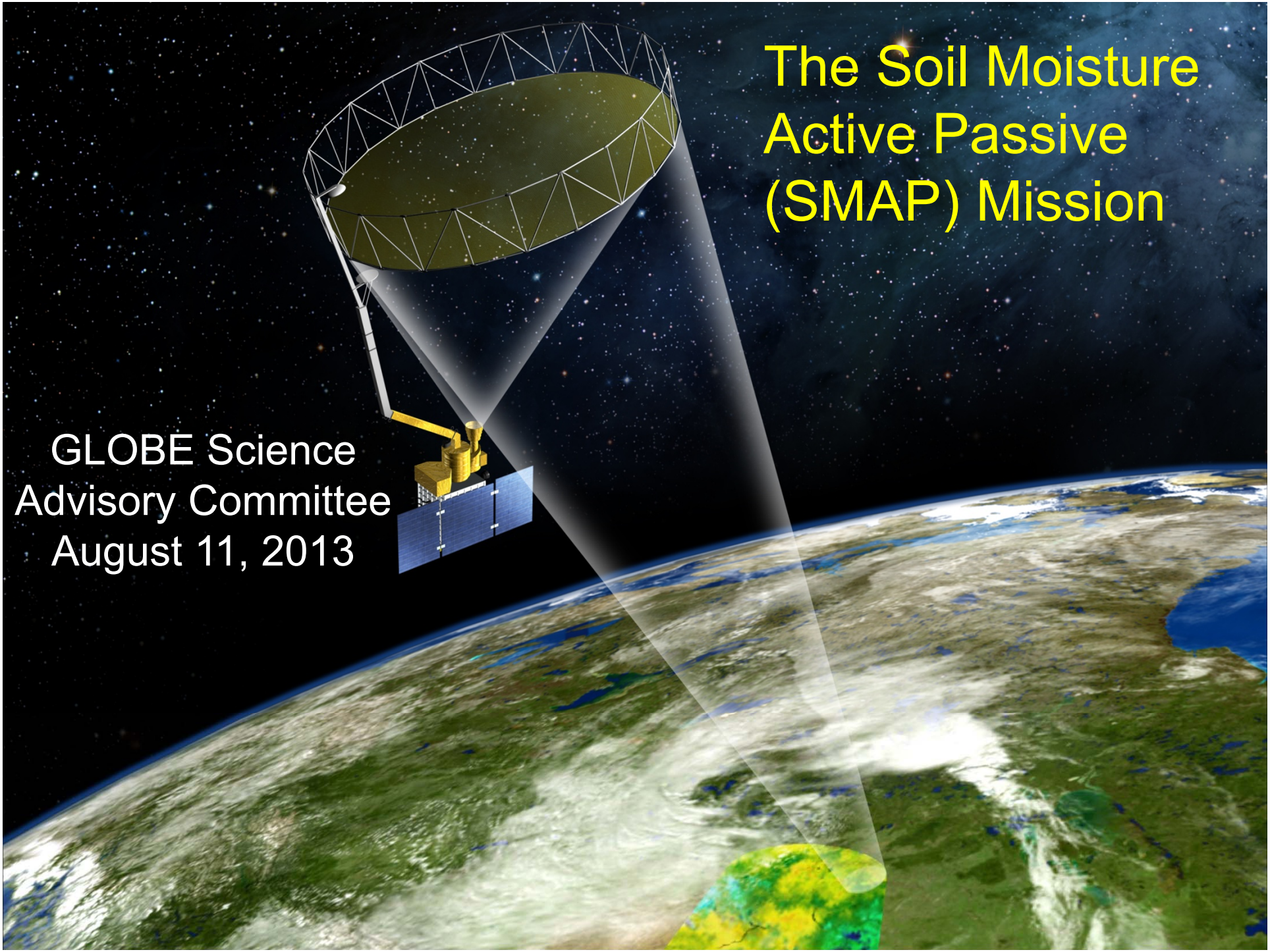
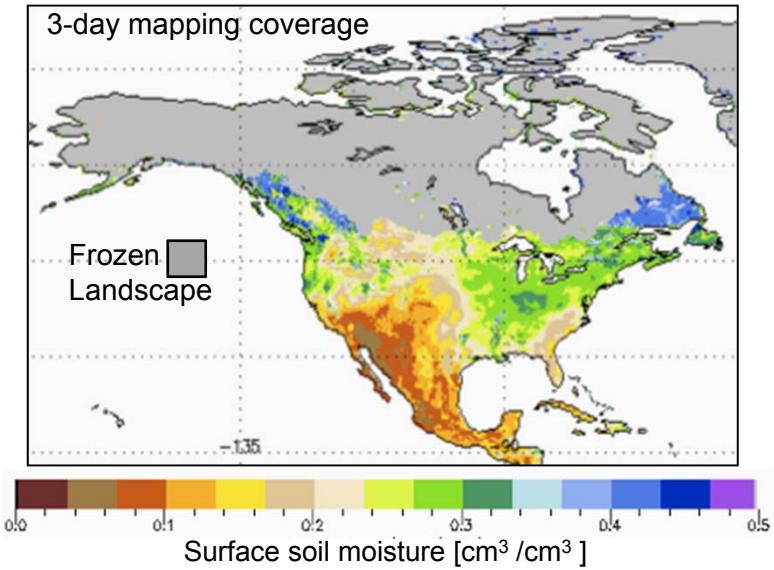

