Small-scale surface salinity variability from thermosalinograph data

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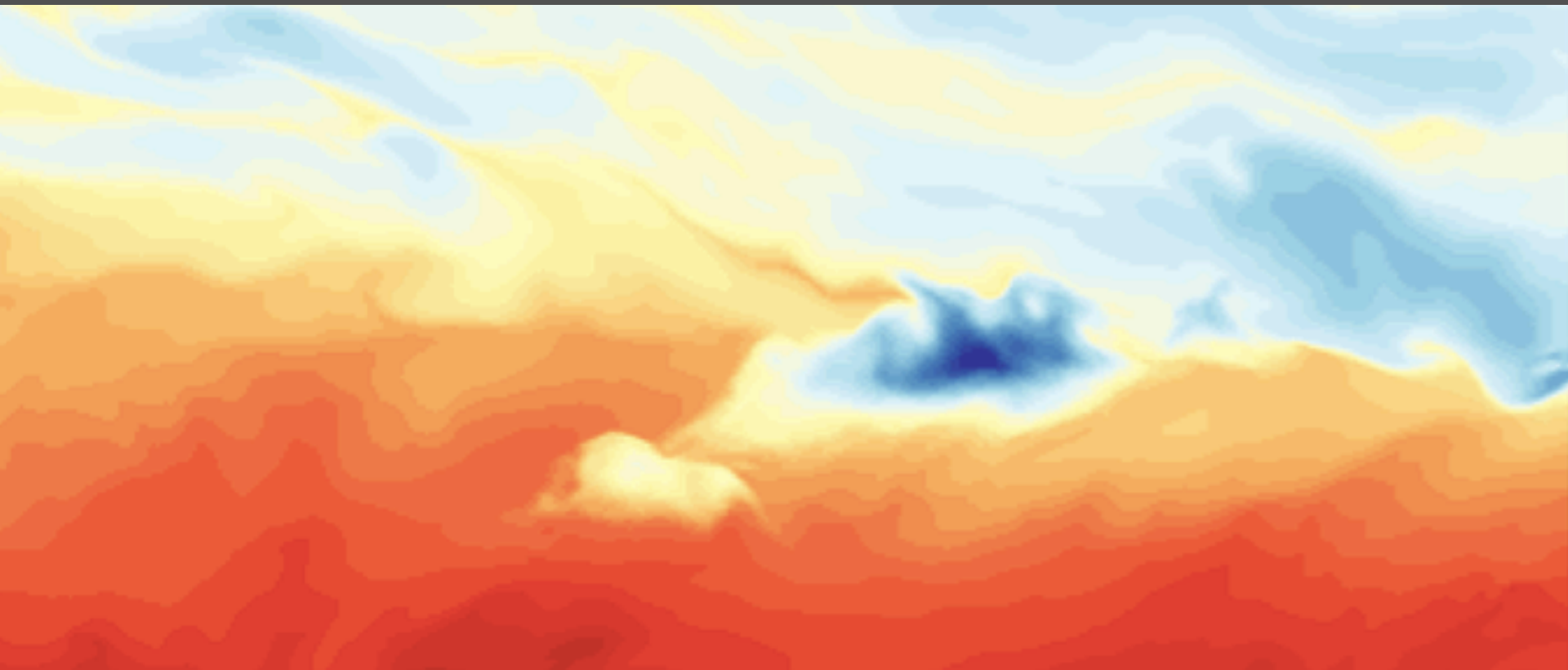
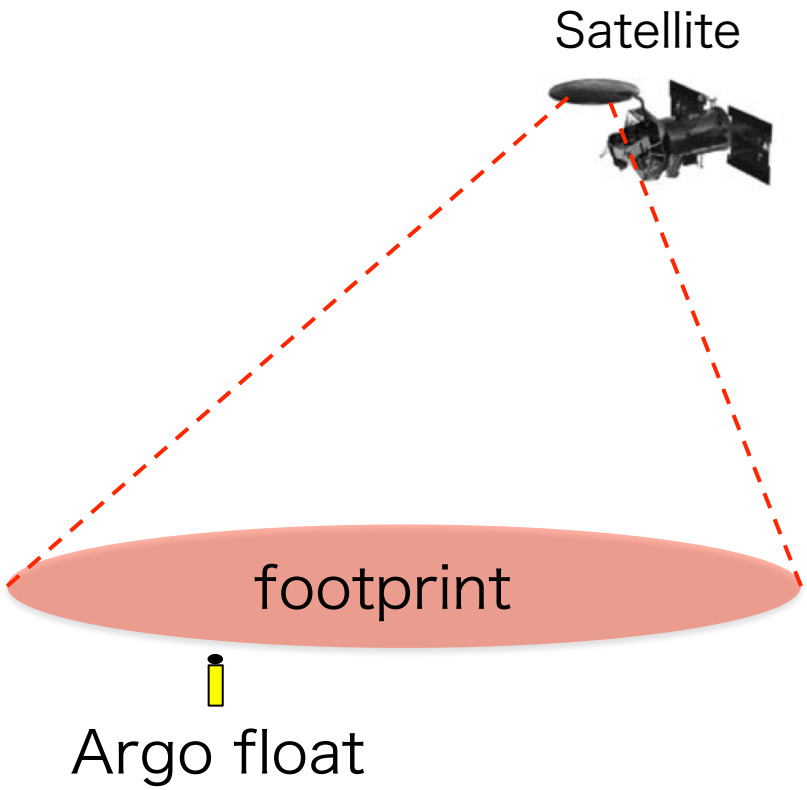
Salinity and Freshwater Changes in the Ocean – Hamburg – 12 Oct 2015



Small-scale salinity variability matters for:

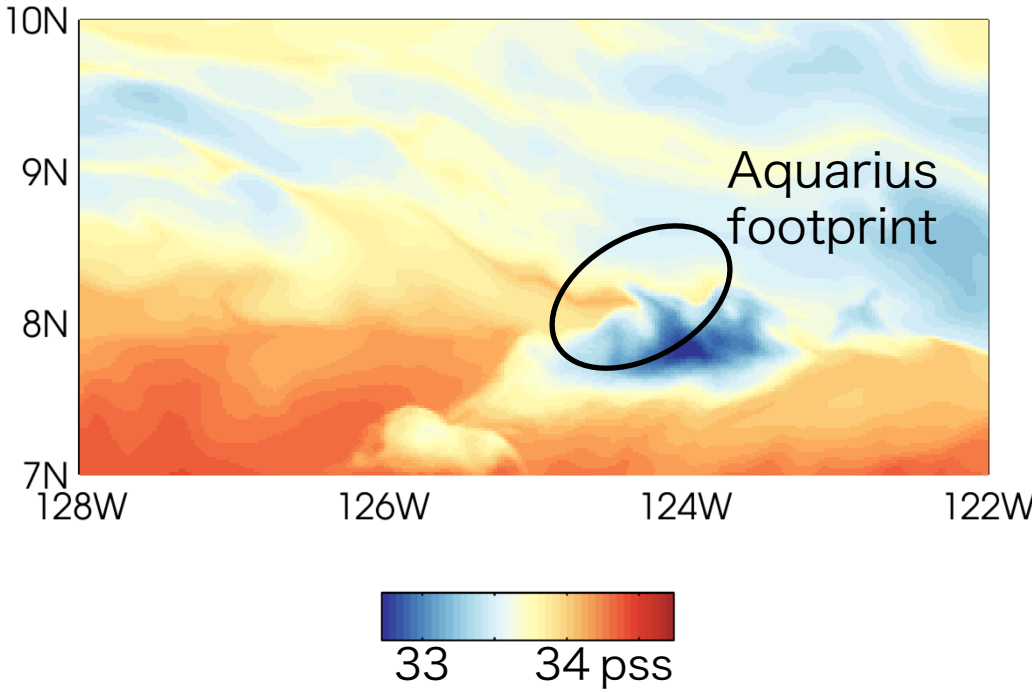
- Dynamics related to small-scale density fronts
- Larger-scale exchanges
- Biology (fronts, river plumes)

Small-scale salinity variability matters for satellite validation & interpretation



