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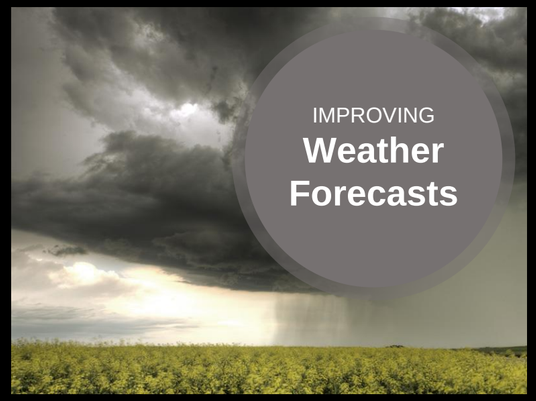
Version 8 of the SMAP Level-4 Soil Moisture Data Assimilation Product

Rolf Reichle[1], Qing Liu[1], Joseph Ardizzone[1], Michel Bechtold[2], Wade Crow[3], Gabrielle De Lannoy[2], John Kimball[4], Randal Koster[1]

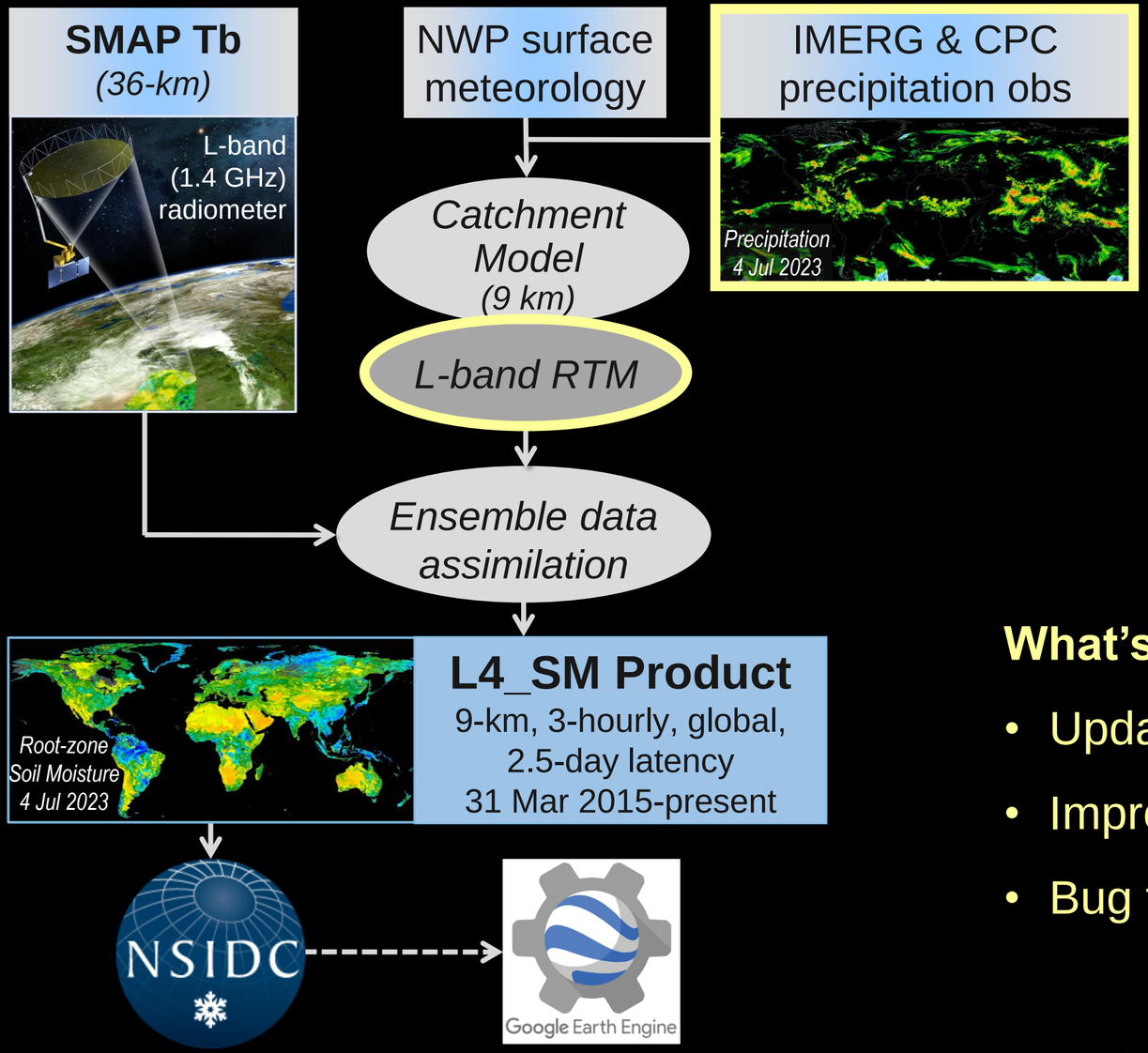
[1]NASA Goddard Space Flight Center, Greenbelt, MD, USA
[2]KU Leuven, Leuven, Belgium
[3]USDA-ARS, Beltsville, MD, USA
[4]U Montana, Missoula, MT, USA

