Applications of Soil Moisture

Better/enhanced weather & climate Forecasting

More accurate agriculture productivity

Drought early warning

Extent of flooding

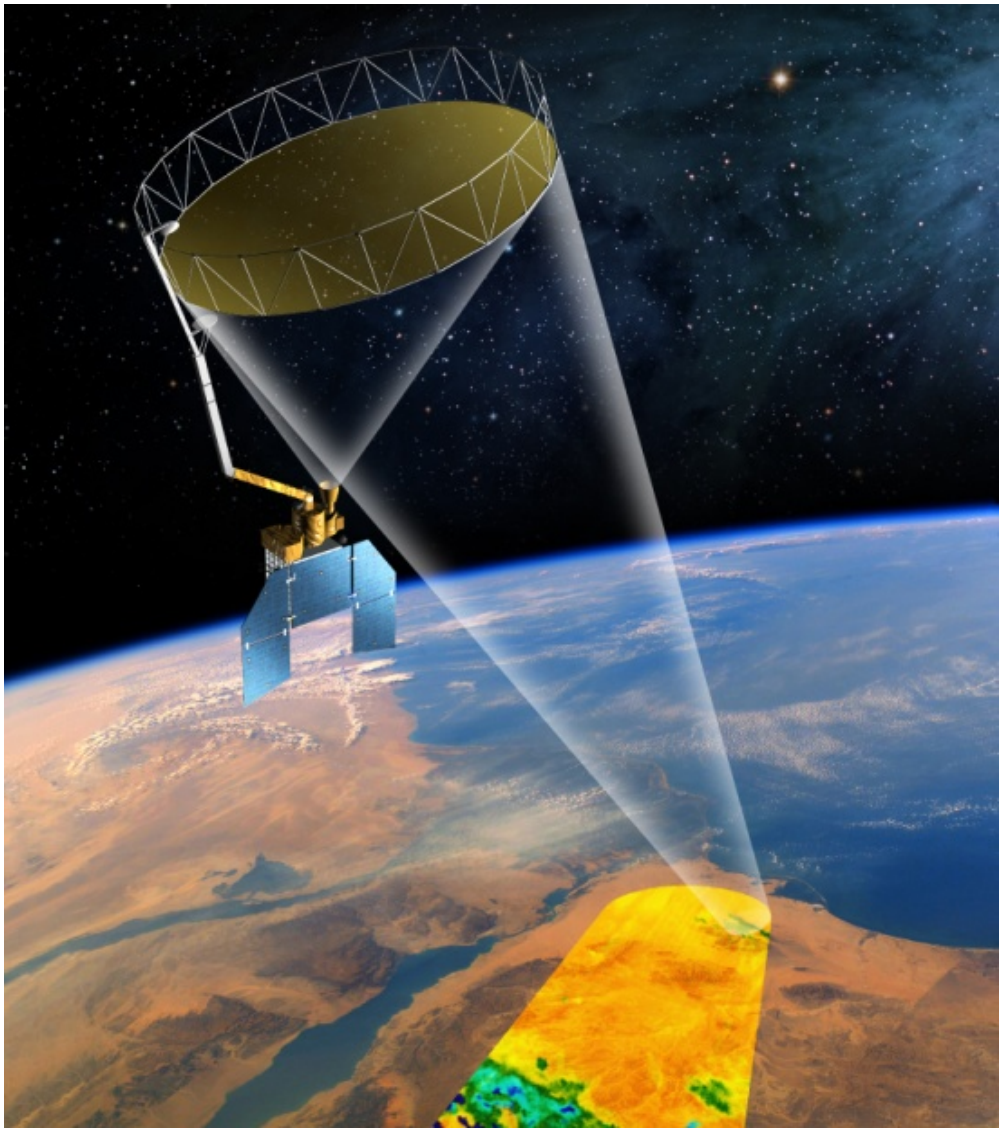
Human health: Vector borne disease

Past and Current Capabilities

AMSR-E aboard Aqua satellite
Launched: May, 2002
C-/X-band sensors
Spatial resolution: 56 km
Sensing depth: ~2 cm
Ceased operation in Oct, 2011

