DOAS Meeting
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First data analysis results Falcon flights

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Falcon SCIAVAL: Goals

The Falcon SCIAVAL flights specifically aim at the validation of SCIAMACHY lv2 products by

- covering a large number of SCIAMACHY target species in both stratosphere and troposphere
- flying in the tropopause region to separate troposphere and stratosphere
- covering a wide latitude range
- covering two different seasons
- covering clean and polluted regions
- covering vortex / out of vortex situations
- synchronising flights with ENVISAT overpasses
- including several locations with ground-based stations in the flight tracks
Falcon SCIAVAL: Campaign Planning

- Base station is Oberpfaffenhofen in Germany
- Two successful test campaigns have been performed above Munich and Northern Italy
- First SCIAVAL campaign in **September 2002**:  
  - Northern leg to Kiruna, Spitsbergen, Greenland  
  - Southern leg to  
    Algeria, Cameroon, Kenya, Seychelles  
- Second SCIAVAL campaign in **February 2003**:  
  - Southern leg to  
    Algeria, Cameroon, Kenya, Seychelles  
  - Northern leg to Kiruna, Spitsbergen, Greenland
Falcon SCIIVAL: Northern Route
Falcon SCIVAL: Southern Route
**AMAXDOAS**  

- Measurement principle

(1) Zenith

(2) +2° elevation

(3) -2° elevation

(4) Nadir

- Simultaneous observation of different viewing angles
- UV and Vis instrument
- High temporal resolution
- Separation of tropospheric and stratospheric column

Typical CCD Image, visible Spectrometer

Wavelength [nm]

400 450 500 550
Falcon flight data introduction

**Flight configuration:**
- two spectrometers:
  - AMAX-VIS 402 – 571 nm, 1.5 nm FWHM at 435.83 nm
    1.1 nm FWHM at 546.07 nm
  - AMAX-UV: 303 – 440 nm, 0.8 nm FWHM at 346.62 nm
- two telescope domes:
  - upper dome: zenith, Zenith 2° above horizon
  - lower dome: nadir, Nadir 2° below horizon
Falcon flight data introduction

**Calibration:**
- dark signal
- HgCd line lamp after flight

**Data rate:**
- automatic exposure time during flight
- integration time 10 seconds (full images).

**Ancillary data:**
- spectrometer temperatures
- Falcon flight data.
Data preparation

- spectra binned excluding dark regions
- Spectra binned subtracting straylight
- wavelength calibration
- flight information added
- spectra averaged over 300 seconds
Data analysis and first results

Reference spectra used:
- O3 Burrows et al., 221 K and 273 K
- NO2 Burrows et al., 221 K
- O4 Greenblatt et al., corrected
- BrO Wahner et al., 228 K, corrected
- H2O HITRAN-96, 296 K
- Ring. SCIATRAN without molecular filling in

- background spectrum: full altitude(10km), actual spectra
- no smoothing
AMAX-UV/Vis: NO2 analysis

AMAX-UV
Fitting windows:
• A: 345 - 359 nm
• B: 345 - 380 nm

Cross-sections used:
• O3 (221K and 273K)
• NO2 (221K)
• BrO
• O4
• Ring

AMAX-Vis
Fitting windows:
• A: 410-460 nm
• B: 425-450 nm

cross-sections used:
• O3(221K)
• NO2(221K)
• H2O
• O4
• Ring(GOMETRAN)
AMAX-UV O3 slant column

AMAX-UV
Fitting windows:
• A: 345-359 nm
• B: 329-339 nm

cross-sections used:
• O3(221K, 273K)
• NO2(221K)
• BrO
• O4 (Not for window B)
• Ring(GOMETRAN).
• Back ground spectrum: actual spectra

AMAX-Vis
Fitting windows:
• A: 450-495 nm

cross-sections used:
• O3(221K)
• NO2(221K)
• H2O
• O4
• Ring(GOMETRAN).
Spectrometer temperature 020904

Spectrometer warm up to 40°C

Temperature variation during flight is about 0.1°C
A good NO$_2$ fit.

Background spectrum measured at about 16:30
File 20904_G.NAM0, 18:41:07, SZA = 91.68°

A good NO2 fit.

Background spectrum measured at about 16:30
BrO is in the spectra
Background spectrum measured at about 16:30
A good O3 fit.
Background spectrum measured at about 16:30
Vis O3 Fit 020904

O₃ Fit 020904 Vis (92°), 18:46:31, SZA = 92.34°
Nadir and Zenith have similar NO2 slant column.

The background spectra are measured at same time.
VIS NO2 slant columns 020904

![Graph showing NO₂ slant columns vs. SZA (°)]
UV and Vis NO2 Slant Columns 020904 Zenith

UV
345-380nm
Vis
410-460 nm
Different AMF
UV + Vis O3 slant column 020904 Zenith

020904 O3 Slant columns UV + Vis

- UV Slant Column O3 [Molec / cm²] AM
- UV Slant Column O3 [Molec / cm²] PM
- Vis Slant Column O3 [Molec / cm²] AM
- Vis Slant Column O3 [Molec / cm²] PM

- UV
- 345-359 nm
- Vis
- 450-495 nm
- Different AMF
020904 BrO Slant columns (View angle 88°)

