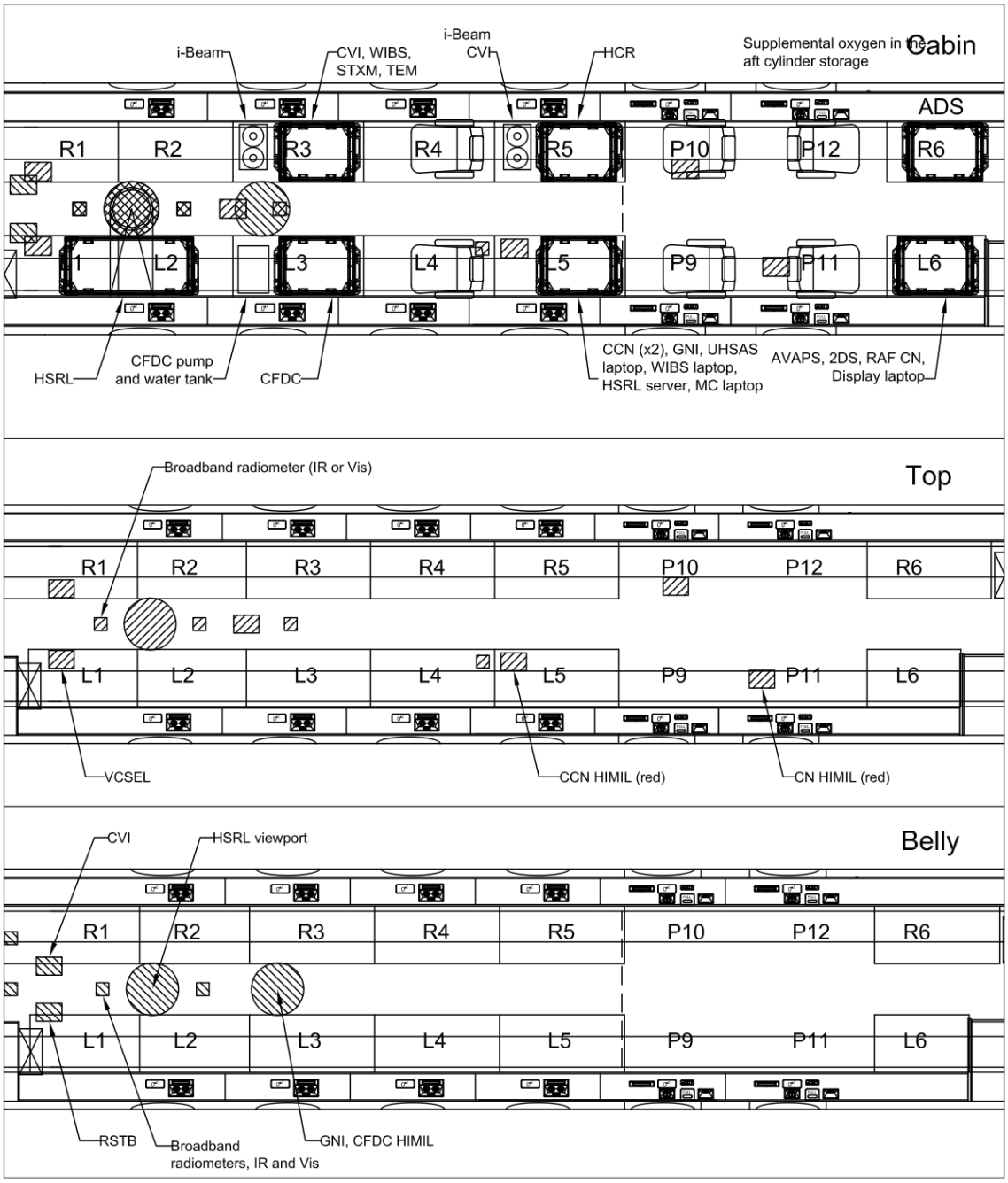
SOCRATES (2018) Project Manager Report

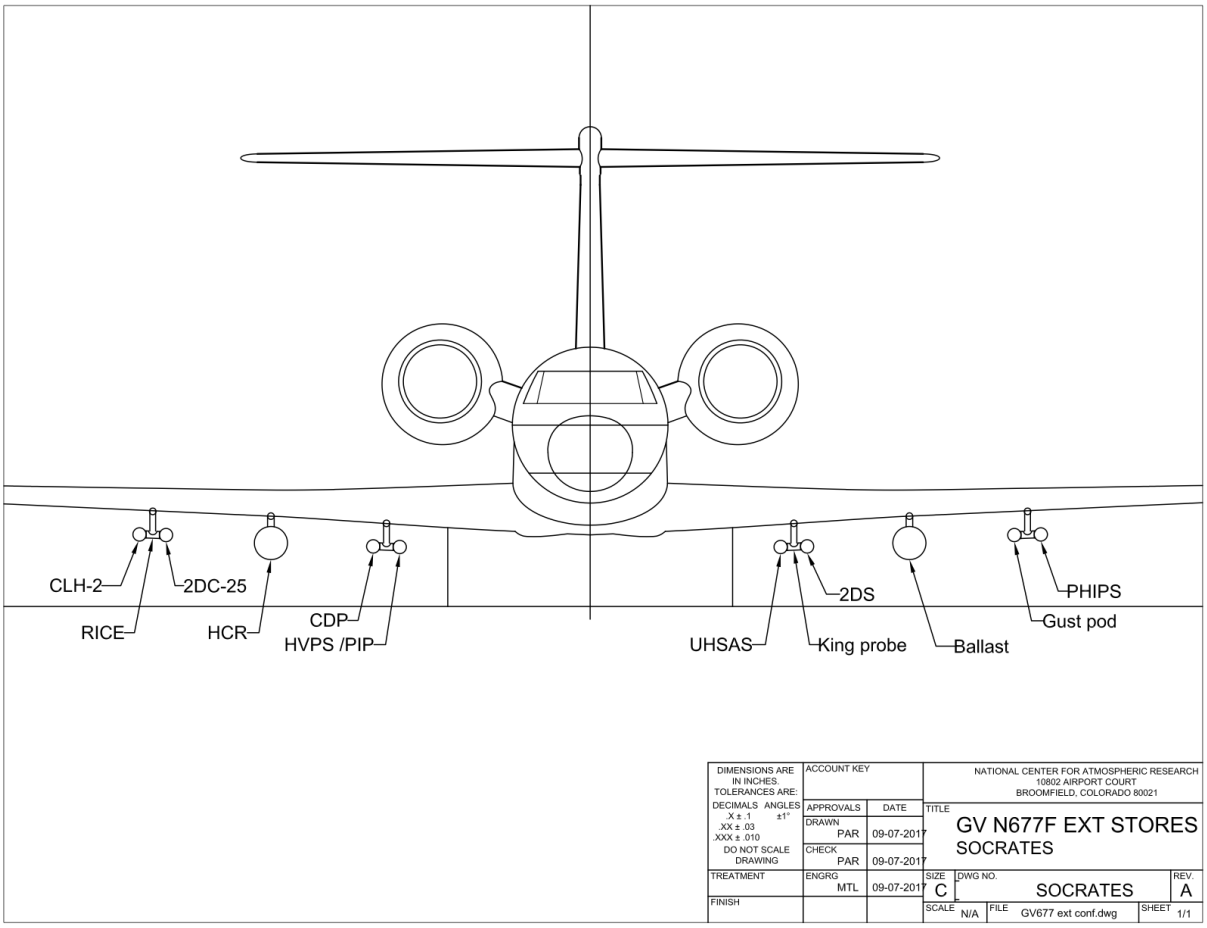
McFarquhar et al.

I. Aircraft Payload and Layout

SOCRATES GV payload

06-16-2017





This summary has been written to outline basic instrumentation problems affecting the quality of the data set and is not intended to point out every bit of questionable data. It is hoped that this information will facilitate use of the data as the research concentrates on specific flights and times.

This summary covers only the RAF supplied instrumentation on the GV and is organized into the following sections. Section II provides a general overview of the data collected and lists recurring problems, general limitations, and systematic biases in the standard RAF measurements. A discussion of the performance of RAF specialized instrumentation (i.e. GNI) will be provided separately, along with the data. Section III describes any issues occurring on a flight-by-flight basis. The final section is a list and description of variables found in the quality controlled netcdf data files.

II. General Data Notes

RAF staff have reviewed the data set for instrumentation problems. When an instrument has been found to be malfunctioning, specific time intervals are noted. In those instances the bad data intervals have been filled in the netCDF data files with the missing data code of -32767. In some cases a system will be out for an entire flight.

1. Position and Altitude Data

The GPS operated well during SOCRATES. TerraStar decimeter quality was available for most of every flight except those on and after February 21 (RF14, RF15, FF08, and FF09) when the TerraStar subscription expired and a delay in credit card processing caused it to remain down. For these last flights, the precision is around 1.5 m horizontal and 2 - 3 m vertical. See the GGxxxSD variables for estimated standard deviation.

In order to keep the aircraft and HCR INS accurate maneuvers were done about every 30 minutes during research flights. These consisted of a left turn of 10 degrees followed by a right turn of 10 degrees before returning to course. These maneuvers are evident in PITCH, ROLL, THDG, SSLIP, AKRD, and others and are obvious in some flights more than others.

