

**DATA ARCHIVE AND VISUALIZATION FOR LUNAR ORBITER KAGUYA (SELENE).** H. Okumura<sup>1</sup>, S. Sobue<sup>1</sup>, H. Hoshino<sup>1</sup>, A. Yamamoto<sup>2</sup> and T. Fujita<sup>2</sup> <sup>1</sup>Japan Aerospace Exploration Agency (JAXA), SELENE Project Team, 2-1-1, Sengen, Tsukuba, Ibaraki 305-8505 Japan, [okumura.hayato@jaxa.jp](mailto:okumura.hayato@jaxa.jp), <sup>2</sup>Remote Sensing Technology Center Of Japan (RESTEC).

**Introduction:** The Japanese Lunar Orbiter KAGUYA (SELENE), which was launched on Sep. 14th 2007, started extended observation mission from Nov. 1st 2008 after completion of nominal mission. KAGUYA has 15 observation missions and obtains various scientific data of the moon. The processed observation data (we call them Level-2 data) are archived in the Level-2 Data Archive and Distribution system (L2DB) located at JAXA Sagami-hara Campus in Japan. Level-2 data will be open to the public from Nov. 2009.

In addition to data archive system, SELENE project are developing the web-based GIS system for the purpose of promotion for both research and EPO. The visualized observation data is stored in the KAGUYA Web Map Server (WMS) and will be released using GIS browsers such as NASA World Wind. Web-based GIS is useful for the research of KAGUYA integrated science because it allows scientists to map, overlay and share the data of multiple instruments easily. Also it is effective way to promote the observation data to the public.

**1. KAGUYA Data Archive:** KAGUYA Data Archive System (Level-2 Data Archive and Distribution system: L2DB) allows us to store, retrieve, order and download KAGUYA Level-2 data [1]. The data storage of L2DB is about 50TB which can store Level-2 data for all 14 scientific observation missions. The file format of the Level-2 data is "PDS-like Format" designed based on NASA/JPL PDS.

Level-2 data will be distributed from the Data Distribution Subsystem. Users can retrieve the data through a web browser with search keys such as product name, observation period, observation area, etc.. It is also possible to select observation area in the rectangle and to retrieve it on the three dimensional globe interface. The mosaic processing and the cutting out processing can be performed especially for PDS map object type products with latitude and longitude information. Also the map product can be converted into various map projections by this system. As for the retrieved and ordered data, it is possible to download from the FTP server.

These KAGUYA Data Archive System will be open to the public from Nov. 2009 when is one year after completion of the nominal mission.

**2. Web Map Server and World Wind for KAGUYA:** KAGUYA has 15 ongoing observation

missions and obtains various physical quantity data of the moon such as elemental abundance, mineralogical composition, geological feature, magnetic field and gravity field. KAGUYA science team plans the integrated science using these various physical quantity data to obtain the new findings of origin and evolution of the moon. In the research of the integrated science, scientists have to access, compare and analyze many type of data with different resolution. Web-based GIS is considered to be the best way to progress such a study because it allows users to search, map, overlay and share the data and information easily.

To construct a web-based GIS, we are developing the KAGUYA Web Map Server (WMS) which is adhere to OGC (Open GIS Consortium) standard. KAGUYA WMS is located at JAXA Sagami-hara Campus the same as L2DB [2,3]. As of Dec. 2008, the following data are ingested to WMS and tested by internal KAGUYA scientists: global topographic map by Laser Altimeter (LALT), global gravity anomaly map by Relay Satellite (RSAT), global gamma-ray count rate map by Gamma-ray Spectrometer (GRS), coverage information of High-definition Television Camera (HDTV), etc.. This server will be open to the public on Nov. 2009.

We selected NASA World Wind as a platform to browse the data from KAGUYA WMS. We are customizing the source code of World Wind JAVA SDK ver. 0.5.0 with supported by NASA World Wind project [4,5]. Fig. 1 is an example of displaying the topographic map created by Laser Altimeter (LALT) on the World Wind for KAGUYA. Users can easily map the various scientific data switching layers on the WW for KAGUYA and also display the observation area by polygon and icons which contain links to the original images and movies. In the future, we will try to display place-name using the WFS protocol and take the topographic data acquired by LALT as an altitude parameter information for 3D display.

