Pacific 2001

PACIFIC 2001 Convair 580 AIRCRAFT DATA REPORT

In August of 2001 two aircraft were based in Abbotsford British Columbia in support of the Pacific 2001 field program. The Canadian NRC (National Research Council) Convair 580 is a four-engine research airplane that was tasked with mapping of the vertical distribution of aerosol particles in the Lower Fraser Valley using lidar. The CFS (Canadian Forestry Service) Cessna 182 is a single person, single engine small aircraft instrumented to support or complement ground based measurements. This report details the data collected by both of these aircraft. The aircraft data collected during the field program has since undergone reduction to ease access. Value-added parameters have been created and quality control initiatives were implemented to produce a data-set that should be ready to use. Of course, this does not mean that an investigator cannot easily mis-use or mis-interpret the data. The key to avoiding this pitfall is to recognize the capabilities and failings of the instruments. In order to help investigators in this regard, this report has been assembled with the help of several scientists and technicians who are familiar with the instruments, configuration, and other details. Investigators are urged to read this report in its entirety, or at least the portions relating to the instruments of interest.

In this report aircraft are introduced and kept separate. Although instrument catgories may have similar names, the contents are different for each aircraft.

NRC CONVAIR 580

The Convair flew 9 project flights during Pacific 2001. The aircraft flew on days clear of clouds generally, with the possible exception of Convair flight 09. The few time periods that the aircraft did venture into cloud are listed in the file "CNVInCloudTim.pdf".

Although many instruments were installed before the field project, a portion of those were intended for the project that immediately following Pacific 2001. Many of those were either not in working order, or not fully installed. For this reason, the following instruments gave no useful raw data:

FSSP 96 & 124
U of Arizona Radiometers
LandSat Simulator
Extinction probe
Nevzorov (LW&TW) probe(s)
King (LW) probe(s)
LiCor CO2/water-vapour probe

1D Archive Parameter Identification

This has information about every tag on the 1D archive. Sometimes you have a choice of several similar measurements and this document may help you decide which one to use. Some important things are only mentioned in this document so you may want to look here first.

"CNVInCloudTim.pdf"

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; Pacific 2001: Convair cloud penetration periods     ↺BACK
; Note: Most occurred on August 30 2001
F03_1,      2001 08 20 19 22 23      2001 08 20 19 22 25
F03_2,      2001 08 20 19 25 04      2001 08 20 19 25 10
F03_3,      2001 08 20 23 24 28      2001 08 20 23 24 37
F08_1,      2001 08 30 09 45 51      2001 08 30 09 45 52
F08_2,      2001 08 30 10 08 30      2001 08 30 10 08 36
F09_1,      2001 08 30 22 02 23      2001 08 30 22 03 16
F09_2,      2001 08 30 22 03 39      2001 08 30 22 03 47
F09_3,      2001 08 30 22 05 02      2001 08 30 22 05 38
F09_4,      2001 08 30 22 08 40      2001 08 30 22 08 47
F09_5,      2001 08 30 22 09 14      2001 08 30 22 09 59
F09_6,      2001 08 30 22 11 08      2001 08 30 22 11 09
F09_7,      2001 08 30 22 11 08      2001 08 30 22 11 09
F09_8,      2001 08 30 22 11 15      2001 08 30 22 11 34
F09_9,      2001 08 30 22 11 42      2001 08 30 22 12 20
F0910,      2001 08 30 22 14 50      2001 08 30 22 15 17
F0911,      2001 08 30 22 15 52      2001 08 30 22 16 14
F0912,      2001 08 30 22 17 25      2001 08 30 22 17 28
F0913,      2001 08 30 22 17 51      2001 08 30 22 17 54
F0914,      2001 08 30 22 20 48      2001 08 30 22 22 10
F0915,      2001 08 30 22 36 19      2001 08 30 22 36 42
F0916,      2001 08 30 23 27 53      2001 08 30 23 29 20
F0917,      2001 08 30 23 30 14      2001 08 30 23 30 18
F0918,      2001 08 30 23 30 35      2001 08 30 23 30 37
F0919,      2001 08 30 23 33 29      2001 08 30 23 33 42
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PACIFIC 2001 CONVAIR PARAMETERS: ↺BACK

Altitude

Three measurements of altitude are available. The radar altimeter measures altitude as an exact distance (in feet) above ground level. It loses "sight" of ground at altitudes higher than ~18800. The radar altimeter altitude should be used whenever possible. The other two altitudes are calculated from pressure and are available in thousands of feet and in meters. The accuracy of these two mean sea level (MSL) altitudes depends on the accuracy of the altimeter reading at the nearest airport. Generally, the uncertainty of that reading is ~±15m.

The tag numbers associated with altitude are:

05000 RADAR ALTIMETER (ft)
06015 ALTITUDE (kft)
06019 ALTITUDE (m)

Avionics

There are three True Air Speed (TAS) measurements made at different locations on the aircraft. The Boom TAS was located sufficiently far from the plane that it should not be affected by air motion around the wings or fuselage. The Wing and Pod are air speeds measured at the "Wing" and "Pod" locations. This means that they are actually "indicated" air speeds, however they are still sometimes referred to as "true" air speeds.

The pitch and roll angles are correct in the "relative" sense, however their absolute values as a measure of degrees from the horizon may be off by as much as ±3 degrees.

In Pacific 2001, the Boom TAS was ~ 10 m/sec lower than the Pod TAS, and ~14 m/sec less than the Wing TAS.

