NDACC Newsletter

Network for the Detection of Atmospheric Composition Change

Exploring the interface between changing atmospheric composition and climate

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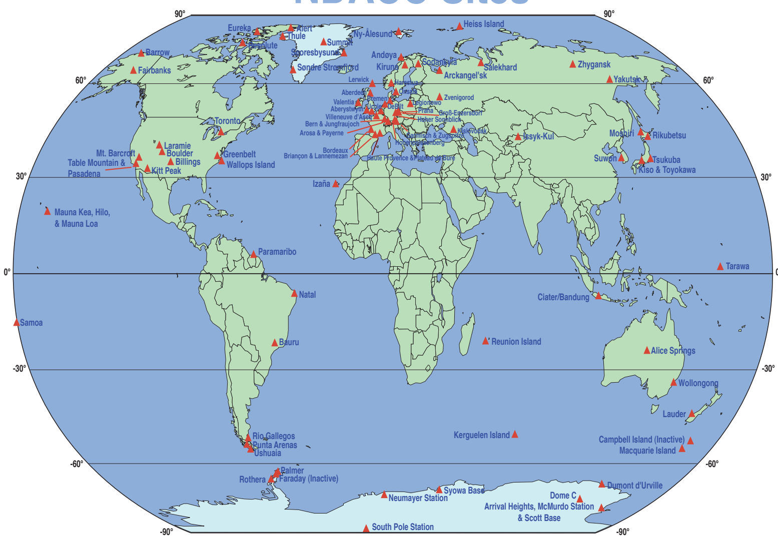
NDACC Sites



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Cover photo: Time-lapse photo of an ozonesonde launch at the South Pole. Photo: Christian Krueger, IceCube.

Remembrances

It is with sadness that we note the passing of two scientists who played leading roles in the establishment and operation of NDACC.

Rodolphe Zander

15 December 1937 – 22 October 2015

In Memoriam

by Emmanuel Mahieu, Paul C. Simon, and Kathy A. Thompson

Professor Rodolphe (Rudy) Zander was an outstanding scientist who made a huge contribution to the study of the composition and evolution of the Earth's atmosphere, analysing high-resolution infrared solar spectra recorded from different platforms.

Rudy graduated with 'la plus grande distinction' from the University of Liège (Belgium) with a PhD in Physics in November 1968. His thesis was dedicated to the study of infrared solar spectra recorded with stratospheric balloons and contributed to the study of water vapour above 25 km altitude. Professor Marcel Migeotte was his supervisor.

In 1964-1965, during his thesis work, he was a visiting scientist at the Johns Hopkins University of Astrophysics and Physical Meteorology, in Baltimore, MD. Working under Professor John Strong, Rudy familiarized himself with the techniques used for observing the Earth's atmosphere with stratospheric gondolas.

One year after receiving his PhD, Rudy was appointed Senior Scientist at the University of Liège (Belgium). In 1998, he was nominated to an academic position, teaching a course on "Physics and Chemistry of the Earth's Atmosphere."

Highlights of his scientific work include:

1. **Stratospheric balloons, using the University of Liège gondola**
   For more than 20 years, Rudy organized and coordinated 27 flights of the University of Liège gondolas, from locations including Palestine, Texas, and Fort Sumner, New Mexico. In 1975, he was the first to detect and report the presence of hydrogen fluoride in the upper stratosphere, an undeniable evidence that the man-made CFCs transported there, and ultimately photolysed to free fluorine and chlorine atoms.

2. **Space-based instruments, notably ATMOS (Atmospheric Trace Molecule Spectroscopy Experiment) on board the U.S. Space Shuttle**
   Since 1976, he was strongly involved in the ATMOS project developed by NASA for the Space Shuttle. As co-investigator and an active member of the scientific committee, he contributed to the definition of the scientific objectives of this pioneering mission, took part in real-time validation of the measurements taken by the ATMOS FTS instrument during its four successive flights on the Space Shuttle between 1985 and 1994, analysed the spectra, and published the results in the scientific literature.

3. **Ground-based observations from the International Scientific Station at the Jungfraujoch, in the Swiss Alps**
   Rudy analysed the infrared solar spectra recorded at this site, first with a grating infrared spectrometer, and then with FTIR instruments.

Thanks to the analysis of these various observations, he significantly and undoubtedly contributed to a better characterization and understanding of the chemical composition of the Earth's atmosphere, of its long-term evolution, and of the anthropogenic perturbations affecting it.

Rudy also was a key participant in the inception and extension of NDSC (now NDACC) over the course of more than 20 years. He joined the Steering Committee in 1991, the recognized date of the official inception of the Network. In 1995, Rudy was unanimously elected as the new Vice-Chairman of the NDSC Steering Committee. This designation was changed to Co-Chair at the 1999 meeting, to acknowledge the significant contributions that Rudy was making in his role.

In relation to the implementation of NDSC in Europe, he was a very active co-investigator of several EU projects

Rudy studying an infrared spectrum.

during the 1990s. In 2000, Rudy proposed the use of a standardized form for the annual NDSC meeting. This form is an important source of information, and one that still is used in advance of every meeting.

In 2002, Rudy stepped down as NDSC Steering Committee Co-Chair, in concert with his retirement from the University of Liège. Because of his significant contributions to NDSC, and the consensus that his expertise remained valuable, the Steering Committee unanimously elected Rudy as a Peer and Ex Officio Representative.

He was a member of several scientific committees and societies, including the American Geophysical Union, the International Radiation Commission, and the Belgian Committee of Geodesy and Geophysics. He also was Associate Editor for the Journal of Geophysical Research and Journal of Quantitative Spectroscopy and Radiative Transfer. He led the University of Liège infrared group (Groupe Infra-Rouge de Physique Atmosphérique et Solaire, GIRPAS) until his retirement in 2003.

During his scientific career, Rudy wrote over 160 papers on atmospheric research pertaining to man's impact on the atmosphere. He also received several awards, including:

- The Louis Melsens prize of the Royal Belgian Academy of Sciences, Letters and Arts (1976)
- The Agathon de Potter prize, from the Royal Belgian Academy of Sciences, Letters and Arts (1988)
- The National Aeronautics and Space Administration (NASA) Group Achievement Award for his contribution to the development and success of the ATMOS missions on board the Space Shuttle (1995).

The following papers are a small representation of his extensive publication list:

– Zander, R.: Présence de HF dans la stratosphère supérieure, C. R. Acad. Sc. Paris, 281, 213–214, 1975. [The first report on the detection of HF in the stratosphere]

– Zander, R.: Recent observations of HF and HCl in the upper stratosphere, Geophys. Res. Lett., 8, 413–416, doi:10.1029/GL008i004p00413, 1981.

– Zander, R., Rinsland, C. P., Farmer, C. B., and Nor- ton, R. H.: Infrared spectroscopic measurements of halogenated source gases in the stratosphere with the ATMOS instrument, J. Geophys. Res., 92, 9836, doi:10.1029/JD092iD08p09836, 1987.

– Zander, R., Demoulin, P., Ehhalt, D. H., Schmidt, U., and Rinsland, C. P.: Secular increase of the total vertical column abundance of carbon monoxide above central Europe since 1950, J. Geophys. Res., 94, 11021, doi:10.1029/JD094iD08p11021, 1989.

– Zander, R., Gunson, M. R., Farmer, C. B., Rinsland, C. P., Irion, F. W., and Mahieu, E.: The 1985 chlorine and fluorine inventories in the stratosphere based on ATMOS observations at 30° north latitude, J. Atmos. Chem., 15, 171–186, doi:10.1007/BF00053758, 1992.

– Zander, R., Mahieu, E., Demoulin, P., Duchatelet, P., Roland, G., Servais, C., De Mazière, M., Reimann, S., and Rinsland, C. P.: Our changing atmosphere: Evidence based on long-term infrared solar observations at the Jungfraujoch since 1950, Sci. Total Environ., 391, 184–195, doi:10.1016/j.scitotenv.2007.10.018, 2008.

A complete list of Rudy's publications is available from the University of Liège electronic repository: https://orbi.uliege.be/browse?type=authorulg&rpp=%2020&value=Zander,+Rodolphe+p001142.

Rudy was well recognized by the international scientific community. His kind and modest personality was combined with intellectual rigour, great clarity of expression, and broad scientific interests. Rudy was a brilliant scientist and a valued colleague, and he will be sorely missed by all who knew and/or worked with him, especially by the NDACC scientific community.

We remember Rudy for his contributions to NDACC, and we extend our heartfelt condolences to his family.

Michael H. Proffitt

1942-2016

In Memoriam

by Kathy A. Thompson
with input from David W. Fahey, Herman Smit, and Adrian F. Tuck

Michael H. Proffitt (Mike) attended New Braunfels High School, New Braunfels, Texas. He received his Bachelor of Arts, Master of Arts (under H.S. Wall), and Ph.D. (under R. L. Moore) in Mathematics, Physics, and Chemistry from the University of Texas at Austin (1960-1968).

He was an Assistant and Associate Professor of Mathematics, the youngest tenured professor, at the State University of New York from 1968 to 1972. He then conducted stratospheric ozone research as a Research Scientist at the NOAA Aeronomy Laboratory, now the NOAA Earth System Research Laboratory (ESRL) Chemical Sciences Division, from 1980 to 1999.

While at NOAA, Mike developed a dual-beam absorption photometer for ozone measurements on high-altitude balloons, and later on the NASA ER-2 high-altitude aircraft. In situ measurements in the stratosphere were still largely under-developed in the early 1980s, when compared to the present. Mike also participated in an international balloon-based intercomparison project to help improve the accuracy of stratospheric ozone measurements (Balloon Experiment on Standards for OzoneSondes (BESOS)).

Mike's instrument flew on board the NASA high-altitude ER-2 aircraft when it first sampled the Antarctic ozone hole in 1987 during flights from Punta Arenas, Chile. In total, the instrument has flown on more than 350 stratospheric flights of the NASA ER-2 and WB-57F high-altitude aircraft since 1985.

Mike's ozone data, combined with data from Jim Anderson's (Harvard University) ClO instrument, formed the 'smoking guns' in linking reactive chlorine to large-scale ozone destruction. The datasets are on the cover of the March 2016 Anderson Festschrift in the Journal of Physical Chemistry (Volume 120, Number 9). It seems appropriate that Mike's ozone instrument belongs in the Smithsonian collection along with the Harvard ClO instrument in recognition of their singular contribution to understanding the cause of the ozone hole.

In 1999, Mike became the Senior Scientific Officer of the WMO Global Atmospheric Watch Program. During that time, he served as WMO Representative to the NDSC (now NDACC) Steering Committee. He retired from WMO in 2004.

In retirement, Mike lived in Buenos Aires. He later returned to Texas, where he enjoyed working on projects and playing his guitar. He also was a certified Texas master gardener.

David Fahey, Director of the NOAA ESRL Chemical Sciences Division, and a former colleague of Mike, recollects that "*Mike's ozone research and accomplishments and his service to the community are a great legacy. He was measuring stratospheric ozone before the ozone hole was discovered, and lived to see the effectiveness of the Montreal Protocol in regulating ozone-depleting substances, and the* *first signs of recovery of the Antarctic ozone hole. I and many others consider Mike a good scientific colleague who shared his interests in the chemistry and dynamics of the stratosphere. We will miss his exacting approach to science, and his ever-present sense of humour and enthusiasm for his ozone measurements, and what they told him about the atmosphere."*

Adrian Tuck, who was Mike's Group Leader at NOAA, remembers that "*When I did the statistical multi-fractal analysis of the ER-2 data with Susan Hovde, Mike's ozone instrument was the only one on AAOE and AASE that had good enough noise characteristics to sustain the full analysis for all three scaling exponents, along with being much easier to make meteorological measurements. It was the basis for the work that eventually became my book."*

Herman Smit, of the Forschungszentrum Jülich and a former colleague of Mike's, noted that "*We continue to use the very first prototype of the dual-beam ozone UV-photometer balloon instrument, which he developed at the NOAA Aeronomy Laboratory in the early 1980s, as the ozone reference instrument of JOSIE (Jülich OzoneSonde Intercomparison Experiment) at the WCCOS (World Calibration Centre of OzoneSondes) as part of the QA/QC plan of the WMO/GAW-NDACC-SHADOZ programs. After 35 years, the instrument still has a very high precision and accuracy, and is so stable that it also serves as the reference standard for the global ozonesonde network."* On a personal level, Herman notes that "*I have known Mike, not only as an excellent, critical, and precise scientist, but also as a modest and heartfully feeling and thinking person."*

We remember Mike for his contributions to NDACC, and we extend our heartfelt condolences to his family.

Mike inspecting the balloon payload gondola during the BESOS campaign in April 2004.

Latest News

Visit to South American SHADOZ stations

From 7-14 March 2017, NDACC Co-Chair Anne Thompson, Senior Scientist for Atmospheric Chemistry, NASA-Goddard Space Flight Center, made visits to two South American countries that host SHADOZ ozonesonde stations: Suriname (to the Meteorological Department of Suriname [MDS] in Paramaribo) and Ecuador. Paramaribo is an NDACC station, hosting an FTIR and a Brewer (Photo 1). In Suriname, Thompson was accompanied by NASA postdoc Ryan Stauffer (USRA/614) and Drs. Ankie Piters and Arnoud Apituley of KNMI (Royal Dutch Meteorological Institute), that sponsors weekly Paramaribo soundings (Photo 2). Dr. Apituley briefed MDS on the GRUAN project. These instruments as well as the first SHADOZ soundings (1999) were initiated by Dr. Cornelis ("Cor") Becker of the MDS (Photo 3). On 8 March, the visitors observed preparation and calibration of the sonde and a launch that measured ozone to 34 km (Photo 4). On 9 March, Thompson visited the Deputy Ambassador G. Webster and two staff at the US Embassy in Suriname to discuss activities in Suriname; this is the first time a NASA scientist had visited Paramaribo. Thompson

Photo 1. Brewer on MDS rooftop at NDACC Paramaribo station. Main ozone personnel: George Paiman (left), Mohamed Firozali Amierali (right) with Ankie Piters, far right. Photo credit: R. M. Stauffer, NASA

Photo 2. MDS visit by SHADOZ and NDACC. Left to right: Sukarni Sallons, Director, MDS; Anne Thompson and Ryan Stauffer (NASA-Goddard); Ankie Piters, KNMI, sponsoring partner of ozonesonde program at MDS. Photo credit: A. Apituley, KNMI.

Photo 3. Cor Becker, who initiated NDACC and SHADOZ measurements at Paramaribo, with FTIR at MDS. Photo credit: A. Apituley, KNMI

delivered a lecture on 9 March to the Anton de Kom University on "Environmental Success Stories: A View from Space."

