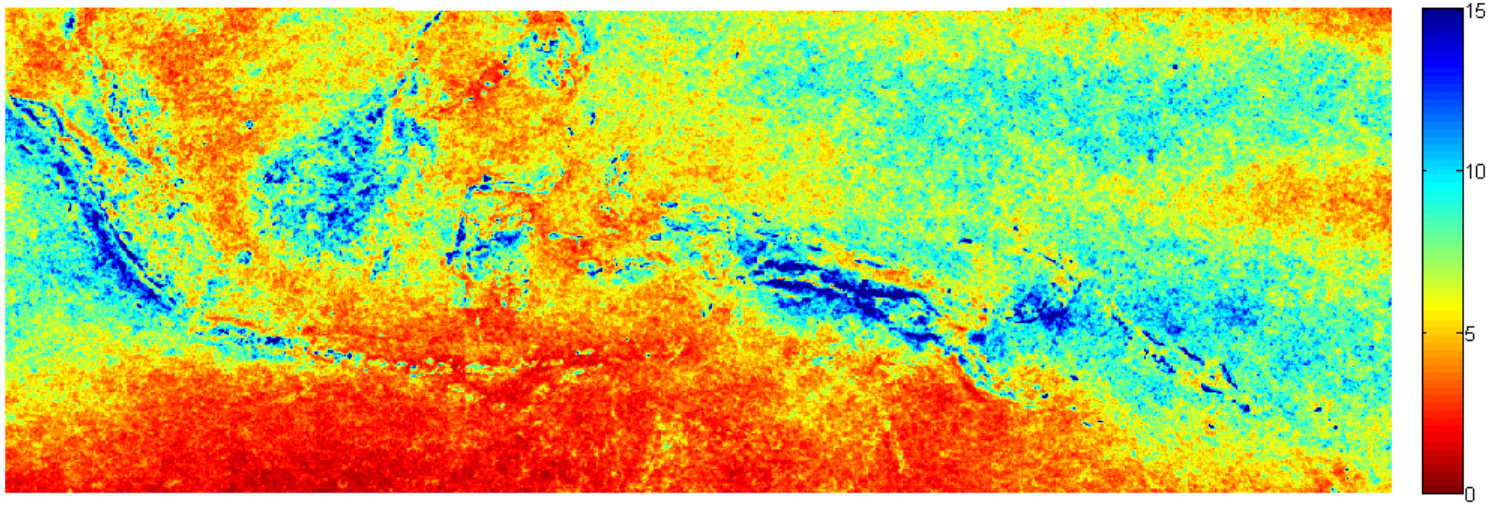
The Role of the Diurnal Cycle in the Tropical Climate



