JSBACH performance in comparison to observations and other models

T. Raddatz[1], V. Brovkin[1], D. Dalmonech[2], A. Loew[1], S. Hagemann[1], C. Reick[1], S. Zaehle[2]

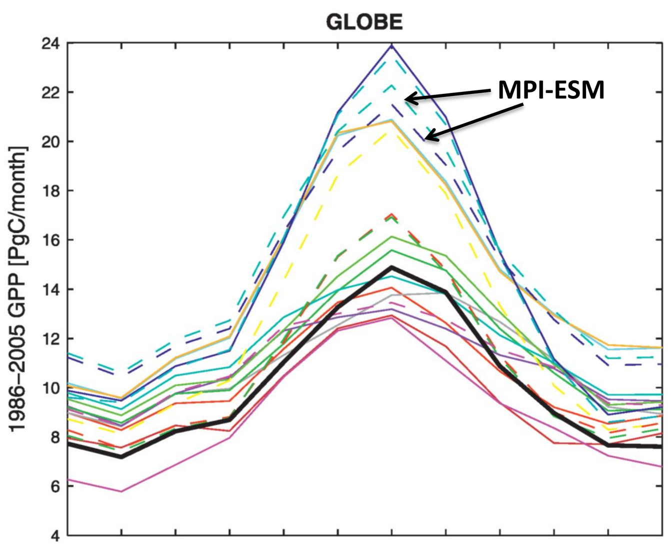
[1]MPI for Meteorology, Hamburg; [2]MPI for Biogeochemistry, Jena

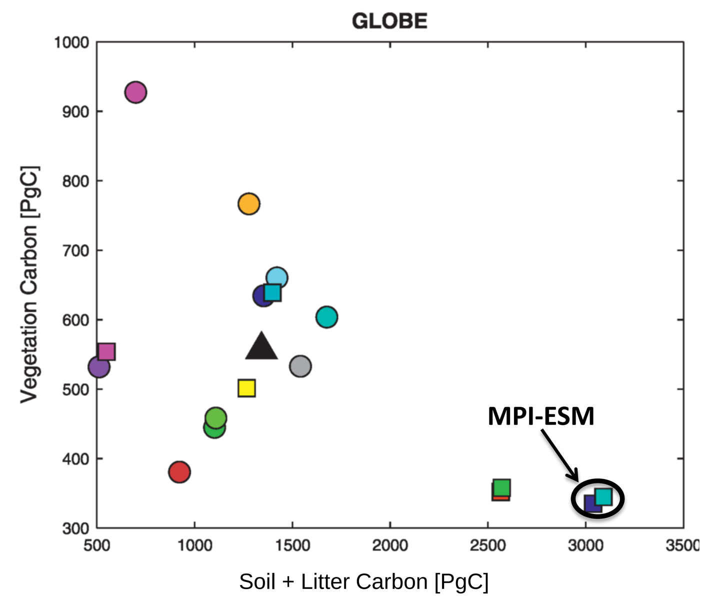
introduction

A comprehensive evaluation of JSBACH is difficult as observational constraints to some key results of global land surface models exhibit a large and not well quantified uncertainty (e.g. large scale amount of soil carbon). Furthermore, some land surface processes, that are important for feedbacks in the Earth System (e.g. strength of snow-masking by boreal forest) cannot be observed directly. Therefore, we aim at understanding how biases arise on the process level. We work in collaboration with the MPI for Biogeochemistry on a set of standard tests that are robust with respect to uncertainties in observations. Here we present some examples based on CMIP5 results.

