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Katabatic flow: a closed-form solution with spatially-varying eddy diffusivities MARCO G. GIOMETTO, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland; University of British Columbia, Vancouver, BC, Canada, RICCARDO GRANDI, JIANNONG FANG, PETER A. MONKEWITZ, École Polytechnique Fédérale de Lausanne, Lausanne, Switzerland, MARC B. PARLANGE, University of British Columbia, Vancouver, BC, Canada — The Nieuwstadt closed-form solution for the stationary Ekman layer is generalized for katabatic flows within the conceptual framework of the Prandtl model. The proposed solution is valid for spatially-varying eddy diffusivities (O'Brien type) and constant Prandtl number (Pr). Variations in the velocity and buoyancy profiles will be discussed as a function of the dimensionless model parameters $z_0 \equiv \hat{z}_0 \hat{N}^2 Pr \sin(\alpha) |\hat{b}_s|^{-1}$ and $\lambda \equiv \hat{u}_{\text{ref}} \hat{N} \sqrt{Pr} |\hat{b}_s|^{-1}$, where $\hat{z}_0$ is the hydrodynamic roughness length, $\hat{N}$ is the buoyancy frequency, α is the surface sloping angle, $\hat{b}_s$ is the imposed surface buoyancy, and $\hat{u}_{\text{ref}}$ is a reference velocity scale used to define eddy diffusivities. Profiles show significant variations in both phase and amplitude of extrema with respect to the classic constant K model and with respect to a recent approximate analytic solution based on the Wentzel-Kramers-Brillouin theory, hence shedding new light on the problem.

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