Major water balance variables Estimation, soil moisture and evaporation time series, using X-band SAR moisture products

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During the last decades, the rain scarcity in front of long periods of drought especially in semi-arid regions, have a negative impact on the available water resources. In addition, a major part of the intercepted water is lost either by evaporation from the soil back to the atmosphere or by drainage, deep percolation and subsurface runoff. Therefore, knowledge and calculating the water fluxes within the soil-atmosphere system is a major issue for the improvement of water use efficiency. Many studies have been carried out to quantify these fluxes by developing various tools which estimate the soil water regime and may consequently the sustainable management of natural resources (Simmoneaux et al., 2008; Zhang et al., 2010; Sutanto et al., 2012 and Saadi et al., 2015). The amount of water stored in the soil is a crucial parameter that can be used as inputs to simulate surface evaporation fluxes and vertical water circulation as surface water capillarity movements and underground percolation. Great progress has been made in the recent decades aiming at developing soil moisture (SM) retrieval techniques by using Imaging Synthetic Aperture Radar (SAR) sensors. Several algorithms have been developed to retrieve SM from radar data (Zribi et al., 2011 Baghdadi et al., 2008 and Gorrab et al., 2015). The assimilation of SM SAR products into hydrological balance models is one exciting aspect that offers an opportunity to improve hydrologic model forecasts.

In this context, the present study highlighted the capability of the high resolution TerraSAR-X SM products in reproducing real conditions of SM variations. We developed a soil hydrological model MHYSAN (Modelisation de Bilan HYdrique des Sols Agricoles Nus) over agricultural bare soil in Central Tunisia (North Africa). The MHYSAN tool computes surface evaporation and SM time series to simulate water balance in Central Tunisia. The accuracy of the MHYSAN tool was assessed at both regional scale (calibration based on ground continuous Thetaprobe measurements) and plot scale (calibration based on SAR moisture products with very high resolution). Two principal approaches were considered in this research. Firstly, the MHYSAN model was calibrated using a network of seven continous thetaprobe measurements to estimate surface water balance at regional scale. Results gave after calibration an average Nash efficiency which indicates that the MHYSAN model could reproduce correctly SM profiles observed by the major permanent probes at two depths. On the second approach, the MHYSAN model was calibrated for a short period using seven SAR (TerraSAR-X) SM outputs with very high resolution. After considering only three similar texture classes between permanent probes and reference fields (fine, intermediate and coarse groups), validation of the proposed approach was carried out for a long temporal resolution using continuous thetaprobe measurements. These results reveal a good model performance and show that high accurate SM estimations can be achieved after calibrating a bare soil hydrological balance model from SAR moisture products. Overall, the two different approaches reproduce the soil moisture temporal variations well and are in good agreement with modeled MHYSAN SM outputs.