

National Aeronautics and Space Administration

**The Legacy of Aquarius
Within the Aquarius/SAC-D Mission
Eric Lindstrom, NASA Headquarters
Gary Lagerloef, Earth and Space Research
David Levine, NASA Goddard Space Flight Center**

Understanding
the Interaction
Between Ocean
Circulation, the
Water Cycle,
and Climate by
Measuring
Ocean Salinity

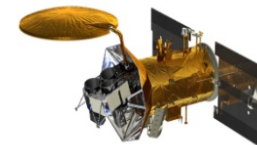
Aquarius/SAC-D Science Team Meeting
17-19 November 2015
Buenos Aires, Argentina

www.nasa.gov

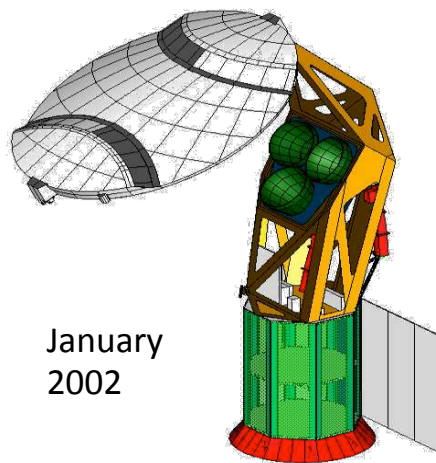
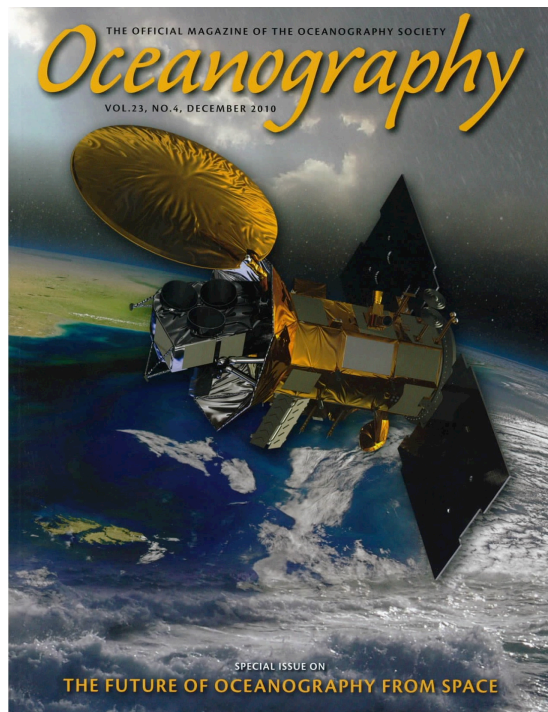
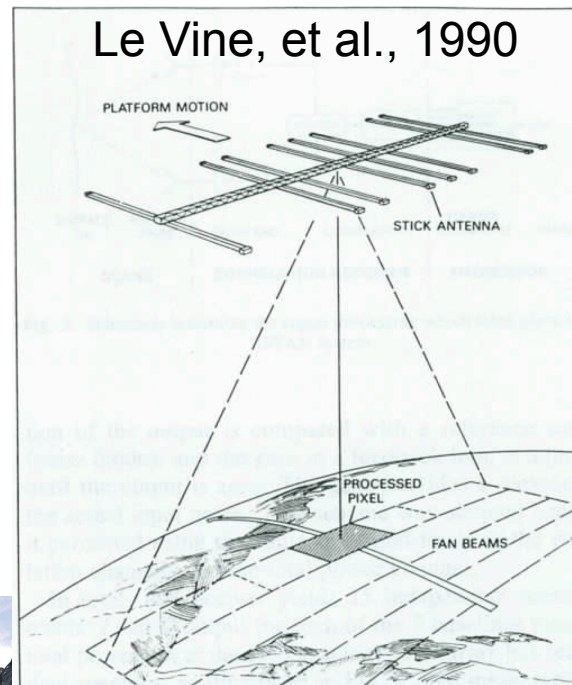
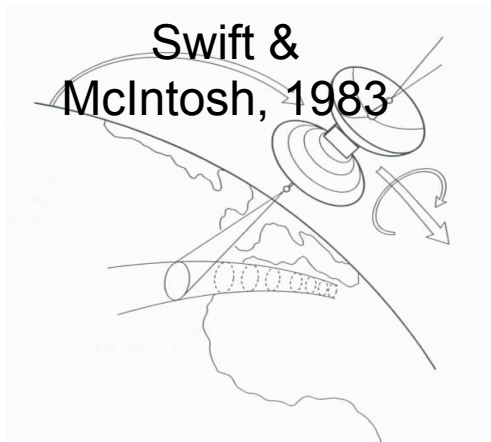
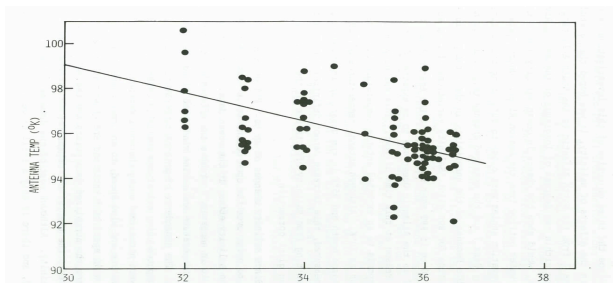


Aquarius/SAC-D





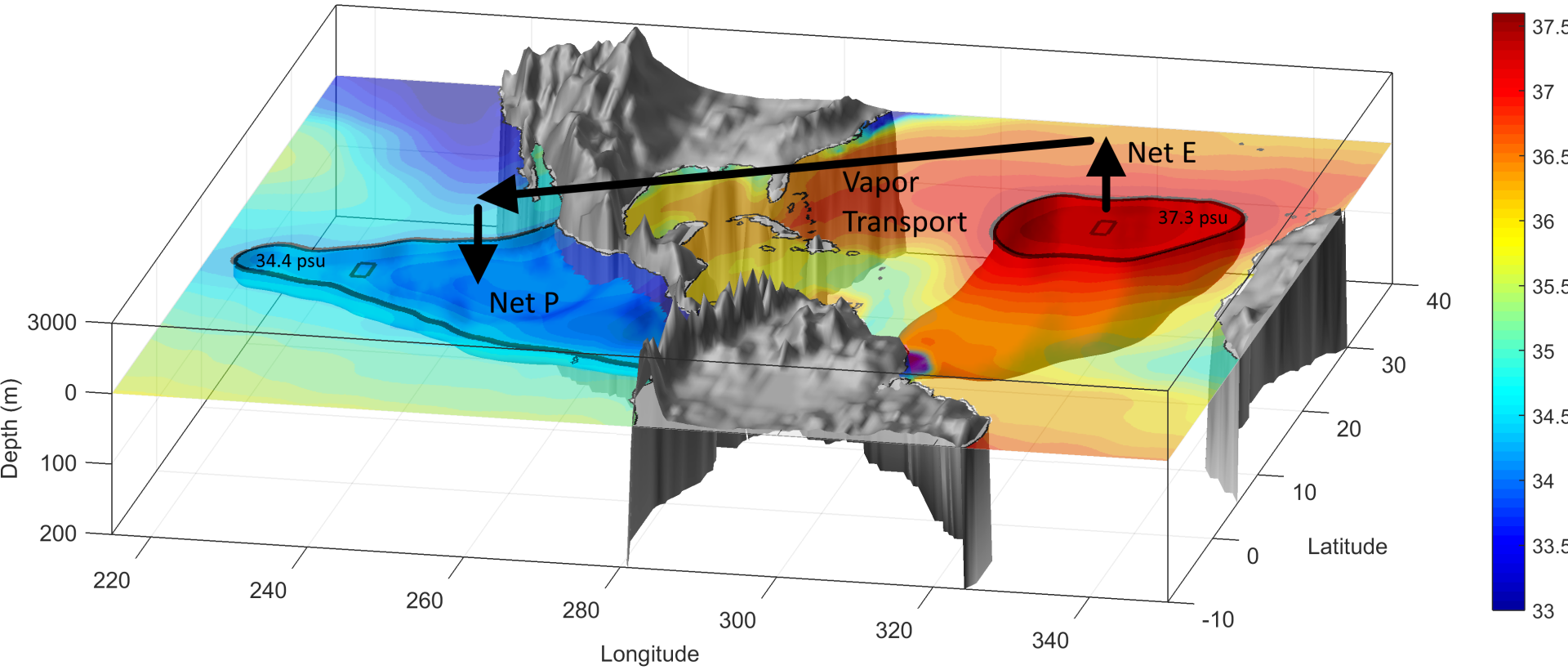
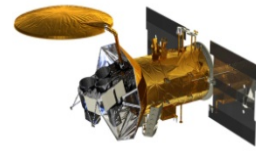
- SKYLAB 1973 – First Salinity from Space

