National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology

Soil Moisture Active Passive Mission

SMAP

Level 2/3 Passive Soil Moisture Products

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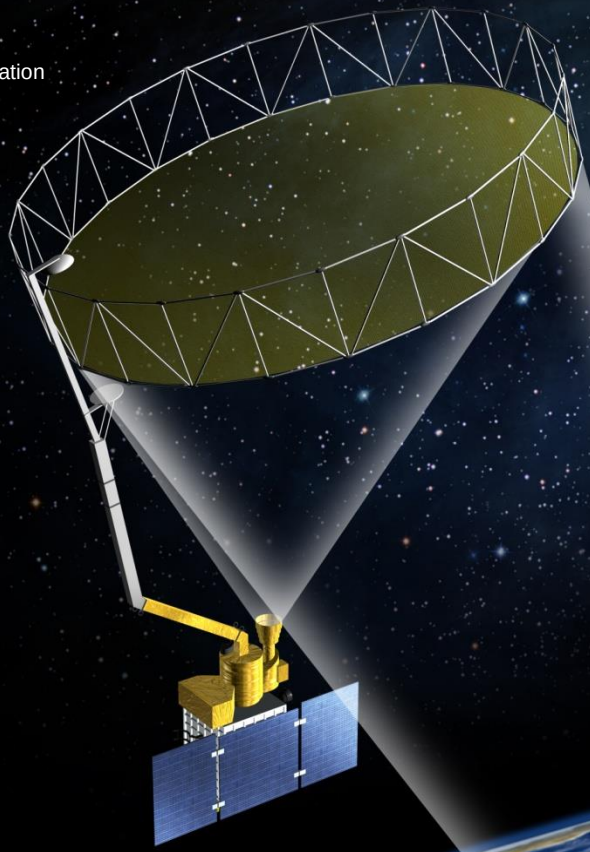

SMAP L2_SM_P At a Glance

- Derived from SMAP TB and ancillary data.
- Processed and posted on global 36-km EASE2-Grid projection.
- Soil moisture retrieved using Single Channel Algorithm (SCA).
- 6:00 am descending passes only.
- Project 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/m^2 (averaged over the spatial resolution scale)."

"SMAP shall provide a Level 2 data product (L2_SM_P) at 40 km spatial resolution representing the average soil moisture in the top 5 cm of soil."

L2_SM_P Cal/Val Methodologies

Methodology	Role	Constraints	Resolution
Core Validation Sites	Accurate estimates of products at matching scales for a limited set of conditions	• In situ sensor calibration • Limited number of sites	• In Situ Testbed • Cal/Val Partners
Sparse Networks	One point in the grid cell for a wide range of conditions	• In situ sensor calibration • Up-scaling • Limited number of sites	• In Situ Testbed • Scaling methods • Cal/Val Partners
Satellite Products	Estimates over a very wide range of conditions at matching scales	• Validation • Comparability • Continuity	• Validation studies • Distribution matching
Model Products	Estimates over a very wide range of conditions at matching scales	• Validation • Comparability	• Validation studies • Distribution matching
Field Campaigns	Detailed estimates for a very limited set of conditions	• Resources • Schedule conflicts	• Airborne simulators • Partnerships

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L2_SM_P in Phase 1 Cal/Val Rehearsal

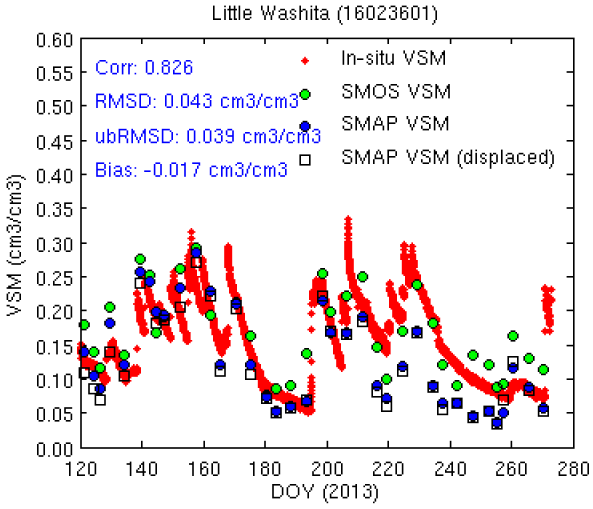
- L2_SM_P simulated using SMOS TB:
  - SMOS 6:00 am TB interpolated at 40 deg (same as SMAP incidence angle) on EASE2 Grid
  - SMAP ancillary data on EASE2 Grid
  - SCA applied, adjusted for effects of water, vegetation, surface temperature, and roughness.
  - Output packaged in hdf5
- L2_SM_P soil moisture retrieval extracted at core validation sites.
- Matchup continuously updated as new data became available during rehearsal.
- Validation metrics computed from L2_SM_P soil moisture retrieval time series and in-situ soil moisture time series at core validation sites.