- Slant Column BrO [Molec / cm²] AM
- Slant Column BrO [Molec / cm²] PM

Correct tendency but noisy

UV
345-359nm
AMAXDOAS NO2

GOME NRT NO2 columns 2002/09/04

Kiruna, 67°N, Ground (06.09.): AM: 3.5e15 PM: 5.0e15 molec/cm²

Ny-Ålesund, 79°N, Ground: AM: 4.3e15 PM: 4.8e15 molec/cm²

=> No significant NO2 in the troposphere
AMAXDOAS O3

GOME NRT O₃ columns 2002/09/04

AMAXDOAS O₃ VCD, 04.09.2002, Kiruna - Spitsbergen - Kiruna

Latitude

SZA

Kiruna, 67°N, Ground (06.09.):
AM: 264 DU  PM: 271 DU

Ny-Ålesund, 79°N, Ground:
AM: 305 DU  PM: 305 DU

Falcon Flight
Track 04.09.2002

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UV NO2 slant columns 020917

Long flight track

Background spectrum at 10:30
SZA 22°

Fit window 345-380nm

Similar NO2 slant column in nadir and zenith at beginning
Fit window
345-359nm

Similar O3 slant column in nadir and zenith at beginning
VC1: assume NO2 is 2.0e15 in background spectra

VC0: = (SC-SC0)/(AMF-AMF0)
Summery and Outlook AMAX Falcon Campaign

- AMAX measured O3 NO2 BrO H2O in the Falcon Campaign
- There are some good results on Sep. 4, 7, 17 and 26
- Good results depend on the measured date and time
- Low signal in flight altitude
- Clouds in the nadir and off-axis directions

- Calculate reasonable AMFs for all directions
- Deal with the Slit function difference in different direction and different days
- Compare with other data ...
First data analysis results from Partenavia flight
Best AMAX image in Format campaign

10 directions

- 97°
- 284°
- 287°
- 290°
- 12°
- 192°
- 272°
- 275°
- 278°
- 105°
AMAXDOAS: NO2 and HCHO data analysis

- **Raw Spectra**
  - UV spectrometer 020729
  - VIS spectrometer 020815

- **Fitting window**
  - A: 324 – 357 nm (020729) (HCHO and NO2 UV instrument)
  - B: 337 – 357 nm (020815) (HCHO vis instrument)
  - C: 405 – 450 nm (020815) (NO2 vis instrument)

- **Background spectra**
  - same viewing direction, same flight

- **Reference spectra used**
  - A: NO2(293K), HCHO, O3(293K, 221K), BrO, Ring
  - B: NO2(293K), HCHO, O3(293K, 221K), O4, BrO, Ring
  - C: NO2(293K), O3(221K), O4, H2O, Ring
AMAXDOAS-UV: HCHO Fit result

UV spectrometer
Date 020729
Time 09:22:04
Viewing direction:
Nadir5 (97°)

⇒ Excellent detection of HCHO!
AMAXDOAS-UV: NO2 Fit result

UV spectrometer
Date 020729
Time 09:20:19
Viewing direction:
Zenith2 (272°)

⇒ Excellent detection of NO2!

272°

Flight
AMAXDOAS-Vis: HCHO Fit Result

HCHO Fit 020815, 11:58:43, SZA = 32.06°

Good detection of HCHO!

Vis spectrometer
Date 020815
Time 11:58:43
Viewing direction
Nadir3 (287°)

⇒ Good detection of HCHO!
AMAXDOAS-Vis: NO2 Fit Result

NO$_2$ Fit 020815, 11:58:43, SZA = 32.06°

Vis spectrometer
Date 020815
Time 11:58:43
Viewing direction
Nadir3 (287°)

⇒ Excellent detection of NO2!

287° Flight
AMAX: NO2 and HCHO Slant column time series 020729

HCHO and NO2 plumes are seen at the same time and location

⇒ sources seem to be correlated

97° Flight
AMAX NO2 and HCHO Slant column time series 020815

HCHO and NO2 slant columns 020815 N3(287°)

HCHO and NO2 Slant columns have similar structure.
AMAX: HCHO Slant column Nadir and Zenith 020815

More NO2 in downward direction than in upward direction

⇒ HCHO plume is clearly located below aircraft

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Forward telescope sees HCHO plume earlier than the backward telescope.
The plume is repeated twice because of flight route.
HCHO slant column on map

Date 020815
Nadir 3 287°
AMAX: HCHO Slant column along flight track 020815

HCHO slant columns are similar in two flights

Values in the plume are lower during the second flight

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Summary and Outlook AMAX Format Campaign

- during the FORMAT campaign, the AMAXDOAS instrument has for the first time been used for measurements in the middle and lower troposphere
- in spite of some technical and logistical problems 14 successful measurement flights have been performed
- NO2 and HCHO absorptions could clearly be identified in the measurements
- the measurements are consistent with respect to spectral range (UV / vis), viewing directions (forward / backward and upward / downward) and repeated flights
- plumes of NO2 and HCHO in the boundary layer could be identified on many occasions close to Milano
- analysis of all flights and conversion to mixing ratios is still ongoing
First results from EUPLEX campaign

A Nice OCIO fit
background spectra
SZA = 89.6°
View angle 92°
Intensity 030126

Low intensity

Intensity 030126 AMAX-UV

Intensity [Counts/s]

Time [UTC]
Intensity 030126 1

9.2 take off
10.3-11.0
SZA > 95°
No rapid intensity variation except for nadir.
Intensity 030126

N4 too bright, lots of straylight in other directions. Why N4 shutter didn’t close?
OCIO Slant columns along flight track

Kiruna
67.82°N
-20.34°W
OCIO Slant Columns, after straylight correction

OCIO Slant Column (92°)

Slant Column OCIO [10^14 Molec / cm^2]

Solar Zenith Angle [°]

89 90 91 92 93 94
OCIO Slant columns zenith off-axis, after straylight correction

OCIO Slant Column (92°)

Spectra without average

Flight 92°
OCIO Slant columns zenith

zenith view direction
SZA 90-92 the slant column almost the same for two flights.