

# Aquarius SSS space/time biases with respect to Argo data

P. Hacker, O. Melnichenko, N. Maximenko, and J. Potemra

## *Motivation-*

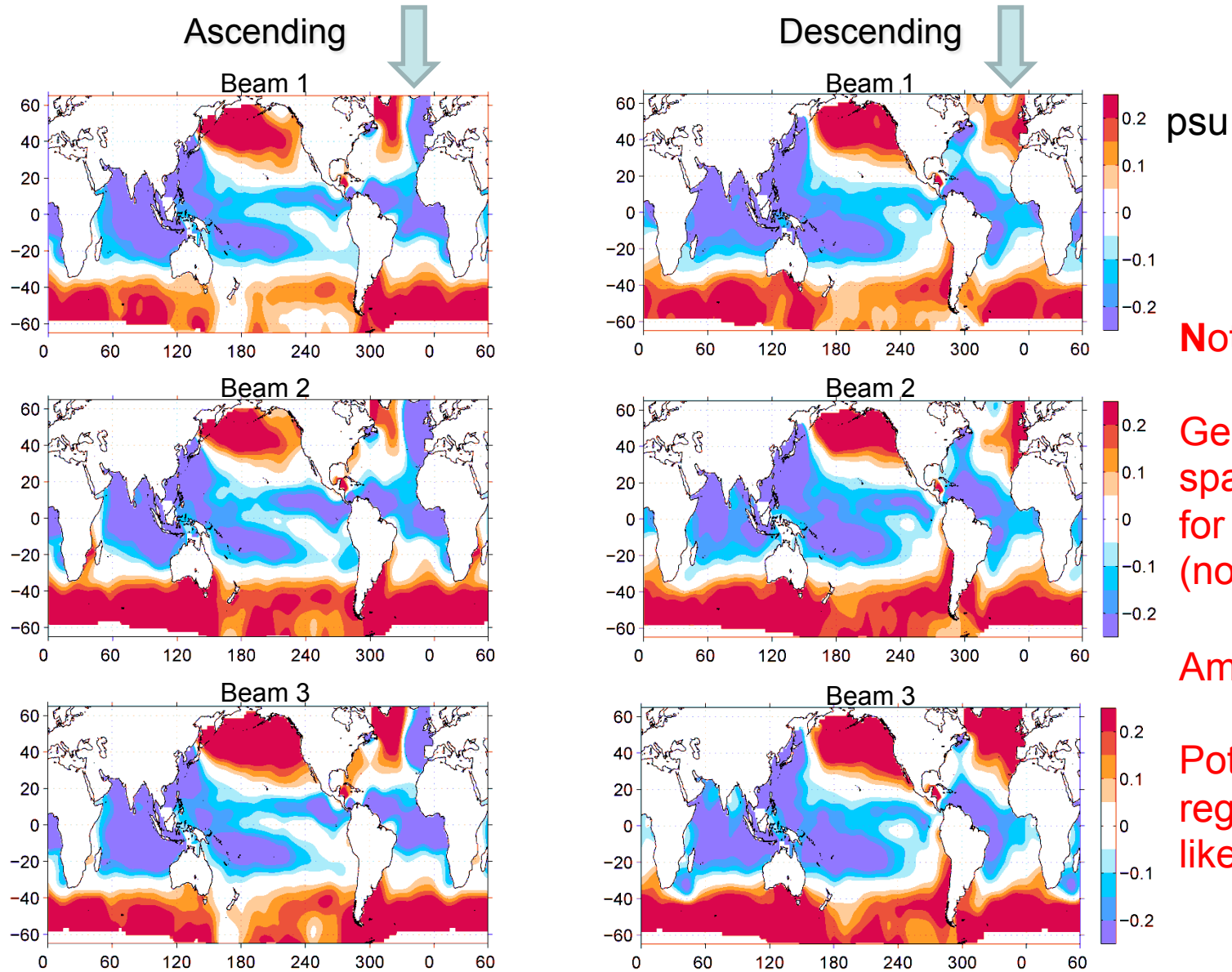
*Significant mean and time-varying Aq-Argo SSS biases persist in version 3.0;*  
*Quantify biases for researchers;*  
*Quantify and provide input for algorithm improvements;*  
*Suggest methods for improving L-3 and L-4 products.*

## References on Aquarius Validation-

Lagerloef et al., 2013; Aquarius Project Document, AQ-014-PS-0016.  
Drucker and Riser, 2014; JGR-Oceans, 119, 4626-4637.  
Tang et al., 2014; JGR-Oceans, 119, 6171-6189.  
Vinogradova et al., 2014; JGR-Oceans, 119, 4732-4744.  
Presentations at this meeting.

2014 Aquarius/SAC-D Science Team Meeting  
11-14 November 2014, Seattle, Washington

# Aquarius-Argo Static (Time-Mean) Biases



**Note-**

Generally similar spatial patterns for asc and dsc (not everywhere).

Amplitudes differ.

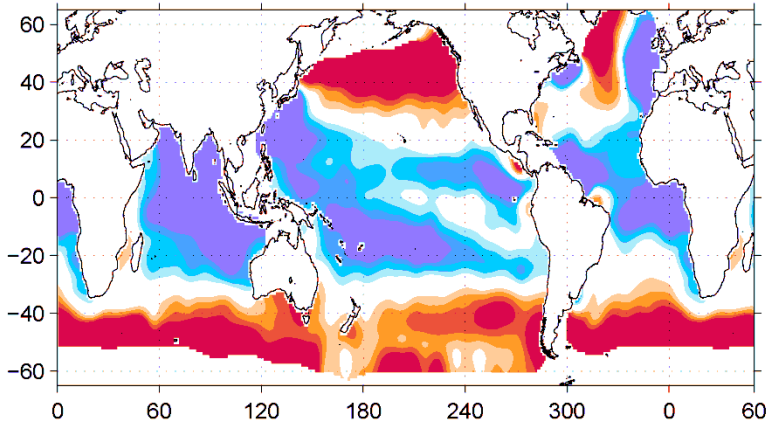
Potential RFI regions are likely correctable.

