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Sticky stuff! Seasonal flocculation in a hypertidal estuary

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Suspended particular matter (SPM) is a highly variable and important aspect of estuarine systems. It determines turbidity; impacting water quality, generates benthic fluff, modifies biogeochemical exchanges, and constrains primary productivity. Further, SPM carries biogeochemical components (e.g. carbon, nitrogen), deciding the fates of anthropogenic system inputs.

Outside of the non-cohesive fraction (sand), little is known of the properties of estuarine SPM (i.e. sizes, densities, settling velocities) and how these impact sedimentation as most SPM is in the form of flocs (aggregates of dead and living organic matter, cohesive inorganic matter, and water) that are easily ruptured and/or may aggregate during sampling. As such, we lack reliable information on parameters such as settling velocities, particularly since floc properties change over tidal (suspension/advection), lunar (spring-neap cycle), and seasonal (storm resuspension and biological production) time scales.

Turbulence is an important mediator of floc characteristics; low turbulence promotes collisions and flocculation, while high levels cause shear-induced rupture, literally tearing flocs apart. Because of this, turbulence parameterisation is key to understanding the relationship between turbulence and particle size.

The results of an extensive field campaign in the Dee Estuary (N.W. United Kingdom) are presented, investigating the fates of SPM. Using data from a combination of acoustics, optics, moored deployments and CTD stations particle characteristics varied across tidal, spring-neap, and seasonal time-scales. This was due to seasonal changes in both river input and levels of biological activity.

During winter, turbulence-mediated flocculation and breakup dominated, with particles coming together under quiescent conditions, and breaking up during high turbulence conditions. By contrast, stronger, more shear-resistant flocs were present during summer with increased yield strength providing significant resistance to breakup.

These changes significantly altered the Ws of SPM within the estuary, which would affect particle flux as Ws for similar density particles in summer may be in excess of nine times greater during summer than in winter. Models with a constant settling velocity may therefore be inaccurate.