Supplement S2

December 15, 2021

1 Sensitivity of soil layer thickness

1.1 Soil moisture profiles

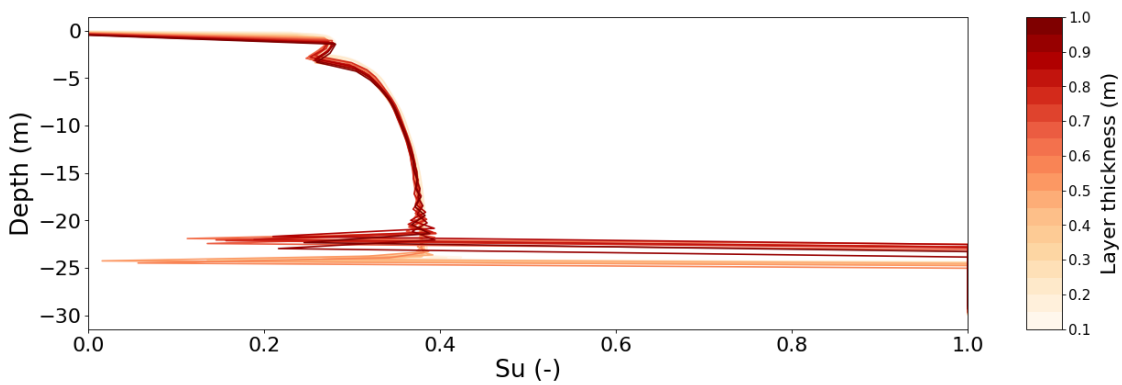

Figure S2.1. *Average soil moisture profiles for different soil layer thicknesses at Howard Springs. Generally, results remain rather similar for the upper layers, especially for the lower values of layer thickness. Jumps in the lowest layers can be observed, starting from a depth of 40m.*

1.2 Differences in profiles

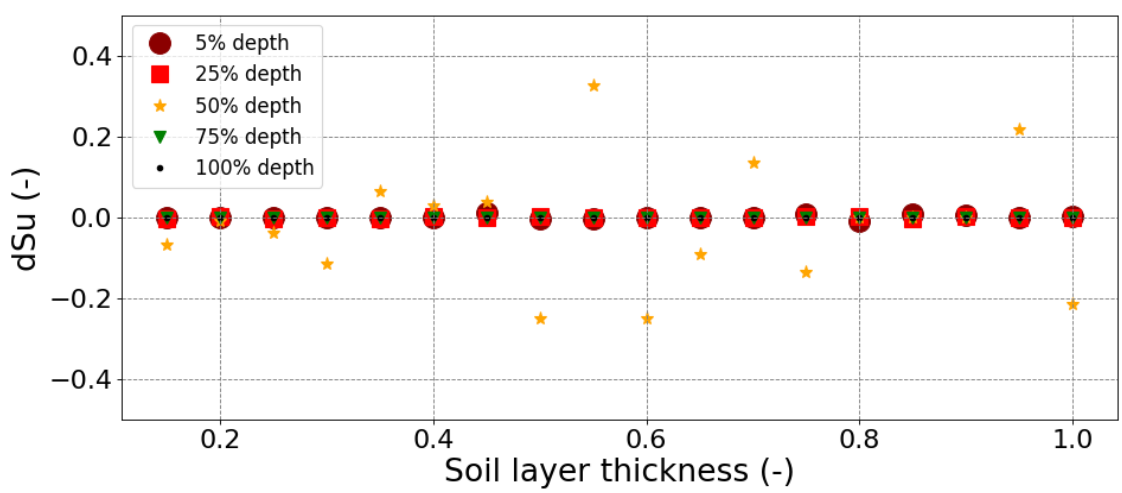

Figure S2.2. *Differences at different depths (5%, 25%, 50%, 75% and 95% depth) between the average soil moisture for a specific soil layer thickness and the subsequent soil layer thickness (e.g. the difference between 0.25m and 0.30m soil layer thickness at 50% depth) at Howard Springs. From soil layers smaller then 0.5 m, the differences at the difference depths become very small, and are negligble from 0.25m.*

