Cirrus Cloud Particles Concurrently Measured with In-Situ Aircraft Probes and a High-Resolution, C-Band Radar



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| Introduction | Aircraft Measurements | Aircraft Analysis |
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| The North Dakota Citation Research Aircraft conducted measurements of cirrus cloud particles produced by Florida thunderstorms in 2015 | | Spatial Distribution of Cloud ParticlesPOISSONPATCHYPATCHYImage: Addition of the second secon |

(CAPE2015 field project). Cloud sampling instruments included the two-dimensional stereographic probe (2D-S), cloud droplet probe (CDP), two-dimensional cloud imaging probe (2D-C), and Nevzorov hot wire probe (Nevzorov). Concurrent with the aircraft measurements, remote sensing observations were made by the United States Navy's Mid-Course Radar (MCR). The CAPE2015 field project observed pure ice particles between an altitude of 29,000 ft and 40,000 ft during eight research flights. Two analyses have been conducted: 1) comparison between derived reflectivity from in-situ probe data with measured MCR reflectivity and 2) patchiness of cloud particles measured with in-situ probes.

Methodology

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 (Delene, 2011). The MCR is a C-band, dualpolarization radar that operates at 3 MW and alternates transmissions between two wave forms with a range resolution of 37 m or 0.546 m (Schmidt et al. 2012). The aircraft position 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.







LWC Probe

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.



Radar Measurements **Radar Analysis** Future Work MCR VS105 Reflectivity (Shading) and Aircraft Subset 18 Flight Track (blue line) Maximum Reflectivity and 2D-S Derived Reflectivity Find an autocorrelation of both data sets of Maximum MCR values between 10.7151 km and 11.2097 km 11.85 independent reflectivity the and compare



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.



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

- measurements to see if a statistical agreement exists between the data sets.
- Classify particles by their aspect ratio to eliminate current spherical particle assumption.

References

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