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An efficient cellular flow model for cohesive particle flocculation in turbulence

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We propose a one-way coupled model that tracks individual primary particles in a conceptually simple cellular flow setup to predict flocculation in turbulence. This computationally efficient model accounts for Stokes drag, lubrication, cohesive and direct contact forces on the primary spherical particles and allows for a systematic simulation campaign that yields the transient mean floc size as a function of the governing dimensionless parameters. The simulations reproduce the growth of the cohesive flocs with time and the emergence of a log-normal equilibrium distribution governed by the balance of aggregation and breakage. Flocculation proceeds most rapidly when the Stokes number of the primary particles is O(1). Results from this simple computational model are consistent with experimental observations, thus allowing us to propose a new analytical flocculation model that yields improved agreement with experimental data, especially during the transient stages.