Improved bias mitigation and rain effect estimate in SMOS SSS CATDS 2018 processing

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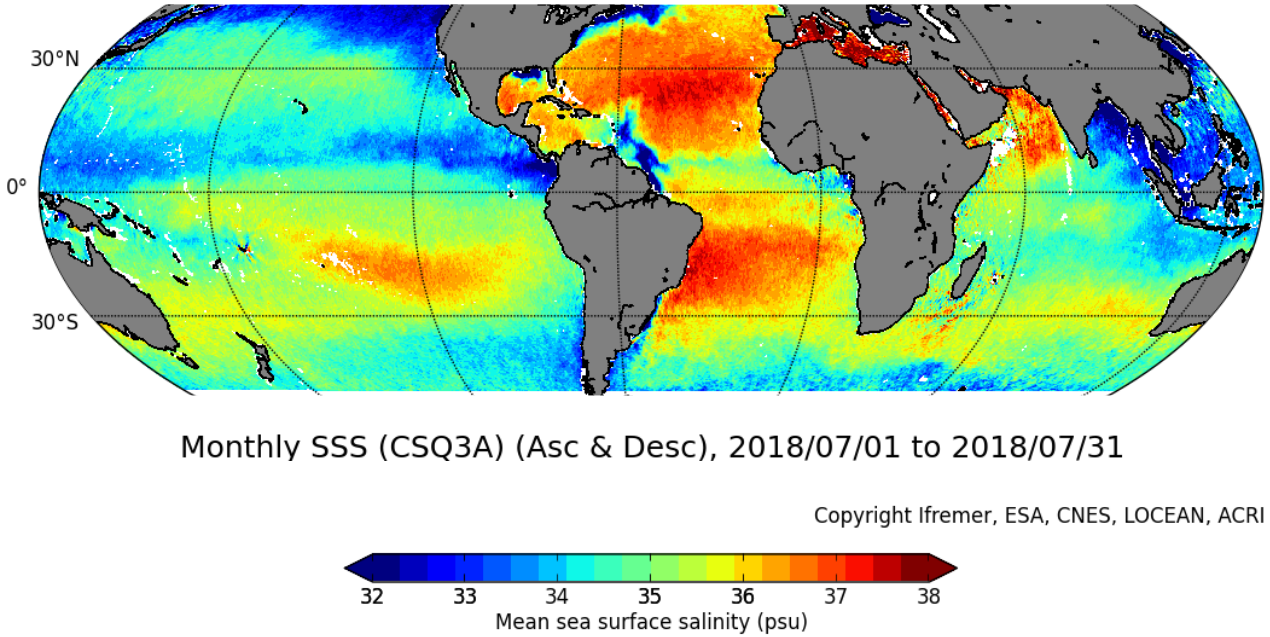
and the CATDS users team, [(1)]LOCEAN-IPSL, [(2)] ACRI-st, [(3)] IFREMER, France

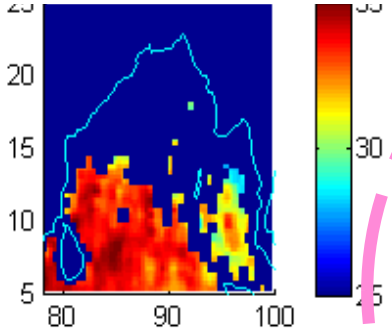
SMOS SSS – July 2018



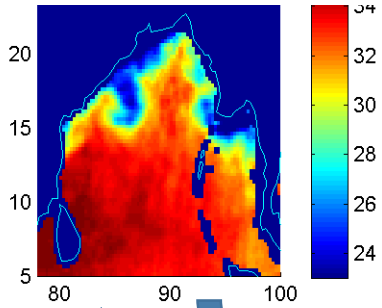
Operational debias_v2 L3Q SMOS SSS product (Boutin et al. 2018) available at CATDS
(Visualization tool available on maps.catds.fr)

CATDS debiased products

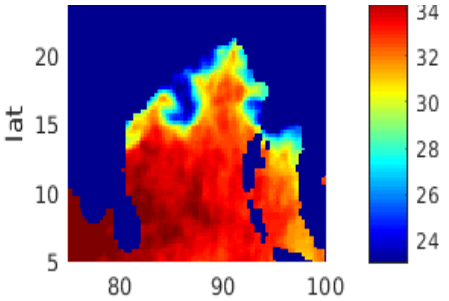
No debiasing, CATDS



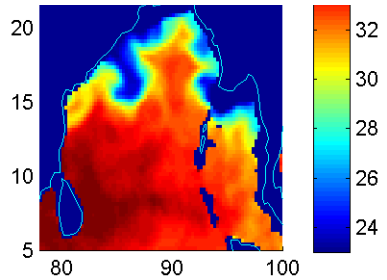
CATDS CEC LOCEAN Debias v2



CATDS CEC LOCEAN Debias v3



SMAP CAP v3



In progress

NRT CATDS CPDC L3Q

NRT CATDS CPDC L3Q & L3G

Boutin et al. RSE 2018

This presentation

LAND CONTAMINATION SSS CORRECTION IN CATDS

Kolodziejczyk et al. RSE 2016.

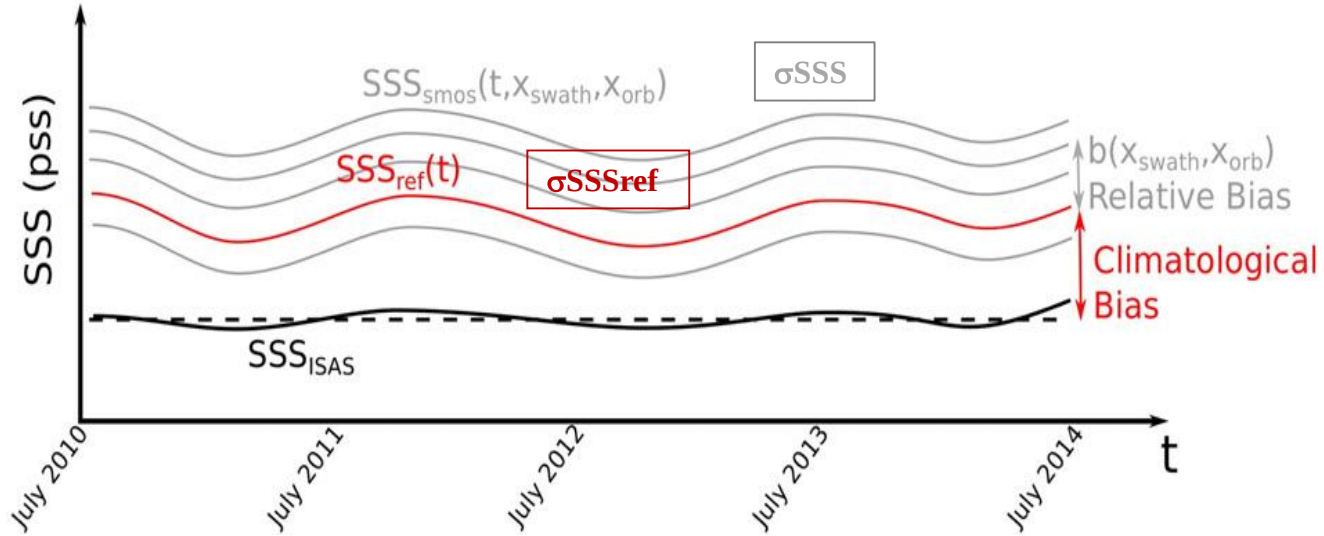
Bias_tot(lat, lon, xswath, t, Pass)

= Bias_Land(lat, lon, xswath, Pass)

Pass = pass orientatio (Ascending/Descending).
Xswath = distance across swath
t = month of the year

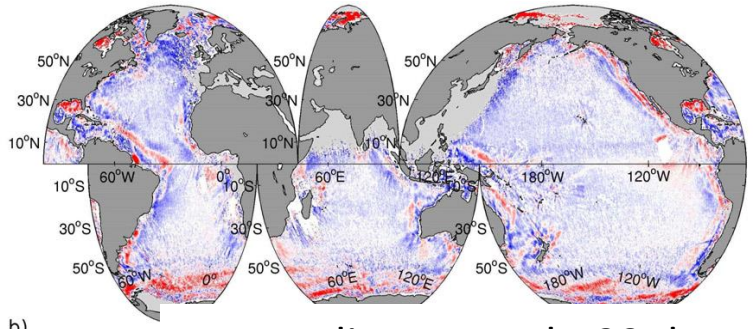
Bayesian method => SMOS SSS biases in different Xswath over several years (SMOS self-consistent method)

Climatological adjustment:
multi-year median (SMOS SSS) = median (ISAS (Argo OI) SSS).

