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Wind forcing response of the dispersal of Minho estuarine plume

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Estuarine plumes play a significant role in the transport of matter to the coastal ocean and have important effects in marine ecosystems. They can directly influence coastal sediment budgets, ocean biogeochemistry, pollution patterns and circulation in coastal waters.
The Minho River is located south of Rias Baixas and is the most important freshwater source flowing into the Western Galician coast (NW Iberian Peninsula). This discharge is particularly important in driving the circulation and hydrology in these coastal regions, and therefore particular attention should be given to this forcing.
In this work, a set of validated 3D baroclinic nested models (MOHID), with realistic bathymetry and coastline of the whole Western coast of the Iberian Peninsula is used. The model considers the main physical processes and the main features of circulation. Ambient shelf conditions include FES Global tidal solution and low frequency circulation downscaled from Mercator Open Global Solution. River discharge and atmospheric forcing are considered as landward and surface boundary conditions. This work aims to study the response of the Minho estuarine plume dispersal to an idealized wind forcing during the dry and wet seasons, respectively. To examine the response of the Minho estuarine plume to different wind directions, four scenarios of moderate winds were considered blowing from each of the main four compass points. Two markedly different realistic scenarios were chosen: low (148.9 m3s-1) and high (2108.2 m3s-1) Minho River discharges.
During both discharge events, the numerical results indicate that the dispersal of the Minho estuarine plume is mainly due to the wind forcing. Without wind forcing, during the wet season, the plume expands offshore, creating a bulge in front of the river mouth. Then, the low salinity waters are advected to the right due to the Coriolis effect and after the establishment of the geostrophic balance, the plume water extends northward (along the coastline). However, within 4 days, the plume influences the salinity distribution of the southernmost ria of the Rias Baixas (Ria de Vigo). When the wind blows southwards, the main feature is the offshore extension of the plume. This is associated with the development of a surface southwestward flow plume. Otherwise, northward wind spreads the river plume, towards the Rias Baixas. The plume is confined close to the coast and vertical mixing reduces stratification in the plume, where the velocities are strong. The plume reaches the mouth of the Ria de Vigo after 1.5 days and influences its inner physical properties.Westward wind is more effective at pushing freshwater out of the mouth of the Minho River than any other wind condition.
In summary, the dispersal of the Minho estuarine plume responds rapidly to wind variations and is also influenced by the bathymetry and geography of the coastline.