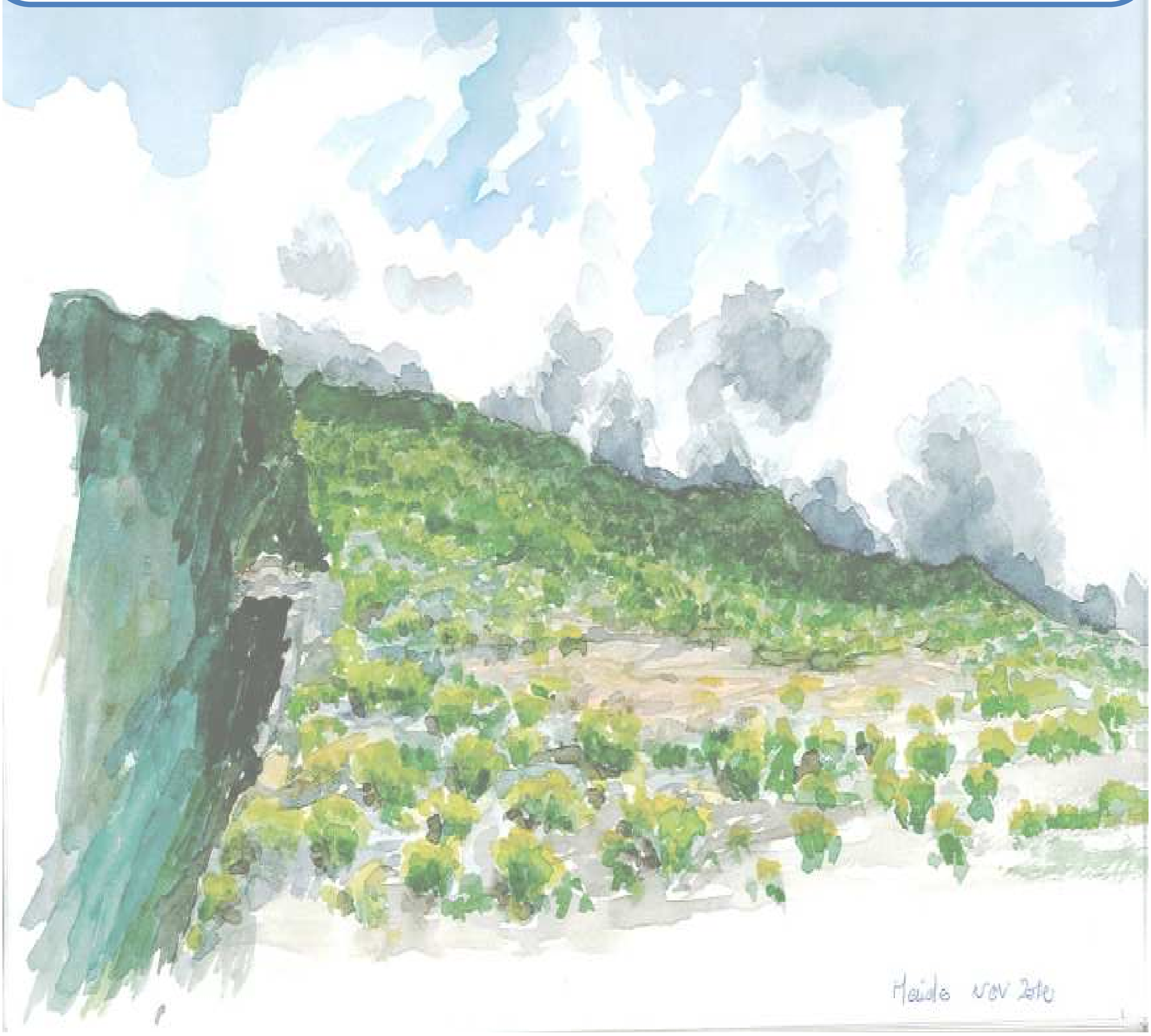
2011 NDACC Symposium

Network for the Detection of Atmospheric Composition Change

SESSION 9

AEROSOLS, RADIATION AND SPECTRAL UV



Oral Session

9-1 New balance of risks and benefits of UV radiation – a challenge for the NDACC ?

