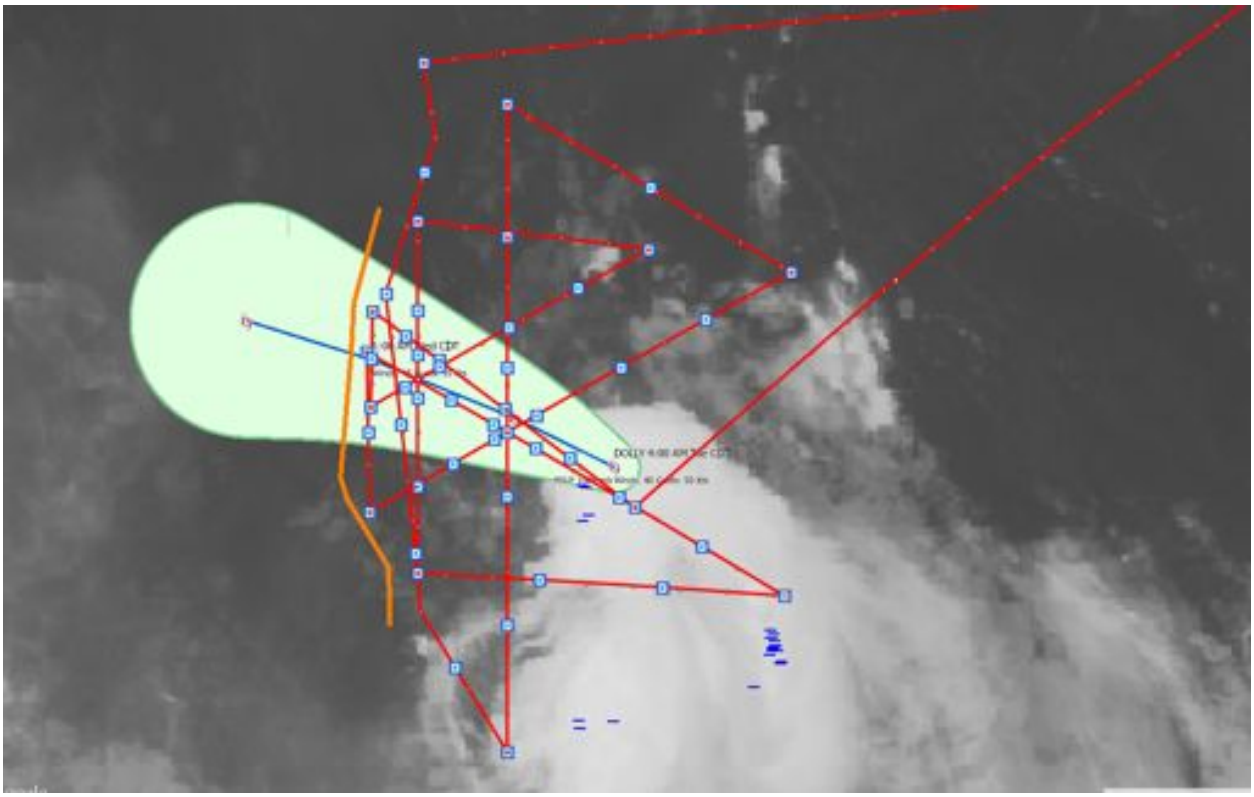
Hurricane and Severe Storm Sentinel (HS3) Mission

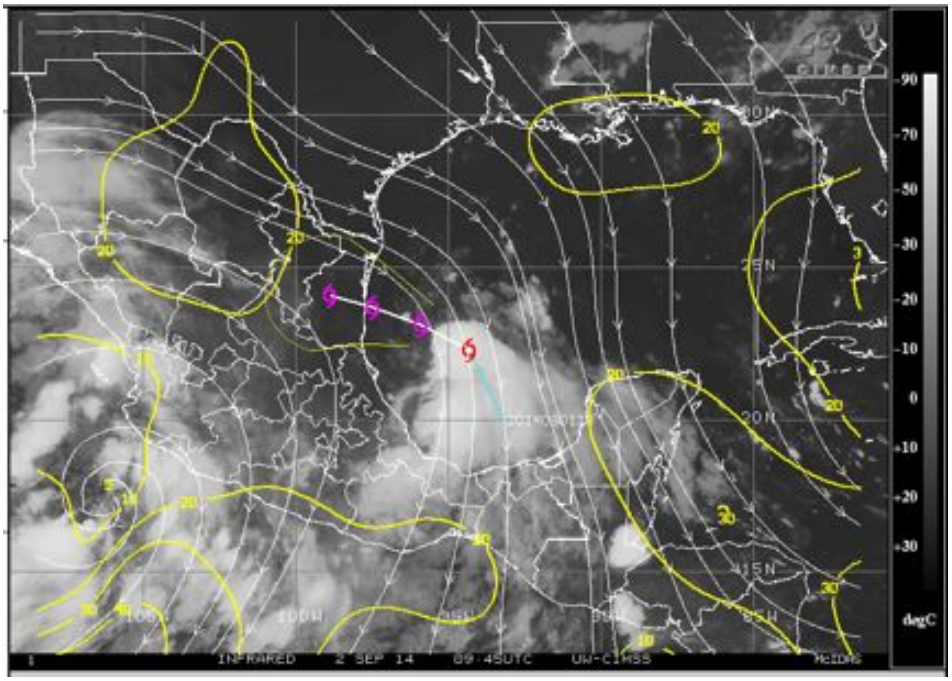
HS3 2014-09-02 Flight Report: GLOBALHAWK AV-6 Dolly Flight

Flight Scientists:
Shift 1 (0400-1300 EDT): Scott Braun, Pete Black, Gerry Heymsfield, Chris Velden
Shift 2 (1200-2100 EDT): Paul Newman, Jason Sippel, Bob Houze, Ed Zipser
Shift 3 (2000-0500 EDT): Dan Cecil, Steve Guimond, Jason Dunion
Shift 4 (0400-1300 EDT): Scott Braun, Pete Black, Gerry Heymsfield, Chris Velden

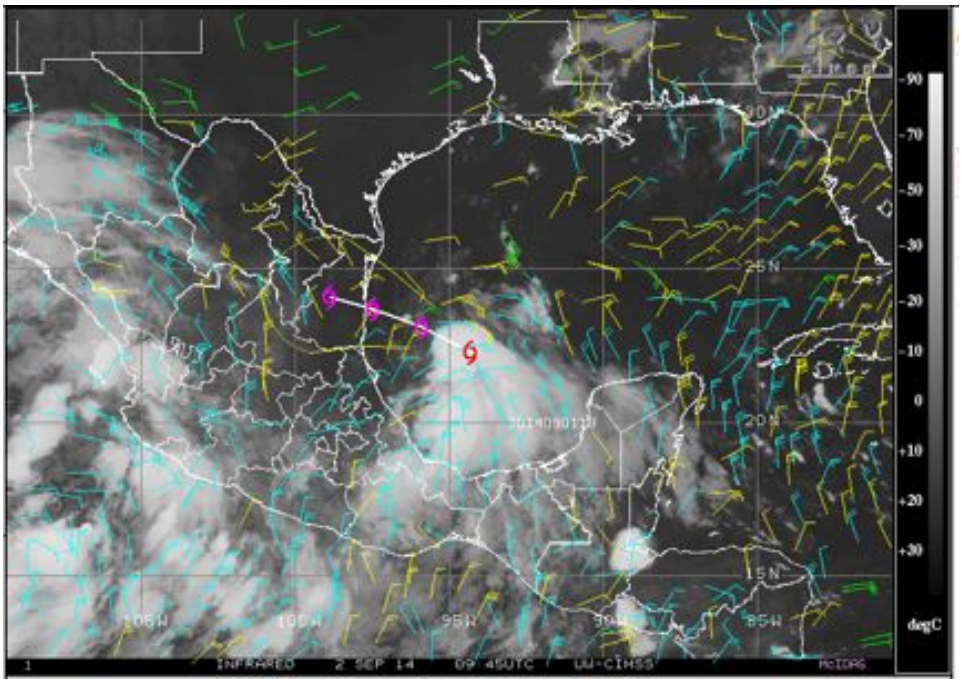
Mission goal: Science flight to investigate TS Dolly in the Gulf of Mexico.



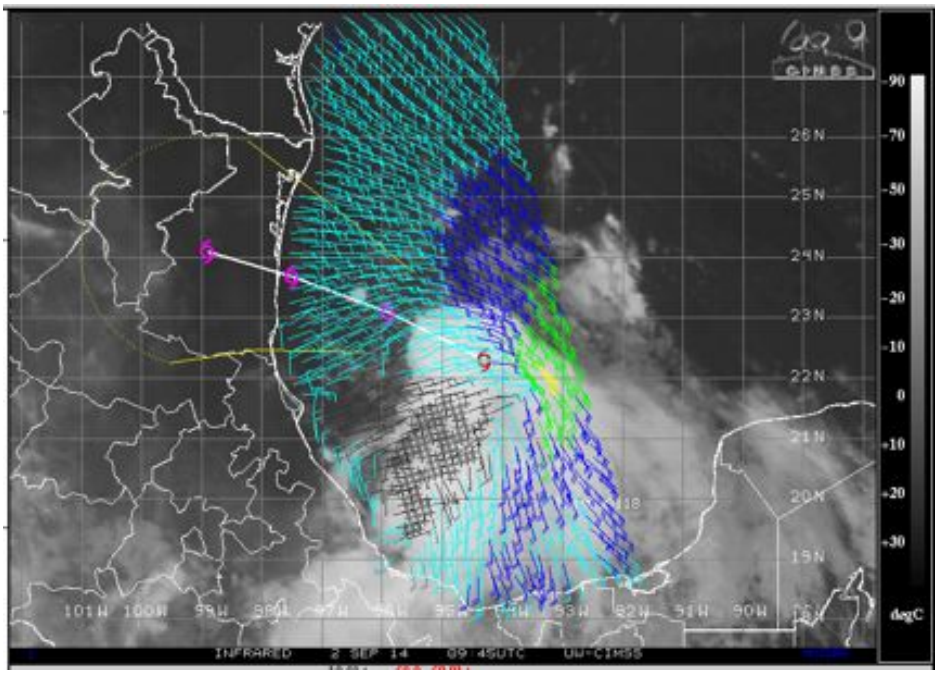
Deep convection seen in the downshear-left side of the storm as Dolly is experiencing moderate (~<20 kt) northerly shear (see below). This should make the center of the storm and its western side more accessible during the flight. Current pattern looks good but will have to be adjusted due to westward motion of the storm.



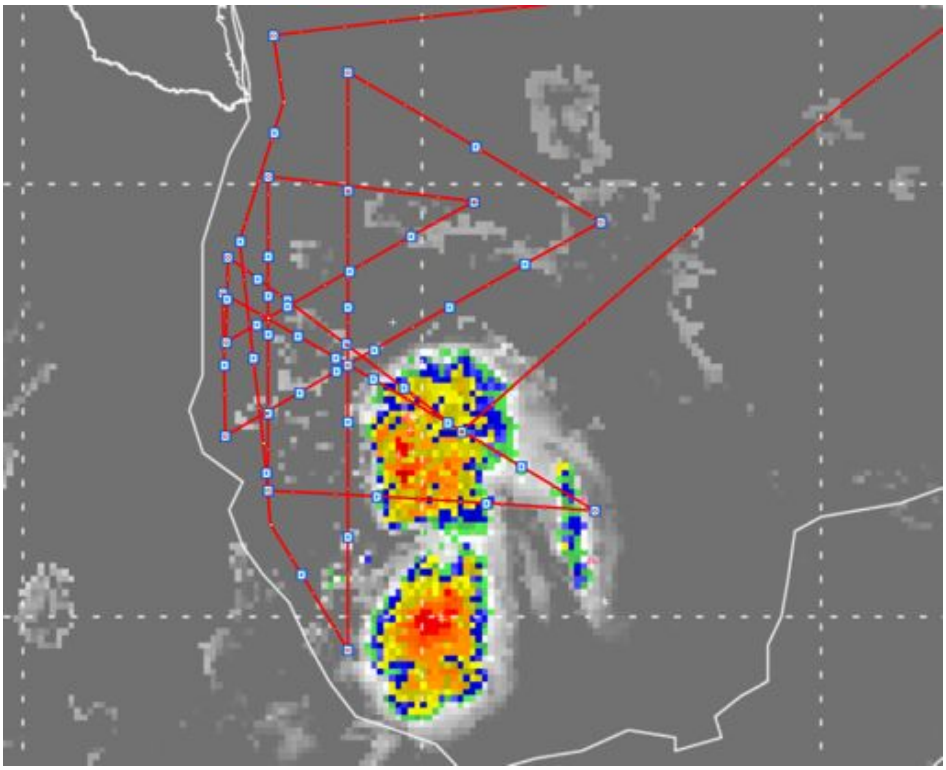
Deep layer shear at 0945Z.



Good upper-level outflow to the east and south of the convection. Might be a target for later in the flight.



ASCAT data (from a time earlier than the GOES image) showing strong winds on the eastern side of the storm, but still a fairly broad circulation with possibly multiple centers.

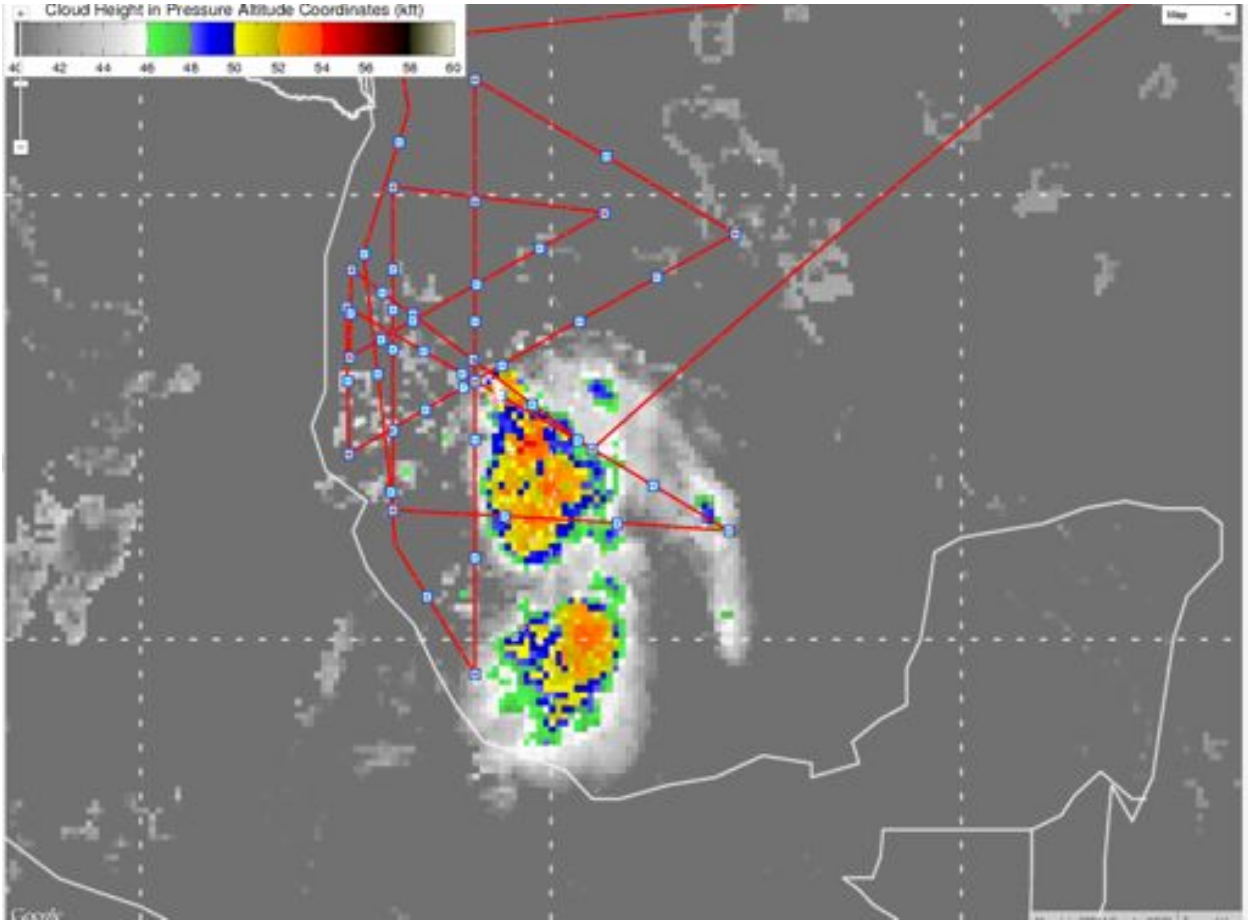


Cloud top heights at 1030 UTC show deep clouds with some lightning to the south and east of the storm center. If they persist, it will be tough to overfly these until late in the flight.

