



VERIFICATION OF THE SMAP LEVEL-4 SOIL MOISTURE ANALYSIS USING RAINFALL OBSERVATIONS IN AUSTRALIA

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Yokohama, 28 July – August 2, 2019

SKILL OF THE SMAP LEVEL-4 PRODUCT IN A DATA-SPARSE REGION.

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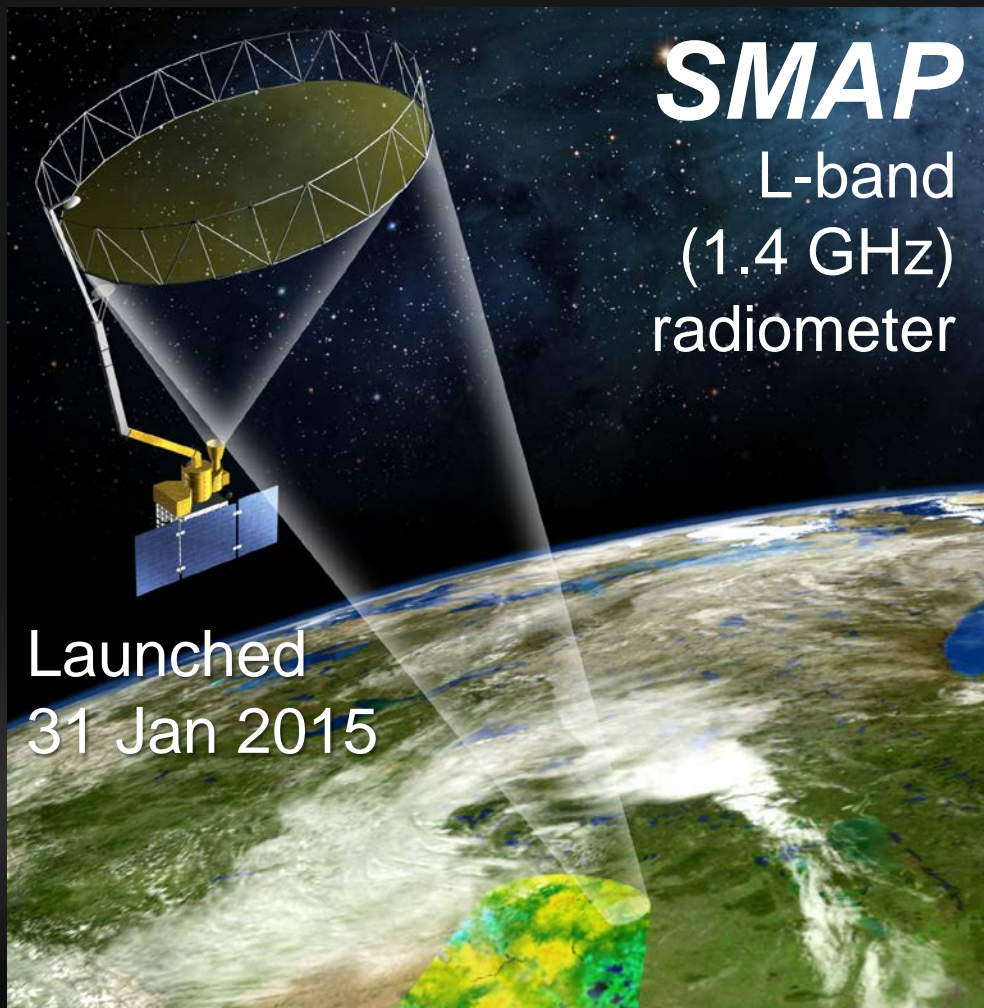
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Motivation

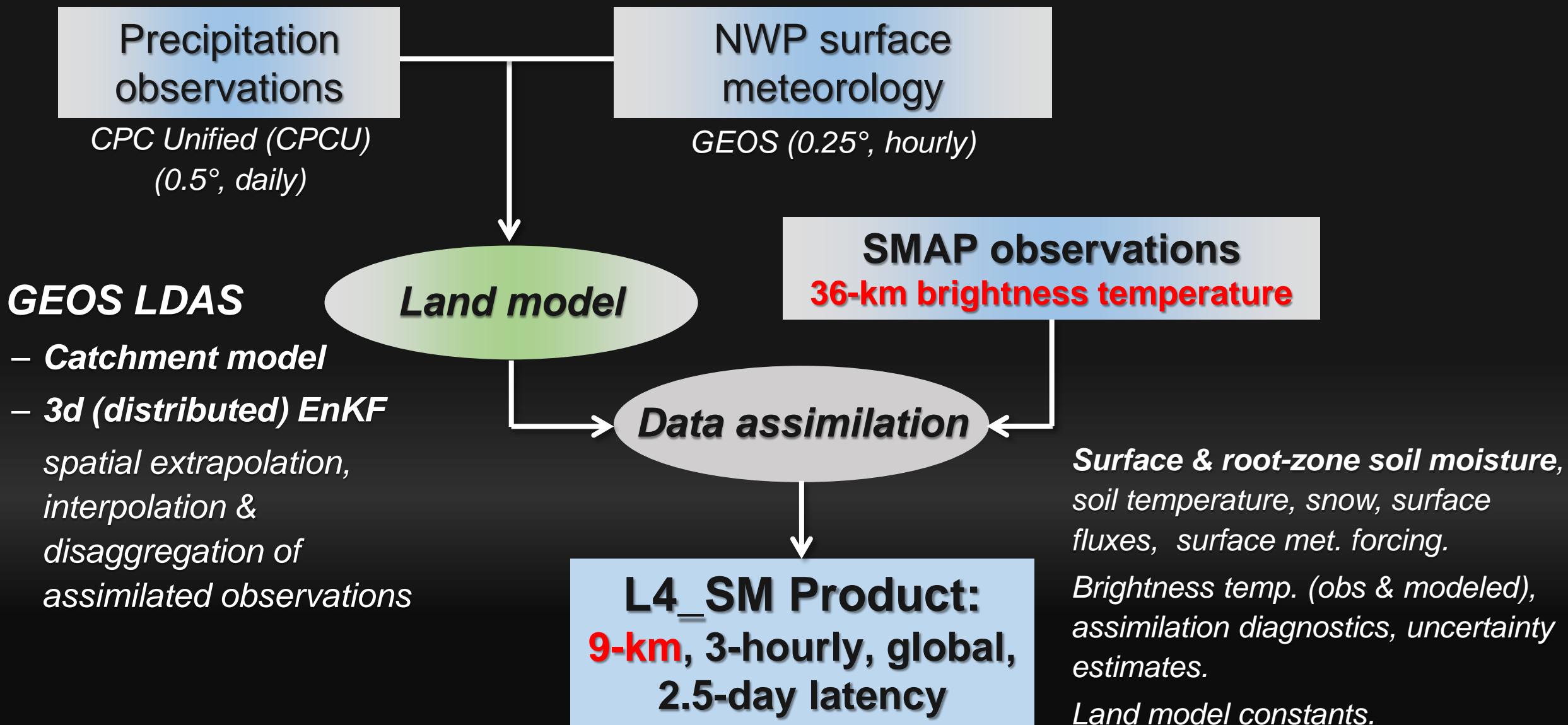


*Key Objectives of the
Level 4 Surface & Root-Zone Soil Moisture
(L4_SM) product:*

