Comparison Analysis Between Aquarius Sea Surface Salinity and World Ocean Database In Situ Analyzed Sea Surface Salinity

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Natural measurement of the Global Water Cycle

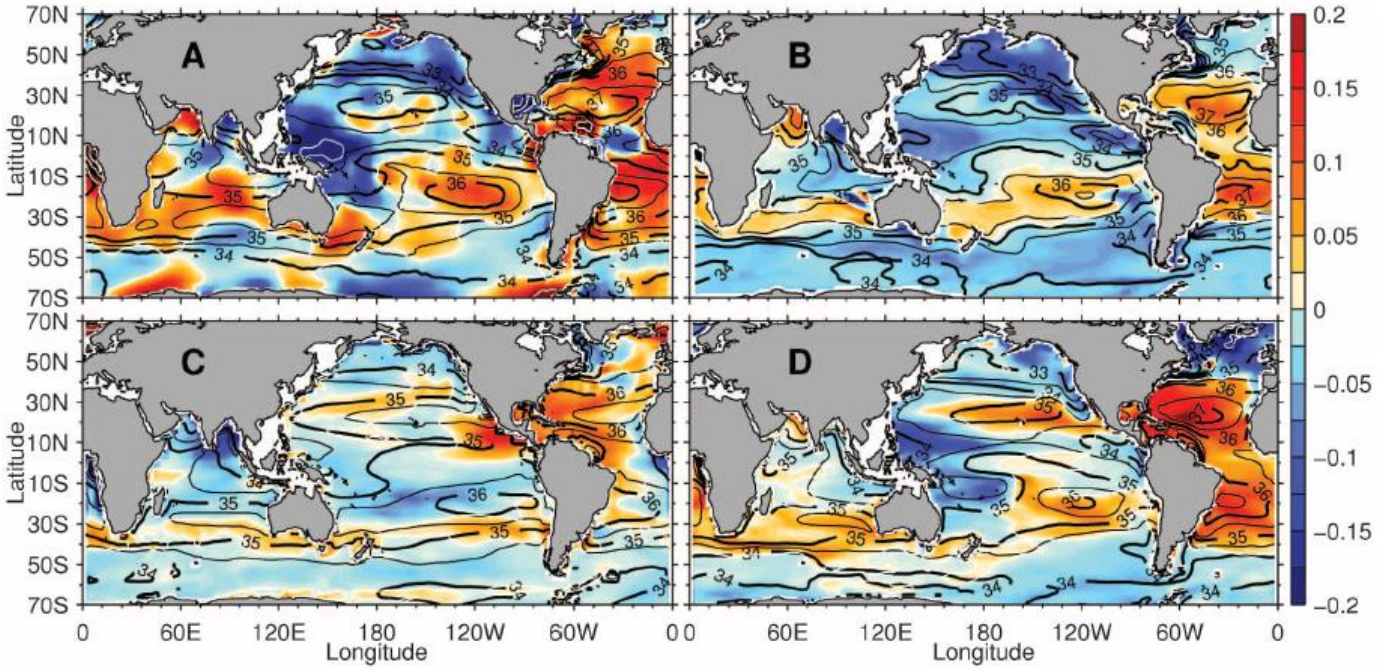
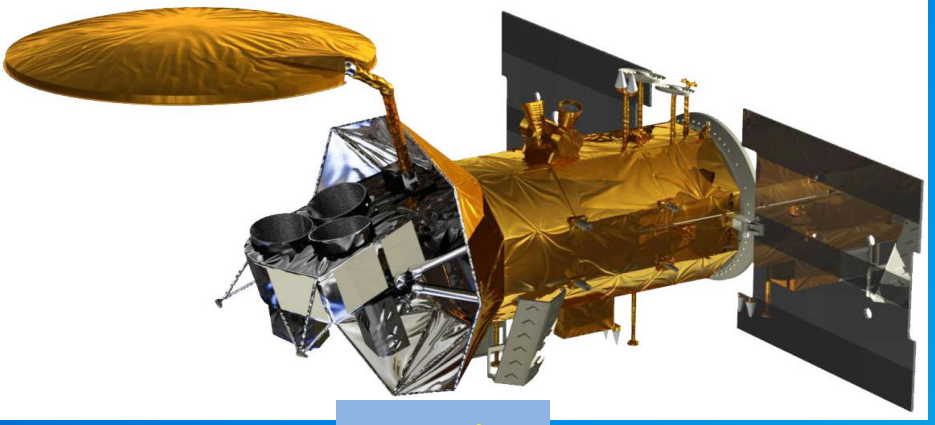


Fig. 3. Patterns of 50-year surface salinity changes (PSS-78 50 year^{-1}). **(A)** The 1950–2000 observational result of (*25*). **(B)** From an ocean model forced with an idealized surface 5% E-P enhancement (50 year^{-1}; see text). **(C)** For an ensemble mean from 1950–2000 of the CMIP3 20C3M simulations that warm <0.5°C (24 simulations; see table S2). **(D)** For an ensemble mean from 1950–2000 of the CMIP3 20C3M simulations that warm >0.5°C (26 simulations; see table S2). In each panel, the corresponding mean salinity from each representative data source is contoured in black, with thick lines every 1 (PSS-78) and thin lines every 0.5 (PSS-78).

Durack et al. (2012)

Estimated that for every **1°C** increase in surface warming, the global hydrological cycle intensifies by **8 ± 5%**.

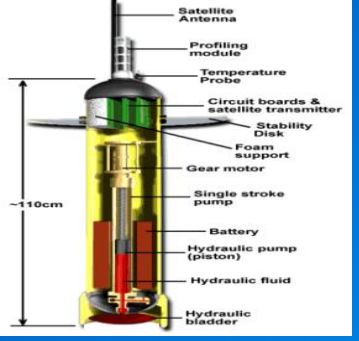


Aquarius

Sea Surface Salinity is now being measured almost globally through the use of satellites, namely Aquarius and SMOS.

But how accurate are they?

Aquarius Launch



Data

WOD-Derived SSS

- Globally analyzed monthly SSS fields created through an objective analysis scheme utilizing calculated salinity climatologies and quality controlled *in situ* data.
  - *In situ* data is composed mostly of Argo floats, however, CTD, bottle, moored buoys, drifting buoys, and glider data were also included
    - Only salinity observations less than 5.25 m from the surface were used.

Aquarius SSS

- Passive Satellite
- 675km Altitude, 0.2 psu accuracy (goal), 3 beam resolution (~150km)
- Global coverage in 7 Days
- Microwave Radiometer measures thermal emission in the L-Band (1.413GHz, near peak sensitivity to salinity)
- Actual product used in our analysis is the globally mapped level-3 (v2) non-smoothed monthly SSS fields.

WOD-Derived Fields

Profile with salinity observation less than 5.25m from surface

↓

Difference between profile and climatological (WOA09) mean value

↓

Average anomaly values into one degree bins

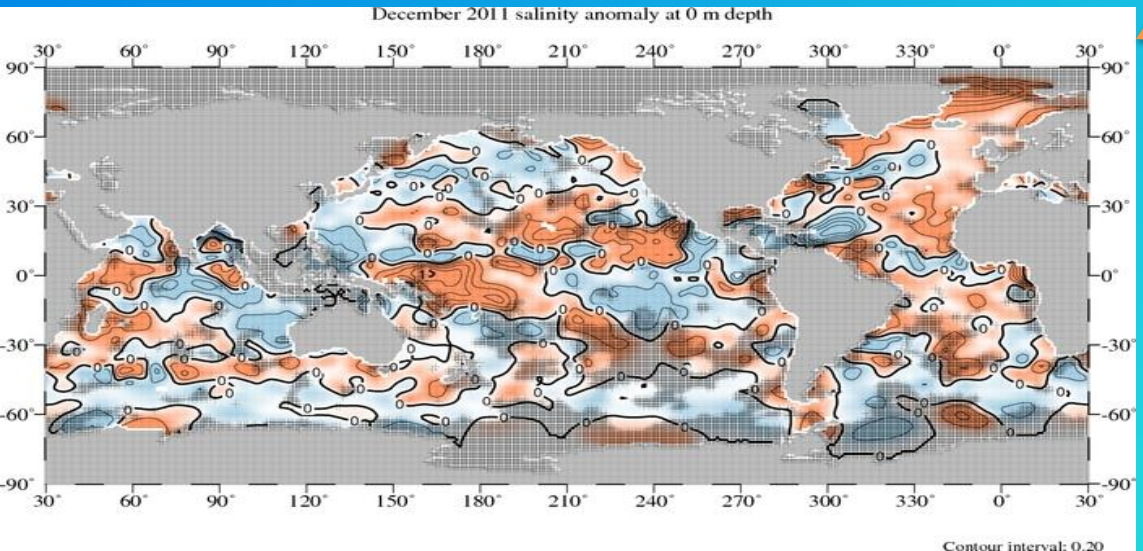
→ Use first guess field = 0 and objectively analyze the anomaly values

↑

Remove any suspicious profiles that are contributing to bullseyes in the analyzed anomaly fields

