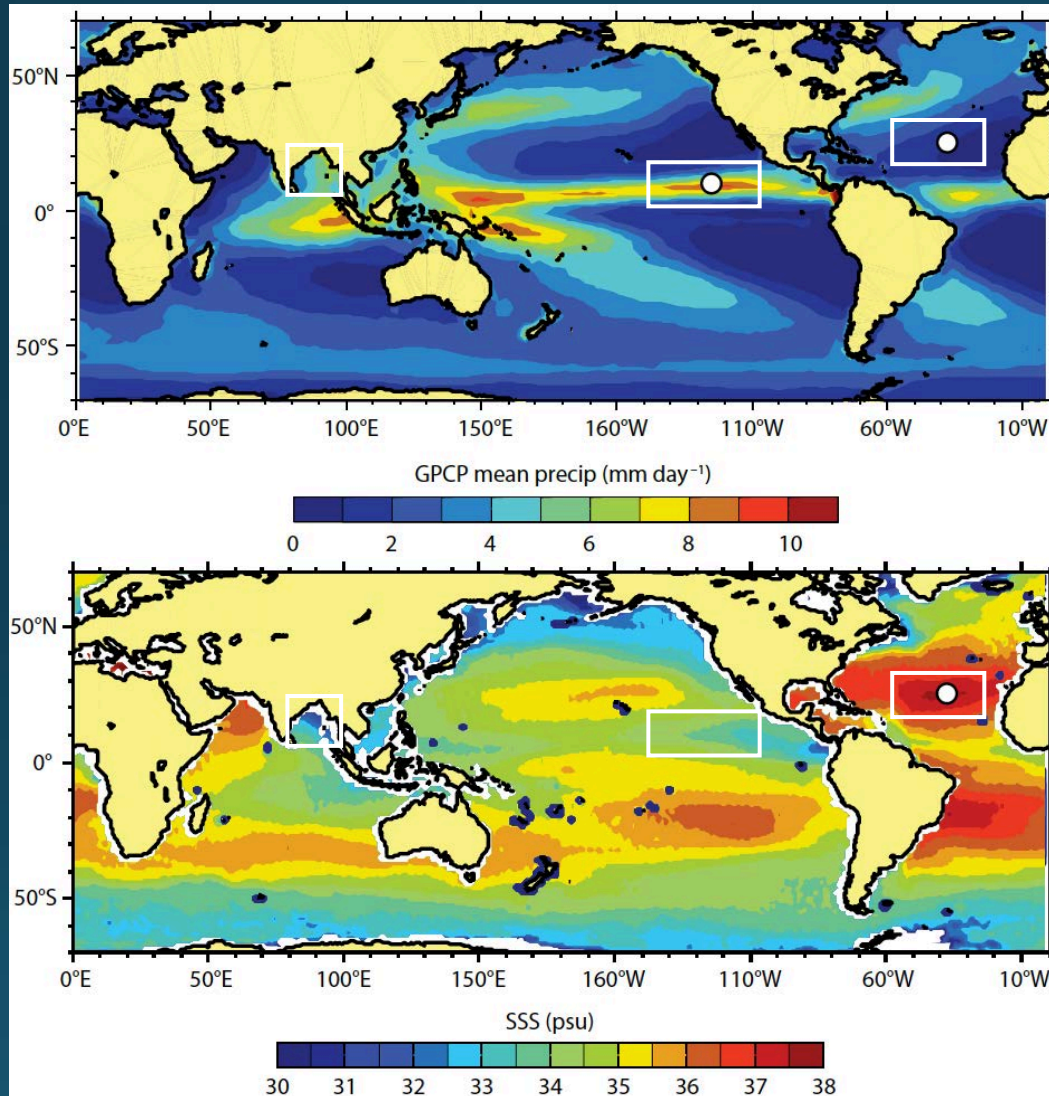




Lagrangian Drifter Observations of Near-Surface Circulation and Sea Surface Salinity during SPURS-2

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Global Water Cycle

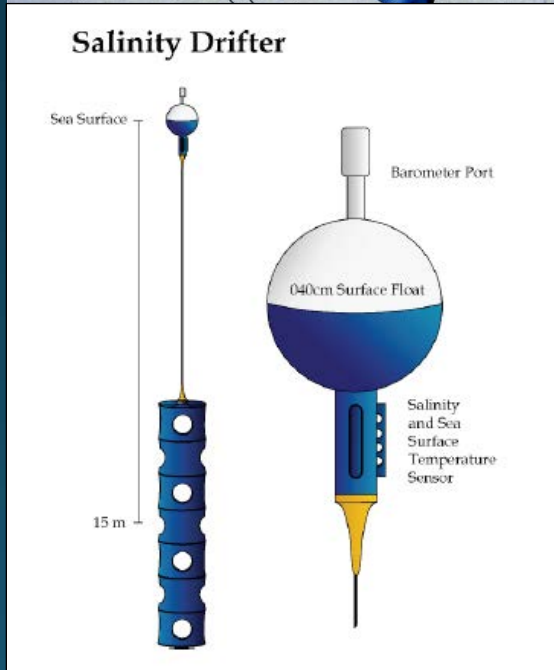


- Distribution of salinity in the world ocean is a poorly understood part of the global water cycle, with different upper-ocean physics in evaporating and precipitating regimes

SPURS-2 Scientific Objectives

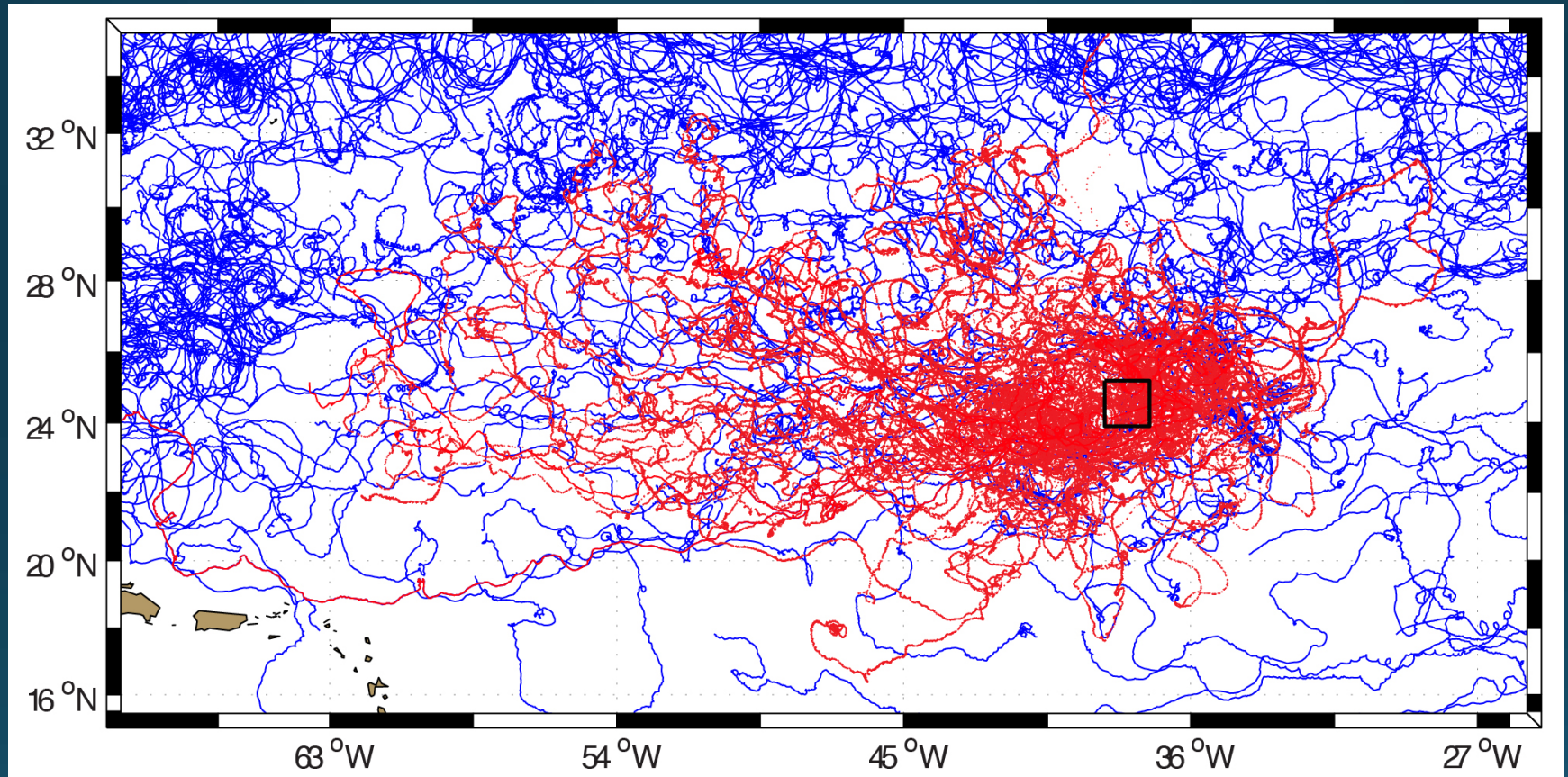
- “Where does the freshwater go?”
 - Investigating the effect of the large-scale circulation on the development and location of the salinity minimum, and the dispersion of patchy “puddles” of freshwater in the northeastern tropical Pacific
- “What impact will this horizontal and vertical variability have on the performance of satellite based measurements of sea surface salinity (SSS)?”
 - Measuring the horizontal variability of SSS on multiple spatial scales, and examining the impact of this horizontal variability on satellite-retrieved salinity

