Identification of the ITCZ Using Ocean Vector Wind Fields During SPURS-2

Aaron C. Paget & James B. Edson

Department of Marine Sciences, University of Connecticut

International Ocean Vector Winds Science Team Meeting

2-4 May 2017, La Jolla, California

Image Source: Shades of Blue, SPURS-2 Notes from the Field

Episode: SPURS-II
THE FATE OF FRESH WATER

A long time ago in an ocean far, far away...

It is a period of summer heat. Scientists on the Revelle ship, striking from a Hawaiian base, have won their first victory against the observing salinity in the Atlantic Ocean desert (SPURS-1).

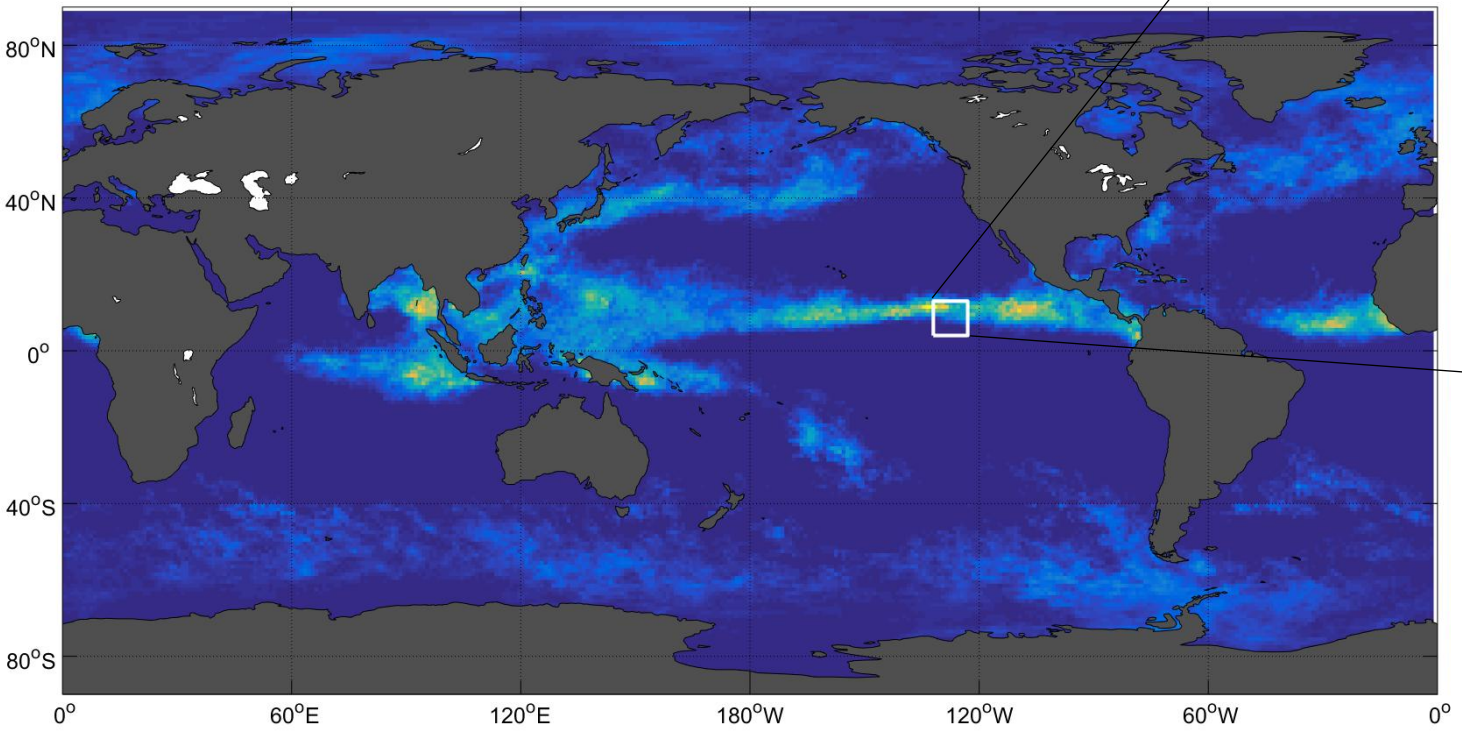
During this new mission, the NASA funded scientists manage to make observations of Precipitation, Salinity, and Latent Heat Flux to study processes in the Earth's moisture budget in this relatively-freshwater tropical oasis.

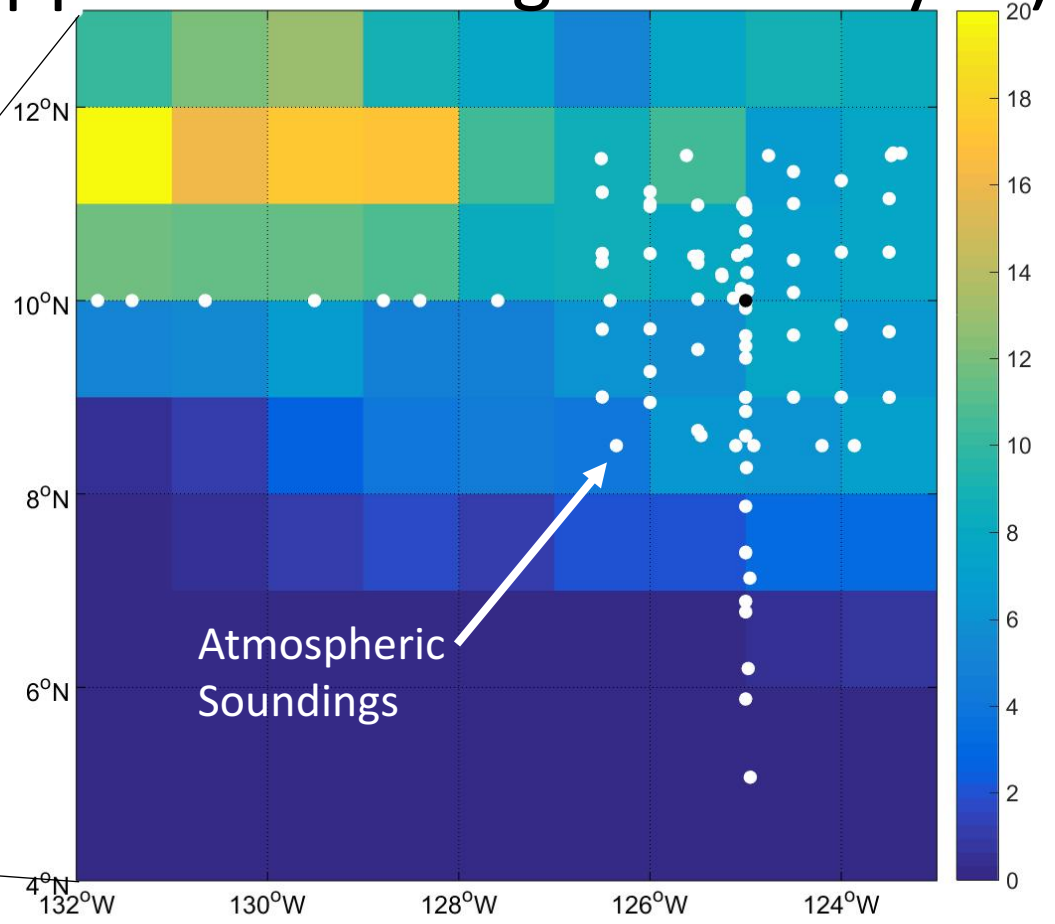
Driven by the scientific inquiry, Jim Edson races home, custodian of the tropical observations that can explain the atmospheric moisture budget and determine the fate of freshwater in the Eastern Tropical Pacific....

