Center for Western Weather and Water Extremes

SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

# Evaluation of SMAP Soil Moisture Products in California Using In-situ Observations from the Hydrometeorology Testbed

Maryam A. Lamjiri[1], Scott L. Sellars[1], Narendra N. Das[2], Brian M. Henn[1], F. Martin Ralph[1]

[1]Scripps Institution of Oceanography, University of California San Diego

[2] Jet Propulsion Laboratory, California Institute of Technology

30 May, 2017

# Introduction-Soil Moisture Active Passive (SMAP)

- Launched on March 31, 2015.
- provides global map of (surface) soil moisture observations every 2-3 days.
- Radiometer operating at L-band frequency (1.4 GHz)
  - Retrieves soil moisture through moderate vegetation conditions.
  - Independent of cloud cover and night or day.
  - Deeper sensing depth relative to C-band and X-band.
- Benefits from RFI mitigation approach.

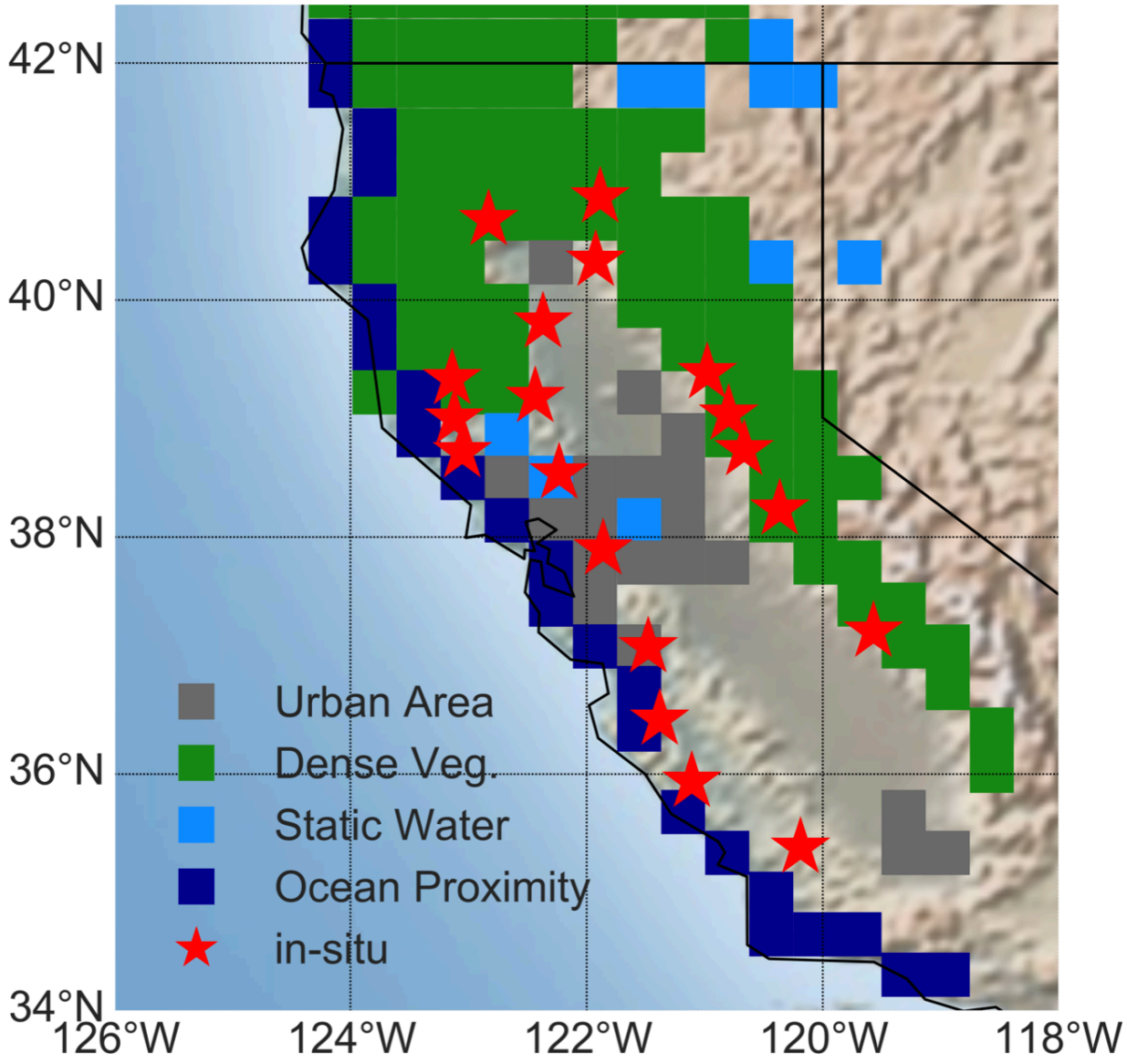
