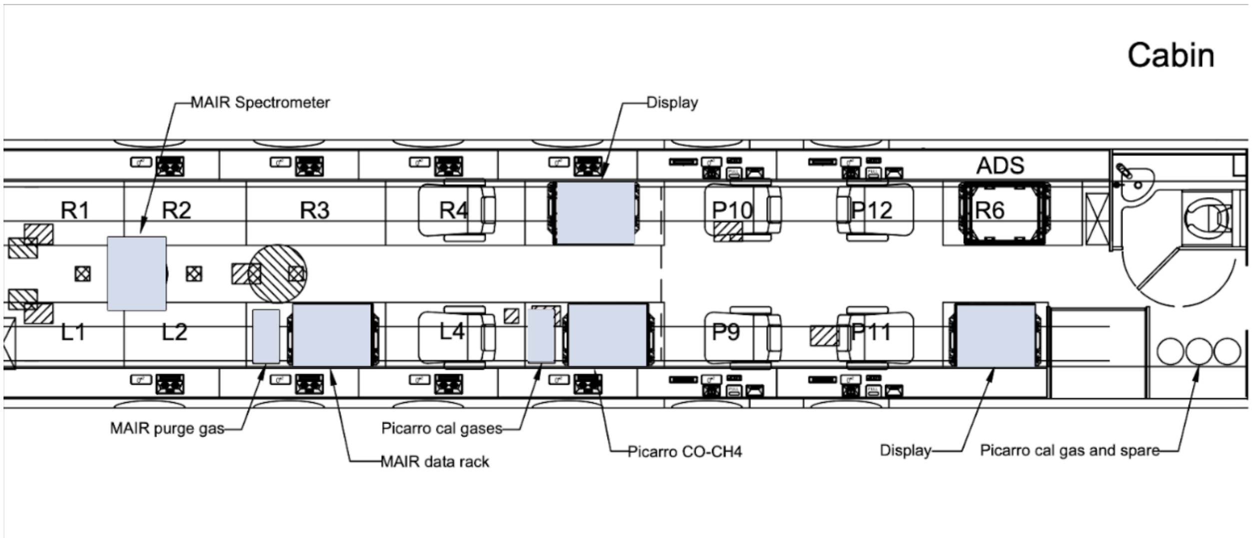
MAIR-E (2022) Project Manager Report

Wofsy

I. Aircraft Payload and Layout



This report is written to provide documentation for the challenges encountered, instrumentation issues, data quality and the flight operations during the experiment. The goal is to provide sufficient background information to assist data users when analyzing the project data set.

The report 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 MAIR-E. Terrastar corrections were active on all flights. Data was 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 MAIR-E, 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 MAIR-E (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). 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 the project.

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 dew pointers (_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.

FF01 (10/22/2022, 1751Z - 2039Z)
The flight departed approximately 15 minutes prior to scheduled departure; and total flight time was shorter than planned. Users reported that their equipment was functioning properly.

RF01 (10/25/2022, 1531Z - 2202Z)
The flight was delayed due to some technical flight planning issues. The issues were resolved and the flight departed approximately 30 minutes later. The ADC variables were lost in Aeros during pre-flight when powering on the Dew Pointers. This resulted in a brief data gap. The left Dew Pointer entered uncontrolled state at 1538Z remained noisy for flight duration. Power cycled Left Dew Pointer at 2020Z and issues were not resolved. The Picaro/Aerodyne was disabled at 1710Z for the 300 second auto cal. A total of two auto cal cycles were completed before enabling the instrument. Another Picaro/Aerodyne auto cal (1200 second) was initiated at 2030Z.

RF02 (10/28/2023, 1449Z - 1959Z)
The GV aircraft experienced an issue with the flap/stabilization system after the low approach. The issues could not be resolved in flight and led to a safety call to divert the aircraft to Centennial Airport. The left and right Dew Pointer data are noisy and unreliable when altitude is above 20 kft. The vertical wind measurements are biased during takeoff, prior to 1504Z.

RF03 (10/29/2022, 1454Z - 2219Z)
This research flight profiles near Salt Lake City. The right Dew Pointer data became noisy after climbing above 25 kft, around 1501Z. The vertical winds are biased during both takeoff and landing (altitude < 11km).

RF04 (11/01/2022, 1449Z - 2229Z)
The target profiling area is west of Oklahoma City. The right and left Dew Pointer data are noisy after ascending above 20kft, as it is expected. The SATCOM dropped between 1808Z to 1812Z. Analyze the wind measurements of RF04 with extra caution. The vertical winds showed a low frequency oscillation that is not addressed by typical calibration procedures, resulting in time-evolving biases of about 0.5 m/s.