**12/10/2009**

**ADELE / SPRITE**
**NCAR GV**
**Data Quality Report**
**Smith / Nielsen**

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.

The following report covers only the RAF supplied instrumentation and is organized into two sections. The first section lists recurring problems, general limitations, and systematic biases in the standard RAF measurements. The second section lists isolated problems occurring on a flight-by-flight basis. A discussion of the performance of the RAF chemistry sensors will be provided separately, as will the respective data sets.

## Section I: General Discussion

1. 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.

2. **Position Data.** A Garmin Global Positioning System (GGPS) was used as a more accurate position reference during the program. The system generally performed well. It is recommended that the GPS data be used as the position reference (GGLAT, GGLON). There may be occasional spikes or discontinuous shifts in these values due to satellite geometry and aircraft maneuvering. The algorithm referred to in (3) below also blends the GPS and IRS position to yield a best position (LATC, LONC) that generally removes the GPS spikes.

3. **3D- Wind Data.** The wind data for this project were derived from measurements taken with the radome wind gust package. As is normally the case with all wind gust

systems, the ambient wind calculations can be adversely affected by either sharp changes in the aircraft's flight attitude or excessive drift in the onboard inertial reference system (IRS). Turns, or more importantly, climbing turns are particularly disruptive to this type of measurement technique. Wind data reported for these conditions should be used with caution.

Special sets of in-flight calibration maneuvers were conducted on flights TF01, TF03 and FF02 to aid in the performance analysis of the wind gust measurements. The calibration data identified a systematic bias in the pitch and sideslip parameters. These offsets have been removed from the final data set. The time intervals for each set of maneuvers have been documented in both the flight-by-flight data quality review and on the individual Research Flight Forms prepared for each flight. Drift in the IRS accelerometers are removed using an algorithm that employs a complementary high-pass/low-pass filter that removes the long term drift with the accurate GPS reference and preserves the shorter term fluctuations measured by the IRS.

Both the GPS corrected and basic uncorrected values are included in the final data set for the purpose of data quality review. RAF strongly recommends that the GPS corrected inertial winds be used for all research efforts (WSC,WDC,UXC,VYC,WIC,UIC,VIC).

4. **SPECIAL NOTE:** RAF flies redundant sensors to assure data quality. Performance characteristics differ from sensor to sensor with certain units being more susceptible to various thermal and dynamic effects than others. Good comparisons were typically obtained between the two static pressures (PSFC. PS_A), the three standard temperatures (ATFR, ATHR1, ATHR2), three dynamic pressures (QCRC, QCFC, QC_A), and the two dew pointers (DPT,DPB). Exceptions are noted in the flight-by-flight summary. The primary static pressure system failed early in the project and was out for 5 flights. PS_A was substituted as the reference pressure (PSXC) on those flights with only a minor decrease in overall accuracy.

5. **Ambient Temperature Data.** Temperature measurements were made using the standard heated HARCO sensor (ATHR1, ATHR2)and an unheated Rosemount temperature sensor (ATFR) Performance of all three “insitu” sensors remained stable

throughout the project and showed excellent agreement. Due to its fast response, ATFR was selected as the reference value (ATX) used in calculating the derived parameters.

6. **Humidity Data.** Humidity measurements were made using two thermoelectric dew point sensors. A comparison of the dew point sensors (DPLC, DPRC) yielded good correlation in instrument signatures during the largest portions of the flights when both instruments were functioning normally. Under conditions where the units had been cold soaked at high altitude or experienced a rapid transition into a moist environment, both units showed a tendency to overshoot or lag in time by multiple seconds. This problem can also result in loss of data. On certain flights, there are extensive gaps in one or both signals. Even at their best, the response of the thermoelectric dew point sensors is roughly 2 seconds. Response times are dependent upon ambient dew point depression and can exceed 10-15 seconds under very dry conditions. During the rapid climbs characterizing most of the project flights, the slow time response resulted in unrealistic super-saturation dew points. These data have been left in the data sets to provide an indication of vertical dew point trends as opposed to accurate values at specific altitudes. The extensive high altitude work during the project place the units under stress with extreme dew point depressions. Under these conditions overall accuracy is reduced. Based on overall performance DPRC was selected as the reference signal (DPXC) used in the derived moisture related variables.

