OVERVIEW OF KOMPSAT APPLICATION PRODUCT VALIDATION SITE AND THE RELATED ACTIVITIES

Kwangjae Lee, Boyeol Youn, Dukjin Kim, and Younsoo Kim

Korea Aerospace Research Institute, 45 Eoeun-dong, Yuseong-gu, Daejeon, 305-333, Korea
kjlee@kari.re.kr, byoon@kari.re.kr, djkim@kari.re.kr, and younsoo@kari.re.kr

ABSTRACT: In recent years, there has been an increasing demand for improved accuracy and reliability of Earth Observation Satellite (EOS) data. Most of the data users in the field of remote sensing require understanding of product accuracy and uncertainty. Especially, EOS application products should be validated for practical application in the field. In order to evaluate the availability and applicability of application products, it will be necessary to establish a systematic validation system including techniques, equipments, ground truth data, etc. The Product Validation Site (PVS) for generation and validation of KOMPSAT application products was designed and established with various in-situ equipment and dataset. This paper presents the status of PVS and summarizes some results from experiment studies at PVS.

KEY WORDS: KOMPSAT, Product Validation Site (PVS), EOS, Ground Truth Data

1. INTRODUCTION

In order to fully realize the potential of EOS data for various earth science applications such as geology, environment, and etc., it is necessary that data should be calibrated and validated in terms of product quality. It is now generally recognized that Calibration and Validation (Cal/Val) are an essential component of any EOS system. In recent years, there has been an increasing demand for improved accuracy and reliability of EOS data. Generally, Cal/Val of EOS system has been accomplished by systematic experiment in the laboratory and field. Also the procedure of Cal/Val is well organized depend on each system and item. Nevertheless, in most cases, data users have no consideration for the Cal/Val because it is carried out in the ground station. The remote sensing data are usually not ready for use directly, but need to undergo a series of pre-processing steps (Song, 2001). However, in most cases, data users have to utilize the remote sensing data that have already been collected and archived (Lee, 2004) so that it is difficult to evaluate the pre-processing result and improve the data analysis in many ways. Also most of data users require understanding of product accuracy and uncertainty because it is necessary to evaluate the applicability and availability of application products of remote sensing data before the application in the field. But, in order to fully understand an accuracy of final application products, the systematic validation plan would be prepared including test site, sensing instrument, various dataset, and etc.

The purpose of this study is to design and establish the Product Validation Site (PVS) in order to generate and evaluate the KOMPSAT application products such as ortho-rectified image, DEM, and many others. In this study, characteristic of validation site on the Committee on Earth Observation Satellite (CEOS) were surveyed and its results were used to define a concept of product validation and to design a validation site for KOMPSAT. This paper summarizes the status of experimental studies for design and establishment of PVS and presents some expected results from related activities.

2. PRODUCT VALIDATION SITE

2.1 EOS Land Validation Core Site

The Land Product Validation (LPV) is a subgroup of Working Group on Calibration and Validation (WGCV) which is a standing working group of CEOS. The LPV consists of land-cover, biophysical, fire/burn, and surface radiation. The LPV performs its primary validation activities at the EOS Land Validation Core Sites (Fig. 1).

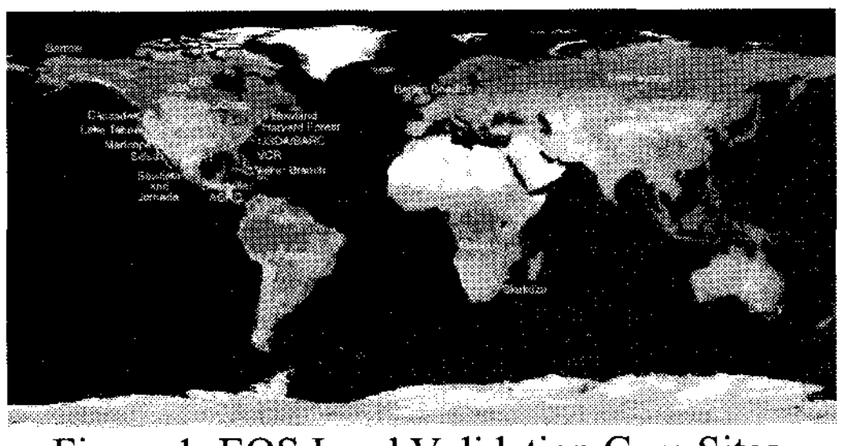

Figure 1. EOS Land Validation Core Sites.

