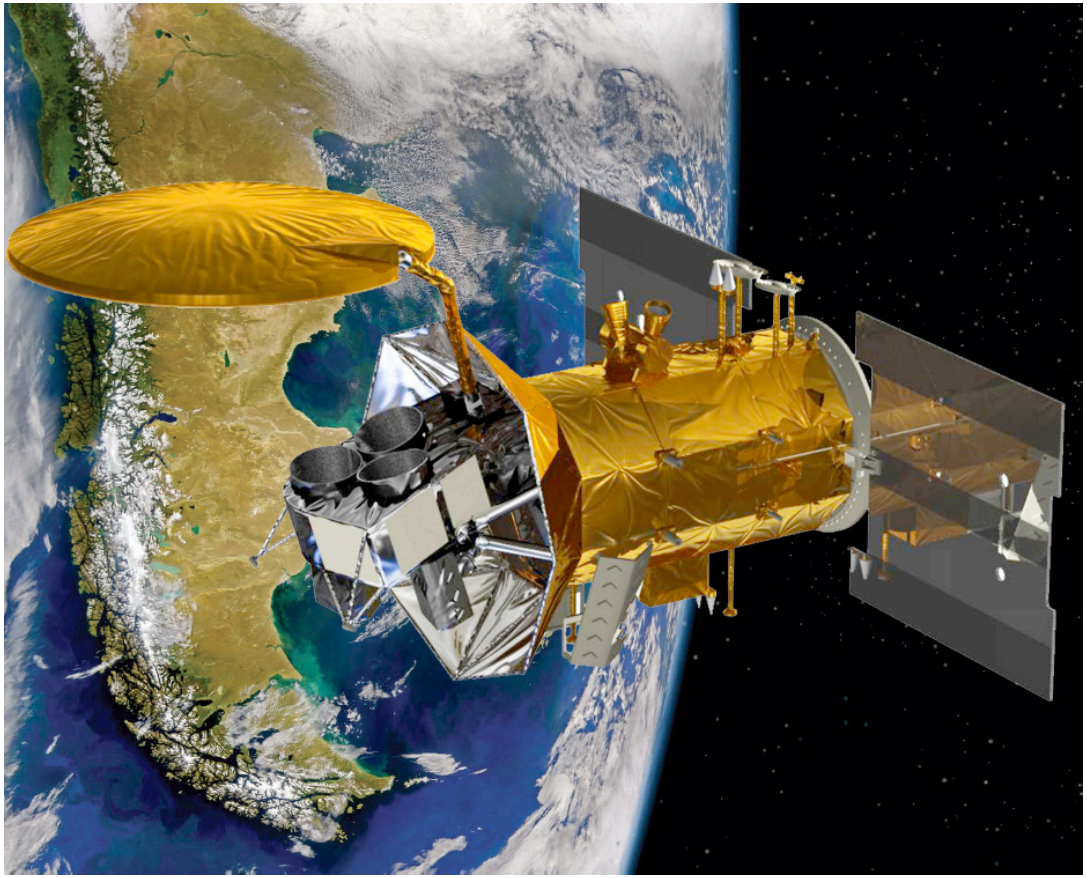
POS breakout session

Salinity at the ocean surface boundary layer

Kyla Drushka
Fred Bingham

Aquarius & SMOS satellites have motivated recent study of near-surface salinity variability

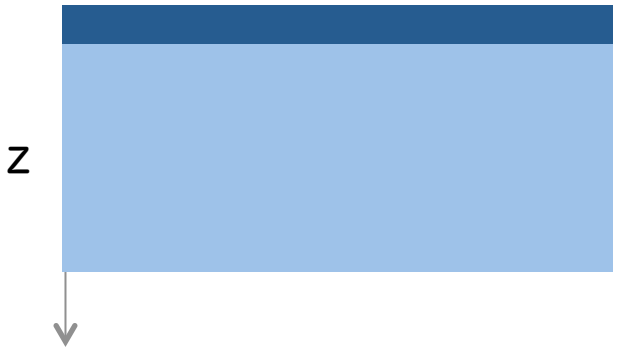


Salinity variations at the ocean surface boundary layer also of interest

In the context of air-sea interaction (observations & modeling)

Salinity can control the mixed-layer depth

Thin mixed layer:
Surface forcing has
a stronger effect

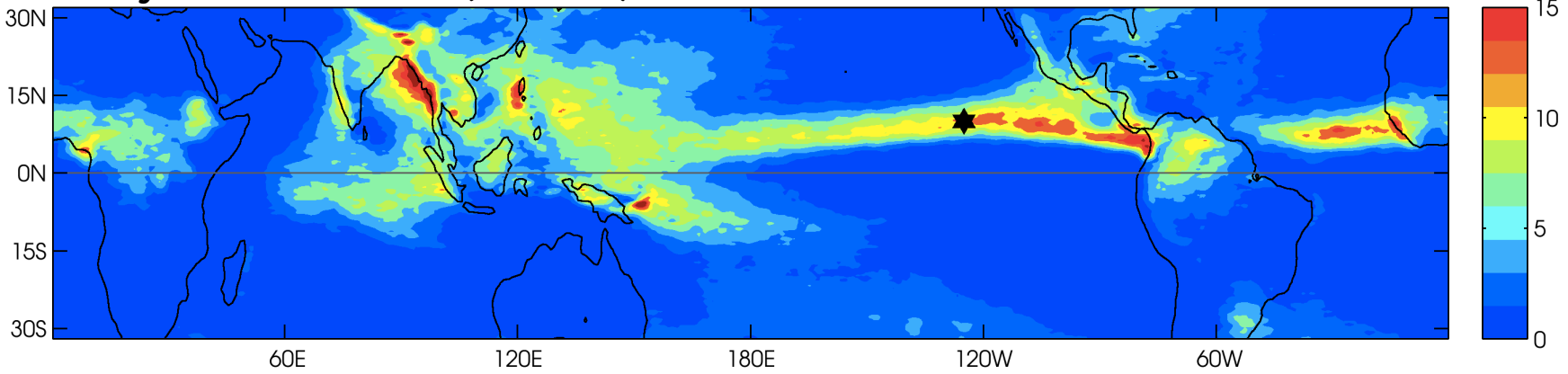


Thick mixed layer:
Surface forcing has
a weaker effect

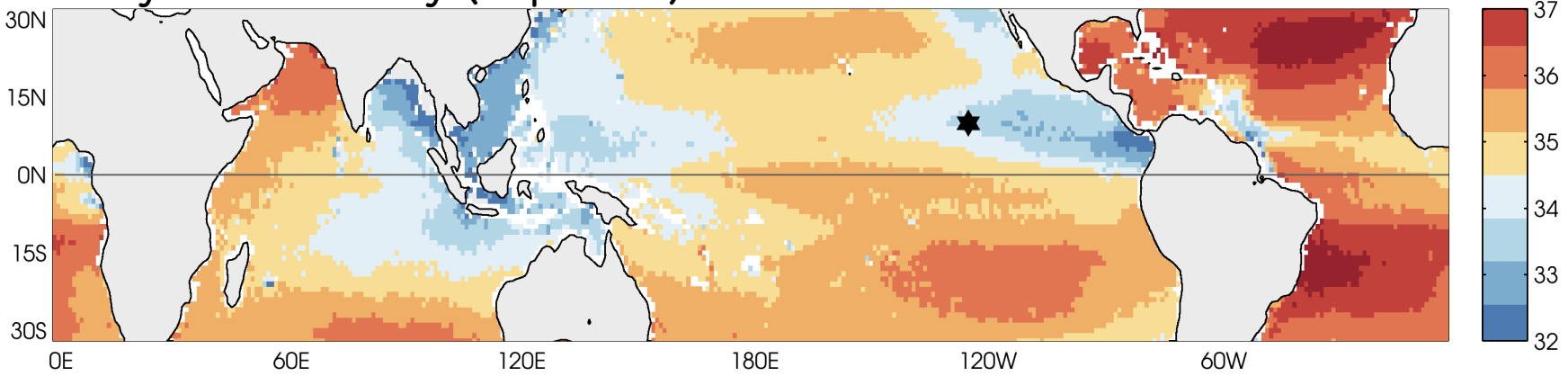
Salinity variations at the ocean surface boundary layer also of interest

