Hurricane and Severe Storm Sentinel (HS3) Mission

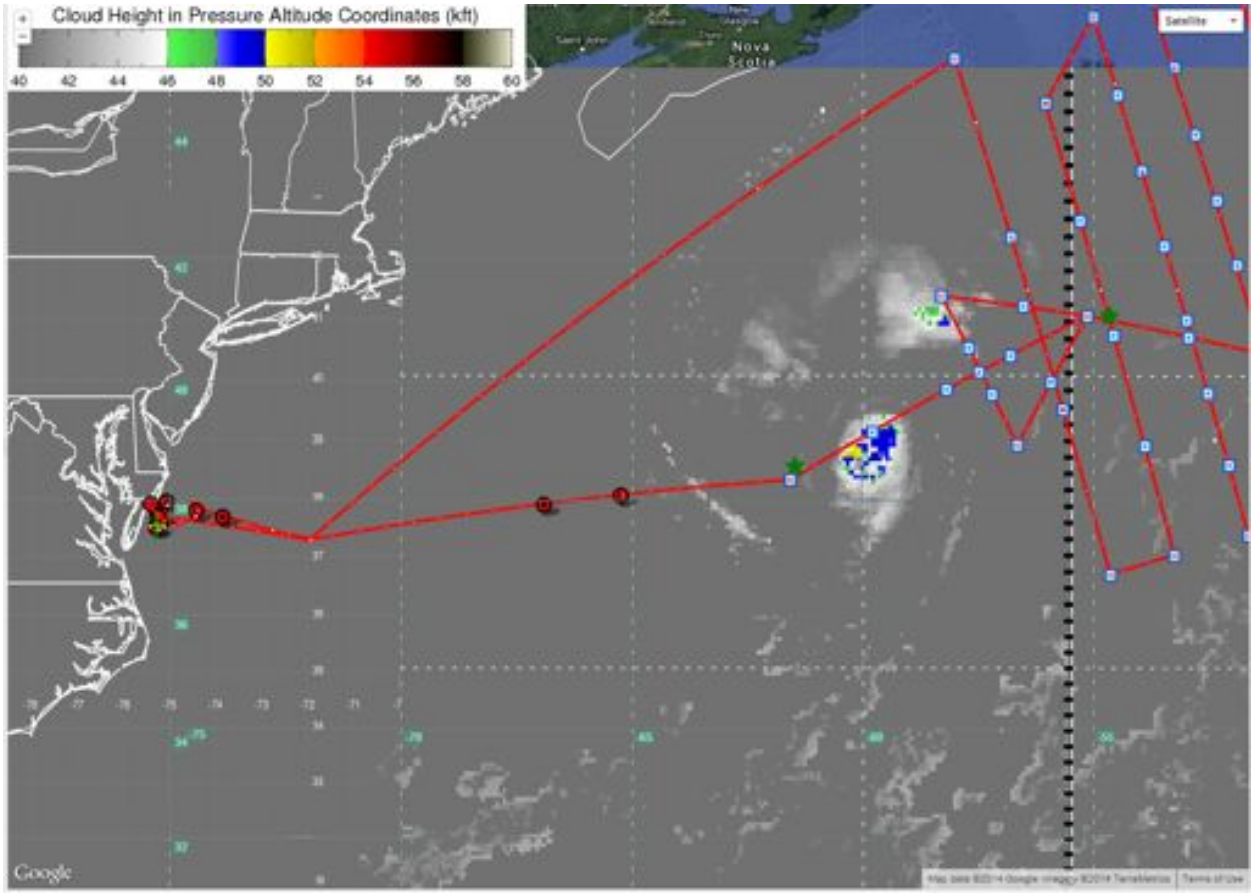
HS3 2014-08-28 Flight Report: GLOBALHAWK AV-6 2nd Cristobal Flight

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

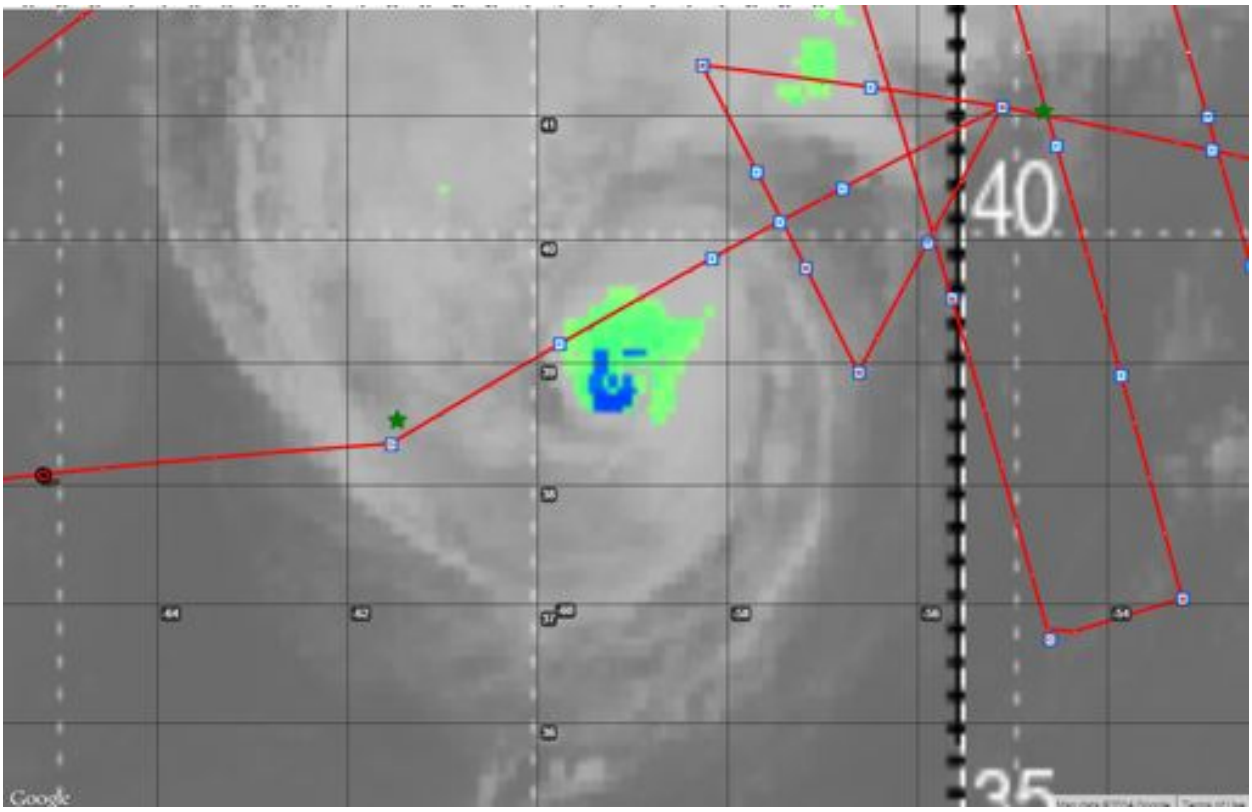
Mission goal: Second science fight into Hurricane Cristobal. Cristobal is still fairly strong, and will start its extratropical transition.

2257 Takeoff

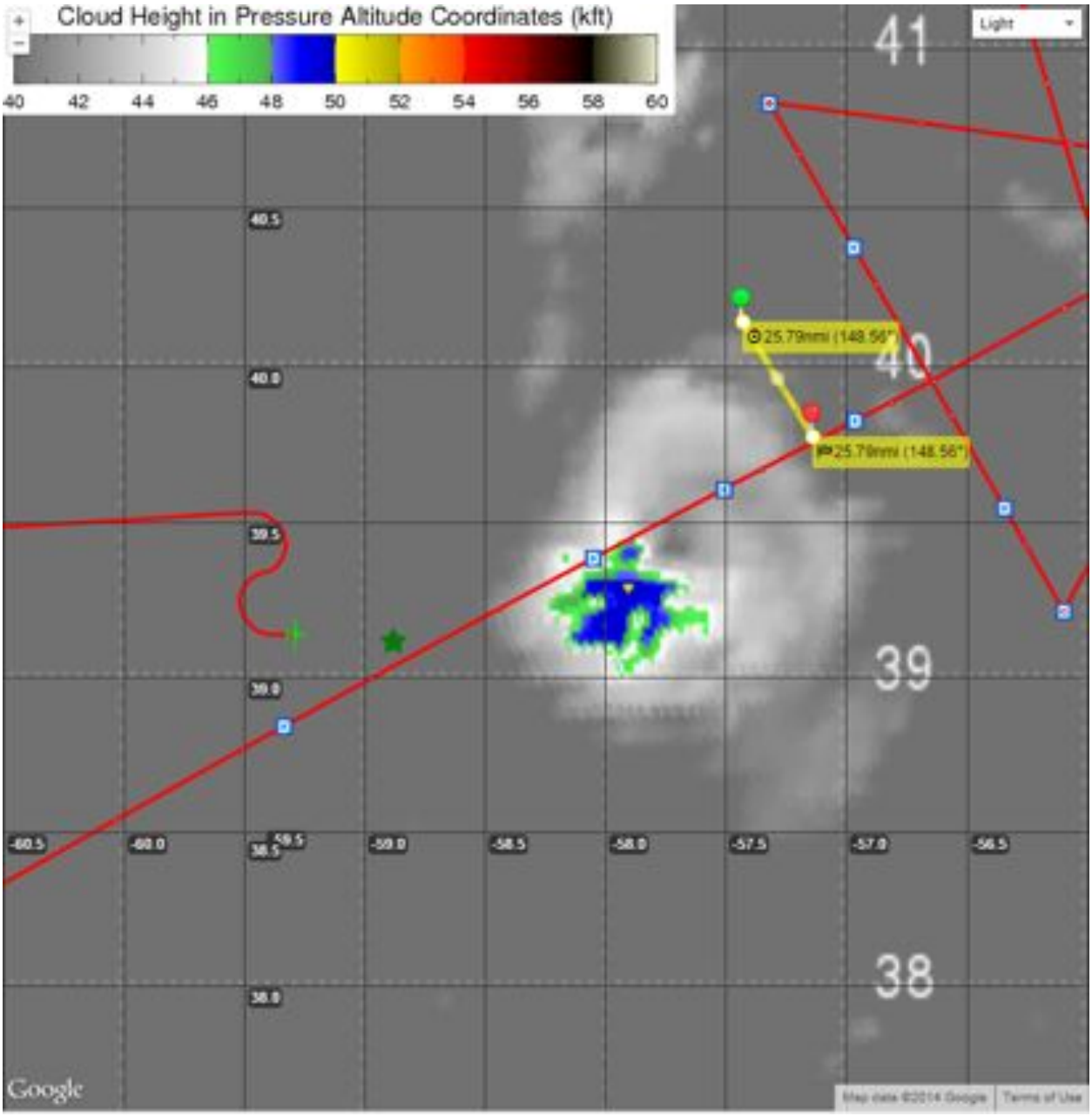
0000 Flight plan has been adjusted as the storm's track varies. Convection appears to be dying.



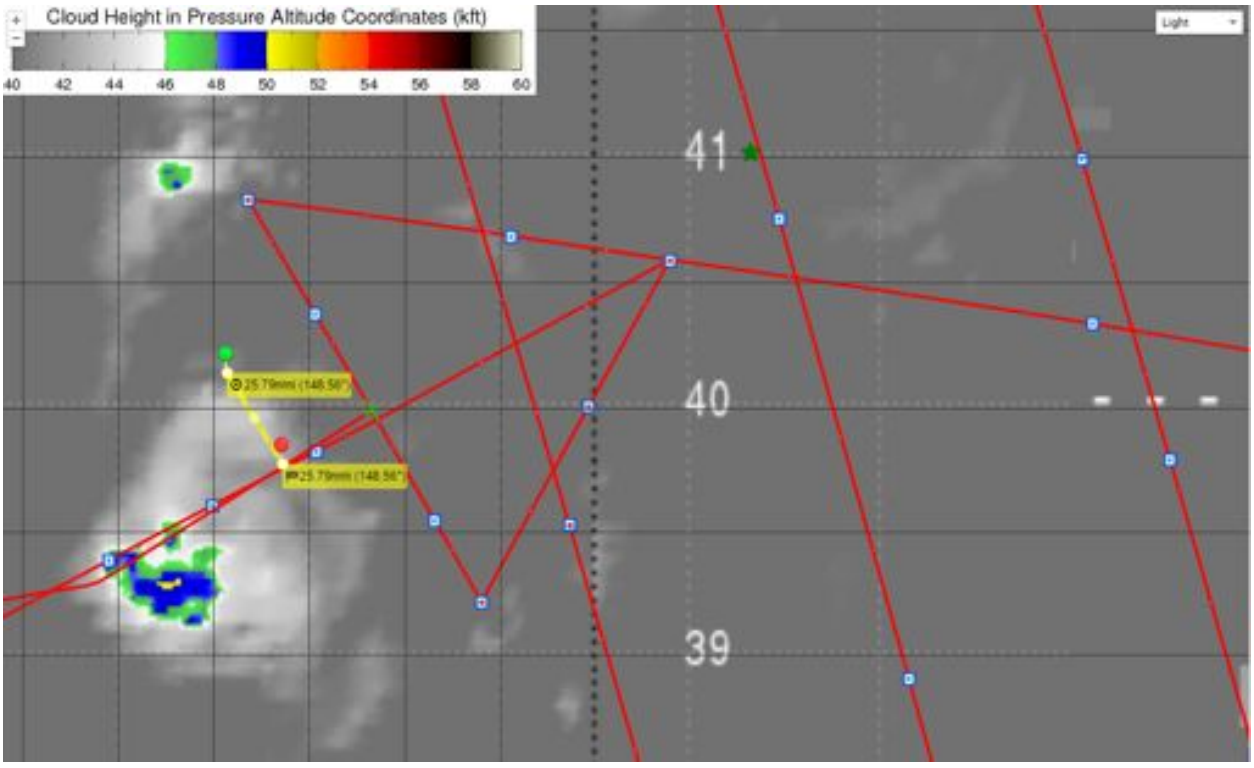
0012 The eye of the storm is a bit farther south than we thought. The attache image shows the IR BT at 2345Z.



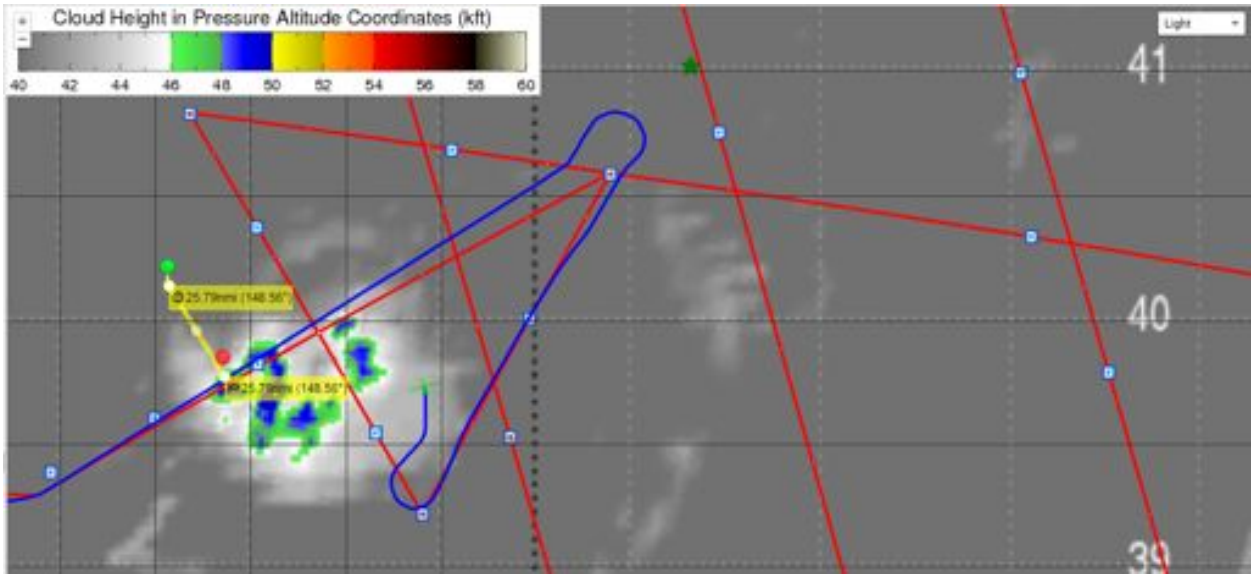
0013 Flight track to be adjusted to account for storm motion.



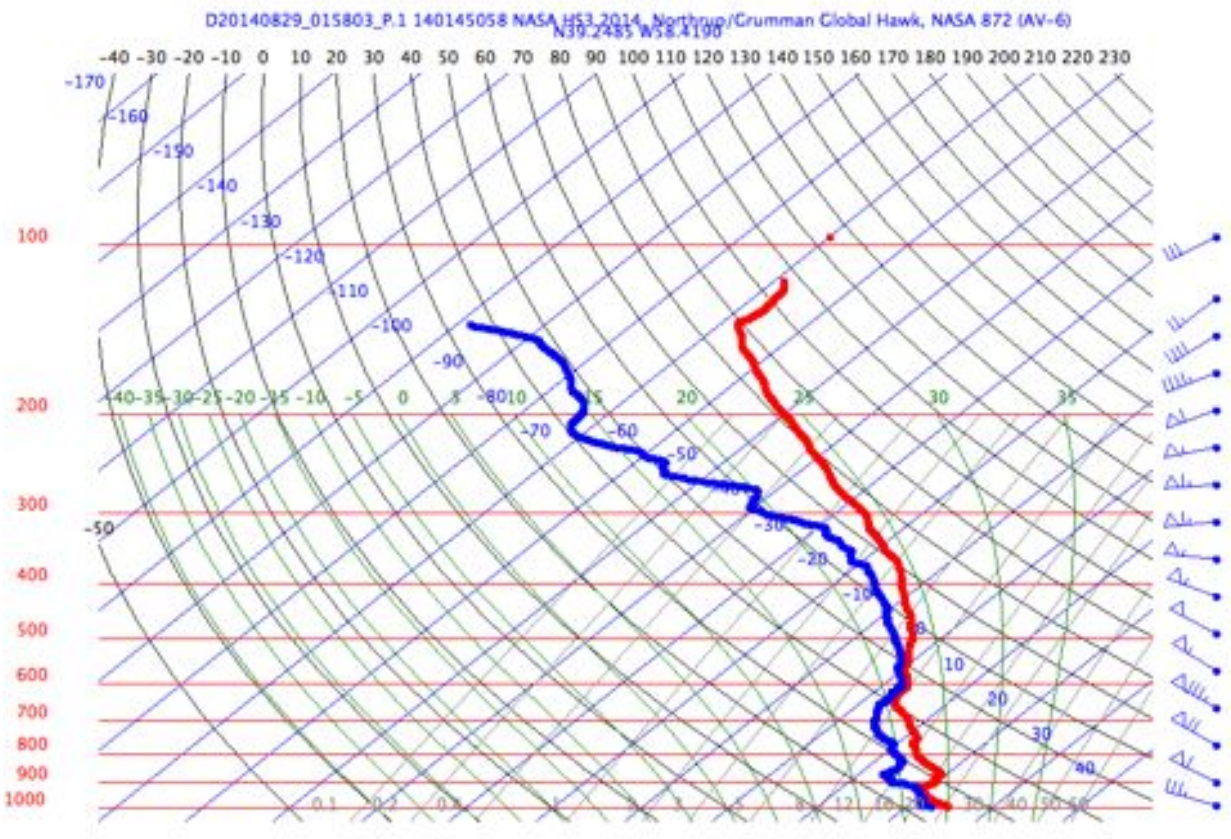
0153 UTC. Pilots had some trouble getting new flight plan (to adjust for storm motion) approved so they had to wander around a bit before getting back on track. This image is a reflection of that.



