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Version 3 of the SMAP Level 4 Soil Moisture Product

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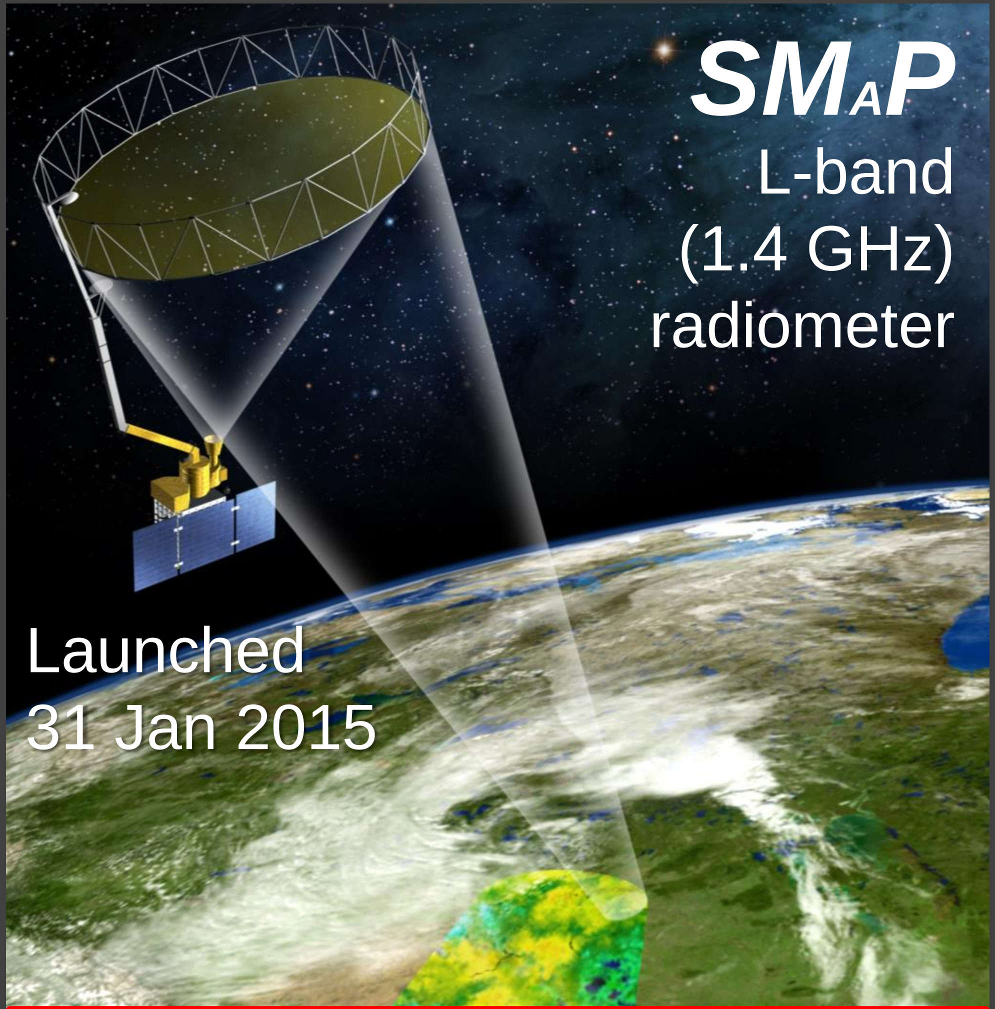
Motivation



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

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**

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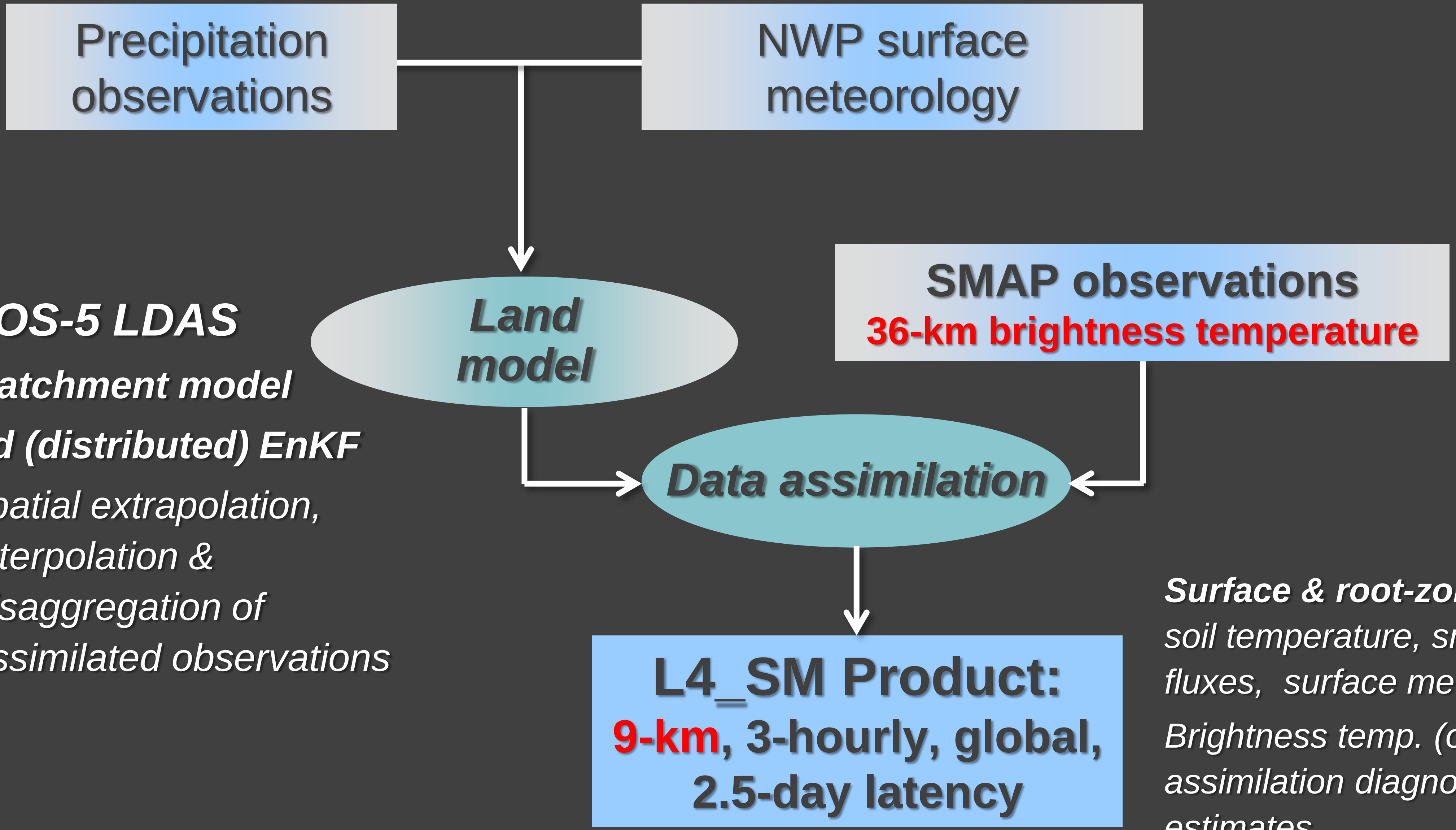
Algorithm Overview



GEOS-5 LDAS

- ***Catchment model***
- ***3d (distributed) EnKF***

  spatial extrapolation, interpolation & disaggregation of assimilated observations

Surface & root-zone soil moisture*, soil temperature, snow, surface fluxes, surface met. forcing.*

Brightness temp. (obs & modeled), assimilation diagnostics, uncertainty estimates.

