AirMOSS

Airborne Microwave Observatory of Subcanopy & Subsurface Mission

In Situ Soil Water Content / Soil Hydraulic Properties

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MOISST Workshop, Stillwater, OK

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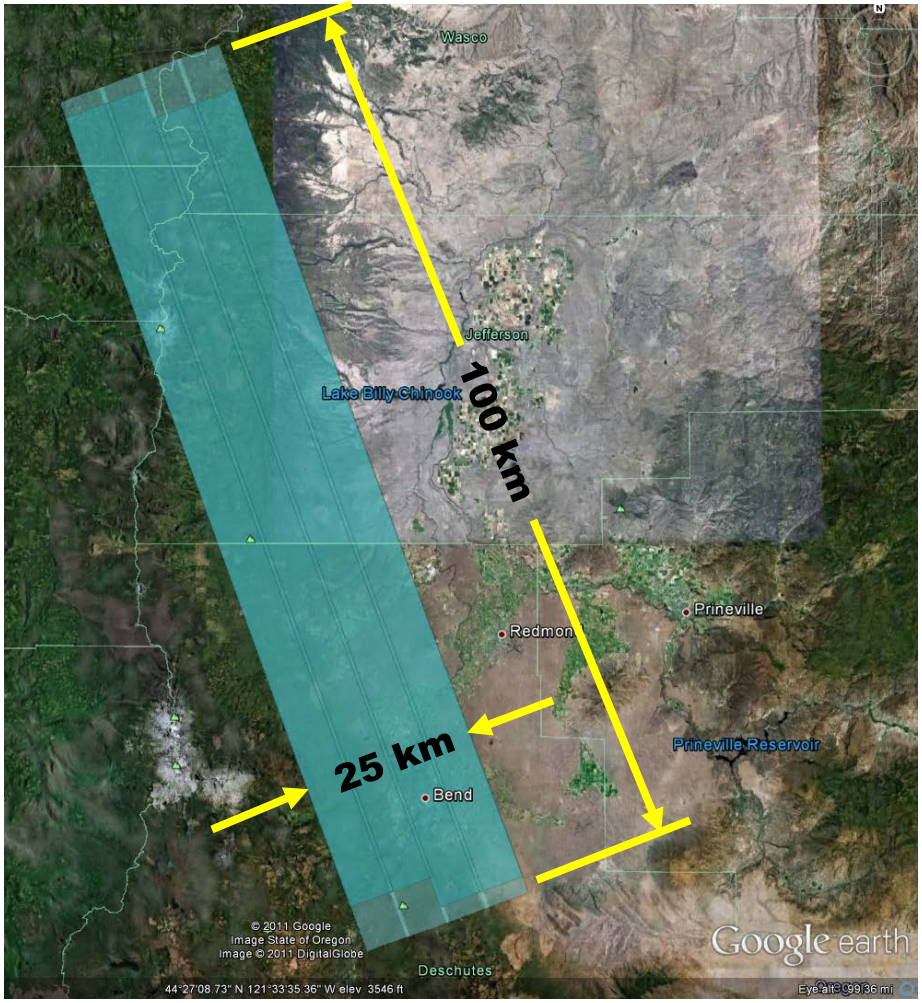
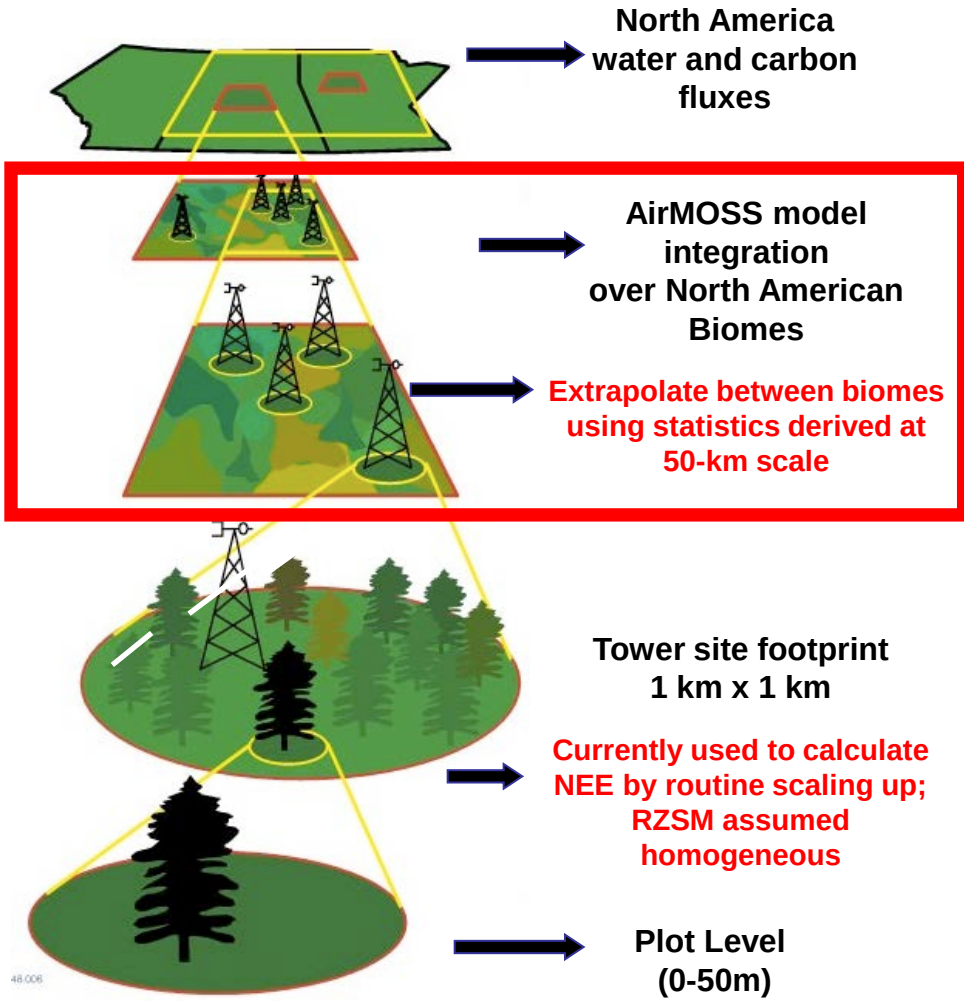
NASA AirMOSS
Experiment
Nine North American Biomes
Seasonally Spring 2012 to Fall 2015
8 Forested / Brush Sites; 1 Agricultural Site

