

# OBSERVATIONS OF EARLY WINTER STRATOSPHERIC CONDITIONS IN 2002/03 ABOVE ALOMAR

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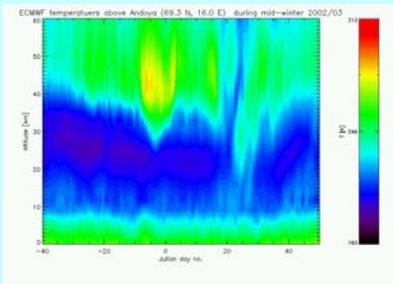
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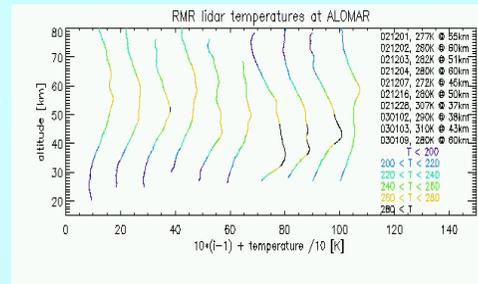
The polar stratospheric vortex in winter 2002/03 formed early, and from late November, the cold air pool resided over the North Atlantic and Northern Scandinavia. Due to simultaneous excellent observation conditions in Northern Norway, the development of the vortex and the strongest PSC displays since January 1996 were monitored by means of the ozone differential absorption lidar (DIAL) and the Rayleigh-Mie-Raman (RMR) lidar at the ALOMAR facility (see **Table 1**). The season started with PSC type Ia on December 1, 2002. On December 5, the layer reached its maximum vertical extension (about 20-27 km) with a maximum average backscatter ratio of about 2.5 at 353 nm. PSCs were further observed on any measurement occasion in December and early January 2003 when the vortex was located over the station. During the December period the PSC layer successively progressed downward to below 20 km in late December due to a combination of downward forcing by a minor stratospheric warming occurring around December 23th (see **Figure 1 and 2**), and to a lesser extent due to sedimentation of the particles which had grown to sizes above 1 μm (not shown here). The latest PSC measurements by lidar from ALOMAR were made on January 9, 2003 at around 18.5 km altitude (see also photo). A more detailed analysis of the multi-wavelength measurements and a comparison with satellite measurements is ongoing.

Date	RMR	Altitude [km]	R at 532 nm	O3 DIAL	Alt. [km]	R at 353 nm	Type
01.12.2002	18.51-01.15	24.1-26.7 (25.4)	1.98±0.02	18.47-00.29	24.5-26.4	1.6 (25.6)	Ia
02.12.2002				10.06-12.58	23.5-23.9	< 1.05	
	13.37-22.36	22.0-26.3 (23.6)	1.46±0.02	14.01-22.29	21.1-25.6	1.4 (22.4)	Ib
03.12.2002				09.42-13.30	24.2-25.1	< 1.05	
	13.37-22.36	22.5-27.0 (24.6)	2.41±0.06	13.49-19.22	23.2-26.2	1.6 (24.7)	Ib+Ia
04.12.2002	08.00-13.30	21.8-27.0 (24.0)					Ib+Ia
	13.30-22.00	21.0-27.3 (23.4, 25.1)	>4.7±0.1 <7.7±0.8	13.55-21.27	21.8-26.8	2.45 (23.3)	Ib+Ia
05.12.2002				13.50-17.10	20.0-26.7	2.45 (22.5)	
07.12.2002	13.20-21.00	19.5-28.0 (23.1, 25.4)	2.95±0.07, 4.5±0.1	13.38-19.25	20.6-27.5	2.2 (25.1)	Ib+Ia, variable
16.12.2002	08.00-09.10	19-26 (22.5)	1.50 ±0.04	07.32-08.53	21.7-24.0	1.23 (23.8)	Ib
25.12.2002	12.05-12.24	19-24 (20.0)	3.2 ±0.1	12.20-14.47	18.8-21.6	1.4 (19.6)	Ib
28.12.2002	11.59-16.34	18-22.5 (19.1)	1.21 ±0.02	13.17-16.50	18.2-20.6	1.2 (19.4)	Ia
02.01.2003	14.38-17.31	No PSC					
03.01.2003	13.23-15.33	18-19.5 (18.6)	1.09 ±0.01	14.51-15.30			?
09.01.2003	11.58-19.00	17.1-20 (18.5)	1.19 ±0.01	14.31-17.40	18.5-19.6	1.13 (18.7)	Ia?

