

Preparing for a coupled climate-hydrological model: The influence of domain characteristics on the HIRHAM regional climate model

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Background

This study is a part of the HYACINTS project which will develop a fully coupled distributed climate-hydrological model based on the HIRHAM regional climate model and the MIKE SHE hydrological model.

Two steps prior to the coupling is presented:

1. The impact of domain characteristics on the HIRHAM performance (with ERA-Interim reanalysis) in order to choose the optimal setup for the study site.
2. Results from three uncoupled one-column MIKE SHE model simulations each describing distinct surface types (agriculture, forest and meadow – Figure 1). Included in the setup is the energy-based two-layer land surface-atmosphere component SW ET.

Study Site



Figure 1. 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.

Method

- HIRHAM model resolution, domain extent and placement of study site within the domain were varied as shown in Table 1, and validated against temperature and both bias-corrected and uncorrected precipitation observations.
- Three surfaces were simulated in MIKE SHE/SW ET forced by both observed values and HIRHAM simulation data and validated against observed heat flux data.

Model run	Resolution (km)	Domain size (km - lon x lat)
SK2	5.5	1400x1400
SK3	11	1350x1350
SK4	11	2800x2800
SK5	5.5	1400x1400
SK6	5.5	2000x2000
SK7	11	4000x4000
SK8	11	4000x2800
EN5	12	5500x5200

Table 1. Characteristics of the eight HIRHAM model runs varying resolution, domain size and placement of study site.

Results 1

- HIRHAM (uncorrected precipitation): Model overestimations in winter (DJF) (0.1-0.5 mm/day), and underestimations in summer (JJA) and fall (SON) (0-0.6 mm/day).
- HIRHAM (corrected precipitation): Model underestimations in all seasons (0.2-1 mm/day).
- HIRHAM (temperature): Winter months are generally underestimated (0.1-0.7 °C/day) and the remaining three seasons are overestimated (0-0.6 °C/day) (all HIRHAM results see Figure 2 and 3).

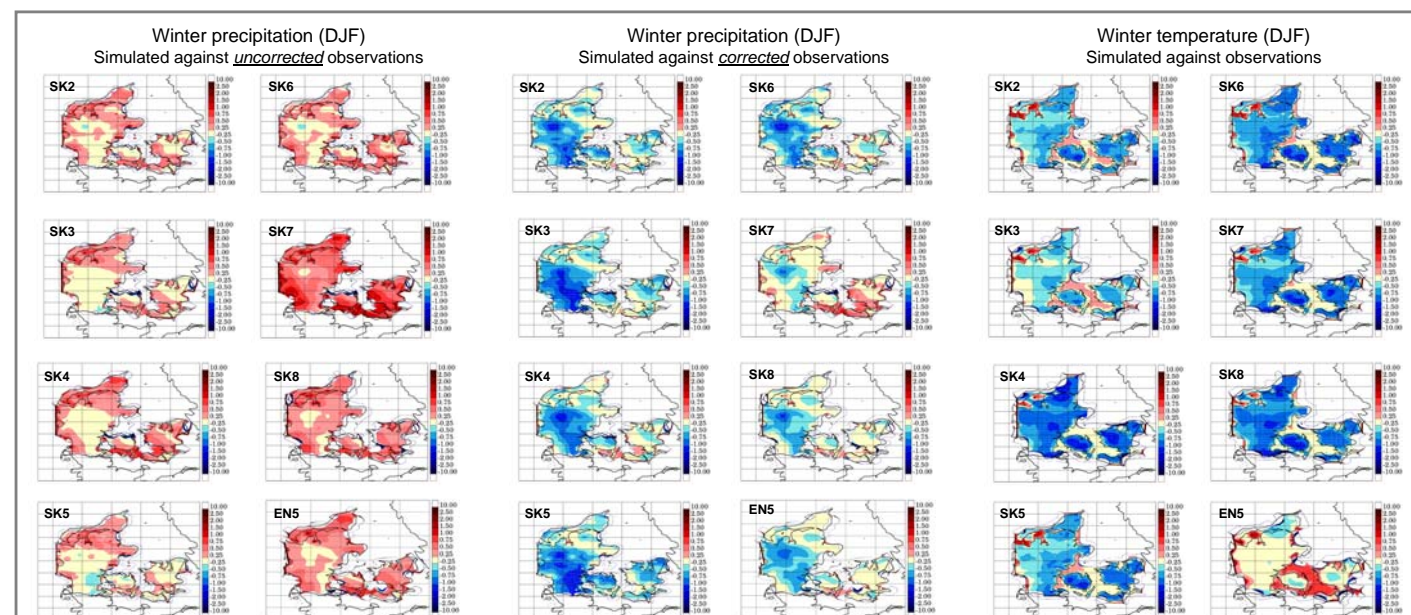


Figure 2. Error maps from the 8 model runs with observations. Subtracted from simulations. Only winter results are shown.