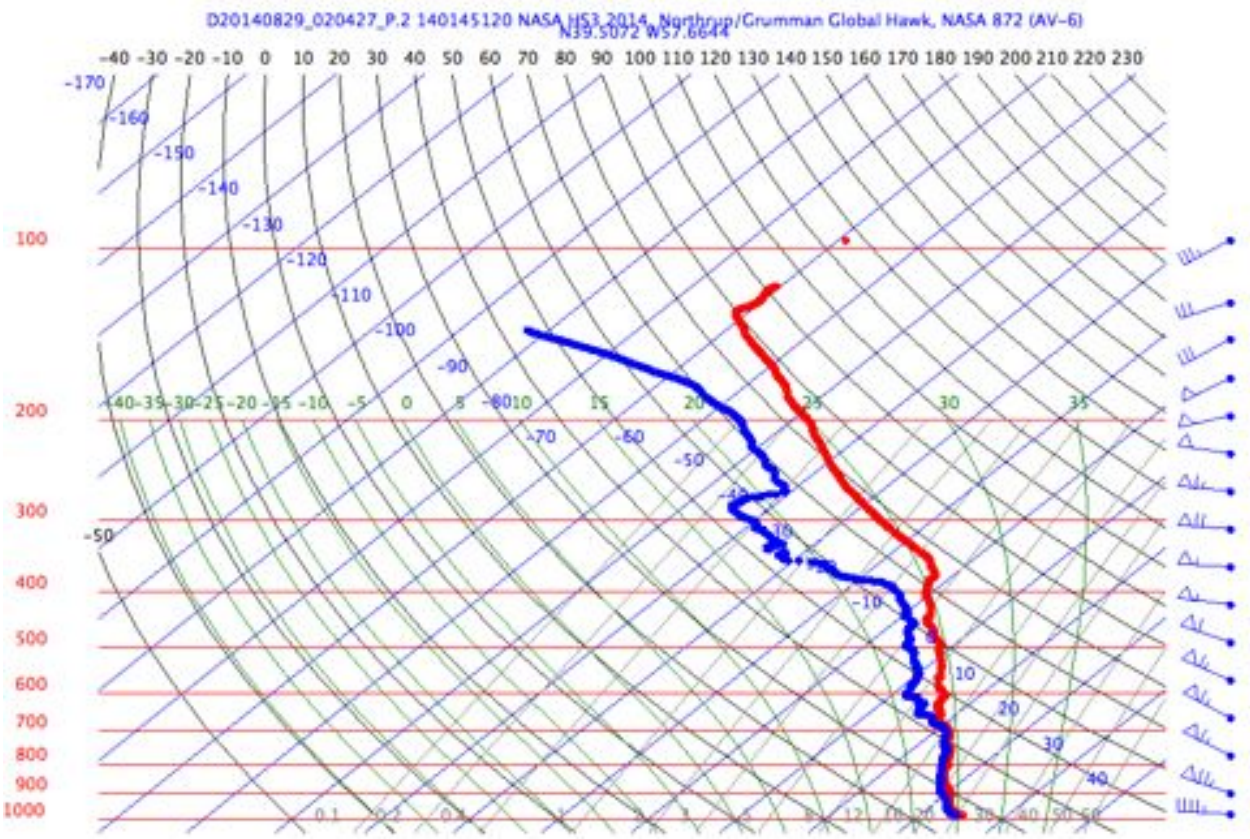
0214 UTC. We performed rapid dropsonde deployments across the storm center and the plane is back on track with planned flight track.



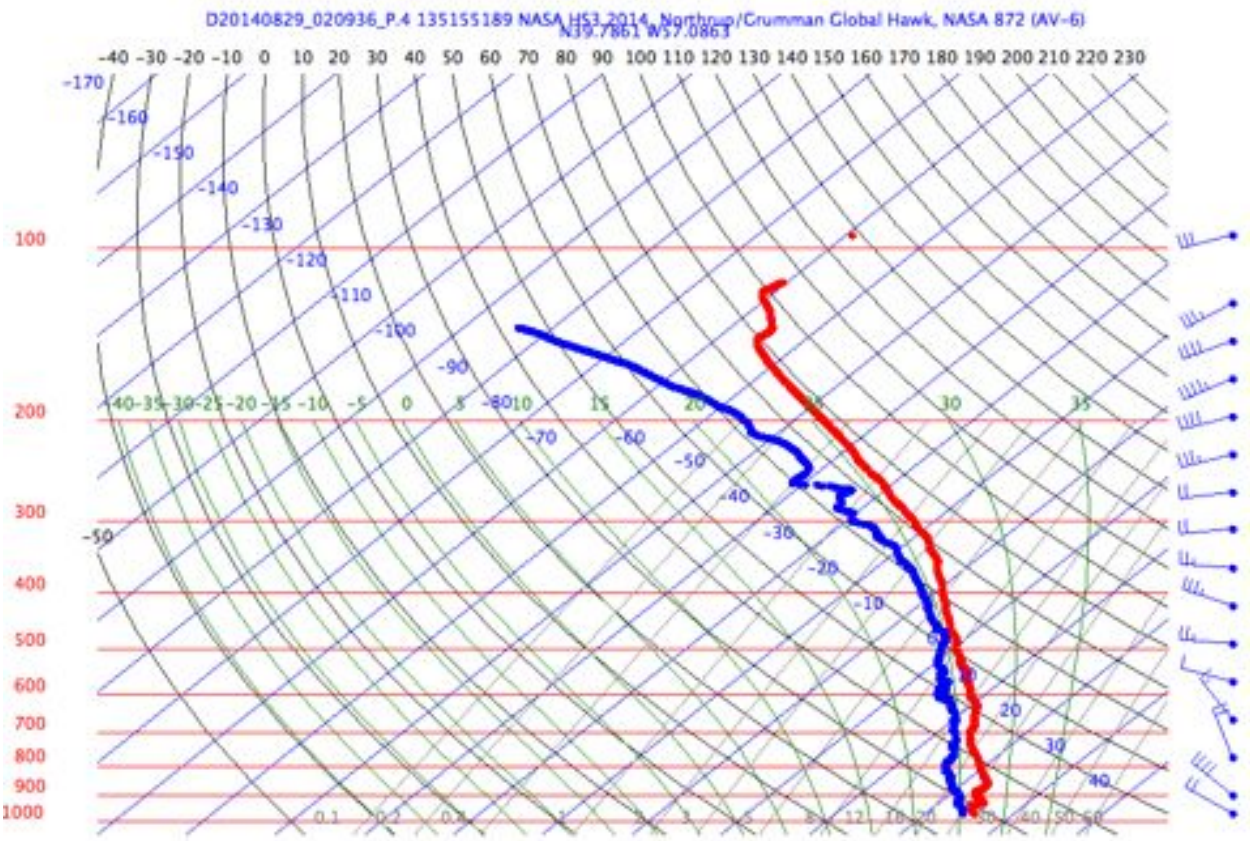
0257 UTC. Making more adjustments to flight track to account for storm motion. Satellite images appear to be refreshing at 30 minute intervals and thus hard to pin down the center. Sonde fault with last drop and AVAPS is diagnosing software problem. Had to hold off on a drop or two because of this.



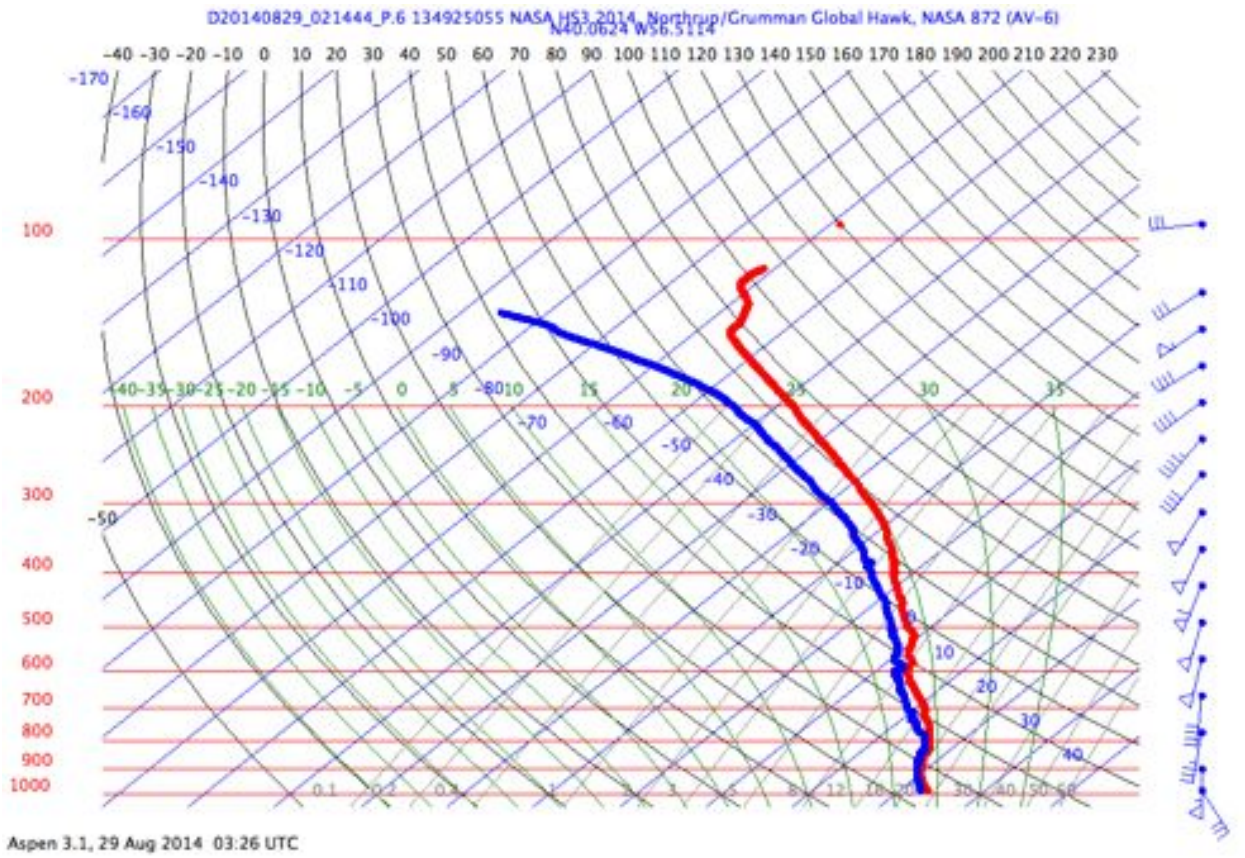
0311 UTC. First sonde data coming online in MTS. This sonde was released west of the center and shows very interesting structure. Peak winds are at 85 kts at 650 hPa with near surface winds of 35 kts. Either this is a local structure not reflective of the mean circulation or Cristobal is showing its extratropical transition to a cold-core cyclone. In any case there is a deep layer (900 to 200 hPa) of 50+ kt winds from the West. Fairly strong inversion at 875 hPa as well and isothermal layer below. This sonde shows well some of the hybrid structure of Cristobal.



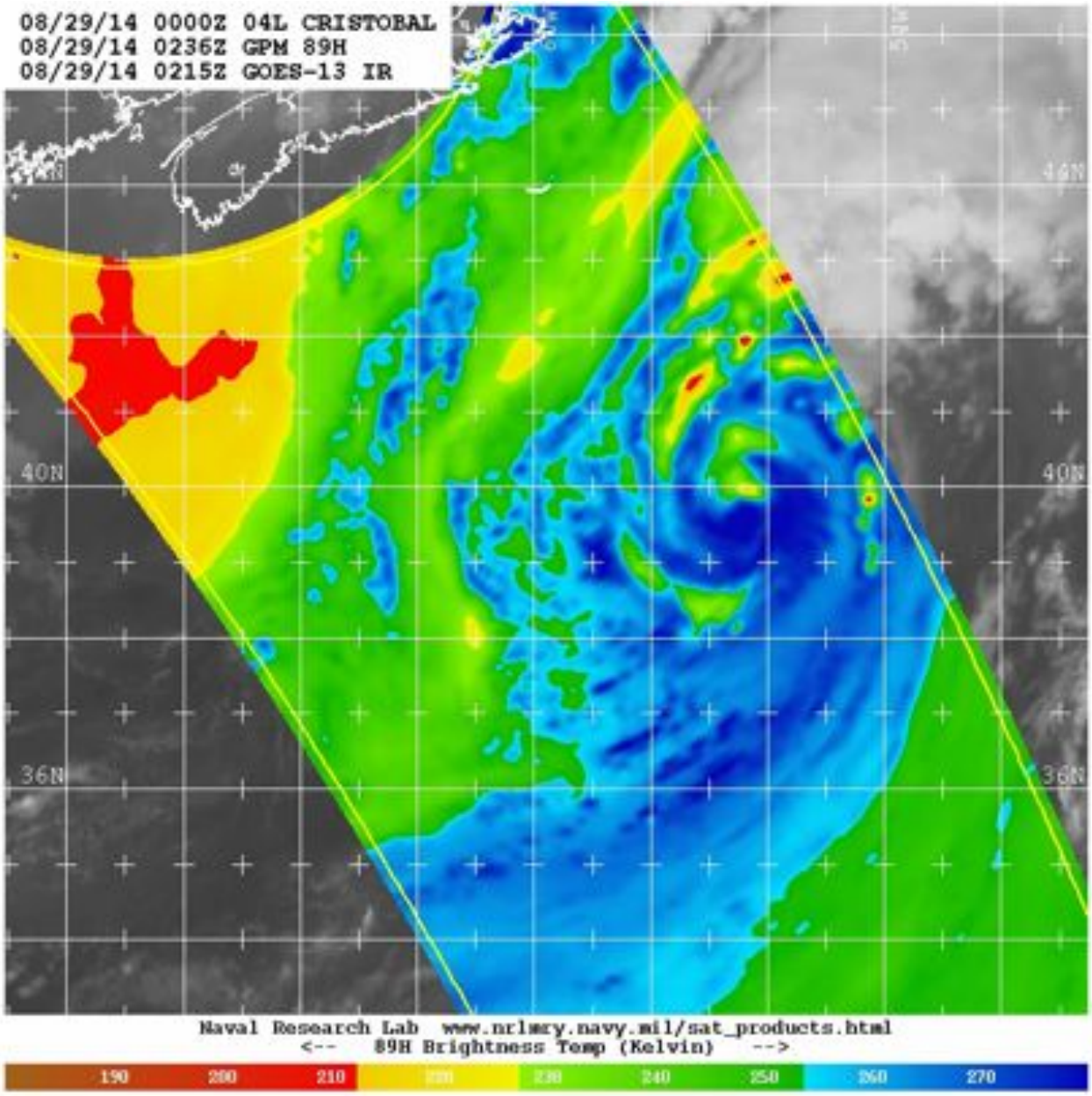
0331 UTC. Next sonde in the track going towards the storm center. Strongest winds at 900 hPa of 75 kts from the West with a continued very deep layer of 50+ kt winds extending up to 175 hPa. Deep saturated low to mid-levels.



0341 UTC. Sonde close to the storm center. The winds have decreased by 20 – 40 kts in some places so perhaps this is an “eye” dropsonde. 40 kt winds at upper levels still pretty strong and some low level inversion also indicative of an eye location.

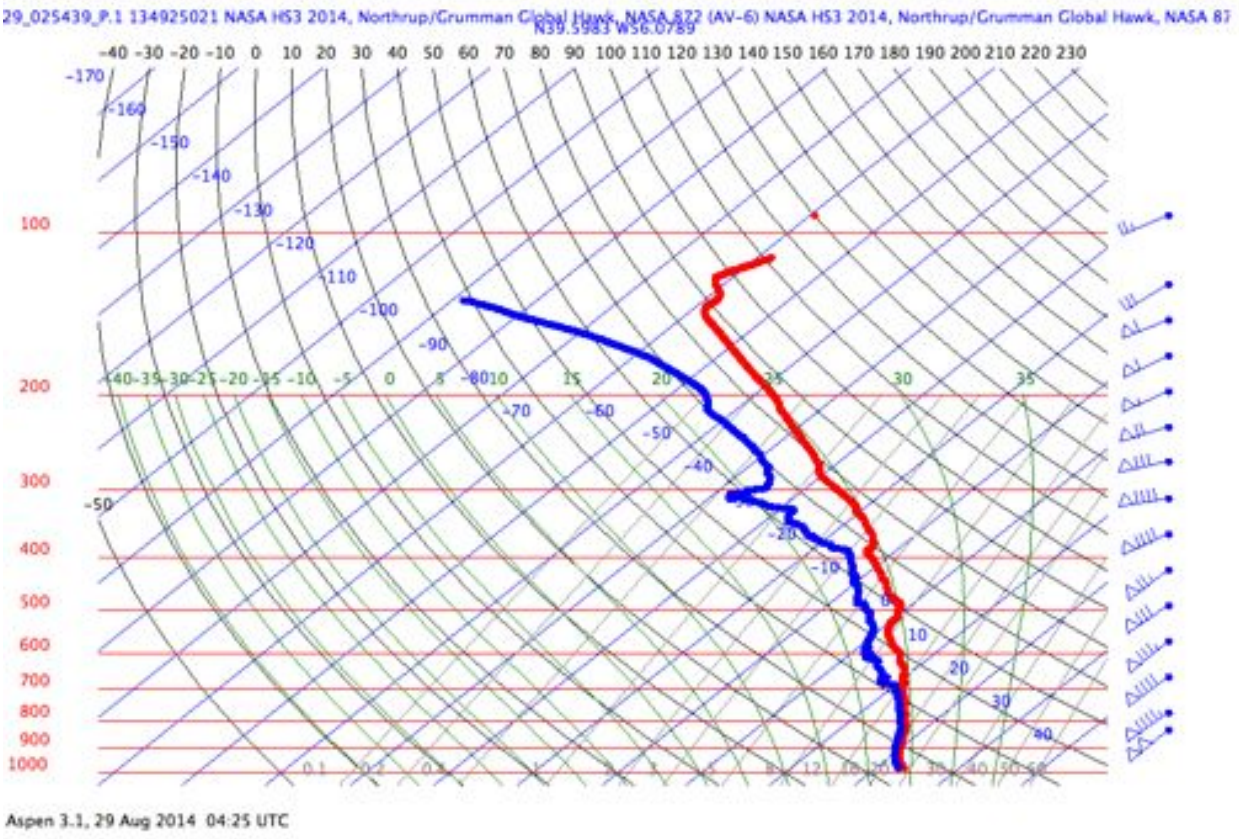


0406 UTC. Next sonde along the track through the center shows winds picking back up considerably to 50 kts. South to southwesterly flow. Saturated low to mid-levels. A 60 kt wind observation at 150 hPa may be indicative of upper level trough interaction.

