

Regional/Seasonal Biases in Aquarius/SMAP SSS

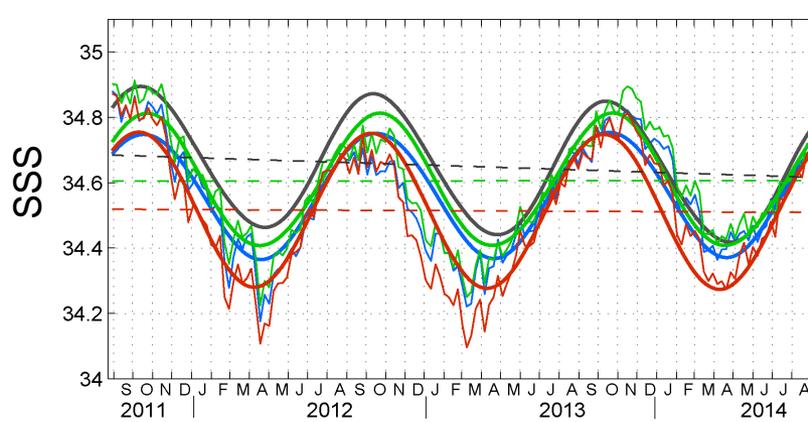
Oleg Melnichenko & Peter Hacker

International Pacific Research Center, SOEST, University of Hawaii

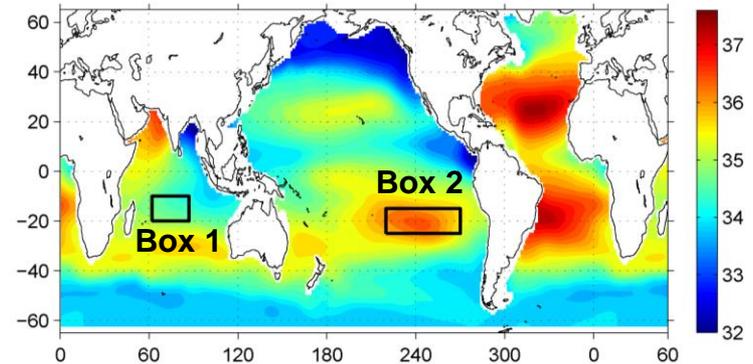
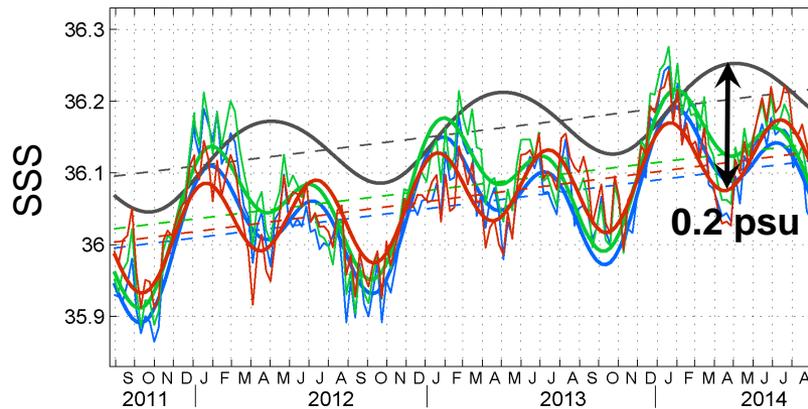
Aquarius Cal/Val Meeting, 10-12 January 2017, Santa Rosa, CA

Box analysis: $S(t) = A_{12} \cos(\omega_{12}t + \phi_{12}) + A_6 \cos(\omega_6t + \phi_6)$

Box 1



Box 2



SSS averaged over a box area:

- V4.0 (A+D)
- V4.5.0 (A+D)
- V4.5.1 (A+D)
- Argo APDRC

Thin – original weekly time series; thick – best fit approximations including annual and semi-annual cycles

Long-term trends seem to be real; seasonal variability is contaminated by seasonal/regional biases (significant in some places)

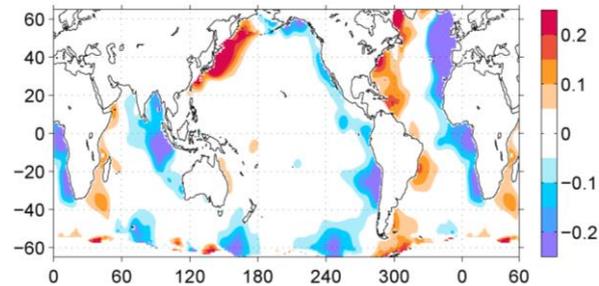
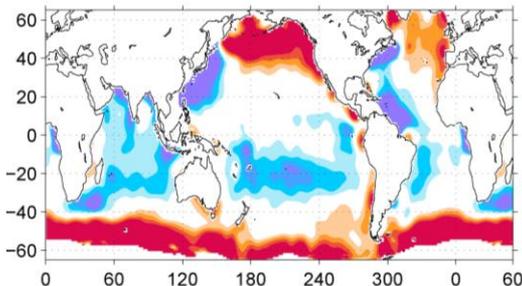
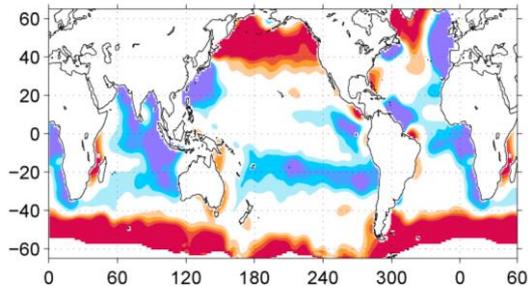
Static bias (3-year mean) with respect to Argo (APDRC)

