Water-Witching From Space

Farmers will soon have a new tool for getting the most out of their fields. NASA's Aqua satellite will provide crucial information about the water in the ground and the weather on the horizon.

Marshall Space Flight Center

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May 23, 2001 -- Back in the old days, when farmers wanted to find water in the ground, they hired a fellow called a "dowser" who held a forked stick and went "water-witching." When the forked stick "dowsed," or dipped toward the earth -- supposedly under the influence of hidden water -- that's where water would be found. Or so they said. But now NASA has a better way to find moisture in the Earth.

Using data from NASA's Aqua satellite -- due to launch in December 2001 -- scientists hope to be able to map the moisture content of soils over most of the Earth's surface. This information will also improve forecasts of potential rainfall and other meteorological factors such as winds, temperature and humidity. Better knowledge of water and weather should be a boon to agriculture.

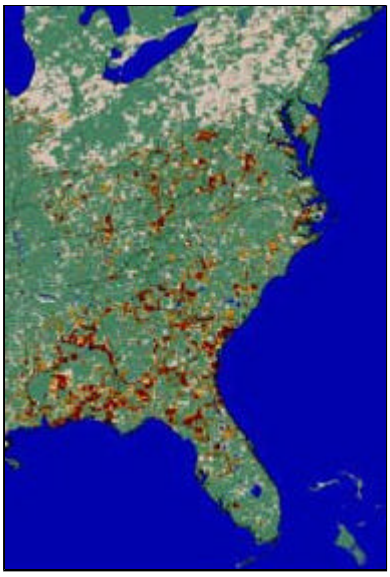
Above: The moisture in the soil of this northern Tennessee farm is connected to the water in the river and the water vapor in the air through the hydrologic cycle. Because of this connection, soil moisture not only affects crops directly, but also indirectly by its impact on weather. Data from NASA's Aqua satellite will keep farmers informed about both the direct and indirect effects of soil moisture. Photo by Marion Post Wolcott.

"What this improved information on current soil moisture means for farmers is that we can improve long range weather forecasting and consequently improve forecasts of crop yields," explains Bill Crosson, a scientist with the Universities Space Research Association (USRA) working through NASA's Global Hydrology and Climate Center (GHCC). "The key is a combined system through which we obtain global data on soil moisture and integrate it into weather prediction models."

Such data will produce a bumper crop of real-world applications for agriculture and meteorology.

Farmers will be able to use the data and the potentially improved long-range weather forecasts to help plan growing seasons, schedule crop irrigation, prevent excessive

fertilizer use, and predict plant strength and resistance. Data and forecasts will also be useful to water resource managers and they will help agriculture officials estimate crop productivity.



"When the soil is dry, there is less water for plant nutrition -- but there is also less evaporation, and drier soil heats up faster," Crosson says. "There is a direct link between soil moisture and atmospheric humidity. Both humidity and rising heated air affect local and regional temperatures and winds."

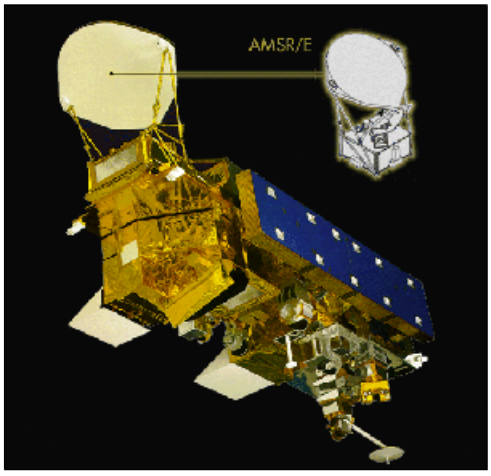
Left: This Earth Observation System integrated data image prepared by the University of Montana School of Forestry is part of the Upper Midwest Aerospace Consortium (UMAC) Surface Moisture Index. Note the extreme soil moisture stress (dark orange) in the drought-stricken southeastern U.S.

Crosson believes the data could be especially helpful to large agribusiness operations where farmers cannot easily obtain accurate long-term soil moisture data for fields covering hundreds of square kilometers.

