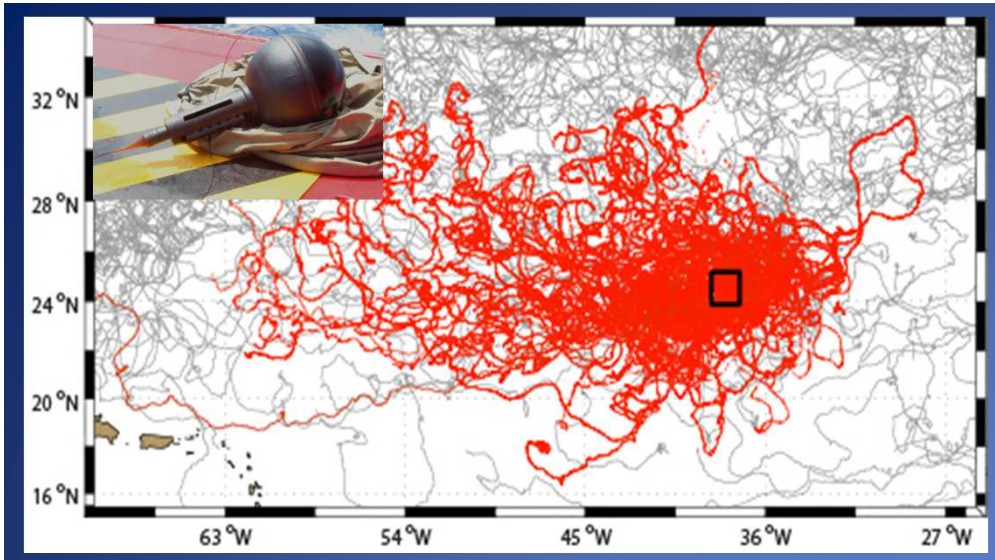
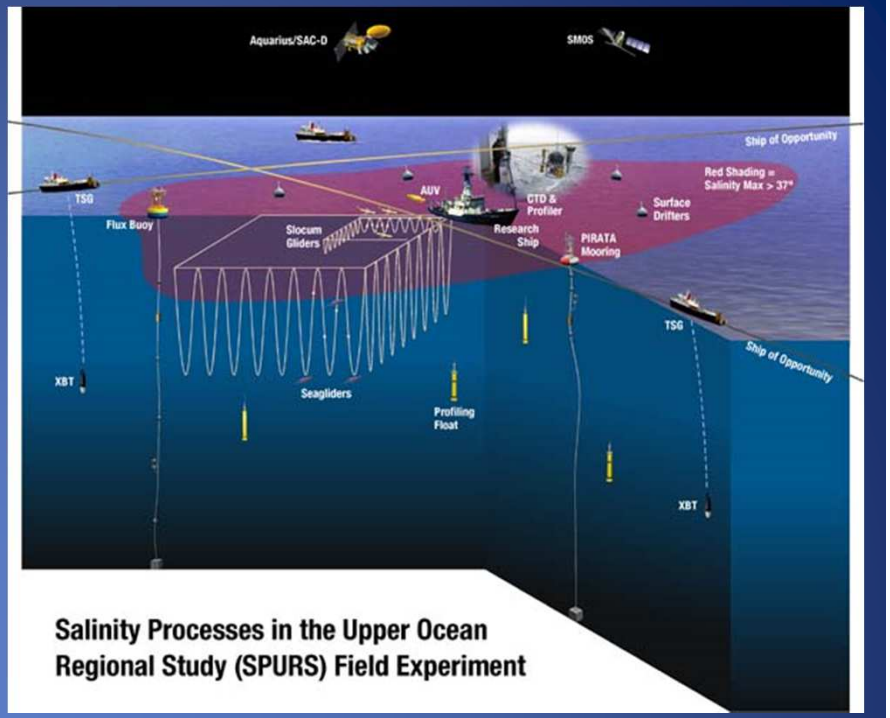




Sea Surface Salinity Observations from Drifters During SPURS

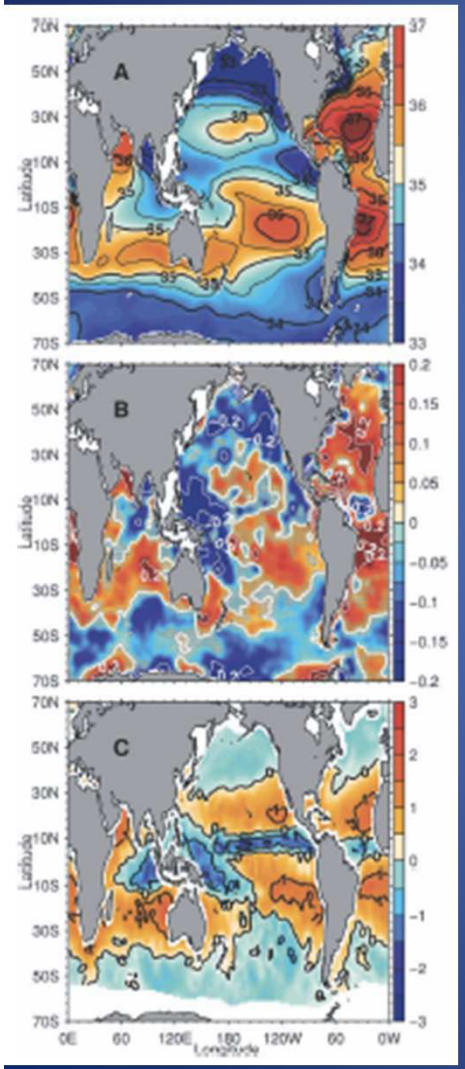
By
L.R. Centurioni[1], V. Hormann[1]
and
Y. Chao[2]
[1]Scripps Institution of Oceanography, La Jolla, California
[2]Remote Sensing Solutions, Pasadena, California

SPURS: A SSS study in the North Atlantic

GOALS:

- Quantify the processes that control the distribution of SSS to better understand the link between observed SSS trends and amplifications of the water cycle on climate scales
- Closure of the salinity budget of the upper ocean in the subtropical N. Atlantic
- Collection of in-situ data for satellite Cal/Val and for assessing the impact of sub-grid SSS variability

SSS distribution, trends and FW fluxes



sss

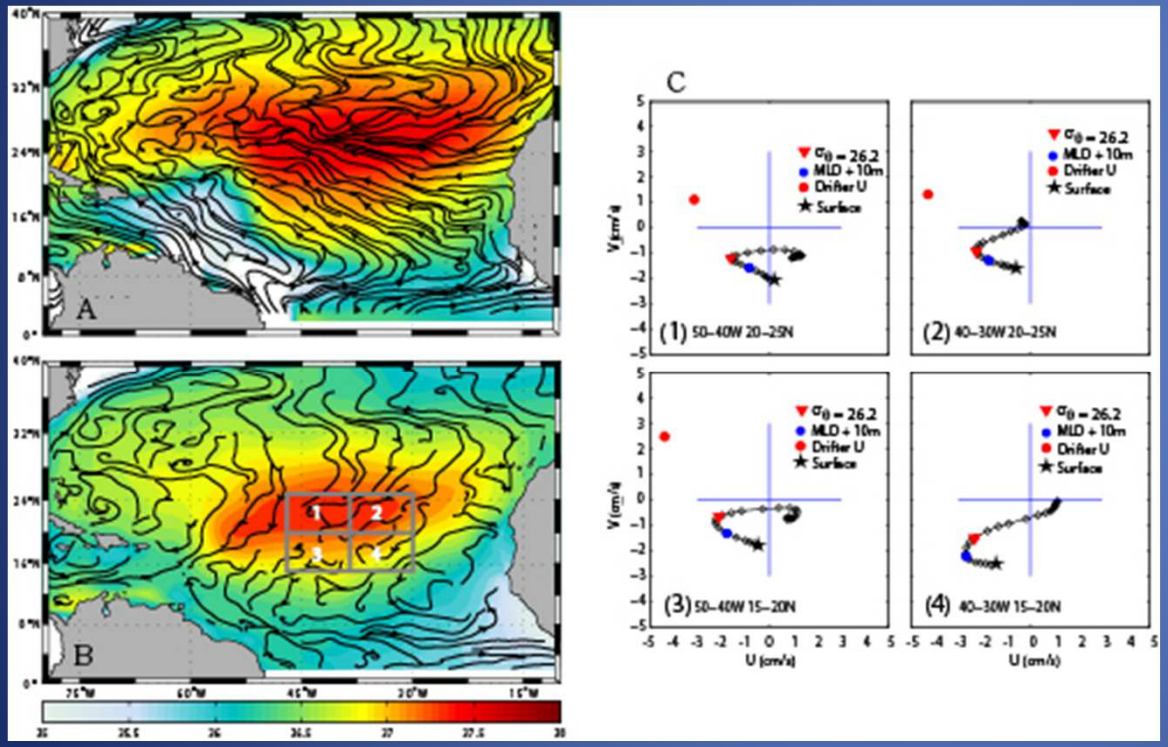
d(SSS)/dt

FW flux

- Anthropogenic climate change is projected to amplify the global hydrological cycle
- Such amplification is thought to result in increasing SSS in evaporating regions and decreasing SSS in high precipitation regions
- Coupled models are unable to reproduce spatial patterns of climatological mean salinity

