EFFECTS OF PERSISTENT VERSUS EVOLVING SST ON MJO SIMULATIONS

MPO 624 Applied Data Analysis Project

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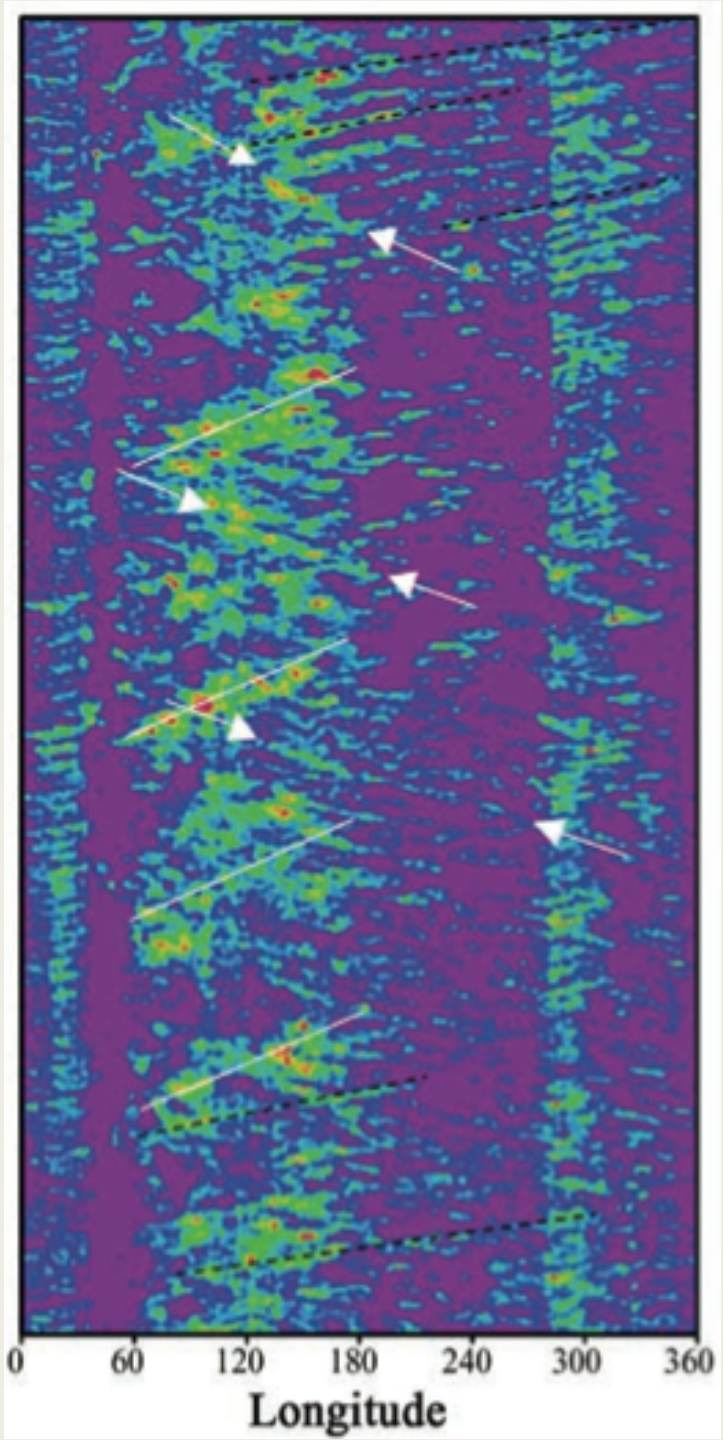
Background

- The Madden Julian Oscillation (MJO)
  - *Quasiperiodic (30-90 days)*
  - *Coupled atmospheric circulation and deep convection*
  - *Originates over the Indian Ocean*
  - *Propagates east ~5m/s*
- Largest source of intraseasonal variability in the tropics
- Affects global weather and climate



