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Integration of an environmental stress factor in SEBS for improving the estimation of evapotranspiration in environments under water stress

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Surface energy balance models such as SEBS assume that the influence of soil moisture and biophysical parameters on ET, are implicitly encompassed in the land surface temperature variable. This simplification may generally be suitable for environments in which the available energy constrains ET, but may prove to be inadequate for water stressed environments. Consequently, this may lead to the over-estimation of the evaporative fraction (EF) and total evaporation (ET), especially for regions dominated by sparse vegetation coverage.

In order to address this limitation, a modified version of SEBS was applied, using an evaporative scaling factor (ESF) that considers the combined influence of the factors: soil moisture, land surface temperature and vegetation on fluxes. This approach was tested by comparing the SEBS ET estimates derived using Landsat and MODIS data, against Eddy covariance (EC) ET measurements, along a riparian reach of the Groot Letaba River in north-eastern South Africa. The results of these investigations indicated that the modified version of SEBS was able to better capture the ET for sparse vegetation coverage, whilst still adequately capturing the ET for moderate/dense vegetation coverage.

Comparisons between the ET estimates acquired from the implementation of the original SEBS formulation against EC ET measurements, produced R2 and RMSE values of 0.10 and 1.59 mm d-1 and 0.09 and 2.58 mm d-1, respectively for Landsat and MODIS. Through the implementation of the modified version of SEBS, the R2 and RMSE values improved to 0.65 and 0.90 mm d-1and 0.31 and 1.31 mm d-1, for Landsat and MODIS respectively.

The integration of the ESF in SEBS can be applied for local or regional mapping of ET, under varying land cover conditions. While further testing and validation of this approach is recommended in other environmental settings. The results discussed in this study highlights the potential of this approach in the mapping of energy and water fluxes. Furthermore, the incorporation of ET data emanating from this approach into procedures such as downscaling, may allow for the improved estimation of ET at moderate spatial resolutions and high temporal resolutions. This in turn can prove to be extremely beneficial in furthering our understanding of the interrelations between hydro-meteorological fluxes and the natural functioning of ecosystems. Subsequently providing an opportunity to facilitate the improved management of our limited water resources, especially in arid and semi-arid environments, through the relatively timeous and cost-effective quantification of ET.