DETERMINATION OF NO AND NO\textsubscript{2} AIRCRAFT EMISSION INDICES AT AIRPORTS BY OPEN-PATH DOAS

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Motivation

• Airport air quality is not well known because emission inventories are estimated only

• On airports, aircraft engines are one of the major sources for air pollutants

• Emission indices of ICAO* are used to calculate aircraft emissions: 4 different thrust levels – Idle, approach, climb out, take off (LTO cycle)

=> Applicability of ICAO data must be shown with measured data, but not yet done

*ICAO: International Civil Aviation Organization
Methods

- Passive remote sensing using FTIR-spectroscopy (K300, SIGIS) for determination of emission indices of one single engine

- Concentration measurement in the plume with FTIR & DOAS

- Determination of emission indices

- Inverse modelling to estimate multiple sources
Measurement – Set up

- airport
  - taxi way (idle) or
  - parking area (idle) or
  - maintenance area (different) or
  - gate (idle)

- measurement time
  - 1 - 3 minutes

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Data Processing

The determination of emission indices from concentration measurements:

- Use of the known emission index of CO₂ (3.15 g/kg)
- Background measurement of CO₂ and the gaseous compound
- Measurement in the plume of CO₂ and the gaseous compound

\[ EI_{\text{Gas}} \sim EI_{\text{CO₂}} \frac{\Delta_{\text{Gas}}}{\Delta_{\text{CO₂}}} \]
Measurement – Instrumentation

FTIR spectrometry with a spectrometer from Kayser Threde and the use of glowbars as IR-source

DOAS from Opsis in monostatic configuration with retroreflectors
Measurement Locations

Airport Zurich Kloten (ZRH)  
Airport Paris Charles de Gaulle (CDG)

Vienna
Measured components

Measured compounds:

- FTIR: CO, CO$_2$ – simultaneous
- DOAS: NO, NO$_2$ – one after another

Averaging temporal interval: ~ 3 Minutes
Measurement results

![Graph showing CO and CO2 concentration over time with specific measurements at 10:00, 10:48, 11:36, and 12:24 on 03-07-2004 CET.]

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Measurement results

![Graph showing NO-concentration measurements on taxiway and parking place on 06.07.2004 (CET)]

- NO-Concentration \([\mu g/m^3]\)
- 06:00 to 18:00
- Taxiway: Red line
- Parking place: Blue dashed line

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Measurement results

NO$_2$-Concentration [µg/m$^3$]

06:00 08:00 10:00 12:00 14:00 16:00 18:00

06.07.2004 [CET]

Taxiway
Parking place
Results Vienna

Stopping aircraft for measurements at taxiway

Summer and winter campaign

Cooperation with University of Technology Graz:

Summary

**CO:** more than 100 aircrafts, 36 different engines

**NO\textsubscript{x}:** more than 100 aircraft, 24 different engines
Results Zurich

One measurement – one aircraft
One engine type – several emission measurements
⇒ One ICAO value compared with multiple measurements

Summary

CO: 44 aircrafts, 8 different engines

NO$_x$: 6 aircraft, 3 different engines
Results Zurich

Emission index CO

Emission index NO$_x$

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Results Paris CDG

One measurement – several aircraft

⇒ One measured emission index – multiple ICAO values

Summary

CO: 9 measurements, 4 – 18 aircrafts / measurement

NO\textsubscript{x}: 4 measurements, 6 – 10 aircrafts / measurement
Results Paris CDG

Emission index CO

Emission index NO\textsubscript{x}

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Variability of data

The power settings of an aircraft control the emission characteristic.

The power settings for the individual measurements is unknown.

Other sources may influence single measurements.
Conclusions

The presented method is a tool to determine emissions of a single aircraft.

For better conclusions, more measurements are necessary for a statistical treatment of the data.

Emission indices for idle conditions are different under in-use conditions in comparison to ICAO data base: $E_{l}(CO)$ higher, $E_{l}(NO_x)$ slightly smaller.