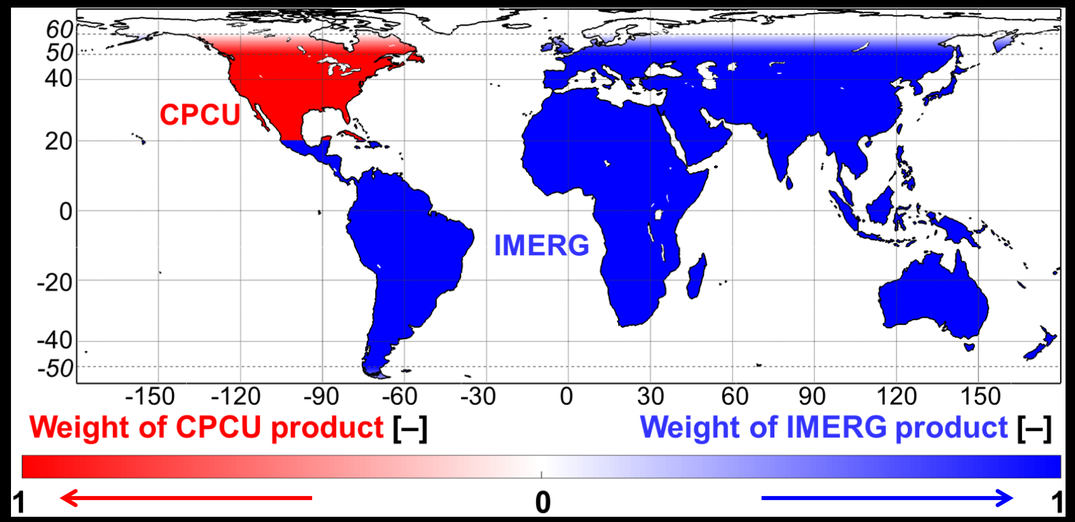
Motivation

Soil moisture is an “Essential Climate Variable” and important for agriculture, droughts & floods, weather & seasonal forecasting, vegetation & carbon cycle, etc.



SMAP Level-4 Soil Moisture (L4_SM)





What's new in L4_SM Version 8?

- Updated IMERG precipitation inputs.
- Improved L-band radiative transfer model (RTM).
- Bug fixes.

L4_SM Version 8

L4_SM	Version 7	Version 8
Released	Nov 2022	Mar 2025

L4_SM Version 8

L4_SM	Version 7	Version 8
Released	Nov 2022	Mar 2025
IMERG inputs	Version 6	Version 7

Necessitated by IMERG issues & version change.

L4_SM Version 8

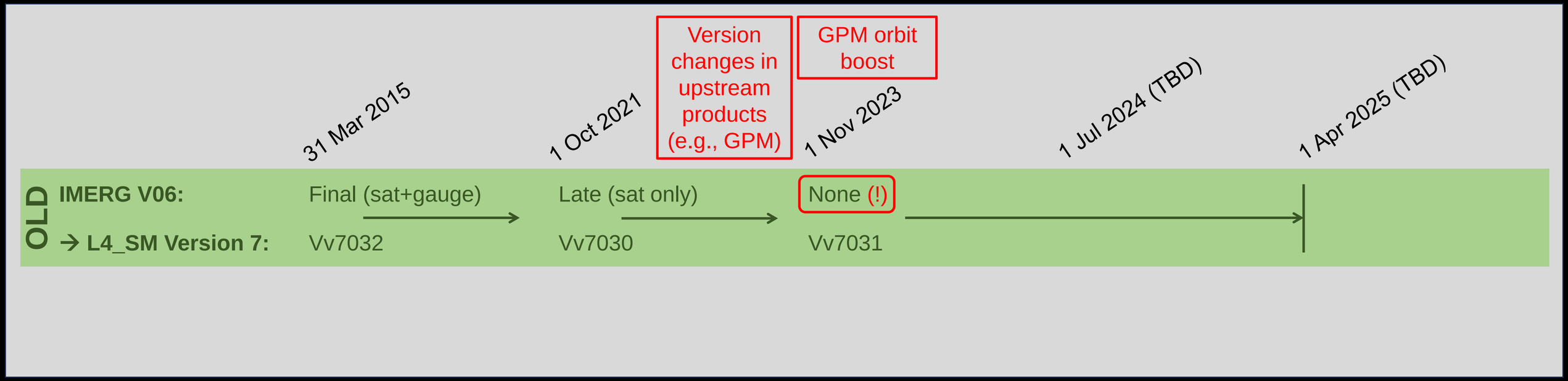
	OLD	*NEW*
L4_SM	**Version 7**	**Version 8**
Released	Nov 2022	Mar 2025
IMERG inputs	Version 6	Version 7
SMAP L2_SMP inputs (L-band scattering albedo, soil roughness, and climatology of vegetation opacity)	Version 5	Version 6
Soil dielectric mixing	Wang & Schmugge	Mironov (as in L2)
Polarization mixing for rough surface reflectivity	None	As in L2

Necessitated by IMERG issues & version change.

