The Soil Moisture Active and Passive Mission (SMAP)

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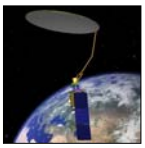
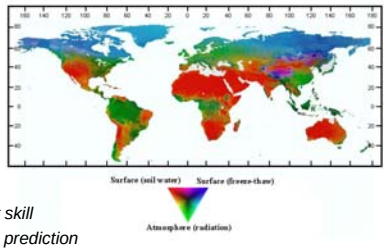


SMAP is one of four first-tier missions recommended by the NRC Earth Science Decadal Survey Report. SMAP will provide global views of Earth's soil moisture and surface freeze/thaw state, introducing a new era in hydrologic applications and providing unprecedented capabilities to investigate the cycling of water, energy and carbon over global land surfaces. **The target launch date for SMAP is March 2013.**

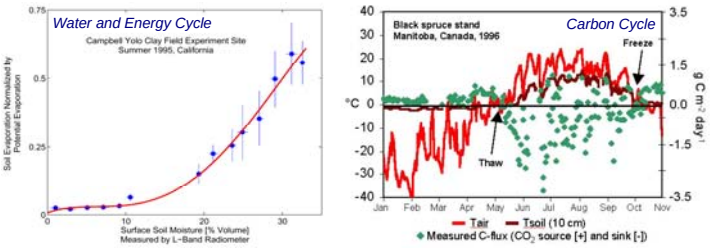
Science Objectives:

- Global, high-resolution mapping of soil moisture and its freeze/thaw state to:
  - *Link terrestrial water, energy and carbon cycle processes*
  - *Estimate global water and energy fluxes at the land surface*
  - *Quantify net carbon flux in boreal landscapes*
  - *Extend weather and climate forecast skill*
  - *Develop improved flood and drought prediction capability*

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



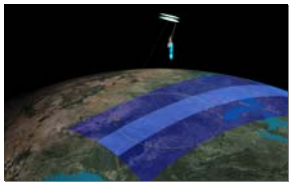
Terrestrial Water, Energy and Carbon Cycle Processes

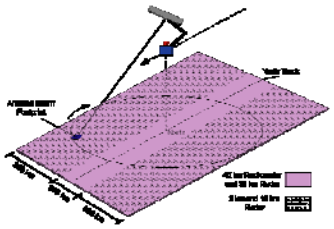


SMAP measurements of soil moisture and freeze-thaw will provide an integrated measure of critical controls on the rate of continental water and energy cycles and associated constraints on ecosystem processes. Decreasing water content imposes increasing constraints to CO_2 exchange, as do seasonal and episodic freezing. These temperature and moisture controls relate directly to land-atmosphere latent energy and water exchange, vegetation productivity, and sequestration of atmospheric CO_2.

SMAP is the first L-band combined active/passive mission providing ***both*** high-resolution and frequent revisit observations

SMAP Mission Architecture

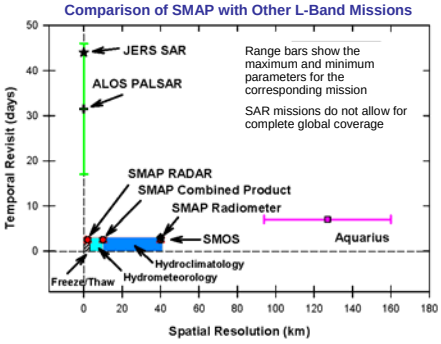




- **Orbit:**
  - *Sun-synchronous, 6 am/6pm nodal crossing*
  - *670 km altitude*
- **Instruments:**
  - ***L-band (1.26 GHz) radar***
    - *Polarization: HH, VV, HV*
    - *SAR mode: 1-3 km resolution (degrades over center 30% of swath)*
    - *Real-aperture mode: 30 x 6 km resolution*
  - ***L-band (1.4 GHz) radiometer***
    - *Polarization: V, H, U*
    - *40 km resolution*
  - ***Instrument antenna (shared by radar & radiometer)***
    - *6-m diameter deployable mesh antenna*
    - *Conical scan at 14.6 rpm*
    - *incidence angle: 40 degrees*
      - *Creating Contiguous 1000 km swath*
      - *Swath and orbit enable 2-3 day revisit*
- **Mission Ops duration:** 3 years

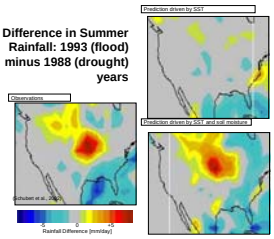
- L-band radiometer provides coarse-resolution (40 km) high accuracy soil moisture for climate modeling and prediction
- L-band radar provides high resolution (1-3 km) to accurately measure freeze/thaw transitions in boreal landscapes
- Combined radar-radiometer soil moisture at intermediate (10 km) resolution provides high resolution and accuracy for hydrometeorology and weather prediction
- Frequent global revisit (~3 days, 1-2 days for boreal regions) at high spatial resolution (1-10 km) enables critical applications in hydrologic prediction, flood monitoring, and human health

