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Basin-wide, year-round estimation of actual evaporation for the Volta Basin using remote sensing

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During the last decade, a growing number of satellite algorithms have been developed toestimate actual areal-averaged evapotranspiration. Since most of these algorithms are based on the radiometric temperature, they are limited to cloud-free situations, which makes it difficult to obtain evapotranspiration on a daily or weekly basis under the conditions in West Africa. Schüttemeyer *et al.* (2007) show that the simple algorithm of Choudhury and De Bruin (1995) is able to predict well both the diurnal and yearly variation of actual evapotranspiration of two savannah sites in Ghana.

The algorithm of Choudhury and De Bruin (1995) is based on the assumption that the green vegetation fraction adjusts itself to the available amount of water in such a way that the part of the surface covered with vegetation is transpiring at its optimal rate (note that agricultural crops, when under water stress, may transpire sub-optimally *without* adjusting there vegetation fraction). That optimal evaporation is estimated using the Makkink formula, needing only global radiation and temperature as its input.

In the present work, the original algorithm is extended to include, apart from transpiration, evaporation from intercepted water and bare soil evaporation. Besides, the formulation of the transpiration part has been extended with the inclusion of a crop factor in order to differentiate between different vegetation types.

The extended algorithm is fed with the following data:

- global radiation and near surface temperature from METEOSAT-7 data (product of DLR Stuttgart, algorithm of Perez *et al*, 2002)
- 16-daily vegetation fraction based on MODIS EVI data

- crop factors based on land-cover data from the USGS data base
- daily rainfall maps from RFE 2.0 (an operational product from NOAA)

The rainfall data is primarily needed for the estimation of evaporation from intercepted water and soil evaporation. Since the different data sources have different resolutions, all data have been translated to the METEOSAT resolution.

The algorithm has been applied for the entire years 2002 and 2003, over an area that encompasses the entire Volta Basin. The results show a clear spatial variation of evaporation along a north-south gradient, as well as seasonal variation following the variation of the rainfall. Furthermore, the contrast between the relatively wet year 2002 and the relatively dry year 2003 is clear. Evapotranspiration has been validated using in-situ observations at two savannah sites in Ghana for part of 2002.

The method is not strictly tied to the data sources used here. For example, data from the Land Surface Analysis Special Application Facility (LSA-SAF) could be used for global radiation (pre-operational) and vegetation fraction (demo status). The near-surface temperature could alternatively be derived from operational weather models. For remotely sensed rainfall, other algorithms, based on various sensors are available as well.

Although the proposed algorithm is rather simple, it has the strength of robustness and the advantage that no cloud-free images are needed. Furthermore it could be used operationally for continuous monitoring of actual evapotranspiration, both for water management purposes and to better understand the Sahelian climate (also through reprocessing of existing remote sensing data).

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