Mean spatial bias correction fields for Aquarius ascending (left) and descending (right) data and for each of the three beams, version 3.0, standard product.

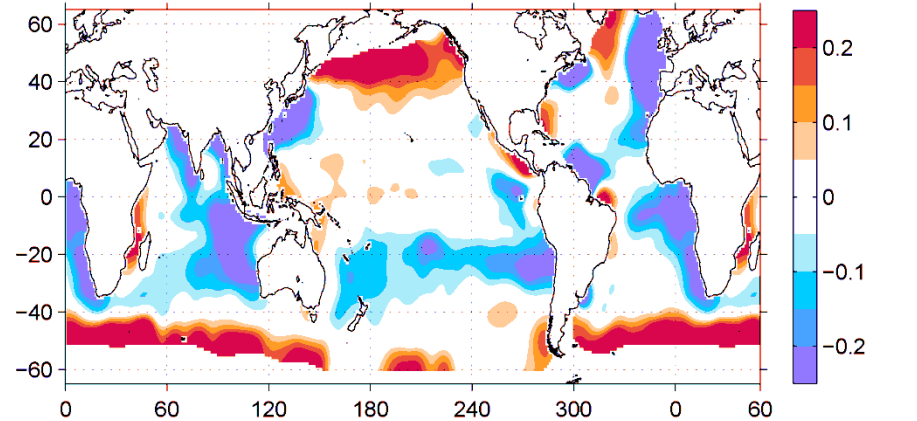
# Static Bias (3-year mean)

Ascending

Standard Aquarius SSS

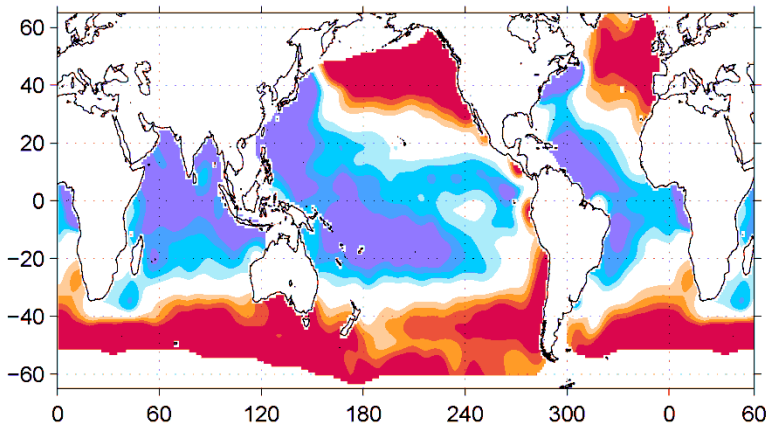


SST-adjusted SSS

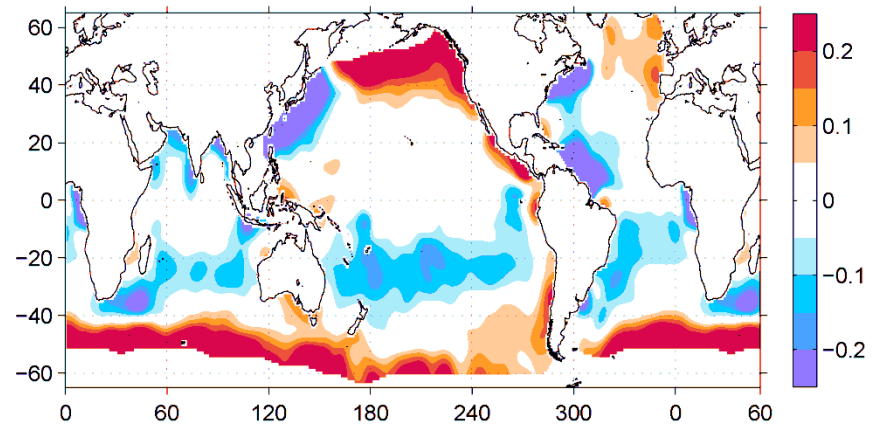


Descending

Standard Aquarius SSS



SST-adjusted SSS

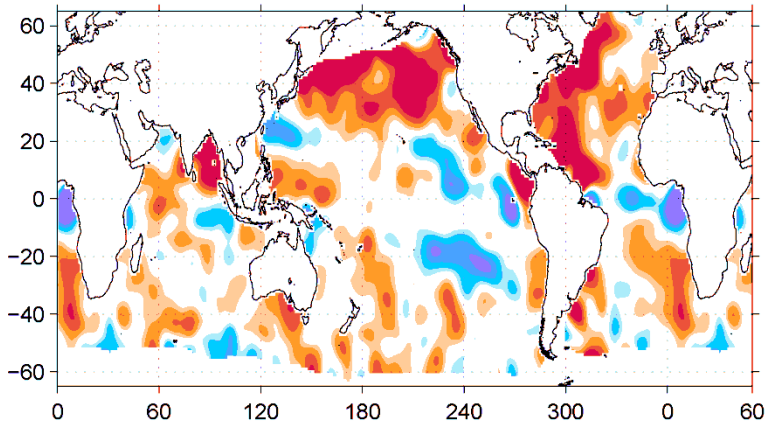


**SST-based adjustment improved static bias in many areas, but not everywhere. Note: Central Pacific; Indian Ocean; N Atlantic; SE Atlantic; asc/dsc differences.**

