3.3 EVAPORATION OVER A HETEROGENEOUS LAND SURFACE: THE EVA-GRIPS PROJECT

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1. Introduction

Land surface - atmosphere interaction processes play an important role in the energy and water cycle over a wide magnitude of scales. An adequate description of these processes in numerical weather prediction and climate models is fundamental for a reliable simulation of near surface weather and climate conditions. However, considerable deficits are still to be noticed concerning our understanding and ability to properly describe these processes consistently over a variety of scales ranging from the local patch to the regional landscape scale. To overcome these deficits, both experimental and modeling activities have to contribute.

The major issue of EVA_GRIPS, a project under the auspices of the Climate Research Programme (DEKLIM) of the German Federal Ministry of Education and Research, is the determination of the area-averaged evaporation and sensible heat flux over a heterogeneous land surface through experimental and modeling activities. Through a combination of near-surface and boundary layer observations, the analysis of satellite data and numerical simulations EVA-GRIPS aims at testing and implementing concepts for the description of area-averaged turbulent fluxes in land surface schemes. The spatial scale considered in EVA-GRIPS corresponds to the grid scale of a regional atmospheric NWP or climate model (here in particular the "Lokal-Modell", LM, of the Deutscher Wetterdienst, DWD, and the model REMO of the BALTIMOS group), but also to the pixel scale of currently available satellite images.

Experiment and modelling activities focus on an area of roughly 20 x 20 km2 around the Meteorological Observatory Lindenberg (MOL) of DWD. The continuous measurement program of the MOL as a CEOP reference site formed the basis for a major field experiment in May and June, 2003.

2. The LITFASS-2003 experiment

As an integral part of EVA-GRIPS the LITFASS-2003 experiment took place in a 20x20 km2 area near the Meteorological Observatory Lindenberg, Germany. Turbulent fluxes of momentum, sensible, and latent heat were measured at nine agricultural sites, two grassland sites, one forest site, two lake sites, and at two levels of a 100 m tower.

Vertical profiles in the boundary layer were sampled by lidar and radar. A set of scintillometers, a helicopter borne turbulence probe HELIPOD (Bange et al., 1999) and an infrared camera for surface photography on board a Tornado aircraft as well as satellite images completed the set of instruments. The spatial sampling and footprint scales of this suite of measurement systems covered five orders of magnitude (10^{-1} - 10^{4} m for the sampling scale) and three orders of magnitude (10^{1} - 10^{4} m for the footprint scale), respectively.

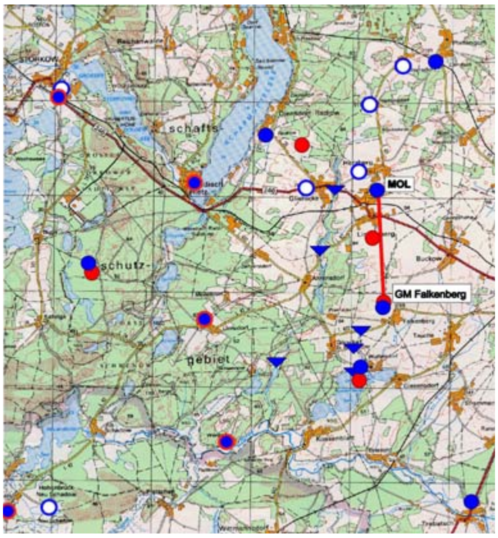

Fig. 1: Set-up of the LITFASS-2003 experiment. Surface energy balance stations and scintillometer paths.

Pronounced differences in surface characteristics (e.g. surface temperature) can be found over the different types of land use in the LITFASS area.

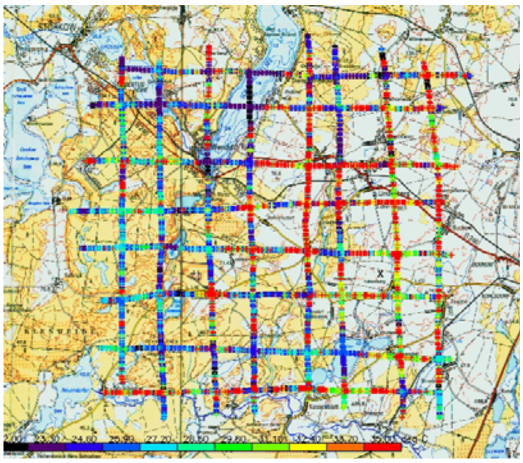

Fig. 2: Regional distribution of surface temperature in the LITFASS area measured by the Helipod during a grid flight pattern on June 17, 2003 (picture by J. Bange, TU Braunschweig)

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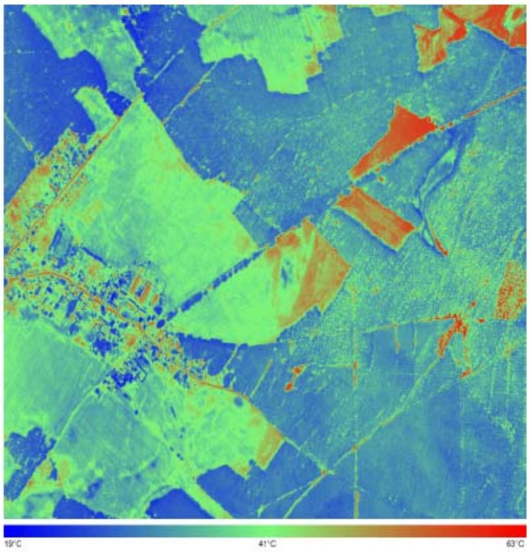

Fig. 3: Calibrated infrared surface temperature. Photo taken from the Tornado aircraft over a small part of the LITFASS area on June 17, 2003 (picture by J. Bange, TU Braunschweig)

Significant heterogeneities in surface temperature even over areas which look quite homogeneous at the first glace are caused by surface wetness variations. This has to be considered when judging the representative footprint area for flux measurements.

