SMAP Data Products and Applications
Contents:

1. Overview and Mission Objectives
2. Instruments (radar and radiometer)
3. Retrieval Algorithms
4. Data Products
5. Calibration/Validation
6. Applications

- Details provided in SMAP Handbook

- Credits: SMAP Project Team
  SMAP Science Team

http://smap.jpl.nasa.gov/mission/description

What Is SMAP?

• SMAP is the Soil Moisture Active Passive mission, a NASA Earth science mission

• SMAP’s science objective is to provide high-resolution, frequent-revisit, global observations of soil moisture and 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 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

SMAP was initiated in 2008 in response to recommendations of the NRC Earth Science Decadal Survey (2007) and was launched in January 31, 2015
Why Soil Moisture?

- Enhanced weather & climate forecasting
- Improved agricultural productivity and crop yield predictions
- Drought monitoring and early warning
- Flood monitoring and prediction
- Human health and vector borne diseases
Why Measure from Space?

SMAP provides a capability for global observations of soil moisture and its frozen or thawed state with high spatial resolution and frequent temporal revisit

- Current ground measurements of soil moisture are sparse and have limited global coverage
- Previous space missions have relatively low soil moisture accuracy, resolution, and coverage
- SMAP provides 10-40 km spatial resolution, 3-day global revisit, accuracy of 0.04 m³/m³

Inter-storm soil moisture dry-down

[Sun et al. (2006): How often does it rain?, J. Climate, 19]

- Average inter-storm period implies 3-day sampling or better is required to resolve soil moisture variability
SMAP uses both “Passive” and “Active” Remote Sensing to measure Soil Moisture

Passive Sensors:
The source of radiant energy arises from natural sources... Sun, Earth, other “hot” bodies

Active Sensors:
Provide their own artificial radiant energy source for illumination... RADAR, Synthetic Aperture Radar (SAR), LIDAR
• With optical and infrared wavelength sensors the soil is masked by clouds and vegetation. Also, optical sensors operate by measuring scattered sunlight and are “daytime only.”

• Microwaves can penetrate through clouds and vegetation, operate day and night, and are highly sensitive to the water in the soil due to the change in the soil microwave dielectric properties.
Radiometers measure “brightness temperature”, $T_B$ (K)  
Radar measure “backscatter cross-section”, $\sigma_o$ (dB)  
Contributions to emission and backscatter include three terms: soil, vegetation, and soil-vegetation interaction  
Soil moisture is the dominant contributor to the signal  
$L$ is the vegetation attenuation factor, $\exp(-\tau_v / \cos\theta)$  
Retrievals invert these equations to obtain soil moisture, with corrections for vegetation, roughness and surface temperature

\[
T_{Bp}^l = T_{Bp}^s L_{p} + T_{Bp}^v + T_{Bp}^{sv} \quad \text{(Emission)}
\]
\[
\sigma_{pq}^l = \sigma_{pq}^s L_{pq}^2 + \sigma_{pq}^v + \sigma_{pq}^{sv} \quad \text{(Backscatter)}
\]
SMAP Mission Design

INSTRUMENT
- L-band (1.2-GHz) radar (JPL)
- L-band (1.4-GHz) radiometer (GSFC)
- Shared antenna (6-m diameter)
- Conical scan: 13–14.6 rpm; 40° incidence
- Contiguous 1,000-km swath width

SPACECRAFT (& RADAR ELECTRONICS)
- JPL developed & built
- JPL’s MSAP/MSL avionics, power assys with a small number of new mission-unique card designs
- 951-kg wet mass (Observatory-level)
- 1450-W capacity (Observatory-level)
- 80-kg propellant capacity
- Commercial space electronics elsewhere

SCIENCE DATA PRODUCTS
- Soil Moisture & Freeze/Thaw State Data Products
- Alaska Satellite Facility Data Center (radar L1 products)
- National Snow and Ice Data Center (all other products)

Near-Earth Network
Surface Validation
SMAP Mission Operations & Data Processing (JPL, GSFC)

Delta II 7320-10C
Launch: January 31, 2015 6:22 AM pacific
Vandenberg Air Force Base
SMAP Instrument and Operating Characteristics

SMAP’s objective is to provide high-resolution and frequent-revisit global mapping of soil moisture and landscape freeze/thaw state