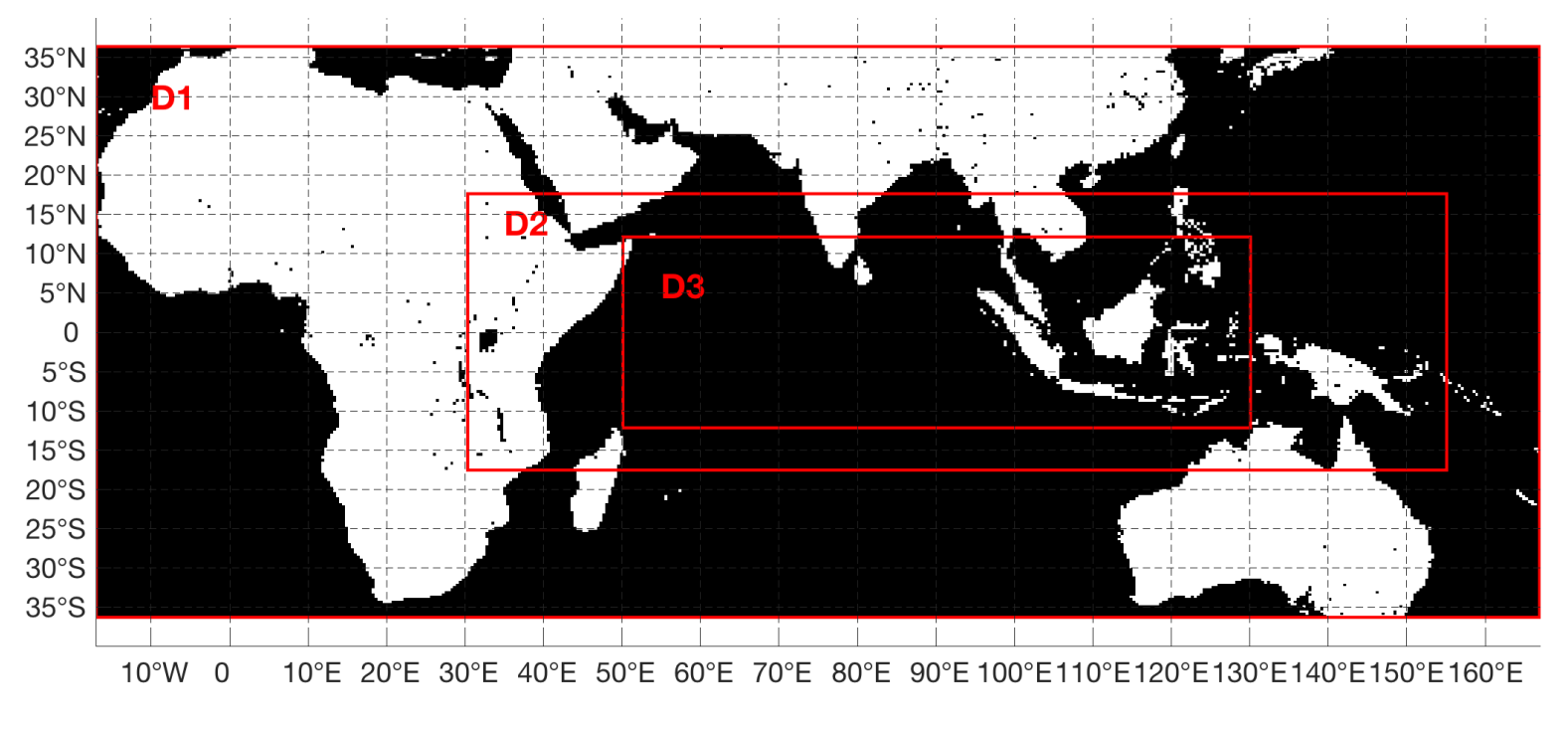
Zhang 2005

Motivation

- Many global circulation models are unable to reproduce MJO-like variability (Hung et al. 2013); related to their inability to produce MJO initiation (Ling et al. 2013)
- Ocean coupling
  - *organizes and intensifies intraseasonal variability in the tropics (Waliser et al 1999; Fu and Wang 2004; Fu et al. 2017).*
  - *a negligible or negative impact on MJO simulations (Miura et al. 2007; Newman et al. 2009)*
- Use of regional model can improve MJO simulations and predictions by allowing spatial resolution for convection to be resolved (Holloway et al 2013).