"Salinity as a rain gauge" concept:
can we use SSS to infer rainfall?

July mean rainfall (TRMM):

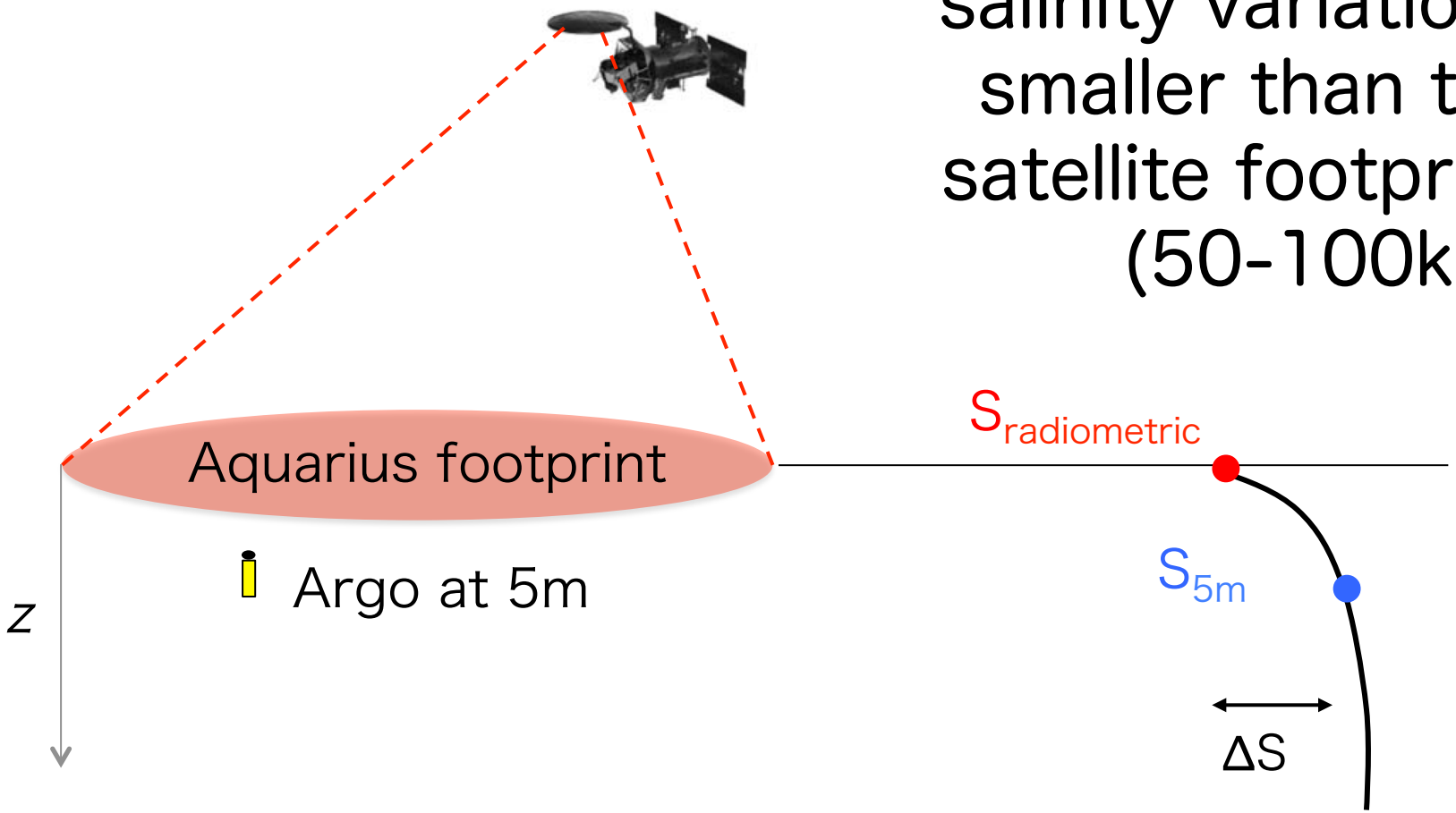


July mean salinity (Aquarius):



Vertical salinity gradients affect validation/interpretation of satellite salinities

So do horizontal salinity variations smaller than the satellite footprint (50-100km)

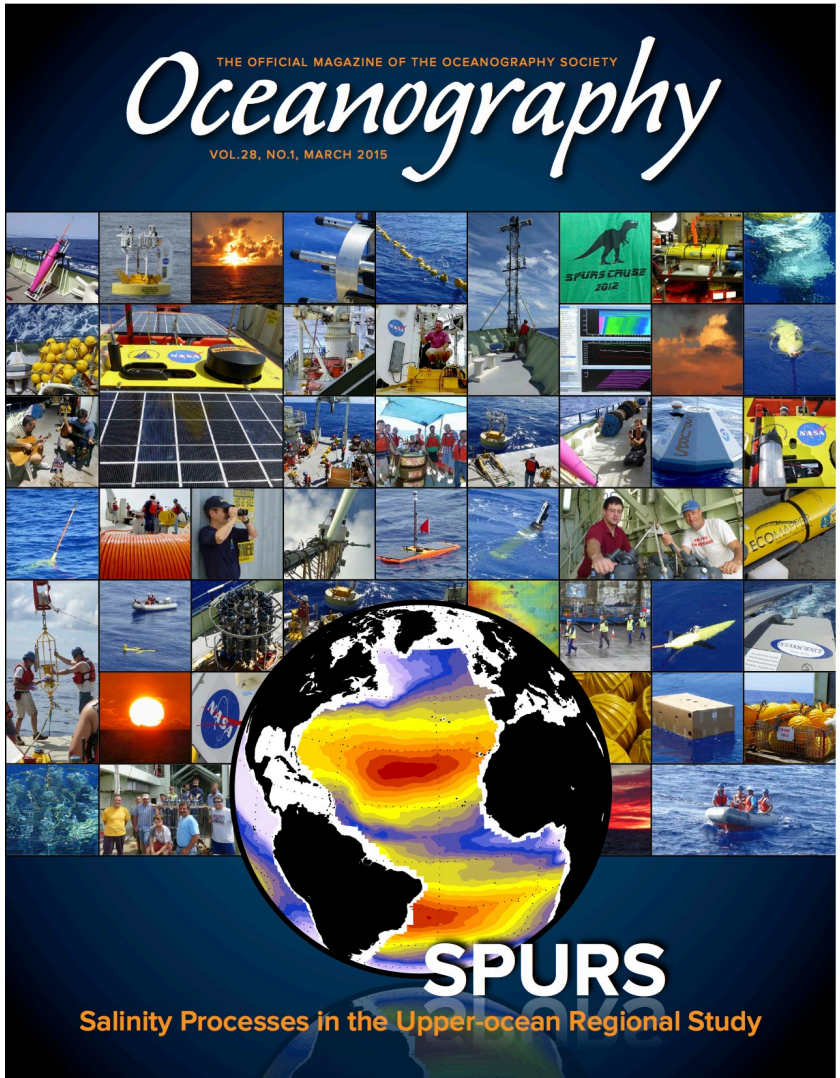


Challenges

- Rain events are episodic, brief, and small
- Evaporation impacts confined very near the sea surface
- Difficult to sample in the upper meter of the ocean
- Difficult to make rainfall measurements that capture the spatio-temporal structure of of rain

