ON THE ENHANCED SMOOTHING OVER TOPOGRAPHY IN SOME MESOMETEOROLOGICAL MODELS

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ABSTRACT

An equation is derived for the components of the horizontal (turbulent) frictional force in the σ-coordinate system with special attention to mesometeorological flow models. The starting point is the horizontal equation of motion in its "flux-form" in the σ-system in which we replace (following Reynolds' procedure) the velocity components u,v and $\dot{\sigma}$ as well as other relevant quantities by terms of the form $u = \overline{u} + u', \ldots, \sigma = \overline{\sigma} + \dot{\sigma}'$, etc. ($\overline{u}$ = time average of u; u' = fluctuating part of u.) Next, the equation is averaged with respect to time and terms which we believe are small in mesometeorological flows, are neglected. On expressing $\dot{\sigma}'$ by an appropriate expression that involves w', the result shows the appearance of two new terms which have not been considered previously in the published literature. While the expression earlier used in the literature involved the σ-derivative of $\overline{u'w'}$ alone, the new terms add the σ-derivatives of $\rho\alpha\,\overline{u'^2}$ and $\rho\beta\,\overline{u'v'}$ for the x-component of the force, and the σ-derivatives of $\rho\beta\,\overline{v'^2}$ and $\rho\alpha\,\overline{u'v'}$ for the y-component, where α and β are the slopes of the σ-surfaces in the x- and y-directions, respectively. Further, a few numerical simulations of the sea-breeze over topography are carried out with and without the correction terms. It is shown that when corrections terms are not included the effective smoothing is stronger above the sloping regions and may amount to as high as 50 percent of the convergence with slopes of $\sim .04$. The inclusion of the new terms does not lead to any special computational difficulties and for that reason there is no compelling reason to neglect them, all the more so because, as is shown, the addition of the new terms results in a consistent apportioning of the 'degree' of horizontal diffusion.

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