Stuart McDermid
Table Mountain Facility
Jet Propulsion Laboratory, California Institute of Technology

with acknowledgment to:

Michael J. Kurylo & Geir O. Braathen
(Steering Committee Co-Chairs)

NDACC Steering Committee & Working Groups
More than 200 Members of the NDACC Science Team
Brief History of NDACC

- 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.

- This was in response to the urgent need to document and understand worldwide stratospheric perturbations resulting from increased anthropogenic emissions of long-lived halogenated 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 and ozone layer, and to understand the causes and impacts of observed changes on the underlying troposphere and earth surface.

- This was achieved through the implementation of a distributed network of ground-based stations equipped with a suite of remote measurement instruments.
  - Quasi-simultaneous observations of a large number of chemical compounds and physical parameters.
Brief History of NDACC

- While the network remains committed to monitoring changes in the stratosphere, with an emphasis on changes in the ozone layer (decay – recovery), its priorities and capabilities have broadened considerably.

- To better reflect the free tropospheric and stratospheric coverage of the Network measurements, and to convey the linkage to climate change, the Steering Committee debated changing the name and finally reached accord with:

  **Network for the Detection of Atmospheric Composition Change:**

  *Tracking Changes in the Earth’s Atmosphere*

  NDACC
What is the NDACC?

- A set of more than 70 high-quality, remote sensing research sites for:
  - Observing and understanding the physical / chemical state of the stratosphere and upper troposphere
  - Assessing the impact of stratospheric changes on the underlying troposphere and on global climate
What is the NDACC?

- A major component of the international upper atmosphere research effort formulated to:
  - Document and understand naturally occurring and human-induced stratospheric and upper tropospheric changes
  - Further our capability to forecast the future state of the atmosphere
NDACC Priorities

- Studying the temporal and spatial variability of atmospheric composition and structure
- 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
- Testing and improving theoretical models of the atmosphere
## NDACC Priorities & Instruments

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>O₃ Column</strong></td>
<td>Dobson, Brewer, FTIR</td>
</tr>
<tr>
<td></td>
<td>UV-Vis spectrometer</td>
</tr>
<tr>
<td><strong>O₃ Profile</strong></td>
<td>Lidar, Ozonesonde, (FTIR)</td>
</tr>
<tr>
<td></td>
<td>Microwave Radiometer</td>
</tr>
<tr>
<td><strong>Temperature Profile</strong></td>
<td>Lidar</td>
</tr>
<tr>
<td><strong>CIO Profile</strong></td>
<td>Microwave Radiometer</td>
</tr>
<tr>
<td><strong>H₂O Profile</strong></td>
<td>Lidar, Hygrometer Sonde, Microwave Radiometer, (FTIR)</td>
</tr>
<tr>
<td><strong>Aerosol Profile</strong></td>
<td>Lidar, Backscatter Sonde</td>
</tr>
<tr>
<td><strong>NO₂ Stratosphere Column</strong></td>
<td>FTIR, UV-Vis Spectrometer</td>
</tr>
<tr>
<td><strong>HCl, ClONO₂ Column</strong></td>
<td>FTIR</td>
</tr>
<tr>
<td><strong>N₂O, CH₄, CFCs Column</strong></td>
<td>FTIR, Microwave Radiometer</td>
</tr>
<tr>
<td><strong>HNO₃, NO Column</strong></td>
<td>FTIR</td>
</tr>
<tr>
<td><strong>HF, COF₂ Column</strong></td>
<td>FTIR</td>
</tr>
<tr>
<td><strong>Other (OH, HO₂, OCS, …)</strong></td>
<td>Research Mode</td>
</tr>
<tr>
<td><strong>UV Radiation</strong></td>
<td>UV Spectroradiometer</td>
</tr>
</tbody>
</table>
Observational Capabilities of the Network for the Detection of Atmospheric Composition Change

Ripples indicate approximate vertical resolution. Plain bars represent column measurements.
The success of the NDACC has resulted primarily from its simple and flexible organization: a **Steering Committee** and a **Science Team**

**The Steering Committee** consists of:
- Two Co-Chairs
- Representatives of the various Science Team Working Groups
- Independent scientists serving as peer reviewers
- Ex-officio representatives of the main NDACC sponsoring or partnering international agencies or institutions
- Representatives from the various Cooperating Networks

**Primary managerial body of the Network:**
- Responsible for tasks such as internal operational and scientific oversight
- Recommends implementation and funding actions
- Meets once a year
NDACC Organization

The Science Team consists of:

- the Principal Investigators (PIs) at all NDACC stations / sites
  - Acts as a forum for conducting NDACC operations coordinated through Working Groups (WGs)

WGs are organized around specific instrument types:

- Dobson and Brewer, FTIR
- Lidar, Microwave
- Ozone and Aerosol Sondes, Spectral UV
- UV/Visible

WGs are also organized for other relevant activities

- Satellites, Archiving
- Theory and Modeling

and species / parameters of focus

- presently Ozone and Water Vapor

Each WG includes the associated PIs and has the responsibility of setting actions to reach maximum internal consistency among the Network’s data

- WGs meet regularly, some annually, some every two years
Quality Control

A Commitment to Data Quality

- NDACC Investigators subscribe to instrument specific protocols designed to ensure that archived data are of as high a quality as possible within the constraints of measurement technology and retrieval theory.