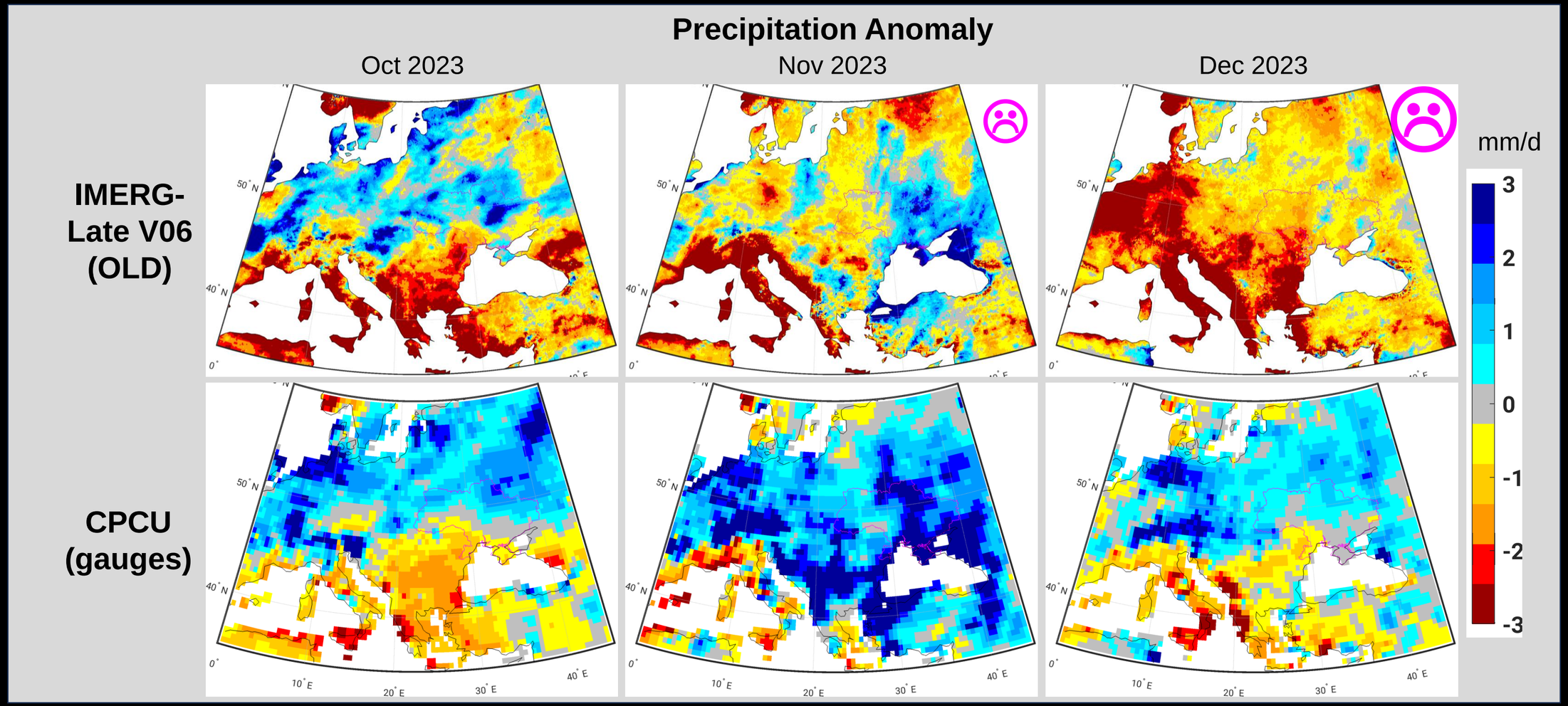
Make L-band RTM more consistent with that of SMAP L2 soil moisture retrieval algorithm.

IMERG Precipitation Inputs

Quality of OLD L4_SM product impacted by degrading quality of OLD IMERG product:

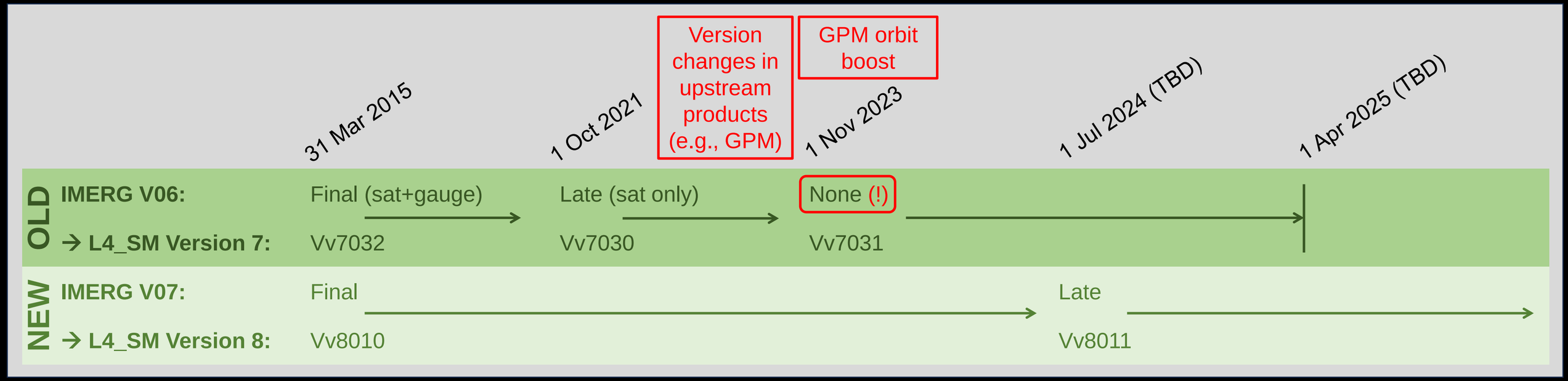


IMERG Precipitation Inputs (OLD)



7-8 Nov 2023: GPM orbit boost
IMERG-Late V06d → V06e

IMERG Precipitation Inputs



NEW L4_SM product uses NEW IMERG-Final, which includes a calibration adjustment for the GPM orbit boost and provides 3 additional years of satellite+gauge data. However, …

IMERG Precipitation Inputs (NEW)

New problem:

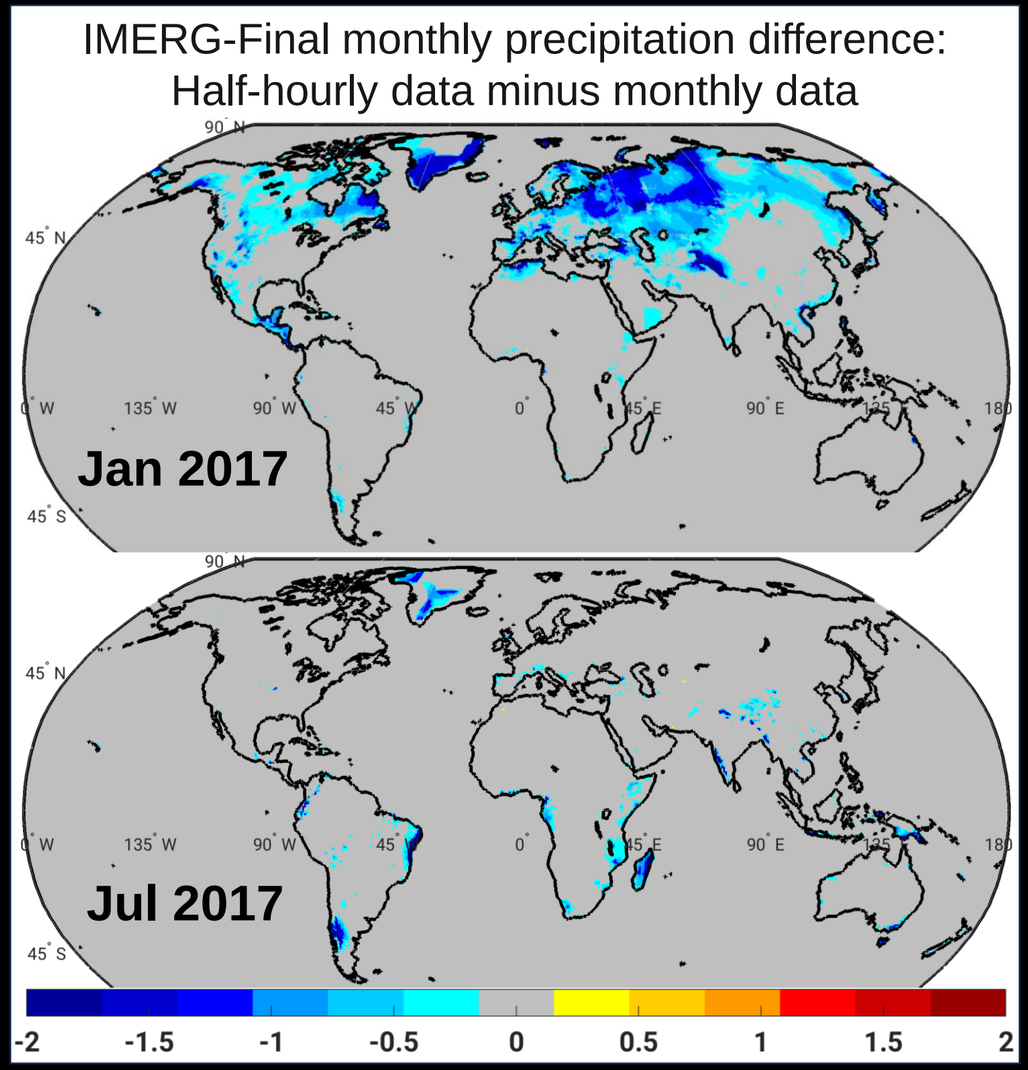
IMERG-Final V07 half-hourly and monthly data do not match!

- Mostly, but not exclusively, a winter issue (snowfall).
- Similar differences across years → impacts climatology.

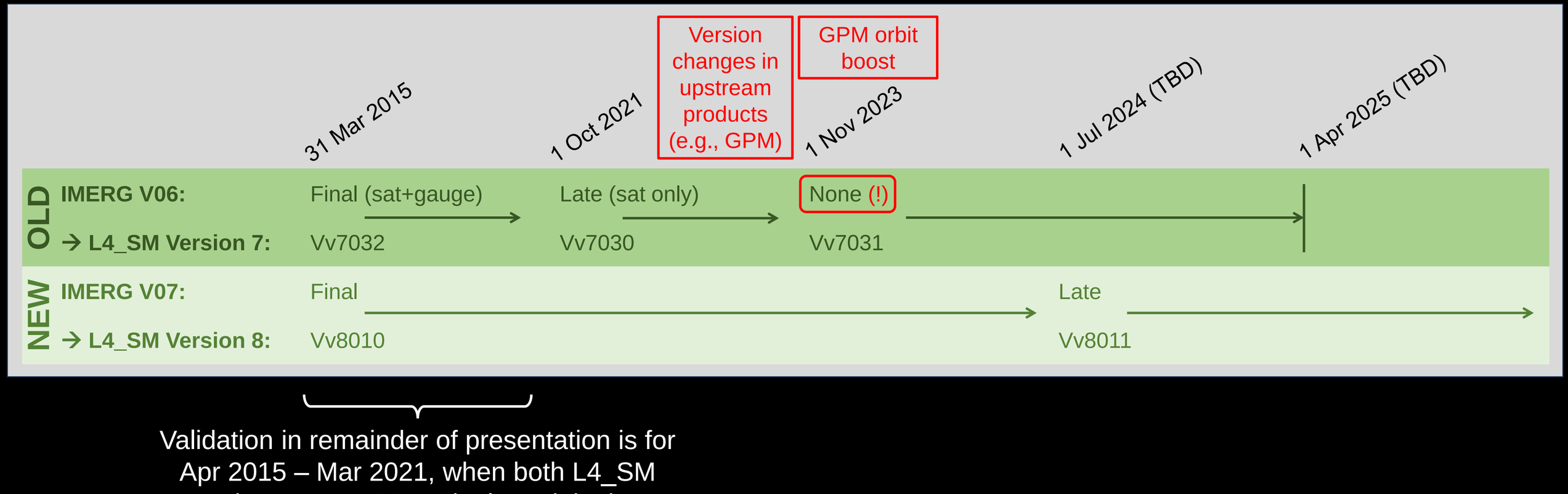
- Normally, L4_SM precipitation is corrected for each day separately.

- **Solution**:

  Where/when the mismatch between half-hourly and monthly data exceeds 0.1 mm/d, adjust background precipitation to match only the monthly total from the monthly file.



