The Northern Hemisphere Stratosphere in the 2000/01 Winter

This report was prepared by the European Ozone Research Coordinating Unit and is based on preliminary results provided by European and collaborating scientists working in projects in the European research cluster SOLO.

The European Ozone Research Coordinating Unit is based at the Department of Chemistry at the University of Cambridge and is funded by the Environment and Sustainable Development

Summary

Ozone loss over the Arctic has been one of the main objectives of stratospheric ozone research in Europe over the last ten years. This research has been conducted within several major field campaigns, most recently the Third European Stratospheric Experiment on Ozone (THESEO) in 1988-2000, and through long term observational programmes. Continuity of observation is important as a striking feature of Arctic ozone loss has been its large interannual variability. There was no large-scale observational campaign during the 2000/01 winter, as it immediately followed the intense scientific efforts during THESEO. However there are many on-going research projects which include studies of this winter's stratosphere. This research is coordinated through the European research cluster SOLO of EC and nationally funded projects.

The Arctic vortex developed during October and November 2000. By the end of November, the lowest temperatures were close to those at which polar stratospheric clouds (PSCs) can form. However there was a strong warming in the upper stratosphere, temperatures rose and the vortex was greatly disturbed. From late December until mid-January, the vortex strengthened and cooled. Over quite large areas, temperatures were below those at which PSCs can form, and there were many observations of PSCs inside the vortex. From mid-January the stratosphere warmed. Areas with conditions cold enough for the existence of PSCs were reduced and the minimum temperature rose above the PSCs threshold in mid-February.

During the warming, the polar vortex was heavily disturbed and drifted over central Europe for a few days. Dynamical effects in the troposphere then led to a short term cooling of the vortex, resulting in PSC conditions and low total column ozone amounts over large parts of central Europe with a minimum around 250 DU on 14th February. A combination of natural dynamical effects was the main cause of this 'ozone mini-hole' event. However the accumulated chemical depletion of ozone inside the polar vortex up to mid-February would have further reduced the minimum ozone column reached during the event.

Measurements and models indicate that the vortex was fully activated in January, consistent with the temperatures and observed PSC formation. In the presence of sunlight chemical ozone loss then occurred. Preliminary estimates of ozone loss inside the Arctic vortex suggest that there was a chemical loss of about 20% of the ozone at altitudes around 18km between mid-January and mid-February and of about 10% in the total ozone column. These losses are broadly consistent with the losses calculated by the models. The model results also underline the sensitivity of ozone loss to temperature in the Arctic.

The ozone losses in the vortex lie well within the range of the losses observed over the last decade. They were limited by the warming of the vortex in mid-February which meant that there was no chemical activation or ozone loss in late February and March. In the 1995/96 and 1999/2000 winters when cold conditions extended into February and March, column losses of 25-30% occurred with around 70% loss at 18km. Total ozone values at high latitudes lay within the range seen in the January to March period in the last few years.

The size of the chemical loss, coupled with the meteorological situation in the 2000/01 winter, meant that the total ozone amounts over Europe and the northern mid-latitudes were close to the average for the 1978-1988 period. For example, in March 2001, the total ozone amounts over

northern mid-latitudes were between normal and 5% below those in the 1978-1988 period, although over southern Europe total ozone was 10% lower.

1 Background

A prime objective of stratospheric research in Europe over the last ten years has been to gain an improved understanding of the processes underlying the observed Arctic losses and of the influence on mid-latitudes. A number of pan-European campaigns have been mounted to investigate these processes:

- European Arctic Stratospheric Ozone Experiment (EASOE) in 1991/92;
- Second European Stratospheric Arctic and Mid-latitude Experiment (SESAME) in 1994/95;
- Third European Stratospheric Experiment on Ozone (THESEO) in 1998/99; and
- THESEO 2000, an extension of THESEO, through the 1999/2000 winter and spring.

Other field activities have taken place in other winters such as POLSTAR, APE, and the ILAS validation, which also involved balloons, aircraft, ozone sondes, ground-based measurements and satellite monitoring. In all these winters, the observational activities were complemented by modelling studies of the high latitude stratosphere.

No large-scale observational campaign was planned for the 2000/01 winter, as it immediately followed the intense scientific effort for THESEO and THESEO 2000. However there are many on-going research projects coordinated within the SOLO research cluster which have studied this winter's stratosphere. Details can be found in a planning document "European Research On Arctic Ozone in the 2000/01 Winter – Minimum Requirements and Planned Activities" available on the EORCU web site (http://www.ozone-sec.ch.cam.ac.uk).