7. **Altitude Data.** The altitude of the aircraft was measured in several ways. A pressure based altitude (PALT,PALTF) is derived from the static pressure using the hydrostatic equation and normally using the U.S. Standard Atmosphere, which assumes a constant surface pressure of 1013mb and a mean surface temperature of 288 K.

The GPS positioning system also provides an altitude readout (GGALT). This output normally provides a fairly accurate MSL altitude based on a ellipsoid model of the Earth (WGS-84).

8. **Aerosol & Cloud Droplet Sizing Data.** Four PMS 1D particle probes (SPP300, SPP100, SPP200, CDP) were used on the project. Some specific details on each of the probes are summarized below:

**UHSAS -** The UHSAS aerosol particle probe functioned

well for a majority of the flights during the project with performance deteriorating as the project progressed. On selected flights, the unit exhibited atypically high concentrations which were attributed to noise in the lowest six sizing bins. Where possible, the data were reprocessed dropping the problem bins. On some occasions the data were simply flagged as being bad for the flight. Such occurrences are noted in the flight-by-flight summary below.

Note: **Due to the sampling technique employed by this probe it is not suitable for use in clouds.**

**CDP** - This probe basically measures cloud droplets (3 – 50 um). It is designed specifically to sample water droplets and will significantly under sample ice particles such as the ones encountered during this program. Beyond that problem the probe itself functioned very well. Some data were lost due to a communications problem with the wing pod DSM transmitting the probe data to the ADS console.

9. **Precipitation Sizing Data.** One OAP probe was flown during the project. The one was a standard 2D-C probe with 25 um resolution. This system functioned well though out the entire project. Some data were lost due to a communications problem with the wing pod DSM transmitting the probe data to the ADS console.

10. All Weather Wind Gust Pod. This system was flown as a preliminary test of new technology. Data include a CMIGITS inertial platform to determine the orientation of the probe on the wing pylon. These data are generally good. The Honeywell pressure transducers intended to sample inputs from the 858 gust probe tip attached to the nose of the pod turned out to be thermally sensitive and failed to function at pod temperatures below -40 C. Due to the high altitude targeting of the project, most of these data are missing. Sensor installed for ADIFR_GP was the wrong type. Data limited to negative values

11. **SPECIAL NOTE:** 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 as valid.

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**Section II: Flight-by-Flight Summary**

**RF01** Intermittent drop outs in the radome analog channels. Ambient temperatures & radome winds were affected. Flight data processed using PS_A & QC_A as the reference static & dynamic pressure values.

**RF02** ADS failures in flight. DSM reboot required. All data missing from 032327 to 032437 and 035314 to 035432 CUT.

Research static pressure sensor failed. PS_A used as the reference pressure in all calculations.

Uncharacteristic response from reference dew point sensor. All moisture related variables bad from 0351 to 0426 CUT.

Uncharacteristic response from right dew point sensor. DPRC data bad from 0323 to 0547 CUT.

**RF03** GPS drop out. Loss GGLAT, GGLON & GGALT data from 065256 to 070011 CUT.

Loss of communication with Fwd DSM. Reboot required. 3-D wind, temperature and humidity data missing from 040216 to 040343 CUT.

Research static pressure sensor failed. PS_A used as the reference pressure in all calculations.

**RF04** Uncharacteristic response from left dew point sensor. DPLC data bad from 1712 to 1927 CUT.

Radome dynamic pressure orifice obstructed by ice. QCRC bad From 1738 to 2214 CUT.

Uncharacteristic response from right dew point sensor. DPRC data bad from 2128 to 2211 CUT.

