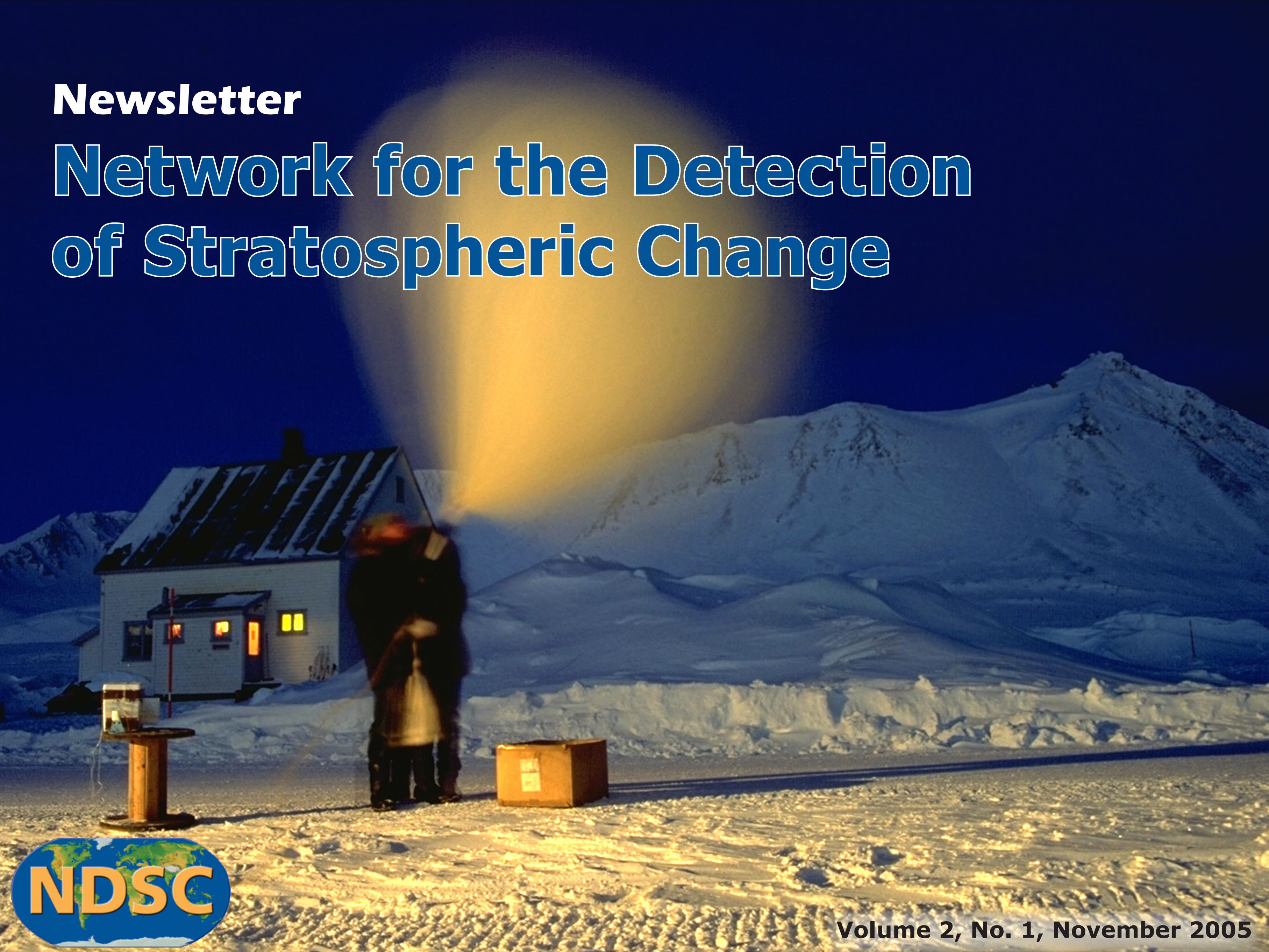


Newsletter

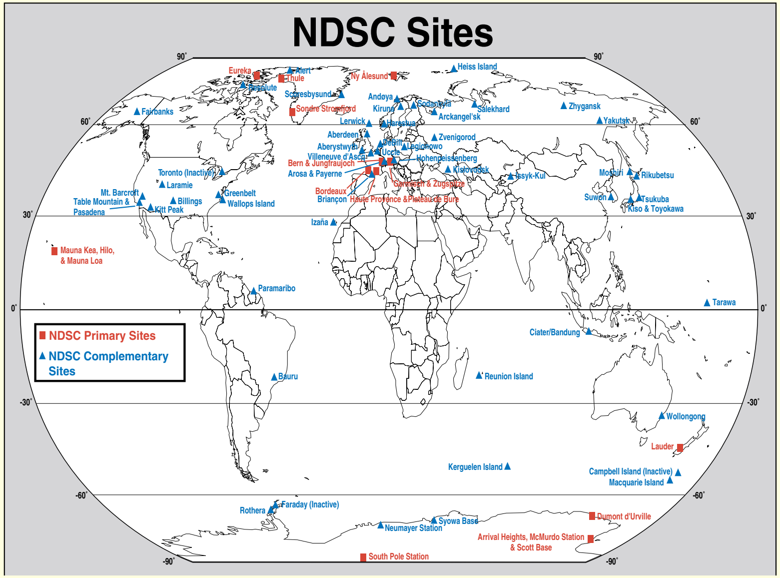
Network for the Detection of Stratospheric Change

NDSC

Volume 2, No. 1, November 2005

The NDSC Newsletter is published by the NDSC Steering Committee. This is the second issue. The plan is to make one issue per year. The next issue is planned for the autumn of 2006

Editor:
Geir O. Braathen,
World Meteorological Organization
E-mail: GBraathen@wmo.int

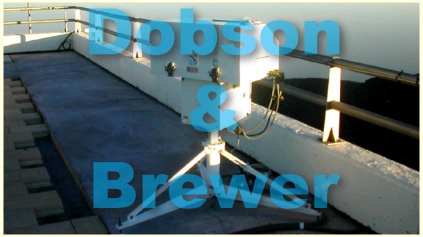


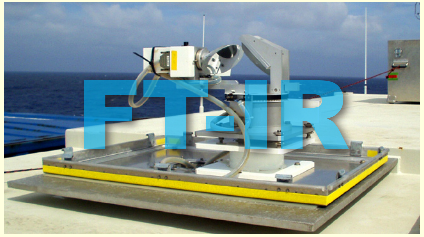
Cover photo: Ozonesonde launch from the Koldewey station in Ny-Ålesund, Spitzbergen. Photo: Thomas Seiler.

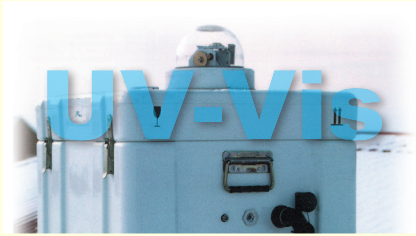
Contents

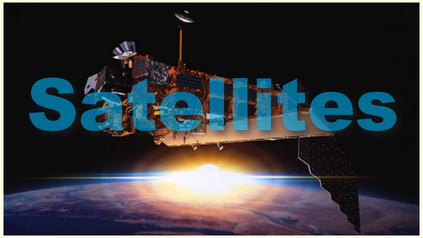
Working Group news

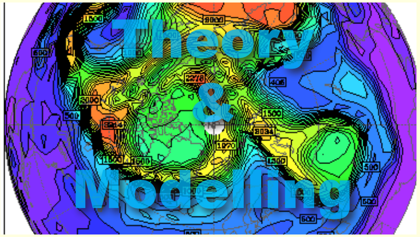
The NDSC consists of 9 working groups representing the various techniques that are used in the network: Spectral UV, Dobson and Brewer, Ozone and Aerosol sondes, FT-IR, UV-visible, Lidars, Microwave, Satellites, and Theory and Analysis. In this section we bring news from the various working groups. The text on each image is clickable.











Spectral UV

Intercomparison of UV spectroradiometers at Table Mountain, near Boulder, Colorado in June 2003. Photo: Gunther Seckmeyer.

A travelling standard for the NDSC spectroradiometers

Gunther Seckmeyer[1] and Richard L. McKenzie[2]

[1]University of Hannover, Germany; [2]National Institute of Water and Atmospheric Research, New Zealand

The newly developed spectroradiometer of the Institute of Meteorology and Climatology, University of Hannover, Germany, is capable of covering the spectral range from the UV to the near infrared (290 – 1050 nm) with relatively fine resolution. The instrument fulfils the stringent requirements set up by the Network for the Detection of Stratospheric Change (NDSC). Furthermore the data of this instrument showed little deviation over a wide range of atmospheric conditions compared to an NDSC spectroradiometer operated by New Zealand's National Institute of Water and Atmospheric Research (NIWA) during the 5th North American Intercomparison for UV spectroradiometers. The UV Intercomparison for spectroradiometers was held at Table mountain, near Boulder, Colorado, and the results have been compared to the NDSC instrument operated by NIWA/CMDL. The intercomparison took place on 22 June 2003; this day was nearly ideal, only few clouds were present during the afternoon and provided a large range of solar zenith angles where the performance of the instruments could be tested. ✔

Dobson and Brewer

Intercomparison of Dobson spectrophotometers at Dahab, Egypt in February/March 2004. Photo: Ulf Köhler.

Quality Assurance and Quality Control (QA/QC) in the Dobson Network

Ulf Köhler[1] and Tom McElroy[2]

[1]Deutscher Wetterdienst - Met. Obs. Hohen-peissenberg; [2]Meteorological Service Canada - Toronto

Introduction

The most important criterion for a successful use of any data set of atmospherical, physical or chemical parameters in trend analyses and climatological investigations is its high quality. This is not a brand new conclusion of the past few years, as already more than 20 years ago people working with Dobson spectrometers realized that no knowledge existed about the quality of the retrieved total ozone data sets. Sporadic intercomparisons started in the 1960s and revealed considerable differences (up to 10%) between the compared instruments (Figure 1).

Thus it was decided to establish a sophisticated calibration system to control and to assure the quality of total ozone data obtained by the global network of Dobson spectrophotometers. This calibration system has been refined step by step during the past 25 years to meet the increasing requirements of data

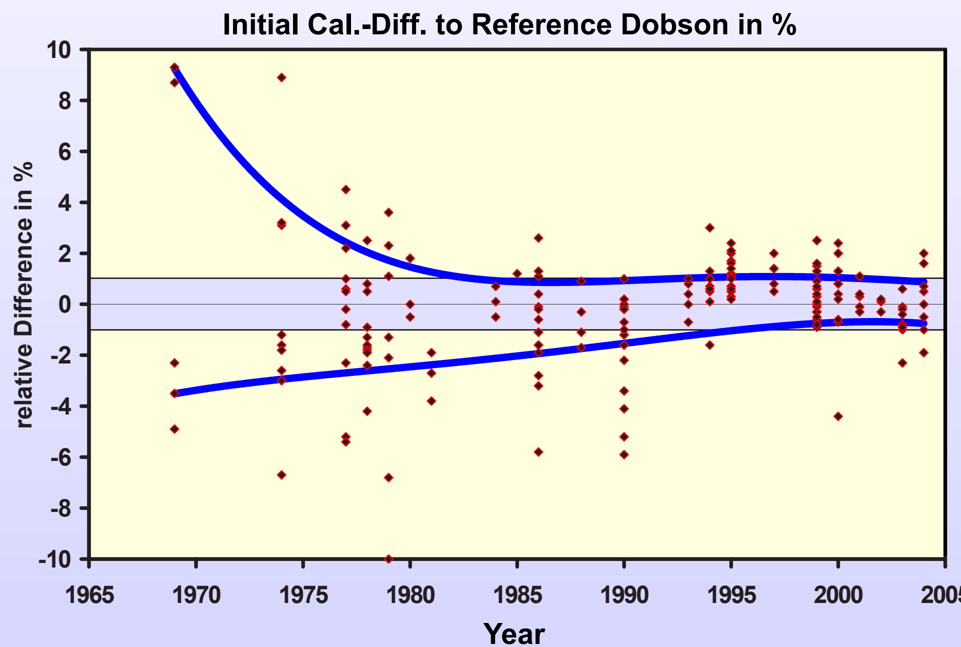


Figure 1: Relative difference of the calibrated Dobsons to the reference instruments during the Initial Calibrations (Status Quo at the beginning of an Intercomparison).

quality due to new tasks (e.g. validation of satellite data) and the increasing number of stations (approx. 100 operational instruments) all over the world (see also Figure 1).

The currently existing calibration network consists of:

- One World Dobson Calibration Centre (WDCC) at NOAA, Boulder with two primary standard instruments D065 (travelling) and D083.
- Three already operational Regional Dobson Calibration Centres (RDCC) and additionally two centres currently under construction, each with at least one regional standard Dobson, of which the calibrations are traced back to the primary standards.

Results of Recent Activities

One of these RDCCs is located at the Meteorological Observatory Hohenpeissenberg (MOHp) in Germany, working since 1999 in close co-operation with the Solar and Ozone Observatory Hradec Kralove (SOO-HK) in the Czech Republic. This RDCC-E is responsible for the QA/QC of approx. 30 operational European Dobsons. Twenty four of them have got a regular calibration during 7 intercomparisons in the last four-years calibration cycle, as recommended by WMO. Additionally the regional standards D064 (MOHp) and D074 (SOO-KH) got two absolute calibrations towards the primary standards.

Highlights of the activities during the past year were:

- Intercomparison of all Dobsons in the WMO RA I Africa at Dahab, Egypt in February/March 2004 (DICE) including an absolute calibration of D064 towards D065.
- Three WMO intercomparisons at MOHp from May to July 2004 including the complete refurbishment of two Dobsons from the British Antarctic Survey (BAS). One of them (D123) was at the BAS station Halley Bay during the detection of the ozone hole in the mid eighties.

