ID: DE-AI05-07OR23285
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Title: ***ARM CLASIC ER2 CRS/EDOP***

Final Report (2007)

The Cloud and Land Surface Interaction Campaign (CLASIC) was conducted as an Intensive Observation Period (IOP) at the SGP Climate Research User Facility during the summer of 2007 by the Department of Energy's Atmospheric Radiation Measurement program. The primary purpose of CLASIC was to study how land surface processes influence cumulus convection. Most measurements occurred over the ARM Southern Great Plains field site. Low-flying aircraft measured radiation and surface fluxes, while the high-altitude ER-2 provided remote sensing using the Cloud Radar System (CRS), Cloud Physics Lidar (CPL), and the MODIS Airborne Simulator (MAS). Because the ER-2 was flying an A-Train simulator payload, under flights of the CALIPSO and CloudSat satellites also occurred as part of CLASIC.

The general goal for the ER-2 flights was to collect remote sensing data over the SGP site. CRS was to provide cloud radar coverage of clouds and convection that developed. The specific goal of this work was to support the NASA Cloud Radar System (CRS) that was installed on the NASA ER-2 aircraft. The CRS is a 94 GHz nadir pointing Doppler radar. DOE support for this work included flight and ground support of the instruments, as well as data product delivery.

1. Participation in CLASIC with CRS instrument.

The CRS was was installed on the ER-2 at NASA Dryden at Edwards AFB CA prior to the CLASIC IOP. The ER-2 then ferried to NASA Johnson Space Flight Center in Houston where it was based for CLASIC. A short test flight was performed in Houston to test all the instruments. CRS had intermittent transmitter problems starting with the ferry flight and test flight. The high-voltage transformer wires were brittle from age and were repaired several times during the campaign. All the CLASIC ER-2 flights are summarized in Table 1. Seven science flights were conducted during the IOP. The weather was generally uncooperative for the CLASIC science goals since there was often widespread, persistent rain during the IOP. Some of the flights had severe weather present nearby the SGP, where significant CB's were present. The goals for obtaining weak convection near the SGP were marginally accomplished in view of the uncooperative weather. Several of the passes over the ARM SGP site were relatively cloud free so that CRS did not detect any scatterers.

Table 1. Summary of CRS Flights During CLASIC

Date	Description	Comments
06/07/2010	Ferry flight attempted. High winds at the landing site forced the plane to return to California.	
06/08/2007	This is the transit flight from Dryden to Houston	CRS transmitter problems, data quality low.
06/10/2001	Short test flight at Houston	CRS transmitter problems, data quality low.
06/11/2007	Popcorn convection, 2 passes over DoE ARM site, strong convection to east, along with smaller Cu near ends of lines 3 & 4.	CRS had startup problems
06/12/2007	A-Train overpass at 19:47:18 UTC. At that time the aircraft was approximately 10 m off the subsatellite track. Variety of cloud types. Significant Cb's to east; 3 major cells	
06/21/2010	A-Train underpass at 19:39:54 UTC..	
06/22/2007	Science flight.	Data has high noise level.
06/23/2007	Science flight.	
06/26/2007	This is a special DoD-requested flight (not a CLASIC science flight)	
06/28/2007	A-Train underpass at 19:47:06 UTC. Lots of clouds	
06/29/2007	Flights over TX/OK panhandle	Data has hight noise level.
06/30/2007	Ferry flight back to Dryden	

Not much cirrus or isolated weak convection as desired. Instead, the month of June was mainly widespread continuous rain.

2. Post Processing of CRS Data and Products Delivered.

During CLASIC, we made available quick-look image products for CRS (reflectivity and Doppler velocity). After the data collection, data processing and archival was performed. Universal Format (UF) data files segmented into flight lines were created similar to previous field campaigns. This data conversion requires several steps (flight leg determination, merging of GPS and INS navigation data with radar parameters, reflectivity calibration, Doppler unfolding, aircraft motion removal (for Doppler), etc.). The data was calibrated similar to previous field campaigns (CRYSTAL-FACE, TCSP) and the processed data files were placed in the CRS data archive located at Goddard Space Flight Center. The CRS data is accessible through the High-altitude Radar Group web site:

https://har.gsfc.nasa.gov. This site contains quicklook images such as in Fig. 1 and subsampled ASCII files of reflectivity, spectral width, and Doppler velocity. The UF files are available on request since they are relatively large files. This data is stored on a RAID but it is backed up a sufficient number of times elsewhere. An example produced from the quality controlled UF data files is shown in Fig. 2.

