Norwegian Validation of ENVISAT Atmospheric Chemistry Products (NOVENA) status: january 2003

Overall objective:

To contribute to the validation of level-2 products of three ENVISAT instruments (SCIAMACHY, MIPAS, GOMOS) by means of the Norwegian Atmospheric Monitoring network.

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- Arne Dahlback (University Oslo)
- Reidar Lyngra, Kolbjørn Bekkelund, Michael Gausa (ARR)

- AOID 9079, PI: G. Hansen, NILU
  final report: 'Implementation of a daylight receiver in the ALOMAR ozone lidar', December 2002.

- contribution to AOID 158 (CINAMON), Coord.: J.-C. Lambert, BIRA
  Pole-to-pole geophysical validation, interpretation and application of ozone-related ENVISAT-1 level-2 products, using correlative observations associated with the NDSC.

- contribution to AOID 360 (VETO), Coord.: Ph. Keckhut, Service d'Aeronomie du CNRS
  Validation of stratospheric and mesospheric ENVISAT temperature, ozone and aerosols with NDSC ground profilers by direct comparisons and with an assimilation model.

Contents:

- Work packages, persons involved
- ALOMAR ozone lidar: daylight receiver
- Data, uploaded to CalVal database
- WP 1 & 3: Validation of total ozone and other trace gases
  - Preliminary validation results for SCIAMACHY total O_3 and NO_2
  - Brewer ozone observations
- WP 2: Validation of ozone profiles
  - Ozone over ALOMAR during 2002
  - Preliminary validation results of MIPAS and GOMOS O_3 profiles
- WP 4: Asynoptic mapping of ozone and other trace gases
  - Synoptic maps of ozone (pole-to-pole)
  - Southern hemispheric vortex: disappearance of the 'ozone hole'
- Economy status
- Polar stratospheric clouds seen by DIAL and MIPAS (CTH)
- Outlook

Work packages and persons involved

WP1 Validation of total ozone

Kåre Edvardsen[1], Arne Dahlback[2], Kerstin Stebel (Brewer, GUV)
Bill Arlander[1], Kjersti Tørnkvist[1] (Symocs-Vis)
Britt Ann Kaastad Høikar[1] (SAOZ)

WP2 Validation of ozone profiles

Åsmund Fahre Vik[1], Tor Ofstad[1], Ola Engelsen[1] (ozone sondes)
Georg Hansen[1] , Kerstin Stebel[1] , Kåre Edvardsen[1] ,
Kolbjørn Bekkelund[3], Michael Gausa[3], Reidar Lyngra[3] (lidar)

WP3 Validation of other trace gases

Bill Arlander[1], Kjersti Tørnkvist[1] (Symocs-Vis)
Britt Ann Kaastad Høikar[1] (SAOZ)

WP4 Asynoptic mapping of ozone and other trace gases

Yvan Orsolini[1]

[1]: NILU, [2]:University Oslo, [3]: Andøya Rocket Range

Implementation of a daylight receiver in the ALOMAR ozone lidar

Trude Storelvmo, ALOMAR, Michael Gausa, ALOMAR,
Georg Hansen, NILU, Kåre Edvardsen, NILU, Kerstin Stebel, NILU

Final report, December 2002

Ozone DIAL at ALOMAR (69.28°N, 16.01°E)

Laser:

- XeCl Excimer laser (Lambda Physics LPX 150T)
- Wavelengths 353.2, 307.95, 308.2 nm
- Pulse frequency: 200 ± 5 Hz, energy: ca. 150 mJ
- Divergence ≤ 0.15 mrad (after 3x expansion)

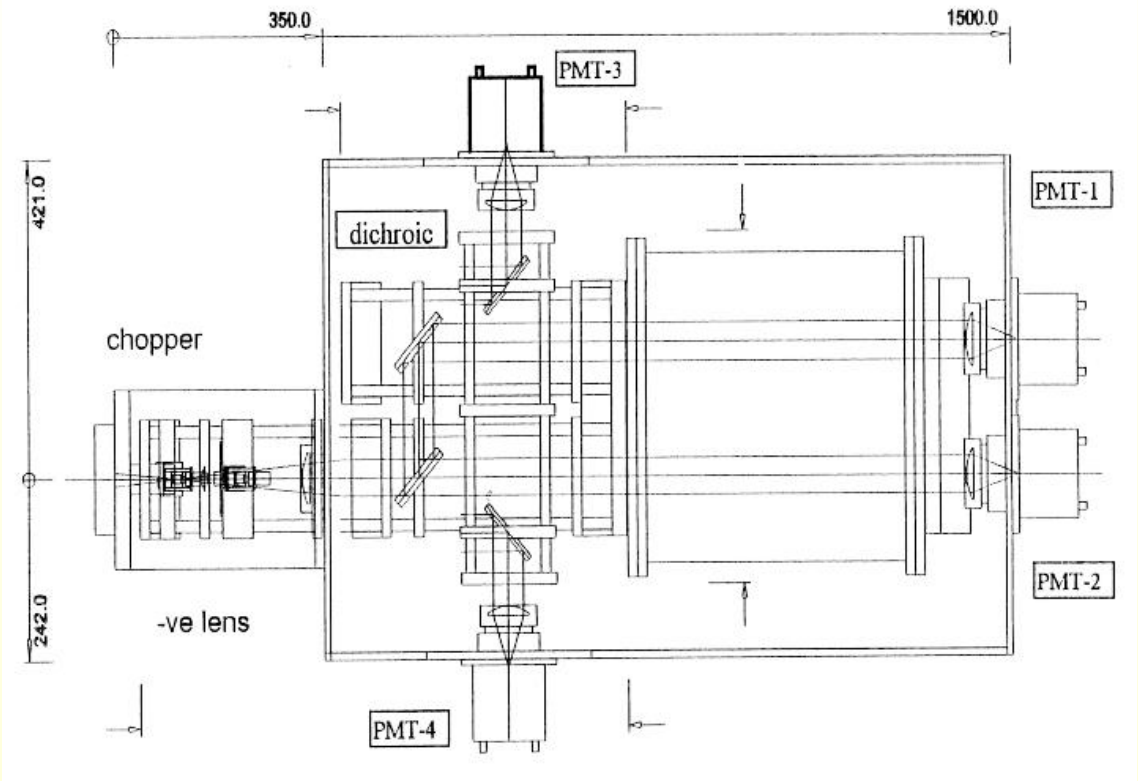
Telescope:

- Diameter: 1 m, Focal length:2.45 m

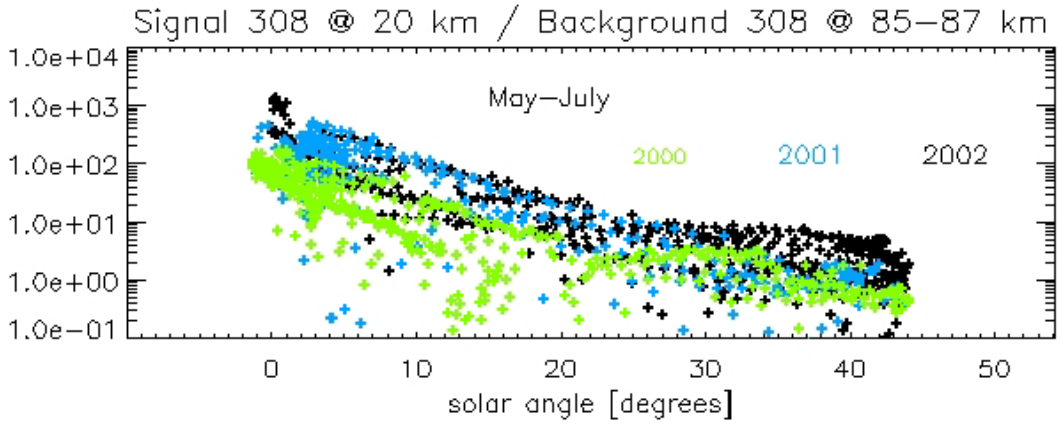
Daylight detector:

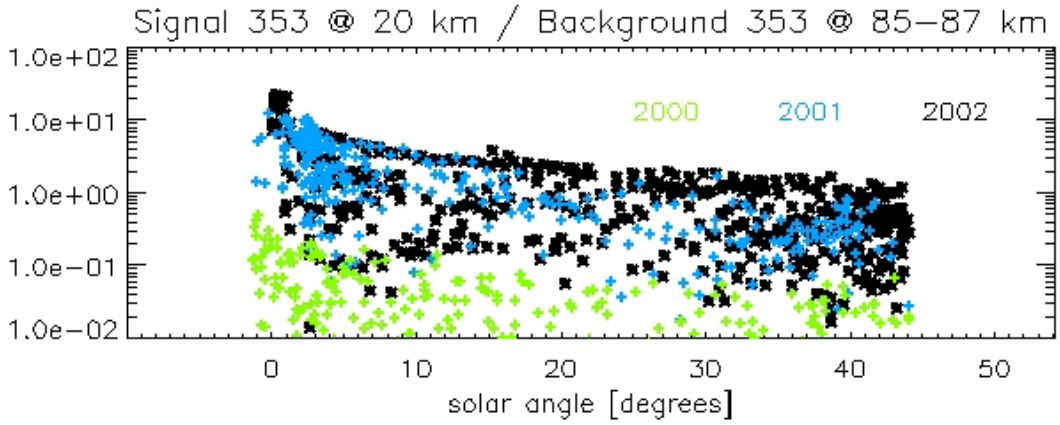
- Etalon system

- Standard altitude resolution: 100 m (max. 30 m)
- Single file acquisition duration: typically 5 minutes (2.5 minutes)

