J11.8 Multi-objective calibration of the land surface model SEWAB

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1. Introduction

A complex land surface model is generally characterized by a multitude of parameters, which are not exactly known a priori. Therefore a model calibration is needed. The success of a manual calibration essentially depends on the experience of the modeler and their knowledge of the basic approaches and interactions in the model. A manual calibration therefore is always subjective to some extent. Moreover, it can be extremely time consuming. Methods of automatic calibration can improve these shortcomings.

Following, the land surface model SEWAB (**S**urface **E**nergy and **Wa**ter **B**alance) [1] is calibrated by use of the multi-criteria optimization algorithm **MOSCEM** (**M**ulti-**O**bjective **S**huffled **C**omplex **E**volution **M**etropolis) of the University of Arizona.

For the calibration and validation period measurements of turbulent heat fluxes during the LITFASS 2003 campaign (LITFASS = '**L**indenberg **I**nhomogeneous **T**errain – **F**luxes between **A**tmosphere and **S**urface: a Long-term **S**tudy') [2] within the project **EVA-GRIPS** (Regional **Eva**poration at **Gri**d/**P**ixel **S**cale over heterogeneous Land Surfaces) [3] are used. The measurement site is around the Meteorological Observatory Lindenberg (MOL) of the Deutscher Wetterdienst (DWD).

2. Measurements

At 13 different sites in the heterogeneous landscape micrometeorological stations measured latent and sensible heat fluxes during the vegetation period in May and June 2003. The figures show the significant differences in the local fluxes on May 25 over the main classes of land use.

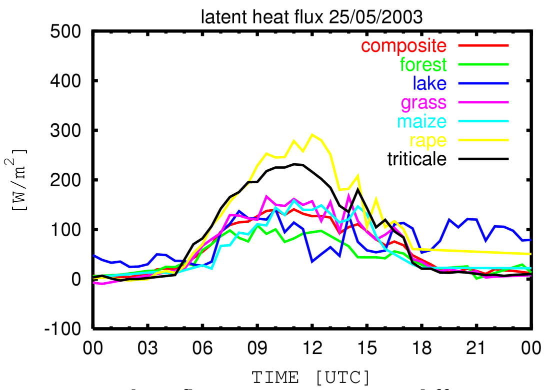

Fig.1: Latent heat flux measurement over different types of landuse in the LITFASS area on May 25, 2003, 30-min-average.

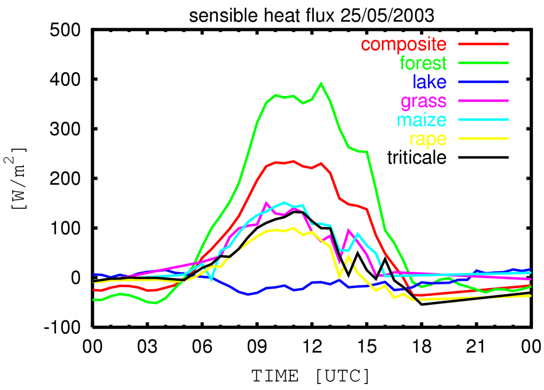

Fig.2: Daytime evolution of the sensible heat flux over different types of landuse on May 25, 2003, 30-min-average.

3. Calibration

To calibrate the SEWAB-model the MOSCEM-algorithm is applied to obtain global minima of independent objective functions. As objective functions a Nash-Sutcliffe criteria is applied to the differences between the measured and calculated heat fluxes. The algorithm allows to optimize N independent objective functions simultaneously. Here is N=2 for the latent (E(θ)) and sensible (F(θ)) heat fluxes. The algorithm determines the set of pareto-optimal objective function vectors of rank N.

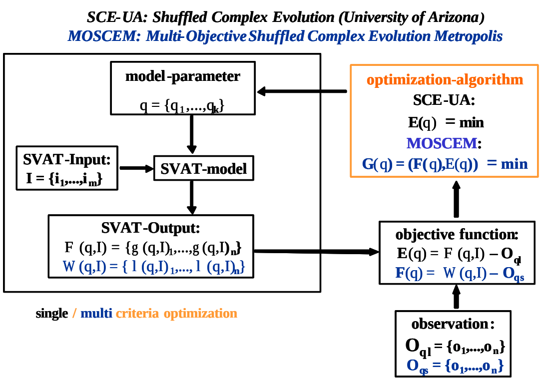

Fig.3: Flow diagram of SEWAB calibration with the MOSCEM-algorithm.

