ASCOS-2008 Helicopter Profiling of Aerosol and Meteorological parameters

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General

For vertical and horizontal profiling of aerosol, trace gases and meteorological parameters, 70 flights, and about 40 hours of helicopter time, were performed. The aerosol particle size concentrations were measured at 1 Hz in several size ranges using two Condensation Particle Counters ((Ultrafine)UCPC diameters >3nm and CPC diameters >14nm) and an Optical Particle Spectrometer (CLASP): diameters >300nm). The meteorological mapping was performed (logged at 2-3 Hz) with Thermoelements and a T, P and RH sensor PTU300 (Vaisala, Finland). More details concerning the instrumental set up is given below. The helicopter was very successfully deployed but its inability to penetrate cloud meant restricted measurements to clear sky episodes. The ideal solution would have been to use an all-weather (de-iced) helicopter, which was unfortunately not possible.

The helicopter was flown perpendicular to the wind direction to the ship, and turned slightly upwind before the return flight. This method was chosen in order to ensure unpolluted air to be sampled, as well as not to disturb the measurements onboard the ship. The air was sampled through an inlet isokinetically at helicopter air speed of 70 km/h, which the pilot maintained manually.

Flights are labeled according to date [MMDD] and flight number [nr] for each day. Certain flight numbers for a particular day are not included for use, indicating that these flight data were either: 1) not quality-controlled because the flight was a reconnaissance rather than research flight; 2) instruments were not operational. The flight schedule for the Quality-Controlled files is given in the file: *ASCOS08_Flight_Schedule_QC_072011*.

A data logging system was implemented within the cabin of the helicopter for aerosol and meteorological profiling measurements. Measurements were logged onto the hard disk of a Lenovo Thinkpad X61s PC laptop via National Instruments data acquisition software LabVIEW.

First hand draft graphs of each of the Quality Controlled flights together with real time photos, when available, are also attached.

All flights (#70)

Flight0804nr1, Flight0804nr2, Flight0804nr3, Flight0804nr4, Flight0804nr5, Flight0805nr1, Flight0805nr2, Flight0806nr1, Flight0806nr2, Flight0806nr3, Flight0807nr1, Flight0807nr2, Flight0807nr3, Flight0808nr1, Flight0809nr1, Flight0809nr2, Flight0810nr1, Flight0810nr2, Flight0810nr3, Flight0811nr1, Flight0815nr1, Flight0816nr1, Flight0817nr1, Flight0820nr1, Flight0820nr2, Flight0820nr3, Flight0820nr4, Flight0820nr5, Flight0821nr1, Flight0822nr1, Flight0824nr1, Flight0824nr2, Flight0824nr3, Flight0824nr4, Flight0824nr5, Flight0825nr1, Flight0825nr2, Flight0825nr3, Flight0826nr1, Flight0826nr2, Flight0826nr3, Flight0826nr4, Flight0827nr1, Flight0827nr2, Flight0827nr3, Flight0827nr4, Flight0828nr1, Flight0828nr2, Flight0828nr3, Flight0829nr1, Flight0829nr2, Flight0829nr3, Flight0830nr1, Flight0830nr2, Flight0830nr3, Flight0831nr1, Flight0831nr2, Flight0831nr3, Flight0831nr4, Flight0901nr1, Flight0901nr2, Flight0901nr3, Flight0901nr4, Flight0903nr1, Flight0904nr1, Flight0905nr1, Flight0905nr2, Flight0906nr1, Flight0907nr1, Flight0907nr2

Flights Quality Insured (#45)

Flight0810nr3, Flight0815nr1, Flight0816nr1, Flight0817nr1, Flight0820nr1, Flight0820nr3, Flight0820nr4, Flight0820nr5, Flight0821nr1, Flight0822nr1, Flight0824nr1, Flight0824nr3, Flight0824nr4, Flight0824nr5, Flight0825nr1, Flight0825nr2, Flight0825nr3, Flight0826nr1, Flight0826nr2, Flight0826nr3, Flight0826nr4, Flight0827nr3, Flight0827nr4, Flight0828nr1, Flight0828nr3, Flight0829nr1, Flight0829nr2, Flight0829nr3, Flight0830nr1, Flight0830nr2, Flight0830nr3, Flight0831nr1, Flight0831nr2, Flight0831nr3, Flight0831nr4, Flight0901nr1, Flight0901nr2, Flight0901nr3, Flight0901nr4, Flight0903nr1, Flight0905nr1, Flight0905nr2, Flight0906nr1, Flight0907nr1, Flight0907nr2

The files *ASCOS08_QCdata_072011 and ASCOS08_QCdata_072011_heli.mat* contain data from the helicopter flights during the period 10 Aug - 7 Sept 2008. All data is given with 1 second time resolution. Columns labeled "mean" or "med" represent 11 seconds running mean/med values. Height was calculated using observed pressure and temperature. Data time is given in MatLab datenum format. Data entries labeled -99 999.00 indicates missing data.

The files include the following data columns:

1. time (YY-MM-DD Hour:Min:Sec).

