Measurements of Total Ozone at Ny-Ålesund since 1991

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Introduction

Total ozone column abundances have been monitored at Ny-Ålesund (79°N, 12°E) since the fall of 1990 with an u.v. – visible spectrometer of the type SAOZ (System for Observations at Zenith). Vertical column amounts are measured during morning and evening twilights by analysis of the sunlight scattered at zenith with the differential optical absorption technique (DOAS). The spectral data have been re-analysed with an updated analysis procedure in order to provide a consistent data set (Fayt et al., 2001).

In this study we report ten years of total ozone measurements. The ozone data are compared with total ozone data from TOMS and GOME. Observed ozone columns from SAOZ have also been compared with data from a 3D-CTM (SLIMCAT) to see if there are any systematic differences between measured and modelled data.

Instrument and analysis

- **Spectrometer:** Jobin Yvon CP-200, commercial
- **1991-1995:** 512 diode array, no cooling, ~1 nm resolution, sampling ratio:1
- **1996-2001:** 1024 diode array, no cooling, ~1nm resolution, sampling ratio:2
- **Analysis procedure:** WinDOAS 2.1 (Fayt et al., 2001) using the most recent cross sections.

Model data

The model used in this study is the SLIMCAT 3D CTM, described in detail by Chipperfield (1999). For the present study, the model was initialised in October 1991 and integrated until November 2000. Photochemical reaction rates and absorption cross sections were taken from the JPL97 compilation (DeMore et al., 1997). The model run included 12 isentropic levels from 330 K to 2700 K, and includes a parameterisation of heterogeneous reactions on sulphate aerosols and polar stratospheric clouds (PSCs).

SAOZ and TOMS

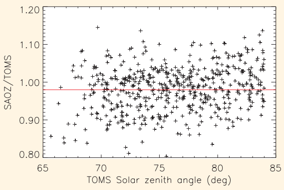
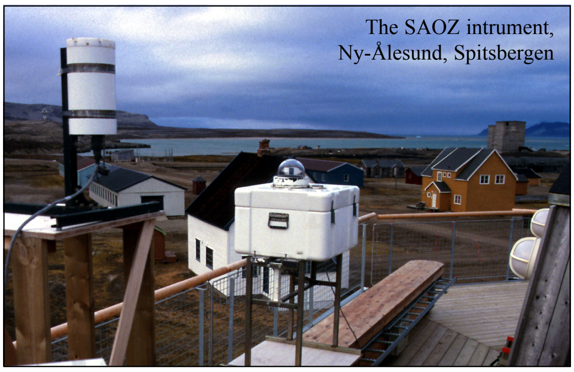


Figure 1: *Ratio between total ozone from SAOZ and TOMS vs SZA(TOMS) for the years 1991-2001. The solid red line shows the average ratio for all years when SZA(TOMS) < 80°.*

Table 1: *Comparison of total ozone data from the SAOZ instrument and the three TOMS instruments onboard the Nimbus-7 (N7), Meteor-3 (M3) and the Earth-Probe (EP) satellite platforms. TOMS data measured at SZA(TOMS)>80° are not included in the comparison.*

	1991 N7	1993 N7/M3	1994 M3	1997 EP	1998 EP	1999 EP	2000 EP	2001 EP	All years
SAOZ/TOMS	0.98	0.89	0.93	1.02	0.97	1.01	0.99	1.01	0.98
Stdev (1σ)	0.05	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.06
Number of days in mean	65	53	35	60	61	62	50	29	414

- No SZA dependence in the SAOZ/TOMS-ratio, figure 1.
- The average ratio between SAOZ and TOMS is 0.98 ±0.06% for SZA(TOMS)<80, table 1.
- SAOZ measures too low ozone values during 1993, 1994 and 1995. The agreement is very good between SAOZ and TOMS for the remaining years. The offset in the SAOZ data for 1993-1995 needs to be studied further.