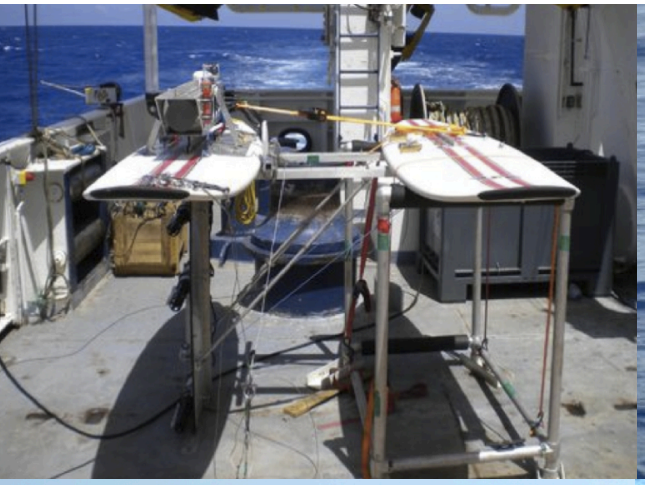
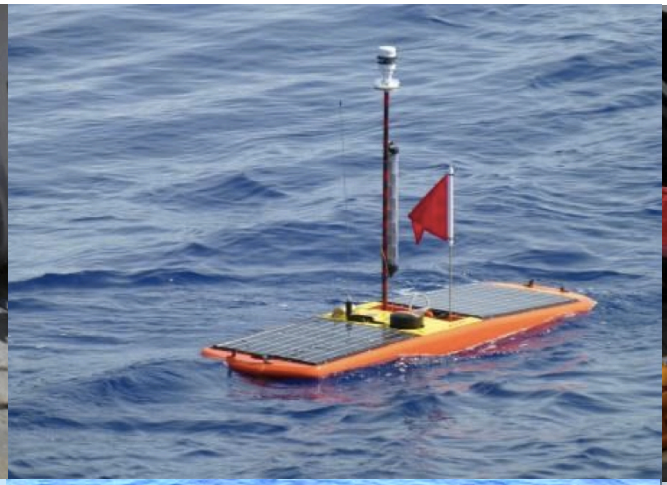
Current activities

SPURS-1 analysis & synthesis



Current activities

Developing/improving observational tools to be used in SPURS-2

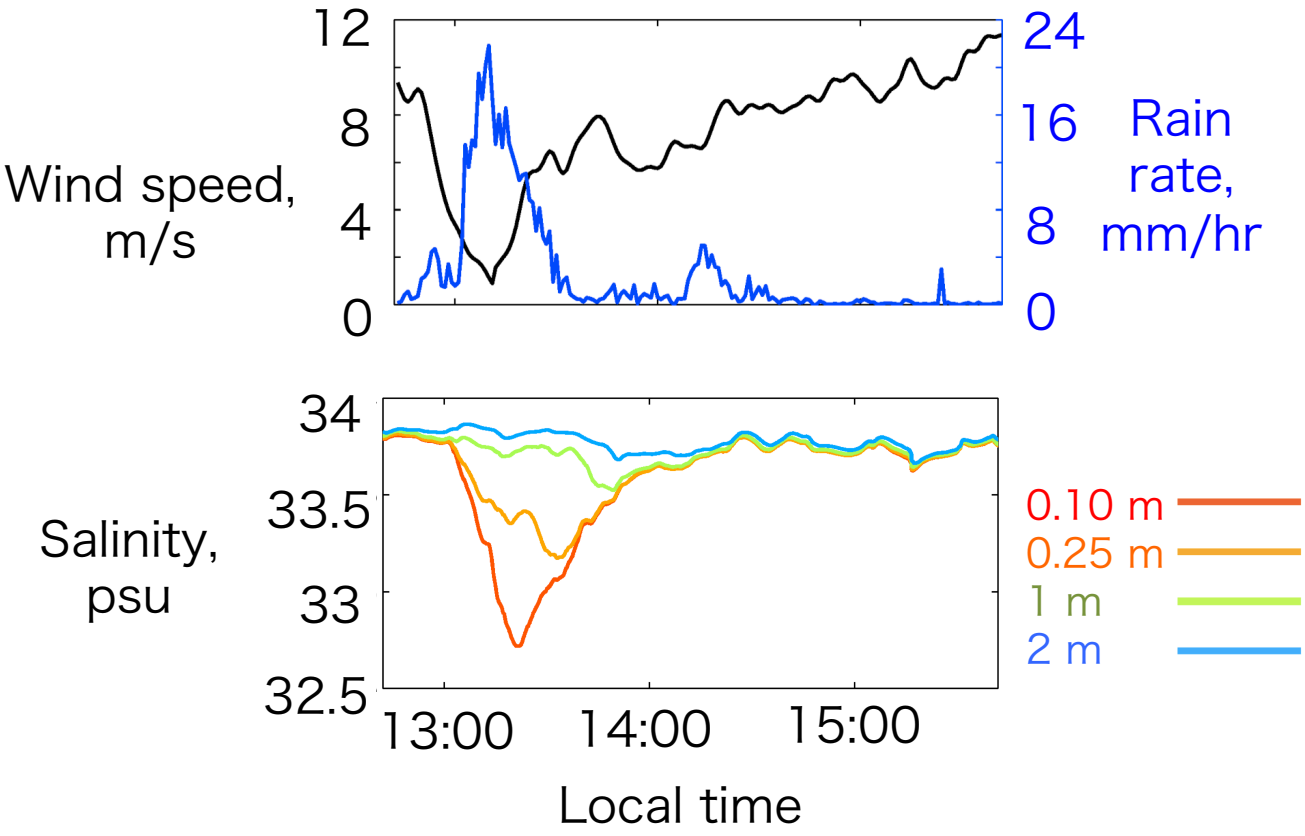





Current activities

Quantifying the vertical salinity gradients produced by rain:

- From direct observations



From Asher et al. JGR 2014

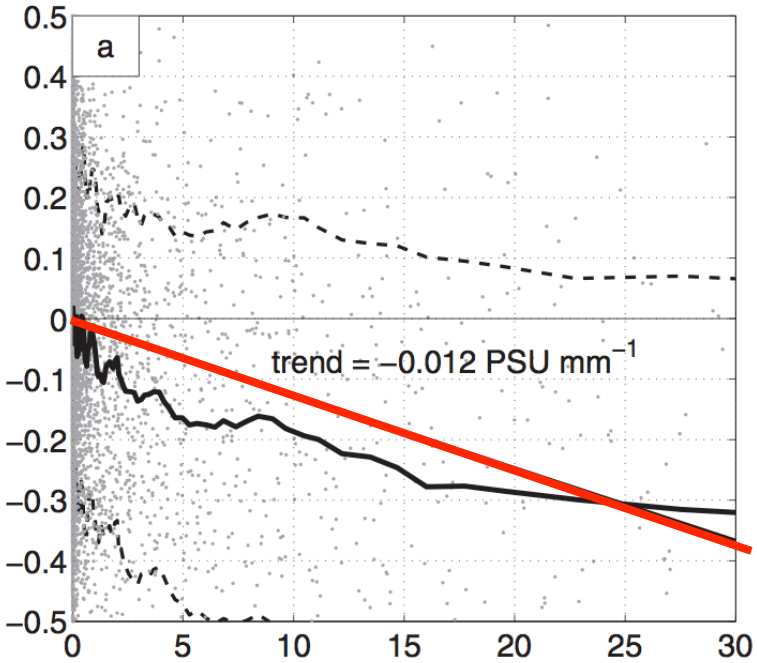
Current activities

Quantifying the vertical salinity gradients produced by rain:

- From satellite-Argo matchups

(Drucker and Riser 2014, Boutin et al 2014)

$S_{Aquarius} - S_{Argo}$, psu



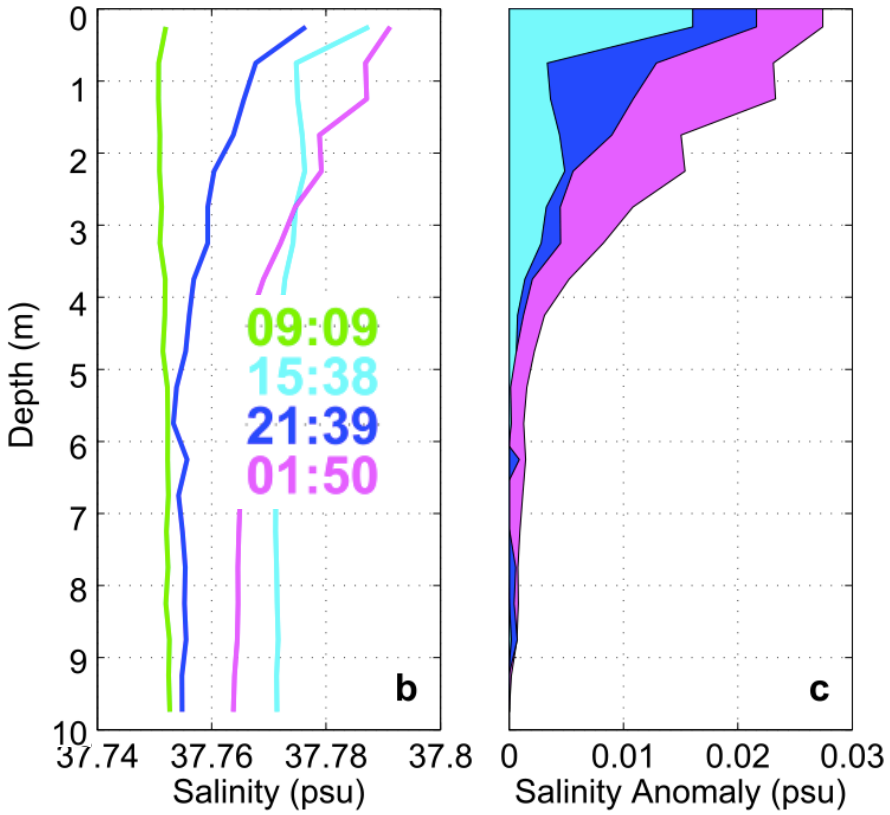
Salinity gradient is a function of rain rate

From Drucker and Riser JGR 2014

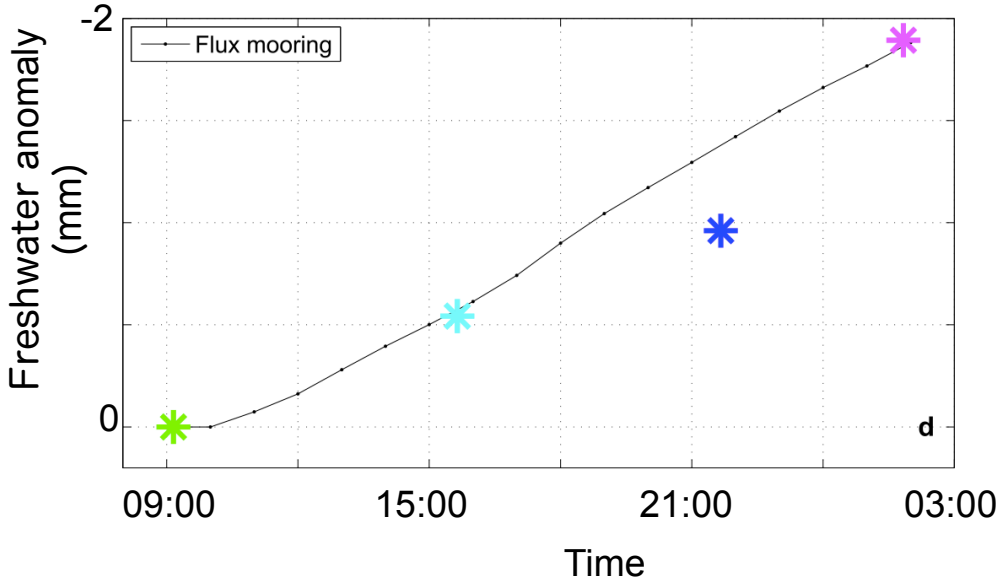
Current activities

Quantifying the effects of evaporation:

- From near-surface in situ instruments



Evaporation from flux mooring = evaporation inferred from salinity

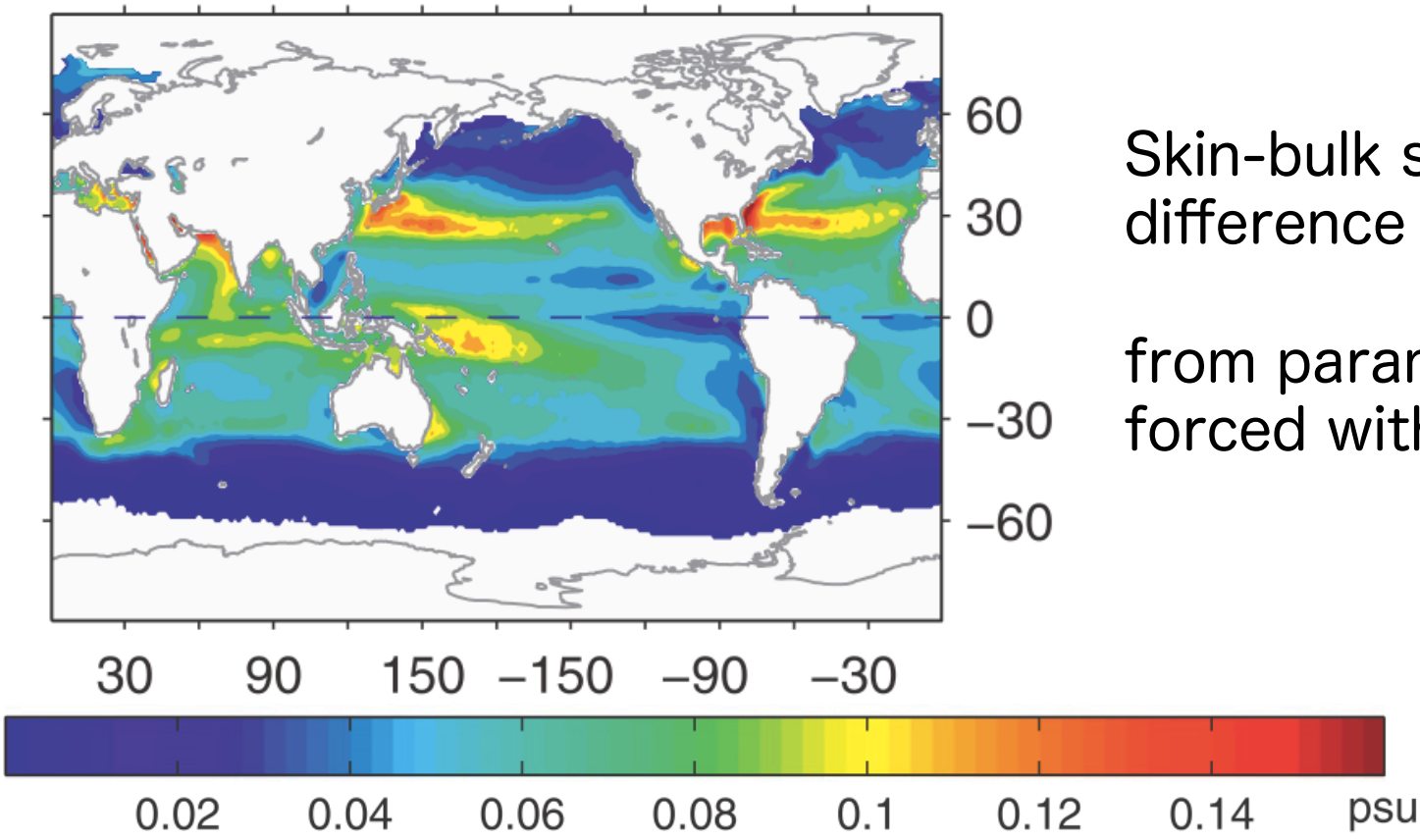


From Hodges & Fratantoni JPO 2014

Current activities

Quantifying the effects of evaporation:

- Globally with a model



Skin-bulk salinity difference (December)

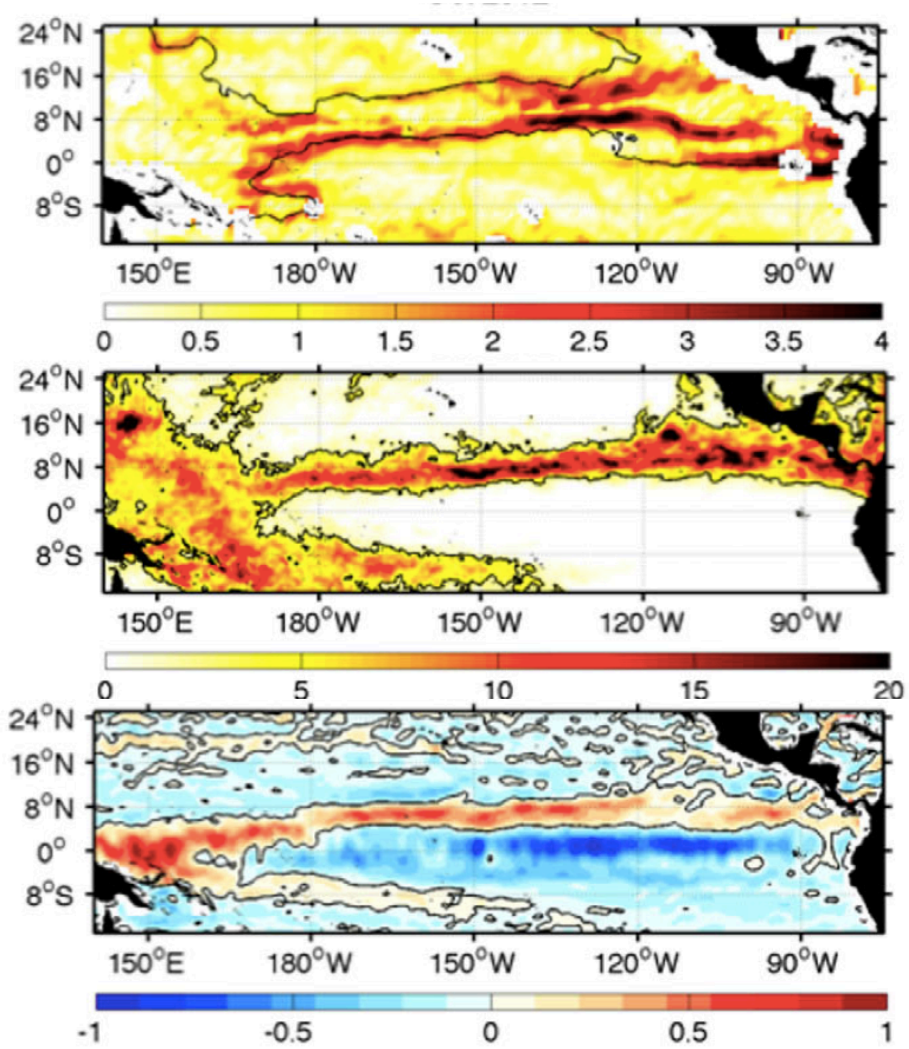
from parameterized model forced with OAFlux

From Yu JPO 2010

Current activities

Quantifying horizontal salinity variability

- Using satellite data



Salinity fronts
(psu/km)

Precipitation
(mm/hr)

Zonal currents
(m/s)

From Kao and
Lagerloef JGR 2015

Current activities

Many recent publications

JGR special collection: Early scientific results from the salinity measuring satellites Aquarius/SAC-D and SMOS (2014-2015)