SVP/SVP-S Specifications



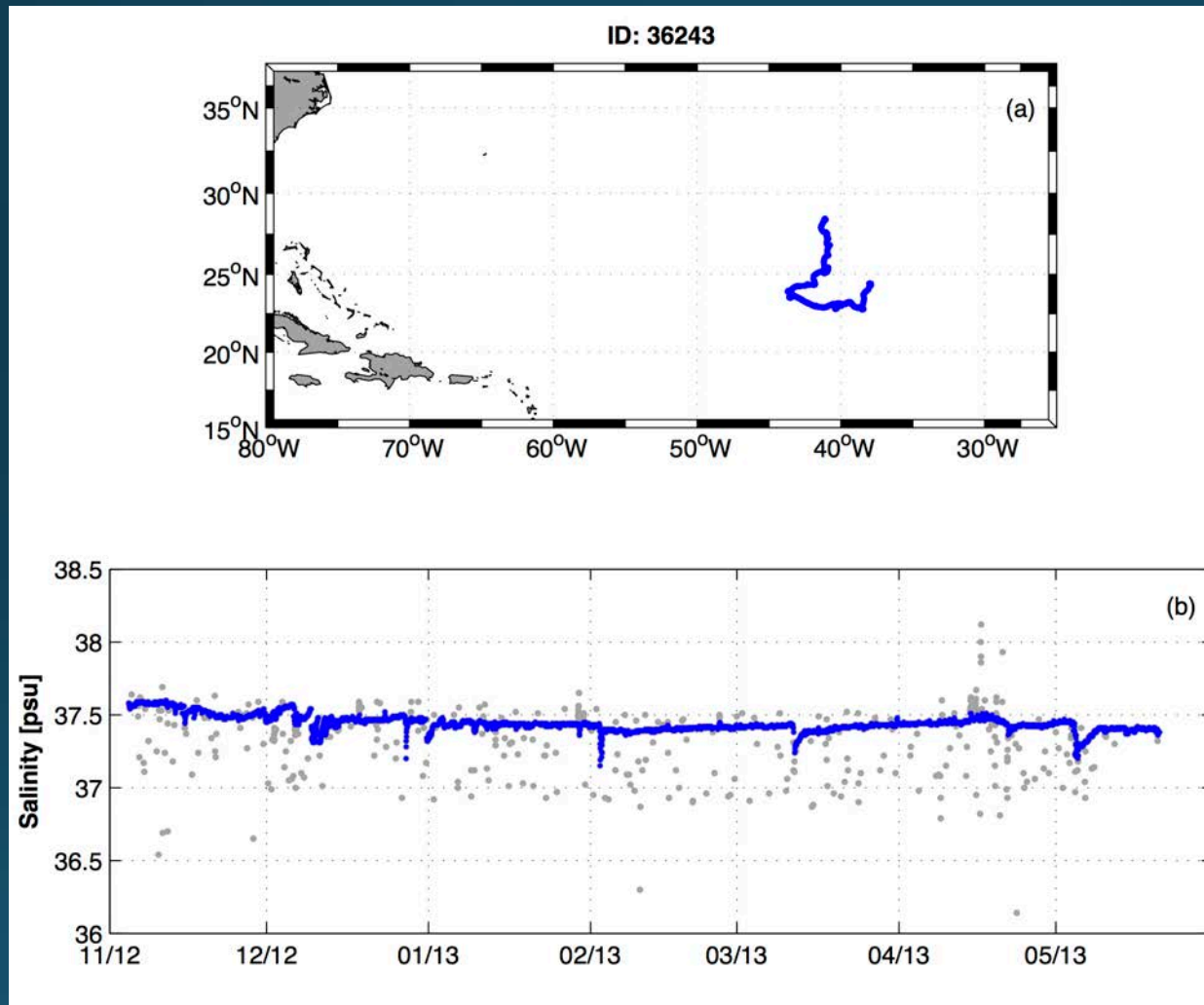
- ❑ Iridium with GPS (accuracy: ± 50 m)
- ❑ Drogue on/off sensor: strain gauge
- ❑ Lagrangian currents at 15 m
- ❑ Sea Surface Temperature (SST)
 - Thermistor: ± 0.05 - 0.1°C
- ❑ Salinity at 0.5 m
 - Standard sampling: every 30 min.
- ❑ SBE37-SI (unpumped, poisoned cell)
 - Conductivity: ± 0.0003 S/m
 - Temperature: $\pm 0.002^{\circ}\text{C}$
- ❑ Air pressure (optional): ± 0.5 hPa
- ❑ Endurance: ~ 1 -2 yrs

SPURS-1 Drifter Experiment



Deployment of 88 SVP-S (red) and 56 SVP (blue) drifters in the subtropical North Atlantic

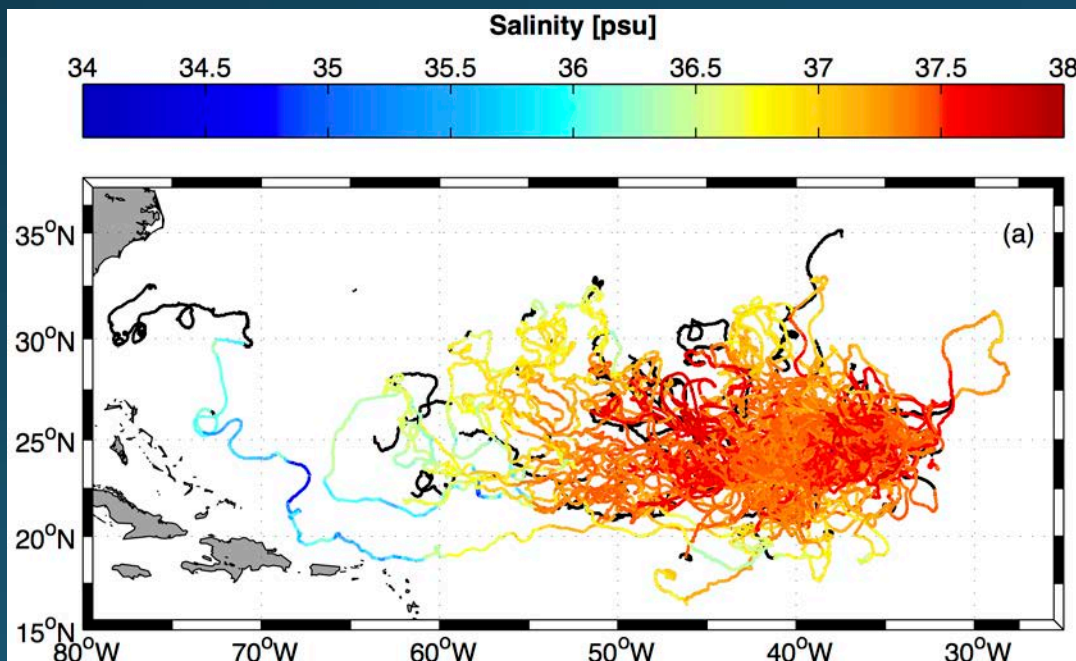
SVP-S Data Quality



- Averaging sampling mode introduced fresh bias in the salinity noise level
- Bias most likely due to air bubbles within the measuring cell

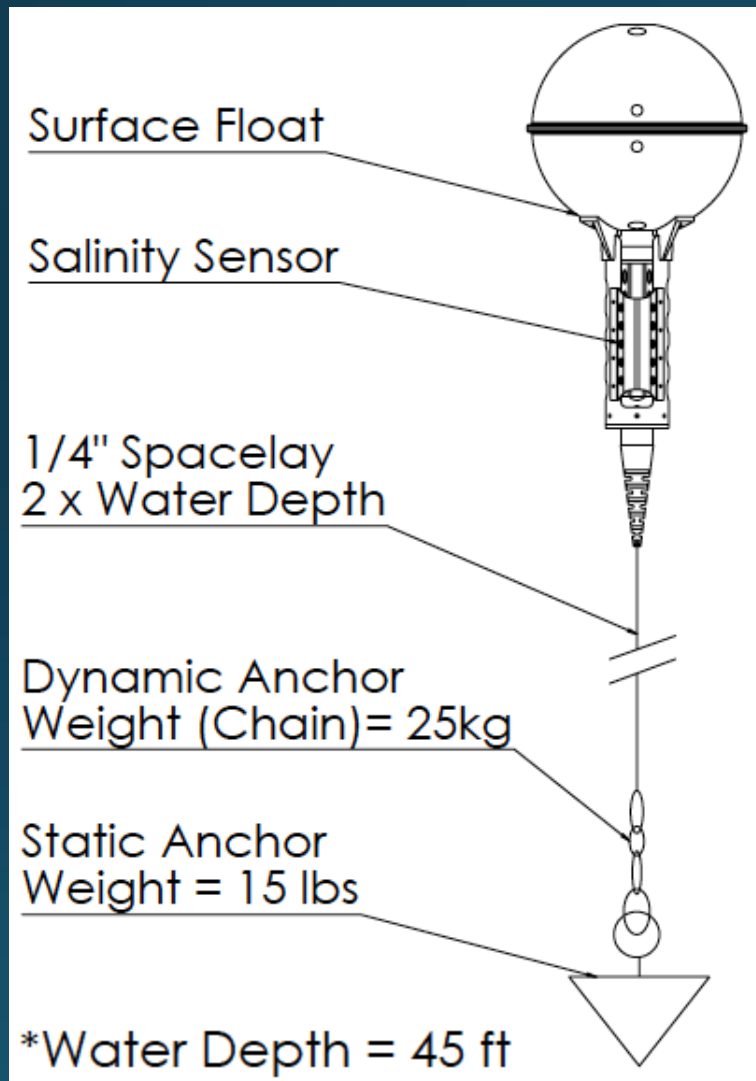
Quality Control

- ❑ Elimination of isolated salinity and temperature spikes
- ❑ Visual inspection of individual salinity measurements to manually remove the data noise
- ❑ Verification of drifter salinities against independent data sets and by drifter inter-comparisons



Quality-controlled drifter salinities in the SPURS-1 region, with reliable observations for up to one year