Durack and Wijffels, 2010 and Durack et al, 2013

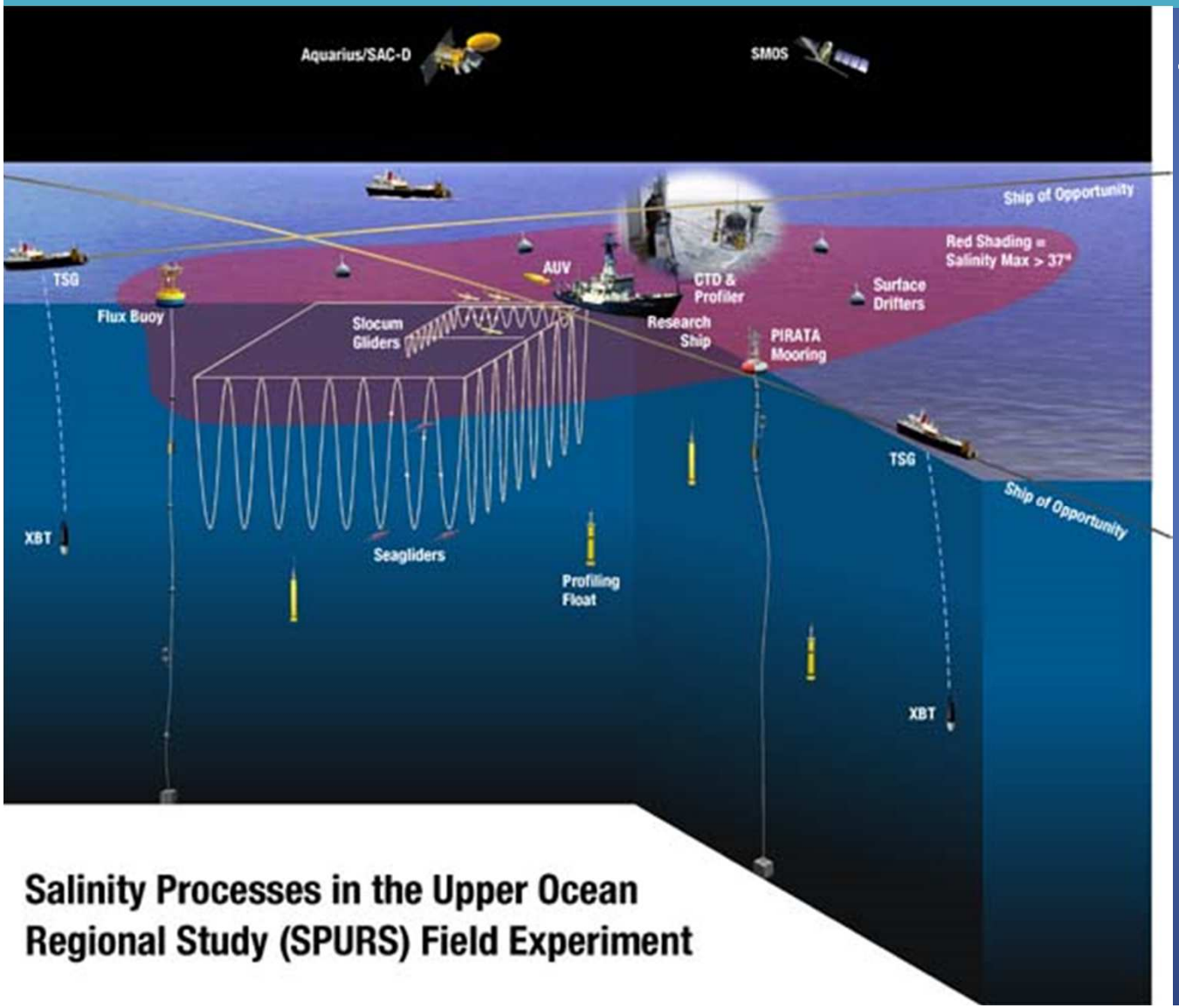
SSS maximum and circulation



- SPURS focused on the subtropical N. Atlantic, in the evaporating region
- Direct current measurements are needed!

Centurioni et al. 2014, accepted

The SPURS concept

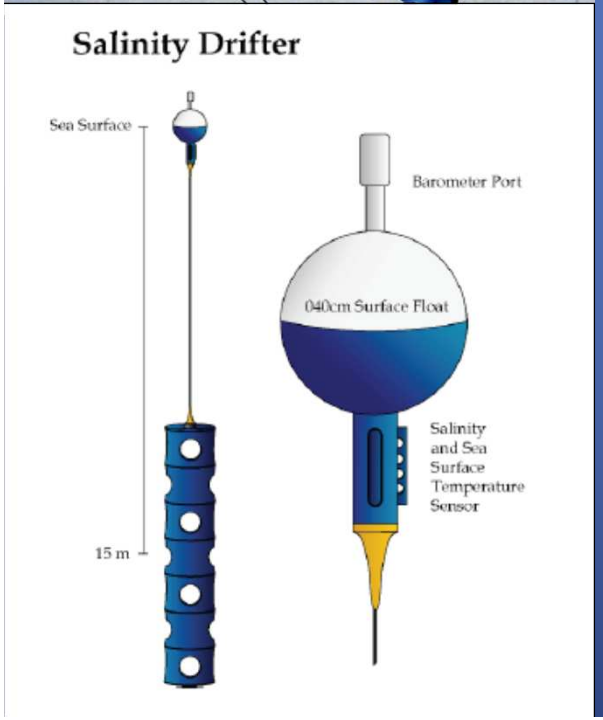


Salinity Processes in the Upper Ocean Regional Study (SPURS) Field Experiment

SSS from drifters provides:

- Direct measurements of surface salt fluxes
- Cal/Val for SSS retrievals from space, a clear benefit for climate scientists

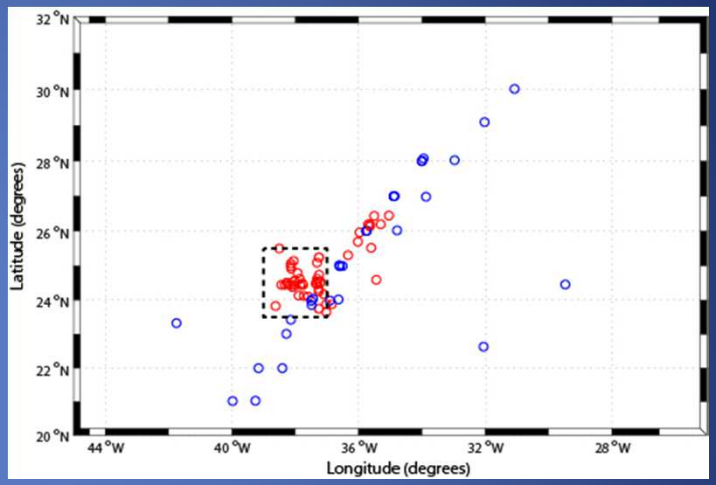
SVP-S drifter

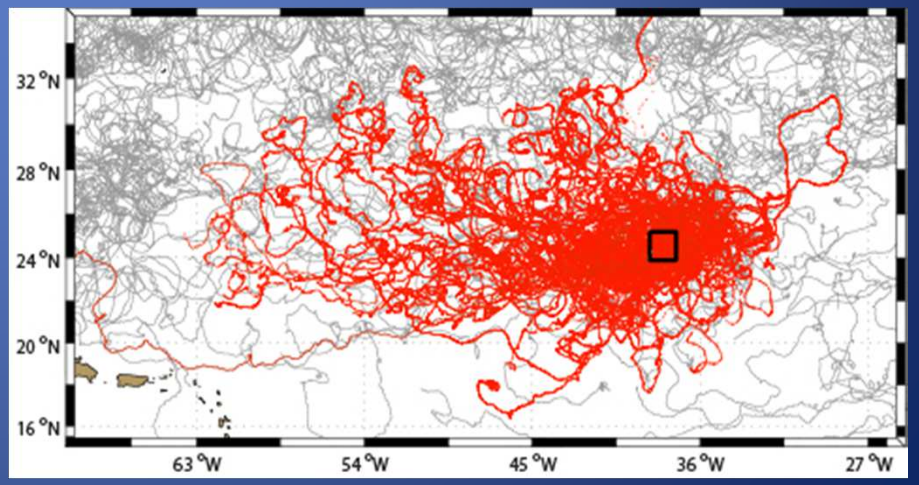


- GPS: ± 50 m (rms)
- SSS every 30 minutes
- Conductivity: ±0.0003 S/m
- Temperature: ± 0.002°C
- SSS: ± 0.02-0.04 PSU [Reverdin et al., 2007]
- Air pressure (optional): ± 0.5 hPa
- Endurance: ~ 2 years
- Depth of SSS sensor: 0.5 m
- Poisoned cell

