

## **General Data Notes**

**(Apply to the entire project)**

OTREC project had two mission critical instruments, HIAPER Cloud Radar (HCR) and Airborne Vertical Atmospheric Profiling System (AVAPS). Other instruments included VCSEL, KT19 remote surface temperature sensor, up and down looking pyranometers, RICE, CDP and two 2D-C probes. The cloud probes and RICE were deployed primarily for the purpose of providing information on the liquid and ice water content for the Mission Coordinator. However, QC-ed data from these instruments are also available for research. It should be mentioned that in situ cloud physics observations were not an objective of the project.

**Aircraft position (all GGx variables):** Very good for the entire project. Some data gaps were present due to data system dropouts. On rare occasions the GPS signal quality (GGQUAL) dropped to 9 (WAAS precision, ~1 m) from the normal 5 (indicating the full Terrastar, decimeter precision). This is seen on climb out (RF01, RF09) or descent (RF19) for very brief periods.

**Ambient air temperature (ATH1, ATH2):** There were various issues with the research temperature measurement during the project due to the failures of the data acquisition computer on a number of flights. For these flights, the reference temperature is set to AT\_A, and a note is made in the Flight Specific section of this report.

An algorithm that applies two separate recovery factors to the two sensing elements of the Harco temperature sensor and also included altitude effects, was used to generate the final data set for OTREC. This resulted in ATH1 and ATH2 values that differ by 0.2 to 0.3 degrees instead of near 0.6 degrees when a constant recovery function was used during in-the-field data processing. This is most noticeable at high altitudes, where OTREC flights took place most of the time.

**Chilled mirror dewpoint sensors (DP\_DPL, DP\_DPR):** DPR responded strongly to clouds while DPL also spiked up but not as strongly as DPR did. Both should be blanked out when passing through clouds. Data has also been blanked out for certain periods due to instrument flooding and out of balance conditions, which occur during rapid altitude changes and are seen in the data as sharp spikes and oscillations. It is possible that not every instance of such bad data has been removed, so please watch out for such signs. Both DPR and DPL exhibited oscillations and higher than realistic dew points at high altitudes, where the instruments reach their design limits.

**Humidity data:** VCSEL hygrometer performed best at high altitudes encountered during OTREC. Since the dew point sensors frequently encountered problems, reference variables DPXC and EWX are set to the VCSEL data for the entire project.

**Radiation measurements (VIST, VISB):** Kipp & Zonen radiometers are not stabilized, so artifacts occur during turns, ascents, and descents. Be cautious about using data outside of

straight and level flight segments. Limiting the data to straight and level portions of flights is the safest way to avoid the influence of these artifacts.

**Radiometric surface temperature (RSTB):** This value represents the temperature of cloud top when the aircraft flew over a cloud deck, or the temperature of the sea surface in clear skies. At high altitudes like those flown in OTREC, the sensor may not truly represent the SST since water vapor in the layer between the surface and the aircraft is also contributing to the radiation detected by the sensor.

**Wind measurements (WIC, UIC, VIC):** Three-dimensional wind vectors (U, V, and W) were calibrated using standard flight maneuvers. Notably, the vertical wind (W) calibration was optimized for the higher altitudes at which most OTREC flying occurred. As a result, W for this campaign is most accurate when flying speeds exceed 100 m/s. Flight periods at slower speeds (i.e. lower altitudes) and also periods when the aircraft roll exceeds 2 degrees in magnitude should be used more cautiously.

The vertical wind calibration is particularly sensitive to the aircraft angle of attack, which itself was calibrated by balancing equation 2.11 (for W) in RAF Bulletin 23, assuming a mean vertical wind of zero during speed runs, performed during the test flights and first research flights.

Because aircraft attitude angles, like the angle of attack, are key elements of the 3-D wind calculations, icing of the aircraft radome (where these angles are measured) negatively impacted wind calculations for many of the OTREC flights. Consequently, research-grade winds from the aircraft cannot be reported for large segments of RF01 and RF06, and for most (if not the entirety) of research flights 9, 12, 15, 16, and 22. RF08 and RF13, in comparison, are affected by only very short duration “drop outs” in radome measurements.

During RF01 and RF15, icing affected the measurements required for angle of attack more extensively than the measurements required for sideslip. Consequently, it was possible to estimate the horizontal wind vectors (U and V) using the simplified equations of 2.11 in RAF Bulletin 23 for some periods of these flights. These periods are readily identifiable because no vertical wind is reported for them. Horizontal winds during these periods should be used cautiously.

**Cloud particle probes (RWOI = 10 micron 2D-C probe; LWOI = 25 micron 2D-C probe):** These instruments may experience periods of bad data for a variety of reasons, most typically due to condensation of moisture on the optics after cold soaking at high altitude.

***Examples of 2DC-10 and 2DC-25 faulty data: Condensation on optics (probe tip 45-degree mirrors, telescope lenses, electronics card 45-degree mirror or diode array)***

We present the example of OTREC RF01, last part of flight during a descent to land. The GV had been at high altitude for about 5 hours, so the 2D probes were thoroughly cold soaked. On descend, the diode voltages for both the 25-micron probe (LWOI) and the 10-micron probe (RWOI) decreased dramatically, see Fig. A1.

Both 2D probes show a decrease in the recorded diode intensity from about 17:32:15 or earlier. The 25-micron probe (LWOO) has a particular strong decrease at about 17:34:00, and this decrease is likely due to condensation (dew or ice) on the optics.

Both probes appear to recover the diode voltages somewhat at 17:42:40, but this recovery is insufficient.

Figures A2, A3 and A4 show examples of 2D images from three time periods. The first one (A2) was collected in a wholly glaciated cloud (many irregular ice particles), where the images do not show any evidence of condensation on the probe optics. In contrast, figures A3 and A4 should show round raindrops, but they have many missing horizontal stripes and ragged particle edges; This is likely due to condensation on the probe optics.

