Quantification of P-E and Air-Sea Exchange during SPURS-2

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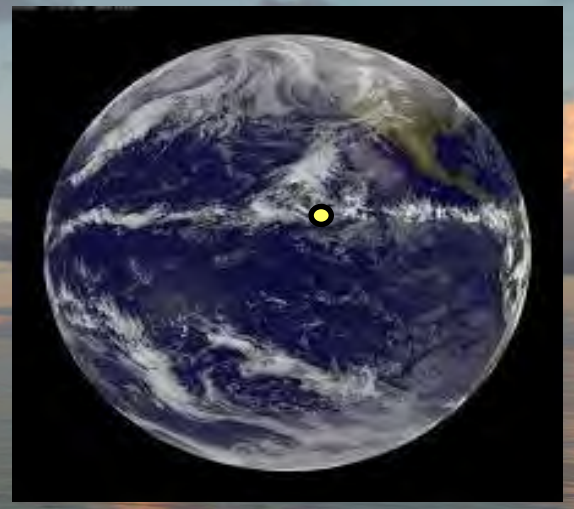
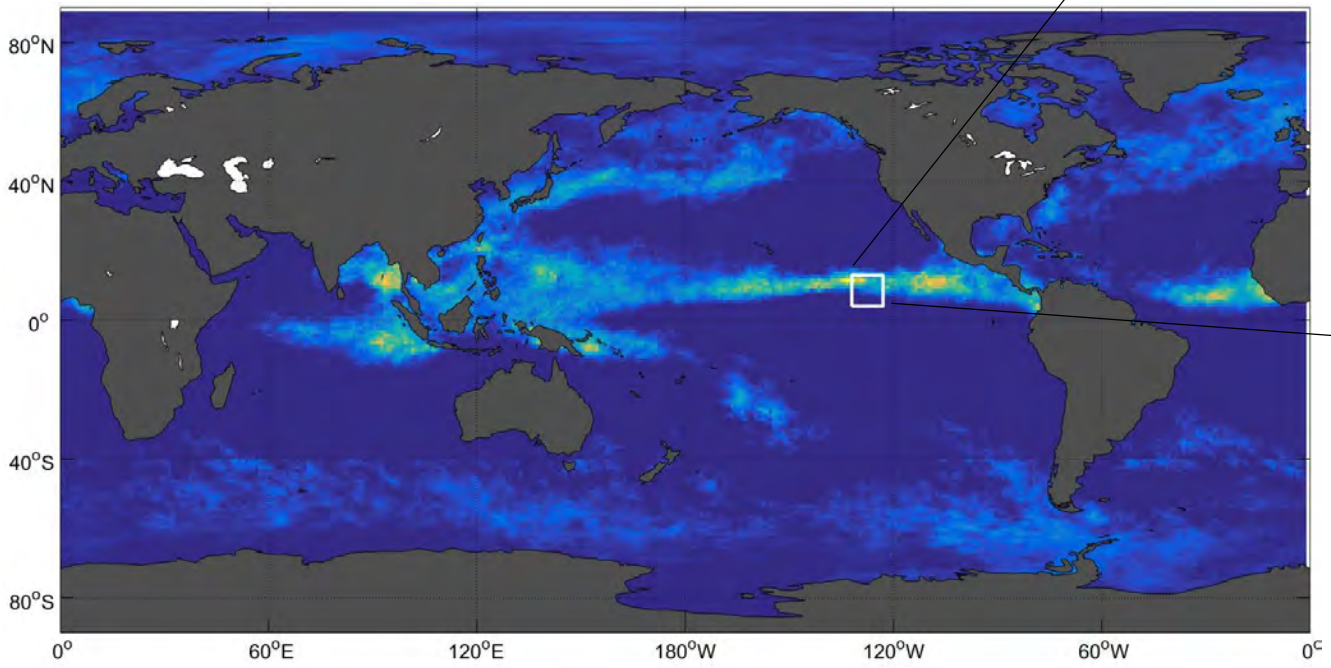


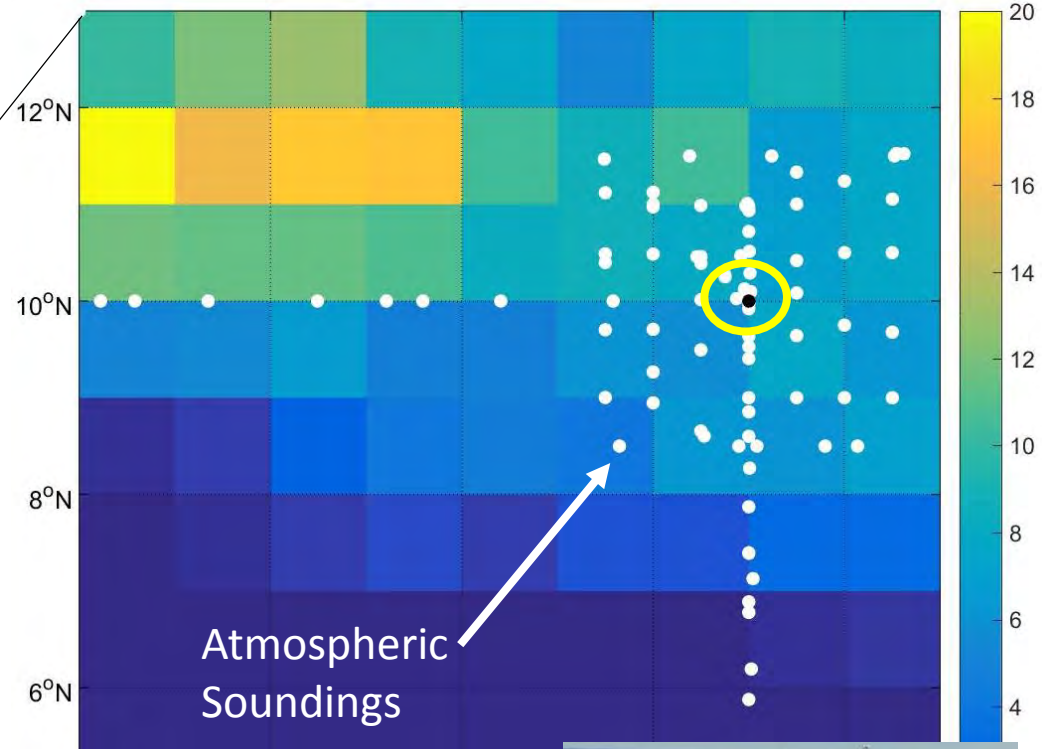
Salinity Processes in the
Upper Ocean Regional Study

NASA SPURS-2 (Salinity Processes in the Upper Ocean Regional Study -2)

To study the fate of fresh water (Precipitation) in the Intertropical Convergence Zone (ITCZ)

- Cruise dates: August – September 2016
  September – November 2017
- WHOI Buoy Mooring at 10°N, 125°W
- Atmosphere and ocean observations
- Other resources deployed as well