↑

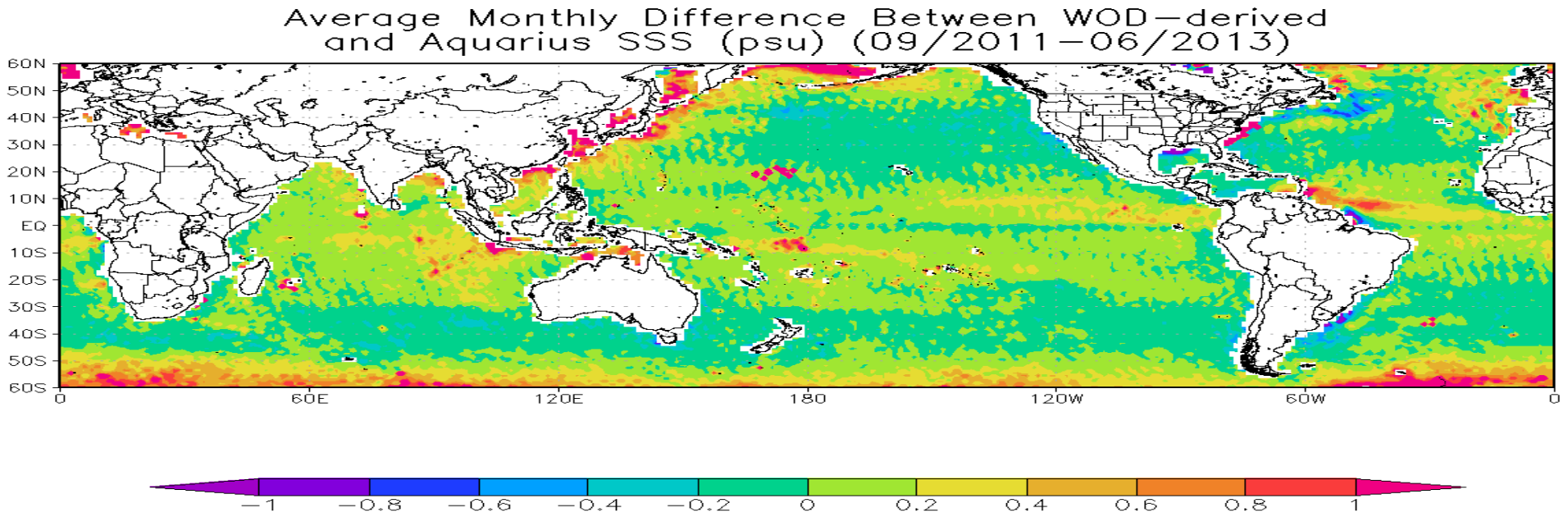
Add anomaly field to climatology (WOA09) to create full salinity field

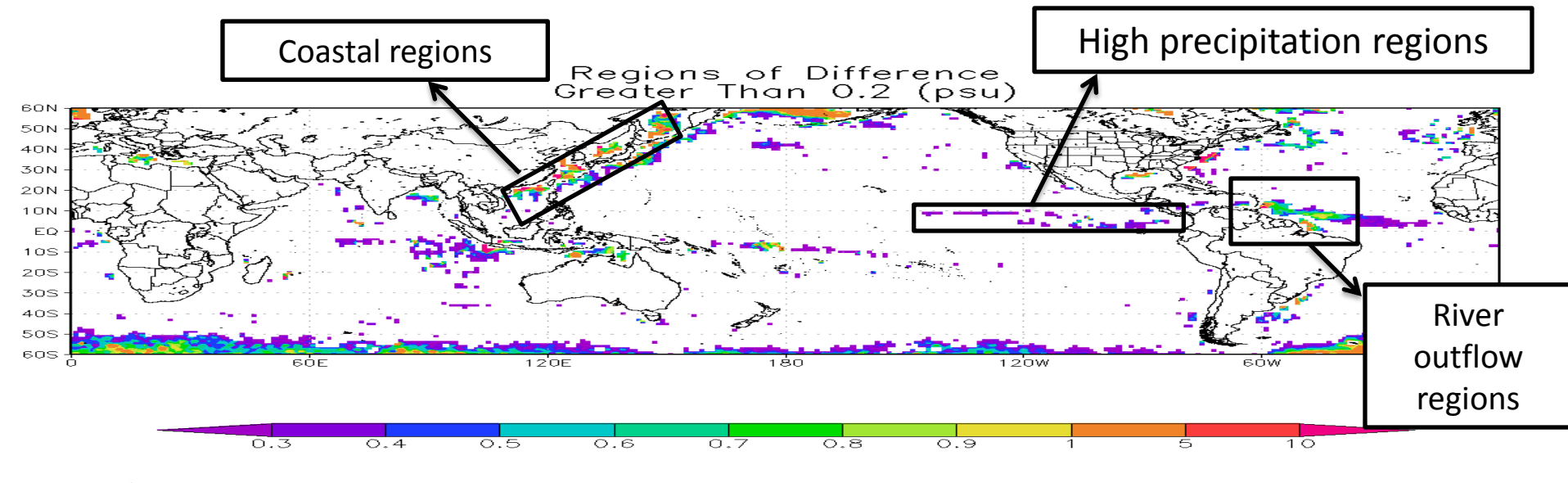


Regions that lack in situ data will be close to monthly climatological mean (WOA09)

*Data Located at NODC's Global Ocean Heat and Salt Content page: http://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/

