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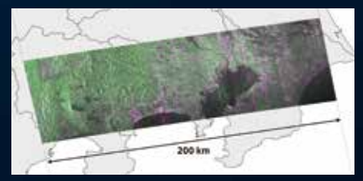
EORC's Earth Science Challenge
and Addressing Social Issues

JAXA
Explore to Realize

Toward a better understanding of Earth's diversity

DAICHI (ALOS) Series

DAICHI (ALOS) series satellites - ALOS-2 and ALOS-4 - are contributing to a wide range of fields including disaster assessment, national land management, agriculture, forestry, oceanography etc. by using Synthetic Aperture Radar (SAR) instruments. ALOS (mission ended in 2011) was equipped with an optical sensor and a SAR. The precise global digital 3D map "ALOS World 3D" (AW3D) which was developed by using optical observations, is still widely used today.



The first image from ALOS-4 observed over a 200 km swath width on July 15, 2024. By applying the Digital Beam Forming technology that is the world's first demonstration as the spaceborne SAR, ALOS-4 achieved an observation width up to four times wider than that of ALOS-2.

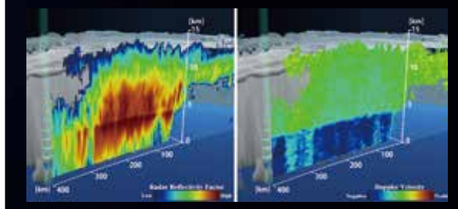
GPM Core Observatory

Global Precipitation Measurement (GPM) Mission is the international joint mission to measure worldwide precipitation. Dual-frequency Precipitation Radar (DPR) of GPM Core Observatory was developed in Japan and contributes analysis of water cycle on the Earth.

©NASA

Hakuryu (EarthCARE)

The Earth Cloud Aerosol and Radiation Explorer (EarthCARE) is a European-Japanese joint satellite mission. Its four sensors elucidate the movement of clouds and actions of aerosols, improving the accuracy of climate change forecasting.



The first image observed by the Cloud Profiling Radar (CPR) on June 12 and 13, 2024. It observed the cloud area in a rainy season front over the sea east of Japan, captured the inside of cloud, and succeeded in measuring the vertical cloud motion from space for the first time in the world.

©JAXA/NICT/ESA

The vertical distribution of the radar reflectivity factor (left) and Doppler velocity (right) by the CPR. The horizontal distribution of clouds is calculated using data from Himawari-9 provided by the Japan Meteorological Agency.

©ESA

SHIKISAI (GCOM-C)

SHIKISAI (Global Change Observation Mission-Climate, GCOM-C) that equipped with the Second Generation Global Imager (SGLI), having multiband from near-ultraviolet to thermal infrared wavelengths and polarimetry, observes clouds, aerosols, ocean color, vegetation, snow, ice and surface temperatures for monitoring and understanding of the climate change.

SHIZUKU (GCOM-W)

SHIZUKU (GCOM-W) that equipped with the Advanced Microwave Scanning Radiometer 2 (AMSR2), observes a variety of water-related parameters, such as water vapor, rain, sea surface temperature & wind speed, sea ice, soil moisture and snow depth, for monitoring and understanding climate and water cycle variations. The next generation sensor, AMSR3 equipped in GOSAT-GW, will be launched soon.

IBUKI (GOSAT) Series

IBUKI (GOSAT) measures global distribution of carbon dioxide (CO_2) and methane (CH_4). JAXA processes data and provides the analytical results to the general public in cooperation with the Japan's National Institute for Environmental Studies and the Ministry of the Environment. The next generation satellite GOSAT-GW will be launched soon.

Note : JAXA also processes and distributes data from Himawari (a geostationary meteorological satellite operated by the Japan Meteorological Agency) and other countries' satellites.

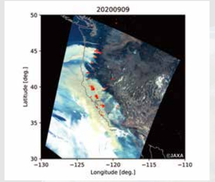
Assessing Behavior of the Atmosphere, Rain and Clouds

Monitoring of Aerosols

EarthCARE | GCOM-C | GOSAT | Himawari

JAXA estimates aerosols by integrated use of satellites from JAXA and other agencies, and provides data and images to both researchers and the general public.

JAXA is also developing data assimilation systems for combining satellite data with aerosol transport models in collaboration with other organizations. The aim of this effort is to create a common environmental information about when, from where, which type, and how much aerosols are coming.



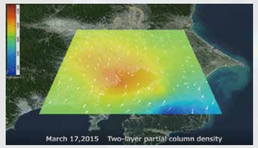
▶Visible images and hotspots in the west coast of USA on September 9, 2020 observed by "SHIKISAI". The pixel which exceed certain threshold value of brightness temperature is extracted as hotspots during the night using the 250-m resolution thermal infrared band of "SHIKISAI".

