CGWaveS Project Report

The CGWaves field campaign was held in Des Moines, IA from 16 May to 14 June, 2025. This report summarizes the overall project payload, instrument status and issues encountered during the project. All known events at the time of this report were outlined here to provide data users additional information on the data quality. The users should not expect all questionable data to be identified at the initial data release. It is hoped that this information will facilitate use of the data as the research concentrates on specific flights and times.

This report includes all RAF supplied instrumentation on the NSF/NCAR GV and is organized into the following sections. Section I 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 release. Section II lists issues encountered during each research flight. Section III includes the final payload configuration.

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.

Information on the processing algorithms used to produce the final dataset can be found at: https://www.eol.ucar.edu/content/raf-bulletins

I. General Data Notes

The project data has undergone the data quality process after the completion of the project. When instruments experience issues or problems, the time intervals are noted in this section for user's information. In those instances, the intervals have been filled as "missing data (code -32767)". In situations where the instrument was down, the data will be missing for the entire flight.

1. NetCDF File Changes

Particle probe histograms and size-distributions have changed some from past conventions. For CGWaveS this change applies to the CDP, 2DC, and 2DS. Up until 2022 the histograms and size-distributions had a legacy unused bin added at the small end. For example, the CDP is a 30 channel probe, but the data was stored as 31 bins. This has been removed, and now the 30 channel probe will have 30 bins in the NetCDF file. The bin sizing is still in the NetCDF file as an attribute to the size-distribution, called CellSizes, and remains as 31 end point elements (for the CDP). For more information on this change, plus general information on RAF NetCDF conventions, please visit: https://field.eol.ucar.edu/docs/raf/software/netCDF.html

2. Position and Altitude Data

The position data were lost in some flights during aircraft ascend and descend. The users can see the GPS status using the GGSTAT GGQUAL variables. The GGLAT, GGLON, GGALT are the variables used for the latitude, longitude and altitude information.

3. Three Dimensional Winds

The radome wind system was calibrated using RAF's standard calibration maneuvers, comprising speed runs, pitch maneuvers, yaw maneuvers, reverse heading maneuvers, and drifting circles.

The angle-of-attack (AoA) was calibrated specifically for straight-and-level flight above 39 kft MSL, excluding climbs and descents. To calibrate AoA, five speed runs were used from PP03, TF02, RF01, RF04, and RF08, conducted at 33, 41, 40, and 42 kft MSL, respectively. Additionally, all straight and level data (excluding climbs and descents) above 39 kft MSL from all ferry, test, and research flights were used in the AoA calibration as well, weighted equally to the maneuver data. This blends highly-varying and highly-steady aerodynamic states equally.

Angle-of-Sideslip was calibrated using two yaw maneuvers from TF02 and RF01, a reverse heading maneuver from TF02, and drifting circle maneuvers from TF02.

No icing issues affecting the wind data were noted.

Overall, vertical wind data during climb, descent, or below 39 kft MSL may exhibit significant biases (~0.5 m/s) due to the altitude-specific radome calibration applied here, but perturbations may still be used quantitatively. Wind errors in all wind components will be elevated in turns. Otherwise, wind data are full quality.

4. Humidity

Humidity is measured by two thermoelectric (chilled mirror) dew point sensors and the VCSEL hygrometer. The chilled mirror sensors (DP_DPT, DP_DPB) may perform poorly during ascents and descents as they can flood and take time to restabilize. There are also non-physical oscillations that occur occasionally in these sensors. DPT and DPB should only be used when VCSEL data (DP_VXL) are missing and even in these situations, should be used with caution. For the conditions sampled during CGWaveS, the Aerodyne In situ absorbance sensor should be considered a more suitable alternative when the VCSEL humidity sensor is not available.

In general, the VCSEL performed extremely well during flights, with over 90% data coverage, and is set to the reference dewpoint (DPXC). The chilled mirror dew point sensor data has been removed from final production data files, but can be obtained upon request. There are a couple of caveats in using the VCSEL data in analyses. At low humidities, the VCSEL data may have a low bias, on the order of ~10% in some cases. Caution is also advised for flux analyses when the instrument undergoes frequent mode switching (MODE_VXL) as different mode data have different measurement variance. The CGWaveS data set does not suffer from this deficiency.

