Lagrangian turbulence and time irreversibility

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Abstract

Accurate and efficient models of turbulence are key in a multitude of applications, ranging from cardiology and engine optimization, to atmospheric circulation and planet formation. Flows develop in an unsteady and chaotic turbulent state when the amount of injected kinetic energy overwhelms viscous damping. This excess, measured by the Reynolds number, results in a cascading process where a wide range of excited scales are strongly tied up. Energy dissipation is then sustained by violent fine-scale structures, leading to the persistence of a finite viscous dissipation in the limit of infinite Reynolds numbers. This phenomenon, dubbed "dissipative anomaly", rests on the singular nature and deep irreversibility of turbulent flows, and is the primary source of difficulties when developing turbulence models. I will present recent quantitative progress in the understanding of this highly singular behaviour, by focusing on the irreversible nature of turbulence. A special emphasis will be given on the signature of irreversible processes on the motion of tracers transported by the flow.

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sciencesconf.org:jmgambaudo60:213868