2. Three Dimensional Winds

Information on general retrieval of radome winds can be found here. The vertical wind data obtained from the radome has been corrected via the algorithm/processing method documented in a NCAR Tech Note authored by Al Cooper et al. that is currently under review. The premise of this wind calibration methodology is to calculate a reference Angle of Attack (AOA) by assuming that the mean vertical wind over a level flight segment is zero. After the reference AOA is calculated, linear regression is used to determine the coefficients that provide the best fit. The reference winds are WDC, WSC, and WIC. There is a known altitude dependency of the corrected vertical wind (WIC). For SOCRATES, the sensitivity coefficients derived for recent GV projects have been applied in three altitude ranges. They are surface - 6500 m, 6500 to 9300 m, and 9300+ m. WIC should not be used during climbs and descents.

The gust pod was flown during SOCRATES. However, correcting the data gathered from it requires additional processing and calibration that has not yet been done, and the gust pod variables are not included in the final dataset. If these measurements are requested they will be provided on a flight by flight basis.

3. Pressure

Static pressure (PSF) on the GV is measured using a static port on the fuselage and then corrected (PSFC) using the angle of attack and dynamic pressure. This sensor worked well through the entire project and its measurements are the reference for SOCRATES (PSX, PSXC). There are two traditional measurements for dynamic pressure: a heated pitot tube on the fuselage (QCF) and the forward hole on the radome (QCR), which is unheated. Both are

also then corrected (QCFC and QCRC) using the static pressure and angle of attack. Water can sometimes get into the radome tubing and cause poor measurements. QCF and QCFC are chosen as the reference raw and corrected dynamic pressures (QCX, QCXC), respectively, for SOCRATES.

