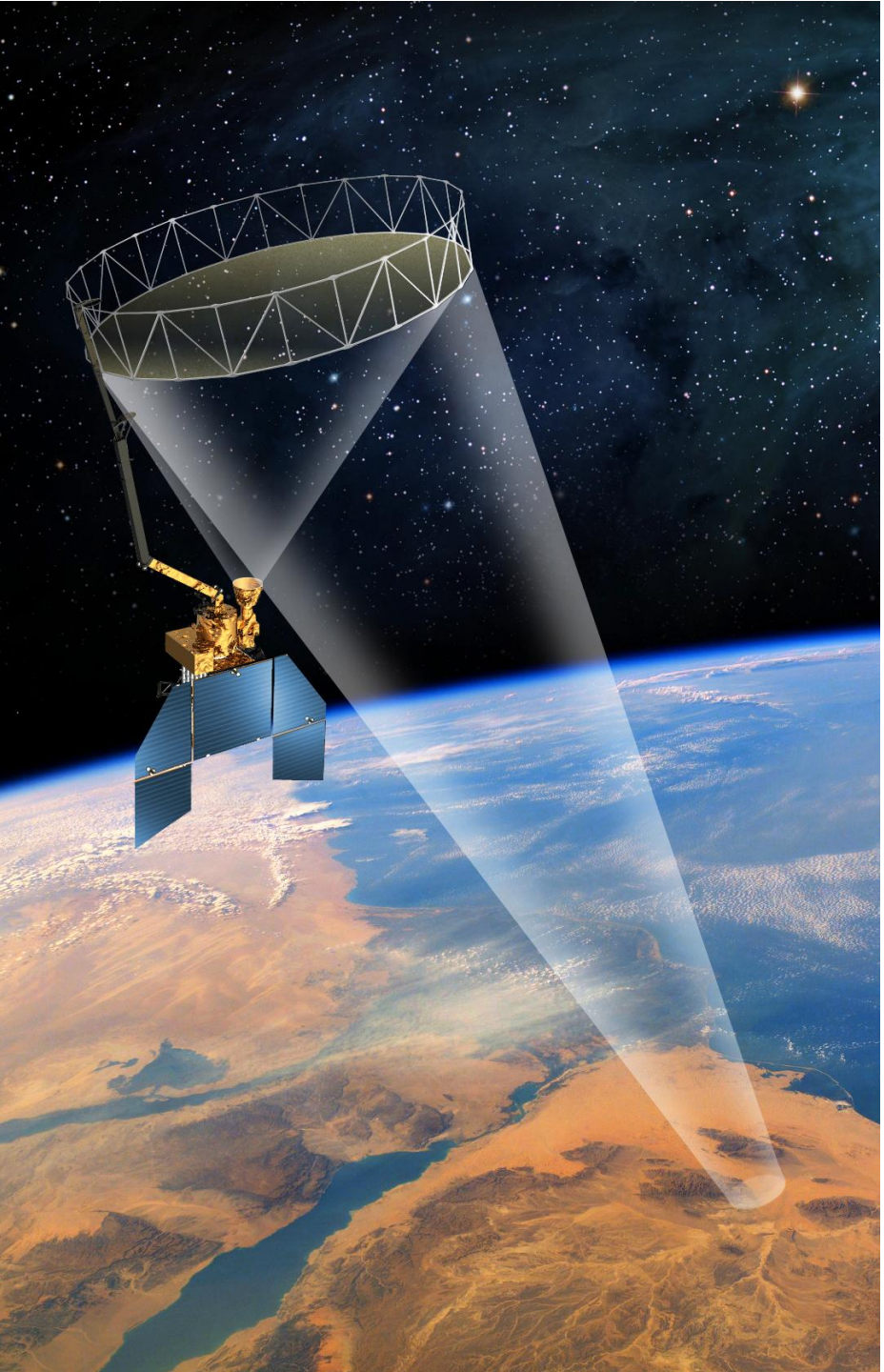


SMAP Data Product Overview

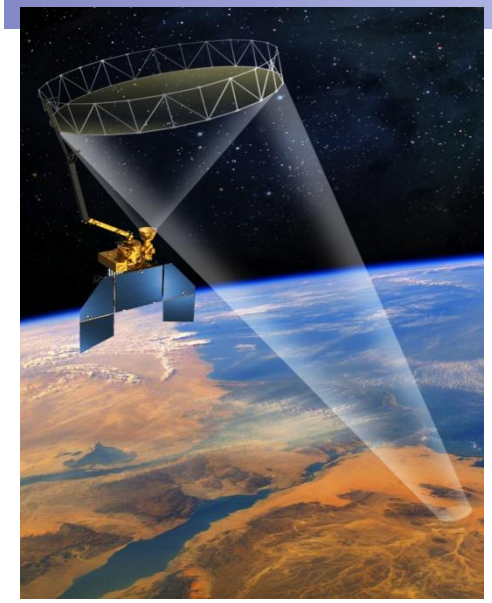
ESIP – Summer 2014
Copper Mountain, Colorado

