Understanding satellite, aircraft, balloon, and ground-based composition trends: Using dynamical coordinates for consistent analysis of UTLS composition

Abstract

The determination of atmospheric composition trends in the upper troposphere lower stratosphere (UTLS) is still highly uncertain. The project Observed Composition Trends And Variability in the UTLS (OCTAV-UTLS) will use different coordinate systems (for example, horizontal distance to the sub-tropical jet and vertical distance to the tropopause) to study the large spatial and temporal variability caused by competing transport, chemical, and mixing processes near the tropopause. The goal of this ISSI project is to combine satellite, aircraft, balloon and ground-based observations with meteorological reanalysis in a physical consistent way in order to understand the impact of the dynamical and/or chemical processes driving the natural variability on the observed UTLS trends by the different sensors on different platforms. Thus, the success of this project depends on the participation of several satellite, reanalysis and UTLS experts complemented by airborne, balloon-borne, and ground-based specialists to fully capture the UTLS complexities. This OCTAV-UTLS-ISSI proposal will focus mainly on reduction of ozone variability for the assessment of long-term changes in the UTLS leading to two publications and two publicly available datasets.

ISSI facilities provide an ideal place for the face-to-face discussions and collaborative work needed to study all the possible meteorological coordinate combinations for different satellite instruments as well as the complementary measurement techniques, to determine their intrinsic advantages and disadvantages when reducing and understanding the impact of natural ozone variability. The international team is well gender-balanced, with four women and five men, from four different countries.

Scientific rationale

Despite decades of space-borne, airborne, balloon-borne, and ground-based measurements, confidence in UTLS long-term composition ozone trends remain low [e.g., Steinbrecht et al. 2017, Ball et al 2019, SPARC/IO3C/GAW, 2019]. This limits our understanding of the radiative impact of this climate-relevant specie on the surface temperature and weather. Major obstacles to quantifying UTLS trends are the large dynamical variability of the tropopause region and upper tropospheric jets, and varying representativeness of measurements from platforms with diverse vertical/spatial sampling and resolutions.

Analyzing satellite data in conventional coordinates (e.g. pressure, latitude grids) does not account for the local and regional variability near the jets and tropopause. To increase confidence in UTLS composition trends, *we propose to analyze ozone measurements from the different platforms in consistent coordinate systems that account for the geophysical variability of the jets and tropopause*. The use of these well-suited coordinates will allow us to increase the homogeneity of the air masses sounded by the observation platforms, and thereby reduce noise owed to natural variability, thus reducing the uncertainty in the inferred UTLS composition trends. *Analysis of the satellite records will provide the global picture while airborne, balloon-borne, and ground-based measurements will complement it with localized but more detailed picture of the processes affecting UTLS composition.*

A key aspect of this analysis is using consistent meteorological information from modern reanalysis fields to derive, for all datasets, the same dynamical coordinates (e.g. jet or tropopause referenced), thus consistently accounting for the variability of the underlying dynamics. These coordinate variables are computed using the JEt and Tropopause Products for Analysis and Characterization (JETPAC) software. JETPAC is described in detail by Manney et al. 2011, 2014, 2017 and Manney and Hegglin, 2018. In short, JETPAC provides equivalent latitude, tropopause characterization, and jet identification consistently for the vastly different UTLS datasets. Figure 1 shows an example of ozone fields from the Microwave Limb Sounder (MLS) onboard the Aura satellite mapped into traditional (latitude versus altitude) and dynamical (latitude with respect to the subtropical jet versus altitude with respect to the 2PVU tropopause) coordinate systems. *This dynamical coordinate almost completely stratifies the ozone fields by separating the tropospheric and stratospheric air and by displaying the local impact of the subtropical jet*. This figure also shows ozonesonde and lidar measurements mapped into this dynamical coordinate. *This mapping expands the ozonesonde and lidar profile view by revealing its dynamical sampling*.