Land model constants.

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L4_SM Version 3

Data available publicly from NSIDC for 3/31/2015-present.

Used here (unless indicated otherwise): ***Version 3***
April 2015 – March 2017

New in Version 3:

Updated brightness temperature (Tb) scaling factors *based on:*

- *Newer & more SMOS Tbs where available (6 years of v6, rescaled to v5)*
- *SMAP Tbs elsewhere (2 years of Version 3)*
- *Model Tbs from updated "Nature Run" (NRv4.1)*

Retrospective forcing is better and more consistent w/ 2015-present data.

→ More SMAP observations assimilated.

Unchanged *Catchment model version & 2015-present forcing (w/ minimal exceptions).*

Objective was to avoid recalibration of L4_C algorithm.

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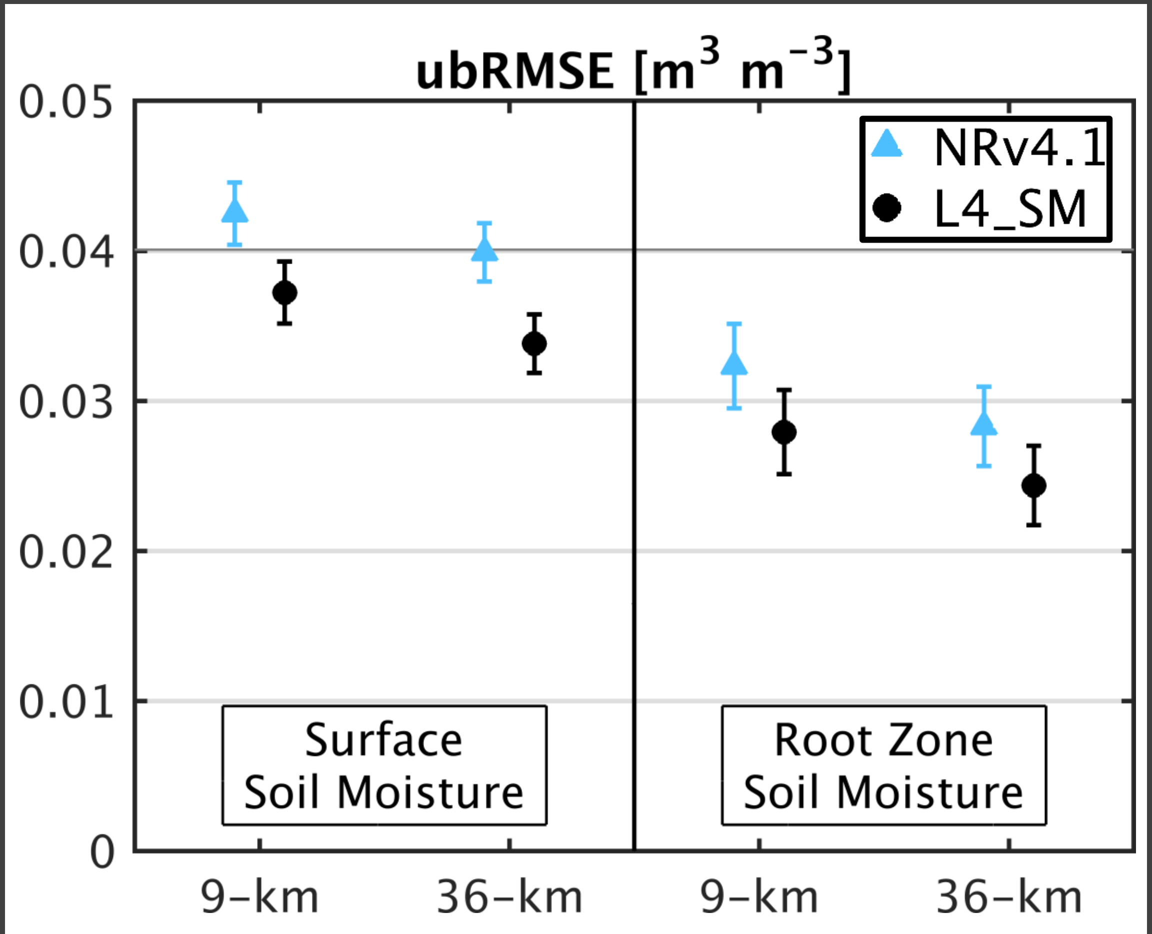
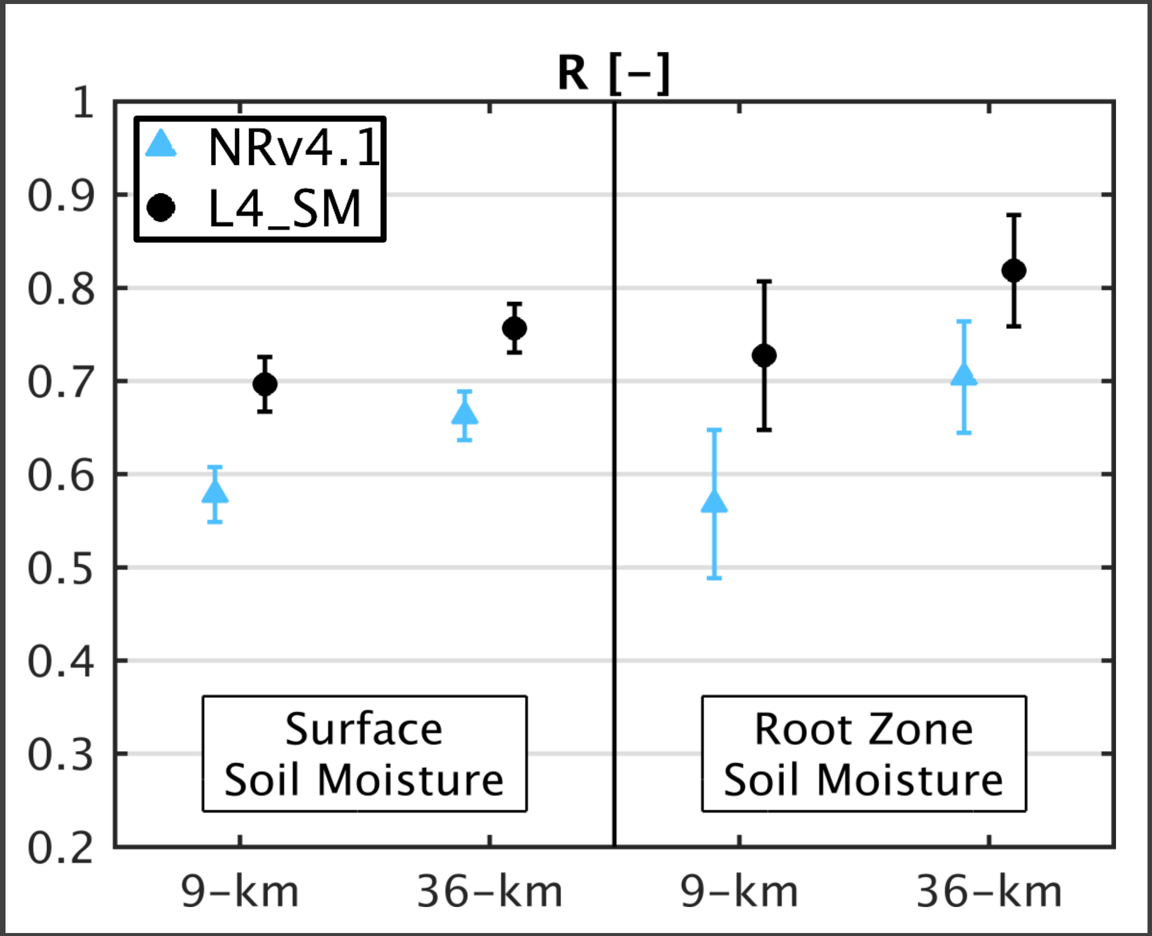
Validation vs. Core Site In Situ Measurements





