

DOAS Meeting

Feb. 5 2003

First data analysis results Falcon flights

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Falcon SCIAVAL: Goals

The Falcon SCIAVAL flights specifically aim at the validation of SCIAMACHY Iv2 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

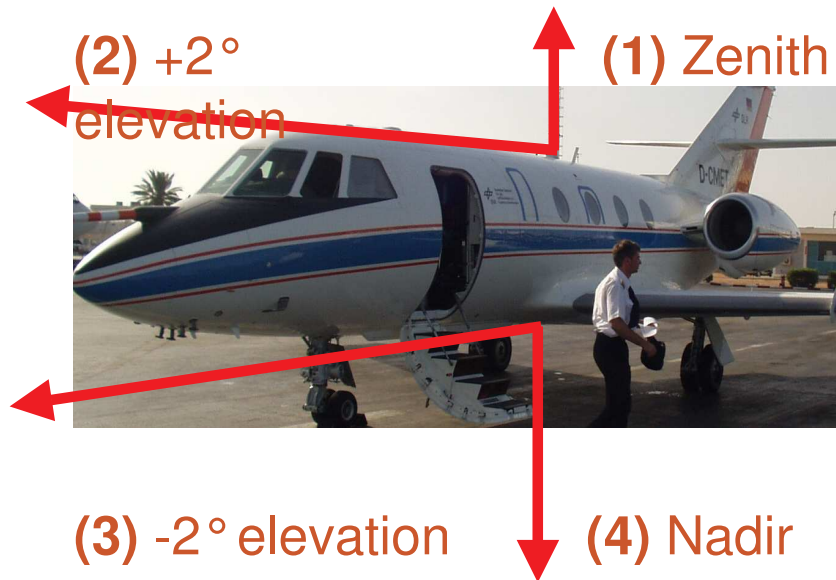
Falcon SCIAVAL: Northern Route



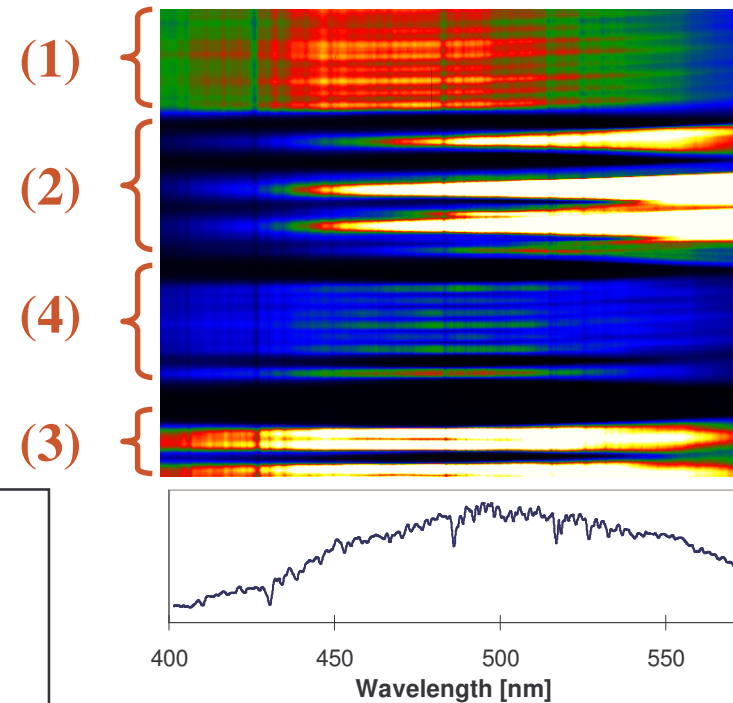
Falcon SCIAVAL: Southern Route



AMAXDOAS § Measurement principle



Typical CCD Image, visible Spectrometer



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



IUP, Uni-Bremen



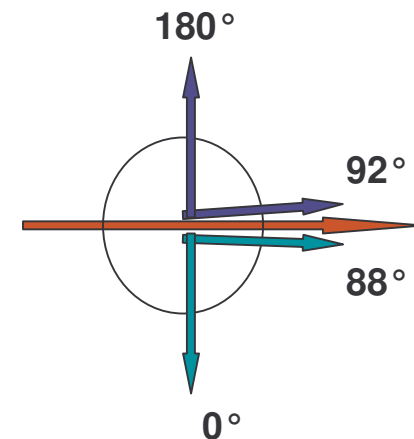
IUP, Uni-Heidelberg



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, Zenith4 2° above horizon
 - lower dome: nadir, Nadir4 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

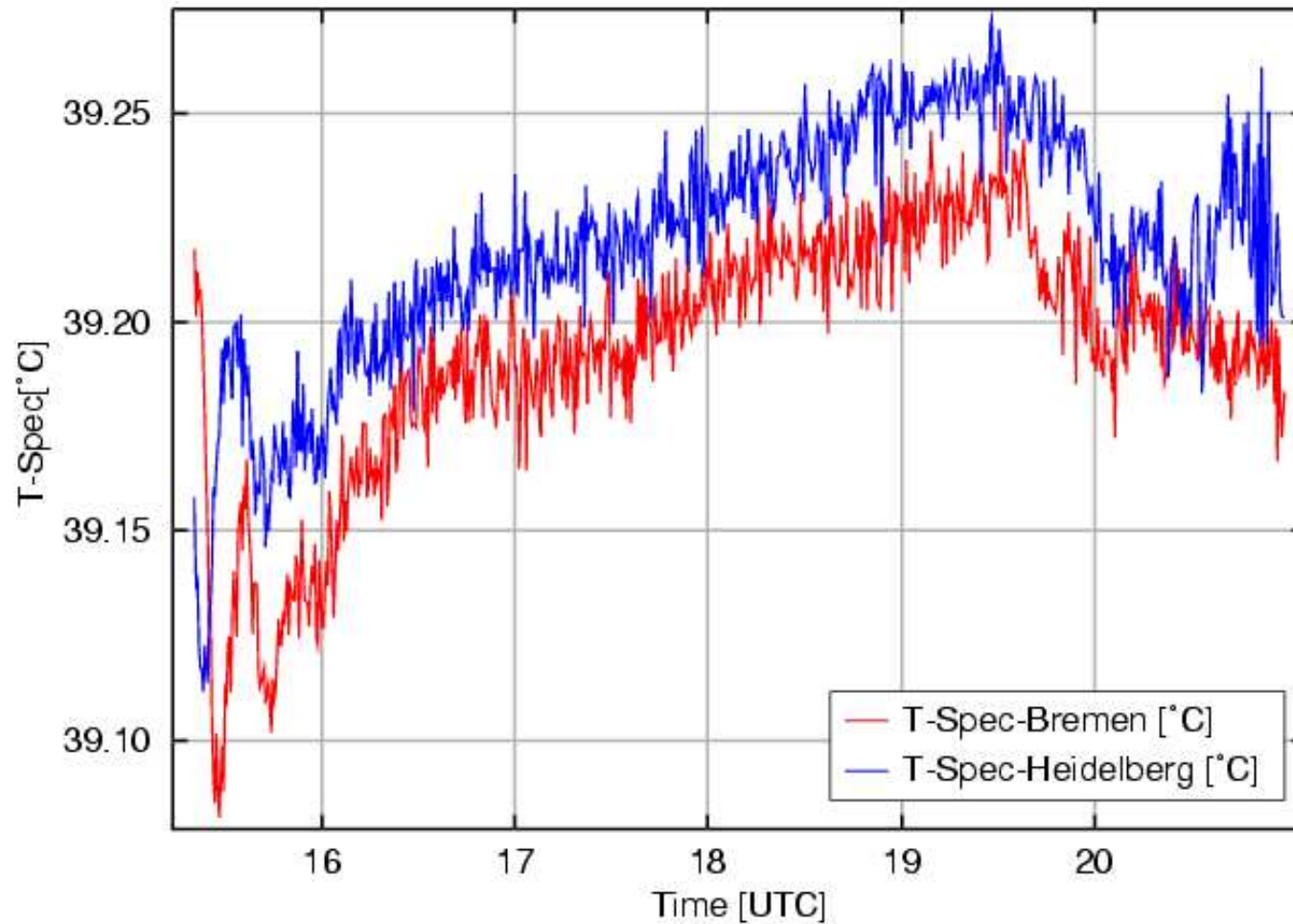
Fitting windows:

- A: 450-495 nm

cross-sections used:

- O3(221K)
- NO2(221K)
- H2O
- O4
- Ring(GOMETRAN).

Spectrometer temperature 020904

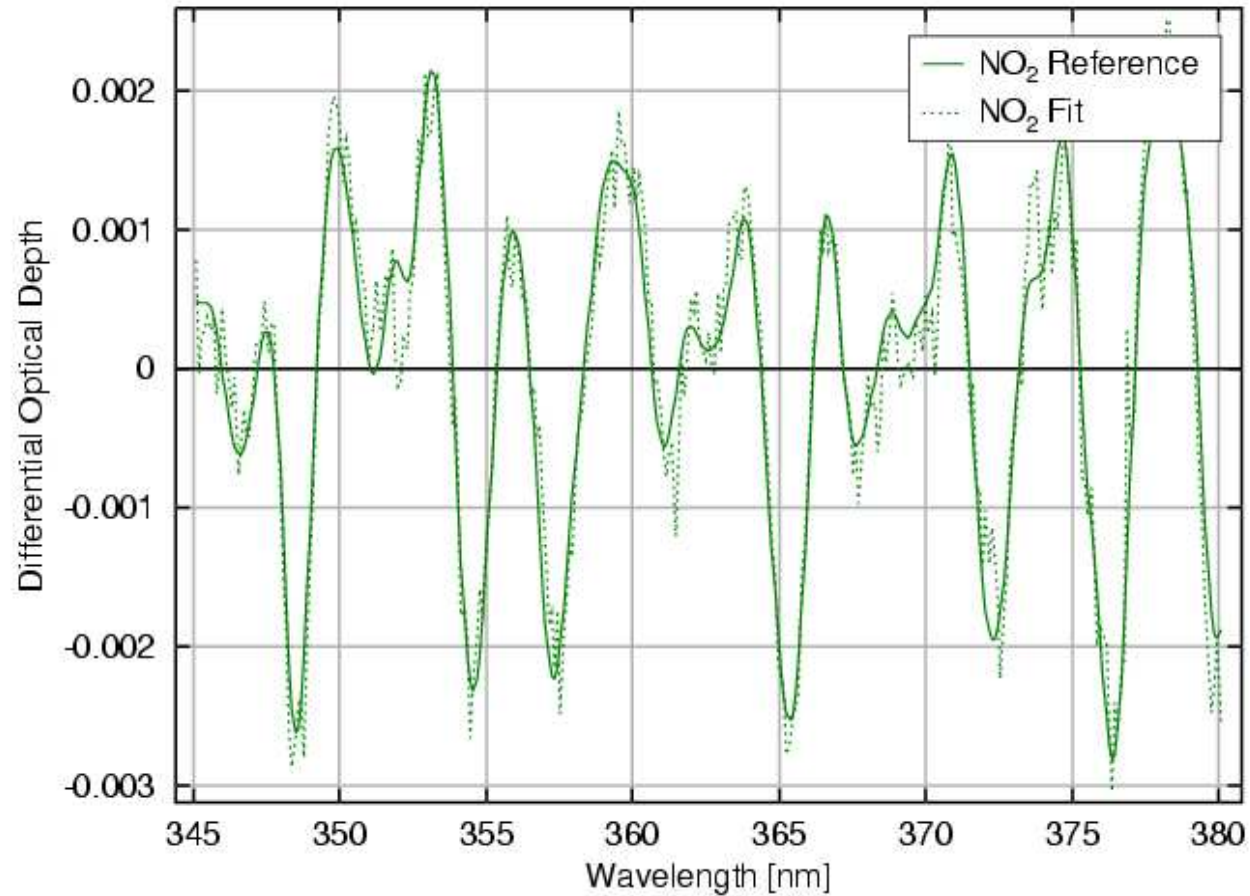


**Spectrometer
warm up to
40 °C**

**Temperature
variation
during flight
is about
0.1 °C**

UV NO2 Fit 020904

File 20904_F.CAM2, 18:10:41, SZA = 87.86°

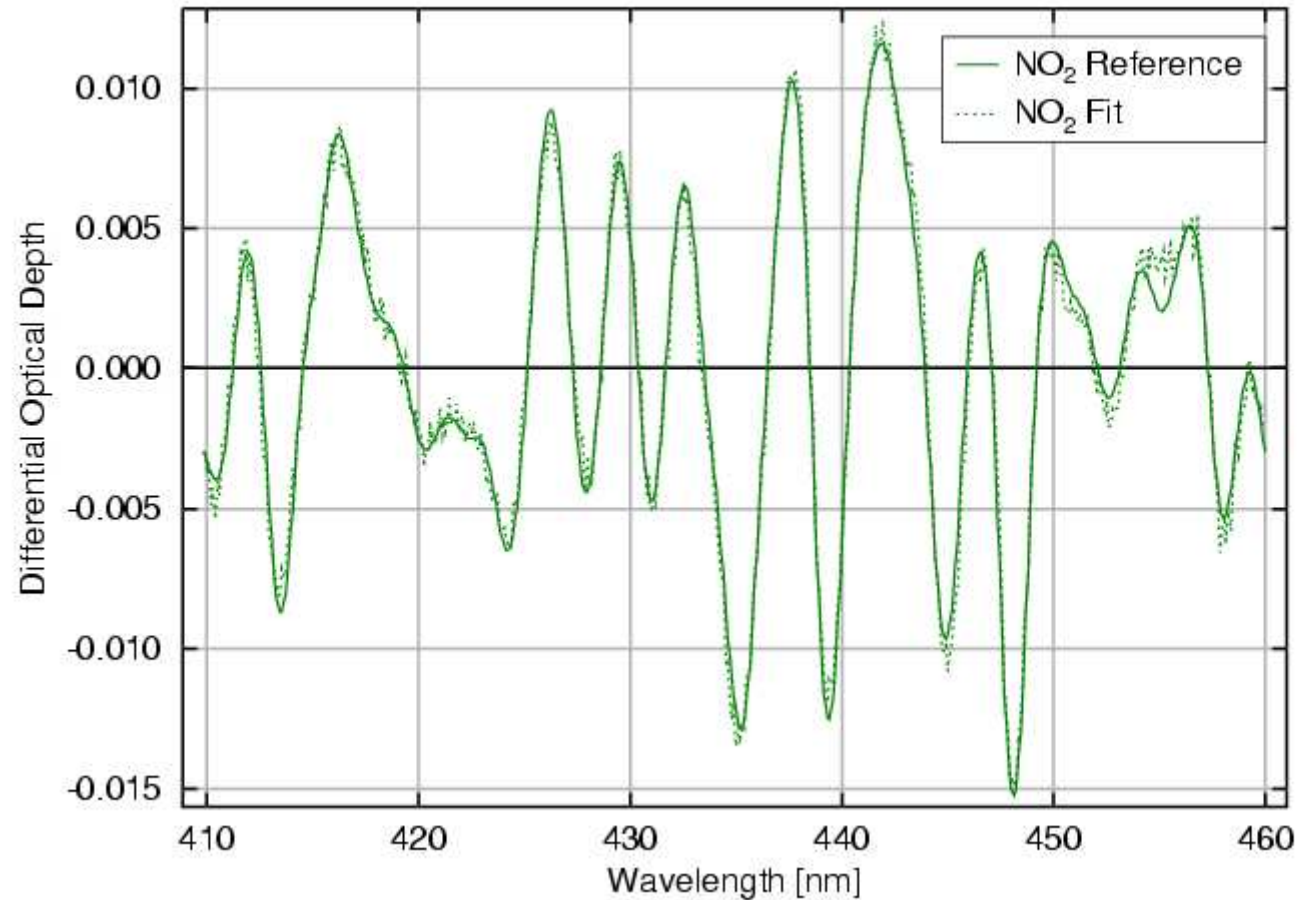


A good NO₂ fit.

Background spectrum measured at about 16:30

Vis NO2 Fit 020904

File 20904_G.NAM0, 18:41:07, SZA = 91.68°

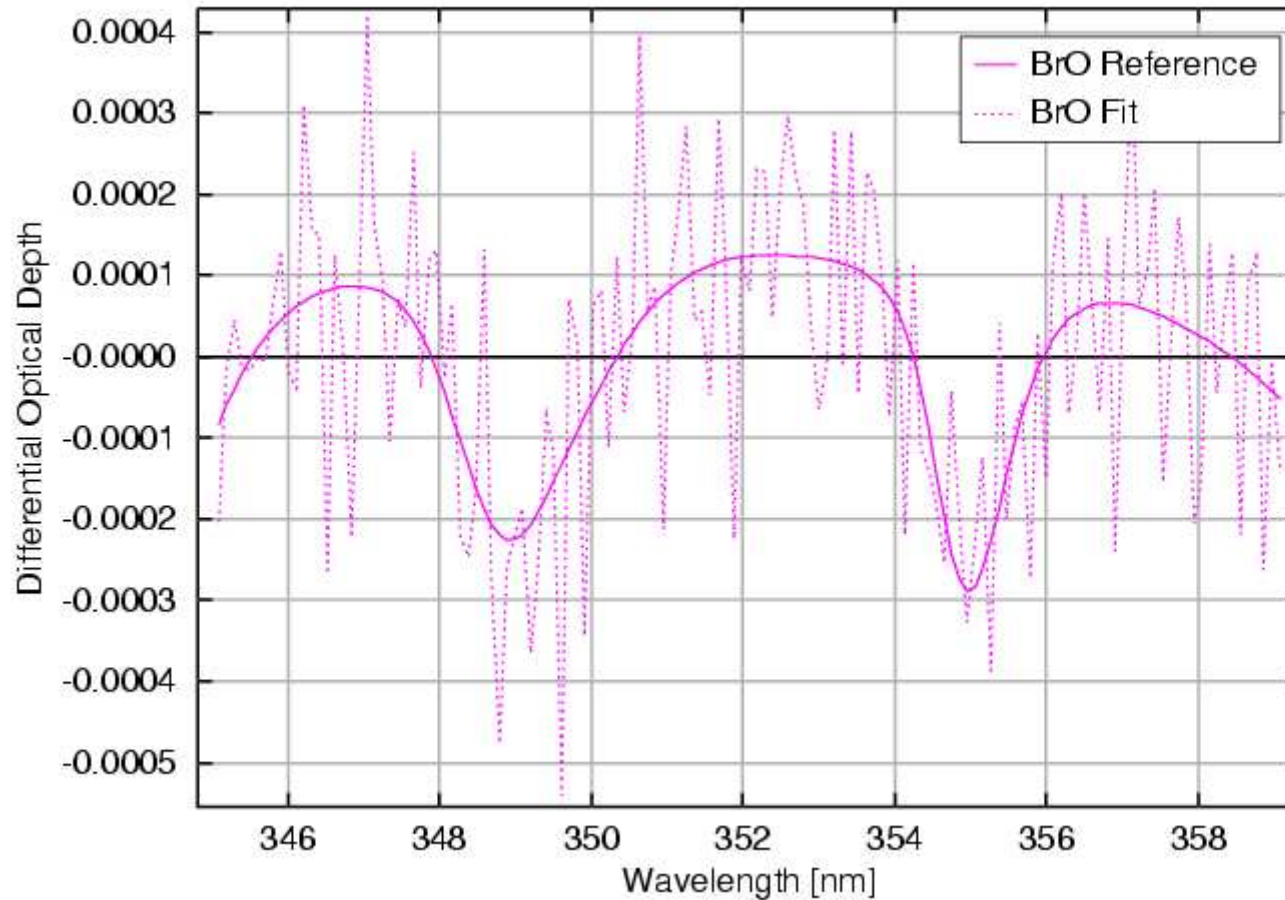


A good NO₂ fit.

