An atmospheric correction method for remotely sensed hyperspectral thermal infrared data

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Atmospheric correction plays an important role in the retrieval of land surface temperatures and emissivities from remotely sensed thermal infrared images. Under the condition of multispectral imaging, atmospheric effects are usually estimated by means of external synchronously observed data which comes from other sensors or platforms. However, when imaging technology upgrades from multispectral to hyperspectral, an opportunity appears that atmospheric compensation can be resolved only according to hyperspectral thermal infrared data itself. The narrow band width makes atmospheric absorption features stand out on the sensor's observation radiance spectrum, which we may make use of to estimate the atmospheric effects.

A method is now presented to carry out atmospheric correction for the purpose of land surface temperature/emissivity separation. Required remote sensing data must be hyperspectral thermal infrared data. The whole method mainly contains four steps. Firstly, two nearby located spectral channels are choosed to form a channel pair and the transmittance ratio between them is estimated. These two channels are both located in thermal infrared atmospheric window spectral range, but one (which we called absorption channel) sits in certain atmospheric absorption line feature, while the other (which we called reference channel) doesn't, and they are close to each other so that land surface emissivity distinction between them is small enough. Under these conditions the observed radiances of the two channels will obey a kind of linear correlation, which can be deduced from thermal infrared radiative transfer model equations, as D. Gu had pointed out [1]. In the linear relation graph, slope stands for atmospheric transmittance ratio of the channel pair, while intercept stands for atmospheric upwelling radiance difference weighted by the transmittance ratio. As an actual image is concerned, we can use those pixels around current central pixel to fit the straight line, so as to obtain the transmittance ratio and the weighted upwelling radiance difference between the absorption channel and the reference channel. Secondly, atmospheric transmittance of each channel within 10~12.5 micron atmospheric window is estimated through the inter-channel transmittance ratio gained in the first step. In this article we design a kind of logarithmic method to describe their intrinsic relationship. Parameters needed in such conversion could be ascertained by simulated data set in advance. Thirdly, calculate atmospheric upwelling radiance of each channel. Here the weighted upwelling radiance difference between absorption channel and reference channel which has been estimated in the first step will show its good usefulness. By introducing an intermediate variable, i.e. equivalent atmosphere temperature, in conjunction with foregoing calculated channel transmittances and upwelling radiance difference, we can work out every channel’s upwelling radiance. Fourthly, we will calculate atmospheric downwelling radiance of each channel. There lies rather strong correlation between upwelling atmospheric radiance and downwelling atmospheric radiance. We apply a sort of experiential model to figure out downwelling radiance according to upwelling radiance. As a result, spectral atmospheric transmittance, upwelling radiance, and downwelling radiance will be successfully extracted, and these important entry parameters are now ready for the land surface temperature / emissivity separation processing.

The most obvious virtue of the method is that it demands little external auxiliary data. Tests using simulated hyperspectral thermal infrared data show that it can lead to fairly good correction effect. However, we did not take viewing angle, neighborhood pixel effects, and cloud’s influence into consideration, and these problems will impulse us to do much further research work in the future.

REFERENCE

[1] Gu, D., Gillespie, A. R., Kahle, A. B., and Palluconi, F. D., Autonomous Atmospheric Compensation (AAC) of High Resolution Hyperspectral Thermal Infrared Remote-Sensing Imagery. IEEE Transactions on Geoscience and Remote Sensing, 38 (6): 2557-2570, 2000.