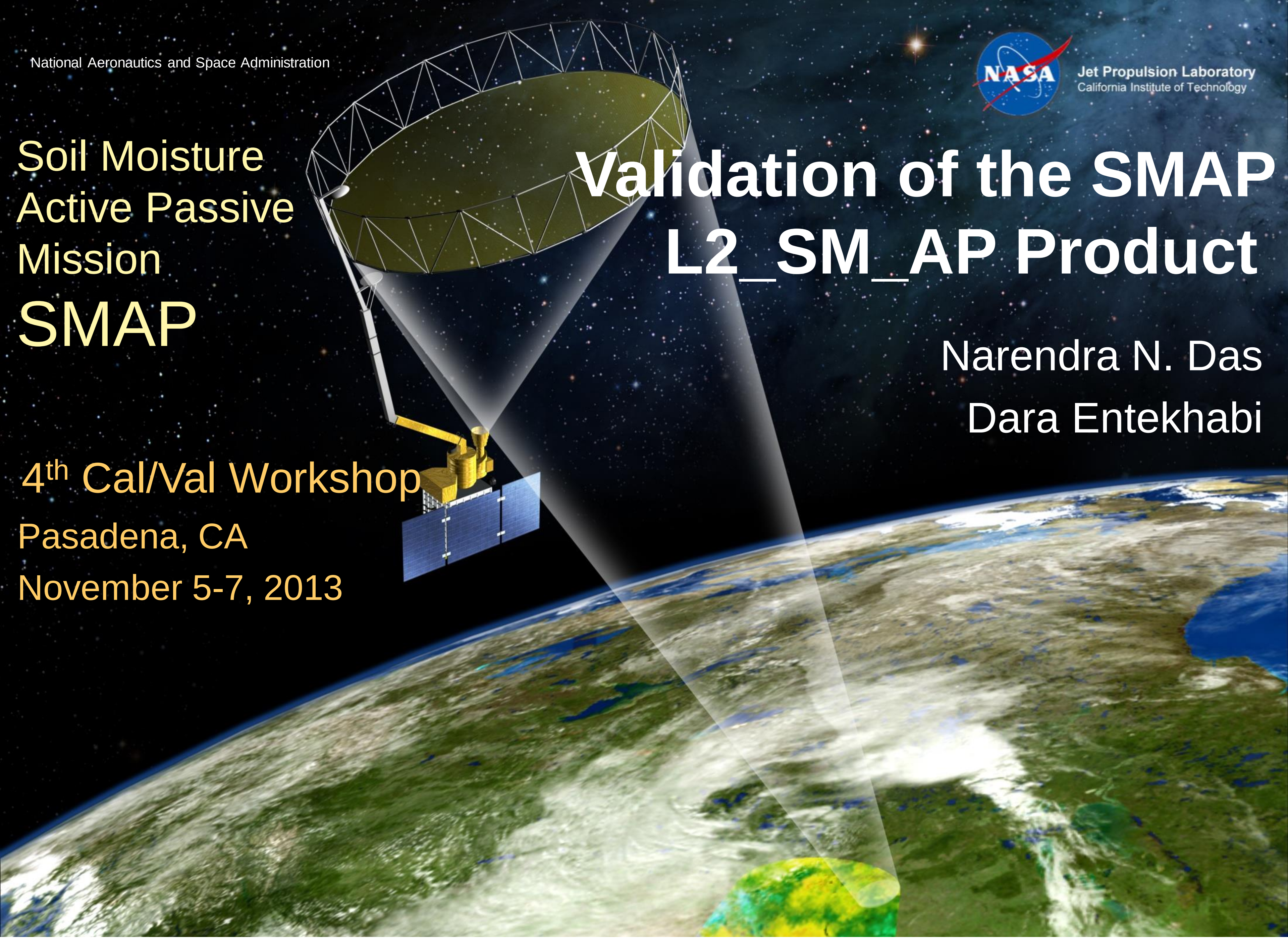

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology

Soil Moisture
Active Passive
Mission
SMAP

Validation of the SMAP L2_SM_AP Product

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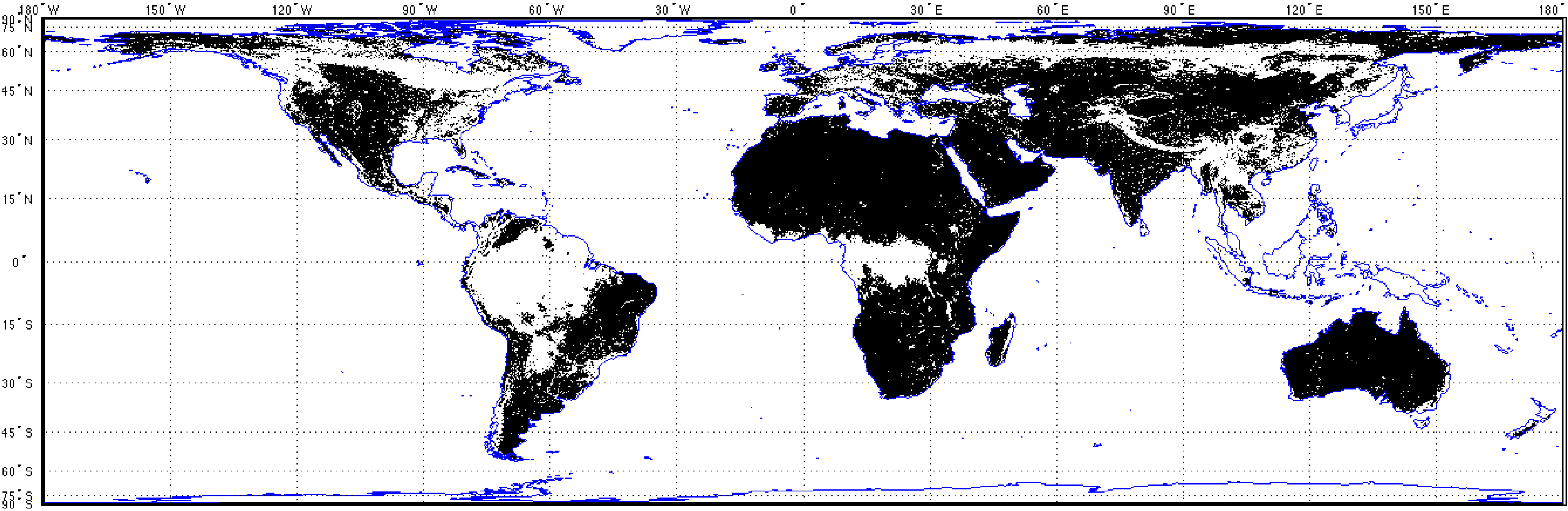
Dara Entekhabi

4th Cal/Val Workshop
Pasadena, CA
November 5-7, 2013

SMAP BASELINE SCIENCE REQUIREMENTS

The baseline science mission shall provide estimates of soil moisture in the **top 5 cm of soil with an error of no greater than 0.04 cm^3/cm^3 (one sigma) at 10 km spatial resolution and 3-day average intervals over the global