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A new mechanism of upwelling generated filaments based on potential vorticity balance

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Upwelling filaments are typical features in Eastern Boundary Upwelling Systems and were the object of numerous in situ or numerical studies. However physical processes that generates filaments are not perfectly understood. Recent works suggest that tehy arise from a combination of three phenomena:

- baroclinic instability of the coastal upwelling jet;
- interaction of the flow with coastline and topography shape;
- coastal convergence due to wind stress.

In order to explain the generation process with a simple theory, we assume that filament arise from an injection of positive vorticity; as the flow gains positive vorticity, it becomes unable to continue southward and detaches from the coast.

The filament-rich region of Cape Ghir (NW Africa) acts as a suitable zone for testing our hypothesis. Several numerical experiments with ROMS model were carried out to assess the role of various process (wind curl, bottom friction, variable topography etc) which may be responsible for positive vorticity injection.

The model reference configuration allows us to reproduce the filament with spacial and time scales compatible with in situ observations. Results of the experiments highlight the role of wind stress, since it is at the origin of the upwelling itself. Decreased coastal winds caused multiple filaments around Cape Ghir. Smoothed topography has significant effects on the solution, meaning that the model is sensitive to this parameter. With flattened bathymetry, filaments tend to be much weaker and have lower extension.