Gunther Seckmeyer Leibniz University of Hannover, institute of meteorology

Richard McKenzie NIWA

Historically, one of the major motivations to set up high accuracy long-term observations within NDACC has been the effect of a changing atmospheric composition on humans. The link between changing atmospheric composition an its effect was primarily seen via the connection of decreased ozone levels and increased Ultraviolet radiation. In fact, ultraviolet radiation from the sun causes a considerable global disease burden including acute and chronic health effects on the skin, eye and immune system. Worldwide up to 60,000 deaths a year are estimated to be caused by ultraviolet radiation, most of which are due to malignant melanoma. On the other hand some UV is essential for the production of vitamin D in people. Emerging evidence suggests an association between vitamin D levels as an indicator of health risk relating to some cancers, cardiovascular disease and multiple sclerosis among others, along with the established link with musculo-skeletal health. This lead to the conclusion to pay more attention to the positive role of UV radiation – a change in perspective which is also relevant with the expected ozone recovery, which may result in higher ozone levels than those observed before the ozone hole became apparent. This new perspective of the impact of UV radiation partly requires new instrumentation and a focus on winter UV rather than on summer UV only. Instead of rotating the grating to scan the spectrum across an exit slit onto a photomultiplier detector, in these instruments the spectrum of UV irradiance is imaged onto a detector consisting of many elements e.g., a diode array. Thus the entire spectral region of interest is measured at essentially the same time. This is the so-called multiplex advantage. The major advantage of array spectroradiometers is their relatively fast detection of the spectrum. While scanning spectroradiometers typically measure a spectrum within several minutes, the array instruments are capable of measuring a spectrum within a second or faster. This enables new applications of these instruments, such as measuring spectral radiance or irradiance under changing conditions. Other advantages include: (1) portability that arises from their compact design, (2) stability and reliability that arises from having no moving parts, and (3) good stability of the photodiodes compared with photomultipliers. For the measurement of solar UV radiation received at the Earth’s surface, the main disadvantage of array spectroradiometers is their inability to reduce stray light to an acceptable level. In conventional scanning instruments, the stray light problem can be reduced appreciably by the use of double dispersion. This option is not available in array instruments, and typically limits the lowest wavelength achievable to longer than 300 nm for solar measurements. Other disadvantages include: (1) the higher detection threshold of diode array spectroradiometers compared with scanning spectroradiometers using photomultipliers, and (2) the uncertainties associated with the correction of the dark current, which may vary from diode to diode and is strongly temperature dependent. The array spectroradiometers for the

measurement of the above four physical UV quantities are defined and their specifications are given, including remarks on how these specifications are connected to the scientific objectives of UV research.

Oral Session

9-2 Long-term Observations of Surface UV Radiation in Polar Regions

Germar Bernhard Biospherical Instruments Inc.

Charles R. Booth Biospherical Instruments Inc.

