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# Optimum parameter and state estimation of the land and biosphere

For the 2014/2015 period, PastLand aimed to investigate the suitability of Transformation of Algorithms in Fortran (TAF) as superior method for soil moisture initialization. Furthermore, a soil moisture initialization experiment was conducted to learn about the life time of soil moisture perturbations in an Earth System Model (ESM).

## Soil moisture initialization experiment

In order to evaluate whether the initialization of soil moisture has the potential to improve the prediction skill of coupled climate models at seasonal to decadal time scales, an elaborated AMIP-type experiment was conducted. The experiment design considered soil moisture initialization in different seasons and years, and yields information about the life-time (memory) of extreme yet realistic soil moisture perturbations. Our analyses were focused on root zone soil moisture (RSM) as it comprises the part of the soil that directly interacts with the atmosphere via bare soil evaporation and transpiration. We found that RSM memory differs not only spatially but also depends on the time of initialization. Long memory up to one year is evident mostly for dry soil moisture regimes, after heavy precipitation periods or prior to snow covered conditions. Short memory below two weeks prevails in wet soil moisture regimes and prior to distinct precipitation periods or snow melt. Furthermore, RSM perturbations affect other land surface states, e.g. soil temperature and leaf carbon content, and even induce anomalies with specific memory in these variables. Especially for deep layer soil temperature these anomalies can last up to several years. As long as RSM memory is evident, we found that anomalies occur periodically in other land surface states whenever climate conditions allow for interactions between that state and RSM. Additionally, anomaly recurrence is visible for RSM itself. This recurrence is related to the thickness of the soil layer below the root zone and can affect RSM for several years. From our findings we conclude that soil moisture initialization has the potential to improve the predictive skill of climate models on seasonal scales and beyond. However, a sophisticated, multi-layered soil hydrology scheme is necessary, to allow for the interactions between RSM and the deep soil layer reservoir.

Further information about this study are published in Stacke and Hagemann (2015).

## Revision of planned simulations

While being a superior method which does not violate the water and energy balances, TAF has the shortcoming that it cannot utilize the most recent observation data for the initialization of predictions but enforces a certain time lag. Thus, a comparison of an ideal prediction ensemble (which is not possible with TAF) with the realistic prediction ensemble (which can be done with TAF) was planned to learn about the decrease in prediction skill due to the enforced time lag. However, this experiment became infeasible due to severe cuts in our requested computing time.

Instead, we utilized our granted resources for different simulations dedicated to improve process representation on the land surface. Furthermore, an ensemble simulation using optimized soil parameters derived from different satellite data sets is currently prepared and will be conducted soon. Please note, that this ensemble is still part of PastLand I which was extended until the end of the 2015.

# References

Stacke, T. and S. Hagemann (2015). Life time of soil moisture perturbations in a coupled land-atmosphere simulation. *Earth Syst. Dynam. Discuss.* 6(2), pp. 1743–1788. ISSN: 2190-4995. DOI: 10.5194/esdd-6-1743-2015 (cit. on p. 1).