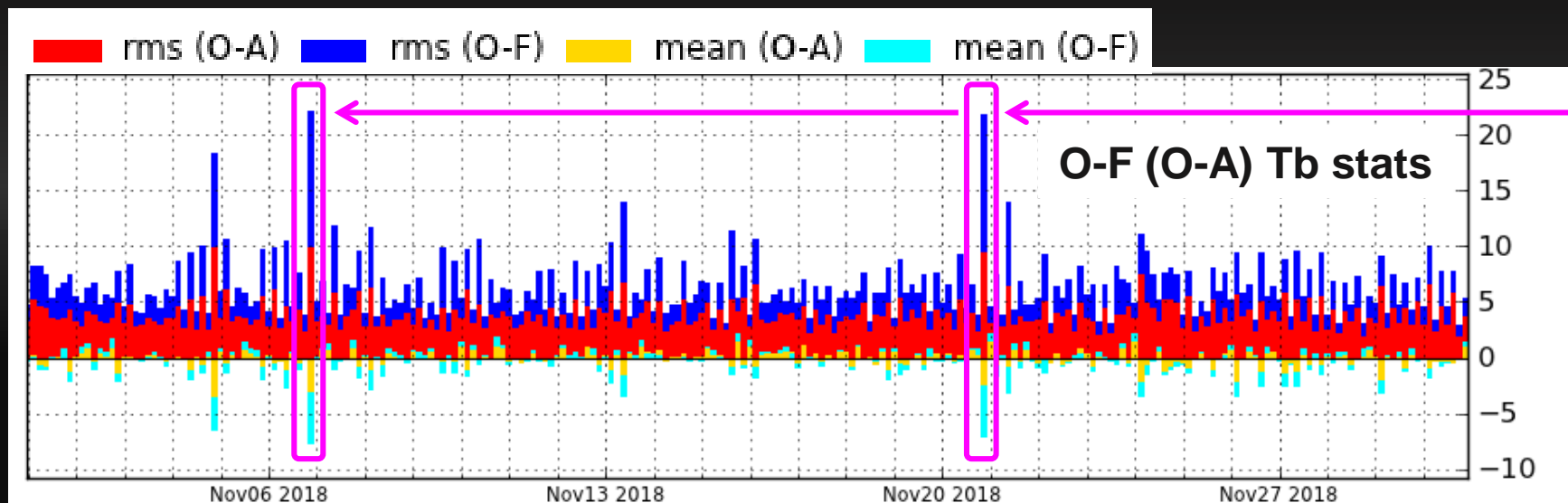
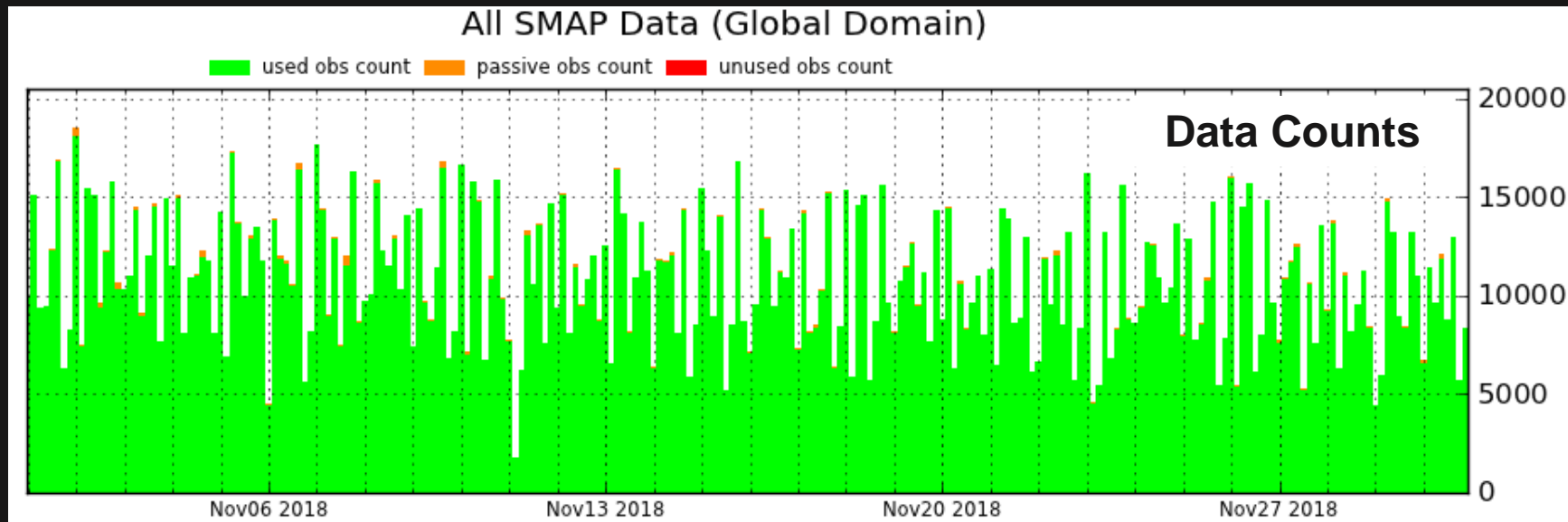
1. **Root-zone soil moisture (0-100 cm)**
2. **Spatially & temporally complete**

