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Segmentation and prediction of surface currents using satellite SST and SSH observations

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In the last two decades, multi-satellite measurements of altimeter-derived Sea Surface Height (SSH) and Sea Surface Temperature (SST) have provided a wealth of information about ocean circulation. As a depth-integrated quantity dependent upon the density structure of the water column, altimeter SSH estimations capture mesoscale structures, i.e. horizontal scales from 50 km to few hundred kilometers. Moreover, SSH estimations allow to retrieve surface currents using the geostrophy balance. This rich mesoscale circulation further stirs the large-scale SST fields. Accordingly, our picture of upper ocean dynamics has considerably evolved towards a complex system characterized by strong interactions, whose spatio-temporal variability extends over a wide range of scales. Furthermore, several recent studies rationalize and demonstrate that SST fields can become an active tracer coupled to the dynamics leading to strong correlations between SST and SSH fields.

Following this idea and within an observation-driven framework, we investigate in this presentation the extent to which mesoscale ocean dynamics may be decomposed into a superposition of dynamical modes, characterized by different linear relationships between SSH/currents and SST fields. Formally, we propose a latent class regression model to identify hidden dynamical modes from joint satellite altimeter-derived SSH/currents and microwave SST measurements. We use a maximum likelihood approach, the expectation maximization algorithm, to estimate the parameters of the model.

Applied to the highly dynamical Agulhas region, we demonstrate and discuss the geophysical relevance of the proposed mixture model to achieve a spatio-temporal segmentation of the upper ocean dynamics. In particular, we identify and track regions where the SST can be considered as an active or passive tracer of the upper ocean dynamics. Moreover, we show the accuracy of the proposed model to predict mesoscale surface currents from SST single maps, in comparison with the classical maximum cross-correlation technique that needs a sequence of SST images.