Forschungszentrum Karlsruhe
in der Helmholtz-Gemeinschaft

DETERMINATION OF NO AND NO_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

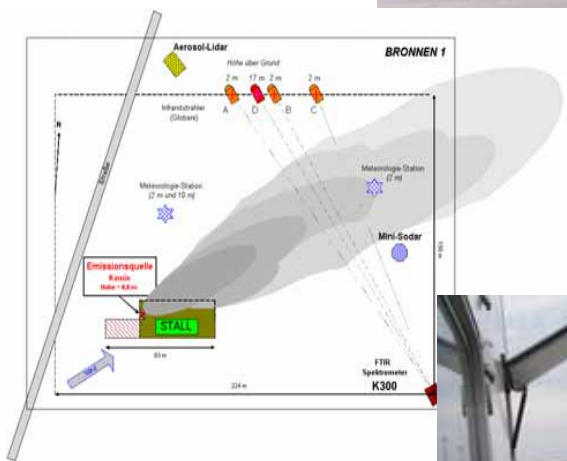
• Emission indices of ICAO* are used to calculate aircraft emissions: 4 different thrust levels – Idle, approach, climb out, take off (LTO cycle)

=> 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

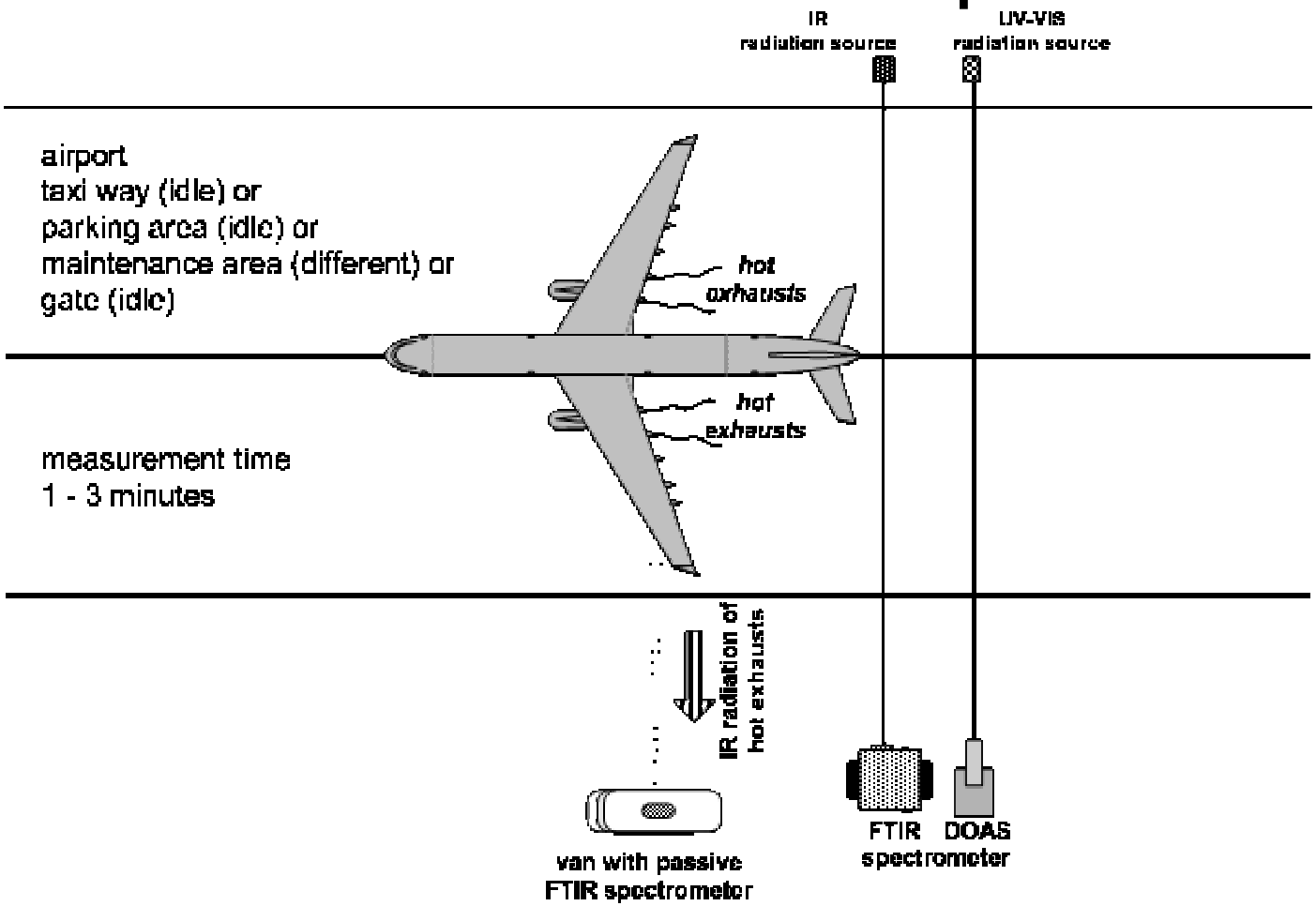


- **Concentration measurement in the plume with FTIR & DOAS**

- Determination of emission indices

- Inverse modelling to estimate multiple sources

