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Impacts of the mesoscale ocean-atmosphere coupling on the Chile biological activity

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The influence between the ocean and the atmosphere at the air-sea interface (through the sea surface radiative balance, heat exchanges, fresh water fluxes and friction) is mutual. Indeed, on one hand, a forcing of the ocean by the atmosphere is suggested by satellite data at the basin scale. On the other hand, the atmospheric surface fields are modified by the presence of mesoscale structures (typical size ∼10-100 km) in the ocean. As this modification of the atmosphere by the oceanic mesoscale affect the air-sea energy fluxes, it may impact in return the oceanic dynamics, with potential consequences on the biological activity.
The impact of the mesoscale air-sea interaction on the Chile marine biological activity is the purpose of this study. The Chile coastal region is indeed of major interest because of its highly productive ecosystem. Along the South American coast, a wind-forced upwelling enriches the surface waters in nutrients, setting favorable conditions for the primary productivity. Coastal current instabilities generate mesoscale activity that structures the biological activity. In the last decade, this regional dynamics has been studied quite extensively with ocean models that generally do not take into account the feedback of the ocean mesoscale on the atmospheric forcing. Over the Chile region, mesoscale air-sea interactions studies are needed to evaluate the importance of this feedback on the ocean, in particular on the biological activity.
Here, an high-resolution (1/12°) regional ocean-atmosphere coupled model (WRF-ROMS) with a biogeochemical compound (PISCES) is used for the first time to model the regional dynamics. The results are compared to a forced oceanic approach (that is usually used to study the biological activity in the region) to answer the questions :
- What is the bias introduced by the use of a forced oceanic model?
- Considering the much higher computational cost, is it worth using an ocean-atmosphere coupled model?
We analyze in particular the coastal biological activity associated to the upwelling dynamics and also the coherent eddy content. We show that the small scales structures induced in the atmosphere by the oceanic mesoscale modifies the coastal circulation (alongshore coastal currents and vertical velocities), impacting the nutrient transport. Attenuation of the coherent eddy structure and large modifications of the vertical velocities inside the eddy affect the biogeochemical dynamics.