LIDAR AND THE NETWORK FOR THE DETECTION OF ATMOSPHERIC COMPOSITION CHANGE (NDACC, FORMERLY NDSC)

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1. INTRODUCTION

The international Network for the Detection of Stratospheric Change (NDSC) was formed to provide a consistent standardized set of long-term measurements of atmospheric trace gases, particles, and physical parameters via a suite of globally distributed research stations. Officially operational since 1991, the NDSC was conceived and formalized during the late 1980s in response to the need to document and understand worldwide stratospheric perturbations resulting from increased anthropogenic emissions into the atmosphere of long-lived halogenated source gases with strong ozone-depleting and global-warming potentials.

The initial objective of the NDSC was to monitor, from pole to pole, the temporal evolution of the stratosphere, including its protective ozone layer, and to understand the causes (i.e., natural versus anthropogenic, chemical versus dynamical) of the observed changes and their impacts on the troposphere and at the ground. This dual goal of long-term global measurement and understanding led to the implementation of a ground-based network of “primary” and “complementary” NDSC stations equipped with a suite of remote measurement instruments, allowing the quasi-simultaneous study of a large number of chemical compounds and physical parameters.

Due to its worldwide dimension, the NDSC was recognized as a major component of the international atmospheric research effort. As such, it was endorsed by national and international scientific agencies, including the United Nations Environmental Programme (UNEP) and the International Ozone Commission (IOC) of the International Association of Meteorology and Atmospheric Physics (IAMAP). It was also recognized by the World Meteorological Organization (WMO) as a major contributor to its Global Atmosphere Watch (GAW) Programme.

While the network remains committed to monitoring changes in the stratosphere, with an emphasis on the long-term evolution of the ozone layer (its decay, likely stabilization, and expected recovery), its priorities and measurement capabilities have broadened considerably to encompass:

- detecting trends in overall atmospheric composition and understanding their impacts on the stratosphere and troposphere,
- establishing links between climate change and atmospheric composition,
- calibrating and validating space-based measurements of the atmosphere,
- supporting process-focused scientific field campaigns, and
- testing and improving theoretical models of the atmosphere.

Many members of the atmospheric science community noted that this expanded emphasis was not adequately reflected in the name of the Network and, in fact, that the word “Stratospheric” has led to a mistaken impression that the focus of NDSC activities is that of a “solved problem” (i.e., stratospheric ozone depletion). Hence, to better reflect the free tropospheric and stratospheric coverage of Network measurement, analysis, and modeling activities, as well as to convey the linkage to climate change, the Steering Committee voted to change the name of the network to the Network for the Detection of Atmospheric Composition Change (NDACC): Monitoring Changes in Atmospheric Composition and Their Links to Ozone Depletion and Climate. Accordingly, the network web site has been changed to http://www.ndacc.org.

2. NDACC MEASUREMENTS

The objectives of the NDACC require high-precision measurements of a broad range of chemical species, long-lived tracers and atmospheric parameters that influence ozone and climate. To achieve this, a variety of ground-based remote sensing instruments were selected for their capability for continuous, long-term operation. These are summarized in table 1.

Another desire of the NDACC was to have stations located to provide as much latitudinal coverage as possible. Ideally, the minimum network would consist of seven fully equipped primary stations: polar, mid-latitude, and tropical in both hemispheres, plus an equatorial station. Currently there are five primary stations, as there is no equatorial or southern hemisphere tropical station although possible sites are still being considered. These primary stations are enhanced by more than 40 other sites where complementary measurements of one or more of the parameters of interest are being measured. More sites will be added as they meet the NDACC protocols and data-quality criteria.

Particular efforts are being made to identify facilities and involve groups in Asia, Africa, and South America.