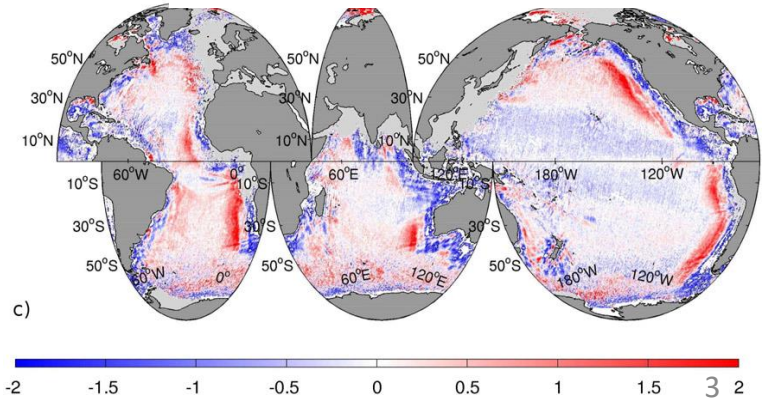


Median SSS bias

Ascending, Xswath=0



Descending, Xswath=225km



LAND CONTAMINATION & LATITUDINAL SSS CORRECTION

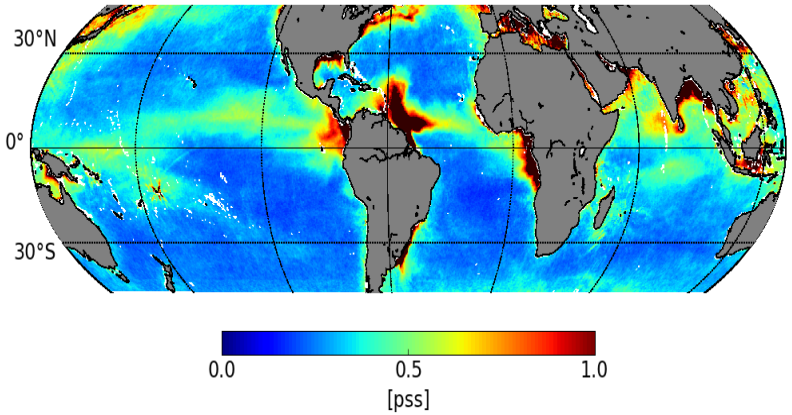
*Debias_v2 & **Debias v3***

Pass = pass direction.
Xswath = distance across swath
t = month of the year

Bias_tot(lat, lon, xswath, t, Pass)

= Bias_Land(lat, lon, xswath, Pass) + Bias_Lat(lat, xswath, t, orbit)

Improved filtering using SMOS inferred
SSS natural variability
Debias v2: yearly variability
Debias v3: seasonal variability



Climatological adjustment:
Debias v2: 7yr median (SSS_{SMOS}) = 7yr median (SSS_{ISAS})
Debias v3: 7yr Q80(SSS_{SMOS}) = 7yr Q80(SSS_{ISAS}) + ξ

LAND CONTAMINATION & LATITUDINAL SSS CORRECTION

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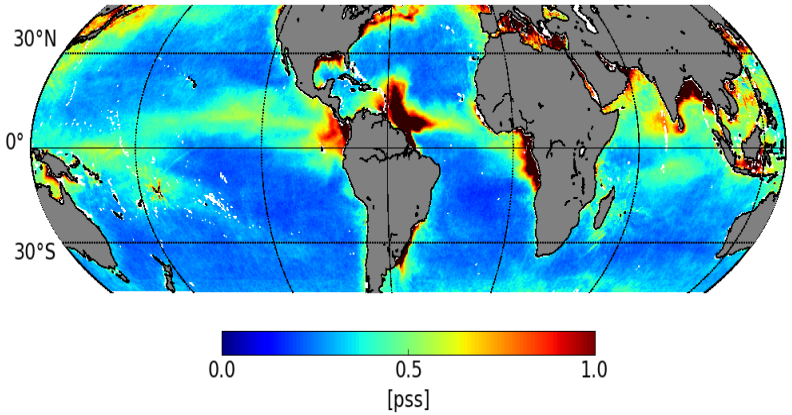
Improved filtering using SMOS inferred
SSS natural variability
Debias v2: yearly average
Debias v3: seasonal variability



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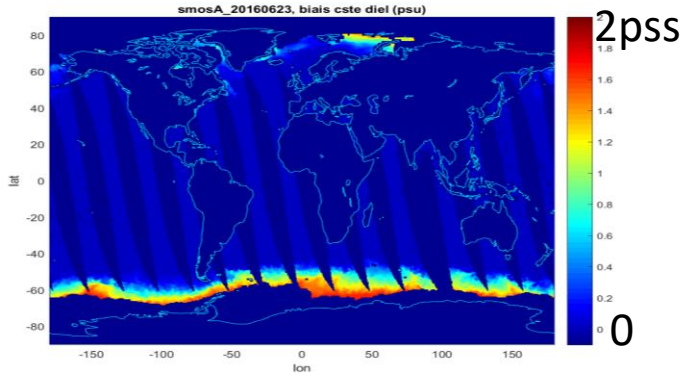
Debias v2: 7yr median (SSS_{SMOS}) = 7-yr median (SSS_{ISAS})
Debias v3: 7yr Q80(SSS_{SMOS}) = 7-yr Q80(SSS_{ISAS}) + ξ

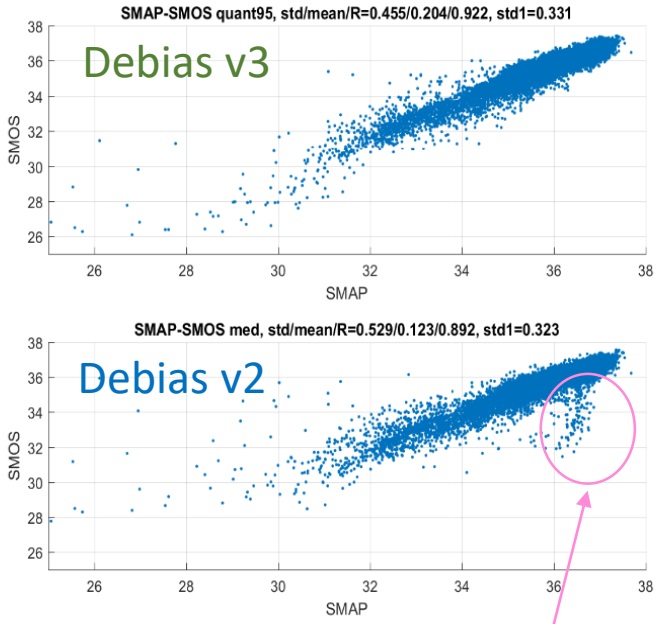
Seasonal latitudinal bias (issues with sun, sun glint, galactic noise effects) computed over 7 years
Reference: the less biased Xswath in the Pacific Ocean (debias v2) ; Atlantic Ocean (debias v3)

In debias v3: empirical SST correction (SST<7°C ~difference between KS and MW retrieved SSS for SST<5°C; Dinnat et al. 2017 URSI)

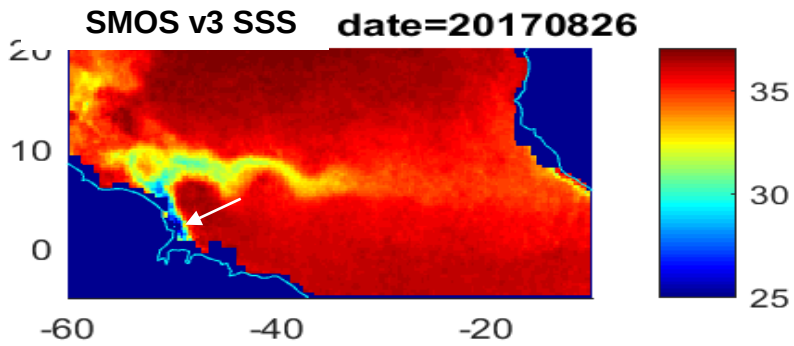


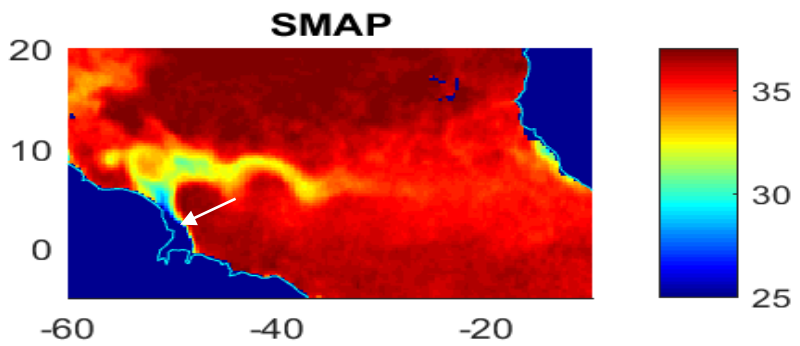
What's new in CATDS debias v3?
Multi-year climatological adjustment (Q80 instead of median)