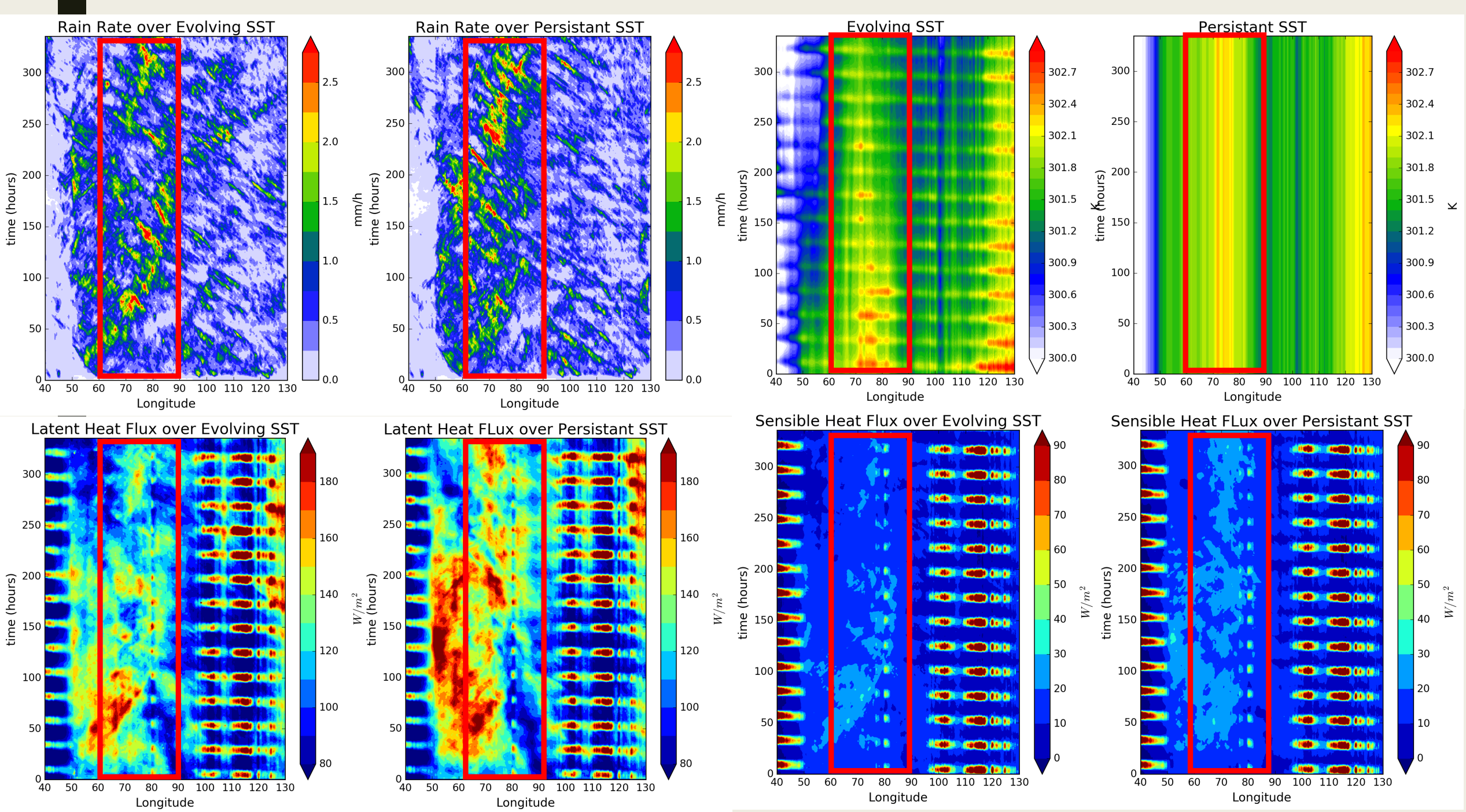
Model

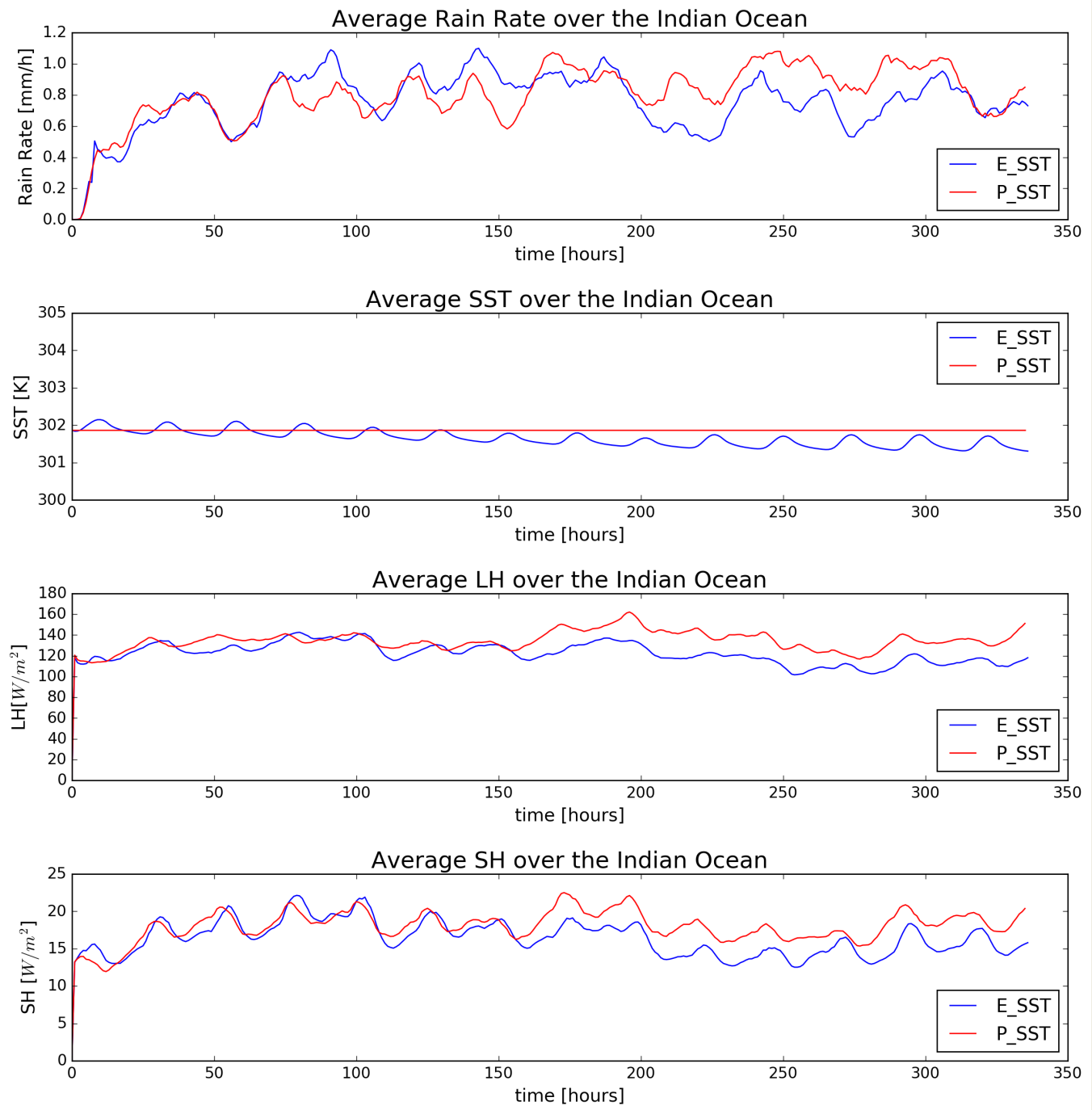
- The Unified Wave Interface Coupled Model (UWIN-CM; Chen et al. 2016)
  - *Weather Research and Forecasting (WRF) Atmosphere*
  - *D1 36km, D2 12km, D3 4km (Explicit Convection)*
- the Hybrid Coordinate Ocean Model (HYCOM) ocean, 0.08° resolution
- ERA-Interim reanalysis boundary conditions



