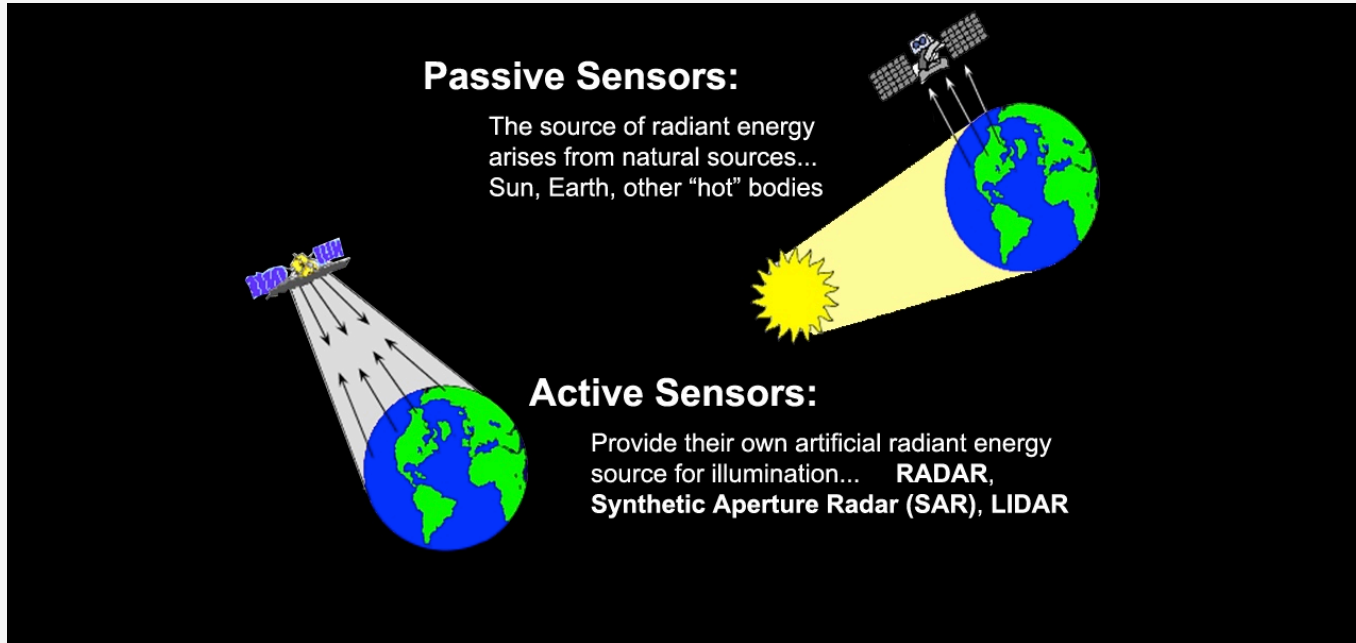


Description of the Instruments and Algorithm Approach

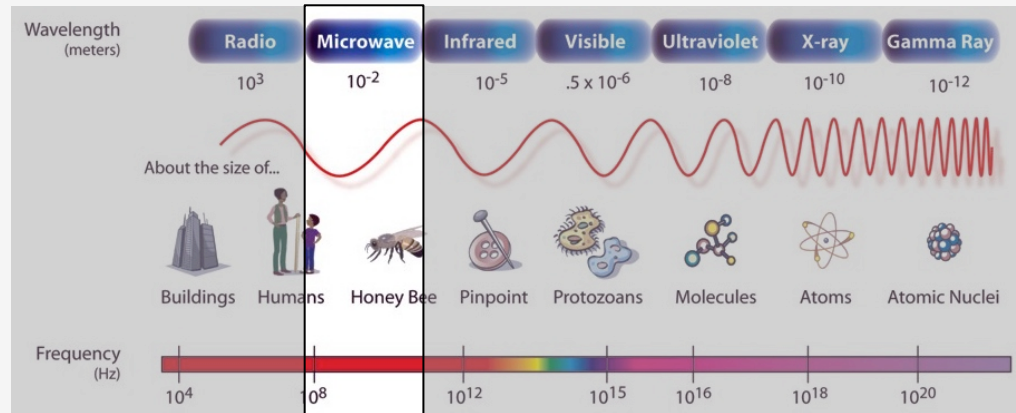
Passive and Active Remote Sensing

SMAP uses active and passive sensors to measure soil moisture



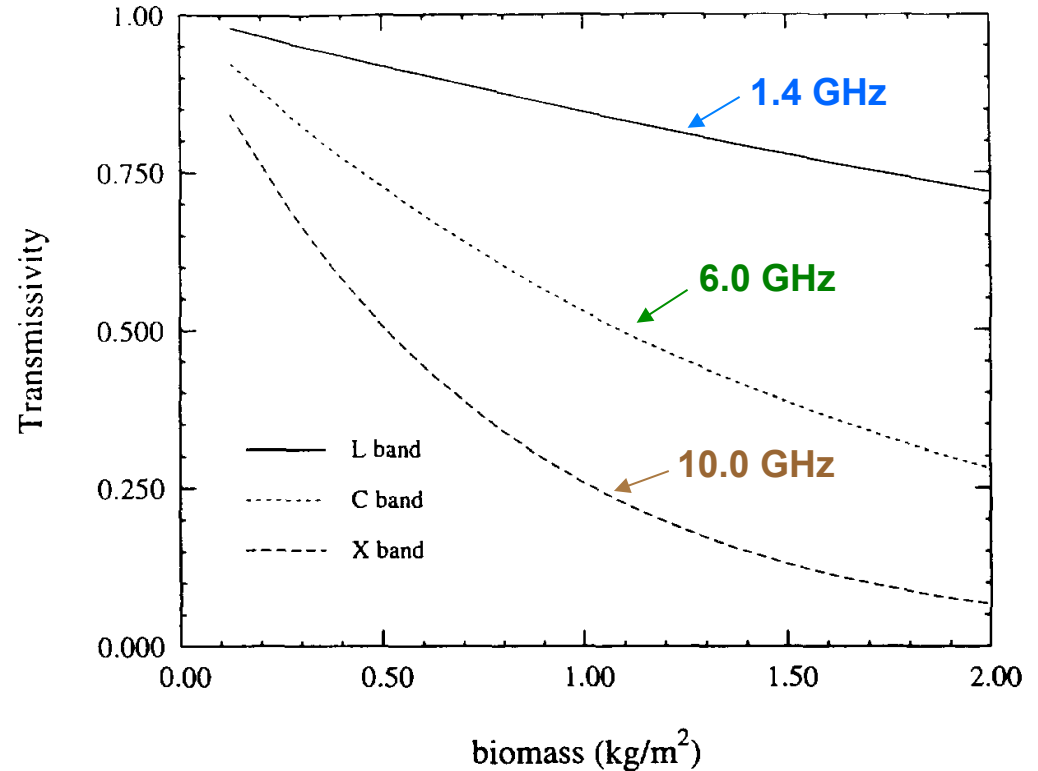
Microwave Remote Sensing

- With Visible and Infrared sensors the soil is masked by clouds and vegetation. 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.