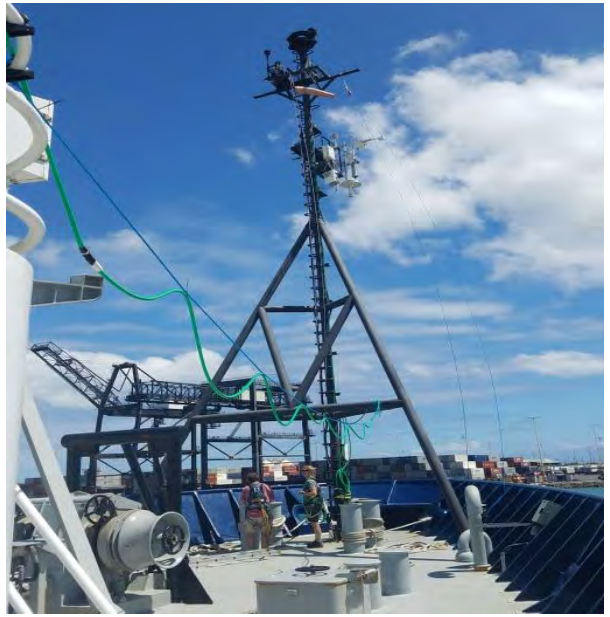


~80 Rawinsonde Launches

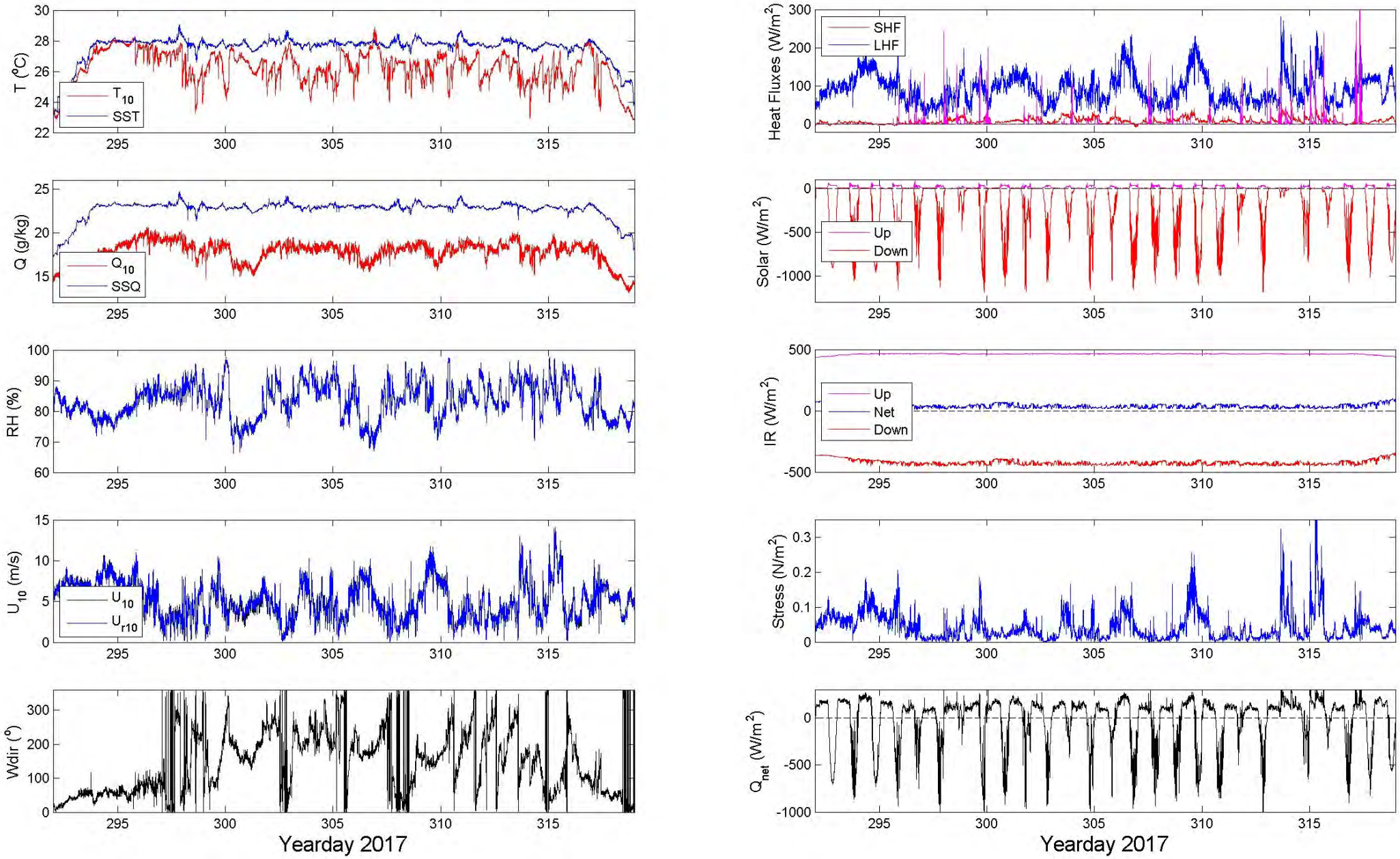
10°N, 125°W

Ship-board Meteorology

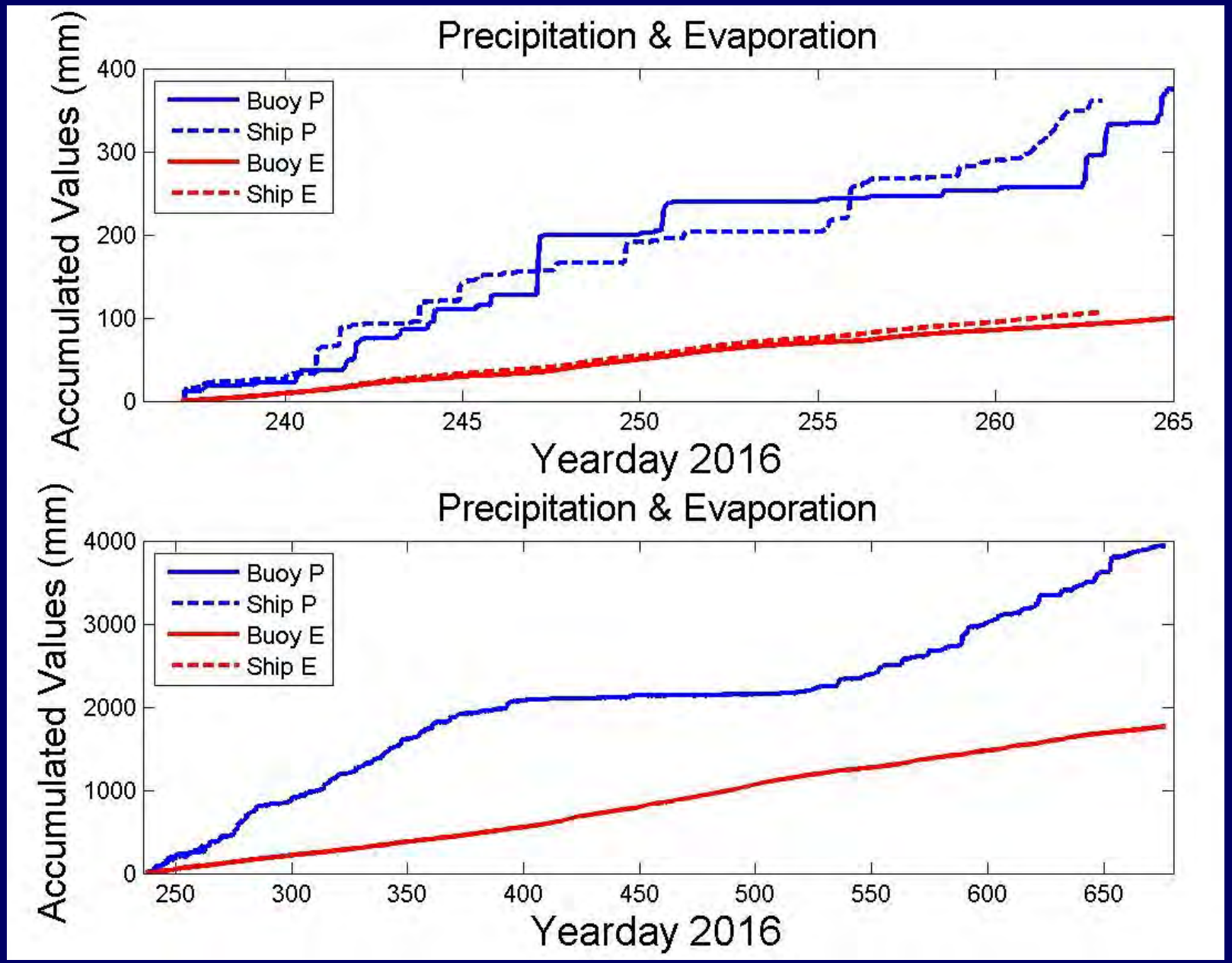
- Met Mast
  - 2 DCFS/Licors
  - Optical Rain Gauge (ORG)
  - 2 Aspirated RH/T
  - 1 Shielded RH/T
  - Pyanometer (Solar radiation)
  - Pyrgeometer (IR radiation)
- O2 Deck
  - 2 Self-Siphoning Rain Gauges
  - 5 Read & Dump Rain Gauges
  - 2 Pressure Sensors
- Sea Snake (Near Surface T_{sea})
- Fantail
  - 2-axis Sonic
  - Pyanometer (Solar radiation)
  - Pyrgeometer (IR radiation)
  - 2 Self-Siphoning Rain Gauges
  - 1 Shielded RH/T



