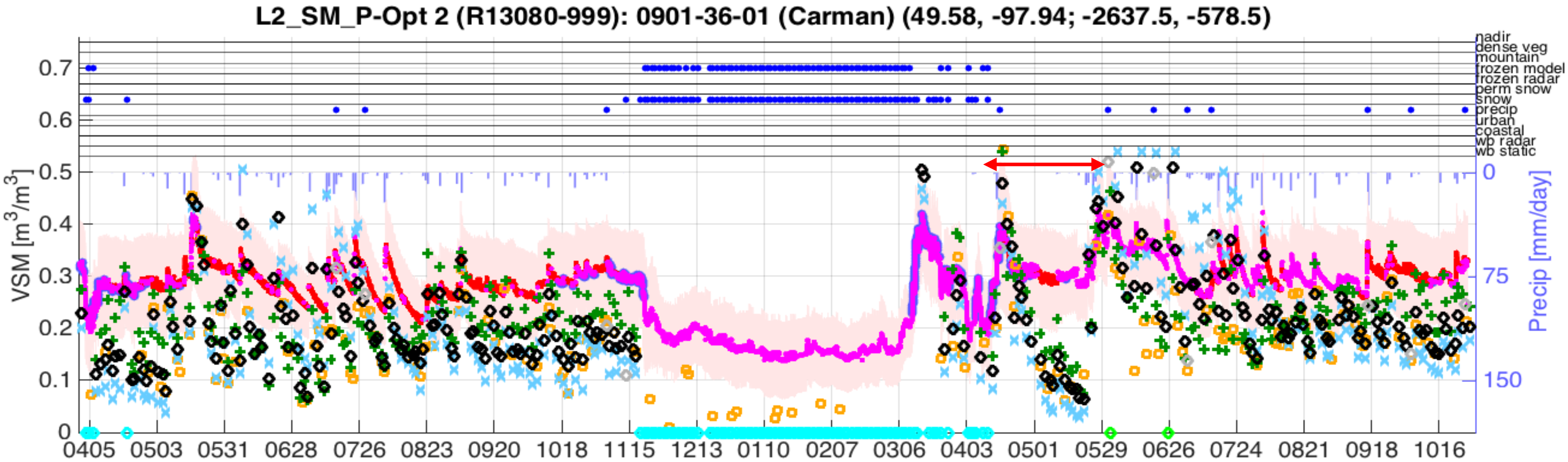
Jet Propulsion Laboratory
California Institute of Technology

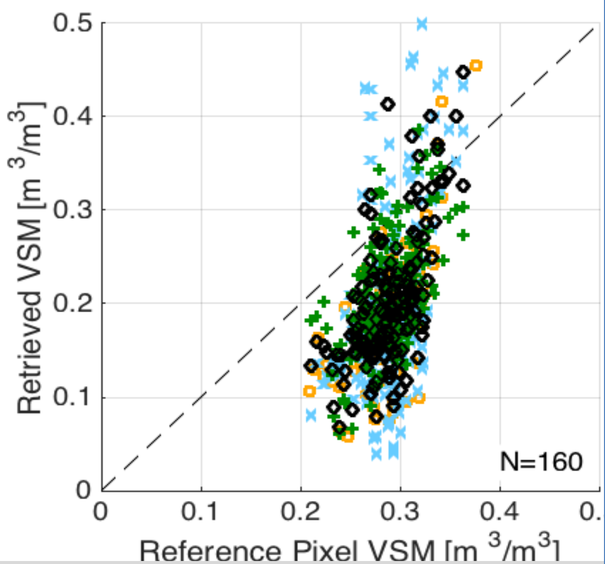
# Carman (Core Pixel)




| Alg | ubRMSE | Bias | RMSE | R |
|---|---|---|---|---|
| SCA-H | 0.092 | -0.086 | 0.126 | 0.478 |
| SCA-V | 0.058 | -0.086 | 0.104 | 0.602 |
| DCA | 0.052 | -0.076 | 0.092 | 0.519 |
| SMOS | 0.056 | -0.108 | 0.122 | 0.729 |
| In Situ | | | | |

Climate class: Cold (Dfb)
Landcover: Croplands

Soil texture:
S-%: 26
C-%: 34
BD: 1.18




- SMAP has an underestimation bias for all algorithms
- SMOS also has an underestimation bias and similar behavior
- During drydowns, SMAP decreases faster than the in situ obs
- The range of soil moisture is larger for SMAP
- The May 2016 time period is very interesting. Need further verification of what rainfall actually occurred during this period.