The algorithm is closely related to the **SCE-UA** (**S**huffled **C**omplex **E**volution)-algorithm developed at the **U**niversity of **A**rizona. The SCE-UA-algorithm is used to minimize only one objective function.
For the calibration the chosen model-parameters are varied within prescribed ranges.

4. Results:

The calibration results of a triticale dataset are shown below. In the objective space (Fig.4) the results of the single-objective algorithm (blue) mark the boundaries of the pareto-set solution (rank 1) of the multi-objective algorithm.

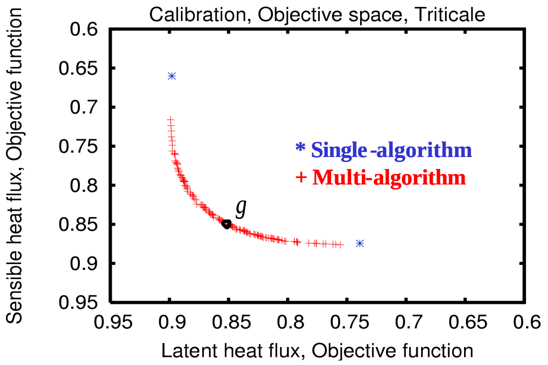

Fig. 4: Objective space, calibration days.

The parameter set g is one solution of the two-criteria-problem and minimizes all objective functions.
The validation results of this parameter set are shown for the latent and sensible heat flux (bottom). Every 2nd days of the time series are selected for the calibration, the other days for the validation period.

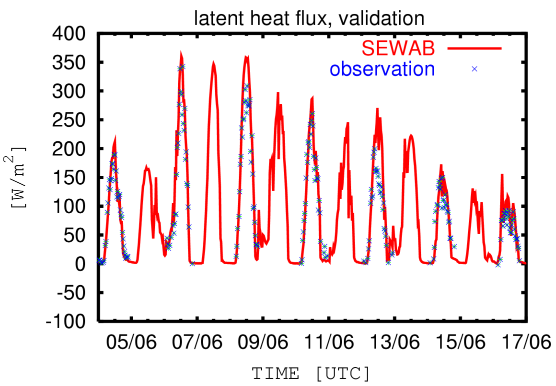

Fig. 5: Comparison of measured and simulated latent heat flux above triticale during the LITFASS 2003 experiment (validation days).

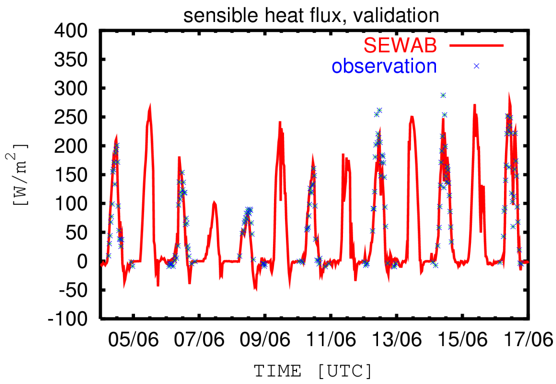

Fig. 6: Comparison of measured and simulated sensible heat flux above triticale during the LITFASS 2003 experiment (validation days).

References:

[1] H.-T. Mengelkamp, K. Warrach and E. Raschke, 1999: SEWAB – a parameterization of the surface energy and water balance for atmospheric and hydrologic models, *Adv. Water Res, 23, 2.*

[2] Beyrich F. (Editor), 2004: Verdunstung über einer heterogenen Landoberfläche. Das LITFASS-2003 Experiment. *Deutscher Wetterdienst, Forschung und Entwicklung, Arbeitsergebnisse 2004, Nr.79*

[3] H.-T. Mengelkamp and the EVA-GRIPS-Team, 2004: Energy and water vapour fluxes over a heterogeneous land surface: The EVA-GRIPS project, *this issue.*