Investigating the Role of Lateral Water Transport in Modulating Land Surface- Atmosphere Interactions in Southern Great Plains

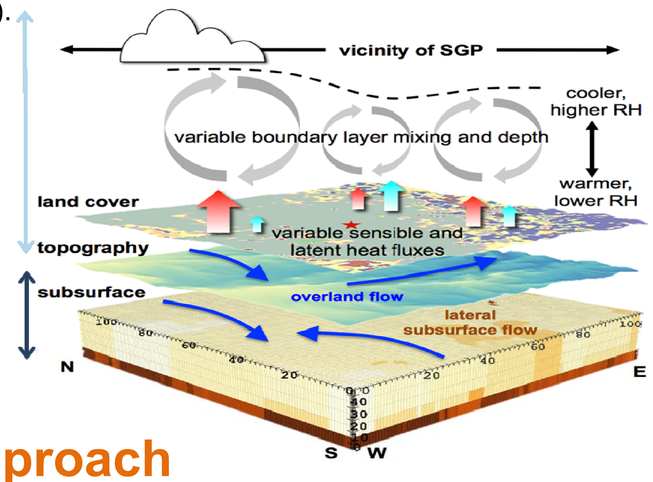
Maoyi Huang, Larry Berg, Heng Xiao

Pacific Northwest NATIONAL LABORATORY

Proudly Operated by Battelle Since 1965

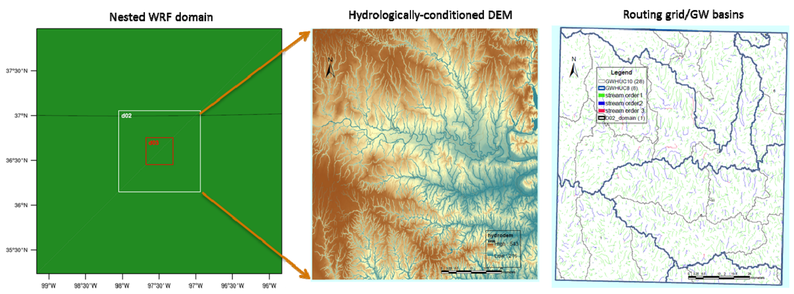
Introduction

- The potential influence of the land surface on the atmosphere raises the question of whether a more detailed representation of land processes in numerical atmospheric models, for example, terrestrial hydrology and vegetation dynamics, would significantly alter our simulations of surface fluxes, the structure of the boundary layer, and the initiation of convective clouds.
- Recent progress in integrated models have enabled scientific explorations of interactions and feedback mechanisms in the aquifer-soil-vegetation-atmosphere continuum using a holistic and physically based approach.
- In this study, we aim to use an integrated model to explore such complex interactions over the Southern Great Plains (SGP).



Approach

- Offline simulations of WRF-hydro 4.0 beta over a 100 km by 100 km domain centered Southern Great Plains (SGP) site, representative of a one-degree box used in current generation general circulation models.
- The domain is discretized into 300m for water and energy simulations in the vertical direction; The lateral routing of overland and river flow is computed at 100 m resolution.
- Different model structures were tested to evaluate the importance of hydrologic processes.