Tim Cronin

Thesis Proposal, 2/1/2011

Advisor: Kerry Emanuel

Outline

- Introduction
- Preliminary Results
- Proposed Work

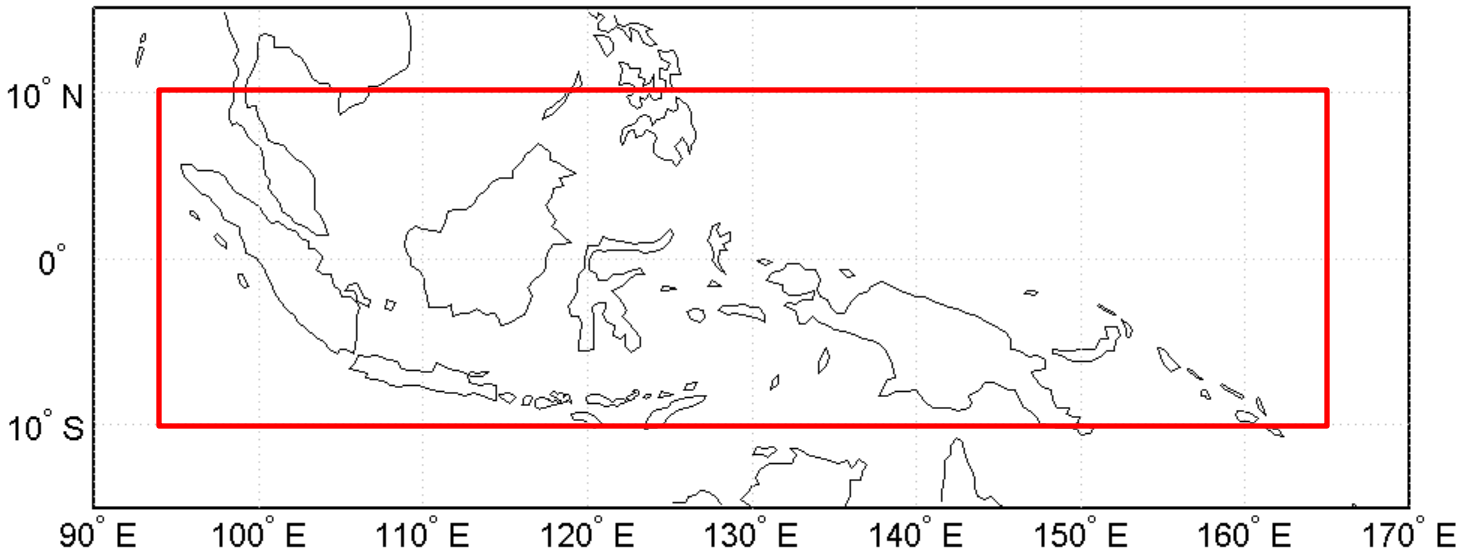
General Question

- What impact does the diurnal cycle have on the time-averaged climate?
- Might the diurnal cycle be responsible for strong nonlinear behavior in some regions?
- Is the diurnal cycle an *essential* element of the climate system?

"…one of the most important questions to answer in the study of climate is to understand just what is a detail and what is essential. If one is studying the climate as a whole, then one might regard the presence of a small island in the northeast Atlantic as a detail, and it surely is" (Vallis, 2011; Oceans and Climate)

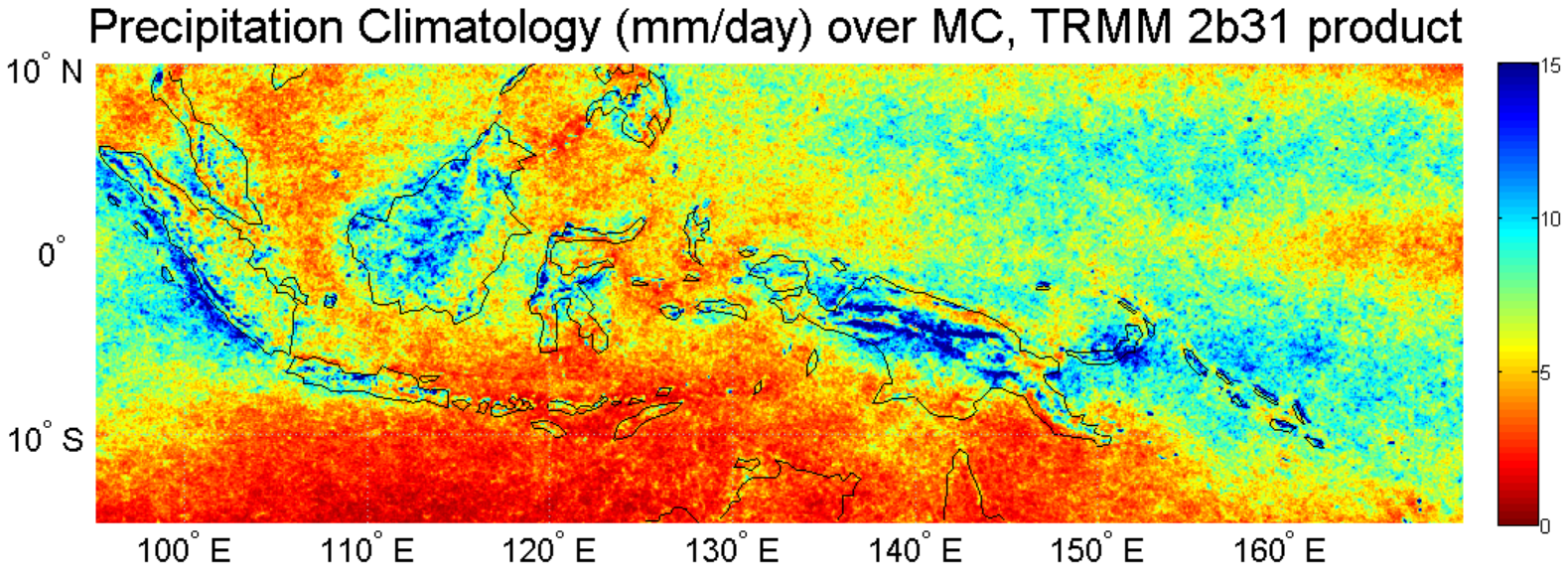
Diurnal Cycle and the MC

- A good place to look for impacts of the diurnal cycle on the mean climate might be the Maritime Continent (MC)