The Soil Moisture Active Passive (SMAP) Mission
GLOBE Science Advisory Committee
August 11, 2013

SMAP Science Introduction

SMAP will provide high-resolution and frequent-revisit global observations of soil moisture and freeze/thaw state

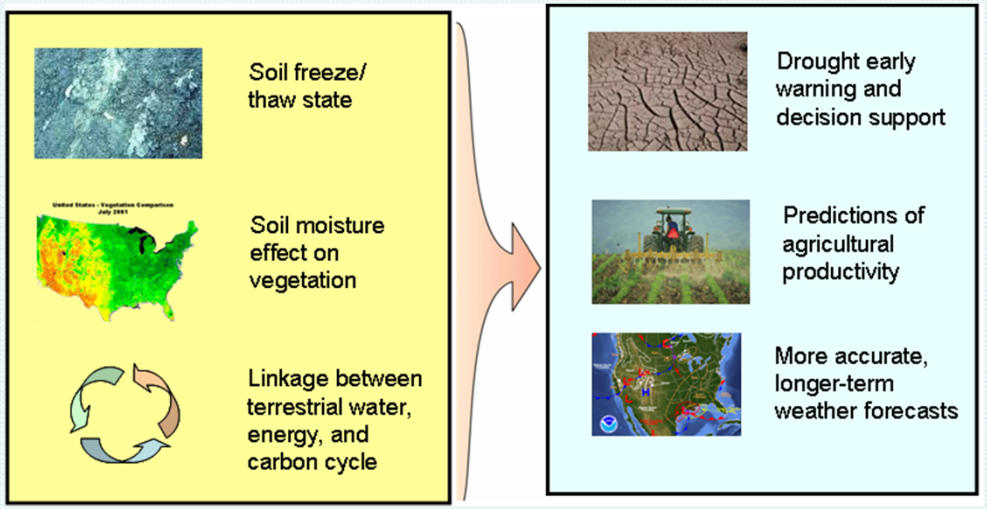
Soil moisture is defined in terms of volume of water per unit volume of soil.

Freeze/thaw state is defined as the phase of the water contained within the landscape including soil and vegetation.



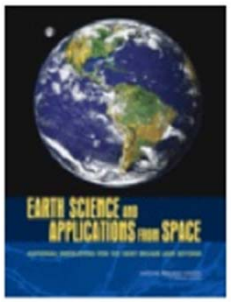
Surface soil moisture [cm^3 /cm^3]

SMAP measurements of soil moisture and freeze/thaw state address a wide range of Earth science applications



US National Research Council Earth Science Decadal Survey Report, 2007

Mission Context



US National Research Council Report: *Earth Science and Applications from Space: National Imperatives for the next Decade and Beyond*

SMAP is one of four missions recommended by the NRC "Decadal Survey" for launch in the 2010–2013 time frame