Ascending

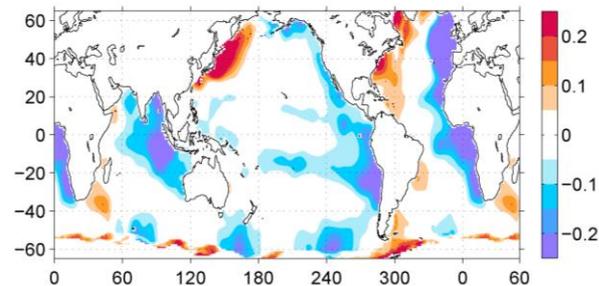
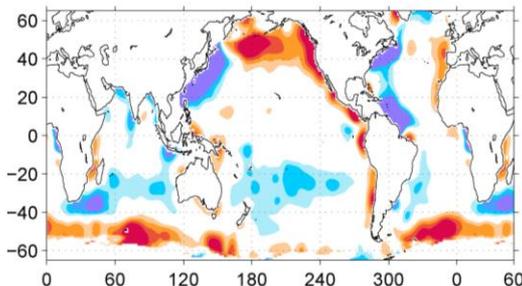
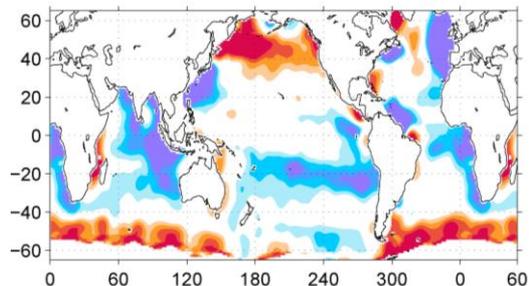
Descending

Difference (A-D)

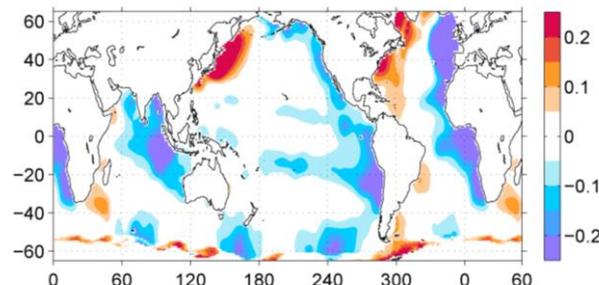
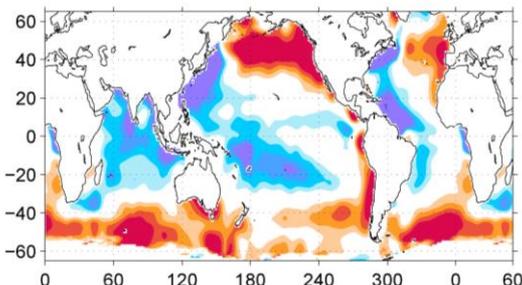
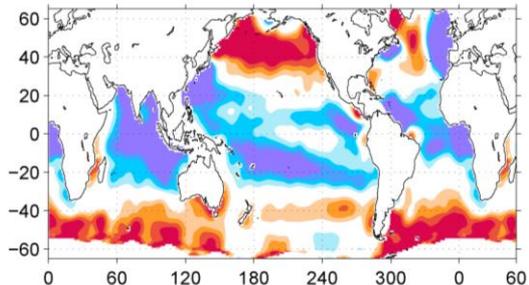
V4.0



V4.5.0



V4.5.1



Considerable improvements from 4.0 (4.2.1) to 4.5.0 at high latitudes

Bias maps are computed from monthly fields using 6 x 6 degree boxes on a 3-degree grid. To suppress unwanted small scale signals, the bias maps are smoothed with a 2D filter of ~800 km cut-off wavelength.

Static bias (3-year mean) with respect to Argo (APDRC)

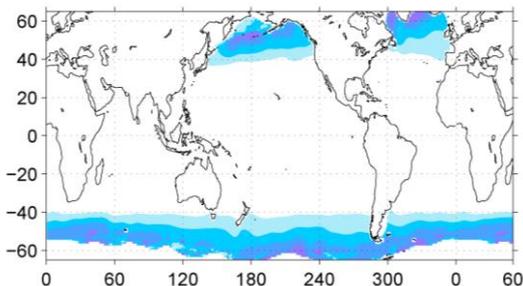
Ascending

Descending

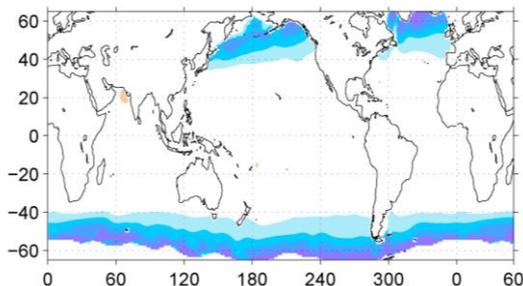
Difference (A-D)

Differences between data versions (from previous slide)