**Instrument Configuration**

**Radar**
- Frequency: 1.26 GHz
- Polarizations: VV, HH, HV
- Resolution: 1-3 km
- Relative Accuracy: 1.0 dB (HH, 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**
- 6-m diameter deployable mesh antenna
- Conical scan at 14.6 rpm
- Constant incidence angle: 40 degrees
- 1000 km-wide swath

**Orbit**
- Sun-synchronous, 6 am/pm, 685 km altitude

**Mission Operations**
- 3-year baseline mission

- **Radar** - High spatial resolution (1-3 km) but more influenced by surface roughness and vegetation
- **Radiometer** - High accuracy (less influenced by roughness and vegetation) but coarser spatial resolution (40 km)
- **Combined Radar-Radiometer** – Soil moisture product (9 km) provides optimal blend of resolution and accuracy
## SMAP Data Products

<table>
<thead>
<tr>
<th>Data Product Short Name</th>
<th>Description</th>
<th>Grid (Resolution)</th>
<th>Granule Extent</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1A_Radar</td>
<td>Parsed Radar Instrument Telemetry</td>
<td></td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L1A_Radiometer</td>
<td>Parsed Radiometer Instrument Telemetry</td>
<td></td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L1B_S0_LoRes</td>
<td>Low Resolution Radar $\sigma_o$ in Time Order</td>
<td>(5x30 km) (slices)</td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L1C_S0_HiRes</td>
<td>High Resolution Radar $\sigma_o$ on Swath Grid</td>
<td>1 km</td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L1B_TB</td>
<td>Radiometer $T_B$ in Time Order</td>
<td>(39x47 km)</td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L1C_TB</td>
<td>Radiometer $T_B$</td>
<td>36 km</td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L2_SM_A</td>
<td>Radar Soil Moisture (includes Freeze-Thaw)</td>
<td>3 km</td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L2_SM_P</td>
<td>Radiometer Soil Moisture</td>
<td>36 km</td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L2_SM_AP</td>
<td>Active-Passive Soil Moisture</td>
<td>9 km</td>
<td>Half Orbit</td>
</tr>
<tr>
<td>L3_FT_A</td>
<td>Daily Global Composite Freeze/Thaw State</td>
<td>3 km</td>
<td>North of 45° N</td>
</tr>
<tr>
<td>L3_SM_A</td>
<td>Daily Global Composite Radar Soil Moisture</td>
<td>3 km</td>
<td>Global</td>
</tr>
<tr>
<td>L3_SM_P</td>
<td>Daily Global Composite Radiometer Soil Moisture</td>
<td>36 km</td>
<td>Global</td>
</tr>
<tr>
<td>L3_SM_AP</td>
<td>Daily Global Composite Active-Passive Soil Moisture</td>
<td>9 km</td>
<td>Global</td>
</tr>
<tr>
<td>L4_SM</td>
<td>Surface &amp; Root Zone Soil Moisture</td>
<td>9 km</td>
<td>Global</td>
</tr>
<tr>
<td>L4_C</td>
<td>Carbon Net Ecosystem Exchange</td>
<td>9 km</td>
<td>Global</td>
</tr>
</tbody>
</table>
Data Delivery Schedule

- **L-5 yr**
  - Pre-launch Preparation
  - Launch
  - In-Orbit Checkout (3 months)
  - Formal start of SMAP Science Mission

- **January 31, 2015**
  - Beta release of L1 products and start of routine delivery
  - L1 validation (6 months)
  - Delivery of validated L1 products to Data Center

- **April 30, 2015**: L+3 mo
- **July 31, 2015**: L+6 mo
- **October 31, 2015**: L+9 mo
- **April 30, 2016**: L+15 mo

- **Beta release of L2-L4 products and start of routine delivery**
- **L2-L4 validation (12 months)**
  - Delivery of validated L2-L4 products to Data Center
## Current Status