SMOS
Launched: Nov, 2009
L-band sensor
Spatial resolution: 40 km
Sensing depth: ~5 cm

The SMAP Mission



SMAP
Launch date: Oct, 2014
Passive L-band sensors
(Spatial resolution: ~40 km)
Active L-band sensors
(Spatial resolution: ~3 km)
Sensing depth: ~5 cm

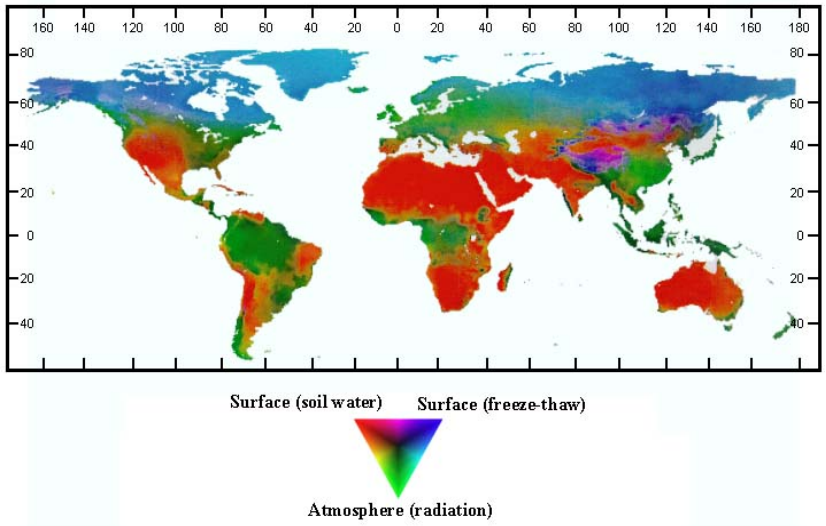
http://smap.jpl.nasa.gov

Overview of the SMAP mission

SMAP Science Objectives

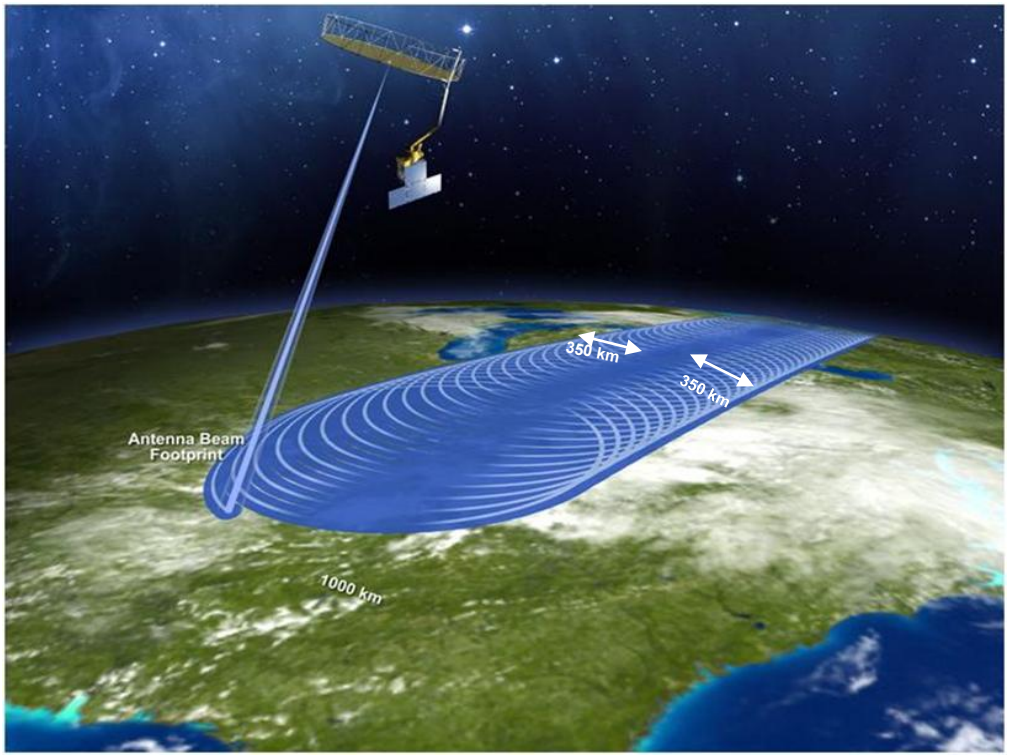
- SMAP science objectives are to provide high-resolution and frequent-revisit global mapping of soil moisture and freeze/thaw state that enable science and applications users to:
  1. Understand processes that link the terrestrial water, energy and carbon cycles
  2. Estimate global water and energy 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