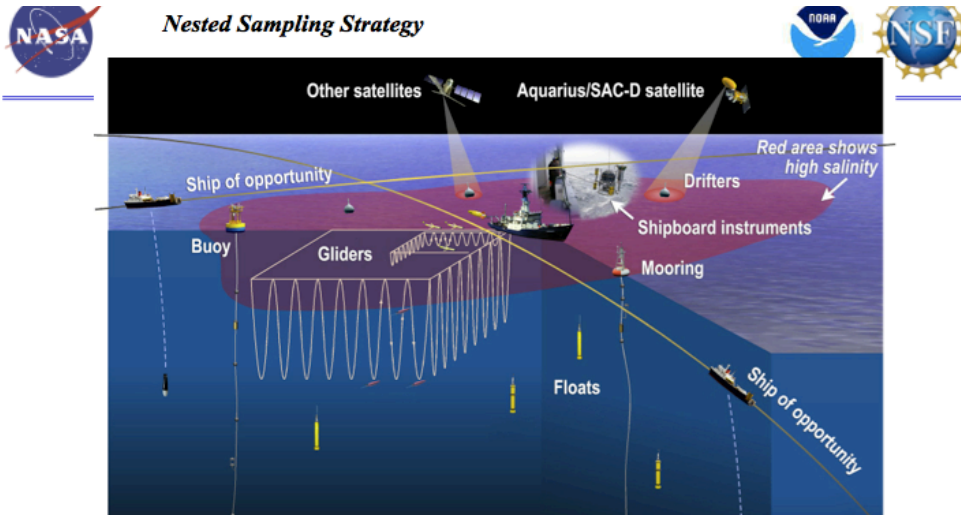
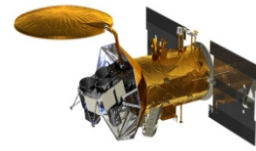


January 2002

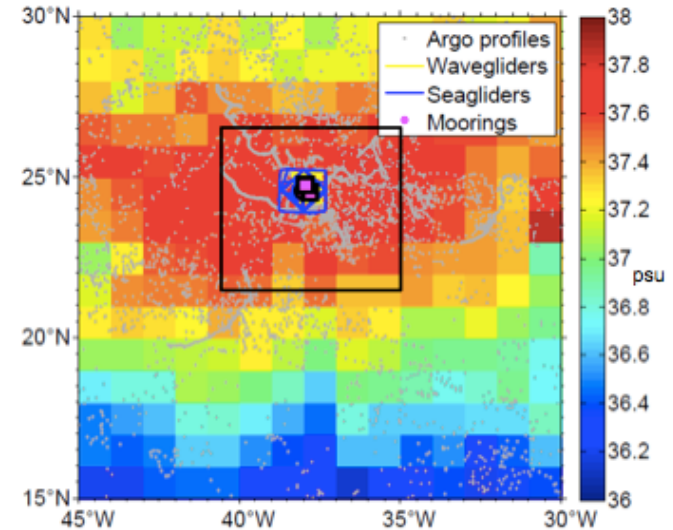


PALS
~2000





Aquarius salinity, March 2012



R/V Roger Revelle

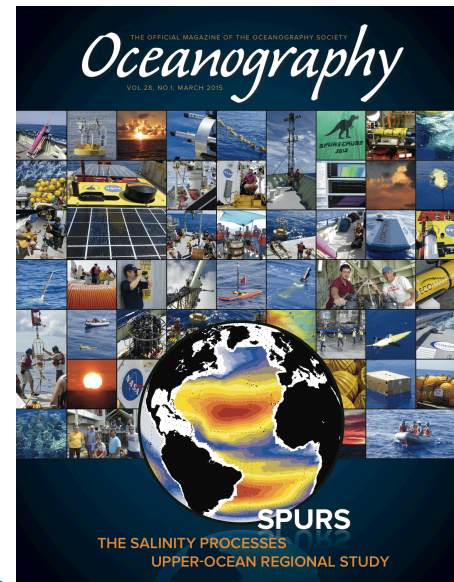
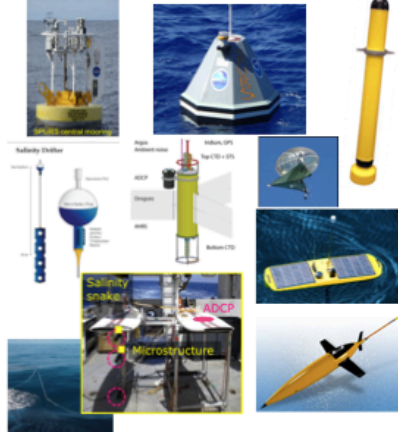