1.3 Relative errors mean annual fluxes

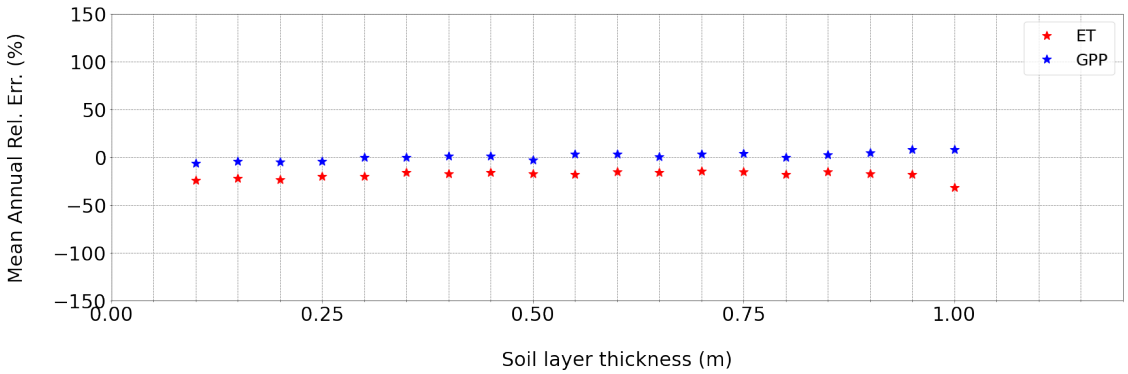

Figure S2.3. *The errors between observations from the flux towers and modelled fluxes of evaporation (red) and assimilation (blue) at Howard Springs. The errors are generally in the same order of magnitude, only for a value 0.90 m a large error is observed, also due to numerical instabilities.*

