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Assimilating SMOS soil moisture observations into GLEAM to improve terrestrial evaporation estimates over continental Australia

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Terrestrial evaporation (ET) is an essential component of the climate system that links the water, energy and carbon cycles. Despite the crucial importance of ET for climate, it is still one of the most uncertain components of the (global) hydrological cycle. During the last decades, much effort has been put to develop and improve techniques for measuring the evaporative flux from the land surface in the field. However, these in situ techniques are prone to several errors and, more importantly, only provide relevant information at a very local scale. As a consequence, evaporative models have been designed to derive ET from large-scale satellite data. In this study, GLEAM (Global Land Evaporation – Amsterdam Methodology) is used to simulate evaporation fields over continental Australia. GLEAM consists of a set of simple equations driven by remotely-sensed observations in order to estimate the different components of ET (e.g., transpiration, interception loss, soil evaporation and sublimation). The methodology calculates a multiplicative evaporative stress factor that converts Priestley and Taylor's potential into actual evaporation. Unlike in most other ET-dedicated global models, the stress factor in GLEAM is derived as a function of soil moisture (simulated using a precipitation-driven soil water balance model) and observations of vegetation optical depth (VOD, retrieved from microwave remote sensing).

This study investigates the merits of using SMOS soil moisture (SM) and VOD retrievals in GLEAM. The Level 3 SMOS SM retrievals are assimilated into the soil water module using a simple Newtonian Nudging approach. Prior to the assimilation, SM observations are rescaled to the climatology of the model using a standard CDF-matching approach. Several assimilation experiments are conducted to show the efficiency of the assimilation scheme to improve ET estimates over continental Australia. Simulations are validated using both in situ observations of soil moisture and ET-measurements from flux towers. The performance of the model run with assimilation of SMOS SM and VOD is compared against an assimilation experiment using AMSR-E SM and VOD. Results indicate that GLEAM estimates of ET and soil moisture dynamics are realistic over Australia, and that SMOS soil moisture has the potential to improve the model's performance at different spatial scales. Results from this study contribute to a better understanding of the magnitude and dynamics of terrestrial ET over continental Australia and their dependency to soil water availability.