**Sensitive only to surface
soil moisture (~0-5 cm)**

L4_SM Algorithm Overview



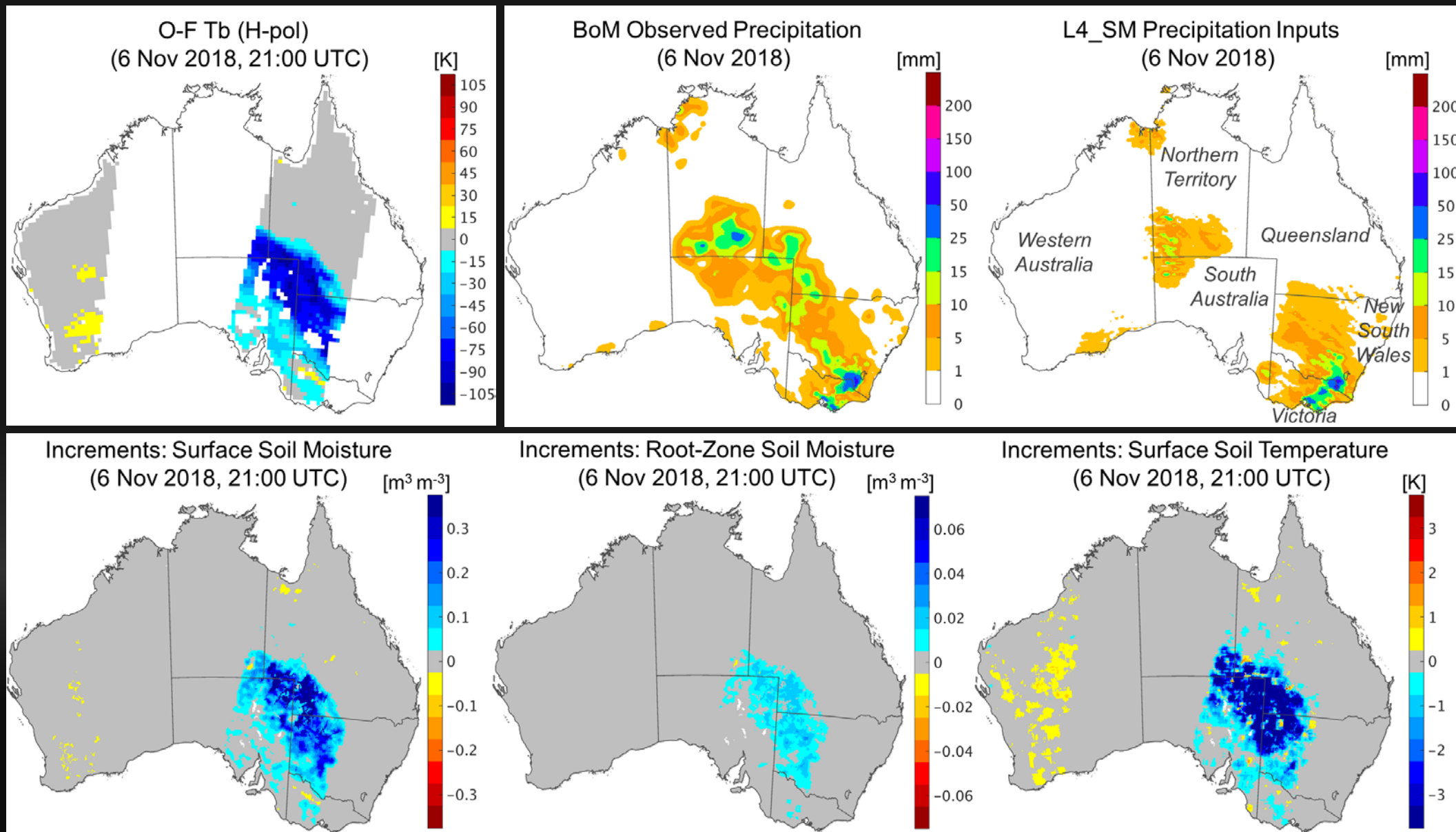
L4_SM Monitoring (Nov 2018, Vv4030)



RMS(O-F) > 20 K:
21z on 6 Nov 2018
21z on 20 Nov 2018

System prevents operators from exporting L4_SM data until approved by scientist.

Tb Analysis in Australia (6 Nov 2018, 21z)



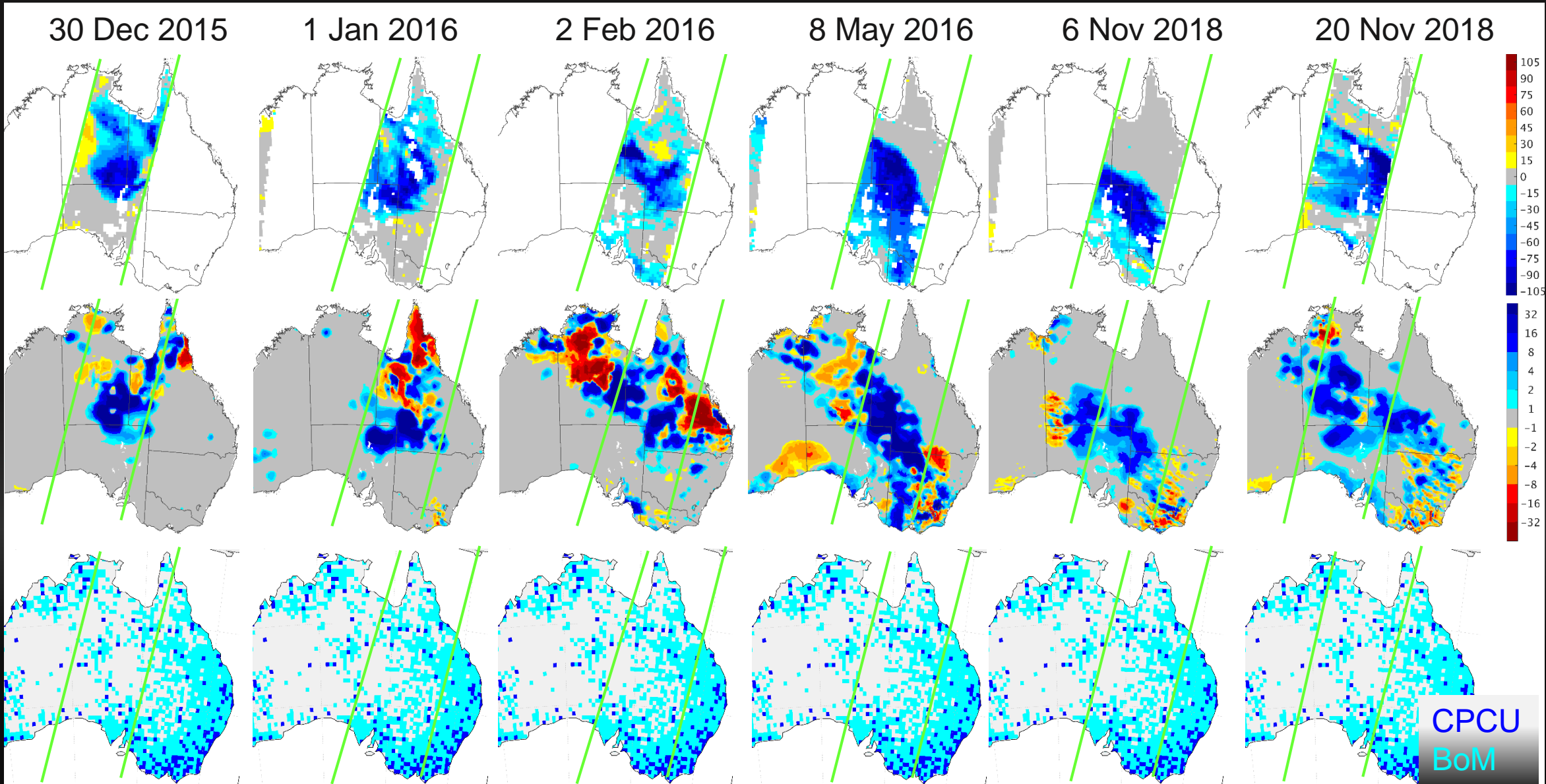
A similar case for May 8, 2016 is discussed in *Reichle et al. 2017*
[doi:10.1175/JHM-D-17-0130.1](https://doi.org/10.1175/JHM-D-17-0130.1)