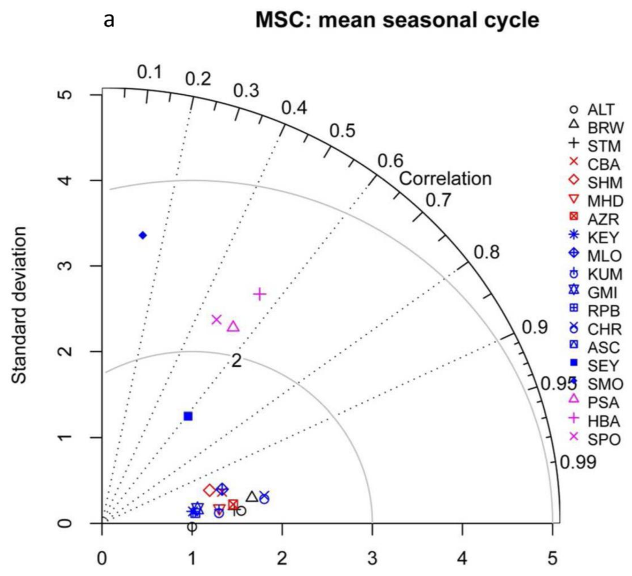
carbon

JSBACH vegetation productivity is high as water stress is underestimated with a single-layer soil hydrology. Additionally, soil and litter decomposition rates are under-constrained on short (< 1 year) and long (> 10 years) time scales. This results in large soil carbon stocks and an overestimated amplitude of the seasonal cycle in atmospheric CO2 concentration.





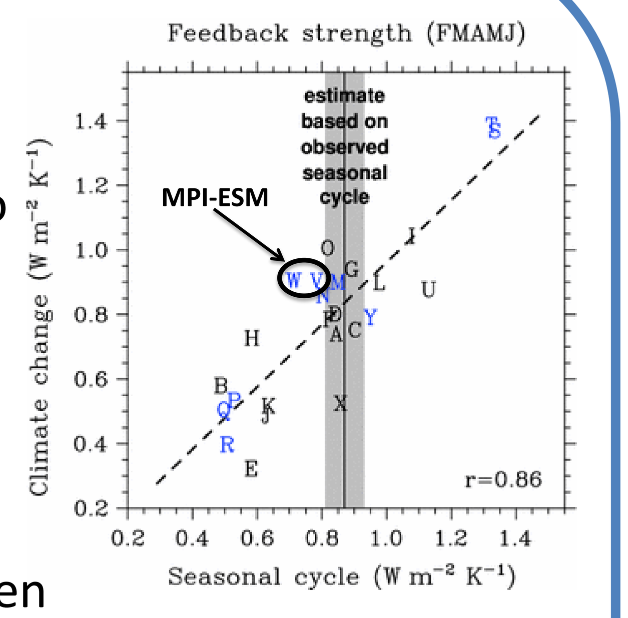
Anav et al., 2013, J Climate



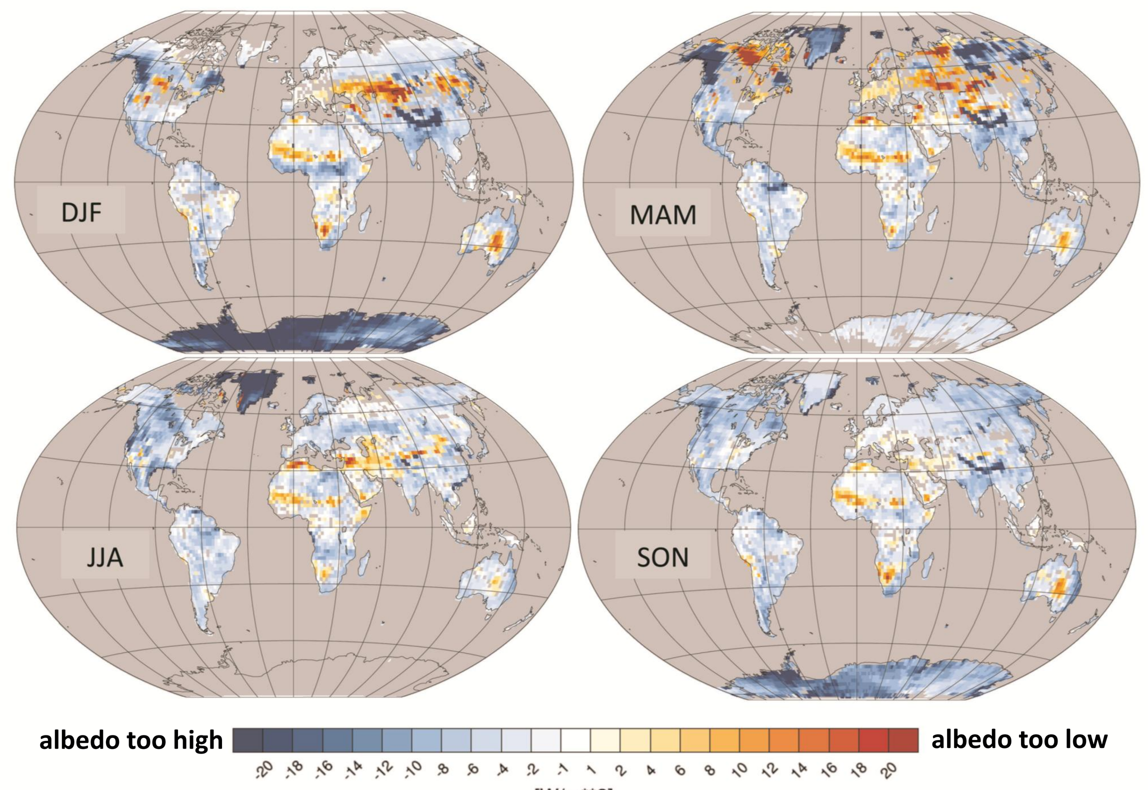
Dalmonech & Zaehle, 2013, Biogeosciences

