Land Surface Temperature Retrieval from MODIS and AMSR-E on the Tibet Plateau

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Abstract:

The Land surface temperature (LST) is one of the most important weather and climate variables and contributes to energy and water exchange at the land-atmosphere interface. Remote sensing can provide an efficient way to obtain LST at regional or global scale. Various algorithms have been developed to retrieval LST from satellite data and auxiliary data, especially from infrared (IR) radiances and microwave signals. The IR channels have the advantage of finer resolution, but they can’t obtain LST in cloudy areas. Microwave signals have minimally influenced by atmosphere conditions and can operate in day and night and all weather conditions, but they were limited to low spatial resolution and complications in determining surface emissivity. However, LST can be retrieved with passive microwave brightness temperature without an a priori knowledge of the emissivity, absorption, or scattering for known surface conditions. In 1990, McFarland have developed linear regression models between SSM/I brightness temperature and 1.2m air temperature to retrieval LST for three surface type categories, but the point observation of air temperatures were limited.

The most reliable global LST products at present are derived from the Moderate Resolution Imaging Spectroradiometer (MODIS) carried on the Earth Observation System satellites Terra and Aqua, but the products have many data gaps due to extensive cloudiness. So the Average Surface Temperature (AvgSurfT) generated by the Global Land Data Assimilation System (GLDAS) used to fill up the MODIS LST gaps.

Firstly, we compare the MODIS LST (Land Surface Temperature/Emissivity Daily L3 Global 0.05DEG CMG) and the AvgSurfT under clear sky conditions to establish correlation between them. Then a Combined Temperature(CT) without data gaps was formed by using MODIS LST and AvgSurfT.

Secondly, we aggregate similar categories from the land surface type classification (MODIS/Terra Land Cover Types Yearly L3 Global 0.05Deg CMG) into six categories. The regression algorithm established by using the equation as:

$$CT=C1*37V+C2*(37V-22V)+C3*(37V-18H)+C4*89V$$

CT is the combined temperature of MODIS LST and AvgSurfT, 37V, 22V, 18H, 89V is the

AMSR-E brightness temperature (AMSR-E/Aqua L2A Global Swath Spatially-Resampled Brightness Temperatures). The 37V is the primary channel to retrieve the Land surface temperature. Three corrections were made to this equation. The brightness temperature difference between 37V and 22V was used to correct atmospheric water vapor. The polarization difference between 37 and 18 was used to correct land surface water. The brightness temperature of 89V was used to correct atmospheric influence.

The regression analysis was performed for each surface type between the Combined Temperature and AMSR-E brightness temperature by using data of the year of 2003 over the Tibet Plateau area. Then we use the AMSR-E brightness temperature and the coefficients obtained from above equation to retrieval the LST of the year of 2004.

Finally, we validated the retrieved LST with ground truth data obtained from weather stations. The retrieved LST and MODIS LST were also examined to evaluate the algorithm. It was found that the retrieved results may be good under the surface type categories of shrub, crop and grass due to the minimal variety of the land surface emissivity.