

# Validation of Aquarius Sea Surface Salinity Data with In Situ Measurements from the SPURS Field Experiment

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Data provided by:

Tom Farrar (WHOI Mooring)

Dave Fratantoni and Ben Hodges (WHOI Wave Gliders)

Luca Centurioni (SIO/UCSD Drifters)

Thanks to:

SPURS Data Management: Frederick Bingham (UNCW)

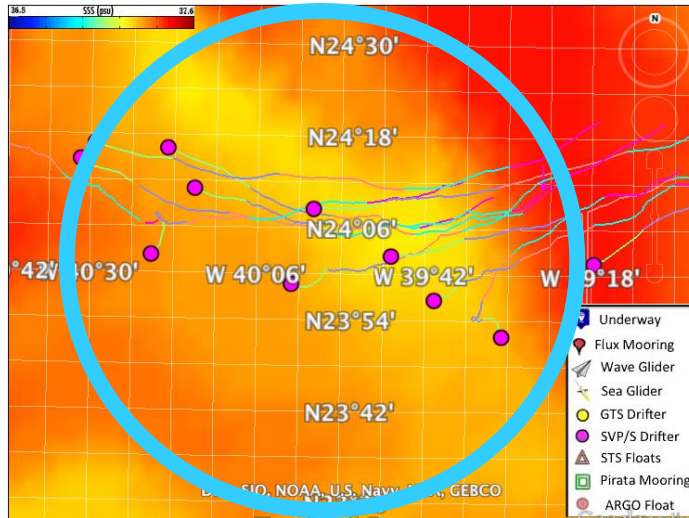
Aquarius Project, JPL PODAAC, SPURS Science Teams