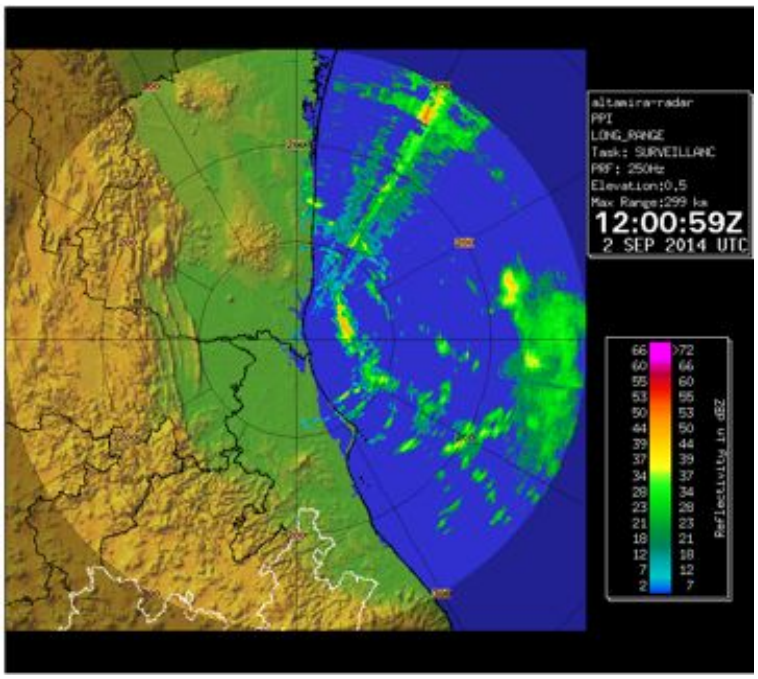
AV-6 Pin pull at 11:25. Takeoff was delayed because they had trouble getting Ku-band up.

11:51 Ku band came up.

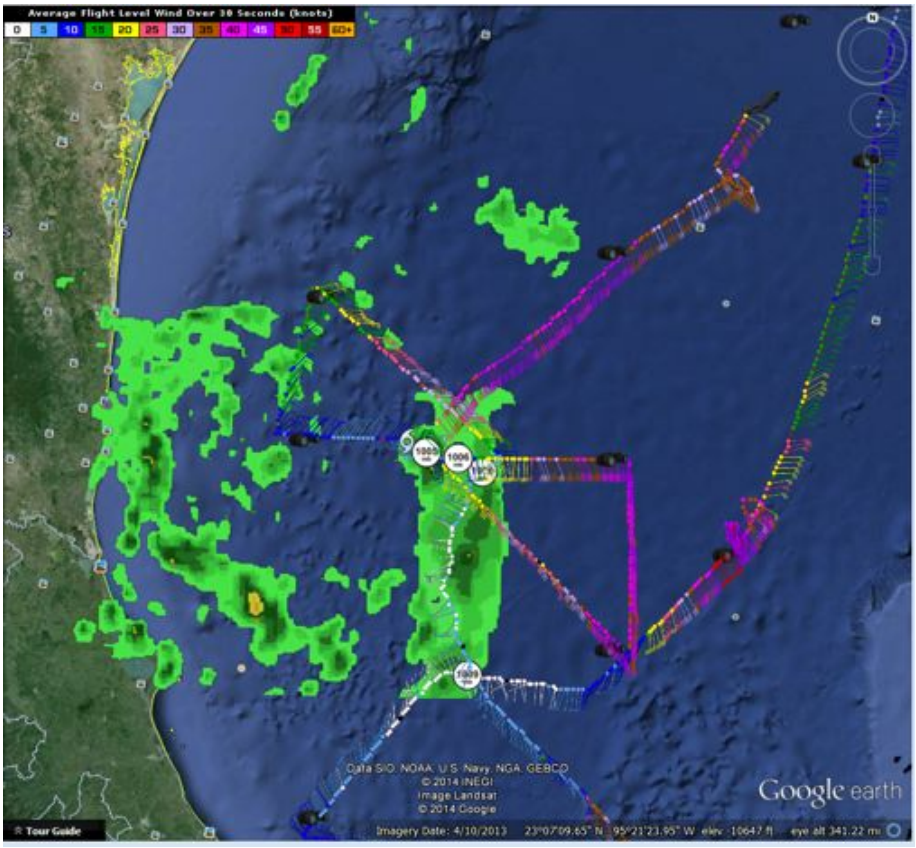
11:55 Takeoff



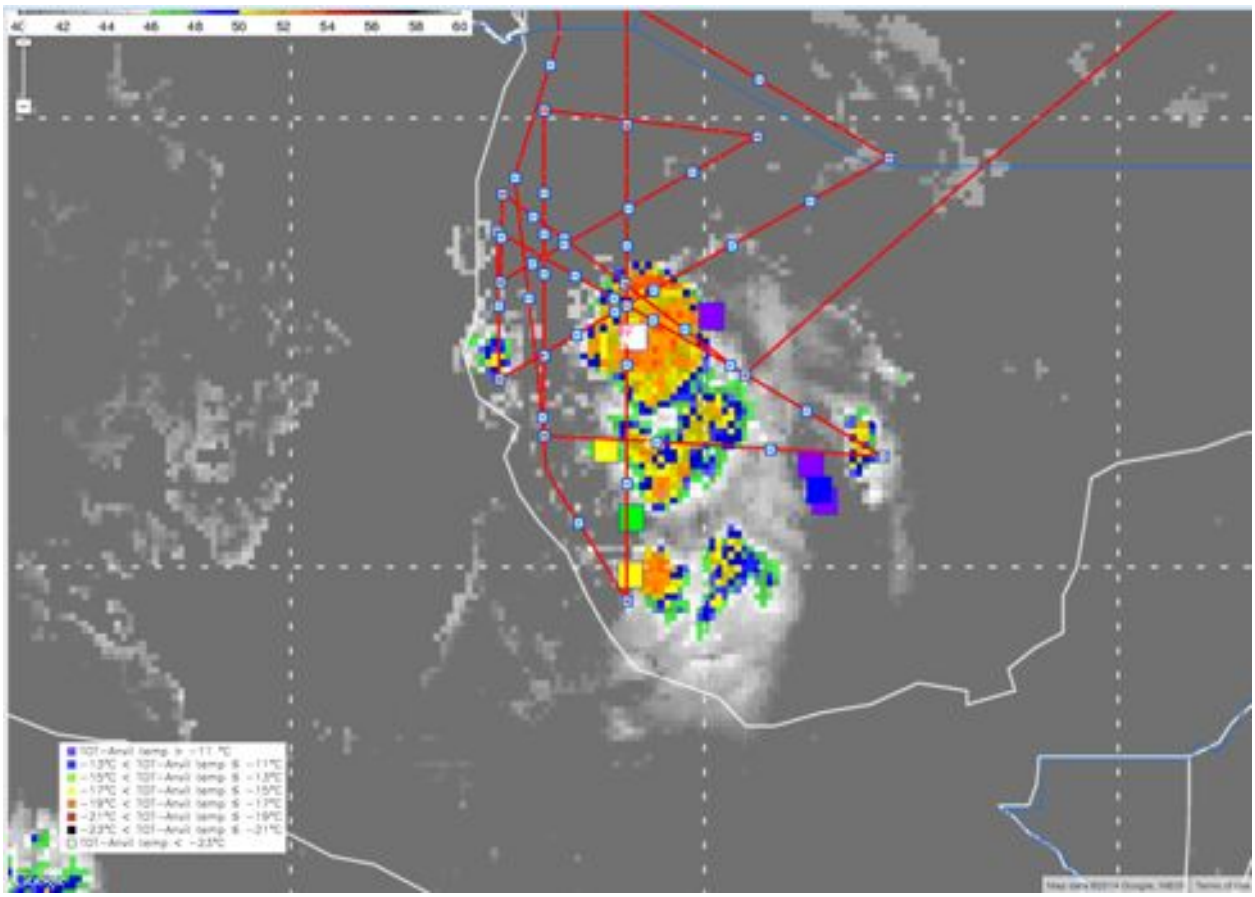
1130 IR image. Slight weakening of southern convective region.



Altamira Mexico radar at 1200.

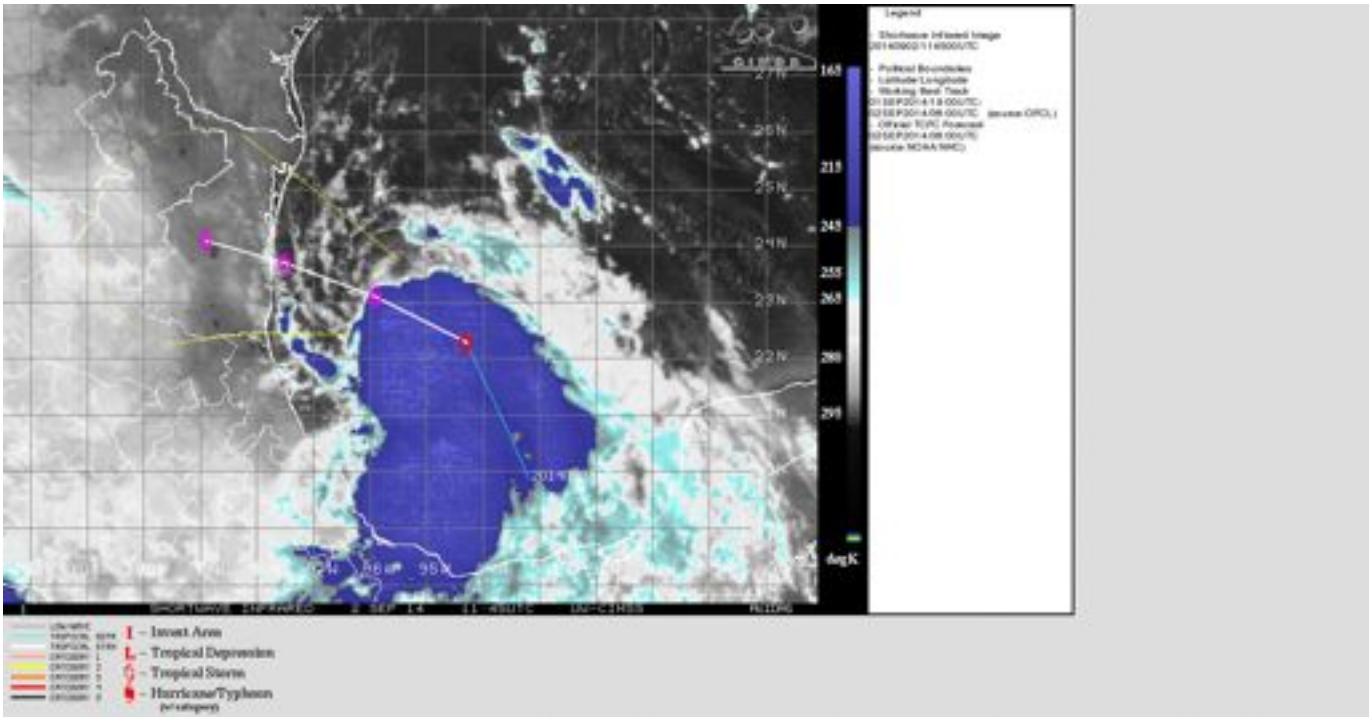


1230 AF C130 recon with radar superimposed. From a few hours earlier. From Atlantic Tropical weather site. Radar appears to be a few hours old.

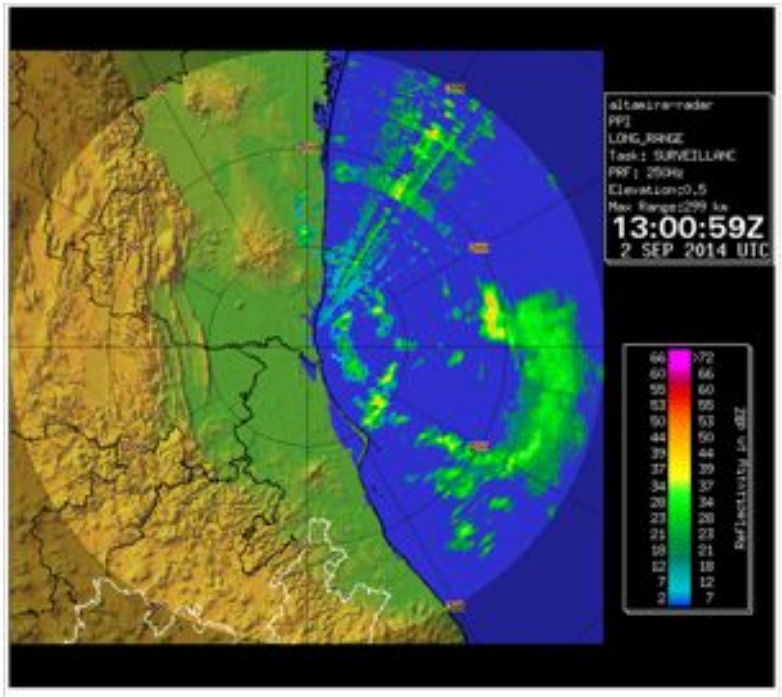


1230Z IR. Some overshooting tops. Strongest convection on north side.

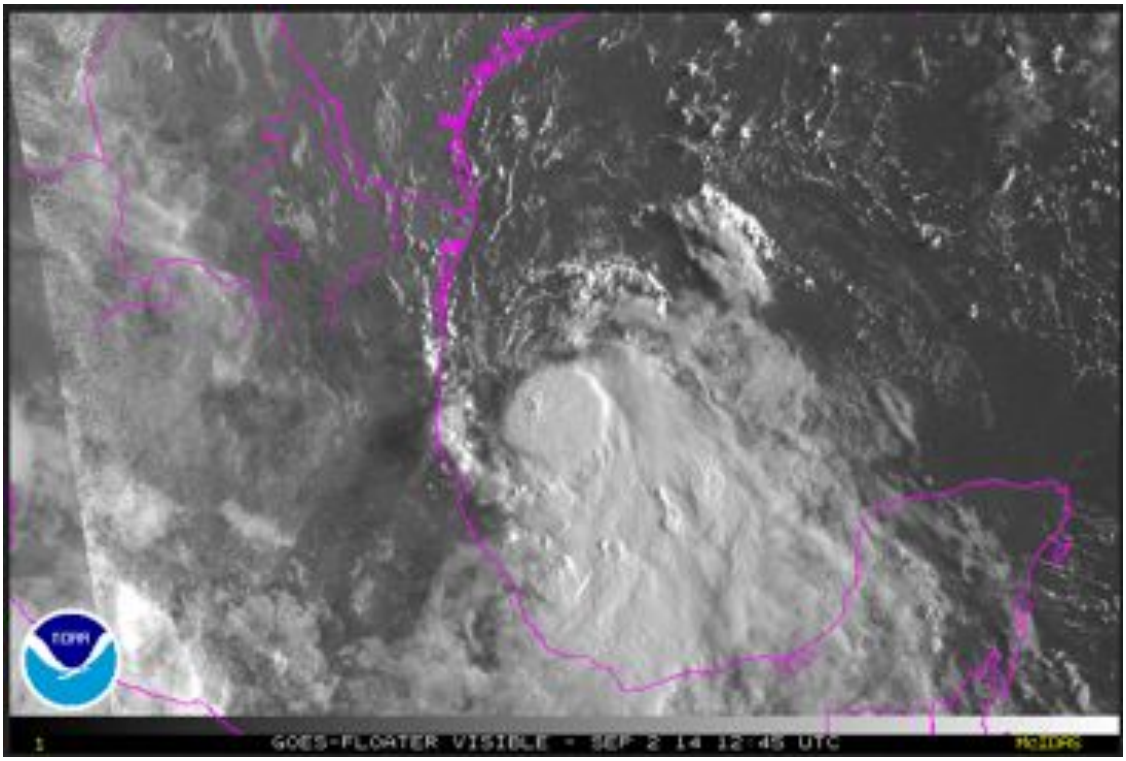
1230Z – AV-6 deviated around overshooting top with lightning on route.