albedo

The albedo of glaciers is too high, which leads to a cold bias over Greenland and Antarctica in the respective summer season. Furthermore, the snow-masking by the summergreen East Siberian larch forest is too weak, whereas the albedo of snow covered open land is too low. This contributes to a slightly under-estimated global snow-albedo feedback.

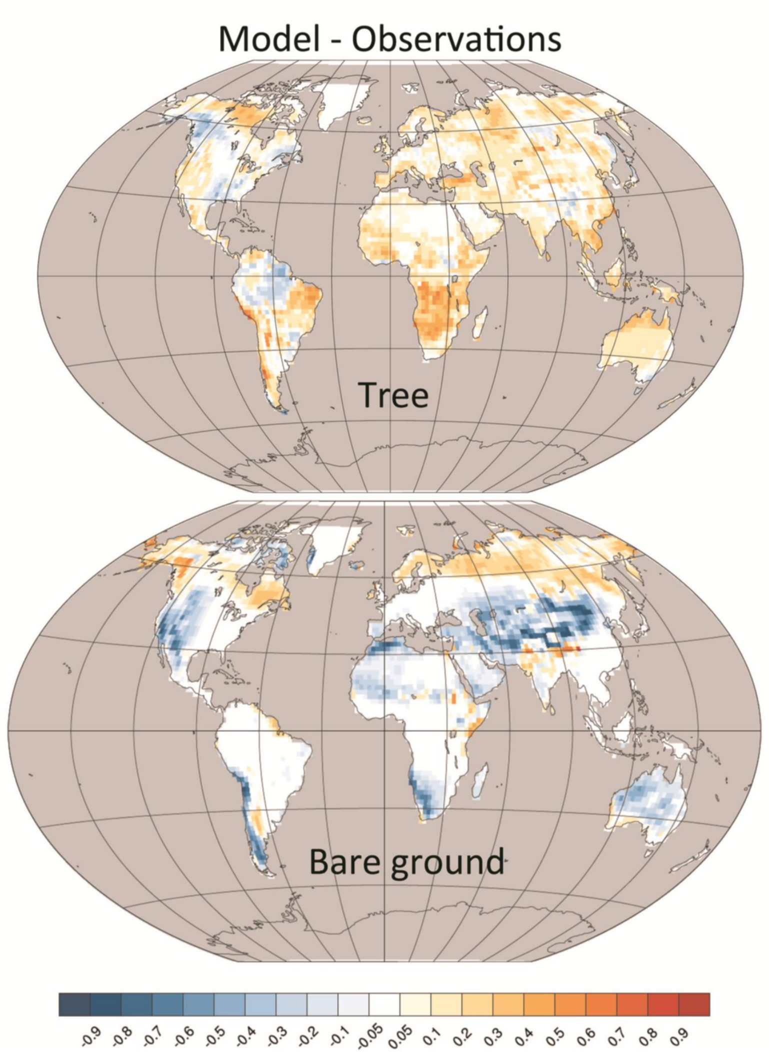


Qu & Hall, 2014, Clim Dyn