L4_SM shows small but consistent improvements over model-only data (NRv4.1).

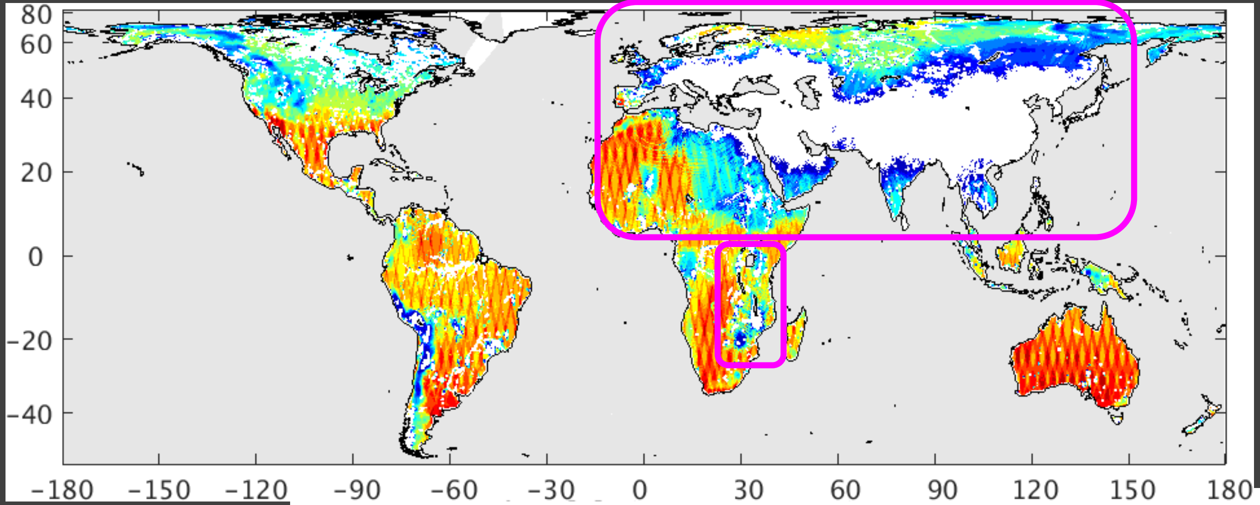
L4_SM meets ubRMSE accuracy requirement of 0.04 $m^3 m^{-3}$.

Results nearly identical for Version 2 (Reichle et al. 2017; doi:10.1175/JHM-D-17-0063.1).

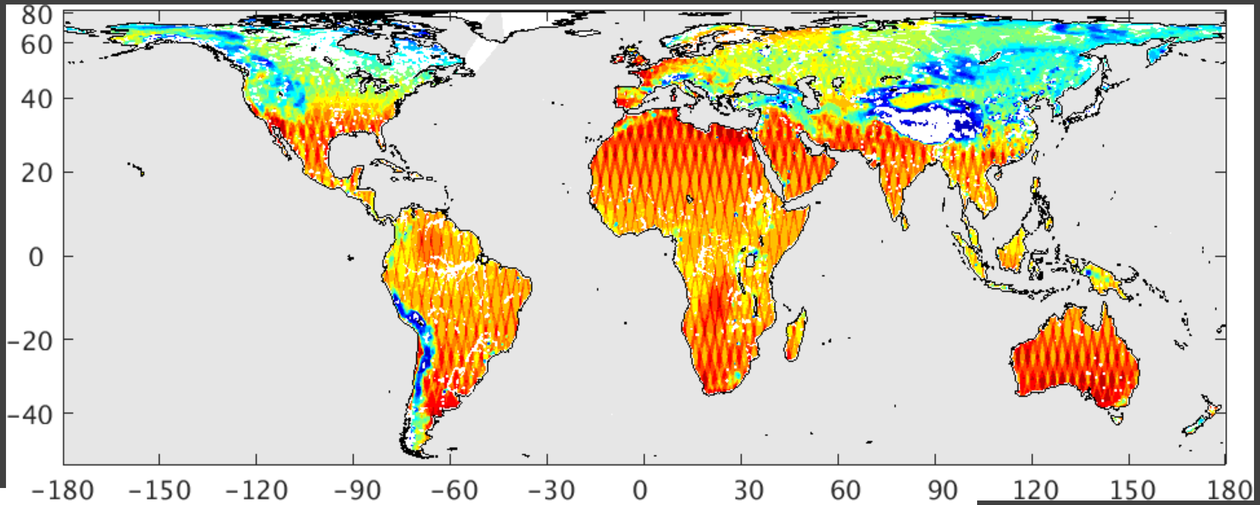
	# Ref. Pixels
SFSM 9 km	26
SFSM 36 km	17
RZSM 9 km	9
RZSM 36 km	7

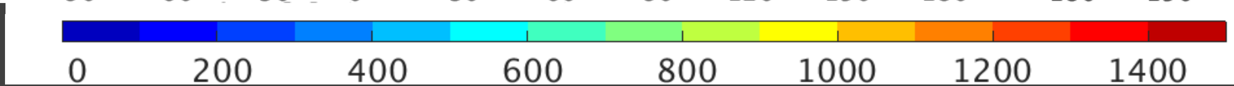
Number of Assimilated SMAP L1C_TB Observations