Table 1. NDACC measurement priorities and instruments

Measurement	Instrument
O_3 Column	Dobson, Brewer, UV-Vis spectrometer
O_3 Profile	Lidar, Ozonesonde, Microwave Radiometer
Temperature Profile	Lidar
ClO Profile	Microwave Radiometer
H_2O Profile	Lidar, Hygrometer Sonde, Microwave Radiometer
Aerosol Profile	Lidar, Backscatter Sonde
NO_2 Stratosphere Column	FTIR, UV-Vis Spectrometer
HCl, $ClONO_2$ Column	FTIR
N_2O, CH_4, CFCs Column	FTIR, Microwave Radiometer
HNO_3, NO Column	FTIR
HF, COF_2 Column	FTIR
Other (OH, HO_2, OCS, …)	Research Mode
UV Radiation	UV Spectroradiometer

3. NDACC LIDAR

Lidar has played an integral and critical role in the NDACC since its inauguration. Instruments and techniques have improved and matured over the lifetime of the NDACC and the current complement of lidar instruments and measurements includes:

- Differential Absorption Lidar (DIAL) measuring O_3
- Backscatter lidars measuring aerosol
- Raman and Rayleigh lidars measuring temperature
- Raman lidar measuring water vapor

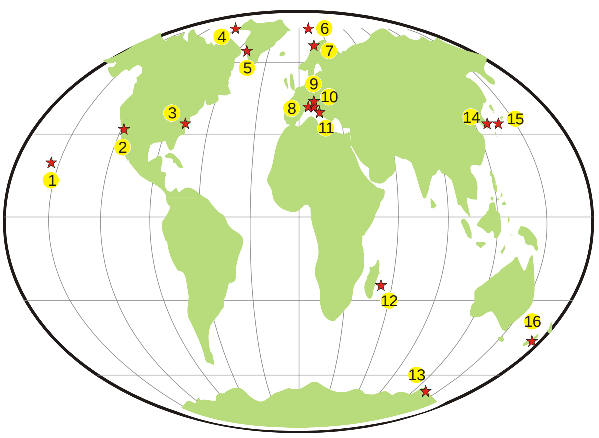

Fig.1. Locations of NDACC Lidar Stations (also see Table 2)

The distribution of NDACC stations where lidars are located is shown in fig.1. Note that this is not a map of all of the NDACC sites, only those with lidar. More details of these sites and the lidar measurements being made there are given in table 2.

Table 2. NDACC Lidar Stations. Number refers to that shown in fig.1. Measurements: O-Ozone, A-Aerosols, T-Temperature, W-Water Vapor.

#	Site	Lat.	Lon.	Meas.
1	Mauna Loa, Hawaii, USA	19.5N	155.6W	OATW
2	Table Mountain, Calif., USA	34.4N	117.7W	OATW
3	Greenbelt, Maryland, USA	38.9N	76.7W	OATW
4	Eureka, Canada	80.1N	86.4W	O
5	Sondestrom, Greenland	67.0N	50.6W	T
6	Ny Alesund, Spitzbergen	78.9N	11.9W	OAT
7	Andoya, Norway	69.3N	16.0E	O
8	Haute Provence, France	43.9N	5.7E	OATW
9	Hohenpeissenberg, Germany	47.8N	11.0E	OT
10	Zugspitze, Germany	47.5N	11.0E	AW
11	Tor Vergata, Rome, Italy	41.8N	12.7E	W
12	La Reunion, France	21.8S	55.5E	OT
13	Dumont D'Urville, Antarctica	66.7S	140.0E	OAT
14	Suwon, Korea	37.2N	127.6E	A
15	Tsukuba, Japan	36.0N	140.1E	OAT
16	Lauder, New Zealand	45.0S	169.7E	OAT

To ensure quality and consistency of NDACC operations and products, a number of protocols have been formulated covering such topics as primary and complementary measurements, data, instruments intercomparisons, theory and analysis, and validation. Details of these protocols and much more information regarding the NDACC can be found on the website:

http://www.ndacc.org

All NDSC data more than two years old is public data. Additionally some PIs have authorized their data for early release. This is available as soon as it is cataloged in the database. All NDSC data newer than two years from acquisition and not authorized for early release is proprietary data and available only through direct accounts on the NDSC database. Parties interested in general access to this data should prepare a proposal to the NDSC Steering Committee for consideration as NDSC collaborators. Otherwise, the use of any individual NDSC data set prior to its being made publicly available (i.e., for use associated with field campaigns, satellite validation, etc.) is possible via collaborative arrangement with the appropriate PI(s).

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