In total 9 African Dobsons participated in DICE, which was held from February 21 to March 13, 2004 at Dahab, near the Red Sea. Experts from the WDCC (Boulder) and the RDCC-E (MOHp and SOO-HK)

Final calibration after the refurbishment of the two Halley Bay Dobson instruments. Photo: Ulf Köhler.

organized and conducted this intercomparison. In addition the regional reference D064 was absolutely calibrated towards the primary standard D065 (see photo on page 6).

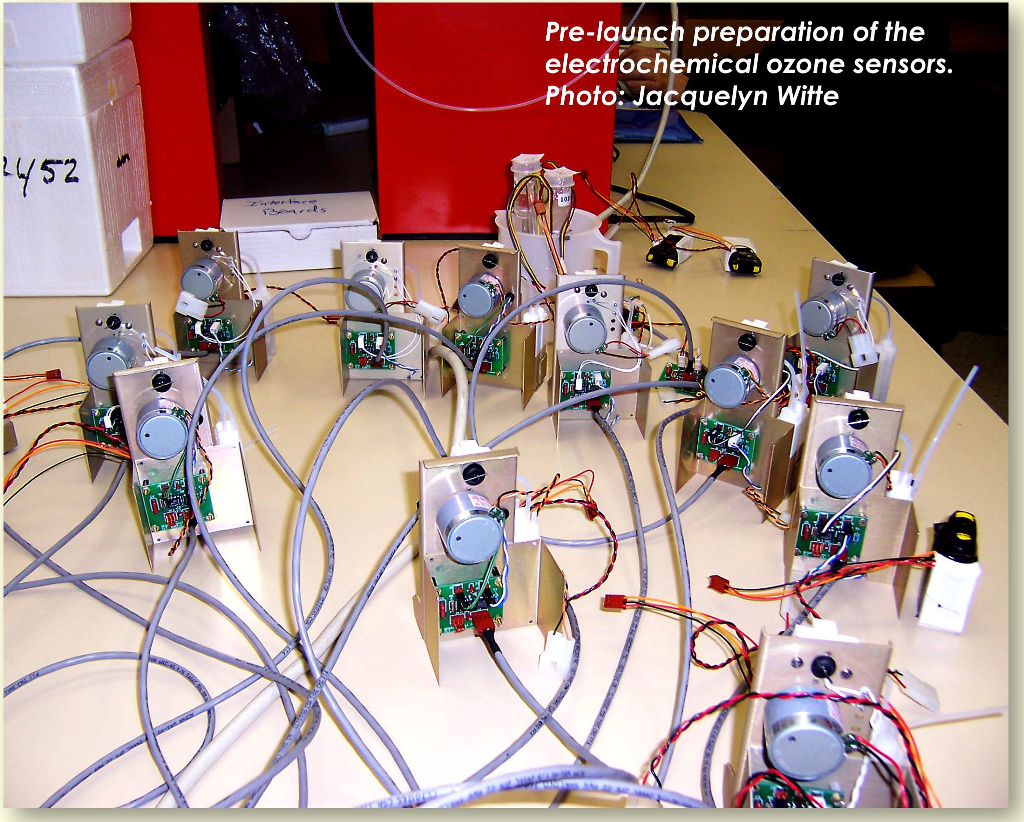
Two findings of this event are remarkable: On the one hand the performance of the participating instruments and subsequently their data quality has generally been improved significantly during the past years since the last campaign in Pretoria, South Africa in 2000, on the other hand there are still some problems existing with individual instruments (operation and in particular maintenance and skill of the operators). Thus, it turned out to be necessary to send the Kenyan Dobson No. 018 to MOHp for a complete refurbishment, as it was not possible to repair it on the spot. The other 8 instruments got final calibrations, which enables measurements of total ozone at the African Dobson sites within the error limits of ±1%.

A special highlight for the staff at Hohenpeissenberg was the inquiry from the BAS in the autumn of 2003 whether it would be possible to overhaul two of their Dobsons, which are normally deployed at the British Antarctic station Halley Bay. As these instruments were still equipped with the original electronics (tubes instead of modern amplifying circuits) and did not participate in any of the regular WMO intercomparisons during the past decades, this was really a challenge for the RDCC team. Dobson No. 073 and No. 123 were subject to initial tests in November 2003 to check the original calibration level before any work was started. The results were very encouraging, as both instruments agreed with the reference D064 within 2%. This confirms that the ozone data obtained with these instruments at Halley Bay during the past years are reliable. The final calibrations in May/June 2004 (photo on page 8) after the refurbishment work during the winter season 2003/04 were successful. Special emphasis was put on the calibration of the CD wavelength pairs (ozone observations at lower latitudes are normally done with the AD wavelength pair) and very low sun with relative optical path through the ozone layer $\mu > 4$, which corresponds to a solar zenith angle > 75^0. Both instruments met the given criterion of an allowed difference of ±1% to the reference instrument. ✔

BESOS – Balloon Experiment on Standards for Ozone Sondes

Terry Deshler, University of Wyoming

Balloon-borne ozonesondes are used worldwide to measure vertical profiles of ozone concentration from 0 to ~35 km. These instruments have many advantages. They are inexpensive, small, relatively simple to operate, and have a high precision, ~5%. The disadvantages include: there are at least three different instrument types and 4 manufacturers of ozonesondes, each instrument is flown once and lost, each instrument must be individually prepared by an operator, and there are variations in standard preparation procedures which influence the measurements even for similar instruments. All of these factors influence instrument accuracy. Of the three different types of instruments, the electrochemical concentration cell (ECC) instrument has become the dominant instrument due to its repeatability, reliability, and ease of preparation. For ECC sondes there are two manufacturers; Environmental Science Corporation (ENSCI) and Science Pump Corporation (SPC), and different recommendations for operating procedures.



Pre-launch preparation of the electrochemical ozone sensors. Photo: Jacquelyn Witte

Ozone and aerosol sondes

The debate on operating procedures centres primarily on the concentration of the potassium iodide (KI) solution used in the ECC, and whether it should be buffered with potassium bromide. The recommendations range from 0.5% buffered (ENSCI, Komhyr, 1997) to 1.0% buffered (SPC, Komhyr, 1986) to 2.0% unbuffered (Johnson, 2002). These differences have lead to some confusion concerning: how ozonesondes should be prepared, how accurate tropospheric ozone measurements are, and how ozone trends are influenced by variations in instrument type and preparation. Answers to these questions are of interest to any global data base, such as the NDSC.

In 1996, a series of intercomparison experiments were begun with the goal of defining standard operating procedures (SOPs) for ECC ozonesondes. This work was sponsored by the World Meteorological Organization's (WMO) Global Atmospheric Watch (GAW) program.

The experiments utilized a facility at Forschungszentrum Jülich, Germany, to simulate balloon flights

Tom Thompson assembling the payload while Michael Proffitt, Rigel Kivi and Herman Smit are watching attentively. Photo: Jacquelyn Witte

Preparing the balloon and the payload for launch. Photo: Herman Smit.

Balloon and payload about to take off.
Photo: Terry Deshler

within an environmental chamber, JOSIE-1996 (Smit and Kley, 1998), JOSIE-1998, JOSIE-2000 (Smit and Straeter, 2004a,b). The next step in this series of experiments was to complete a similar systematic intercomparison in the atmosphere.

The Balloon Experiment on Standards for Ozone Sondes (BESOS) was held at the balloon facility of the University of Wyoming, Laramie, Wyoming, in April 2004. Instrument preparation began on 5 April. The gondola was ready for flight on 10 April. The gondola was flown on 13 April 2004 from Laramie, Wyoming (41°N, 105°W), reaching an altitude of 32km, 7.3hPa. All instruments were recovered the next day without extensive damage.

The BESOS balloon gondola contained 18 ozonesondes, and a reference ozone photometer. The reference photometer was the same as used in the Jülich laboratory experiments. Of the 18 ozonesondes, 12 represented the core experiment consisting of 6 ENSCI and 6 SPC ozonesondes. In each group three ozonesondes were flown with 1.0% buffered KI solution and three with 0.5% buffered KI solution. These ozonesondes were selected at random from instruments the investigators had available to them. The additional ozonesondes included two Japanese ozonesondes, two ENSCI sondes flown with 2.0% unbuffered solutions, and 2 reconditioned

ENSCI ozonesondes flown with 1.0% buffered solutions. All instruments were prepared with the same standard operating procedures, with the exception of solution strength. Slight differences between other standard operating procedures were resolved with the investigators present. In addition to the balloon-borne measurements ground-based measurements of total column ozone were made with a Dobson spectrophotometer and a Brewer photometer.

The experiment was a blind intercomparison. Thus data from each set of instruments was prepared independently by each investigator. No access to other measurements was available until all data were placed on a common data base open to the investigators. This was completed on 1 July 2004. The data intercomparison continued at the "WMO-Workshop for establishment of SOPs for Ozone Sondes" from 20-23 September 2004 at Jülich, Germany.

Participants in the BESOS field experiment were: Bob Evans, Bryan Johnson, Dorothy Quincy, Sam Oltmans, Tom Thompson (National Oceanic Atmospheric Administration), Jacquelyn Witte, George Brothers (National Aeronautics and Space Administration), Gilbert Levrat, René Stübi (Meteo Suisse), Jonathan Davies (Meteorological Services Canada), Rigel Kivi (Finnish Meteorological Institute), Tatsumi Nakano, Toshifumi Fujimoto (Japan Meteorological Agency), Mike Proffitt (WMO), Herman Smit (Research Centre Jülich), and Jennifer Mercer, Terry Deshler (University of Wyoming). ✔

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Report from a meeting on standard operating procedures for ozonesondes

Terry Deshler, University of Wyoming

The following report gives a summary of the Assessment of Standard Operating Procedures for Ozone Sondes (ASOPOS) meeting held 20-24 September 2004, hosted by the Research Centre Jülich, Institute for Chemistry and Dynamics of the Geosphere: Troposphere, under the auspices of the World Meteorological Organization.

The first two days of the meeting were comprised of detailed discussions of the results from the Balloon Experiment on Standards for Ozone Sondes (BESOS) completed in Laramie, Wyoming, in April 2004. For BESOS all ozonesondes worked well; however, there were some problems with the ozone photometer, which were attributed to oscillations in the plasma lamp as the instrument moved in flight in the earth's magnetic field. These oscillations created significant problems in data reduction; however, two independent data reduction efforts resulted in nearly the same set of usable data. So while the ozone photometer data frequency is reduced to a fraction of what was expected, the quality of the remaining data is satisfactory. All data are now open to all BESOS experimentalists, but will remain private until analysis is complete and publications prepared. While further details cannot be presented it can be said that the BESOS experiment was consistent with the Jülich ozone sonde intercomparison experiment (JOSIE) laboratory results.

The following two days of the meeting focused on impacts from the JOSIE and BESOS experiments for standard operating procedures (SOPs) and how best to implement and document these SOPs for the community. The first day focused on a detailed discussion of each element of the SOPs for which there were still questions, and consensus was reached within the meeting on all detailed points of the SOPs. The second day focused on how best to document this effort and make the SOPs available to the community. The decisions were to prepare a Global Atmospheric Watch publication which would include a detailed rationale for all steps in the SOPs and pedagogical elements which can be used for training. Supporting documentation for this GAW report will be provided by two primary scientific papers: a) results from the JOSIE 1996 and JOSIE 2000 laboratory ozonesonde intercomparison experiments, b) results from BESOS, the atmospheric ozonesonde intercomparison experiment. Additional scientific papers which were discussed include: a) a comparison of Japanese KC ozonesondes with electrochemical ozonesondes. b) an analysis of individual comparisons of simultaneous measurements using ozonesondes with different solution strengths, and c) an analysis of the reduction in ozonesonde efficiency at low pressure. We anticipate the JOSIE and BESOS papers as well as the GAW report will be available by the end of 2005. ✔

FT-IR spectroscopy

The annual infrared working group meeting in 2003 assembled more than 40 scientists.

Reports from the FT-IR working group meetings

2003 FT-IR working group meeting

Justus Notholt, University of Bremen

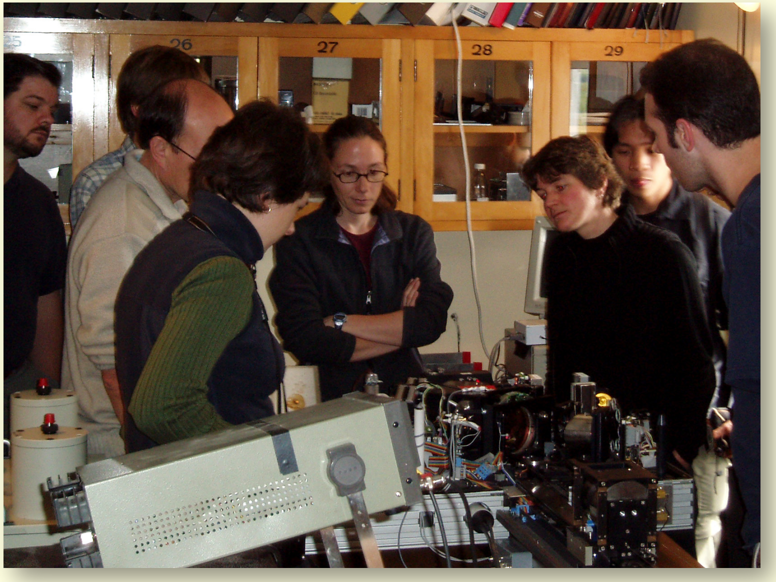
The annual infrared working group meeting in June 2003 took place in Bremen with the participation of about 40 scientists. Local organizer was Justus Notholt from the University of Bremen. The picture on the previous page was taken at the conference place in the center of the city, directly at the river Weser.