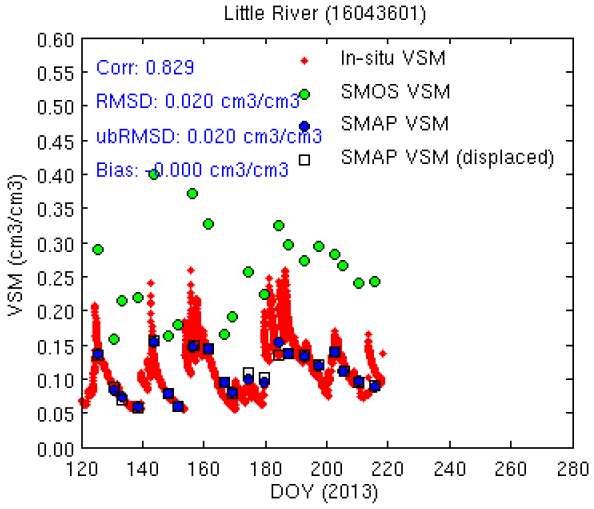
L2_SM_P Phase 1 Cal/Val Core Sites

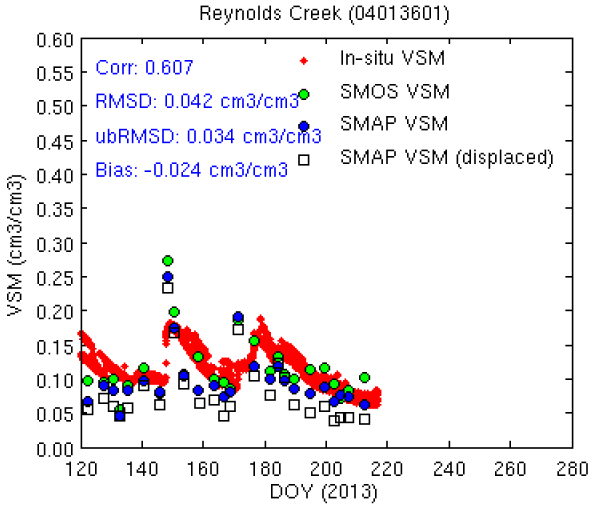
Calibrated in-situ data available in some sites only

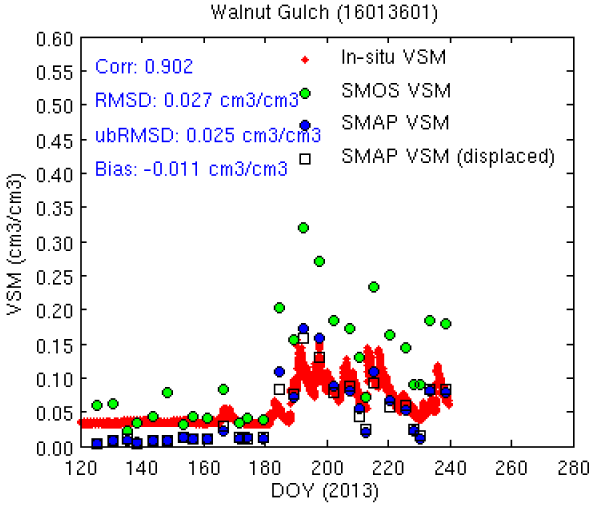
Core sites	36-km EASE2 indices (row,col)	3-km EASE2 indices (row,col)
Little Washita, OK, USA	(87,220)	(1042,2633)
Little River, GA, USA	(97,259)	(1158,3097)
Reynolds Creek, ID, USA	(64,170)	(768,2032)
Walnut Gulch, AZ, USA	(97,188)	(1155,2248)
Fort Cobb, OK, USA	(86,219)	(1026,2618)
St. Josephs, IN, USA	(69,255)	(823,3053)
South Fork, IA, USA	(66,232)	(790,2782)
Tonzi Ranch, CA, USA	(77,159)	(921,1897)
REMEDHUS1, Spain	(69,468)	(827,5611)
Valencia1, Spain	(74,479)	(883,5743)
Yanco1, Australia	(319,874)	(3825,10479)
Yanco2, Australia	(320,874)	(3834,10486)
Kyeamba, Australia	(321,878)	(3848,10526)
Bell Ville, Argentina	(310,310)	(3711,3713)