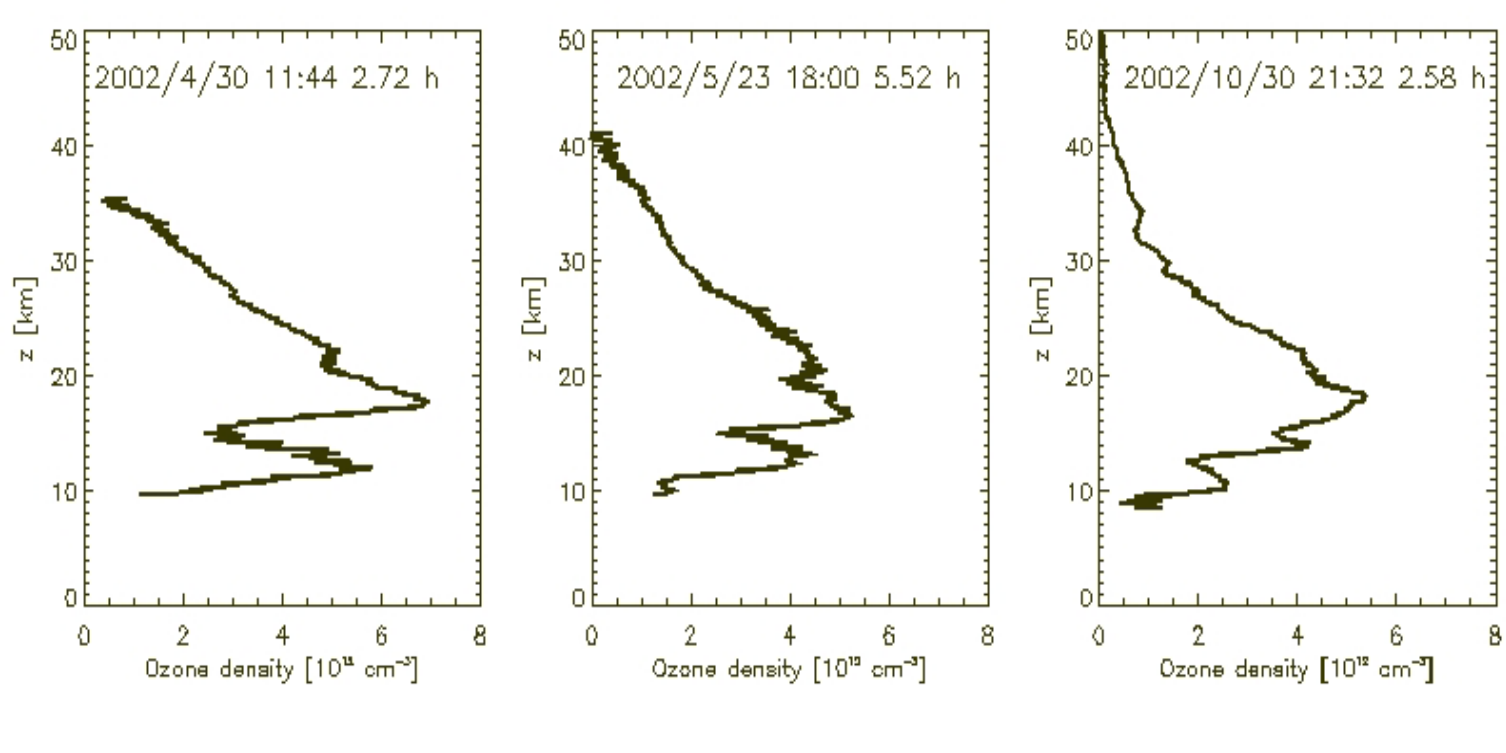


Drawing of the 2 channel daylight detection system (by Howermere Ltd., UK), based on capacitance-stabilised etalons (308 nm: single, 353 nm: double). During night time the light is divided into at the side mounted photomultipliers by-passing the etalon system.





Signal-to-noise ratio for summer time (May - July) measurements in 2000, 2001 and 2002 as a function of solar elevation angle. An improvement since summer 2000 (green values) can be clearly seen. Additional efforts in 2002 led to better results in particular at high solar zenith angles.



Ozone density profile from a. April 30, 2002, 10.26 -13.04 UT (solar elevation 35-30°) [left], b. May 23, 2002, 15.17 - 20.42 UT (solar elevation: 28-4°) [middle], c. October 30, 2002, 20.23 22.39 UT (night time system) [right panel]. Reliable ozone density profiles can be measured during full daylight conditions up to a maximum altitude of 36 km (optimal conditions, larger sza: 42 km) from less than 2 hours of continuous measurements (nighttime: the maximum altitude is ca. 50 km, about 1 hour averages).

Data:

mostly uploaded to CalVal database !

only exception:

SAOZ data (O_3, NO_2) from Ny-Ålesund,
not uploaded yet due to personell leave

Symocs-UV data (OClO, BrO) from Andøya,

no data due to detector failure

List of ozone density profiles from ozone lidar at ALOMAR, Sept. - Dec. 2002.

September:	8d, 14d, 19dn, 20xn, 21xn, 22d, 30dn
October:	3d, 4n, 5d, 7n, 8d, 9d, 10dn, 12x-, 13xn, 14x-, 21xx, 23d, 30n, 31xn
November:	7dn, 8n, 10n, 11xn, 12d, 13n, 14n, 15n, 20d, 21dn, 22n, 24n, 30n
December:	1n, 2dn, 3xn, 4n, 5n, 7n, 16n, 25n, 28n

d:daylight, n: nighttime measuremenst

x: data of lower quality, not uploaded to CalVal database

Cal/Val measurements during 2003

Oslo, Blindern (59.9 N, 10.7 E)

GUV:	0601 - 1019 (138 days, 15 min avg., sza < 70°)	**O_3 column**
Brewer:	0821 - 1023 (60 days, x min, direct sun, sza < 80°)	**O_3 column**

Ørland (63.4 N, 9.2 E)

O_3 sondes:	0606 - 1127 (23 sondes)	**O_3 profile**

Andøya (69.3 N, 16.0 E)

Ozone DIAL:	0908 - 030109 (49 profiles)	**O_3 profile**
Symocs-Vis:	0719 - 1115 (in 6 files, sza: 90 dawn,dusk)	**O_3, NO_2 column**
Symocs-UV:	detector failure -	
Brewer	0602 - 1017 (107 days, direct sun, zsa < 80°)	**O_3 column**
GUV	0601 - 0827 (88 days, 15 min avg., zsa < 60°)	**O_3 column**

Ny Ålesund (78.9 N, 11.9 E)

GUV	0601 - 0830 (91 days, 15 min avg., zsa < 60°)	**O_3 column**
SAOZ	0909 - 2010, data not uploaded yet	**O_3, NO_2 column**

WP 1 & 3:

Validation of total ozone and other trace gases

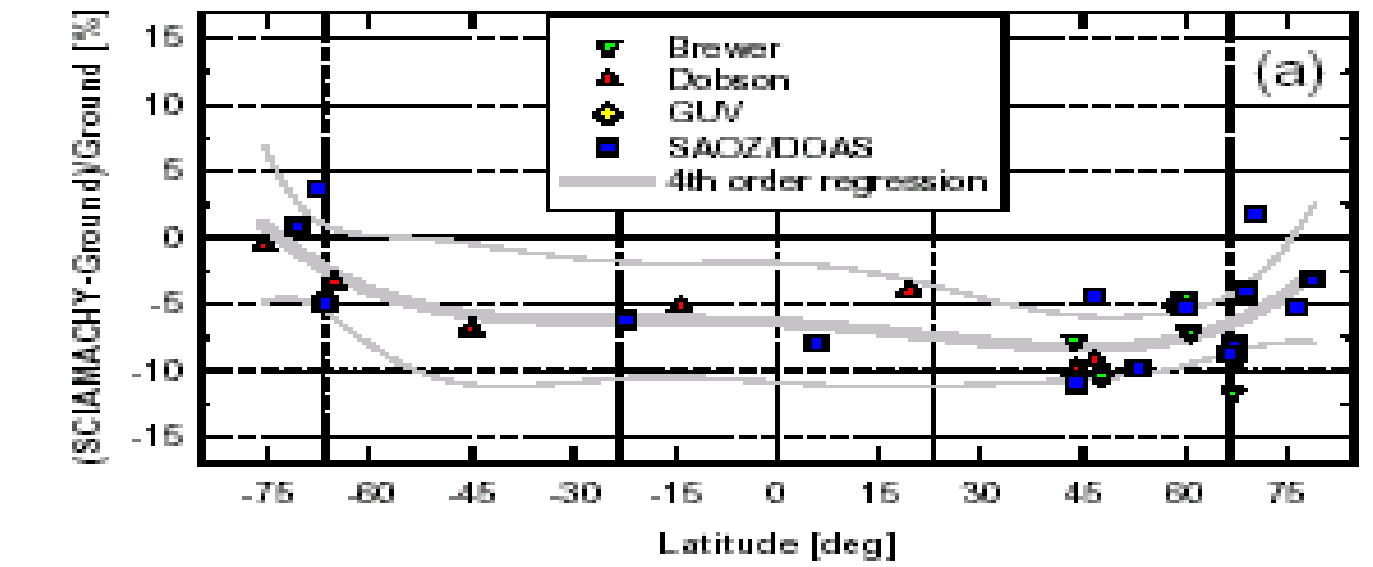
present validation results :

- contribution to AOID 158 (CINAMON), J.-C. Lambert, BIRA

  Validation of SCIAMACHY total O_3 and NO_2 column densities

Results from GOME validation, Brewer ozone observations

Mean agreement between SCIAMACHY V 3.53 and UV-visible total O_3



Plot from J.-C. Lambert (4), BIRA, Belgium

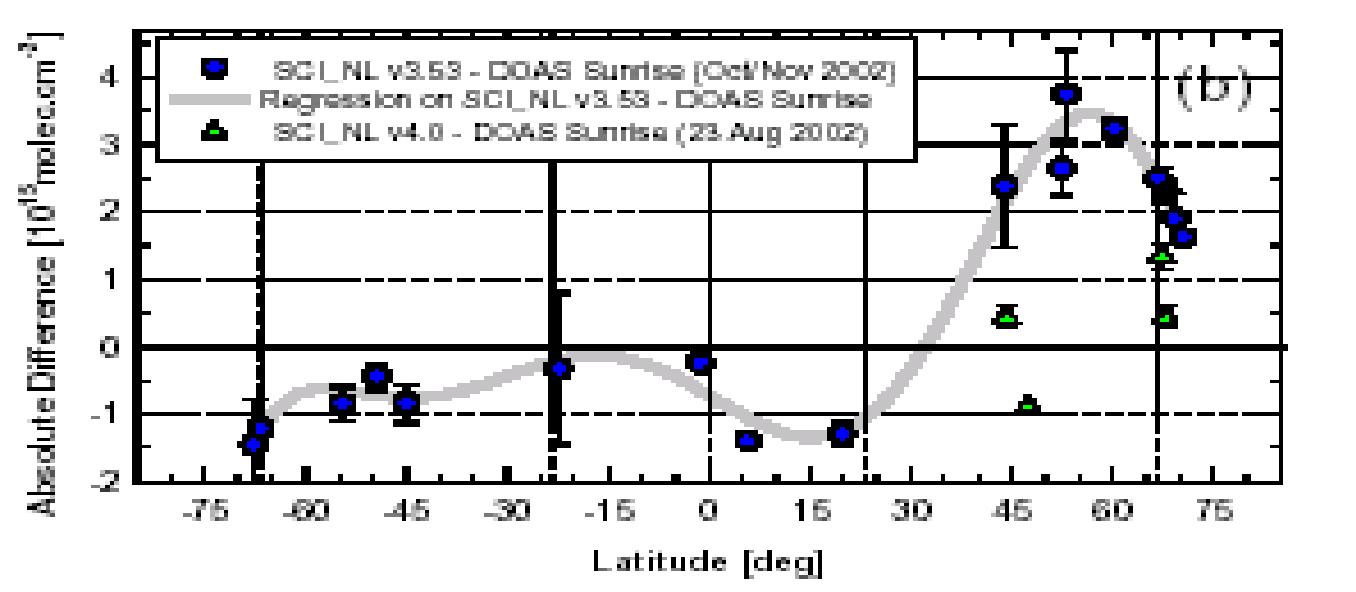
J.C.Lambert: 'A general 5-8 % underestimation of groundbased values by SCIAMACHY vanishes near the poles.'

