REFLECTANCE-BASED CALIBRATION OF BEIJING-1 MICRO-SATELLITE

Zhengchao Chen[1], Bing Zhang[1], Hao Zhang[1], Junseng Li[1], Xiaoyong Zhang[2]

1. Center for Earth Obsercation and Digital Earth, Chinese Academy of Sciences, Beijing, 100190
2. Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, 100101

Email: zcchen@ceode.ac.cn

ABSTRACT

Beijing-1 is Chinese first applied Earth observation micro-satellite. It carries two Earth imaging payloads providing: (1) 32-metres GSD multispectral imaging in 3 spectral bands (NIR, red, green) with up to a 600km imaging swath. (2) 4-metres GSD panchromatic imaging with a 24km imaging swath. Supported by a variety of real-time and stored-data operating modes and large store capacity, Beijing-1 enables a highly flexible and extensive mission. Magnanimous image data have been obtained by Beijing-1 since its launch day Oct.27 2005 and used widely in agriculture, land use, and so on.

To update the radiometric calibration coefficients and monitor the performance of Beijing-1 micro-satellite, a field calibration and validation campaign was performed at China Dunhuang Calibration Site (40° 05′ 25″ N, 94° 23′ 35″) during September, 2008. Dunhuang calibration site is a standard calibration and validation site of China. It is wide and flat and has good reflectance homogeneity. The ground reflectance is few varieties from 0.10 to 0.35 during 0.35-2.5μm. The in-situ calibration data were taken synchronization with Beijing-1 overpass in Sept.3, 6, 8 and 13, 2008. Field reflectance and directional reflectance of several calibration targets at Dunhuang calibration site were obtained by ASD field spectrometer and BRDF observation systems. The sun irradiance, the sky light, the aerosol data were obtained by CE318 sun photometer. The diffuse irradiance and the total irradiance were obtained by OL754 spectroradiometer. And the vertical distribution of temperature, humidity and pressure below 30,000 meter altitude were acquired by sounding balloon. During the period of the calibration and validation experiments, the deep sky images and the dark sea images were captured to calculate the dark current of Biejing-1 multispectral cameras.

All of the in-situ data and the images were well analyzed and processed. The average spectral reflectance of the calibration targets was calculated from these measurements with compensation for the bidirectional

reflectance distribution function of the reference panel at the illumination zenith angle at the time of Beijing-1 overpass. The atmospheric measurements were used with the Langley method to derive total and estimates instantaneous atmospheric optical depths. The vertical distribution of temperature, humidity and pressure were interpolated and normalized along the attitude levels which were specified in 6S. With the reflectance of calibration targets, atmospheric optical depths, and water vapor constraints, the 6S radiative transfer code was used to calculate the equivalent radiance of Beijing-1 to the top of the atmosphere (TOA). 6S was constrained with the illumination and observation geometry at the calibration targets. The reflectance calibration algorithm was taken to calculate the absolute radiometric calibration coefficients of Beijing-1 multi-spectral cameras.

Because the weather of Sept. 8 was cloudy and the atmosphere was unstable, the data acquired in this day was not used for Beijing-1 calibration and validation. The error of the in situ measurements, the error of the data and image processing, and error of the 6S model were analyzed. It is can estimate the total error of the calibration is about ±7-10%. A comparison between the calibration results of Sept. 2008 experiments and the results in on-orbit test period was also carried out. From the comparison result, it is can concluded that Beijing-1 is in good performance in the past three years.

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