The on-going observation of ozone loss during successive Arctic winters is important as substantial losses can occur. A striking feature of Arctic ozone loss has been the large interannual variability of the ozone loss and its strong dependence on temperature. For example, there were losses of <10% in 1998/99 and >65% in 1999/2000 at around 18 km. Losses of 50% or more have been seen at the same altitudes in the Arctic in several winters since the early 1990s. A decrease in total ozone in the Arctic region has been observed since 1980, although there is considerable year-to-year variation in the observed values. This variability in the ozone loss is to be contrasted with the Antarctic where nearly complete ozone loss has taken place in all winters in the 1990s at altitudes between about 15 and 20 km.

In this document, the stratospheric evolution and some preliminary results from studies in the 2000/01 winter are presented. In Section 2, the meteorology is described. The implications for and observations of PSC formation are discussed in Section 3. The chemical evolution, particularly the aspects important in rapid ozone loss, is considered in Section 4, and in Section 5 the ozone fields and chemical ozone loss are discussed. Finally, in the Annex, a brief description of the activities is given.

2 Meteorology

The winter 2000/01 demonstrated the variety of possible "events" that occur in the northern hemisphere stratosphere:

- strong Canadian warming at the end of November;

- very strong minor warming in December;
- undisturbed cold period in January;
- major warming with a vortex break-down in February; and
- late winter cooling in March, leading to a re-established, long-lasting vortex in April.

The temporal development of the stratospheric temperature and circulation can be seen from the time-height sections of the North Pole temperature (Fig. 1 – upper panel) and the zonal mean zonal wind at 60ºN (Fig. 1 – lower panel) derived from the ECMWF analyses. The seasonal cooling of the polar region and the strengthening of the vortex were interrupted in the second half of November by a Canadian warming in the lower stratosphere. This was one of the strongest Canadian warmings observed since 1965, leading to strongly positive temperature anomalies over the Canadian Arctic in the November monthly mean (Fig. 2 – upper left). The seasonal decline of minimum temperatures was halted after reaching the PSC I threshold for some days around 22nd November (Fig. 3).

While the Canadian warming slowly weakened in the beginning of December, a strong upper stratospheric warming developed. The temperature profile from the ALOMAR lidar in northern Norway showed on 9th December a maximum temperature of +40ºC around 40 km altitude – typical behaviour during a strong minor warming. The warming penetrated downward until mid-December (Fig. 1, upper panel), and the lower stratospheric vortex temporarily split but did not break down. The zonal mean zonal winds at 60ºN changed to easterlies only in the uppermost stratosphere (Fig. 1, lower panel). The monthly mean temperature deviations at 30 hPa again show strongly positive values, now centred over northern Siberia (Fig. 2, upper right).

From late December to mid-January the vortex strengthened and cooled (Fig. 1). There was a period of about one month with minimum temperatures below the PSC existence threshold at 30 hPa (Fig. 3). Accordingly, the 30 hPa monthly mean temperature anomalies were negative over the polar region (Fig. 2, lower left) but not as much as during the extremely cold January 2000. Record low temperatures were reached around the middle of the month when the cold centre was located over northern Scandinavia. Together with a tropospheric anticyclone beneath, this led to a mini-hole event with ozone column densities below 250 DU on 13th January. Simultaneously, the next warming pulse in the polar region started, reaching its climax in the upper stratosphere at the end of January and beginning of February (Fig. 1, upper panel).

In February, this warming penetrated downwards (Fig. 1, upper panel) and developed into a major warming with a circulation reversal over the polar region throughout the stratosphere around mid-February (Fig. 1, lower panel). The remnants of the stratospheric cold air were shifted to central Europe where another ozone mini-hole event (with total ozone values around 250 DU on 14th February) occurred, again in conjunction with a tropospheric anticyclone. PSC formation was no longer possible (Fig. 3) and the 30 hPa monthly mean temperature anomalies show strongly positive values over the polar region (Fig. 2, lower right).

A pronounced late winter cooling and a re-establishment of the polar vortex started in the upper stratosphere at the beginning of March (Fig. 1), which slowly became established in the lower stratosphere although the temperature distribution there remained disturbed for a longer time. In April a relatively cold, persisting vortex governed the circulation and the final transition to

3 Polar Stratospheric Clouds (PSCs)

There were two periods when minimum temperatures were below those at which PSCs can form. The possible areas for PSC existence are shown in Figure 4 as a function of altitude. The general picture is similar to that seen at 30hPa (around 550 K potential temperature), with the possibility of some PSCs existing in mid November to early December period and the main period for PSC occurrence in January and early February. In mid-January the absolute extent of regions cold enough to allow PSC I existence was not as large as in some previous cold winters. However the vortex was also quite small, so that a relatively large fraction of the air inside the vortex was exposed to PSC conditions.