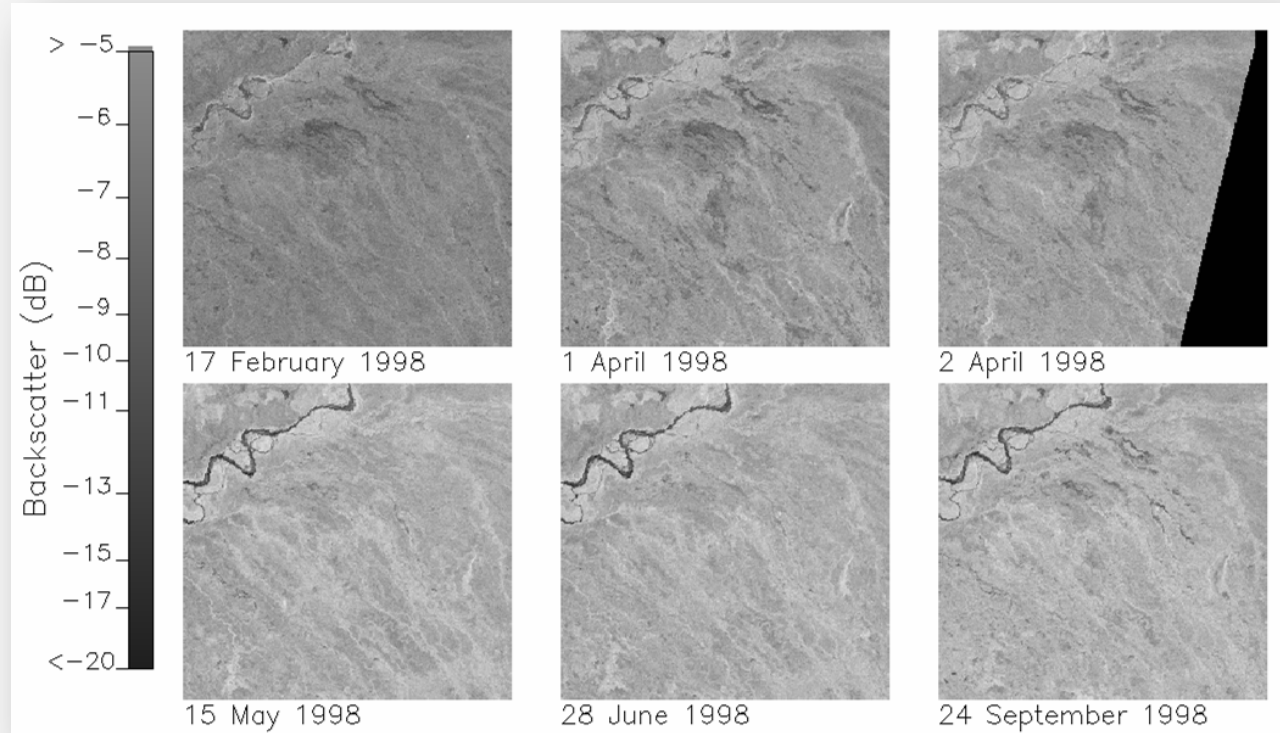
Advantages of L-Band

Vegetation attenuation increases as frequency increases

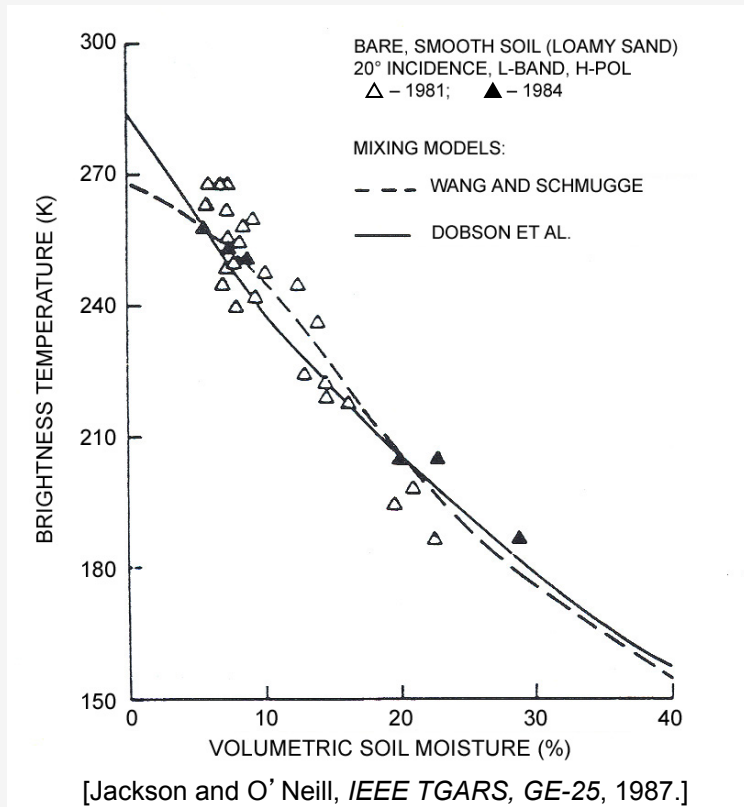


Land Surface Dielectric: Surface Freeze/Thaw State

As the land surface transitions from frozen to thawed, there is a large change in dielectric producing a notable increase in radar backscatter, on the order of 3 dB.



Relation Between Brightness Temperature and Soil Moisture

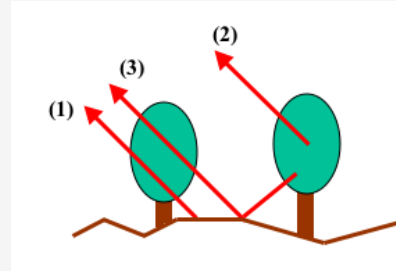


Measurement Approach

- p = H, V (radiometer) y pq = VV, HH, HV (radar)
- Contributions from the: soil, vegetation, and soil-vegetation interaction
- Soil moisture is the dominant contributor to the signal
- Soil moisture measurements are corrected for the effects of vegetation, surface roughness and temperature

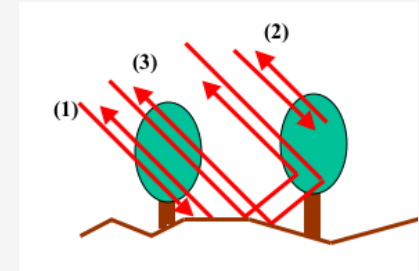
Emission

$$T_{Bp}^t = T_{Bp}^s L_p + T_{Bp}^v + T_{Bp}^{sv}$$



Backscatter

$$\sigma_{pq}^t = \sigma_{pq}^s L_{pq}^2 + \sigma_{pq}^v + \sigma_{pq}^{sv}$$

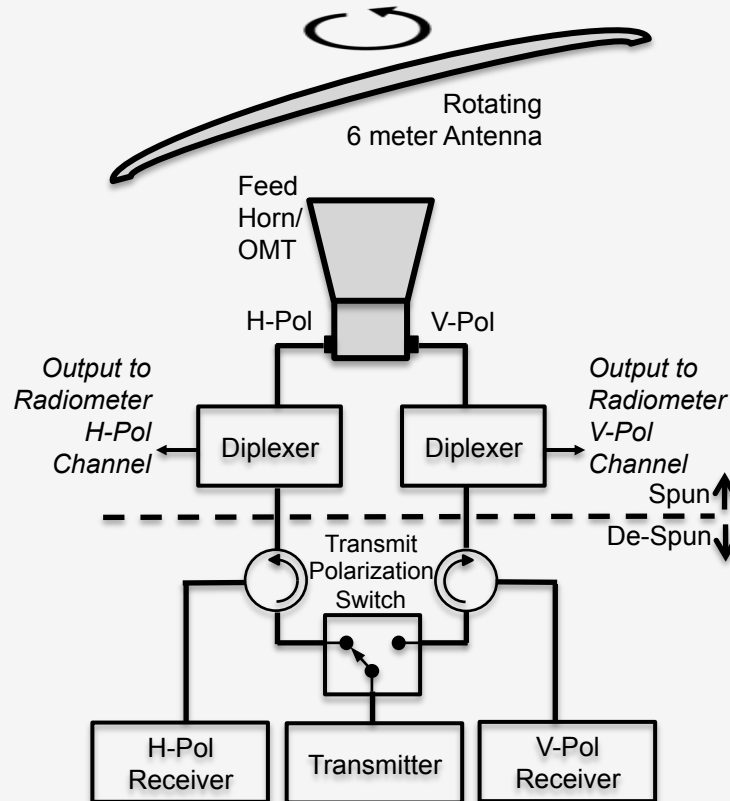



Ancillary Data Sources

Ancillary data are used to estimate the key unknown parameters: surface temperature (\approx surface air temp. at 6 am), vegetation opacity, surface roughness and soil texture

Parameter	Description/Sources
Surface air meteorology	<ul style="list-style-type: none">- Data assimilation (GEOS/DAO)- Forecast models (NCEP and ECMWF)
Vegetation opacity	<ul style="list-style-type: none">- Vis/IR satellite-derived NDVI, LAI, landcover (MODIS, IGBP-DIS)- Historical phenology (AVHRR)
Surface topography	<ul style="list-style-type: none">- Digital elevation models (USGS and SRTM)
Soil texture	<ul style="list-style-type: none">- Soils databases (Global, NGDC; US, STATSGO)
Land/water boundaries	<ul style="list-style-type: none">- Coastal boundaries and inland water bodies (NGDC)

Radar and Radiometer Operation



A 3D rendering of the Soil Moisture Active Passive (SMAP) satellite in orbit above Earth. The satellite is a complex structure with a large, circular, green-tinted antenna dish at the top, supported by a white framework. Below the dish is a smaller, yellow-colored instrument package. The satellite is positioned in the upper left, with a wide, white, conical beam of radiation extending downwards towards the Earth's surface. The Earth is shown in the lower half of the image, with a curved horizon. The visible portion of the Earth includes green landmasses, blue oceans, and white cloud cover. A specific area of land in the lower right is highlighted with a false-color map overlay, showing yellow and green patches. The background is the deep black of space, filled with numerous small, distant stars.

