Local emissions and distributed sources – technical meteorology and field immission measurements in complex environments

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- Problems
- Scientific questions
- Tasks and results
- Outlook

Problems

Climate protection or improvement of air quality / health protection? Or both?

Decisions for emission reduction measures

- Gasoline or Diesel motor (NO_2, NH_3)
- NO_x, VOC, CO aircraft emissions or GHG emissions / contrails
- Odour and noise emissions or GHG emissions

Problems

- Changing NO_2/NO_x ratios in ambient air
- Threshold exceedances - sustainable reduction of NO_2, PM_{10}
- Load, character and source apportionment of ultrafine particles in the urban background
- Air pollutants and health impact
  - Which pollutants are relevant?
  - Which concentrations influence health impacts?

Scientific questions

Emission source strengths from hard to measure and inhomogeneous sources

- Important input data for emission inventories
- High effort of in situ measurement techniques
- Influences on measured emission data by sampling techniques
- Continuous measurements to determine temporal variations

Tasks

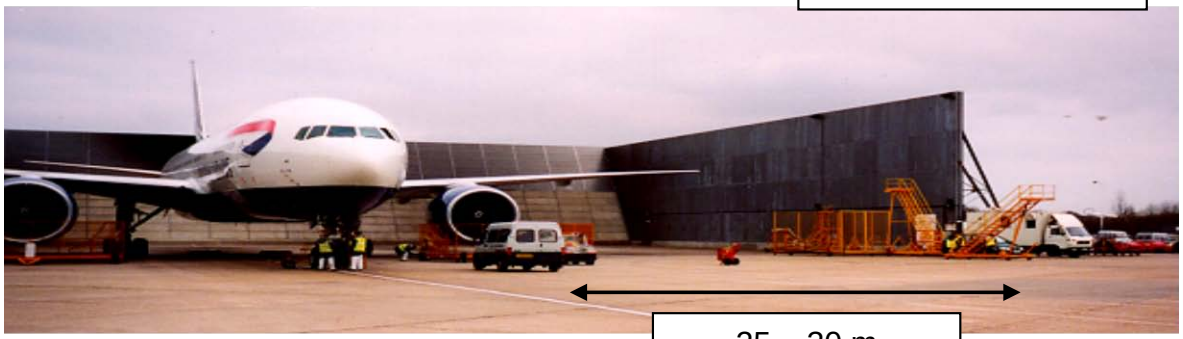
Development of non-intrusive measurement methods

- Determination of gas concentrations by spectrometric measurements: CO, CH_4, CO_2, N_2O, NO, NO_2, NH_3, SO_2, HCl, HNO_3, Ozone, BTX, HCHO
- Application in measurement vans
- Fusion with dispersion modelling to get emission source strengths

Tasks

- Passive FTIR spectrometry: hot gases
  - Path-integrated concentration through the whole plume
  - Determination of emission source strengths together with Doppler-LIDAR
- Smoke stack effluent dispersion model from Michael in 1992
- Retrieval of emission source strengths from spatial concentration distribution