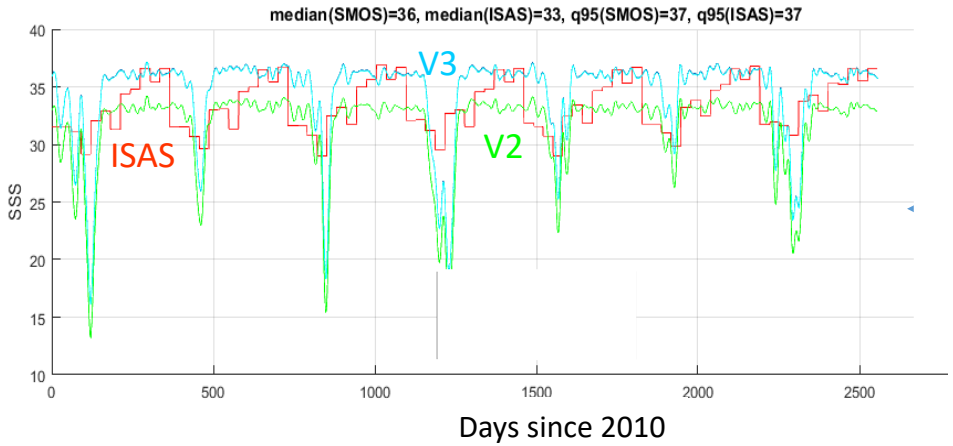
Amazone Plume



An effect of median adjustment wrt ISAS climatological mean





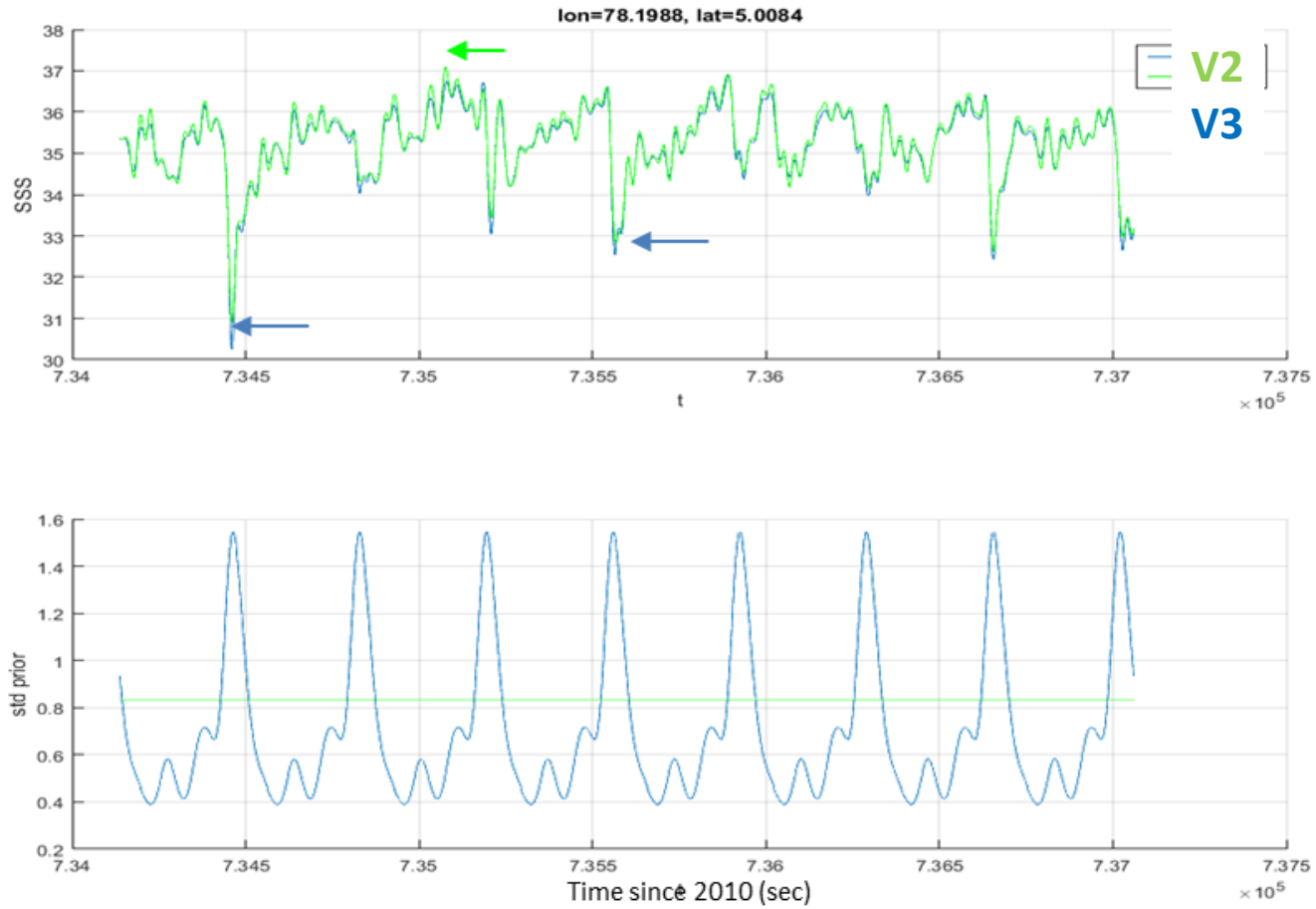


Top,left) 9-d SMOS v3; Top right) 8-d SMAP; bottom left) time series of SMOS SSS (v2 green), v3 (blue), ISAS (red), in a region where SMOS SSS distribution very skewed contrary to ISAS.

What's new in CATDS debias v3?
Seasonal (instead of yearly mean) natural variability

Fresher SSS during very fresh events
Less oscillations during salty periods (more stable solution)

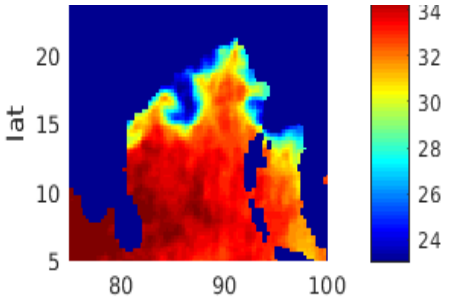
Bay of Bengal



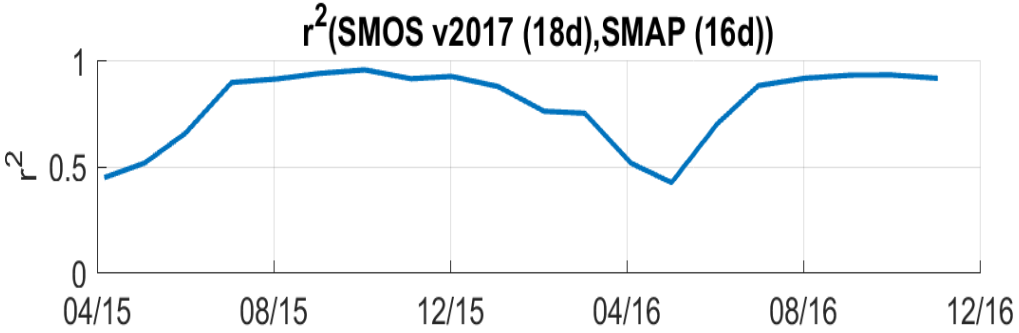
Impact of seasonal natural variability (bottom) in a pixel during 8 years. Top: Time series of SMOS v3 (blue) and v2 (green) SSS.

