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Fine-resolution altimetry data for a regional application in the Bay of Biscay

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The Bay of Biscay, in the North-East Atlantic, is a complex environment with a chaotic topography and a wide range of ocean dynamics, including a weak anticyclonic basin-wide circulation, a coastal poleward current, mesoscale propagating features and also high frequency shelf dynamics. The region has strong cloud cover, so visible and infra-rouge satellite observations are sparsely distributed. Satellite altimetry measurements are also limited near the coasts by missing data, but also by the need for complex coastal dynamic atmospheric corrections and tidal models. Recent studies have shown that the use of state-of-the-art de-aliasing models and improved data processing significantly improves the quality of the data in these highly dynamic regions and enables analysis of finer scale dynamical processes.

The combined use of altimetric maps and along-track altimeter data is a keypoint of this study. First, along-track data provide fine scale information about local circulation (ie. at instrumental resolution), especially in the coastal zone where the slope currents can be observed using data from the X-TRACK coastal oriented processor. On the other hand, AVISO gridded data have a coarser resolution (1/3°) but are widely used for mesoscale studies, as they estimate the sea level variability over 2 dimensions.

A Wavelet Analysis has been applied to the along-track data to assess characteristics of the mesoscale dynamics at a regional level. This has revealed fine scale dynamics, with greater occurrences closer to the generation sites. Detected eddies also tend to increase in diameter and amplitude offshore, suggesting an inverse cascade from smaller scales to larger scales, in agreement with the 2D geostrophic turbulence theory.

Inter-comparisons between along-track data and altimetric maps suggested that the latter is not able to reproduce properly the local dynamical scales, which results in a weaker eddy field, with geostrophic velocities reduced by a factor of 2, though some evidence of westward propagation can be observed. Indeed, the mapped and alongtrack spectral slopes diverge significantly at scales larger than the decorrelation scale used to produce these maps.

Based on these results, we propose a higher resolution multi-scale Optimal Interpolation scheme, adapted to the region and its dynamics. This involves applying a detailed knowledge of the local scales, and how they evolve spatially and temporally, using observations and/or modelling. Resulting maps allow the investigation of finer-scale features ($<$100km), with greater details in the vicinity of the continental slope.

To systematically validate the maps, we adopt an approach based on multiple independent data sets (satellite images, subsurface drifters, current-meters and tide gauges) and lagrangian statistical techniques. First results show a good agreement between the fine scale structures observed on generated maps and high resolution satellite images. These structures are coherent in both space and time, and drift in the Bay of Biscay. This also allows the assessment of the effect on the horizontal stirring of passive tracers by these structures (e.g. chlorophyll and sea surface temperature), and even to reproduce the complexity of coastal dynamics.