The extent of temperatures low enough for PSC II (ice) formation (Fig. 5) is comparable to, and at some altitudes larger than that during the coldest winters on record (1995/96, 1999/2000). Around 12th January, particularly low temperatures (below -88˚C in the ECMWF analyses) accompanied by ice cloud formation occurred over tropospheric disturbances in northern Scandinavia (see below). Otherwise the lowest temperatures were generally over Spitzbergen.

This overall picture deduced from the temperature fields is confirmed by measurements. Observations by the POAM III instrument on the SPOT IV satellite indicate the existence of marginal PSCs near the vortex edge in mid November / early December. There are no other known measurements of these PSCs, but that might well be because PSCs did not form near the few stations that were operating at this time. The most noteworthy period of PSCs was between 12th and 18th January, with some PSC signals close to the POAM maximum extinction threshold. POAM continued to observe PSCs up to 11th February.

At Ny-Ålesund (79ºN, 12ºE) PSCs were measured from late December until late January. They were present over a wide altitude range (19-26 km), several km higher than during the SOLVE/THESEO 2000 campaign in 1999/2000. The PSC signals in January were the strongest ever observed above Ny-Ålesund, with a maximum backscatter ratio of 8 at 532 nm. The PSCs often displayed a so-called sandwich structure with a bulk central layer of non-depolarising (i.e. spherical, liquid) particles and thinner layers of depolarising (i.e. aspherical, crystaline) particles.

The mid-January event was also unusual at Sodankyla (67ºN, 27ºE) where PSCs were seen each day from 12-17 January. Nacreous clouds were also seen at Kiruna, Apatity and Lovozero. On 15 January, the vortex passed over the Scandinavian Alps (upwind of Sodankyla) at the same time as a strong mountain wave event in the troposphere. During that event, a record low temperature of –96.5ºC was recorded at 25.2 km altitude. At this time, the PSC layer was more than 8 km in vertical extent (18-26 km). Backscatter sonde measurements on 13th January indicated the presence of ice particles as well as NAT particles and STS droplets.

The CIPA balloon payload was launched from Esrange (68ºN, 21ºE) on 12th January, upstream of Sodankyla. A large PSC layer between 19.5 km and 27 km was observed. The largest particle radius seen in significant amount was 2.5 μm suggesting the virtual absence of ice particles. The colour index measurements also indicated mainly liquid particles. Temperatures throughout the flight were just above the ice frost point although they approached it at some altitudes. Unfortunately there were technical problems with three instruments, including the mass spectrometer used for chemical analysis of PSCs. The LEANDRE backscatter lidar on board the French Mystère 20 aircraft flew in coordination with the CIPA balloon flight, flying upstream and along the balloon trajectory. PSCs were detected between 18 and 24 km, all along the flight. The layer was generally thick and homogeneous both vertically and horizontally, indicating a large synoptic PSC field. Depolarisation was not evident. Along the balloon trajectory, a more layered structure was observed, presumably as a result of local wave activity. The DLR Falcon flew in conjunction with the CIPA balloon and the Mystère 20, and also observed more wave structure over the mountains, similar to that seen in 1999/2000. Some weak depolarisation at 24 km (at 532 nm) was also seen, indicating the existence of some ice particles in the region of the mountains.

4 Chemistry

The main period of interest is in January / February as halogen activation would occur while PSCs are present. Measurements from GOME show that the column OClO amounts in mid-January were high and similar to those in late January 2000. This picture of full halogen activation is supported by the MIPAS balloon observation on 12th January of a broad layer with low $ClONO_2$.

At the same time, MIPAS observed a large difference in the gaseous HNO_3 abundance in the colder region to the north and the warmer region to the south indicating that most of the gaseous HNO_3 was taken up by the particles in the PSC layer. Low column NO_2 amounts were seen over wider areas by GOME, consistent with HNO_3 being the primary form of NO_y.