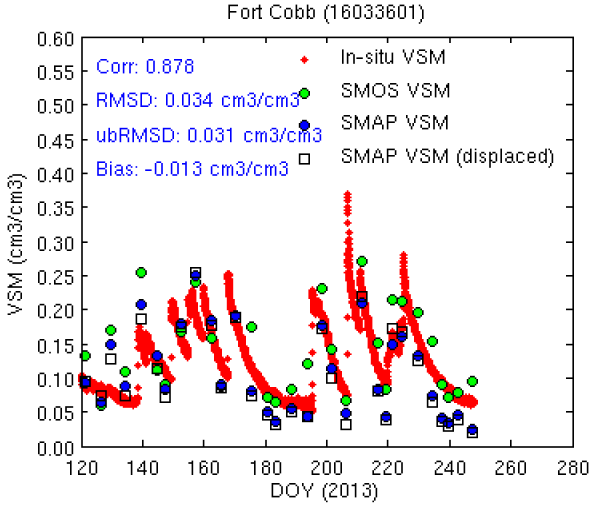
L2_SM_P Time Series Comparison (1)

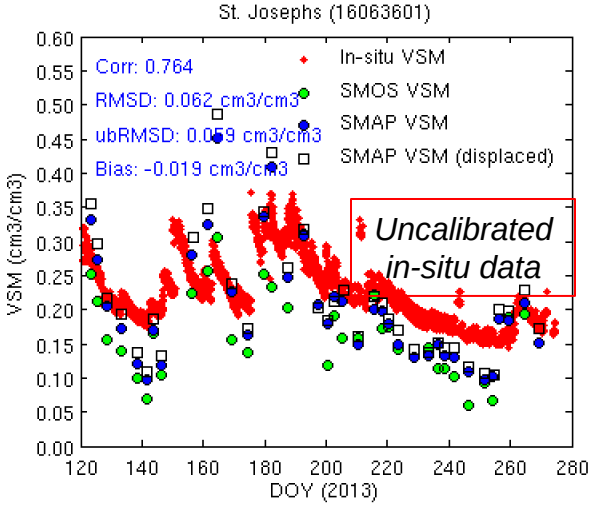




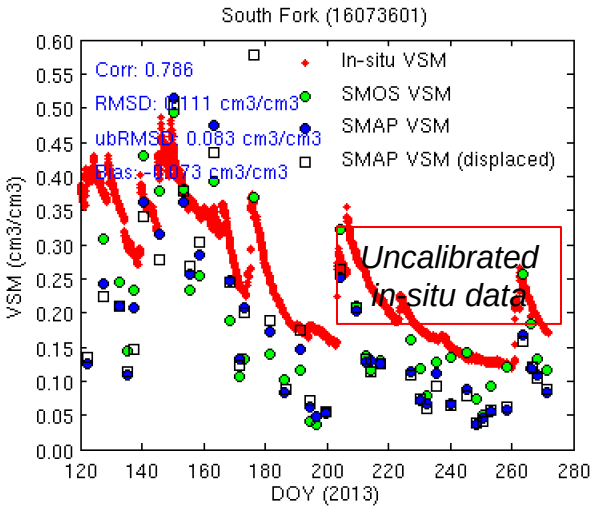


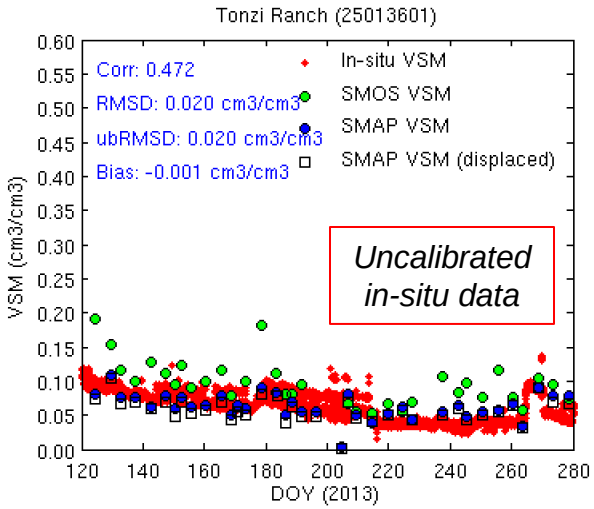


