Characterization of non-methane volatile organic compound (NMVOC) emissions from aircraft turbine engines

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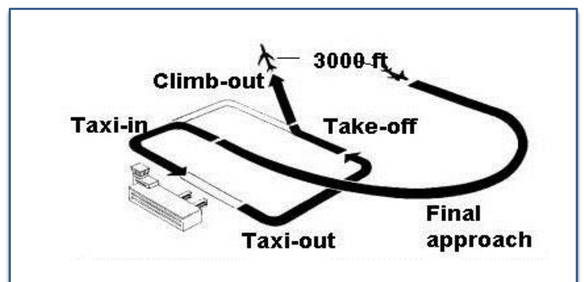
Why?

- **Most of the emissions at airports are coming from aircrafts [1]**
- **These emissions have potential to effect the air quality of an area within a radius of 16km around the airport [2].**
- **Aircrafts spend most of the time in planetary boundary layer at idling (Figure 1).**
- **Idling VOC emission index (EI) is highest at idling [3]**
- **Some of the VOCs, e.g. many PAHs, known or suspected carcinogens [4]**



Operating Mode	Power setting	Time in mode
1. Taxi/Idle	≥7% take-off thrust	26.0 min
2. Take-off	100% std. take-off thrust	0.7 min
3. Climb	85% take-off thrust	2.2 min
4. Approach	40% take-off thrust	4.0 min

Source: ICAO

Figure 1

Figure 2

Where & How?

- **Measurements were conducted at SR Technics at Zurich Airport (Figure 2).**
- **More than 300 VOCs quantified via PTR**
- **7 engines & 52 tests mimicking idling, take-off, climb and approach by the setup sketched below:**

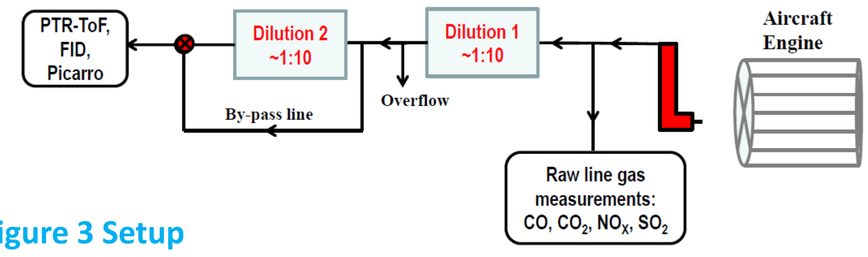


Figure 3 Setup

NMVOC Emissions varibility

i) Flight-mode/thrust dependence

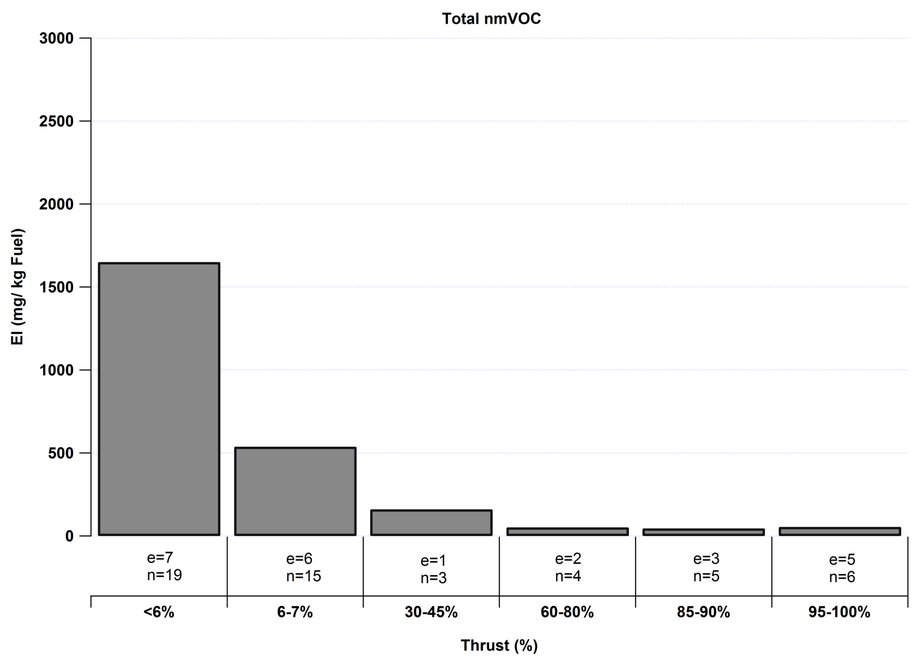


Figure 4

- **CFM56 7B engine NMVOC EIs are given as an example (Figure 4)**
- **Highest NMVCO EI at Idling <6% : ≈ 1.6 g / kg fuel**
- **Idling thurst < 6% NMVOC EI was at least 3 times higher than ICAO standard idling thrust level of 7%**