Special guests during the 2003 meeting were Prof. Clive Rodgers from the University of Oxford, who is the 'father' of the optimal-estimation-method, used to retrieve concentration profiles of trace gases. Furthermore, Prof. Luc Delbouille attended the meeting. Luc retired already about 10 years ago but he is still very active in the field and performs regular observations at the Jungfraujoch site. Luc together with others, like Jim Brault, Peter Fellget, Pierre Jaquinot, Ludwig Genzel and Alastair Gebbie have developed the FT-IR spectroscopy to what it is today. ✔

2004 FT-IR working group meeting

Stephen Wood, National Institute of Water and Atmospheric Research Ltd., Lauder

The 2004 meeting was held in Queenstown, New Zealand in November. Local organiser was Stephen Wood of NIWA. Among the topics discussed were new methods of ensuring instrument calibrations and data analysis were consistent across the group, given

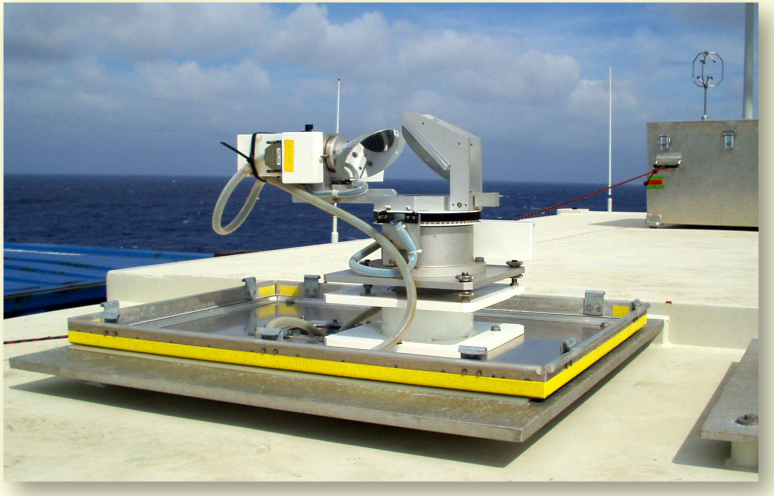


Participants at the 2004 FT-IR Working Group are admiring the inner workings of an FT-IR instrument installed at the NDSC station at Lauder in New Zealand.

that meaningful side-by-side instrument comparisons are difficult to achieve. New members of the group are now asked to compare their analysis of recorded IR spectra, from their own site and an existing NDSC site, with another group to check consistently. Also, some of the set of HBr calibration cells for monitoring instrument alignment around the network were brought to New Zealand to check how they had aged since manufacture by NCAR in 2001. Some of the group took the opportunity to visit the NDSC site at Lauder on the last day of the meeting where one of the two FT-IR instruments is being tested for making high precision measurements of greenhouse gases such as carbon dioxide and methane in the near infrared region. ✔

Polarstern

The latitudinal variability of trace gases is observed regularly by recording solar absorption spectra using the mobile FT-IR spectrometer 120M on board the German research vessel Polarstern. Typically, the observations cover the latitudes 50°N to 50°S in the Atlantic. The measurements are performed through a cooperation between the Alfred Wegener Institute and the University of Bremen. The instrument is installed in the white container on the top of the observer deck. The active solar tracker has to follow the course of the sun and compensate for the ship movements. ✔



MAX-DOAS UV/Vis measurements

A new technique to derive information on tropospheric trace species and aerosols

Michel van Roozendael, Belgian Institute for Space Aeronomy

Introduction

Ground-based UV/visible measurements of the light scattered from the zenith sky have been used for about two decades to monitor atmospheric columns of several important stratospheric trace gases such as NO_2, O_3, BrO and OClO. UV/visible DOAS instruments have a number of advantages. They are relatively cheap, easy to automatise, autocalibrated and, since the technique does not rely on absolute radiometric measurements, they are also largely insensitive to long-term instrumental degradation effects. In the conventional setup commonly used so far within NDSC, optimal sensitivity to the stratosphere is obtained by performing observations at low sun when geometrical enhancement factors are largest in this altitude region. Although maintaining capabilities for long-term monitoring of stratospheric trace species remains an important task, current scientific issues associated with atmospheric composition change also call for the development of improved methods to monitor trace gases in the troposphere.

Folkard Wittrock adjusting the optical head of the MAX-DOAS instrument on the roof of the NDSC building at Ny-Ålesund. Photo: Hilke Oetjen, courtesy of IFE, University of Bremen

Here we briefly report on recent efforts in Europe to extend the UV/visible DOAS technique towards the troposphere, based on a new approach called Multi-Axis DOAS (MAX-DOAS). Such developments are in line with the evolution of NDSC goals to address both stratosphere and upper troposphere monitoring. They complement similar efforts performed as part of other NDSC working group (e.g. FT-IR). The key idea of the MAX-DOAS approach is to enhance the sensitivity of the measurements to the lowest atmospheric layers by performing simultaneous observations of the skylight at different viewing elevations close to the horizon. When treated in combination with zenith sky data, these multi-axis measurements can be used to derive a coarse vertical profile of absorbers such as NO_2, HCHO, O_3, BrO, SO_2 and IO (see Hönninger and Platt, 2002; Leser et al., 2003; Wittrock et al., 2004; Heckel et al., 2004). In addition, since radiative transfer in the lower atmosphere is strongly dependent on the aerosol content,

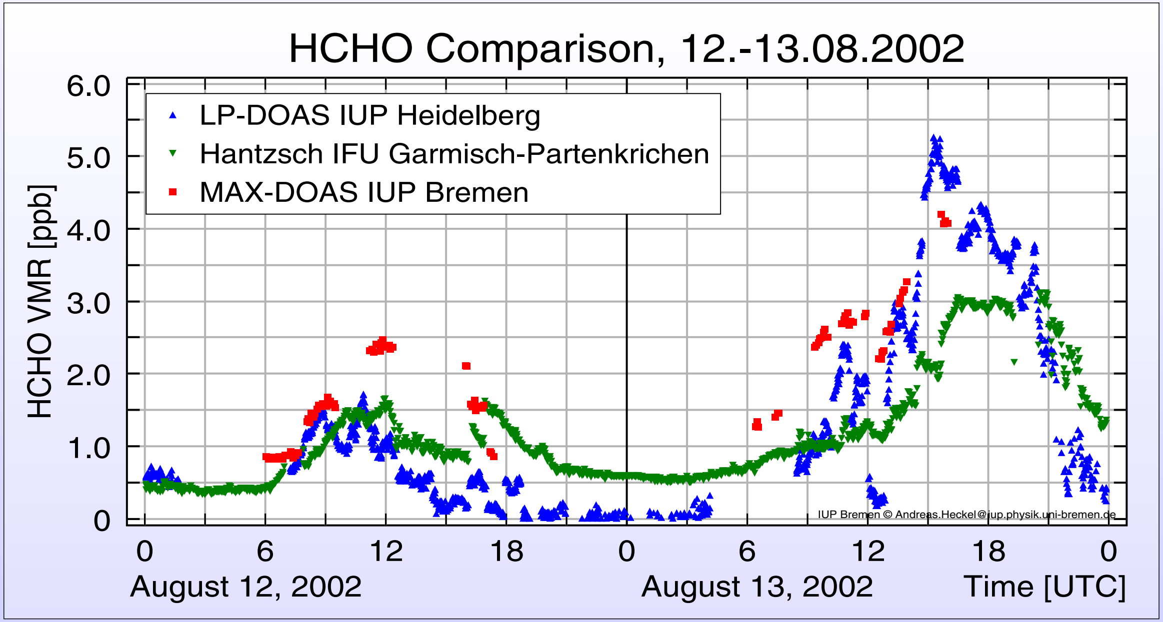


Figure 2: Intercomparison of HCHO mixing ratio measurements derived from MAX-DOAS analysis, in situ technique (Hantzsch) and long-path DOAS during the first FORMAT campaign in the Po Valley, Northern Italy (adapted from Heckel et al., 2004)

MAX-DOAS measurements of the oxygen dimer (O_4) can serve for the determination of aerosol properties (Wagner et al., 2004). This aerosol information provides essential input for the quantitative analysis of the tropospheric trace species.

Recent results

Major progress in the development of the MAX-DOAS technique has recently been achieved, mainly under the impulse of scientists from the University of Bremen and the University of Heidelberg, as part of two recently completed EU funded projects both coordinated at NILU by Geir Braathen: QUILT (Quantification and Interpretation of Long-Term UV-Visible Observations of the Stratosphere) and FORMAT (Formaldehyde as a tracer of photooxidation in the troposphere). The QUILT project is closely linked to NDSC activities. Its main aims are the consolidation of existing UV/visible data series as well as the improvement of both retrieval algorithms and atmospheric chemical transport models. The FORMAT project addresses the issue of improving our knowledge of formaldehyde distribution and chemistry, with a particular focus on assessing the consistency of different techniques that can be used to measure this key tropospheric molecule.

As part of FORMAT, two large measurement campaigns were organized in the heavily polluted Po Valley in Northern Italy, one in summer 2002, the second in autumn 2003. During these campaigns, ground-based measurements were performed at three locations, using a wide range of different in situ and remote-sensing techniques, among them MAX-DOAS instruments from three different institutes. These campaigns provided a unique opportunity to intercompare MAX-DOAS raw observations (slant

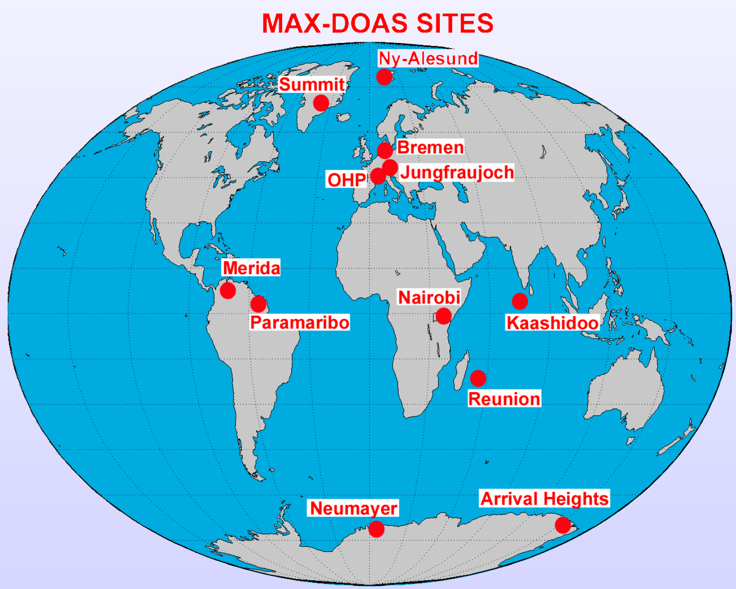


Figure 3: Map of stations currently equipped with MAX-DOAS instruments

columns), develop retrieval algorithms and validate resulting tropospheric data products based on comparisons with other techniques. As a result of these activities it was shown that, on clear days, MAX-DOAS measurements can provide accurate tropospheric columns and some profile information on HCHO with an automated and simple instrument. The capability of the method to retrieve HCHO in the boundary layer could in particular be demonstrated based on comparisons with independent local measurements (Heckel et al., 2004; see also Fig. 2). In addition, the possibility to derive relevant aerosol properties from O_4 measurements was demonstrated (Wagner et al. 2004).

Despite these successes, MAX-DOAS retrieval schemes are still in an early stage of development, and more work is needed before automated and properly characterized measurements can be obtained in routine mode. Nevertheless, the technique offers great potential in the context of the extension of NDSC activities towards the lower atmosphere. Currently a growing number of instruments are being deployed at various locations (see Figure 3), in particular in the tropical and equatorial regions where the NDSC coverage has been relatively poor until now. In summary, the MAX-DOAS technique is a promising tool for automated continuous measurements of the column and vertical distribution of several trace gases at NDSC stations. ✔

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Single lidar system reaches record temperature measurement range: 5.9 - 96.5km

Thierry Leblanc and Stuart McDermid

Jet Propulsion Laboratory , California Institute of Technology

A Differential Absorption Lidar (DIAL), designed to measure stratospheric ozone (15-55 km) and temperature (30-80 km) profiles, was developed in the late 1980s at the Jet Propulsion Laboratory Table Mountain Facility (TMF) in California. As part of the Network for the Detection of Stratospheric Change (NDSC), the system has been operating on a routine basis (3-4 nights per week) since 1988, and has produced more than 2000 ozone and temperature profiles.

From its beginning until July 1999, the system used a dual-beam excimer laser system emitting at 308 nm. One of the beams was Raman-shifted to 353 nm in order to utilize the DIAL technique (308 nm being the absorbed wavelength and 353 nm, the reference wavelength). Unlike ozone profiles, temperature profiles can be retrieved using the single reference wavelength only. In 1999-2000, two new excimer lasers and a Nd:YAG laser were purchased to replace the old lasers. The absorbed wavelength at 308 nm was still produced by the excimer lasers, while the new Nd:YAG laser produced the reference wavelength at 355 nm.

The Table Mountain lidar observatory, Wrightwood, California.

Both before and after the laser changes, temperature could be measured between approximately 20 and 85 km. Using a 91 cm diameter telescope, and appropriate gating and optical attenuation, low-range Rayleigh temperature was retrieved between 20 and 55 km, and high-range Rayleigh temperature between 30 and 85 km. Due to the presence of aerosols, even during a period of quiet volcanic activity, the temperature profiles were usually cut off higher than the effective measuring range, i.e., around 28 km.

