Report on a comparison of modelled and observed 2m-temperature during LITFASS-2003

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(published June 2005)

Model configuration

Two different model integrations are used for this report: operational LM forecasts (LM_OP) and experimental integrations (LM7), which have been performed in the framework of the EVA_GRIPS project. The operational forecasts are retrieved from the data base of DWD and consist of 24h simulations starting at 00UTC each day. LM7 runs are based on the LM version 3.2 with the following configuration: Model domain of 55x55 grid points with 0.0625° resolution centred over the LITFASS domain; prognostic TKE scheme but transfer scheme according to Louis; vertical layers like in the operational configuration of 2003 (~33m height of the first half level), LM-analyses as boundary and initial fields; re-initialisation of all fields except soil temperatures at 00UTC; soil moisture prescribed by a measurement forced soil moisture analysis (MSMA) scheme; land-use dependent albedo and stomatal resistance. Both model integrations use the two layer soil module.

Observational data

Surface and boundary layer measurements are provided by the LITFASS-2003 campaign, which took place from 19 May until 17 June 2003 in the LITFASS-domain. 14 eddy-covariance stations were operated above different land surfaces. Measurements of 2m-temperature T_{2m} are obtained from these stations. Some sites measured also the ("radiative") skin temperature of the surface T_s. Time series of the atmospheric reference temperature T_{atm} are available from the 99m tower at the GM-site. Values at 40m height, which is the measurement height closest to the lowest model half level, are used in the following.

Results

Fig. 1 shows mean daily cycles (averaged over 30 days of LITFASS-2003) of T_{2m}. The model values are averages for the LITFASS-domain, which means that nine LM grid boxes have

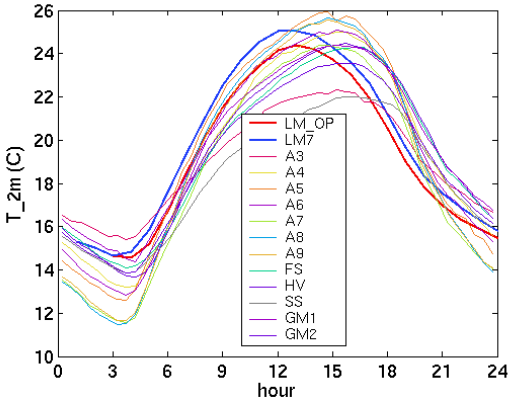

Fig.1: Mean daily cycle of T_{2m} from model integrations and measurements at sites above various land surfaces: Ax: crops; FS, SS: lakes, GM: grass; HV: forest.

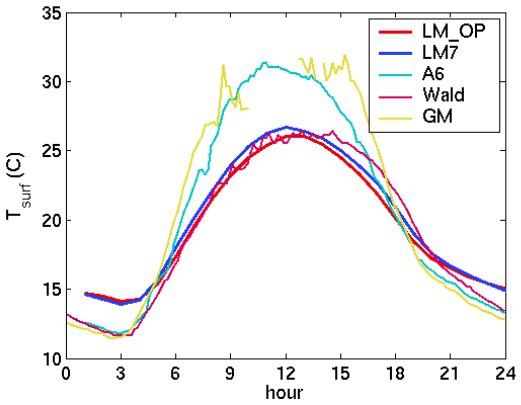

Fig.2: Mean daily cycle of surface temperature.

been averaged. Obviously there is a phase shift between model results and observations: The model reaches its maximum T_{2m} at 12-13UTC, whereas the observed maximum occurs at approximately 15-16UTC. It's worthwhile to note that this clear phase error appears neither in the surface temperature (Fig. 2) nor in the atmospheric temperature at the lowest model layer (Fig. 3). These two figures show two additional model deficiencies which are not in the scope of this report: The amplitude of T_s is underestimated (multilayer soil module will probably cure this problem) and the maximum of T_{atm} in the late afternoon is underestimated probably due to an underestimation of entrainment at the top of the boundary layer. Since T_{atm} and T_s do not exhibit a phase error, the diagnosis of T_{2m} may be erroneous. Comparing the phases of T_{atm}, T_s and T_{2m} in Fig 4 reveals that in the observation T_{2m} and T_{atm} are nearly in phase, whereas in the model results T_{2m} and T_s are closely in phase. This plot indicates that the model overestimates the impact of T_s on T_{2m}. The scatterplots Fig. 5 and Fig. 6 support this hypothesis: Under unstable conditions T_{2m} is getting only slightly warmer than T_{atm}, whereas the model simulates a much more pronounced temperature excess. The model configuration (e.g. transfer-scheme) seems to have a significant impact on T_{2m}, but nevertheless both configurations put too much weight on T_s.