Precipitation within the MC

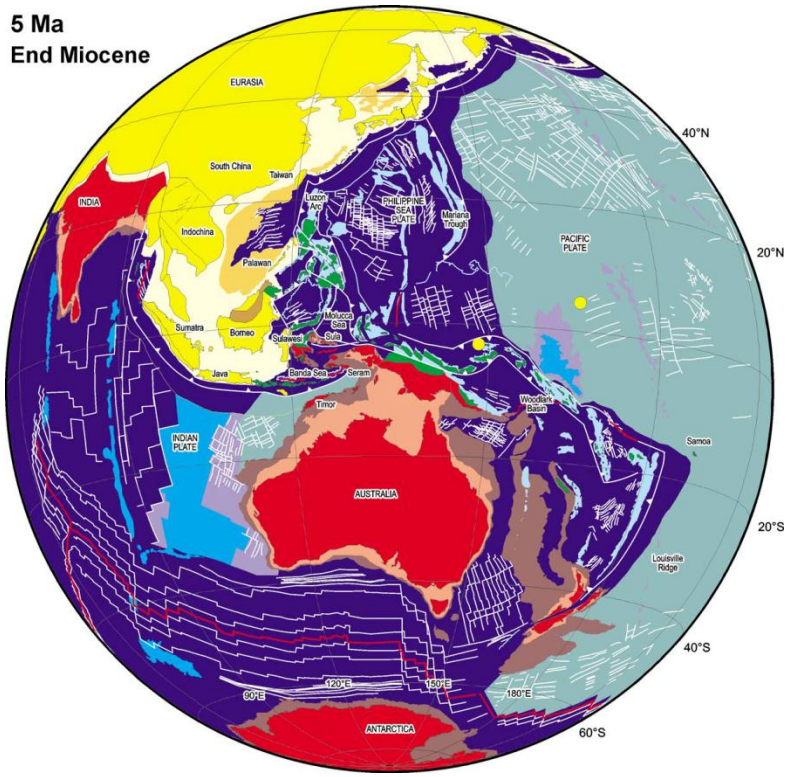
- Does the diurnal cycle play an essential role in the precipitation distribution within the MC?



Mulligan, M (2006) Global Gridded 1km TRMM Rainfall Climatology and Derivatives. Version 1.0. Database: http://www.ambiotek.com/1kmrainfall

Changes in MC and Tropical Climate

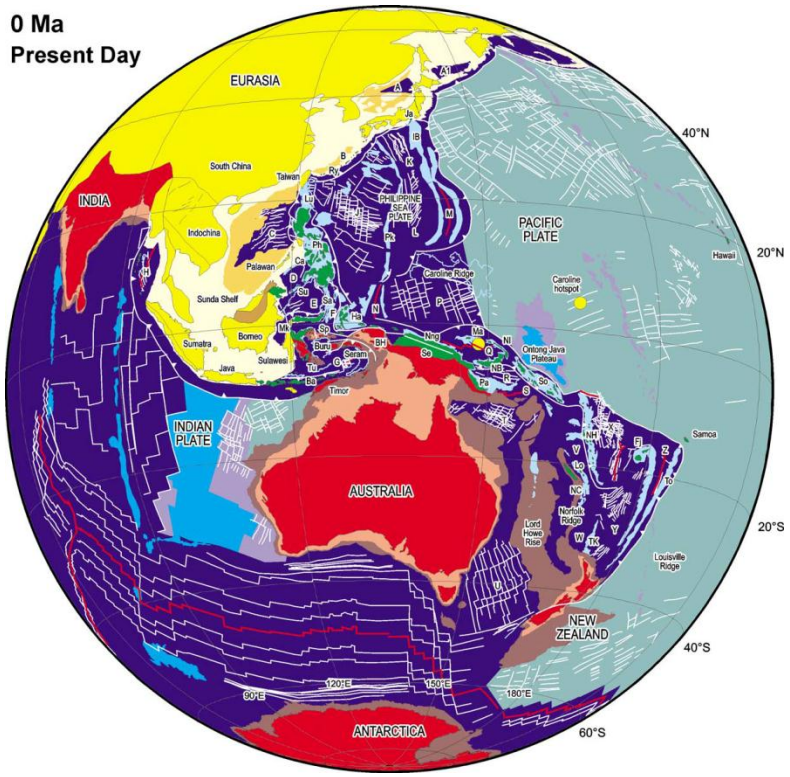
- Does the diurnal cycle play an essential role in the zonal asymmetry of the tropical Pacific?