# Challenges in Aquarius Validation

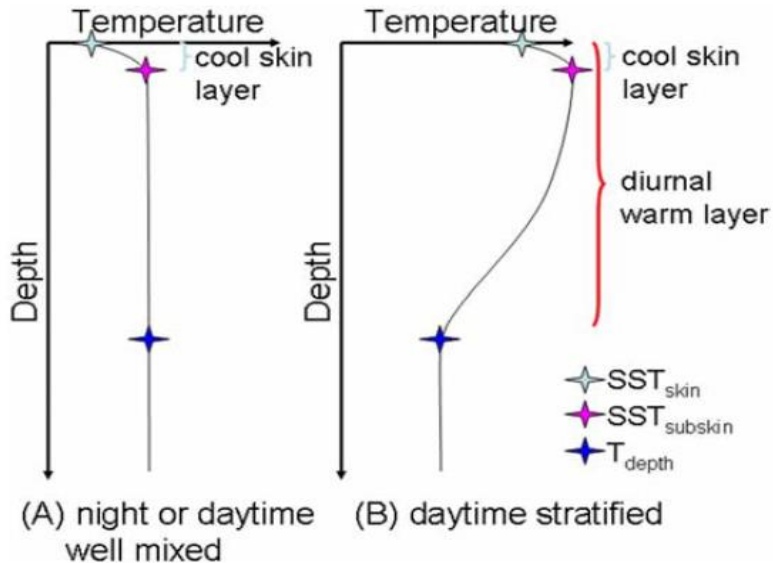


In Situ Platforms

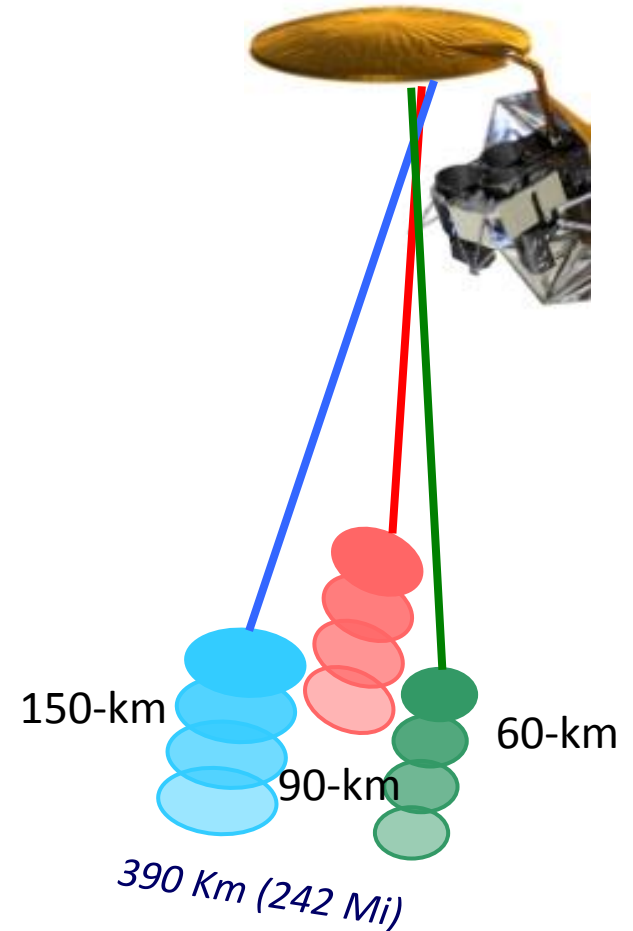
Satellite



Point measurement



Vertical stratification



weekly

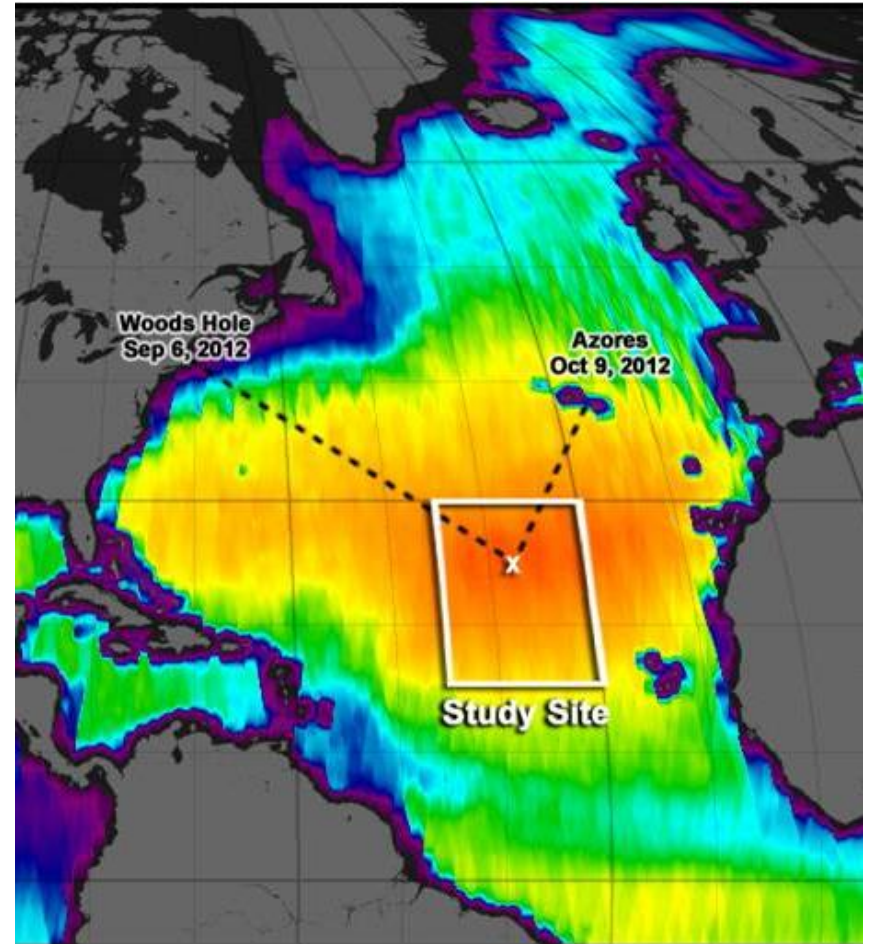
# Questions to be addressed

- What is the Aquarius retrieved data error in the SPURS region?
- What is the ground-truth salinity over 150-km & week?
  - Vertical stratification between the surface skin layer (~ 1 cm) and the near surface layer (~10 m)
  - Variability within the Aquarius footprint (150-km)
  - Variability within the weekly (Aquarius repeat time) time scale?

# Salinity Processes in the Upper Ocean Regional Study (SPURS)

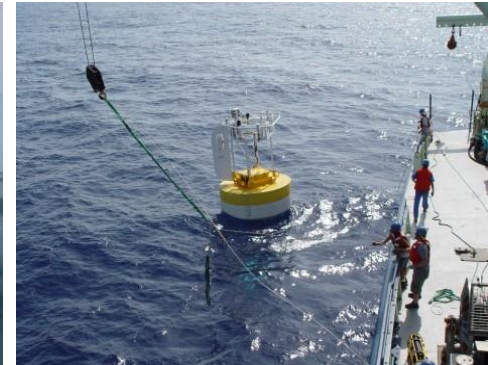
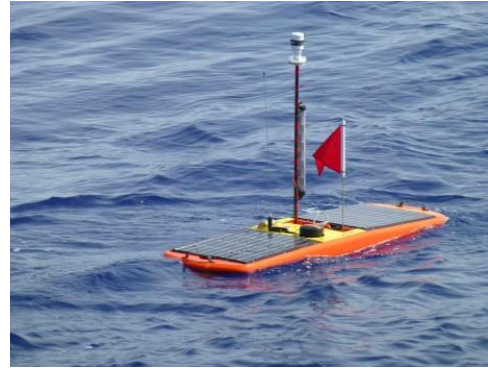
Five (5) cruises during  
September 2012 – October  
2013

1. Thalassa/Frence-2012 (8/16 - 9/13)
2. Knorr/US-2012 (9/6 – 10/9)
3. Sarmiento/Spain-2013 (3/14 – 4/20)
4. Endeavour/US-2013spring (3/14 – 4/14)
5. Endeavour/US Cruise-2013fall (9/19-10/10)



# SPURS Salinity Measurements from Surface to 10 meters Depth

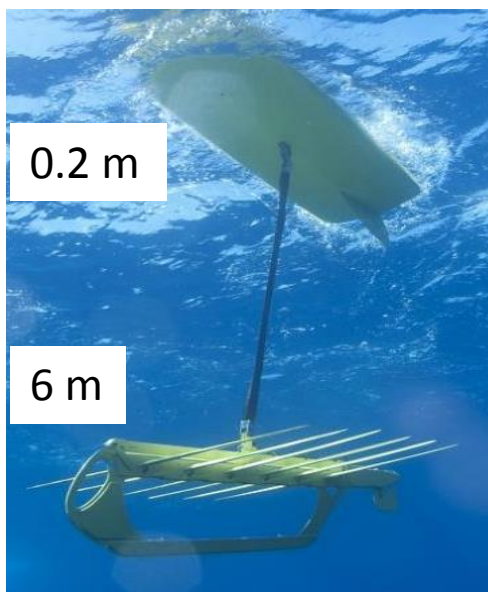
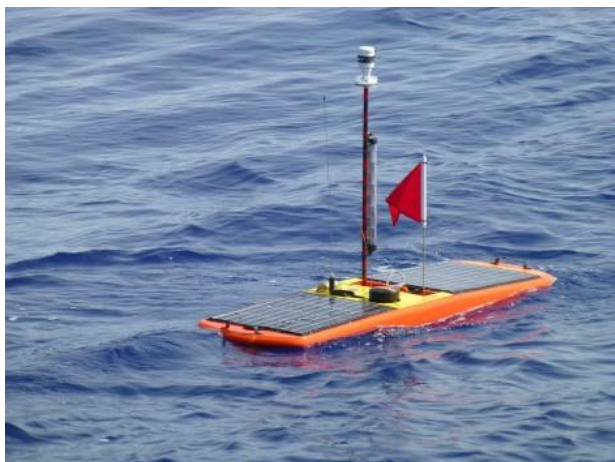
- Waveglider-1: 0.2
- Drifter: 0.5
- WHOI Mooring: 0.75 (2)  
2.1  
5.2  
8.0
- Waveglider-2: 6
- STS Float: 0-3  
3-10
- Seaglider: 0-10



