Evaluate Deep Convection in the MMF using satellite data

a part of the ARM joint project

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Outline

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  - Precipitation radar (PR) simulator
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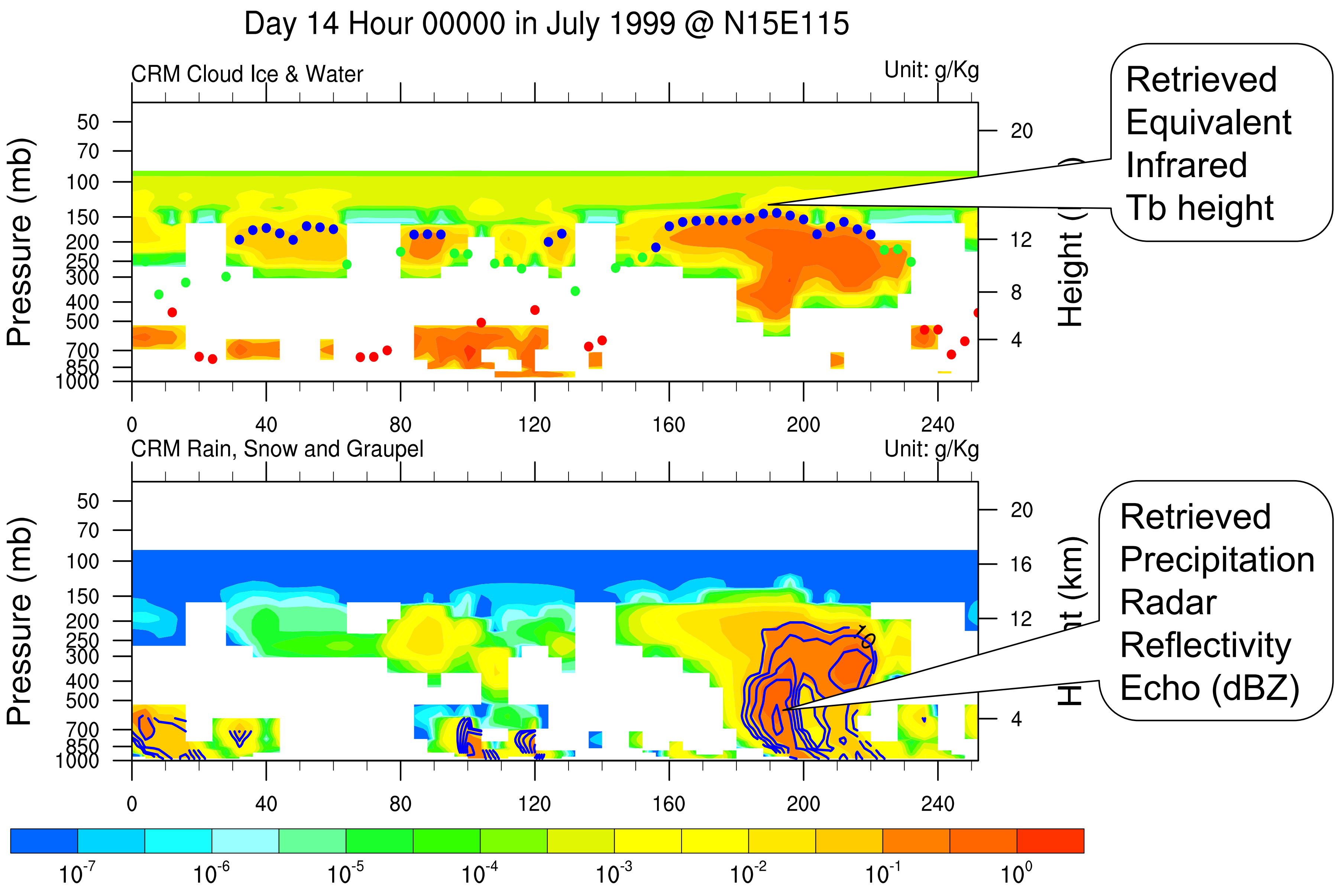
Introduction