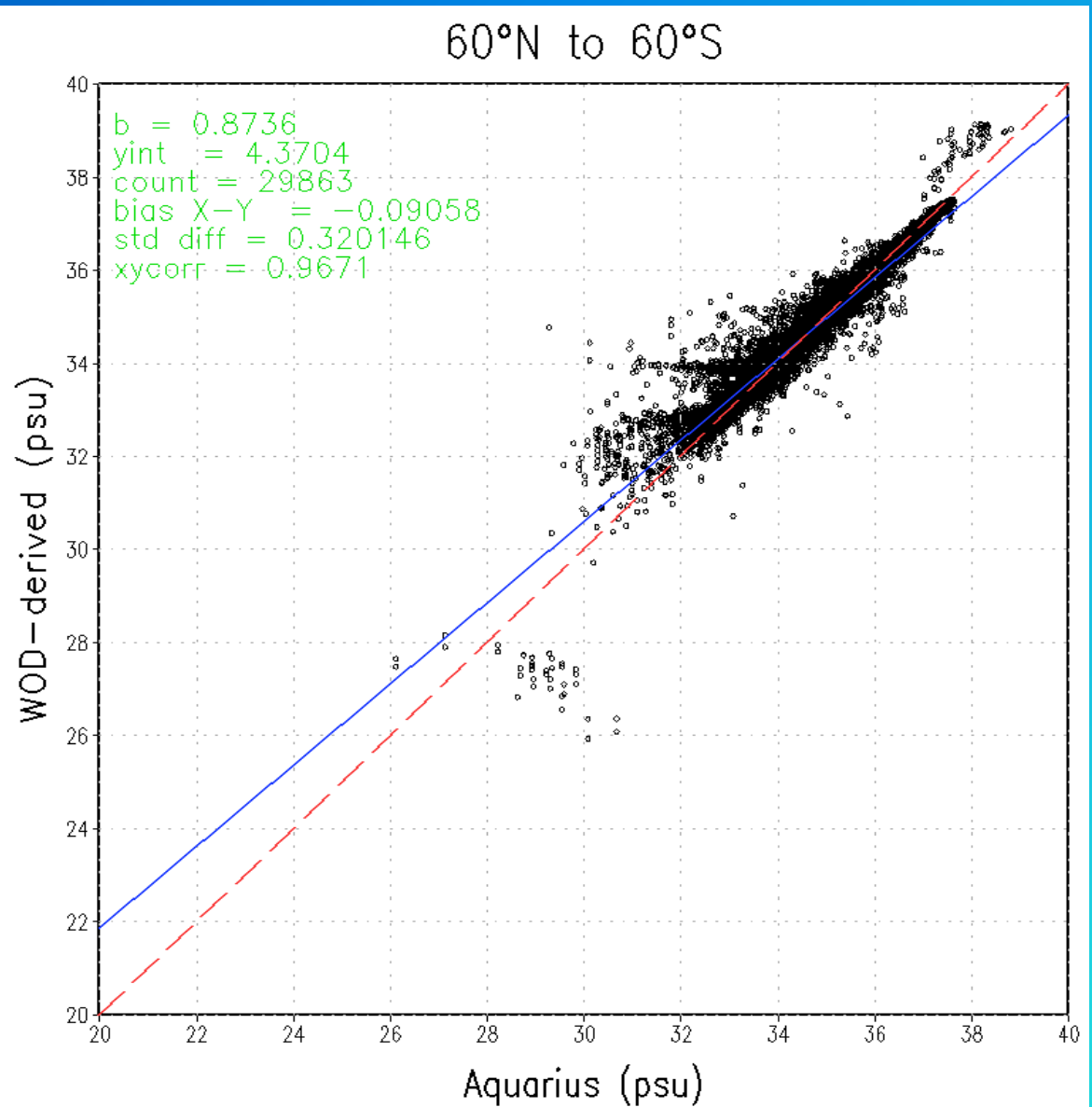
Comparison

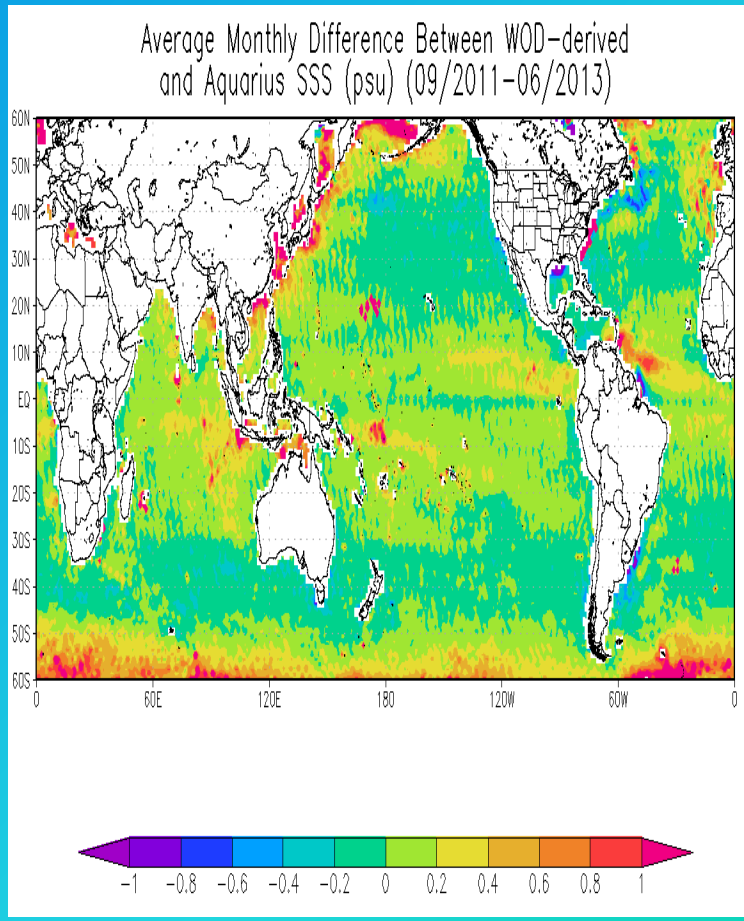




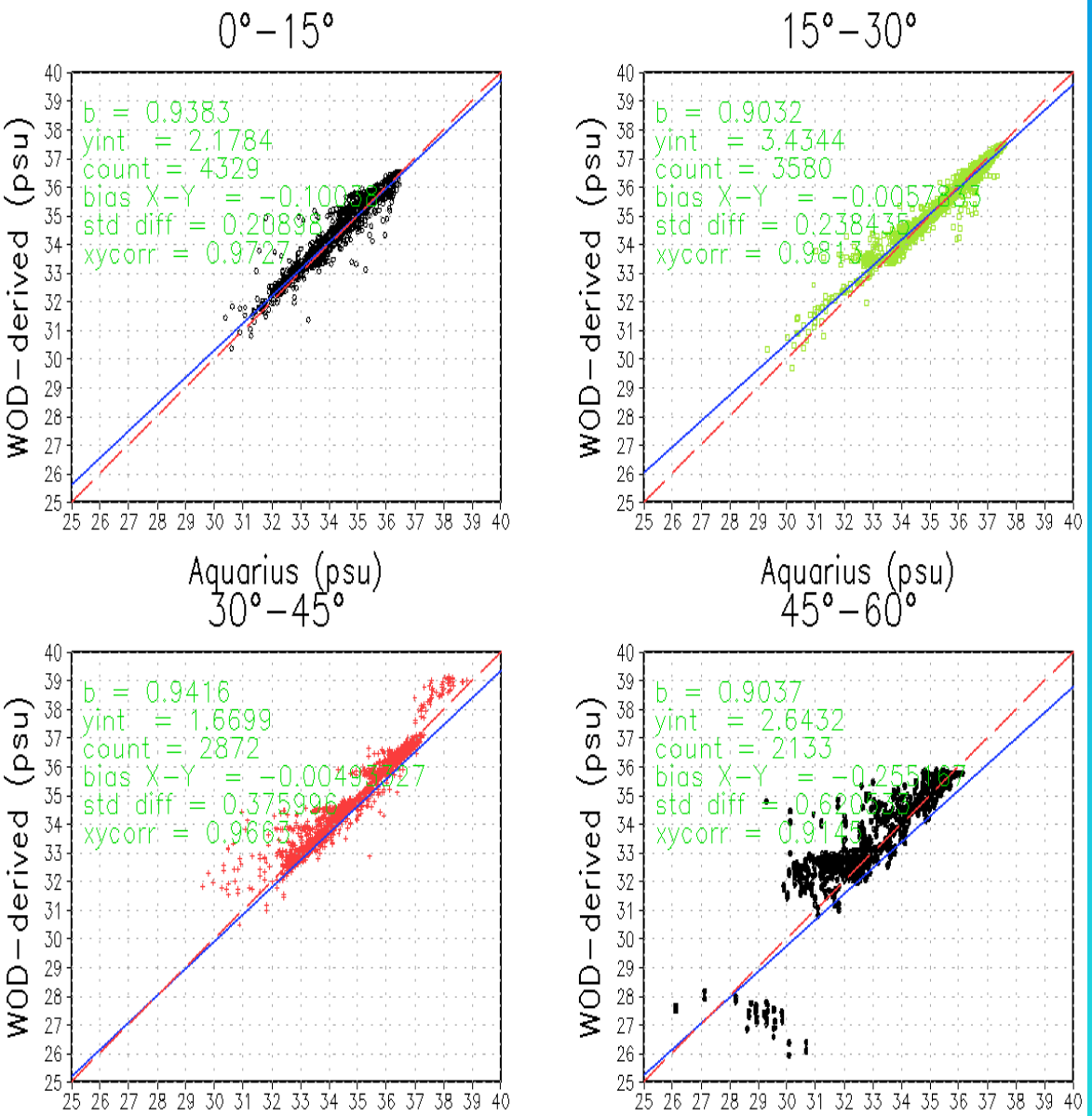
GrADS: COLA/IGES

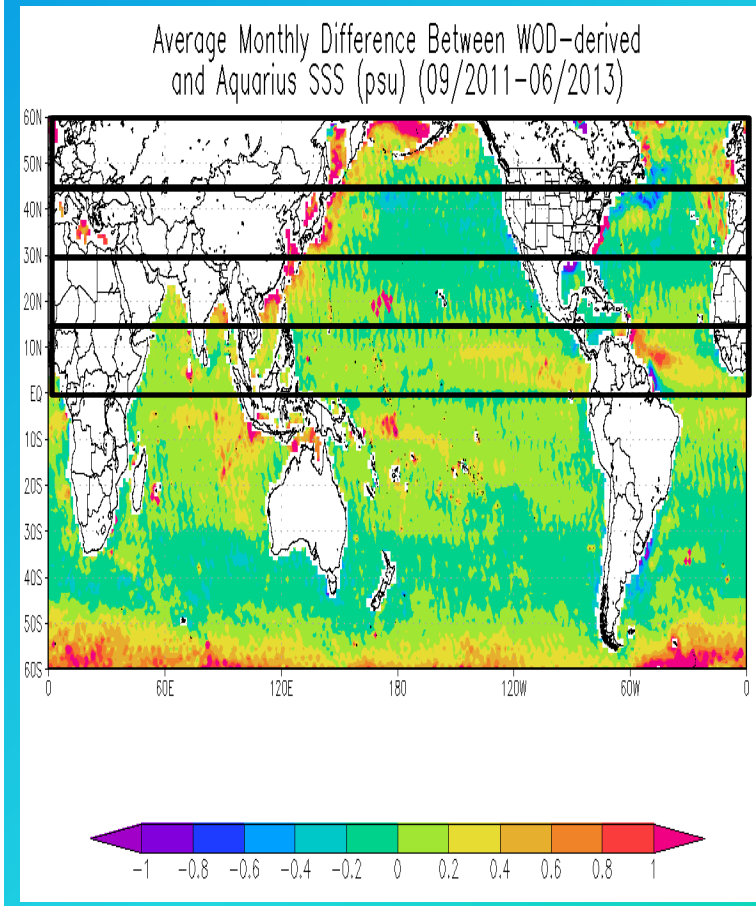
Aquarius vs WOD-derived



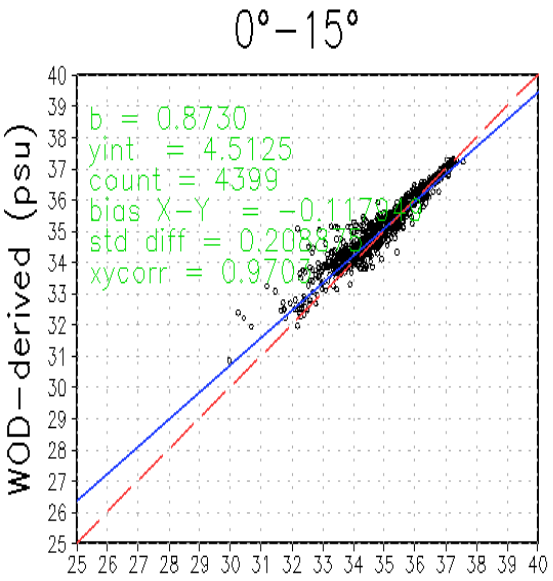


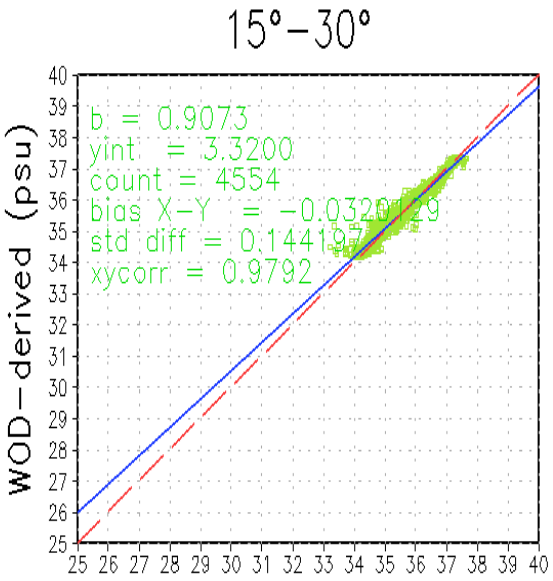
Northern Hemisphere

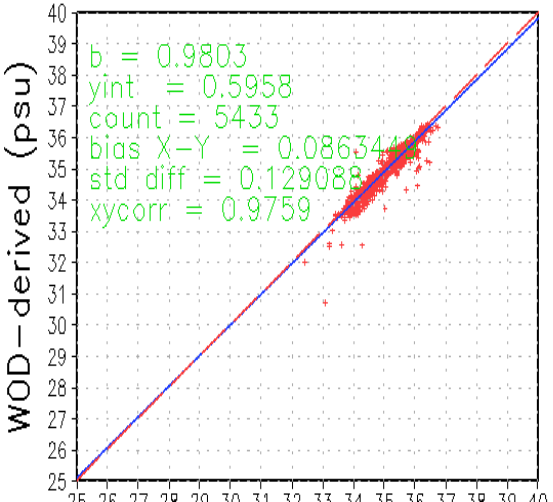