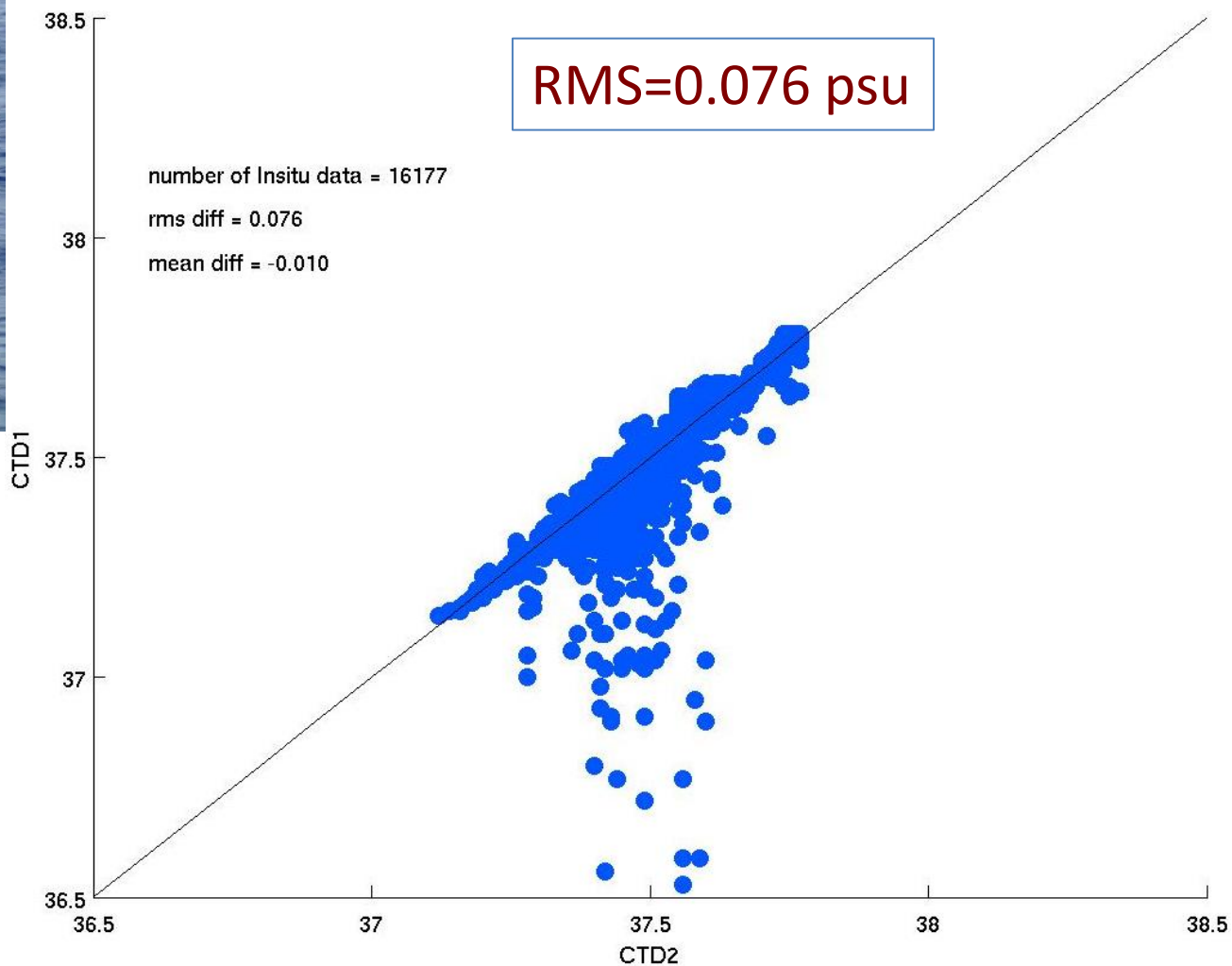
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# Vertical Stratification: Wave Glider CTD-1(0.2m) vs. CTD-2 (6m)



