

# OVERVIEW OF THE SMAP APPLICATIONS AND THE SMAP EARLY ADOPTERS PROGRAM – NASA’S FIRST MISSION-DIRECTED OUTREACH EFFORT

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## ABSTRACT

*Satellite data provide global observations of many of the earth’s system processes and features. These data are valuable for developing scientific products that increase our understanding of how the earth’s systems are integrated. The water, energy and carbon cycle exchanges between the land and atmosphere are linked by soil moisture. NASA’s Soil Moisture Active Passive (SMAP) mission provides soil moisture and freeze/thaw measurements from space and allows scientists to link the water energy and carbon cycles. In order for SMAP data to be best integrated into decision support systems, the mission has engaged with the stakeholder community since 2009 and has attempted to scale the utility of the data to the thematic societal impacts of the satellite product applications. The SMAP Mission, which launched on January 31, 2015, has actively grown an Early Adopter (EA) community as part of its applications effort and worked with these EAs to demonstrate a scaled thematic impact of SMAP data product in societally relevant decision support applications. The SMAP mission provides global observations of the Earth’s surface soil moisture, providing high accuracy, resolution and continuous global coverage. Through the Early Adopters Program, the SMAP Applications Team will spend the next 2 years after launch documenting and evaluating the use of SMAP science products in applications related to weather forecasting, drought, agriculture productivity, floods, human health and national security.*

## 1. INTRODUCTION

SMAP is one of four first-tier missions recommended in the Decadal Survey report of the National Research Council’s Committee on Earth Science and Applications from Space (2007).

SMAP is also the first NASA mission to develop and implement a dedicated Applications and Early Adopter Program that facilitates the integration of mission science data products into societal applications and decision-making frameworks. The SMAP mission’s primary science objective is to produce a high-resolution global map of soil moisture and freeze-thaw state every 2–3 days using an L-band radar and an L-band radiometer. The primary goal of SMAP Mission Applications is to engage SMAP end users and build broad support for the applications of SMAP products through a transparent and inclusive process. Toward this goal, the mission appointed an Applications Team and formed a SMAP Applications Working Group (a community of scientists, researchers, educators and entrepreneurs that are interested in assessing the value of SMAP data) to be guided by the Applications Team. By formally coupling science and applied research into the framework of mission objectives, SMAP has defined methods of incorporating applications into mission science which uniquely reflects the NASA Applied Sciences Program strategic goals to “ensure that NASA’s flight missions plan for and support applications goals in conjunction with their science goals, starting with project planning and extending through the project life cycle.” SMAP, via the Applications Program, facilitates applications that help demonstrate the impact and value of soil moisture and freeze thaw data in societally relevant areas. As a result, SMAP has successfully identified a wide range of earth

science applications for its data in 7 major categories: Agriculture, Hydrology, Hazards/Disasters, Climate/Weather, and Health.

The SMAP Applications Program was initiated in 2007, seven years before the launch of SMAP in early 2015. Since 2009, during the prelaunch stages of the mission, SMAP has been conducting outreach, education as part of the end user engagement through a formal Applications Program. A dedicated “SMAP Applications Team” composed of mission scientists and outreach specialists have engaged a broad community of users interested in applying SMAP science data products to their research applications, modeling systems, policies and decision support frameworks. During the prelaunch stages of the mission, the SMAP Applications Team provided guidance to the SMAP Applications Working Group toward the use and familiarization of SMAP data through simulated data sets, educational workshops and tutorials. This community led to the creation of the SMAP Early Adopter program. Since 2010 Early Adopters have been selected to help demonstrate the value and impact of SMAP data in their existing research. The SMAP Early Adopters are a diverse subset from within the SMAP user community that have volunteered their own time and resources to conduct research on behalf of the mission and provide feedback on the impact of the mission data in areas of weather, drought, agriculture, health and national security. The SMAP EAs represent an international group of scientists, engineers, and entrepreneurs that represent applications in a broad range of areas (Figure 1).

Over the last six years, leading up to the SMAP launch, the SMAP mission worked with the Applications Working Group and Early Adopters to establish relationships in mission relevant communities; elicit feedback with regards to data needs and challenges; conduct workshops that helped broaden the understanding and applications of SMAP data; explore opportunities for applications beyond the science objectives; and to integrate commercial applications into the framework of science engagement.

During the operational (science data acquisition) phase of the mission (2015-2018), SMAP worked closely with its Early Adopters and remaining Application Community to understand the utility and potential reach of the SMAP products. Workshops helped identify challenges with SMAP data, the access to pre beta data and discussions regarding application impacts. Tutorials gave the community an opportunity to have thematically driven one-on-one hands-on experience with SMAP data products. Now in the operational phase (“Phase E”) of the mission, SMAP continues to lead by example via its sustained engagement with end users and the stakeholder community.

## **2. ENGAGEMENT WITH SMAP EARLY ADOPTERS**

A rare characteristic of the SMAP Project is its emphasis on serving both basic Earth System science as well as applications in operational and practice-oriented communities. The SMAP Early Adopter Program attracts groups and individuals from around the world to conduct applied research of how soil moisture and freeze thaw information from SMAP could be used to support decision making frameworks. EA research showcases SMAP products that aid in business and/or management activities, integrating SMAP into decision-support systems, using SMAP in decision-making efforts, as well as using SMAP data to inform public policy at multiple scales.

