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2011 NDACC Symposium
Network for the Detection of Atmospheric Composition Change

SESSION 6

STRATOSPHERIC COMPOSITION AND LONG-TERM TRENDS

Oral Session

6-1 Constructing a Long Term Ozone Climate Data Record (1978 – 2010) from v8.6 SBUV/2 Profiles

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Understanding past and anticipating future ozone changes requires consistently calibrated long-term ozone climate data records. Updated retrievals of total and profile ozone from the SBUV(/2) series of instruments derived using a new version (v8.6) of the retrieval algorithm were released in the summer of 2011. The SBUV(/2) series of instruments covers the period from 1978-present using data from Nimbus 7 SBUV, and NOAAs 9, 11, 14, 16, 17, 18, and 19 SBUV/2. The NOAA instruments are onboard the Polar Orbiting Environmental Satellites (POES) which are nearly sun-synchronous usually with afternoon equatorial crossing times. However, the orbits of the satellites slowly drift, and the long-lived satellites provide measurements over a wide range of local times during the measurement life. POES from NOAA 16 on, have an adjusted orbit to minimize the drift in the early record. Previous versions of the SBUV(/2) data have exhibited intra-satellite biases, as well as drifts in a single satellite data record due to the changing satellite equatorial crossing time, and hence sensitivity to the diurnal nature of the ozone profile. This has been particularly evident in ozone profile data from NOAA 9 and 11. The new algorithm includes updated calibrations for each of the instruments optimized to produce consistent satellite records that can be easily combined into an ozone climate data record. We evaluate the SBUV(/2) v8.6 individual satellite data sets, concentrating on the overlap periods between successive satellites. We also examine the internal structure of the NOAA 9 and 11 records with particular attention to diurnally associated changes. We use various statistical methods, including the method developed by Wild and Long (in press), to investigate the variability between instruments and evaluate the need for additional external offsets when constructing the climate record. The result is a merged daily zonal mean climate data record (CDR) for the ozone vertical distribution which can also be summed for an associated total ozone product. This record is completely independent of other instruments as it is created with only internal SBUV(/2) to SBUV/2 comparisons. The final merged CDR is compared

with other long term ozone observational data sets from satellite-based SAGE II, and MLS instruments, and from NDACC ground-based lidar and microwave measurements. NDACC instruments are particularly useful in this exploration because of their high quality and long-term nature. Comparisons will also be made to determine the remaining limitations of the data record because of the satellite drift and the ramifications of the diurnal nature of the ozone profile.

Oral Session

6-2 The SPARC/IO3C/WMO-IGACO Initiative on Past Changes in the Vertical Distribution of Ozone

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The current draft of the chapter in the 2010 UNEP/WMO Assessment which describes the past evolution of ozone contains a limited extension of the observed global changes in the vertical distribution of ozone since 2005. This situation results from the fact that the SAGE and HALOE records ended that year and no core satellite record has replaced them. The problem is that there is no single measurement record that really matches them. (A parallel question about how to extend the record into the future is equally important1, but is not considered here as the required approaches are different.) Scientifically, the interest in stratospheric ozone amounts remains high. In the second half of the 1990s, EESC was close to its maximum since when it has been slowly decreasing (for midlatitudes for more than a decade). However, it is still difficult to document the beneficial effect of the Montreal Protocol to protect the ozone layer, mainly as a result of natural variability. In addition the attribution of changes in ozone due to ODS changes is complicated by the possible changes in Brewer-Dobson circulation resulting from climate change. More generally there is an increasing awareness of the role of stratospheric ozone in climate change both as an important atmospheric constituent and as an indicator of changes in climate. For example a changed Brewer-Dobson circulation will change the ozone flux into the troposphere as well as UV radiation. The difficulty of the challenge should not be underestimated. Expected ozone recovery trends are about 2-3% per decade at most. If these trends are to be detected, separated from the solar cycle, etc., instrument-related drifts in the data sets should be limited to ~1% per decade. While it is not easy to maintain that level of stability from one instrument, it is far more difficult to achieve it when data from various instruments (and even various types of instruments) are merged together. Different instruments measure "different" ozone due to difference in their spatial and vertical resolution, observation time (sunrise/sunset, mid-day or night), algorithms, ozone cross-sections, etc. Satellite records are generally better validated over shorter periods than longer ones. A variety of work is already in train to address this gap, with programmes supported by several agencies including CSA, ESA and national European space agencies, and NASA. The SBUV-SBUV/2 combined data set has been carefully homogenized, but its vertical resolution is not as good and the coverage is not sufficient in the lower atmosphere. A number of microwave emission sounders exist but as yet there is no homogenous data set which can be used for multi-decadal studies. Finally work is on-going to use the SCIAMACHY and ACE-FTS occultation measurements to extend the SAGE & HALOE records. Whether these can be linked to limb or scattered sunlight measurements (e.g. OSIRIS) with their higher spatial coverage is also being investigated. In addition, the ground-based station GAW and NDACC network (comprising ozonesondes, Umkehr, lidars and microwave instruments) is strong, and so there is a good basis to assess the quality of the homogenised satellite datasets which provide near-global coverage. However, with the probable exception of the combined SBUV record, the fundamental work has not been performed to know what aspects to trust for the determination of long term trends and what aspects not to trust. An international initiative is required to coordinate the various strands, identify any gaps and to highlight the need for coordinated efforts in the longer term. In 1998 the SPARC/IOC/GAW: "Assessment of Trends in the Vertical Distribution of Ozone" was published2. This assessment took two years to complete and provided a framework for fruitful international collaboration involving all the main groups. The results were valuable for the following WMO/UNEP Ozone Assessment as well as for stratospheric ozone and climate change researchers more generally. We propose that it is time for a new initiative to provide quality-assessed ozone datasets of near-global coverage in the stratosphere and upper troposphere. Activities 1. Satellite records. There are several satellite instruments making measurements of the vertical distribution of ozone. However only some of the measurements can be used in conjunction with earlier measurements to investigate decadal changes. There seem to be three types of instruments suitable for making homogenous records which go back to the early 1990s or before: (i) SBUV & SBUV/2; (ii) Solar occultation (SAGE, HALOE and SCIAMACHY); and (iii) microwave (MLS and ODIN). This approach raises common questions such as: How to combine ozone profile records from different satellite instruments? What other records could be looked at (e.g. OSIRIS)? How to deal with uncertainties related to composites of satellite records? How well can limb and occultation records be combined? How do the records depend on the available meteorological data used? 2. Ground-based records. The ground-based records are faced with similar issues. Combining measurements by different instrument approaches should be avoided except where that is the only option, but even within individual approaches, changes of instrument type (e.g. versions of ozonesondes) or algorithm must be handled with care. 3. Quality assessment. In order for revealing comparisons to be made, it is important to find the most suitable way to compare ozone profile information derived from different type of instruments, such as different satellite instruments, measurements from ground including measurements averaged over time and altitude (such as from a Lidar or a microwave instrument) and in-situ measurements such as from ozonesondes. Developing a common framework for comparisons, which deals consistently with measurement uncertainties, averaging kernels, etc., is important. 4. Evaluation and interpretation. The final aspect is to interpret the revised and assessed long term ozone records. It is still difficult to document the effect of the Montreal Protocol on the ozone layer because the attribution of changes of the ozone layer to ODS changes is difficult due to natural variability and the influence of climate change (e.g. changes in Brewer-Dobson circulation). The complex, coupled nature of the atmosphere means that numerical simulations are required in conjunction with analyses of the ozone and other atmospheric measurements. Part of a new initiative could be to identify how the stratospheric ozone profile changed over the past decades and to attempt to identify the effects of reducing chlorine levels. Possible procedure and planning An international and scientifically neutral framework is helpful, if not essential, if this initiative is to achieve its aims. SPARC and IOC have expressed strong interest in helping to organize such an initiative. These organizations would need support from the space agencies (particularly ESA & NASA), meteorological agencies involved in satellite and ground-based measurements as well as the leading scientists in the field. Involvement in such an initiative would require a commitment in terms of expert time and financial support. The international organizations, IGACO-O3/UV (as part of GAW and with its aim of combining ozone measurements from ground and space) and CEOS, support it. We suggest that IGACO-O3/UV organizes a workshop with SPARC and IOC in order to discuss the goals and the planning of the initiative. The workshop should be held in late 2010 or early 2011 following an open discussion period using electronic means. At the workshop, the details of the process (e.g.