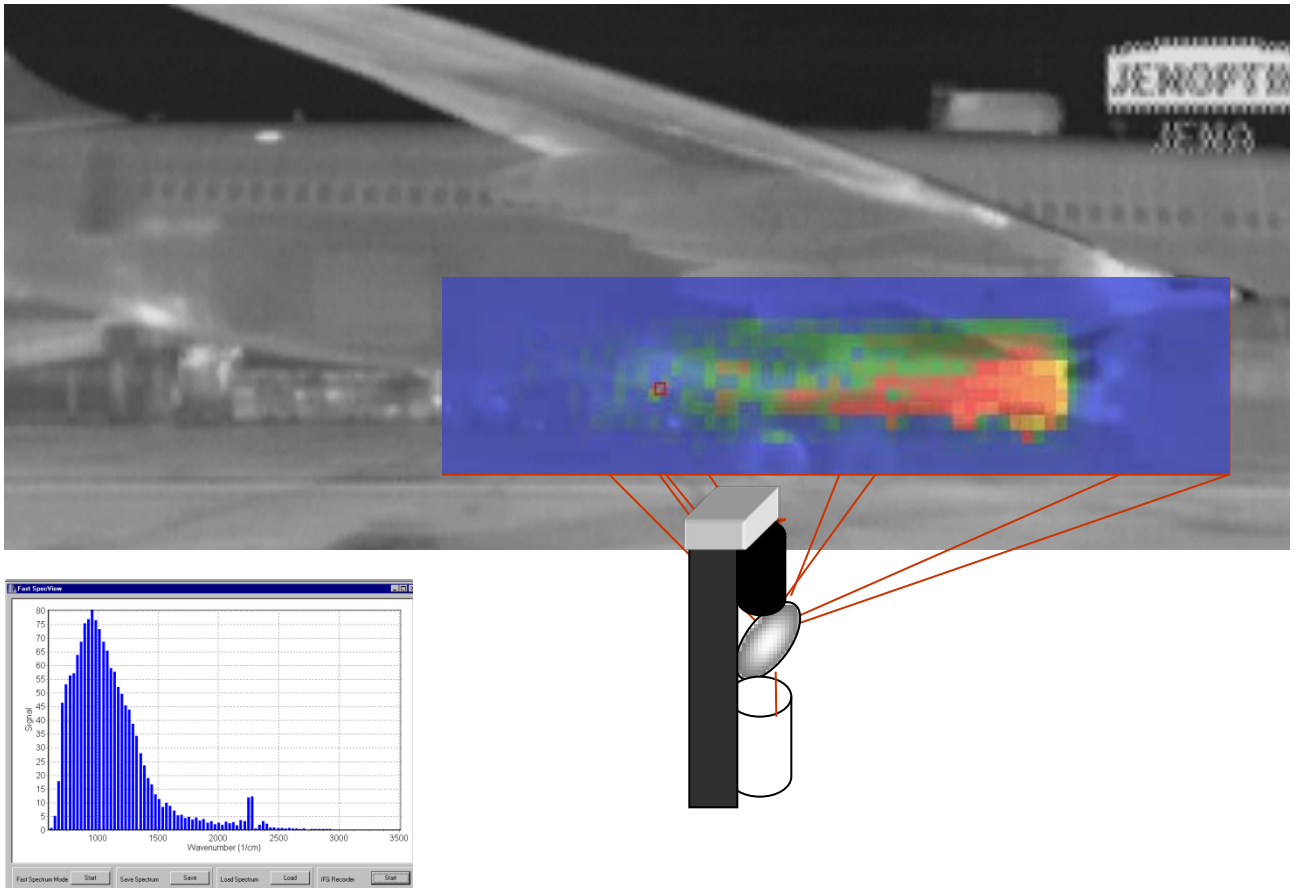
Measurement van



Imaging FTIR with scanning mirror

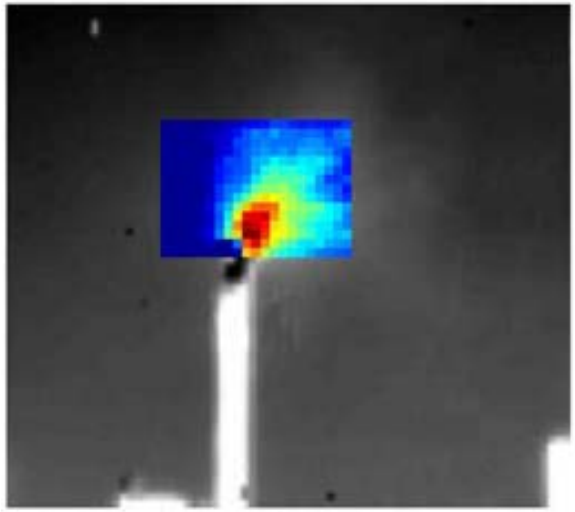
Main engine: gas temperature mode

approximated length 11 m, diameter 2.4 m

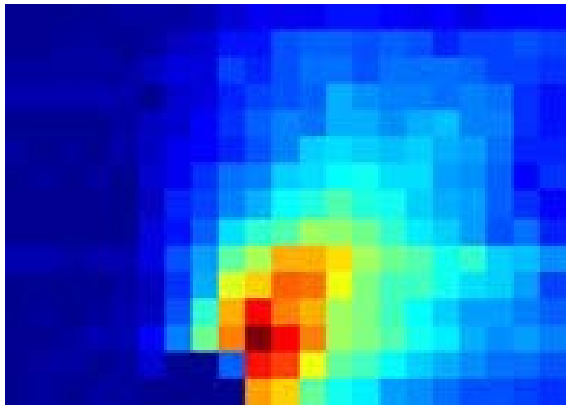


Imaging FTIR with array detector

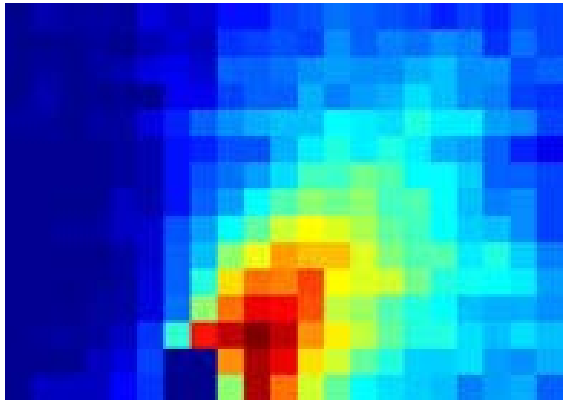
Temperature



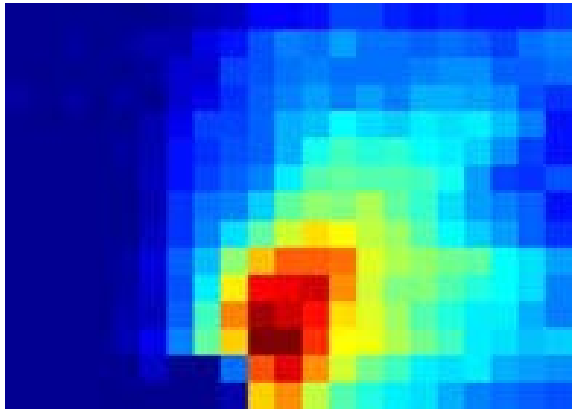
Isobutane
column density [ppmm]



Isopentane
column density [ppmm]



Butane
column density [ppmm]



Butene
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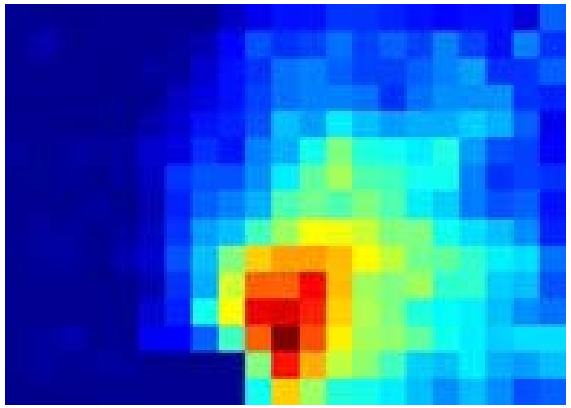


Tasks

- Active spectrometry
  - FTIR spectrometry and Differential Optical Absorption Spectroscopy
  - Infrared radiation source / lamp
  - Absorption paths of 50 up to 500 m
  - Path-integrated concentration through the whole plume
- Dispersion modelling of inhomogeneous area sources with Martina Stockhause from 1997 until 2000

Schäfer, K., Steinecke, I., Emeis, S., Stockhause, M., Sussmann, R., Trickl, T., Reitebuch, O., Hoechstetter, K., Sedlmaier, A., Depta, G., Gronauer, A., Seedorf, J., Hartung, J.: Inverse Modelling on the Basis of Remote Sensing to Determine Emission Rates. Meteorologische Zeitschrift, Neue Folge 7 (1998), 7-10.

