



Estimates of rapid variability in surface salinity and potential for aliasing in Aquarius measurements*

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*Ocean Surface Salinity Science Team Meeting
7th Aquarius/SAC-D Science Meeting
April 2012, Buenos Aires*

***Vinogradova & Ponte (2012) J. Atmos. Oce. Tech.**

- **Rapid SSS variability**

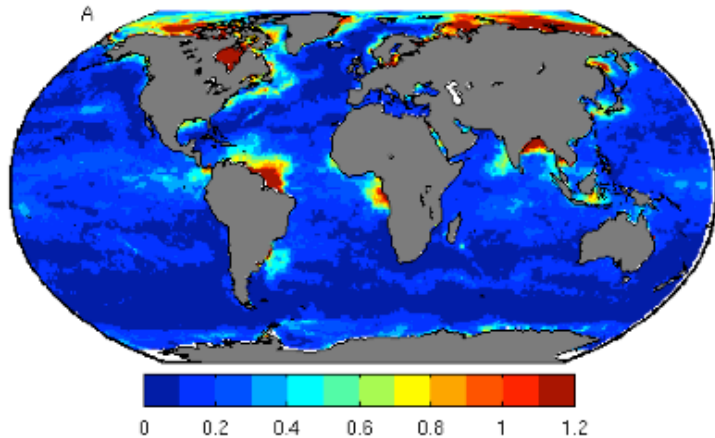
- How much variance expected at high frequency end of the spectrum at ~ 100 km scales?
- How does rapid variability map into monthly Aquarius estimates?
- What are contributions of temporal aliasing to overall error budget?

- **SSS estimates**

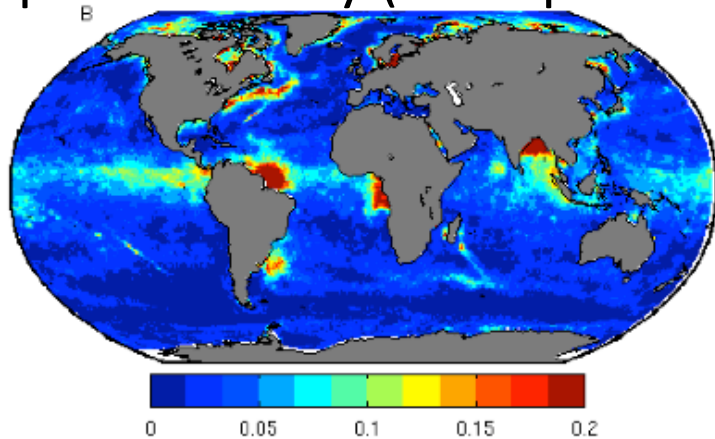
- HYCOM global fields (daily, average over top 3 m, May09-April10, expt_90.8 with data assimilation, $1/12^\circ$ grid)
- TAO, PIRATA and RAMA moorings (hourly, 1 m depth, 2 to 10 years long)

Rapid variability (HYCOM)*

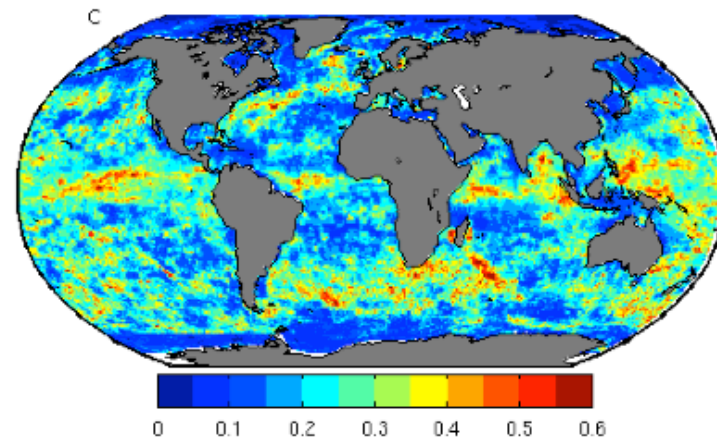
Total variability (all periods)



Rapid variability (<14d periods)