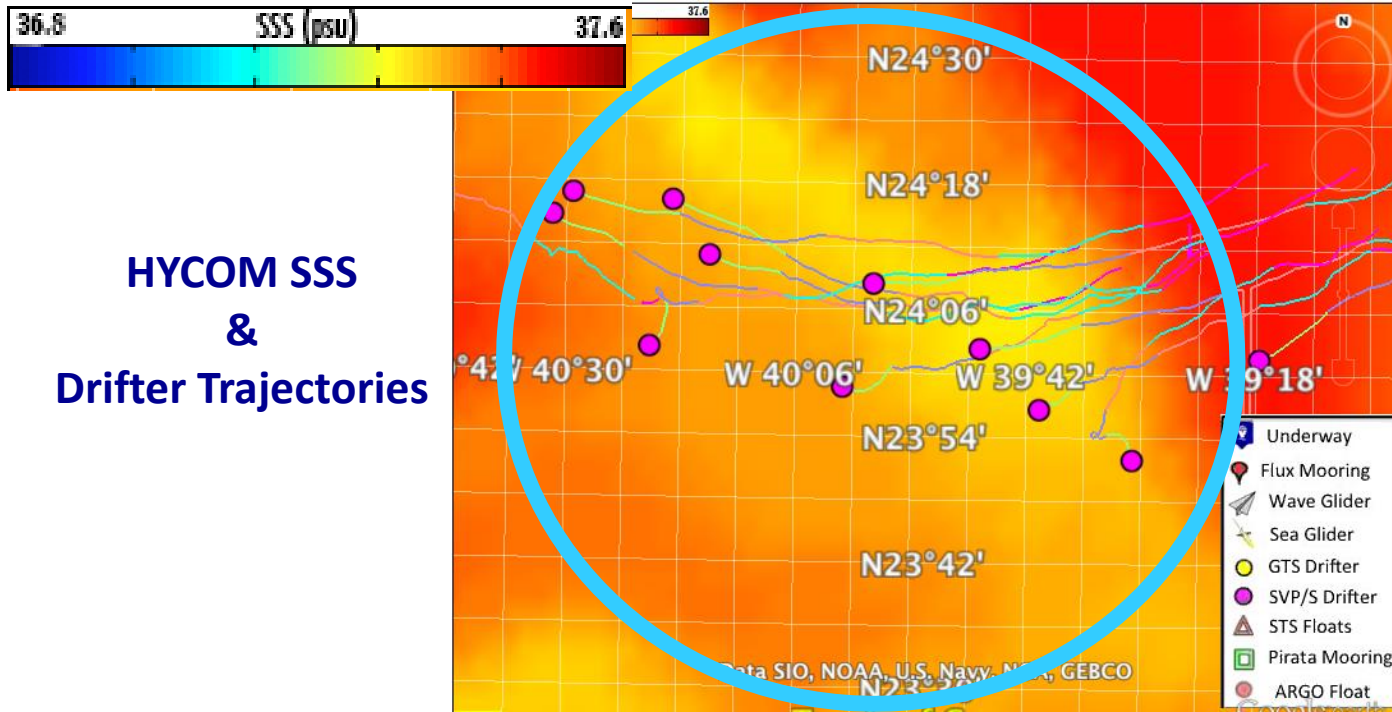
Wave Glider



# Questions to be addressed

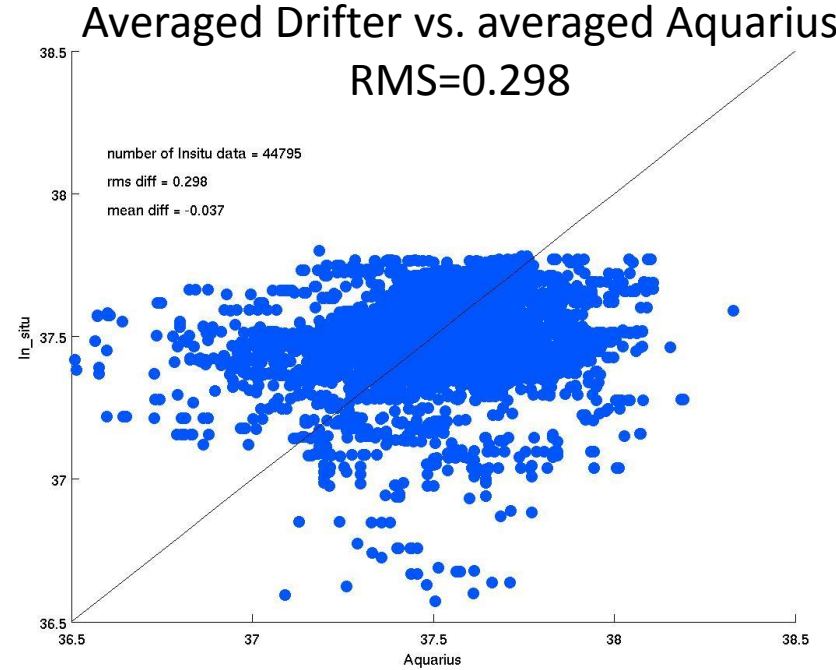
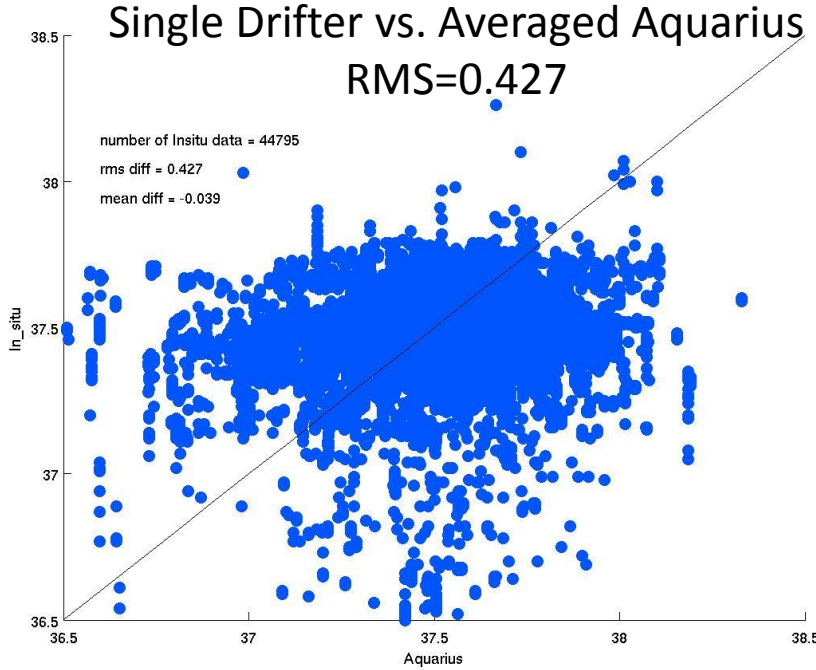
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**HYCOM SSS  
&  
Drifter Trajectories**