NASA AirMOSS Scientific Approach

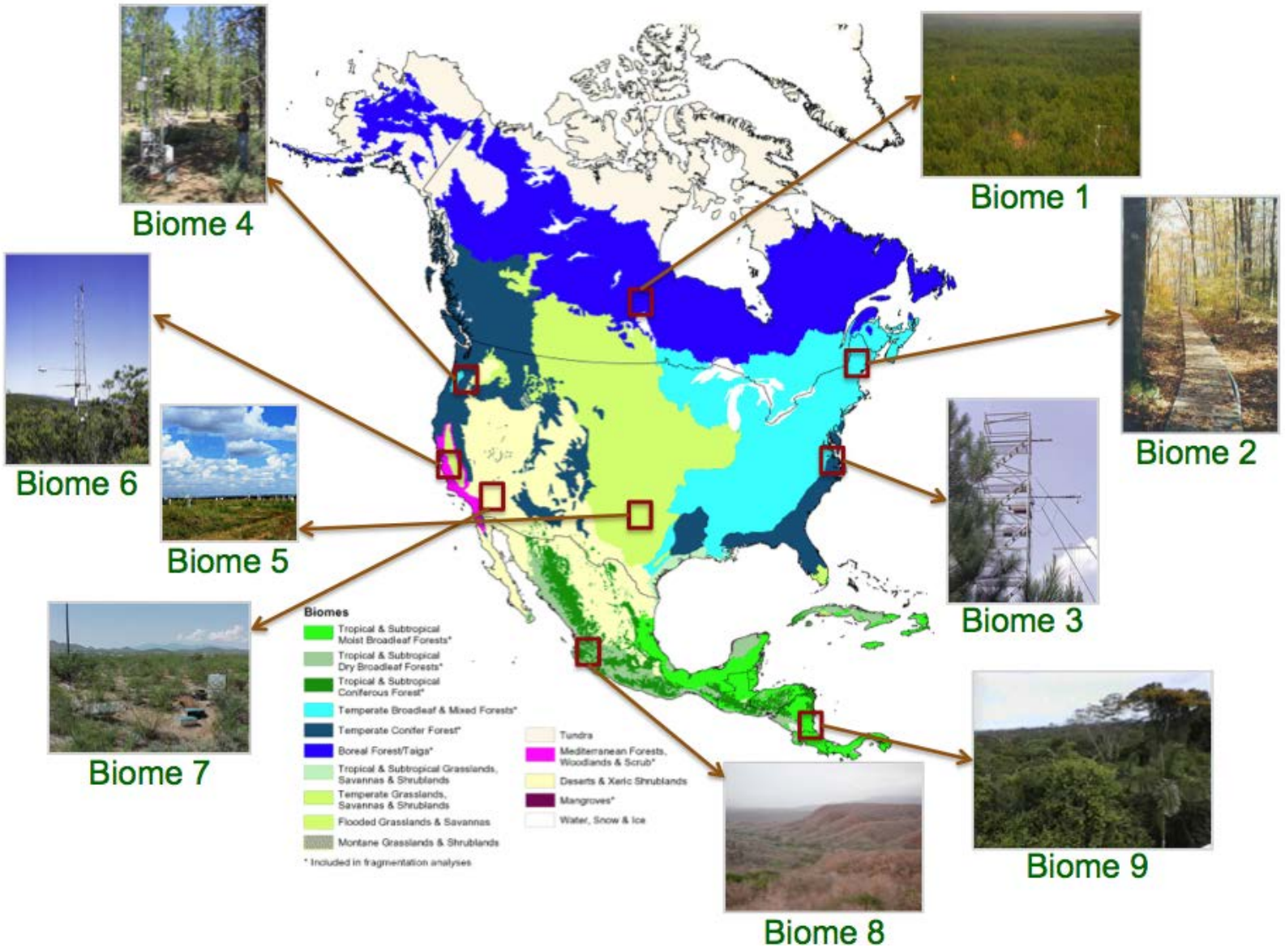
Flight Path – Metolius Site, OR



Bottom-up scaling



NASA AirMOSS Site Selection



P-Band Radar for RZSM Measurement

Significance of P-band (microwave with long wavelength)

Microwaves: 1 mm to 1 m wavelength

Divided into different frequency (wavelength) bands

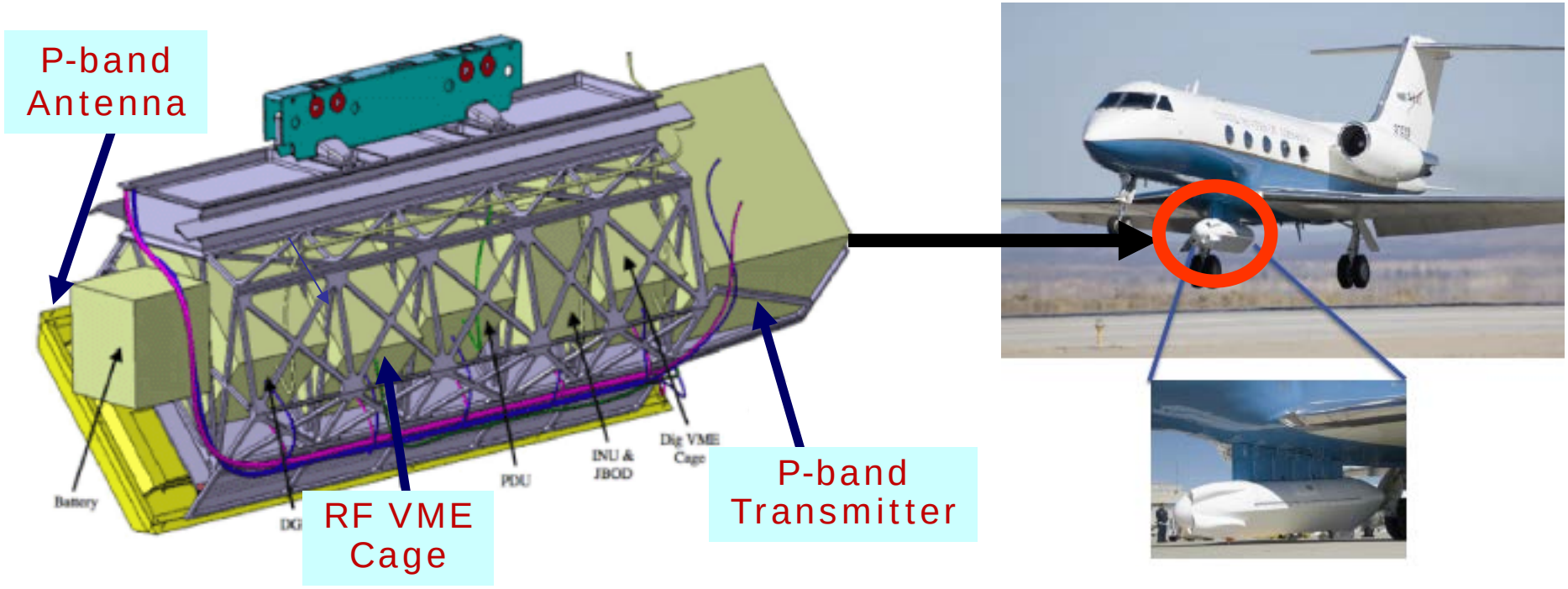
- **P band**: 0.3 - 1 GHz (30 - 100 cm) AirMOSS
- **L band**: 1 - 2 GHz (15 - 30 cm) SMAP / SMOS
- **S band**: 2 - 4 GHz (7.5 - 15 cm)
- **C band**: 4 - 8 GHz (3.8 - 7.5 cm)
- **X band**: 8 - 12.5 GHz (2.4 - 3.8 cm)
- **Ku band**: 12.5 - 18 GHz (1.7 - 2.4 cm)
- **K band**: 18 - 26.5 GHz (1.1 - 1.7 cm)
- **Ka band**: 26.5 - 40 GHz (0.75 - 1.1 cm)

- Surfaces - scattering depends on moisture and roughness
- We could get penetration into soils at longer wavelengths or with dry soils

NASA AirMOSS Hardware

AirMOSS hardware is primarily based on UAVSAR heritage. Existing UAVSAR design made accommodations to add the P-band capability.

- Antenna frame was sized to fit the GeoSAR P-band antenna
- Space in the nose cone was reserved for P-band transmitter



UAVSAR pod layout showing modularity of the electronic assemblies; assemblies in red are new build while all others are shared with UAVSAR

Models for Profile Soil Water Content Distribution

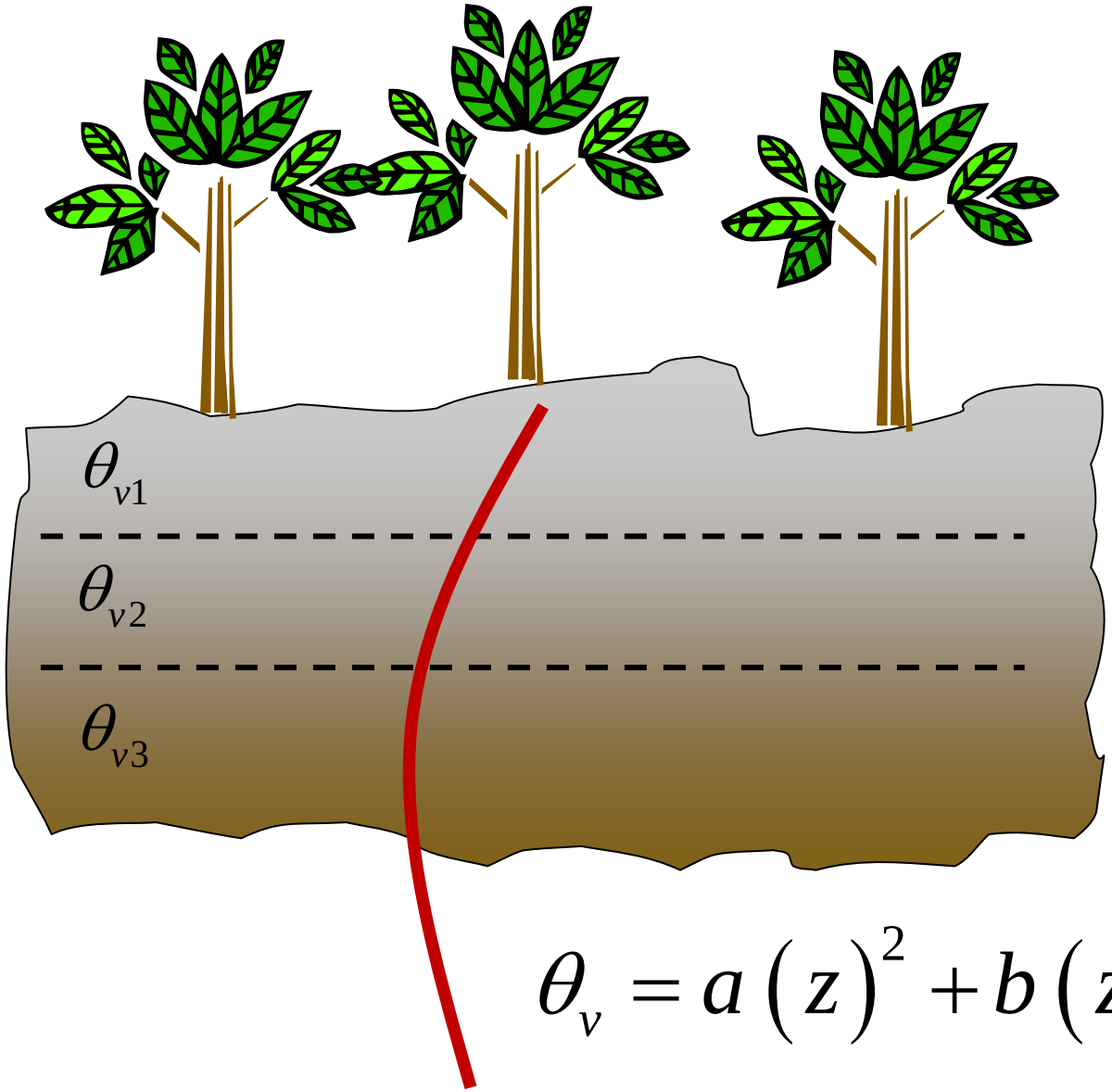
Models tested in this analysis:

- Power Model $\theta_i = \alpha_0 e^{\alpha_1 z_i}$
- 1st Order Model $\theta_i = \beta_0 + \beta_1 z_i$
- 2nd Order Model $\theta_i = \gamma_0 + \gamma_1 z_i + \gamma_2 z_i^2$
- 3rd Order Model $\theta_i = \delta_0 + \delta_1 z_i + \delta_2 z_i^2 + \delta_3 z_i^3$

θ_i = volumetric soil water content (cm^3/cm^3)

z_i = depth (cm)

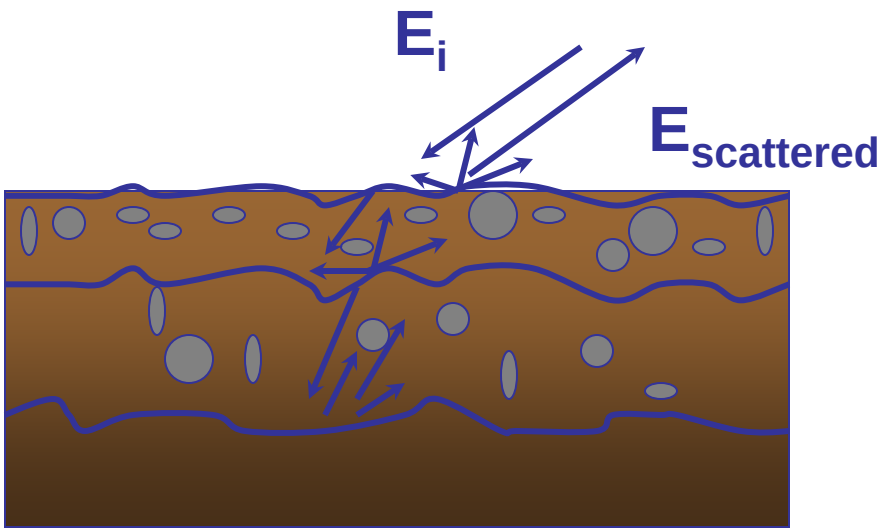
Inversion of Soil Water Content



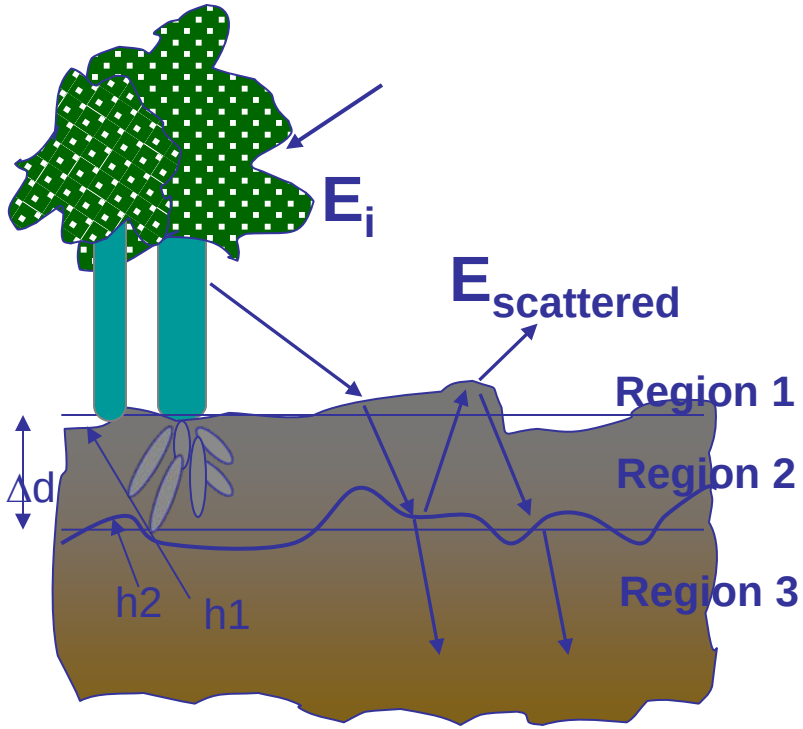
$$\theta_v = a(z)^2 + b(z) + c$$

Radar Signal Echo Paths Below Surface

- **For bare surfaces, subsurface layers can cause significant backscattering. Random volume scatterer can do the same.**



- **Vegetation can cause further interaction with subsurface layers, mostly evident in the coherent field.**



Sampling Transects, Harvard Forest, MA

reas near flux towers (mixed forest), Harvard Forest, MA

flux tower

sampling points

OSU sensors

In-Situ Ground Observation System

Three Profiles

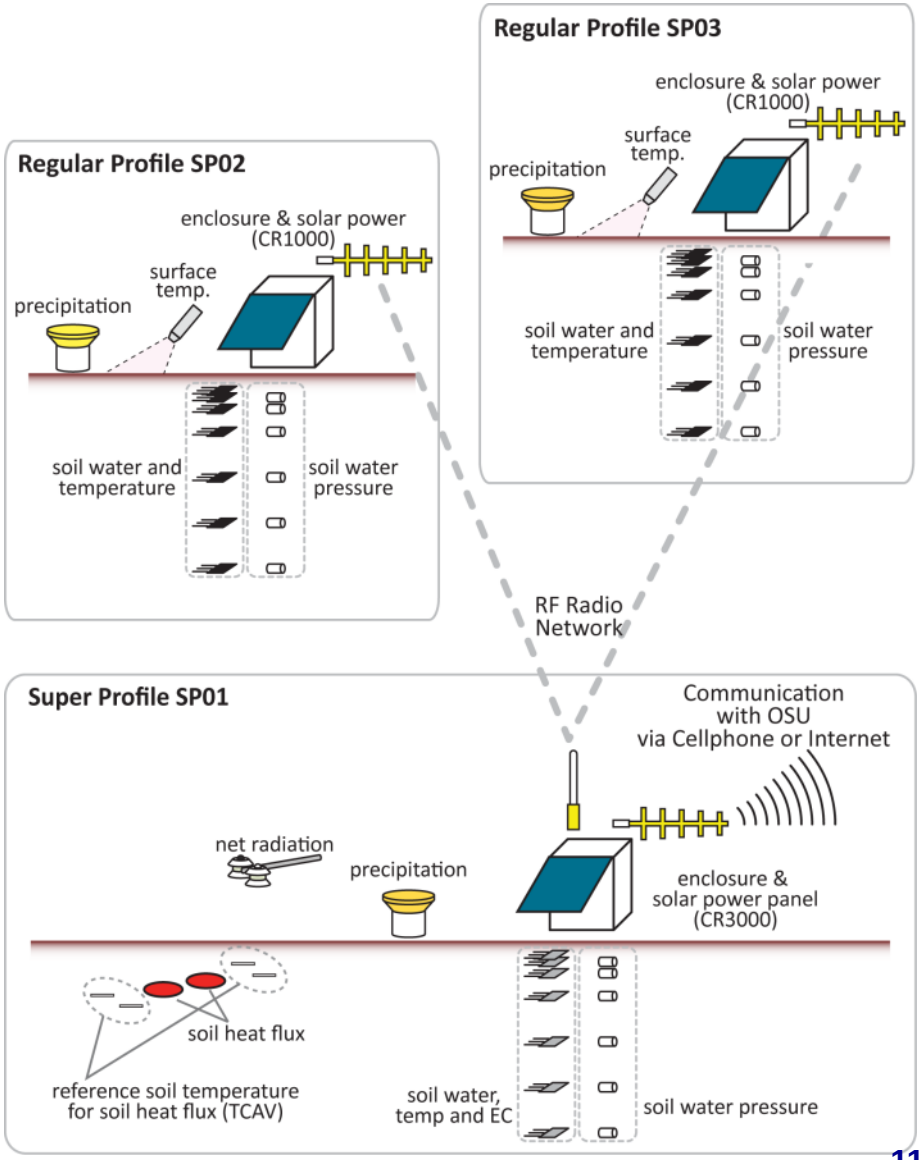
- Super Profile
  - Remote communication
  - Radiation balance
  - Soil water/temperature profile
- Regular Profiles
  - Soil water/temperature profile