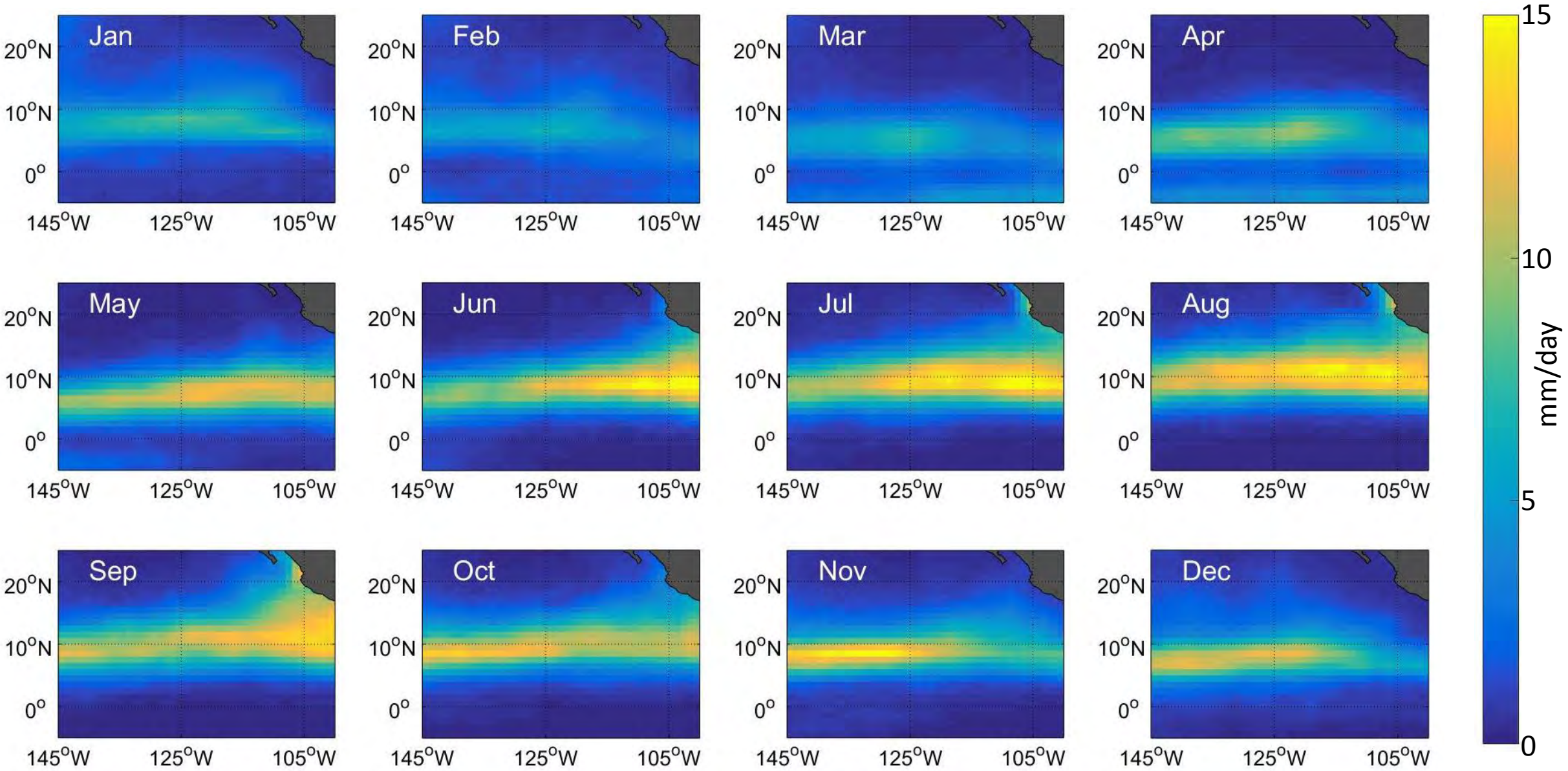
Ship-board Meteorology



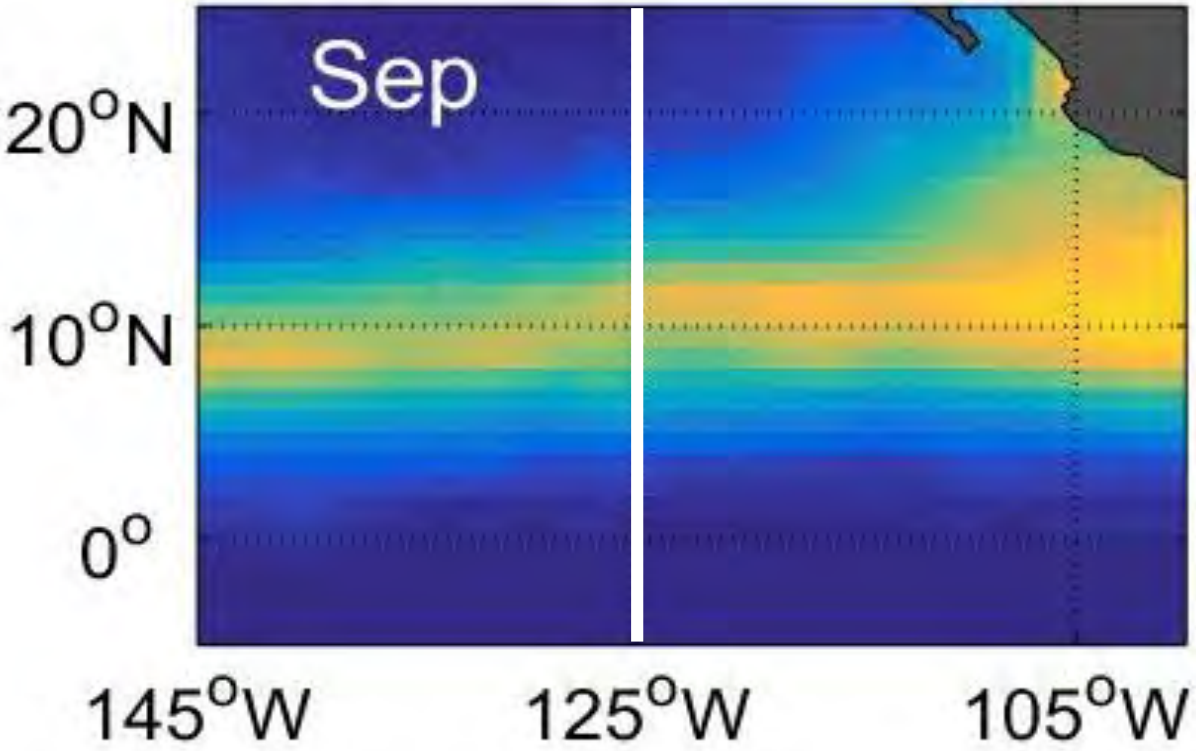
Ship versus Buoy Comparisons

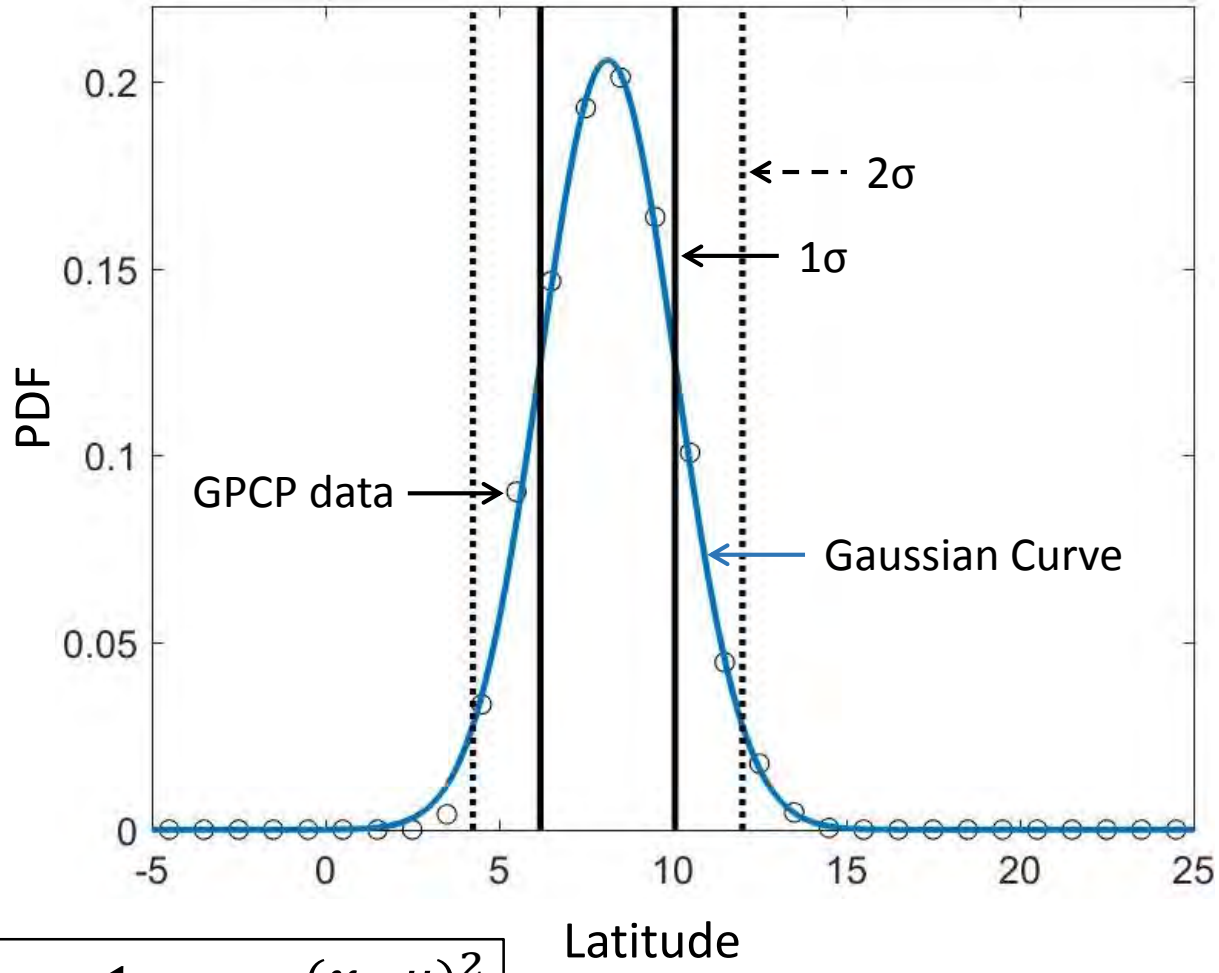


