

# Relationships between Electrical and Radar Characteristics of Thunderstorms Observed During ACES

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**ABSTRACT:** The Altus Cumulus Electrification Study (ACES) took place near Key West, Florida during August 2002. A high altitude, remotely piloted aircraft obtained optical pulse and electric field data over a number of thunderstorms during the study period. Measurements of the vertical electric field and cross sections of radar reflectivity along the flight track are shown for 2 overpasses of a thunderstorm that occurred on 10 August 2002.

## INTRODUCTION

The Altus Cumulus and Electrification Study (ACES) was conducted in south Florida during August 2002 (Blakeslee et al., 2003). The experiment consisted of a high altitude Unmanned Aerial Vehicle (UAV) outfitted with various instruments to measure electrical properties of thunderstorms. The mission capitalized on the capabilities of the UAV to fly at high altitude for extended periods of time so that continuous observations of thunderstorms could be made throughout their life cycle. Radar data during this period were available from the KBYX (Key West, FL) and KAMX (Miami, FL) WSR-88D National Weather Service radars and can be used to document storm structure and its evolution. In addition, data from NASA's NPOL multiparameter radar, located on Ramrod Key, were available for some of the experiment period.

A number of thunderstorms were observed during the ACES experiment. This paper contains preliminary analysis of radar and electric field measurements during two overpasses of a storm observed on 10 August 2002. This storm was observed for multiple overpasses and results from other passes will be shown at the conference.

## AIRCRAFT & INSTRUMENTATION

The Altus II aircraft was chosen in part, based on performance capabilities that included the ability to fly up to 15-15.5 km for 4-8 hours. Its maximum airspeed of about 80 kts and turning ability allows for consecutive storm overpasses just a few minutes apart. Since the aircraft can remain close to a storm, measurements of some storm electrical parameters can be continuously monitored. The aircraft was outfitted with a number of electrical, magnetic, and optical sensors designed to characterize the lightning activity and the electrical environment within and around the thunderstorms. This paper shows results of vertical electric field measurements taken over a thunderstorm. Some results from the optical sensors are shown in Mach et al., 2003.

## RESULTS

Radar reflectivity and vertical electric field observations are shown for 2 overpasses of a cell observed on 10 August 2002 over Cape Sable, located at the southwestern-most tip of the Florida peninsula. Reflectivity data from the 18:34-18:39 UTC scan of the KAMX WSR-88D radar were interpolated to a 1 km by 1 km by 1 km 3-dimensional grid. The aircraft track for 18:32:55 – 18:39:42 UTC is superimposed on the radar reflectivity plots at 2, 5, 7, and 10 km altitude in the 4 bottom panels of Figure 1. The beginning and ending times of the track are labeled "A" and "B", respectively. The storm was about 12 km in diameter at the 2 km level, with peak reflectivity values exceeding 45 dBZ. At 10 km, the storm diameter was about 5 km with maximum reflectivity values between 15-25 dBZ.

The vertical electric field strength and the vertical cross-section of radar reflectivity during the two overpasses are shown in the top two panels of Figure 1. These plots illustrate the rapid revisit time possible with the ALTUS, in this instance about 3.3 min. The radar reflectivity shows that the 15 dBZ storm top is between 11-12 km, with 25-35 dBZ reflectivity up to 9 km. The vertical electric field begins to rise as the aircraft moves towards each storm overpass. The rapid 'jumps' in the electric field data is due to lightning activity occurring within the thunderstorm. As the aircraft moves over the storm at each overpass, the peak electric field is observed to occur in conjunction with the maximum vertical development of the radar reflectivity.

## SUMMARY

Radar and electrical measurements of a thunderstorm on 10 August 2002 were shown. The capabilities of the aircraft allowed for consecutive overpasses of this storm at about 3 min intervals. Further analysis of the measurements will be shown at the conference, including estimates of storm flashing rate derived from the optical sensors.

