Soil Moisture Active Passive (SMAP) Applications: A Professional Review of Prelaunch Data and the SMAP Mission User Community

Vanessa M. Escobar[1] Molly E. Brown[2]

1 Sigma Space Corporation 2 NASA Goddard Space Flight Center

Introduction

NASA's Soil Moisture Active Passive (SMAP) mission is planned for launch in October 2014 and will provide global measurements of surface (top 5 cm) soil moisture and its freeze/thaw state (Das et al. 2011). After launch, the mission will provide high quality, daily, 9-kilometer resolution global soil moisture data, which is expected to have both high science and applications valu. These measurements will be used to enhance the understanding of processes that link the water, energy and carbon cycles, and to extend the capabilities of weather and climate prediction models (Brown et al. 2011). As part of its development, SMAP has funded an active applications program that seeks to engage the science data user community early in the mission design and development processes of the SMAP mission. Providing actionable and user friendly data to decision makers has become a priority as world leaders try to understand and communicate about earth system, specifically issues that surround climate and climate change. Applications have quickly become an integral part in converting satellite data into knowledge that can be used to inform policy and enhance decision-making processes. Thus clarification to how we define applications is important when communicating efforts for improving the applications of data for societal benefits.

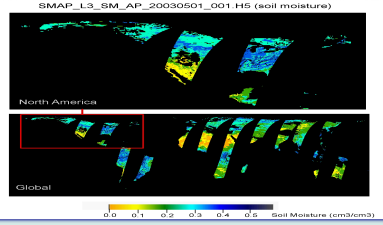
The SMAP applications program (Brown et al. 2011c) uses the mission's prelaunch test data to engage with a broad range of environmental monitoring and decision making systems ranging from drought and flood guidance to disease risk assessment and national security during the mission development phases for SMAP (four years prior to launch). These efforts are designed to increase the ingestion of SMAP data into critical processes and research, improving its impact on society once the satellite has been launched and is functioning. Understanding how users intend to apply SMAP soil moisture data, prior to the satellite's launch is an important component of the SMAP Applied Sciences activity and has become part of the way NASA will measure the mission's success. This paper focuses on understanding how individuals and organizations assess and plan for use of satellite mission data before launch.

The objective of this study was to solicit data requirements, accuracy needs and a current understanding of the SMAP mission from the user community and relay that information back to the mission scientists. We present an analysis of an on-line professional review of expert end-users and earth science researchers associated with the SMAP applications program. The review focuses on how pre-launch activities and research are being conducted in organization identifying the boarder communities who have participated in pre-launch applications meetings and briefings and recognizing gaps between scientific development and operational applications.

Product	Description	Gridding (Resolution)	Latency*	
L1A_TB	Radiometer Data in Time-Order	-	12 hrs	Instrument Data
L1A_S0	Radar Data in Time-Order	-	12 hrs	
L1B_TB	Radiometer T_B in Time-Order	(36x47 km)	12 hrs	
L1B_S0_LoRes	Low Resolution Radar σ_o in Time-Order	(5x30 km)	12 hrs	
L1C_S0_HiRes	High Resolution Radar σ_o in Half-Orbits	1 km (1-3 km)***	12 hrs	
L1C_TB	Radiometer T_B in Half-Orbits	36 km	12 hrs	
L2_SM_A**	Soil Moisture (Radar)	3 km	24 hrs	Science Data (Half-Orbit)
L2_SM_P	Soil Moisture (Radiometer)	36 km	24 hrs	
L2_SM_AP	Soil Moisture (Radar + Radiometer)	9 km	24 hrs	
L3_FT_A	Freeze/Thaw State (Radar)	3 km	50 hrs	Science Data (Daily Composite)
L3_SM_A**	Soil Moisture (Radar)	3 km	50 hrs	
L3_SM_P	Soil Moisture (Radiometer)	36 km	50 hrs	
L3_SM_AP	Soil Moisture (Radar + Radiometer)	9 km	50 hrs	
L4_SM	Soil Moisture (Surface and Root Zone)	9 km	7 days	Science Value-Added
L4_C	Carbon Net Ecosystem Exchange (NEE)	9 km	14 days	

* The SMAP Project will make a best effort to reduce the data latencies beyond those shown in this table
** Research product with possible reduced accuracy
*** Over Outer 70% of Swath

SMAP Soil Moisture from Radiometer Radar Combined Product
SMAP_L3_SM_AP_20030501_001.H5 (soil moisture)



Defined Terms

Applications are defined as innovative uses of mission data products in decision-making activities for societal benefit.

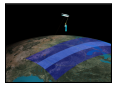
Applications research will provide fundamental knowledge of how mission data products can be scaled and integrated into users' policy, business and management activities to improve decision-making efforts.

User Community includes
- individuals or groups
- public or private sectors
- national or international organizations
- local to global scales of decision making

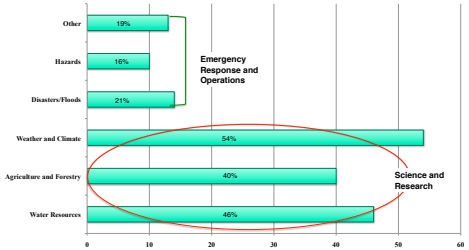
Questionere Structure

- A 28-question on-line professional review sent to the SMAP Applications Working Group (APPWG)
- Received 63 responses of 200 questioners-30% response rate.
- Responses provided insight on the uses and applications of SMAP mission data
- 96.8% of participants are professionals with 7+ years experience

