10 March 2023

ACCLIP Project Manager Data Quality Report

08-2022, Osan Air Base, S. Korea

Rev. 1.0

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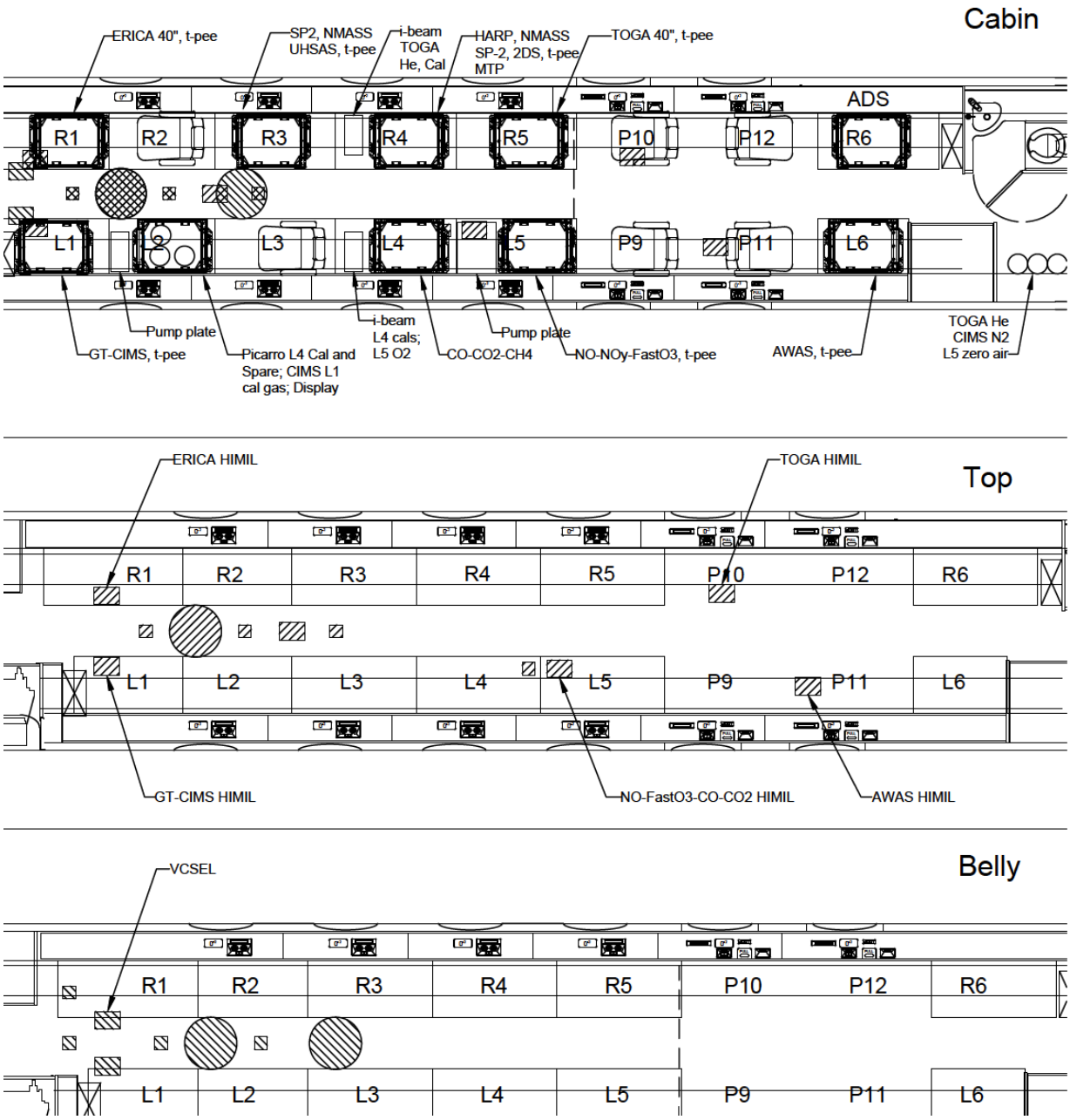
Payload



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General Data Notes

Ambient temperature

RTH1 and RTH2 data from the two sensing elements of the Harco heated probe exhibit increased noise levels at frequencies > 0.5 Hz at altitudes over 13 km. This noise is attributed to the activation of the anti-icing heaters at high altitude.