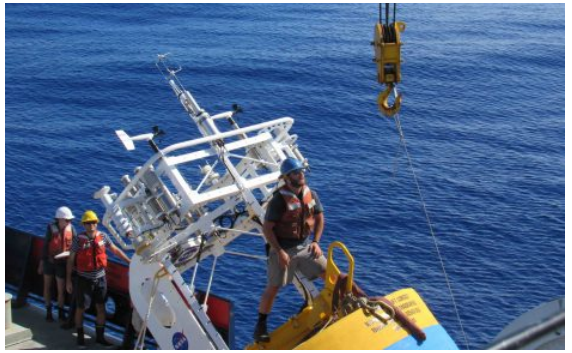
NASA SPURS-2 (Salinity Processes in the Upper Ocean Regional Study -2)

To study the fate of fresh water (Precipitation)

- In the Intertropical Convergence Zone (ITCZ)
- Cruise dates: August – September 2016
- WHOI Buoy Mooring at 10°N, 125°W
- Atmosphere and ocean observation
- Other resources deployed as well

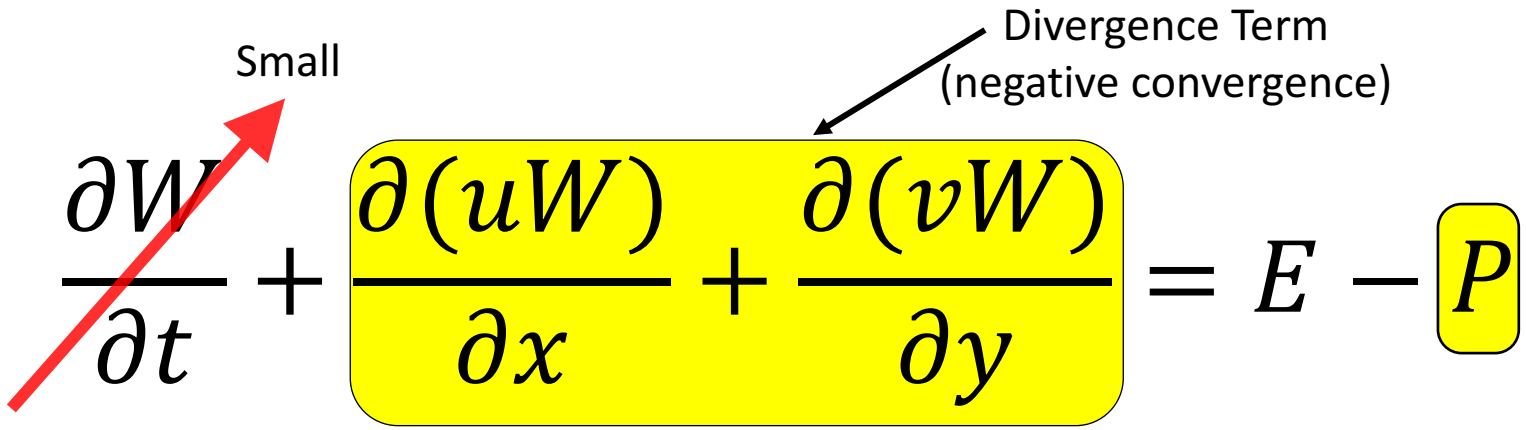






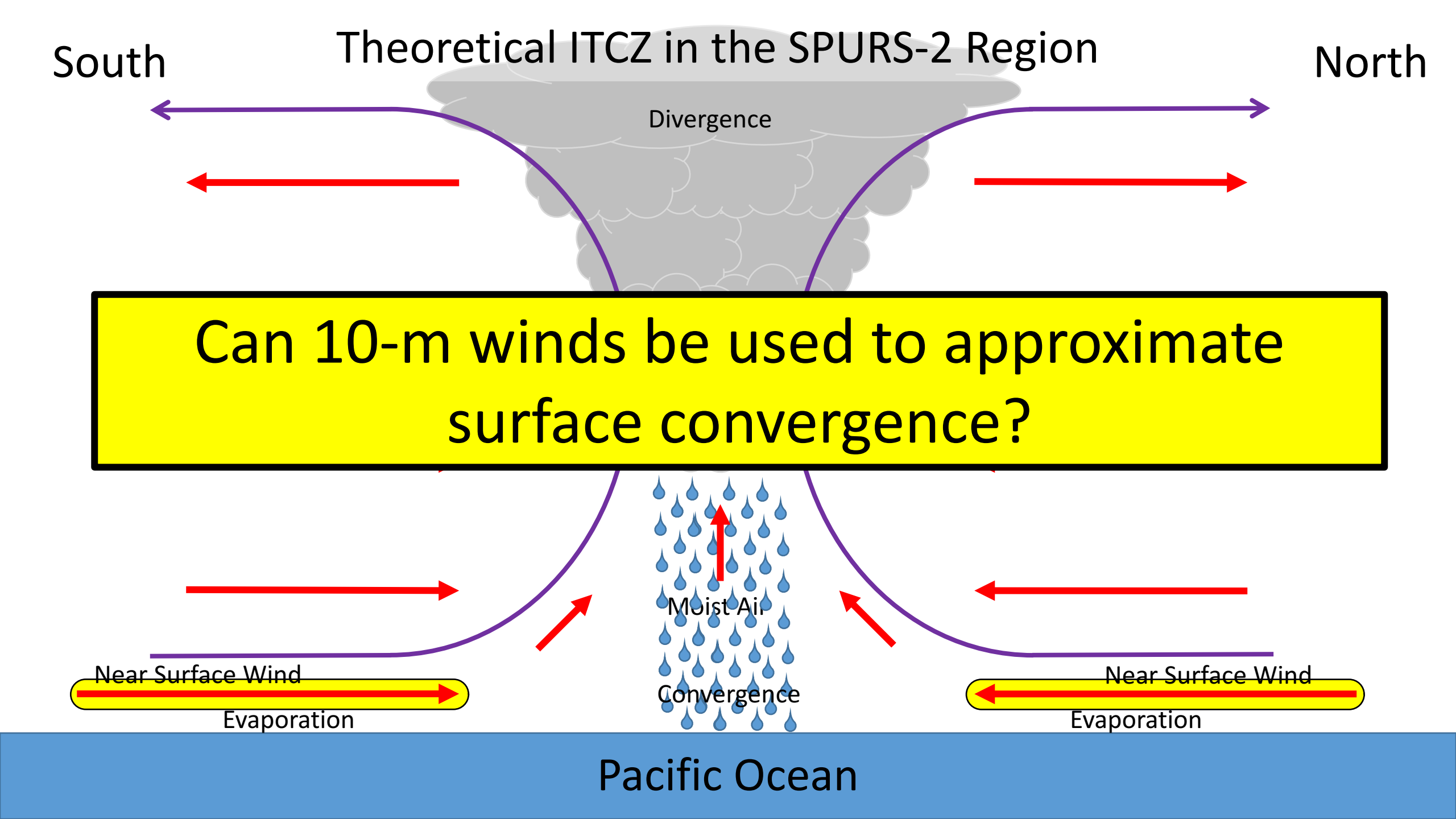
Convergence is related to precipitation

Basic water vapor conservation recycling model



Dominguez et al. 2006

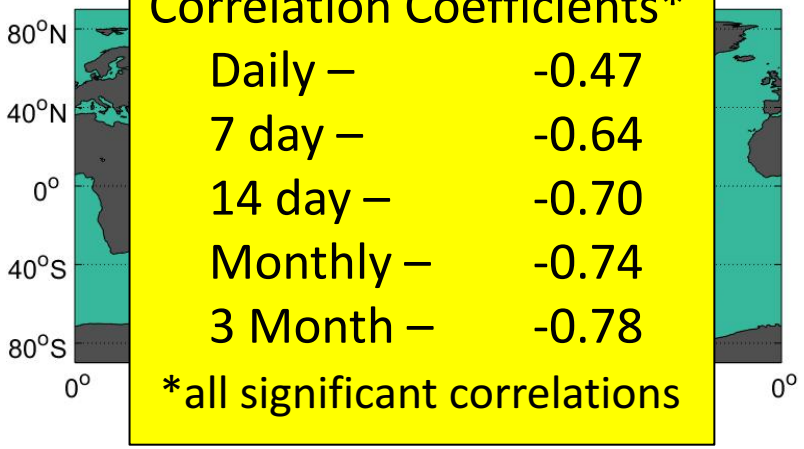
W is the precipitable water vapor in the atmosphere