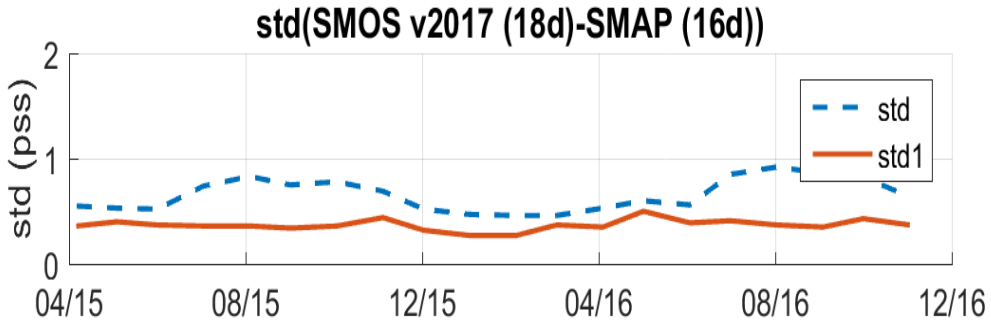
Impact of seasonal natural variability on SMOS-SMAP comparisons

Bay of Bengal

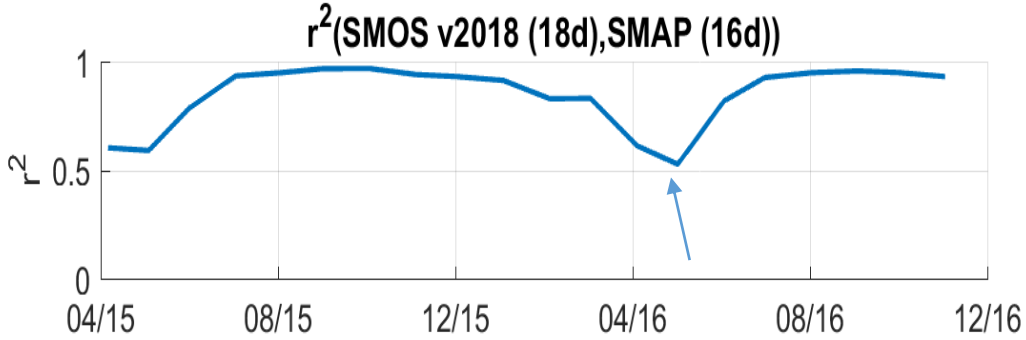


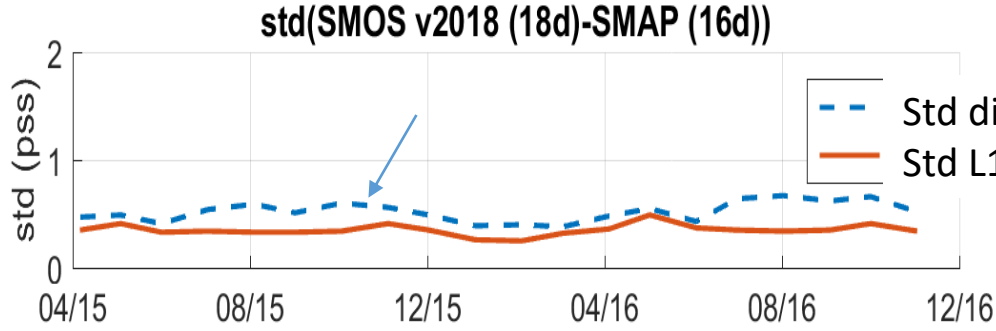
Debias_v2





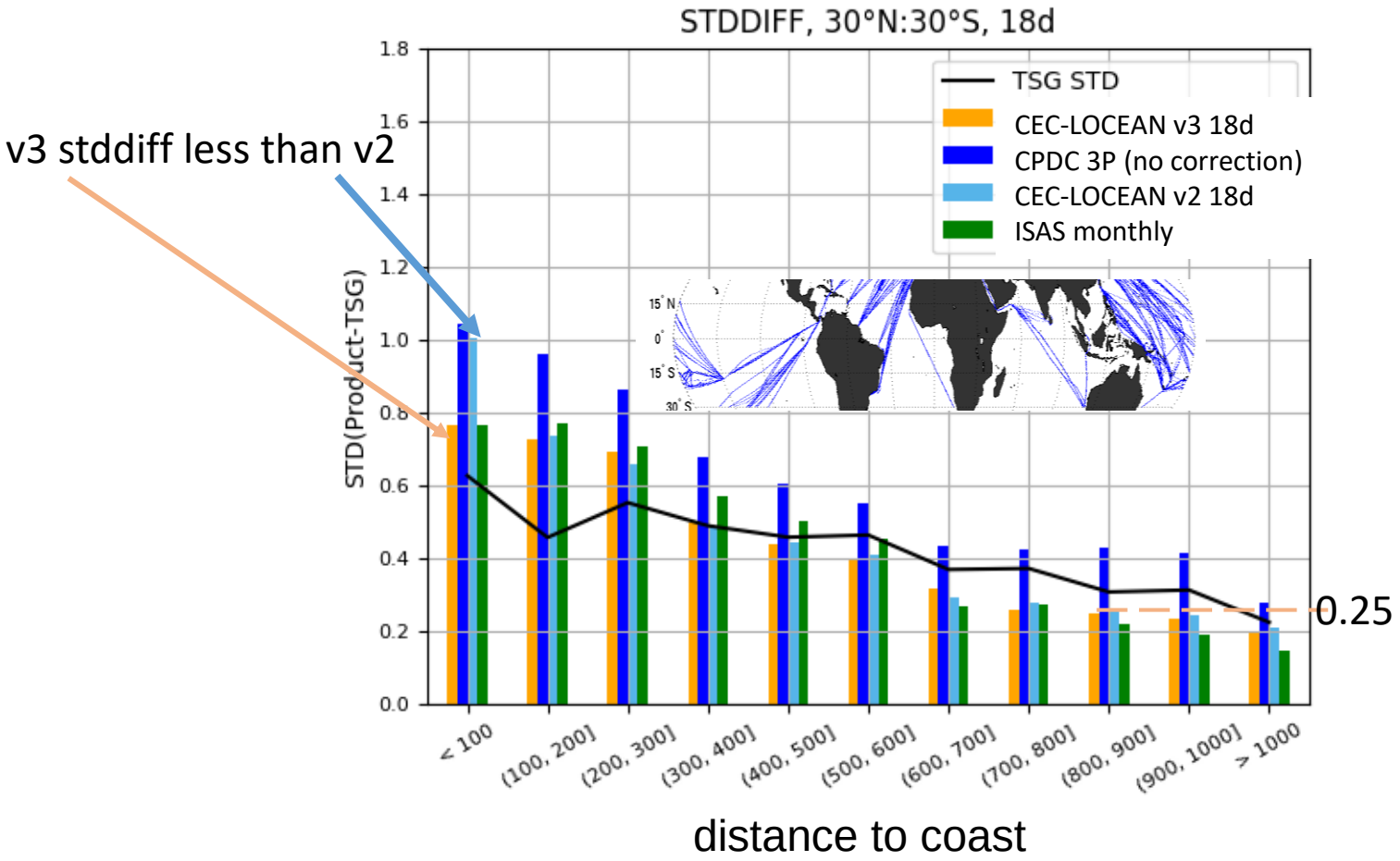
Debias_v3





SMOS closer to SMAP SSS: better r2 especially during low variability periods, lower stddifference (better outlier filtering)

SMOS (18 days) and ship (0.5°) SSS comparisons
Standard deviation of the difference (30N-30S)