Soil Profile Monitoring

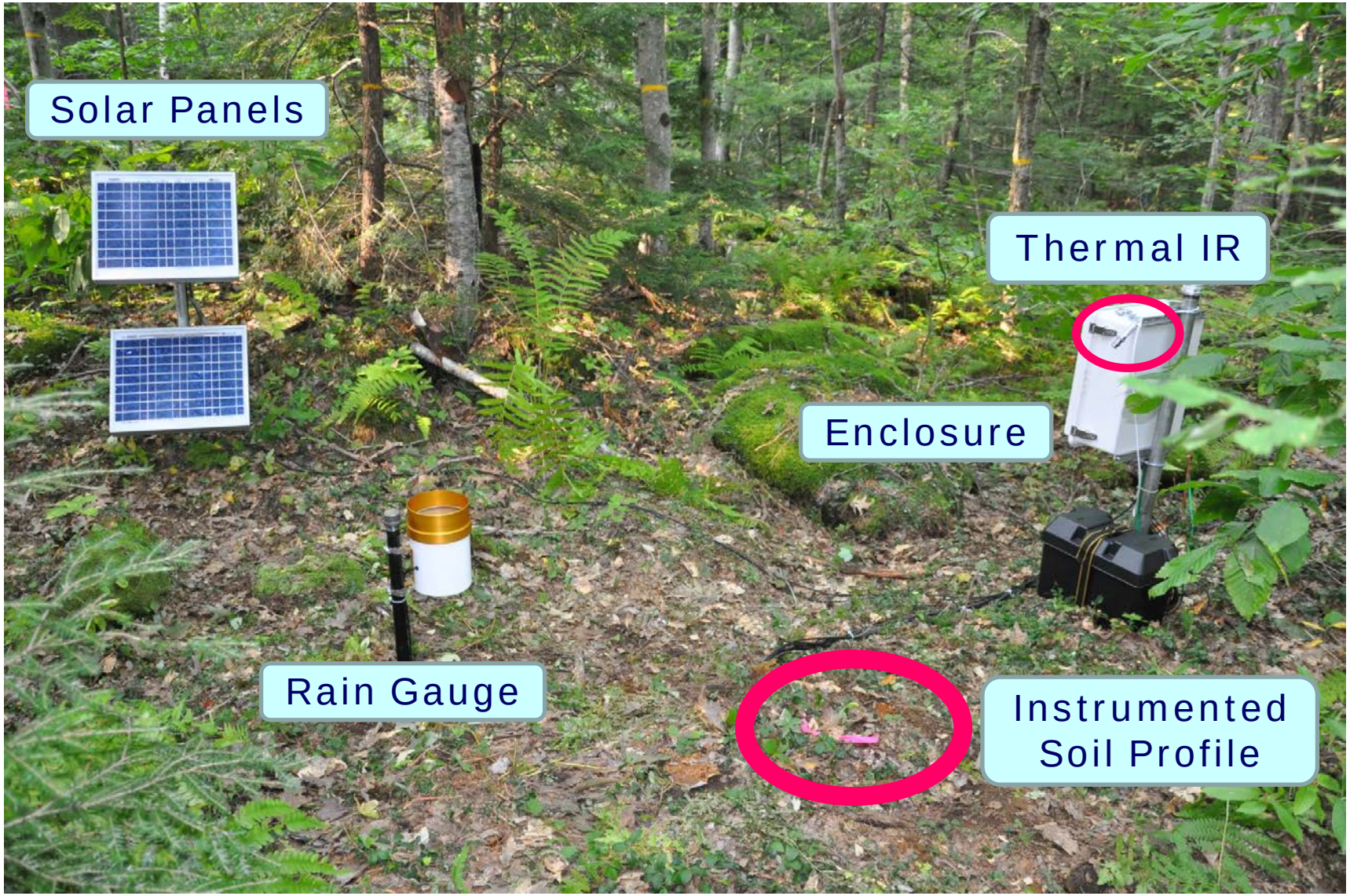
- Soil water content
- Soil matric potential
- Rain gauge

Energy and Heat Balance

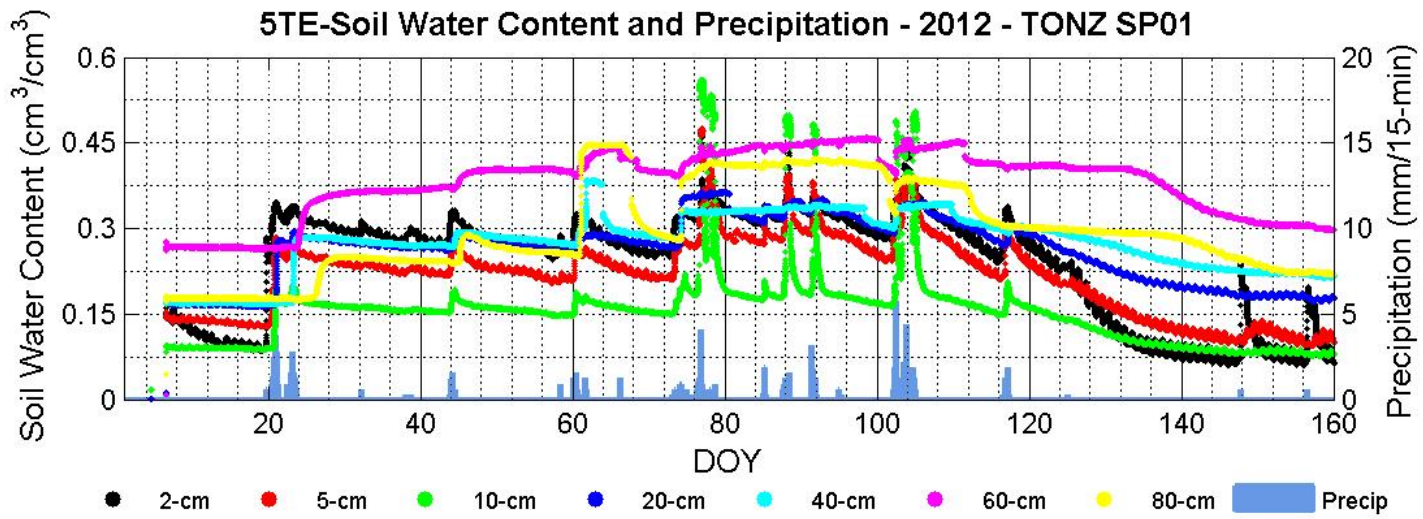
- 4-Component radiometer
- Thermal infrared temp sensor
- Soil temperature profile
- Soil heat flux plates