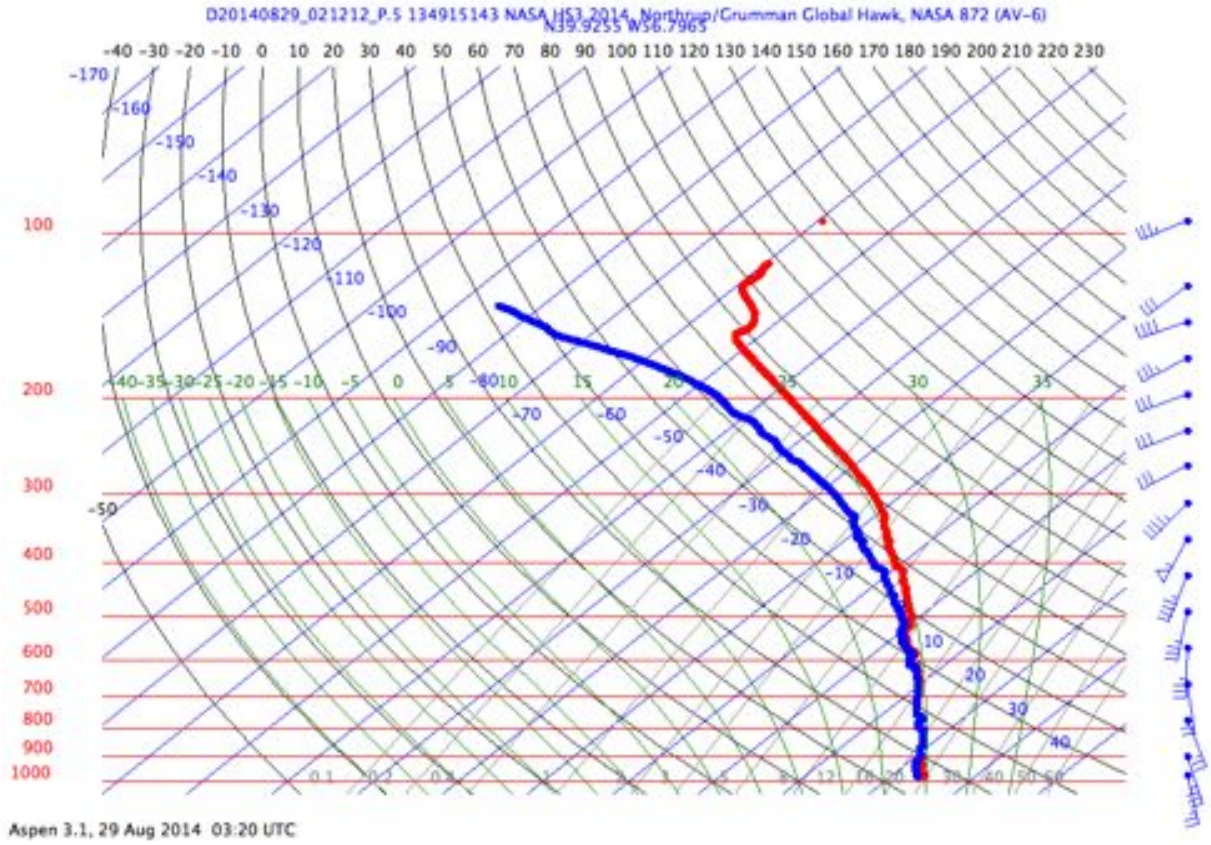


This GPM passive microwave image shows Cristobal near the time the GH passed through the center. There are still bands surrounding the center that indicate tropical characteristics, but the extension of convection to the NW of the center shows clear mid-latitude characteristics. Also, the circulation has expanded quite a bit, which is another indication of transition to extratropical.

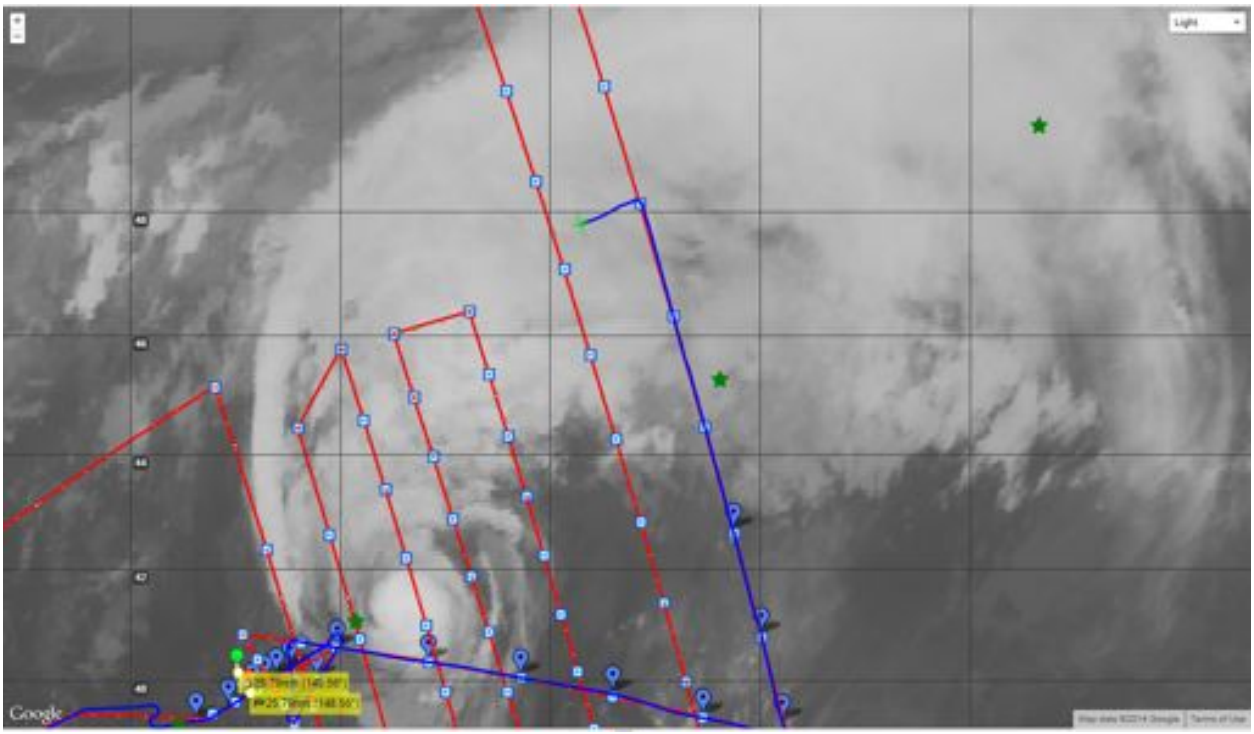
0520 UTC. We were just informed that extensive air traffic in our northern planned flight section will prevent us from dropping sondes, which is the primary instrument for this mission. These aircraft are "non-cooperative" in the sense that they don't have communications with them so we can't approach them with sondes. We are revising the flight plan accordingly to cut off that northern section and weave that time back into the lawnmower to add more sampling near the storm center.



0553 UTC. This sonde was dropped in the S/SE portion of the eyewall with peak winds of 100 kts at 850 hPa with winds of 60 + kts over the entire troposphere.



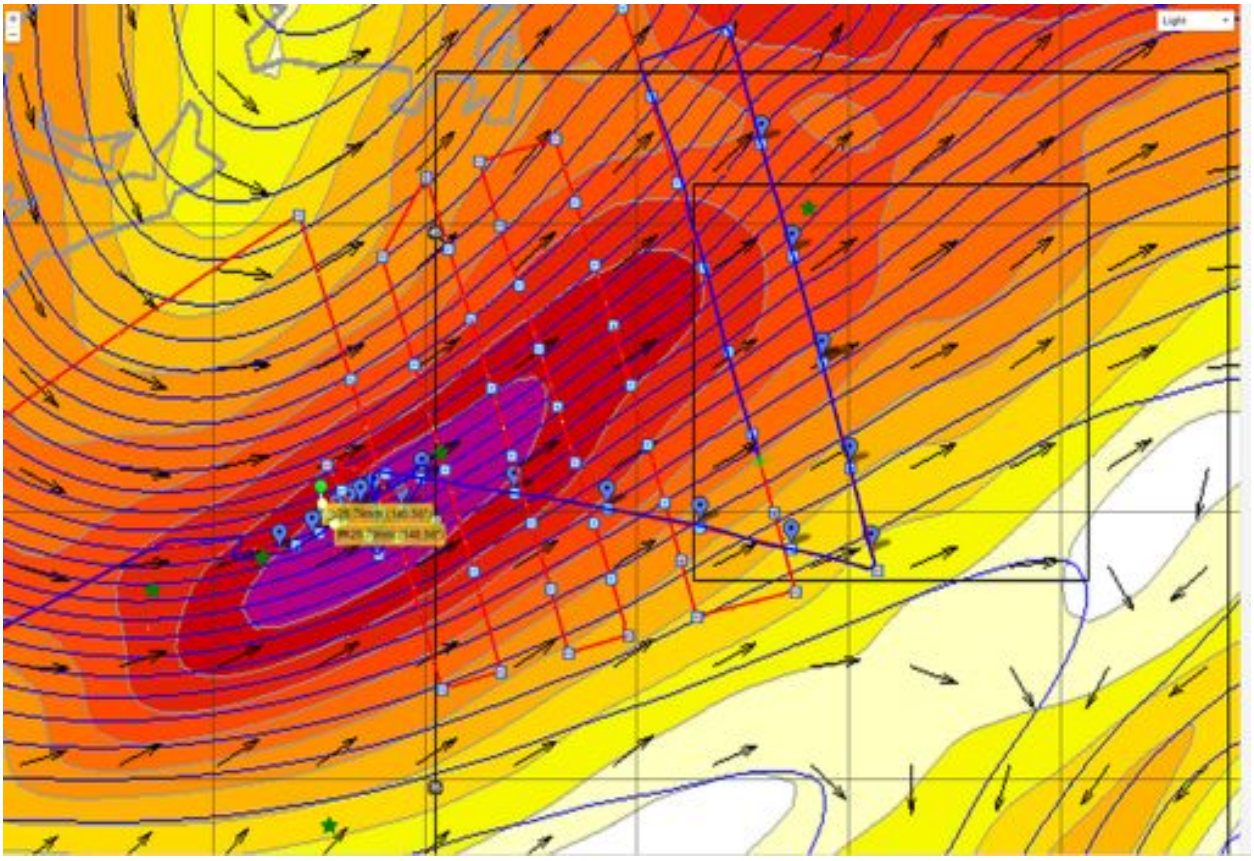
0341 UTC. Sonde close to the storm center. The winds have decreased by 20 – 40 kts in some places so perhaps this is an “eye” dropsonde. 40 kt winds at upper levels still pretty strong and some low level inversion also indicative of an eye location.



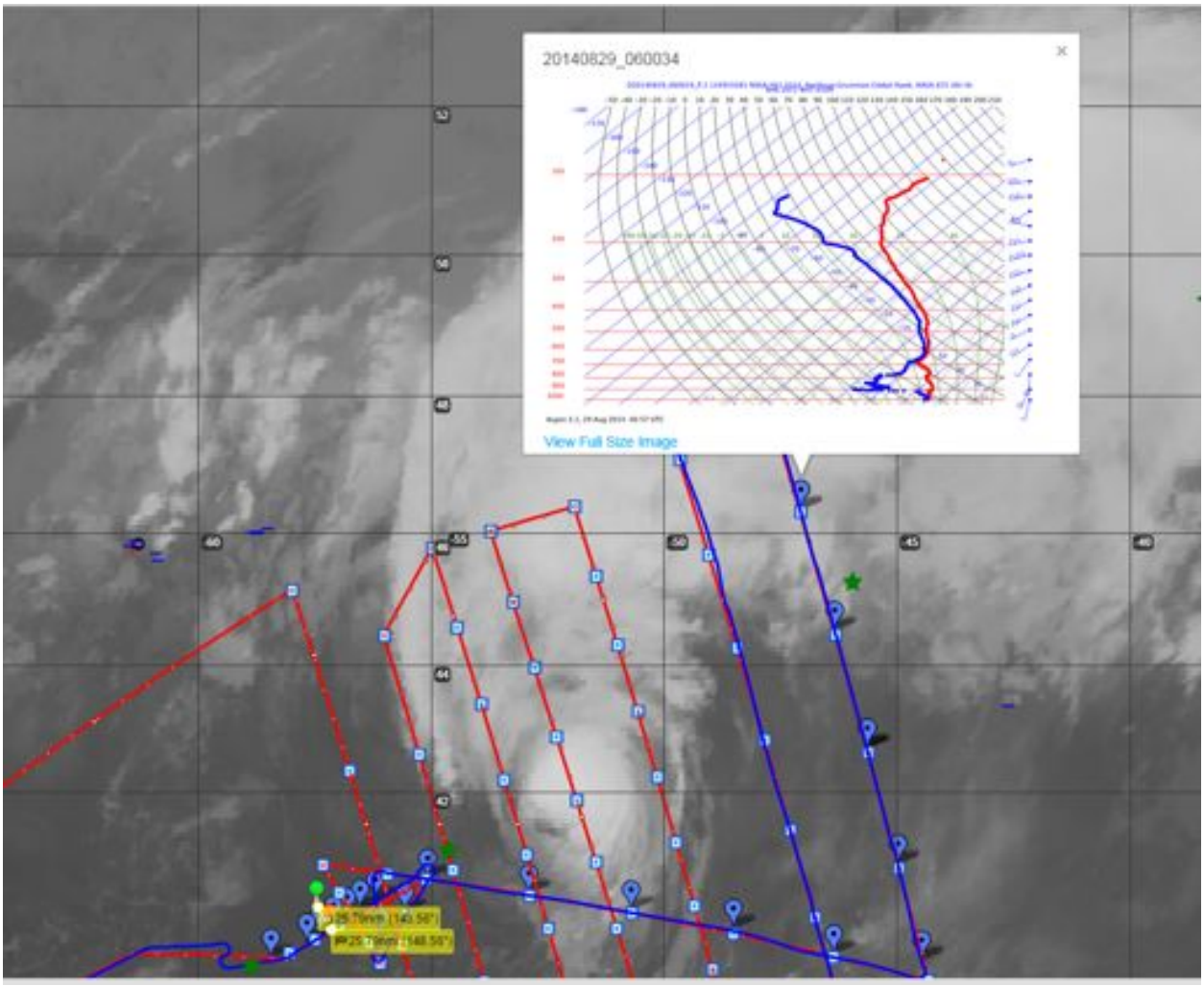
0637 UTC. IR image of Cristobal showing huge asymmetric cloud pattern. GH is cutting off northern extension due to air traffic. We are going to some sampling West of the storm center to capture an evolving jet region seen in the models and sampled by a few of our dropsondes. This should provide some good data for analyzing the trough interaction with Cristobal.

0653 UTC. Delayed update on NHC evaluation/forecast of Cristobal from 11 pm EDT…storm intensified a bit to 75 kt with minimum pressure of 970 hPa. Cooler SSTs coming up, but baroclinic effects may intensify further, uncertain though so glad HS3 is getting data.

0729 UTC. We missed a few sondes along the GH position in the above image because of continued air traffic in that region. We are saving those sondes for later and possibly more interesting features to sample.

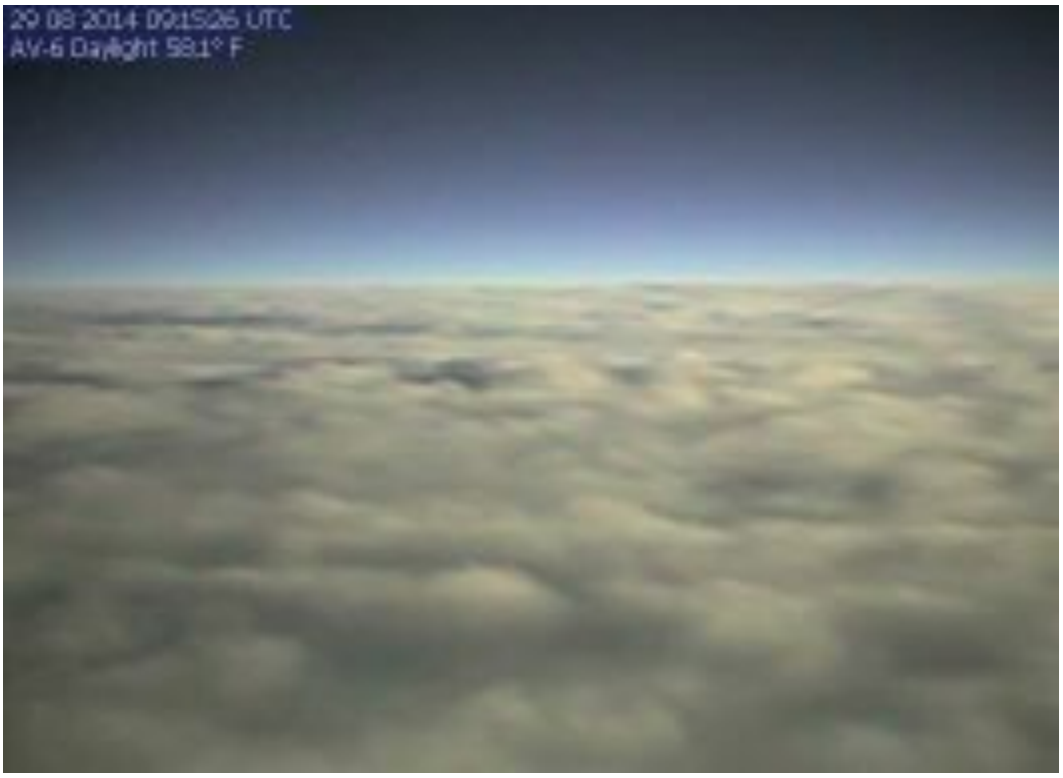


0752 UTC. Forecasted (COAMPS) jet location that we are going to try and sample by adding a leg to the West. Earlier sondes already showed very strong deep layer winds in this region. Updated flight plan going to be loaded in MTS.

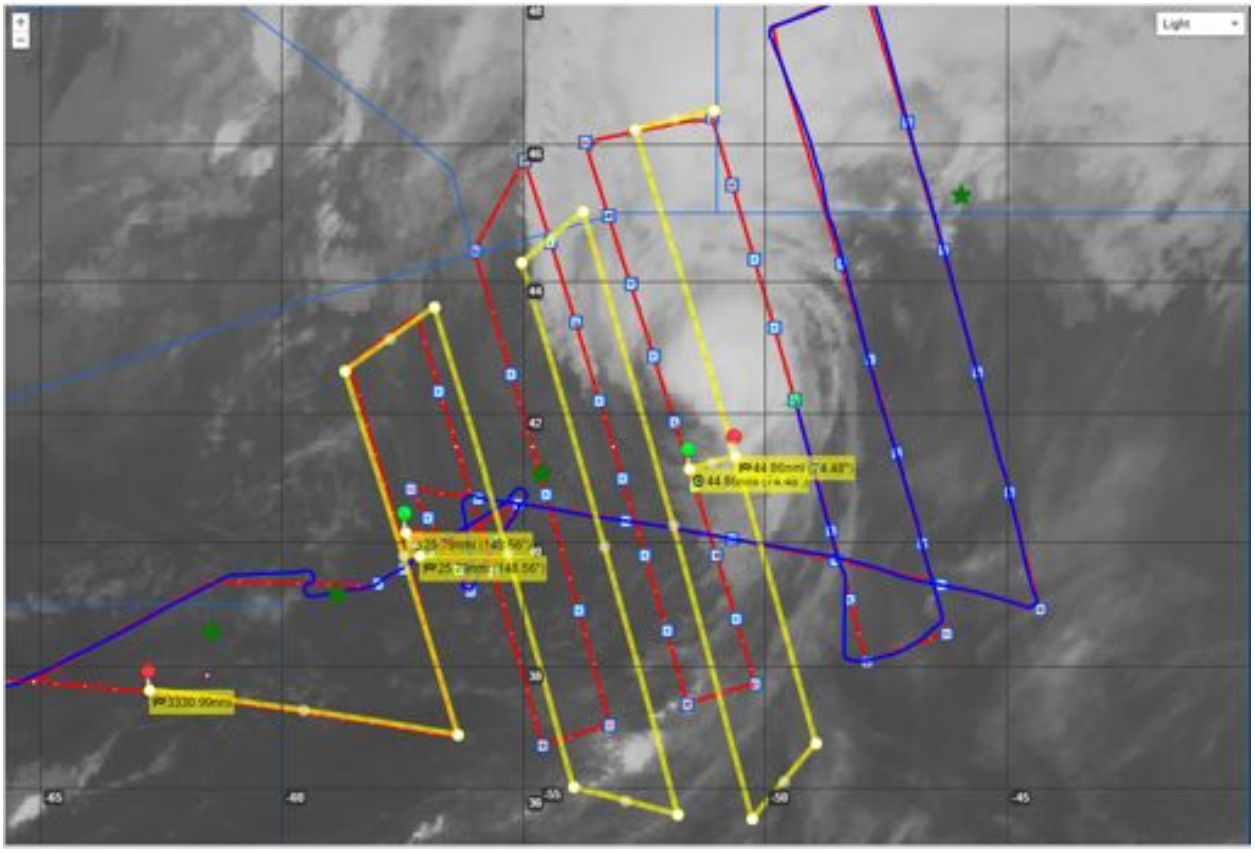


0815 GOES IR image. Plane is at southern end of second leg. Dropsonde to northeast shows nearly 100 mb deep 0 deg isothermal layer associated with a deep melting layer.

