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Coherency and Large Scale Motions in Turbulent Ekman Flow[1]

CEDRICK ANSORGE, JUAN PEDRO MELLADO, Max Planck Institute for Meteorology — We study turbulence in the planetary boundary layer using direct numerical simulations of neutrally and stably stratified Ekman flow. The Reynolds number is varied in the range $500 < \delta^+ < 1500$ where δ^+ is the boundary layer thickness δ expressed in wall units. We vary the stratification, expressed in terms of a bulk Richardson number from very weak stability, where turbulence acts as a passive scalar, to very strong stability, where the flow relaminarizes partly. When the aspect ratio is sufficiently large, i.e. at a horizontal extent of about $(20\delta)^2$, large-scale modes are present in the flow. These large-scale modes govern the spatio-temporal structure of external and global intermittency in the flow. We use a dual approach to investigate the large-scale motions and coherency in the flow: The analysis of spatially resolved fields of the turbulent flow is complemented by temporally fully resolved data at vertical intersections through the domain. From this data we quantify the expected error of local measurements carried out over a finite period of time with respect to the ensemble average. Moreover, we analyze the coherency in this complex flow, in particular of the large-scale structures occurring when the flow is exposed to a stable stratification.

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