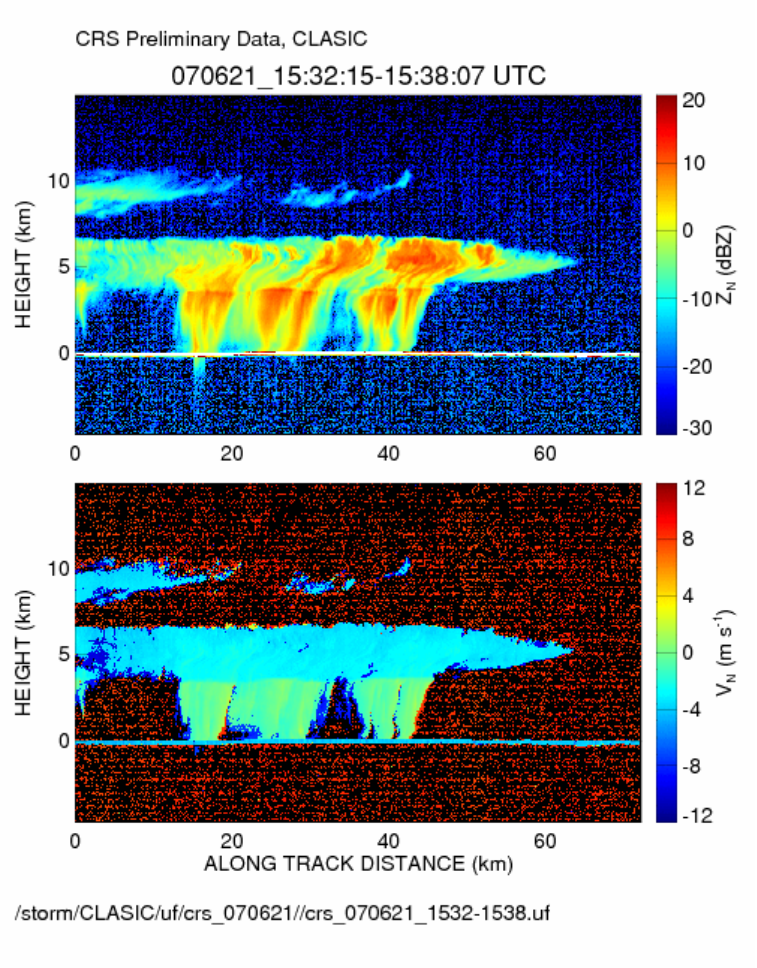

Figure 1. Quicklook example provided during CLASIC.

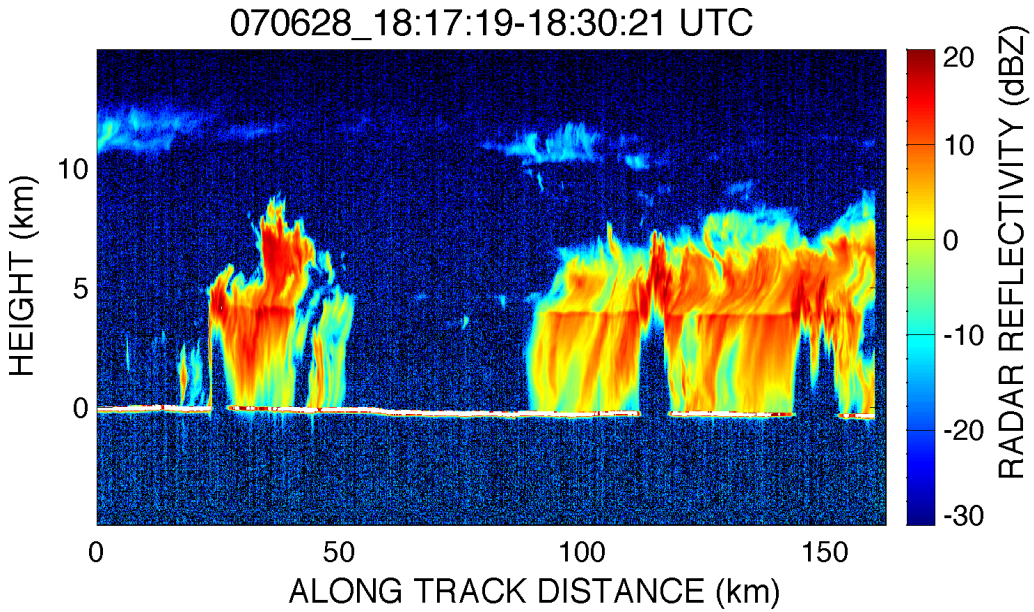

Figure 2. Example of CRS quicklook product.