Observing Greenhouse Gases

GOSAT

GOSAT and GOSAT-2 was launched in January 2009 and October 2018, respectively and have been providing global carbon dioxide (CO_2) density from space.

A decade-long global GOSAT data show annual increase of CO_2 density that exceeded 400 ppm. GOSAT carries the world's highest resolution spectrometer which can measure CO_2 in the lower troposphere. Estimating CO_2 emission from individual mega city by combining wind speed and partial column density data will contribute to the global stocktake.



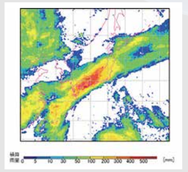
▲CO_2 concentrations in the lower atmosphere of the Kanto region as observed by GOSAT on March 17, 2015

Monitoring the Water Cycle Variation

GPM | EarthCARE | GCOM-W

JAXA distributes high-accurate and high-resolution global precipitation data, called the Global Satellite Mapping of Precipitation (GSMaP), in real time basis by combining multiple satellite data and information. GSMaP especially realizes effective rainfall monitoring in developing countries that have few ground observation facilities.

JAXA is also seeking and expanding new users of satellite data on the water cycle variation and precipitation to realize social implementation by local governments and private businesses that had not been used satellite data in fields such as disaster and agriculture.



▶Observation of heavy rainfall in July 2018 using GSMaP. The figure shows total precipitation over the 72-hour period from 10:00AM, July 5 to 9:59AM, July 8.

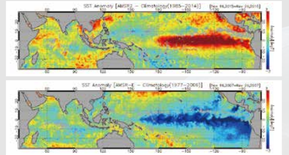
Monitoring Ocean Environment

Ocean Environment Monitoring

GPM | GCOM-W | GCOM-C | Himawari

Ocean surface observation data by satellites are widely used not only in climate change researches but also in other fields, such as meteorology and fishery, since it is difficult to measure the ocean widely by other means.

JAXA produces and distributes information related to ocean environment, including sea surface temperature (SST), wind speeds and ocean colors, by using satellite data from microwave radiometers that can observe the ocean surface even through clouds, and infrared radiometers that can observe even the coastal area with fine spatial resolution.



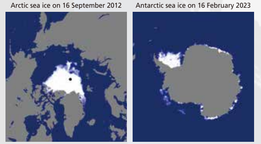
▲SST anomalies from climatology during El Niño (upper: 5-day averaged SST from Nov. 16 to 20, 2015 observed by GCOM-W/AMSR2) and La Niña (lower: same as upper but in 2007 observed by Aqua/AMSR-E). Since microwave radiometers are able to observe status of ocean surface through clouds, it is suitable for frequent monitoring of the ocean environment over broad areas.

Sea Ice Monitoring

ALOS | GCOM-W | GCOM-C

JAXA provides monitoring information of sea ice status by using GCOM-W microwave imager that is little affected by weather status, GCOM-C optical imager that offers powerful resolution and the synthetic-aperture radar (SAR) mounted on the ALOS series satellites.

The images on the right shows the Arctic and Antarctic sea ice distribution at its minimum extent ever, observed by GCOM-W. JAXA will continue to monitor the polar sea ice for the long term from both a scientific and practical perspective.



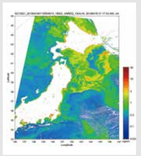
▲Sea ice distribution when the recorded minimum sea ice extent by satellite in the Arctic and Antarctic was observed by GCOM-W

Ocean-Color Monitoring

ALOS | GCOM-C | Himawari

Satellite ocean color observation enables us to monitor the distribution and variation of phytoplankton from the coasts to the global ocean. Phytoplankton plays a role as a primary producer in carbon fixing through photosynthesis in the ocean ecosystem.

The ocean color observation will elucidate how climate change affect ocean ecosystems and help to predict change of the marine biological resources.



▶Image of chlorophyll a density around Japan as observed by "SHIKISAI" on April 16, 2019. Values can be found in the scale at right. Phytoplankton propagation (the spring bloom) can be seen occurring from the coasts of Hokkaido to the seas around Tohoku (northeastern Honshu).

Detecting Land Changes

Monitoring the Forests

ALOS

The Synthetic Aperture Radar (SAR) mounted on the ALOS series satellites can observe the Earth's surface without effects of clouds and rainfalls, and enables to monitor global forests including tropics that frequently covered by clouds. JAXA has published the global forest/non-forest map that was created by analyzing huge number of SAR images in the world. JAXA contributes the protection of tropical rain forests and its ecosystems by monitoring forests using space technology in cooperation with the Japan International Cooperation Agency (JICA).

