National Aeronautics and Space Administration

ARSET

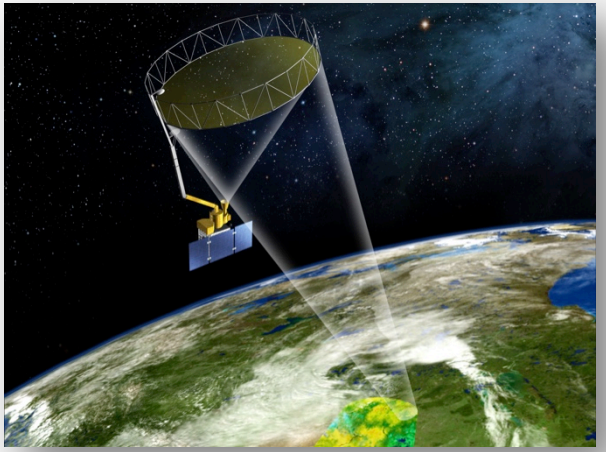
Applied Remote Sensing Training

http://arset.gsfc.nasa.gov

@NASAARSET

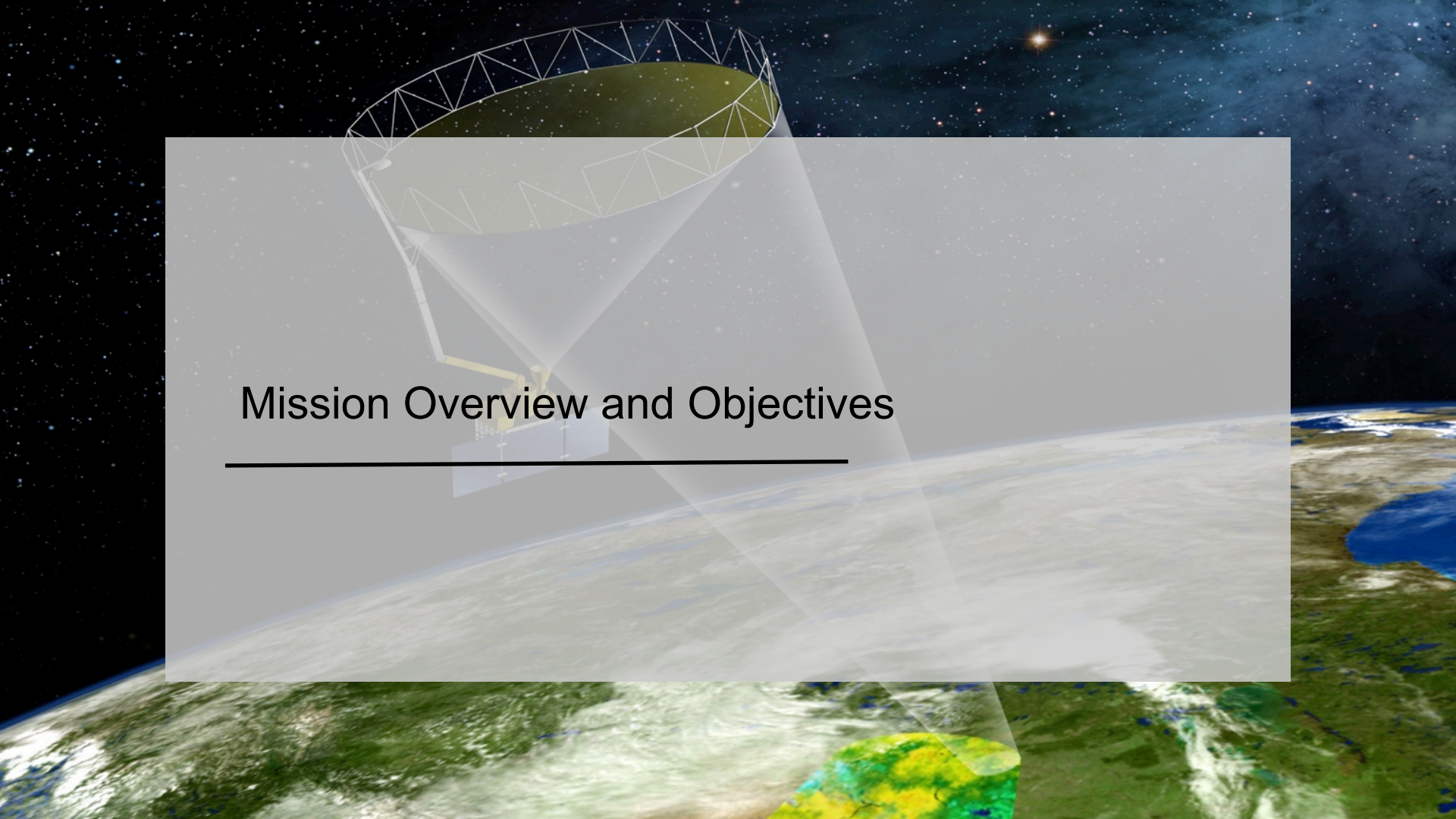
Introduction to SMAP

Jul. 20, 2016



Outline

1. Mission objectives
2. Instruments and algorithm approach
3. Products
4. Calibration and Validation
5. Applications



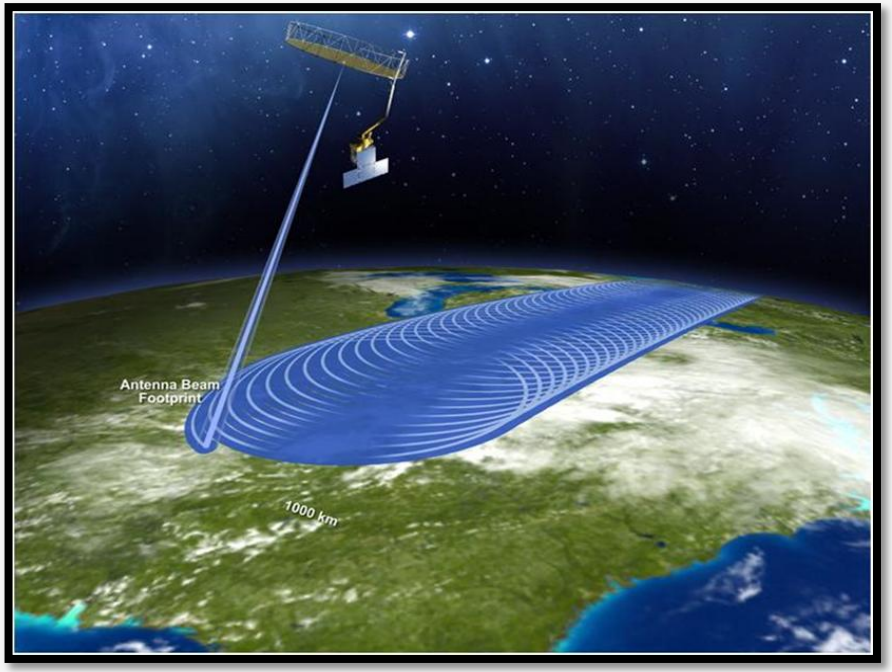
Mission Overview and Objectives

NASA Satellite Fleet

Fuente: NASA Goddard Visualization Lab

SMAP Overview

Instruments



Launched on Jan. 31, 2015

Radar (no longer working)