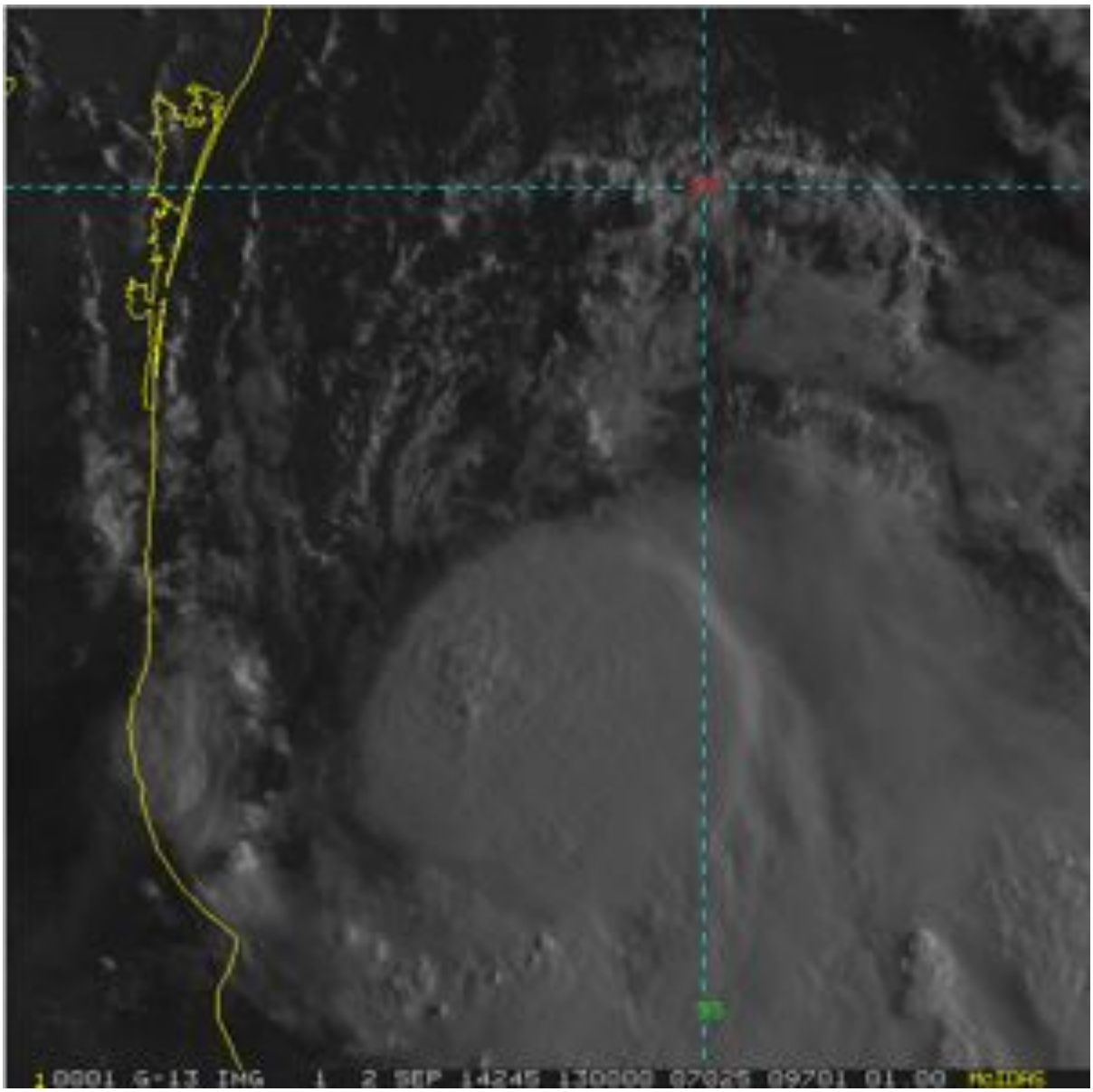
1145 - CIMMS SWIR product.



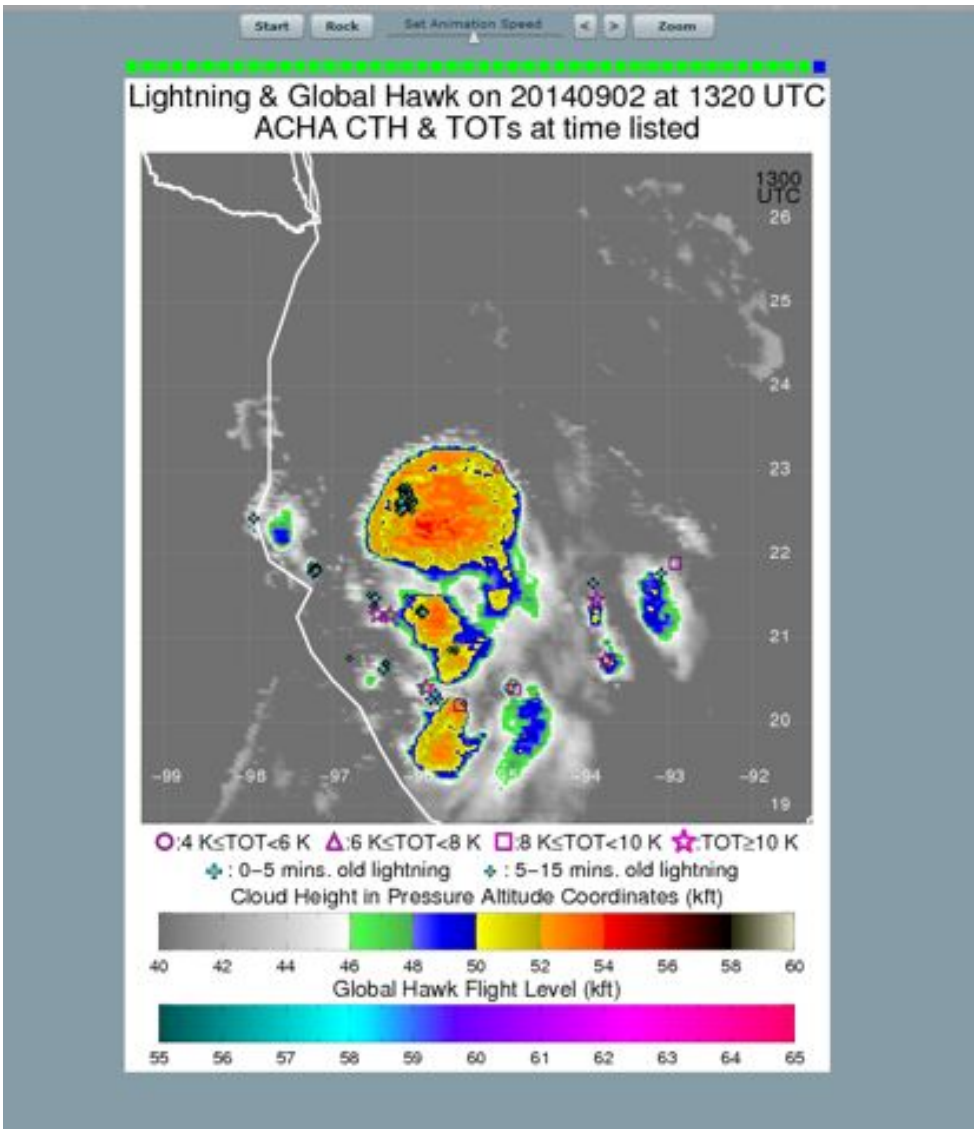
1300 Altamira radar.



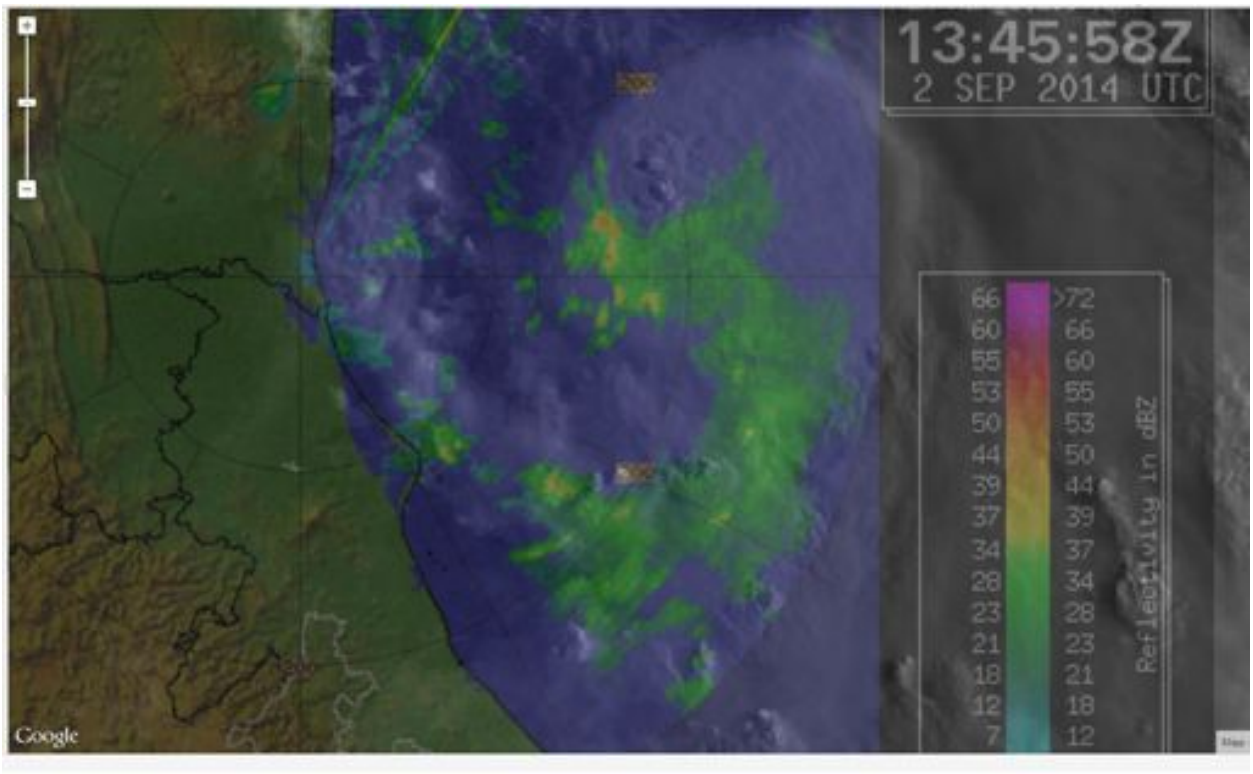
1245Z Strong overshooting tops on north side.



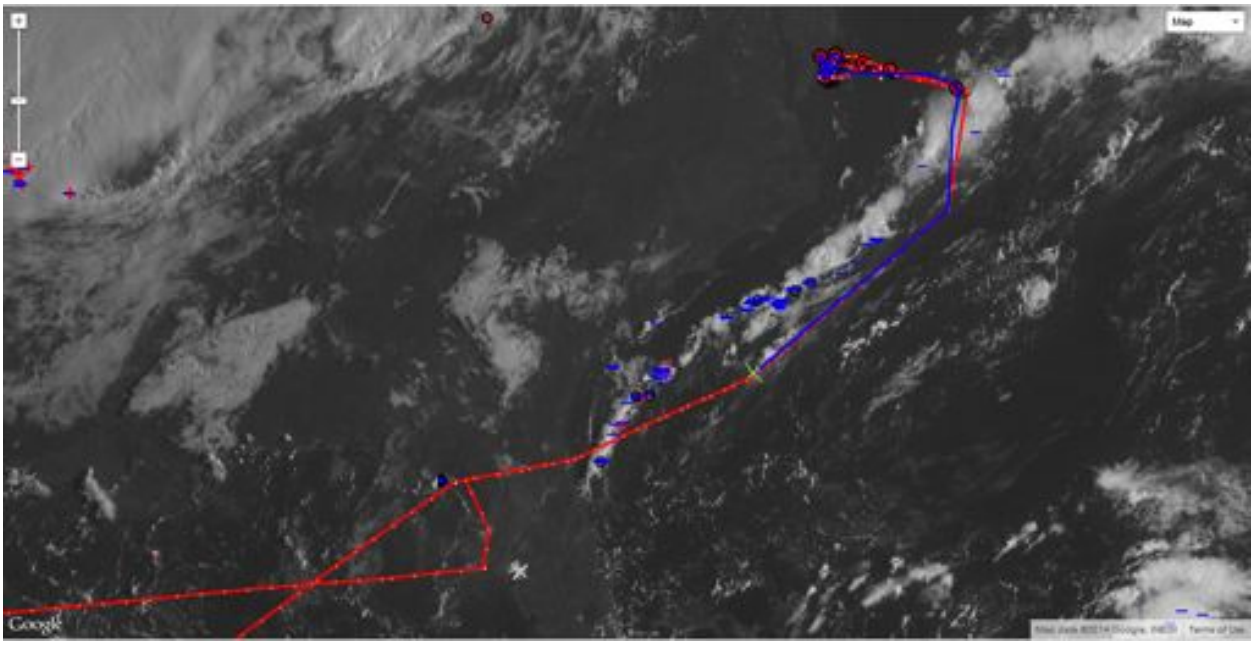
Zoom of overshooting top showing low-level center at the north edge of anvil boundary- north of turret.



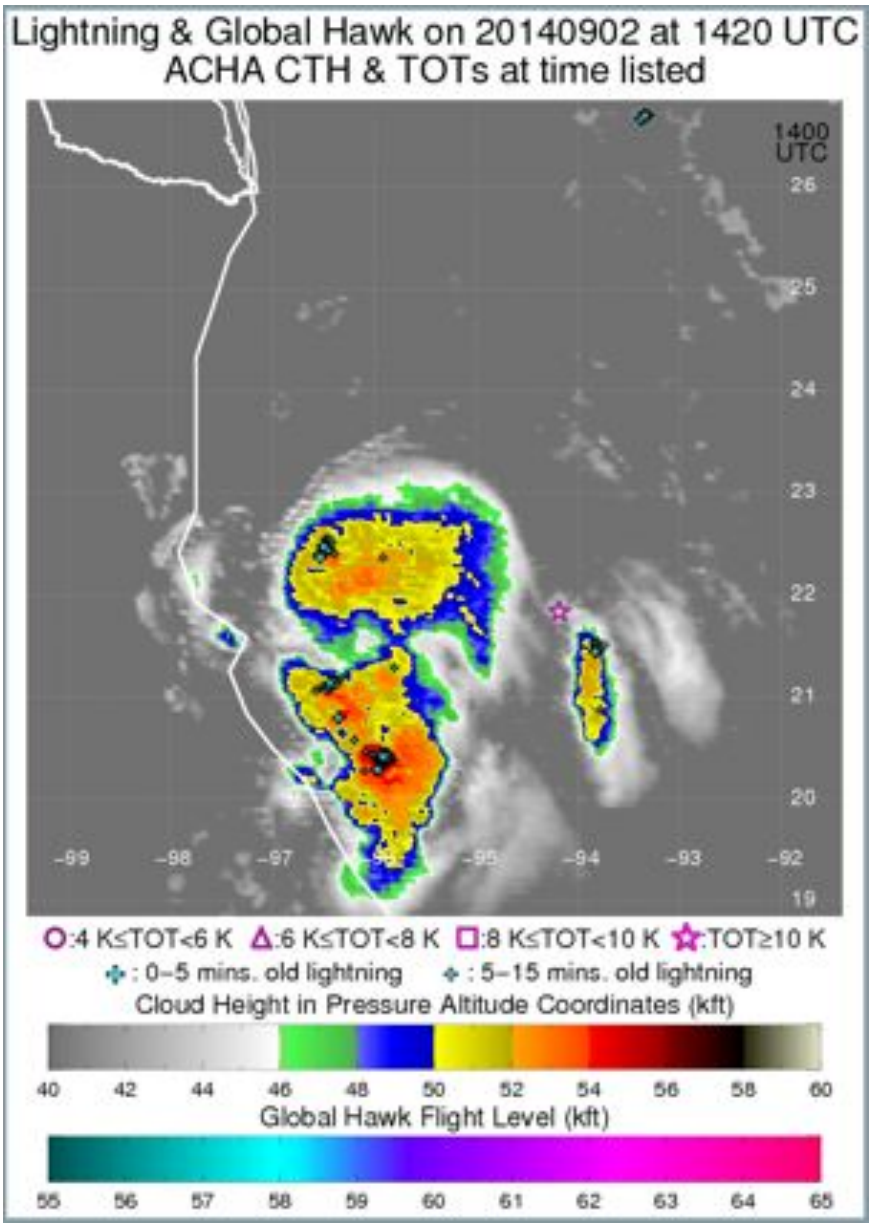
1320 CIMMS AV6 product. Based on visible loop, low-level center of circulation appears to be noth of strong lightning region. Based on Altimara radar animation, mid-level center appears to be centered within overshooting top region and just east of lightning cluster.



