Comparison of Concurrent Radar and Aircraft Measurements of Cirrus Clouds

Nick Gapp – June 7, 2019

Data from a summer 2015 field project near the Cape Canaveral Air Force Station in Florida (CAPE2015 field project) are analyzed. The highly instrumented North Dakota Citation Research Aircraft and the U.S. Navy's Mid-Course Radar (MCR), a unique, high-resolution radar on the Atlantic coast of Florida, obtained concurrent measurements of thunderstorm anvil cirrus clouds during seven research flights. The MCR alternatively transmits two waveforms, a lower-resolution (narrowband) beam and a high-resolution (wideband) beam with along-beam range resolutions of 37 m and 0.5 m, respectively. A specialized MCR scanning strategy allows the MCR to track the aircraft using the downlinked position information from the aircraft to set the wideband beam ahead of the aircraft in real-time, thus obtaining concurrent, high-resolution in-situ and remote observations. Equivalent radar reflectivity factor is derived and the associated uncertainties are calculated at 1 and 10 second averaging intervals. Both are compared with the wideband reflectivity factor and its associated uncertainties at the same averaging intervals for one flight during the CAPE2015 field project. A relationship between the wideband reflectivity factor (Z) and measured total water content (TWC) is also derived and found to be $TWC = (0.0995 \pm 0.005) Z^{(0.492 \pm 0.0408)}$ which agrees well with other published research. An average of 95 % of examined 1 second-averaged values of derived reflectivity factor and observed wideband reflectivity factor agree within their respective uncertainties across a -20 to 20 dBZ range; however, only 71 % of the values agree at an averaging interval of 10 seconds. Additional observations and analysis that include all thunderstorm cloud microphysical conditions will enable a complete vertical profile of water content, with corresponding uncertainty, to be obtained using the MCR's wideband reflectivity factor.