AMS 24[th] Conf. On Hurricanes and Tropical Meteorology. 29 May – 2 June, 2000, Ft. Lauderdale, Flordida.

5B.5 EARLY RESULTS FROM TRMM-LBA: KINEMATIC AND MICROPHYSICAL CHARACTERISTICS OF CONVECTION IN DISTINCT METEOROLOGICAL REGIMES

Steven A. Rutledge*, Walter A. Petersen, Robert C. Cifelli, Lawrence D. Carey
Department of Atmospheric Science, Colorado State University

1. INTRODUCTION

In order to validate TRMM cloud models and satellite products over the interior of a tropical continent, the TRMM-LBA field experiment was held in the southwestern Amazon from January to February 1999. A variety of instrumentation was deployed during the field campaign including airborne microphysical and radar platforms, sounding stations, surface meteorological towers, and ground-based C-band Doppler (NASA TOGA) and S-band polarimetric (NCAR S-pol) radars. In this study we report on results from the TRMM-LBA field campaign emphasizing the kinematic and microphysical characteristics observed in two specific convective systems utilizing ground based dual-Doppler and S-band polarimetric radar data. This analysis is set in the framework of "large-scale forcing" by identifying the selected case studies as having occurred in either a *monsoon* or *break*-period meteorological regime.

2. METEOROLOGICAL REGIMES

Two primary meteorological regimes were observed during the TRMM-LBA: monsoon and break. The monsoon regime was characterized by west to northwest surface flow and the presence of a relatively moist troposphere. During monsoon periods, convection typically produced copious amounts of rainfall but was only weakly electrified, exhibiting weak vertical development similar to that associated with tropical oceanic/monsoon regimes (e.g., Rutledge et al., 1992). During the break regime, convection occurred in a slightly dryer troposphere coincident with low level easterly flow. Break period convection typically exhibited robust vertical development and was highly electrified.

3. CONTRASTS IN VERTICAL STRUCTURE

Two MCSs (Mesoscale Convective Systems) from TRMM-LBA were selected for analysis: 26 January 1999 (break) and 25 February 1999 (monsoon). The 26 January event formed as a squall line with a leading line of convection and a trailing region of decaying convection and weak, stratiform precipitation. The leading line was quite intense, with peak reflectivities near 60 dBZ and echo tops approaching 19 km in selected cores. Figure 1a shows a cross section through a vigorous cell. Note the tilted updraft and corresponding differential reflectivity (Z_{DR}) structure indicating a significant amount of liquid water that is being lofted into the mixed phase region. Z_{DR} values exceeding 3 dB below the melt level suggest the presence of relatively large drops (see also Fig. 2a). The dip in the Z_{DR} contours in the weaker updraft region on the right side of the cell in Fig. 1a corresponds with an LDR (linear depolarization ratio) enhancement, suggesting a hail production mechanism via the freezing of mm-sized raindrops. Some of the larger frozen drops likely fell back through the weaker updrafts on the northern fringe and re-melted, causing a peak in rainwater content. Some of the hailstones likely rose in the updraft and rimed, causing a slight enhancement in LDR in the updraft core. Fig. 2a shows that the updraft is able to support an efficient collision-coalescence precipitation process, as evidenced by the high liquid water contents and large drop diameters, as inferred from the polarimetric radar measurements. Note also the significant amount of ice being lofted into the mid and upper troposphere.

The contrasting vertical structure of the 25 February MCS is shown in Fig. 1b and 2b. Typical of monsoonal events, this system exhibited little organization and was best characterized by stratiform precipitation with embedded convective elements that evolved slowly. Consistent with the weaker updrafts, there is a relatively sharp reflectivity gradient above the melt level (Fig. 1b) and paucity of ice in the mid to upper troposphere (Fig. 2b).