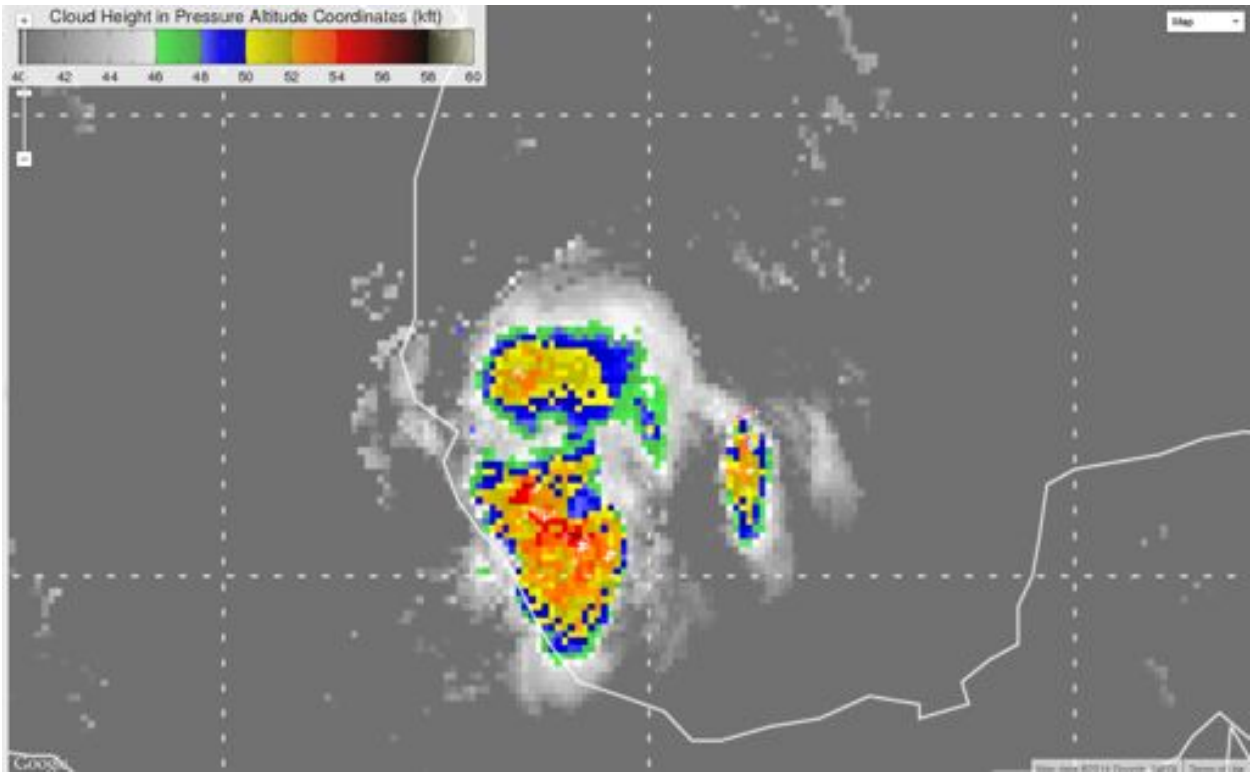
1345 Alamira radar + visible image. Visible data appears to be old since radar cells are much further SW. Latency of radar is order 15 min while latency of VIS image is order of an hour or more. Overshooting turrets appear to be co-located with reflectivity max when adjusted to same time.



1413 Convection and lightning along Gulf Stream on route to Dolly.



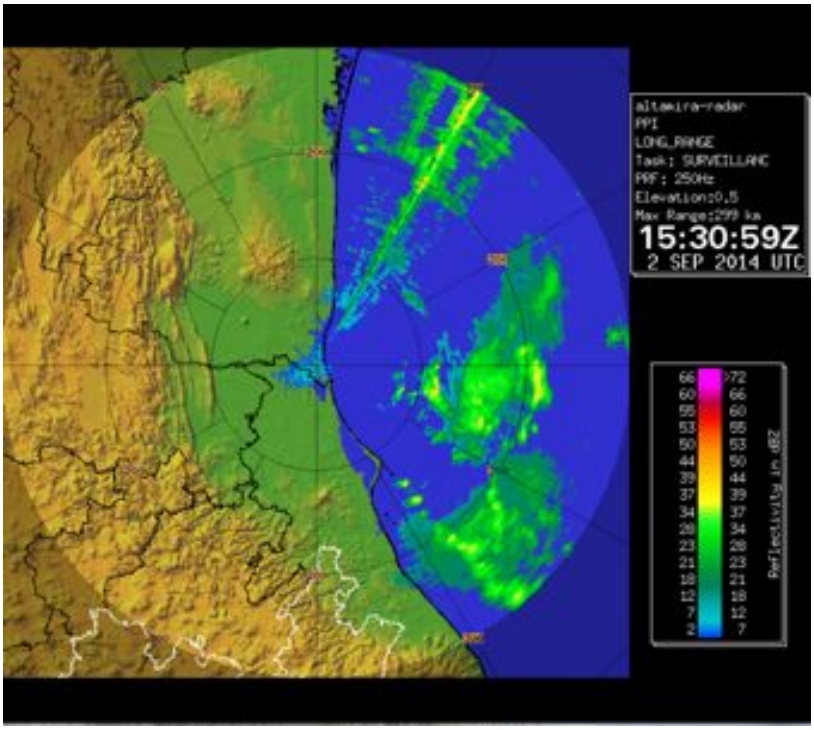
1420 CIMMS product. Convection picking up with south cluster.



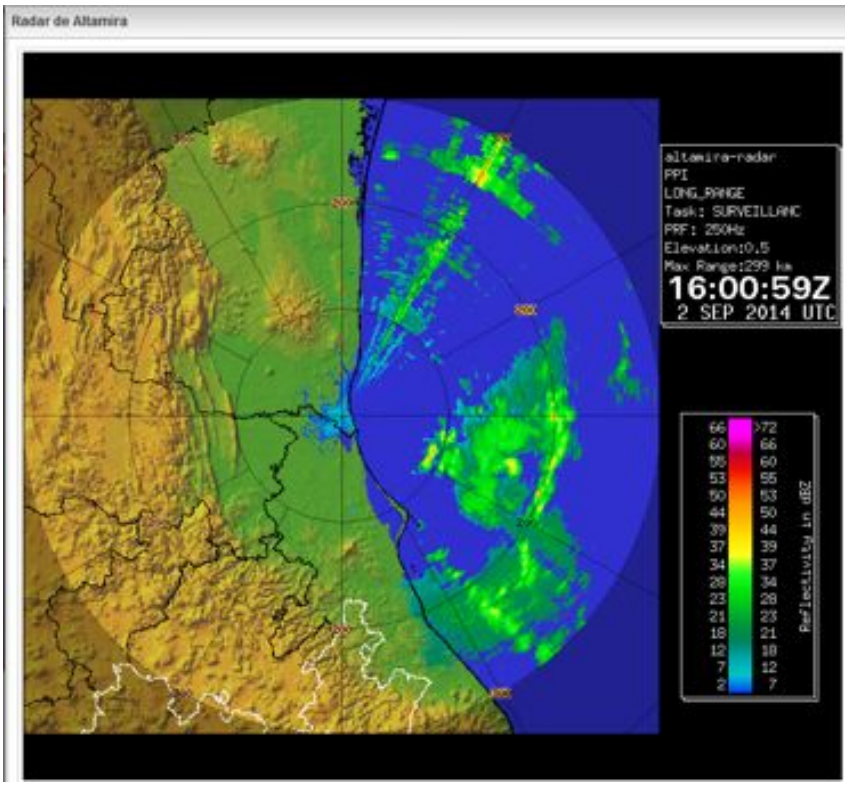
1445 IR + lightning.

1535Z GH will go directly to dropsonde point D03 since first two points are too far north.

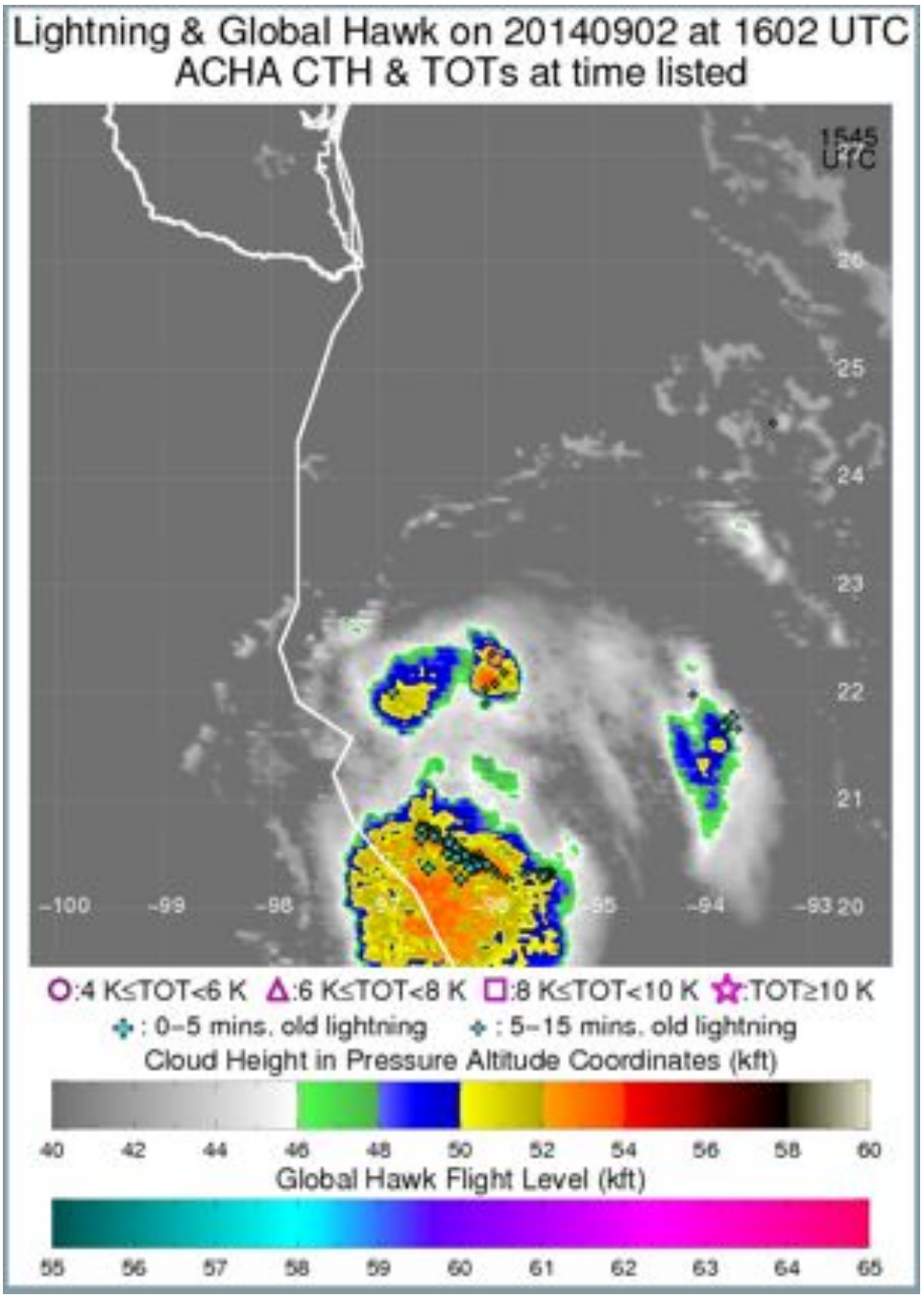
1535Z SHIS is doing a 15 minute reset to thermal cycle instrument.



1530Z radar. Reflectivity max, associated overshooting turrets and low-level circulation have all rotated around edge of anvil from north of suppercell anvil center to SW of supercel anvil- suggesting some larger scale mid-level circulation center further to the east. This appears to be substantiated by appearance a short time later (see below) of a distinct small scale circulations center in the form of a transient partial eye feature.



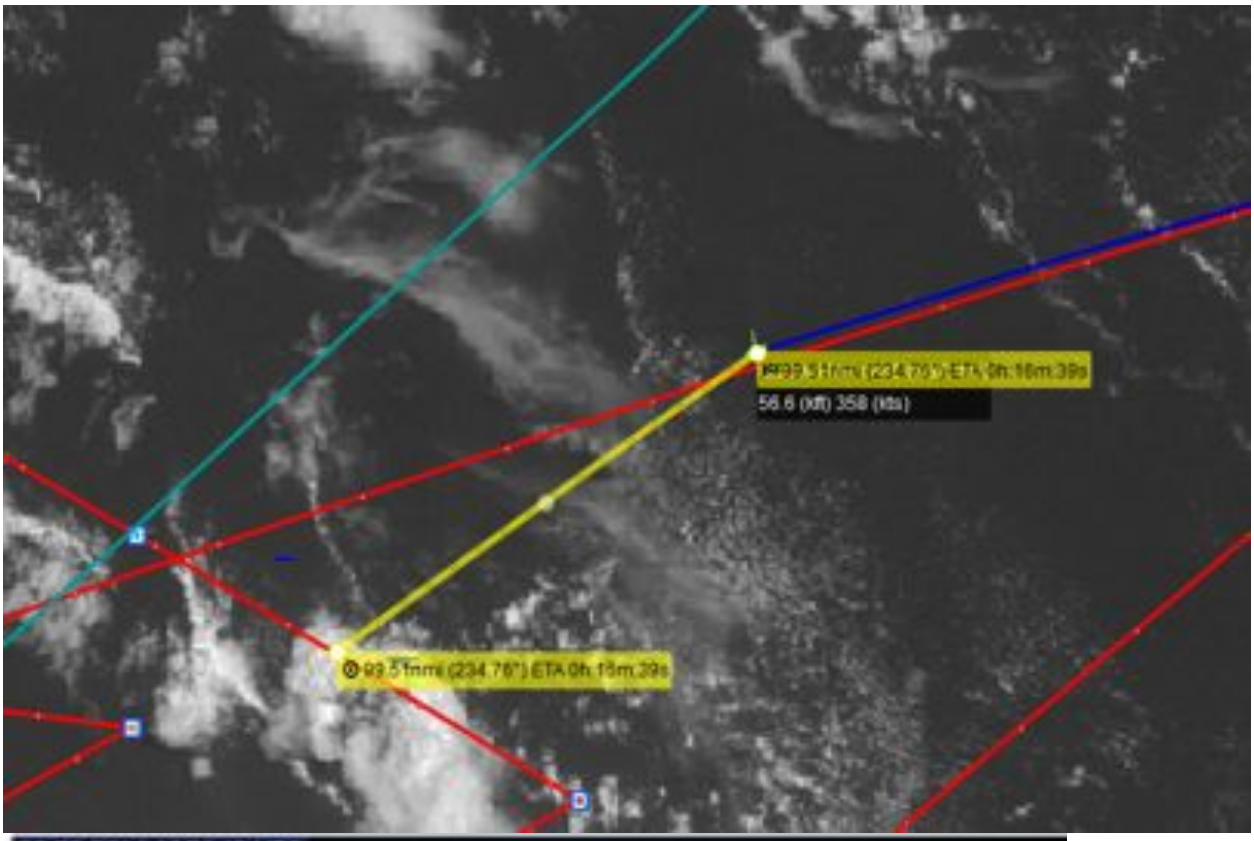
1600Z small cell is popping up near what appears to be center.