Ratio rapid/total

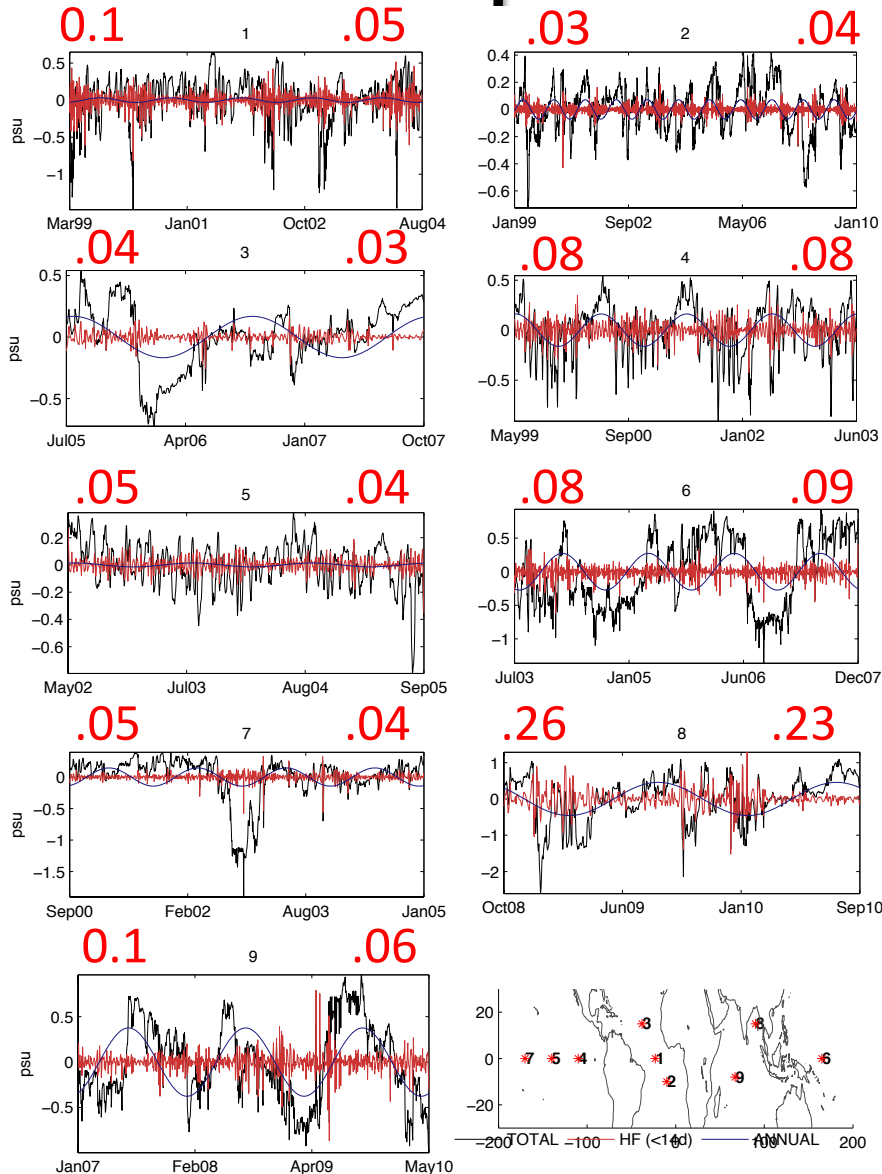


- Average ratio ≈ 0.2 but quite variable in space
- Ratios > 0.5 are seen in many regions