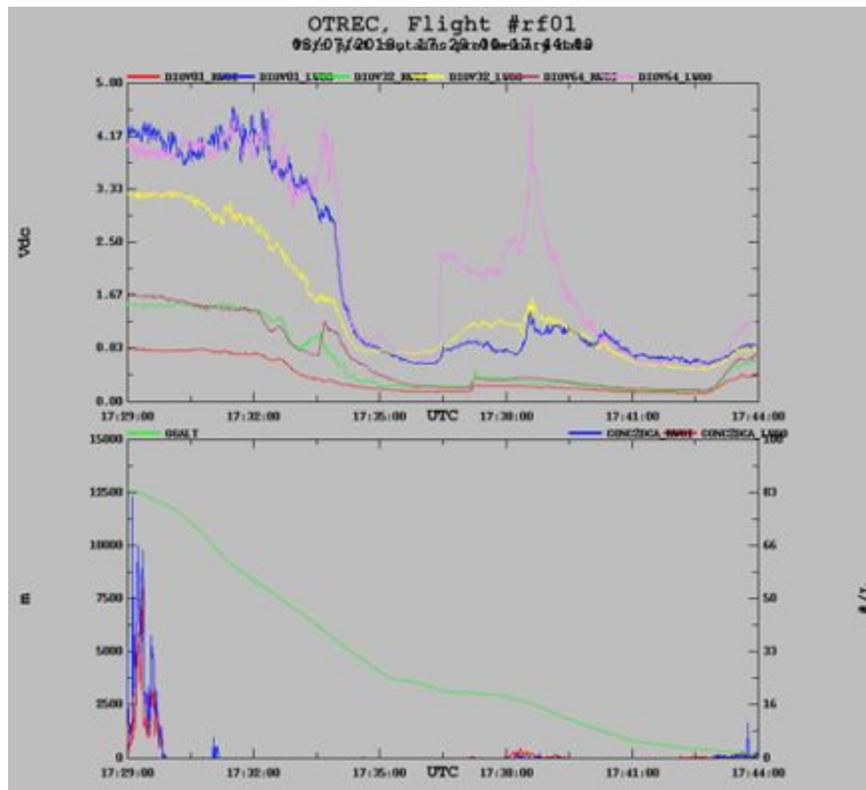


Figure A1. Time series from OTREC RF01. Upper box shows diode voltages for the 25-micron probe (LWOO) (generally large values), and from the 10-micron probe (RWOI) (generally smaller voltages). Bottom box shows altitude and concentrations of all particles from the two probes.

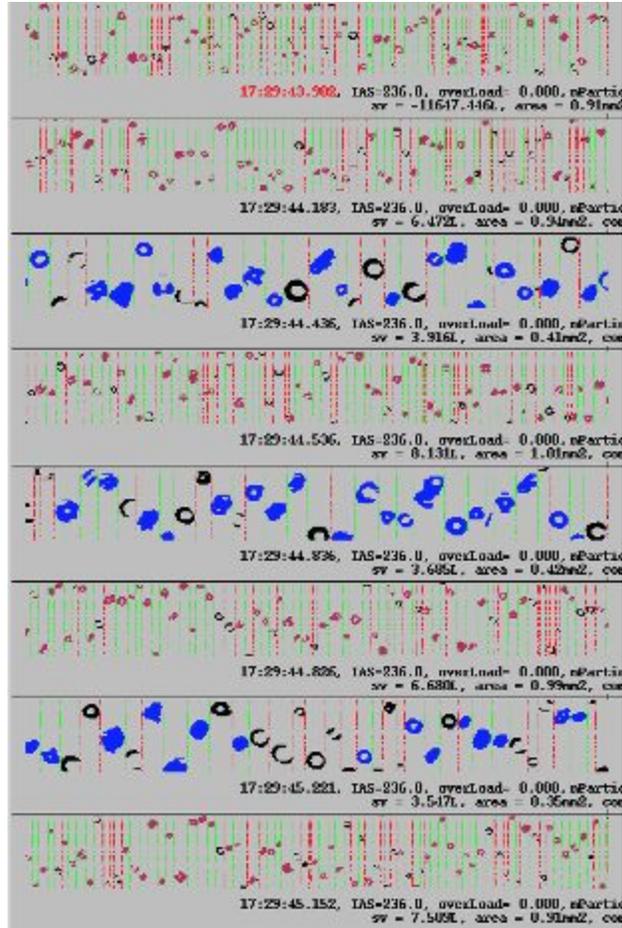


Figure A2. Particle images from 17:29:44. Red particles are from the 25-micron probe (LWOO), and blue particles are from the 10-micron probe (RWOI). These particle images are considered good. The blue particles are collected from a 640-micron wide section, and the red images are collected from a 1600 micron wide section.