Black: Use recommended [Retrieval Quality Flag bit(0)=0]
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# Resolving Anomalous SMAP Retrievals: Carman

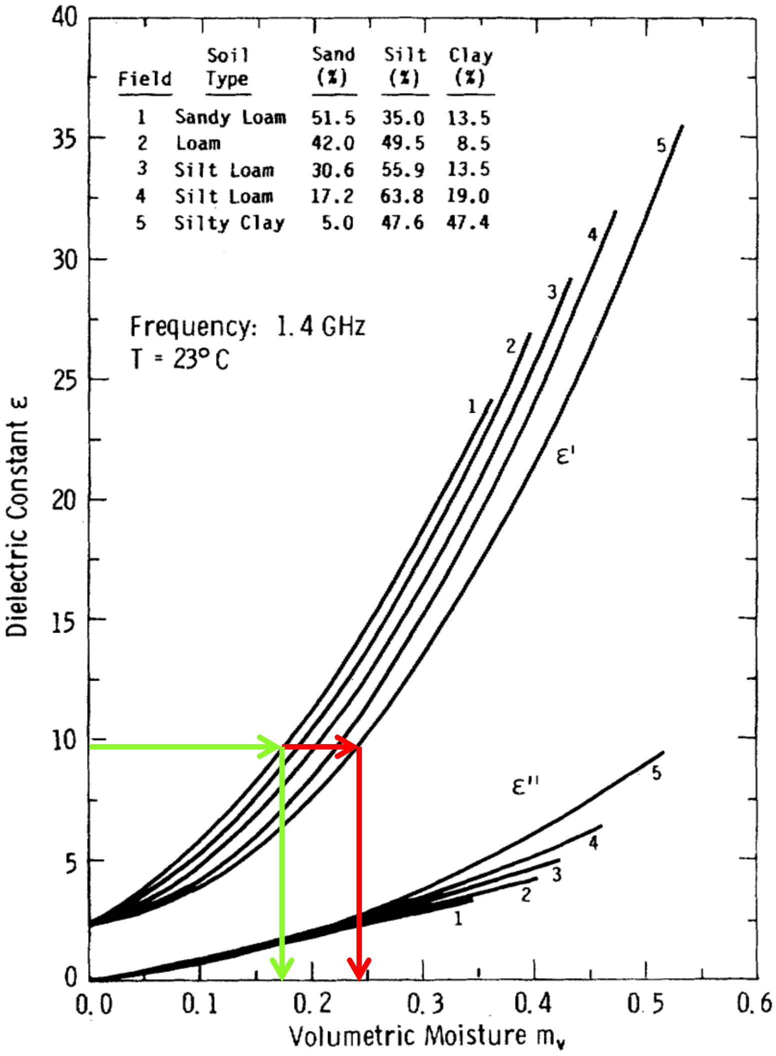
| Source of Error | Resolve/Investigate | Expectation | Status of Assessment |
|---|---|---|---|
| Calibration of *in situ* probes | Conduct gravimetric/bulk density sampling and compare to probe estimates | | Data were collected. |
| Bias in SMAP top-down versus *in situ* at depth | Profile sampling and vertical vs. horizontal probe measurements | Overestimation after rain, potential underestimation otherwise. | Need to compare the 0-5 to at 5 cm measurements collected.<br>*Preliminary results from A. Colliander* |
| Soil texture | Sensitivity analysis and review dc vs. SM relationships | Clay soils can have lower dielectric constants for a given SM due to bound water. Underestimating clay fraction can lead to underestimating SM. | *Requested S. Chan to make some runs.* |
| Upscaling approach | Compare to a dense set of samples from field campaigns, etc. Compare alternative upscaling methods. | | Comparison of RISMA network to ~45 temporary station (both vertical probes) showed a small underestimation bias for RISMA. **This does not explain the SMAP bias.** |
| Dielectric model | Review alternative methods | Different models produce varying SM<br>For Hallikainen, underestimating the clay fraction underestimates SM | No action yet. |
| Soil emission model | All use Fresnel, which assumes uniform properties over the contributing depth | | No action expected. |
| Surface roughness characterization | Do the conditions change significantly over time? Collect roughness data. | Underestimating roughness effects would underestimate SM | Data collected. |
| VWC (NDVI) climatology vs. actual | Compile data sets | Underestimating VWC would underestimate SM | A. Pacheco and R. Bindlish plots. Actual<estimate. **This does not explain the SMAP bias.** |
| b parameter | b values are based on limited experimental data sets | | |
| Alternative tau estimates | Look at DCA and SMOS tau vs, climatology tau | Underestimating VWC would underestimate SM | *R. Bindlish 2015 plots, 2016 requested.* |
| Vegetation model | The current model is a simplification. However, it is difficult to implement more complex approaches<br>Compare SMAP and SMOS parameters and retrievals | | No action yet. |
| Spatial heterogeneity | Compare to PALS | | Data were collected |
| RFI | Review data for potential issues | RFI would lead to underestimates of SM | No action expected. |
| Assuming Ts=Tv | Sensitivity analyses | | No action yet. |
| Source of T data | Compare alternative products; ECMWF, Ka-band<br>Is there a bias? | | No action yet. |
| Temperature normalization model | | Underestimating Ts will underestimate SM | No action yet. |