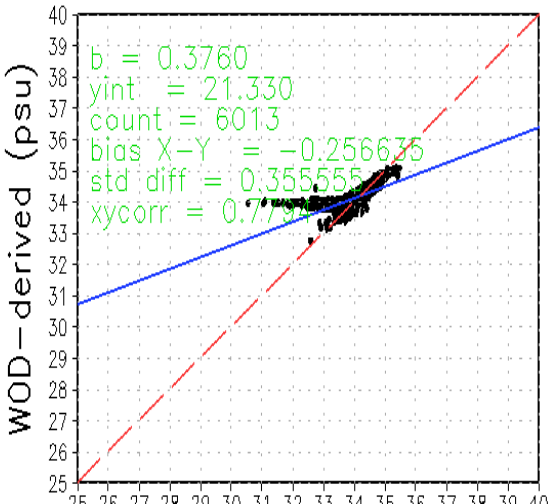


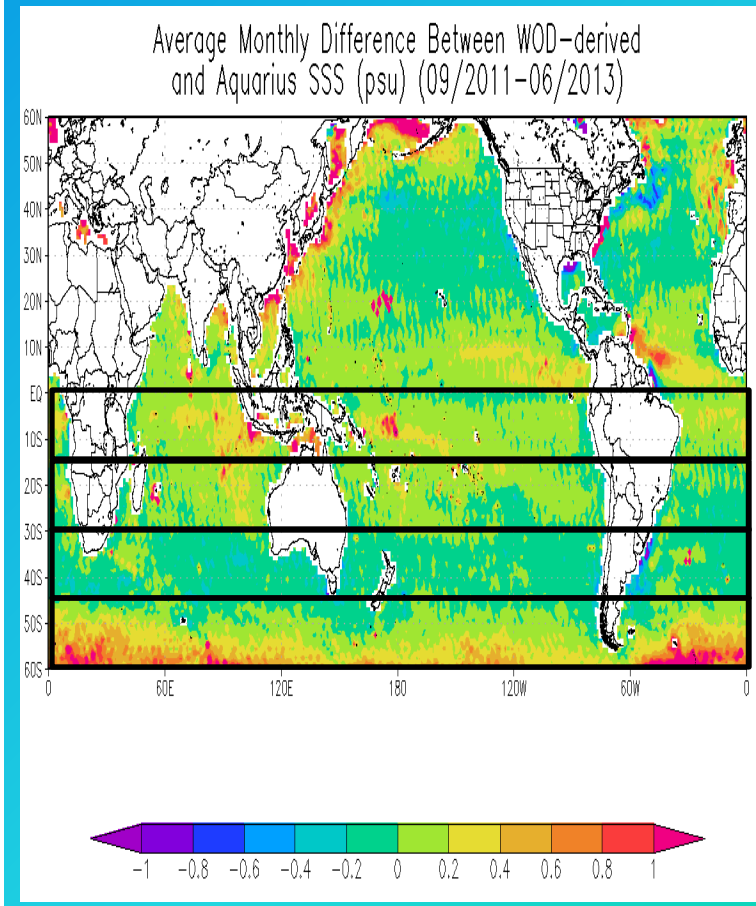
Southern Hemisphere



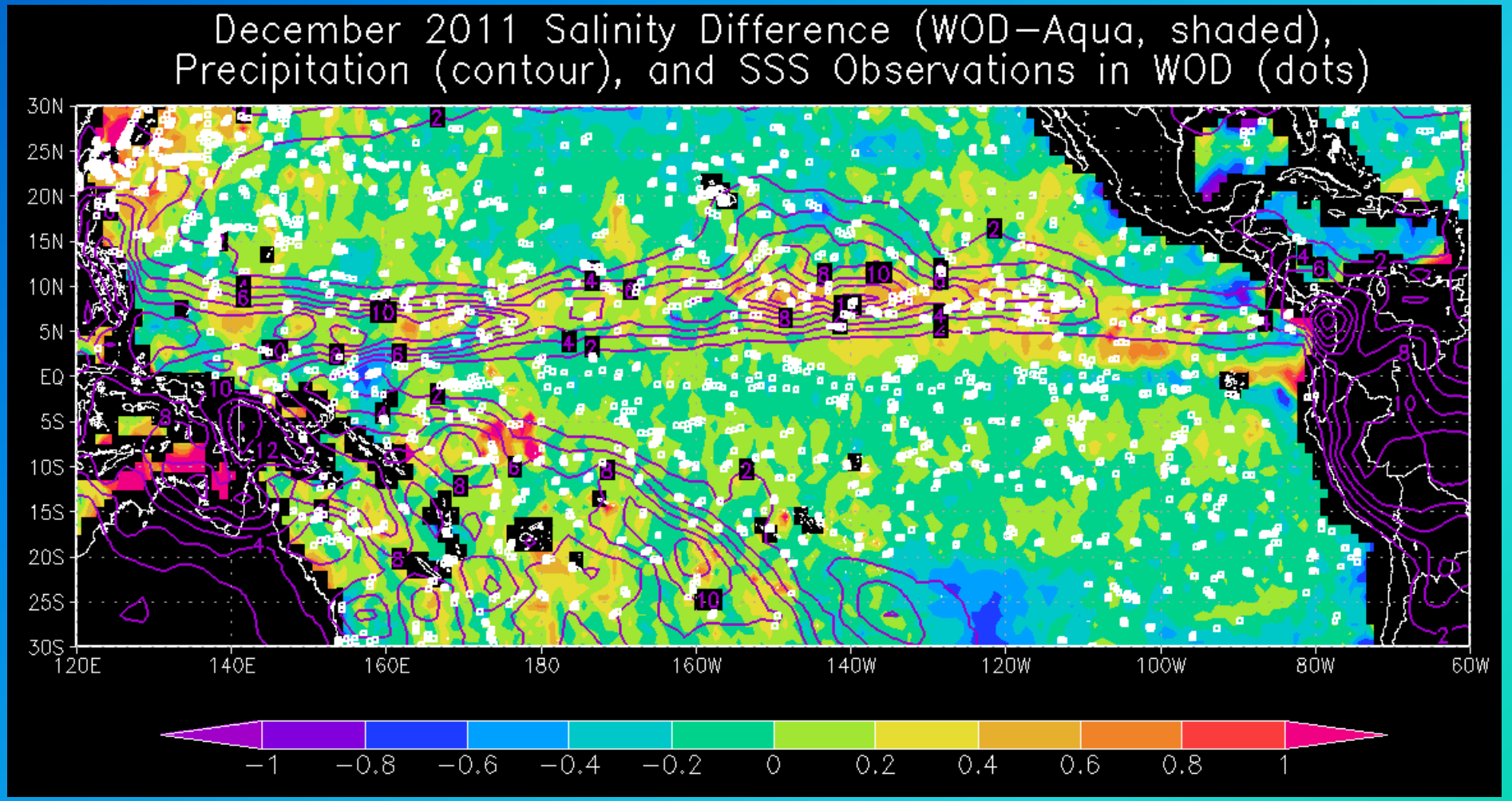








Precipitation



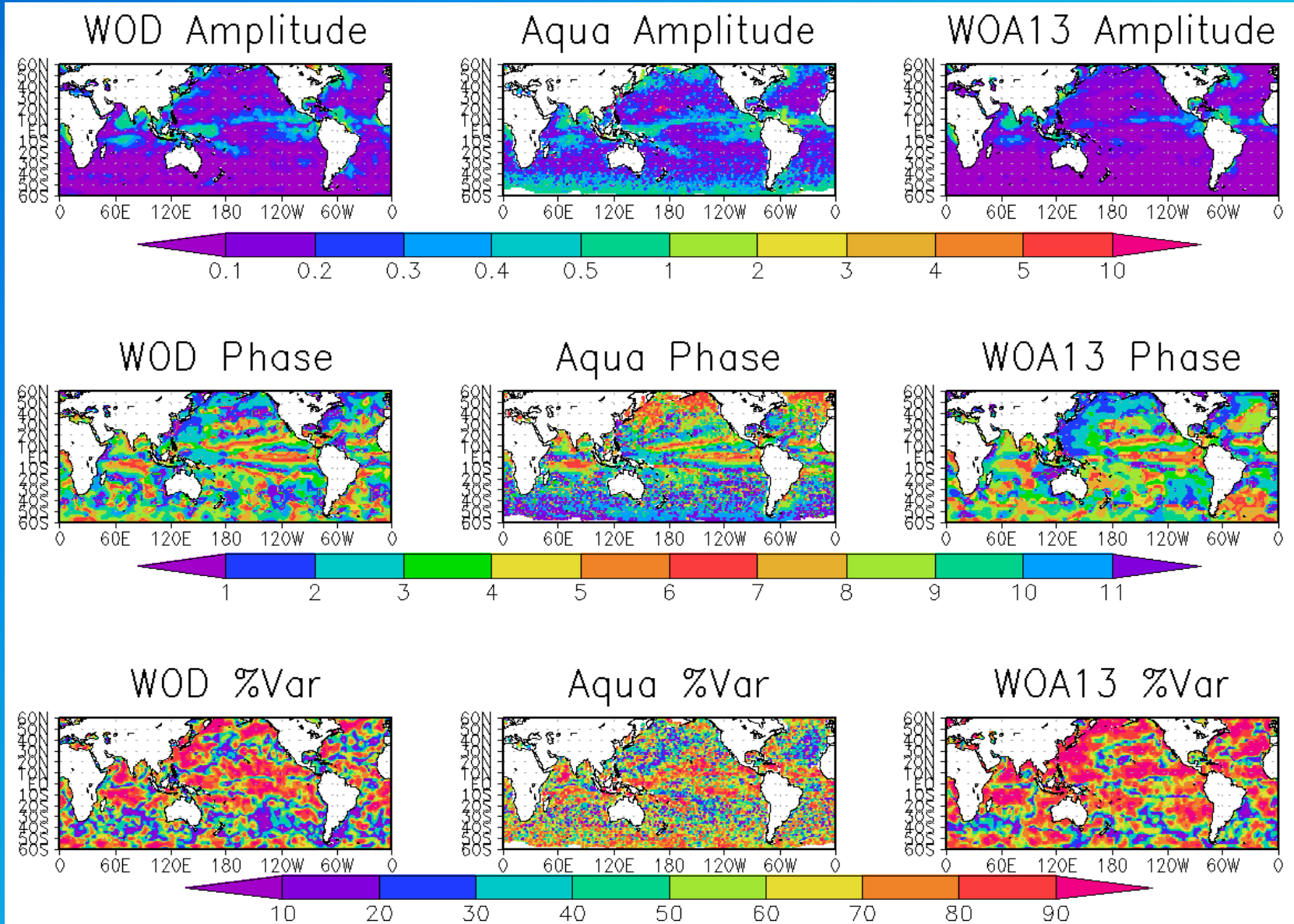
There appears to be sufficient in situ data in precipitation zones, yet WOD-derived analyzed SSS is consistently higher than Aquarius

