Activities for the Environmental Satellite Data Center at the Science University of Tokyo

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NOAA satellite data and GMS data have been received at the Institute of Industrial Science, University of Tokyo since early 80's and 1994, respectively. So far, all data are archived and users can look their quick look images through the Internet and get the data by request. The following processed data set will be available soon with the corporation with the Science University of Tokyo: Radiometrically corrected by 6S code and geometrically corrected NOAA data with the corporation with Iwate University and NDVI, SST and cloud classified images as their products. 1 km AVHRR Land Project Data Set of Asia and their 14 regional subsets. Geometrically corrected GMS images and surface temperature maps, sea surface temperature maps and cloud classification maps.

1. Introduction

The Institute of Industrial Science, University of Tokyo has started to receive NOAA satellite data and GMS data have been received at since early 80's and 1994, respectively, to promote the academic researches on the earth environment utilizing satellite data.

Through the Special Research on "Higher Order Utilization of Remote Sensing Data from Space" from 1985 for three years and the Priority Area Programme on "Better Understanding of Earth Environment via Satellite" from 1989 for three years, funded by the Ministry of Education, Science and Culture, it was realized that the enhancement of research infrastructure, to provide satellite data reception, processing, distribution and archive systems, to provide database to utilize satellite data, and to promote network utilization, and so forth, is mandatory to promote academic researches on earth environment utilizing satellite data,

And to enhance the infrastructure, the concept of "Satellite Data Center Based on Network" was proposed. As an experimental step to realize this concept, "Construction of Distributed Global Environmental Database Based on Network" project has started since last year for five years, supported by the Telecommunications Advancement Organization (TAO). This project has the following 7 members: Science University of Tokyo (Mikio Takagi), Faculty of Engineering, Iwate University (Ryuzo Yokoyama), Center for Atmospheric and Oceanic Studies, Tohoku University (Hiroshi Kawamura)

Faculty of Engineering, Nagaoka Technology and Science University (Toshio Koike), Institute of Industrial Science, University of Tokyo (Masaru Kitsuregawa), National Center for Science Information Systems (Kinji Ono), and Center for Environmental Remote Sensing, Chiba University (Yoshiaki Honda).

In this paper, the current activities at the Science University of Tokyo to assist the Institute of Industrial Science, University of Tokyo, which is playing the central role in this project will be described.

So far, all data are archived and users can look quick look images through the network and get the data by request. The following processed data sets will be available soon:

In corporation with Iwate University radiometrically corrected by 6S code and geometrically corrected NOAA data and NDVI, SST and cloud classified images as their products.

1 km AVHRR Land Project Data Set of Asia and their 14 regional subsets.

Geometrically corrected GMS images and surface temperature maps, sea surface temperature maps and cloud classification maps.

2. Geometric Correction

Global environmental satellite database requires very accurate correction as the primary processing; i.e. sensor calibration, atmospheric correction, conversion of observed data to physical parameters, geometric correction (mapping) and so on. Recently Prof. Yokoyama's group of Iwate University has developed the radiometric correction algorithm of NOAA data using 6S code. And this is implemented at the Institute of Industrial Science and under test.

For geometric correction, since satellite data are extremely huge, high speed algorithm for complicated correction should be developed. And validation of Its accuracy for database is mandatory. The required accuracy becomes severer and severer and is expected to register within 1 pixel for time series analysis using multiple images.

The required mapping accuracy for NOAA image is 0.01 degree (1 km resolution at the nadir) and that of GMS images are 0.01 degree (1.25 km at the nadir) for visible images and 0.04 degrees (1.25 km at the nadir) for infrared images. The coast line database was provided to overlay the coast lines on geometrically corrected images in various scales and the GCP (Ground Control Point) database was prepared to measure the errors in geometric correction by template matching to check its accuracy and to develop more precise geometric correction algorithms using error vectors at the GCP's.

Figure 1 shows a GMS visible global image and its geometrically corrected image is shown in Figure 2. And The geometric correction algorithms are under development in the accuracy of 0.01 degree and 0.04 degrees for NOAA and GMS visible data and for GMS infrared data, respectively.

In the systematic geometric correction method, first the longitude and latitude of each observed pixel are calculated using the satellite orbit parameters and the transformation, in which each point data in the earth coordinate system is picked up from the corresponding image pixel, is taken place. But, this method needs a lot of computation, if the calculation is made at each earth coordinate point in mapping. Therefore, to speed up this process, the map in the earth coordinate system is divided into blocks and the correspondence of only 4 corner points is calculated precisely and the corresponding image pixel to the point within the block are calculated by simple bilinear interpolation has been developed.