*HYCOM fields averaged over Aquarius L3 1° grids to match spatial resolution



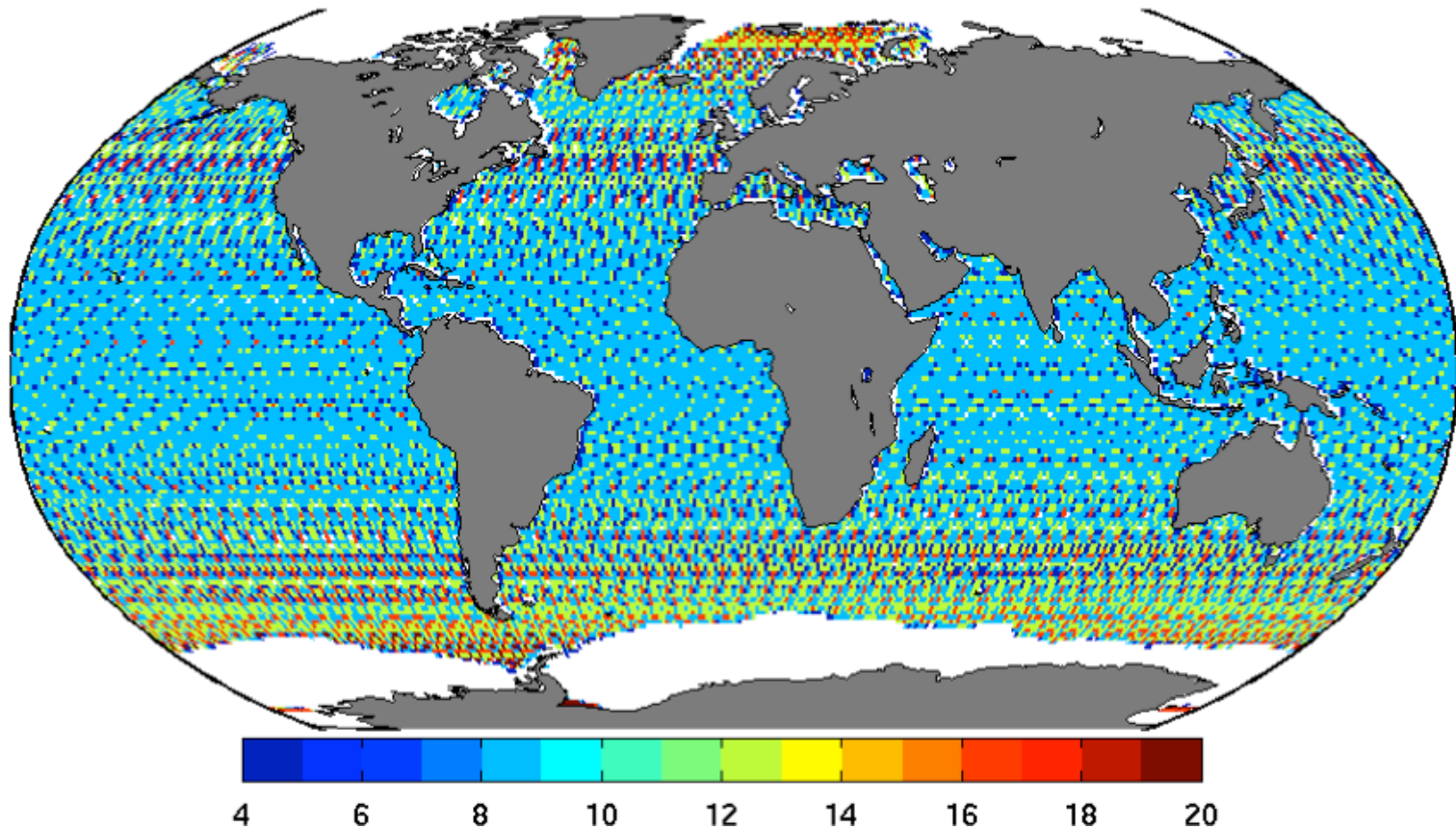
Rapid variability (moorings)*



- Annual cycle (thin black) quite variable and not a dominant component in many sites
- Rapid variability (< 14-day, red) is substantial
- Same order of magnitude in data and HYCOM estimates, but data tends to show larger rapid variability

* Based on daily averages

Aquarius monthly sampling (1°)



- # samples highly variable in both latitude and longitude (from 4/mo in tropics to 28/mo in high latitudes)
- Irregular sampling interval in time (from few hours to few days)

Defining aliasing error

Ability to represent true monthly* means:

