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How different is Buoyant Turbulence from Isotropic Turbulence?

JULIEN CLARET, ENSTA ParisTech, GUILLAUME BLANQUART, CalTech —

This work seeks to establish a new approach for simulating variable density turbulent buoyant flows by extraction of the anisotropic component inherent to buoyant flows. This anisotropy is known to be the main difficulty when simulating buoyant flows. We perform for this an *a priori* analysis using the DNS data from [Caroll, Blanquart TCFD (2015)]. The anisotropy is quantified first through variance of the velocity field, two-point autocorrelation and energy spectra. The main observation is that for buoyant flows the velocity has a dependency on density shown by a non null conditional mean whereas this is not observed In isotropic flows. This allows to decompose Homogeneous Buoyant Turbulence (HBT) into three terms. The first corresponds to the conditional mean velocity on density that contains -but is not reduced to- the small scales anisotropy. The second term corresponds to the mean velocity averaged only in the direction of gravity which contains large scale anisotropy. The final term corresponds to a field of Homogeneous Isotropic Turbulence (HIT). This decomposition allows the reduction of the problem to the study of an HIT field which is well known. It also sheds light onto the development of a new Sub-Grid Scale (SGS) to simulate flows driven by buoyancy.

Julien Claret
ENSTA ParisTech

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