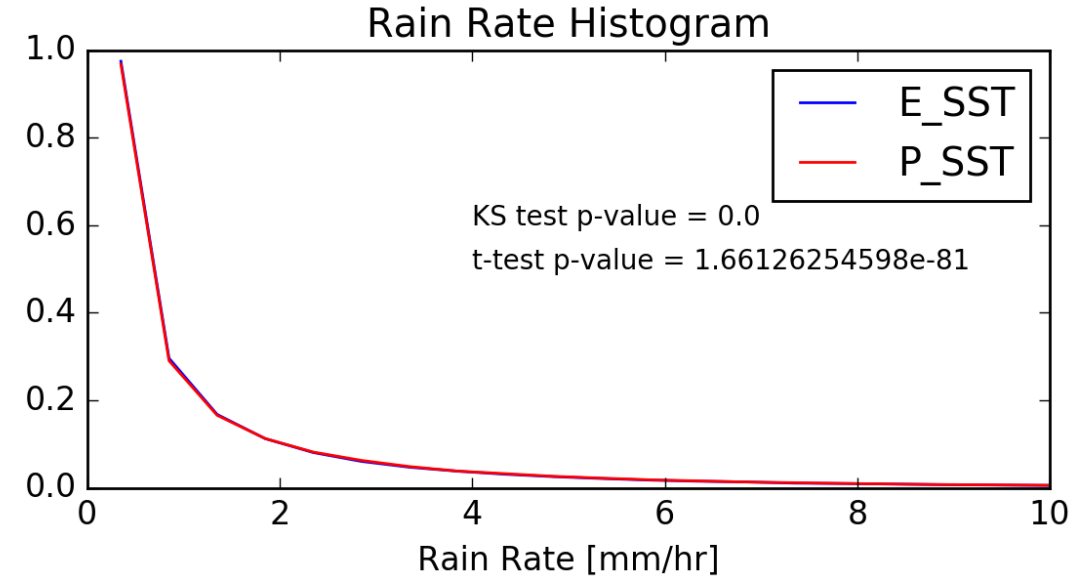
How *Applied Data Analysis* Fits In

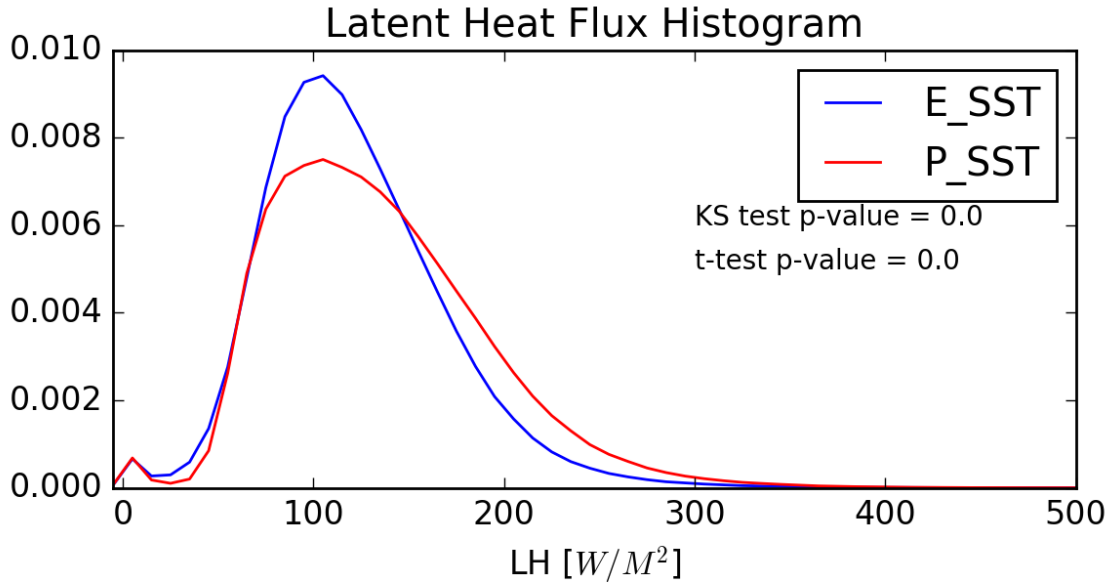
- Data Visualization
  - *More comfortable writing scripts in Python*
  - *Python has more options than Matlab for plotting figures*
- Data Analysis
  - *Leaned more about statistical tests*
  - *Learned how to do correlations and regressions*
- Apply tools from class to persistent-SST experiment (P_SST) and evolving-SST experiment (E_SST) to visualize and quantify the differences

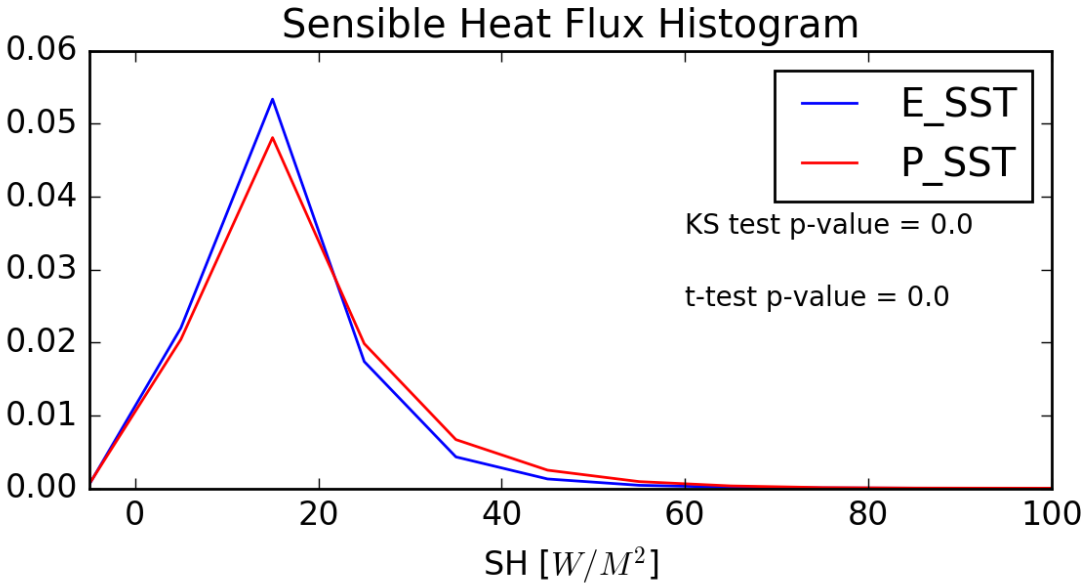

Rain Rate over Evolving SST
Rain Rate over Persistant SST
Evolving SST
Persistant SST
Latent Heat Flux over Evolving SST
Latent Heat FLux over Persistant SST
Sensible Heat Flux over Evolving SST
Sensible Heat FLux over Persistant SST
time (hours)
Longitude
mm/h
K
W/m^2



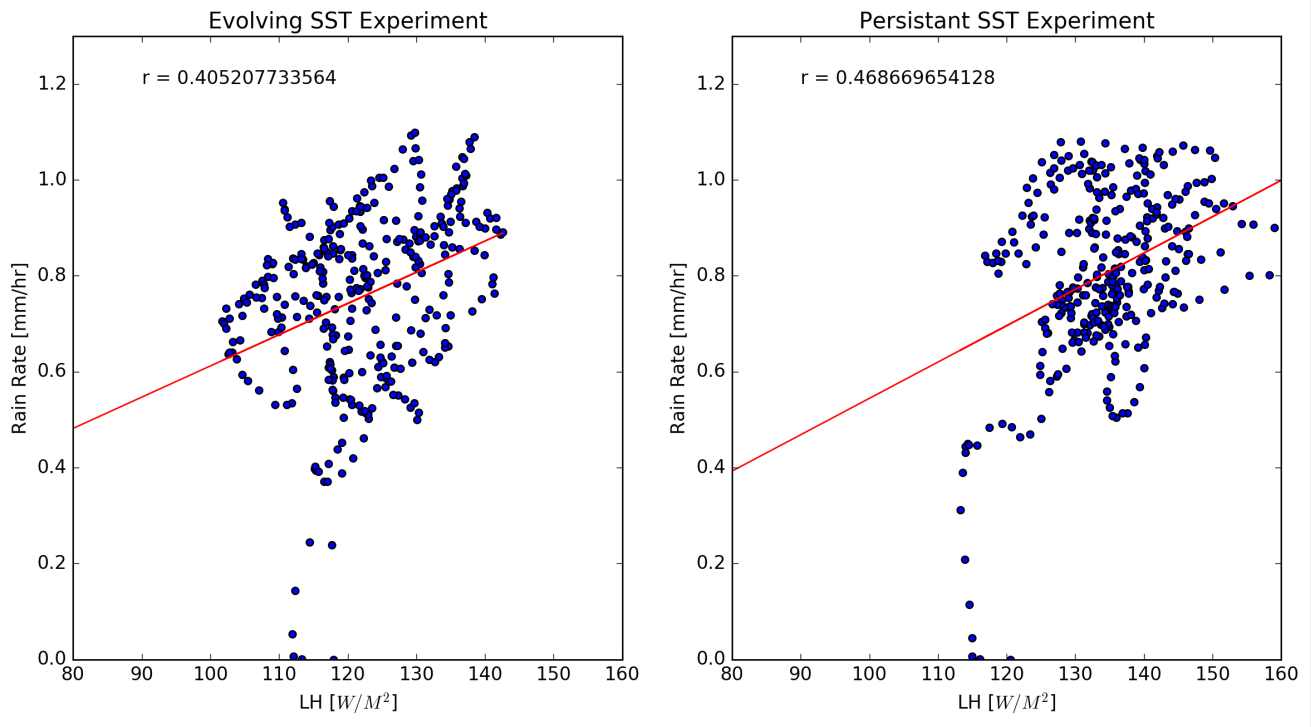
- Hourly area-average over 60°E-90° and 10°S-10°N
- Values of all variables for persistent SST experiment become higher during second half of time period

