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JAXA EARTH OBSERVATION DASHBOARD WITH COG AND WMS/WMTS

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ABSTRACT:

JAXA has developed and implemented earth observation (EO) dashboard jointly with ESA and NASA. The development of the JAXA dashboard, along with the "Earth-graphy" website and the newly developed "JAXA Earth API" service, demonstrate JAXA's commitment to providing climate change and earth science information to users worldwide.

The EO dashboard serves as a platform to deliver valuable data and information related to climate change. The WMS/WMTS technology allows users to visualize and interact with geospatial information by providing web-based mapping services. This technology enhances the user experience by enabling the display of satellite imagery, overlays, and other geospatial data layers within the EO dashboard. To further facilitate the efficient use of satellite data, JAXA has developed the JAXA Earth API service. This service offers a user-friendly interface for accessing and utilizing JAXA's Earth observation satellite image data. By providing an easy-to-use format, JAXA aims to promote the effective utilization of satellite data and encourage its widespread use. Overall, the development and operation of the JAXA dashboard, with its integration of COG format data, WMS/WMTS technology, Python-based API. This paper introduces the status of development of JAXA Earth Observation dashboard with COG format data, WMS/WMTS technology, phyton based API and JAXA Earth Observation missions.

1. JAXA’S EARTH OBSERVATION MISSIONS

1.1 History of JAXA’s Earth Observation Missions

The Japan Aerospace Exploration Agency (JAXA) plays a crucial role in providing solutions to societal challenges through its Earth observation satellites. These satellites have the capability to monitor various regions around the world, making the data they gather invaluable for addressing global challenges. To effectively utilize this data, collaboration with international partners and stakeholders is essential. JAXA's journey in Earth observation by satellite began in February 1987 with the launch of the Marine Observation Satellite-1 (MOS-1) from the Tanegashima Space Center. This marked the start of Japan's full-scale involvement in satellite-based Earth observation. Over the past three decades, JAXA has faced challenges and setbacks, including the loss of satellites before completing their missions. Despite these difficulties, JAXA has persevered and launched a total of 15 Earth observation satellites into space thus far. Currently, 6 Earth observation satellites operated by JAXA are actively collecting valuable data. These satellites contribute to monitoring various aspects of the Earth, including climate patterns, weather conditions, land cover changes, and natural disasters. The data obtained from these satellites is vital for scientific research, environmental monitoring, disaster management, and decision-making processes.

Through international collaboration and partnerships, JAXA aims to expand the impact and reach of its Earth observation efforts. By working with other nations, organizations, and stakeholders, JAXA can leverage expertise, resources, and data sharing to address global challenges and promote sustainable development.

JAXA's Earth observation satellites have significantly contributed to understanding and addressing societal challenges. Despite past setbacks, JAXA continues to develop and operate satellites that provide valuable data for a wide range of applications, and collaboration with international partners remains a crucial aspect of their work.

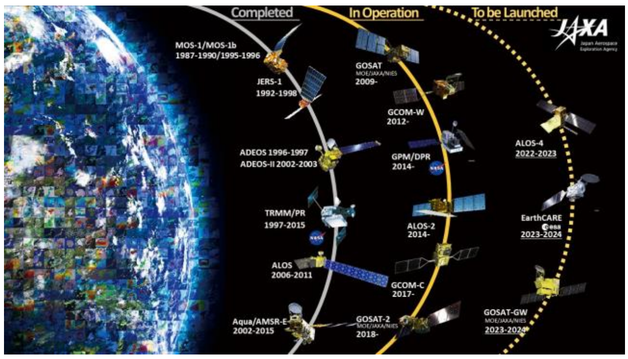

Figure 1. JAXA Earth Observation Missions.

1.2 Water cycle and climate studies

JAXA's Earth observation missions encompass a various type of applications, including water cycle and climate studies, disaster mitigation, and various research areas like weather forecasting. One notable mission among the six is the Global Precipitation Measurement (GPM) mission, which aims to provide high spatial-temporal hourly global precipitation observations.

The GPM mission comprises the GPM Core Observatory, a collaborative effort between the United States and Japan, along with Constellation Satellites equipped with microwave radiometers provided by partner agencies. The GPM Core Observatory, launched in February 2014, with the Dual-frequency Precipitation Radar (DPR) developed by JAXA and the National Institute of Information and Communications Technology (NICT). This mission plays a vital role in enhancing our study of precipitation patterns and their impact on the Earth's water cycle.

Within the framework of the GPM mission, the Global Satellite Mapping for Precipitation (GSMaP) plays a significant role in

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generating high temporal and spatial resolution global rainfall maps. The GSMaP algorithm utilizes observations from multiple satellite passive microwave radiometers and Geostationary InfraRed (IR) instruments, to produce rainfall maps. These maps provide detailed information on precipitation patterns at a global scale. GSMaP offers hourly rainfall information with a horizontal resolution of 0.1 degrees. Since November 2007, JAXA has been operating the near-real-time version of the GSMaP product, making it readily available for users. The JAXA GSMaP website (http://sharaku.eorc.jaxa.jp/GSMaP/) provides access to browse images and binary data, allowing users to access and utilize this valuable satellite-based rainfall information.

