The First Network for the Detection of Stratospheric Change (NDSC) International Symposium
Celebrating 10 years of global atmospheric research
September 24-27, 2001

The stratosphere plays a critical role in the Earth system. Its composition, chemistry, and circulation are affected by, and at the same time significantly influence, processes in the troposphere below and mesosphere above. Its susceptibility to human-induced change, exemplified by chlorofluorocarbon-induced ozone depletion, makes it imperative that we measure and understand the ongoing changes and their effects on Earth's climate and biosphere. Toward this end, the international Network for the Detection of Stratospheric Change (NDSC) was initiated eleven years ago. A landmark conference has recently recorded the remarkable accomplishments of the first decade of this global network.

At its annual meeting in 2000, the NDSC Steering Committee decided that it was timely to organize the first NDSC scientific symposium after ten years of careful and comprehensive worldwide observations of a large number of atmospheric parameters had been obtained, and when theoretical analyses of these data were yielding exciting new environmental insights. The main objectives of the NDSC 2001 Symposium, held at the Palais des Congrès 'Le Palatium' in Arcachon, near Bordeaux, France on 24-27 September 2001, were to: (a) assess the current state of activities and data products; (b) evaluate related data analyses in support of global change and climate; and (c) to emphasize scientific results obtained through the analysis of NDSC data acquired over the past decade, in relation with other data sources such as balloon-borne, aircraft, and satellite measurements, and with model computations. A further goal was to generate discussions and collaborations among the various NDSC working groups as well as among NDSC data producers and external users.

The NDSC began operations in January 1991 to observe ozone, ozone-related chemicals, and meteorological variables primarily at a globally distributed set of ground-based remote-sensing stations (see NDSC Site Map). The Network includes active lidars; passive ultraviolet, visible, infrared, and microwave instruments for total column and vertical profile measurements; and in situ balloon sounding instruments. The NDSC currently involves over 250 scientists from Europe, USA, Canada, Japan, Russia, New Zealand, Australia, and other countries (see http://www.ndacc.org for details). The Symposium included presentations concerning all of the major Network activities.

Approximately 250 participants registered in advance for the Symposium; however, the tragic events of 11 September 2002 in New York and Washington, DC, USA, discouraged or prevented about 30 colleagues from making such a trip less than two weeks after the tragedy.

A special feature of the Symposium was the Poster Session, comprising 200 posters that were displayed for the entire duration of the Symposium in a room that was also used during breaks, allowing attendees to converse frequently on scientific issues with the poster authors. Another special feature was the interactive Plenary Sessions, which enabled all participants to actively discuss key measurements and conclusions.

At the onset of the Symposium, the Scientific Programme Committee and the Local Organizing Committee expressed their gratitude to the various institutions for their generous grants that made the organization of the NDSC 2001 Symposium possible on a worldwide basis: specifically, the European Commission, ESA, CNES, UNEP, NASA, Ministère de l'Environnement, SPARC/WRCP, CNRS/INSU, CNRS/PNCA, IPSL, and some local institutions. Thanks were also given for the support of SPARC/WRCP and NASA, which enabled researchers from Egypt, Kenya, and Brazil to attend.

The Symposium was organized into seven complementary sessions:

1. Coupling between Stratospheric Change and Surface UV
2. Polar Ozone Loss
3. Global Ozone: Trends and Variability
4. Ozone-Related Chemical Species: Distribution and Trends
5. Dynamics and Climate-Related Studies
6. Satellite Calibration and Validation
7. Prospects: New Algorithms and Analysis Methods, Instruments, and Sites.

Each session began with a review talk, followed by two or three additional short presentations selected from among the posters to illustrate the session, a long break around the posters related to the scientific theme of the session, and a discussion about the results presented in posters, lead by a chairman, a reviewer, and two discussion leaders, who were also in charge of reviewing and synthesizing the information in the various posters.

The following results highlighted during the sessions bear mention.

- Long-term trends of UV radiation in the Northern Hemisphere derived from ground-based measurements and satellite data are in the range of several percent per decade.
- The coupling of stratospheric change and surface UV was discussed for several future climatic scenarios, in both the troposphere and the stratosphere. It is evident that the combination of a warming troposphere and a cooling stratosphere, as expected from increasing greenhouse gases (GHGs), will affect ozone levels and surface UV fluxes in significant ways.
- Arctic ozone loss was extensively studied by different techniques showing good agreement among them. Satisfactory agreement was also seen in the Antarctic. The roles of polar stratospheric clouds and dynamics were emphasized, and a study of the polar vortex using aerosol and lidar measurements provided estimates of subsidence rates in good agreement with theory.
- Several important aspects of ozone variations were highlighted on time scales ranging from the transient appearance of polar vortex filaments over mid-latitude locations to long-term changes documented by both satellite and ground-based observations. New aircraft and NDSC ground-based observations now better define the ozone distribution all the way from the troposphere to the mesosphere. Atmospheric dynamics were shown to have played a significant role in long-term changes in the lower stratosphere.