John Frederick The University of Chicago

Biospherical Instruments (BSI) has been operating the National Science Foundation’s UV Spectral Irradiance Monitoring Network (UVSIMN) since 1988. Spectroradiometers are located in Antarctica (South Pole, McMurdo and Palmer Stations); Ushuaia, Argentina; San Diego, California; Barrow, Alaska; and Summit, Greenland. The datasets include measurements of spectral irradiance between 290 and 600 nm at 1 nm resolution; derived data products such as the UV Index, total ozone, effective surface albedo, and cloud optical depth; and results of calculations with a radiative transfer model. In 2009, the quality of the datasets was assessed by members of the NDACC Spectral UV Working Group and the Steering Committee, and the measurements were accepted for inclusion in the NDACC database. Measurements of all UVSIMN sites with the exception of San Diego have now been submitted to the NDACC archive. In 2010, the UVSIMN has been reorganized. The Arctic sites, Barrow and Summit, are now part of the NSF Arctic Observing Network (http://aoncadis.ucar.edu/). Operation of the systems at South Pole, McMurdo, and Palmer is now overseen by NOAA's Global Monitoring Division, and measurements at Ushuaia were discontinued. Data from the Arctic and Antarctic sites continue to be processed by BSI and submitted to the NDACC data archive. At the South Pole, McMurdo, and Summit, the retrieval of total ozone from global UV spectra takes advantage of ozone and temperature profile measurements that are regularly performed at these sites. The accuracy of these ozone data is similar to that of Dobson and Brewer measurements and can be used as an independent dataset for the validation of satellite ozone observations. The dataset is now long enough to establish climatologies (average and variability) and trends of UV radiation with confidence. The analysis indicates a large effect of the ozone hole on UV-B radiation at the three Antarctic sites. For example, UV Indices measured at the South Pole during the ozone hole period (October and November) are 20% – 80% larger than measurements at comparable solar elevations during summer months. In October and November, the average UV Index between 1991 and 2006 derived from UVSIMN measurements was 55% – 85% larger than the UV Index for the years 1963 – 1980, estimated from proxy measurements and model calculations. The annual cycle of UV radiation at Barrow is governed by large seasonal changes of total ozone, albedo, and cloud cover, indicating that factors other than ozone are important drivers for long-term changes. Estimates of trends of UV radiation and their uncertainty depend on (1) the actual variability, (2) measurement uncertainties (including step-changes in dataset caused by modification to instruments and data processing methods), and (3) data gaps. A new method has recently been developed to address all three factors and was applied to the UV dataset for Barrow and South

Pole. Step-changes in the data record were assessed and corrected by comparing measurements with model calculations for times when the atmospheric attenuation is well defined (e.g., no clouds, minimal aerosols, known surface albedo). The effect of data gaps on trend estimates was also quantified. For the month of October at Barrow, we observed a surprisingly large and statistically significant downward trend of 12% per decade for both the UV Index (affected by ozone) and spectral irradiance at 345 nm (not affected by ozone). This trend is likely caused by long-term changes in cloudiness and surface albedo, which in turn is determined by snow cover. We also found positive trends in total ozone for spring and summer months, which are consistent with the recently observed onset of the ozone layer's recovery.

Oral Session

9-3 The Odin-OSIRIS Stratospheric Aerosol Data Product

Nick Lloyd University of Saskatchewan

Douglas Degenstein University of Saskatchewan

Nick Lloyd University of Saskatchewan

The Optical Spectrograph and Infra-Red Imaging System (OSIRIS) on board the Odin spacecraft has been routinely measuring height profiles of aerosol extinction from the upper troposphere (~7km) to middle stratosphere (~45 km) since November 2001 using limb scattered sunlight. The aerosol 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. The current algorithm, which produces the version 5.0x series of aerosol extinction, is relatively mature but must assume the aerosol particles are spherical and have a given a-priori mode radius and width. Extensive comparison with Sage III is good. Seasonal differences do occur and are probably attributable to errors in our knowledge of the scattering phase-matrix. The Odin-OSIRIS aerosol product is able to provide valuable insights into both the long term and short term evolution of stratospheric aerosols and have been used to investigate the impact of both volcanic activity and pyro-convective (forest fires) events upon the stratosphere. Aerosols continue to be a major uncertainty in climate modeling and the Odin-OSIRIS aerosol data product is an important international contribution to our further understanding of this complex interaction.