preparation of an assessment) and the commitments of the contributors would be clarified in meeting including the organization of the work, contributions of individual groups, time planning, formal procedure in relation to SPARC, IOC and other institutions or agencies involved.

Oral Session

6-3 Consistency of the ten years (2001-2011) Odin SMR and OSIRIS stratospheric ozone time-series (2001-2011) with long-term NDACC observations

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The Odin satellite, launched in 2001, provides a number of different long-term ozone products derived from observations of its two instruments which are analysed in terms of internal consistency and with respect to long-term observations provided by the NDACC network. The Sub-Millimetre Radiometer (SMR) is a limb emission sounder measuring trace gases in the stratosphere, mesosphere, and lower thermosphere using several different measurement modes and bands within the 486-581GHz range. Ozone data measured in the 488.9GHz, 501.8GHz and 544.6GHz bands are used in this study. The Optical Spectrograph and InfraRed Imager (OSIRIS) makes regular stratospheric ozone observations in the UV/VIS spectral range. A study on stratospheric ozone trends has been published recently, highlighting the facts that ozone loss observed in the upper stratosphere has levelled off after 1997 and that a small ozone increase has been observed at mid-latitudes for the 1997-2008 period (however not significant different from a zero trend at the 95% confidence level). In order to further quantify the recovery of ozone, we investigate the internal consistency of the Odin ozone data sets in terms of differences in the long-term (2001-2011) trends and observed variability. Separation of day and night observations allows to study the diurnal variation effect on ozone trend estimation in the upper stratosphere. Odin ozone time-series are compared to independent long-term NDAAC data sets, for example available from lidars, microwave radiometers, and sondes. Related Odin stratospheric temperature observations are analysed as well. Odin is a Swedish-led satellite project funded jointly by Sweden (SNSB), Canada (CSA), Finland (TEKES), and France (CNES), with support by the 3rd party mission programme of the European Space Agency (ESA).

Oral Session

6-4 RELATIVE DRIFTS AND STABILITY OF SATELLITE AND GROUND-BASED STRATOSPHERIC OZONE PROFILES AT NDACC LIDAR STATIONS

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The long-term stability of stratospheric ozone vertical distribution is evaluated at various NDACC lidar stations. The analysis is performed by comparing the collocated lidar ozone profiles with ozonesondes and long-term space-borne observations such as SBUV(/2), SAGE II, HALOE and the more recent Aura MLS extracted around the stations. The stations involved in the study are the Meteorological Observatory of Hohenpeissenberg – 47.8◦N; 11◦E, Haute-Provence Observatory – 43.93◦N; 5.71◦E, Tsukuba – 36◦N; 140◦E and Table Mountain Facility – 34.5◦N; 117.7◦W), Mauna Loa Observatory – 19.5◦N; 155.6◦W and Lauder – 45◦S; 169.7◦E. A statistical analysis is performed on the relative differences between ozone measurements in order to evaluate biases and temporal changes with respect to time. All measurement techniques show the best agreement for the comparison with respect to the lidars at 20–40 km, where the average biases are within ±5%. In addition to drifts evaluated with respect to the lidar measurements, the stability of the latter data is analyzed with respect to the other measurements involved in the study. Drifts between coincident satellite measurements at the studied stations are also investigated. Time series of ozone differences with respect to the lidar measurements from the SAGE II and HALOE older data sets are then combined with those of Aura MLS to obtain longer time series of differences at the stations and evaluate the potential of MLS measurements to continue these older data sets. Relative drifts derived from these combined time series are evaluated. The objective of the study is to evaluate the stability and potential of various satellite and lidar measurements for validation and trend studies in the context of ozone recovery and climate change.

Oral Session

6-5 TEMPERATURE TRENDS DERIVED FROM LIDAR AND SATELLITE SERIES

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The capability of the longest lidar data sets to monitor the long-term temperature changes in the middle atmosphere have been evaluated through comparisons with the successive Stratospheric Sounder Units (SSU), Advanced Microwave Sounding Unit (AMSU) and NDACC Rayleigh lidar. Cross-consistency investigations between SSU, AMSU and the lidar network can be considered as a first attempt to demonstrate how the synergistic use of space and ground-based instruments could provide reliable monitoring of the temperature of the middle atmosphere. However, these investigations reveal numerous uncertainties that will be presented. The breakdown of the temperature cooling trend, and the following flattening require to use more sophisticated methods for deriving trends including non-linear term, temperature distribution and to estimate the contribution of the dynamical feedback. The continuity of global temperature trends requires to take into account tidal effects while their characteristics are not well described.

Oral Session

6-6 Comparisons of long-term stratospheric nitric acid and hydrogen fluoride variations using satellite and ground-based measurements

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We investigate the long-term variations of stratospheric nitric acid (HNO3) and hydrogen fluoride (HF), based on several satellite and ground-based measurement records. We use results from the Upper Atmosphere Research Satellite (launched in late 1991 and decommissioned in late 2005), the Aura satellite (launched in summer 2004, with on-going measurements), and the Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS) (from 2004 to present), in conjunction with several long-term ground-based datasets from the Network for the Detection of Atmosphere Composition Change (NDACC). In particular, we investigate the time series of HNO3 and HF, using NDACC column data for validation. We focus here on a few NDACC sites with long-term and frequent measurements, namely the Jungfraujoch (46°N, 8°E), Lauder (45°S, 170°E), and Mauna Loa (20°N, 204°E) s ites, where ground-based Fourier Transform Infrared (FTIR) measurements have covered both the UARS and Aura/ACE-FTS time periods (1991 to present). For HNO3, we investigate whether there are indications of a systematic offset between the measurements by the Microwave Limb Sounder (MLS) instruments aboard both UARS and Aura. For hydrogen fluoride, the HALogen Occultation Experiment's HF time series are connected to the ACE-FTS dataset, and we analyze the correlation of this time series with the ground-based datasets. In addition, model runs from the Whole Atmosphere Community Climate Model (WACCM) and the TOMCAT/SLIMCAT model are used as part of the long-term time series intercomparisons. We note that there is a significant gap in the HNO3 time series from the satellite measurements used here. The long-term satellite datasets studied here include zonal average Earth Science Data Records (ESDRs) being produced under the Global Ozone Chemistry And Related trace gas Data records for the Stratosphere (GOZCARDS) project, part of the NASA Making Earth Science data records for Use in Research Environments (MEaSUREs) program. We also analyze coincident measurements, for the comparisons between satellite and ground-based observations.