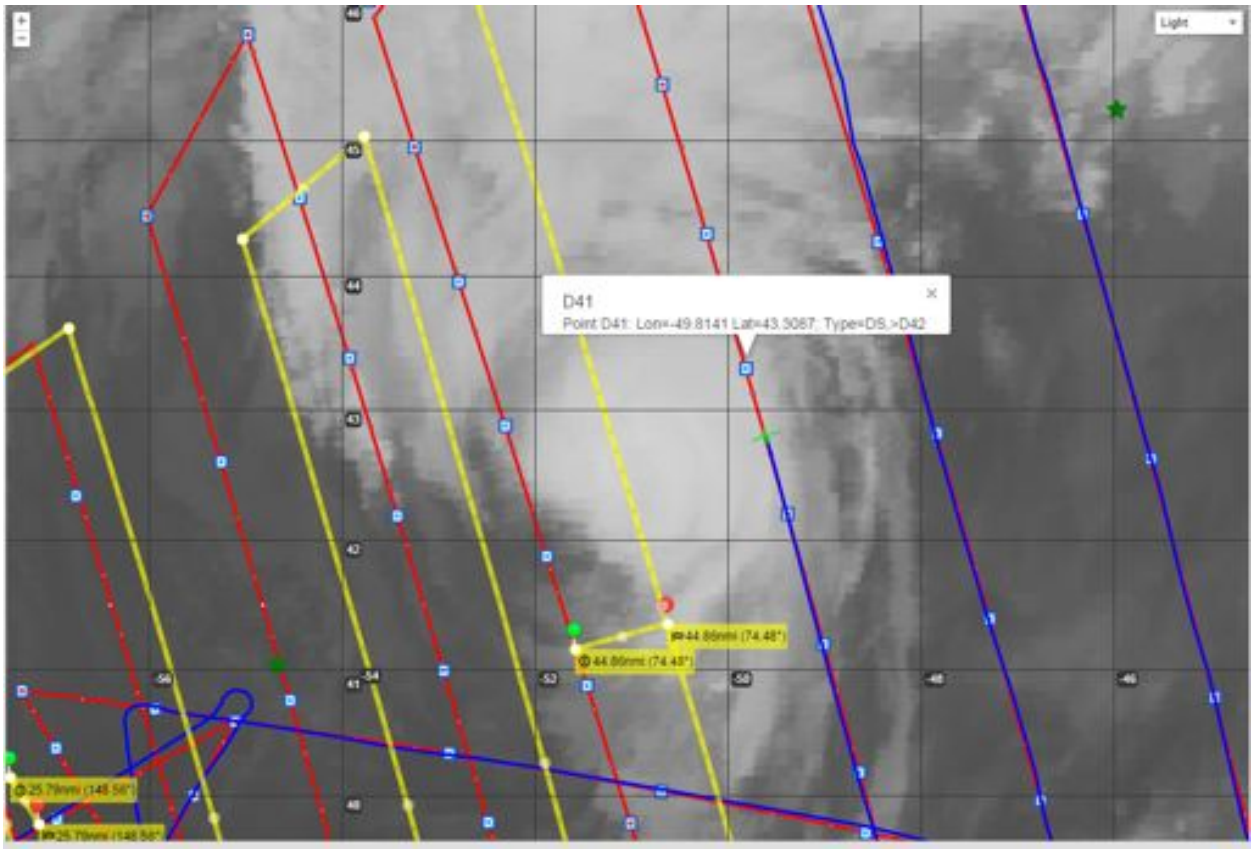
0838 Slight delay along southern end of next leg while we wait for clearance to turn northward.



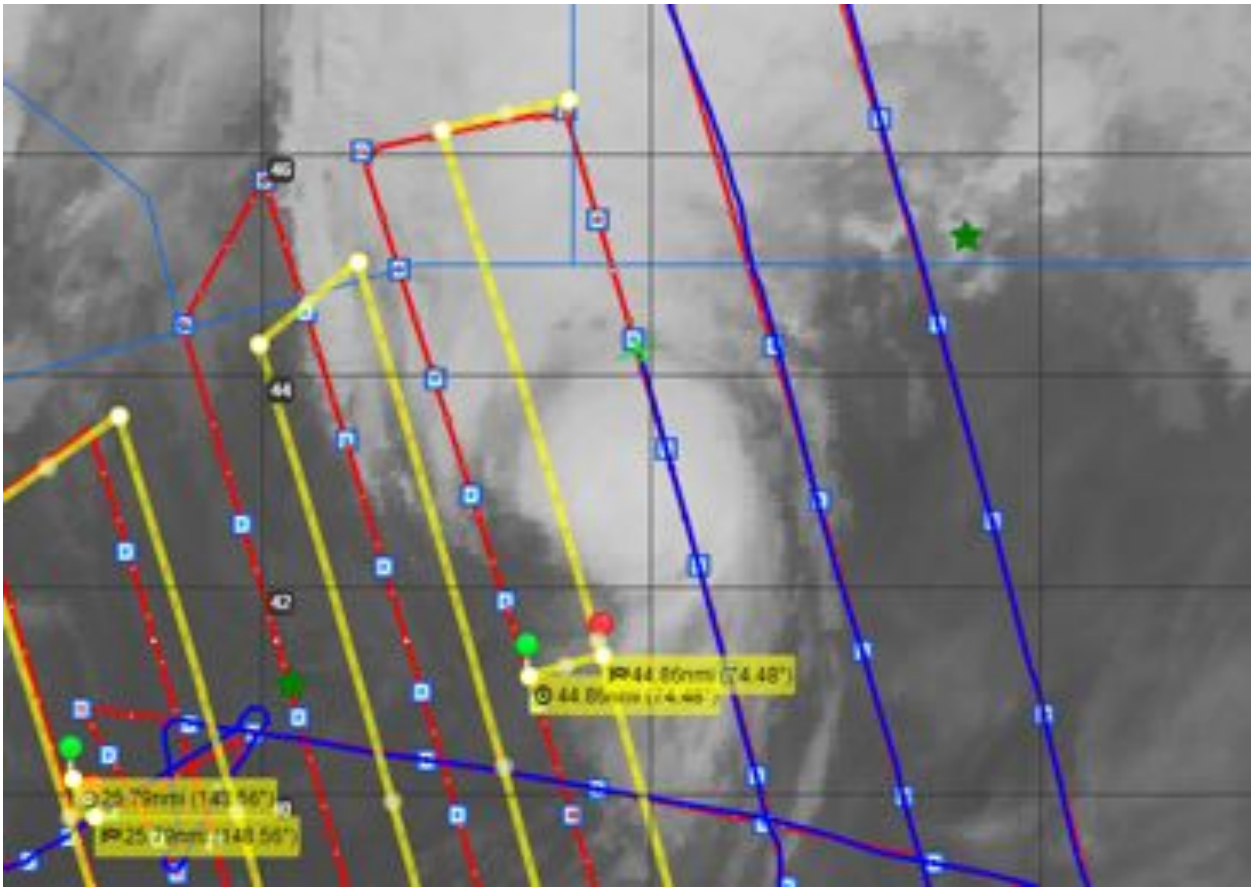
0915 Morning image on the daylight camera.



0916 Working on new flight pattern that will shift remaining legs eastward a bit and also southward to cross the developing cold front. We have 11 extra sondes at the moment, so will add sonds to last two legs.



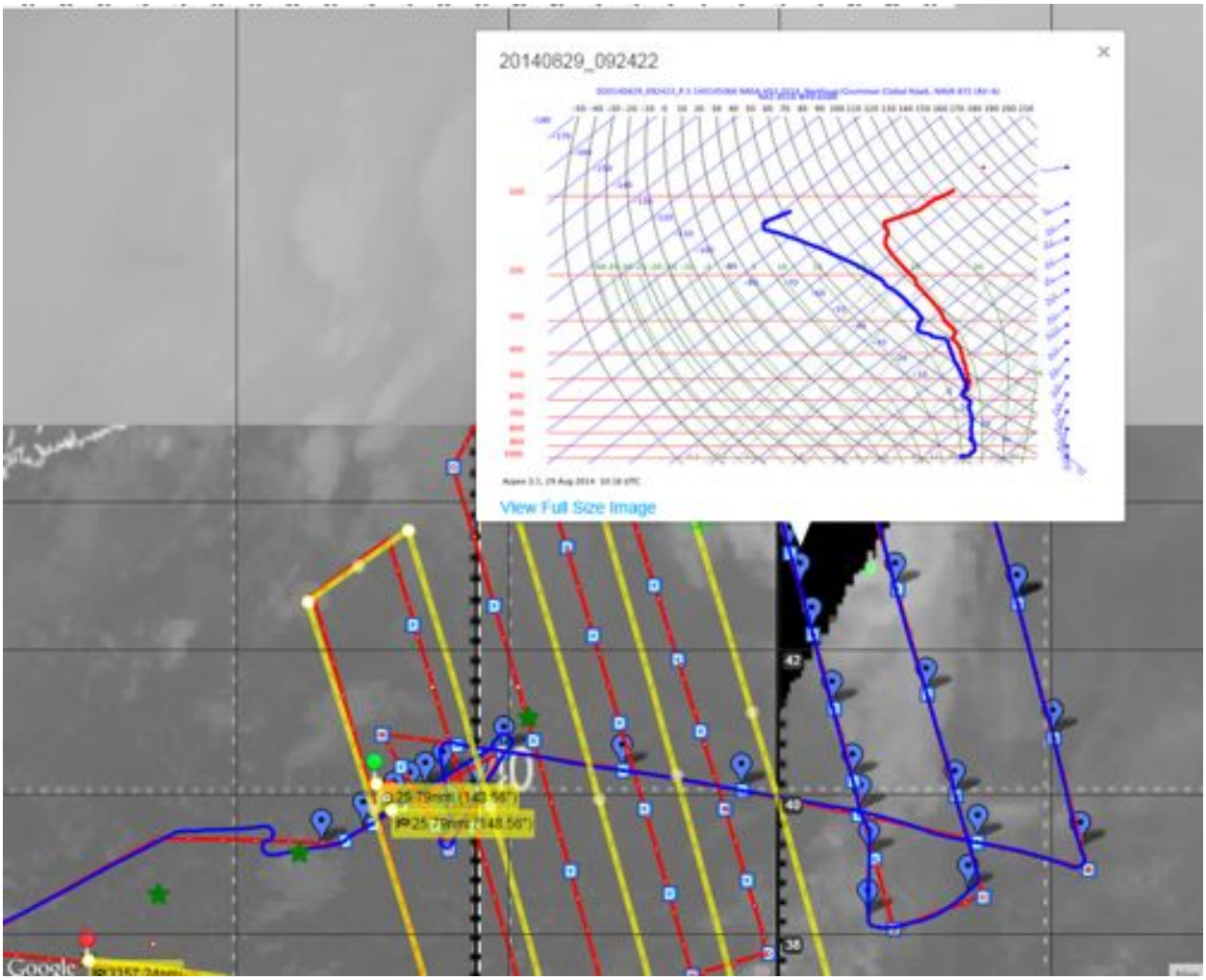
Adding two new drops on current leg before and after original drop D41. The first is at the location of the plane in the above image, the next between D41 and D42. The remaining 9 drops will be added to later legs. Flight planning is working on new flight pattern and will add new drop points to MTS.



0940 Have to suspend drops because we haven't heard from Gander ATC to get clearance. Hoping to get it since there isn't a lot of traffic on Flightradar24.com.

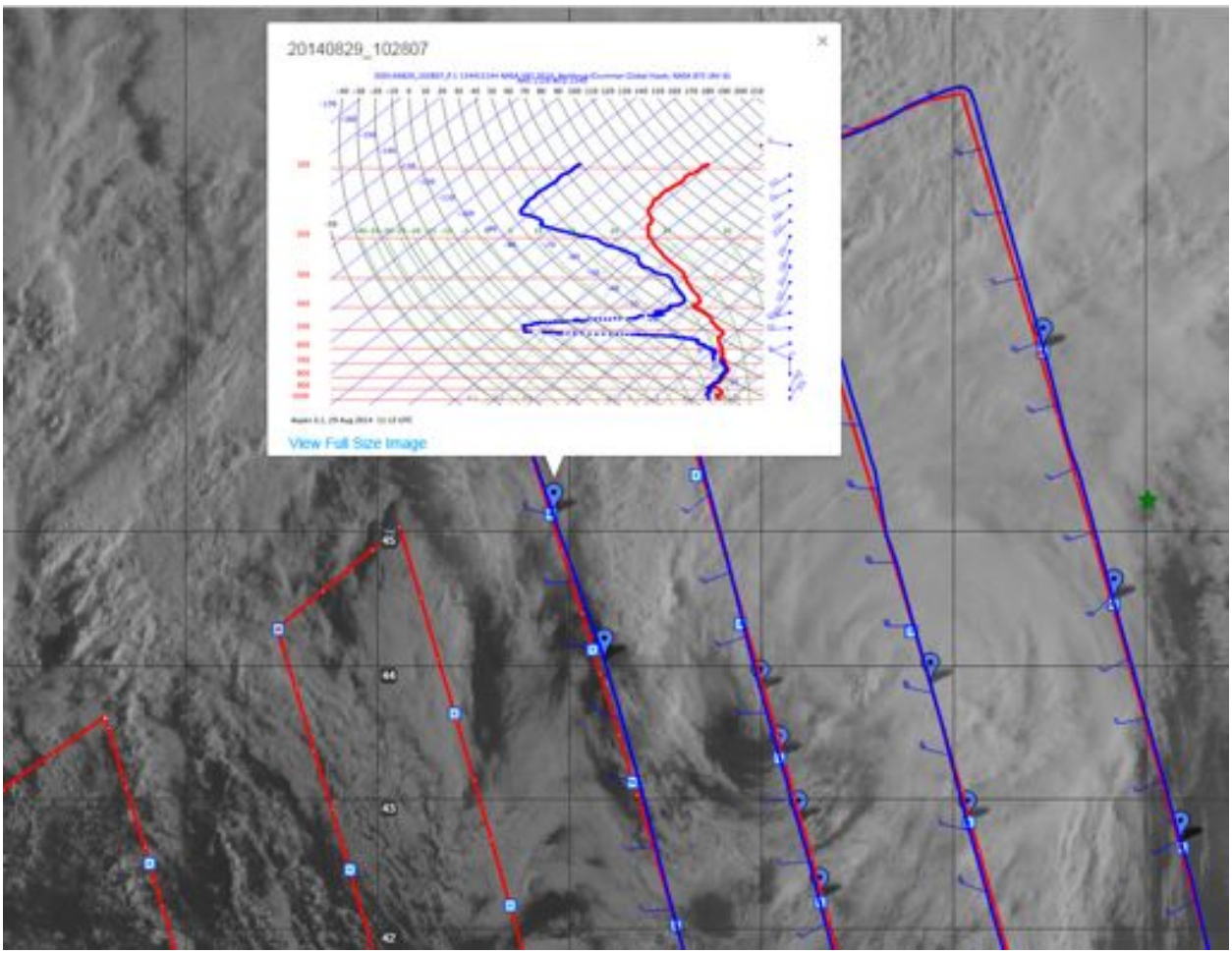
0952 Don't expect to get clearance until we get back south of 44degN. Couldn't get northern part of path cut short because by the time we would get clearance, we would already be on the northern part of the pattern.

1016 Finally heard from Gander. Will resume drops at beginning of southbound leg.

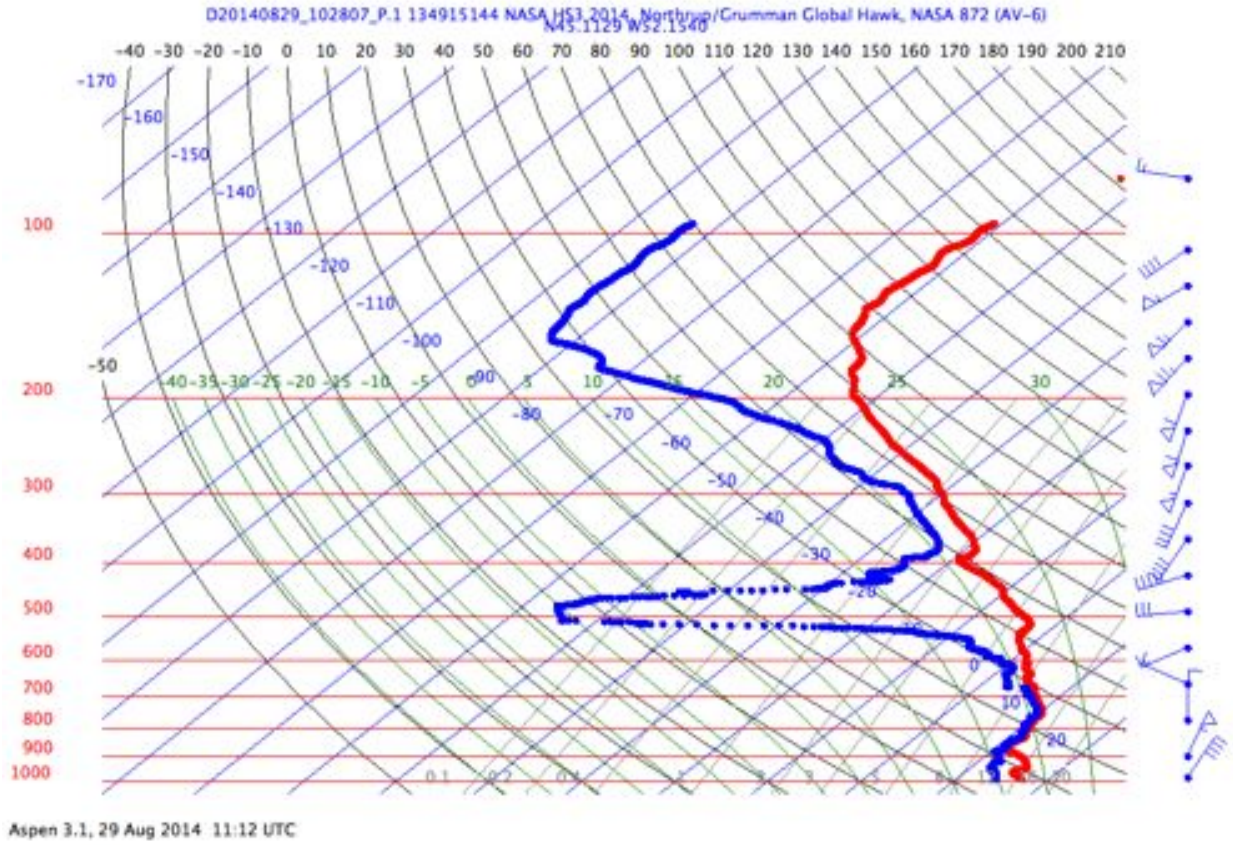


One of the drops near the center (shortly before sondes were suspended) shows 90 kt winds near 800 mb. Moist profile, possibly impacted by sensor wetting.

