Absolute-convective instability of mixed forced-free convection boundary layers

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Abstract

A spatio-temporal inviscid instability of a mixed forced-free convection boundary layer is investigated. The base flow considered is the self-similar flow with free-stream velocity $u_e \sim x^n$. Such a boundary-layer flow presents the unusual behaviour of generating a region of velocity overshoot, in which the streamwise velocity within the boundary layer exceeds the free-stream speed. A linear stability analysis has been carried out. Saddle points have been located and a critical value for the buoyancy parameter, $G_{0c} \approx 3.6896$, has been determined below which the flow is convectively unstable and above which the flow becomes absolutely unstable. Two spatial modes have been obtained, one mode being convective in nature and the other absolute. The convective-type spatial mode shows mode crossing behaviour at lower frequencies. Thermal buoyancy is shown to be destabilizing to the absolutely unstable spatial mode.