Hall, 2002

Changes in MC and Tropical Climate

- Does the diurnal cycle play an essential role in the zonal asymmetry of the tropical Pacific?



Hall, 2002

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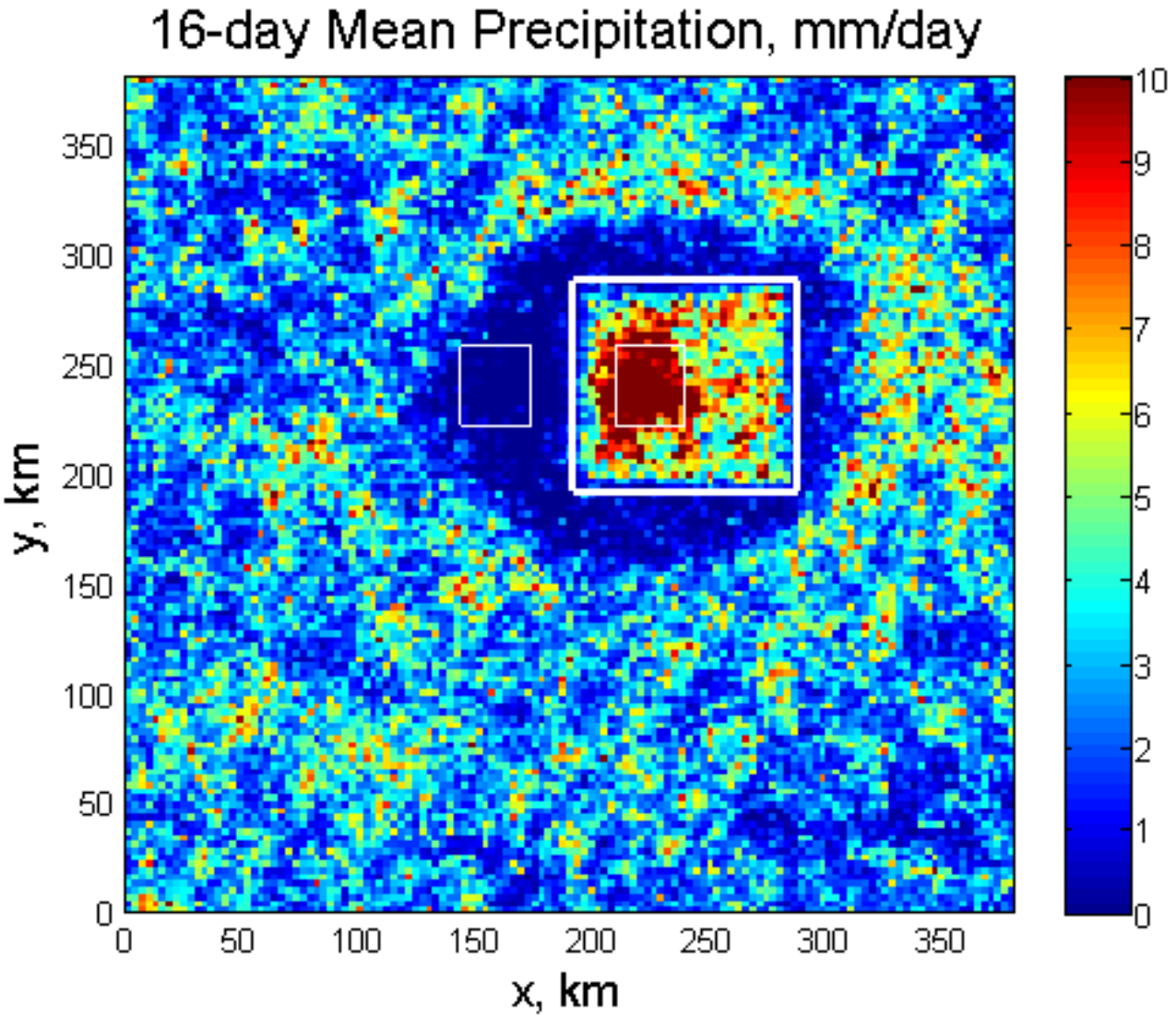
Cloud-top temperature movie