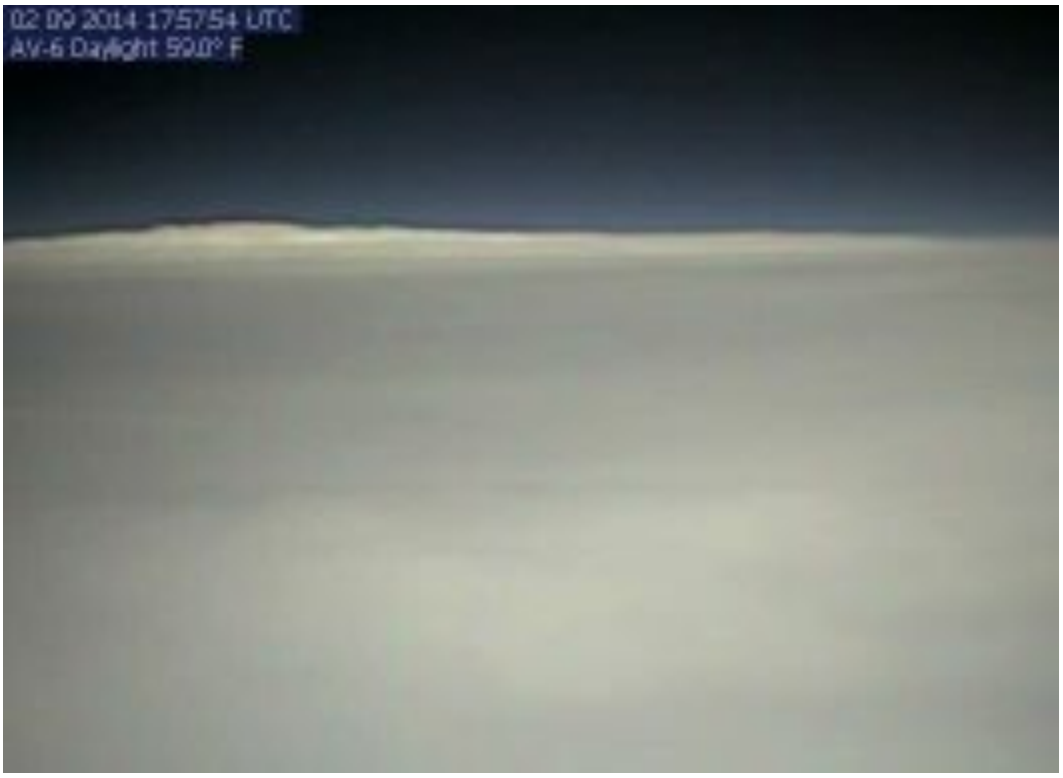
1545Z

1630Z 2nd shift of Houze, Zipser, Sippel and Newman take over.

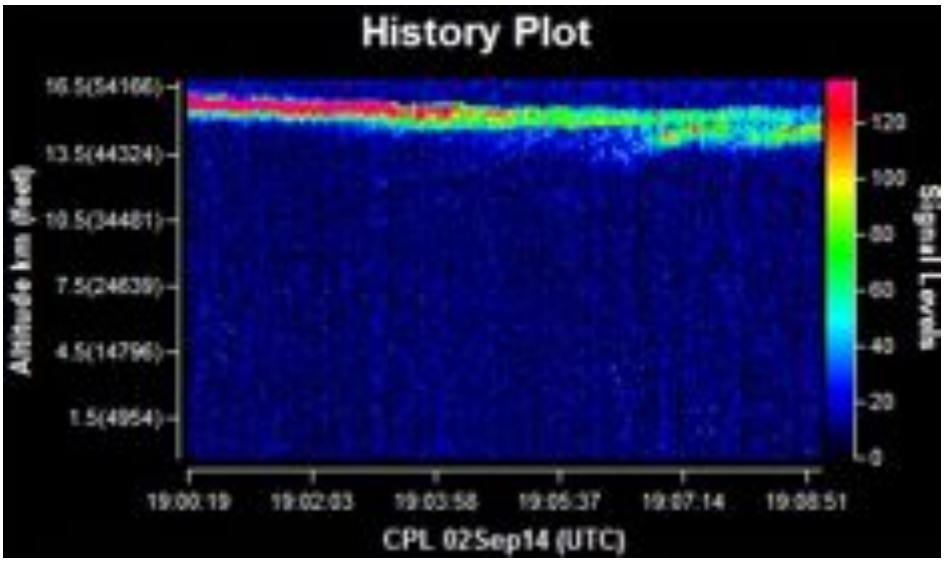
1658Z Nose camera and GOES vis imagery show strong system to our SW. See images below. CIMSS cloud top estimated this to be a 40+ kft cloud.



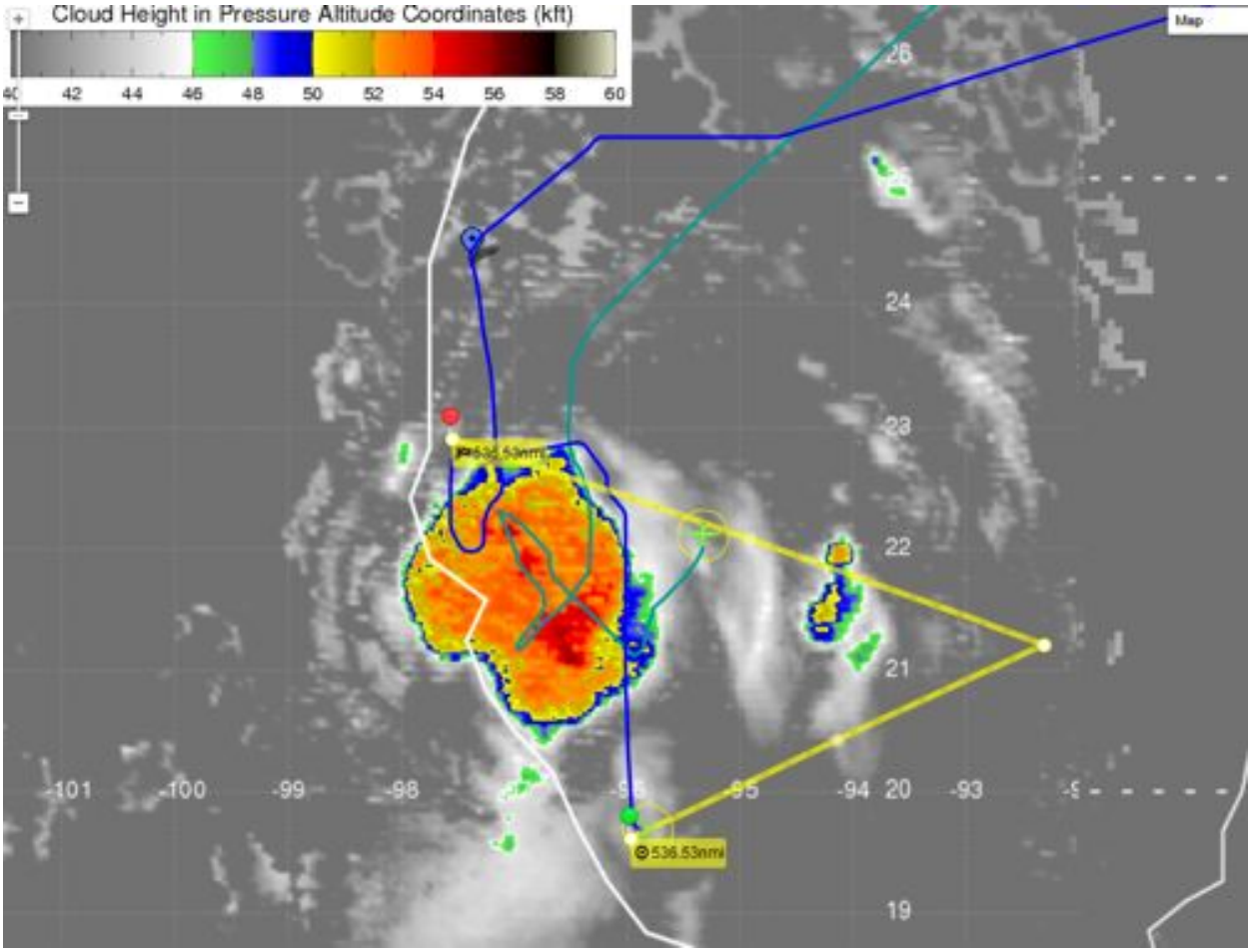
1734Z Modifying drop locations and track.

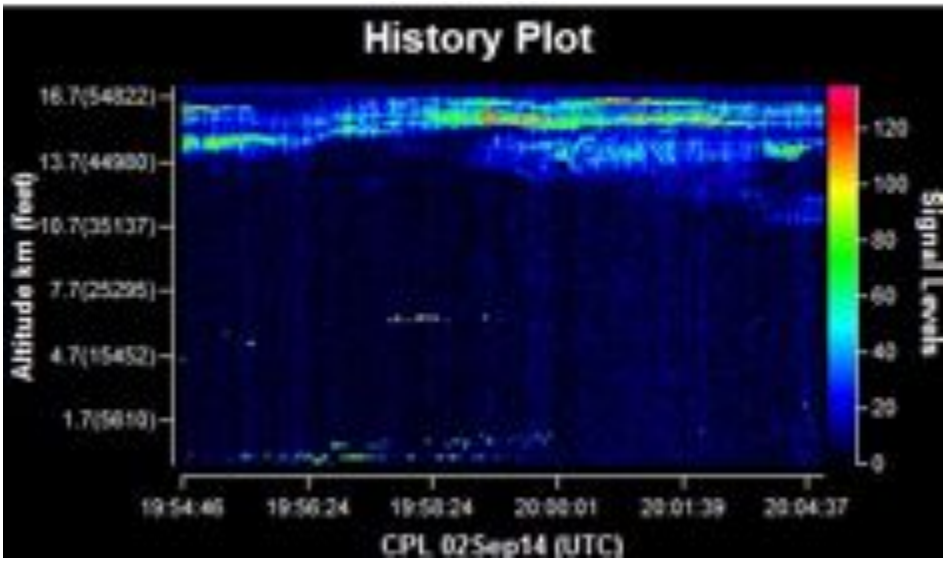


1910 After some intense maneuvering around the cirrus anvil – pilots are nervous about overflying high cirrus. CPL shows some very high cirrus.

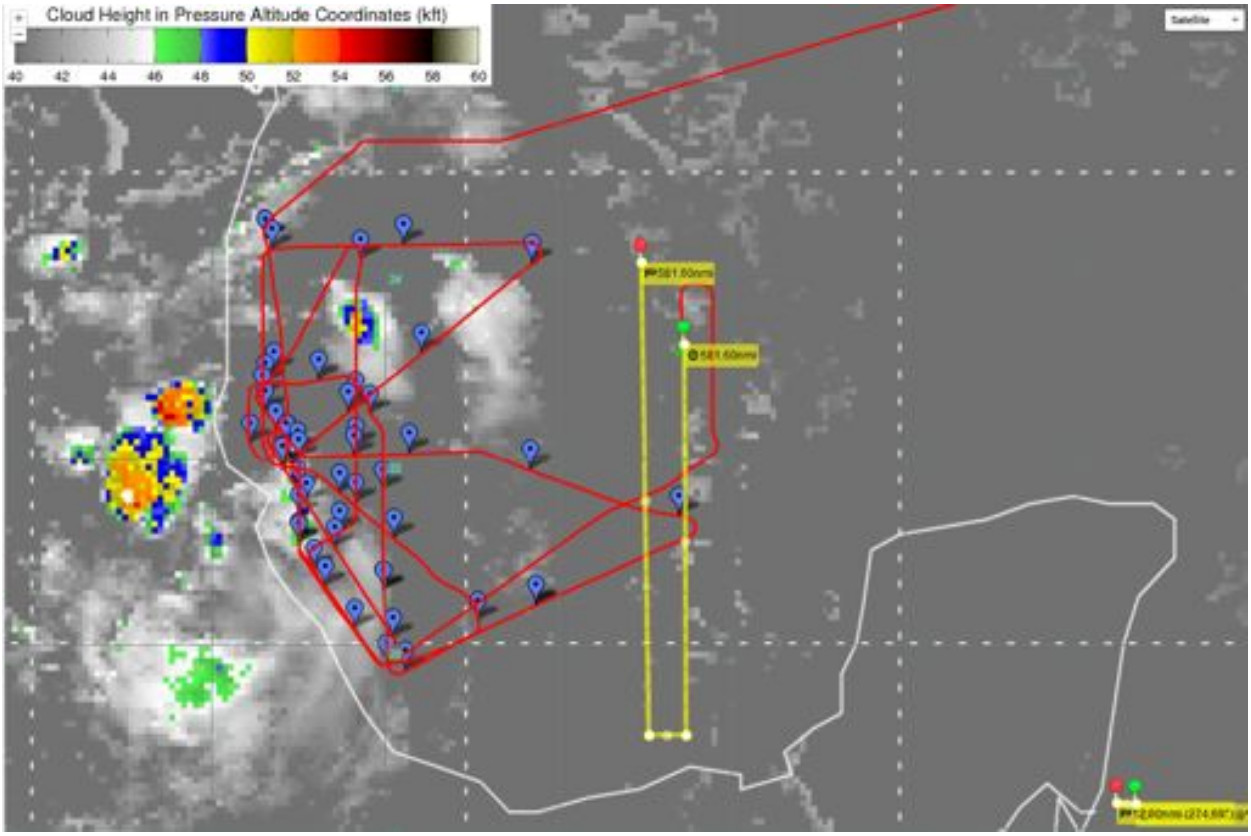


1915Z CIMMS cloud top heights are extremely high, but this is mainly cirrus blow off.

