Ocean-Atmosphere Coupling Related to Excitation and Lifecycle of Deep Moist Convection and Mesoscale SST Gradients

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4-yr distribution of rainfall-onset SST/-LSST and background

We have examined 4-years of satellite-derived SST (GHRSST) and rainfall data (CMORPH) in anticipation of a relationship between SST structure and the excitation of convective rainfall.

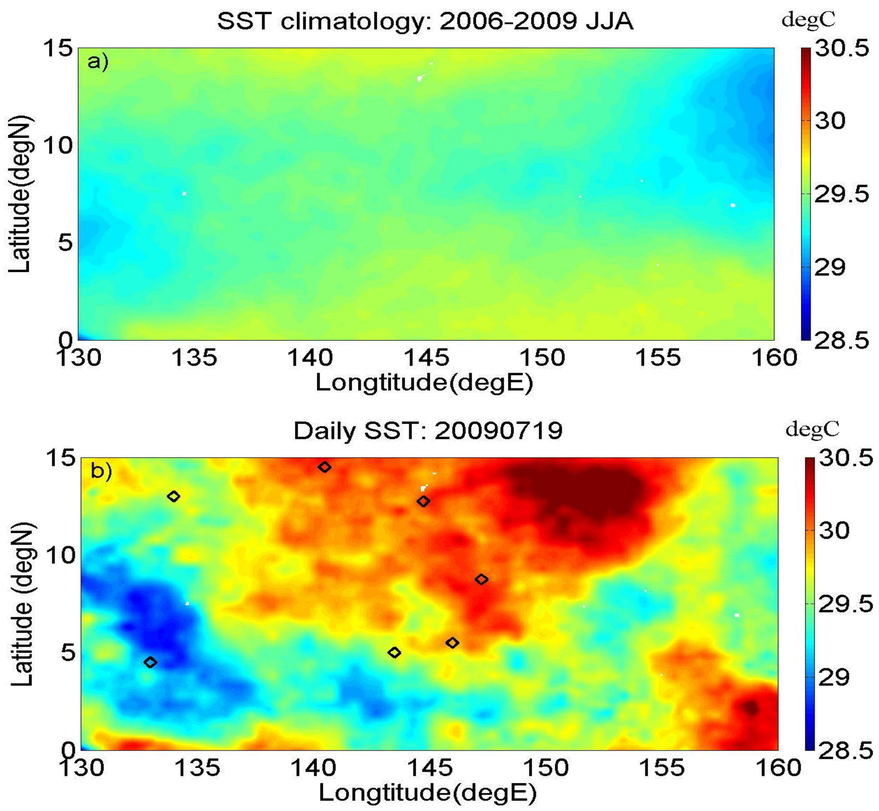

Figure 1: a) SST climatology, b) SST daily reality. Daily SST areas and gradients thereof are multi-scale and extend over a large dynamic range.