1.4 Timeseries

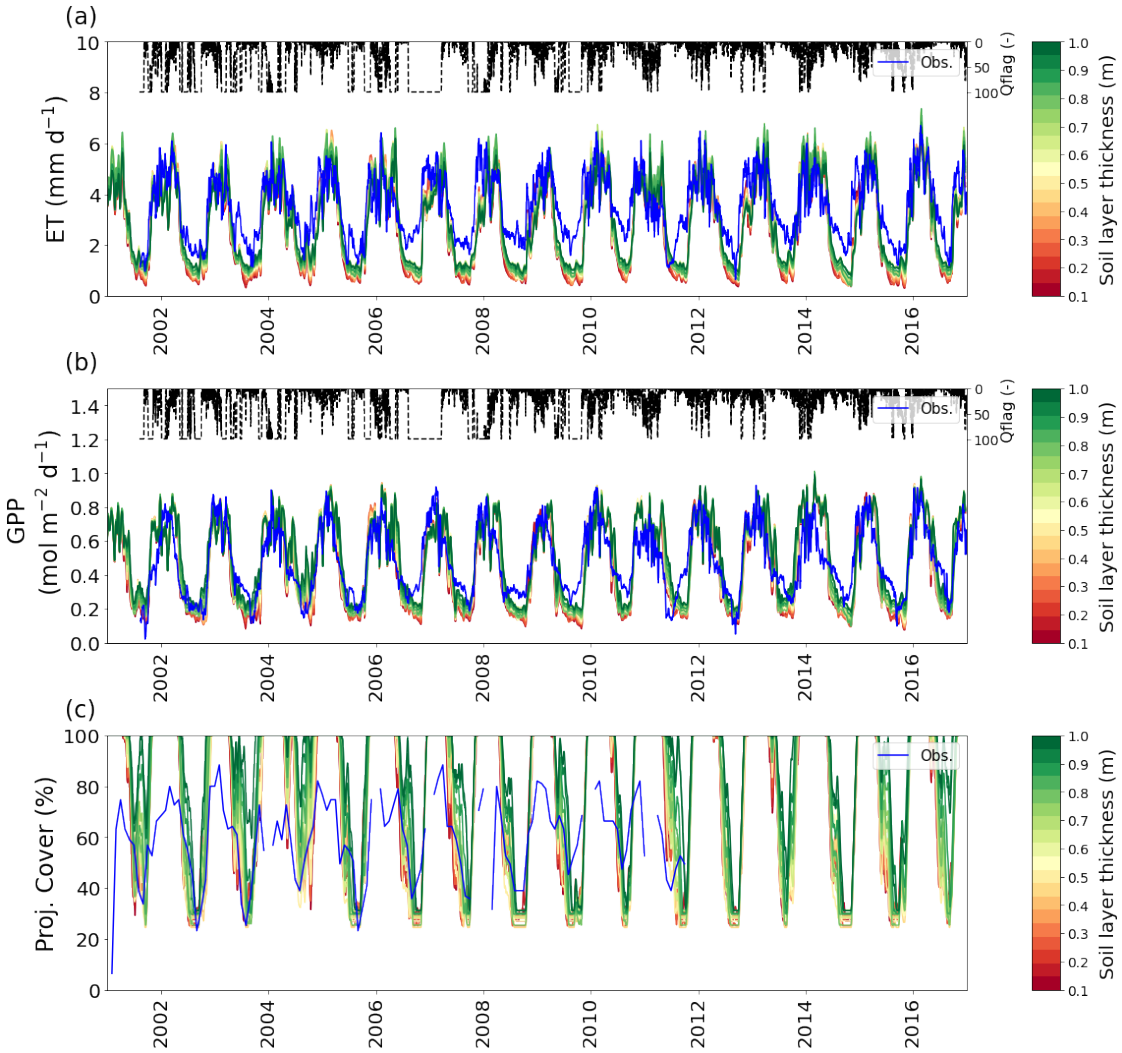

Figure S2.4. *VOM-results for different values of the soil layer thickness (color scale) for Howard Springs from 2001-2016 (subset from 1980-2016), with a) the evapo-transpiration (ET), with flux tower observations in blue b) gross primary productivity (GPP), with flux tower observations in blue and c) projective cover, with the observed fraction of vegetation cover based on fPAR-data (Donohue et al, 2008) in blue. Modelled ET and GPP are smoothed with a moving average of 7 days.*