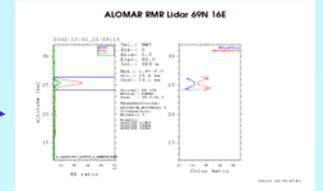
**Table 1** : PSC observations during winter 2002/03 above ALMOR (69.3 N, 16.0 E) by RMR lidar and ozone DIAL.



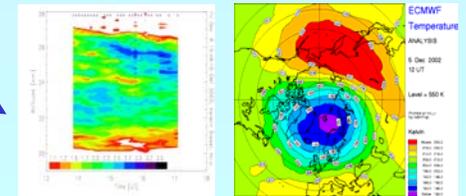
**Fig. 1**: ECMWF temperatures during mid-winter 2002/03 (T106 resolution).



**Fig. 2**: Temperatures measured by the RMR lidar at ALOMAR during December 2002 and the beginning of January 2003. The stratospheric warming can be seen at the end of December.



PSC measurements by the RMR lidar at ALOMAR, December 1, 2002.

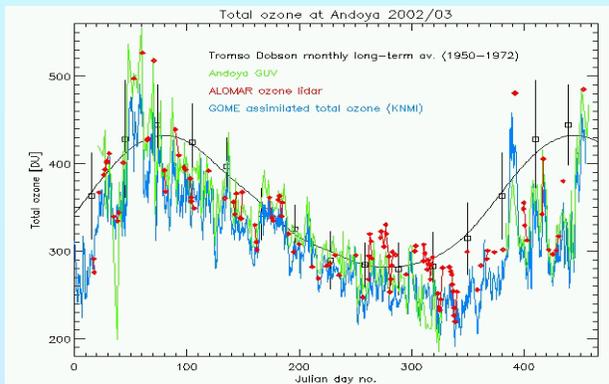


PSC measurements by the ALOMAR ozone DIAL during December 5, 13:50-17:11 UT, and Northern hemispheric ECMWF temperatures at 550 K (ca. 23 km altitude).

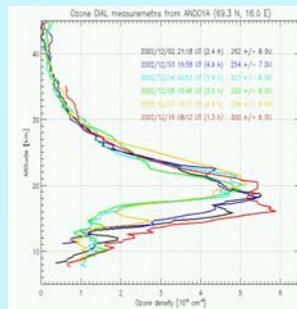


Photo from K. Bekkelund, ALOMAR, January 9, 2003.

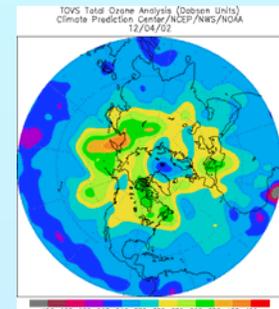
Another remarkable feature observed in November / December 2002 was a sequence of three periods with very low total ozone values, in late November, early December and late December. A pronounced ozone mini-hole was observed on December 5, revealing a total ozone value of 219 DU (see **Fig. 3 and 4**). This was due to the coincidence of a strong upper tropospheric anticyclone, lifting the tropopause to more than 13 km and causing tropospheric ozone levels up to 17 km altitude, and a strong vortex at higher altitudes with significant reduced ozone levels above 20 km. The feature has been observed by TOVS (see **Fig. 5**), several Arctic ozonesonde stations and was also reproduced by the SLIMCAT CTM (M.Chipperfield, priv. comm.).



**Figure 3**: Total ozone column at the ALOMAR facility in 2002: from ozone DIAL, from a multi-channel UV filter instrument (GUV) which is part of the Norwegian ozone and UV monitoring network, and from GOME with the TM3-DAM operational assimilation model of the Royal Netherlands Meteorological Institute (KNMI), which is available on the Internet.



**Figure 4**: Ozone profiles measured by the ozone lidar at ALOMAR between December, 2nd and 16th, 2002.



**Figure 5**: TOVS total ozone analysis for December 4, 2002 (Figure from Climate Prediction Center / NCEP / NWS/NOAA).

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