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A comparison of all-weather land surface temperature products

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The Satellite Application Facility on Land Surface Analysis (LSA-SAF, http://landsaf.ipma.pt) has been providing land surface temperature (LST) estimates using SEVIRI/MSG on an operational basis since 2006. The LSA-SAF service has since been extended to provide a wide range of satellite-based quantities over land surfaces, such as emissivity, albedo, radiative fluxes, vegetation state, evapotranspiration, and fire-related variables. Being based on infra-red measurements, the SEVIRI/MSG LST product is limited to clear-sky pixels only. Several all-weather LST products have been proposed by the scientific community either based on microwave observations or using Soil-Vegetation-Atmosphere Transfer models to fill the gaps caused by clouds. The goal of this work is to provide a nearly gap-free operational all-weather LST product and compare these approaches.
In order to estimate evapotranspiration and turbulent energy fluxes, the LSA-SAF solves the surface energy budget for each SEVIRI pixel, taking into account the physical and physiological processes occurring in vegetation canopies. This task is accomplished with an adapted SVAT model, which adopts some formulations and parameters of the Tiled ECMWF Scheme for Surface Exchanges over Land (TESSEL) model operated at the European Center for Medium-range Weather Forecasts (ECMWF), and using: 1) radiative inputs also derived by LSA-SAF, which includes surface albedo, down-welling fluxes and fire radiative power; 2) a land-surface characterization obtained by combining the ECOCLIMAP database with both LSA-SAF vegetation products and the H(ydrology)-SAF snow mask; 3) meteorological fields from ECMWF forecasts interpolated to SEVIRI pixels, and 4) soil moisture derived by the H-SAF and LST from LSA-SAF. A byproduct of the SVAT model is surface skin temperature, which is needed to close the surface energy balance. The model skin temperature corresponds to the radiative temperature of the interface between soil and atmosphere, which is assumed to have no heat storage. The modelled skin temperatures are in fair agreement with LST directly estimated from SEVIRI observations. However, in contrast to LST retrievals from SEVIRI/MSG (or other infrared sensors) the SVAT model solves the energy budget equation under all-sky conditions.
The SVAT surface skin temperature is then used to fill gaps in LST fields caused by clouds. Since under cloudy conditions the direct incoming solar radiation is greatly reduced, thermal balance at the surface is more easily achieved and directional effects are also less important. Therefore, a better performance of the model skin temperature may be expected. In contrast, under clear skies the satellite LST showed to be more reliable, since the SVAT model shows biases in the daily amplitude of the skin temperature.
In the context of the GlobTemperature project (http://www.globtemperature.info/), all-weather LST datasets using AMSR-E microwave radiances were produced, which are compared here to the SVAT-based LST. Both products were validated against in situ data - particularly from Gobabeb & Farm Heimat (Namibia), and Évora (Portugal) - to show that under cloudy conditions the agreement between in-situ LST and modelled skin temperature is acceptable. Compared to the SVAT-based LST, AMSR-E LST is closer to satellite observations (level 2 product); the complementarity of the two approaches is assessed.