JAXA remains committed to providing satellite-based information related to the global water cycle, including precipitation data. By leveraging the combined capabilities of multiple satellites and advanced algorithms like GSMaP, JAXA contributes to the understanding and monitoring of global precipitation patterns, which is crucial for various applications such as water resource management, weather forecasting, and disaster mitigation.

Figure 2. Observation of heavy rainfall in July 2020 by Global Satellite Mapping of Precipitation (GSMaP) (24 hour accumulated precipitation at 17:00 in July 2020).

Global Change Observation Mission (GCOM) plays a crucial role in forecasting future global climate and improving our understanding of water circulation mechanisms and climate change. GCOM is composed of two satellite series: GCOM-W and GCOM-C. GCOM-C is equipped with the Second Generation GLobal Imager (SGLI), which enables surface and atmospheric measurements for the carbon cycle and radiation budget. The SGLI instrument allows for observations of various parameters such as clouds, aerosols, ocean colour, vegetation, snow, ice, etc.

By monitoring aerosols, clouds, vegetation, and temperatures over the long term, SGLI observations contribute to our understanding of climate change mechanisms. These observations also play a vital role in improving the accuracy of predictions regarding future environmental changes with enhancing the sub-processes in numerical climate models.

Furthermore, SGLI-derived data on phytoplankton and aerosol distributions are utilized for mapping fisheries and monitoring the transport of yellow dust and/or wildfire smoke. This application demonstrates the versatility of GCOM-C's observations and their relevance to environmental monitoring beyond climate change studies.

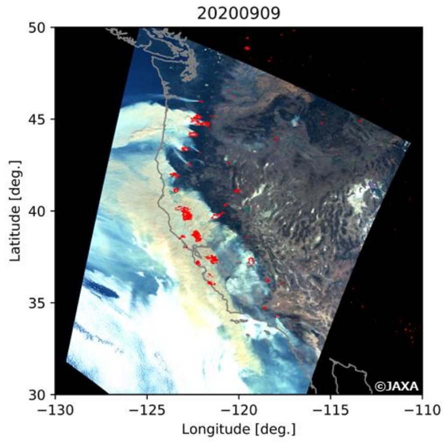

Figure 3. Visible image and the locations of forest fires (shown as red colour) in the west coast of USA on September 9, 2020, observed by GCOM-C.

Overall, GCOM-C, with its SGLI instrument, provides valuable measurements and data that significantly contribute to our understanding of climate change, carbon cycling, radiation budget, and various environmental phenomena. These observations support climate modelling efforts, advance our knowledge of Earth's ecosystems, and aid in monitoring and managing environmental changes for the benefit of society.

1.3 Land observing - ALOS

Advanced Land Observing Satellite (ALOS) succeeded the Japanese Earth Resources Satellite-1 (JERS-1) and the Advanced Earth Observing Satellite (ADEOS). These satellite data are useful for various applications such as cartography, regional observation, disaster monitoring, resource surveying.

Cartography: ALOS has played a crucial role in generating high-resolution, accurate maps of the Earth's surface. It has provided valuable data for creating detailed topographic maps and updating existing maps for various purposes, such as urban planning, infrastructure development, and environmental management.

Regional Observation: For regional-scale observation efforts, capturing valuable data on land cover, land use changes, and natural resources. This information aids in monitoring ecosystem health, agricultural practices, forest management, and urban expansion.

Disaster Monitoring: As a valuable tool for disaster management and response. It enables the monitoring of disaster damaged area by natural disasters including earthquakes, tsunamis, floods, landslides. The satellite's data assists in assessing damage, coordinating rescue efforts, and planning for recovery and reconstruction.

Resource Surveying: For resource surveying activities, including monitoring and managing forests, water resources, and mineral deposits. The satellite's observations provide critical data for assessing resource availability, supporting sustainable resource management practices, and informing decision-making in various sectors.

Through its advanced land-observing capabilities, ALOS has significantly contributed to our understanding and management of the Earth's land resources. It has been an important asset for applications related to mapping, regional observation, disaster monitoring, and resource surveying, supporting a wide range of scientific, environmental, and societal endeavours.

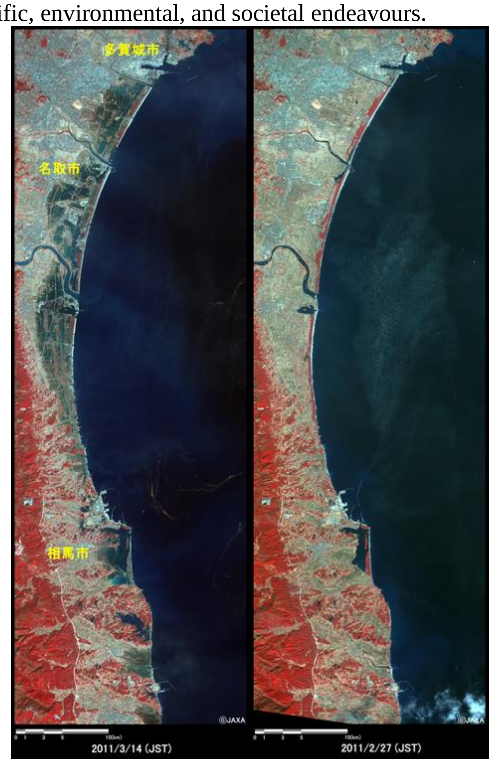

Figure 4. Coastal areas of the Tohoku region before (right) and after (left) the East Japan great earthquake observed by ALOS.

