PRJ1/AIS4-2
Invited

JAXA Earth : Prototype of Earth Observation Data Distribution System and Application for Interdisciplinary Studies

Yoshinobu Sasaki[1], Kohei Kawamura[1], Kei Oyoshi[1]

sasaki.yoshinobu@jaxa.jp
[1]Earth Observation Research Center, Japan Aerospace Exploration Agency, 2-1-1 Sengen, Tsukuba, Ibaraki, Japan
Keywords: Satellite, COG, Database, API

ABSTRACT

Specifications of earth observation images differ among satellites, sensors, and distribution systems, so the hurdles of cross-sectional using of the data are still high. Therefore, we are developing the prototype of satellite data distribution service, "JAXA Earth", which enables us to use JAXA's multiple satellite data immediately and intuitively.

1 Introduction

JAXA has launched and operating various earth observation satellites. Currently, we have a total of six earth observation satellites in operation. For example, ALOS-2, a high-resolution satellite launched in 2014, is equipped with a synthetic aperture radar to observe land surface deformation and disasters. GCOM-C and GCOM-W provide global, multidisciplinary products across land, sea and air on a global scale, such as normalized vegetation index (NDVI), land surface temperature (LST), aerosols optical thickness (AOT) , soil moisture content (SMC) and so on. JAXA uses its own data distribution sites such as standard product in G-portal [1], elevation data in AW3D site[2], precipitation data on GSMaP[3], and so on.

These satellite data are used for disaster monitoring, environmental monitoring, and other purposes, but the combined use of each type of data can be expected to further promote the use of data in the fields of agriculture , public health and other interdisciplinary studies.

Specifically, in the field of agriculture, data such as precipitation, solar radiation, and vegetation indices can be used to monitor crop conditions and estimate yields over a wide area where on-site observation is difficult. Similarly, in the field of public health, data such as precipitation, vegetation index, and ground surface temperature can be used to estimate the habitat of pathogen-borne organisms and to understand environmental conditions.

However, Users need to do their own pre-processing products for each type of satellite, sensor, and distribution site. So the hurdle of combining, using and visualizing the data is currently high. In addition, it is not feasible for JAXA to build its own cloud platform that does not require data download and performs advanced computational processing due to cost.

Therefore, we are developing a Cloud-Optimized GeoTIFF (COG) based tools and data distribution systems and applications, "JAXA Earth" services, to unify the different site that using different satellite data format. The service's database uses only COG format, so users don't mind various format specifications. In addition, the data will be provided through Application Programming Interface (API) or Web application. It is expected that our data will be used more and more directly in various services and systems.

2 Cloud Optimized GeoTIFF (COG)

COG is one of the format styles of GeoTIFF, which is often used as a satellite imaginary. While standard GeoTIFF stores only the highest resolution image, COG is a data set that contains the highest resolution image plus multiple overview images which is downsampled as Fig.1. Each image split to tile to send only interest area's data. Due to this feature and internal structure, COGs placed in a cloud server can immediately receive data of the required resolution and region of interest by HTTP range request, which is highly beneficial in terms of immediacy and communication bandwidth. In addition, COGs can be visualized immediately by free GIS tools and software, and it is also easy to generate. Because of these features, we adopted COG as the data distribution format.

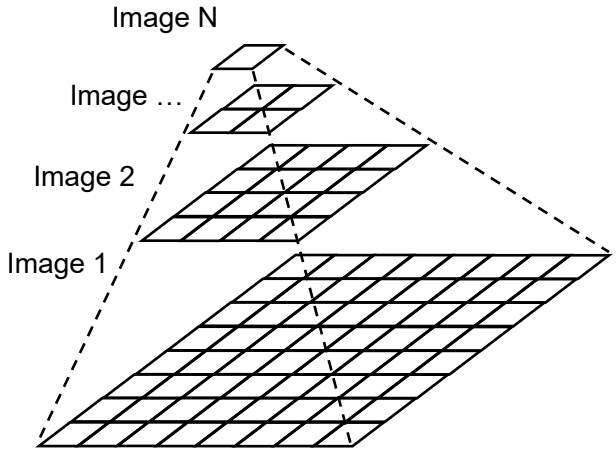

Fig.1 COG Internal file structure (images only)

3 “JAXA Earth” services

The overall tools/systems/applications configuration of the services is shown in Fig. 2. Tool (ASIST: Automated Satellite Image Stacking Tool) allows users to acquire source data and pre-process it. It supports more products than a database but requires a processing computer and time. Pre-processing system converts the pre-selected high-demand products into COG format and transfers them to the database. The database sends data via API, but it is also possible to directly retrieve the stored COG files. The API serves as an interface to request the user's required layer, area of interest, time period, etc. In addition, a web application using the API is under development.

