DEPARTMENT OF GEOGRAPHY & GEOLOGY
UNIVERSITY OF COPENHAGEN

Coupling of a climate-hydrological model: Initial studies on characteristics and parameterization

Morten Andreas Dahl Larsen (1), Karsten Høgh Jensen (1), Jens Christian Refsgaard (2), Jens Hesselbjerg Christensen (3), Michael Butts (4) and Martin Drews (3)

Background

The study is a part of the Danish HYACINTS project (www.hyacints.dk). A central part of the project is a fully coupled climate-hydrological model involving the HIRHAM regional climate model, the MIKE SHE hydrological model and the SW ET land-surface model component.

This poster presents results from three initial studies prior to the coupling. The studies are performed to aid in the parameterization of each component in the coupled model setup:

Study 1 - The atmosphere component
Study 2 - The Land surface component
Study 3 - The distributed hydrological model

Study area

Study 1 includes data from all of Denmark (43000 km^2) whereas study 2 and 3 are focusing on the Skjern catchment (2500 km^2) located in the western part of the Jutland peninsula (fig. 1).

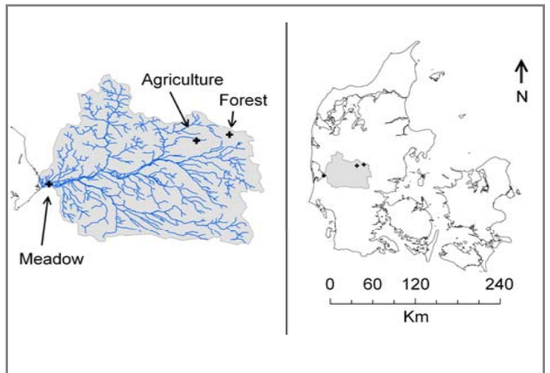

***Figure 1**. The location of the three sites in Denmark where the MIKE/SW ET model has been applied. The same sites are used for point validation of the climate model*

Study 1 (the atmosphere component)

This study investigated the simulated temperature and precipitation of the HIRHAM regional climate model using systematic variations of resolution, domain size and domain location (table 1).

Simulation	Cell size (km)	Domain size (km)	Cell extent
SIM1	5.5	1400x1400	252x252
SIM2	11	1350x1350	122x122
SIM3	11	2800x2800	252x252
SIM4	5.5	1400x1400	252x252
SIM5	5.5	2000x2000	362x362
SIM6	11	4000x2800	362x252
SIM7	12	5500x5200	452x432

***Table 1**. The characteristics of the HIRHAM simulations*

The validation comparing the performance of the simulations was done using two methods:

1. A bootstrap test giving significance levels to which the simulations were better than observations sampled randomly in subdomains corresponding to the decorrelation length of the variable and season in question (fig. 2 – top).

2. An error analysis subtracting observation data from simulation output (fig. 2 – bottom).

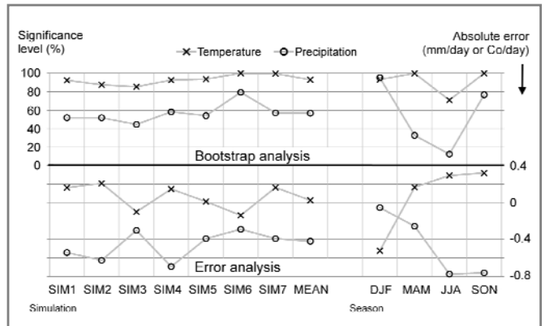

***Figure 2**. The results of the bootstrap and error analysis validation*

Study 2 (the land-surface component)

Three extensively monitered sites representing distinct surface types in the Skjern catchment (fig. 1) were autocalibrated in 1D MIKE SHE setups. The parameterization results were transferred to the distributed model (study 3) to minimize the number of parameters.

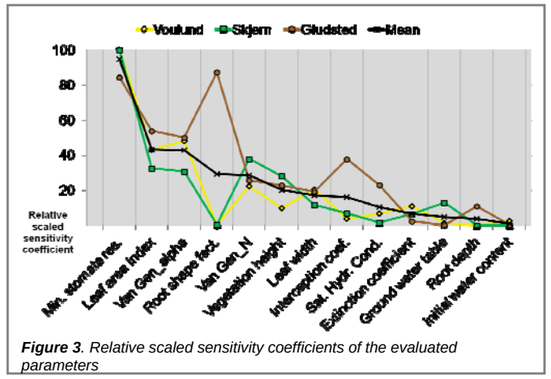

***Figure 3**. Relative scaled sensitivity coefficients of the evaluated parameters*

The sensitivity and optimization results from the three surface types agriculture (55%), meadow/grass/heath (35%) and forest (7%) are shown in fig. 3, 4 and table 2 respectively.

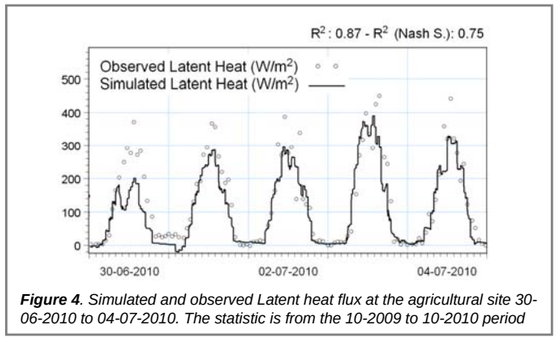

***Figure 4**. Simulated and observed Latent heat flux at the agricultural site 30-06-2010 to 04-07-2010. The statistic is from the 10-2009 to 10-2010 period*

	Agriculture	Meadow	Forest
Minimum stomata resistance (s/m)	104	186	234
Leaf area index (summer)	3.49	3.68	4.39
Vegetation height (summer) (m)	0.79	0.20	14.1

***Table 2**. Optimization results from the three surface types*

Study 3 (the distributed hydrological model)

This study used the vegetation and soil parameterization results from study 2 in a distributed MIKE SHE setup. Several scenarios are transferred to the distributed setup each constituting different assumptions on how to close the energy budget in study 2. Fig 5. shows the simulated latent heat flux from the agricultural site illustrating less accuracy than for the 1D setup (study 2).

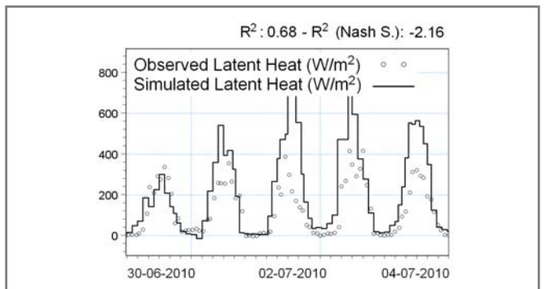

***Figure 5**. Distributed results of simulated and observed Latent heat flux at the agricultural site for the same period as in fig. 4*

Main conclusions and findings

1. (Study 1) Domain size is more important than resolution.

2. (Study 2) Assumptions need to be made on how to close the energy budget producing significant variations in the optimized parameter values.

3. (Study 3) Care must be taken when transferring parameter values from study 2.

Authors
1) University of Copenhagen, Department of Geography and Geology, Copenhagen, Denmark (ml@geo.ku.dk)
2) Geological Survey of Denmark and Greenland
3) Danish Meteorological Institute
4) DHI Water and Environment

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