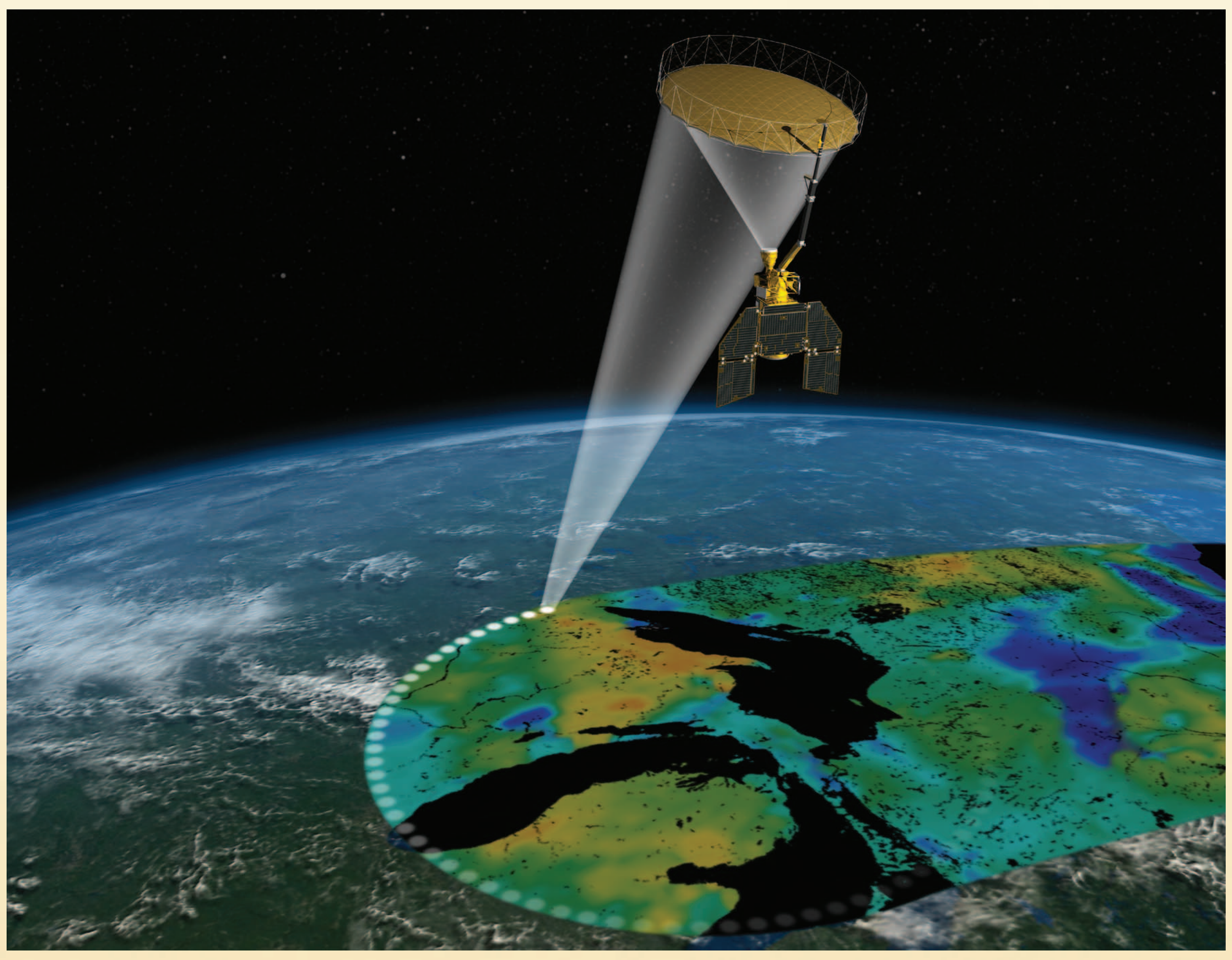
Soil Moisture Active Passive (SMAP)

APPLIED SCIENCE

Mapping soil moisture and freeze/thaw state from space



The SMAP Mission

Objectives: SMAP measurements will be used to enhance understanding of processes that link the water, energy, and carbon cycles, and to enhance the predictive skill of weather and climate models. SMAP data will also be used to quantify net carbon flux in boreal landscapes and to develop improved flood prediction and drought monitoring capabilities.