Barry Weiss

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA

July 9, 2014

Mission Overview



The proposed SMAP mission was in the first tier recommended by 2007 NRC Earth Science Decadal Survey

Primary 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

Observatory Features:

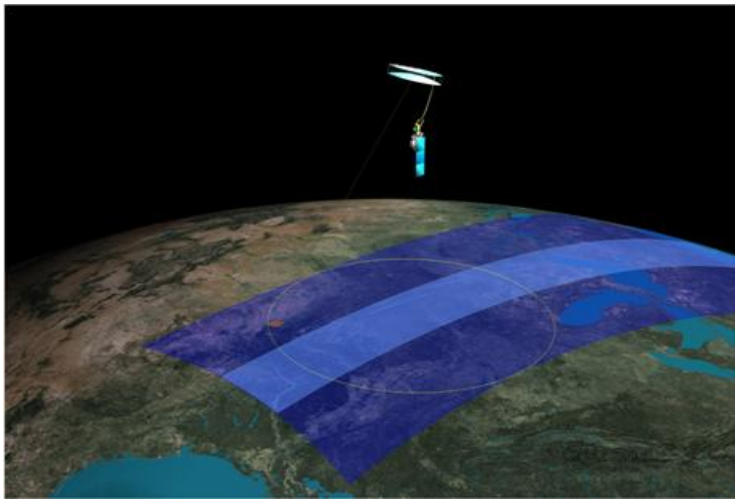
- 3-axis stabilized spacecraft with zero momentum biased attitude control
- Single string avionics and power control/distribution electronics
- Selected redundancy in ACS sensors, actuators, and telecom radios
- Deployable fixed solar array
- Command Telemetry & Doppler via S-band to NEN & SN
- Science data return at 130 Mbps via an X-band link to the NEN
- Hydrazine blow-down propulsion

Proposed Mission Implementation:

Partners	• JPL (project & payload mgmt, science, spacecraft, radar, mission operations, science processing) • GSFC (science, radiometer, science processing)
Risk	• 7120.5D Category 2; 8705.4 Payload Risk Class “C”
Launch	• Oct. 2014, the baseline plan launch vehicle is Delta-2
Orbit	• Polar sun synchronous; 685 km altitude
Duration	• 3 years
Payload	• L-band SAR (JPL) • L-band radiometer (GSFC) • Shared 6m rotating (13 rpm) antenna (JPL)

Proposed SMAP Measurement Approach

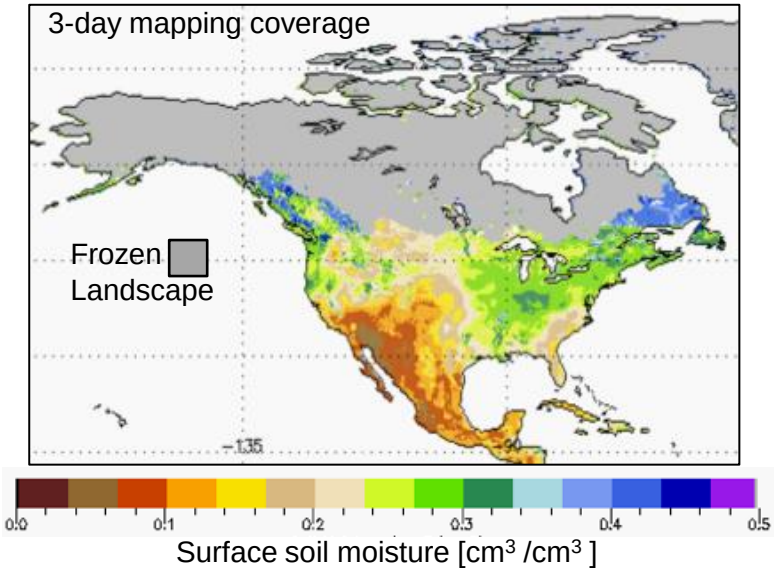
- Instruments:
  - Radar: L-band (1.26 GHz)
    - High resolution, moderate accuracy soil moisture
    - Freeze/thaw state detection
    - SAR mode: 3 km resolution
    - Real-aperture mode: 30 x 6 km resolution
  - Radiometer: L-band (1.4 GHz)
    - Moderate resolution, high accuracy soil moisture
    - 40 km resolution
  - Shared Antenna
    - 6-m diameter deployable mesh antenna
    - Conical scan at 13 rpm
    - Constant incidence angle: 40 degrees
      - 1000 km-wide swath



