Comparison of LST Retrieval Algorithms between Single-Channel and Split-Windows for High-Resolution Infrared Camera

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Abstract:

Land surface temperature (LST) is a very important parameter controlling the energy and water balance between the atmosphere and the land surface. Thermal infrared (TIR) remote sensing is the only possibility to retrieve LST over large portions of the Earth surface at different spatial resolutions and periodicities. Usually single-channel and split-window are introduced to retrieve LST for high-resolution thermal infrared camera such as TM on Landsat 5, ASTER on Terra, and IRMSS on CBERS02. And a sensitivity analysis of these algorithms could be carried out to answer the problem if the accuracy of LST retrieval would be improved after the channel settings for camera were changed from single-channel to split-window when NE△T increased. In this paper, the accuracy and error sources of satellite measured land surface temperature were studied based on the change from single-channel to split-window of high-resolution thermal infrared camera to supply scientific channel settings for camera. We supposed that the proposed camera was the same as CBERS02 with 156m resolution and a single channel (10.4~12.5μm). The bands of split window were the same as AVHRR thermal bands(10.3~11.3μm and 11.5~12.5μm). And the spectral response function curves of single channel and the two split window were supposed as square-wave which would have little influence on the analysis.

Firstly, the generalized split-window algorithm and JM&S single-channel algorithm were chosen for comparison of LST Retrieval Algorithms. The algorithm coefficients were simulated based on TIGR (TOVS Initial Guess Retrieval) database which have been widely used for the development of LST and SST algorithms using MODTRAN4.0 code. We selected 388 profiles of TIGR mid-latitude summer profiles, including latitude, longitude, near-surface temperature, temperature, humidity and ozone content profiles for the atmospheric profile database. At the same time the atmospheric upward transmittance, the atmospheric upward radiation and the atmospheric downward radiation against water vapor content were simulated. And 29,876 simulation cases were computed (388 atmospheric profiles×11 emssivities×7LST values) to fit algorithm coefficients using least square method. Secondly, algorithm fitting precision analysis of the two algorithms was carried out. And the result showed that the algorithm fitting precision of JM&S single-channel algorithm, which decreased with the increase of water vapor, was worse than that of the generalized split-window algorithm. Lastly, the sensitivity analysis was carried out to compare the total errors of the generalized split-window algorithm and JM&S single-channel algorithm. The total errors of land surface temperature were estimated by means of evaluating the influence of several parameters: atmospheric water vapor, land surface emissivity and noise of the sensor. For the single-channel algorithm, the most important error source is due to algorithm fitting precision and for the split-window algorithm the most important one is noise of the sensor. In low atmospheric water vapor, the accuracy of the single-channel algorithm is about 1K, equal to the accuracy of the split-window algorithm. In high atmospheric water vapor, the accuracy of the

single-channel algorithm increase to about 2K and that of the split-window algorithm was invariant.
Key words: Single-channel algorithm and split-window algorithm, sensitivity analysis, NE△T