Global Variability of Mesoscale Convective System Anvil Structure

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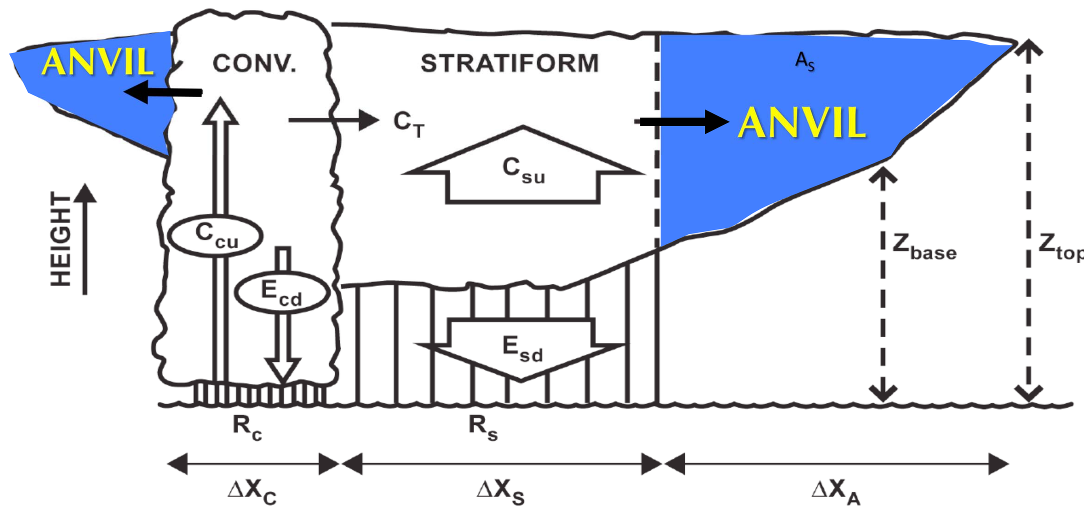
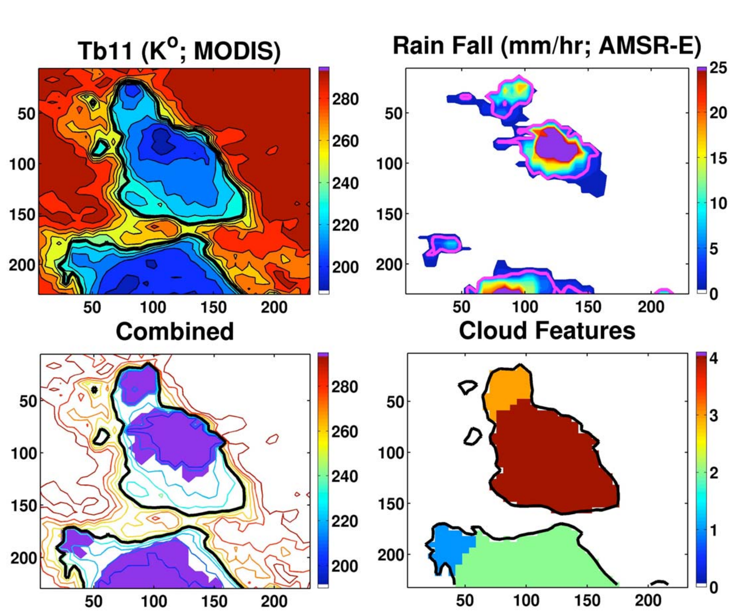
Introduction

Mesoscale Convective Systems (MCSs) are identified both manually using geostationary satellite data and objectively using the AMSR-E rain rate and the IR brightness temperature from the MODIS. Anvil cloud structures associated with MCSs are then studied using CloudSat observations and compared with ARM ground measurements. This study lays the groundwork for calculating and understanding of the global radiative effects of MCSs.