# Based on J. Powers Slides

- If the RISMA network is calibrated and the upscaling is correct then the errors lie in the retrieval/validation process.
- Examine
  - Clay fraction and dielectric mixing model
  - Vertical vs. horizontal probes

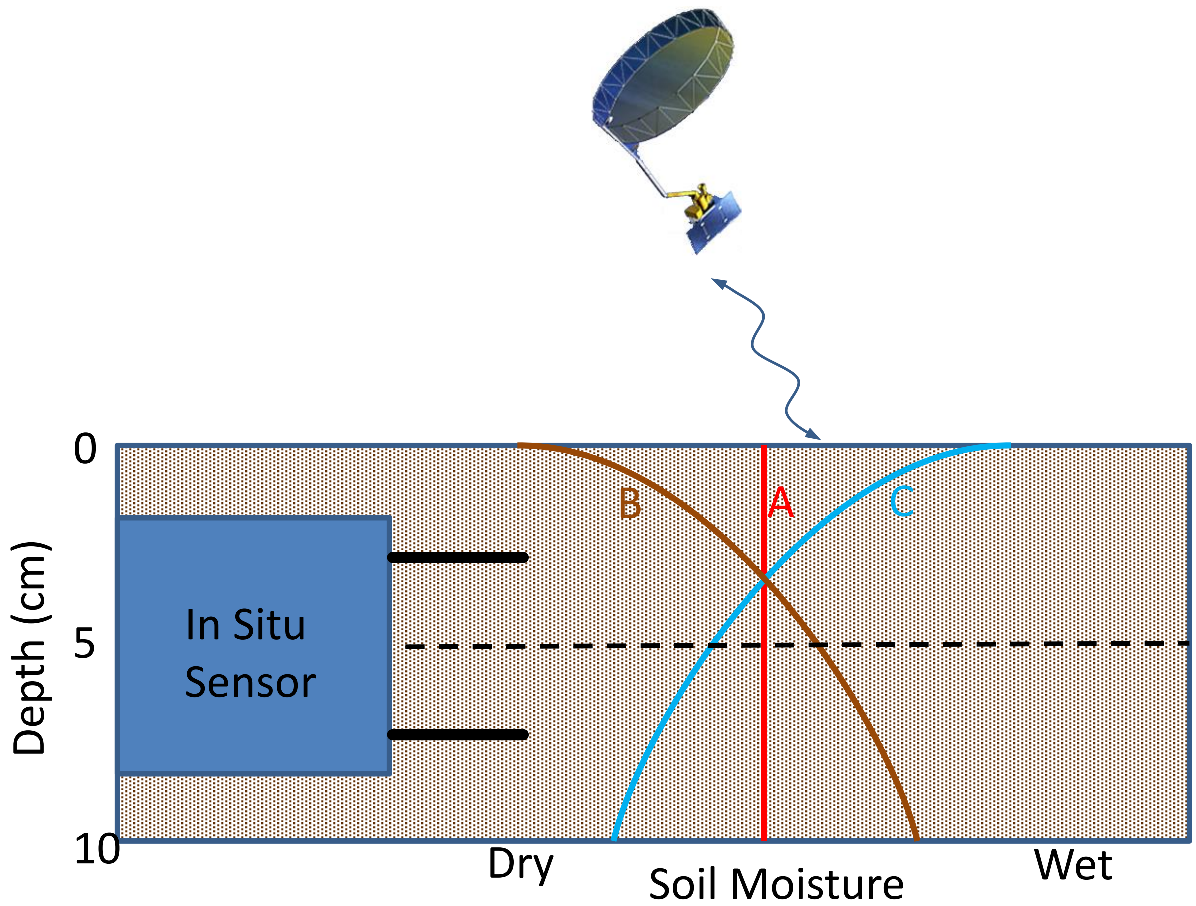
# Impact of Soil Texture on Dielectric Constant-Soil Moisture Relationships

