

## **GEWEX Atmospheric Boundary Layer Study (GABLS)**

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### **1. About GABLS**

The objective of GABLS is to improve the representation of the atmospheric boundary layer in regional and large-scale models for weather and climate studies. For additional information see <http://www.met.wau.nl/projects/Gabls/index.html>. The first focus of GABLS is on stable boundary layers (SBLs) over land. At the moment about forty scientists are active participating within GABLS, including members of university groups seeking for international cooperation.

### **2. Background and Achievements in 2004**

In 2002, a first GABLS bench-mark case was selected to discuss the state of the art and to compare the skills of single column (1D) models and Large-Eddy Simulation (LES) models for the Stable Boundary Layer. The case was based on the results presented in a study by Kosovic and Curry (2000) for a shear-driven and stable case. As such the boundary layer is driven by an imposed, uniform geostrophic wind, with a specified surface-cooling rate over ice, which attains a quasi-steady state SBL (after about 9 hours). The findings were presented and discussed at a workshop at the University of the Balearic Islands in Mallorca, September 22-26, 2003.

Overall the results indicate that the models show quite significant differences for the mean temperature and wind profiles as well as the turbulent fluxes and other model outputs for the same initial conditions and forcing conditions. It appears that this is very strongly related to the choice of the turbulent length scale and/or the stability functions in the turbulence schemes, and not so much to the vertical resolution. Overall the results for the different LES models are much more closely than for the 1D models.

Interestingly the models in use at operational weather forecast and climate centres typically allow for enhanced mixing resulting in too deep boundary layers, while the typical research models show less mixing in more in agreement with the 'Large Eddy Simulation' results for this case. Because of the enhanced mixing in weather and climate models, these models tend to show a too strong surface drag, too deep boundary layers, and an underestimation of the wind turning in the lower atmosphere. At the other hand, by decreasing the mixing and surface drag, a direct impact on the atmospheric dynamics ('Ekman pumping') may be noted. Consequently, cyclones may become too active, corresponding in too high extremes for wind and precipitation, et cetera. When the models with enhanced mixing are coupled to a surface energy balance, they also produce too high surface temperatures.

On basis of the first GABLS bench-mark case, eight articles have been compiled and submitted to a special issue of Boundary Layer Meteorology on GABLS. This includes two papers with summary results for the LES and the 1D models, as well as six additional papers highlighting specific issues. So far two papers are accepted, and the others are under review or have been re-submitted after review. It is expected that the special issue will appear in 2005.

Given the GABLS findings, there is a clear need for a better understanding and a more general description of the atmospheric boundary layer under stably stratified conditions in atmospheric models for weather and climate. As such a summary report on the GABLS findings was written for the new IPCC report of working group 1 (Chapter 8). In August 2004, several GABLS related papers were presented at the '16<sup>th</sup> Boundary Layers and Turbulence Conference', in Portland, USA. In addition a GABLS workshop was held afterwards discussing the state of art and setting up a second GABLS bench-mark case.

### **3. Future Plans**

The second GABLS bench-mark case will be based on a realistic boundary-layer case covering three diurnal cycles over land within the CASES99 data set. This case has been studied and prepared by the Meteorology group at Wageningen University (Steenefeld, Van der Wiel and Holtslag, J.Atmos. Sci,

2004, Submitted). Detailed observations for three nights are available with rather different characteristics (fully turbulent, intermittent turbulent and non-turbulent). Steeneveld et al use a one-dimensional model with prescribed advection and full physics, e.g. first order turbulence closure, a grey body approximation radiation scheme and refined descriptions for the coupling of the atmosphere to the land surface and soil processes. Despite the totally different characteristics of the three nights, the column model was able to predict the major quantities and the evolution of the stable boundary layer. Especially the evolution of the vegetation temperature, soil heat flux and the sensible heat flux during the transition from day to night is simulated rather well.

It is proposed to use this case for the inter-comparison of different column models within GABLS using prescribed surface temperature. For an intercomparison of LES models probably only one night will be selected (currently in preparation). The focus of the next intercomparison of column models is again on the behavior and performance of the various boundary layer parameterizations, this time both for day and night conditions. In addition, the proposed intercomparison case has received interest from the GLASS/LOCO community as a suitable case to study also the interaction of the ABL with the land surface. A combined LOCO/GABLS workshop on this is planned for 19-23 September 2005 in De Bilt, NL (hosted by Bart van den Hurk and Bert Holtslag).