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Modeling simple katabatic Flows

B. Grisogono (1), I. Kavcic (1), D. Durran (2), D. Belusic (1), M. Zagar (3), L. Enger (4), L. Mahrt (5)

(1) Dept. of Geophysics, Univ. of Zagreb, Croatia, (2) Atmospheric Sciences, Univ. of Washington, Seattle, WA, USA, (3) Meteorol. Office, EAS, Ljubljana, Slovenia, (4) Enger KM-Konsult AB, Uppsala, Sweden, (5) COAS, Oregon State University, Corvallins, OR, USA.

The focus is on analytical and numerical modeling of simple katabatic flows blowing over short and long cool slopes. Since it was verified that classical scaling via Monin-Obukhov length performs over such slopes rather poorly (a low-level jet usually determines the surface fluxes), a modified Prandtl model is used instead. This linear analytic 1D model is extended for 1.) almost any gradual eddy diffusivity K(z) via the WKB method, and 2.) it includes the Coriolis effect. Its asymptotic (WKB) solution is checked against its more complete numerical solution and versus a mesoscale model (MIUU model). The Prandtl model is further used to determine one of the coefficients in the MIUU model turbulence length-scale for stable “z-less“ conditions, L; L = min[2a(TKE)ˆ(1/2)/N, a(TKE)ˆ(1/2)/S] where N and S are buoyancy frequency and absolute vertical wind shear and 2a = 0.537 is the standard coefficient in this higher-order turbulence closure scheme.

The result can be useful in parameterizing shallow persistent katabatic flows in NWP and climate models, in data interpretation and for improving characteristic length-scales in other numerical models.