Background spectrum measured at about 16:30

BrO Fit 020904

File 20904_F.MBA2, 16:58:41, SZA = 84.26°

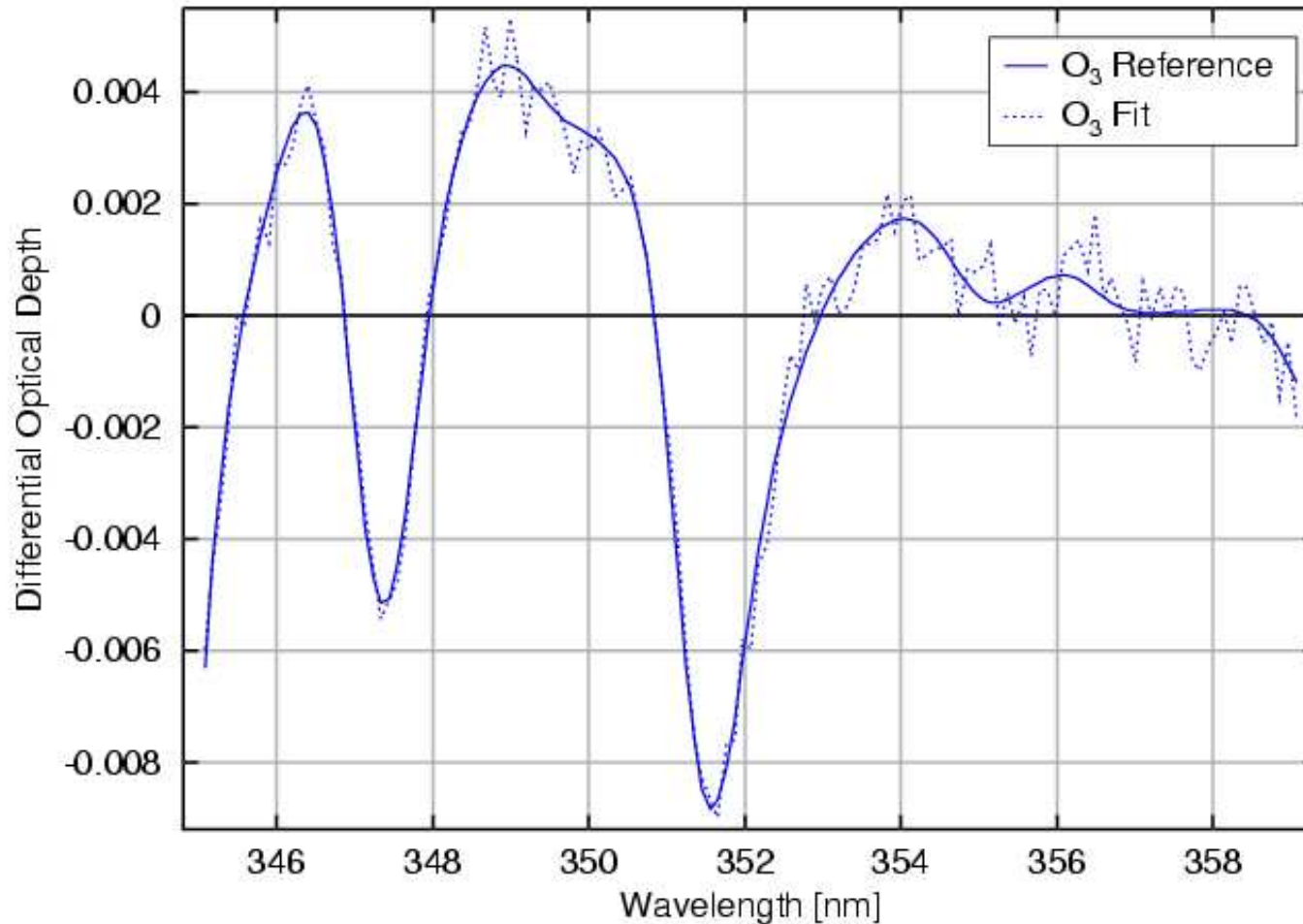


BrO is in the spectra

Background spectrum measured at about 16:30

UV O3 Fit 020904

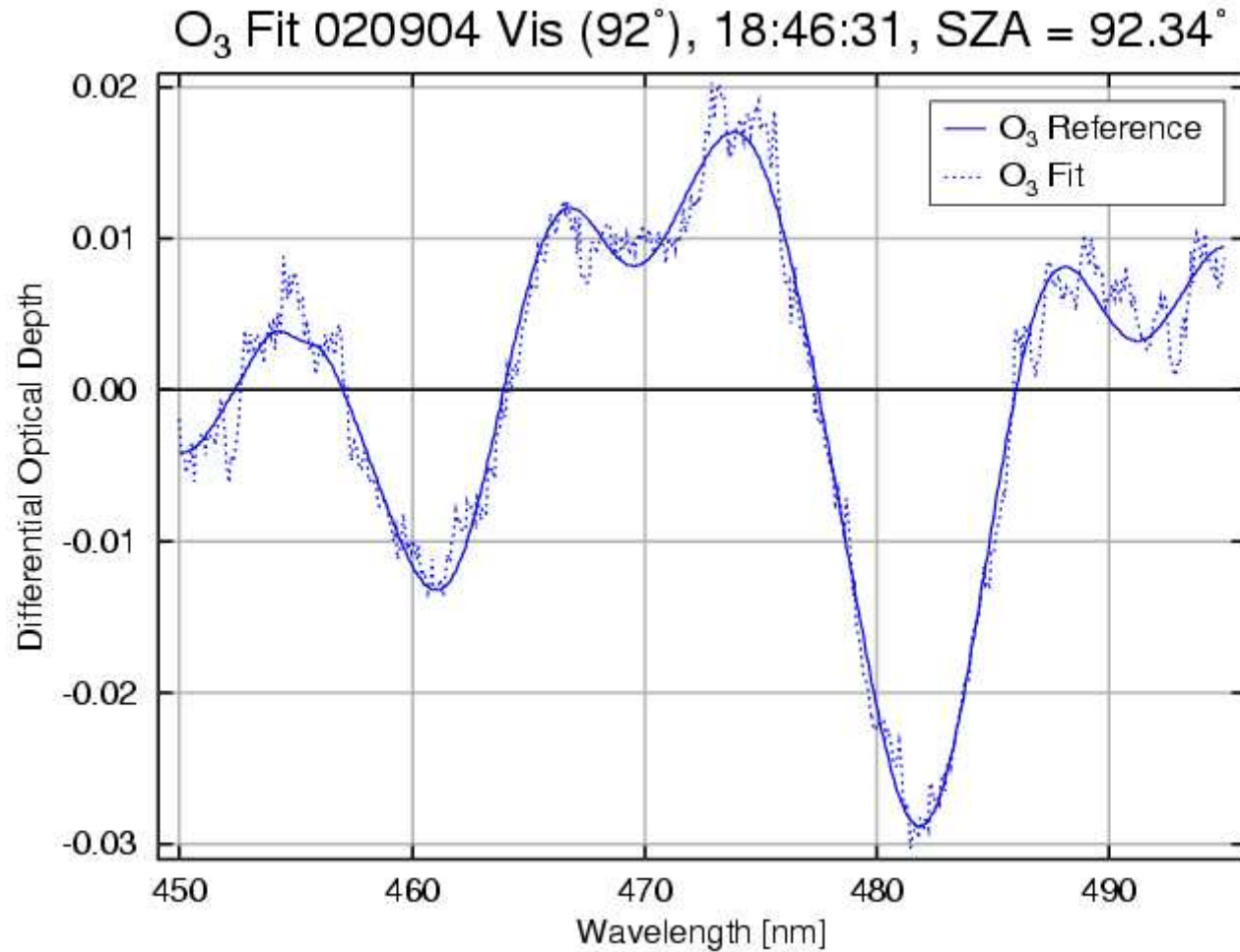
File 20904_F, 18:36:37, SZA = 91.13°



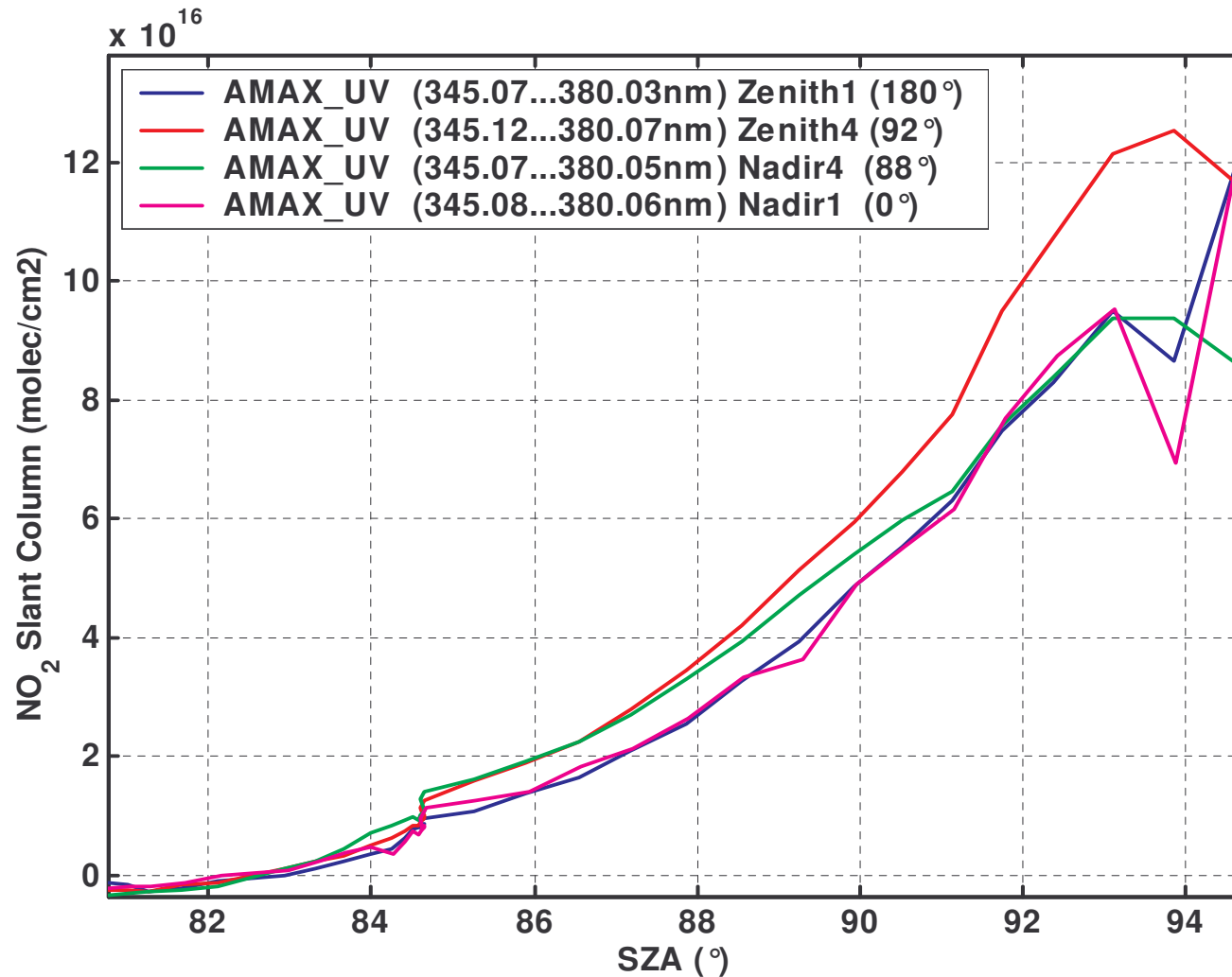
A good O₃ fit.