# Data

| Soil Moisture Products | Depth | Spatial Resolution | Temporal Resolution | Limitations |
|---|---|---|---|---|
| SMAP Level 3 | Top 5cm | 36km (9km) | 2-3 days | • Low temporal and spatial resolution<br>• Limited to the top 5cm<br>• Adverse impacts of surface flags |
| SMAP Level 4 | 5 cm | 9km | 3 hours | • Model-derived<br>• Errors in representation of soil properties and processes |
| In-Situ Observations * | 10 cm | Point-Scale | 2 minutes | • Representativeness issue<br>• Different sensing depth |

* These data are currently going through another level of QC, this analysis will be redone with the revised data, so the results may change.

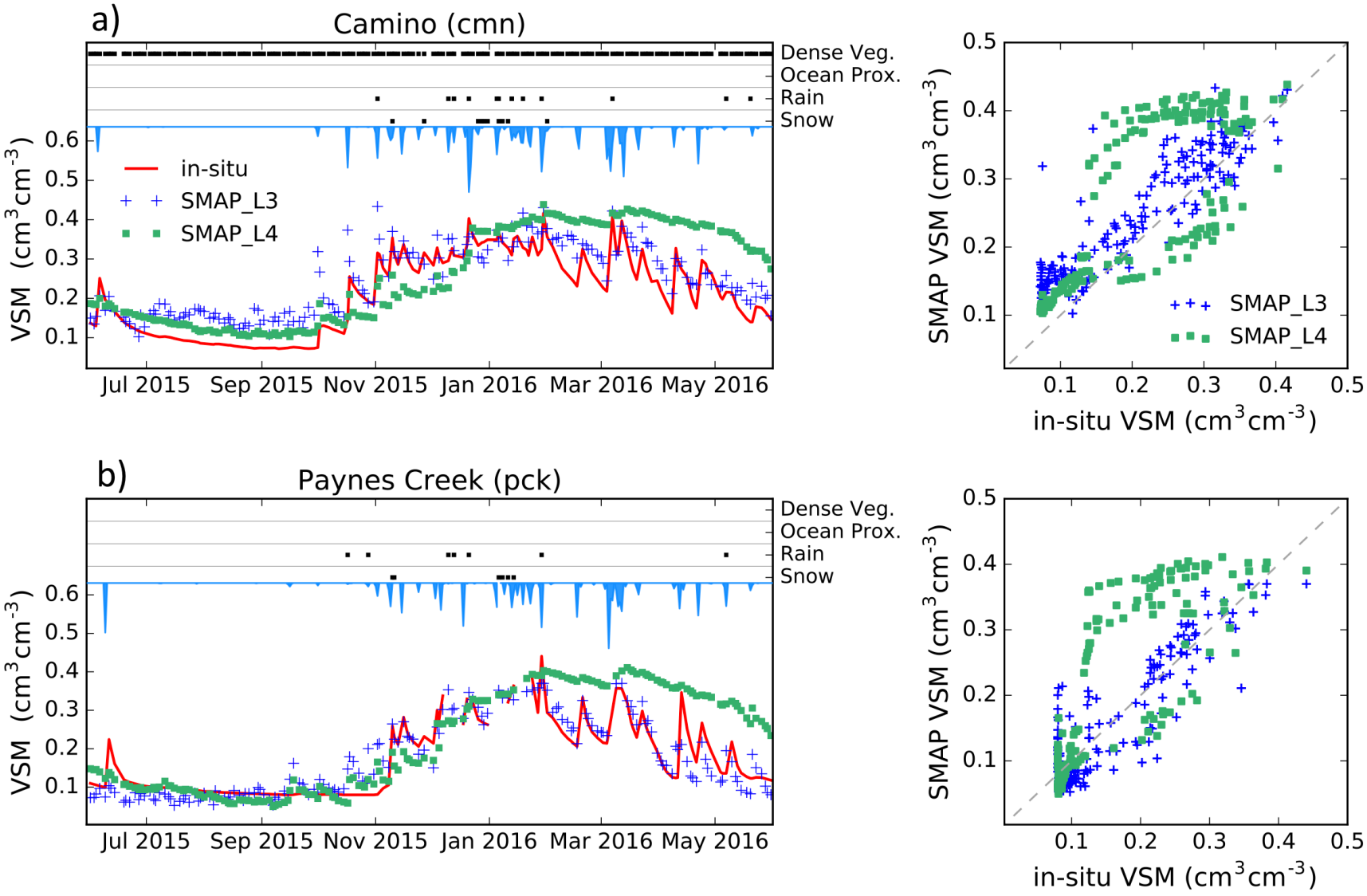
# Data-Surface Flags

- Ocean Proximity
  - Grid cells within 36km of the coast.
- Dense Vegetation
  - 5<VWC < 30 kg/m$^2$
- Urban Area
  - 0.5< Urban fraction < 1
- Static Water
  - 5% < Grid cell water fraction < 10%