VCSEL data are unavailable for RF02 and for the ascent and descent of RF10: after 27250 ut_sec (07:34:10) and before 6480 (01:48:00). Aerodyne humidity data are not available after the first hour of flight during RF01.

5. Gas Phase Measurements

The NSF NCAR in situ chemical tracers, ozone, nitrous oxide, and carbon monoxide, are measured by chemiluminescence for ozone, and optical absorbance for the other two trace gases. Both sensors performed well with ozone yielding full data coverage except for the final 2 hours of RF03. Over 90% of flights were operational for the CO and N2O sensor, with only RF01 yielding data for only ~20% of the flight. Periods of bad, missing, calibration and zero observations have been masked from the final data set. The production data release contains 1-Hz resolution data. High rate ozone data (10 samples/s and 5-Hz frequency response) will be made available upon request.

6. Cloud Particle Size

For cloud particle size, number concentration, area, and estimated mass, the CDP, Fast 2D-S, and 2DC were installed. All performed well throughout the project. The CDP data can be found in the LRT and HRT NetCDF files. The 2DC was a backup probe for the F2DS, and was more susceptible to optical occlusion on descents and has therefore not

been thoroughly archived, but is available upon request. The F2DS data is available in separately archived 1 Hz NetCDF files along with representative particle images. For full probe and processing details, please reference the ReadMe file accompanying the separately archived products. Full imagery and particle-by-particle data for the F2DS is available upon request.

7. Liquid Water Content

The King liquid water content probe (PLWCC) was included on the payload, and nominally performed well, but its data should only be considered reliable in liquid cloud conditions since it has larger uncertainties in ice. In its stead, the CDP and 2DS may be used for assessing cloud water content in mixed phase and ice clouds, as were sampled in CGWaveS.

8. Supercooled Liquid Water indicator

The Rosemount Icing Probe (RICE) was installed. When its signal voltage oscillates, it provides indication of the presence of supercooled water. The RICE nominally performed well throughout the project, though its measure will only be of use on climbouts and final descents since the majority of sampling was performed at temperatures colder than mixed phase.

II. Individual Flight Summary

The flight notes, takeoff and landing time for each research flight are listed in the table below. Please note that the time is in UTC.

RF01	
Date	5/21/25
Takeoff	0118
Landing	0613
Flight Notes	
0226: CO and N2O instrument stopped working for the remainder of flight.	
RF02	
Date	05/24/2025

Takeoff	0249
Landing	0817
Flight Notes	
0318: VCSEL rebooted due to dew point. 0322: VCSEL rebooted. Data loss for approximately 3 minutes.	

RF03	
Date	5/25/25
Takeoff	0210
Landing	0911
Flight Notes	
0712: ACD_FO3 stopped working for the remainder of the flight.	

RF04	
Date	05/26/2025
Takeoff	0201
Landing	0906
Flight Notes	
0338 In the cloud, data on all probes. 0551 2DC voltages on Diode #1 seems low at 1V vs 1.6V for the other diodes. 0845 in cloud, data on all probes.	

RF05	
Date	05/28/2025
Takeoff	0145
Landing	0835
Flight Notes	
0152: VSCEL is ON and operating properly. Left OH imager missing some data (~500 images), likely due to errant VNC clicking.	

RF06

Date	05/29/2025
Takeoff	0210
Landing	0937
Flight Notes	
0216 Seeing lots of 2D-S and 2D-C data but not any CDP data in the cloud, CDP housekeeping okay, likely only large particles present.	

RF07	
Date	06/03/2025
Takeoff	0158
Landing	0658
Flight Notes	
No issues to report.	

RF08	
Date	06/04/2025
Takeoff	0215
Landing	0845
Flight Notes	
No issues to report.	

RF09	
Date	06/06/2025
Takeoff	0139
Landing	0904
Flight Notes	
0548 - 0624: Lots of nan's on the ADS rack GPDAQ housekeeping during turbulence.	

RF10	
Date	06/07/2025
Takeoff	0145
Landing	0745
Flight Notes	
No issues to report.	

RF11	
Date	06/09/2025
Takeoff	0125
Landing	0927
Flight Notes	
0716: ADS-Laptop8 went dark and the software for the left OH camera stopped. The laptop was rebooted to revive the camera process. Lost about 6 minutes of data.	

