

A Deep Water Dispersion Experiment in the Gulf of Mexico

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The Experiment: Surface drifters and RAFOS floats (drifting at 300 and 1500 dbar) were released in pairs in the Western Gulf of Mexico (GoM) between 2016 and 2018.

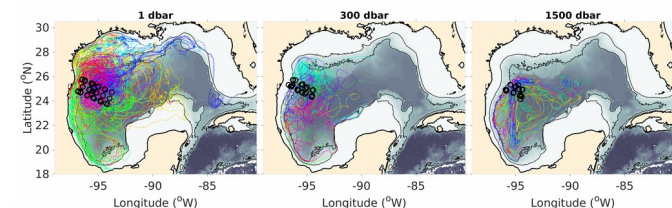


Figure 1: Float trajectories at 1, 300, and 1500 dbar. the floats preferentially spread along isobaths.

Aim and focus: Relative dispersion statistics were computed from the float pairs to characterize the dominant turbulent regimes and to quantify relative diffusivity at all depths.

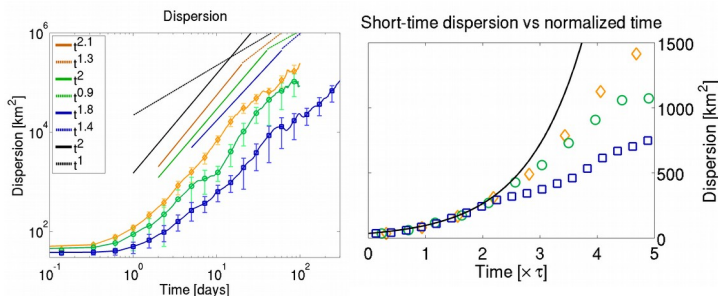


Figure 2: Relative dispersion. At small time scales, dispersion growth is consistent with an exponential law at all depths. At intermediate time scales, growth is quadratic, consistent with a ballistic regime. In the long time limit, Dispersion grows linearly as expected from a Rayleigh regime.

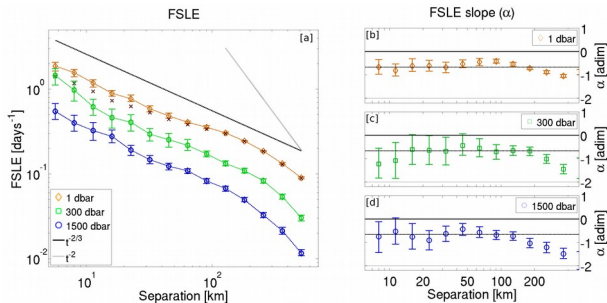


Figure 3: Finite size Lyapunov exponent (FSLE): at all depths, FSLE follows a Richardson law ($k^{-2/3}$) at scales below 200 km. There is no evidence of an exponential regime at small scale (k -cst). Richardson law at scales smaller than the Rossby radius could be indicative of intense submesoscale activity or near-inertial waves.

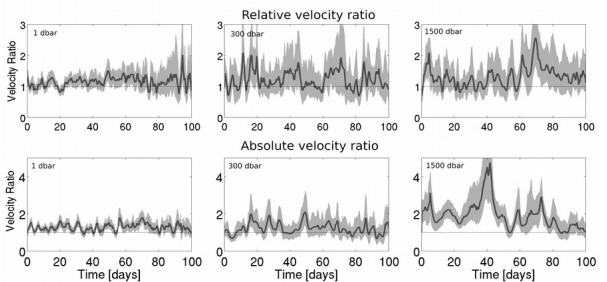


Figure 4: Along/across bathymetry velocity ratio. The top panels represent relative velocity (pair separation velocity), while the bottom panels represent absolute velocity. At all depths, along bathymetry absolute velocity is significantly larger than cross-bathymetry velocity. To a lesser extent, relative velocity is also affected by topography. This anisotropy is enhanced at 1500 dbar and might be driven by the boundary currents circling around the GoM.

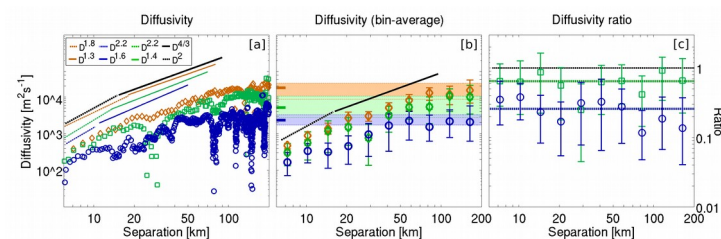


Figure 5: Relative diffusivity at 1, 300, and 1500 dbar. The left-hand side panel shows raw data, while the center panel shows separation-averaged values. At all depths a Richardson law is evident between 20 and 80 km. The right-hand side panel shows the ratio of 300 and 1500 dbar diffusivity to surface diffusivity. Relative diffusivity at 300 (1500) dbar is about 2 (5) times smaller than at the surface. The ratio seems to be scale-independent.

Summary and conclusions:

- # Topography plays a major role in absolute dispersion: floats follow isobaths.
- # Relative dispersion is also influenced by the topography: pair separation velocity is larger in the along-bathymetry direction and dispersion follows a ballistic regime, associated with the sheared boundary currents.
- # The existence of an exponential regime at small time and space scales is uncertain (contradictory information from FSLE and dispersion).
- # Relative diffusivity is, on average, twice smaller at 300 dbar and 5 time smaller at 1500 dbar, than at the surface.
- # Surface Taylor diffusivity in the western GoM belongs to the high end of the Global Ocean range.