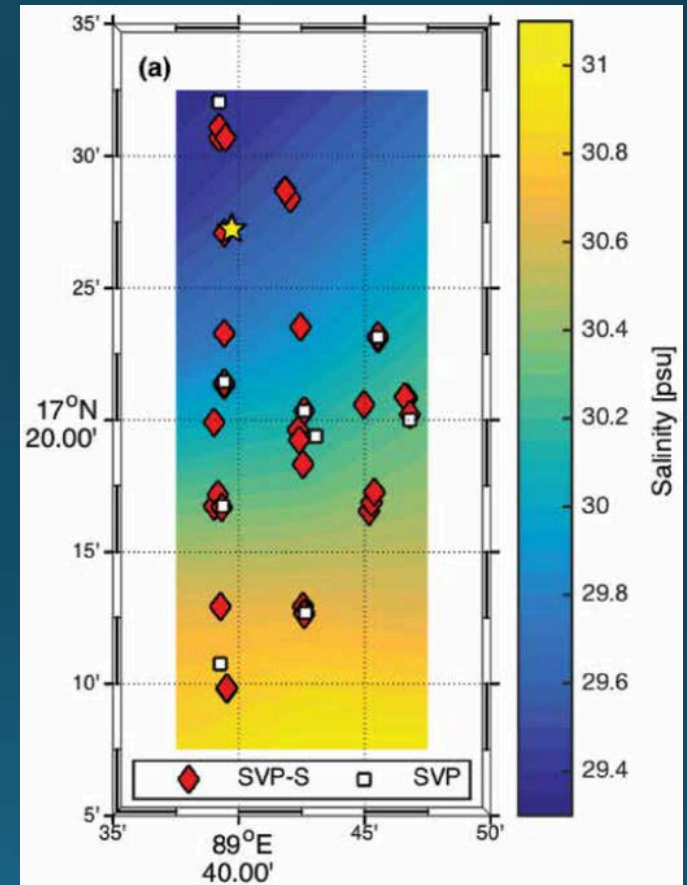
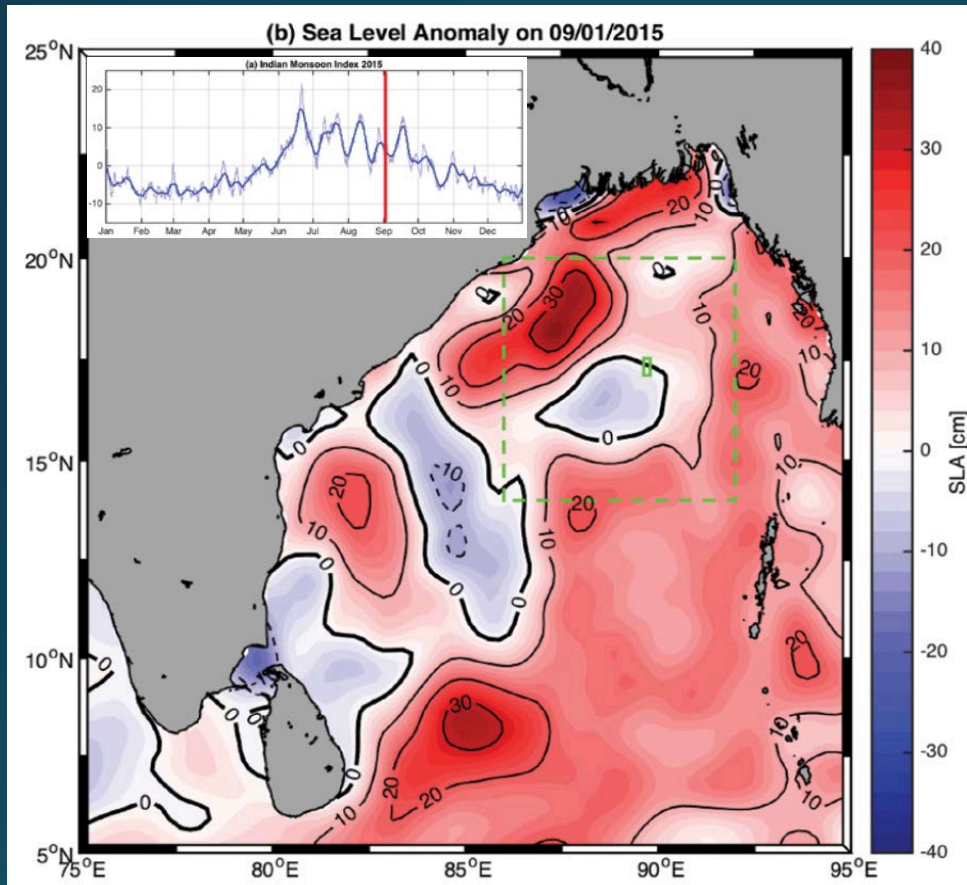
Next SVP-S Generation



- ❑ Revision of the sensor's sampling algorithm needed to enable onboard/real-time filtering of incorrect salinity measurements



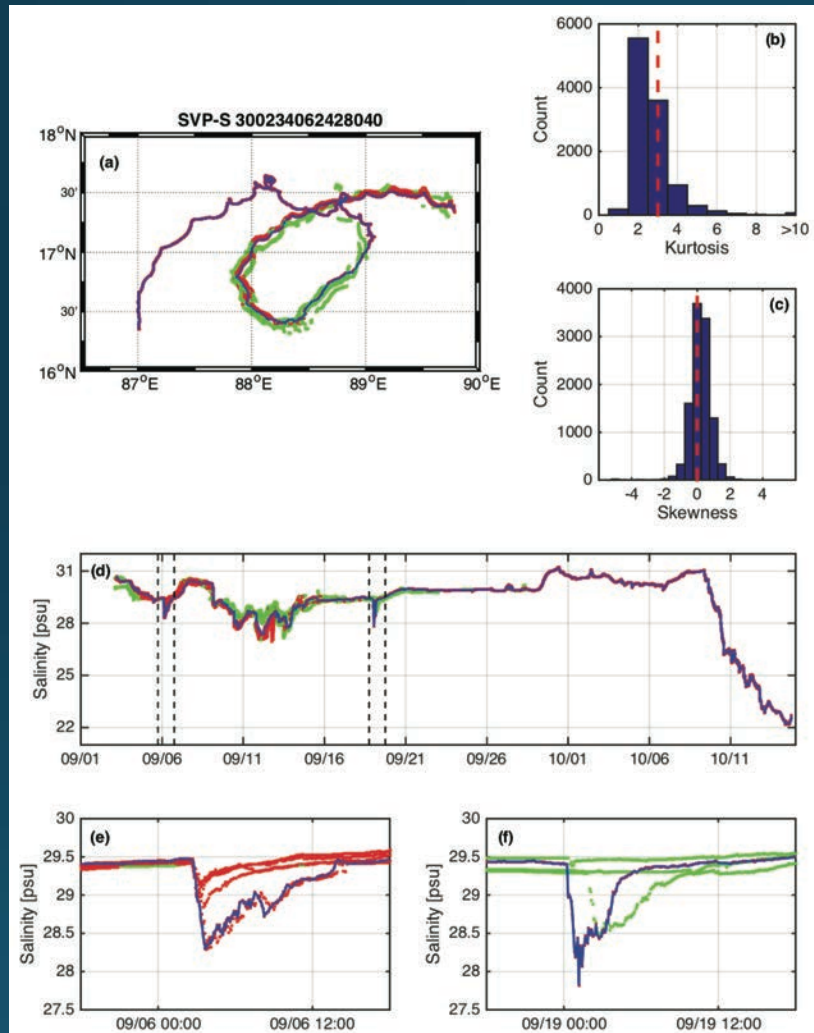
2015 Drifter Experiment



□ Dedicated deployment of 36 (10) SVP-S (SVP) drifters in a tight array across a freshwater front in the Bay of Bengal