<table>
<thead>
<tr>
<th>Date</th>
<th>Milestone</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 31, 2015</td>
<td>SMAP launch</td>
</tr>
<tr>
<td>February 24</td>
<td>Antenna reflector deployed</td>
</tr>
<tr>
<td>March 26</td>
<td>Antenna spin-up to 14.6 RPM</td>
</tr>
<tr>
<td>March 31</td>
<td>Radiometer begins routine science operation</td>
</tr>
<tr>
<td>April 13</td>
<td>Radar begins routine science operation</td>
</tr>
<tr>
<td>July 7</td>
<td><strong>Radar stops transmitting (traced to low-voltage power supply of radar amplifier)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Radiometer continues to operate normally</strong></td>
</tr>
<tr>
<td>July 31</td>
<td>Beta data for L1 Radiometer and Radar released to public</td>
</tr>
<tr>
<td>September 2</td>
<td>NASA official announcement that all efforts to restart the radar are unsuccessful</td>
</tr>
<tr>
<td>September 9</td>
<td>Beta data for L2/3 Soil Moisture Passive (radiometer) released to public</td>
</tr>
<tr>
<td>Early November</td>
<td>Validated data for L1 Radiometer and Radar released to public</td>
</tr>
<tr>
<td>Early November</td>
<td>Beta data for L2-L3 Soil Moisture and Freeze/Thaw, L4 Soil Moisture and L4 Carbon released to public</td>
</tr>
<tr>
<td>Through April 2018</td>
<td>Science data available through data centers are used to demonstrate SMAP science and applications</td>
</tr>
</tbody>
</table>
Data Product Descriptions

- The following slides describe the SMAP data products
- The slides will be updated with browse images from the data center portals (ASF and NSIDC) once these are available
Level 1B Radar Product

- Each granule contains time ordered data that covers one spacecraft half orbit
- Coverage is continuous over all surface types
- Contains Earth-located, calibrated radar backscatter measurements for co-pol and cross-pol data
- Estimated Kp errors are assigned to each measurement
- Includes spacecraft orbit and attitude information and instrument pointing geometry
- Includes short term and external calibration data used to generate product output
- Provides calibrated backscatter measurements for approximately ten range-resolved “slices” of the full radar FOV footprint (~30 km by 5 km)
Level 1C Radar Product

- Each granule contains geographically ordered data in 1 km grid cells in an along track/cross track swath grid
- Coverage is restricted to land and coastal water over one spacecraft half orbit
- SAR provides high-resolution single-look measurements. Resolution varies from ~400 m at the swath edge to about 1.2 km at 150 km from the nadir sub-track. Nadir looks are thin slices as wide as the beam footprint
- Contains Earth located and calibrated h-pol, v-pol and cross-pol backscatter measurements, each separately multilooked

- Radar measurements achieve approximately 1 km resolution over the outer 70% of the swath Resolution degrades in the nadir region (middle 30% of swath)
- Forward looking and aft looking measurements are stored separately
- Includes spacecraft orbit and attitude information and instrument pointing geometry
- Includes short term and external calibration data used to generate product output
- Provides reference to global and polar 1-km EASE grid coordinates
Level 1B Radiometer Product

- Each granule contains time ordered data that covers one spacecraft half orbit
- Effective field of view footprint is a 39 km by 47 km ellipse
- Coverage continuous over all surface types.
- Earth-located calibrated data for each EFOV
  - Surface-referenced brightness temperatures
  - Antenna temperatures included
  - Corrections for galactic, solar, lunar, ionospheric, atmospheric, and antenna pattern effects
- All four modified Stokes parameters (V, H, T_3 & T_4)
  - 3rd Stokes used for Faraday rotation correction
- Time-frequency-polarization rotation diversity used for RFI detection and removal
- Forward looking and aft looking measurements stored separately
- Includes spacecraft orbit and attitude information and instrument pointing geometry
Level 1C Radiometer Product

- Consists of level 1B Radiometer data gridded on a 36 km Earth-fixed grid
- Data appear in three projections
  - Global cylindrical grid
  - North polar grid
  - South polar grid
- Forward looking and aft looking observations are stored separately
- Direct input to level 2 passive soil moisture product (36 km) and level 2 active-passive soil moisture and level 4 soil moisture products (9 km)
Level 2 Passive (Radiometer) 36 km Soil Moisture Product

- Each granule contains one half orbit of data posted on 36 km cylindrical EASE grid cells
- Data are represented in a one dimensional array
- Product lists only those EASE grid cells within the half orbit swath
- Provides retrieved soil moisture over land with 0.04 m$^3$/m$^3$ estimated accuracy for low-to-moderately vegetated areas
  - Low to moderate vegetation defined as vegetation water content $\leq 5$ kg/m$^2$
- Uses water body and freeze-thaw state information generated from the high resolution radar data
- Estimates soil moisture based on 6 am (descending pass) observations
- Includes quality masks for urban areas, mountainous terrain, dense vegetation, precipitation, snow and ice

