ESTIMATES OF OBSERVATIONAL ERRORS RELATED TO SMALL-SCALE HORIZONTAL AND VERTICAL VARIABILITY IN SALINITY FIELDS

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I. OBJECTIVES

The objectives are to estimate expected differences between monthly satellite and in situ salinity related to

1. Small-scale horizontal variability (<1°)
2. Vertical near-surface stratification (<10m)

Such estimates can be used in

1. Comparison between the satellite and in situ salinity
2. Formulating appropriate weights for assimilation of satellite salinity into climate models

II. TOOLS

Salinity estimates are based on

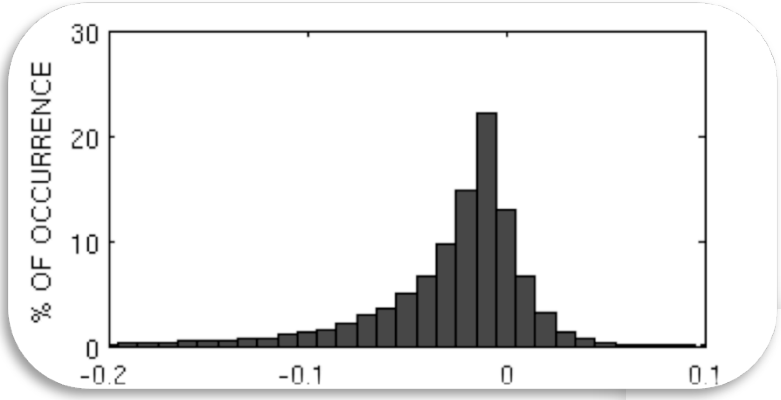
1. HYCOM model/data synthesis:
   - Global, 1/12° (90.9)*
   - "Surface" is ~50 cm
   - Daily fields, 1-year period (09/11-09/12)

2. Climatology
   - WOA05 monthly objectively analyzed fields**
   - "Surface" is "0m", "Near-surface" is 10 m
   - $\forall$ t: $\Delta S_{CLIM} = S_{"0"m} - S_{10m}$

*Chassignet et al. 2009; Oceanography (22)

