Simultaneous Inboard and Outboard, Inflight Measurements of Ultrafine Particle Concentrations

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International Aircraft Cabin Air Conference 2021
Online, 15 – 18 March 2021

Overview

- Motivation & the UK research aircraft
- The 3686 LP Ultrafine Condensation Particle Counter
- Data – total of 12 flights, 3 with aerosol composition
- Conclusion

Motivation

- Pre-pandemic, on average 4 billion passengers per annum.
- The indoor-outdoor interface at airports is unique – distinct from urban, for example.
- Exceptionally high concentrations of UFP from aircraft engines.
- Inflight events of UFPs have been reported.

Motivation

- Inflight events – suggestions are ingress of external air, cooking, passengers and contamination of bleed air (oil or decomposition products such as TCP).
- Previous studies speculate source of aerosol only.

BAe 146 research aircraft

A BAe 146 aircraft
4000 kg of science equipment and 18
people
Duration of 1-6 hours
Range: surface to 10 km
Reduce galley – Hot drinks only

Quant/TSI 3786 LP UCPC

- Water based UCPC
- A modified version of a 3786 for low pressure applications
- D_{50} 2.5nm
- Range: Ambient to 180hPa
- Single count mode to $9.99e^5 \text{ cm}^{-3}$
- Sadly obsolete

3786 LP performance

Over 4 – 5 years of intercomparison,
the maximum deviation of the 2
CPCs is 12%

Data –opportunist sampling

- Volcanic and Atmospheric Near- to far-field Analysis of plumes Helping Interpretation and Modelling (VANAHEIM – based at Keflavik, Iceland)
- Methane Observations and Yearly Assessments (MOYA – Dakar, Senegal)
- Cloud and Aerosols Radiative Impact and Forcing (CLARIFY – Ascension Island).

Results – P153 transit style

Plume event and in cabin

C008 landing – oil contribution?

C040 Results – oil?

Context - number

Context - number

Context - mass

Context - mass

Conclusions

- On the ground, before doors close, the number is dominated by ground sources.
- Number inside the cabin peak after doors close in 75% of flights.
- In flight, in cabin only UFP events occur in over 50% of cases on approach – change in aircraft engine.
- Chemical composition is a mixture of sources, but oil appears to be one component for the 146.
- There needs to be at least 3 parameters to have some confidence to identify the source of aerosol.

Conclusions

- Converting to average concentration, total exposure ($\mu\text{g m}^{-3}$ hour) and average exposure per flight for mass all produce values below current workplace limits (comparing to 8 hour day) and ambient air quality limits.
- Calculated first estimate of number concentration total exposure and exposure per flight between 23,000 – 60,000 N cm^{-3} Hour and 6,800 – 10,800 N cm^{-3} per flight.
- Number concentration – equivalent to a London main road for events
- Mass concentration – Better than the underground; similar/worse* then main road (*delete as appropriate)
- published AS&T, 2021,
<https://doi.org/10.1080/02786826.2021.1880544>