P is precipitation
E is Evaporation
u,v are the moisture-weighted velocities that contain both the mean and eddy components for zonal and meridional wind speeds


South
Theoretical ITCZ in the SPURS-2 Region
North
Divergence
Can 10-m winds be used to approximate surface convergence?
Moist Air
Near Surface Wind
Evaporation
Convergence
Near Surface Wind
Evaporation
Pacific Ocean

GPCP Precipitation and CCMP Wind (V1) Convergence (Daily, 1°)

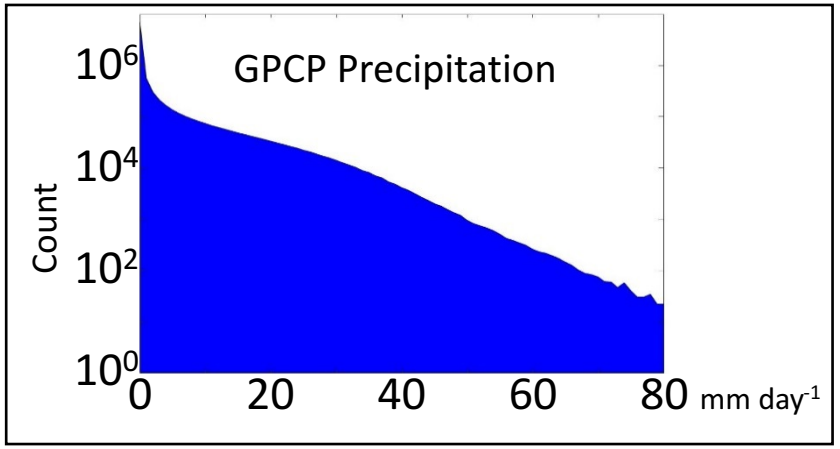
For SPURS-2 analysis region (30°N – 10°S, 145°W – 100°W) (1996-2011)

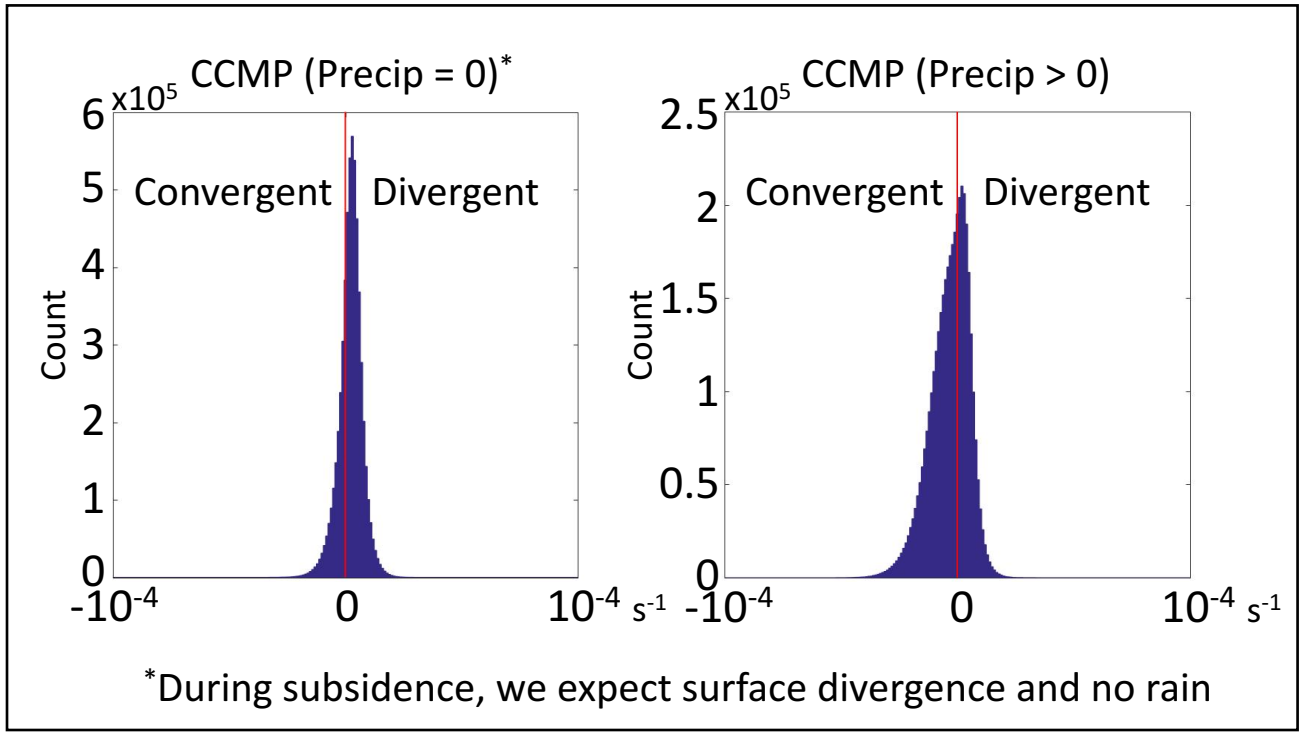
- 60% of the Precipitation rate is 0 mm/day



