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Disaggregation of MODIS land surface temperature using Sentinel-1 radar and Sentinel-2 optical data over an irrigated crop area

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The use of land surface temperature (LST) for monitoring the consumption and water status of crops requires data at fine spatial and temporal resolution. Unfortunately, the current spaceborne thermal sensors provide data at either high temporal (e.g. MODIS: Moderate Resolution Imaging Spectro-radiometer) or high spatial (e.g. Landsat-8) resolution separately. Disaggregating low spatial resolution (LR) LST data using ancillary data available at high spatio-temporal resolution could compensate the lack of high spatial resolution (HR) LST observations. Nevertheless, existing downscaling approaches do not take into account the soil water availability to explain the variability in LST at HR. In this context, a new method is developed to disaggregate kilometric MODIS LST at 100 m resolution by relying on Sentinel-1 (S-1) backscatter, which is indirectly linked to surface soil moisture and Sentinel-2 (S-2) reflectances, which characterize the green and total vegetation covers. The approach is tested over an 8 km by 8 km irrigated crop area in central Morocco (Marrakech) on the dates when S-1, S-2, and Landsat-7 or Landsat-8 acquisitions coincide with a one-day precision during the 2015-2016 growing season. The approaches are first applied to the 1 km aggregated Landsat LST as an initial step. Then, the 100 m disaggregated LST are compared to Landsat LST in three cases: no disaggregation, disaggregation using a green vegetation index (NDVI) derived from S-2 data, disaggregation using both S-2 NDVI and S-1 backscatter. When including S-2 NDVI only in the disaggregation process, the root mean square error in LST decreases from 1.87 to 1.37 ˚C and the correlation coefficient (R) increases from 0.72 to 0.94 compared to the non-disaggregated case. The new methodology including the S-1 backscatter as input to the disaggregation is found to be more slightly more robust on the available dates with a disaggregation error decreasing to 1.30 ˚C and an R increasing to 0.95. As a second step, these approaches will be also tested using the 1 km resolution MODIS data as input.