Observations in support of coupled SST, deep convection and rainfall research

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Can satellite really see the local structure of ocean surface?

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.

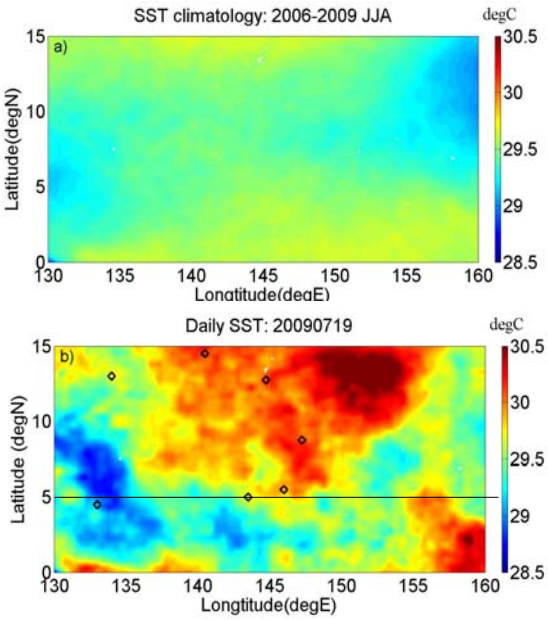

Figure 1: a) SST climatology, b) SST daily reality. Daily SST areas and gradients thereof are multi-scale and extend over a larger dynamic range.

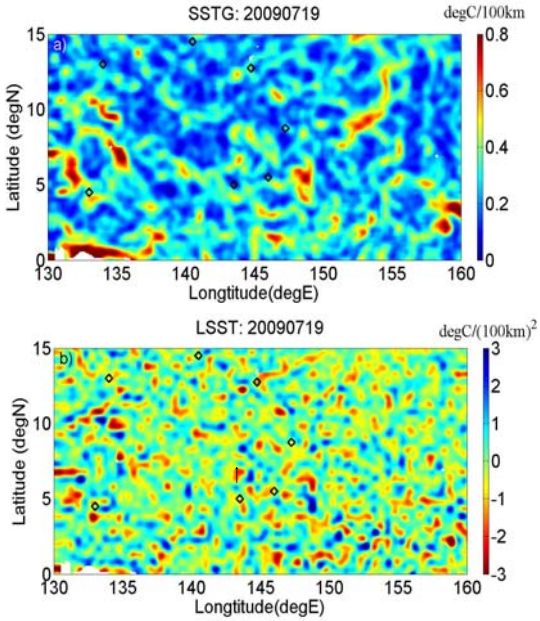

Figure 2: a) Multi-scale variation of large amplitude SST gradient field, cellular structure throughout and mesoscale structure on the large scale gradient. b) Examples of –Laplacian SST (LSST) field and precipitation onset locations. Symbols illustrate precipitation onset locations. Positive values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

We need data that has improved temporal and spatial resolution.

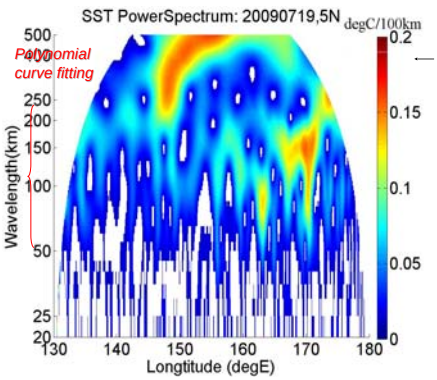

Figure 3: Wavelet analysis for GHRSST on July 19, 2009 at 5N. SST variation at wavelengths, λ < 150 km is damped owing to a dominant ~25 km microwave footprint in the merged product. SST gradient zones may be characterized as ½ λ, thereby capturing a substantial fraction of true amplitude for scales ≥ 75 km.

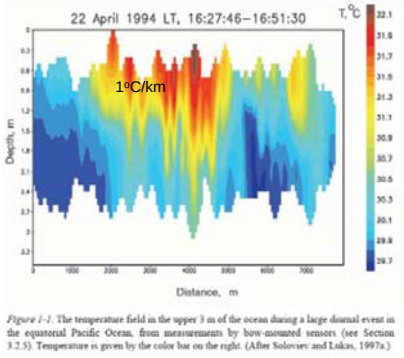

Figure 1-1. The temperature field in the upper 3 m of the ocean during a large diurnal event in the equatorial Pacific Ocean, from measurements by bow-mounted sensors (see Section 3.2.5). Temperature is given by the color bar on the right. (After Soloviev and Lukas, 1997a.)

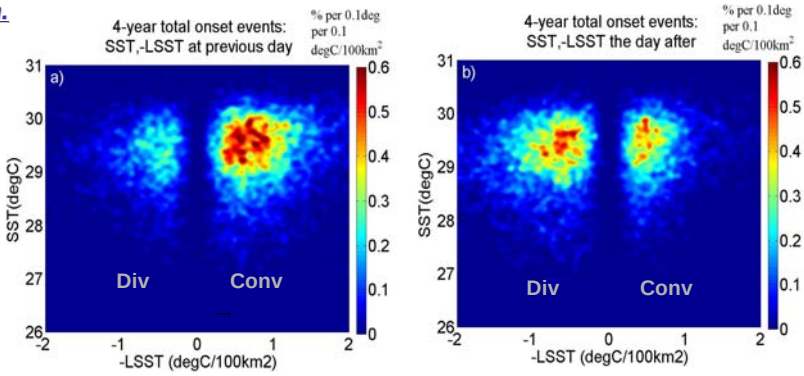

Figure 4: SST, -LSST distribution before and after onset events: (a) previous day (b) following day.

Conclusion:

1. Approximately 75% of rainfall events are spatially and temporally coincident with a maximum of surface convergence (-LSSTmax).

2. Satellite observed SST structure reveal a high time rate of change in patches of order 100km dimension. The SST gradients derived local convergence is ~10^{-5} s^{-1}, one order of magnitude larger than regional background convergence.

Future ocean observation suggestions:

To gain increased understanding of rainfall occurrence and improved representation in global models will require additional investigations of coupled ocean atmosphere responses. This can be achieved through *regional scale* observations that resolve *mesoscale structure* for *seasonal to interannual* periods. Observations should include SST structure at scales from 1 - 200 km; corresponding lower atmospheric convergence fields; phasing with deeper transient atmospheric forcings; and related interfacial fluxes. We believe that routine monitoring for seasonal to interannual periods by small UAVs; a regionally enhanced density of drifting buoys; and short-period intensive flux measurements from research vessels and manned aircraft will fill the gap when combined with satellite observations..

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Reference: Yanping Li, and R. E. Carbone, 2012: Excitation of rainfall over the tropical western Pacific. *in press. J. Atmos. Sci.*,