

# Quantifying and comparing settling velocity within the San Francisco Bay-Delta Estuary, northern California, USA

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The San Francisco Bay-Delta Estuary (Bay-Delta) has a long history with sediment transport and flocculation research, dating back to the classic work of H.A. Einstein, R.B. Krone and E. Partheniades (e.g. Einstein, 1941; Einstein and Krone, 1962; Krone, 1962; Partheniades, 1962; Krone, 1963). The Estuary comprises two distinct regions: San Francisco Bay (SFB) and the Sacramento-San Joaquin River Delta (Delta). The inland Delta region is where the rivers of the Central Valley of California merge to become the San Francisco Estuary. Importantly the rivers deliver fine sediment from the Central Valley watersheds to the Delta. Deposited sediment helps create and sustain the landscape in the Sacramento-San Joaquin River Delta (Delta), including desirable habitats such as tidal marsh, shoals, and floodplains. A key management question is whether the existing Delta landscape can be sustained as sea level rises. The erosion and deposition processes are strongly dependent on the local sediment properties, particularly when cohesion and flocculation are important, as they are in the Delta. Thus, it is important to make local, *in-situ* measurements of erosion rates and settling velocities in order to guide parameterization of a numerical model.

The US Geological Survey collects data that supports the development, calibration, and validation of numerical models of sediment transport and turbidity in the Bay-Delta system. Research questions include: How much flocculation of sediment particles occurs in the Bay-Delta, and what are the settling velocities of the flocs? How do floc settling properties vary spatially and temporally? To address these questions, a Co-operative Agreement was established between the USGS and HR Wallingford (UK).

This abstract presents measurements of floc depositional properties throughout the Bay-Delta during 2008-2011. The floc data were acquired using the INSSEV-LF: IN-Situ Settling Velocity instrument. The LF (LabSFLOC) version of INSSEV is a hybrid system which combines two key components: i) the low intrusive LabSFLOC (version 1) system (a high resolution video-based device to measure the individual floc properties; ii) an *in-situ* estuarine floc sampling acquisition unit (to initially obtain the suspension sample). For the latter, a 2.2L Van Dorn horizontal sampling tube with a 14kg torpedo-shaped weight suspended from the underside of the tube was used to collect a water sample nominally 0.7m above the estuary bed. Manning *et al.*, (2010) provide further details of these floc acquisition procedures. The LabSFLOC- Laboratory Spectral Flocculation Characteristics - instrument (Manning, 2006) was set-up in the various research vessels.

Thirty-one floc population samples were obtained from 21 sites within the Delta, with a similar number of floc samples (30) collected throughout SFB (Manning and Schoellhamer, 2013). Flocculated particles were observed throughout the Delta, including in freshwater. Suspended-sediment concentrations (SSC) in the near-bed region ranged from 4-52mg.l<sup>-1</sup> in the Delta, rising to 230mg.l<sup>-1</sup> in SFB (South Bay). A combined total of more than 2,200 individual flocs were measured in the Delta, with double the number of flocs observed in the SFB populations. In the Delta, floc sizes (D) ranged from 27µm microflocs (D < 160µm) to macroflocs of 500µm, with flocs 639µm in diameter observed in SFB. Settling velocities (Ws) ranged between 0.04mm.s<sup>-1</sup> to 15.8mm.s<sup>-1</sup> during a longitudinal transect of SFB. Within the Delta, Macrofloc settling velocities (Ws) were 0.7-5mm.s<sup>-1</sup> (mean 2.25mm.s<sup>-1</sup>) and macroflocs comprised 1-56% (mean 24%) of the suspended mass. Microfloc Ws was smaller (0.3-4.0mm.s<sup>-1</sup>, mean 1.63mm.s<sup>-1</sup>), but comprised more (44-99%, mean 76%) of the suspended mass and thus, mass settling fluxes (spanning 0.1-80mg.m<sup>-2</sup>s<sup>-1</sup>) were dominated by microflocs, albeit an order of magnitude less than depositional fluxes within San Francisco Bay. This presentation will indicate how floc population settling velocities and mass distributions vary throughout the Bay-Delta, and identify characteristic floc dynamical properties and structural composition, at key locations within both SFB and the Delta. The depositional mass settling fluxes

spanned three orders of magnitude, ranging from  $4\text{--}767\text{mg.m}^{-2}\text{s}^{-1}$  in the Bay-Delta. The composition of individual floc population's mass settling flux (MSF in terms of  $W_s$  and SSC combinations) will be examined, as will the spatial patterns of the MSF, and findings will be linked to both a new Delta conceptual model for sediment transport and to  $W_s$  parameterisations commonly used in numerical sediment transport modelling.

## References

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