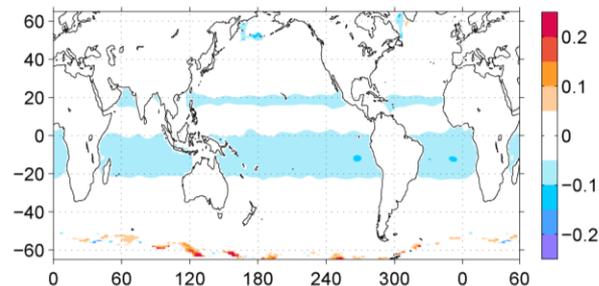
V4.5.0-V4.0



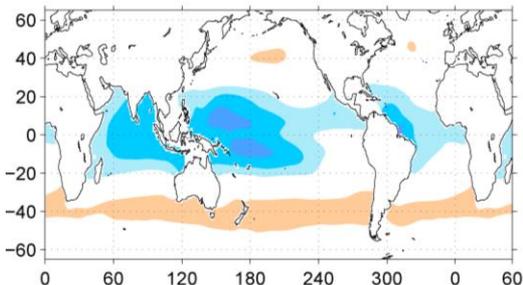
V4.5.0-V4.0



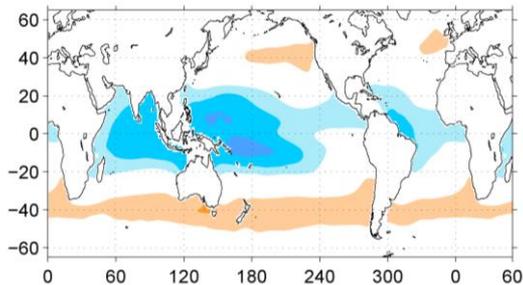
V4.5.0-V4.0



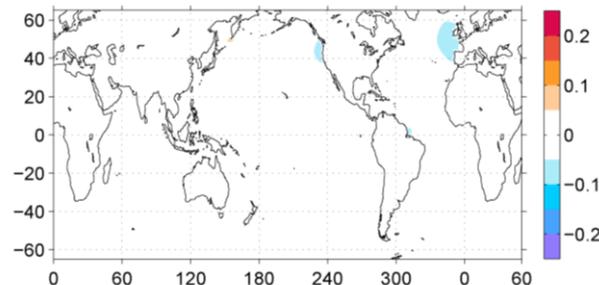
V4.5.1-V4.5.0



V4.5.1-V4.5.0



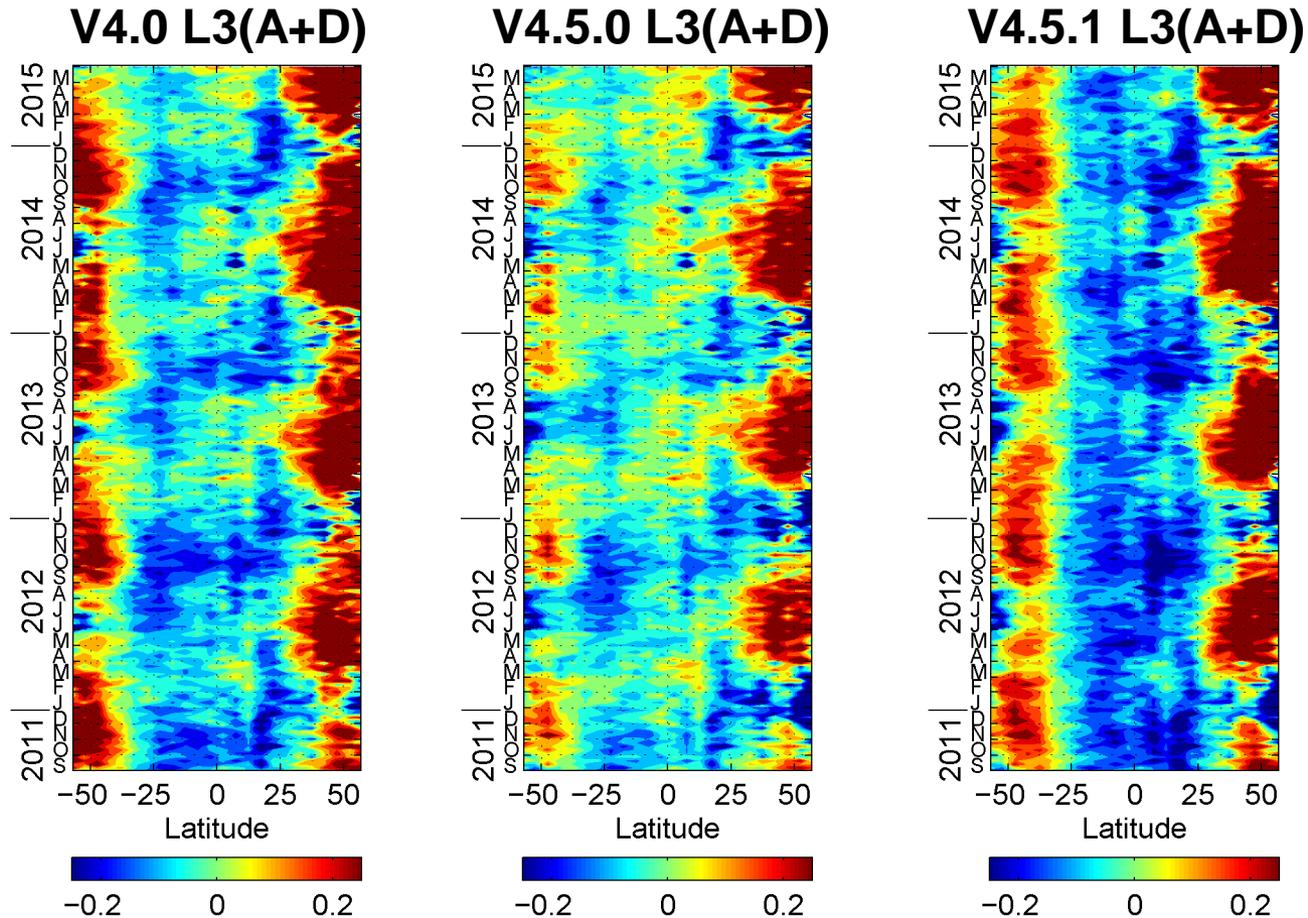
V4.5.1-V4.5.0



Considerable improvements from 4.0 (4.2.1) to 4.5.0 at high latitudes

Bias maps are computed from monthly fields using 6 x 6 degree boxes on a 3-degree grid. To suppress unwanted small scale signals, the bias maps are smoothed with a 2D filter of ~800 km cut-off wavelength.

