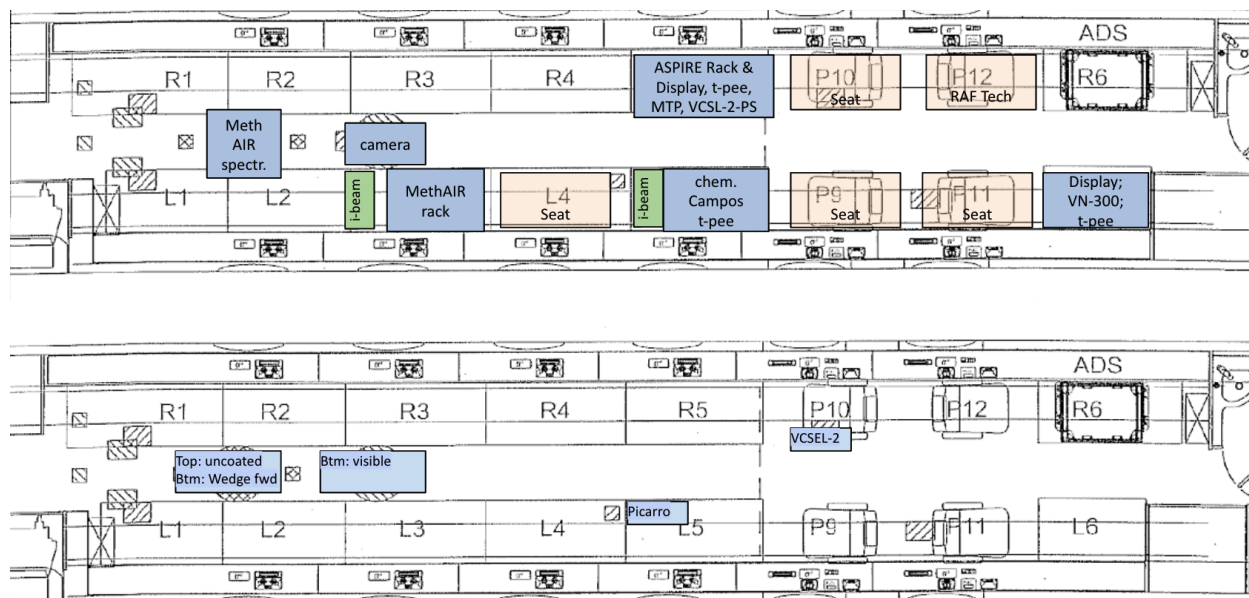


MethaneAIR-2021 Project Manager Report

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I. Aircraft Payload and Layout



- Viewports: lower fwd: special “wedge”, wedge facing aft; lower aft: visible with Harvard camera; top: uncoated to be swapped with “wedge” window for the last flight
- VCSEL-2: aperture above P10 seat
- Wings: CLEAN WINGS
- Picarro inlet: above L5
- R5 and L6: unchanged from ASPIRE-Test, MTP components removed

This summary has been written to outline basic instrumentation performance 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 will be provided separately, along with the data. Section III describes issues that occurred on a flight-by-flight basis.

Information on the processing algorithms used to produce the final dataset can be found at:

<https://www.eol.ucar.edu/content/raf-bulletins>

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 MethaneAIR. Terrastar corrections were active on all flights. Data were collected at 20 Hz. The horizontal standard deviation was typically below 0.1 m. Vertical standard deviation was less than 0.2 m except during and following turns, where loss of GPS data quality is expected. These are represented in the GGxxx variables in the dataset.

2. Three Dimensional Winds

Vertical wind has been optimized by applying calibration to the angle of attack, with the aim to achieve the mean vertical wind of zero. Angle of attack was calibrated using a linear model based on two predictors: the ratio of the vertical differential pressure (on the radome) to the dynamic pressure and the dynamic pressure alone. The model was fit to near-level legs, in clear sky conditions and with minimal roll. WIX is the variable for vertical wind during MethaneAIR, and had to be calculated slightly differently for subsets of flights for reasons not presently understood. Vertical wind data during climbs and descents may be subject to artifacts and used with caution.

The reference horizontal wind variables are WDC and WSC.

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 MethaneAIR (PSX, PSXC). There are two 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 corrected using the static pressure and angle of attack (QCFC and QCRC). 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 MethaneAIR. The corrected measurements from the pitot-static sensor mounted on the nose of the GV (QCTFC and PSTFC) track well with the traditional variables described above but are not used as the reference measurements here; their intent is to reduce the line length and resonance in the lines, which has not been found significant in MethaneAIR.

4. Ambient Temperature

Temperature measurements were made using heated sensors from Harco (ATH1 & ATH2). The temperature sensors tracked well throughout the project with the greatest differences of ~0.25C seen during high altitude cruise. The published reference temperature, ATX, is equal to ATH1.

5. Humidity

Humidity is measured by two thermoelectric dew point sensors. These chilled mirror dewpointers (_DPL, _DPR) typically perform poorly in the flight profiles of the GV as they become very cold at high altitude and subsequently flood with condensation on descent into more humid lower atmosphere and take a long time to evaporate condensation and re-stabilize. There are also non-physical oscillations that occur occasionally in the chilled mirror sensors. DPL performed best and is used as the reference humidity measurement (DPX and EWX).

III. Individual Flight Summary

All times are UTC.

RF01

No significant issues with the data.

RF02

No significant issues with the data.

RF03

No significant issues with the data.