SCIAMACHY (V 3.53) total NO_2 validation: UV-visible DOAS instruments (October-November 2002)

Station/Location	Lat.	Long.	Sensor	Institute	Deviation
Ny-Ålesund/Spitsbergen	79°N	12°E	SAOZ	NILU	
			DOAS	IUP/Bremen	
Thule/Western Greenland	77°N	69°W	SAOZ	DMI	**+2**
Scoresbysund/Eastern Greenland	70°N	22°W	SAOZ	CNRS/DMI	**+1.62**
Andøya/Norway	69°N	16°E	DOAS	NILU	**+1.9**
Kiruna/Sweden	68°N	20°E	DOAS	NIWA	**+2.31**
			DOAS	IUP/Heid.	
Sodankylä/Finland	67°N	27°E	SAOZ	CNRS/FMI	**+2.42**
Zhigansk/Eastern Siberia	67°N	123°E	SAOZ	CNRS/CAO	**+2.5**
Salekhard/Western Siberia	67°N	67°E	SAOZ	CNRS/CAO	
...	...		...	...	

Table adapted from J.-C. Lambert, BIRA, Belgium

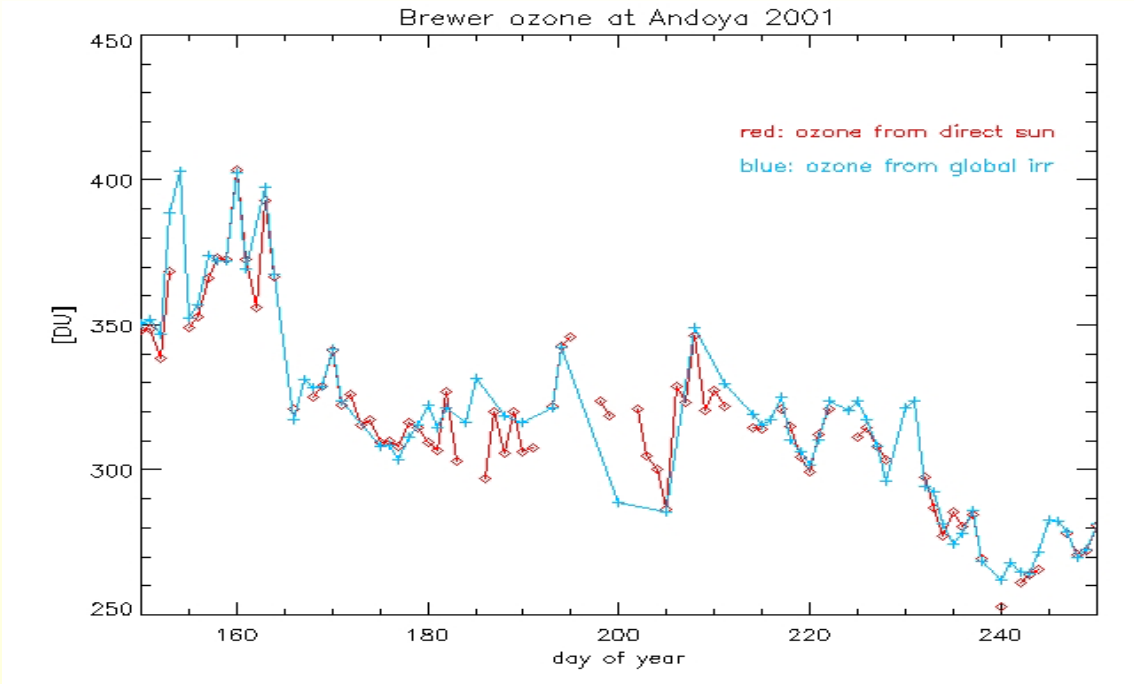
Mean agreement between SCIAMACHY V 3.53 and UV-visible total NO_2



Plot from J.-C. Lambert (4), BIRA, Belgium

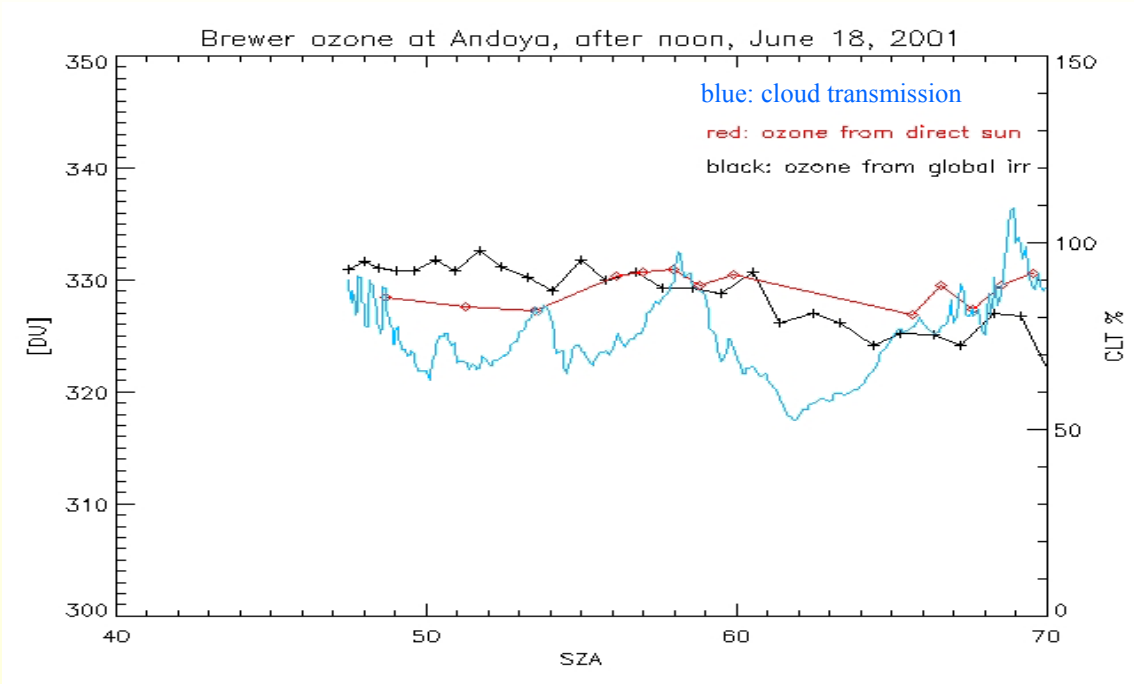
J.C.Lambert:' The deviations between SCIAMACHY V 3.53 and UV-visible total NO2 shows a strong latitudinal structure, which might be related to the use of an improper atmospheric profile database for the calculation of the SCIAMACHY airmass factors.'

Brewer ozone observation



Further development of the analysis software for Brewer data allow us to calculate O_3 not only from direct sun observations, but also from global irradiance measurements. The agreement of the ozone column derived from these two methods is good.

Brewer ozone, June 18th, 2001



Global irradiance measurements are independent of direct sun (DS) and therefore important when cloudy conditions may prevent DS measurements. This will improve the measurement statistics for Andøya significantly

WP 2:

Validation of ozone profiles

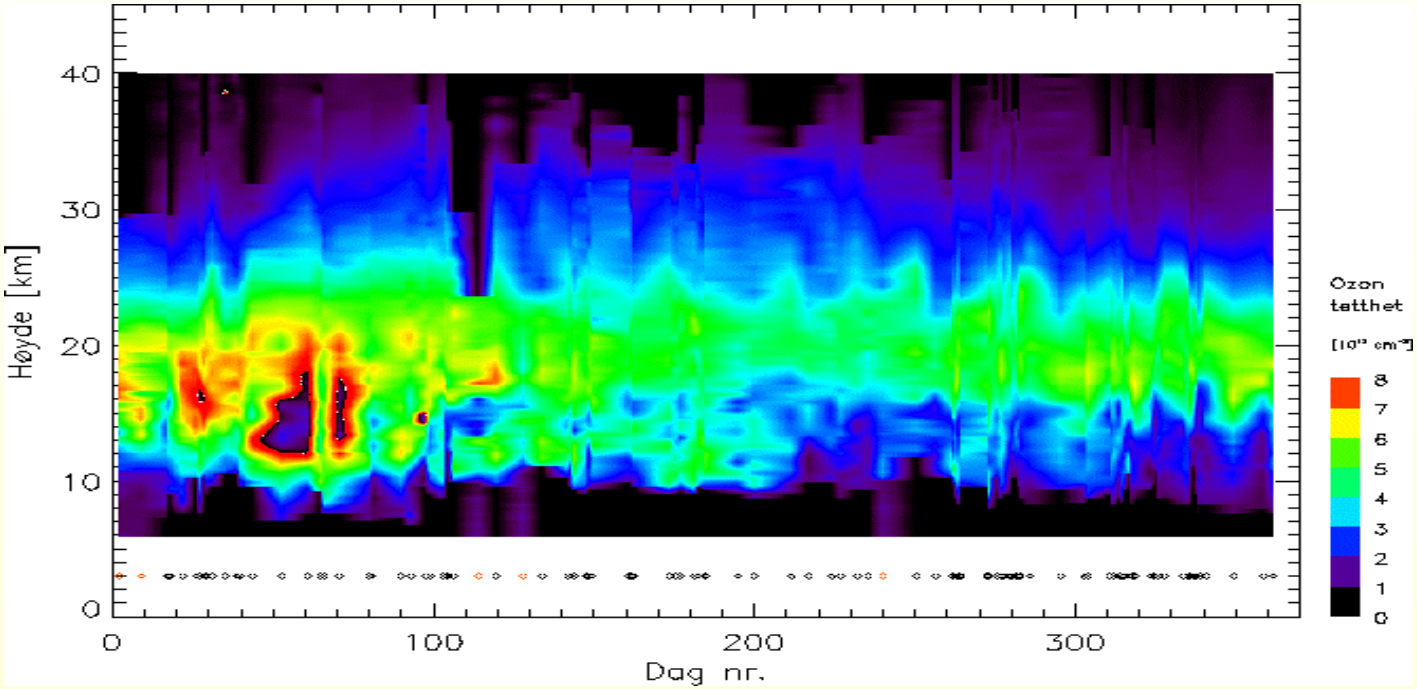
- contribution to AOID 158 (CINAMON), J.-C. Lambert, BIRA
- contribution to AOID 360 (VETO), Ph. Keckhut, Service d'Aeronomie du CNRS

Ozone over ALOMAR during 2002

present validation results :

- Comparison of O_3 profiles from MIPAS & lidar from ALOMAR
- Comparison of O_3 profiles from GOMOS & lidar from ALOMAR

Ozone distribution over ALOMAR during 2002



The ozone distribution over ALOMAR as a function of altitude and day of the year for 2002. The black (red) diamonds at the bottom of the plot show days with lidar observations (ozone sondes from Sodankylae). About 130 measurements have been collected in 2002, more than half of which were during daylight conditions.