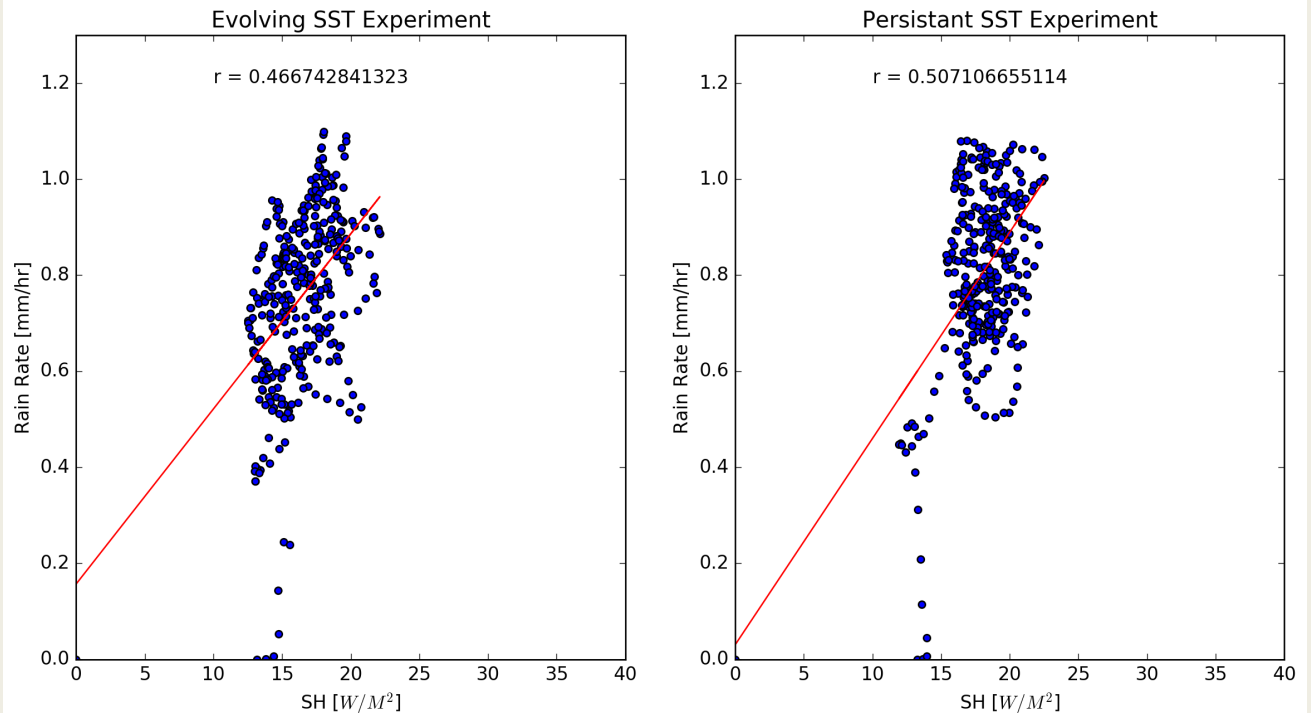




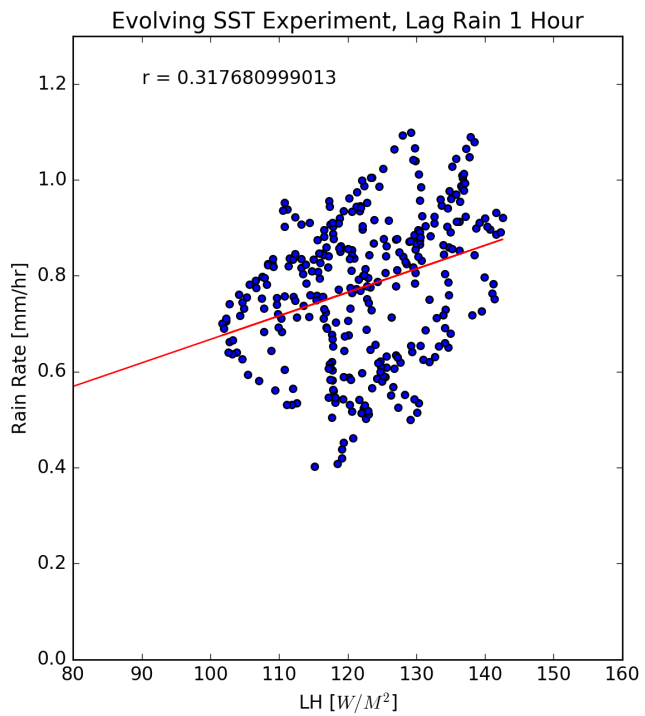


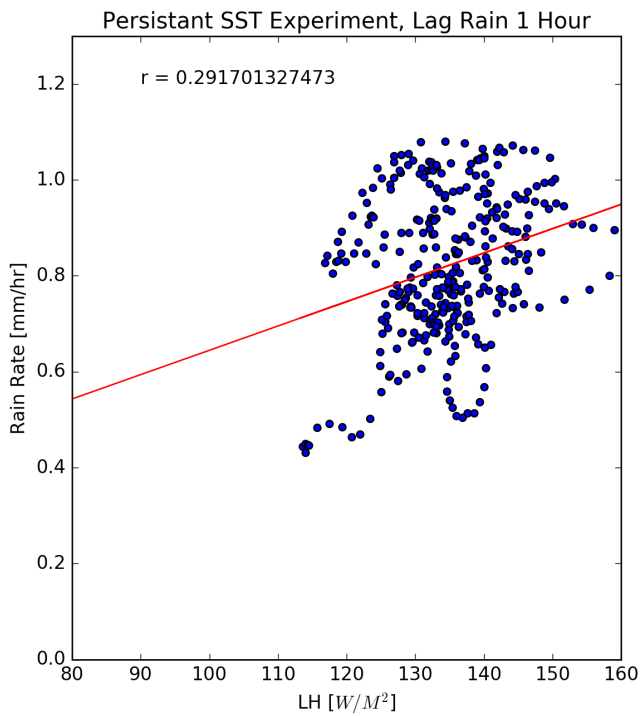
- KS test null hypothesis
  - *Two data samples come from the same distribution*
- T-test null hypothesis
  - *Two data samples have the same mean*
- Rain Rate histograms look same, maybe differences come from extreme values