Oral Session

6-7 Trend analysis of stratospheric BrO using long-term ground-based UV-visible observations

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Stratospheric bromine monoxide (BrO) columns have been derived from ground-based zenith-sky UV-visible observations made since 1995 at the NDACC stations of Harestua (60°N, 11°E) and Lauder (45°S, 170°E), and since 1998 at the Observa toire de Haute Provence (OHP; 44°N, 5.5°E). We present an updated analysis of the long- term trend in stratospheric BrO based on these observations. The time series of BrO vertical column densities are fitted using a multi-linear regression model including terms for annual, semi-annual and four-month period variations, 10.7 cm solar flux, Quasi-Biennal Oscillation, Southern Oscillation Index, and volcanic terms. The inclusion of such functions enables to represent most of the natural variability of BrO in the stratosphere, leaving a clear long term trend signal. As reported in a previous study, a positive trend of approximately 2.5%/year is observed for the 1995-2001 period, while more recent data display a systematic negative trend of about 1%/year. Such trend values are in agreement with trend values independently derived from SCIAMACHY measurements on the ENVISAT satellite platform. When accounting for the age of stratospheric air masses, they are also consistent with the reported decline of long-lived bromine source gases observed since the second half of 1998 as a result of the Montreal Protocol limiting the production of brominated and chlorinated source gases. The continued monitoring of the evolution of the halogen load in the stratosphere is essential to understand the expected future recovery of the ozone layer in a changing climate.

Oral Session

6-8 Trend analysis of stratospheric NO2 above Jungfraujoch (46.5°E, 8.0°E) using long-term ground-based UV-visible, FTIR, and satellite nadir observations

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Nitrogen dioxide (NO2) plays an important role in controlling ozone abundances in the stratosphere, either directly through the NOx (NO+NO2) catalytic cycle, or indirectly by converting active chlorine, bromine, and hydrogen into their reservoir forms, reducing their availability for ozone-destroying catalytic cycles. Ground-based zenith-sky UV-visible and Fourier transform infrared (FTIR) solar absorption measurements of the stratospheric NO2 column have been performed at the NDACC (Network for the Detection of Atmospheric Composition Change) station of Jungfraujoch (46.5°E, 8.0°E) since 1991 and 1984 , respectively. Also available at this station are coincident satellite nadir observations from the ERS-2/GOME, ENVISAT/SCIAMACHY, and METOP/GOME-2 instruments. The merging of the different satellite data sets allows covering the period from 1996 up to now. In this presentation, we will first investigate the consistency between the UV-visible, FTIR, and satellite NO2 column data sets given their respective error budgets. Then a trend analysis performed on monthly means time-series using a multi-linear regression model including terms for annual, semi-annual and four-month period variations, 10.7 cm solar flux, Quasi-Biennal Oscillation, Southern Oscillation Index, and volcanic terms will be presented. The volcanic terms are essential since both UV-visible and FTIR observations started before the Mount Pinatubo eruption. The consistency between inferred NO2 trend values and the increase of N2O (nitrous oxide) also monitored at Jungfraujoch will be discussed.

Poster Session

6P-1 Assimilation of the Dobson to Brewer total ozone data series, Hradec Králové, Czech Republic, 1961-2010 – some impacts on evaluation of long-term changes

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The 50-year period of continuous observations of total ozone (X) has been completed in 2010 at the Solar and Ozone Observatory (SOO) Hradec Kralove, Czech Republic. Two data series originated by the Dobson D074 (1951-2010) and by the Brewer B098 (1994-2010) spectrophotometers are maintained separately. Up to 4% seasonal differences, well known also from other stations operating collocated instruments, have been found between the D074 and B098 observations at SOO (Vanicek, ACPD, 2008). To eliminate this instrumental signal in statistical analyses an assimilated data series XASIM has been created by conversion of the D074 daily averages XD of (1961-1997) to the instrumental level of the B098 that has been taken as the reference spectrophotometer for total ozone observations (XB) at SOO since 1997.The conversion of the XD data onto XASIM values was performed by a multi-regression transfer function of the same shape suggested for the data sets from Arosa (Scarnato et. al., JGR, 2011) but with the regression coefficients related to the XD and XB observations (instruments) from SOO. Ozone effective temperature Tef and slant-path ozone Mu*XD have been taken as the proxies in the transfer function to characterize influence of temperature dependence of the ozone cross sections at the stray-light effects of the instruments. A complex analyses between the Tef values derived from ozone sonde profiles taken at the aerological station Praha-Libuš (80 km apart from the SOO) and temperatures at the standard pressure levels showed, that the temperature at 20 hPa level (T20) gives the best fit with the Tef values and with the reference Dobson temperature (-46.3oC). Together with Tef derived from the ozone sonde profiles the T20 values measured in Prague (1978-2010) and those taken from the ERA-40 re-analyses (1961-1978) have been used to create representative Tef daily values of the 1951-2010 period that were used as the input data in the transfer function. In this way 12.437 daily averages of XD have been corrected and then merged with the regular XB observations into the XASIM data set that contains 14.683 (80% of possible days) daily averages of total ozone. Up to now statistical analyses allow the following conclusions. The seasonal differences between the Dobson assimilated and the Brewer simultaneous observations of total ozone have been reduced below 1% that is the threshold

accuracy of calibration of the instruments. Comparison with the overpass satellite observations shows a better fit of the assimilated data set with the DOAS data (less than 1% in the average) than with the observations processed by the TOMS algorithms (1-2 % average differences). In the winter-spring season (JFMA) the assimilated data indicate almost twice faster increase of total ozone during the last 15 years (a recovery?) than the original Dobson data XD. In the spring-summer season (MJJA) both data sets show almost identical results – surprisingly significant and persistent reduction of total ozone of the same magnitude like for the winter-spring months but without any positive tendency in the recent years (a climate change in the stratosphere?). Recently the original Dobson XD data set of Hradec Kralove has been analyzed together with other long-term European ground-based total ozone time series applying methods from extreme value theory (Rieder et al., Tellus, 2011). The analysis showed that about 1/3 of the changes during the 1970s-1990s can be attributed to changes in the frequency of extreme low and high ozone events. Further it was concluded that significant “fingerprints” of atmospheric dynamics (NAO, ENSO), ODS and volcanic eruptions (El Chichón, Mt. Pinatubo) can be identified in the frequency distribution of extremes even if no attribution from standard metrics (i.e., mean value analysis) is possible. The analysis was repeated for the assimilated XASIM data series of the SOO, confirming the above mentioned significant fingerprints and importance of extremes for long-term total ozone trends. Currently the EVT methods are applied to analyze the significant downward trend in spring-summer total ozone at Hradec Kralove, and link this phenomenon to changes in the atmospheric dynamics and chemistry. The presented activities are supported by the Project No.P209/10/0058 of the Czech Grant Agency

