ASTER DIGITAL ELEVATION MODEL AND ORTHORECTIFIED IMAGES GENERATED ON THE GEO GRID

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1. INTRODUCTION

National Institute of Advanced Industrial Science and Technology (AIST) developed an on-demand processing service on the GEO Grid system [1] to generate a Digital Elevation Model and orthorectified images from an ASTER data [2]. It is designed to support the latest algorithms for radiometric and atmospheric corrections developed by researchers as well as the geometric correction and other DEM processing options. The functions and options in this service are developed and implemented as modules, so that they can be arranged as the user requires. Although the system is an experimental, it can provide higher quality data sets than the standard products. In this paper, we present an overview of ASTER DEM and orthoimage data set (ASTER Data BETA).

2. ADVANCED ON-DEMAND DEM/ORTHOIMAGE PROCESSING

The ASTER Data BETA consists of a DEM and orthoimage data set accompanied with metadata files. The DEM and image data set are projected in a Geographical Latitude/Longitude or Universal Transverse Mercator (UTM) coordinate system, stored in GeoTIFF format or as flat binaries with ENVI header files.

Fig.1 shows a schematic flow diagram of DEM/Orthoimage processing. The DEM is generated using bands 3N and 3B of an ASTER Level-1A image without any GCPs. The default spatial resolution of the DEM is 15m. The original geolocation accuracy of the ASTER DEM is better than 20m in the horizontal plane, and 10m along the vertical axis (1σ)[3]. In order to generate a higher quality DEM and make it applicable to a practical use, we implemented 4 options on our system; (1) Parameter set for extremely dark area, (2) Parameter set for steep topography, (3) Height above the geoid surface, and (4) Geometric correction using a reference DEM. Option (1) is enables to generate a DEM in a dark region, such as volcanoes covered by fresh or dark lava flow. Option (2) allows to generating a DEM in a mountainous area. The DEM generation program with a standard parameter set limits the maximum slope gradient to 65 degrees to eliminate abnormal pixels due to an error in stereo matching process. However, the slope gradient sometimes exceeds the threshold in mountainous area such as Himalaya Mountains. The option (2) is useful for such a special case.

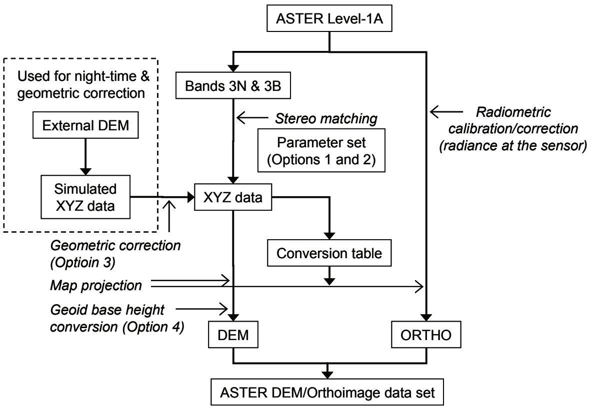

Fig.1 Schematic flow diagram of DEM/Orthoimage processing at AIST.

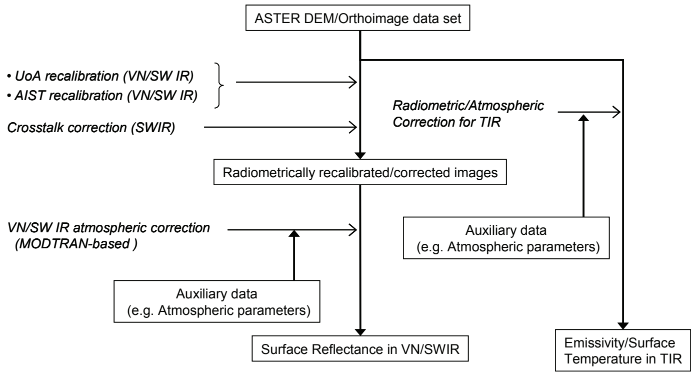

Fig.2 Schematic flow diagram of radiometric recalibration/correction and atmospheric correction.

Option (3) calculates the height above the geoid surface using the EGM96 geoid model [4], while the standard data set uses a height above the WGS-84 ellipsoid surface. Option (4) corrects the geolocation of the DEM by estimating the horizontal and vertical offsets between the ASTER DEM and a reference (external) DEM. When the geolocation correction is used, the standard deviation is improved to be less than 7.5m in the horizontal plane, and the vertical accuracy is to be less than 3.3m (1σ).