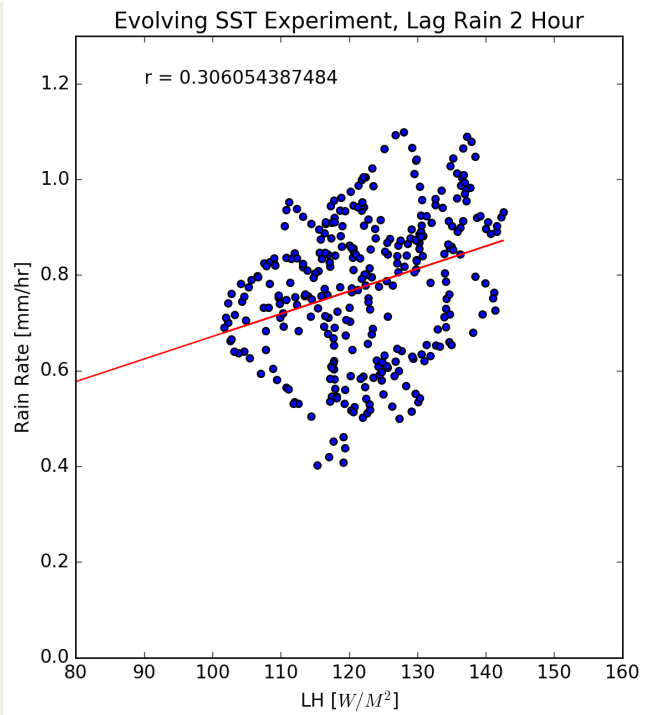


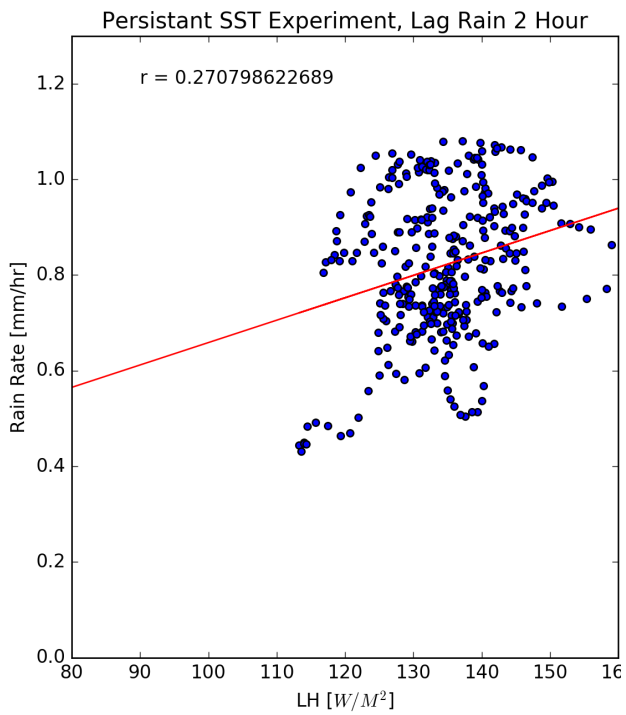
- Latent heat flux versus rain rate (top), sensible heat flux vs rain rate (bottom)
- R-values similar for both experiments for LH and SH
- SH line fit is a little suspect
- Is there a lag relationship with fluxes and rain, takes time for fluxes to affect the rain?

