1. Introduction

Objectives of aircraft imaging DOAS measurements:
- Retrieval of tropospheric trace gases, here nitrogen dioxide \( NO_2 \)
- Mapping of \( NO_2 \) pollution sources, identification of source regions and strengths
- Satellite data validation, investigation of sub-pixel variability

Positive aspects of aircraft measurements and imaging DOAS:
- High spatial resolution \(-100\,\text{m} (\text{down to } \approx 30\,\text{m})\) at useful spatial coverage
- Several viewing directions across track are observed simultaneously
- No data gaps occur along track

The IODAS instrument in the Polar-5 aircraft

2. Instrumental setup and viewing geometry

Technical information:
- Wide angle objective and fibre bundle: \((35\,\text{fis})\) as entrance optics
  - Acton 300i imaging spectrometer
  - Grating 6000/mm, blazed \( \lambda = 500\,\text{nm} \)
  - Spectral window \( 412 \pm 43\,\text{nm} \)
  - Spectral resolution: \( 0.7 \pm 1.0\,\text{nm} \)
  - Frame transfer (FT) CCD Detector, \( 512 \times 512 \text{ pixels}, 8.2 \times 8.2\,\text{mm}^2 \)
- Gap-free measurements (due to FT CCD) and flexible positioning in the aircraft (due to sorted fibre bundle)

Viewing geometry:
- 2 nadir ports: spectrometer & camera
- Geolocation: from GPS & grrometer
- Viewing directions: max. \( 35\,\text{typ.} 9\,\text{lines of sight}, (LOS, i) \) from 35 lines of sight
- Field of view: \( 48^\circ \) across track (\( \vartheta \))
- Swath width of \( \varphi \) in altitude \( \alpha \)
- Exposure time \( t_{\lambda} \): typ. \( 0.5\,\text{ms} \)
- Spatial resolution: \( 30\,\text{m} \ldots 100\,\text{m} \)

3. Imaging quality and \( NO_2 \) retrieval quality

Demonstration of imaging quality

4. \( NO_2 \) vertical columns and emission flux calculations above a power plant

\( NO_2 \) retrieval above a power plant

Air mass factors, AMF (SCIATRAN calculations)

Dispersion of concentration \( c \) across plume \((\vartheta)\) and over altitude \((\alpha)\)

Approximation of source strength is achieved via discrete summation over the product of vertical columns \((Vz)\), wind speed and path length \( L \)

5. Summary & Outlook

Summary
- The imaging DOAS instrument shows good imaging quality and good performance for \( NO_2 \) measurements
- Aircraft pitch, roll and yaw angles are fully taken into account for correct ground geolocation
- \( NO_2 \) column amounts have been retrieved, pollution sources are observed (power plant, cities, etc.)
- For typical situations (geometry, albedo, SZA) spatial resolution of \( 30\,\text{m} \) (along and across track)
- Further findings: Large spatial \( NO_2 \) variability and consistent \( NO_2 \) retrieval results for different LOS divisions
- \( NO_2 \) emission fluxes are calculated for a power plant point source in agreement with emission reports

Activities for the future
- Air mass factor consideration will be refined in future analyses
- Further dedicated campaigns will be conducted with the imaging DOAS instrument above pollution sources

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Selected References