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

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A foremost problem in climate system research and prediction is the prevalence of large systematic errors associated with retrieved and predicted distributions of precipitation. Improved understanding and model representations are necessary to mitigate such errors. Systematic errors in precipitation distribution can be caused by errors in large scale tropospheric forcing as well as errors in lower boundary (oceanic) thermal forcing. Deep tropospheric forcing is a mature area of continuing research. However, scant attention has been paid to most aspects lower boundary forcing beyond the climatology of SST.

We propose to establish the morphology of tropical Indian Ocean convection in conjunction with lower boundary forcing, as inferred by mesoscale SST gradient structure. By means of satellite precipitation and SST data, Li and Carbone (JAS, 2012) examined 4 years of daily SST structure (e.g. Fig.1) associated with excitation of precipitation events in the tropical western Pacific. The results reveal a disproportionate coincidence between mesoscale SST gradients of order 50-200 km scale and the onset of rainfall events. In Fig. 3, 3/4ths of 10,000 rainfall events are shown to be spatially and temporally coincident with local surface convergence, as inferred by the negative Laplacian of SST (i.e. convex curvature of the gradient). Fig. 2 shows that mid-SST locations are preferred compared to the area-wide SST background distribution, whereas SST extremes are relatively disfavored.

At the Workshop, we will present recent results with respect to large scale (1000-3000 km), low frequency (20-100 days) coupling, as evidenced by phase/amplitude relationships between SST structure and precipitation. We propose to conduct a similar Indian Ocean study with the following objectives:

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 hypotheses.

3. Precipitation event lifecycles and their relationship to the SST/windshear environment.

4. Coupled responses to propagating precipitation events within the eastward propagating MJO.