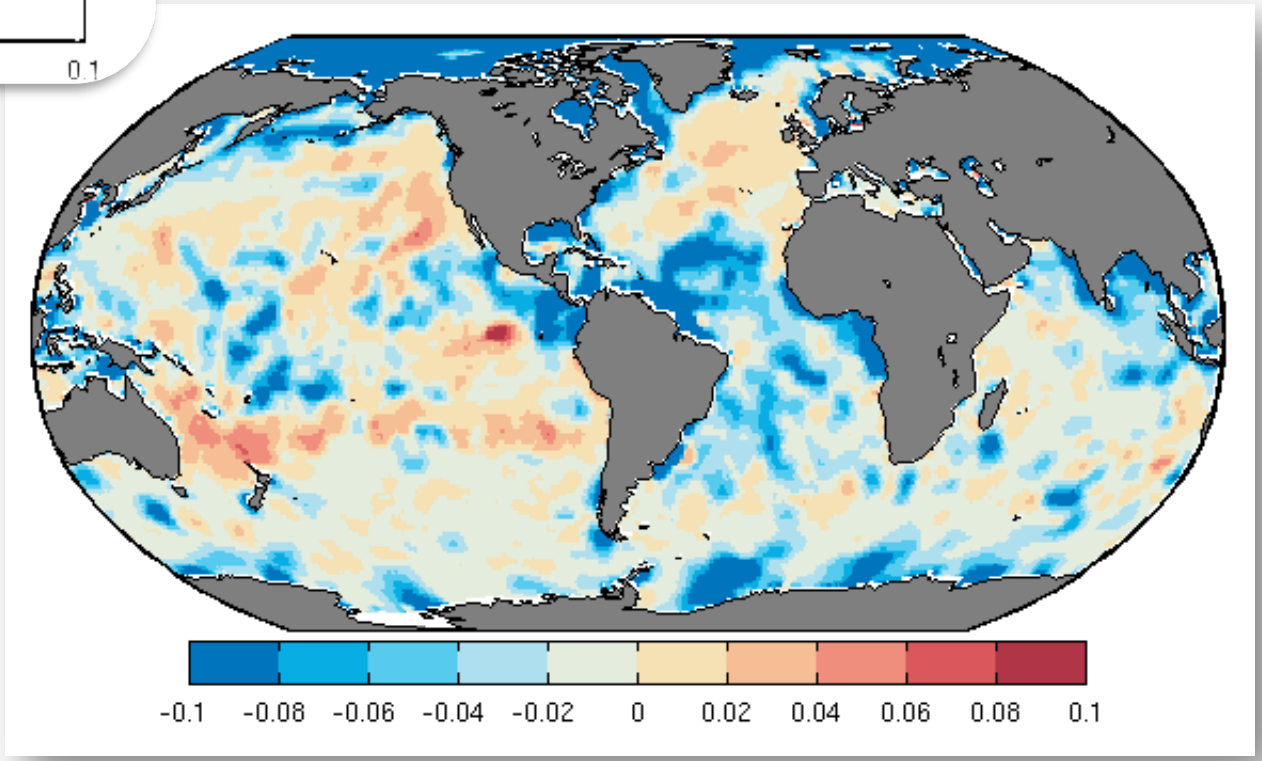
** Antonov et al. 2005; NOAA Atlas

III. VERTICAL VARIABILITY



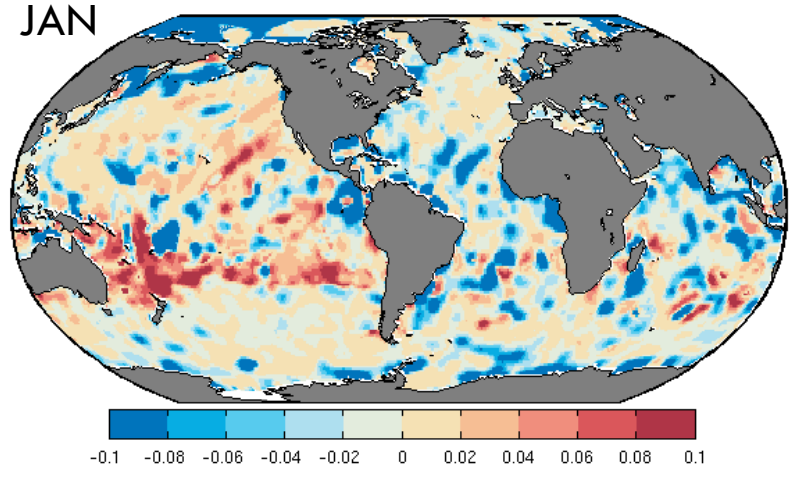
MEAN (ΔS_{CLIM})
Average bias for monthly salinity in the presence of near-surface stratification

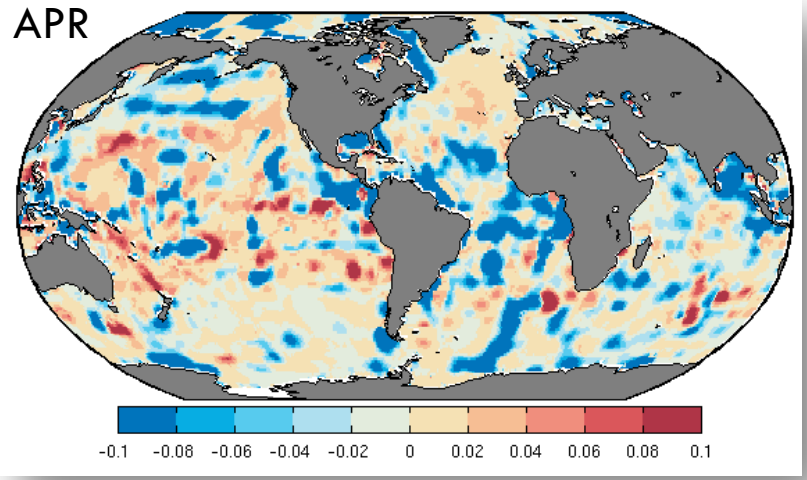
- Global Mean = -0.18
- Tropical Mean = -0.05
  (cf. -0.046 by Henocq et al. 2010)
- Global Median = -0.02
- 87% of bias [-0.2 0.2]