1.5 Parameter values

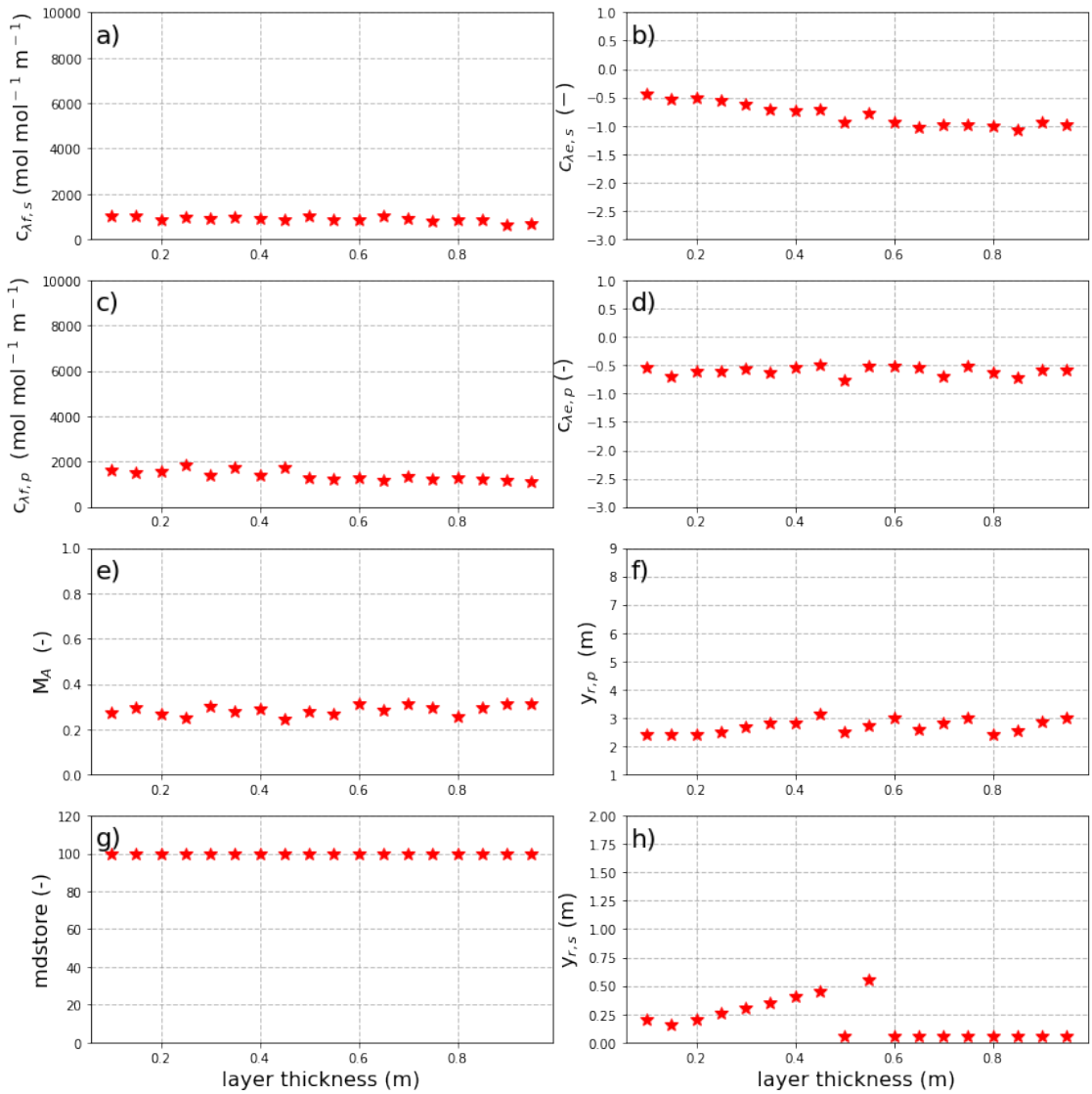

Figure S2.5. *Optimal vegetation parameters for different soil layer thickness, for a) and b) the two parameters $c_{\lambda f,s}$ and $c_{\lambda e,s}$ effecting the water use for perennial vegetation, c) and d) the two parameters $c_{\lambda f,p}$ and $c_{\lambda e,p}$ effecting the water use for seasonal vegetation, e) vegetation cover of the perennial vegetation $M_{A,p}$, f) the rooting depth for the perennial vegetation $y_{r,p}$ and g) the plant water storage (fixed) and h) the rooting depth for the seasonal vegetation $y_{r,s}$. Generally, the parameters are not very sensitive to the soil layer thickness, only the rooting depth for grasses drops to the minimum value when the soil layer thickness is set to values larger than 0.5 m.*

2 Fixed parameters for different soil thickness

The optimal parameters from the SCE-runs for 0.5 m depth were used to run the VOM also for other soil layers thicknesses. Theoretically, the results should remain exactly the same, but this

will not happen due to the different soil discretizations.

