Radar-observed Convective Characteristics During TWP-ICE

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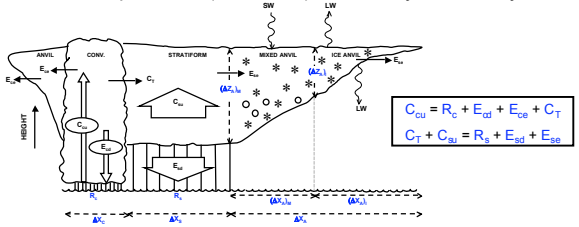
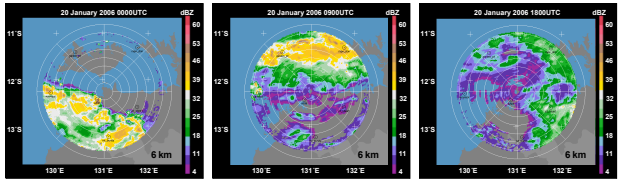
INTRODUCTION

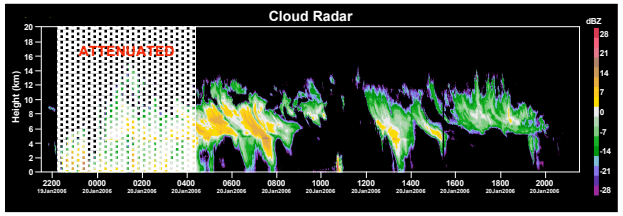
This study focuses on the composite water budget of tropical convective systems observed during the Tropical Warm Pool-Ice Cloud Experiment (TWP-ICE) in January - February 2006.

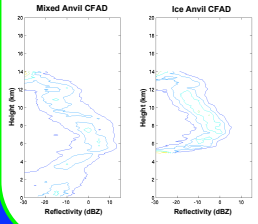


Deep convection injects hydrometeors into the upper troposphere, where they affect the radiation budget and water cycle. We use the water budget derived from radar data to investigate how anvil forms in these complex systems.

TWP-ICE EXAMPLE CASE





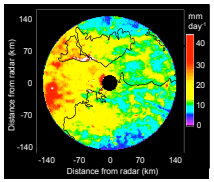


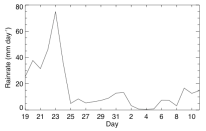
- A large MCS moved northward over the ARM site 19-20 January.
- Anvil persisted for ~15h afterwards.
- Anvil with fallstreaks below the 0°C level (~5 km) had a wider spread of reflectivity values compared to the ice-only anvil.

C-POL SUMMARY

Rainfall (R_c and R_s)

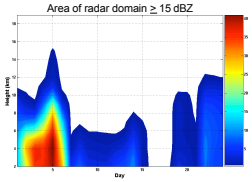
- The average rainfall ($R_c + R_s$) over the radar domain for 19 January - 11 February was 16 mm day^{-1}.
- Stratiform rain (R_s) accounted for 19% of the overall rain (3 mm day^{-1}).





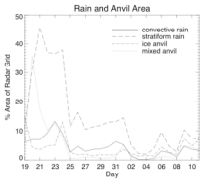
Rainfall and % stratiform rain by wind regime:
Active monsoon 1/19 - 1/24 (42 mm d^{-1}, 23%)
Strong westerlies 1/25 - 2/2 (8 mm d^{-1}, 15%)
Break easterlies 2/3 - 2/11 (7 mm d^{-1}, 11%)

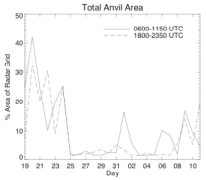
Vertical Echo Distribution



- The amount of echo reaching upper levels was max during the active monsoon, with a secondary max during the break period.
- Echo during the strong, dry westerlies rarely reached > 8 km.

Rain (ΔX_C and ΔX_S) and Anvil (ΔX_A) Area





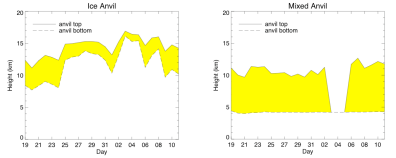
ΔX_C and ΔX_S Convective and stratiform rain covered roughly 40% of the radar domain during the active monsoon, but rain area decreased dramatically during the dry monsoon and break periods.

ΔX_A Ice and mixed (i.e., non-precipitating cloud with a base 3-6 km AMSL and at least 3 km thick) anvil covered 15-30% of the radar domain during the active monsoon and 2-10% during the rest of the experiment.

Diurnal ΔX_A In general, total anvil area did not vary diurnally during the active monsoon, but peaked in the afternoon during the dry monsoon and break periods.

ANVIL THICKNESS (ΔZ_A)

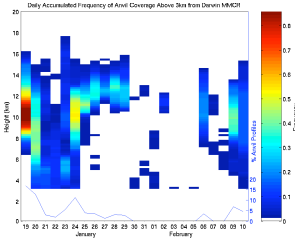
Precipitation Radar (C-Pol)



$(\Delta Z_A)_I$ C-Pol ice anvil had a mean thickness of 2 km with an average base of 11 km. Ice anvil was thicker and had a lower base during the active monsoon.

$(\Delta Z_A)_M$ Mixed anvil had an average base near 4 km and a mean thickness of 7 km, with little variation during the experiment.

Cloud Radar (MMCR)



MMCR anvil measurements are consistent with C-Pol's; however, the cloud radar's sensitivity allows it to see thinner anvil and the full extent of the anvil depth, which are necessary for calculations of anvil mass, E_{ce} and E_{se}.

CONCLUSIONS AND FUTURE WORK

- Radar observations during TWP-ICE have shown:
  - -organized rain systems with large, thick, and persistent anvil during the active monsoon westerlies
  - -shallow cells and high, thin anvil suggesting aged, remotely produced anvil during the strong but dry westerlies and daytime convection producing intermittent anvils at various heights during the break easterlies
- We've calculated the water budget parameters R_c, R_s, ΔX_C, ΔX_S, ΔX_A, and ΔZ_A for TWP-ICE convective systems. Our next step is to calculate the other water budget parameters for TWP-ICE and the longer dataset at Darwin to help describe the magnitude and mechanisms of anvil generation by convective systems.

ACKNOWLEDGEMENTS: We'd like to thank Stacy Brodzik for her invaluable efforts in the field. Brad Atkinson, Tim Hume, and Michael Whimpey also made essential contributions. Tom Ackerman and Ed Zipser provided much appreciated discussions.