Events with $\text{std-dev}(\text{O-F}) > 20 \text{ K}$ (through Dec 2018)

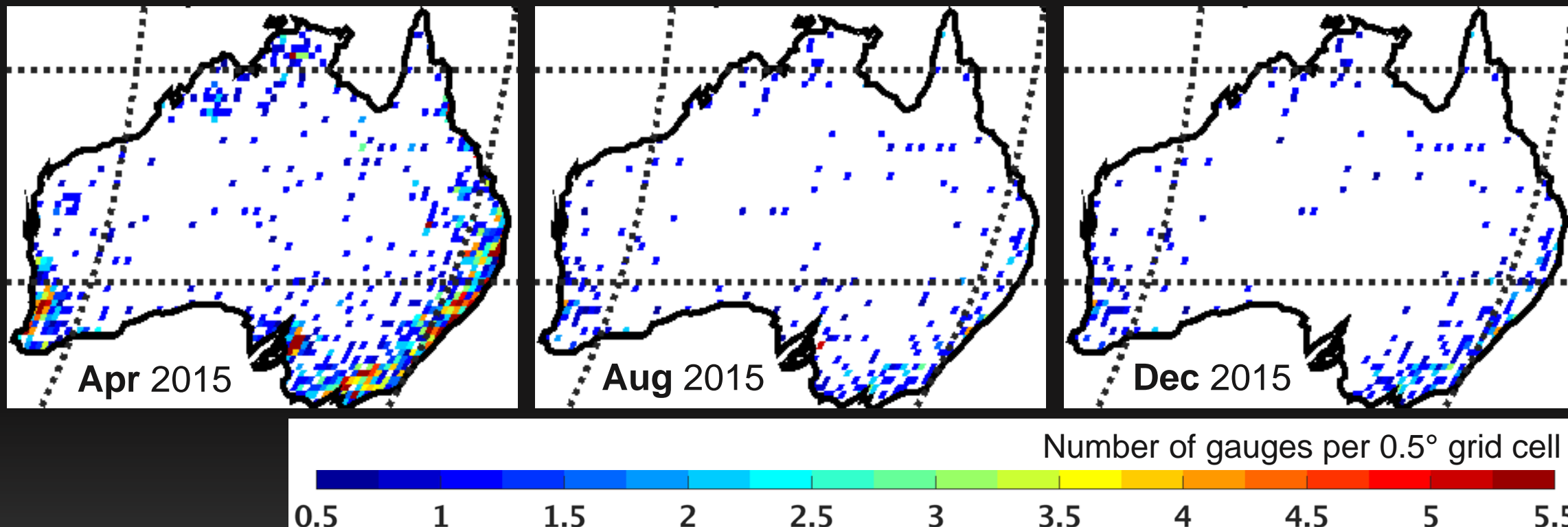
O-F Tb
(H-pol)
[K]

BoM
minus
L4_SM
precip
[mm]

Precip
gauges
(8/2015-
7/2018)



Disappearing CPCU Gauges



During the first few months of SMAP, there was a considerable drop in the number of gauges that contribute to the CPCU product.

Subsequent analysis is for Aug 2015 to Jul 2018.

From Case Study to Systematic Investigation

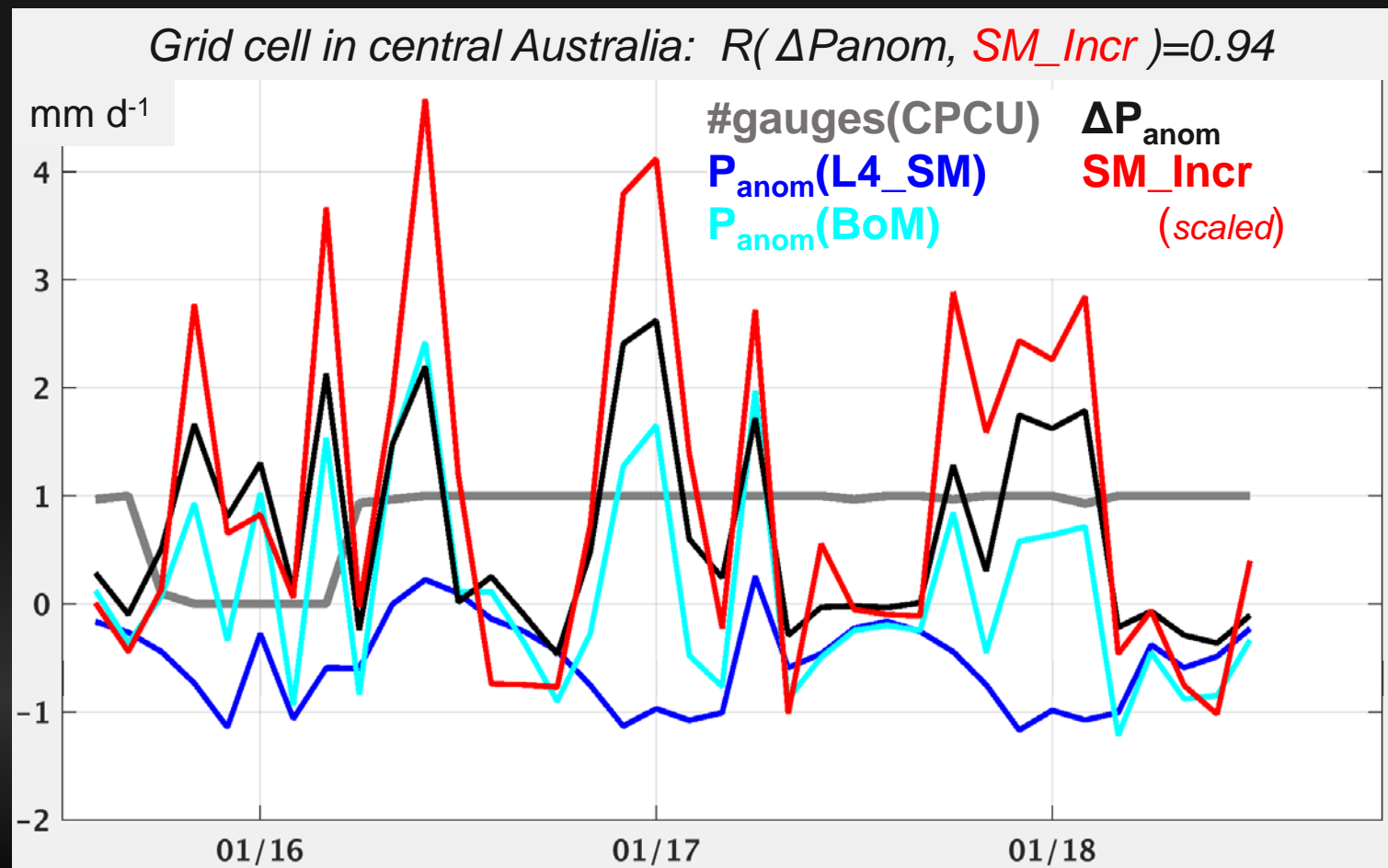
Objective:

