A SINGLE-CHANNEL ALGORITHM FOR LAND SURFACE TEMPERATURE RETRIEVAL FROM HJ-1B/IRS DATA BASED ON A PARAMETRIC MODEL

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1. INTRODUCTION

Land surface temperature (LST) is a key parameter resulting from the physical interactions in the surface-atmosphere system, particularly the energy and water fluxes between the atmosphere and the ground. The extensive requirement of LST for environmental studies and many other scientific researches has made the determination of LST become an important area of remote sensing. Significant progresses have been made in estimation of LST from remotely sensed thermal infrared (TIR) data during the past two decades. Various algorithms have been developed to retrieve LST from different satellite sensors: single-channel algorithm, split-window algorithm and dual-angle algorithm. Many efforts have been devoted to the last two algorithms and they can provide better results than single-channel on a global scale, because current single-channel algorithms based on empirical relationships between the atmospheric parameters and atmospheric water vapor content which are unstable for wet atmospheres (water vapor content higher than $3g/cm^2$)[1]. Therefore, it is very important to obtain accurate atmospheric parameters for single-channel LST retrieval. Ellicott *et al.*(2009) have developed a parametric model based on the MODTRAN 4 for atmospheric correction of MODIS thermal infrared (TIR) data[2]. The parametric model can achieve the same accuracy as MODTRAN 4 with less computation time.

The HJ-1A/B satellite of China, were launched on September 6, 2008, which are used for disaster and environment monitoring. It is a national project proposed by the Ministry of Environmental Protection and National Committee for Disaster Reduction. The HJ-1A and HJ-1B are on sun-synchronous orbits at the altitude of 650 km. The HJ-1A satellite is equipped with two CCD cameras and a hyper-spectral optical camera, while the HJ-1B

satellite is equipped with the same CCD cameras and one infrared scanner (IRS). The specifications of HJ-1B are shown in Table 1.

Table 1 Specifications of the HJ-1B main payloads

Sensor	Band	Spectral range (μm)	Spatial resolution(m)	Swath width	Field of view	Revisit time
CCD	1	0.43-0.52	30	360 km *2	31°	2 days
	2	0.52-0.60				
	3	0.63-0.69				
	4	0.76-0.9				
IRS	1	0.75-1.10	150	720km	29°	2 days
	2	1.55-1.75				
	3	3.50-3.90				
	4	10.5-12.5	300			

The purpose of this paper is to develop a single-channel algorithm for retrieving LST from HJ-1B/IRS data by using the parametric model.

2. METHODOLOGY

The proposed single-channel algorithm includes two steps. For the first step, the atmospheric parameters (transmittance, upwelling and downwelling radiances) are calculated by the parametric model and NCEP data is used as inputs of the parametric model. In this process, the parametric model firstly computes the band's transmittance, upwelling and downwelling radiance on a layer basis, after that the layer results are integrated along the optical path to obtain the total transmittance and radiances. Three components, the water vapor, water vapor continuum and other gases are considered in the layer transmittance calculation.

For the second step, the LST is retrieved based on the simplified Planck function. In practice using, it is very important for LST retrieval algorithms to simplify the Planck function. In this paper, a quadratic expression between the channel radiance and temperature is applied for HJ-1B/IRS LST retrieval.

3. VALIDATION

In this paper, two methods are used to validate the algorithm. Firstly, we utilize simulated data to validate our algorithm. The TIGR3 database and MODTRAN 4 have been used to simulate the TOA radiance. The TIGR3 database includes 2311 radiosoundings, LST has been assumed equal to the temperature of the first level of each radiosounding. Emissivity value of 0.98 is assumed. Fig. 1 shows the difference between LST retrieved by our algorithm and LST extracted from the radiosoundings versus the atmospheric water vapor content for different databases. The results indicate the proposed algorithm can obtain good results for the whole range of water vapor contents, with RMSE value equal to 0.22K.

