Radar and Aircraft Reflectivity Comparisons of Florida Thunderstorm Cirrus Clouds

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Introduction

The Florida 2015 Airplane and Cloud Measurements (CAPE2015) project is a field project designed to improve the United States Navy's high-resolution Mid-Course Radar (MCR). Over 20 hours of aircraft and MCR measurements of thunderstorm anvils near Cape Canaveral, Florida, are obtained. CAPE2015 is unique in that both the in-situ and remote measurements are concurrently obtained and allow for the direct comparison of the data sets.

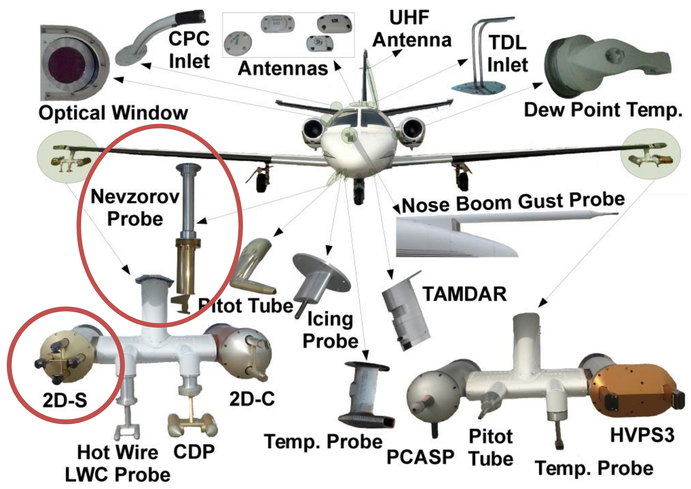
Methodology

Two main instruments concurrently collect data during CAPE2015:

- UND's Cessna Citation II Research Aircraft is used to conduct 21.86 hours of research measurements during eight flights. Ice water content and reflectivity are derived assuming spherical ice particles from measurements taken by the Two-Dimensional Stereographic (2D-S) probe and Nevzorov Water Content Probe (Nevzorov probe) onboard the aircraft.
- The MCR is a C-band, dual-polarization radar that operates at 3 MW and alternates transmissions between two wave forms with a range resolution of either 37 m or 0.546 m (Schmidt et al. 2012).

The position of the aircraft is downlinked in real-time to the MCR which enables the aircraft to be located and followed by the beams of the MCR. The derived reflectivity from the instruments onboard the aircraft is then directly compared with the maximum reflectivity values from the MCR within a 500 m column surrounding the aircraft.

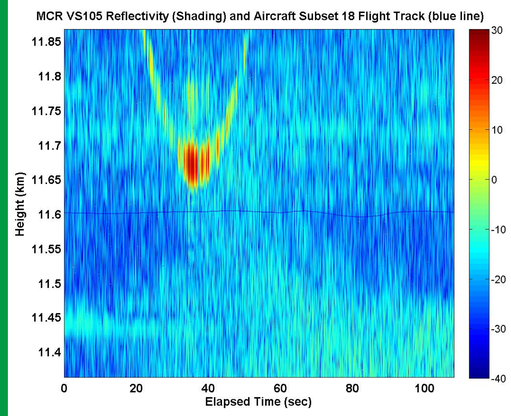
Aircraft Measurements



External instruments deployed on the UND Cessna Citation II Research Aircraft. This study focuses on the two circled instruments, the Two-Dimensional Stereographic (2D-S) probe and the Nevzorov Water Content Probe (Nevzorov Probe).

Radar Measurements

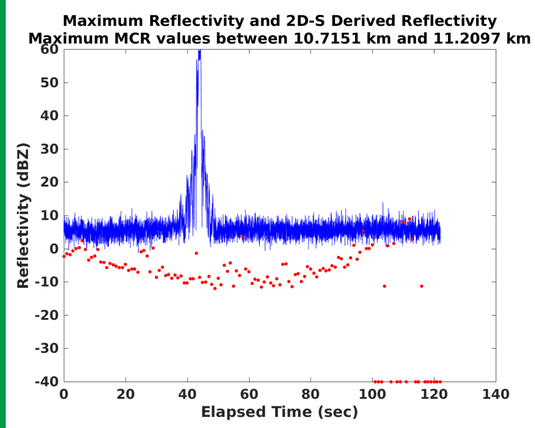
Probes onboard UND's Cessna Citation II Research Aircraft (left) are being flown above the MCR (right). The MCR is located about 20 miles north of Space Coast Regional Airport (KTIX) in Titusville, Florida.



A volume scan from the MCR showing reflectivity (shading, values in dBZ) and the track of UND's Cessna Citation II Research Aircraft (blue line) on a time-height plot. The parabolic shape in the MCR reflectivity is the aircraft as it passes over the MCR. The highest values at the vertex correspond to the aircraft's closest approach with the MCR. Differences in height calibrations between the MCR and aircraft cause the heights to not perfectly align.

Results

Some cases show large differences between derived and measured reflectivity values while others do not.



A case where the comparison between the derived reflectivity values from the aircraft (red dots) and the measured values from the MCR (blue line) shows a reasonable difference between the data. The MCR values shown are the maximum values in a 500 m column surrounding the aircraft. The spike in MCR reflectivity is the aircraft dominating the return signal from the MCR.

Future Work

Future work includes finding an autocorrelation of both data sets of reflectivity and comparing the independent measurements to see if a statistical agreement exists between the data sets.

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References

Schmidt, J. M., and Coauthors, 2012: Radar observations of individual rain drops in the free atmosphere. PNAS, **109**, 9293-9298, doi: 10.1073/pnas.1117776109.