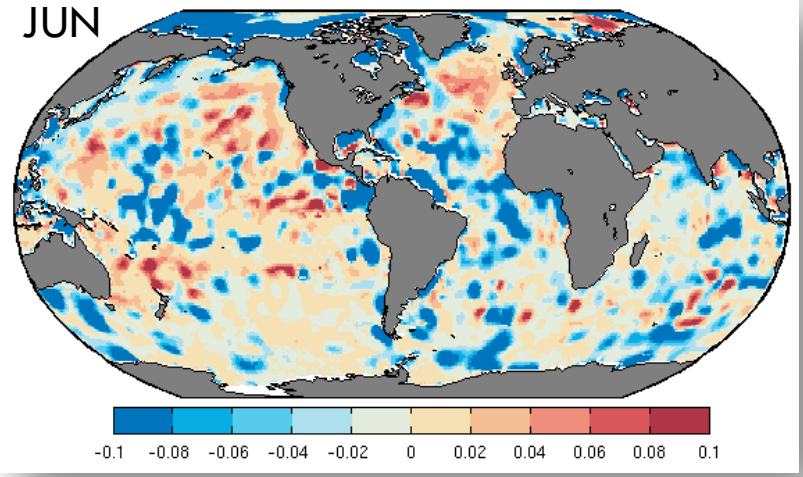


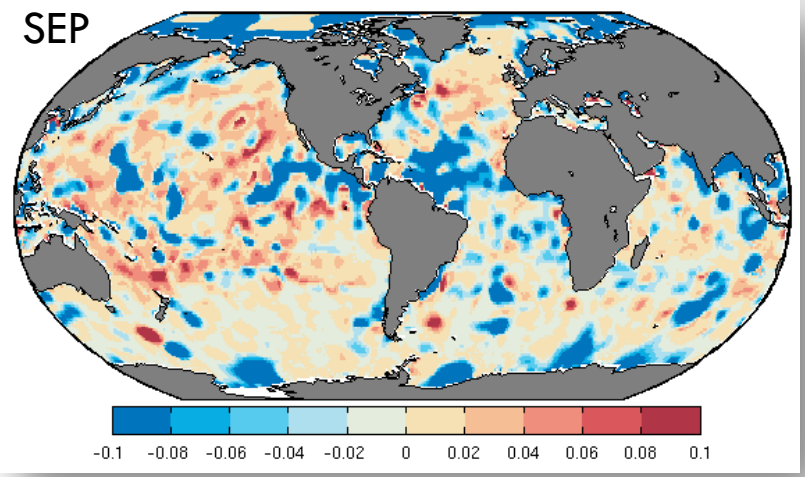
III. VERTICAL VARIABILITY

Seasonal variations of monthly ΔS_{CLIM}









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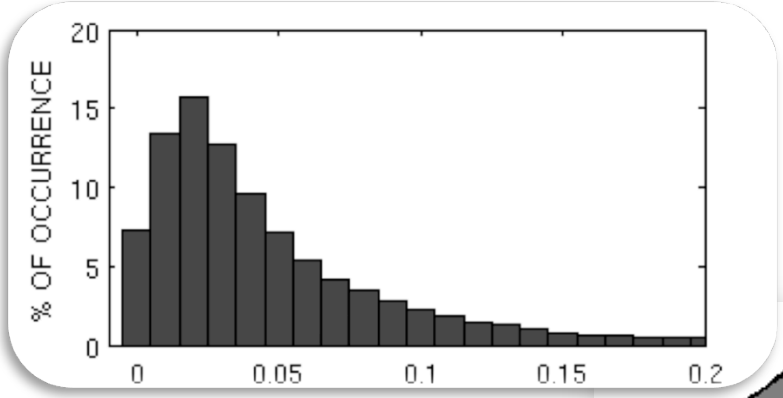
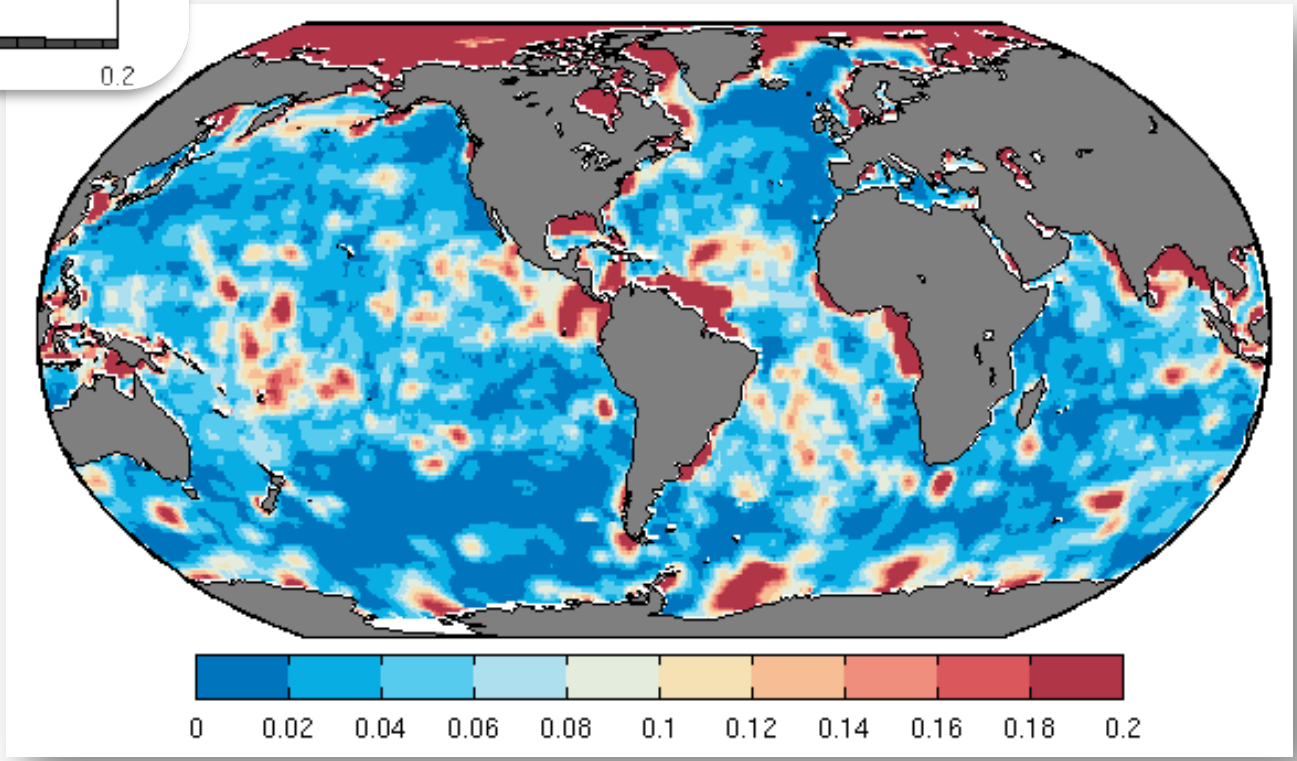