Open-path measurement systems

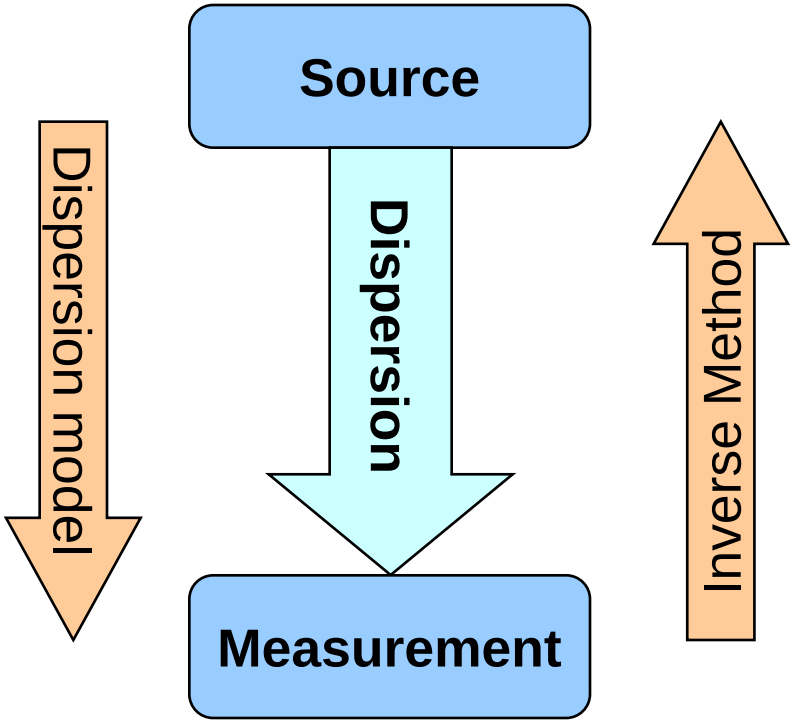
Tasks

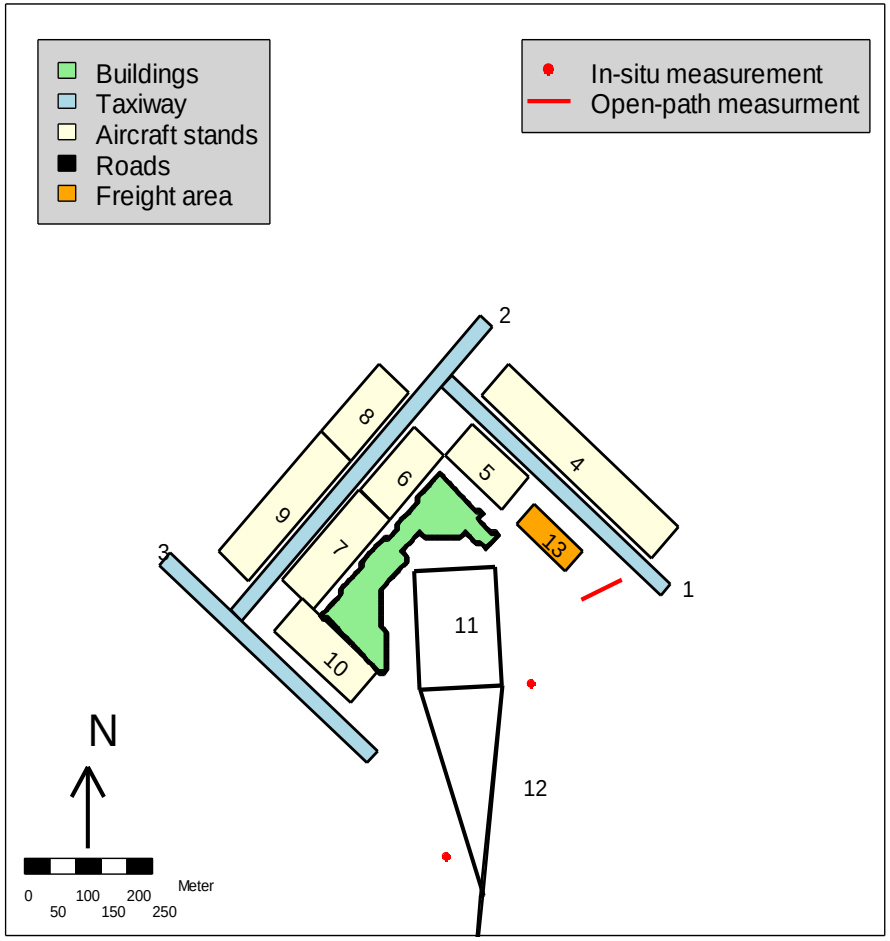
Determination of emission source strengths by inverse dispersion modelling

- back-calculation of the dispersion in the atmosphere i.e. inversion
- determination of the spatial distribution of emission sources:
  - accuracy increases with number of measurement paths
  - Singular Value Decomposition necessary
  - to reduce influences of wind fluctuations open-path techniques advantageous

Friedrich, R., Wickert, B., Emeis, S., Engewald, W., Hassel, D., Hoffmann, H., Michael, H., Schäfer, K., Sedlmaier, A., Schmitz, T., Stockhause, M., Weber, F.-J.: Development of Emission Models and Improvement of Emission Data for Germany. Journal of Atmospheric Chemistry 42 (2002), 179-206, doi: 10.1023/A:1015711116639.