ii) Engine type dependence

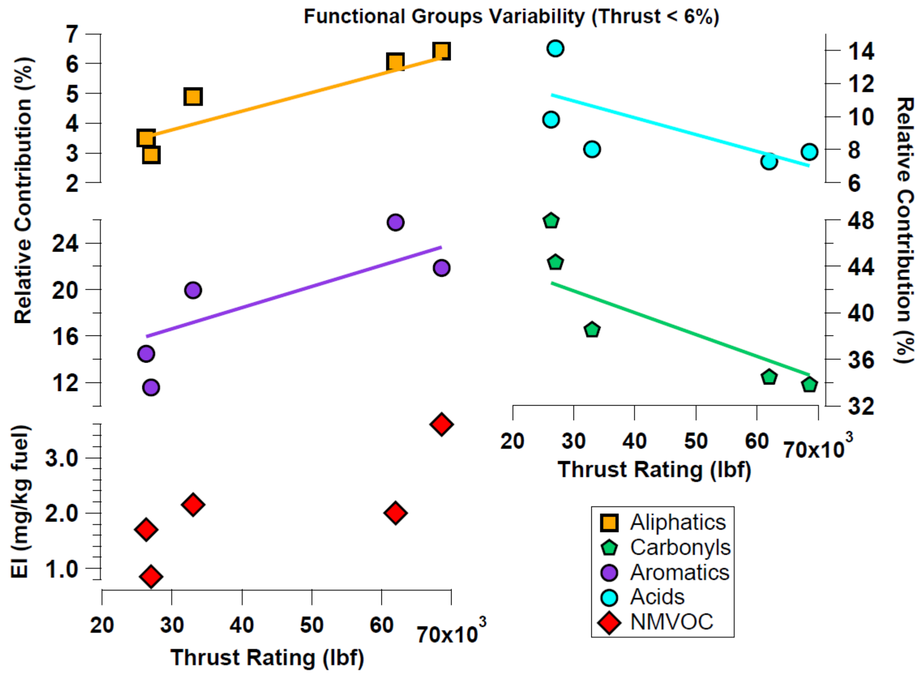


Figure 5

- **Carbonyls were dominant functional group**
- **Non-Oxydized HC increased with thrust rating while Oxydized HC decreased**

Swiss aviation-related NMVOC emission

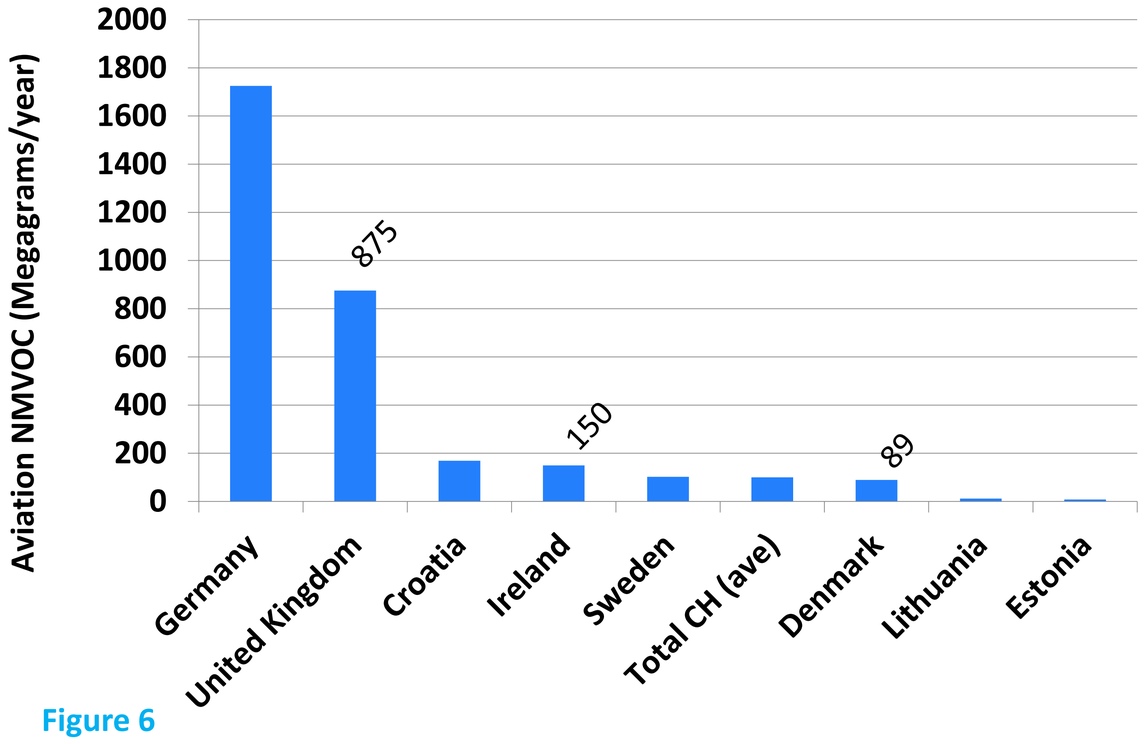


Figure 6

- **By making use of NMVOC EIs, Airport Traffic Data in Switzerland and ICAO standard fuel consumption per LTO, Swiss aviation related NMVOC emission for 2010 estimated: 100 megagrams/year**

Conclusions

- **EI of all functional groups decrease with thrust/flight mode**
- **Exhaust chemical composition alters with thrust/flight mode**
- **EI estimations based on ICAO database could underestimate total NMVOC since NMVOC EI at 3-5% is higher than 7% (ICAO thrust level accounts for idling)**

References

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Acknowledgements

- This work is supported by the Swiss Federal Office of Civil Aviation (FOCA)
- We are also grateful to SR Technics, Zurich and their test cell team.