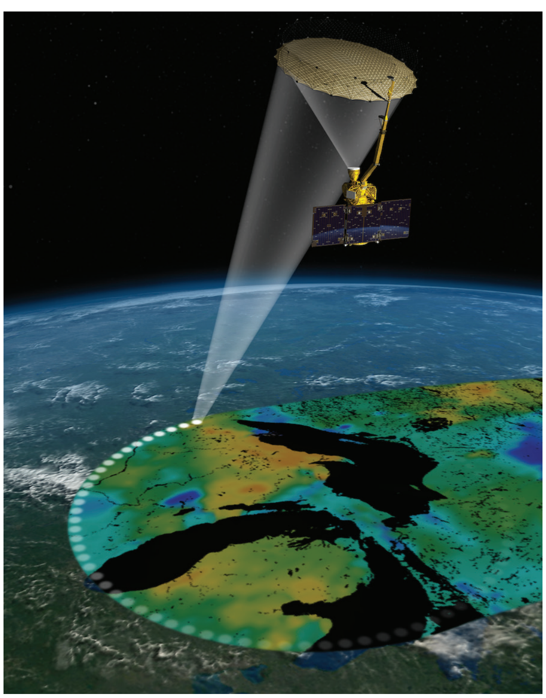
NASA facts

Soil Moisture Active Passive

Iowa's deep black topsoil, Georgia's red clay, the wine-growing fields of France — without water, they're all dust. The moisture that lodges in soil is only a tiny fraction of Earth's water, but it's a key player in the vitality of the Earth system. Soil moisture regulates plant growth, which, in turn, affects animals. It affects how water and heat are exchanged between Earth and the atmosphere's clouds, rain and snow. Saturated ground can multiply the damage caused by floods, and bone-dry soil inhibits rain clouds from forming, adding to the extent and severity of drought. Yet there are currently no satellites making global high-resolution measurements of this critical component of life on Earth.

Scheduled to launch in November 2014, NASA's Soil Moisture Active Passive (SMAP) mission will collect data to provide the most accurate and highest-resolution maps of soil moisture ever obtained. SMAP will do this by observing the land surface worldwide every two to three days from space for at least three years. Among the users of the highly anticipated data will be hydrologists, weather forecasters, climate scientists, agricultural and water resource managers, disease control and prevention managers, emergency planners and policy makers.



Mission Overview

The SMAP mission has been in preparation since 2008, but the value of high-resolution measurements of soil moisture from space has been recognized for decades. Existing ground-based measurements of soil moisture are too sparse, and the best current satellite measurements have a resolution of about 25 miles (40 kilometers) across. That resolution is too coarse to show detailed variations within, for example, a river basin. This mission will improve that resolution to about 6 miles (10 kilometers).

SMAP's data will have broad applications for science and society. Because variations in soil moisture affect the cycling of water between the land and atmosphere, weather forecasters will be able to use the mission's data to improve their predictions. Hydrologists will be able to model water flow down to the scale of individual river basins. Emergency managers will be able to use the data for forecasting and planning connected with floods, landslides, droughts and wildfires. Policy makers worldwide need to understand what climate change is likely to do to their freshwater supplies and food production. SMAP will improve the accuracy of climate models that are used to predict regional water availability. It will also improve the models that produce seasonal climate and crop-yield forecasts.

The mission provides another important measurement: it detects whether soil is thawed or frozen (its freeze-thaw state), indicating the length of a location's growing season. Plants absorb carbon dioxide from the air while they grow but not after they freeze in the winter, so knowing the length of the growing season is important for understanding the global carbon cycle. Freeze dates are currently estimated from information such as air temperature, but as any gardener knows, that correlation is far from perfect.

The SMAP team is engaged with “early adopters” — groups and individuals that foresee immediate uses for its data. Through workshops and tutorials, the SMAP Applications Working Group is partnering with these early adopters to test and integrate SMAP data products into many different types of operations. The early adopters include weather forecasters from several nations and researchers and planners from the U.S. Department of Agriculture, U.S. Geological Survey, U.S. Centers for Disease Control and Prevention, U.N. World Food Programme and other organizations. Their regions of expertise range from the North Carolina coastal plains to the Sahara Desert, and the applications they’re researching range from improving management of New York City’s water supply to providing better tactical support for the U.S. Army.

Instrument Overview

To obtain a measurement with both high resolution and high accuracy, SMAP will combine data from two instruments, a radar and a radiometer, in a way that uses the best features of each while working around their individual limitations. The instruments can peer into the top 2 inches (5 centimeters) of the soil, through clouds and moderate vegetation cover, day and night.

“Active Passive” in the mission name refers to the two types of instruments used by SMAP, which operate in the microwave frequency. The synthetic aperture radar instrument actively emits a signal and measures the backscatter that returns from Earth, whereas the radiometer instrument passively records Earth’s own naturally emitted microwave signal. Variations in these signals contain information on soil moisture changes. The instrument’s radar observations have high resolution but lower accuracy than the radiometer observations. The radiometer observations have higher accuracy but lower resolution than the radar. The combined, processed measurements have intermediate resolution and high accuracy.

SMAP’s 19.7-foot (6-meter) scanning antenna is made of a lightweight mesh that can be packaged into a small package for launch and then unfurled in space. The width of the region scanned on Earth’s surface during each orbit is about 620 miles (1,000 kilometers). This allows SMAP to cover the equatorial regions within three days and Earth’s higher latitudes within two days.

SMAP data products will include:

- The combined measurement mentioned above, with 6.2-mile (10-kilometer) resolution and high accuracy;
- The lower-accuracy radar measurement with a resolution of 0.6 to 1.8 miles (1 to 3 kilometers);
- The coarse-resolution but highly accurate radiometer data (25 miles or 40 kilometers, similar to the resolution of a global climate model); and
- The freeze-thaw state measurements.

By combining SMAP observations with other available data such as precipitation and solar radiation in a land hydrology model, the mission team will also generate two additional products: an estimate of moisture in the top 3 feet (1 meter) of soil, known as the root zone, and an estimate of the exchange of carbon between the atmosphere and the land surface.

Launch and Orbit

SMAP is scheduled for launch no earlier than Nov. 5, 2014, from Vandenberg Air Force Base, Calif. The launch vehicle is a United Launch Alliance Delta II expendable rocket. The spacecraft will be placed into a 426-mile (685-kilometer), near-polar, sun-synchronous orbit, with equator crossings at 6 a.m. and 6 p.m. local time.

Mission Duration

SMAP is designed to operate for at least three years.

Partners

SMAP is managed by NASA’s Jet Propulsion Laboratory, Pasadena, Calif., with participation by NASA’s Goddard Space Flight Center, Greenbelt, Md. JPL is responsible for project management, system engineering, instrument management, the radar instrument, mission operations and the ground data system. Goddard is responsible for the radiometer instrument. Both centers are responsible for science data processing and delivery of science data products to the Alaska Satellite Facility and to the National Snow and Ice Data Center for archiving and public distribution.

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