2. lat (°): latitude

3. lon (°): longitude

4. w_e (0=**w**est 1=**e**ast)

5. z (m): height

6. P_ptu (hPa): Pressure

7. P_ptu mean (hPa): Pressure

8. P_ptu med (hPa): Pressure

9. T_tc (Celsius): Temperature

10. T_tc mean (Celsius): Temperature

11. T_tc med (Celsius): Temperature

12. RH_ptu (%): Relative humidity

13. RH_ptu mean (%): Relative humidity

14. RH_ptu med (%): Relative humidity

15. WVmr_calc (gkg^{-1}) : Water Vapor mixing ratio

16. WVmr_calc mean (gkg^{-1}) : Water Vapor mixing ratio

17. WVmr_calc med (gkg^{-1}) : Water Vapor mixing ratio

18. ucpc (particles by number per cm^3, Diameters> 3nm)

19. ucpc_mean (particles by number per cm^3, Diameters> 3nm)

20. ucpc_med (particles by number per cm^3, Diameters> 3nm)

21. cpc (particles by number per cm^3, Diameters> 14nm)

22. cpc_mean (particles by number per cm^3, Diameters> 14nm)

23. cpc_med (particles by number per cm^3, Diameters> 14nm)

24. clasp (particles by number per cm^3, Diameters> 300nm)

25. clasp_mean (particles by number per cm^3, Diameters> 300nm)

26. clasp_med (particles by number per cm^3, Diameters> 300nm)

Aerosol Instrumentation and measurements

A rack (Figure 1) was fitted instead of the left backseat in the helicopter, which contained on lowest shelf the OPC (Optical Particle Counter) - CLASP operated by Leeds. On the mid shelf there was an UCPC (model 3025, serial# 101/1993) measuring particles larger than 3 nm diameter. On the top shelf was a CPC (model 7610 serial# 747) measuring >14 nm diameter. (For more details see the attached file: *ASCOS_Helicopter Aerosol Layot.ppt.*

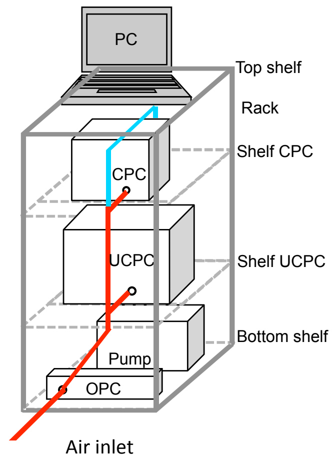

Figure 1.

UCPC

The UCPC uses a ΔP sensor over a capillary to measure the flow. This signal regulates with a PID loop, a pump in that instrument. The pump keeps the ΔP constant. As the altitude increases both the density of the air and the ΔP signal decreased which made the pump to increase the flow. This made the concentration recorded artificially high. In the Quality Controlled data this has been corrected for. Also corrections for mishaps such as butanol floods have been corrected for.

CPC

The CPC flow was controlled with a critical orifice. This maintains a constant volume flow if the Temperature of the orifice and the air stream are constant. This was the case (resulting estimated error due 10K change from that assumption ca. 3%). No correction was needed. The CPC flow was measured manually at occasions during the campaign. A correction factor per flight has been used in the Quality Insurance of the data.

CLASP

A detailed description on the performance of the CLASP and the Quality Insurance of its data mapping is posted by Sarah Norris, Leeds University, UK, on the ASCOS data base.

Meteorological Instruments and Measurements

The meteorological measurements logged during profile flights include atmospheric pressure [hPa], air temperature [°C] and relative humidity [%]. Within the cabin, a Vaisala Combined Pressure, Humidity and Temperature Transmitter [PTU300] was mounted onto the instrument rack which also housed the logging laptop and aerosol counter instruments. Measurements of physical variables were sent directly from the transmitter to the logging laptop via a USB cable. Additionally, four thermocouples included for measuring higher-frequency temperature variations were logged. Thermocouple voltages were transmitted to the laptop via a National Instruments Data Acquisition Signal Processing unit, which was connected to the laptop via a USB cable. Calibration constants were then applied to record physical temperatures. All meteorological data was logged at 2-3 Hz, and these measurements were used to produce 1-Hz mean values to match temporal sampling from the aerosol instruments onboard. Table 1 provides specifics on the meteorological sensors.

Table 1. Meteorological instrument sensor, reported accuracy and instrument housing location onboard the helicopter during ASCOS. TC is short for thermocouple.

Measurement	**Sensor**	**Accuracy**	**Instrument mounting location**
Pressure [hPa]	Vaisala BAROCAP	± 0.15 hPa	Helicopter's static pressure port
Relative humidity [%]	Vaisala HUMICAP 180	± 1.7% (90-100% RH)	Outside, front of helicopter
Temperature [°C]	Pt100 RTD1	± 0.3°C at 0°C	Outside, front of helicopter
TCTemperatures [°C]	Type T thermocouples (4 pcs)	± 0.5°C at 0°C	Outside, front of helicopter

Besides the PTU300 pressure sensor, which was connected to the helicopter's static pressure port, temperature and relative humidity was measured at the front of the helicopter. This location allowed for good instrument ventilation and avoided backwash from the rotors. Fig. 2a is a photo showing the location of the PTU sensors and 3 thermocouples. The thermocouples were spaced evenly throughout the PVC housing, which acted as a shield from direct solar radiative heating. The thermocouple wires were wrapped in aluminum heat shield to minimize solar heating. The open housing allowed for sufficient instrument ventilation. Fig. 2b shows the copper pipe that was used as the aerosol inlet. The 4^{th} thermocouple was attached to the pipe and measured air temperature near the inlet.

a)

b)

Figure 2. a) PVC housing containing the PTU300 temperature/humidity sensors (silver cylinder resting on the bottom of the housing, and 3 thermocouples spaced approximately 5 cm apart across the length of the PVC housing. b) The 4th thermocouple was attached to copper pipe aerosol inlet, measuring temperature slightly below the inlet. The PVC housing can also be seen to the lower left.

Analysis has shown that the PTU300 temperature sensor has a consistent slower response time compared to the thermocouple temperature variations. In addition, the single thermocouple attached to the aerosol inlet has a positive bias on the order of 0.2-0.5°C compared to the shielded PTU and thermocouple temperature sensors. Therefore, the 1-Hz temperature measurements provided in the dataset are a mean value of the 3 thermocouples within the PVC housing.

Acknowledgement

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