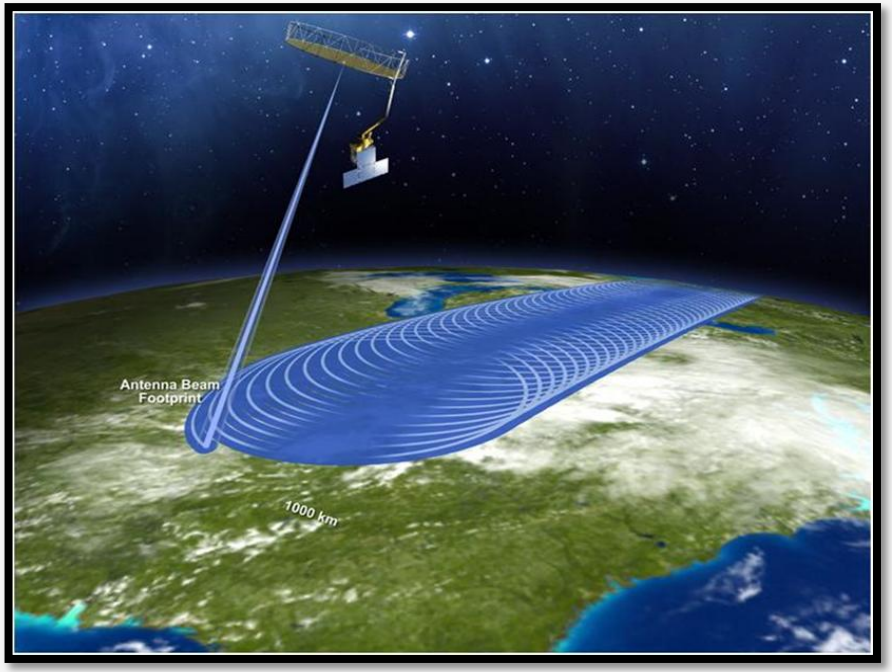
- Frequency: 1.26 GHz
- Polarization: VV, HH, HV
- Resolution: 3km
- Relative Accuracy: 1.0 dB (HH and VV), 1.5 dB (HV)

Radiometer

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

SMAP Overview

Instruments



Lanzamiento: 31 de enero del 2015

Shared Antenna

- 6m diameter
- Conical scanning at 14.6 r.p.m.
- Constant incidence angle: 40 degrees
- Swath 1000km – wide
- Swath and orbit allow global coverage every 2-3 days

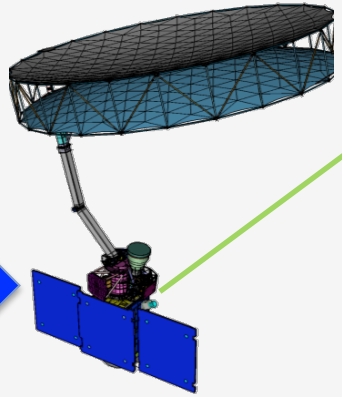
Orbit

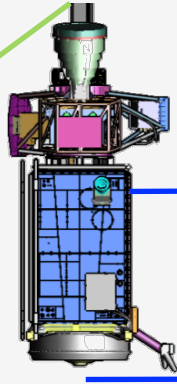
- Sun synchronous, 6 am/pm orbit
- **685km** altitude

