NOAA Global Monitoring Laboratory

Virtual Global Monitoring Annual Conference (eGMAC)

Observing the Stratosphere in an Era of Rapid Change, part 1

July 17, 2020, *8:30 am MDT*

Register for the eGMAC at https://www.esrl.noaa.gov/gmd/annualconference/ *to receive webinar information*

Session Overview: GML maintains long-term UTLS and stratospheric records of water vapor, ozone, and ozone depleting substances, and since 2012, regular records of greenhouse and other trace gases using the AirCore. This session will be focused on all aspects of long-term UTLS and stratospheric observations and change on all timescales, as related to the anthropogenic drivers and associated climate feedbacks in both hemispheres. Attribution of observed and modeled long-term change will be discussed in this session as well as the need for strong and reliable observational constraints. We also emphasize the importance of maintaining long-term atmospheric composition observations in the UTLS and stratosphere with current and future ground-based and spaceborne platforms.

Session Chair: Irina Petropavlovskikh
Chat Moderator: Bryan Johnson

All times below are in Mountain Daylight Time (UTC -6)

Time	Title	Presenter and Affiliation
0830-0835	Introduction	**Irina Petropavlovskikh**
0835-0850	Overview of ozonesondes networks, observational needs and outstanding science questions	**David Tarasick** Environment and Climate Change Canada, Canada
0855-0910	SHADOZ Project Update: 2020 Archive and the ASOPOS Activity	**D. E. Kollonige** NASA/Goddard Space Flight Center, USA
0915-0930	A Post-2013 Drop-off in Total Ozone at a Third of Global Ozonesonde Stations: ECC Instrument Artifacts?	**Ryan M. Stauffer** University of Maryland, College Park, MD, USA
0930-0935	Trends in Tropical Ozone and Convection (1998-2018) Based on v06 SHADOZ Profiles	**Anne Thompson** NASA/Goddard Space Flight Center, USA
0935-0940	Break	
0945-1000	A unified analysis of stratospheric and tropospheric ozone anomalies above western North America and Europe	**Kai-Lan Chang** CIRES, NOAA Chemical Sciences Division, USA
1005-1020	South Pole ozonesonde record and anomalous years	**Bryan Johnson** NOAA Global Monitoring Laboratory, USA

SESSION ABSTRACTS

Understanding Atmospheric Concentrations of Trace Gases Affecting Ozone and Climate

0835-0850 **David Tarasick[1],**
[1]Environement and Climate Change Canada, Toronto, Canada

Title: Evaluating long-term changes in atmospheric ozone

Abstract: Ozonesondes have made inexpensive, accurate measurements of ozone from the ground to 30km for more than 50 years. The data are used extensively for trend analyses and for evaluation of satellite and model data products, and are also part of climatologies that are used as a priori data for satellite retrievals. They are essential as a transfer standard when merging shorter satellite-derived time series, and are the most important source of trend-quality long-term records below about 18 km.The importance of long-term ozonesonde records as a stable reference has led to increased attention to quantifying uncertainties and changes in ozonesonde data. Based on past intercomparison data, ECC sondes show a modest (~1-5%) high bias with respect to UV-absorption measurements (including MOZAIC-IAGOS) in the troposphere, with an uncertainty of 5%, but no evidence of a change with time. Other sonde types show an increase of 5-20% in sensitivity to tropospheric ozone from 1970-1995. Agreement in the stratosphere is much better.
Recently many of the most important ozonesonde records have been re-evaluated and corrected, and detailed estimates made of their biases and uncertainties as a function of altitude. Several quality assurance issues remain, but are tractable problems that can be addressed with further research. This will be required if the present goal of better than 5% overall uncertainty throughout the global ozonesonde network is to be achieved.
Some recent examples of scientific results that rely on the accuracy and high vertical resolution of ozonesondes illustrate these points.

