Hyper-resolution aquifer parameterization: estimating aquifer thickness, vertical structure, and conductivity for North-America

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Motivation
Groundwater is an important part of the freshwater cycle. Groundwater basins help to sustain river flow during times of drought, while surface water basins support river systems. Also, groundwater is the world’s largest accessible freshwater resource and is critically important for irrigations for global food security.

Despite the importance of groundwater, most global-scale hydrological models do not include a groundwater flow component. The main reason for this omission is the lack of consistent hydrological information at the global scale. This information includes estimates of aquifer thickness, vertical structure, and conductivity. A new high-resolution parameterization is needed to better estimate groundwater dynamics and specific yield, and to especially needed when moving from fine resolutions when groundwater flow between grid-cells can be more accurately represented.

Objective
To provide current aquifer parameterization spatial resolution and to develop a framework to include local available data in global scale estimates.

Methods
- Estimate aquifer thickness and vertical structure at hyper-resolution (250 m x 250 m) for North America by applying previously published methods (3,4) and including local information on spatial and vertical distribution.
- Test the new parameterization hydrologically, focusing on a smaller test area, and evaluate results against observed data in order to make recommendations for stepping forward in large-scale hyper-resolution hydrological modeling.

Results: Hyper-resolution aquifer map
- Estimated aquifer thickness of the top layer, and total aquifer thickness.
- Isolines of total aquifer thickness indicate areas with elevated values in the shallower aquifer layers and lower conductivity values.
- Aquifer thickness is estimated to be finer than any other layer at depth. Data is then compared with the shrinkage of the top layer at depth in the model.

Results: Sensitivity analysis
- Simulated water table depths at the four different resolutions using the Hyper-resolution model.
- Sensitivity analysis indicates that water table depths can be compared with the model.

Conclusions
- Methane-water interaction with higher resolution and vertical resolution, and including local parameterization on spatial and vertical distribution.
- The methods used in this study are relatively simple and can be easily expanded to data poor regions of the world.
- This study showed the importance of realistic aquifer parameterization at higher resolutions, and thereby the need for robust hydrological data at larger scales.

References