SOCRATES was the first field project flown with a new pitot-static sensor mounted just aft of the radome on the nose of the GV. This was added to shorten line lengths and make the pressure measurements from the same position on the aircraft. The corrected measurements from it (QCTFC and PSTFC) track well with the traditional variables described above but are not used as the reference measurements here.

4. Ambient Temperature

Temperature measurements were made using heated (ATH1 & ATH2) and fast response (ATF1) sensors. The temperature sensors generally tracked well throughout the project. There were occurrences where ATF1 iced up due to flight segments in clouds with supercooled liquid water. Though it always recovered it should be used with caution and compared with ATH1/2 as slight damage may have occurred. There were also occurrences where ATF1 cooled up to 0.5 degrees in clouds with large drops, precipitation, or high liquid water content due to wetting and evaporative cooling on the sensor. This causes what appears to be large areas of supersaturation and may result in the appearance of instability in a well mixed cloud. Again, the probe recovered after every instance, but users should use caution when interpreting the fast response temperature data when in cloud. ATH1 is chosen as the reference temperature (ATX) for SOCRATES.

5. Humidity

Humidity is measured by two collocated thermoelectric dew point sensors and the VCSEL hygrometer. The chilled mirror dewpointers (_DPL, _DPR) typically perform poorly in the flight profiles of the GV as they flood on descent and take time to restabilize. There are also non-physical oscillations that occur occasionally in the chilled mirror sensors. The chilled mirror dewpointers should only be used when VSCEL data are missing and even in these situations, should be used with caution. DPL is the best option in these cases as it has fewer oscillations and less noise than DPR during the project. The VSCEL performed generally well throughout the campaign and is used as the reference humidity measurement (DPXC). Low and decreasing laser intensity RF01 - RF06 caused some problems collecting measurements. During these periods the VCSEL might quit reporting data, or periods were blanked out. Despite that the data looks reasonable when LSRINT_VXL > 500. After a thorough cleaning, flights RF07 to the project end look good except in occasional periods of heavy cloud/icing when the laser intensity drops to near zero.

6. Radiometric Data

The measurement of radiometric surface temperature (RSTB) is generally good throughout the project. Users of RSTB should note times when TRSTB (sensor temperature) does not fall

within 15 to 22 °C, as uncertainty in the measurement is proportional to the difference between sensor temperature and scene temperature. During rapid ascents and descents the heater may not keep the sensor temperature in the desired range. No major issues with the broadband measurements (IR on top, IR and VIS on bottom) were noted, except during two flights (RF01, RF15) when water accumulated in the VIS sensor.

7. Liquid Water Content

In almost every flight the King liquid water content measurement (PLWCC) had spurious, high values right after takeoff before returning to zero. PLWCC should not be used for the first 15 minutes after takeoff. For clouds encountered during this time the LWC measurements from the CDP (PLWCD_RWIO) should be used. PLWCC also often shows non-zero values on descent after high-altitude ferry and sometimes during descents in dry air while profiling. At times these values reach up to 0.05 g m^{-3}. PLWCC also has persistent and consistent non-zero values out of cloud that spike up to 0.01 g m^{-3} and higher. These should be ignored unless PLWCD_RWIO is also non-zero. These bad times have been blanked out as much as possible, but PLWCD_RWIO should be compared with PLWCC for all liquid cloud penetrations.

8. Supercooled Liquid Water Indicator

RICE should be used only as a qualitative indicator of the presence of icing. It functioned well during SOCRATES.

9. CN Concentration

The CN counter operated well throughout SOCRATES. The lone exception was a late startup on RF15, when several minutes of data were lost. The length of sample tubing between the external inlet and the CN counter leads to a time lag in the instrument response to changes in ambient particle concentration. The sample line is made as short as possible within the constraints of rack and inlet positioning, but some lag is unavoidable. Measured total flow, and comparisons with the wing-mounted UHSAS total concentration, indicate the CN counter lags by about 2 +/- 0.5 seconds. A constant 2 second correction has therefore been applied to the CN data. Two factors contribute to the uncertainty in this time lag. First, the CN total flow rate varies somewhat with ambient pressure and other state parameters. Second, and more importantly, CONCN and CONCU are not tightly correlated in general due to combined effects of their very different size ranges and variability in the ambient aerosol size distribution, and at times they are anticorrelated.

10. Aerosol and Cloud Particle Size

Two 1D particle probes (UHSAS, CDP) and three 2D cloud/precipitation probes (2DC-25µm, 2DS, PIP) were used for SOCRATES.

UHSAS: The UHSAS generally ran well during SOCRATES, but was not without problems. The probe experienced intermittent but frequent times of laser instability of varying intensity and lasting seconds to minutes. These events produce spurious counts in the first few small-diameter bins. They have been identified to the extent possible and discarded, but in

balancing removal and preservation of valid data, some noise counts may still be present at a low level.

CDP: The CDP worked very well during the project with only small issues that are discussed in the flight specific notes.

2DC: There were no major problems with this probe during SOCRATES. Post project processing with in-house software has added new variables to the dataset. These variables contain the string 2DCA or 2DCR where 2DC refers to the 2D cloud probe. "A" represents all counted particles while "R" represents only those that are identified as round. The "round particle" population is intended to represent liquid water particles. The "all particle" population follows the more traditional method of processing 2D image data, placing both round and irregularly shaped particles together into the same particle size distribution. More information on this post processing step can be found at this webpage.
UPDATE (25 May 2022): Further review of the data indicates that the 25 micron 2DC has diodes with maximum voltages starting in RF07 until the end of the project. These data should be treated as questionable and used with care. The 2DS horizontal channel should be the preferred source of cloud particle data during these flights.