The main source of information about the chemical evolution in the 2000/01 winter is from models, as there are currently only a limited number of chemical observations available. Both the SLIMCAT and REPROBUS 3-D chemical transport models have been run for the 2000/01 winters. The activation calculated by the two models is similar (Fig. 6). It started in late December / early January and full chlorine activation was present from mid-January to early February with ClO_x values around 2.5 ppbv. From then on ClO_x declined and there was negligible activation by the end of the third week of February. Calculated ClO_x values were above 1 ppbv for 5-6 weeks. For comparison, ClO values were greater than 1 ppbv for about 12 weeks in 1999/2000, and significant activation lasted well into March.

There is currently no information from measurements as to whether any denitrification occurred - analysis of the data from the MIPAS flight should provide this. This issue is important as denitrification enhances ozone loss. The SLIMCAT model diagnosed widespread and nearly complete denitrification as a result of the very low temperatures in mid January. However, its ice PSC treatment is simplistic with sedimentation and denitrification being triggered by the particle formation at the ice point. Although less than in SLIMCAT, the Reprobus model also diagnosed a substantial denitrification in the second half of January. The maximum calculated reduction in NO_y is about 50% at 550 K. Sedimentation in Reprobus is triggered by the formation of sufficiently large NAT or ice particles.

5 Ozone and ozone loss

5.1 Ozone evolution

Preliminary analysis of total ozone maps based on TOMS and ground-based data show that total ozone values over the middle and high latitudes of the Northern hemisphere during the winter-spring season 2000-2001 were generally within about 5% of the 1978-88 climatological mean values. (Wintertime values over northern mid-latitudes prior to 1978 were about 2% higher than for the 1978-1988 period.) During December 2000 total ozone was above the long-term mean values over almost all the middle latitudes, with a region over the N. Atlantic where total ozone was 10% above the normal levels. In January 2001 ozone values were 5% below normal over N. America and Eastern Europe, while they were slightly above their long-term mean values over Scandinavia and Siberia. During February total ozone over the high latitudes of N. America and Scandinavia was on average 5% above the normal values, while over the middle latitudes total ozone levels were 5% below normal. In March the relatively high ozone values over Scandinavia persisted, while over the high latitudes of N. America and Siberia as well as over all the middle latitudes total ozone values were between normal and -5%, with exception of Southern Europe where ozone was 10% below the long-term mean (Fig. 7).

In the Arctic (north of 60ºN), average total ozone during January to March was intermediate between the values in the cold winters 1995/96, 1996/97 and 1999/2000 and the values in the warm winter in 1998/99 (Fig. 8). It was comparable with those in the 1997/98 winter. Overall these total ozone data reflect the strong variability due to the varying meteorological conditions encountered each winter.

A comparison of the total ozone in the SLIMCAT model for the two winters shows that total ozone north of 60ºN was higher during winter 2000/01 compared to 1999/2000 by about 50 DU during January and early February. During the major warming in the second half of February 2001 total ozone was higher by about 100 DU compared to February 2000. These differences in total ozone are almost exclusively due to differences in transport between the two winters.

5.2 Ozone loss

Ozone losses derived from observations were calculated in near real-time by two established techniques – Match and the SAOZ network. In addition, ozone losses were calculated by the SLIMCAT and Reprobus 3-D chemical-transport models.

The coordinated Match campaign started in early January and finished on 19 February. Over 250 ozone sondes were launched inside the Arctic vortex. Preliminary analysis for the 475 K potential temperature level (around 18 km) indicates increasing ozone loss rates through January, reaching a peak value of about 40 ppbv chemical ozone destruction per day in late January (Fig. 9). The ozone loss rates then declined and became negligible in mid-February. The accumulated loss of ozone at that level was found to be roughly 20% (0.7±0.2 ppmv). This chemical loss of ozone is moderate compared to previous Arctic winters during the last decade, when ozone losses as high as 70% have been observed. The time evolution of the chemical ozone loss and the maximum loss rates reached are comparable to those found in January in previous winters with a similar temperature evolution. The model ozone losses at this altitude are ~20% for Reprobus and ~30% for SLIMCAT.

The cumulative loss of ozone in the Arctic vortex found by comparing the total ozone measurements of SAOZ with the ‘passive’ ozone in Reprobus is ~10% (~50 DU). The average loss rate from 20th January to 10th February was 0.5% per day. No further loss is found after mid-February, consistent with the disappearance of the PSCs. The two models found losses in the average total column of 5% (Reprobus) and 12% (SLIMCAT), with vortex average ozone loss rates of 0.2-0.3% per day. Maximum losses in the vortex of around 10% were found away from the SAOZ sites by Reprobus. The estimated total ozone losses from 1993/94 to 2000/01 are shown in Fig. 10.