Research static pressure sensor failed. PS_A used as the reference pressure in all calculations.

**RF05** Failure of All Weather Gust Pod. No CMIGITS or _GP pressure data available from the flight.

Research static pressure sensor failed. PS_A used as the reference pressure in all calculations.

**RF06** Loss of communication with Fwd DSM. 3-D wind, temperature and humidity data missing from 2012 to 2034 CUT.

Radome dynamic pressure orifice obstructed by ice. QCRC bad From 2009 to 2244 CUT.

Failure of All Weather Gust Pod. No CMIGITS or _GP pressure data available from 2005 to 2104 CUT.

Uncharacteristic response from right dew point sensor. DPRC data bad from 1950 to 2220 CUT.

Uncharacteristic response from left dew point sensor. DPLC data bad from 2003 to 2035 and 2124 to 2204 CUT.

**RF08** Uncharacteristic response from right dew point sensor. DPRC data bad from 2146 to 2211 CUT.

Lost communication with Icing Rate detector. RICE data missing from 1849 to 1930 CUT.

Excessive noise in lowest six bins of the UHSAS aerosol probe. CONCU data reprocessing dropping contributions from those size bins.

**RF09** Uncharacteristic response from right dew point sensor. DPRC data bad from 0153 to 0320 and 1104 to 1139 CUT

Uncharacteristic response from left dew point sensor. DPLC data bad from 0153 to 0320 and 1104 to 1139 CUT

Excessive noise in lowest six bins of the UHSAS aerosol probe. CONCU data reprocessing dropping contributions from those size bins.

Lost communication with 2D-C optical particle probe. No data for the flight.

GPS drop out. All data from 0805 to 0811 CUT. GPS corrected data switched to avionics GPS (VEW_G, VNS_G, ALT_G).

**RF10** Intermittent drop outs in the radome analog channels. Ambient temperatures & radome winds were affected. Flight data processed using PS_A & QC_A as the reference static & dynamic pressure values.

Loss of communication with Fwd DSM. 3-D wind, temperature and humidity data missing from 220142 to 220255 CUT.

Electric field surge takes out analog channels in the nose DSM. ATRR, ATHR1 & ATHR2 missing from 220142 to 2244.

Uncharacteristic response from right dew point sensor. DPRC data bad from 2050 to 2244 CUT

Failure of All Weather Gust Pod. No CMIGITS or _GP pressure data available from the flight.

**RF11** Loss of communication with Fwd DSM. 3-D wind, temperature and humidity data missing from 2023 to 2046 CUT.

Electric field surge takes out analog channels in the nose DSM. ATRR, ATHR1 & ATHR2 missing from 2157 to 2255 CUT.

Uncharacteristic response from right dew point sensor. DPRC data bad from 1924 to 2255 CUT

UHSAS aerosol probe unresponsive. All data missing for flight.

Radome dynamic pressure orifice obstructed by ice. QCRC bad From 2022 to 2255 CUT.

**RF12** Both dew pointers left in off position. No humidity data for the flight. Operator error.

Intermittent drop outs in the radome analog channels. Ambient temperatures & radome winds were affected. Flight data processed using PS_A & QC_A as the reference static & dynamic pressure values.

UHSAS aerosol probe unresponsive. All data missing for flight.

**TF03** Right side dew point sensor unresponsive. DPRC data missing for the entire flight.

**TF04** Intermittent communications problems with All Weather Wind Gust Pod. Gaps in CMIGITS and _GP pressure data.

Right side dew point sensor unresponsive. DPRC data missing for the entire flight.

**FF02** Failure of DSM communications with All Weather Gust Pod. No CMIGITS or _GP pressure data available from the flight.

Right side dew point sensor unresponsive. DPRC data missing for the entire flight.

UHSAS aerosol probe unresponsive. All data missing for flight.

Failure of DSM communications with CDP Cloud probe. No data from this flight.

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