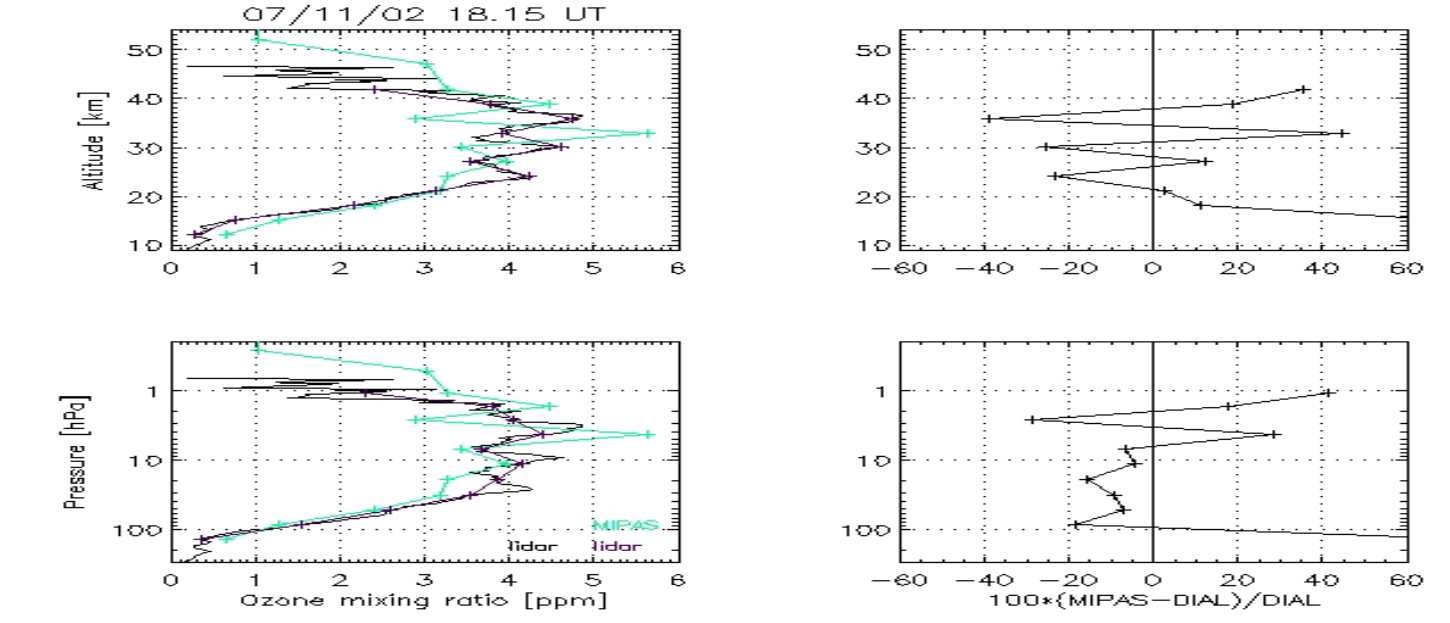
Colocated MIPAS & lidar measurements from ALOMAR (69.28°N, 16.01°E)

Criteria: 3 degrees in long./lat. spatial distance

max.10 hours temporal offset

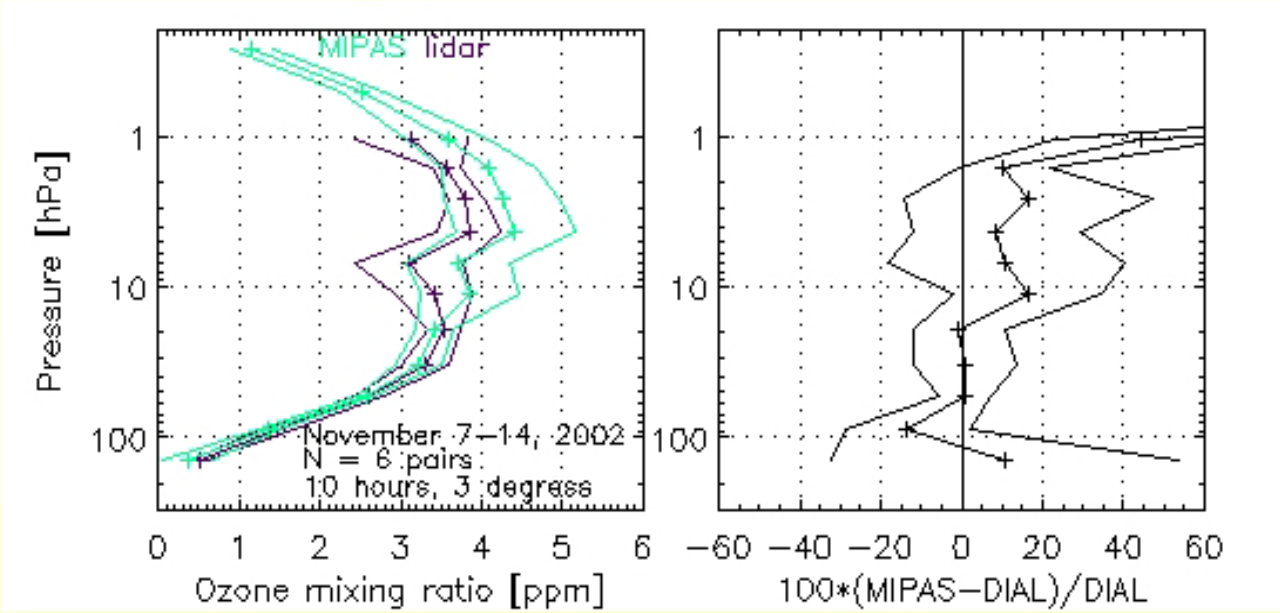
DIAL	MIPAS
07/11/02 11:57 UT (5.0 h)	09:17 UT (71.8 N, 16.9 E)
07/11/02 18:15 UT (2.0 h)	20:50 UT (69.3 N, 19.2 E)
10/11/02 16:42 UT (1.6 h)	20:56 UT (69.3 N, 17.6 E)
11/11/02 18:16 UT (3.1 h)	08:53 UT (67.0 N, 21.4 E)
14/11/02 17:55 UT (1.9 h)	08:57 UT (71.8 N, 21.9 E)
14/11/02 17:55 UT (1.9 h)	08:59 UT (67.0 N, 19.9 E)

MIPAS O_3 02/11/07 20:50 UT (69.3N,19.2E) compared to ozone from the lidar at ALOMAR (69.3N,16.01E) 18:15 UT (2.0 h)



During this day the ozone profile was dynamically disturbed; the lidar profile shows three local maxima. The vertical fine structure is very well seen by lidar as well as by MIPAS. Further, the pointing miss-alignment of MIPAS, which has been reported by ESA and has been corrected on November, 13th is obvious.

Comparison of ALOMAR DIAL O_3 profiles and MIPAS data (6 pairs) between November 7th and 14th 2002.



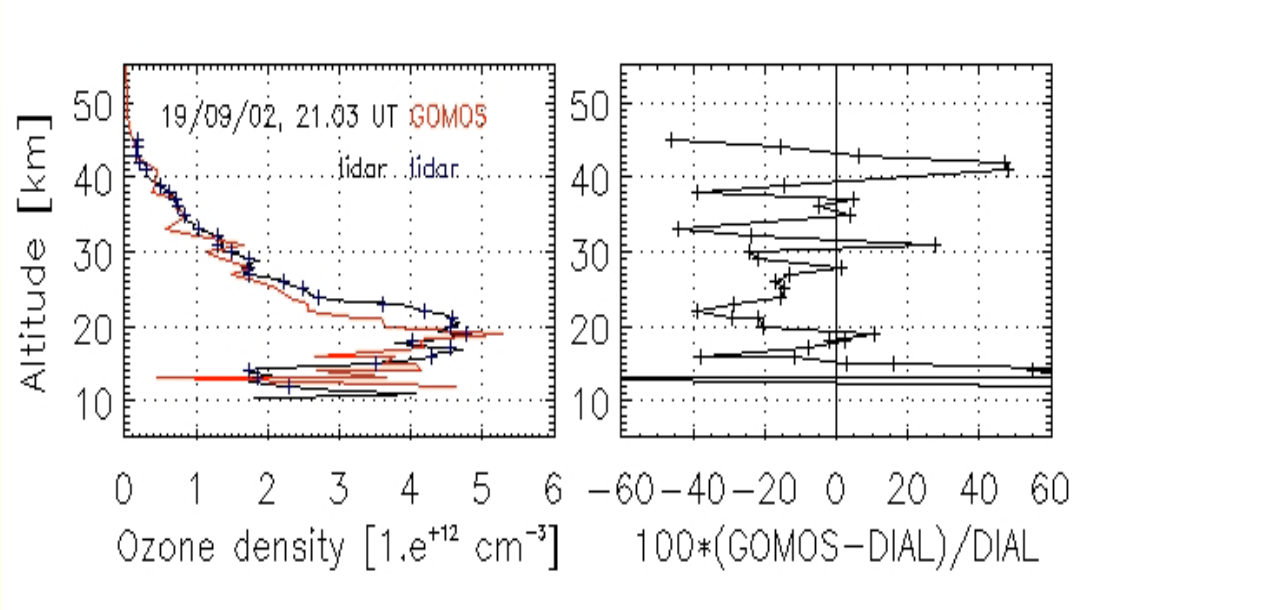
The comparison shows good agreement between the ALOMAR lidar and MIPAS data above 100 hPa, particularly below 20 hPa (0±10 %). Mean differences of about 15 % are seen between between 1 and 10 hPa.