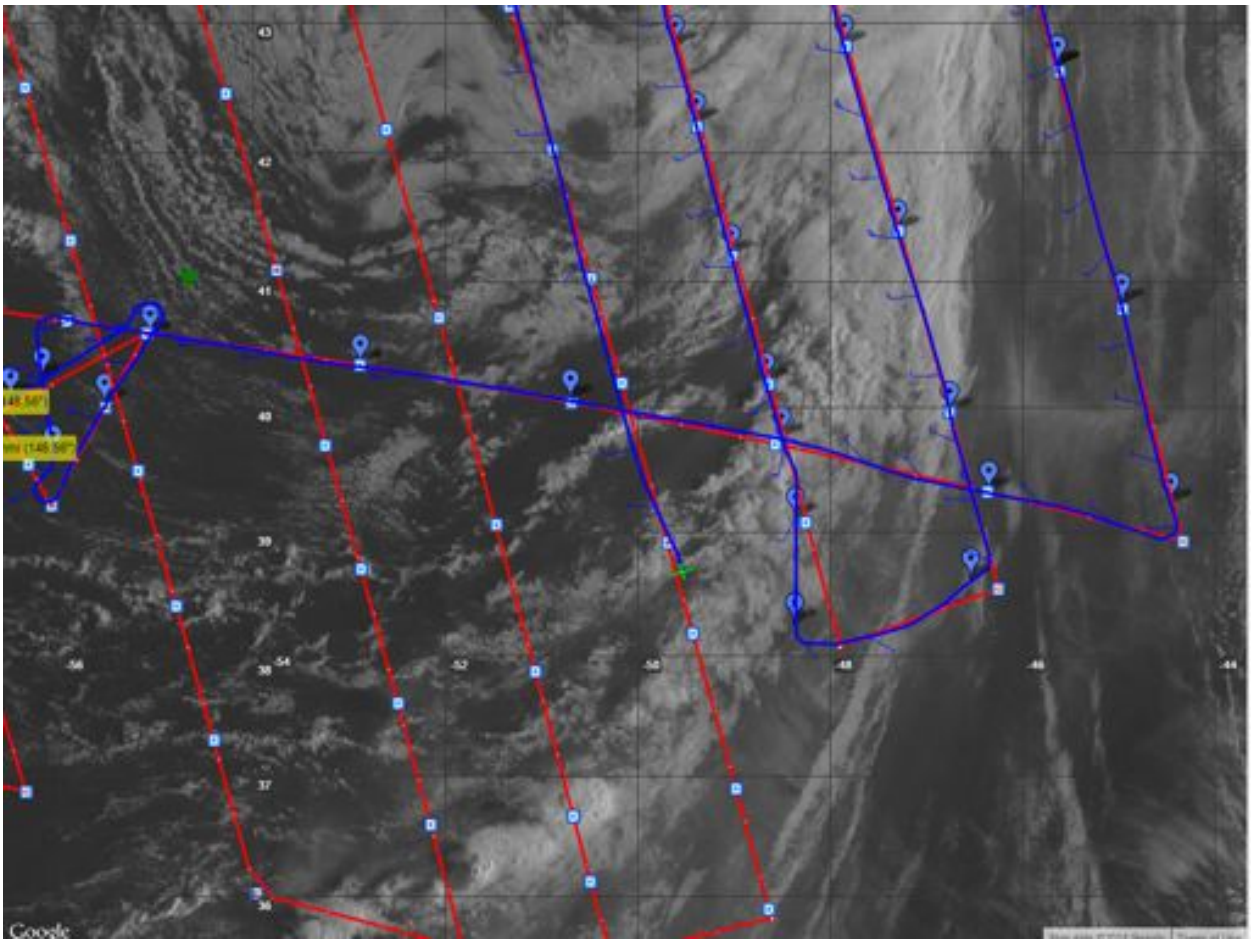
1100 Nice image of postfrontal clouds from HDVIS.



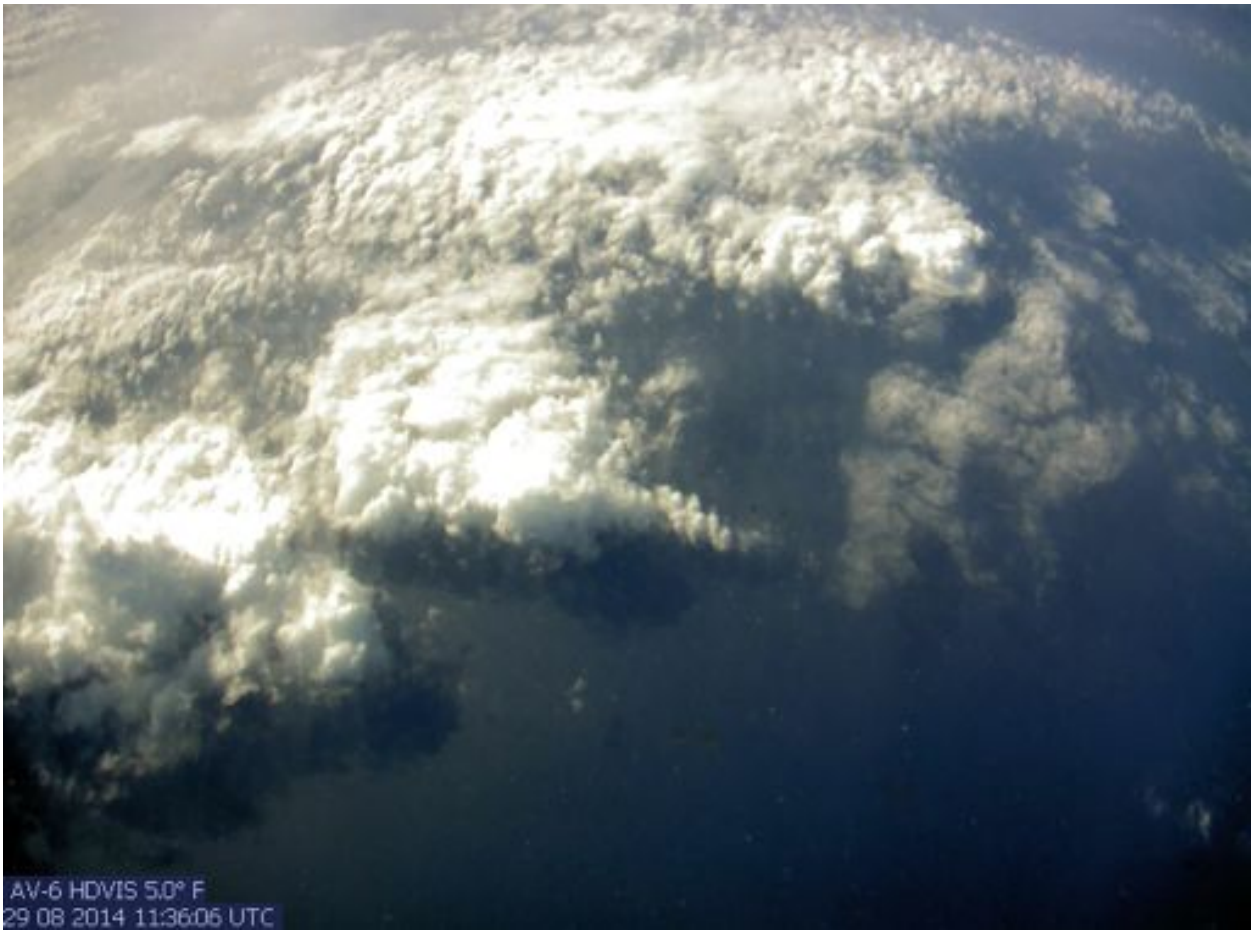
1134 Image shows drop location for expanded plot below.

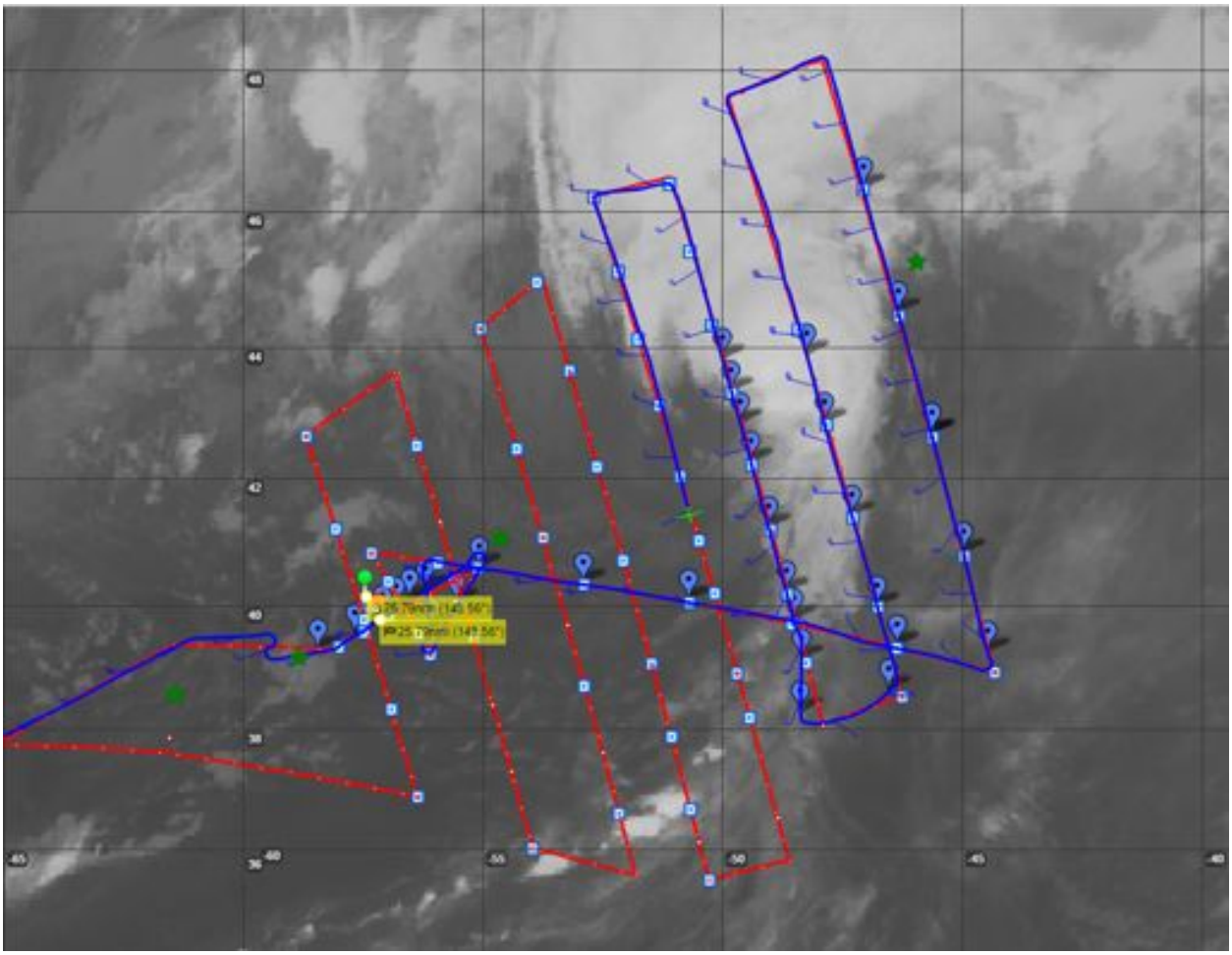


Deep inversion layer below 700 mb with significant backing of the wind.

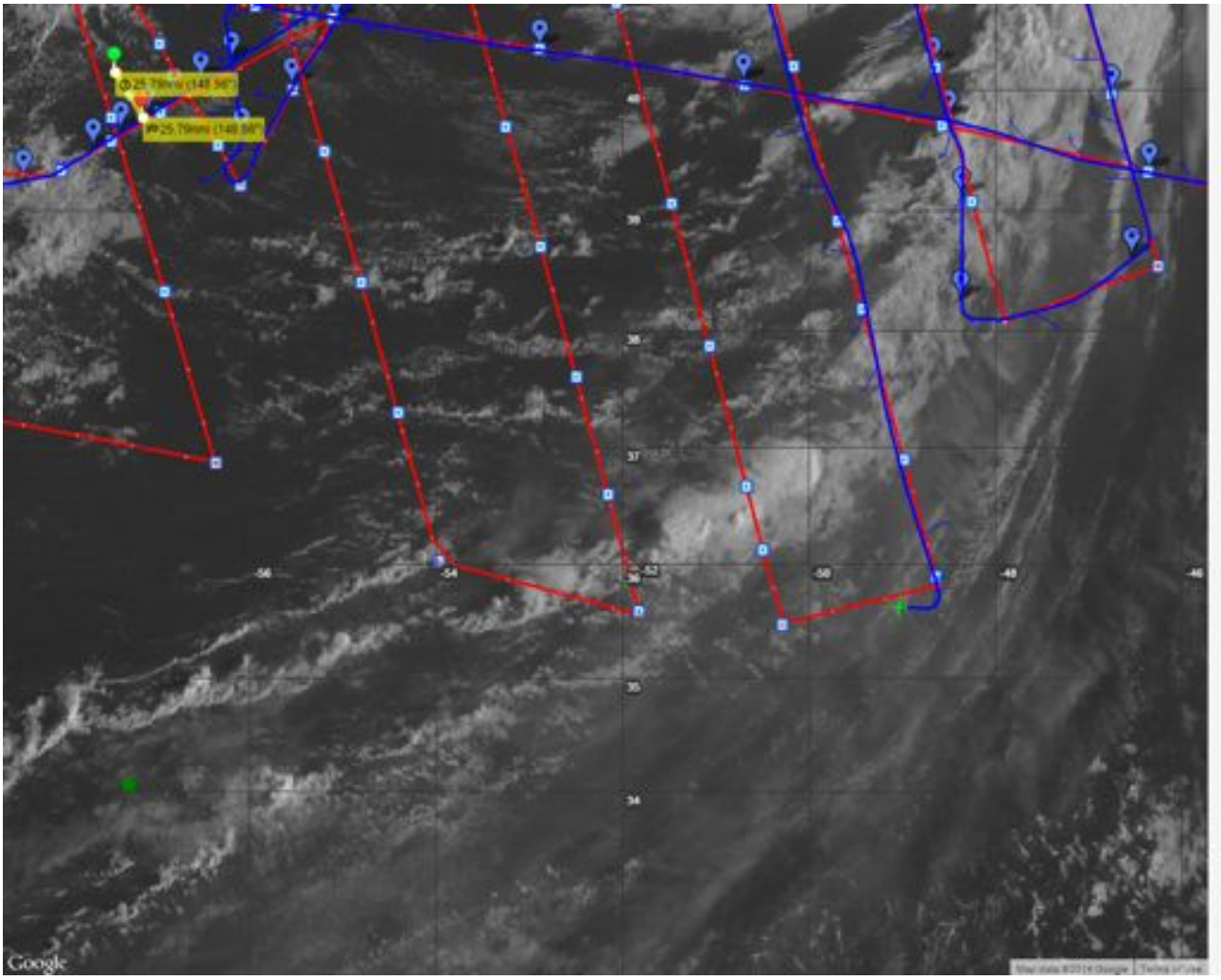


1140 Image show aircraft location at time of HDVIS image below. Note that satellite image is old, so HDVIS may be showing post-frontal convection.


AV-6 HDVIS 5.0° F
29 08 2014 11:36:06 UTC

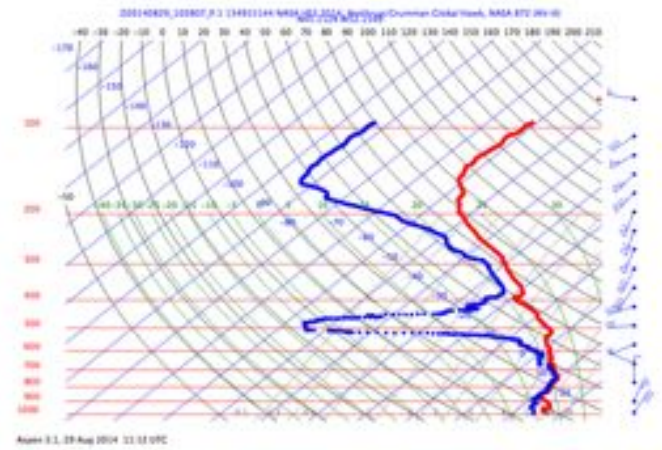


1108 New waypoints in MTS. Not all drop locations are showing—flight planners working to correct it.

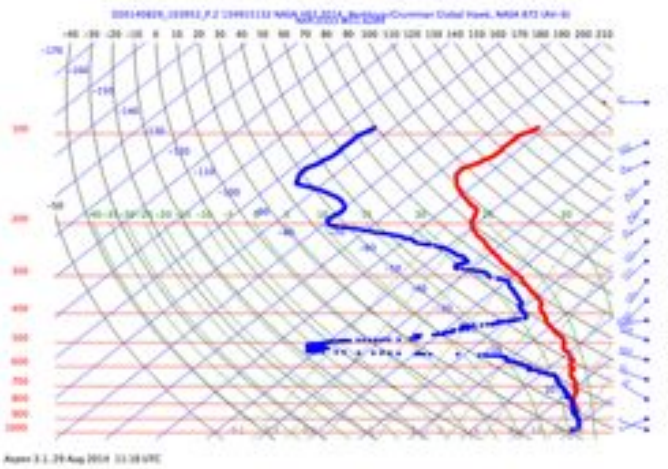


0816Z Convection associated with front.