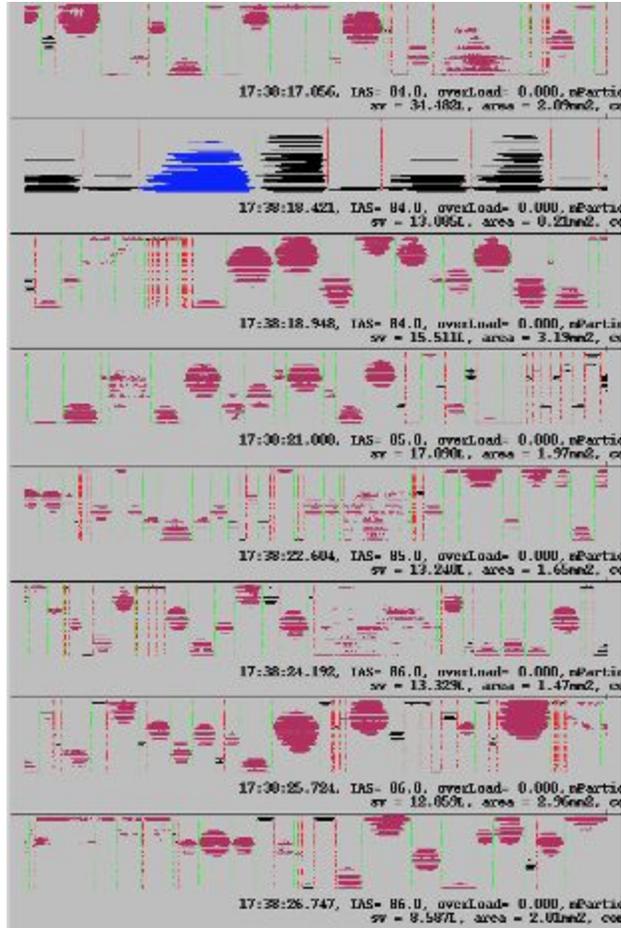


Figure A3. Particle images from 17:38:20. Red particles are from the 25-micron probe (LWOO), and blue particles are from the 10-micron probe (RWOI). These particle images should show solid round raindrops; instead the images have missing horizontal stripes and ragged edges where diodes are not triggering (likely due to condensation). These images are considered bad, and they should not be used for analysis.

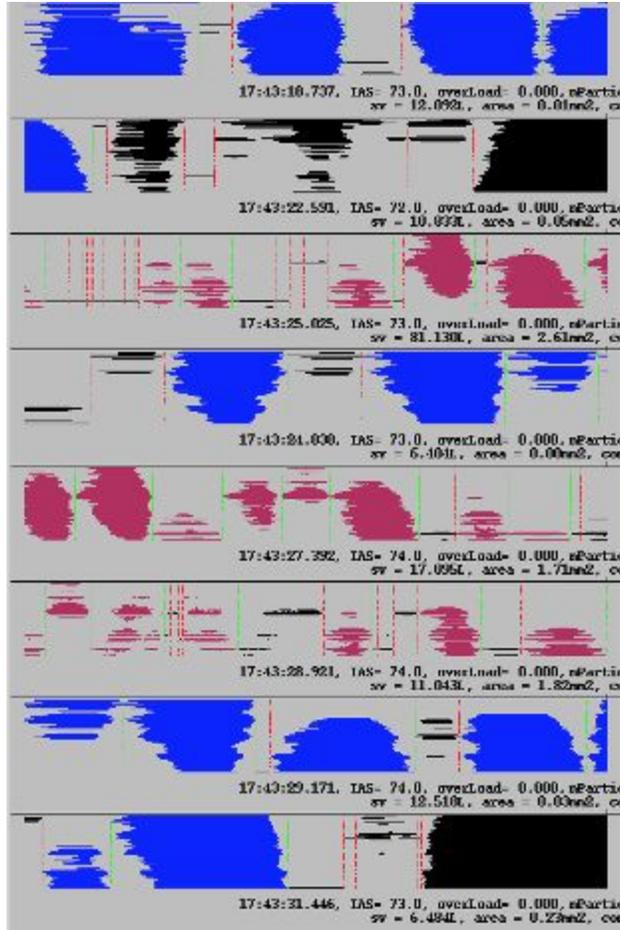


Figure A4. Particle images from 17:43:25. Red particles are from the 25-micron probe (LWOO), and blue particles are from the 10-micron probe (RWOI). These particle images should show solid round raindrops; instead the images have missing horizontal stripes and ragged edges where diodes are not triggering (likely due to condensation). These images are considered bad, and they should not be used for analysis.

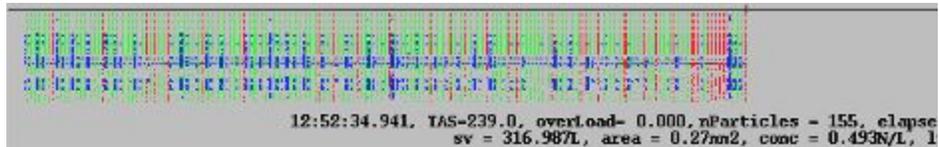


Figure A5. 2D image from the 10-micron probe. The images were obtained during a time of extremely low diode voltages, likely caused by condensation or similar on the probe optics. These particles are not real.

## Flight Specific Data Notes

**RF01, 8/7/2019:** Loss of ADIFR measurement from 12:44 - 16:00, therefore wind calculations are not available during this period. Starting around 12:48 both ATH1/2 are affected by the penetration of a cloud that caused icing in the radome. Both temperatures are suspect until 14:42 when they return to normal. Reference temperatures are set to AT\_A.

### Technician notes (KH):

- During initial startup, had to recycle the LWOO 2D probe to achieve proper end diode voltages.
- 12:32 RWO DSM reboot during the initial ascent, unknown reason.
- Lost VCSEL dew point at 12:40. ACGAIN never at zero. Rebooted at 13:01. Possibly iced over. Did not see RICE go off but lots of 2D and CDP concentrations at that time. VCSEL dew point back at 13:04.
- Went through some clouds with moisture at approx 12:42 which lasted about 5 to 6 minutes. Sharp decline in ADIFR around 12:44. NAN at 12:53. Most likely frozen. QCR had issues at this time and appears to have recovered around 12:54. QCTF was affected as well and recovered around 13:21. All this started at approx 28000 feet with temps around -25c.
- Lost satcom at 13:31. Came back 13:34.
- RICE should have reacted during that ascent. Rebooted RWO at 14:03 with the hopes that RICE would get fixed but no success. I suspect a cabling issue.
- ADIFR came back at 16:00.

