



LAWRENCE
LIVERMORE
NATIONAL
LABORATORY

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

B. Kosovic, J. K. Lundquist

March 30, 2004

16th Symposium on Boundary Layers and Turbulence
Portland, ME, United States
August 9, 2003 through August 13, 2004

Disclaimer

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

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

Branko Kosovic and Julie K. Lundquist
Atmospheric Science Division
Lawrence Livermore National Laboratory

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.

This work was performed under the auspices of the U.S. Department of Energy by University of California, Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.