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SMOS satellite launched

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Environmental mission investigates fundamentals of water cycle and climate change

SMOS satellite in orbit

The SMOS (**S**oil **M**oisture and **O**cean **S**alinity) satellite was launched on Monday, 2 November 2009 at 02:50 Central European Time (CET) from the Plesetsk Cosmodrome, 800 kilometres north of Moscow. The satellite is beginning a unique mission: the large-area mapping of soil moisture and ocean salinity. The German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) has already initiated a number of research projects in order to evaluate the environmental data.

Both ocean salinity and soil moisture content are core parameters for the understanding of the Earth's water cycle and climate change. The information from SMOS will be much more accurate and more meaningful than previous satellite data or point measurements, which were carried out on the ground or at sea. It will facilitate improved analyses and forecasts concerning ocean circulation, availability of water resources and extreme weather events.

Salinity as a watchdog for polar ice cap melting

SMOS is the first mission that is devoted to the determination of ocean salinity over large areas. The salt content of the oceans is an important parameter for environmental monitoring. For instance, if the salinity in the polar regions drops unexpectedly, this is an alarm message, because it can indicate faster than predicted melting of the ice caps.

Animation of the MIRAS instrument on SMOS

In addition to this indicator function, ocean salinity is an important driving force behind global ocean circulation. Salinity and temperature affect the density and hence the weight of water. Heavy water masses descend, while lighter ones rise, forming the 'pump' responsible for many ocean currents.

The climate depends very strongly on oceanic circulation, because water masses drive moist warm or cold air masses along with them. If the circulation is disturbed on a long-term basis, this can have strong effects, for instance, on regional rain quantities, wind systems and temperatures. Until now, there have been hardly any time series investigations into ocean salinity. Point measurement data exist,

derived from measurements made by research ships or buoys. However, no reliable results can be derived from these data for larger regions – including the global situation.

Investigations into global water circulation

The determination of the water content of the soil is another task for SMOS. Analyses of soil moisture content are, on the one hand, important for long-term studies of the global water cycle. On the other hand, they help to predict the likelihood of extreme events, such as floods, with improved accuracy. With the data from SMOS, a global map of soil moisture distribution will be available for the first time.

Rockot launcher

New measuring technique with the MIRAS instrument

On SMOS, a brand new measuring technique will be used. The microwave radiometer MIRAS (Microwave Imaging Radiometer using Aperture Synthesis) is the only instrument onboard the satellite and it measures the spectrum of the microwave radiation emitted by the oceans and by the Earth's land surface. Dry ground has different surface properties to damp soil and water masses with low salt concentration differ from those with high salinity. These property variations result in distinctive radiation emissions, from which the soil moisture content and ocean salinity to be determined.

Just like a radar-based instrument, MIRAS functions independently of sunlight and cloud coverage. In contrast to radar systems, this passive microwave radiometer does not transmit its own radiation, relying instead on the natural emissions from its targets. The instrument has a two-dimensional field-of-view, which images a hexagonal area of about 1000 square kilometres every 1.2 seconds. The radiometer works in the L-band, at a frequency of 1400 megahertz. MIRAS was built by the Spanish company EADS CASA, after a decade of development. The total cost of the SMOS satellite is 210 million Euro, to which additional contributions were made by the French and Spanish space agencies.

Unpacking the transport containers

German project office coordinates the scientific work

Already, in several European countries as well as in Germany, various projects are under way in order to validate and calibrate the SMOS data. In this way, the data can be used sooner. For this purpose, scientists are employing measuring campaigns with in-situ measurements, together with data from

other satellites, to develop computing techniques for processing the data to obtain reliable results. These results will then be integrated into forecast models. Existing models and forecasting systems will also be further developed and improved using the SMOS data.

In addition to research projects, which are preparing for data utilisation, a German SMOS Project Office has been set up at the University of Hamburg. Promoted by DLR, with funds from the German Federal Ministry of Economics and Technology (Bundesministerium für Wirtschaft und Technologie; BMWi), the office's task is it to coordinate the scientific work in Germany and Europe in order to better serve additional users outside the scientific field and to serve as an information and contact point. The projects will reach the most intense phase of their work during the approximately six-month-long satellite test phase, but will continue to supply important insights and results regarding the use of the data during the operational phase of the mission.

Earth systems research with 'Living Planet'

SMOS is the second mission in the ESA Living Planet Programme, in which the selected science satellites carry out measurements aimed at answering important questions in Earth systems research. The first of the 'Earth Explorer' satellites, GOCE, commenced its mission early in 2009. At the end of February 2010, another Explorer mission, CryoSat-2, is scheduled to start. For the period to 2016, another four missions are planned. With a 24 percent stake, Germany is one of largest contributors to the ESA Living Planet Programme. German companies such as Kayser-Threde, Astrium and Tesat are involved in the building of the satellites. The Rockot launcher is operated by Eurockot GmbH.

Related Contacts

Dr. Christiane Lechtenbörger
German Aerospace Center
Space Administration, Earth Observation
Tel: +49 228 447-581
Fax: +49 228 447-747
E-Mail: Christiane.Lechtenboerger@dlr.de