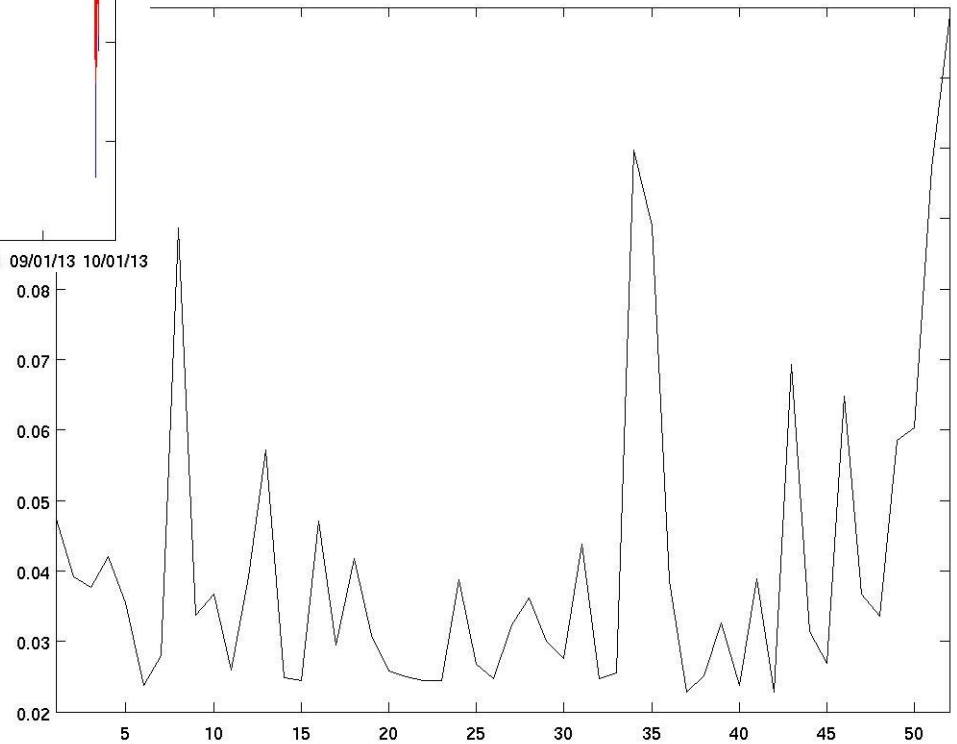
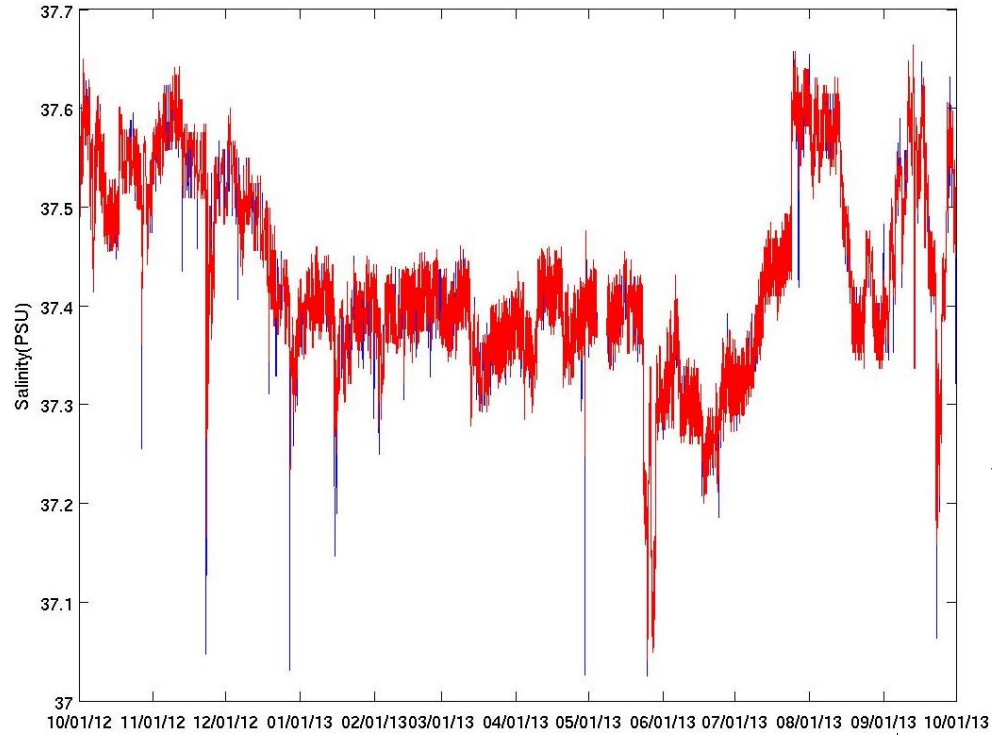
**Conclusion:  
Averaging single-  
point data  
significantly  
improves the  
agreement with  
Aquarius  
(averaged) data**



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# Sub-weekly variations from WHOI mooring