The discrepancies between the model and empirically derived values in this winter are the shorter period of observed losses, the higher peak ozone loss rates and the apparently different vertical extent over which the ozone loss took place. While the uncertainties associated with the empirical ozone losses need to taken account, the discrepancies are probably related to the model description of a number of processes, including PSC formation, denitrification and high solar zenith angle photochemistry. SLIMCAT and REPROBUS use different meteorological analyses (UKMO and ECMWF, respectively) which can differ slightly in the reported temperatures.

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Annex Field activities

European research activities on ozone loss in the Arctic is coordinated within the EU research cluster SOLO which covers research on long term ozone changes. More information can be found at the web site of the European Ozone Research Coordinating Unit (http://www.ozone-sec.ch.cam.ac.uk/).

The following reports were received on activities carried out in the 2000/01 winter. Analysis of the results is continuing.

QUILT

QUILT (Quantification and Interpretation of Long-Term UV-Vis Observations of the Stratosphere) is a three-year EU project devoted to the improvement and development of GOME data products, UV-Vis ground-based and balloon-borne data, 3-D CTM and RTM optimisation and internet-based near real-time (NRT) data dissemination. QUILT aims to improve our understanding of global concentrations and trends of stratospheric ozone and related trace gas species (NO_2, BrO, OClO, IO). The entire data record of the global NDSC UV-Vis network and balloon-borne measurements are being reanalysed with the purpose of determining ozone loss in the past, monitoring its development in the present and investigating its relation to active halogen and nitrogen species.

During the 2000/01 winter, near real-time GOME measurements were produced (see below for fuller report). The project did not start until early 2001 and so real-time information from the ground-based network was not available as the system was being prepared. Near real-time information will be available in future winters. More information can be found on the QUILT project website at http://nadir.nilu.no/quilt/index.php/

GOME

Observations by the ESA GOME instrument on the ERS-2 satellite were made in a near-real-time mode through combined support from the QUILT project, ESA and DLR. The observations show the evolution of ozone and other trace species in the sunlit portions of the atmosphere during winter. Some problems with the satellite operation (a failure of a gyroscope aboard ERS-2) have meant that the data have been analysed more slowly than anticipated, and, further, no data are available for the period from 17th January and 23rd February 2001. More information is available at the GOME near real-time data website at http://www.iup.physik.uni-bremen.de/gomenrt2001/

MAPSCORE

The EU project MAPSCORE (Mapping of Polar Stratospheric Clouds and Ozone levels relevant to the Region of Europe) is investigating the role of PSCs in ozone destruction. Stratospheric ozone levels over the region of Europe are profoundly influenced by lower stratospheric temperatures and the stability of the polar vortex, as ozone loss is sensitive to the threshold nature of polar stratospheric cloud (PSC) formation and denitrification. This coupling is important for the evolution of climate over the next fifty years. In the EU MAPSCORE providing maps of PSC properties, maps of denitrification, new observations of PSCs, and fields from chemical data assimilation for entire winter/spring periods.

CIPA

CIPA is an EU project whose objective is to measure and understand the composition of polar stratospheric cloud (PSC) particles. Simultaneous balloon-borne observations are made of the chemical and physical properties of PSC particles and condensation nuclei, including size distributions, aerosol backscatter ratios and depolarisation, along with the gas phase water vapour concentrations and temperature. The results of this winter's scientific activities within CIPA, the balloon flight from Esrange on 12th January, are described in section 3 (Polar Stratospheric Clouds). The CIPA web site is http://www.dmi.dk/pub/CIPA/

POSTA

The German BMBF support the POSTA project which complements the research in CIPA. During the 2000/01 winter POSTA involved a flight of the MIPAS balloon instrument from Esrange, deployment of the OLEX lidar on the DLR Falcon in Kiruna and the operation of the Univ. Bonn lidar at Esrange. The MIPAS balloon was launched on 11th January, in conjunction with the PSC analysis payload the following night. The flight took place inside the vortex in cold conditions, with a ceiling altitude between about 7 and 9 hPa. MIPAS measures a wide range of chemical species, including most important halogen and nitrogen species. The data are currently being analysed.

The DLR Falcon was in Kiruna from 12th January to 22nd January. Two transit flights and one science flight were made. The preliminary results of this science flight, made in conjunction with the CIPA balloon and the LEANDRE lidar on the Mystere 20 are described in section 3 (Polar Stratospheric Clouds). In addition a number of measurements were made from the ground during the strong PSC event that occurred during this period. High cirrus were observed during a mountain wave event on 15th January.

