Fiducial Reference Measurements for Ground-Based DOAS Air-Quality Observations

FRM_4DOAS

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FRM_4DOAS Instrument Operation and Calibration Guidelines

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1 Introduction

This document is a brief summary of the most important requirements for instruments, operations and calibration of MAX-DOAS instruments contributing to the FRM4DOAS fiducial reference measurements. It is meant as a quick and concise check-list, to be used in combination with the more detailed and complete discussion in the "MAXDOAS Calibration and Operations Best Practices" document available at :
http://frm4doas.aeronomie.be/ProjectDir/Deliverables/FRM4DOAS_D4_MAXDOAS_Best_Practices_Document_20180110_v1_0.pdf.

2 Instrument guidelines

- Wavelength resolution better than 0.8 nm (UV) and 1.5 nm (visible)
- Sampling better than 5
- FOV of 1.5° or better in vertical direction
- GPS signal / time server for proper time information
- Quartz fibre / polarisation scrambler for removal of polarisation features
- Optical low pass filter for UV instruments for straylight removal
- Wavelength coverage should follow NDACC / CINDI-2 recommendations as far as possible. At least one O_4 band covered well

3 Operation guidelines

- SZA range up to 85° for MAX-DOAS and up to 94° for zenith-sky observations
- Zenith-sky observations at least every 30 minutes during MAX-DOAS observations
- At least one zenith-sky measurement per degree SZA at twilight
- At least 1°, 2°, 3°, 5°, 10°, 30° elevation in scan
- Off-axis viewing directions away from the sun (if possible)
- Dark signal daily (or continuously if possible with instrument, see below for details)
- Slit function on a regular basis (daily but at least once per year, see below for details)
- Horizon scan on a regular basis (daily but at least once per week, see below for details)

4 Data processing guidelines

- Apply dark signal correction
- Apply wavelength calibration using line lamp or Fraunhofer atlas
- Apply non-linearity correction if necessary
- Average spectra to reach SNR of at least 3000 (vis) or 4000 (UV)
- Use prescribed format for spectra (see http://frm4doas.aeronomie.be/ProjectDir/Guidelines/L1_format_20180308_v1.pdf for details)

5 Instrument calibration guidelines

5.1 Calibrations before first operation

- Straylight if possible
    - Measurements of white light source with and without cut-off filters
- Nonlinearity
    - Simple white light source or very clear day zenith observations
    - Measurements at different exposure times
    - Ratio of dark signal (and smear) corrected intensities as function of larger intensity
- Polarisation dependency
    - Simple white light source with polariser mounted in turntable
    - Measurements at different polariser positions
    - Ratio to (arbitrary) reference measurement
- Slit function including T-dependence if not T stabilised
    - Line lamp with many emission lines OR line lamp at different grating positions
    - If necessary: Variation of instrument temperature over expected T-range
- FOV
    - Simple white light source (with diffuser and aperture if needed)
    - Sufficient distance to light source (> 3 m)
    - Vertical and horizontal scan in at least FOV / 10 ° steps
- Pointing accuracy
    - Strong light source at know position and altitude (if possible)
    - Horizon scan (in different azimuths if possible)
    - Solar scan at different solar elevation and azimuth angles (if possible)

5.2 Calibrations during operations

- Dark signal daily (or continuously if possible with instrument)
    - Minimum 2 measurements (very short and very long exposure time)
    - OR all used exposure times
    - Average at least over 20 measurements
- Slit function on a regular basis (daily but at least once per year)
- Horizon scan on a regular basis (daily but at least once per week)
    - Short integration time measurements from at least –3° … + 3° in 0.1° steps towards unobstructed horizon
- If possible: regular solar scans
    - at different SZA and VZA angles,
    - both in the vertical and horizontal
    - to derive pointing accuracy and FOV