0855-0910 **Debra E. Kollonige[1,2], Anne M. Thompson[2], and Ryan M. Stauffer[2,3]**
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3- ESSIC, University of Maryland College Park, College Park, MD

Title: SHADOZ Project Update: 2020 Archive and the ASOPOS Activity

Abstract: The Southern Hemisphere Additional Ozonesondes (SHADOZ) network, jointlyoperated by NASA-Goddard Space Flight Center, NOAA's Global Monitoring Lab and partners from 15 nations, collects and archives ozonesonde-radiosonde data records for 14 stations in the tropics and subtropics. There are now >8500 ozone and P-T-U profiles with 100m vertical resolution at the SHADOZ archive (https://tropo.gsfc.nasa.gov/shadoz) with data ranging from 1998-2020. There are several stations with 1-2-decade long records including NOAA-affiliated stations: Hilo, Samoa, and Fiji. The electrochemical concentration cell (ECC) ozonesonde used in the SHADOZ network is subject to variations (e.g., chemical composition of the sensing solution, manufacturer, calibration procedures) that can introduce artifacts into the measurement. Recent reprocessing efforts have helped to improve discontinuities in data records and recent updates to published evaluations show that total column ozone (TCO) agreements between SHADOZ ozonesondes and Aura OMI/SNPP OMPS are within 5%. With the advent of new satellite missions and products, there is a demand for high-quality ozone profiles in the tropics. We present updates on the SHADOZ archive and ongoing quality assurance and capacity building activities (eg. Assessment

of Standard Operating Procedures for OzoneSondes (ASOPOS)) with the goal of safeguarding the continuity of long-term global ozonesonde records and ensuring the best quality data reach the end users..

0915-0930 Ryan M. Stauffer[1,2], Anne M. Thompson[2], Debra E. Kollonige[3,2], Jacquelyn C. Witte[2*] David W. Tarasick[4], Jonathan Davies[4], Holger Vömel[5], Gary A. Morris[6], Roeland Van Malderen[7], Bryan J. Johnson[8], Richard R. Querel[9], Henry B. Selkirk[10,2], Rene Stübi[11], and Herman G. J. Smit[12]

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[3]Science Systems and Applications, Inc., Lanham, MD, USA
[4]Environment and Climate Change Canada, Downsview, ON, CA
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[6]St. Edwards University, Austin, TX, USA
[7]Royal Meteorological Institute of Belgium, Uccle (Brussels), Belgium
[8]Global Monitoring Laboratory, NOAA Earth System Research Laboratory, Boulder, CO, USA
[9]National Institute of Water & Atmospheric Research (NIWA), Lauder, NZ
[10]Universities Space Research Association, Columbia, MD, USA
[11]Federal Office of Meteorology and Climatology, MeteoSwiss, Aerological Station, Payerne, Switzerland
[12]Institute of Chemistry and Dynamics of the Geosphere: Troposphere, Jülich Research Centre, Jülich, Germany

Title: A Post-2013 Drop-off in Total Ozone at a Third of Global Ozonesonde Stations: ECC Instrument Artifacts?

Abstract: An international effort to improve ozonesonde data quality and to reevaluate historical records has made significant improvements in the accuracy of global network data. However, between 2014 and 2016, ozonesonde total column ozone (TCO; O_3) at 14 of 37 regularly reporting stations, including several NOAA stations, exhibited a sudden drop-off relative to satellite measurements. The ozonesonde TCO drop is 3-7 % compared to satellite and ground-based TCO, and 5-10 % or more compared to satellite stratospheric O_3 profiles, compromising the use of recent data for trends, although they remain reliable for other uses. Hardware changes in the ozonesonde instrument are likely a major factor in the O_3 drop-off, but no single property of the ozonesonde explains the findings. The bias remains in recent data. Research to understand the drop-off is in progress; this presentation is intended as a caution to users of the data. Our findings underscore the importance of regular ozonesonde data evaluation.