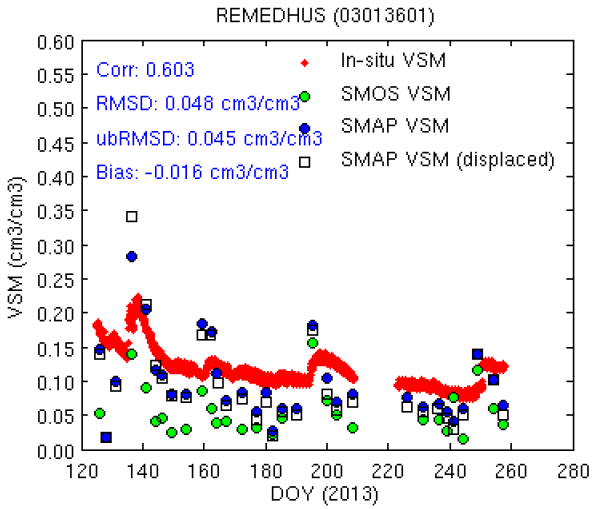


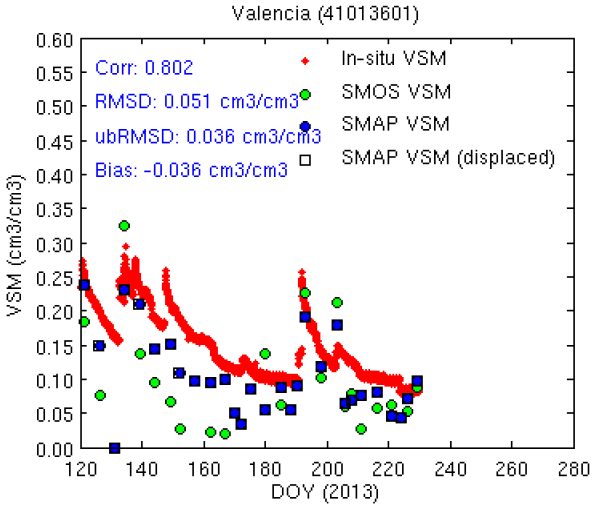


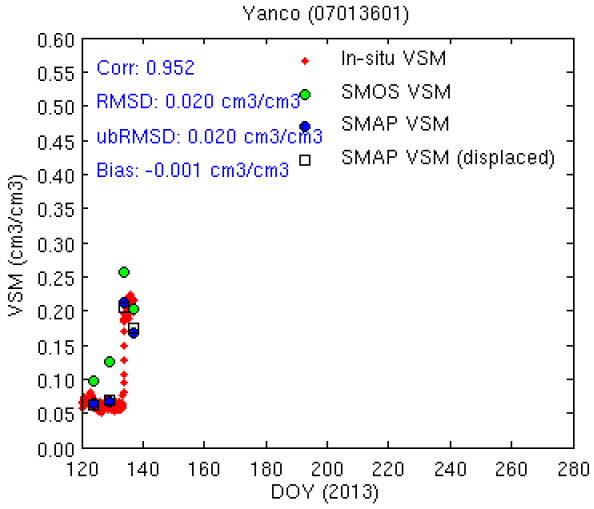
L2_SM_P Time Series Comparison (2)







