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Monitoring daily evapotranspiration in the Alps exploiting Sentinel-2 and meteorological data

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The lack of satellite data with high spatial resolution (<100 m) and temporal frequency (<daily) has long limited the modelling of spatially explicit evapotranspiration (ET) for supporting the management of agricultural and natural resources, especially in regions with heterogeneous land-cover and topography. The recent availability of the Sentinel family of satellites of the European Space Agency (ESA) opens new possibilities for exploiting and improving existent modelling chains. The objective of this work is to implement a process to estimate actual ET of mountain natural and agricultural ecosystems, taking advantage of the high spatial resolution of Sentinel-2. Given the absence of high resolution climate model data in the area of interest, that is located in the North-eastern Italian Alps, we rely on ground meteorological data, and combine them with Sentinel-2 and Meteosat Second Generation (MSG) satellite data, in the framework of a simplified water balance model. Firstly, we calculate daily potential ET (ETo) by the Penman-Monteith (PM) equation driven by sub-hourly meteorological data (air temperature, wind speed, air humidity) collected at the stations of the Province of Bolzano, and net radiation derived from MSG SEVIRI shortwave and longwave radiation, emissivity and albedo. We test and compare two approaches to estimate spatially distributed ETo by geostatistical interpolation methods, with the aid of a high-resolution digital elevation model: i) interpolating and downscaling meteorological parameters and then calculating ETo; ii) calculating ETo at stations with a full set of parameters, and then interpolating ETo. Secondly, we compute a water stress coefficient based on the ratio between cumulated ETo and precipitation, which represents the short-term water scarcity effect on transpiration and evaporation. Thirdly, we calculate actual ET by the classical FAO dual Kc approach, modified to be applied both over managed and unmanaged vegetated land. We separate transpiring and evaporating surfaces by an estimate of the fractional green vegetation cover derived from Sentinel-2 NDVI data, assumed constant during the five days revisit time of Sentinel-2. Finally, to assess the model, we compare ET with latent heat measured at eddy covariance towers located in areas belonging to different land-use classes. The operational implementation of this procedure can be exploited in agriculture to forecast water demand and plan irrigation, and in the management of natural resources, to design strategies to face climate changes and extremes.