Background spectrum measured at about 16:30

Vis O3 Fit 020904



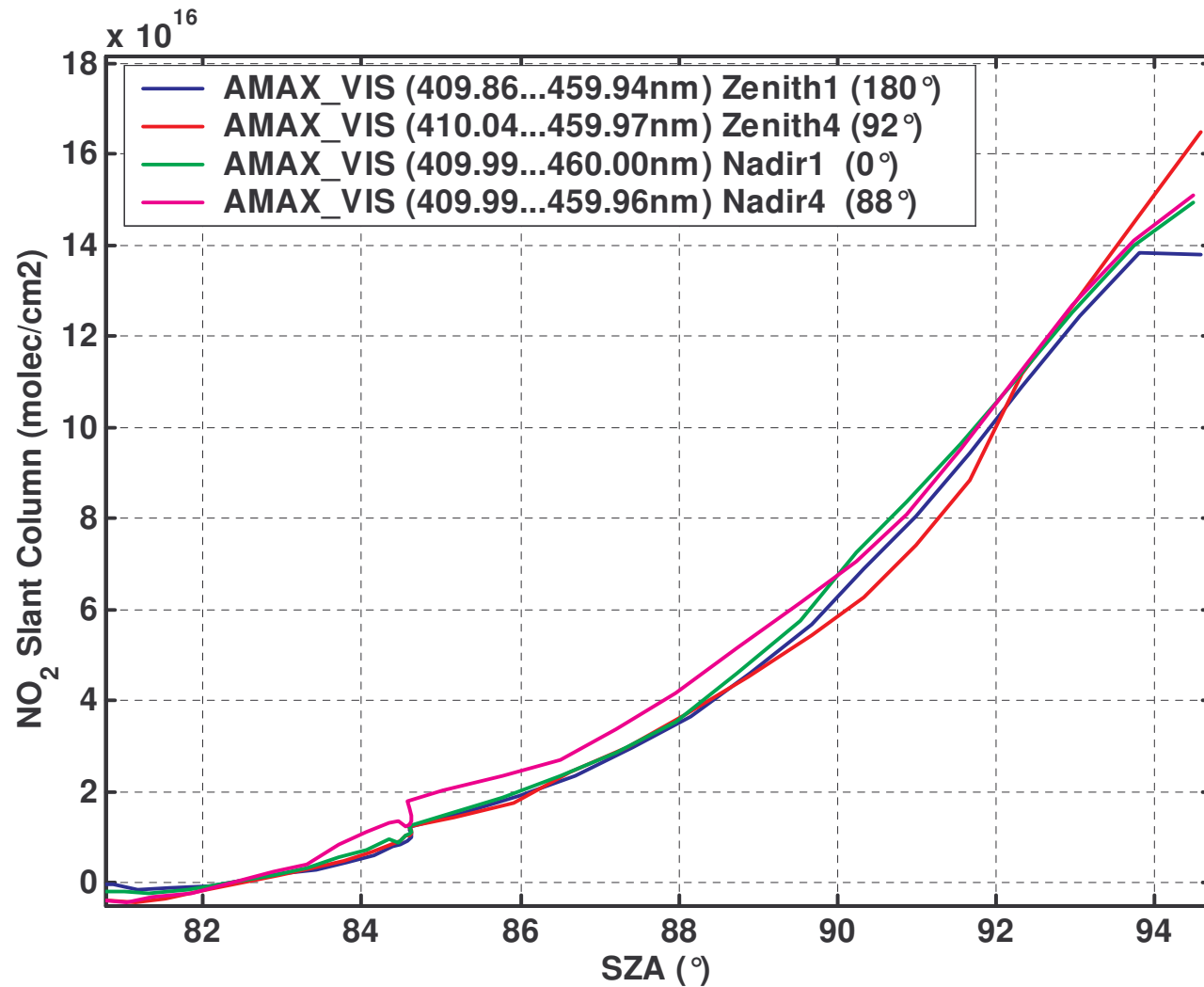
UV NO₂ slant columns 020904



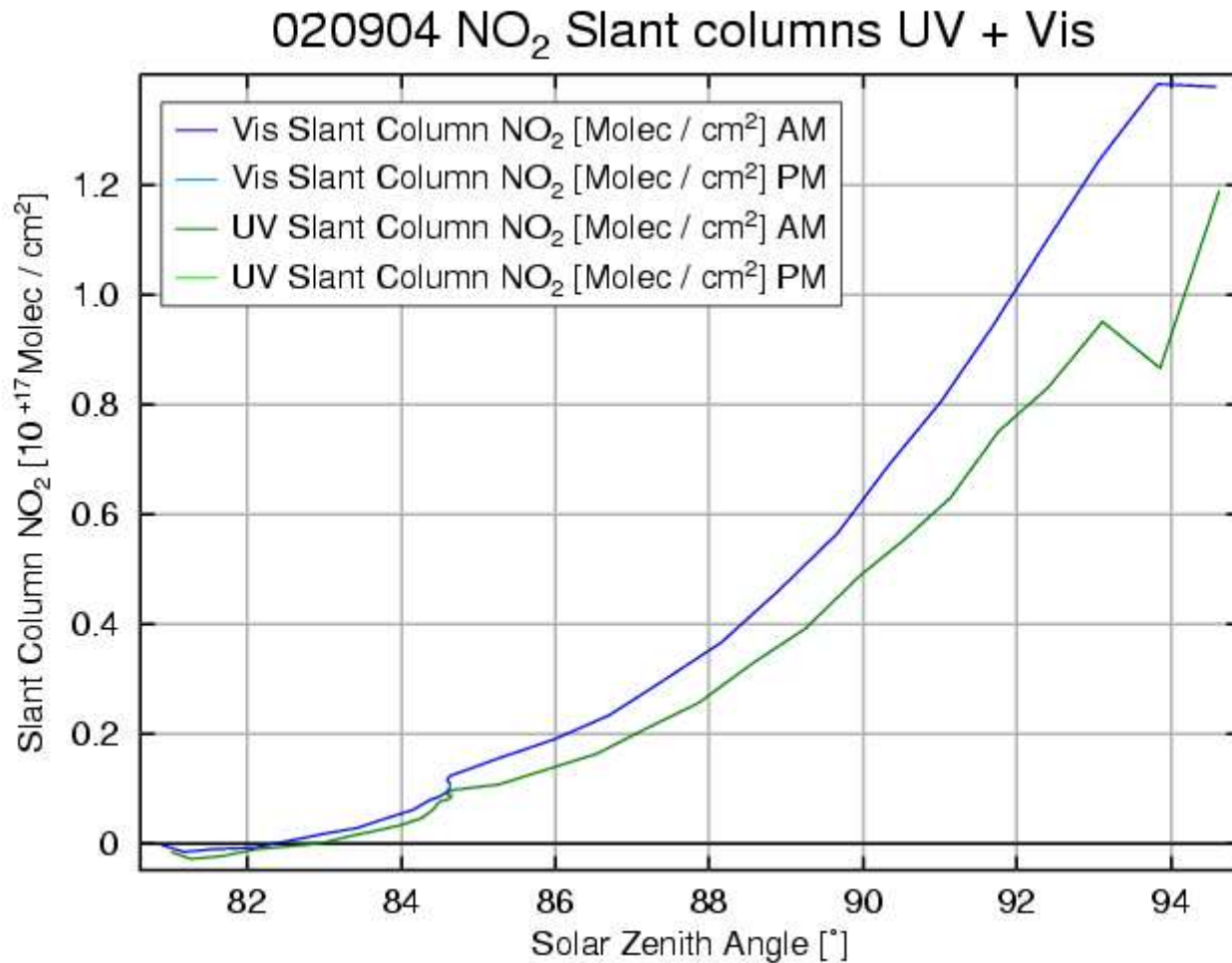
Nadir and Zenith have similar NO₂ slant column.

The background spectra are measured at same time.

VIS NO₂ slant columns 020904



UV and Vis NO₂ Slant Columns 020904 Zenith



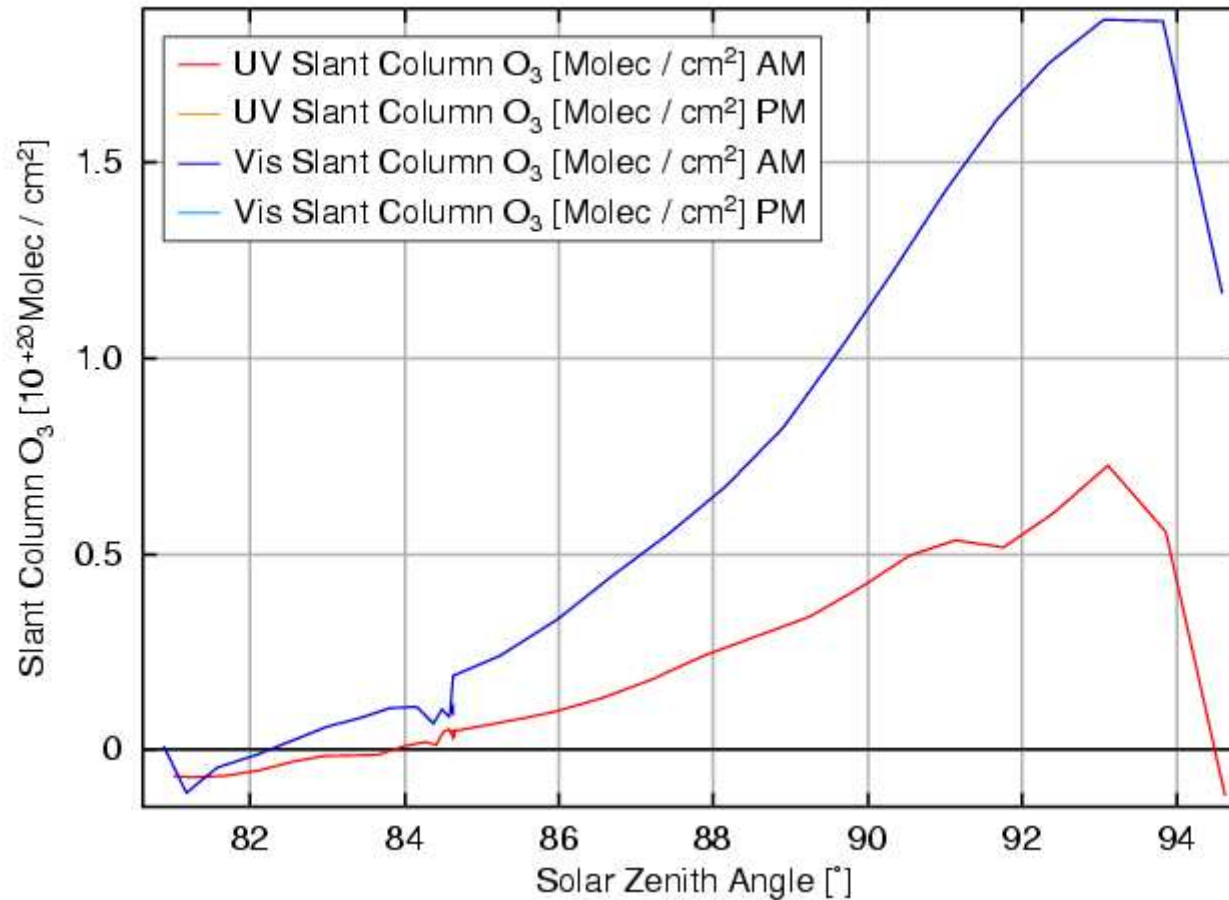
UV
345-380nm

Vis
410-460 nm

Different
AMF

UV+Vis O₃ slant column 020904 Zenith

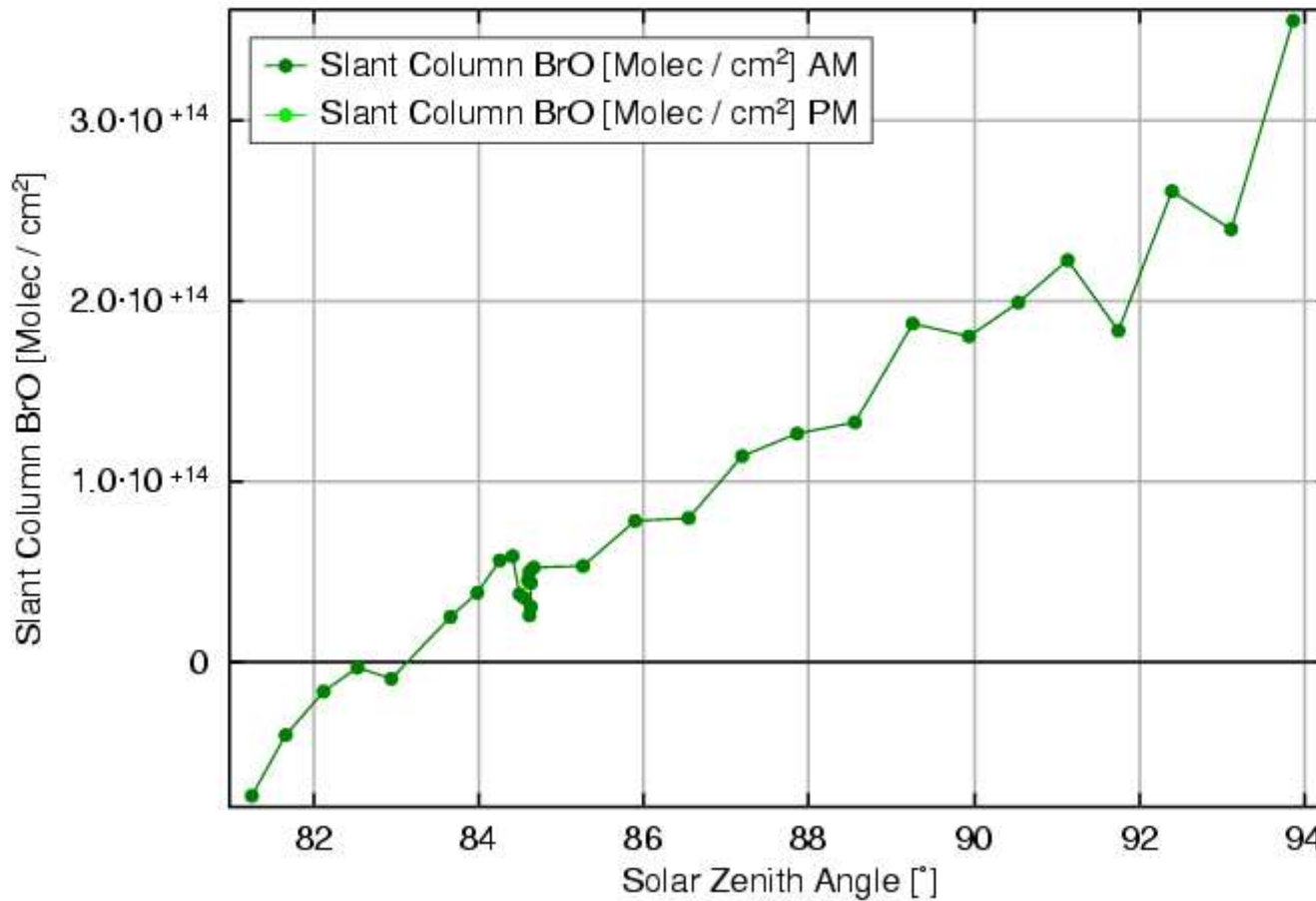
020904 O₃ Slant columns UV + Vis



UV
345-359 nm
Vis
450-495 nm
Different
AMF

BrO Slant Column 020904

020904 BrO Slant columns (View angle 88°)

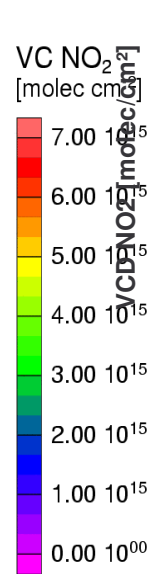
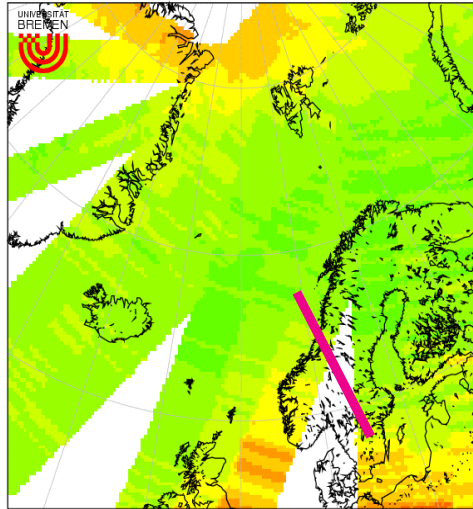


UV
345-359nm
Correct
tendency
but noisy

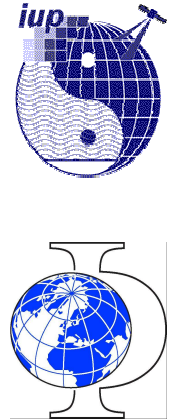
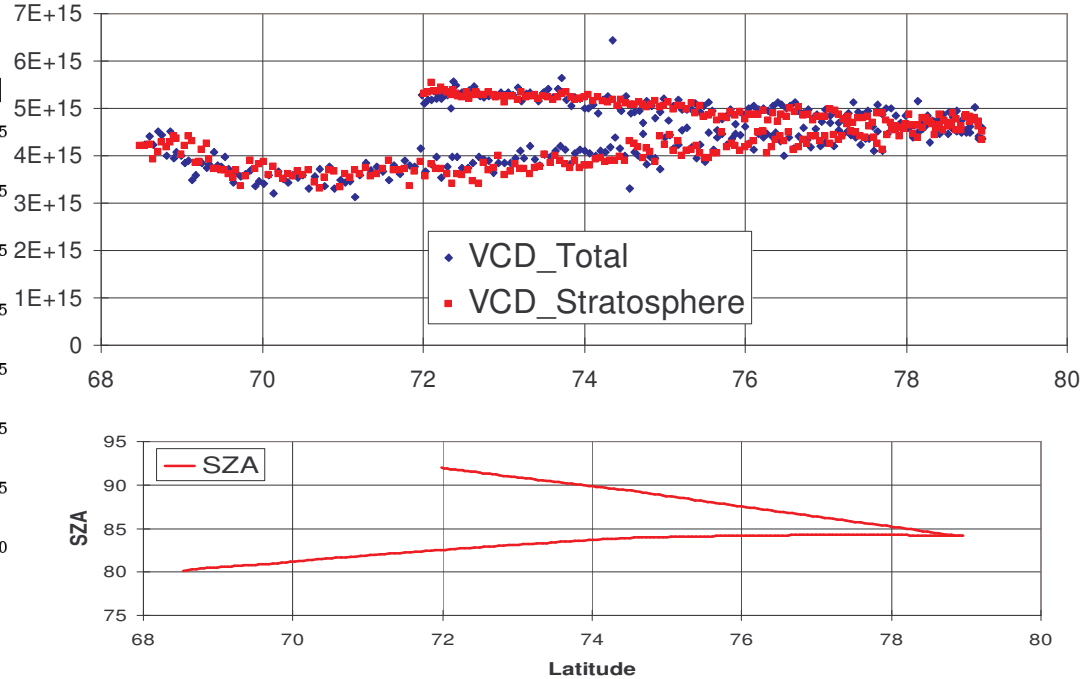
NO2 vertical column 020904

AMAXDOAS NO2

GOME NRT NO₂ columns 2002/09/04



AMAXDOAS NO2 VCD, 04.09.2002, Kiruna - Spitsbergen - Kiruna



Falcon Flight
Track 04.09.2002

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

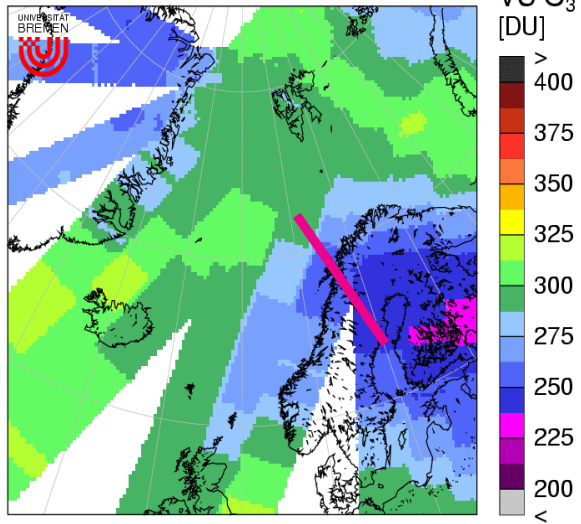
Ny-Ålesund, 79°N, Ground:
AM: 4.3e15 PM: 4.8e15
molec/cm²

=> No significant NO2 in the troposphere

O3 vertical column 020904

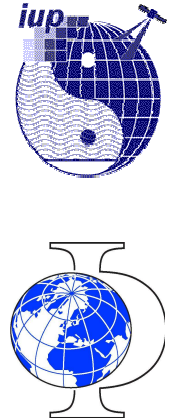
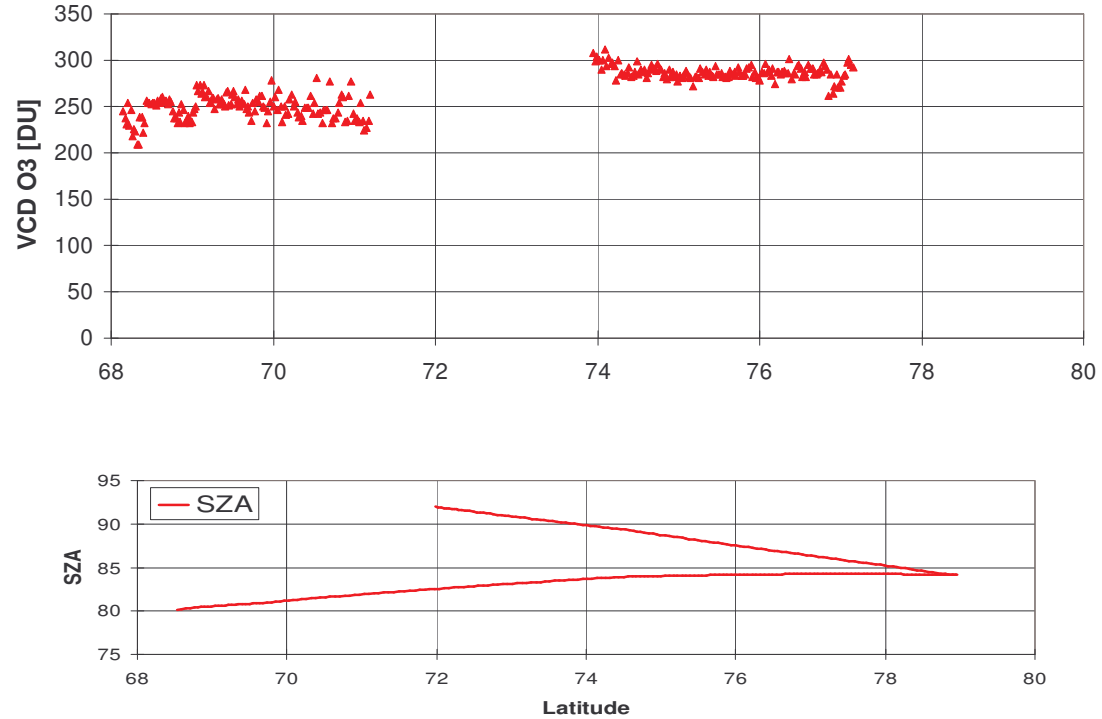
AMAXDOAS O3