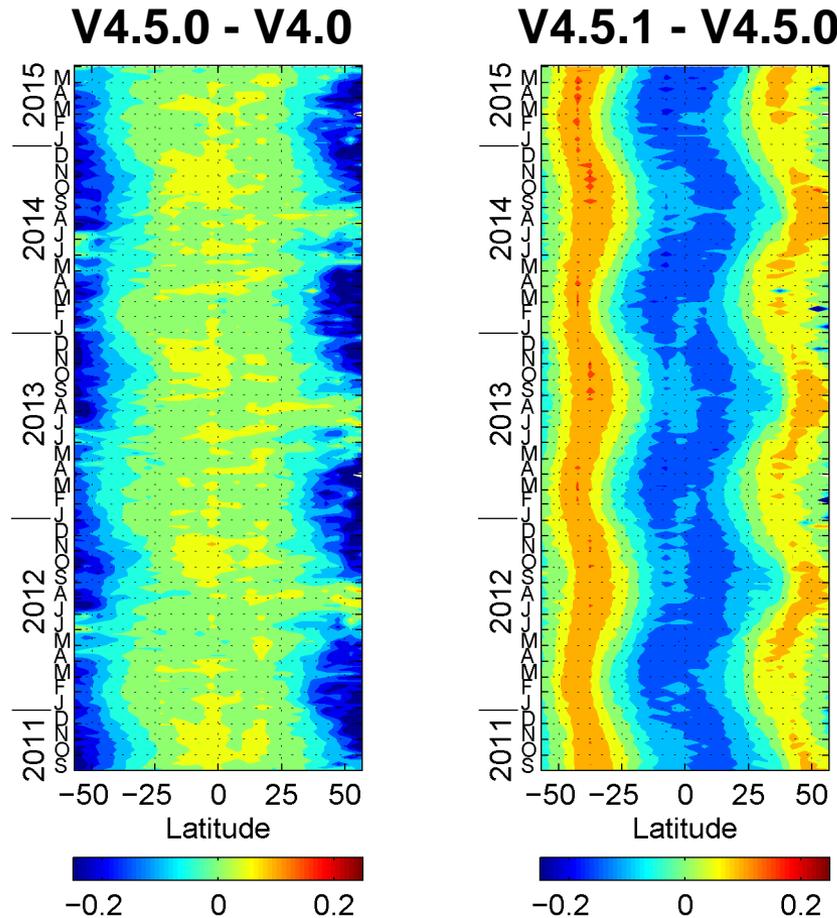
Latitude-time distribution of the zonally averaged differences between weekly L3 SSS maps and the corresponding Argo buoy data



The error statistics are calculated by comparing Argo buoy measurements ($z < 6\text{m}$) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps.

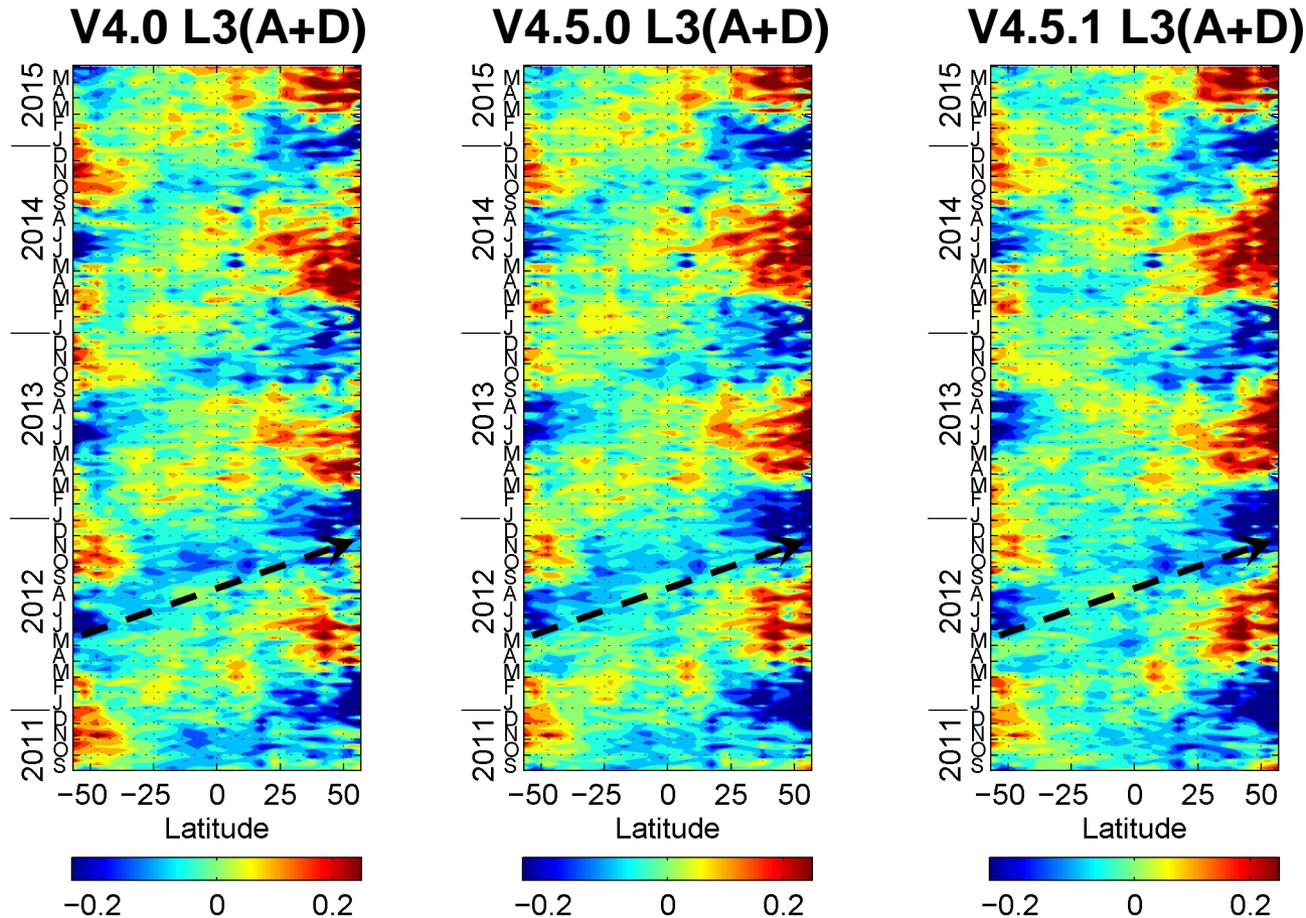
Latitude-time distribution of the zonally averaged differences between weekly SSS maps and the corresponding Argo buoy data

Differences between data versions (from previous slide)



The error statistics are calculated by comparing Argo buoy measurements ($z < 6\text{m}$) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps.