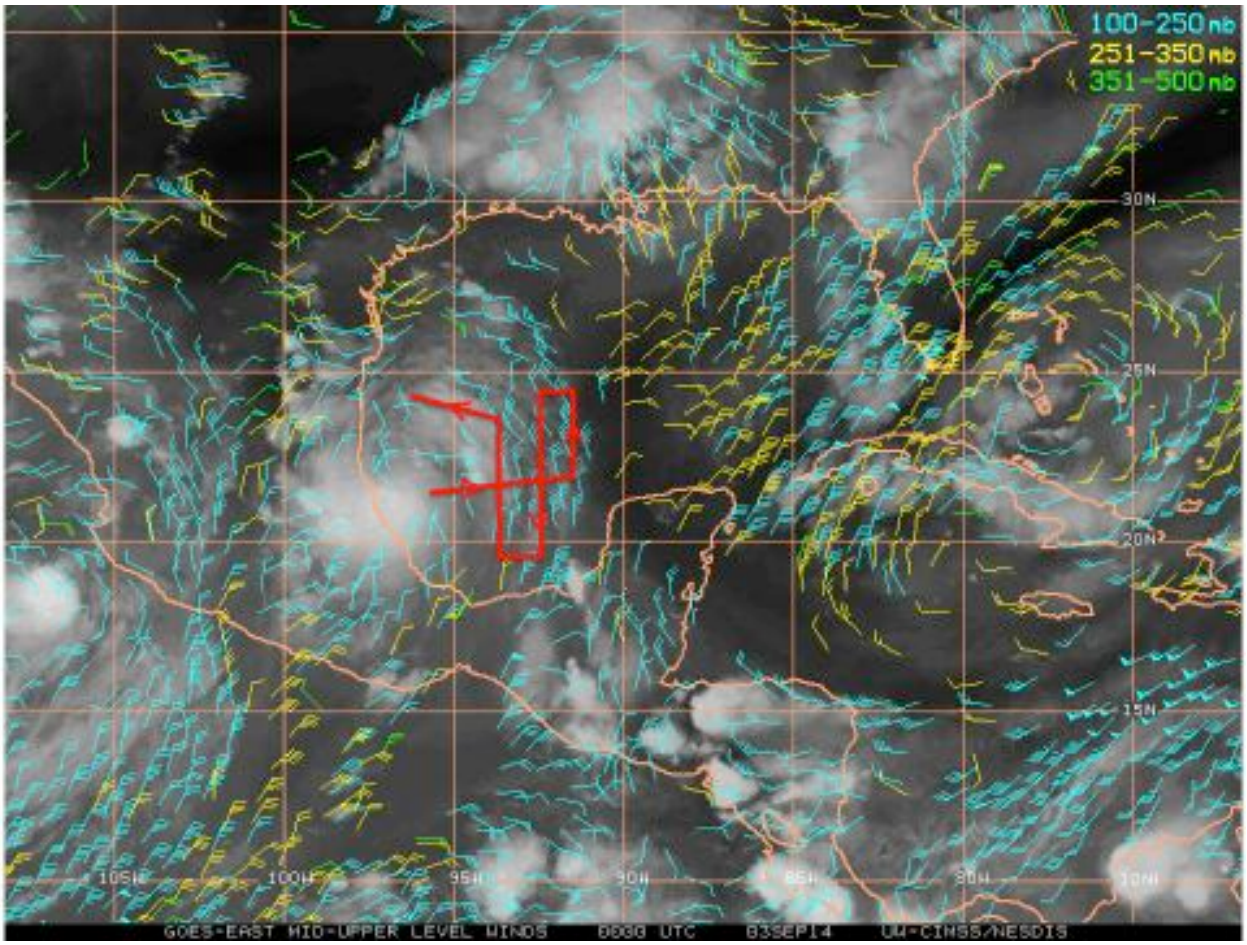




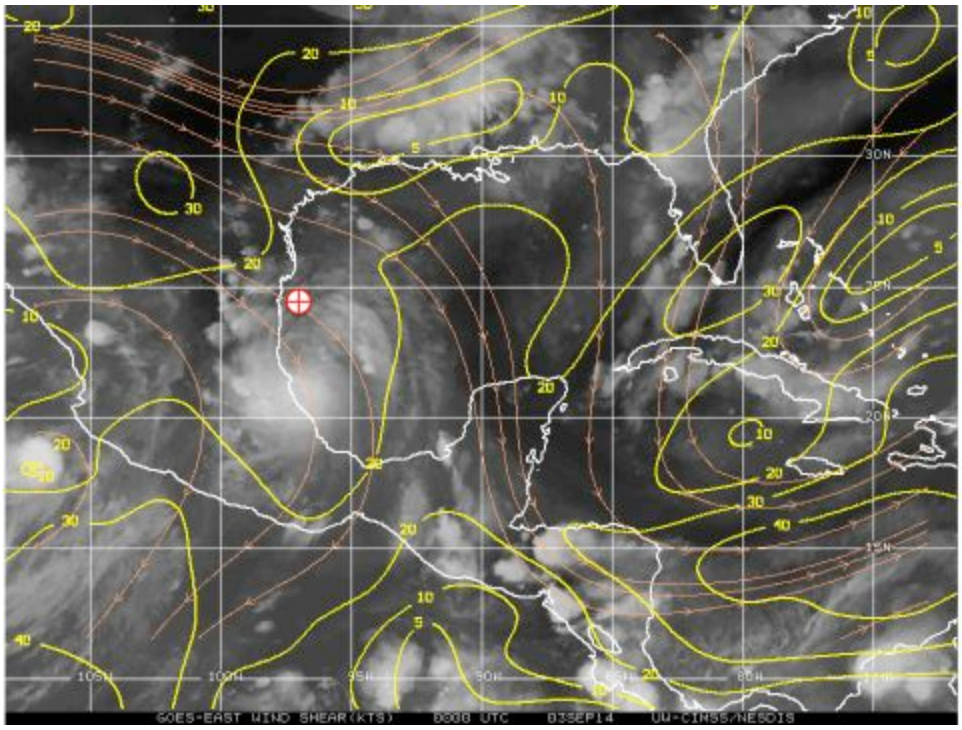
2324Z Storm is moving onshore between 0200 and 0300Z based on Teal 73 fixes.



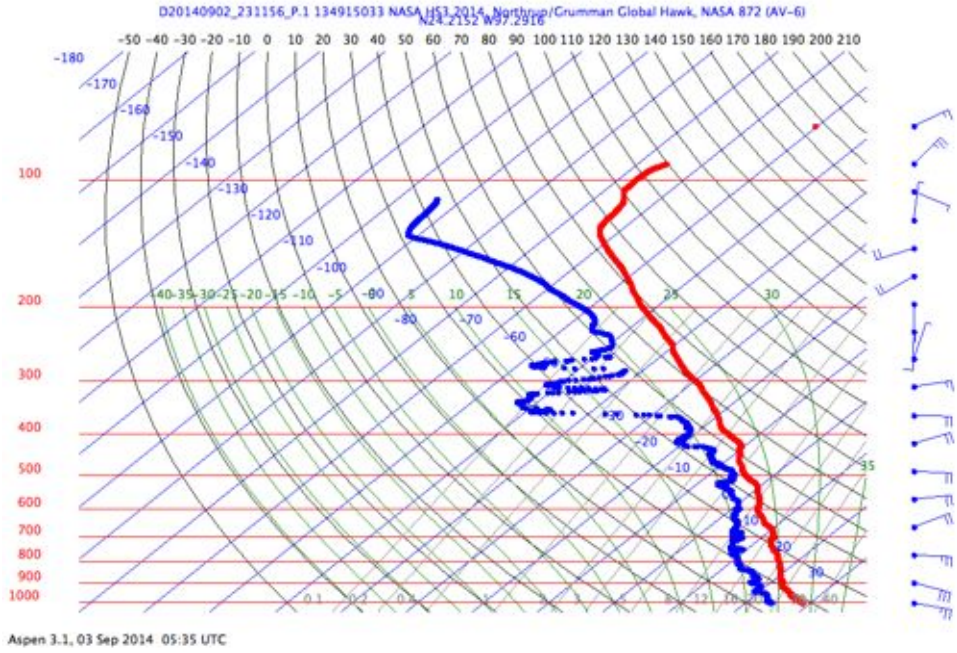
0307 started N-S racetrack to sample equatorward outflow jet for CPL. Eastern and northern bounds of the race track were bounded by limits of the NOTAMS that were filed. Last 2 dropsondes launched at N end of the 1st N-S leg and S corner of 2nd S-N leg.



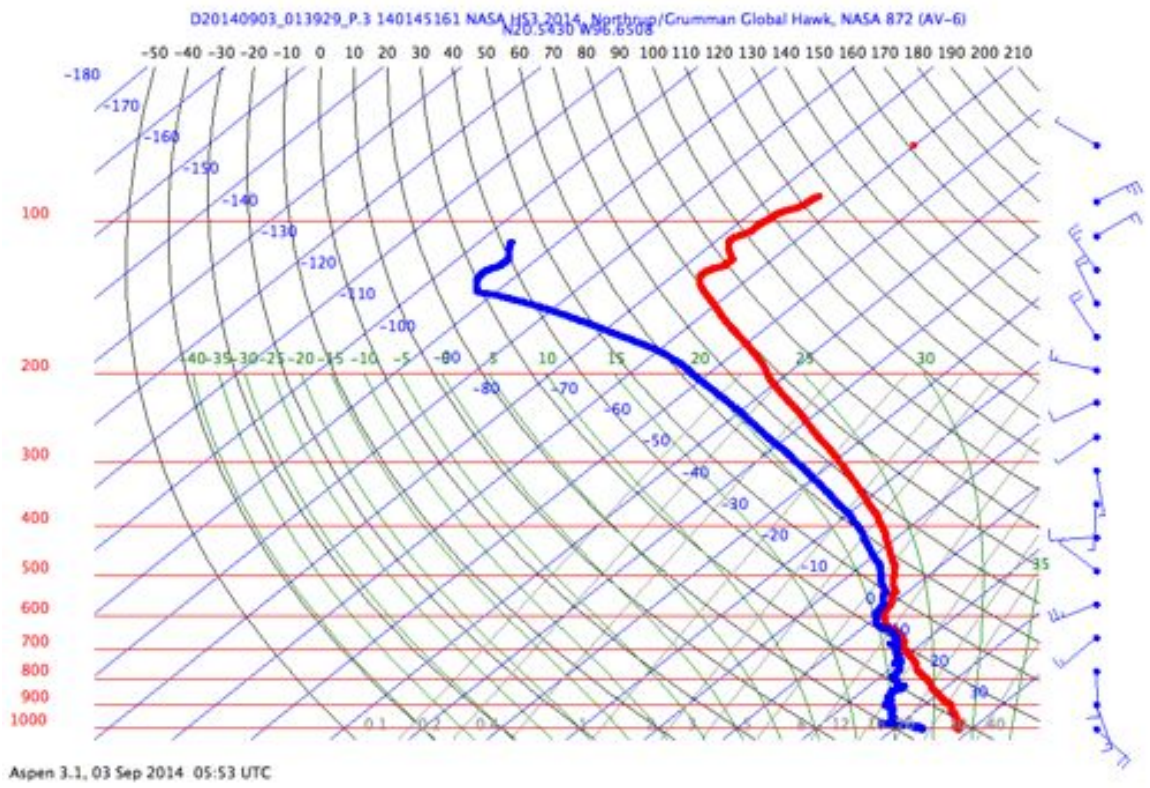
0200 Well-developed equatorward outflow jet in Dolly's eastern semi-circle. Race track set up to sampe and then over toward the coast before heading home.



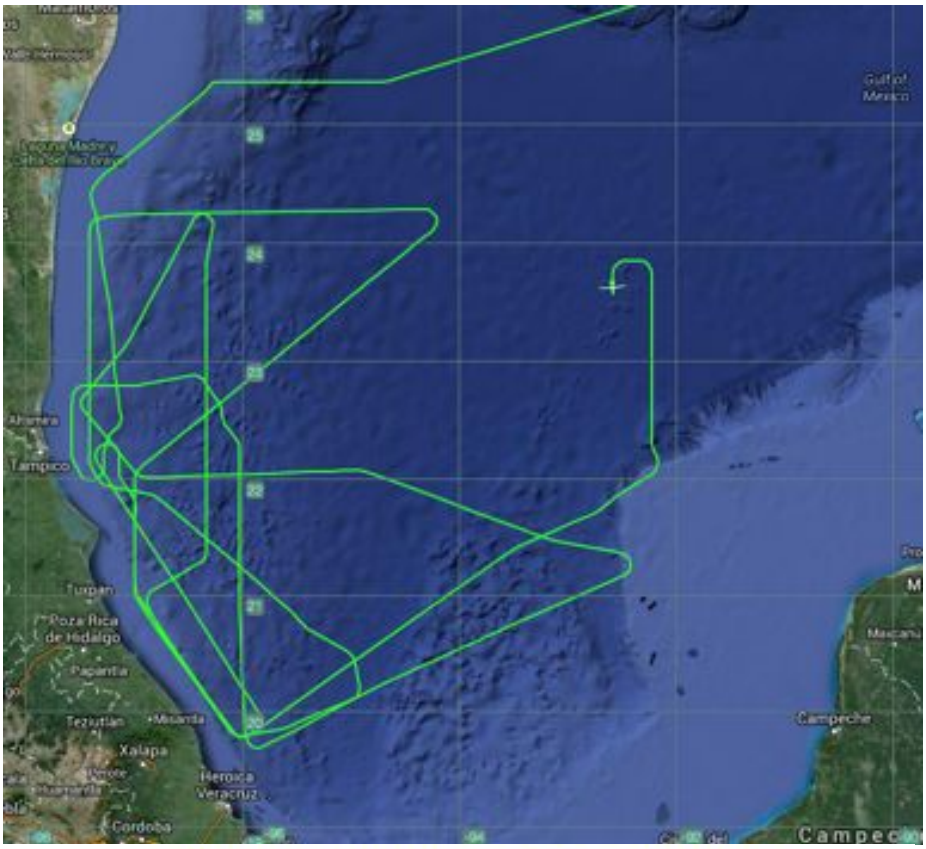
0000 wind shear analysis shows ~15-20 kt of NW shear over Dolly

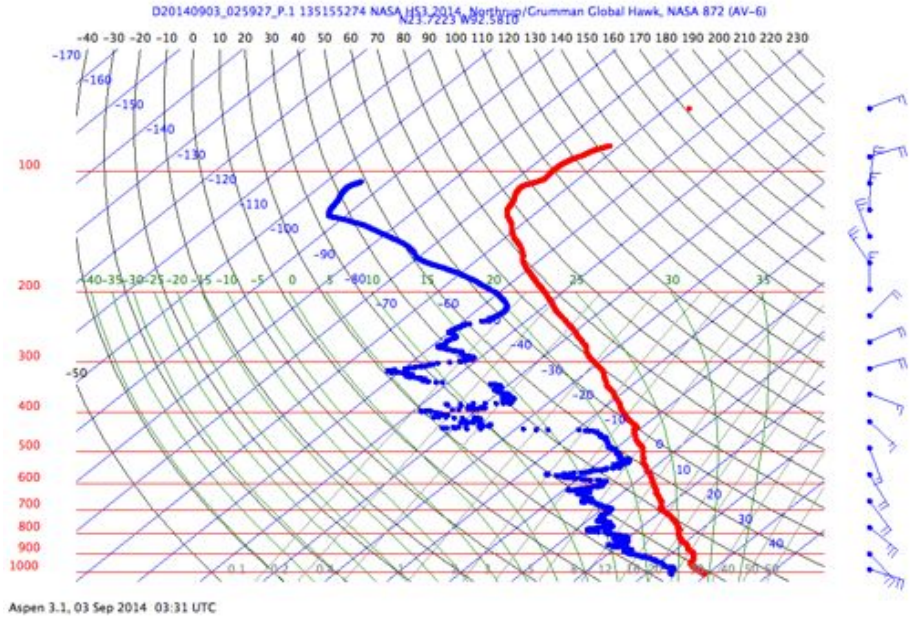


GPS dropsonde (231156z; 24.22N, 97.29W, see the symbol in the above image). 200-850 hPa shear: 30 kt 267 deg; 200-700 hPa: 21 kt 244 deg; 350 hPa RH: 9%.

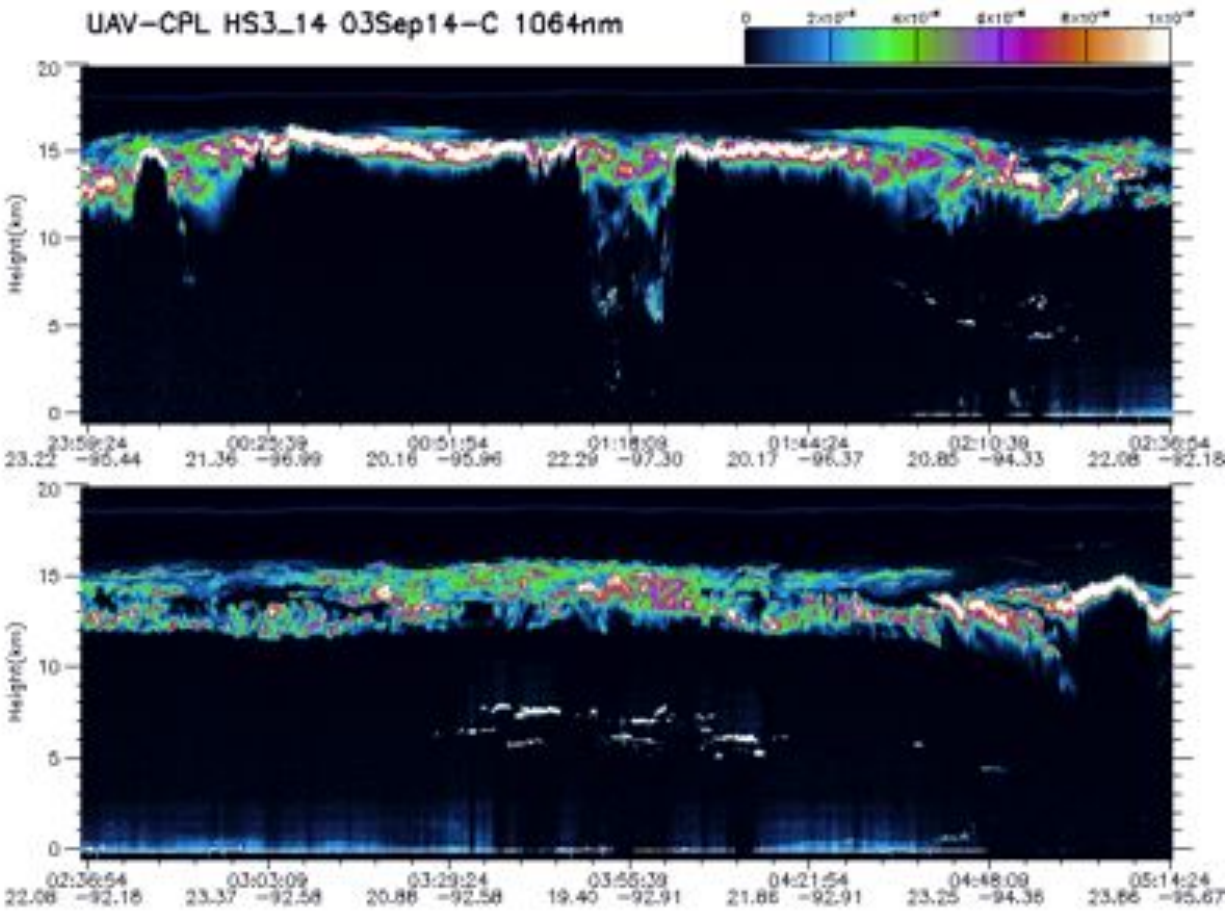


GPS dropsonde (013929z; 20.54N, 96.65W) dropped along a NW-SE coastal leg south of the center. Double tropopause structure (lower inverison likely marks the top of the cirrus canopy and related to post sunset cooling. Lower temperature is 2.5^{o}C and 291 m deep. Low levels appear to be fairly dry as well: surface RH: 76%; 925 hPa RH: 62%.

