Ozone_cci User Workshop

Tuesday, 16 March 2021 - Wednesday, 17 March 2021

Webex

Scientific Programme

The full programme is available in section "Overview".

Background: The European Space Agency Climate Change Initiative (CCI) aims to realise the full potential of the long-term global Earth Observation archives that ESA, together with its member states, has established over the past 30 years. This workshop focuses on the generation and exploitation of CCI’s harmonised multi-decadal Climate Data Records (CDRs) of atmospheric ozone observations suitable to assess long-term changes in total ozone and its vertical distribution, and their interaction with climate change.

Objectives: The aim of this workshop is to bring together scientists involved in the generation of ozone CDRs, data users of ozone CDRs, and the broader ozone community, in order to present the state of the art in ozone CDR production, to discuss results from major CDR users (e.g. stratospheric and tropospheric ozone assessments, UT/LS studies, evaluation of climate modelling, data assimilation and reanalysis), to collect and update user requirements for CDRs from current and future EO missions, and to discuss remaining challenges for the generation of ozone CDRs.

Organising team: M. Dameris, M. Van Roozendael, M. van Weele, M. Coldewey-Egbers, V. Sofieva, J.-C. Lambert, D. Hubert, N. Kalb, C. Retscher

16-17 March 2021; 2 half-day virtual sessions via Webex

The final programme & meeting information can be found in the section overview.

Day 1: Ozone_cci Climate Data Records and Quality Assessment
Presentation by the CCI team of the ozone climate data records in the CCI portfolio. We explain how the ozone CDRs are created within CCI, discuss main characteristics and data availability, and present an assessment of data quality.

Day 2: Scientific use of Ozone_cci data
Presentations by external researchers on selected scientific topics and international initiatives to which Ozone_cci climate data records (could) provide important contributions.

Abstracts

“**The 2022 WMO/UNEP Ozone Assessment**”, B. Hassler, DLR

Reliable and well-documented measurements of ozone are a crucial prerequisite for analyses of the evolution of stratospheric ozone as such presented in the WMO/UNEP Ozone Assessments. Especially long-term monitoring providing time series of total column and vertically resolved ozone is essential for analyses of trends and variability describing the current state of the ozone layer. Well-characterized measurements also help to cross-check if the observed evolution of ozone is following our expectations from model experiments or if there are still gaps in our understanding of stratospheric chemistry or dynamics.
In this presentation, I will introduce the main research questions of the upcoming 2022 WMO/UNEP Ozone Assessment, as well as the overall timeline of the report preparation. I will also point out where ESA-CCI ozone data was already used in analyses for previous WMO/UNEP Ozone Assessments, the SPARC project LOTUS (Long-term Ozone Trends and Uncertainties in the

Stratosphere), and the Tropospheric Ozone Assessment Report (TOAR), and where analyses of ESA-CCI ozone data could contribute to these assessments in the future.

"**Trends in total column and stratospheric ozone**", W. Steinbrecht, DWD

Ground- and space-based observations show that the large ozone decline from the 1970s to the 1990s has been stopped, thanks to the international ban of ozone depleting substances by the Montreal Protocol and its amendments. We are now in a phase of slow recovery of the ozone layer, with substantial natural variability superimposed. So far, only the regions of largest ozone depletion, the upper stratosphere and the Antarctic ozone hole, show clearly improving trends. Total ozone columns and ozone in the lower stratosphere, so far, show no significantly increasing trends. Part of that is due to the small slope of the expected recovery, about three times slower than the fast decline from the 1970s to the 1990s.

"**Assessment of tropospheric ozone by TOAR-II**", J. L. Neu, NASA JPL

& Paul Palmer3, Helen M. Worden2, Kevin W. Bowman1
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Given the importance of tropospheric ozone as a greenhouse gas and a hazardous pollutant that impacts human health and ecosystems, it is critical to quantify and understand long-term changes in its abundance. Satellite records are beginning to approach the length needed to assess variability and trends in tropospheric ozone, yet an intercomparison of time series from multiple satellite instruments undertaken as part of the Tropospheric Ozone Assessment Report – Phase I (TOAR-I) shows substantial differences in the net change in ozone over the past decade. We discuss the possible sources of differences in these datasets and describe the methodology to be used in TOAR-II for quantifying expected differences in the ability of each product to capture long-term variations in ozone.

"**OCTAV-UTLS: Ozone distribution and the effect of dynamical variability**", P. Hoor, JGU Mainz

& L. Millan, I. Petropavlovskikh

The composition of the upper troposphere / lower stratosphere (UTLS) is affected by the Brewer-Dobson Circulation (BDC) as well as transport across the tropopause and the jets. Since these dynamical processes involve the coupling of transport and mixing processes on very different temporal and spatial scales, long-term changes or even mean distributions from observational data sets on the distribution of tracers in the UTLS are therefore difficult to detect.