- Our understanding of stratospheric ozone has improved remarkably using the detailed knowledge of the free radicals involved in catalytic ozone destruction, as well as their source gases and sinks or reservoir species, obtained from NDSC observations and analyses.

We are now at the point where the impressive NDSC database is being compared with theoretical models to answer fundamental scientific questions. The models generally agree qualitatively with observations, but there are differences that appear due (in part) to inaccuracies in model circulation. Nevertheless, the models whose circulations are based on observed meteorology are precise enough to interpret specific chemical events. An impressive array of observations of ozone-related chemical species (most of which are NDSC-targeted species) was reported, including ClO, OClO, ClONO2, HCl, NO2, BrO, HNO3, and N2O. Our knowledge of stratospheric water vapor is incomplete, despite the fact that it is a key constituent in chemical, dynamical, and radiative processes in the stratosphere and the upper troposphere. One of the discussion sessions stressed that more priority should be given to measurements of H2O in all time and altitude ranges, particularly in the free and upper troposphere, as well as in the lower stratosphere. Further study is needed on irreversible processes and their associated implications, such as ozone depletion due to rising GHGs (e.g., N2O and H2O). Another issue, which became clear in plenary discussions, was the need to increase the scope of the NDSC by including more tropospheric measurements. Several examples include: the use of global measurement networks for all major GHGs; for FTIR total and partial column measurements of tropospheric tracers such as COS, HCN, C2H6, and CO; and for cirrus clouds.

One of the major objectives identified at the inception of the NDSC was the role of ground-based measurements in the validation of satellite observations and, particularly, on the identification of and correction for their possible long-term drift. Many examples of such satellite validation activities using NDSC products were presented relevant to TOMS, ILAS, POAM, MOPITT, SBUV, SBUV/2, GOME, SAGE II, MSX/UVISI, CLAES, and HALOE. Looking to the future, there was a strong request dictated by the new generation of spaceborne instruments to extend NDSC observations toward lower altitudes including the lower stratosphere, upper troposphere, and even the free troposphere. Given the strong diurnal cycle of tropospheric chemical species, most useful tropospheric data for satellite validation would require the measurements to be performed at the precise time of the satellite overpass, which would be possible in some, but certainly not all, circumstances.

Given the importance of the climate issue, it was suggested that NDSC investigators widen their focus to include measurements that can improve the present-day uncertainties in the role of aerosols and clouds in climate change. For this to succeed, researchers involved in measurements and those involved in climate-change models need to have closer interactions. It was suggested that the NDSC convene a meeting to discuss measurement needs and the rationale for observations that will help answer climate-change questions. The “Prospects” discussion session stressed the need for new instrumentation, and the development of new remote-sensing algorithms with an objective assessment of errors in the retrieved products. The importance of refining publicly available datasets and databases, assimilating data into models, and conducting more instrument intercomparisons was emphasized. Finally, as evident from the NDSC sites map, additional stations are needed in the Southern Hemisphere as well as at tropical latitudes to address many outstanding key questions of global relevance to ozone and climate-change research.

The presentations clearly demonstrated that the NDSC, in its first decade, has made major steps toward achieving its founding goals. It has made challenging observations through which key changes in the stratosphere have been determined and understood in a timely way. It has established key links between changes in stratospheric ozone, tropospheric chemistry, surface UV, and climate. The Network has provided independent calibrations of space-based instruments, and has produced accurate publicly available data sets for testing and improving atmospheric models. While much still remains to be done, the accomplishments of the first decade bode well for future successes.

Based on the opinions of a large majority of the participants, the NDSC Steering Committee has concluded that the NDSC Symposium was a "tremendous success as a celebration of the first ten years of scientific operations of NDSC. It provided a unique opportunity for the attendees to report and discuss scientific results obtained through the analysis of NDSC data in relation with other sources such as aircraft-, balloon- and satellite-borne measurements, and model computations. Through the oral and poster presentations and extensive discussion periods, the goal of fostering new collaborations among and with the various NDSC Working Groups was certainly advanced. Participants also contributed to discussions aimed at identifying new opportunities and directions for the Network's activities during the next decade."