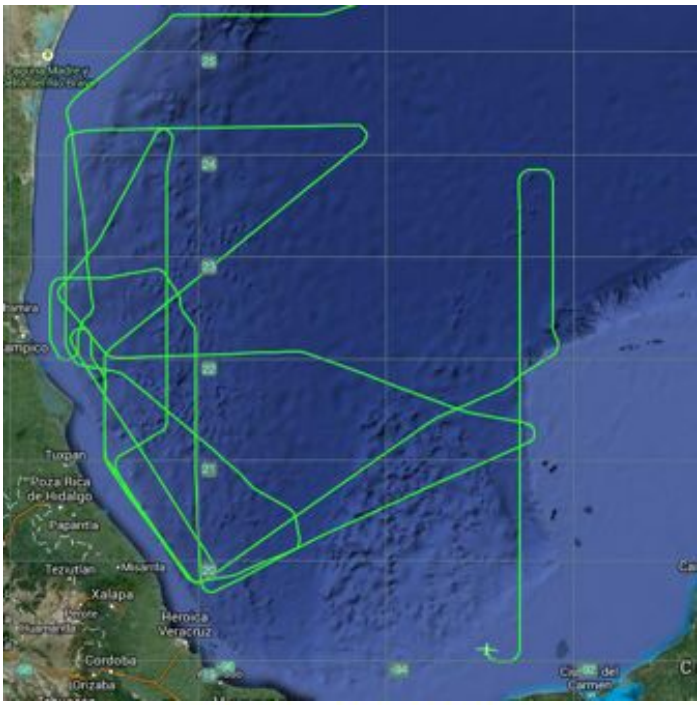


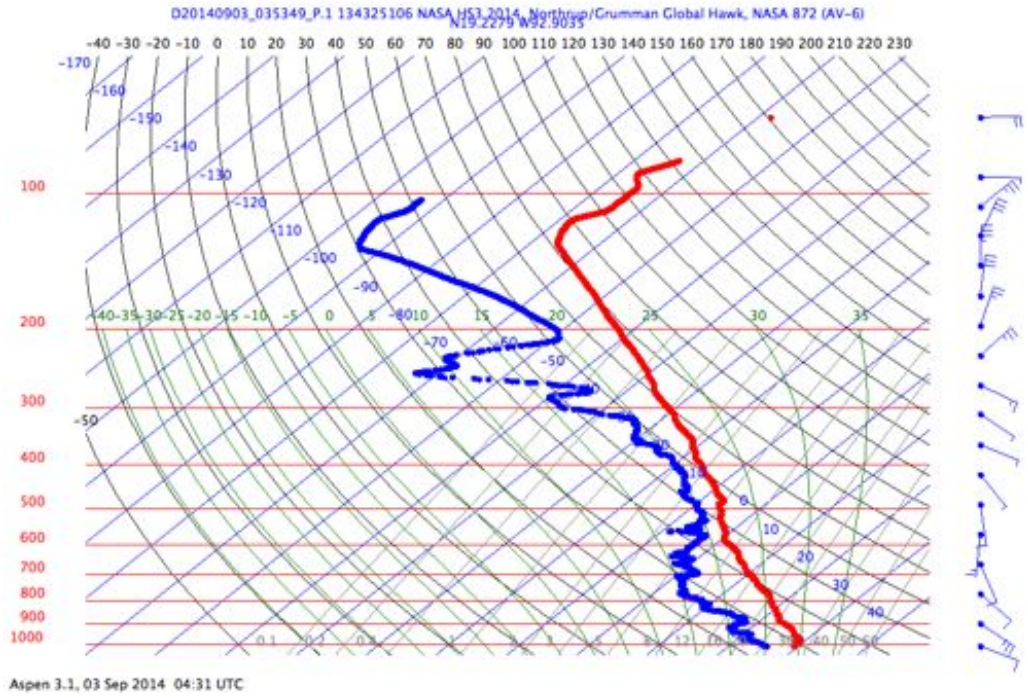


0300 Top image above shows the flight track up to 0300Z where a dropsonde was released to sample the outflow layer. The skew-T diagram shows data from that sonde which indicates easterly to southeasterly flow at low levels switching to northerly flow aloft.

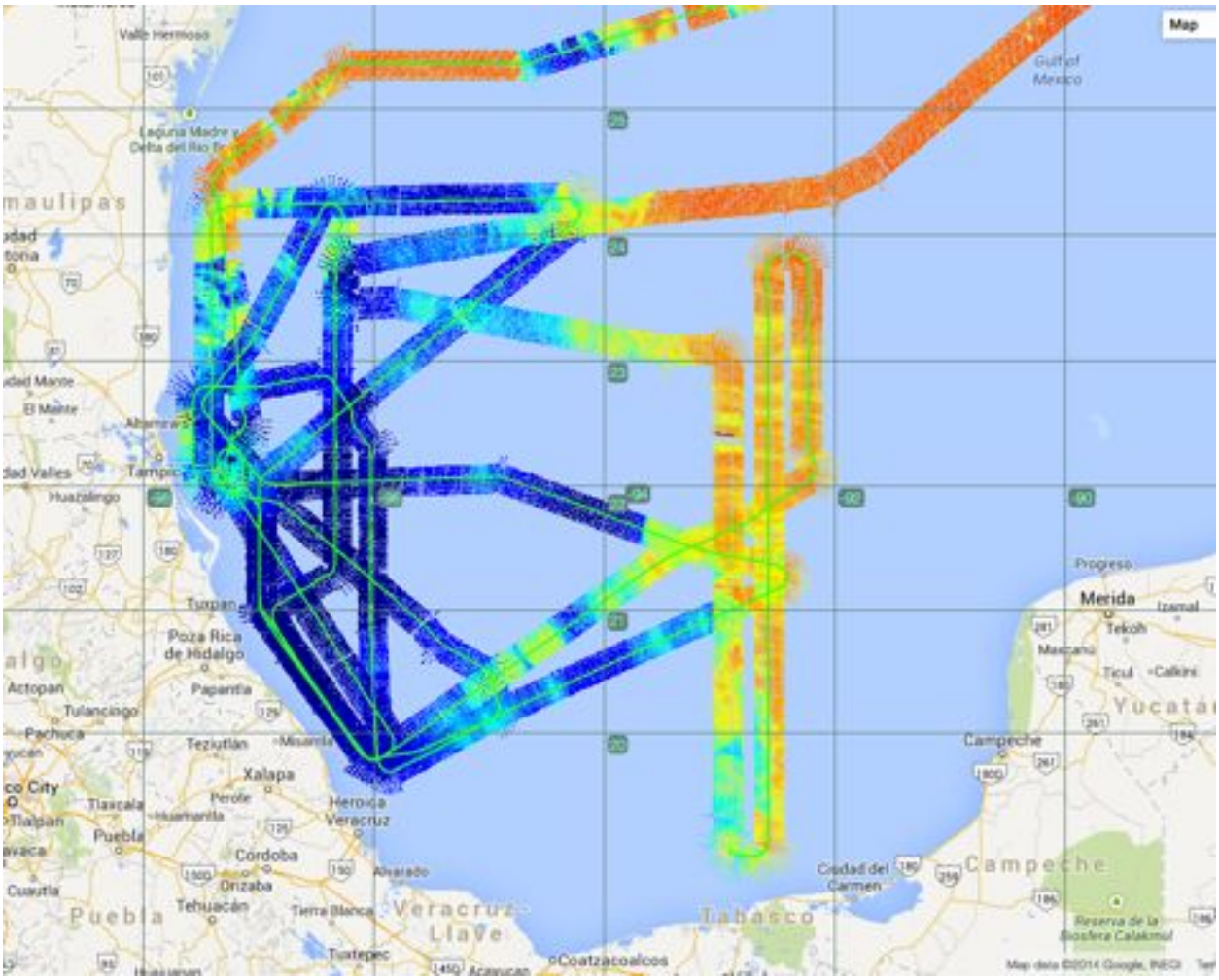


CPL time series from 00-05Z. At the time of the 03Z dropsonde above, CPL was seeing a highly variable layer of cirrus between 12-15 km.

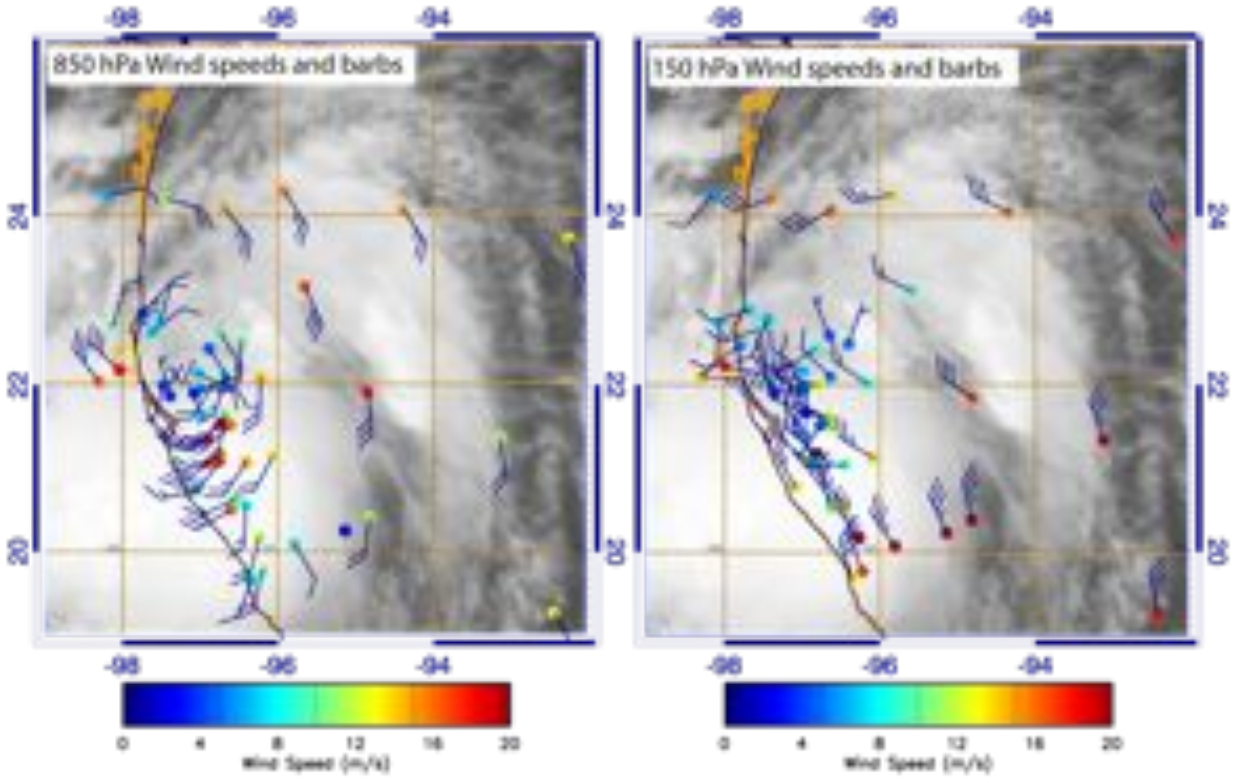




0354 Dropsonde at the southern end of lawnmower pattern (this was the last drop of the flight). Results are similar to the northern region, but somewhat weaker flow at lower levels and stronger flow aloft. The profile above 600 mb is very moist with the exception of a dry layer just beneath the anvil region. CPL shows a stronger cloud signal in this region with cloud tops ner 16 km.



S-HIS brightness temperature from the entire flight.



The above figures show the sonde distribtion in a storm-relative reference frame. Wind barbs show storm-relative winds. Color filled circles show total ground-relative wind speed at 850 and 150 hPa. Low-level winds depict the closed circulation. The strongest winds are generally located at fairly large radius, consistent with the system being a somewhat disorganized tropical storm. At upper levels, the outflow is primarily to the SE at up to 35 kt.

Instrument Reports

AVAPS
Station 9 (AVAPS Science): Gary Wick, Ryan Spackman*, Natalie Gaggini
Station 8 (AGS): Terry Hock, Dean Lauritsen, Laura Tudor
* Corresponding author

The third science flight targeted the forecasted rapid development of TS Dolly before landfall on the SE coast of Mexico. This was a 100% successful flight for AVAPS with 50 of 50 sondes deployed. Data quality was excellent with no fast falls and essentially no telemetry data gaps despite numerous aircraft turns after sonde launch. Also, AVAPS performed smoothly during a couple 3-to-4 min drop interval sequences. All data were processed in real time, transmitted through the GTS, and preliminary data

made available to science team members. The instrument is fully operational and prepared for the next flight opportunity.

Another major real-time processing achievement was realized during this flight. All the raw D-files are now available to the outside world and we are able to access them from the AVAPS science station (Station 9). During the next flight, we will be working to automate our scripts to grab them directly without the external drive transfer that currently occurs between data networks in the GHOC.

Sondes Allocated		**750**	
Remaining		**555**	**74.0%**
Released		**195**	**26.0%**
Flight	**Take off Date**	**Sonde Usage**	**Sondes Left**
RF01	8/26/2014	75	675
RF02	8/28/2014	70	605
RF03	9/3/2014	50	555

S-HIS Flight Summary

Dan DeSlover, Joe Taylor, Bill Smith, Sr., Lori Borg; SSEC, University of Wisconsin-Madison

Summary:

S-HIS MTS products were severely impacted due to fragmentation of the S-HIS data on the aircraft network. This was a factor during the entire flight, but not due to any issues with the S-HIS instrument or software. Complete S-HIS data will be available in post-processed products.

An at-altitude power cycle of the S-HIS at 45 minutes prior to the first science waypoint was requested to mitigate S-HIS cooler temperature drifting occurred at 1524 UTC. The power off cycle was 15 minutes duration.

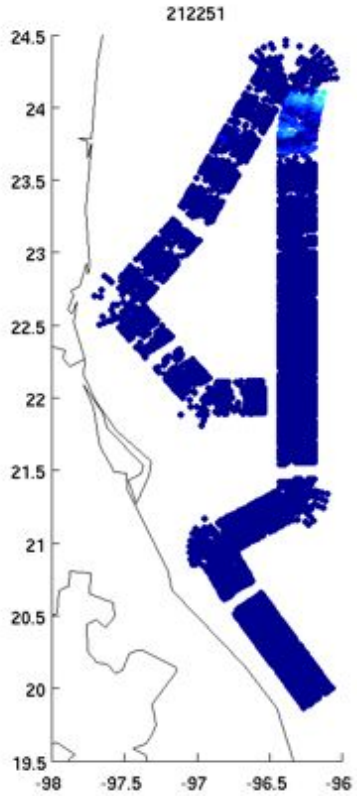
S-HIS crew spent much of the flight working with IT to determine potential issues with a significant decrease in datagram packets being transferred via Ku. This impacted the real-time display of observed brightness temperature, though sounding and other products were still available. Figure 1 shows a very periodic dropout in the real-time observations and then noted improvement once IT decreased the bandwidth used for VOIP communications. Note that this improved S-HIS datagram transmission, but the resultant S-HIS data downlink was still much less than that of prior flights and insufficient to generate adequate real-time products. Figure 2 shows the reduced real-time cross-track brightness temperature product display as a result of the poor data transfer efficiency over Ku.