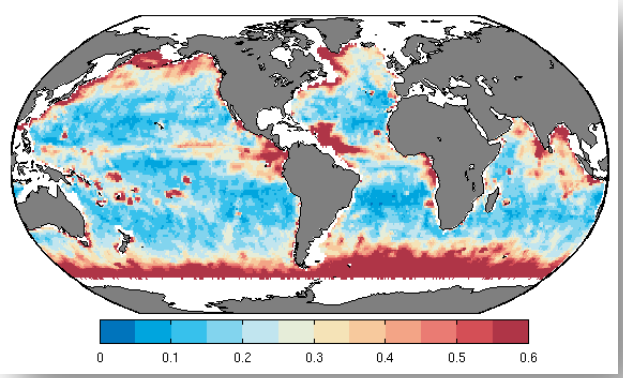
- Global Mean = 0.15
- Tropical Mean = 0.1
  (cf. 0.14 by Henocq et al. 2010)
- Global Median = 0.02
- 84% of ε_{vert} <0.2

RMS (ΔS_{CLIM})
Vertical error related to near-surface stratification for monthly salinity (ε_{VERT})

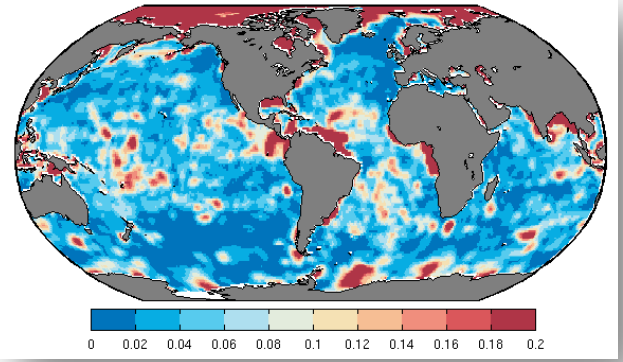


III. VERTICAL VARIABILITY

ε_{RMS} = RMS {$Aquarius_{2.0}$ - $Argo_{VI\_IPRC}$}

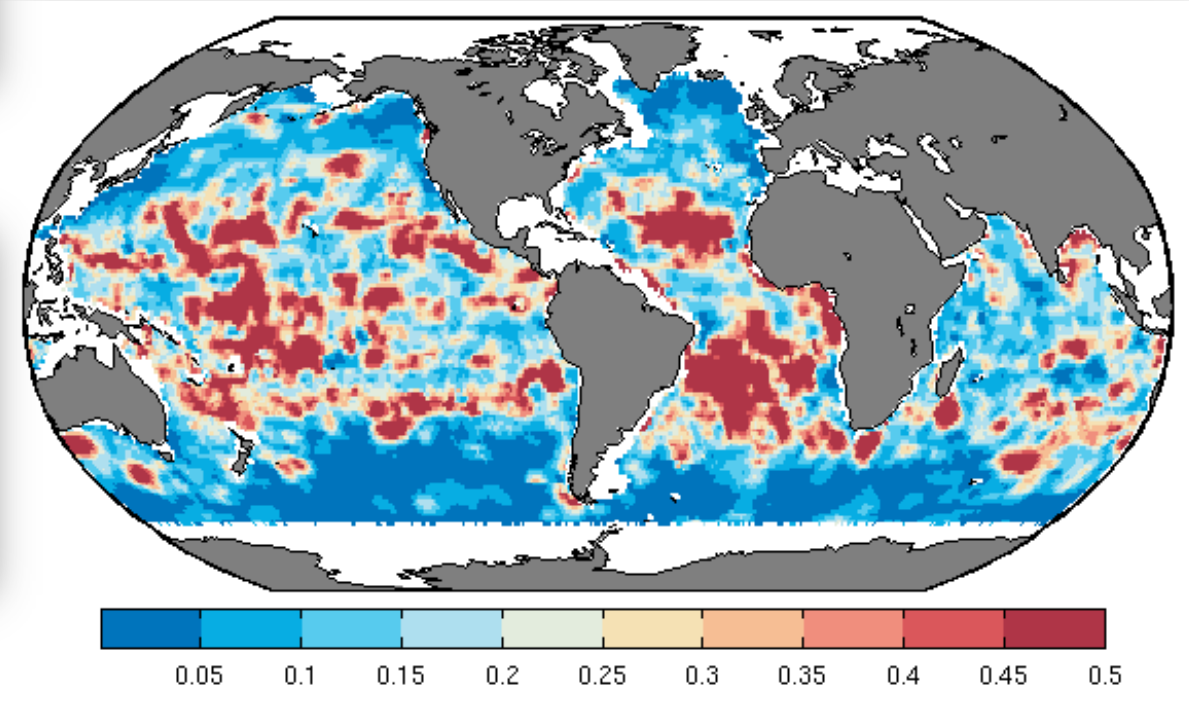


ε_{VERT} = RMS (ΔS_{CLIM})



