

Keeping an eye on climate change

Orbiting hundreds of kilometres above the Earth's surface, satellites launched by the Japan Aerospace Exploration Agency (JAXA) are at **THE FOREFRONT OF CLIMATE RESEARCH**

Climate change caused by humans threatens to have serious consequences for populations around the world through its impact on both terrestrial and marine ecosystems. More frequent and extreme weather events, including heat waves, droughts and flooding, will exact significant tolls for generations to come.

Understanding how climate is influenced by greenhouse gases, such as the main drivers of global warming, carbon dioxide and methane, is essential to tackle the problem. But this presents an enormous scientific challenge, since it requires monitoring the factors that influence climate at local, regional and global scales over decades. That is where satellite observations play a vital role.

Using state-of-the-art satellite technology, the Japan Aerospace Exploration Agency (JAXA) is at the vanguard of climate science and research.

"Continuous and detailed monitoring by satellites allows us to observe changes at the global scale," says JAXA's president, Hiroshi Yamakawa. "They provide scientists with the data to better understand the changes occurring in the Earth's climate."

SATELLITES JOIN A GLOBAL NETWORK

An extensive network of atmospheric, oceanic and land-based monitoring systems — including weather stations, buoys, ships, balloons and aircraft — collect data on more than 50 parameters that influence the planet's climate, including sea ice coverage, forest cover and precipitation. JAXA, the National Institute for Environmental Studies (NIES) and the Japanese Ministry of the Environment (MOE) jointly launched the first satellite dedicated to monitoring the sources and sinks of greenhouse gases in 2009. Since then, greenhouse-gas observation



satellites have joined this global network, becoming an integral tool in climate research.

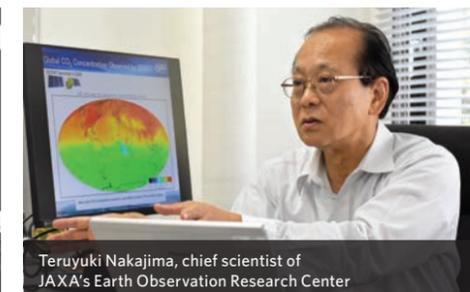
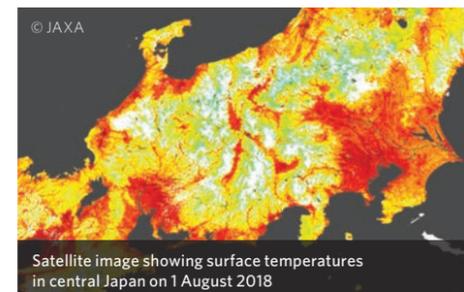
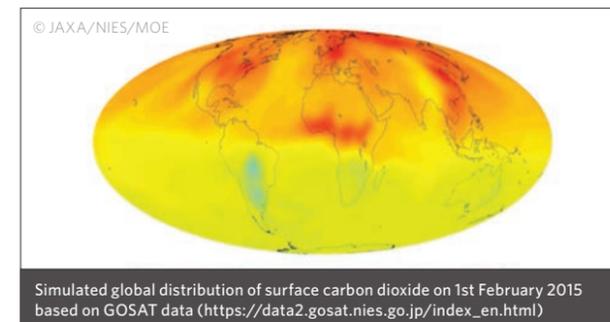
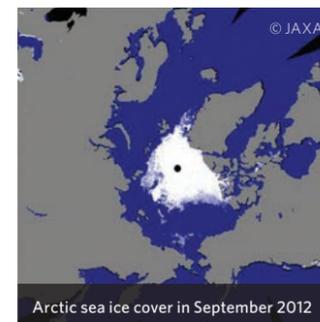
The Greenhouse gases Observing SATellite (GOSAT) — a collaboration between JAXA, NIES and MOE — has provided invaluable data for verifying the reductions in greenhouse-gas emissions agreed under the Kyoto Protocol to the United Nations Framework Convention on Climate Change, adopted in 1997.

"We're now integrating data from GOSAT with observations from aircraft, ships and land-based monitoring systems," explains Nobuko Saigusa, director of the Center for Global

Environmental Research at NIES. "This is leading to significant improvements in monitoring greenhouse gases emitted by man-made and natural systems."

TRACKING WATER AND ICE FROM SPACE

Of the many factors that influence climate, the Earth's water cycle is particularly important. To understand how climate change impacts the global water cycle, JAXA is driving the Global Precipitation Measurement (GPM) mission and the Global Change Observation Mission (GCOM), which consists of two satellites, GCOM-W and GCOM-C.



Since its launch in 2012, GCOM-W has been monitoring precipitation, sea ice, sea surface temperature, and soil moisture. Using the world's largest scanning antenna — the Advanced Microwave Scanning Radiometer 2 (AMSR2) — GCOM-W is able to cover over 99% of the Earth's surface in just two days. In September 2012, AMSR2 measured the smallest extent of Arctic sea ice on record. And in July 2017, AMSR2 captured dramatic images of a giant iceberg splitting from the Larsen C ice shelf in Antarctica. At nearly 6,000 square kilometres — more than twice the size of

Luxembourg — and weighing over a trillion metric tonnes, the calving event reduced the ice shelf by 10%. Launched by JAXA in 2017, GCOM-C is monitoring aerosols, clouds, vegetation and temperatures over land and oceans, which is helping to enhance the accuracy of forecasting environmental changes.

GPM is a joint mission between JAXA and NASA to measure global rain and snow with high frequency and high accuracy by using multiple satellites. Its core observatory, which carries a dual-frequency precipitation radar and GPM microwave imager, was

launched in 2014. By mapping global precipitation from the Arctic to Antarctic, GPM is providing greater insights into the Earth's weather and climate change studies.

"Modern satellites collect huge amounts of data from across the oceans, the Arctic and other sparsely populated zones, which are difficult for humans to monitor," notes Teruyuki Nakajima, chief scientist of JAXA's Earth Observation Research Center.

THE FUTURE OF EARTH OBSERVATION

This year, JAXA, NIES and MOE will jointly launch GOSAT-2, the

successor to GOSAT. Carrying advanced pointing capabilities that allow it to avoid cloud cover, GOSAT-2 will measure carbon dioxide, methane and carbon monoxide levels with greater accuracy across a broader range of locations, including industrial and densely populated areas. Its data will contribute to the first global greenhouse-gas inventory required under the Paris Agreement, which is scheduled for release in 2023.

Scheduled for launch, the EarthCARE is an international collaboration between JAXA, Japan's National Institute of Information and Communications Technology (NICT) and the European Space Agency (ESA). Japan is contributing one of its on-board instruments, the cloud profiling radar. It will monitor the structures of clouds and aerosols in three dimensions and promises to significantly reduce uncertainties in estimates of the Earth's radiation budget for better climate change prediction.

JAXA is also leading international collaboration on the deployment of Earth-observation technologies, through agreements with NASA and ESA, as well as the French and German space agencies. "Reliable data that can be analysed and transformed by scientists into useful information for policymakers cannot be achieved by one agency," says Yamakawa. "It requires collaboration between space agencies around the world." ■