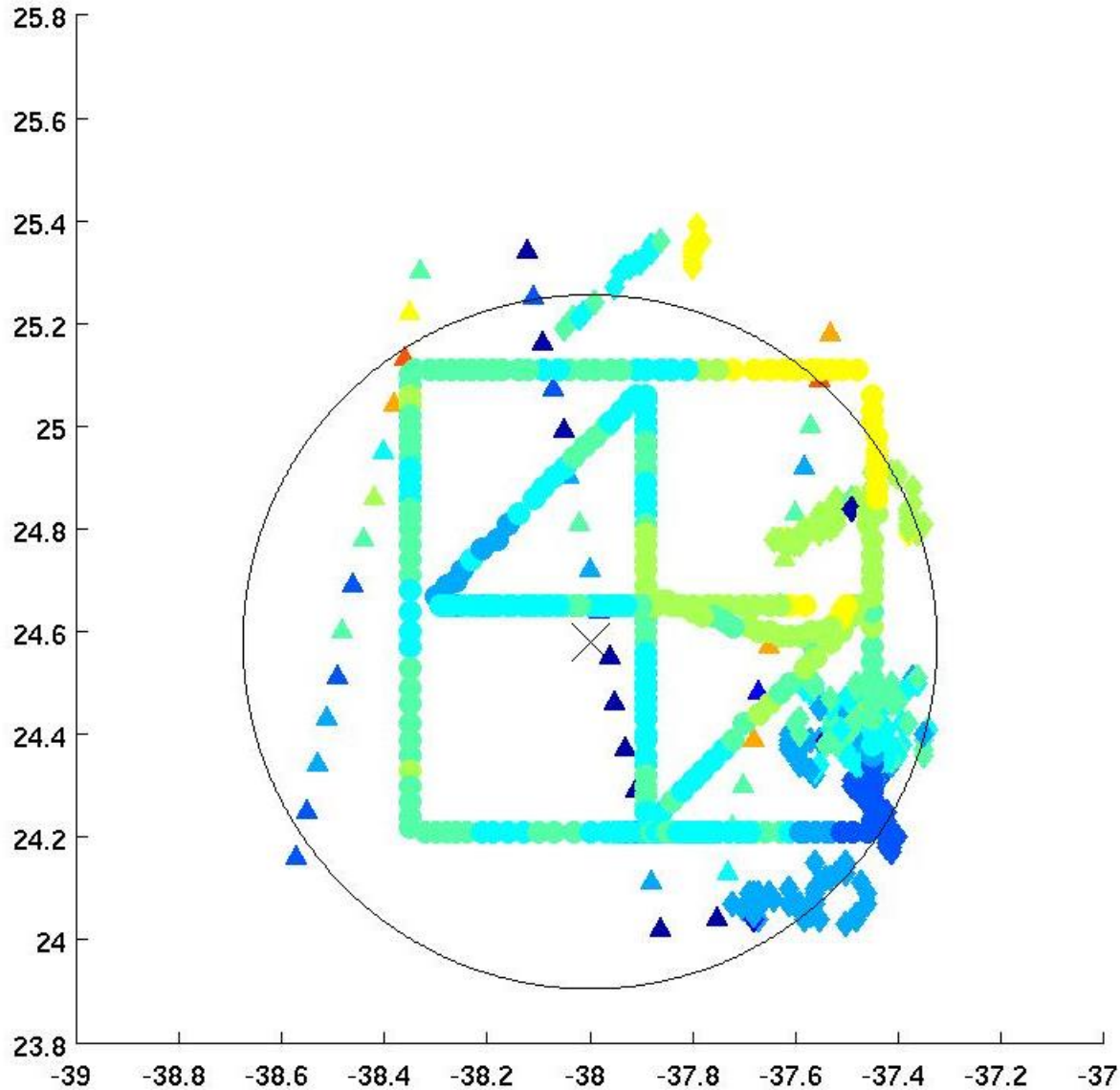


# Questions to be addressed

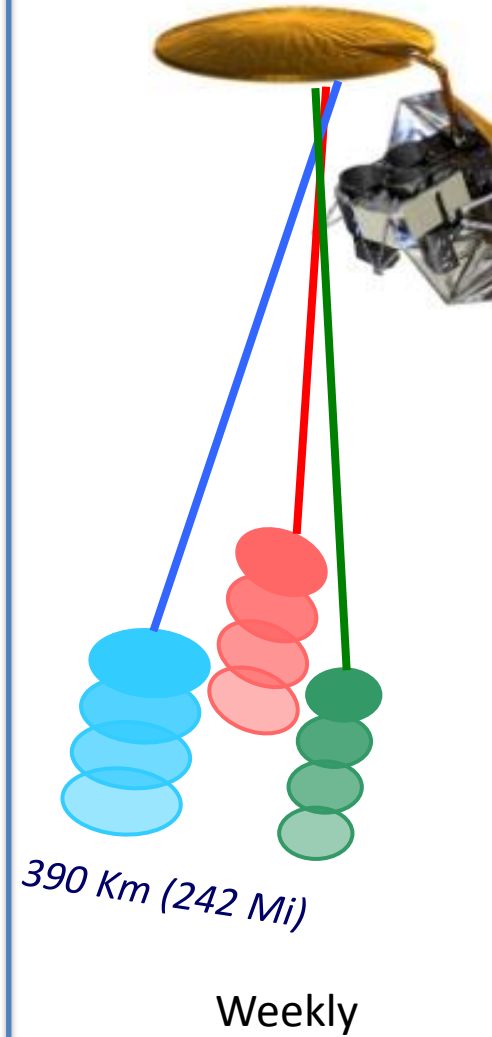
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# SPURS In Situ Measurements