land area** excluding regions of snow and ice, frozen ground, mountainous topography, open water, urban areas, and vegetation with water content greater than 5 kg/m2 (averaged over the spatial resolution scale)

Regions Where SMAP is Expected to Meet Science Requirements



<u>At 9 km</u>:

VWC ≤ 5 kg m^{-2}

Urban Fraction ≤ 0.25

Water fraction ≤ 0.1

Elevation Slope Standard Deviation ≤ 3 deg

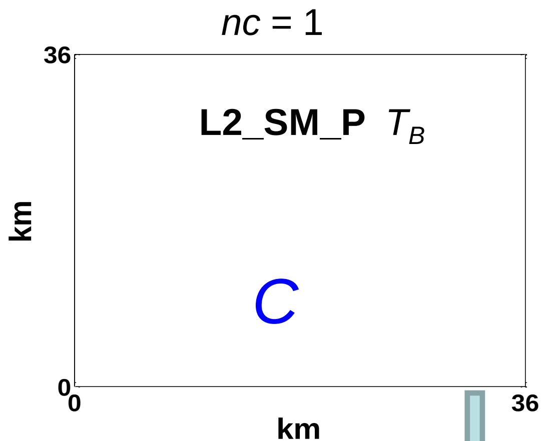
L2_SM_AP Algorithm Overview

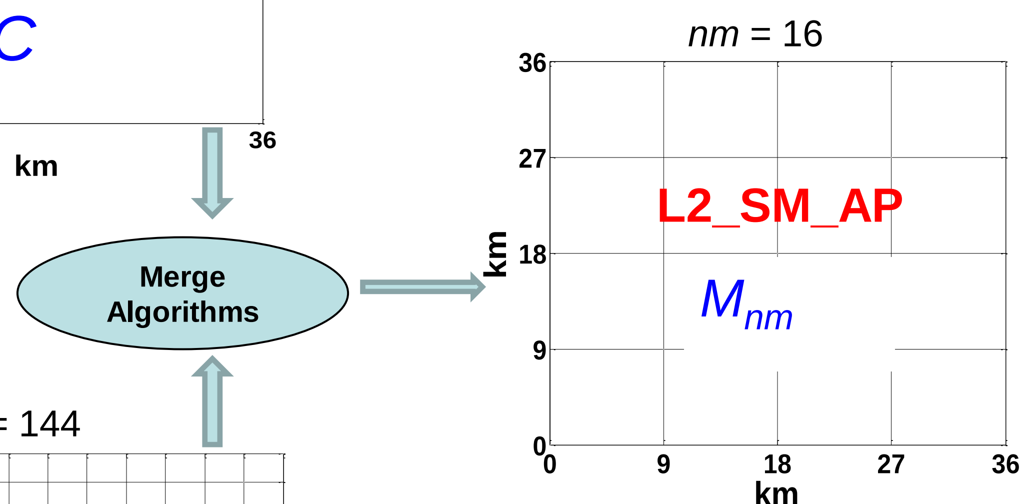
Baseline Algorithm

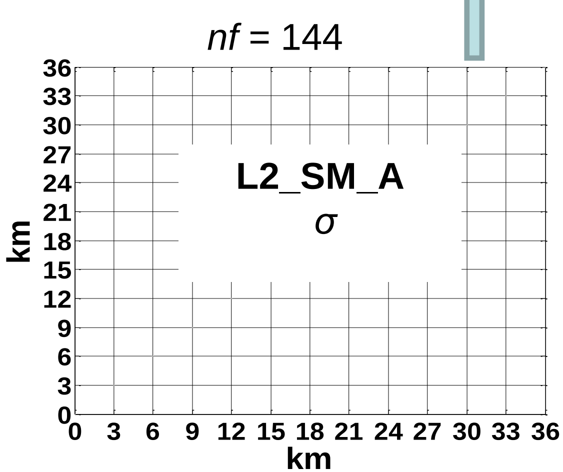
T_B disaggregation

(Das et al., ATBD)