Dewpoint measurements

The dewpoint data is frequently lost during descents. This is because the chilled mirror dewpoint sensors become cold-soaked and are susceptible to excessive condensation in the cavity during descents from high altitude into the humid air at lower altitudes. The sensor frequently becomes inoperable for a period of time until the body of the instrument warms up and the excess water is expelled from the cavity.

The VCSEL Hygrometer multipass absorption cell partially lost alignment in the early stages of the project. By comparison to the post-project calibrated Picarro 2401 and the Aerodyne 108 water vapor mixing ratio values, along with the chilled mirror dewpoints, the effective pathlength of the VCSEL multipass cell could be derived and corrected water vapor mixing ratios calculated for mixing ratios below 1000 ppmv and above 10 000 ppmv. Much of the data in the range from 2000 - 10 000 ppmv was unrecoverable due to saturation effects. The uncertainty in the data should be considered larger than the usual published value for the VCSEL hygrometer. An uncertainty of 10% would be reasonable.

Cloud microphysics and liquid water content data

CDP

CDP (SN16) laser died at the start of RF01, so was inoperable for RF01 and RF02. Switched to spare (SN56) after RF02, good data for RF03-RF14.

F2D-S

Excessive noise issues were encountered during RF01-RF04 while flying F2D-S SN20 for a variety of reasons. This noise was slightly mitigated when SN20 was swapped for SN19, producing more moderate noise for RF05-RF06. Operational changes were then made, mitigating to lesser intermittent noise for RF07-RF14 (SN19). In summary, noise issues were more prominent RF01-RF06, and more manageable RF07-RF14. The noise was intermittent throughout flight, but more intense climbing through mid-altitudes. Optical occultation was encountered on all research flights over long descents, lasting from 15-40 minutes. Data on these descents should be used with caution.

King LWC

Inoperable RF05. King probe is unreliable in ice, and should only be relied upon in liquid clouds. Also note, the King probe sometimes shows background drift in clear air, therefore it best to use it in conjunction with CDP data.

Cloud Flag, Buffer, and Class variables

The **Cloud Flag** product is developed from a composite of CDP, F2DS, and King probe data.

CloudFlag: 0 = no cloud, 1 = in cloud.

The **CloudBuffer** = cloud flag +/- 3 seconds (an extended cloud flag to account for variation in timing of different inlet locations from cloud probe locations).

The **CloudClass** is a basic cloud classification that combines the cloud flag and temperature.

CloudClass: 2 = liquid cloud, precipitation, or haze; 3 = mixed phase or glaciated cloud (or precipitation); 4 = ice cloud or ice precipitation.

This cloud classification is generic, and analysis of F2D-S imagery as well as supplementary flight information should also be utilized for more advanced phase or cloud type classification.

More detailed information on the cloud microphysics data is in the table below.

Flight #	**CDP**	**F2DS**	King	RICE	Cloud Flag	***Cloud Coverage***
RF01		V				*Significant cirrus*
RF02		V				*Minimal cirrus*
RF03		V				*Minimal cirrus*
RF04		V				*Minimal cirrus*
RF05		H / V				*Moderate cirrus*
RF06		H				*Moderate cirrus, some mid-level mixed phase*
RF07		H				*Moderate cirrus, some mid-level mixed phase*
RF08		H				*Moderate cirrus*

RF09		H				*Moderate, intermittent cirrus, mid-flight profiles could have mixed phase or liquid cloud*
RF10		H				*Moderate, intermittent cirrus*
RF11		H				*Moderate, intermittent cirrus, some mid-level mixed phase*
RF12		H				*Moderate, intermittent cirrus, some mid-level mixed phase*
RF13		H				*Significant cirrus first half, intermittent last 3rd, some mid-level mixed phase*
RF14		H				*Significant cirrus first 3rd, cloud free till descent*

3D winds data

Note that the wind data is generally not reliable during climbs, descents and turns. Only straight and level legs data should be used for sensitive calculations, such as fluxes.