Define $\Delta = \hat{S} - S$

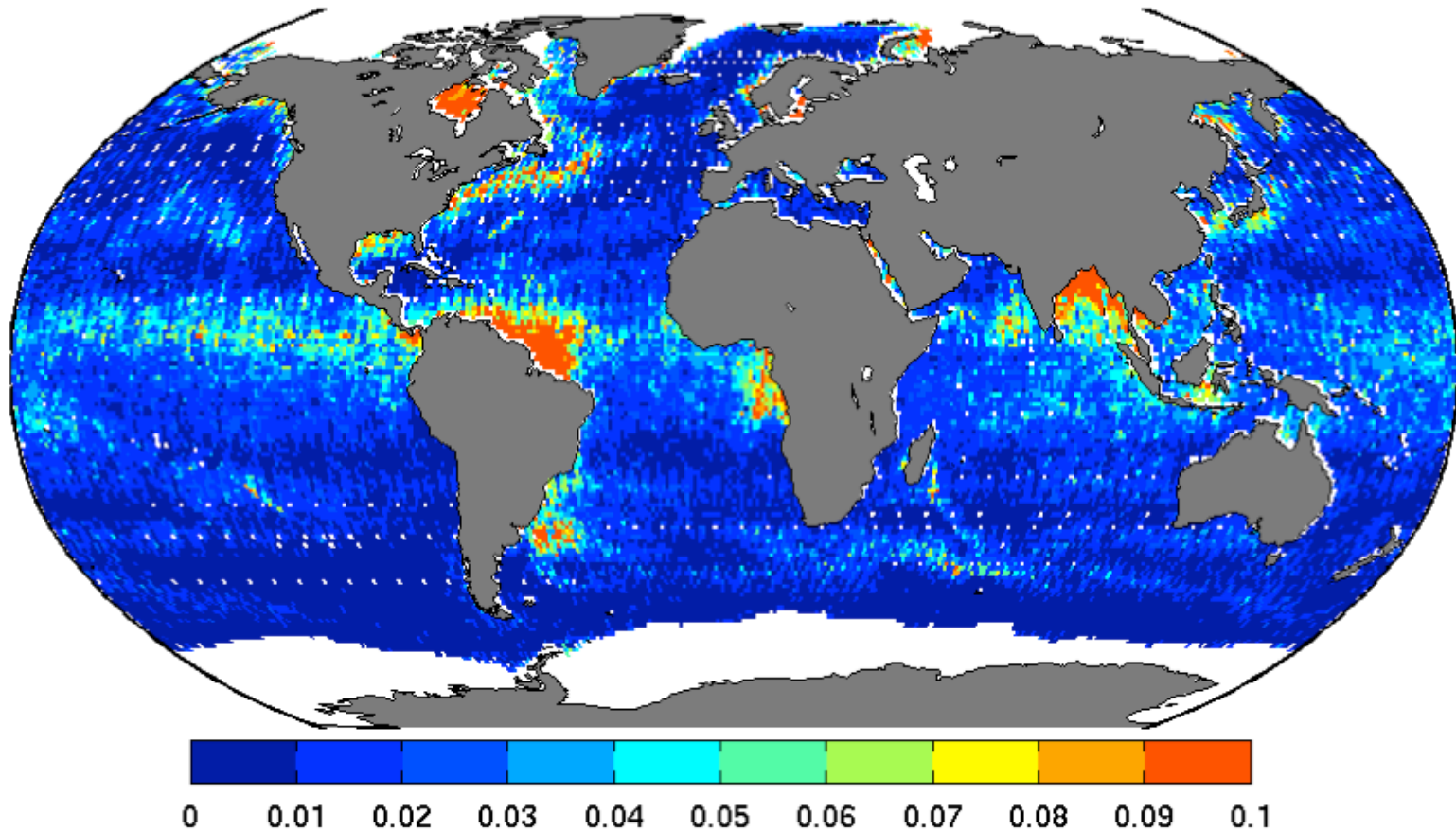
\hat{S} : estimated monthly mean based on Aquarius sampling

