論 文 の 内 容 の 要 旨

論文題目　Development of Cloud Distribution Mapping Method with Satellite Image Processing
（衛星画像処理による雲分布図作成手法の開発）

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The detection of clouds and the analysis of cloud frequency and distribution play an important role for operational weather prediction as well as for climate-ecological studies. To improve the quantitative estimation of cloud distribution at large spatial, space-based instruments are the only means by which the cloud distribution can be adequately sampled. In this thesis, satellite image processing for cloud distribution mapping is presented based on MODerate Resolution Imaging Spetroradiometer (MODIS) data.

MODIS aboard Terra and Aqua platforms was intended to provide frequent high-resolution images for monitoring land, ocean and atmospheric conditions over large areas. MODIS data are suitable for other quantitative, environmental applications, for example, radiation budget studies, surface albedo mapping, cloud variability studies, and etc. Unfortunately, MODIS data are contaminated by stripe noises which give serious errors in the analysis results. There are three types of stripe noises in MODIS data: detector-to-detector stripe, mirror side stripe, and random noisy stripe. Without correction, stripe noises will cause processing errors to the MODIS products included MODIS cloud detection.

In this thesis, a noise reduction algorithm is developed to reduce the stripe noise effects in both Terra MODIS and Aqua MODIS data by combining histogram-matching with iterated weighted least-squares facet filter. Histogram matching reduces detector-to-detector stripe and mirror side stripe. Iterated weighted least-squares facet filter reduces random noisy stripe. The method was

tested on a heavily striped Terra MODIS and Aqua MODIS images. Results of Terra MODIS and Aqua MODIS data show that the proposed algorithm reduced stripes noises without degrading image quality. To evaluate performance of the proposed method, quantitative and qualitative analyses were carried out by visual inspection and quality indexes of destriped images.

Another problem of MODIS data is degradation of data quality in Aqua MODIS band 6 (1.628 - 1.652 μm) . Fifteen of the twenty detectors in Aqua MODIS band 6 are either nonfunctional or noisy. Furthermore, the rest of the functional detectors are also contaminated by detector-to-detector stripe. The striping in Aqua MODIS band 6 caused by its nonfunctional or noisy detectors has been a serious problem for MODIS products and applications. MODIS band 6 is primarily used for cloud and snow detection, aerosol product, and forest biomass estimation. MODIS scientists have been using Aqua MODIS band 7 (2.105- 2.155 μm) instead of band 6 for computing the MODIS products. This thesis retrieve Aqua MODIS band 6 by first eliminate detector-to-detector stripe using Histogram matching and then restore missing data by using a gray-level transformation at each pixel of the non-functional detectors. Polynomial regressing is used to quantify the relationship between Aqua MODIS band 6 and 7. Validation efforts show that gray-level transformation work well as quantified by such measures as correlation coefficient and root-mean-square error when compared the simulated Terra band 6 and its original one. The detector-to-detector stripe is also incredible reduced as shown in noise reduction ratio.

After MODIS noise reduction and restoration, cloud detection is performed for daylight passes by applying several threshold tests, which also include ancillary terrain information. This thesis also validates the cloud detection result through visual inspection of the spectral and spatial features. One year of both Terra and Aqua MODIS daylight passes over East Asian region is analyzed, and exploratory cloud-amount climatologically distributions are developed.

In this thesis, cloud distribution results of Terra/Aqua MODIS daylight passes are compared with AMeDAS (Automated Meteorological Data Acquisition System) data. Comparisons with sun duration and precipitable water showed very good agreement for horizontal cloud distributions. The most evident problems were encountered in the summer season due to difficulties in identifying thin cirrus cloudiness.

The Terra/Aqua MODIS cloud distributions show low cloud frequencies found in the lee of the major alpine feature in the analysis domain (the Eastern Alps) and over mountain-sheltered valleys and adjacent sea areas. Over the sea adjacent to the coast on the western side of the Eastern Alps, there is a distinct minimum in cloud amount that appears to be related to the orography. Over Khrebet Sikhote Alin and Sakahalin Island, Russia, the striking pattern is a strong land/sea contrast in cloudiness, with higher cloud amount over the land areas.