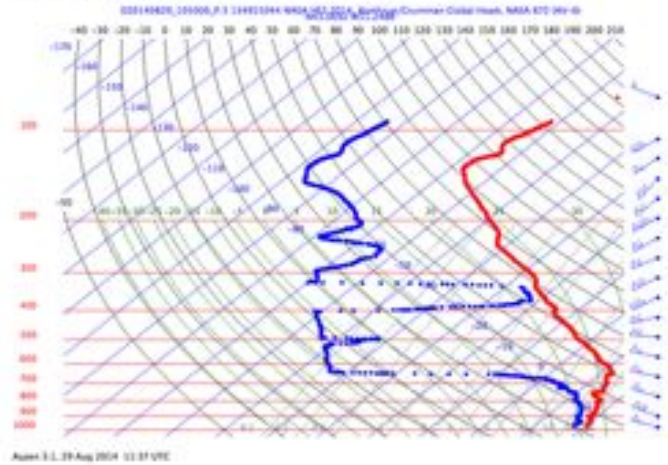
20140829_102807



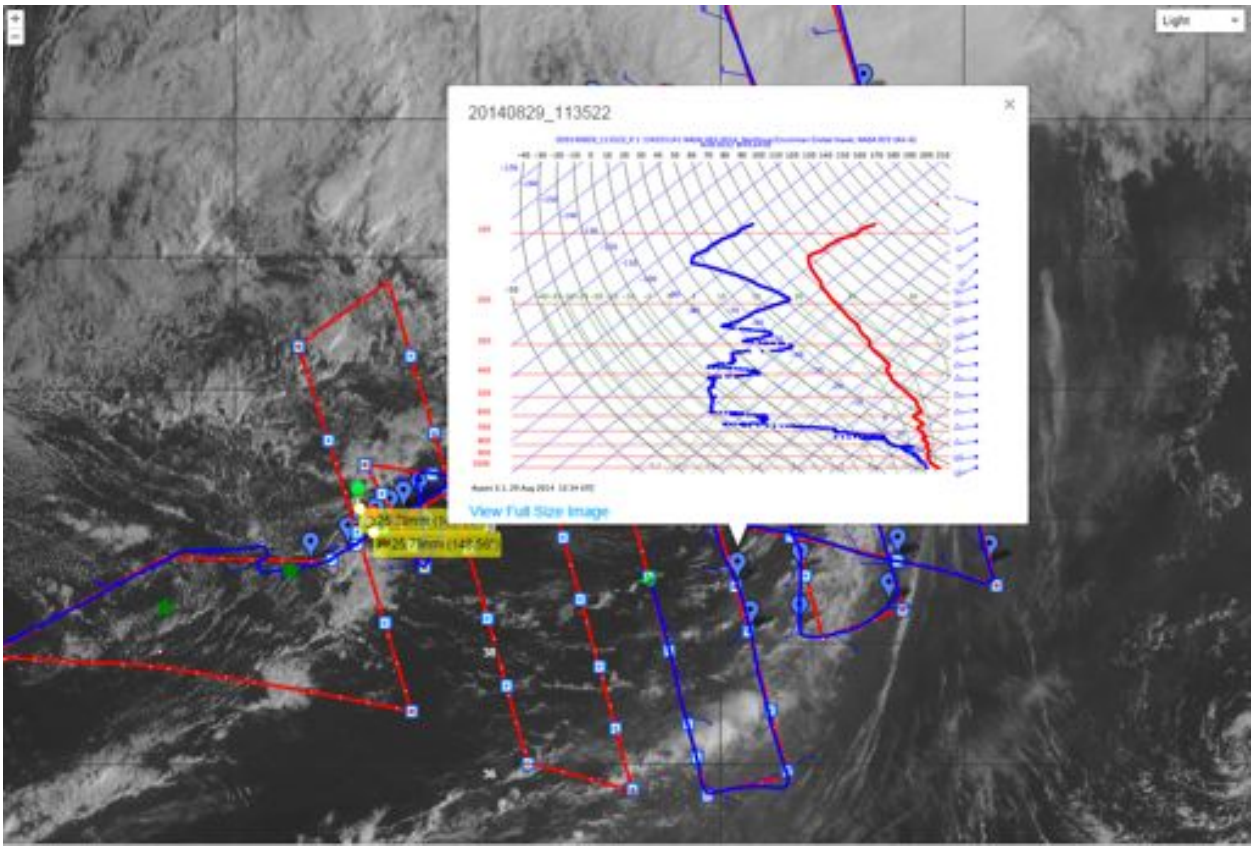
20140829_103952



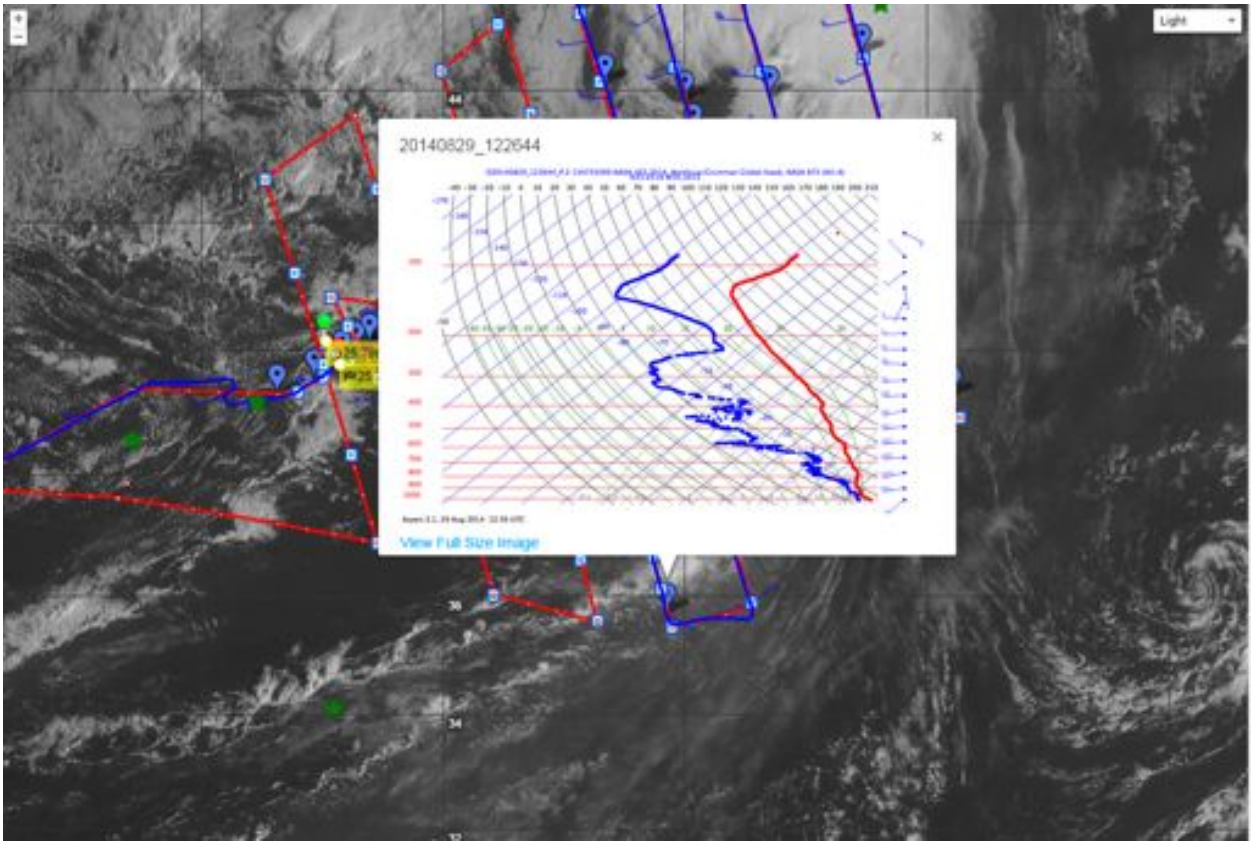
20140829_105006



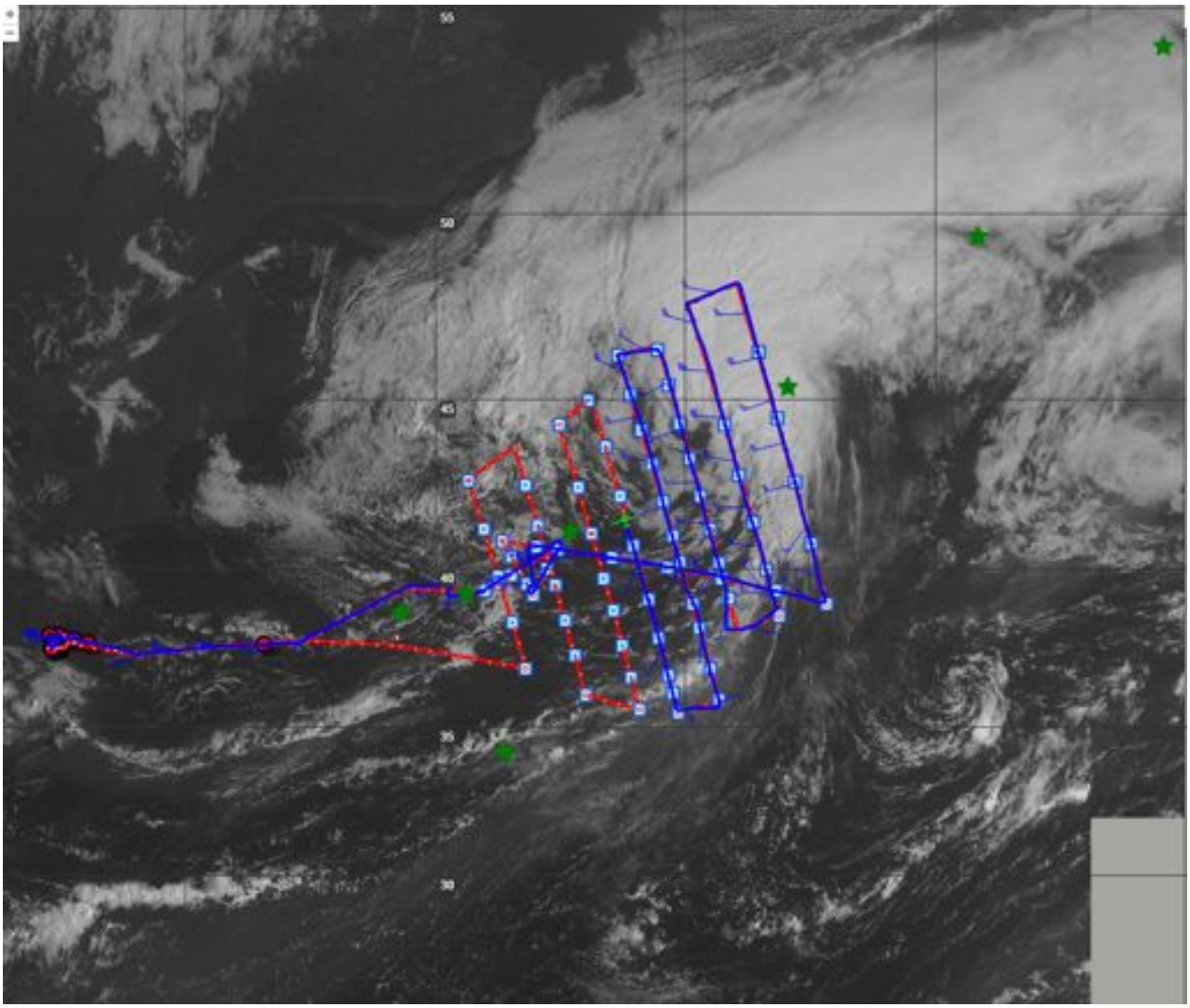
3 consecutive sondes – north to south from 1112 to 1137. Note calm region near surface between first and last sondes and inversion in last sonde .



1304 image with earlier post frontal sounding.



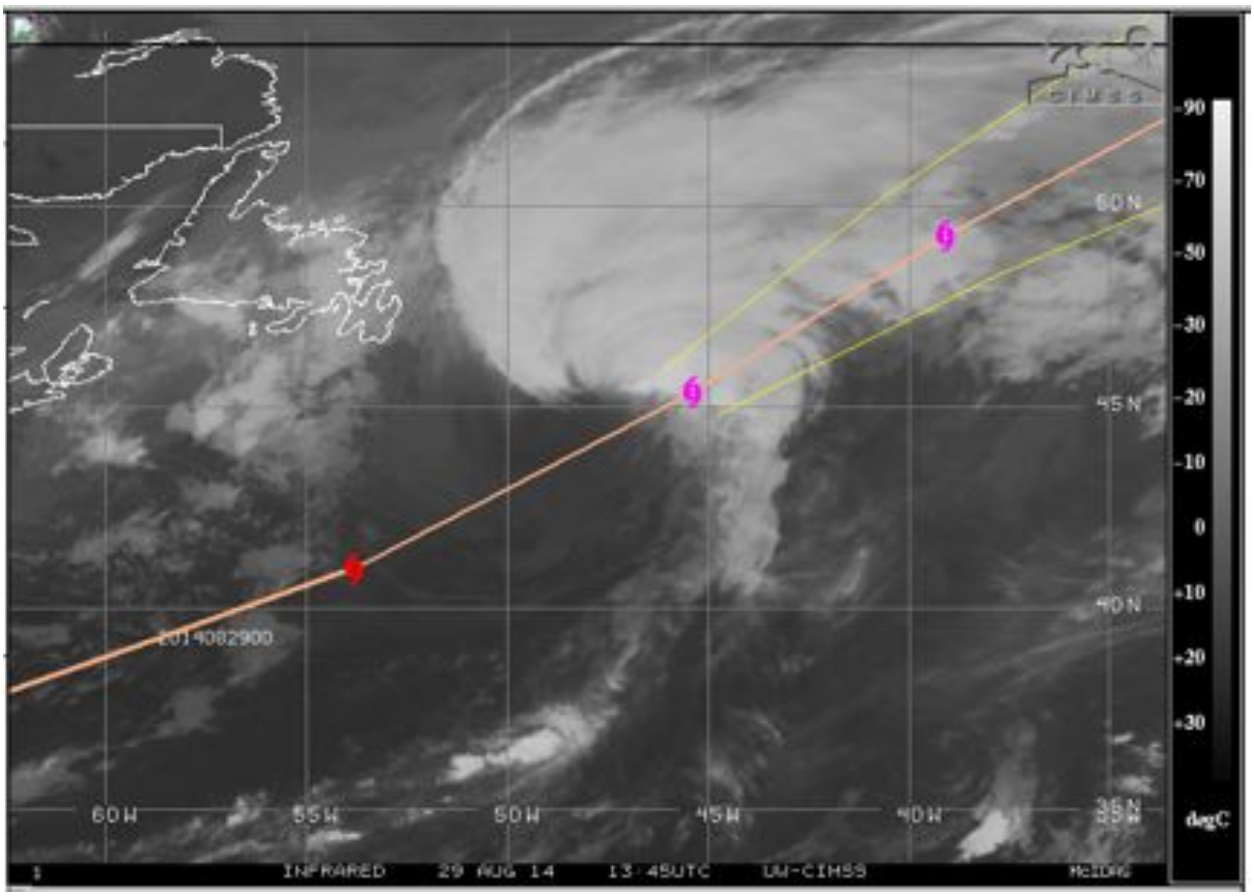
1316 – Pre-frontal sounding.



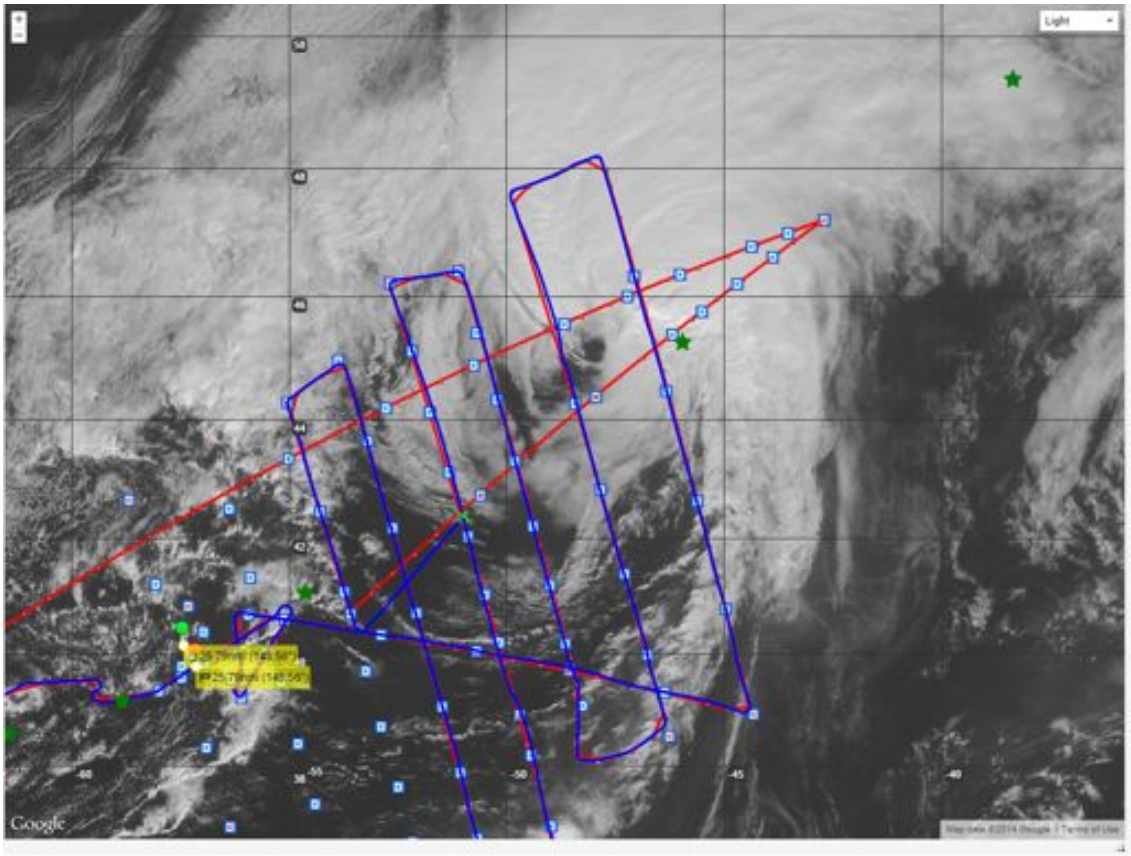
1330 – large scale shot

1408 – Very dry air on west side. Working on changing flight plan by cutting off last 3 legs. Instead fly ENE across and ahead of system and than WSW back home. This will be difficult because crew change is occuring. Working on the change.

