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Large-Scale Semi-Organized Structures in Geophysical Turbulent Convection

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A new mean-field theory of turbulent convection is developed by considering only the small-scale part of spectra as turbulence, whereas the large-scale part is treated as a mean flow, which includes both, regular and semi-organized motions. In a shear-free turbulent convection the theory predicts the convective wind instability which causes formation of large-scale semi-organized fluid motions in the form of cells. The theory predicts also the convective-shear instability in a sheared turbulent convection which results in appearance of large-scale semi-organized convective rolls. This instability can cause also a generation of helical convective-shear waves which propagate perpendicular to convective rolls. The increase of shear promotes excitation of the convective-shear instability. Predictions of this theory are in a good agreement with the modern knowledge about the atmospheric convective boundary layer and observed semi-organized large-scale structures: three-dimensional Bénard-type convective cells (cloud cells) and convective rolls (cloud streets) stretched along the mean wind.

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