Colocated MIPAS & lidar measurements from ALOMAR (69.28°N, 16.01°E)

Criteria: 500 km, 3 hours

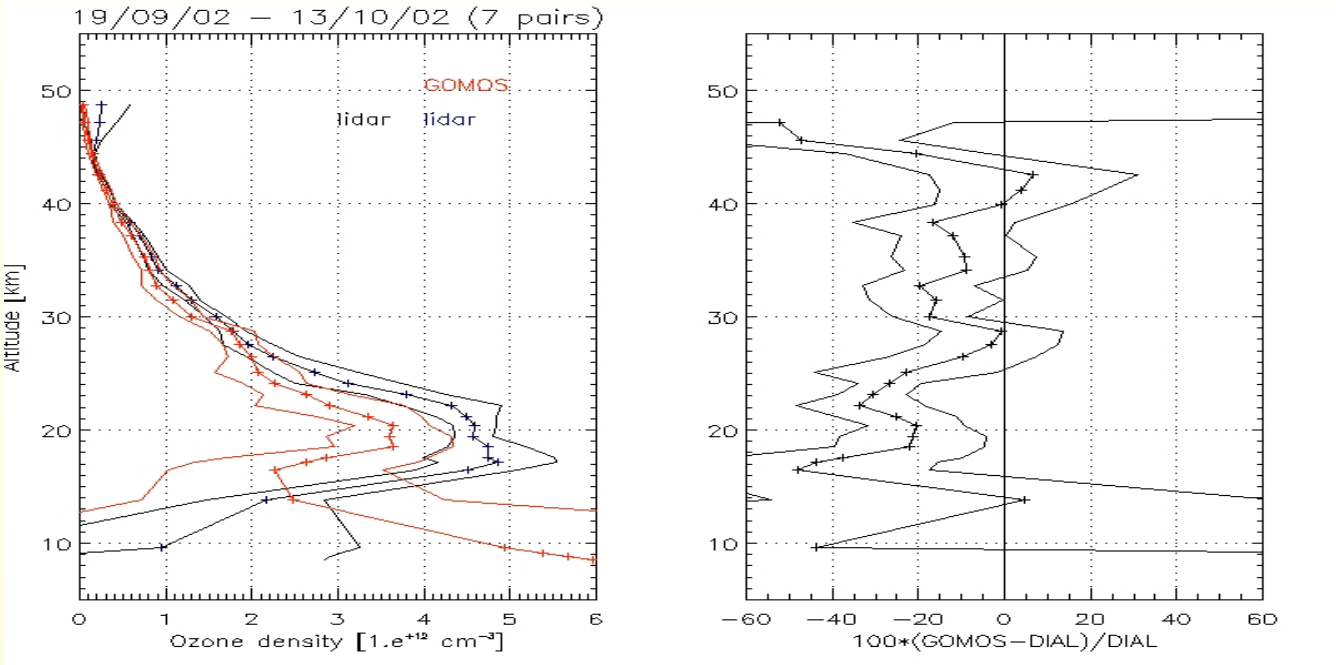
DIAL	GOMOS
19/09/02, 21.03 UT, solar angle: -16°	18.11 UT (orbit: 2091, T_{star} = 8900 K)
19/09/02, 21.03 UT, solar angle: -16°	23.12 UT (orbit: 2904, T_{star} = 4500 K)
20/09/02, 20.24 UT, solar angle: -20°	19.20 UT (orbit: 2915, T_{star} = 8900 K)
20/09/02, 20.24 UT, solar angle: -20°	22.40 UT (orbit: 2918, T_{star} = 4500 K)
21/09/02, 20.10 UT, solar angle: -14°	18.49 UT (orbit: 2930, T_{star} = 8900 K)
30/09/02, 22.50 UT, solar angle: -22°	22.26 UT (orbit: 3061, T_{star} = 4500 K)
13/10/02, 19.37 UT, solar angle: -19°	20.37 UT (orbit: 3246, T_{star} = 4500 K)

GOMOS O_3 profiles for September 19th, 2002 18:11 UT ALOMAR DIAL from 21:02 UT (1.1 h)



Comparison between a single ozone profiles measured by GOMOS and the lidar at ALOMAR on September 19th, 2002. Strong fluctuations of the GOMOS profile can be seen. Further, the values below 25 km altitude show deviations of GOMOS with regards to the lidar data of about –30 %.

Comparison of ALOMAR lidar ozone profiles and GOMOS data (7 pairs) September 19th - 13 October 13th, 2002.



The comparison using 7 closely co-located profiles. All lidar profiles where taken with the night-time detector system. GOMOS shows lower ozone values than the lidar. An underestimation of about 20 % at around 20 km altitude can be seen, which we do not expect to result from the lidar ozone retrieval.Whether this is due to the twilight situation GOMOS experienced during that time or is caused by real atmospheric differences needs to be studied further.

Preliminary validation results (1/3)

Mean agreement between **SCIAMACHY V 3.53** and UV-visible total O_3 and NO_2

O_3 column: J.C.Lambert: 'A 5-8% underestimation of groundbased values by SCIAMACHY'. The difference vanishes near the poles.' Whether this is a real improvement of the product near the poles or results from two problems compensating each other needs further studies.

NO_2 column : J.C.Lambert:' A strong meridian structure appears, that might be related to the use of an improper atmospheric profile database for the calculation of the SCIAMACHY AMF.'

Preliminary validation results (2/3)

Comparison of MIPAS ozone profiles with lidar measurements from ALOMAR (69.3° N, 16.0°E)

- ca. 1-1.5 km offset

  (before Nov. 13th, pointing characterisation corrected by ESA)
- fine structure in lidar/MIPAS ozone profile
- above 100 hPa good agreement

  20-100 hPa: very good with 0 ± 10% deviation
- 1-10 hPa mean differences ca. 15 %

Preliminary validation results (3/3)

Comparison of GOMOS ozone profiles with lidar measurements

from ALOMAR (69.28°N, 16.01°E):

- GOMOS: twilight measurements
- ALOMAR: night time detector (sza:104-112°)
  - large fluctuation in GOMOS ozone profiles
  - ca. 20% negative bias in the altitude range 18 - 27 km

WP 4:

Asynoptic mapping of ozone and other trace gases

- Instrument involved: MIPAS Level-2 ”Meteo-Product” : O3
- Synoptic maps of pole-to-pole ozone: October –November 2002
- MIPAS ozone profile for WP 2
- Case study: Final disappearance of the 2002 Antarctic polar vortex

  (ENVISAT special initiative on southern hemisphere vortex)

Work and product scheme

ESA FTP Site

ENVIVIEW: PDS to hdf

IDL codes

- profile extraction
- histograms
- **gridding and mapping**
- along-track data analysis

PRODUCTS

- **Synoptic Maps (pole-to-pole)**
- **MIPAS ozone profiles for comparisons in WP 2**

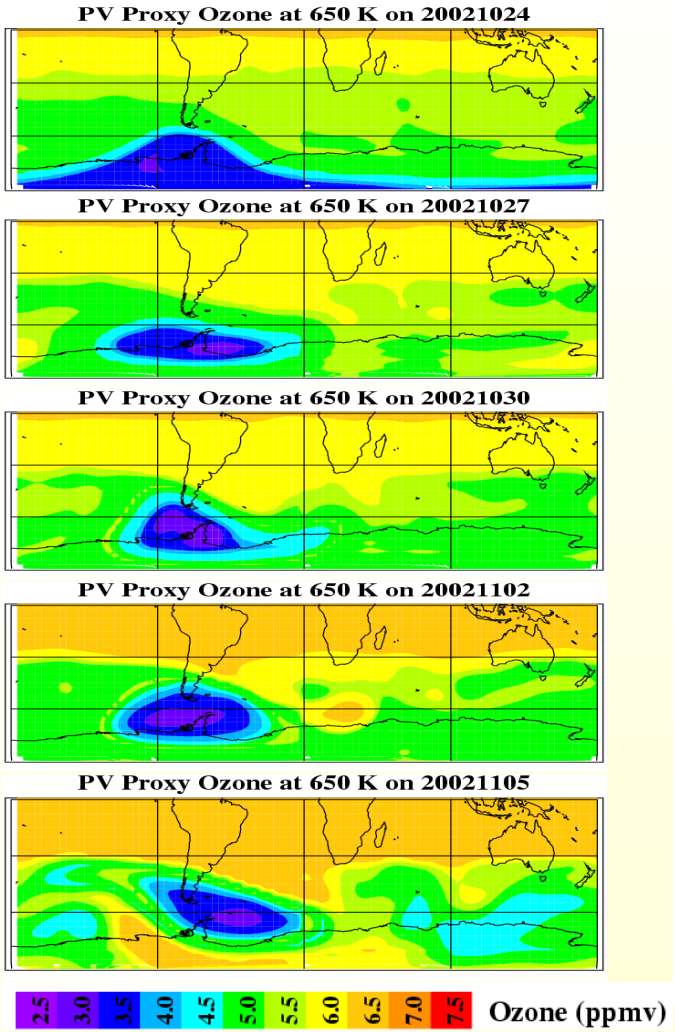
Mapping of MIPAS ozone

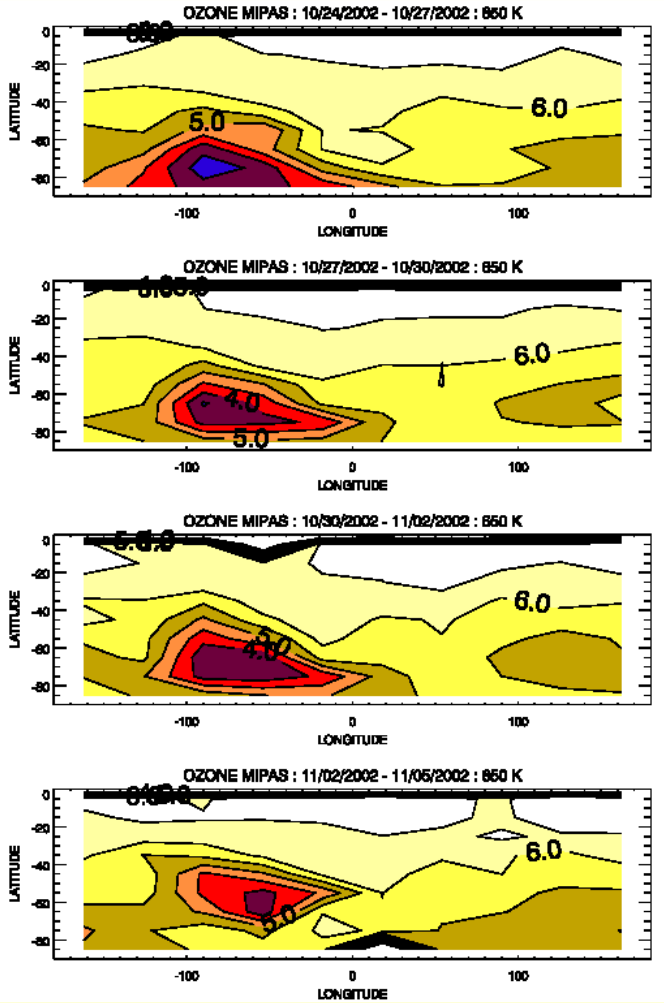
Southern Hemisphere spring 2002:
final disappearance of the southern hemisphere polar vortex

period October 24 - November 15
along-track, level-2 MIPAS , “Meteo Products”
interpolated onto potential temperature levels
height range [15 to 45 km]