The Working Group on Information System and Services (WGISS) is one of three subgroups supporting the CEOS. The WGISS promotes collaboration in the development of systems and services that manage and supply earth observation data to users world-wide. The WGISS Test Facility (WTF) sites have been managed and operated in order to support the various dataset by U.S. Geological Survey (USGS).

Recently, in order to organize a network of "CEOS Land Validation Core Sites", a joint research program is performed by both WGCV and WGISS (Morisette, 2005). The objective of joint program is to collaboratively

collect a ground truth data using in-situ measurement equipment and to share a dataset for land product validation.

Each of the EOS Core Sites is archived various ground truth data and established in-situ measurement equipment in accordance with the site's objectives. Fig. 2 shows in-situ measurement equipments at Sevilleta LTER site which is 16th sites of the EOS Core Sites. The measured data from ground sensing instruments were provided by internet website. The Sevilleta LTER site also provide a useful dataset such as Ground Control Point (GCP), Digital Elevation Model (DEM), land-cover/use maps, soil maps, satellite and aerial image data, and many others for land product validation.

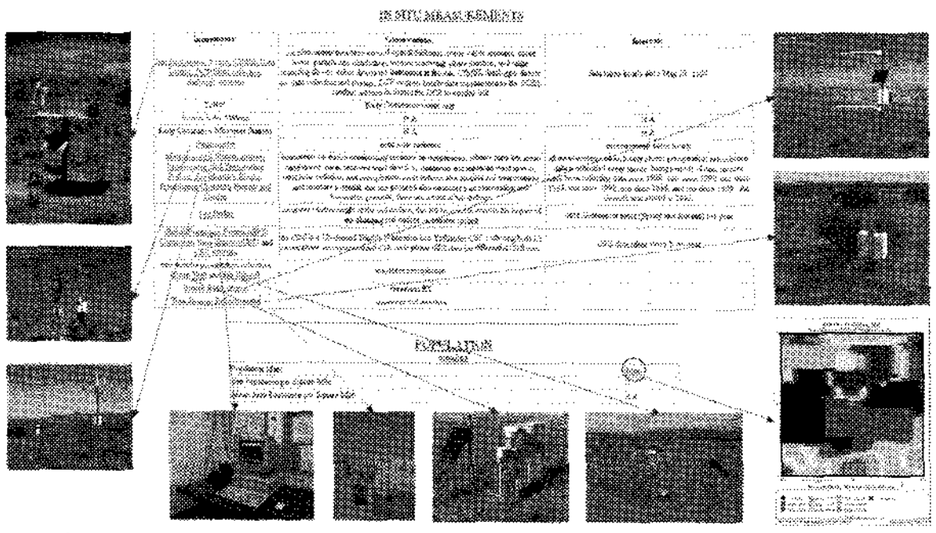

Figure 2. In-situ measurement equipments at Sevilleta LTER site.

Fig. 3 shows one of the results from field campaign with EO-1 Hyperion data at Manfredi INTA site. Various in-site data were measured by ground sensing instrument during satellite over-flight and used for validation of the land product of EO-1 Hyperion. Also in-site measured data were significantly useful to evaluate an algorithm for data processing and analysis.

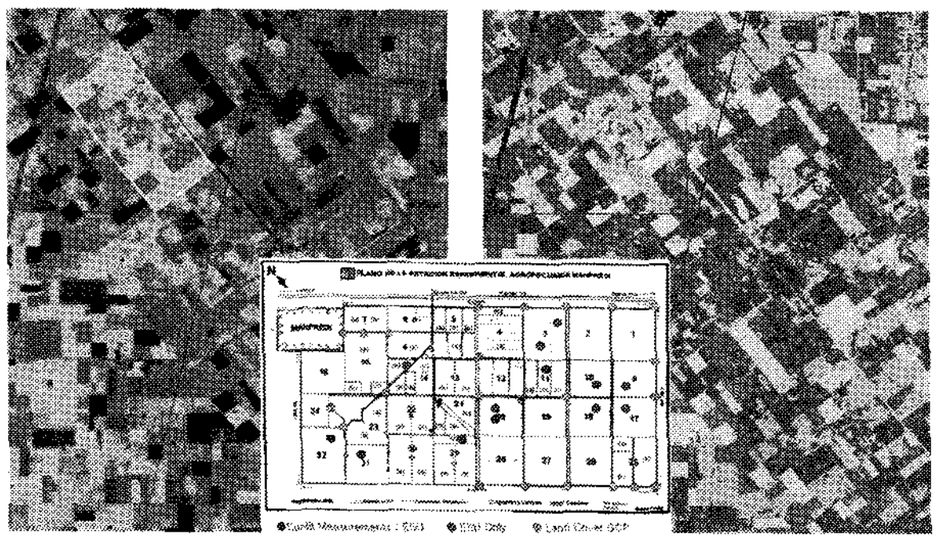

Figure 3. Example of Manfredi INTA site.