1450 Abandoning plan and heading back ENE to revisit storm center. Replanning in still in progress.

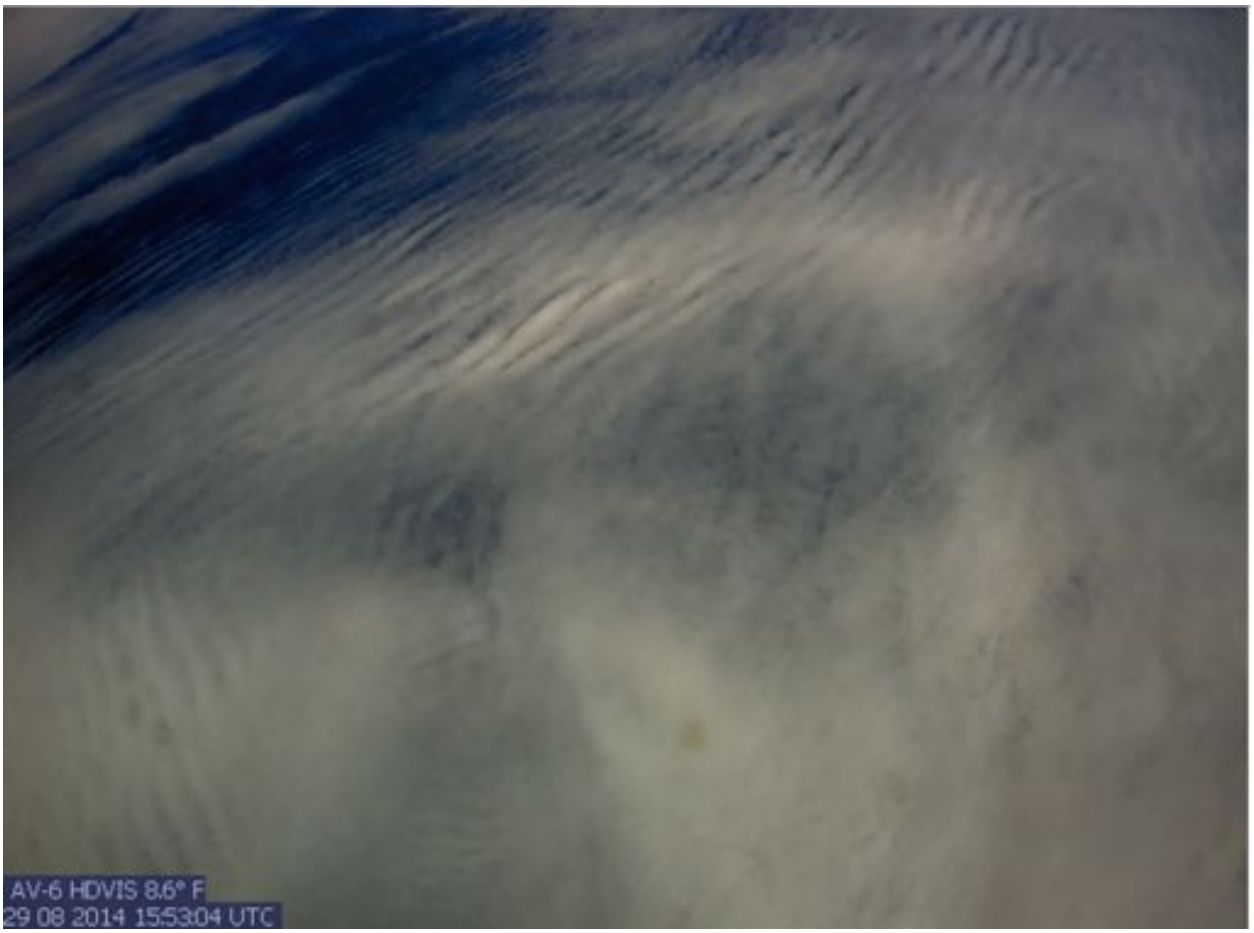


1345 IR image.

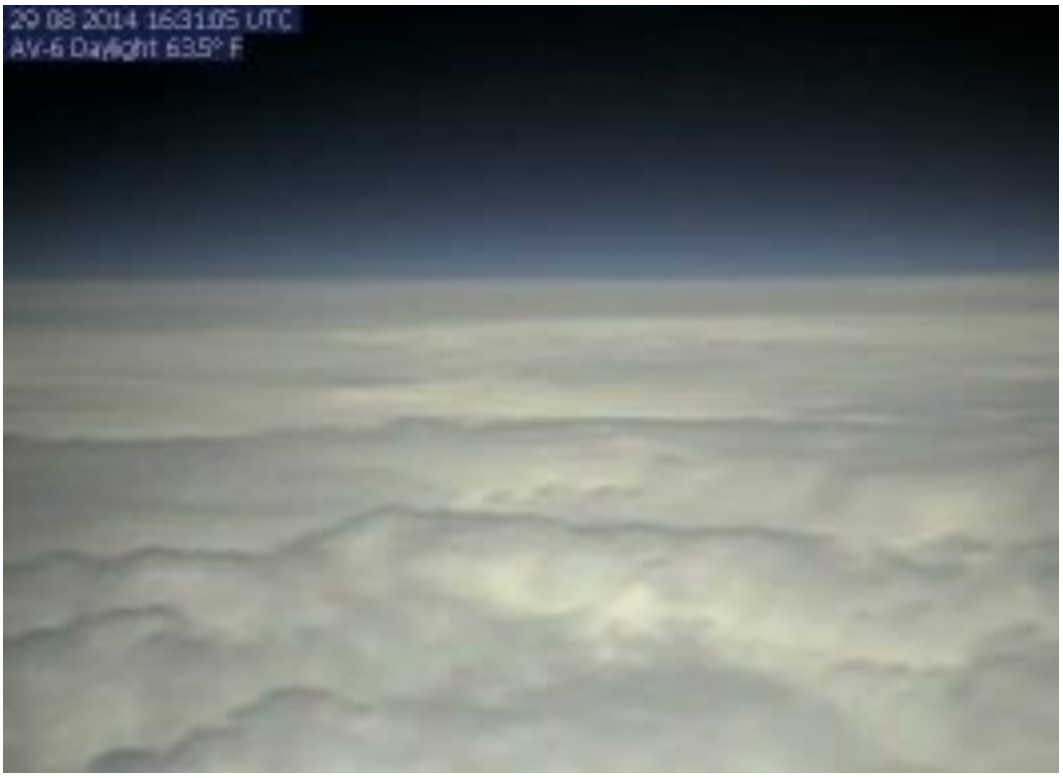


1530: Revised flight plan.

1537 HDVIS image when plane heading NNE.



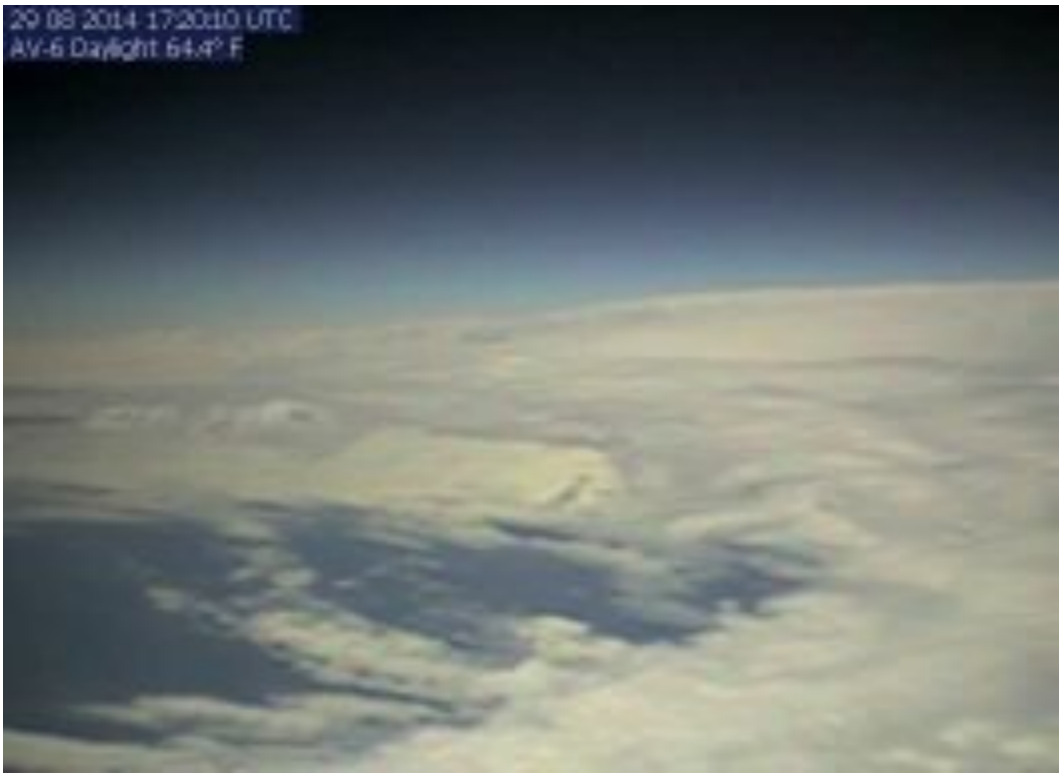
1554 KH waves heading ENE.


29 08 2014 163105 UTC
AV-6 Daylight 63.5° F

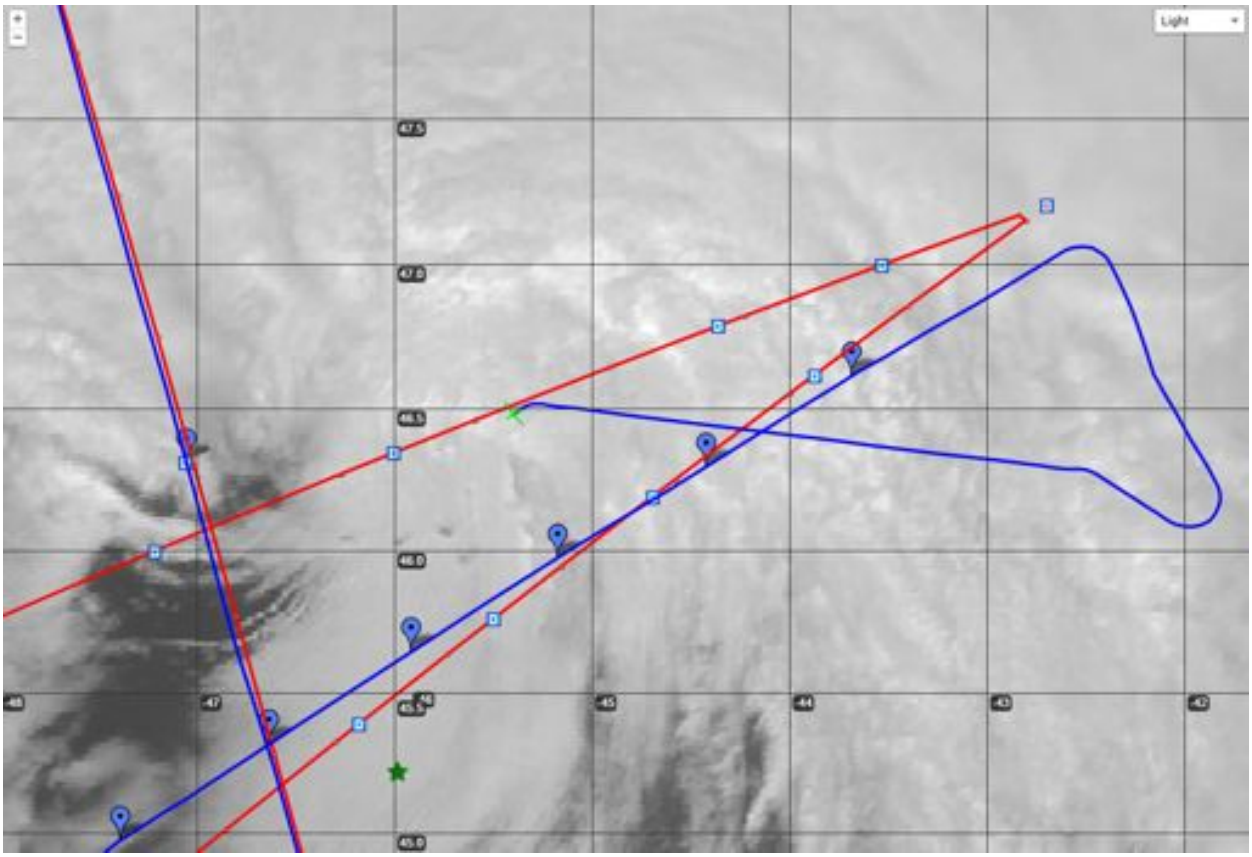

29 08 2014 170758 UTC
AV-6 Daylight 64.4° F


29 08 2014 17:17:09 UTC
AV-6 Daylight 64.4° F


AV-6 HDVIS 12.2° F
29 08 2014 17:18:12 UTC


29 08 2014 172010 UTC
AV-6 Daylight 64.4° F


AV-6 HDVIS 12.2° F
29 08 2014 17:20:43 UTC

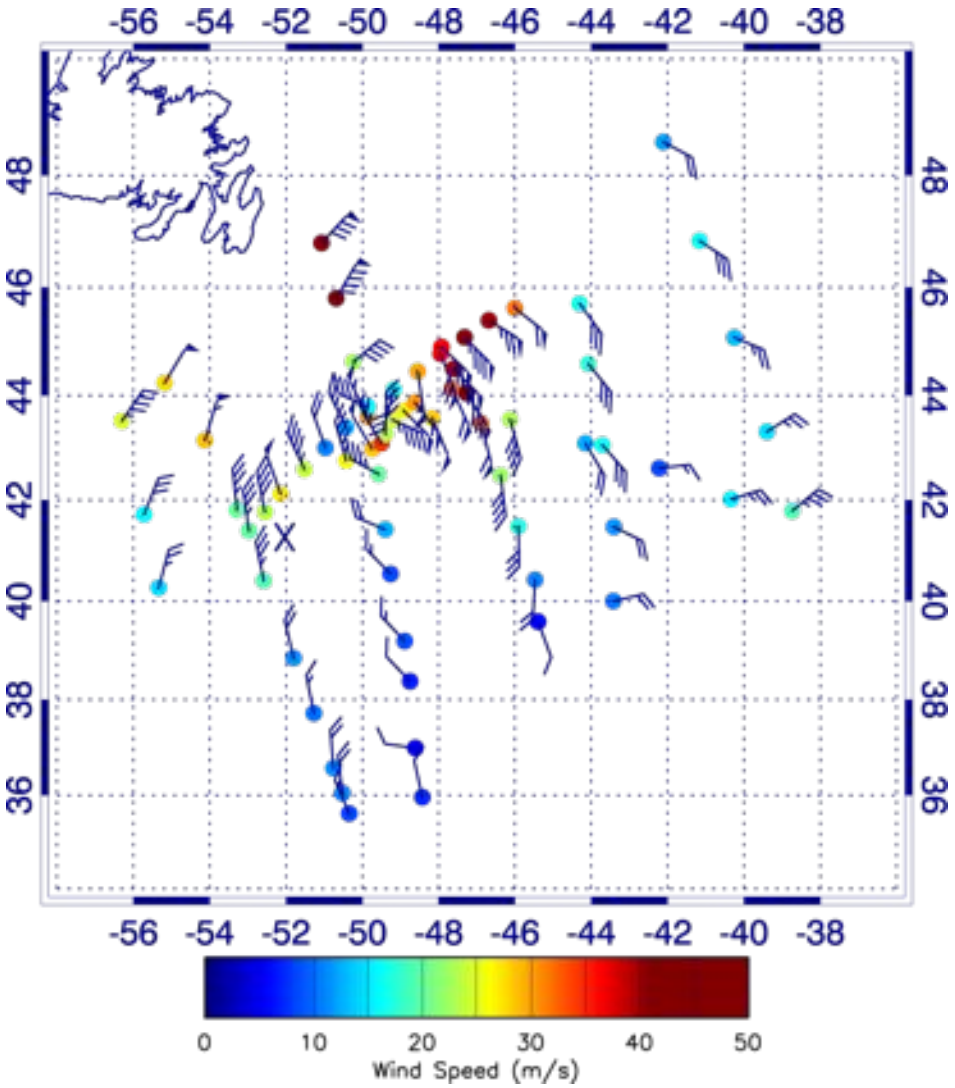

Light
47.5
47.0
46.5
46.0
45.5
45.0
-48
-47
-46
-45
-44
-43
-42


AV-6 HDVIS 13.1° F
29 08 2014 18:36:23 UTC

2122 Very uneventful transit back to WFF.

2130 Powering paylaod down for descent.

2237 Landed.



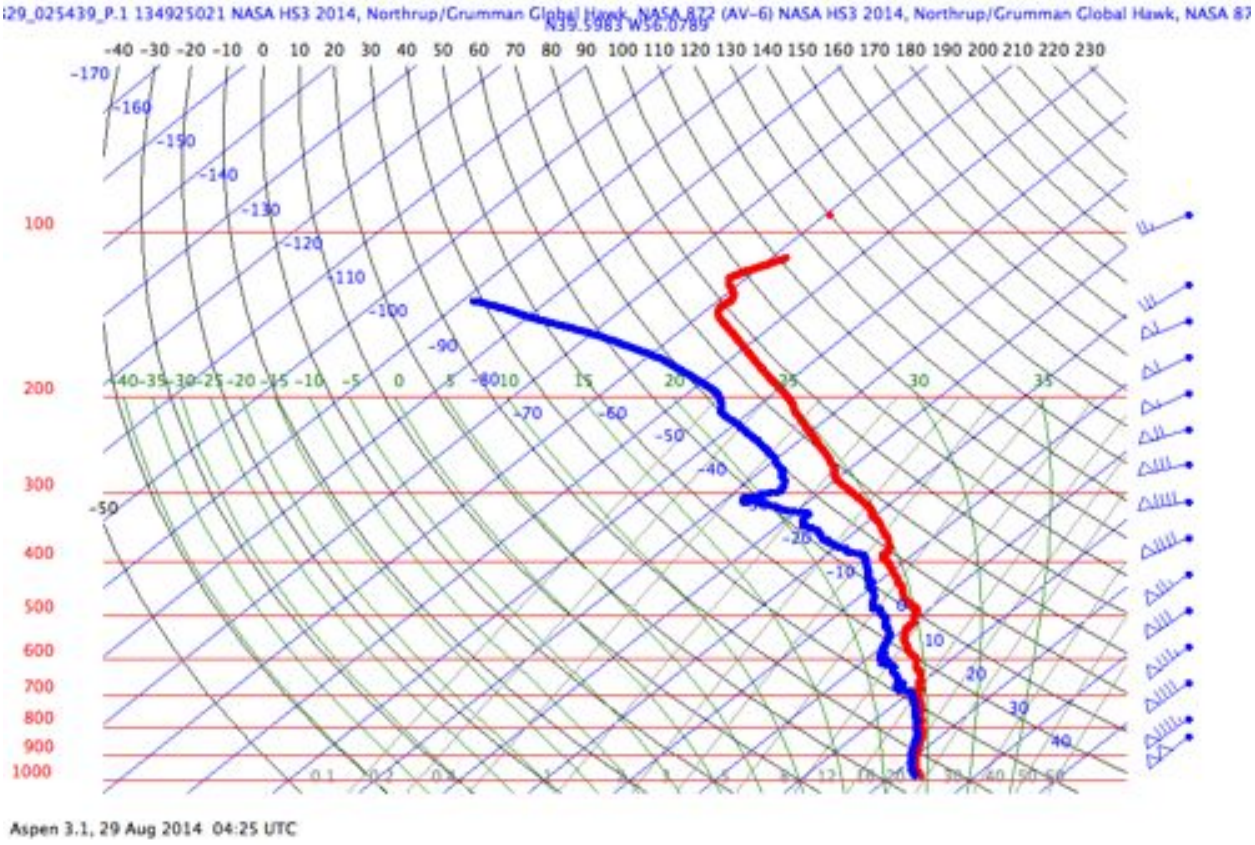
The above figure shows the sonde distribtion in a storm-relative reference frame using a rough estimate of the storm motion. Wind barbs show storm-relative winds at 925 hPa and colors show ground-relative total wind speed.

Instrument summaries

AVAPS

AVAPS system performance and data quality were excellent on the second science flight. 70 sondes were loaded and 70 were deployed. Data were returned from 69 sondes and telemetry performance was excellent. No fast falls were experienced. All data was processed in real time, transmitted through the GTS, and preliminary data made available to science team members. Only one small system issue occurred where, due to delayed receipt of load confirmation during a Ku outage, a second sonde was loaded before the first was launched. Software checks to prevent this from happening had been relaxed

for use of the software on an NCAR aircraft. Since it was unclear at the time that a second sonde had been loaded, this second sonde was unexpectedly deployed during efforts to reset the system. Valid data was obtained from the first sonde, but no data was obtained from the second. Problems of this nature will be avoided in the future by software modifications and a change in operator procedures. The system is ready and fully green for future flights. Scientific value of the data appears quite high with wind speeds up to near 100 knots observed below 900 mb as shown in the following graphic obtained during first passage of the system.