Poster Session

6P-2 Evaluation of the absorption cross section of ozone in the Huggins band – ACSO summary

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The "ACSO" ("Absorption Cross Sections of Ozone") committee was established in spring 2009 as a joint ad hoc commission of the WMO SAG-ozone of GAW and IO3C of the IAMAS with the mandate to (i) review the presently available ozone absorption cross sections with priority on Huggins band, and in particular cross section data by Bass and Paur (BP) and Brion, Daumont, Malicet (BDM), (ii) 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, (iii) recommend whether a change needs to be made to the presently used WMO/IO3C standard ozone absorption cross section data (by Bass and Paur, 1985). The ACSO work was organized in three groups: ground based instruments, satellite instruments and laboratory measurements. Effects of changing absorption cross sections from BP to BDM are expected to be small for Dobson total ozone, Dobson and Brewer Umkehr and DIAL-LIDAR, with largest effects predicted for Brewer total ozone up to 3%.The retrieval analysis of the satellite measurements generally showed that the BDM cross sections are more accurate than BP with good wavelength calibration and better temperature dependence. The differences observed in satellite measurements are typically few percents in total ozone. In this presentation the summary of the ACSO work will be presented.

Poster Session

6P-3 Brewer Umkehr ozone profile retrievals.

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The Dobson Umkehr network has been a key data set for stratospheric ozone trend calculations (WMO Ozone assessments) and has earned its place as a benchmark network for stratospheric ozone profile observations. The Umkehr data has also been used to provide a long-term reference to the merging of the satellite ozone records (MOD), estimate the seasonal influence of an 11-year solar signal in the vertical distribution of stratospheric ozone, and to assess the ability of several remote and in-situ sensing systems in capturing ozone variability. It was found that Dobson Umkehr measurement errors were often comparable to errors derived for satellite and ozone-sounding methods. The Umkehr measurements are also available from the Brewer spectrophotometers [McElroy et al., 1995]. In 2005, the Dobson Umkehr algorithm (UMK04) was modified to retrieve ozone profile data from Brewer Umkehr measurements taken at two spectral channels [Petropavlovskikh et al, 2011]. The PC version of the Brewer algorithm was developed by M. Stanek (IOC, Canada and Czech Republic Meteorological Institute) in close collaboration with I. Petropavlovskikh. It was implemented at the NEUBrew network for operational processing of Umkehr data. The NEUBrew website (http://www.esrl.noaa.gov/gmd/grad/neubrew/) posts Umkehr profiles retrieved daily for all operational sites. Several years ago, the Brewer Umkehr ozone profile algorithm was developed at NASA/Goddard that was based on the multi-angular measurements of the sky radiance from the optically modified Brewer MK III instrument [Tzortziou et al, 2008]. The profile retrieval is optimized to derive about 5 km thick layer ozone in troposphere and lower stratosphere several times a day, yet the method required changes to the Brewer design and operations. The most recently developed Brewer ozone retrieval algorithm (MSBU) utilizes measurements that are currently available from the operational Brewer instruments. Umkehr measurements at multiple wavelength channels (similar to the satellite BUV method) and significantly reduced range of solar zenith angle are used for the twice a day operational ozone profile retrievals. Intercomparisons against ozone climatology, sounding,

satellite overpasses and Dobson ozone datasets for NOASA/Goddard, Boulder, CO and MLO, HI sites are presented in this paper. The MSBU algorithm reduces noise in the intra-annual variability of the Brewer retrieved ozone as compared to the single pair ozone retrieval. Tropospheric ozone retrievals also appear to be very promising. Addition of the new Brewer ozone data extracted from current measurements at selected US continental sites is expected to enhance global ground-based ozone data sets when used in the future trend analysis. The multi-spectral algorithm allows retrieving profiles for measurements taken at shorter SZA range (between 88 and 90 degrees) as compared to the 70-90 SA range of the standard Umkehr retrieval. It shortens operational time and allows for better data management. This addition to the well-established, but aging Dobson Umkehr network assures continuous ground-based support for current and future satellite-based global monitoring of stratospheric ozone recovery. The new dataset is expected to contribute to the understanding of the sources, transformation, and transport of trace species in the Earth's atmosphere which will be based on the continuous NOAA/SBUV, Aura/OMI, and future OMPS aboard the JPSS (former NPOESS) Earth observations from space.

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Poster Session

6P-4 Inexpensive Stratospheric Profiling as Basis of Stratospheric Transport Monitoring Program

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Climate change drives change in tropospheric weather. This in turn modifies the generation of wave activity, the major driver of stratospheric circulation. State-of-the-art coupled chemistry-climate models predict that the stratospheric overturning circulation has been strengthening in recent decades, and will continue to strengthen [e.g. Butchart et al., 2010]. Knowledge of the strength of the stratospheric circulation and how it may change is of significant importance. Examples are the recovery of ozone [Butchart, et al., 2010] and the concentration of stratospheric water vapor, which has been shown to influence climate [Solomon et al., 2010]. Climate-monitoring programs will benefit substantially by having a stratospheric-circulation monitoring component to track the coupling of these two regimes.

To validate model predictions of change in stratospheric circulation requires high quality, long-term measurements. The trace gases, SF6, N2O, CFC-12, CFC-113, CFC-11, and halon-1211, are uniquely influenced by stratospheric circulation time scales, through changes in the "age" of stratospheric air [Waugh and Hall, 2002], and stratospheric path and recirculation which manifests in both age distributions and, the "maximum path height" distributions [Hall, 2000] through photolytic loss. A recent study by Engel et al. [2009] and extended by Ray et al. [2010] pieced together available balloon based SF6 and CO2 measurements over the past three decades to show that the mean age of stratospheric air had increased, in apparent opposition to the decreased mean age predicted by these models that have increase in stratospheric circulation.

This study highlighted the role long-lived trace gas measurements can play in helping to understand model predictions, but also clearly revealed the limitations of the currently available stratospheric measurements. Recent laboratory studies have proven the feasibility of using the low cost AirCore techniques of Tans [2009] coupled with our fast chromatograph, Moore et al. [2003], to acquire such stratospheric data. We demonstrate that the data quality and cost is such that a sustainable long-term monitoring program for stratospheric circulation is feasible.

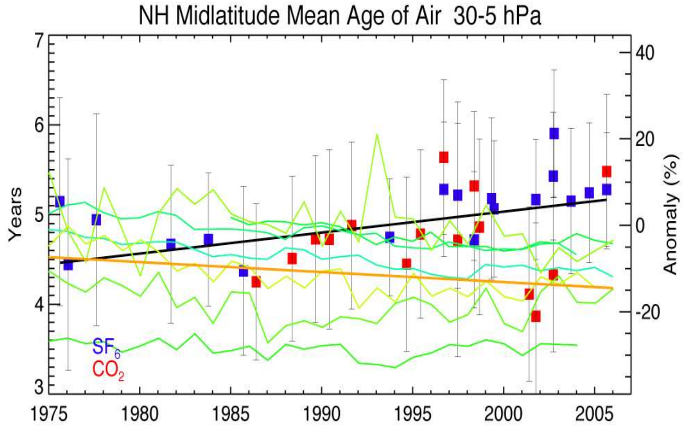

Figure 1. Decreasing mean ages caused by an increasing strength of the stratospheric circulation are consistent, robust results in nearly all CCMs, (green lines) yet appear to be inconsistent with age of air data (black line) Ray et al. [2010].