Precipitation cont…

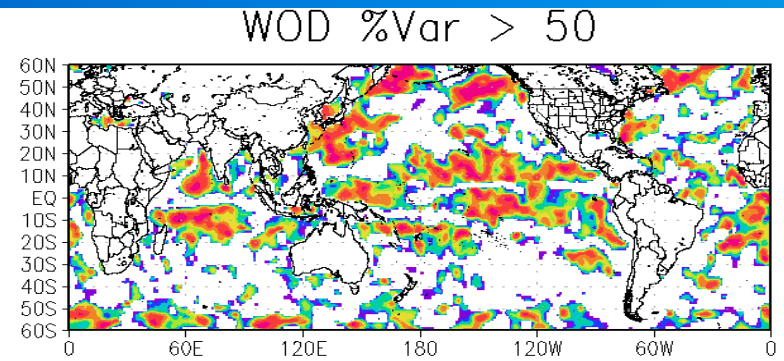
- Salinity stratification in the upper few meters must be further studied
  - Projects such as the Salinity Processes in the Upper Ocean Regional Study (SPURS) is helping to bridge this gap
    - SPURS, in particular, has looked at the subtropical North Atlantic where precipitation is at a minimum and evaporation at a maximum.
      - Future plans include precipitation dominated regions?

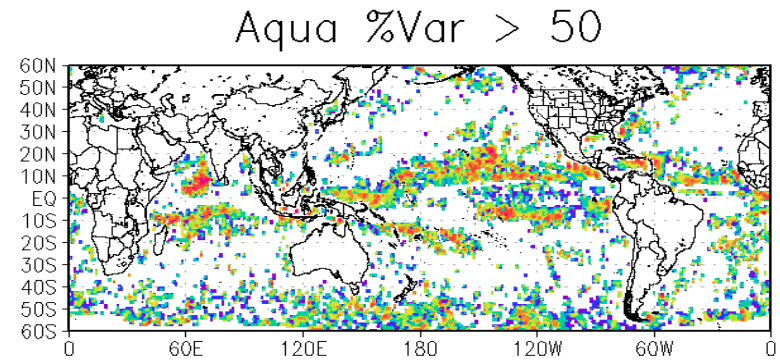
Annual Cycle Comparison

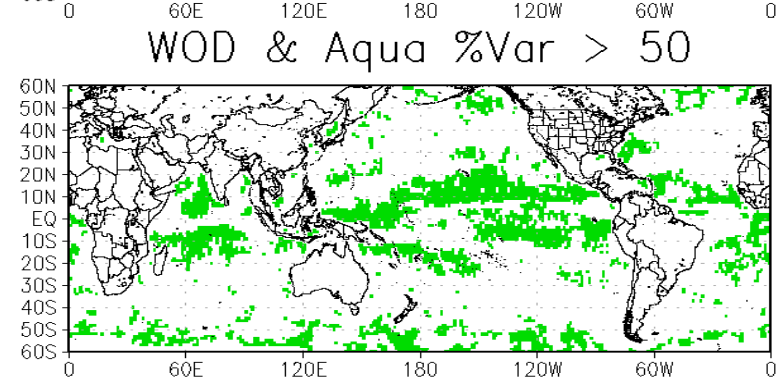
First Harmonic for 2012

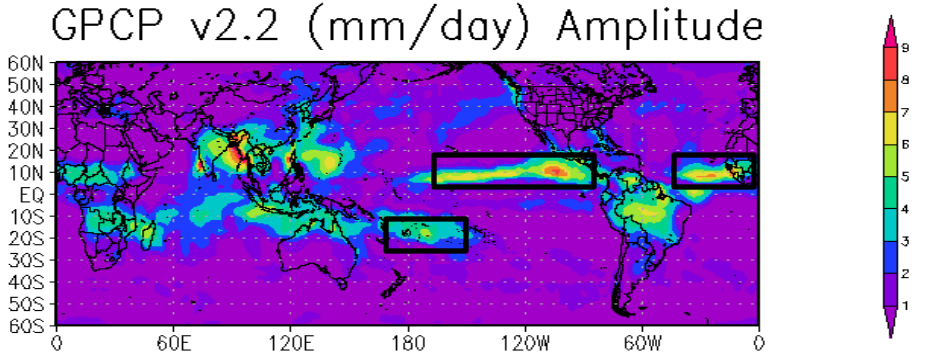


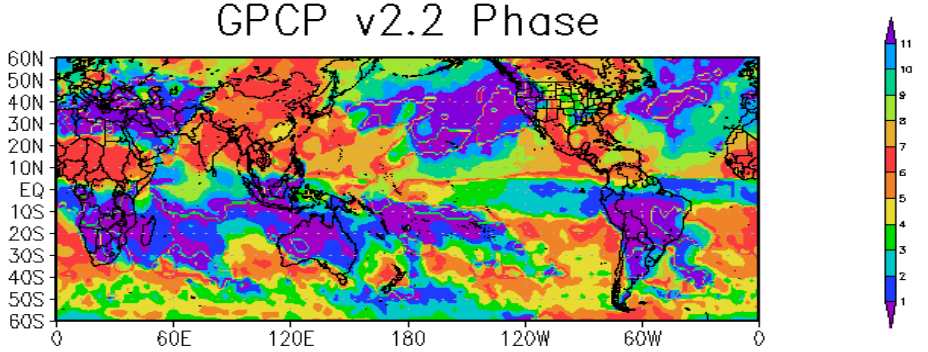
How well does the SSS annual cycle correlate with the annual cycle of precipitation?