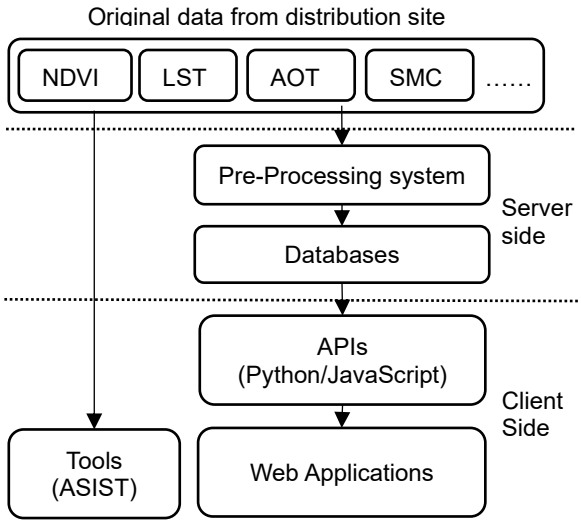

Fig. 2 “JAXA Earth” services data distribution flow

3.1 JAXA Earth Tools

We have developed a tool (Automated Satellite Image Stacking Tool : ASIST) to automatically acquire and pre-process data from JAXA's source data sites, and are released it to the public in July 2021 [5]. ASIST supports preprocessing of more than 200 JAXA products and can convert original data to png, npz, geojson, GeoTIFF, COG, etc. It can also perform differential interferometric SAR processing of ALOS-2 satellite data. On the other hand, ASIST requires downloading all the necessary source data, and the visualization also requires computer resources and time. Therefore, it is a tool for users who have computer resources and want to use a lot of products.

3.2 Pre-Processing system

The pre-processing system is a private system that generates COG data as defined in the COG database. It also performs multi-day composite processing of source data as needed. Since the server only processes predetermined data sets and transfers them to the database, it is easy to estimate the cost. Therefore, we built this system in the cloud.

3.3 JAXA Earth Databases

The database contains metadata indicating the logical and physical layers. The logical layer metadata defines the protocol for band operations, so that multiple physical layer data can be referred to as needed, such as the calculation of normal year differences and vegetation indices, and the application of land cover masks and quality flags. Therefore, each physical layer stores information of only one layer.

The COG database, which is the physical layer, currently stores four levels of images with the image size of 180*180 deg, 90*90 deg, 10*10 deg, and 1*1 deg per data. Each file contains images of three levels of resolution so that images of any zoom level from the global level to the 30m level can be acquired.

As for the COG itself, the tiling format of the equirectangular grid allows for the extraction of tiles at arbitrary locations. The data compression format is deflate compression, which works well with web scripts. The data type is not standardized as much as possible, and the data type of the source data is used.

We use a cloud database that does not increase costs even as the number of users increases, so we are able to reduce operating costs. Even if an on-premise server is used, the database administrator only needs to store the COG as a static file on the server and publish it so that it can be accessed from the Internet via HTTP.

The detailed specifications of the databases will be released in the future, and by changing the endpoints on the API side, it will be possible to use multiple databases across the board if necessary.

3.4 JAXA Earth API

API that runs on the client side is being developed, which allows users to check and change the process as needed. In addition, since it uses client PC resources, it is expected to be more distributed and faster than centralized server processing.

Two versions of APIs are available: One is Python version, "JAXA Earth API for Python," for users who want to use the data in a console. The other is JavaScript version, "JAXA Earth API for JavaScript," for users who want to use the data in web applications.

The API can acquire metadata of any layer and satellite data of any area and date. It is under development as a package with functions such as land cover masking using logical and physical layer information, quality flag masking, and time series data acquisition.

It is expected that the development and release of this API will facilitate data use and service development.

3.5 JAXA Earth Apps

Using these databases and APIs, we are also working on a prototype application that can run on a browser. The main functions of the prototype of the satellite data viewer that we are currently testing are shown in Table.1, and the interface on the browser is shown in Fig.3-4.