Soil moisture and freeze/thaw state are primary environmental controls on Evaporation and Net Primary Productivity



SMAP Measurement Approach

SMAP science objectives are to provide high-resolution and frequent-revisit global mapping of soil moisture and freeze/thaw state



Expected Launch: November 2014

SMAP Instrument Configuration

Radar
Frequency: 1.26 GHz
Polarizations: VV, HH, HV
Resolution: 3 km
Relative Accuracy: 1.0 dB (HH and VV), 1.5 dB (HV)

Radiometer
Frequency: 1.41 GHz
Polarizations: H, V, 3rd & 4th Stokes
Resolution: 40 km
Relative Accuracy: 1.3 K

Shared Antenna
Constant Incidence Angle: 40°
Wide Swath: 1000 km

Orbit
Sun-synchronous, 6 am/pm orbit, 680 km altitude

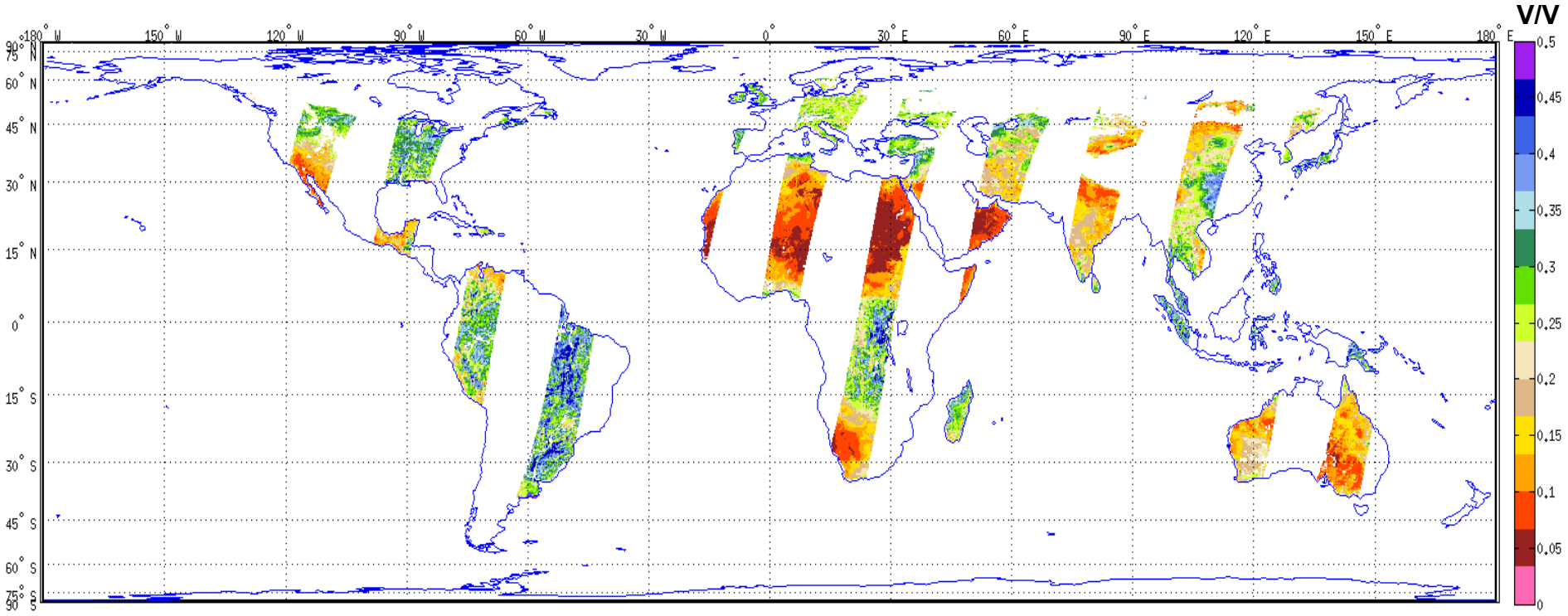
Mission Operations
3-year baseline mission