Latitude-time distribution of the **time-varying part** of the differences between weekly L3 SSS maps and the corresponding Argo buoy data

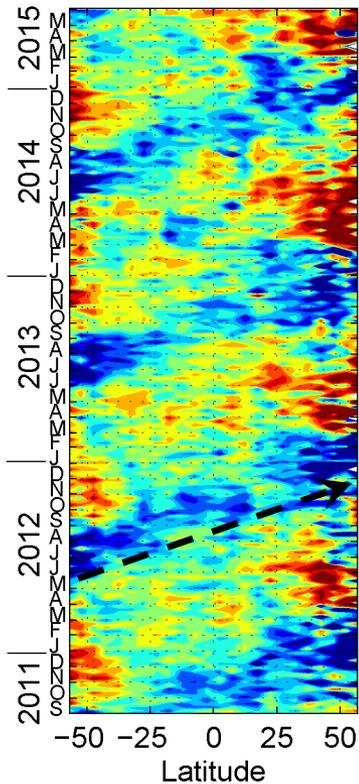


The error statistics are calculated by comparing Argo buoy measurements ($z < 6\text{m}$) for a given week with SSS values at the same locations obtained by interpolating the corresponding Aquarius L3 SSS maps. **The static (3-yr mean (September 2011-August 2014)) biases are subtracted.**

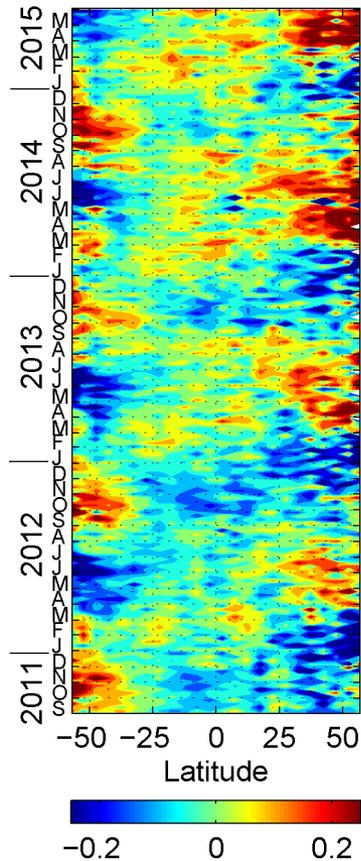
Latitude-time distribution of the **time-varying part** of the differences between weekly L3 SSS maps and the corresponding Argo buoy data

V4.0 L3

Ascending

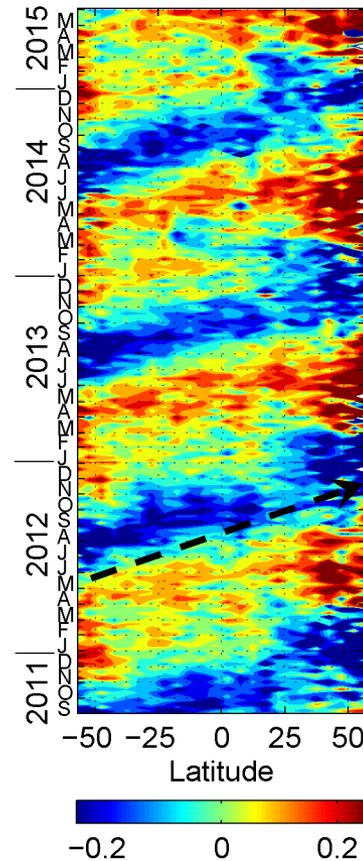


Descending

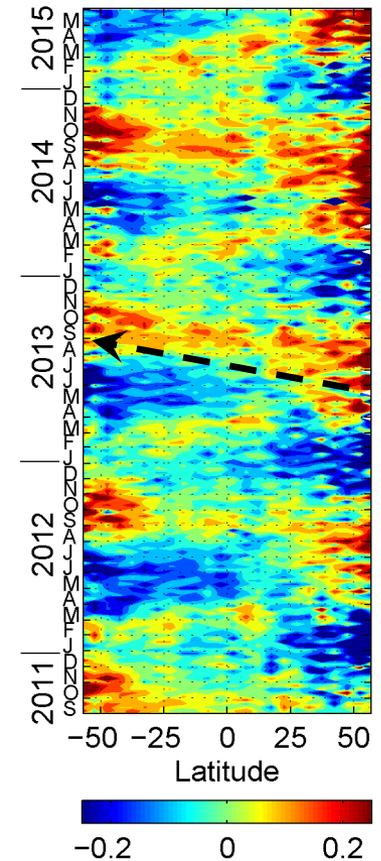


V4.5.0 L3

Ascending

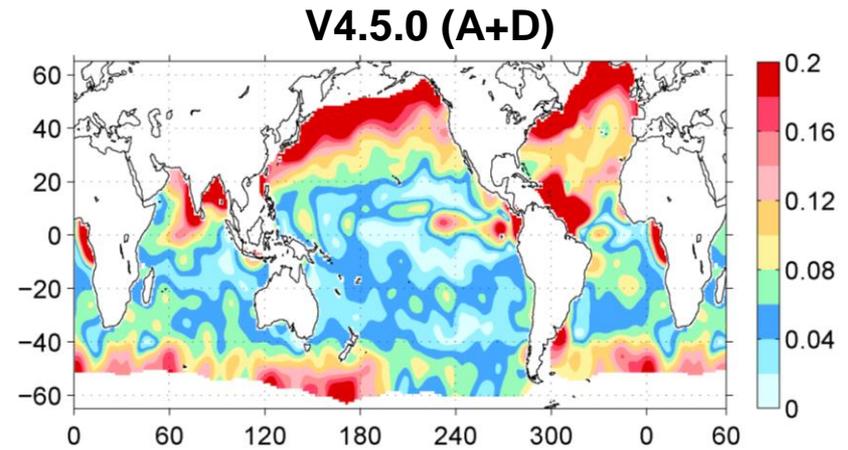
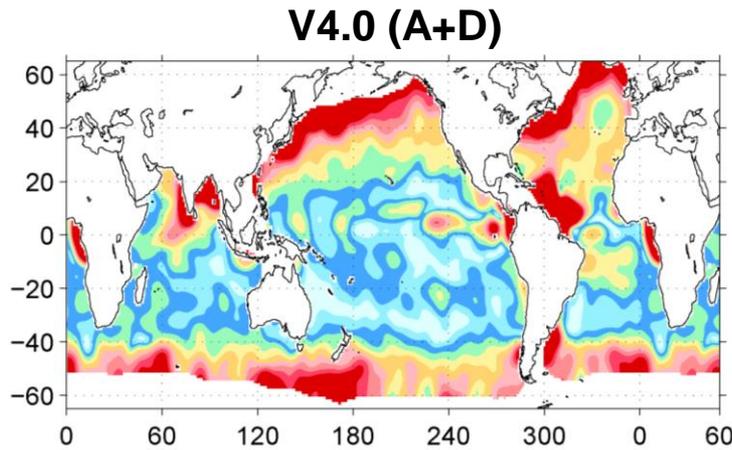