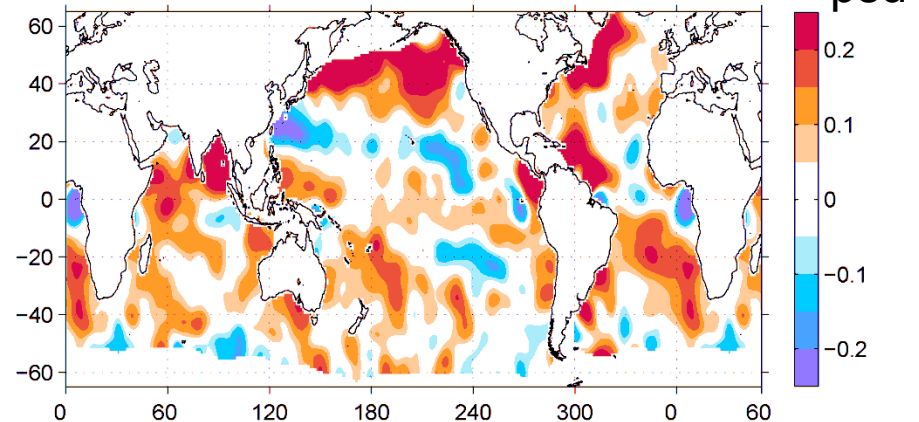
# Time-Varying Bias (example for April 2013)

Ascending

Standard Aquarius SSS

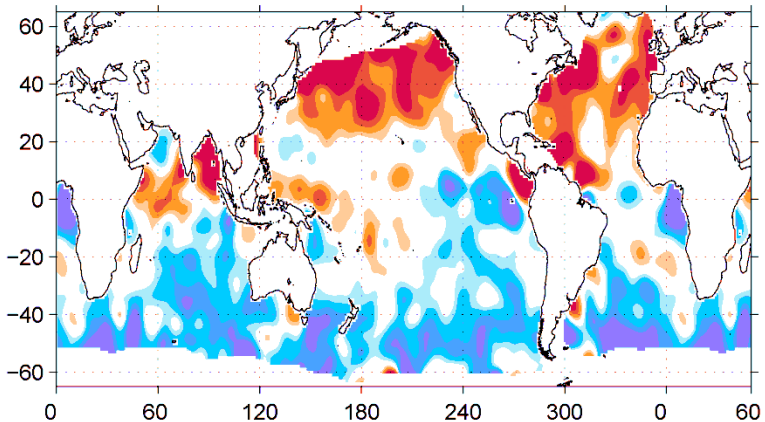


SST-adjusted SSS

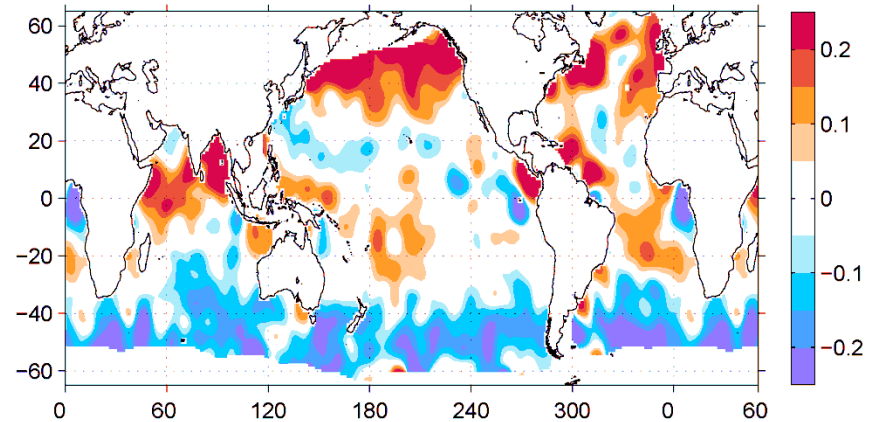


Descending

Standard Aquarius SSS

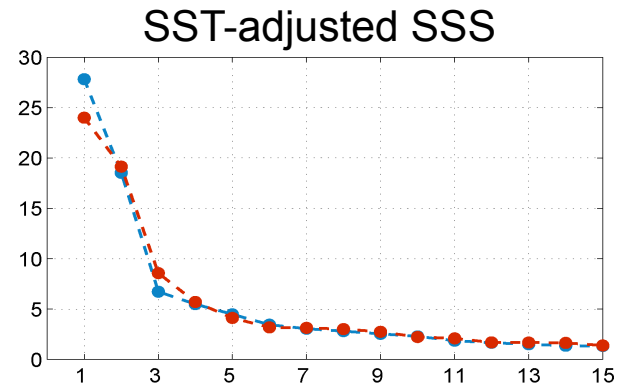
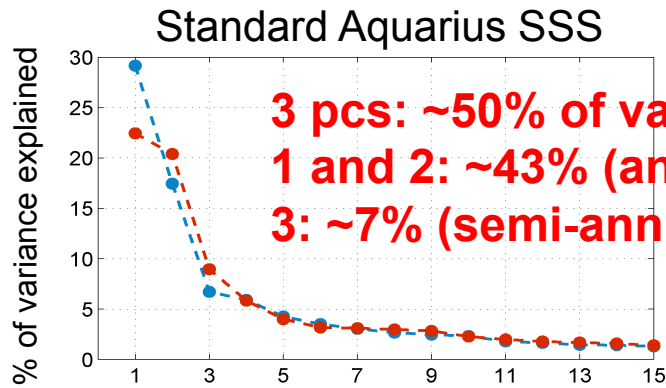