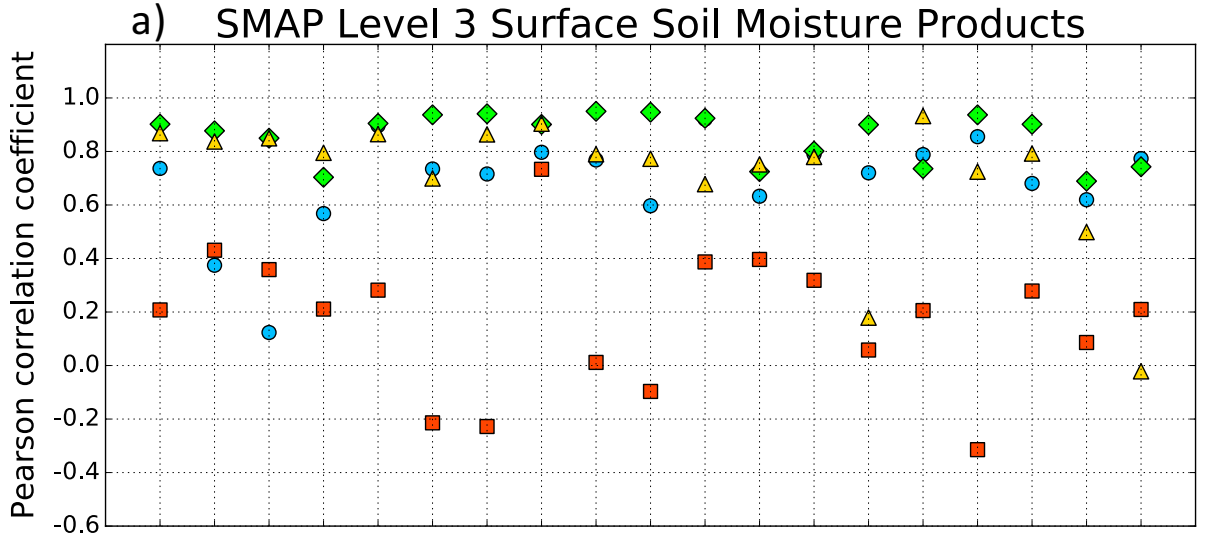
# Results-Annual Performance

- Both capture seasonality of surface soil moisture.
- Low dry-down rates of SMAP_L4
  - Positive bias during late winter and spring season.
- Reasonable agreement, despite presence of dense vegetation (a)