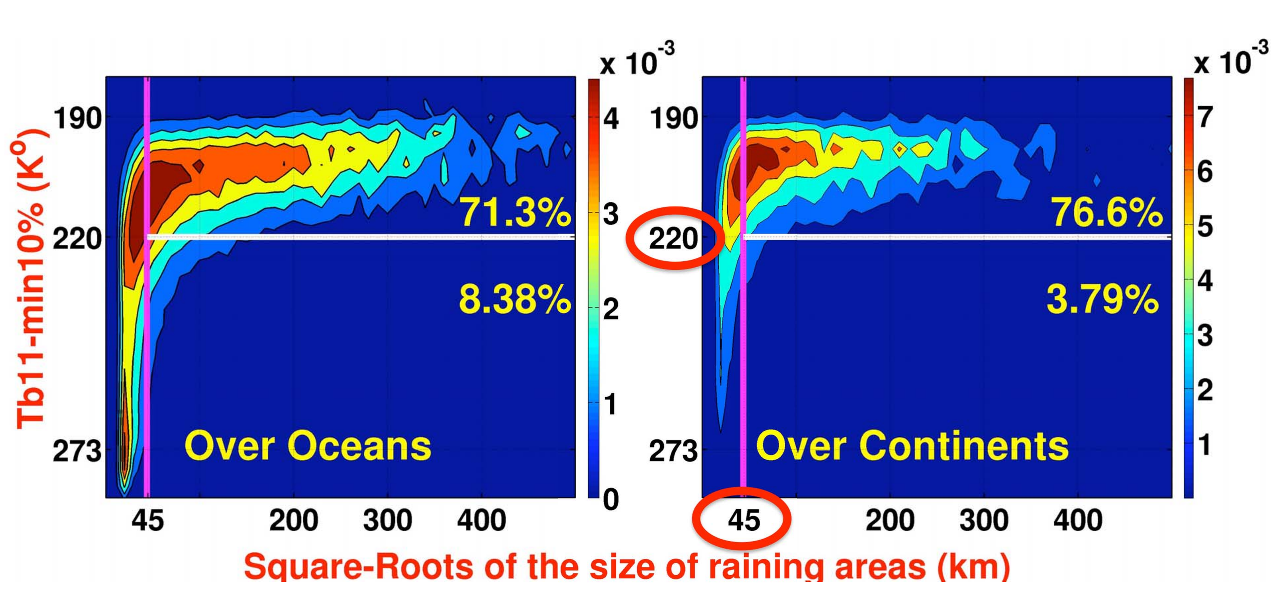
Objective Cloud Feature Identification



X and Y axes show lengths in Km

- Define cloud systems and cold centers based on MODIS Tb11.
- Identify raining cores using AMSR-E rain rates.
- Mask out both raining and non-raining cores.
- Determine cloud features based on the distance to their centers.

Joint-PDF of Latent Heat Contribution



- Large-deep systems produce most of the precipitation.
- Small-Shallow systems mainly occur over the Ocean.

