluxes, respectively. In addition, the statistical link between upwelling across the system and large-scale climate variability modes was analysed. We performed an EOF analysis of the passive tracer concentration time series in order to evaluate EBUS shared variability. The El Niño–Southern Oscillation, exerts influence on Pacific Systems, while Atlantic Meridional Oscillation is the predominant modes of variability on the Atlantic Systems. The remaining variability, instead, reveals sub-basin variability, influenced by Meridional Modes in the Northern Hemisphere and by Antarctic Oscillation in the Southern Hemisphere.