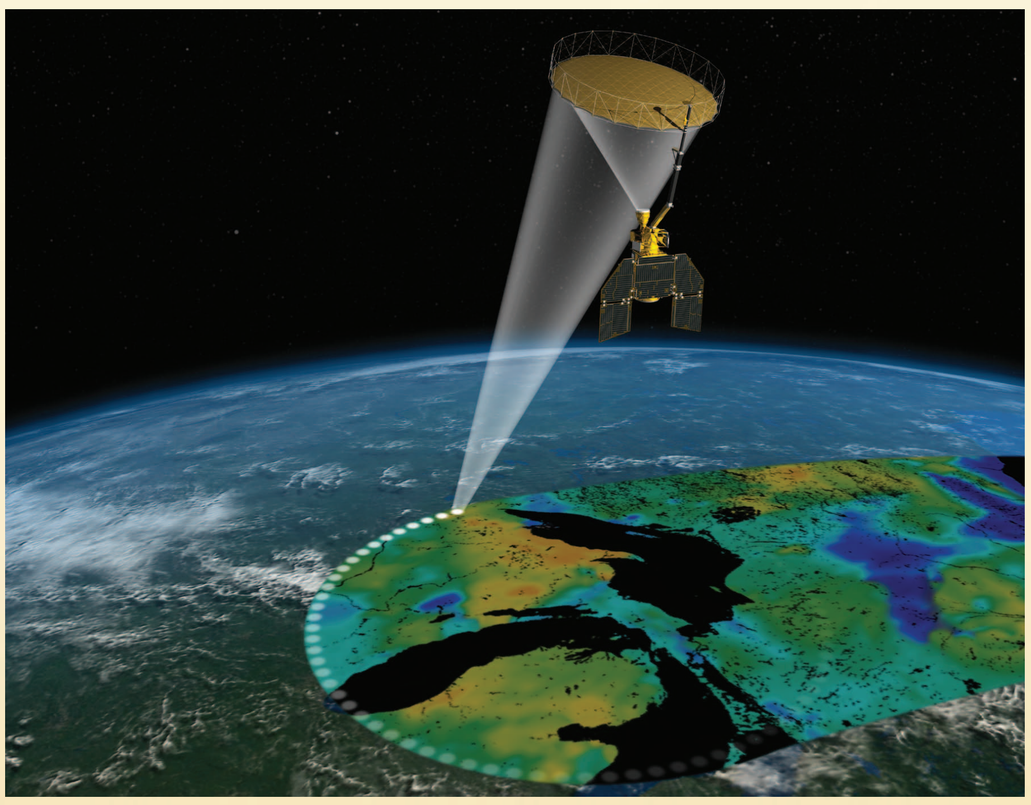
National Aeronautics and Space Administration

Soil Moisture Active Passive (SMAP)

PRODUCTS

Mapping soil moisture and freeze/thaw state from space



The SMAP Mission

Objectives: SMAP measurements will be used to enhance understanding of processes that link the water, energy, and carbon cycles, and to enhance the predictive skill of weather and climate models. SMAP data will also be used to quantify net carbon flux in boreal landscapes and to develop improved flood prediction and drought monitoring capabilities.

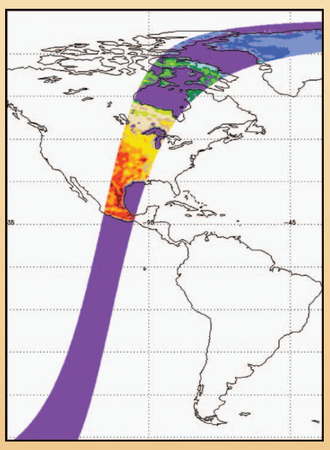
Observatory: The SMAP observatory employs a dedicated spacecraft with an instrument suite that will be launched on an expendable launch vehicle into a 680-km near polar, sun-synchronous orbit, with equator crossings at 6 AM and 6 PM local time.

Instrument: The SMAP instrument includes a radiometer and a synthetic aperture radar operating at L-band (1.20-1.41 GHz). The instrument is designed to make coincident measurements of surface emission and backscatter, with the ability to sense the soil conditions through moderate vegetation cover. The conically-scanning antenna covers a 1000 km swath providing global coverage within 3 days at the equator and 2 days at boreal latitudes (>45° N).

Operations: SMAP science measurements will be acquired for a period of three years. A comprehensive validation program will be carried out after launch to assess the science data products. The products from these activities will be made available through a NASA data archive center.

