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 (dₚ), and primary particle density (ρₚ) by fitting a simple fractal model to observations of effective floc density (Δρ) as a function of floc diameter (dₕ) while ensuring the integrated particle size distribution was consistent with measurements of bulk apparent density (ρₐ). When fractal fits were statistically justified, application of the above methods showed the bulk fraction of organic matter (fₒrg) to be well correlated to multiple floc properties. As fₒrg increased, dₚ and ρₐ also increased, while ρₚ, total suspended solids (TSS), and median floc size decreased. Notably for microflocs, neither F nor Δρ was significantly related to either fₒrg 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 fₒrg 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, ρₚ 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.