Median Monthly Precipitation Rate for GPCP (1996-2016)



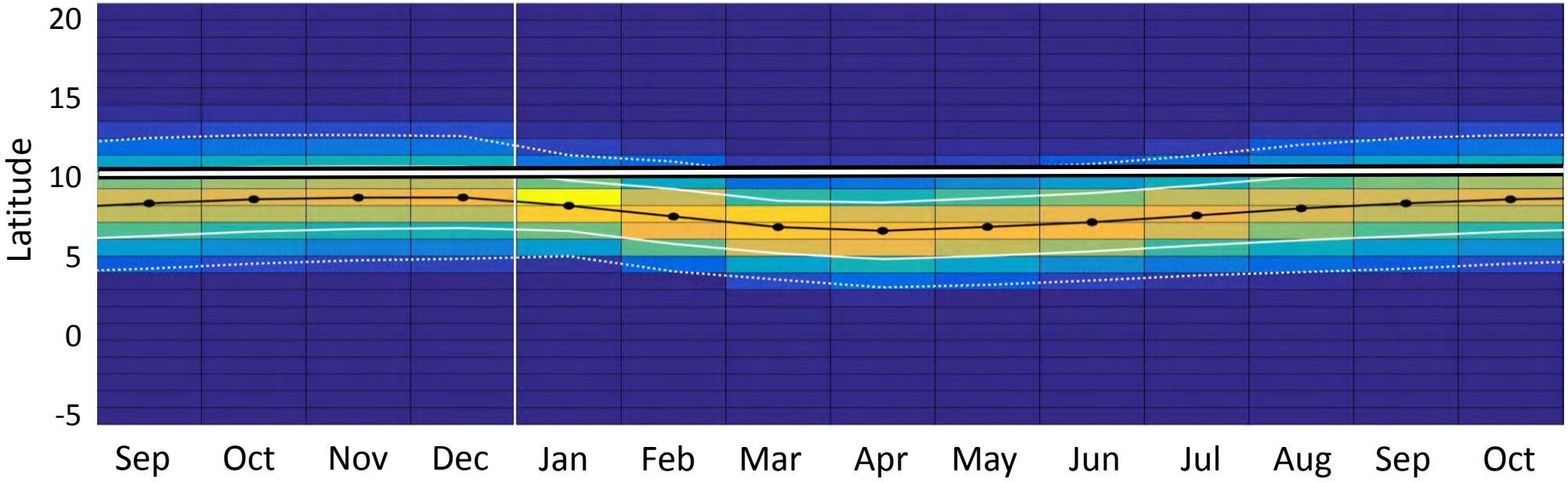
Gaussian Curve Fit to Precipitation along 125 W for September