For example, in the case of GMS images if the block size is 50x50 points, the accuracy of this bilinear interpolation method is within 0.5 pixels. As the result, the computation time required to map a GMS visible image to 14,000x14,000 pixels in the accuracy of 0.01 degree can be shortened to 284.2 seconds, compared to that of 11,494.4 seconds in the case of each pixel calculation method. Figure 1 shows a GMS visible global image and its geometrically corrected image is shown in Figure 2. Figure 3 shows a example of NOAA image.

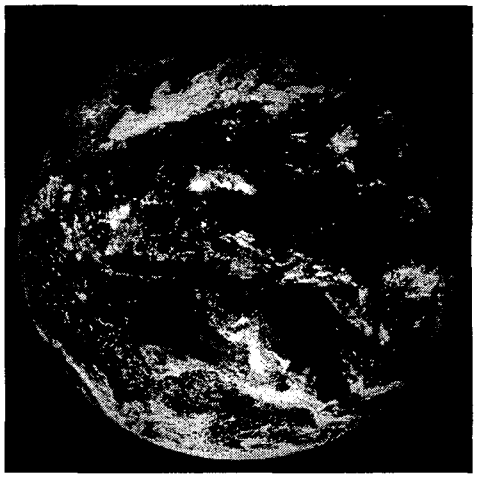

Figure 1 GMS Global Image

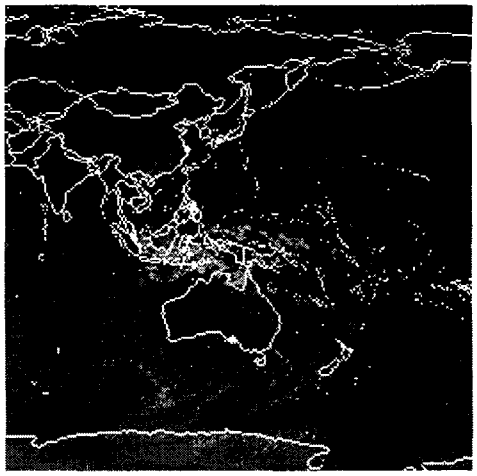

Figure 2 Geometrically Corrected Global GMS Image

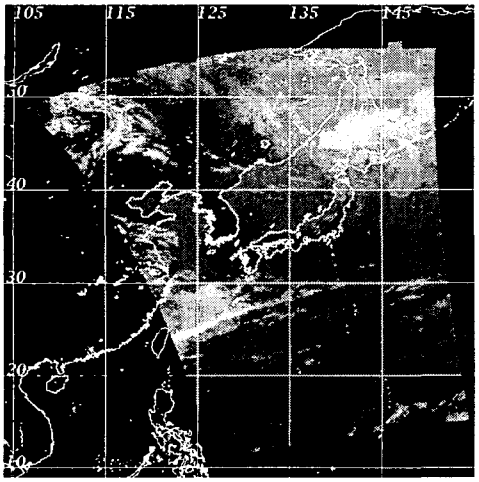

Figure 3 Geometrically Corrected NOAA Image

3. Data Set Generation

To promote academic researches in global environmental studies, the data sets generation for various users are essential. From this viewpoint, the integrated NOAA data processing system from reception, processing, archiving, and to data set generation is under testing at the Institute of Industrial Science, University of Tokyo. Iwate University has developed a sophisticated radiometrical correction system based on 6S code and geometrical correction based on PaNDA, which was developed during the Special Research on "Higher Order Utilization of Remote Sensing Data from Space". This software system has been implemented and under test. Some modification will be necessary, but it is under planning to provide the data sets derived from NOAA data such as NDVI, SST and cloud classified images as their products. It is expected that these data sets will be available through the academic network (SINET) in the near future.

The 1 km AVHRR Land Project started April, 1992 to monitor the global vegetation. The Institute of Industrial Science, University of Tokyo joined the project from the beginning and has been contributing in sending dairy daytime data of 100 MB to 200 MB to the EROS Data Center everyday through the Internet. And the first 40 global NDVI and related data in 10 channels of every 10 days were sent from the EROS Data Center for academic use. But, these data is too big, even they are compressed, for ordinary users to process. Then, hearing the requests from academic users in Japan, data sets of Asia and 14 regional data sets were generated. Figure 4 shows an example of NDVI image of Asia in early April, 1992. These data sets are open on the home page.

