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Insights in time dependent cross compartment sensitivities from ensemble simulations with the fully coupled subsurface-land surface-atmosphere model TerrSysMP

Bernd Schalge (1), Jehan Rihani (2), Barbara Haese (3), Gabriele Baroni (4,5), Daniel Erdal (6), Vincent Haefliger (1), Natascha Lange (7), Insa Neuweiler (7), Harrie-Jan Hendricks-Franssen (8,9), Gernot Geppert (10), Felix Ament (10), Stefan Kollet (8,9), Olaf Cirpka (6), Pablo Saavedra (1), Xujun Han (8), Sabine Attinger (4), Harald Kunstmann (3,11), Harry Vereecken (8,9), and Clemens Simmer (1)

(1) University of Bonn, Meteorological Institute, Bonn, Germany (bschalge@uni-bonn.de), (2) University of Cologne, Mahtematical Institute, Cologne, Germany, (3) University of Augsburg, Institut fuer Geographie, Augsburg, Germany, (4) Helmholtz-Center for Environmental Research, Leipzig, Germany , (5) University of Potsdam, Institute of Earth and Envirenmental Science, Potsdam, Germany, (6) University of Tuebingen, Center for Applied Geoscience, Tuebingen, Germany, (7) Leibniz University Hannover, Institut fuer Stroemungsmechanik und Umweltphysik im Bauwesen, Hannover, Germany, (8) Forschungszentrum Juelich GmbH, Agrosphere (IBG-3), Juelich, Germany, (9) Centre for High-Performance Scientific Computing (HPSC-TerrSys), Geoverbund ABC/J, Juelich, Germany, (10) University of Hamburg, Meteorological Insititute, Hamburg, Germany, (11) Karlsruhe Institute of Technology (KIT), Institute of Meteorology and Climate Research (IMK-IFU), Garmish-Partenkirchen, Germany

Currently, an integrated approach to simulating the earth system is evolving where several compartment models are coupled to achieve the best possible physically consistent representation. We used the model TerrSysMP, which fully couples subsurface, land surface and atmosphere, in a synthetic study that mimicked the Neckar catchment in Southern Germany. A virtual reality run at a high resolution of 400m for the land surface and subsurface and 1.1km for the atmosphere was made. Ensemble runs at a lower resolution (800m for the land surface and subsurface) were also made. The ensemble was generated by varying soil and vegetation parameters and lateral atmospheric forcing among the different ensemble members in a systematic way. It was found that the ensemble runs deviated for some variables and some time periods largely from the virtual reality reference run (the reference run was not covered by the ensemble), which could be related to the different model resolutions. This was for example the case for river discharge in the summer. We also analyzed the spread of model states as function of time and found clear relations between the spread and the time of the year and weather conditions. For example, the ensemble spread of latent heat flux related to uncertain soil parameters was larger under dry soil conditions than under wet soil conditions. Another example is that the ensemble spread of atmospheric states was more influenced by uncertain soil and vegetation parameters under conditions of low air pressure gradients (in summer) than under conditions with larger air pressure gradients in winter. The analysis of the ensemble of fully coupled model simulations provided valuable insights in the dynamics of land-atmosphere feedbacks which we will further highlight in the presentation.