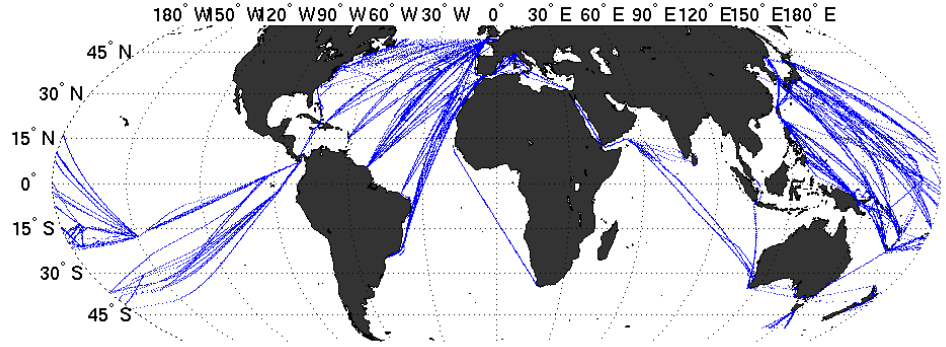


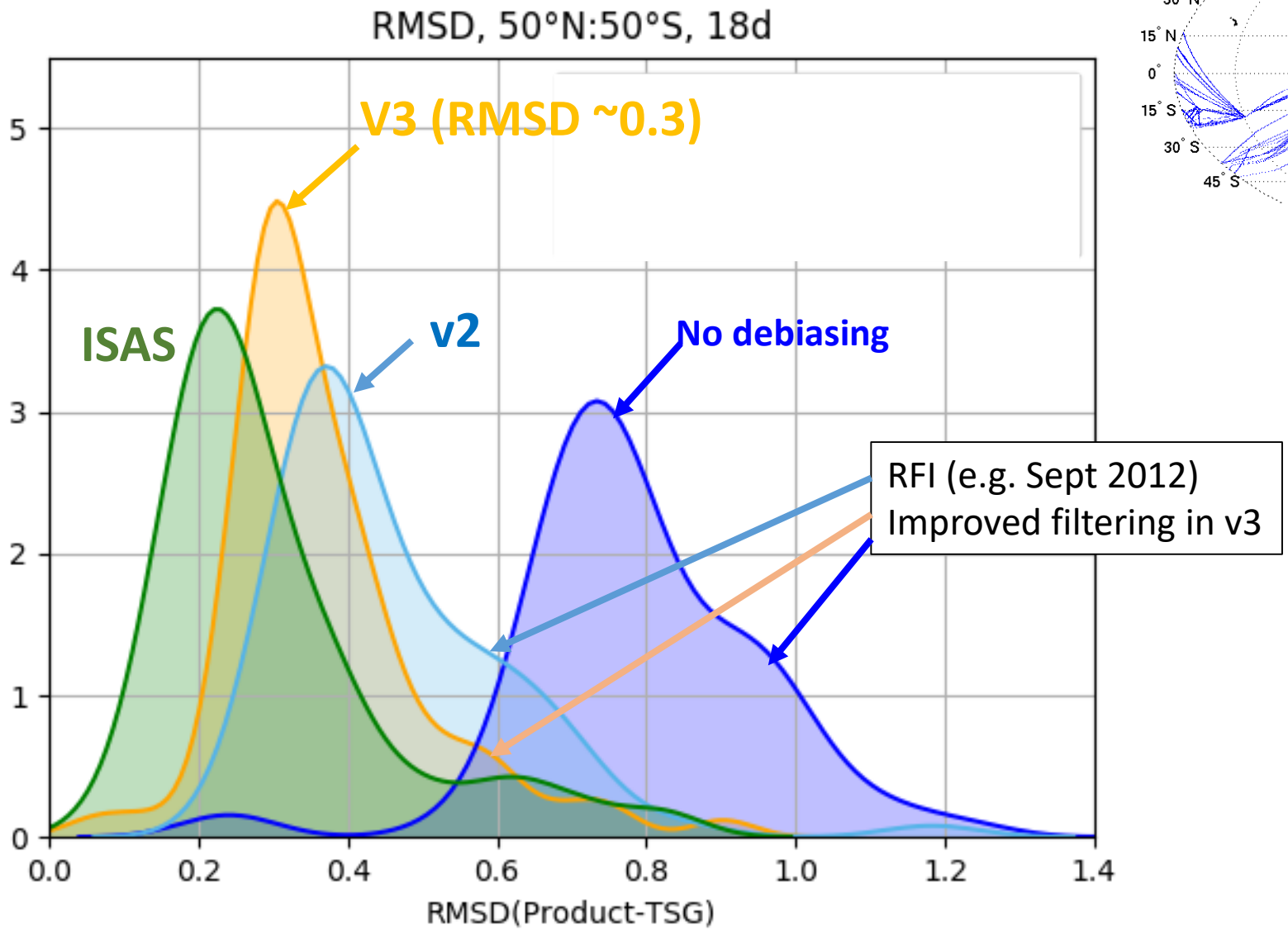
Debias_v3-ship stddiff <~ monthly ISAS-ship stddiff up to 500km from coast

18days debias_v3-ship stddiff <0.25 further than 800km from coasts

Ship SSS averaged over 0.5°. ISAS (Argo OI, yellow), SMOS CATDS CPDC SSS without correction (monthly, blue), with correction ~v2 (monthly 3Q, light blue), CATDS CEC-LOCEAN (v2 18d, green), (v3 18d, pink).

SMOS (18 days) and ship (0.5°) SSS comparisons
PDF of monthly RMSD (50N-50S including coastal areas)



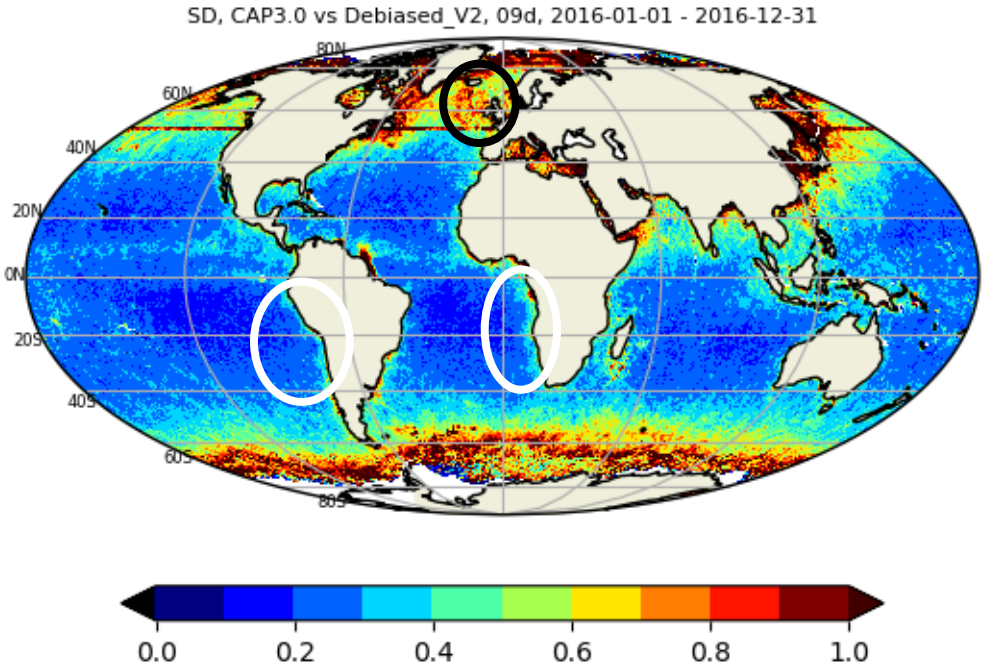


SMOS debias_v3(9 days) and SMAP CAPv3 (8 days) SSS STDDIFF

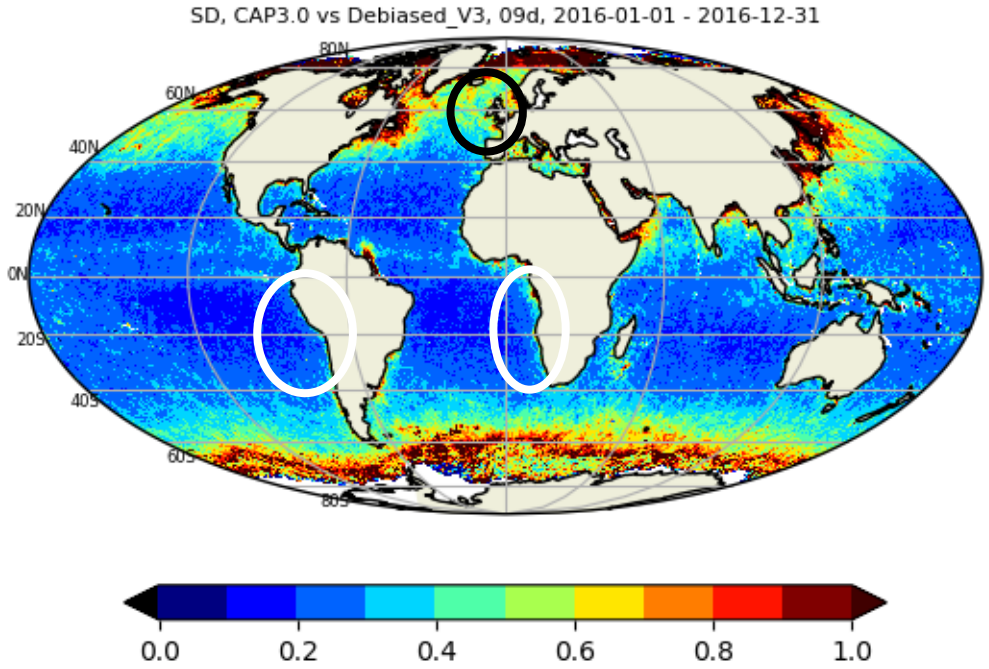
Better agreement in near coastal regions