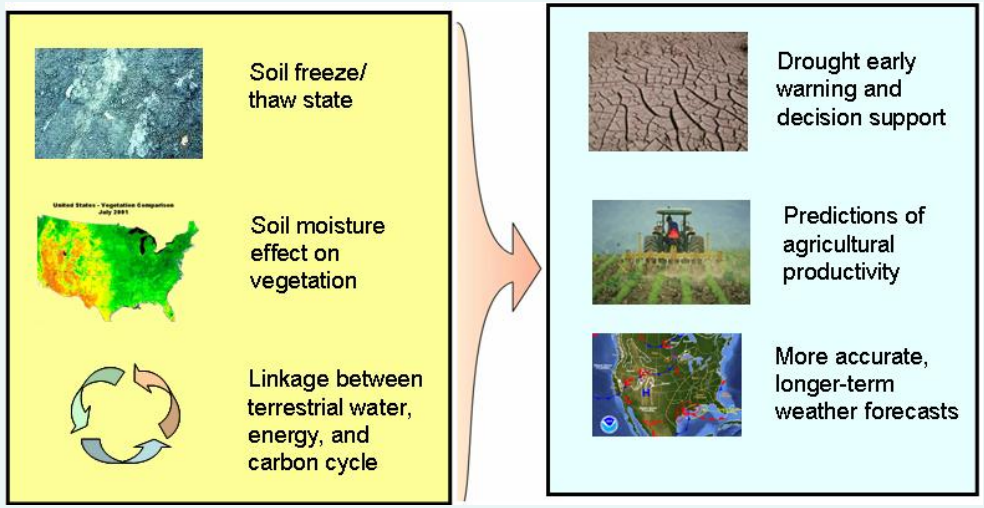
- Orbit:
  - Sun-synchronous orbit
  - 6 am local time descending
  - 6 pm local time ascending
  - 685 km altitude
  - Global coverage once every three days
- Mission Operations:
  - 3-year baseline mission

SMAP Science

- SMAP will provide high-resolution and frequent-revisit global observations of soil moisture and freeze/thaw state
  - *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 surface soil and vegetation



SMAP measurements of soil moisture and freeze/thaw state address a wide range of Earth science applications



NRC Earth Science Decadal Survey Report, 2007

SMAP Science Applications

Decadal Survey Objective	Application	Science Requirement
Weather Forecast	Initialization of Numerical Weather Prediction (NWP)	Hydrometeorology
Climate Prediction	Boundary and Initial Conditions for Seasonal Climate Prediction Models	Hydroclimatology
	Testing Land Surface Models in General Circulation Models	
Drought and Agriculture Monitoring	Seasonal Precipitation Prediction	Hydroclimatology
	Regional Drought Monitoring	
	Crop Outlook	
Flood Forecast Improvements	River Forecast Model Initialization	Hydrometeorology
	Flash Flood Guidance (FFG)	
	NWP Initialization for Precipitation Forecast	
Human Health	Seasonal Heat Stress Outlook	Hydroclimatology
	Near-Term Air Temperature and Heat Stress Forecast	Hydrometeorology
	Disease Vector Seasonal Outlook	Hydroclimatology
	Disease Vector Near-Term Forecast (NWP)	Hydrometeorology
Boreal Carbon	Freeze/Thaw Date	Freeze/Thaw State

Requirement	Hydro-Meteorology	Hydro-Climatology	Carbon Cycle	Baseline Mission		Minimum Mission	
				Soil Moisture	Freeze/ Thaw	Soil Moisture	Freeze/ Thaw
Resolution	4–15 km	50–100 km	1–10 km	10 km	3 km	10 km	10 km
Refresh Rate	2–3 days	3–4 days	2–3 days[a]	3 days	2 days	3 days	3 days
Accuracy	0.04-0.06 [c]	0.04-0.06	80–70% [b]	0.04	80%	0.06	70%

[a] North of 45N latitude [b] Percent classification accuracy (binary freeze/thaw) [c] Volumetric water content, 1-σ in [cm^3/cm^3] units

SMAP Applications

SMAP Applications of Surface Soil Moisture and Freeze/Thaw Measurements

- Discovery of Fundamental Links in the Earth System: Over land regions the water, energy and carbon cycles are interrelated through soil moisture and its freeze/thaw state.
- Improved Weather Forecasts: Initialization of the soil moisture state in Numerical Weather Prediction (NWP) models improves the predictability of weather events influenced by land-surface fluxes.
- Advanced Capability to Assess Land Productivity: Soil moisture is a primary factor in the growth of plants in both natural and agricultural ecosystems.
- New Era in Monitoring Flood Hazards: Surface soil moisture information enhances early warnings of costly flood and landslide hazards.
- Accurate Carbon Budgets: Forests in northern latitudes take up carbon dioxide from the atmosphere during their growing season (thawed state). Carbon dioxide is released during the rest of the year. Knowledge of the timing of freeze and thaw conditions enables calculation of the contribution of forests to climate change.

Proposed SMAP Data 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