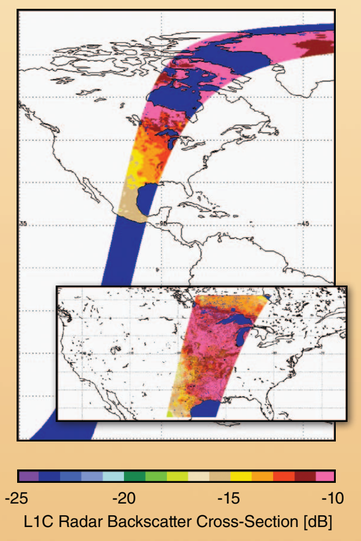
Sample Products

Level 1B Radiometer



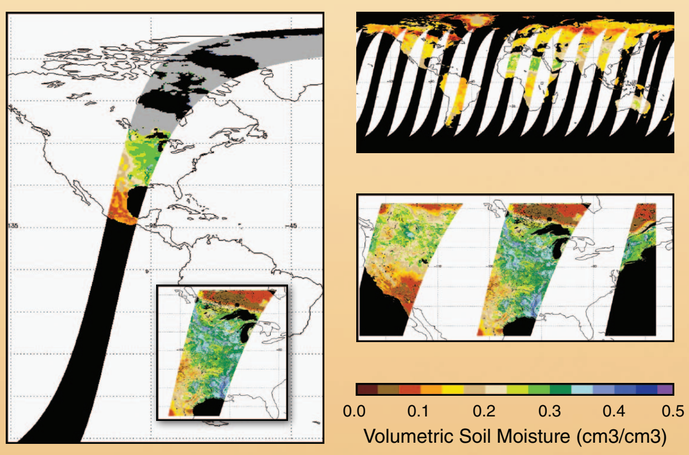
- L1B radiometer coverage is continuous (AM or PM, fore/aft scans) over all surface types
- Contains Earth-located, calibrated brightness temperatures at H, V, and 3rd & 4th Stokes polarizations for each FOV footprint, in time-order
- FOV footprint resolution is approximately 40 km
- 3rd Stokes measurements are used to infer Faraday rotation corrections to the H & V T_B measurements
- EASE grid coordinates for global & polar 36 km grid for each footprint

Level 1C High Resolution Radar



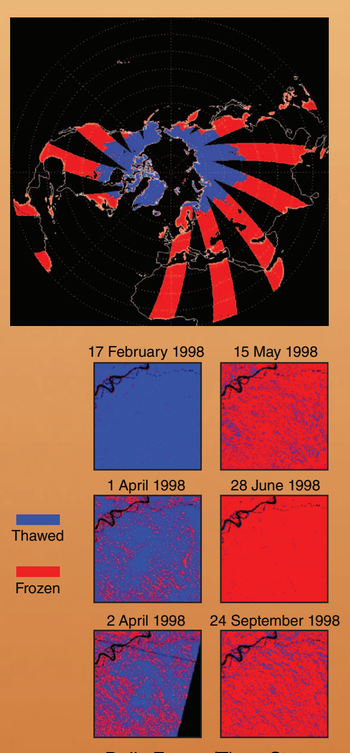
- Has coverage over land and coastal oceans, on the AM orbit pass (AM and PM for regions above 45° N), and uses the forward and aft parts of the scan for the AM pass
- Allows SAR processing to enable high-resolution single-look measurements; has varied resolution from ~400 m at the swath edge to about 1.2 km within 150 km of the nadir subtrack; has nadir looks that are thin slices as wide as the beam footprint
- Contains Earth-located and calibrated radar backscatter measurements for HH, VV and HV

Level 2 and 3 Soil Moisture Active/Passive



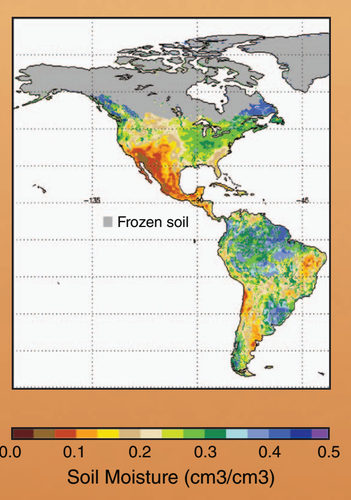
- Merges active (radar HH and VV) with passive (radiometer H and V) channels using a time-series algorithm and spatial heterogeneity of L1C radar products to retrieve ~9 km soil moisture product over land with 0.04 cm^3 cm^{-3} accuracy for low-to-moderately vegetated areas (VWC ≤ 5 kg/m^2)
- Depends on transient water body and freeze-thaw state retrievals from HiRes radar
- Level 3 daily composite made from Level 2 half-orbits
- Provides global coverage in 3 days