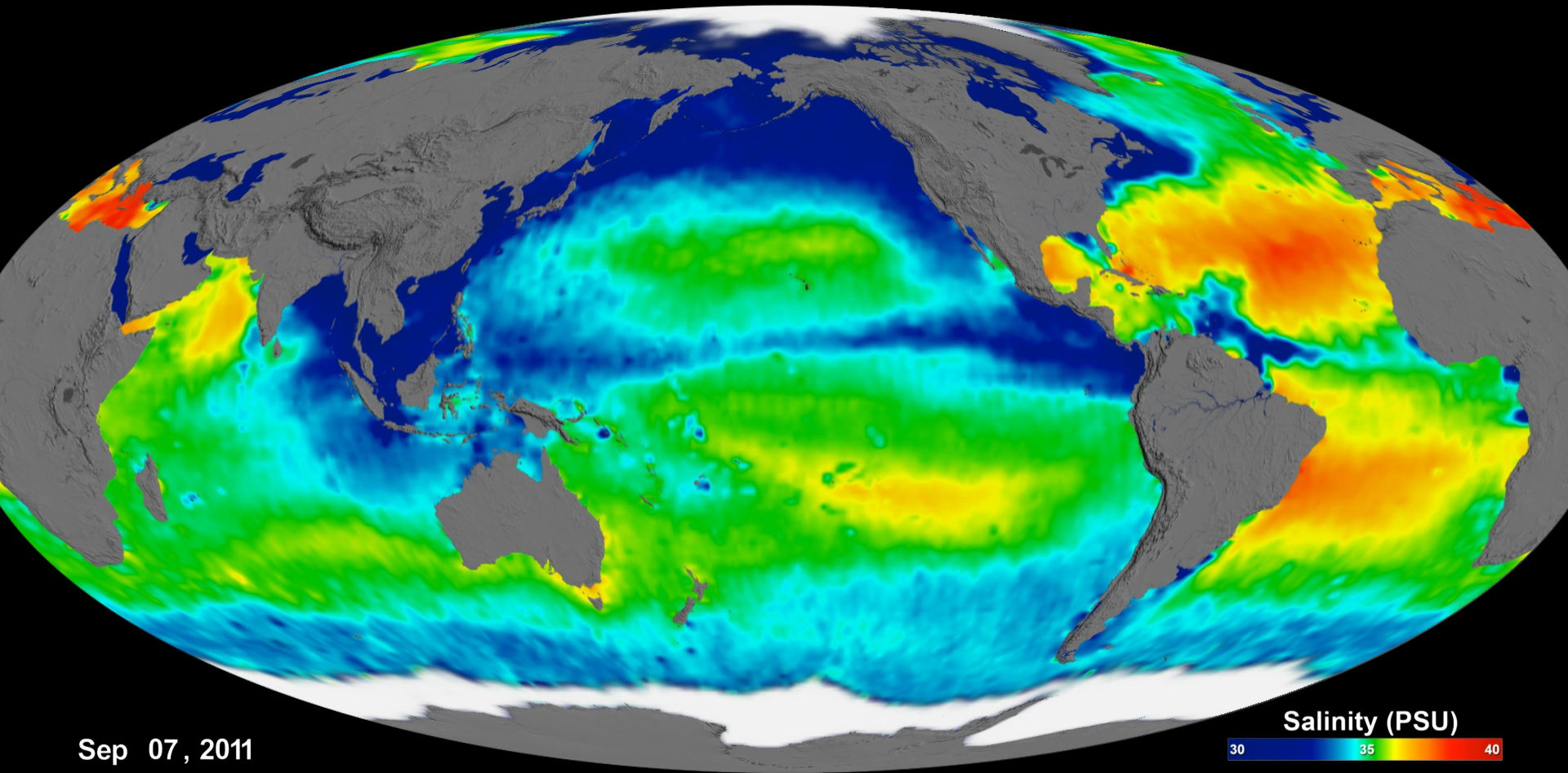
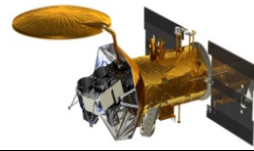
2016 Cruise Plan

Summer/Fall Rainy Season Cruise
 Depart Honolulu: 12 Aug
 Arrive 10 N, 125 W: 19 Aug
 26 Science days
 Depart site: 14 Sep
 Arrive Honolulu: 22 Sep

Activity

- Installation of 3 moorings
- Deployment of Lagrangian assets
 - Seagliders
 - Wavegliders
 - Mixed Layer Floats
 - Drifters
- Hydrographic Survey
- Ship-based sampling of rain events
 - Surface Fluxes
 - Near-surface salinity and turbulence
 - Balloon-based IR camera





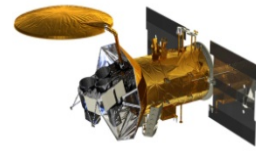
Sep 07, 2011

Salinity (PSU)

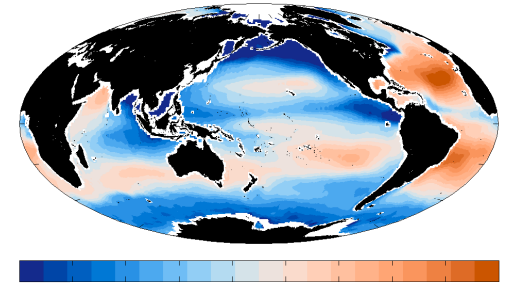
30 35 40



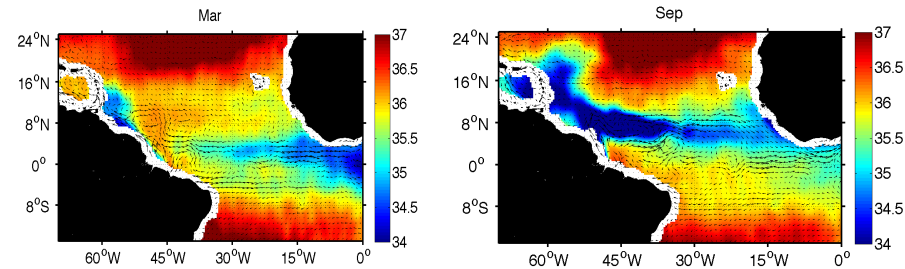
Three Main Measurement Objectives Achieved



1. Global Mean Sea Surface Salinity (SSS)

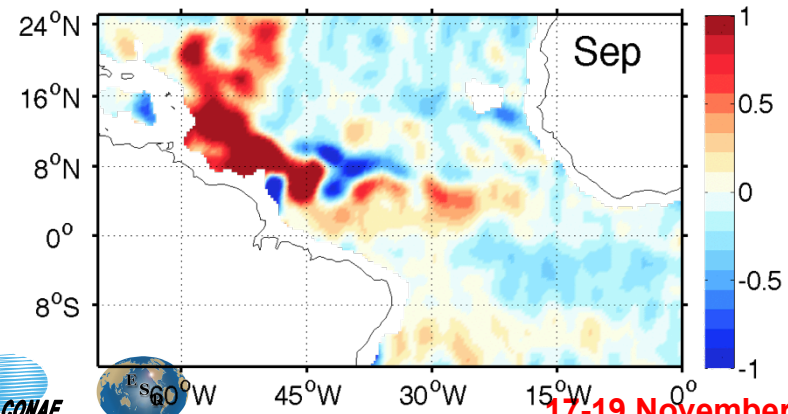


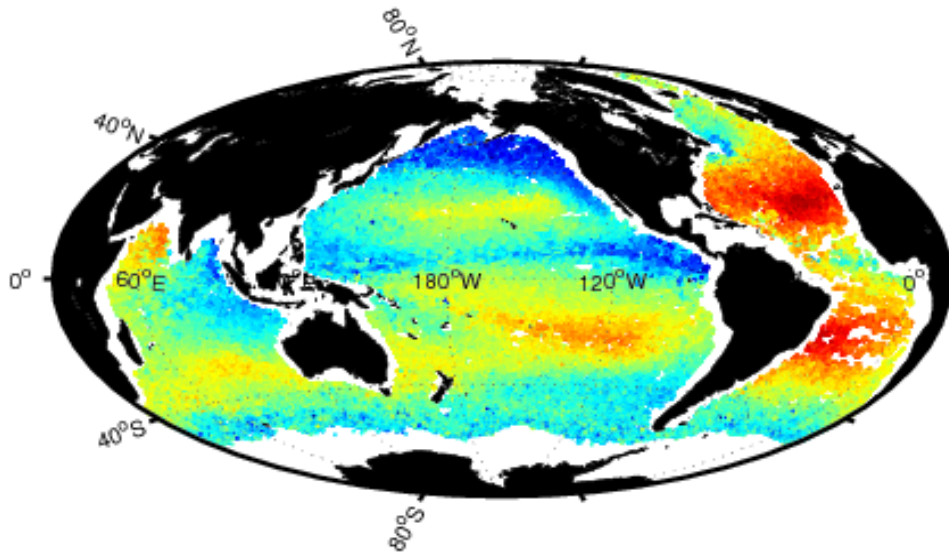
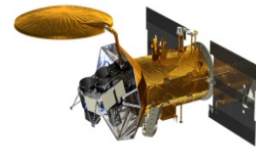
2. Seasonal Cycle