Defining MCS

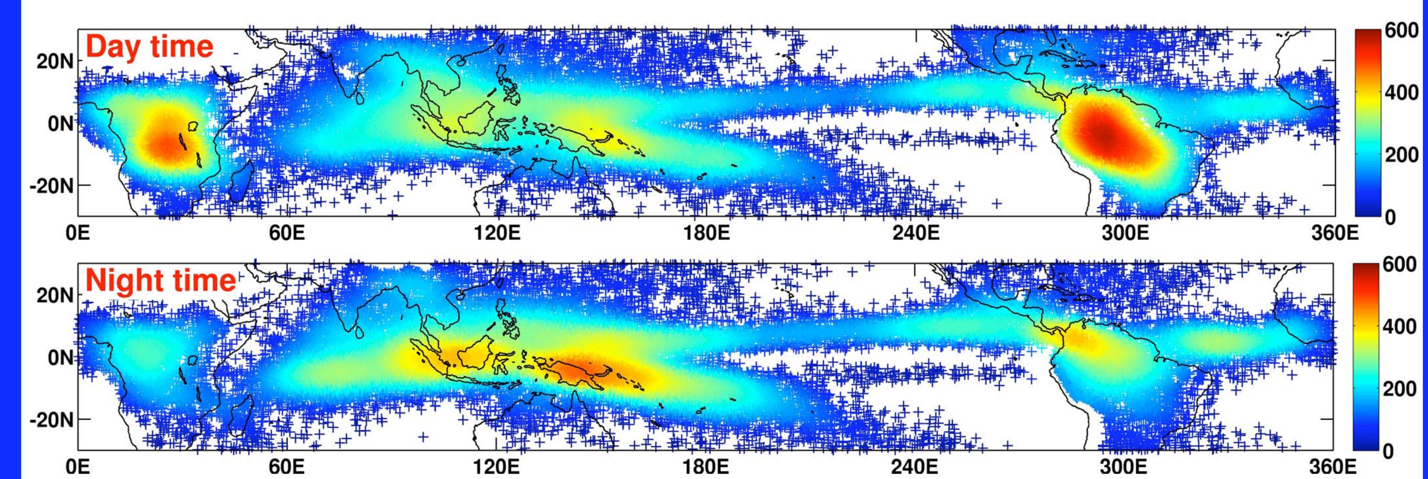
Precipitating systems that have

- a contiguous raining area >(45 km)^2.
- mean Tb11 of the coldest decile of the raining area T<220 K°.

Additional requirement:

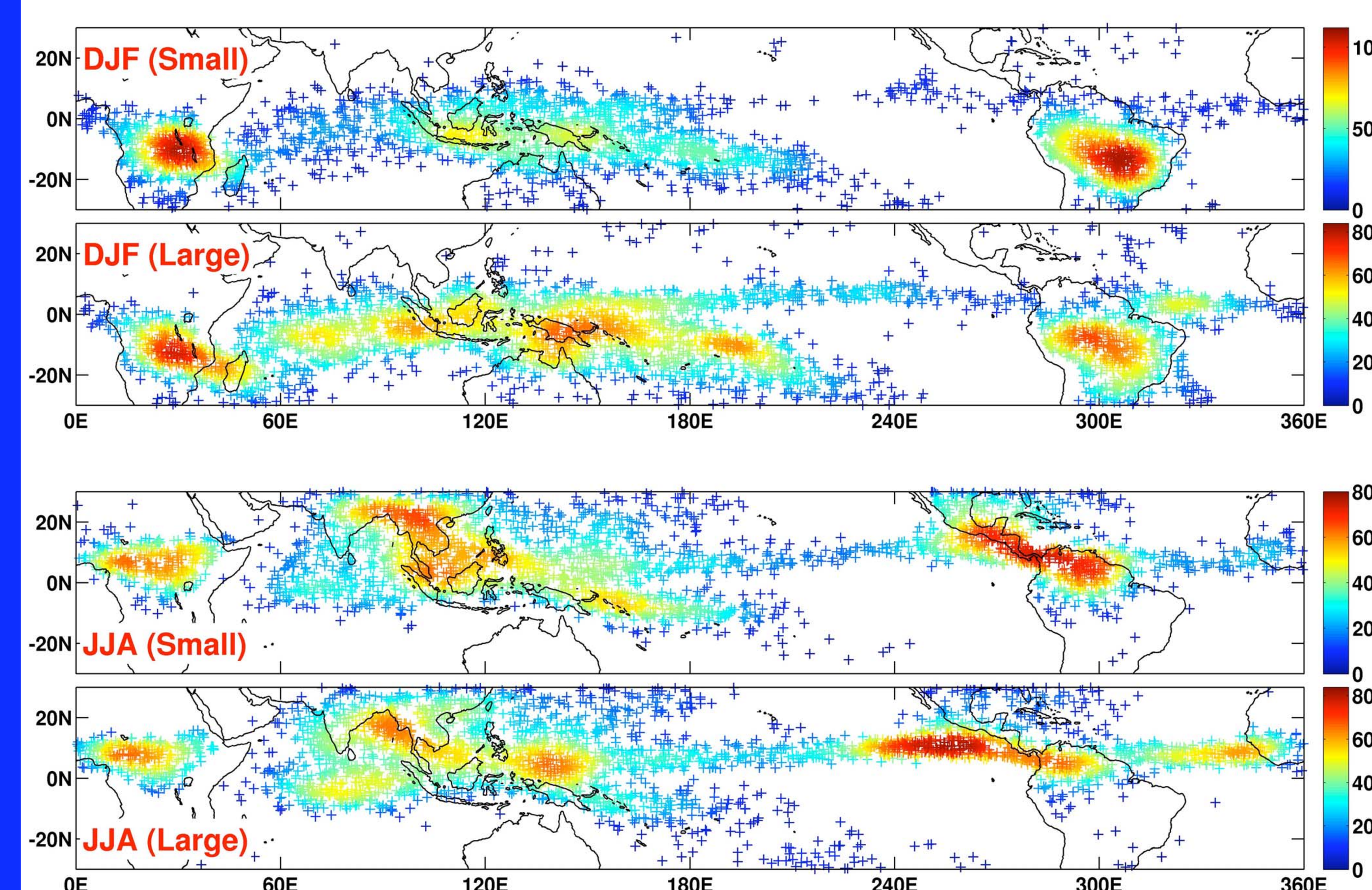
- Intense raining area (R>10 mm/hr)>200 km^2