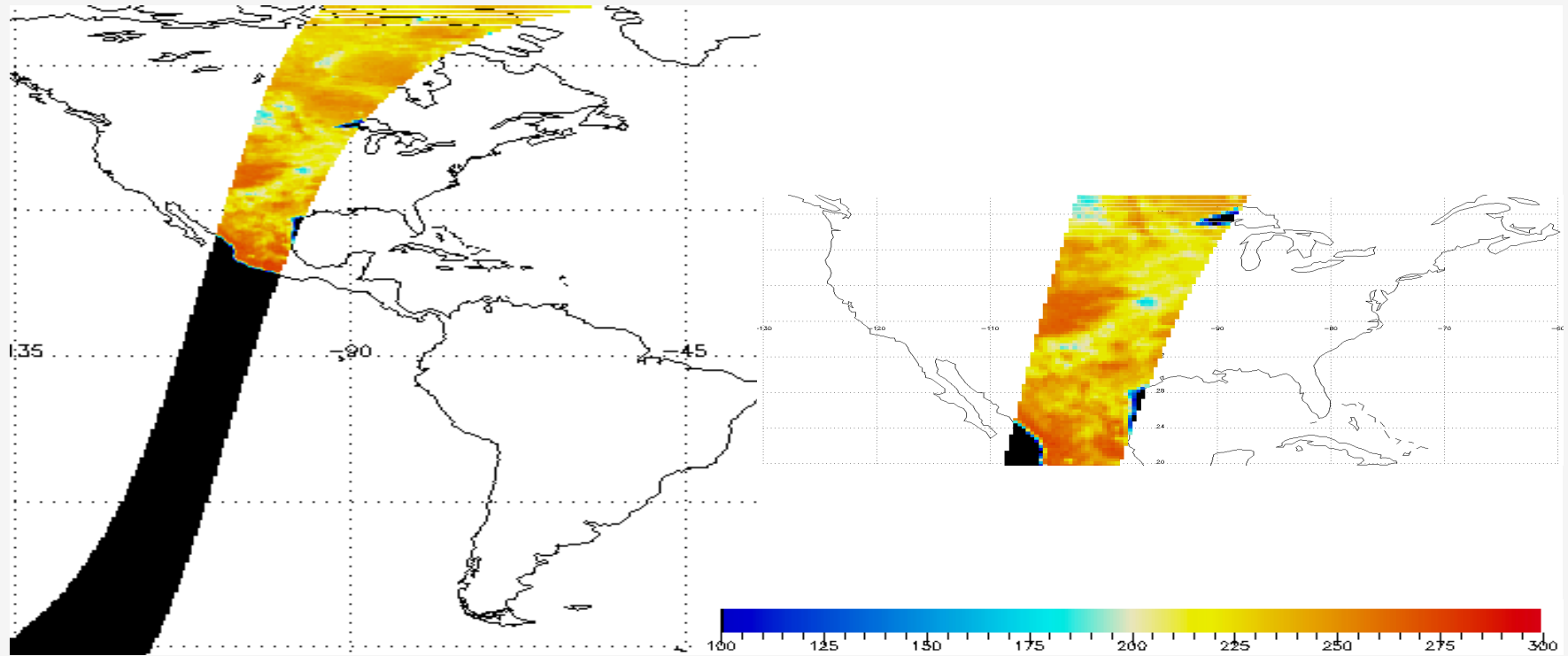
SMAP Products

Data Product Short Name	Description	Grid Resolution	Granule Extent
L1A_Radar	Parsed Radar Instrument Telemetry		Half Orbit
L1A_Radiometer	Parsed Radiometer Instrument Telemetry		Half Orbit
L1B_S0_LoRes	Low Resolution Radar σ_o in Time Order	5x30 km (10 slices)	Half Orbit
L1C_S0_HiRes	High Resolution Radar σ_o on Swath Grid	1 km	Half Orbit
L1B_TB	Radiometer T_B in Time Order	39x47 km	Half Orbit
L1C_TB	Radiometer T_B	36 km	Half Orbit
L2_SM_A	Radar Soil Moisture (includes Freeze-Thaw)	3 km	Half Orbit
L2_SM_P	Radiometer Soil Moisture	36 km	Half Orbit
L2_SM_AP	Active-Passive Soil Moisture	9 km	Half Orbit
L3_FT_A	Daily Global Composite Freeze/Thaw State	3 km	North of 45° N
L3_SM_A	Daily Global Composite Radar Soil Moisture	3 km	Global
L3_SM_P	Daily Global Composite Radiometer Soil Moisture	36 km	Global
L3_SM_AP	Daily Global Composite Active-Passive Soil Moisture	9 km	Global
L4_SM	Surface & Root Zone Soil Moisture	9 km	Global
L4_C	Carbon Net Ecosystem Exchange	9 km	North of 45° N

