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Kinematic properties variability at the submesoscales from surface drifter measurements in the Gulf of Mexico

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The transport and spreading of surface tracers at sea is relevant in many contexts, such as oil spills, search and rescue, marine litter, and biochemical properties. Dispersion in the ocean results from mechanisms acting simultaneously at different scales which can be difficult to disentangle. Geostrophic mesoscale dynamics (10 to 100 km, days to weeks) are globally monitored through satellite altimetry, but direct observation of the ageostrophic submesoscale (a few hundred meters to 10 km, hours to a few days) remains challenging, since it requires targeted experiments.

In this study we focus on the submesoscale dynamics observed in the northern Gulf of Mexico, near the location of the 2010 Deepwater Horizon oil spill and home to many oil platforms. Observations have been collected during the LAgrangian Submesoscale ExpeRiment (LASER), in the winter of 2016. LASER employed a multi-platform approach: high resolution airborne Sea Surface Temperature (SST) measurements identified submesoscale structures (fronts and eddies) as guidance for in situ monitoring activity involving massive drifter releases.

Drifter triplets are extracted from these releases to investigate the quasi-synoptic and scale-dependent characteristics of the flow over a time scale of 1 day. From the evolution and deformation of each triplet, the flow's kinematic properties (strain, divergence and vorticity) are computed at scales between 100 m and 5 km. The statistics of the kinematic properties estimated in winter during LASER is compared with that of kinematic properties calculated from the drifter observations collected in summer in the same area during the 2012 Grand LAgrangian Deployment (GLAD) experiment.

In both seasons, kinematic properties increase in magnitude at decreasing scales. For winter flows, vorticity and divergence are of order f at scales of 1 km (further increasing at smaller scales), indicating ageostrophic flows capable of trapping flotsam and inducing vertical velocities. In summer, the ageostrophic submesoscales are smaller than in winter, of the order of 100-500 m, consistent with shallower stratification. Also, the magnitude of divergence is significantly smaller than in winter.