Mission Duration: 3 years

Mission Design

Delta II 7320-10C



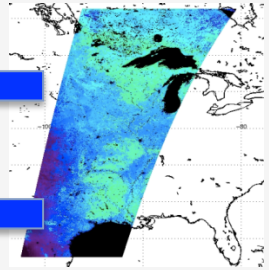


Communication Network

Data Validation

Control Center and Data Processing (JPL/GSFC)

Scientific Products

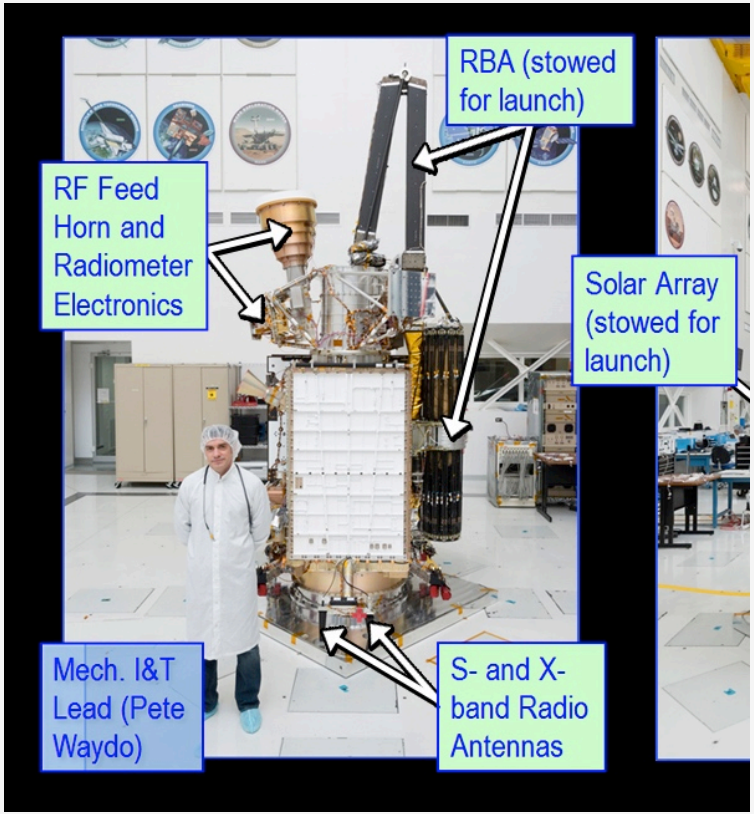


Soil Moisture and Freeze/ Thaw Products

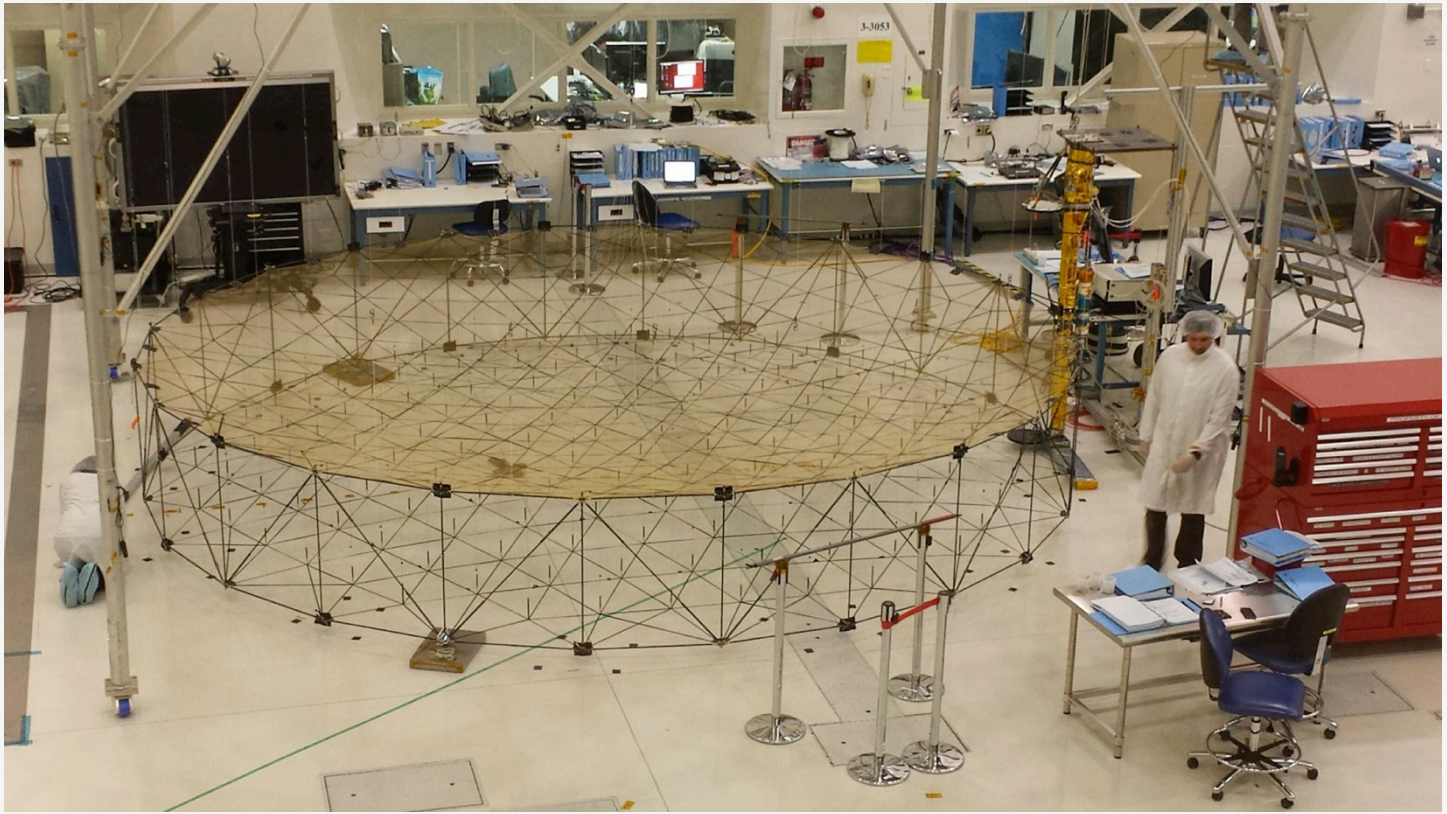
Alaska Satellite Facility Data Center (Radar products – L1)