3. Data Analysis.

While not specifically part of this work, CRS data from CLASIC data was analyzed jointly with Cloud Physics Lidar (CPL) data. In a joint effort, a merged HDF format was developed for CRS and CPL data. These instruments are airborne simulators for CloudSat and Calipso, respectively. One of the CLASIC flights that went over the SGP site, 28 June 2007 (1816-1833 UTC), was studied even though the scene was not the type of clouds of most interest to CLASIC.

The result of the merged data set produced by Dennis Hvlaka at Goddard is shown in the following figures. The first flight line is over the SGP site (Fig. 3). The second flight line is from an underpass of the A-Train and CloudSat and Calipso. Figs. 3 and 4 show

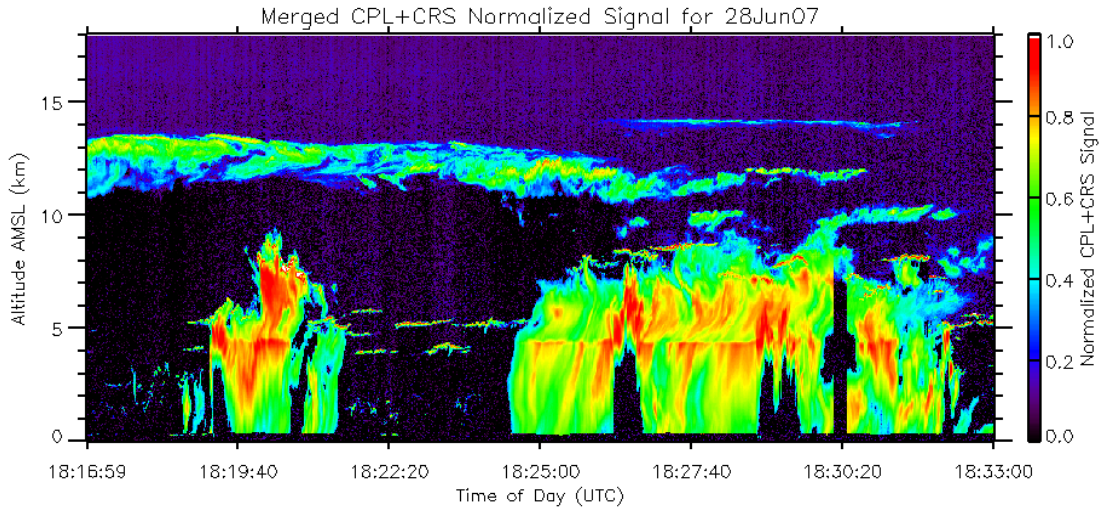

Figure 3. Overpass of SGP site on 28 June 2007. This is a merged CRS and CPL product from backscattered signal that maximizes the cloud and precipitation detection.

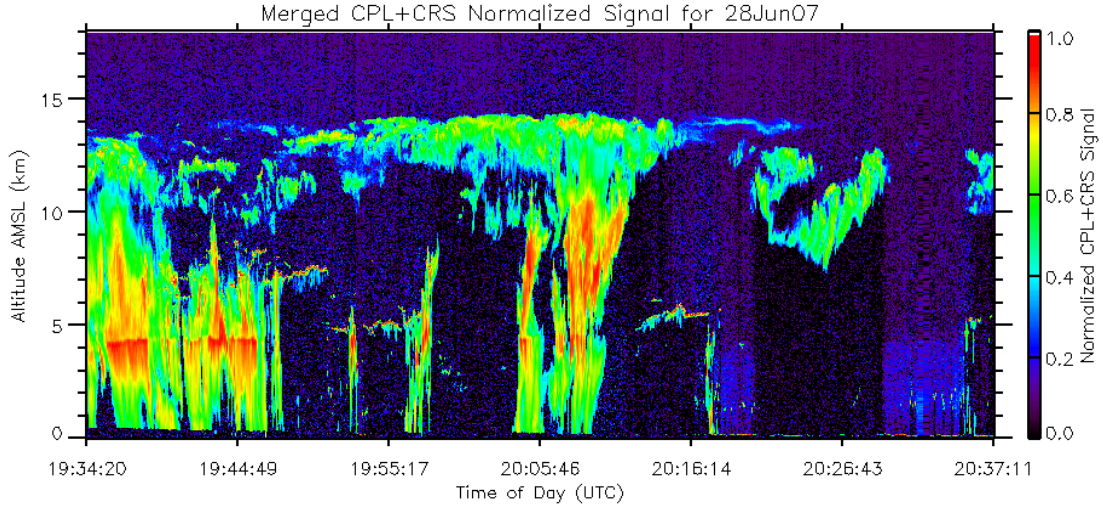

Figure 4. Underpass of CloudSat and Calipso similar to Figure 3 and from 28 June 2007.