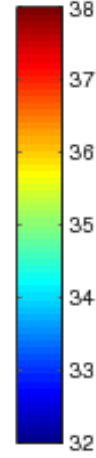
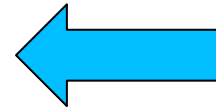
3. Interannual Variations

Monthly Year 2 – Year 1 Difference SSS

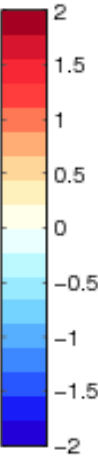
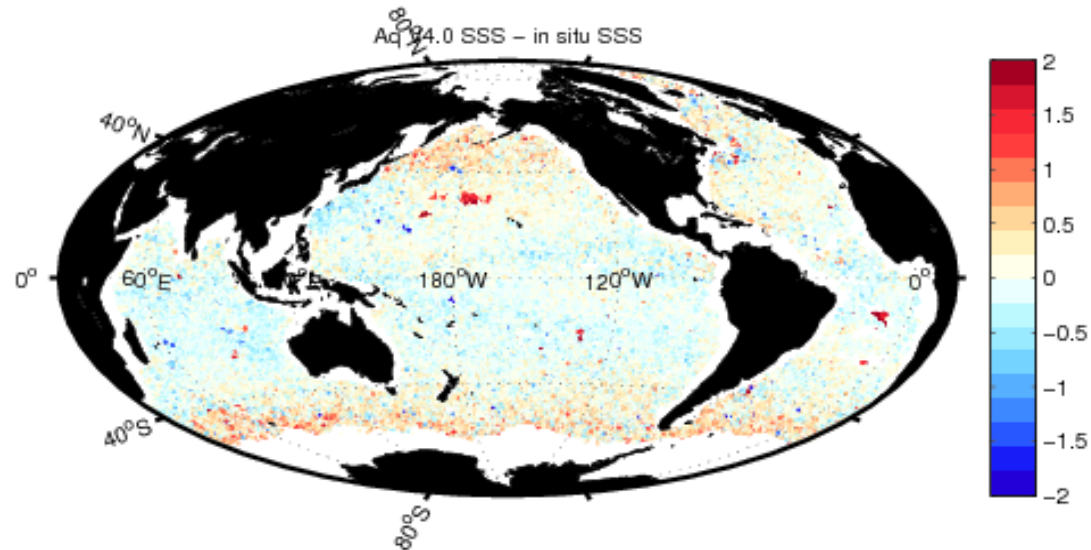


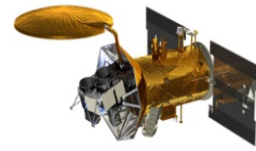


Map of Aquarius V4.0 SSS at *in situ* co-locations.

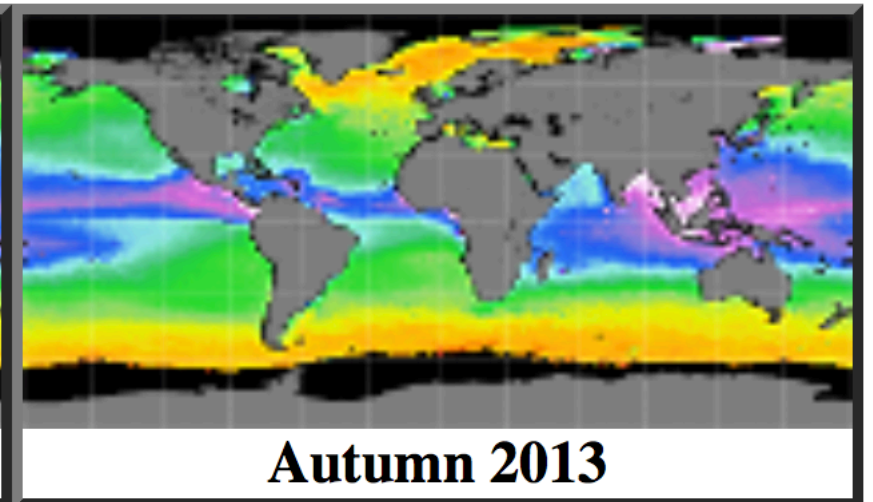
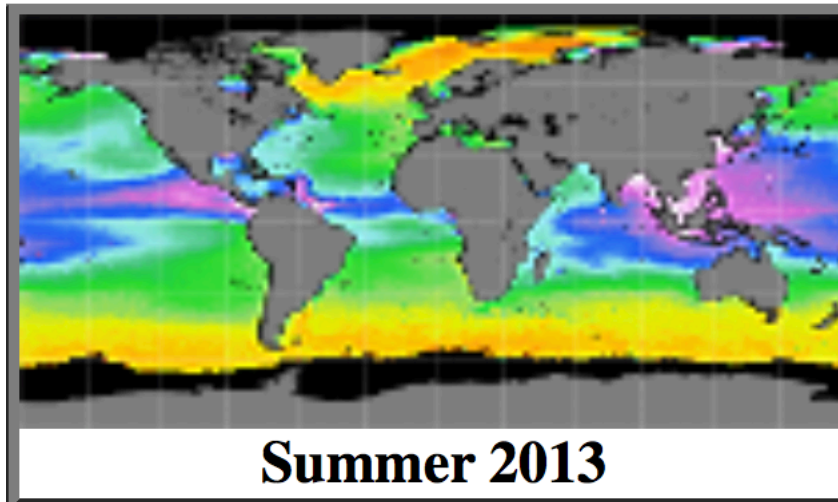
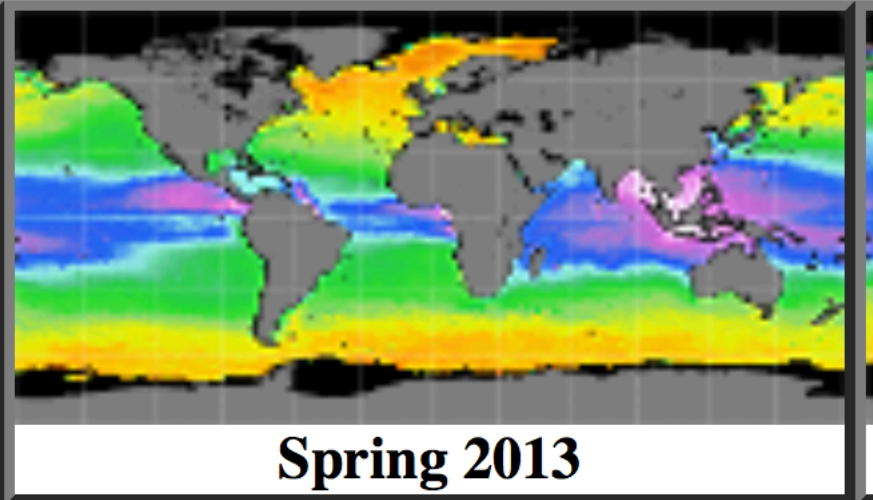
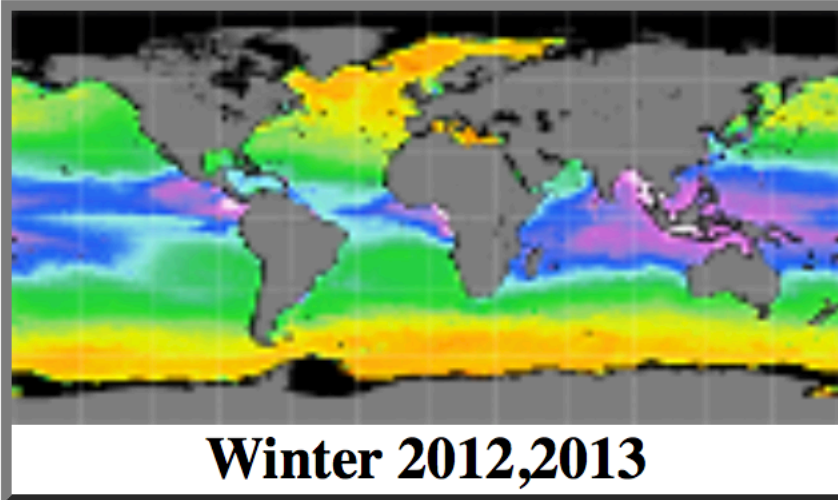