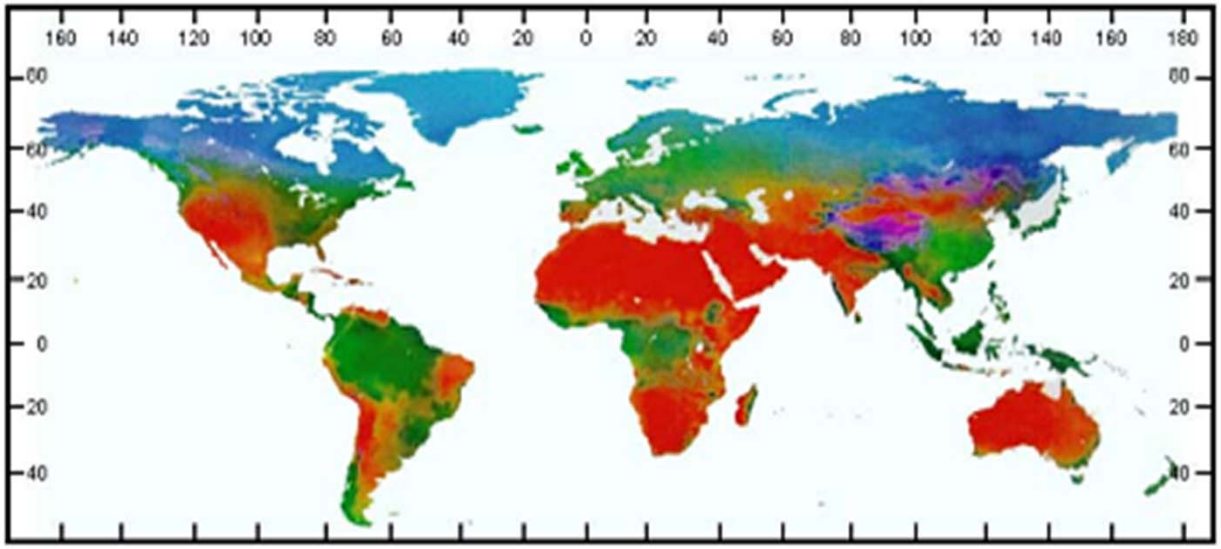
- The SMAP Mission is Currently in System Integration and Testing Phase
- Launch is Scheduled for October 2014

Tier 1: 2010–2013 Launch	
	Soil Moisture Active Passive (SMAP)
	ICESAT II
	DESDynI
	CLARREO
Tier 2: 2013–2016 Launch	
	SWOT
	HYSPIRI
	ASCENDS
	GEO-CAFE
	ACE
Tier 3: 2016–2020 Launch	
	LIST
	PATH
	GRACE-II
	SCLP
	GACM
	3D-WINDS

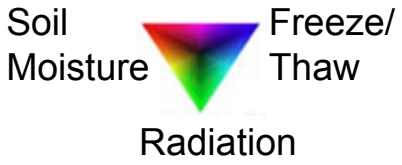
Mission Science Objectives

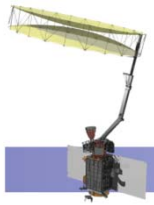
- Through global mapping of soil moisture and freeze/thaw state:

  1. Understand processes that *link* the terrestrial water, energy and carbon cycles;
  2. Estimate global water and energy fluxes at the land surface;
  3. Quantify net carbon flux in boreal landscapes;
  4. Enhance weather and climate forecast skill;
  5. Develop improved flood prediction and drought monitoring capability



Primary controls on land evaporation and biosphere primary productivity





Science Requirements

Decadal Survey Objective	Application	Science Requirement
Weather Forecast	Initialization of Numerical Weather Prediction (NWP)	Hydrometeorology
Climate Prediction	Boundary and Initial Conditions for Seasonal Climate Prediction Models	Hydroclimatology
	Testing Land Surface Models in General Circulation Models	
Drought and Agriculture Monitoring	Seasonal Precipitation Prediction	Hydroclimatology
	Regional Drought Monitoring	
	Crop Outlook	
Flood Forecast Improvements	River Forecast Model Initialization	Hydrometeorology
	Flash Flood Guidance (FFG)	
	NWP Initialization for Precipitation Forecast	
Human Health	Seasonal Heat Stress Outlook	Hydroclimatology
	Near-Term Air Temperature and Heat Stress Forecast	Hydrometeorology
	Disease Vector Seasonal Outlook	Hydroclimatology
	Disease Vector Near-Term Forecast (NWP)	Hydrometeorology
Boreal Carbon	Freeze/Thaw Date	Freeze/Thaw State