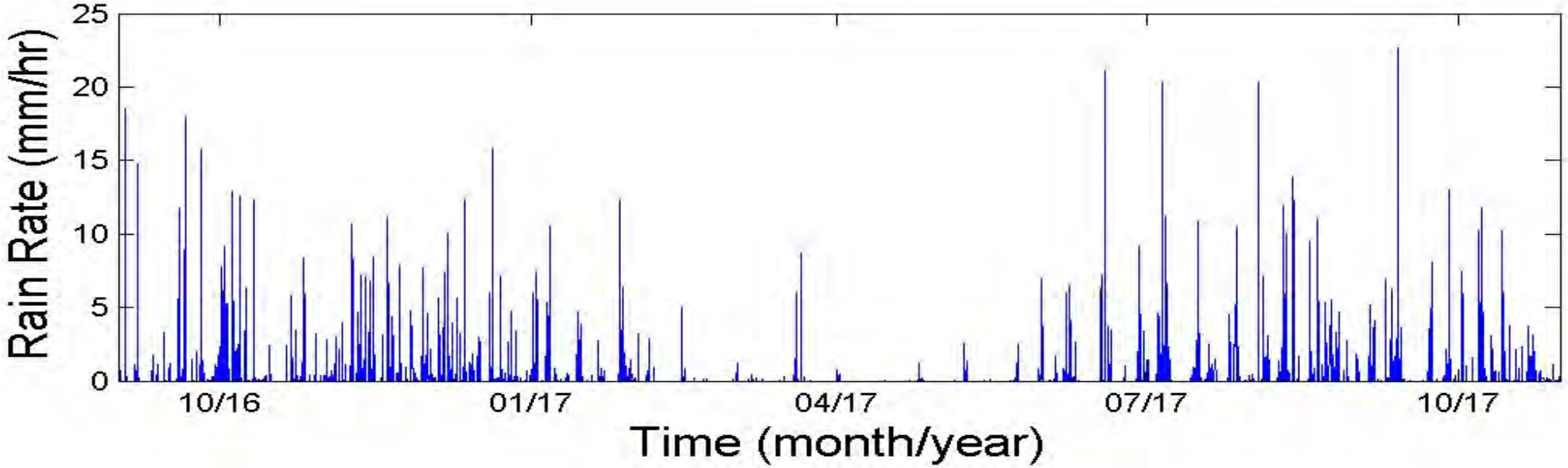




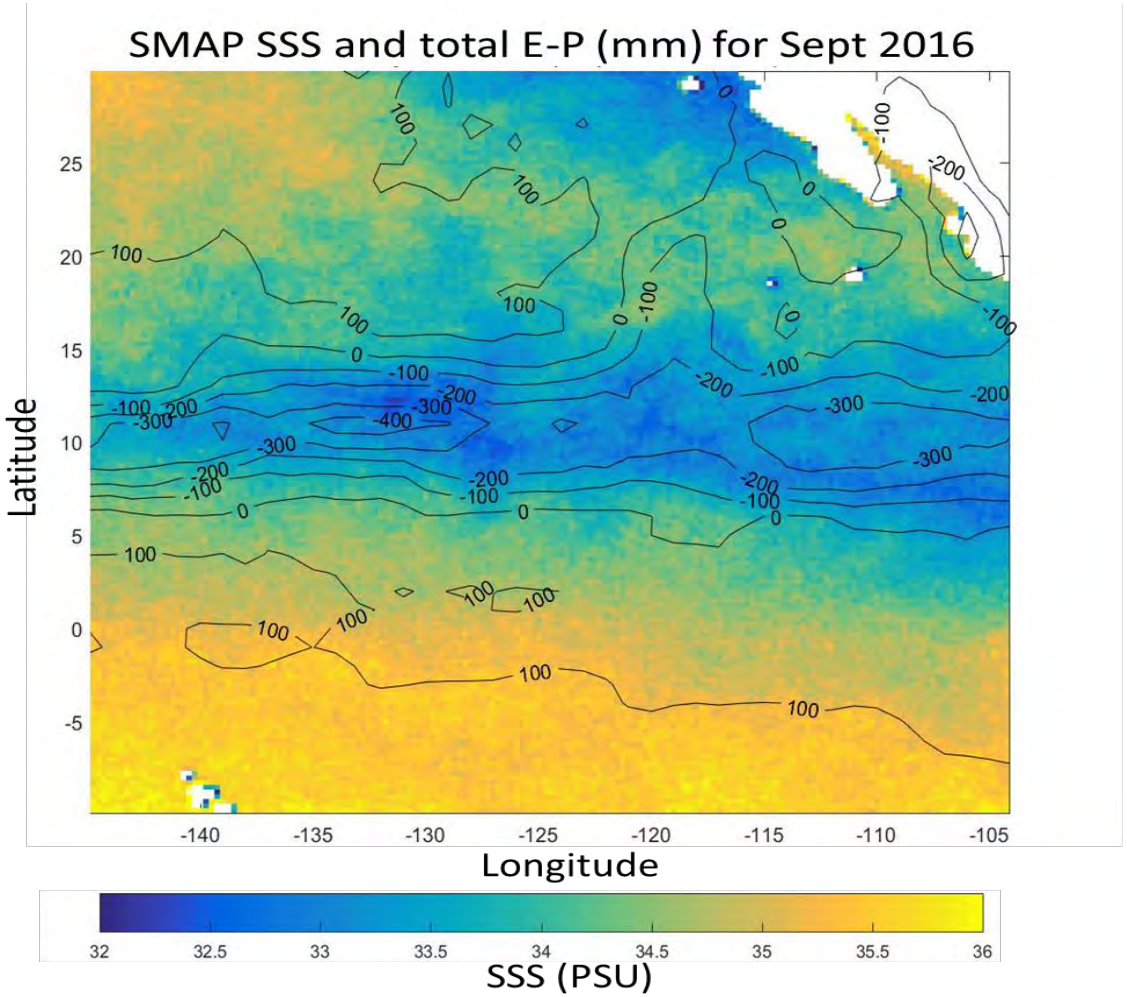
$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