- ***Radiometer*** - High accuracy (less influenced by roughness and vegetation) but coarser spatial resolution (40 km)
- ***Radar*** - High spatial resolution (1-3 km) but more sensitive to surface roughness and vegetation
- **Combined Radar-Radiometer** product provides optimal blend of resolution and accuracy to meet science requirements

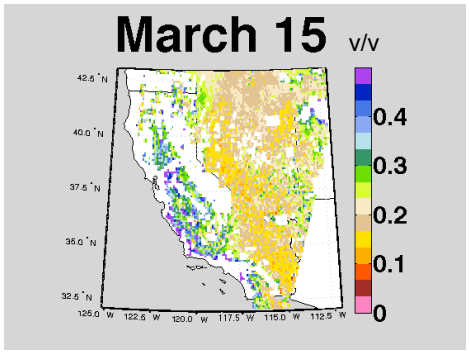
SMAP Animation

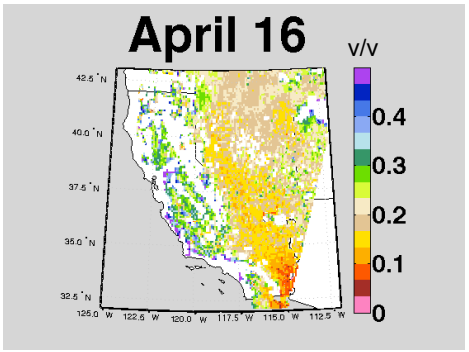
Sample of Global 9km Output from SMAP Algorithm Testbed

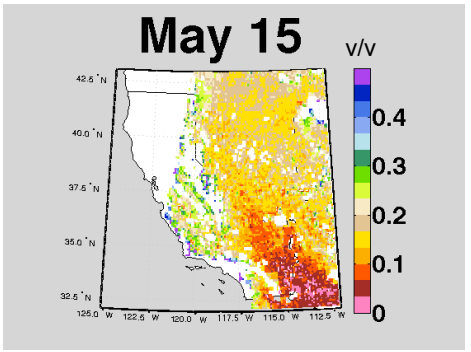
Global Composite Map of Soil Moisture for one day in April