2DS: SOCRATES was the first field deployment that RAF used a standalone 2DS. Both channels needed to be watched very carefully during flights as they were susceptible to noise and stuck bits, especially the vertical channel (*_2V), which is generally noisier than the horizontal channel (*_2H) during SOCRATES. Care should be taken when using output from this probe, and its observations should be compared with the other cloud probes on the payload in order to verify the validity of the measurements (e.g. in/out of cloud). Large time ranges of noise have been called out below but spikes of spurious data may remain. As with the 2DC post project processing with in-house software has added new variables to this dataset. These variables contain the string 2DSA or 2DSR. A problem with the timing of the 2DS computer caused all collected data to be delayed. For each research flight the 2DS concentrations were compared with the CDP and 2DC to come up with a lag for that flight, estimated to the nearest second, applied to the 2DS data, and reported below.

PIP: A PIP was borrowed from NCAR/RAL for SOCRATES. Particle concentrations were collected without issues and were used to calculate distributions, average size, and all other standard derived variables. However, particle image data were corrupted due to a communication issue and no images were collected from the PIP during the project.
UPDATE (25 May 2022): Further review of the PIP data by multiple groups has shown that due to a bad true air speed (TAS) input and timing issues the data from the PIP is unusable. All PIP variables have been removed from the dataset.

11. Camera Images

Forward, left, and right looking camera images and movies from the right wing pylon and interior

windows are available for all flights. The images are taken at one second intervals and then combined at 15 fps to create the movies.

SPECIAL NOTE: Only the standard variables were recorded on the ferry flights to/from Hobart as well as the evacuation and return flights during the project. Data from these flights will only be quality controlled on special request as no project related research was performed on them.

Please note that virtually all measurements made on the aircraft require some sort of airspeed correction or the systems simply do not become active while the aircraft remains on the ground. None of the data collected while the aircraft is on the ground should be considered valid.

III. Individual Flight Summary

All times are UTC.

RF01
The King probe was inoperable for this flight due to a bad element.
The bottom visible radiometer provided bad data for this flight due to water accumulation in the sensor. VISB has been blanked out for the entire flight.
The DSM server went down briefly and all data were lost 02:31:46 - 02:33:15. Another outage occurred later in the flight and most data were lost 03:23:23 - 03:26:53.
The 2DS is noisy, especially in the vertical channel. All data from the vertical channel should not be used 00:31:00 - 02:06:50 and 02:40 to end of flight due to noise.
The 2DS lag is set to 11 seconds.

RF02
The 2DC and RICE were down for this flight due to a faulty DSM on the wing pylon.
The DSM server crashed near the end of the flight, and all data were lost 07:29:24 - 07:36:56.
ATF1 has been blanked out due to icing on the sensor 04:47:39 - 05:09:27.
ATF1 shows signs of condensation/cooling errors 05:55:28 - 05:55:52, 05:57:02 - 05:57:18, 06:03:21 - 06:03:44, 06:16:00 - 06:20:49, 06:21:31 - 06:22:04, and 06:22:52 - 06:23:40.
PLWCC is blanked out from takeoff to 00:58:02 due to spurious, high values on climb out.
ADIFR is bad due to water or ice in the lines 04:49:00 - 04:54:41 and has been blanked out for that period. This affects all measurements derived from ADIFR such as ATTACK, WIC, etc.
The vertical 2DS channel is noisy in places and should not be used 06:41:25 - 06:48:54 and 06:50:00 - 07:00:00.
The 2DS lag is set to 12 seconds.

RF03
The gust pod was inoperable for this flight as the power supply from its DSM was removed and used to power the DSM for the 2DC and RICE, which were higher priority instruments.

Low power on the King probe due to a faulty element resulted in bad data in PLWCC for almost the entire flight. PLWCD_RWIO should be used for LWC measurements on this flight.
Low laser intensity on VCSEL caused some instability in the measurements. The VCSEL is blanked out 01:15:02 - 01:16:09, 03:24:00 - 03:25:00, and 03:32:00 - 03:40:00.
QCR iced up for part of the flight and is blanked out 02:10:58 - 02:39:34.
ATF1 had icing/condensation issues and is blanked out 00:41:17 - 00:42:33, 00:47:43 - 00:49:27, 02:34:00 - 02:37:33, 03:15:51 - 03:16:40.
The vertical 2DS channel is noisy in places and should not be used 22:16 - 22:49, 01:02 - 01:18, 01:29 - 01:31, 01:43 - 02:10, 02:56 - 03:01, and 03:23 - 03:37.
The 2DS lag is set to 14 seconds.

RF04
Data acquisition failed early in the flight and the system needed to be restarted. All data were lost 23:50:44 - 23:51:12.
Low power on the King probe due to a faulty element resulted in bad data in PLWCC for almost the entire flight. PLWCD_RWIO should be used for LWC measurements on this flight.
VCSEL is blanked out 03:32:30 - 03:34:00 due to low laser intensity.
ATF1 is blanked out 04:13:26 - 04:21:34 due to icing.
The vertical 2DS channel is noisy in places and should not be used 00:28:00 - 00:53:05, 02:38:00 - 02:46:42, and 04:07:00 - 04:57:00.
The horizontal 2DS channel is noisy and should not be used 02:34 - 02:41.
The 2DS lag is set to 15 seconds.