RF12	
Date	06/10/2025
Takeoff	0215
Landing	0950
Flight Notes	
0219: VCSEL dropped out for 4 min right after takeoff before recovering itself, no action taken.	

RF13	
Date	06/12/2025
Takeoff	0143
Landing	0931
Flight Notes	

~0220: QCR compromised. 2DC concentrations peaked at that time as well. It was not as granular as QCF the rest of the flight.
08:56 IRIG Status on 304 glitched to from 0 to 3 momentarily. Light turbulence at that time.

III. Project Payload

The final payload configuration and the actual deployment calendar are included in this section for user's reference. The nomenclature for flight designations are: (1) maintenance flights (MF); (2) pilot proficiency flights (PP); (3) project test flights (TF); (4) ferry flights to project destination (FF). For the operations, all staff are required to take a Hard Down Day (HDD) every six consecutive working days.

12/8/2025

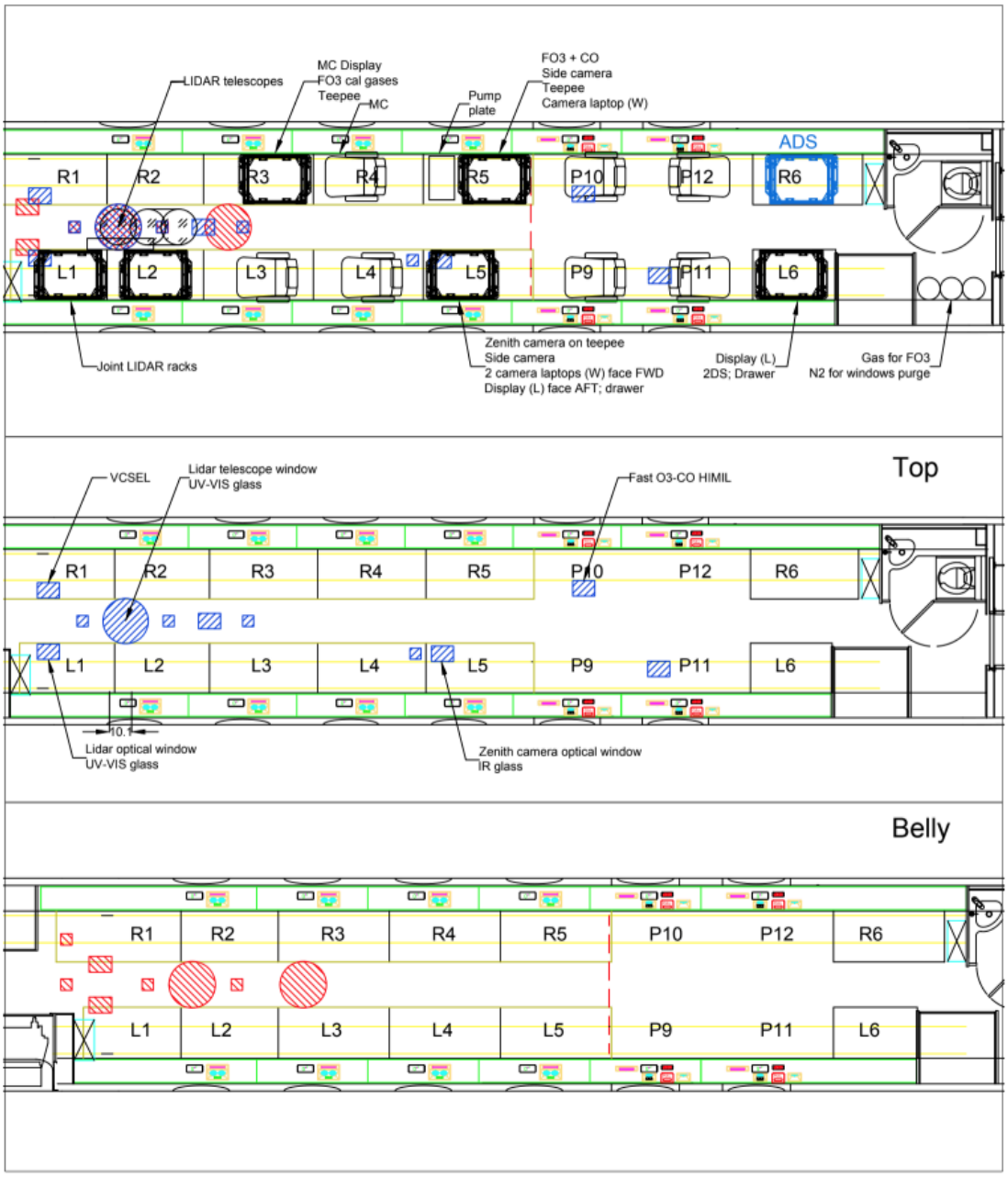
Schedule for CGWaveS-25 May-June 2025

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
4/27	4/28 EMI#2	4/29 MF01 / PP01	4/30	5/1 PP02	5/2 PP03	5/3
5/4	5/5	5/6 TF01	5/7 Duncan Aviation	5/8	5/9	5/10 HDD
5/11 TF02	5/12	5/13	5/14 TF03	5/15	5/16 FF01 Day/afternoon flight	5/17 HDD
5/18 Outreach Day	5/19 Transition to Night Schedule 5/19 0800 - 5/20 2000	5/20 RF01	5/21 PP05	5/22 HDD	5/23 RF02	5/24 RF03
