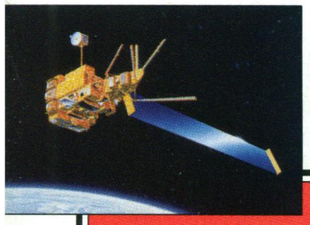
EARTH SCIENCE

New Satellite Puts Japan in Top Tier of Remote Sensing

TOKYO—Japan's remote Earth-sensing program literally got off the ground last weekend when an H-II rocket rose majestically from the launch pad at the Tanegashima Space Center and lofted the $1 billion Advanced Earth Observing Satellite (ADEOS) into orbit. The satellite, bristling with sensors for measuring everything from stratospheric ozone to ocean turbulence, is a significant addition to the growing international fleet of spacecraft peering down on Earth. But for Japan's National Space Development Agency (NASDA), which is leading the mission, ADEOS is something more: It is the beginning of an ambitious program that should take the agency beyond its historic role as a rocket and satellite developer to become a major player in research. If all goes according to plan, ADEOS will be joined by three more earth-science satellites by 2000.

In the works for a decade, ADEOS is carrying eight instruments from Japan, France, and the United States (see table). It will gather data on basic Earth and ocean processes, global climate change, and environmental degradation and regeneration. The satellite's international flavor is a fortuitous blending of NASDA's wish to make use of the 5-ton payload capacity of the H-II—the pride of its fleet—and the need for other space agencies to economize on their own remote-sensing programs. And its 3-year stay in low Earth orbit could boost Japanese researchers into the front rank of global activity in the field.



NASDA

Hiroshi Kawamura, a physical oceanographer at Tohoku University, says he and his colleagues around the world have been waiting for an instrument like the Ocean Color and Temperature Scanner (OCTS) ever since the last major satellite-borne ocean color sensor, part of a U.S. mission, gave out 10 years ago. By measuring ocean chlorophyll levels, OCTS will indicate production of phytoplankton, the bottom link in the ocean food chain, and thus infer how much carbon is exchanged between the atmosphere and the oceans. Kawamura says OCTS data will be joined with information from the NASA Scatterometer and sensors on other satellites to study how currents and waves interact with phytoplankton production. OCTS will also monitor environmental changes such as the flow of vast amounts of sediment into coastal waters from the logging of rain forests in Asia. "We don't know how [this material] circulates in the open ocean," Kawamura says.

While OCTS will be keeping tabs on the world's oceans, three other instruments will train their sights on the upper atmosphere, providing the most detailed profile so far of ozone concentrations. The Total Ozone Mapping Spectrometer (TOMS) will generate maps of the global distribution of ozone, while the Improved Limb Atmospheric Spectrometer (ILAS) will track how those concentrations vary by altitude over the poles. The third instrument in this suite, the Interferometric Monitor for Greenhouse Gases, will yield rough data on the vertical distribution of ozone in the areas ILAS misses.

INSTRUMENTS ABOARD ADEOS

Name	Agency	How It Works
Ocean Color and Temperature Scanner (OCTS)	Japan space agency (NASDA)	Radiometer measures ocean color to infer productivity, infrared light for temperature
Advanced Visible and Near-Infrared Radiometer (AVNIR)	NASDA	Optical sensor measures light to determine vegetation and soil conditions
Interferometric Monitor for Greenhouse Gases (IMG)	Japan trade and industry ministry (MITI)	Thermal infrared radiation spectra infer levels of greenhouse gases
Improved Limb Atmospheric Spectrometer (ILAS)	Japan Environment Agency	Spectra indicate concentrations of ozone and various greenhouse gases
Retroreflector in Space (RIS)	Japan Environment Agency	Laser system takes profile of atmospheric trace elements
Scatterometer (NSCAT)	NASA	Pattern of microwave radar pulses reflected from ocean infers wind speed and direction
Total Ozone Mapping Spectrometer (TOMS)	NASA	Direct and scattered readings of ultraviolet light infer atmospheric ozone levels
Polarization and Directionality of the Earth's Reflectances (POLDER)	CNES (French space agency)	Various measurements of Earth's radiation budget

ADEOS's ozone monitors should be perfectly placed to record a rare success in protecting Earth's environment. P. K. Bhartia, TOMS project scientist and head of atmospheric chemistry and dynamics at NASA's Goddard Space Flight Center in Maryland, notes that the buildup of chlorofluorocarbons (CFCs) has peaked, thanks to global agreements to phase out the use of these ozone-depleting chemicals.

ADEOS gives NASDA an opportunity to evolve from being "technology-driven to science-driven," says Tasuku Tanaka, director of NASDA's Earth Observation Research Center (EORC). NASDA is taking the lead in studying what the ADEOS data mean, a significant expansion of its previous responsibilities of just managing and distributing data from its weather and marine observation satellites. Tanaka says NASDA hopes that the 1-year-old EORC, its first center dedicated to scientific research, will become the leading facility in Japan for the use of such data.

To succeed, EORC must first build up the field. NASDA and its partners have tapped 150 scientists worldwide as principal investigators for ADEOS data. Haruhisa Shimoda, a specialist in remote-sensing technology at Tokai University and ADEOS program scientist for NASDA, says that while the 50 or so U.S. investigators represent only a fraction of their community, the 50-person Japanese team "represents almost all the Japanese scientists working in this area."

About a fourth of EORC's $38 million annual budget goes to support those Japanese researchers, typically based at universities. More importantly, the center is leading the way by building up its own research staff with talented young scientists like Takashi Nakajima, who completed a master's degree in geophysics at the University of Tokyo in 1994 and joined the group at NASDA that was reorganized into EORC last year.

Nakajima says that one of the advantages of the EORC is the chance to assemble a large, multidisciplinary team. In particular, Nakajima intends to use data from ADEOS and future satellites to study how clouds and aerosols affect the Earth's radiation budget by reflecting sunlight, and how that affects climatic conditions.

EORC's budget is a small fraction of the $1.68 billion NASDA spends every year. But NASDA has made remote-sensing satellites an integral part of its plans. It will launch three more Earth-observing satellites by 2000 that will track tropical rainfall, monitor changes in land formations, and replace ADEOS. It is also developing instruments to be carried on U.S. and European satellites. In short, NASDA officials hope that the high-flying ADEOS mission will boost the agency—and Japan—into the upper realms of remote-sensing science.

–Dennis Normile