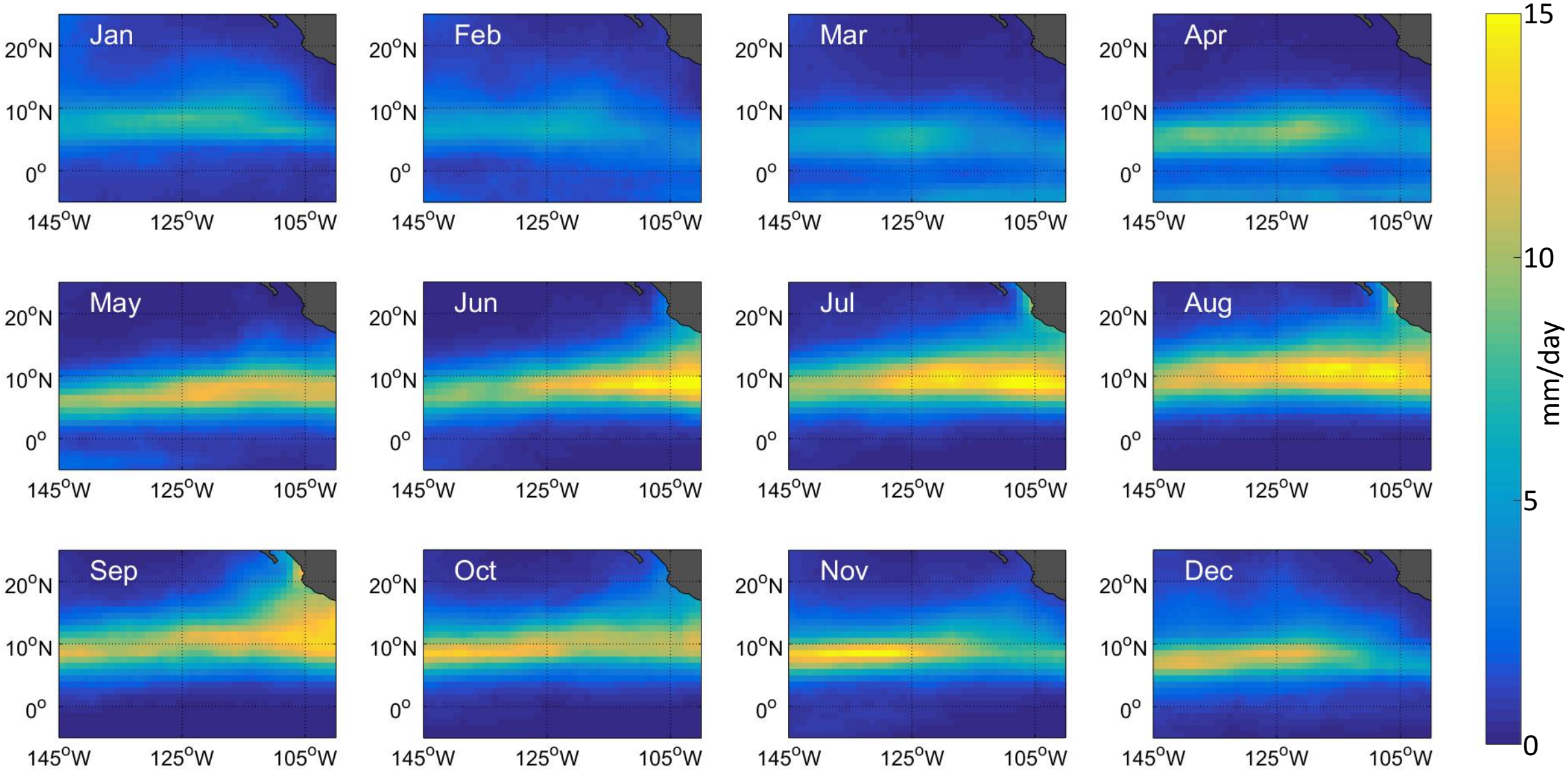
Correlation Coefficients*	
Daily –	-0.47
7 day –	-0.64
14 day –	-0.70
Monthly –	-0.74
3 Month –	-0.78