Diurnal Cycle Impacts on Tropical MCSs



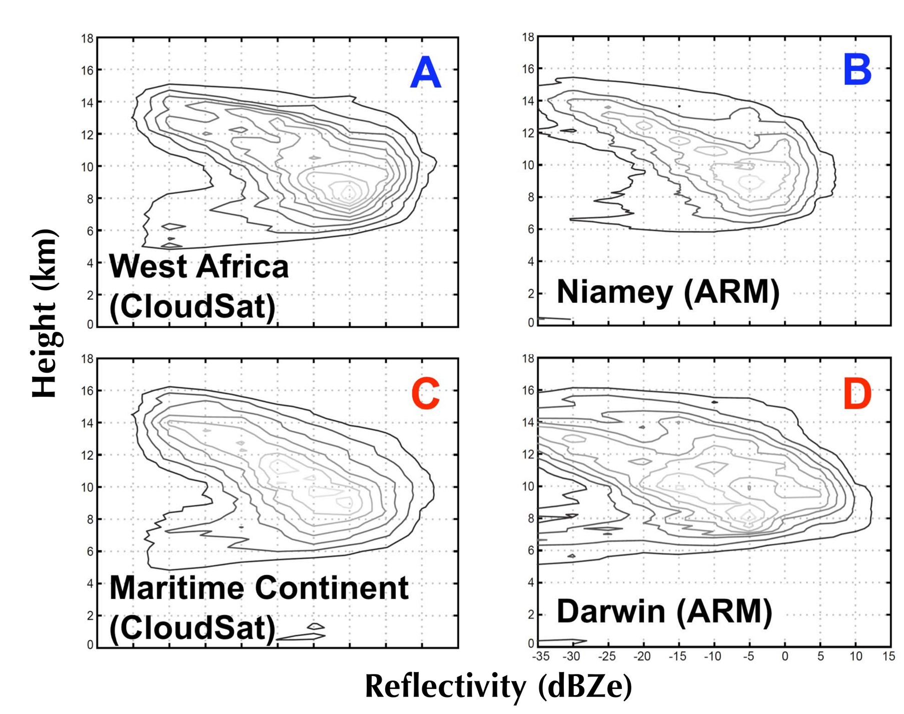
- Continental MCSs happen more frequently during the day time.
- Oceanic MCSs have weak diurnal cycles.

Seasonal Variations of Tropical MCSs with Different Sizes



- Small/large MCSs tend to happen more over the land/ocean.
- Winter MJO and Indian summer Monsoon favor large MCSs.

CloudSat-ARM Comparison



Figures are adapted from Cetrone&Houze 2008

- The CFAD associated with thick anvils sampled by the WACR in Niamey (B) is very similar to that sampled by the CloudSat over the west Africa (A).
- The presence of higher reflectivity anvils occurs more often in Darwin (D) than over the Maritime Continent (C) as a whole, likely due to the influence of continentally driven MCSs that propagate past Darwin during breaks in the monsoon.