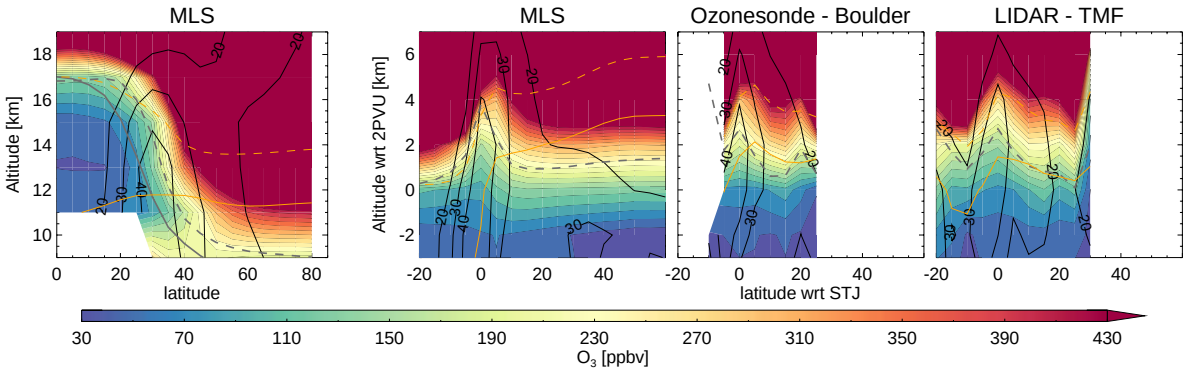

Figure 1: Ozone data for December-January-February (DJF) 2005-2018 using conventional coordinates (left panel) and dynamical coordinates (right panels) for MLS, ozonesonde in Boulder Colorado, and a lidar in Wrightwood California, with overlaid windspeeds from MERRA-2 interpolated to the measurement locations (black), 2PVU dynamical and WMO tropopauses (solid and dashed gray lines), and 345K and 380K potential temperature contours (solid and dashed orange lines).

The goal of this proposal is to analyze long-term ozone trends based on satellite observations in dynamical coordinates and compare them with trends from higher resolution but much sparser complementary datasets to identify and quantify long-term changes and their driving processes in the UTLS. This goal directly aligns with the goals of OCTAV-UTLS SPARC (Stratosphere-troposphere Processes And their Role in Climate) activity. This work also builds on several current and past SPARC activities, including the SPARC-Reanalysis Intercomparison Project (S-RIP), the SPARC Data Initiative, the SPARC Long-term Ozone Trends and Uncertainties in the Stratosphere (LOTUS), and on previous ISSI projects, including the international teams on Network for the Detection of Atmospheric Composition Change (NDACC) Standardized Lidar Algorithms and on the Atmospheric Trace Gas Data Set Inter-Comparison Project.

Expected outputs

We plan to produce at least two publications and two datasets. The *first publication* will explore which meteorological coordinate systems best reduces natural UTLS ozone variability, exploring for example transport and seasonal effects, and quantifying the impact of different sampling patterns from each instrument. We will use MLS, the Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS), and the Stratospheric Aerosol and Gas Experiment (SAGE II and SAGE III/ISS) data. These satellite datasets will be complemented by lidar, ozonesonde, and airborne measurements. These complementary measurements with sparse coverage but high temporal and spatial resolution will be used to validate the satellite datasets in a consistent meteorological framework and to study the impact of local small-scale processes on the natural variability in more detail. The *second publication* will use the meteorological coordinates that best reduce the impact of ozone variability to compute long-term trends. Trends will be computed using different methodologies (i.e. simple linear fits, multiple linear regression, and dynamical linear modelling) to maximize reduction of uncertainties. In the publication, a common trend methodology will be used for all platforms.

The datasets that will be made publicly available are:

- The JETPAC files (derived meteorological conditions, tropopause characterization, and jet identification) for the spaceborne, airborne, balloon-borne, and ground-based measurements. These files will be made publicly available by the owners of the original datasets.
- The ozone records, binned and remapped into different coordinate systems upon which the trend analysis is based.