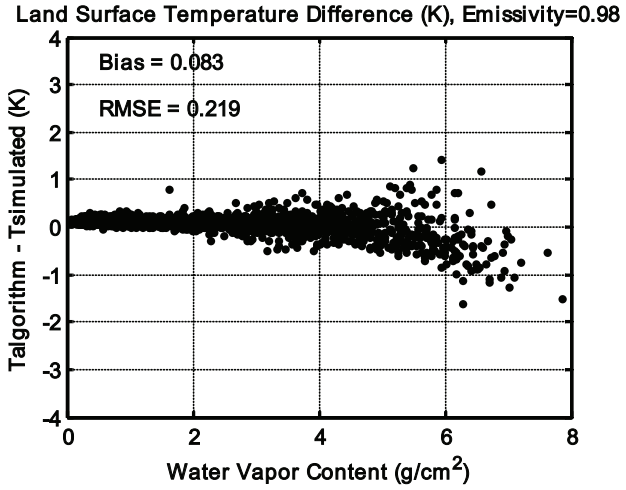


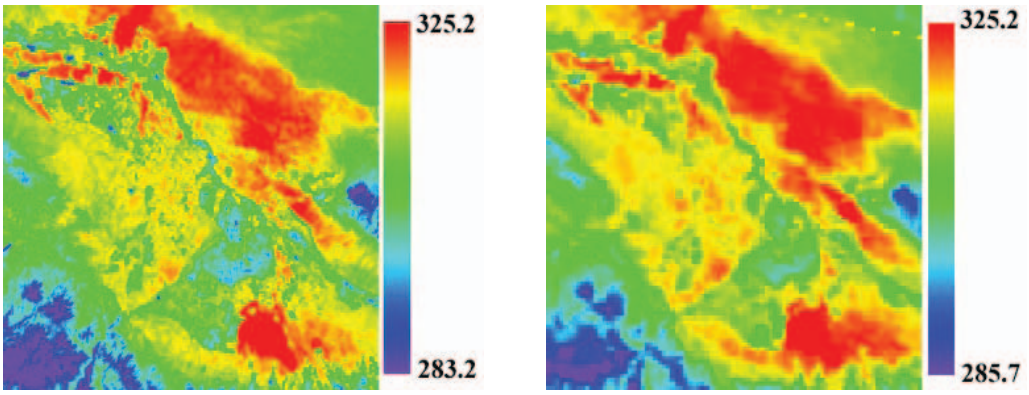
Fig. 1 Difference between the LST retrieved with the proposed algorithm (Talgorithm) and the one extracted from the radiosoundings data (Tsimulated) versus the atmospheric water vapor content.

Secondly, the algorithm is validated by comparing with MODIS LST products (MOD11_L2). An 85×85 km^2 square region (285×285 pixels for HJ-1B/IRS TIR data) located in northwest of China, Ganshu province, is chosen as the validation site, the average altitude is 1.5km. From May 22, 2009 to September 27, 2009, six days' HJ-1B/IRS and MODIS images are collected and the overpass time differences of these images are less than 10 minutes. All the images are geo-referenced to the Universal Transverse Mercator(UTM) coordinate system and the HJ-1B/IRS LST images have been re-sampled to 1km pixel size to match the MODIS LST products. Then, the HJ-1B/IRS LST results are subtracted to the MODIS LST products. Table 2 gives out the LST differences between the IRS and MODIS for the six days. Fig. 2 shows LST images of the validation site on May 22, 2009. The comparison result indicates

that the HJ-1B/IRS LST is basically consistent with the MODIS LST product with a reasonable accuracy.

Table 2 Values of difference between IRS LST results and MODIS LST products

Date	Bias (K)	RMSE (K)	Percentage (%) (<±5K)
22/05/2009	0.036	1.735	96.169
07/06/2009	-0.162	1.390	97.595
30/06/2009	-0.747	2.095	85.956
27/07/2009	1.284	2.093	91.386
19/08/2009	-0.378	1.656	95.733
27/09/2009	0.066	1.412	95.244
Average	0.017	1.730	93.681



(a) (b)

Fig. 2 LST images of the study area on May 22, 2009 (a)HJ-1B/IRS LST image (b)MOIDS LST product (MOIDS product is re-sampled to a resolution of 300m for display)

4. CONCLUTION

In this paper, a single-channel algorithm based on a parametric model is proposed for retrieving LST from HJ-1B/IRS data and the validation indicates the proposed algorithm perform very well.

5. R EFERENCES

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