- The Multi-scale Modeling Framework (MMF)
  - SP-CAM (*cf.* Khairoutdinov et al, 2005)
  - Run by R. Marchand and T. Ackerman at PNNL and UW
  - Finite volume dynamical core

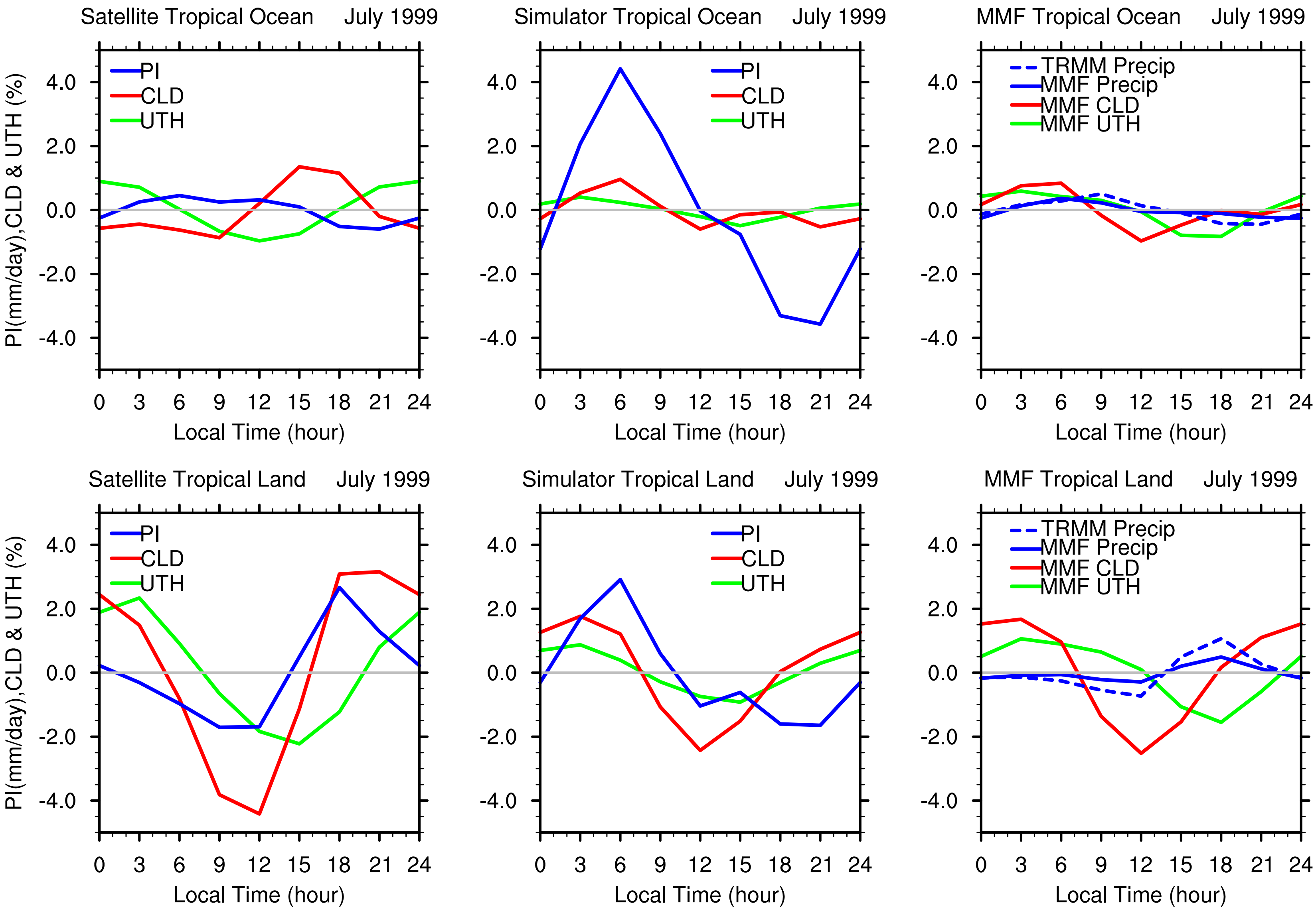
- Observational dataset
  - Geo-stationary satellite radiance, represented by brightness temperature, T11 and T6.7 (*cf.* Tian et al, 2004)
    - Precipitation (deep convection) Index (PI)
    - High Cloud Amount (CLD)
    - Clear-sky Upper Troposphere relative Humidity (UTH)
  - TRMM Precipitation Radar reflectivity at nadir view of 4.3 km horizontal and 250 meter vertical resolution, 20 dBZ statistics (*cf.* Liu et al, 2007)