Poster Session

6P-5 New ECC Ozonesonde Pump Efficiency Measurements

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A new set of ozonesonde pump flow rate efficiencies at low ambient pressures have been directly measured by an oil bubble flow meter from 300 to 5 hectopascals (hPa) inside a 1 cubic meter environmental chamber. Regular measurements of pump efficiencies from batches of newly manufactured ozonesondes are important for accurate long term monitoring of stratospheric ozone through tracking consistency in the pump performance. The volumetric flow rate of an ozonesonde pump is constant at surface pressure and remains nearly 100% efficient down to 300 hPa pressure. Below 300 hPa, however, the volumetric flow rate steadily decreases due to the greater effect of leakage and piston volume dead space when pumping against the cathode sensor solution fluid under low pressure conditions. The ozonesonde manufacturer manuals and other standard operating procedures recommend using correction algorithms that were derived from pump efficiencies reported by Komhyr in 1986 and a second set of experimental values in 1995 using an RPM method. These measurements can be difficult to undertake and have uncertainties among the Komhyr techniques and 5 other different experimental methods reported from 1981-2002. Currently, it has been several years since any new measurements have been reported. Therefore, the pump efficiency measurements in these experiments were completed for a variety of new, old, and reconditioned ozonesondes using the NOAA/ESRL bubble flow meter technique and a modified Komhyr RPM method.

Poster Session

6P-6 Changes in the vertical distribution of ozone over Canada from ozonesondes: 1980-2010

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Abstract. Measurements of the vertical profile of ozone concentration using balloon-borne ECC ozonesondes have been made weekly since 1980 at four sites in Canada (Edmonton, Goose Bay, Churchill and Resolute), since 1987 at Alert, since 1992 at Eureka and since 2003 at four southern mid-latitude sites, Kelowna, Bratt's Lake, Egbert and Yarmouth. We present here an updated analysis of trends in the vertical distribution of ozone with data up to the end of 2010. Detailed attention to some potential sources of bias: total ozone correction, background current correction, and time-of-launch (diurnal) variation, as well as hardware changes, suggests that the uncertainties due to such effects are small. For the 1980-2010 period the overall linear trends are generally quite small, and both positive and negative trends are seen, both in tropospheric and lower stratospheric ozone. However, the time series show a strong decline until about 1993, followed by an increase until 2002 or 2003, with insignificant trends afterward. The time series also show large variations from year to year. Some of these anomalies can be related to cold winters (in the Arctic stratosphere), or changes in the Brewer-Dobson circulation, which may thereby be influencing trends. In the Arctic surface trends appear to be driven by an increase in the frequency of halogen-catalyzed surface ozone depletions. The long-term changes in free tropospheric ozone concentrations over Canada appear to correspond with lower stratospheric changes. Interannual variability is also similar: statistically significant (95% confidence) correlations are found for the lowest stratospheric layers with all tropospheric layers. This suggests that ozone levels in the troposphere over Canada are partly controlled by stratospheric ozone. The most evident reason for this is stratosphere-troposphere transport, and this interpretation is supported by Lagrangian dispersion-model studies which suggest that much of the variability of ozone in the free troposphere over midlatitude sites in Canada is due to stratospheric intrusions.

Poster Session

6P-7 Transfer functions between ECC ozonesondes operated under different condi-tions: results from dual flight campaigns

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Ozonesondes are reference instruments with long historical records at different stations around the world. These records are used for ozone trend analysis from the ground to the middle stratosphere as well as for other measuring system validation and model validation/calibration exercises. Over the last decade, a consequent effort has been deployed to improve the operating procedures for the sondes in order to achieve the required quality for the status of a reference system. From the suc-cessive JOSIE (Smit, 2007) laboratory experiments, proper operating procedures have been estab-lished for use of the ECC ozone sondes. The BESOS (Deshler, 2008) large balloon experiments have proved that the sondes performance in the field were similar to the laboratory results. The extension of these two experiments to operational conditions is however necessary to assure that the day to day operation at the network stations is well represented by the two experiments mentioned above. The dual flight campaigns performed at different stations play that role of “experiments” to “opera-tional” consistency checks of the sondes performances. Unlike JOSIE and BESOS, it is not possible to have an independent reference measurement (e.g. a UV photometer) in the dual flight campaigns. Therefore, only the differences between two sondes operated under different conditions (e.g. sonde provider, sensing solution) are measured. However, incorporating in the present analysis the JOSIE and BESOS data assure the consistency of the global picture as derived by the three distinct methods: laboratory (JOSIE), single large balloon (BESOS) and dual flights. In this study, the results of the analysis of dual flight data collected at different stations will be pre-sented. The aim is to evaluate the variability of the results from station to station and the consistency with the results from the JOSIE and BESOS experiments. The main emphasis being addressed here is the influence of ECC sonde provider as well as of the change of sensing solution concentration on the ozone profiles. Based on these results, transfer functions are developed to correct the bias intro-duced by such changes that have occurred in many stations of the global networks (e.g. NDACC, GAW, SHADOZ). An illustration of the application of the transfer function will be presented with the Nairobi station re-cord where the solution concentration has been changed in 2010. Other station records will be con-sidered. The transfer function method will be further developed and applied within the ESA-CCI ozone project in

order to validate the reprocessed satellite data with a more homogenous set of station re-cords. References: Smit, H. G. J., et al. (2007), Assessment of the performance of ECC-ozonesondes under quasi-flight conditions in the environmental simulation chamber: Insights from the Juelich Ozone Sonde Intercomparison Experiment (JOSIE), J. Geophys. Res., 112, D19306, doi: 10.1029/2006JD007308 Deshler, T., et al. (2008), Atmospheric comparison of electrochemical cell ozonesondes from different manufac-turers, and with different cathode solution strengths: The Balloon Experiment on Standards for Ozonesondes, J. Geophys. Res., 113, D04307, doi: 10.1029/2007JD008975

Poster Session

6P-8 Ozone and Temperature Long-Term Variability as Observed by the JPL Lidars at Mauna Loa Observatory, Hawaii, and Table Mountain Facility, California.