Oral Session

9-4 35 Years of Stratospheric Aerosol Measurements at Garmisch-Partenkirchen (1976-2011)

Thomas Trickl Karlsruher Institut für Technologie, IMK-IFU, Kreuzeckbahnstr. 19, D-82467 Garmisch-Partenkirchen

Helmuth Giehl Karlsruher Institut für Technologie, IMK-IFU, Kreuzeckbahnstr. 19, D-82467 Garmisch-Partenkirchen

Horst Jäger Karlsruher Institut für Technologie, IMK-IFU, Kreuzeckbahnstr. 19, D-82467 Garmisch-Partenkirchen

The powerful backscatter lidar at Garmisch-Partenkirchen (Germany) has almost continually delivered backscatter coefficients of the stratospheric aerosol since 1976. The time series is dominated by signals from the particles injected into the stratosphere by major volcanic eruptions, in particular those of El Chichon (Mexico, 1982) and Mt. Pinatubo (Philippines, 1991). The volcanic aerosol disappears within about five years, the removal from the stratosphere being modulated by the phase of the quasi-biennial oscillation [1]. During the long-lasting background period since the late 1990s the stratospheric backscatter coefficients have reached a level even below that observed in the late 1970s. This suggests that the predicted potential influence of the strongly growing air traffic on the stratospheric aerosol loading is very low. Some correlation of the background aerosol with strong forest fires is found. Detailed case studies have been carried out for two pyro-cumulonimbus events [2,3]. From 2003 to 2006 there was some indication of a growing aerosol. This increase is much less obvious than that registered at Boulder (U.S.A.) and Mauna Loa (Hawaii) even many years earlier, both stations being located at lower latitudes. There, it was ascribed to the influence of the growing East Asian air pollution [4]. The pronounced latitudinal difference of the stratospheric aerosol background is difficult to understand since, for comparison, volcanic aerosol is redistributed in the northern hemisphere within less than one year. A more thorough analysis, also clarifying the differences in seasonal cycle and involving the results from other NDACC stations, is needed for a full interpretation. Unfortunately, in recent years, reviving volcanic activity has ended the long background period making a clear trend analysis for the growing background very difficult. During this volcanic period, a special event for Central Europe was the Eyjafjallajökull eruption on April 14, 2010. The plume reached the Dutch and German coast on April 16 and then proceeded to the Alps on the following day where it was blocked by a low-pressure system. The Icelandic plume was observed over Garmisch-Partenkirchen up to the lower stratosphere between April 17 and 20, with both the aerosol lidar and the 817-nm Zugspitze water-vapour lidar. The maximum altitude, almost 15 km a.s.l., was reached as late as on April 20, long after the initial strong blast up to 11 km a.s.l. above Iceland. However, the main portion of the plume stayed below 5 km, with a horizontal visual range of the order of 20 km. The ash was observed by a large number of EARLINET (European Aerosol

Research Lidar Network) stations in a major co-ordinated effort emphasizing the important role of ground-based lidar networks. [1] H. Jäger, Long-term record of lidar observations of the stratospheric aerosol layer at Garmisch-Partenkirchen, J. Geophys. Res. 110 (2005), D08106, doi: 10.1029/ 2004JD005506, 9 pp. [2] M. Fromm et al., The stratospheric impact of the Chisholm PyroCumulonimbus eruption: 2. Vertical profile perspective, J. Geophys. Res. 113 (2008), D08203, doi: 10.1029/2007JD009147, 19 pp. [3] M. Fromm, D. T. Lindsey, R. Servranckx, G. Yue, T. Trickl, R. Sica, P. Doucet, S. Godin-Beekmann, The Untold Story of Pyrocumulonimbus, Bull. Am. Met. Soc. 91 (2010), 1193-1209 [4] D. Hofmann, J. Barnes, M. O'Neill, M. Trudeau, R. Neely, Increase in background stratospheric aerosol observed with lidar at Mauna Loa Observatory and Boulder, Colorado, Geophys. Res. Lett. 36 (2009), L15808, doi: 10.1029/2009GL039008, 5 pp.

Oral Session

9-5 AERONET Contributions to NDACC

Brent Holben NASA

Thomas Eck NASA/GSFC GESTAR

Alexander Smirnov NASA/Sigma Space Corp.

David Giles NASA/Sigma Space Corp.

Joel Schafer NASA/Sigma Space Corp.

Ilya Slutsker NASA/Sigma Space Corp.

Aliaksandr Sinyuk NASA/Sigma Space Corp.