The ADIFR measurement is slightly dependent on the flight altitude. This is an ongoing issue and results in a mean vertical wind that is not zero during straight and level flight at some altitudes. WIC variations during those periods are still valid.

On occasion, ADIFR is affected by the ingestion of liquid water into the radome pressure transducer tubing. This may result in a damped frequency response and sometimes in a drift of the attack measurement and variables that depend on it (namely WIC).

The winds are optimized for the research flights, not the test or ferry flights. Science users hoping to use the ferry flights from Colorado to the Pacific should contact RAF for additional guidance.

Flight Specific Data Notes

RF01

DPR is missing for the entire flight. VCSEL humidity measurement dropped out at 2:28 for unknown reason, recovered at 2:38 after instrument restart. ADIFR and dependent variables (WIC in particular) are affected by water ingestion into the radome tubing; the result is spiking in

the attack angle on the final descent and variations in WIC, causing a non-zero average. CDP laser failed during preflight, so there is no CDP data available. 2DS data was noisy and requires significant manual post processing.

Technician notes:

Cleaned the 2DS during preflight. Horizontal element voltages look much better. No noise preflight. Spray test showed up in both H and V. Again, we see particles when detected in both channels but the noise does persist and I believe all good data can be cleaned up post processing.

No DPR on this flight. DPR flashing “service mirror”. Attempted to blow it out with no success. Not enough time [preflight] to take it apart and clean.

CDP issue. After power up the laser current went to 90 mA for about 20 seconds and down to zero. Laser power monitor voltage spiked to 4.68 for about 2 seconds and dropped to zero. Last flight the current was at 84 mA and the voltage was at 2 volts. I suspect that laser is done. We flew at 40000+ feet for about 7 hours at very cold temperatures and then landed in Guam.

Cycled power on VCSEL at 02:37. Appears to have gotten iced over going through some rime. Gone at 02:28. Back at 02:39.

RF02

CDP was inoperable on this flight due to the dead laser.

VCSEL line lock issues early in flight, most likely due to water on mirrors; performance restored after 1:49. Dewpointers lost data due to bad cavity pressure data for approximately 3 hours in the middle of the flight. Aerodyne CO/N2O software froze and had to be restarted mid flight, causing a 20 min data loss.

Technician notes:

Unable to connect to 2DS during pre-flight. All values for network and probe were re-entered and we still could not connect. After extensive troubleshooting, Josh loaded an older configuration file and we were able to collect ground data after that.

SATCOM intermittently cut out on the ground, likely due to military aircraft activity.

NO2 Ozone instrument computer froze in-flight and had to be shut down. TOGA was also inoperable for the entire flight, likely due to excessive moisture in lines.

At 0259, Right TEMP-DACQ lost connection (RTH1, RTH2, CAVP_DPL, CAVP_DPR), as well as some associated values for ambient temp, wind, ATX. Reset Nose DSM breaker and restarted Nimbus, which brought back some of the values on Aeros. Right TEMP-DACQ still appears inoperable and needs to be replaced with spare.

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Excessive moisture/condensation formed on inlets during quick descent from 38000 ft down to 15000 ft towards Jeju Island.

After 0633, after descending to Jeju Island, RTH1, RTH2, CAVP_DPL and CAVP_DPR all read values - so right TEMP-DACQ seems to be back online.

Left Hygrometer in re-balance state after last ascent to 16000 ft.

Excessive noise in 2DS data when unmasked and going through clear air.

RF03

CDP was replaced for this flight, LWC compares well with the King probe.