GOME NRT O₃ columns 2002/09/04



Falcon Flight
Track 04.09.2002

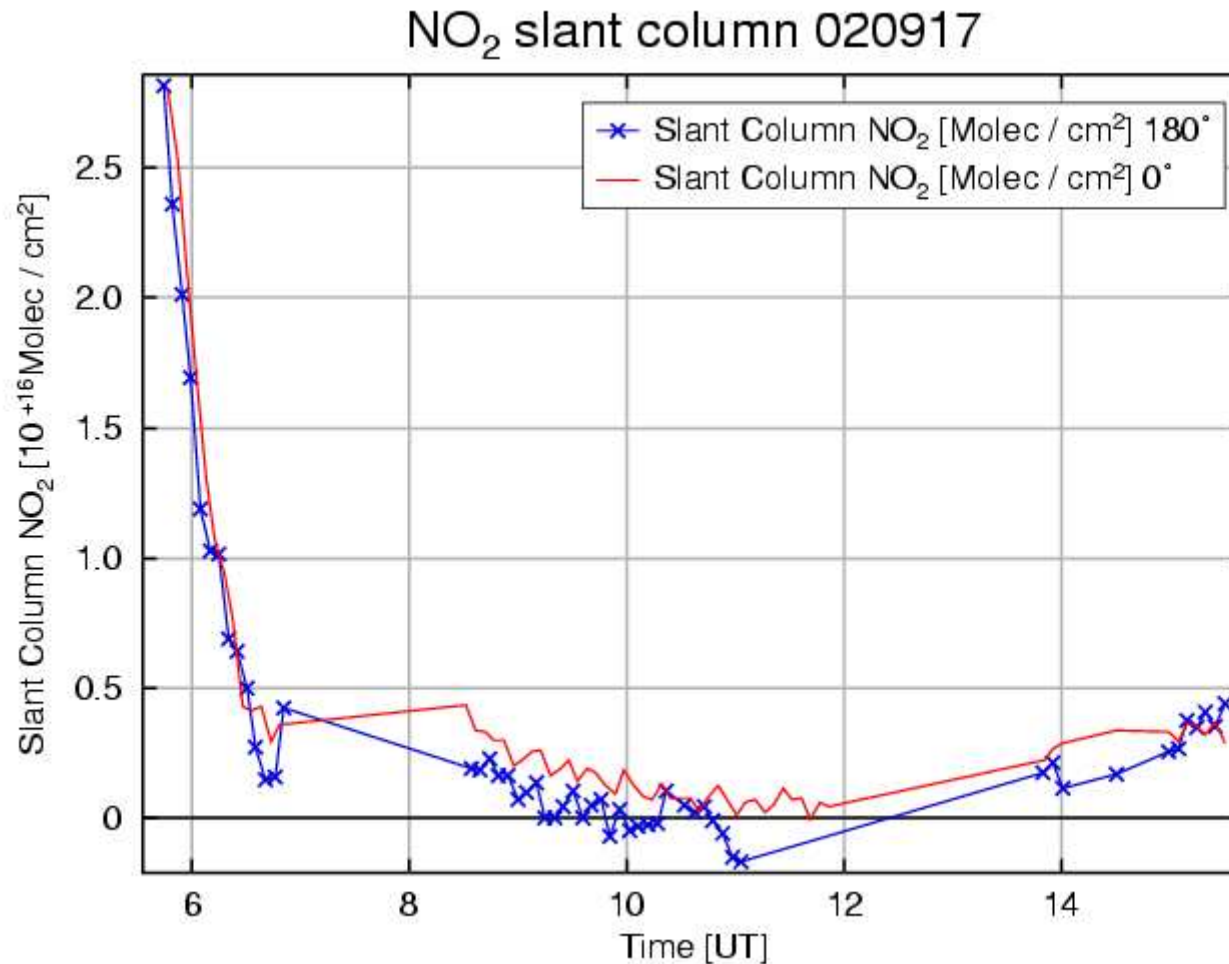
AMAXDOAS O3 VCD, 04.09.2002, Kiruna - Spitsbergen - Kiruna



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

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

UV NO₂ slant columns 020917



Long flight track

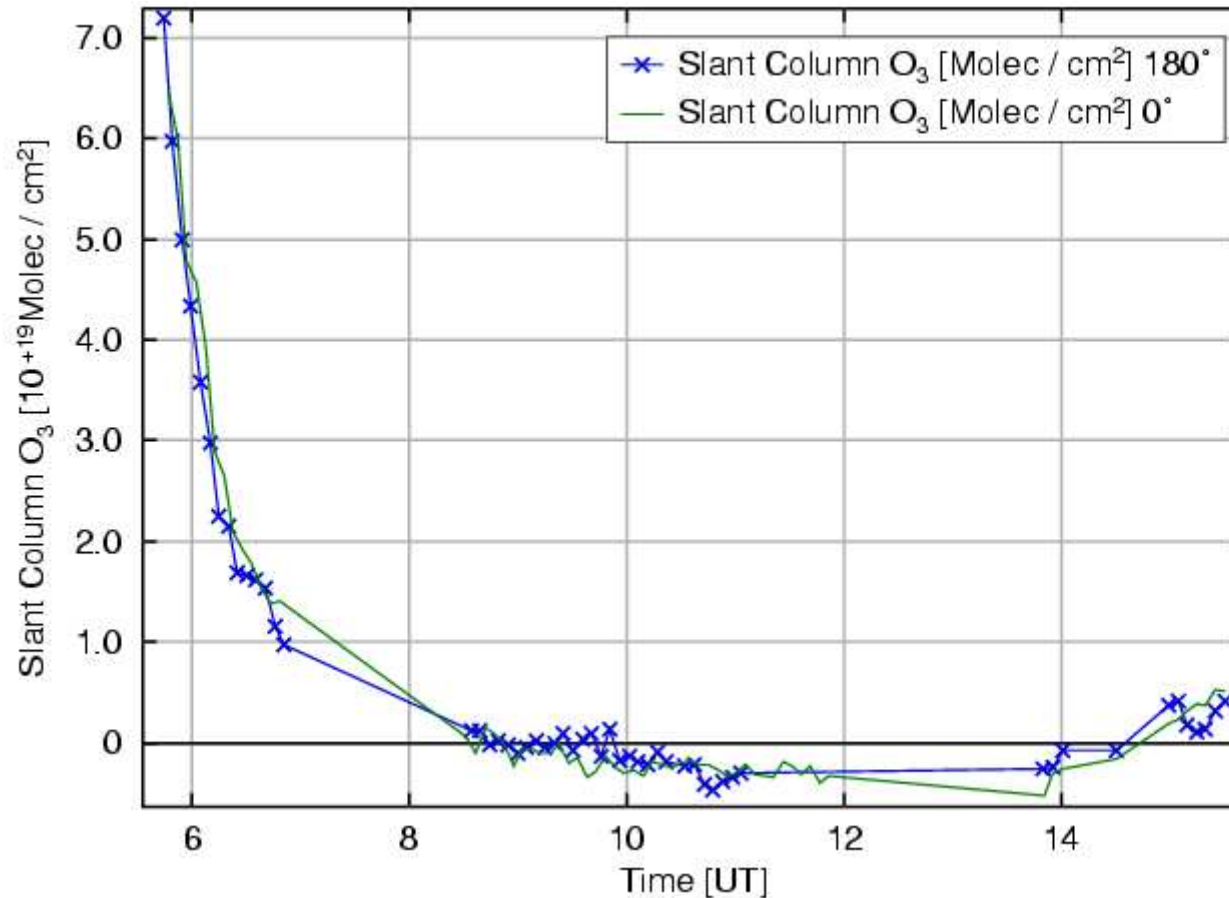
Background spectrum at 10:30
SZA 22°

Fit window 345-380nm

Similar NO₂ slant column in nadir and zenith at beginning

UV O3 slant columns 020917

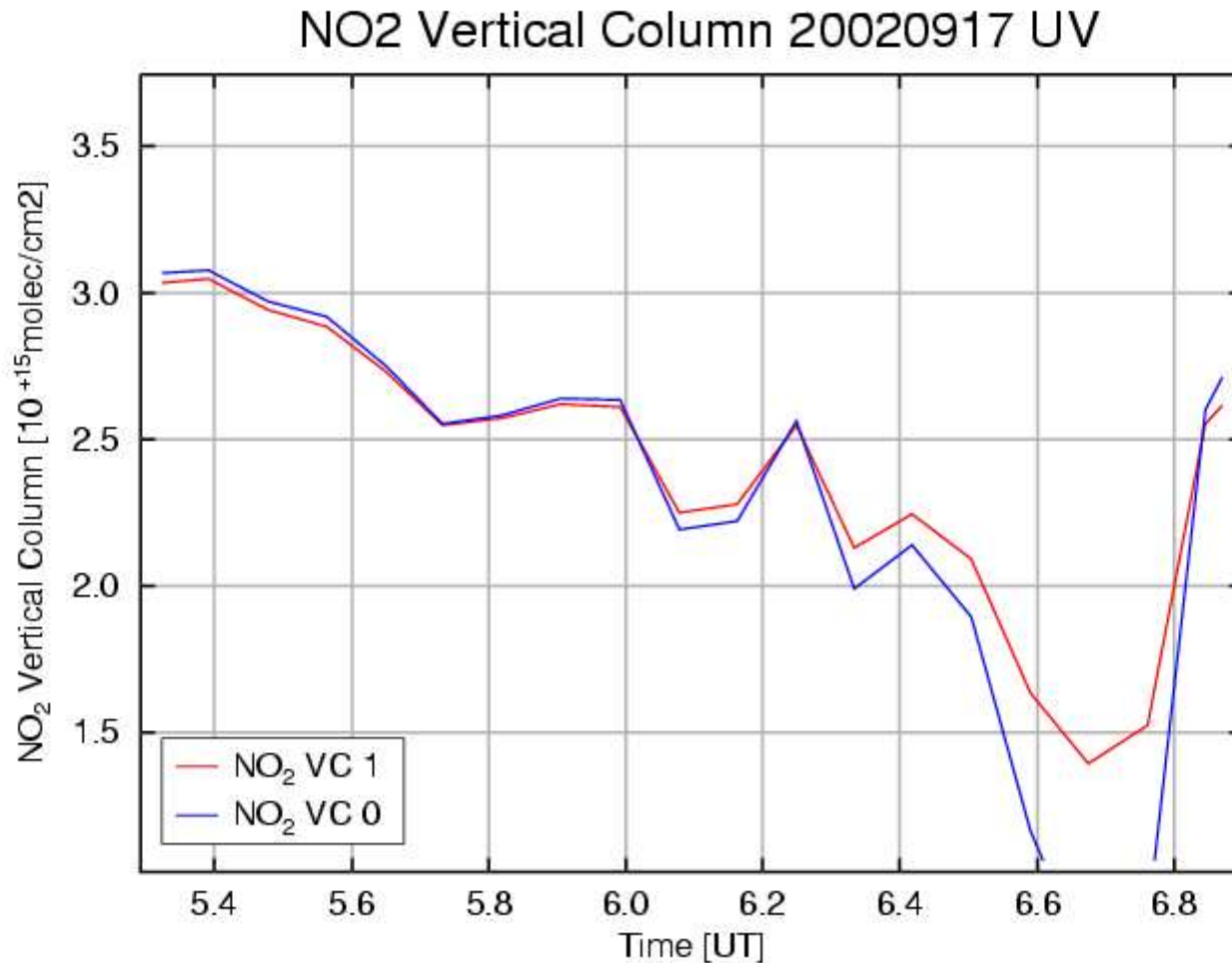
O₃ slant column 020917



Fit window
345-359nm

Similar O₃ slant
column in nadir
and zenith at
beginning

NO₂ vertical Column



VC1:
assume NO₂
is 2.0e15 in
background
spectra

VC0: =
(SC-SC0)/
(AMF-AMF0)

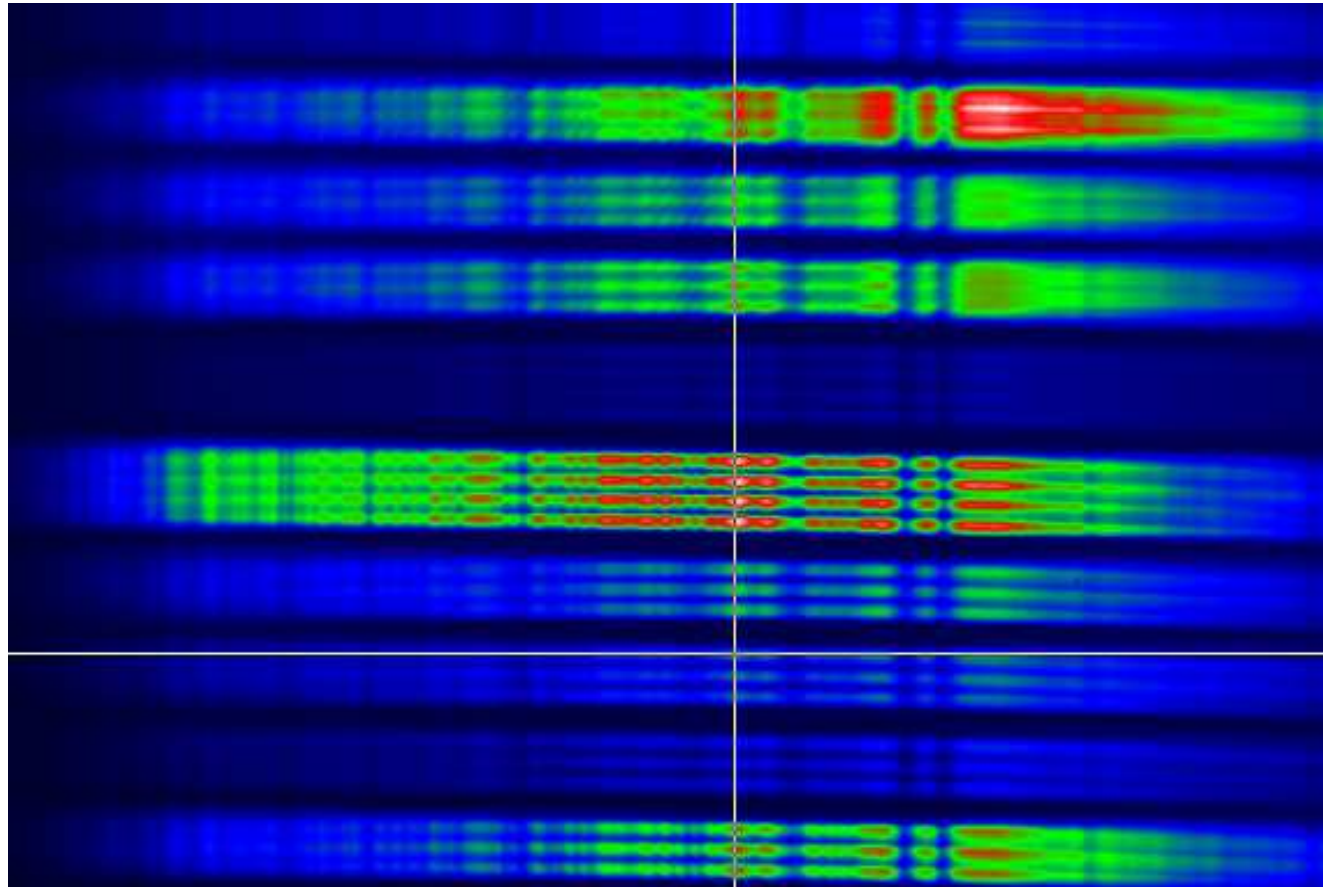
Summery and Outlook AMAX Falcon Campaign