In April 2004, major changes were made to the lidar receiver. The original telescope was replaced by a similar 91 cm diameter telescope but of much higher quality. Four new small telescopes were also added. A double-blade mechanical chopper was implemented, and four new Raman channels were set up. The telescopes were coupled to the chopper and detectors using fiber optics. Each chopper blade has four slots, which then allows four independent opening delays to accommodate the relative signal magnitude of each channel. The new receiver configuration was optimized for each telescope, and to cover the widest possible atmospheric range.

The procedure for retrieving temperature profiles is as follows: Rayleigh-scattered signal is collected by the large telescope, electronically gated, slightly attenuated, and used to obtain the high-range Rayleigh

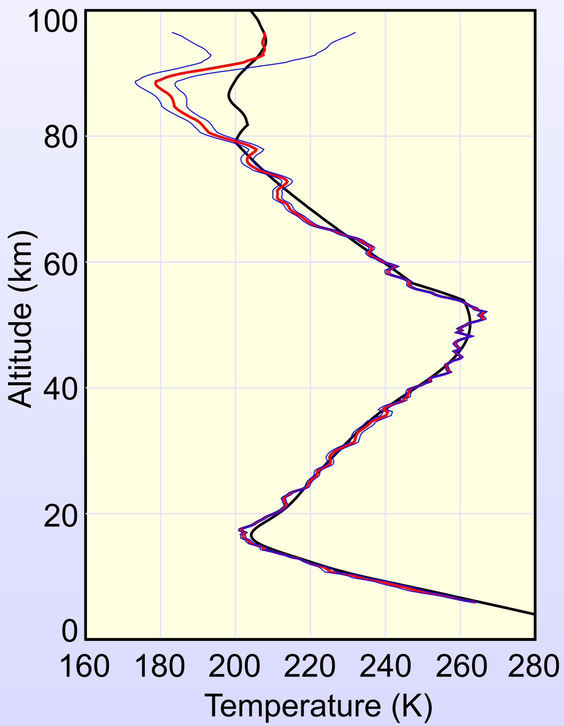

Figure 1. September 16, 2004. 2-h integrated TMF lidar temperature profile from 5.9 to 96.5 km. The TMF lidar profile plus and minus the total error is plotted in red. For reference, the thin black dash-dotted curve is a combination of local radiosonde (5-25 km), NCEP (25-45 km), MSIS-90 (45-80 km), and Na lidar climatology (85-100 km).

temperature profile (30-95 km). The vibrational Raman scattered signal (from atmospheric nitrogen) is also collected by the large telescope to retrieve the mid-range Raman temperature profile (12-45 km). Additionally, the vibrational Raman scattered signal is collected by one small telescope (75 cm diameter) to retrieve a low-range Raman temperature profile (4-20 km). Finally, Rayleigh scattered signal is collected from the smallest telescope (25 cm diameter), to retrieve a mid-range Rayleigh temperature profile, with a signal magnitude close to that of the mid-range Raman channel.

The four ranges described above can be combined to produce a single temperature profile extending from altitudes near 6 km to around 95 km. From September 15, 2004, the JPL temperature profiles archived at NDSC will be a combination of the ranges described above: The high-range Rayleigh, the mid-range Raman and low-range Raman will normally be used. The mid-range Rayleigh may be used in the future only if the mid-range Raman becomes too weak to guarantee reliable measurements above 35 km. Due to the presence of tropospheric aerosols, water vapor, or clouds, temperature retrieval down to 6 km is not always possible. Finally, the maximum altitude of the profile varies by ± 3 km depending on the Moon brightness. Overall, it is expected that temperature profiles over the range 8-93 km will be routinely obtained.

Soon, radiosonde and Raman lidar measurements of tropospheric water vapor and temperature will be performed simultaneously. The unique set of instruments available at TMF will present an outstanding opportunity to study upper troposphere/lower stratosphere processes in detail. ✔

Review of ozone and temperature lidar validation performed within the framework of NDSC

Philippe Keckhut, Service d'Aéronomie du CNRS.
Published in J. Environ. Monit. 6, 721-733, 2004.

Regular exercises have been organized, in the framework of the NDSC, to ensure the data quality at each individual site for each technique. Since its inception, the NDSC has provided systematic measurements of vertical ozone and temperature profiles with lidar at several places around the world that are well adapted for satellite validation. However, such a tool requires a good spatial homogeneity. The use of assimilation tools for satellite validation also requires a true estimate of the accuracy of the reference data. NDSC is a research network, so each system has its own history, design, and analysis, and has ensured data compatibility through participation in several validation exercises. The work conducted by NDSC teams can be separated into three categories: large-scale inter-comparisons using multiple instruments (including a mobile lidar); satellite observations as a geographic transfer standard to compare measurements at different sites with the same instrument; and comparative investigations of the analysis software.


The Mauna Loa observatory, Hawaii.

After more than 10 years of operation, it was decided to review all those comparisons to estimate the overall homogeneity of the network and to be able to experimentally quantify the overall accuracy of stratospheric lidar measurements.

To date, more efforts have been devoted to characterizing ozone measurements than temperature observations. The synthesis of the published works shows that this technique can potentially allow homogeneous measurements from site to site within 2% between 20 and 35 km for ozone and 1 K between 35 and 60 km for temperature. Outside these altitude ranges, larger biases are reported and so efforts need to continue. In the lower stratosphere, Raman channels seem to improve comparisons but such capabilities were not systematically compared. At the top of the profiles, more investigations on analysis methodologies are still probably needed. SAGE II and GOMOS appear to be excellent tools for future ozone lidar validation but need to be better coordinated and take more advantage of assimilation tools. Also, temperature validations face major difficulties caused by atmospheric tides and therefore require more intercomparisons with the mobile systems at many other sites. ✔

The GSFC/NASA mobile ozone and temperature lidar in operation at the Mauna Loa site in the Big Island of Hawaii during an intercomparison campaign. The station is located 3397 masl on the northern side of the Mauna Loa volcano. In the background one gets a glimpse of Mauna Kea between the clouds.

WALIDNet: Water vapour Raman lidar efforts within the NDSC

Philippe Keckhut, Service d'Aéronomie du CNRS

Measuring water vapour in the upper troposphere and lower stratosphere (UTLS) is important for climate research because of the radiative role of this molecule as the main greenhouse gas in this region. During the last decades, the Raman lidar technique has been developed at several places around the world. The Network for the Detection of Stratospheric Change has decided to include this type of instrument in the list of recommended tools to monitor the atmosphere on a long-term basis. The Raman lidar technique has already demonstrated is great potential for both atmospheric monitoring and case studies. However, it is a recent technique compared to other types of lidar and some efforts are still required to provide reliable data on a routine basis. The lidar Working Group of the NDSC has set-up a group to suggest some investigations to complement the Network with adequate instruments and to improve the delivery of homogeneous and reliable data that can be used for both satellite validation and to study the vertical distribution of water vapour in the vicinity of the tropopause. This group is composed of investigators already involved in the NDSC and of some teams already operating water vapor lidars outside the NDSC. They come from the US, Europe (Italy, Germany, France, Switzerland, United Kingdom, The Netherlands) and South Korea. The group activities were first organized within the framework of the AURA satellite validation. In this context the following tasks have been proposed:

- Set up an adequate network to address satellite validation and some key issues on climate research,
- Provide information on the validation and the homogeneity of the network,
- Set up calibration procedures, and evaluate their respective capabilities,
- Define a common data format,
- Deliver data for satellite validation in the upper troposphere including first AURA experiments (HIRDLS and MLS),
- Derive some local climatologies, and compare them among themselves and with satellite measurements,
- Perform some assimilation tests around Europe where the density of instruments is the largest.

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Microwave spectroscopy

The multi-hygrometer payload ready for launch during the LAUTLOS campaign.

Middle Atmospheric Water Vapour Radiometer - MIAWARA

A new NDSC instrument

Beat Deuber and Nik Kämpfer

University of Bern

The Middle Atmospheric Water Vapour Radiometer, MIAWARA, is in operation since the fall of 2002. The instrument is operated from the ground and measures the 22.235 GHz rotational transition of water vapour. Profiles in the range of 20-80 km are retrieved from the measured spectra. The instrument was developed to fulfil two major goals:

- Long term monitoring of the middle atmospheric water vapour content over Bern, Switzerland,
- Stand-alone, self-calibrating instrument for campaign use.

For a detailed description of the instrument refer to Deuber et al., 2004 and http://www.iapmw.unibe.ch/research/projects/MIAWARA/.

MIAWARA has undergone a validation process and is now certified as an NDSC instrument.

Routine operation at Bern, Switzerland

MIAWARA has been operated since the fall of 2002 in Bern, Switzerland (46.95°N, 7.45°E, 550masl). If the tropospheric conditions allow measurements (no rainfall, moderate tropospheric opacity) a water vapour profile can be retrieved each day. The instrument was operational in Bern from the fall of 2002 until November 2003 and was reinstalled after the LAUTLOS campaign (see below) in May 2004. In Figure 1 the daily water vapour content over Bern, as measured by MIAWARA, is given for the period of December 2002 to November 2003.

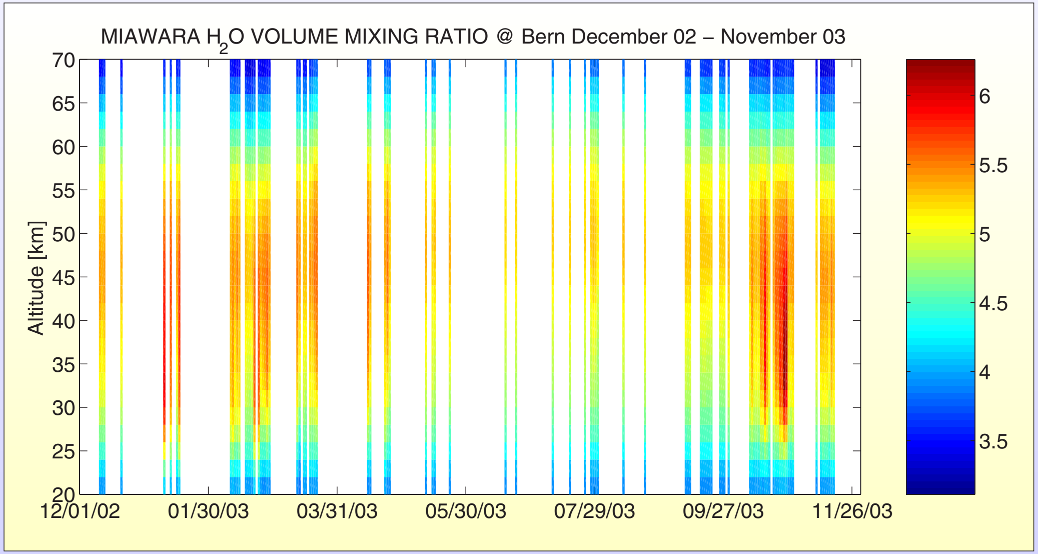

Figure 1: Daily water vapour mixing ratio at Bern from December 2002 to November 2003.

LAUTLOS / WAVVAP Campaign

In early 2004, the radiometer MIAWARA took part in the LAUTLOS/WAVVAP - Lapbiat Upper Tropospheric Lower Stratospheric Water Vapor Validation Project - campaign in Sodankylä (Northern Finland, 67.4°N, 26.6°E, 180masl). During this campaign multi-hygrometer balloon payloads with the stratospheric humidity sensors FLASH (Lyman-α) and NOAA/CMDL (chilled mirror) were launched. Besides the balloon instruments the microwave radiometers MIAWARA (ground-based) and AMSOS (airborne) were operated during LAUTLOS at Sodankylä. The combination of balloon sensors and microwave radiometry opened the rare opportunity to measure the water vapour profile from the ground into the mesosphere.

A total of 10 flights of FLASH and NOAA sondes could be compared to the MIAWARA profile for the overlapping region between 20 and 26 km. The mean relative difference for all these flights between MIAWARA and the balloon sensors is less than 3%. In Figure 2 (next page), the 18 February flight and the corresponding MIAWARA 24 h integrated profile are given as an example. ✔

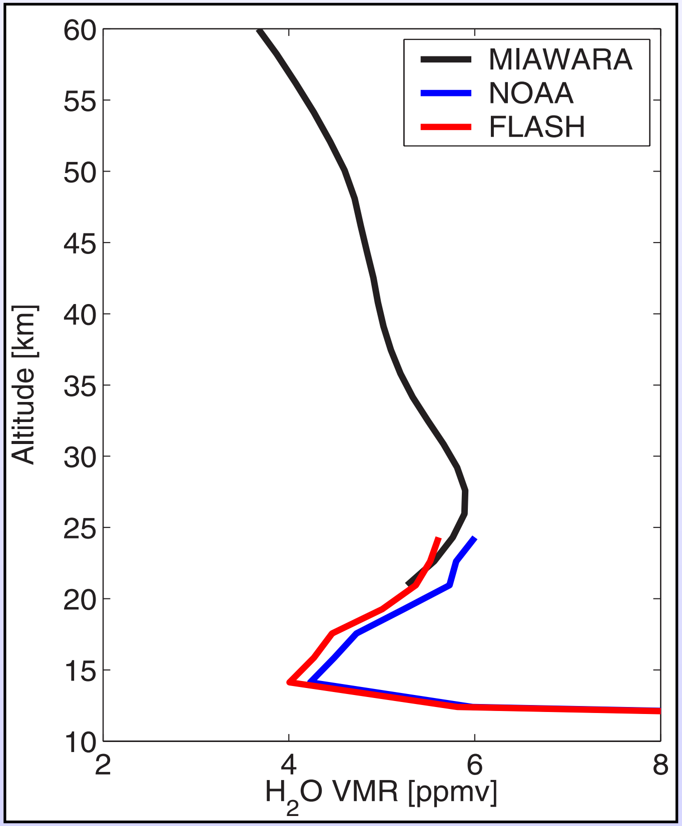

Figure 2: Comparison of the 18 February 2004 flight of FLASH and NOAA with MIAWARA 24h integrated profile (Balloon profiles reduced to MIAWARA retrieval grid using Curtis-Godson).