Ratio ε_{VERT} / ε_{RMS}

Potential regions where stratification can affect comparison between Aquarius and Argo monthly salinity

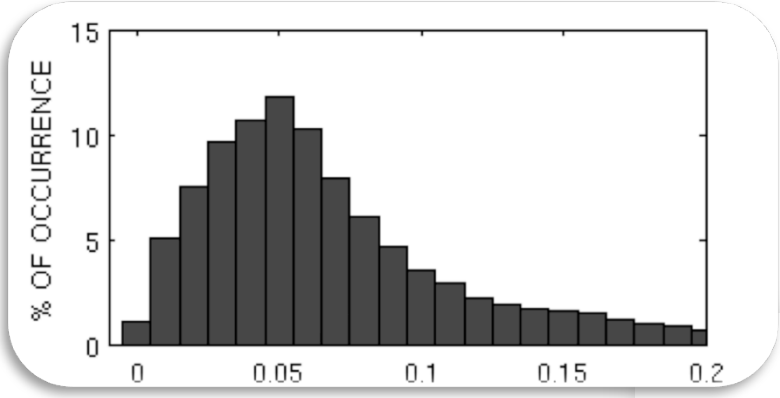


IV. SMALL-SCALE VARIABILTY

Estimating sampling error due to small-scale variability using HYCOM 1/12° solution:

1. $\forall\ S_{1/12^\circ}$ that fall in 1°x1° box, we compute:
   Spatial mean → S
   STD from S → σ_{SMALL}
2. S(t), $\sigma_{SMALL}(t)$, t=1.. 365
3. $\varepsilon_{SMALL} = RMS\{\sigma_{SMALL}(t)\}$

