# AN EXPERIMENTAL STUDY ON THE ESTABLISHMENT OF PRODUCT VALIDATION SITE AND THE RELATED ACTIVITIES

Kwangjae Lee[(1)], Younsoo Kim[(1)], Yongseung Kim[(1)] and Bianca Hoersch[(2)]

[(1)]Korea Aerospace Research Institute, 45 Eoeun-dong, Yuseong-gu, Daejeon, 305-333, Korea
kjlee@kari.re.kr, younsoo@kari.re.kr, yskim@kari.re.kr
[(2)]European Space Agency, Via Galileo Galilei - Casella Postable 64 - 00044 Fascati, Italy
Bianca.Hoersch@esa.int

**ABSTRACT:**

In order to evaluate KOrea Multi-Purpose SATellite (KOMPSAT) application products and develop the multi-sensor data application technologies, the Product Validation Site (PVS) will be designed and constructed by Korea Aerospace Research Institute (KARI). Also KARI has a plan for acquisition of multi-sensor data such as ENVISAT ASAR and Project for On Board Autonomy (PROBA) Compact High Resolution Imaging Spectrometer (CHRIS) data through international cooperation with European Space Agency (ESA). These data will be utilized with KOMPSAT-2 Multi-Spectral Camera (MSC) data. KARI and ESA have identified a mutual interest in creating synergy in the joint exploitation of Earth Observation data for science and applications both in Korea and Europe. This paper summarizes the status of joint experimental studies between KARI and ESA for further applications and presents some expected results from related activities.

**KEY WORDS:** KOMPSAT, MSC, PROBA, CHRIS, PVS

## 1. INTRODUCTION

Digital analysis of Earth Observation Satellite (EOS) data such as KOMPSAT, PROBA, and ENVISAT has become an important component of a wide variety of earth science studies. Also EOS data have been used for various earth science applications, such as geology, mapping, atmosphere, ocean, environment, etc. However, in order to fully realize the potential of EOS data for such applications, it is necessary that data should be calibrated and validated for product quality. Especially, in recent years there has been an increasing demand for improved accuracy and reliability of EOS data (Fox, 2004). It is now generally recognized that calibration and validation are an essential component of any satellite system. Also product validation is an important component for domestic and foreign data users because of its reliability and usefulness demonstration.

For these reasons, KARI considers the Product Validation Site (PVS) for evaluation of EOS data application results. KARI will support research activities with the forthcoming KOMPSAT-2 and other satellite data such as CHRIS on board PROBA and ENVISAT. Also KARI has a plan for development of multi-sensor data application technologies by using the PVS and the related activities.

## 2. PRODUCT VALIDATION SITE AND THE RELATED ACTIVITIES

### 2.1 Cooperation between KARI and ESA

A long-lasting cooperation between Korea and the ESA Member States as precursor, KARI and ESA have identified a mutual interest in strengthening their international cooperation and creating synergy in the joint exploitation of EO data for science and applications both in Korea and Europe.

A study performed within the European and Canadian EO Community (Curtis and Knops, 2004) revealed that most EO data users rely not only on one, but on several missions, both to increase sustainability of their service and to widen the range of observation parameters. In addition to its own missions, ESA therefore offers access to the scientific and applications community to so-called 'Third Party Missions'. Third Party missions are complementing the observations of ESA missions, are used to prepare for future ESA missions including cross-calibration and create synergy to favor a wider use of EO data within ESA Member States.

In this regard, the KOMPSAT series is of primary interest to the European User Community, as are ERS, ENVISAT, PROBA and at a later stage the Earth Explorers to the Korean EO Users.

Therefore and in order to strengthen the cooperation between both Agencies, a 'Roadmap for Earth Observation' is jointly being designed for the upcoming years, in order to prepare the following activities at mutual benefit:

- Evolution of data exchange and data access agreements for the KOMPSAT series and the ESA

EO missions. For the joint exploitation and exchange of EO data, the Roadmap foresees a multi-step approach of cooperation:

- Pilot scientific projects with KOMPSAT-1 and ENVISAT/ERS/PROBA data in Korea and Europe.
- Joint Announcement of Opportunity (AO) and preparation of KOMPAST-2 ground segment cooperation in Europe under the ESA Third Party Mission scheme.
- Ground segment sharing and further enlargement of joint AO for upcoming EO missions.