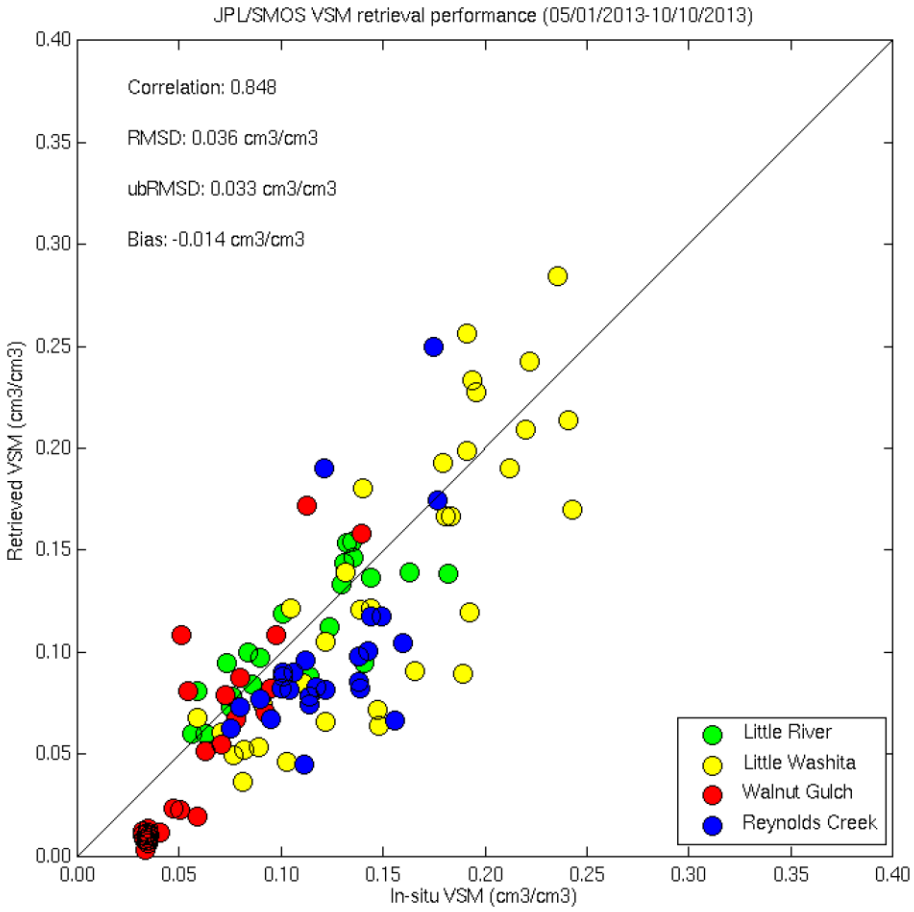




L2_SM_P at USDA Core Sites

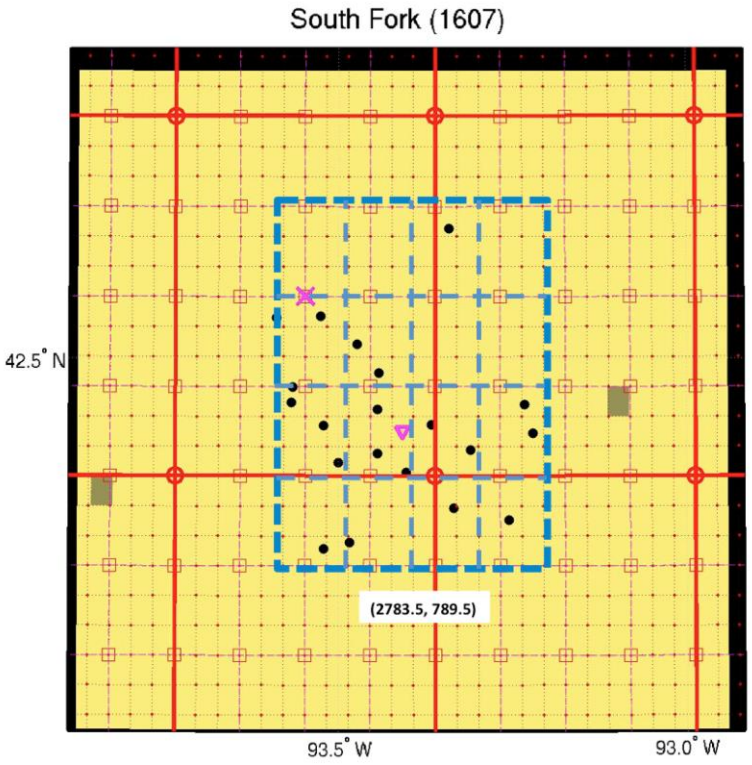
Five-month comparison between simulated L2_SM_P and calibrated in-situ soil moisture data from USDA ARS watershed sites

- High temporal correlation: *SMOS TB registered actual soil moisture variability.*
- RMSE = 0.036 cm3/cm3: *L2_SM_P's accuracy meets SMAP science requirement with very small bias.*
- Longer data records needed to more accurately estimate of L2_SM_P's performance.



Displaced Pixel L2_SM_P Retrieval

- During Phase 1 Cal/Val Rehearsal, we noticed:
  - Individual sensors in certain sites are not uniformly distributed within a 36-km grid cell
  - Some sites even have sensors covering multiple 36-km grid cells
  - Potential increase in uncertainty in comparison between satellite retrieval and in-situ data
- Solution: Displace L2_SM_P nominal processing domain (on 36-km EASE2 Grid) in small increments (multiples of 3 km) to better match the actual distribution of individual sensors.