- Our work aims to evaluate the CRM component in MMF by applying simulators to CRM-grid-scale data and comparing the simulator results to observations, focusing on mean states and diurnal cycles
  - The IR (*cf.* Tian et al, 2004) and PR (*cf.* Haynes et al, 2007) simulators
    - Infrared (IR) brightness temperature, T11 and T6.7, from T11 and T6.7, we further retrieve PI, CLD and UTH
    - Precipitation Radar (PR) reflectivity

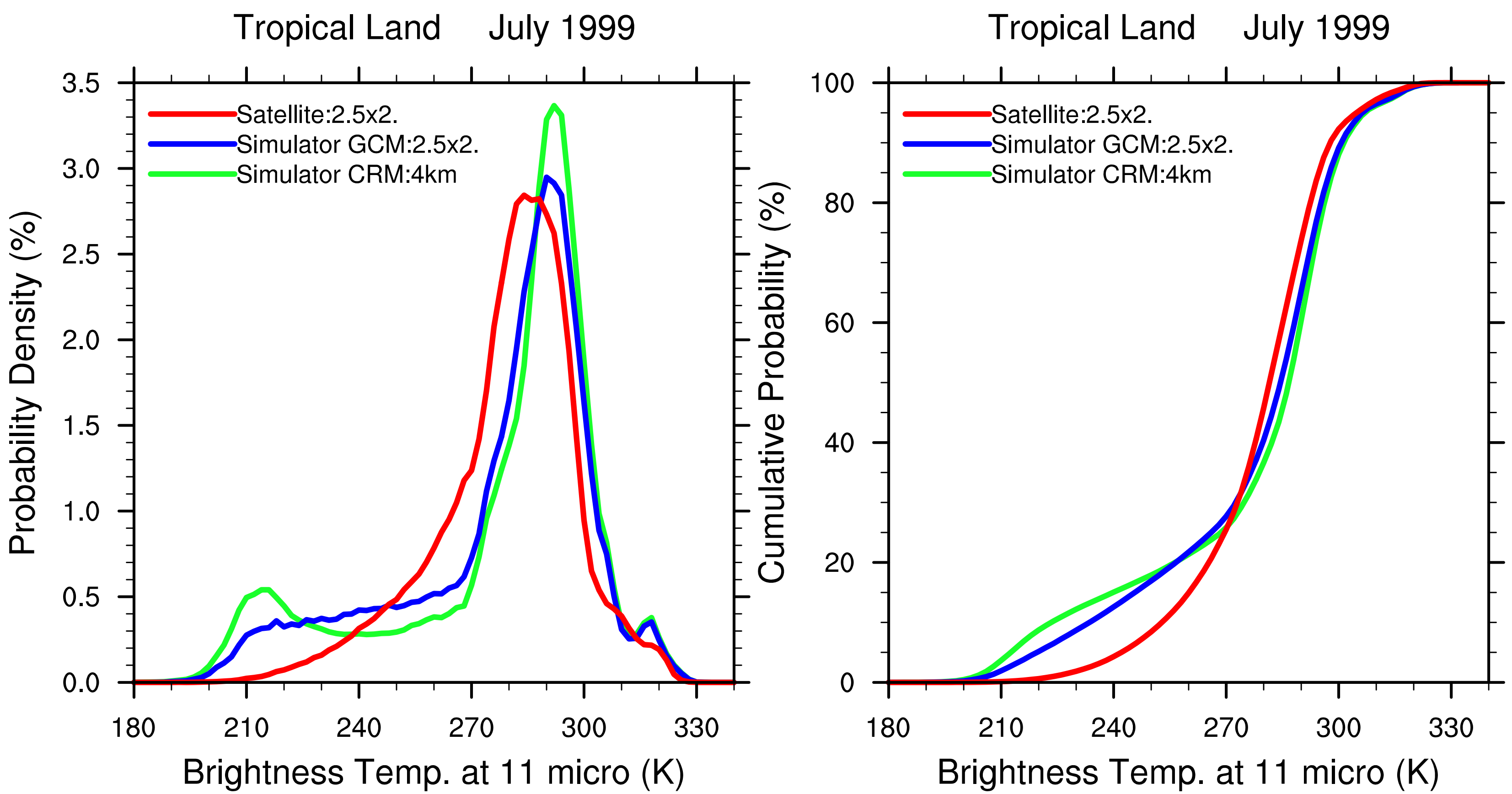
The IR and PR simulators