On 13 March, Thompson gave a presentation on NASA satellite ozone observations to an all-day Environmental Symposium in Quito, Ecuador, attended by 70 students, faculty and agency personnel at the University of San Francisco-Quito (USFQ). Thompson met with the Executive Director J. Olmedo and several senior staff at INAHMI (Institute for Hydrology and Meteorology) in Quito on 14 March (Photo 5) to work out resumption of SHADOZ sonde launches at San Cristóbal, Galapagos, which have been suspended for a year. In the afternoon of 14 March, Thompson gave a lecture to a Women in Science and Engineering Group at USFQ and visited the roof-top atmospheric lab of host Prof Maria Cazorla, a former GSFC NASA Postdoctoral Program postdoc (Photo 6).

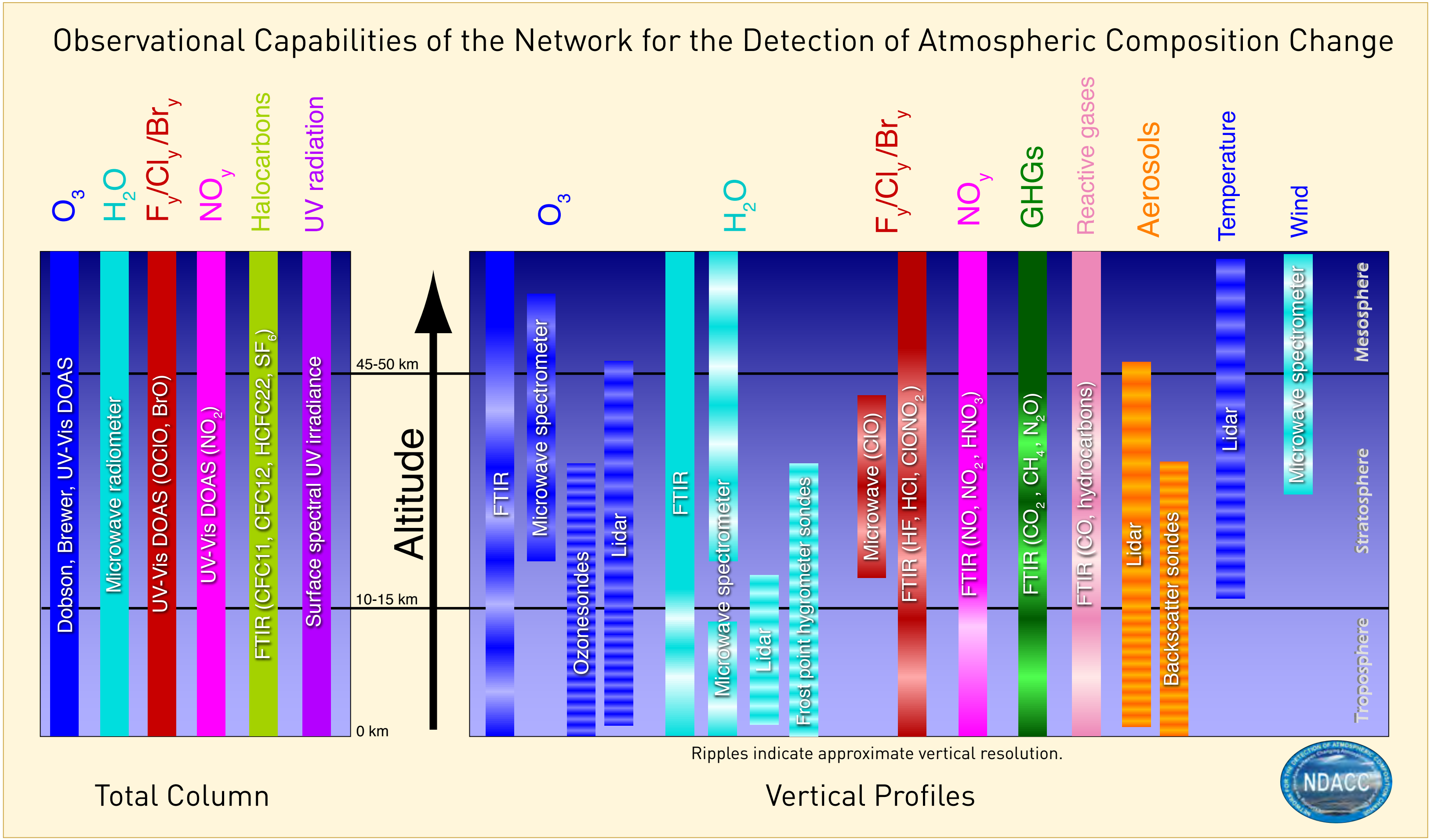
Photo 4. Ozonesonde launch at Paramaribo, Suriname, SHADOZ station. Photo credit: A. M. Thompson, NASA

Photo 5. INAMHI Director J. Olmedo, third from left, with other senior staff, Anne Thompson and Prof. M. Cazorla (2nd from right)

Photo 6. Anne Thompson and Prof. M. Cazorla in the rooftop atmospheric lab of USFQ, Quito, Ecuador.

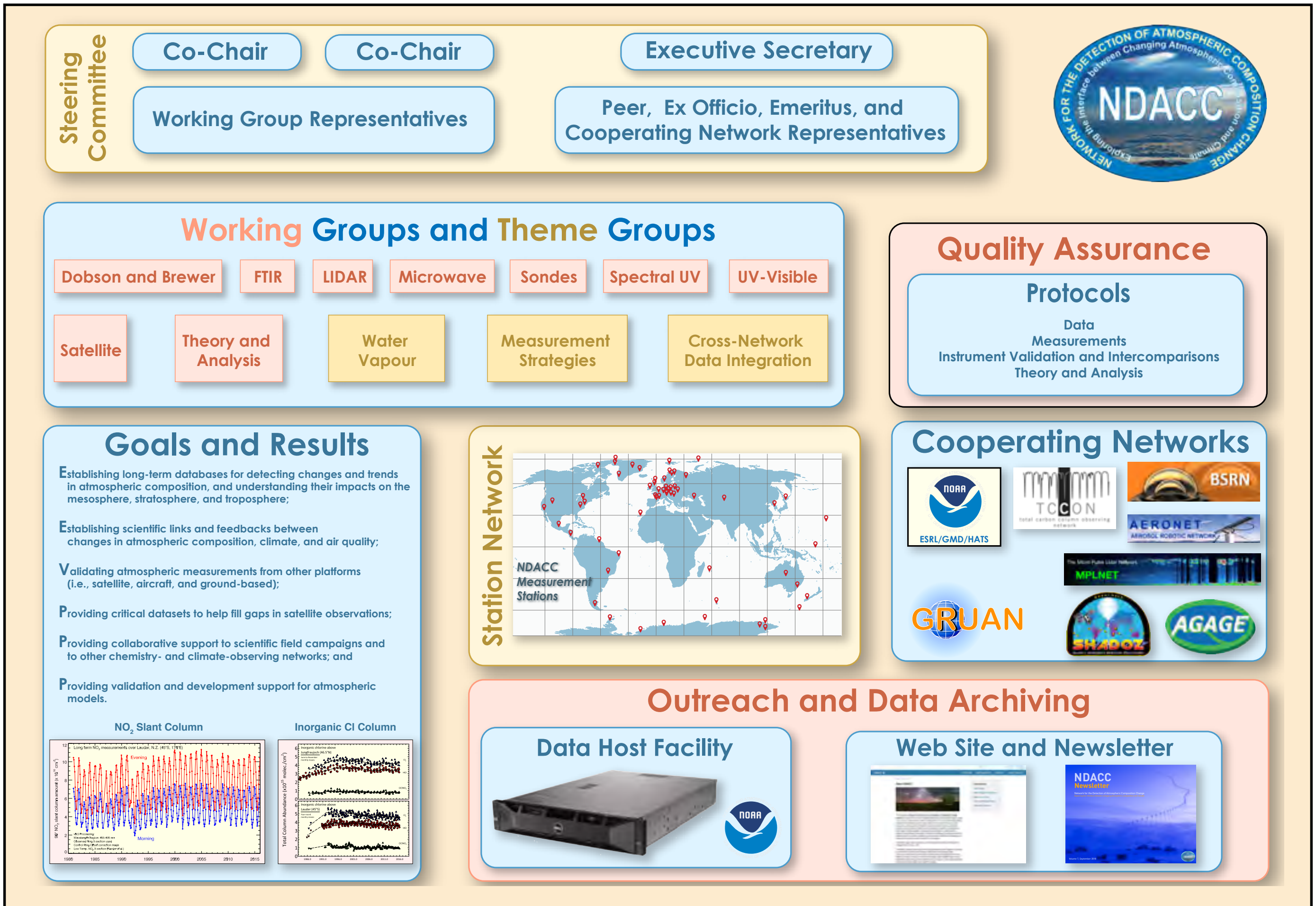
Observational Capability Chart

The NDACC Observational Capability Chart shows the wide range of species and parameters that are measured with NDACC instruments. Bars with uniform colour represent column measurements and bars with ripples show measurements that are vertically resolved. The denser the ripples, the better the vertical resolution.



NDACC Organisational Chart

The NDACC Organisational Chart shows how NDACC is governed by a Steering Committee and by Working Groups and Science Teams. Other important elements, such as the Data Host Facility, web site and outreach activities are also shown. Quality assurance form an important component of NDACC activities and there are agreements signed with Cooperating Networks.



Working and Theme Group web sites

Several NDACC Working and Theme Groups have their own dedicated web sites that are linked to from the main NDACC web site, http://www.ndacc.org

Working/Theme Group	Web site
Dobson and Brewer	http://www.eubrewnet.org
Dobson and Brewer	http://www.o3soft.eu/dobsonweb/welcome.html
FTIR	https://www2.acom.ucar.edu/irwg
Lidar	http://ndacc-lidar.org/
Microwave	http://www.iapmw.unibe.ch/research/collaboration/ndsc-microwave/
Satellite	http://accsatellites.aeronomie.be
Sondes	http://www-das.uwyo.edu/~deshler/NDACC_O3Sondes/NDACC_O3sondes_WebPag.htm
Theory and Analyses	http://www.ndacc-theory.org/
UV/Vis	http://ndacc-uvvis-wg.aeronomie.be/
Spectral UV	http://www.ndsc.ncep.noaa.gov/UVSpect_web/
Water Vapour	http://www.iapmw.unibe.ch/research/projects/issi/index.html

News from the Ozone Theme Group

Absorption Cross Sections of Ozone (ACSO)

Johanna Tamminen, Finnish Meteorological Institute, Helsinki, Finland,
Johannes Staehelin, Swiss Federal Institute of Technology Zurich, Switzerland,
Johannes Orphal, Karlsruhe Institute of Technology, Germany and
Geir Braathen, World Meteorological Organization

The Absorption Cross Sections of Ozone (ACSO) Committee, which was established in spring 2009 was a joint ad hoc committee of the Scientific Advisory Group (SAG) for Ozone of the Global Atmosphere Watch (GAW) of the World Meteorological Organization (WMO) and the International Ozone Commission IO_3C) of the International Association of Meteorology and Atmospheric Sciences (IAMAS).

The mandate of ACSO included:

- Review the presently available ozone absorption cross sections. Priority on Huggins band.
- Determine the impact of changing the reference ozone absorption cross sections for all of the commonly used (both ground-based and satellite) atmospheric ozone monitoring instruments.
- Recommend whether a change needs to be made to the presently used WMO/IO_3C standard ozone absorption cross section data (by Bass and Paur, 1985).

In ACSO, different sets of laboratory ozone absorption cross-section data (including their dependence on temperature) of the group of Reims (France) (Brion et al. 1993, 1998, Daumont et al. 1992, Malicet et al. 1995, abbreviated as BDM, 1995) and those

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Absorption cross-sections of ozone in the ultraviolet and visible spectral regions: Status report 2015

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ABSTRACT

The activity "Absorption Cross-Sections of Ozone" (ACSO) started in 2008 as a joint initiative of the International Ozone Commission (IO3C), the World Meteorological Organization (WMO) and the IGACO ("Integrated Global Atmospheric Chemistry Observations") O_3/UV subgroup to study, evaluate, and recommend the most suitable ozone absorption cross-section laboratory data to be used in atmospheric ozone measurements. The evaluation was basically restricted to ozone absorption

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The ACSO paper that has been published in the Journal of Molecular Spectroscopy.

of Serdyuchenko et al. 2014, and Gorshelev et al. 2014, (abbreviated as SER, 2014) were examined for use in atmospheric ozone measurements in the Huggins band.

In conclusion, ACSO recommends:

- The spectroscopic data of BP (1985) should no longer be used for retrieval of atmospheric ozone measurements.
- For retrieval of ground-based instruments of total ozone and ozone profile measurements by the Umkehr method performed by Brewer and Dobson instruments data of SER (2014) are recommended to be used. When SER (2014) is used, the difference between total ozone measurements of Brewer and Dobson instruments are very small and the difference between Dobson measurements at AD and CD wavelength pairs are diminished.
- For ground-based Light Detection and Ranging (LIDAR) measurements the use of BDM (1995) or SER (2014) is recommended.
- For satellite retrieval the presently widely used data of BDM (1995) should be used because SER (2014) seems less suitable for retrievals that use wavelengths close to 300 nm due to a deficiency in the signal-to-noise ratio in the SER (2014) dataset.

The work of ACSO also showed:

- The need to continue laboratory cross-section measurements of ozone of highest quality
- The importance of careful characterization of the uncertainties of the laboratory measurements
- The need to extend the scope of such studies to other wavelength ranges (particularly to cover not only the Huggins band but also the comparison with the mid-infrared region)
- The need for regular cooperation of experts in spectral laboratory measurements and specialists in atmospheric (ozone) measurements.

The status as of 2015 was published in WMO/GAW report no. 218 and in Orphal et al. (2016).

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D. Daumont, J. Brion, J. Charbonnier, J. Malicet, Ozone UV spectroscopy I: absorption cross sections at room temperature, J. Atmos. Chem. 15 (1992) 145–155.