Volumetric Soil Moisture (m$^3$/m$^3$)

ID_020
Level 2 Active (Radar)
3 km Soil Moisture Product

- Each granule contains one half orbit of data posted on a 3-km cylindrical EASE grid cell
- Data are represented in a one dimensional array
- AM Product covers entire Earth land mass, PM product restricted to land north of 45 North longitude
- PM data acquired specifically for freeze-thaw retrievals
- Employs 1 km high resolution radar L1C data averaged over 3 km EASE grid cells to reduce Kp noise
- Soil moisture retrievals use snapshot and/or time-series algorithms
- Provides freeze-thaw state and transient water body information that the other Level 2 soil moisture processes require
- Includes quality masks for urban areas, mountainous terrain, dense vegetation, snow and ice
Level 2 Active-Passive 9 km Soil Moisture Product

- Each granule contains one half orbit of data posted on 9 km cylindrical EASE grid cells
- Data are represented in a one dimensional array
- Product lists only those EASE grid cells within the half orbit swath.
- Merges radar and radiometer data using a time series algorithm
- Provides disaggregated brightness temperatures at 9 km resolution
- Provides retrieved soil moisture over land with 0.04 m³/m³ estimated accuracy for low-to-moderately vegetated areas
  - Low to moderate vegetation defined as vegetation water content <= 5 kg/m²
- Uses water body and freeze-thaw state information from high resolution radar data
- Includes masks for urban areas, mountainous terrain, dense vegetation, precip, snow and ice
Level 3 Passive (Radiometer) 36 km Soil Moisture Product

- Composite of all Radiometer Level 2 half orbit products where local acquisition time is the same UTC day
- Multiple measurements may overlap at high latitudes. Algorithm selects measurements acquired closest to 6 AM local solar time
- Posted on a 36 km cylindrical EASE grid using a two dimensional array
- Product lists all EASE grid cells, regardless of whether data are available
- Provides retrieved soil moisture over land with 0.04 m$^3$/m$^3$ accuracy for low-to-moderately vegetated areas
  - Low to moderate vegetation defined as vegetation water content <= 5 kg/m$^2$
- Based exclusively on AM data

Volumetric Soil Moisture (m$^3$/m$^3$)
Level 3 Active (Radar) 3 km Soil Moisture Product

- Composite of all Radar Level 2 half orbit products where the local acquisition time is the same UTC day
- Multiple measurements may overlap at high latitudes. Algorithm selects those measurements acquired closest to 6 AM local solar time
- Posted on a 3 km cylindrical EASE grid using a two dimensional array
- Product lists all EASE grid cells, regardless of whether data are available
- Soil moisture retrievals use snapshot and/or time-series algorithms
- Depending on the terrain classification, multiple optional models/algorithms may be employed for retrieval
- Based exclusively on AM data
Level 3 Active/Passive 9 km Soil Moisture Product

- Composite of all Active/Passive Level 2 half orbit products where local acquisition time is the same UTC day
- Multiple measurements may overlap at high latitudes. Algorithm selects measurements acquired closest to 6 AM local solar time
- Posted on a 9 km cylindrical EASE grid using a two dimensional array
- Product lists all EASE grid cells, regardless of whether data are available
- Provides retrieved soil moisture over land with 0.04 m³/m³ accuracy for low-to-moderately vegetated areas
  - Low to moderate vegetation defined as vegetation water content <= 5 kg/m²
- Based exclusively on AM data
Level 3 Freeze/Thaw 3 km Product

- Uses the 1 km Level 1C high resolution radar data and a time-series change detection algorithm to infer freeze/thaw state
- Quantifies daily freeze/thaw state as a binary condition for land surface
- Includes both AM and PM data, with intra-day state transition flags
- Posted on a 3 km polar EASE grid using a two dimensional array
- Each product represents a single calendar day UTC
- Target is to achieve 80% freeze/thaw state classification accuracy
Level 4 Surface and Root-Zone 9 km Soil Moisture Product

- Global product, presented in two collections
- Based on assimilation of SMAP brightness temperatures from the L1C_TB and L2_SM_AP products into a state-of-the-art land surface model