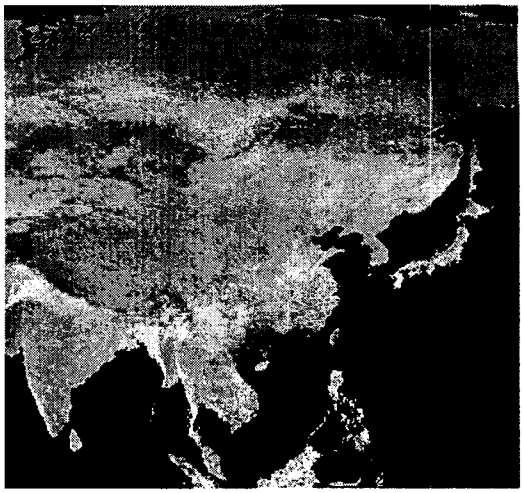

Figure 4 NDVI Image of Asia Early April, 1992

And data sets generation of GMS images has started. Figure 5 shows an example of cloud classification and Figure 6 shows a SST map.

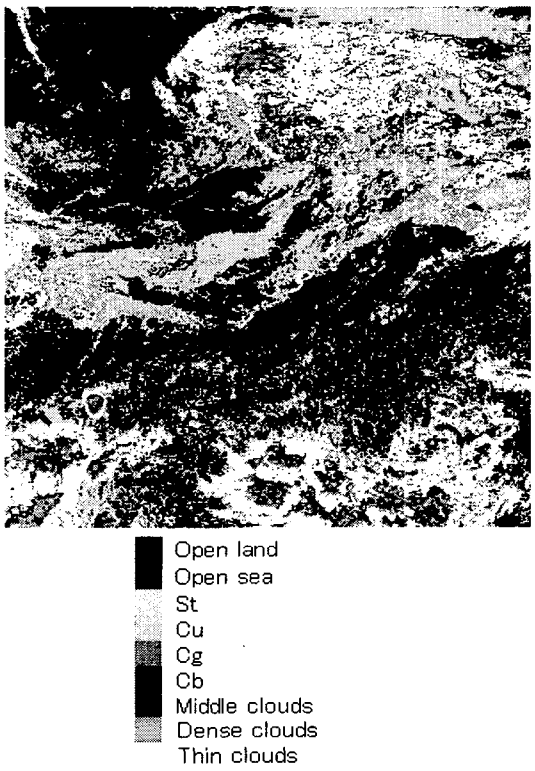

Figure 5 Cloud Classification

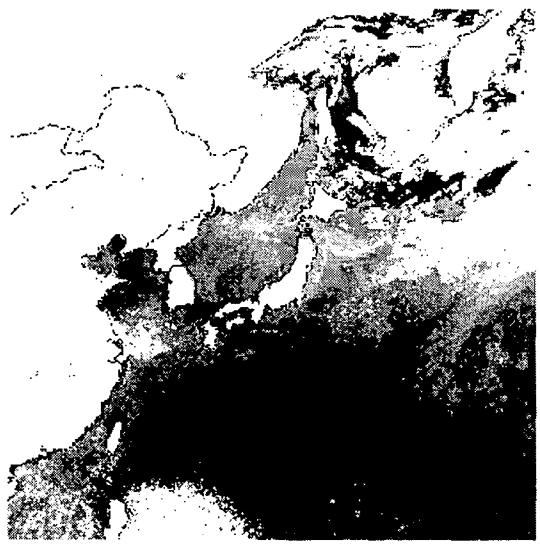

Figure 6 SST Map

4. Conclusion

Activities to develop an integrated system for global environmental monitoring satellites NOAA and GMS are introduced. It took a very long time back to the early 80's and there still a lot of works to be done. Among them the improvement of the accuracy of geometric correction should be done in the first priority. For more precise geometric correction, after the systematic correction by orbit calculation, an iterative method, in which using the errors of GCP's and estimating the attitude of satellite, and adjusting the orbital parameters, systematic correction is done iteratively, should be developed.

And in generation of various kinds of data sets refinement of their algorithms through validation needs a lot of study and effort and data sets for validation should be provided for these research.

The problems in archiving a tremendous huge data have been almost solved owing to the efforts of Prof. Kitsuregawa and his laboratory members. And the access to the huge database is open only to the limited academic users, but soon it becomes possible that users search the data they need and get the data they require and process them using the facilities at the Institute of Industrial Science, if the volume is small through network, and if the volume is large in back ground job.

The huge data are archived in a hierarchical memory system. A new database access method will be developed, the huge image database is structured hierarchically and to access the region of interest as quick as possible.

As a major node of the distributed global environmental database based on network, further efforts will be paid to offer the better environment for academic users to promote global environmental studies using satellite data.