WAGENINGEN UNIVERSITY
ENVIRONMENTAL SCIENCES

KNMI

Water Watch

Testing of modifications in the land surface scheme HTESSEL

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Dry summers

The operational version of the Royal Netherlands Meteorological Institute (KNMI) Regional Climate Model RACMO2 tends to predict too high temperatures for dry summers in certain regions of Europe (e.g. Hungary and the Netherlands). The main reason is the desiccation of the soil during summer when transport of moist air from the Atlantic is blocked (Fig. 1). Soil moisture availability in atmospheric models controls the partitioning of the net radiation at the surface into the fluxes of latent heat (Q_{le}), sensible heat (Q_h) and heat into soil (Q_g). For that reason soil moisture is considered a key parameter to climate models.

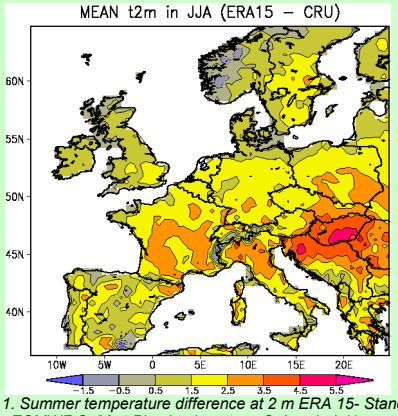

Figure 1. Summer temperature difference at 2 m ERA 15- Standard Version ECMWF Cy23r4 Physics (courtesy G. Lenderink)

Sensitivity analysis and modifications

Based on a sensitivity analysis using the detailed 1D soil-water-atmosphere-plant model SWAP (Fig. 2), priorities have been formulated regarding the improvement of the current land surface scheme of RACMO2, referred to as HTESSEL. This scheme is also used in the ECMWF model. HTESSEL has been revised including flexible numerical discretization, a soil depth according to the FAO soil map, a modification of root water uptake parameters, and the effect of shallow groundwater (Fig. 3).

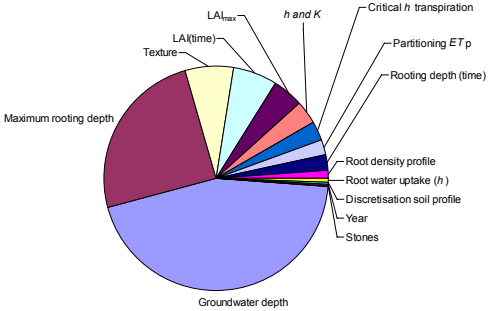

Figure 2. Estimation of effect of individual variables on different water balance terms, such as evapotranspiration, analyzed for two locations in Europe with different climates.

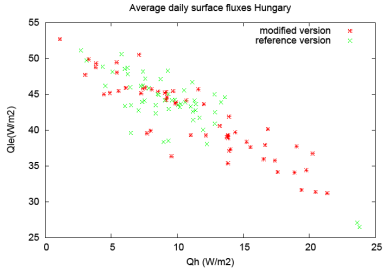

Figure 5. Sensible heat (Q_h) and latent heat (Q_{le}) fluxes for modified and reference version of the Land Surface Scheme applied to the region as given in Fig.4.

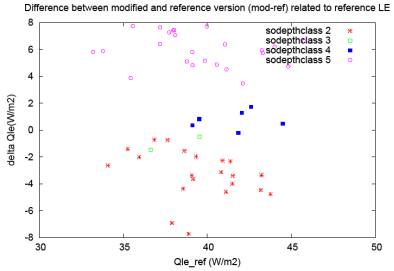

Figure 6. Effect of soil depth on the latent heat flux (Q_{le}). On the x-axis the latent heat flux of the reference scheme is projected. The difference between Q_{le} of the modified version and the reference version is projected on the y-axis. Soil depth classes are (1) 20 cm, (2) 40 cm, (3) 60 cm, (4) 80 cm, (5)> 120 cm

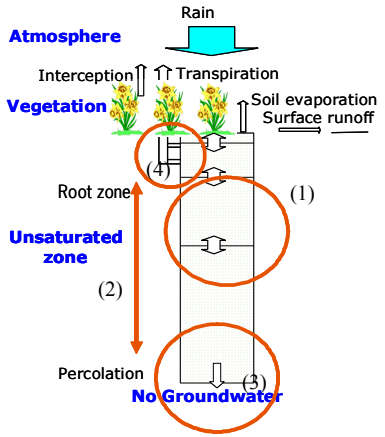

Figure 3. Modifications to the land surface scheme: (1) discretisation from 4 to n soil layers, (2) variable soil depth, (3), groundwater effect included, (4) root water uptake function changed

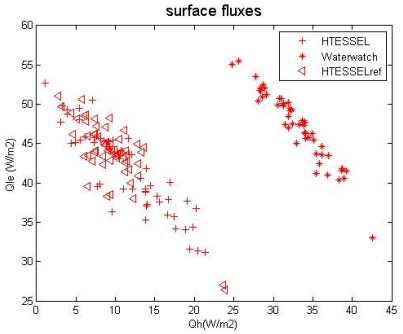

*Figure 7. Preliminary results: Surface fluxes of satellite (Water Watch) and Land Surface Scheme driven by the meteo taken from a run with the reference version of RACMO2. HTESSEL is the modified version, HTESSEL$_{ref}$, the reference version. The differences in fluxes are caused by differences in net radiation. See also '**Ongoing work**'.*

Testing region: Hungary

Model modifications were tested offline for a (dry) region in Hungary (Fig 4) against field observations from a tower (Bugac) and against fluxes derived from satellite images using the Surface Energy Balance Algorithm for Land (SEBAL). The meteorological forcing is taken from a one-year RACMO2-run nested in ECMWF operational analyses.

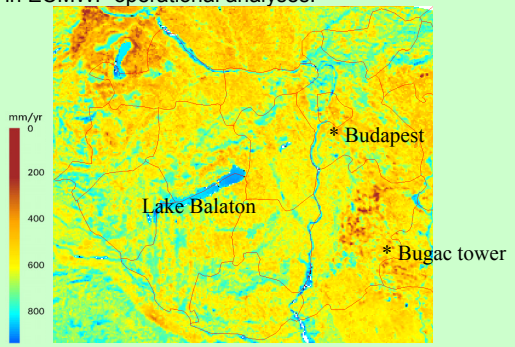

Figure 4. Annual Q_{le} (mm/y) for western Hungary based on remotely sensed data using SEBAL routine.

Results

Sensitivity analysis shows that the modifications to the land surface scheme have an enlarging effect on the Q_{le} variability (Fig. 5). Especially the variable soil depth class contributes to the enlarged Q_{le} variability (Fig. 6).

Ongoing work

The comparison between the model results and the remotely obtained latent heat fluxes is ongoing. Preliminary results show a significant difference between the net radiation of RACMO and the satellite data (Fig. 7). We presently discuss the best evaluation strategy for the modifications in the Land Surface Scheme in an offline mode. Ideas are welcome!

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