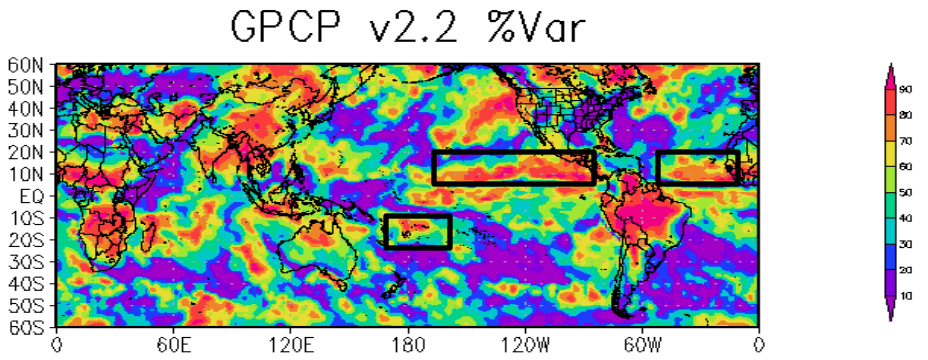




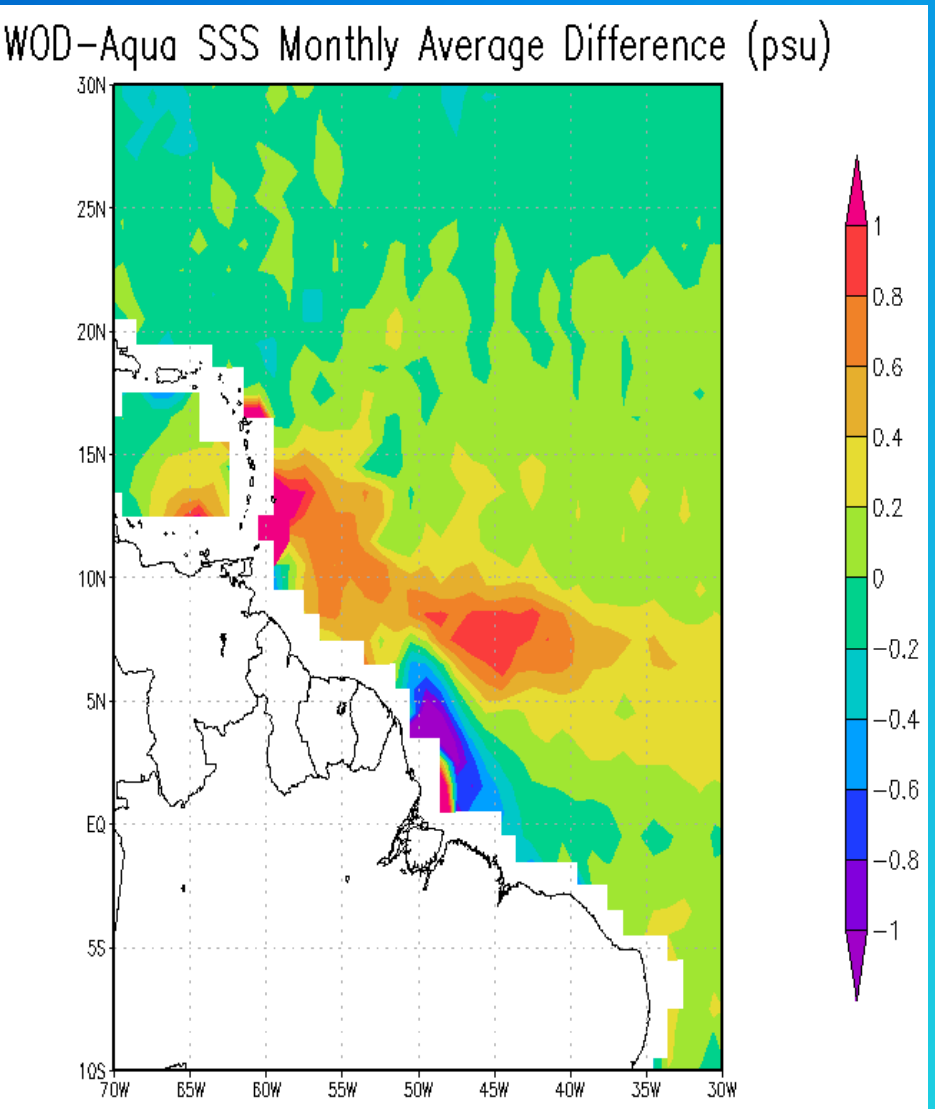


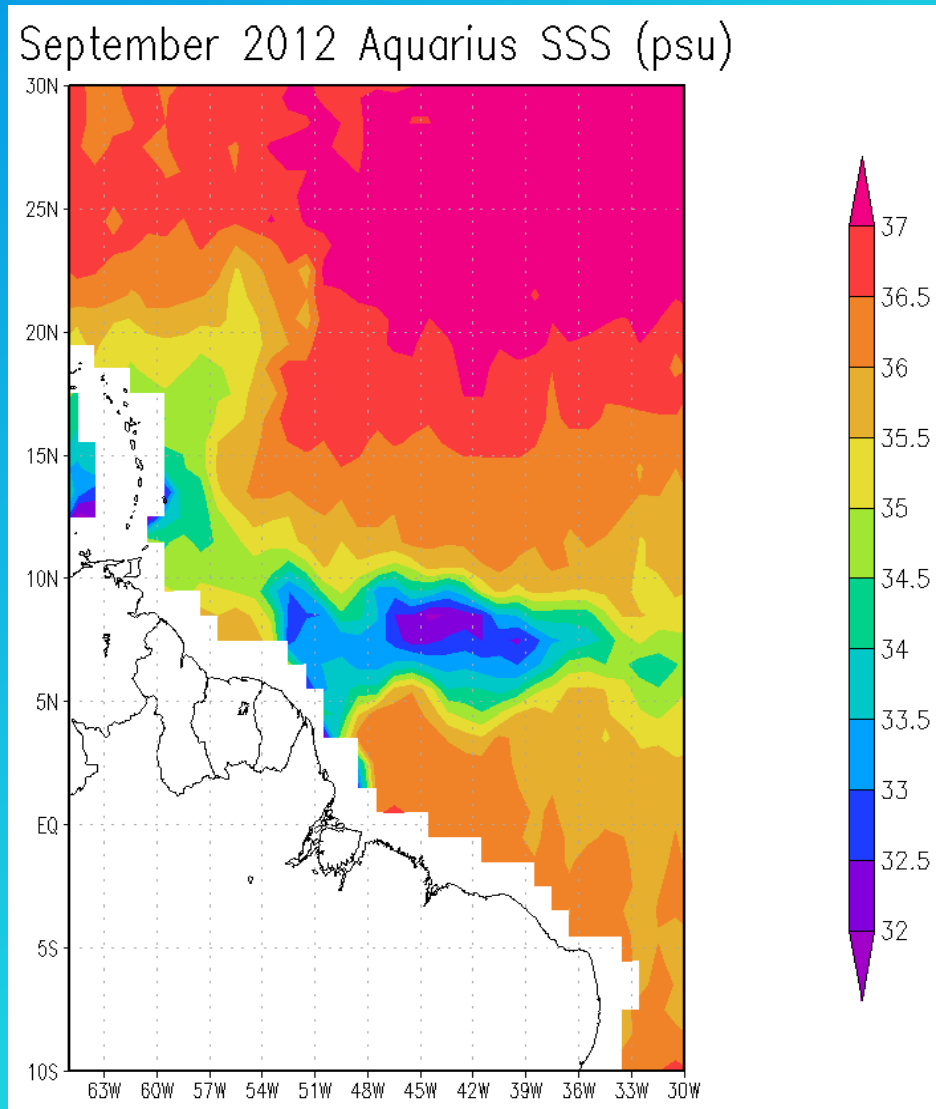




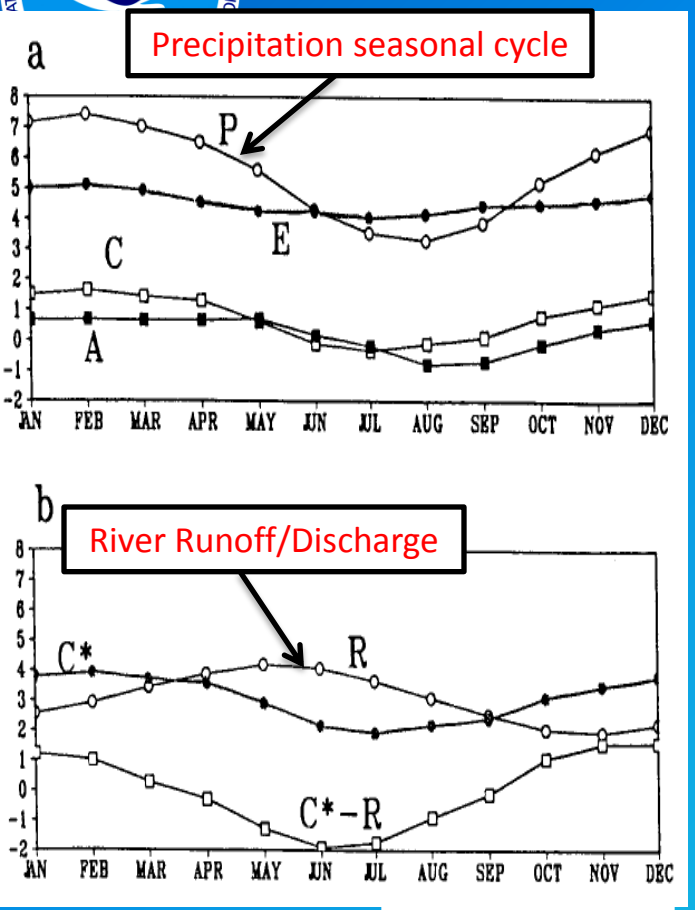


Amazon River Analysis

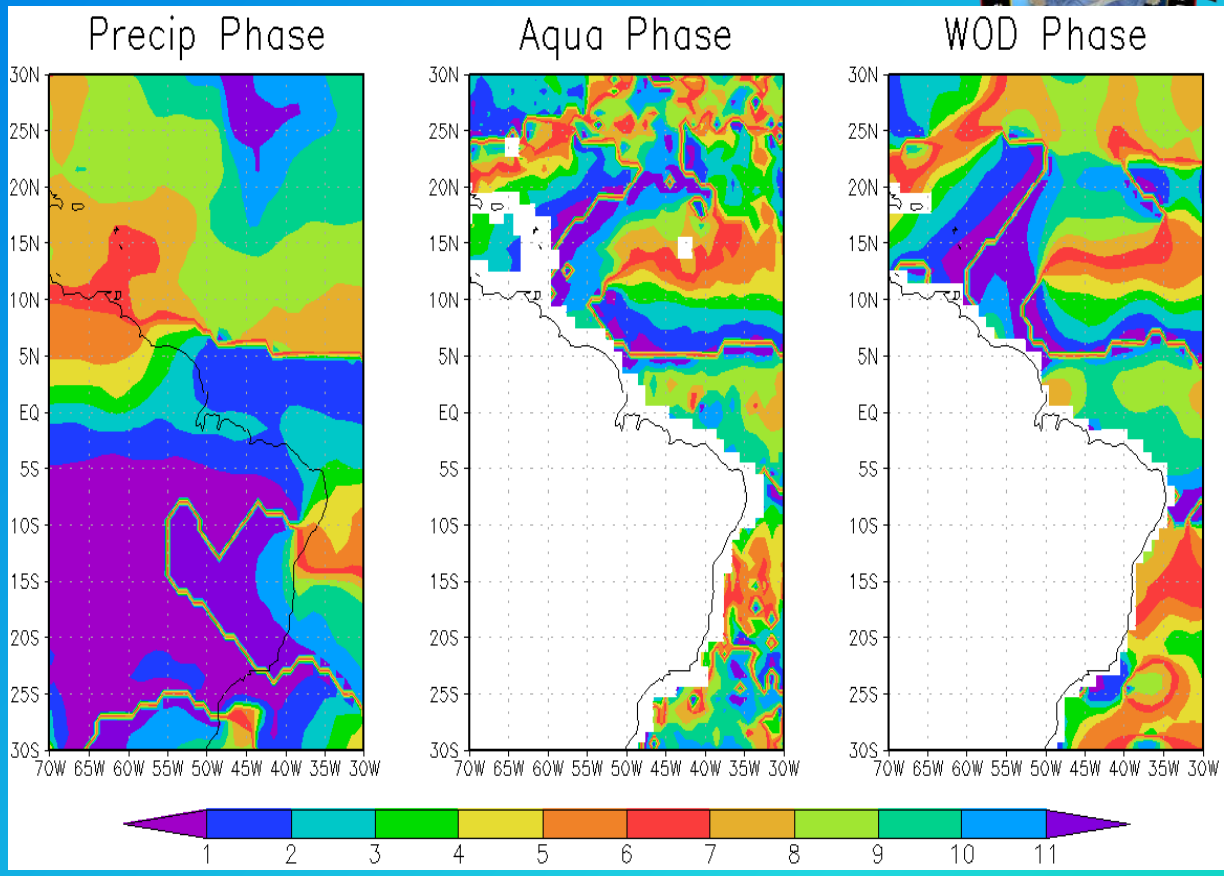




Amazon cont…



Zeng (1999)