Using this viewer, users can visualize satellite data as layers without being aware of the differences in specifications of satellites, sensors, resolution, etc. The visualized data is the result of band operations (NDVI, Anomaly, etc.) using multiple physical layers as needed. In addition to this, quality flag masks and land cover masks can also be applied, and all calculations are processed and applied in the user's browser.

Various color adjustments (color bar, color map, transparency) can be made to the visualized layers, and the 2D/3D display can be switched. In addition to this, multiple layers can be overlayed, and there is a function to compare and display different layers at different times.

The displayed layers can be downloaded as COG files as they are, as well as png files, time series statistics, and movies. In addition, the multi-platform support makes it possible to display the data on a smartphone, making it easy to check the satellite data values in the field.

We are developing the application to reduce the hurdles for using satellite data as much as possible, and to make it possible to use satellite data dynamically and immediately on a browser.

Table-1 Main specification of the viewer

No.	Category	Function
1	Products (Layers)	Elevation (AW3D30 [1]) Precipitation (GSMaP [2]) NDVI (JASMES [3]) …
2	Spatial Resolution	from 30m to 10km (depends on products)
3	Time Resolution	Daily/8-day/Monthly (depends on products)
4	Multi-layer Processing	Band calculation (NDVI, Anomaly) Quality mask Land cover mask Administrative boundary mask
5	Visualization	Color map adjustment Color bar adjustment transparent adjustment 2D/3D switching
6	Comparison	Two layer comparison
7	Output data	COG, png Timeseries statistic data Movie file
8	Others	Multi-platform (PC, smartphone)

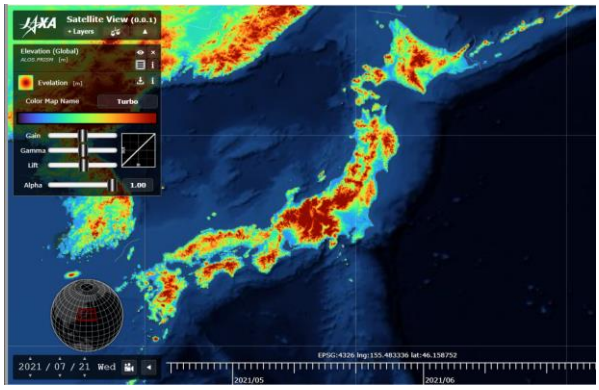

Fig.3 Web Application's Interface sample (Displaying elevation (AW3D) in japan)

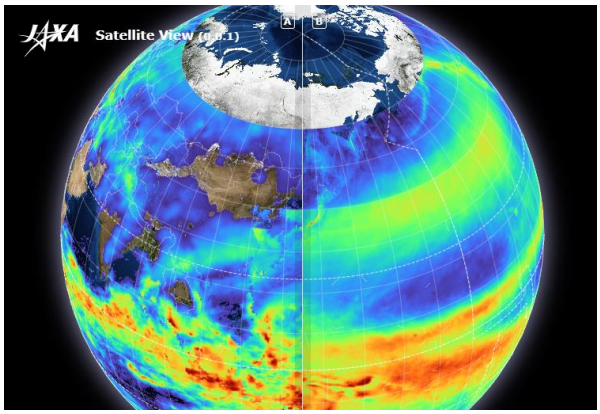

Fig.4 Two layer's comparison mode in 3D (Displaying Precipitation (GSMaP))

4 Conclusions

It is explained that the systems and applications that make up "JAXA Earth", a user-friendly service that lowers the hurdle of using JAXA's satellite data.

The DB and API will be opened to the public sequentially after expanding the data and improving the functions and quality. As for the applications, in addition to the satellite data viewer, we are planning to develop applications for individual use cases such as educational applications.

References

[1] JAXA G-portal (https://gportal.jaxa.jp/gpr/?lang=en)

[2] ALOS Global Digital Surface Model "ALOS World 3D - 30m (AW3D30)" (https://www.eorc.jaxa.jp/ALOS/en/aw3d30/index.htm)

[3] Global Satellite Mapping of Precipitation : GSMaP (https://sharaku.eorc.jaxa.jp/GSMaP/index.htm)

[4] JAXA Satellite Monitoring for Environmental Studies :JASMES (https://kuroshio.eorc.jaxa.jp/JASMES/index.html)

[5] JAXA's Automated Satellite Image Stacking Tool : ASIST (https://earth.jaxa.jp/en/earthview/2021/07/21/5583/index.html)