Diurnal cycle of PI, CLD and UTH

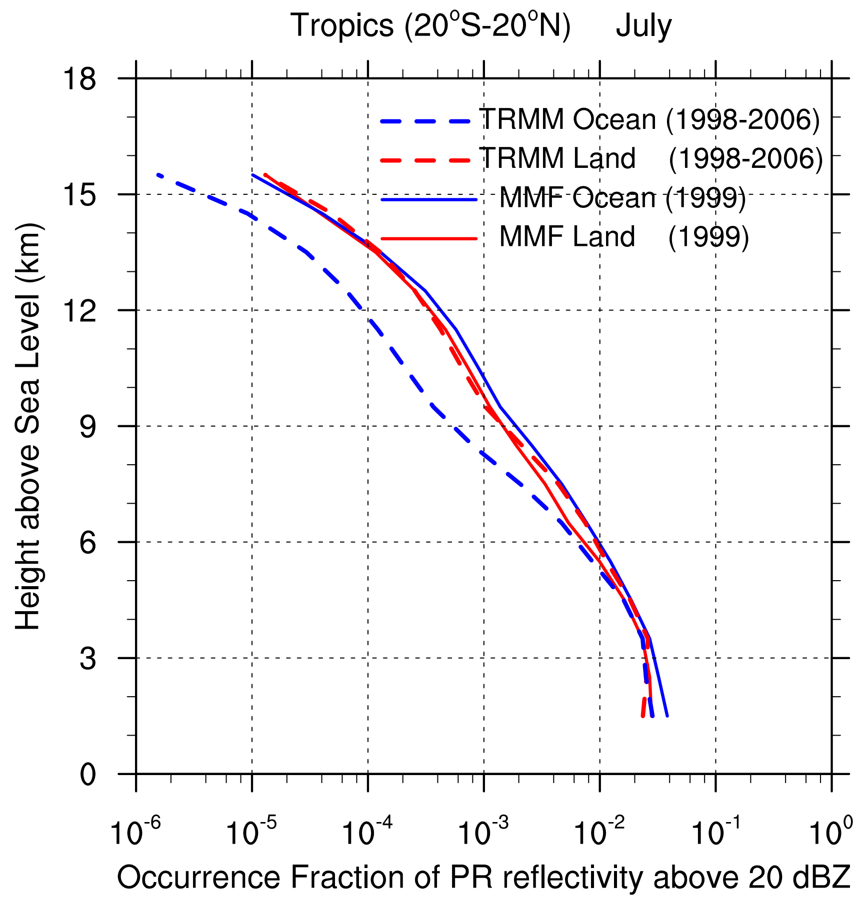


Brightness Temperature



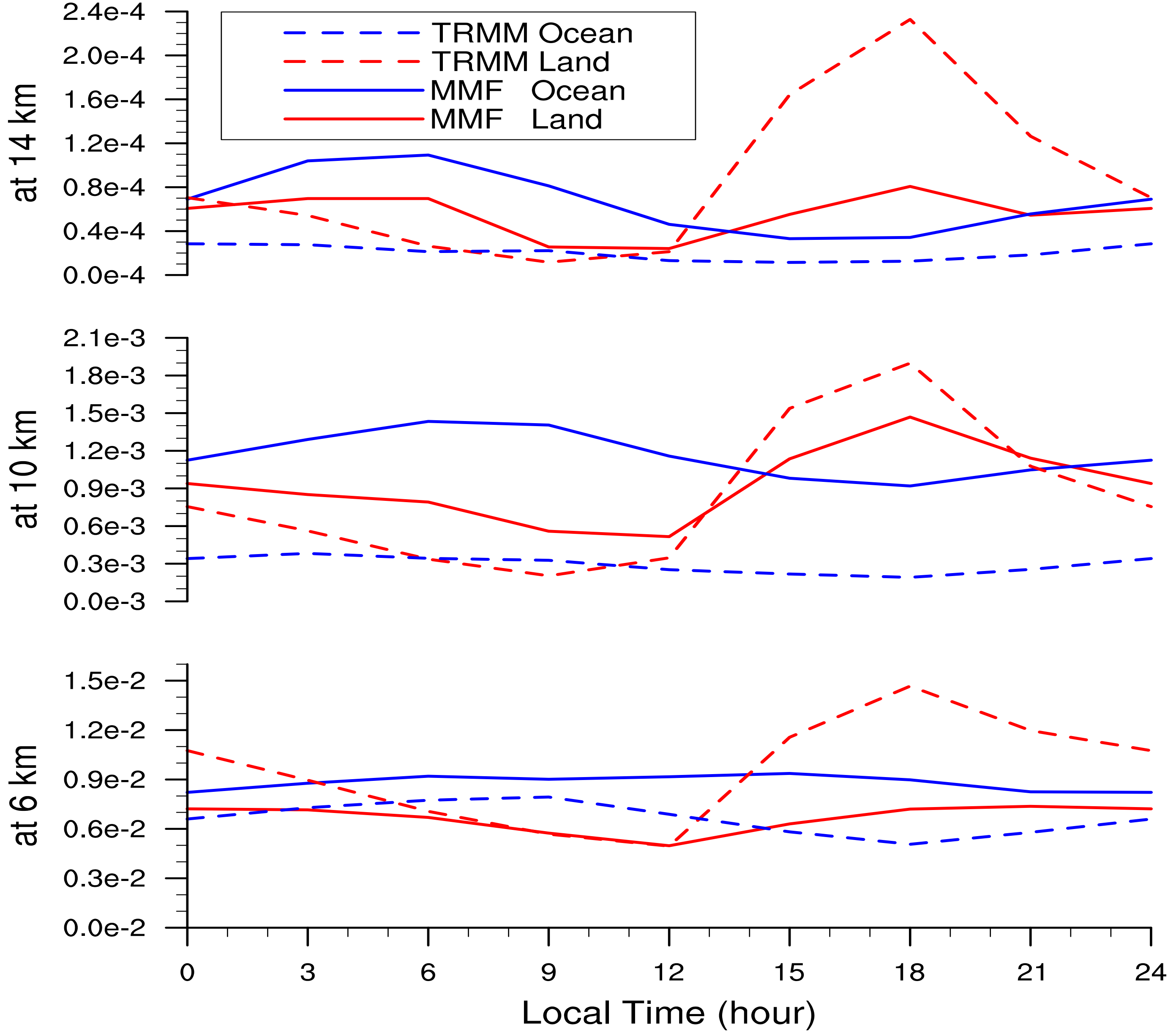
- Cold bias related to high clouds, thick and persistent, with diurnal peak before sunrise