SST-adjusted SSS

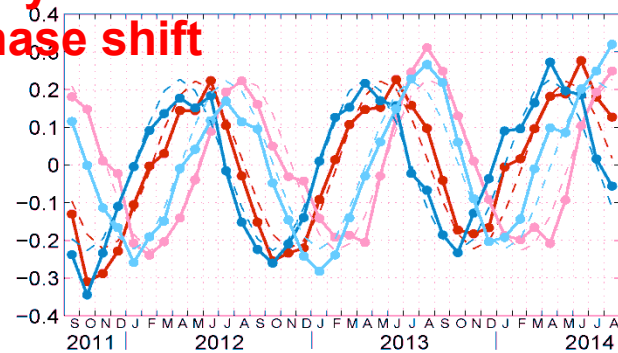
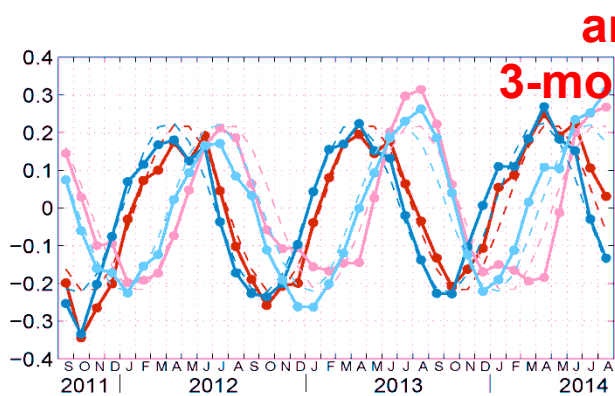


**SST-based adjustment provides no significant improvements in time-varying bias. Asc/dsc differences persist. Some regions are somewhat better, others somewhat worse.**

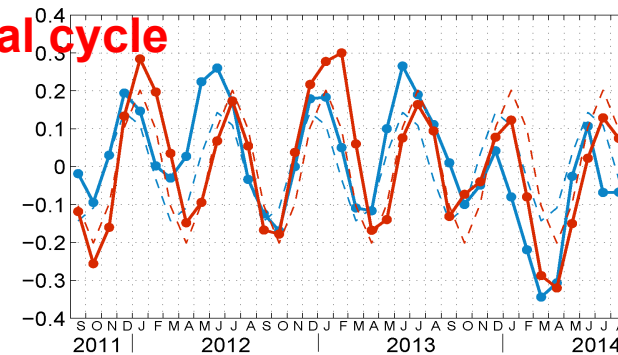
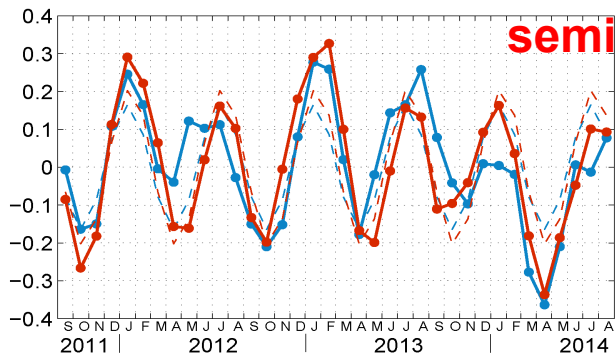
# EOF Decomposition of Time-Varying Bias



- Asc
- Desc



- PC1 Asc
- PC1 Desc
- PC2 Asc
- PC2 Desc



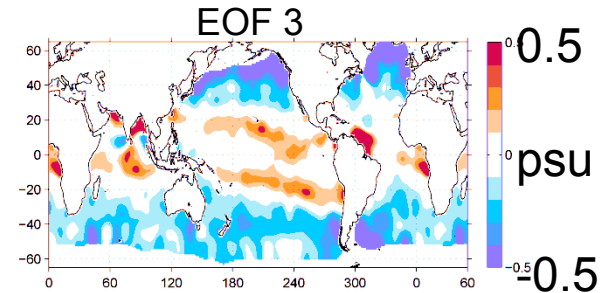
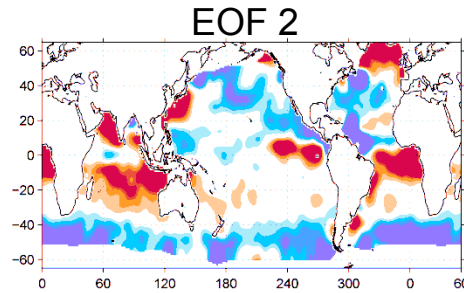
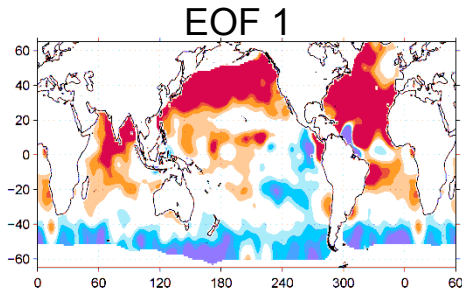
- PC3 Asc
- PC3 Desc



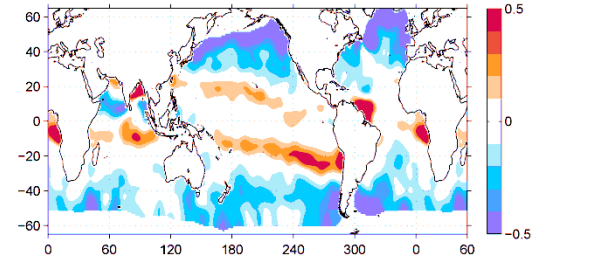
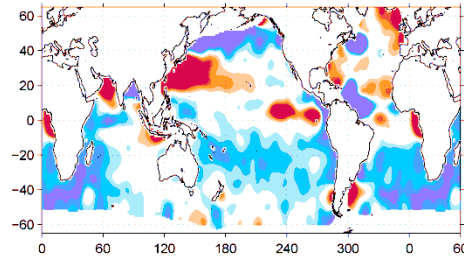
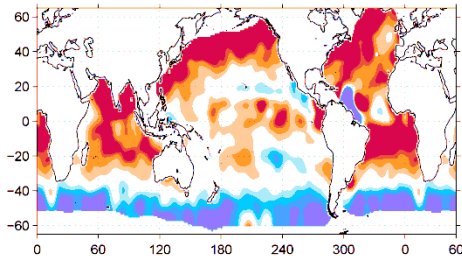
# EOF Spatial Structure