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GAW Report No. 218: Absorption Cross-Sections of Ozone (ACSO) Status Report as of December 2015, Lead Authors: Johannes Orphal, Johannes Staehelin and Johanna Tamminen. Can be downloaded from: http://library.wmo.int/pmb_ged/gaw_218_en.pdf

Orphal, Johannes; Staehelin, Johannes; Tamminen, Johanna; Braathen, Geir; De Backer, Marie-Renée; Bais, Alkiviadis; Balis, Dimitris; Barbe, Alain; Bhartia, Pawan K.; Birk, Manfred; Burkholder, James B.; Chance, Kelly; von Clarmann, Thomas; Cox, Anthony; Degenstein, Doug; Evans,; Robert; Flaud, Jean-Marie; Flittner, David; Godin-Beekmann, Sophie; Gorshelev, Viktor; Gratien, Aline; Hare, Edward; Janssen, Christof; Kyrola, Erkki; McElroy, Thomas; McPeters, Richard; Pastel, Maud; Petersen, Michael; Petropavlovskikh, Irina; Picquet-Varrault, Benedicte; Pitts, Michael; Labow, Gordon; Rotger-Languereau, Maud; Leblanc,Thierry; Lerot, Christophe; Liu, Xiong; Moussay, Philippe; Redondas, Alberto; Van Roozendael, Michel; Sander, Stanley P.; Schneider, Matthias; Serdyuchenko, Anna; Veefkind, Pepijn; Viallon, Joele; Viatte, Camille; Wagner, Georg; Weber, Mark; Wielgosz, Robert I; Zehner, Claus: Absorption cross-sections of ozone in the ultraviolet and visible spectral regions: Status report 2015, Journal of molecular spectroscopy, 327 (2016), 105-121.

News from the Sonde Working Group

Thomas Schmidt, meteorologist of the 2012 overwintering crew, launching an ozonesonde from the roof of the Neumayer III station during stormy weather conditions on 5 September, 2012. © Stefan Christmann.

Ozonesonde Data Series Homogenisation

Project Status as of November 2016

Jacquelyn Witte, NASA, USA

The SHADOZ, GAW and NDACC communities are actively engaged in reprocessing their long term ECC ozonesonde datasets that go back to the 1980s. The 2016 Quadrennial Ozone Symposium and the Ozonesonde Data Quality Assurance workshop, which was held on 1-3 September in Edinburgh, served as important venues to present preliminary homogenised datasets from several SHADOZ and GAW sites and discuss outstanding issues such as metadata recovery, reduction of uncertainties, and aspects of the conditioning process. As a follow-on to previous JOSIE (Jülich OzoneSonde Intercomparison Experiment) campaigns a joint JOSIE-GAW-SHADOZ-NDACC campaign is being planned for late 2017 at the WWCOS (World Calibration Centre of OzoneSondes) at the Research Centre Jülich (Germany) with a focus on outstanding instrumental issues specific to tropical soundings (see the article that follows right after this). The campaign will bring together international collaborators from a number of sites world wide with diverse ozone-radiosonde systems and provide additional coaching and guidance on best practices where needed. GAW, NDACC and SHADOZ were well represented at the ozonesonde workshop and QOS with a number of stations highlighting and summarising their operations and measurements.

Participants at the Ozonesonde Expert Workshop, 1-3 September 2016, Edinburgh, Scotland.

JOSIE-2017: SHADOZ-NDACC-GAW cooperation for ozonesondes

René Stübi, MeteoSwiss; Jacquelyn Witte, NASA GSFC;
Bryan Johnson, NOAA/ESRL and Herman Smit, FZ Jülich

In order to assess the performance of the various ozonesonde instruments and standard operating procedures used within the Global Atmosphere Watch (GAW) networks, the environmental simulation chamber (ESC) at the Forschungszentrum Jülich (FZJ), Germany was established as the World Calibration Center for OzoneSondes (WCCOS) by WMO in 1996. The simulation chamber (Figure 1) enables control of pressure, temperature, and ozone concentration as it simulates flight conditions of ozone soundings up to an altitude of 35 km [Smit et al., 1998]. This controlled environment and comparison of the ozonesonde profiles with an accurate UV-photometer as a reference [Proffitt and McLaughlin, 1983] are essential requirements for evaluating instruments and addressing issues that arise from field and laboratory operations. The Jülich OzoneSonde Intercomparison Experiments (JOSIE) listed in Table 1 all show similar objectives: evaluate quality assurance (QA), accuracy, and precision of ozonesonde manufacturer models, sensing solutions, and standard ozonesonde preparation procedures. The JOSIE-2017/SHADOZ campaign in October and November of 2017 was the latest

Figure 1. Environmental chamber at the Forschungszentrum Jülich with four ozonesondes positioned for a simulation run.

TABLE 1. JOSIE and BESOS Campaigns from 1996 to 2017.

Campaign	Objective
JOSIE-1996 GAW Report #130	✎ Operating Procedures ✎ Profiling Capabilities ✎ Intercomparison sonde types (ECC, BM, Meisei)
JOSIE-1998 GAW Report #157	✎ Manufacturing ECC sondes (SPC, En-SCI)
JOSIE-2000 GAW Report #158 Smit et al., 2007	✎ Operating Procedures ✎ Focus on ECC sonde • Different sensing solution types • Different manufacturers (SPC, En-Sci)
BESOS-2004 Deshler et al., 2008	✎ Operating Procedures under real flight conditions ✎ Focus on ECC sonde • Different sensing solution types • Different manufacturers (SPC, En-Sci)
ASOPOS 2002-2012 GAW Report #201	✎ Define and establish Standard Operating Procedures
JOSIE-2009	✎ Manufacturers (SPC, En-SCI)
JOSIE-2010	✎ Refurbished sondes
O3S-DQA Guide-lines Smit and O3S-DQA-Panel, 2012	✎ Homogenization and Uncertainties
JOSIE-2017/ SHADOZ	✎ Operating procedures ✎ Tropical simulations ✎ Different sensing solution types ✎ Different manufacturers (SPC, En-Sci)

calibration experiment held at FZJ that addressed ozonesonde operations within tropical regions.

SHADOZ – NDACC

The Southern Hemisphere Additional Ozonesonde (SHADOZ) network began in 1998 as an international partnership to enhance the number of tropical ozone soundings [Thompson et al., 2004] from operational stations. Currently there are 14 sites around the globe launching ozonesondes within remote, tropical regions. SHADOZ was affiliated with NDACC as a Cooperating Network in 2009, even though half of the stations were already part of the NDACC network. The JOSIE 2017 campaign was therefore organised as a close collaboration between WMO, NDACC, and SHADOZ, and as an independent confirmation of the accuracy of the large SHADOZ dataset that was recently homogenized and compared to data from satellite and ground-based instruments (Thompson et al., 2017; Witte et al., 2017). The experiment design focused on comparing the two ECC sonde types, different SHADOZ and WMO procedures, and sensor solutions through a series of tropical profile simulations.

JOSIE-2017 Campaign

The preliminary planning for JOSIE-SHADOZ-2017 focused on bringing international ozonesonde groups and SHADOZ field site operators to FZJ -Jülich for hands-on participation and preparation of ozonesondes for the simulations (see session participants in Figure 2).

The campaign was divided into two 10-day sessions (Oct 10-20 and Oct 23 - Nov 03). Each of the 4 ozonesonde preparation stations in the FZJ laboratory followed WMO and SHADOZ preparation standards. Figure 3 shows an example of four ozonesonde profiles and the OPM reference along with total column ozone. The complete data analysis will be released later in 2018 by the FZJ. A workshop was held in Geneva in September 2018 immediately following the NDACC Steering Committee meeting. A preliminary summary shows that all 8 stations in JOSIE-SHADOZ-2017 measured ozone that agreed well with the OPM. The slight ENSCI and Science Pump Corporation ozone bias (ENSCI reads slightly higher) previously observed (Smit et al., 2007) remained in JOSE-SHADOZ 2017, but overall affirms the very high quality of the SHADOZ methods that use SOP and SST-instrument combinations based on earlier JOSIE campaigns and field tests (Smit et al., 2007; 2012).

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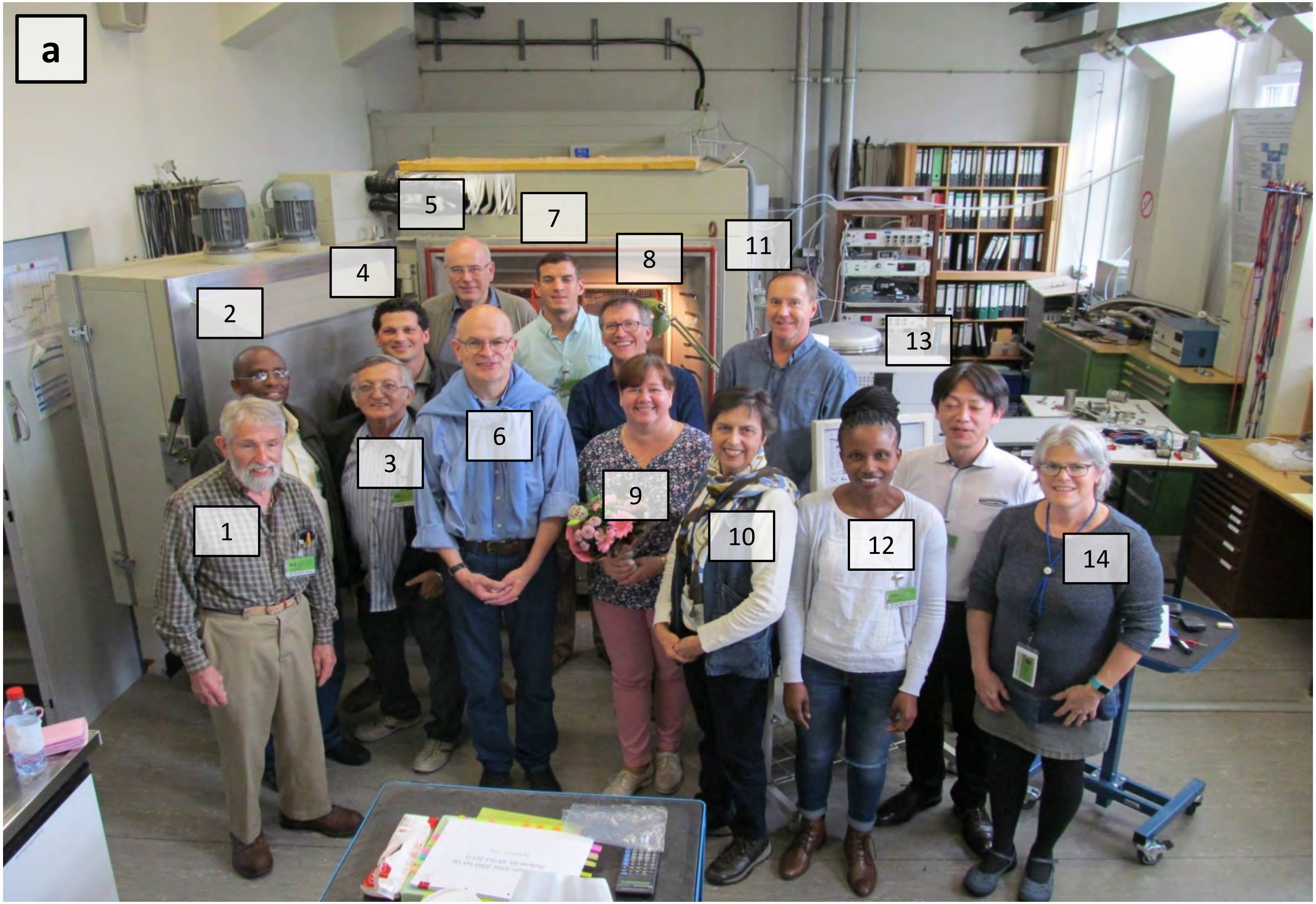

Figure 2a. Session 1 participants in the JOSIE-SHADOZ 2017. (1) George Brothers (NASA/WFF); (2) Kennedy Thiong'o (Kenya Met. Dept.); (3) Francisco Raimundo da Silva (INPE Natal); (4) Ernesto Corrales (Univ. Costa Rica); (5) Peter von der Gathen (Alfred Wegener Institute); (6) Herman Smit (FZ Jülich); (7) Ryan Stauffer (NASA/GSFC); (8) Gary Morris (St. Edward's Univ.); (9) Gabi Nork (FZ Jülich); (10) Anne Thompson (NASA/GSFC); (11) Bryan Johnson (NOAA ESRL); (12) Tshidi Machinini (South African Weather Service); (13) Tatsumi Nakano (Japan Met Agency); (14) Rhonie Wolff (NASA/WFF).