Occurrence of PR reflectivity

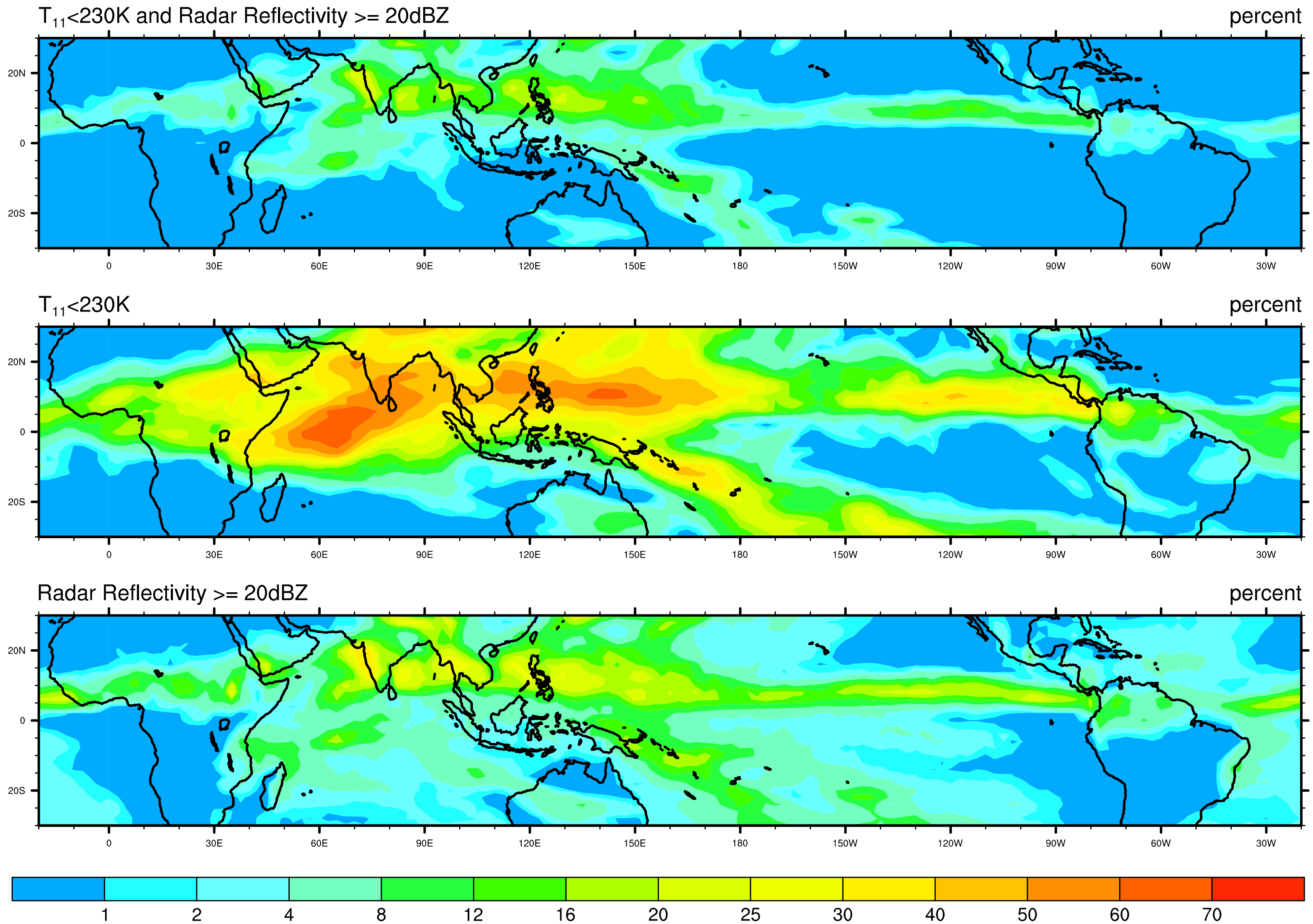


- The deep convections are over active in MMF tropical ocean regions
- The land-sea contrast in MMF deep convections is not as evident as TRMM