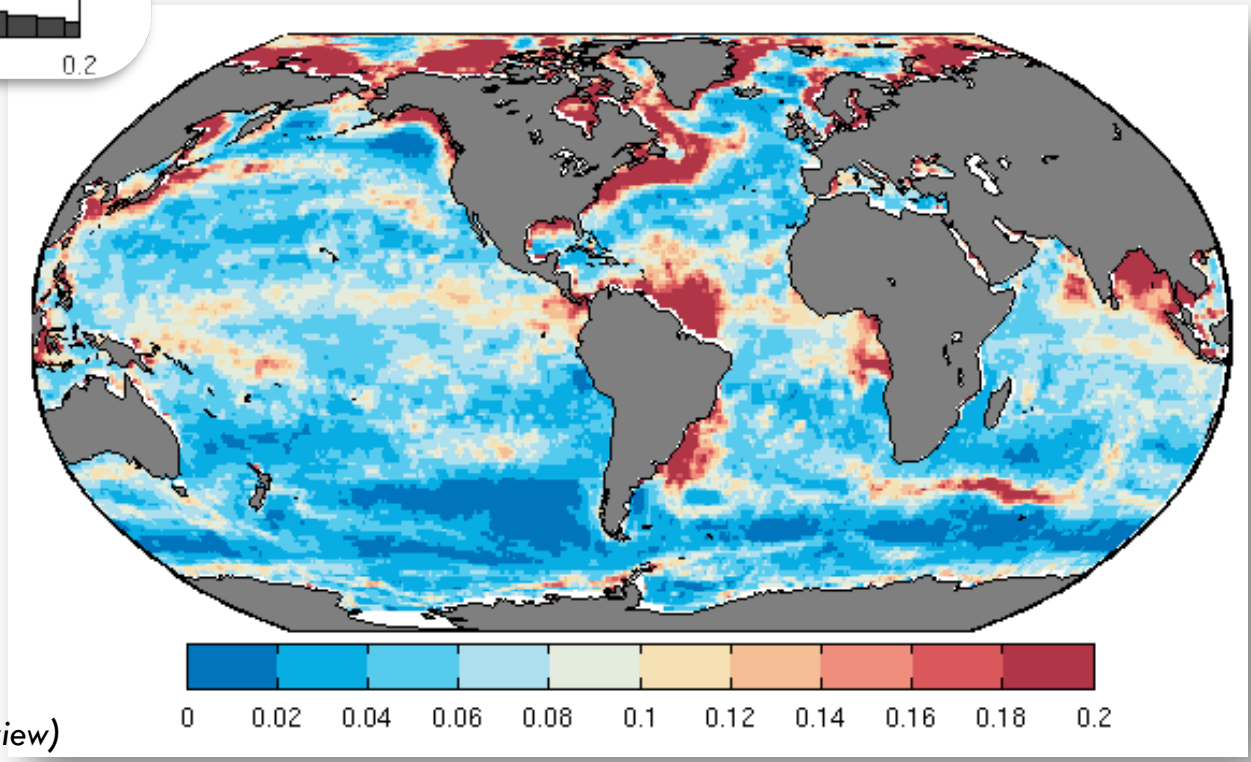
IV. SMALL-SCALE VARIABILITY



$\varepsilon_{SMALL} = RMS\{\sigma_{SMALL}(t)\}$

Sampling error due to unresolved small-scale variability for daily salinity

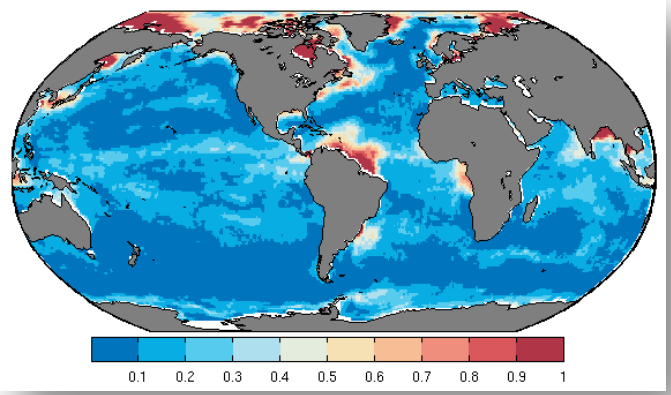
- Global Mean = 0.09
- Global Median = 0.05
  (cf. 0.05 by Lagerloef et al., 2010)
- 93% of ε_{SMALL} <0.2



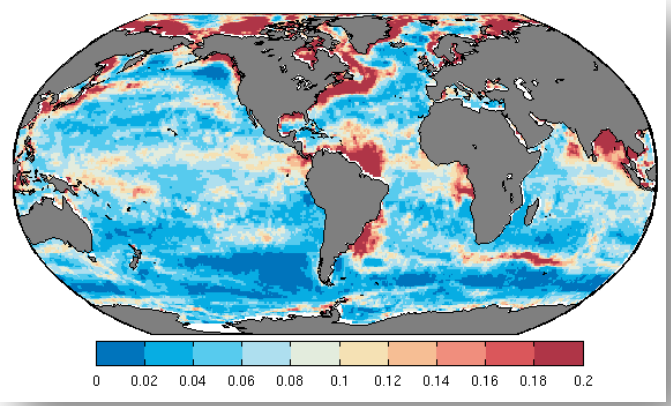
Vinogradova and Ponte, JTECH (under review)

IV. SMALL-SCALE VARIABILITY

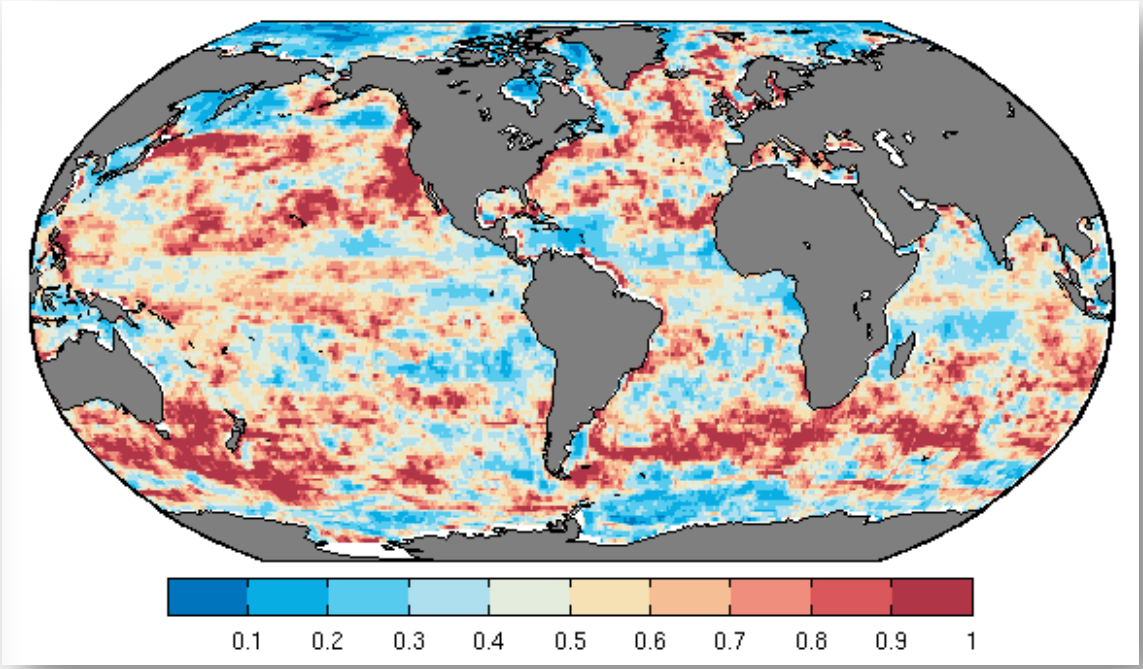
STD (S):
Temporal variation in daily salinity



ε_{SMALL}:
Small-scale error for daily salinity



Ratio ε_{SMALL} /STD (S):
Potential regions where small-scale error can affect the inference of variability in salinity



