SOIL MOISTURE CONTENT RETRIEVAL IN AN ARID TO SEMI-ARID REGION IN THE XINJIANG PROVINCE

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ABSTRACT

In the Arid and Semi-Arid regions of the Xinjiang province in Northwestern China, soil moisture content (SMC) controls vegetation growth. SMC is a determinant as well for water and energy exchange between land surfaces and the atmosphere. With regard to quantifying SMC, we applied the apparent thermal inertia (ATI) approach. With the launch of AQUA and TERRA MODIS, a new opportunity was created to determine SMC based on the application of ATI and the thermal bands of MODIS.

This paper focuses on the determination of ATI and land surface temperature (LST) using locally received MODIS data. The Tarim River basin is taken as a representative region for the application of the SMC and energy exchange algorithms. SMC has been calculated for the whole basin at 1 km² resolution for the year 2005. The day and night LST difference is a proxy for the calculation of actual ATI. LST estimation is based on an adapted split window method, based on vegetation cover for emissivity estimation. In the ATI approach, the day-night LST difference (ΔLST) and broadband albedo (αo) are used to quantify ATI.

Typically, the higher ATI, the higher SMC. The retrieval of SMC is based on the rationale that the highest ATI values correspond to the maximum SMC and vice versa for the lowest ATI values in a multitemporal ATI profile for a certain ROI. Since SMC is retrieved with remote sensing, the soil moisture saturation index (SMSI) is used to estimate SMC. It is defined as the ratio of the difference in ATI at time t and the minimum ATI over the difference of maximum ATI minus the minimum ATI. With those boundary conditions SMC can be estimated using the SMSI.

For the retrieval of SMC for a 1 m depth soil profile using MODIS data, a semi-empirical modelling approach is used. Soil surface SMI,0(t) is converted to SMI(t) for a 1 m soil profile using a Markov type filter for this purpose. It is based on a two layer water balance equation (for the surface layer and the reservoir below).

From the results we can observe that the Tarim river is more sharply delineated in winter than during summer. In summer, some parts of the Tarim river even fall dry. For the validation of the MODIS ATI SMC product, TDI probe measurements were used. The TDI probes monitor SMC at three sites e.g. Yinsu, Alagan, Yiganbjima for the Julian dates in 2005 of 1, 32, 60, 79, 110, 140, 191, 232, 264, 293, 321, 352. When the time series of SMC is compared with SMC measurements at the sites cited above, the regression slopes vary between 0.810 and 1.108. R² values are located between 0.75 and 0.77 for the pooled case. The pooled RRSME is 0.11, the minimum and maximum RRMSE is 0.056 and 0.43, respectively.
We could conclude from this first validation result, that the ATI approach seems suitable for SMC retrieval for a 1 m depth profile in an Arid to Semi-Arid region using MODIS data at 1 km² resolution. During 2005, average SMC pooled validation site values on January 1st, March 1st, May 1st, July 1st, September 1st and December 1st are 0.243, 0.238, 0.259, 0.271, 0.264 and 0.251 m³moisture/m³soil respectively.

**KEYWORDS**

Arid and Semi-Arid region, Xinjiang province, Soil Moisture Content, Apparent Thermal Inertia, MODIS.