Until recently, environment and climate measurements were either on a small scale involving ground-based readings on fields less than one kilometer square -- or they looked at huge areas of oceans and continents from space. Now scientists will attempt to fill in the void for local areas and regional zones with more diverse and accurate remote sensing techniques, says Charles Laymon, another USRA scientist working on the project.

"Any farmer can stick his finger in the soil to measure soil moisture, but there is no global context in that," Crosson notes. "He doesn't know the large scale moisture patterns that influence the future weather for his fields. A wet patch in one corner of a field, or a dried-out hilltop, reveals little about the farm's imminent crop productivity -- especially if he's farming thousands of acres."

Right: The Advanced Microwave Scanning Radiometer-EOS (AMSR-E) package is at the top front of the EOS Aqua spacecraft. Image courtesy the Aqua Project, Goddard Space Flight Center.

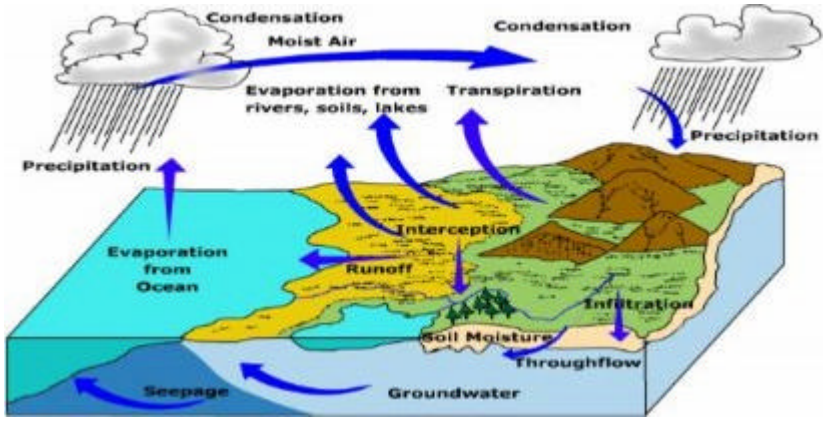


The instrument on Aqua that will sense soil moisture is called the Advanced Microwave Scanning Radiometer-EOS (AMSR-E, called "amser"). The Aqua satellite -- the second in a series of satellites called NASA's Earth Observing System (EOS) -- will have an orbit that covers the globe every 16 days during a planned six-year mission life. AMSR-E's moving "footprint" will be about 25-by-25-kilometers.

The deployment of AMSR-E will mark a bold step in applied soil moisture research. Other past and present space-based instruments obtained some soil moisture data, but were not specifically designed for that purpose. Crosson and Laymon say that what was once a practice of "using the wrong tool for the right task" is now being replaced with designed and targeted observations.

"Putting microwave scanning radiometer technology to use in the Earth Observing System is an important step for soil hydrology," concludes Laymon. "Combining the diverse long-term daily observations of land, oceans and atmosphere by EOS will produce knowledge that ultimately improves everyone's quality of life by improving the way we use the natural resources and systems of our Spaceship Earth."

Hydrology as a science deals with the properties, distribution and circulation of water on and below the Earth's surface and in the atmosphere. Soil moisture is a key factor in many climate processes, so it has long been of interest to hydrologists, soil scientists, ecologists and meteorologists.



Above: The hydrologic cycle, or water cycle, is the sum of the movement of water through the Earth system. Because the water can carry stored heat, it is a cycle of energy as well. Graphic courtesy Michael Ritter, Univ. of Wisconsin at Stevens Point. [more information]

The effects of soil moisture are most significant during warmer weather, Crosson says, whereas the dominant factor in cold seasons is stronger, fast moving storms.

"The warm season is characterized by stagnant, slower moving weather systems," Crosson explains, "and when weather is relatively static for many weeks, subtle factors and effects such as very dry or wet soil can play a larger role in the weather patterns."

Summer conditions are heavily dependent on springtime soil wetness, as that moisture eventually translates into humidity. Low spring moisture in recent years has too often left farmers woefully unprepared for ensuing summer and fall drought conditions.

Crosson, Laymon and their NASA colleagues hope that evaluations of remote-sensing data from current and future space-based instruments will enable better farm productivity with fewer losses from droughts and crop failures.

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