EMS Annual Meeting Abstracts
Vol. 15, EMS2018-630, 2018

Revising conventional theory of turbulence in atmospheric surface layer

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Until now, comprehending and modelling of turbulence in the surface layer of the atmosphere is based on universally recognised Monin-Obukhov Similarity Theory (MOST). Since first publications in 1953 and 1954, this theory underlies comprehending and modelling of turbulent fluxes at the Earth surface, turbulence energetics, and turbulent diffusion in the surface layer, and mean structures of this layer. In spite of well-documented inconsistencies in unstable and strongly stable stratifications, MOST has not been principally questioned.

Common reluctance to revise MOST is not surprising. Its major drawbacks root in the commonly recognised paradigm attributed to Kolmogorov (1941-1942) and underlying development of the theory of turbulence over almost a century. However, the above quoted papers were limited to the shear-generated turbulence in neutrally stratified flows, where the key postulates of the paradigm, namely, (i) direct energy cascade – from larger to smaller shear-generated chaotic eddies towards viscous dissipation and (ii) down-gradient turbulent fluxes, serve as reasonable approximations. Moreover, Kolmogorov was not responsible for the extension of his vision of turbulence to essentially stratified flows. This was done by his followers without proof, just under impression of great success of the Kolmogorov theory.

This talk highlights irrelevance of the conventional paradigm to essentially stratified turbulent flows; demonstrates principal failures of MOST; and outlines an alternative theory of the turbulence in stratified sheared flows based on novel Energy- and Flux-Budget (EFB) turbulence-closure theory, admitting non-gradient turbulent energy transfer and inverse energy cascade – from larger to smaller buoyancy-generated chaotic plumes, towards self-organised convective motions: cells or rolls in calm and windy weather, respectively.