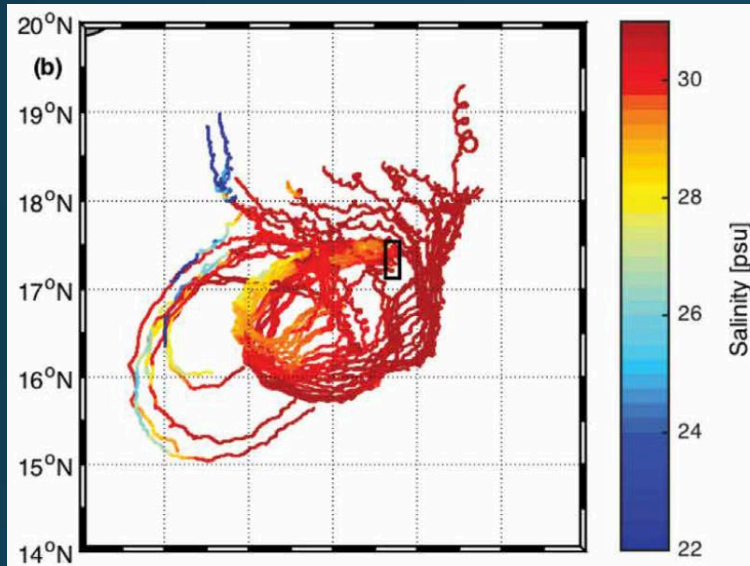
Hormann, Centurioni et al., 2016

SVP-S Performance

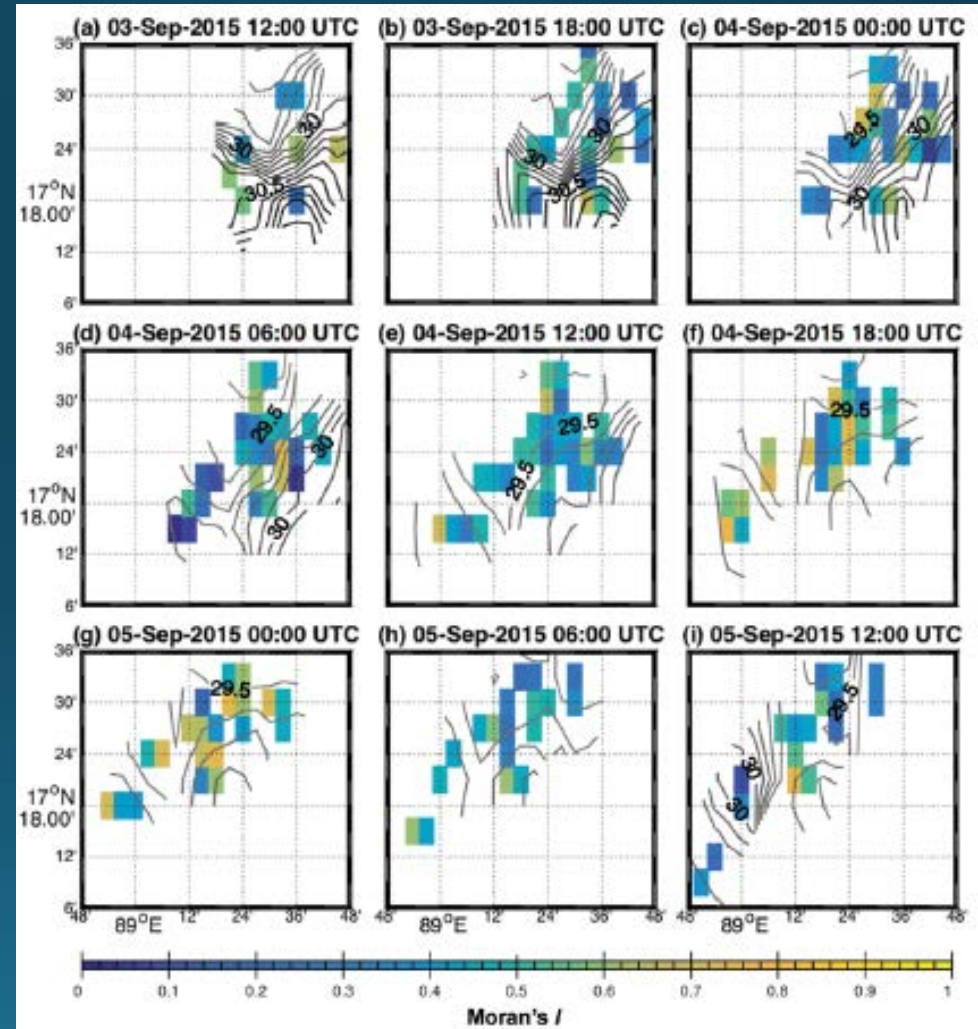


- Transmission of additional statistics as measure of data quality
- Inter-comparisons between salinity drifters confirm fresh events and build confidence in the revised sensor algorithm
- Observed salinity patches had amplitudes in excess of 1.5 psu

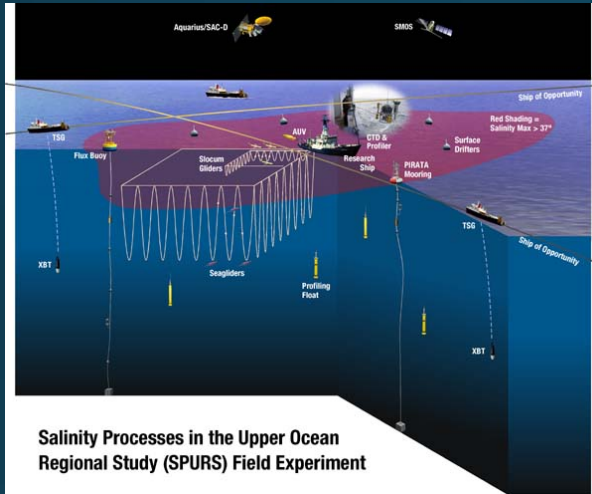
Salinity Variability



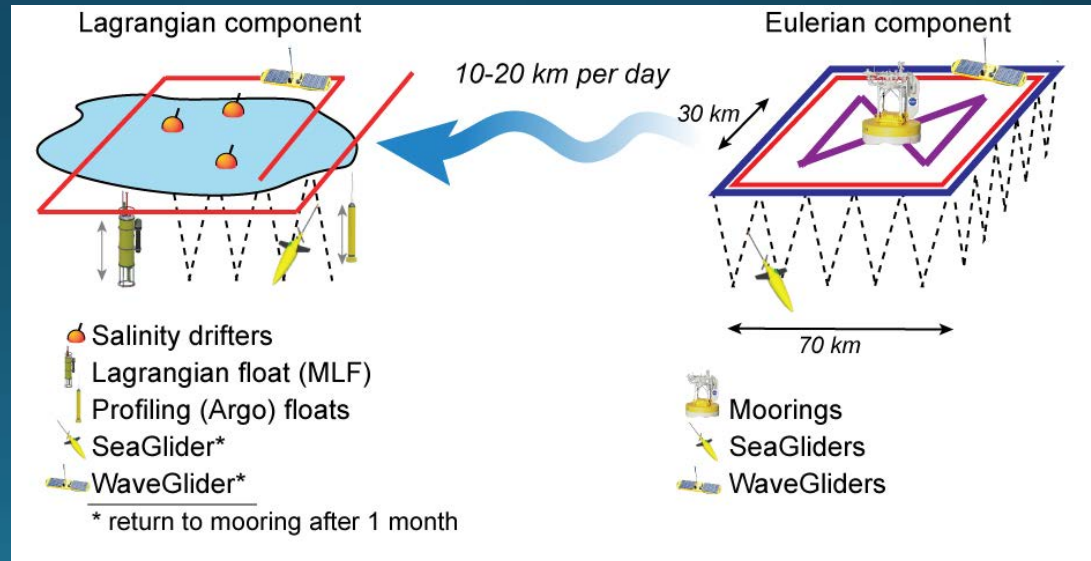
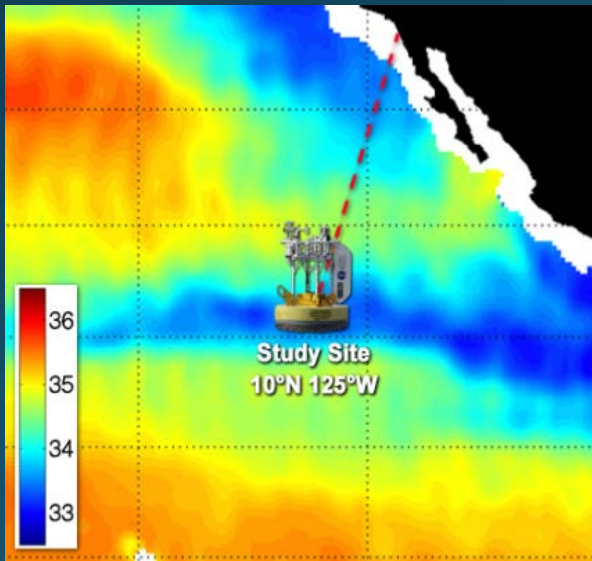
Autocorrelation analysis of high-resolution drifter salinities revealed space and time scales of less than 5 km and of the order of a few hours