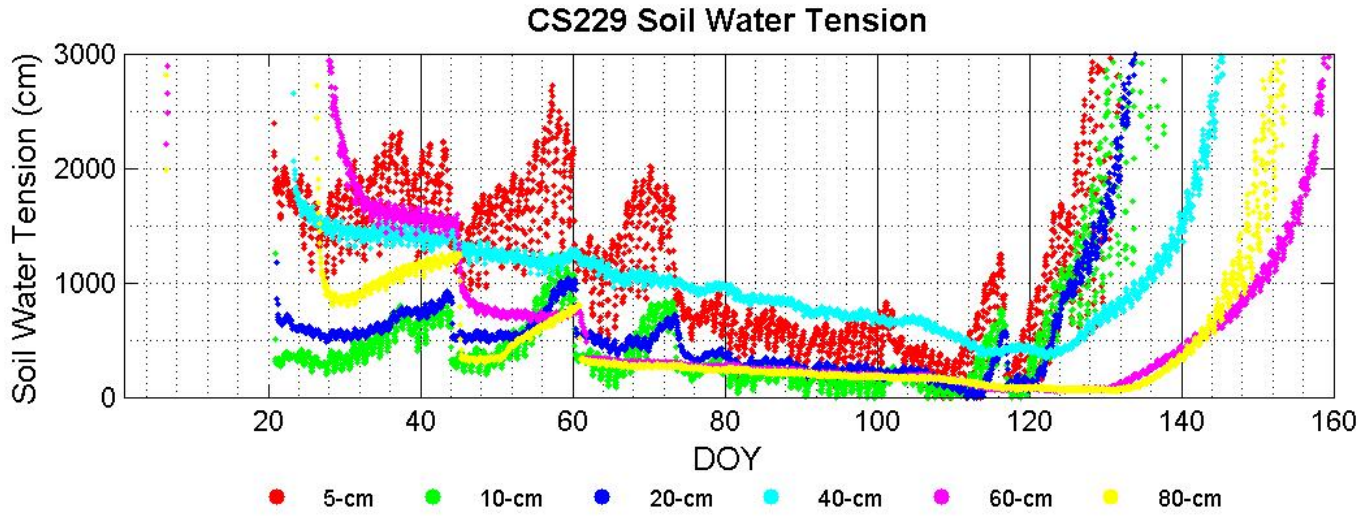


Standard Profile - HARV

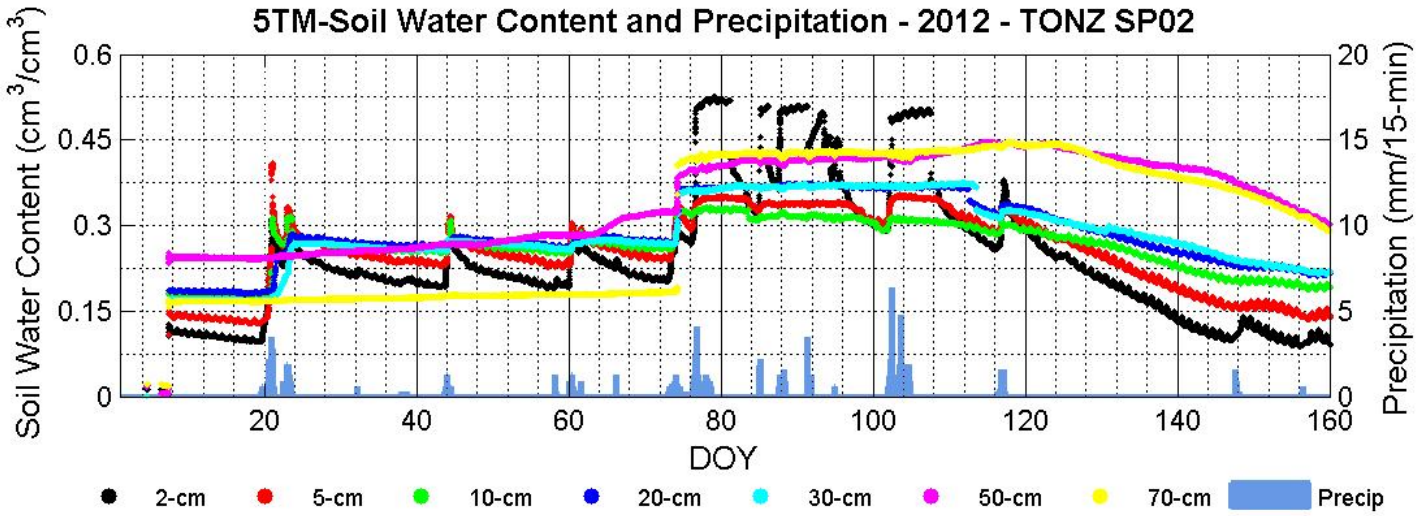


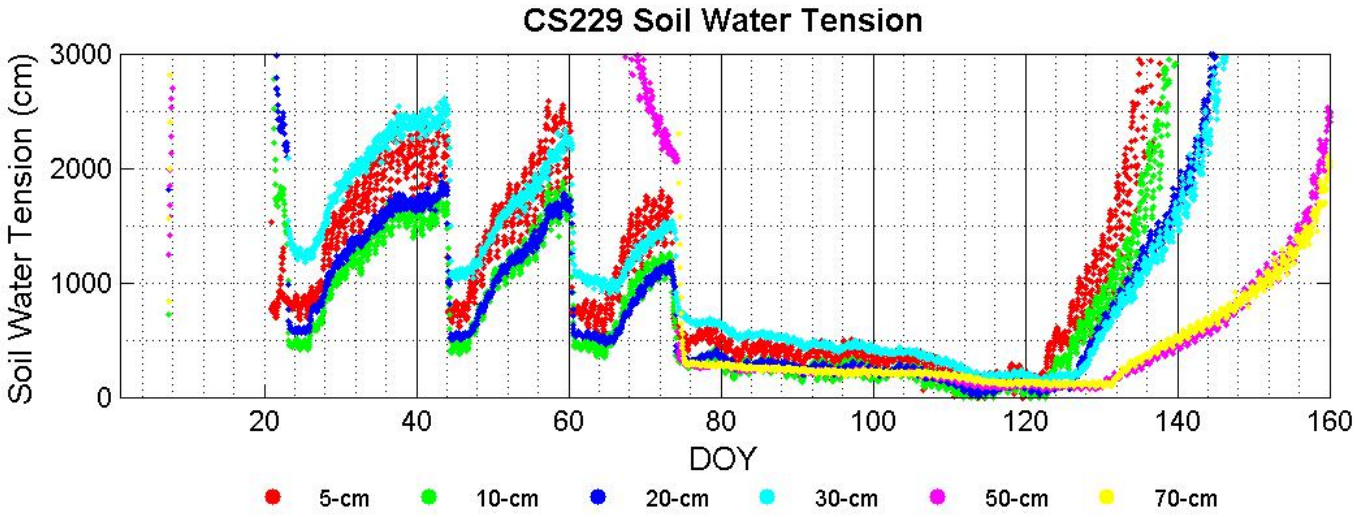
Soil Water Content/Potential – TONZ – SP01