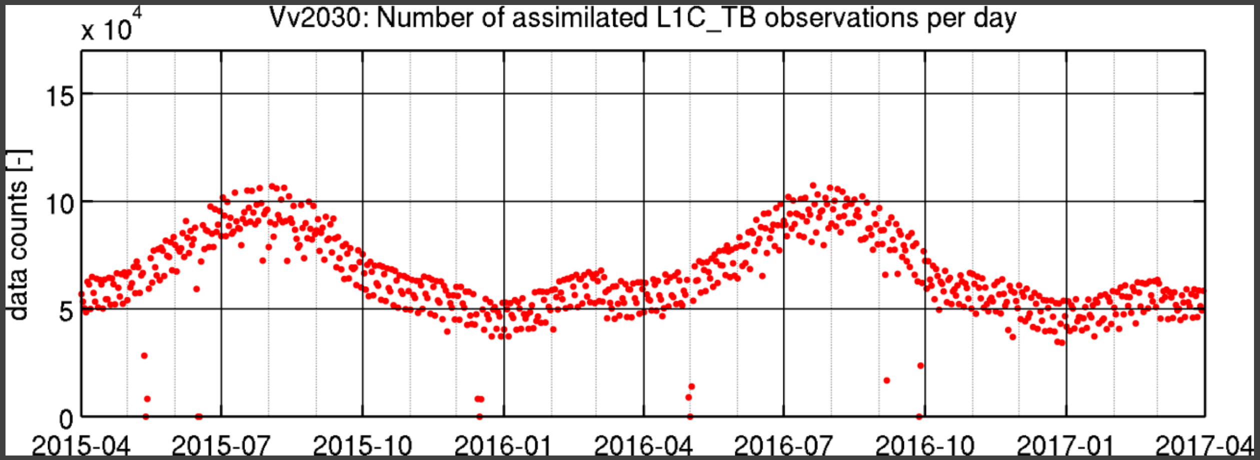
Version 2

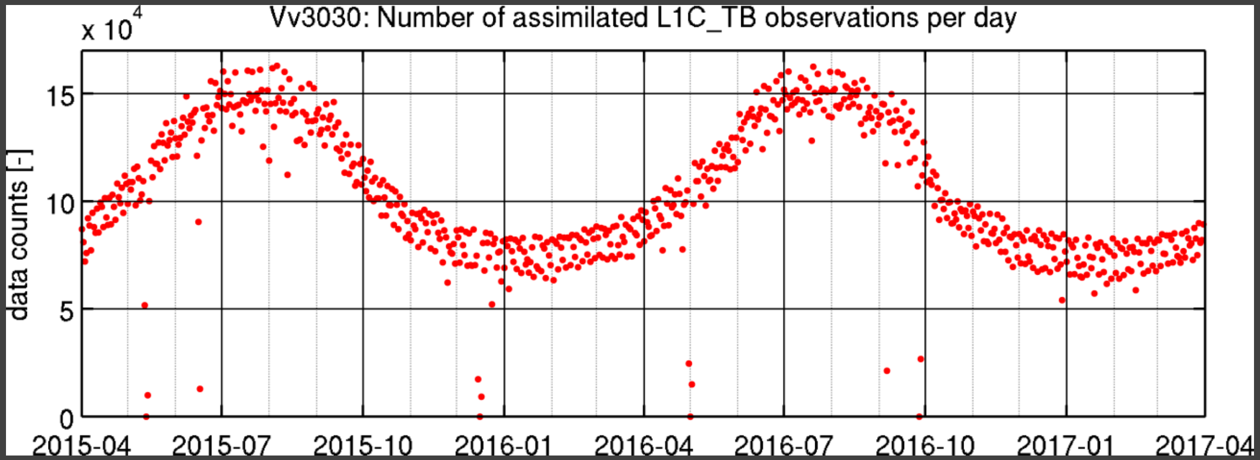


Version 3





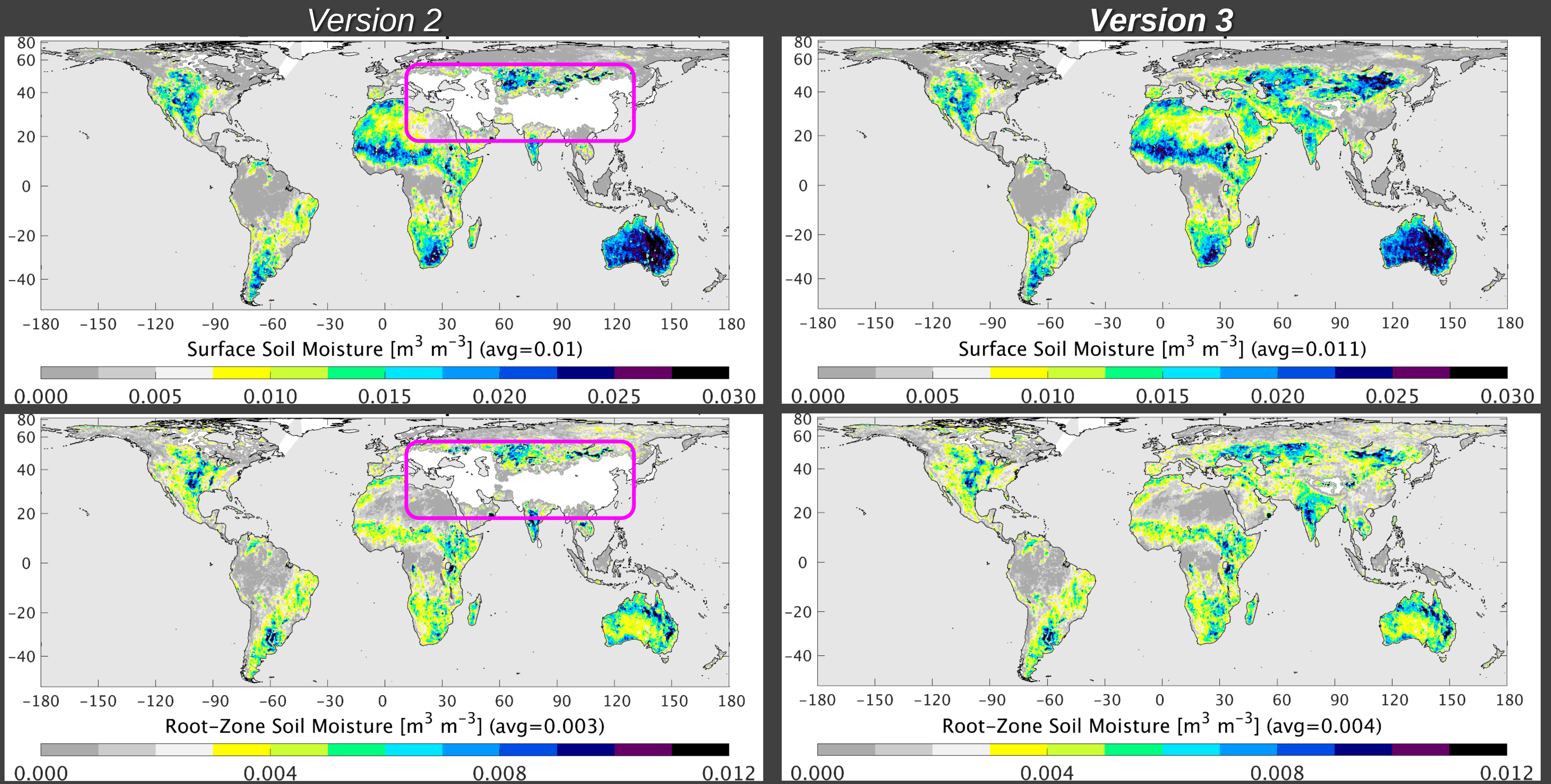