Aquarius: 50-100 km footprint
SMOS: ~45 km footprint

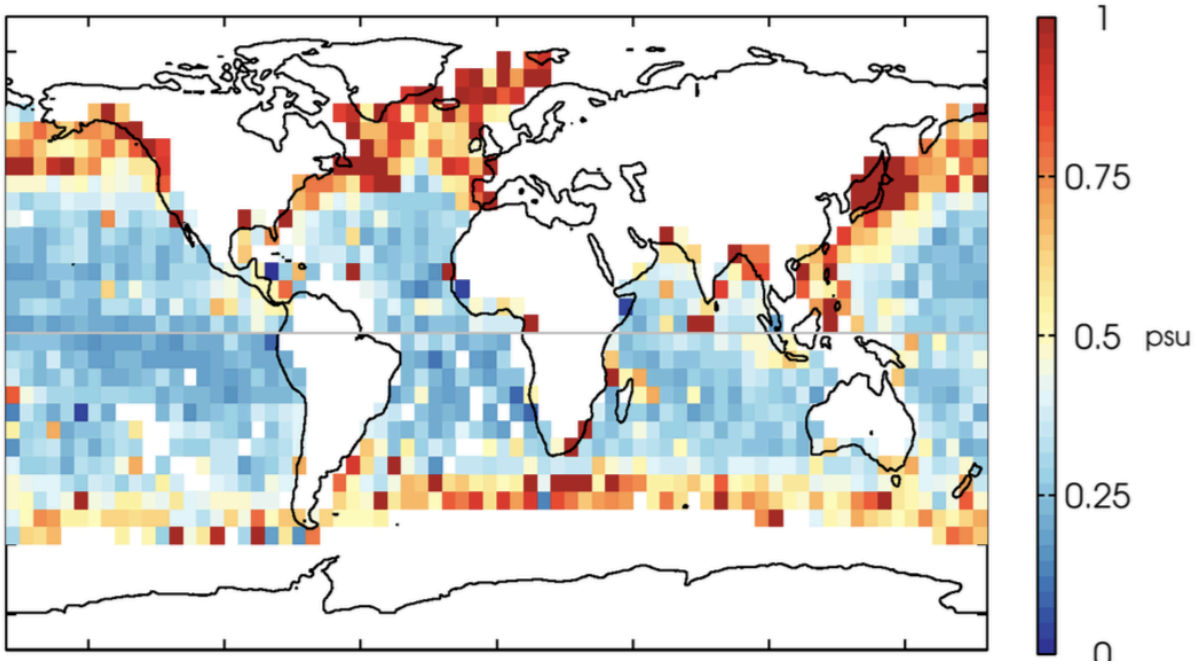
Snapshot of SSS from a 1/48° ECCO-2 model (eastern tropical Pacific)



Model output courtesy of Dimitris Menemenlis

How much of the satellite salinity noise is due to sub-footprint variability?

Aquarius-Argo RMS difference



- Aquarius V4 L2 data, 2012-2014.
- Matched to Argo profiles shallower than 5m within 50 km & 1 day.
- 1.2×10^5 matchups. RMSD calculate from matchups in 2°x2° bins.

Thermosalinograph (TSG) data: an opportunity to characterize "surface" salinity variability

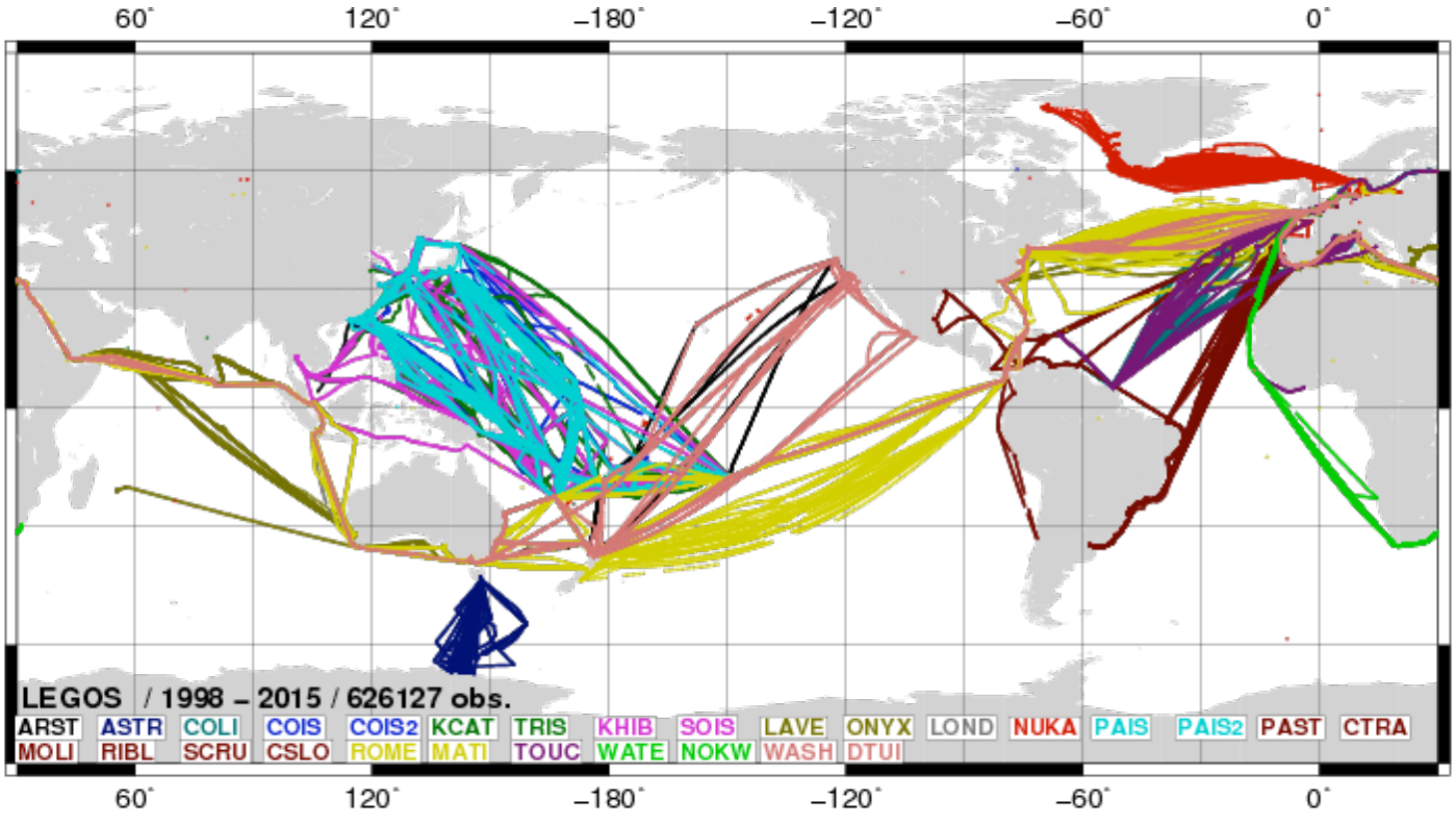
Seawater intake ~5 m below the water line
(www.whoi.edu/)

1. Characterize "sub-footprint-scale" salinity variability:
   - Typical strength of variability
   - Where/why it is strong
2. Quantify the depth dependence of small-scale salinity variability
3. Estimate the impact on satellite uncertainties

Dataset 1:
LEGOS Sea Surface Salinity Observation Service

http://www.legos.obs-mip.fr/observations/sss/

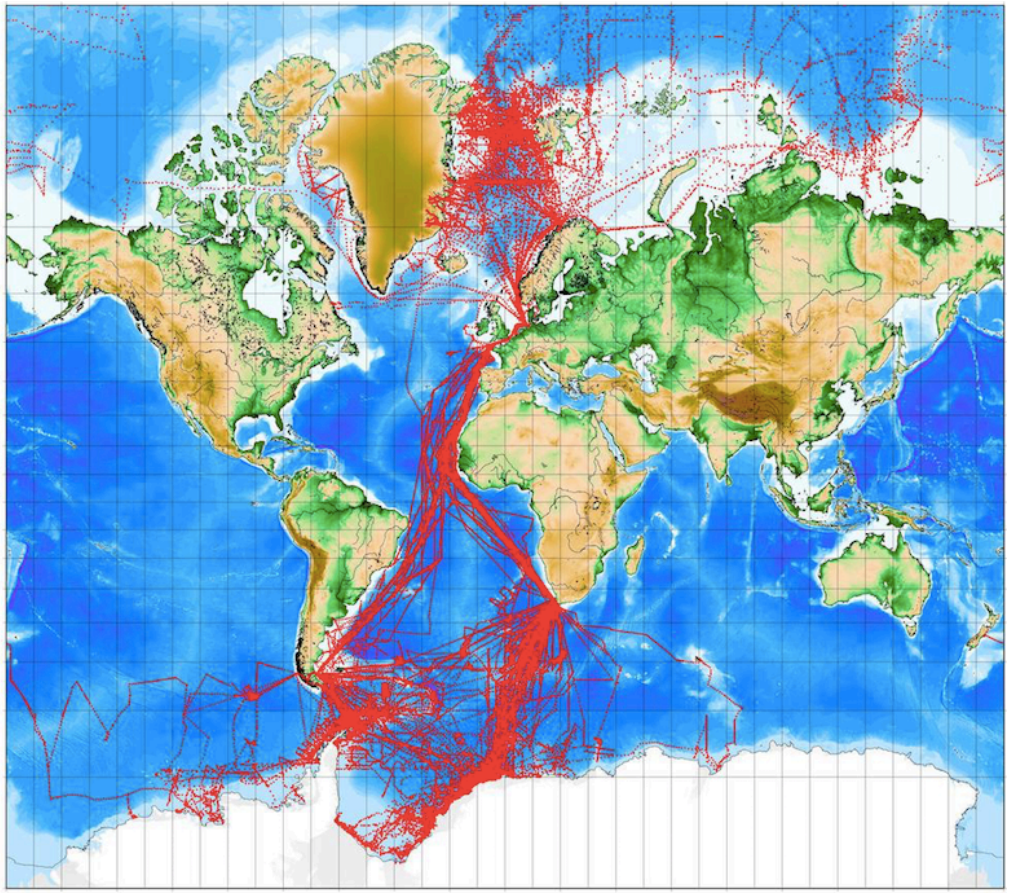
Delayed-mode data: since 2002,
24 ships, 930 transects, ~8x10^6 good measurements