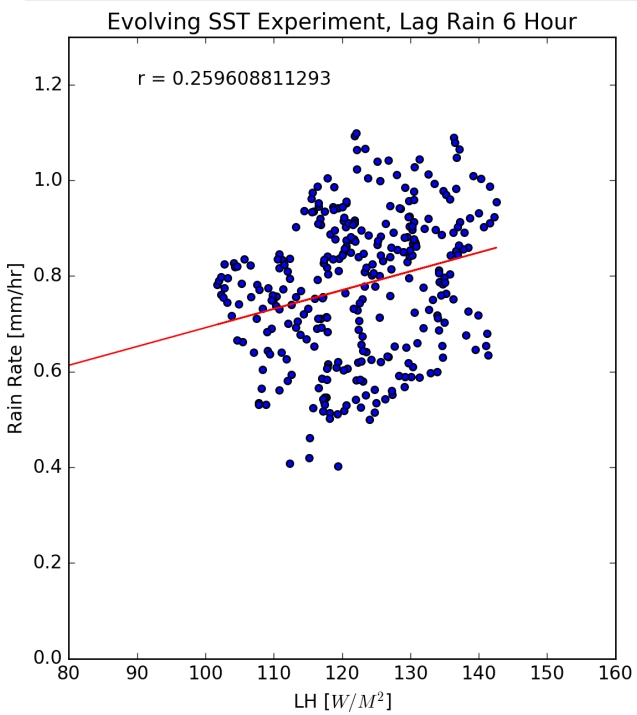


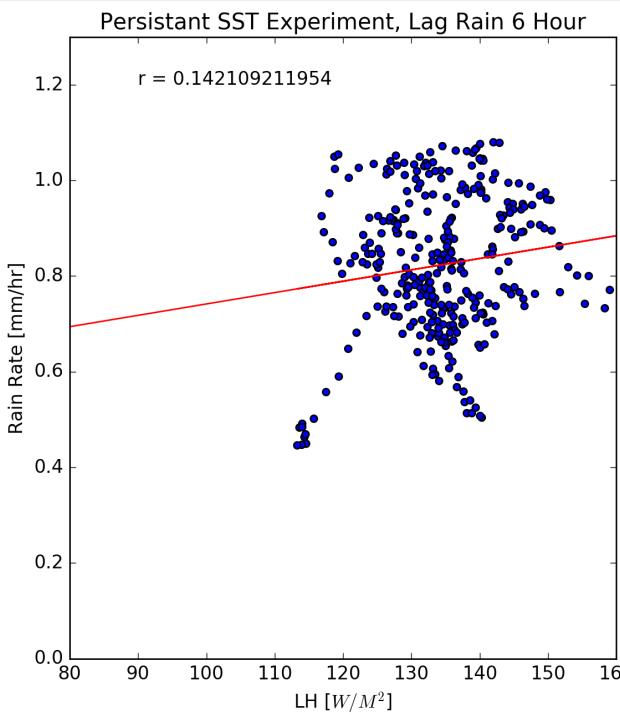


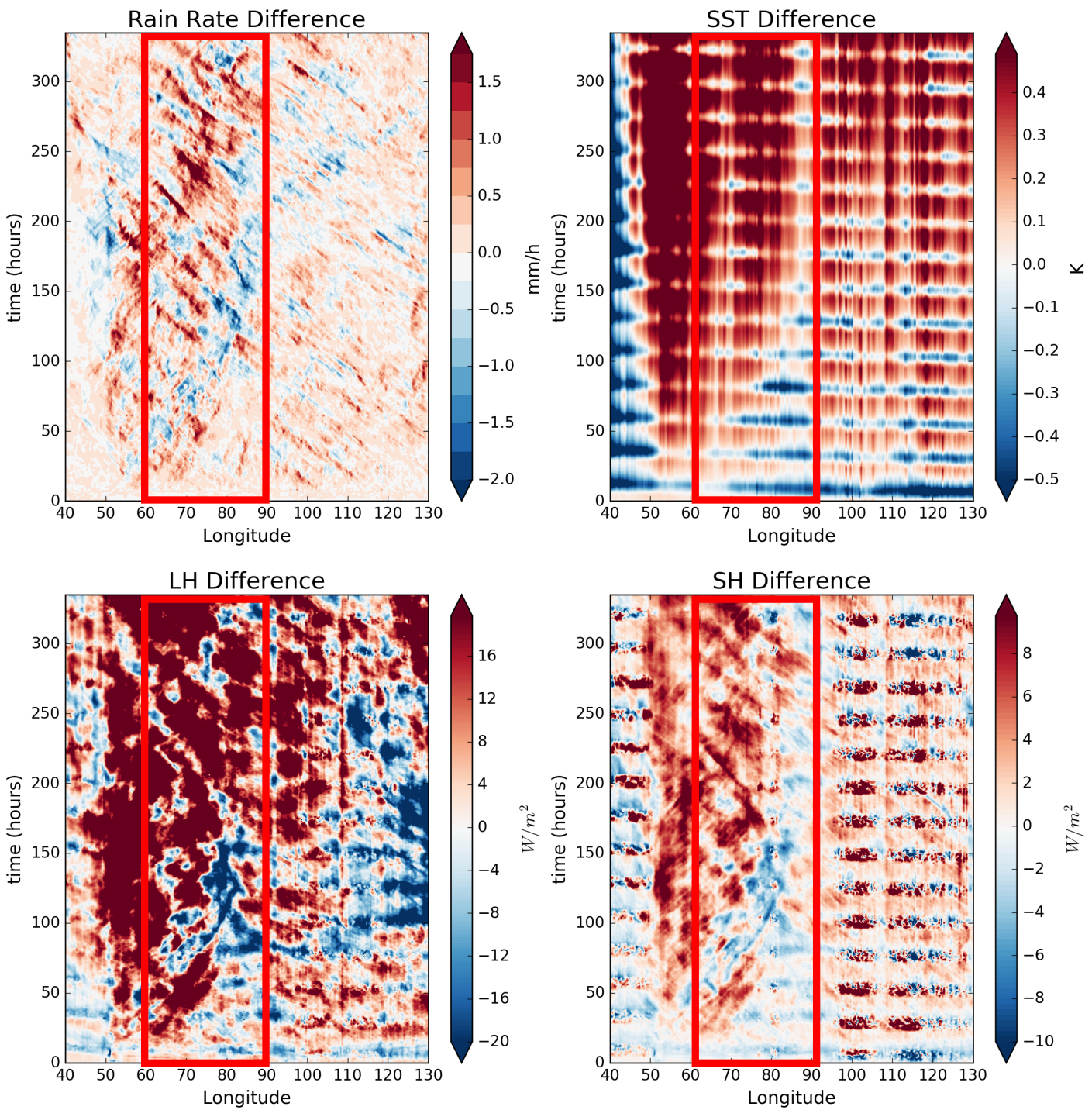
- Lagging rain by 1, 2, and 6 hours shows less correlation than not lagging rain



