Jet-like Lagrangian Coherent Structures in the Madagascar Plankton Bloom

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We study the relation between advection by mesoscale eddies and jets and the remarkable eastward propagation of the Madagascar plankton bloom. Analyzing geostrophic velocity fields from altimetry with Lagrangian methods, we find fast coherent zonal jets in the recently discovered South Indian Ocean Countercurrent (SICC) at the exact position of the bloom. A new simple Lagrangian metric, the Finite-Time Zonal Drift (FTZD), allows for a quantification of the zonal transport, and we find that the jets can partly explain the explosive eastward propagation of the plankton bloom. Numerical experiments with a passive tracer concentration released at a known upwelling region south of Madagascar also supports the hypothesis that an important nutrient source of the plankton bloom might be located in that area. Moreover, we extract zonal jet-like Lagrangian Coherent Structures (LCS) from fields of the Finite-Time Lyapunov Exponent (FTLE) that can be identified with barriers to meridional transport. Comparing these LCS with fields of chlorophyll concentration of the Madagascar plankton bloom measured by the Sea-viewing Wide Field-of view Sensor (SeaWiFS), we show that the location of jet-like LCS coincide with the boundaries of the plankton bloom, e.g. a jet-like LCS prevents cross-transport and confines the bloom to one side of the LCS. Similar plankton patterns appearing in other countercurrents suggest that the results presented here might be valid more generally.

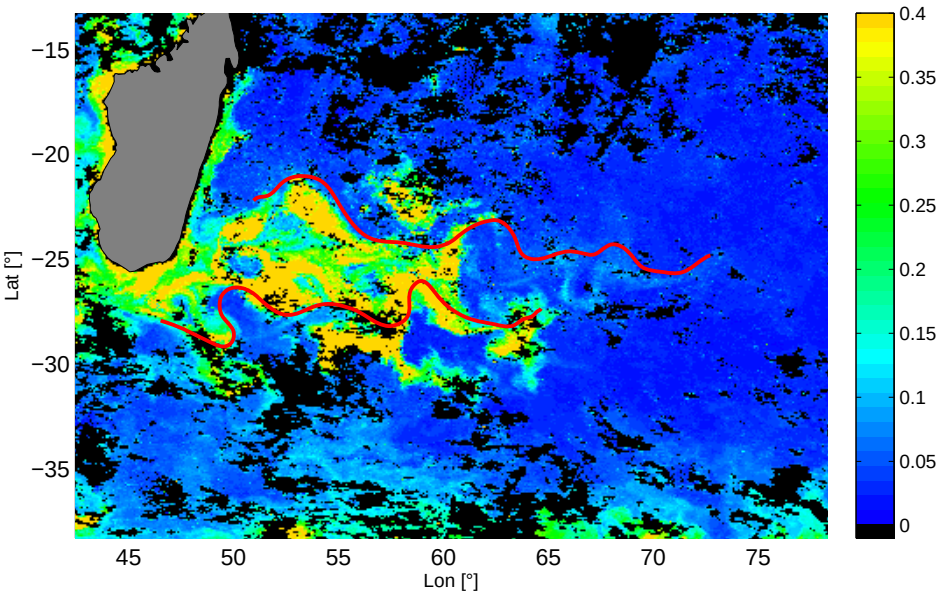

FIG. 1: SeaWiFS chlorophyll concentration [mg/m^3] of the Madagascar plankton bloom on 21 February 1999 with marked position of the jet-like LCS extracted from FTLE fields.

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