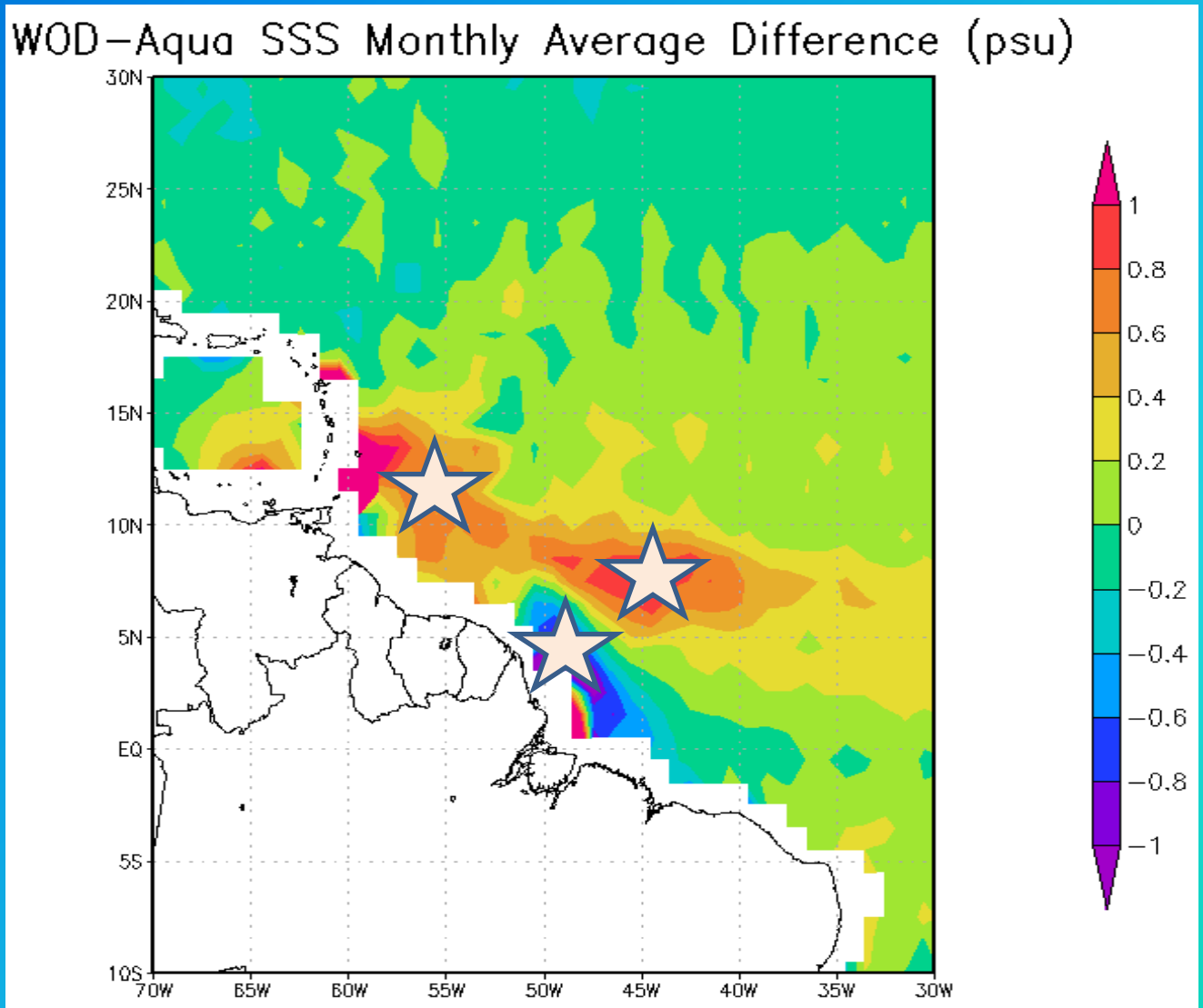


Amazon river discharge:
- Max = April-June
- Min = October-December

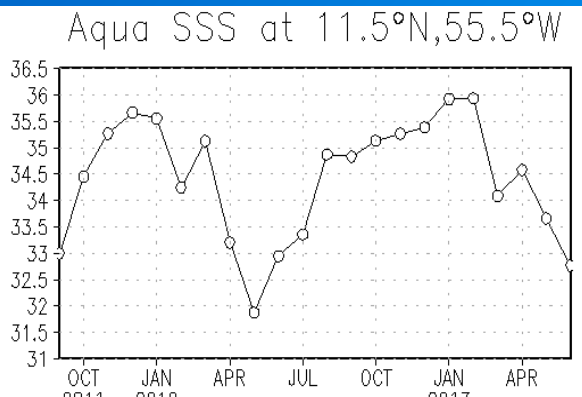
Precip Phase (GPCP v2.2) for 2012:
- Max Precip over Amazon Basin: Dec, Jan, Feb

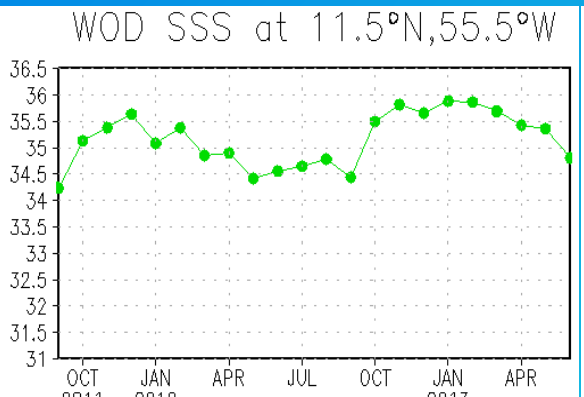
Aquarius and WOD-derived Salinity Phase:
- Max Salinity: Dec, Jan, Feb

Amazon cont…


WOD−Aqua SSS Monthly Average Difference (psu)
30N
25N
20N
15N
10N
5N
EQ
5S
10S
70W
65W
60W
55W
50W
45W
40W
35W
30W
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1

Amazon cont…


Aqua SSS at 11.5°N,55.5°W
36.5
36
35.5
35
34.5
34
33.5
33
32.5
32
31.5
31
OCT 2011
JAN 2012
APR
JUL
OCT
JAN 2013
APR


WOD SSS at 11.5°N,55.5°W
36.5
36
35.5
35
34.5
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33.5
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32.5
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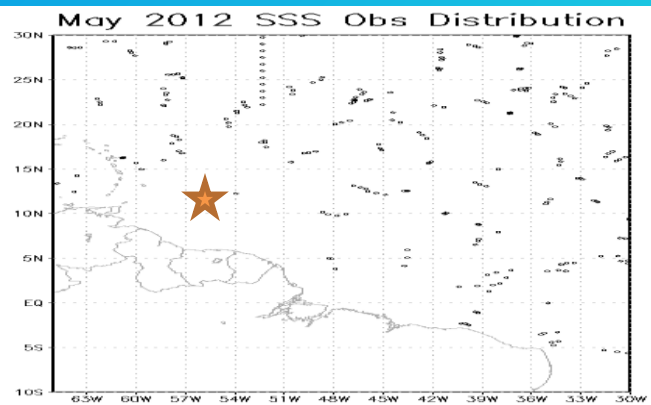
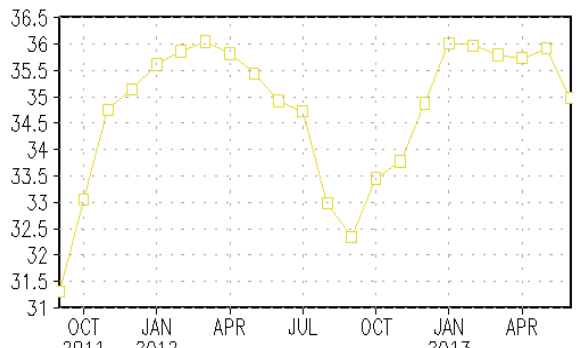
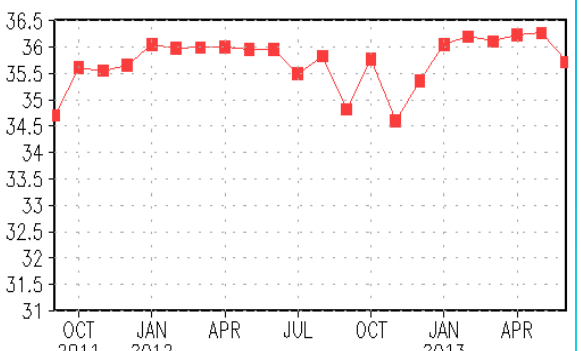
31.5
31
OCT 2011
JAN 2012
APR
JUL
OCT
JAN 2013
APR


May 2012 SSS Obs Distribution
30N
25N
20N
15N
10N
5N
EQ
5S
10S
65W 60W 57W 54W 51W 48W 45W 42W 39W 36W 33W 30W


