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River-groundwater interactions at the regional scale: evidence from surface stations and satellite observations and a new parameterization in the Community Land Model.

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Groundwater is an important component of the hydrological cycle. It is included in many land surface models to provide a lower boundary condition for soil moisture, which in turn plays a key role in all the land-vegetation-atmosphere interactions and in particular in the surface energy budget that determines surface temperature. Land surface models resolve the vertical moisture and heat fluxes in the vadose zone, but traditionally neglect the contribution of lateral hydrological processes (e.g. the role of rivers) to groundwater.
Through the analysis of observed soil moisture from the Mesonet (Oklahoma Mesoscale Network) stations in Oklahoma (US) and land surface temperature derived from MODIS on Terra and Aqua satellites, we show evidence that the regional scale soil moisture and temperature pattern are affected by the lateral stream flows. This is demonstrated on the basis of simulations from a land surface model (i.e. the Community Land Model – CLM, version 3.5) that does not account for lateral flows. It is shown that the model cannot reproduce the observed soil moisture and surface temperature spatial patterns, and that the underlying mechanism can be explained by stream-groundwater interactions.
Specifically, we implement a parameterization of this mechanism in the TOPMODEL based runoff generation approach used in CLM. The modified model exhibits ability to reproduce considerable fraction of the soil moisture and surface temperature spatial variabilities that relate to the river distribution at regional scale. The CLM with the new stream-groundwater interaction parameterization is used to evaluate impacts of the lateral hydrological processes on water cycle parameters and the surface energy budget at regional scale.