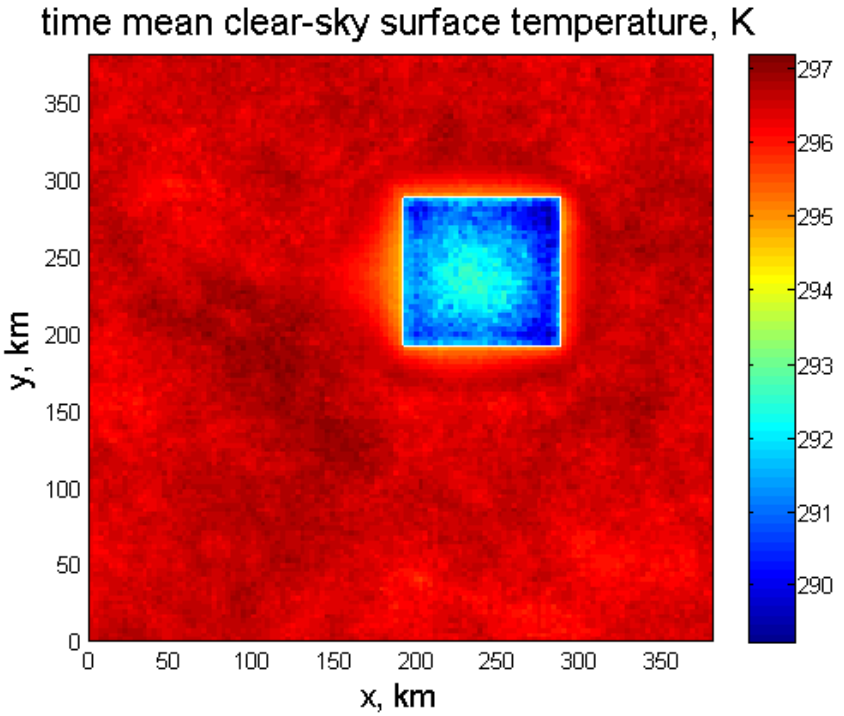
- Run SAM Model to RCE over a mixed- land/ocean domain

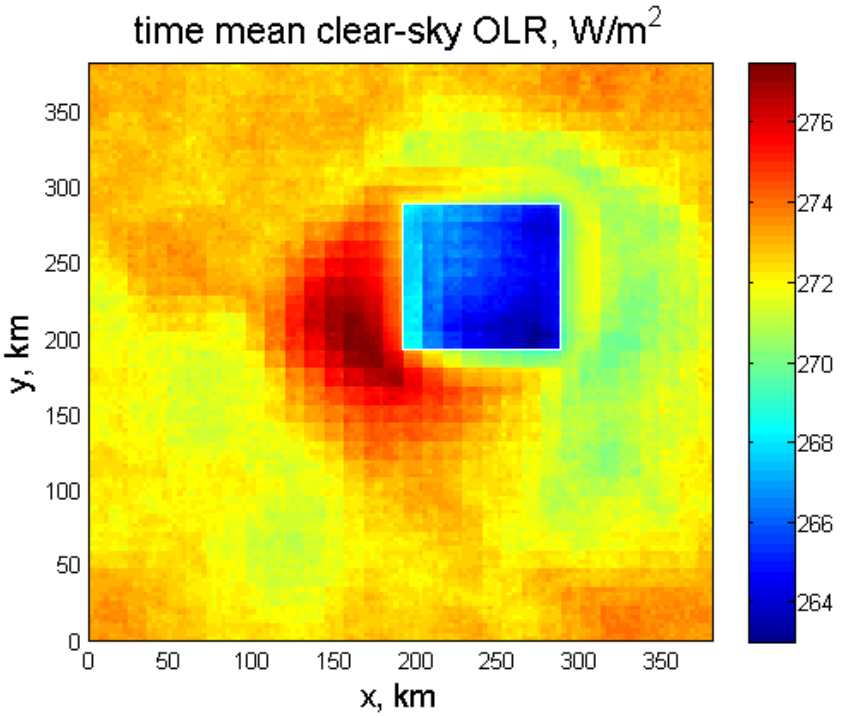
Precipitation contrast



Rectification Mechanism? (1)