- If the algorithm "retrieves" the dielectric constant and then uses the soil texture to estimate soil moisture, the soil moisture will be smaller for a sand than a clay.
- If there is an underestimation bias for soil moisture, decreasing the clay content would improve retrievals.




M. T. Hallikainen, F. T. Ulaby, M. C. Dobson, M. A. El-rayes, and L. Wu. 1985. Microwave Dielectric Behavior of Wet Soil-Part 1: Empirical Models and Experimental Observations. IEEE Transactions on Geoscience and Remote Sensing. GE-23: 25-34, DOI: 0.1109/TGRS.1985.289497

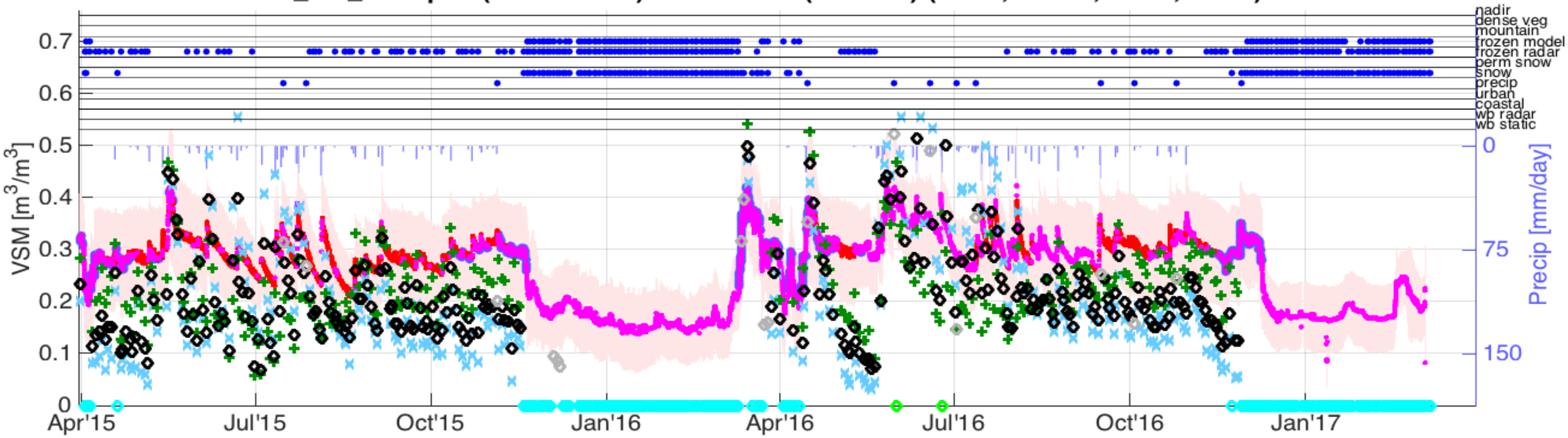
# Top-down Versus at Depth Measurements



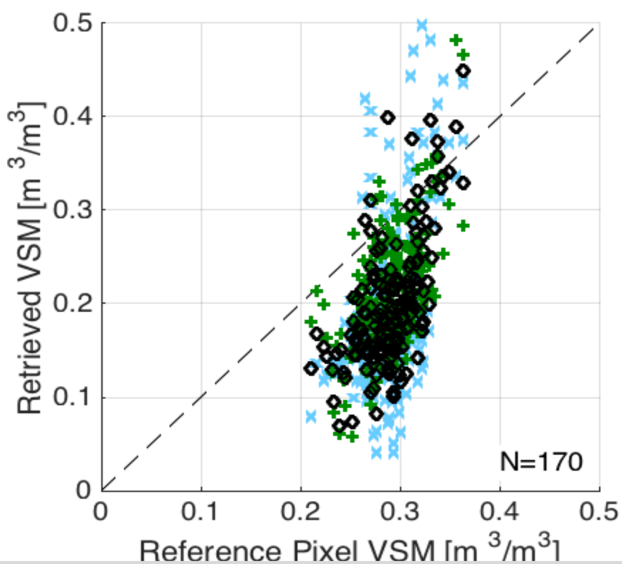

A. Uniform soil moisture with depth: OK!
B. Dry down: Satellite may underestimate vs. in situ
C. Recent rain/irrigation: Satellite may overestimate vs. in situ