Legend: values in 0.25 mm/day or °C/day. Red colors: Model overestimation, Blue colors: Model underestimation, Yellow colors: within +/- 0.25 mm/day or °C/day.

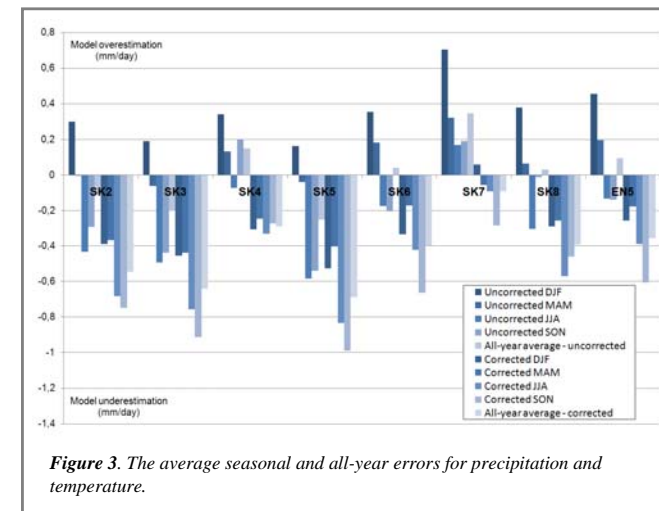


Figure 3. The average seasonal and all-year errors for precipitation and temperature.

Results 2

- MIKE SHE/SW ET: For the modeled period Apr 2009-Apr 2010 results were generally satisfactory for both observed and HIRHAM data simulations with correlation coefficients in the range 0.70 to 0.80 and Nash-sutcliffe coefficients in the range 0.43 to 0.62 validated against latent and sensible heat flux (Figure 4).

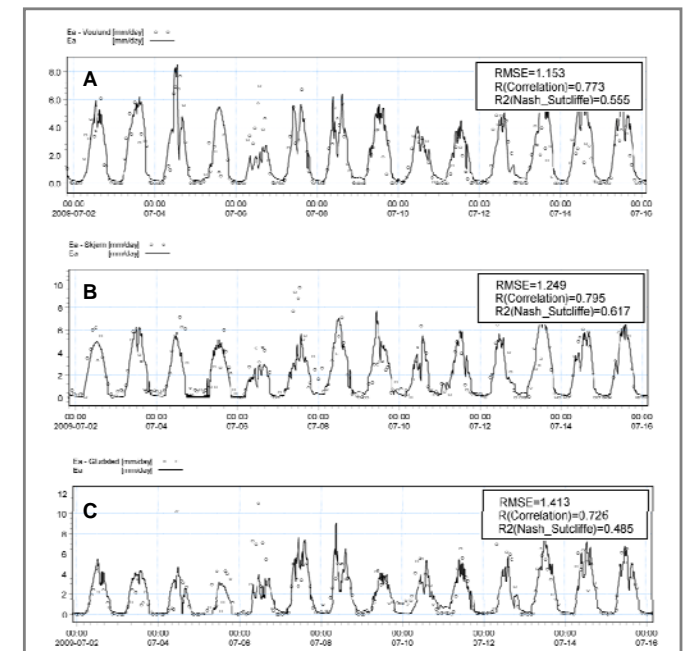


Figure 4. MIKE SHE/SW ET simulated actual evapotranspiration (Ea) at the three sites for the period 2-16 July 2009 with observed data as input. A) Agriculture, B) Meadow and C) Forest.

Main conclusions

- Domain size proved more important to HIRHAM outputs than resolution (tested between 5.5 and 12km).
- Placement of study site within domain is highly important.
- MIKE SHE/SW ET performs well in simulating sensible and latent heat fluxes.

Acknowledgments

For help in the process Søren H. Rasmussen, Philippe Lucas-Picher, Martin Stendel, Ole B. Christensen, Fredrik Boberg, Sara M. Lerer and Simon Stisen are acknowledged.

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