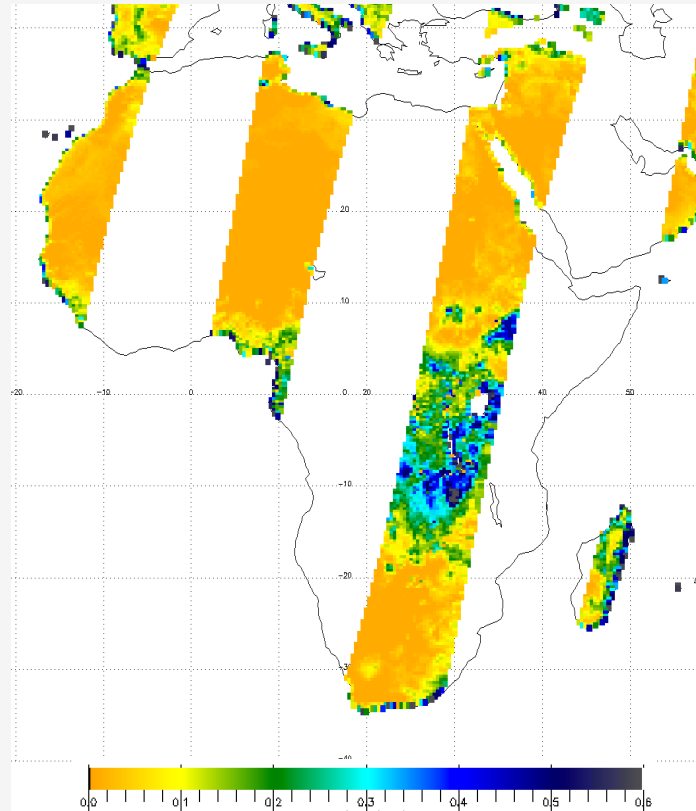
Data Product Design

- **All products are in HDF5 format**
 - Each SMAP HDF5 file contains the primary data parameters (e.g., soil moisture, freeze/thaw, sensor data) and all data used in the production of those primary parameters. These files also include metadata, geolocation information, quality flags, etc.
- **Projection: EASE-Grid 2.0**
 - Equal-area projection
 - Level 2, 3, 4, and radiometer L1C are in this projection
- **Values**
 - Radiometer data (brightness temperature) is in Kelvin
 - Radar data is in sigma naught
 - Soil moisture is a volumetric measurement expressed as cm^3/cm^3
 - Freeze/thaw is a binary measurement, either frozen or thawed
 - Net ecosystem exchange is in grams of carbon/square meter per day