(TGARS, Published in 2013)







$\boldsymbol{C}$ = Coarse (~36 km Radiometer)

$\boldsymbol{M_{nm}}$ = Medium (~ F_{nf} Merged Product)

$\boldsymbol{F_{nf}}$ = Fine (~3 km Radar)

Evaluate $T_{B_p} = \alpha + \beta \cdot \sigma_{pp}$ at scales C and M:

$$T_{B_p}(C) = \alpha(C) + \beta(C) \cdot \sigma_{pp}(C)$$

$$T_{B_p}(M) = \alpha(M) + \beta(M) \cdot \sigma_{pp}(M)$$

Subtract one from another:

$$T_{B_p}(M) - T_{B_p}(C) = [\alpha(M) - \alpha(C)] + \beta(M) \cdot \sigma_{pp}(M) - \beta(C) \cdot \sigma_{pp}(C)$$

Add and subtract $\beta(C) \cdot \sigma_{pp}(M)$ to rewrite as:

$T_{B_p}(M) =$ — Disaggregated brightness temperature

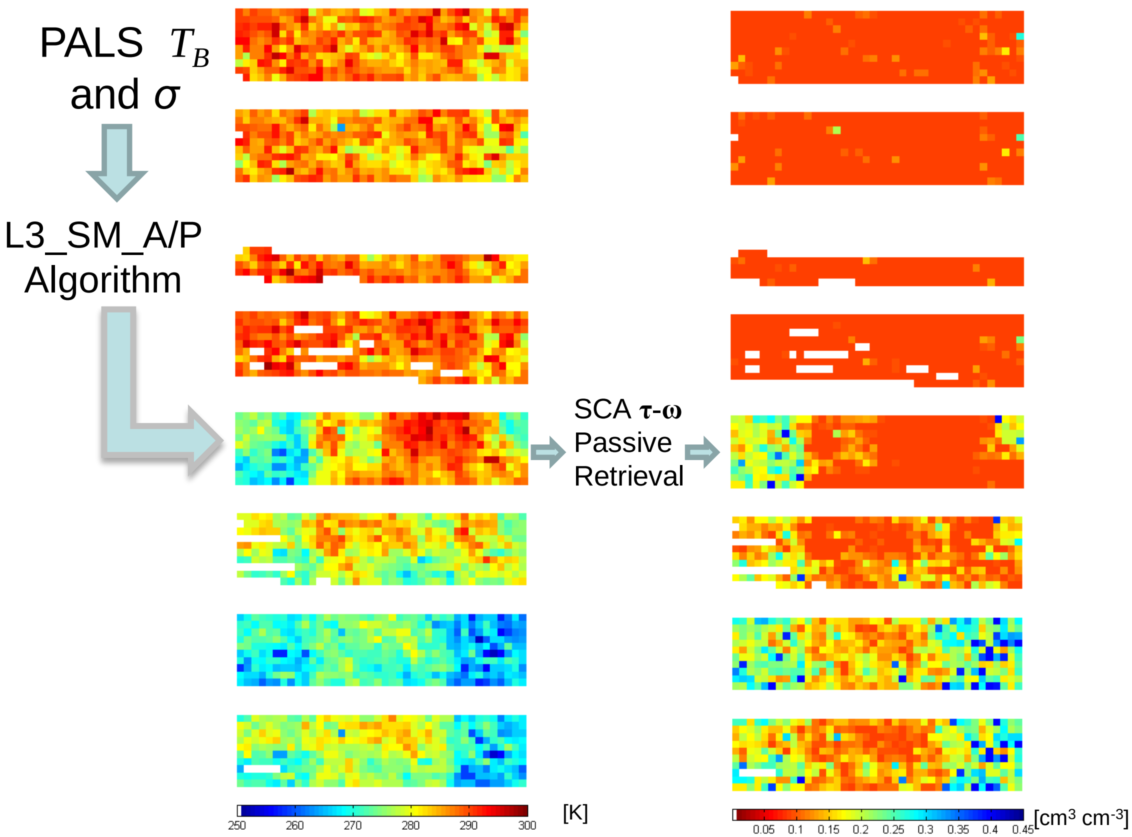
$T_{B_p}(C) +$ — Parent scale-C brightness temperature

$\beta(C) \cdot [\sigma_{pp}(M) - \sigma_{pp}(C)] +$ — Scale-C sensitivity parameter β times smaller scale-M variations in σ_{pp}

$[\alpha(M) - \alpha(C)] + [\beta(M) - \beta(C)] \cdot \sigma_{pp}(M)$ — Contribution of scale-M variations of the parameters