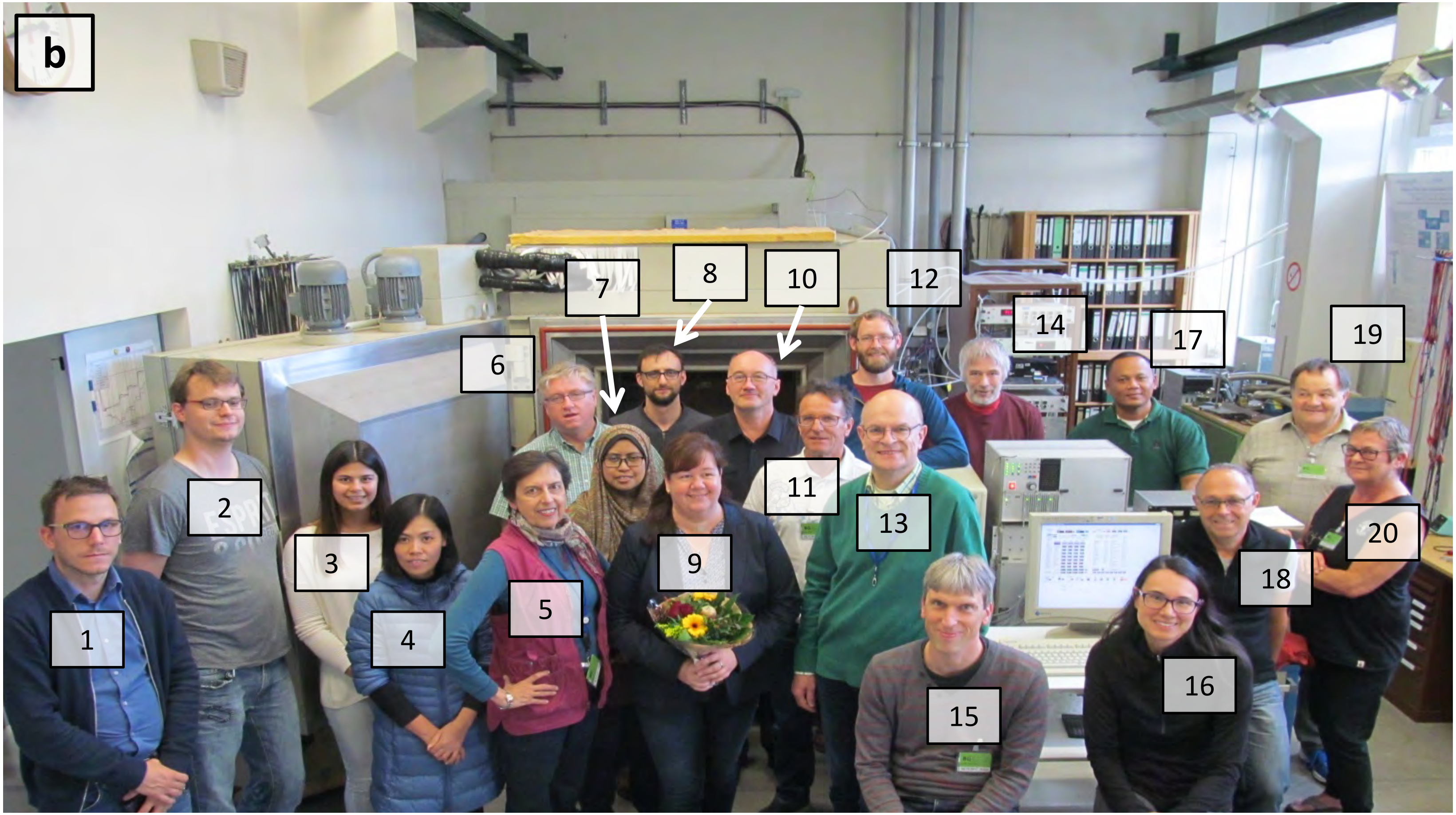

Figure 2b. Session 2 participants in the JOSIE-SHADOZ 2017. (1) Gonzague Romanens (MeteoSwiss); (2) Torben Blomel (FZ Jülich); (3) Jennifer Gläser (FZ Jülich); (4) Nguyen Thi Hoang Anh (Vietnam Meteorological and Hydrological Administration); (5) Anne Thompson (NASA/GSFC); (6) Jonathan Davies Env. Climate Change Canada); (7) Zamuna Zainal (Met Malaysia); (8) Patrick Neis (FZ Jülich); (9) Gabi Nork (FZ Jülich); (10) Rigel Kivi (FMI); (11) Rene Stübi (MeteoSwiss); (12) Patrick Cullis (NOAA ESRL); (13) Herman Smit (FZ Jülich); (14) Marc Allaart (KNMI); (15) Roeland Van Malderen (Royal Meteorological Institute of Belgium); (16) Jacquelyn Witte (NASA/GSFC); (17) George Paiman (Met. Dept. of Suriname); (18) Andreas Petzold (FZ Jülich); (19) Gilbert Levrat (MeteoSwiss); (20) Françoise Posny (Univ. of La Réunion).

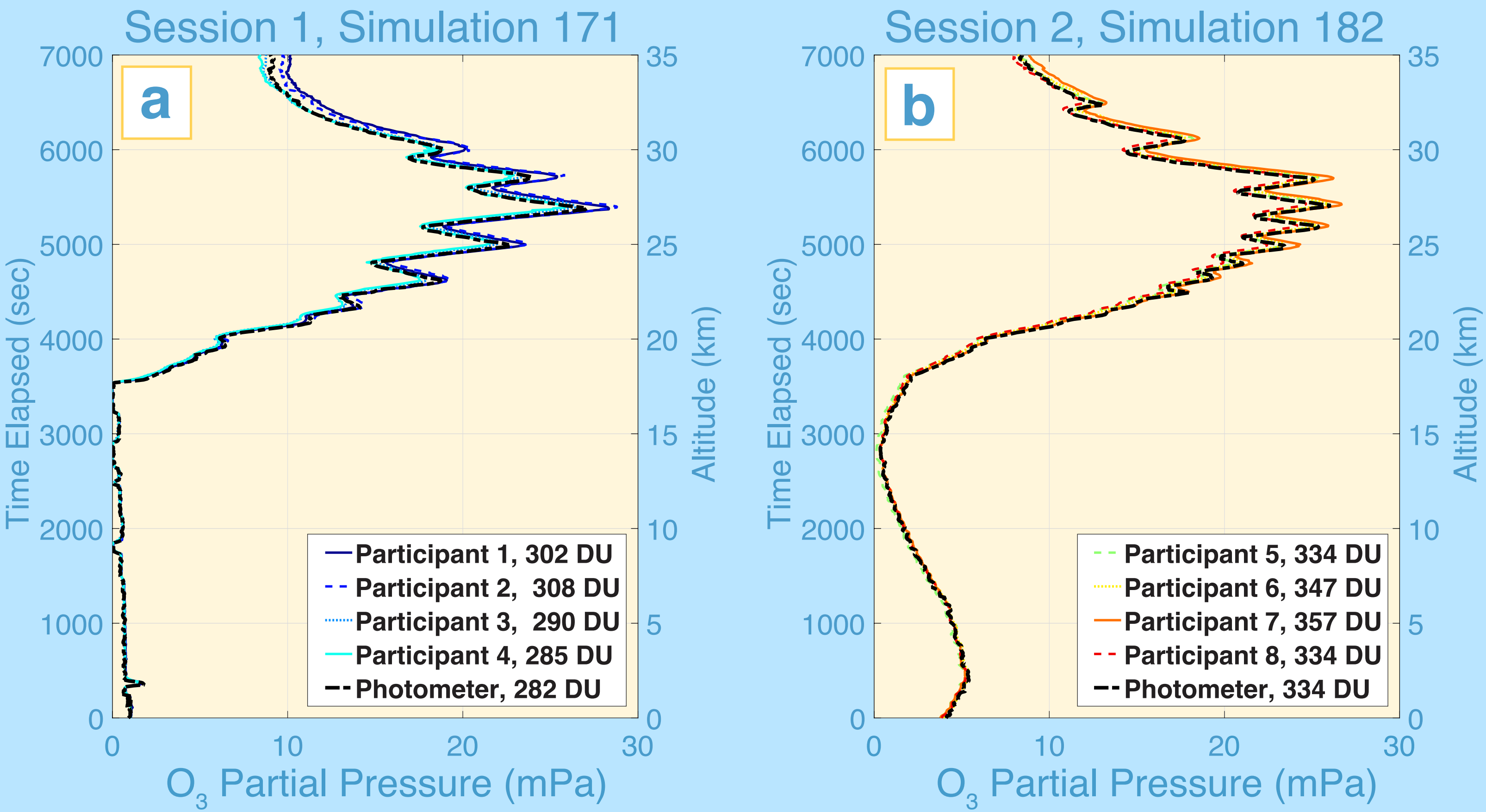

Figure 3. Ozone "raw" profiles and total column ozone of typical simulations in Sessions 1 and 2 of the 2017 JOSIE-SHADOZ ozonesonde campaign.

News from the Infrared Working Group

The Jungfraujoch Station in the Bernese Alps.
Photo courtesy of: https://www.jungfrau.ch/en-gb/

Using FTIR spectrometry and a chemical transport model to investigate the sources and sinks of carbonyl sulfide (OCS) and its link to CO_2

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Carbonyl sulfide (OCS) is the most abundant and longest lived sulphur-containing compounds in the atmosphere (Chin and Davis, 1995; Griffith et al., 1998). OCS is well mixed in the troposphere and can be transported to the stratosphere where it provides an important source of sulphur to the stratospheric aerosol layer. The NDACC Infrared Working Group (IRWG) has previously contributed significantly to monitoring OCS changes and investigating its impact on the stratospheric aerosol burden (Rinsland et al., 1992; 2002; 2008; Notholt et al., 2003; 2006; Deutscher et al., 2006; Kremser et al., 2015).

A developing application of OCS is studying the biospheric processes within the carbon cycle. The land carbon sink absorbs more than a quarter of the CO_2 emissions released by human activities, mitigating the increase of atmospheric CO_2 concentration; terrestrial exchange drives CO_2 variability in the atmosphere on seasonal and inter-annual time scales. Therefore understanding CO_2 biospheric processes is a key point for predicting CO_2 trends and climate change. However, our knowledge of these processes is limited because (a) the net biospheric CO_2 flux (net ecosystem production, NEP) is the sum of two much larger terms: the photosynthetic uptake and the respiration emission; (b) these fluxes respond independently to different climate drivers; (c) these two fluxes are co-located and therefore cannot be separated directly. To improve our knowledge of CO_2 biospheric processes, in particular how ecosystems will respond to a changing climate, it is important to understand the individual contributions of these two fluxes. Recent studies (e.g. Campbell et al., 2008) suggest that OCS holds great promise as an additional constraint on the carbon cycle, because it is taken up by plants during photosynthesis through a similar pathway as CO_2, but is not emitted by respiration. Therefore OCS might act as a tracer of photosynthesis and provide a means to separate photosynthesis and respiration and their relative contributions to NEP.

The estimates of OCS sources and sinks still have significant uncertainties. To use OCS as a photosynthetic tracer, it is necessary to first improve our knowledge of the OCS fluxes with the help of more measurements at different latitudes and ecosystem regions. The existing long-term OCS surface measurements (such as the NOAA/ESRL/GMD network) are sparse. Satellite measurements, while providing a wide coverage of OCS, are mainly sensitive in the upper troposphere and stratosphere (Barkley et al., 2008; Kuai et al., 2014), and are therefore have limited use in constraining the land fluxes.

The NDACC IRWG provides a potential database of OCS that can be used to evaluate OCS fluxes. Compared to satellites, ground-based FTIR OCS retrievals are also sensitive to the lower troposphere and can therefore more directly capture the variations due to biospheric processes. Our recent study aims to exploit the

FTIR measurements of OCS to evaluate its sources and sinks, and further to use OCS to study the carbon cycle in combination with TCCON using co-located and quasi-simultaneous CO_2 and OCS measurements (Wang et al., 2016).

As a starting point, we selected several NDACC sites located in the Northern Hemisphere to investigate the relationship between OCS and CO_2. Figure 1 shows the FTIR measurements at Ny-Ålesund as an example. The measurements show a similar seasonal cycles between OCS and CO_2, with a ratio of the relative seasonal amplitudes of OCS:CO_2 of about six, which is in line with the in situ measurements (Montzka et al., 2007), and confirms the atmos-

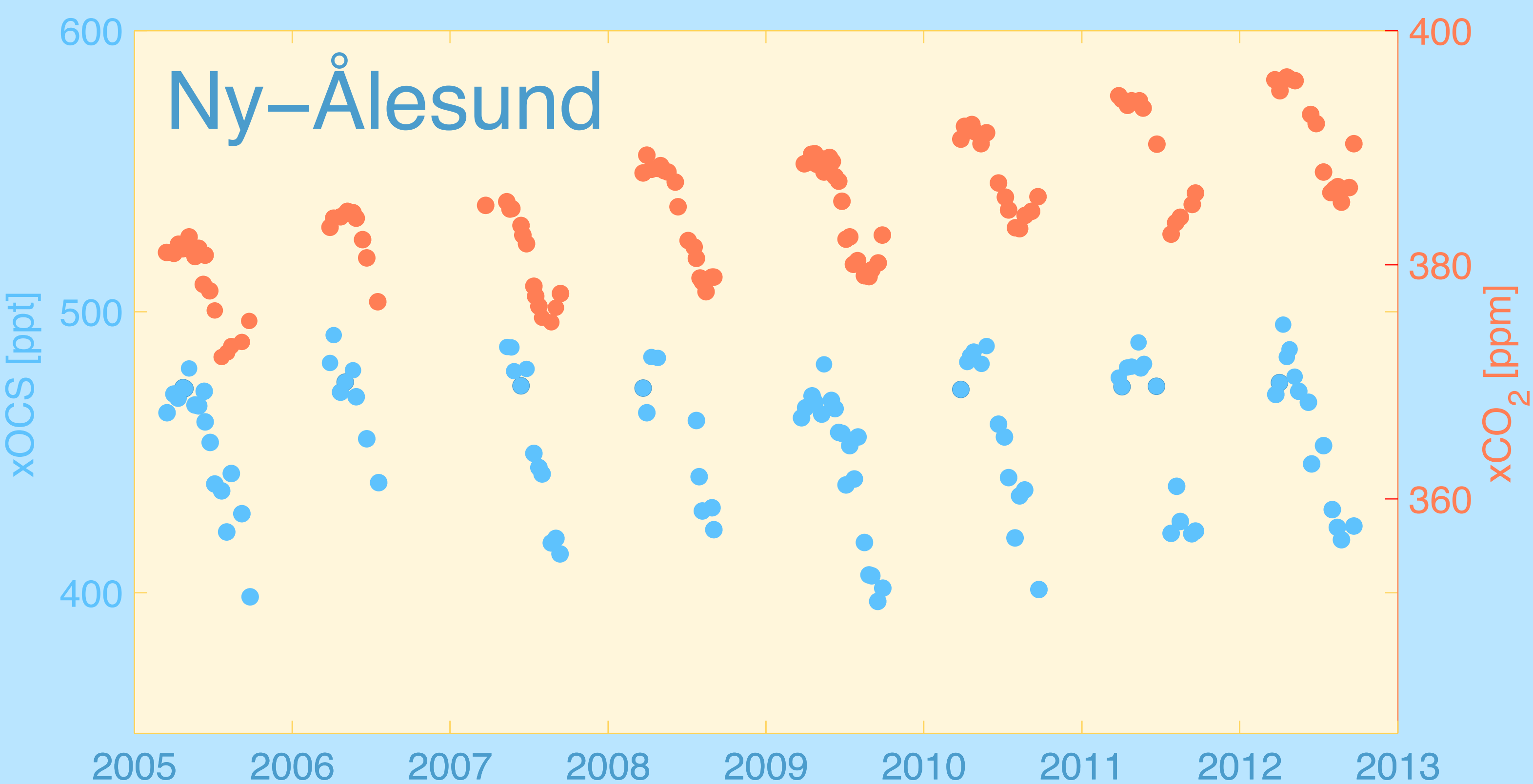

Figure 1. Weekly mean xOCS (blue dots) and xCO_2 (orange dots) retrieved from FTIR spectra at Ny-Ålesund.