2.1 Soil moisture profiles

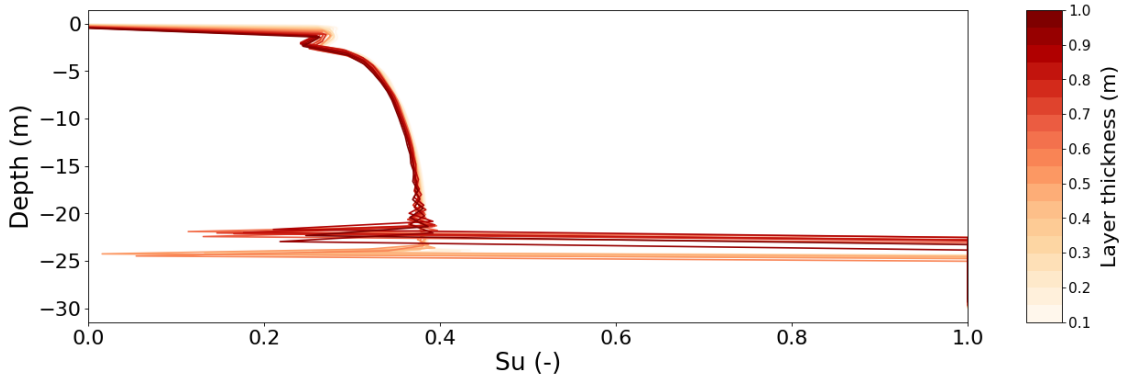

Figure S2.6. *Average soil moisture profiles for different soil layer thicknesses at Howard Springs, but with the same vegetation parameters, determined with a soil layer thickness of 0.5 m. The profiles are similar to the profiles in Figure S2.1, and differences can be related to different outcomes of the SCE-optimization. Only for the lower layers differences start to increase again between the model runs with different soil layer thickness.*

2.2 Differences in profiles

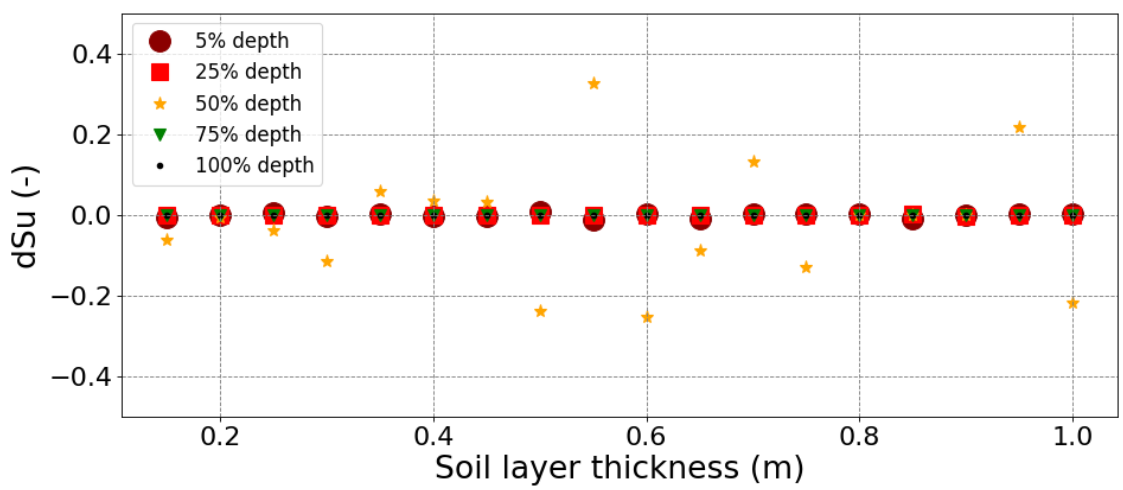

Figure S2.7. *Differences at different depths (5%, 25%, 50%, 75% and 95% depth) between the average soil moisture for a specific soil layer thickness and the subsequent soil layer thickness (e.g. the difference between 0.25 m and 0.30 m soil layer thickness at 50% depth) for the same vegetation parameters (determined with a soil layer thickness of 0.5 m) at Howard Springs. From*

soil layers smaller then 0.5 m, the differences at the difference depths become very small. Results for a soil layer of 0.90m thickness are not shown due to numerical instabilities.