Key Level 1 Requirements (Derived from science objectives)

Requirement	Hydro-Meteorology	Hydro-Climatology	Carbon Cycle	Baseline Mission		Minimum Mission	
				Soil Moisture	Freeze/ Thaw	Soil Moisture	Freeze/ Thaw
Resolution	4–15 km	50–100 km	1–10 km	10 km	3 km	10 km	10 km
Refresh Rate	2–3 days	3–4 days	2–3 days[a]	3 days	2 days	3 days	3 days
Accuracy	0.04-0.06 [c]	0.04-0.06	80–70% [b]	0.04	80%	0.06	70%

[a] North of 45N latitude

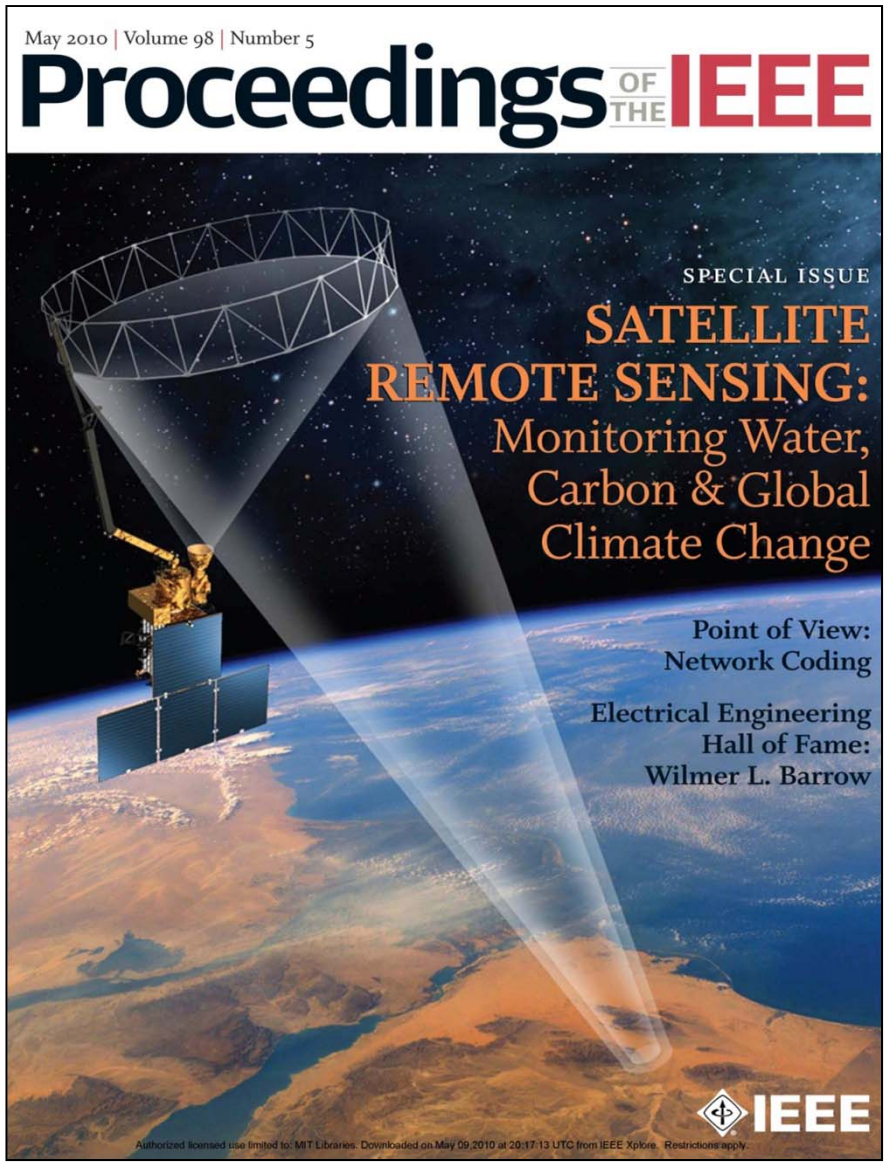
[b] Percent classification accuracy (binary freeze/thaw)