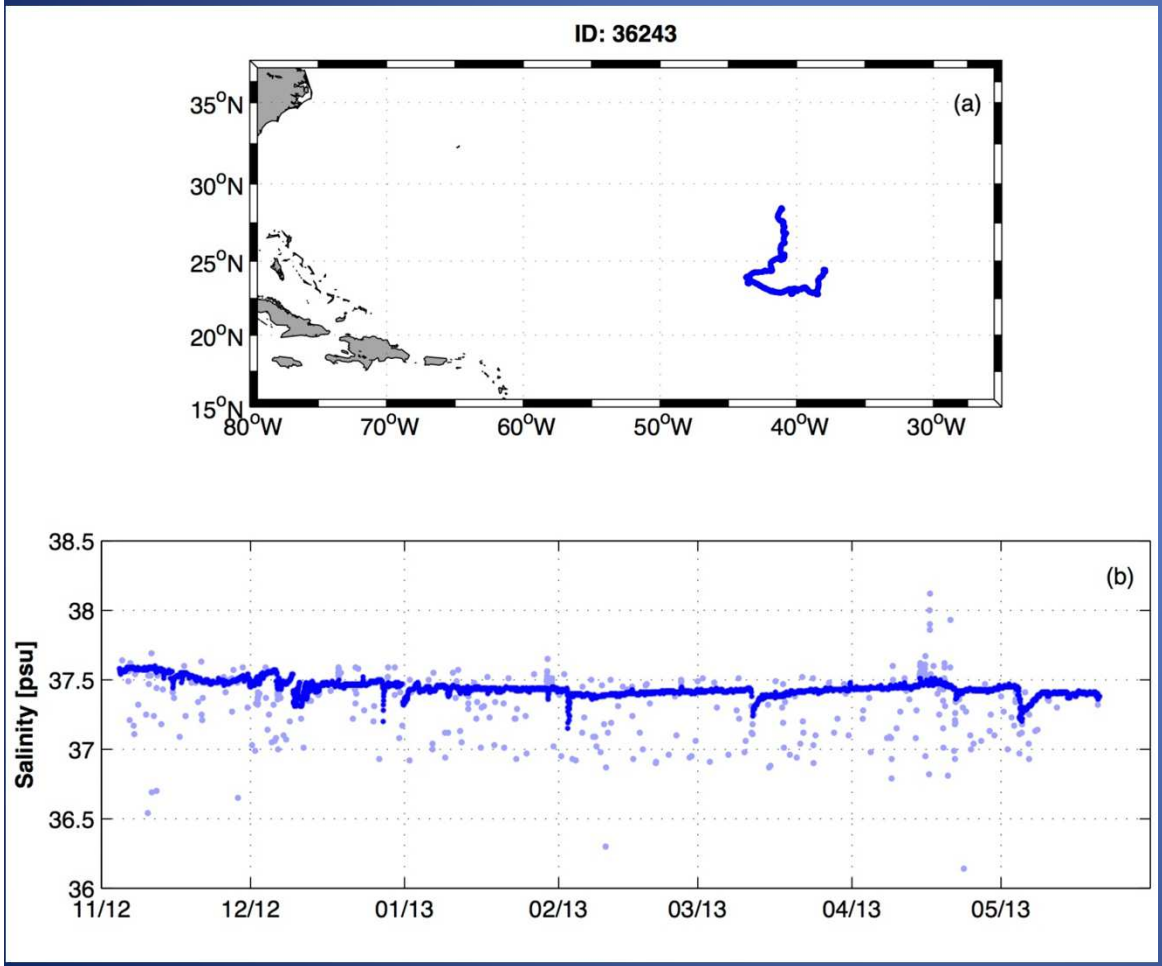
Drifter deployments and Tracks

Ship/cruise	SVPS	SVP	Deployment times
Strasse-R/V Thalassa	10	10	8/21-8/27/2012
SPURS-R/V Knorr	18	-	9/17-10/3/2012
RAPID-RRS Discovery	9	-	10/04/2012
MN Colibrí	3	-	11/27-11/28/2012
MIDAS-R/V Sarmiento	36	-	16/3-17/4/2013
MN Colibrí	-	10	3/28-3/30/2013
MN Colibrí	-	2	4/10-4/11/2013
EN522-R/V Endeavour	6	-	3/19-4/5/2013
R/V L'Atalante	-	6	5/29-5/30/2013
MN Colibrí	-	8	7/14-7/15/2013
MN Toucan	-	5	10/12/2013
Gamin	6	-	10/27/2013
MN Colibrí	-	5	12/8-12/9/2103
MN Colibrí	-	5	4/23-4/24/2014
MN Colibrí	-	5	7/10-7/11/2014
Total number of GDP drifters deployed for SPURS	**88**	**56**	