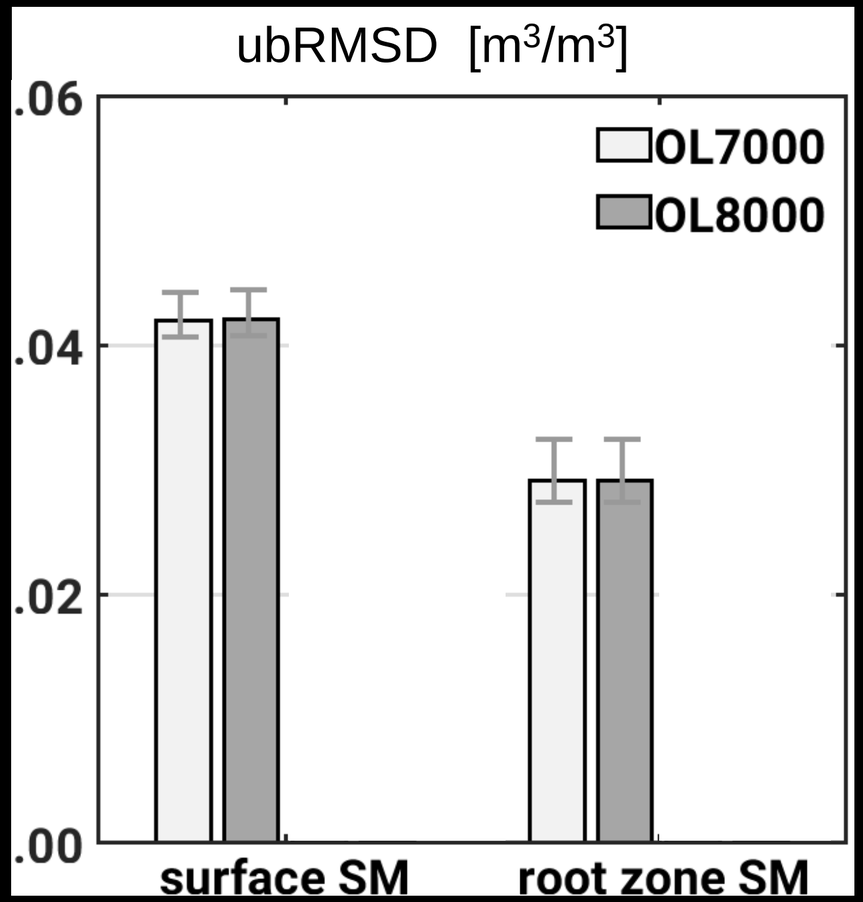
IMERG Precipitation Inputs

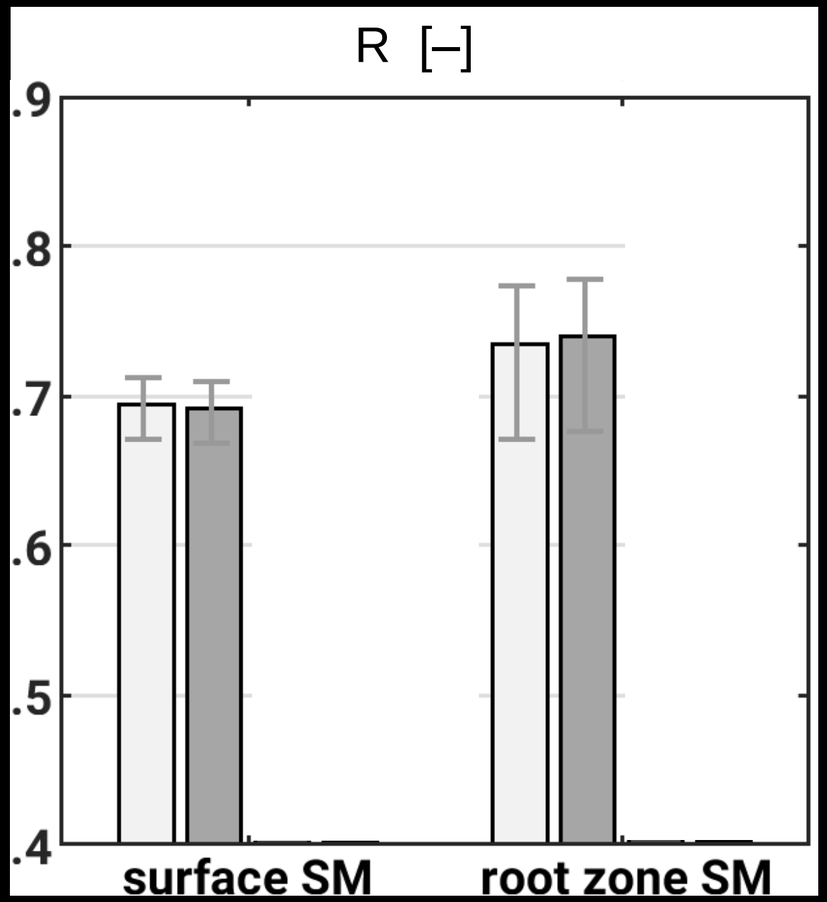


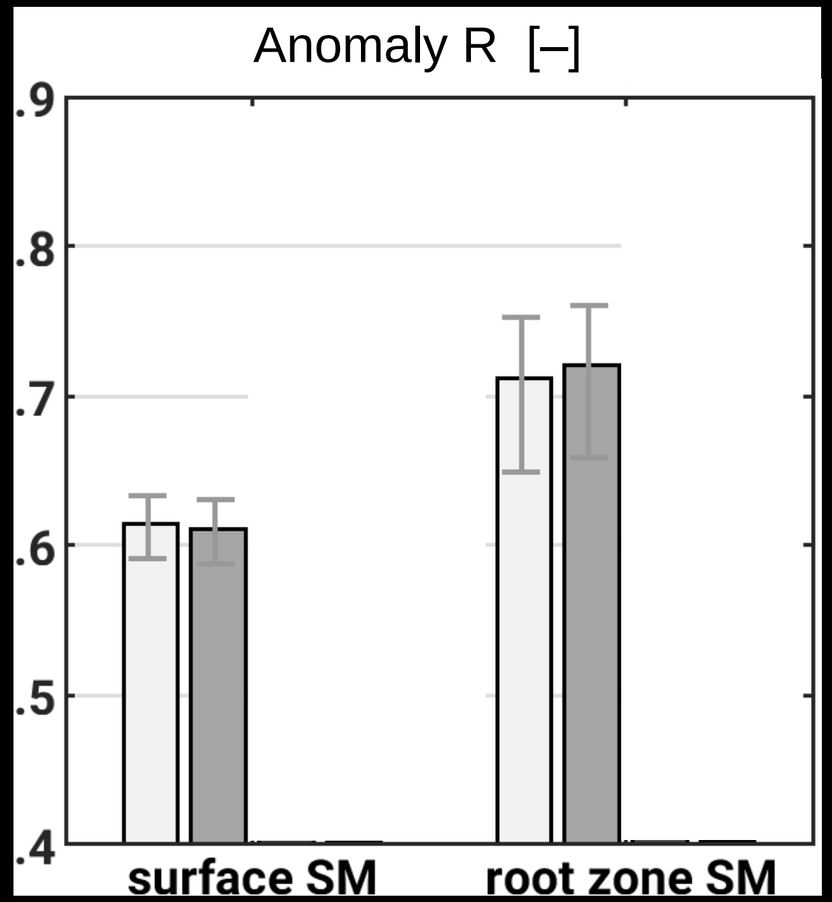
Validation in remainder of presentation is for Apr 2015 – Mar 2021, when both L4_SM versions use IMERG-Final precipitation.

Validation vs. In Situ Measurements
(Apr 2015 – Mar 2021)

9-km reference pixels at SMAP core validation sites ($N_{surface}$=18, $N_{rootzone}$=7); majority in N America.