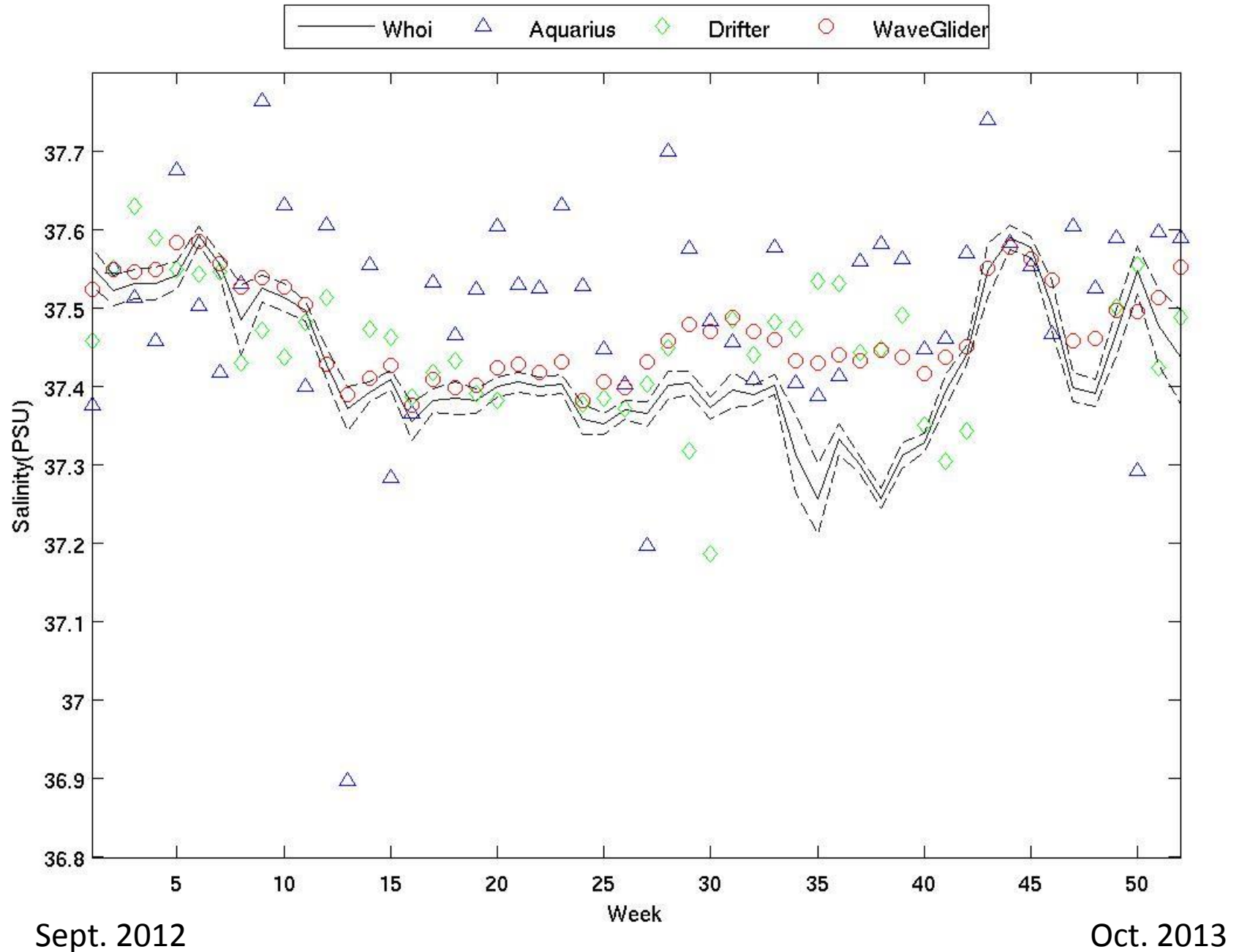
× Whoi    ▲ Aquarius    ◆ Drifter    ● WaveGlider



# Aquarius



# Aquarius & SPURS In Situ SSS (150-km, weekly)



RMS (psu)

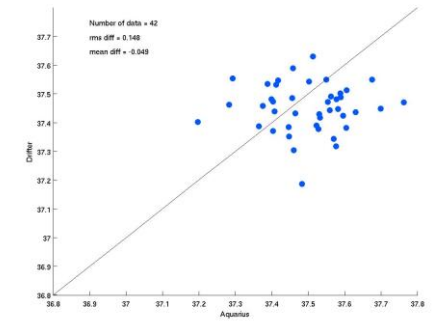
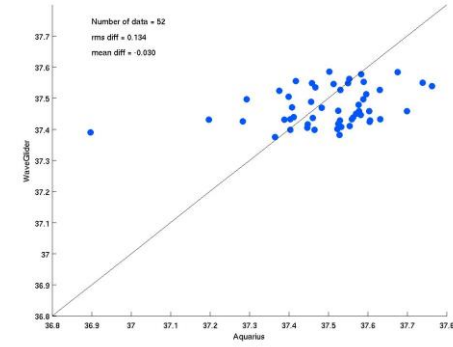
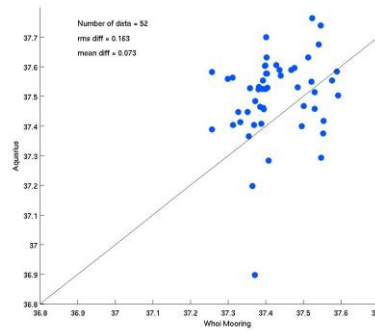
Aquarius

WHOI Mooring

Wave Glider

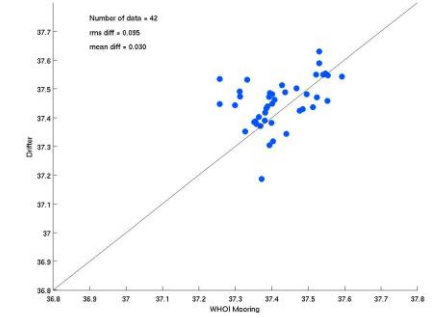
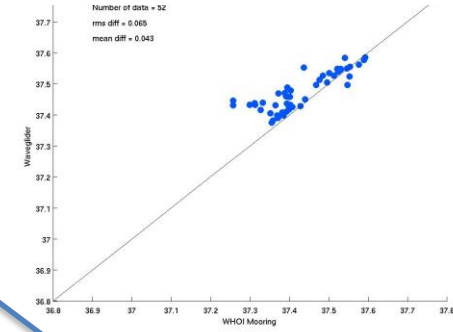
Drifter