Mikhail Sorokin NASA/Sigma Space Corporation

Alex Tran NASA/Sigma Space Corporation

Since 1993, AERONET data has provided total column aerosol properties (e.g., spectral aerosol optical depth) at hundreds of globally distributed surface sites including over 450 currently active stations. Because the program imposes standardization of equipment, calibration, processing and data distribution, the resulting data products are widely used to characterize aerosol properties, develop data climatologies and climate data records, validate retrievals from satellite aerosol algorithms, verify aerosol chemical transport models, and improve global scale assimilation models. Most of these endeavors were completed with quality assured level 2 data to minimize uncertainty in the analysis. In 2011,two major thrusts for the AERONET program are expected to improve the quality of the data available to the user community. AERONET has operated under Version 2 data processing since 2006. Release of Version 3 data reprocessing is expected near the time of the NDACC Symposium. Version 3 will provide improved cloud screening, retrieval of column integrated aerosol micro-physical and radiative properties, and accuracy estimates of all measurement products in addition to providing near real time QA data products. Several improved ancillary databases for NO2, BRDF, ozone, new data corrections, additional quality screening and a vector radiative transfer code are expected to improve the AERONET accuracy for the entire 18 year data record. Several of these salient improvements and new products will be presented to the NDACC Symposium with emphasis on the near real time quality assured product. Quality assured data from any AERONET site requires that an instrument has pre-field and post field calibrations, thus after a field deployment of approximately one year, a level 2 product will be available 1 to 2 months later. For assimilation and forecast models, near real time data are needed without which AERONET data are limited to retrospective studies. Under the new Version 3 of the AERONET processing expected in late 2011, a near real-time (nominally 1 to 3 hours after acquisition) aerosol observation product will be available to the community that will incorporate real-time cloud

screening and demanding QA checks to provide a reliable product for the community. Secondly the AERONET program has embarked on a series of field campaigns to spatially and temporally sample aerosol properties from a mesoscale gridded network that facilitates comparison of results to ground-based and airborne in situ monitoring. These campaigns called DRAGON (Distributed Regional Aerosol Gridded Observation Networks) will be implemented under several different aerosol regimes. The first, DRAGON USA campaign scheduled for July 2011, will emphasize fine mode aerosols of the mid-Atlantic region of the US. Gridded AERONET observations analyzed in concert with the considerable resources of NASA's Earth Venture DISCOVER AQ campaign to relate surface and airborne in situ particulates and trace gas measurements to remote sensing observations for air quality assessment will provide an opportunity to compare, understand and eventually validate independently derived aerosol properties such as particle size distribution, single scattering albedo and particle phase function. Future DRAGON campaigns are planned in East Asia in spring of 2012.

Oral Session

9-6 The NASA Micro Pulse Lidar Network (MPLNET)

Ellsworth Welton NASA Goddard Space Flight Center

Timothy Berkoff UMBC/Goddard Space Flight Center

James Campbell Naval Research Laboratory Monterey

Sebastian Stewart SSAI/Goddard Space Flight Center

Larry Belcher SSAI/Goddard Space Flight Center

Jasper Lewis ORAU/Goddard Space Flight Center

Brent Holben NASA Goddard Space Flight Center

The NASA Micro Pulse Lidar Network (MPLNET) is a federated network of Micro Pulse Lidar (MPL) systems designed to measure aerosol and cloud vertical structure continuously, day and night, over long time periods required to contribute to climate change studies and provide ground validation for models and satellite sensors in the NASA Earth Observing System (EOS). At present, there are eighteen permanent sites worldwide, and several more to be completed soon. Numerous temporary sites have also been deployed in support of various field campaigns since the start of MPLNET in 2000. Most MPLNET sites are co-located with sites in the NASA Aerosol Robotic Network (AERONET) to provide both column and vertically resolved aerosol and cloud data. MPLNET has been providing quality near real time (NRT) lidar data through a public website since 2000. MPLNET NRT data products include: Level 1 lidar signals and diagnostics; Level 1.5b cloud, aerosol, and PBL heights; and Level 1.5a aerosol properties (e.g. profiles of extinction and other inherent properties). The data are acquired continuously, day and night, using a standard resolution (1 minute temporal, 75 m vertical) and are available in NRT (one hour to one day delay). The operational NRT products are not quality assured (no data screening). Level 2 quality assured products are available, but not in NRT. We will provide an overview of the MPLNET project, including instrumentation, calibration, and data processing. We will present examples that demonstrate the utility of MPLNET data, particularly those from synergistic observations with AERONET.