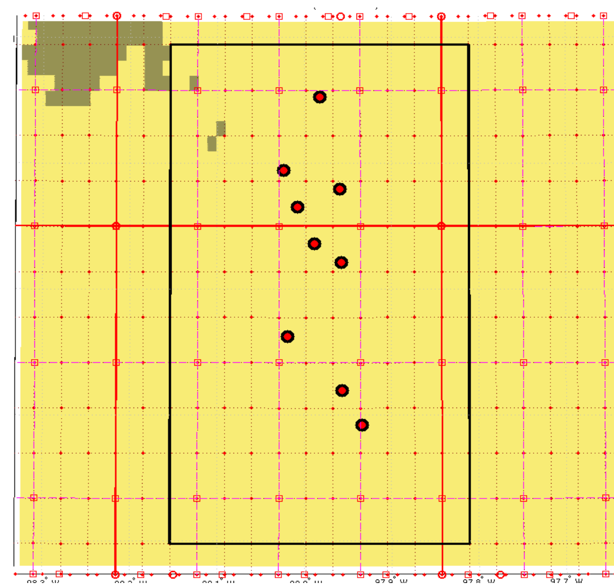
# Carman (Core Pixel)






| Alg | ubRMSE | Bias | RMSE | R |
|---|---|---|---|---|
| SCA-H | 0.092 | -0.092 | 0.130 | 0.434 |
| SCA-V | 0.055 | -0.090 | 0.105 | 0.599 |
| DCA | 0.054 | -0.073 | 0.091 | 0.566 |
| In Situ | | | | |



Climate class: Cold (Dfb)
Landcover: Croplands

Soil texture:
S-%: 30
C-%: 31
BD: 1.18

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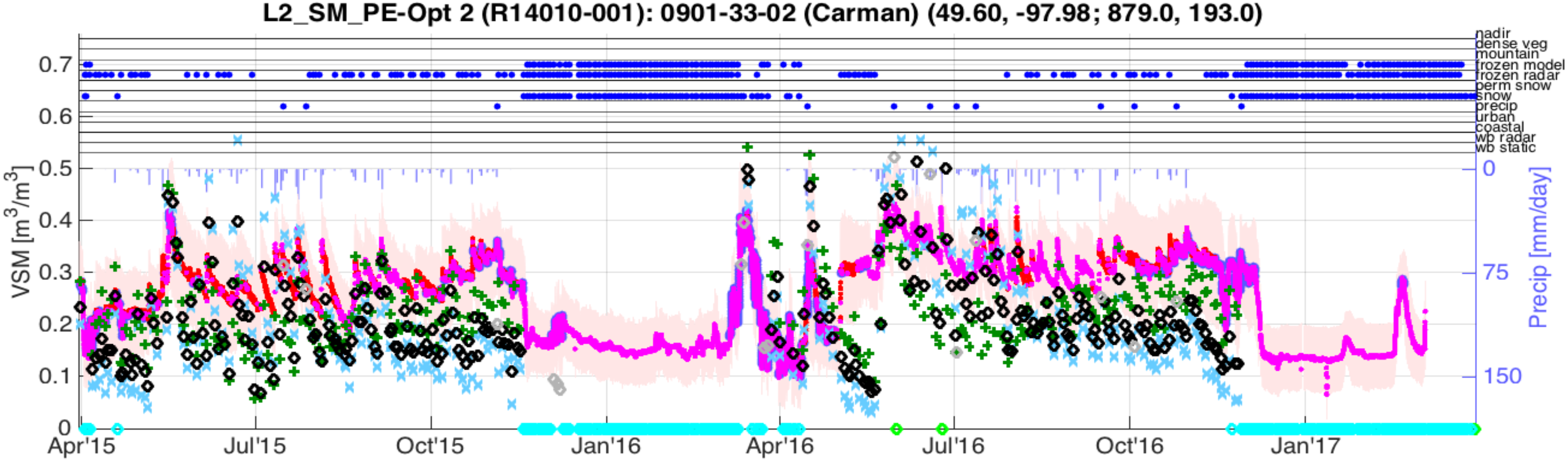
# Carman (Candidate Pixel)