Aircraft heading is measured in degrees from true (as opposed to magnetic) North. The direction convention used is:

0-90° == true North→East
90-180° == East→South
180-270° == South→West
270-360° == West→North

The tag numbers associated with avionics are:

06025 BOOM TAS (m/sec)
05034 WING TAS (m/sec)
05043 POD TAS (m/sec)
05014 INS AIRCRAFT HEADING (Deg True)
05015 INS PITCH ANGLE (Deg)
05016 INS ROLL ANGLE (Deg)
05232 CALCULATED GROUND SPEED (m/sec)

Condensation Particle Counters

See the file 'Aerosol Instruments.pdf' for details on the operation of this instrument. In Pacific 2001 the only condensation nuclei counter was a TSI 7610. The CN counts data was stored in the the the 17th

channel of the 2nd PCASP card. These counts must be divided by ten before dividing by the flow in cubic centimetres per second to get the condensation nuclei concentration. The spikes seen in most CN concentration time history plots look 'real' since the spikes vary in duration, and appear to be unrelated to radio frequency communications

The counts data looks to be of very good quality. The flow has many spikes that will have to be removed.

The tag numbers associated with the TSI 7610 Condensation Particle Counter:

01924 PMS 7610 CLOUD NUCLEI (cm^{-3})

Flowmeters

The CN flowmeter monitors the air flowing out of the CN-7610 particle counter. The serial number of this flowmeter is AW710277. It's manufacturer is Tylan, and it monitors 0-2.5 lpm over 0-5 volts. The calibration used was: Volts x 0.4882 +0.0062 = the CN flow in lpm.

The HiVol flowmeter monitors the high-volume airflow for filters collected aboard the Convair. No calibration was performed on the HiVol flowmeter this year. The only calibration we have is the one that came from the manufacturer in 1998, which is as follows: Volts x 145.4 + 8.12 = HiVol Flow (lpm). To get the zero right, we assume the calibration is of the form: Flowmeter_Volts x 145.4 + b = air flow in litres per minute. By averaging the voltage when the flowmeter is off, we found the value intercept 'b' for each flight. These are listed below:

Flight#9 → Flow (lpm) = 145.4 x Volts – 5.73 [Average of zero now = 0.0117, StanDev=0.686]
Flight#8 → Flow (lpm) = 145.4 x Volts – 5.34 [Average of zero now = 0.004, StanDev=0.634]
Flight#7 → Flow (lpm) = 145.4 x Volts – 5.67 [Average of zero now = 0.0022, StanDev=0.777]
Flight#6 → Flow (lpm) = 145.4 x Volts – 5.51 [Average of zero now = -0.0013, StanDev=0.567]
Flight#5 → Not turned On
Flight#4 → Flow (lpm) = 145.4 x Volts – 5.56 [Average of zero now = 0.0032, StanDev=0.871]
Flight#3 → Flow (lpm) = 145.4 x Volts – 5.47 [Average of zero now = 0.0012, StanDev=0.628]
Flight#2 → Flow (lpm) = 145.4 x Volts – 5.72 [Average of zero now = -0.0039, StanDev=0.676]
Flight#1 → Flow (lpm) = 145.4 x Volts – 5.78 [Average of zero now = 0.0002, StanDev=0.786]

Since this intercept value did not vary much from flight to flight, the values obtained from each flight were averaged to yield a 'b' value of –5.6 (+/-0.3). This value of intercept 'b' was used for each Convair flight in Pacific 2001. The times when the flowmeter was turned off now generate flows generally within 1 lpm of zero if we allow the flow to be negative. Nominal values of Hi-Vol flow are in the range of 260 to 340 lpm.

Small periods where spikes from radio frequency interference were observed in either of these flows have subsequently been removed.

The tag numbers associated with these flowmeters are:

08073 CN-7610 flow (lpm)
08553 HiVol flow (lpm)

Latitude and Longitude

Several instruments were available from which to obtain these parameters: they were the inertial navigation system (INS) and the NORTH STAR and Trimble Geographic Positioning Systems (GPS). Rather than supply the values from all of these instruments, we have created a master latitude & longitude list of either of the two GPSs available. The positions of the North Star and Trimble GPSs were nearly identical with no relative bias. However, since the accuracy of the GPSs is dependent on the number of satellites available in the line of sight and there were relatively few in the region where FIRE ACE took

place, we would expect the accuracy of the instruments to also be at a minimum. As quoted by the manufacturer, the typical accuracy of the Trimble GPS is as follows:
Position: 15 meters RMS Altitude: 35 meters RMS Velocity: 0.1 knots RMS steady-rate

Two versions of latitude and longitude are given in the archive. The first is in integral degrees and decimal minutes, and the second is in decimal degrees. In both cases, the longitude is expressed as absolute degrees west rather with the negative value it should have.

Ground site locations for Pacific 2001 can be found in file "P2001Sites.pdf".

The tag numbers associated with position are:

05054 Master LATITUDE (Deg) in integral degrees
05055 Master LATITUDE (Min) in decimal minutes
05056 Master LONGITUDE (Deg) in integral degrees
05057 Master LONGITUDE (Min) in decimal minutes
05164 Master LATITUDE (Deg) in decimal degrees
05165 Master LONGITUDE (Deg) in decimal degrees

O_3 Analyzer

See the file 'GaseousCom.pdf' for details on the operation of this instrument. A post-PACIFIC 2001 calibration (Sept 12 2001) yielded → Teco O3 ppb = 94.193 x Volts +1.4051. All PACIFIC 2001 in-flight zero data occurs in the 580mb to 597mb pressure range, so we are unable to define the pressure dependence of the zero.

Including all PACIFIC 2001 in-flight zero data gives an average zero = -13 mv, at average pressure of 585mb. In FIRE-ACE the zero_in_mv = -0.0565 x pressure + 73.489. So for Pacific2001, the zero_in_mv = -0.0565 * 585(mb) + b = -13. So the zero_in_mv = -0.0565 * pressure(mb) + 20.1. This was used in the following manner, O3 ppb = (mv_sig – zero_in_mv) / 10.62. Small periods where spikes from radio frequency interference were observed in the O3 signal have subsequently been removed. Likewise in-flight zero times have also been nulled out.