*all significant correlations

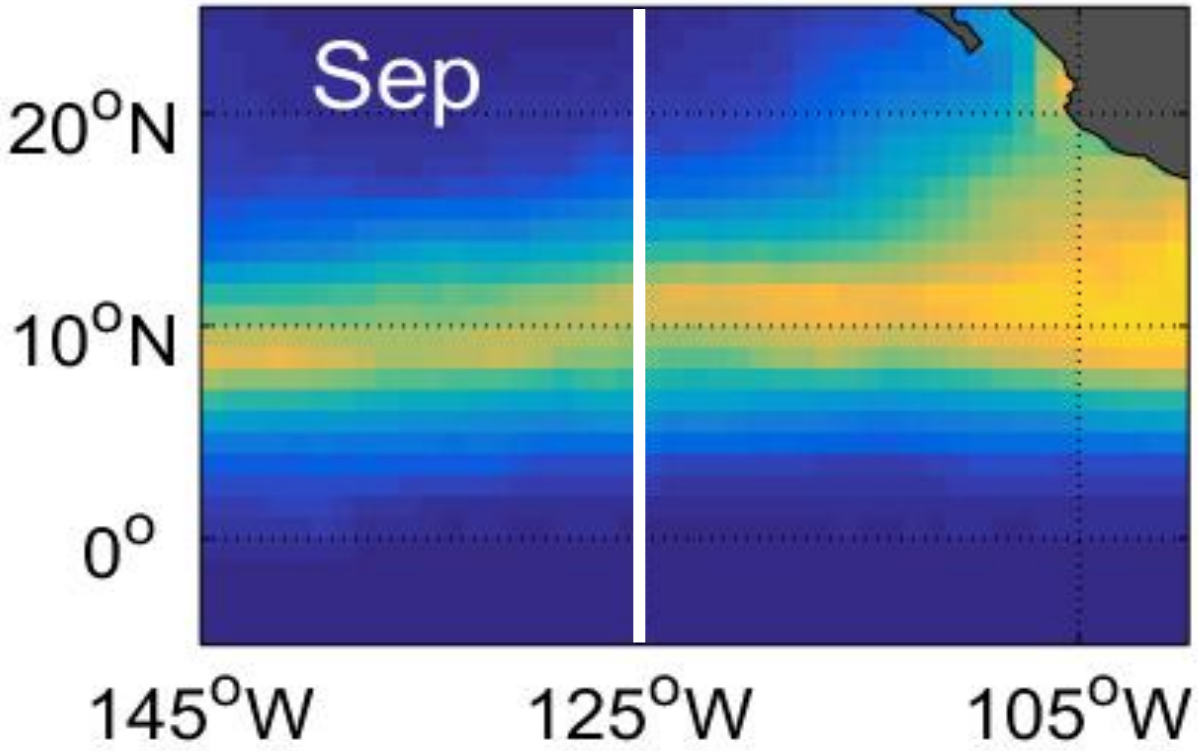


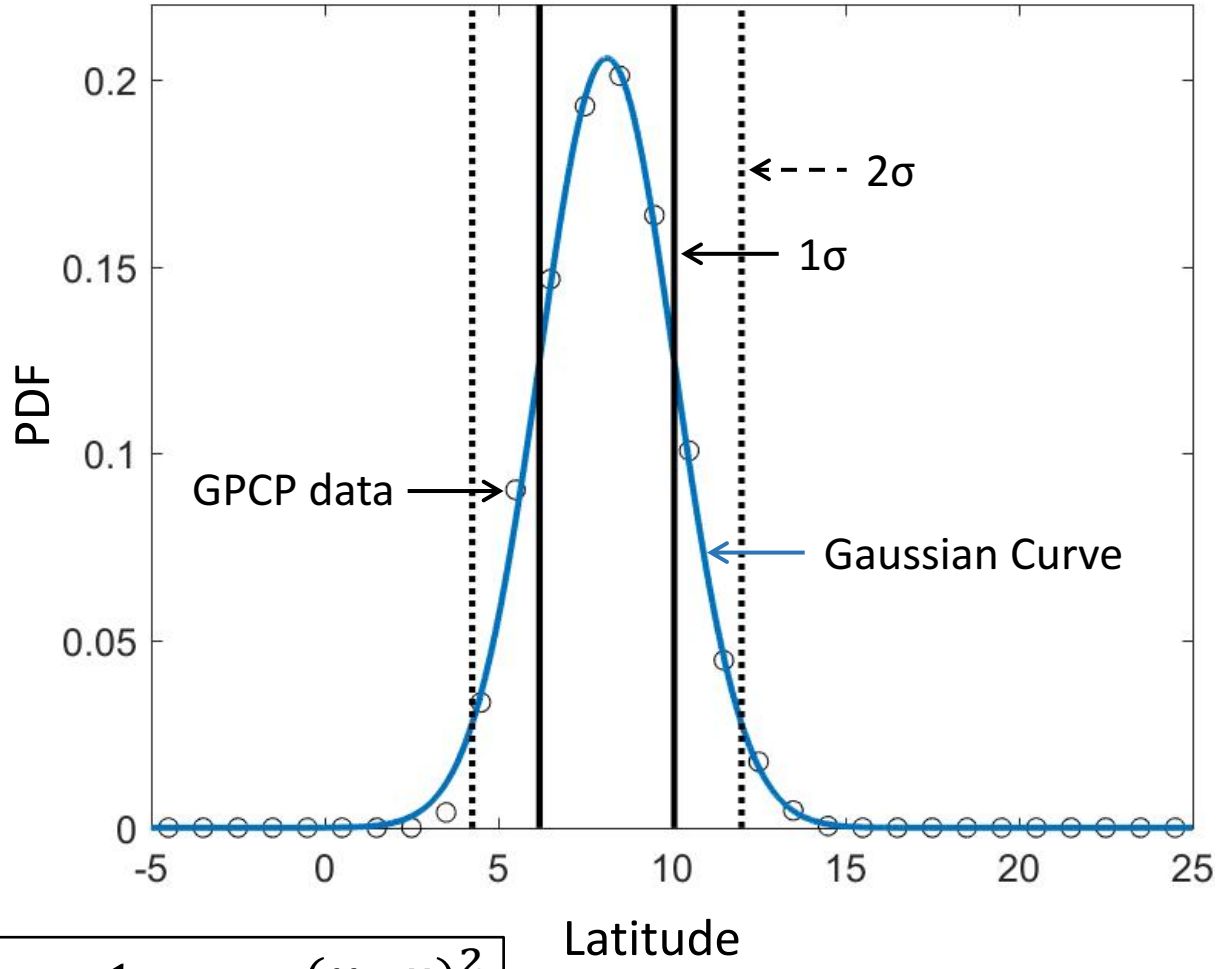


Median Monthly Precipitation Rate for GPCP (1996-2016)



Gaussian Curve Fit to Precipitation along 125 W for September





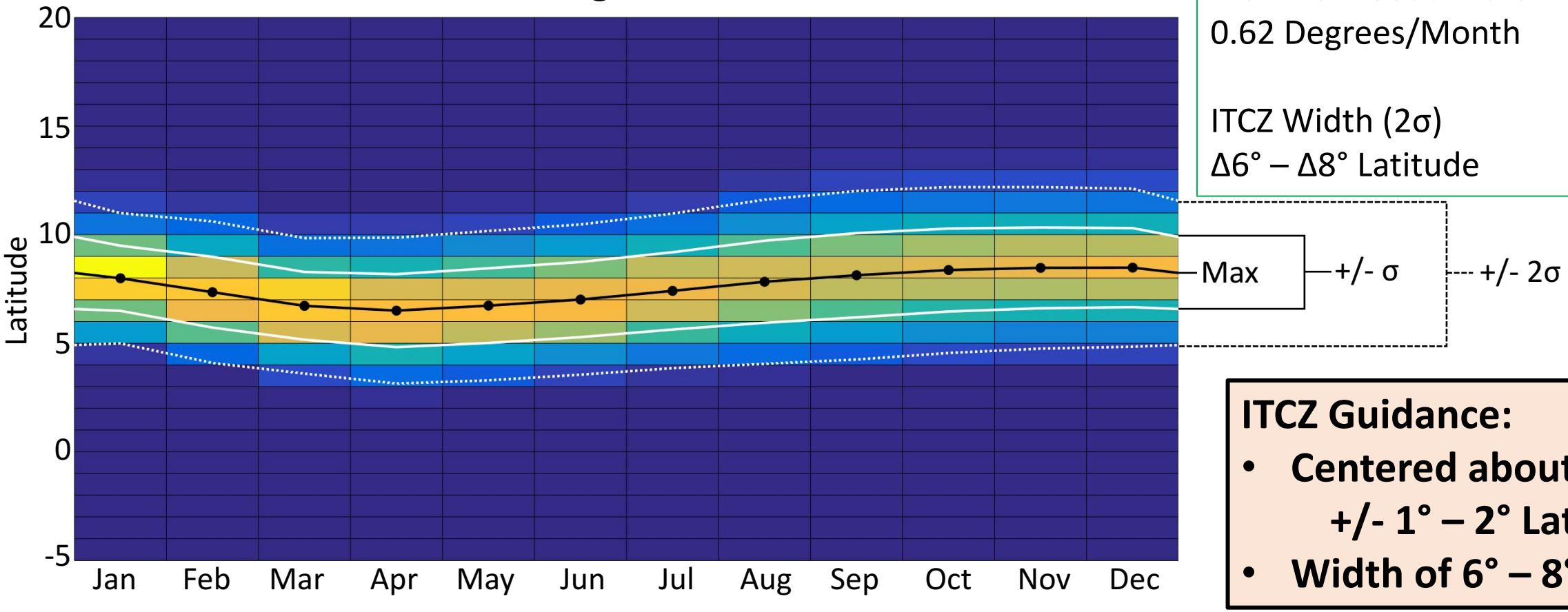
$$y = \frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-(x-\mu)^2}{2\sigma^2}}$$