| Alg | ubRMSE | Bias | RMSE | R |
|---|---|---|---|---|
| SCA-H | 0.095 | -0.086 | 0.128 | 0.324 |
| SCA-V | 0.068 | -0.081 | 0.106 | 0.416 |
| DCA | 0.071 | -0.061 | 0.094 | 0.357 |
| In Situ | | | | |

Climate class: Cold (Dfb)
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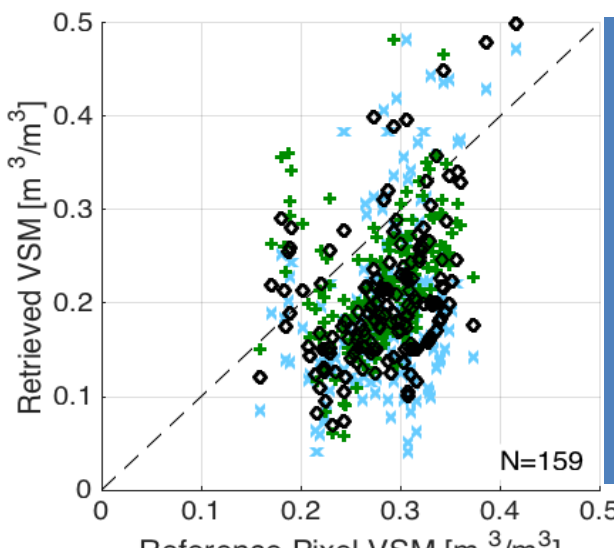


- The range of in situ soil moisture increases when we use the vertical probe data (as opposed to the horizontal).
- Bias improves a bit but all other metrics degrade.
- Results might support using a shallower depth for validation.

