The importance of organic content to fractal floc properties in estuarine surface waters: Insights from video, LISST, and pump sampling

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To better understand the nature of flocs of varying organic content in estuarine surface waters, LISST, video settling, and pump sampling were deployed in the York River estuary. A new in-situ method was developed to simultaneously solve for floc fractal dimension (F), primary particle size (d_p), and primary particle density (ρ_p) by fitting a simple fractal model to observations of effective floc density ($\Delta\rho$) as a function of floc diameter (d_f) while ensuring the integrated particle size distribution was consistent with measurements of bulk apparent density (ρ_a). When fractal fits were statistically justified, application of the above methods showed the bulk fraction of organic matter (f_{org}) to be well correlated to multiple floc properties. As f_{org} increased, d_p and ρ_a also increased, while ρ_p, total suspended solids (TSS), and median floc size decreased. Notably for microflocs, neither F nor $\Delta\rho$ was significantly related to either f_{org} or TSS. This indicates that organic matter may partially displace water content within microflocs without fundamentally changing the flocs' inorganic structure. When pooling multiple samples, a marked decrease in F was seen at the transition to macroflocs, and most strongly for high f_{org} cases. This suggested that settling velocities ≥ ~ 1 mm/s may produce turbulent stresses that tend to tear macroflocs apart. This study also found that when fractal theory held, ρ_p had a near 1:1 correlation with the bulk dry density of filtered TSS, implying that primary particles are tightly bound aggregates of combined mineral and organic components.

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