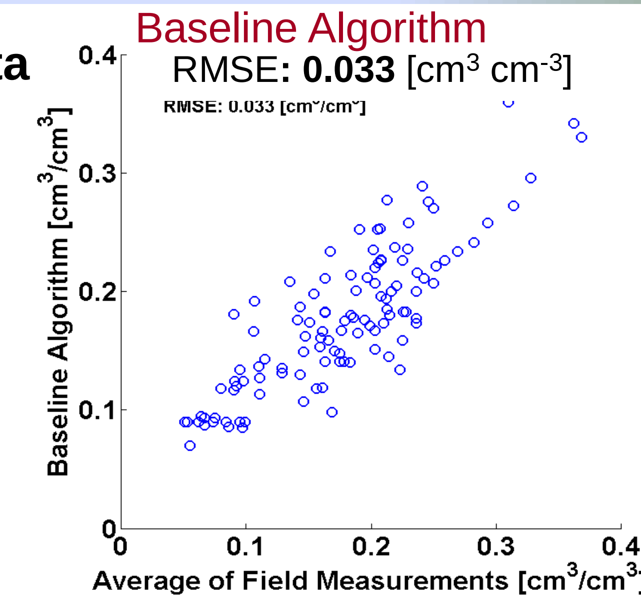
L2_SM_AP Algorithm Overview

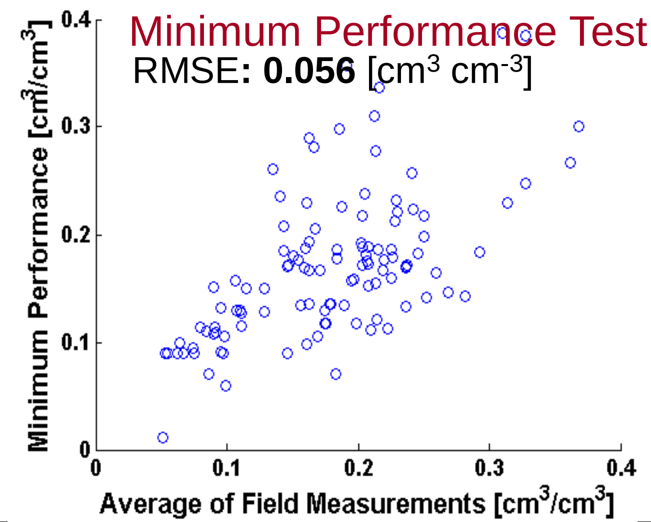
Test of Baseline Algorithm Using SMEX02 PALS Data



Disaggregated T_B (0.8 km)

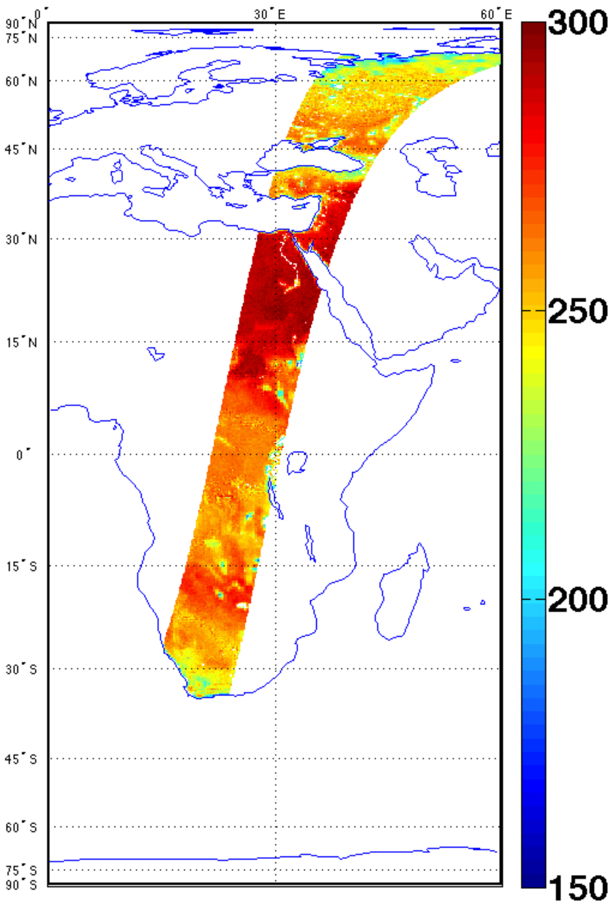
Estimated Soil Moisture (0.8 km)



