TOWARDS SOLELY REMOTELY SENSED OPERATIONAL EVAPOTRANSPIRATION ESTIMATION OVER HETEROGENEOUS LAND SURFACE USING TWO SOURCE ENERGY BALANCE MODEL

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Abstract

Spatio-temporal variability and distribution of evapotranspiration (ET) are crucial for weather and climatic systems and its variable patterns over the earth surface from local to regional scales. ET is an important component of the water cycle. It is a highly dynamic process and may vary on a very short temporal scale. The controlling factors include; incoming net radiation (R_n), temperature, wind, vegetation and other meteorological variables. In situ methods are more accurate and precise for measuring ET. However, being point-based, these methods cover very small footprint and hence unable to capture the spatio-temporal trends in ET for vast heterogeneous land surfaces. In situ methods are mostly utilized to validate ET products calculated from remote sensing data. This data especially with its recent spatial, spectral and temporal advancements, are most suitable for mapping spatio-temporal variability and distribution for large heterogeneous surfaces. Energy balance approaches have been developed for various remote sensing data. Based on energy balance approach, one source models (OSM) and two source models (TSM) are developed and modified from time to time. Being sensitive towards canopy level micrometeorological variations, the TSMs are capable of estimating separate evaporation and transpiration from soil and vegetation, respectively, hence TSMs are preferred over OSMs. In this study, ALEXI (Atmospheric Land EXchange Inverse), a two source energy balance model, was applied to remotely sensed energy fluxes and vegetation data on catchment scale in the west of Germany, the Rur catchment, near the borders of Belgium and The Netherlands. First, hourly time series of the latent heat flux (LE_{EBM}) was estimated for a period of five years (2011-2015), and then the estimated hourly time series was compared to in situ latent heat flux (LE_{in_situ}) measured through direct micrometeorological eddy covariance technique (EC). The LE_{in_situ} was only used for validating the remotely sensed fluxed without incorporating it into the ALEXI model. The LE_{EBM} showed a correlation coefficient (r) of 0.83, 0.80, 0.84, 0.90, 0.85 and a root-mean-square difference (RMSD) of 63.41, 75.41, 66.16, 118.25 and 150.00 W/m^2 with in situ latent heat (LE_{EC}) at five sites in the Rur catchment (Germany), namely, Selhausen, Merzenhausen, Selhausen-Ruraue, Rollesbroich and Wuestebach, respectively. Later the latent heat fluxes were converted from W/m^2 units to mm/hour and mm/year. The present study reveals a high ET rate (mm/year) during 2011 (dry year) and a low ET rate in 2012 (wet year) with respect to all test sites. In general, the ET rate shows an increasing trend toward 2015. This approach, exclusively based on remotely sensed data, allows for the quantitative estimates of evapotranspiration and can be extended towards catchments with no or limited in situ networks. Also, it may help to better plan hydrological risk management, e.g. to evaluate the effect of hydrological extremes (floods and droughts) while incorporating into water balance of the catchment.