The tag number associated with the TECO O_3 Analyzer is:

08600 TECO O3 (ppb)

PCASP Measurements

Two PCASPs were employed during Pacific 2001. See the file ProbeID.pdf for how the PCASPs are identified, and relative differences between them. Probe#3 was mounted on the Convair to the Primary card on all flights except for Convair flight 06. Probe#1 was mounted on the Cessna for all Cessna flights and mounted on the Convair to the Primary card for Convair flight 6 (only), and mounted on the Convair to the Secondary card for Convair flights 07 and 08. So both probes #3 & #1 flew on the Convair side-by-side on flights 07 & 08.

Probe#3 had the pump fail approximately 1/3 of the way into Convair flights 1 and 5. The flow rate from Probe#3's internal flowmeter was obtained as follows: Mass Flow in cc/sec = flowmeter_Volts * 0.1666. This calibration is at least 5 years old.

Probe#1 did not have a working internal flowmeter, and so all flow rates through this probe were estimated as a function of pressure. This estimate was based on data collected from Convair flights 7&8, when both probes flew side by side. The flow rate used for probe #1 was: Mass Flow Rate in cc/sec = Pressure in mb * 0.0006 + 0.128.

Normally our wing mounted PCASPs experience problems due to lack of sufficient heating at temperatures below –35 °C. Insufficient heating of optical detectors causes anomalously high particle counts, primarily in size bins corresponding to the smallest particles. This problem occurred during Pacific 2001 even though temperatures experienced by the Convair were higher than -35°C. However, the impact in this case was slight, only manifesting occasionally as spikes in the first channel at high altitudes when the ambiant total aerosol particle concentration detected by the probe was small. Since the size of the spikes were small and the quality of the data between the spikes was unknown, the spikes were intentionally not removed from the first channel.

The tag numbers associated with the Primary card PCASP are:

01123 PCASP TOTAL CONC (/cm^3)
01124 PCASP CHAN 1 CONC (/cm^3)
01125 PCASP CHAN 2 CONC (/cm^3)
01126 PCASP CHAN 3 CONC (/cm^3)
01127 PCASP CHAN 4 CONC (/cm^3)
01128 PCASP CHAN 5 CONC (/cm^3)
01129 PCASP CHAN 6 CONC (/cm^3)
01130 PCASP CHAN 7 CONC (/cm^3)
01131 PCASP CHAN 8 CONC (/cm^3)
01132 PCASP CHAN 9 CONC (/cm^3)
01133 PCASP CHAN 10 CONC (/cm^3)
01134 PCASP CHAN 11 CONC (/cm^3)
01135 PCASP CHAN 12 CONC (/cm^3)
01136 PCASP CHAN 13 CONC (/cm^3)
01137 PCASP CHAN 14 CONC (/cm^3)
01138 PCASP CHAN 15 CONC (/cm^3)
01139 PCASP MEAN VOL DIAMETER (micro-m)
01140 PCASP MASS (micro-g/cm^3)

The tag numbers associated with the Secondary card PCASP are:

01625 2ND PCASP TOTAL CONC (/cm3)
01184 PCASP 2ND CH 1 CONC (/cm3)
01185 PCASP 2ND CH 2 CONC (/cm3)
01186 PCASP 2ND CH 3 CONC (/cm3)
01187 PCASP 2ND CH 4 CONC (/cm3)
01188 PCASP 2ND CH 5 CONC (/cm3)
01189 PCASP 2ND CH 6 CONC (/cm3)
01190 PCASP 2ND CH 7 CONC (/cm3)
01191 PCASP 2ND CH 8 CONC (/cm3)
01192 PCASP 2ND CH 9 CONC (/cm3)
01193 PCASP 2ND CH 10 CONC (/cm3)
01194 PCASP 2ND CH 11 CONC (/cm3)
01195 PCASP 2ND CH 12 CONC (/cm3)
01196 PCASP 2ND CH 13 CONC (/cm3)
01197 PCASP 2ND CH 14 CONC (/cm3)
01198 PCASP 2ND CH 15 CONC (/cm3)

01615 2ND PCASP MEAN VOL DIAMETER (micro-m)
01616 2ND PCASP MASS (micro-g/m)

Pressures

All pressures given are measures of outside air pressure, with the exception of the (interior) cabin pressure, which is a measure made inside the pressurized aircraft. We tend to use the "Noseboom" pressure as our true outside air pressure while the other pressure measurements are equally good measures of pressure at their given locations. The only pressures of interest to investigators are 'static' pressures.

In Pacific 2001, the Noseboom pressure was generally 10mb lower than the boom or pod pressure.

The tag numbers associated with pressure are:

06011 CABIN PRES (mb)
06023 BOOM STAT PRES (mb)
05039 NOSEBOOM PRESSURE CORR (mb)
05049 POD STATIC PRESSURE (mb)

PRT-5

The PRT-5 is designed to give readings of equivalent black body temperatures in the range of -20 ^{o}C to 75^{o}C. The detector is a hyper-immersed thermister bolometer and the spectral filter limits the measurement to wavelengths in the range of 8 -14 µm. The instrument receives IR radiation from a very narrow solid angle resulting in a measure of planetary surface temperature from a relatively small footprint on the earth's surface. The instrument is intended for use over quasi-black body surfaces like deep lakes and oceans, but can also be used to discern, among other things, the existance of cloud below the aircraft.