Oral Session

9-7 New Instruments for In-Situ Validation of Passive and Active Remote Sensor Measurements

Darrel Baumgardner Universidad Nacional Autonoma de Mexico

Greg Kok Droplet Measurement Technologies

A new generation of single particle spectrometers is being developed at Droplet Measurement Technologies for identifying particles by their depolarization signatures. The cloud particle spectrometer with depolarization (CPSD), aerosol particle spectrometer with depolarization (APSD) and backscatter cloud probe with depolarization (BCPD) are instruments that measure the degree of light depolarization of individual particles as it relates to the particle morphology. These instruments are suitable for validation programs designed to compare in situ measurements with ground and space-borne remote sensors using aircraft platforms to carry the CPSD and APSD and aerosondes (balloon or dropsondes) to do vertical profiles with the BCPD. The BCPD, because of its small size and weight is also suitable for use on commercial airliners or Unmanned Airborne Vehicles (UAVs). An early version of the CPSD has already taken several hundred hours of cloud data, the APSD has been operating for months at the SIRTA research site in France, and the non-polarization version of the BCPD has been tested on the British BAE 146 in comparison with other cloud probes. This presentation will describe the instruments' theory of operation, show examples of the data taken with them, and discuss future plans for use on aerosondes, commercial airliners and UAVs.

Poster Session

9P-1 LONG TERM BIOMASS BURNING OBSERVATIONS IN SOUTH AMERICA AT BUENOS AIRES LIDAR STATION

Lidia Ana Otero CEILAP (CITEDEF - CONICET)

Pablo Roberto Ristori CEILAP (CITEDEF - CONICET)

Jacobo Omar Salvador CEILAP (CITEDEF - CONICET)

Eduardo Jaime Quel CEILAP (CITEDEF - CONICET)

Human initiated biomass burning events of massive surfaces in South America after the harvest can be observed at Buenos Aires close to September every year. These evens involve the transport of aerosol plumes along several measuring sites in Argentina, especially over two Aeronet and one lidar station. The Lidar Division at CEILAP (CITEFA-CONICET) performs routine lidar measurement and observes these events since the construction of the multiwavelength lidar in 2003. The lidar detect the atmospheric incoming radiation from the first three harmoics of a Nd:YAG laser, its nitrogen Raman shifted wavelength atmospheric returns of the visible and ultraviolet wavelengths and the water vapor Raman return of the ultraviolet wavelength atmospheric returns. This work summarizes the analysis and the conclusions achieved during of these observations periods. In general during the biomass burning event the aerosol optical depth at Buenos Aires is as far as two times the expected value. The layers arrive at heights between 3 and 6 km, normally not being donward mixed into the boundary layer.

Poster Session

9P-2 Impact of the eruption of the Sarychev volcano during the 2009 STRAPOLETE campaign

Fabrice Jégou Laboratoire de Physique et Chimie de l'Environement et de l'Espace

Gwenaël Berthet Laboratoire de Physique et Chimie de l'Environement et de l'Espace

James M. Haywood Climate, Chemistry and Ecosystems, Met Office Hadley Centre

Jean-Batiste Renard Laboratoire de Physique et Chimie de l'Environement et de l'Espace

Quentin Bourgeois ETH Zürich Institut, f. Atmosphäre und Klima

Gisèle Krysztofiak Laboratoire de Physique et Chimie de l'Environement et de l'Espace

Valéry Catoire Laboratoire de Physique et Chimie de l'Environement et de l'Espace

Cathy Clerbaux Laboratoire Atmosphères Milieux Observations Spatiales

Nathalie Huret Laboratoire de Physique et Chimie de l'Environement et de l'Espace

Two mobile Aerosol Raman Lidars (MARL, ComCAL) have been built at AWI [1,2] in order to be able to make measurements in different geographical regions. The lidar systems are installed in 20 ft laboratory containers and can thus be easily shipped to places of interest. The lidars allow us to detect particles in the atmosphere with high vertical and temporal resolution.