Advanced Land Observing Satellite-2 (ALOS-2) is the successor to ALOS SAR(PALSAR) and was launched on May 24, 2014. One of the significant advantages of radar technology is its ability to acquire images day and night, regardless of sunlight availability. Unlike optical sensors, radar can operate under all lighting conditions. Additionally, radar signals can penetrate through clouds, enabling image acquisition even in cloudy weather conditions. Building upon the achievements of its predecessor, ALOS-2 has enhanced capabilities to meet evolving societal needs and contribute to various applications. The main objectives of ALOS-2 can be summarized as follows:

Disaster Monitoring: Support natural disasters management, including earthquakes, volcanic eruptions, landslides, flooding, and tsunamis. By capturing wall-to-wall observations, the satellite facilitates rapid disaster response and aids in assessing the extent of damage and supporting relief efforts.

National basemap: Provide basemap related to national land and infrastructure, agriculture, natural resources, and ocean information. By providing regular and up-to-date data, the satellite supports decision-making processes in various sectors, including urban planning, resource management, and environmental monitoring.

Global Environmental Monitoring: To monitor and understand environmental changes on a global scale. It enables the assessment of forest coverage, carbon stocks in forests, wetland extent and inundation, and movements of ice sheets. These observations assist in studying climate change, ecosystem dynamics, and the impacts of human activities on the environment.

By focusing on these objectives, ALOS-2 aims to fulfil social needs by providing valuable information for disaster management, land and infrastructure monitoring, and global environmental assessments. The satellite's enhanced wide and high-resolution observation technologies build upon the advancements made during the ALOS mission, further expanding our capabilities for remote sensing and Earth observation.

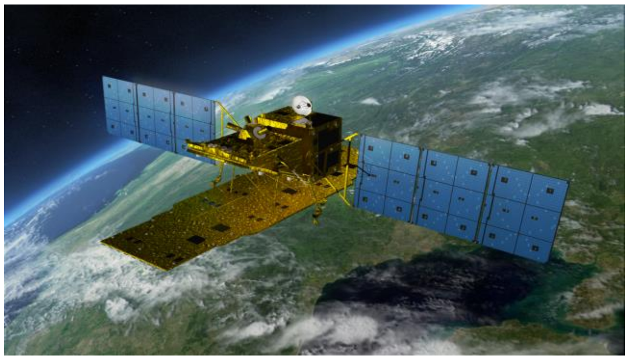

Figure 5. ALOS-2

The quick response capability of ALOS-2, along with its unique interferometric observations with L-band SAR and the availability of consistent and systematic data, has made it an invaluable tool for monitoring and assessing various types of natural and human-induced phenomena. Its contributions extend to disaster management, environmental monitoring, infrastructure monitoring, and more, enhancing our understanding of Earth's dynamics and supporting decision-making processes in a wide range of fields.

The Global PALSAR-2/PALSAR Forest/Non-Forest Map is a dataset that provides information on the distribution of forests and non-forest areas worldwide. It is based on the PALSAR-2/PALSAR imagery, which is collected by the Advanced Land Observing Satellite (ALOS) and its successor, ALOS-2.

The map offers a resolution of 25 meters, meaning that each pixel in the map represents an area of 25 square meters on the ground. It covers different time periods: the 2007-2010 interannual maps are derived from ALOS PALSAR imagery, while the 2015-2021 interannual maps are derived from ALOS-2 PALSAR-2 imagery. This allows for monitoring changes in forest distribution over time.

The primary purpose of the Global PALSAR-2/PALSAR Forest/Non-Forest Map is to support forest monitoring activities and assist in climate change countermeasures. By analysing the changes in forest cover year by year, researchers and policymakers can gain insights into deforestation, reforestation, and other forest-related trends. This information is crucial for assessing climate change impact on forests and implementing appropriate measures to address deforestation and promote sustainable forest management.

It's worth noting that while the PALSAR-2/PALSAR imagery and the resulting forest/non-forest maps provide valuable information, they are just one tool among many for monitoring forests. Other data sources, such as optical satellite imagery and ground-based observations, are often used in conjunction with radar data to obtain a more comprehensive understanding of forest dynamics.