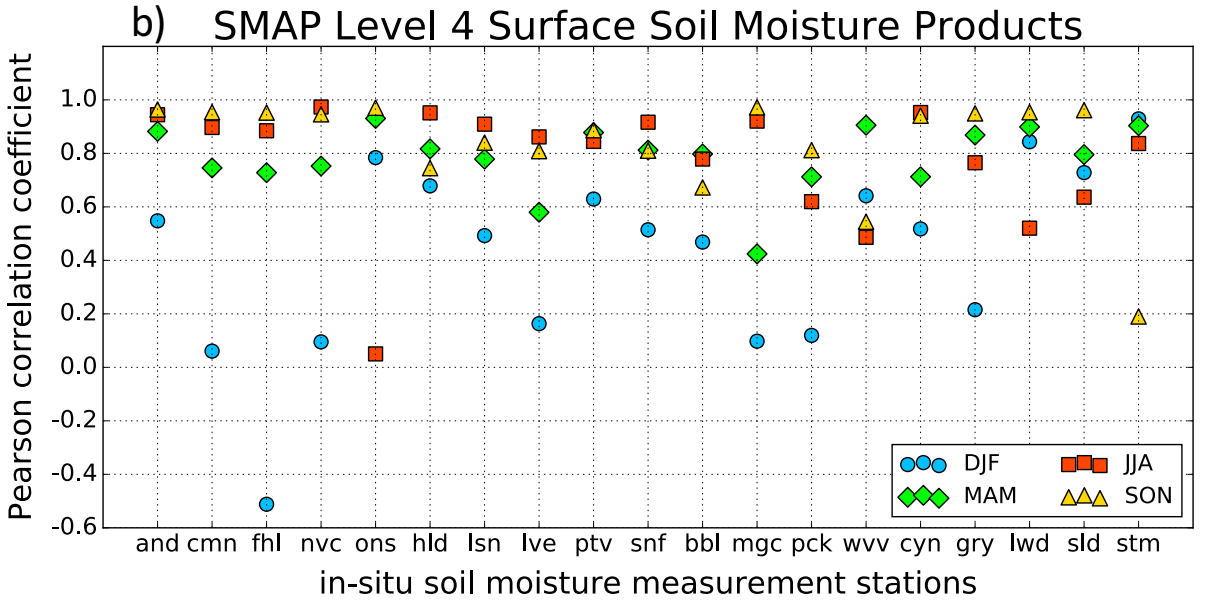


# Results-Correlation

- SMAP_L3
  - Strong correlations during DJF, MAM, and SON.
  - Weak correlations during JJA, possibly due to very dry soils.
- SMAP_L4
  - Strong correlations during JJA, SON, and MAM.
  - Weak correlations during DJF, possibly due to low dry-down rates.