The Aerodyne N2O for RF03 are largely not usable between 03:30 and 06:00. Other smaller data gaps continue later in the flight.

Technician notes:

2DS V channel is much less noisy this flight. H channel diode voltages dropped significantly during flight. H channel still noisy. V channel diode voltages dropped as well. RH is around 15%. Bumped up heater setpoint at 3:28. Before, setpoints of H and V Arms were 5 and Lasers were 20. After, set to 10 and 30 respectfully. Probe failed around 3:40. Disengaged 400Hz and 28V breakers to the probe. Engaged and restarted software. Probe came back with temperatures looking much better. Is it possible that the 400Hz breaker wasn't fully engaged from the start. Set heater thresholds back to their original settings.

RF04

No specific data notes for this flight.

Technician notes:

Cleaned VXCEL, CDP and 2DS during pre-flight. Removed and cleaned Right Dewpointer during pre-flight due to service mirror light flashing red.

Excessive noise on 2DS, especially during bumpy ascent, appears to be getting worse.

Mission scientist reported that RIC was delayed by 30sec according to scientists on ground.

UHSAS values showed -32676 on aeros mid-flight. Unable to ping using "cat/ etc/hosts" in the terminal window, confirming that the issue is on the instrument end.

RF05

King probe stopped sending data soon after take-off, following LW cloud penetration, possibly due to the damage to the sensing element.

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At 1:11:19, RICE experienced a low voltage event without a related SLW encounter. The probe recovered soon after.

2D-S S/N 20 was replaced with S/N 19 before this flight.

Technician notes:

Cleared the tubing to ADIFR and QCR prior to flight.

Satcom SBU keeps dropping out and coming back on the ground. Not sure if it's due to this air base. Tried a reboot but problem still exists. During flight it stays up. Although, the SDU led went out a few times during flight but it didn't seem to affect anything.

RIC is inoperable on this flight. Catherine and crew are investigating.

Just after takeoff, PLWC and CDP PLWC reacted. PLWC dropped to zero. May have lost an element.

Forward camera had a hard time coming up just after starting them up. It eventually started working with no explanation. Possible water intrusion to pylon firewire to fiber converter.

Turned off 2DS TX/RX arm heaters per Josh's request from 02:39 to 03:09.

Need to keep consistent temps for ERICA. 68F for mid zone and 72F for aft zone.

2DS H channel is very noisy. Built a mask for it and the V channel gets noisy. Take the mask away from the H channel and the V channel stops being noisy. Repeated this three times. Once with auto laser control off. Same result.

RF06

VCSEL laser intensity was low at take-off and landing, presumably to the very high dewpoint on the ground (>20C). Laser intensity was optimal at high altitude.

King probe clear air drift was observed during this flight (dissipated power <10W). Very little time in cloud during this flight didn’t allow a good comparison with the CDP.

2D-S heaters were swapped from 400Hz to 60Hz prior to this flight. Noise persisted.

Technician notes:

Forward camera did not work at startup. Stopping cameras and starting cameras again did not resolve the issue. Switched the camera feed going to ground from forward to right camera.

Dew pointers re-balanced after -50.

2DS channel noisy - masking H channel caused V channel to be noisy as well. Masked in clean air for duration of flight. H laser temp fluctuated +/- 5 degrees C while V laser temps fluctuated +/- 10 degrees C. After removing masks from both channels before flying in clouds again, only H channel picked up cloud particles while V channel picked up noise.

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RF07

Forward camera was not working from 8:05 to 8:45.

Temporary reduction in the GPS accuracy from Terrastar to WAAS at 5:19, likely related to the direction of flight.

VCSEL switched operating modes incorrectly around 1:00 coincident with cloud penetration, resulting in bad data; proper operation restored at 1:32.

Technician notes:

Prior to flight, cleaned CDP and 2DS windows.

Forward camera worked this flight. Lost it at about 08:05 and back at 08:45

RF08

VCSEL was cleaned prior to this flight but laser intensity was still below optimal, potentially slightly degrading accuracy.

