LOCALIZED LAND SURFACE TEMPERATURE RETRIEVAL FROM THE MODIS LEVEL-1B DATA USING WATER VAPOR AND IN SITU DATA

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1. INTRODUCTION

Land surface temperature (LST) is involved in many land surface processes such as evapotranspiration, net radiation, or air temperature modeling [1, 2]. In this paper, we explored localizing the general split window method using water vapor and *in situ* data [3].

The land surface emissivity was calculated by NDVI Threshold Method using ground measured emissivity [4]. For the total column water vapor amount, it were derived from MODIS data using near-IR “water vapor” channels (0.905 μm and 0.940 μm) in addition to existing “window” channels (0.865 μm and 1.24 μm)[5]. With the atmosphere profile fetched by sounding balloon, we simulated the variables in the formula by MODTRAN 4. Then with the emissivity data, water vapor amount and formula variables estimated above, we simulated LST from MODIS data.

In addition, we validated the retrieval result with multi-scale data: ASTER Surface Kinetic Temperature Product and ground temperature measurements [6].

2. METHODOLOGY

In this study, we adopted MODIS Terra Level-1B data, and localized a split window method proposed by Wan and Dozier (1996) to simulate LST [3] .

$$T_s = \left(A_1 + A_2 \frac{1-\varepsilon}{\varepsilon} + A_3 \frac{\Delta\varepsilon}{\varepsilon^2} \right) \frac{T_{31} + T_{32}}{2} + \left(B_1 + B_2 \frac{1-\varepsilon}{\varepsilon} + B_3 \frac{\Delta\varepsilon}{\varepsilon^2} \right) \left(T_{31} - T_{32} \right) + C$$

Where $\varepsilon = 0.5(\overline{\varepsilon_{31}} + \overline{\varepsilon_{32}})$ and $\Delta\varepsilon = \overline{\varepsilon_{31}} - \overline{\varepsilon_{32}}$, T_{31} 、 T_{32} are the radiance temperature of MODIS band31 and band 32, and $A_1, A_2, A_3, B_1, B_2,$ B_3 and C are variable coefficients in this algorithm.

For the land surface emissivity, NDVI Threshold Method combined with ground measured emissivity was used from recovery [4]. In this method, surfaces emissivity is calculated according to its NDVI value: when NDVI<0.2, the sample is regarded as bare soil; when NDVI>0.5, the sample is regarded as vegetation covered area, then is equal to a constant; when 0.2<NDVI<0.5, the target is assumed as a mixture of bared soil and vegetation, which is the case for most research areas,

$$\varepsilon = \varepsilon_v P_v + \varepsilon_s (1 - P_v) + d\varepsilon$$

In which, ε presents land surface emissivity, ε_v presents vegetation emissivity, ε_s presents bared soil emissivity, P_v presents vegetation coverage. $d\varepsilon$ is a term that depends on the surface characteristics and that takes in account the internal reflections(cavity effects).

$$d\varepsilon = (1 - \varepsilon_s)(1 - P_v) F \varepsilon_v$$

F is a morphological parameter, depends on geometric distribution, and its average value is 0.55.

For the total column water vapor amount, it were derived from MODIS data By using near-IR "water vapor" channels (0.905 μm and 0.940 μm) in addition to existing "window" channels (0.865 μm and 1.24 μm). Kaufman (1992) compared the result of different combination of" water vapor" channels and "window" channels, it shows that the combination of channel of 0.940 μm and channel of 0.865 μm is the optimized access to calculate the total column water vapor from MODIS [5].

$$T_w(940/865) = \exp(\alpha - \beta\sqrt{W}), r^2 = 0.999$$

In which, r^2 is the correlation. For a mixture of all surfaces, $\alpha = 0.020$, $\beta = 0.651$.

With the atmosphere profile fetched by sounding balloon, we simulated the variables in the formula by MODTRAN 4. Then with the emissivity and water vapor amount estimated above, we simulated LST from MODIS data.

3. RESULT

The experiment was carried out in Yingke, Gansu province, June 2008. Yingke is in the Heihe River Basin, China's second largest inland river basin. During the filed campaign, field measurements of emissivity and temperature were carried out in the test site over sample areas. In addition, atmosphere profile was fetched by sounding balloons at satellite passing time. We also adopted MODIS Terra Level-1B data and ASTER Surface Kinetic Temperature Product (Level-2 AST-08: LST from TES) in this study.

ASTER Temperature product was firstly adjusted and validated by in situ LST measurements. The adjusted ASTER LST imagery was applied to geometrical correction, and then an up-scaling process which took account geometrical information of moderate imagery. Finally, moderate spatial resolution LST was validated by the up-scaled ASTER LST.

Finally, we were able to calculate the accuracy of the retrieved LST of MODIS Terra Level-1B data. The accuracy is 1.64K

4. CONCLUSION

The split-window method implemented by in situ data is both feasible and effective in retrieving LST. Validated by ASTER LST product, the accuracy of the retrieval result is better than 1.64K.

With the geometrical processing method and remote sensing data with fine resolution, we can better evaluate the LST retrieval result with a statistical way, which is more appropriate and accurate in depicting the retrieval result.

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