Complications arise particularly from the short-term variability of the tropopause and jet locations, which introduce variability in tracer distributions, especially for those with strong gradients at the tropopause. It is therefore essential to account for the dynamically induced variability by, e.g., the tropopause location when looking at trends in dynamical processes such as STE or the BDC and assessing their effects on trace gas distributions and long-term changes.

The relationship of tracer distributions to the tropopause and jet locations as given in reanalysis data thus plays a key role in accounting for the variability and in the interpretation of tracer distributions. OCTAV-UTLS uses different observational data sets from soundings, lidar, aircraft, and satellite to investigate the effect of dynamical variability on the ozone distributions. This is done by remapping observations in a different jet or tropopause-based coordinates with the JETPAC tool using MERRA-2 reanalysis data. Some examples of the method are shown demonstrating the effect on the distribution and a reduction of variability.

"**Comparison of GTO-ECV and MERRA-2 & further plans**", S. Frith, NASA, GSFC

In this study we compare the satellite-based Global Ozone Monitoring Experiment (GOME)-type Total Ozone Essential Climate Variable (GTO-ECV) record, generated as part of the European Space Agency's Climate Change Initiative (ESA-CCI) ozone project, with the adjusted total ozone product from the Modern Era Retrospective Analysis for Research and Applications version 2 (adjusted MERRA-2) reanalysis, produced at the National Aeronautics and Space Administration (NASA) Global Modeling and Assimilation Office (GMAO). GTO-ECV is a merged satellite total ozone product characterized by very high inter-sensor consistency, good spatial resolution, and near global coverage. The adjusted MERRA-2 product combines the high spatial and temporal resolution of the MERRA-2 assimilation with the long-term consistency of the SBUV merged satellite record. In this work we evaluate the consistency between both products spatially and in time, as well as discuss future applications of the GTO-ECV data record.

"**On the comparison of observational ozone data to chemistry-climate models**", H. Garny, DLR

& S. Dietmüller, R. Eichinger, W. Ball
Chemistry-climate models have been developed and used extensively over the last decades to project the future development of the stratospheric ozone layer. To validate the models, continuous observations with global coverage are an essential necessity.
Traditionally, model timeseries from hindcast simulations are compared to observational timeseries of (partial) column ozone in order to assess the performance of the models. However, in particular when considering shorter time periods of about 2 decades, internal variability strongly influences ozone trends and therewith complicates conclusions on (dis-)agreement between modeled and observed time series. Ozone trends over the past two decades are of particular interest, as ozone depleting substances (ODS) started to decline in this period. In this presentation, I will show results from a detailed comparison of ozone trends in the recent decades (around 1998-2018) between model simulations as part of the Chemistry-Climate model Initiative (CCMI) and merged satellite ozone records. The focus will be in particular on the lower stratosphere, because in this regions, discrepancies between models and observations have been reported: Observational data indicate a decline in ozone mixing ratios in a broad latitudinal region extending well into the mid-latitudes, while models predict an ozone decline only in the tropics, but an increase in mid-latitudes. It has been argued that those differences might be due to inter-annual variability. Here, we use a statistical approach to assess the likelihood of the observational trend to be a realization of the model's trend distribution, and we conclude that the observed mid-latitude lower stratospheric ozone trend is an extreme value given the models distribution. We further analyze the contributions of ODS versus greenhouse gas (GHG) forcing in contributing to the model's trends, and discuss possible reasons for the discrepancies between modeled and observed lower stratospheric ozone trends. Overall, this study demonstrates how the combination of a suite of model simulations and observational satellite data can serve to assess our understanding of the current processes affecting the stratospheric ozone layer.

"**CAMS current and planned ozone data assimilation activities, including plans for a CAMS-II reanalysis**", A. Inness, ECMWF

In addition to meteorological reanalyses, reanalysis data sets of atmospheric composition have been emerging in the last decade. The EU funded Copernicus Atmsphere Monitoring Service (CAMS), implemented by ECMWF, has recently produced the so-called CAMS reanalysis

(CAMSRA) in which satellite retrievals of O3, CO, NO2 and AOD were assimilated in addition to the usual meteorological observations. This talk will show how the CAMS ozone reanalysis can be used to assess ozone anomalies, e.g. related to the ozone hole. It will give some background information about the CAMS ozone data assimilation activities, document the O3 retrievals that are used in CAMSRA and in the CAMS near-real time system, and stress the importance of good quality, long term datasets as input for reanalysis activities. The talk will also discuss plans, data needs and the anticipated time frame for a new CAMS-II reanalysis production which is scheduled to start in 2023, as well as briefly presenting the ozone data requirements for the ERA6 reanalysis planned by C3S and scheduled to start in 2024.