Quantitatively relate soil moisture analysis increments to precip errors.

Assuming that

- 1) BoM precip is correct and L4_SM precip is wrong,
- 2) soil moisture errors result *only* from precip errors, and
- 3) seasonally varying *climatological* bias in L4_SM precip does *not* result in soil moisture increments (b/c of L4_SM calibration):

→ L4_SM soil moisture increments should be correlated with errors in L4_SM precip *anomalies* (w.r.t. BoM).



From Case Study to Systematic Investigation

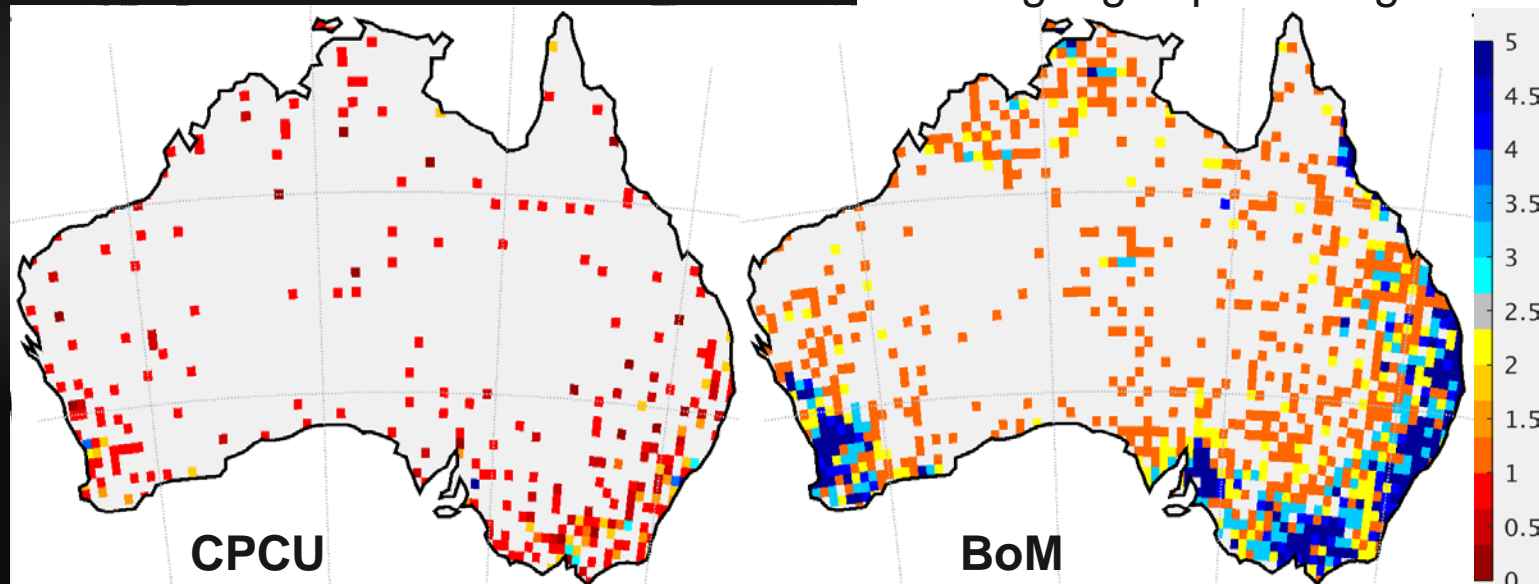
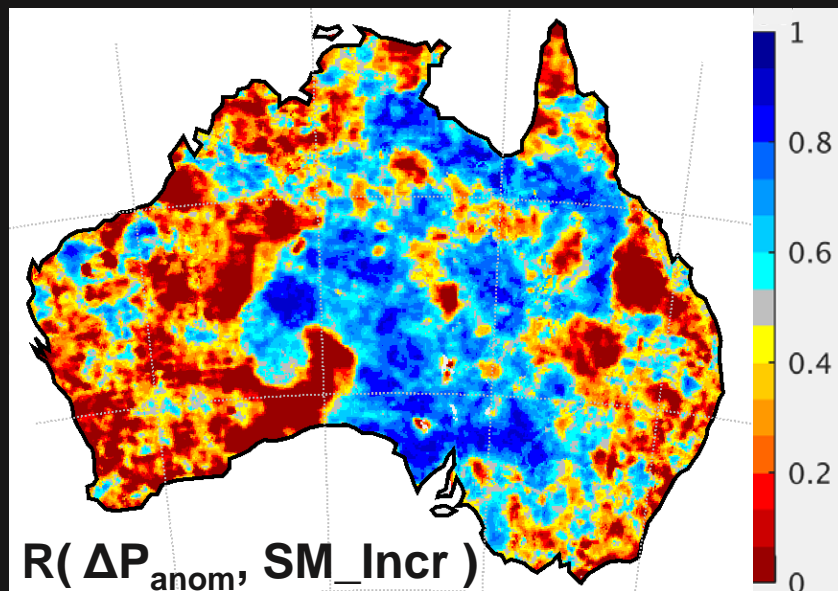
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- 1) BoM precip is correct and L4_SM precip is wrong,
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- 3) seasonally varying *climatological* bias in L4_SM precip does *not* result in soil water increments (b/c of L4_SM calibration):