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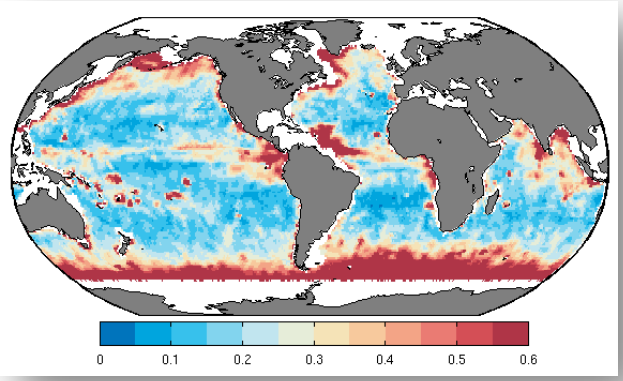
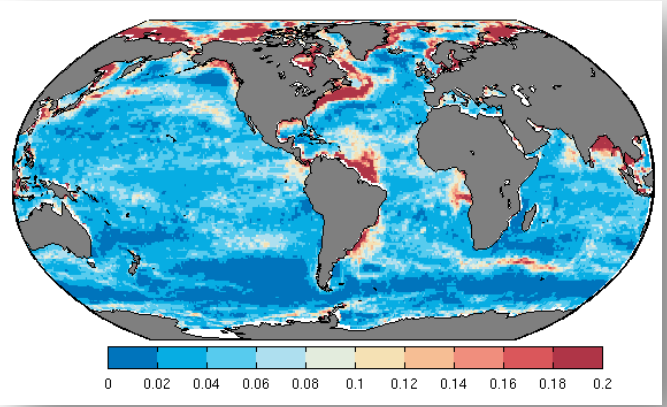
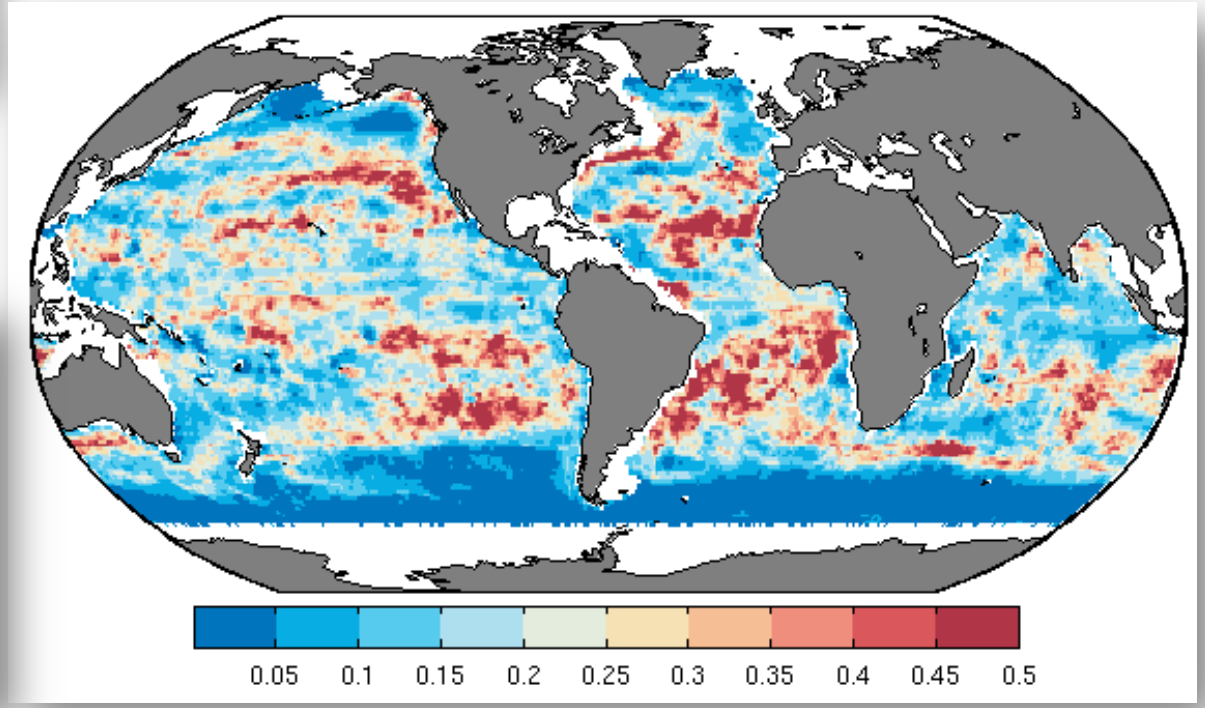
ε_{RMS} = RMS {$Aquarius_{2.0}$ - $Argo_{VI\_IPRC}$}



ε_{SMALL}:
Small-scale error for monthly salinity



Ratio $\varepsilon_{SMALL} / \varepsilon_{RMS}$
Potential regions where small-scale variability can affect comparison between Aquarius and Argo monthly salinity