Aquarius



WHOI Mooring

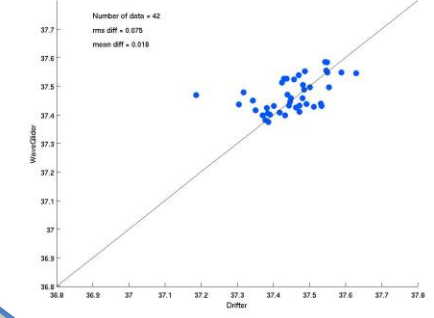
0.163



Wave Glider

0.134

0.065



Drifter

0.148

0.095

0.075

# Triple-Point Analysis

**Formulation:**

$$S_A = S \pm e_A$$

$$S_1 = S \pm e_1$$

$$S_2 = S \pm e_2$$

**If  $e_A$  and  $e_1$  are uncorrelated, then**

$$\langle \Delta S_{A-1}^2 \rangle = \langle e_A^2 \rangle + \langle e_1^2 \rangle$$

$$\langle \Delta S_{A-2}^2 \rangle = \langle e_A^2 \rangle + \langle e_2^2 \rangle$$

$$\langle \Delta S_{1-2}^2 \rangle = \langle e_1^2 \rangle + \langle e_2^2 \rangle$$

**Solving above equations, then**

$$\langle e_A^2 \rangle = \{ \langle \Delta S_{A-1}^2 \rangle + \langle \Delta S_{A-2}^2 \rangle - \langle \Delta S_{1-2}^2 \rangle \} / 2$$



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**Aquarius Data Retrieval Error (psu):**

*[Aquarius, Drifter, Wave Glider]*

0.13

*[Aquarius, WHOI Mooring, Wave Glider]*

0.14

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0.14

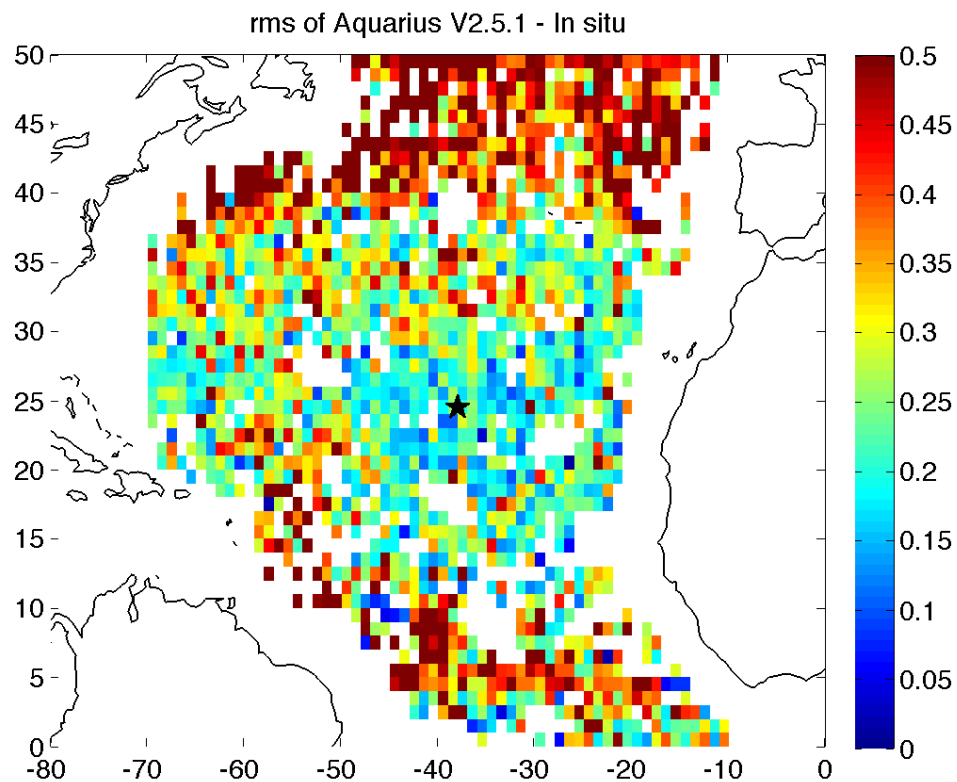
Errors for drifter, mooring and wave glider are 0.072, 0.062, & 0.02 psu, respectively

# Aquarius meets the accuracy requirement in the SPURS region!

Aquarius retrieved weekly data error is 0.13-0.14 psu near 25°N/38°W, & is smaller than the monthly allocation of 0.16 psu at this latitude.

Latitude Range	Mean Sensitivity (dT <sub>s</sub> /dS)	Mean # Samples in 28 Days	Baseline Mission Monthly Salinity Error (psu)	
			Allocation	CBE
0-10	0.756	10.9	0.15	0.11
11-20	0.731	11.3	0.16	0.11
21-30	0.671	12.1	0.16	0.12
31-40	0.567	13.5	0.18	0.13
41-50	0.455	15.9	0.21	0.15
51-60	0.357	20.3	0.24	0.17
61-70	0.271	30.2	0.26	0.18
Global RMS (psu)			0.20	0.14

(Lagerloef et al., 2008)



RMS=0.25 psu (from Hsun-Ying Kao) --

# SUMMARY & CONCLUSIONS

- Variability that cannot be resolved by Aquarius and in situ measurements
  - 0.05 to 0.1 psu associated with the vertical stratification (between surface < 1 m and near surface 3-10 m)
  - 0.1 psu associated with sub-footprint (150-km) variations
  - 0.05 psu associated with the sub-weekly fluctuations
- In the SPURS region near 25°N and 38°W, the Aquarius retrieved weekly data error is estimated as 0.13-0.14 psu (smaller than the 0.16 psu allocated for the monthly error), meeting the accuracy requirement!

# FUTURE WORK

- Re-do the analysis with delayed mode data
  - WHOI mooring (redundant sensor at 0.75 m; sensors at 2.1, 5.2, 8.0 meters)
  - UCSD/SIO drifters (CTD sensor drift after 6 months)
- Include data from
  - STS floats (Steve Riser, UW)
  - Seagliders (Craig Lee, UW)
- How can we apply lessons learned from SPURS in the global Aquarius validation?

**Thanks!**

**Questions?**

**Contact Information:**

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