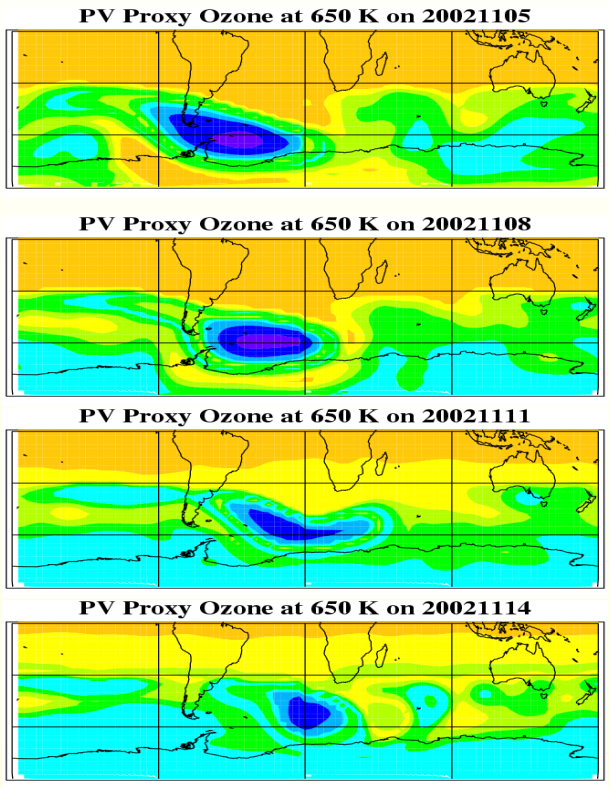
MIPAS pressure and temperature

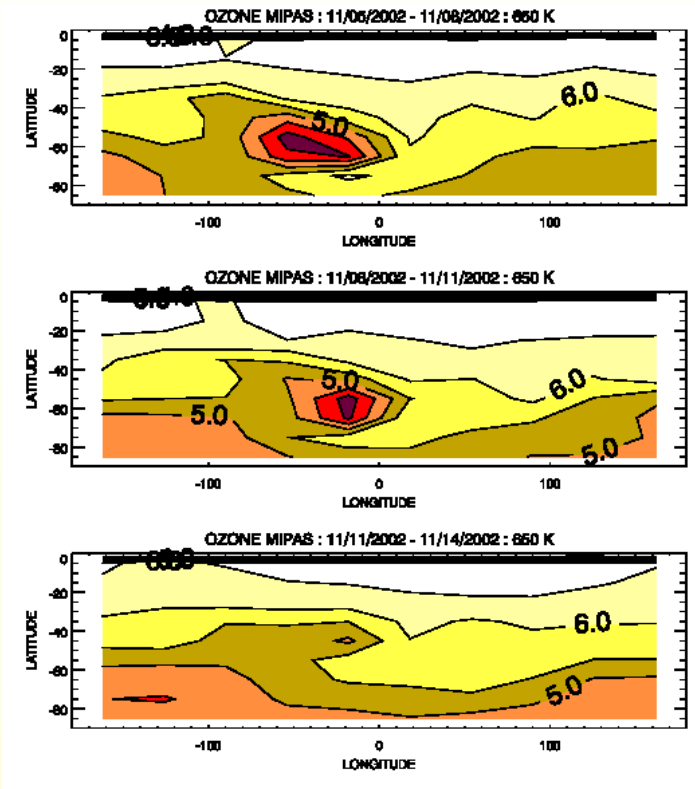
3-day data groups, and binned in longitude and latitude



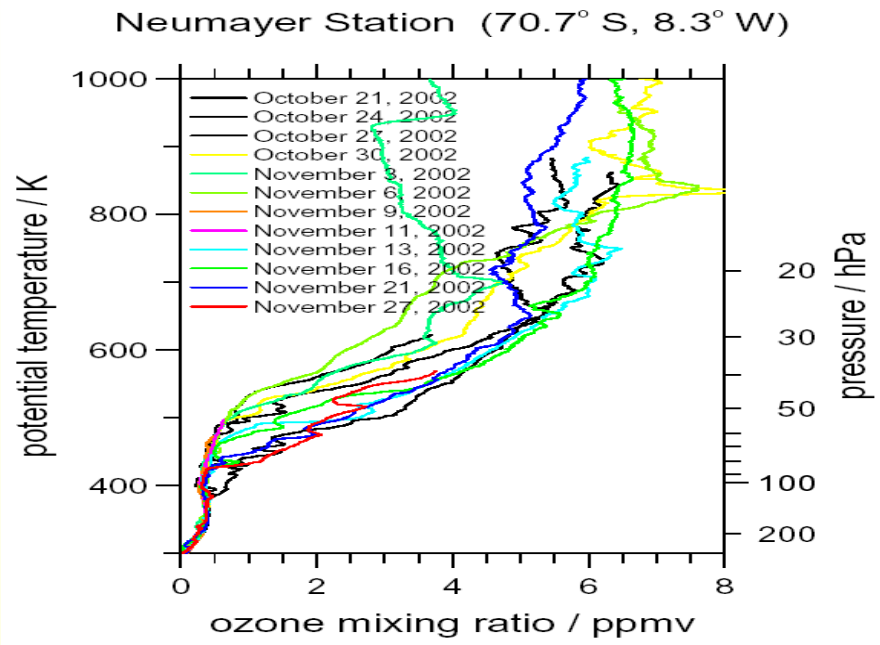


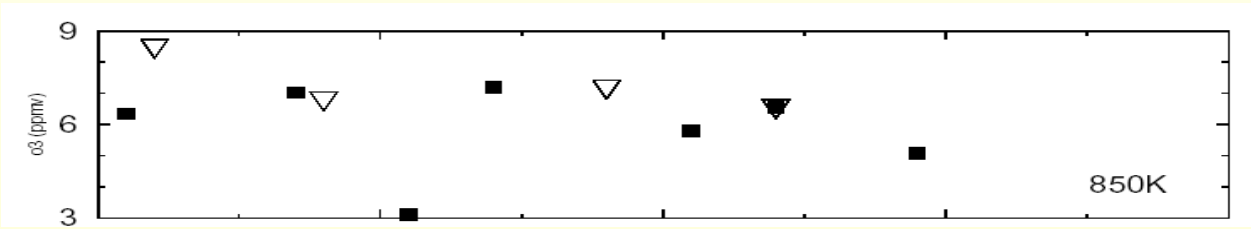
Ozone mixing ratio over the southern hemisphere (in ppmv) from MIPAS L-2 observations at 650K. Contours by 0.5 ppmv. Left-side figures indicate ozone at 650K reconstructed from ozone/potential vorticity correlations (Courtesy of Cora Randall).





Ozone mixing ratio over the southern hemisphere (in ppmv) from MIPAS L-2 observations at 650K. Contours by 0.5 ppmv. Left-side figures indicate ozone at 650K reconstructed from ozone/potential vorticity correlations (Courtesy of Cora Randall).