2.3 Timeseries

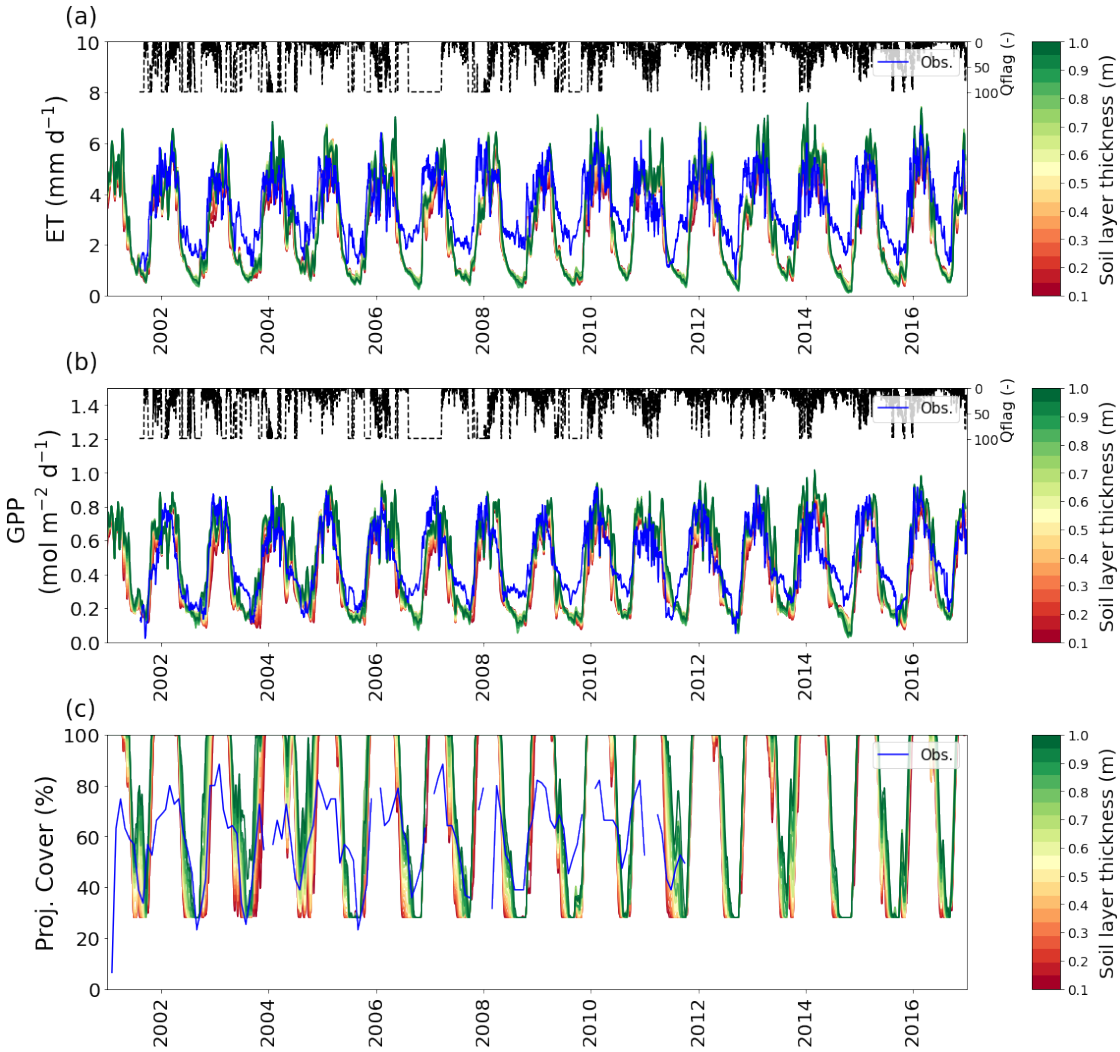

Figure S2.8. *VOM-results for different values of the soil layer thickness (color scale) with the same vegetation parameters for Howard Springs from 2001-2016 (subset from 1980-2016), with a) the evapo-transpiration (ET), with flux tower observations in blue b) gross primary productivity (GPP), with flux tower observations in blue and c) projective cover, with the observed fraction of vegetation cover based on fPAR-data (Donohue et al, 2008) in blue. Modelled ET and GPP are smoothed with a moving average of 7 days. Results for a soil layer of 0.90m thickness are not shown due to numerical instabilities.*