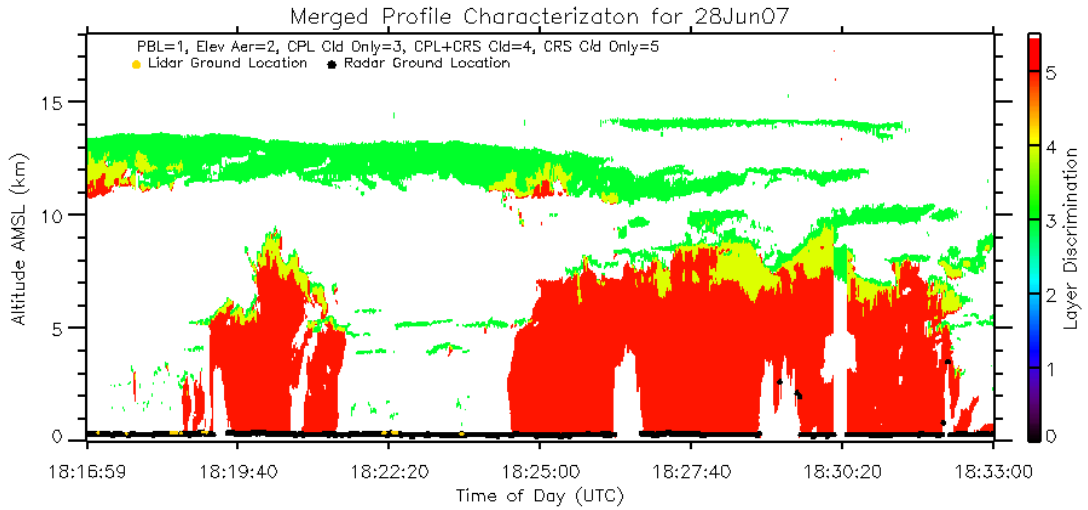

Figure 5. Merged CPL and CRS product. Colors: green (lidar only detection), yellow (overlap between radar and lidar), and red (radar only detection).

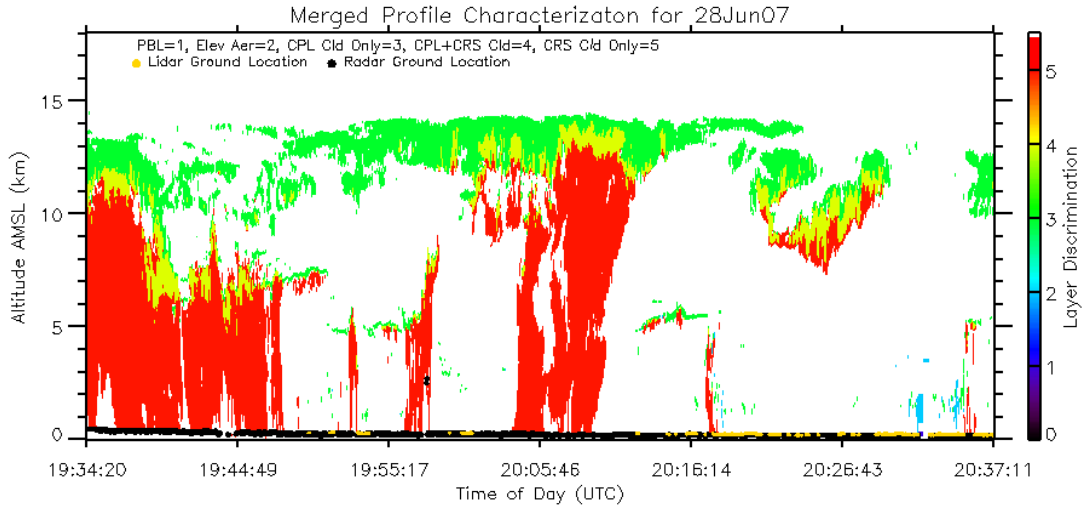

Figure 6. Similar to Fig. 5 except for A-Train underpass.