PARSL Observations at the Western Ground Site. Part II: Microphysical Retrievals from several Convective Events.

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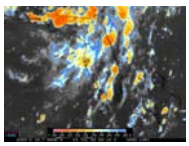
Objective:

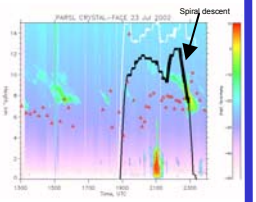
• Analyze microphysical properties of several convective events that originated over the Florida peninsula or just off shore that spread anvils over the Western Ground Site (WGS).

• Compare microphysical retrievals derived from ground based instruments with aircraft in situ measurements and satellite retrievals.

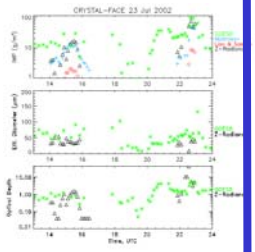
Continental Convection Case 23 July 2002

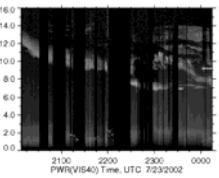


GOES IR imagery at 2015 UTC showing the anvil spreading toward the WGS from Lake Okeechobee.



Microphysical Retrievals





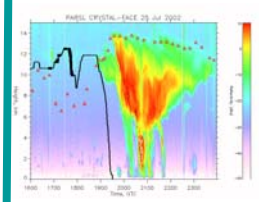
University of Alaska Polarization Diversity Lidar (PDL) operated approx. 10 km N of PARSL site.

PARSL 94 GHz radar reflectivity with Citation flight track overlay in black and WB-57 in white. Stars indicate times when the aircraft were within 15 km of WGS. Red triangles are GOES-8 cloud top heights.

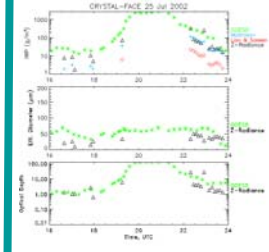
Microphysical properties derived using the Z-Radiance Technique ZRT (Mace et al. 1998), empirical relationships from Matrosov et al. (1994) and Liao and Sassen (1994), and GOES8 retrievals (Minnis).

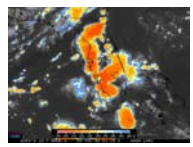
ZRT is limited to optical depths τ<10 when IR measurements become saturated. Retrievals are not run when boundary layer clouds block cirrus and should be considered preliminary.

Continental Convection Case 25 July 2002



Microphysical Retrievals





Goes-8 IR imagery at 2115 UTC showing strong cell that passes over PARSL.

Timeline 25 July 2002

• Thin cirrus fragments pass over PARSL between 1600 and1800 that appear to be remnants from large maritime convective system to the south. The Citation flew through sections of this anvil.

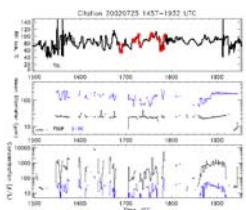
• Southerly flow produces a cell ~1800 just south of PARSL and grows very large spreading thick anvils and rain over the site. The PARSL 94 GHz radar is able to capture both thin and thick sections of this spreading anvil. The cell moves north by 2200 UTC and merges with other large cells to the north over the peninsula.

Anvil Characteristics (7/25)

• Gravity waves are visible in the radar reflectivity around 2200 UTC.

• IWP and optical depth decrease as the anvil dissipates after 2200 UTC.

• Effective radius is relatively constant in the dissipation phase in both the GOES and ZRT retrievals.



Citation Measurements (7/25)

• The thin cirrus layers produced by the earlier decaying maritime system have RHice<100%.

• Ice crystal concentrations were ~100-1000 #/L.

Microphysical Properties Comparisons

• IWP: GOES and ZRT compare best when τ>1.0. ZRT compares well with Matrosov empirical formula. Cloud thickness estimates may contribute to differences.

• Effective Diameter: ZRT is lower than GOES for nearly all points.