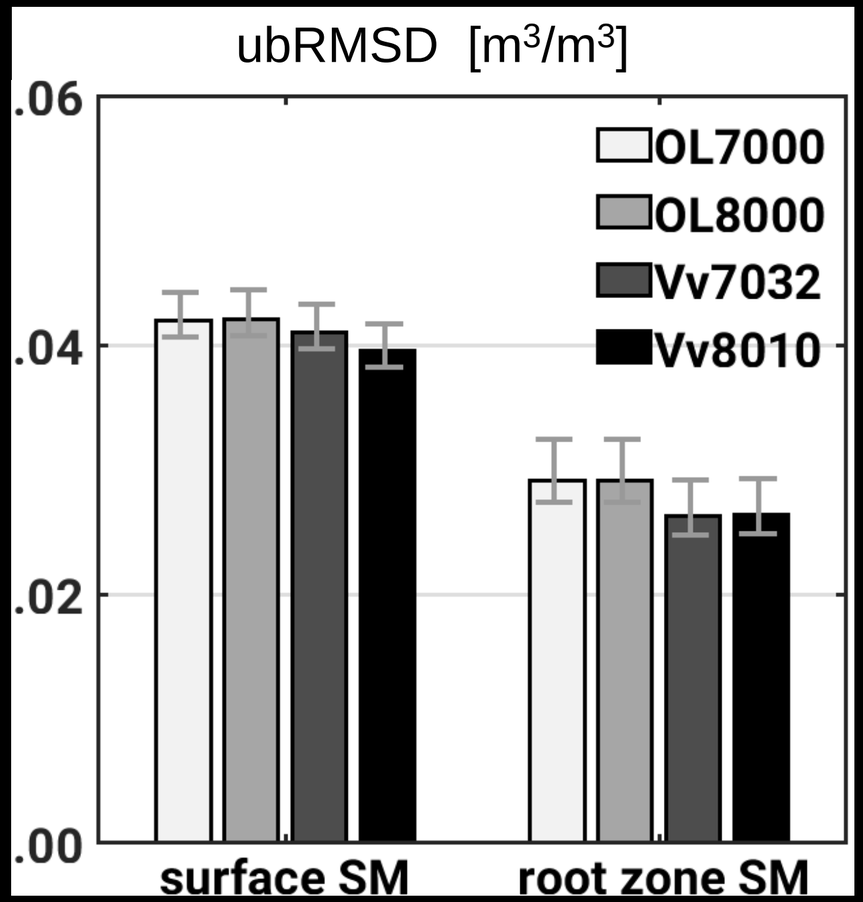


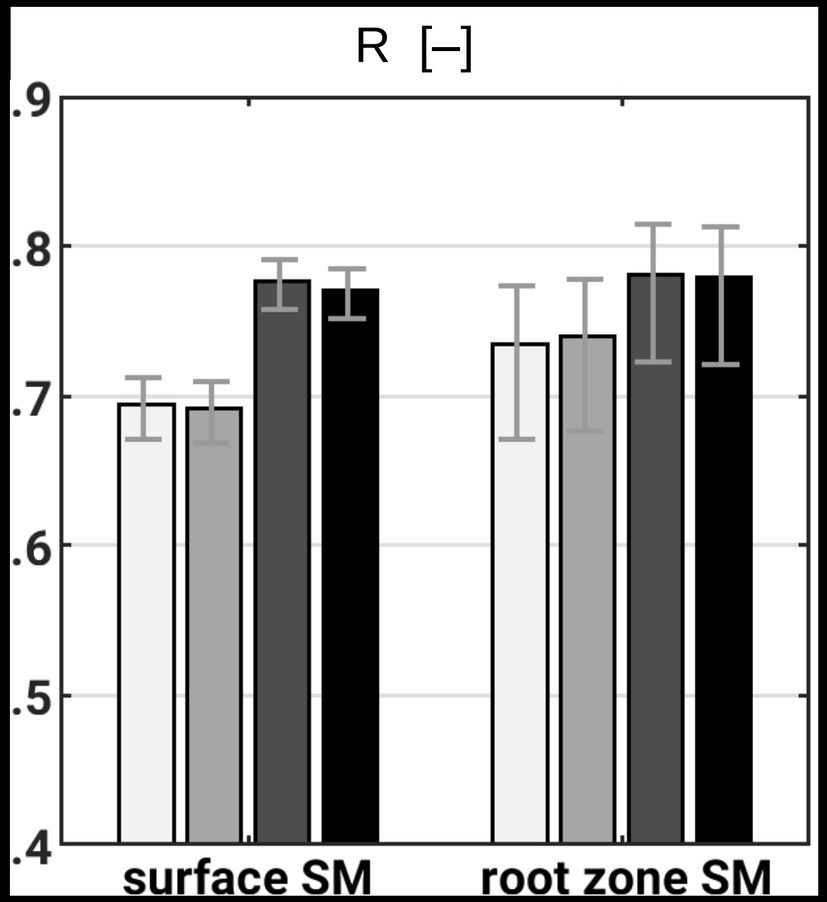


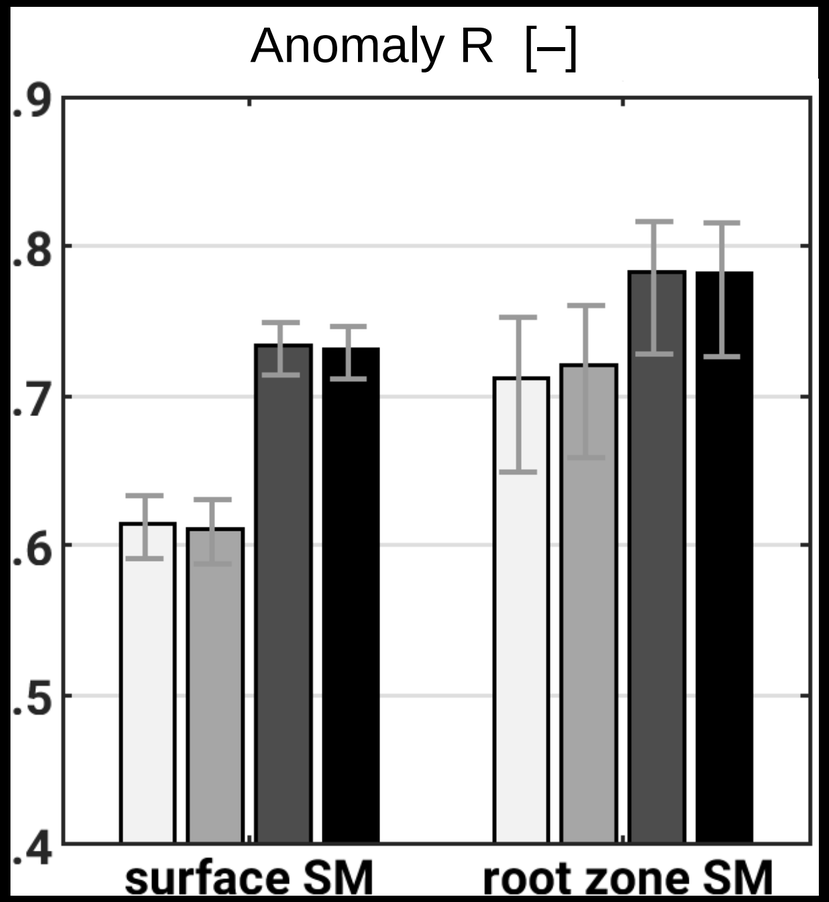
No change in skill of “Open Loop” (that is, <u>without</u> SMAP data assimilation).

Validation vs. In Situ Measurements
(Apr 2015 – Mar 2021)

9-km reference pixels at SMAP core validation sites ($N_{surface}$=18, $N_{rootzone}$=7); majority in N America.