RF04

No significant issues with the data.

RF05

No significant issues with the data. Reference dewpointed exhibited excessive oscillation from 20:35:34 to 20:41:51. No humidity data are available during this interval. As a result, variables dependent on humidity are also not available for this interval (THETA*, etc.)

RF06

GPS position data was not logged from the beginning of the flight until approximately 15:15 due to an issue with the data acquisition module. The position data from the INS is available throughout that period. Please use LAT and LON for the position data for this flight.

Note that some dependent variables, specifically WIX, are also missing during that interval. If desired, some of these variables could be derived from the inertial data. If this is the case, please inquire with the RAF to generate a special data set for this flight.

RF07

No significant issues with the data. Reference dewpoint exhibited excessive oscillations from 20:11:12 to 20:39:14 and from 18:03:48 to 18:36:30. No humidity data are available during this interval. As a result, variables dependent on humidity are also not available for these intervals (THETA*, etc.)

RF08

No significant issues with the data.

RF09

No significant issues with the data.

RF10

No significant issues with the data.

IV. Flight Notes by Flight

RF01

Ran Auto_Cal pre-flight. DSM 304, A/D 1605, Ch. 0, Dummy, has 140mV offset.

All instruments in good working order prior to takeoff.

Novatel sees 8 satellites on the ground outside the hangar. 9 in flight.

Forward-looking camera image not available on Catalog Maps. Though it did work on the Camera Viewer page.

Lost RWO DSM for 6 minutes 1814-1820.

1837 - DPR ran away just after reaching 40k feet.

RF02

Pre-flight

- Ran A2D auto-cal, results have not changed from RF01. All channels with instruments are within acceptable range.
- Found that issue with camera on not displaying in maps on rf01 to have resolved itself.
- All vars in aeros are functioning correctly.
- Novatel Sats: 9

Flight Notes

17:39 - RICE dropped out and recovered on its own. DSM rebooted during ascent.

18:04 - Lost DP_DPR. Was lagging DP_DPL prior to dropout.

21:28 - ADIFR spiked during descent.

RF03

All instruments operated well.

*Mission altitude was 45k ft. DPL and DPR reported around -70 at this altitude. Both flooded on descent as expected.

Once parked, Left Side Engine was shutdown which killed the Left Side Research Bus. Cause is unknown. No equipment or data was lost.

RF04

Pre flight

Auto A/D cal not functioning, but there are no analog channels.

Both Pdumps reading low around 583mb on the ground. No pumps running especially on the right side.

1433 looks like not getting data from IRS 3

1453 IRS3 is okay, there were some extra variables in the header.

1906 DPR balance number seems high at 3000+

1931 DPR is working much better than DPL in the descent.

I would say dew pointers are okay but really ugly in the descent.

RF05

Pre-flight Notes:

-Had to restart the timeserver and data acquisition due to INS alignment issue.

-No ground connection through Satcom (It is unclear to me what happened with satcom. The Thrane & Thrane page showed a connection with IP address 204.246.18.8 and we were getting UDP position data from that address on the ground. I could not ssh to that IP and no other services worked)

-VN300 would not sync to the timeserver. Laptop shows no internet connection.

Flight Notes:

14:50 - No VCSEL2 data. Reset breakers at R5 rack with no result. Status lights on the ethernet jack indicate a good network connection. Prior to reset all 3 status indicators were on. After reset only 1 would turn on. (4 attempts were made to restart over the duration of the flight)

16:47 - 15 second drop in IRS variables. LON_A, LAT_A, AKRD, and PALTF variables. Numerous dropouts throughout the flight.

20:35 - DSM304 Critical Status, IRIG Extended Status: NO_SYNC, NOPPS_LOCK, NO_CODE, NOSYNC. Resetting DSM fixed status error, but still showed NO_CODE and IRIG-UNIX=1.000 flags (There appear to be ten gaps of duration 9 seconds in dsm304 sprinkled throughout the flight. Will look at logs when we get power)

RF06

Pre-flight:

Noted ADS started when research power available, before "on" button push at computer. Rebooted ADS when timeserver on.

verified INS aligned, waited for satcomm (slow today), verified connection with external news website, today's date and headlines

All vars look good

1438Z wheels up, check variables, no Novatel GPS or position on map. Relayed to SEs. fixed quickly

1650Z Checked ADIFR and BDIFR during turn. Matches avionics in proportion and direction.

RF07

Stuart handled the startup of VCSEL 2. Still no useful numbers on AEROS.

Viewports frosted over when we landed on the ground in Midland, TX. Had to wait around for an hour+ for them to dry. Used the fan in the baggage compartment to assist in the drying process. Will not likely stop for fuel again during this project for this reason.

1951 - Powered OFF DPL and DPR (flooded)

2014 - Powered ON DPL and DPR.

RF08

Pre-flight:

13:06 - Noted brief drop in DSM304 variables of around 15 seconds. (Did not see any drops in flight)

Flight:

No issues observed.

RF09

I noticed at 18:00 that the timeserver's Ref Time LED was red. The Novatel is seeing 22 sats, ggqual is 5(Good), and ggstatus(rcvr) is 1(OK). Checked all connections with no success. I was able to login to it's web browser interface. Says it's seeing 16 satellites but they are no good. At 19:54, I noticed it came back with good satellites. All green LED's now. I created a Meinberg statistics file and is on the usb drive with the rf09 ads file. Not sure if it can be read but thought it was worth a try.

RF10

No issues reported.