DSM305 was rebooted shortly after takeoff, causing a short period of data loss for the ADIFR, BDIBR, QCR and temperatures.

Technician notes:

2DS Arm Heaters disabled after take-off

SP2 not seeing data on the ground. Checked network connection cables. Instrument re-start, per Georgia's request, resolved the issue.

Green Swagelock bellows valve on TOGA's cylinder regulator fell off during flight. Eric confirmed it is not an issue and re-attached the fitting.

Approximately 0247: Satcom went down, even though SDU and SBU Available lights still green. Pilots cycled SATCOM button which did not resolve issue. Resetting Satcom circuit breaker in cockpit did not resolve issue. Pilots called Pavel using Iridium phone to check in. Pavel later sent an additional message and instructions to Teresa. [After landing, we assessed all LEDs at the ADS station, SBU, and SDU. All looked good. I had sent Ivana a text message during flight and noticed the message led was lit. We proceeded to access the Thrane & Thrane dashboard with no success. Next, we tried to ping the satcom and router with no success. This led us to the router. It is the only piece between the satcom and server. After a reboot, the Satcom was communicating with the data system again. We plan on swapping it out with a configured spare the next maintenance day.]

During final descent to Osan, onboard cameras lost connection and restart did not resolve the issue.

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During final descent, Status Page showed all components (except for Chrony Logs) were in the red "Critical" state, even though all Aeros data were still reading normally. Status page components went back to green after ~30 seconds.

RF09

VCSEL laser intensity is at optimal level following additional cleaning.

King probe shows drift in clear air but compares well with the CDP in clouds.

Technician notes:

Forward camera: Lost 01:03; Back 01:43; Lost 04:07

2DS: TX/RX Arms Heaters set to off. Did some manual masking.

Was instructed to Rebalance DPR during our first dip to 500ft. Service Mirror Indicator came on and stopped recording. In my experience, we should not rebalance in flight.

Post flight maintenance for a rf10 back to back research flight:

- Serviced DPL and DPR.
- Blew out radome tubing.

RF10

VCSEL middle humidity mode reported low dewpoint, low laser power and delayed switching to high humidity mode on descents.

ADIFR and winds were noisy and suspect from 5:56 - 6:02

Technician notes:

2DS Arm Tip Heaters disabled for flight

Rain during pre-flight and take-off, likely contributing to noise on 2DS

Restarted VCSEL right before takeoff

0213: Camera images stopped updating. Status page showing "Critical Stopped." Catherine advised that it would require ac server reboot to possibly fly, which we don't want to do in-flight.

RF11

Technician notes:

Prior to flight:

Cleaned 2DS

Cleaned CDP

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Forward Camera: Lost at 01:34

Went to look at how big 2DS files were getting. There were none there. I must have clicked the black arrow instead. Started recording at 03:08. Hopefully we all can learn from my mistake and check to make sure the folder is being written to. It would be nice to have some colorful verification in the GUI that it is recording. Not sure if SPEC would accommodate.

Cameras stopped working at 05:29. A zombie process was created, which is unrecoverable without rebooting.

RF12

No specific data notes for this flight.

Technician notes:

Cleaned VCSEL, 2DS and CDP before flight

Unplugged forward camera firewire before flight; no zombie processes on this flight

Headset Push-to-Talk device intermittently not working, changed out before take-off

RF13

No specific data notes for this flight.

Technician notes:

Prior to flight, noticed that all three IRS's are showing around -10m. After further diagnosis, this is coming from the cockpit with these values. Novatel GPS is recording around 14m. After looking at a number of flights from TIGER and ACCLIP, in preflight, the Aircraft IRS Altitudes vary from negative numbers up to much higher than the Novatel altitude.

Forward camera worked the entire flight. I moved the firewire to another port in the cabin firewire to fiber converter.

RF14

No specific data notes for this flight.

Technician notes:

Nothing to report.