Geophysical Research Abstracts
Vol. 13, EGU2011-12245, 2011
EGU General Assembly 2011

Aggregation and fragmentation of inertial particles in chaotic advection and random flows

Ulrike Feudel (1), Jens C. Zahnow (1), Rafael Vilela (2), and Tamas Tel (3)

(1) University of Oldenburg, Institute for Chemistry and Biology of the Marine Environment, Oldenburg, Germany (ulrike.feudel@uni-oldenburg.de, +49-(0)441-7983404), (2) Universidade Federal do ABC, Santo Ande, Brazil, (3) Eötvös University Budapest, Hungary

Inertial particles in fluid flows are of increasing interest in different disciplines of science such as dynamical systems theory, atmospheric and marine science as well as engineering. In many cases particles are not only transported passively by advection but exhibit a dynamics of their own as they can form larger particles upon collision or can break up. Examples of particle dynamics are raindrop formation in clouds, sedimentation of particles in lakes and the ocean or flocculation of marine aggregates and cells.
We present a coupled model for advection, coagulation and fragmentation that is based on the dynamics of individual, spherical inertial particles in two-dimensional flows. The basic equations describing the dynamics of these particles are the Maxey-Riley equations. We consider idealized flows like periodic flows leading to chaotic advection of the particles as well as random flows. Due to the particle inertia advection leads to the accumulation of the particles on certain spatial patterns in the flow. The collision of the particles leads to aggregation and larger aggregates are formed. These can in turn fragment due to shear forces in the flow. Two different mechanisms of fragmentation are taken into account: On the one hand aggregates can fragment if their size exceeds a predefined maximum size. On the other hand fragmentation can take place when the shear forces in the flow become larger than the binding forces of the aggregate. We find that the combination of aggregation and fragmentation leads to an asymptotic steady state for the size distribution of the aggregates which depends crucially on the considered mechanism of fragmentation. We discuss the dependence of the final size distributions on the properties of the aggregate as well as of the flow.