**RF02, 8/11/2019:** Data acquisition failure at 12:34:06 - 12:36:28, resulting in the loss of all data.

### Technician notes (JM):

- Preflight:
  - A2D Autocal froze at 19% again. Use Test A2D, cards okay
  - Instrument check, Visible Radiometers (VISB and VIST) values look too low, referred to lead tech and Haggerty, will watch during flight. The sun is not yet up.
  - RWO all vars nan, reboot 2 times, data logging recovered
- 12:30 RWO all vars nan, attempt soft reboot, ADS rebooted.
- 12:40 RWO all vars nan, multiple attempts at reboot, power cycle and DC-DC inhibit. Did not fix the issue.
- 12:57 RWO is back
- 13:05 Pilots inform me, will level off at 35kft for speed runs
- 13:13 VISB and VIST look reasonable
- 13:32 RWO dsm, all values nan, reboot
- 13:34 RWO is back

- 14:50 cloud edge, both 2dcs and cdp have histograms. both 2dcs show images
- 15:42 noted lack of response of RICE probe, check with pilots, GV ice sensor didn't sense ice either.

**RF03, 8/12/2019:** Radome icing on climb out caused loss of QCR from 12:36:09 to 17:43:14. Angle of attack measurement and wind calculations are unaffected. VCSEL data was lost from 12:34 to 13:03, most likely due to the icing of mirrors on climb out.

**Technician notes (KH):**

- Swift Broadband Unit (SBU) led was off and on a few times just prior to and after takeoff. Maybe we are in between satellites. Rebooted Satcom at 12:28. Back at 12:31. Stayed stable after reboot. If this happens again, we need to look at the Thrane & Thrane web browser. It's typically on the Americas satellite. Check to see if it's trying to talk to a different one. Take a screenshot when this is happening and compare it to "Satcom when good" screenshot on the desktop.
- Lost RWO at 12:30. Waited 3 minutes and could not ping it. Seatbelt sign is on. Tried remote power cycle from ADS rack with no success. Power cycle at 12:40 with breaker. I can ping it but still no data. It eventually came back but not talking to the 2D probe. I rebooted it again at 13:10 and all is talking now.
- Lost VCSEL dew point during accent through liquid water clouds. AC gain was never at 0. I waited to see if it would come back. Finally rebooted at 12:59. Have a dew point at 13:03.
- QCR iced up during the accent through liquid water clouds.
- QCTF iced up a bit. This one makes no sense since this is a heated pitot. Back at 13:06. Will wet towel test with WOW bypass switch during next maintenance day.
- Successfully tested with a multimeter that we did have 400Hz anti-ice in the cabin during flight.
- Camera processes stopped at 13:47. Camera process stalled and we would have needed to reboot the ADS server, which we decided not to do. No forward, left, or right camera for the rest of the flight. The down camera is still logging because it runs a different process.

**RF04, 8/16/2019:** No issues.

**Technician notes (JM):**

- Preflight
  - A2D Test good
  - A2D autocal run and saved, good.

- users report AEROS connection to real time data is grayed out, called SE, problem resolved
- PSTF nan, soft reboot, dsm304, did not fix, cycled power to DSM, PSTF okay
- 12:39 status page, cameras stopped, commands stop and start cameras, status page says cameras okay, recent files seen on hard drive.
- 12:44 dsmRWO stopped, cycle power
- 12:50 dsmRWO, cycled power,
- 12:55 dsmRWO, data came back briefly, then nan again, cycled power again
- 13:12 Julie Haggerty and ADS report no conc or images LWO 2DC, end diode voltages present, cycled power to probe, will have to wait for the next cloud
- 13:45 LWO 2DC is now ok
- 15:03 cloud edge, histograms on all probes, images on both 2dc probes. DPR above RTHx, DPL does not follow.
- 15:40 Ferry to Caribbean leg
- 16:20 Beginning first leg, Caribbean side

**RF05, 8/17/2019:** DPR data is missing from the beginning of flight to 14:26.

**Technician notes (KH):**

- Everything is very wet this morning. No dew point in DPR prior to and after takeoff. Need to service it. After a little tinkering, DPR got a reasonable dew point around 14:41.
- RWO gone at 12:32:30. Waited 2 minutes for reboot with no success. Cycled power with breaker at 12:35. Could ping at 12:38. All red on status page and nan's in aeros. Now is the time to look at post flight data to see if it is there. Data 12:39:20 to 12:39:37. Back solid at 12:41:20.
- During preflight and after takeoff, 2DC-10 end diode voltages are really low. Pretty sure optics were wet prior to takeoff. Cycled power on just the 2D probe at 12:46. Diode voltages did not get larger. My assumption is that the optics have some ice on them. It appears the optics cleared at 12:54.
- Occasionally, on the Status Page, the Onboard Cameras goes yellow and the time is lagging. This event lasts a couple seconds and then goes green again. Possibly, this is why Onboard Cameras went red on RF03 and stopped recording.
- Radome tubing was drained of water post flight.
- Note: aircraft experienced lightning strike of nose RF05, no burn marks or pitting noted.

**RF06, 8/18/2019:** All data were lost from 15:59 to 17:18 due to data system failure. 3D wind calculations are not available.

**Technician notes (JM):**

- Preflight
  - A2D Autocal, no evidence of channel shifting, A2D sn1706 ch 2-6 have shifts in y-int greater than 10mV, none greater than 100mV.
  - DPR service mirror light blinking, rebalance on, cycled power then used rebalance x3, still stuck in rebalance
  - VXCEL reboot
  - RWO dsm came up fine this time, turned probe on before DSM
  - Cycled power LWO dsm multiple times, called SE, informed lead tech who informed PI, decision made to fly anyway. Affected instruments are CDP and 2dc-10um
- 13:28 Wheels up, will try rebalance then power cycle to DPR in dryer, low pressure air
- 13:38 DPR is back, numbers in line with DPL and VXCEL. LWO dsm still out. Camera on status page is red but seeing images, will take no action
- 13:40 Camera web page shows error, cycle stop/start, camera status page green, seeing images advance
- 13:58 DP\_VXL nan, other vars present, serial data dsm MPDB present, cycle power, DP\_VXL came back
- 14:39 after multiple power cycles gave up on LWO dsm, pulled breaker to probes to limit hours on instrument. Left AI breakers engaged.
- 16:08 AC server is up, dsm server and everything downstream is down, cisco web page shows all ports with a red arrow down. Called SE and lead tech, conference by chat. Restart Nimbus, no help. Restart Nimbus by terminal window command, no help. Restart data acquisition, no help. Restart data acquisition as RF07, no help. Restart ADS computer, no help. Restart router, problem solved. Lost about 1 hr of data, Dropsondes and radar store data locally. Checked dsms and instruments, condition same as start of mission.