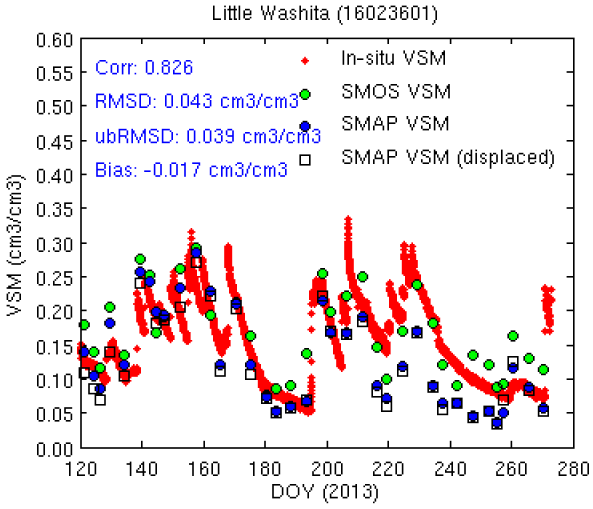


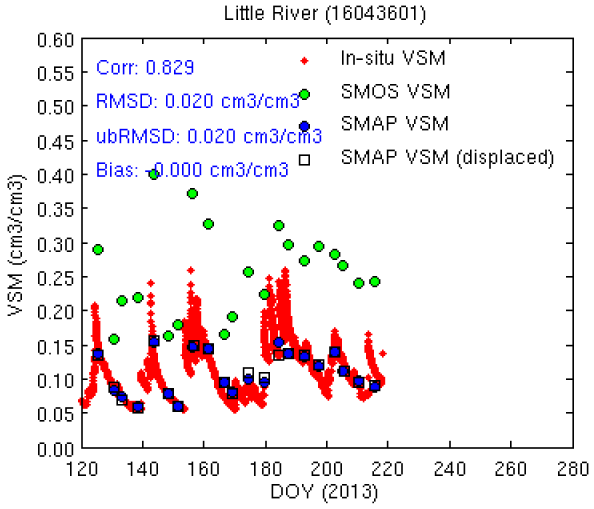
Displaced Pixel L2_SM_P Retrieval

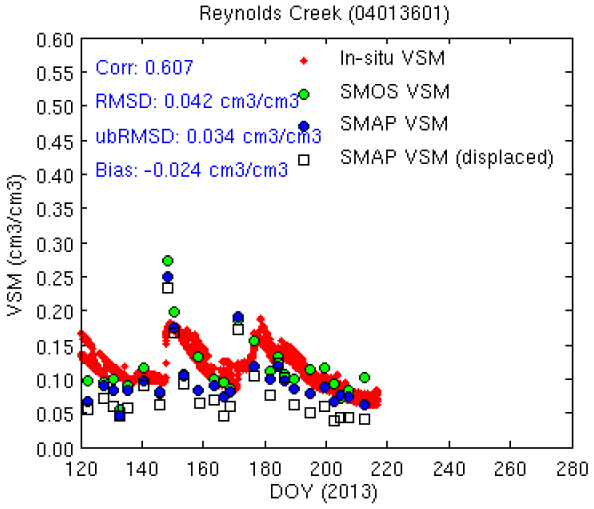
Steps:

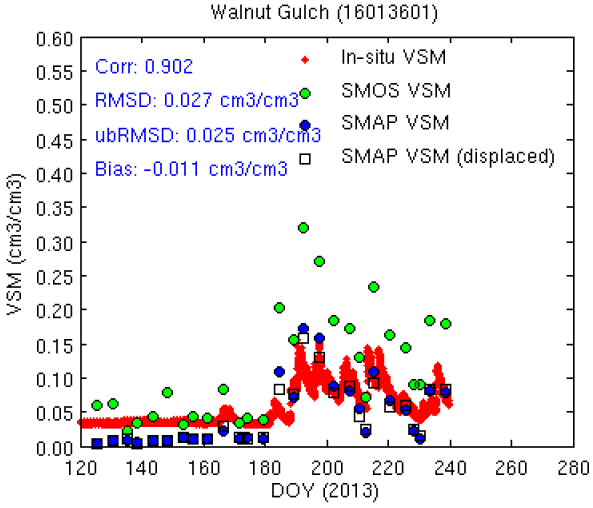
- Start with Level 1 time-ordered SMOS 40-deg data (TB, TSURF, and VSM)
- Express displaced 36-km processing domain in 3-km EASE2 (row,col) bounding indices
- [A] Bin TB and TSURF in displaced 36-km grid cells
- [B] Bin 3-km ancillary data (NDVI, VWC, soil texture) in displaced 36-km grid cells
- Use [A] and [B] to perform Displaced Pixel L2_SM_P Retrieval using optimal coefficients obtained without displacement

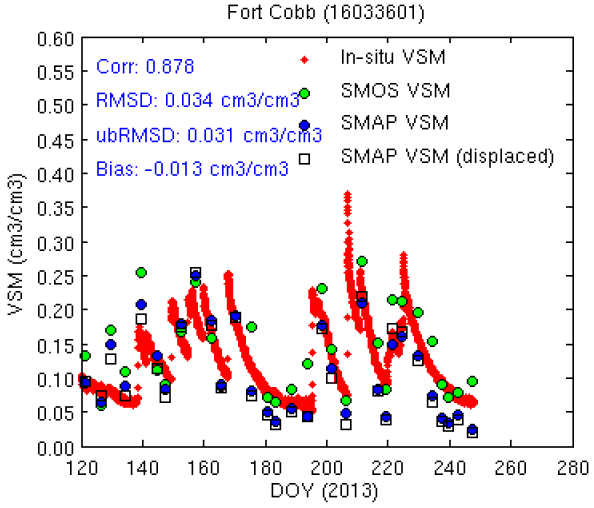
L2_SM_P Time Series Comparison (1)