Median Monthly Probability Distribution Function (PDF) of Precipitation (GPCP 1996-2016)

Maximum Northward Velocity
0.42 Degrees/Month

Maximum Southward Velocity
0.62 Degrees/Month

ITCZ Width (2σ)
Δ6° – Δ8° Latitude

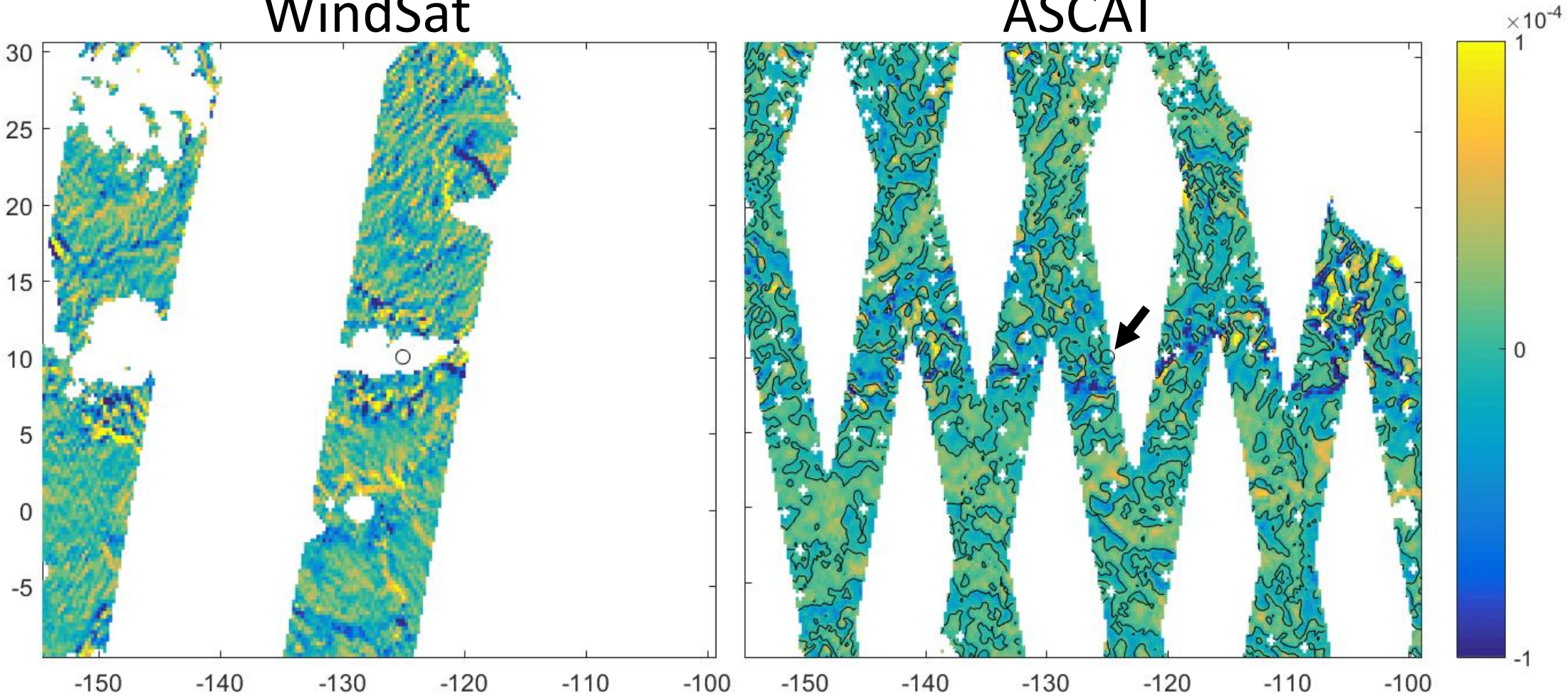


ITCZ Guidance:

- **Centered about 8°N +/- 1° – 2° Latitude**
- **Width of 6° – 8°**

Convergence of 10-m Winds from WindSat and ASCAT

23 August 2016 – Swaths



QuikSCAT L3 – 14 Day (0.25x0.25) during August 2008

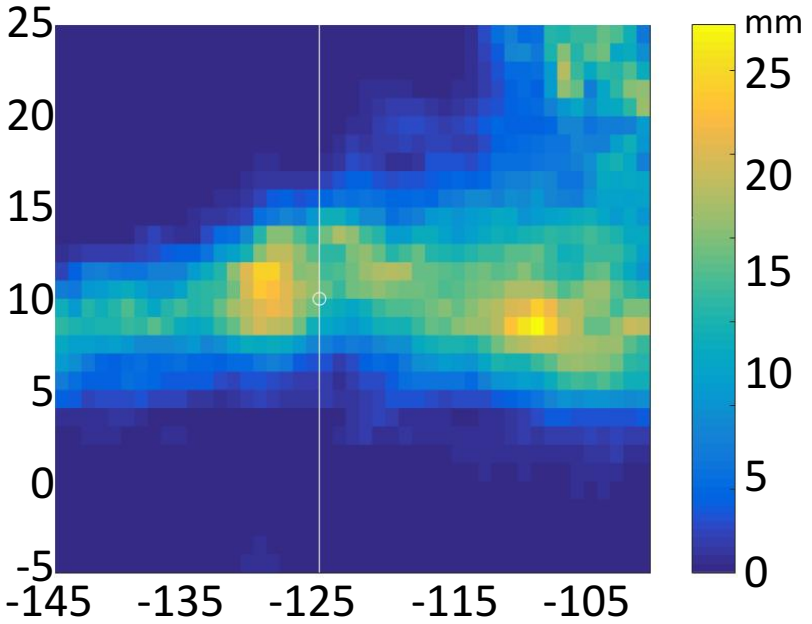
<u>GPCP Total Precipitation</u>

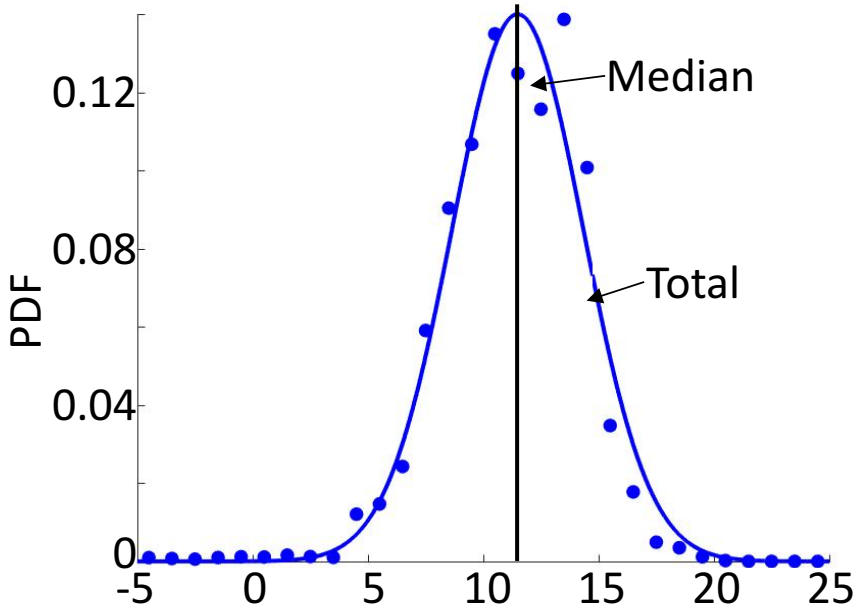
Peak at 11.5°N

σ= 2.85

Range: 8.6°N – 14.4°N (1σ)

5.8°N – 17.2°N (2σ)