**RF07, 8/22/2019:** No issues.

**Technician notes (KH):**

- Fog delayed scheduled takeoff time.
- Grounding the RICE twinax shield to the airframe via the RICE MS connector did not solve the signal and noise issue. The only other things I can think of is to take that shield and connect it to the negative 28VDC and signal return on the RICE MS connector. The 28VDC return and signal return share the same pin on the MS connector. It might be worth physically pulling the RICE instrument apart and inspecting it as well.
- Lost RWO 2DC-10 during moderate turbulence at 18:00. Reboot at 18:05. Two reboots did not bring it back. Could be the USB cable. Will check post flight. (Update: Post flight check found that there may have been a crooked and loose connection at the DSM. Tested but could not get it to fail after the discovery. 2D probe is working now and ready for RF08.)

- No unsolicited RWO DSM reboots prior and during flight today. Trick preflight is to engage both 2D probe and DSM breakers at the same time.
- No indication that the router had any fatal issues with timeserver today. On one of the previous maintenance days, we moved the timeserver Ethernet cable from the network switch and plugged it directly into the router. Possibly, this is our fix.
- Lost VCSEL during descent at 19:00. AC Gain value at 0. Rebooted at 19:02. After looking at the playback camera (which is pretty cool), it got supercooled liquid water or iced up. Dewpoint was back at 19:05.

**RF08, 8/23/2019:** Data gap from 14:25 to 14:28 due to data acquisition system problem. Additionally, GPS data were lost from 14:39 to 14:42.

**Technician notes (DA):**

- Preflight
  - DPR initialized in "Service Mirror" mode. Removed flag and blew out sensor with canned air. Fixed Service Mirror but now it is stuck in "Rebalance" mode. Informed Project Manager. DPL and VXL are good. Will try cycling DPR in the air.
  - Tested RICE on the ground. Fully operational.
- 1226 - Cycled power on DPR to see if the mirror is dry enough to attain dew point. Successful.
- 1247 - All 3 cloud physics probes functioning and displaying images/histogram.
- 1419 - Lost SATCOM to the ground. Every item on the status page went RED. Data still being reported on Aeros.
- 1425 - Cycled power on Router. Items on the status page going back to green.
- 1429 - SATCOM to ground returned. ACSERVER NOT RETURNING TO GREEN ON STATUS PAGE. Chris W. helped to fix via several terminal commands.
- 1440 - Entire status page green again.
- RICE is noisy for the entirety of flight.
- 1618 - Stuart B. asked that the camera process be stopped so he could make an update to the down-looking camera.
- 1619 - Restarted cameras. Everything is still functioning properly.
- 1729 - Lost VCSEL on descent. Likely iced up the lenses flying through the cloud. Cycled VCSEL but did not come back. Very close to landing.
- 2D Probe End Diode Voltages are very unstable prior to landing. Again, likely flying through the clouds and getting cold-soaked.

**RF09, 8/25/2019:** Most of the research data are not available for this flight due to the nose DSM failure. Wind speed, direction, pressures, temperatures and position are available from the GV avionics systems. IWD and IWS should be used for wind speed and direction; ATX, PSXC,

QCXC are set to avionics data. VCSEL humidity data are available for most of the flight. Due to the loss of QCF and ATTACK, corrected static and dynamic pressures were computed using QC\_A and PITCH as surrogates; during straight and level flight any differences will be minimal but during ascents and descents PSXC and QSXC should not be used.

#### Technician notes (JM):

- Preflight
  - dsm305 (nose) red on status page, no data in Aeros, responds to ping, does not allow ssh login. No change in behavior from yesterday's maintenance day. All of us concur that the CPU card is the likely culprit. Changed the CPU and the A2D card (different issue, offsets from yesterday). Now cannot even ping the CPU. Decision made with PI to fly anyway.
  - A2D cards show no signs of channel shifting.
  - VXCEL has intensity over 1000 but no DP\_VXL, cycle power. Still does not come back (Note: DP\_VXL depends on nose DSM variables in the field so in absence of those will be NAN in real time. This can be fixed in post processing).
  - MIRROR\_DP<sub>x</sub> has data but no DP<sub>x</sub>, could be DP<sub>x</sub> uses values from nose dsm for calculation.
- 12:37 Wheels up, position not updating on map.
- 13:11 DP\_VXL nan, intensity over 1100, cycle power to VCSEL. (After later referring to manual, I believe that output depends on ATX, which is not available today because dsm305 is down.)
- 13:15 LRINT\_VXL has been gradually decreasing to about 500
- 13:16 Down camera not producing new files, cycle stop/start
- 15:12 In cloud. CDP shows concentrations. Only RWO 2DC has images and shows concentrations. LWO conc are 0 and no images shown, end diode voltages are still within range so I think the concentrations are just outside the LWO 2DC range.
- 15:44 DPR stuck at -35C, DPL is -67C, cycle power DPR to get a rebalance cycle.
- 16:42 Chris Webster had me stop and restart Nimbus
- 16:42 DP\_VXL is back
- 17:23 In cloud again, CDP and 2DC on right wing show concentrations, 2DC on Left wing does not show concentrations.

**RF10, 9/3/2019:** The redundant research measurement of temperature, ATH2 appeared to have a problem during RF10. This does not impact ATX, which is set to ATH1 and is very close to AT\_A.

