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In-situ estimate of submesoscale horizontal eddy diffusion coefficients across a front

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Fronts, jets and eddies are ubiquitous features of the world oceans, and play a key role in regulating energy budget, heat transfer, horizontal and vertical transport, and biogeochemical processes. Although recent advances in computational power have favored the analysis of mesoscale and submesoscale dynamics from high-resolution numerical simulations, studies from *in-situ* observations are still relatively scarce. The small dimensions and short duration of such structures still pose major challenges for fine-scale dedicated field experiments. As a consequence, *in-situ* quantitative estimates of key physical parameters for high-resolution numerical models, such as horizontal eddy diffusion coefficients, are still lacking.

The Latex10 campaign (September 1-24, 2010), within the LAgrangian Transport EXperiment (LATEX), adopted an adaptive sampling strategy that included satellite data, ship-based current measurements, and iterative Lagrangian drifter releases to successfully map coherent transport structures in the western Gulf of Lion. Comparisons with AVHRR imagery evidenced that the detected structures were associated with an intense frontal feature, originated by the convergence and subsequent stirring of colder coastal waters with warmer open-sea waters.

We present a method for computing horizontal eddy diffusion coefficients by combining the stirring rates estimated from the Lagrangian drifter trajectories with the shapes of the surface temperature and salinity gradient (assumed to be at the equilibrium) from the ship thermosalinograph. The average value we obtained from various sections across the front is 2.5 m^2s^{-1}, with horizontal scales (width of the front) ranging between 0.5 and 2.5 km. This is in line with the values commonly used for high-resolution numerical simulations. Further field experiment will be required to extend the results to different ocean regions and regimes, and to thoroughly test the robustness of the equilibrium hypothesis.

Remote sensed measurements of sea surface temperature and elevation could also be used to compute fine-scale horizontal eddy diffusion coefficients over larger areas and for different ocean regions. However, the coarse resolution of current sea surface topography observations, and their unreliability over coastal regions, represent important limitations for this type of application. The velocity fields provided by the SWOT mission will allow to retrieve accurate high-resolution stirring rates across the ocean. Combining these rates with remote-sensed SST gradients will make possible to extend our analysis and investigate patterns and variability of submesoscale horizontal eddy diffusion at the global scale.