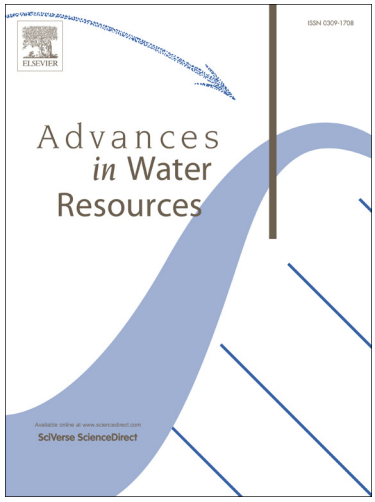
Accepted Manuscript



Embedding complex hydrology in the regional climate system – dynamic coupling across different modelling domains

Michael Butts, Martin Drews, Morten A.D. Larsen, Sara Lerer, Søren H. Rasmussen, Jesper Grooss, Jesper Overgaard, Jens C. Refsgaard, Ole B. Christensen, Jens H. Christensen

PII: S0309-1708(14)00187-0
DOI: http://dx.doi.org/10.1016/j.advwatres.2014.09.004
Reference: ADWR 2267

To appear in: *Advances in Water Resources*

Received Date: 20 October 2013
Revised Date: 9 September 2014
Accepted Date: 9 September 2014

Please cite this article as: Butts, M., Drews, M., Larsen, M.A.D., Lerer, S., Rasmussen, S.H., Grooss, J., Overgaard, J., Refsgaard, J.C., Christensen, O.B., Christensen, J.H., Embedding complex hydrology in the regional climate system – dynamic coupling across different modelling domains, *Advances in Water Resources* (2014), doi: http://dx.doi.org/10.1016/j.advwatres.2014.09.004

Embedding complex hydrology in the regional climate system – dynamic coupling across different modelling domains

Michael Butts [a*], Martin Drews [b,e], Morten A.D. Larsen [c], Sara Lerer [a,f], Søren H. Rasmussen [b,g], Jesper Grooss [a], Jesper Overgaard [a], Jens C. Refsgaard [d], Ole B. Christensen [b], Jens H. Christensen [b].

[a] *DHI, Agern Alle 5, DK 2970, Hoersholm, Denmark, Tel +45 45169200, mib@dhigroup.com, jgr@dhigroup.com, jov@dhigroup.com*
[b] *Danish Meteorological Institute, Lyngbyvej 100, DK 2100 Copenhagen, Denmark, obc@dmi.dk, jhc@dmi.dk*
[c] *University of Copenhagen, Øster Voldgade 10, DK 1350 Copenhagen, Denmark, ml@geo.ku.dk*
[d] *Geological Survey of Denmark and Greenland (GEUS), Øster Voldgade 10, DK1350 Copenhagen K, Denmark, jcr@geus.dk*
[e] *Now at Technical University of Denmark, Frederiksborgvej 399, DK 4000 Roskilde, Denmark, mard@dtu.dk*
[f] *Now at Technical University of Denmark, DTU Miljø, DK 2800 Kgs. Lyngby, Denmark, smrl@env.dtu.dk*
[g] *Now at EnviDan, Fuglebækvej 1A, DK 2770 Kastrup, Denmark, shr@envidan.dk*

[*] Corresponding author Tel: +45 45169200, Direct: +45 45169272, mib@dhigroup.com

Abstract

To improve our understanding of the impacts of feedback between the atmosphere and the terrestrial water cycle including groundwater and to improve the integration of water resource management modelling for climate adaption we have developed a dynamically coupled climate-hydrological modelling system. The OpenMI modelling interface is used to couple a comprehensive hydrological modelling system, MIKE SHE running on personal computers, and a regional climate modelling system, HIRHAM running on a high performance computing platform. The coupled model enables two-way interaction between the atmosphere and the groundwater via the land surface and can represent the lateral movement of water in both the surface and subsurface and their interactions, not normally accounted for in climate models. Meso-scale processes are important for climate in general and rainfall in particular. Hydrological impacts are assessed at the catchment scale, the most important scale for water management. Feedback between groundwater, the land surface and the atmosphere occurs across a range of scales. Recognising this, the coupling was developed to allow dynamic exchange of water and energy at the catchment scale embedded within a larger meso-scale modelling domain. We present the coupling methodology used and describe the challenges in representing the exchanges between models and across scales. The coupled model is applied to one-way and two-way coupled simulations for a managed groundwater-dominated catchment, the Skjern River, Denmark. These coupled model simulations are evaluated against field observations and then compared with uncoupled climate and hydrological model simulations. Exploratory simulations show significant differences, particularly in the summer for precipitation and evapotranspiration the coupled model including groundwater and the RCM where groundwater is neglected. However, the resulting differences in the net precipitation and the catchment runoff in this groundwater dominated catchment were small. The need for further decadal scale simulations to understand the differences and insensitivity is highlighted.

Keywords: climate change, water resources management, dynamic model coupling, groundwater-atmosphere interaction, atmospheric feedback, adaptation