- 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

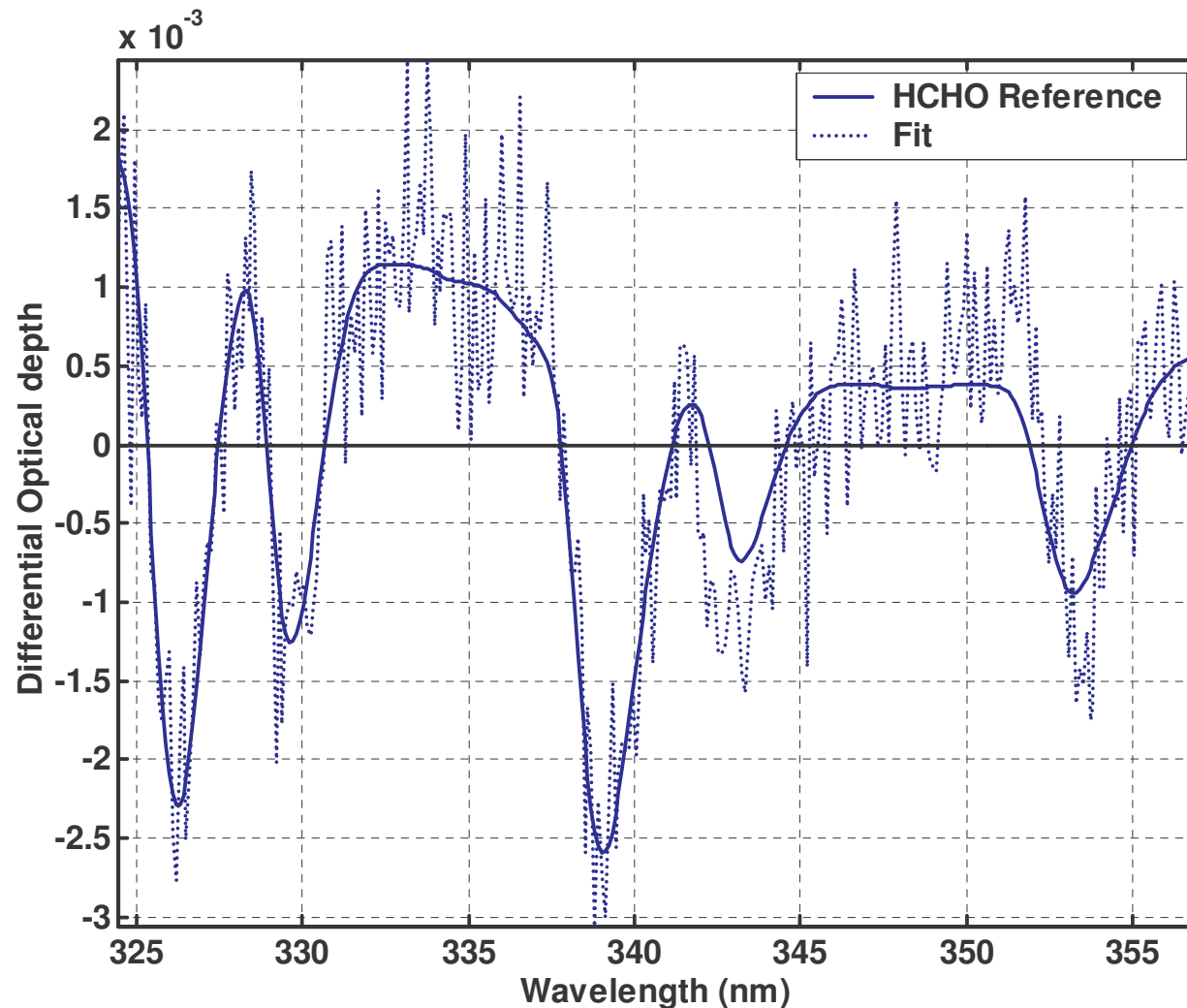
- **Reference spectra used**

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

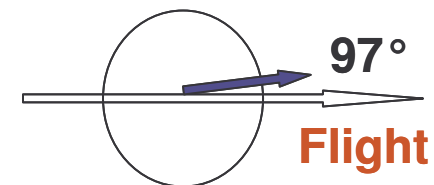


UV spectrometer
Date 020729

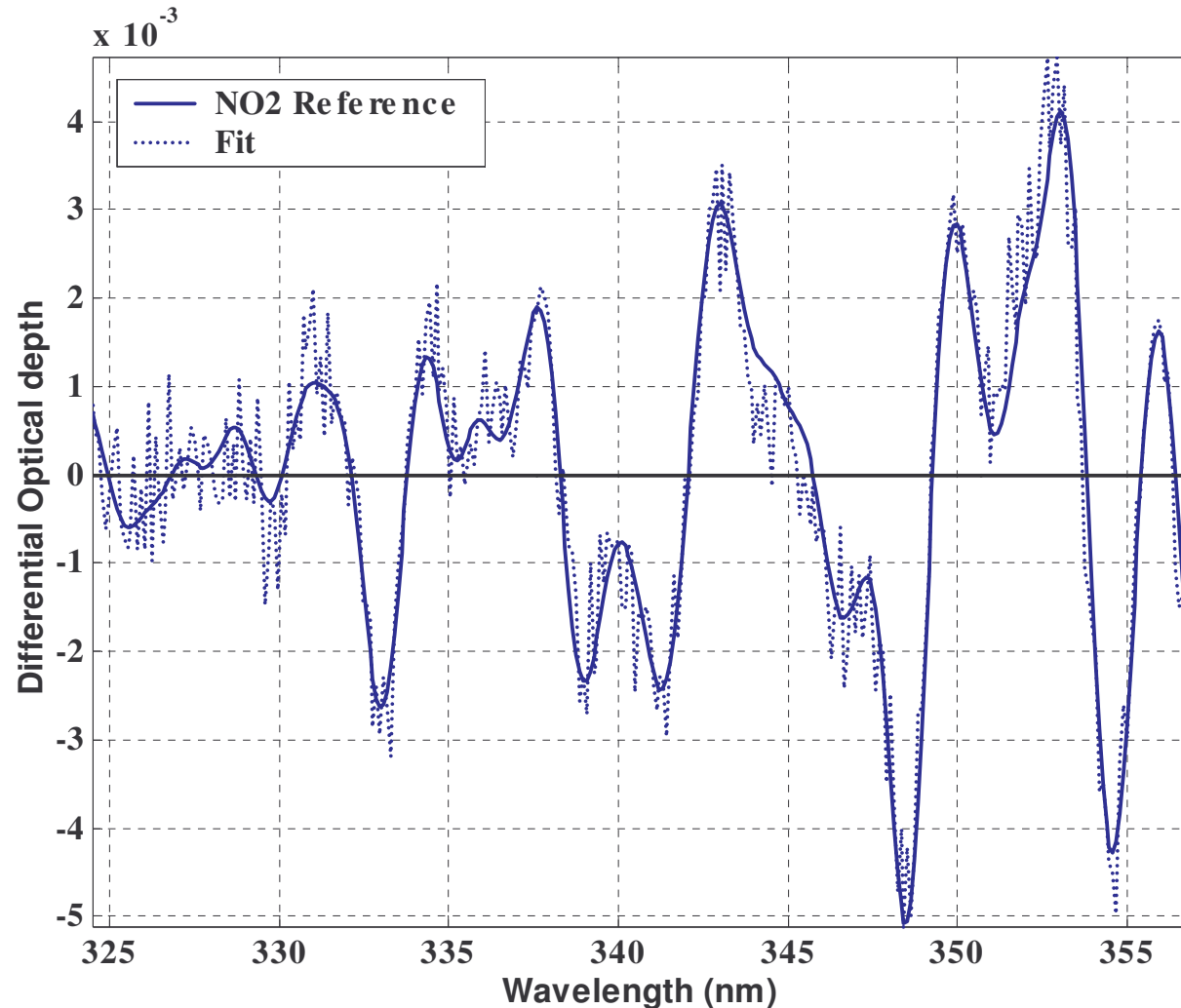
Time 09:22:04

Viewing direction:
Nadir5 (97°)

⇒ Excellent
detection of
HCHO!



AMAXDOAS-UV: NO2 Fit result



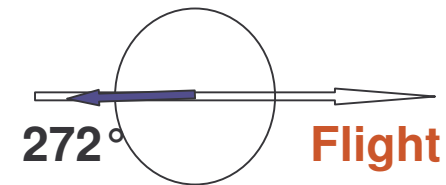
UV spectrometer
Date 020729

Time 09:20:19

Viewing direction:

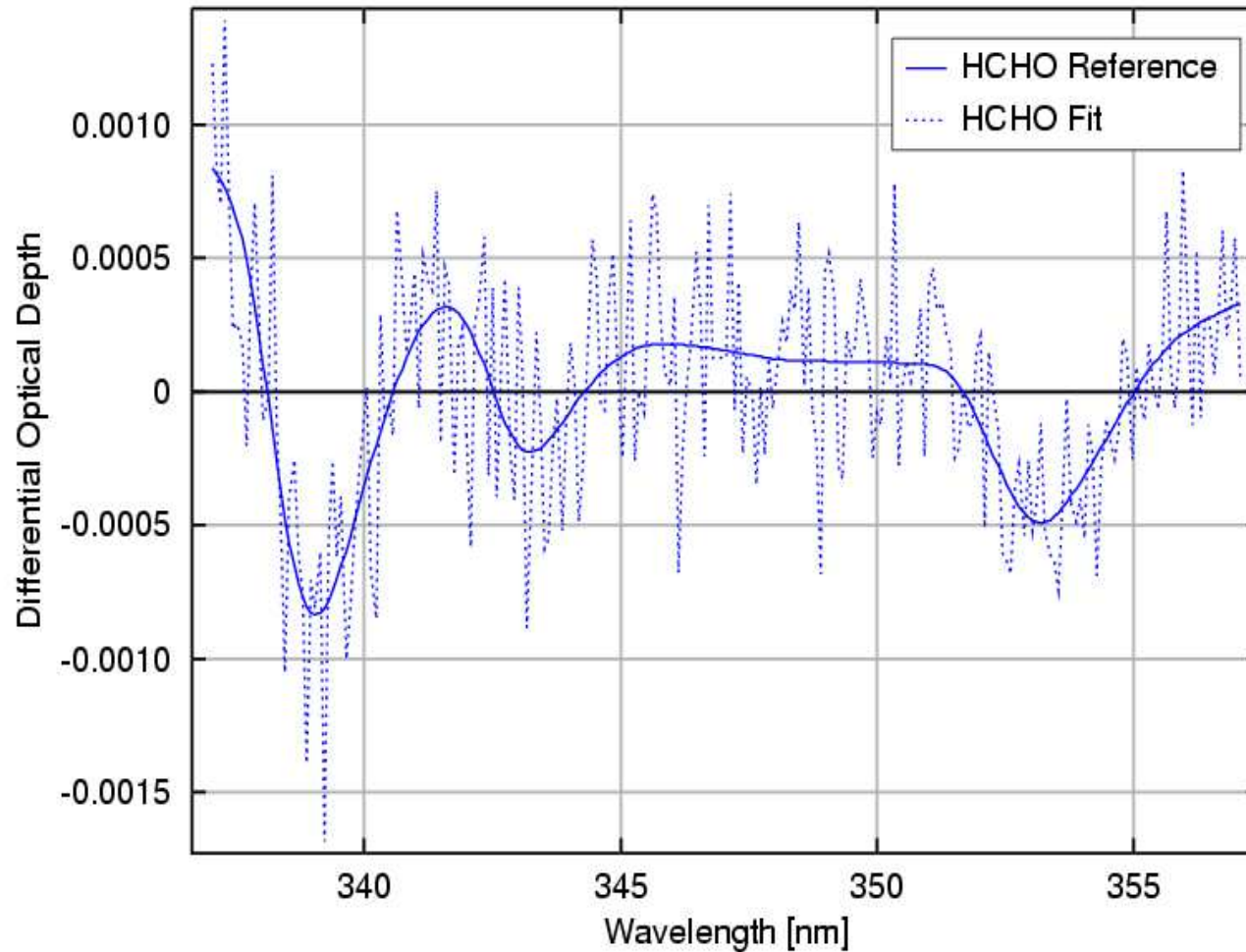
Zenith2 (272°)

⇒ Excellent
detection of
NO2!



AMAXDOAS-Vis: HCHO Fit Result

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



Vis spectrometer

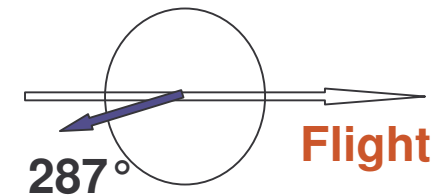
Date 020815

Time 11:58:43

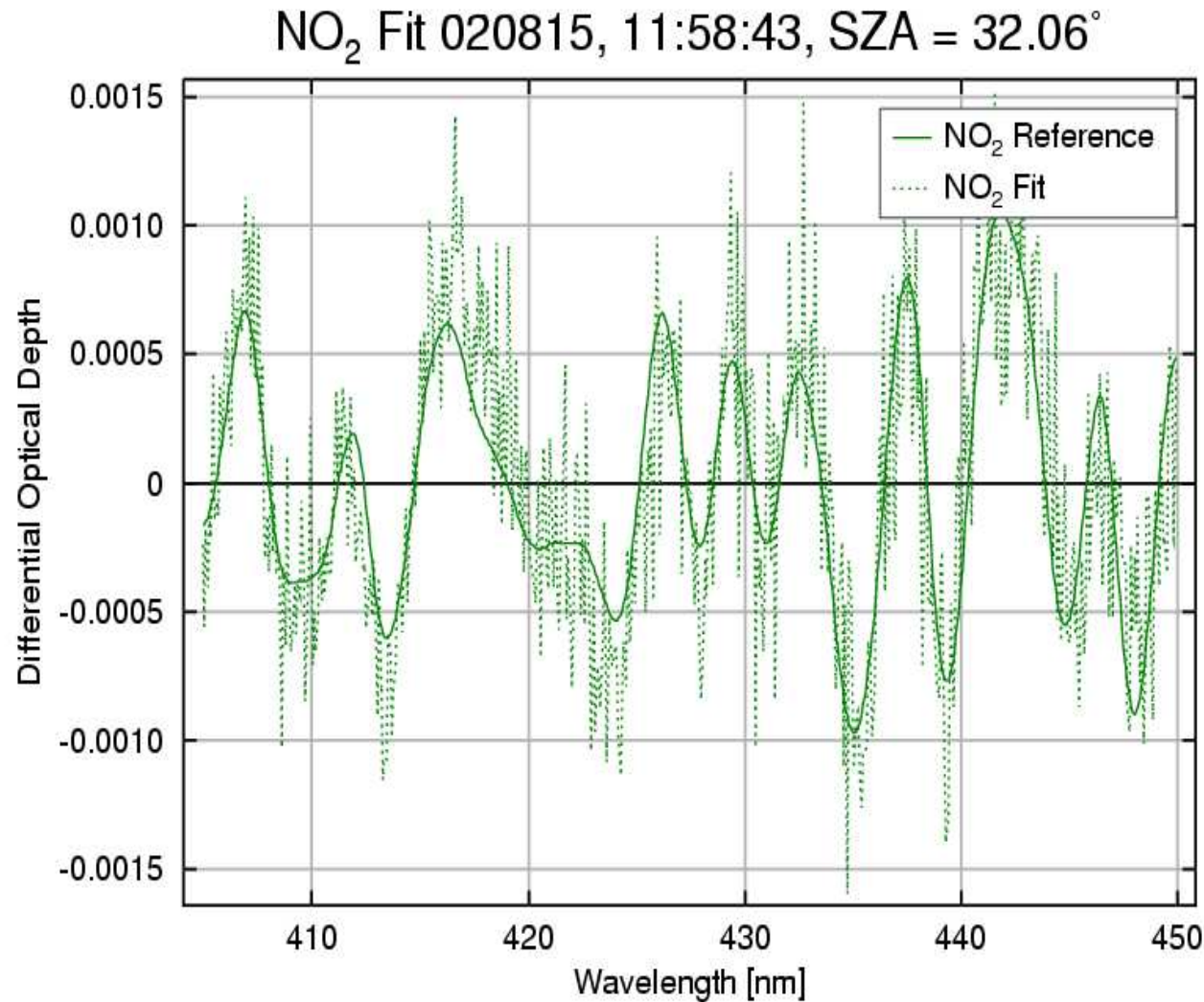
Viewing direction

Nadir3 (287°)

⇒ **Good
detection of
HCHO!**



AMAXDOAS-Vis: NO₂ Fit Result

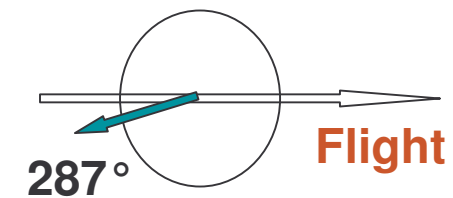


Vis spectrometer
Date 020815

Time 11:58:43

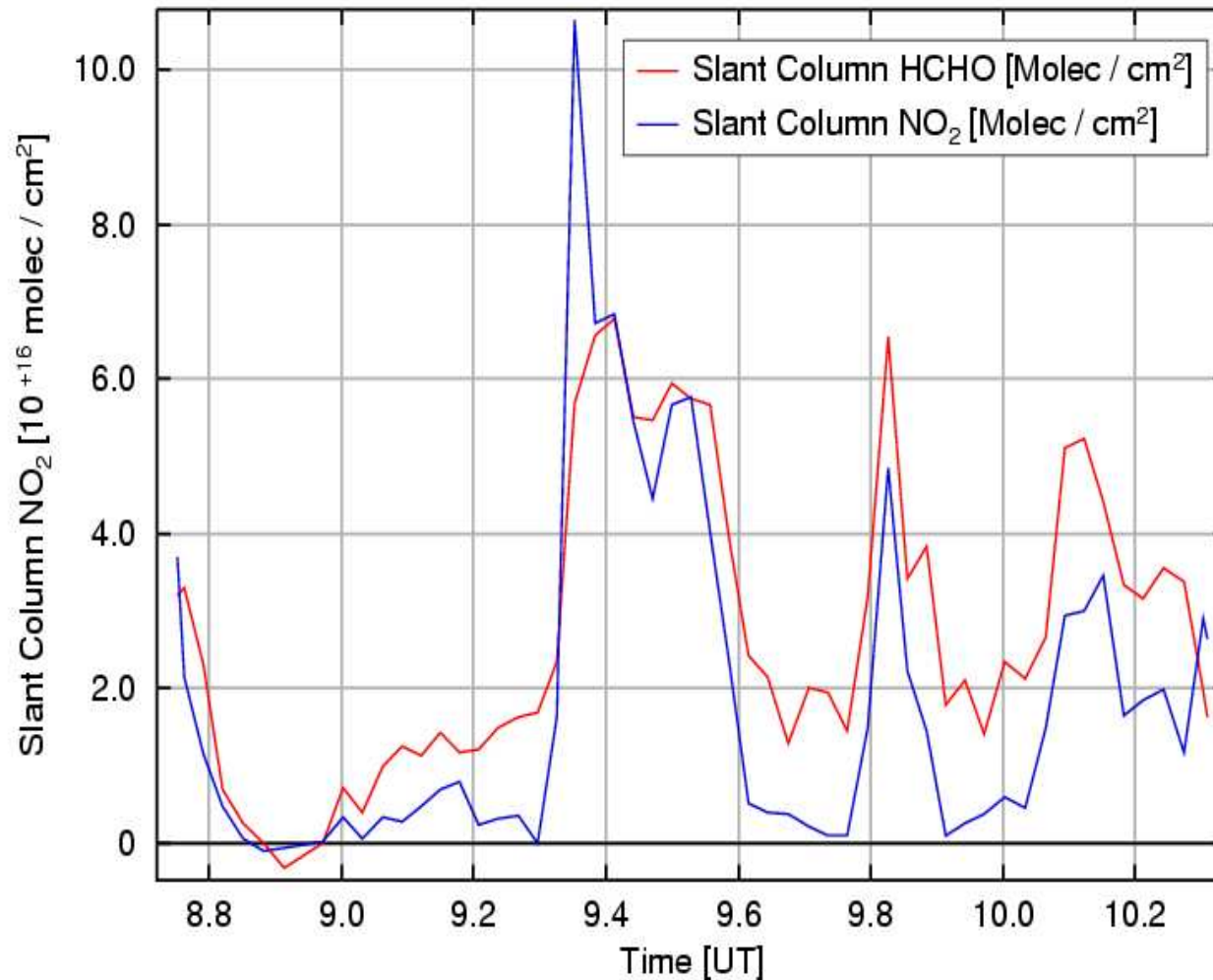
Viewing direction
Nadir3 (287°)