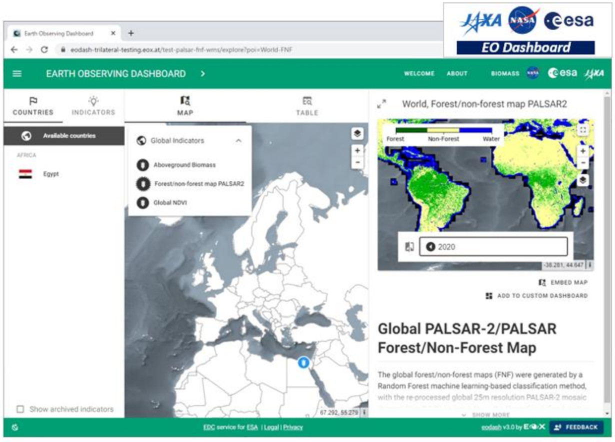

Figure 6. Global PALSAR-2/PALSAR Forest/Non-Forest Map on EO dashboard.

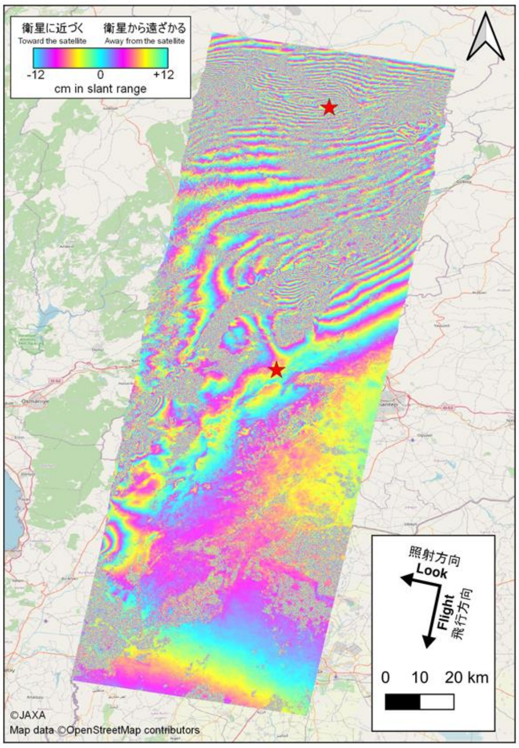

Figure 7. Crustal deformation map based on observation data on April 6, 2022 (before the earthquake) and February 8, 2023 (after the earthquake) observed by ALOS-2.

In addition, time-series interferometric SAR (InSAR) analysis provides useful information for monitoring land subsidence and large infrastructure including dams, high way. By analysing the temporal changes in SAR data, researchers and practitioners can gain insights into ground movements and deformations, aiding in infrastructure management and environmental monitoring efforts.

ALOS-4 is a successor of ALOS-2 to observe the Earth's surface utilizing a phased array type L-band synthetic aperture radar (PALSAR-3) as its primary instrument. The development of L-band radar technology has been a continuous effort in Japan, and ALOS-4 aims to further enhance the observation capabilities compared to its predecessor, PALSAR-2 on board ALOS-2. The goal is to achieve both high resolution and a wider observation swath.

ALOS-4 will leverage these benefits to enhance its observations and monitoring capabilities for a variety of applications. Disaster-hit areas can be effectively monitored to assess the extent of damage and support relief efforts. Forest monitoring can track changes in vegetation cover, deforestation, and forest health. Sea ice observations aid in understanding climate dynamics and its impact on polar regions.

In addition, ALOS-4 aims to venture into new areas, such as monitoring infrastructure displacement. With its advanced radar technology, the satellite can detect subtle movements and deformations in infrastructure, including buildings, bridges, and dams. This capability holds significant potential for infrastructure management, early warning systems, and urban planning.

2. OVERVIEW OF JAXA'S EARTH OBSERVATION DASHBOARD

2.1 Purpose of JAXA's EO dashboard

JAXA has developed and operates G-Portal to provide a standardized product dissemination system and offers various value-added product services to users including ALOS-2 ScanSAR (wide range 100m resolution mode) products

When searching for specific products on G-Portal, users have the option to filter their search based on spacecraft, sensor, processing level, and other parameters to narrow down the results according to their requirements.

Another service available on G-Portal is JASMES (JAXA/MRI Alaska Satellite-based Monitoring of Ecosystems), which provides information on climate-related physical quantities. JASMES offers data on various geophysical quantities such as solar radiation, cloudiness, snow and sea ice cover, vegetation dryness, soil moisture, wildfires, precipitation, land and sea surface conditions and so on. These data contribute to understanding the current status and seasonal/interannual variability of climate-related parameters.

The products and services on G-Portal cover a wide range of geophysical quantities classified into different groups such as atmosphere, cryosphere, terrestrial, and ocean. This classification allows users to search for and access products specific to their area of interest, whether it be precipitation, snow depth, vegetation, or ocean colour, among others.

Overall, G-Portal serves as an important platform for users to access and utilize JAXA's Earth observation satellite data, enabling various applications in climate monitoring, disaster management, environmental studies, and more.