- Validation is a continuing process:
  - Instruments and data analysis methods are evaluated prior to NDACC acceptance and are continuously monitored throughout their use.
  - Formal intercomparisons are used to evaluate algorithms and instruments.
Ozone Profile Intercomparison

- Simultaneous LIDAR and Ozonesonde measurements
- Two different LIDARs
- Excellent agreement between profiles
- Note profile structure below 20km
- Shows intrusion of polar air filament
Data Archiving and Availability

- Data must be submitted to the central archive within one year of the measurement
  - NDACC-Data Host Facility, NOAA, Washington, DC

- All data are publicly available via anonymous ftp from the NDACC website within two years of measurement
  - http://www.ndacc.org

- Most NDACC investigators have agreed to make their data publicly available regularly on a shorter timescale (i.e., immediately upon archiving)

- The use of any NDACC data prior to its being made publicly available (e.g., for field campaigns, satellite validation, etc.) is possible via collaborative arrangement with the appropriate PI(s)
NDACC Cooperating Networks

- NDACC established the designation of “Cooperating Network” to formalize the relationship with regional, hemispheric, or global networks of instruments that operate independently of NDACC, but where strong measurement and scientific collaboration is mutually beneficial.

- **AERONET**
  - The AErosol RObotic NETwork program is a federation of ground-based remote sensing networks measuring aerosol optical depth, inversion products, and precipitable water.

- **AGAGE**
  - The Advanced Global Atmospheric Gases Experiment performs real-time, high-frequency measurements of 45 trace gases at stations around the world.

- **HATS**
  - The Halocarbons and other Atmospheric Trace Species network measures over 30 trace species in the atmosphere at NOAA and cooperating stations.

- **MPLNET**
  - The NASA Micro Pulse Lidar NETwork is a federated network lidar systems designed to measure aerosol and cloud vertical structure.

- **SHADOZ**
  - The Southern Hemisphere ADditional OZonesondes is a project to augment balloon-borne ozonesonde launches in tropical and sub-tropical locations.

- **TCCON**
  - The Total Carbon Column Observing Network is a network of ground-based Fourier Transform Spectrometers recording direct solar spectra in the near-infrared spectral region.
Workshop on Understanding Past Changes in the Vertical Distribution of Ozone

WMO, Geneva, January 2011

- Johannes Staehelin – tomorrow
- A workshop to discuss how to improve our knowledge and understanding of the past changes in the vertical distribution of ozone
- Many NDACC stations now have data records extending over 20 years
- An action plan was developed with the aim of providing much improved knowledge of ozone changes for the UNEP/WMO Assessment expected in 2014
- NDACC Working Groups (Lidar, Microwave, FTIR, Ozonesondes, Dobson/Brewer) are working on critical assessments of their instrumental and data records
Absorption Cross Sections of Ozone (ACSO)

The ACSO Committee, established in spring 2009, is a joint ad hoc commission of the Scientific Advisory Group (SAG) of the Global Atmosphere Watch (GAW) and the International Ozone Commission (IO$_3$C).

The committee includes many representatives from NDACC:
- Lidar, UV-Vis, Dobson, Brewer, FTIR

The mandate of ACSO includes:
- Review the presently available ozone cross sections
- Determine the impact of changing the reference ozone absorption cross sections for all of the commonly used atmospheric ozone monitoring instruments
- Recommend whether a change needs to be made to the presently used standard ozone absorption cross section data (Bass & Paur, 1995)

There are clearly problems with the Bass & Paur cross section, especially the temperature dependence:
- Currently preferred data are from Brion, Daumont, & Malicet
- New measurements are being undertaken
Upper Stratosphere (35-45km) Ozone Anomalies

Steinbrecht et al., IJRS, 2009

- Ozone is showing signs of recovery
- Montreal Protocol is working
Record Ozone Loss in the Arctic in 2011

SAOZ / NDACC UV-Vis spectrometers Arctic network

F. Goutail, J.P. Pommereau, A. Pazmino, CNRS
Average ozone inside vortex @ $e\Theta=465K$

Minimum reached during 1985 Antarctic ozone hole at this level.

Markus Rex and the Match team*

*includes the Match coordination group at AWI and PIs and operators of about 40 ozone sounding stations in the high latitudes of both hemispheres
Ozone loss profiles: Arctic - Antarctic

Antarctic:
- Ozone hole range (indicated by 1985 & 2003)

Arctic:
- 2000
- 2005
- 2011 (as of March 31)

Markus Rex and the Match team*

*includes the Match coordination group at AWI and PIs and operators of about 40 ozone sounding stations in the high latitudes of both hemispheres
A) Mean March O3 profile for the 10y 2000-2009 outside of the vortex
B) same dataset but for days in the vortex (defined by PV > 2.5PVU at PT=440K)
C) mean March 2011

J. Hannigan
Time Series of Ozone Partial Pressure

- Antarctica, 70°S
- Weekly ECC radiosondes
- Values at 70 hPa (~17 km) represent values in the ozone layer

G. König-Langlo
Ozone Trends from Lidar at MLO and TMF

Mauna Loa
(Hawaii, 19.5°N, 155.6°W)

Table Mountain
(California, 34.5°N, 117.7°W)

G. Kirgis, T. Leblanc and I. S. McDermid
Long Term anti-correlation between Ozone and UV

R. McKenzie, B. Connor and G. Bodeker
Network for the Detection of Atmospheric Composition Change

2011 NDACC Symposium

An International Symposium Celebrating 20 Years of Global Atmospheric Research Fostered by NDACC/NDSC Observations
7 – 10 November 2011, Reunion Island, France
http://ndacc2011.univ-reunion.fr/

- Long-term evolution and trends in ozone, atmospheric composition, temperature, aerosols, and surface UV radiation in the polar regions and at mid-latitudes
- Tropical and sub-tropical observations and analyses
- Interactions between atmospheric composition and climate, in collaboration with NDACC Cooperating Networks
- Satellite calibration / validation
- New observational capabilities