Measurement – Set up



Data Processing

The determination of emission indices from concentration measurements:

- Use of the known emission index of CO_2 (3.15 g/kg)
- Background measurement of CO_2 and the gaseous compound
- Measurement in the plume of CO_2 and the gaseous compound

$$EI_{Gas} \sim EI_{CO_2} \frac{\Delta_{Gas}}{\Delta_{CO_2}}$$

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)

Vienna

Airport Paris Charles de Gaulle (CDG)

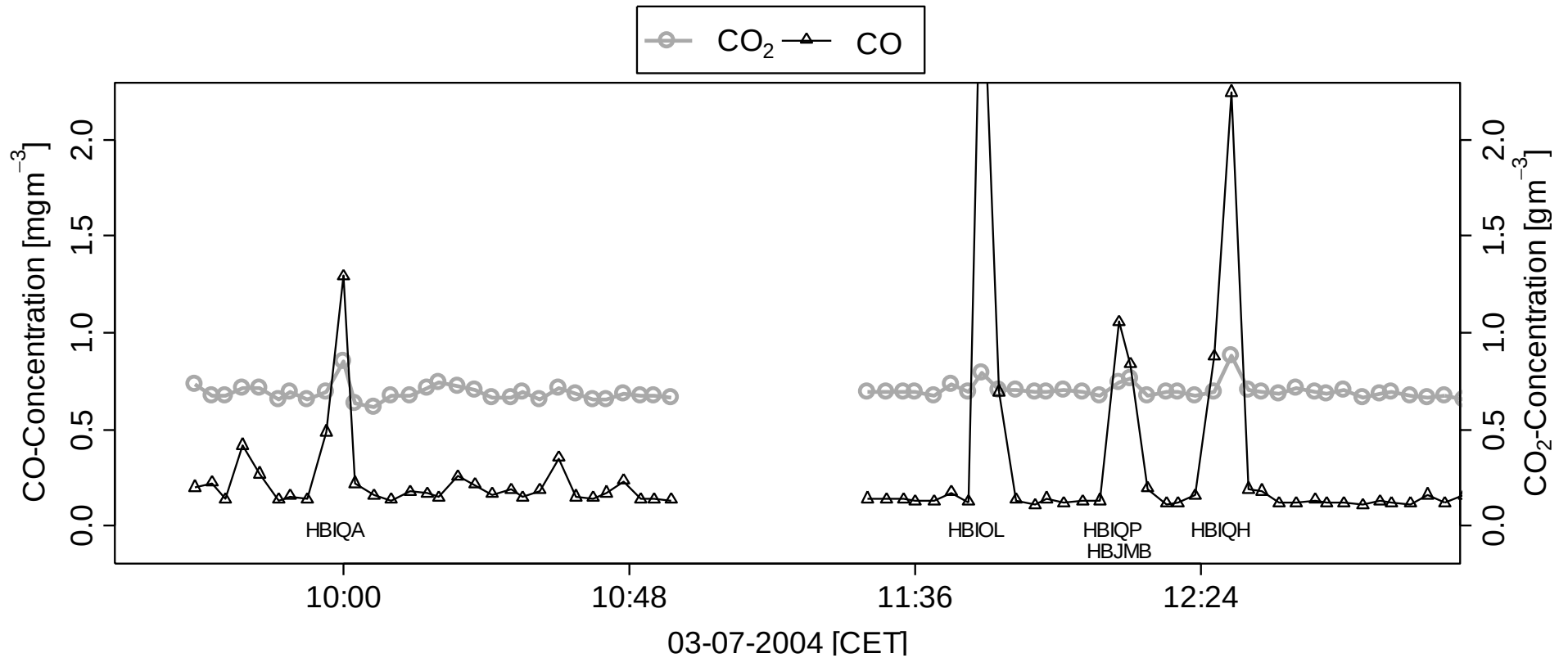
Measured components

Measured compounds:

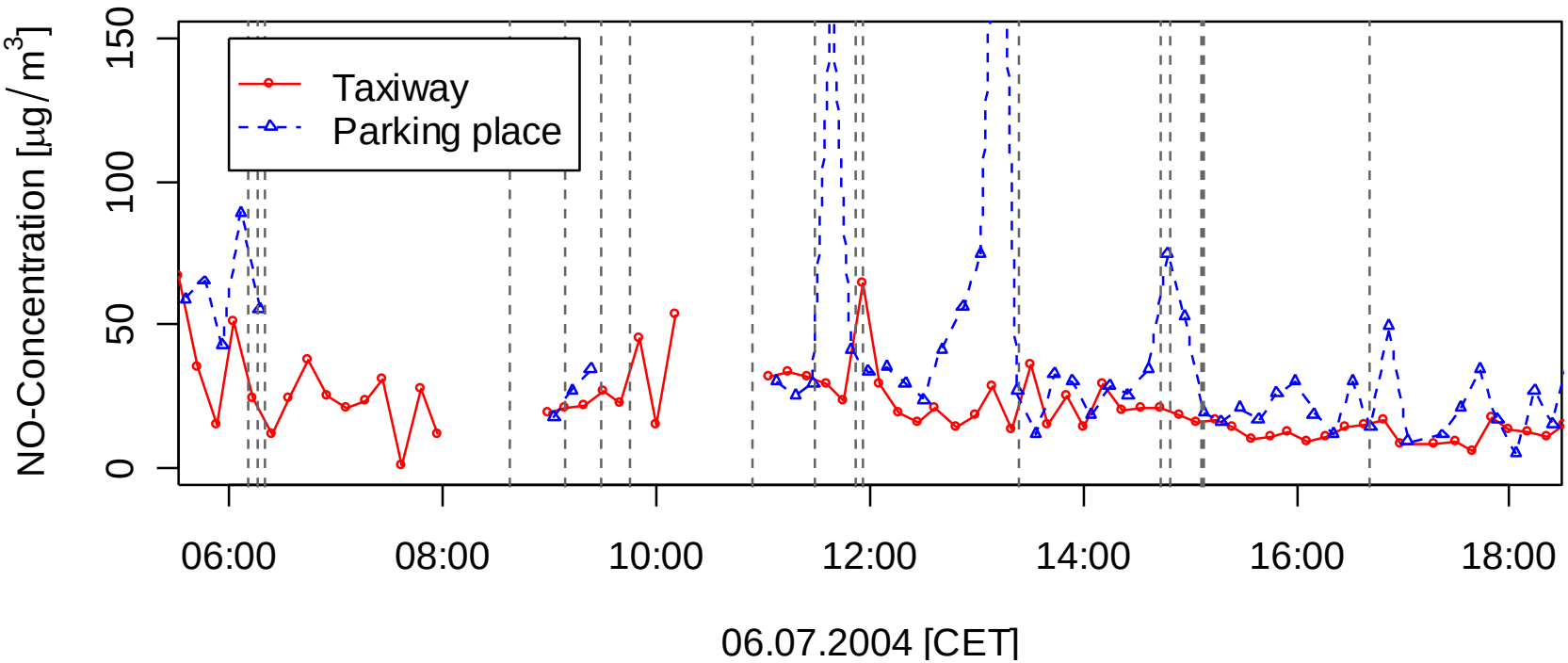
- FTIR: CO, CO_2 – simultaneous
- DOAS: NO, NO_2 – one after another