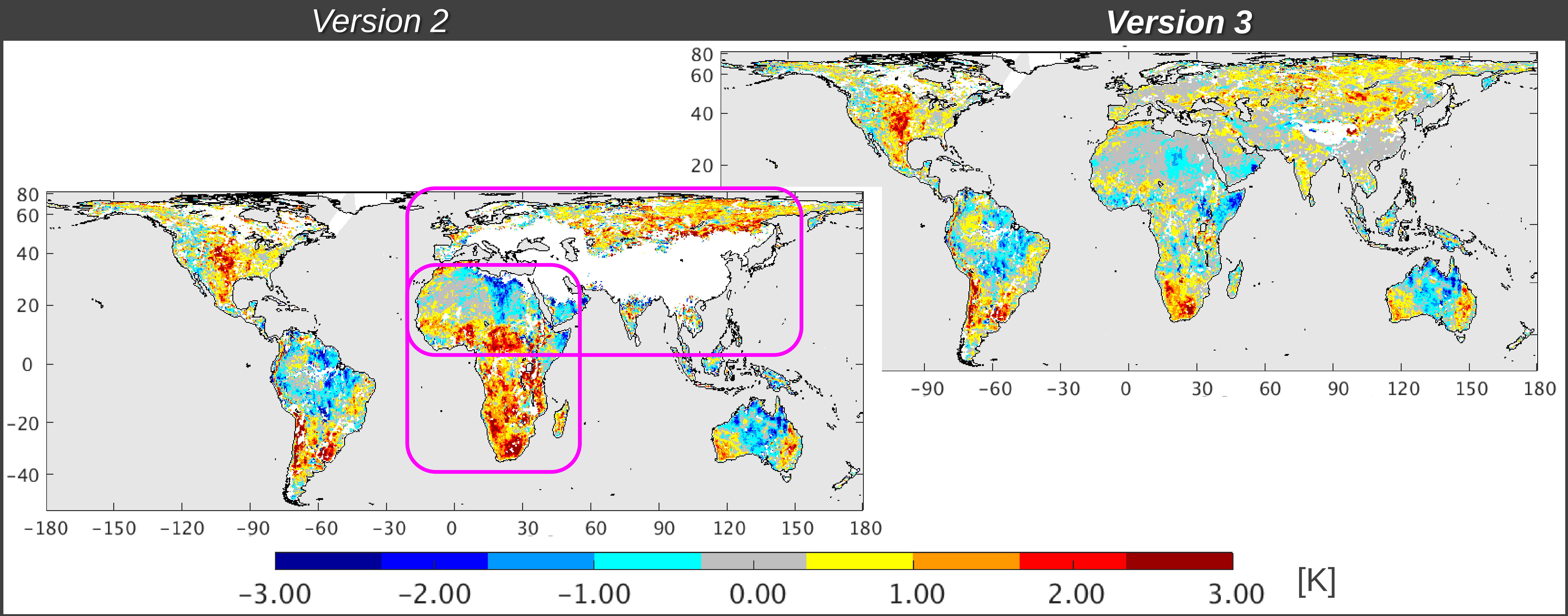
Average: 65,000 / day

Average: **104,000** / day

Std-dev Increments



Mean O-F