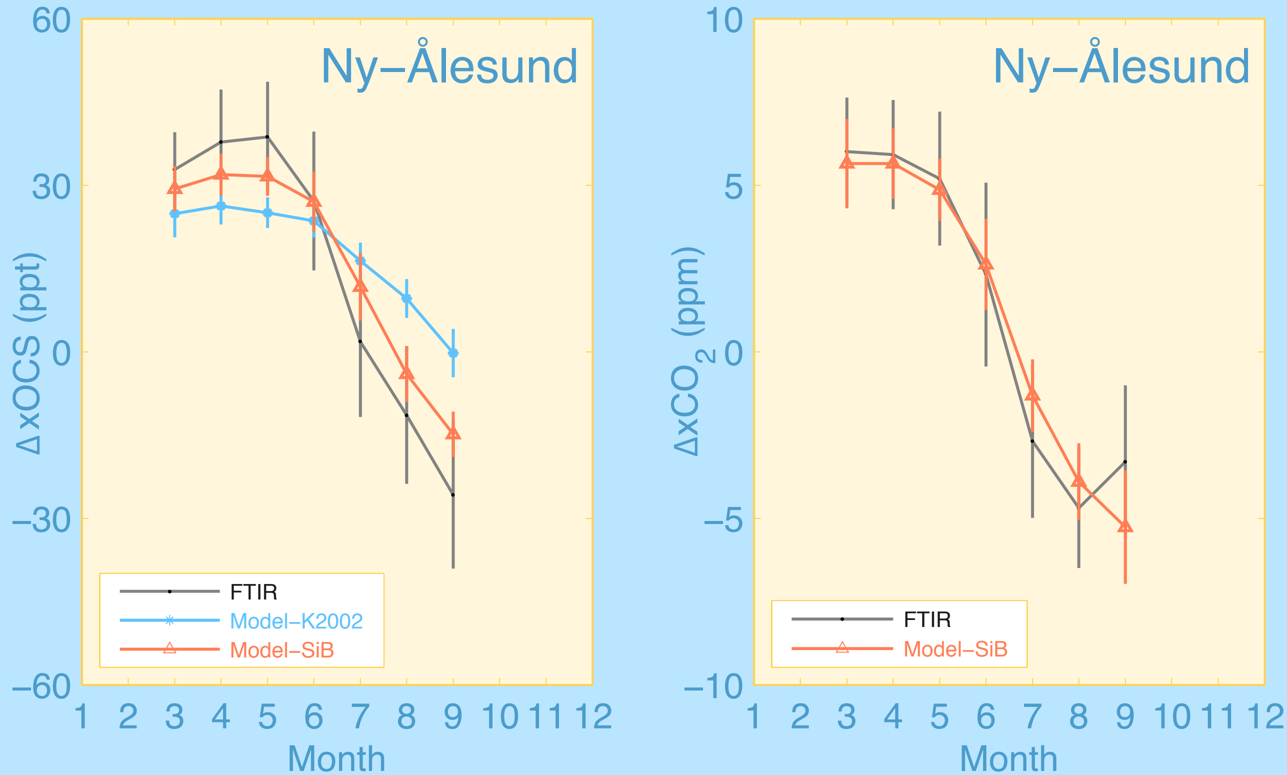

Figure 2. Comparison of FTIR measurements of OCS (left) and CO_2 (right) to model simulations at Ny-Ålesund. The dots are the monthly mean relative xOCS (relative to annual mean) and xCO_2 averaged for multiple years (2005-2012). The error bars are the standard deviations of each month. The FTIR retrievals are shown in black. The OCS simulations are driven by K2002 (blue), and SiB (magenta), respectively, and the CO_2 simulation is driven by SiB.

pheric relationship between OCS and CO_2.

We simulated OCS and CO_2 concentrations in the atmosphere using a chemical transport model (GEOS-Chem). The initial OCS simulation was based on a widely used flux inventory from Kettle et al. (2002) (referred to as K2002, blue line in Figure 2), which largely underestimated the seasonal amplitude at the measurement sites. We then used the coupled biospheric fluxes of OCS and CO_2 from the simple biosphere model (SiB) to simulate these two gases simultaneously (magenta lines in Figure 2) (Berry et al., 2013). The OCS simulation with SiB fluxes resulted in bigger seasonal amplitude than K2002, but still produced a weaker drawdown than FTIR measurements at selected sites; the CO_2 simulation agreed with the measurements well. The seasonal cycle of OCS is mainly influenced by the photosynthetic uptake, while the CO_2 seasonality results from the NEP, the sum of photosynthetic and respiration. Using OCS as a photosynthesis proxy, it indicates that the photosynthesis estimation in the Northern Hemisphere could be too low in SiB, while the net flux is reasonable. However, the relationship between OCS and CO_2 photosynthetic uptake in the model needs to be further verified.

This study shows the use of ground-based FTIR measurements in evaluating the sources and sinks of OCS and investigating the relationship between OCS and CO_2. This work will be further extended to more NDACC sites. Together with TCCON, the FTIR networks will provide an additional database for using OCS to constrain photosynthesis.

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Altzomoni, the new tropical ground-based FTIR station in Mexico

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The Altzomoni mountain site in Central Mexico (19.12°N, 98.66°W) is a unique place for investigating a great variety of interesting atmospheric phenomena. At a distance of 60 km from Mexico City and at an altitude of nearly 4'000 m above the sea level, the station is located in a national park which surrounds the second and third highest peaks in Mexico: the Popocatépetl and Iztaccíhuatl volcanoes. The altitude of this research facility, now the highest NDACC station operating a ground-based high resolution FTIR spectrometer, benefits from low interferences despite being near highly urbanized and industrial centers.

The Altzomoni Atmospheric Observatory was established in 2011 by the Group of Spectroscopy and Remote Sensing working at the Center of Atmospheric Sciences of Mexico's National Autonomous University (UNAM), although several measurements have been carried out there in previous years on a campaign basis (Grutter et al. 2008, Baumgardner et al. 2009). The group has ample experience in applying remote sensing methods, in particular using FTIR and UV/visible spectrometers to study the composition of the atmosphere. Since 2007, solar absorption FTIR measurements have been recorded in Mexico City, at the UNAM campus, with moderate spectral resolution (Stremme 2009, Bezanilla 2014). This group has also developed instrumentation and is currently operating a network of four MAX-DOAS instruments in Mexico City (Arellano et al. 2016).

In 2009, the Karlsruhe Institute of Technology (KIT) started a collaboration with UNAM and acquired one year later a used high-resolution FTIR spectrometer from Deutsche Luft und Raumfahrt. Its electronics and interface were updated, mounted in a temperature stabilized container, coupled to a solar-tracking system developed by KIT (Gisi et al, 2011) and shipped to Mexico. In March 2012, the container was placed in Altzomoni and after a couple of months the FTIR instrument (Bruker IFS 120/5 HR) began operations. The measurements and retrievals are performed by the UNAM group, using the retrieval code PROFFIT (Hase et, 2004), in close cooperation with the KIT colleagues. The recorded spectra, analysis routines and results were evaluated by the IRWG, and the NDACC certification was finally achieved in 2015. There are

Figure 1. The Altzomoni Atmospheric Observatory, Mexico.

now several studies going on using data taken from Altzomoni in which several undergraduate and graduate students from UNAM are involved.

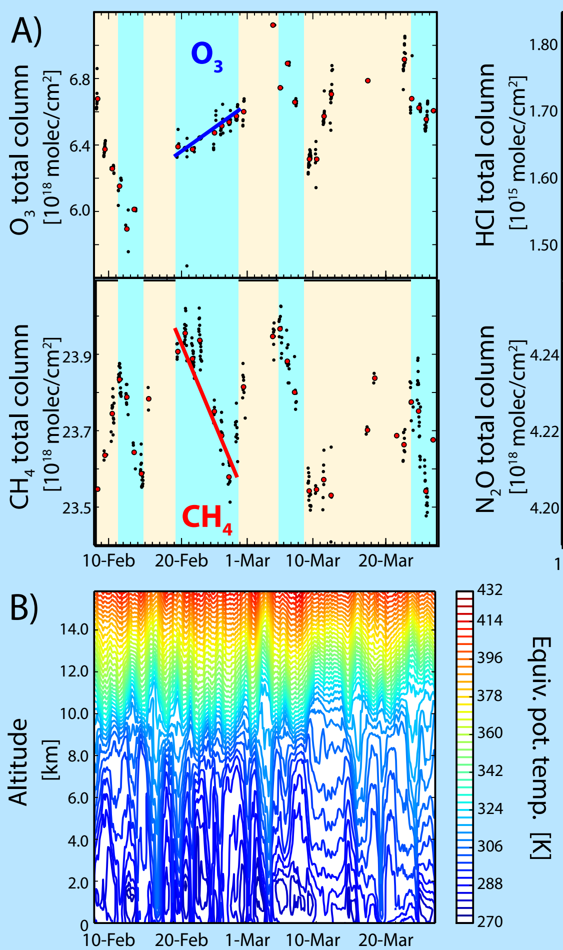

Figure 2. A) Time series of O_3, HCl, CH_4 and N_2O total columns measured in Altzomoni between February 8th to March 27th of 2013. B) Equivalent potential temperature (coloured contours) as a function of height for the two months in question. Areas in light blue depict periods in which air from the stratosphere is mixing with lower altitudes.

Downmixing of stratospheric air

Being inside the tropics at 19°N, the station offers the opportunity not only to contribute to the scarce information available for the annual variability, trends and vertical distribution of important gases at these latitudes, but also to study the exchange processes between the stratosphere and the troposphere. An example of a two-month time series during the spring of 2013 is shown in Figure 2.

Short-term variability of ozone and HCl, which are predominately stratospheric, show a distinct anti-correlation with other typical tropospheric gases such as CH_4 and N_2O. This can clearly be seen in the areas shaded in light blue of Figure 2. The potential temperature plot shows that this is a period of strong instability and that the Tropical Tropospause Layer (TTL) is frequently breaking, allowing an exchange into lower altitudes. These types of events will be analysed further and could contribute to our general understanding of the dynamics of the TTL and its impact on future stratospheric ozone and climate.

Transport of air pollution

Even though Altzomoni lies in the free troposphere most of the time, the regional boundary layer is known to have a strong diurnal variability reaching 2 km or higher over Mexico City, which is well above the height of the station (Stremme et al. 2009). A large suite of in situ

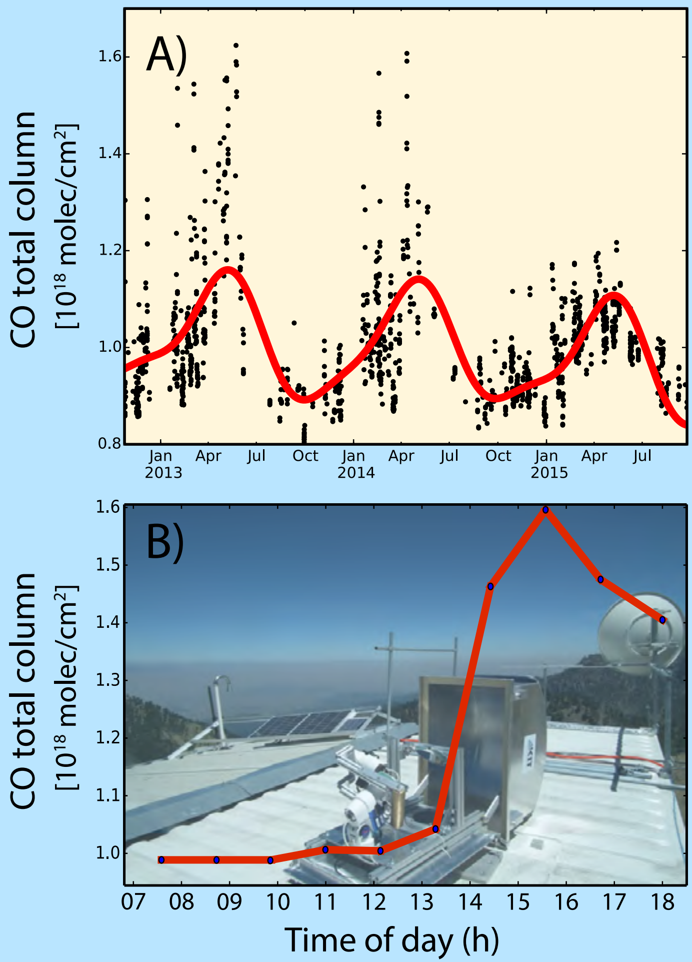

Figure 3. Carbon monoxide total column amounts measured from Altzomoni shown as A) a 3-year time series with an annual cycle dominated by biomass burning and urban sources. B) Example of day (Feb 17, 2014) with high CO column increase detected as the regional mixing layer grows in the afternoon. A picture of the solar tracker and the polluted regional boundary layer is also shown.

instrumentation has been installed at Altzomoni mainly through its incorporation in RUOA (www.ruoa.unam.mx) in 2013 in collaboration with Mexico City's Ministry of the Environment. This is a nationwide multi-institutional network of atmospheric observatories measuring surface concentrations of the common reactive gases (O_3, NO_x, SO_2, CO), greenhouse gases (CO_2, CH_4), particulate matter (PM2.5, black carbon) and meteorological parameters. The influence of the boundary layer can be detected at Altzomoni during the afternoon allowing the study of typical transport patterns from the adjacent basins and in the broader regional scale. The impact of carbon monoxide (CO) in this high altitude station from both biomass burning and the adjacent urban areas can be appreciated in Figure 3.

Volcanic gases

The Altzomoni site has served as host for several remote sensing instruments to study the chemical composition of the volcanic plume as well as its dispersion dynamics from sensors with imaging capabilities. The Popocatépetl, an active passive degassing volcano with frequent eruptive events, has its crater only 12 km away from the observation site. A scanning DOAS instrument has been deployed to retrieve SO_2 emission fluxes and an instrument with a 2-D scanning mirror is used for the visualization of the plume. A thermal emission FTIR spectrometer has also been used to record the variability of the column integrated amount of certain gas pairs, but also to visualize the plume in 2-D with a fast scanning mirror (Stremme et al. 2012).