Ascending

Original

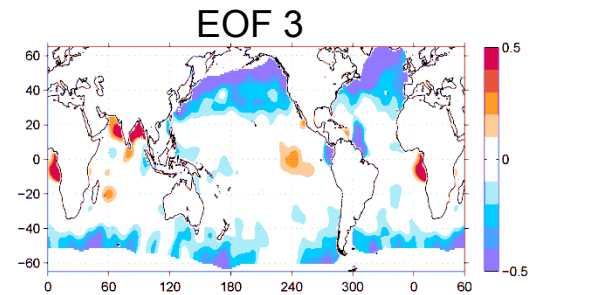
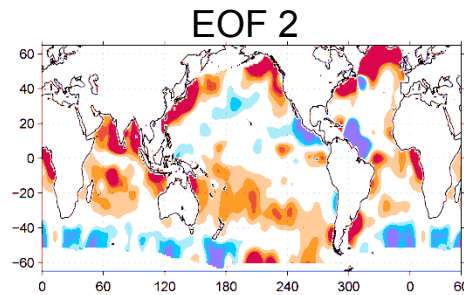
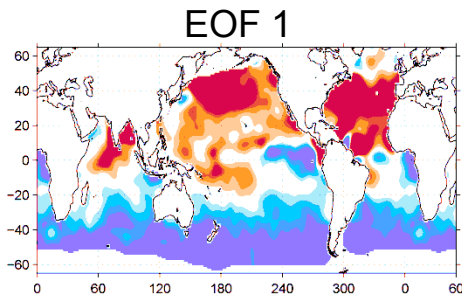


Bias\_adj

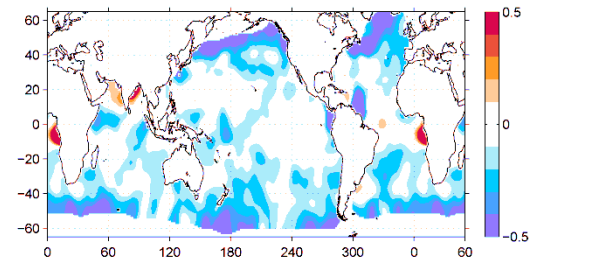
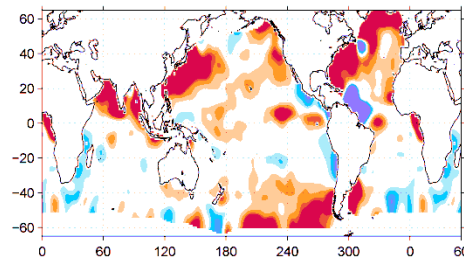
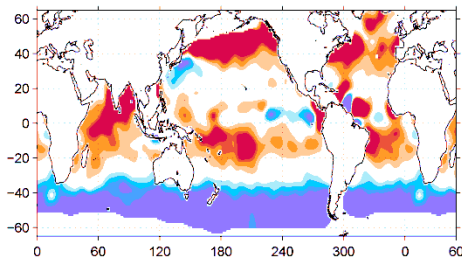


Descending

Original



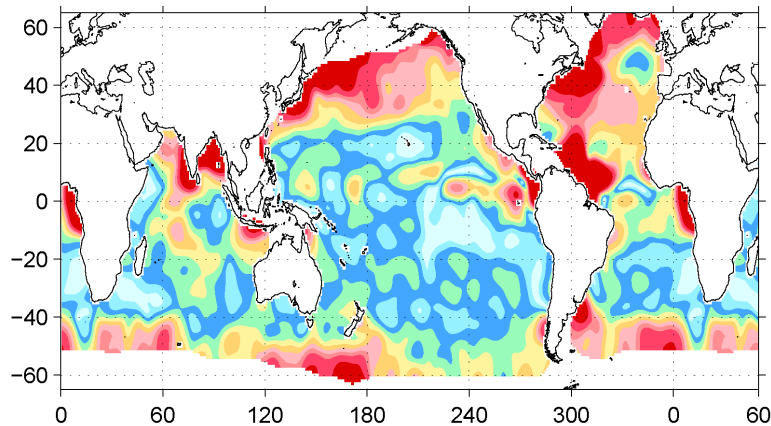
Bias\_adj



# Amplitude of the Annual Cycle in the Bias Field

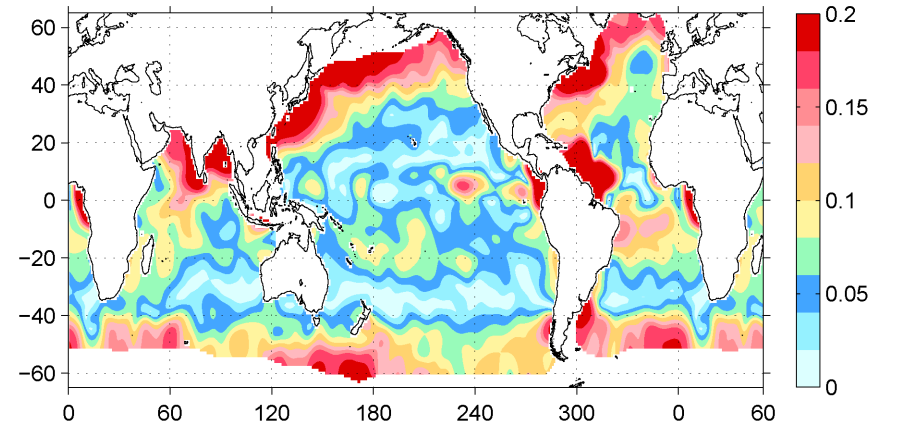
$$\text{Bias}(x, y, t) = A(x, y) \cos(\omega t + \varphi)$$