Comparison of SMAP with Other L-Band Missions



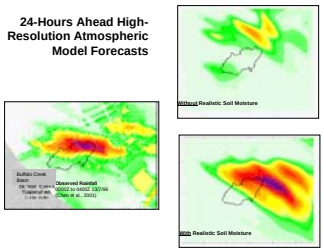
Science and Applications

Difference in Summer Rainfall: 1993 (flood) minus 1988 (drought) years



Predictability of seasonal climate is dependent on boundary conditions such as sea surface temperature (SST) and soil moisture – Soil moisture is particularly important over continental interiors

24-Hours Ahead High-Resolution Atmospheric Model Forecasts

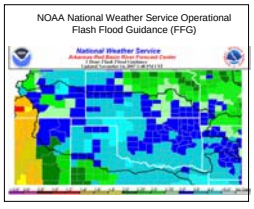


High resolution soil moisture data will improve numerical weather prediction (NWP) over continents by accurately initializing land surface states

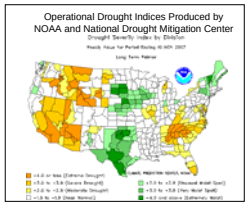
Delivery of flash-flood guidance to weather forecast offices is dependent on the availability of soil moisture estimates and observations

SMAP will provide realistic and reliable soil moisture observations that will potentially open a new era in drought monitoring and decision-support

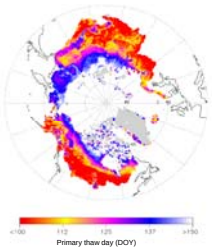
NOAA National Weather Service Operational Flash Flood Guidance (FFG)



Operational Drought Indices Produced by NOAA and National Drought Mitigation Center



Mean growing season onset for 1988 – 2002 derived from coarse resolution SSM/I data



SMAP will complement the Orbiting Carbon Observatory (OCO) mission by providing important information on the land surface processes that control land-atmosphere carbon source/sink dynamics.

Science Data Products

Data Product	Description	
L1B_S0_LoRes	Low Resolution Radar σ^o in Time Order	Global Mapping L-Band Radar and Radiometer
L1C_S0_HiRes	High Resolution Radar σ^o on Earth Grid	
L1B_TB	Radiometer T_B in Time Order	
L1C_TB	Radiometer T_B on Earth Grid	
L2/3_F/T_HiRes	Freeze/Thaw State on Earth Grid	High-Resolution and Frequent-Revisit Science Data
L2/3_SM_HiRes	Radar Soil Moisture on Earth Grid	
L2/3_SM_40km	Radiometer Soil Moisture on Earth Grid	
L2/3_SM_A/P	Radar/Radiometer Soil Moisture on Earth Grid	
L4_F/T	Freeze/Thaw Model Assimilation on Earth Grid	Observations+Model Value Added Science Data
L4_4DDA	Soil Moisture Model Assimilation on Earth Grid	

SMAP Mission Requirements

SMAP mission requirements have been developed from Hydros heritage and extensive community interaction through science workshops

Scientific Measurement Requirements	Instrument Functional Requirements	Mission Functional Requirements
Soil Moisture: ~4% volumetric accuracy in top 5 cm for vegetation water content < 5 kg m^{-2}; Hydrometeorology at 10 km; Hydroclimatology at 40 km	L-Band Radiometer: Polarization: V, H, U; Resolution: 40 km; Relative accuracy*: 1.5 K L-Band Radar: Polarization: VV, HH, HV; Resolution: 10 km; Relative accuracy*: 0.5 dB for VV and HH Constant incidence angle** between 35° and 50°	DAAC data archiving and distribution. Field validation program. Integration of data products into multisource land data assimilation.
Freeze/Thaw State: Capture freeze/thaw state transitions in integrated vegetation-soil continuum with 2-day precision, at the spatial scale of landscape variability (3 km).	L-Band Radar: Polarization: HH; Resolution: 3 km; Relative accuracy*: 0.7 dB (1 dB per channel if 2 channels are used); Constant incidence angle** between 35° and 50°	
Sample diurnal cycle at consistent time of day Global, 3-4 day revisit Boreal, 2 day revisit	Swath Width: 1000 km Minimize Faraday rotation (degradation factor at L-band)	Orbit: 670 km, circular, polar, sun-synchronous, ~6am/pm equator crossing
Observation over a minimum of three annual cycles	Minimum three-year mission life	Three year baseline mission***

* Includes precision and calibration stability, and antenna effects

International Workshop on Microwave Remote Sensing for Land Hydrology: Research and Applications, Oxnard, California, USA, October 20-22, 2008

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