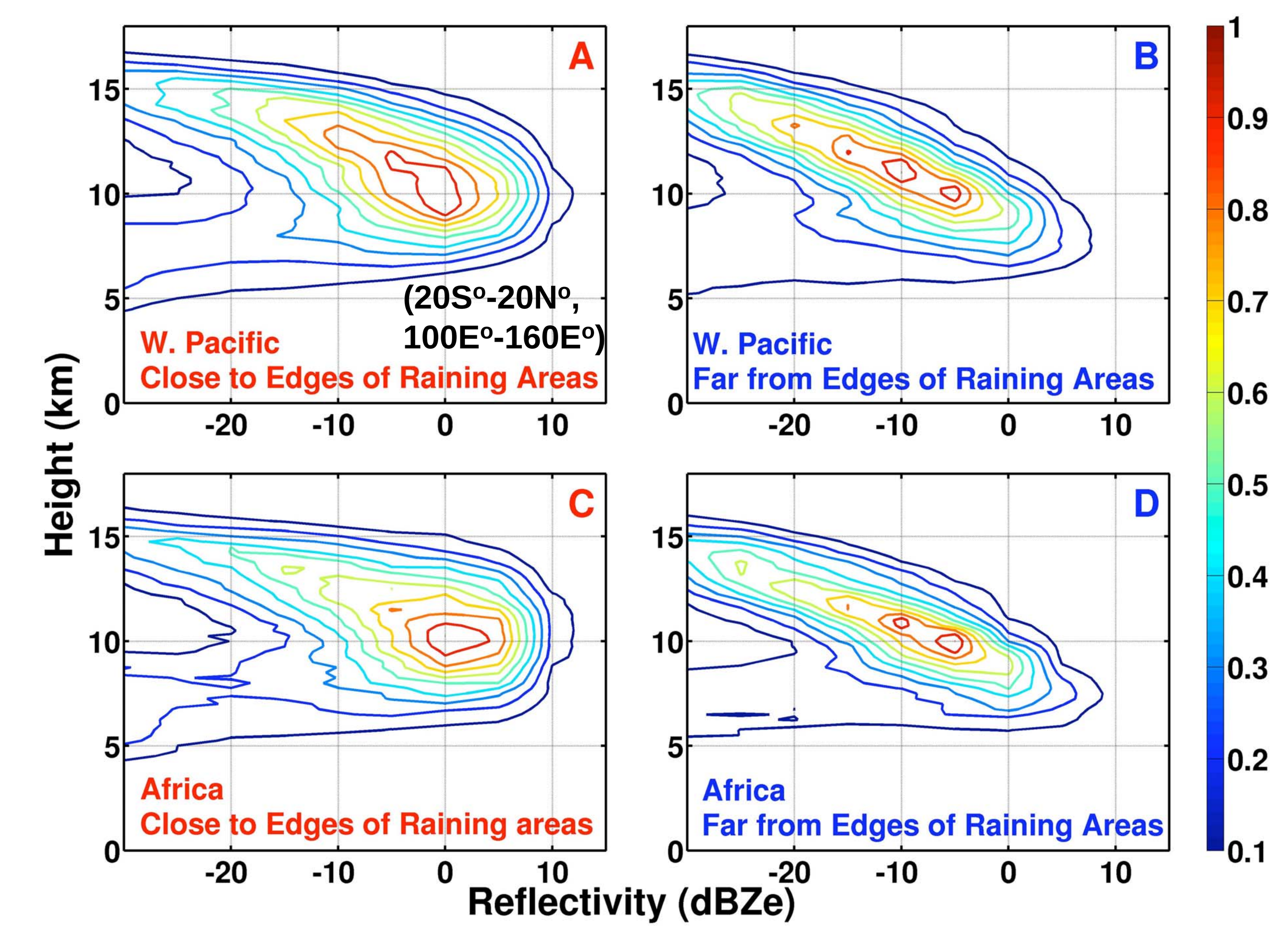
Conclusions and Summary

- MCSs objectively identified show consistent spatial & temporal distributions with prior knowledge & previous work.
- The portions of anvil clouds located far away from the raining area of the MCS are likely older clouds with small ice particles, which remain aloft longer and grow by vapor diffusion.
- The newer portions of anvils located closer to the raining area of the MCS contain larger, heavier particles grown in the updrafts of the convective or stratiform regions of the MCS.
- Particles in newer anvils associated with Africa MCSs are likely detrained more from convective regions compared to that of oceanic MCSs.

Future work

Understanding the radiative effects of MCS anvil clouds.

Anvil Cloud Structure Changes with Locations Relative to the Raining Area



- Sampled pixels are over open water (W. Pacific) or over continental land areas (Africa). CFADs are for thick anvils (6 km-11 km).
- Higher reflectivity occurs more frequently in the upper portion of anvils in C compared with that in A, suggesting that anvil clouds represented in C are likely more closely associated with convective regions compared with A.
- CFADs in B and D have almost the same structure, probably dominated by "stratiform" type microphysics.
- It is suggested that A and C are associated with newly detrained anvil particles while B and D are related to older anvils from which bigger particles have fallen out.

Acknowledgements

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