The Early Adopter program grew quickly from originally hosting 12 Early Adopters in 2010 to hosting over 40 by the time the mission launched. Currently, SMAP has 55 Early Adopters (Figure 2) whose research is expected will provide a more clear demonstration of the impact of SMAP data in society and that addresses both basic and applied science questions. The SMAP Early Adopter applied research is geared to inform not only the mission, but also the public so that there is a balanced understanding to the benefits and the impact of SMAP data. The continued outreach

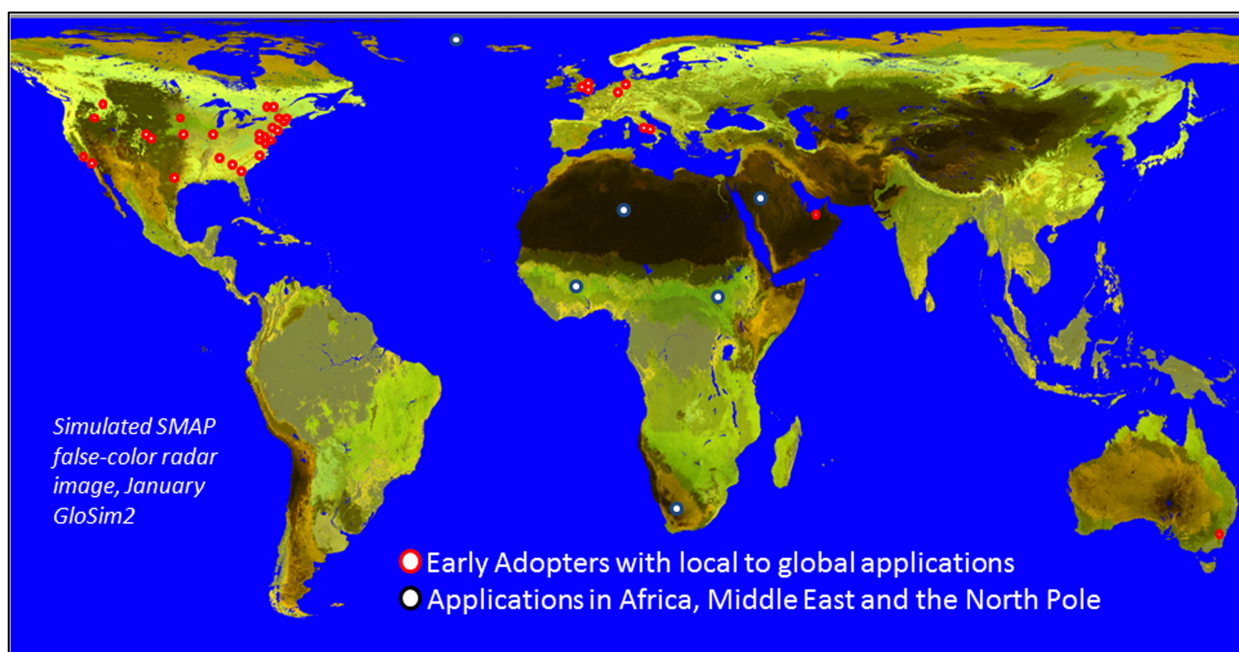


Figure 1. is a simulated image of SMAP radar data scaled backscatter triplets in the order VV, HH, and HV to a 24-bit color map and overlain with the locations of 37 of 55 early adopters conducting applied research over local-to-global domains, and specific applications in Africa, the Middle East, and the North Pole. (Moran et al, 2015).

brings together members of diverse communities who already benefit, or could potentially benefit, from the SMAP mission and other similar earth-observing science missions and data products.

In summer of 2015, the SMAP mission closed the Early Adopter Program and is now focused on the impact of the SMAP data. As part of the Operational (Phase) Applications work, the Applications Team continues to work closely with the SMAP Early Adopter community in an effort to better understand the impact the SMAP data products have on the applications identified in Early Adopter research. By enabling a clear path for feedback from the EA to the SMAP Science Team, and through a series Early Adopter impact case studies, the mission is learning the value of SMAP in societally relevant applications that impact our daily lives. Moving forward the SMAP Applications Team will continue to facilitate discussions and share creative ideas about how SMAP-related satellite data can be exploited to provide value to a broad set of societally relevant applications.

The SMAP Early Adopters share a common goal of providing feedback as a means of improving product development, distribution and knowledge. The unexpected loss of the SMAP Radar in July, 2015, has increased the importance of feedback from Early Adopters and lessons learned are being documented with regards to the impacts and potential value demonstrated by using the existing 10 weeks of available SMAP Radar (from April – July). The ongoing relationships with the SMAP Early Adopters, has allowed the SMAP mission to successfully collect examples that specifically demonstrate the value of SMAP radar data to inform the next Decadal Survey. Overall, through the Early Adopters, SMAP learns specifically *how* the observations and data products inform research topic and decision frameworks related to: flood forecasting, agriculture productivity, drought monitoring, human health impacts, ground mobility, carbon sequestration, sea ice thicknesses, sea surface winds, data fusion and informatics.

### 3. SMAP APPLICATIONS: LOOKING AHEAD

The SMAP Applications Program and the Early Adopters Program was initiated to integrate applications needs into mission planning as encouraged by the U. S. Congress, the National Research Council, and the NASA Earth Science Division. The SMAP mission and its Early Adopters have redefined how NASA looks at the intersect of science and applications, bringing attention to the value of engagement and relationships and bringing perspective to the mission scientists. When SMAP completes its operational phase in 2018, the analysis of Early Adopter applied research will demonstrate how the investments in pre-launch applications and early adopter efforts contributed to an increased understanding of mission value and the impact of SMAP data products for various decision processes in 6 specific areas of applications. SMAP has successfully inspired NASA to adopt this formal applications format across all future missions. The impact and value stakeholder engagement has redefined how applications are conducted at NASA thereby enhancing mission success.



Figure 2. 55 SMAP Early Adopter Logos

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