Standard Aquarius SSS (A+D)



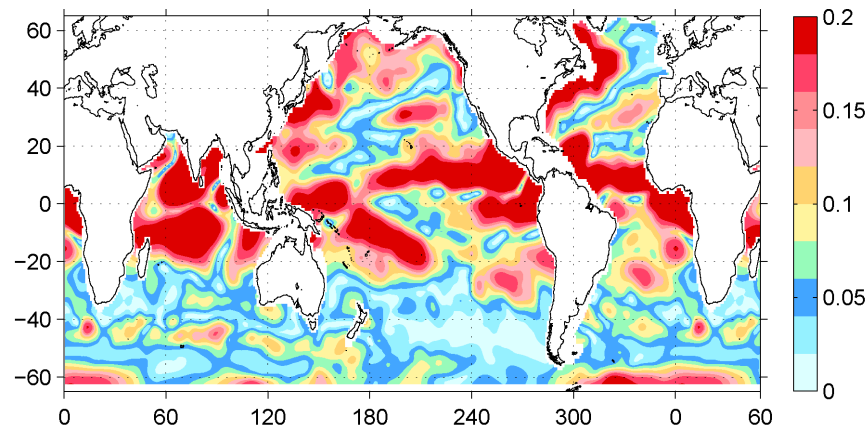
**median= 0.073 psu**

SST-adjusted SSS (A+D)



**median= 0.074 psu**

Amplitude of the annual cycle in Argo gridded SSS



**Note-**

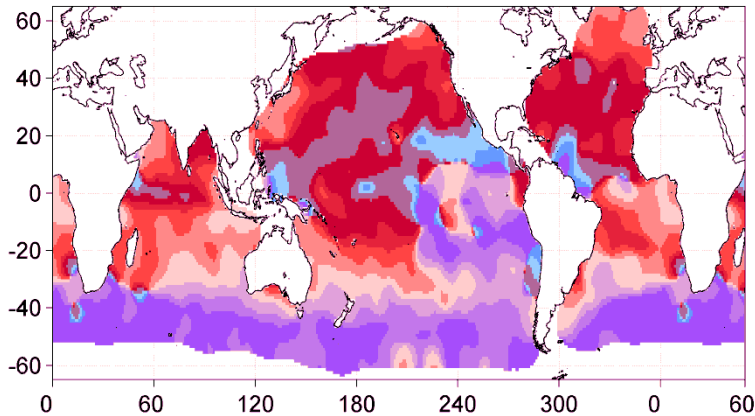
**Very similar patterns for standard and SST-adjusted fields;**

**Modest differences in structures and amplitudes (ie NW Pacific).**

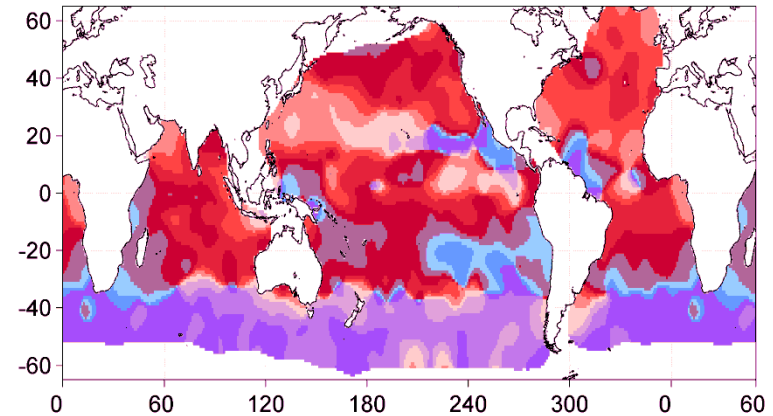
# Phase of the Annual Cycle in the Bias Field

$$\text{Bias}(x, y, t) = A(x, y) \cos(\omega t + \varphi)$$

Standard Aquarius SSS (A+D)

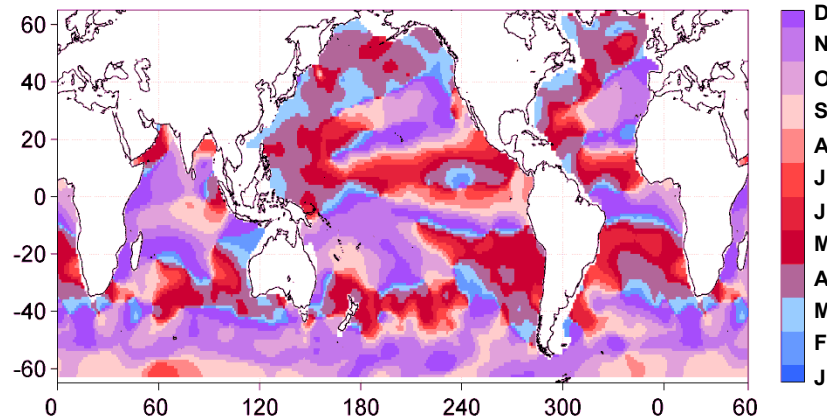


SST-adjusted SSS (A+D)



**3-month lag for PC-1 and PC-2 implies a propagating pattern, which can confuse analysis of propagating ocean signals.**

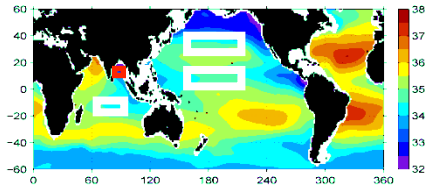
Phase of the annual cycle in Argo gridded SSS



