

Modeling floc dynamics observed during the OASIS experiment

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The 2011 OASIS (Optics, Acoustics and Sediments In Situ) Experiment provided unique observations of particle distributions in the bottom boundary layer of the inner shelf. The observations were made at the Martha's Vineyard Coastal Observatory (Massachusetts, USA) at 12-m water depth with instruments mounted on a moving arm that obtained profiles of optical and acoustic measurements between about 0.5 and 2m above the sea floor (Sherwood *et al.*, 2012). The measurements reveal resuspension and settling of flocs and fine sand, and evolution of the particle field through floc dynamics (aggregation and disaggregation). We have simulated these processes using a coupled modelling system that links a wave model (SWAN) with a three-dimensional hydrodynamic model (ROMS) and with a mixed-sediment model that includes the floc-dynamics model FLOCMOD (Verney *et al.*, 2011). In addition, we have modelled the response of our sensors to the simulated particle field using optical response to particle areas and recently developed functions for acoustic response to floc volumes (Thorne *et al.*, 2014). Simulations with this modelling system reproduced the measured bottom stress and sand resuspension, and generated an evolving floc population that captured some of the features observed during the experiment. In particular, the model resuspended fine cohesive material and generated larger flocs during times of increased wave-current stresses, and the flocs settled rapidly during less energetic conditions. Shear-induced disaggregation was confined to the bottom-most layer of the model, also consistent with observations. However, the model did not reproduce features we attribute to lateral advection, or the low concentrations of large flocs observed during a period of low wave energy and neap tides. The model was sensitive to floc-model coefficients (for example, aggregation- and disaggregation-rate coefficients) and the sediment flux conditions imposed at the bottom boundary. The model results demonstrate the relative advantages of optical and acoustic sensors, and the need for both to measure concentrations of flocs and sand. The model also highlighted some of the difficulties in reproducing realistic floc conditions, including numerical challenges (computational cost and solution of stiff non-linear equations), uncertainty about floc behaviour during deposition and erosion, the role of biogenic contributions to the floc population, and the data requirements for setting initial and boundary conditions in a spatially explicit domain.

References

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