<table>
<thead>
<tr>
<th>Geophysical Data (&quot;gph&quot; Collection)</th>
<th>Analysis Update Data (&quot;aup&quot; Collection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-hour time averages</td>
<td>3-hour instantaneous (snapshots)</td>
</tr>
<tr>
<td>Surface and root zone soil moisture, soil temperature, snow, land surface fluxes, surface meteorological forcing data</td>
<td>Brightness temperatures (observed and modeled), soil moisture and soil temperature (model forecast and analysis), uncertainty estimates</td>
</tr>
</tbody>
</table>
Level 4 Carbon Product (9 km)

- Daily global maps of net ecosystem CO₂ exchange (NEE) at 9 km resolution with 14-day latency
- Quantifies the net carbon flux in boreal landscapes
- Reduces uncertainty with regard to existing carbon sinks on land
- Applies a soil decomposition algorithm driven by SMAP L4_SM and Gross Primary Production (GPP) inputs to compute net land-atmosphere CO₂ exchange (NEE)
- **Accuracy** commensurate with tower based CO₂ observations (RMSE ≤ 30 g C m⁻² yr⁻¹ or 1.6 g C m⁻² d⁻¹)
SMAP Resources at the ASF DAAC

The ASF DAAC archives and supports user services for SMAP radar level 1 products

1. ASF SMAP web interface at https://www.asf.alaska.edu/smap

2. ASF Data Access and Distribution
   a. ASF API at https://portal.asf.alaska.edu/get-data/api
   b. Vertex at https://vertex.daac.asf.alaska.edu

3. ASF User Services and Points of Contacts
   a. User Services Representative (uso@asf.alaska.edu)
   b. Project Manager – Scott Arko (saarko@alaska.edu)
   c. Product Owner – Angela R. Allen (arallen@alaska.edu)
SMAP Resources at the NSIDC DAAC

The NSIDC DAAC archives and provides user support for level 1 radiometer products as well as all SMAP level 2, level 3 and level 4 products

• SMAP Web site
  – http://nsidc.org/data/smap/

• NSIDC Data Search
  – http://nsidc.org/data/search/

• SMAP Data Tools
  – Will be released with data products
  – Subsetting and reformatting on-demand services
  – HDF utilities. Matlab and IDL readers

• User Support
  – http://nsidc.org/forms/contact.html
  – nsidc@nsidc.org
SMAP Portal at the ASF DAAC

SMAP

SMAP maps the world’s soil moisture every three days. Data and imagery will be available at no cost to registered users at ASF DAAC (Level 1 radar) and NSIDC DAAC (Level 1 radiometer and all Levels 2, 3, & 4).

Global Significance

SMAP data on soil moisture and freeze/thaw state will aid climate forecasting; flood, landslide, and drought monitoring; agricultural planning; and much more.

Documents & Tools

Access the ASF SMAP User Guide, the SMAP Handbook, tools such as MapReady, a table of ancillary data reports with links to the data they cite, and more.

Data & Imagery

A rare characteristic of the SMAP Project is its emphasis on serving both basic Earth System science as well as applications in operational and practice-oriented communities.

— SMAP Handbook
SMAP Portal at the NSIDC DAAC

Overview
The National Snow and Ice Data Center (NSIDC) and the Alaska Satellite Facility (ASF) will jointly manage SMAP science data on behalf of the NASA ESDIS Project. Currently, NSIDC distributes

Measuring Soil from Space
SMAP is a NASA Earth science mission that uses microwave radar and radiometer instruments to measure soil moisture from space.
Read more ...

RELATED RESOURCES
SMAP Handbook
Essential information on the programmatic, technological, and scientific aspects of SMAP data and the mission.

SMAP Radar Data at ASF

SMAP Information at NASA
SMAP on Worldview
EOSDIS Data Visualization, Discovery, and Download Tool for GIBS

• General-purpose, full-resolution satellite imagery browser built to
  – Explore
  – Compare
  – Download
  – Share
  – Educate

• Web browser-based and open source

https://earthdata.nasa.gov/worldview
https://github.com/nasa-gibs/worldview
• Passive (36 km) data processed into soil moisture 3-day global images centered on April 5 and 14, 2015
• Soil moisture patterns agree with expected geographical soil moisture distribution

• Soil moisture changes are evident in the time-sequence
• Rainfall in India, Bangladesh, and Vietnam
• Dry-down in eastern Australia and Argentina
• Regions where SMAP soil moisture retrievals are expected to meet L1 accuracy requirement of 0.04 m$^3$/m$^3$

• Retrieval expected quality mask (black colored pixels indicate good quality) with following specifications:
  a) Vegetation water content $\leq$ 5 kg/m$^2$
  b) Urban fraction $\leq$ 0.25
  c) Water fraction $\leq$ 0.1
  d) DEM slope standard deviation $\leq$ 3 deg
Value of Soil Moisture Data to Weather and Climate

New space-based soil moisture observations and data assimilation modeling can improve forecasts of local storms and seasonal climate anomalies.