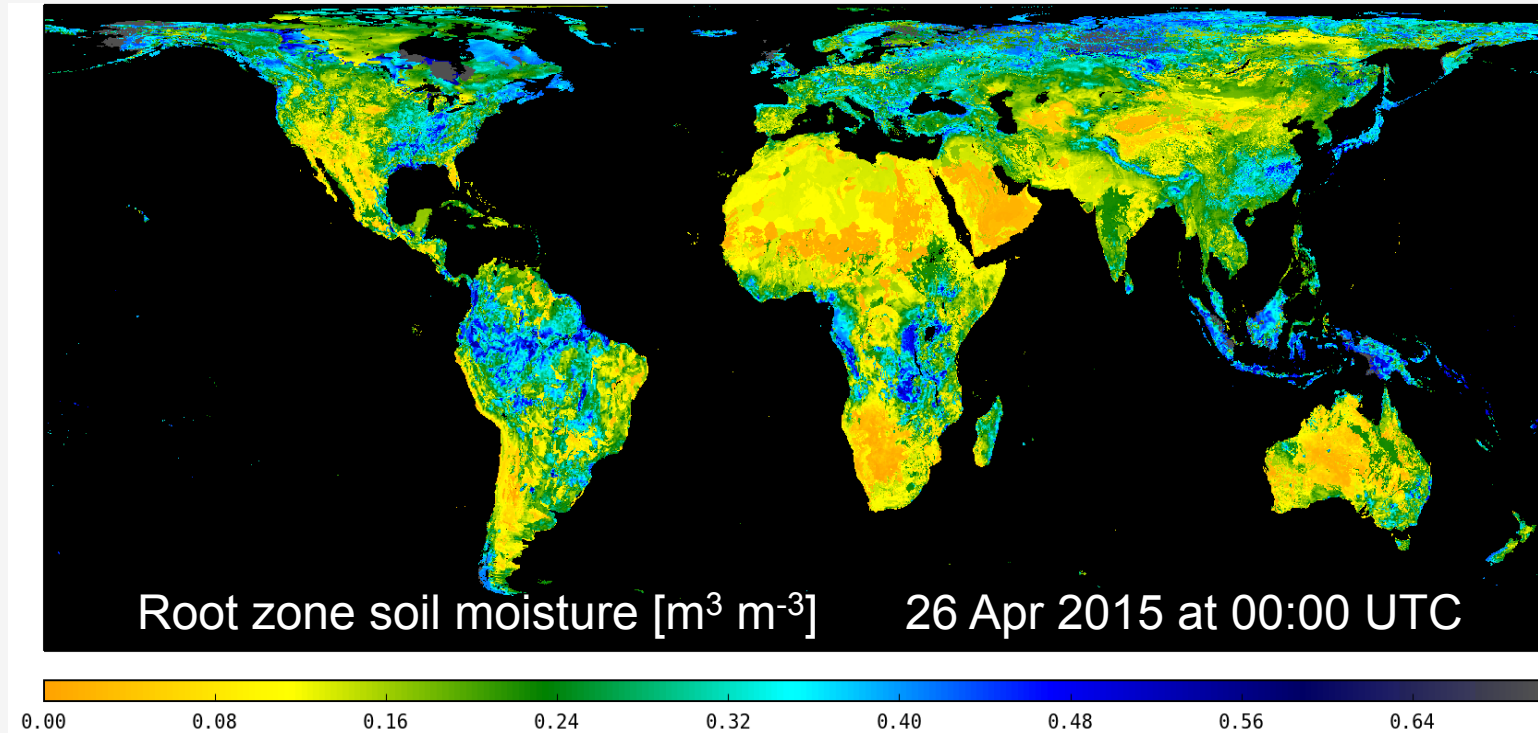
Radiometer Data – Level 1C



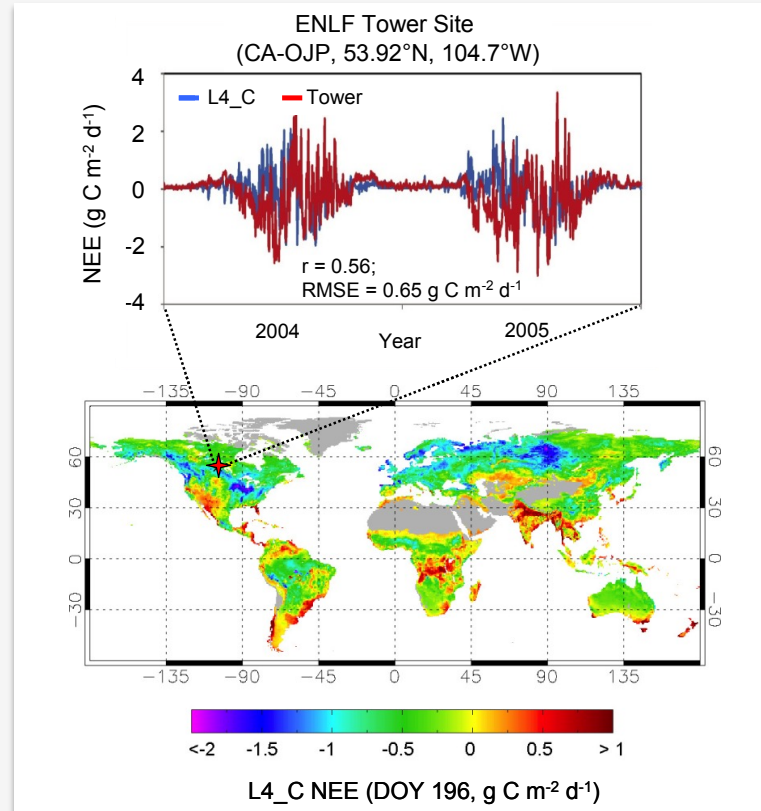
Soil Moisture Derived from the Radiometer- Level 3



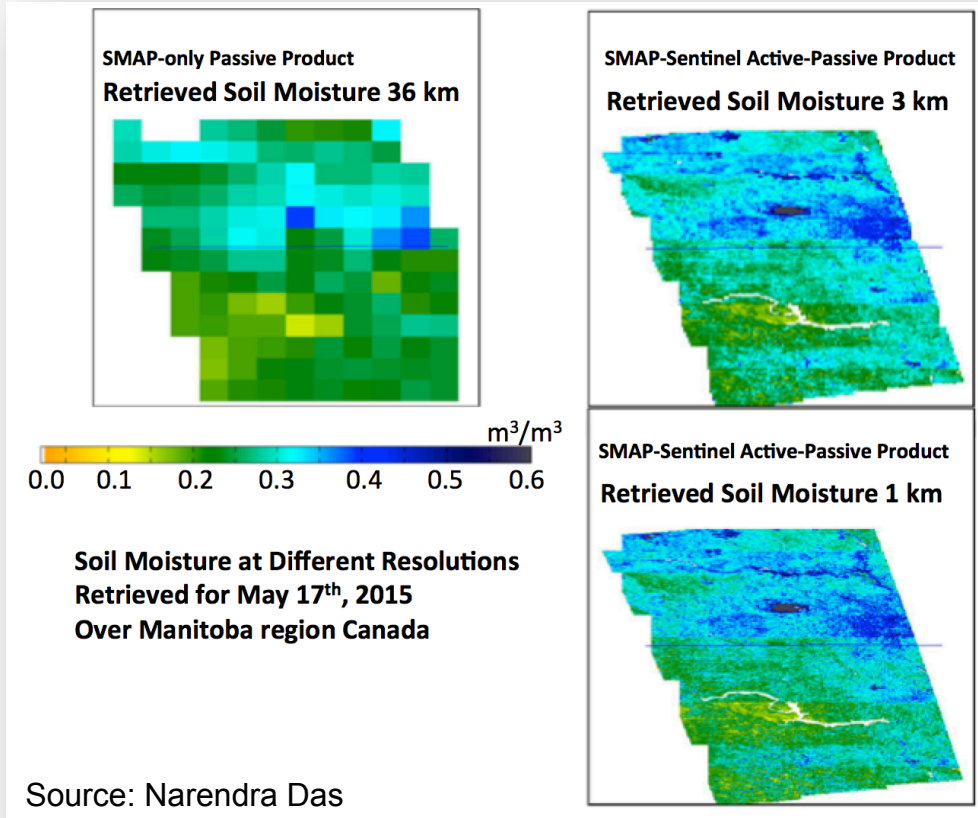
Surface and Root Zone Soil Moisture- Level 4