[c] Volumetric water content, 1-σ in [cm^3/cm^3] units

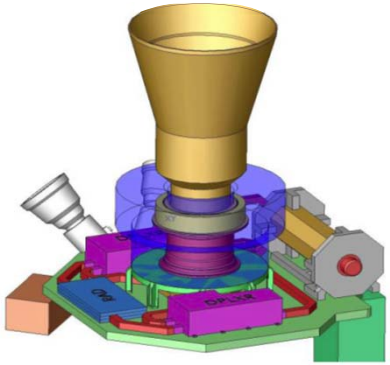
National Aeronautics and Space Administration

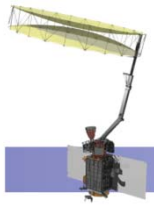
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

SMAP Mission Concept



- L-band unfocused SAR and radiometer system, offset-fed 6 m light-weight deployable mesh reflector. Shared feed for
  - 1.26 GHz dual-polarization Radar at 1-3 km (30% nadir gap)
  - 1.4 GHz polarimetric Radiometer at 40 km
- Conical scan, fixed incidence angle across swath
- Contiguous 1000 km swath with 2-3 days revisit
- Sun-synchronous 6am/6pm orbit (680 km)
- Launch October 31, 2014





An Opportunity For Engagement With GLOBE

Among NASA's Earth and Space measurements, soil moisture is a particularly tangible one for the K-12 audience. It is a variable that most can understand and appreciate (floods, crop growth, etc.).

SMAP can engage GLOBE K-12 students in tangible and meaningful ways through their taking data following the Gravimetric Soil Moisture Protocol. Students can make valuable contributions to mission science.

As stated in the SMAP Cal/Val Plan, the gold-standard for all soil moisture measurements is ultimately the tin-can sample. It is simple and inexpensive enough that K-12 students can actually do it daily.

Needed Material:

1. Soil sample can
2. Graduated cylinder
3. Balance
4. Drying oven

Here are the steps:

1. Measure the volume (V) of the sample can
2. Take soil sample in the sample can
3. Weigh moist sample (mass M_w)
4. Dry the sample
5. Weigh dried sample (mass M_d)

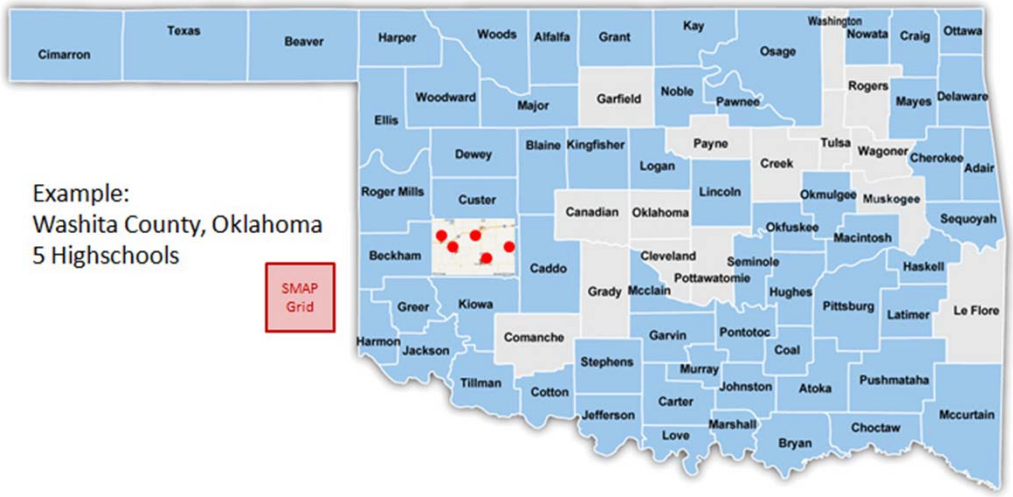
The soil moisture (in the same units as SMAP measurements) is:

$$\textbf{soil moisture} = (M_w - M_d) / (V * \rho) \ \ cm^3/cm^3$$

where $\rho = 1\ g\ cm^{-3}$ – the density of liquid water

An Opportunity For Engagement With GLOBE

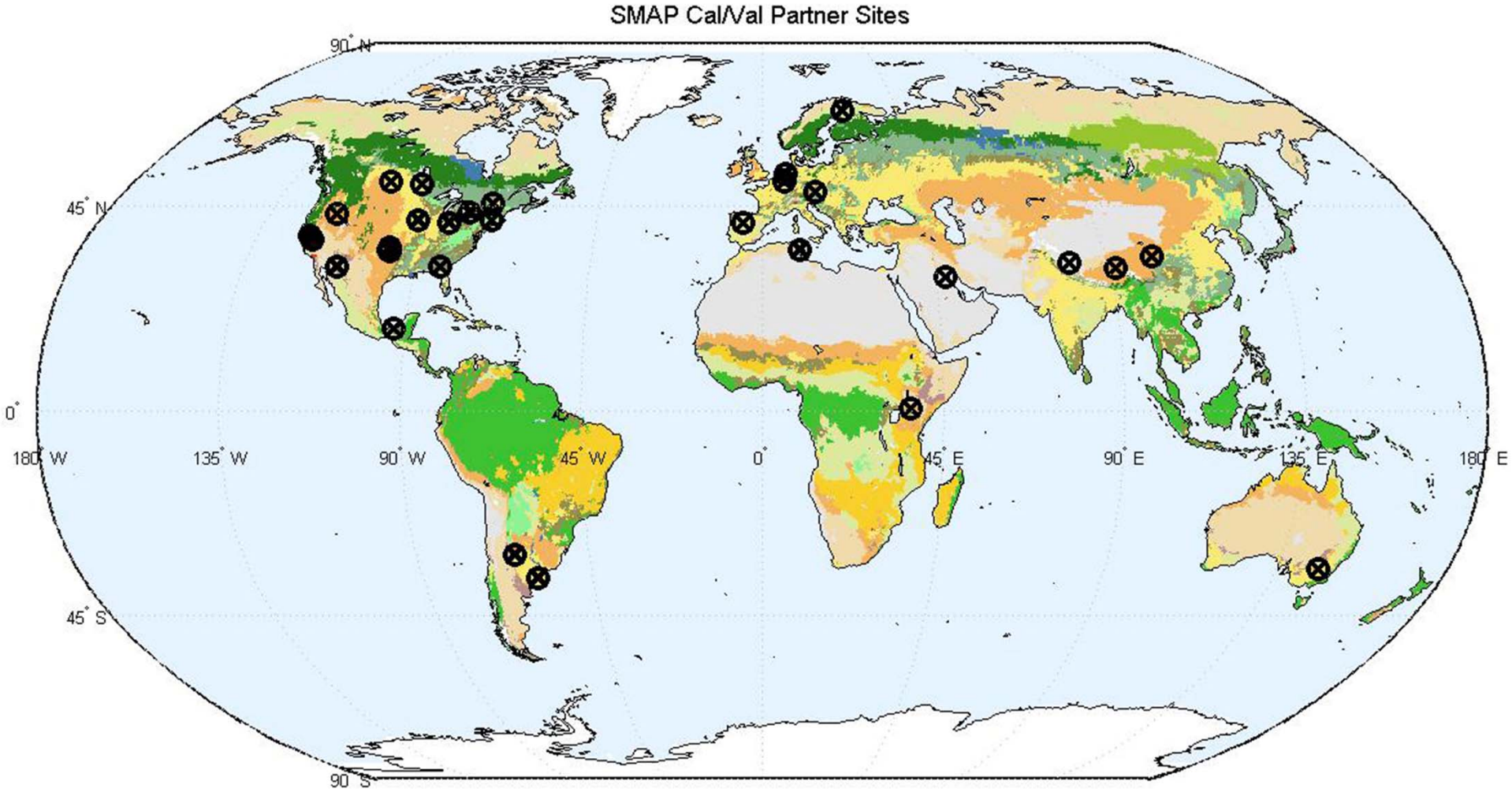
High priority for comparison to SMAP data will be clusters of 10 or more schools routinely measuring surface soil moisture (to 5 cm depth) within an area of roughly 40 km x 40 km. SMAP has selected 23 calibration/validation sites around the world and would like clusters of schools surrounding them.