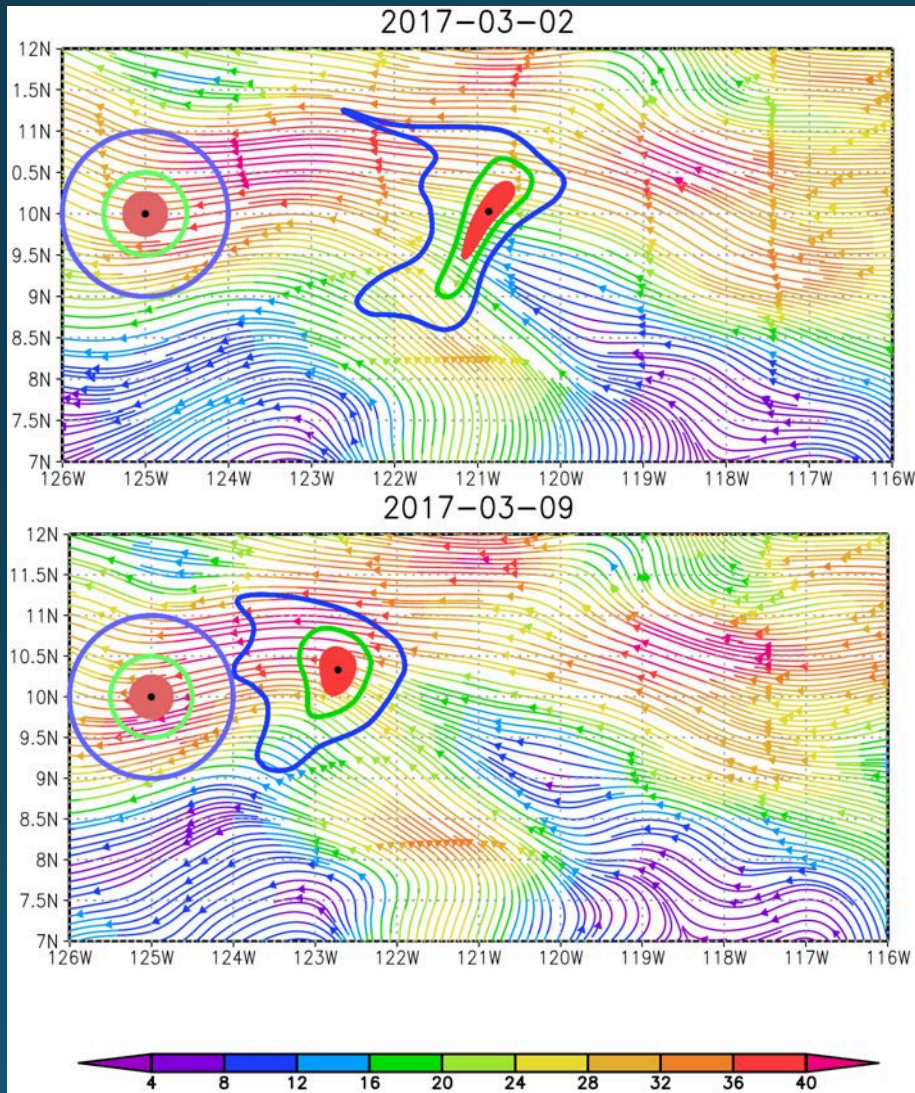
SPURS-2 Concept



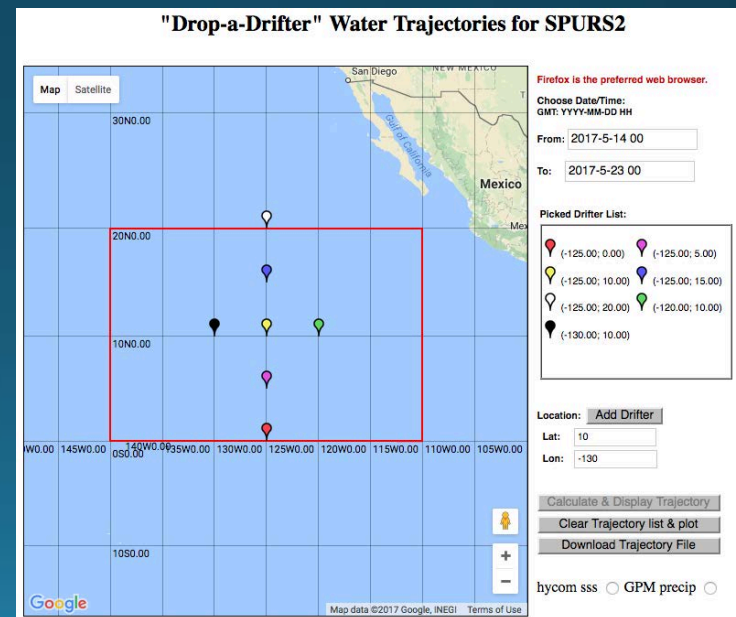
- SPURS-2 designed as a coordinated experiment to achieve sampling over a large spatial footprint
- Drifters provide an expanding context to observations at the central mooring site



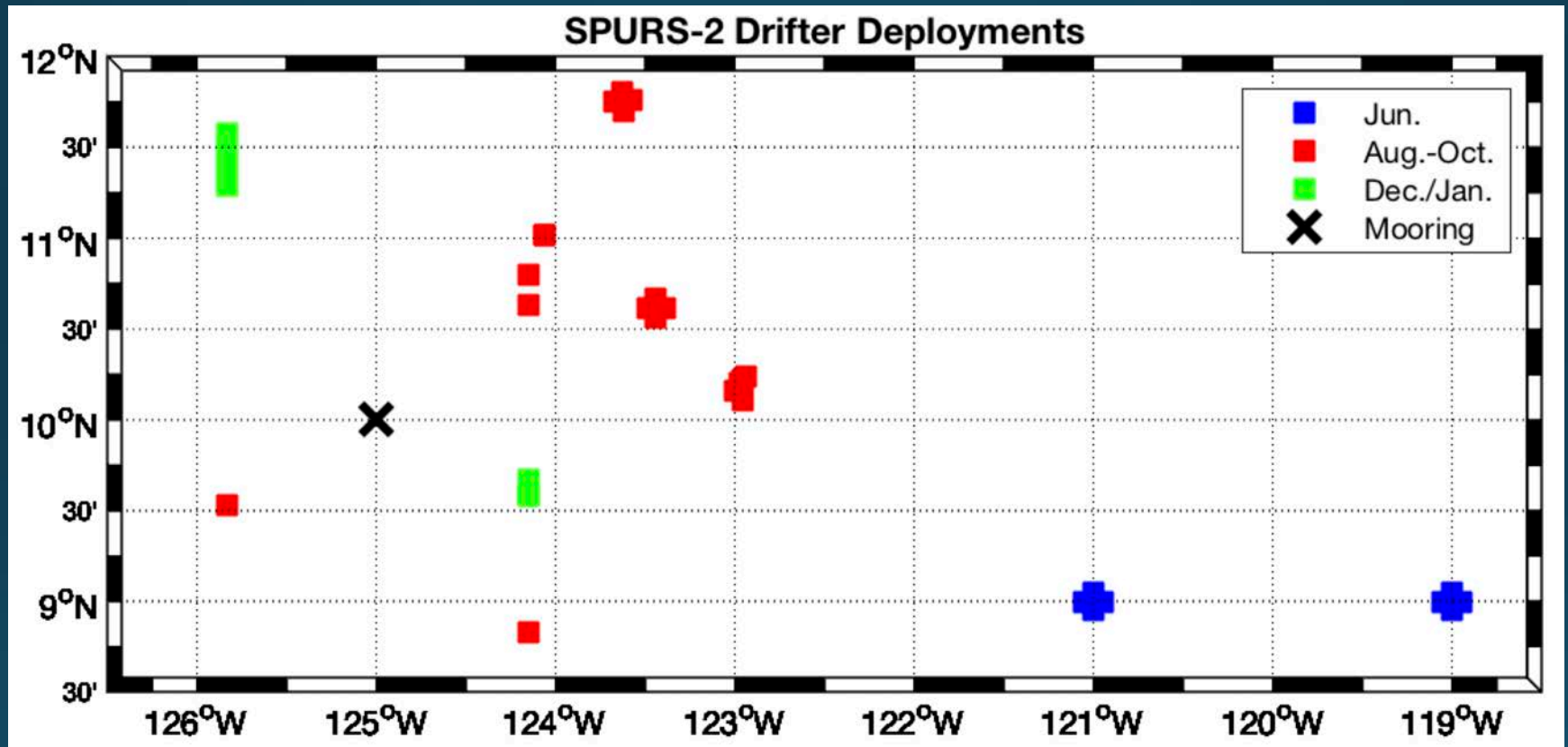
Drifter Experiment



- Particle simulations in SCUD model, and interactive "Drop-a-Drifter" website to plan deployments

