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Capability of MODIS radiance to analyze Iberian turbid plumes

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River plumes are formed near river mouths by freshwater and riverine materials. Therefore, the area influenced by freshwater (salinity plume) is usually negatively correlated with the area occupied by suspension and dissolved material (turbid plume). Suspended material results in a strong signal detected by satellite sensors whereas ocean clear waters have negligible contributions. Thus, remote sensing data, such as radiance obtained from Moderate Resolution Imaging Spectroradiometer (MODIS), are a very useful tool to analyze turbid plumes due to the high spatial and time resolution provided. Here, MODIS capability for characterizing similarities and differences among the most important Iberian plumes was assessed under the influence of their main forcing.

Daily radiance data from MODIS-Aqua and MODIS-Terra satellite sensors were processed obtaining a resolution of 500 m. Two approaches are usually used for atmospheric correction treatments: Near-Infrared (NIR) bands and a combined algorithm using NIR and Short Wave Infrared (SWIR) bands. In the particular case of Iberian Peninsula plumes both methods offered similar results, although NIR bands present a lower associated error.

MODIS allows working with several bands of normalized water-leaving radiances (nLw). Focusing in the resolution provided, nLw555 and 645 were the most appropriate because both provide the best coverage and correlation with river discharge. The nLw645 band was chosen because has a lower water penetration avoiding overestimations of turbidity caused by shallow seafloor areas and/or upwelling blooms.

Daily data from both satellites were merged to enhance the robustness and precision of the study by increasing the number of available pixels. Results indicate that differences between radiance data from both satellites are negligible for Iberian plumes, justifying the merging.

By last, each turbid limit, to delimit the respective plume from adjacent seawater, was obtained using two alternative methods. The first method evaluates the maximum correlation between river discharge and plume extension and the second one analyzes a histogram of radiance distribution for days characterized by a negligible plume and days showing a well-developed plume.

The capability of MODIS radiance to delimit each river plume was tested by means of salinity data from Atlantic-Iberian Biscay Irish-Ocean Physics Reanalysis (IBI) database. Significant and negative correlations were found in the Atlantic Iberian plumes, showing the capability of MODIS to adequately track them. However, no correlation was found for Ebro River. This discrepancy is due to the presence of fresh water associated to other external sources (Rhone River), promoting low salinity values when Ebro discharge is low. In this particular case, the MODIS methodology is better to determine the river plume.

In general, Atlantic Iberian plumes show a moderate or high dependence on river discharge, being wind a secondary forcing and tide the third one, although each plume presents particular features. On the other hand, Ebro plume has low dependence on river discharge and wind, and a negligible one on tide, being mainly driven for the Liguro-Provençal current.