⇒ **Excellent
detection of
NO₂!**



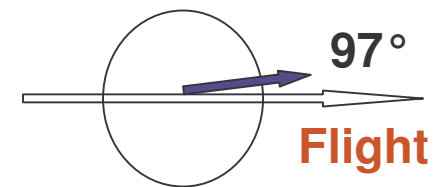
AMAX: NO₂ and HCHO Slant column time series 020729

AMAXDOAS_UV 020729 HCHO and NO₂ Slant column

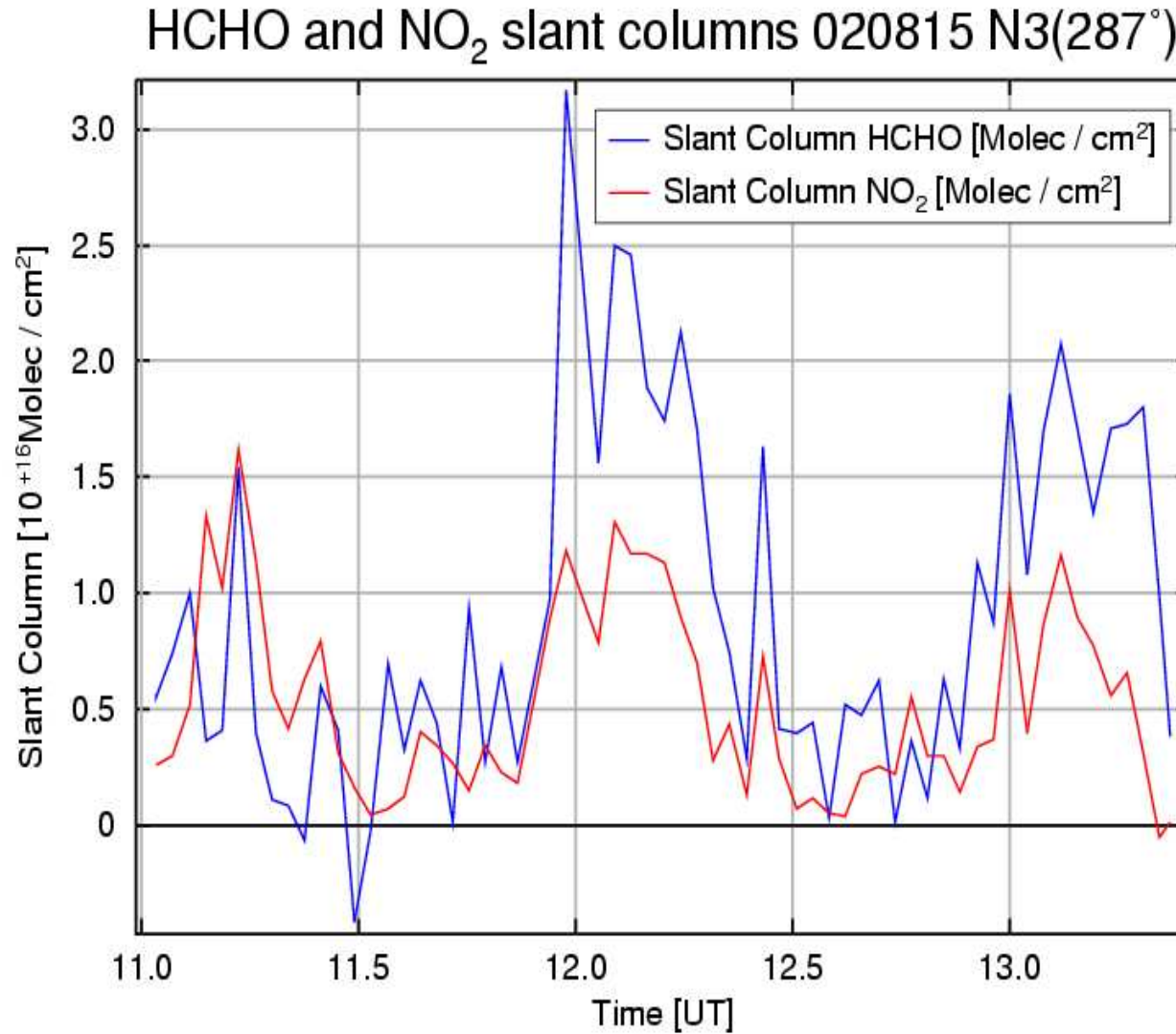


HCHO and NO₂ plumes are seen at the same time and location

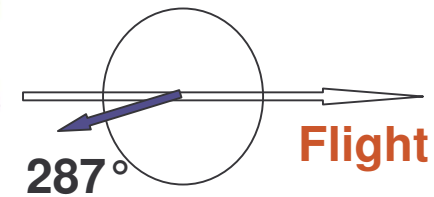
⇒ sources seem to be correlated



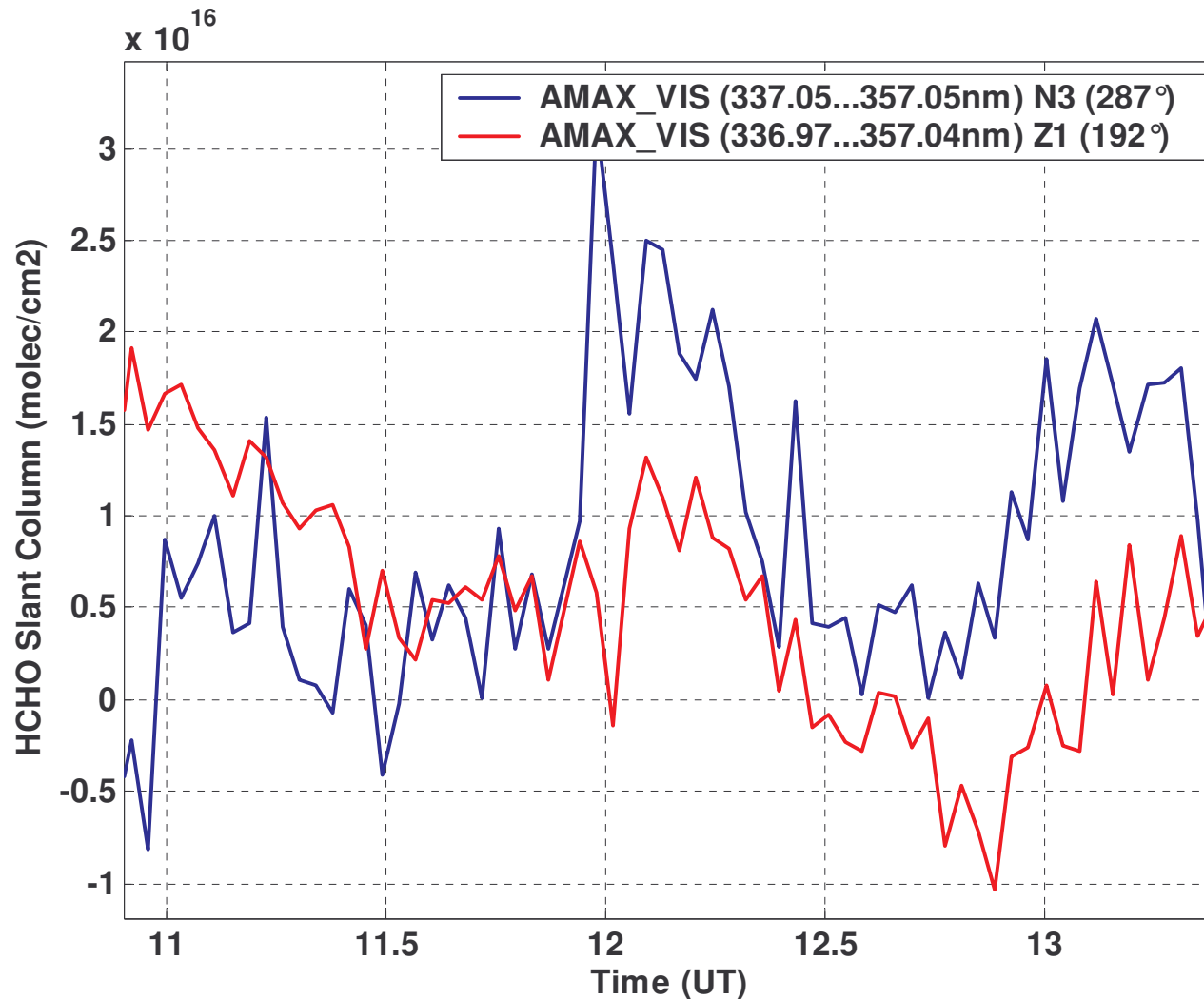
AMAX NO₂ and HCHO Slant column time series 020815



HCHO and NO₂ Slant columns have similar structure.

