An integral model of the convective jet including the pressure effect and the forms of the vertical fluxes in the turbulent surface layer of the atmosphere

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Abstract:

The study presents a modified integral model of the convective jets that includes the effect of the pressure. The model corresponds to the steady turbulent jets that arise from the point sources of the heat and the momentum in the neutral or unsteady stratified atmosphere. The analytical solutions of this model are presented in the polynomial forms of the dependence of the vertical velocity and the buoyance on the height. The comparison between the exact solutions of this model and the analytical solutions of the integral models of the stationary jets, which are based on the vertical boundary-layer approximation, is performed.

It is shown that for the buoyant jet in the neutral stratified atmosphere the effect of the pressure force increases the amplitude of the temperature variance and decreases the amplitude of the vertical velocity by 10%. For the spontaneous jet in the unsteady stratified atmosphere the effect of the pressure force maintains the amplitude of the temperature variance and increases the amplitude of the vertical velocity by 15%.

It is found that there are dynamic invariants expressing the law of the uniform distribution of potential, available potential and kinetic energies along the axis of a jet. Essentially, the assemble of the spontaneous jets forms the profiles of the second turbulent moments of the vertical velocity and buoyance near the horizontal homogeneous heated underlying surface in the convective layer of the atmosphere and the ocean.