More recently, the solar absorption spectra measured with the high resolution FTIR spectrometer has been analysed from which important gases of volcanic origin, such as HF, SiF_4, HCl and SO_2, can be detected. An example of an HCl absorption line contaminated with volcanic gas is shown in Figure 4. For all the stratospheric species reported in the NDACC archive, the spectra in

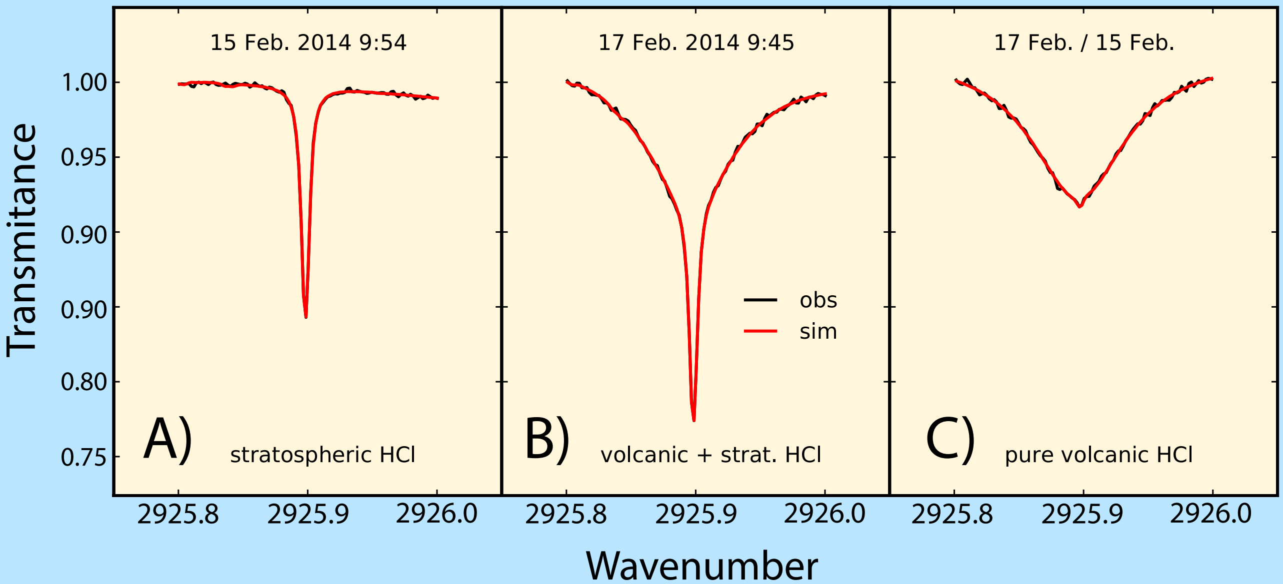

Figure 4. Absorption line of HCl measured with the FTIR (HR 120/R) spectrometer using the sun as radiation source. The shape of the line shows a) distinct contributions from the stratospheric abundance of this gas (narrow, doppler-broadened line) and b) the pressure-broadened tropospheric HCl from the volcano. The Lorentz-type spectral line feature in c) results from the ratio of b/a and represents the tropospheric contribution of HCl coming from the volcano.

which tropospheric HCl is detected are filtered out. The pressure-broadened absorption line in Figure 4b indicates the presence of HCl from the volcano and this is confirmed by the detection of an enhanced SO_2 column amount retrieved from the same spectrum. The Altzomoni site thus offers the unique opportunity not only to study a large variety of atmospheric-related phenomena, but also to detect changes in the composition of a volcanic plume that are related to its magmatic and eruptive activity.

The NDACC IRWG Meeting in 2018

Between the 11th and the 15th of June, UNAM hosted the 2018 NDACC IRWG and TCCON Annual Meeting at the Hotel Hacienda Cocoyoc in Cuautla, Mexico. With 63 participants representing 14 different countries, this successful meeting concluded with an excursion which included a visit to the Altzomoni Atmospheric Observatory. Information and photographs can be consulted at the following URL: https://sites.google.com/site/irwgtccon2018/

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News from the Lidar Working Group

Photo: The water vapour lidar at Maïdo (Reunion Island) in operation.
Photo taken by Jean-François Mariscal, LATMOS/CNRS, Guyancourt, France.

May 2018 Joint TOLNet and NDACC Lidar Working Group Meeting in Huntsville, AL

Kristen Pozsonyi [1], Michael J. Newchurch [1], Thierry Leblanc [2] and Wolfgang Steinbrecht [3]

[1] University of Alabama, Huntsville, AL, USA

[2] Jet Propulsion Laboratory, California Institute of Technology, Wrightwood, CA, USA

[3] Deutscher Wetterdienst, Hohenpeissenberg, Germany

The (North American) Tropospheric Ozone Lidar Network (TOLNet) and the (global) Network for the Detection of Atmospheric Composition Change's (NDACC) Lidar Working Group (LWG) held a joint meeting from 7-11 May 2018 in Huntsville, AL on the University of Alabama in Huntsville (UAH) campus. These networks share the focus of using lidar to provide high-resolution profile observations of temperature, trace gases and aerosols in the troposphere and stratosphere. These observations are necessary in research areas of air quality, long-term trends, atmospheric composition, satellite validation, and numerous other scientific applications. Dr. Michael J. Newchurch, an Atmospheric Chemistry professor in the Atmospheric Science Department at UAH and the TOLNet PI, hosted the meeting in coordination with the NDACC Lidar Working Group Co-Chairs, Dr. Thierry Leblanc and Dr. Wolfgang Steinbrecht.

Monday and the first half of Tuesday consisted of TOLNet-specific sessions, beginning with brief status reports on each of the seven stations. The status reports highlighted science activity, system updates, and publications occurring since the last TOLNet meeting, as well as future plans for each site moving forward. The following scientific sessions included topics such as using lidar network observations to help satellites better understand tropospheric ozone, campaign results (CABOTS, FAST-LVOS, SCOOP, OWLETS), horizontal lidar measurements, and an autonomous lidar system. Attendees heard from Barry Lefer and Jack Kaye (both NASA/HQ), the TOLNet sponsors. Both Dr. Lefer and Dr. Kaye acknowledged TOLNet's important role in validating NASA's future geostationary satellite (TEMPO) observations in the lower troposphere and in many tropospheric process studies. They both praised the current work coming from TOLNet, and encouraged continued cooperation with other ground-based networks. These sessions sparked important conversations on mechanisms for collaboration both within TOLNet and with other networks.

The joint TOLNet/NDACC sessions held Tuesday afternoon and all-day Wednesday provided an opportunity for members of both networks to discuss common objectives and accomplishments, and to present scientific and technical results on topics relevant to both groups. These joint sessions were the most beneficial and productive days of the meeting. Commonality already exists between the networks, including current interests in satellite validation, theory and analysis, instrument accuracy assessment, and potential future shared interests in Stratosphere-Troposphere exchange, boundary-layer studies, climate and air-quality observations, and mobile lidar systems. Moving forward, especially toward topics of mutual interest, it makes sense to strive for synergy rather than competition between networks.

Sessions on Wednesday comprised mostly upper troposphere lower stratosphere (UTLS) talks with a heavy focus on the NDACC LWG. NDACC lidar data user and meeting guest Mike Fromm (Naval Research Laboratory) focused on aerosols, emphasizing characteristics of the plumes from the "Mother of all PyroCbs" that occurred in British Columbia in August 2017, while Sergey Khaykin reviewed more than 20 years of past achievements in characterizing stratospheric aerosol long-term trends and variability. NDACC Theory and Analysis Working Group Representative Susan Strahan reviewed the numerous synergical aspects of using NDACC observations together with re-analysis and/or chemistry-transport models (e.g., MERRA-2) to address core science issues relevant to NDACC and TOLNet. A day filled with interesting science talks was topped off with a summary of the 2018 WMO Stratospheric Ozone Assessment Report by Wolfgang Steinbrecht (German Weather Service), and Tropospheric Ozone Assessment Report (TOAR) by Audrey Gaudel (NOAA-CIRES), which led to discussions on the challenges and successes of inferring trends in the UTLS. Both TOLNet and NDACC ozone lidars can observe and monitor stratospheric intrusions (see example in figure 1) and therefore contribute to understanding their role in the tropospheric ozone budget and UTLS ozone variability and trends.

After the afternoon sessions concluded, meeting attendees toured the Space and Rocket Center, a unique facility located in Huntsville that serves as the official visitor center for NASA Marshall Space Flight Center. Attendees were able to tour part of the museum, including an authentic Saturn V rocket (see figure 2) and many other hardware items of the manned space-flight program, enjoy a delicious meal, as well as have some fun riding the Space Shot, a rocket-themed ride that launches riders 140-feet straight up, allowing them to experience 4 G's of force on launch!

During the final two days of the meeting, NDACC-specific sessions reported activities from the 23 NDACC lidar stations highlighting the current status of each station, including operations and data availability, as well as future plans. The science talks on Friday included a diverse group of speakers; from a summary of the Eureka ozone DIAL by Alexey Tikhomirov (Dalhousie University), to Susan Kizer and Travis Knepp (Science Systems and Applications, Inc. (SSAI)), both data users who take advantage of NDACC data

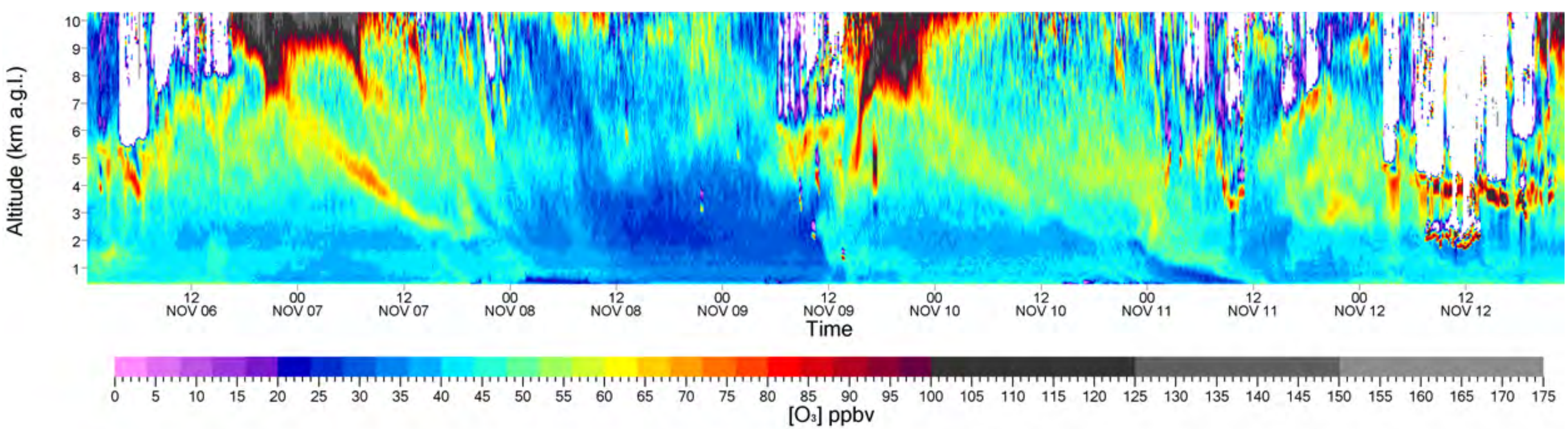

Figure 1: 7-day time-altitude cross-section of tropospheric and lower stratospheric ozone as measured in November 2016 in the Canadian Oil Sands Region by the TOLNet lidar AMOLITE. Note the occurrence of two stratospheric intrusions within a 2-day interval (adapted from figure 9 of Strawbridge et al., 2018).

for SAGE III satellite validation. It is clear that the work being done by NDACC's LWG is valuable to a large portion of this community.

The meeting clearly showed that the NDACC and TOLNet lidar networks are complementary and synergistic and that all involved scientists benefit from increased collaboration of both networks. Currently, TOLNet focuses on air quality, whereas NDACC has a broader focus, including stratospheric changes and satellite validation. Both networks, however, share common interests, and both are striving to provide long-term atmospheric composition records with rigorously defined precision, accuracy, and resolution. Both networks face challenges in routine operations, and in processing and sharing data on a timely basis. The joint NDACC and TOLNET meeting emphasized that the focus for the newer generation of scientists has moved to the use of lidars for process understanding, and away from lidar hardware and technology, which have matured substantially. The meeting provided an excellent forum for both TOLNET and NDACC to share the science that is driving these two different networks.

For more information on this meeting, including links to all the presentations, please visit the meeting website (https://www.nsstc.uah.edu/TOLNet_NDACC/).

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Meeting attendees visiting the Saturn V moon rocket hall at the Davidson Space and Rocket Center in Huntsville.

Report from the NDACC Data Host Facility

Jeannette Wild and Roger Lin, National Oceanic and Atmospheric Administration National Center for Environmental Prediction (NOAA/NCEP), Camp Springs, MD, USA

Data Submissions

The number of data files stored in the NDACC Data Host Facility (DHF) continues to increase at an appreciable rate. Figure 1 shows the total number of files stored in the DHF and Figure 2 shows the number of new files submitted every year.

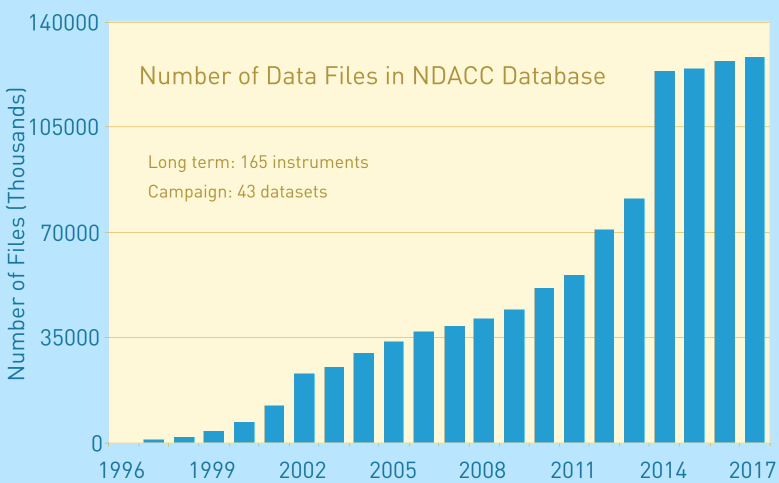

Figure 1: Number of data files stored in the NDACC Data Host Facility. The rapid increase from 2013 to 2014 is related to the transition to HDF files. When data is stored in HDF format, the data becomes more granulated, and the number of files increases.

Data availability

The NDACC web page, http://www.ndacc.org, has several visualisations of the contents of the NDACC database: The NDACC Observational Capabilities Chart (available here) depicts a high-level overview of NDACC's core measurements; the Measurements and

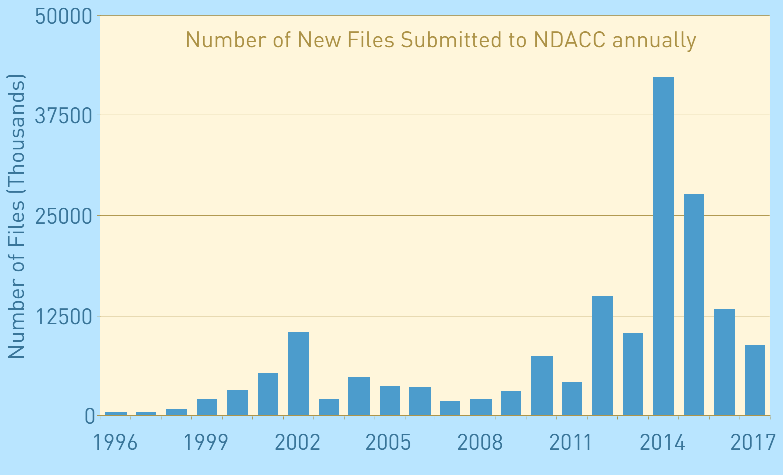

Figure 2: Number of new data files submitted to the NDACC Data Host Facility annually. The large number of files submitted in 2014 is related to the transition to HDF files. When data is stored in HDF format, the data becomes more granulated, and the number of files increases.