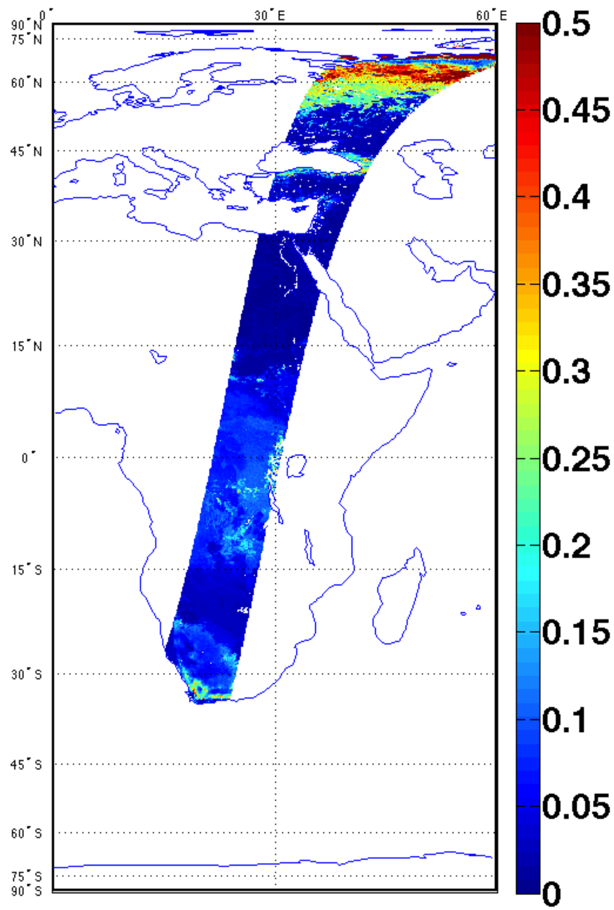


Sample of L2_SM_AP Data

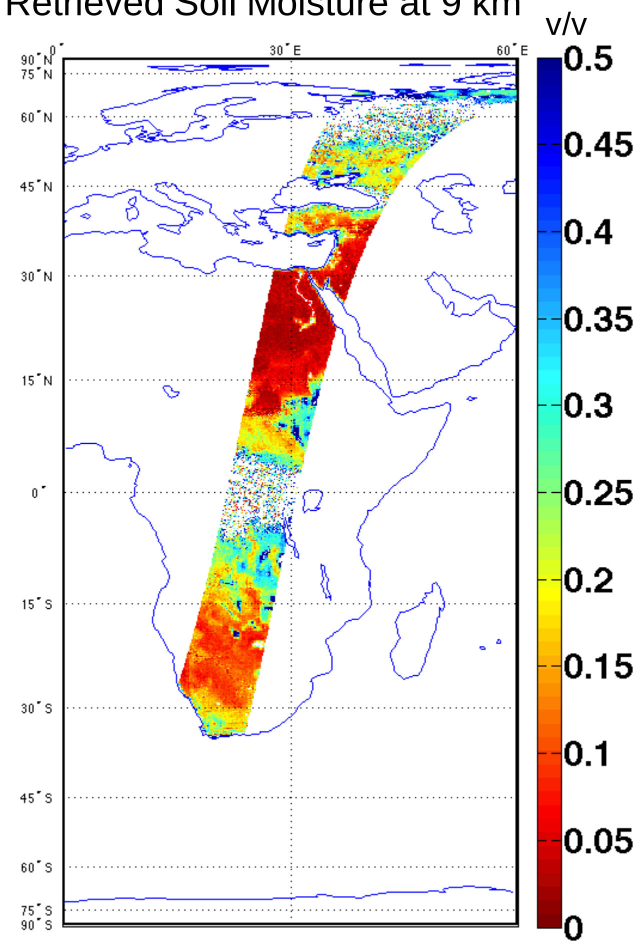
Disaggregated Tbv at 9 km K



Aggregated S0vv at 9 km



Retrieved Soil Moisture at 9 km



From Global Simulation

SMAP L2_SM_AP Cal/Val Approach

- Pre-launch objectives are to:
  - *Acquire and process data with which to calibrate, test, and improve models and algorithms used for retrieving SMAP science data products;*
  - *Develop and test techniques and protocols used to acquire validation data and to validate SMAP science products in the post-launch phase.*

- Post-launch objectives are to:
  - *Verify and improve the performance of the science algorithms;*
  - *Validate the accuracy of the science data products with respect to the requirements*

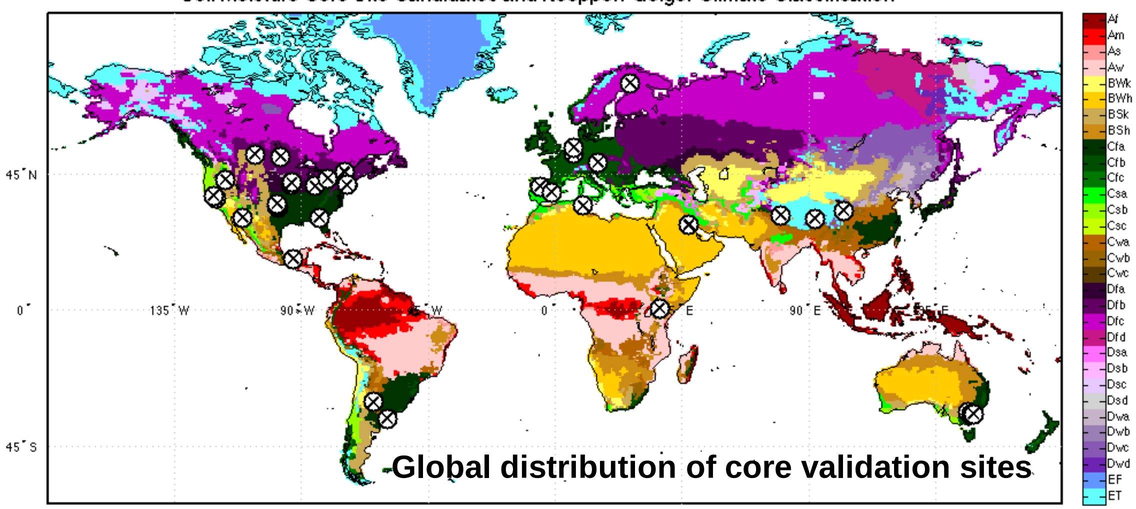
SMAP L2_SM_AP Cal/Val Approach

Methodology	Data	Importance	Metric
Core Sites	Grid Cell averages for each overpass (time- continuous)	Primary	RMSE, Bias, Anomaly, Correlation
Sparse Networks	Spatially scaled grid cell values for each overpass (time-continuous)	Secondary: Pending results of scaling analyses	RMSE, Bias, Anomaly, Correlation
Satellite Products	GPM, SMOS, GCOM-W	Secondary	Pattern matching, correlation
Model Products	Global model outputs (ECMWF, NCEP, GMAO Merra)	Secondary	Correlation
Field Experiments	Detailed estimates for a very limited set of conditions	Primary	RMSE, Bias, Correlation