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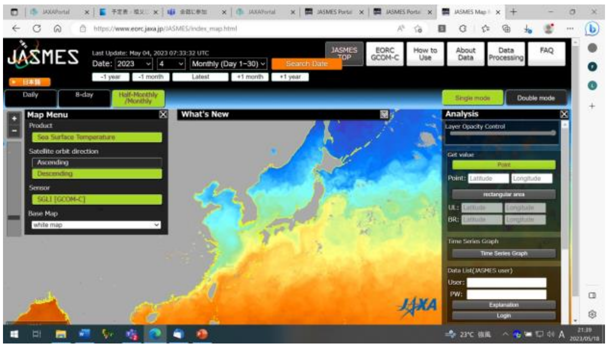

Figure 8. JASMES.

Accessing and utilizing data from platforms like G-Portal and JASMES has traditionally been challenging for non-experts in the field of Earth observation. The process of searching for data, downloading files from FTP sites, and performing tasks like map projection and value conversion requires specialized knowledge in remote sensing, limiting the accessibility of these systems to a small number of users.

However, with the introduction of APIs and databases, the data utilization process has become more user-friendly and efficient. Users can now utilize APIs to query specific products of interest, select desired date ranges, define areas of interest, and specify resolution requirements. The API query then retrieves the relevant data, providing the user with the specific band, surrounding area, and resolution they need. This streamlined approach eliminates the need to download entire files and perform additional processing tasks, resulting in significant savings in data traffic and time spent on data acquisition.

The introduction of APIs and databases has greatly enhanced the accessibility and usability of Earth observation data for a wider range of users. Non-experts can now easily interact with these systems and obtain the specific data they require, without the need for extensive knowledge in remote sensing. This advancement contributes to increased efficiency in data utilization and expands the potential user base for Earth observation
applications.

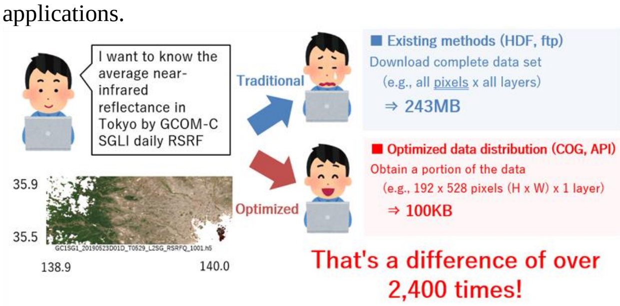

Figure 9. Difference in data traffic due to API and database use.

JAXA's collaboration with ESA and NASA to develop and implement an Earth observing (EO) dashboard demonstrates a global effort to monitor the environmental and socio-economic impacts of COVID-19 using earth observation and other space-based technologies. This EO dashboard serves as a valuable tool for providing indicators related to COVID-19 to the public and decision-makers, enabling them to monitor and assess the effects of the pandemic on various aspects of the environment and economy.

Additionally, JAXA's "Earth-graphy" website acts as a one-stop shopping portal, offering a centralized platform for accessing news, articles, and images related to JAXA's Earth observation activities. This portal site serves as a comprehensive resource for users worldwide, providing them with information and updates on climate change, earth science, and other relevant topics. By consolidating these resources in one place, JAXA makes it easier for users to stay informed and engaged with their Earth observation initiatives.

These initiatives reflect JAXA's commitment to leveraging Earth observation data and technology to address global challenges, such as monitoring the impacts of COVID-19 and providing climate change information. The collaboration with international partners and the development of user-friendly platforms demonstrates JAXA's dedication to making Earth observation data accessible and actionable for a wide range of users, from the general public to decision-makers.

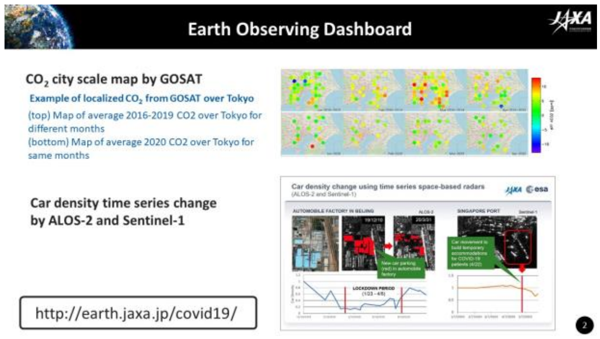

Figure 10. JAXA data example on NASA/ESA/JAXA COVID-19 dashboard.

2.2 Function of JAXA's EO dashboard

The development of the "JAXA Earth API" service is a significant step towards enhancing the accessibility and usability of their Earth observation data through the "Earth-graphy" website. The JAXA Earth API service is designed to provide various type of JAXA Earth observation satellite data in an easy-to-use format, promoting efficient and effective utilization.

The JAXA Earth API service comprises three main components: an API, a database, and a web application. The API is offered in two versions, catering to different programming languages and user preferences. The Python version is targeted towards data science applications, leveraging the popularity and versatility of Python in the field. The JavaScript version is currently under development and intended for use in browser-based applications, expanding the accessibility of the API.