Observatory: The SMAP observatory employs a dedicated spacecraft with an instrument suite that will be launched on an expendable launch vehicle into a 680-km near polar, sun-synchronous orbit, with equator crossings at 6 AM and 6 PM local time.

Instrument: The SMAP instrument includes a radiometer and a synthetic aperture radar operating at L-band (1.20-1.41 GHz). The instrument is designed to make coincident measurements of surface emission and backscatter, with the ability to sense the soil conditions through moderate vegetation cover. The conically-scanning antenna covers a 1000 km swath providing global coverage within 3 days at the equator and 2 days at boreal latitudes (>45° N).

Operations: SMAP science measurements will be acquired for a period of three years. A comprehensive validation program will be carried out after launch to assess the science data products. The products from these activities will be made available through a NASA data archive center.

Area	Likely Mission Applications	Potential Mission Applications
Weather	More accurate weather forecasts; prediction of severe rainfall	Regional weather prediction improvements
Natural Disasters	Drought early warning decision support; key variable in floods and landslides; operational flood forecasts; lake and river ice breakup; desertification	Fire susceptibility; heat-wave forecasting
Climate Variability and Change	Extended climate prediction capability; linkages between terrestrial water, energy, and carbon cycles; land/atmosphere fluxes and carbon (CO_2) source/sink activity for atmospheric greenhouse gases	Long term risk assessments
Agriculture and Forestry	Predictions of agricultural productivity; famine early warning; monitoring agricultural drought	Crop management at the farm scale; input to fuel loading models
Human Health	Landscape epidemiology; heat stress and drought monitoring; insect infestation; emergency response plans	Disease forecasting and risk mitigation
Ecology	Carbon source/sink monitoring; ecosystems forecasts; improvements in monitoring of vegetation and water relationships over land	Wetlands resources and bird migration monitoring; cap-and-trade carbon inventory assessment and monitoring
Water Resources	Regional and local water balance; more effective management	Variability of water stored in lakes, reservoirs, wetlands and river channels monitoring
Ocean Resources	Sea ice mapping for navigation, especially in coastal zones; temporal changes in ocean salinity	Provision of ocean wind speed and direction, related to hurricane monitoring
Insurance Sector	More accurate forecasts of weather; prediction of severe rainfall; operational severe weather forecasts; mobility and visibility	Crop insurance programs; flood insurance programs; tourism and recreation
Coastal Inundation	Input to sea level rise products	Maps of coastal inundation; ocean winds monitoring for hurricanes
Drought	Early warning decision support; drought monitor products	Desertification identification
Flood	Improved forecasts, especially in medium to large watersheds; flood mapping; protection of downstream resources; soil infiltration conditions; prediction of ice breakup	Prediction of the impact of tropical storms on hydrology
Ecosystem Health	Improvements in monitoring of vegetation health and change; ecosystem dynamics	Wetlands and bird migration monitoring; Rangeland forage productivity forecasts
Wildfires	Input into fire potential models	Improvements in fuel loading models, especially for non-heavily forested areas

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Applications Objectives

The overall goal of the SMAP Applications Program is to engage SMAP end users and build broad support for SMAP applications through a transparent and inclusive process. SMAP is one of four first-tier missions recommended by the National Research Council's Committee on Earth Science and Applications from Space *[Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond, Space Studies Board, National Academies Press, 2007]*. SMAP data have both high science value and high applications value. The accuracy, resolution, and global coverage of SMAP soil moisture and freeze/thaw measurements are invaluable across many science and applications disciplines including hydrology, climate, carbon cycle, and the meteorological, environmental, and ecology applications communities.