Diurnal Cycle of 20 dBZ Occurrence

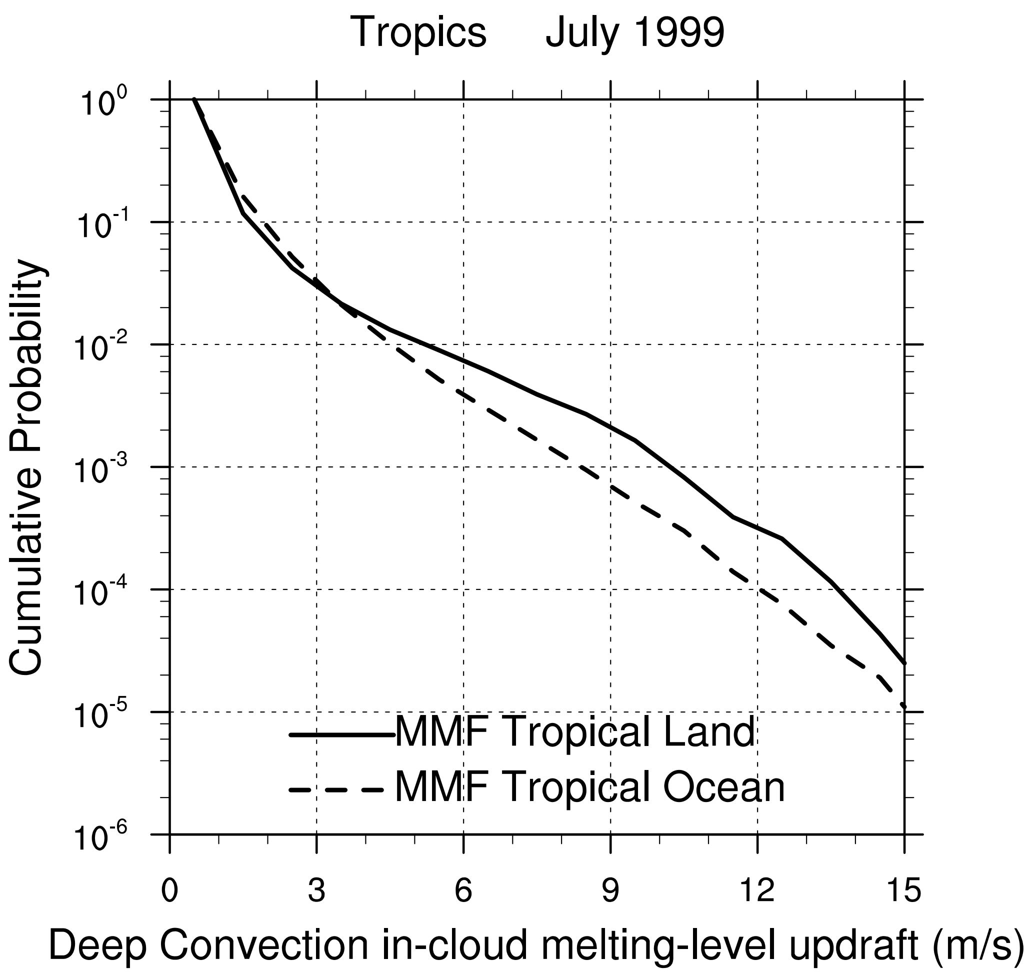


Both Simulators



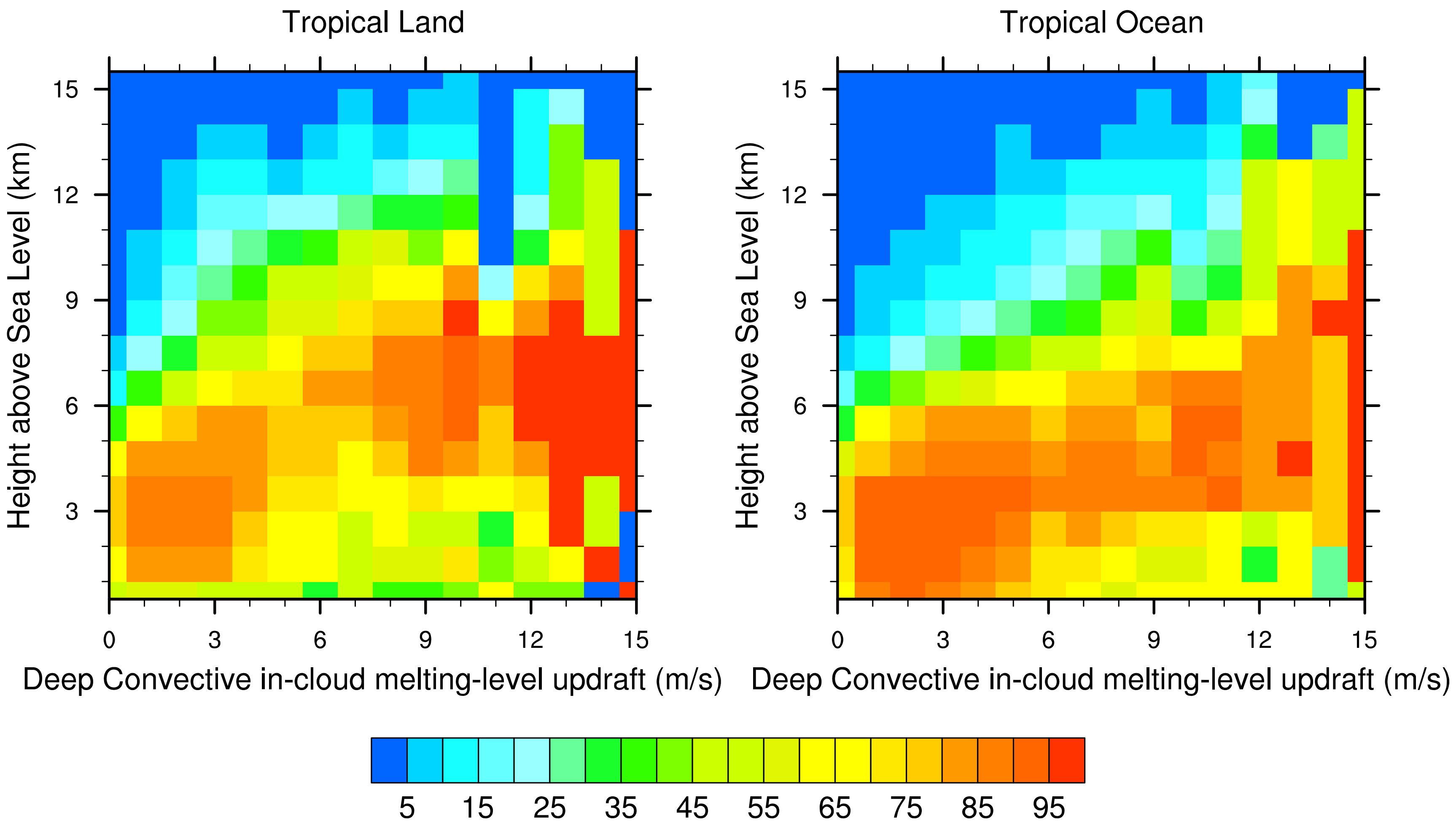
- Large portion of high clouds with cold cloud tops are not with strong precipitation
- Some of deep convective clouds with strong precipitation may not penetrate deep

Convective Updraft



- 90% are below 2m/s
- More stronger updrafts are found over MMF tropical land regions

Convective Updraft



- MMF tropical land deep convections usually penetrate deeper

Summary

- Excessive high clouds (with cloud top Tb < 220 K) are found in MMF and peak before sunrise. This leads to the overestimation in the simulator mean fields and also the failure in representing the diurnal phase relationship between deep convections, high clouds and UTH.
- Deep convections in MMF tropical ocean regions are overactive; while in land regions, they are underestimated especially around sunset, the diurnal peak time.
- The deep convective in-cloud melting-level updrafts are weak. This might be resulted from poor resolutions and might be one of the reasons for high cloud biases.
- More stronger updrafts are found over land regions and usually penetrate deeper.