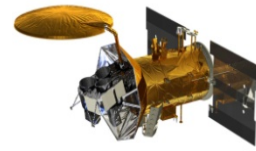
Map of Aquarius V4.0 and *in situ* SSS Differences



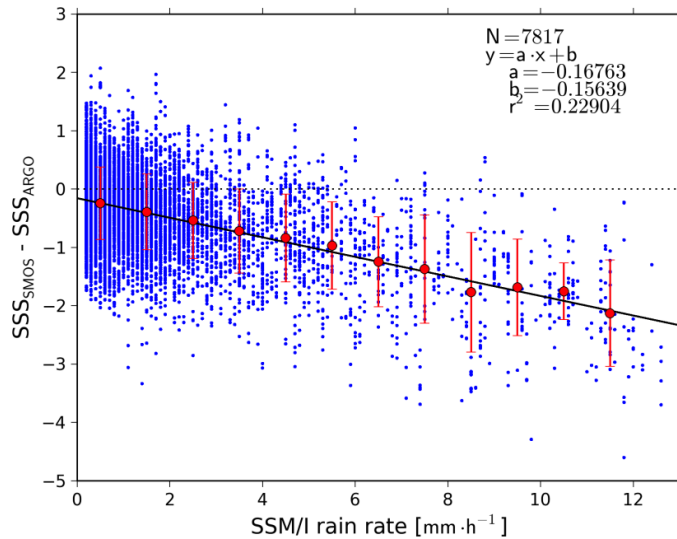


Density Seasonal Maps for 2013;



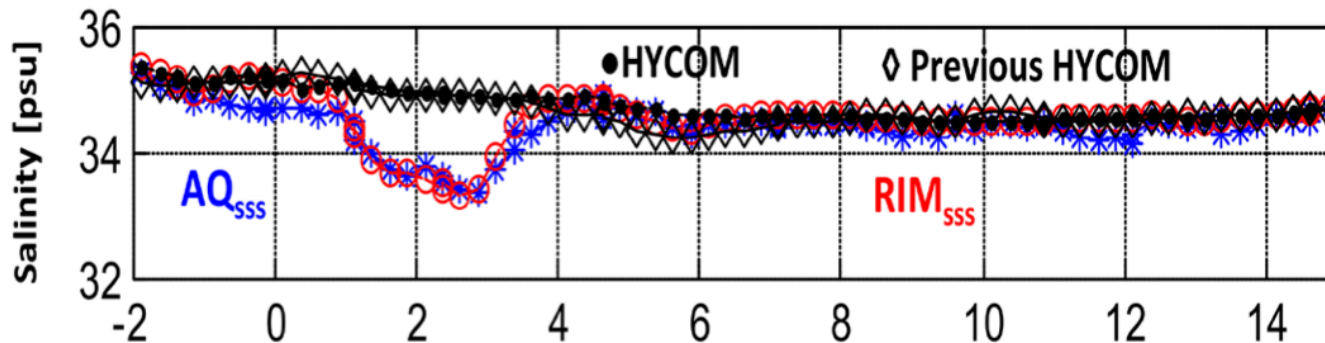


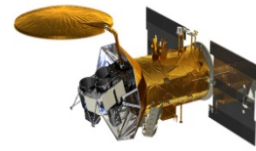
Satellite & In Situ Salinity (SISS) Working Group: Understanding Stratification and Sub-Footprint Processes



-0.18 pss/ mm/hr
r = -0.5

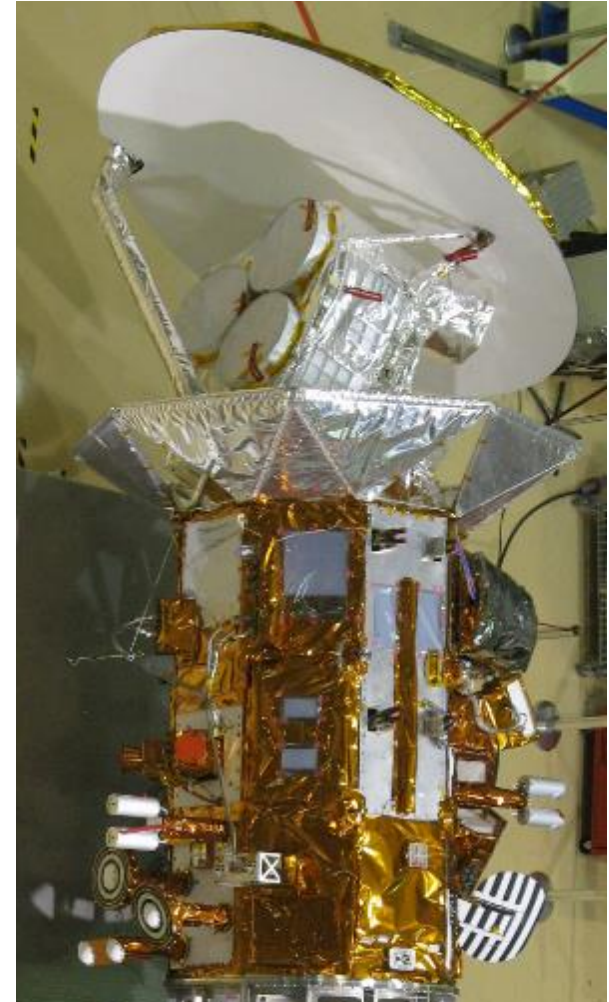
From J. Boutin, et al,
Ocean Sciences 2014
Meeting, Honolulu

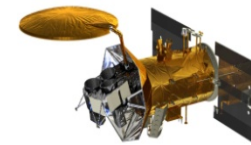




Aquarius: Special Features Lead to New Applications

- **Special Feature**
 - Avoid Sun: Fly on terminator; look toward night side
 - Third Stokes parameter: Correct for Faraday Rotation
 - Include radar: Correct for waves (roughness)
 - Average to reduce noise: High accuracy
 - Rapid sampling: Avoid RFI
 - Stability: On always: (i.e. Over land, ocean, ice)
- **New Applications**
 - Soil moisture maps over land (exceptional accuracy)
 - Maps of sea ice thickness
 - Understanding of ionosphere (TEC)
 - Radiometer-Radar synergy
 - Effect of topography
 - Improved resolution