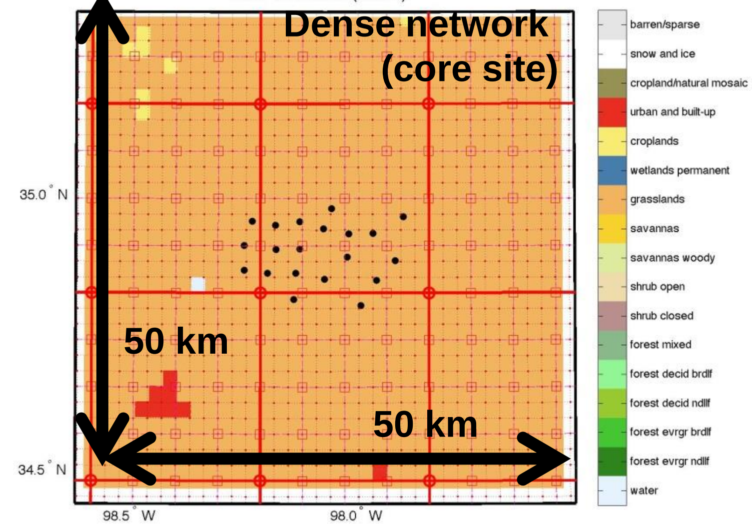
SMAP L2_SM_AP Cal/Val Approach

- Primary calibration and validation approach is utilization of dense in situ soil moisture measurement networks (means multiple soil moisture measurement within the 3-km to 36-km SMAP footprint)

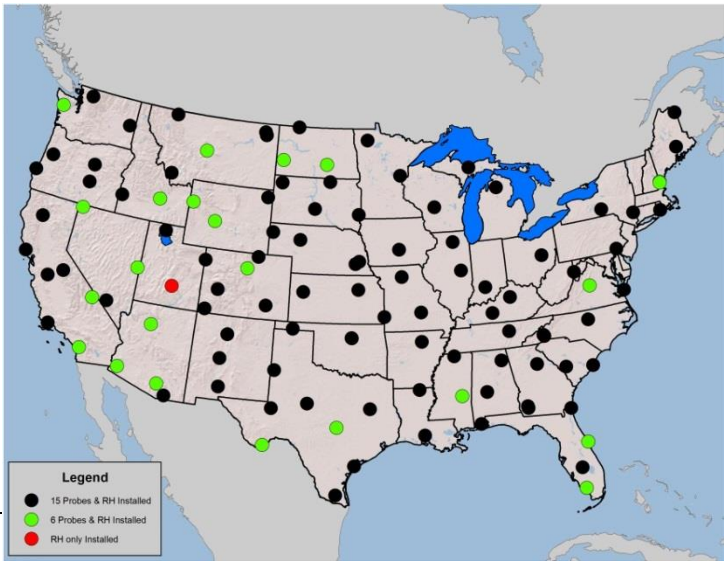
Soil Moisture Core Site Candidates and Koeppen-Geiger Climate Classification



Little Washita (1602)