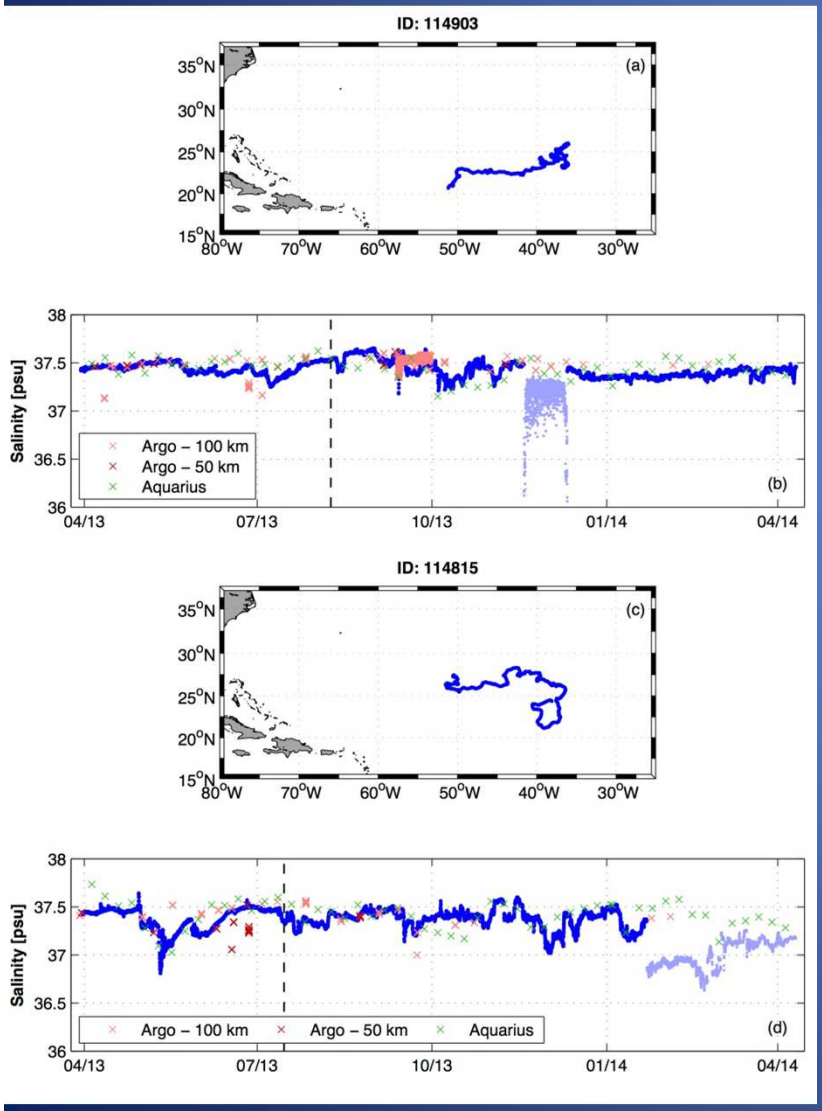
Quality of the Salinity Data: QC



- Low bias noise due to air bubbles requires manual edits

Hormann et al. 2014, submitted

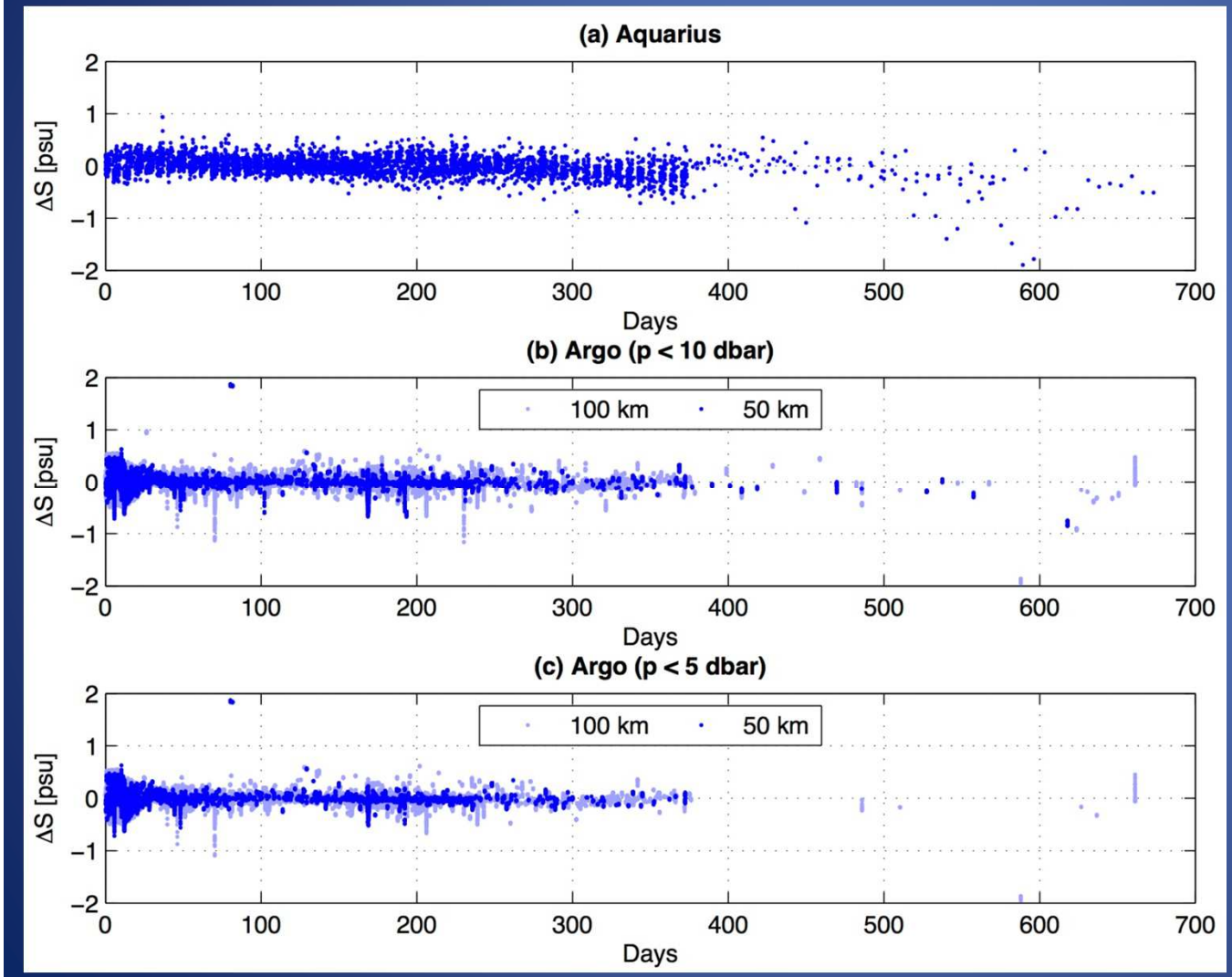
Quality of the Salinity Data: QC



- Other corrections needed for step-like features and anomalous spikes not verified by nearby Argo floats or Aquarius data