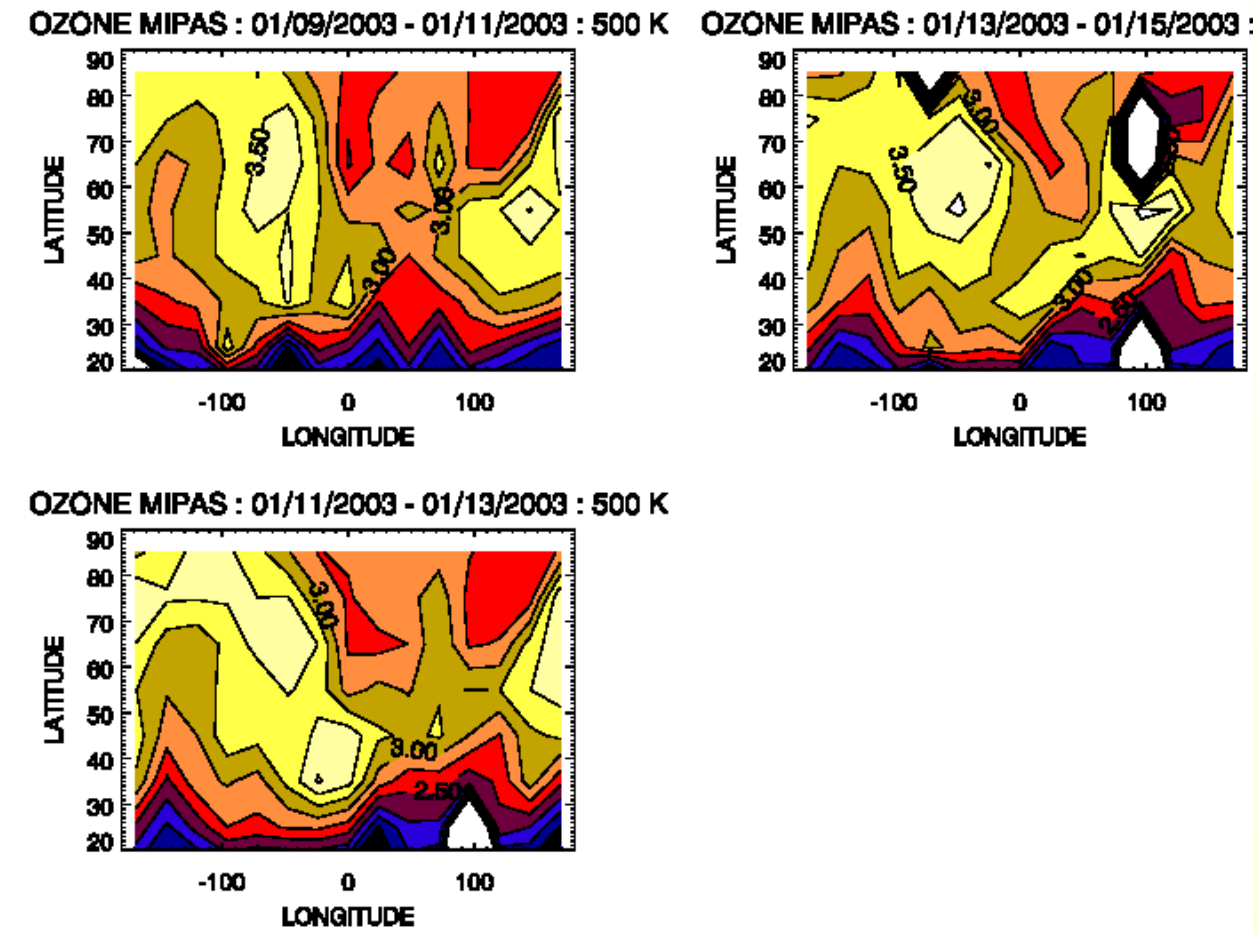


DAYS SINCE OCTOBER 24

▽ MIPAS COLLOCATIONS ■ OZONE SONDES

Series of ozone sondes from Neumayer station over OCT-NOV 2002, and comparison of ozone at 850K between sondes and collocated MIPAS measurements [G. KONIG-LANGLO (AWI-Bremerhaven) Y. ORSOLINI (NILU)]

ENVISAT CALIBRATION/VALIDATION DURING VINTERSOL CAMPAIGN



Ozone maps from MIPAS at 500 K (20 km) in northern hemisphere in first half of January 2003.

Proceedings of the Envisat Validation Workshop, ESA-SP531, 2003

- 1 The preliminary validation of GOMOS, MIPAS and SCIAMACHY by groundbased instrumens and soundings, Koopman, R.M. et al.
- 2 Comparison of MIPAS O_3 profiles with ground-based measurements, Blumenstock et al.
- 3 Validation of GOMOS Ozone Profiles using NDSC Lidar: Statistical comparisons, Keckhut P. et al.
- 4 Coordinated ground-based validation of ENVISAT atmospheric chemistry with NDSC network data: Commissioning Phase report, Lambert, J-C., et al.
- 5 Comparison of GOMOS and MIPAS ozone profiles with Lidar measurements from ALOMAR (69.28^{o}N, 16.01^{o}E), Stebel et al.

Funding status

Total funding from ESA (01/09/00 – 21/08/02) via PRODEX:

125.2 kEURO, equal to **1030 kNOK** (exchange rate: 8.2)
9.8 kEURO, for equipment (10 ozonesondes)

2001: 119 kNOK total
2002: 532 kNOK salary
122 kNOK direct costs: travel, sonde launches, ...
105 kNOK user fee

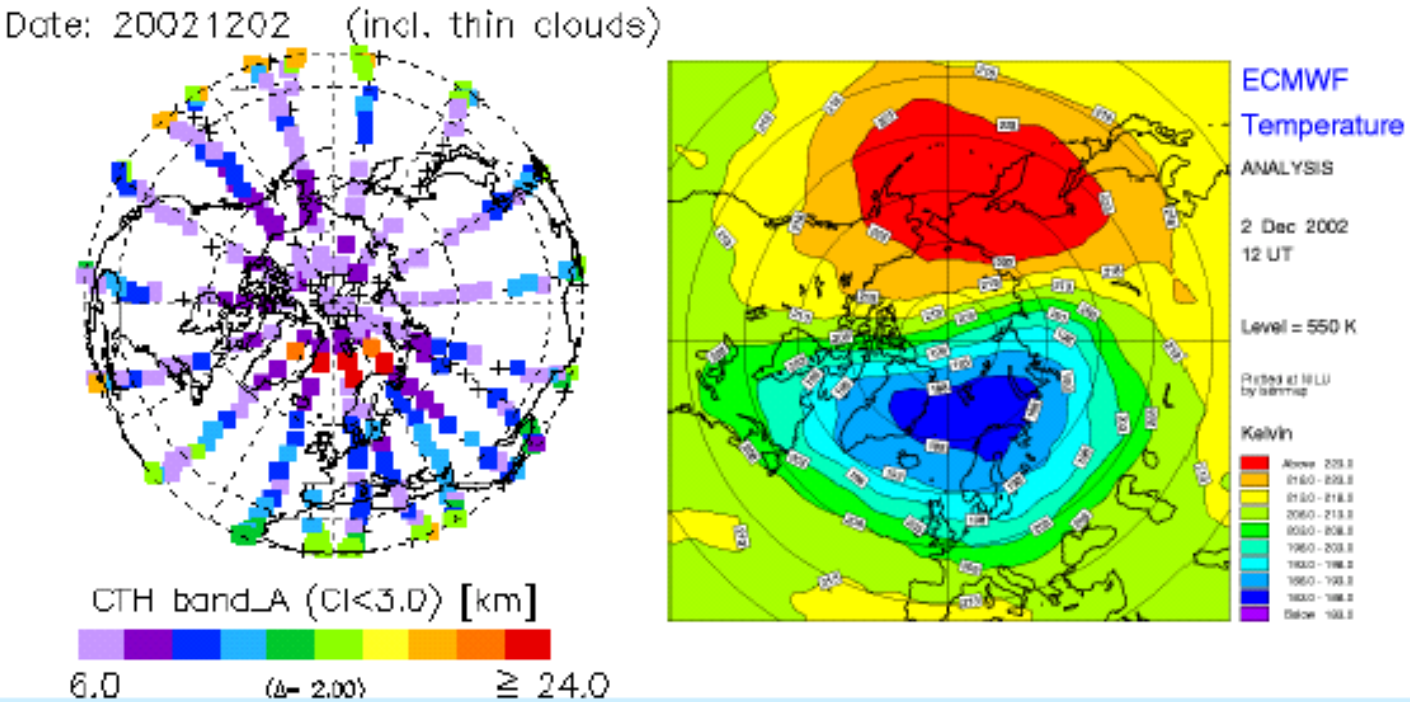
2003 **152 kNOK** **available in 2003**

Future validation options:

Polar stratospheric clouds (PSCs)

Tromsø, December 2nd, 2002, 13:25 UT

First PSC over Greenland/Scandinavia



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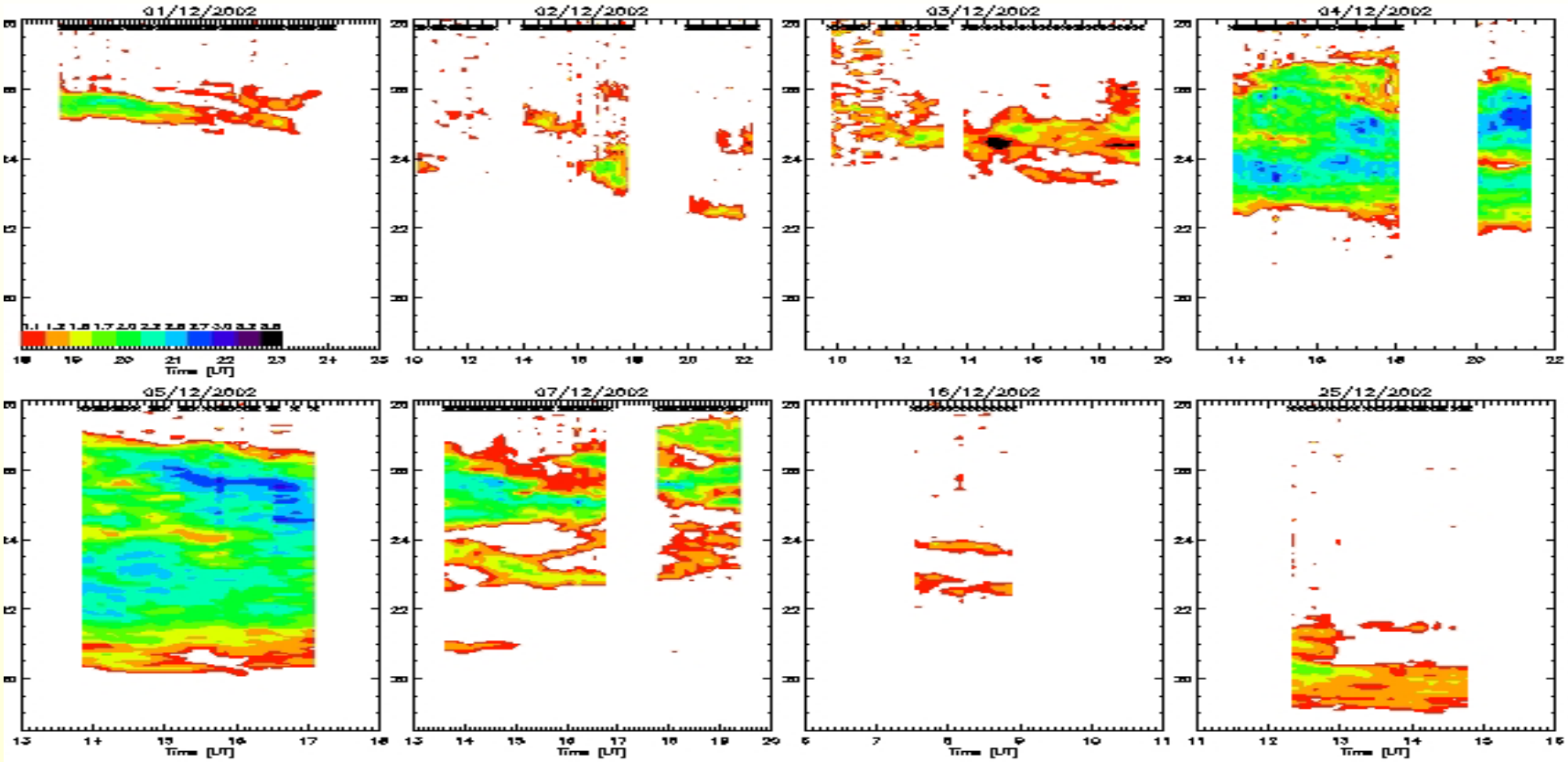
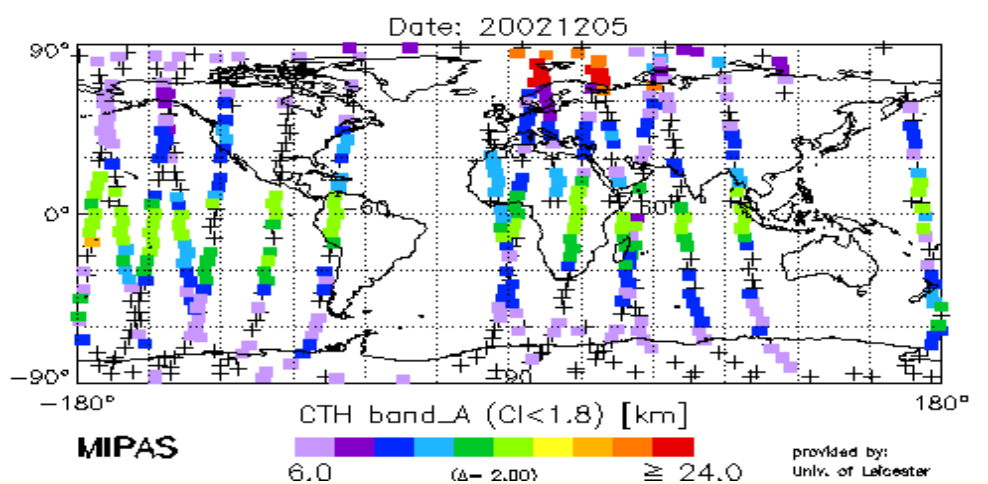
J. Remedios, EOS, Univ. Of Leicester, UK