However, unfortunately, most of the EOS Core Sites is somewhat different with the proposed site in this study because they are focused on validating the middle and low resolution products. The PVS for KOMPSAT should be designed and established in order to validate the high resolution application products.

2.2 Concept of PVS

Product validation needs to be an integral part of remote sensing applications. Validation activities should consider user accuracy needs and feedback to algorithm improvements. Explicit statements of uncertainty foster an informed user community and improved use of data.

Ideally, a way that utilizes ground truth data is the most accurate in terms of validation for application products. However, because of the limited ground truth data, this is unacceptable for many applications and is often impossible, as when using historical data set or when working in very remote locations.

The PVS is intended as a focus for validation of KOMPSAT application products over a range of thematic type; however, it will also be useful for generation of application products because most of ground truth data in PVS can be used for pre- and post-processing step. To generate acceptable application results, method are required that typically uses *in-situ* measurements to correct for radiometric and geometric effects. The PVS will support not only the validation of KOMPSAT application products, but also the multi-sensor application research because each on-board payload of KOMPSAT will be different depending on its purpose. Multi-sensor products offer great potential. However, the related algorithms will require an understanding of the basic characteristic of each sensor with its real image data and various ground truth data for experiments.

The basic concept of PVS is somewhat different with the Cal/Val site. The PVS is based on the KOMPSAT application products. On the other hand, the purpose of Cal/Val site is to validate the system level performances such as Modulation Transfer Function (MTF), Ground Sample Distance (GSD), etc. and calibrate the radiometric and geometric distortion of image data by using special targets. So the related activities with PVS should be distinguished with Cal/Val activities and performed by the validation system.

2.3 Design and Establishment of PVS

Each of the validation tasks depending on application products requires substantial resources in terms of sensing instrument and ground.

The validation sites for land products in this study are Daejeon (urban area) and Dangjin (rural area). These sites will be used to generate and validate the land application products such as thematic maps using various sensor data. On the other side, the validation site for ocean product is Ieodo which is located in southwest of Jeju island. Especially, ocean validation site in Ieodo will be used to develop the algorithm for ocean products and validate its results such as wind, wave, and current products using multi-sensor data.

Table 1. The status of major ground truth data at land validation sites.

Items	GCP	DEM	Aerial Photo	Digital map

Sites	0.5pixel	1pixel	0.5pixel	1/1,000
Daejeon	completed	completed	completed	completed
Dangjin	completed	will be completed	completed	1/1,500 (exchange)

In the case of land validation with high resolution image data, validation of geometric accuracy is an important factor to generate various thematic maps. So requirement of GCP, DEM is very strict as shown in the Table 1. Especially, various GCP targets were tested by using high resolution image data before the establishment of GCP database. The GCP database for high resolution optical remote sensing data was established as shown in the Fig. 4. The corner reflector which is a reference GCP target for KOMPSAT-5 Synthetic Aperture Radar (SAR) data will be established as soon as possible.