Better RFI filtering in N latitude

Debias v2



Debias v3

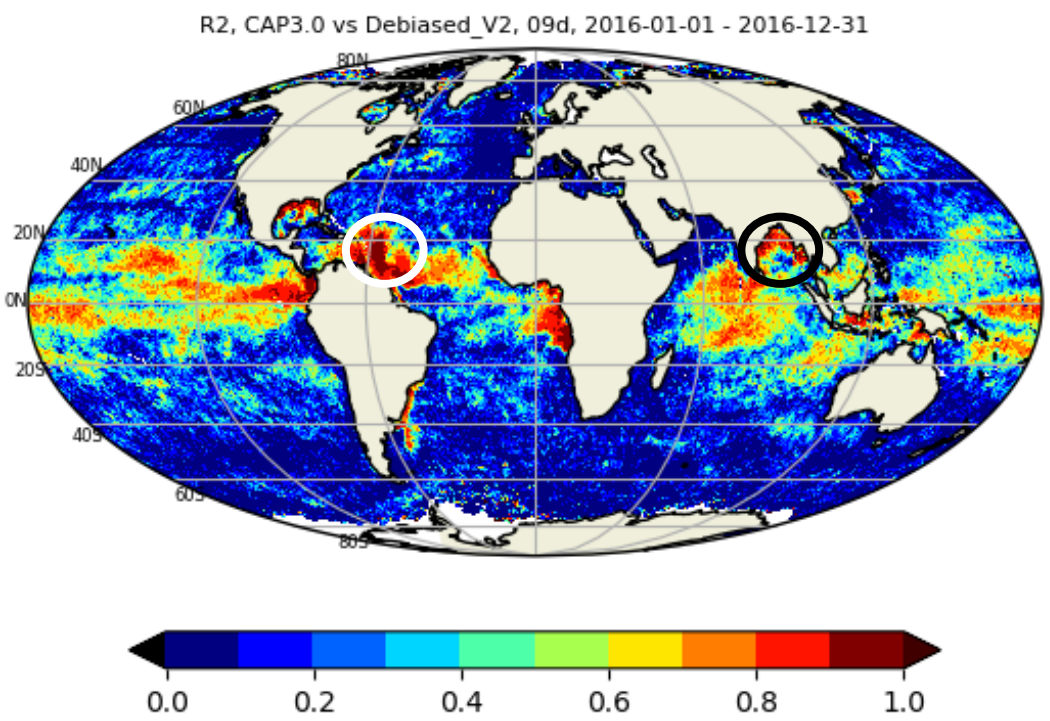


Still large stddiff in cold regions: large noise in both SMOS & SMAP SSS but also still some issues close to ice edges & because of dielectric constant issue

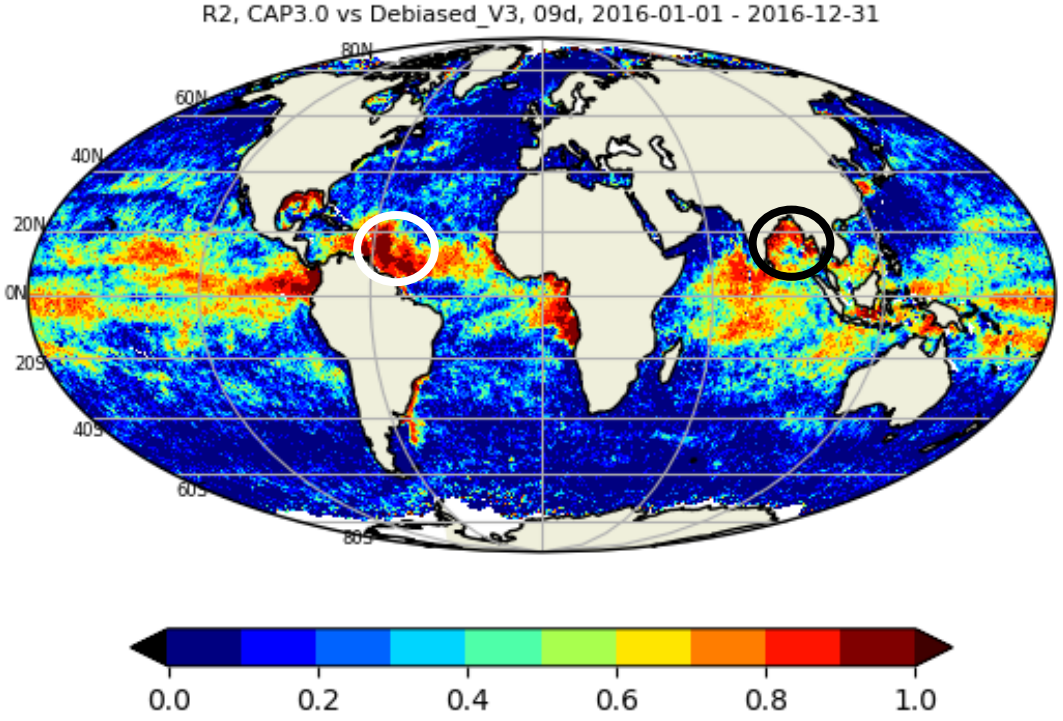
SMOS debias_v3 (9 days) and SMAP CAPv3 (8 days) SSS R^2 (signal to noise ratio)

Very good consistentcy of r2 in highly variable regions ;
improvements with debias_v3 (e.g. Amazone plume, Bay of Bengale)

Debias v2



Debias v3



Summary & Perspectives 1/4

- **Major improvements in SMOS SSS debias_v3** (CEC LOCEAN available at CATDS since July 2018):
  - Very variable areas & close to coast: improved absolute calibration & signal to noise ratio
  - High latitudes: improved RFI filtering & SST influence (still room for improvement)

- **SMOS (18days) & ships (0.5°):**

  In the tropics
  - >800km from land: stddifference (SMOS-ship) <0.25
  - <500km from land: SMOS SSS closer to ship than ISAS (high SSS natural variability)

  At high latitude, better filtering of RFIs

- **'Weekly' SMOS and SMAP CAPv3 SSS**
  - very consistent (r^2>0.8) in variable areas; improvement at high latitudes but still issues with ice border and low SST
  - To be checked with SMAP CAP & RemSS new versions

- **SMOS-SMAP comparisons & origin of differences to be deepened in ESA CCI+SSS project**

Summary & Perspectives 2/4

CATDS CPDC (Near Real Time) products
Updates before end of 2018

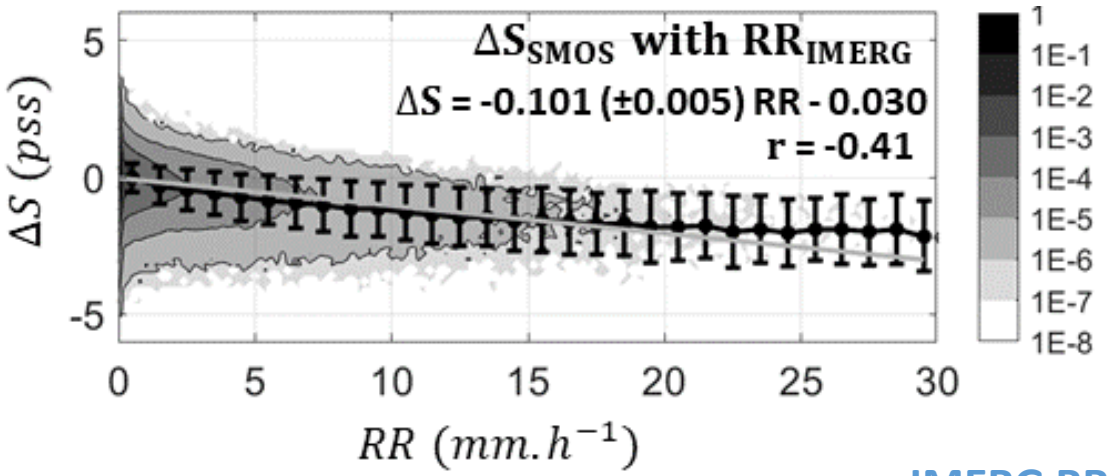
- Debias_v3 methodology

- 9day maps each day (instead of the 10d average generated 3times a month). (closer to SMAP 8day means):
  - Simple average (generated at ~D+5d (OTT constraint)).
  - Gaussian average with a 9d FWHM window (generated at ~D+25d).

- Correction for instantaneous rain effect using IMERG rain rate:

SMOS SSS without RR imprint (see A. Supply presentation)

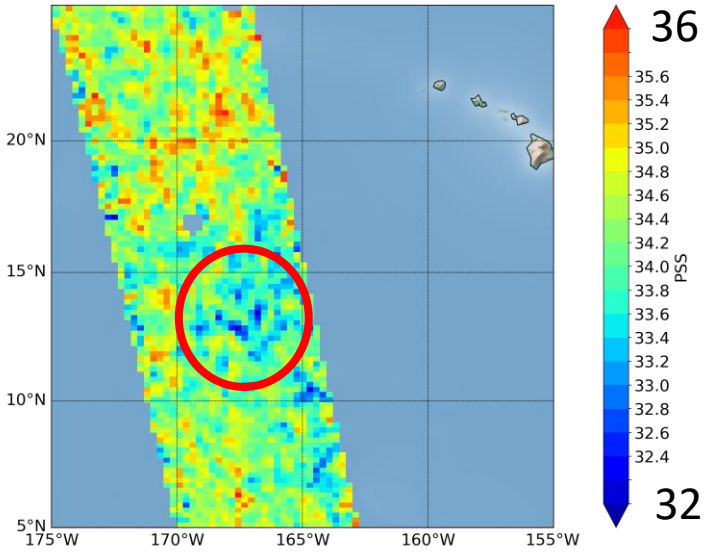
Relationship between SMOS ΔS and IMERG RR derived between 50°S and 50°N during 2016