Allocated		**750**	
Remaining		**605**	**80.7%**
Released		**145**	**19.3%**
Flight	**Take off Date**	**Sonde Usage**	**Sondes Left**
RF01	8/26/2014	75	675
RF02	8/28/2014	70	605

S-HIS Flight Summary: 28-29 August 2014

Revision: 31 Aug 2014

J. Taylor, Dan DeSlover, Claire Pettersen; SSEC, University of Wisconsin-Madison

Summary:

The Scanning-HIS operated nominally throughout the flight. An instrument power cycle (15 minutes off) at 45 minutes prior to the first science waypoint was implemented to address the cooler behavior noted in Science Flight #1. This power cycle successfully addressed the cooler issue, and detector temperatures remained nominal and stable throughout the flight. We will plan to continue this procedure for remaining flights and will re-visit the procedure if necessary.

There was a Ku outage (Ku Link Mod) at approximately 1745UTC (140928). The issue was resolved by IT, but the S-HIS datagram packet transmission never returned to normal functionality. The loss of datagrams was significant enough that S-HIS data records were not downlinked for the remainder of the flight. There are approximately 40-45 datagrams in a Scanning-HIS real-time data record, and logs showed losses of 5 or more datagrams for each record (on average). All datagrams must be transmitted for a record to be properly reconstructed for real-time processing. Accordingly, the datagram losses resulted in no real-time products for S-HIS after the outage.

A small change was made to the format of the S-HIS real-time brightness temperature plots. The new plots more clearly show the individual Scanning-HIS footprints and reduced interpolation artifacts (see Figure 1, Figure 2, Figure 3).

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

- 20140828T2212 GH engine start
- 20140828T2239 Ku ON and transmitting
- 20140828T2251 SHIS Power on
- 20140828T2257 Takeoff
- 20140829T2310 S-HIS detectors cooled
- 20140829T0004 S-HIS power cycle; 60 minutes prior to science waypoint 1 (15 minutes off)
- 20140829T0021 S-HIS power cycle complete, IL41 on
- 20140829T0042 S-HIS detectors cooled, cooler current nominal
- 20140829T1745 Ku link mod down; Ku link mod power cycled and Ku link restored, but no S-HIS real-time data after this time
- 20140829T2055 S-HIS descent heaters on
- 20140829T2131 Instrument power OFF before descent (IL42, IL41, DC42, DC41)
- 20140829T2144 Instrument power ON (DC41, DC42, IL41, IL42)

- 20140829T2210 Instrument power OFF (DC41, DC42, IL41, IL42)
- 20140829T2238 Landing

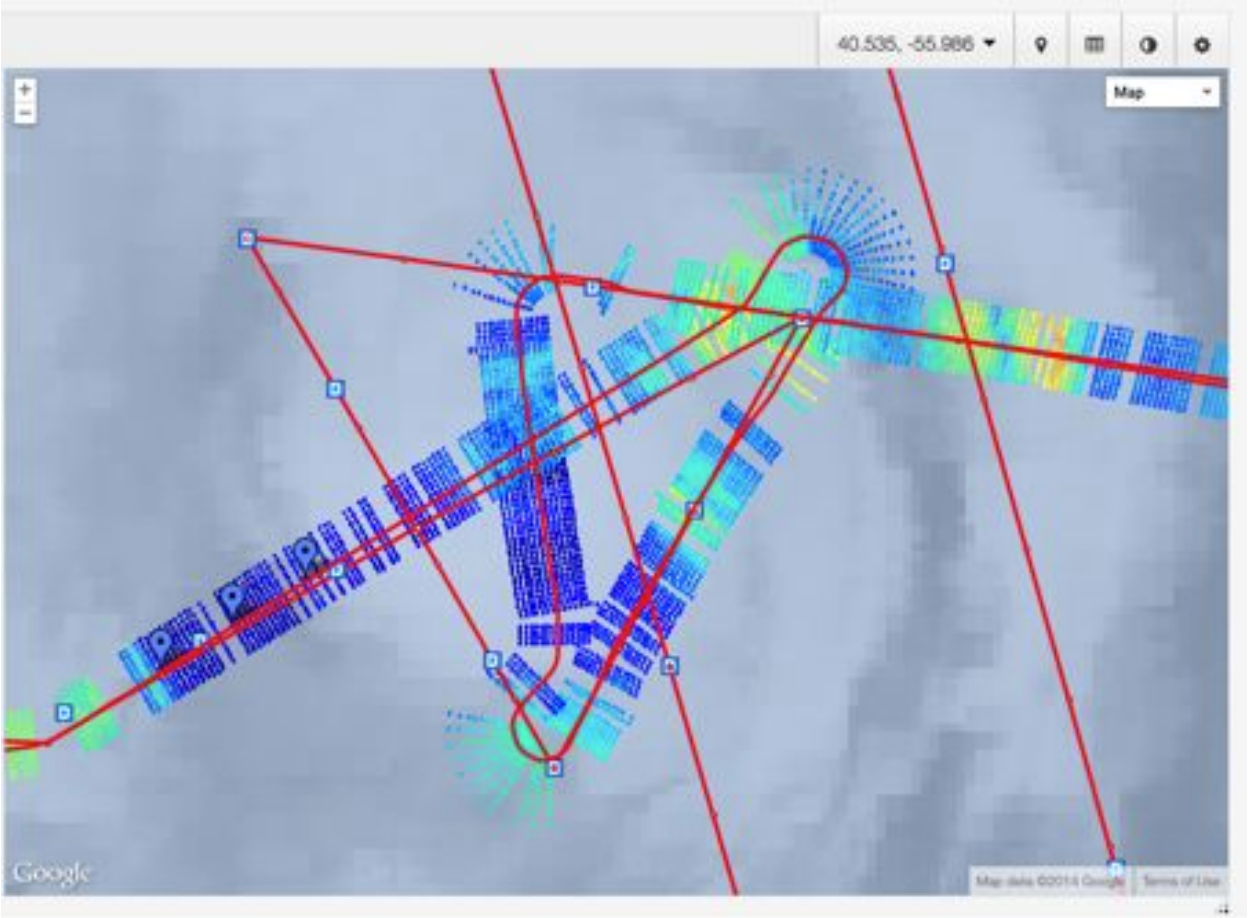


Figure 1: S-HIS 895-900 cm^{-1} Brightness Temperature image overlaid on GOES IR in MTS. The format of the S-HIS brightness temperature images has been changed to provide more clear indication of the S-HIS footprints and scan lines and reduced interpolation error in the image. Gaps are associated with data loss during downlink.

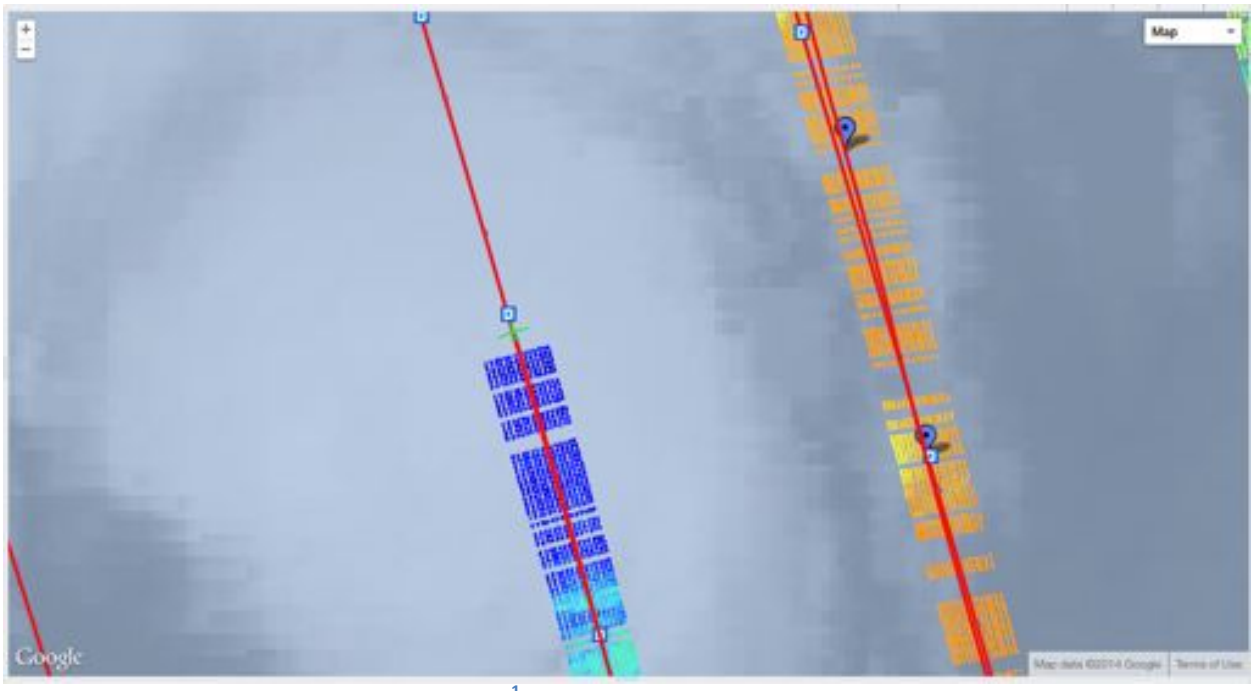


Figure 2: Screenshot of S-HIS 895-900 cm^{-1} Brightness Temperature image overlaid on GOES IR in MTS (2014-08-29 09.29.21) as AV-6 passes over center of Cristobal.

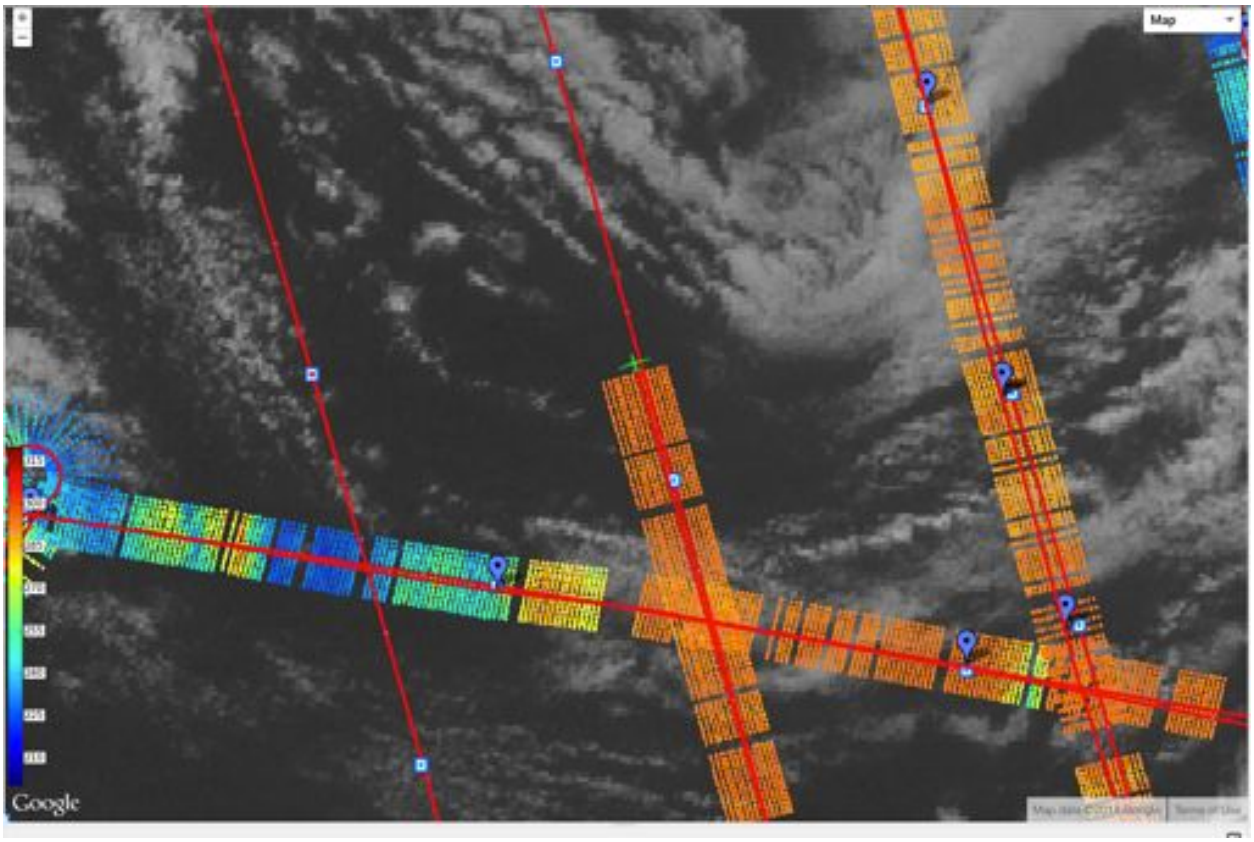
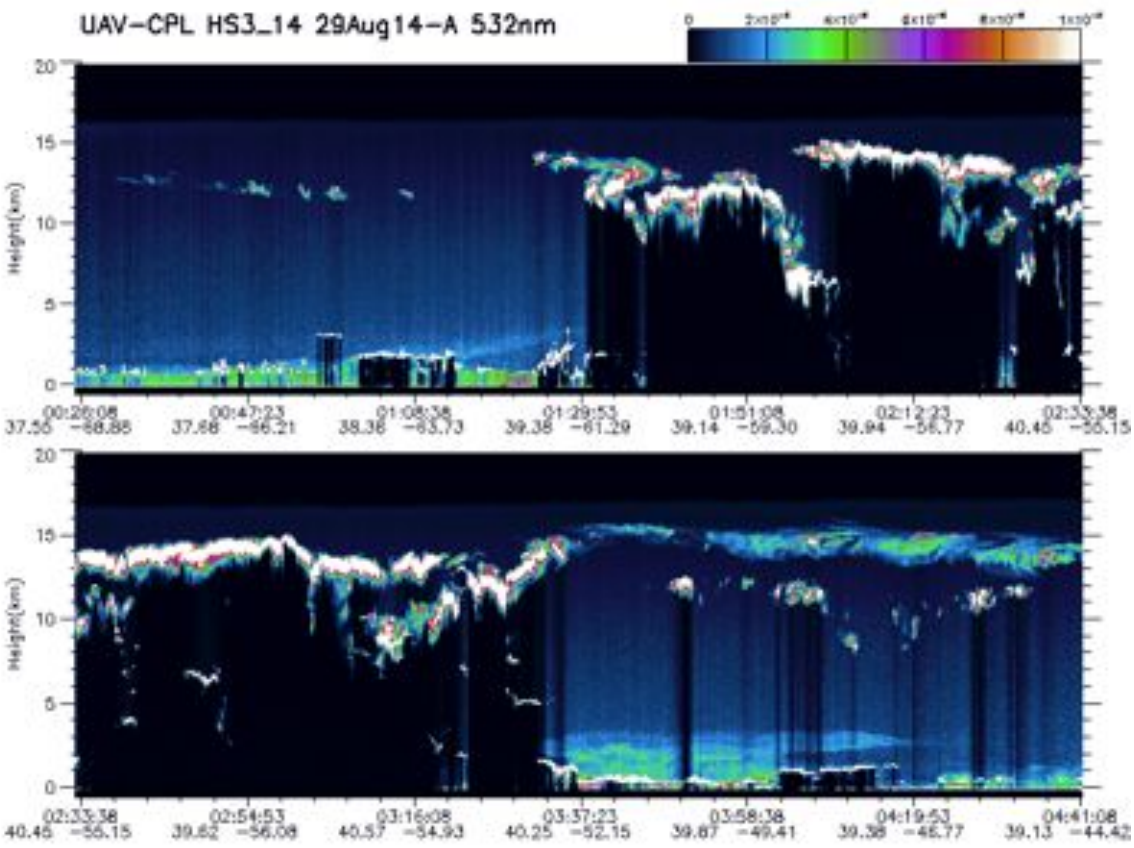
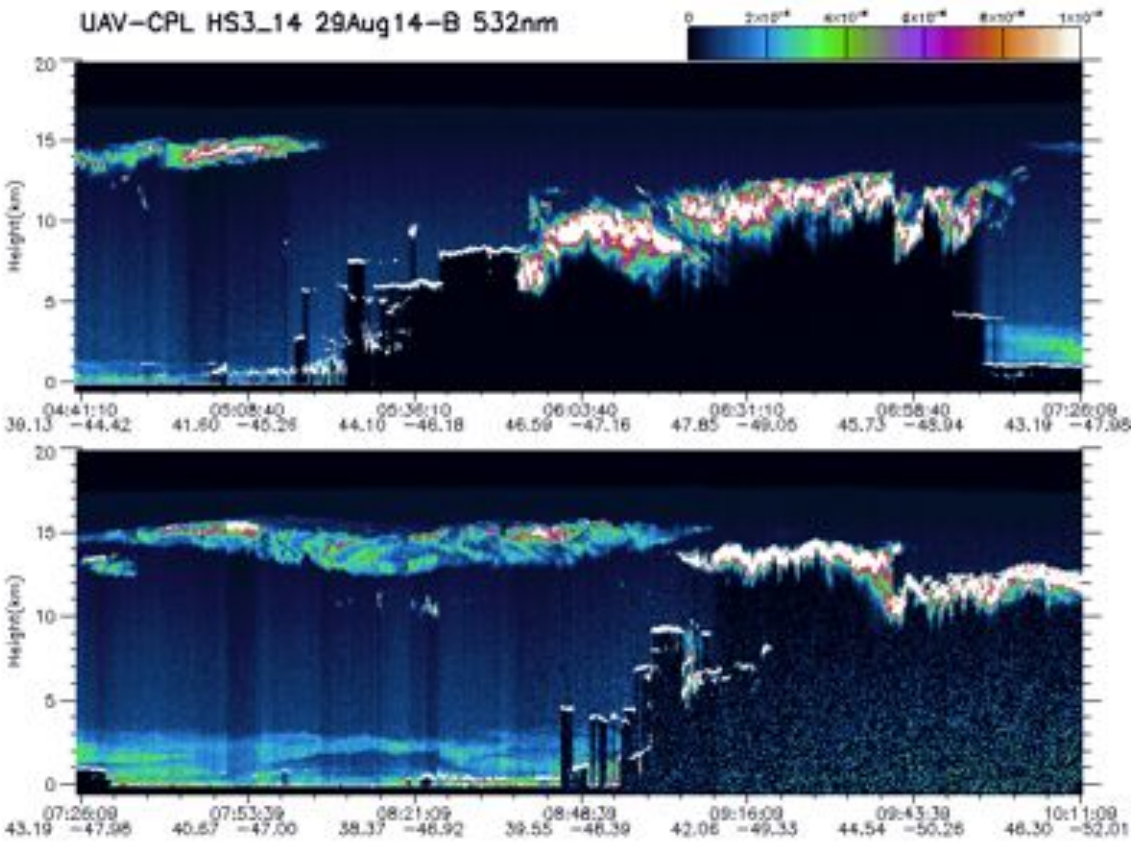


Figure 3: Screenshot of S-HIS 895-900 cm^{-1} Brightness Temperature image overlaid on GOES visible in MTS (2014-08-29 13.25.52).

CPL Summary

CPL worked well for the 28-29Aug14 flight. No data issues were discovered and the instrument temperatures remained inside thresholds. CPL started data flow at 00:26:08 UTC on 29Aug. and ended data flow at 21:21:06 UTC on 29Aug. Some complex cloud/aerosol systems were overflown, with an example attached (Flight summary image for Segment B where there appears to be lofted aerosols over stratus at 07:26, with some indications that it was dust). Approximate time of first closest approach of the hurricane center was near 02:05 in Segment A (summary image attached).




UAV-CPL HS3_14 29Aug14-B 532nm
Height(km)
04:41:10
05:08:40
05:36:10
06:03:40
06:31:10
06:58:40
07:26:09
07:26:09
07:53:39
08:21:09
08:48:39
09:16:09
09:43:39
10:11:09