Aqua SSS at 7.5°N,44.5°W
36.5
36
35.5
35
34.5
34
33.5
33
32.5
32
31.5
31
OCT 2011
JAN 2012
APR
JUL
OCT
JAN 2013
APR


WOD SSS at 7.5°N,44.5°W
36.5
36
35.5
35
34.5
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33.5
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32.5
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31.5
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OCT 2011
JAN 2012
APR
JUL
OCT
JAN 2013
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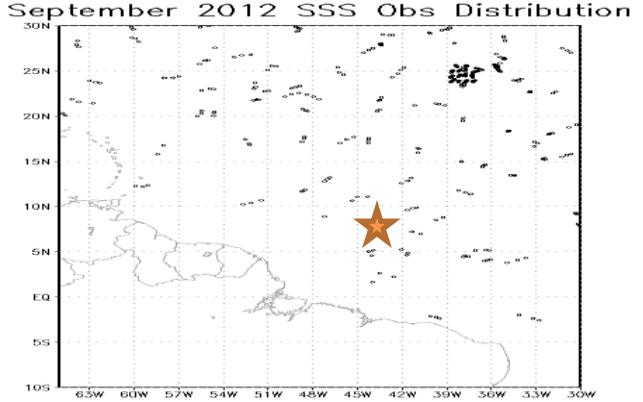
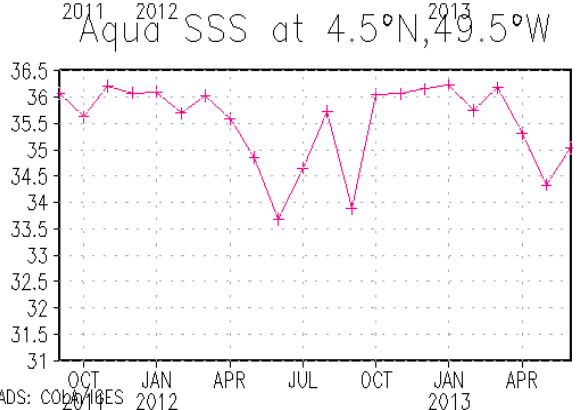
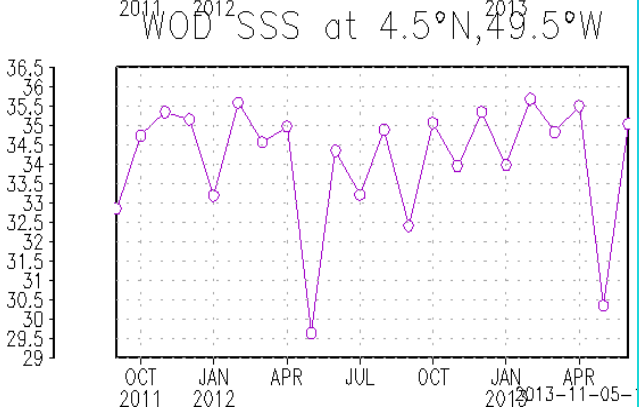

September 2012 SSS Obs Distribution
30N
25N
20N
15N
10N
5N
EQ
5S
10S
65W 60W 57W 54W 51W 48W 45W 42W 39W 36W 33W 30W


Aqua SSS at 4.5°N,49.5°W
36.5
36
35.5
35
34.5
34
33.5
33
32.5
32
31.5
31
OCT 2011
JAN 2012
APR
JUL
OCT
JAN 2013
APR


WOD SSS at 4.5°N,49.5°W
36.5
36
35.5
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34.5
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33.5
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32.5
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31.5
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30.5
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29.5
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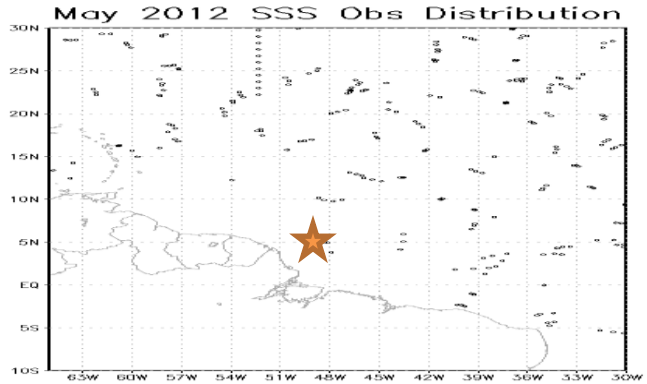
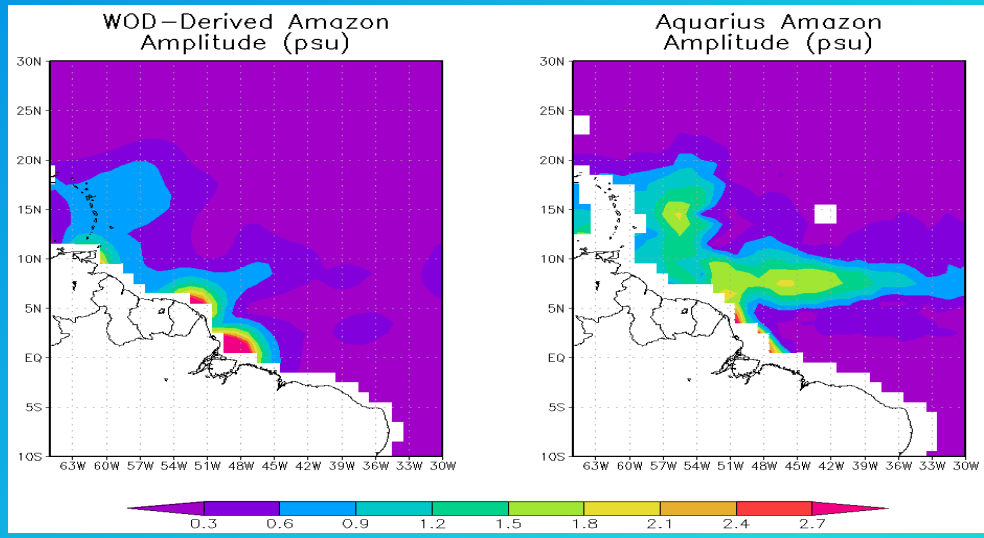
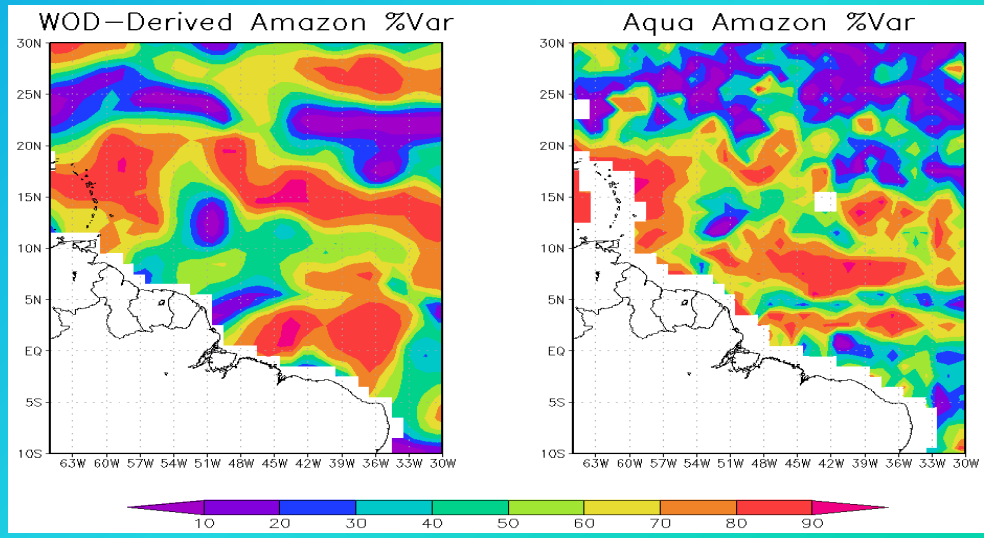
OCT 2011
JAN 2012
APR
JUL
OCT
JAN 2013
APR


May 2012 SSS Obs Distribution
30N
25N
20N
15N
10N
5N
EQ
5S
10S
65W 60W 57W 54W 51W 48W 45W 42W 39W 36W 33W 30W

River Outflow Conclusions

- Aquarius displays a strong annual cycle for the Amazon River plume.
  - WOD-derived SSS does not.
    - There appears to be a lack of in situ data.
- For ocean regions immediately next to the mouth of the river, there appears to be very strong differences between Aquarius and WOD-derived SSS
  - Combination of a lack of in situ data with potential land contamination in the salinity retrievals?
- Further research should also look into the movement of the Amazon plume, in both the horizontal and vertical.
  - Salinity stratification?





General Conclusions

- Aquarius SSS and WOD-derived SSS compare very well to one another outside of the following areas:
  - Regions with large freshwater fluxes
  - High latitudes
  - Coastal Regions
- The annual cycles also compare very well to one another.

Future Work

- Compare interannual variability
- Continue to study near surface salinity variability and how it changes with depth, especially in precipitation dominated regions
- Begin to look at regional scale SSS variability, preferably in regions where in situ and Aquarius compare reasonably well.
- Compare higher order harmonics, as in some regions the higher order harmonics become very important.
- Perform similar annual cycle analysis with evaporation data.

References

1. Durack, P. J., S. E. Wijffels, and R. J. Matear, 2012: Ocean salinities reveal strong global water cycle intensification during 1950 to 2000. Science, 336, 455–458.
2. Zeng, N., 1999: Seasonal cycle and interannual variability in the Amazon hydrologic cycle, *J. Geophys. Res.*, 104, 9097-9106.

Data Access

1. World Ocean Atlas 2013
   - ftp://ftp.nodc.noaa.gov/pub/data.nodc/woa/WOA13/
2. World Ocean Database 2013
   - ftp://ftp.nodc.noaa.gov/pub/data.nodc/woa/WOD13/
   - http://www.nodc.noaa.gov/OC5/WOD13/
   - http://www.nodc.noaa.gov/OC5/SELECT/dbsearch/dbsearch.html
3. Global Ocean Heat and Salt Content
   - http://www.nodc.noaa.gov/OC5/3M_HEAT_CONTENT/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Thank You