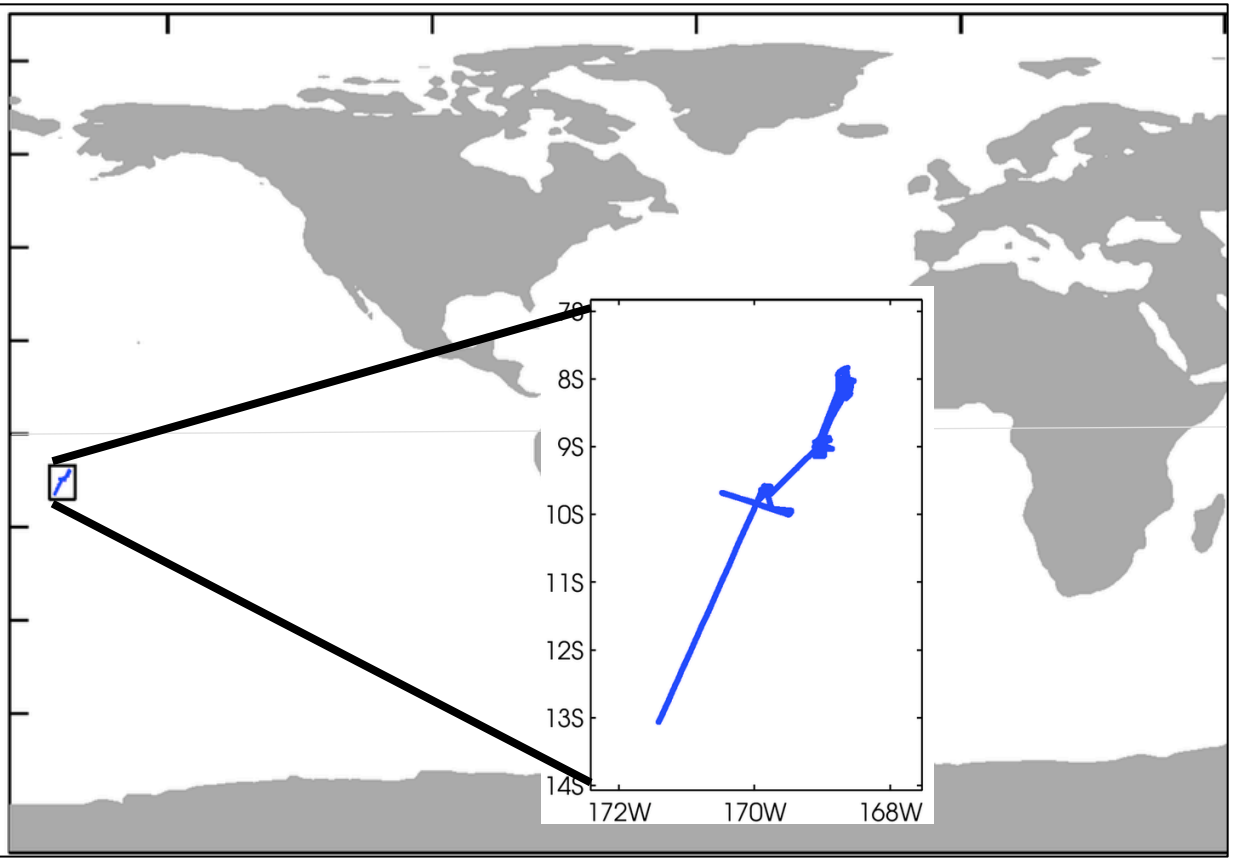
Dataset 2:
R/V Polarstern data from Alfred Wegener Institut

From 1993-2014: ~4.5 x 10^5 good observations

Data from http://www.pangaea.de



Dataset 3:
R/V Thomas G. Thompson

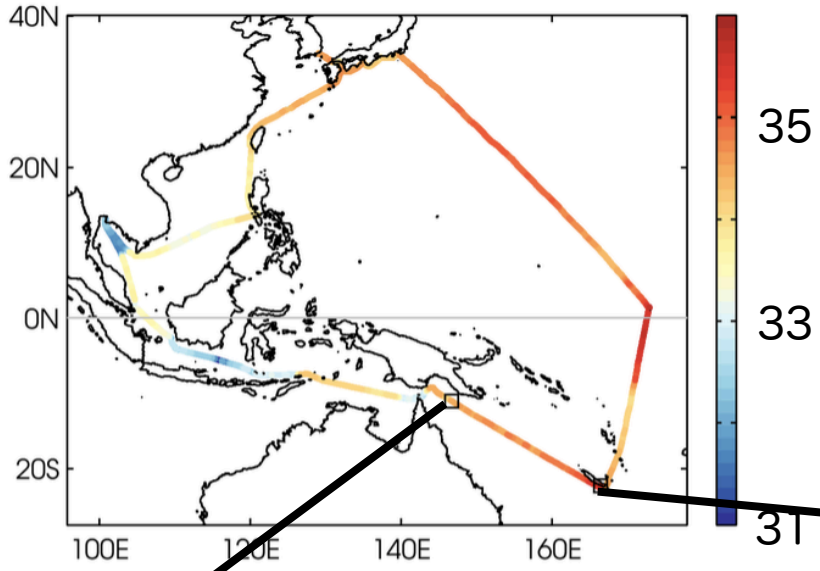


TSGs at 2, 3, 5m depth

32 days of data in 2014

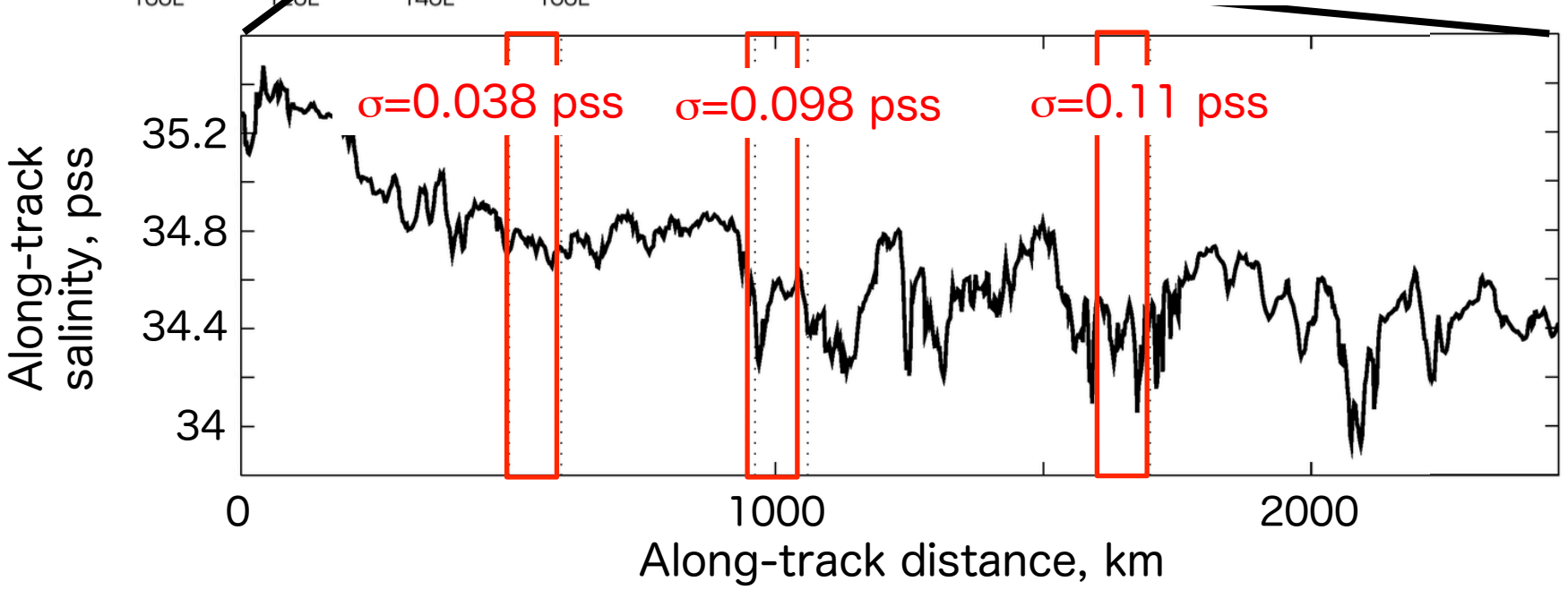
Also, meteorological data (rain, wind, etc.)