Descending

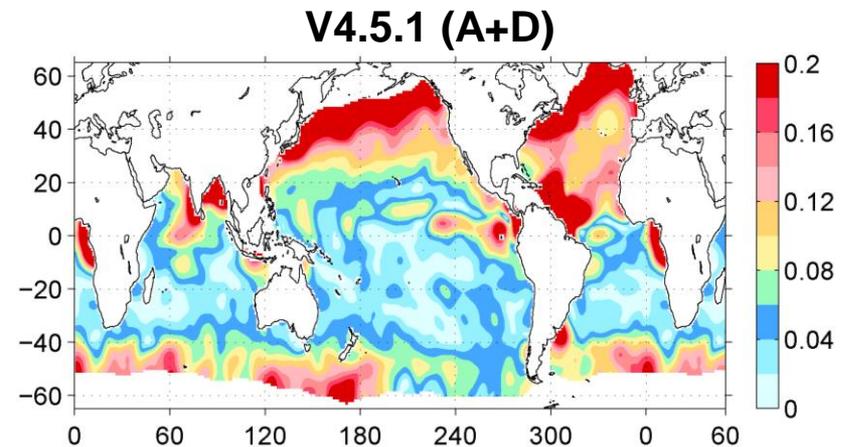
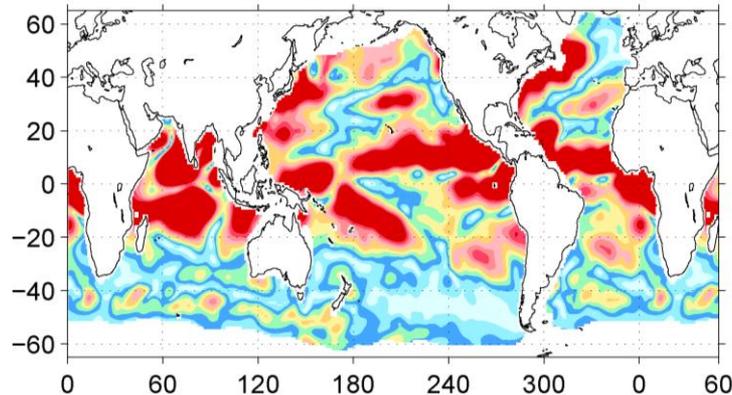


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Amplitude of the annual cycle in the bias field



**Compare with the annual cycle in
Argo gridded SSS**

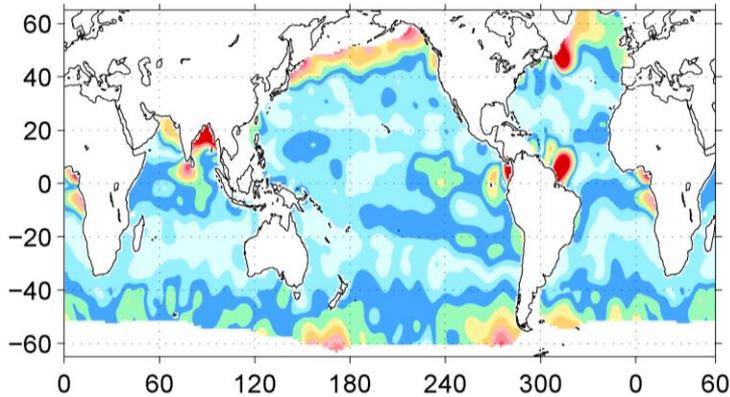


Amplitudes of the annual and semiannual cycles in the bias are determined by harmonic analysis of the bias fields

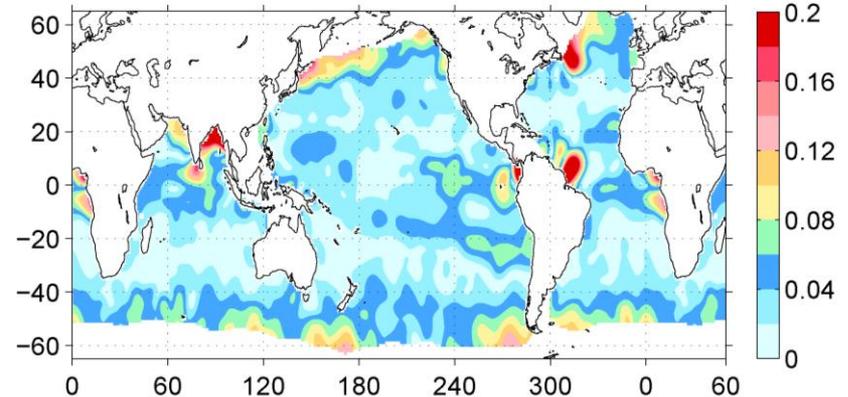
$$\text{Bias}(x, y, t) = A_{12}(x, y) \cos(\omega_{12}t + \varphi_{12}(x, y)) + A_6(x, y) \cos(\omega_6t + \varphi_6(x, y))$$