MIAWARA in operation at Sodankylä during the LAUTLOS campaign.

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Report from MW working group meeting

Gerald Nedoluha, Naval Research Laboratory

Fourteen members of the NDSC Microwave Working Group attended a workshop in May 2004 before the Quadrennial Ozone Symposium in Kos. The workshop focused on the issue of validation. There were several presentations given by groups with NDSC candidate instruments which showed their progress in validation of their data, and a presentation on the retrieval of profiles with different altitude grids. In addition, there were presentations on the use of microwave instruments for validation of satellite instruments on ENVISAT, and on the validation of satellite trend measurements, such as those from HALOE. There was also a lengthy discussion on formatting issues for AURA validation, and a general consensus was reached on a microwave instrument format which would be used for data submission. Details of the agenda, as well as the actual presentations, are available at the NDSC Microwave Working Group web site: http://www.iapmw.unibe.ch/research/collaboration/ndsc-microwave/workshop/2004/programme.html.

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Protection of Passive Radio Services

Jérôme de La Noë, Université Bordeaux 1

A workshop on "Active Protection of Passive Radio Services: towards a concerted strategy" was held in Cagliari, Sardinia, Italy, on 28th and 29th October 2004. The workshop was sponsored by the European Science Foundation, with additional support from the European project RadioNet. The meeting addressed the threats to scientific use of passive radio frequency bands from rapidly increasing use of the radio spectrum, from growing levels of radio pollution, and from commercial pressures to relax regulatory control. Deregulation is used to increase competition in the market, but how can passive users compete? The meeting brought together, for the first time, the radio astronomical and remote sensing communities, in a relaxed informal venue. There were 26 delegates from 9 countries, who between them represented 5 national and international space agencies, the meteorology community, the aeronomy community, the geodetic community, and 6 major radio astronomy observatories.

Jérôme de La Noë described techniques for studying the middle atmosphere from the ground using passive microwave radiometry to obtain vertical profiles of atmospheric gases. The Network for the Detection of Stratospheric Change (NDSC) runs monitoring stations that have no official status within the ITU, but which play an important complementary role to satellite sensors, tracking time evolution. Limb sounding from space using the Odin satellite at sub-mm wavelengths was discussed by Joachim Urban, while Dietrich Feist described stratospheric sounding of water vapour from aircraft, and interference over certain regions.

The organization and role of IUCAF was explained by the Chairman, Wim van Driel. ICSU in its recent review recommended that IUCAF becomes truly interdisciplinary to take care of all passive services. The meeting was strongly in favour of adding lectures on remote sensing to the second IUCAF Summer School in Spectrum Management, to be held in June 2005.

The heart of the workshop was the subsequent Open Discussion chaired by Edoardo Marelli, ESA, which covered the following topics:

1. Organizational Situation. It was felt that the CRAF-IUCAF Summer School 2005 will be of interest to the passive sensing community, and should include some lectures on those issues. In the longer term a more formal structural solution could come through enlarging the mandate and constitution of IUCAF.

2. Political Aspect. We need to target the decision makers in frequency management at national level, so they can support us better internationally. We need to stress the economic value of keeping passive frequency bands empty. We also need to improve our high level contacts so that our case is known at political level.

3. Regulatory Situation. Within Europe, only 5 of the 45 CEPT national authorities are aware of the need to protect passive services. We need to increase this awareness, to avoid the situation where individual national administrations take (uniformed) unilateral actions to our detriment. In the long term we need a definition of the ground-based passive atmospheric sensors as a service, perhaps via meteorological aids.

4. WRC-07 Specific Issues. For the WRC-10 agenda we need good coordination on the agenda item for frequencies above 275 GHz, to ensure that we have a compelling case before the WRC-10 agenda is decided at WRC-07. It was decided that our 3 contact points for the three areas should be Wim van Driel (radio), Guy Rochard (passive sensing from satellites) and Jérôme de la Noë (passive sensing from the ground). The contact persons are to gather data, perhaps via the new wiki, and we will try to make a workshop to merge the 3 cases. In the long term we need to develop a position on the question of regulation of optical and infrared frequencies. ✔

Multi Sensor Match Approach

A way to determine stratospheric ozone losses and to validate different kinds of sensors simultaneously

Peter von der Gathen, Markus Rex, Martin Streibel et al., Alfred Wegener Institute for Polar and Marine Research

The Match approach, a statistical Lagrangian technique based on combining ozone measurements linked by trajectories, has proven to be a reliable tool to quantify stratospheric ozone losses. First introduced by using the Arctic ozonesonde station network (e.g. von der Gathen et al., 1995; Rex et al., 1997, 2002; Schulz et al., 2000) the technique was later adapted using data from the satellite-borne Improved Limb Atmospheric Spectrometer (ILAS) (Sasano et al., 2000; Terao et al., 2002).

During the southern hemisphere winter of 2003 the first Antarctic ozonesonde Match campaign was coordinated in the frame of the EU project "Quantitative Understanding of Ozone losses by Bipolar Investigations" (QUOBI) with further participants from Argentina, Australia, Japan and USA. The achieved data set together with data from the satellite-borne sensors ILAS II and Polar Ozone and Aerosol Measurement III (POAM III) were used as input for the novel Multi Sensor Match Approach.

Ozone loss rates are computed by calculating linear fits between the measured differences in ozone and the times the individual air masses spent in sunlight between the measurements. By analysing various subsets of the data, the evolution of ozone loss rates through the winter as well as the vertical profile of ozone loss can be studied. In the standard Match approach only the ozone loss rate is fitted as a single parameter. In the Multi Sensor Match Approach matches involving measurements from different sensors, e.g. ILAS II - ozonesonde, are used in addition to the standard matches that rely on measurements from identical sensors only. For these 'mixed' matches a bias term is used as an additional fit parameter, which contains information about the biases between the different sensors. By using more than one sensor the overall number of matches increases by a much larger factor than the number of parameters that are fitted. Hence, the statistical uncertainty of results from the Multi Sensor Match Approach is considerably smaller than for those from the standard approach. Furthermore the latitudinal coverage of measurements is improved (see Figure 1).

In the future, this new method has the potential to intercompare and validate various sensors. Since the measurements do not have to be coincident, even biases between different modes of operation of satellite sensors or various ozonesonde type/solution combinations can be precisely examined under atmospheric conditions, as long as enough additional measurements (e.g. satellite-borne) are available. ✔

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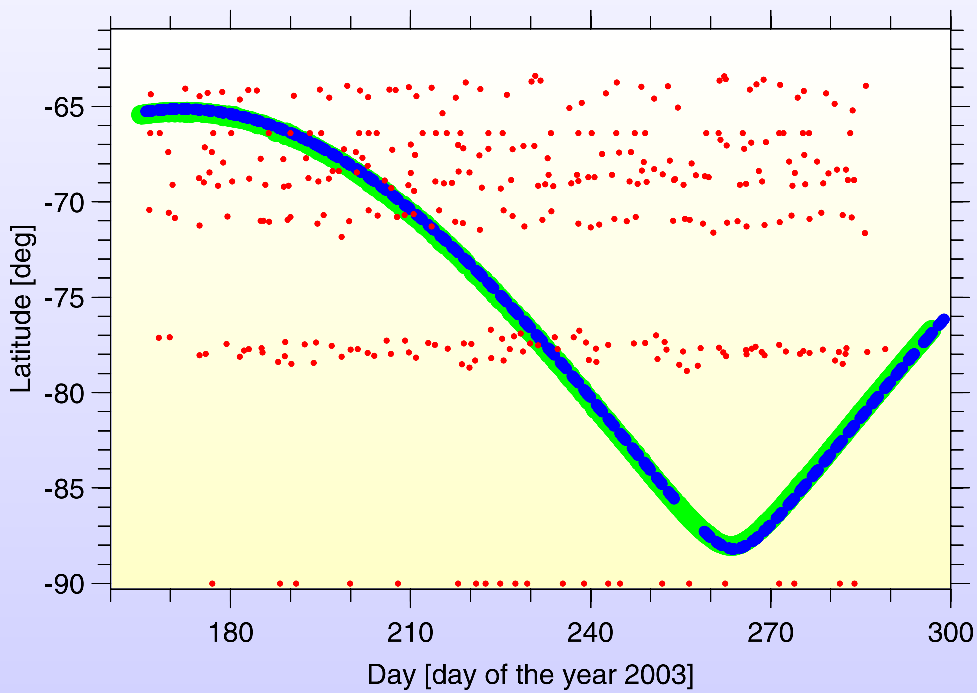

Figure 1: Latitudinal coverage of measurements (green: ILAS II, blue: POAM III, red: ozonesondes) at 475 K potential temperature during the Antarctic winter 2003.

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Comparisons of long-term ozonesonde measurements at McMurdo Station, Antarctica with the SLIMCAT 3-D model

Jennifer Mercer[1], Martyn Chipperfield[2], Terry Deshler[1]

[1]University of Wyoming, U.S.A, [2]University of Leeds, U.K.

A key test of our understanding of any physical system is to compare model predictions for that system with observations. The longer and more extensive the observational database, the more critical can be the comparison with the model. The fundamental aim of the NDSC is to provide high quality observations which can be used for such model evaluation. Important aspects of this are to provide both a wide range of observations at certain sites and to ensure long time series of observations.

In the 1990s our understanding of stratospheric polar chemical ozone loss matured to a level of good qualitative understanding. Three-dimensional (3-D) atmospheric chemistry models also matured to a state where they can be run over long time periods but still compared in detail with specific observations. Many studies of winter/spring ozone loss have been performed in the Arctic and are on-going. Here we illustrate two approaches for such model tests using in situ ozone profile observations in the Antarctic, one in a Lagrangian framework and one in an Eulerian framework. In this short article we will mainly concentrate on the Eulerian study.

At the primary NDSC site of McMurdo Station, Antarctica, regular ozone profile measurements have been obtained between late August and late October every year since 1986. These measurements span the ozone loss period each year. The measurements use balloon-borne electrochemical concentration cell ozonesondes, an NDSC-approved instrument. These, and similar measurements at other sites, have been the focus of recent comparisons between ozone loss measured using the MATCH technique and 3-D chemical transport models (CTMs). The MATCH technique uses air parcel trajectory forecasts to trigger the release of ozonesondes from fixed stations. The measured ozone change in a tagged air parcel can be compared with CTM or box model predictions for this Lagrangian frame of reference. Many years of such experiments have been conducted in the Arctic where topography perturbs the stratospheric polar vortex causing it to be unstable and warm, and thus ozone loss to be less severe than in the colder and more stable Antarctic vortex. These Arctic MATCH comparisons have identified certain time periods when models do not capture the observed ozone loss well. In 2003, the first Antarctic MATCH campaign, involving nine Antarctic stations, seven of which are NDSC sites, was conducted to test if these discrepancies also exist in the colder more stable southern polar vortex. The results of this comparison, involving the collaboration of scientists from 16 countries, are currently being analysed.

Another approach to test our quantitative understanding of ozone loss is to compare multi-year ozone measurements at a single station with predictions from a long run of a 3-D CTM. This is the approach underlying an investigation undertaken by the Universities of Wyoming and Leeds. The McMurdo ozone profile measurements performed by the University of Wyoming are being compared with the Leeds SLIMCAT CTM. For this work SLIMCAT used prescribed temperature, pressure, humidity and wind fields from the European Centre for Medium-range Weather Forecasts (ECMWF) ERA-40 reanalysis to prescribe air motion on 24 isentropic levels. The model was initialized in 1977 and integrated through to 2003 using time-dependent tropospheric loadings of source gases. The model profile and total column ozone are compared with McMurdo sonde measurements between late August and late October for the years 1989 - 2003. In addition SLIMCAT is compared to wintertime measurements in 1994.

In broad terms, the model agrees with the measurements fairly well. Figure 1 presents a comparison of measured and modeled ozone mixing ratios for the entire data set examined. Although there is quite a bit of scatter, the overall correlation is high.

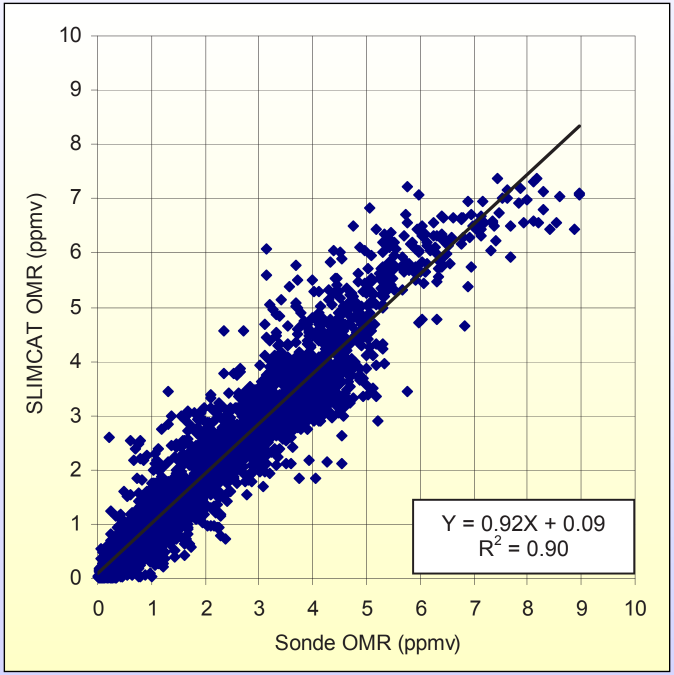


Figure 1: Comparison of ozone mixing ratios modeled by SLIMCAT and measured by balloon-borne ozonesondes for the entire McMurdo data set investigated, 1989-2003.

