

TOPOGRAPHIC BLOCKING OF FLOWS IN NONUNIFORM STATIC STABILITY

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Abstract: We use an idealized model to bridge a gap between theoretical understanding and practical application to determine the likelihood of flow blocking upstream of a mountain barrier in the presence of a low-level inversion. Two competing theories exist to predict stagnation in flow over a mountain of height h . The first is the continuously stratified theory for flow with constant Brunt-Vaisalla frequency N and wind speed U , which depends on the non-linearity parameter $\epsilon = Nh/U$ and the ratio of cross-stream to along-stream mountain width β . The second is the reduced-gravity shallow-water theory in which stagnation depends on the upstream Froude Number Fr and the non-dimensional mountain height $M = h/H$, where H is the depth of the shallow-water layer. We conduct a set of numerical simulations initialized with a finite thickness inversion superimposed on a stably-stratified background flow. We map this sounding into either the Fr - M parameter space, by approximating the inversion as an infinitesimal discontinuity, or into the ϵ - β parameter space, using either of the two alternate methods to define ϵ ; a bulk estimation of the low level stability or a vertical average of the low level stability. Our results show that the map into the ϵ - β parameter space is generally more accurate than the map into the Fr - M parameter space. In particular the averaging method mapped closer to the true stagnation point in eight out of eleven cases that spanned two inversion strengths, two inversion levels, and three mountain shapes, ranging from $\beta = 1$ to $\beta = 4$. The bulk method more accurately maps the amount of mass going around the mountain into the ϵ - β parameter space than does the shallow water method.