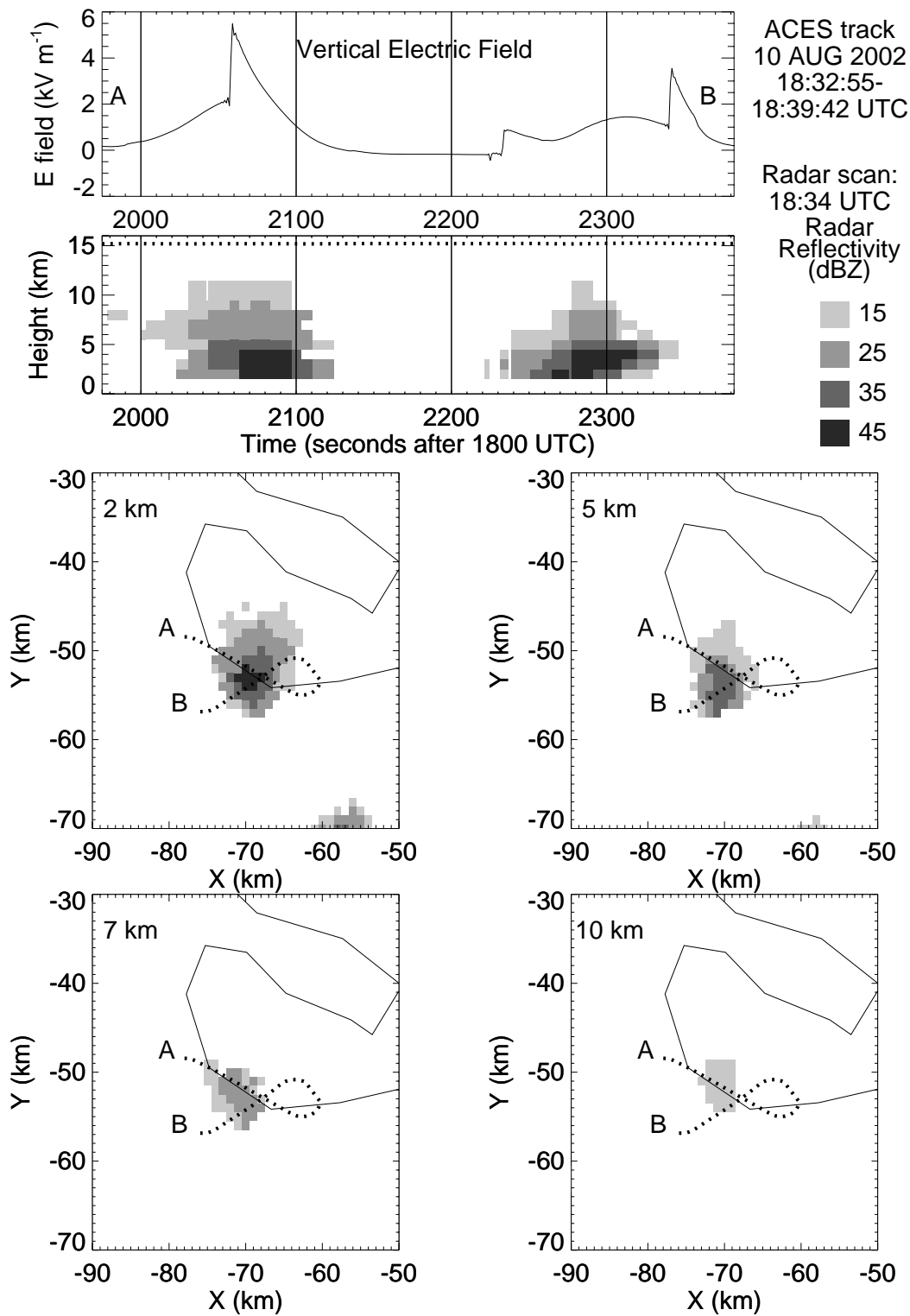


Figure 1. Radar and vertical electric field observations of the 10 August 2002 storm. The top panel shows the trace of the vertical electric field for two overpasses of the cell. The panel under this shows the vertical development of the reflectivity structure as the plane flew overhead (the dotted line is the aircraft height). The bottom four panels show a horizontal view of the storm and the aircraft track (A- begin track, B- end track) at four different heights. The solid outline is Florida's Cape Sable.

#### REFERENCES

- Blakeslee, R. J., C. L. Croskey, M.D. Desch, W. M. Farrell, R. A. Goldberg, J. G. Houser, H. S. Kim, D. M. Mach, J. D. Mitchell, and J. C. Stoneburner, The ALTUS Cumulus Electrification Study (ACES): A UAV-based science demonstration, *Preprints, 12<sup>th</sup> Int. Conf. on Atmos. Electr.*, June 2003, this issue.
- D. M. Mach, R. J. Blakeslee, J.C. Bailey, W. M. Farrell, R. A. Goldberg, M. D. Desch, and J. G. Houser, Preliminary optical and electric field pulse statistics from storm overflights during the ALTUS Cumulus Electrification Study, *Preprints, 12<sup>th</sup> Int. Conf. on Atmos. Electr.*, June 2003, this issue.