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Combining Optical/Microwave remote sensing data (multi-resolution) and surface-atmosphere exchange modeling for mapping evapotranspiration

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A precise estimate of ET is fundamental for determining the crop water needs and subsequently for optimizing water management practices and irrigation regimes. Soil moisture and land surface temperature are the essential components of the hydrological cycle, especially, for controlling soil evaporation, plant transpiration and partition rainwater into infiltration and runoff. In semi-arid regions, a knowledge of the root zone soil moisture represents an important stake for monitoring water resources, because it contributes at a time in detecting the periods of water stress and anticipating the water need of the cultures. For that purpose, the microwave-derived near-surface soil moisture and thermal-derived land surface temperature are integrated simultaneously within a new energy balance model. In practice, both information types are used to retrieve the main parameters of soil evaporation via the soil resistance (rss) and plant transpiration via the Priestly Taylor coefficient (αPT). A two-source energy balance model named TSEB-SM is first derived from the TSEB formalism by explicitly representing soil evaporation using the empirical parameters (a_rss, b_rss) of the relationship between r_ss and soil surface moisture. For the fraction cover fc =<0.5, the model calibration consists of inverting r_ss at Terra and Aqua overpass times. When fc>0.5, the calibration consists in estimating αPT at the daily scale. The procedure is applied over a rainfed wheat field in the Tensift basin, central Morocco. The field was seeded during three wheat seasons (September 2014-Juin 2015 (S1), September 2016-Juin 2017 (S2), and October 2017-May 2018 (S3)), while it had remained under bare soil conditions during the 2015-2016 (B1) agricultural season. The mean retrieved values of soil resistance calculated for the entire study period using satellite data are (7.32, 4.58), which are relatively close to those estimated in Sellers et al. (1992) (8.2, 4.3). The calibrated daily αPT for S1 and S2 ranges between 0 and 1.38, and is mainly dependent on the rainfall distribution along the agricultural season. Moreover, the retrieved αPT shows similar dynamics when using in-situ and satellite data, with a relative error of about 11 and 19 % for S1 and S2 respectively. The calibrated daily αPT for S3 remains at a mostly constant value ($\sim$0.7) throughout the study period, and a significant relative difference of about 34% is obtained when comparing results using satellite and in-situ data. For all four seasons TSEB tends to significantly overestimate latent heat fluxes. The overall mean bias is 119, 181, 94 and 128 W/m2 for S1, B1, S2 and S3 respectively, when using satellite data. The errors are much reduced when using TSEB-SM witha mean bias of 39, 62, 4 and 7 W/m2 for S1, B1, S2 and S3 respectively. The analysis of the retrieved (arss, brss) and αPT variabilities using satellite data indicate the robustness of the approach, which combines microwave and optical/thermal data to retrieve a water stress indicator at the daily time scale.