4. PARTITIONED VERTICAL STRUCTURE

Composite characteristics of each MCS were analyzed by partitioning reflectivity and vertical air motion for each dual Doppler synthesis volume (9 volumes for 26 January and 6 volumes for 25 February) into convective and stratiform components and calculating mean profiles. The results are shown in Fig. 3. As expected, the break MCS had higher peak reflectivities and a smaller reflectivity gradient above the melt level (convective region) compared to the monsoon event (Fig. 3a). The break MCS mass flux in the convective region is larger with a slightly broader peak compared to the monsoon system (Fig. 3b), consistent with the stronger updrafts in the 26 January event. The magnitude of the stratiform mass fluxes are similar; however, the shape of the profiles are different (especially in the lower troposphere), suggesting different kinematic processes in the stratiform portion of these MCSs.

5. SUMMARY

Two MCSs have been analyzed using dual Doppler and multiparameter radar data collected during TRMM LBA. The MCSs occurred in distinct meteorological regimes (break and monsoon). Consistent with differences in the large-scale environment, the MCSs displayed significant differences in microphysical and kinematic features. These results have important implications for TRMM since the diabatic heating profiles are directly coupled to the kinematic and microphysical structure. Future research will focus on a statistical analysis of TRMM-LBA MCS characteristics within the break and monsoon regimes.

* *Corresponding author*: Prof. Steven A. Rutledge, Department of Atmospheric Science, Colorado State University, Fort Collins, CO. 80523-1371. e-mail: rutledge@radarmet.atmos.colostate.edu

6. REFERENCES

Rutledge, S.A., E. R. Williams, and T.D. Keenan, 1992: The Down Under Doppler and Electricity Experiment (DUNDEE): Overview and preliminary results. *Bull. Amer. Meteor. Soc.*, **73**, 3-16.

Acknowledgements. This research was supported by NASA TRMM grant NAG5-4754.

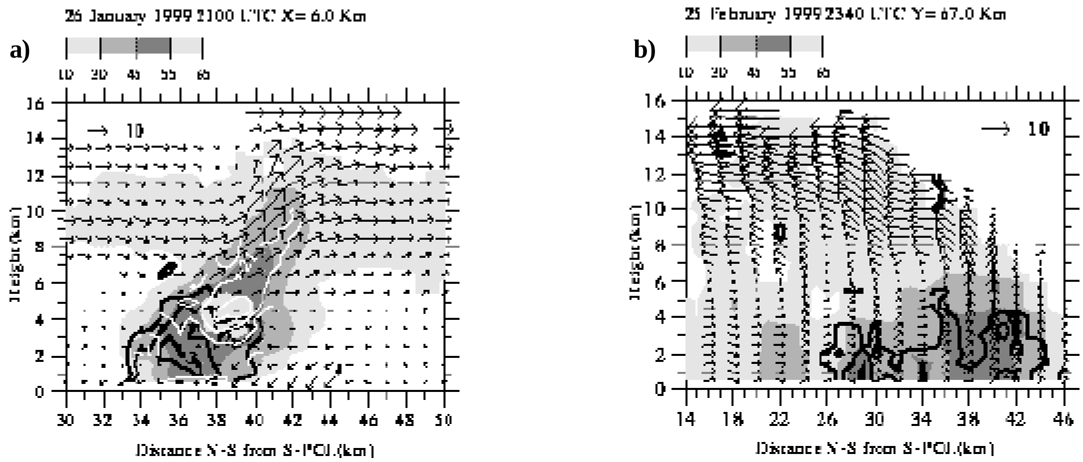

Figure 1. **a)** North-south vertical cross-section through 26 January 1999 break period convective cell at 2100 UTC. Radar reflectivity is shaded as indicated, Z_{DR} is contoured in black from 1 dB at an interval of 1dB. LDR is contoured in white for values of –23, -21 and –19 dB. Velocity vectors are plotted in a storm-relative framework (scale indicated in figure). **b)** as in (a) except 25 February 1999, 2340 UTC. East-west cross-section through monsoon convection (strong LDR signals absent in this case).

