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Lateral plume spreading in a medium size river plume using surface Lagrangian drifters

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Groups of 27 Lagrangian drifters deployed in the Merrimack River plume over twelve tides, with river discharges ranging between 150-800 m3/s, are used to understand the external forcing mechanisms responsible for the extent of spreading in river plumes. The transition of buoyant flow from a confined estuary to an unconfined coastal ocean introduces the complicated phenomenon of lateral spreading, which occurs preferentially near the surface and results in a flow that spreads laterally as plume water propagates forward in the direction of mean flow. In this work, the temporal and spatial scales of the active spreading region are estimated in the sampled plumes and related to environmental parameters at the river mouth such as inflow river discharge, initial drifter velocity at the point of release, initial reduced gravity and initial internal wave speed. The initial wave speed was found to be the environmental parameter that best predicts the magnitude of the spatial and temporal scales of the active spreading region. Previous studies have asserted the importance of initial plume parameters in near-field plume evolution and here we extrapolate this idea to the mid-field. Interestingly, we find that that lateral plume spreading is arrested at approximately one inertial radius from the river mouth. We therefore propose that the shutdown of spreading is controlled almost exclusively by Coriolis force and it is responsible for converting spreading motion to spinning motion after the mid field region.
The outcomes of this research are widely applicable to other energetic, medium size river plume systems and to the author's knowledge this is the first study to estimate lateral plume expansion using observations beyond the immediate near field region of a river plume. This work will provide further development in understanding plume dynamics and the fundamental physical processes that influence coastal ecosystems.