An Unsupervised Machine Learning Algorithm for the Identification and Tracking of Lagrangian Mesoscale Eddies

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Abstract

Mesoscale eddies are the dominant mechanism of ocean heat transports from the tropics to the poles that help to maintain the extra-tropical climate. In addition to their role in moving heat poleward, mesoscale eddies affect a vertical transfer of heat in the ocean, largely moving heat upwards to partially compensate for the downward heat transport by time mean fields. Automation of the identification and tracking of mesoscale eddies are critical to global climate models that include ocean mesoscale eddies, and to understand the role of eddies in climate. This work proposes a fully automated method that identifies and tracks from a single Lagrangian advection, all mesoscale eddies from birth to death, without prior knowledge of their lifespans. The eddies' detection and tracking use an unsupervised machine learning algorithm, which consists of a hybrid method based on geometrical properties of the evolving velocity along Lagrangian trajectories and a grid density-based clustering algorithm. The high eddies' monitoring capacity of the proposed method is demonstrated by automatically identifying and tracking these structures from two different datasets: satellite-derived surface geostrophic velocity fields and a two-dimensional fluid simulation. The proposed approach gives complete dynamical features and evolution of the detected mesoscale eddies by identifying their genesis event, monitoring their coherent core, and describing their splitting and vanishing image.

Keywords: Unsupervised learning, grid density-based clustering, FFT, Coherent vortex, Eddies, Fluid dynamics, Angular momentum, Vortex dynamics.

References

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