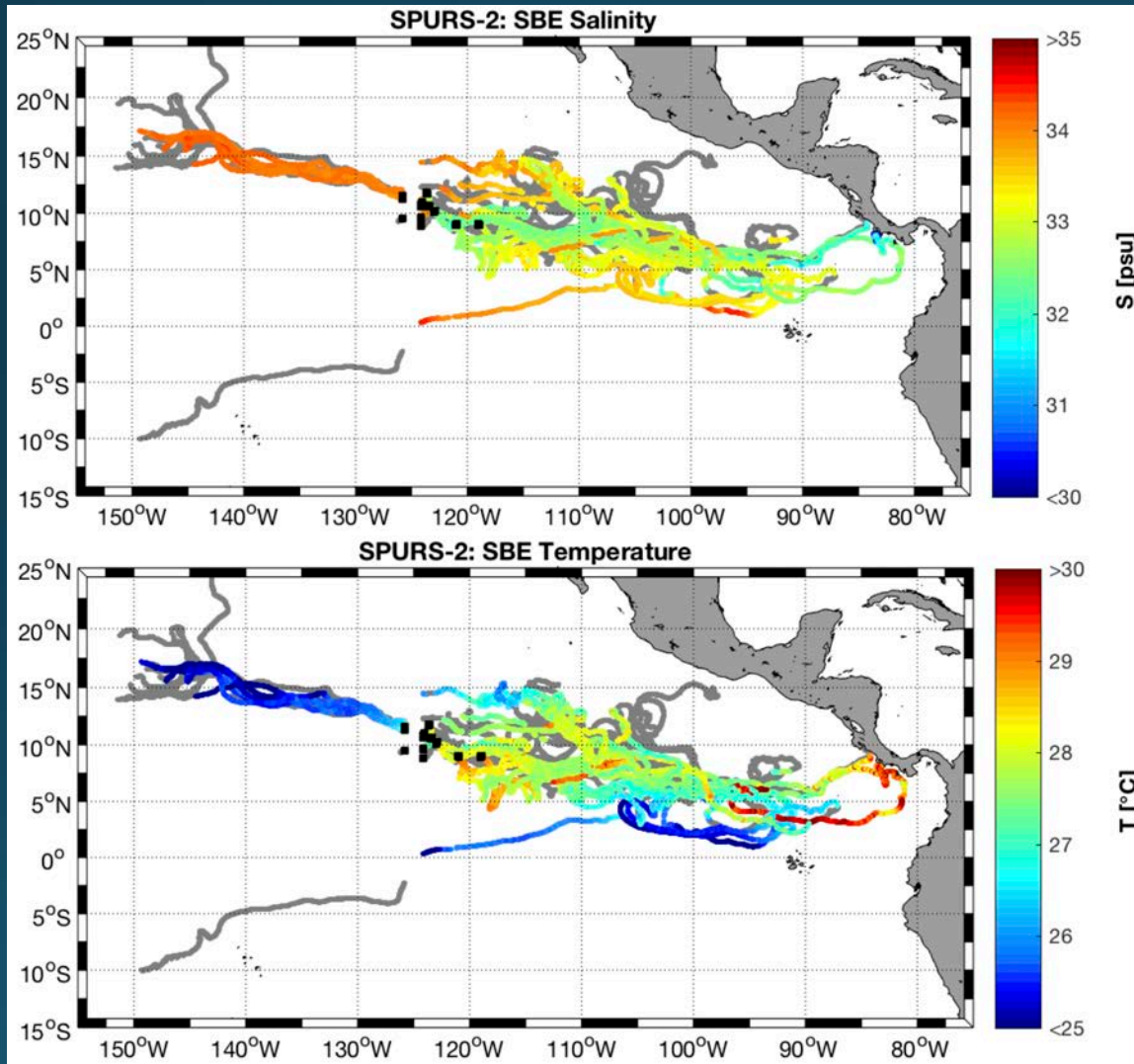


2016/17 Deployments



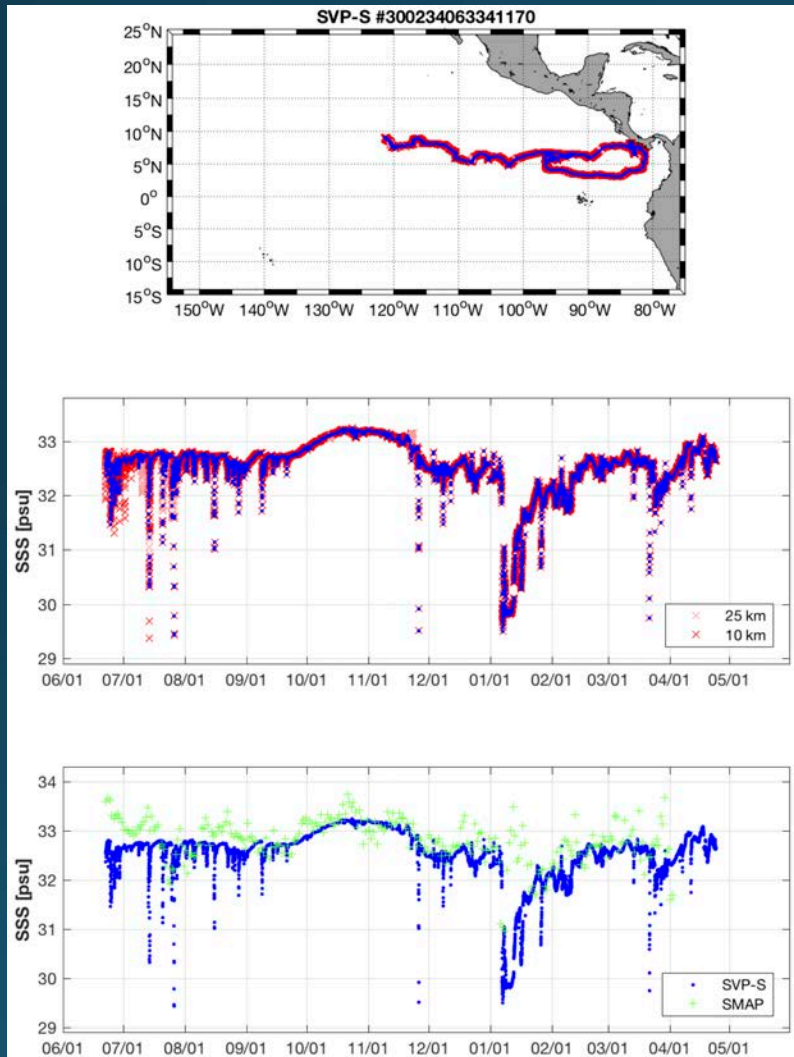
- Ongoing drifter releases largely organized in clusters of five have begun in June 2016 (10 SVP-S) from the R/V Lady Amber

Spatiotemporal Variability



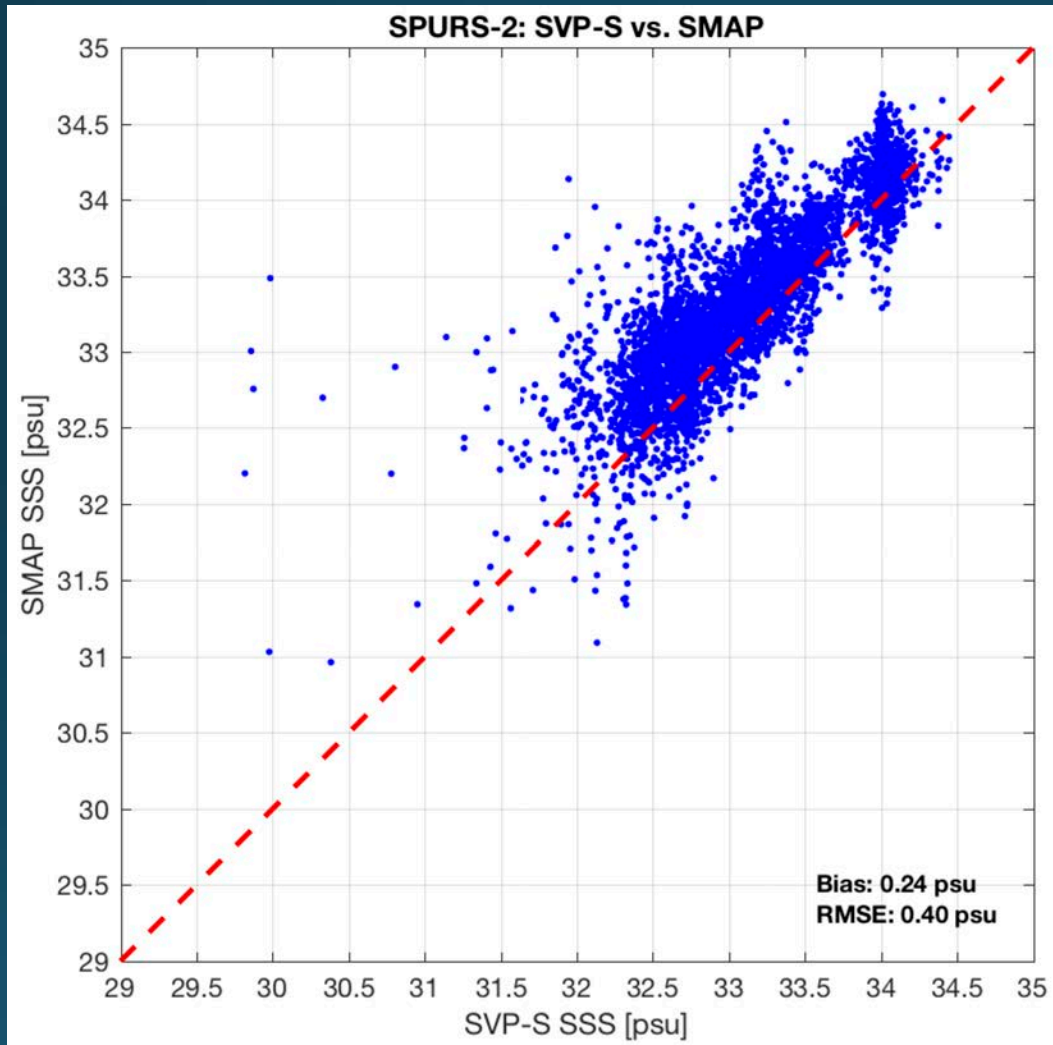
- Drifters largely moved south-eastward toward the coastline
- Pronounced variability in both SSS and SST, with saltier and colder waters in the northwest during winter

SSS Validation



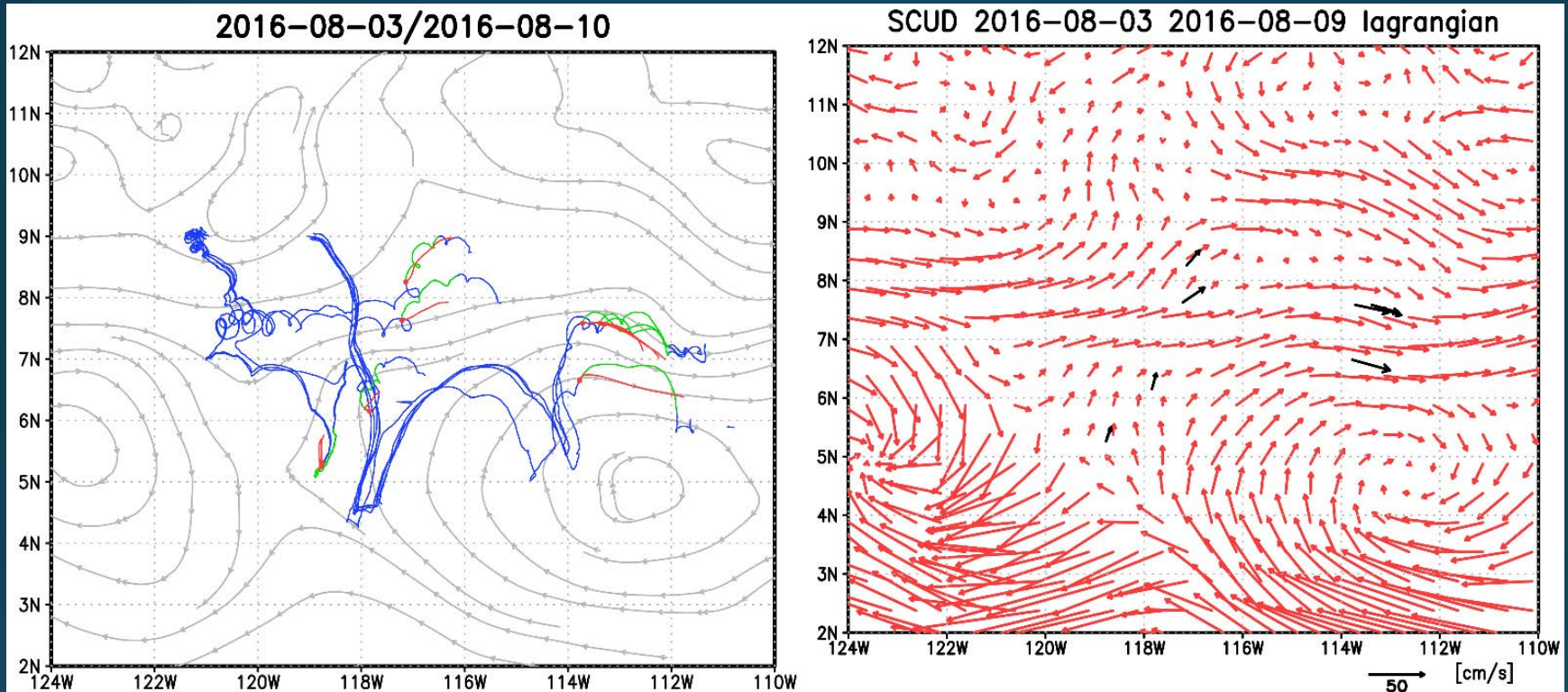
- Verification of individual drifter salinities by inter-comparisons with nearby drifters shows overall good agreement
- Drifter comparisons with remotely-sensed SMAP SSS are generally within the satellite's accuracy in the SPURS-2 region