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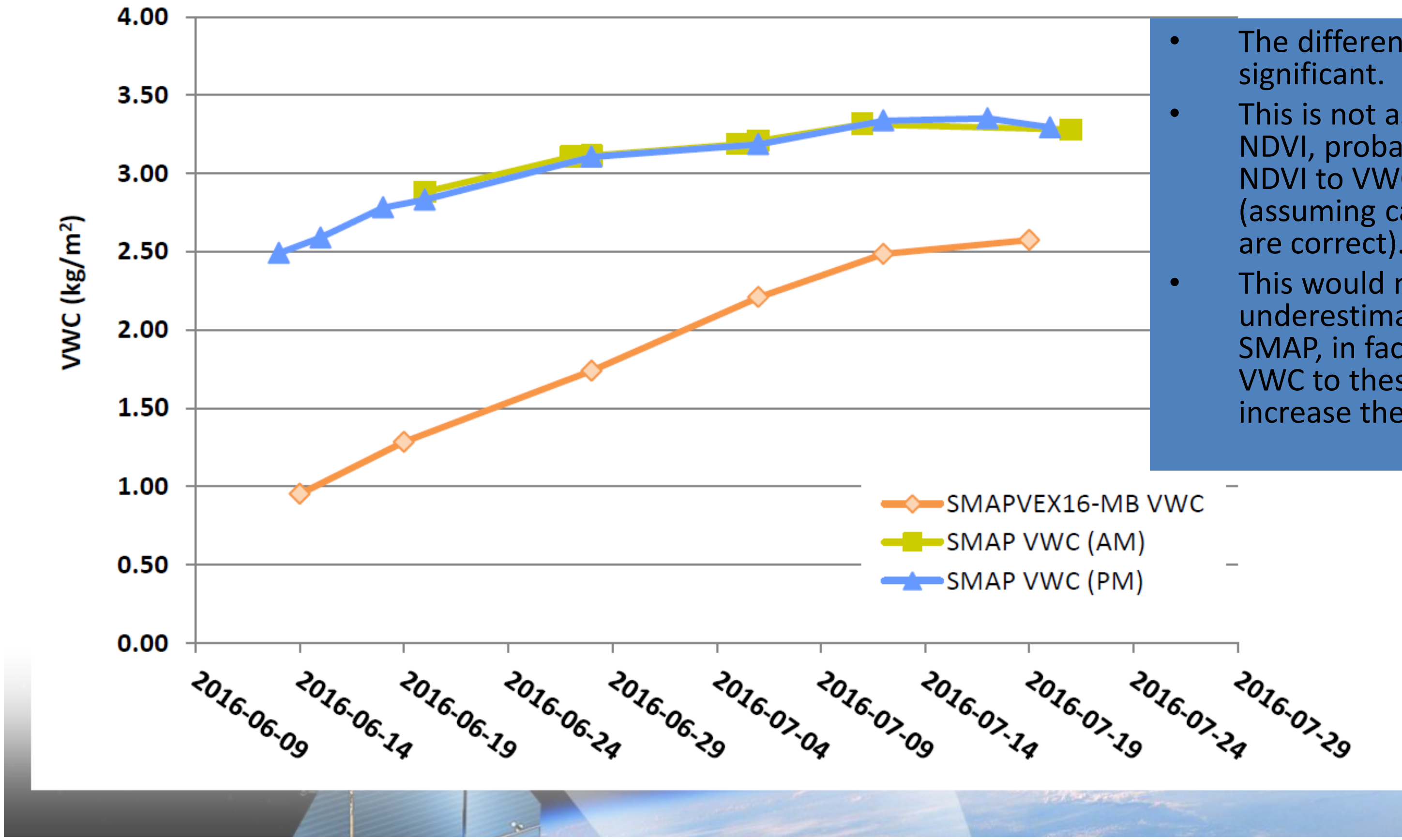
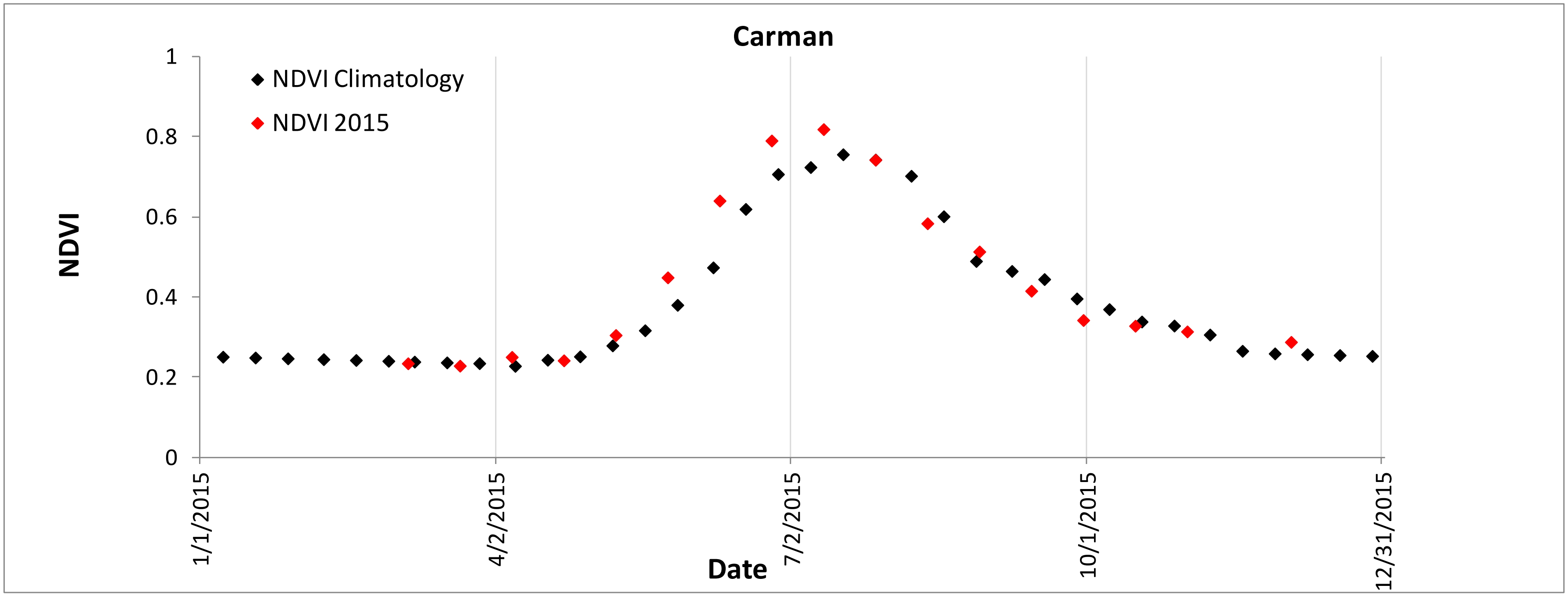
| Temperature normalization model | | Underestimating Ts will underestimate SM | No action yet. |

