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.

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.

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).

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).

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.

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