NSIDC (all other products

SMAP

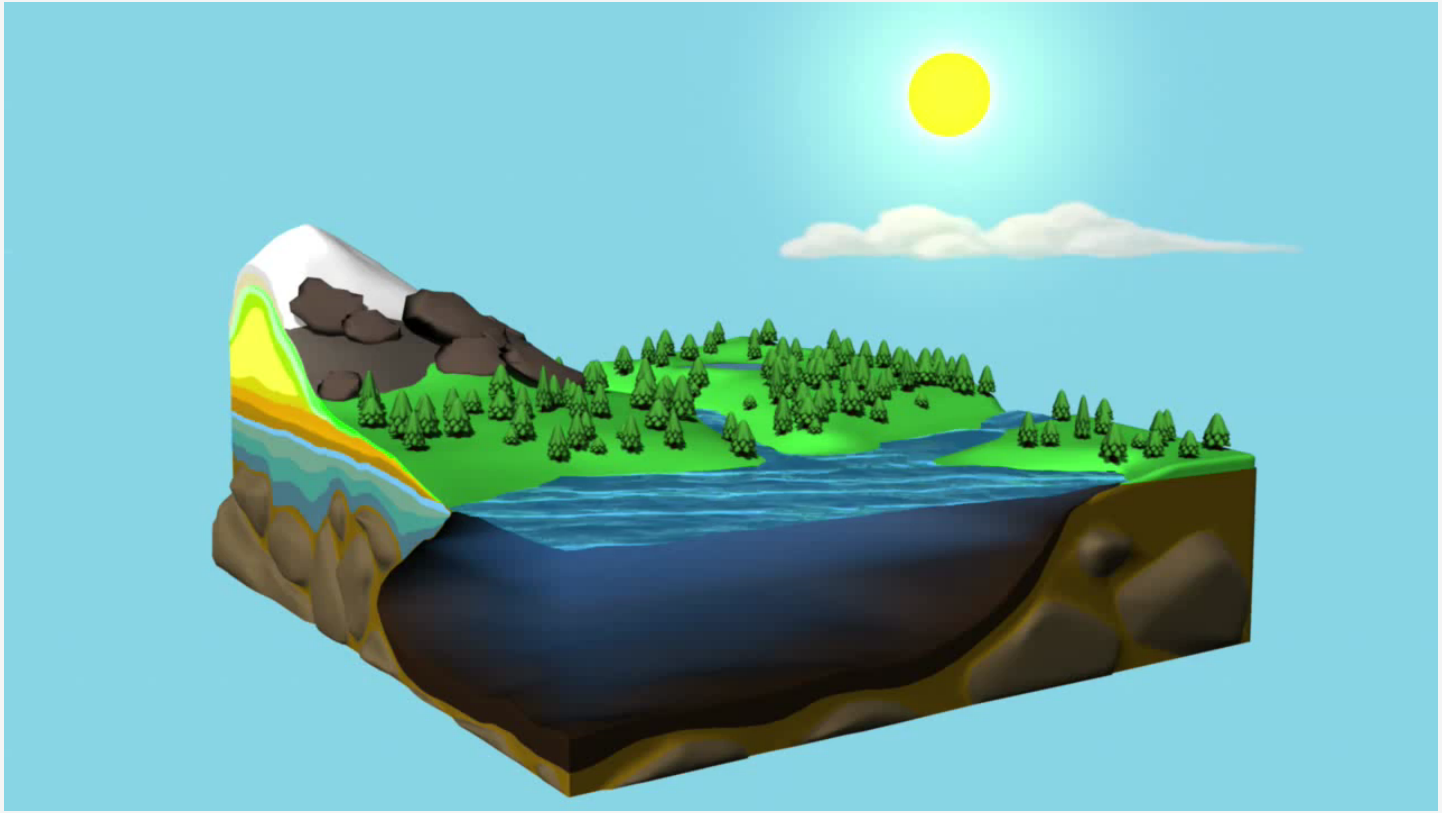

RBA (stowed for launch)
RF Feed Horn and Radiometer Electronics
Solar Array (stowed for launch)
Mech. I&T Lead (Pete Waydo)
S- and X-band Radio Antennas