# Comparison of SMAPVEX16-MB VWC and SMAP Climatology-based Estimates (From Anna Pacheco)

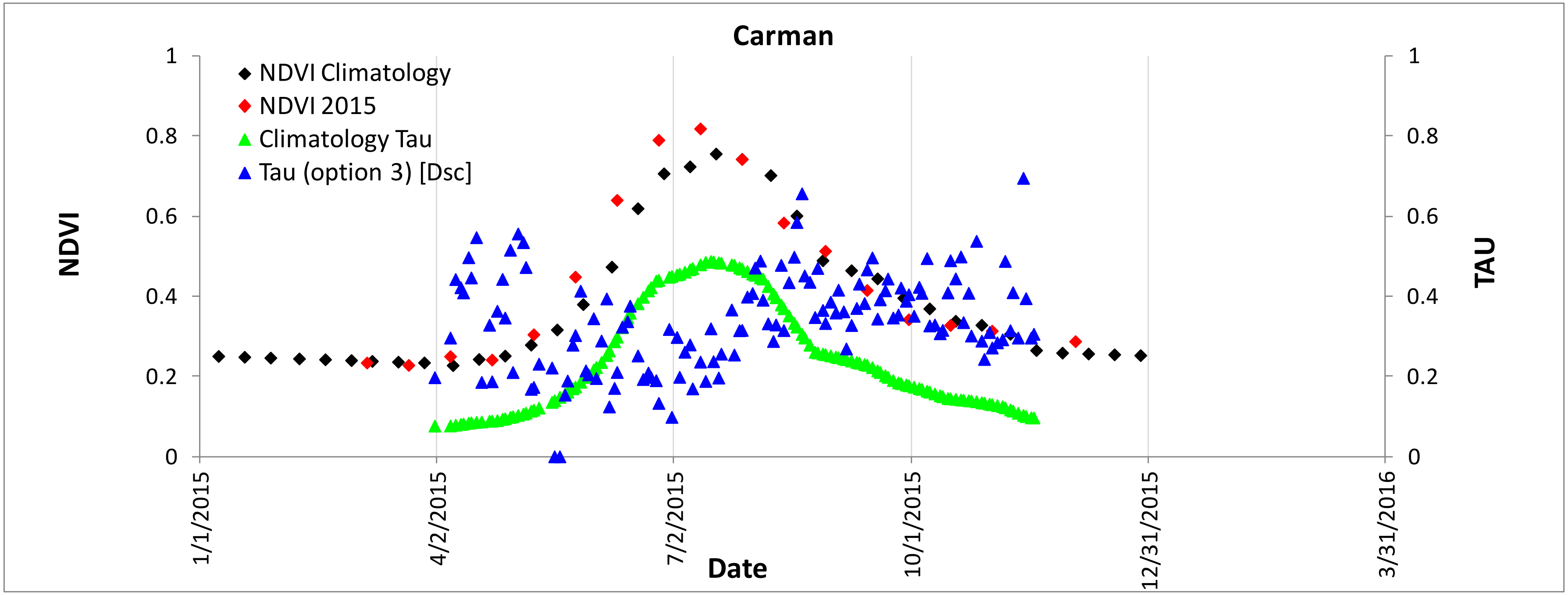



- The differences in VWC are significant.
- This is not associated with NDVI, probably need a better NDVI to VWC function (assuming campaign results are correct).
- This would not explain underestimation bias of SMAP, in fact decreasing VWC to these levels would increase the bias.

# Comparison of Actual and NDVI Climatology for 2015 (Carman)



# Comparison of Actual and NDVI and Tau Climatology for 2015 (Carman)




- What's happening with the DCA retrieved VWC???

# What Would “fix” the Carman Soil Moisture Retrievals

- Increase surface roughness
- Increase tau (~~VWC/NDVI~~ or b) (Omega?)
- Use a surface biased in situ observation or shallower depth
- Decrease clay fraction
- Decrease physical temperature