VALIDATION OF WATERSHED SCALE SOIL MOISTURE DERIVED FROM MODIS REMOTE SENSING DATA: A CASE STUDY IN THE YIHE BASIN OF CHINA

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1. EXTENDED ABSTRACT

Accurate prediction of spatially distributed soil moisture content at watershed scale is essential not only for hydrological simulations, water resources management, and farm planning and environmental evaluation but also for accurate projection of land surface-atmosphere interaction. Even though SAR data may be reliable data resources for determining the spatial pattern of surface soil moisture, yet it is not able to substitute MODIS data in some vegetated regions where strong affects of vegetations often skew the backscatter coefficient of the SAR remote sensors.

In the past several years, some methods [1-4] have been proposed for retrieving land surface soil moisture using MODIS data, and the satisfying results were achieved. However, the studies to further validate the surface watershed scale surface soil moisture inversion from MODIS data are few. And this restricts the development of the soil moisture inversion method's improvement and applications. In order to give the assessment of retrieved soil moisture from MODIS data, in this work, we retrieve the surface soil moisture from the MODIS imagery and validate it using field measurements and the modeled soil moisture of the study watershed (150*180 km^2 area) in the Yishushi River Basin located at the Linyi district, Shandong Province, China, where adequate surface soil moisture observations were made available in recent years. This selected watershed characterizes a typical semi-arid rangeland with sparse vegetation, farm land and some small towns covered. For the first stage of this study, the spatial pattern of the soil moisture content was retrieved from the MODIS imagery based on a semi-empirical method [5, 6]. This semi-empirical method involves two steps. Firstly, the statistical relationship between the Temperature Vegetation Dryness Index (TVDI) and in-situ soil moisture measurements was established with the spatially distributed field measurements of soil moisture in this basin during the period of January 1~30, 2006. Total 22 sites of soil moisture measurements within the basin are used. The soil moisture is regularly measured on 8th, 18th and 28th day of every month at the top several centimeter of surface. Then the four parameters of TVDI formula is calculated from the Ts/NDVI space, where a dryness index (TVDI) holds the values of 1 at the "dry edge" (limited water availability) and 0 at the "wet edge" (unlimited water access) can be defined. With these dry and wet edge equations, the soil moisture dynamics of the other days from Jan to June, 2006 can be retrieved. The land surface temperature is retrieve using the split-window method proposed by Mao et al. [7, 8].

For the assessment of this MODIS 1B derived soil moisture dataset, validation of MODIS surface soil moisture product was conducted by using the field observations. The soil water index (SWI) proposed by Wagner [9] was used as a detective measure for comparison, and it was calculated from both the MODIS surface soil moisture product and the field soil moisture measurements. In the second stage, the other estimates were derived from the simulation of the ESSI distributed hydrological model [10] for further validations. The model was run for each 1*1 km^2 grid within the Yihe watershed over the same period of year 2006, which is equivalent to the spatial resolution of the MODIS remotely sensed dataset. The simulation gave the outputs including surface soil moisture and root zone soil moisture content…etc. The MODIS derived soil moisture was thus directly compared with the ESSI modeled surface soil

moisture and the RMS error and efficiency coefficient were evaluated over the same period of 2006. Finally, a sensitivity study was performed to quantify effect of modeling data noise level on the comparison. Results of comparison show a better correspondence between the field measurements and MODIS derived surface soil moisture than that between the MODIS soil moisture and modeled ones, which may strongly be affected by precipitation input. Till now, very few studies conduct comparison of soil moisture estimations derived from the hydrological simulation and from remotely sensed information. This study will contribute to knowledge of accuracy of MODIS derived soil moisture and the compatibility between the remotely sensed soil moisture and the hydrological model simulated ones, which is potentially vital for guiding four dimensional data assimilation studies by using remotely sensed data and hydrological models.

Keywords: Soil Moisture; MODIS 1B data; ESSI distributed model; Semi-Arid Region; Yihe Basin

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