The Network for the Detection of Atmospheric Composition Change:

Evolution of NDACC since the 9th ORM and its responses to recommendations

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http://www.ndacc.org
Evolution of Measurement Capabilities

+ cooperating networks (e.g., GRUAN, TCCON) and co-located sites
New/enhanced capabilities (1)

• PANDORA

(a) Pandora schematic; (b) spectrometer and early instrument; (c) GSFC/ Bldg33 calibration center with multiple Pandoras on roof in 2015.
Pandora/Pandonia network

Extensive network calibration plan, under implementation
New/enhanced capabilities (2)

- **MAXDOAS**

**CINDI-2 intercalibration campaign**
Cabauw, The Netherlands, 1-30 September 2016

- 42 DOAS-type spectrometers
- + in-situ systems
- + ancillary data

Focus on NO2 plus O3, HCHO, aerosol

Certification of MAXDOAS as NDACC-UVVis instruments
New/enhanced capabilities (3)

Microwave radiometry
- Diurnal variation of ozone down into stratosphere
- New Temperature radiometer would be ready for NDACC
  - 15–65 km alt. T-profiles, typically 2 hrs time resolution
- Cf. so far only temperature profiles from lidar in NDACC

Wind radiometry is successful
- Zonal and meridional wind is measured by observing Doppler shift in pressure broadened emission lines of O3 at microwave frequencies
- Two transitions are used: 142.175 GHz resp. 110.836 GHz
- Observations during day and night, also in cloudy conditions
- Typically one wind profile in a few hours

Fourier transform Infrared Spectrometry
- Additional standard species: H2CO, CCl4, OCS, and NH3
- New/enhanced capabilities
  - $\mu$ wave wind radiometer WIRA at Andoya, 69° N
  - 28-30, 2017
New focus on Water Vapour

• Bring frostpoint soundings into NDACC

• Coordinate observations of water vapor within NDACC
  • Soundings (Frostpoint)
  • Lidars (Currently only Raman lidar)
  • Microwave radiometers (Stratospheric / Mesospheric)
  • FTIR (Tropospheric water and isotopologues)

Coordinate observations with other networks:
• GRUAN
• Operational Networks
Urgent need for inner tropical site for UTLS water vapor high altitude lidar or sounding site
Evolution of network coverage / capacity building

New candidate sites or sites under development

- ▶ FTIR
- ▲ Dobson
- ▰ LIDAR

But, several existing sites (obs or data processing) are threatened!
NDACC as a reference

- Several activities to ensure the evolution of NDACC data towards Fiducial Reference Measurements (FRM), with ESA support:
  - FRM - Pandonia
  - FRM4DOAS: Develop prototype system for centralised processing of (MAX)DOAS data in support of satellite validation
  - FRM4GHG: assess more compact / mobile / cheaper spectrometers for precise GHG measurements
    → Campaign ongoing in Sodankyla co-locating 4 instruments with a TCCON FTIR spectrometer and with in-situ vertical profile measurements
- Efforts for better harmonisation of data, incl. standard data processing tools, a.o. with EU support
- Efforts for better characterisation of data
- Efforts for better documentation of data
- Efforts for better traceability of data
Example of traceability chain
NDACC as a reference network

- Efforts for improved uncertainty evaluation, in all IWGs, for example for LIDAR (3 dedicated publications), IR and UVVIS

Proposed standardized definitions for vertical resolution and uncertainty in the NDACC lidar ozone and temperature algorithms: Part 3: Temperature uncertainty budget

Thierry Leblanc ¹, Robert J. Sica ², J. Anne E. van Gijsel ³, Alexander Haeßele ⁴, Guillaume Payen ⁵, and Gianluigi Liberti ⁶
Uncertainties

Figure 17: Same as Fig. 16, but for the tropospheric ozone DIAL system located at the JPL Table Mountain Facility (California).
Dobson/Brewer network

• Traceability for atmospheric total column ozone (ATMOZ)

Http://projects.pmodwrc.ch/atmoz/index.php:

Total Ozone Measurements Intercomparison at Izaña, Tenerife, September 12 – 30, 2016
Ozone sondes
Homogenization of Long Term Data

Homogenizing long term ozonesonde data sets in order to reach the general goals of the SPARC/IO3C/IGACO-O3/NDACC “Initiative on Past Changes in the Vertical Distribution of Ozone”.

Manuscripts published and in progress:

• **Canadian Network** reprocessed:

• **Uccle & De Bilt** O3S-DQA corrections applied:

• **SHADOZ Network**: Jacquie Witte - 7 SHADOZ stations complete soon with outline of papers planned.

• **NOAA Network**: Chance Sterling: All long term NOAA stations completed by Dec 1. Manuscript outline started.

• **Lindenberg**, Germany: completed reprocessing.
Ozone sondes

Homogenization of Long Term Data


- **Lauder**: The homogenisation work is still underway.

- **Emilio**: Dr. Natalia Prats will be the PI of the *Izana* ozonesonde programme. She will implement data homogenization in collaboration with Dr. Herman Smit (KFA). A specific mission to KFA is schedule by the end 2016.

- Other PIs are working on their data sets ...

⇒ 30 stations by the end of 2016
JOSIE-SHADOZ 2017 campaign

• World Calibration Centre Ozone Sondes: Jülich, Germany
• 2 x 12 day periods each running 10 simulations comparing ozone sondes with the reference UV photometer.
• 4 groups attending during each 12 day period.