The database component plays a crucial role in storing and managing the Earth observation data. It ensures efficient storage and retrieval of the satellite image data, enabling quick and reliable access for users. By maintaining a well-organized database, JAXA can effectively handle large volumes of data and facilitate smooth data retrieval through the API.

The web application component serves as the user interface for the JAXA Earth API service. It provides a user-friendly platform, accessible through the "Earth-graphy" website, where users can search, access, and visualize the available data. The web application streamlines the process of finding and utilizing the Earth observation data, making it easier for users to extract valuable insights and information.

Overall, the JAXA Earth API service combines these three components to deliver a comprehensive solution for accessing and utilizing JAXA's Earth observation data. It offers flexibility in programming language choice, efficient data management, and a user-friendly interface, aiming to enhance the usability and effectiveness of the provided satellite image data. By combining these components, the JAXA Earth API service facilitates seamless access to JAXA's Earth observation data that is under development as of June 2023, which shall enable users to extract the information they need for their specific applications and analyses. This integration of the API with the "Earth-graphy" website enhances the overall user experience and promotes the effective utilization of JAXA's Earth observation data for various purposes.

There are three specific components within the JAXA Earth API service, each serving a distinct purpose:

The JAXA Earth Data Explorer provides users with a platform to explore and analyse a wide range of satellite data stored in its database. It focuses on various geophysical parameters, such as elevation, surface temperature, vegetation index, precipitation, and land cover classification maps. The data in the database is stored in the cloud optimized GeoTIFF (COG) format, which is a file format optimized for efficient access and processing of geospatial data in cloud environments. This format enables users to access and analyse the satellite data efficiently. Additionally, the satellite data in the JAXA Earth Data Explorer is accompanied by metadata in the Spatiotemporal Asset Catalog (STAC) format. STAC is a specification that provides a standardized way to describe geospatial assets, including their spatial and temporal characteristics. The application specifically uses the "CEOS Analysis Ready Data for Land (CARD4L)" standard, which ensures that the data is prepared and processed in a consistent and interoperable manner for land-related applications.

The JAXA Earth API for Python provides a streamlined and user-friendly approach to acquiring and working with satellite data for a given area. By utilizing the JAXA Earth API, users can programmatically access and retrieve satellite data in an efficient manner. This allows users to focus on utilizing the data for their specific needs without having to worry about the intricacies of individual satellite systems. One notable feature of the API is its integration with QGIS, a popular free GIS software. The API includes an interface function that enables users to directly acquire and display the satellite data within the QGIS environment. This integration simplifies the workflow for users who are already familiar with QGIS, allowing them to seamlessly incorporate satellite data into their existing GIS projects.

The JAXA Earth Database appears to be a comprehensive repository of Earth observation data, housing a diverse range of information, including the 74 types you mentioned earlier, such as elevation, surface temperature, vegetation index, precipitation, and land cover classification information. Accompanying the data, JAXA Earth Database includes metadata in the Spatiotemporal Asset Catalog (STAC) format. The STAC metadata provides standardized information about the datasets, including spatial and temporal characteristics, acquisition details, and other relevant metadata. This helps users understand and utilize the data effectively for their specific needs. With its wide range of data types and the use of standardized formats like COG and STAC, the JAXA Earth Database offers users a valuable resource for accessing and utilizing Earth observation data. Researchers, scientists, and analysts can leverage the database to explore and analyze different datasets.

JAXA has implemented the OGC Web Map Service (WMS) and Web Map Tile Service (WMTS) as a frontend system for JASMES and Earth-graphy website. This integration allows for the seamless provision of data and information to the Trilateral Cooperation EO dashboard mentioned above, promoting collaboration and data sharing among different organizations.

By linking the future JAXA EO dashboard with the jointly developed EO dashboard, users worldwide can access JAXA's data and information through this unified platform. This integration enhances data accessibility and enables users to explore, acquire, and utilize satellite data more efficiently and effectively.

Additionally, JAXA's commitment to developing a Japanese language version of the user interface for the jointly developed EO dashboard is commendable. This effort will further enhance user experience and ensure that Japanese users can access the platform and benefit from the increasing range of products and information available.

Overall, these initiatives highlight JAXA's dedication to enhancing data accessibility, promoting collaboration, and providing valuable Earth observation data and information to users worldwide.

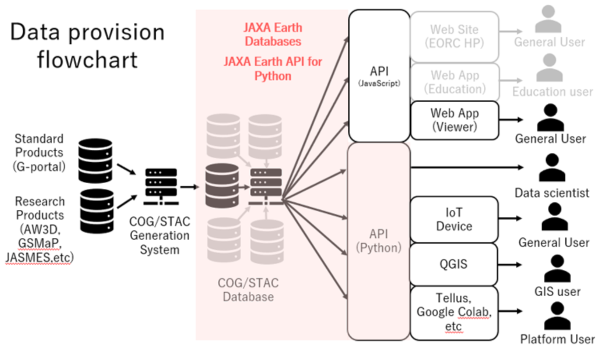

Figure 11. Image sample of Data Explore.