Figure 2 compares measured and modeled total column ozone for February - October 1994 (including the wintertime observations) and late August - October for 1996 and 1998. The model captures the general features of the observed column as well as the timing and magnitude of the springtime loss. There are, however, differences – for example the model slightly underestimates the observed column. Differences are also seen when model ozone profiles are compared to measurements.

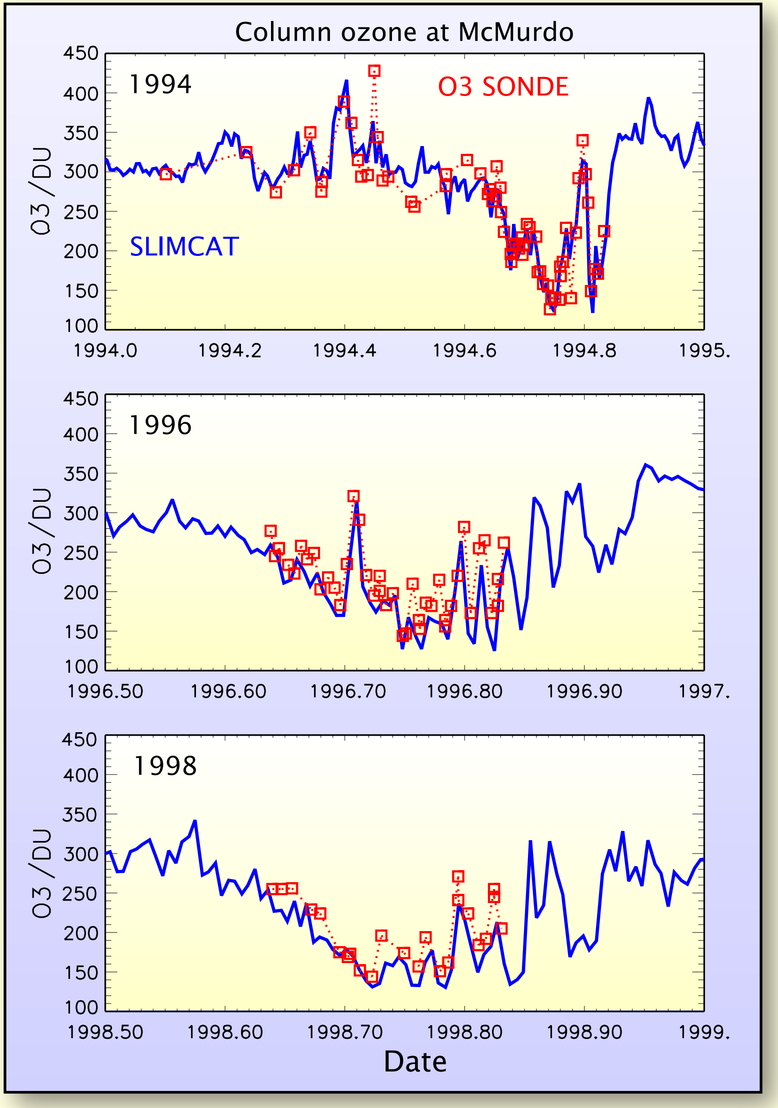


Figure 2: Total column ozone measured by balloon-borne ozonesondes (red squares) and modeled by SLIMCAT (blue solid line) for January-December 1994 and June-December 1996 and 1998. Note that the time scale in the upper panel is different from that of the two lower panels.

For this comparison, the measurements are averaged to provide an ozone measurement on each of the SLIMCAT isentropic levels. Large differences in the profiles begin to occur at isentropes above ~450 K, while the model compares better to measurements below these values. Figure 3 presents examples of these comparisons.

In summary, SLIMCAT predicts the timing of the onset of ozone loss and the magnitude of the very low ozone observed in October well. The differences with measurements appear in the absolute magnitude of ozone in late winter and in details of the ozone profile. Overall these comparisons in the Antarctic are similar to comparisons in the Arctic, but point to the presence, in the atmosphere, of lower ozone partial pressures occurring in late austral winter than are presently captured by the model's reflection of our understanding of stratospheric ozone chemistry. The reasons for these differences are not presently understood. Possibilities include: difficulties quantifying atmospheric bromine, difficulties accounting for chlorine activation, difficulties in quantifying polar stratospheric cloud reaction sites, or additional chemistry not presently understood. ✔

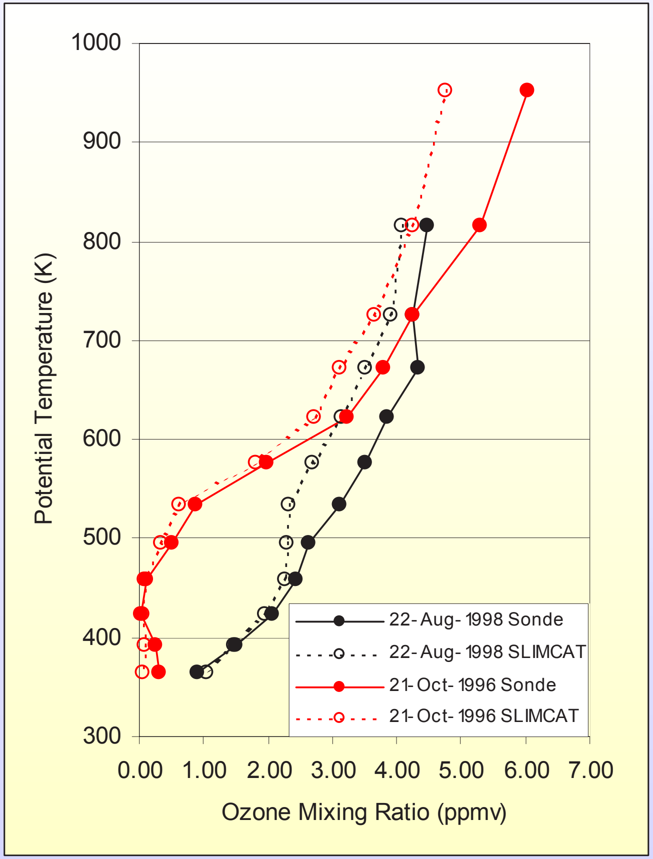


Figure 3: Vertical profiles of ozone mixing ratios measured by balloon-borne ozonesondes and modeled by SLIMCAT for examples in August (1998) prior to the beginning of ozone loss and October (1996) when ozone depletion is large.

A report on the NDSC data base

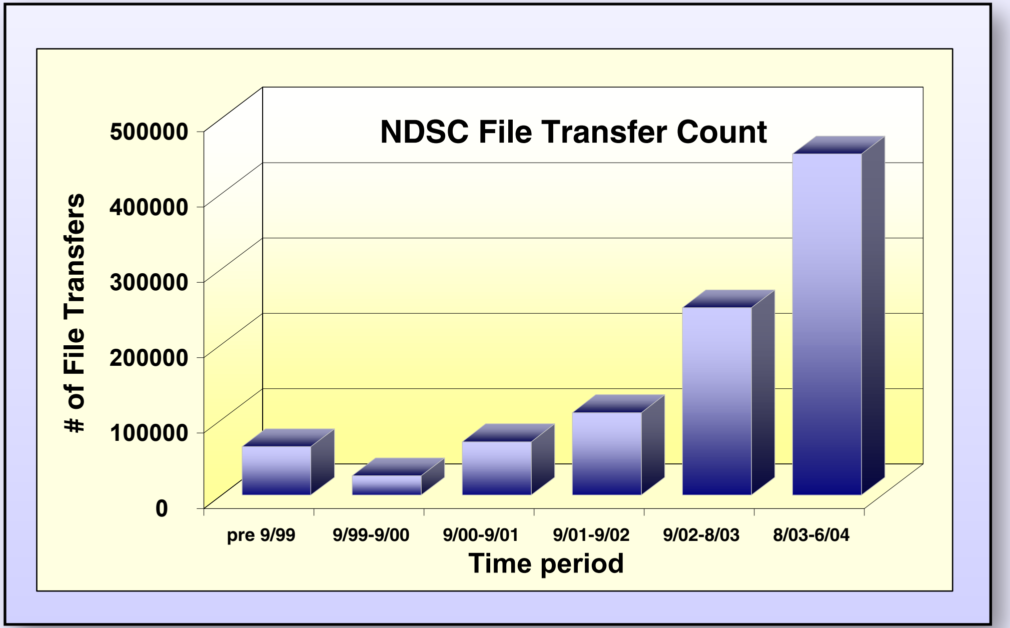
Jeannette Wild and Roger Lin, NOAA, NCEP

Large increase in the use of NDSC data

Data from the NDSC network is stored in the central data handling facility at NOAA. The instrument PIs are obliged to submit their observations to the database no later than one year after the observation. Within two year of the observation date the data are moved to the open FTP site, where it can be downloaded by everyone. This open access to the data has resulted in a large increase in the demand for NDSC observations. The figure below shows the number of file transfers that have occurred from year to year and one can see that the number of file transfers from August 2003 - June 2004 was close to 500.000.

Transfer of NDSC data to WOUDC

The increasing number of data bases causes extra work for the data providers when it comes to submission of data. The fact the various data centres rarely use the same format for data storage causes even more work for the data suppliers. This situation leads to a certain reluctance among data providers to submit data. In order to alleviate this the NDSC DHF has agreed to transfer ozonesonde data collected from the NDSC ozonesonde stations to WOUDC. For the data providers this means one data base less to submit data to. In a first try 3076 ozonesonde files were sent from NOAA to WOUDC of which 1264 were accepted. This is considered a good result for a first try. ✔



News from stations

The NDSC consists of more than 70 stations. This section brings news about new developments at the stations.

Summit, Greenland

In 2003 a microwave radiometer was installed at Summit in the middle of Greenland (72°N) at an altitude of 3300 m. The high altitude with its low tropospheric water content make the site very suitable for microwave observations. The figure shows the container, where the radiometer and a DOAS spectrometer is installed. The observations are performed within an EU-project by the University of Bremen, University of Leeds, University of Bordeaux, Danish Meteorological Institute, and the Naval Research Center.

Merida, Venezuela

The tropics have been identified as a key region for understanding the global climate, but no ground based observations station has existed so far in the tropical belt. In 2003, microwave and DOAS observations started in the tropics at the Pico Espejo near Merida/Venezuela (8°N) at an altitude of 4700 m. The observations are performed through a collaboration between the University of Bremen and the Forschungszentrum Karlsruhe. The small building on the photo hosts the microwave and the DOAS instrument.

Bremen

The FT-IR trace gas measurements in Bremen (53°N) were accepted in 2003 as complementary NDSC observations. The place can be described as a medium polluted industrial city. Since the surrounding area is very flat with maximum altitude variations of 20 m, it is very suitable for satellite validation with their limited ground size resolution. The FT-IR observations are completed by microwave and DOAS measurements. The photo shows the dome of the new Environment Institute building, where the instruments are located.

The dome used for sending the sunlight into the FT-IR instrument

Toronto, Canada

The FT-IR at the recently established University of Toronto Atmospheric Observatory (TAO) was accepted as a Complementary NDSC instrument in March 2004, based on the successful completion of an algorithm and data comparison exercise that was set by the IRWG. This FT-IR is at an urban mid-latitude site (44°) and has been used to make regular measurements since May 2002. It is intended for long-term measurements of both tropospheric and stratospheric constituents. Activities to date have focussed on the implementation and optimization of retrieval algorithms, comparisons with the Canadian Middle Atmosphere Model, and comparisons with satellite data (particularly MOPITT and OSIRIS). The photo shows the view from TAO, looking south over Toronto.

This section brings information on ongoing and new projects that are relevant to the NDSC. These can be both national and international projects.

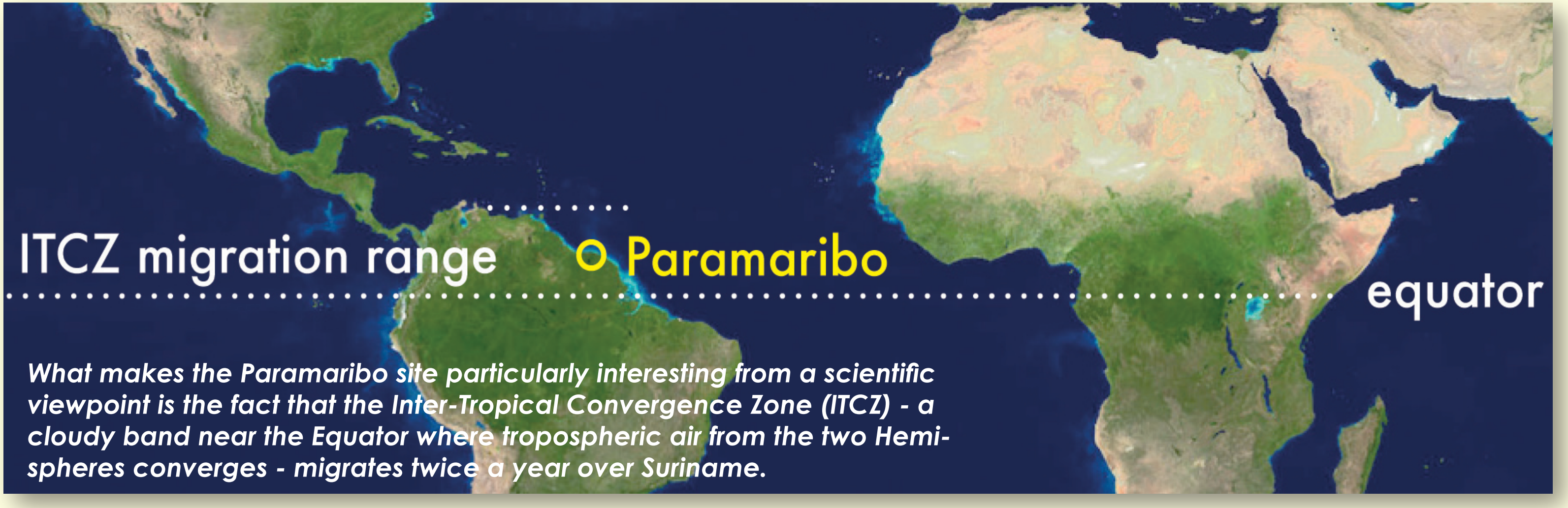
STAR - a project for support of tropical atmospheric research

Gé Verver[1], Paul Fortuin[1], Cor Becker[2], Otto Schrems[3], Justus Notholt[4]

[1]Royal Netherlands Meteorological Institute (KNMI), De Bilt; [2]Meteorological Service Suriname (MDS), Paramaribo; [3]Alfred Wegener Institute for Polar and Marine Research (AWI), Bremerhaven, Germany; [4]Institute of Environmental Physics (IUP), University of Bremen

The **STAR** project (**S**upport for **T**ropical **A**tmospheric **R**esearch) has been approved for funding under the Sixth Framework Programme of the European Union for Global Change and Ecosystems and its duration is from April 2004 to September 2006.