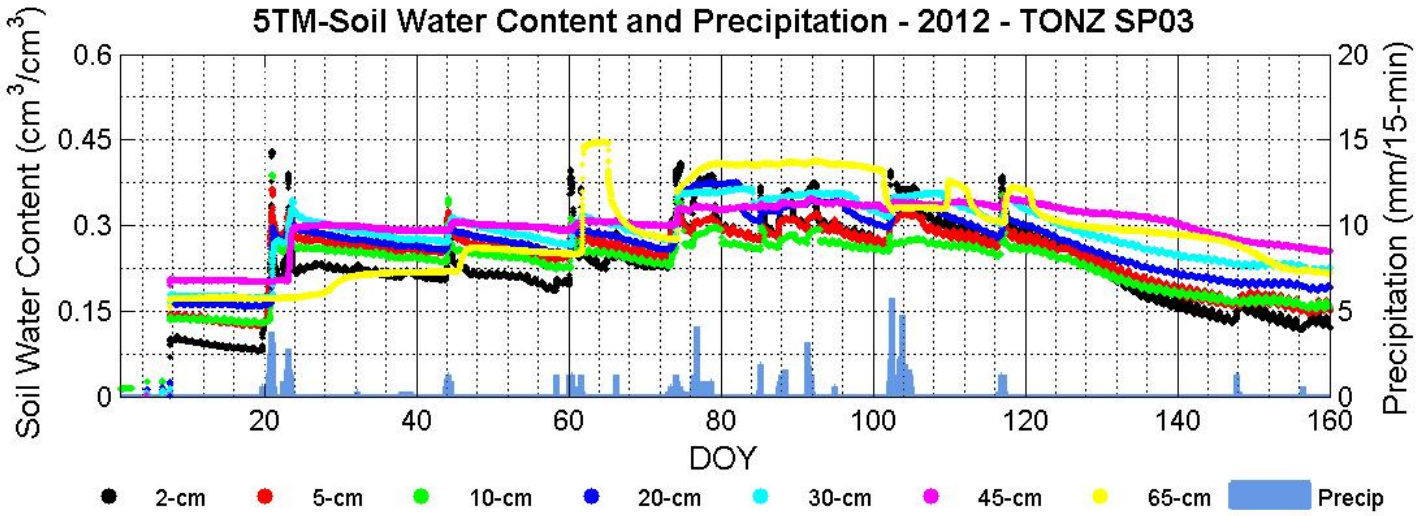


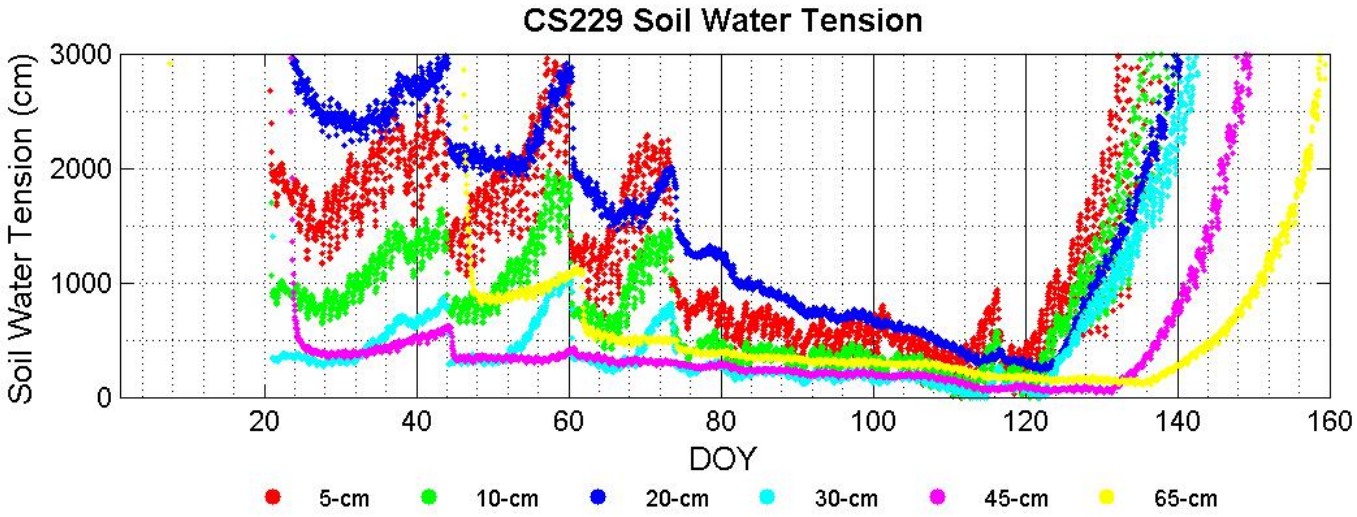
Soil Water Content/Potential – TONZ – SP02