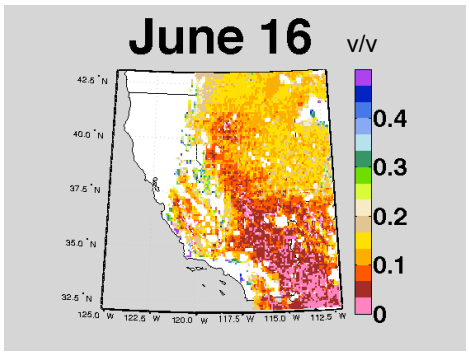


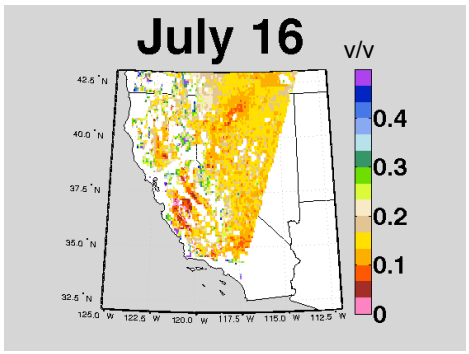
Soil Moisture Map Over California

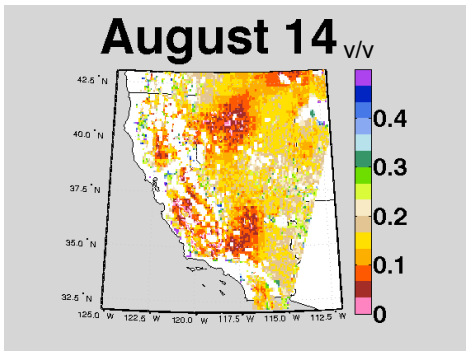


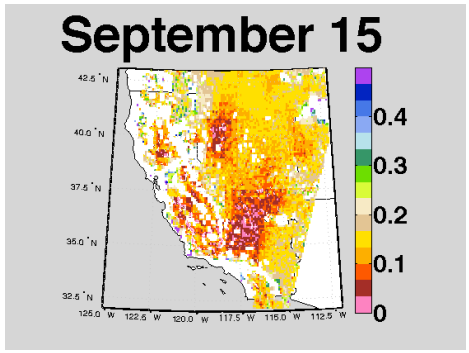


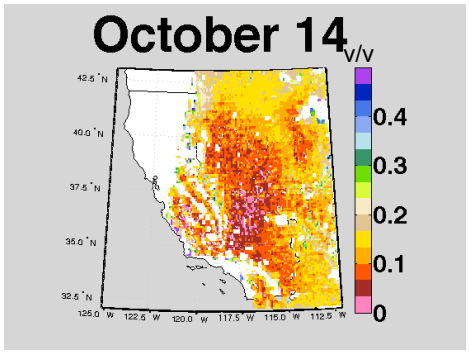


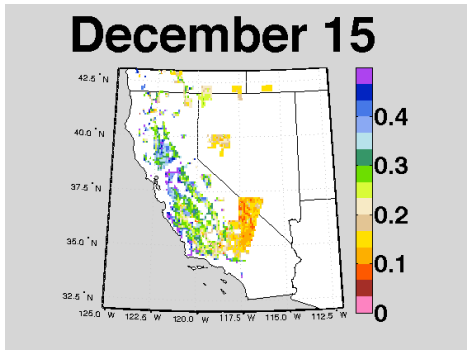








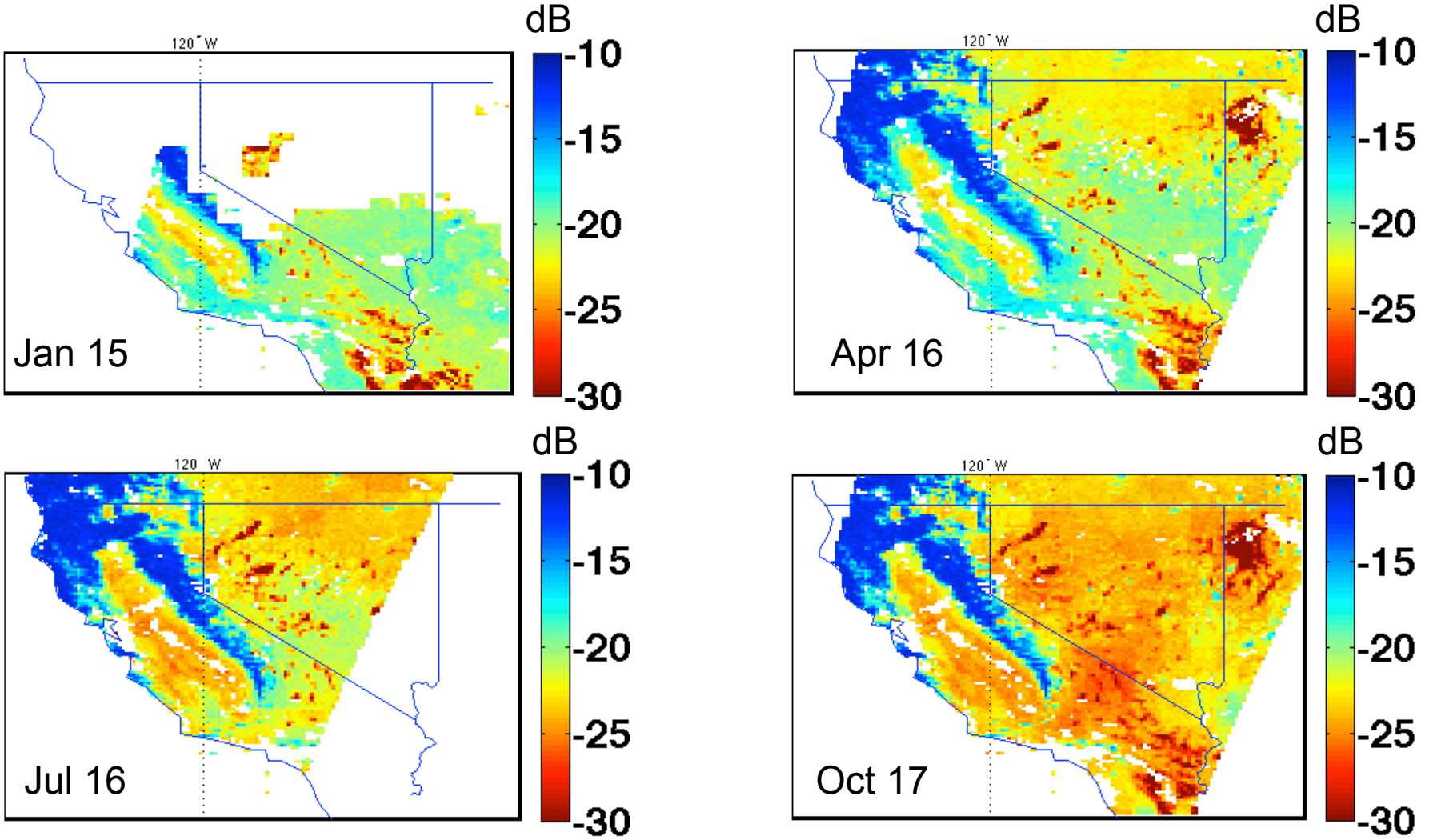




Purple represents high soil moisture and **Red** is low soil moisture

SMAP Radar Capability to Detect Vegetation Status

SMAP Radar cross-pol (Hv) backscatter



Blue represents presence of dense vegetation and **Red** almost no vegetation / bare ground

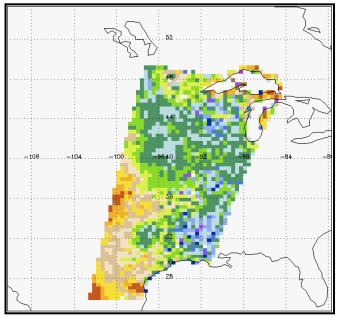
Characteristics of SMAP Soil Moisture Products

SMAP will provide soil moisture products a three different resolutions:

Radiometer only (36 km spatial resolution):

- Higher accuracy
- coarse resolution
- Soil moisture for ~5 cm depth

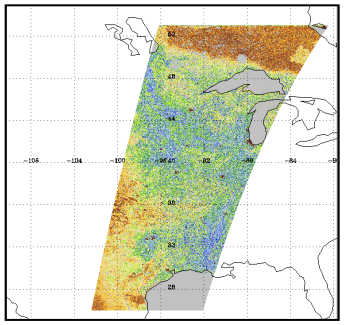
L2_SM_P (36 km)