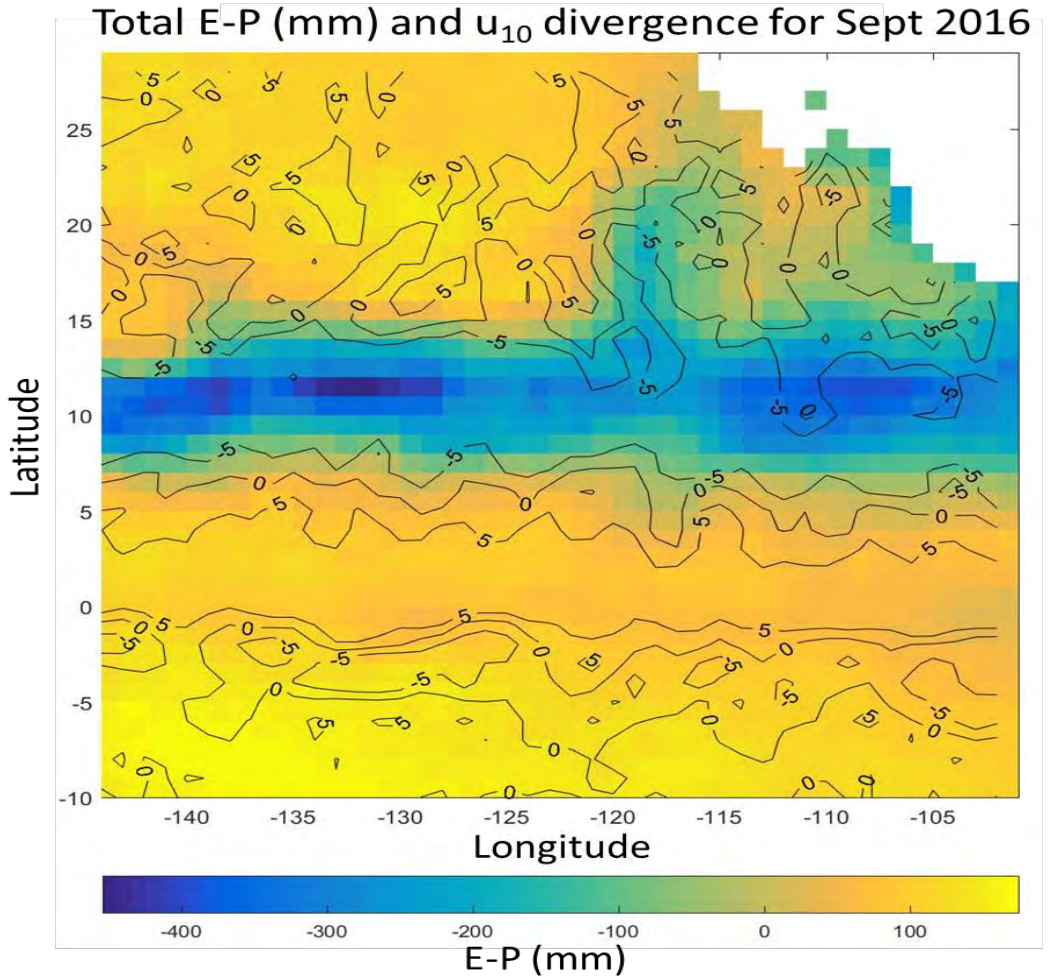
Buoy Precipitation





Salinity (SMAP), E-P (SeaFlux – GPCP), and Divergence (ASCAT)

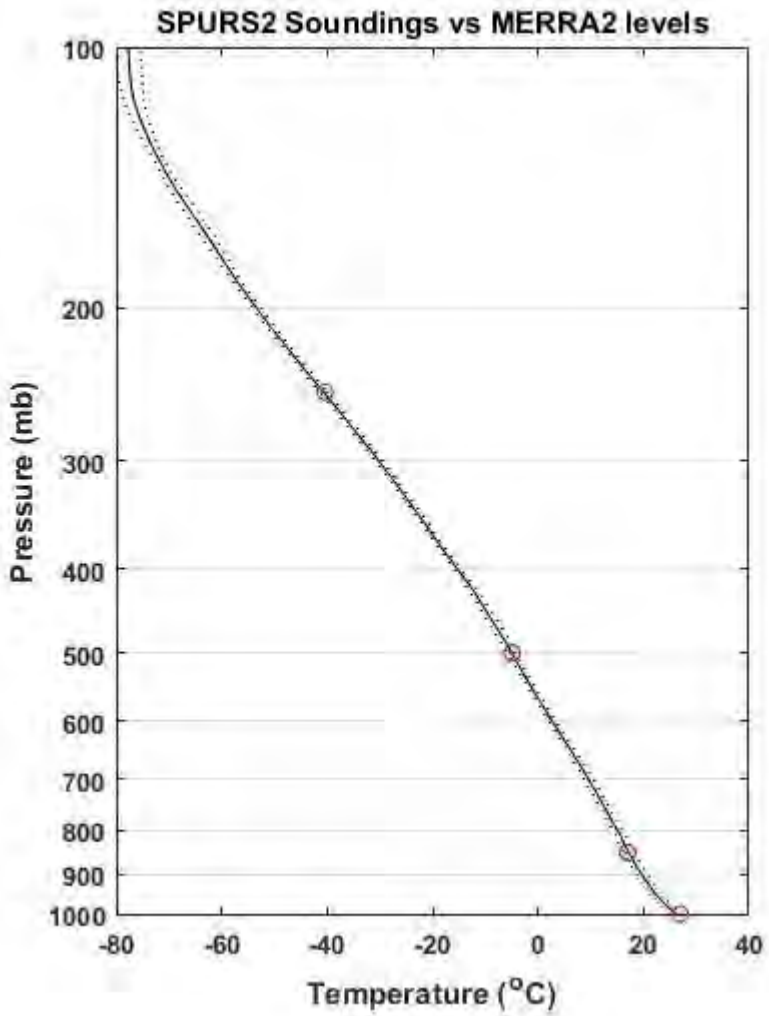


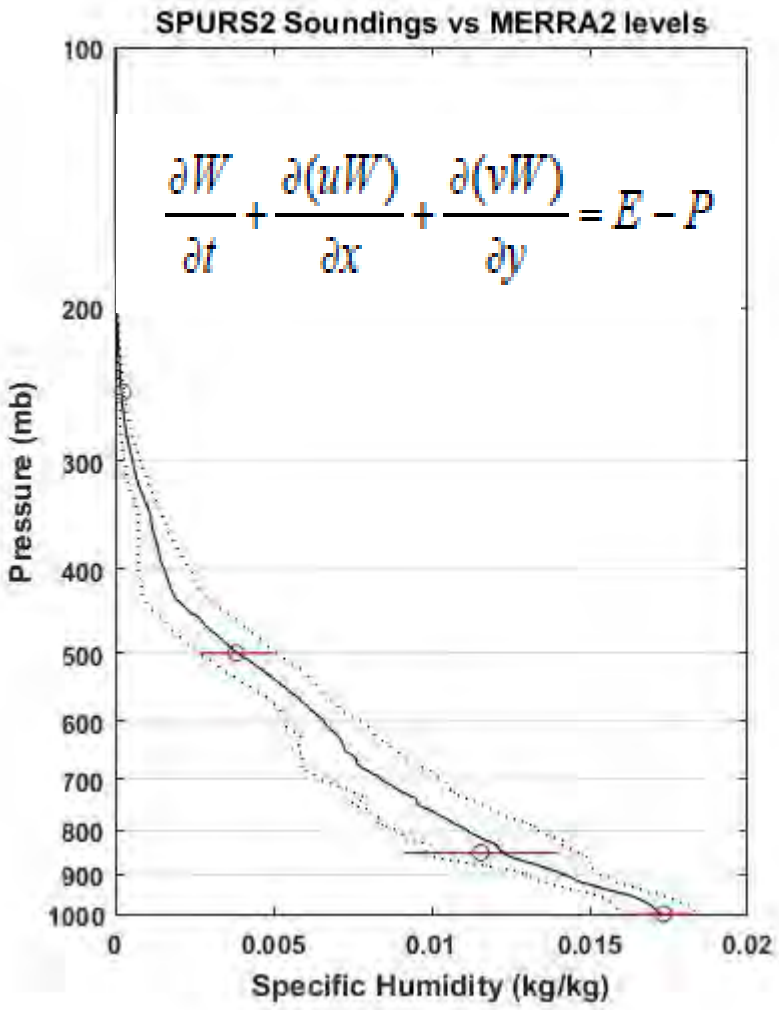


$$\frac{\partial W}{\partial t} + \frac{\partial (uW)}{\partial x} + \frac{\partial (vW)}{\partial y} = E - P$$

We are within a factor of ~3 of closing the moisture budget using remotely sensed surface winds only.