RF05
ATF1 is blanked out 01:54:17 - 02:06:18 due to icing/condensation.
VCSEL is blanked out due to low laser intensity 04:45 - 04:54.
The King probe element was replaced and PLWCC measurements are mostly good for this flight. There are some oscillations in the voltage that cause some very low values in PLWCC that should be ignored. PLWCC is blanked due to noise 00:45:21 - 00:59:23, 04:19:25 - 04:36:30, and 05:45:58 - 05:52:01. PLWCC is also high right after takeoff and is blanked out 22:53:00 - 23:02:15. PLWCD_RWIO should be used in during these times.
All radiometric variables (VISB, IRBC, IRTC, IRBHT, IRTHT) all have a data spike at 23:06 and should be ignored.
The 2DC is down from 03:46 to the end of the flight due to low diode voltages.
The vertical 2DS channel is noisy and should not be used 03:47:00 - 03:59:00.
The 2DS lag is set to 17 seconds.

RF06
A software glitch after takeoff caused a loss of most data 22:55:55 - 22:58:31, though some didn't come back until 23:03:35.
The data system went down about 10 minutes before landing. All data are lost starting at 06:10.
VCSEL is blanked out due to low laser intensity 01:54 - 01:55 and 02:07:00 - 02:07:30. It also begins to oscillate more than usual, likely due to borderline low laser intensity, toward the end of

the flight, starting at 05:05 and continuing until data are lost. The data are not blanked out during this time but should be used with caution.
ATF1 is blanked out due to icing/condensation issues 01:47:57 - 01:56:25, 02:06:32 - 02:06:49, and 05:36:17 - 06:10.
QCR is blanked out due to water in the line 05:18:00 - 06:00:03. No other radome measurements are affected.
PLWCC is high right after takeoff and is blanked out 22:54:20 - 23:08:52.
The vertical 2DS channel should not be used 01:28 - 01:35 due to noise. It appears the operator masked the vertical channel starting from 01:55 to the end of the flight.
The horizontal 2DS channel should not be used 03:45 - 04:55 due to noise.
The 2DS lag is set to 19 seconds.

RF07
Left side camera was down during this flight. Right and forward camera images are available.
There were problems with the gust pod on startup. It works for about the first 30 minutes of flight and then drops out and doesn't recover for the rest of the flight.
Data acquisition fails on approach and all data are lost from 08:21:36 to the end of the flight.
ATF1 is blanked out due to icing/condensation issues 04:18:15 - 04:37:09, 04:58:38 - 05:00:44, and 05:02:07 - 05:02:35.
ADIFR and BDIFR ice up and are blanked out 04:18:00 - 04:29:05. This affects a large number of derived variables.
PLWCC is high right after takeoff and is blanked out 00:58:20 - 01:04:36.
PLWCC shows erroneously high LWC in dry air and is blanked 03:21:12 - 03:33:12.
The vertical 2DS channel should not be used due to noise 04:27:55 - 04:31:33, 04:46:46 - 04:49:13, 04:55:25 - 05:03:40, 05:23:55 - 05:25:29, and 05:38:35 - 05:47:51.
The 2DS lag is set to 20 seconds.

RF08
A data system reboot causes all data to be lost 23:51:57 - 23:55:50.
There were some short gust pod dropouts between 00:48 and 00:54.
Data acquisition again went down on approach and all data are lost from 06:38:01 to the end of the flight.
All cameras went down for the last 45 minutes of the flight.
ATF1 is blanked out due to icing/condensation issues 03:04:45 - 04:08:14, 05:14:34 - 05:15:39, 05:19:29 - 05:20:40, 05:27:18 - 05:28:14, and 05:31:39 - 05:32:49.
QCR and QCTF are blanked out 03:51:30 - 04:08:15 after an icing encounter.
PLWC is high after takeoff and again on descent from initial ferry and is blanked out 23:14:18 - 23:22:36 and 01:57:41 - 02:07:55.
The 2DS vertical channel should not be used due to noise 03:24:53 - 03:32:56, 03:57:50 - 04:10:33, 04:18:41 - 04:46:00, 04:54:48 - 04:59:53, and 05:52:41 - 06:19:35. In many places the vertical channel consistently has much higher concentrations than the horizontal channel, which is not normal. The vertical channel measurements should be used with caution.
The 2DS lag is set to 24 seconds.

RF09

Left camera down for this flight. Forward and right cameras are operational.
ATF1 is suspect for most of the profiles due to icing and is blanked 03:00:56 - 05:18:27.
The VCSEL had trouble keeping good laser intensity, possibly due to icing, which results in some data dropouts 04:10 - 04:17. DPL or DPR can be used, but they show some serious overshoots and oscillations during this time and should be used with caution.
QCR is blanked due to icing 04:11:24 - 04:31:27.
ADIFR is blanked 04:45:26 - 04:48:54 due to icing.
PSFC and PSTFC have odd deviations on a descent and are blanked 04:45:27 - 04:48:54.
PSTFC is also blanked 04:14 - 04:20 due to a similar deviation.
There is a negative bias in WIC during the high altitude return leg approximately 04:58 - 06:47.
PLWCC is high on climb out and is blanked 22:55:42 - 23:15:28.
The 2DS vertical channel should not be used due to noise 01:33:55 - 02:05:33 and 04:20:59 - 04:23:39.
The 2DS lag is set to 26 seconds.

RF10

VCSEL has some issues near the beginning of the flight with many mode changes and low laser power. It has not been blanked out but DPL is a better choice to use for moisture measurements 21:06 - 21:38.
VCSEL loses laser intensity due to icing and is blanked 00:34:00 - 00:36:36.
QCR is blanked due to icing 00:40:24 - 00:47:41.
PLWCC is high on climb out and is blanked 20:54:35 - 21:04:34.
PLWCC has issues getting back to 0 out of cloud, after going through a cloud. PLWCC is blanked 00:35:20 - 00:35:46, 00:37:17 - 00:39:47, 00:42:34 - 00:52:39, 00:53:32 - 00:56:01, 01:06:41 - 01:10:10, 01:13:07 - 01:13:53, 01:17:31 - 01:19:52, 01:43:04 - 01:57:22. During the period of profiling, 00:22 - 04:08, it should be used with caution and compared with PLWCD to verify the presence of cloud.
2DS vertical channel should not be used due to noise 04:08:35 - 04:29:30.
The 2DS lag is set to 27 seconds.