Small-scale salinity variability from TSG
Example from LEGOS SSS dataset



Along-track salinity, pss

Standard deviation over 100-km segments



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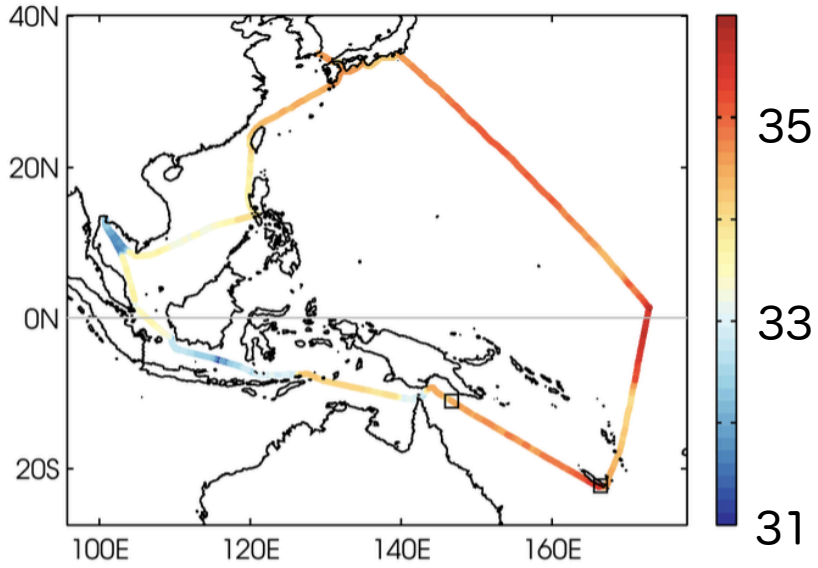
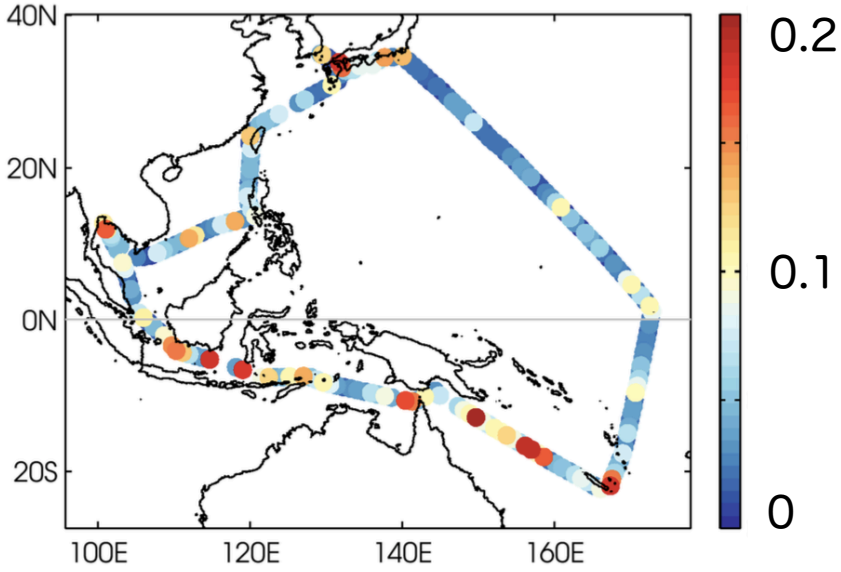


