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NW Iberia shelf dynamics and the behaviour of the Douro River plume

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The study and modelling of the river plumes is a key factor to complete understand the coastal physics and dynamic processes and sediment transport mechanisms. Some the terrestrial materials that they transport to the ocean are pollutants, essential nutrients, which enhance the phytoplankton productivity or sediments, which settle on the seabed producing bathymetric modifications. When the riverine water join the ocean several instabilities can be induced, generating bulges, filaments, and buoyant currents over the continental shelf. Offshore, the riverine water could form fronts that could be related with the occurrence of current-jets, eddies and strong mixing.
This study focused on the Douro River plume simulation. This river is located on the north-west Iberian coast. Its daily averaged freshwater discharge can range values from 0 to 13000 m3/s, which impacts on the formation of the river plumes and its dispersion along the continental shelf.

The Regional Oceanic Modeling System (ROMS) model was used to reproduce scenarios of plume generation, retention and dispersion (Shchepetkin and McWilliams, 2005). Three types of simulations were performed: schematic winds simulations with prescribed river flow, wind speed and direction; multi-year climatological simulation, with river flow and temperature change for each month; extreme case simulation.

The schematic wind case-studies suggest that the plume is wind-driven. Important differences appear in its structure and dispersion pathways depending on the wind direction and strength. Northerly winds induce plumes with a narrow coastal current meanwhile southerly winds push the river water to the north finding water associated with the Douro River in the Galician Rías. The high surface salinity on the plume regions during strong wind events suggests that the wind enhances the vertical mixing. Extreme river discharges, associated with southerly winds, can transport debris to the Galician coast in about 60 h, helping to explain the tragic events of the Entre-os-Rios accident of March 2001.

The multi-year climatological study showed that the plume response depends as well on the behavior of the offshore geostrophic current system. Offshore eddies and filaments were found, being also responsible for the cross-shore transport, through the horizontal advection of plume waters.

In order to classify the obtained plumes several numbers were used (Chao, 1988; Vaz et al., 2012): Rossby deformation radius, densimetric Richardson number, equilibrium depth and Froude and Kelvin numbers. The obtained values reveal that the plumes are surface-advected and strongly affected by planetary rotation and less mixed on the cases that the bulges are fully developed. It is expected that the plume front will move slower that the coastal current allowing the development of instabilities.

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