Session: C28 Poster: W51A

Achievements of the GEWEX Atmospheric Boundary Layer Study (GABLS)

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The aim of the GEWEX Atmospheric Boundary study (GABLS) is to improve the understanding and representation of the atmospheric boundary layer in weather-forecast and climate models on regional to global scales, which should also benefit atmospheric chemistry and earth system studies. The first study (GABLS1) covered a simplified case for a stable boundary layer with moderate geostrophic forcing and prescribed surface temperature over ice, in which the single column models were compared with an ensemble of Large Eddy Simulation models. One of the striking outcomes of GABLS1 is the issue that many operational weather models show too deep boundary layers in stable conditions which results in the erosion of low level jets and underestimation of the turning of wind with height. This is directly related to the enhanced mixing which models often use to compensate for model errors and possibly also to have sufficient Ekman pumping and realistic pressure distributions on the larger scale. The second single column model inter-comparison case (GABLS2) dealt with the diurnal cycle over land and is based on observations of CASES-99 using a prescribed surface temperature and simplified geostrophic wind forcing. From this we learned that models in this set up produce very different results in all parameters and that they all differ substantially from the observations of CASES99. In particular, the underestimated diurnal cycle in the 10-m wind speed is noted as well as the large variety for sensible heat fluxes. In fact, by prescribing the surface temperature over land it seems to be a severe and a more critical test for boundary layer schemes than allowing surface interactions. The previous GABLS achievements and experiences led to the set up of the third inter-comparison case using data gathered by the Royal Netherlands Meteorological Institute (KNMI) at the Cabauw tower. The Cabauw site with its 200 m meteorological tower is situated in a flat environment dominated by grassland. On many nights a low level jet develops due to decoupling and inertial oscillation. Thus the focus of GABLS3 is on the development of a LLJ and the morning time transition into a clear atmospheric boundary layer and how single column models and LES models represent this in a realistic comparison with the Cabauw observations.. As such a relatively ideal, baroclinic night (July 1, 2006) was selected from the multi-year data archive of Cabauw. Detailed dynamic forcings and surface conditions were prescribed on the basis of local observations and the outcome of 3D-atmospheric models. In total 12 institutes with 18 models cooperate in the GABLS3 Single Column evaluation and intercomparison study and they were able to run their single column version model with interactive land surface through there own soil-vegetation scheme. Evaluation shows that most models follow the basic observations (temperature, temperature and moisture) much better then in the previous GABLS2 intercomparison study with prescribed surface temperature. Emphasis is now on analyzing in more detail how the models perform at the onset of decoupling at sun set, the evolution of the Low Level Jet during the night and the onset of convection at sun rise. In addition an intercomparison of LES models is made based on the same case with focus on the nighttime stable conditions and early morning transition period building on the achievements of the GABLS1 intercomparison study. More than ten LES modeling groups from around the world participated in the intercomparison study. In the presentation, we will describe the setup of the GABLS3 - LES intercomparison case. Emphasis will be given on the evolution of low-level jets (LLJs) and the morning transition as well as the impact of sub-grid closures.