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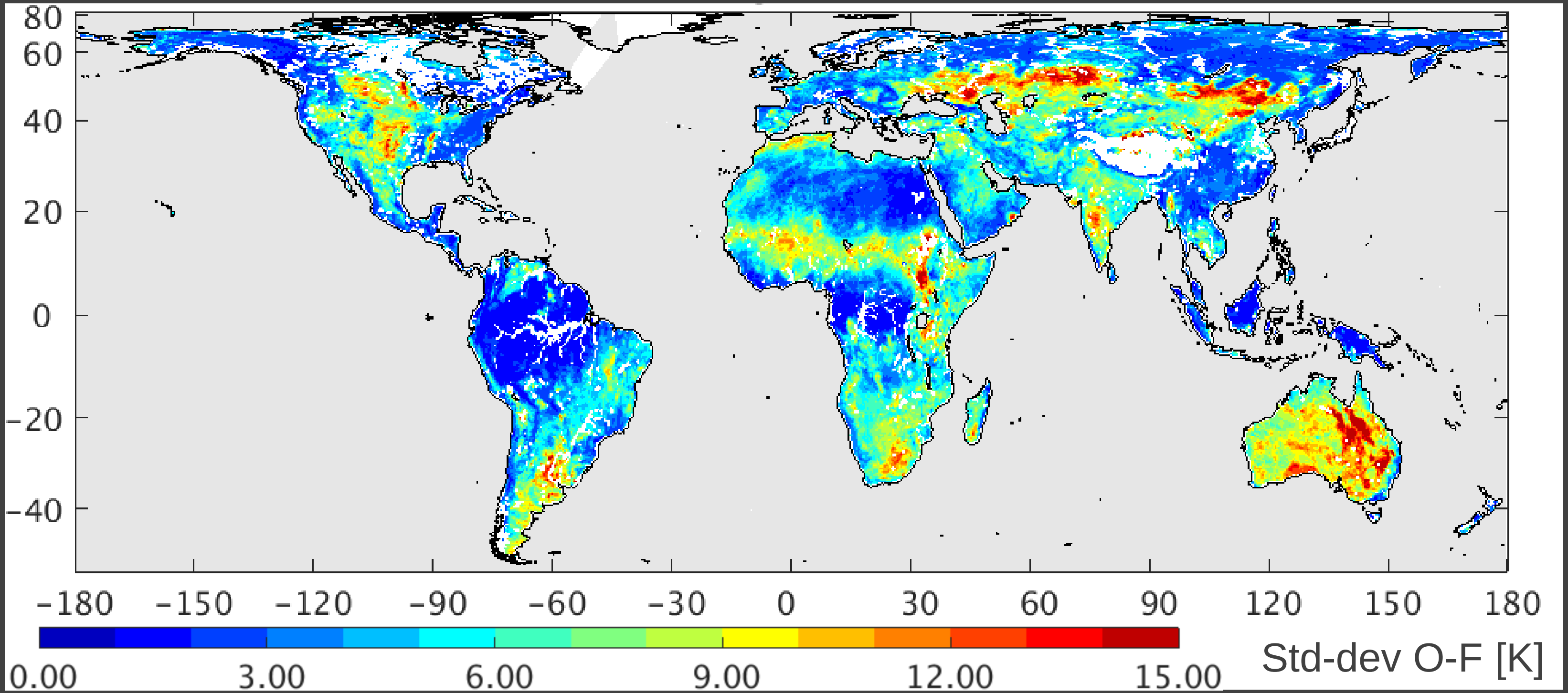
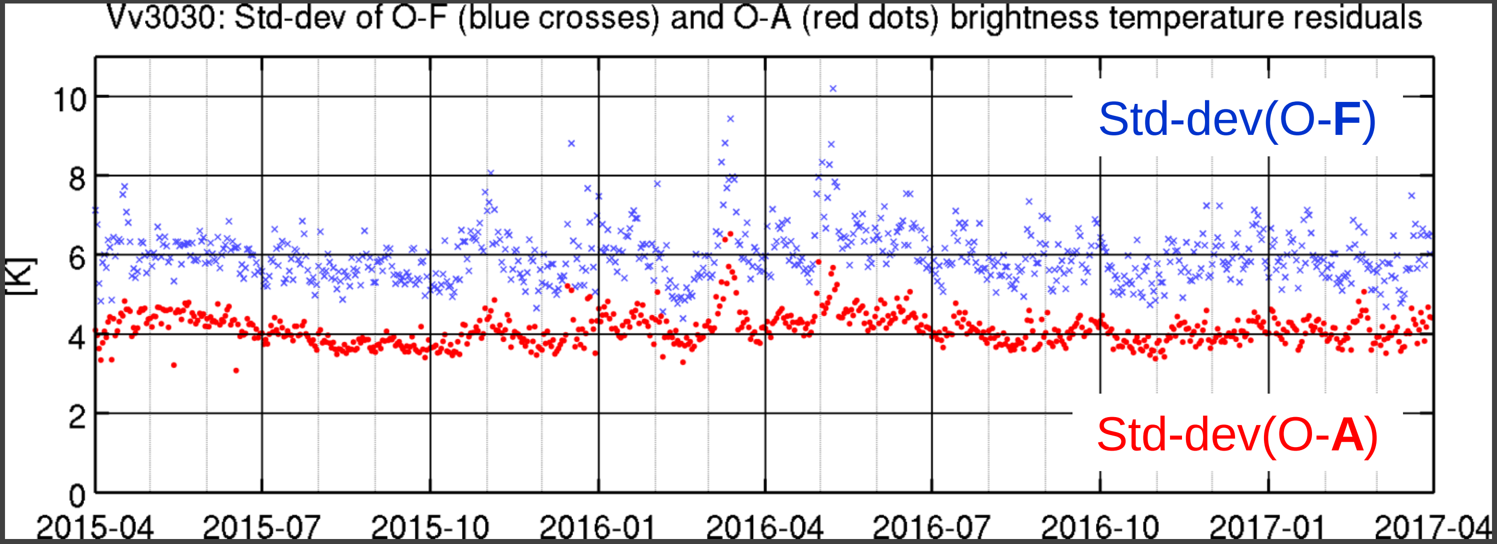
Std-dev O-F





