Radiative Heating Profiles of Thick Anvil Estimated From the TRMM Precipitation Radar

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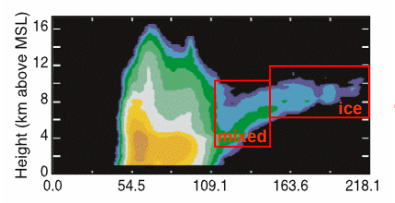
INTRODUCTION

The Tropical Rainfall Measuring Mission (TRMM) Precipitation Radar (PR) provides extensive information on precipitation and anvil clouds (i.e., thick, non-precipitating cloud associated with deep convection) across the tropics. This poster focuses on the vertical and geographical variability of radiative heating of tropical thick anvil using an MMCR look-up table based on data from Manus and Darwin to convert PR-derived IWC and LWC profiles to radiative heating profiles. Since clouds with different composition lead to different radiative properties, we differentiate the thick anvil into ice anvil (composed only of ice hydrometeors) and mixed anvil (composed of a mix of ice and water hydrometeors) by applying a echo base and thickness threshold:

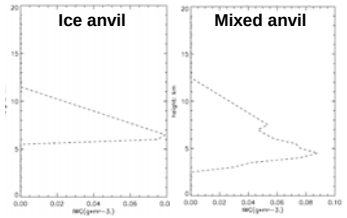
- ice anvil – echo base ⩾ 6 km
- mixed anvil – echo base between 3-6 km and at least 3 km thick

In addition, the TRMM PR echo-top height is modified by using cloud-top information from the lidar aboard NASA's ICESat due to the insensitivity of the PR to smaller hydrometeors.

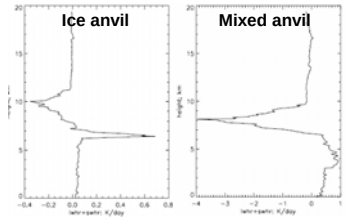
METHODOLOGY



TRMM PR thick anvil

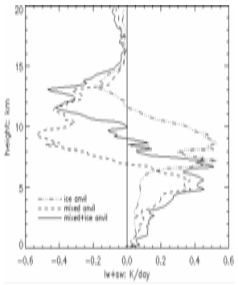


IWC/LWC profile estimated from TRMM PR



Matched heating rate profile from MMCR

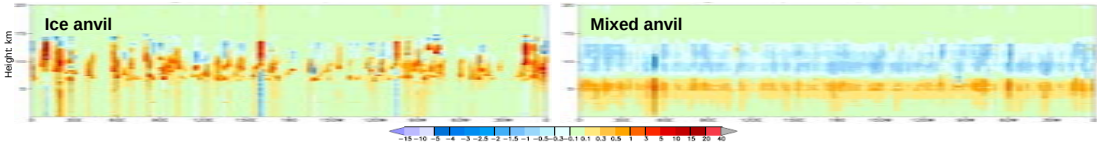
THICK ANVIL RADIATIVE HEATING DISTRTIBUTIONS



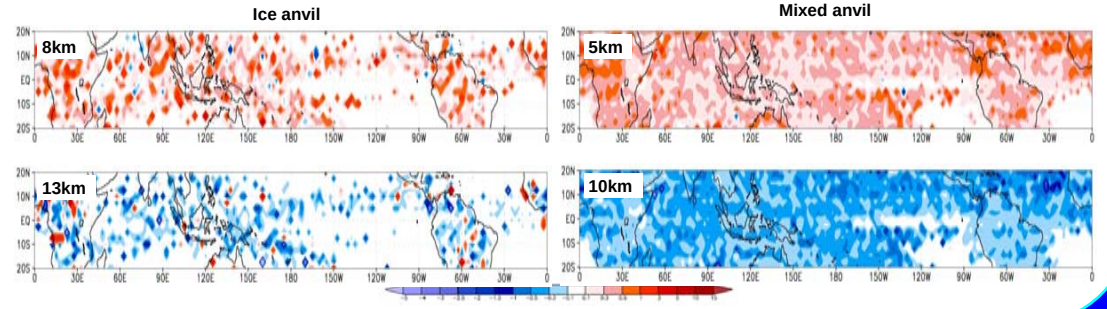
Cloud radiative heating profile of thick anvil in regions of deep convection in the tropics

(Annual Mean for 2006)

CROSS SECTION ALONG 10° N (Annual Mean for 2006)



GEOGRAPHICAL DISTRIBUTION (Annual Mean for 2006)



CONCLUSIONS

- Thick ice anvil contributes a maximum of 0.5 K/day of radiative heating near 8 km, while mixed anvil contributes a maximum of 0.4 K/day near 5km and -0.5 K/day near 9km. In a column-integrated sense, ice anvil shows a heating effect while mixed anvil shows a cooling effect.
- Ice anvil observable by the TRMM PR occurs primarily in regions of deepest convection, whereas mixed anvil is more prevalent across the tropics.
- Future work will force NCAR's community Atmosphere Model (CAM) with MMCR-refined heating profiles to investigate the impact of radiative heating on the large-scale circulation of the tropics, as well as the net effect of anvil cloud radiative heating relative to latent heating by the precipitating cloud regions.

References:

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3. James H. Mather, Sally a. McFarlane, Mark A. Miller, and Karen L. Johnson, 2007: Cloud properties and associated radiative heating rate in the tropical western Pacific. J. Geophys. Res.,112,D5201,doi: 10.1029/2006JD007555

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