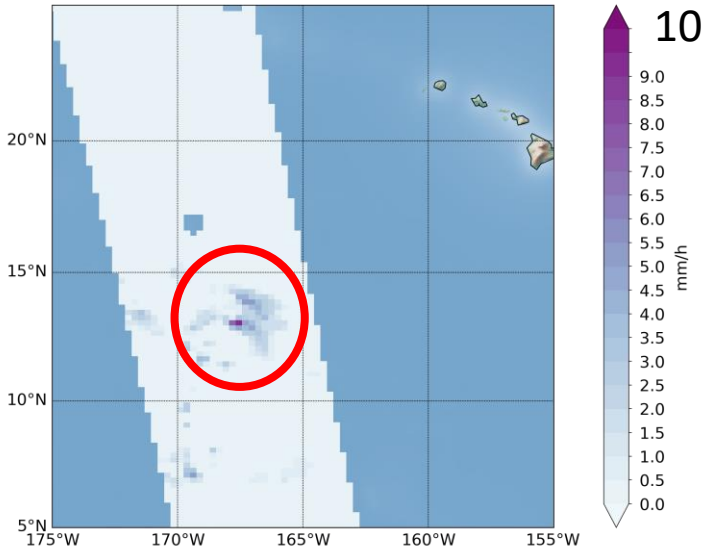
Methodology:

- Relationship derived from SMOS L2Q SSS (*Boutin et al, 2018*) and IMERG RR (*Huffman et al, 2018*) collocated data during 2016 using salinity anomaly methodology (*Supply et al. 2017*).
- Only instantaneous RR considered (*Supply et al. 2018, submitted*).
- Non-linear relationship taking into account flattening of SMOS versus IMERG at high RR.

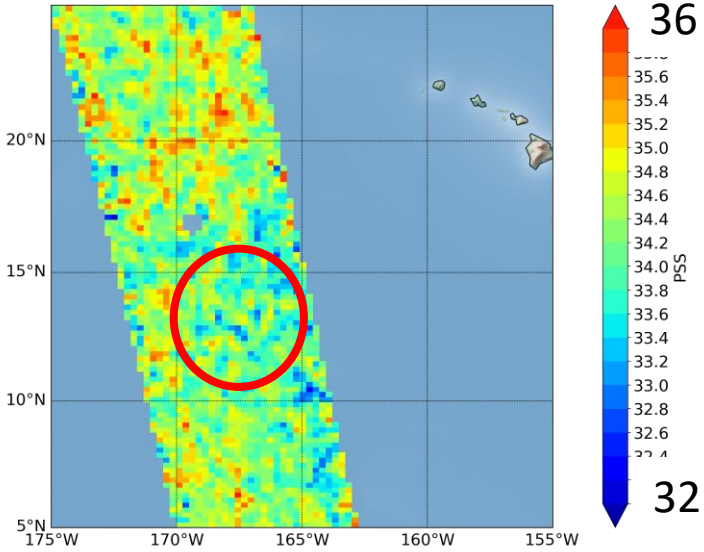
SMOS SSS asc. 20171010



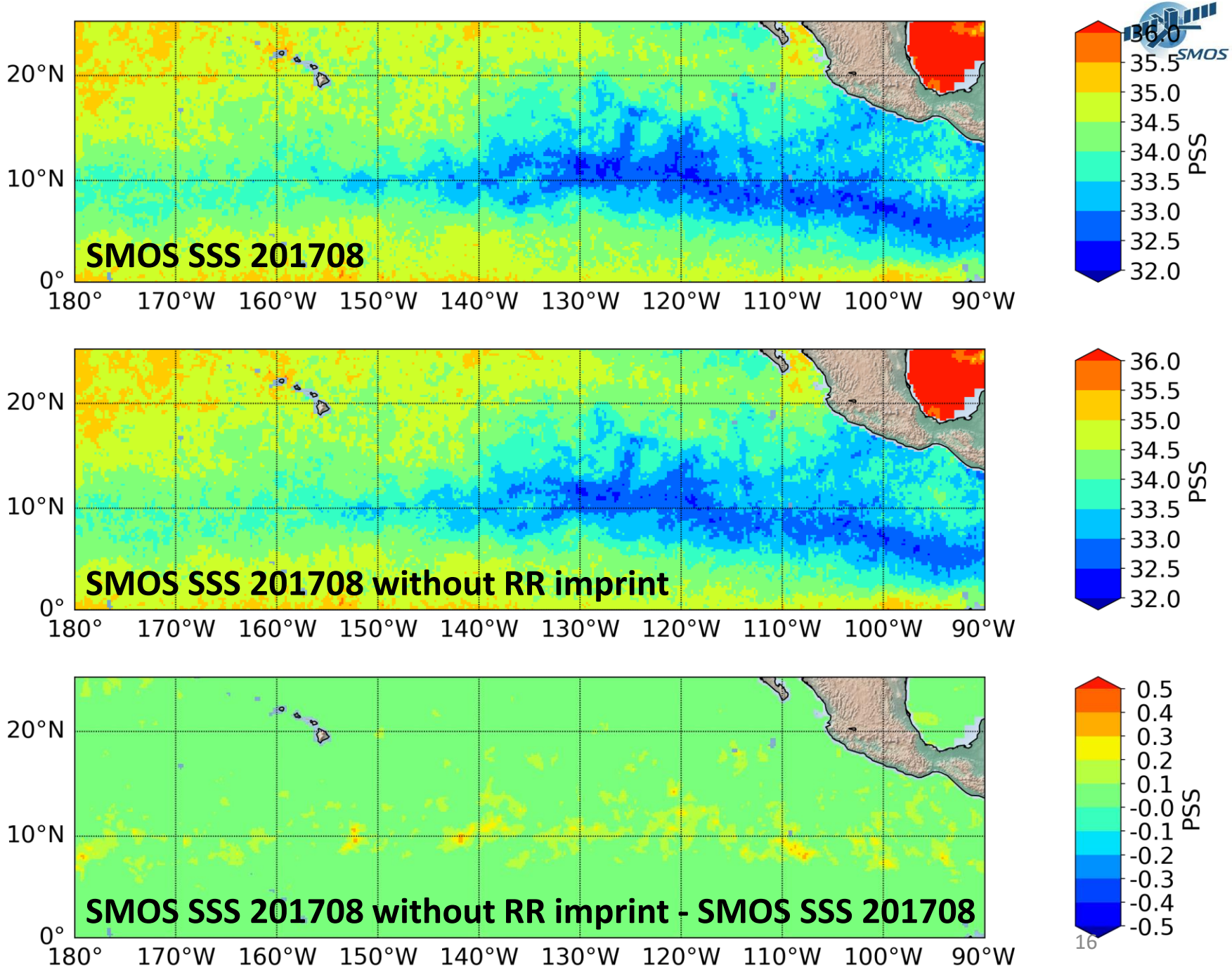
IMERG RR collocated with SMOS asc.