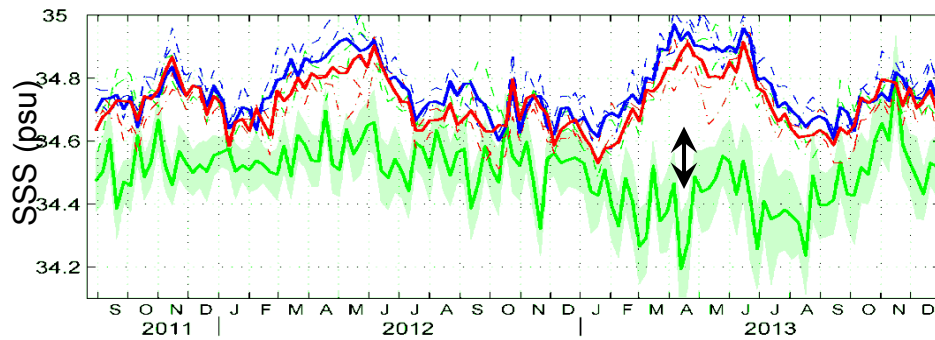


# Regional Time-Series (Aq. L2, v2.7.1, Argo)

Hacker et al., 2014, OSM



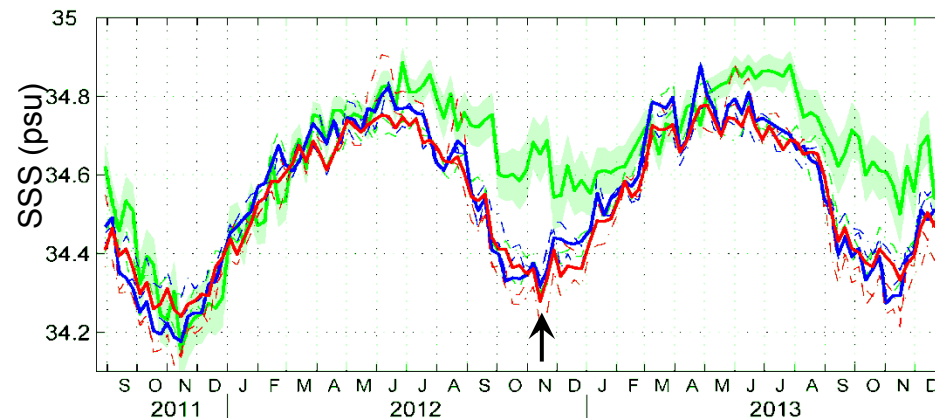
## Box 1 in NP [158°E-140°W, 28-40°N]



Examples show the quantification of the steady state bias and the annual cycle bias for regional studies.

Aquarius is saltier than Argo and has larger magnitude annual cycle.

## Box 2 in NP [158°E-140°W, 2-14°N]



Aquarius is fresher than Argo and has a somewhat larger magnitude annual cycle during 2012-2013.

Time-series of weekly box-averaged Aquarius and Argo data. Light green line shows weekly Argo mean with shading indicating the standard error. Heavy green line shows the weekly Argo mean calculated from the gridded APDRC Argo product available at <http://apdrc.soest.hawaii.edu/>. Solid red and blue lines show weekly Aquarius mean SSS from ascending and descending tracks. Dashed/dotted green, red and blue lines show the individual beams.

# Conclusions

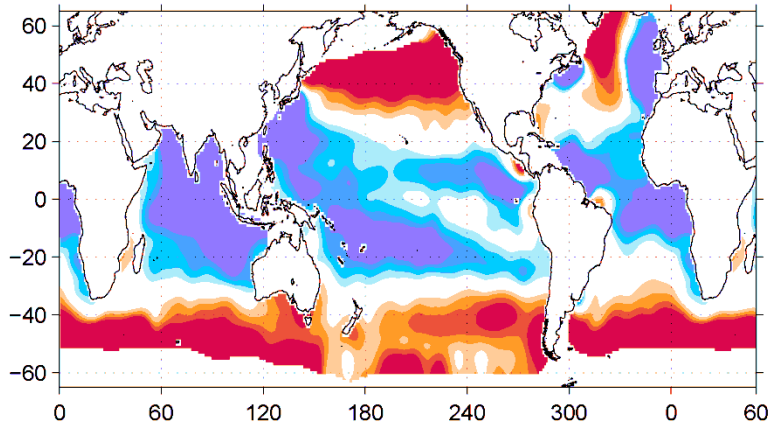
For the present version 3.0 data from September 2011 to August 2014:

- Time-mean and annually varying Aquarius-Argo biases are significant.
- Compared to Argo, [ascending and descending biases for each of the three beams, the 3-year mean, and time-varying biases for both the standard Aquarius and SST-adjusted SSS products](#) have typical ranges of spatial variability of +/- 0.25 psu globally.
- The amplitude of the annual cycle in the bias field can be a significant bias compared to the Argo-derived annual cycle regionally.
- An EOF analysis provides the amplitude and spatial structure for the first three components, which account for ~50% of the time-varying Aquarius-Argo SSS bias.
- The first two components are annually varying with a 3-month lag.
- The third component is primarily semi-annual.
- The quantified biases can be used to improve L-2, L-3 and L-4 products (currently) and for version 4.0 in the future (Melnichenko et al.,2014).