Hormann et al. 2014, submitted

Long Term Drift of SVP-S data

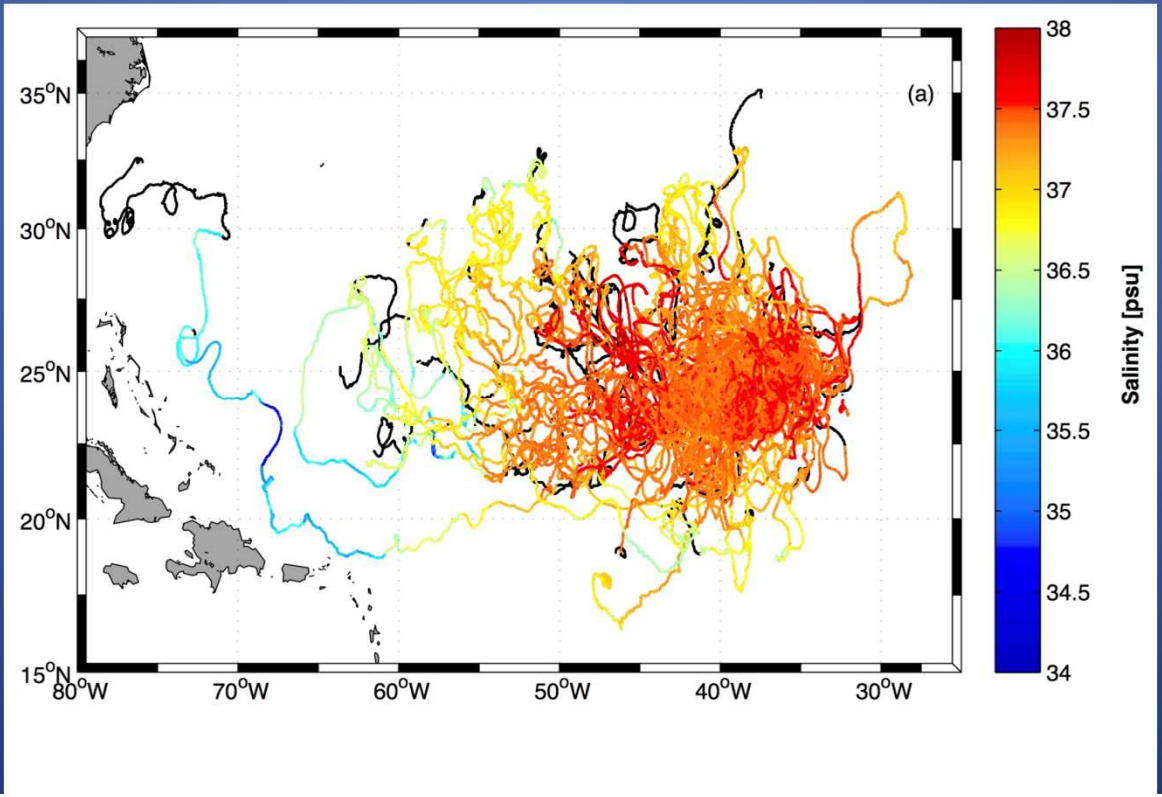


Hormann et al. 2014, submitted

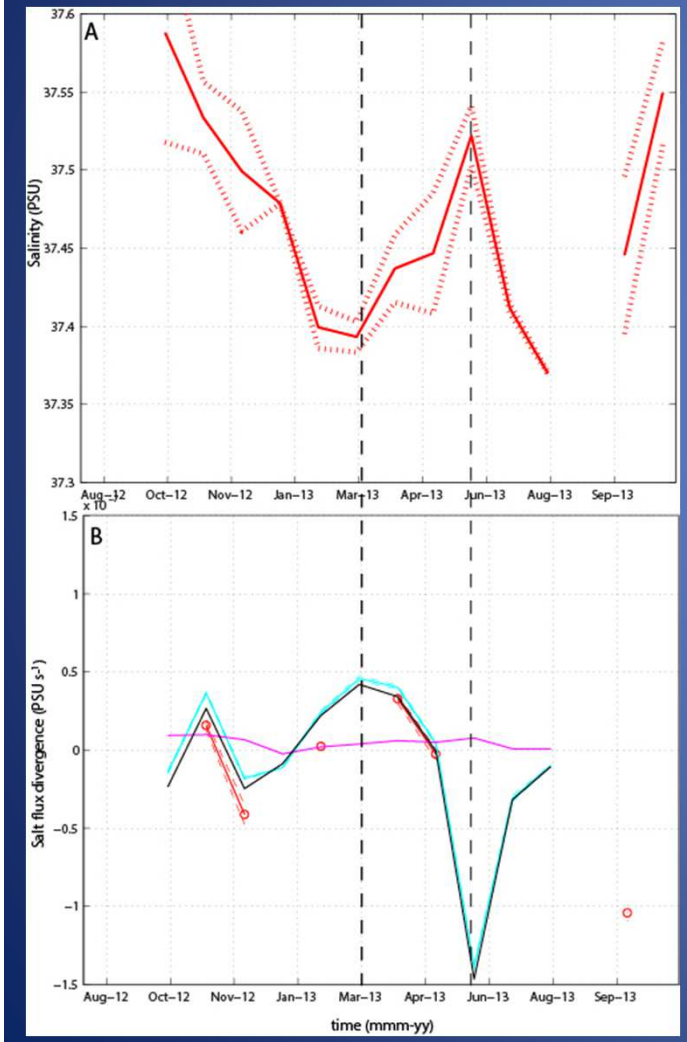
- Aquarius shows an apparent drift
- No obvious drift for up to about one year when compared with Argo data