Seasonal Climate Predictability

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.

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

(Schubert et al., 2002)

In weather forecasting, SMAP surface soil moisture, with x10 higher resolution than existing model estimates, will result in enhanced predictions.

Without Realistic Soil Moisture

With Realistic Soil Moisture

NWP Rainfall Prediction

24-Hours Ahead High-Resolution Atmospheric Model Forecasts

Observed Rainfall 0000Z to 0400Z 13/7/96 (Chen et al., 2001)
**Flood and Drought Applications**

**Current:** Empirical soil moisture indices based on rainfall and air temperature (by counties >40 km and climate divisions >55 km)

**Future:** SMAP soil moisture direct observations of soil moisture at 9 km
A Flood Example

Application of a SMAP-Based Index for Flood Forecasting in Data-Poor Regions

Current Capability: The UN-WFP uses satellite derived flood maps to locate floods and map delivery routes to affected areas.

Enhanced Capability: Use SMAP to expand their current flood database with look-up information that produces flood indices for a given rainfall forecast (ECMWF) and soil moisture condition (SMAP).

Study Area: Zambezi basin and its delta in Mozambique.

Algorithm Structure: VIC output on flow is input into a hydrodynamic model (LISFLOOD-FP), which is complemented with a sub-grid channel formulation to generate flood inundation variables (inundated area, floodplain water volume) for the lower Zambezi basin. ECMWF archived forecast rainfall data is used to compute flows for daily inundation patterns over 10 years.
Long-term variations in upstream rainfall and soil moisture column vs. floodplain inundation volume (top left panel) and downstream top layer soil moisture (top right panel). Upstream rainfall plus soil moisture 0.88 and rainfall only 0.49. Downstream top layer soil moisture 0.52. The map depicts long-term variations in floodplain inundation patterns from the LISFLOOD-FP flood model. Regression model results for predicting floodplain inundation volume are shown in the bottom left scatter plot.

These variables were used to regress and predict floodplain inundation volume for the February 2007 flood event, which was taken out when regressing. The regression model had a relative bias of 17%, with a relative error in predicting the 2007 event of 33%.

Courtesy of Guy Schumann, UCLA
Agricultural models have been developed to predict the yield of various crops at field and regional scales. One key input of the agricultural models is soil moisture. The conceptual diagram relates variation in regional domain-averaged soil moisture to variation in total crop yield. Statistical analysis would lead to the development of probability distributions of crop yield as a transformation of the probability distribution of domain averaged soil moisture at the beginning of the growing season.
Agricultural Crop Yield and Food Security Applications

• Water is the defining link between the climate and agriculture. To improve agricultural drought decision support systems and ensure food security, better quality and better use of soil moisture information is vital.

• This information will increase the lead time and skill of crop yield forecasts.

Corn yields with improved estimation and optimal forecasts based on the use of SMAP-like soil moisture estimates

- Statement of Problem: The world faces an uphill struggle in feeding a projected nine to ten billion people by 2050

Crop Simulation Model for Maize Yield Prediction. KSE-D-12-008/2R2: Remote Sensing of Environment, In Press

Courtesy of Narendra Das, JPL
A primary goal of NASA’s SMAP Mission is to engage applications end users and build broad support for SMAP applications through a transparent and inclusive process.