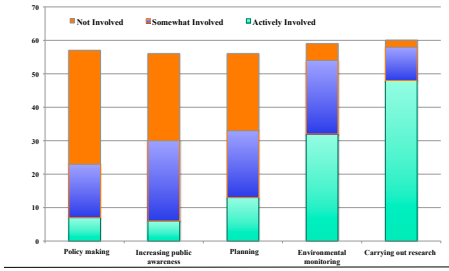
Questionere Responses



- 98% self identified as "Science Data Users" but were divided between science and operational applications
- Major gaps in communities represented:



- Carrying out research vs. involvement with decision making and public policy
- 80% of the population responded that their involvement was mainly research driven. 60% of the respondents conducting research claimed they were NOT involved in policy making efforts. *Those involved with research feel they are not involved or connecting to policy bodies.*



Opportunities for the SMAP mission to better address users latency needs may be better accomplished by engaging with the scientific and operational community after launch where lower latency products can be developed by end users in the way that the Earth Observing System (EOS) missions have done with the Land Atmosphere Near Real-time Capability for EOS (LANCE). Although these near-real time products may have lower accuracy than standard science products, many users are willing to accept lower accuracy in exchange for timely access-i.e. Maryland Emergency Management Agency (MEMA). The mission will continue to identify thematic needs and challenges. Our individual communication with users evolves into focused sessions where we gather to discuss how to best address challenges and improve applications for SMAP data as we near launch.

Questionere Responses con't

Perceived Value of Soil Moisture

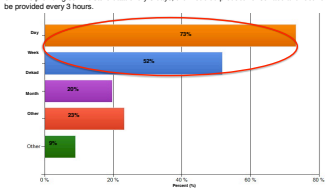
	Vital	Somewhat Valuable	Marginal	Not Valuable	NA	Response Count
Rainfall	44	10	1	1	2	58
Temperature	42	9	5	0	2	58
Humidity	28	17	8	0	2	55
Evapotrans	18	23	10	1	1	53
Snowpack	45	6	6	0	1	58
Soil Moisture	47	10	0	0	1	58
Land Cover	43	7	4	2	1	57
Clean Solid Estimates	15	14	11	6	6	52
Snow Cover	28	13	7	6	2	56

When we asked our audience about the importance of environmental variables, Soil moisture ranked the highest, along with vegetation, land cover temperature and rainfall **81%** (47 of 58 respondents) of the respondent felt soil moisture was vital to their analysis.

Other questions were also asked about the different types of soil moisture data respondents use. **56%** of respondent claimed to use ground soil moisture observations, and over **30%** claimed they would be interested in using SMAP like information if it were available.

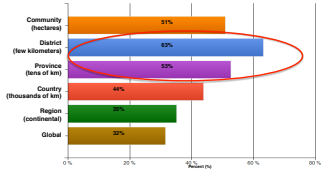
Temporal Frequency

73%-52% of respondents felt a a daily-weekly temporal frequency would satisfy their needs for data. SMAP is providing soil moisture data every 3 days, the modeled product for surface and root zone will be provided every 3 hours.



Spatial Resolution

63% of respondents felt few kilometers would be sufficient for their work, and 53% agreed to 10s of kilometers of spatial resolution. The SMAP radar products fall into the needed range of 3km, while the radiometer data satisfies communities that can work at a 36KM Resolution. The combined active/passive product (with a 9KM resolution) has the potential to satisfy a majority.

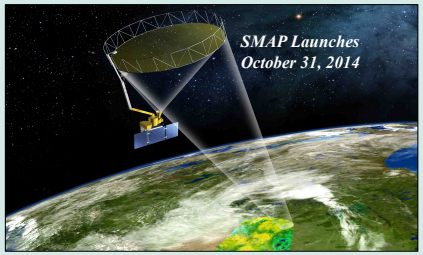


Four Key Findings:

- Gap between research and policy applications
- Uncertainty as to how ground observations will scale to remotely sensed data
- High perceived value of soil moisture
- Uncertainty as to how ground observations will scale to remotely sensed data
- Where to access SMAP-like data

Actions based on Findings:

- Continue to engage and communicate with more users involved in hazards and operation disciplines
- Facilitate the movement of science data into policy applications
- Help interested users access SMAP mission data (CAL/VAL and Pre Launch simulation data)
- Translate how *known* accuracies will relate to the accuracies of SMAP observations.



Conclusion

The results of this review provided responses that showed the connection between the needs of the user community and the high quality soil moisture data planned to be provided by the mission. A broad diversity was found in the spatial, spectral and temporal needs of the user community. The existing plans of the SMAP mission is to provide highly accurate, global 4 and 9km soil moisture products meeting 95% of the respondents needs in an extent or coverage, 37% in terms of spatial resolution, 63% of the temporal frequency, and 21% of the latency needs. The stated accuracy of the soil moisture products will meet the majority of users needs.

The review also identified the communities interested in using SMAP data by identified users that use soil moisture for research but are not connected to policy or decision making processes. It also highlighted the gap between users interested in SMAP products but unfamiliar with the mission, mission data or simply did not have access to mission products. Having this information provides us with further insight on areas that need more information about SMAP mission products and the SMAP applications program. For example, when we asked about using real time soil moisture vs. historical soil moisture data, and going from using in situ data to gridded historical data, respondents' uncertainty increased. Thus the review provided insight on the confidence and accuracies of combining satellite data with ground data.

The information collected from this review has further motivated the distribution of SMAP test products as well as other soil moisture data set (SMOS, SSM/I, simulation products, and ground observations) that will help increase familiarity and truly broaden and improve the field of applications.

For more information on SMAP Applications please contact Vanessa Escobar at vanessa.escobar@nasa.gov or Molly Brown at molly.brown@nasa.gov.

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For further information

Please contact ***vanessa.escobar@nasa.gov*** ***or molly.brown@nasa.gov***. More information on this and related projects can be obtained at *http://smap.jpl.nasa.gov/science/wgroups/applicWG/*