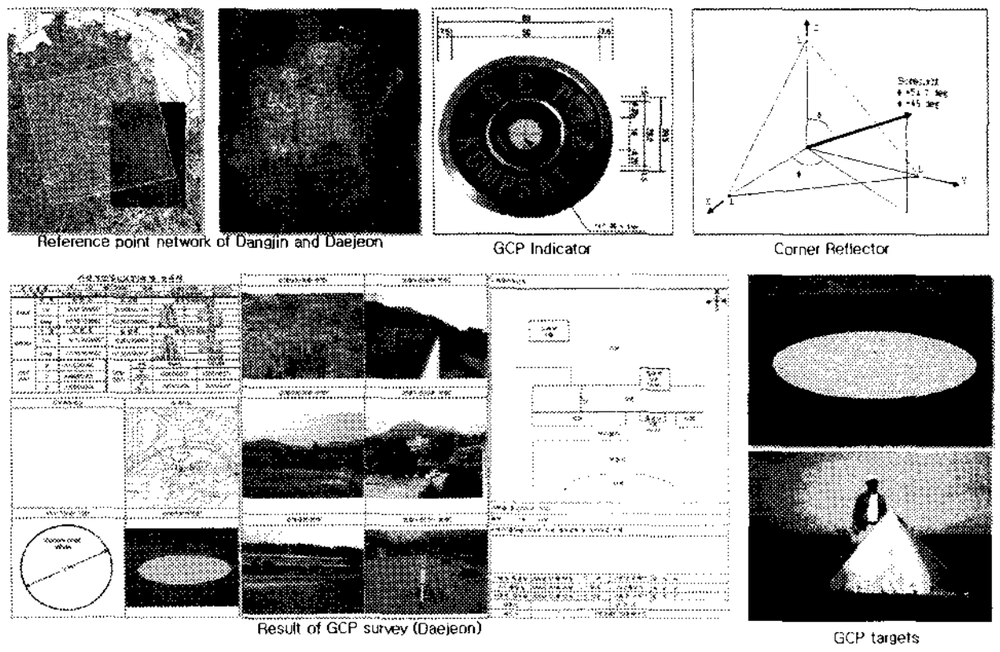

Figure 4. GCP database at land validation site.

Some other ground truth data such as Fig. 5 are also an essential element in the land product validation. The in-situ measurement equipments such as spectroradiometer, skyradiometer, and etc. were used during satellite over-flight. Also we have a plan for acquisition of TerraSAR-X, COSMO-SkyMed through Announcement of Opportunity (AO) and use of airborne hyper-spectral imaging system in the near future.

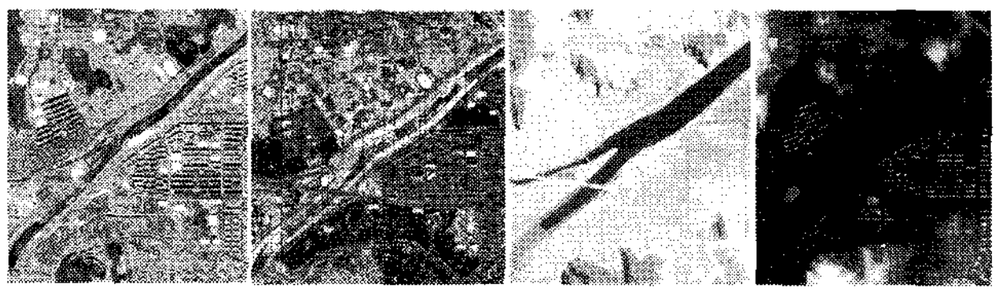

Figure 5. Ground truth data (aerial photo, digital map of 1/1,000, DEM, DSM) at land validation site.

2.4 Experimental Studies

The experimental studies with a field campaign were performed during the establishment of land validation sites. An example of the field test is illustrated in Fig. 6. The primary goal of such test in Fig. 6 was to make an experiment on microwave scatterometer measurement and then to get a idea from its experience for developing new ground experiment equipment in terms of KOMPSAT-5 X-band SAR data. The X-band equipment will be needed to acquire and analyze the backscattering coefficient from surface target and develop the algorithm for application products.

Figure 6. Experiment of microwave scatterometer measurement for SAR data.

The mapping is one of the most important application fields using high resolution satellite image data instead of aerial images. However, the mapping result based on high resolution satellite image data should be synthetically evaluated from data pre-processing to final result stage. Also data users should clearly understand characteristic of each dataset because each product from satellite data has a different accuracy by level processing.

In this study, the stereo dataset of IKONOS-2 standard geometrically corrected product (7 February 2002) and QuickBird-2 1B product (15 January 2005) were used for generation and validation of the land products. Also DEM from digital maps of 1/5,000 and GCPs were used for data processing. The experiment was systematically performed with different processing step. On the basis of the RPC, DEM, GCPs, and Tie points were gradually added according to each processing step for generation of ortho-rectified image and DEM such as Fig. 7.