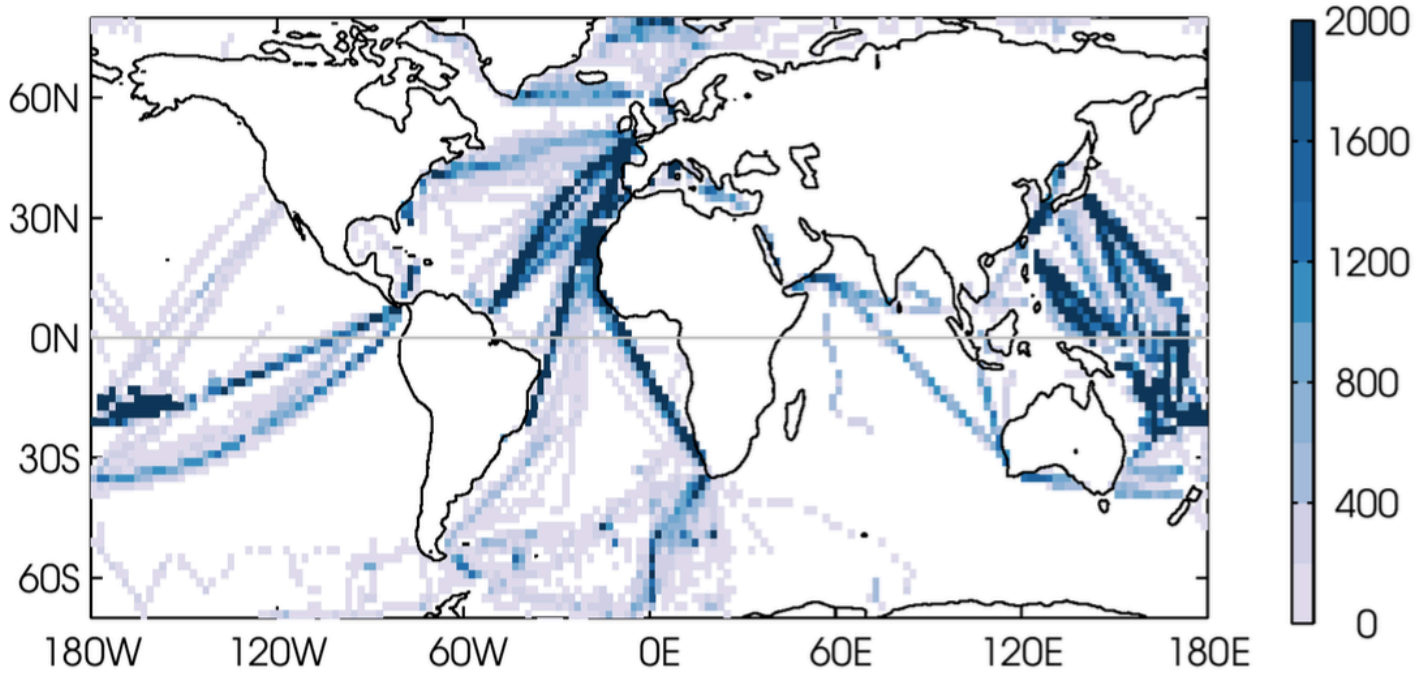
Along-track salinity, pss



Standard deviation of salinity over 100-km segments, pss

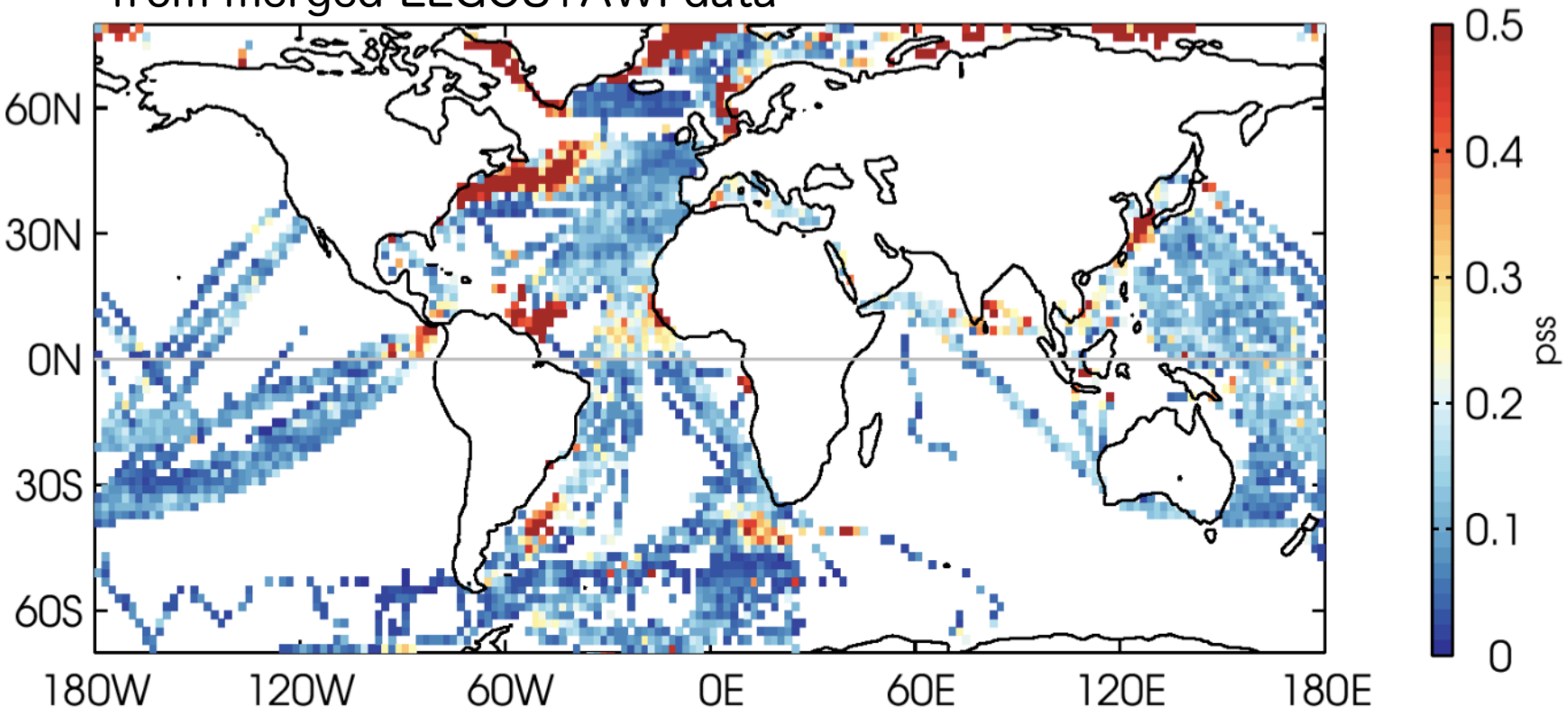
Number of TSG observations per 2°x2° gridbox

Total number of TSG observations
(LEGOS+AWI datasets)