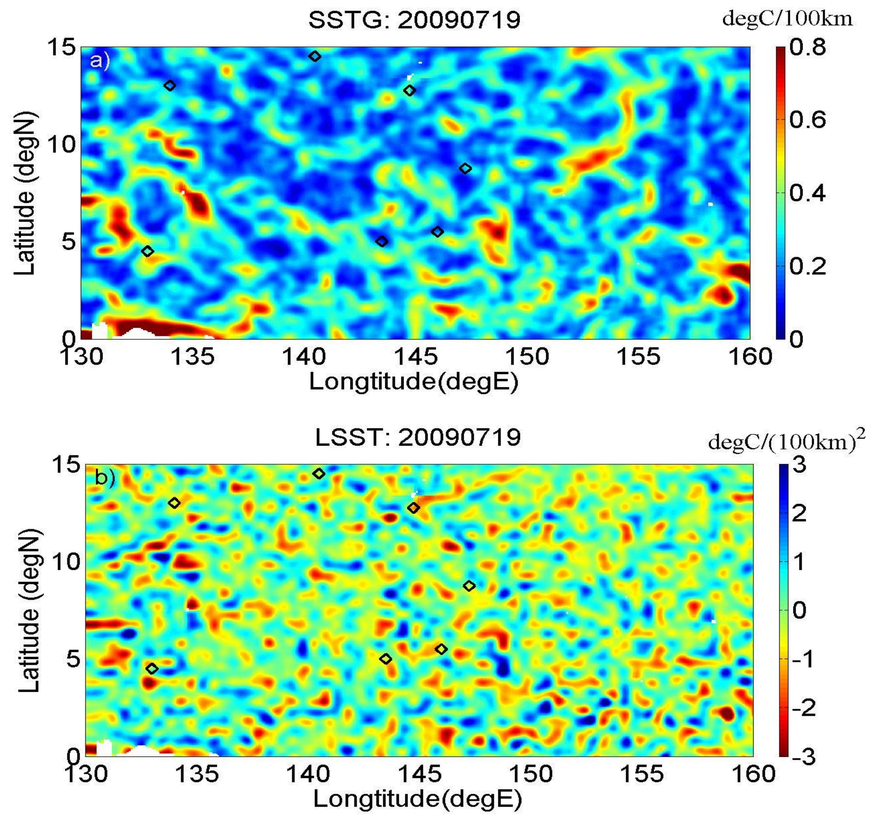

Figure 2: a) Multi-scale variation of SST gradient field, cellular structure throughout and mesoscale structure on the large scale gradient. b) Laplacian SST (LSST) field and precipitation onset locations. Symbols illustrate precipitation onset locations. Negative values (yellow-red) connote likely enhanced lower boundary convergence from hydrostatic pressure gradients.

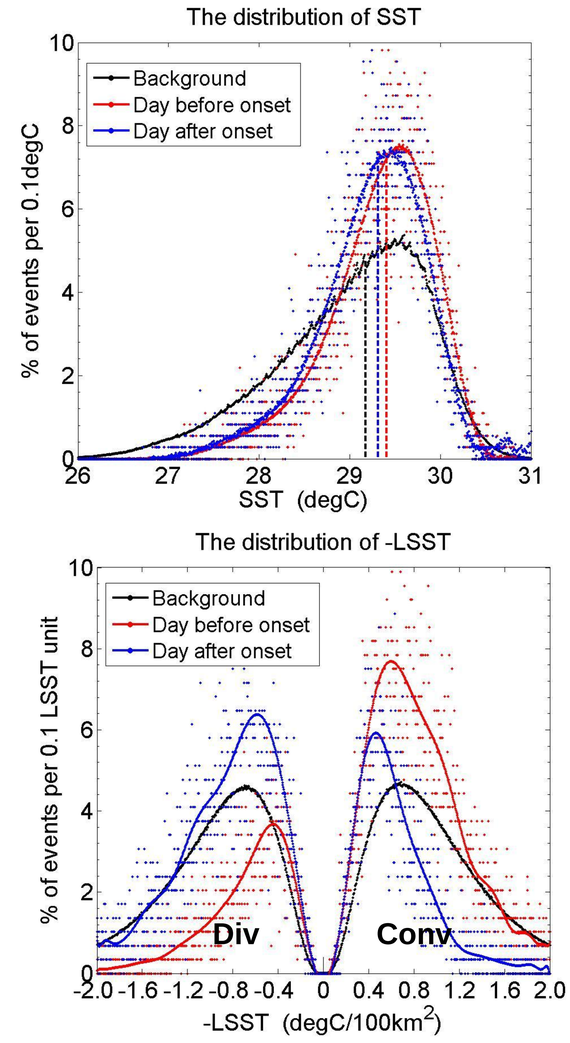

Figure 3: *Upper:* rainfall-onset SST and background SST. Mean onset-SST is slightly higher than background mean. Onset occurrence is disproportionately concentrated in mid-SST range, circa 29.5. *Lower:* the before-after onset shift in relation to background -LSST. The shift represents approximately a factor of two from background LSST frequency in each phase.

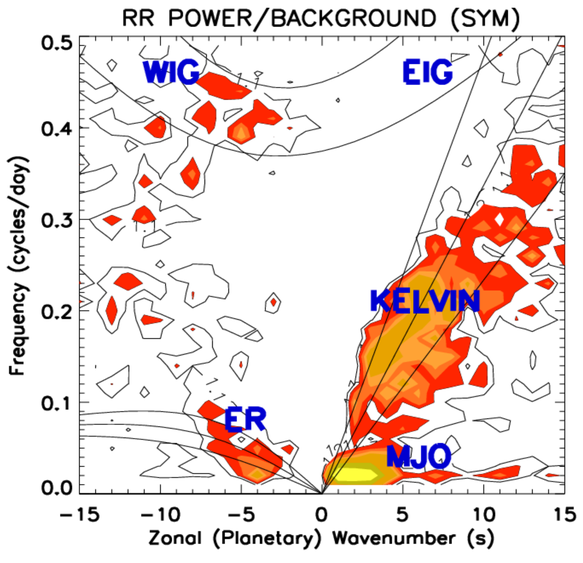

Figure 4: Dispersion diagram for rainfall.