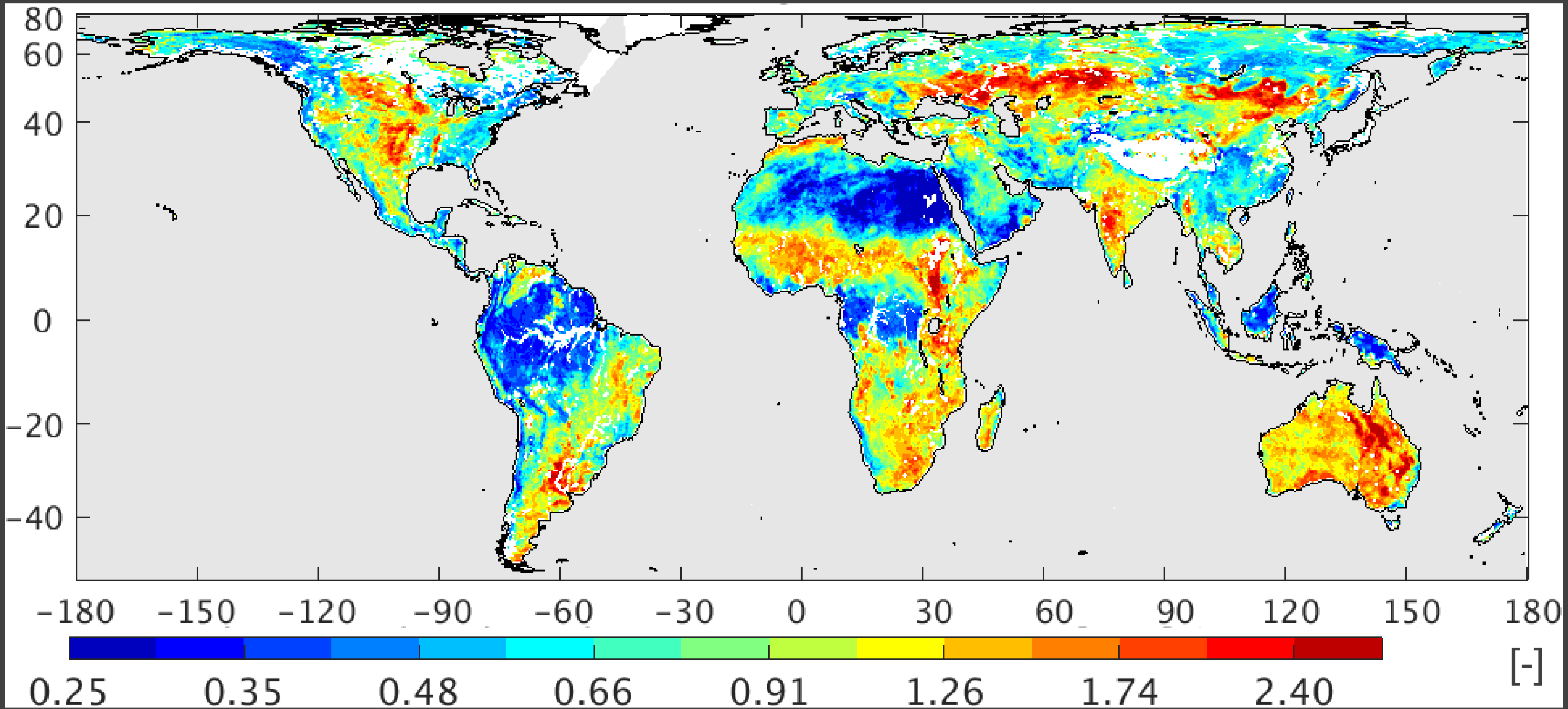
Average:
O-F: 6 K
O-A: 4 K

Cf. Tb obs error = 4 K

includes

instrument error = 1.3 K
&
representative-ness error = 3.8 K

Std-dev Normalized O-F

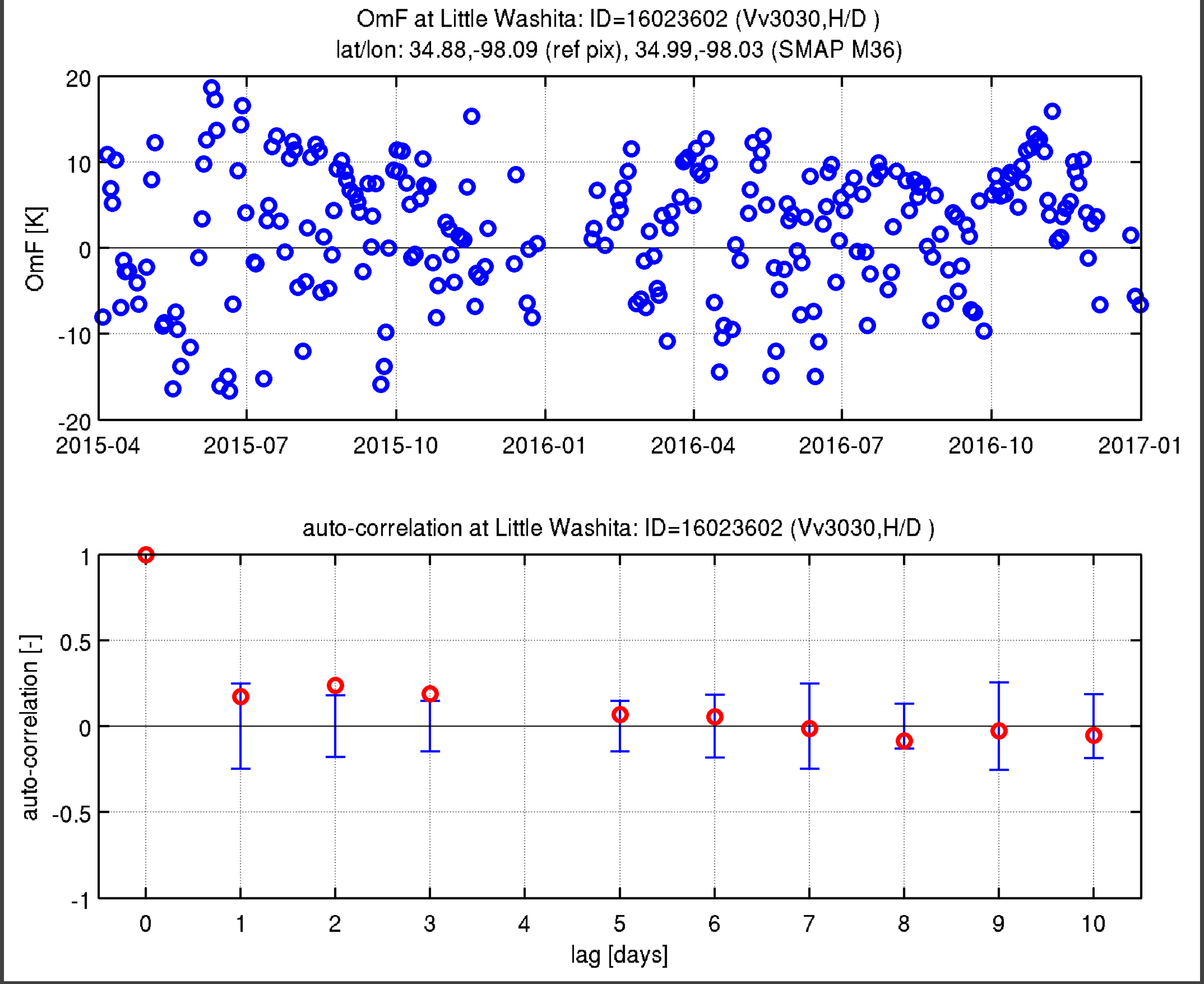


Average:
1.0

over-estimation **under-estimation**

of actual O-F errors

O-F at Little Washita (Oklahoma)



O-F auto-correlation measures “efficiency” of assimilation system.