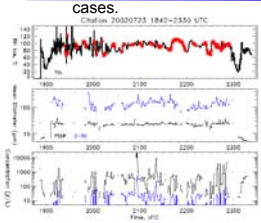
• GOES τ are generally higher than ZRT for small τ cases.

Discussion (7/23)

• The thin cirrus that passed over the WGS was physically thick, yet optically thin. The 94 GHz radar did not detect the upper layers, indicating that the cirrus was either below the radar sensitivity or the upper layers were primarily composed of small ice crystals. U of Alaska lidar measurements detect thin layers up to 14 km.

• The WB-57 sampled the upper layers of this system. The SPP-100 detected an increase in small particle concentration near the convective core. IWC also increased near the core.

• The upper cirrus layers were supersaturated with respect to ice up to 150%. In the lower layers where the Citation was flying, RH (ice) is closer to 100%, but still supersaturated in some portions of the cloud. The higher portions of the cloud could have regions of ice crystal generation, while the lower sections are regions of large particle sedimentation.



Citation Measurements (7/23)

• Mean diameter and concentration are 30 sec. avg.

• Crystal concentrations are highest during the spiral descent.

• Cloud sampled by Citation during the spiral (2200-2300) might be anvil from second cell to the south of WGS.

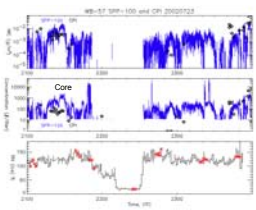
Red symbols indicate aircraft is within 15 km of WGS

WB-57 Measurements (7/23)

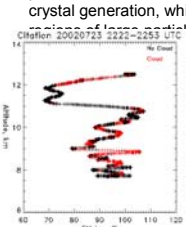
• IWC is relatively low (~10^{-4}-10^{-3} g/m^3) for the small particle probe (SPP-100)

• Ice crystal concentrations and IWC tend to be lower as WB-57 approaches WGS and higher near the convective core.

• Composite size distributions both near the core and over the WGS will help analyze anvil microphysics at varying distances from the core.



RH Ice Measurements (7/23)



• Height dependence of RH (ice) during the Citation spiral descent over the WGS between 2222-2253 UTC.

• Nearly all sections of the spiral descent were below 100% except near 9 km. This is the thickest portion of the cloud detected by the 94 GHz radar, with τ~10.0.

Final Overview of Convective Anvil Microphysics

• Ice crystal concentrations appear to be higher near the convective core and for anvils that occur closer in time to the maximum in convective strength.

• Ice crystal sizes tend to be smaller near the core, at least in the upper portions of the anvil.

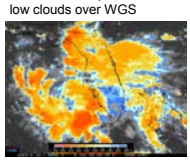
• IWP and optical depth decrease dramatically as the anv dissipates in continental convection cases.

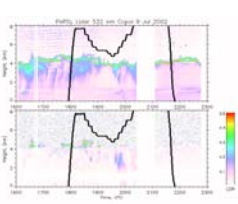
• Anvils due to continental convection were much more prevalent at the WGS than maritime convection. Maritime systems tended to produce thinner anvils and widespread rain over the WGS.

• Continental convection produced strong explosive cells that were fairly short lived. Maritime systems were larger in area and sometimes spread thin cirrus/anvils over large distances.

Maritime Case: 9 July 2002

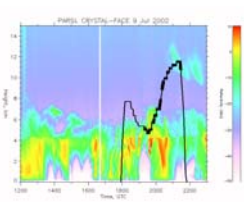
Large maritime convection over Gulf of Mexico produces rain and low clouds over WGS





PARSL backscatter (left top) and depolarization ratio (left bottom) from precipitating mixed phase cloud (1600-1900). After rain passes (2100), the lowest portion of cloud is primarily water.

PARSL 94 GHz Radar (right) showing cloud tops at 5-6 km. Citation flight track (black line) passed through the mixed phase cloud and high cirrus generated by maritime convection.



Citation measurements showing high concentrations of small cloud particles in mixed phase cloud, which has supersaturated layers (RHice>100%). In the high cirrus layer (10-12 km), particle concentrations are lower and RHice approaches 120%.