SVP-S vs. SMAP



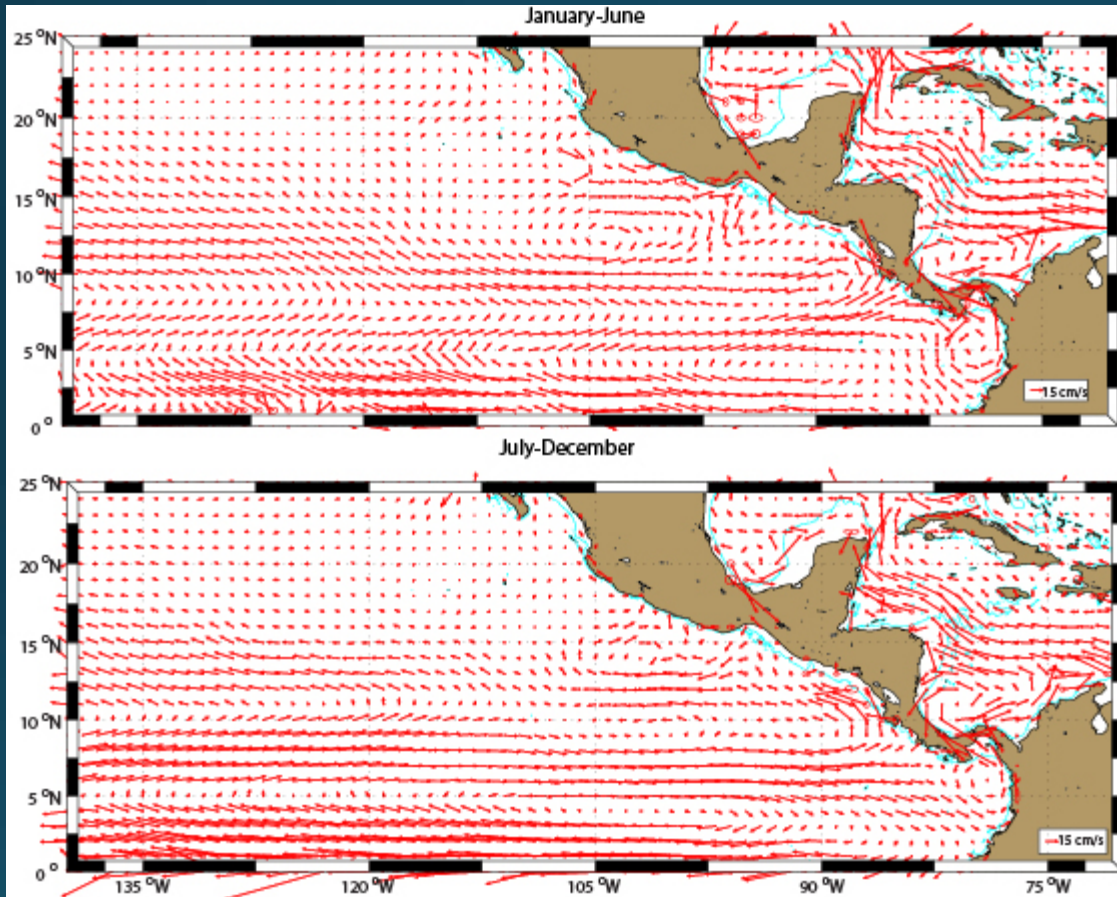
- Statistics indicate an overall positive bias of SMAP SSS compared to SVP-S measurements in the SPURS-2 region, with a RMSE of 0.4 psu

Model-Data Comparison



- SCUD velocities applied to 3 – 7-day segments of SPURS-2 drifter trajectories confirm the model's usefulness for planning drifter deployments

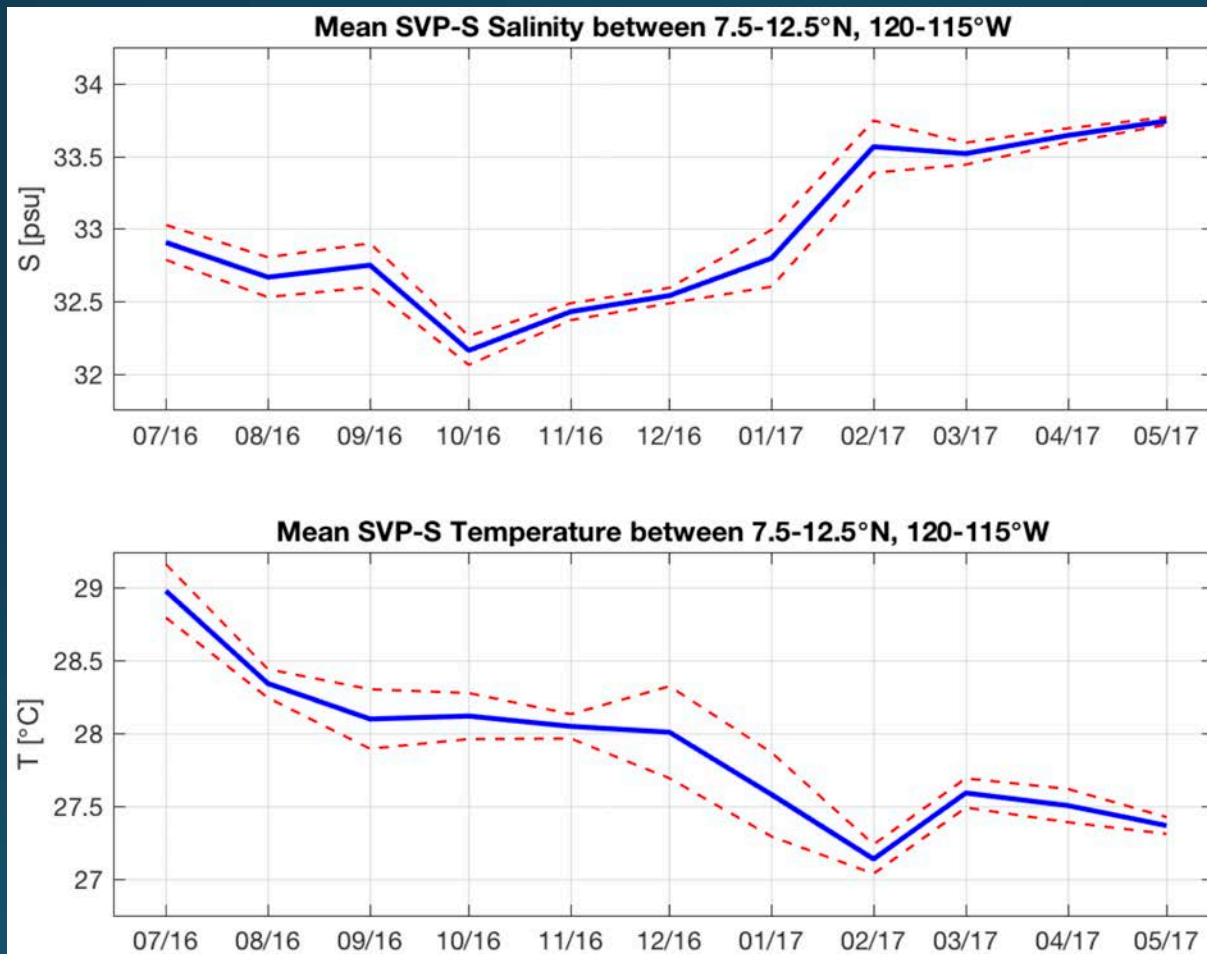
Seasonal Variability



- Mean drifter currents show large seasonal differences in the SPURS-2 region, with both the SEC and NECC intensifying in summer/fall