Brovkin et al., 2013, J Adv Model Earth Syst

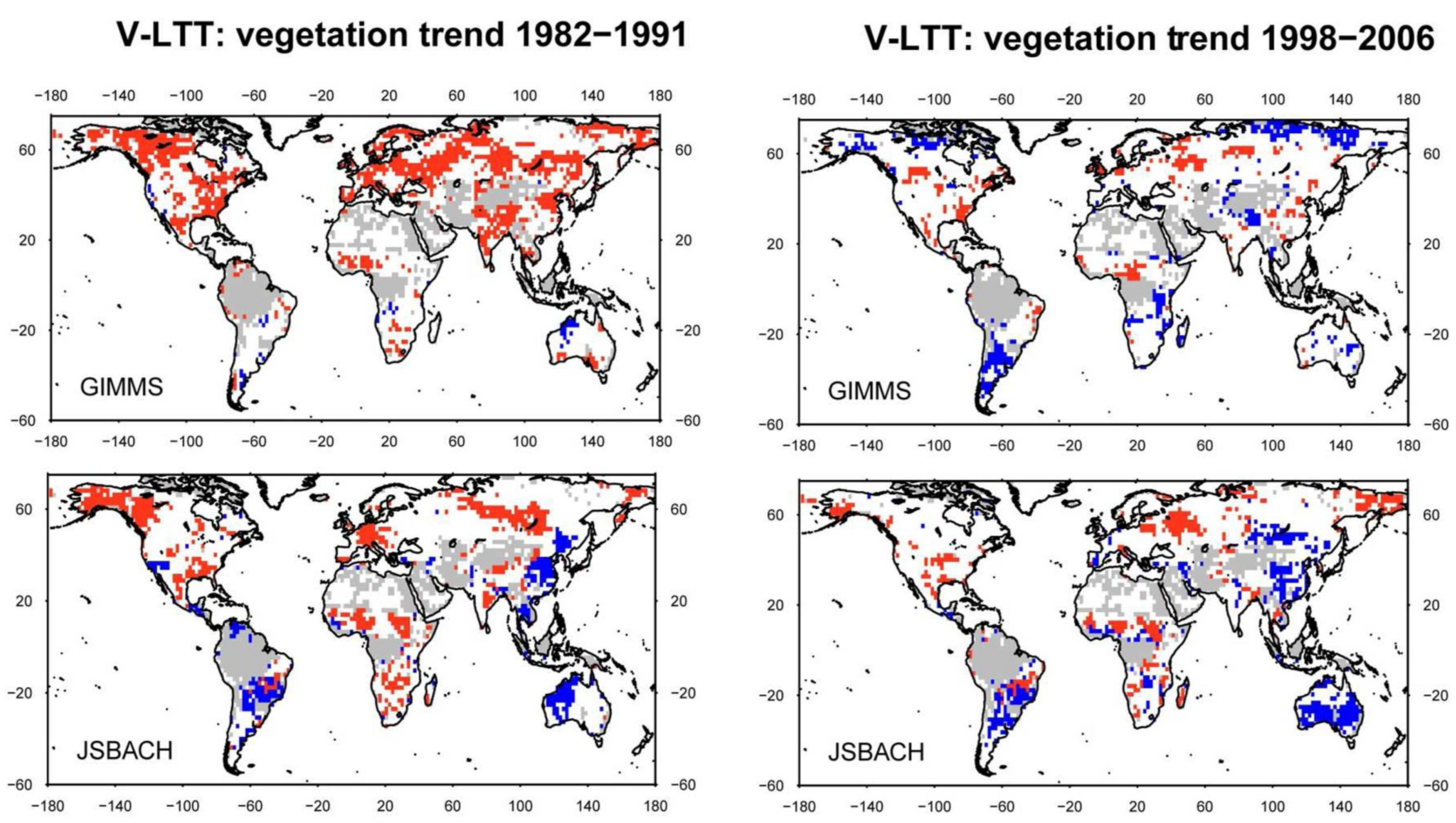
vegetation



Brovkin et al., 2013, J Adv Model Earth Syst

In CMIP5 simulations the dynamic vegetation module of JSBACH compiles a reasonable vegetation distribution. Nevertheless, it simulates too high tree cover, in particular in drylands. Also, vegetation cover is overestimated in water limited regions, whereas it is underestimated in the boreal zone.