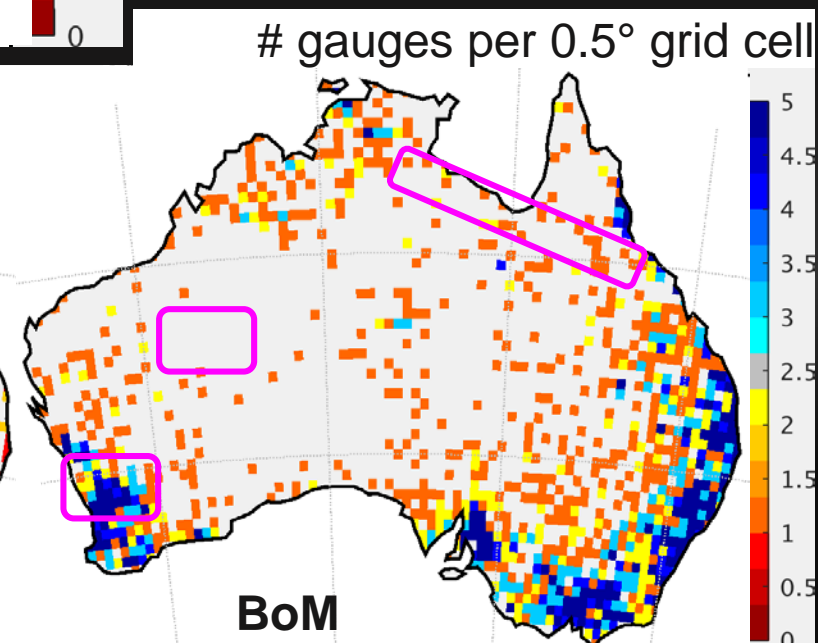
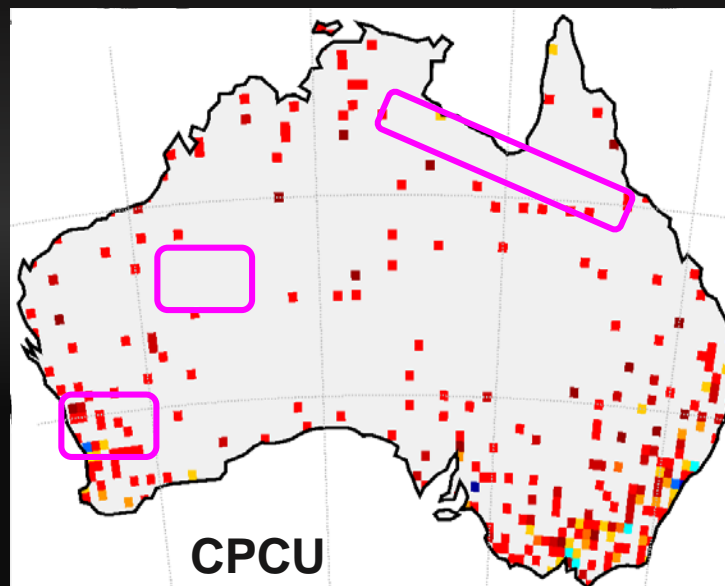
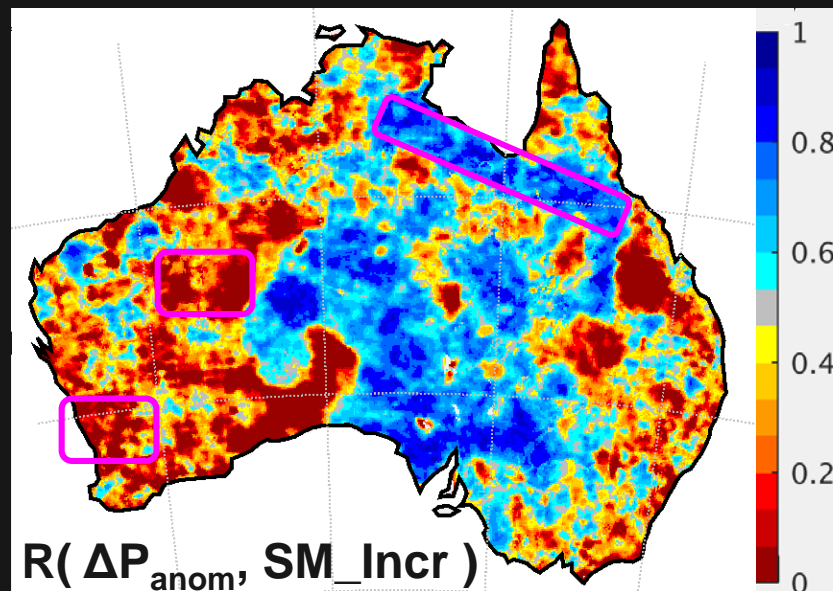
→ L4_SM soil moisture increments should be correlated with errors in L4_SM precip *anomalies* (w.r.t. BoM).



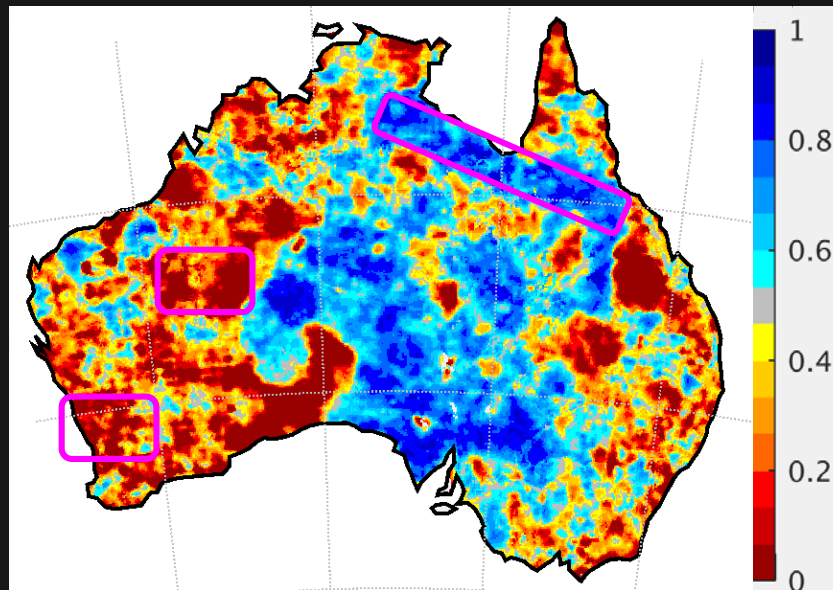
From Case Study to Systematic Investigation

Expect **high** correlation where BoM has good gauge coverage and CPCU has little or none.