The objective of **STAR** is to strengthen the European contribution to the global observation system, the NDSC network and to support international cooperation in setting up these observation systems in the tropics. It is a joint effort of European, Suriname and Japanese research groups to establish an atmospheric observatory in Paramaribo, the capital of Suriname at the northern coast of South America at 5.8°N and



What makes the Paramaribo site particularly interesting from a scientific viewpoint is the fact that the Inter-Tropical Convergence Zone (ITCZ) - a cloudy band near the Equator where tropospheric air from the two Hemispheres converges - migrates twice a year over Suriname.

55.2°W. The Paramaribo station has been operational since 1999, and is located on the premises of the Meteorological Service of Suriname (MDS). Although the observatory lies on the southwestern edge of the city, it is still in a relatively pristine environment due to its close proximity to the ocean and to the Amazone forest, which stretches all the way past the southern boarders of Suriname. A further advantage of the site is the relatively flat orography on this part of the South American continent, leaving the background atmosphere relatively unperturbed as it is advected by the easterly trade winds over this location. This is especially useful for tracing the atmospheric composition, measured at the ozonesonde site, back to its regions of origin.

STAR will facilitate access of European and other research groups to the observatory, enhance the technical capabilities of the site, build capacity for global change research and monitoring in the tropics, and improve the conditions for the execution of a long-term observational program. A long historic time series of atmospheric observations will be retrieved and homogenized as well and made available to the scientific community. More information can be found on the STAR web site (http://www.knmi.nl/samenw/star).

Within the framework of pilot studies, which started in September 2004, the capabilities and limits of instruments in a tropical environment will be assessed. These instruments are: An ozonesonde facility, an FT-IR spectrometer, a DOAS instrument, a Raman Aerosol Lidar, a sun photometer, a UV spectral radiometer, a sky imager and a chilled mirror sensor for balloon soundings to obtain accurate humidity profiles in the upper troposphere. ✔

Institutes participating in STAR:

Institute	PI
Royal Netherlands Meteorological Institute (KNMI), The Netherlands	Gé Verver
Meteorological Service of Suriname (MDS), Suriname	Cor Becker
Belgian Institute for Space Aeronomy (BIRA/IASB), Belgium	Martine De Mazière
University of Heidelberg, Institute of Environmental Physics (IUP-Heidelberg), Germany	Thomas Wagner
University of Bremen, Institute of Environmental Physics (IUP-Bremen), Germany	Justus Notholt
Eindhoven University of Technology, Department of Technical Physics (TU/e), Netherlands	Hennie Kelder
Anton de Kom University of Suriname (AdeK), Suriname	Sieuwnath Naipal
Alfred Wegener Institute for Polar and Marine Research, Bremerhaven (AWI), Germany	Otto Schrems
Hokkaido University, Graduate School of Environmental Earth Science	Masatomo Fujiwara

The Future of Eureka: CANDAC and PEARL

Kimberly Strong, James R. Drummond, and the CANDAC Science Team, Department of Physics, University of Toronto

The Canadian Network for the Detection of Atmospheric Change (CANDAC) is a new initiative to bring together researchers and resources dedicated to addressing the issues of air quality, climate change, and ozone depletion over Canada, with particular emphasis on the Arctic. The initial focus of CANDAC is the revitalization of measurements at Eureka, which is part of the NDSC's Arctic Primary Station. Significant funding has been obtained for a suite of instrumentation to be installed at the new Polar Environment Atmospheric Research Laboratory (PEARL) at Eureka (80°N, 86°W).

The existing facility at Eureka (AStrO – the Arctic Stratospheric Ozone Observatory) has been operated by the Meteorological Service of Canada (MSC) since 1993. However, it was mothballed in summer 2002 due to budget constraints. Brewer and ozonesonde measurements continue to be made at the Eureka weather station, about 15 km away. Support was obtained from the Canadian Foundation for Climate and Atmospheric Sciences for a limited spring 2003 campaign (FT-IR, UV-visible spectrometer) and from the Canadian Space Agency and MSC for a spring 2004 ACE satellite validation campaign (FT-IR, ACE-FTS and MAESTRO clones, two UV-VIS spectrometers, DIAL, ozonesondes). However, with the recent award of more than CAD 7M in infrastructure funding from the Canada Foundation for Innovation and partners, the future of atmospheric measurements at Eureka is now looking very promising. The facility will be leased from MSC, renamed PEARL, and run as a continuously operating station with a broader research scope. Efforts are currently underway to secure operating funds for PEARL and CANDAC.

The equipment to be installed at PEARL is a complete atmospheric monitoring system, running from the surface to about 100 km. A total of 14 instruments will be deployed (see table below). In addition we expect to run a "guest instrument" program for other experimenters who wish to place instrumentation temporarily or permanently at PEARL. We are also negotiating with the Study of Environmental Arctic CHange (SEARCH) group in the USA for a co-operative use of resources, which will bring in additional instruments. Installation will begin in early 2005 and will be complete in time for International Polar Year 2007-2008.

The research program at PEARL has been divided into six themes: waves and turbulence; coupling of the lower, middle, and upper atmosphere; radiative forcing in the Arctic; Arctic tropospheric transport and air quality; middle atmospheric chemistry in the Arctic; and satellite validation. These themes are not independent, and the strength of the PEARL initiative relies on the cross-coupling at the instrument, dataset and science levels of these themes.

In addition to establishing PEARL, CANDAC has a wider set of objectives aimed at understanding atmospheric change over Canada. We envision the establishment of additional research stations across Canada, as well as additional laboratory facilities and data management capabilities. CANDAC will use a variety of observation methods (e.g. remote sounding and in situ sampling) and platforms (space, aircraft, balloons and the ground) to make long-term quality-controlled research measurements of tropospheric and stratospheric ozone, particulate matter, greenhouse gases and other constituents, temperature, vertical and horizontal structure, winds, turbulence and clouds. The network will also undertake extensive analyses to interpret the resulting data. Training of skilled personnel and public education are also part of CANDAC's mandate.

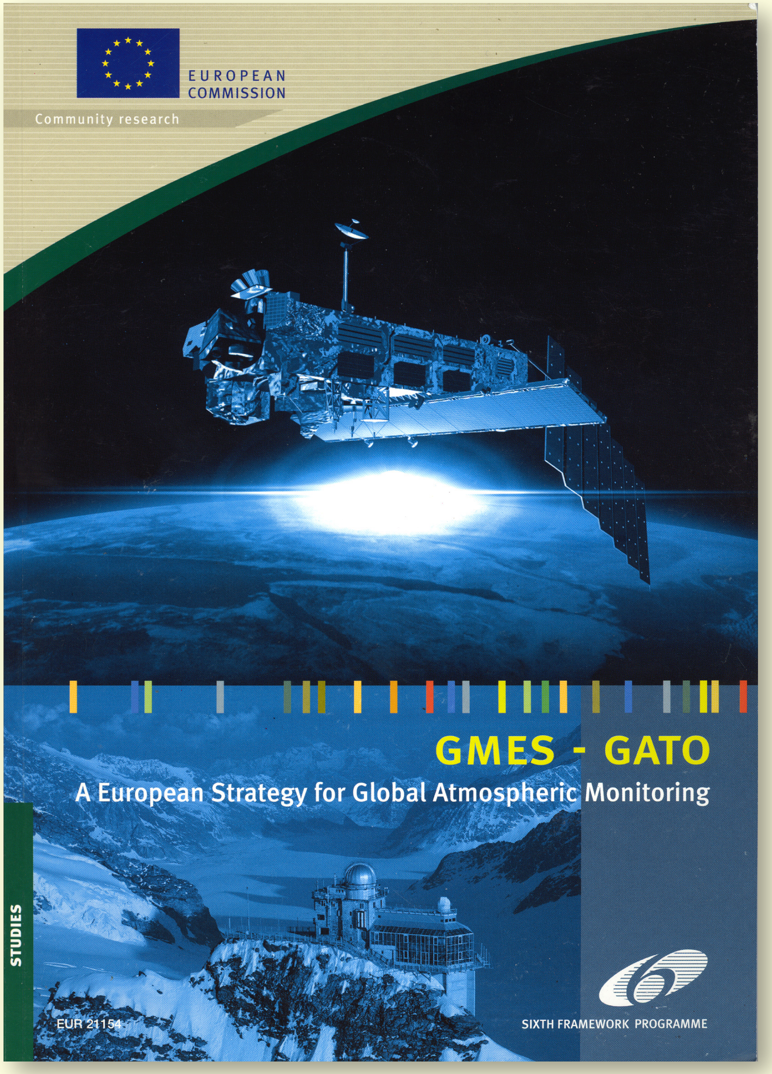
Linkages are very important for CANDAC, and we anticipate working in a collaborative mode with Canadian and international organizations. We hope to have CANDAC forge strong links with NDSC, which would include incorporating some of the procedures and practices developed by NDSC and applying to have the relevant instruments at PEARL certified as part of the NDSC's Arctic Primary Station. ✔

PEARL Instruments	Planned Measurements	Instrument Mentors
Rayleigh / Mie / Raman Lidar	Cloud / aerosol / NLC properties, temperatures, gravity waves, tropospheric water vapour	Tom Duck, Dalhousie U.
Solid-State Ozone Lidar	Tropospheric and lower stratospheric ozone	Jim Whiteway, York U.
VHF Wind Tracker Radar	Winds and turbulence 0.4-15 km, meteor winds, summertime PMSE	Stephen Argall, U. of Western Ontario
SKiYMET++ Meteor Wind Radar	Meteor winds (76-98 km)	Alan Manson , U. of Saskatchewan
Spectral Imaging Interferometer (SATI)	Mesopause temperatures and gravity waves	Marianna Shepherd, York U.
Airglow Imager	OH airglow intensity	William Ward, U. of New Brunswick; Stella Melo, U. of Toronto
Michelson Wind Interferometer (ERWIN)	Airglow winds	William Ward, U. of New Brunswick; Marianna Shepherd, York U.
Fourier Transform Infrared Spectrometer	Trace gas columns and profiles, including O_3, NO, NO_2, N_2O_5, HNO_3, $ClONO_2$, N_2O, HCl, HF, CFC-11, CFC-12, CO, CH_4, HCN	Kimberly Strong, U. of Toronto
UV-Visible Grating Spectrometer	Columns of O_3, NO_2, BrO, NO_3, OClO; profiles of NO_2	Kimberly Strong, U. of Toronto
Brewer Spectrometer	Ozone column	Thomas McElroy, MSC
Millimeter Cloud radar	Reflectivity, velocities, polarimetric products	David Hudak, MSC
Atmospheric Emitted Radiance Interferometer (AERI)	Cloud absolute infrared spectral radiance, profiles of temperature and water vapour in lower troposphere, CH_4, N_2O, HNO_3 columns	Kimberly Strong, U. of Toronto
Sun and Star Photometers	Radiances, aerosol properties, water vapour content	Norm O'Neill, U. of Sherbrooke
Aerosol Mass Spectrometer	Chemical composition, number and size distribution of ground level particulate matter	Jim Sloan, U. of Waterloo

Relevant reports & publications

The GMES-GATO report

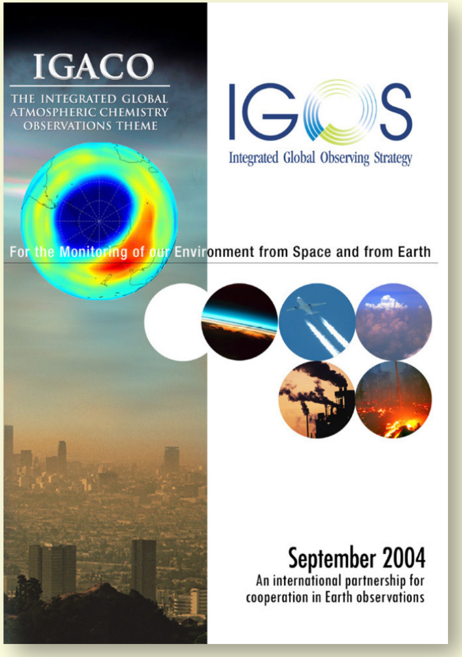
The GMES-GATO strategy report assesses the current European capabilities and describes how a more rational European monitoring system could be developed. It examines the observational capability itself, quality assurance and control, data storage and accessibility, and the provision of useful information (often in the form of derived products) to all concerned parties. The recommendations of the report would help achieve the best overall use of data from ground-based and satellite observation systems. The report complements the European Commission's publication, 'A Global Strategy for Atmospheric Interdisciplinary Research in the European Research Area, AIRES in ERA', which describes a balanced research programme to improve our understanding of atmospheric issues. The GMES-GATO report is highly relevant to the NDSC. The full report can be downloaded from http://www.nilu.no/gmes-gato.