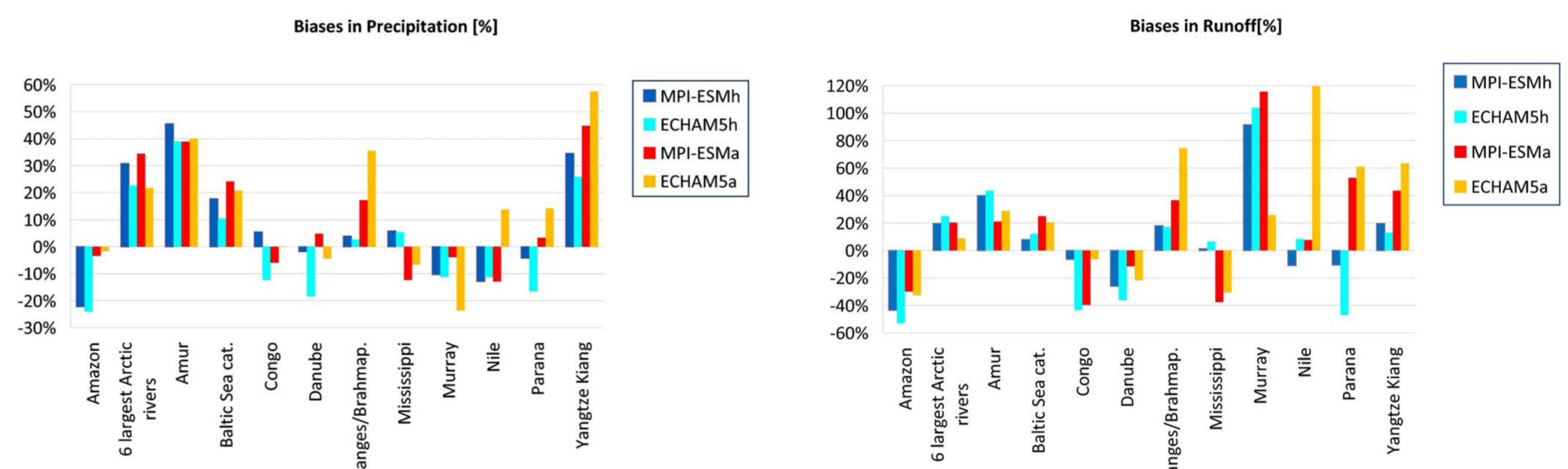
The sign of the decadal trend in vegetation greenness is determined at each grid point by a Mann-Kendall test. The phenology module of JSBACH can largely reproduce these observed trend patterns shown in GIMMS data.



Dalmonech & Zaehle, 2013, Biogeosciences

hydrology

Although MPI-ESM includes a dynamic vegetation scheme, which typically aggravates regional climate biases, precipitation and runoff at the catchment scale are at the same bias level as in ECHAM5 simulations with prescribed vegetation distribution. The current version of MPI-ESM includes a multi-layer soil hydrology (Hagemann & Stacke, 2014), which improves the seasonality of evaporation.



Hagemann et al., 2013, J Adv Model Earth Syst

conclusions: lessons from CMIP5

Many studies were published in the context of CMIP5 providing a comprehensive evaluation of Earth System models (including JSBACH) with datasets based on observations. By accounting for this information and by performing additional analysis we gained useful guidance for the development of JSBACH:

- The soil carbon model employed so far is too simplistic and structurally not suited to be constrained by observations. Therefore, the new default soil carbon model is YASSO (see poster by Goll et al., PB-G-1711) with decomposition rates inferred from measurements, which results in much better patterns of soil carbon storages.
- Now a multi-layer soil model leads to higher water stress for plants in arid regions, which lowers global GPP and improves the distribution of deserts.
- Adjustment of parameters was sufficient to remove biases in the calculation of land surface albedo (high glacier albedo, weak snow-masking).

Max-Planck-Institut für Meteorologie

DKRZ DEUTSCHES KLIMARECHENZENTRUM

MAX-PLANCK-GESELLSCHAFT