SMAP Antenna

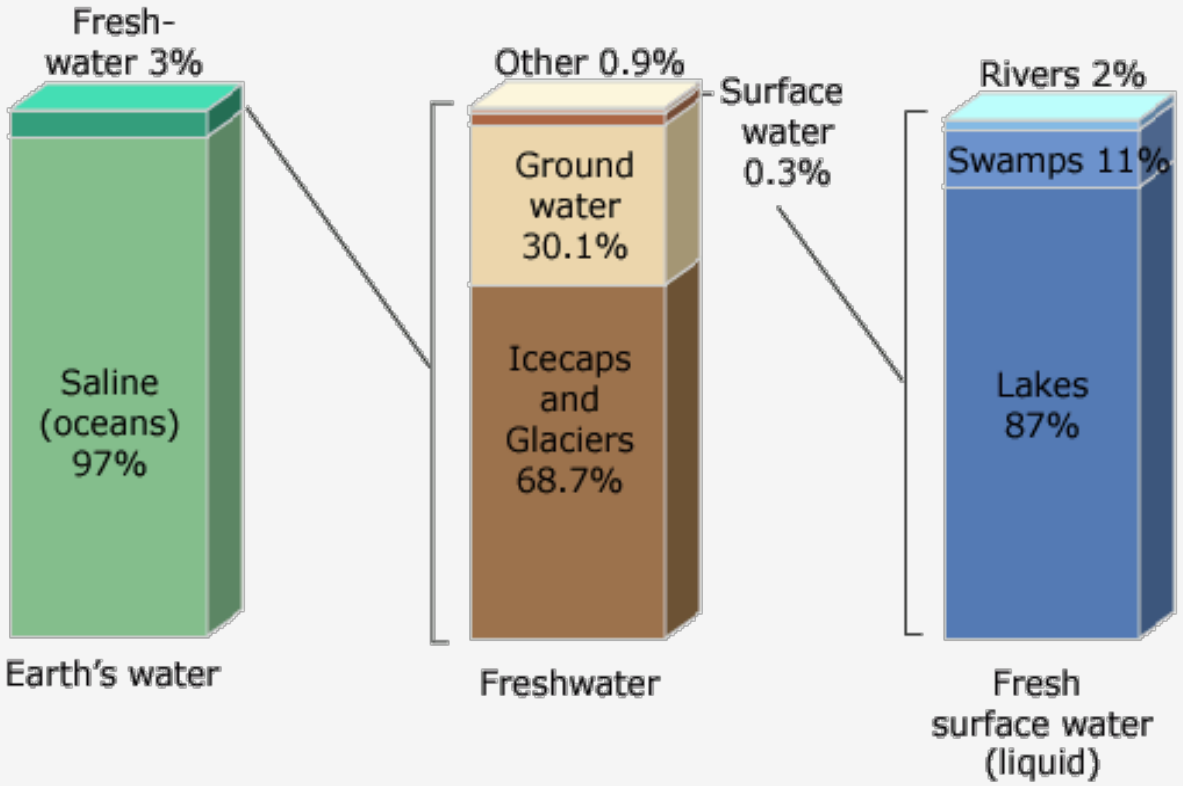


Why SMAP

The Water Cycle

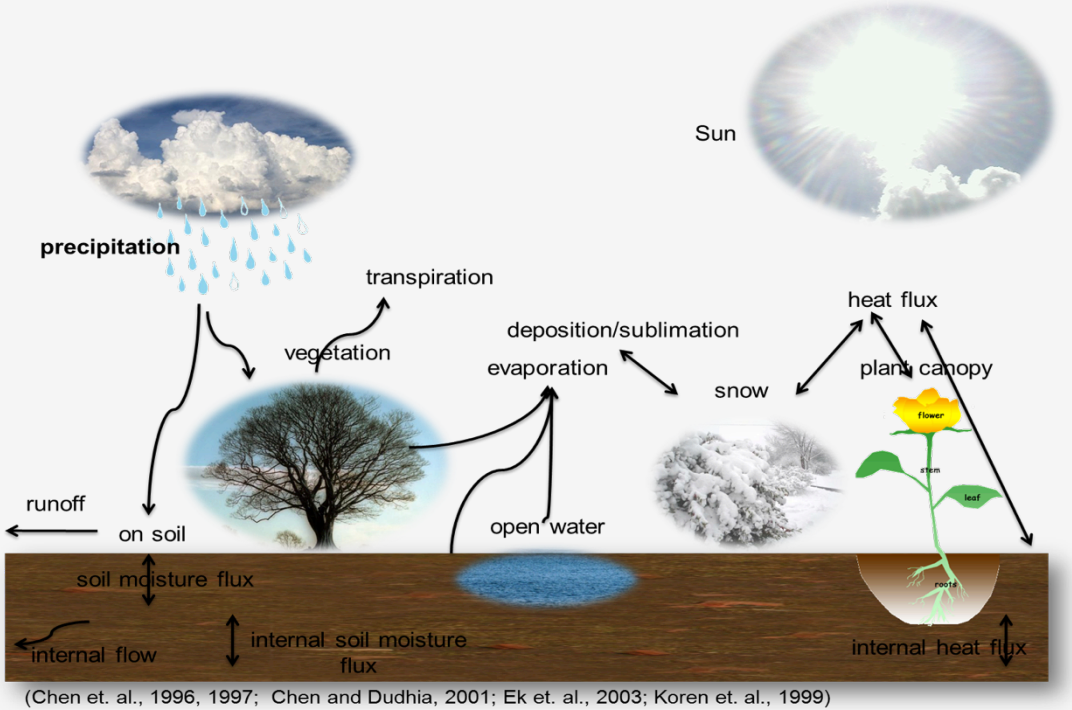


Water Distribution on Earth



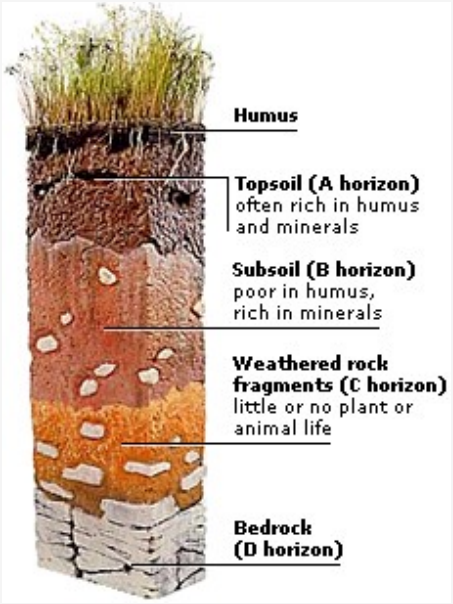
The Importance of Soil Moisture

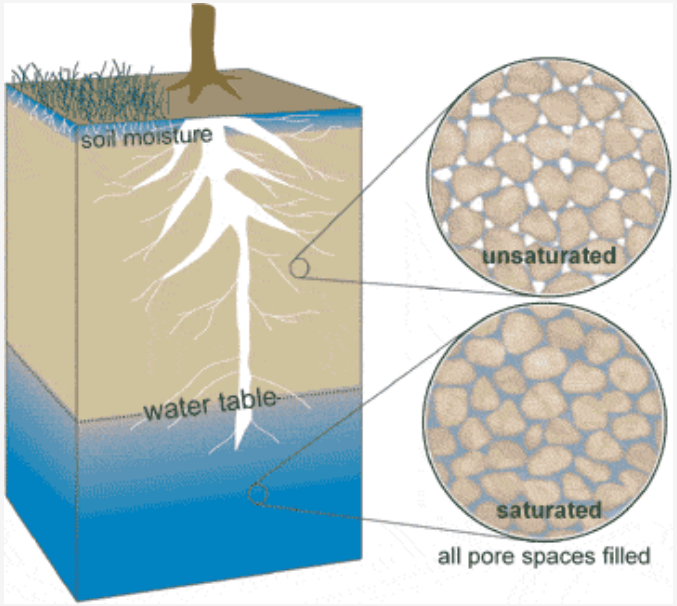
For each kilogram of water on earth, only one milligram is stored as soil moisture. Yet this miniscule amount of water exerts *significant* control over various hydrological, ecological and meteorological processes.



(Chen et. al., 1996, 1997; Chen and Dudhia, 2001; Ek et. al., 2003; Koren et. al., 1999)

Soil Profile





Factors Influencing Soil Moisture

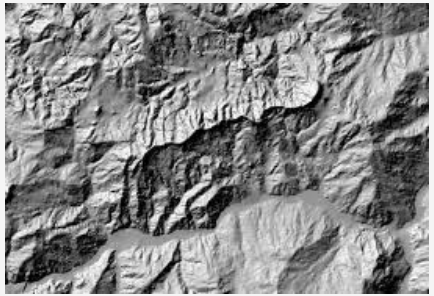
Soil Moisture varies with space and time.
Primary factors that influence distribution of soil moisture:

Rainfall

Soil Texture

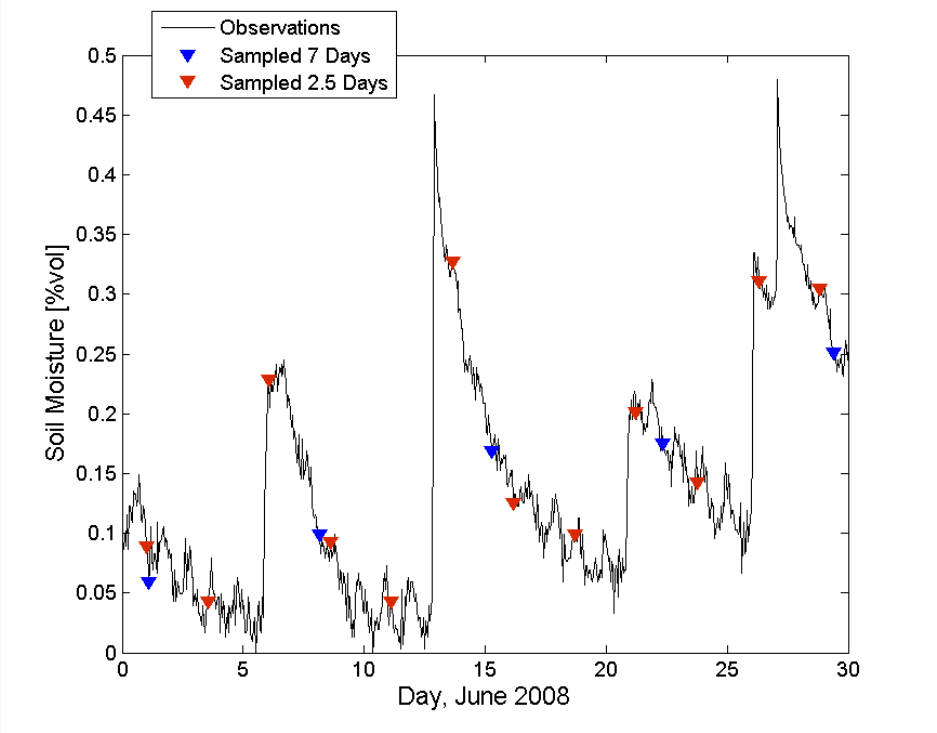
Vegetation

Topography



Justification for Observations Every 3 Days

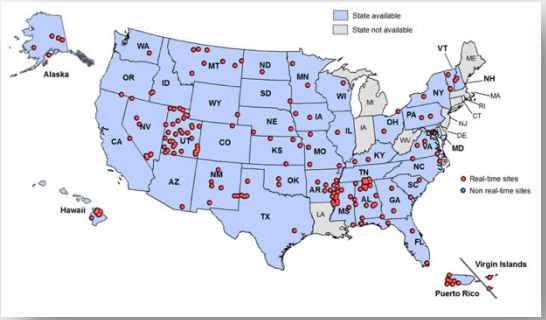
- Observations are needed every 3 days or less to optimally determine the variability in soil moisture.



Primary Objectives of SMAP

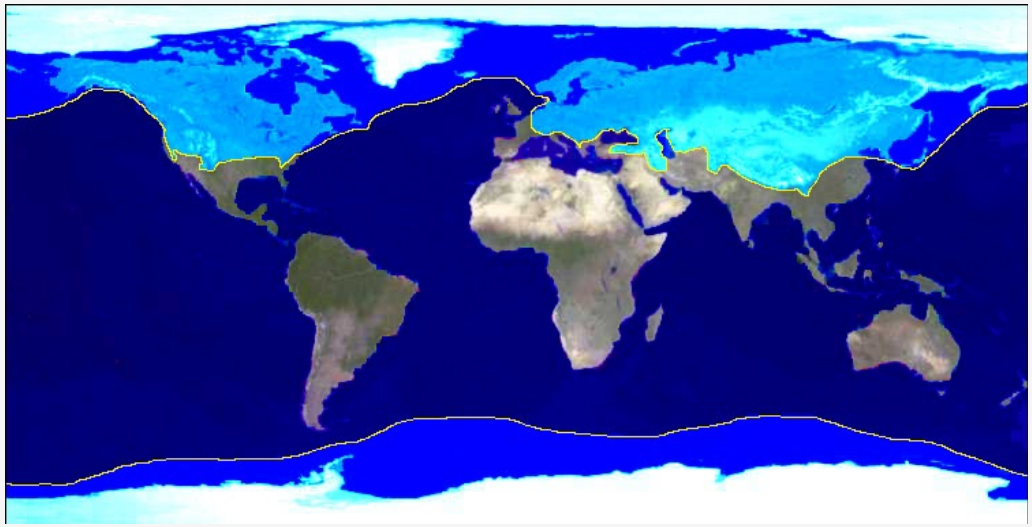
Soil Moisture and Freeze/Thaw State

- Limitations in measuring soil moisture:
  - In situ measurements of soil moisture are few and far between.