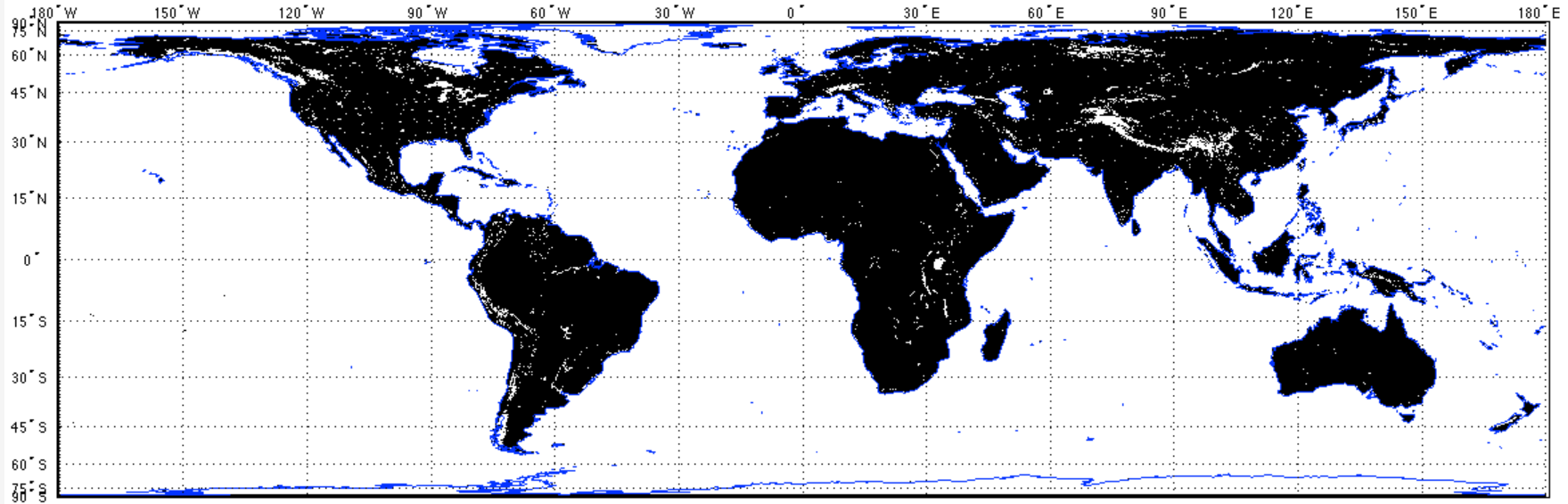
Net Ecosystem Carbon Exchange- Level 4



SMAP Enhanced Active-Passive Product Using Sentinel



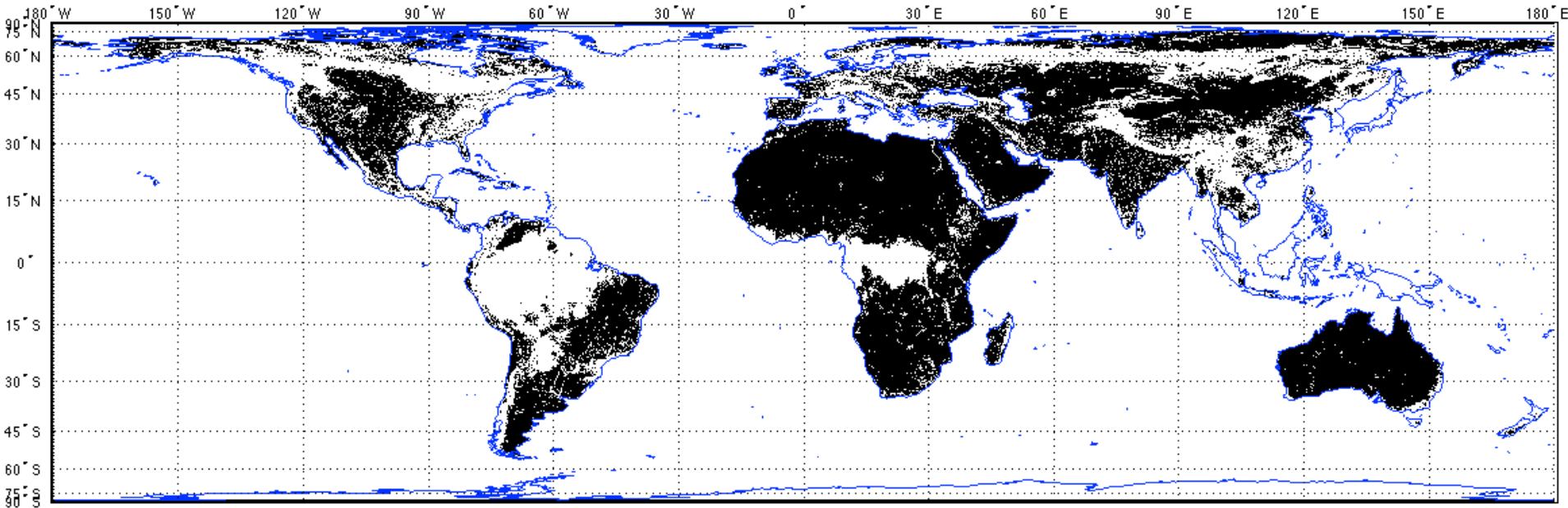
Soil Moisture Retrieval Map



Retrievable Mask (Black Colored Pixels) Prepared with Following Specifications:

- a) Urban Fraction < 1
- b) Water Fraction < 0.5
- c) DEM Slope Standard Deviation < 5 deg