Toward that goal, the SMAP Mission:

1. Formed the SMAP Applications Working Group (200+ members)
2. Supports a SMAP Applications Coordinator
3. Developed the SMAP Applications Plan (right)
4. Developed the “Early-Adopter” program (50+ members)
5. Holds SMAP Applications Workshops at user agencies and institutions (e.g., NOAA, USDA, USGS)
6. Conducts hands-on tutorials and workshops

http://smap.jpl.nasa.gov/science/applications/
SMAP Applications Early Adopters


<table>
<thead>
<tr>
<th>Early Adopter PI and institution</th>
<th>Applied Research Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Weather and Climate Forecasting</strong></td>
<td></td>
</tr>
<tr>
<td>* Stephane Belair, Meteorological Research Division, Environment Canada (EC); SMAP Contact: Stephane Belair</td>
<td>Assimilation and impact evaluation of observations from the SMAP mission in Environment Canada’s Environmental Prediction Systems</td>
</tr>
<tr>
<td>* Lars Isaksen and Patricia de Rosnay, European Centre for Medium-Range Weather Forecasts (ECMWF); SMAP Contact: Eni Njoku</td>
<td>Monitoring SMAP soil moisture and brightness temperature at ECMWF</td>
</tr>
<tr>
<td>* Xiwu Zhan, Michael Ek, John Simko and Weizhong Zheng, NOAA National Centers for Environmental Prediction (NCEP), NOAA National Environmental Satellite Data and Information Service (NOAA-NESDIS); SMAP Contact: Randy Koster</td>
<td>Transition of NASA SMAP research products to NOAA operational numerical weather and seasonal climate predictions and research hydrological forecasts</td>
</tr>
<tr>
<td>* Michael Ek, Marounane Temimi, Xiwu Zhan and Weizhong Zheng, NOAA National Centers for Environmental Prediction (NCEP), NOAA National Environmental Satellite Data and Information Service (NOAA-NESDIS), City College of New York (CUNY); SMAP Contact: Chris Derksen</td>
<td>Integration of SMAP freeze/thaw product line into the NOAA NCEP weather forecast models</td>
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<td>* John Galantowicz, Atmospheric and Environmental Research, Inc. (AER); SMAP Contact: John Kimball</td>
<td>Use of SMAP-derived inundation and soil moisture estimates in the quantification of biogenic greenhouse gas emissions</td>
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<td>◊ Jonathan Case, Clay Blankenship and Bradley Zavadsky, NASA Short-term Prediction Research and Transition (SPoRT) Center; SMAP Contact: Molly Brown</td>
<td>Data assimilation of SMAP observations, and impact on weather forecasts in a coupled simulation environment</td>
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<td><strong>Droughts and Wildfires</strong></td>
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<td>* Jim Reardon and Gary Curcio, US Forest Service (USFS); SMAP Contact: Dara Entekhabi</td>
<td>The use of SMAP soil moisture data to assess the wildfire potential of organic soils on the North Carolina Coastal Plain</td>
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<td>* Chris Funk, Amy McNally and James Verdin, USGS &amp; UC Santa Barbara; SMAP Contact: Molly Brown</td>
<td>Incorporating soil moisture retrievals into the FEWS Land Data Assimilation System (FLDAS)</td>
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<td>◊ Brian Wardlow and Mark Svoboda, Center for Advanced Land Management Technologies (CALMIT), National Drought Mitigation Center (NDMC); SMAP Contact: Narendra Das</td>
<td>Evaluation of SMAP soil moisture products for operational drought monitoring; potential impact on the U.S. Drought Monitor (USDM)</td>
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<td>◊ Uma Shankar, The University of North Carolina at Chapel Hill – Institute for the Environment; SMAP Contact: Narendra Das</td>
<td>Enhancement of a Bottom-up Fire Emissions Inventory Using Earth Observations to Improve Air Quality, Land Management, and Public Health Decision Support</td>
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<tr>
<td><strong>Floods and Landslides</strong></td>
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<tr>
<td>* Fiona Shaw, Willis, Global Analytics; SMAP Contact: Robert Gurney</td>
<td>A risk identification and analysis system for insurance; eQUIP suite of custom catastrophe models, risk rating tools and risk indices for insurance and reinsurance purposes</td>
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Applications Early Adopters Video

Soil Moisture Active Passive

SMAP Early Adopters video

This diverse group represents a cross-section of end-users of SMAP data who collaborate to ensure integration of SMAP data into operations that affect our day-to-day lives. Examples include the U.S. Forest Service, the UN World Food Programme, and the U.S. Department of Agriculture.

VTT files: English (VTT, 18 KB) | Italian (VTT, 18 KB) | Spanish (VTT, 19 KB)

Early Adopters

http://smap.jpl.nasa.gov/applications/
## SMAP Documents

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