Level 3 Freeze/Thaw



- Quantifies daily land surface freeze/thaw state as a binary condition of land surface
- Uses the 1 km L1C radar HiRes data with a time-series change detection algorithm to infer freeze/thaw state
- 80% F/T spatial classification accuracy
- Results in the posting of output data at 1-3 km spatial resolution with 2 day average temporal intervals for regions above 45° N

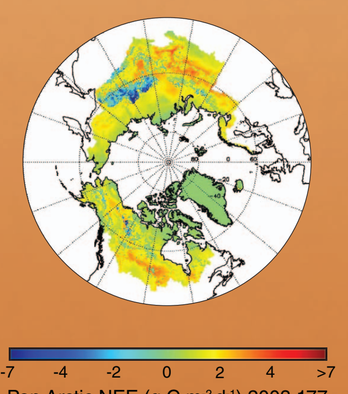
Level 4 Surface and Root Zone Soil Moisture (L4_SM)



- Merges SMAP observations with soil moisture estimates from a land surface model in a land data assimilation system, yielding a product that is superior to satellite or land model estimates alone
- Provides global surface (top 5 cm) and root zone (top 1 m) soil moisture estimates at ~9 km and 3-hourly resolution that are spatially and temporally complete and consistent with SMAP observations
- Includes surface meteorological forcing fields, land surface fluxes, soil temperature and snow states, runoff, and error estimates as research output (validated on a best effort basis)

Level 4 Carbon Net Ecosystem Exchange (L4_C)

- Constrains carbon flux estimates from a soil respiration model and satellite observations of gross primary productivity with SMAP observations



- Provides enhanced global estimates of carbon fluxes at ~3 km and daily resolution
- Uses L3_F/T and L4_SM based soil moisture and temperature with ancillary land cover and vegetation productivity inputs to predict net ecosystem CO_2 exchange (NEE) with the atmosphere
- L4_C accuracy (RMSE) commensurate with in situ tower measurements (NEE <30 g C m^{-2} yr^{-1} or 1.6 g C m^{-2} d^{-1})
- Results posted to 9-km global grid with daily temporal fidelity

www.nasa.gov

See reverse side for complete list of data products

Soil Moisture Active Passive (SMAP)

PRODUCTS

Mapping soil moisture and freeze/thaw state from space

Science Objectives

SMAP will provide a capability for global mapping of soil moisture and freeze/thaw state with unprecedented accuracy, resolution, and coverage. SMAP science objectives are to acquire space-based hydrosphere state measurements over a three-year period to:

- understand processes that link the terrestrial water, energy, and carbon cycles;
- estimate global water and energy fluxes at the land surface;
- quantify net carbon flux in boreal landscapes;
- enhance weather and climate forecast skill;
- develop improved flood prediction and drought monitoring capabilities.

The SMAP mission will enable global soil moisture mapping with unprecedented resolution, sensitivity, area coverage, and revisit. Soil moisture, as the state variable of the water cycle over land, determines water fluxes between the atmosphere, surface, and subsurface. Because a large amount of heat is exchanged when water changes phase, the water cycle is also fundamental to the dynamics of the Earth's energy cycle. Since water is the ultimate solvent in the Earth system, biogeochemical cycles (carbon, nitrogen, methane, and others) are embedded in the water cycle. Through these effects, which are linked directly to climate and the environment, SMAP observations will be transformational for elements of Earth system science, for water resource assessment, and for natural hazards mitigation.

Radiometer	
Frequency:	1.41 GHz
Polarizations:	H, V, 3rd and 4th Stokes
Relative accuracy:	1.3 K
Data collection:	Continuous over full scan
Includes designs to detect and mitigate Radio-Frequency Interference (RFI)	
Radar	
Frequency:	1.26 GHz
Polarizations:	VV, HH, HV
Data collection:	• High-resolution/high-rate data collected over land and coastal waters for SAR processing • Low-resolution real-aperture data collected continuously
Antenna Configuration	
Conically-scanning reflector shared by both radar and radiometer	
Diameter:	6 meters
Rotation rate:	14.6 RPM
Forms 1000 km wide swath	
Resolution:	40 km radiometer, 1-3 km SAR
Beam efficiency:	90%
Constant Incidence Angle (40°)	