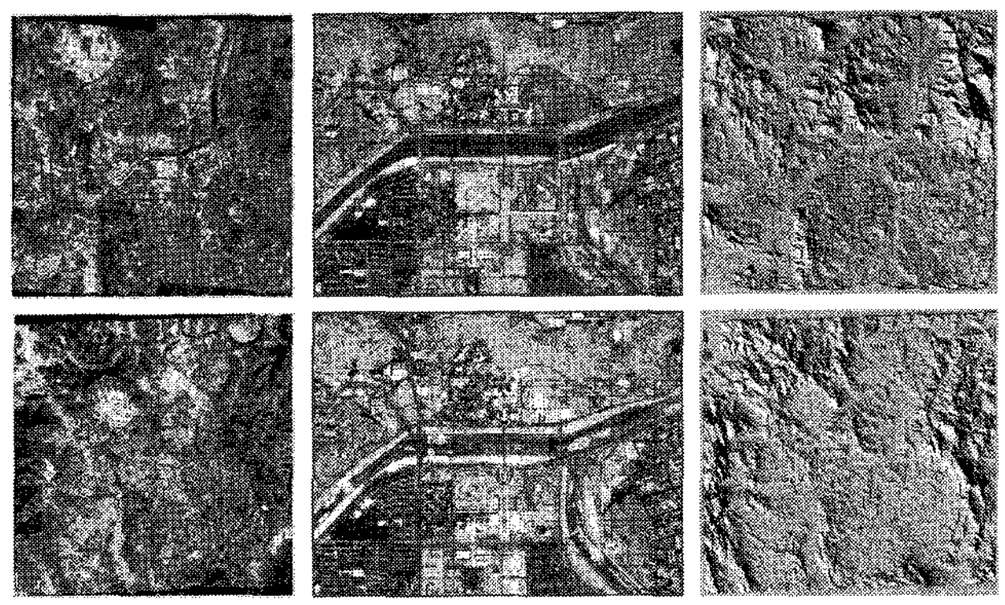

Figure 7. Generation of ortho-rectified images and DEM using IKONOS-2 (top) and QuickBird-2 (bottom) data.

In order to validate results from each step, digital maps of 1/1,000 were overlaid with ortho-rectified images such as Fig. 8. The result of Fig. 8 clearly shows that the difference was existed depend on with GCP or without GCP. As we already known that it was impossible to use the only RPC for generation of precise ortho-rectified image, even the case of RPC and DEM which is RPC_D in Fig. 8. The accuracy of RPC_D_G which was used twenty GCPs is very close to RPC_D_G_T which was

automatically added twenty tie points and both Root Mean Square (RMS) errors were 0.59 and 0.43.

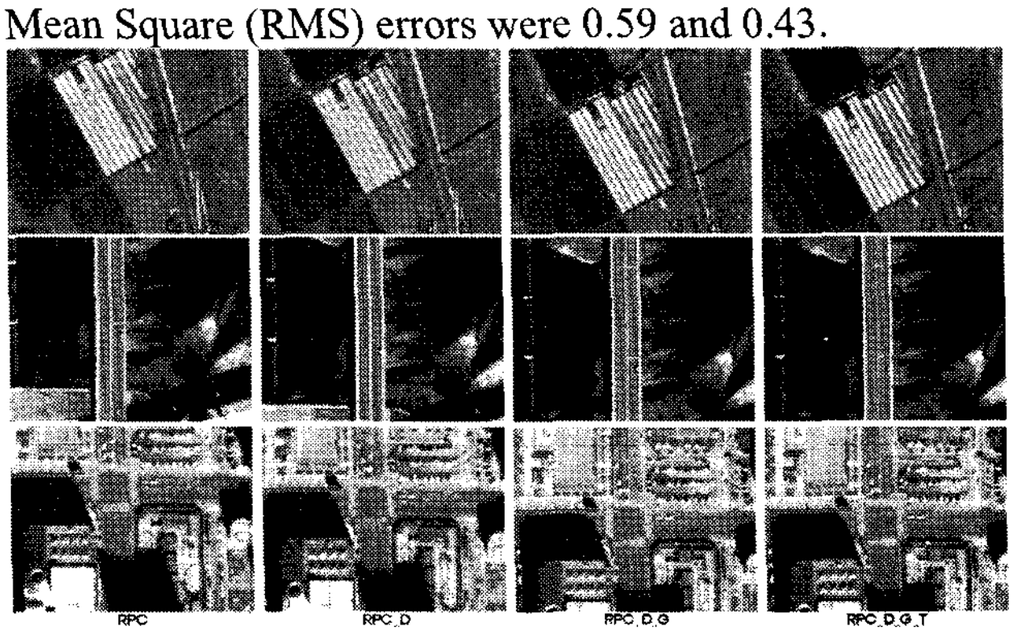

Figure 8. Validation of IKONOS-2 ortho-rectified images by processing step.