ISSI support will be acknowledged in all publications and datasets.

Added value of ISSI for the implementation of the team activities

A consistent analysis in dynamical coordinates is complicated by the different observation geometries, vertical resolutions and sampling techniques, and thus requires using consistent coordinate systems across the different platforms. Given the large number of potential coordinate combinations, all of which affect the representation of ozone and hence the comparison across different platforms, direct interaction and real-time collaborative work on site among the platform experts is essential — the success of this project depends on bringing space-borne measurement experts together with ground-based, balloon-borne, and airborne measurement experts for brain-storming and hands-on testing of common coordinates that can benefit trend analyses for all or individual data records. *ISSI facilities and resources are ideally suited to encourage the face to face discussions and collaborative work on-site needed to find innovative ways to fully exploit the available UTLS datasets, to understand potential sampling biases, and to assess the implications for process-dependent analysis in the UTLS.*

Schedule of the project

The two meetings will last four days each. During the first meeting we will work on the first publication. Bin sizes and coordinate systems to test and compare datasets during this meeting have been pre-determined during a recent OCTAV-UTLS meeting. The first meeting will also be used to show preliminary results on trends analyses and to determine specifics of the analysis methods to be used in the second study. To keep up momentum, telecons will be organized quarterly to finalize the first paper and discuss advances, obstacles, or solutions as necessary for the trend analysis.

The second meeting will be planned for approximately 12 months later to exchange and discuss trend results and to outline the second manuscript. Completion of this manuscript will be ensured through post-meeting quarterly telecons and as part of the OCTAV-UTLS workshops.

List of confirmed International Team members

The team consists of members with leading expertise on the relevant measurements from all platforms, the JETPAC developers, and trend analysis experts to ensure that the data analysis generate the best available information on data quality and adequacy for future use in model/measurement inter-comparisons, instrument development, and trend analysis.

List of team members

- Harald Bönisch (IMK, regular commercial aircraft data)
- Michaela Hegglin (University of Reading, reanalysis, data analysis)
- Peter Hoor (Johannes Gutenberg University Mainz, research aircraft data)
- Daniel Kunkel (Johannes Gutenberg University Mainz, aircraft data)
- Thierry Leblanc (NASA JPL, lidar data / trend analysis)
- Gloria Manney (NWRA / NMT, reanalysis, satellite data / JETPAC)
- Luis Millán (NASA JPL, satellite data / JETPAC / team leader)
- Irina Petropavlovskikh (NOAA, Ozonesondes / trend analysis)
- Kaley Walker (University of Toronto, satellite data)

Facilities required

- Meeting room with projector (preferably with video conference capabilities)
- Wireless internet access
- White board

Financial support requested from ISSI

- Accommodation and per diem are requested for the 9 members for the two four-day meetings.
- Travel support for one of the team members.
- Early career scientist support as specified in the ISSI call for proposals.

References

Manney et al (2011) - Jet characterization in the upper troposphere/lower stratosphere (UTLS): applications to climatology and transport studies, doi: 10.5194/acp-11-6115-2011

Manney et al (2014) - Climatology of Upper Tropospheric–Lower Stratospheric (UTLS) Jets and Tropopauses in MERRA, doi: 10.1175/JCLI-D-13-00243.1

Manney et al (2017) - Reanalysis comparisons of upper tropospheric–lower stratospheric jets and multiple tropopauses, doi:10.5194/acp-17-11541-2017

Manney and Hegglin (2018) - Seasonal and Regional Variations of Long-Term Changes in Upper-Tropospheric Jets from Reanalyses, doi:10.1175/jcli-d-17-0303.1

Steinbrecht et al (2017) - An update on ozone profile trends for the period 2000 to 2016, doi: 10.5194/acp-17-10675-2017, 2017.

Ball et al (2019) - Stratospheric ozone trends for 1985–2018: sensitivity to recent large variability, doi:10.5194/acp-19-12731-2019.

