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Influences on the Height of the Stable Boundary Layer as seen in Large-Eddy Simulations

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Influences on the height of the stable boundary layer as seen in large-eddy simulations

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Numerical weather prediction (NWP) models and atmospheric dispersion models rely on parameterizations of planetary boundary layer height. In the case of a stable boundary layer, errors in boundary layer height estimation can result in gross errors in boundary-layer evolution and in prediction of turbulent mixing within the boundary layer.

We use large-eddy simulations (LES) of moderately stable boundary layers to characterize the effects of various physical processes on stable boundary layers. The stable boundary layer height is assumed to be a function of surface friction velocity, geostrophic wind, Monin-Obukhov length, and the strength of the temperature inversion atop the stable boundary layer. This temperature inversion induces gravity waves with a frequency determined by the strength of the temperature inversion.

Using LES, we show that gravity waves atop a stable boundary layer do influence the height of the stable boundary layer, and the domain size of an LES of a SBL must be sufficient to resolve those gravity waves and their effects on an evolving stable boundary layer. We also show that the correct SBL height is crucial to correctly approximating the bulk Richardson number across the layer. The geostrophic drag coefficient, however, is not found to be particularly sensitive to the stable boundary layer height.

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