The IGACO report

The Integrated Global Observing Strategy (IGOS) is a partnership of international organisations that are concerned with global environmental-change issues. It links research, long-term monitoring and operational programmes, bringing together the producers of global observations and the users that require them, to identify products needed, gaps in observations and mechanisms and to respond to needs in the science and policy communities. Its principal objectives are to integrate satellite, airborne, ground-based and in situ observation systems.

The 'Integrated Global Atmospheric Chemistry Observations' (IGACO) theme is a component of the Integrated Global Observing Strategy (IGOS) partnership; it was approved as the fourth theme of IGOS in June 2001, following those for the Ocean, the Global Water Cycle, and the Global Carbon Cycle. A panel of international scientists were convened by the WMO and ESA to produce this theme report.



The objective of this report is to initiate a process leading towards a globally coordinated development of future observation and integration programmes, whose components are either in place or, with careful planning, can be implemented within the next 10 years. The report

- identifies the current major societal and scientific issues associated with atmospheric composition change;
- establishes the requirements for observations of atmospheric composition and their analysis, integration and utilisation;
- reviews the existing observational systems, including data processing and distribution, and validation programmes vis-à-vis these requirements; and
- proposes an implementation plan to adapt the systems to meet the identified requirements.

The report is highly relevant to the NDSC and the NDSC is mentioned many times in the report. The full report can be downloaded from:
http://www.nilu.no/gmes-gato

Meetings

This section brings information on recent and upcoming meetings that are relevant to the NDSC

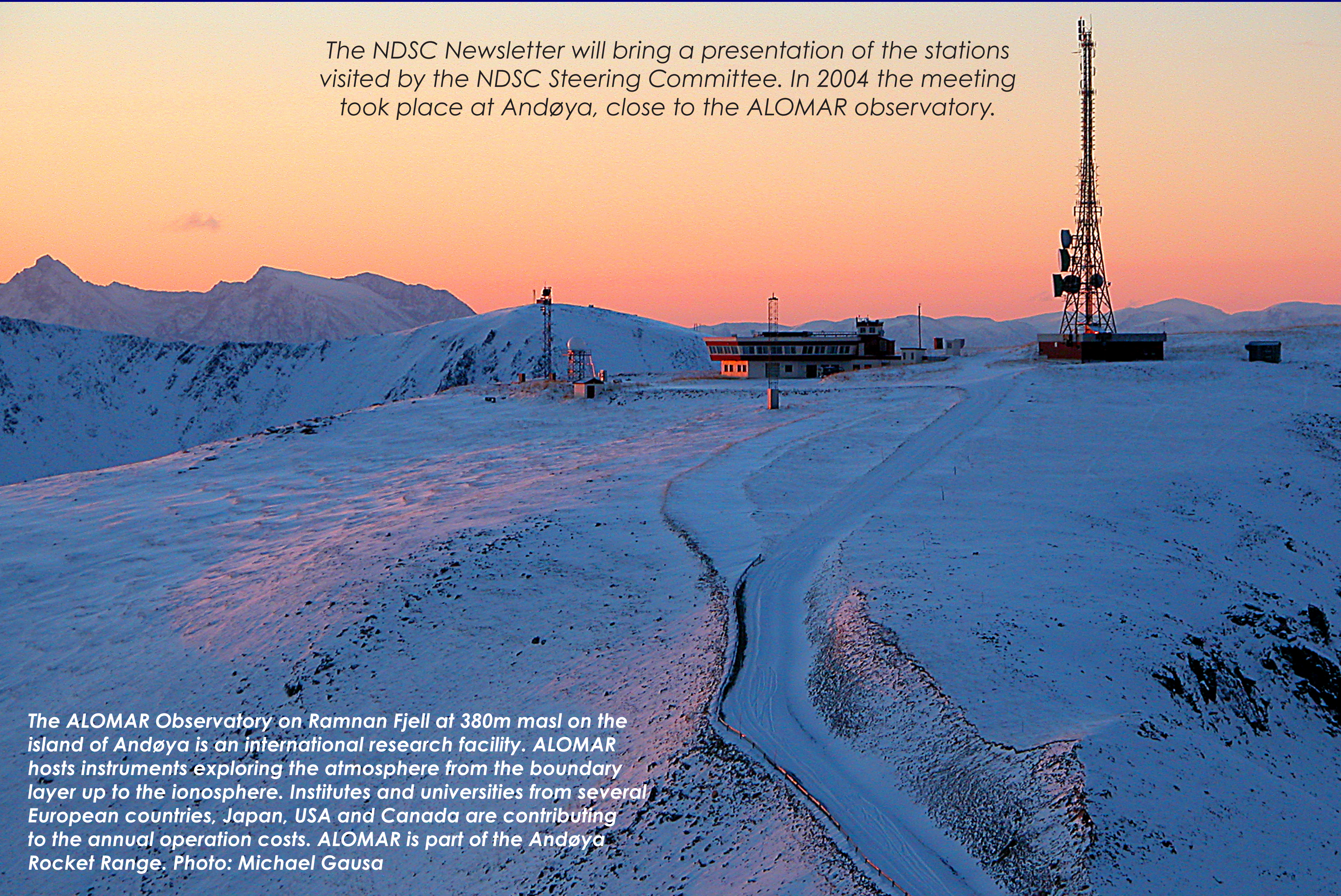
The 2004 meeting of the NDSC Steering Committee took place at the Andøya Rocket Range from 14-16 September. Scientific highlights presented at Steering Committee meetings will be conveyed through the NDSC Newsletter.

The NDSC Steering Committee at the 2004 meeting at Andøya, Norway.

NDSC Steering Committee meetings	Place	Date
2003 Steering Committee meeting	Wellington, New Zealand	December 2003
2004 Steering Committee meeting	Andenes, Norway	14-16 September 2004
2005 Steering Committee meeting	Puerto de la Cruz, Tenerife, Spain	8-10 November 2005
2006 Steering Committee meeting	Observatoire de Haute Provence, France	26-28 September 2006
2007 Steering Committee meeting	Kona/Mauna Loa, Hawaii	Autumn 2007
Working group meetings		
FT-IR working group	Queentstown, New Zealand	November 2004
Lidar working group	Hohenpeissenberg, Germany	26 -30 September 2005
Lidar working group	Bilthoven, The Netherlands	April/May 2007
Microwave working group	Kos, Greece	May 2004
Dobson & Brewer WG: Brewer workshop	Delft, The Netherlands	31 May - 3 June 2005
UV-Vis working group	Madrid, Spain	6-8 June 2005
Other meetings		
Workshop on IGACO-O3	Greece	May or June 2006

The ALOMAR observatory

The NDSC Newsletter will bring a presentation of the stations visited by the NDSC Steering Committee. In 2004 the meeting took place at Andøya, close to the ALOMAR observatory.



The ALOMAR Observatory on Ramnan Fjell at 380m masl on the island of Andøya is an international research facility. ALOMAR hosts instruments exploring the atmosphere from the boundary layer up to the ionosphere. Institutes and universities from several European countries, Japan, USA and Canada are contributing to the annual operation costs. ALOMAR is part of the Andøya Rocket Range. Photo: Michael Gausa

ALOMAR Observatory

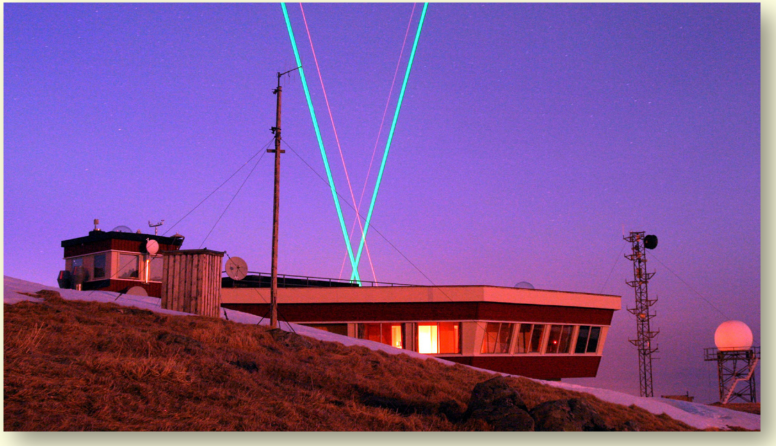
Arctic Lidar Observatory for Middle Atmosphere Research

Michael Gausa, Head of ALOMAR

The ALOMAR Observatory is located on the island Andøya in northern Norway, at 69°N, 16°E on top of the Ramnan Mountain. ALOMAR houses a unique set of instruments exploring various atmospheric parameters from ground up to 120 km. The observatory is operated by the Andøya Rocket Range, a scientific launch site for sounding rockets and balloons. ALOMAR was initiated by an international effort, where institutes and scientists from European and overseas countries agreed to install their instruments in a new building close to the Andøya Rocket Range, and to coordinate their scientific investigations.

In the ten years since the first measurements were performed at ALOMAR the number of instruments has increased continuously. Presently, ALOMAR's instrumentation comprises four advanced lidar systems, covering a height range from the lower troposphere to about 120 km. The four radar systems can continuously monitor height dependent winds, wind directions, turbulence and electron density from the troposphere up to the lower thermosphere. Photometers, all sky cameras and magnetometers have been used at the Andøya Rocket Range for several decades for ground support for sounding rockets exploring auroral and ionospheric phenomena.

Corresponding to the wide range of different instruments, the user's scientific aims are varying: troposphere aerosols and cirrus clouds on the one hand and measurements of the thermal and dynamic structure of the stratosphere and up the mesopause on the other. During summer,



The ALOMAR Observatory in full operation with simultaneous operation of all lidars. The tilted laser beams are used for doppler-wind-detection. The green beams belongs to the RMR lidar (Rayleigh-Mie-Raman) for troposphere and middle atmosphere investigations. The amber beams are used by the sodium lidar, its high precision wind and temperature measurements reach up to over 100 km.
Photos: Gerd Baumgarten

noctilucent clouds are observed. A sodium lidar allows high precision analysis of winds, wind directions and neutral temperatures in the lower thermosphere by a sodium lidar. From the beginning, the measurements are foreseen to have a long term character to monitor trends in the Arctic atmosphere layers.

Although all instruments at ALOMAR are aimed for performing high standard stand-alone research, the unique opportunity to combine with rocket or balloon borne instruments from the Andøya Rocket Range makes Andøya a unique site for all kinds of atmosphere research.

The Norwegian Institute for Air Research (NILU) uses ALOMAR as a major atmospheric monitoring site in Norway. Continuous ozone and trace gas monitoring by Brewer and DOAS instruments are performed at ALOMAR. These measurements are complemented by ozone profiling measurements by lidar and balloon. New aerosol initiatives extend the height range to the UTLS region and down to the boundary layer. ✔

ALOMAR's location on a mountain top close to the ocean, often allows measurements even when heavy sea fog covers the island.

The international Network for the Detection of Stratospheric Change (NDSC) was formed to provide a consistent, standardised set of long-term measurements of atmospheric trace gases, particles, and physical parameters via a suite of globally distributed sites.

The principal goals of the network are:

- To study the temporal and spatial variability of atmospheric composition and structure in order to provide early detection and subsequent long-term monitoring of changes in the physical and chemical state of the stratosphere and upper troposphere; in particular to provide the means to discern and understand the causes of such changes.
- To establish the links between changes in stratospheric ozone, UV radiation at the ground, tropospheric chemistry, and climate.
- To provide independent calibration and validation of space-based sensors of the atmosphere and to make complementary measurements.
- To support field campaigns focusing on specific processes occurring at various latitudes and seasons.
- To produce verified data sets for testing and improving multidimensional models of both the stratosphere and the troposphere.

The primary instruments and measurements of the NDSC are:

- Ozone lidar (vertical profiles of ozone from the tropopause to at least 40 km altitude; in some cases tropospheric ozone will also be measured)
- Temperature lidar (vertical profiles of temperature from about 30 to 80 km)
- Aerosol lidar (vertical profiles of aerosol optical depth in the lower stratosphere)
- Water vapour lidar (vertical profiles of water vapour in the lower stratosphere)
- Ozone microwave (vertical profiles of stratospheric ozone from 20 to 70 km)
- H_2O microwave (vertical profiles water vapour from about 20 to 80 km)
- ClO microwave (vertical profiles of ClO from about 25 to 45 km, depending on latitude)
- Ultraviolet/Visible spectrograph (column abundance of ozone, NO, and, at some latitudes, OClO and BrO)
- Fourier Transform Infrared spectrometer (column abundances of a broad range of species including ozone, HCl, NO, NO_2, $ClONO_2$, and HNO_3)
- Ozone and aerosol sondes (vertical profiles of ozone concentration and aerosol backscatter ratio)
- UV spectroradiometers (absolutely calibrated measurements of UV radiance and irradiance)

Contacts

For more information, please go to the NDSC web site (http://www.ndsc.ws) or contact the co-chairs:

Dr. Michael J. Kurylo
Science Mission Directorate
National Aeronautics and Space Administration
Washington DC 20546, USA
E-mail: Michael.J.Kurylo@nasa.gov

Dr. Geir O. Braathen
World Meteorological Organization (WMO)
Case postale 2300
CH-1211 Geneva 2, Switzerland
E-mail: GBraathen@wmo.int

NDSC