The sub-goals of the SMAP Applications Program are to:

- establish a SMAP Applications Working Group;
- promote the use of SMAP products to develop a community of end-users and decision makers who understand SMAP capabilities and are interested in using SMAP products in their applications;
- facilitate feedback between SMAP user communities through the SMAP Applications Working Group and the SMAP Mission and the SMAP Science Definition Team;
- provide information on and documentation of collaboration with different classes of users and communities and design communication strategies to reach out to these new communities, including those of precipitation, drought detection, agriculture, and ecosystem modeling, among others;
- guide new users using resources and SMAP experts and associated personnel to assist with integration of data into user processes and systems; and
- coordinate with the public outreach group and the media to publicize SMAP products, users, and objectives to help improve the visibility of the mission.

Web Site

Please visit our web site for more information about SMAP:

http://smap.jpl.nasa.gov

User Engagement

The user engagement strategy will follow a pathway from simple knowledge of the SMAP data configuration and availability to actively using the data in the user system or process. ***Figure 1*** shows the general strategy for engagement of users. Users will learn about the SMAP mission in a variety of ways, including those listed in the next section. Users will be ready to use SMAP data when they engage in analysis, demonstration and have an understanding of the impact of the data on their own processes. It is not expected that all users will achieve readiness to integrate SMAP data, but those that do will be powerful examples for others to follow. In the pre-launch phase when only testbed simulations of soil moisture datasets are available, the SMAP team will work with organizations to move them along as far as possible in the cycle of engagement. Through this work the Science Definition Team will connect with additional organizations and communities who may be interested in SMAP data.

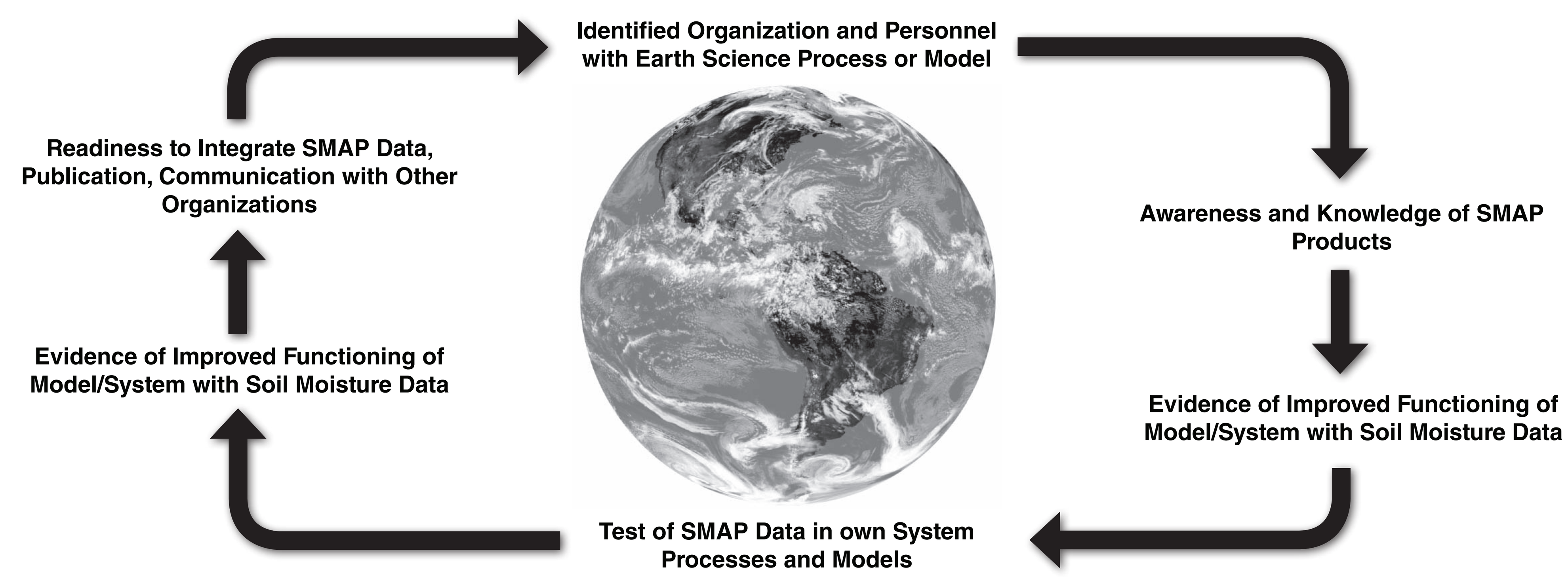

Figure 1. *Flow of engagement of users from passive awareness to actively using SMAP data once they become available.*