Airport Budapest





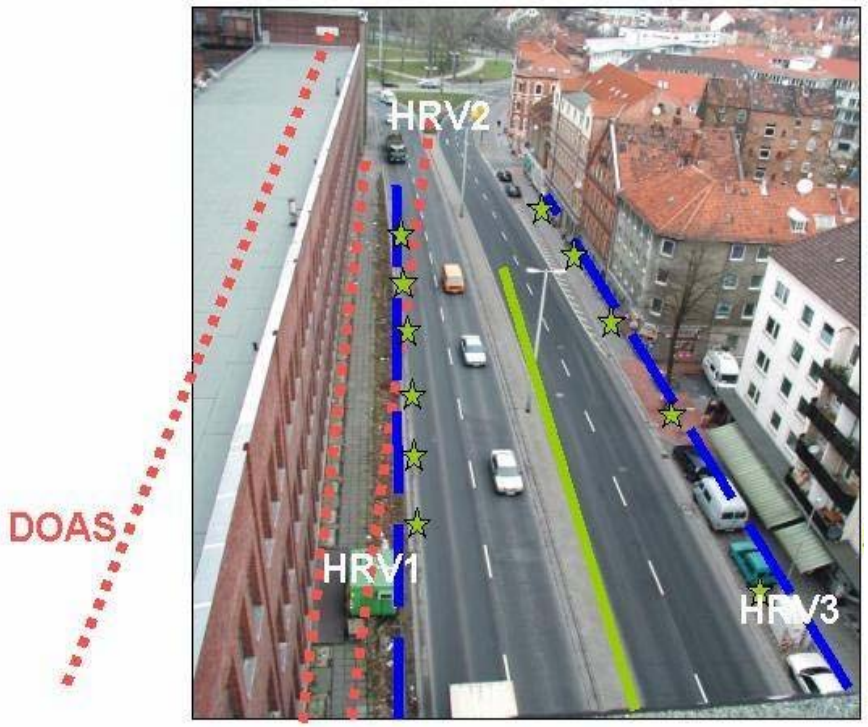
Tasks

Instruments for the application of the European Guideline 96/62/EU: creation of 12-months air pollutant maps

Project “Development and validation of instruments for the realisation of European air quality politics" (VALIUM) 2001 – 2004

- Validation of a meso-/micro-scale model system with a spatial resolution of 200 m^2 (14 m x 14 m)
- Data from measurements in a street canyon and in 1 km x 1 km surrounding (Göttinger Straße, Hannover)
- Data bank ValiData established

Street canyon Göttinger Straße in Hannover



SF6 line source and sampling sites (stars)

FTIR

Tasks

Study of the overall wind direction on the air transport in the street canyon - vortex circulation

=> Investigation of the horizontal concentration distribution at the ground as well as at the roofs by long-term path-integrated CO and SF_6 measurements

- westerly winds: western side walk higher values
- easterly winds: eastern side walk higher values
- winds along the street canyon: lowest values

Schäfer, K., Hoffmann, H., Jahn, C., Emeis, S., Müller, W.J. Heits, B., Bächlin, W., Schlünzen, K.H., Schatzmann, M.: Untersuchung von Luftbelastungen in einer Straßenschlucht mittels Fernerkundungs- und In-situ-Messungen. Gefahrstoffe – Reinhaltung der Luft, 64, 6 (2004), 281-289.

Schäfer, K., Emeis, S., Hoffmann, H., Jahn, C., Müller, W.J., Heits, B., Haase, D., Drunkenmölle, W.-D., Busch, W., Beyer, R., Tharsen, J., Nolte, T.: Feldmessungen in einem Stadtquartier zur Erzeugung eines Validierungsdatensatzes. 6. Materialienband für Maßnahmepläne nach der EU-Richtlinie zur Luftqualität, Reihe Nachhaltiges Niedersachsen, Heft 32, 2004, 131 p., ISSN 0949-8265

Outlook

Further development of non-intrusive methods to determine emission source strengths

- Inverse dispersion modelling (aerosols)
- Continuous determination of mixing layer heights – mass balance method
- Open-path flux gradient method

Acknowledgement to Michael Schatzmann

Our cooperation is an example of interdisciplinary research of meteorologists and physicists which originate new methodological approaches in the atmospheric environmental research.

Michael Schatzmann is due the merit that he looked for such ways, not stopped at obstacles and found success by pertinacity and wide experiences.

It is a work together which we have searched over a long time and which me never disappointed.