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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*).

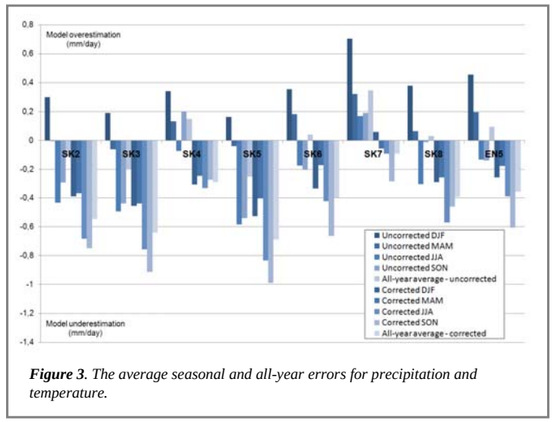

Figure 3. *The average seasonal and all-year errors for precipitation and temperature.*

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*).

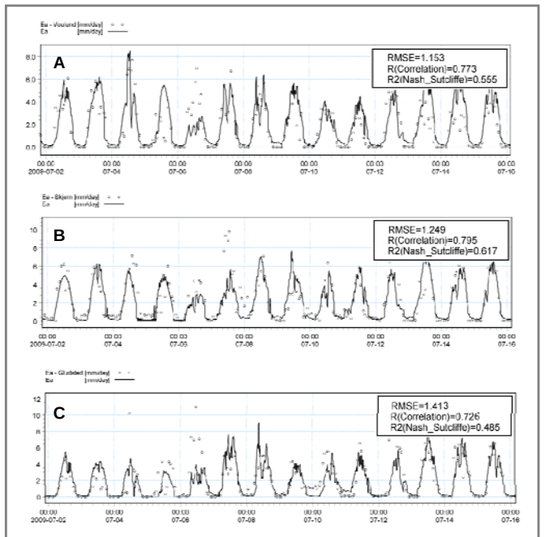

Figure 4. *MIKE SHE/SW ET simulated actual evapotranspiration (Ea) at the three sites for the period 2-16 July 2009 with observed data as input. A) Agriculture, B) Meadow and C) Forest.*

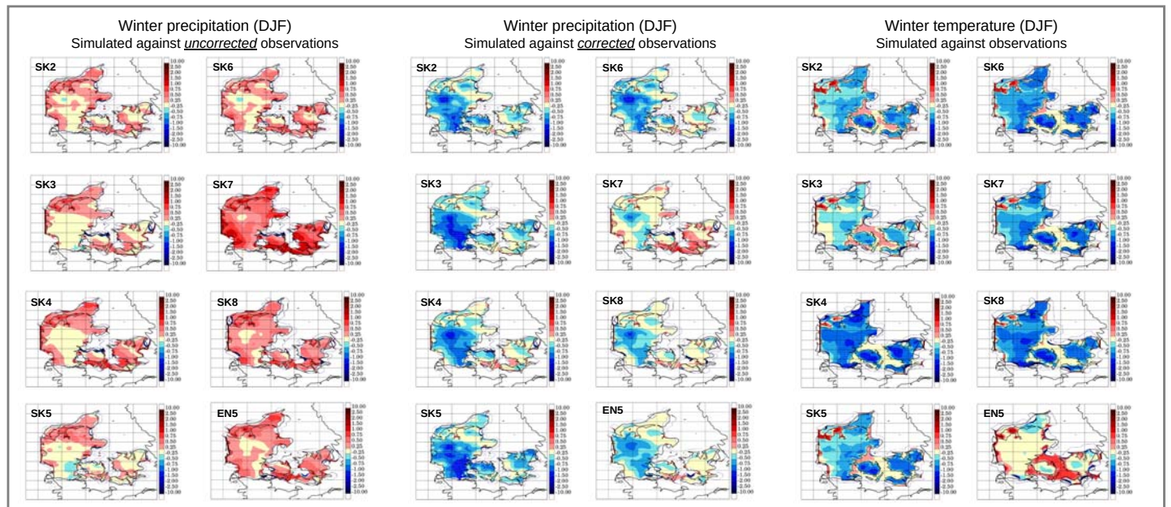

Figure 2. *Errormaps from the 8 model runs with observations Subtracted from simulations. Only winter results are shown.*

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.

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 perfomes well in simulating sensible and latent heat fluxes .

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