Validation and Utilization of MERRA-2 over the SPURS Region





Paula J. Brown, Christian D. Kummerow, 2014: An Assessment of Atmospheric Water Budget Components Over Tropical Oceans, *J.Climate*, **27(5)**, 2054-2071 DOI: 10.1175/JCLI-D-13-00385.1

Research Objectives

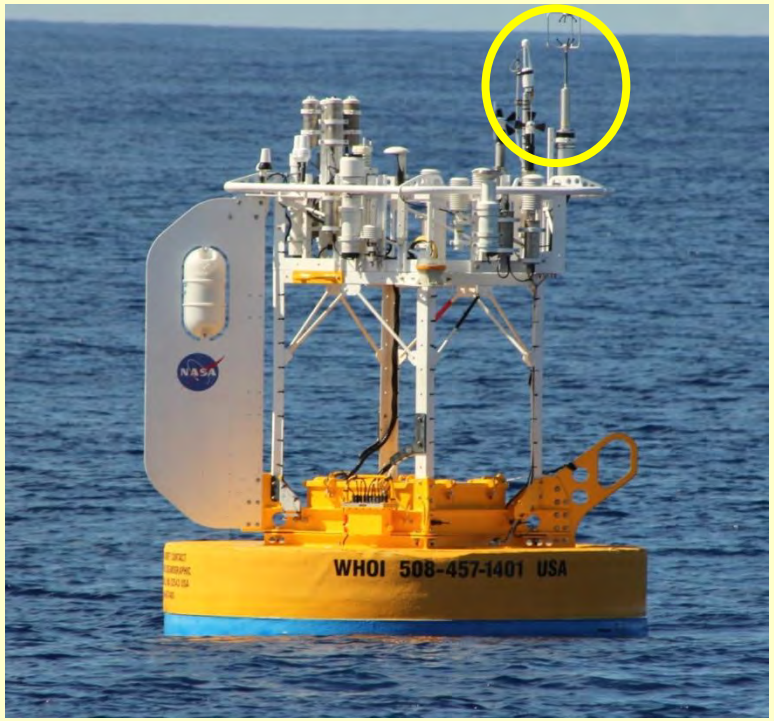
- To improve our understanding of the processes that control the exchange momentum, heat and mass across the air-sea interface.
- To develop platform and systems that directly measures the momentum, sensible heat and latent heat fluxes.
- To improve parameterization of these fluxes for use in numerical models and process studies.

Momentum Flux: $\tau_0 = \rho_a \overline{uw} \cong \rho_a C_D S_r \Delta U$

Latent Heat Flux: $Q_E = \rho_a L_v \overline{wq} \cong \rho_a L_v C_E S_r \Delta Q$

Sensible Heat Flux: $Q_H = \rho_a c_{pa} \overline{wT} \cong \rho_a c_{pa} C_H S_r \Delta \Theta$

Transfer Coefficients



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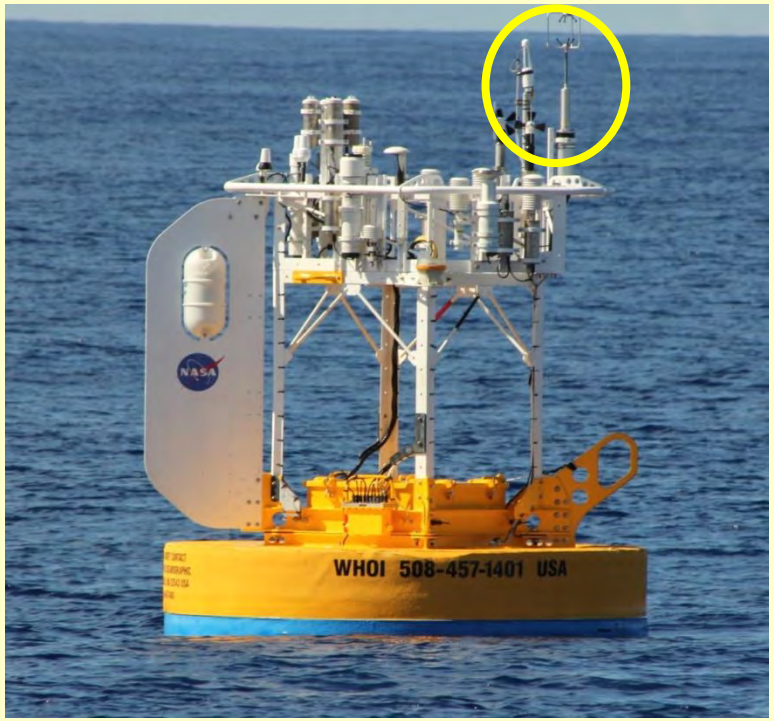
Momentum Flux: $C_D = \overline{uw} / S_r \Delta U$

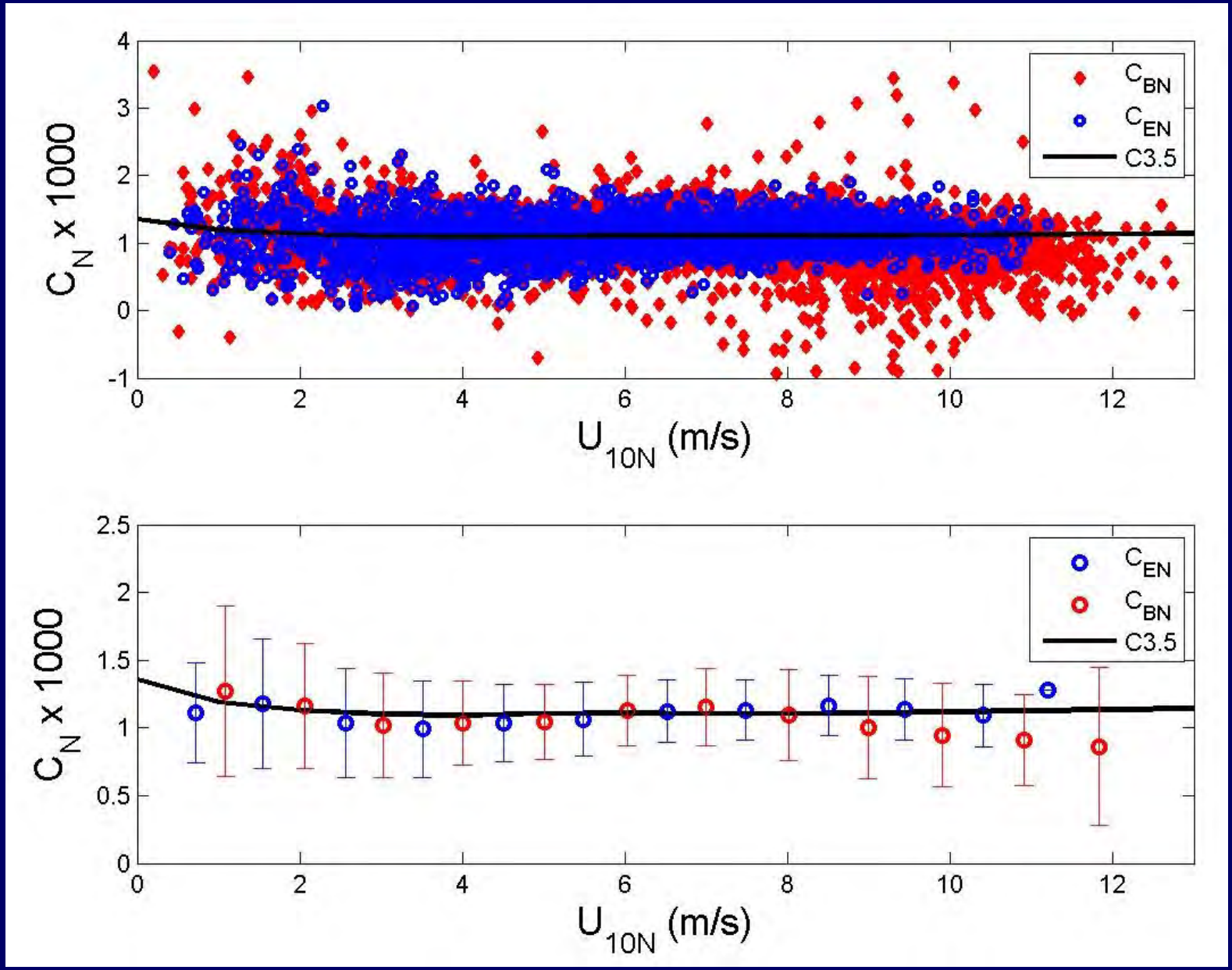
Latent Heat Flux: $C_E = \overline{wq} / S_r \Delta Q$