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Tao Li School of Earth and Space Sciences

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Two Jet Propulsion Laboratory lidars, at the Mauna Loa Observatory, Hawaii (MLO, 19.5°N) and the Table Mountain Facility (TMF, California (34.5°N), have been measuring vertical profiles of temperature and stratospheric ozone routinely since the early 1990's. Multi-linear regression analysis was performed on the deseasonalized monthly mean lidar temperature (in Kelvin) and ozone (in %) time series for each 1 km-altitude bin from January 1995 to December 2010, a period of low volcanic aerosol loading. The altitude ranges considered are 20-45 km for ozone profiles, and 20-75 km and 30 -70 km for temperature profiles at MLO and TMF respectively. As proxies, we have selected interannual and annual components representing the 11-year solar cycle (SC), El Nino Southern Oscillation (ENSO), the Quasi-Biennial Oscillation (QBO) and a linear trend for temperature. For ozone, we added the Eliassen-Palm flux (EPf), horizontal and vertical transport. A backward elimination method was applied to select the best proxies to use. Proxies were eventually selected if their percentage of variance exceeded 5%. Noise sensitivity on the regression model was tested. Increasing the noise fraction on the original time series gives a limit beyond which the model becomes purely mathematical. As a subtropical site, MLO analysis revealed the dominance of the QBO up to 50 km (~2 K, ~6% per 15 m.s-1) and a strong negative winter signature of ENSO in the lower stratosphere and positive in the mesosphere (~1.5 K, ~5% per MEI index). The temperature annual mean response to the solar cycle shows two statistically significant maxima of ~2 K/100 F10.7 units at 35 and 55 km. The ozone annual mean response to SC is negative below 30 km (~2% per 100 F10.7 units) and positive above (~2.5% per 100 F10.7 units). Negative trends are found between 20 and 25 km. Temperature time series analysis at TMF show the dominance of QBO until the stratopause and a strong alternated signature of ENSO is observed above 50 km. The expected cooling is observed above 40 km (~1K per decade) and started in 2001. The explained variance for the ozone time series revealed a mixed influence of each proxy on each side of the ozone maximum altitude with a strong seasonal dependence, typical of mid-latitudes. The use of a mid-latitude Ozone Depleting Gas Index instead of the classical trend proxy increased the explained variance by 15% above 30 km and 9% below while reducing statistical error and increasing trends. Statistically significant maxima were found at 27 km in the annual response to SC, ODGI, ENSO and at 37 km for EPf. Higher maxima were found

at 42 km in the annual response to Solar Cycle. QBO response is out-of-phase compared to MLO's. Trends are negative below 25 km and positive above, reaching 6% per decade with a linear proxy and 12% per decade with the ODGI index at 42 km. Also for both stations, similar features in ozone lidar responses are found between SC and horizontal transport, ENSO and vertical transport.

Poster Session

6P-9 SHORT TERM AND LONG TERM EVOLUTION OF STRATOSPHERIC OZONE AT NORTHERN MID-LATITUDE STATION

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Since the mid-eighties, stratospheric ozone has been monitored at Observatoire de Haute-Provence (OHP - 44°N, 6°E) by a variety of instrume nts: Ozone total column measurements are provided by Dobson and DOAS spectrometers since respectively 1983 and 1992 while ozone vertical distribution is measured by lidar, sondes and Umkehr methods since respectively 1985, 1984 and 1983. The short term and long term evolution of ozone is analysed both regarding the total and partial ozone columns at various altitude ranges using the various measurements. Short term ozone variability is evaluated using potential vorticity (PV) time series at OHP from a high resolution PV advection model. These PV time series are compared with thresholds representative of polar and subtropical dynamical barriers at various altitude ranges. The advection of polar and tropical air masses over OHP is quantified on a multi-annual basis and its long term trend is assessed. The long term ozone evolution is analysed using a multi-linear regression model, providing a statistical relationship between stratospheric ozone variations and parameters such as the quasibiennal oscillation (QBO), the strength of the Brewer-Dobson circulation, the solar flux or the equivalent effective stratospheric chlorine (EESC). The contribution of the various proxies to ozone variability is evaluated as a function of altitude and the coherence of ozone evolution as deduced from the various time series is assessed.

Poster Session

6P-10 Ozone time series from GOMOS and SAGE II measurements

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Marko Laine Finnish Meteorological Institute

Simo Tukiainen Finnish Meteorological Institute

Viktoria Sofieva Finnish Meteorological Institute

Johanna Tamminen Finnish Meteorological Institute

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Satellite measurements are essential for monitoring changes in the global distribution of stratospheric ozone. Both the natural variation and the anthropogenic change in the vertical distribution of ozone are strongly dependent on altitude. Stratospheric ozone has been measured from space with good vertical resolution since 1984 by the SAGE II solar occultation instrument. The advantage of the occultation principle is self-calibration, which is essential for ensuring stable time series. SAGE II measurements in 1984-2005 have been a central data set in investigations of trends in the vertical distribution of ozone. This time series can now be extended by the GOMOS measurements started in 2002. GOMOS is a stellar occultation instrument and offers, therefore, a natural continuation of SAGE II measurements. In this paper we study how well GOMOS and SAGE II ozone measurements agree with each other in the period 2002-2005 when both instruments were measuring. We detail how the different spatial and temporal samplings of these two instruments affect the conformity of measurements. We also study how the modeling assumptions like absorption cross sections and aerosol-modeling affect the results. Various combined time series from GOMOS and SAGE II measurements are constructed using different estimators and latitude-time grids. We show preliminary results from a novel time series analysis based on Markov chain Monte Carlo approach.

Poster Session

6P-11 Ten years of global ozone profiling with limb-scattered sunlight by Odin-OSIRIS

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Tony Bathgate University of Saskatchewan

Chris Roth University Of Saskatchewan

The Optical Spectrograph and Infra-Red Imaging System (OSIRIS) on board the Odin spacecraft has been routinely measuring height profiles of ozone from the upper troposphere (~7km) to lower mesosphere (~60 km) since November 2001 using limb scattered sunlight. The ozone data product is retrieved using a Multiplicative Algebraic Reconstruction Technique (MART) coupled with a spherical radiative transfer model to invert the measured limb radiance profile. Sensitivity across the large height range is achieved by utilizing retrieval vectors from the both the UV (Huggins) and visible (Chappuis) sections of the ozone cross-section. The current algorithm, which produces the version 5.0x series of ozone, is sufficiently mature that all major systematic issues have been addressed. Extensive comparison with Sage III and other measurements shows excellent agreement, typically within 2% at all stratospheric altitudes and slightly larger discrepancy at the lower and higher altitudes. This data set represents an important contribution to the international monitoring of the long term evolution of ozone in the stratosphere and provides a valuable opportunity for comparison and validation of ground-based observations.

Poster Session

6P-12 Characterization of recent advances in vertical profile retrievals from the Fourier-transform infrared spectrometers in the NDACC IRWG

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Over the now more than 20 year time frame of the Network for the Detection of Atmospheric Composition Change (NDACC) both instrumentation and data analysis techniques have improved. Adapting to such changes has been an important effort within the Infrared Working Group (IRWG). During the last decade the data produced by an IRWG group has increased many fold. The number of required archival gases has doubled, initially these were O_3, HCl, HF, $ClONO_2$, HNO_3, and N_2O and recently has been increased to include CH_4, CO, C_2H_6 and HCN. The information about each gas has increased where initially only the daily average total column and its uncertainty were delivered now profiles and their associated uncertainty covariences as well as averaging kernels are available at the archive and to data users. This is done for each measurement which may be several per day. The higher vertical resolution data product places a more stringent demand on instrument and processing. It requires careful instrument lineshape (ILS) calibration of the FTS, more sophisticated retrieval processing and network wide, requires a more homogeneous sets of input retrieval parameters to obtain the desired quality of global data products.