Radar only (3 km spatial resolution):

- Lower accuracy
- Higher resolution
- Soil moisture for ~5 cm depth

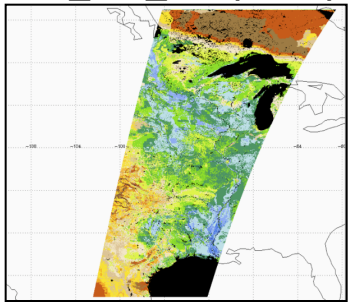
L2_SM_A (3 km)

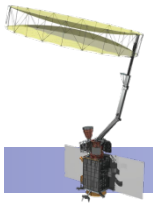


Combined (Radiometer – Radar) product (9 km spatial resolution):

- optimal accuracy
- moderate resolution
- Soil moisture for ~5 cm depth

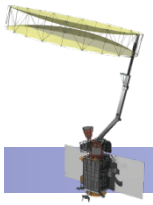
L2_SM_AP (9 km)





SMAP Data Portal

- SMAP data will be available in public domain.
- National Snow and Ice Data Center (NSIDC) a NASA Data Archive Center (DAAC) will host SMAP Data (http://nsidc.org/daac/projects/)
- Early Adopters are given preferred access to prelaunch Cal/Val and simulated dataset
- SMAP data will be available in HDF5 format with requisite metadata information. Super easy to read the data file in ESRI GIS and Matlab.
- The data comes at simple EASE2 projections. Typically at 9 km resolution the data array has 1624 rows and 3856 columns
- The data comes with latitude and longitude information that make it easy to render on GIS software.



SMAP Early Adopter Program

The SMAP project has created an outreach initiative that seeks to jumpstart the work of SMAP "Early Adopters" (EA) in developing real-world applications for the SMAP data.

At present there are 24 EAs, and SMAP project is looking for relevant EAs

Early Adopter	Applied Research Topic
Weather and Climate Forecasting	
Stephane Bélair, Meteorological Research Division, Environment Canada (EC); SMAP Contact: **Stephane Bélair**	Assimilation and impact evaluation of observations from the SMAP mission in Environment Canada's Environmental Prediction Systems
Lars Isaksen and Patricia de Rosnay, European Centre for Medium-Range Weather Forecasts (ECMWF); SMAP Contact: **Patricia de Rosnay**	Monitoring SMAP soil moisture and brightness temperature at ECMWF
Xiwu Zhan, Michael Ek and John Simko, NOAA National Environmental Satellite Data and Information Service, Center for Satellite Applications and Research (NOAA-NESDIS-STAR); SMAP Contact: **Randy Koster**	Transition of NASA SMAP research products to NOAA operational numerical weather and seasonal climate predictions and research hydrological forecasts

Early Adopter	Applied Research Topic
Droughts and Wildfires	
Jim Reardon and Gary Curcio, US Forest Service (USFS); SMAP Contact: **Dara Entekhabi**	The use of SMAP soil moisture data to assess the wildfire potential of organic soils on the North Carolina Coastal Plain
Chris Funk, Amy McNally and James Verdin, USGS & UC Santa Barbara; SMAP Contact: **Molly Brown**	Incorporating soil moisture retrievals into the FEWS Land Data Assimilation System (FLDAS)
Kashif Rashid, UN World Food Programme; SMAP Contact: **Guy Schumann**	Application of a SMAP-based index for flood forecasting in data-poor regions
Agricultural Productivity	
Amor Ines and Stephen Zebiak, International Research Institute for Climate and Society (IRI) Columbia University; SMAP Contact: **Narendra Das**	SMAP for crop forecasting and food security early warning applications
Curt Reynolds, USDA Foreign Agricultural Service (FAS); SMAP Contact: **Wade Crow**	Enhancing USDA's global crop production monitoring system using SMAP soil moisture products

Thanks