The result of Fig. 8 is quite similar to the result from experiment of DEM extraction and validation. However, we could not extract the same resolution of DEM from both stereo dataset because of the processing time and memory. In this test, 3 by 3 filter was basically applied for calculation of TIN model. However, it could not apply to 27,000 x 28,000 pixels of QuickBird-2 stereo data. So finally 3m and 9m DEM was individually extracted from IKONOS-2 and QuickBird-2 stereo data. The experiment for generation and validation of DEM was limited with both different outputs. However, this experiment will be continually carried out with other processing method.

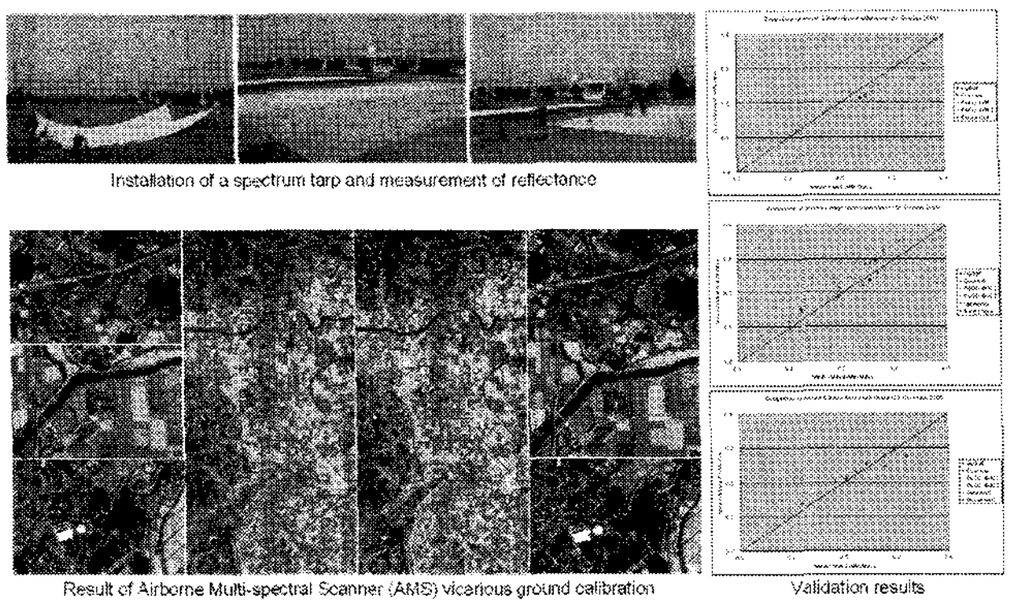

Figure 9. Result of AMS vicarious ground calibration by field campaign.

Recently, the vicarious ground calibration technique was experimented to examine the radiometric calibration of Airborne Multispectral Scanner (AMS) image data using spectral tarps and in-situ measurement equipments. The results of Fig. 9 show that the proposed method based on field campaign is substantially suitable in terms of radiometric calibration of AMS image data. Also the calibration result was validated by measured reflectance data from different surface target (Lee, 2006). However, the experiment of those days was very limited to simple interactions within reflectance of spectral tarp and DN value of AMS, ignoring atmospheric conditions and effects.

3. SUMMARY

The product validation activities are an important component for revitalization of KOMPSAT applications. However these activities should consider user accuracy needs and feedback to algorithm improvements. Most of data user requires understanding of product accuracy and uncertainty for practical applications. In order to validate both land and ocean application products of KOMPSAT data, it will be necessary to establish the validation sites and systematic validation system. This paper presents the status of PVS and summarizes some results from experiment study at PVS. Current work has focused on, developing the operation concept, designing the in-situ equipment, coordinating the acquisition and archiving of existing and future data for the sites.

RERERENCES

Lee, K., and Y. Kim, 2004. Satellite-derived surface reflectance using the image-based atmospheric correction. IRS 2004: Current problems in atmospheric radiation, pp.199-202.

Lee, K., Y. Kim, and J. Han, 2004. Vicarious ground calibration of Airborne Multispectral Scanner (AMS) and based on field campaign. International Symposium on Remote Sensing 2006 Pan Ocean Remote Sensing Conference, Busan, Korea, DVD publication.

Morisette J., 2005. Land product validation subgroup report-presentation material, 22nd WGCV Plneary, USA

Song. C., C.E. Woodcock, K.C. Seto, M.P. Lenney, and S.A. Macomber, 2001. Classification and change detection using Landsat TM data: When and how to correct atmospheric effects. Remote Sensing of Environment, vol 75, pp.230-240.

ACKNOWLEDGEMENT

This work was supported by a grant from the Korean Ministry of Science and Technology (MOST).