The use by all groups and instruments of HBr calibration cell spectra was adopted early and has increased to where 55 HBr cells have been carefully produced in 3 large batches with equal amounts of low pressure HBr. The consistent use of a retrieved lineshape from these spectra in modeling atmospheric spectra is now routine. The common use of the optimal estimation (OE) method for constituent retrieval is also now fully adopted and this for instance has allowed more formal and rigorous comparisons with satellite retrievals. It also relies on a priori information that consequently constrains the network to have this as consistent as possible. Here we review the network wide effort that has lead to sets of common or consistent data to be used by all sites. These include in part the spectral regions used for each species, line parameters, interfering species, and initial constituent profiles. The use of common parameters is confounded by site humidity, altitude and latitude. For all species and sites common spectral regions are obtained. Common a priori profiles are far from appropriate. An approach similar to pressure-temperature profiles was adopted in that a specified general Whole Atmosphere Community Climate Model (WACCM) model output was determined to be the most consistent source for both the target and interfering species. The implementation and characterization of these parameters are given by the consistent uncertainty budgets and information content derived from the retrievals from across the network.

Poster Session

6P-13 Bridging the gap: Using ground based measurements to link the HCl and HNO3 satellite records

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Dan Smale NIWA

Stephen Wood NIWA

Satellite observations of atmospheric trace gases have provided extremely important data sets for quantifying atmospheric composition, global trace gas distribution, variability and evidence of long-term change. From the earliest satellites to the current suite of international and wide-ranging instruments, these measurements have provided unique and extensive data sets. Nonetheless, each instrument has its own biases and uncertainties, which can challenge measurement comparisons or inter-calibrations, particularly when data sets may be separated in time by years. For instance ozone has been measured by a variety of overlapping instruments, and ground-based measurements have often been used to fill in gaps in the satellite record. For many other species, however, there may be fewer correlative ground based measurements. In this work, comparisons of profile retrievals of HNO3 and HCl from the UARS (1991-2000) and AURA (2004-current) MLS and UARS HALOE instruments are compared with coincident profiles measured from the ground using Fourier transform spectroscopy. The ground based instruments, continuously maintained and validated are the NDACC instruments located at Lauder NZ (45S), Mauna Loa, HI (20N) and Thule, Gr (76N). Data records spanning 10-15 years, are used to provide a "bridge" between the satellite data sets, helping to ensure that time series determined from the combined UARS and AURA data sets are consistent.

Poster Session

6P-14 Observed and simulated trends of HCl, ClONO2, and HF total column abundances

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Measurements of hydrogen chloride (HCl), chlorine nitrate (ClONO$_2$), and hydrogen fluoride (HF) total column abundances with ground-based Fourier Transform InfraRed (FTIR) spectrometers are performed within the InfraRed Working Group (IRWG) of the Network for the Detection of Atmospheric Composition Change. The results from 17 such sites located between 80\,\textdegree N and 77\,\textdegree S are compared with simulations of five models with different architecture, ranging from the Bremen 2-D model through the 3-dimensional chemistry transport models (CTMs) KASIMA and SLIMCAT to the chemistry climate models (CCMs) EMAC and SOCOL. \\ Some of the measurement time series were already started in the 1980s and thus show an increase of the atmospheric chlorine and fluorine content which is due to the anthropogenic emission of chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and halons. The chlorine reservoir gases HCl and ClONO$_2$ started to decrease around 1992--1994 in the troposphere and in the mid to late 1990s in the stratosphere due to the restriction of CFC and HCFC emissions in the Montréal Protocol in 1987 and its amendments and adjustments. As fluorine is not involved in stratospheric ozone depletion, it was not restricted. However, being contained in CFCs and HCFCs, it is expected to be influenced by the Montréal Protocol, too, so that the peak or rather plateau of HF is reached around 2002--2004. \\ In this research work, the focus is on the time range 2000--2009 because at most of the measurement sites considered here, operation started before. This is well after the chlorine peak, while the fluorine one occurred within this period. \\ Trends of HCl, ClONO$_2$, and HF are calculated by fitting a linear function combined with a third order Fourier series to account for the seasonal cycle. The precision of these trends is calculated with the bootstrap method. \\ The sensitivity of the trend results to whether the Fourier series is included or not is investigated. Furthermore, trends calculated for the summer/autumn period where the variability is assumed to be less strong are compared to the results from the whole series. \\ The overall agreement between models and measurements concerning the absolute total column abundances, the seasonal cycle and the order of magnitude of the trends of HCl, ClONO$_2$, and HF is very good. HCl and ClONO$_2$ decrease as expected, while for HF, the trend is positive at most stations. However, at a few measurement sites on the northern hemisphere, there is no significant HF trend detectable or it is even negative. The measurements show a stronger latitudinal and hemispheric dependency of the trends than the model calculations. \\ At the moment, a publication on this research is in preparation.

Poster Session

6P-15 BREDOM: Using MAX-DOAS measurements for long-term observations of atmospheric trace gases

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The Bremian DOAS network for atmospheric measurements (BREDOM) is a network of high quality UV/visible spectrometers for atmospheric observation that has been set up by the University of Bremen, Germany. The aim is to provide long-term, continuous measurements of a number of stratospheric and tropospheric species at latitudes ranging from the Arctic to the equator. This is particularly useful for satellite validation, as a broad range of atmospheric situations (summer/ winter; high / low ozone, NO2, H2O; vortex/ non vortex conditions; changing albedo, cloud cover, ...) and also of different measurement conditions (high / low solar elevation) is covered. In addition, the network is also well suited for studies of tropospheric chemistry (e.g. halogen emissions), because all instruments are equipped with the MAX(multi-axis)-DOAS technique. An important step in passive remote sensing was the development from ground-based zenith sky observations to multi-axis measurements, which has enabled us to validate findings from satellite observations and study the behaviour of important trace gases in the troposphere on a local scale. Applying the Optimal Estimation Method to measured slant columns yield profile information on numerous trace gases in the troposphere. Furthermore the aerosol optical depth and other aerosol features can be retrieved using measurements of the oxygen dimer O4. This study shows time series for atmospheric amounts of trace gases like ozone, NO2, HCHO, BrO and CHOCHO for the BREDOM stations (covering 79°N to 1°S) and for different field campaigns like the Cabauw intercomparison for nitrogen dioxide measuring instruments (CINDI), which has been carried out with the support of NDACC in 2009. These data sets have been compared to satellite observations.