Amplitude of the semi-annual cycle in the bias field

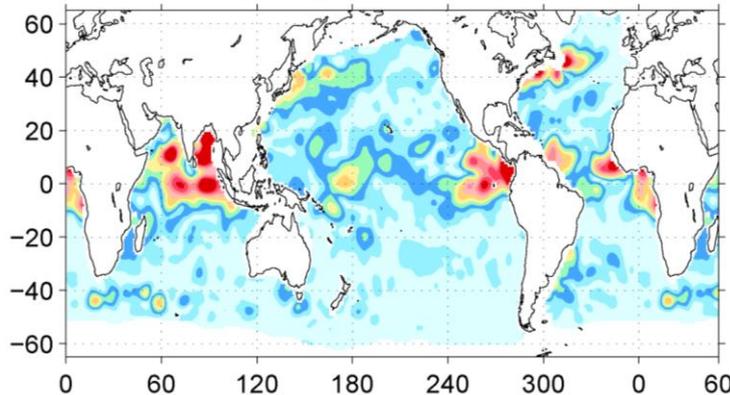
V4.0 (A+D)



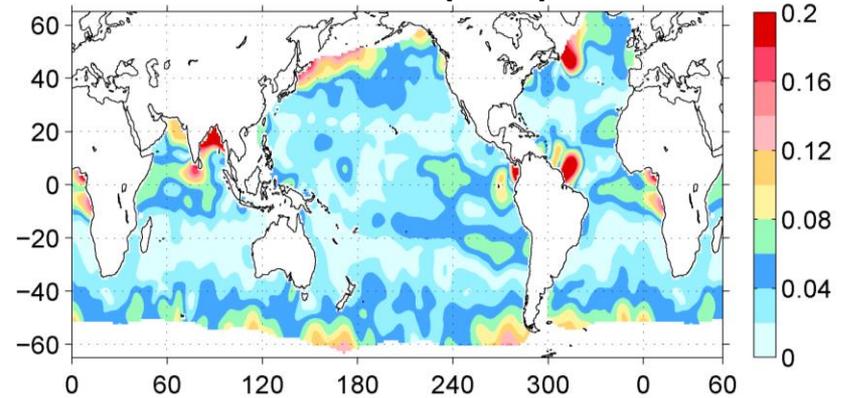
V4.5.0 (A+D)



Compare with the semi-annual cycle in
Argo gridded SSS



V4.5.1 (A+D)



Amplitudes of the annual and semiannual cycles in the bias are determined by harmonic analysis of the bias fields

$$\text{Bias}(x, y, t) = A_{12}(x, y) \cos(\omega_{12}t + \varphi_{12}(x, y)) + \boxed{A_6(x, y)} \cos(\omega_6t + \varphi_6(x, y))$$

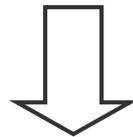
Comments

Static biases: significant reduction in V4.5.0, particularly at high latitudes

Time-varying biases: persist; no apparent reduction in V4+. The time varying biases consist of primarily annual and semi-annual signals

The amplitude of the spurious annual (semi-annual) signal can be a significant error compared to the Argo-derived annual (semi-annual) cycle regionally; thus, the biases need to be characterized and quantified (e.g., spatial distributions of amplitude and phase) for science and applications users.

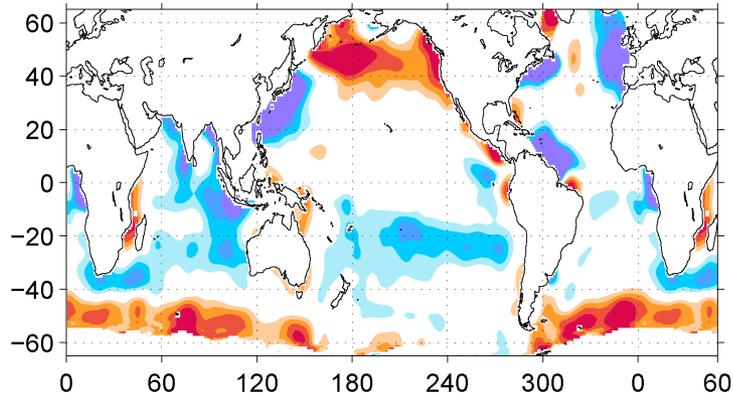
Aquarius vs SMAP



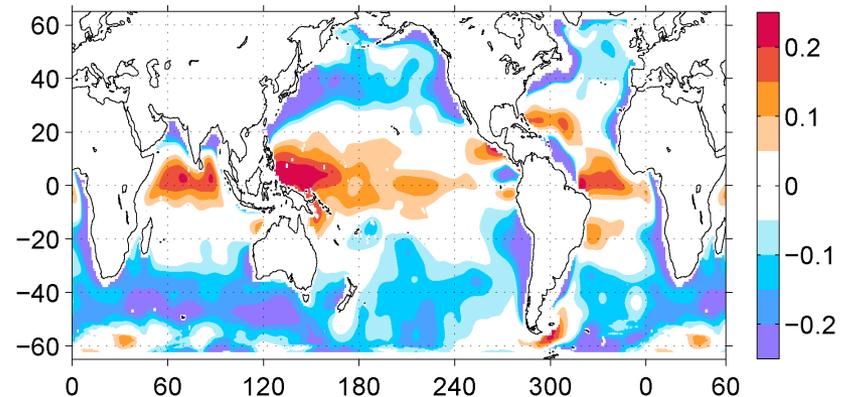
Aquarius vs SMAP

Static (time-mean) bias with respect to Argo (APDRC)