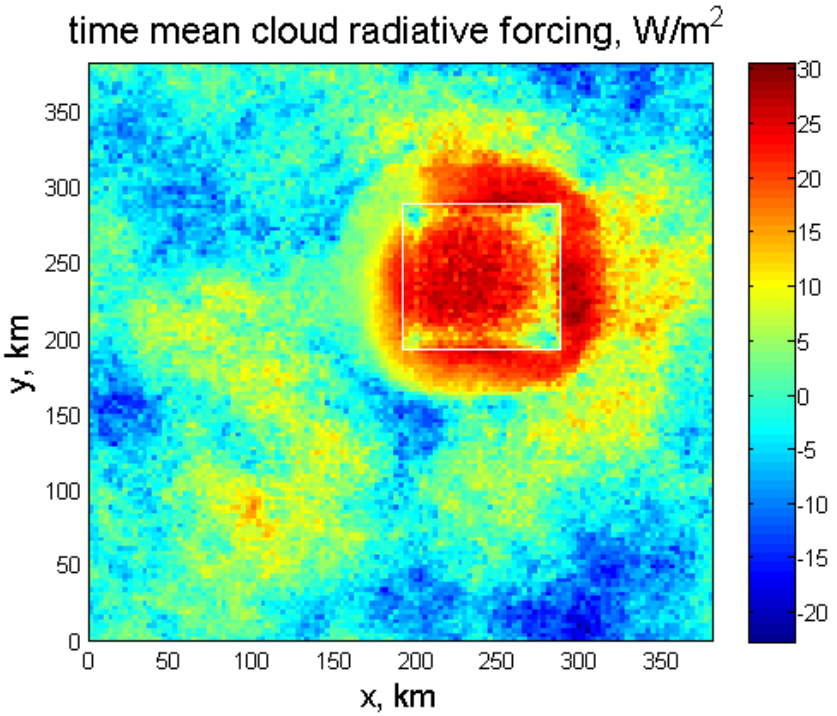
- Energetic contrast: Surface temperature/fluxes
  $\mathrm{H} = \rho_0 c_p c_D |\boldsymbol{v}| (T_s - T_A)$; $\mathrm{E} = \rho_0 L_v c_D |\boldsymbol{v}| ({q_s}^* - q_A)$

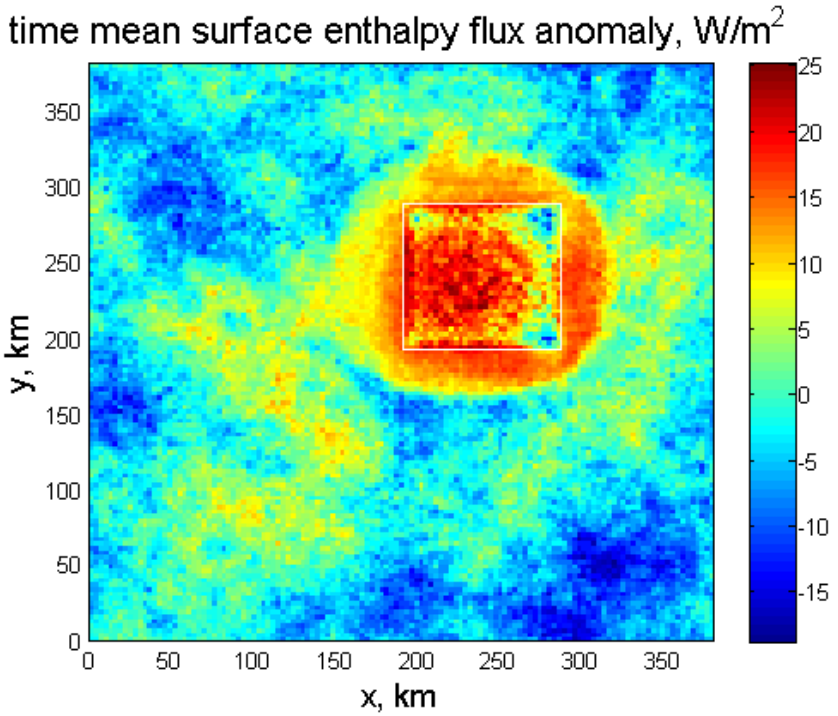




Rectification Mechanism? (2)