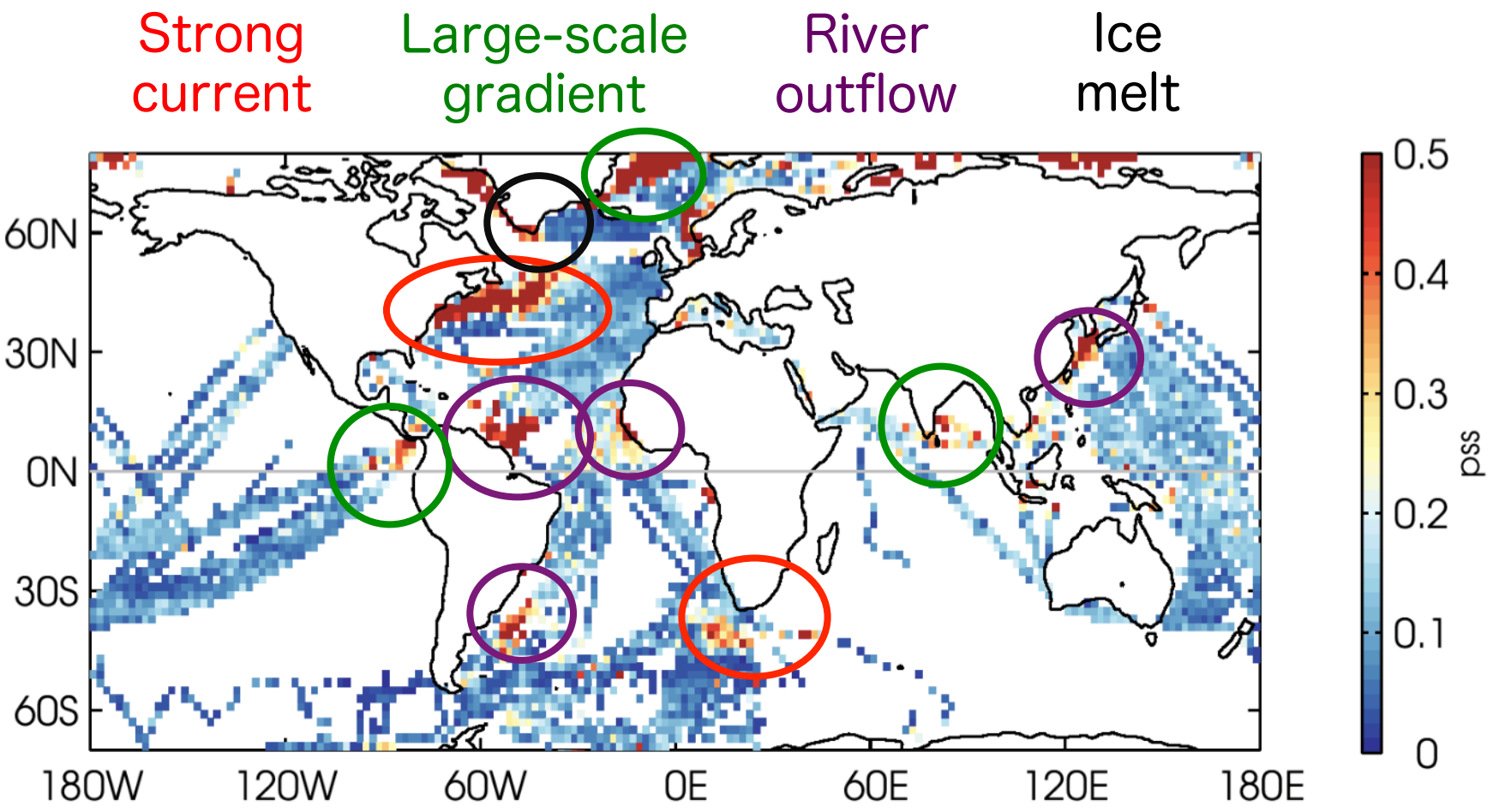


Small-scale salinity variability

Binned 100-km standard deviation (95th percentile)
from merged LEGOS+AWI data

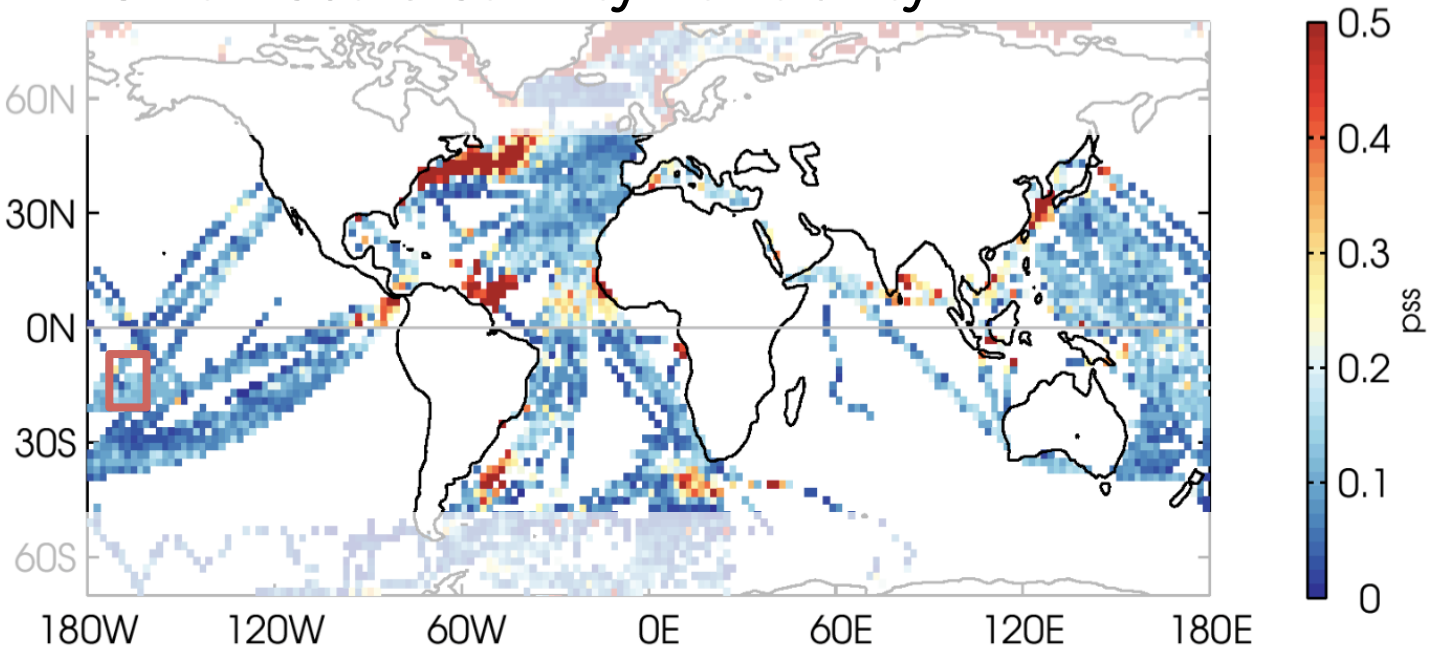


Small-scale salinity variability

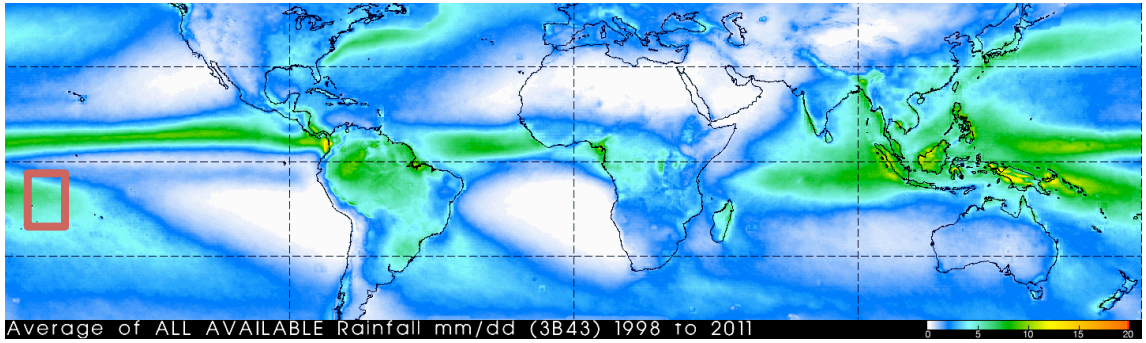


Salinity variability in rainy regions is weak

Small-scale salinity variability



Annual mean rain rate from TRMM 3B42

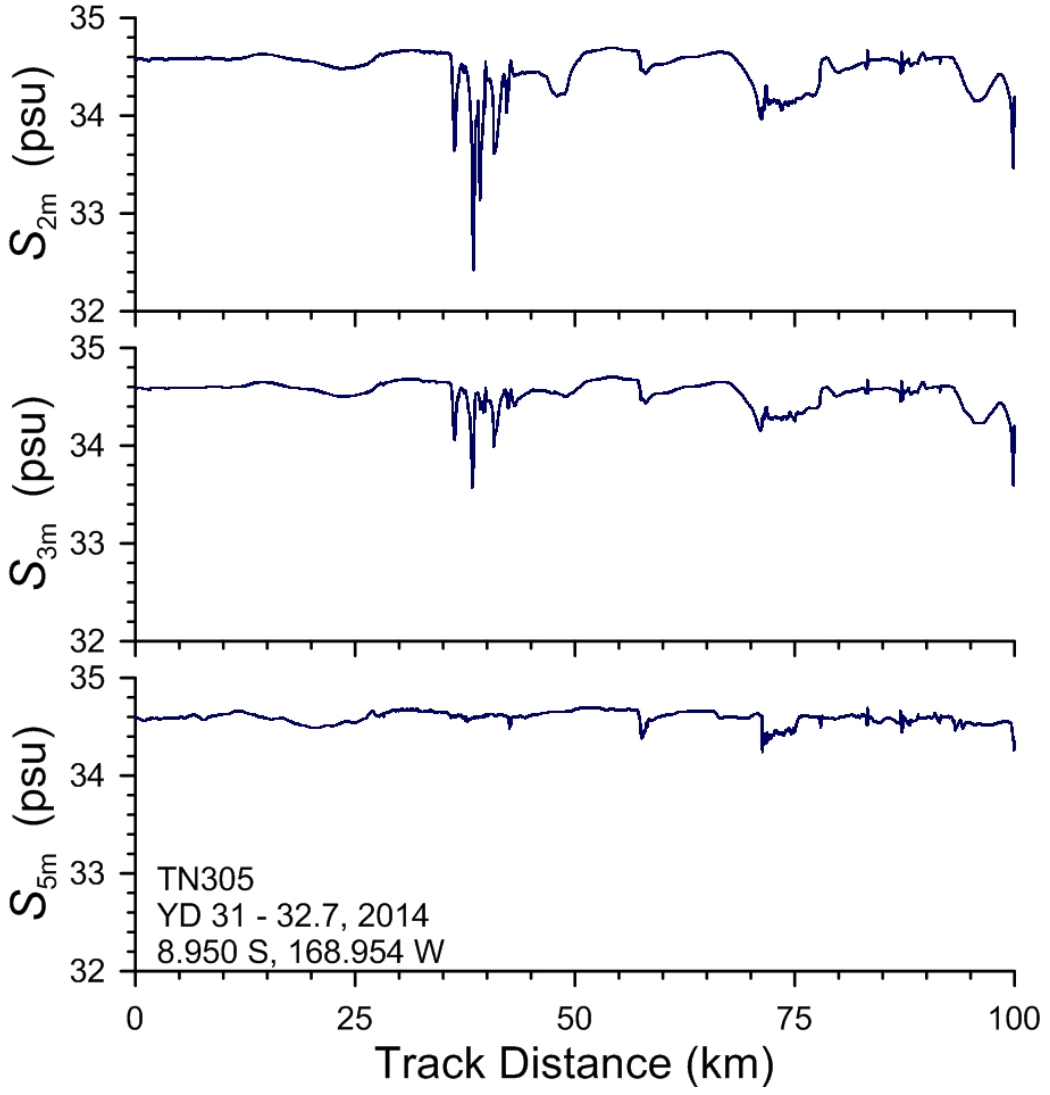


Example from the *R/V Thompson* TSGs: Salinity at three depths

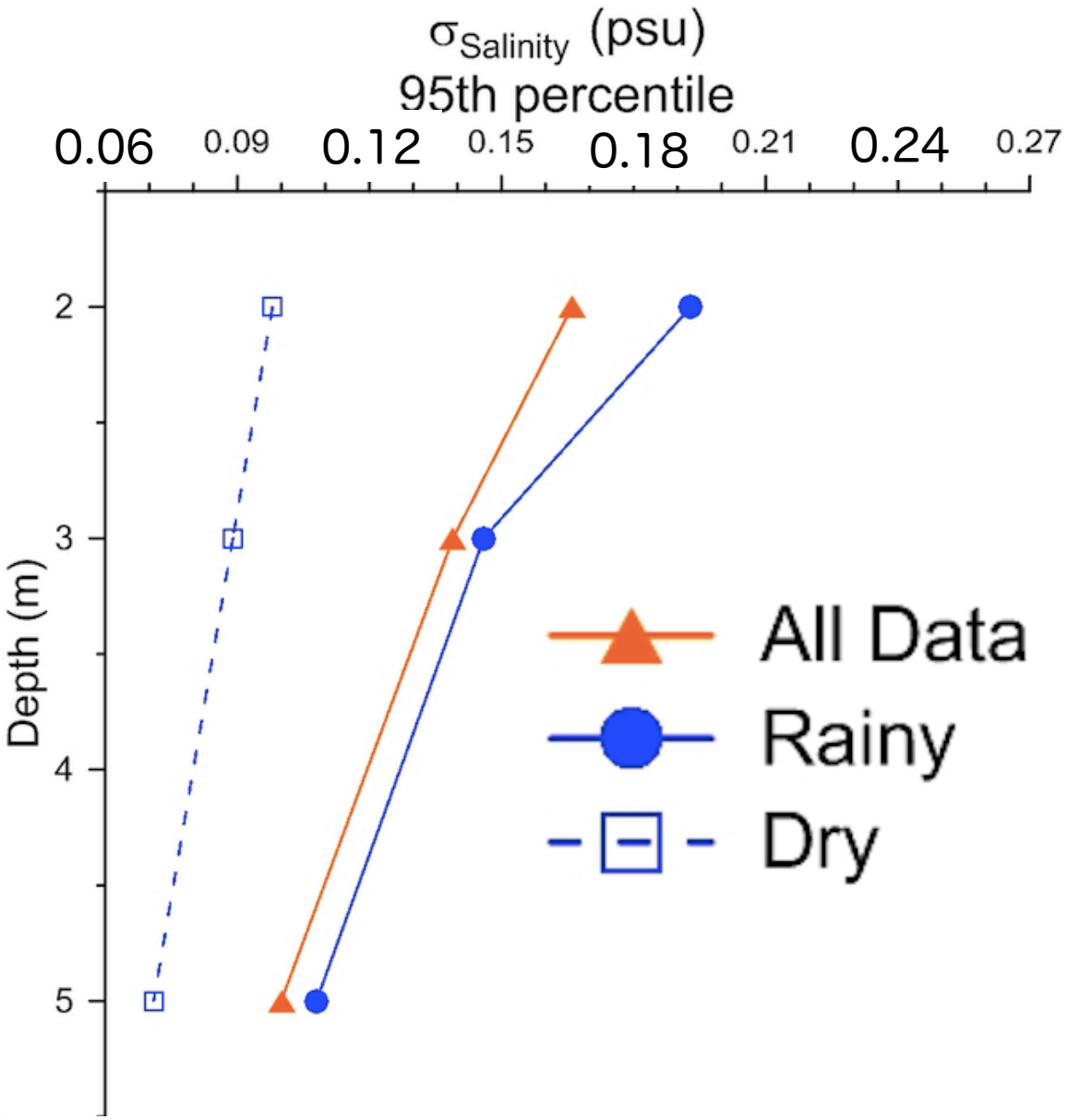
S at 2m

S at 3m

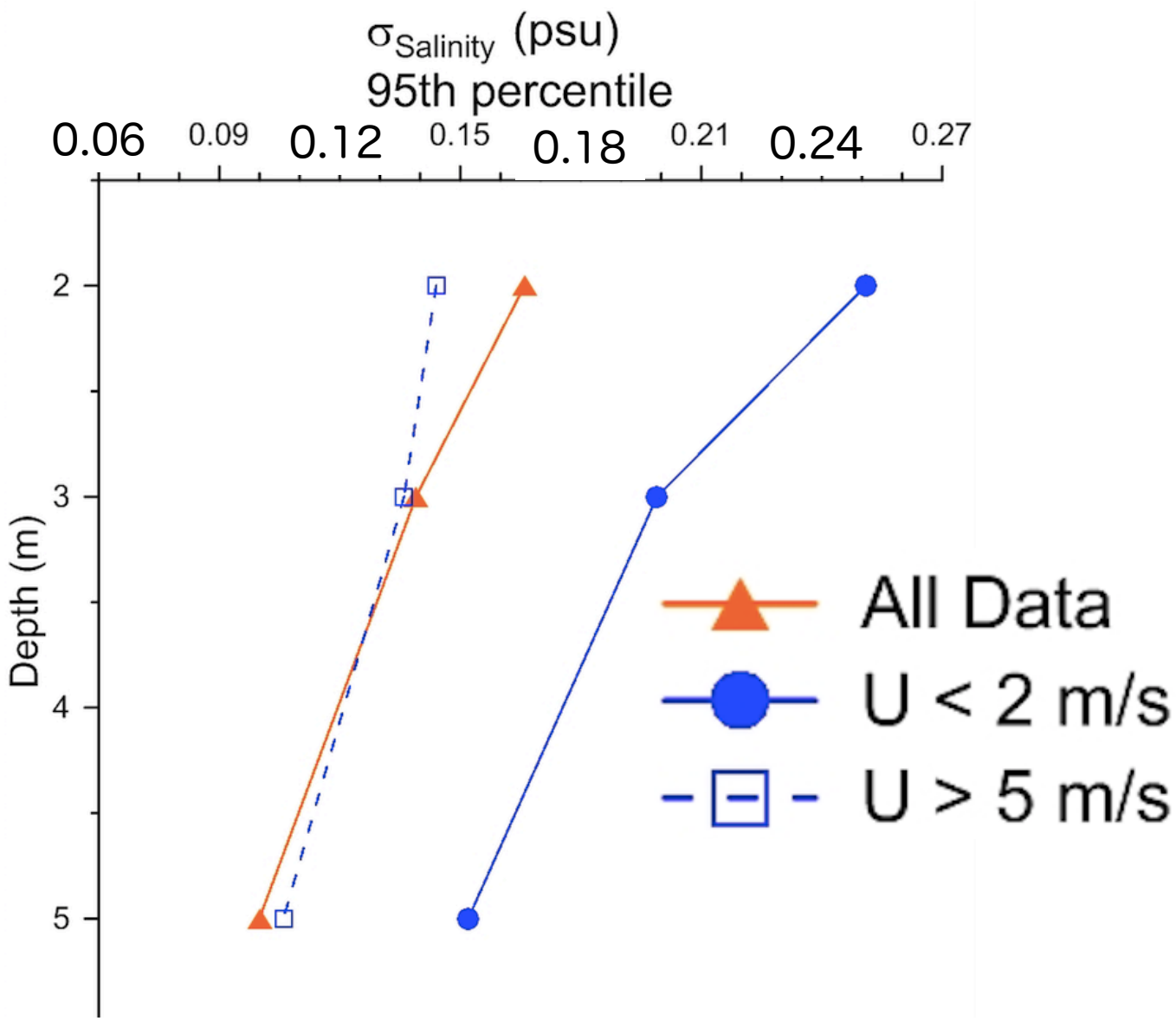