▲2019 PALSAR-2 25m Global Mosaic

▲2019 PALSAR-2 Forest/Non-Forest Map

▲2017 PALSAR-2 25m Global Mosaic

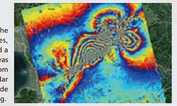
▲2017 PALSAR-2 Forest/Non-Forest Map

Crustal Deformation Monitoring

ALOS

SAR can observe the Earth's surface deformations caused by an earthquake, volcanic activity, a landslide, and other geological phenomena with centimeter-level precision.

JAXA contributes the disaster management using SAR Interferometry by measuring the surface displacement.



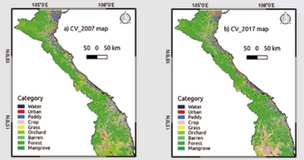
▶Crustal deformation from the 2016 Kumamoto Earthquakes, whose strongest temblor reached a magnitude of 7.0. This image was obtained by processing data from the PALSAR-2 synthetic-array radar on ALOS-2. Applications include earthquake source-fault modeling.

Land-Cover Classification and Ecosystem Modeling

ALOS | GCOM-C

The land-cover classification maps using combined multi-sensors and multi-satellites data are produced.

It can contribute to solve urgent problems i.e., ecosystem and environmental protection, a disaster management, a public health by creating comprehensive, high-quality fundamental land-cover classification information.



▲High-resolution land-cover map of central Vietnam

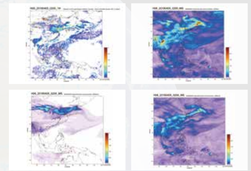
Predicting the Future with Models

Atmospheric and Aerosol Models

EarthCARE | GCOM-C | GOSAT | Himawari

JAXA has developed a system to assimilate multiple satellite data to aerosol transport models in cooperation with other organizations. The images and data are available online.

URL▶https://www.eorc.jaxa.jp/ptree/aerosol_model/



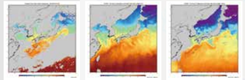
▲Aerosol optical thickness, 02:00 UTC, April 5, 2019. Upper left and upper right panels show the aerosol optical thickness estimated by Himawari-8 observation data and aerosol transport model, respectively. Lower left and lower right panels are contribution of the dust aerosol and the sulfuric-acid aerosol to the total optical thickness estimated by the model, respectively.
(The model results are provided by the Meteorological Research Institute.)

Ocean Modeling

GPM | GCOM-W | GCOM-C | Himawari

JAXA has developed a system to assimilate satellite sea surface temperature data (GCOM-W, GCOM-C, Himawari, etc.) into regional ocean model with high -spatial resolution in cooperation with the ocean model community. Model outputs including short-term forecasts from the system are available online and it enables to produce more accurate and seamless ocean analysis and forecasts of sea surface and under water.

URL▶https://www.eorc.jaxa.jp/ptree/ocean_model/



▲Observation of SST by Himawari at 9:00AM, May 5, 2019 JST (left); Forecast of SST by model with satellite data assimilation (center); Forecast of water temperature at depth of 100m by model (right). By coordinating satellite observations with ocean models, it is possible to estimate and forecast ocean information of underwater and regions where satellites cannot observe.
(Images produced by: JAXA/JAMSTEC)

Land & Flood Modeling

GPM | GCOM-W

JAXA has developed and operated a system called "Today's Earth" that calculates and visualizes water cycle parameters on land based on meteorological model analysis and satellite data, under a joint partnership with the University of Tokyo. The system is applicable to both globally and regionally (1km spatial resolution in Japan area) and output data is available online with risk indices. Application study on floods forecasts and warning more than 30-hour before the event in Japan area is conducted in collaboration with local governments and private companies. We also contribute to elucidate the Earth's hydrology by analyzing water resources, such as river flow depths by using the system.

URL▶https://www.eorc.jaxa.jp/water/

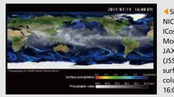
◀Today's Earth portal site: https://www.eorc.jaxa.jp/water/

Climate Modeling

GPM | EarthCARE | GCOM-W | GCOM-C | GOSAT | Himawari

Numerical models of weather and climate require continuous improvement and verification by using satellite data. JAXA developed a satellite-data simulator called "Joint-Simulator" for advanced uses of Earth observation satellites. JAXA also promotes research "NICAM-LETKF JAXA Research Analysis (NEXRA)" that assimilates data from Earth observation satellites.

