Geophysical Research Abstracts,
Vol. 10, EGU2008-A-09279, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-09279
EGU General Assembly 2008

Filament dynamics at the ocean surface: a global climatology based on altimetry

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High-resolution observations of tracer and physical properties at the ocean surface show the ubiquitous presence of filament structures. These structures, associated with the stretching regions of the mesoscale eddy field, are characterized by submesoscale widths (1-50 km) and lengths of the order of the deformation radius. Filament dynamics has a strong impact on lateral transport, upwelling/downwelling, as well as on mixing. Direct observation of filaments is possible due to the growing availability of high-resolution datasets but is limited to campaign or regional coverage.

Here we propose to detect filaments and quantify sub-mesoscale activity indirectly from altimetry by using the Lyapunov exponent calculation. This is done at the global scale, in the same spirit as eddy kinetic energy is used to detect mesoscale activity. The Lyapunov technique exploits both the spatial and the temporal variability of a velocity field and allows to reconstruct the subgrid structure of an advected tracer from the relatively coarse-grain altimetry data.

We find that at first order regions of strong filamentation are associated to regions of high kinetic energy. Some important differences however arise, due to filament formation by permanent currents and especially by the temporal dynamics of the mesoscale activity. These differences include basin-scale patterns and far-field transport effects of eddies characterised by a strong temporal variability.