#### Technician notes (JM):

- Preflight

- dsm305 (nose) red on status page, no data in Aeros, does not respond to ping. Five reboots. Connected Surface Pro to console port in back of ADS. Finally works, no commands given to 305.
- Dave cleaned VCSEL just prior to flight. laser intensity is now above 1100.
- A2D cards show no evidence of channel shifting.
- DIOV01\_LWOO, DIOV32\_LWOO and DIOV64\_LWOO are low, cycled power, now they're good. DIOV01\_RWOI, DIOV32\_RWOI and DIOV64\_RWOI are good
- DPR stuck in rebalance, cycled power, now good and close to DPL.
- 12:14 Wheels up, dsm305 still working.
- 12:21 Cameras stopped, cycled stop and start
- 12:29 dsmLWO stopped, cycled power
- 12:31 dsmRWO stopped, cycled power
- 12:39 cloud, histograms on all probes, images present on both 2DCs
- 13:24 on station
- 14:00 Aspen is installed on Stipo's computer so he can view dropsonde data in real time.
- 14:39 L6 (dropsonde) headset can talk but not hear. Replaced both headset and extension and checked connections inside jacks, didn't fix. Original parts back, no replacements used.
- 17:30 dsm305 still working

**RF11, 9/4/2019:** No issues

**Technician notes (DA):**

- Preflight:
  - DSM 305 booted successfully with Serial to USB Adapter work-around. Did not have any issues in-flight.
  - DPR started with 'Service Mirror' light ON. Blew out both DPR and DPL.
  - Successful boot on both wing DSMs. 2D End Diode Voltages looked good on initial power ON.
- VCSEL looks good until we get higher in altitude. It seems to get cold soaked - maybe the mirrors get frosted over - and it stops providing reliable data. The final point of reliable Dew Point from VCSEL seemed to be at 1236; 38,000 feet; LSRINT\_VXL was ~1,000 cnts.
- 1232 - Lost both wing DSMs. After getting the DSMs back, the End Diode Voltages were low on the 25um and housekeeping did not look correct on the 10um. Cycled power on both probes which corrected all errors.
- \*While power was OFF on the probes, but the DSMs were running, I noticed that the RICE data looked good for a short period...until the 2D\_C was powered back ON. John Cowan and I spoke about this during the flight and determined a possible cause. Cory

gave me the go-ahead to turn OFF the 2D\_C 10um at 1649. RICE data looks good when there is no 2D probe interference. Will troubleshoot during Maintenance Day tomorrow.

- DPR data looks low and unreliable. DPL looks more reasonable. Will attend to DPR during Maintenance.

**RF12, 9/9/2019:** ATTACK, ATH1 and ATH2 down for most of the flight due to DSM 305 becoming inoperable about 40 minutes into the flight. ATX is set to AT\_A and TASX is set to TAS\_A. Humidity data are available from VCSEL; slightly increased inaccuracy in the humidity data may exist due to substitution of PITCH for ATTACK in EW\_VXL calculations. No 3D wind data are available for this flight but wind direction and speed are available from IWD and IWS.

**Technician notes (JM):**

- Preflight
  - dsm305 analog card did not start, cycle power, now see all variables
  - DPR service mirror light on, cycle power, good preflight numbers, match DPL pretty well
  - DP\_VXL nan, all other numbers from it good, cycle power, all vars good
  - probes end diode voltages good
  - all A2Ds good, no channel shifting
- 1403 Wheels up, all vars okay, heavy clouds on climbout
- 1422 dsmLWO stopped, cycled power; looks good. In cloud, all probes show up on histograms, 2Ds show images
- 1439 ADIFR nan, all other vars good, cycle power to dsm because of analog failure earlier. DSM305 IRIG-UNIX=0.1842sec.
- 1444 DSM305 does not come back, multiple restarts. Checked for convertor on console port, present (note: multiple restarts with convertor present and not present on dsm305. down for flight)
- 1507 restart cameras per Stuart
- 1510 restart cameras again
- 1555 restart Nimbus
- 1617 Nimbus back
- 1910 DSM Server and Nimbus stopped, restart data acquisition

**RF13, 9/17/2019:** Data gap from 19:19 to 19:22 due to DSM reboot; no other issues.

**Technician notes (EK):**

- Preflight
  - Rinsed off top & bottom radiometers and KT-19
  - Reboot DSM 305 - analog channels reading now

- Cycle power on LWO & RWO probes - diode V's were low
- Service mirror light blinking and re-balance light on - DPR
- 1431 Takeoff
- 1440 DPR still stuck in re-balance mode
- 1444 Cycle power to LWO CDP & 2DC-25, and again - finally came back
- 1500 Cycle power DPR - re-balance light off, working now
- 1615 Diode V's at 42Kft: 2DC-10; 1.6, 1.4, 1.0V 2DC-25; 2.8, 2.6, 3.5V
- 1919 DSM Server & Nimbus stopped as soon as we began our descent from 44Kft and were headed for home - sure reminds me of SOCRATES (same thing happened)
- 1923 Restart Data Acq (continue RF13) & Nimbus
- 1938 LWO stopped - reboot both CDP & 2DC-25
- 1958 Land

**RF14, 9/21/2019:** DPL was inoperable for the flight, only DPR provided redundant humidity data.

**Technician notes (DA):**

- Pre-Flight
  - Ran "Auto A/D Cal" Ch. 5 on S/N 018 Failed (DSM 305) INTCP = 2012  
SEP 01 -0.1589 2019 SEP 21 -0.3684
  - No data from DPL on AEROS
  - ADIFR was high at initial startup. A non-tech removed the tape on the nose, THEN wiped moisture away and around the holes on the Radome. This is not our standard procedure nor do we approve of others performing this task. I believe water was pushed right into the top ADIFR line. The plane has not flown since the Nose plumbing was last serviced. There is no reason for any malfunction especially had the procedure been followed.
- 1222 - LSRINT\_VXL = 1370
- 1230 - QCR froze up
- 1303 - 2D\_C (25um) End Diode Voltages: 1 = 2.18 32 = 4.15 64 = 4.60
- - 2D\_C (10um) End Diode Voltages: 1 = 1.95 32 = 2.17 64 = 1.19
- 1304 - LSRINT\_VXL = 490
- 1636 to 1647 - DPR is not working well
- 1807 - QCR unfrozen and tracking
- No DSM issues.
- 2D-C End Diode Voltages were within limits up until we started to descend when returning to base.
- \*No DP\_DPL on AEROS today. This variable is dependent upon the cavity pressure reading it gets from CAVP\_DPL. Since CAVP\_DPL is not functioning, there will be no data from DP\_DPL. There were data from all other DPL variables, however, as well as a Dew Point reading on the DPL display at the ADS station.