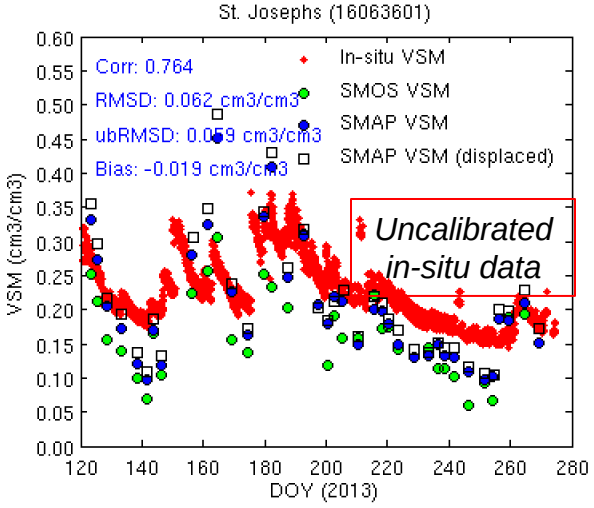




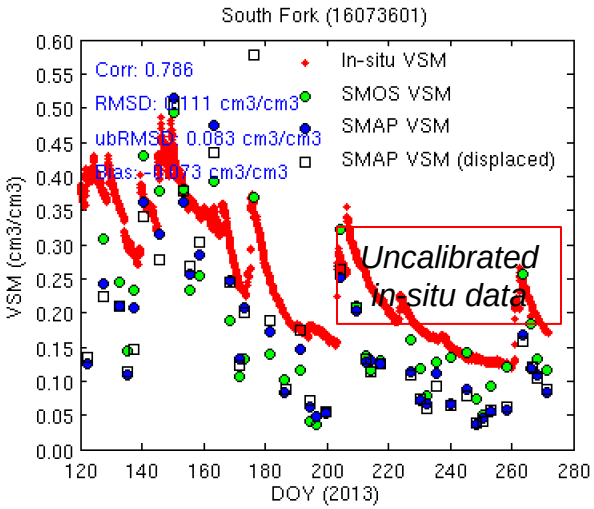


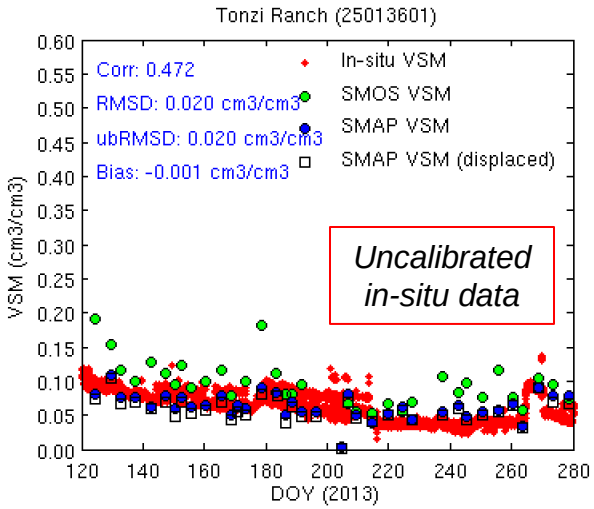


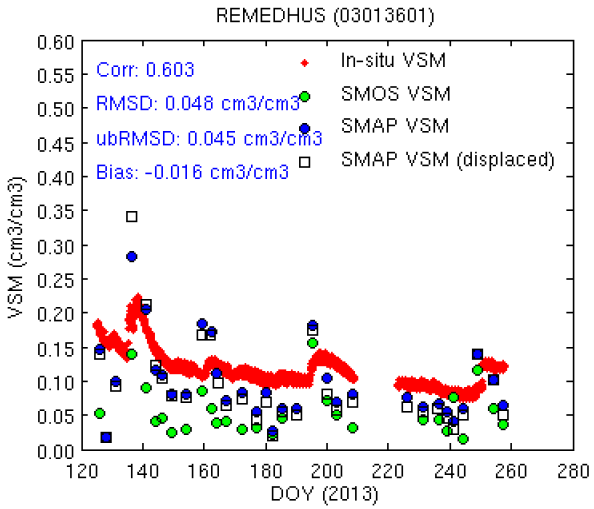


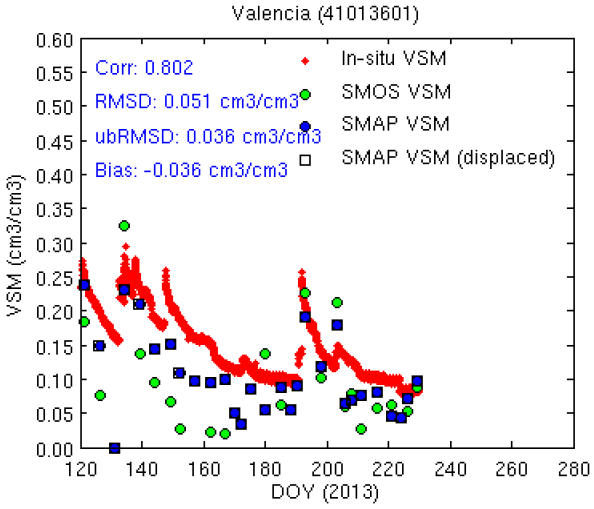


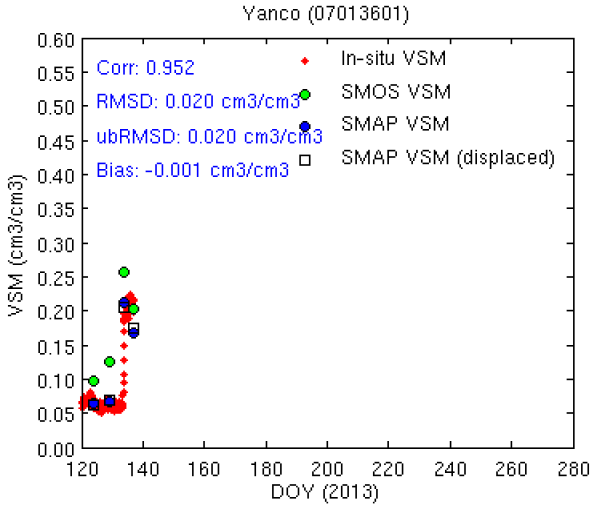
L2_SM_P Time Series Comparison (2)





