Concentration préférentielle de particules lourdes en écoulement turbulent

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Study of inertial particles laden flows is relevant to many industrial and environmental issues, but it is also of fundamental interest. In the many particle case, a striking feature is the trend to preferential concentration that has been observed for long (Eaton and Fessler (1994)) and which is still thoroughly studied. Another interesting feature is the enhancement of the settling velocity of the particles in turbulent flows. Since an explanation of this phenomenon through the existence of clusters has been proposed by Aliseda et al. (2002), different authors have tried to quantify and characterize this clustering numerically. Nevertheless, the "kinematic" simulations used (which are based on equations governing the particles dynamics derived in the limiting case of a negligible size, see. Maxey and Riley (1983) and Gatignol) neglect */most of the forces/* acting on the particles that may play an important role in the particles dynamics. Therefore, experimental investigations are still important to reach a better understanding of the underlying mechanisms.

Do clusters exist as a whole in these flows? How do they form? What is their structure and how does this structure evolve with time? Which effect do they have on the single particle dynamics? Here are some questions that need to be answered. To date, the preferential concentration/cluster problem has been studied with global, Eulerian tools (box counting methods, pair correlation function estimation or topological indicators.). A dynamical study of the Lagrangian dynamics - of the particles and of the local concentration field - would bring new insight in these processes. In particular, it would be worthwhile to get access to the concentration along a particle trajectory, a quantity which has been recognized as very importance in modeling (Reeks et al.).

In that scope, we have exploited Voronoï tessellations that give a measure of the local concentration field at the inter-particles length scale: through Lagrangian measurements, we can simultaneously compute the velocity, the acceleration and the local concentration field associated to each particle. We first */focused/* on the preferential concentration problem on a statistical ground and we have shown that previously obtained results can be recovered with the Voronoï diagrams as a single tool: preferential concentration is quantified and reaches a maximum for Stokes numbers around unity, /clusters show not to have any typical length scale/ and their geometry exhibits fractal structure. This analysis is a first step before studying the dynamics of the clusters/particles with simultaneous measurements of Lagrangian velocity, acceleration and concentration fields allowed by the Voronoï analysis. The experimental data have been collected in a wind tunnel grid turbulence experiment where the flow is seeded with a dense water fog made of droplets whose diameters range from 15 to 150µm. The Reynolds number R_lambda is of order 100. Measurements are performed by Lagrangian tracking of particles with a high speed camera, sampling the flow at 10 kHz.