The orthoimage data set contains 4 bands in VNIR including band 3B, and 6 bands in SWIR, and 5 bands in TIR. The spatial resolution of the orthoimage is 15m in VNIR bands, 30m in SWIR bands, and 90m in TIR bands, respectively. The data set also includes the line of sight vector planes (azimuth and elevation angles) for bands 3N and 3B, which are not included in the standard products of ERSDAC and LP DAAC. We also provide orthoimages of night-time ASTER TIR data, which are generated by using an external DEM.

ASTER radiometric correction contains the onboard calibration (OBC) and the radiometric recalibration by vicarious calibration algorithms and coefficients. They can be applied to ASTER orthoimage data set processed on this system. Fig. 2 shows the schematic flow of the radiometric/atmospheric correction on the GEO Grid system.

OBC is based on data measured by internal OBC units [5]. However, it is known that there are the differences between the ideal applying period and the actual period on ASTER level 1 processing. The GEO Grid adopts the ideal period for OBC. One of the ASTER Radiometric Calibration working groups, Remote Sensing Group (RSG), Optical Sciences Center, University of Arizona makes efforts to obtain the ground measurement data for the vicarious calibration of ASTER VNIR and SWIR [6]. On the other hand, AIST also propose the algorithm and coefficients, which is derived from ground measurement [7]. The GEO Grid system makes it easy to apply these algorithms and coefficients to orthoimage data set. Moreover, it can be reduced the time-consuming of the algorithm revisions for users because it is easy to change the modules.

It is known that the light incident to ASTER band 4 affects to other bands by multiple reflections in the focal plane. A crosstalk correction algorithm has been developed to improve the spectral separation performance of

SWIR [8]. This correction algorithm is implemented in the preprocessing of surface reflectance products on the GEO Grid system, and users can select with or without this crosstalk algorithm.

In TIR region, recent products calibrated by RCC versions 3.x are basically accurate enough. Our system always applies the latest calibration coefficients to the orthoimage data set. However, they still include some errors dependent on a scene observation date. The coefficients are applied to the ASTER orthoimage data set by a modified version of Tonooka's method [9] on the GEO Grid system.

We adopted the MODTRAN3.7-based [10] atmospheric correction algorithms for ASTER VNIR and SWIR bands on our system. This algorithm is originally able to correct Rayleigh scattering, water vapor absorption, and aerosol effects with terrain effects by using ASTER DEM and MODIS Atmosphere L3 gridded product (MOD08_D3) [11]. Atmospheric correction algorithms for VNIR and SWIR bands use the exoatmospheric solar irradiance. The ASTER science team adopts the irradiance model based on World Radiation Center (WRC), however, there are some differences from the other irradiance models, especially in SWIR region. Therefore, we will add the option for selecting the irradiance models on our system.

In TIR bands, we implemented the Water Vapor Scaling (WVS) algorithm [12], which can generate the TIR products with higher accuracy under moist air. Users can select the emissivity/surface temperature products processed by standard [13] or WVS algorithm. This algorithm also uses various auxiliary data and ASTER DEM, and users can select the kind of parameters.

3. CONCLUSION

The ASTER Data BETA contains a DEM and orthoimages and is provided from on-demand ASTER data processing service on the GEO Grid system in AIST. Our system includes the latest algorithm for radiometric and atmospheric corrections as well as the geometric correction and other options for DEM generation, that enables us to provide higher quality/higher level data set to the user. Each optional function is developed and implemented as a module for the core program, making it easier to arrange several functions to generate a special data set the user desires. Especially, we found the following advantages in this implementation on the GEO Grid.

- It is possible to process in near real time by input of various parameters in large scale system. This is very useful to check the quality of output products and the algorithms.
- Users can get the data sets on which the latest algorithms are applied. No need to wait the re-processing of the data set by the algorithm upgrade. This is very useful for the researchers to evaluate the radiometric recalibration and the atmospheric correction.

We continuously update our system including calibration/correction algorithm and parameters to provide higher accuracy/reliable ASTER data. This system can apply the same algorithm to other satellite data, therefore, various higher level processing algorithms are available to other satellite sensor data, and this makes it easy to analyze the factors of difference among various satellite data products.

4. REFERENCES

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