RF11

The right side camera was inoperable for this flight.
The data system went down at 06:17 (near landing) and all data are lost for rest of flight.
ATF1 is blanked due to icing 03:22:06 - 03:22:42, 03:30:29 - 03:32:52, 03:38:10 - 03:38:25, 04:11:35 - 04:12:07, 04:13:53 - 04:14:11, 04:31:55 - 04:33:36.
There is a brief VCSEL outage at 04:26 due to low laser intensity.
PLWCC is blanked 01:39:07 - 01:46:57 due to high values on climb out.
PLWCC has issues getting back to 0 out of cloud, after going through a cloud. PLWCC is blanked 03:38:32 - 03:39:44, 03:39:48 - 03:41:00, 03:42:23 - 03:42:45, 03:42:48 - 03:44:00, 03:44:15 - 03:44:42, 03:44:53 - 03:46:26, 03:46:32 - 03:59:35, 04:35:20 - 04:50:48.
There is no 2DS data until 04:16.

The 2DS vertical channel should not be used due to noise 04:30:00 - 04:32:55, 04:40:46 - 04:41:22, 04:56:52 - 05:21:34, 05:59:03 - 06:00:56.
Both 2DS channels should not be used due to noise 05:21:34 - 05:56:03.
The 2DS lag is set to 32 seconds.

RF12
Data acquisition stopped during taxi and came back after takeoff and stopped again on initial descent for landing. All data missing are 23:48:40 - 23:54:57 and 07:34:49 - 07:39:24.
ATF1 is blanked due to icing/condensation 03:28:03 - 03:44:03, 04:01:19 - 04:02:57, 04:06:52 - 04:07:44, 04:27:18 - 04:48:30.
PLWCC is blanked 23:55:00 - 00:07:34 due to high values on climb out.
PLWCC has issues getting back to 0 out of cloud, after going through a cloud. PLWCC is blanked 03:38:52 - 03:54:30, 04:02:41 - 04:06:43, 04:44:29 - 04:47:52, 05:14:00 - 05:17:00.
The 2DS vertical channel gets noisy after a cloud encounter and should not be used 03:36:37 - 03:44:25 and again 03:55:00 - 04:10:46.
The 2DS lag is set to 34 seconds.

RF13
Data acquisition stopped during taxi and came back after takeoff. All data are missing 22:50:29 - 22:59:32.
All cameras stopped updating and were restarted at 05:18.
PLWCC is blanked 22:59:32 - 23:12:31 due to high values on climb out.
PLWCC has issues getting back to 0 out of cloud after cloud penetration. PLWCC is blanked 02:31:53 - 02:50:58, 02:57:15 - 03:00:36, 03:30:30 - 03:49:43, 03:56:13 - 04:00:24, 04:18:42 - 04:39:50, 04:47:29 - 04:50:38, 05:18:28 - 05:38:27.
The 2DS did not record any data until 03:28.
The 2DS lag is set to 36 seconds.

RF14
ATF1 is blanked due to icing 02:30:57 - 03:08:33.
Moisture in the radome causes ADIFR and BDIFR to go bad at one point during the flight. ADIFR is blanked 02:31:15 - 02:36:08 and BDIFR is blanked 02:33:00 - 02:34:52. Many variables will be unavailable during this time.
There is a negative bias in WIC during the high altitude return leg approximately 05:22 - 06:28.
PLWCC is blanked 22:48:03 - 22:56:36 due to high values on climb out.
PLWCC has issues getting back to 0 out of cloud after cloud penetration. PLWCC is blanked 02:34:08 - 02:37:04, 03:01:04 - 03:06:39, 03:07:10 - 03:25:14, 04:14:20 - 04:33:03.
The 2DS lag is set to 37 seconds.

RF15
The data acquisition computer was restarted during taxi and came back just after takeoff. No data are available until 02:07:53.

VCSEL was rebooted shortly after takeoff due to water on the mirror from precipitation during preflight.
The cameras and CN Counter were not turned on until 02:15.
PLWCC is blanked 02:07:53 - 02:23:00 due to high values on climb out.
PLWCC has issues getting back to 0 out of cloud after cloud penetration. PLWCC is blanked 04:58:54 - 05:01:45, 05:48:27 - 06:21:40, 07:36:30 - 07:55:08, 08:07:32 - 08:10:56.
The bottom visible radiometer provided bad data for this flight due to water accumulation in the sensor. VISB has been blanked out for the entire flight.
No 2DS data are available until 07:40.
The 2DS lag is set to 39 seconds.