V. SUMMARY AND CONCLUSIONS

SUGGESTED ESTIMATES OF SAMPLING ERRORS FOR
MONTHLY-AVERAGED SALINITY FIELDS AVERAGE BY LATITUDE BAND

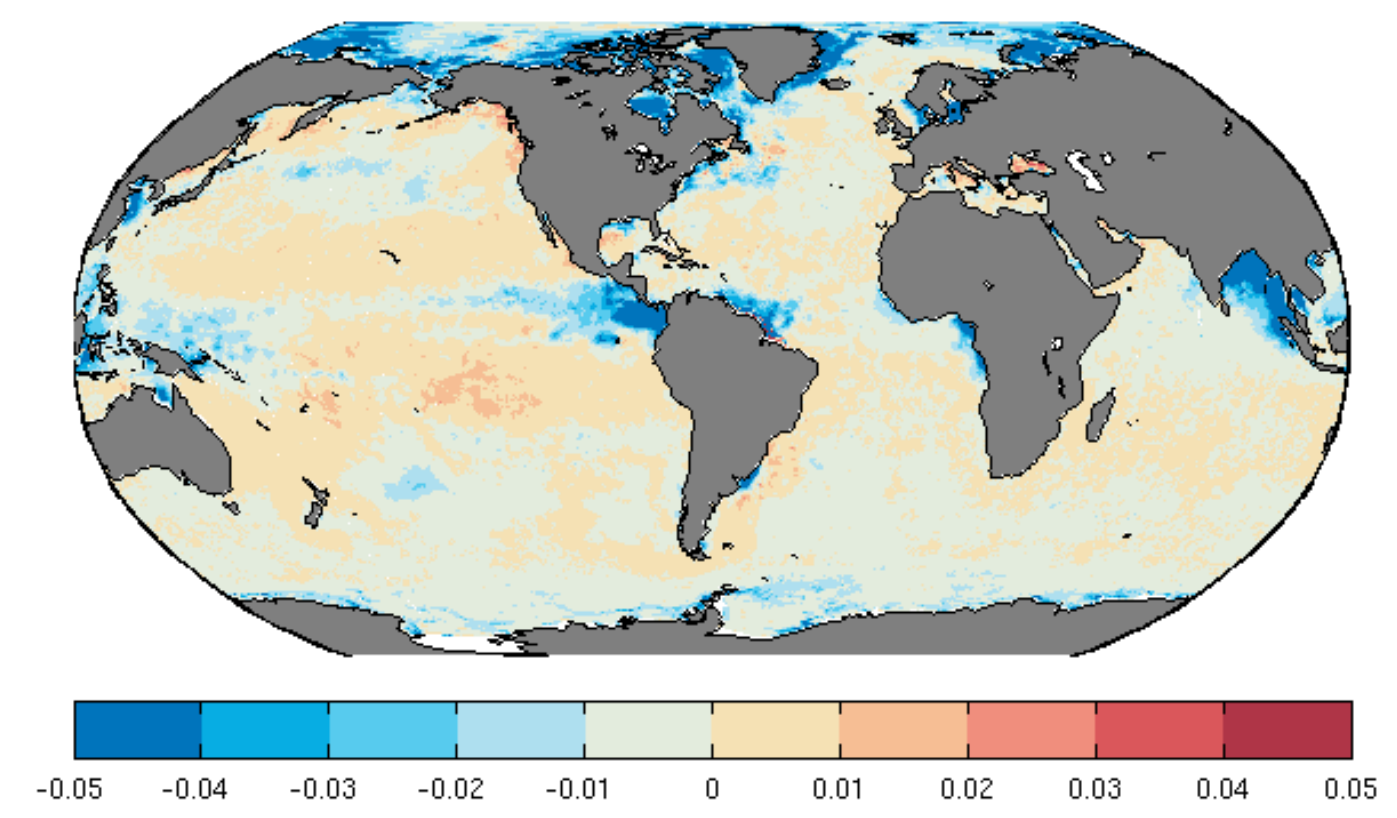
LAT	ε_{VERT}	ε_{SMALL}
0-10	0.15	0.12
11-20	0.09	0.06
21-30	0.06	0.05
31-40	0.06	0.06
41-50	0.06	0.05
51-60	0.07	0.07
61-70	0.10	0.16

V. SUMMARY AND CONCLUSIONS

- In several ocean regions, sampling error related to small-scale horizontal and vertical effects can become an important source of uncertainty when comparing in situ and satellite data.

- Suggested sampling errors ε_{SMALL} and ε_{VERT} can be used
  - As as a guide for a lower bound of expected differences between in situ and satellite values
  - For formulating appropriate weights when assimilating satellite salinity data into climate models

DISCUSSION SLIDES (VERTICAL STRATIFICATION): HYCOM-based BIAS for monthly salinity



- Global mean bias = -0.01.
- Min/Max = [-8; 0.16]
- 97% of all falls between -0.1 and 0.1 (similar to Henocq et al. 2010)

DISCUSSION SLIDES (VERTICAL STRATIFICATION): HYCOM-based ε_{VERT} for monthly salinity