Soil Moisture Expected Accuracy

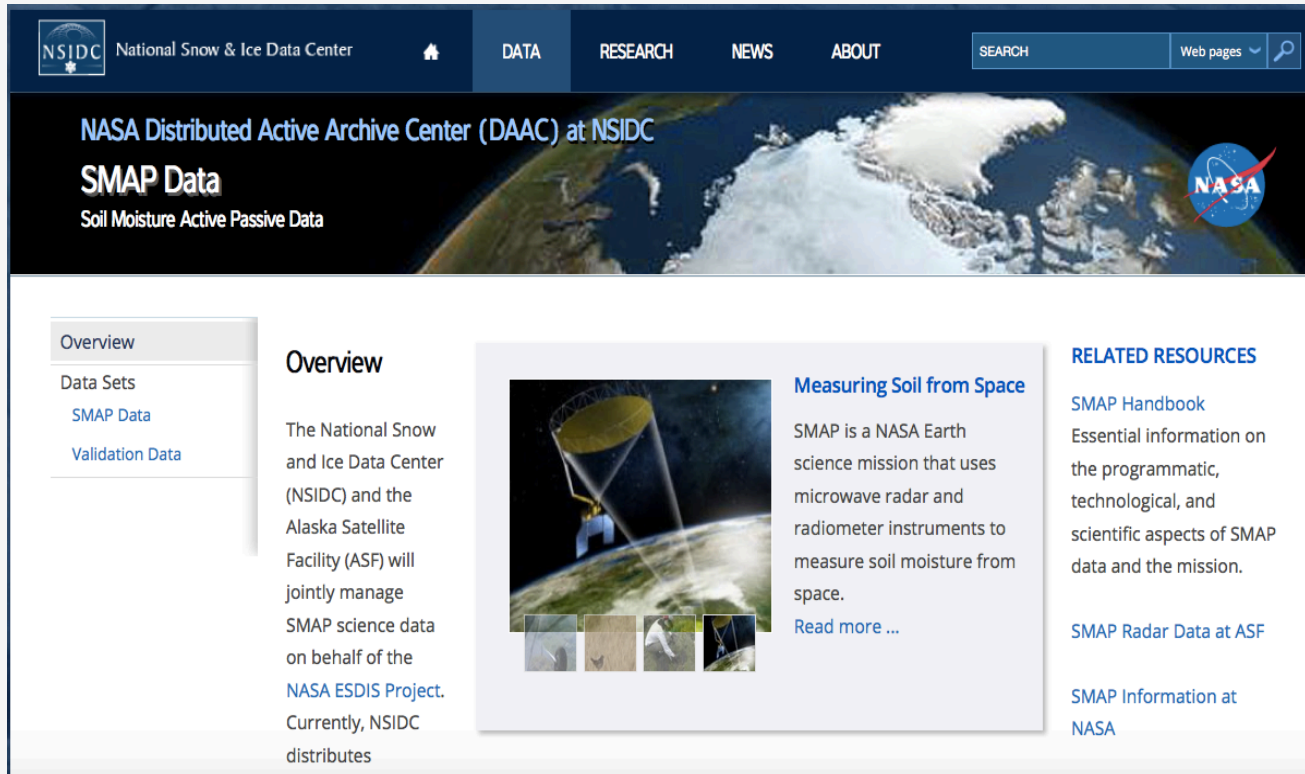


Retrieval expected quality mask (black colored pixels indicate good quality) with following specifications:

- a) Vegetation water content $\leq 5 \text{ kg/m}^2$; b) Urban fraction ≤ 0.25
- c) Water fraction ≤ 0.1 ; d) DEM slope standard deviation $\leq 3 \text{ deg}$

Access to SMAP Data: NSIDC

<http://nsidc.org/data/smap/>



The screenshot shows the NSIDC website's header with navigation links for DATA, RESEARCH, NEWS, and ABOUT. A search bar and a 'Web pages' dropdown are also present. The main banner features a satellite image of Earth with the text 'NASA Distributed Active Archive Center (DAAC) at NSIDC' and 'SMAP Data: Soil Moisture Active Passive Data'. A NASA logo is in the top right of the banner. On the left, a sidebar menu lists 'Overview', 'Data Sets', 'SMAP Data', and 'Validation Data'. The 'Overview' section contains text about the joint management of SMAP data by NSIDC and ASF for the NASA ESDIS Project. A central image shows the SMAP satellite in orbit, with a 'Measuring Soil from Space' text box and a 'Read more ...' link. On the right, a 'RELATED RESOURCES' section lists links to the SMAP Handbook, SMAP Radar Data at ASF, and SMAP Information at NASA.

NSIDC National Snow & Ice Data Center

DATA RESEARCH NEWS ABOUT

SEARCH Web pages

NASA Distributed Active Archive Center (DAAC) at NSIDC

SMAP Data

Soil Moisture Active Passive Data

Overview

Data Sets

[SMAP Data](#)

[Validation Data](#)

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](#)

Access to SMAP Data: ASF

<https://www.asf.alaska.edu/smap>

Sentinel-1

SMAP

About SMAP

Science

Instrument

Applications

Data & Imagery

Documents & Tools

How to Cite

News & Media

Seasat

Wetlands MEaSUREs

Sea Ice MEaSUREs

Terrestrial Ecology

InSAR

ALOS-1 PALSAR

RADARSAT-1

ERS-1

ERS-2


JERS-1

UAVSAR

AirMOSS


AIRSAR


SMAP




SMAP
Soil Moisture Active Passive

Mapping soil moisture and freeze/thaw state from space

 **Data & Imagery**


 **Global Significance**

 **Documents & Tools**

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).

[Read more...](#)

News: NASA Soil Moisture Radar Ends Operations; Mission Science Continues
News: NASA Focused on Sentinel as Replacement for SMAP Radar



"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