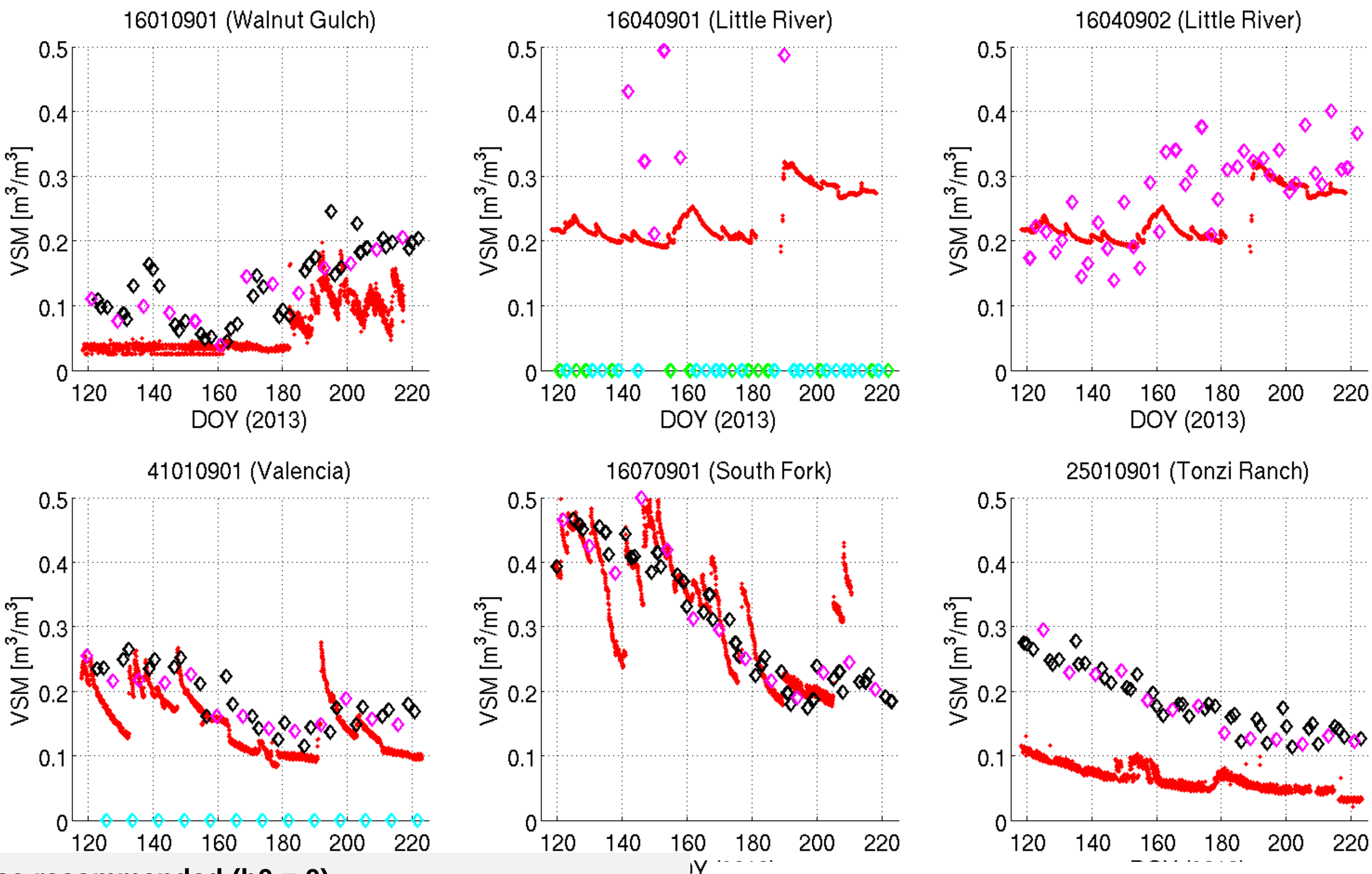


NOAA USCRN



- Secondary approach will utilize large-scale sparse networks (one measurement within footprint), and global remote sensing and model-based soil moisture data products