• Joint project teams for the exploitation of KOMPSAT series and ESA mission data.
• Representation of KARI programs and missions at ESA workshops and symposium and vice versa.

Respective mutual consultation, training, access to scientific project results and exchange of scientists will accompany the cooperation.

## 2.2 CEOS Land Product Validation

Good science and resource management require understanding of product accuracy and uncertainty. Explicit statements of uncertainty foster an informed user community and improved use of data. Validation needs to be an integral part of each mission, funded as with sensor and algorithm development. Land Product Validation (LPV) is a subgroup of Working Group on Calibration and Validation (WGCV) which is a standing working group of the Committee on Earth Observation Satellites (CEOS). The main objectives of LPV is to increase the quality and economy of global satellite product validation via international coordination on developing and promoting standards and protocols for field sampling, scaling, error budgeting, data exchange and product evaluation and to advocate mission-long validation programs for current and future earth observation satellites (Morisette, 2004).

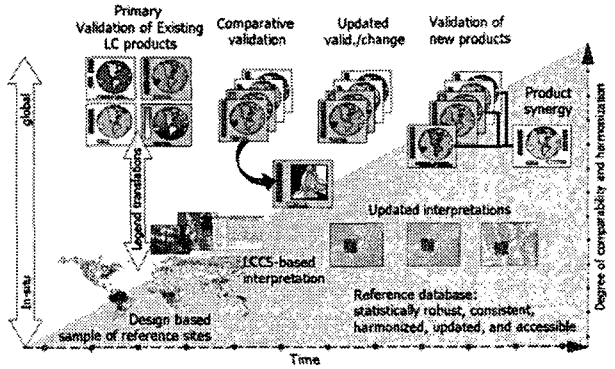


Figure 1. GOFC-GOLD/CEOS Framework (Morisette, 2004).

Figure 1 shows the framework for joint Global Observation of Forest and Land Cover Dynamics (GOFC -COLD)/CEOS harmonization/validation initiative.

## 2.3 Design for Product Validation Site

KOMPSAT-2 will be launched in the end of this year. It will provide the 1m panchromatic image and 4m multi-spectral image with four bands. The spatial resolution and spectral bands of MSC are quite similar to IKONOS so that MSC images will continuously serve the national and international user demand for high resolution images. As part of an effort to promote the development of remote sensing technology and public applications research of satellite data, KARI has established the KOMPSAT-2 application infrastructure and supported the public application research using EO data.

In the case of KOMPSAT-1, it has been used in the various research and application areas of remote sensing and produced the useful results. The one of KOMPSAT-1 payload instrument, EOC has been utilized mainly for land applications including the mapping, change detection, land-use/cover analysis. However, we could not verify the accuracy of these application products because of the ground truth 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. To generate acceptable EO data application results, a method is required that typically uses *in-situ* measurements to correct for radiometric and geometric effects.

KARI has a plan for the calibration and validation of KOMPSAT-2 MSC data using Cal/Val test targets such as Fan-shape target and Tarp target. These Cal/Val targets will be used to evaluate Ground Sample Distance (GSD), Modulation Transfer Function (MTF), and radiometric calibration coefficients. Also other *in-situ* data will be used for geometric and radiometric Cal/Val activities. KARI is preparing the most suitable algorithms and techniques for the MSC data Cal/Val before the launch of KOMPSAT-2.

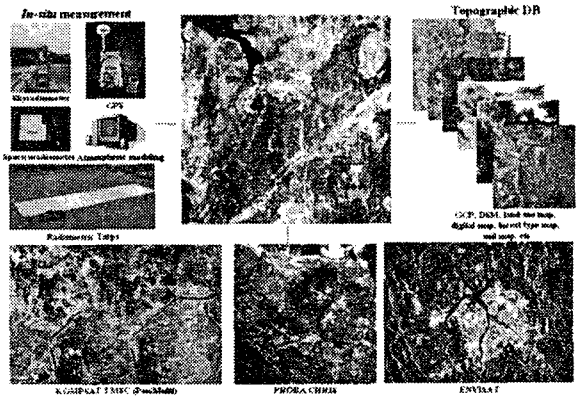

Figure 2. Design for product validation site.

