Grain-Resolved Simulations of Cohesive Sediment

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Cohesive sediment is ubiquitous in natural environments such as rivers, lakes and coastal ecosystems. For this type of sediment, the short-range attractive forces can no longer be ignored, which results in flocculation of aggregates that are much larger than the individual grain size. These flocs are known to carry substantial amounts of nutrients and/or contaminants. Hence, understanding the complex dynamics of the interplay between flocculated sediment and the ambient fluid is of prime interest to manage aquatic environments, but a comprehensive understanding of these phenomena is still lacking. In the present study, we address this issue by carrying out grain-resolved simulations of cohesive particles settling under gravity using the Immersed Boundary Method. First, we present a suitable model formulation to accurately resolve the process of flocculation as will be illustrated by means of the classical Drafting-Kissing-Tumbling test case. The cohesive model is then applied to a complex test case. A randomly distributed ensemble of 1261 polydisperse particles is released in a tank of quiescent fluid. Subsequently, larger particles start to settle faster than smaller ones, thereby replacing fluid at the bottom of the tank, which induces a counter flow opposing the settling direction (Figure 1). This mechanism, known as 'hindered settling', will be compared to experimental studies from literature as well as to the non-cohesive counterpart to address the impact of flocculation on sedimentation. The present study will serve as a benchmark for experimental efforts in our group to study flocculation under the presence and absence of gravity. The latter configuration will be realized by experiments on the International Space Station.

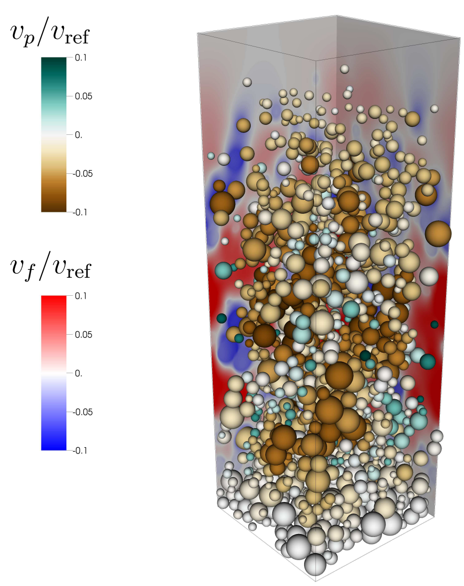

Figure 1: *Cohesive particles settling under gravity colored by their vertical velocity component. Contours of the vertical fluid velocity.*

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