RADAR OBSERVATIONS OF CONVECTIVE SYSTEMS FROM A HIGH-ALTITUDE AIRCRAFT

G. Heymsfield (1), B. Geerts (1,2) and L. Tian (3)

(1) NASA Goddard Space Flight Center, Greenbelt, Maryland, USA

(2) Science Systems and Applications Inc, Lanham, Maryland, USA

(3) Universities Space Research Association, Greenbelt, Maryland, USA

geerts@agnes.gsfc.nasa.gov

Reflectivity data collected by the precipitation radar on board the Tropical Rainfall Measuring Mission (TRMM) satellite, orbiting at 350 km altitude, are compared to reflectivity data collected nearly simultaneously by a Doppler radar aboard the NASA ER-2 flying at 19-20 km altitude, i.e. above even the deepest convection. The TRMM precipitation radar is a scanning device with a ground swath width of 215 km, and has a resolution of about 4.4 km in the horizontal and 250 m in the vertical (125 m in the core swath 48 km wide). The TRMM radar has a wavelength of 2.17 cm (13.8 GHz) and the nadir mirror echo below the surface is used to correct reflectivity for loss by attenuation.

The ER-2 Doppler radar (EDOP) has two antennas, one pointing to the nadir, the other pointing 34° forward (Heymsfield et al 1996). The forward pointing beam receives both the normal and the cross-polarized echos, so the linear polarization ratio field can be monitored. EDOP has a wavelength of 3.12 cm (9.6 GHz), a vertical resolution of 37.5 m, and a horizontal along-track resolution of about 100 m. The 2-D (along-track) airflow field can be synthesized from the radial velocities of both beams, if a reflectivity-based hydrometeor fall speed relation can be assumed. It is primarily the superb vertical resolution that distinguishes EDOP from other ground-based or airborne radars.

Two experiments were conducted during 1998 to validate TRMM reflectivity data over convection and convectively-generated stratiform precipitation regions. One, TEFLUN-A (Texas-Florida Underflight) experiment, was conducted in April and May and focused on mesoscale convective systems (MCS) mainly in southeast Texas. TEFLUN-B was conducted in August-September in central Florida, in coordination with CAMEX-3 (Convection and Moisture Experiment). The latter was focused on hurricanes, especially during landfall, whereas TEFLUN-B concentrated on central Florida convection, which is largely driven and organized by surface heating and ensuing sea breeze circulations. Both TEFLUN-A and B were amply supported by surface data, in particular a dense raingauge network, a polarization radar, wind profilers, a mobile radiosonde system, a cloud physics aircraft penetrating the overflown storms, and a network of 10 cm Doppler radars (WSR-88D).

This presentation will show some preliminary comparisons between TRMM, EDOP, and WSR-88D reflectivity fields in the case of an MCS, a hurricane, and less organized convection in central Florida. A validation of TRMM reflectivity is important, because TRMM's primary objective is to estimate the rainfall climatology within 35° of the equator. Rainfall is estimated from the radar reflectivity, as well from TRMM's Microwave Imager, which measures at 10.7, 19.4, 21.3, 37, and 85.5 GHz over a broader swath

(780 km). While the experiments lasted about three months, the cumulative period of near-simultaneous observations of storms by ground-based, airborne and spaceborne radars is only about an hour long. Therefore the comparison is case-study-based, not climatological.

We will highlight fundamental differences in the typical reflectivity profiles in stratiform regions of MCSs, Florida convection, and hurricanes, and will explain why Z-R relationships based on ground-based radar data for convective systems over land should be different from those for hurricanes. The catastrophically intense rainfall from hurricane Georges in Hispaniola and from Mitch in Honduras highlights the importance of accurate Z-R relationships. It will be shown that a Z-R relationship that uses the entire reflectivity profile (rather than just at 1 level) works much better in a variety of cases, making an adjustment of the constants for different precipitation system categories redundant.

References

Heymsfield, G. M., S. Bidwell, I. J. Caylor, S. Ameen, S. Nicholson, W. Boncyk, L. Miller, D. Vandemark, P. E. Racette, and L. R. Dod, 1997: The EDOP radar system on the high-altitude NASA ER-2 aircraft. *J. Atmos. Oceanic Tech.* **13**, 795-809