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Hydrology and Earth System Sciences Discussions

Interactive comment on "Shallow groundwater effect on land surface temperature and surface energy balance under bare soil conditions: modeling and description" *by* F. Alkhaier et al.

Anonymous Referee #1

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Review of Shallow groundwater effect on land surface temperature and surface energy balance under bare soil conditions: Modeling and description.

This paper presents a simulation study on the effect of groundwater table depth on soil surface temperature. The simulation study shows convincingly that shallow groundwater does indeed affect surface temperatures so that the groundwater depth may be inferred from remote sensing of soil surface temperature. In the study, it is brought forward that soil moisture is a key variable for interpreting soil surface temperature. The effect of the groundwater table on soil surface temperature is therefore an indirect

effect since the groundwater table depth has an influence on the soil moisture content at the soil surface. Besides groundwater table depth, there are also other parameters and variables that influence soil moisture and its spatial pattern. For instance, soil texture and soil hydraulic properties, lateral runoff, but also soil management. Especially soil management may play an important role since soil tillage may have an important impact on the capillary connectivity of the land surface with the subsoil. When this connectivity is broken, the soil surface layer acts as a capillary barrier that blocks capillary rise. This implies that the influence of these other parameters on soil moisture must first be filtered out before the signature of the groundwater table becomes visible. How important the impact of other factors and their spatial distribution are and how well these patterns can be filtered out, will be crucial for using soil surface temperatures to estimate groundwater table depths. I think that the paper can be improved largely if these aspects were considered. The authors could for instance illustrate the effect of soil texture on soil surface temperature and the effect of a tilled soil surface layer on soil surface temperature.

Detailed comments:

p3 ln 15: 'Furthermore, Quiel's study considered only the penetration of the daily temperature variation and totally neglected the yearly temperature oscillation.' From reading the paper further, it did not become clear to me how the authors would propose using yearly temperature oscillations to assess groundwater table depths or what would be the advantage of using yearly oscillation.

p4 ln 11 and following: Therefore, these studies did not provide a complete prospective of shallow groundwater effect. The temporal patterns of that effect on surface temperature, net radiation, and surface heat fluxes (latent, sensible and ground heat fluxes) were not portrayed.

In the work of Kollet and Maxwell, exactly these aspects were considered.

Kollet, S.J., and R.M. Maxwell. 2008. Capturing the influence of groundwater dynamics

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on land surface processes using an integrated, distributed watershed model. Water Resour. Res. 44:W02402.doi: 10.1029/2007wr006004. Maxwell, R.M., F.K. Chow, and S.J. Kollet. 2007. The groundwater-land-surface-atmosphere connection: Soil moisture effects on the atmospheric boundary layer in fully-coupled simulations. Adv. Water Resour. 30:2447-2466.doi: 10.1016/j.advwatres.2007.05.018. Maxwell, R.M., and S.J. Kollet. 2008. Interdependence of groundwater dynamics and land-energy feedbacks under climate change. Nat. Geosci. 1:665-669.doi: doi:10.1038/ngeo315

p 6 ln26-27: Lout was not defined and Eq. 2 represents the relation between albedo and soil moisture.

p 8 ln 15-16: How are the roughness lengths for momentum, zm, and heat, zH, transfer defined?

p 9 Eq. 12: The formulation of the soil thermal conductivity seems different from what is normally considered in text books of soil physics. The hydraulic conductivity depends in a non-linear way on the volumetric soil water content whereas in Eq. 12, a linear relation is proposed (unless the weighting factors are a function of the soil water content).

p 10 Eq. 17: I propose including Kelvin's equation linking air humidity to water pressure head.

p11 ln 17: Could a reference to GEM be given?

p11 Soil profile information: Could the spatial discretization that was used to simulate the profile be given?

p12 ln 9: Is there a rationale behind choosing the upper 2.5 cm of the soil profile to represent the surface conditions? Why isn't simply the surface temperature that represents the skin temperature used?

p 13 table 2 and discussion on the ground heat flux. On the long term, shouldn't the net ground heat flux be equal to zero for both the GWP and NOGWP? I think

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that the authors need to discuss why this net ground flux isn't equal to zero in this case. Is this caused by the fact that the weather generator did not produce years with a yearly average temperature that is exactly equal to the long term yearly average? The fact that the obtained yearly averaged ground flux is positive, is that not just by coincidence? If another series of 4 years would have been generated, couldn't it be then that a negative average ground flux was observed. Therefore, I have questions also about the statement in the conclusions section at p 17 ln 22-23: Nevertheless, the milder surface temperatures of such areas make the upshot of ground heat flux smaller in the long run, i.e. the yearly average.

p 14 ln 30-31: I do not observe in Figure 5c that the net radiation for the GWP is lower than that of NOGWP during night. During night, both are negative but net radiation from NOGWP is more negative than net radiation from GWP.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 8, 8639, 2011.