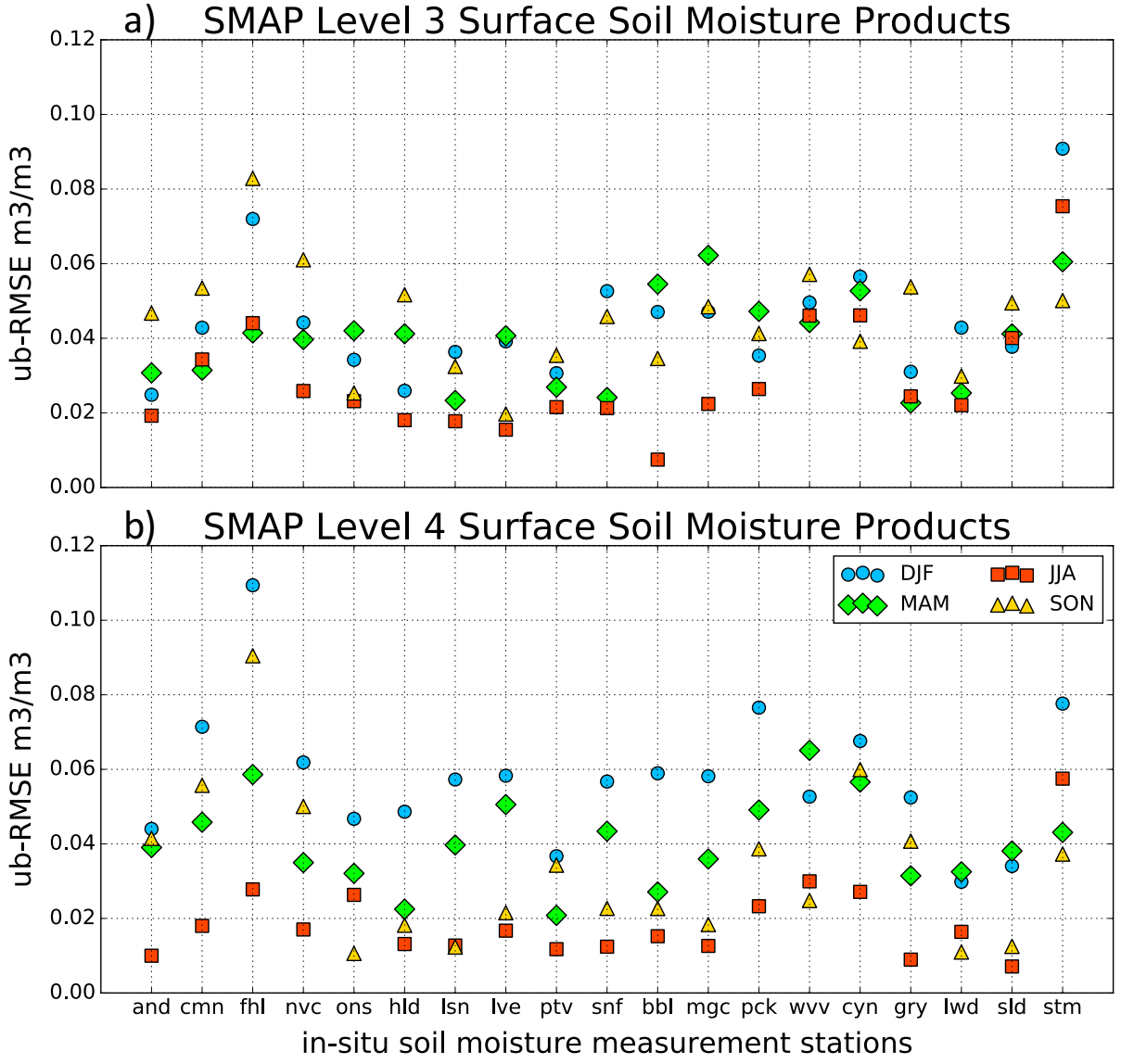

| | Average | Std |
|---|---|---|
| DJF | 0.69 | 0.19 |
| MAM | 0.86 | 0.09 |
| JJA | 0.17 | 0.26 |
| SON | 0.71 | 0.25 |




| | Average | Std |
|---|---|---|
| DJF | 0.42 | 0.35 |
| MAM | 0.78 | 0.12 |
| JJA | 0.77 | 0.23 |
| SON | 0.83 | 0.19 |

# Results-ub-RMSE

- SMAP mission requirement
  - ub-RMSE<0.04 $m^3m^{-3}$
- ub-RMSE values below/or close to the mission requirement despite presence of dense vegetation.
- Low (high) ub-RMSE during summer (winter).
- Better overall performance of SMAP_L3 relative to SMAP_L4

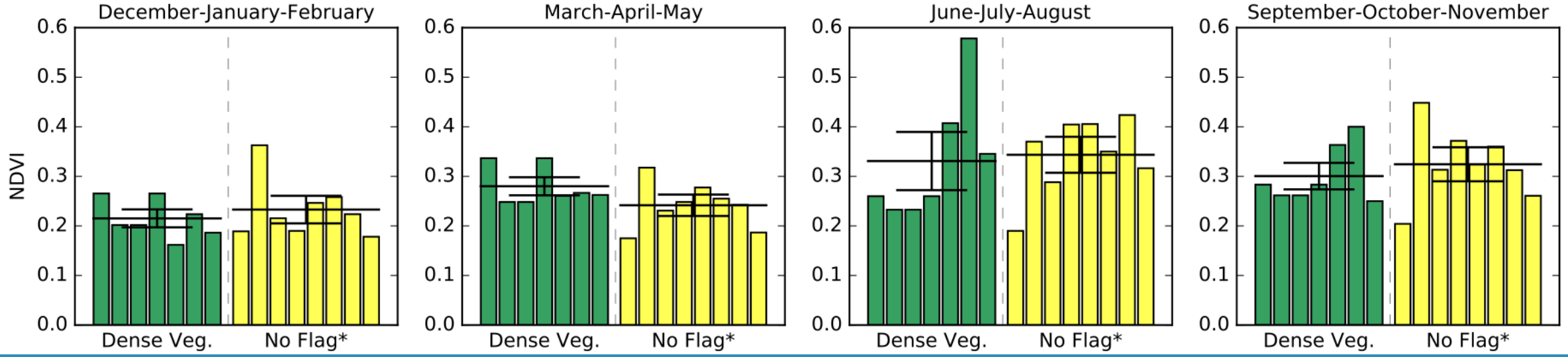



| | Average | Std |
|---|---|---|
| DJF | 0.044 | 0.016 |
| MAM | 0.04 | 0.012 |
| JJA | 0.029 | 0.015 |
| SON | 0.045 | 0.014 |

| | Average | Std |
|---|---|---|
| DJF | 0.058 | 0.018 |
| MAM | 0.04 | 0.012 |
| JJA | 0.019 | 0.011 |
| SON | 0.032 | 0.020 |

# Results-Impacts of Dense Vegetation

- Presence of Dense Vegetation surface flag throughout the year.
- Good agreement of SMAP_L3 products with in-situ observations despite presence of dense vegetation.
- No significant difference between NDVI at the sites with and without dense vegetation.
- **Dense vegetation doesn't have strong adverse impacts on quality of SMAP_L3 products in the regions studied here.**



# Discussion

- Overall, SMAP_L3 products are in good agreement with in-situ observations.
  - Capture seasonality of surface soil moisture.
  - Respond to precipitation events.
  - High correlation coefficients and low ub-RMSE during DJF, MAM, and SON.
  - Are not strongly affected by dense vegetation.
- Assimilating SMAP_L3 products into the hydrologic models to potentially advance streamflow predictions.
- Results are based on soil moisture observation during one year with relatively dry conditions.
- More in-situ observations sites and longer period of SMAP observations are required to confirm these results and remove the bias between SMAP products and in-situ observations.