SSS from drifters

- 996,583 SSS data collected between August 2012 and April 2014 were used to compute the SSS flux divergence
- The high sampling rates allow for investigation of Aquarius' sub-grid scale variability



Horizontal salt fluxes

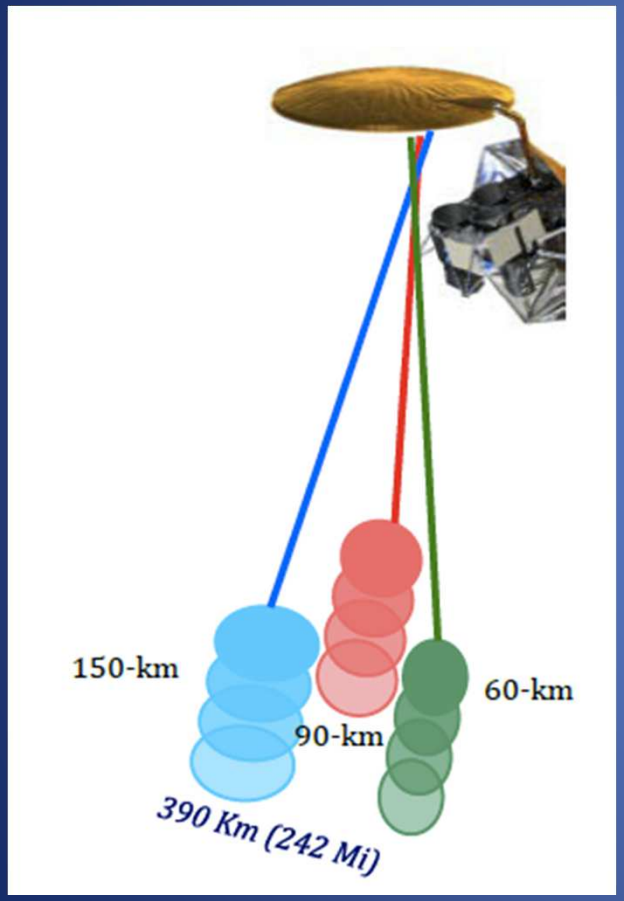


Drifter-derived SSS averaged monthly and over a 1° by 1°, approximately equivalent to the spatial resolution of Aquarius and centered at 25°N, 38.5°W. B

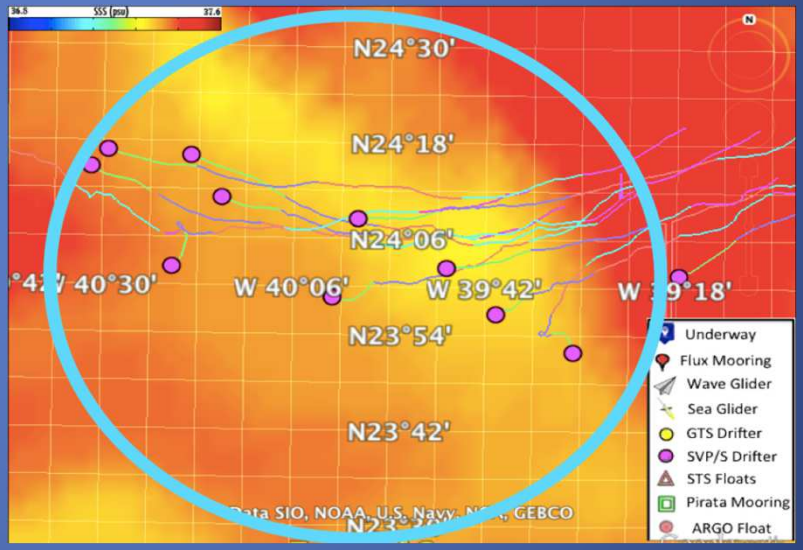
The eddy salt flux divergence dominates over the mean. The drifters validate the salt flux divergence computed from Aquarius and AVISO in the 1° by 1° box

Centurioni et al. 2014, Accepted

Sub-grid variability

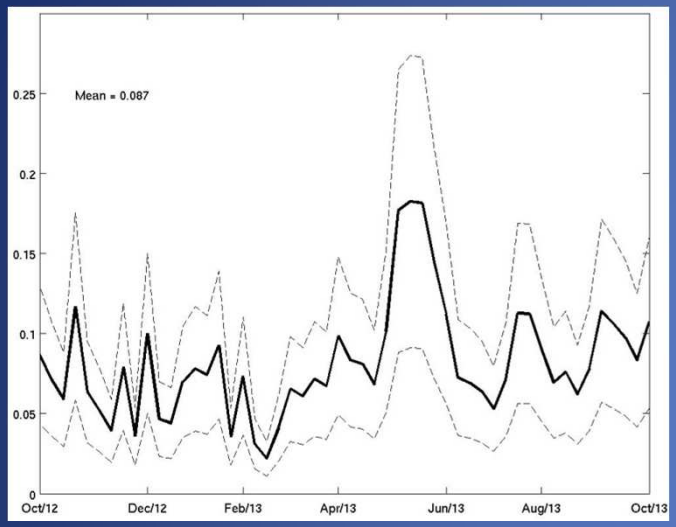


- Aquarius footprints are large. Sub-grid SSS spatial variability may bias the SSS retrieval