SMOS SSS without RR effect asc. 20171010



SMOS – Monthly averaged



- Locally, increase of monthly SSS by 0.2-0.4

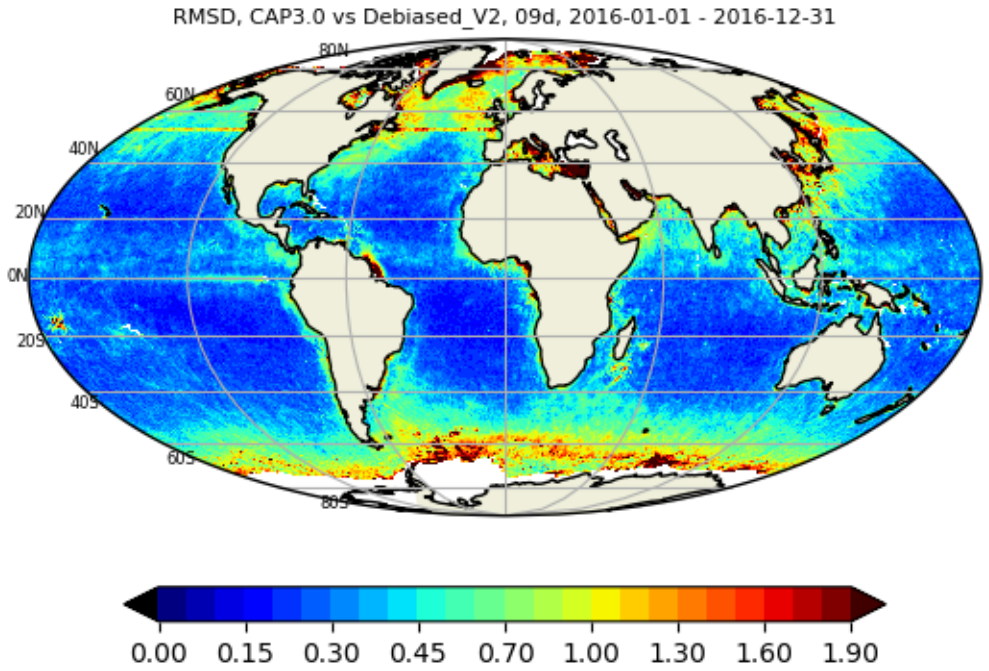
pdf of SMOS-SMAP RMSD

Boutin and Khvorostyanov

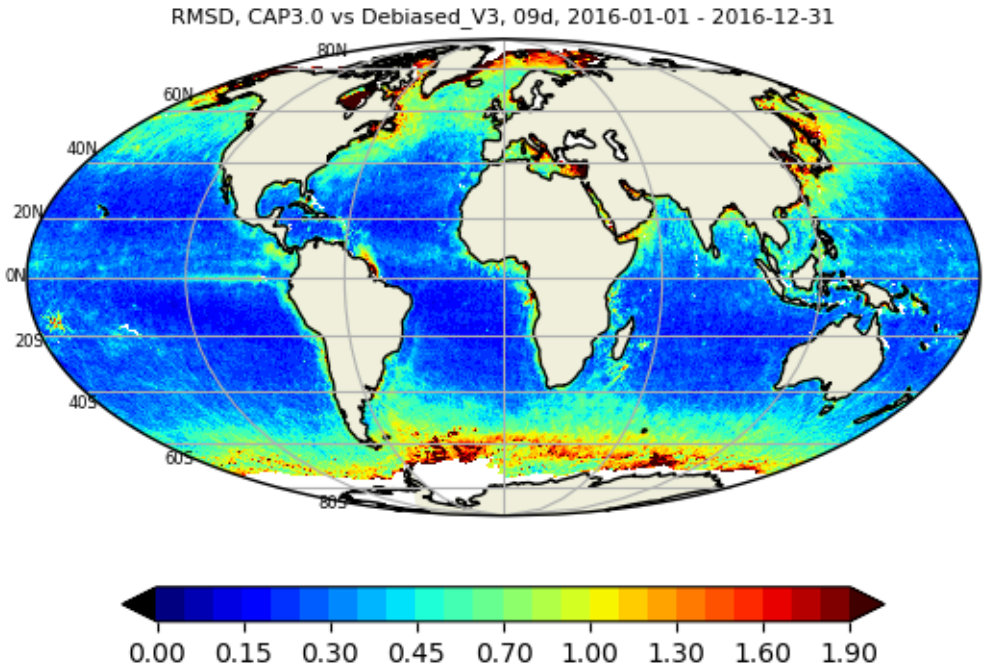
30/8/18

SMOS debias_v3 (9 days) and SMAP CAPv3 (8 days) SSS - 2016 RMSD

Debias v2

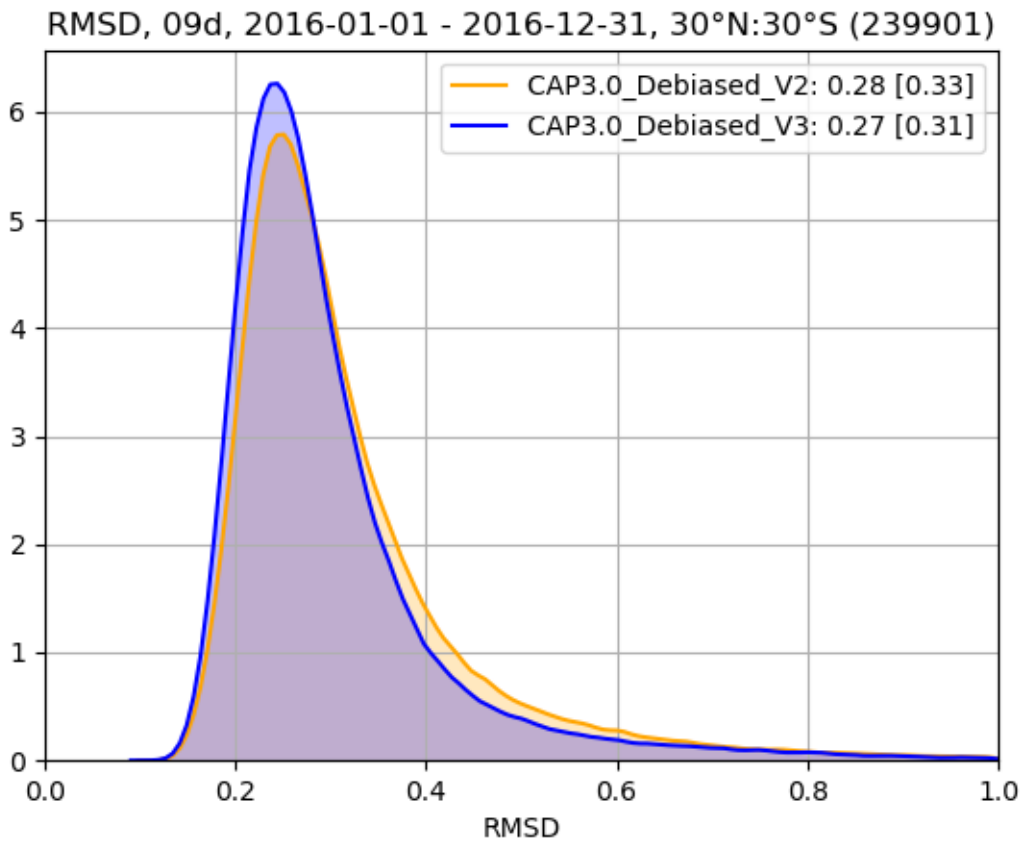


Debias v3

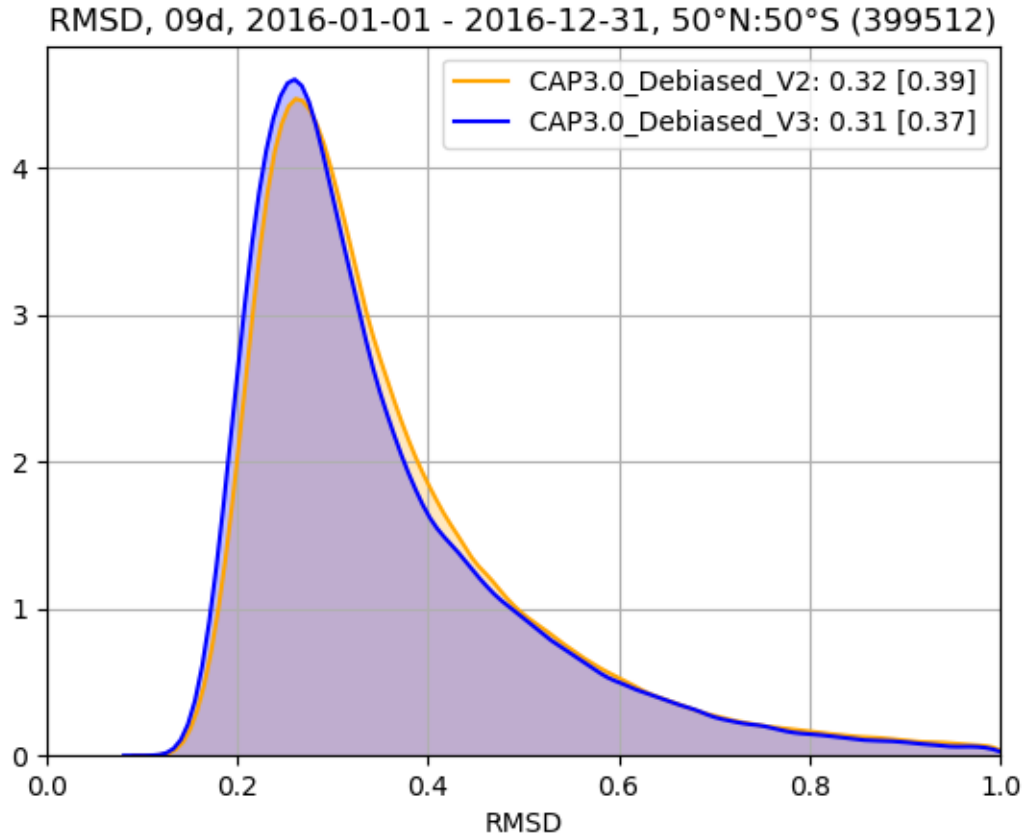


SMOS debias_v3 (9 days) and SMAP CAPv3 (8 days) SSS - 2016
PDF of RMSD maps(previous slide)

30N-30S



50N-50S



Statistics in legend: Median RMSD[averageRMSD]
8/9day ~70km resolution