The science objectives were focused on Tropical Storm Dolly as the system was beginning to make landfall on the coast of Mexico. A number of “figure-4” flight patterns were negotiated by mission science in an effort to observe the quickly moving system. The original flight track was abandoned in favor of dynamic and near-real time modifications to the flight track to optimize the number of

overpasses over Dolly before landfall. The storm produced very high cirrus clouds, Figure 3.

Timeline (All times are UTC and are only approximate):

- 20140902T1043 GH engine start (issues on a/c, re-cycle power)
- 20140902T1111 GH engine restart
- 20140902T1150 Ku ON and transmitting
- 20140902T1155 Takeoff
- 20140902T1156 SHIS Power on (after takeoff due to delays)
- 20140902T1220 S-HIS detector temperature and cooler nominal
- 20140902T1225 Significant SHIS datagram loss noted—begin troubleshooting
- 20140902T1336 VOIP shutdown, strong improvement in SHIS datagram efficiency
- 20140902T1353 Change SHIS PMTU settings—no improvement (several reboots w/ different settings). Believe datagram loss due to VOIP traffic clobbering SHIS Ku bandwidth or other IT setting changes.
- 20140902T1524 SHIS power down for 15 minutes
- 20140903T0952 S-HIS descent heaters on
- 20140903T1011 Instrument power OFF before descent (IL42, IL41, DC42, DC41)
- 20140903T1029 Instrument power ON (DC41, DC42, IL41, IL42)
- 20140903T1117 Instrument power OFF (DC41, DC42, IL41, IL42)
- 20140903T1134 Landing



- **Figure 1: S-HIS real time image showing significant datagram dropout (with periodic gaps) before IT started modifying VOIP bandwidth.**

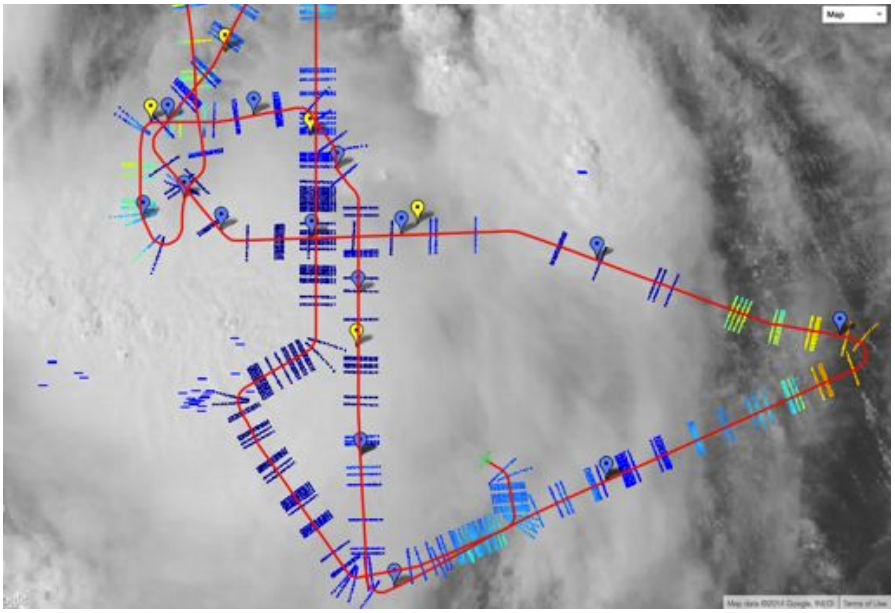


Figure 2: S-HIS 895-900 cm^{-1} Brightness Temperature image in MTS illustrates significant reduction in display product due to Ku data transfer dropouts.

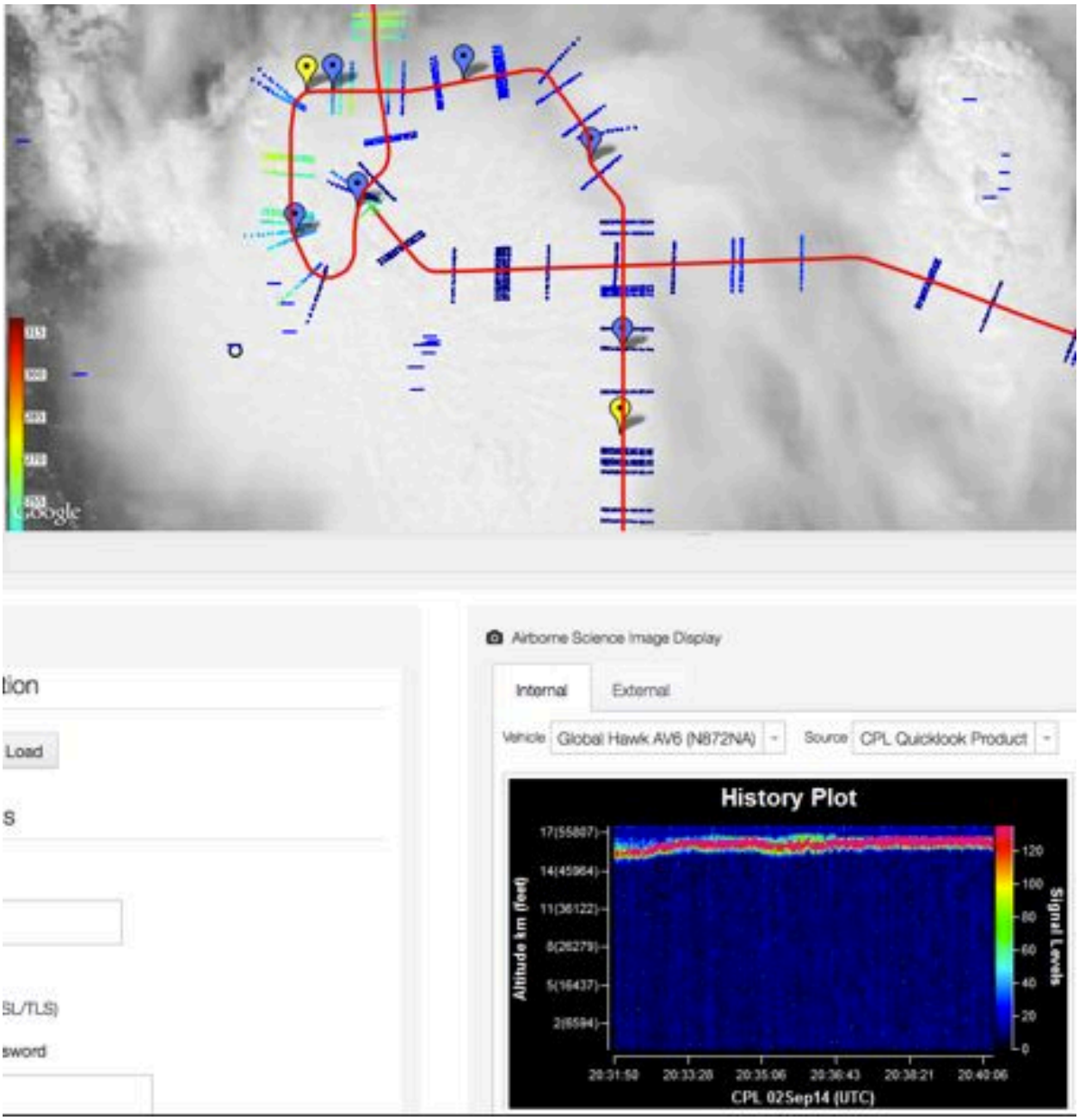


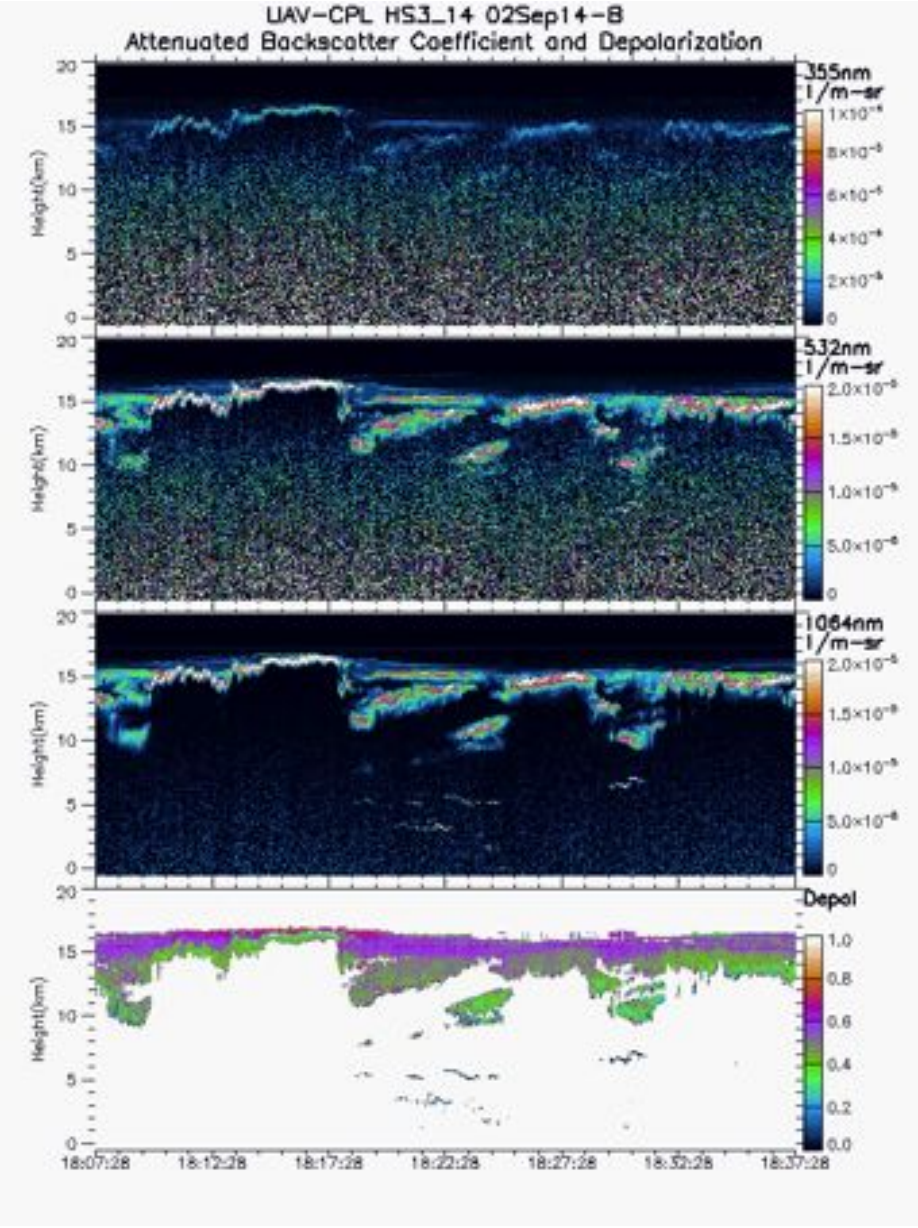
Figure 3: Tropical Storm Dolly produced very high cirrus clouds—good case to test the cloud top component of the S-HIS dual regression retrieval.

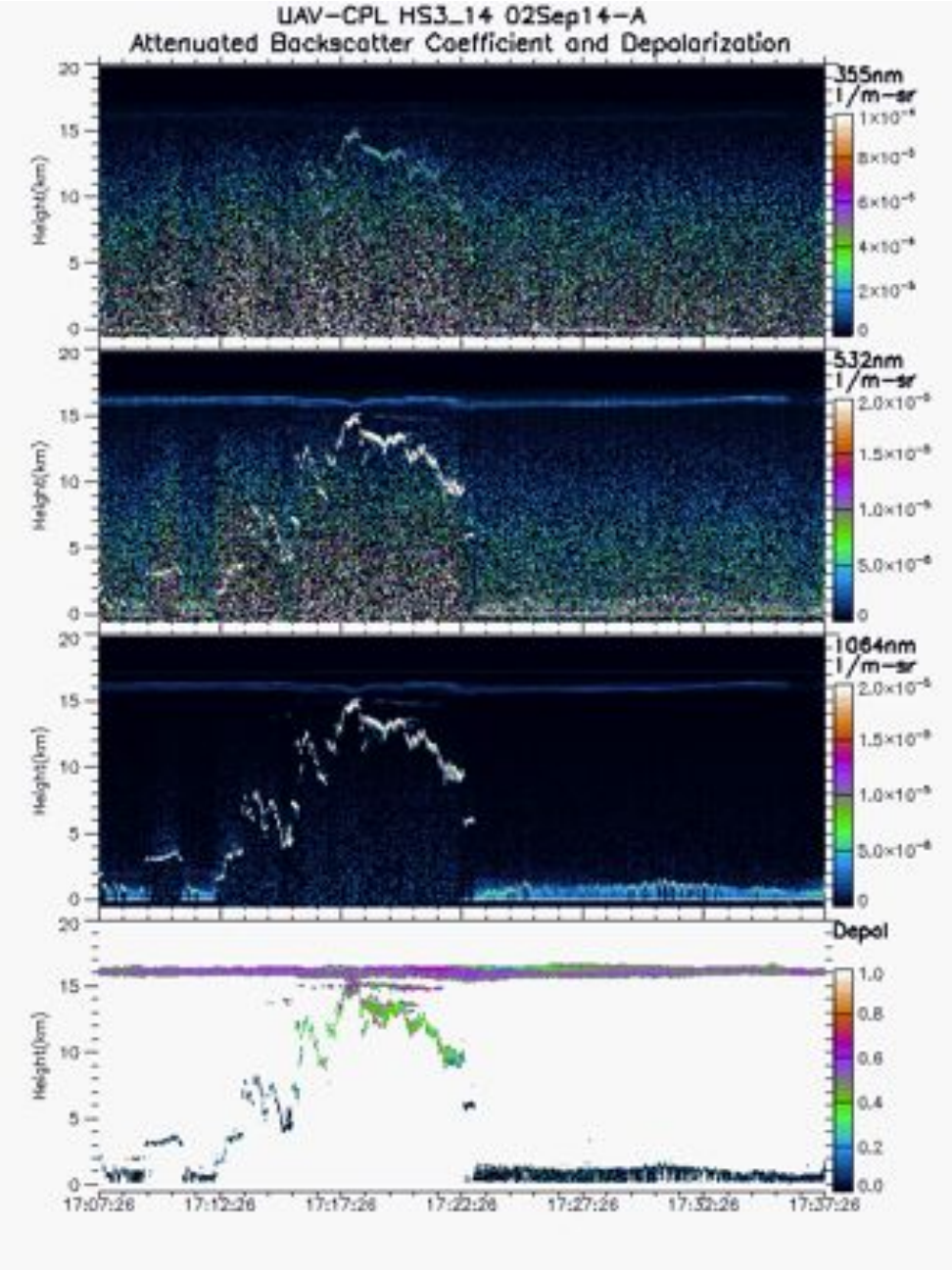
CPL

Overall, CPL worked well for the 02-03Sep14 flight. The 355 and 532nm channels were noisier than we would like and we are looking into why. The 1064nm channel had strong signals throughout. The instrument temperatures remained inside thresholds. CPL started data flow at 15:08 UTC on 02Sep. and ended data flow at 10:05 UTC on 03Sep. Some complex high-altitude cloud systems were overflown with vertical structure in the depolarization ratio near

18:16 utc, as shown in seg B-2 below. A nice thunderstorm complex was observed in seg A-9 (below).

We might have to lower the main instrument box during post-flight on Saturday to trouble shoot the signal issue.




UAV-CPL HS3_14 02Sep14-A
Attenuated Backscatter Coefficient and Depolarization
355nm
1/m-sr
532nm
1/m-sr
1064nm
1/m-sr
Depol
Height(km)
17:07:26
17:12:26
17:17:26
17:22:26
17:27:26
17:32:26
17:37:26