Analyses Directory (click here) gives a listing and short description of the instruments. The number of files transferred from the NDACC Data Host Facility is on the order of tens of thousands of files per month. The statistics for the last eleven years is shown in Figure 3.

Rapid Delivery Data

Several groups (especially in the context of NORS) submit rapid delivery data to the NDACC database. These are available within a month or two of measurement, and may be revised before submission into the standard, fully verified NDACC catalogue. These data are available in the public FTP area at ftp://ftp.cpc.ncep.noaa.gov/ndacc/RD.

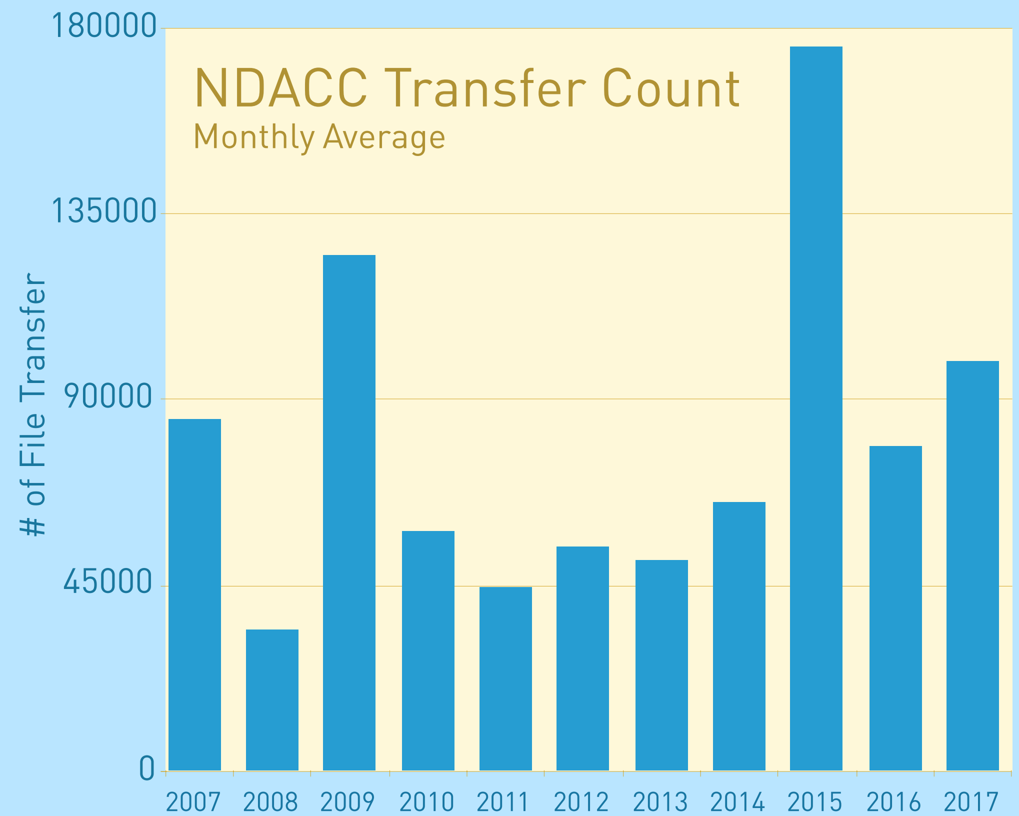

Figure 3: Number of files transferred per month from the NDACC Data Host Facility. The counting is done from one Steering Committee meeting to the next, so the averaging period might not always cover exactly 12 months.

Station Highlights

The Boulder Observatory

Irina Petropavlovskikh
NOAA ESRL Global Monitoring Division
Boulder, Colorado, USA

The NDACC Newsletter traditionally publishes a summary of the stations visited by the NDACC Steering Committee. In 2017 the meeting took place at Boulder, CO, and the group was welcomed by Jim Hannigan at the historical NCAR Table Mesa building (cf. meeting report on pages 41-43). There are several NDACC data collection locations near Boulder. The long-term ozonesonde observations at the Marshall Field site started 50 years ago in 1967. The ozonesondes continue to be launched on the weather balloon weekly. The remote signal from the radiosonde system produces record of the vertical ozone profiles with 1-second resolution, along with temperature and humidity information collected on the way up and down after the balloon burst at 30-39 km altitude. In addition to the ozonesonde the frost point hygrometer is flown once a month (see Photo 1). The Boulder dataset is one of the longest stratospheric water vapour (began in 1980) records available from the balloon-borne system. NOAA Global Monitoring Division that takes care of the Dobson facility in Boulder also monitors measurements of radiation, aerosol, carbons, halocarbons and other atmospheric composition parameters. The flasks are filled with clean air at many locations around the world. The flask are sent to the NOAA lab for analyses of changes in the carbon cycle, atmospheric composition and emissions of halocarbons and other green-house gases. The flasks are filled with clean air at the Niwot Ridge station, part of the Mountain Research Station (MRS) of the Institute of Arctic and Alpine Research (INSTAAR) at CU Boulder. The Mountain Research Station is located 26 miles west of Boulder, Colorado, just off the Peak to Peak Highway (highway 72), between Nederland

Photo 1. Launching a frost point hygrometer sonde from the Marshall Field site outside Boulder.

and Ward. The main facility, which was founded in 1921 as an interdisciplinary facility of CU, is located at 2900 m altitude (9500 feet) in the Front Range of the Colorado Rocky Mountains. The Tundra station, which was built in 1990, is located at 3500 m altitude.

The Marshall Field site is located near Boulder, Colorado and is operated by the National Center for Atmospheric Research (NCAR). PIs of several NDACC instruments located in the Boulder area work at NCAR, the National Oceanic and Atmospheric Administration (NOAA), and the Cooperative Institute for Research in Environmental Sciences of the University of Colorado. The NOAA building hosts the WMO GAW Dobson Central calibration facility that is located at 39.9910° North, 105.2607° West, at an elevation of 1628.00 masl, and the Local Standard Time set at UTC-7.0 hours (Photo 2). The regional standard Dobson calibrations are organized in Boulder. The WMO/GAW standard Dobson #83 resides in Boulder. It is calibrated every other year at the NOAA observatory at Mauna Loa, Hawaii. The Dobson total column ozone record began at the Boulder station in 1966.

At the end of the NDACC Steering Committee meeting the site visit was organized by Jim Hannigan of NCAR at the Research Aviation Facility (RAF) located at the Rocky Mountain Metropolitan Airport (KBJC, formerly Jefferson County Airport, [JeffCo]), 12 miles north of Boulder. The NDACC group was given a tour of NSF/NCAR HIAPER aircraft (Photos 3 and 4, next page) that carries a variety of remote sensing instruments, including optical particle probes, active and passive remote sensors and in situ sensors, canister-mounted sensors, hemispheric radiometers and other research instruments.

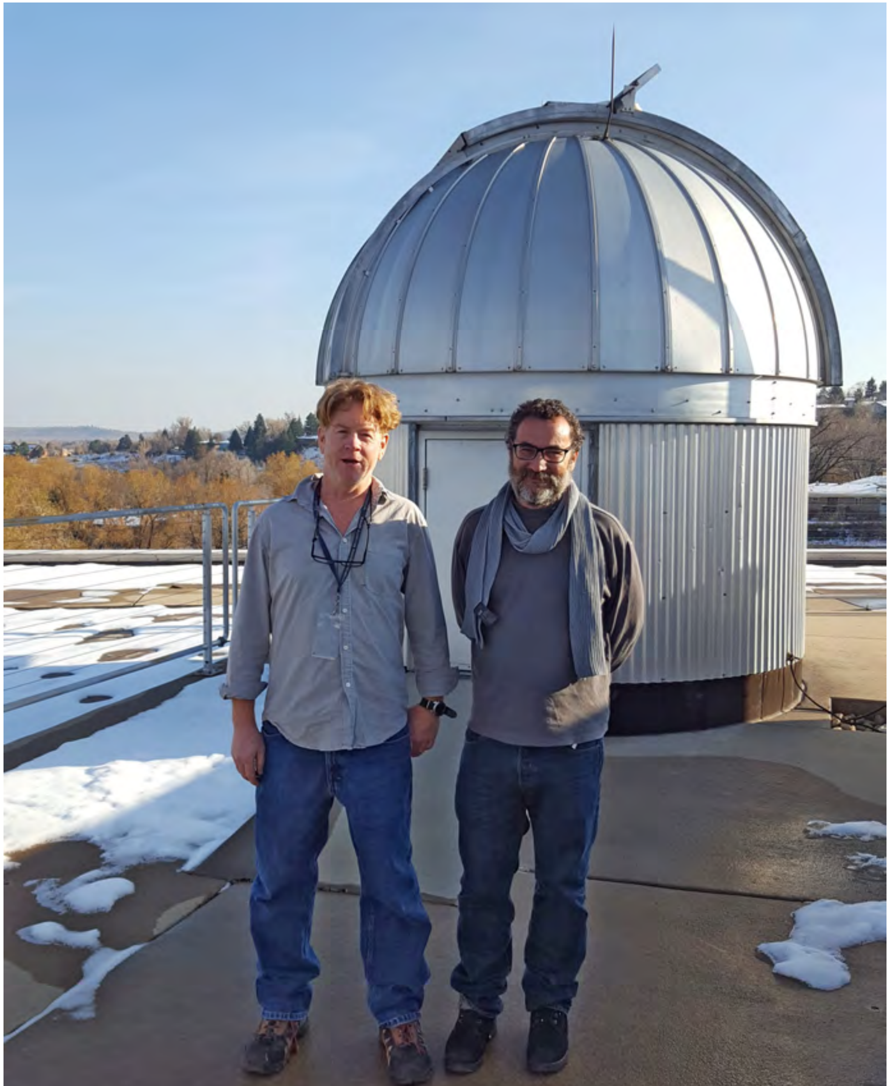

Photo 2. Glen McConville and Alberto Redondas in front of the Dobson observatory dome at NOAA in Boulder.

Photo 3. The HIAPER aircraft.

Photo 4. Jean-Pierre Pommereau, Gerald Nedoluha and Ken Jucks listen attentively to a presentation of the instrumentation on board the HIAPER aircraft.

Celebrating more than 50 years of routine ozone measurements at Hohenpeissenberg

Wolfgang Steinbrecht[1] and Geir Braathen[2]

[1]Deutscher Wetterdienst, Hohenpeissenberg, Germany

[2] World Meteorological Organization, Geneva, Switzerland

On November 2nd 1966, the 09:13 UT launch of a Brewer-Mast Ozonesonde at Hohenpeissenberg marked the beginning of what was to become one of the world's longest high-quality ozone profile records, today combining more than 5700 successful ozone soundings. A twin-sounding launch from the late 1960s is shown in Photo 1. Early in 1968, the ozone profile soundings were complemented by total column measurements with Dobson Spectrometer #104. Since 1978, ozonesonde launch frequency was increased, from previously only one sonde per week to now two per week in summer and three per week in winter (November to April). The manual Dobson Spectrometer was supplemented by automatic Brewer Spectrometer #10 in 1984 and by Brewer #226 in 2014. In 1995, Dobson #64 was transferred from Potsdam to Hohenpeissenberg. This instrument serves as regional standard in the WMO Regional

Photo 1: Twin sonde launch at Hohenpeissenberg in the late 1960s.

Photo 2: The Hohenpeissenberg Observatory with its landmark tower.

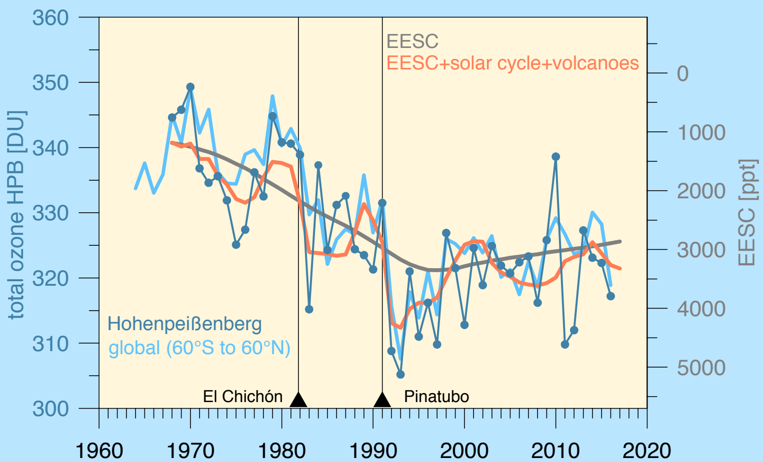

Figure 2: Time series of annual mean total ozone at Hohenpeissenberg (blue dots and lines) and near global mean (60°S to 60°N, cyan line, composited from global ground-based and satellite measurements and linearly scaled to match Hohenpeissenberg mean and variation). The grey line shows the long-term ozone decline and beginning increase attributed to EESC (equivalent effective stratospheric chlorine, released by man-made ozone depleting substances). The orange line shows the combined influence from EESC, the 11 year solar cycles, and major volcanic eruptions. Updated from Steinbrecht et al. 2011.

Dobson Calibration center for Europe (RDCC-E), an important task given to Hohenpeissenberg in 1999. For improved capabilities in the upper stratosphere, a differential absorption lidar was added in 1987, extending the measurement range for ozone and temperature profiles to 50 km altitude. A more powerful replacement lidar was installed in 2016 and has now taken over the routine measurements. Today these 50 years long ozone records document long-term changes in our atmosphere (e.g. Figure 2), and form an important part of both NDACC and WMO's Global Atmosphere Watch.

The 30th anniversary of the Montreal Protocol, celebrated by an International Symposium at the Fondation de Luca in Paris in September 2017 (http://www.montreal30.io3c.org/), gave an excellent opportunity to also meet at Hohenpeissenberg and commemorate 50 years of ozone measurements. About 50 national and international guests, many from the Paris Symposium, arrived in splendid fall weather at the Hohenpeissenberg Observatory for this celebration on September 22nd, 2017. Introductory speeches were given by the President of the German Weather Service (Prof. Dr. Adrian, Photo 3) and by local politicians (Photo 4). They were followed by science-oriented talks from national and international colleagues (e.g. Photos 5 and 6), focusing on long-time series, changes in climate and the ozone layer, and on contributions from Hohenpeissenberg. Program and presentations are available at https://www.dwd.de/EN/research/observing_atmosphere/composition_atmosphere/ozone/cont_nav/o3_50Years_node.html. Very special was the presence of three former directors of the Observatory (see Photo 7). Unfortunately, Dr. Attmannspacher, the director instru-

Photo 3: President of the German Weather Service, Prof. Dr. Gerhard Adrian.