PSCs above ALOMAR, December 2002



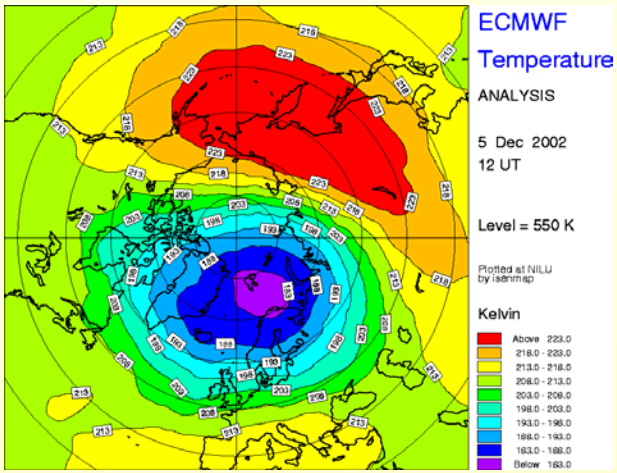
PSC observations with the ozone DIAL in December 2002: backscatter ratios measured with the 353 nm-channel. On December 5, the PSC layer reached its maximum vertical extension (20-27 km) and maximum backscatter ratios (above 3). A minor stratospheric warming starting around 23 December and to a lower extent sedimentation, led to lower PSC altitudes in late December.

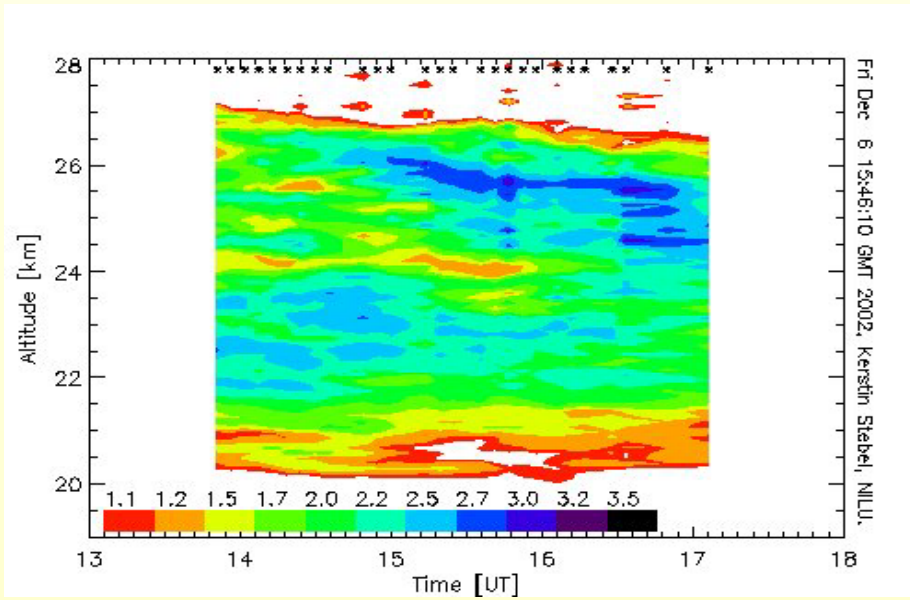
PSCs from MIPAS (CTH) and ALOMAR O_3 DIAL 02/12/05



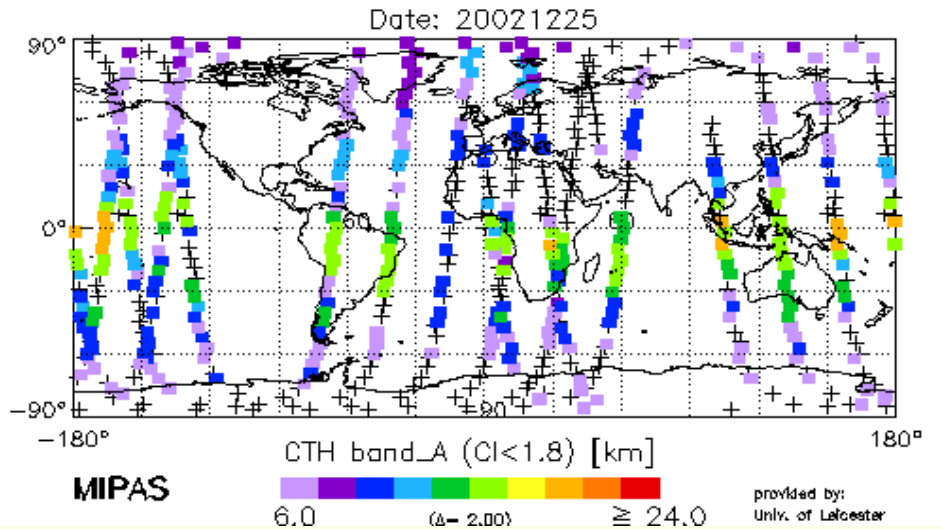
J. Remedios, EOS, Univ. Of Leicester, UK

On December 5, 2002, PSCs were seen by MIPAS as well as by the ALOMAR lidar.





MIPAS (CTH) and PSCs from ALOMAR O_3 DIAL 02/12/25



On December 25, 2002, PSCs were not observed by MIPAS, but by the ALOMAR lidar, despite very close spatial and temporal co-location. More studies are needed.

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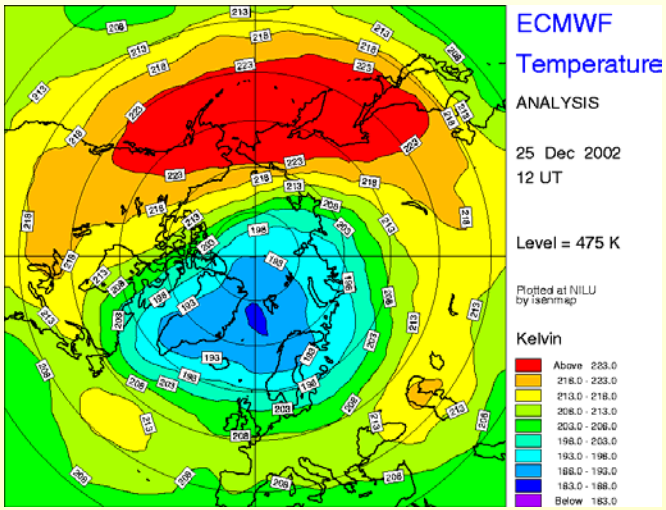

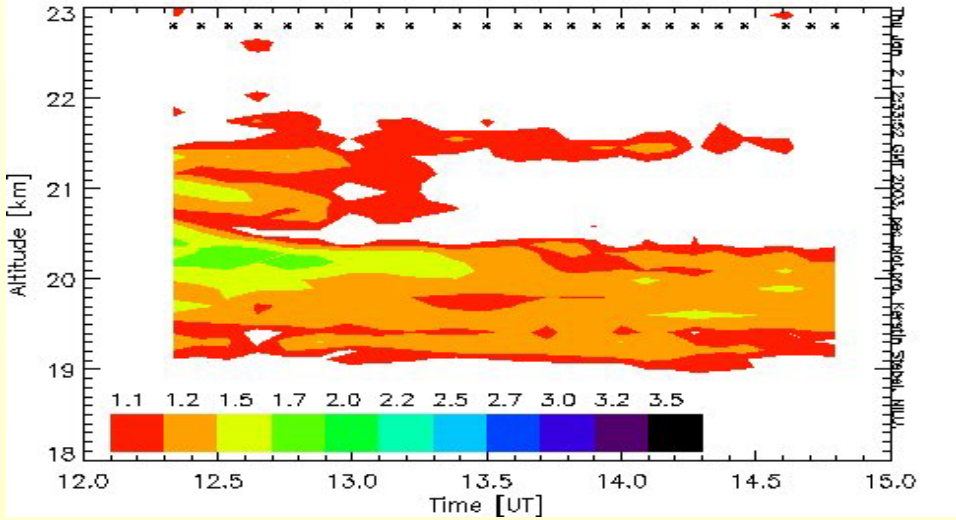

Outlook: Contribution to ESAs long-term validatio activities ?

Long-term validation necessary:

- to get statistically significant validation results
- to perform geophysical check of the validation results obtained by combining maps/groundbased/satellite data.

- use of established Norwegian groundbased network
- use of NDSC instrumentation (ozone lidar at ALOMAR, SAOZ in Ny-Ålesund, SYMOCS: NDSC intercomparison at ALOMAR in March 03)
- wide range of high latitude observations (Oslo, 59.9 N-Ny Ålesund, 78.9 N)
- improved data analysis algorithm (e.g. Brewer) —> more data

- resolve the question about GOMOS twilight ozone products risen by comparison with ALOMAR lidar data
- contribute to the validation of new products, like PSCs resolved from CTH of MIPAS by comparison with lidar PSCs