Fit Cavity Pressure

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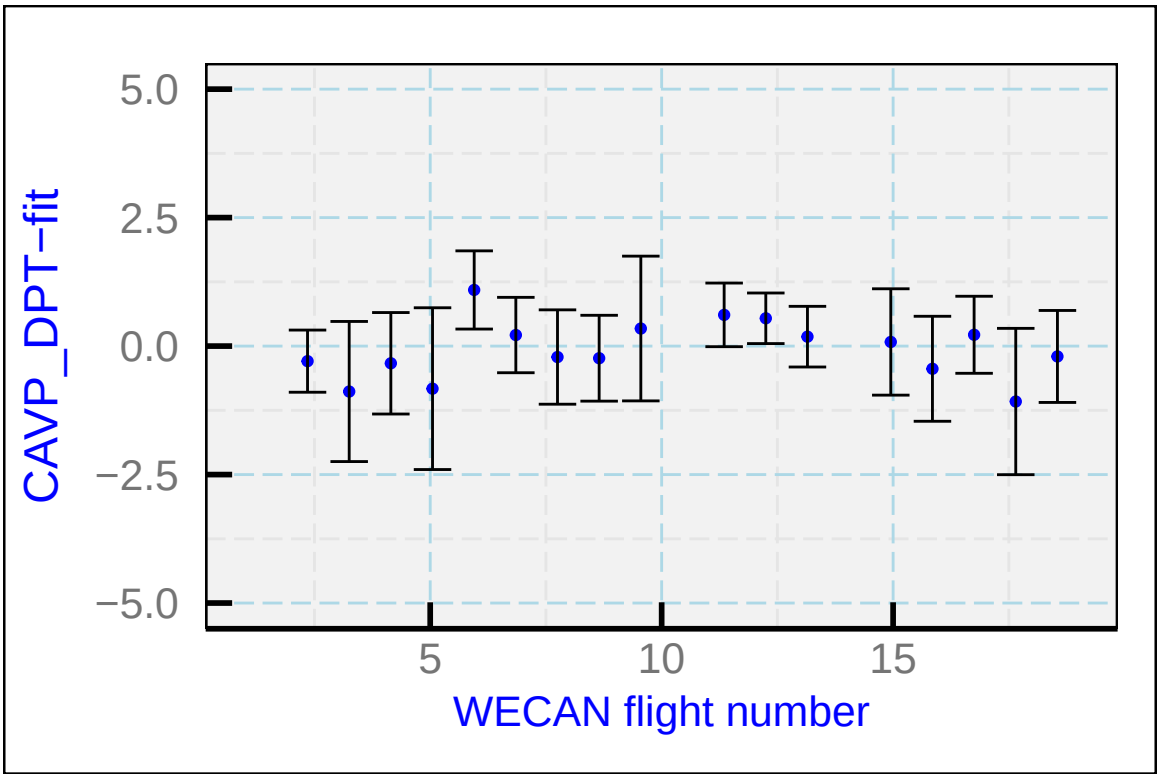
Background

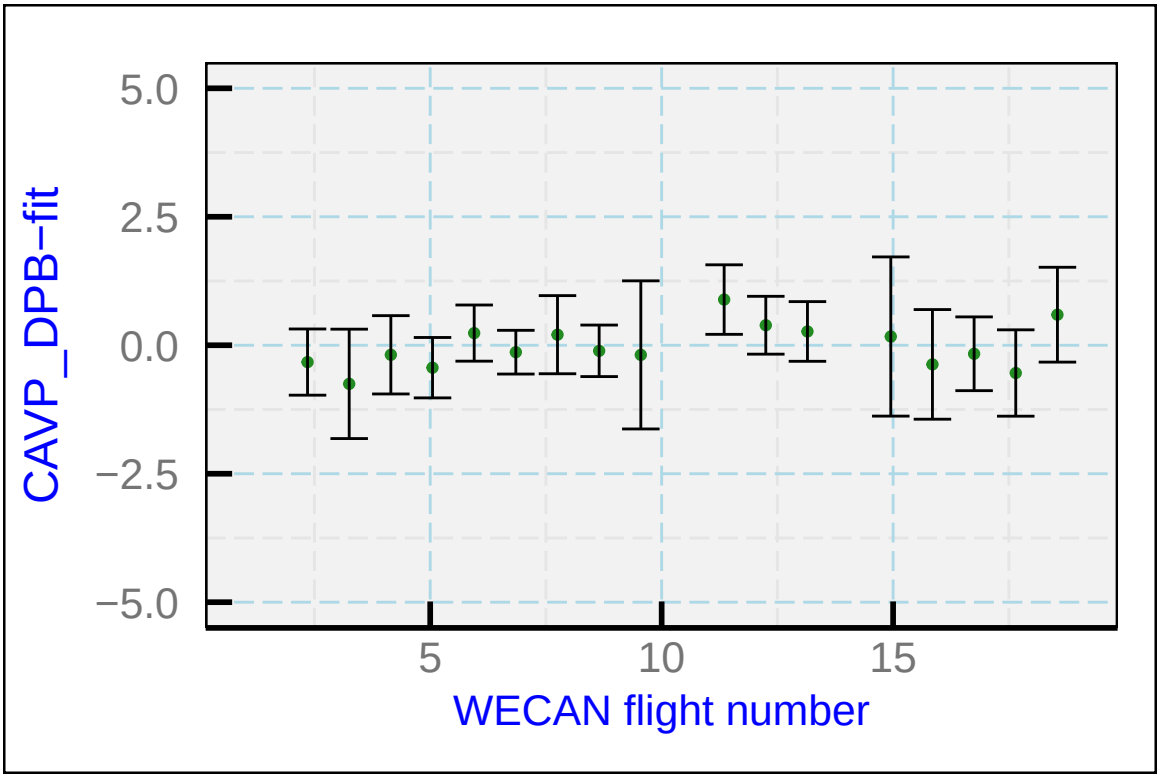
The study reported in the algorithm note "DP_Pressure_Correction.pdf" applied to the GV and found a representation different from that being used in QAtools even for the GV. It appears useful to revisit this issue for both aircraft.