These differences in land use and surface characteristics result in significant evaporation differences. Composites of fluxes representing the respective vegetation type are deduced from measurements at various sites reflecting the same vegetation. These composites then have been used to deduce an area representative composite by weighting them according their area fraction.

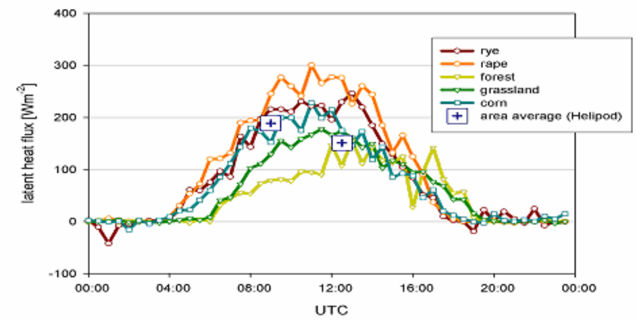

Fig. 4: Diurnal cycle of latent heat flux over various land use types for June 7, 2003 (figure by M. Mauder, University of Bayreuth, including data by GKSS, DWD and TU Braunschweig

3. Modeling component of EVA-GRIPS

Focus of the modeling activities lies on the objective calibration of three land-surface schemes for all different vegetation types and for the composite of water and energy fluxes representing the whole experimental area. Known concepts like the MOSAIC approach, the tile approach, the flux coupling approach and the application of effective parameters were implemented into standalone versions of the SVAT schemes TERRA of the Lokalmodell of the german weather service (DWD, Schrodin et al., 2001) and into that of the REMO/ECHAM model of the Deutsches Klimarechenzentrum (DKRZ, 1994) as well as the SEWAB scheme (Mengelkamp et al., 1999).

The SVAT schemes were calibrated by use of the multi-objective shuffled complex evolution algorithm MOSCEM-UA (Gupta et al., 1999) of the University of Arizona to obtain global minima of independent objective functions. Here this algorithm is not only applied to the different classes of land use but also to the area averaged heat fluxes to estimate effective parameters for the whole area around Lindenberg which is used as an example for one pixel of an NWP model.

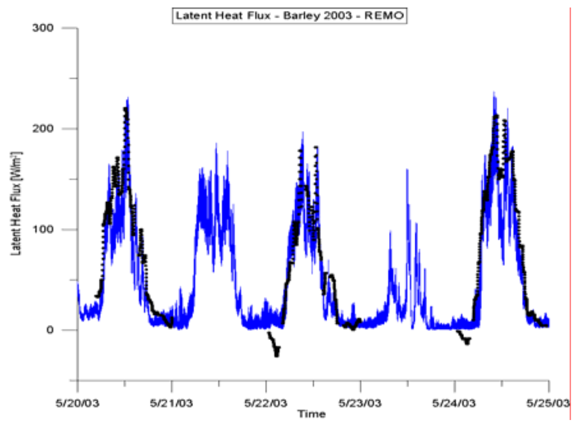

Fig 5: Latent heat flux measurements above barley taken during LITFASS 2003 and compared with the range for all parameter sets with pareto rank 1 (first three days of the calibration period) for the REMO/ECHAM svat scheme.

The concepts for parameterizing grid averaged fluxes are implemented in the operational weather forecast model LM of the german weather service and the local-scale mesoscale model FOOT3d developed at the University of Cologne. The LM was run with a horizontal resolution of 7 km. Comparison was made with a base run using a grid size of 250 m. The daily course for June 17 shows the largest differences between the effective parameter approach and the baseline simulation while the mosaic and the tile approach come close to the baseline run.

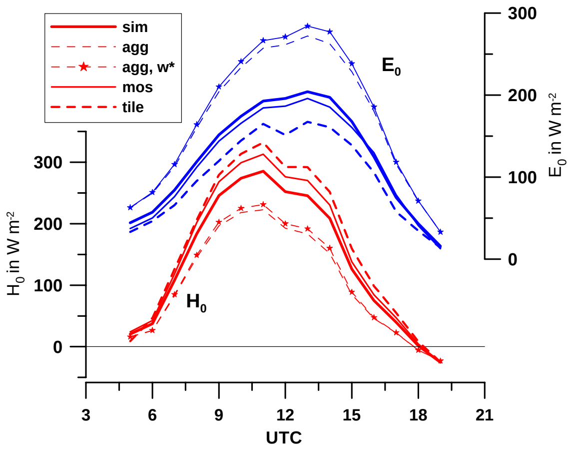

Fig. 6: Diurnal cycle of latent heat flux as simulated with 250 m horizontal resolution (sim), the tile and mosaic approach and the effective parameter method.

4. Acknowledgement

The project is funded by the Federal Ministry of Education, Science, Research and Technology (DEKLIM,project EVA-GRIPS).

5. References

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