Selected Applications

Evolution of L-Band Remote Sensing

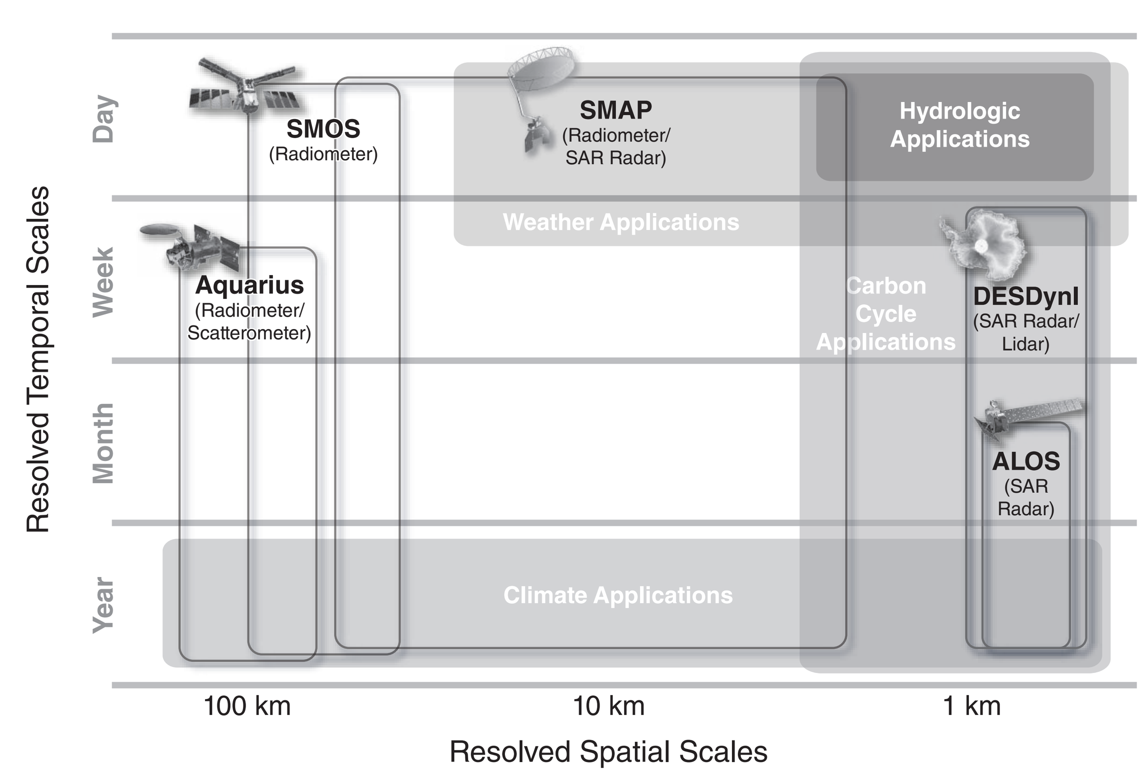

Figure 2. *The SMAP sensor is the result of many years of technological development, and provides a resolution of data appropriate for a variety of applications. These include weather models, hydrological applications, carbon cycle applications, and climate analysis. The figure above shows the required temporal and spatial scales for these applications, along with other sensors that provide the associated measurements.*

