Fractal floc size, density, settling velocity, and implications for water clarity in partially mixed-estuaries: The role of small, organic-rich particles

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Abstract

Typical near-surface estuarine particles are not single solid particles, but clusters of inorganic and organic particles and water, called flocs. Floc properties that influence water clarity (such as size, composition, density and settling velocity) are challenging to observe in-situ, so their influence on the optical properties of the system is not well understood. The preliminary results presented here are part of a larger effort utilizing a combination of particle imaging equipment, water sampling, and optical instrumentation to measure important floc properties, to investigate the influence of organic particles and local hydrodynamics on those properties, and to evaluate the influence of suspended flocs on light propagation in partially mixed estuaries. This presentation focuses mainly on recent field observations collected by our group in the surface waters the York River Estuary, a major tidal tributary of the Chesapeake Bay. Results from our PIV-PTV video settling column demonstrate that the properties of flocs that can be well-resolved by video imaging ($\geq$ ~30 microns in size) are strongly fractal. Pump samples and in-situ laser diffraction measurements highlight the wide abundance of additional organic-rich particles that are likely fractal in nature, which settle very slowly, and which are too small to be resolved by video imagery. Finally, some related patterns revealed by long-term monitoring of the Chesapeake Bay by the EPA Chesapeake Bay Program are discussed. Observations from both the York River Estuary and the Chesapeake Bay suggest that small (< 10 microns in size), very slowly settling, organic-rich particles strongly influence light attenuation.