Deep Learning Representations for Lagrangian Dynamics at sea surface

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The analysis, simulation and reconstruction of the trajectories of objects or particles at sea surface is a major issue for both scientific and societal challenges (e.g., submesoscale ocean dynamics, drift processes for plastics, icebergs, oilspills,...). Major improvements have been reported over the last decade in numerical modeling and assimilation for the representation, reconstruction and forecasting of ocean surface dynamics and exploiting available observation data, especially satellite-derived data. This also applies to the simulation and reconstruction of Lagrangian dynamics. We may for instance cite the insights gained using such approaches for the characterisation and tracking of plastics in the oceans.

However, there is still a significant gap in the ability of the state-of-the-art numerical models to reproduce and predict the variabilities of observed Lagrangian dynamics (e.g., drifters). This motivates the exploration of novel approaches for the analysis and modeling of these Lagrangian dynamics and their conditioning by the underlying upper ocean dynamics. In this context, deep learning and artificial intelligence approaches (LeCun et al., 2015) provide new means to disentangle complex processes and identify computationally-efficient representations from data, including recent advances for dynamical systems (e.g., Ouala et al. 2020; Li et al., 2020). In the context of AI Chair OceaniX in collaboration with MOi (Mercator Ocean International), this PhD will explore such approaches with an emphasis on the exploitation of geophysical knowledge and priors to guide the learning strategies and models.

Key-words: Lagrangian dynamics, deep learning, adversarial learning, reduced-order modeling, stochastic transport