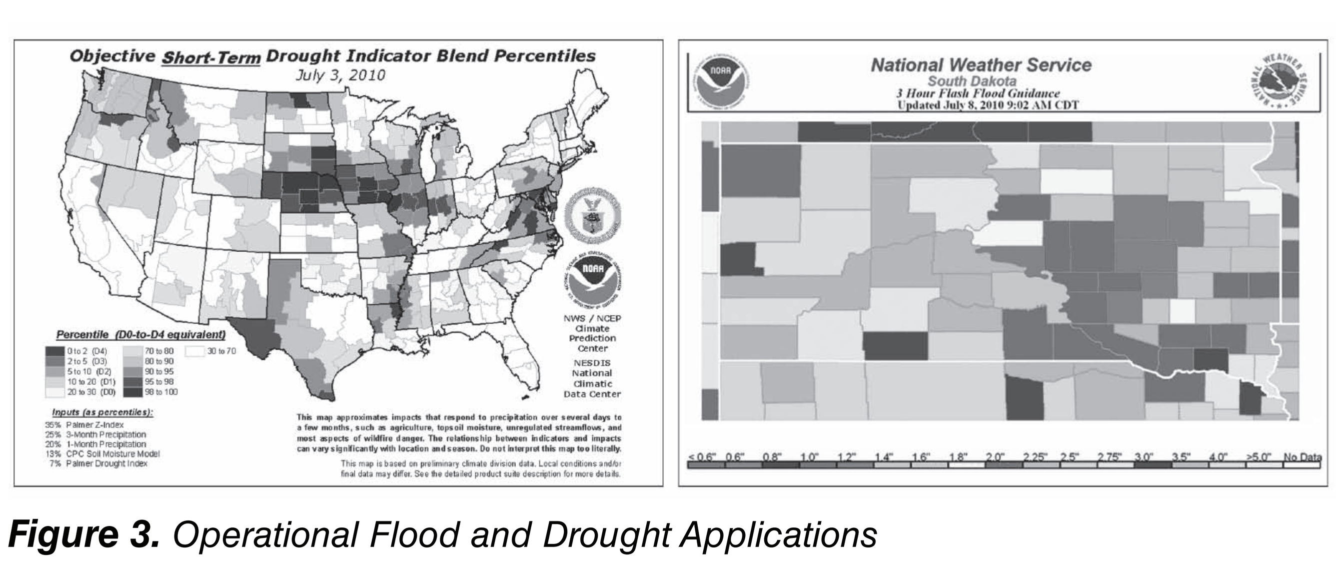

Figure 3. *Operational Flood and Drought Applications*

Current: Empirical Soil Moisture Indices Based on Rainfall and Air Temperature (By Counties >40 km and Climate Divisions > 55 km)
Future: SMAP Soil Moisture Direct Observations of Soil Moisture at 9 km

Drought:

Soil moisture strongly affects plant growth and hence agricultural and rangeland productivity, especially during conditions of water shortage and drought. At present, there is no global in situ network for soil moisture monitoring. Global estimates of soil moisture and plant water stress must be derived from models. These model predictions (and hence drought monitoring) can be greatly enhanced through assimilation of space-based soil moisture observations.

Weather & Climate Forecasting:

Soil moisture variations affect the evolution of weather and climate over continental regions. Initialization of numerical weather prediction and seasonal climate models with accurate soil moisture information enhances their prediction skills and extends their skillful lead times. Improved seasonal climate predictions will benefit climate-sensitive socioeconomic activities, including water management, agriculture, fire, and flood and drought hazards monitoring.

Agricultural and Rangeland Productivity:

SMAP will provide information on water availability for estimating plant productivity and potential yield. The availability of direct observations of soil moisture from SMAP will enable significant improvements in operational crop and rangeland productivity and information systems by providing realistic soil moisture observations as inputs for agricultural prediction models.

SMAP Applications Working Group (AppWG)

Two main user groups in the SMAP AppWG are defined and categorized by their use of SMAP data in their operations and activities. These are:

- ***Community of Practice*** – users who will partner to optimize their use of SMAP products, possibly even before launch as part of the SMAP testbed activities and SMAP calibration/validation; and
- ***Community of Potential*** – users who are unfamiliar with SMAP capabilities but have the potential to benefit from SMAP products in their application.

SMAP AppWG activities will be carried out mainly through emails and telecons. The AppWG will also take advantage of member attendance at conferences such as AGU and IGARSS to meet in person when possible.

To join and follow working groups please visit: *http://smap.jpl.nasa.gov/science/wgroups/*

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