IV. Variable List

ACINS	IRS Vertical Acceleration
ADIFR	Vertical Differential Pressure, Radome
AKRD	Attack Angle, Radome
ALT	IRS Altitude
AQRATIO	Ratio of ADIFR to QCF
ATF1	Ambient Temperature, Fast Response
ATH1	Ambient Temperature, Deiced
ATH2	Ambient Temperature, Deiced
ATTACK	Attack Angle, Reference
ATX	Ambient Temperature, Reference
BDIFR	Horizontal Differential Pressure, Radome
BLATA	IRS Body Latitudinal Acceleration
BLONGA	IRS Body Longitudinal Acceleration
BNORMA	IRS Body Normal Acceleration
CNTS	TSI CN Counter Output
CONC1DC100_RWOI	2DC Concentration, 100 micron and larger
CONC1DC150_RWOI	2DC Concentration, 150 micron and larger
CONC1DC_RWOI	2DC Concentration, all cells
CONC2DCA_RWOI	2DC Concentration, All Particles
CONC2DCR_RWOI	2DC Concentration, Round Particles
CONC2DSA_2H	2DS Horizontal Channel Concentration, All Particles
CONC2DSR_2H	2DS Horizontal Channel Concentration, Round Particles
CONC2DSA_2V	2DS Vertical Channel Concentration, All Particles
CONC2DSR_2V	2DS Vertical Channel Concentration, Round Particles
CONCD_RWIO	CDP Concentration
CONCPIP_RWII	PIP Concentration
CONCN	Condensation Nuclei (CN) Concentration
CONCU100_LWII	UHSAS Concentration, 0.1 micron and larger
CONCU500_LWII	UHSAS Concentration, 0.5 micron and larger

CONCU_LWII	UHSAS Concentration, all cells
CONCU100_CVIU	CVI UHSAS Concentration, 0.1 micron and larger
CONCU500_CVIU	CVI UHSAS Concentration, 0.5 micron and larger
CONCU_CVIU	CVI UHSAS Concentration, all cells
DBAR1DC_RWOI	2DC Mean Particle Diameter, all cells
DBAR2DCA_RWOI	2DC Mean Particle Diameter, All Particles
DBAR2DCR_RWOI	2DC Mean Particle Diameter, Round Particles
DBAR2DSA_2H	2DS Horizontal Channel Mean Particle Diameter, All Particles
DBAR2DCR_2H	2DS Horizontal Channel Mean Particle Diameter, Round Particles
DBAR2DSA_2V	2DS Vertical Channel Mean Particle Diameter, All Particles
DBAR2DCR_2V	2DS Vertical Channel Mean Particle Diameter, Round Particles
DBARD_RWIO	CDP Mean Particle Diameter
DBARPIP_RWII	PIP Mean Particle Diameter
DBARU_LWII	UHSAS Mean Particle Diameter
DBARU_CVIU	CVI UHSAS Mean Particle Diameter
DBZ1DC_RWOI	2DC Calculated Reflectivity, all cells
DBZ2DCA_RWOI	2DC Calculated Reflectivity, All Particles
DBZ2DCR_RWOI	2DC Calculated Reflectivity, Round Particles
DBZ2DSA_2H	2DS Horizontal Channel Calculated Reflectivity, All Particles
DBZ2DSR_2H	2DS Horizontal Channel Calculated Reflectivity, Round Particles
DBZ2DSA_2V	2DS Vertical Channel Calculated Reflectivity, All Particles
DBZ2DSR_2V	2DS Vertical Channel Calculated Reflectivity, Round Particles
DBZD_RWIO	CDP Calculated Reflectivity
DISP1DC_RWOI	2DC Dispersion (sigma/dbarx)
DISPD_RWIO	CDP Dispersion (sigma/dbarx)
DISPPIP_RWII	PIP Dispersion (sigma/dbarx)
DISPU_LWII	UHSAS Dispersion (sigma/dbarx)
DPXC	Dew/Frost Point Temperature, Reference
DP_DPL	Dew/Frost Point Temperature, Left Dewpointer
DP_DPR	Dew/Frost Point Temperature, Right Dewpointer
DP_VXL	Dew/Frost Point Temperature, VCSEL
DVALUE	D-VALUE (GGALT - PALT)
EWX	Ambient Water Vapor Pressure, Reference
EW_DPL	Ambient Water Vapor Pressure, Left Dewpointer
EW_DPR	Ambient Water Vapor Pressure, Right Dewpointer
EW_VXL	Ambient Water Vapor Pressure, VCSEL
FCNC	Corrected BCN Counter Sample Flow Rate
GGALT	Reference GPS Altitude (MSL, m)
GGALTF	Reference GPS Altitude (MSL, ft)
GGALTSD	Standard Deviation of Reference GPS Altitude (MSL)
GGLAT	Reference GPS Latitude
GGLATSD	Standard Deviation of Reference GPS Latitude
GGLON	Reference GPS Longitude