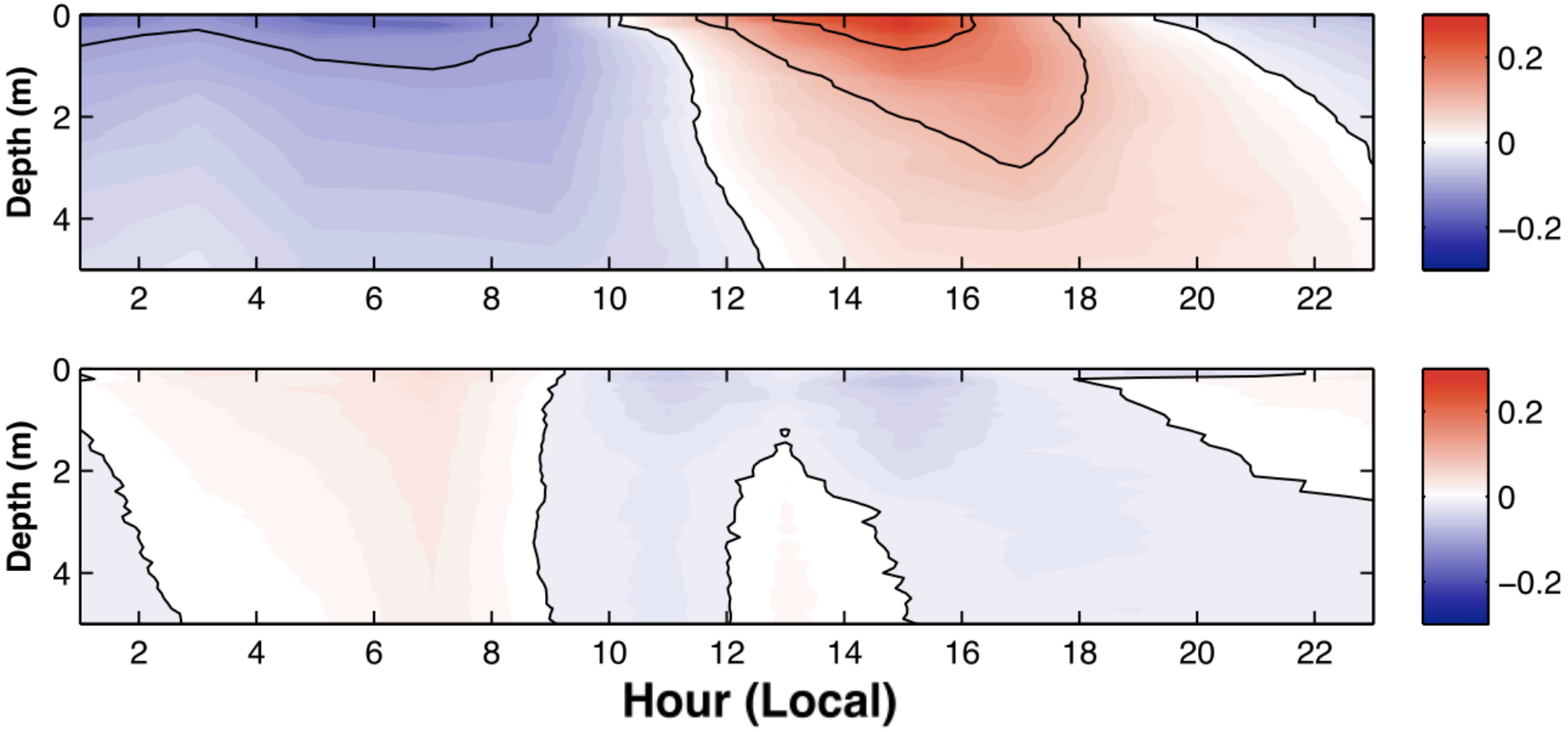
Oceanography special issue on SPURS (March 2015)

BAMS paper on near surface salinity variability (community effort by the international Satellite and In Situ Salinity (SISS) group) (in prep)

New research areas

Argo Surface-Temperature-Salinity (STS) floats

Composite daily cycle of temperature and salinity



From Anderson & Riser, JGR 2014

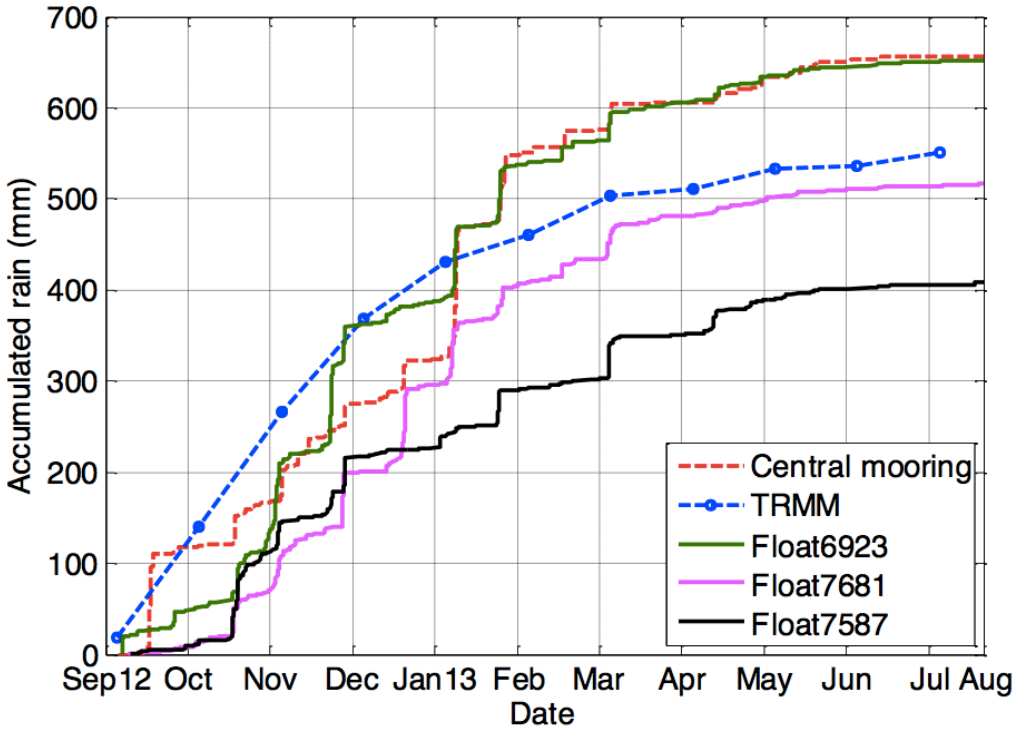
New research areas

Acoustic rain/wind sensor Passive Aquatic Listener (PAL)

– Accurate rain rate and wind speed in most conditions
– Wide-spread deployment possible (on Argo floats)

Deployed on Argo floats, moorings

Accumulated rain from Argo-PALs during SPURS-1. Agree with TRMM.