The tag number associated with PRT-5 radiation is:

10053 BARN RAD PRT-5 (Deg C)

Relative Humidity, Mixing Ratio and Dew Point

The only dewpoint measuring device on board the aircraft was an EG&G hygrometer. Bad dewpoint measures in small time periods from Convair flights 3,4 and 8 have been nulled. Please see Hygrometer.pdf for details on the operation of the EG&G. Since no liquid water content was measured, the "total water mixing ratio" is not what it should be this project. Instead it holds the same value as the water vapour mixing ratio (which we often refer to as just 'mixing ratio').

The potential temperatures, mixing ratios and relative humidities were all derived from EG&G dew point, Rosemount static temperature, and noseboom static pressure.

The tag numbers related to Relative Humidity, Mixing Ratio and Dew Point are:

05095 MIXING RATIO AIR (g/m^3) ; water vapour only
05096 RELATIVE HUMIDITY (%) ; with respect to water
05097 RELATIVE HUMIDITY WRT ICE (%) ; with respect to ice
05098 TOTAL MIXING RATIO (g/kg) ; water vapour + equivalent liquid water
06014 DEWPOINT TEMP (Deg C) ; this is the EG&G dew point
05092 THETA D (Deg K)
05093 THETA E (Deg K)
05094 THETA Q (Deg K)

Temperatures

Four static outside air temperature measurements are available for use. All of these measurements should be the same, however, the "Rosemount" temperature is usually less than the rest by ~1 °C. The instrument that measures the temperature at the "Boom" location is de-iced. All of the other temperature-measuring instruments are susceptible to icing, although no evidence of icing has been detected to date. All of the temperature measurements should be accurate to ~ 1 °C outside of cloud. In cloud, the uncertainty increases up to ± 2 to 3 degrees from the actual temperature.

In Pacific 2001 the "Reverse Flow" temperature is no good in Convair flights 5 to 9 inclusive.

The tag numbers associated with temperature are:

06013 AES WING STATIC RMNT TEMP (Deg C)
06036 BOOM STATIC RMNT TEMP (Deg C)
06012 WING REV FLOW STATIC TEMP (Deg C)
05237 AES PORT STATIC TEMPERATURE (Deg C)

Time

Time is measured by the two data acquisition systems (DAS) aboard the aircraft. The first is the MSC/AES DAS and the second is the Institute for Aerospace Studies (IAR) DAS, which belongs to the aircraft. Each DAS has a clock and its own date and time. Both clocks are set to UTC. These parameters are as close as we are able to achieve to actual UTC dates and times. A third record of date and time is archived in the form of GMT (or Universal Time Coordinated - UTC) time. Most of the time the archived GMT/UTC time is the IAR date and time. The IAR clock is usually set or checked at the beginning of each flight. The GMT/UTC date and time should be used in nearly all situations. The exceptions are: when referring to 2D data, which is always measured using the AES date/time, and in some of the flight notes where IAR times may have inadvertantly been recorded.

In Pacific 2001 the GMT date&time was just the MSC/AES date&time, without exception. The IAR time was usually within a few seconds of this time, and the IAR date was never correct.

The data obtained from the IAR DAS can sometimes be synchronised with the data from the MSC/AES DAS to the milli-second by the correlation of a ramped voltage. This method was not effective for Pacific 2001 Convair flights. All data is likely syncronized to within one second, but without using the correlation ramp there is no guarantee.

See the file "P2001ConvTimes.pdf" for archive and in-air interval times from all of the Convair clocks and flights.

The tag numbers associated with time are:

00001 GMT Year
00002 GMT Month
00003 GMT Day
00004 GMT Hour
00005 GMT Minute
00006 GMT Second
00011 AES Year
00012 AES Month
00013 AES Day

00014 AES Hour
00015 AES Minute
00016 AES Second
00021 IAR Year
00022 IAR Month
00023 IAR Day
00024 IAR Hour
00025 IAR Minute
00026 IAR Second

Winds

Two instruments labelled "POD" and "SYSTEM" measure wind. The data from "SYSTEM" originates from an array of instruments that are a permanent feature of the aircraft. The data from "POD" originates from measurements made with pitot tubes located at the "POD" location on the port wing. The units of the POD wind speed may be incorrectly indicated to be in metres per second, however, it is actually measured in knots. The conversion factor for knots to metres per second is 0.514

Gust velocities are also measured. These are measured in an "earth axis" co-ordinate system where u, v and w represent East-West, North-South and Up-Down axes, respectively. East, North and Up (vertically away from the earth) have positive values. Please note that the vertical gust velocities are relatively correct but not quantitatively correct: a time history of vertical gusts must be de-trended before this data can be used.

The tag numbers associated with time are:

05044 POD uge (m/sec)
05045 POD vge (m/sec)
05046 POD wge (m/sec)
05047 SYSTEM WIND SPEED (m/sec)
05048 SYSTEM WIND DIR (Deg T)
06016 POD WIND SPEED (m/sec)
06017 POD WIND DIR (Deg T)

Aerosol Instruments: ↺BACK

FSSP 300

Use: The FSSP 300 is an optical probe used for measuring cloud droplet size distribution and concentration in the particle size range of 0.3-20 µm at velocities of 10-125 m/s. The FSSP 300 classifies particles into 31 size channels where scattering calculations suppose that aerosol particles are spherical in shape, with an index of refraction close to that of common aerosols.