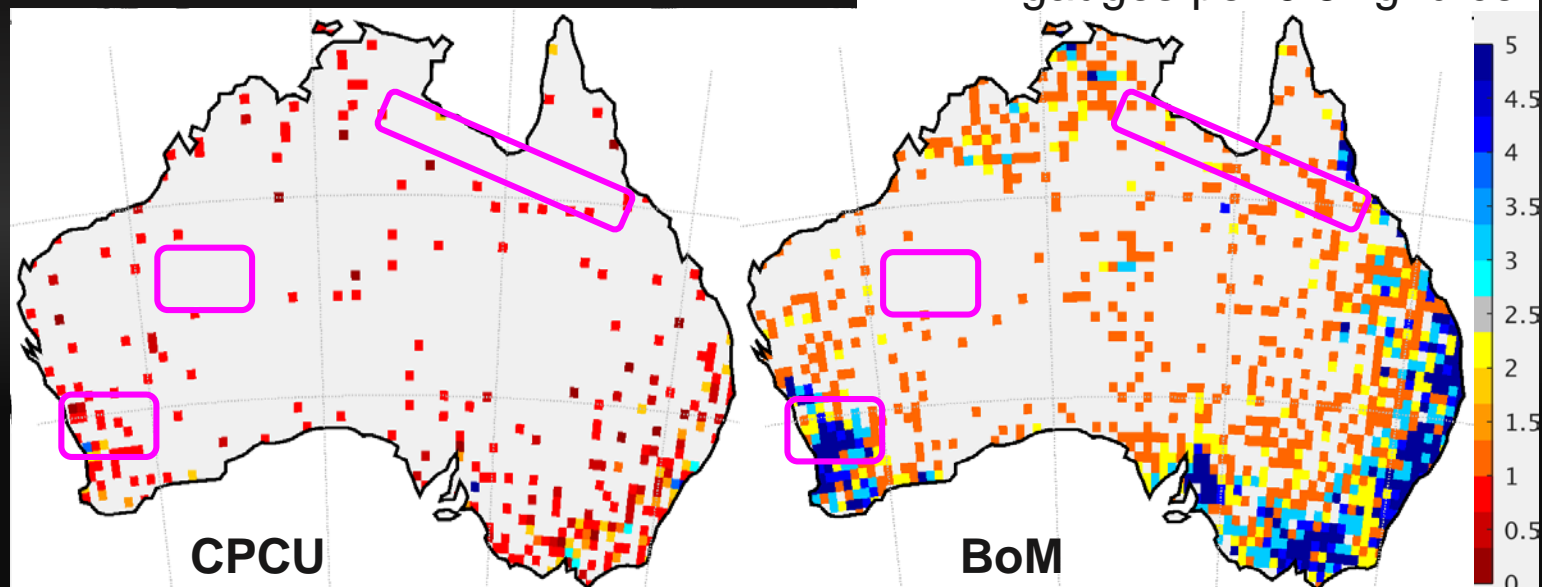
Expect **low** correlation where both CPCU and BoM have sufficient gauges or both do not have gauges.



How Can We Explain the Correlation Pattern?



Gauge density does not work, after all (not shown).



How Can We Explain the Correlation Pattern?

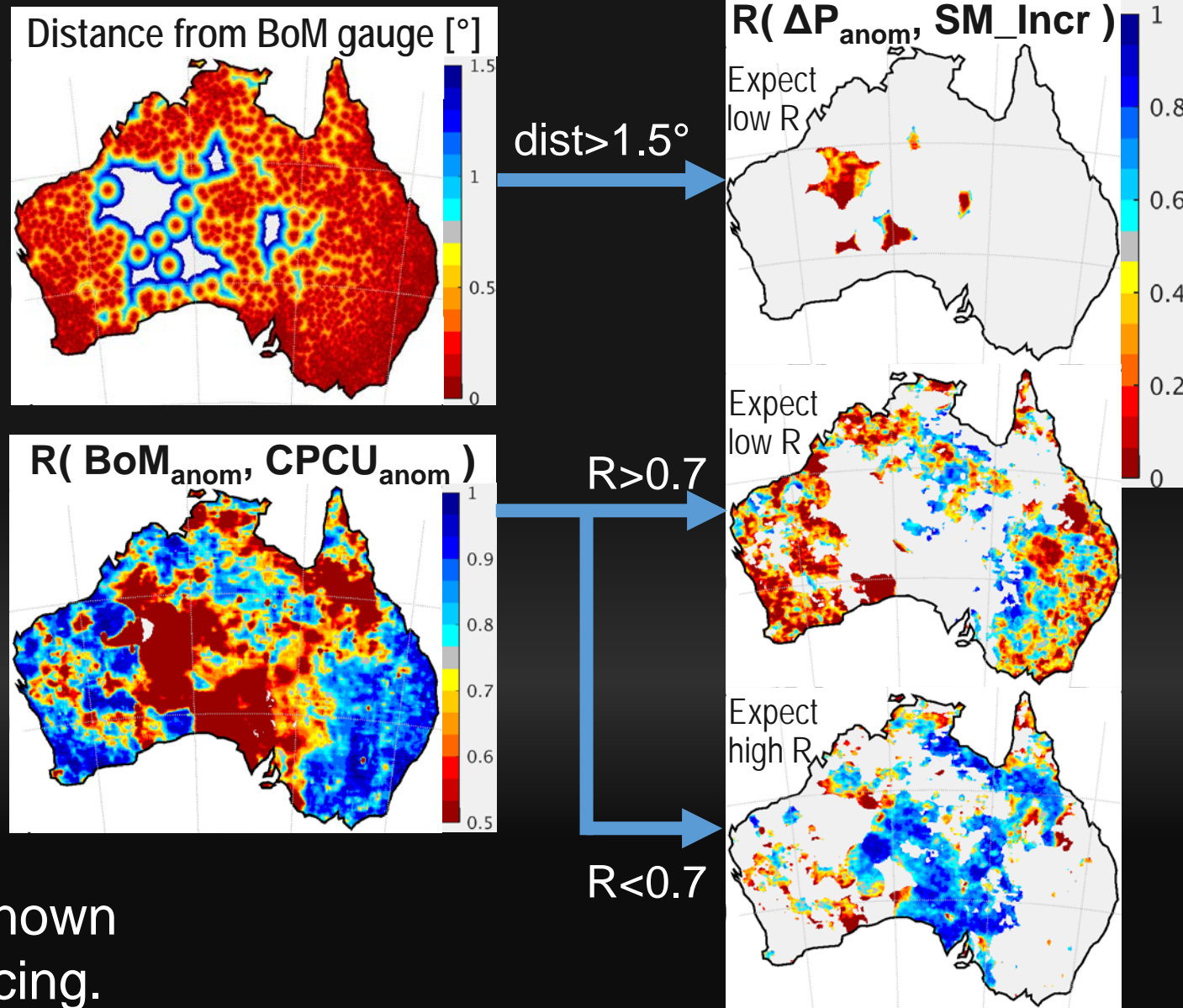
New approach:

- BoM precipitation is bad if distance from nearest gauge $> 1.5^\circ$

- L4_SM precipitation is ok where there is agreement with BoM:

$$R(\text{BoM}_{\text{anom}}, \text{CPCU}_{\text{anom}}) > 0.7$$

→ SMAP soil moisture analysis increments are consistent with known errors in L4_SM precipitation forcing.



Evaluating L4_SM Using ASCAT Soil Moisture

- Triple collocation (TC) can estimate the (anomaly) skill of a soil moisture product (w.r.t. unknown truth), provided two independent products are available.