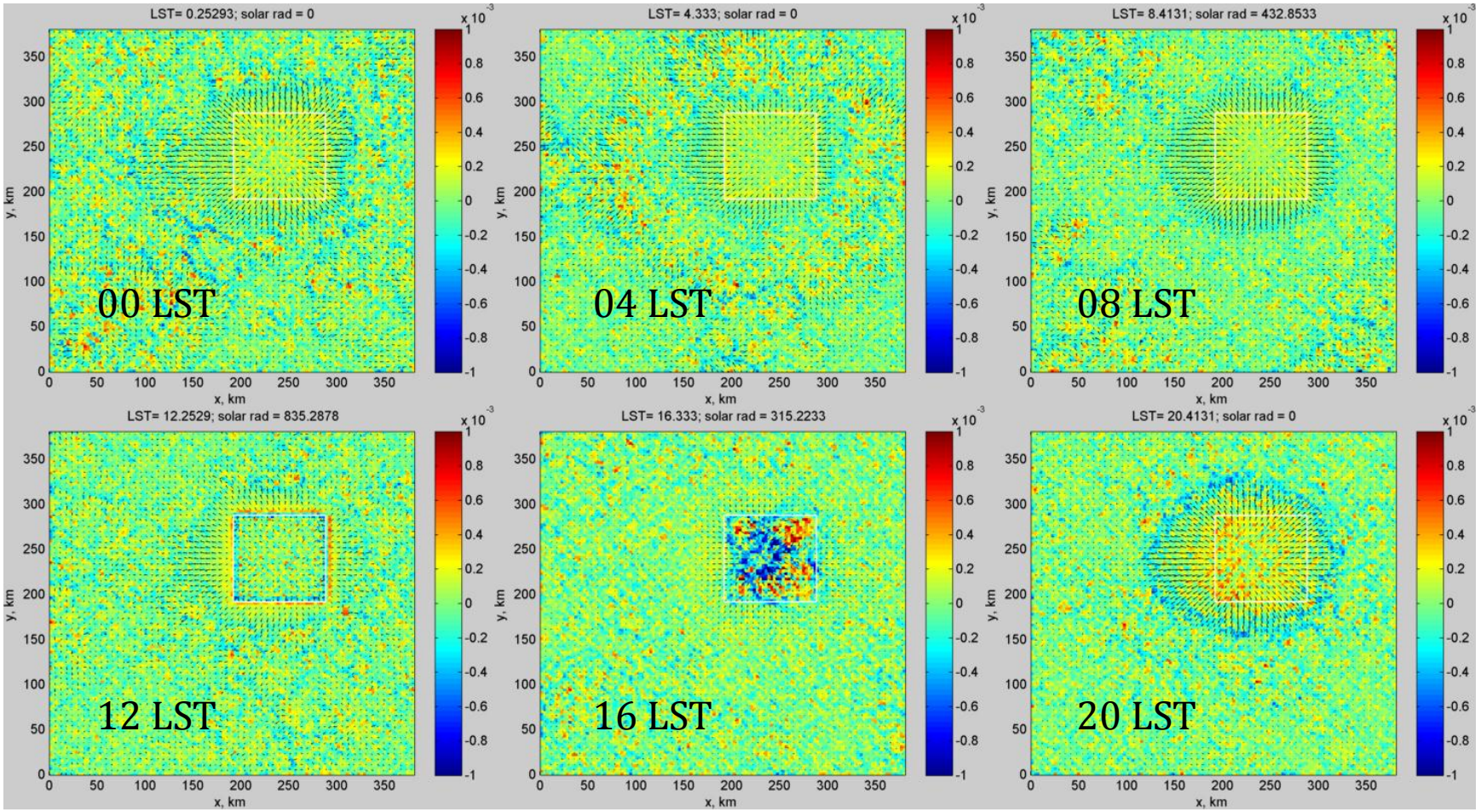
- Energetic contrast: Cloud Radiative Forcing