S : true monthly mean based on daily sampling

$\alpha = \text{rms}(\Delta)$

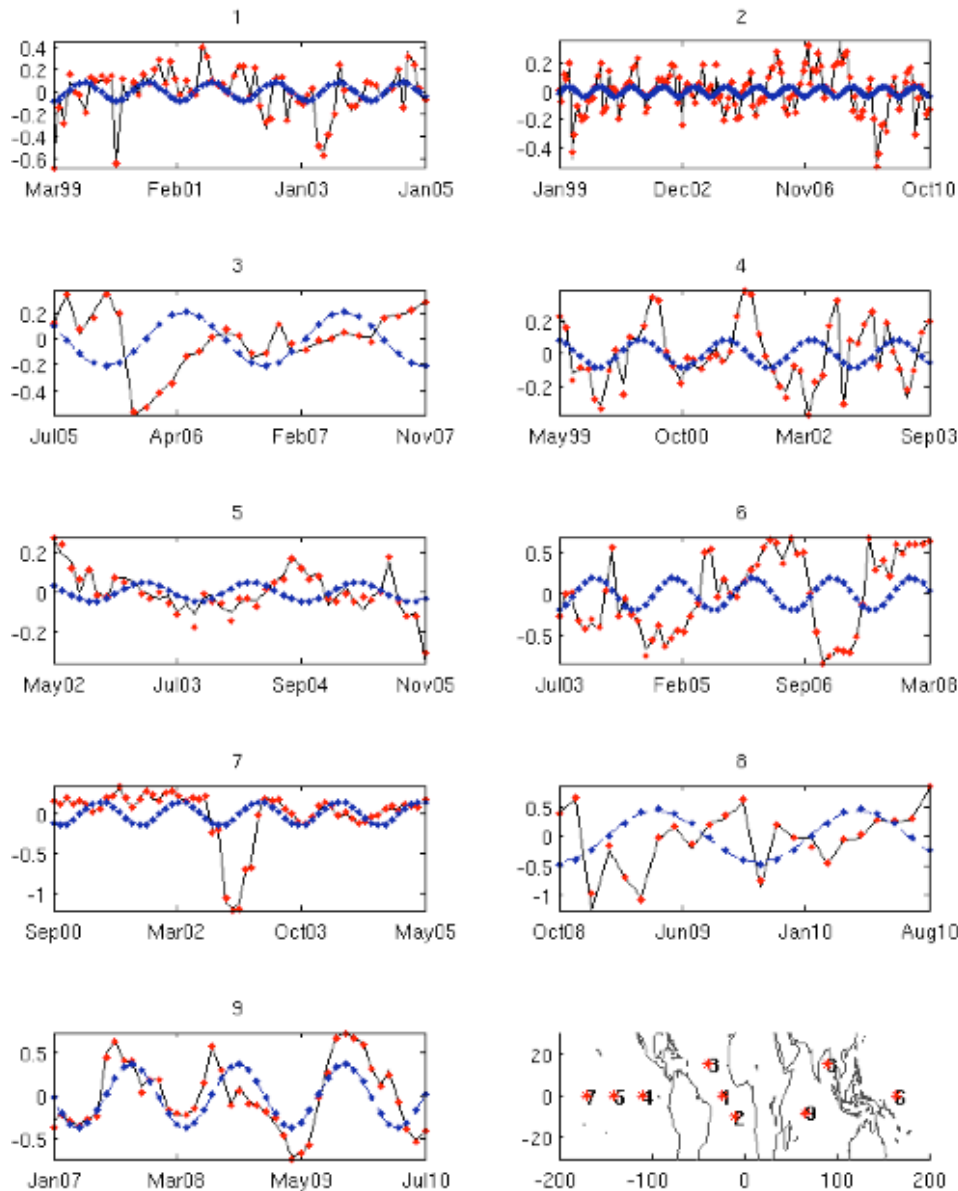
* Defined as 28 days for purposes of Aquarius analysis here

Estimated aliasing (HYCOM)



- Spatial mean $\alpha \approx 0.02$ psu but considerably larger in tropical and coastal regions, and near strong surface currents

Estimated aliasing (moorings)



- Not much aliasing effects at annual period
- HYCOM values weaker

σ_D	σ_H	α_D	α_H	r_{2mo}	r_{4mo}	r_{12mo}
0.10	0.05 (0.07)	0.04	0.02	21	6	1
0.03	0.04 (0.06)	0.02	0.01	6	1	0.4
0.04	0.03 (0.04)	0.03	0.03	23	10	0.7
0.08	0.08 (0.09)	0.02	0.02	16	3	0.06
0.05	0.04 (0.05)	0.03	0.03	13	15	3
0.08	0.09 (0.13)	0.03	0.03	25	9	0.6
0.05	0.04 (0.08)	0.04	0.02	13	16	0.04
0.26	0.23 (0.24)	0.11	0.08	38	2	0.9
0.10	0.06 (0.11)	0.05	0.02	22	1	0.5

Aquarius error budget

Latitude range	Number of samples	α	CBE*	$\sqrt{(\alpha^2 + CBE^2)}$	Allocation*
0–10	8.0	0.04	0.11	0.120	0.15
11–20	7.9	0.03	0.11	0.113	0.16
21–30	7.8	0.02	0.12	0.121	0.16
31–40	8.2	0.02	0.13	0.131	0.18
41–50	8.6	0.01	0.15	0.151	0.21
51–60	8.4	0.01	0.17	0.171	0.24
61–70	9.1	0.02	0.18	0.181	0.26
Global RMS		0.02	0.14	0.141	0.20

- **Estimated aliasing error is small compared to other error components**
- **Largest possible effects at low latitudes**

* From Lagerloef et al. (2008) Oceanography

Summary

- Rapid SSS variability can be a significant part of the total variability (20% on average, >50% in some tropical and coastal regions)
- Aliasing impacts are also dependent on sampling characteristics, including irregular sampling times
- Aliasing errors are small compared to other Aquarius errors on average but can be more important locally
- Effects typically larger at subseasonal periods diminishing towards longer periods, suggesting seasonal cycle not strongly affected
- Results from HYCOM and moorings comparable although HYCOM tends to underestimate aliasing impacts
- Estimates based on hourly (instead of daily) values also suggest our results might be biased low, particularly in places of strong precipitation