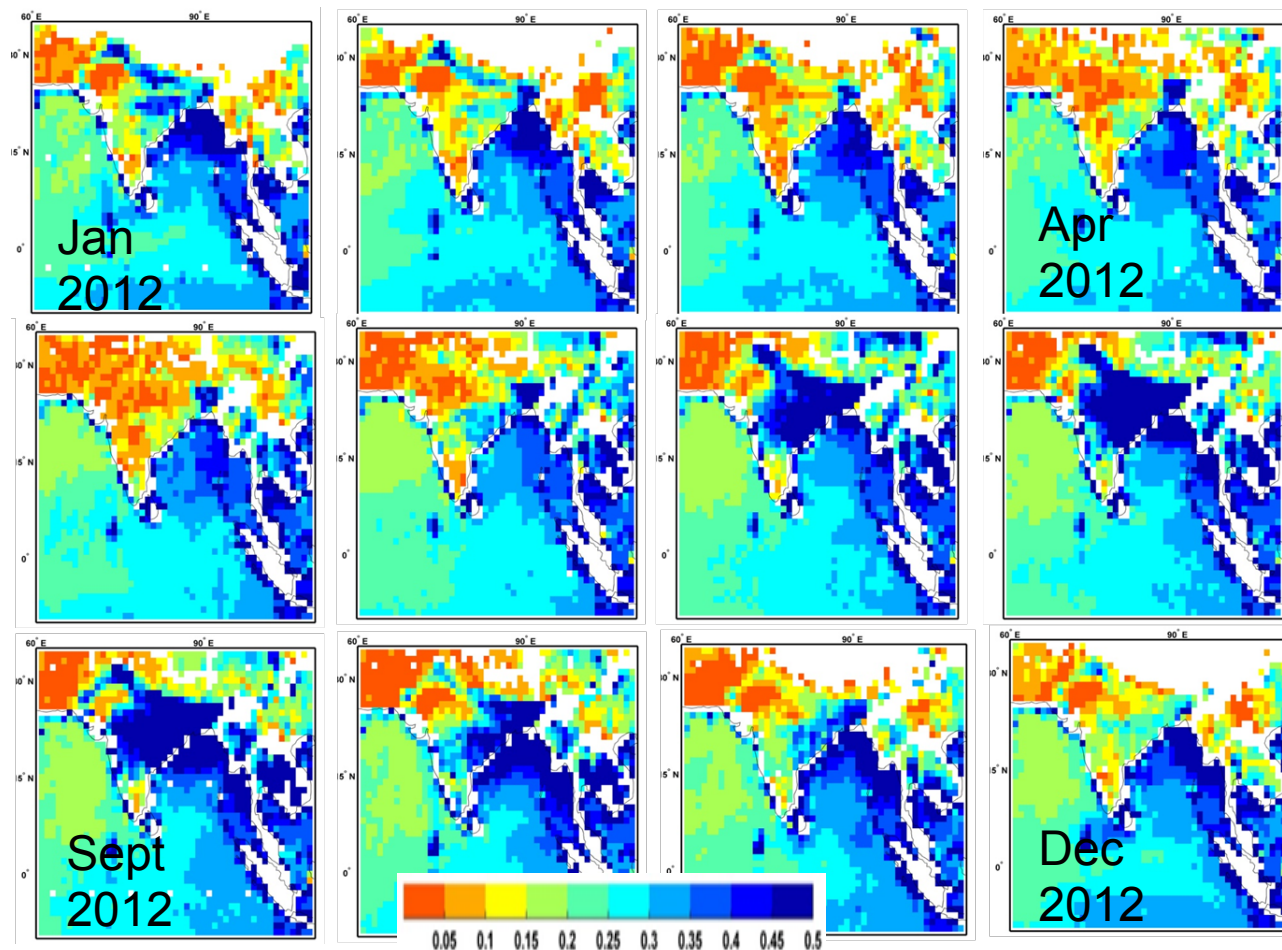


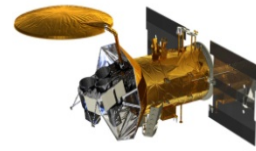
Example

Combined Soil Moisture and Ocean Salinity

- Aquarius always on (i.e. data over land)
- Permits retrieval of soil moisture & salinity
- Combination may yield new information
 - Increase in soil moisture
 - Precedes freshening of Bay water
 - Effect of river outflow?

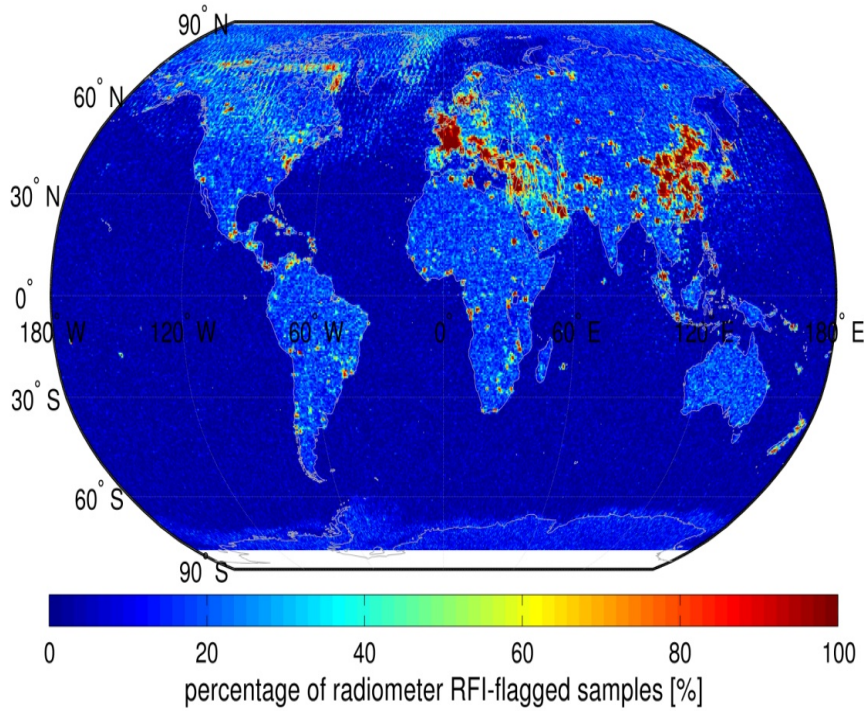
Rajat Bindlish
USDA/ARS



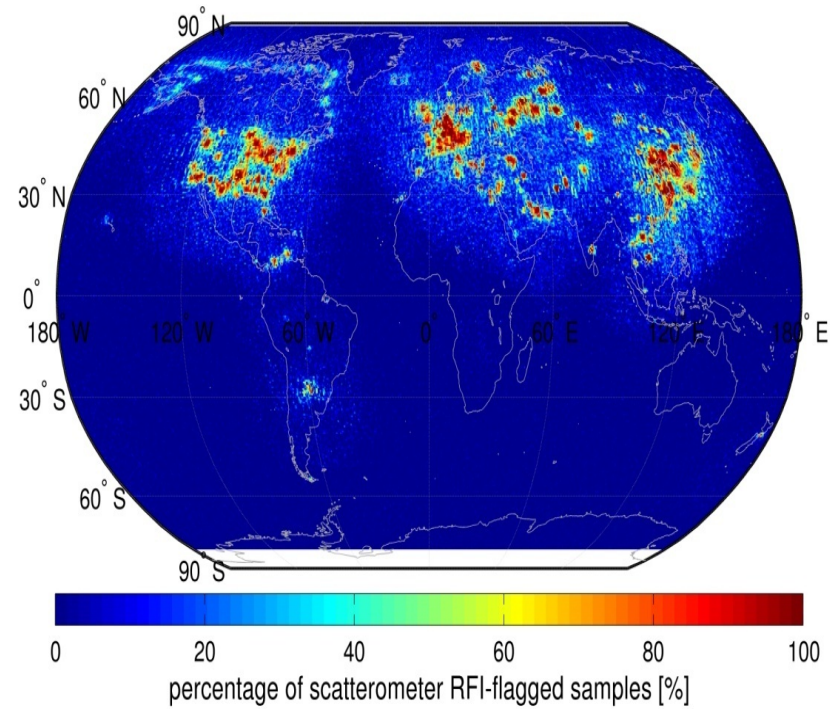


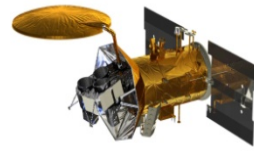
Rapid Sampling Permits Understanding of Radio Frequency Interference (RFI)

