

Evapotranspiration Estimation Based on MODIS Products in Sanjiang Plain, Northeastern China

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There is a growing interest in quantifying regional scale actual evapotranspiration (ET) for water accounting and for water productivity assessments. Methods that provide point values fail to describe the situations at larger scales. Remote sensing measurements can be used at different spatial scales. Daily regional evapotranspiration in Sanjiang Plain has been estimated based on the Surface Energy Balance Algorithm for land (SEBAL) with the remote sensing data in this study. The Surface Energy Balance Algorithm for land (SEBAL) model was developed to estimate land surface fluxes using remotely sensed data and available meteorological observations.

Sanjiang Plain is located in the northeastern part of Heilongjiang Province, China. It is in a low alluvial plain of Heilongjiang River, Songhua River, and Wusuli River, from 129°11'E to 135°05'E, and from 43°49'N to 48° 27'N, with a total area of 108829 km². Sanjiang Plain is the largest concentrated area of the freshwater wetlands in China. Sanjiang Plain was still primeval before the 1950s. From the late 1950s to the early 1990s, a number of large farms, distributing all over the plain, were built concomitant with the loss of wetlands. Now, it is one of the main food and agricultural bases of the nation. Due to large-scale agricultural development, nearly 80% of the freshwater wetlands in Sanjiang Plain had been reclaimed during the past decades. The wetlands landscape had been changed severely and had been fragmented seriously. Intensive human activities led to such variations in ecological environment as increasingly frequent drought, decreased river runoff, decline in groundwater, and so on.

In this paper, SEBAL has been utilized to estimate the surface fluxes over Sanjiang Plain in Northeastern China by using MODIS/TERRA products, in combination with meteorological data collected in 31 meteorological stations distributed over or around the study area. The study was based on MODIS remote sensing data comprising land surface temperature (LST) and emissivity (ϵ), surface albedo (α), Normalized Difference Vegetation Index (NDVI). The MODIS product Quality Assessment Science Data Sets (MODIS QA-SDS) were analyzed and all scenes with valid data covering more than 70% of Sanjiang Plain were selected. This provided 12 overpasses during 192 day vegetation period from April 23rd to October 31st; 2006. The estimated daily evapotranspiration by SEBAL in cloud free days are first compared with measurements by the eddy covariance in Sanjiang Mire Wetland Experimental Station (SMWES). The comparisons show that the estimated evapotranspiration from SEBAL have a good agreement with the ground truth data. The daily ET was estimated

(mean error of 10.52%) for mixed agricultural and natural ecosystem. Based on the validation of the model, a modified version of SEBAL was utilized to analysis the evapotranspiration status over the study area and the spatial-temporal distributions of actual evapotranspiration were analyzed by combination of the land use data in Sanjiang Plain. The results show that seasonal ET was lowest in dry crop (mean value was 428mm) and paddy field (mean value was 480mm) and increased in wetlands to over 554mm. The reason for low ET may be no irrigation management status in the dry crop and well irrigation management but shorter growing season in the paddy field. As expected, there were high values for Xingkai Lake in the southeastern Sanjiang Plain and forest in the southern/western Sanjiang Plain for which the seasonal mean values were 794mm and 659mm, respectively. The time series Daily ET of different land use increased from beginning until June or July and then decreased, which meet the climate change in Sanjiang Plain. In spring, with the thawing of the land and the anabiosis of vegetation, the daily ET increased slowly to a range about 1-4mm. Mean values in spring on different land use result in 3.00 mm day⁻¹, 2.62 mm day⁻¹, 1.60 mm day⁻¹, 2.47 mm day⁻¹, and 4.83 mm day⁻¹, for forest, wetland, dry crop, paddy field, lake, respectively. The daily ET increased constantly to a range of 4-10mm and had highest value during the whole year due to the climatic condition and sufficient soil moisture over Sanjiang Plain in summer. Mean values in summer on different land use result in 7.06 mm day⁻¹, 6.02 mm day⁻¹, 4.25 mm day⁻¹, 5.10 mm day⁻¹, and 7.87 mm day⁻¹, for forest, wetland, dry crop, paddy field and lake, respectively. Due to the low temperature and plant metabolism, the daily ET decreased sharply to a range of 0-2mm in the autumn especially after October. Mean values in autumn on different land uses result in 2.43 mm day⁻¹, 2.09 mm day⁻¹, 1.74 mm day⁻¹, 1.80mm day⁻¹, and 2.98 mm day⁻¹, for forest, wetland, dry crop, paddy field and lake, respectively.

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