Analysis

C-130

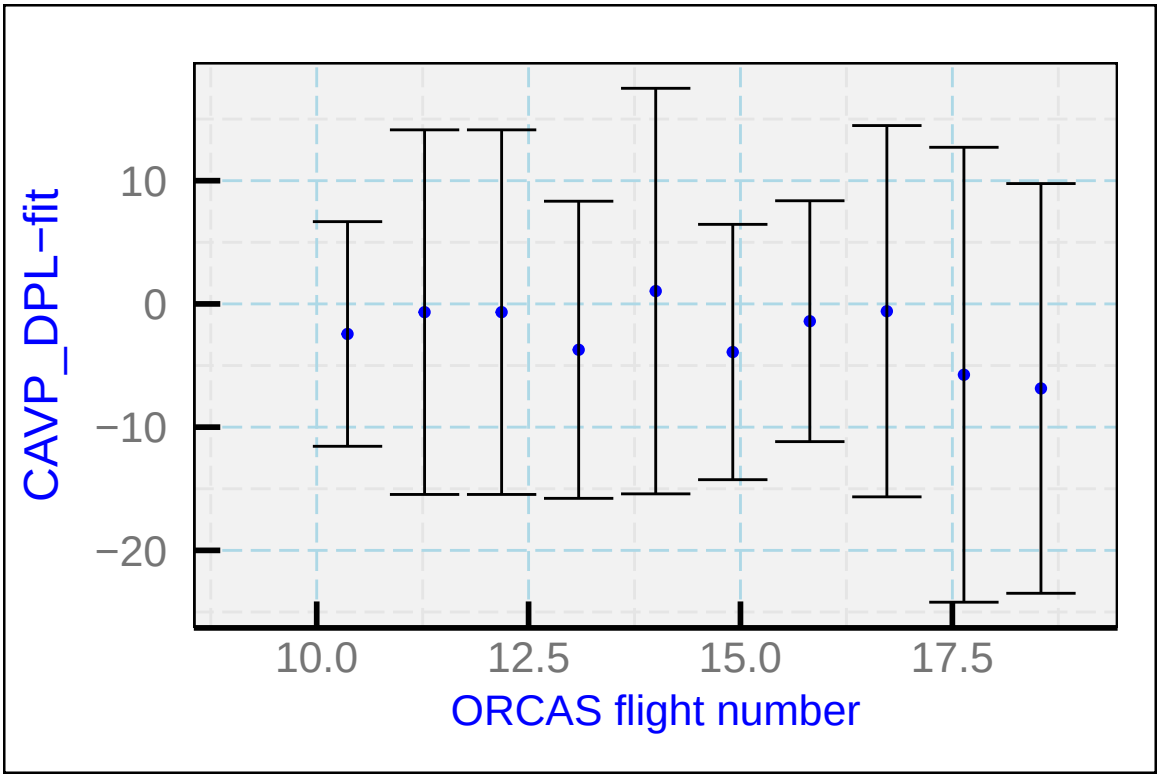
For the C-130, all the research flights from WECAN were used except rf14, which appeared to provide some outlier values compared to other flights. The differences CAVP_DPT-PSXC and CAVP_DPB-PSXC were calculated and an empirical search for reasonable fits led to a reasonable representation of both in terms of QCXC. MACHX, and AKRD where QCXC was the leading contribution to the reduction of variance for CAVP_DPT-PSXC but AKRD was by far the most important for CAVP_DPB-PSXC. The residual error for both fits was about 1 hPa. Furthermore, for the C-130 the measured pressures differ little (typcally <10~hPa) from the ambient pressure so the corrections for these pressure measurements are small.