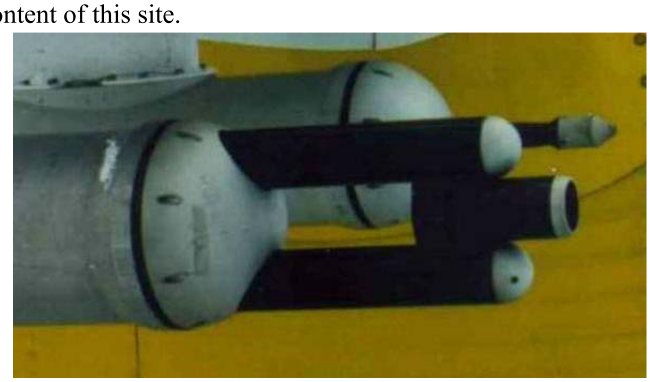
Operation: The FSSP 300 measures the magnitude of laser light scattered from a particle passing through the object plane. A He-Ne laser strikes a particle causing it to scatter light, mainly in the forward direction. A dump spot stops the beam from being collected, while the scattered light is directed by a prism through a set of condensing lenses into a beam splitter, and onto masked and unmasked photodetectors. The photodetectors are arranged so that only particles that pass within a few millimetres of the centre of focus of the laser beam are registered. This distance, combined with the velocity of the aircraft and the dimensions of the sampling cavity, give the volume needed to calculate particle concentration. Particle size is derived from the magnitude of the voltage pulse produced by the photodetectors in response to the scattered light (Baumgartner, 1999).

Factors that influence the performance of the FSSP include: the velocity of the aircraft, the probe response time, the size spectrum and phase of the droplets, the definition of the depth-of-field, the geometry of the optics etc. The sample volume and sizing are important in calibration of the FSSP both as functions of each other and of the airspeed (Vali, 1998).

Errors and Uncertainty: Sources of error include deadtime errors in which droplets are not registered if they pass through the sampling volume during the time when the probe is occupied with processing data. Another source of error, optical coincidence error, occurs when droplets pass through the laser beam simultaneously, appearing to be a single unit. Coincidence errors have the effect of introducing a bias toward the loss of small droplets, sizing droplets greater than actual size, causing a narrow size distribution to appear broader than it is and reducing the total measured concentration of droplets. The above effect is particularly significant when droplet concentration increases beyond 500 cm^3 and is insignificant at less than 100 cm^3 (Cooper, 1988).

Historical Notes: This probe had a series of problems that included: a wire from the PIN diode breaking, mask slit fell off, insufficient heating of photodetector/PIN diode. The duration of these problems, ~10 years, was such that almost no good data was obtained from this probe until Pacific 2001. The heating of the avalanche-type 'PIN' diode appears to be the controlling factor in getting good data from this instrument. However, given the lack to date of a good historical record with respect to use and calibration of this instrument, researchers are advised to be careful when using the data collected by this instrument.

Other information on the FSSP 300 can be found on Darrel Baumgartner's page on the NCAR web site: http://raf.atd.ucar.edu/~darrel/htmlFiles/fssp300.html Please note that Environment Canada is not responsible for the content of this site.



FSSP 300

Passive Cavity Aerosol Spectrometer Probe (PCASP)

Use: The PCASP is an optical particle counter used for measuring the concentration and size distribution of particles assumed to have a spherical shape, and an index of refraction between 1.52 and 1.59. These particles are in the size range of 0.14 µm to 3 µm.

Operation: The PCASP works by collecting light scattered from particles passing through the object plane. Air enters the probe through a heated diffuser cone about 13 cm in length. A diffuser decelerates the air, most of which is exhausted near its rear, and the remainder is sampled with a small needle at a rate of 1 cm^3/s. Particles in the air sample enter the probe's optics where they scatter light as they pass through the object plane and are struck by a focused He-Ne laser beam. The scattered light is sent to a photodetector and its magnitude is compared with light on a reference photodetector. The result is output as a voltage signal which is related to particle size through Mie scattering theory and signal magnitude. The signal is classified into one of fifteen size channels (or bins) ranging from 140 nm to 3000 nm. Incorrect sizing of particles is minimised by evaporation of clinging water and the particles themselves are not volatile and remain intact through the heating process. This is done through heat transmitted by the diffuser, dry sheath air in the detection area and the internal heat of the probe.

Errors and Uncertainty: The PCASP is calibrated in the field using monodisperse particles of NaCl and $(NH_4)_2SO_4$ in the manner described by Liu et al. (1992). Uncertainties in the concentration measurements are related to flow measurement. An internal flow meter provides a continuous measurement of the flow that is used with the particle count to derive a concentration, the uncertainty of which is ± 5%. Uncertainties in the sizing are related to the ability to calibrate each bin and the spread of the near monodisperse particles. The uncertainty in sizing is estimated as the width of each size bin. Please see the file 'PCASPchn.pdf' for bin size definitions.

Other information on the PCASP can be found on Darrel Baumgartner's page on the NCAR web site: http://raf.atd.ucar.edu/~darrel/htmlFiles/pcasp100.html Please note that Environment Canada is not responsible for the content of this site.

PCASP mounted on the NRC Convair 580 in FIRE ACE

Condensation Particle Counter (CPC 7610)

Use: The TSI 7610 Condensation Particle Counter is a single particle counter used for counting particles capable of acting as cloud nucleation sites. Its lower detection limit is approximately 18 nm.

Operation: The particles are grown to micrometer sizes by condensation of butanol from a supersaturated vapour. The large droplets of butanol are detected and counted by light scattering.

Errors and Uncertainty: Comparisons are done in the ARMP lab against other single particle counters. Based on those comparisons, the standard uncertainty in particle concentration is ±10%.

Other information on the CPC can be found on the TSI web page:
http://www.tsi.com/particle/homepage/particlehome.htm. Please note that Environment Canada does not endorse this company or its products and is not responsible for the content of this site.