Soil Water Content/Potential – TONZ – SP03



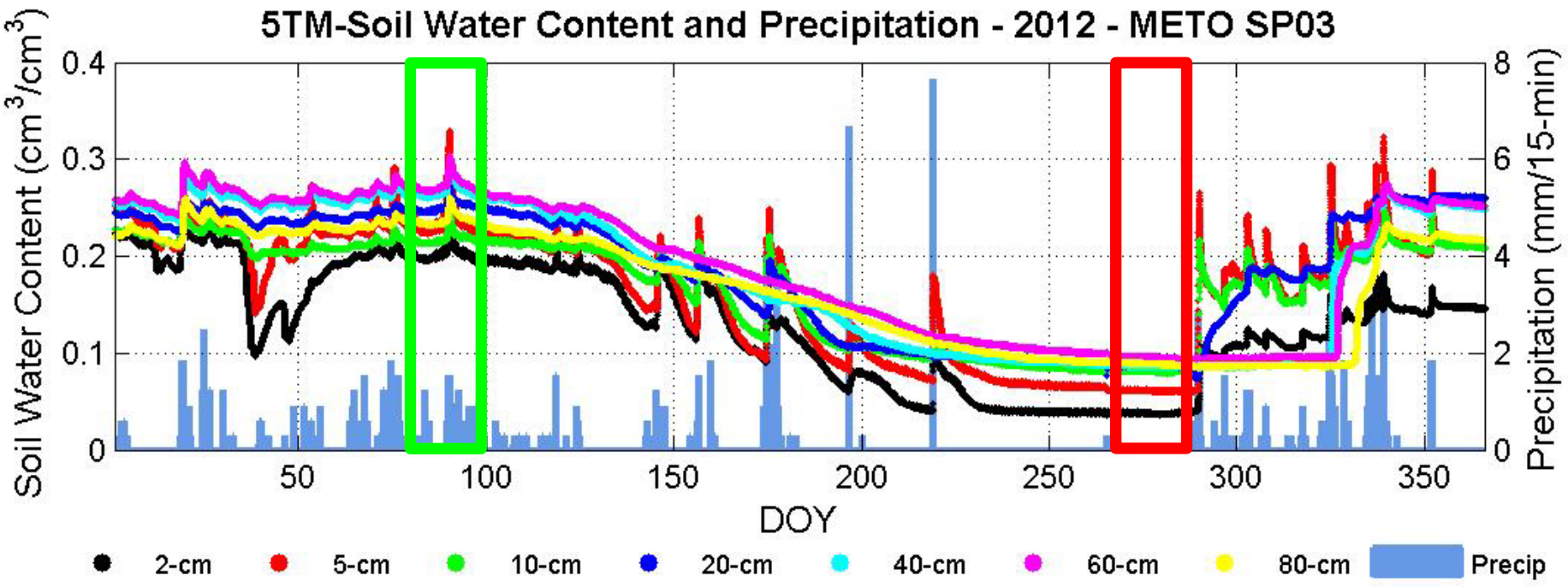


Soil Water Content – 2012 - METO – SP03

Climatic Forcings – Seasonal Trends

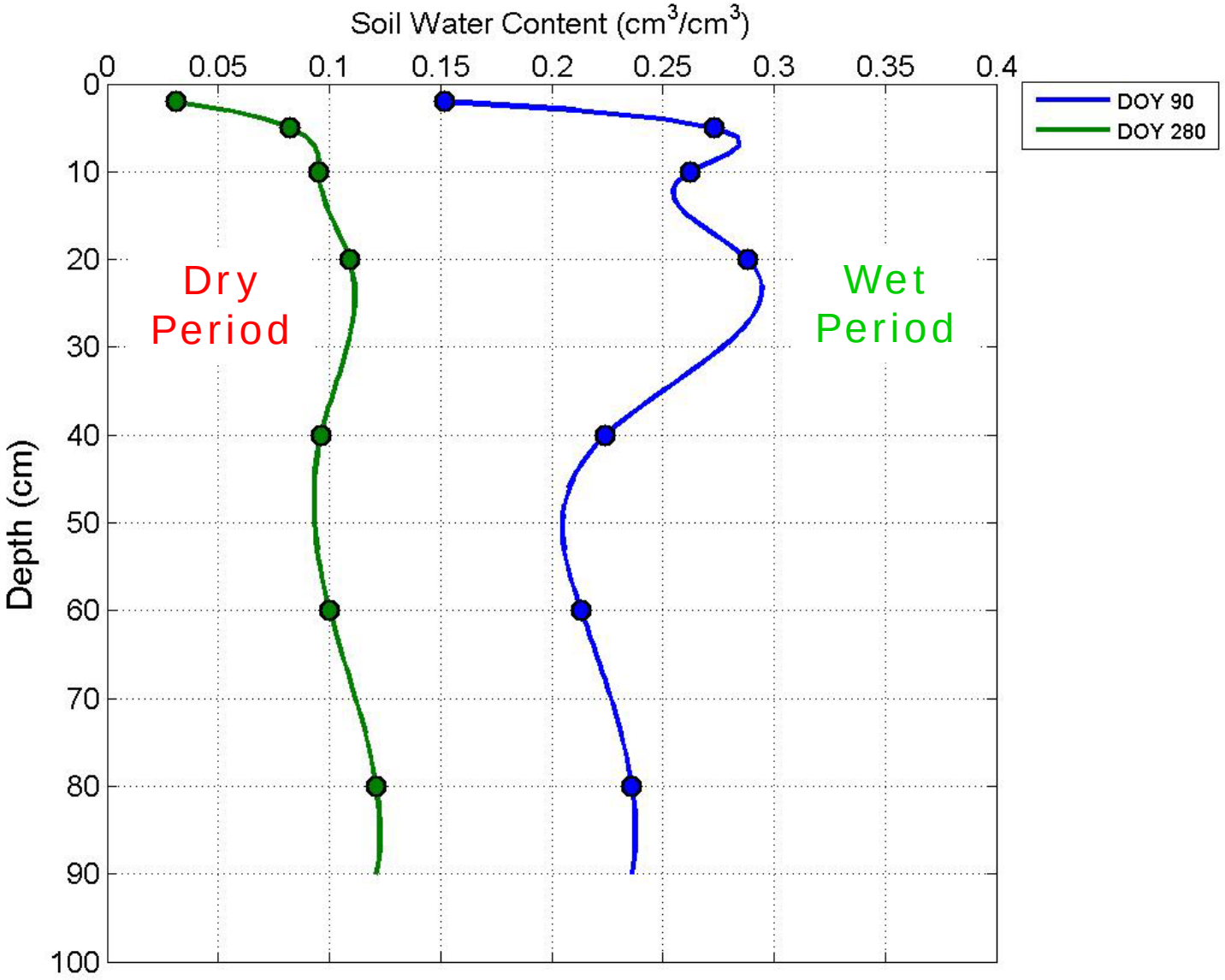
Wet Period

Dry Period



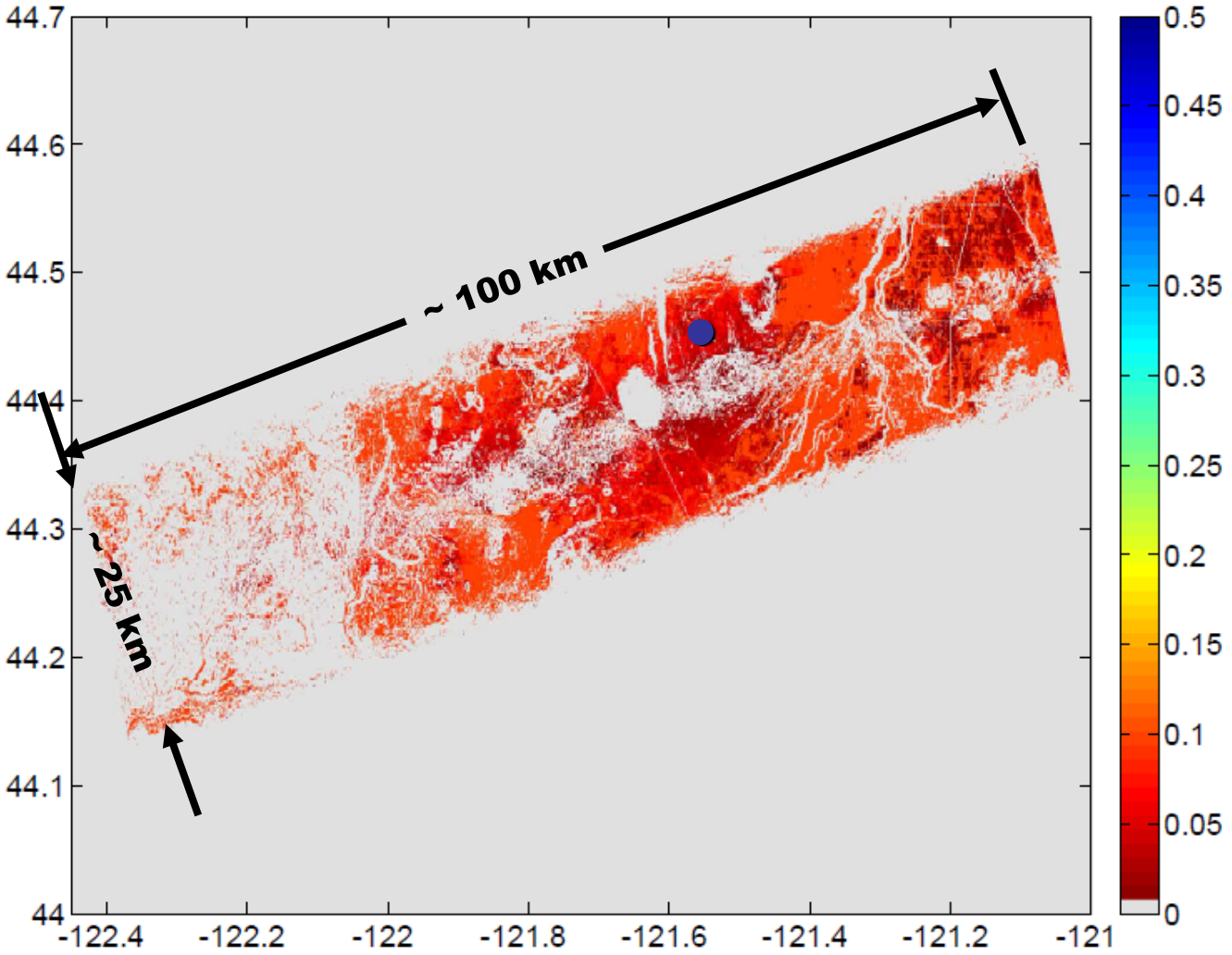
Soil Water Content – 2012 - METO – SP01

Profile Soil Water Content



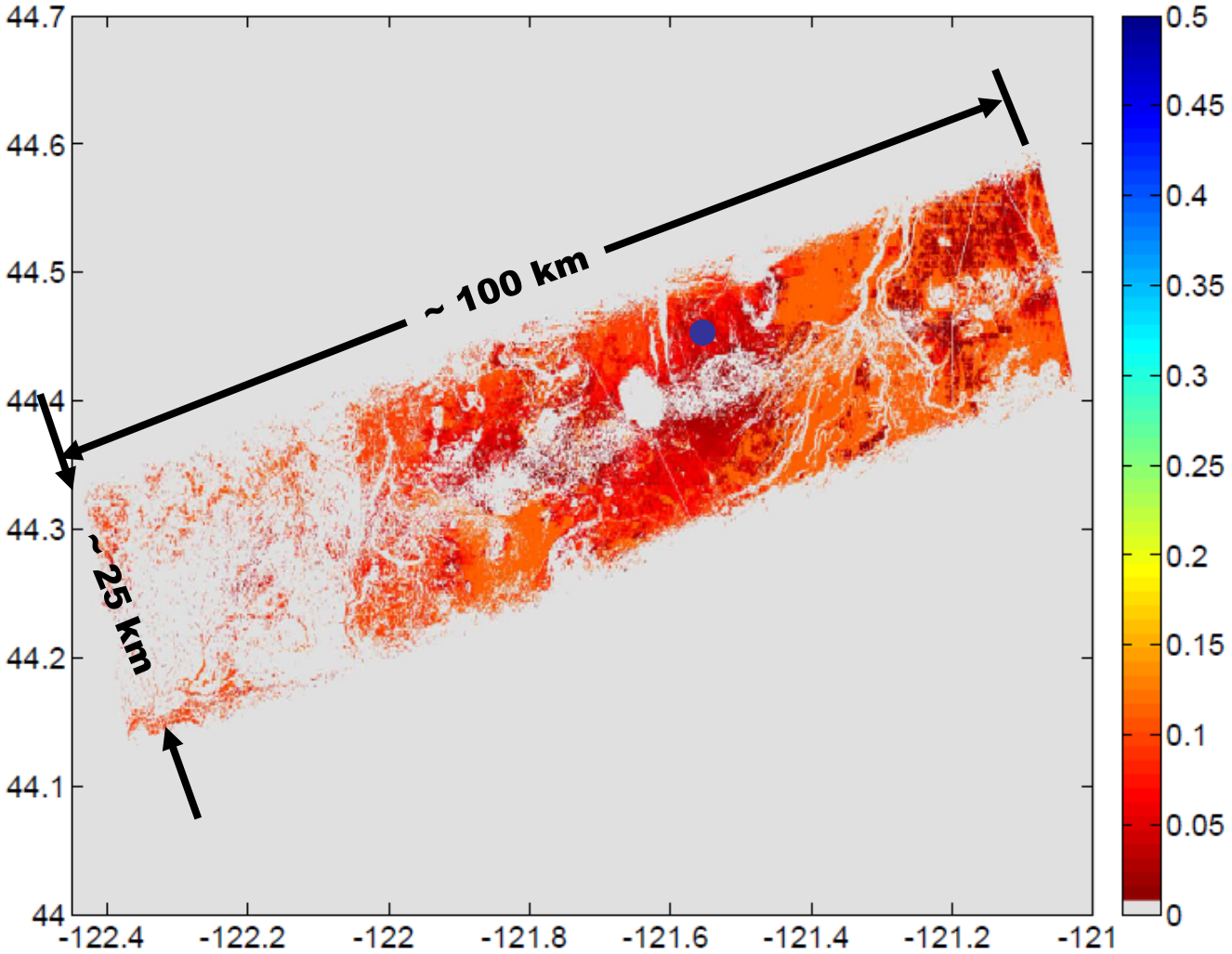
Metolius, OR P-Band Radar Retrievals