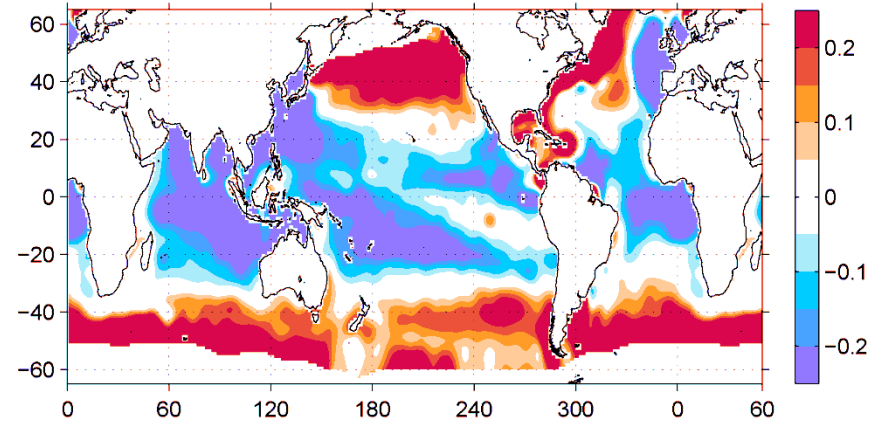
# Static bias (3-year mean)

Ascending

Aquarius - APDRC

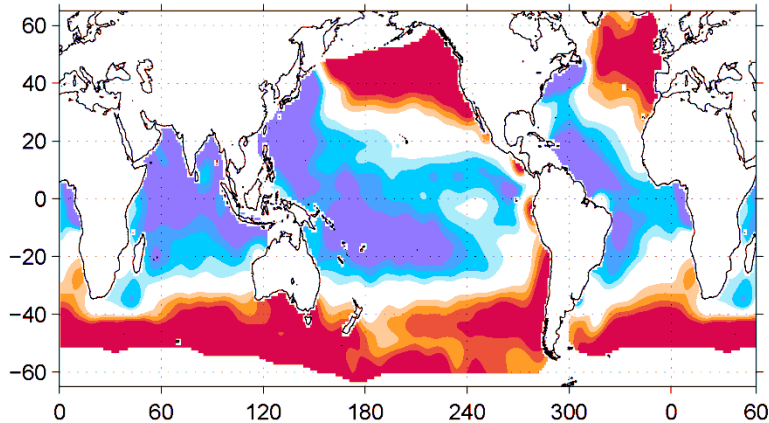


Aquarius - Met Office

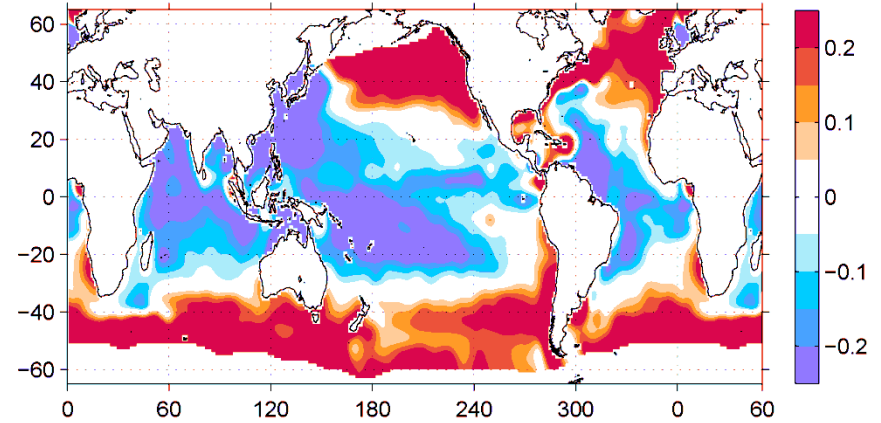


Descending

Aquarius - APDRC



Aquarius - Met Office



**APDRC and Met Office Argo products show very similar large-scale patterns except in the NW Atlantic along the North American boundary currents.**

## Issues and Ideas Towards v4.0

***The need for one or more improved, reference data sets for evaluation of Aquarius SSS.***

Argo, moorings, other in situ, model, climatologies, L-4 products etc. all have limitations and potential utility.

***The need to harmonize Aquarius and Argo products on defined time/space scales.***

OSTST uses both tide stations and satellite data to optimize and harmonize products.

OSST could do the same.

***The need for a coastal focus group to optimize Aquarius near land and islands.***

Both OSTST and OVWST have such very productive groups addressing a host of issues.

***The need and opportunity for improved L-3 and L-4 products for research and applications.***

# Aquarius SSS space/time biases with respect to Argo data

Peter Hacker, Oleg Melnichenko, Nikolai Maximenko and James Potemra

The Aquarius/SAC-D satellite provides an opportunity to observe near-global sea surface salinity (SSS) with unprecedented space and time resolution not available by other components of the Global Ocean Observing System. In order to evaluate and quantify the potential utility of the SSS data for global and regional studies of SSS variability, our research group has been using the Level-2, three-beam swath data and Argo data to characterize and quantify systematic space/time biases and random errors on a global grid. Despite continuing Level-2 product improvement of Aquarius data over the past three years, significant ascending/descending and inter-beam space/time biases with respect to Argo data persist. Time-mean and annual biases are particularly significant. For the present version 3.0 data, our analyses include quantifying the mean spatial biases for ascending and descending data for each of the three beams (typical range of +/- 0.25 psu), and 3-year mean and time-varying biases for the standard Aquarius and SST-adjusted SSS products from September 2011 to August 2014 (typical range of +/- 0.25 psu). An EOF analysis provides the amplitude and spatial structure for the first three significant components, which account for ~50% of the time-varying Aquarius minus Argo SSS bias. The first two components are annually varying with a 3-month lag; the third component is primarily semi-annual. The amplitude of the annual cycle in the bias field varies spatially from 0-0.25 psu and can be a significant bias compared to the Argo-derived annual cycle regionally.

2014 Aquarius/SAC-D Science Team Meeting

11-14 November 2014, Seattle, Washington