S at 5m



Small-scale salinity variability increases with rain, but is weak at 5 m depth

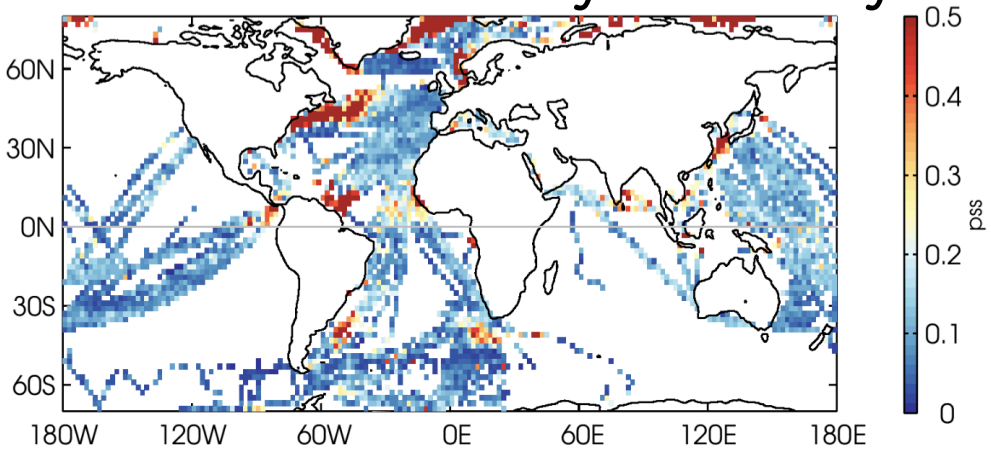


Small-scale salinity variability is much stronger under weak winds

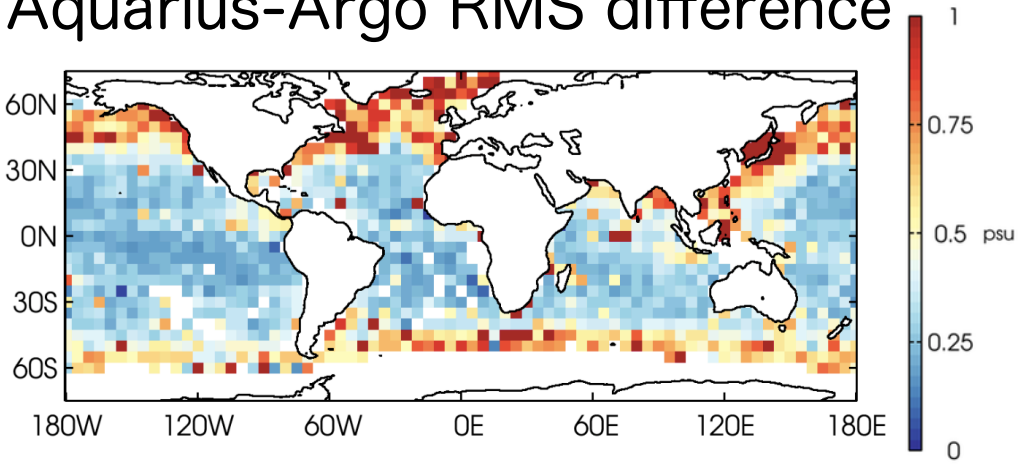


Implication for satellite validation & conclusions

Small-scale salinity variability



Aquarius-Argo RMS difference



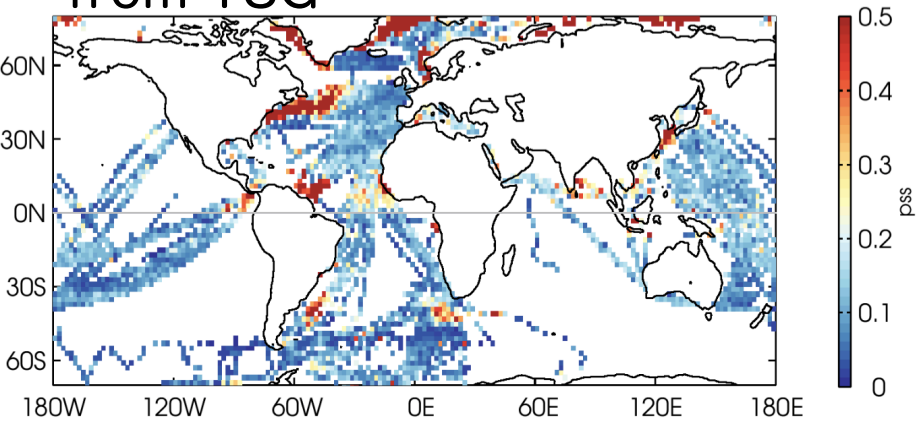
Sub-footprint-scale variability does not appear to be a dominant source of noise in Aquarius

Conclusions

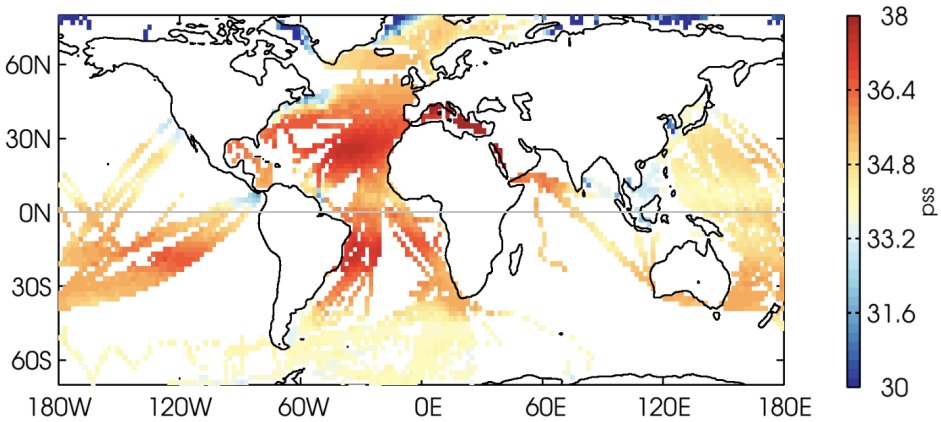