Typical triplet: Model / Passive / Active

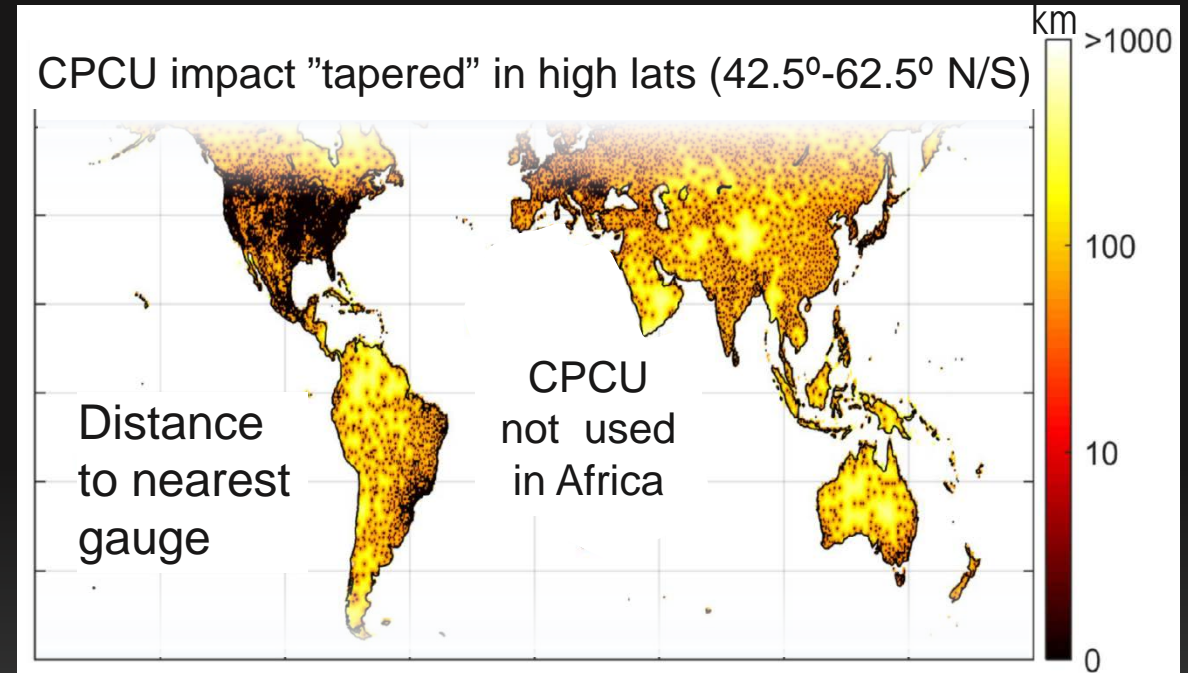
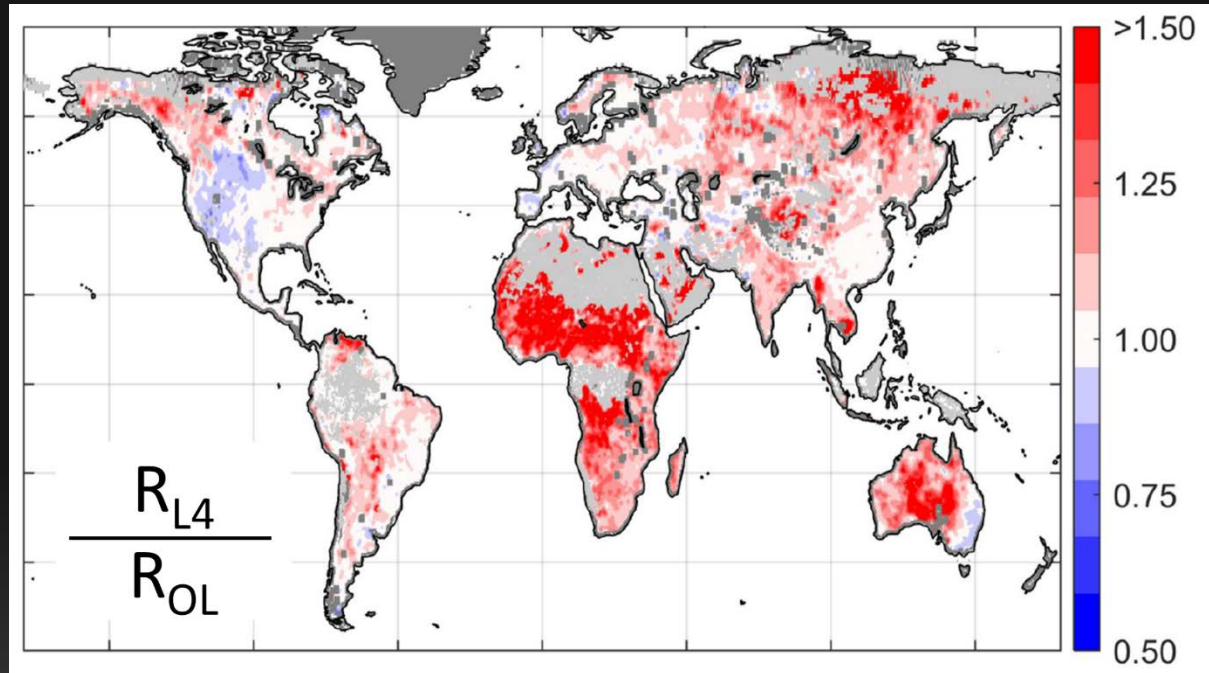
- However, L4_SM merges modeling and passive microwave observations.
- Dong et al. (2019), GRL, introduced a method to compute skill improvement using only one independent product (e.g., ASCAT):

$$R_{\text{ratio}} \equiv R_{L4,\theta} / R_{OL,\theta} \quad (\text{ratio of L4 and OL skill vs. truth } \theta)$$

$$(\text{after some math}) = R_{L4,ASC} / R_{OL,ASC} \quad (\text{ratio of L4 and OL skill vs. ASCAT})$$

where R is the anomaly correlation coefficient and OL is a model-only simulation.

Skill Improvement from SMAP Data Assimilation



Greatest skill improvement from SMAP assimilation in otherwise data-sparse regions.

Verification with in situ measurements suggests that ASCAT-based metric underestimates true skill improvement (not shown).

Summary and Conclusion

Using independent BoM precipitation data, we find that SMAP assimilation corrects known errors in L4_SM precipitation forcing in Australia.

Using independent ASCAT soil moisture retrievals, we find that soil moisture skill improvement from SMAP assimilation is greatest in otherwise data-sparse regions.

The patterns of corrections/improvements are highly consistent, which further confirms the value of SMAP in data-sparse regions.