- Testing and troubleshooting will be performed to diagnose the problem with CAVP\_DPL on our next maintenance day. Right now, though, we are suspecting the pressure transducer. A visual check will be done during pre-flight to ensure there are no obvious problems that can be easily fixed prior to takeoff tomorrow.
- Post Flight Maintenance
  - All Nose pressure lines were opened and blown out.

**RF15, 9/22/2019:** VIST, VISB data not available prior to 1430, radiometers were not powered on at beginning of flight. RSTT and RSTB data not available prior to 1430; sensor was not powered on at beginning of flight. When powered on, sensor heating unit was set at +20C instead of ambient temperature as desired. As a result the sensor housing temperature was much warmer than the scene temperature, causing uncertainty of the RSTB measurement to be higher on this flight. Due to ingestion of water into radome pressure tubes there is no ATTACK data, and, subsequently, no 3D winds data.

#### **Technician notes (EK):**

- Preflight
  - Auto Cal stopped at 79% complete - did not retry
  - PSTF nan (-32767) - reboot dsm 305 - good now
  - CavP\_DPL transducer looked fine in front wheel-well
  - DPR service mirror blinking and re-balance light on
  - DPL re-balance light on
  - Note: we had a lot of rain for most of the night at the El Mangroove hotel (about 20 km from the airport)
  - TCAB reading 500C, reboot TCAB unit - no change, reboot dsm 303 - all good now
  - Blew out both DPR & DPL with can of air after they towed the plane out so we could go - too many P-3s parked too close for comfort
- 1222 Takeoff
- 1230 CavP\_DPL nan, DPR & DPL stable (blue lights only), DPL not plotting
- 1232-ish - through cloud at ~20Kft, spike in RICE ~5.4V, ADIFR iced-up
- 1246 LWO (25um) stopped (red) on control/status page, then went ok (green) by itself
- 1250 RWO (10um) reboot probe - diode V's low, reboot again at 1253 - good now
- 1341 ADIFR was coming back, but got worse from here (goes more neg above 41Kft)
- 1429 reboot dsm 304 - rad data looks suspect, rad data is much better, but we lost the Vicor power supply in the MPDB, we lost DPR, DPL, & PSF (AKRD, TASF, TASR, ?)
- 1457 Vicor ps in mpdb came back to life => DPR, DPL, & PSF are back
- 1547 DPR data jumped way positive for some reason
- 1731 ADIFR is back - it likes it below 41Kft
- 1736 ADIFR nan - reboot dsm 305, ADIFR still nan
- 1800 Land

- ADIFR was back after I turned around. We will blow out the nose P-lines prior to RF16
- No dsm server drop-outs today, acserver stayed ok (green) the entire flight

**RF16, 9/24/2019:** VCSEL was unstable at the start of flight and the data are removed. DPL produced no data. ATX and TASX are set to AT\_A and TAS\_A due to increased separation of the research temperatures from the avionics temperature, which can possibly be related to DSM repairs but is not quantified.

**Technician notes (DA):**

- Preflight:
  - Ran Auto A/D Cal - No significant changes
- Omega set point returned to -30°C (TRSTB)
- 1143 - Cycled Nose/MPDB Control Switch
- DPR still in Service Mirror mode after being blown out
- 1218 - During ascent, 10um end diode voltages are low (~0.2). Cycled power on probe 3x.
- 1229 - Cycled power on RWO DSM and each RW circuit breaker, trying to recover 10um 2D-C
- 1253 - 10um end diode voltages returned to acceptable levels on their own.
- DPR follows DP\_VXL but data does not look as it normally does. Wavier than usual. DPR may need cleaning.
- End Diode Voltages on both 2D-C probes fell below limits during descent.
- 1728 - Thawed (just before landing)
- Post Flight Maintenance
  - Blew out all Nose pressure lines
  - Cleaned 2D mirrors (10um and 25um). Nothing visible on mirrors prior to cleaning
  - Cleaned FWD Camera lens, VISB dome, and RSTB lens.

**RF17, 9/25/2019:** DPL produced no data; no other issues.

**Technician notes (EK):**

- Preflight
  - CavP\_DPL still nan
  - DPL & DPR both in re-balance mode
  - ADIFR is nominal - blew out all radome lines postflight yesterday
- 1214 Takeoff
- 1215 Turned around and noticed dsm server and nimbus stopped

- 1216 Both data acq and nimbus came back on their own - Chris W (onboard) says they both stopped during max acceleration on takeoff - he thinks the disk drive is suspect on acserver
- 1236 Restart DPL & DPR
- 1243 Cycle power to RWO 10um probe 3x - EDVs low
- 1245 ADIFR is working
- 1253 RWO 10um EDVs eventually came back
- 1725 Land

**RF18, 9/27/2019:** Due to several gaps in the data collected by the nose DSM, ATX and TASX are set to AT\_A and TAS\_A, which provide better data coverage. No wind and pressure data are available until 13:17.