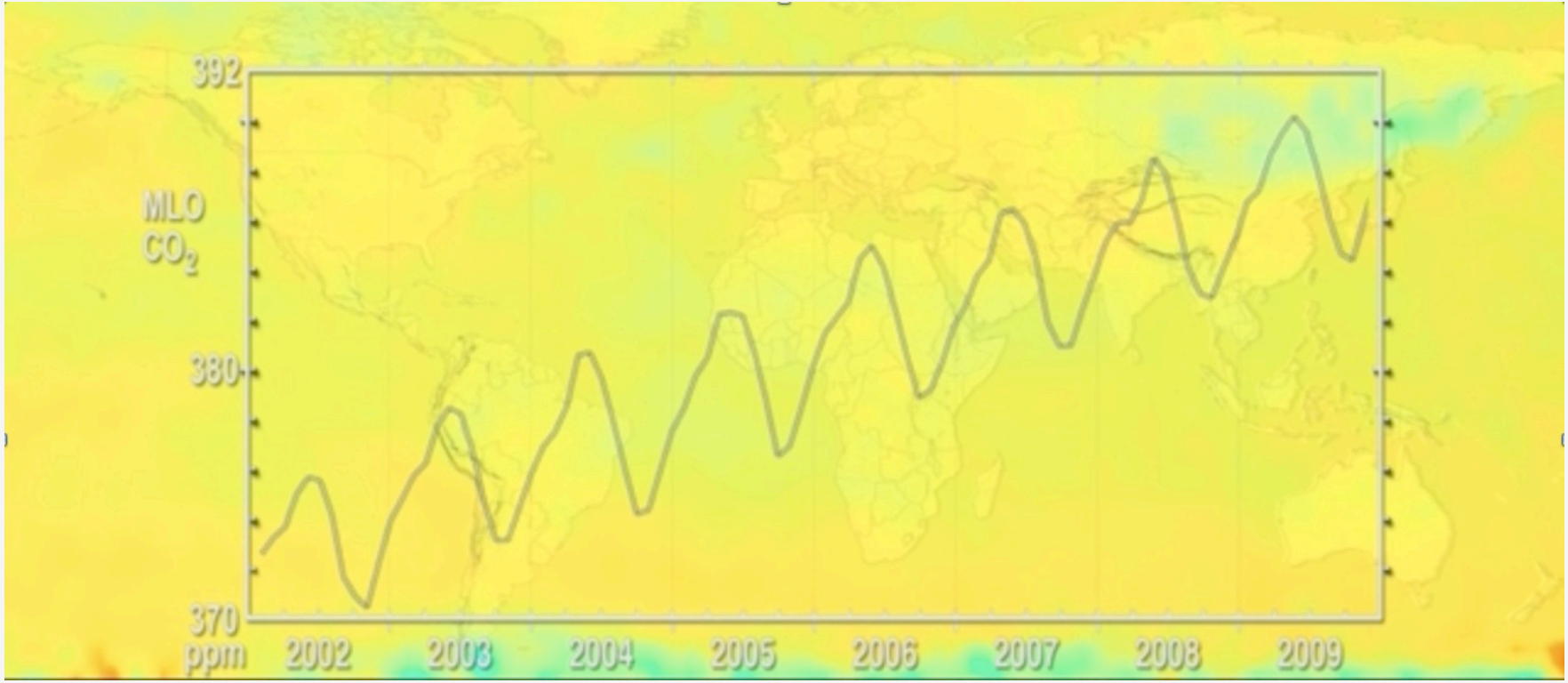


- SMAP supported science and applications
  - Understand processes that link the terrestrial energy, water, and carbon cycles
  - Estimate global water and energy terrestrial fluxes
  - Quantify net carbon fluxes in the northern high latitudes

Importance in Knowing the Freeze/Thaw State of the Land Surface



Average Global Atmospheric CO2 Concentrations



SMAP Requirements

Requirement	Soil Moisture	Freeze/ Thaw
Resolution	~~X~~ and 36 km	~~X~~ km
Refresh Rate	3 days	2 days(1)
Accuracy	0.04 [cm^3/cm^3] (2)	80% (3)
Duration	36 months	

(1) North of 45°N Latitude
(2) % volumetric water content, 1-sigma
(3) % classification accuracy (binary: Freeze or Thaw)

SMAP Requirements

Product Short Name	Description	Resolution
L3_FT_HiRES	Global daily mosaic of surface freeze/ thaw state	1-3 km
L3_SM_P	Global daily mosaic of soil moisture– radiometer	36 km
L3_SM_AP	Global daily mosaic of soil moisture– radar and radiometer	9 km
L4_SM	Surface and root zone soil moisture	9 km
L4_C	Net carbon exchange	9 km

SMAP Status

- Loss of the SMAP Radar
  - On July 7 2015 the SMAP radar suddenly stopped operating (after having collected data for 2.5 months)
  - A team was formed to determine the cause
  - The high power amplifier was identified as the cause
  - Efforts were made to configure the system in different ways with no success
- Implications for SMAP
  - Surface freeze/thaw state product at 3 km will not be produced
  - Soil moisture products at 9 km will not be produced

Soil Moisture Products from Different Satellites

- SMAP - L-Band, 40 km, observations every 3 days

https://nsidc.org/data/smap/smap-data.html

- SMOS - L-Band, 40 km, observations every 3 days

https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/smos/news/-/article/smos-level-2-soil-moisture-data-now-available-via-eumetcast-in-near-real-time

- ASCAT - L-Band, 50 km, observations every 2 days

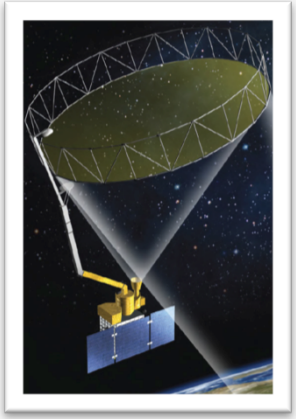
http://rs.geo.tuwien.ac.at/dv/ascat/

Uniqueness of the SMAP Radiometer

Operational L-Band satellite radiometers:

SMOS – ESA satellite
Launched: Nov. 2009
L-band radiometer
Spatial resolution: 40 km
Temporal Resolution: 3 days
Sensing depth: ~5 cm

SMAP satellite
Launched: Jan. 2015
L-band radiometer
Spatial resolution: 40 km
Temporal Resolution: 3 days
Sensing depth: ~5 cm



Uniqueness of SMAP:

1. Aggressive Approach to Radio-Frequency Interference (RFI) Detection and Mitigation
2. Constant incidence angle