Special attention will be paid to:
• Sensor background signal
• Pump flow efficiency
• Sensing Solution Composition
• Uncertainties
Assessment of maturity of NDACC with EU support through GAIA-CLIM, P.W. Thorne et al., submitted to GI, 2017

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Legend:
1 = comprehensive
2 = baseline
3 = reference
4 = Not applicable
5 = Not applicable
6 = Not applicable

28-30, 2017
Significant contributions of NDACC to international research initiatives and assessments

- **SI²N** (O3 vertical profile trends)
  - follow-on in SPARC *LOTUS* initiative: Long-term Ozone Trends and Uncertainties in the Stratosphere

- **TOAR** : Tropospheric Ozone Assessment Report (LIDAR, FTIR, O3 sondes)

- **WMO** Scientific Assessment of Ozone Depletion 2014

- SPARC emerging initiatives **SSiRC** - *Stratospheric Sulfur and its Role in Climate* & **OCTAV-UTLS** - *Observed Composition Trends And Variability in the UTLS*

- SPARC report on **CCl4; trends of CCl4**

- **Network-wide recent trend studies (IRWG): inorganic chlorine, CH4, C2H6, OCS**, combined with modeling for trend attribution (CH4)
Cly- upturn due to prolonged slowing down of stratospheric circulation.

Bader, W., et al,

Ten years of atmospheric methane from ground-based NDACC FTIR Observations

Atmos. Chem. Phys., 2017 doi:10.5194/acp-17-2255-2017
New & significant contributions of NDACC to international programmes

- NDACC is a key network for the validation of
  - satellites
  - chemistry-climate model evaluations (e.g., SPARC CCMI)
  - the Copernicus Atmospheric Monitoring Service (CAMS)
  - The ESA Climate Change Initiatiative (CCI) programme – phase 2, esp, the CCI-O3 project, and the CCI+ programme

- NDACC is a reference network for the Copernicus Climate Change Service (C3S): NDACC data will be turned into Climate Data Records (CDR) for delivery to the Climate Data Store - start with O3, CO, CH4...
New & significant contributions of NDACC to international programmes

- Short-lived climate pollutants NDACC infrastructure and data services will be embedded in the EU ACTRIS Research Infrastructure

The aims are to create better sustainability of the NDACC activities in Europe, and to make NDACC data more visible and better accessible and ‘useful’ for the research community, decision makers and society
Archiving / Databases

- NDACC data must be submitted to DHF at latest 1 year after acquisition; early public release is encouraged
- Progress towards rapid data delivery (RD), within 1 month after acquisition
  - With clear distinction between RD data and consolidated data → for different usage
- Progress towards GEOMS HDF archiving of good quality: data file quality control is being implemented in the frame of the Copernicus Atmospheric Monitoring Service
- Links resumed/improved with other databases and portals
  - NDACC data available on ACTRIS data portal
  - BADC: Automatic nightly copy of database resumed in 1990’s.
  - WOUDC: Discussions ongoing to improve data exchange between NDACC and WOUDC

Issues: improved interoperability, avoiding duplicates, assignment of responsibilities for long-term maintenance, open data policy
The NDACC DHF is moving to more current data! & less data delinquency is observed.
NDACC Web site
Re-design under construction with better access to data

NDACC 2016 Special Issue
Twenty-five years of operations of the Network for the Detection of Atmospheric Composition Change

Interjournal: AMT/ACP/ESSD
/ deadline April 2017

Editor(s): V.-H. Peuch, G. Brasseur, C. Zehner, N. Harris, H. Maring, W. Lahoz, and G. Stiller

Already > 32 papers, and more to come
The Network for the Detection of Atmospheric Composition Change: 25 Years Old and Going Strong

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Introduction

The Network for the Detection of Atmospheric Composition Change (NDACC) is an international research and measurement program composed of more than 70 high-quality, remote-sensing research stations—as shown in Figure 1. The Network conducts long-term measurements for observing and understanding the physical and chemical state of the stratosphere and upper troposphere and for assessing the impact of stratosphere changes on the underlying troposphere and on global climate. The year 2016 marks 25 years of successful operations for NDACC, enabling and enhancing global atmospheric research through:

- analysis of long-term datasets from which trends and changes in atmospheric composition have been determined for international ozone and climate assessments;
- provision of ground-truth and correlative measurements for international satellite investigations;
- scientific collaboration in airborne and balloon campaigns for investigating stratospheric and upper tropospheric processes; and
- validation and development of atmospheric models.

http://eospso.nasa.gov/earthobserver/september-october-2016
Conclusions

• NDACC suffers from risks of station and data loss, but on the other hand
  ✓ ‘gains’ some stations in poorly covered regions, esp. Art. 5 countries
  ✓ is continuously developing new capabilities
  ✓ is moving towards enhanced cost-efficiency
  ✓ Is moving towards a mature and more operational network delivering
    metrologically traceable reference data

• Several recommendations from 9th ORM have been addressed
  – Data quality and consistency; data reprocessing and homogenisation;
  – Data archiving issues; data versioning and traceability
  – Capacity building activities
  – Linkages with climate research , attention to long-lived tracers & BD
    circulation issues
  – Trend studies & trend uncertainties

⇒ NDACC stands as a key reference network that addresses a number of ORM
recommendations in the area of ozone research and linkages to climate
Acknowledgements

• K. Jucks & NASA
• ESA for supporting campaign activities dedicated to satellite validation, advancing NDACC capabilities and their evolution towards FRM
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