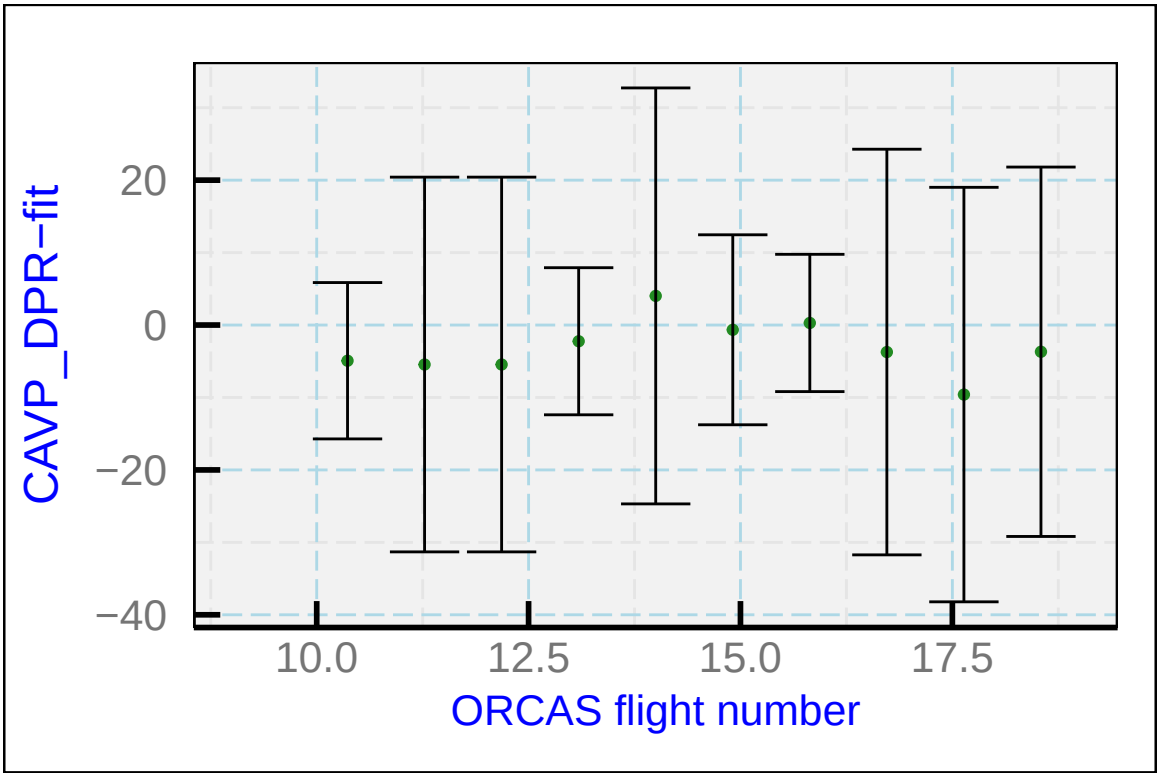




GV:

The same approach was used for the GV, using the data from the ORCAS project, selected because it was recent and yet covered a wider range in altitude than SOCRATES. Only ORCAS flights 9–19 were included because there seemed to be a shift before this and these appeared more consistent. In this case, the measured pressures were significantly different from the ambient pressures and the corrections for the measured pressures are quite important.


CAVP_DPL−fit
10
0
−10
−20
10.0
12.5
15.0
17.5
ORCAS flight number


CAVP_DPR−fit
20
0
−20
−40
10.0
12.5
15.0
17.5
ORCAS flight number

Recommendations

For the C-130, the cavity pressures are represented very well (within about 1 hPa) by these equations:\

$$\text{CAVP\_DPT} = \text{PSXC} + a_0 + a_1\text{QCXC} + \text{a}_2\text{MACHX} + \text{a}_3\text{AKRD}$$

$$\text{CAVP\_DPB} = \text{PSXC} + b_0 + b_1\text{QCXC} + \text{b}_2\text{MACHX} + \text{b}_3\text{AKRD}$$

where $\{a_{0-3}\}$={0.4101, 0.2610, -35.232, 1.4859} and $\{b_{0-3}\}$={-4.5451, 0.0076, 1.0957, 2.4222}.

For the GV, the cavity pressures are represented by\

$$\text{CAVP\_DPL} = \text{PSXC} * (1 + c_0 + c_1\text{QCXC} + \text{c}_2\text{MACHX} + \text{c}_3\text{AKRD})$$

$$\text{CAVP\_DPR} = \text{PSXC} * (1 + d_0 + d_1\text{QCXC} + \text{d}_2\text{MACHX} + \text{d}_3\text{AKRD})$$

where $\{c_{0-3}\}$={0.3073, 1.7557×10^{-4}, -0.9981, 0.0023} and $\{d_{0-3}\}$={0.1858, 0.0018, -0.9702, 0.0139}. In these cases, the standard errors in the resulting representations of the cavity pressure are respectively about 15.7 and 26.4~hPa, while the average differences between the cavity pressures and the ambient pressure are respectively about -90 and -42~hPa. This indicates that, even though the empirical representation has greater standard deviation than would be desirable, it is still important to use these if the direct measurement is missing because the influence on the measured dewpoint would be significant.