SPARC/IO3C/GAW (2019) - SPARC/IO3C/GAW Report on Long-term Ozone Trends and Uncertainties in the Stratosphere, doi: 10.17874/f899e57a20b

Information of team members

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CVs of the Team Members

KUNKEL, Daniel

Affiliation: Institute for Atmospheric Physics
Johannes Gutenberg-University Mainz

Role in the project: Aircraft data / UTLS transport

Current position: Research scientist and junior lecturer (since 2017)

Former Position(s): Postdoctoral researcher, Johannes Gutenberg-University Mainz (2012-2017)
Research assistant, Max Planck-Institute for Chemistry (2009-2012)

Education: PhD (2013, JGU Mainz)
Diploma, Meteorology (2008, JGU Mainz)

Services in National and/or International Committees:
- Convener of EGU Session on "Dynamics and chemistry of the upper troposphere and stratosphere" (since 2020).
- Convener of EGU Session on "Atmospheric transport of trace species and aerosols: Modeling and observations" (since 2014).
- Co-Lead of the German research aircraft (HALO) mission WISE (Wave-driven isentropic transport, 2017)
- Organizer of the 2018 international SPARC-UTLS workshop in Mainz, Germany

Selected Publications:
2019 - Kunkel, D et al: Evidence of small-scale quasi-isentropic mixing in ridges of extratropical baroclinic waves, Atmos. Chem. Phys., 19, 12607–12630, https://doi.org/10.5194/acp-19-12607-2019.

2016 - Kunkel, D et al: The tropopause inversion layer in baroclinic life cycles experiments: the role of diabatic processes, Atmos. Chem. Phys., 16, 541-560, doi:10.5194/acp-16-541-2016.

2015 - Frey, W et al: The impact of overshooting deep convection on local transport and mixing in the tropical upper troposphere/lower stratosphere (UTLS), Atmos. Chem. Phys., 15, 6467–6486, https://doi.org/10.5194/acp-15-6467-2015.

2014 - Kunkel, D., Hoor, P., Wirth, V.: Can inertia-gravity waves persistently alter the tropopause inversion layer, Geoph. Res. Lett., 41, 7822-7829, doi:10.1002/2014GL061970, 2014.

2012 - Kunkel, D et al: Urban emission hot spots as sources for remote aerosol deposition, Geophys. Res. Lett., 39, L01808, doi:10.1029/2011GL049634

2010 - Borrmann, S., Kunkel, D., et al..: Aerosols in the tropical and subtropical UT/LS: in-situ measurements of submicron particle abundance and volatility, Atmos. Chem. Phys., 10, 5573-5592, doi:10.5194/acp-10-5573-2010.

BÖNISCH, Harald

Affiliation: Institute of Meteorology and Climate Research (IMK)
Atmospheric Trace Gases and Remote-Sensing (ASF)
Karlsruhe Institute of Technology (KIT)

Role in the project: Aircraft data / UTLS transport

Current position: Researcher and Co-Coordinator of CARIBIC (Civil Aircraft for the Regular Investigation of the atmosphere Based on an Instrument Container) (since 2016)

Former Position(s): PostDoc at KNMI (2006)
Junior (2007-09) and Senior Scientist (2010-2015) at University Frankfurt

Education: PhD Meteorology (2005, University Frankfurt)
Meteorology (1999-2001, University Frankfurt)
Physics (1994-1998, University Heidelberg)
TH (1991-1993, Karlsruhe)

Services in National and/or International Committees:
- Regular journal reviews
- SSC member of the SPARC activity OCTAV-UTLS
- Co-Author of SPARC Report N°6 (2013) Lifetimes of Stratospheric Ozone-Depleting Substances, Their Replacements, and Related Species
- Convener of EGU Session on “Dynamics and chemistry of the upper troposphere and stratosphere” (since 2010).

Selected Publications:

2019 - Keber, T et al: Bromine from short–lived source gases in the Northern Hemisphere UTLS, Atmos. Chem. Phys. Discuss., 2019, 1-36, 10.5194/acp-2019-796.