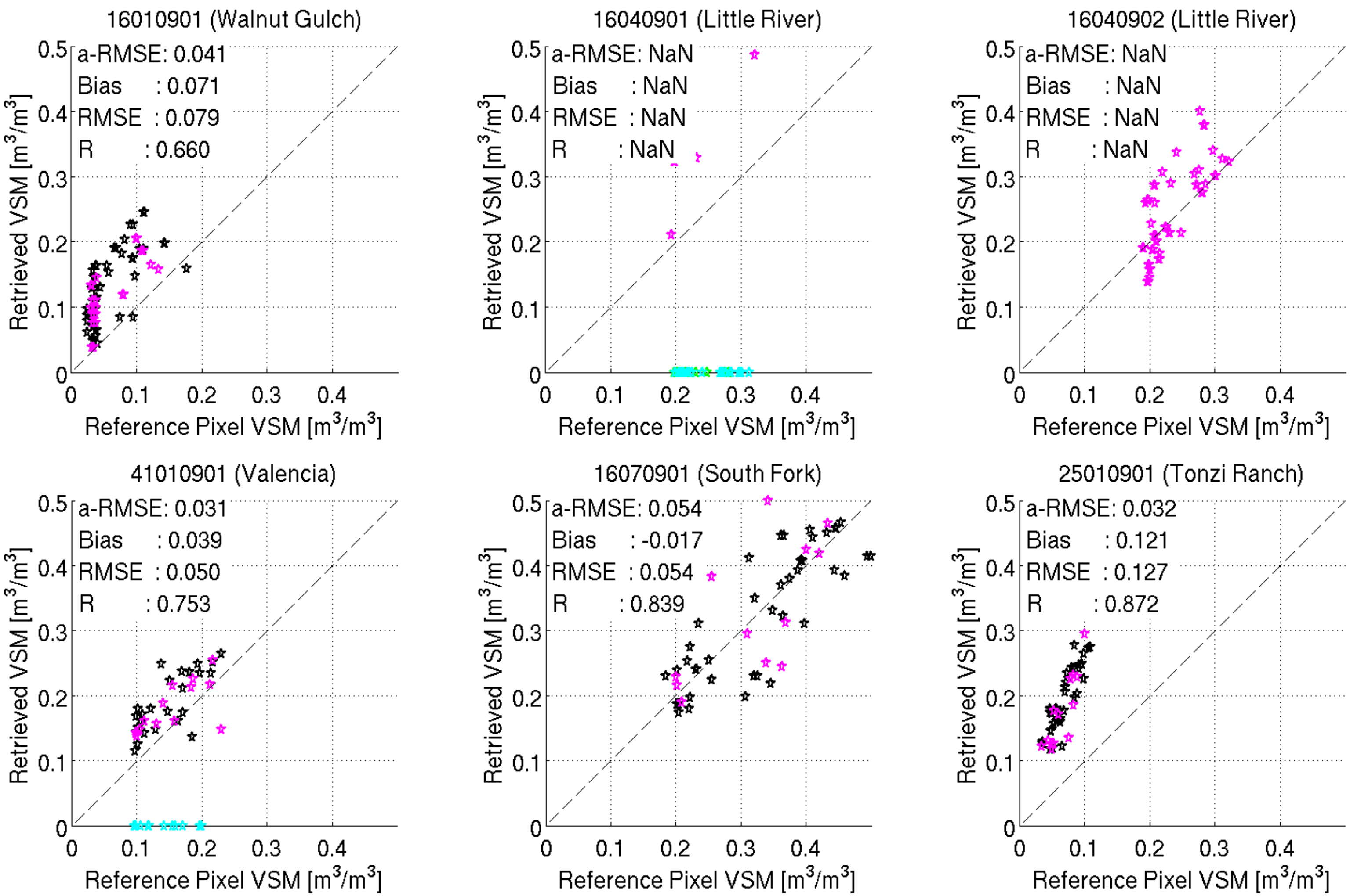
SMAP L2_SM_AP Cal/Val Approach



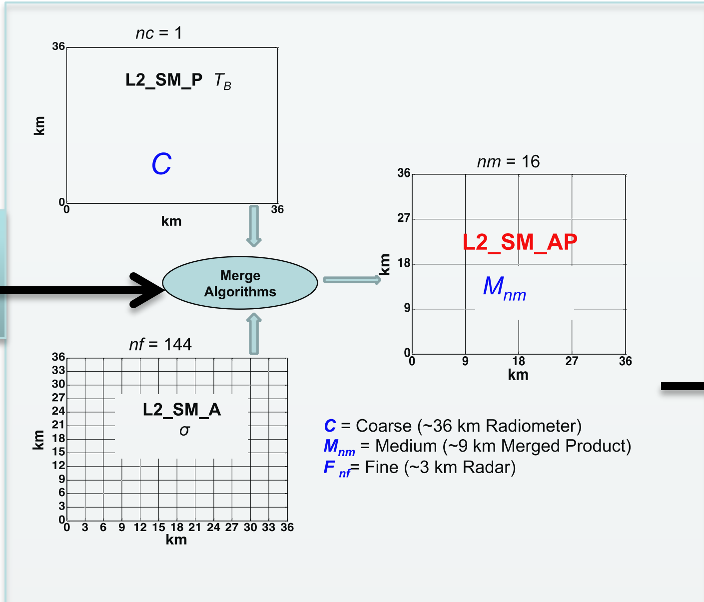
Black: Use recommended (b0 = 0)
Magenta: Retrieval attempted and succeeded but use not recommended (b0 = 1, b1 = 0, b2 = 0)
Green: Retrieval attempted but failed (b0 = 1, b1 = 0, b2 = 1)
Cyan: Retrieval not attempted (b0 = 1, b1 = 1)

- Simulated L2_SM_AP product using land surface parameters from 2001
  - **i.e. not comparable to in situ or other products**
- Surface flag to be included

SMAP L2_SM_AP Cal/Val Approach



SMAP L2_SM_AP Cal/Val Approach



Ancillary Data

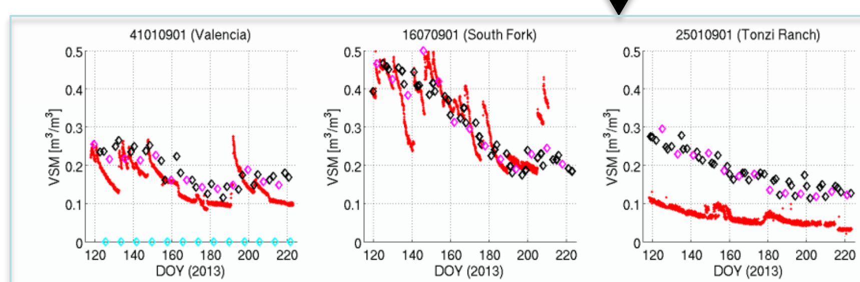
QC and scaling of *in situ* soil moisture data to 9 km grid cell

Core Site *in situ* Soil moisture data

Comparison and evaluation of L2_SM_AP against scaled *in situ* data

Computation of Bias, RMSE and aRMSE

Optimization of algorithm and model parameters



Plan – Rehearsal 2

- **Core validation sites**
  - Classify sites most suitable for validation at 9 km
  - Use displaced pixel technique to encompass most of the in situ observations for Cal/Val
  - Use of relevant scaling function for comparison against L2_SM_AP

- **Sparse network**
  - Identify feasible sites
  - Use triple collocation

- **Model and Algorithm Parameters Optimization**
  - Optimize tau-omega model parameters (b,h,ω) using available data (collaborate with L2_SM_P team)
  - Optimize the L2_SM_AP algoritm parameter over different landcovers and temporal window

- **Tools and Other Data**
  - Use of In-house developed tools for Cal/Val
  - Field Campaign data, Satellite Data (Aquarius), Model data

Postlaunch SMAP L2_SM_AP Cal/Val Approach

Sno.	Cal/Val Analysis
1	Validation of L2_SM_AP soil moisture against soil moisture observations from core sites (*using displaced grid cells)
2	Triple colocation analysis using model data, sparse network sites and L2_SM_AP soil moisture retrievals
3	Pattern mapping with other satellites (GPM, GCOM-W and SMOS)
4	Cross comparison with L2_SM_P and L2_SM_A soil moisture products
5	Assessment of surface/quality flags in L2_SM_AP products
6	Assessment against various ancillary information and landcovers (e.g., closer to large water bodies, highly vegetated regions)
7	Field campaign airborne data analysis for L2_SM_AP Algorithm
8	Comparison of result from field campaign data with output from SMAP L2_SM_AP to validate the disaggregated Tb
9	Validation of the SMAP L2_SM_AP soil moisture against intensive in situ soil moisture observations and retrievals from airborne data

Thanks