- TSG data capture small-scale variations that are dynamically-driven (from fronts, runoff), but underestimate surface-driven variability (from wind, rain).

- Aquarius-Argo noise is likely *not* dominated by sub-footprint-scale salinity variability.

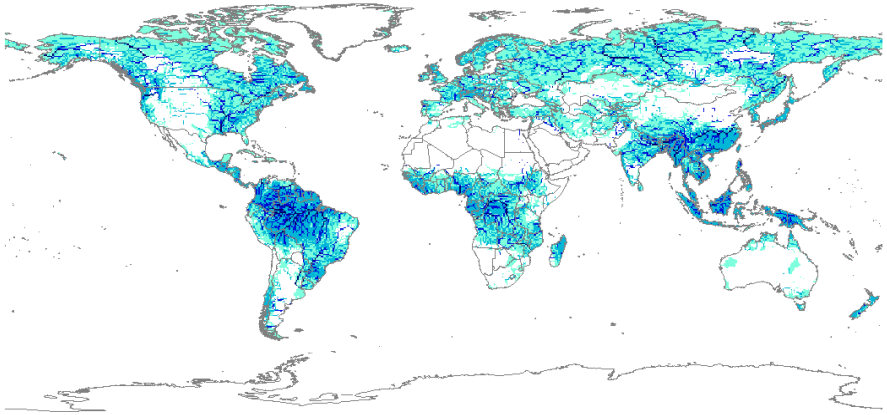
Small-scale salinity variability from TSG



Mean salinity from TSG



River discharge from Global Water System Project



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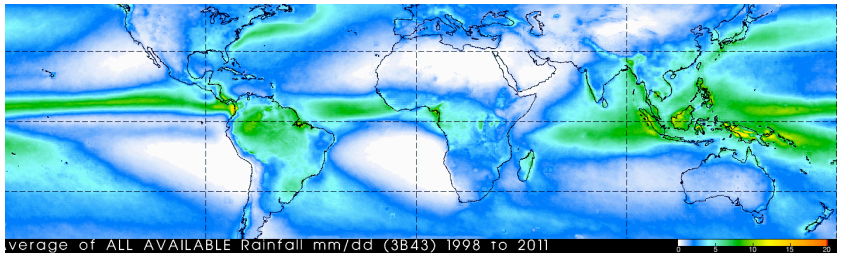
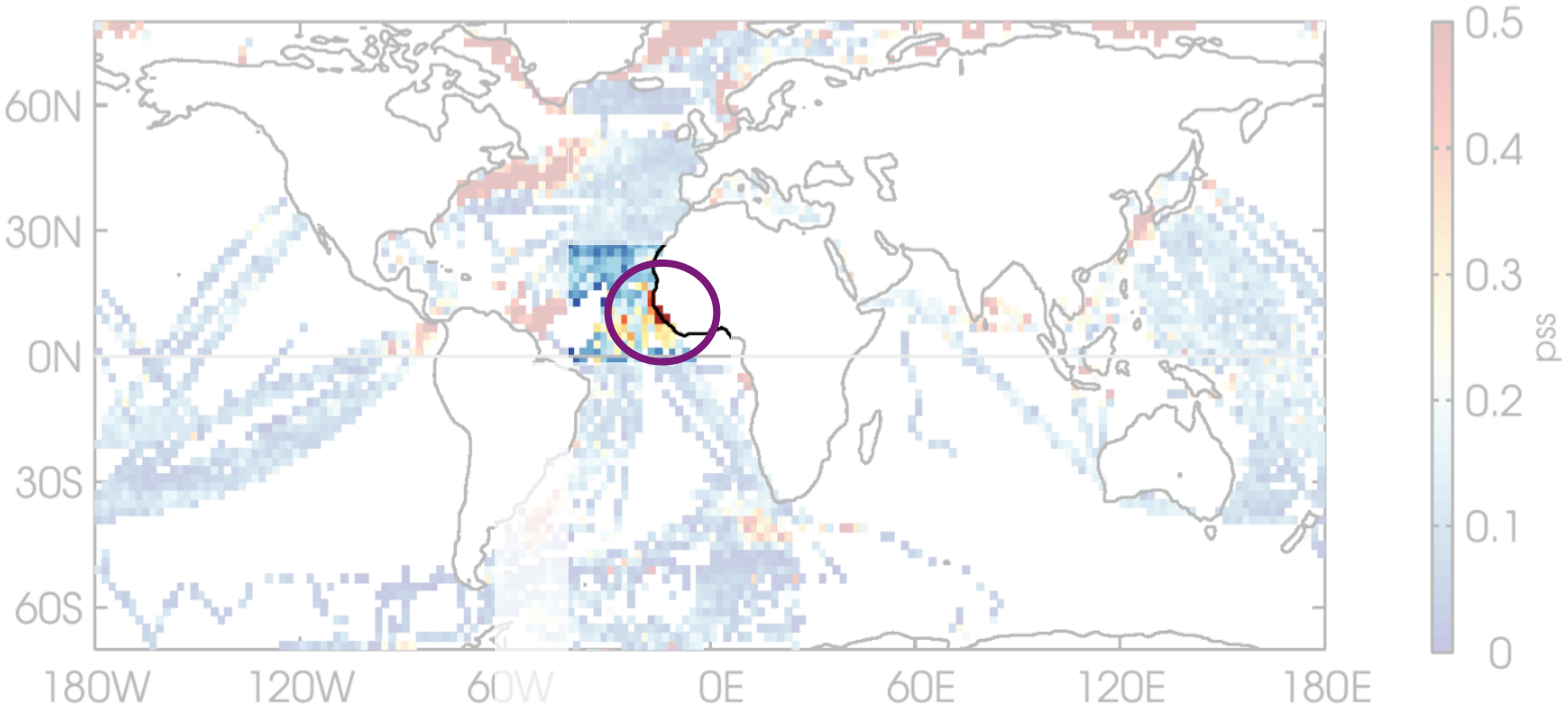


Eastern tropical Atlantic: river runoff



River runoff drives a seasonal cycle in small-scale salinity variability