**Technician notes (DA):**

- Pre-Flight
  - Nose was opened and DSM 305 was dried as much as possible prior to powering ON.
  - ADS server did not startup in fully operational state. Swapped to Spare ADS server @ 1140.
  - DSMs 304 and 305 did not boot. These are not necessary for research so takeoff was not delayed.
- 1245 - Cycled power on 10um 2D. No effect. Came back on its own several minutes later. Exhibits the same behavior during ascent as in previous flights.
- 1309 - Cycled VCSEL. Data came back. DPR did not track VCSEL well.
- 1315 - Cycled NOSE/MPDB Control Switch. Chris eventually found that DSMs 304 and 305 were in a continuous reboot state and he was able to fix them. They remained stable for the remainder of the flight.
- PSTF was -32767; may have been affected by moisture in the Nose when power was applied.
- CAVP\_DPL and CAVP\_DPR had very large offset from one another. At 40K+ feet, CAVP\_DPL -47 hPa; CAVP\_DPR 364 hPa (neither are reasonable values)
- No DP\_DPL display on AEROS
- QCTF had large offset from QCF/QCR
- Large RTH1/RTH2 offset due to A/D card 1706 swap into DSM 305.
- Had a hard time getting Catalog Maps displayed on the plane due to server swap.
- Lost both 2D probes during descent.

**RF19, 9/28/2019:** DPL produced no data. Radome icing occurred at 14:08 and persisted throughout the flight; however, only QCR was affected, ATTACK was not affected and 3D wind data are available for this flight.

**Technician notes (EK):**

- Preflight
  - Did not blow-out nose P-lines postflight yesterday due to imminent rain, no time preflight today
  - Still using spare server, removed original server from R-6 postflight yesterday
  - Chris W worked on original server at ops, back in R-6 today as back-up
  - DPL is blue, DPR in re-balance, DP\_DPL nan in aeros and still not showing, CavP\_DPL=-47hPa
  - RWO 10um EDVs low, cycle probe power 3x, DSM 1x, no change
- 1211 Taxi to runway, fog rolled in, runway closed, return to FBO (need 4km visibility to take off by local rules)
- 1227 RWO, LWO, CDP, DPRs, RSTB, Rads, VXL: 9 sensors off
- 1312 all the above 9 sensors on
- 1340 Taxi
- 1345 Takeoff
- 1356 DPR is back
- 1357 RWO 10um EDVs low on ascent, I did nothing
- 1404 Reboot VXL
- 1410 QCR froze-up
- 1418 RWO 10um EDVs back, I did nothing
- 1420 At 41Kft, CavP\_DPL=-47hPa,CavP\_DPR=386hPa,DP\_VXL=-64C,R-6 DPreadout DPL=-66C,DPR=-63C
- 1910 Land

**RF20, 9/30/2019:** DPL produced no useful data, no other issues.

**Technician notes (DA):**

- Pre-Flight
  - CAVP\_DPL = -46.9
  - CAVP\_DPR = -32767
  - LSRINT\_VXL = 1280
  - 10um - 1 = 0.42 32 = 0.63 64 = 0.37
  - 25um - 1 = 3.42 32 = 2.53 64 = 3.33
  - RTH1 = 22.43
  - RTH2 = 22.22
- 1214 - Cycled VCSEL. Functioned fine for the remainder of the flight.
- 1216 - Cycled DPR

- DP\_DPL displaying on AEROS today but intermittent. Only showing data when CAVP\_DPL is not railed... Both are unstable.
- 1245 - Cycled 10um probe. (41K ft) Did not come back right away. Several minutes later, end diode voltages began to rise much like they have in previous flights.
- RWO DSM went out 4 times between 1545 and 1620. No action was taken; the DSM came back on its own each time. Notified Chris W. He said there was nothing significant in log files, the DSM just rebooted.
- All Nose pressures functioned today with no freezing.

**RF21, 10/1/2019:** DPL produced no useful data, no other issues.

**Technician notes (EK):**

- Preflight
  - DPL is blue, CavP\_DPL=1060hPa, DPR in re-balance, CavP\_DPR=nan
  - RWO 10um EDVs low - no action taken
- 1207 Taxi
- 1210 Takeoff
- 1218 DPR is blue
- 1224 LWO DSM dropout - came back by itself 2x
- 1232 RWO 10um EDVs back - no action was taken
- 1243 CavP\_DPL= -47hPa => railed, DPL was plotting or kinda working
- 1256 Stop and restart data acq & nimbus for Chris W (not onboard)
- 1257 Nimbus status goes from ok to warning on occasion, side effect of CW's change (ignore it)
- 1258 Reboot RWO DSM 2x
- 1307 DPL is working again, highly unstable CavP\_DPL=low & oscillating, CavP\_DPR=372hPa
- 1311 Reboot RWO 10um probe & DSM
- 1314 Stop and restart just nimbus for Chris W
- 1413 RWO DSM dropout - came back by itself 2x
- 1413 Rice baseline from 1.0 to 0.5V
- 1443 RWO DSM dropout - came back by itself 7x
- 1516 Rice baseline from 0.5 to 0.9V
- 1613 RWO DSM dropout - did not come back
- 1620 Reboot RWO 10um probe & DSM
- 1626 RWO DSM dropout - came back by itself
- 1742 Land
- Postflight
  - Could not even look at nose P-lines postflight - it started pouring soon after general tech postflight tasks

**RF22, 10/2/2019:** VISB, VIST, RSTB, RSTT: data spikes, several periods blanked out.

**Technician notes (DA):**

- Preflight:
  - Ran Auto A/D Cal pre-flight. Did not have any failure.
- 1213 - DPL and DPR ON
- 1217 - Cycled VCSEL
- 1220 - Cycled DPR
- 1253 - RWO DSM self-rebooted and subsequently RICE turned to noise and voltage dropped near 0.4V, resembling the problem encountered at the beginning of OTREC.
- 1317 - Cycled RICE. Noise remained.
- 1322 - Restarted DSM Server at the request of Chris Webster. Lost PSTF.
- 1346 - Restarted DSM Server for Chris.
- 1354 - Ran Auto A/D Cal for Chris. DSM 305 was not recognized.
- 1414 - Cycled DSM 305 using circuit breaker.
- 1417 - Chris ran Auto\_Cal remotely.
- Post-Flight Maintenance
  - Blew out DPR and DPL
  - Blew out all Nose pressure lines.