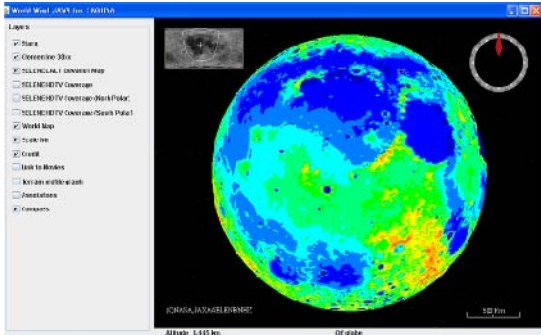


Fig.1 The global topographic map of LALT on WMS with the World Wind for KAGUYA.

**3. KML:** KML is very useful in displaying scientific data on virtual globe. We plan to create KML content related to KAGUYA data to apply them to the Google Moon in the future. Now we are preparing coverage information of High-definition Television Camera(HDTV) and links to HDTV movies on JAXA/SELENE YouTube Channel (refer to additional information). Also we plan to add the function to the L2DB to create KML or geoRSS file for the retrieved data. When we retrieve the data especially for the optical sensors observation data by the Data Distribution Subsystem, KML or geoRSS files containing coverage information with thumbnail for the retrieved data will be produced automatically. It is future tasks to make scientific KML data set like topographic map made by LALT or high resolution images taken by Terrain Camera (TC) and Multi-band Imager (MI).

**4. KAGUYA Image Gallery:** Ahead of data open on Nov. 2009, some visualized images are released from KAGUYA Image Gallery website[7]. Fig.2 shows the visualized altimetry data taken by LALT. In this gallery, not only images of cameras and imagers but also geophysical data derived from scientific instruments are visualized by using GIS. More than three images will be posted monthly.

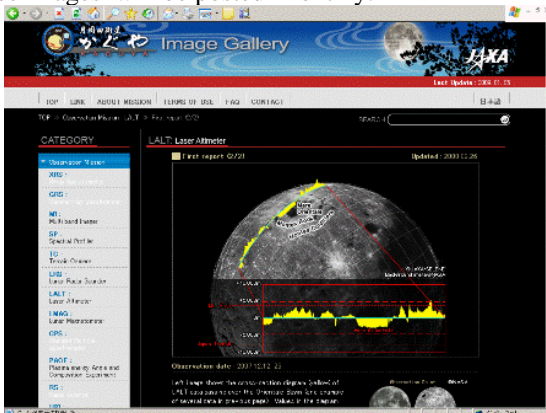


Fig.2 Screen shot of KAGUYA Image Gallery

**Future Plans:** System replacement for KAGUYA Data Archive is planned in 2010. According to this replacement we plan to improve the usability of data archive. The one of this improvement plan is the utilization of web-based GIS technology as a user interface for data retrieval and distribution. The user-friendly interface like World Wind can make the data easily accessible to the users and increase the number of users. In addition, we also plan to implement system interface with Google Moon type systems with KML. The other one is the design based on International Planetary Data Alliance (IPDA) standard. To have catalog interoperability that means independent on kinds of specific archive system such as PDS and PSA, IPDA aims to establish a standard data retrieval protocol (Planetary Data Access Protocol:PDAP). To retrieve the data of multiple orbiters at the same time is considered to become important in the research of lunar science because many lunar orbiters will be launched in the near future. We are considering to develop the system according to IPDA standard as one of the test-bed of IPDA.

As to the KAGUYA WMS, we will continue to add new data to the server and improve the usability as a platform of the integrated science hearing the opinions of scientists. In addition, we will discuss the release of images and data from WMS for the purpose of EPO.

**Reference:** [1] Sobue S. et al (2008) Proc. ISTS 2008. [2] Okumura H. et al. (2008), Proc. AGU 2008 Fall Meeting, IN41A-1135. [3] Terazono J. et al. (2008), Proc. Intl. Symp. on GIS-IDEAS 2008, 239–244. [4] Hogan P. et al. (2008), Proc. AGU 2008 Fall Meeting, IN41A-1125. [5] NASA World Wind <http://worldwind.arc.nasa.gov/> [6] KAGUYA Project Site <http://www.kaguya.jaxa.jp/>, [7] KAGUYA Image Gallery <http://wms.kaguya.jaxa.jp/>.

**Additional Information:** JAXA/SELENE YouTube Channel was open on Dec. 3<sup>rd</sup> 2009. <http://jp.youtube.com/JAXASELENE> We can watch high quality movies such as fly-through movies created by Terrain Camera (TC), Earth-rise/set and moon surface movies taken by HDTV and other documentary programs at this channel.