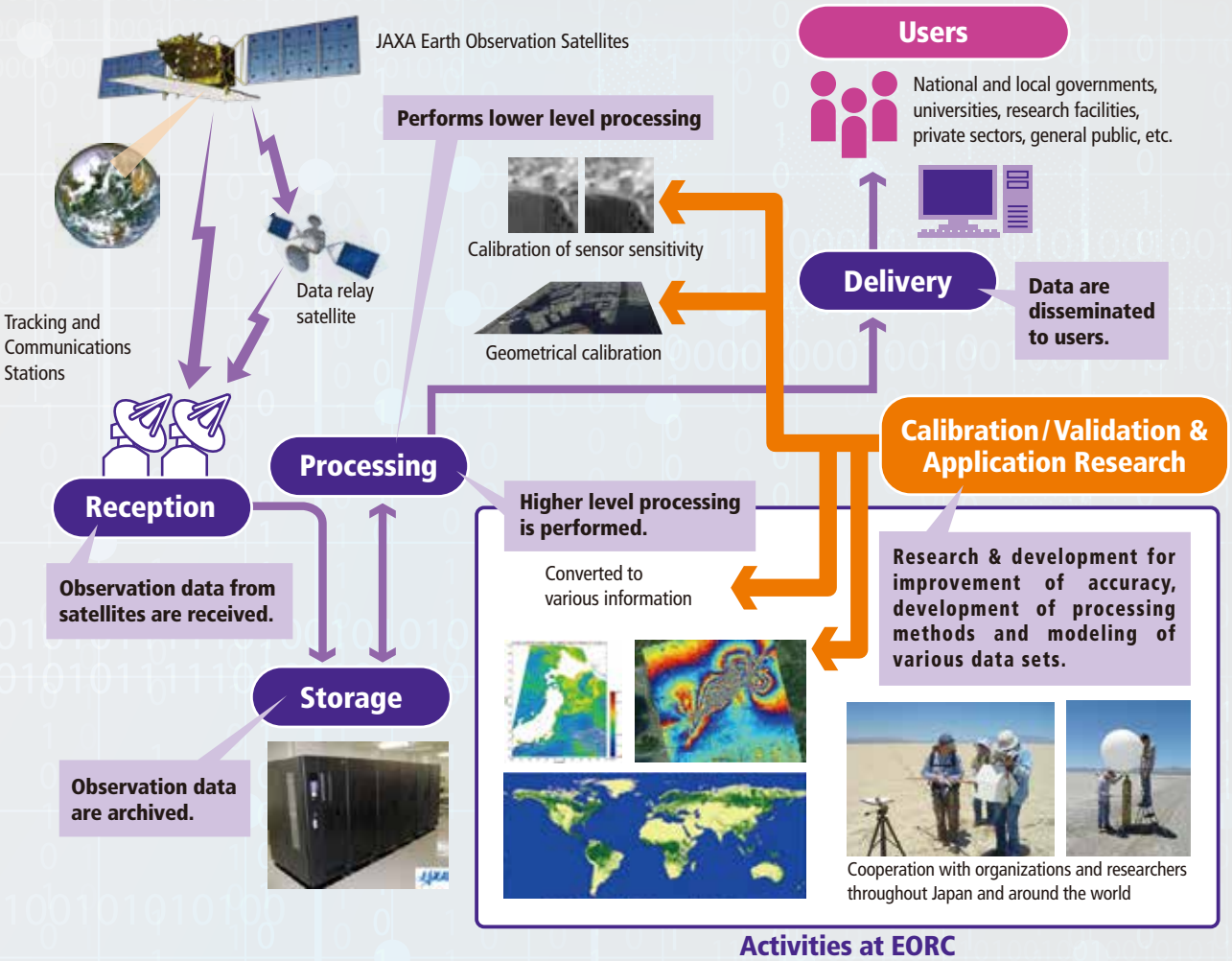
URL▶https://www.eorc.jaxa.jp/theme/NEXRA/



◀Simulation results using NICAM (Nonhydrostatic Icosahedral Atmospheric Model) performed using JAXA's super computer (JSS2). A figure shows surface precipitation and column water vapor at 16:00 UTC, July 13, 2017.

Assuring the Quality of Observation Data

Processing flow of the Earth observation data



Activities at EORC

The data observed by the JAXA Earth observation satellites' sensors are received by ground stations in Japan and overseas and are mainly archived at the JAXA Tsukuba Space Center. The major activities of the Earth Observation Research Center (EORC) are analysis of observation data, development of algorithms to retrieve geophysical parameters, calibration and validation of satellite data, and data dissemination to users. The data are utilized in the fields such as ocean, water cycle, atmosphere, climate, resource managements in agriculture, forestry, fisheries, disaster prevention and land use. EORC distributes data sets of related satellites and ground data collecting on a global scale under international collaboration.

JAXA Explore to Realize

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