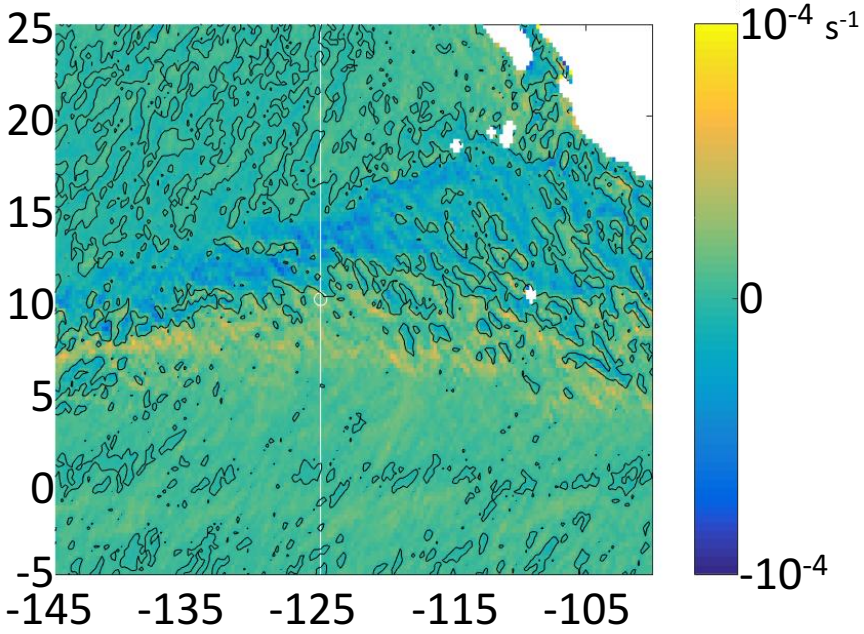


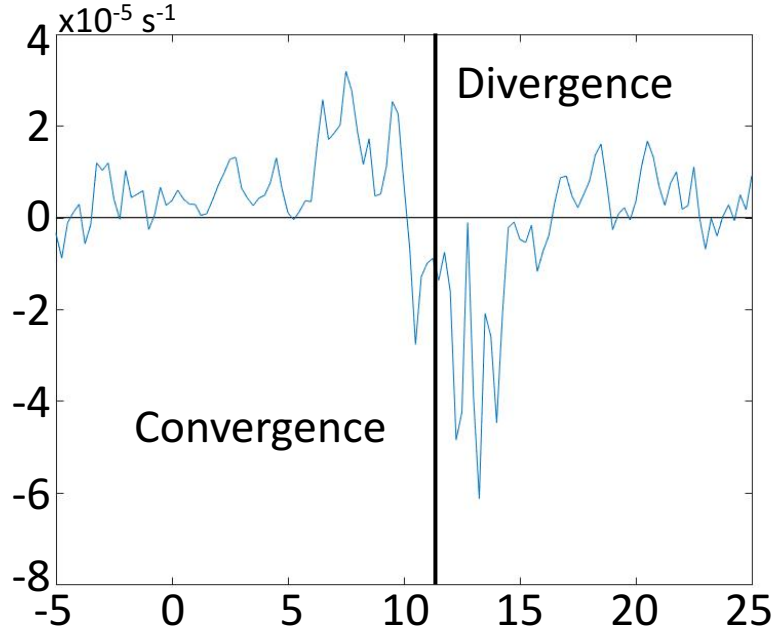


<u>QuikSCAT Convergent</u>

9°N – 16°N

During 14 day period, ITCZ shifting North





QuikSCAT L3 – 28 Day (0.5°x0.5°) during August 2008

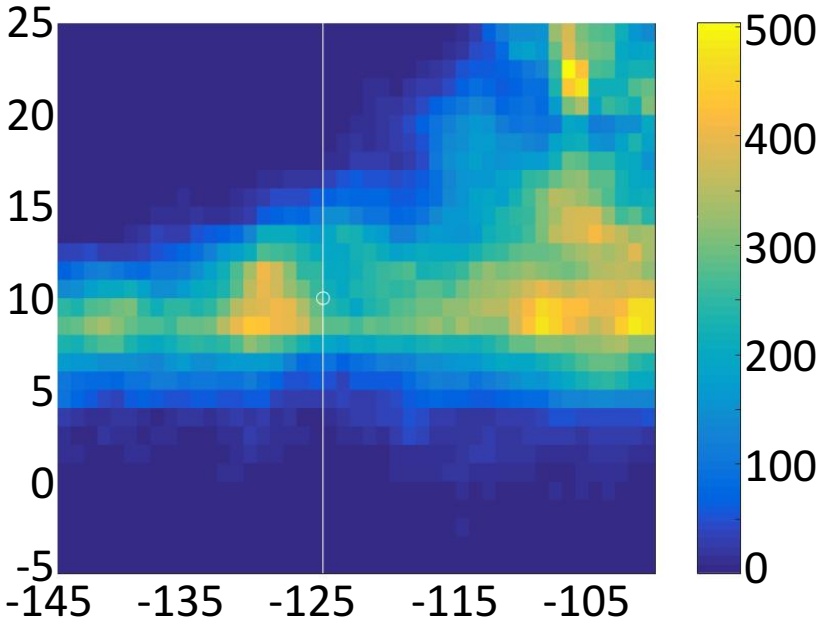
<u>GPCP Total Precipitation</u>

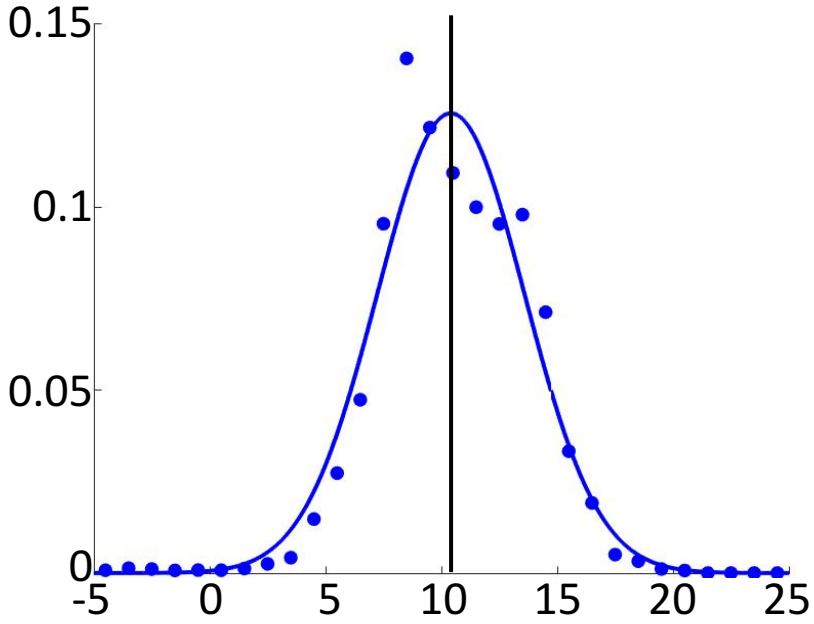
Peak at 10.4°N

σ= 3.2

Range: 7.2°N – 13.6°N (1σ)

4.0°N – 16.8°N (2σ)

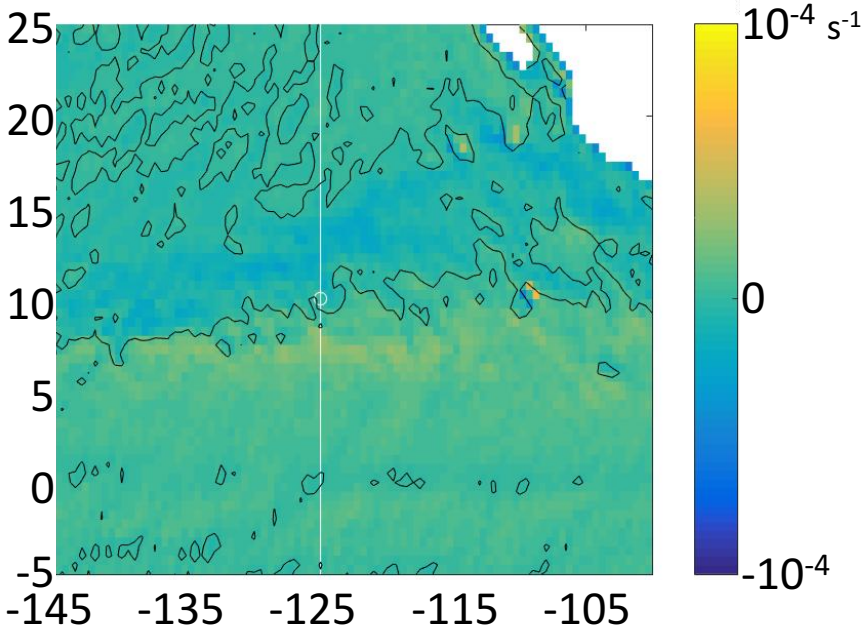


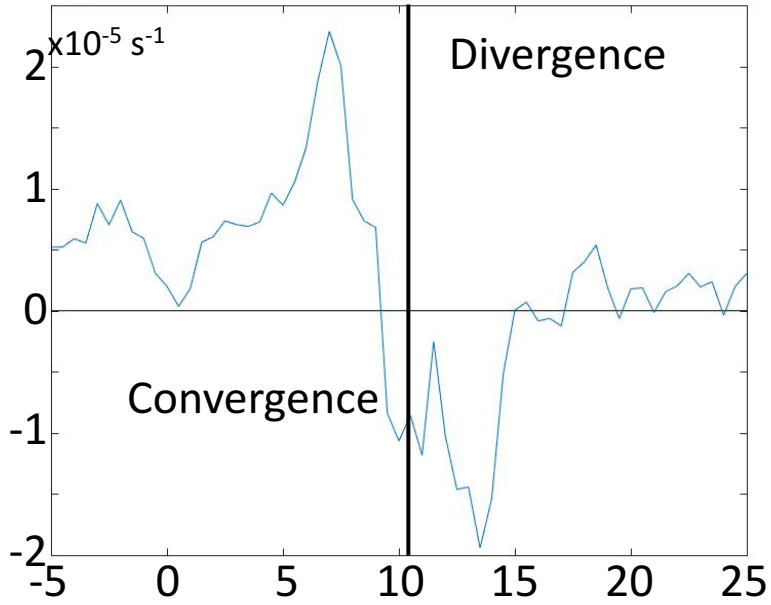


<u>QuikSCAT Convergent</u>

8°N – 15°N

During 28 day period, ITCZ shifting North





Preliminary Conclusions

- Precipitation and Convergence are significantly correlated on daily – seasonal time scales
- On a monthly time scale, the precipitation has a normal distribution North to South in the SPURS-2 region
- Precipitation maximum meanders North and South at a rate of up to +/- 0.5° $month^{-1}$
- 10-m wind convergence does not perfectly match the precipitation pattern

Future Plans

- We need to consider evaporation and atmospheric moisture in our balance
- The moisture budget requires vertically integrated winds – from models?
  - MERRA-2, ERA-Interim, NCEP-NCAR
- SPURS-2 soundings are too coarse for the budget, but can be used to validate models
- More information will be shared at the Salinity Workshop at WHOI (22-26 May)

This slide intentionally left blank