5/25 RF04	5/26 Memorial Day	5/27 RF05	5/28 RF06	5/29 HDD	5/30 PP06	5/31
6/1	6/2 RF07	6/3 RF08	6/4 HDD	6/5 RF09	6/6 RF10	6/7
6/8 RF11	6/9 RF12	6/10 HDD	6/11	6/12 RF13	6/13 Pack Day	6/14 FF02 Transition to Day 6/14 2000
6/15 Transition to Day Schedule 6/14 2000 - 6/16 0800	6/16 Payload Uninstall	6/17 Payload Uninstall	6/18	6/19 Juneteenth	6/20 Payload Uninstall	6/21
6/22	6/23 Payload Uninstall	6/24 Payload Uninstall	6/25	6/26	6/27	6/28

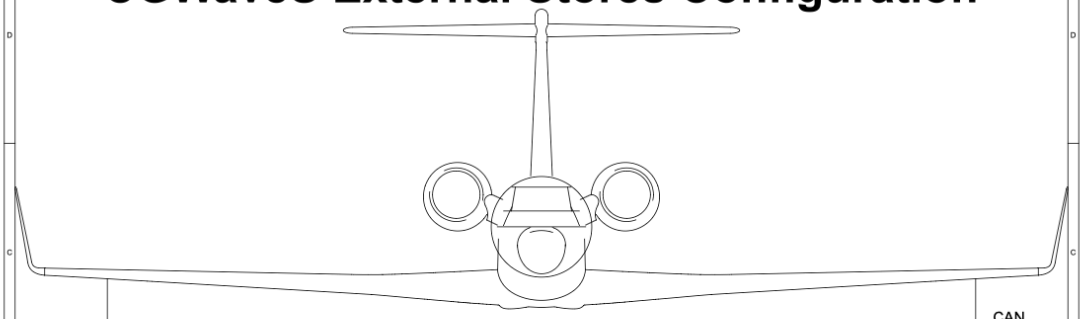
CGwaveS GV payload

v.3 02-23-2023

Wing load: 2DC, CDP, 2DS for Mission Coordinator



CGWaveS External Stores Configuration



CB17 — CB18 (X)
CDP S/N 16

Camera
RICE

3305CB24 (400 Hz)
3305CB1 (28VDC AI)

CAN
H029

CB11
2DC-25 S/N 3
2DS S/N 19

PLWC
DSM

3305CB19 (400 Hz)
3305CB4 (28VDC AI)

Wire/Cable Dado/Conduit Installations Provisions
Per ST03060AT, ST03056AT GAC GV S/N 677

Revisions				
CHG. LET	CHANGES	BY	ENG	DATE
IR	Original	I. Vu	KAZ	2/12/25

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS IN INCHES
DECIMALS = +/-
FRACTIONS = +/-
ANGLES = +/-

DRAWN BY: I. Vu — DATE: 2/12/25
CHECKED BY: Cowan — DATE: 02/24/25
ENGINEERING: K.A.Zrubek — DATE: 02/25/25

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DRAWING TITLE: CGWAVES EXTERNAL STORES CONFIGURATION

SIZE	DRAWING NUMBER:	FILENAME:	REV.	SHEET
A	677-25-EE-500	CGWaveSESC.TCW	IR	1 OF 1