Web Site

Please visit our web site for more information about SMAP:

http://smap.jpl.nasa.gov

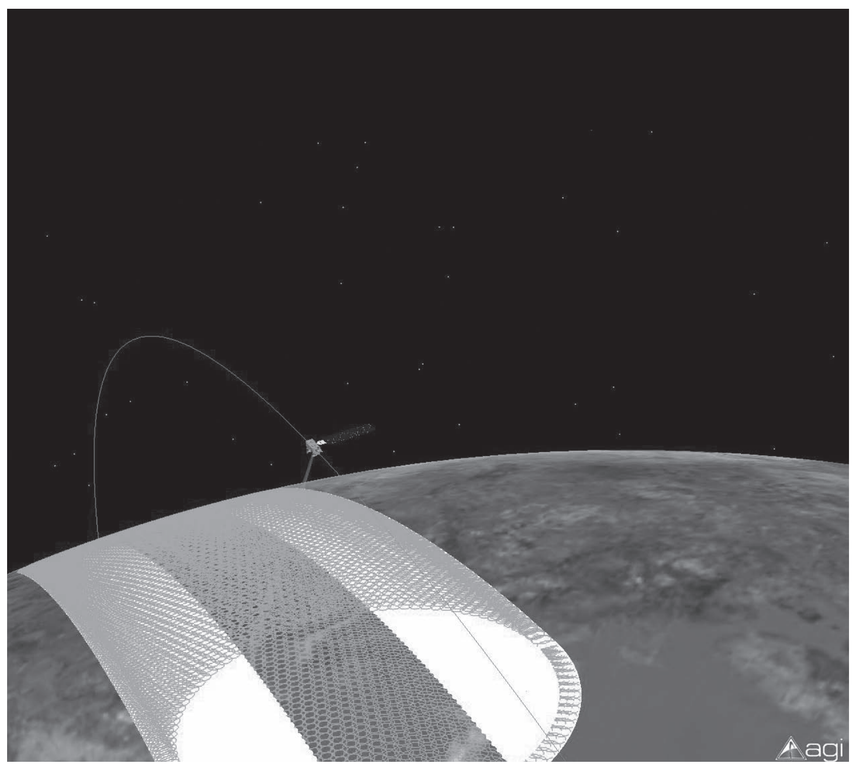
SMAP Science Data Products

Data Product Short Name	Description	Data Resolution	Median Latency*
L1A_Radar	Radar raw data in time order	—	12 hrs
L1A_Radiometer	Radiometer raw data in time order	—	12 hrs
L1B_S0_LoRes	Low resolution radar σ_o in time order	5x30 km	12 hrs
L1B_TB	Radiometer T_B in time order	40 km	12 hrs
L1C_S0_HiRes	High resolution radar σ_o (half orbit, gridded)	1x1 km to 1x30 km	12 hrs
L1C_TB	Radiometer T_B (half orbit, gridded)	40 km	12 hrs
L2_SM_P	Soil moisture (radiometer, half orbit)	40 km	24 hrs
L2_SM_A/P	Soil moisture (radar/radiometer, half orbit)	9 km	24 hrs
L3_F/T_A	Freeze/thaw state (radar, daily composite)	3 km	48 hrs
L3_SM_P	Soil moisture (radiometer, daily composite)	40 km	48 hrs
L3_SM_A/P	Soil moisture (radar/radiometer, daily composite)	9 km	48 hrs
L4_SM	Soil moisture (surface & root zone)	9 km	7 days
L4_C	Carbon and Net Ecosystem Exchange	3 km	14 days

*The SMAP Project will make a best effort to reduce the data latencies beyond those shown in this table. The SMAP baseline science data products are shown in this table. These data products will be made available through a NASA-designated data center. The products will conform to the HDF-5 standard.

Spatial Resolution: Radiometer measurements of surface emission can be inverted to estimate surface soil moisture with high sensitivity but at coarse spatial resolution (40 km). Radar backscatter measurements are at higher spatial resolution (1-3 km) but they are less sensitive to the surface soil moisture. The SMAP observatory and its active-passive approach to L-band measurements is designed to produce a combined radar-radiometer soil moisture product that has an optimal blend of resolution (9 km) and accuracy (0.04 cm^3 cm^{-3} 1-sigma error) to meet science objectives. The high resolution of the radar is also critical for accurate determination of freeze/thaw state in the heterogeneous landscapes of the boreal forest region north of 45° N latitude.

Data Availability: SMAP will coordinate the release of data product versions to a NASA-designated Earth science data center and will ensure the completeness and accuracy of quality control information and validation status of the data products.



SMAP Working Groups

Working Groups have been established as a means to enable broad science participation in the SMAP mission. The working groups are led by Science Definition Team (SDT) members and provide forums for information exchange on issues related to SMAP science and applications goals and objectives. The working groups communicate via email and at meetings, conference sessions, workshops, and other venues.

- Algorithms Working Group (AWG)
- Calibration & Validation Working Group (CVWG)
- Radio-Frequency Interference Working Group (RFIWG)
- Applications Working Group (AppWG)

To join and follow working groups please visit: *http://smap.jpl.nasa.gov/science/wgroups/*

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