Proposition de stage

Machine learning algorithm for the prediction of ocean currents estimated from Sea Surface Temperature (SST) and Sea Surface Height (SSH) time series

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Mots-clés : Machine learning (ML), Deep Learning (DL), Numerical modeling, Remote sensing, Oceanic circulation,

Context:

Some products on the global ocean distributed by the Space Agencies have contributed to detect changes in the response of the ocean to global warming. Indeed, the ocean is a major contributor to the climate state via air sea exchanges, latitudinal heat transport via ocean circulation and climate regulator via the atmospheric CO2 uptake and its heat stockage capacity. Accurate numerical dynamical models of oceanic circulation are now available, they are physic-informed predictive model that reconstruct the evolution of the ocean. The fields they produce are of high quality and consistent to the different physics governing the different scales at which we can observe the ocean. Classical models rely on differential equations that incorporate physical knowledge on the underlying phenomenon. A major problem being that they can present biases when compared to observations.

A classical approach to combine observed satellite data and numerical models is Data Assimilation (DA) initially developed in the field of numerical prediction. The theoretical corpus of DA relies on the Bayesian estimation problem and the usual procedure is a recursive Bayesian estimation. Doing so allows to estimate initial conditions or internal parameters at a given resolution. An alternative approach is to adapt the satellite image distribution to the distribution issued from numerical models. We look for the most likely geophysical state allowing the use of the numerical model. Such an approach is semi supervised, the validation being done afterward when studying the dynamic of the numerical model.

Recently a deep learning method to downscale low-resolution geophysical SSH fields by merging them with high-resolution SST data (RESAC Thiria & all) have proven its ability to perform accurately when using simulated data coming from numerical models. When testing RESAC with satellite observations the performances decrease but remains satisfactory. The major problem is the data distribution difference between simulated and observed data. In a theoretical point of view the problem to be solved belongs to the neural network field and particularly to the generalization field.

The internship will focus on the determination of the Sea Surface Height (SSH) using as additional variable the Sea Surface Temperature, both variables being observed or simulated fields delivered by the space agencies and numerical outputs of NEMO 3.6 code. The study will be restricted to the Gulf-stream region (figure 1) which is the most energetic region of the North Atlantic Ocean (26°N, 45°N; 40°W, 65°W) where a large number of observations are available and will help to validate the propose AI methods resulting from the thesis.

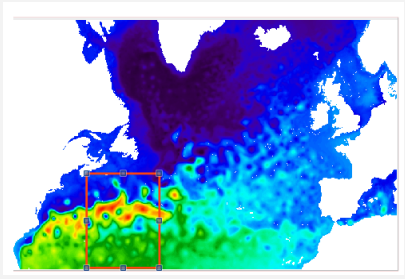

Figure 1.*The domain under study (Red Rectangle) and the SSH*

Proposed study:

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Prérequis

The master student should have prior knowledge of Python programming and some knowledge of neural network modeling with deep learning frameworks such as Keras/Tensorflow or PyTorch.

References

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Thiria S., Sorror C., Archambault T., Charantonis A., Berezia D., Molines J.M., Crepon M:
Downscaling of ocean fields by fusion of heterogeneous observations using Deep Learning algorithms last revision in Ocean Modeling

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Equipe de recherche concernée : (VARCLIM) :
Niveau du stage :M2
Master(s) où sera proposé le sujet : TRIED, WAPE, École d'ingénieur
Thème scientifique de l'IPSL concerné : *Downscalling, Deep Learning, remote sensing*
Durée du stage *: 6 mois*
Période : 01/04/2023 -→ 30/08/2023