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Using Sentinel-3 land surface temperature to derive high resolution soil moisture estimates for desert locust management

Vivien Georgiana Stefan (1), Maria Jose Escorihuela (1), Olivier Merlin (2), Jamal Chihrane (3), Saïd Ghaout (3), and Cyril Piou (4)

(1) isardSAT, Barcelona, Spain (vivien.stefan@isardsat.cat), (2) CESBIO, Université de Toulouse, IRD, UPS, CNRS, CNES, Toulouse, France, (3) Centre National de Lutte Antiacridienne, Aït-Melloul (CNLAA), Inezgane, Agadir, Morocco, (4) UMR CBGP, Université Montpellier, CIRAD, INRA, IRD, SupAgro, Montpellier, France

High resolution soil moisture (SM) estimates are needed for various applications ranging from hydrological to agricultural. One example of applications where SM plays an important role is in the assessment of the potential habitat of desert locusts. This is particularly important over the desert area, where, if SM is high for long enough, the vegetation develops and desert locusts may reach swarm level. In this case, desert locusts might migrate in swarms and become highly dangerous for crops outside of deserts. A preventive management is needed to detect potential breeding areas and take measures before they reach swarm migration levels. SM is important because it affects vegetation growth and therefore enables their reproduction. In particular, it gives an early indication of potential nesting areas, since it precedes vegetation growth. SM estimates from remote sensing data are of particular interest since the breeding areas are extensive and it is often not feasible sending survey teams to cover this extent. However, current remote sensing SM estimates have a very low resolution, of tens of kilometers, which is far from what is needed for an effective prevention management. In this respect, DISPATCH (DISaggregation based on a Physical And Theoretical scale CHange) is an algorithm that downscales the 40 kilometers SMOS (Soil Moisture and Ocean Salinity) SM data using land surface temperature (LST) and vegetation cover data, along with a self-calibrated evaporation model. Two distinct datasets were used for the LST: from MODIS (MODerate resolution Imaging Spectroradiometer) and from the Sentinel-3A SLSTR (Sea and Land Surface Temperature Radiometer) sensor. The vegetation cover is derived from MODIS NDVI (Normalized Difference Vegetation Index). Sentinel-3A (launched on February 16th 2016) is the first of a series that will provide, among other, global LST with a revisit period of less than two days (one day in a dual constellation array) at a spatial resolution of 1 km.
A comparison is performed between the two LST products and also between the SM products derived using these two distinct LST datasets, over a period spanning July to December 2017, over an area covering the entire North of Africa (40°- 10°N, 20°W - 20°E). Preliminary results show good correspondence between the different estimates. Both follow well seasonality and are able to capture the spatial variability over the scene, detecting small water surfaces. Some discrepancies can also be observed, which could be due to different factors (radiometric resolution and/or spatial gridding). A comparison was also performed with in situ measurements over a site located in Morocco, which provides consistent results, with good correlation values and low root mean square error. Results obtained using Sentinel-3 data are encouraging and open paths to future perspectives: integrating them within a downscaling algorithm to obtain high resolution SM products at an operational level; these estimates can be further integrated within different existing desert locust early warning systems in national locust centers and at the Desert Locust Information Service within the Food and Agricultural Organization of the United Nations.