Ground Sites

↺BACK

	Slocan Park	Burnaby South HS	Lochiel School	Sumas Mountain	Cassiar Tunnel	Abbotsford Airport Site
Latitude (N)	49d 14m 38.2s	49d 12.923m	49d 01m 42.2s	49d 03m 07.2s	49d 17m 01.9s	49d 01m 24.5s
Longitude (W)	123d 02m 55.1s	122d 58.918m	123d 36m 13.0s	122d 14m 46.9s	123d 01m 54.2s	122d 20m 37.5s
Elevation (meters)	92	116	94	300	41	72

TECO 49 UV Ozone Analyzer

Use: The Thermo Electron Corporation (TECO) 49 ozone analyzer is used to measure the concentration of ozone in the air.

Operation: The ozone analyzer measures the attenuation of light caused by ozone using a UV photodetector. Light attenuation in an air sample is compared with light attenuation in a reference sample for the wavelength 254 nm. The ratio between the readings from these two samples is related to the ozone concentration through the Beer-Lambert Law.

Error and Uncertainty: The range of this instrument is 0-1 ppm and its accuracy is ± 1% of the reading ± 0.5 ppb. Its detection limit is 0.5 ppb. (Hayden et al. 1994).

Identification of probes serviced by PMI

↺BACK

(Particle Metrics Inc.; Steve Mathews at 303-247-0411)

PCASP

NOTE! Each PCASP has a single signal pulse gain applied to bins 1->2, a second/different signal pulse gain applied to bins 3->6, and a third/different signal pulse gain applied to bins 7->15.

Probe #1

- Origianlly was a 115 VAC 400 Hz ASASP, with Serial Number 1861-0381-02
- Converted from an ASASP to a PCASP in Nov 2000.
- Now is a 115VAC 60Hz PCASP, with Serial Number 1861-1100-28

Heaters: 28 VDC on photo-detector/PIN(Positive-Intrinsic-Negative)diode mount
28 VDC circuit with 3 heaters.
Note: each of these heaters can be bypassed
(1) nose(de-icing) heater
(2) inlet heater
(3) inlet shroud heater
115 VAC circuit for single heater over photo-detector module

Probe #2

- Origianlly was a 115 VAC 60 Hz ASASP, with Serial Number 2834-0582-04
- Converted from an ASASP to a PCASP in Feb 1990.
- Now is a 115VAC 60Hz PCASP, with Serial Number 19370--390-05

Heaters: 28 VDC on photo-detector/PIN(Positive-Intrinsic-Negative)diode mount
28 VDC circuit with 3 heaters.
Note: each of these heaters can be bypassed
(1) nose(de-icing) heater
(2) inlet heater
(3) inlet shroud heater
115 VAC circuit for single heater over photo-detector module

Probe #3

- was/is a 115VAC 400Hz PCASP, with Serial Number 15281-0389-02

Heaters: 28 VDC on photo/PIN(Positive-Intrinsic-Negative)diode mount
28 VDC circuit with 3 heaters.
Note: each of these heaters can be bypassed
(1) nose(de-icing) heater
(2) inlet heater
(3) inlet shroud heater

For Pacific 2001:

Probe#3 - was mounted on the Convair to the Primary card for all flights except
for Convair flight 6
Probe#1 - was mounted on the Cessna for all Cessna flights AND
mounted on the Convair to the Primary card for flight 6 only AND
mounted on the Convair to the Secondary card for flights 7 and 8
So both probes 3 & 1 flew on the convair side-by-side on flights 7 & 8

Cessna PCASP -> 28 VDC heater on photodiode mount was ON
-> 28 VDC heater on nose was OFF
-> 28 VDC heater on inlet was ON
-> 28 VDC heater on shroud was OFF
`-> 115 VAC heater on photodetector module was OFF

Convair PCASP-> 28 VDC heater on photodiode mount was ON
-> 28 VDC heater on nose was ON
-> 28 VDC heater on inlet was ON
-> 28 VDC heater on shroud was ON
`-> 115 VAC heater on photodetector module was ON
Also Note!
The Twin Otter flies Probe#3 almost without exception
Currently Probe#2 is touring with WRL and Nicole

FSSP-300

NOTE! The FSSP-300 has a single signal pulse gain applied to bins 1->8, and a second/different signal pulse gain applied to bins 9->31.

- Serial Number 16010-1189-02, 115ACV 60->400 Hz

Heaters: 28 VDC on photo/PIN(Positive-Intrinsic-Negative)diode mount
115 VAC over Photo-detector module (added after FIREIII, ie 1998)

Series of historical problems with this probe include:
- wire from PIN diode broken
- mask slit fell off
- insufficient heating

For Pacific 2001:
FSSP-300 on Cessna -> 28 VDC heater on photodiode mount was ON
` -> 115 VAC heater on photodetector module was OFF

FSSP-100

NOTE! FSSP-100s don't use avalanche photo-diodes, so the temperature range where additional heating is required for the photo-detector module occurs below –30 Deg C.

Probe #1

- Serial Number 223-176-002, 115ACV 60->400 Hz
- nominally detects particles in the 0.5 to 45 microns diameter range

Heaters: 28 VDC for sample tube & mirror(s) & prism

Probe #2

- Serial Number 4670-1283-096, 115ACV 60->400 Hz,
- nominally detects particles in the 0.5 to 45 microns diameter range

Heaters: 115 VAC for sample tube & mirror(s) & prism

Probe #3

- Serial Number 15421-0389-124, 115ACV 60->400 Hz
- nominally detects particles in the 1.0 to 95 microns diameter range

Heaters: 115 VAC for sample tube & mirror(s) & prism

DEW POINT MEASURING INSTRUMENTS:

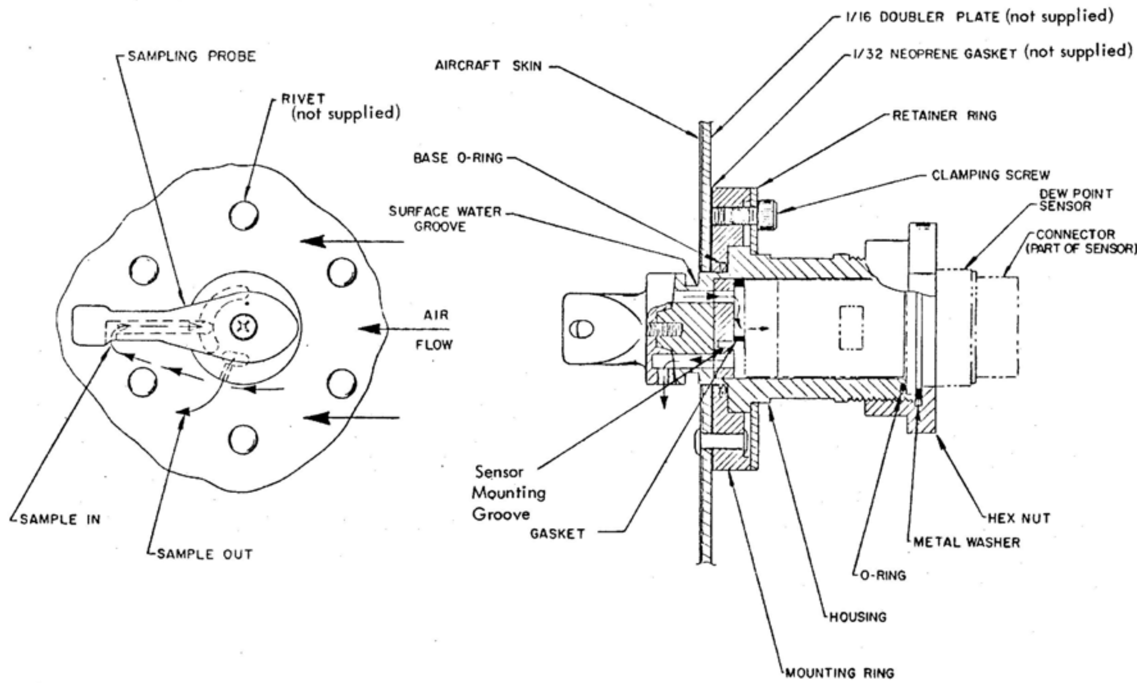
↺BACK

EG&G HYGROMETER

Use: The EG&G hygrometer is used to measure relative humidity through determination of the dew or frost point; the temperature at which water condenses for a given relative humidity.

Operation: The EG&G hygrometer uses a chilled mirror to determine the dew or frost point. The dry, clean mirror is monitored by an optical sensor and cooled until moisture condenses on it. The optical sensor detects the change in the reflective properties of the mirror caused by the moisture and sends a signal to the cooling system to reduce current and allow the mirror to warm. This cycle continues until a layer of constant thickness is formed on the mirror's surface. The temperature at which this occurs is the dew point temperature. Below 0°C, the condensation point may be taken to be the frost point, the point at which gaseous water condenses as a solid. With respect to AES, historically, we have not stored the frost point from this instrument in its own tag. Instead, we have let the EG&G dewpoint tag hold the dew point at above freezing temperatures and kept in mind that it also holds the frost point at below freezing temperatures.

Errors and Uncertainty: Under extremely cold and dry conditions, the EG&G hygrometer is unable to cool the mirror enough to cause water vapour to condense on its surface. This only occurs when the difference between the frost point and the air temperature is quite large (e.g. ~ 40°C): the instrument overestimates frost point and dew point when in cloud because no energy is required to cool the mirror to the point where condensation occurs.



Schematic diagram of the EG&G hygrometer

Figure: Instruction Manual EG&G Model 137-C3 Aircraft Hygrometer System, EG&G International Inc., 1977.

START OF ARCHIVED TIME INTERVAL **↺BACK**

FLT	GMTDATE			GMTSTART		
001	2001	08	14	19	28	37
002	2001	08	15	19	43	12
003	2001	08	20	19	10	30
004	2001	08	25	18	43	09
005	2001	08	26	20	52	58
006	2001	08	27	03	57	41
007	2001	08	29	22	07	26
008	2001	08	30	05	01	57
009	2001	08	30	21	17	17

IAR DATA START

FLT	GMT___DATE			GMT_TIME			IAR___DATE			IAR_____TIME			
	YEAR	MM	DD	HH	MM	SS	YEAR	MM	DD	HH	MM	SS	mse
001	2001	08	14	19	28	42	2001	08	14	19	28	41	156
002	2001	08	15	19	43	31	2001	08	15	19	43	30	031
003	2001	08	20	19	10	37	0000	99	99	19	10	36	781
004	2001	08	25	18	44	11	0000	99	99	18	44	10	281
005	2001	08	26	20	53	06	0000	99	99	20	53	05	031
006	2001	08	27	03	57	48	0000	99	99	03	57	47	000
007	2001	08	29	22	07	32	0000	99	99	22	07	31	437
008	2001	08	30	05	02	05	0000	99	99	05	02	04	312
009	2001	08	30	21	17	22	0000	99	99	21	17	21	343

TAKE-OFF TIMES

FLT	GMTDATE			GMTSTART			IARDATE			IARTIME				AESDATE			AESTIME			
	YEAR	MM	DD	HH	MM	SS	YEAR	MM	DD	HH	MM	SS	mse	YEAR	MM	DD	HH	MM	SS	mse
001	2001	08	14	20	03	55	2001	08	14	20	03	53	750	2001	08	14	20	03	55	000
002	2001	08	15	19	52	06	0000	99	99	19	52	04	937	2001	08	15	19	52	06	000
003	2001	08	20	19	20	34	0000	99	99	19	20	33	156	2001	08	20	19	20	34	000
004	2001	08	25	18	50	05	0000	99	99	18	50	04	062	2001	08	25	18	50	05	000
005	2001	08	26	21	01	06	0000	99	99	21	01	04	906	2001	08	26	21	01	06	000
006	2001	08	27	04	10	59	0000	99	99	04	10	57	718	2001	08	27	04	10	59	000
007	2001	08	29	22	16	42	0000	99	99	22	16	40	843	2001	08	29	22	16	42	000
008	2001	08	30	05	12	52	0000	99	99	05	12	51	031	2001	08	30	05	12	52	000
009	2001	08	30	21	27	59	0000	99	99	21	27	57	968	2001	08	30	21	27	59	000