2011 - Birner, T. and Bönisch, H.: Residual circulation trajectories and transit times into the extratropical lowermost stratosphere, Atmos. Chem. Phys., 11, 817-827, 10.5194/acp-11-817-2011.

2011 - Bönisch, H. et al: On the structural changes in the Brewer-Dobson circulation after 2000, Atmos. Chem. Phys., 11, 3937-3948, 10.5194/acp-11-3937-2011.

2010 - Hoor, P., Wernli, H., Hegglin, M. I., and Bönisch, H.: Transport timescales and tracer properties in the extratropical UTLS, Atmos. Chem. Phys., 10, 7929-7944, 10.5194/acp-10-7929-2010.

2009 - Bönisch, H et al: Quantifying transport into the lowermost stratosphere using simultaneous in-situ measurements of SF6 and CO2, Atmos. Chem. Phys., 9, 5905-5919, 10.5194/acp-9-5905-2009.

HEGGLIN, Michaela

Affiliation: University of Reading

Role in the project: Reanalysis / data analysis / satellite

Current position: Associate Professor in Atmospheric Chemistry (2017)

Former Position(s): Lecturer in Atmospheric Chemistry (2015 – 2017, Reading University)
Senior Research Fellow (2012-2015, Reading University)
PDRA/Research Associate (2005-2012, Toronto University)

Education: PhD (2004, ETH Zurich)
M.Sc. Environmental Sciences - Dipl. Umwelt-Natw. ETH (2000, ETH Zurich)

Services in National and/or International Committees:
- Chair of Scientific Advisory Board for the Helmholtz Gesellschaft 'Earth and Environment' research programme (since 2019)
- Scientific Lead / Principal Investigator, ESA Water Vapour Climate Change I Initiative (since 2018)
- Editorial Board Member, Nature Scientific Reports (Impact factor: 4.3) (since 2017)
- Co-lead of SPARC Data Initiative (2009-2017)

Selected Publications:

2014 - Hegglin, M. I., et al., Variation of stratospheric water vapour trends with altitude from merged satellite data, Nature Geoscience, doi:10.1038/NGEO2236.

2013 - Hegglin, M. I., et al., SPARC Data Initiative: Comparison of water vapour climatologies from international limb satellite sounders, J. Geophys. Res., doi:10.1029/2013JD019614

2011 - Gettelman, A., P. Hoor, L. L. Pan, W. J. Randel, M. I. Hegglin, and T. Birner, The extra tropical upper troposphere and lower stratosphere, Rev. Geophys., doi:10.1029/2011RG000355.

2010 - Hegglin, M. I., et al., Multi-model assessment in the upper troposphere and lower stratosphere: Extra-tropics, J. Geophys. Res., 115, doi:10.1029/2010JD013884.

2009 - Hegglin, M. I., and T. G. Shepherd, Large climate-induced changes in UV index and stratosphere-to-troposphere ozone flux, Nature Geosci., 2, 687-691.

2009 - Hegglin, M. I., et al., A global view of the extratropical tropopause transition layer from Atmospheric Chemistry Experiment Fourier Transform Spectrometer O3, H2O, and CO, J. Geophys. Res., 114, D00B11, doi:10.1029/2008JD009984.

HOOR, Peter

Affiliation: Institute for Atmospheric Physics
Johannes Gutenberg University Mainz

Role in the project: Aircraft / co-lead of the SPARC OCTAV-UTLS initiative

Current position: Professor for meteorology and atmospheric science

Former Position(s): Project scientist: Max Planck Institute for Chemistry, Mainz, Germany
Research Fellow Institute for Atmospheric and climate science (IAC) ETH Zürich, Switzerland

Education: PhD at the Johannes Gutenberg (2000, University Mainz)