Averaging temporal interval: ~ 3 Minutes

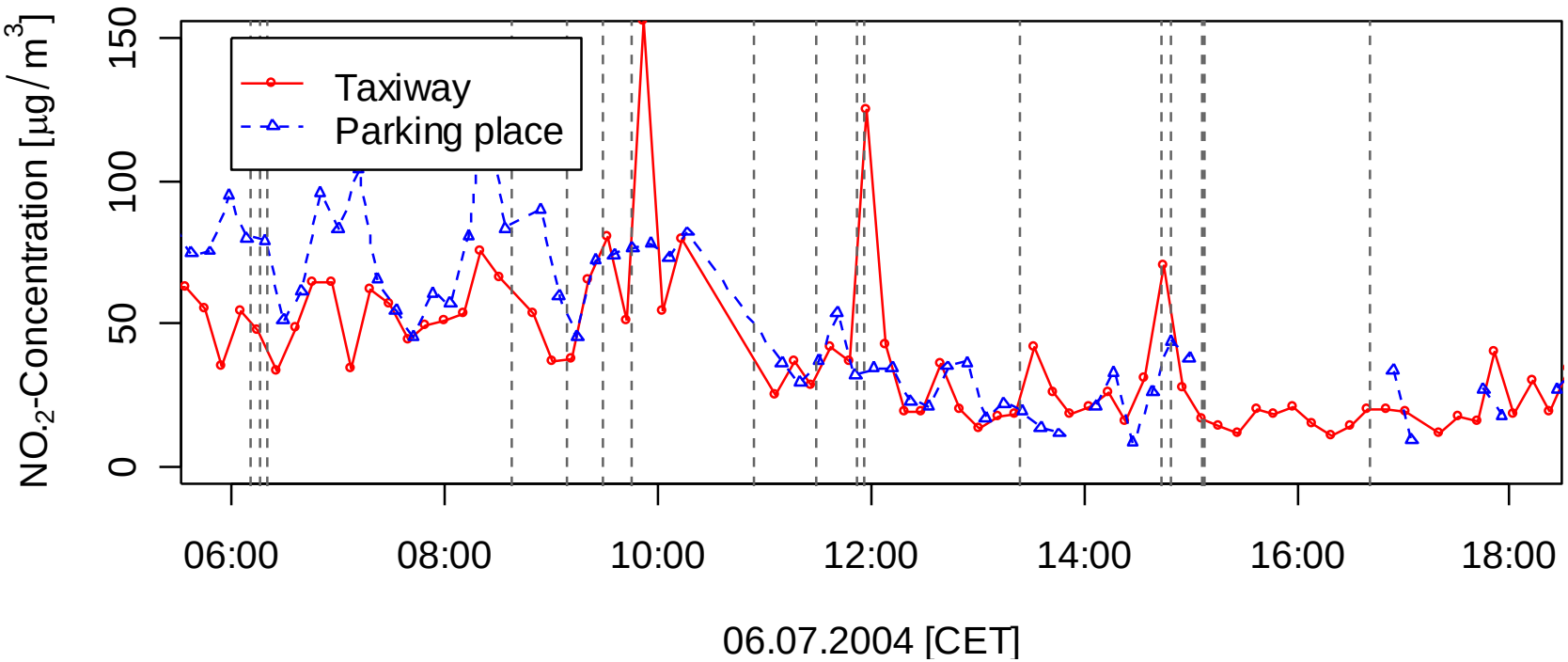
Measurement results



Measurement results



Measurement results



Results Vienna

Stopping aircraft for measurements at taxiway

Summer and winter campaign

Cooperation with University of Technology Graz:
Schäfer, K., Jahn, C., Sturm, P., Lechner, B., Bacher, M.: Aircraft emission measurements by remote sensing methodologies at airports. Atmospheric Environment 37, 37 (2003), 5261-5271