0935-0950 Anne M. Thompson
NASA/Goddard Space Flight Center, USA

Title: Trends in Tropical Ozone and Convection (1998-2018) Based on v06 SHADOZ Profiles

Abstract: Quantifying variability in lowermost stratosphere (LMS) ozone is an important topic in the climate assessment community because of feedbacks among changing temperature, dynamics and species like ozone. Most LMS evaluations are made with satellite observations. Likewise, tropospheric ozone assessments rely heavily on profiles from commercial aircraft. Ozonesondes, with uniform vertical resolution, constitute an independent dataset that encompasses both LMS and troposphere. We used v06 Southern Hemisphere Additional Ozonesondes data from 1998-2018 in a Multiple Linear Regression model to analyze variability and trends in free tropospheric (FT) and LMS ozone across five well-distributed tropical sites. Our findings: (1) Only one SHADOZ site, in the equatorial Americas, exhibits small positive FT and negative LMS ozone trends on an annually averaged basis. (2) At the other 4 sites, trends only occur in isolated layers during months with decreasing (February-April) or increasing (July-

September) convection. (3) The latter ozone changes are always positive in the FT. Because most SHADOZ stations are very remote, the results do not suggest large-scale tropical FT O_3 increases. They do imply that in the urban tropics where rising emissions create additional ozone, the trends observed in aircraft profiles may overlie smaller FT ozone increases caused by perturbed dynamics.

0955-1000 **Kai-Lan Chang[1,2], Owen R. Cooper[1,2], Audrey Gaudel[1,2] and Irina Petropavlovskikh[1,3]**

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2NOAA Chemical Sciences Laboratory, Boulder
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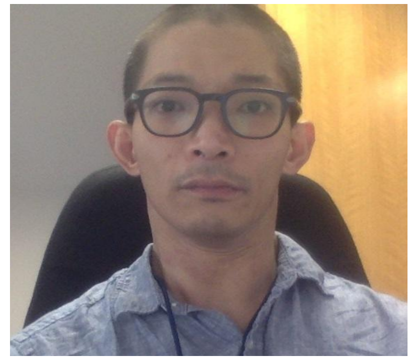

Title A unified analysis of stratospheric and tropospheric ozone anomalies above western North America and Europe

Abstract: Anomaly detection for an atmospheric time series is usually carried out by investigating the aberrant outlier data points relative to climatological values. However, detecting ozone anomalies from sparsely sampled ozonesonde profiles (typically once per week) is challenging due to the noise in the time series resulting from ozone's high temporal variability. The heterogeneity of ozone variation in the stratosphere and troposphere also poses additional complexity to the anomaly detection problem. This work will introduce a novel framework for consistently detecting ozone anomalies across the entire profile (troposphere and stratosphere), through an investigation of the ozone variability above Hohenpeissenberg, Germany (1971-2020) and Boulder, USA (1979-2020). Special focus will be placed on ozone anomalies in recent years (2016-2020) to identify any anomalies that may be related to the decrease in economic activity during the ongoing Covid-19 pandemic.

1005-1020 **Bryan Johnson[1]**, P. Cullis[2], J. Booth[1] G. McConville[2], A. Jordan[2], A. McClure[2], I. Petropavlovskikh[2]

[1] NOAA Earth System Research Laboratory, Global Monitoring Division, Boulder, Colorado, USA, [2] CIRES, University of Colorado, Boulder, USA

Title: South Pole 34-year ozonesonde record: Altitude layers and ozone hole metrics trending upward since 2001.

Abstract: South Pole ozone observations from NOAA ozonesondes (since 1986) and the ground-based Dobson spectrophotometer (since 1963) are important contributors to long-term tracking of the yearly ozone hole over Antarctica. While ozone depleting substances (ODS) are declining, the task of establishing a connection to a similar improvement in ozone is complicated. This is due to the late-winter, early-spring variability in atmospheric conditions of the continental-sized polar vortex and stratospheric temperatures. However, the 34-year ozonesonde profile metrics tracking severity from September 1 – October 15, are showing improvements in the 14-21 km column ozone minimums with decreasing loss rates beginning around 2001. This agrees with the various analysis techniques and models looking at the bigger picture from satellite, ground-based, and balloon observations over the last 4 decades, which all tend to establish 2000/2001 as the turn-around year. In the future, we can expect that additional years of data will confirm that the ozone hole is on track toward complete recovery when ODS concentrations finally reach their 1980 level, which is projected to be around the year 2060. However, we will likely see more years like 2019 that add to the uncertainty in ozone hole metrics. 2019, 2002, and 1988 stand out as outliers when the vortex broke up early, abruptly ending the active chlorine/ozone destruction cycle in September.