Services in National and/or International Committees:
- Co-Lead of the SPRAC (Stratosphere-troposphere processes and their role in climate initiative OCTAV-UTLS (Observed composition trends and variability in the UTLS)
- Co-Lead of the german research aircraft (HALO) missions WISE (wave-driven isentropic transport, 2017) and SOUTHTRAC (Transport and composition of the southern hemisphere, 2019)
- Organizer of the 2018 international SPARC-UTLS workshop in Mainz, Germany
- 2008-2018: European geophysical Union (EGU): session Co-lead of the UTLS session

Honors: Max Planck Medal of the Max Planck Society (2002)

Selected Publications:
2019 - Kunkel, D et al: Evidence of small-scale quasi-isentropic mixing in ridges of extratropical baroclinic waves, Atmos. Chem. Phys., 19, 12607–12630,doi:10.5194/acp-19-12607-2019.
2016 - Müller, S et al: Trace gas observations during TACTS over Europe 2012. *Atmos. Chem. Phys.*, 16(16), 10573–10589. doi:10.5194/acp-16-10573-2016
2014 - Riese, M et al: Gimballed Limb Observer for Radiance Imaging of the Atmosphere (GLORIA) scientific objectives, Atmos. Meas. Tech., 7, 1915–1928, doi:10.5194/amt-7-1915-2014.
2013 - Yoon, J. et al: Temporal change in averaging kernels as a source of uncertainty in trend estimates of carbon monoxide retrieved from MOPITT. *Atmos. Chem. Phys.*, 13(22), 11307–11316. doi:10.5194/acp-13-11307-2013
Gettelman, A. et al: The Extra Tropical Upper Troposphere and Lower Stratosphere. *Rev. Geophys.*, 49, RG3003, doi:10.1029/2011RG000355.
2010 - Hoor, P. et al: Transport timescales and tracer properties in the extratropical UTLS. *Atmos. Chem. Phys.*, 10, 7929-7944.
2007 - Strahan, S.E. et al: Observationally derived transport diagnostics for the lowermost stratosphere and their application to the GMI chemistry and transport model. *Atmos Chem Phys.*, 7, 2435-2445.
2004 - Hoor, P. et al:, Seasonality and extent of extratropical TST derived from in-situ CO measurements during SPURT. *Atmos. Chem. Phys.*, 4, 1427-1442.

LEBLANC, Thierry

Affiliation: California Institute of technology, Jet Propulsion Laboratory, Wrightwood, CA, USA

Role in the project: Lidar and trend analysis expert

Current position: Research Scientist; JPL Lidar Project Manager

Former Position(s): Postdoctoral Fellow at JPL

Education: PhD Atmospheric Physics, Université Pierre et Marie Curie (Paris 6), France

Services in National and/or International Committees:
- NDACC (Network for the Detection of Atmospheric Composition Change) Steering Committee Member, Lidar Representative
- Co-chair of the NDACC Lidar Working Group
- TOLNet Working Group Member
- GCOS Working Group on GRUAN (Member)
- Co-chair of the GRUAN (GCOS Reference Upper Air Network) Task Team on Ground-based Measurements
- JPL Laser Safety Officer for JPL - Table Mountain Facility

Honors: NASA Group Achievement Award (2019): TOLNet Lidars
ICLAS Award (2012): Best ILRC Conference Paper
NASA Group Achievement Award (2008): MOHAVE Campaigns
NASA Board Award (2007): New Calibration Method for Water Vapor Lidars

Selected Publications:

2019 - Chouza, F., Leblanc, T., Brewer, M., and Wang, P.: Upgrade and automation of the JPL Table Mountain Facility tropospheric ozone lidar (TMTOL) for near-ground ozone profiling and satellite validation, Atmos. Meas. Tech., 12, 569-583, 10.5194/amt-12-569-2019

2018 - Leblanc, T., et al.: Validation of the TOLNet lidars: the Southern California Ozone Observation Project (SCOOP), Atmos. Meas. Tech., 11, 6137-6162, 10.5194/amt-11-6137-2018

2016 - Leblanc, T., et al.: Proposed standardized definitions for vertical resolution and uncertainty in the NDACC lidar ozone and temperature algorithms – Part 2: Ozone DIAL uncertainty budget, Atmos. Meas. Tech., 9, 4051-4078, 10.5194/amt-9-4051-2016