Summary

CO: more than 100 aircrafts, 36 different engines

NO_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

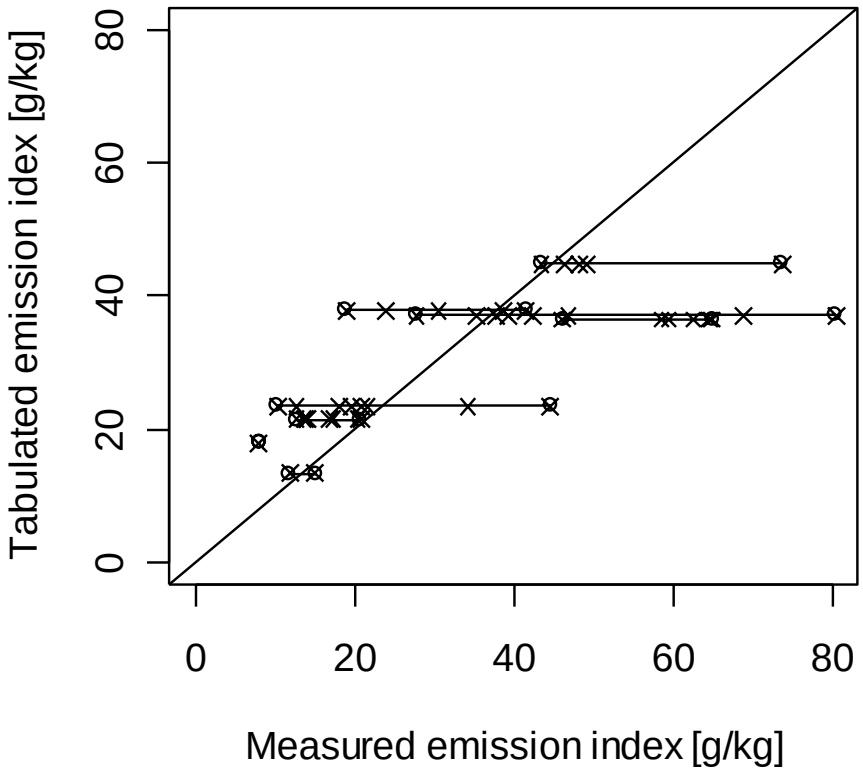
Summary

CO: 44 aircrafts, 8 different engines

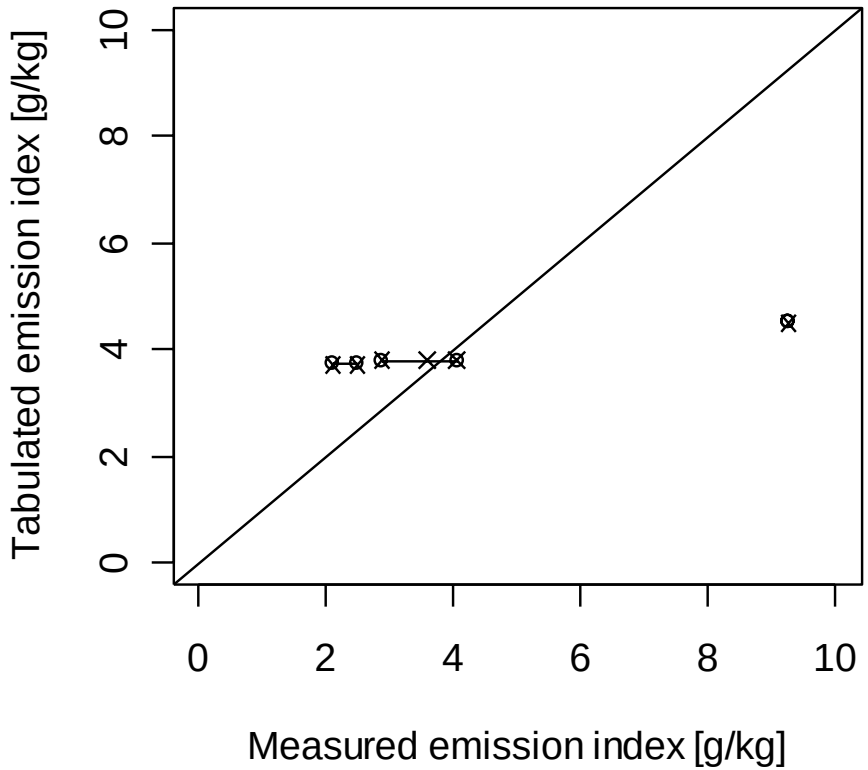
NO_x: 6 aircraft, 3 different engines

Results Zurich

Emission index CO



Emission index NO_x



Results Paris CDG

One measurement – several aircraft