The SAOZ intrument, Ny-Ålesund, Spitsbergen

SAOZ and GOME

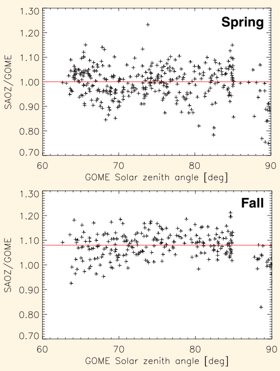


Figure 2 *Ratio between total ozone from SAOZ and GOME vs SZA(GOME) for the years 1996-2001 for the spring (upper panel) and the fall (lower panel). The solid red line shows the average ratio for all years when SZA(GOME) < 85°.*

Table 2: *Comparison of total ozone data from the SAOZ instrument and GOME instrument onboard the ERS-2 satellite platform. GOME data measured at SZA(GOME)>85° are not included in the comparison.*

	1996	1997	1998	1999	2000	2001	All years
Spring:							
SAOZ/GOME	1.0	1.0	1.0	1.04	1.0	0.96	1.0
Stdev (1σ)	0.07	0.97	0.04	0.06	0.06	0.06	0.06
Number of days in mean	49	56	51	57	46	54	313
Fall:							
SAOZ/GOME	----	1.11	1.06	1.1	1.05	---	1.08
Stdev (1σ)		0.04	0.05	0.05	0.04	---	0.05
Number of days in mean		58	57	54	48	---	217

- Good agreement between SAOZ and GOME during spring for SZA(GOME) < 85°.
- GOME data 8% lower then SAOZ data during the fall for SZA(GOME) < 85°.
- Beyond 85° SZA(GOME), the SAOZ/GOME ratio decreases with the SZA.

SAOZ and SLIMCAT

The SAOZ data for the years 1993-1995 needs to be studied further due to the observed offset between SAOZ and TOMS during these years, table 1. These years are therefore not included in the comparison between observed and modelled data.

- The overall agreement between observed and modelled total ozone columns is good for all years during the spring period.
- During the spring period the model reproduces the seasonal variations as well as the year-to-year differences. The large variations in total ozone that occurs as the polar vortex edge passes over Ny-Ålesund are captured by the model (e.g.1996 and 2000)
- For the warm winter of 1998 the model overestimates the total ozone with ~50DU after the break-up of the polar vortex
- The model overestimates the total ozone columns throughout the fall. However, the agreement improves during late fall.

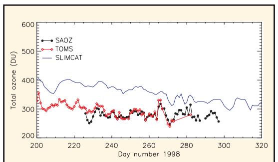


Figure 4 *Comparison of total ozone from SAOZ (black, dotted line) and TOMS (red, dotted line) with data from the 3D SLIMCAT model (blue, solid line) for Ny-Ålesund during the fall periods of 1998.*

Future work

- The SAOZ data for the years 1993-1995 needs to be studied further
- A similar study will be done to obtain a consistent data-set for total columns of NO_2 from the SAOZ instrument for the years 1991-2001.

SAOZ and SLIMCAT

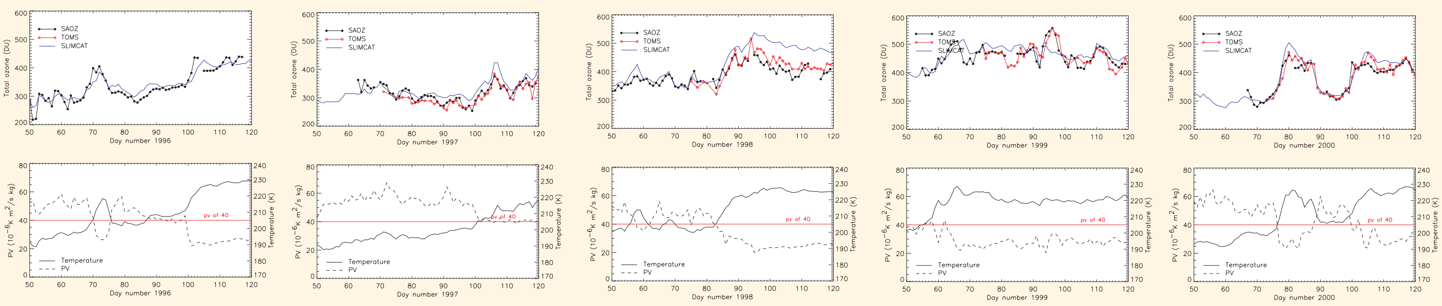


Figure 3 *Comparison of total ozone from SAOZ (black, dotted line) and TOMS (red, dotted line) with data from the 3D SLIMCAT model (blue, solid line) for Ny-Ålesund during the spring periods of 1996-2000. The temperature (solid line) and the PV (dotted line) are shown in separate panels.*

References:

Chipperfield, M.P. (1999) Multianual simulations with a three-dimensional chemical transport model. *J. Geophys. Res.*, *104*, 1781-1805.
DeMore et al. (1997) Chemical kinetics and photochemical data for use in stratospheric modeling. NASA Jet Propulsion Laboratory (JPL 97-4).
Fayt, C.,Van Roozendael, M. WinDOAS 2.1 Software User Manual, 2001.

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