MANNEY, Gloria

Affiliations: NorthWest Research Associates
New Mexico Institute of Mining and Technology

Role in the project: reanalysis fields / satellite data / JETPAC

Current position: NWRA Senior Research Scientist (since 2012)
NMT Adjunct Professor of Physics (since 2005)

Former Position(s): Scientist at JPL (1992 - 2012)

Education: PhD Atmospheric Physics (1988, Iowa State University)
B.S. Engineering Physics (1982, University of Kansas)

Services in National and/or International Committees:
- SPARC Reanalysis Intercomparison Project co-lead (since 2015)
- OCTAV-UTLS co-lead (2016–2018)
- International Ozone Commission (2004–2012)

Honors: 2015 Elected Fellow of American Meteorological Society
2012 NASA Exceptional Achievement Medal
2010 JPL & NASA Contributions and Inventions Board Awards – JETPAC
2007 JPL & NASA Contributions and Inventions Board Awards – "DMPs"
1995 Lew Allen Award for Excellence
1995 NASA Exceptional Achievement Medal

Selected Publications:

2018 - Manney, G.L., and M.I. Hegglin, Seasonal and regional variations in long-term changes in upper tropospheric jets from reanalyses, J. Clim., 31, 423–448, 2018.

2017 - Manney, G.L., et al., Reanalysis comparisons of upper tropospheric/lower stratospheric jets and multiple tropopauses, Atmos. Chem. Phys., 17, 11,541-11,566. 2017.

2015 – Schwartz, M.J, Manney, G.L., et al., Climatology of trace gases in midlatitude double-tropopause regions from MLS, HIRDLS and ACE-FTS measurements, J. Geophys. Res, 120, 843–867, 2015.

2014 - Manney, G.L., et al.: Climatology of upper tropospheric/lower stratospheric (UTLS) jets and tropopauses in MERRA, J. Clim., 27, 3248–3271.

2011 - Manney, G. L., et al.: Jet characterization in the upper troposphere/lower stratosphere (UTLS): Applications to climatology and transport studies, Atmos. Chem. Phys., 11, 6115–6137.

2007 - Manney, G. L., et al., Solar occultation satellite data and derived meteorological products: Sampling issues and comparisons with Aura MLS, J. Geophys. Res., 112, D24S50

MILLÁN, Luis

Affiliation: NASA Jet Propulsion Laboratory (JPL)

Role in the project: Team leader, satellite data / JETPAC

Current position: JPL scientist (since 2015)

Former Position(s): Postdoctoral scholar NASA JPL (2010- 2015)
Postdoctoral scholar Oxford University (2010)

Education: PhD Atmospheric Physics (2010, Oxford University, UK)
MSc Radioastronomy and space science (2005, Chalmers University, Sweden)
B.Sc. in Electronics and Communications, (2003, ITESM CCM, Mexico)

Services in National and/or International Committees:
OCTAV-UTLS co-lead

Honors: 2014 NASA Group Achievement Award for Aura MLS team
2013 JPL Research Poster Conference Award
2003 B.Sc. in Electronics and Communications with Honors

Selected Publications:

2018 - L. Millán et al: Characterizing Sampling and Quality Screening Biases in Infrared and Microwave Limb Sounding, Atmos. Chem. Phys., 18, 4187-4199, doi:10.5194/acp-18-4187-2018

2018 L. W. Thomason et al: A global, space-based stratospheric aerosol climatology: 1979 to 2016, Earth Syst. Sci. Data, doi:10.5194/essd-10-469-2018

2017 - G. Manney, et al: Reanalysis comparisons of upper tropospheric-lower stratospheric jets and multiple tropopauses, Atmos. Chem. Phys., 17, 11541-11566, doi:10.5194/acp-17-11541-2017

2017 - L. Millán and G. Manney: An assessment of ozone mini-hole representation in reanalyses over the Northern Hemisphere, Atmos. Chem. Phys., 17, 9277-9289, doi:10.5194/acp-17-9277-2017