Earth Graphy API package for Python has been developed for the utilization of various earth observation satellite data and products. By using this API, you can easily acquire and process data without worrying about the specifications, sensors, resolution and format of each satellite data. This API also has an IF function with the free GIS software QGIS, allowing for immediate acquisition and display of data.

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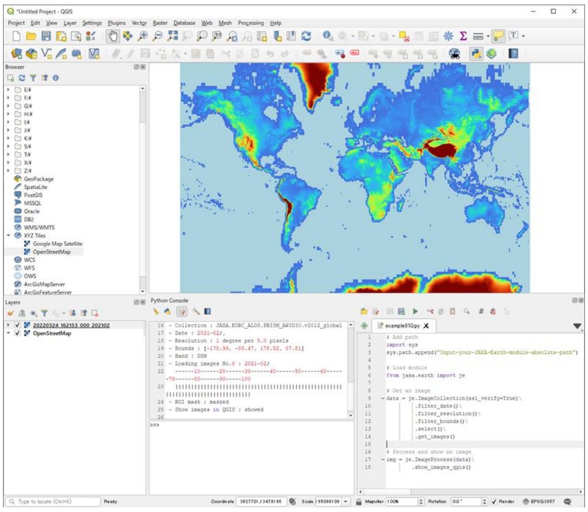

Figure 12. JAXA Earth API access from QGIS.

2.3 Use case – Forest / Non-Forest map

As mentioned above, JAXA provides Earth Observation satellite data in various formats such as HDF5, CEOS, and Geotiff. These formats can sometimes be challenging for users to work with, especially if they are not familiar with them. To address this issue, JAXA analyses the time-series data for the specific areas of interest (AOIs) requested by the user without requiring them to be aware of the data format.

To make data access more convenient, JAXA offers online data access rather than relying on physical media. However, as the spatial and temporal resolution of the satellite data are drastically increasing, downloading large volumes of data over the network can become time-consuming and sometimes difficult to download. To overcome this challenge, JAXA has implemented solutions such as displaying visualized AOI-only time-series data using OGC WMS/WMTS. These services allow users to access and visualize data through web-based dashboards. The use of slide bars in these dashboards enables users to easily distinguish between extreme weather years and normal years.

In addition to data visualization and web-based access, JAXA has been working on improving the convenience of data access by converting the data into COG format. COG format allows for efficient cloud-based data storage and retrieval, enabling users to obtain data for specific AOIs and work with the data without having to be aware of the underlying format details.

These efforts aim to enhance the user experience by simplifying data access and analysis processes, leveraging standardized formats, and utilizing web-based visualization tools for improved data understanding and decision-making.

2.4 Outreach activity

ESA, JAXA and NASA have promoted the EO Dashboard through tutorials in international remote sensing conferences and opportunities such as hackathons, since its launch from June 2020. Through such approach, it is expected to engage new users, by exposing them directly to use the information and data with EO Dashboard. Three agencies have worked together in conferences such as the Committee on Earth Observation Satellites (CEOS), the Group on Earth Observation (GEO) as well as the International Geoscience and Remote Sensing Symposium (IGARSS), AGU, EGU and JpGU. Three agencies also provided training workshops on how to use API and open software on Github at IGARSS and other opportunities in regional conference such as the Asia Pacific Regional Space Agency Forum (APRSAF) and Asian Conference on Remote Sensing. Regional efforts are also undertaken, such as JAXA hosting JAXA earth observation dashboard online training at Asian Conference on Remote Sensing (ACRS) hosted by Mongolia in November 2022.

JAXA data available on WMS and WMTS are listed in Table 1 and 2 respectively. Data on WMS/WMTS can be accessible from EO dashboard as well as QGIS and other system with OGC standard method by WWW shown in Figure 14 and 15. About COG data, earth graphy API provide AOI oriented data access easily and timely fashion.

Table 1. WMS Layers of JAXA Dashboard Service Time-series images

Layer Name	Description
SIC_N	Sea Ice Concentration, North hemisphere
SIC_S	Sea Ice Concentration, South hemisphere
ONPP-GCOMC-World-Monthly	Ocean net primary productivity
NDVI-GCOMC-World-Monthly	Normalized Difference Vegetation Index
NDVI-Anomaly-GCOMC-World-Monthly	Anomaly of Normalized Difference Vegetation Index
SMC-GCOMW-World-Monthly	Soil Moisture Content
SMC-Anomaly-GCOMW-World-Monthly	Anomaly of Soil Moisture Content
PRC-GSMaP-World-Monthly	Precipitation Rate
PRC-Anomaly-GSMaP-World-Monthly	Anomaly of Precipitation Rate
XCO2-GOSAT-Cairo	CO2
NO2-TROPOMI-Cairo-Daily	NO2
SIF-TROPOMI-Cairo-Monthly	Solar Induced Chlorophyll Fluorescence
ODIAC-Cairo-Monthly	The Open-Data Inventory for Anthropogenic Carbon dioxide

Table 2. WMS/WMTS Layers of JAXA Dashboard Service (Forest/Non-Forest Map)