Sensible Heat Flux: $C_H = \overline{wT} / S_r \Delta \Theta$

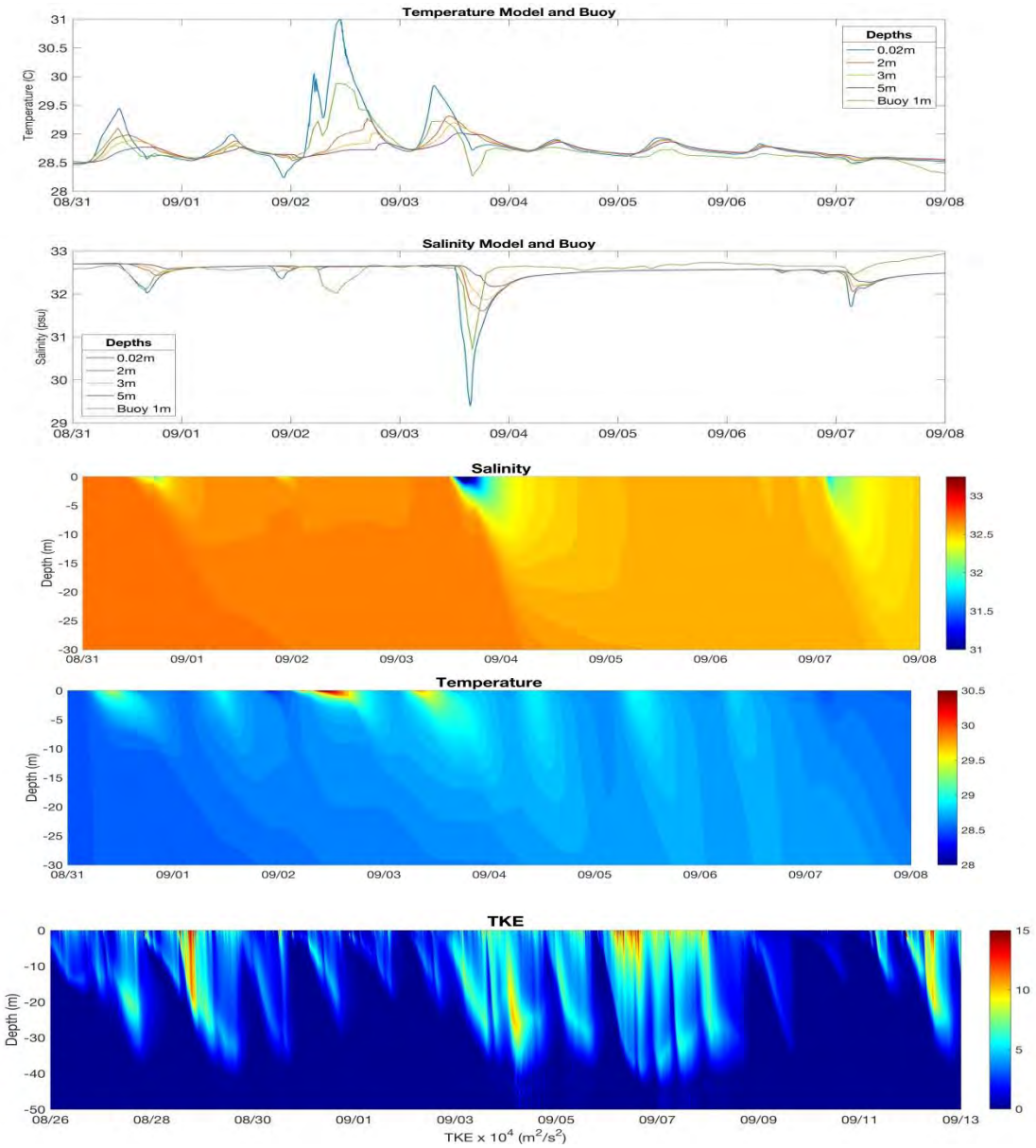
Transfer Coefficients



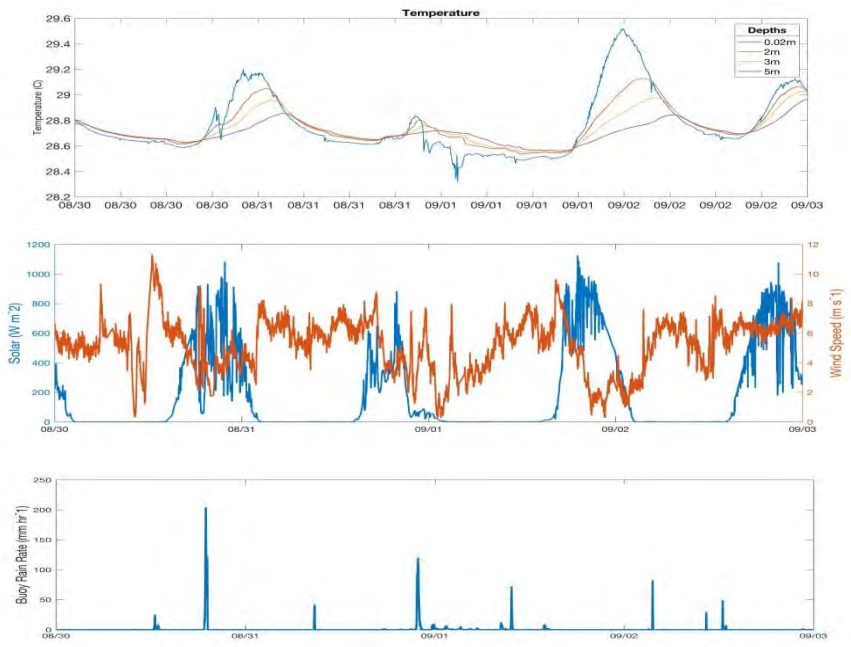
Neutral Dalton & Stanton Number



Upper ocean mixing processes and air-sea flux feedbacks



- Comparison of mixing models with buoy, ship observations
- Evaluation of fluxes and changes through freshwater lenses – time scale of recovery at various depths
- Similarities in local effects and recovery seen with similar variations in precipitation amounts, wind speed



Summary

- Meteorological and near surface data was successfully collected on board the R/V Revelle during the fall 2016 and 2017 field campaigns.
- The WHOI buoy was successfully deployed and recovered with a DCFS and LI-7500 systems capable of measuring momentum, heat and mass fluxes.
- The LI-7500 ran for approximate 5.5 months, while the DCFS ran 8.5 months.
- Analysis and cross-calibration of these systems is well underway and we are sharing the met data and readme files with SPURS PIs.
- To do list includes:
  - Analysis of R/V Revelle DCFS flux system
  - Computation of significant wave height and period (when on station)
  - Inclusion of OSPRE and salinity snake data in Met data file.
- We plan to use these measurements with remotely sensed data and MERRA-2 reanalysis to provide better regional estimates of P-E.
- We plan to use all our buoy-based measurements to improve our heat flux parameterization