2016 - L. Millán, et al: Case Studies of the Impact of Orbital Sampling on Stratospheric Trend Detection and Derivation of Tropical Vertical Velocities: Solar Occultation versus Limb Emission Sounding, Atmos. Chem. Phys., 16, 11521-11534, doi:10.5194/acp-16-11521-2016

2015 - L. Millán et al: Stratospheric and mesospheric HO2 observations from the EOS Microwave Limb Sounder, Atmos. Chem. Phys., 15, 2889–2902, doi:10.5194/acp-15-2889-2015

PETROPAVLOVSKIKH, Irina

Affiliation: Cooperative Institute for Research in Environmental Sciences

Role in the project: Ozonesonde and trend Analysis Expert

Current position: Senior Research Scientist at CIRES, University of Colorado, Boulder, Ozone and Water Vapor group lead for NOAA Global Monitoring Lab

Former Position(s): Research Scientist at CIRES; Graduate Fellow in the Advance Study Program, NCAR.

Education: Ph.D. in Physics, Free University of Brussels, Belgium

Services in National and/or International Committees:
- NDACC (Network for the Detection of Atmospheric Composition Change)
- Steering Committee Member, Dobson and Brewer Working Group Representative.
- Co-chair of the NDACC Dobson and Brewer Working Group.
- Secretary of the International Ozone Commission (IO3C) of the
- International Association of Meteorology and Atmospheric Sciences (IAMAS).

Honors: 2009 - NASA Group Achievement Award, "For outstanding achievements in atmospheric science during the Tropical Composition, Cloud and Climate Coupling (TC4) Mission in Costa Rica and Panama in 2007
2005 - Stratospheric Ozone Protection Award from the U.S. Environmental Protection Agency (EPA) for outstanding scientific contributions to stratospheric ozone protection

Selected Publications:

2019 - Bahramvash Shams, S., Walden, V. P., Petropavlovskikh, I., Tarasick, D., Kivi, R., Oltmans, S., Johnson, B., Cullis, P., Sterling, C. W., Thölix, L., and Errera, Q.: Variations in the vertical profile of ozone at four high-latitude Arctic sites from 2005 to 2017, Atmos. Chem. Phys., 19, 9733–9751, https://doi.org/10.5194/acp-19-9733-2019.

2019 - Minschwaner, K., Giljum, A. T., Manney, G. L., Petropavlovskikh, I., Johnson, B. J., and Jordan, A. F.: Detection and classification of laminae in balloon-borne ozonesonde profiles: application to the long-term record from Boulder, Colorado, Atmos. Chem. Phys., 19, 1853-1865, doi:10.5194/acp-19-1853-2019

2018 - I. Petropavlovskikh, S. Godin-Beekmann, D. Hubert, R. Damadeo, B. Hassler, and V. Sofieva (Eds.), SPARC Report No. 9, WCRP-17/2018, GAW Report No. 241, doi: 10.17874/f899e57a20b, available at www.sparc-climate.org/publications/sparc-reports

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Services in National and/or International Committees:

- Member of ESA Ozone Climate Change Initiative (ozone_cci) consortium (phase 2)
- Member of SPARC Data Initiative ISSI team
- Deputy Mission Scientist for the Atmospheric Chemistry Experiment (ACE) satellite mission (since 2006)

Selected Publications:

2019 - D. Griffin et al: Stratospheric ozone loss in the Arctic derived with ACE-FTS measurements between 2005 and 2013, Atmos. Chem. Phys., 19(1), 577-601.

2018 - R. P. Damadeo et al: The impact of nonuniform sampling on stratospheric ozone trends derived from occultation instruments, Atmos. Chem. Phys., 18(2), 535-554

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2015 - P. E. Sheese, C. D. Boone and K. A. Walker, Detecting physically unrealistic outliers in ACE-FTS atmospheric measurements, Atmos. Meas. Tech., 8, 741–750 (2015).