Radiometer

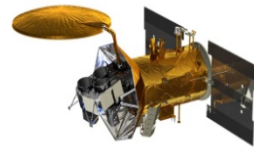


Scatterometer





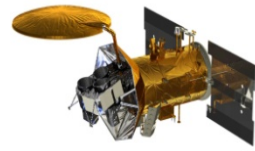
Extra and backup material



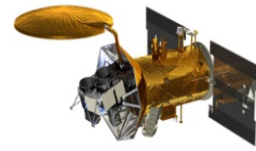
1. Science Accomplishments Summary

- a. All Level 1 Science and Data requirements have been met.
- b. More than 190 science publications are listed on the Aquarius website [publications page](#).*
- c. This includes 40 Papers Published in JGR Special Section.
- d. Details of specific key science results are documented in the End of Prime Mission (EOPM) review (January 2015) and the Aquarius Senior Review 2015 mission extension proposal (March-April 2015).

* http://aquarius.umaine.edu/cgi/sci_publications.htm



1. Aquarius was NASA's first mission dedicated to measuring ocean surface salinity, and demonstrated both technical feasibility and scientific merit.
2. The overarching science goal is to understand the links between ocean circulation, the water cycle and climate.
3. Of the three L-band satellite sensors (SMOS, Aquarius and SMAP), Aquarius provided the most accurate measurements over the ocean. First Passive-Active L-band sensor in space.

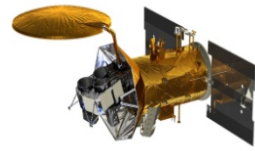


4. Secondary data sets:

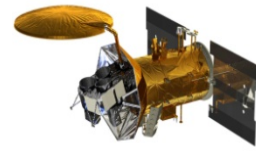
- Soil Moisture (Passive-Active)
- Sea Ice thickness
- Seawater density and spice (from SSS and SST)

5. Ocean and climate modeling and prediction

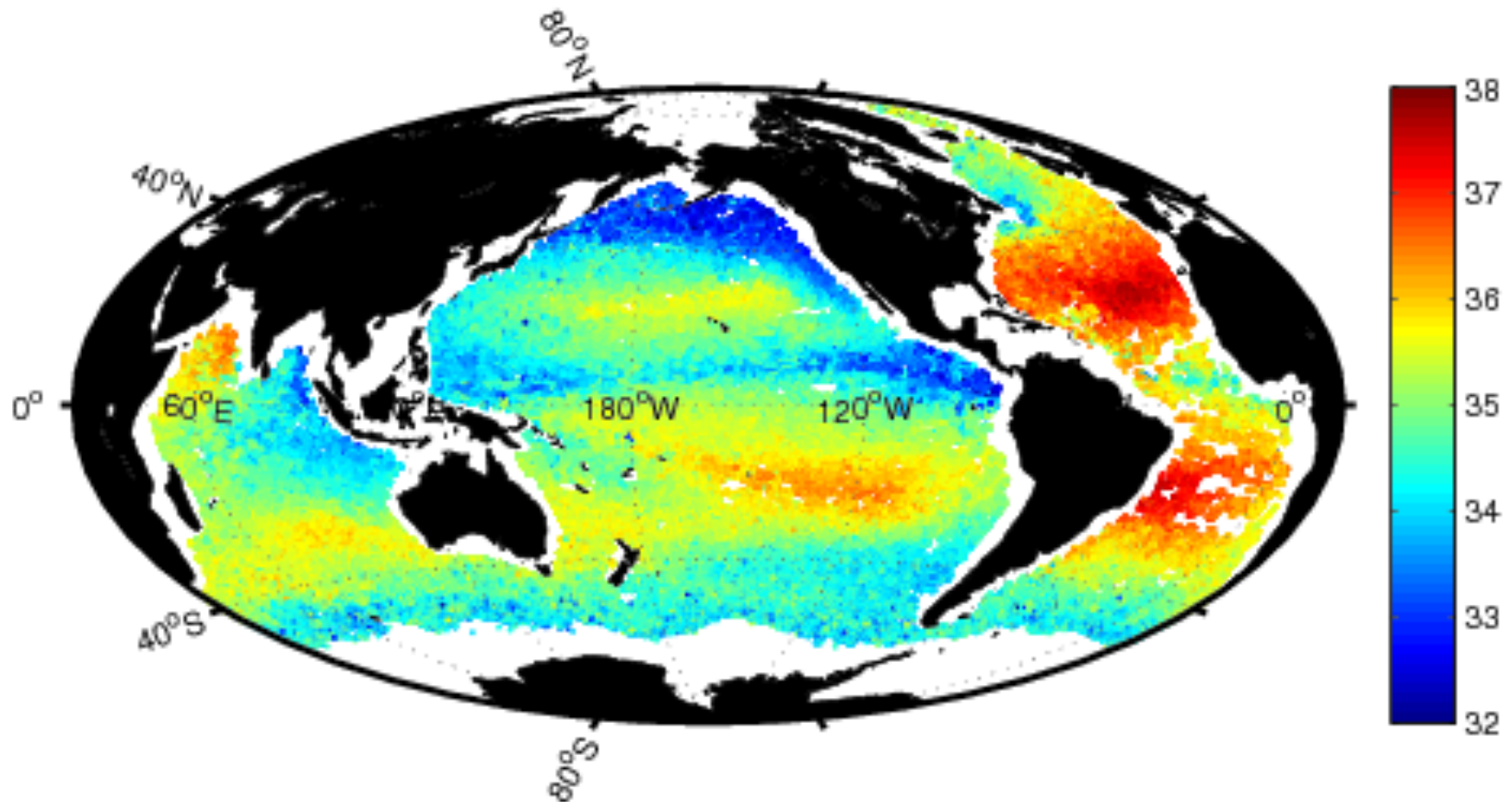
- Measureable improvements for long-lead tropical SST prediction skill
- Ocean data assimilation
- Air-sea fluxes

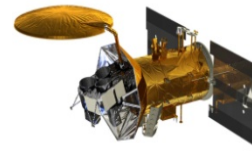


6. The Aquarius data set will stand as a reference baseline for satellite salinity measurement continuity and climate data record using other satellites (SMAP, SMOS).
- Emphasis here on the Phase F V5.0 data revision effort is to provide the best quality data record that we can do with our current understanding of the calibration and geophysical models.
 - Understandings will improve with time, allowing for future upgrades after Phase F.
 - NASA measurement continuity is underway with SMAP salinity project.

