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Deep Learning for Sea Temperature Eddy signature Classification

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Mesoscale eddies are oceanic vortices with radii of tens of kilometers, which live on for several months or even years. They carry large amounts of heat, salt, nutrients, and pollutants from their regions of formation to remote areas, making it important to detect and track them. Using satellite altimetric maps, mesoscale eddies have been detected via remote sensing with advancing performance over the last years **[1]**. However, the spatio-temporal interpolation between satellite track measurements, needed to produce these maps, induces a limit to the spatial resolution (1/12° in the Med Sea) and large amounts of uncertainty in non-measured areas.

Nevertheless, mesoscale oceanic eddies also have a visible signature on other satellite imagery such as Sea Surface Temperature (SST), portraying diverse patterns of coherent vortices, temperature gradients, and swirling filaments. Learning the regularities of such signatures defines a challenging pattern recognition task, due to their complex structure but also to the cloud coverage which can corrupt a large fraction of the image.

We introduce a novel Deep Learning approach to classify sea temperature eddy signatures **[2]**. We create a large dataset of SST patches from satellite imagery in the Mediterranean Sea, containing Anticyclonic, Cyclonic, or No Eddy signatures, based on altimetric eddy detections of the DYNED-Atlas **[3]**. Our trained Convolutional Neural Network (CNN) can differentiate between these signatures with an accuracy of more than 90%, robust to a high level of cloud coverage.

We furtherly evaluate the efficiency of our classifier on SST patches extracted from oceanographic numerical model outputs in the Mediterranean Sea. Our promising results suggest that the CNN could complement the detection, tracking, and prediction of the path of mesoscale oceanic eddies.

[1] *Chelton, D. B., Schlax, M. G. and Samelson, R. M. (2011). Global observations of nonlinear mesoscale eddies. Progress in oceanography, 91(2),167-216.*

[2] *E. Moschos, A. Stegner, O. Schwander and P. Gallinari, "Classification of Eddy Sea Surface Temperature Signatures Under Cloud Coverage," in IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, vol. 13, pp. 3437-3447, 2020, doi: 10.1109/JSTARS.2020.3001830.*

[3] *https://www.lmd.polytechnique.fr/dyned/*