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Multi-scale approach of the surface temperature/vegetation index triangle method for estimating evapotranspiration over heterogeneous landscapes

A. de Tomás
iMdea Water Foundation, Alcalá de Henares, Madrid - Spain (alberto.detomas@imdea.org)

Alberto de Tomás(1), Héctor Nieto(2), Radoslaw Guzinski(2), Gorka Mendiguren(3), Inge Sandholt(2) and Pedro Berliner(1)

(1)iMdea Water Foundation. alberto.detomas@imdea.org; pedro.berliner@imdea.org
(2)Department of Geography and Geology. University of Copenhagen. hn@geo.ku.dk; rag@geo.ku.dk; is@geo.ku.dk
(3)IEGD-CSIC, Economy, Geography and Demographics Institute. Spanish Research Council. gorka.mendiguren@cchs.csic.es

Remote sensing has proved to be a powerful tool for estimating evapotranspiration at regional scales. Yet, the estimation accuracy not only depends on the calculation method, but also on the temporal and spatial resolution, often inversely related, of the dataset used. In order to analyse these influences, the triangle method has been tested over several satellite imagery, including MSG-SEVIRI, ENVISAT-AATSR/MERIS, NOAA-AVHRR, Landsat5-TM and Landsat7-ETM+, and compared to field site scintillometer measurements.

The triangle method assumes a triangular space formed between the surface temperature (Ts) and a vegetation index. When the edges of the triangle are estimated, the evaporative fraction (EF) is computed for all cloud-free pixels through an interpolation method, based on the Priestley-Taylor method. Once evaporative fraction maps are computed, daily evapotranspiration rates can be obtained by combining EF with the available daily net energy (Rn-G).

The highly frequent acquisitions (15 minutes) of the MSG-SEVIRI data provides the possibility of expressing Ts in the triangle method as an increase over time, by using what it is known as thermal inertia (dTs). As it includes more information on sensible heating than Ts alone, better estimates of daily evapotranspiration can be made than the ones obtained from instantaneous Ts as in helisynchronous satellites. In addition, the use of a time-difference temperature allows to minimize possible systematic errors in Ts estimation. However, due to the SEVIRI coarse resolution (3 km at nadir) it is difficult to achieve good results over scattered and heterogeneous areas.

In this work, we have compared the evaporative fraction retrieved from SEVIRI to the one from NOAA and Landsat, both with higher spatial resolution. The main hypothesis of the study is that although the high temporal resolution of SEVIRI would lead to better estimates of surface fluxes, its coarser spatial resolution could lead to greater uncertainties in fragmented and heterogeneous landscapes.

This study has been carried out during two consecutive campaigns over an experimental agricultural site near Madrid, Spain. The landscape is considered heterogeneous due to the high presence of urban areas surrounded by different types of crops. Sensible heat flux was continuously measured with a scintillometer, while a meteorological station registered the available net energy required for estimating the latent heat flux, and afterwards the evaporative fraction.

Preliminary results show good correlation between the high spatial resolution Landsat data and the ground measurements, decreasing as the resolution lowers with NOAA and SEVIRI. However, despite the coarse resolution of the latter, daily variations of surface fluxes remain well represented and further improvements are expected by using dTs instead of Ts.