Wintertime Submesoscale River Plumes in the Bay of Biscay

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Recent observations over the continental shelf in the Bay of Biscay (in the Eastern Atlantic along French and Spanish coasts) has revealed a complex small scale (O(1km)) activity with high frequency variations. A dataset of 11 years' (2003 to 2013) Sea Surface Temperature (SST) remotely sensed by MODIS sensor onboard Aqua and Terra satellites is studied to detail the spatial and seasonal distributions of fronts in this region. Spatial and temporal patterns revealed by this analysis are used to identify the driving mechanisms of these fronts and they are found to be in agreement with the previously well-known tidal or shelf break fronts in the region.

Furthermore, these observations have brought to attention one particular group of fronts that occur in mid-shelf during winter, similar examples of which have previously been studied in other regions (e.g. Mid-Atlantic Bight). These observed SST fronts in our region are shown to be the temperature signature of density fronts occurring along the river plume edges, where the main driver of the density difference is actually the increased freshwater input to the shelf.

A realistic high-resolution (1 km) hydrodynamic model is applied to the region to investigate the dynamics of such fronts. A scale decomposition that distinguishes the large, meso-, and submesoscale components of model results is carried out. Results show that, along the river plume front, submesoscale patterns prevail. They also possess a certain spatial variability such as filamentation in certain parts of the front, which can be indicative of baroclinic instability. Temporal evolution of this submesoscale variability and some of the forcings that can be responsible for it (e.g. surface cooling, wind stress, topography, or background circulation), together with the role of baroclinic instability are explored.