From Jie Yang

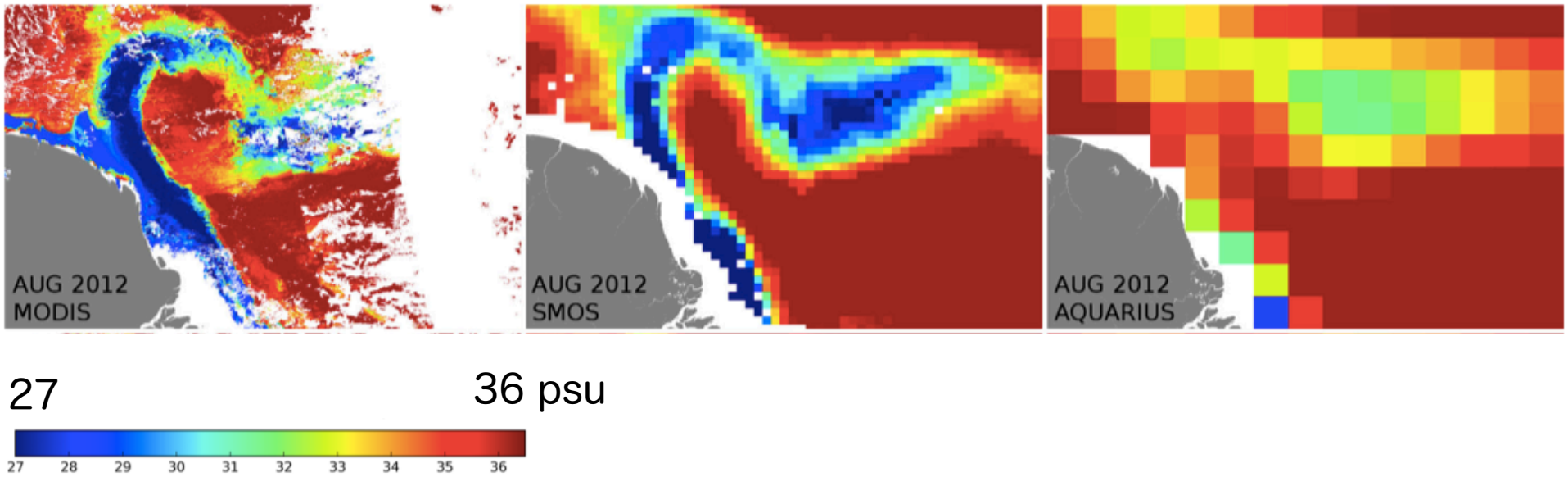
New research areas

Exploiting & improving satellite salinity

- Deriving SSS from MODIS reflectance
- River plume studies

One-month average of SSS in the Amazon plume

from MODIS | from SMOS | from Aquarius



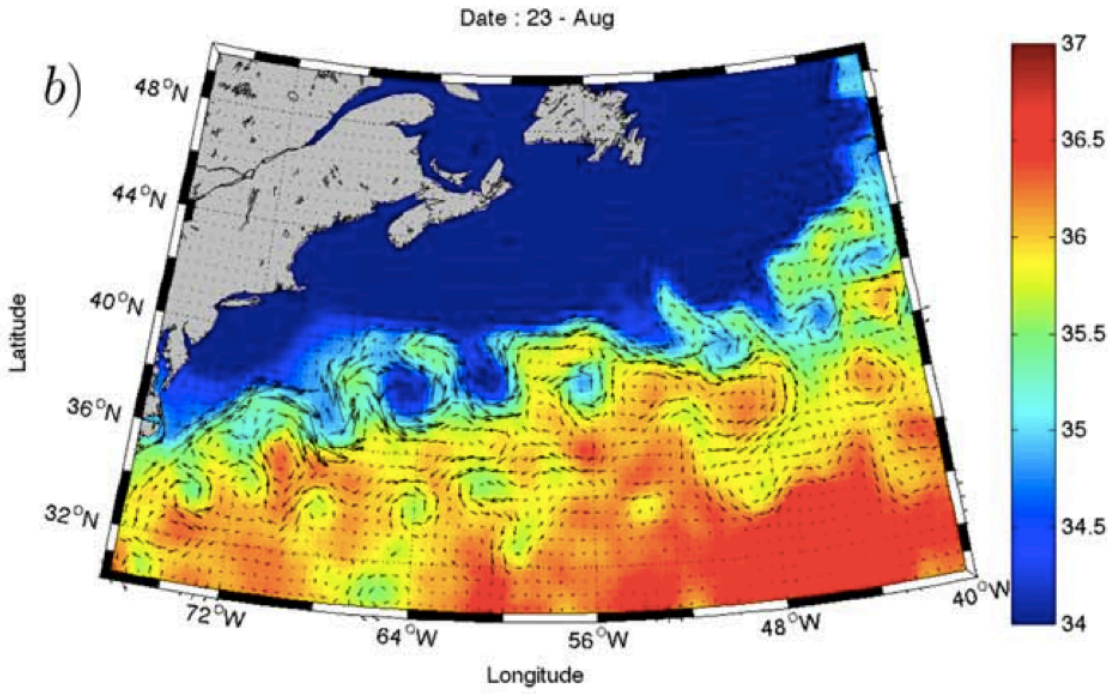
From Korosov et al. JGR 2015

New research areas

Exploiting & improving satellite salinity

– Spatially interpolating Aquarius with other satellite fields

Gulf Stream SSS from Aquarius reconstructed with altimetric SSH

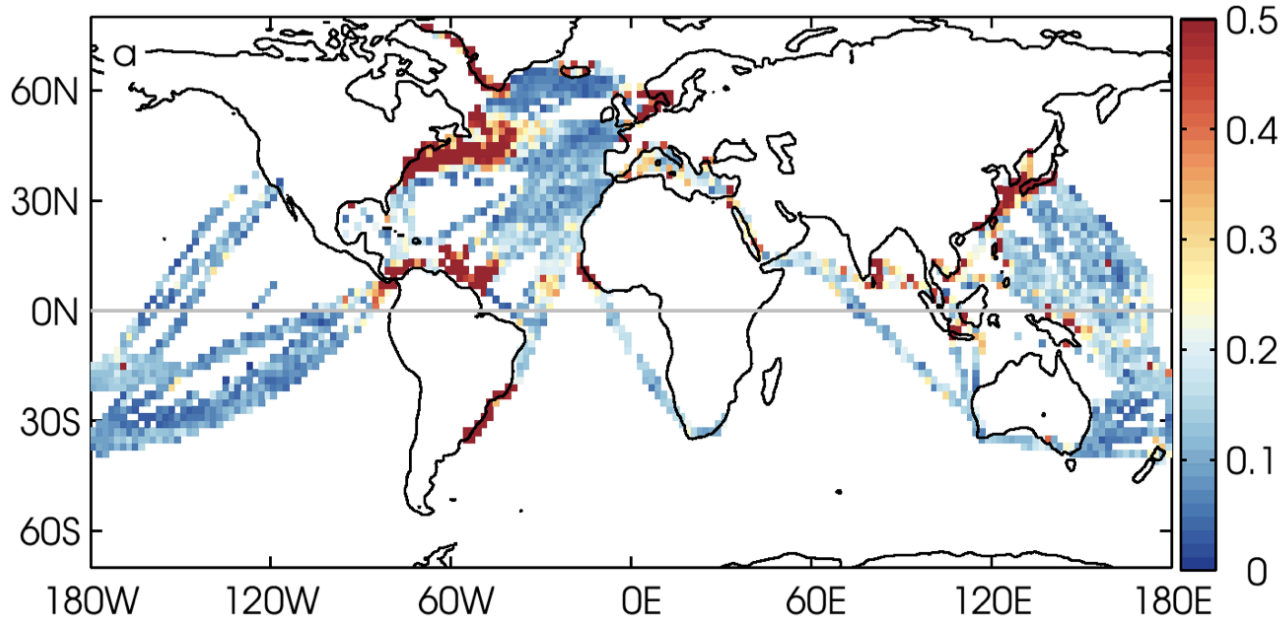


From Umbert et al. JGR 2015

New research areas

Quantifying horizontal salinity variability

– Using Thermosalinograph (TSG) data from Volunteer Observing Ships



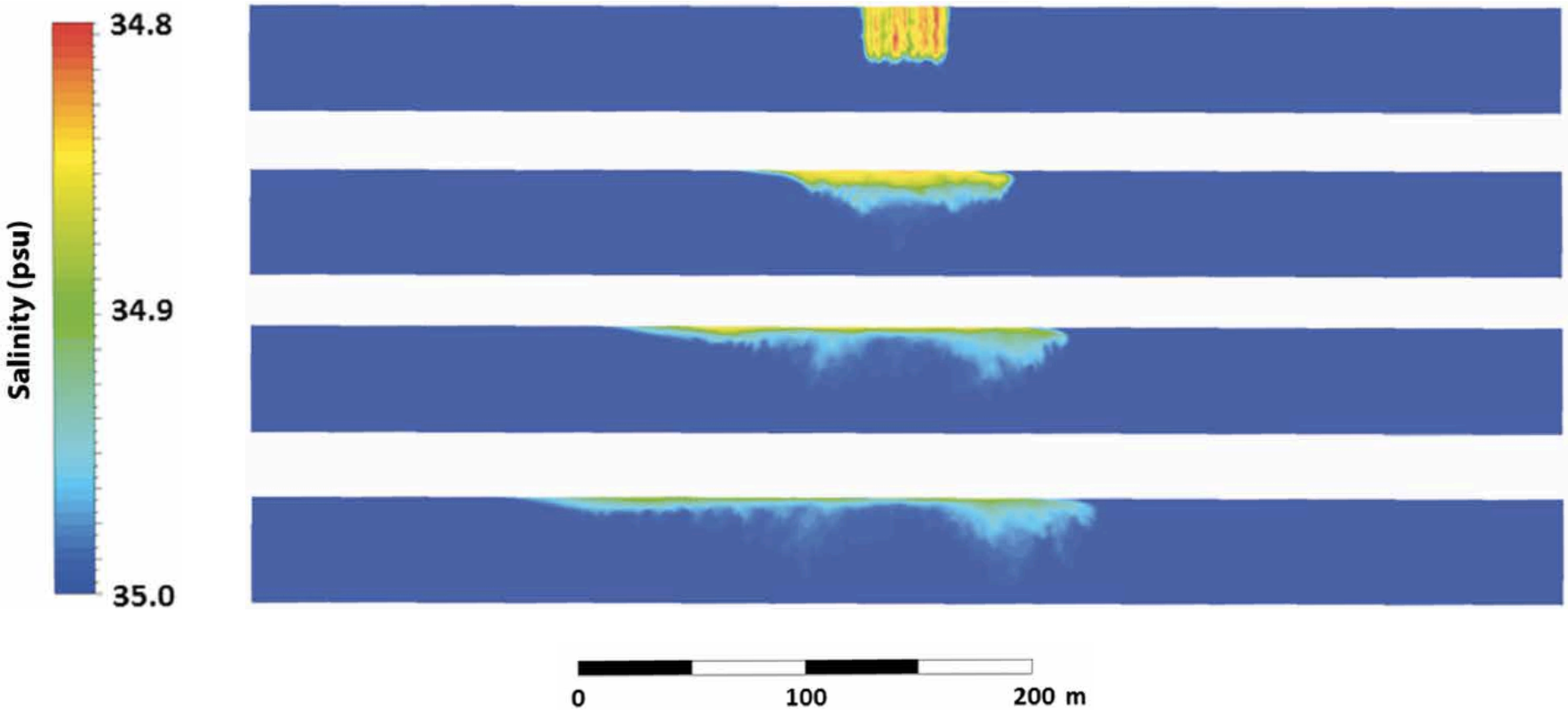
Standard deviation of SSS along 100-km ship transects (psu)

(in prep for BAMS)

New research areas

Modeling

– High-resolution numerical modeling of 3-D lenses

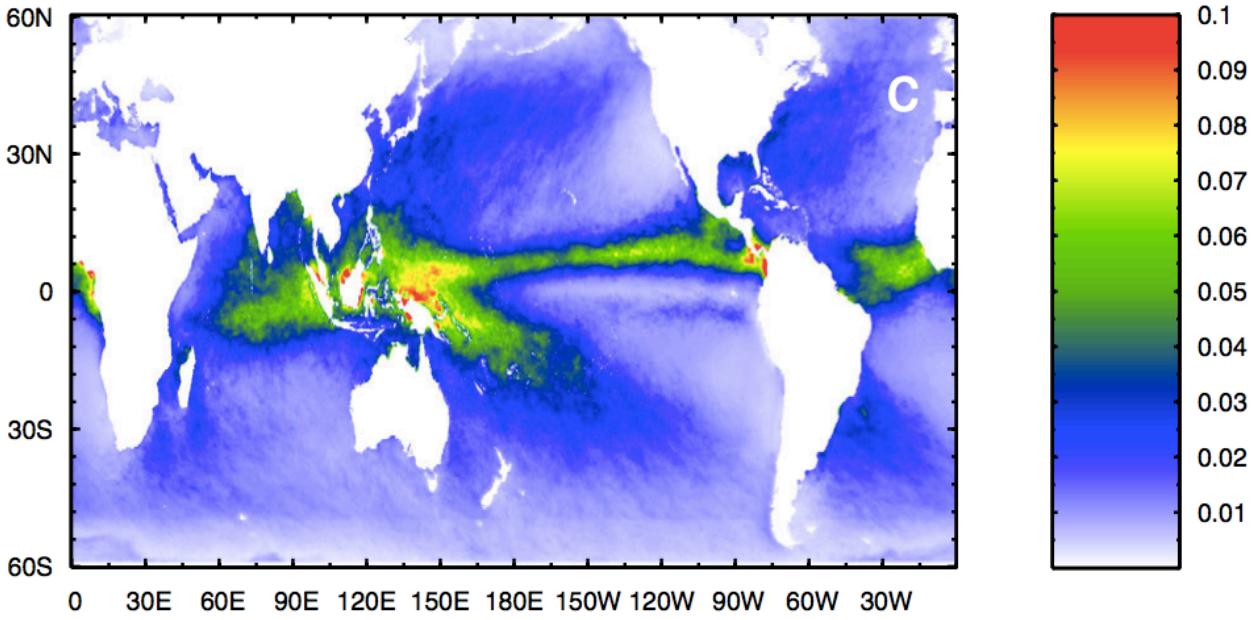


From Soloviev et al. Oceanography 2015

New research areas

Modeling

– Diurnal SSS from a 1-d predictive model



Amplitude of diurnal salinity (psu)

From Fine et al. JGR 2015

Gaps? What's next?

Aquarius

- Mission ended June 7, 2015 (after 3.75 years)
- SMOS still flying (higher resolution, lower accuracy)
- SMAP (Soil Moisture Active Passive) mission will also capture SSS: higher resolution, lower accuracy.

Understanding the dynamics of rainfall:

- Better parameterizations to incorporate rain into climate models?
  - → SPURS-2 (summer 2016 – summer 2017)

Connecting surface and bulk salinity

- For satellite cal/val
- Parameterize so satellite SSS can be better used as a surface boundary condition in models

Discussion points

What are the observational priorities?

- Additional process studies?
- Expand TSG sampling?
    - Volunteer Observing Ships (horizontal variability)
    - TSGs at multiple depths (vertical gradients)
- Expand Argo capabilities:
    - STS floats to measure the upper meter
    - PAL to measure rain/wind acoustically

Aquarius follow-on?

What are modeling priorities?

- Improving rain/evaporation parameterizations?
- Other?