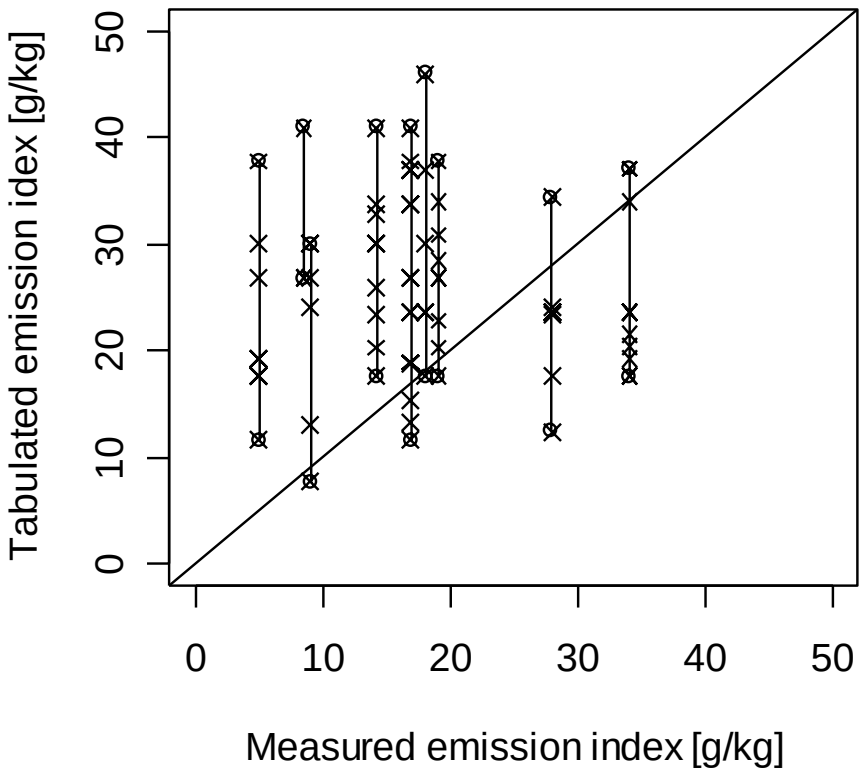
⇒One measured emission index – multiple ICAO values

Summary

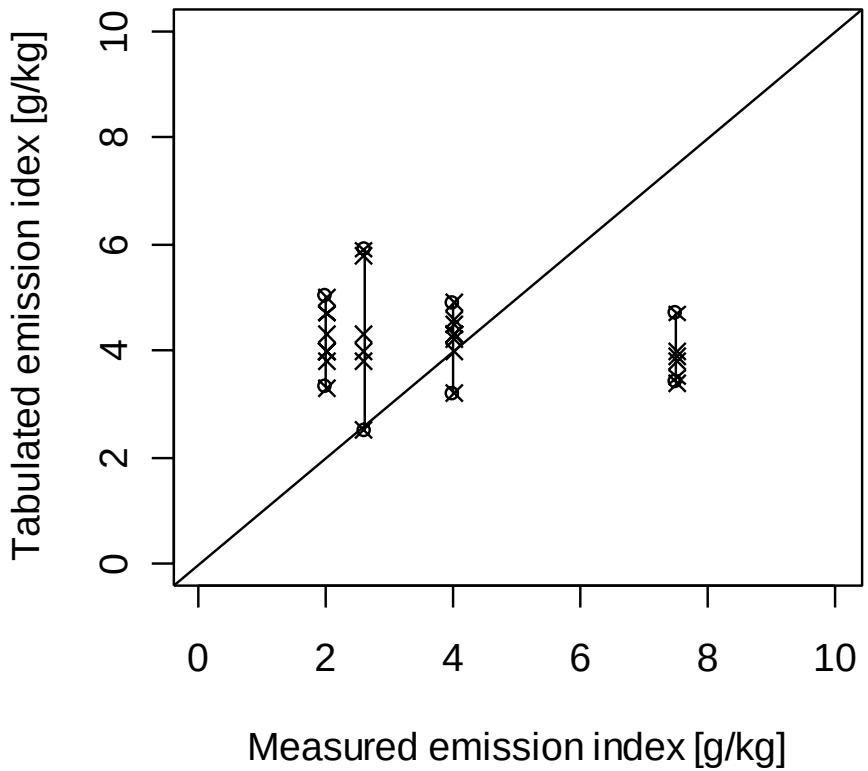
CO:	9 measurements,	4 – 18 aircrafts / measurement
NO_x:	4 measurements,	6 – 10 aircrafts / measurement

Results Paris CDG

Emission index CO



Emission index NO_x



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: EI(CO) higher, EI(NO_x) slightly smaller