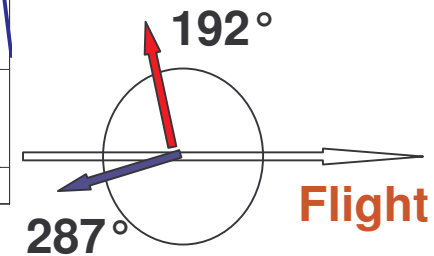


AMAX: HCHO Slant column Nadir and Zenith 020815

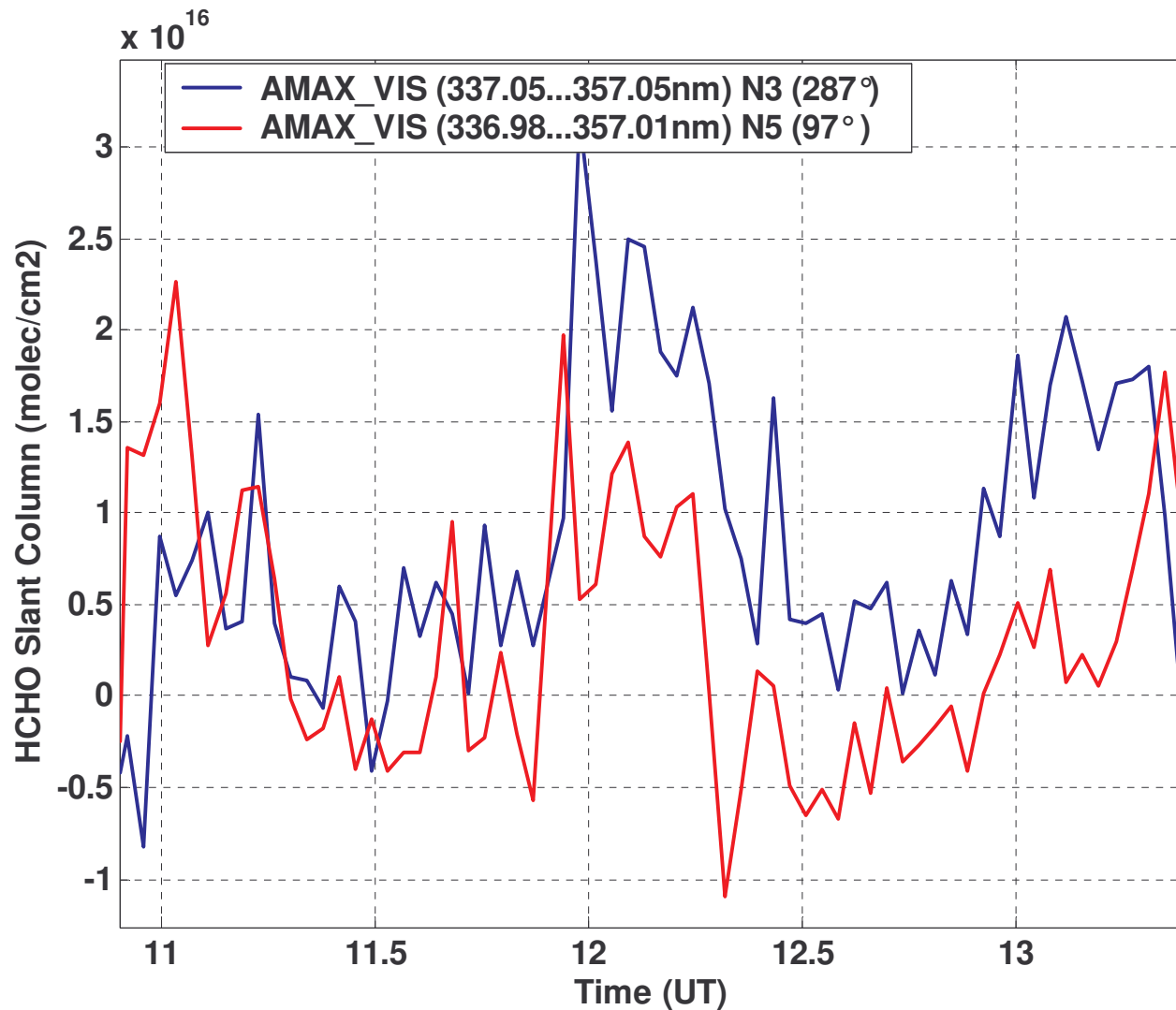


More NO₂ in downward direction than in upward direction

⇒ HCHO plume is clearly located below aircraft

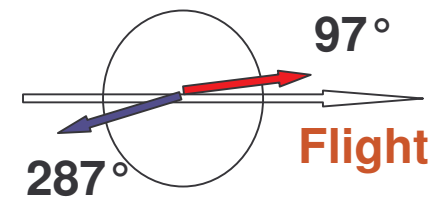


AMAX: HCHO Slant column Reproducibility 020815

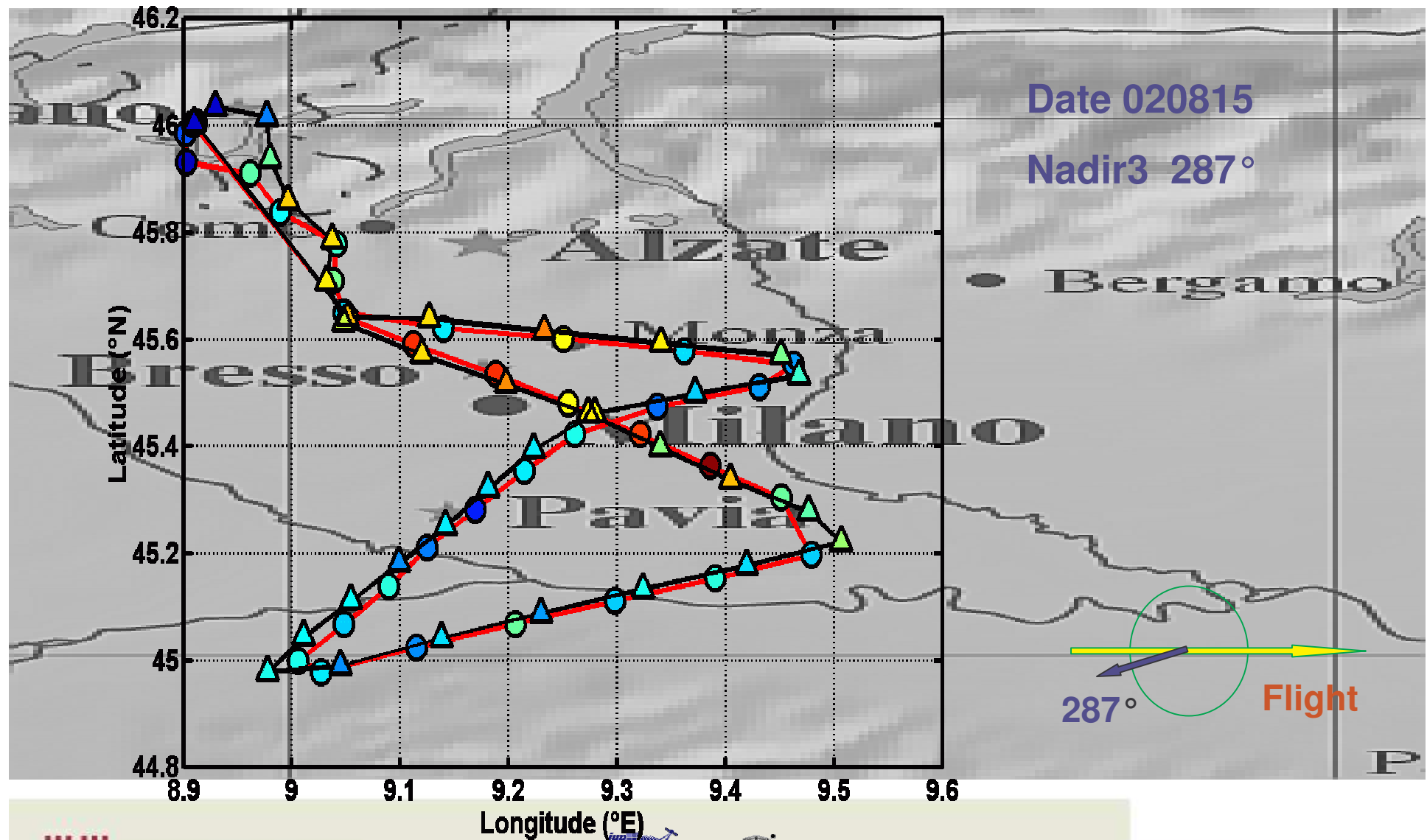


Forward telescope sees HCHO plume earlier than the backward telescope

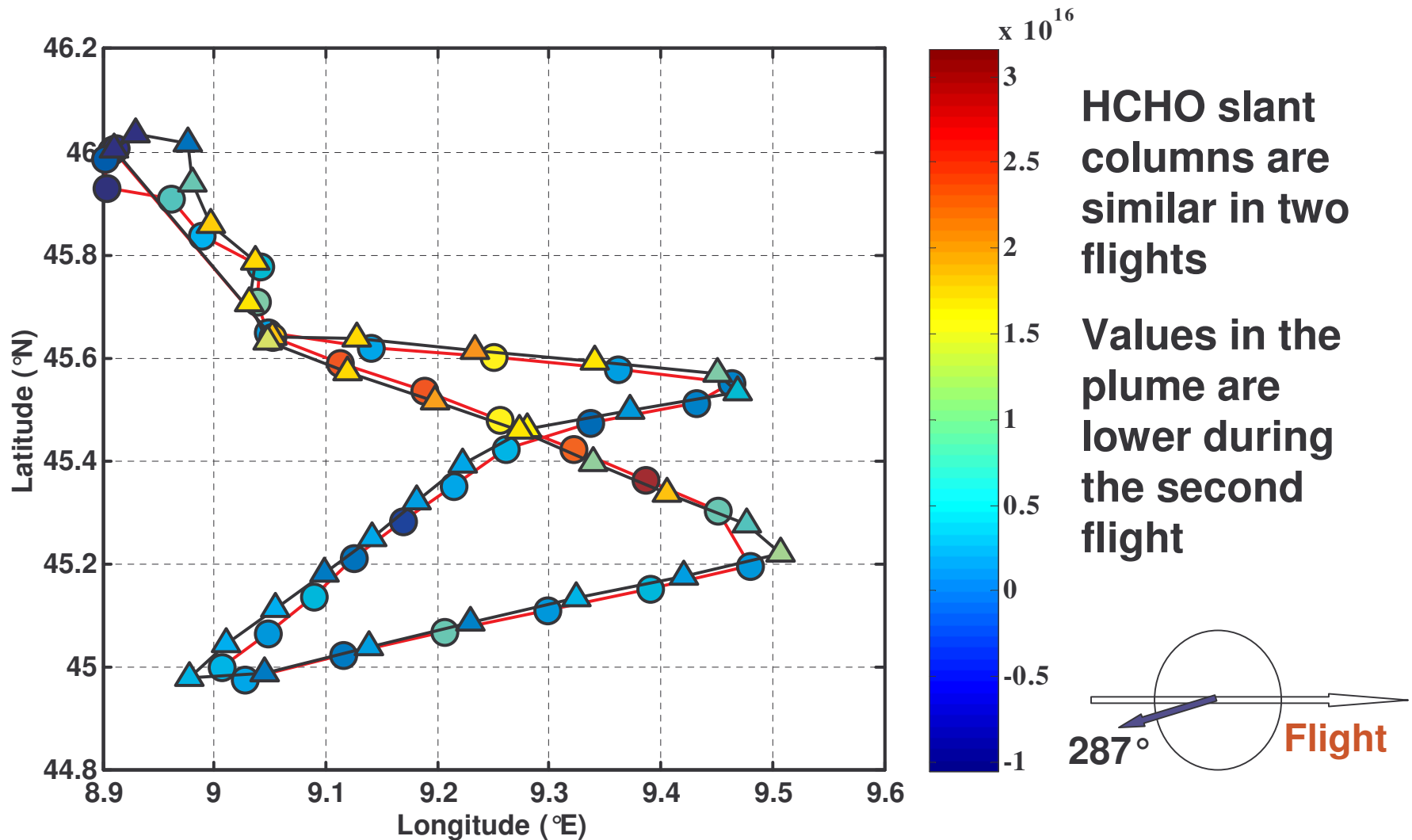
The plume is repeated twice because of flight route



HCHO slant column on map



AMAX: HCHO Slant column along flight track 020815

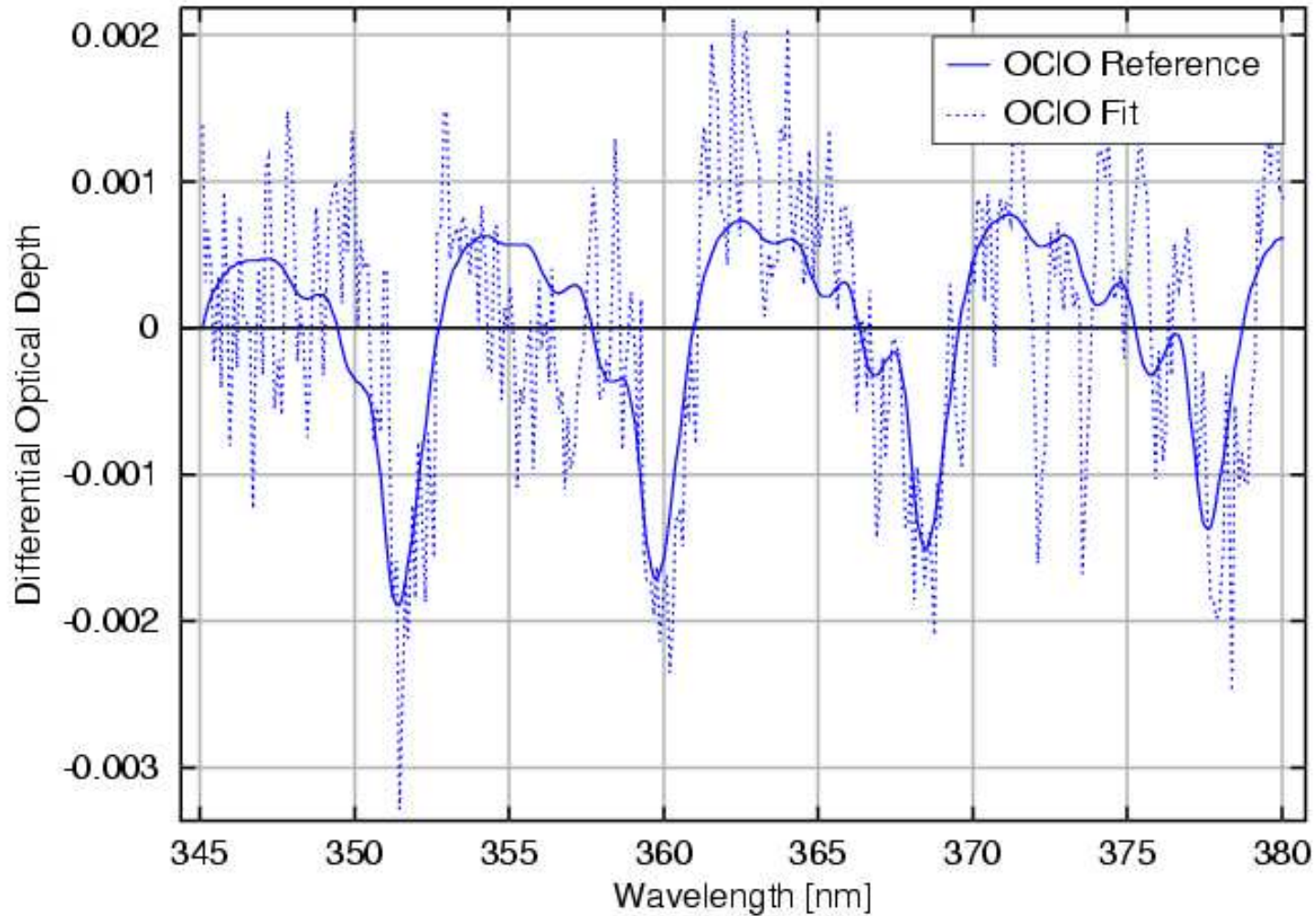


Summary and Outlook AMAX Format Campaign

- 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

File 030126_F.CA1, 09:27:28, SZA = 91.34°



**A Nice
OCIO fit**

background
spectra

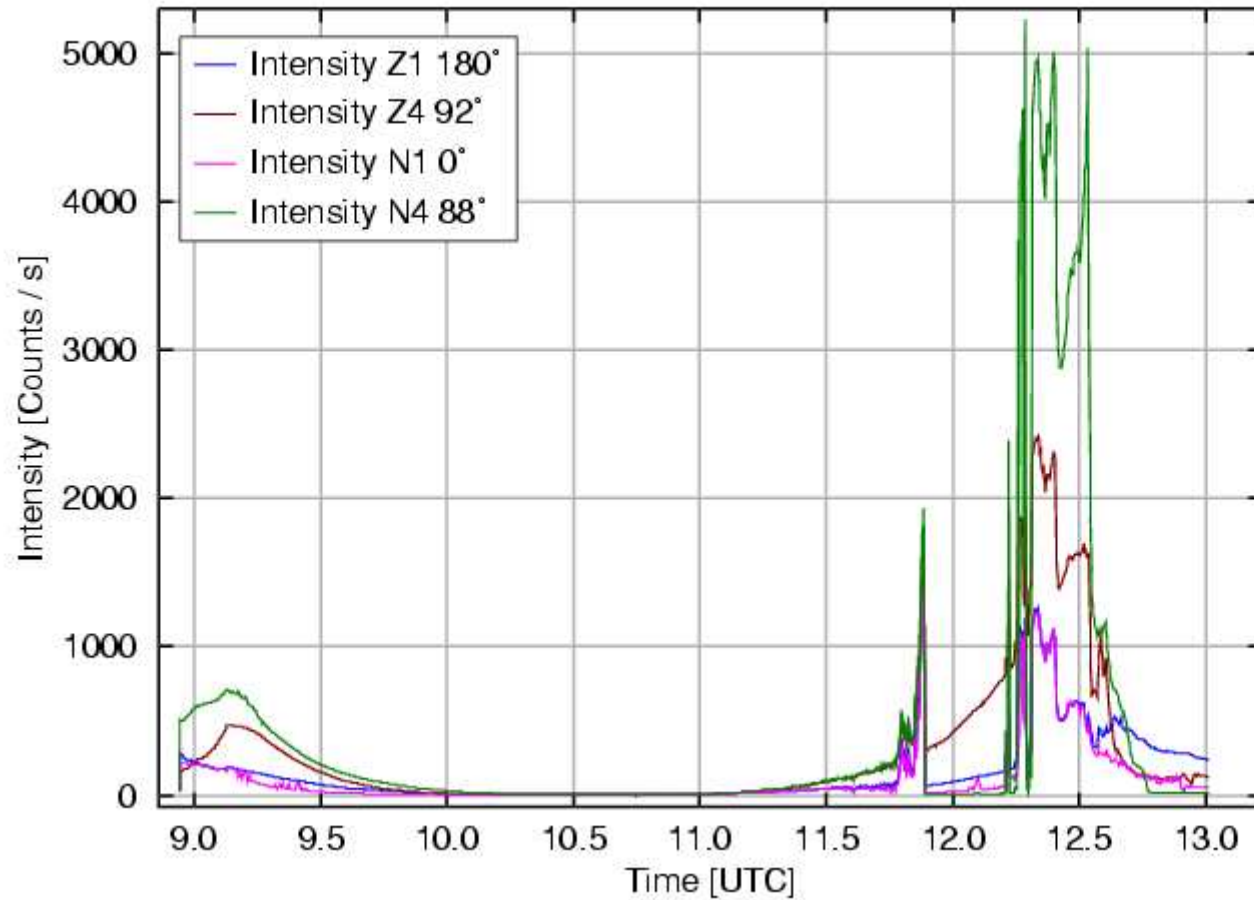
SZA = 89.6°

View angle

92°

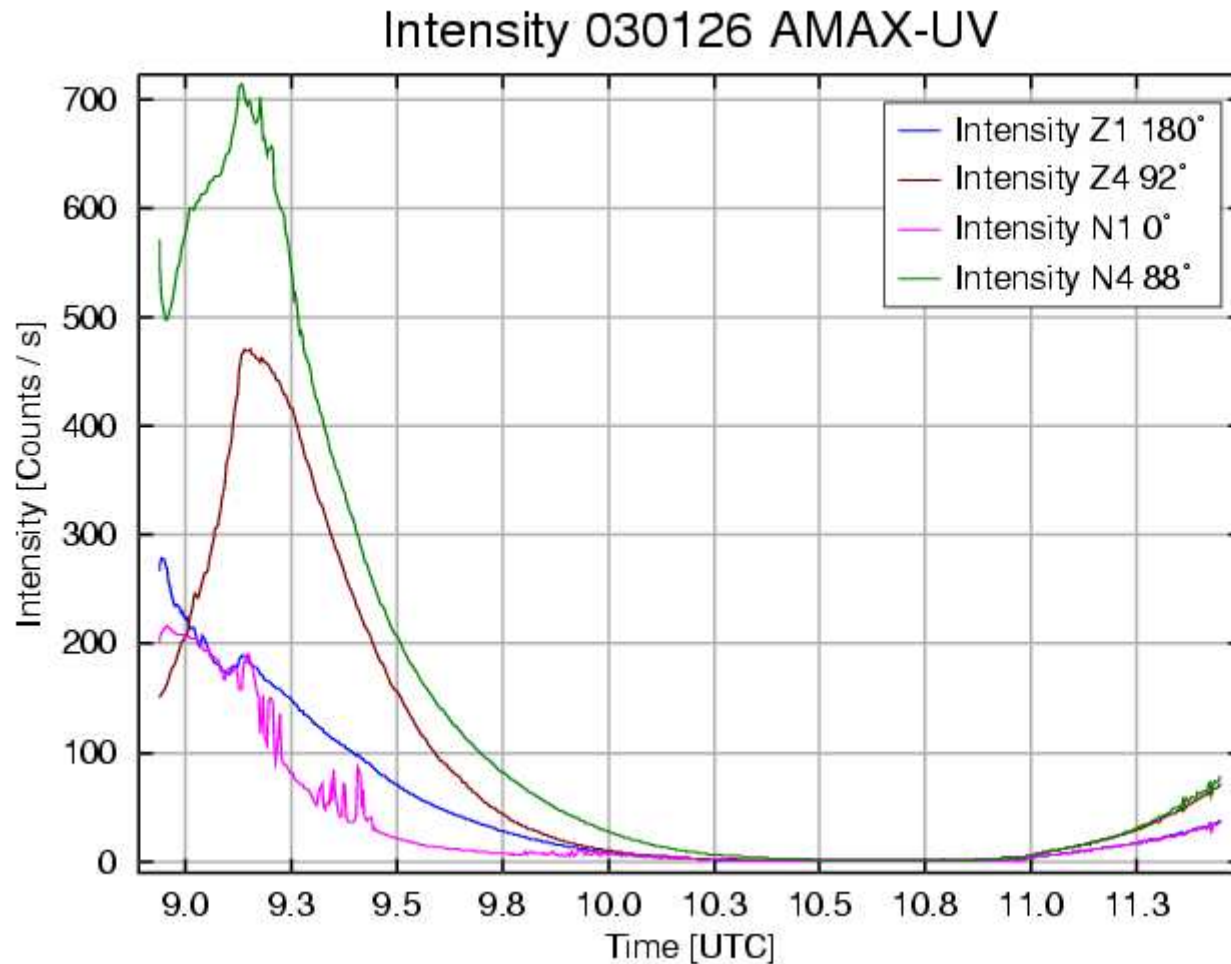
Intensity 030126

Intensity 030126 AMAX-UV



**Low
intensity**

Intensity 030126 1



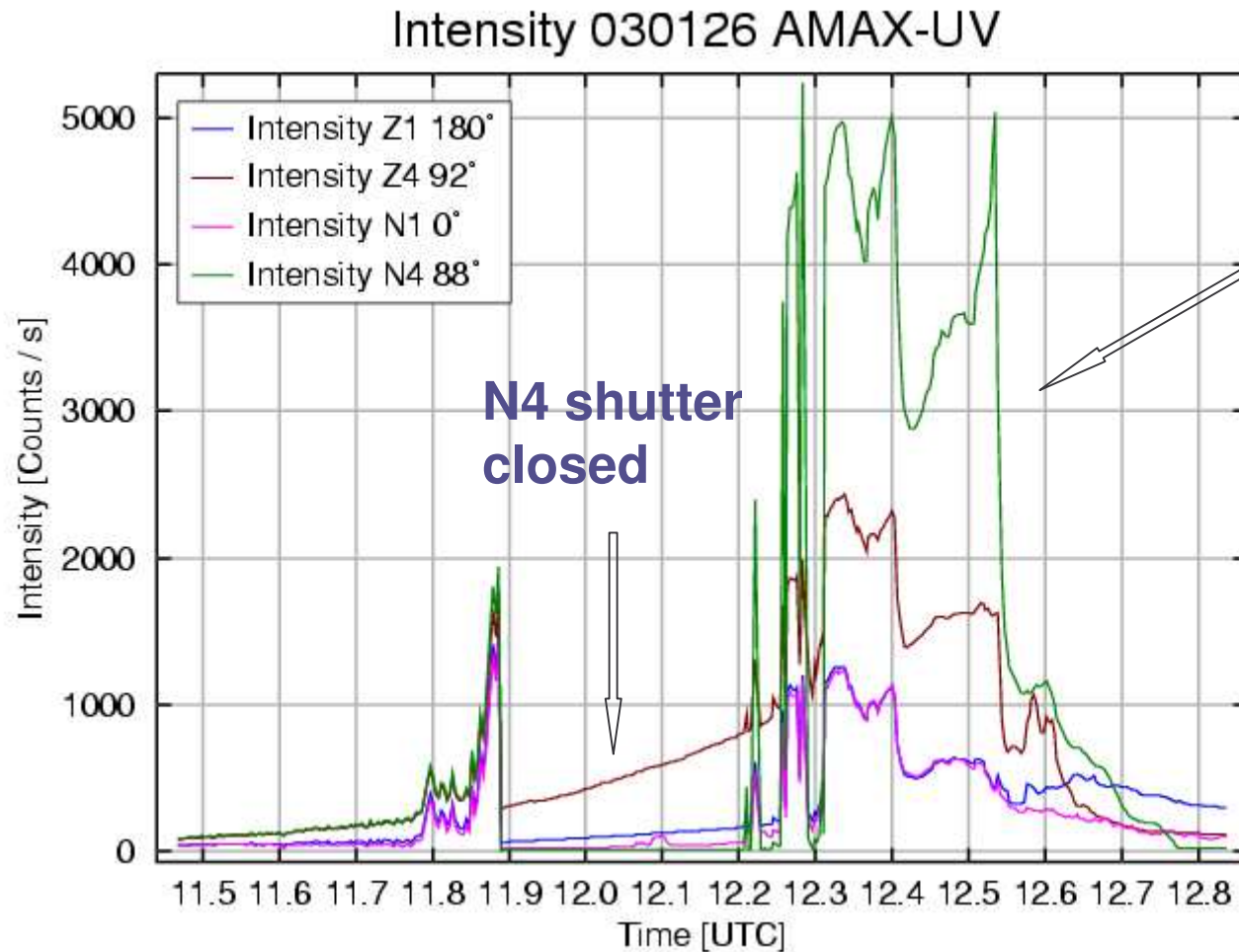
9.2 take off

10.3-11.0

SZA > 95°

No rapid intensity variation except for nadir.