Rectification Mechanism? (3)

- Dynamical contrast: Land-Sea Breeze Divergence



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Rectification mechanism(s) in SAM

- Ocean-only simulation
- Horizontal homogenization of cloud-radiation interactions
- “Lake” simulation; analysis of sea breeze dynamics

Extension of current simulations

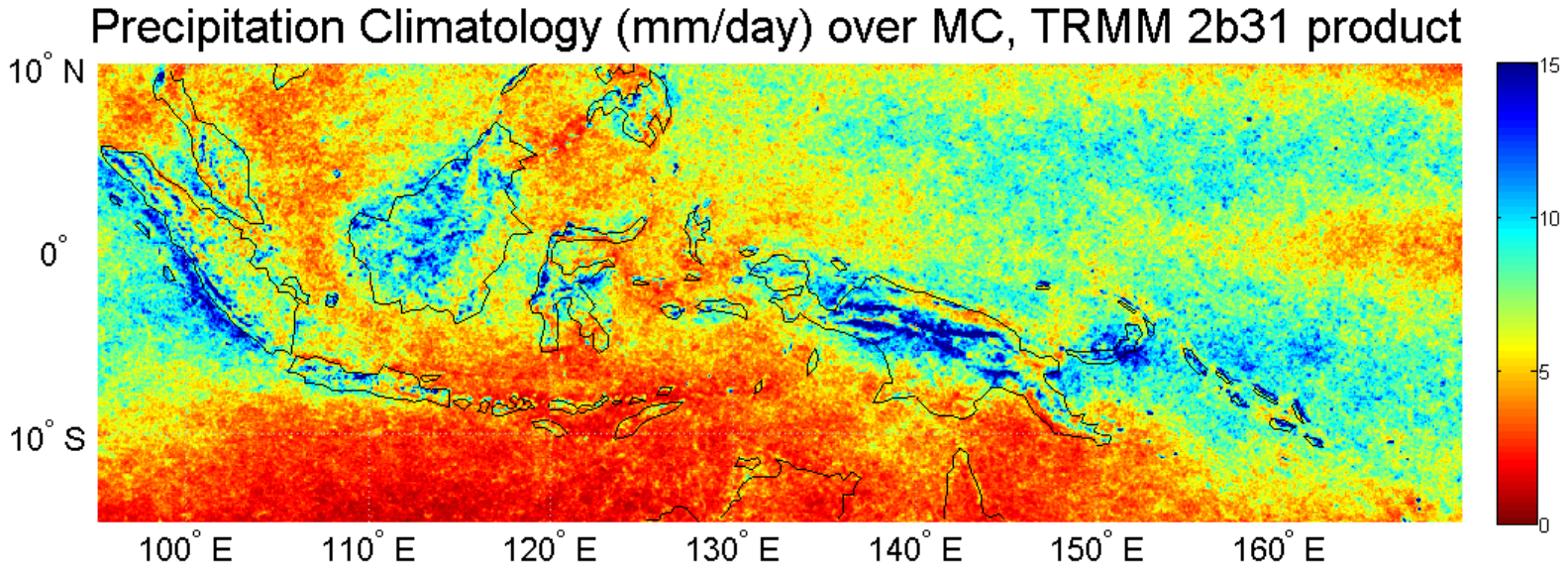
- Parametric sensitivity experiments
- Other land-ocean asymmetries alone and in concert with heat capacity
- Model structure and boundary conditions
- Threshold behavior?

Expand to General Circulation Scale

- GCM (or SAM) with modified parameterized convection
- GCM with superparameterized convection
- SAM (or other CRM) simulations with rescaled parameters (or expensive runs with quasi-3D geometry)

Observations and Theory will also be important

- E.g. – what is land/ocean precip ratio observed over maritime continent?



Summary/Discussion

- Exploration of the role of the diurnal cycle in the tropical climate
- Some indications from preliminary work that it is important, at least for land/ocean precipitation distribution
- Research Goals:
- Better understanding of mechanisms that can rectify diurnal cycle
- Better understanding of whether tropical islands can impact the zonal symmetry of the tropical climate