SMAP can work with GLOBE to provide visualizations that compare SMAP, calibration site, and student data.

SMAP scientists can work with GLOBE teachers and students through the GLOBE International Scientist Network (GISN).

SMAP Cal/Val Partner Sites



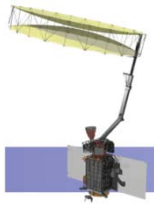
Preparation for an SMAP – GLOBE Partnership

SMAP

- Identify scientists to join the GISN and provide advice and oversight of the GLOBE soil moisture measurement activities and serve as the face of SMAP to the GLOBE community
- Review the sampling strategies and other specifics of the GLOBE Gravimetric Soil Moisture Protocol and propose any additions or modifications to GLOBE for appraisal and eventual implementation
- Work with GLOBE to identify and, through GLOBE international and US partners, recruit potential schools in clusters surrounding calibration/validation sites
- Work with GLOBE to develop educational materials to complement and support the measurement activities [January 1, 2014];

GLOBE

- Identify lead contacts from the staffs of the GLOBE Implementation Office (GIO) and the GLOBE IT team for interface with SMAP scientists and educational outreach personnel
- Integrate SMAP personnel in the GISN and provide and arrange GLOBE training as needed to SMAP participants
- Assess the cost and schedule impacts, practicality, and educational appropriateness, of the proposal from SMAP regarding GLOBE protocol procedures and equipment and provide this to NASA for its decisions regarding costs and schedule for implementation
- Support the identification and recruitment of potential schools in clusters surrounding calibration/validation sites working through the country coordinators
- Structure and package the SMAP-related activities as a GLOBE measurement campaign extending from 2014 to 2018 and support the data collection with educational materials and activities



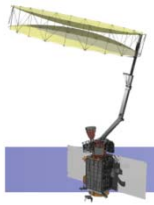
Mutual Support During an SMAP – GLOBE Partnership

SMAP

- Provide material for publication through the GLOBE website that explains the SMAP mission, the contributions to it that can be made by GLOBE schools, and attract and inspire GLOBE school participation
- Establish routine review of all student soil moisture data contributed by GLOBE students
- Participate in GLOBE events in person and via technology [August 2013 through 2018]
- Assist in forming partnerships between GLOBE and other organizations interested in or partnering with SMAP such as 4-H and building ties between the agricultural research and applications communities and GLOBE partners, schools, and teachers

GLOBE

- Distribute and publicize the SMAP activities and materials through www.GLOBE.gov and incorporate SMAP specific data collection requirements in GLOBE training and materials
- Develop and provide appropriate data reporting, archiving, visualization, and data distribution capabilities in support of the SMAP partnership and establish routine provision of soil moisture and related data to designated SMAP team members for quality and accuracy review
- Include SMAP in the planning of and participation in GLOBE events, partner meetings, learning expeditions, etc.
- Work with SMAP to build partnerships with agricultural research, applications, and education communities



Post Launch Activity in an SMAP – GLOBE Partnership

- Organize and provide supporting material and judges for student research contests (science fairs) [several occasions between October 2014 and 2018];
- Provide periodic reports to the GLOBE community on the SMAP mission and its scientific achievements, blog posts from science team members, visualizations of SMAP data and explanations of its results appropriate to K-12 audiences (at different developmentally appropriate levels of sophistication)
- Support the annual assessment of the SMAP – GLOBE partnership [June 2015 and annually thereafter through June 2018]
- Include the partnership with GLOBE in SMAP's publicity and other communications activities [throughout the duration of the partnership].
- Support student research contests organized by SMAP [several occasions between October 2014 and 2018]
- Provide periodic reports to the SMAP community on GLOBE activities and scientific, educational, and environmental achievements, participation levels, and data reporting
- Conduct an assessment of the GLOBE – SMAP partnership [June 2015 and annually thereafter through June 2018]; and
- Include the partnership with SMAP in GLOBE's publicity and other communications activities [throughout the duration of the partnership].

A Potential Partnership

The formal agreement between SMAP and GLOBE,

with NASA concurrence and support commitment as needed,

could be concluded by November 15, 2013 and

form a key element in SMAP Engagement and Public Outreach

and GLOBE growth during the next five years.