EGU21-3480
https://doi.org/10.5194/egusphere-egu21-3480
EGU General Assembly 2021

Developing a climate-driven root zone water stress function for different climates and ecosystems

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Plant roots have less water available when soils have low moisture content and, consequently, limit their root-to-leaf water potential gradient to protect their xylem, which reduces H_2O and CO_2 exchanges with the atmosphere. In vegetation, hydrological and land-surface models, plant responses to reduced available water in the soil have been implemented in various ways depending on data availability, type of ecosystem, and modelling assumptions. Most models use soil water stress functions – commonly known as beta functions – to reduce transpiration and carbon assimilation, by applying a factor that reflects the soil water availability for plants. These functions usually produce reasonably satisfactory results, but rely on the information on soil properties (e.g. wilting point and field capacity) that are not widely available. On a global level, soil information is mediocre, and data uncertainty is compensated by tuning parameters that rarely represent a physiological process. We propose instead the use of a beta function derived from a mass-balance approach focused on the root zone water capacity. This method quantifies the root zone water storage by calculating the accumulated water deficit based on the balance between water influxes and effluxes, and it does not require land-cover or soil information. We assessed how our approach performs compared to those other soil water stress functions. We used global datasets, including WDFE5 and PMLv2, to extract precipitation and evapotranspiration and compute water deficit. For most vegetation types and climates our approach yielded promising results. Worst results were found for some (semi-)arid sites due to the overestimation of the water deficit. We aim to deliver an approach that can be easily applied on global scales.