TOUCH-DOWN TIMES (OR END OF DATA IF THAT COMES FIRST)

FLT	GMTDATE			GMTSTART			IARDATE			IARTIME				AESDATE			AESTIME			
	YEAR	MM	DD	HH	MM	SS	YEAR	MM	DD	HH	MM	SS	mse	YEAR	MM	DD	HH	MM	SS	mse
001	2001	08	15	00	58	19	2001	08	14	99	55	56	781	2001	08	15	00	58	19	000
002	2001	08	16	00	53	25	0000	99	99	99	53	23	125	2001	08	16	00	53	25	000
003	2001	08	21	00	07	43	0000	99	99	99	07	41	375	2001	08	21	00	07	43	000
004	2001	08	26	00	02	37	0000	99	99	99	02	36	375	2001	08	26	00	02	37	000
005	2001	08	27	01	53	46	0000	99	99	01	53	45	937	2001	08	27	01	53	46	000
006	2001	08	27	09	09	34	0000	99	99	09	09	31	937	2001	08	27	09	09	34	000
007	2001	08	30	03	08	15	0000	99	99	99	08	13	062	2001	08	30	03	08	15	000
008	2001	08	30	10	08	36	0000	99	99	10	08	34	250	2001	08	30	10	08	36	000
009	2001	08	30	23	49	49	0000	99	99	23	49	47	625	2001	08	30	23	49	49	000

IAR DATA ENDS

FLT	GMT___DATE			GMT_TIME			IAR___DATE			IAR_____TIME			
	YEAR	MM	DD	HH	MM	SS	YEAR	MM	DD	HH	MM	SS	mse
001	2001	08	15	00	58	19	2001	08	14	99	55	56	781
002	2001	08	16	00	53	39	0000	99	99	99	53	37	093
003	2001	08	21	00	08	07	0000	99	99	99	08	05	343

```
004 2001 08 26 00 02 46 0000 99 99 99 02 45 343
005 2001 08 27 01 54 04 0000 99 99 01 54 03 937
006 2001 08 27 09 09 48 0000 99 99 09 09 45 937
007 2001 08 30 03 08 27 0000 99 99 99 08 25 031
008 2001 08 30 10 08 47 0000 99 99 10 08 44 218


END OF ARCHIVED TIME INTERVAL
FLT GMTDATE    GMTSTART IARDATE IARTIME         AESDATE    AESTIME
    YEAR MM DD HH MM SS YEAR MM DD HH MM SS mse YEAR MM DD HH MM SS mse
001 2001 08 15 00 58 19 2001 08 14 99 55 56 781 2001 08 15 00 58 19 000
002 2001 08 16 00 53 55 8888 88 88 88 88 88 888 2001 08 16 00 53 55 000
003 2001 08 21 00 08 11 8888 88 88 88 88 88 888 2001 08 21 00 08 11 000
004 2001 08 26 00 02 46 0000 99 99 99 02 45 343 2001 08 26 00 02 46 000
005 2001 08 27 01 54 04 0000 99 99 01 54 03 937 2001 08 27 01 54 04 000
006 2001 08 27 09 09 58 8888 88 88 88 88 88 888 2001 08 27 09 09 58 000
007 2001 08 30 03 08 44 8888 88 88 88 88 88 888 2001 08 30 03 08 44 000
008 2001 08 30 10 08 54 8888 88 88 88 88 88 888 2001 08 30 10 08 54 000
009 2001 08 30 23 50 06 0000 99 99 23 50 04 500 2001 08 30 23 50 06 000
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;                           PCASP CHANNEL DEFINITION TABLE        ↺BACK
;                             LITE Calibration
;           using E.C. and NaCl solution,  18 Sept. 1994, Palm Springs
;                             and latex beads
;
;                              VERSION 3
;
;CHN#     MIN      MAX      MID       dD     dlogD     Area      Vol     SArea
   1     .130     .150     .140     .020      .062 .154E-01 .274E-02    .583
   2     .150     .165     .157     .015      .041 .195E-01 .391E-02    .583
   3     .165     .190     .178     .025      .061 .247E-01 .559E-02    .583
   4     .190     .220     .205     .030      .064 .330E-01 .862E-02    .583
   5     .220     .263     .242     .043      .078 .458E-01 .141E-01    .583
   6     .263     .340     .302     .077      .112 .714E-01 .274E-01    .583
   7     .340     .470     .405     .130      .141 .129E+00 .664E-01    .583
   8     .470     .590     .530     .120      .099 .221E+00 .149E+00    .583
   9     .590     .730     .660     .140      .092 .342E+00 .287E+00    .583
  10     .730     .930     .830     .200      .105 .541E+00 .572E+00    .583
  11     .930    1.200    1.065     .270      .111 .891E+00 .121E+01    .583
  12    1.200    1.500    1.350     .300      .097 .143E+01 .246E+01    .583
  13    1.500    2.000    1.750     .500      .125 .241E+01 .536E+01    .583
  14    2.000    2.500    2.250     .500      .097 .398E+01 .114E+02    .583
  15    2.500    3.000    2.750     .500      .079 .594E+01 .208E+02    .583
```