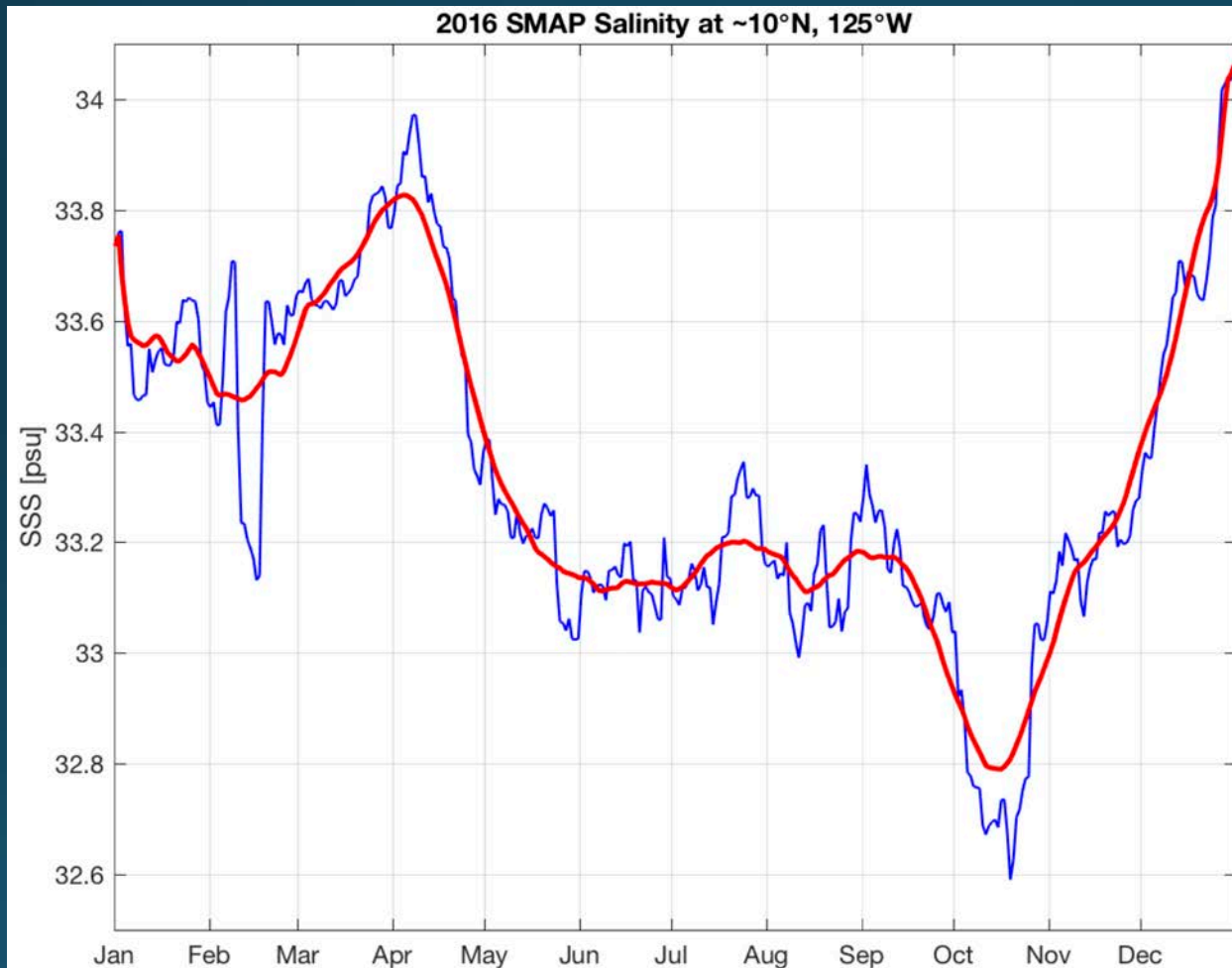
Drifter velocities at 15-m depth binned at $1^\circ \times 1^\circ$ for winter/spring and summer/fall seasons

Seasonal SSS & SST Cycles



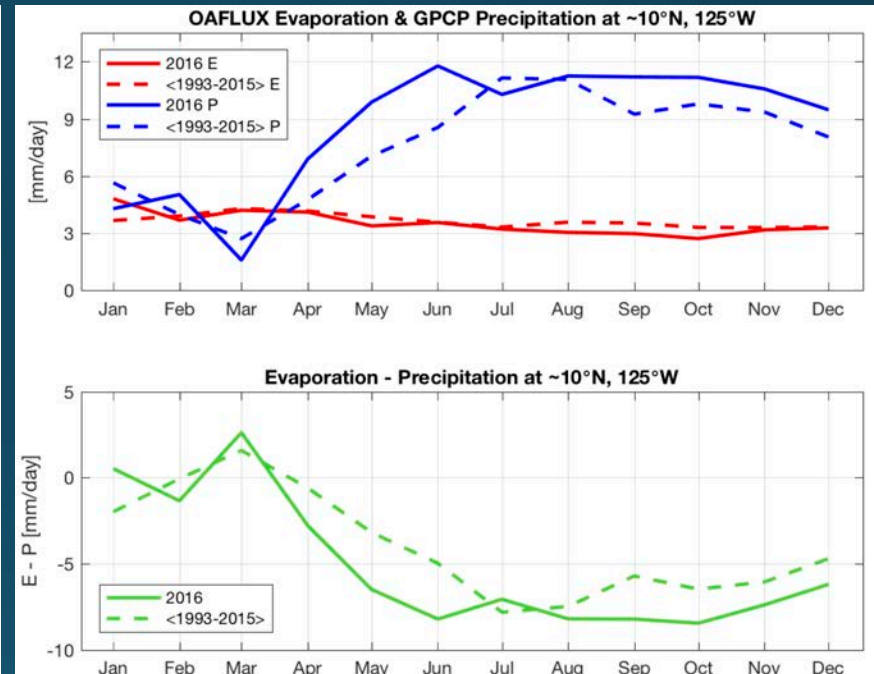
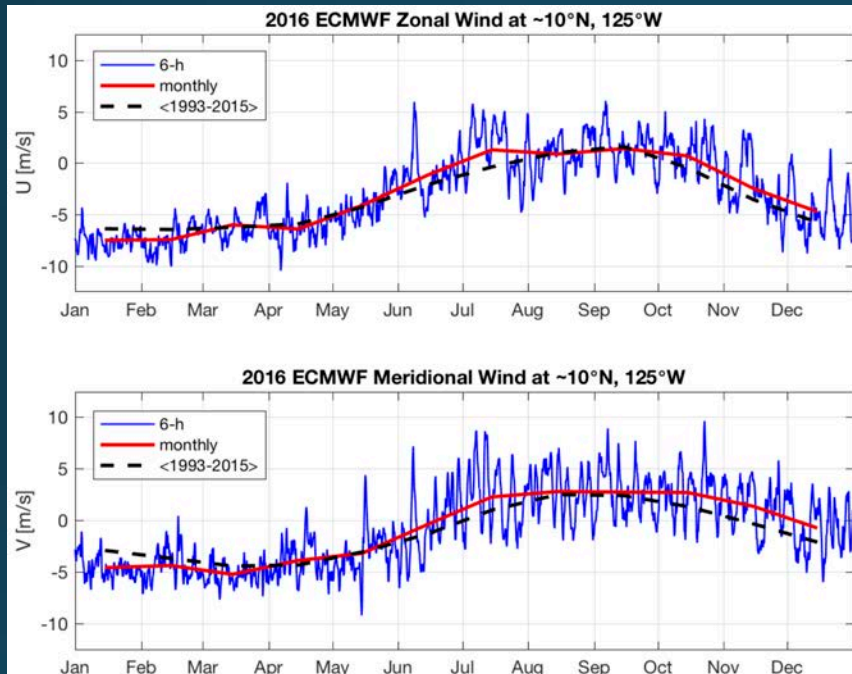
- Consistent with the seasonal ITCZ migration, the drifters indicate a SSS min. in fall and max. in winter/spring

2016 SMAP Salinity



□ Seasonal SSS cycle around SPURS-2 mooring reproduced by SMAP

Interannual Variability



- Close to normal monthly wind forcing in 2016, but apparent differences in freshwater fluxes due to an earlier onset of the rainy season in 2016

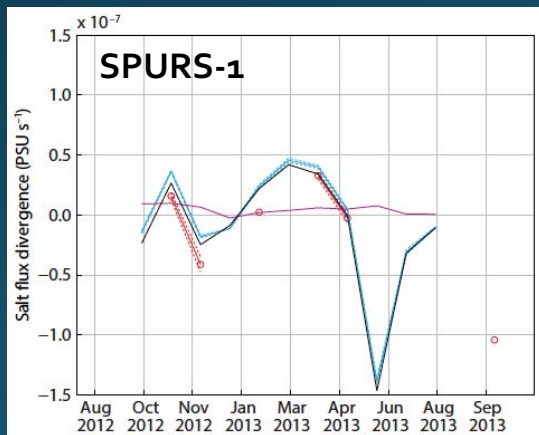
Conclusions

- ❑ Targeted drifter deployments in key regions of the global water cycle to improve understanding of the role of near-surface currents in defining the salinity distribution
- ❑ Revised SVP-S algorithm successfully implemented in the Bay of Bengal and northeastern tropical Pacific
- ❑ 30 SVP-S plus 20 SVP drifters deployed in the SPURS-2 region yet
- ❑ Satellite SSS from SMAP generally overestimate SVP-S measurements in the SPURS-2 region
- ❑ Consistent with the ITCZ migration, SVP-S drifters resolve the seasonal SSS cycle near 10°N , 125°W with a minimum in fall and maximum in winter/spring

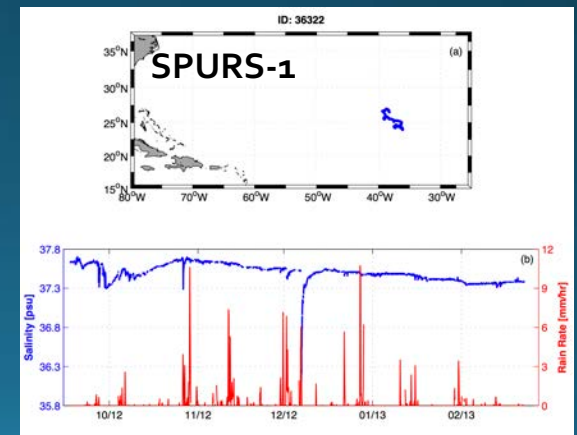
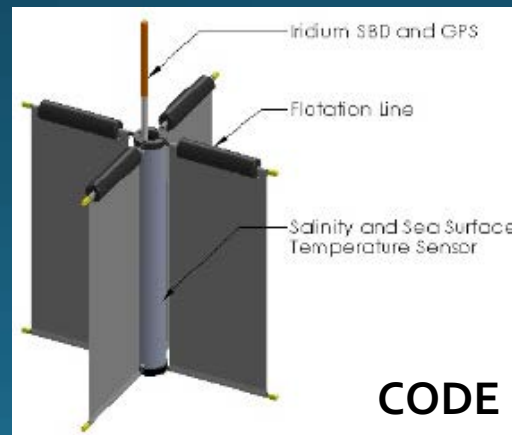


Outlook

- Continuing with regular SVP-S/SVP deployments from the R/V Lady Amber, and contributing to the 2017 R/V Roger Revelle cruise (4 CODE-style drifters for “puddle” experiment plus possibly a few SVP/SVP-S drifters)
- Quantifying horizontal salt fluxes (as done in SPURS-1) and kinematic properties (e.g., vorticity) as well as investigating details of observed fresh events (e.g., comparisons to rain)



Centurioni, Hormann et al., 2015



Hormann et al., 2015