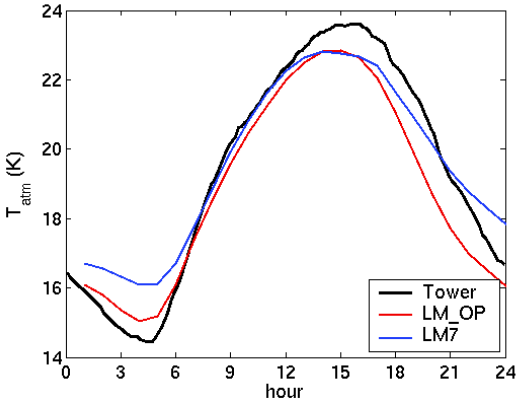

Fig.3: Mean daily cycle of atmospheric reference temperature at 33m (model) and 40m (tower measurements) height, respectively.

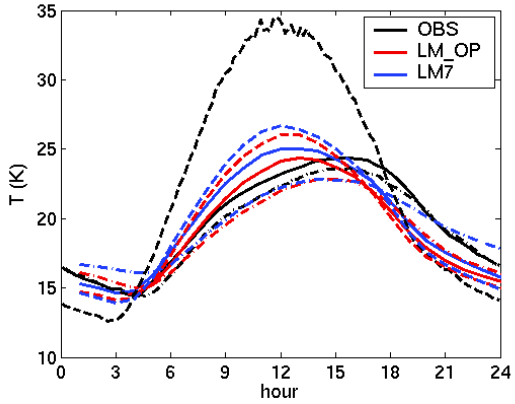

Fig.4: Main daily cycle of 2m-temperature (solid), atmospheric temperature (dash-dotted) and surface temperature (dashed) at the GM-site.

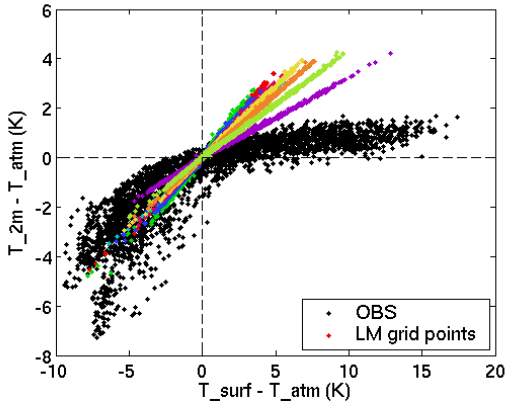

Fig.5: Scatterplot of modelled (LM_OP) and observed temperature differences during LITFASS 2003. Observations are taken at the GM-site; colored points indicate model results from nine LM grid points within LITFASS domain.

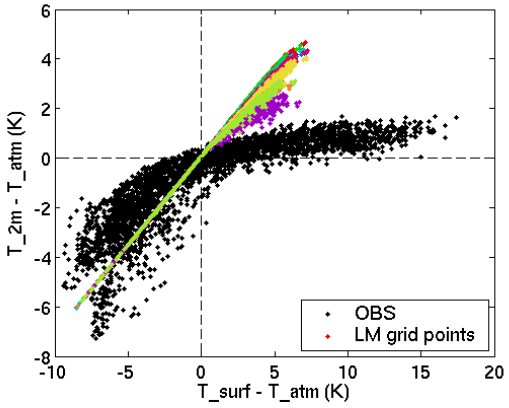

Fig.6: same as Fig. 5, but for LM7.