NDSC-FTIR

The FTIR spectrometers in place at the primary NDSC sites in Europe have been further operated to gather series of solar observations to derive vertical column abundances of a wide range of chemical species, including the key stratospheric compounds of the nitrogen-, chlorine- and fluorine families. Between 1st November 2000 and 30th April 2001, such measurements were performed during 29 days (including moon observations on 8 days during polar night) at Ny Ålesund (78.9°N), 23 days at Zugspitze (47.4°N) and 37 days at the Jungfraujoch (46.5°N). Analyses of these data are in progress. The FTIR activities reported here have been conducted thanks to national funding by Germany for Ny Ålesund and Spitzbergen, and by Belgium for Jungfraujoch.

Preliminary Jungfraujoch results indicate that the fall-winter-spring seasonal variability over central Europe was more perturbed that during the same 1999-2000 period, but less than that of 1999-2000. However, extreme column abundances in the 1985-present database have been observed for O_3 (minimum of 5.17×10^{18} molec./cm^2, or 192 DU) on 29th November 2000, for HCl (max. of 6.02×10^{15} molec./cm^2) on 22 April 2001, and for COF_2 (max. of 4.22×10^{14}

FU Berlin

FU Berlin monitored the stratospheric wintertime circulation and prepared the daily STRATALERT messages mandated by the WMO. This alert programme helps to coordinate research projects all over the world during interesting stratospheric events. FU Berlin also provided guidance on the likely stratospheric evolution to interested measurement groups. See http://strat-www.met.fu-berlin.de/ for more information.

U. Bern

Continuous ozone profile measurements are made over Bern (47˚N, 7˚E) with the U. Bern's ground-based microwave radiometer within the NDSC alpine station. These showed stable ozone VMR values during December-January (~6ppmv at the profile max.), and a sudden increase of the O_3 VMR values in the middle stratosphere after 6th February. The O_3 maximum was reached on 9th February, with VMR values >8 ppmv in the altitude range 25-35 km. After 9th February, O_3 amounts decreased and reached a minimum on 14th February. This "low ozone episode" (with O_3 <5 ppmv in the range 25-30 km) lasted until 20th February. These alternating high and low ozone values are related to the stratospheric warming and the shift of the polar vortex to lower latitudes. Studies of previous events (using back trajectories) that the high ozone seen over Bern were mostly associated with the northward advection of subtropical air along the eastern edge of the distorted vortex, while the low ozone values correspond to the passage of vortex air over Bern.

U. Thessaloniki

During the last winter-spring season the World Ozone Mapping Centre, hosted by the Laboratory of Atmospheric Physics at the University of Thessaloniki, Greece in collaboration with WOUDC, operated in near real-time. Fields of total ozone based on TOMS and ground-based data from stations in the WMO Global Atmospheric Watch ozone monitoring network, as well as daily deviations maps from the long-term mean for the Northern Hemisphere, were provided on a daily basis. Preliminary results are presented in section 5.1 (Ozone Evolution).

U. Leeds

Calculations were performed for winter 2000/01 with the SLIMCAT 3-D chemical transport model in the same configuration as for winter 1999/2000 [e.g., Sinnhuber et al., GRL, 27, 3473, 2000]. This allows a direct comparison of the two winters. As for winter 1999/2000, the model was driven by temperatures and wind fields from the U.K. Met. Office (UKMO) analyses. Results from the model run have been made available online in near real time and can be found on http://www.env.leeds.ac.uk/slimcat.

AWI

At the NDSC station in Ny-Ålesund, AWI performed regular measurements during the winter months with ozone sondes and lidar, aerosol lidar and FTIR spectrometry, using the moon as light source once per month. A microwave radiometer for O_3 and ClO was operated together with Univ. Bremen. The PSC observations by lidar are part of the EU project MAPSCORE. A Match campaign was again coordinated from AWI-Potsdam during January and February 2001.

DLR

In addition to the deployment of the Falcon aircraft (see POSTA description), forecasts and other information about mountain wave events and associated PSC formation were provided in the context of the general meteorological evolution of the stratosphere.

NILU

In conjunction with EORCU, NILU set up a web page with links to current activities on stratospheric ozone for the winter of 2000/01 (http://www.nilu.no/projects/arctic2001/). The NADIR database continued to be operated. Ozone was measured at Andøya, by a lidar and a UV filter instrument. In January there was a maximum negative deviation of 80 DU (about –20%) compared to the long-term monthly average from Tromsø. In February, high values (nearly 600 DU) were seen.