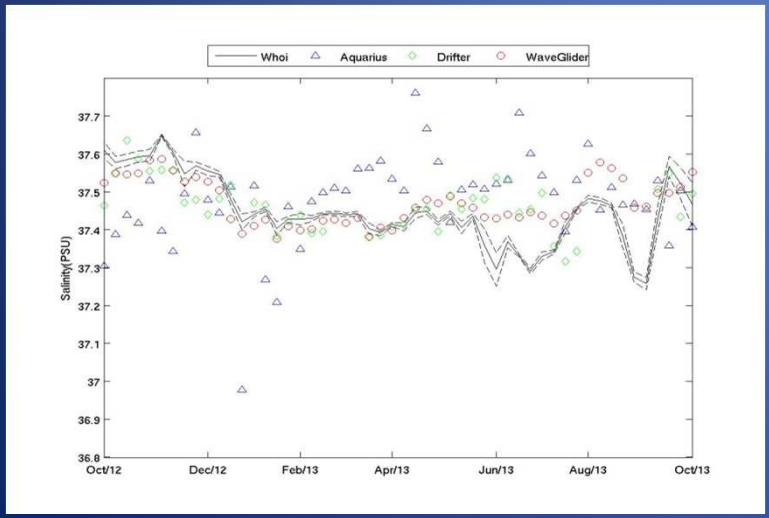


- SPURS sampled the SSS variability from a variety of in-situ sensors

Observed sub-grid variability

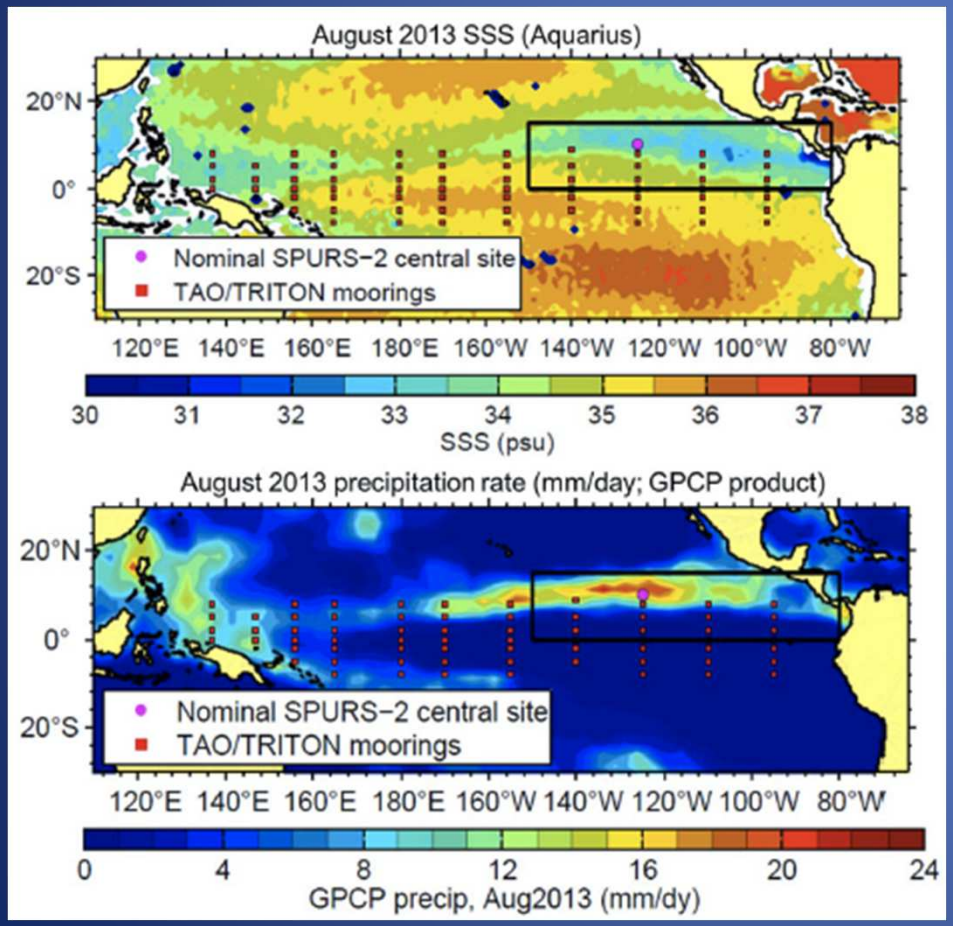


- The sub-grid variability observed with drifters can be large and is comparable to the target accuracy set for Aquarius (0.2 psu)



- The various in-situ datasets are being exploited to determine the accuracy of the Aquarius retrievals (Chao et. al, in preparation)

SPURS2 planned in FY16-17



Overarching goals

- Investigate the ocean's response to the changing global hydrological cycle
- Understanding fate of freshwater (i.e. how the salinity variance is destroyed by ocean processes
- Study the impact of SSS variability on Aquarius retrieval
- Study the role of ocean's circulation on the observed distribution of SSS vs FW fluxes

SPURS2 planned in FY16-17

Table 1

SPURS-1	SPURS-2
Convergent ocean (Subducting) Divergent atmosphere	Divergent ocean (Upwelling) Convergent atmosphere
Salinity maximum	Salinity minimum
Evaporation dominated → Buoyancy loss	Precipitation dominated → Buoyancy gain
Deep mixed layer and thermocline	Shallow mixed layer and thermocline
Weak mean advection	Strong mean advection
Small annual cycle	Large annual cycle
Poleward limit of tropical-subtropical cell	Equatorward limit of tropical-subtropical cell
In the saltiest ocean basin, N. Atlantic	In the freshest ocean basin, N. Pacific
Positive long-term salinity trend	Negative long-term salinity trend

Farrar et al, 2014, **SPURS-2 Diagnosing the physics of a rainfall–dominated salinity minimum**

Conclusions

- Drifters can measure SSS with good accuracy and in SPURS have showed little drift of the conductivity cell for at least one year
- Eddy salt fluxes in the SPURS region dominate over the mean
- Sub-grid variability in the SPURS domain is in excess of 0.15 PSU and is comparable to the target accuracy of Aquarius, and the latter is now being verified with the rich in-situ SSS data collected during SPURS