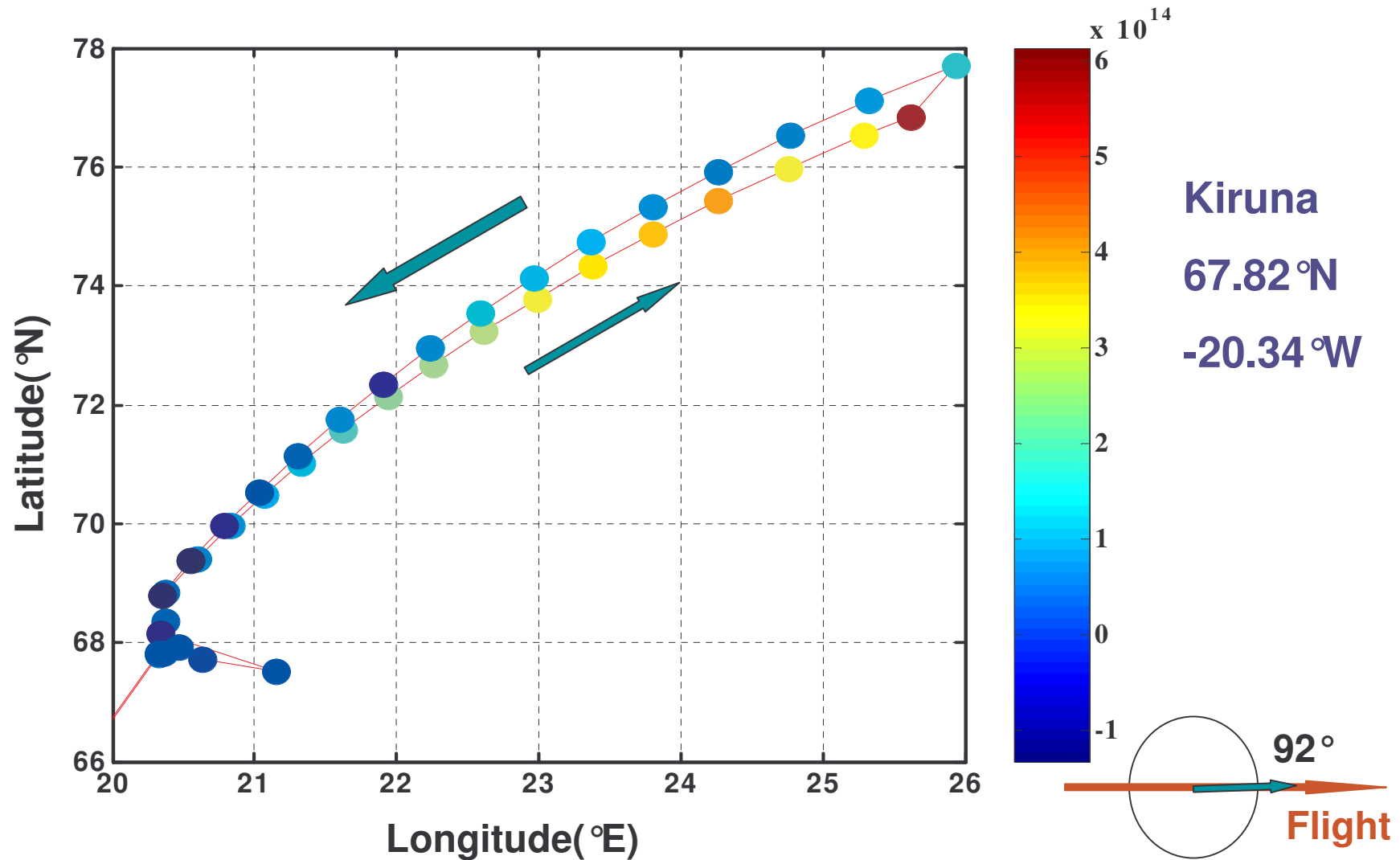
Intensity 030126 2



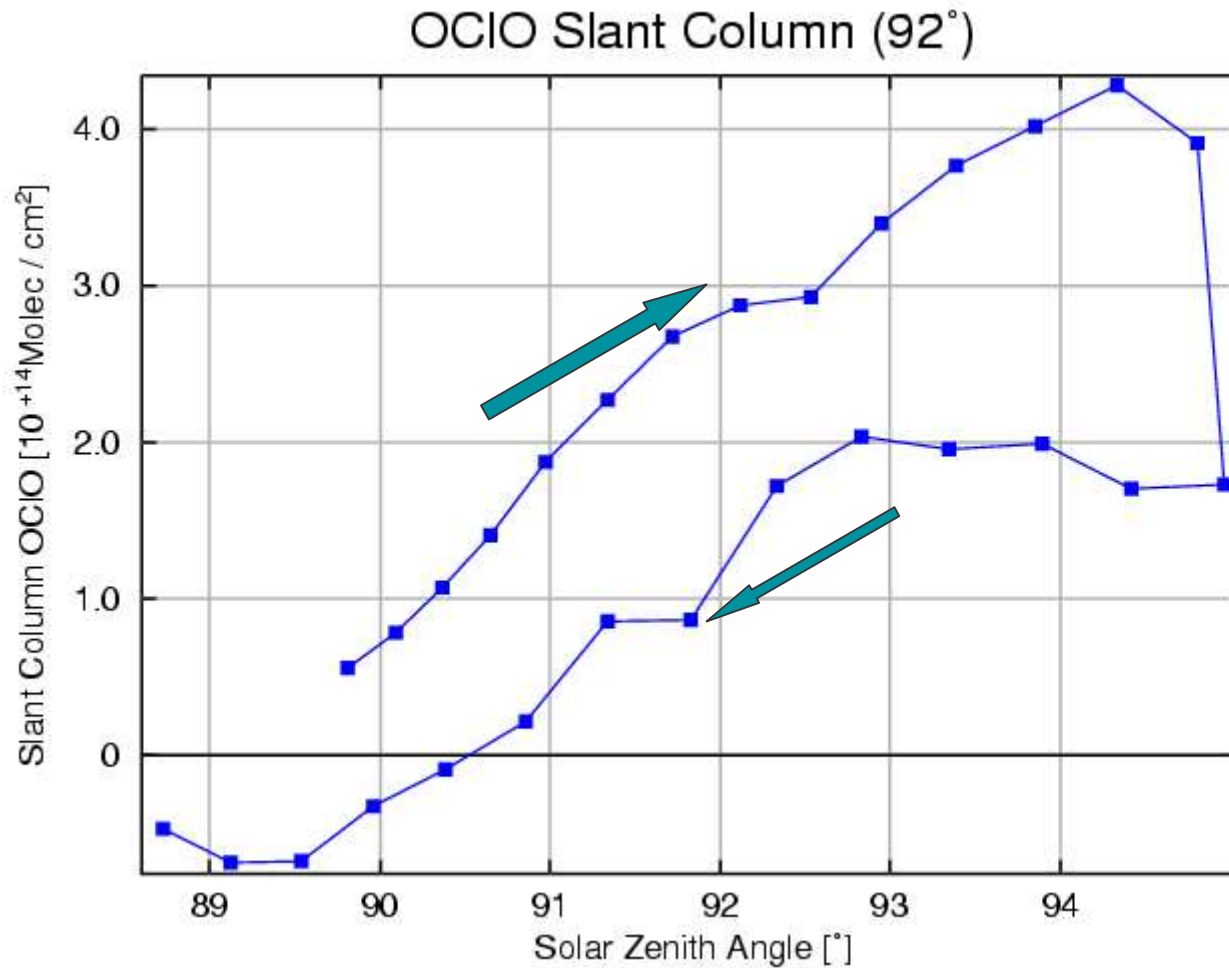
N4 too bright,
lots of straylight
in other directions

Why N4
shutter didn't
close?

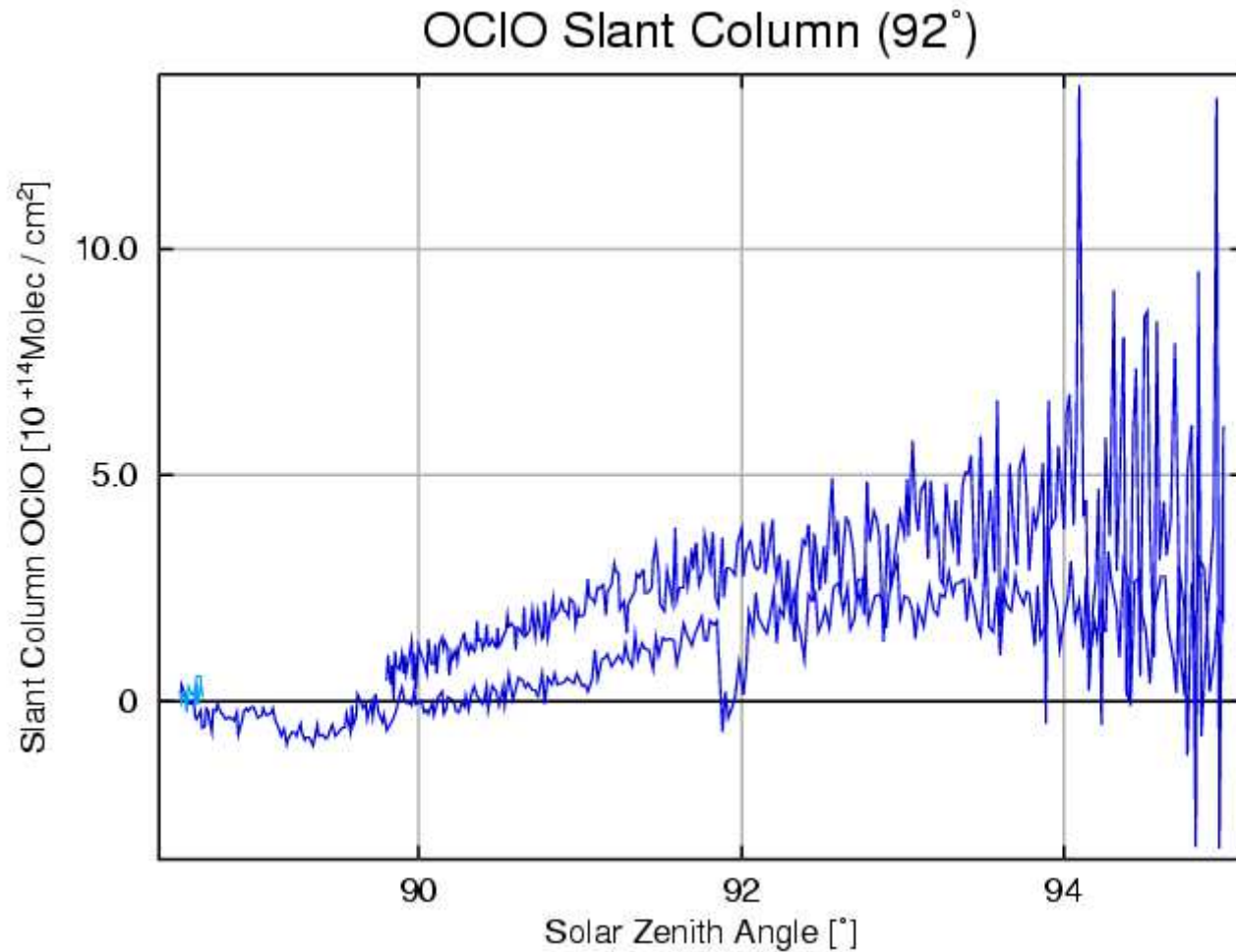
OCIO Slant columns along flight track



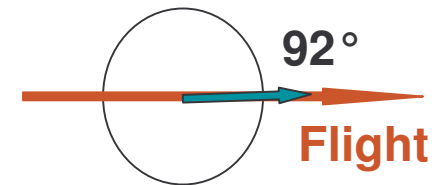
OCIO Slant Columns, after straylight correction



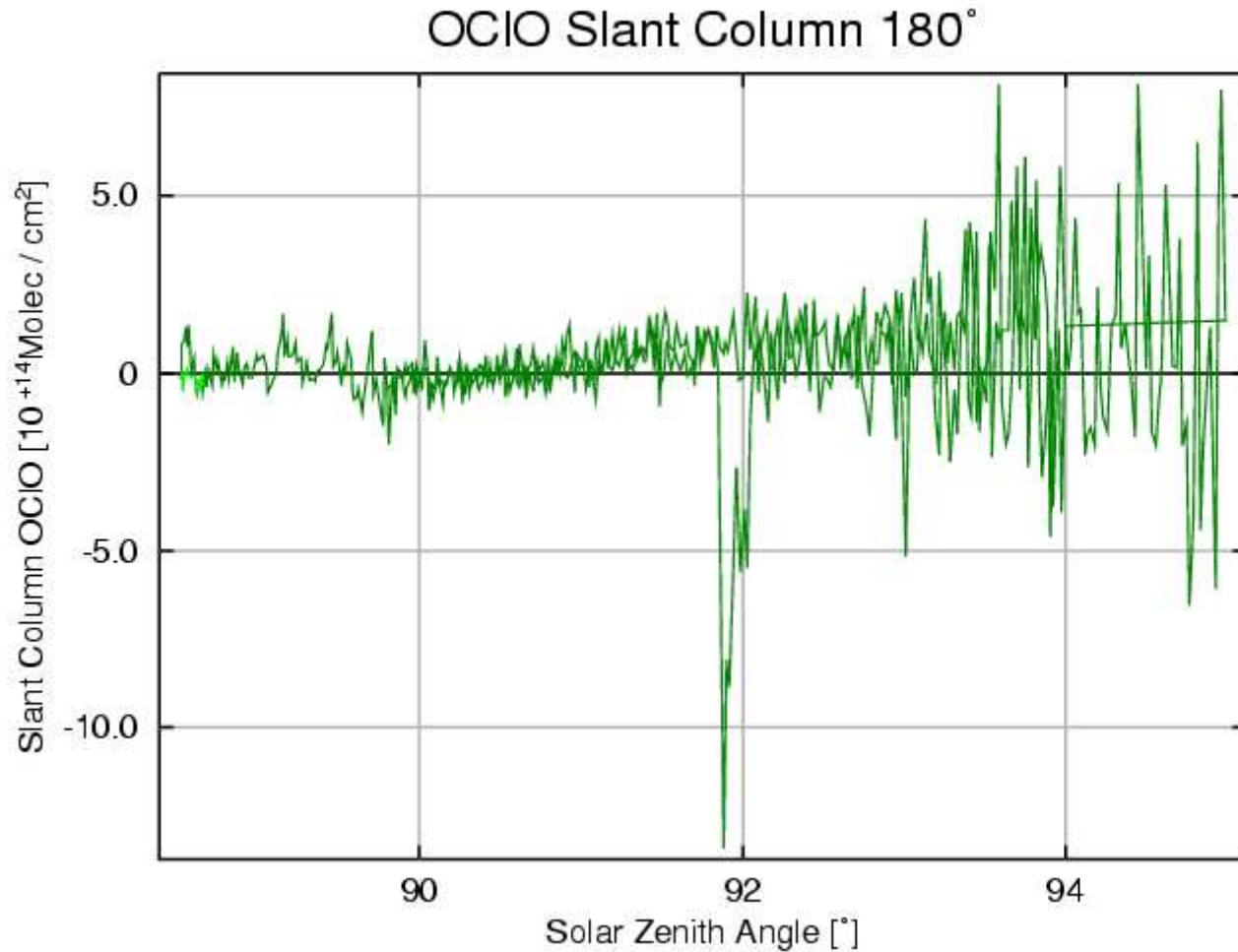
OCIO Slant columns zenith off-axis, after straylight correction



Spectra without average



OCIO Slant columns zenith



zenith view
direction

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