Polarity asymmetry in Lagrangian coherent vortices in the Mediterranean sea

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Abstract

Satellite-derived currents, primarily obtained from radar altimetry and other remote sensing techniques, provide crucial insights into ocean surface dynamics. These data are widely used for Lagrangian modelling, which tracks the movement of fluid parcels over time. Lagrangian analysis is particularly useful for identifying Lagrangian coherent structures, such as eddies and filaments, which can effectively trap and transport materials and tracers during their lifetimes, distributing heat, salt, pollutants, nutrients and biological organisms.

Rotationally Coherent Lagrangian Vortices (RCLV) have been identified through the computation of Finite-time Lagrangian Vorticity (FTLV). Applying RCLV analysis tool to a recently developed altimetry-based geostrophic velocity fields (MIOST) we have created a 7-year atlas of RCLV in the Mediterranean Sea, providing a detailed description of their regional occurrence, lifespan, size and polarity.

Our findings show that the RCLV with longer lifespans typically exhibit larger sizes. As expected RCLV tend to increase in size during the first half of their lifespans and decrease in the second half. Additionally, unlike the observed in the Eulerian vorticity, we found an asymmetry in the Lagrangian vorticity field, with a higher prevalence of supercoherent anticyclonic eddies across the Mediterranean basin. We have also studied the sensitivity of the RCLV detection to different parameters: i) convexity deficiency, ii) spatial compactness index, iii) Lagrangian coherent rate, (i.e. Lagrangian integration period) enhancing our understanding of the stability and persistence of these oceanic structures. By using remote sensed and in-situ data-driven 4D reconstructed velocity fields, we have explored the relationship between the vertical extension of the RCLV with the Lagrangian coherent rate observed at the sea surface.

Acknowledgement

DC-m and IH-C acknowledges financial support from the project 4DMED-Sea funded by the European Space Agency (Ref: 4000141547/23/I-DT) and from the project COPLA (PID2023-153236NA-I00) funded by the MICIN/AEI.