**Lyapunov exponent**

The calculation of the Lyapunov exponent is a robust diagnostic that can be applied to altimetry-derived geostrophic currents, in order to extract the position and strength of sub-mesoscale fronts and filaments induced on any advected tracer by the mesoscale turbulence. Applications include climatological analysis of stirring and mixing, front and filament detection for in-situ research campaign studies, and validation for models.

**Distribution of Lyapunov maps**

The calculation of the Lyapunov exponent is more demanding than traditional diagnostics, requiring the construction of particle trajectories by interpolation and integration of the surface currents. In a joint collaboration between the CTOH-LEGOS in Toulouse, LOCEAN-IPSL and the Institute of Complex Systems (ISC) in Paris, we are constructing maps of Lyapunov exponents from satellite-based surface velocity fields, producing filament-resolving (4-10 km), daily maps. These will be obtained using the delayed-time and near-real-time AVISO altimetry-derived geostrophic velocities, and using the CTOH geostrophic and Ekman near-surface currents. The fine-resolution Lyapunov maps and the code to generate them will be distributed to scientific users via the CTOH and LOCEAN web sites under a joint license.

**Delayed-time altimetry re-analysis**

Stirring diagnosis and altimetry validation

We are reprocessing the historical datasets of delayed-time altimetry data. We plan to release daily maps of Lyapunov exponents at 4-10 km resolution. By looking at the relative dispersion of trajectories initialized around each grid point, the filaments induced by mesoscale turbulence on a passively advected tracer can be reconstructed at a higher spatial resolution than provided by altimetry, since large mesoscale structures can stretch advected tracers into much thinner structures.

The delayed-time product is intended as a submesoscale resolving complement to traditional diagnostics such as (i) eddy kinetic energy (above) for ocean circulation analysis and (ii) for intercomparisons of altimetry with high resolution features in SST or chlorophyll images (right panels).

**Geostrophy+Ekman transport**

Prolonged perturbations of geostrophic currents may have a large impact on advective properties even if instantaneously the mesoscale structure of the velocity field is only marginally modified. We are testing the response of the stretching imposed by Ekman transport by analyzing with the Lyapunov technique near-surface velocities based on altimetry plus a Quikscat-derived Ekman component. The example in the left panel shows the case of the Kerguelen plateau.

**Timeline**

- **2009**: 10-year re-analysis (10 km) restricted access (test)
- **2010**: 15-year re-analysis (10 km) open access
- **2011**: 15-year re-analysis (4 km) open access

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**References**


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