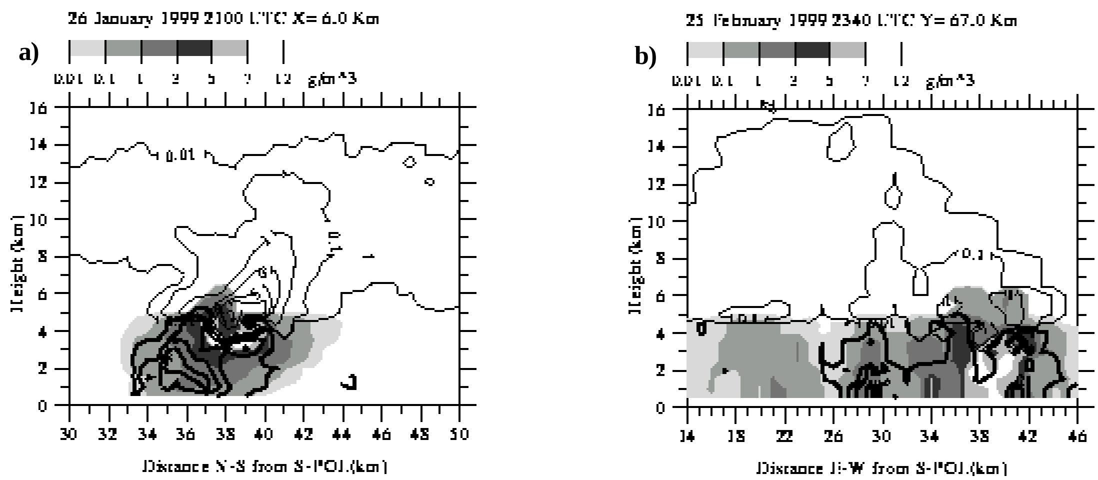

Figure 2. a) Same as (1a) except rain water content (g m^{-3}, shaded as shown), precipitation ice water content (g m^{-3}, contours at 0.01, 0.1, 1, 3, 5, 7, 12 g m^{3}), and mass weighted mean raindrop diameter (mm, thick contour starting at 1 mm every 1 mm). **b)** Same as (2a) except for the cross-section shown in (1b).

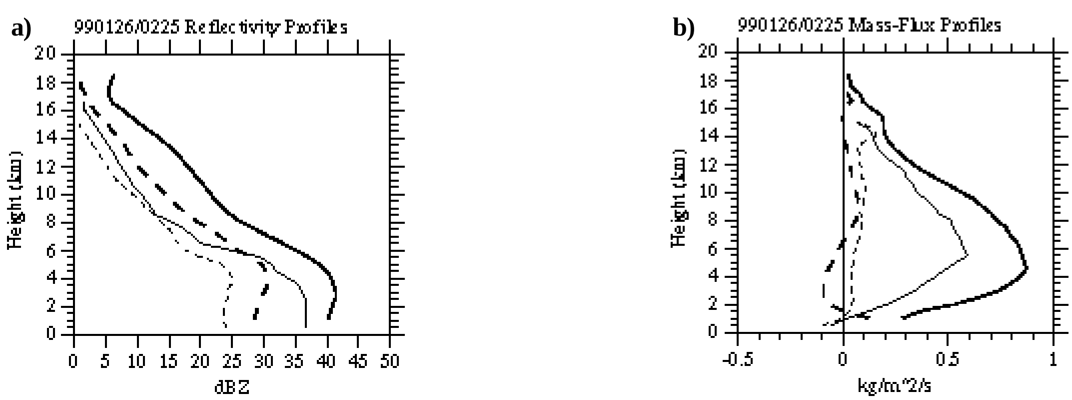

Figure 3. **a)** Volume average vertical profiles of radar reflectivity partitioned by convective (solid) and stratiform (dash) precipitation components for the 26 January 1999 break-period case (bold) and the 25 February 1999 monsoon case (light). **b)** as in (a) but mass flux profiles.