Poster Session

6P-16 Long term and short term variability of NO2 derived from ground-based spectrometric measurements at Zvenigorod, Russia

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Using combination of spectral and multiple regression methods we analyze variability and linear trend in the column NO2 contents measured at Zvenigorod station, 40 km west to Moscow, within the Network for the Detection of Atmospheric Composition Change (NDACC) in 1990-2011. NO2 observations are carried out during morning and evening twilight in the visual spectral range with a zenith-viewing spectrometer. The NO2 amounts in the vertical atmospheric column are obtained by integration of NO2 vertical profiles retrieved by the Chahine method using a one dimensional photochemical model and a single-scattering spherical atmospheric model to calculate the kernels of the inverse problem. This allows us to separate the NO2 content in the boundary layer exposed to atmospheric pollution and the NO2 content in the vertical column above the atmospheric boundary layer, which is very close to the stratospheric column NO2 content. This separation is very important since the NO2 content in the polluted boundary layer can exceed the NO2 content in the stratospheric column. A quality control procedure is used to rejects poor data. A special comprehensive analysis has shown that boundary-layer NO2 does not affect the retrieved stratospheric NO2 contents passed for the use. A multiple linear regression model is used to estimate the linear trend in stratospheric column NO2 and the effects of the equatorial quasi-biennial oscillation (QBO) and the 11-year cycle in solar activity and on stratospheric NO2. The model also takes into account the NO2 seasonal cycle, the effect of the Pinatubo eruption on stratospheric NO2, effects of the El Nino-Southern Oscillation and the North Atlantic Oscillation. The estimated linear trend in stratospheric column NO2 is about –(8.5±2.2)% per decade for morning as well as evening NO2 contents, which confirms the previous trend estimates for Zvenigorod. The solar cycle and equatorial QBO effects on stratospheric NO2 at Zvenigorod are statistically significant. NO2 undergoes variations that are opposite by phase to the 11-year solar cycle. The stratospheric column NO2 contents are by about 9% larger during the phase of solar minimum than during the phase of solar maximum. The quasi-biennial variations in stratospheric column NO2 with about 1% amplitude are approximately in phase with the QBO in the equatorial wind velocity at the 30 hPa pressure level. The NO2 columns are by about 2% larger when the 30 hPa equatorial wind velocity is in maximal westerly phase than when it is in maximal easterly phase. The solar cycle and equatorial QBO effects in stratospheric NO2 are confirmed by spectral and cross-spectral analyses. The power spectrum of stratospheric column NO2 contains also relatively weak spectral maxima at intra-annual periods, for example at periods of about 7 and 20 days, 1.5 and 3 months. Additional analysis shows that there is actually a statistically significant weekly cycle in stratospheric NO_2 with amplitude of 2%. This cycle is characterized by reduced NO_2 contents in the beginning of the week and enhanced contents before the weekend. The NO_2 weekly cycle correlates with the weekly cycle in stratospheric temperature, and the two anticorrelate with the weekly cycle in the stratospheric wind velocity. Unlike stratospheric NO_2 there is no weekly cycle in the boundary layer NO_2 contents, and this result is confirmed by the absence of weekly cycles in meteorological parameters in the lower troposphere near Moscow.

Poster Session

6P-17 ATMOSPHERE: "Long term evolution and trends in ozone, atmospheric composition, temperature, aerosols, & Origin Of Atmospheric Pollution (Aerosols, Clouds , Water Cycle) and study of key sources of satellites , Space Shuttle & Rockets "

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Aerosols is the smallest part of the atmosphere it's activity creating unbalanced the atmospheric composition . The composition of the clouds Aerosols and hydrological cycle are connected with radiation In single word we can say that it's a reaction of various exited and non exited Chemical in the atmosphere . Aerosols origin based on soil erosion , dust particles , Val cones ,forest and the activity of the wild life animals , human activities(Industry , Vehicle Pollution, & etc.) , such as the burning of fossil fuel , dust storms ,Sea spray etc. In similarly the origin of aerosols is effecting to all the part of pollution in other word we can say that aerosols is the smallest unit of the pollution .In the origin of aerosols is the starting process of pollution . The tiny particles (aerosols) origin depend in to the human activity in the atmospheric planet . These aerosols start the absorption of radiation or in other word we can say that start the reaction between the aerosols and radiation because both origin are chemically and the similarity is that both are the exited state of the chemical's in the atmosphere . They also produce brighter clouds that are less efficient at releasing precipitation. These in turn lead to large reductions in the parts of the radiation reaching Earth's surface, these radiation's heating of the atmosphere, changes the composition of the atmospheric temperature, unbalanced rainfall, and small amount removal of pollutants. These aerosol are creating the weaker hydrological cycle in day by day , which is connecting directly to availability and quality of water in the river and other sources of water , a major environmental problem of the today scenario.

Poster Session

6P-18 Overview of the NDACC-France activities within Ether facilities

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Ether is the French Atmospheric Chemistry Data Centre Appointed by the French Space Agency (CNES) and CNRS (Centre National de la Recherche Scientifique)/INSU (Institut National des Sciences de l'Univers). The objective is to process, disseminate and archive the data from several sensors and to ensure the services oriented towards end-users. Currently, Ether evolves to integrate functions of valorization of data, of assistance to the use of the products by a broad community, including nonscientist, and positions within national and international projects (e;g. GMES). Ether activities include data management produce by space borne, ground based or balloon borne instruments and the development of tools to help data use and data analysis. The NDACC activities in France, grouped in the Service d'Observation NDACC-France of CNRS/INSU and coordinated nationally by OVSQ (Observatoire de l'Université de Versailles) benefit from the support of the Ether data centre with : - the management and maintenance of a common data base for the level 2 products provided by the respective principal investigators, - data delivery to the international NDACC database in the required format, - documentation, bibliography, data access and added-value productions like visualizations available through a devoted web site : http://ether.ipsl.jussieu.fr/NDACC/, - users assistance and site maintenance. The Ether contribution to the NDACC activities in France will be detailed as well as the future plans for improved support to data analyses including the provision of data file conversions tools, more sophisticated data visualizations, new data ordering tools, the development of a bibliography database and an user intranet. Ether ensures through this activity the promotion of the NDACC French network and permits to gather data and information in one focal point.

6P-19 Long-term Trends in Fluorinated Species: Comparison of NDACC and ACE Satellite Observations with a 3-D Model

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Although fluorine does not catalytically destroy stratospheric ozone it is important to observe long-term trends in F-containing species. Many fluorine source gases also contain chlorine (e.g. CFCs) and therefore the observations act as a check on the success of the Montreal Protocol. Other F-containing species which do not destroy ozone (e.g. HFCs) are still potent greenhouse gases. Observations of the stratospheric degradation products (e.g. COFCl, COF_2 and ultimately HF) provide a an important test that we understand the overall budget and loss rates of F-containing species. In this study we have compared long-term simulations of the SLIMCAT 3-D chemical transport model (CTM) with NDACC column observations and ACE/HALOE satellite observations.

The TOMCAT/SLIMCAT off-line 3-D CTM was integrated from 1977 until the present day using ECMWF ERA-40 and ERA-Interim meteorology. The model had a resolution of 5.6o x 5.6o and 32 levels from the surface to ~60km. The model contained a detailed treatment of stratospheric chemistry and an explicit treatment of the major F-containing source gases including CFCs, HCFCs, HFCs and halons. The model was forced with surface mixing ratios of the source gases from datasets prepared for the WMO/UNEP assessments.

We will discuss the modelled distribution and trends of the F-containing species. The ACE instrument (Brown et al., 2011) provides profiles of a wide number of relevant species from 2004 to the present day. These data are used to test the model loss processes of the source gases and the production rates of the COFCl, COF_2 and HF products. The profile information complements the longer term NDACC ground-based data.

Brown, A., M. Chipperfield, C. Boone, C. Wilson, K. Walker and Peter Bernath, The success of the Montreal Protocol: Trends in atmospheric halogenated gases since, J. Quant Spectroscopy and Radiative Transfer, (in press), 2011.