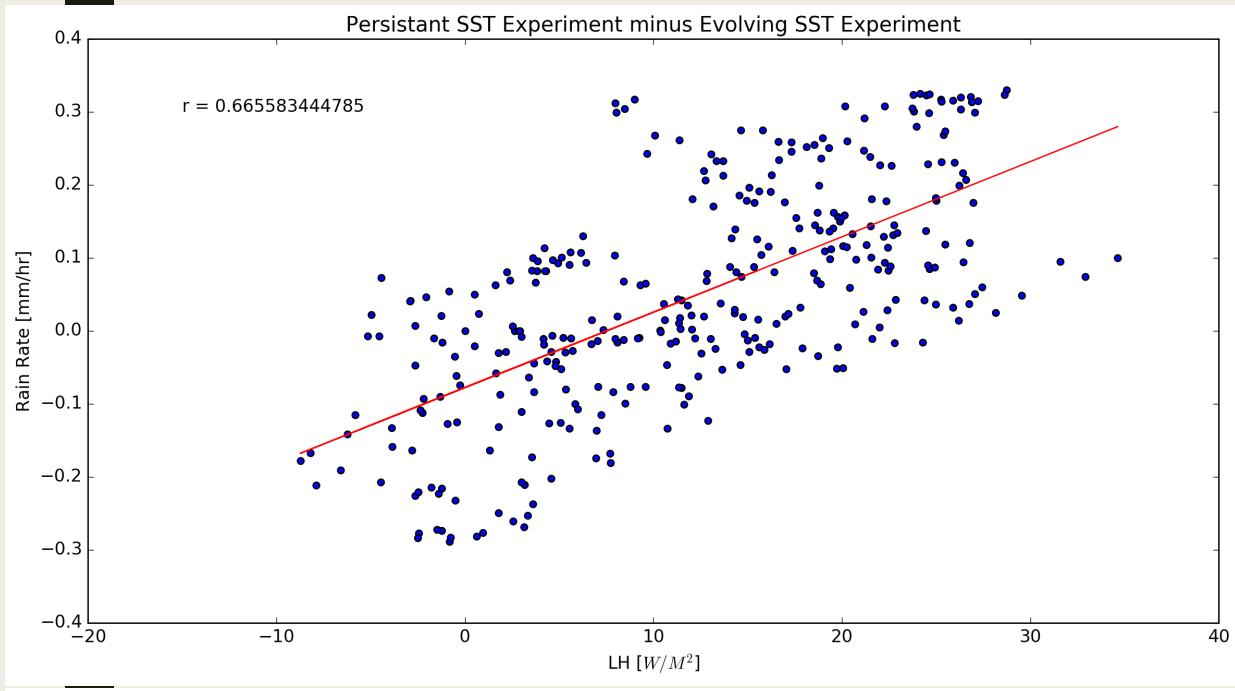


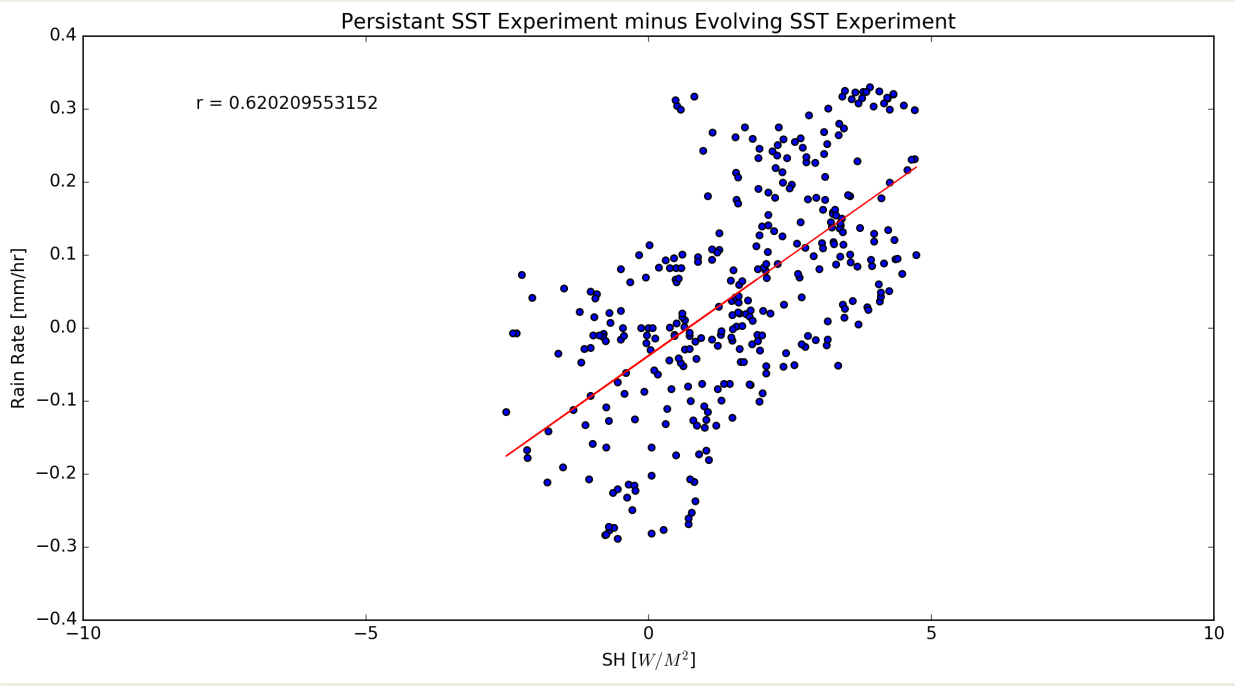


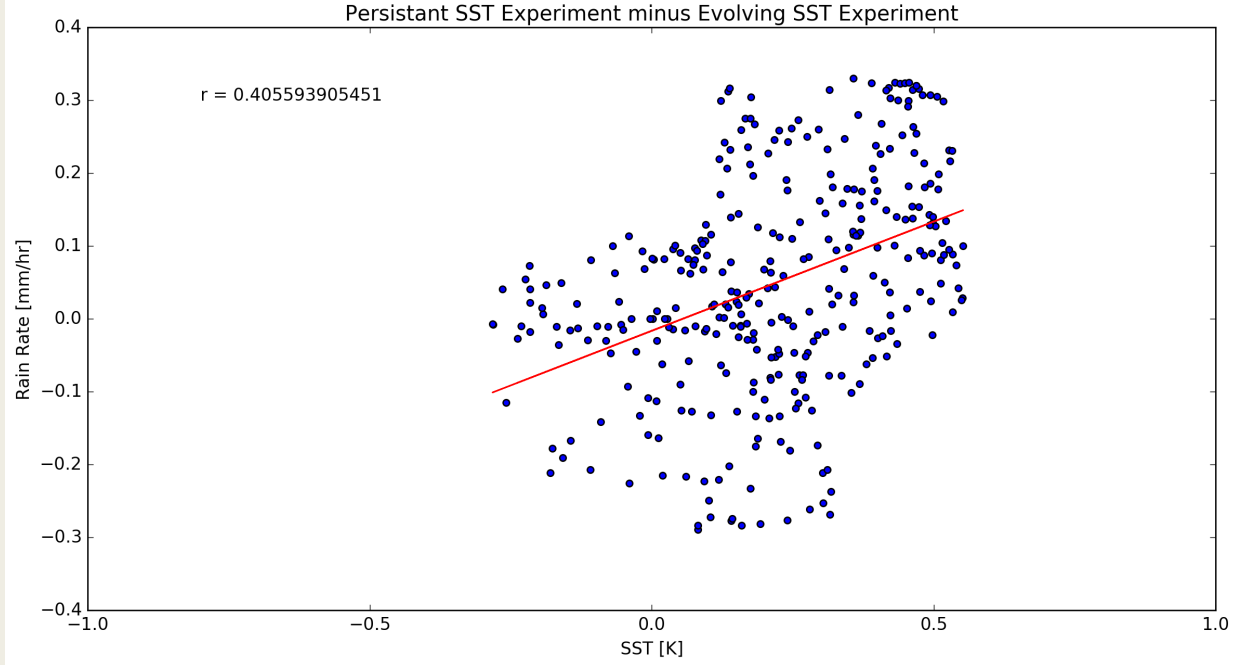




- Hovmoellers of difference between persistent SST experiment and evolving-SST experiment
- Red – persistent-SST experiment has higher values
- Blue – evolving-SST experiment has higher values







- Stronger correlations between difference fields than the relationship found for the individual model experiments
- The higher fluxes in P_SST experiment contribute to the higher rain rates.
- Similar relationship to SST and rain rate

Conclusions

- Persistent SST experiment has generally higher values of rain rate, latent heat flux, and sensible heat flux
- The correlation between rain rates and heat fluxes are similar between experiments
- No lag relationship was found between rain rates and fluxes
- Stronger correlations found between the difference fields giving a way to quantify the differences found between experiments