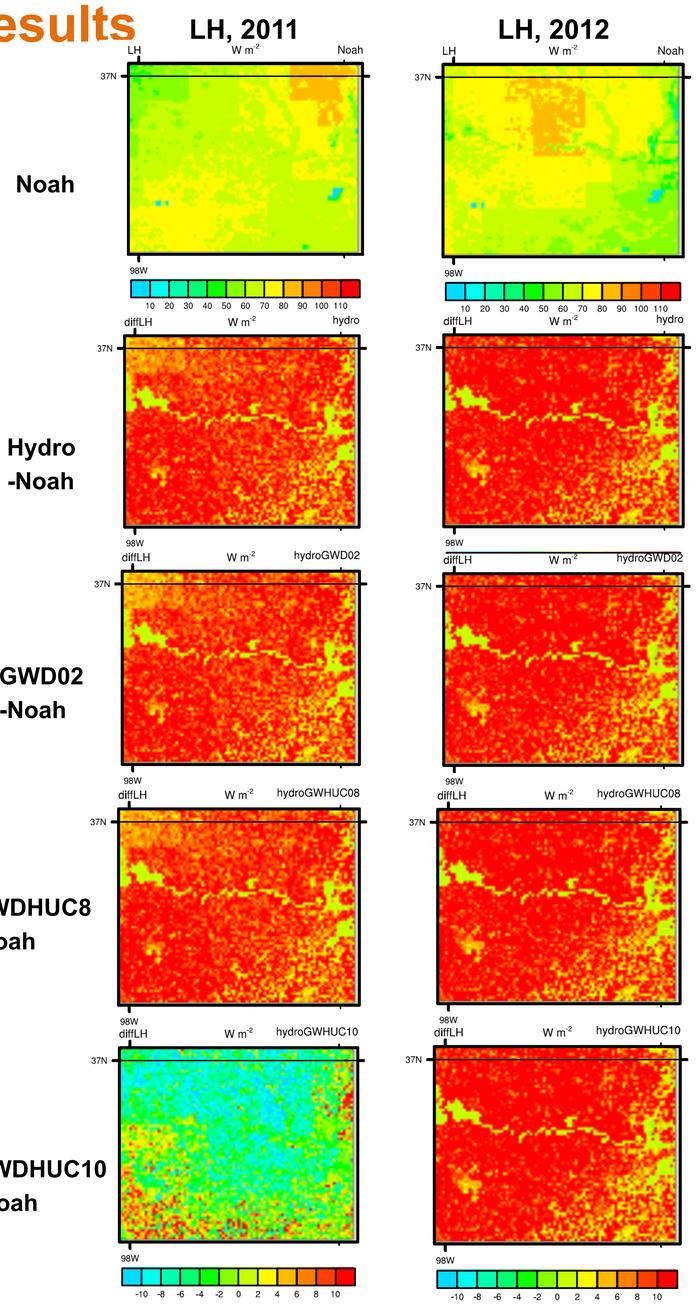
Xiao et al., Poster

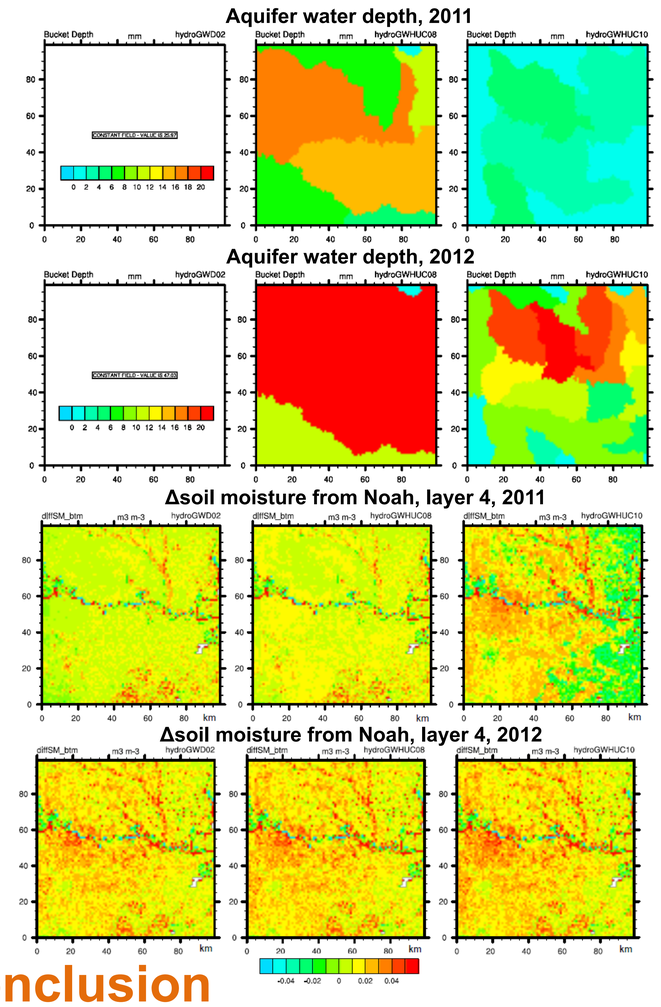
Numerical experiments

- Driven by meteorological forcing from the North American Land Data Assimilation System (NLDAS) for 2011 and 2012;
- Spun up by recycling 2011 forcing for two years.

Experiment	Noah	hydro	GWD02	GWHUC8	GWHUC10
Terrain Routing	no	yes	yes	yes	yes
Unconfined aquifer	no	no	1	8	28

Results





Conclusion

Conceptualizations of Lateral hydrologic processes have profound impacts on simulated surface energy budget:

- Lateral flow routing enhances soil moisture availability over SGP in general, by transporting water down the hillslope;
- Assumptions on sizes and connectivity of groundwater aquifers could alter the picture. The aquifers could serve as sinks for extra soil water percolation, or as sources for replenishing soil moisture through capillary rise, depending on the hydrometeorologic condition;

Future work

- Benchmark model simulated hydrologic components against observations (surface energy fluxes, streamflow, soil moisture) available at SGP;
- Assess model parametric uncertainties to determine the best model configuration;
- Perform fully coupled simulations to quantify impact of aquifer-soil-vegetation-atmosphere interactions.

Contact: maoyi.huang@pnnl.gov

www.pnnl.gov

U.S. DEPARTMENT OF ENERGY

ASR Atmospheric System Research

ARM CLIMATE RESEARCH FACILITY