Also the PVS will be designed and established for evaluation of the KOMPSAT application products and development of the multi-sensor data application technologies. Figure 2 shows the basic idea of PVS. The

validation sites in the Figure 2 are Daejeon (Site A) and Dangjin (Site B). The ground truth data will be collected by using various *in-situ* measurement equipments such as GPS, Spectroradiometer, Skyradiometer, and etc. Also KARI has a plan for acquisition of multi-sensor data such as ENVISAT ASAR and PROBA CHRIS data through international cooperation with ESA.

The fundamental concept of PVS is similar to the KOMPSAT Cal/Val site. However, the PVS is somewhat different with the KOMPSAT Cal/Val site such as Fan-shape target about the main function. The primary operation of the KOMPSAT Cal/Val site is to validate the MSC CCD performances using GSD, MTF, and etc. and to calibrate the some parameters such as radiometric calibration coefficient for high quality data. In the PVS, the accuracy of thematic maps such as the forest type map, the land-use/cover map will be validated by using ground truth data. Also the algorithm for change detection and classification will be evaluated with the applied results. Figure 3 shows an example of PVS application plan.

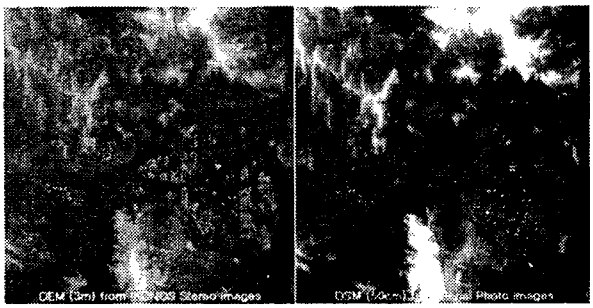

Figure 3. An example of DEM validation.

The other example in the Figure 4, KARI examined the image-based atmospheric correction models using the data from Landsat ETM+ and IKONOS that have quite similar spectral characteristics to the forthcoming KOMPSAT-2 MSC and the *in-situ* measured surface reflectance data during satellite overflight. *In-situ* field measurements are used to evaluate the accuracy of each method that computes the surface reflectance from the ETM+ satellite image. Figure 4 shows the one of results that two cases have substantially removed the atmospheric effects on the images (Lee, 2004).

Figure 4. An example of image-based atmospheric correction using IKONOS image (before: left, after: right).

The PVS will support not only the validation of KOMPSAT application products, but also the multi-sensor application products. Multi-sensor data such as ENVISAT ASAR and PROBA CHRIS will be acquired from ESA. The high resolution mapping for forest type and vegetation index, sometimes the hyper-spectral data are needed. Therefore, PROBA CHRIS data will be used to generate the high spatial and high spectral resolution thematic maps and develop the multi-sensor data processing algorithms with KOMPSAT series data. Also ENVISAT data will be used for generation of thematic maps and development of data processing algorithms. Figure 5 shows the concept of the product generation and validation using multi-sensor data.

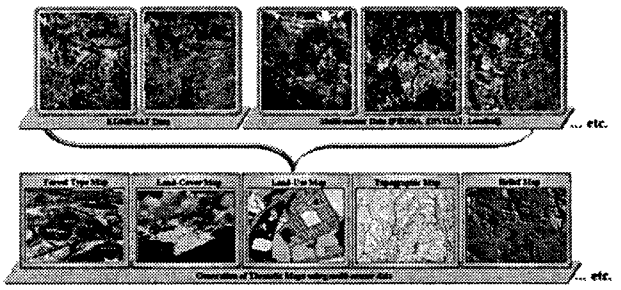

Figure 5. Generation and validation of the multi-sensor data application products.