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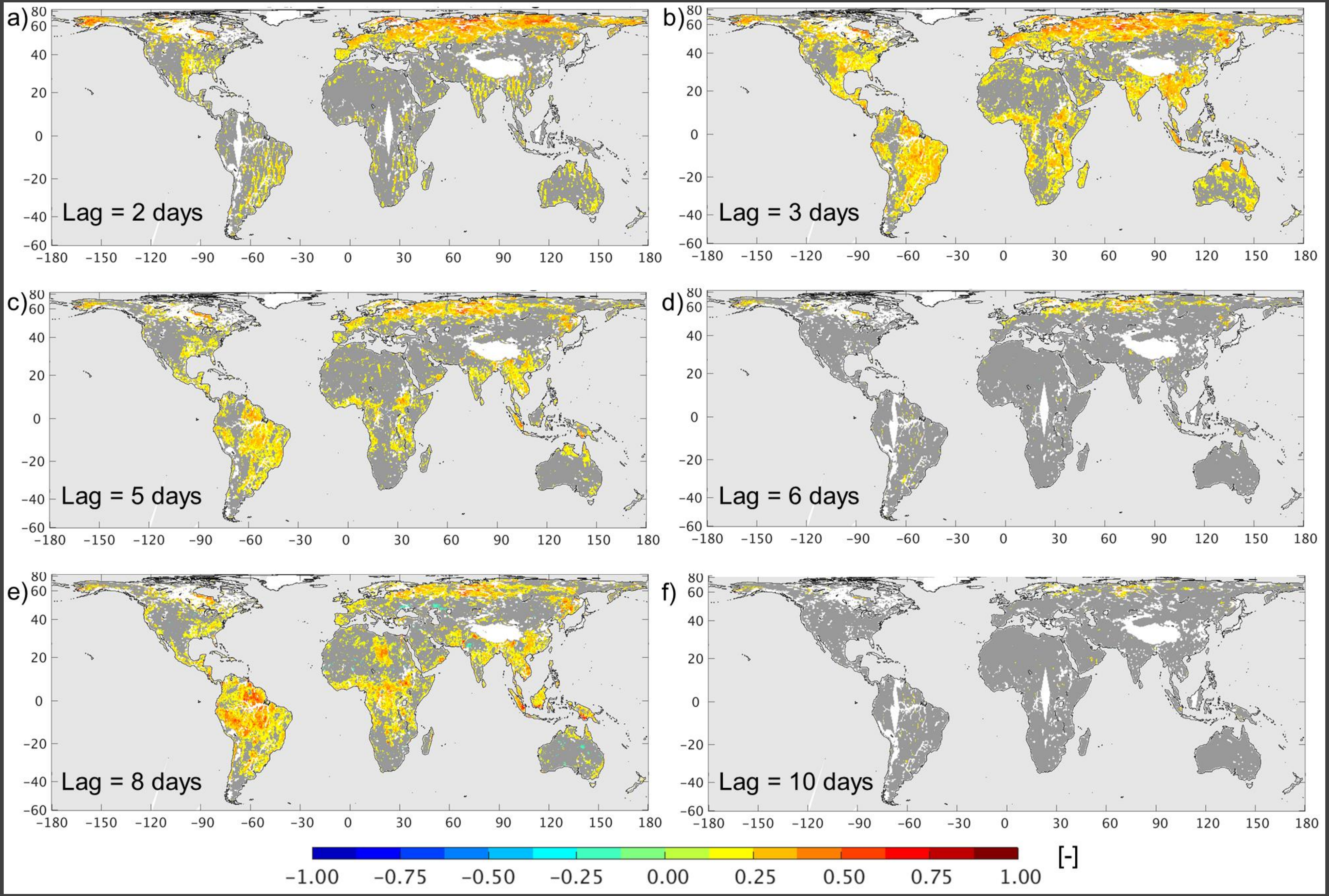
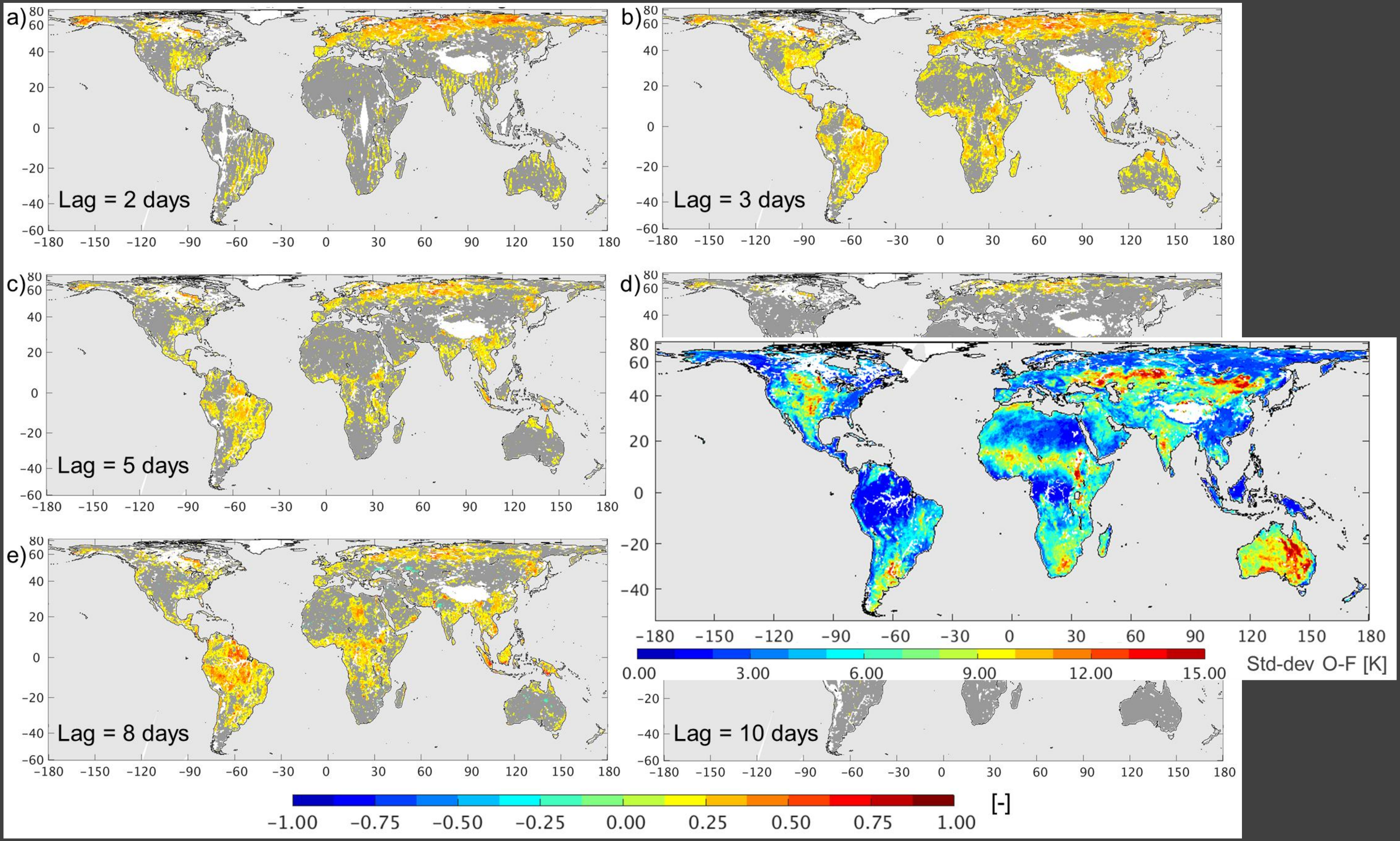
O-F Auto-correlation



O-F Auto-correlation



Summary

- *The L4_SM algorithm assimilates SMAP brightness temperature (Tb) observations into the NASA Catchment model using a distributed (3d) EnKF.*
- *The L4_SM product provides global, 9-km, 3-hourly estimates with ~2.5-day latency.*
- *Version 3 of the L4_SM algorithm also assimilates SMAP Tbs in RFI-prone regions.*
- *The L4_SM analysis is largely unbiased, but there are modest regional biases in the O-F Tb residuals (<3 K).*
- *Typical instantaneous values are ~6 K for O-F Tb residuals and ~0.01 (~0.004) $m^3 m^{-3}$ for surface (root-zone) soil moisture increments.*
- *Actual errors are overestimated in deserts and densely vegetated regions and underestimated in agricultural regions and wet-dry transition zones.*
- *SMAP observations are assimilated efficiently in western North America, the Sahel, and Australia, but not in many forested regions and the northern high latitudes.*

SMAP L4_SM Documentation

***Data Archive** & HTML Doc*

http://nsidc.org/data/smap

Product Specification Document

Algorithm Document

Data Assessment Reports

http://gmao.gsfc.nasa.gov/GMAO_products/SMAP_L4

10.5194/hess-20-4895-2016

In Review

10.1175/JHM-D-15-0037.1

10.1175/JHM-D-17-0063.1

Peer-reviewed SMOS and SMAP Papers