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Spatial and Seasonal Distributions of Frontal Activity over the French continental shelf  
in the Bay of Biscay observed from satellite Sea Surface Temperature

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Abstract:

Physical processes (i.e. eddies, fronts, filaments) at mesoscale (10-100 km for periods of a few weeks) and sub-mesoscale (1-10 km daily to weekly periods) play a fundamental role in biological activity. While these processes are widely studied in offshore regions, their intensity and spatio-temporal frequencies over the continental shelves remain little known. In this context, this study proposes to explore the spatial and seasonal distributions, and development mechanisms of frontal structures (~ 1-100 km) in river plume boundaries from the main French rivers (Gironde and Loire) over the continental shelf north of 45°N in the Bay of Biscay. A dataset of 11 years' (2003 to 2013) nighttime remotely sensed Sea Surface Temperature (SST) by MODIS sensor onboard Aqua and Terra satellites has been constructed. This dataset has ~1km spatial and daily temporal resolutions. Front detection is achieved through the Singularity Analysis (*i.e.* the process of calculating the degree of regularity or irregularity of a function at each point in a domain) such that negative values of Singularity Exponents (SE) indicate that the signal is irregular/discontinuous and encounter abrupt shifts (strong frontal activity) while positive values indicate regular/continuous signals (weak frontal activity). The spatial distributions of front occurrence frequency, defined as the percentage of number of times the pixel is a front pixel out of the times that pixel is cloud-free, are investigated seasonally. Seasonality of frontal activity in the Bay of Biscay is shown for the first time from the long-term satellite SST archive. The localized hot spots of higher frontal occurrences allow distinguishing the potential drivers in action. It has been revealed that the occurrence of frontal activity over the shelf varies spatially, and has a significant seasonal behavior. Results showed that in winter, density fronts are prominent in an alongshore band in vicinity of the fresh water occupied coast; in spring, winter structures were diminished to estuaries and tidal fronts started to appear; in summer, tidal fronts in Ushant region and internal wave activity along shelf break dominated; in autumn, alongshore density fronts re-appeared as the fresh water increased, and weakened stratification caused a dispersion of Ushant and shelf break fronts. The dynamics of these fronts has been investigated and interpreted based on concomitant *in situ* observations and model outputs from operational oceanography.