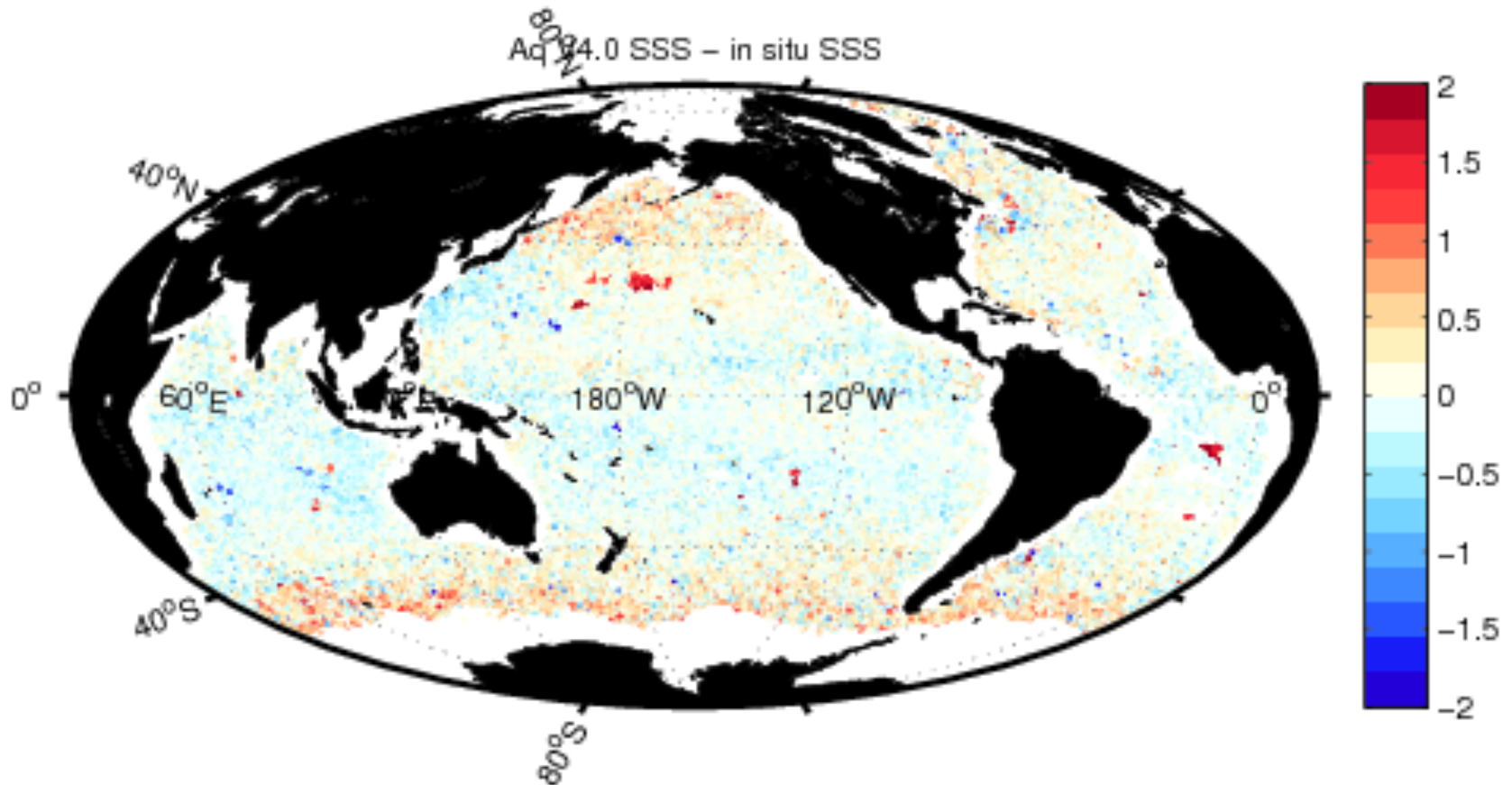


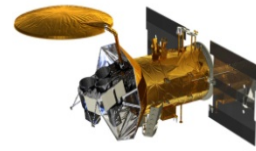
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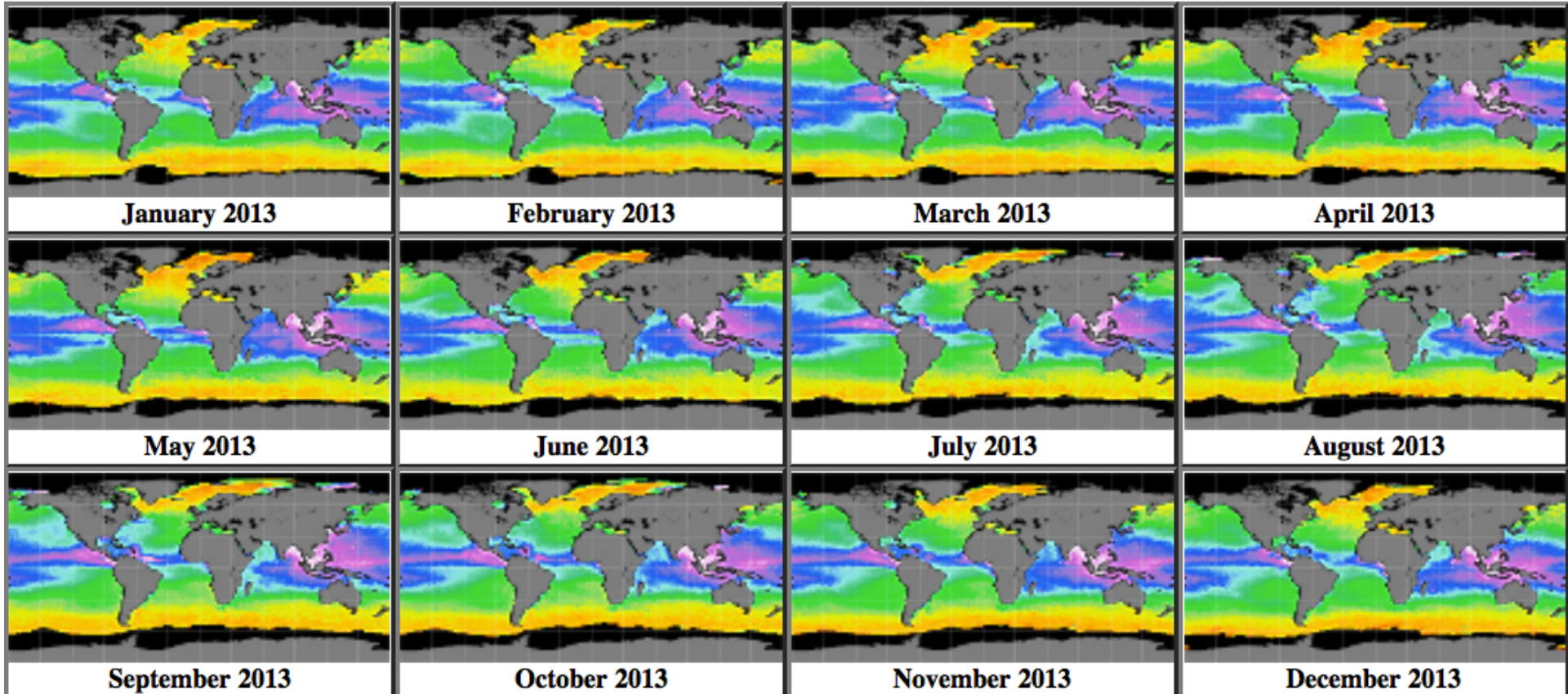
Map of Aquarius V4.0 and *in situ* SSS Differences





V4.0 Includes Density [TEOS-10] (and Spice in V5.0)

Density example for 2013;



AQUARIUS/SAC-D