### 2.4 Field Campaign

PROBA has provide data successfully ever since its launch on 22nd Oct 2001. Hosting two EO instruments FHRIS and High Resolution Camera (HRC), PROBA is since 2004 managed by ESA's Ground Segment Department within the Directorate of EO at ESA/ESRIN.

From a 600km orbit, CHRIS can image the Earth in a 14km swath with a spatial resolution of 18m. The CHRIS is programmable so that a variety of band selections are possible. It operates over the visible/near infrared band from 400nm to 1050nm and can operate in 63 spectral bands at a spatial resolution of 36nm, or with 18 bands at full spatial resolution. Spectral sampling varies from 2-3nm at the blue end of the spectrum, to about 12nm at 1050nm. Sampling is about 7nm near the red edge (~690-740nm). The instrument is very flexible and different sets of bands can be used for different applications. CHRIS has five different modes for all site (Mode 1), water studies (Mode 2), land/aerosols (Mode 3), Chlorophyll (Mode 4), land (Mode 5) (www.chris-proba.org.uk).

As shown Figure 5, CHRIS will be used for the land-use/cover classification, the high resolution mapping, and even Bidirectional Reflectance Distribution Function (BRDF) with other satellite data. For these plans, we will carry out field works for *in-situ* field measurements during each satellite overflight at our validation site.

Figure 6 shows the one of results from PROBA CHRIS field campaign. Surface reflectance was measured by using GER 3700 instrument at 8 different ground targets. The measured surface reflectance data will be used for analysis of the CHRIS spectral

characteristics, generation and validation of the application products with other EO data. All of data sets will be release for science and applications in Korea.

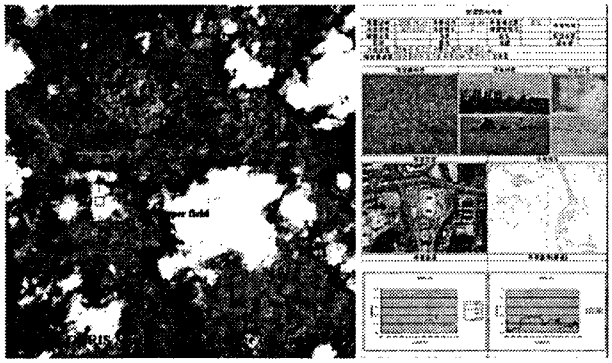

Figure 6. PROBA CHRIS field campaign (03 June 2005).

## 3. CONCLUSIONS

This paper summarizes the status of joint experimental studies between KARI and ESA for further applications and presents some expected results from related activities. KARI organized the task force team for this prototype program with other research institutes. The Product Validation Site (PVS) was designed for generation and validation of the KOMPSAT application products and development of the multi-sensor application technologies. Also KARI has a plan for acquisition of multi-sensor data such as ENVISAT, PROBA, QuickBird, and etc. The ground truth DB will be collected from field campaign by using various *in-situ* measurement equipments during satellite overflight. KARI and ESA will be able to create the synergy effects in the joint exploitation of EO data for science and application both in Korea and Europe by the international cooperation program.

## REFERENCES


Curtis P. and Knops F., 2004. The state and health of the European and Canadian EO services industry, http://www.eomd.esa.int/documents.asp (accessed 01 Sep. 2005)

Fox N. P., 2004. Validated data and removal of bias through traceability to SI units, Post-launch calibration of satellite sensors. Balkema Publishers.

Lee K. and Kim Y., 2004. Satellite-derived surface reflectance using the image-based atmospheric correction, International Radiation Symposium 2004.

Morisette, J., 2004. Land product validation subgroup report, 22nd WGCV Plenary, USA.

Morisette, J., 2005. Land product validation subgroup report, 23rd WGCV Plenary, USA.

The CHRIS instrument, 2002. http://www.chris-proba.org.uk/frames/index2.html (accessed 25 Feb. 2005)


## ACKNOWLEDGEMENTS


The authors would like to thank Korea Institute of Geoscience and Mineral Resources for cooperating PROBA field campaign on June 03, 2005.