DOWNSCALING OF SOIL MOISTURE RETRIEVED FROM MULTI-SENSOR REMOTE SENSING DATA OVER THE ZHANGHE IRRIGATION AREA, CHINA

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EXTENDED ABSTRACT

Soil moisture plays a vital role in the atmosphere-land interactions, hydrological simulation, weather numerical prediction and agricultural arid monitoring. It may control the partition of water and energy into sensible heat flux, latent heat flux, evapotranspiration, runoff and baseflow between land and atmosphere respectively. In order to obtain the profile of soil moisture, point measurement often was carried out in many large field-experiments, but data observed from single station could not meet the spatial distributed requirements in many applications because of the spatial heterogeneity of soil moisture. Fortunately, satellite remote sensing provides an effective way to acquire the spatial distributed information of soil moisture in continental or basin scale. In general, a large number of satellite sensors could be used to estimate the spatial distribution of surface soil moisture, including optical, thermal infrared, active microwave and passive microwave sensors at various platforms. Moreover, a large amount of satellite images with different temporal and spatial resolutions also was acquired in recent decades all over the world.

In fact, the successive soil moisture dataset with higher spatial resolution is necessary for studying the dynamic change of water resource in basin scale, especially for simulating hydrological processes using the distributed hydrological model. Optical remotely sensed image, such as MODIS data, is sequential in temporal scale and also possess appropriate spatial resolution, but images often are polluted by cloud or worse atmospheric state, which limited the application of optical remote sensing data in the estimation of soil moisture. Electromagnetical wave in microwave band can penetrate cloud or opaque atmosphere. So soil moisture retrieving from microwave remote sensing data was not affected by cloud, which was convenient for obtaining the successive soil moisture dataset. But the spatial resolution of images from passive microwave sensors, such as AMSR-E, is usually very coarse for monitoring the dynamic change of water resource in catchment scale. And active microwave remotely sensed data may be acquired every almost a half month at the same site in despite of higher spatial resolution. Therefore, a downscaling algorithm of soil moisture should be developed to integrate optical, active and passive microwave, thermal and infrared remote sensing data for the sake of dynamic monitoring of water resources in basin scale.

So a downscaling algorithm was developed to fuse a variety of soil moisture products derived from multi-sensor satellite images for further simulation and assimilation of soil moisture in distributed hydrological model in this paper. At first, soil moisture was estimated from ENVISAT ASAR active microwave remote sensing images using a semi-empirical inversion scheme and the AIEM radiation transfer model. Then soil moisture product from AMSR-E passive microwave data was selected as large-scale soil moisture map, which can be downloaded from the website of National Snow and Ice Data Center, U.S.A. MODIS images, as thermal or infrared remote sensing data sources, also was used to calculate the spatial distribution of soil moisture with the thermal inertia method at agricultural region over the Zhanghe Irrigation Area, China. It must be explained that MODIS retrieved soil moisture was utilized as a bridge between AMSR-E and ENVISAT ASAR estimated soil moisture products in terms of scale. The geostatistics and neural network theory were integrated to downscale multi-sensors soil moisture products in this paper. Each pixel of large-scale AMSR-E soil moisture products was regarded as an observed station, and analyzed by the geostatistical theory to interpolate at higher resolution. Then a BP neural network model trained in advance by samples from AMSR-E, MODIS and ENVISAT ASAR images was used to simulate the spatial distribution of soil moisture at higher resolution. The validated results by observed soil moisture showed that the downscaling algorithm could be used to obtain the spatial distribution of soil moisture at higher temporal scale, and have better performance of acquiring soil moisture dataset for studying dynamic change of crop requirement water over the Zhanghe Irrigation Area, China.

Keywords: Soil Moisture, Downscaling, Microwave Remote Sensing, Geostatistic, Artificial Neural Network

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