Project title: Leveraging Tracer Observations to Infer Ocean Dynamics Using Machine Learning.

About the internship:
Lagrangian Coherent Structures (LCS) serve as fundamental indicators of ocean dynamics, delineating transport barriers and guiding pathways for water masses, nutrients, and pollutants. Typically derived from ocean currents, LCS reveal intricate features of ocean flow that are challenging to observe directly. However, tracers like Sea Surface Temperature (SST) and chlorophyll, which are shaped by underlying ocean dynamics, often exhibit strikingly similar patterns to LCS. This suggests that these tracers inherently embed information about the dynamic processes governing ocean circulation.

Machine learning, with its ability to capture complex nonlinear relationships, provides a good opportunity to explore these embedded connections.

This project aims to leverage machine learning to predict LCS directly from SST, uncovering the latent dynamical information within this readily observed ocean tracer.

Objective:
The primary aim is to design a machine learning model that utilizes SST observations to infer dynamic flow features typically derived from velocity fields.

Specific objectives include:
1. Identifying the nonlinear relationships between tracer fields and ocean circulation patterns.
2. Developing a robust machine learning framework to retrieve flow features from SST images.
3. Exploring the use of these inferred dynamics in improving ocean model predictions through data assimilation.

Motivation:
Satellite-derived SST is one of the most consistently observed variables in oceanography, offering high spatial and temporal coverage. In contrast, direct observations of ocean currents are limited. By leveraging the rich information embedded in SST to infer dynamic structures, this project can provide new insights into ocean circulation while enhancing the predictive capabilities of numerical models. Such innovations hold promise for improving ocean forecasting, particularly in regions where direct measurements of ocean dynamics are unavailable.

Prerequisites:
We are looking for a Master's student in Machine Learning, preferably in computer vision, with the following skills:
- Proficiency in Python
- Good level of English

Familiarity with oceanography or fluid dynamics is considered an asset.

Supervisor:
Anass El Aouni (aelaouni@mercator-ocean.fr)

Useful references:
El Aouni, Anass. "A hybrid identification and tracking of Lagrangian mesoscale eddies." Physics of Fluids 33.3 (2021).

Haller, George. "Lagrangian coherent structures." Annual review of fluid mechanics 47.1 (2015): 137-162.

Internship Master Project - M/W

5-6 months (starting early 2025)

How to apply:
 Send your cover letter and detailed resume with the following reference 2024-12/OM/AI_LCS to recruitment@mercator-ocean.fr

Date of publication: 10/12/2024

Dosovitskiy, Alexey. "An image is worth 16x16 words: Transformers for image recognition at scale." arXiv preprint arXiv:2010.11929 (2020).

Kingma, Diederik P. "Auto-encoding variational bayes." arXiv preprint arXiv:1312.6114 (2013).

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