Layer Name	Description
FNF-PALSAR2-World-2017-Yearly	Global Forest/Non-Forest (FNF) map
FNF-PALSAR2-World-2018-Yearly	Global Forest/Non-Forest (FNF) map
FNF-PALSAR2-World-2019-Yearly	Global Forest/Non-Forest (FNF) map
FNF-PALSAR2-World-2020-Yearly	Global Forest/Non-Forest (FNF) map

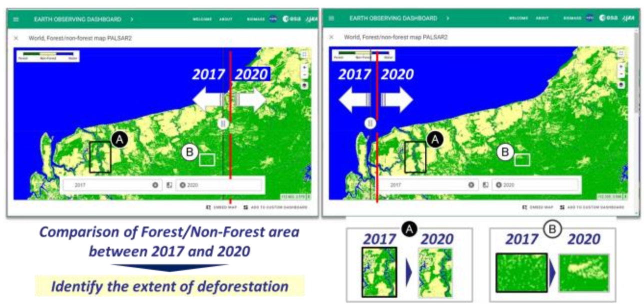

Figure 13. Global PALSAR-2 FNF using OGC WMS/WMTS through EO dashboard or QGIS

By using OGC WMS/WMTS through EO dashboard or QGIS, users can easily understand forest cover change derived from Global PALSAR-2/PALSAR Forest/Non-Forest area map

3. CONCLUSION

These efforts have realized with the advancement in computation tools and software However as expressed in the declaration by three agencies, sending out the message to "enhance and sustain Earth observation as an indispensable tool" by addressing complex issues related to interactions between the human activities and Earth natural phenomena. The evolution of collaboration of COVID-19 Dashboard to EO Dashboard by three space agencies reflected the will to make satellite data, information and service derived from EO data available for wider use, by making it accessible as well as providing stories to enhance understanding. JAXA will also develop and hopefully enhance its earth observation dashboard in the future, utilizing the positive aspects of cooperation with NASA and ESA.

REFERENCES

Maeda, K., Wakabayashi, H., Tasaki, K., Shimada, M., Sato, H., 2008: Outline of MOS - 1 verification program (MVP), Geocarto International, 13-20

doi.org/10.1080/10106048809354144

Hori, M., Murakami, H., Miyazaki, R., Honda, Y., Nasahara, K., Kajiwara, K., Nakajima, T. Y., Irie, H., Toratani, M., Hirawake, T., Aoki, T., 2018: GCOM-C Data Validation Plan for Land, Atmosphere, Ocean, and Cryosphere. Trans. JSASS Aerospace Tech. Japan, Vol. 16, No. 3, 218-223.

DOI: 10.2322/tastj.16.218

Tanaka, K., Okamura, Y., Mokuno, M., Amano, T., Yoshida, J., 2018: First year on-orbit calibration activities of SGLI on GCOM-C satellite, Proc. SPIE 10781, Earth Observing Missions and Sensors: Development, Implementation, and Characterization V, 107810Q

DOI: 10.1117/12.2324703

Kachi, M., et al., 2014: Recent improvements in the global satellite mapping of precipitation (GSMaP). IEEE Geoscience and Remote Sensing Symposium, 3762-3765,

Doi.org/10.1109/IGARSS.2014.6947302.

Tadono, T., Ishida, F., Oda, S., Naito, K., Minakawa, H., 2014: Precise Global DEM Generation By ALOS PRISM. ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Vol.II-4, 71-76.

Sobue, S., 2017: Status of the advanced land observing satellite-2 (ALOS-2) and its follow-on L-band SAR mission. IEEE International Geoscience and Remote Sensing Symposium (IGARSS), 2427-2429.

JAXA Earth API for Python API.

https://data.earth.jaxa.jp/api/python (June 12, 2023)

Joint declaration on trilateral collaboration by NASA, ESA and JAXA, 2020.

https://eodashboard.org/eodash-data/general/Joint%20Declaration_with_signature_JAXA_ESA.pdf (June 12, 2023)

JAXA Earth Data Explorer.

https://data.earth.jaxa.jp/app/explorer (June 12, 2023)

Sasaki, Y., Kawamura K., 2021: JAXA Earth: Prototype of Earth Observation Data Distribution System and Application for Interdisciplinary Studies. The 28th International Display Workshops. doi.org/10.36463/idw.2021.0622

Ikehata, Y., Natsuisaka, M., Miyoshi, T., Ohara, M., Fukushima, K., Taga, M., 2022: Improvement of usability for Earth Observation data analysis by using WebAPI, Remote Sensing Society of Japan

Sobue, S., Desnos, Y.L, Murphy, K., Anghelea, A., Maskey, M., Falkowski, M., 2021: Tri-Agency Cooperation to Identify the Impact of COVID-19.

doi.org/10.1109/IGARSS47720.2021.9553694

Sugita, N., Anghelea, A., Maskey, M., Sobue, S., Hamamoto, K., 2023: Earth Observing Dashboard and Societal Benefits: The Development of Trilateral Collaboration and Beyond. Global Space Conference on Climate Change (GLOC) 2023.