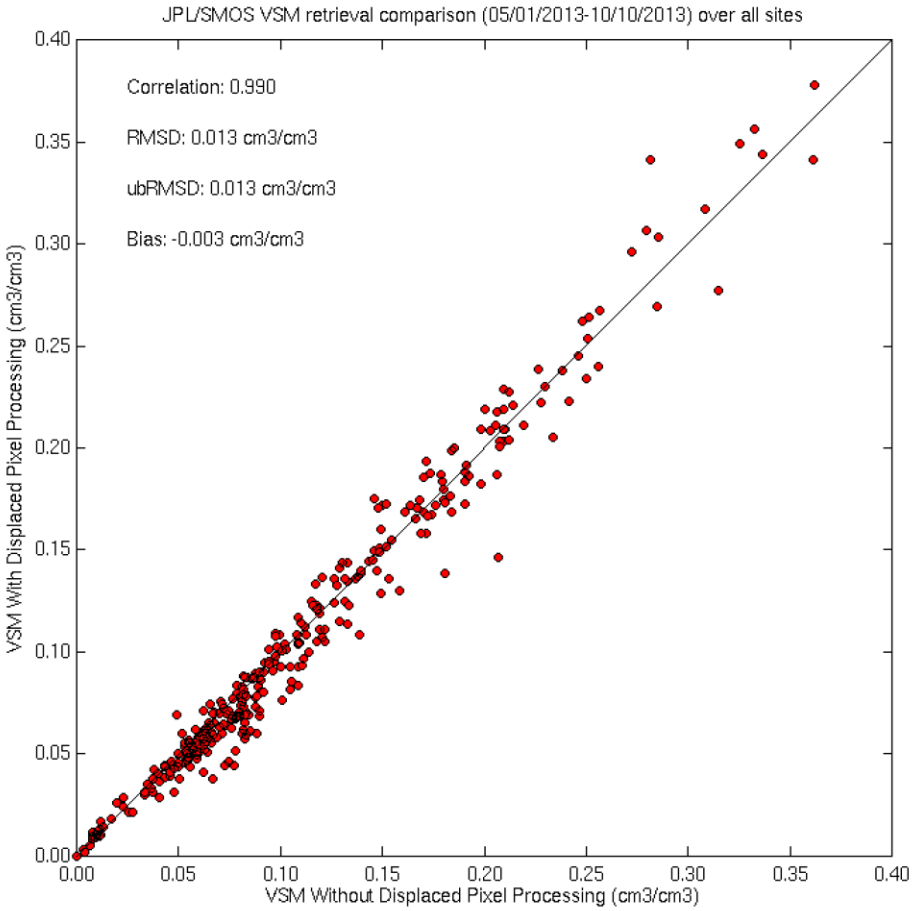






Displaced Pixel Retrieval: Before vs. After

- Not much difference in L2_SM_P retrieval on original EASE2 Grid vs. displaced EASE2 Grid
- Expected because % displacement in TB main beam IFOV is small
- Time-consuming, can't run operationally without 'forking out' SPS inversion module and running it in a different environment, output format not compatible with SMAP product specifications



Conclusion

- Postlaunch Cal/Val of L2_SM_P successfully tested using simulated L2_SM_P derived from SMOS.
- Time-series comparison with calibrated in-situ data demonstrated L2_SM_P's accuracy meets the SMAP science requirement (RMSE < 0.04 cm3/cm3).
- Potential value of Displaced Pixel L2_SM_P Retrieval explored. Small change in retrieved soil moisture does not justify the code complexity and software maintenance involved.
- Ongoing work on Phase 2 Cal/Val Rehearsal.

Backup

L2_SM_P Cal/Val Rehearsal Activities

Timeline

Launch

In-Orbit Checkout (3 months)

- Compare retrieval with core validation site data aggregated to footprint scale
- Compare retrieval with SMOS retrieval for spatial and temporal consistency

- Understand impacts of primary processing ‘knobs’ (geophysical thresholds, algorithm coefficients, ancillary data, or dielectric models) on retrieval using baseline and option algorithms.

- Develop fine-tuned algorithm that attains L1 accuracy requirement
- Correct any long-term bias through RMSE and correlation analysis
- Compare retrieval with other satellites during hurricane season

- Complete delivery of validated (in Stage 1 sense) Level 2 and 3 products to DAAC

L+3 mo

L+6 mo

L+9 mo

L+15 mo