GGLONSD	Standard Deviation of Reference GPS Longitude
GGNSAT	Reference GPS number of satellites used in solution
GGQUAL	Reference GPS Qual, 0=Invalid,1=GPS,2=DGPS
GGSPD	Reference GPS Ground Speed
GGTRK	Reference GPS Track Angle
GGVEW	Reference GPS Ground Speed Vector, East Component
GGVNS	Reference GPS Ground Speed Vector, North Component
GGVSPD	Reference GPS Vertical Speed
IRBC	Corrected Infrared Irradiance, Bottom
IRBHT	Pyrgeometer (IR) Housing Temperature, Bottom
IRTC	Corrected Infrared Irradiance, Top
IRTHT	Pyrgeometer (IR) Housing Temperature, Top
LAT	IRS Latitude
LATC	GPS-Corrected Inertial Latitude
LON	IRS Longitude
LONC	GPS-Corrected Inertial Longitude
MACHF	Aircraft Mach Number, Fuselage
MACHR	Aircraft Mach Number, Radome
MACHX	Aircraft Mach Number, Reference
MIRRTMP_DPL	Raw Dew/Frost Point Temperature, Left Dewpointer
MIRRTMP_DPR	Raw Dew/Frost Point Temperature, Right Dewpointer
MODE_VXL	VCSEL Mode
MR	Mixing Ratio, T-Electric
PALT	NACA Pressure Altitude (m)
PALTF	NACA Pressure Altitude (ft)
PCAB	Interior Cabin Static Pressure
PCN	Pressure in BCN counter inlet
PDUMPPL	Pressure of instrument exhaust duct, left
PDUMPPR	Pressure of instrument exhaust duct, right
PITCH	IRS Aircraft Pitch Angle
PLWC1DC_RWOI	2DC Water/Ice Content, all cells
PLWC2DCA_RWOI	2DC Water/Ice Content, All Particles
PLWC2DCR_RWOI	2DC Water/Ice Content, Round Particles
PLWC2DSA_2H	2DS Horizontal Channel Water/Ice Content, All Particles
PLWC2DSR_2H	2DS Horizontal Channel Water/Ice Content, Round Particles
PLWC2DSA_2V	2DS Vertical Channel Water/Ice Content, All Particles
PLWC2DSR_2V	2DS Vertical Channel Water/Ice Content, Round Particles
PLWCC	Corrected PMS-King Liquid Water Content
PLWCD_RWIO	CDP Water/Ice Content
PLWCPIP_RWII	PIP Water/Ice Content
PSF	Raw Static Pressure, Fuselage
PSFC	Corrected Static Pressure, Fuselage
PSTF	Raw Static Pressure, Top of Fuselage

PSTFC	Corrected Static Pressure, Top of Fuselage
PSX	Raw Static Pressure, Reference
PSXC	Corrected Static Pressure, Reference
PS_A	ADC Static Pressure
QCF	Raw Dynamic Pressure, Fuselage
QCFC	Corrected Dynamic Pressure, Fuselage
QCR	Raw Dynamic Pressure, Radome
QCRC	Corrected Dynamic Pressure, Radome
QCTF	Raw Dynamic Pressure, Top of Fuselage
QCTFC	Corrected Dynamic Pressure, Top of Fuselage
QCX	Raw Dynamic Pressure, Reference
QCXC	Corrected Dynamic Pressure, Reference
QC_A	ADC Dynamic Pressure
REFF2DC_RWOI	2DC Effective Radius, Raw
REFF2DCA_RWOI	2DC Effective Radius, All Particles
REFF2DCR_RWOI	2DC Effective Radius, Round Particles
REFF2DSA_2H	2DS Horizontal Channel Effective Radius, All Particles
REFF2DSR_2H	2DS Horizontal Channel Effective Radius, Round Particles
REFF2DSA_2V	2DS Vertical Channel Effective Radius, All Particles
REFF2DSR_2V	2DS Vertical Channel Effective Radius, Round Particles
REFFD_RWIO	CDP Effective Radius
RHODT	Absolute Humidity, T-Electric
RHUM	Relative Humidity
RICE	Raw Icing-Rate Indicator
ROLL	IRS Aircraft Roll Angle
RSTB	Radiometric Surface Temperature
RTF1	Recovery Air Temperature, Fast Response
RTH1	Recovery Air Temperature, Deiced
RTH2	Recovery Air Temperature, Deiced
RTX	Recovery Temperature, Reference
SOLAZ	Solar Azimuth Angle
SOLDE	Solar Declination Angle
SOLEL	Solar Elevation Angle
SOLZE	Solar Zenith Angle
SSLIP	Sideslip Angle, Reference
SSRD	Sideslip Angle, Radome Diff. Pressure
STATUS_VXL	VCSEL Status Code
TASF	Aircraft True Airspeed, Fuselage
TASFLG	TAS Humidity Correction Flag
TASDRY	Aircraft True Airspeed, Not Humidity Corrected
TASR	Aircraft True Airspeed, Radome
TASX	Aircraft True Airspeed, Reference
TCAB	Cabin Temperature at ADS Rack Location

TCNTD_RWIO	CDP Total Counts (all cells)
TCNTU_LWII	UHSAS Total Counts (all cells)
THDG	IRS Aircraft True Heading Angle
THETA	Potential Temperature
THETAE	Equivalent Potential Temperature
THETAP	Pseudo-adiabatic Equivalent Potential Temperature
THETAQ	Wet Equivalent Potential Temperature
THETAV	Virtual Potential Temperature
TRSTB	RSTB Sensor Temperature
TVIR	Virtual Temperature
Time	Time of Measurement
UI	Wind Vector, East Component
UIC	GPS-Corrected Wind Vector, East Component
UX	Wind Vector, Longitudinal Component
UXC	GPS-Corrected Wind Vector, Longitudinal Component
VEW	IRS Ground Speed Vector, East Component
VEWC	GPS-Corrected Inertial Ground Speed Vector, East Comp
VI	Wind Vector, North Component
VIC	GPS-Corrected Wind Vector, North Component
VISB	Corrected Pyranometer Visible Irradiance, Bottom
VMR_VXL	Volume Mixing Ratio, VCSEL
VNS	IRS Ground Speed Vector, North Component
VNSC	GPS-Corrected Inertial Ground Speed Vector, North Comp
VSPD	IRS Vertical Speed
VY	Wind Vector, Lateral Component
VYC	GPS-Corrected Wind Vector, Lateral Component
WD	Horizontal Wind Direction
WDC	GPS-Corrected Horizontal Wind Direction
WI	Wind Vector, Vertical Gust Component
WIC	GPS-Corrected Wind Vector, Vertical Gust Component
WS	Horizontal Wind Speed
WSC	GPS-Corrected Horizontal Wind Speed
WOW_A	Aircraft Weight on Wheels