EGU21-2438
https://doi.org/10.5194/egusphere-egu21-2438
EGU General Assembly 2021


# A numerical method for simulations of cohesive, porous sediments

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The dynamics of cohesive sediments under various flow conditions are of special interest in the framework of aquatic ecosystems. Being one of the main sources of transport for minerals and organic matter, the constituents of cohesive sediments are the source of food for many aquatic organisms. Due to the additional complexity of physical mechanisms, there are only a few simulation techniques for cohesive sediments, which do not cover all spatial scales. The primary cohesive clay particles are platelets smaller than 2 μm, which is small enough to experience Brownian motion. Composed together under the influence of van der Waals forces, they shape rounded aggregates also known as microflocs that are rather stable. These microflocs can form fragile, larger macroflocs with complex shapes exceeding 100 μm in size. Owing to the huge difference in the spatial scales, it is almost impossible to simulate macroflocs as the assembly of primary clay particles in the context of cohesive sediment transport modeling. In contrast to separate sediment grains, microflocs represent porous aggregates. To perform direct numerical simulations of microflocs transported in a viscous fluid flow, we are developing a computational model for immersed porous particles. The model resolves the flow outside and inside porous aggregates and accurately computes the hydrodynamic forces on the microflocs. The simulation of macroflocs is also attainable by employing cohesive forces between microflocs, which assembles them into bigger aggregates with the propensity of breaking up under high shear rates. Our computational model solves the system of Navier - Stokes equations directly with an additional Darcy term inside the porous aggregate. Using this approach, it becomes feasible to consider the influence of the flow inside porous media, so that we can study its impact on the mean flow characteristics depending on the properties of the porous flocs. The hydrodynamic forces are calculated implicitly based on the pressure and shear stress distribution. By comparison with methods that use Stokes-based drag coefficients, our approach allows estimating the influence of local flow conditions and the presence of neighboring aggregates on the resulting fluid force.