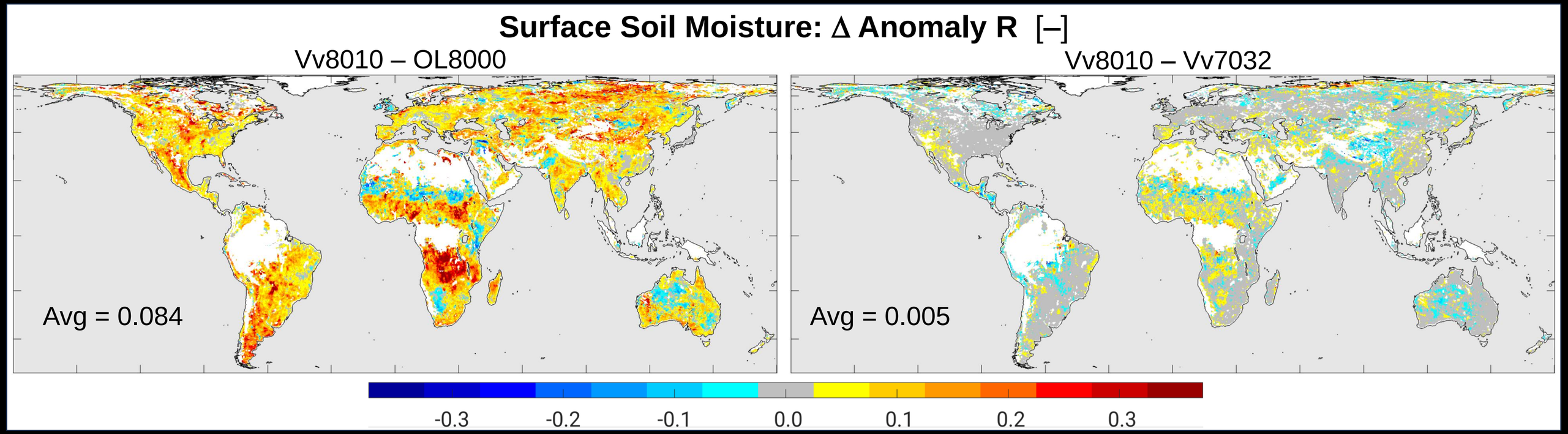






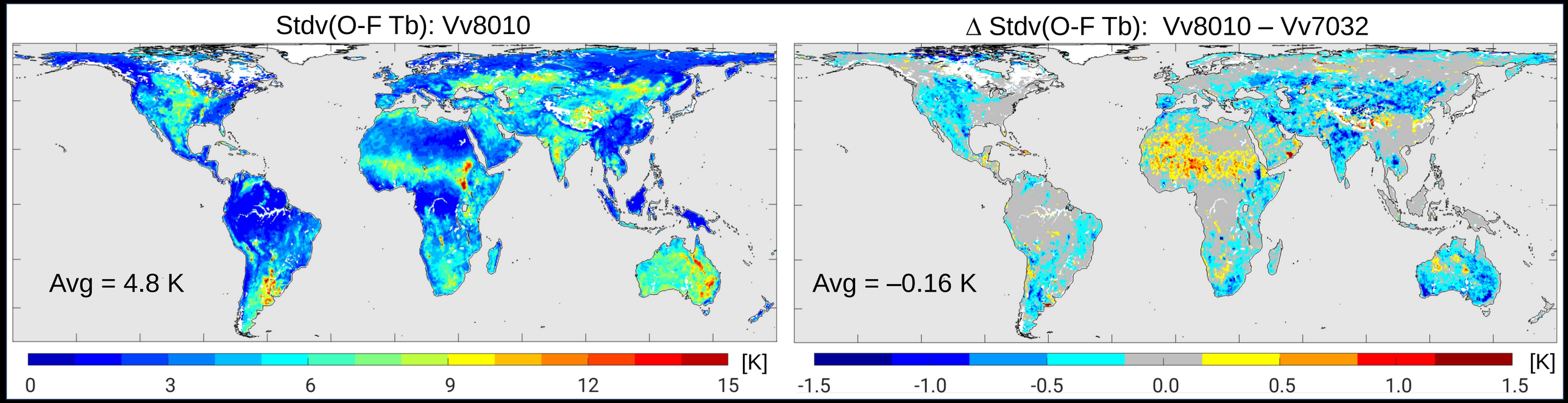
L4_SM Version 8 has slightly smaller ubRMSD for surface soil moisture owing to RTM changes.

Validation vs. Satellite Retrievals
(ASCAT as Instrumental Variable; Apr 2015 – Mar 2021)



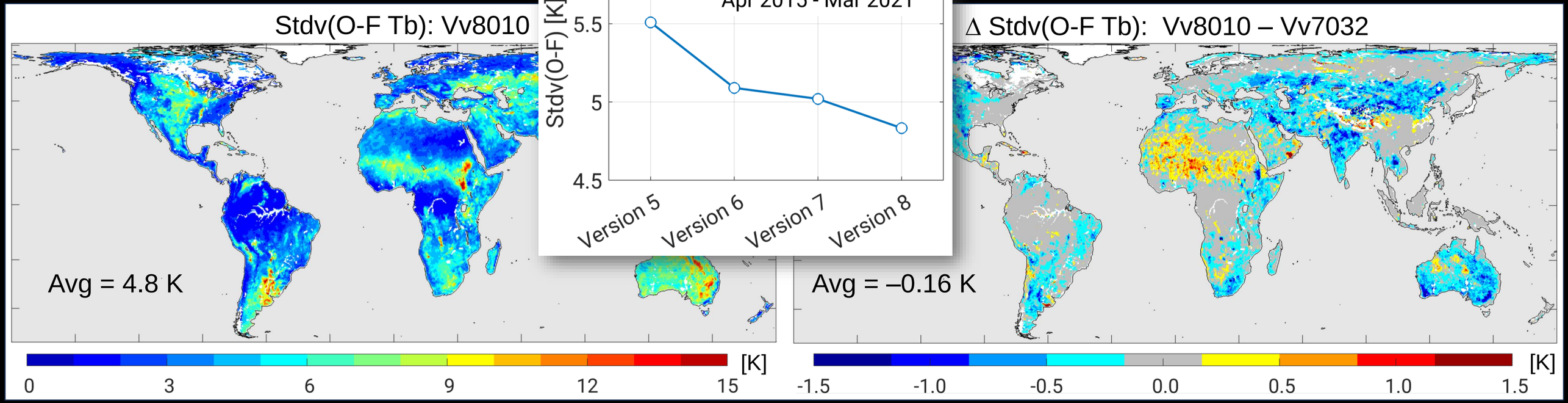
- SMAP Tb assimilation improves surface soil moisture.
- No change in L4_SM skill.

Observation-Minus-Forecast Tb Residuals
(Apr 2015 – Mar 2021)



Typical magnitude of O-F residuals smaller in Version 8.

Observation-Minus-Forecast Tb Residuals
(Apr 2015 – Mar 2021)



Typical magnitude of O-F residuals smaller in Version 8.

Now below 5 K!

<u>Caveat:</u> No cross-masking of O-F residuals in comparison across Versions 5-8.

Summary

- SMAP L4_SM Version 8 to be released this March, incl. full reprocessing.
- Fixes problems with IMERG precipitation inputs, in the old and new IMERG versions!
- L-band RTM revisions in Version 8 yield small improvement in ubRMSD vs. in situ soil moisture.
- Typical magnitude of O-minus-F Tb residuals in Version 8 is less than 5 K.

Thanks for listening!