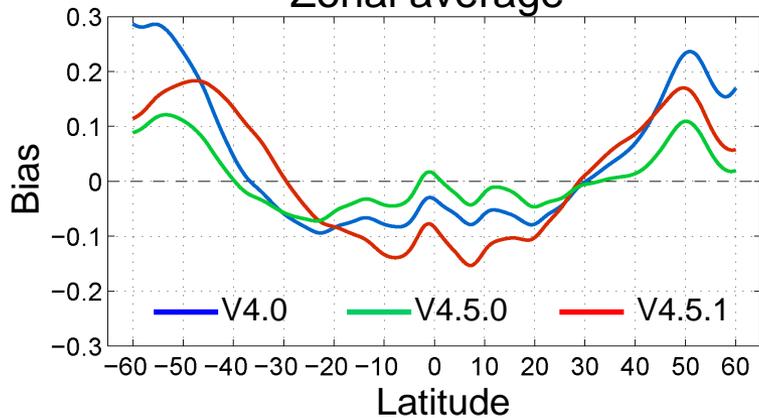
Aquarius V4.5.0 (A+D)



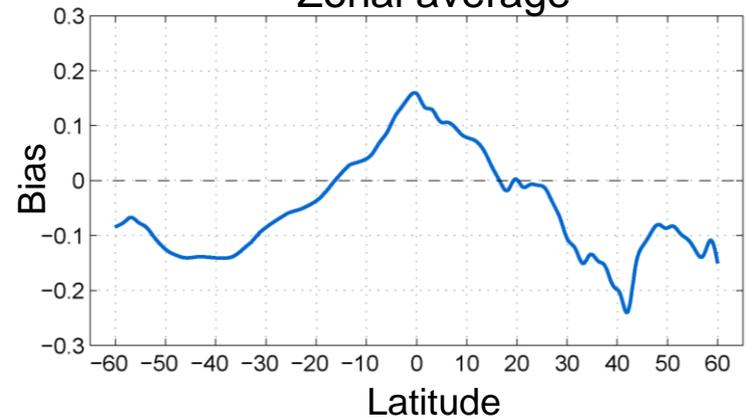
SMAP V2.0



Zonal average

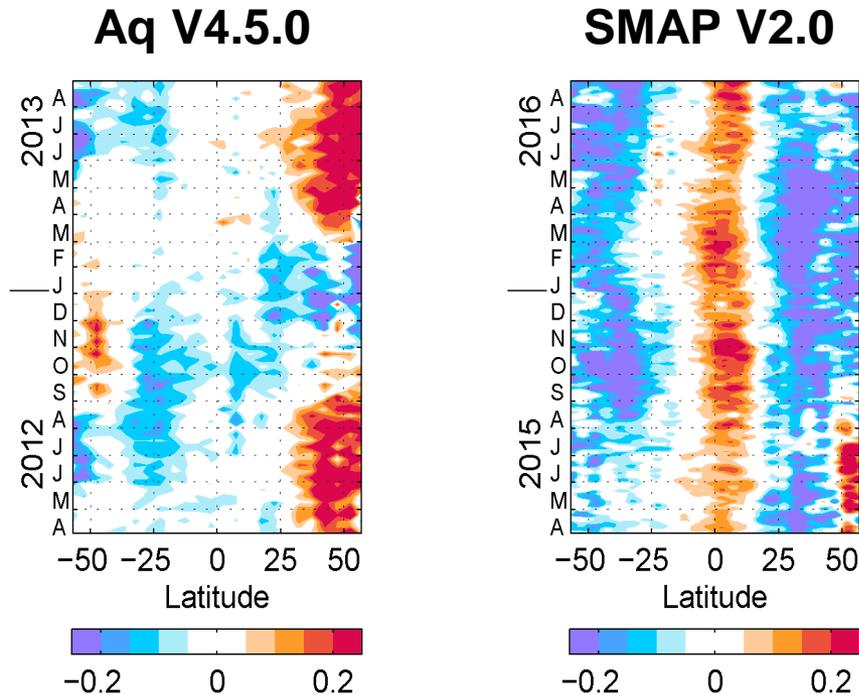


Zonal average



Aquarius vs SMAP

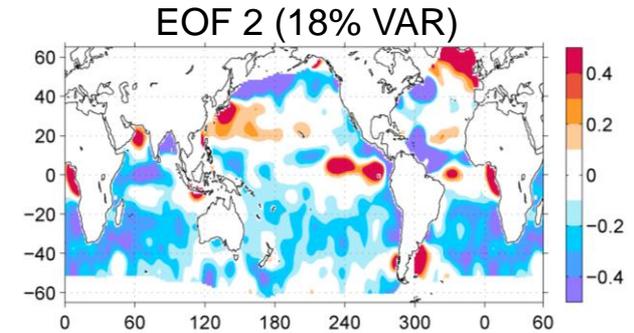
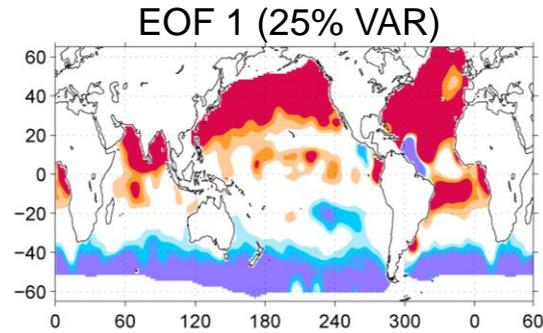
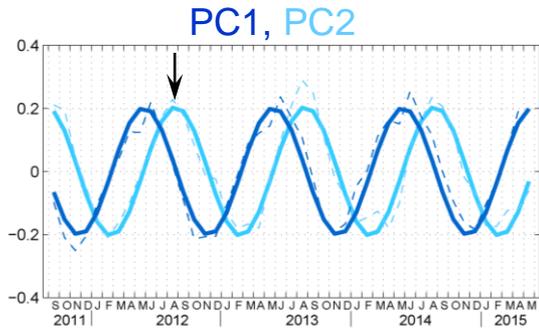
Zonally averaged biases with respect to Argo buoy observations



The error statistics are calculated by comparing Argo buoy measurements ($z < 6\text{m}$) for a given week with SSS values at the same locations obtained by interpolating the corresponding L3 SSS maps.

EOF decomposition of time-varying bias

Aquarius V4.0 (ascending)



SMAP V2.0