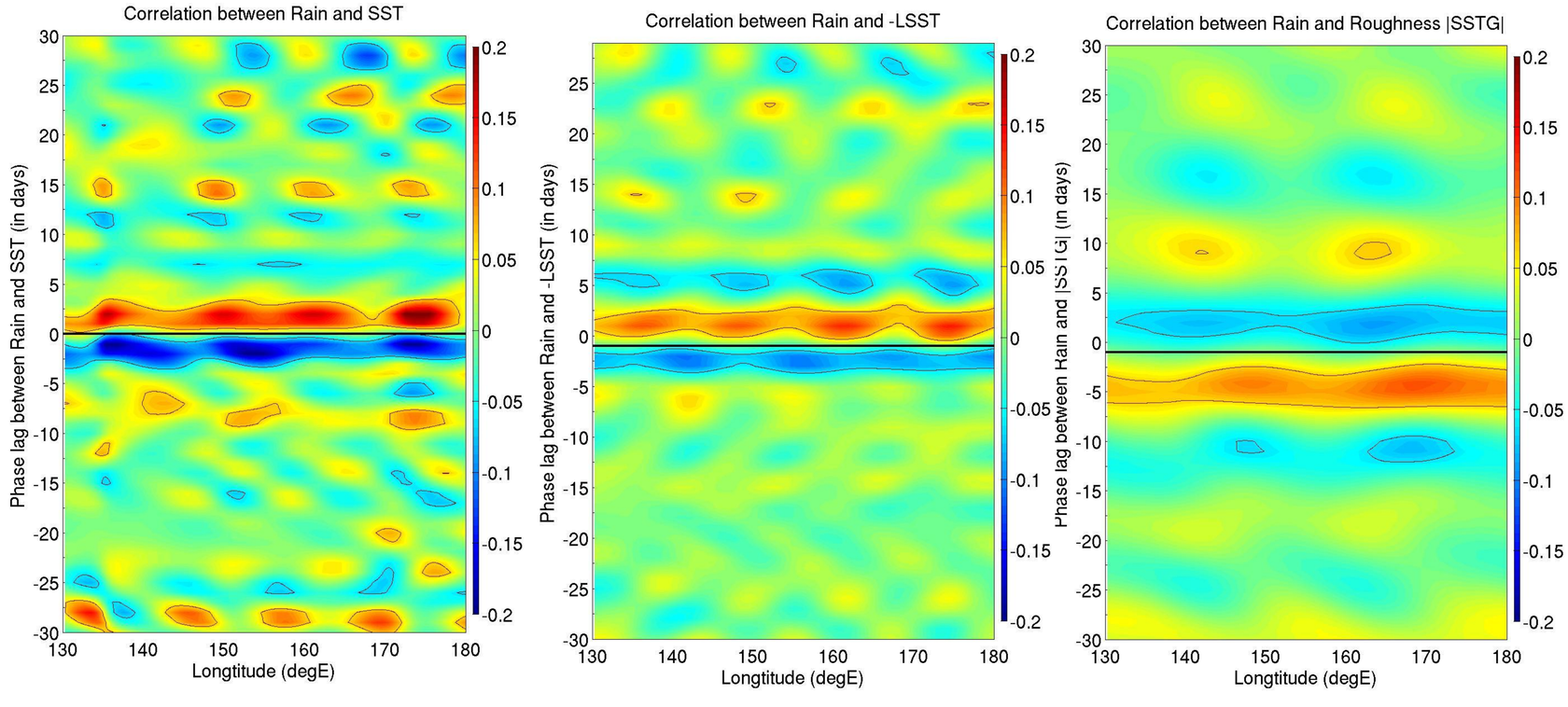

Figure 5: SST, -LSST, SST gradient - Rain Phase Relationship.

Conclusions:

1. Approximately 75% of rainfall onset events are spatially and temporally coincident with a maximum of surface convergence (-LSSTmax).
2. Events are favored across mid-range SST, less so at extremes.
3. SST and convergent LSST lead rainfall by 1-2 days; especially strong SST gradients lag rainfall by 2-5 days.
4. LSST field exhibits large, systematic, time-space variation: temporal variation from ~2 weeks - 3 months; spatial pattern variation of order 500-2000 km (Hovmoller diagrams not shown).

Future work: DYNAMO area

Exploration of MJO ocean-atmosphere coupling warranted because of systematic model errors.

1. Statistical confirmation of the Laplacian mechanism and coupled responses in the Indian Ocean.
2. DYNAMO case study verification of the underlying breeze/gravity current hypothesis.
3. Precipitation event lifecycles and their relationship to the SST/wind shear environment.
4. Coupled responses to propagating precipitation events within eastward-propagating MJO.

Reference: Yanping Li, and R. E. Carbone, 2012: Excitation of rainfall over the tropical western Pacific. *J. Atmos. Sci.,* Vol. **69**, No. 10, 2983–2994.