Soil water content at 0-cm depth: 24 July 2013



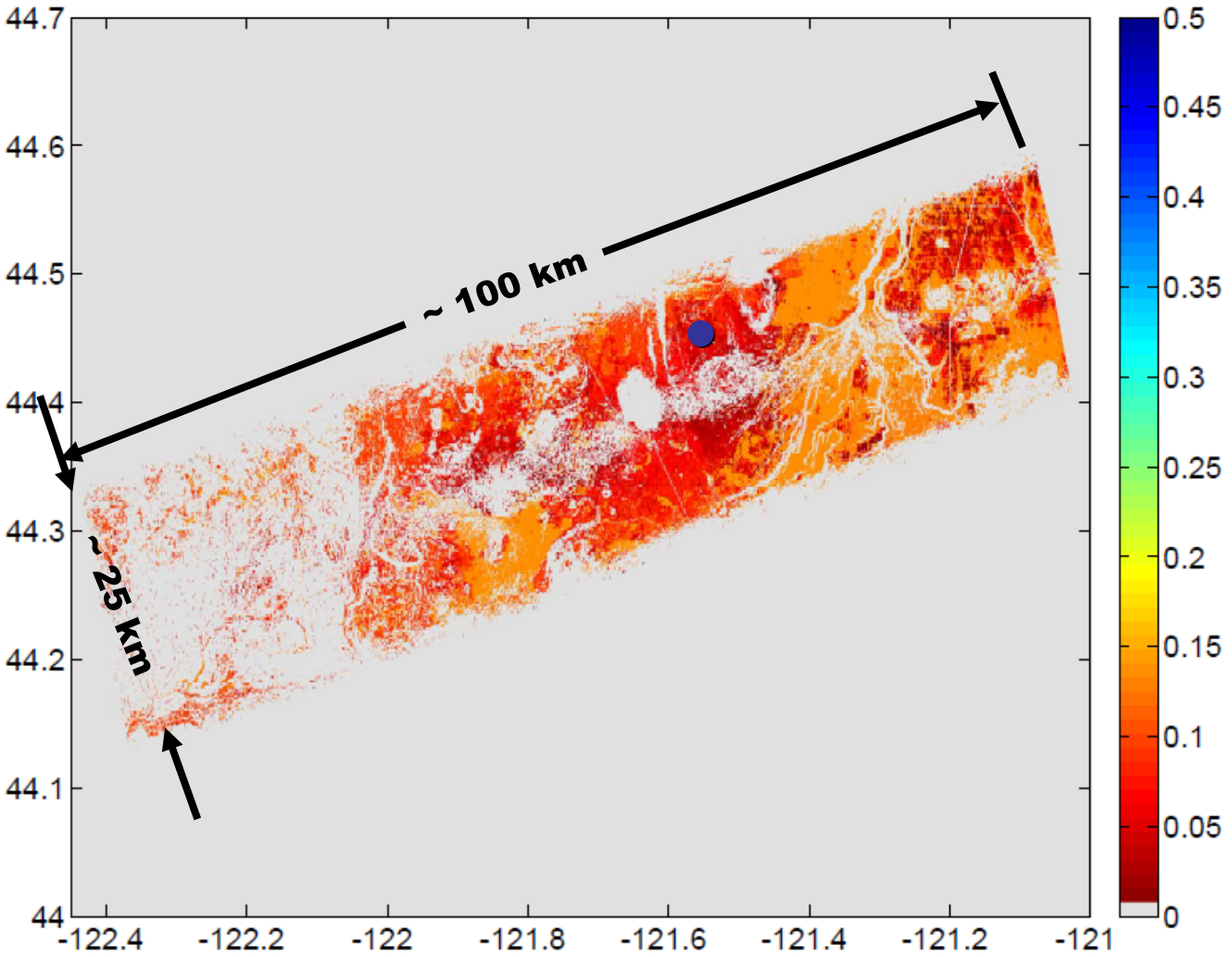
Metolius, OR P-Band Radar Retrievals

Soil water content at 10-cm depth: 24 July 2013



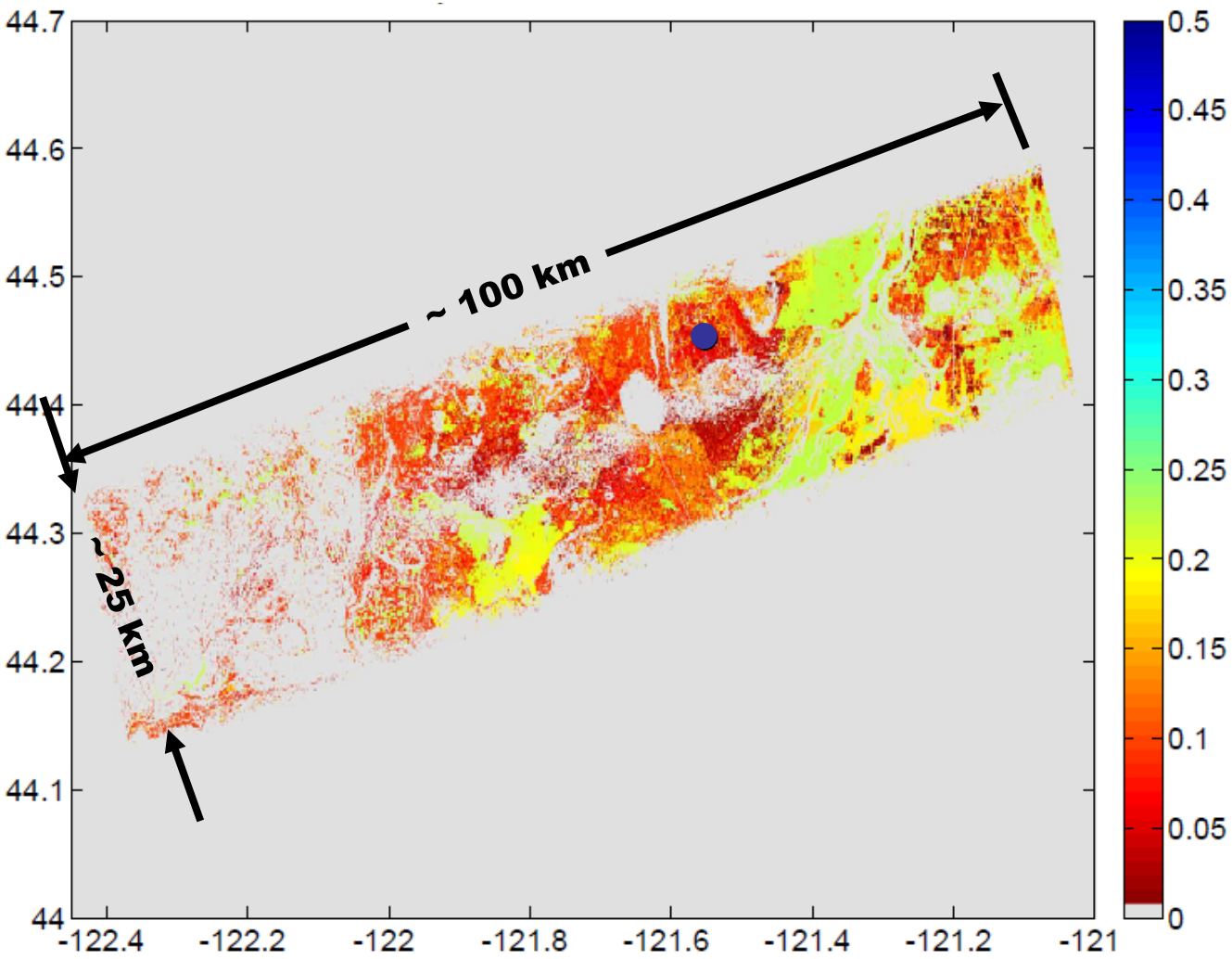
Metolius, OR P-Band Radar Retrievals

Soil water content at 30-cm depth: 24 July 2013



Metolius, OR P-Band Radar Retrievals

Soil water content at 70-cm depth: 24 July 2013




Finito
http://airmoss.jpl.nasa.gov/