Photo 4: Mayor of Hohenpeissenberg, Mr. Thomas Dorsch.

Photo 5: Dr. Irina Petropavlovskikh talks about NDACC and the importance of standards, calibrations and independent measurements.

Photo 6: Prof. Dr. Johannes Staehelin talks about the value of long-term measurements for ozone and climate research.

mental for the start of the ozone measurements in the late 1960s, passed away in 1991.

Speeches and celebrations were rounded off by the launch of an ozonesonde, successfully executed by Peter Braesicke (a modeller) and Irina Petropavlovskikh (see Photo 8). Of course there were food and drinks, and there was ample room for discussions and memories (see Photos 9 and 10).

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Photo 7: Four generations of Hohenpeissenberg Observatory directors. From left: Peter Winkler, director 1993 to 2005; Klaus Wege, director 1986 to 1993; Wolfgang Fricke, director 2006 to 2013; Christian Plass-Dülmer, director since 2014. Photo: Ulf Köhler.

Photo 8: Irina Petropavlovskikh and Peter Braesicke help to get the balloon up in the air.

Photo 9: Some of scientists taking part. From left: Wolfgang Steinbrecht, Christoph Brühl, Paul Newman, Gabrielle Stiller, Michael Kurylo and Martin Dameris. Photo: Ulf Köhler.

Photo 10: Peter Braesicke and Herman Oelhaf were among the participants.

Recent NDACC Steering Committee Meetings

The 2015 Steering Committee Meeting, La Jolla, California

The annual meeting of the international Steering Committee (SC) for NDACC was held from October 12 to 15 at the Scripps Institution of Oceanography in La Jolla, CA, a research site for the AGAGE Cooperating Network. A detailed report from the NDACC Data Host Facility (DHF) on data archiving status and data utilization was followed by reports from the various NDACC Instrument Working Group (WG) Representatives. As in the past, these reports highlighted WG activities and/or meetings during the past year, summarized NDACC measurement and analysis activities, described proposals (pending and received) seeking NDACC affiliation, and outlined possible new sites for consideration. Over the next several weeks, the WG Representatives will work with the DHF representative to bring any delinquent data archiving up to date.

The Scripps Forum, where the 2015 Steering Committee meeting was held.

Subsequent reports from representatives of the Satellite and Theory and Analysis working groups and from the NDACC Cooperating Networks focused on new activities and initiatives pertinent to NDACC interests and to possible future collaborations. In particular, the Theory and Analysis WG will be providing simulated data to begin the process of examining station variability and representativeness, thereby better informing network expansion priorities.

Representatives from the Water Vapour Theme Group summarized a first draft of an NDACC water vapour measurement strategy. While focusing initially on the use of frost point sondes (a recently accepted NDACC measurement capability), this strategy has expanded to include lidar, microwave, and FTIR measurement capabilities. A preliminary report from the Theme Group for Combining Trace Gas Data from NDACC and its Cooperating Networks was also presented. Both Theme Groups will continue their activities over the next year and report their progress at the next SC meeting.

A number of miscellaneous business discussions followed covering such items as NDACC involvement in various international projects, improved NDACC communications, future strategies and implementation, and the scheduling of future SC meetings. Following the close of the meeting, many SC members visited the JPL Table Mountain Observatory in Wrightwood, CA and the NASA Aircraft Facility in Palmdale, CA.

The 2016 Steering Committee Meeting, Bremen

The annual meeting of the international Steering Committee (SC) for NDACC was held from October 17 to 21 in Bremen, Germany at the University of Bremen Guesthouse 'Teerhof'. Justus Notholt of the University of Bremen hosted the meeting.

The meeting began with a detailed report from the NDACC Data Host Facility (DHF) on the status of data archiving and on data utilization. This was followed by reports from the NDACC Instrument Working Groups (IWGs). As in the past, these reports highlighted IWG activities and/or meetings during the past year, summarized NDACC measurement and analysis activities and recent accomplishments, reviewed the status of proposals (received and pending) seeking NDACC measurement affiliation, and outlined possible new sites for consideration. While there are some cases where data archiving is not up to date, these are becoming smaller in number due to the proactive involvement of the various IWG Co-Chairs and the DHF Manager in contacting the people responsible for data submission from the various sites and assisting them in resolving any issues associated with such submission. The IWG Co-Chairs will continue to work with the DHF representative to reduce even further the number of cases of delinquent data archiving.

The Satellite Working Group updated the current international satellite inventory for atmospheric observations and their current and future validation needs, and indicated how NDACC data could be made more valuable for such activities, especially in the light of upcoming geostationary satellites. The Theory and Analysis WG presentation included a summary of the data files recently generated using chemistry transport models and their use for bridging the irregular space and time sampling of ground-based measurements and the global perspective. In addition this WG described how NDACC column measurements could be used to assess the credibility of residual circulation trends in reanalysis products.

Participants at the 2015 Steering Committee meeting.

The NDACC Cooperating Network (CN) presentations focused on new CN activities and initiatives pertinent to NDACC interests and to possible future inter-network collaborations. The Water Vapour Measurement Strategy Theme Group provided an update on the strategy document, which includes lidar, microwave, and FTIR measurement capabilities as well as frost point sondes. The strategy document will be augmented with an appendix referring to results on past intercomparisons between measurement techniques. In particular the presentation stressed the importance of establishing realistic uncertainties in frost point data, data from the other NDACC water vapour instruments, and water vapour data from other networks. The Theme Group for Combining Trace Gas Data from NDACC and its Cooperating Networks presented a status report on Group's activity (its near term priorities and the scientists who will be participating).

Other presentations at the meeting included:

- A summary of the article "the Network for the Detection of Atmospheric Composition Change: 25 Years Old and Going Strong", which was the feature article in the September-October 2016 issue of NASA's Earth Observer Newsletter (see the associated Hot News item on this site),
- A report from the International Ozone Commission highlighting its objectives with an emphasis on the use of NDACC data in support of ozone science,
- An update on the Ozone Profile Trends activity under the Stratosphere-troposphere Processes And their Role in Climate (SPARC) project of the World Climate Research Programme,
- A report about the Tropospheric Ozone Assessment Report (TOAR),
- A summary of the findings from the SPARC Report (No. 7) on the "Mystery of Carbon Tetrachloride" and suggestions regarding the associated need for continuing atmospheric observations,
- A status update for the SPARC activity on Stratospheric Sulphur and Its Role in Climate (SSiRC), and
- Ongoing and upcoming projects funded by the EU or ESA that are supporting NDACC, such as GAIA-CLIM, QA4ECV, FRM4DOAS, FRM4GHG, CINDI-2 and the possible involvement of NDACC in the Year Of Polar Prediction (YOPP).

The SC was also treated to a number of excellent presentations on the research being conducted by local scientists and by SC members themselves.

A number of miscellaneous discussions followed covering such items as changes and improvements to the NDACC web site, NDACC involvement in and data availability for various international projects, including ACTRIS and the Copernicus Services, and NDACC communications (including an introductory paper for the inter-journal Special Issue commemorating NDACC's 25th year anniversary), future strategies and implementation, and updates to the various operational protocols for the network.

A visit to the ice-core laboratory at the Alfred Wegener Institute in Bremerhaven.

Following the close of the meeting, many SC members visited the Alfred Wegener Institute in Bremerhaven where they were given an overview of polar research and sea exploration activities and a tour of the ice laboratory. While in Bremerhaven they also had the opportunity to visit the Klimahaus (Climate House) and German Maritime Museums.

The 2017 Steering Committee Meeting, Boulder

The annual meeting of the international Steering Committee (SC) for NDACC was held 6-10 November 2017 in Boulder, CO, USA at the National Center for Atmospheric Research (NCAR). James Hannigan of NCAR hosted the meeting. Dr. James Hurrell, a climate scientist and Director of NCAR, welcomed the attendees and gave a brief introduction to the Center's facilities, mission, and associated programs in atmospheric and related sciences (cf. station report on pages 35-37).

Following a brief discussion of the agenda and recurring action items, the status of the appointments of Instrument Working Group (IWG) Representatives was reviewed, and the recommended renewals and elections by the IWGs were approved. A review of the status, departure, needed replacement, and possible addition of members of the SC followed. The imminent end of Dr. Anne Thompson's 3-year term as SC Co-Chair was noted, and the required election was conducted. Dr. Thompson's excellent performance over the past three years was acknowledged, and she was nominated and unanimously elected for a second term. Congratulations, Anne!

The review of the annual Instrument Report Form, required for submission by all NDACC Principal Investigators (PIs), led to some minor revisions for improved clarity and content. Detailed reports from each of the IWGs followed (Dobson/Brewer, Infrared, Lidar, Microwave, Sondes, Spectral UV, and UV/Vis.). These reports highlighted working group activities and/or meetings during the past year, summarized NDACC measurement and analysis activities and recent accomplishments, reviewed the status of proposals (received and pending) seeking NDACC measurement affiliation, and outlined possible new sites for consideration. The reports also reviewed the funding status of the various instruments and stations, and detailed the archiving status reported by the various PIs. The latter was later compared to that reported by the Manager of the NDACC Data Host Facility (DHF).

The Satellite Working Group report included a review of the WG objectives, a comprehensive update of satellite missions (current and planned), a discussion of the harmonization of calibration and validation and quality-assurance practices, and considerations of Network strategies for enhanced satellite validation and complementary science. The Theory and Analysis WG presentation included a summary of the model support that is being provided by this WG to the Instrument WGs. In particular, the availability of new GMI-MERRA2 station support files for various instruments, and the use of GMI-MERRA2 constituent variability simulations to reduce sampling bias in NDACC multi-decadal data sets, were highlighted.

Reports from seven of the NDACC Cooperating Networks followed (AERONET, AGAGE, BSRN, GRUAN, MPLNET, NOAA HATS, and SHADOZ), with a focus on current Network activities pertinent to NDACC interests, and possible future collaborations. The Water Vapour Theme Group report focused on frostpoint hygrometer calibration and validation and the documentation of uncertainties. The Theme Group on Cross-Network Data Integration reported that it has initiated a Chloromethanes Project that will focus on CH_3Cl, CH_2CCl_2, $CHCl_3$, and CCl_4 remote-sensing measurements from NDACC FTIRs and in situ measurements from AGAGE and NOAA HATS.

The report by the NDACC Data Host Facility (DHF) Manager summarized the archiving status of all NDACC-affiliated instruments, and provided the latest statistics on NDACC data acquisition and use. While there are some cases where data archiving is not up-to-date, these situations continue to become smaller in number due to the proactive involvement of the various IWG Co-Chairs and the DHF Manager in contacting the people responsible for data submission from the various sites, and assisting them in resolving any issues associated with such submission. The IWG Co-Chairs will continue to work with the DHF Manager to reduce even

The participants at the 2017 Steering Committee meeting in Boulder, Colorado.

further the number of cases of delinquent data archiving.

In an effort to enhance NDACC communications and public outreach, a new NDACC website was initiated over the past year, and its current and planned features were reviewed. A decision was made to reinstate a "Latest News" column (formerly "Hot News"), and to continue the publication of the NDACC Newsletter, but on a more frequent (annual) schedule. The NDACC Organisational and Observational Capabilities charts were updated. These will be included in a generic NDACC poster, into which the presenter can insert specific science results. The report on the multi-journal special issue commemorating 25 years of NDACC operations included a list of the 39 papers that have been submitted, including a comprehensive introductory paper on the history, status, and perspectives of the Network.

A special session was dedicated to European initiatives that promote and support NDACC activities in Europe. During that session, particular attention was given to the integration of NDACC into the ACTRIS Research Infrastructure that is being prepared, to the role of NDACC as a reference network in the Copernicus Atmospheric Monitoring Service and Climate Change Service, and to the EU H2020 GAIA-CLIM project. A demonstration of the outcomes of the GAIA-CLIM project was given to collect feedback from the NDACC SC members for making sure that the project results are representative of the expectations of the community dealing with non-satellite Essential Climate Variables observations.

The proposal to hold the 2018 SC meeting at the World Meteorological Organization (WMO) in Geneva from 10-14 September was accepted. The meeting likely will include a visit to the Payerne or Zimmerwald measurement site on 14 September.

The 2017 meeting closed with presentations by several NDACC SC members and invited guests highlighting the results from recent science studies, as well as international agency activities and projects.

Following the meeting, many SC members visited the NCAR Research Aircraft Facility where they were given an overview of NCAR's airborne science capabilities (utilizing a C-130 and Gulfstream V) and instrument development activities. A tour of the Gulfstream V followed.

Upcoming NDACC Steering Committee Meetings

The 2018 NDACC Steering Committee meeting took place from 10 - 14 September 2018 in Geneva, Switzerland. A report will be included in the next issue of the Newsletter.

The 2019 NDACC Steering Committee meeting will take place in Japan in October 2019.

About NDACC

The primary goal of the Network for the Detection of Atmosphere Composition Change (NDACC) is to obtain consistent, standardized, long-term measurements of atmospheric trace gases and chemical species, particles, physical parameters, and spectral UV radiation reaching the Earth's surface. Since its inception in 1991 as the Network for the Detection of Stratospheric Change (NDSC), the network focus has expanded considerably. NDACC remains committed to making observations through which changes in the physical and chemical state of the stratosphere can be determined and understood, with an emphasis on the long-term evolution of the ozone layer (i.e., its decay, likely stabilization and expected recovery). However, its measurement and analysis priorities now encompass both the stratosphere and free troposphere in its exploration of the interface between changing atmospheric composition and climate. Thus, NDACC's broadened objectives are presently centred on the following priorities:

- Establishing long-term databases for detecting changes and trends in atmospheric composition, and understanding their impacts on the stratosphere and troposphere;
- Establishing scientific links and feedbacks between climate change and atmospheric composition;
- Calibrating and validating atmospheric measurements from other platforms (i.e., satellite, aircraft, and ground-based);
- Providing critical datasets that fill gaps in satellite observations;
- Providing collaborative support to scientific field campaigns and to other chemistry and climate observing networks; and
- Providing validation and development support for atmospheric models.

The primary instruments and measurements of NDACC 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)
- Tropospheric Ozone Lidars
- Temperature lidar (vertical temperature profiles 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)
- Dobson Spectrophotometers
- Brewer Spectrometers

Contacts

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