With the elastic backscatter signals at 355 nm and 532 nm ice clouds are detected in the altitude range between 2 km and 30 km. Separate channels detect the elastic backscatter with a polarization plane perpendicular with respect to the polarisation of the outgoing laser beam, allowing the determination of the particle backscatter. The depolarisation is an indicator of the particle shape and therefore allows the discrimination between large (r > 5 µm) ice particles which give rise to strong depolarization and small spherical particles which are considered as aerosol.

We will present an overview over the most interesting results obtained in the last decade, which also contribute to NDACC, the global Network of Detection of Atmospheric Composition Change. Within this period numerous measurement campaigns have been performed either aboard a ship (research vessel Polarstern) or at selected locations ranging from the Arctic (Ny-Alesund, 79°N) to Southern Chile (Punta Arenas, 53°S). Among the camp aigns performed are ALBATROSS, INCA, PAZI, ACCENT-ACLIT, PEP, ZTT, STAR, ACCENT-ACTROP and LAPBIAT. Major target of the measurements are cirrus clouds including extremely thin cirrus which frequently occur in the tropical tropopause layer (TTL).

During the European heat wave summer 2003 with predominant high pressure conditions we performed a detailed study of upper tropospheric humidity and ice particles which yielded striking results concerning the occurrence of ice supersaturated regions (ISSR), cirrus and contrails. The lidar measurements were performed at Lindenberg/Germany (52.2°N, 14.1°E). Cirrus clouds were detected in 55% of the lidar profiles and a large fraction of them were subvisible (optical depth < 0.03). Thin ice clouds were particularly ubiquitous in high pressure systems.

In recent years we have conducted a number of field campaigns in the tropics with our Lidar systems at Paramaribo/Suriname (5.8°N, 55.2°W). Whe n analyzing the Lidar data obtained from measurements in the tropics we paid special attention to the occurrence of ice clouds in the TTL. With a newly developed trajectory model we found that ice particles form in slow ascent [1]. We could show that the temperature in the TTL is influenced by downward propagating equatorial Kelvin waves and that cirrus formation is strongly correlated with the activity of these waves. Radiosonde as well as operational ECMWF analysis show that temperature anomalies caused by equatorial Kelvin waves propagate downward, well below the cold point tropopause (CPT).

We find a clear correlation between the temperature anomalies introduced by these waves and the occurrence of thin cirrus in the TTL. In particular we found that extremely thin ice clouds form regularly where cold anomalies shift the tropopause to high altitudes. Our observations and model studies suggest that in-situ formed cirrus clouds efficiently dehydrate the ascending air in the TTL. Obviously, Kelvin waves play an important role for the dehydration mechanism of the TTL and thus for stratospheric water vapour concentration.

References:

[1] F. Immler, K. Krüger, S. Tegtmeier, M. Fujiwara, P. Fortuin, G. Verver, O. Schrems, J. Geophys. Res. 112, D03209, doi: 10.1029/2006JD007440 (2007).

[2] F.Immler, R. Treffeisen, D. Engelbart, K. Krüger, O. Schrems, Atmos. Chem. Phys. 8, 1689 (2008)

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Poster Session

9P-3 Lidar observations of thin ice clouds in mid latitudes and in the tropics

Otto Schrems Alfred Wegener Institute for Polar and Marine Research, Climate Siences, Bremerhaven

Franz Immler German Weather Service, GRUAN lead centre, Lindenberg

Two mobile Aerosol Raman Lidars (MARL, ComCAL) have been built at AWI [1,2] in order to be able to make measurements in different geographical regions. The lidar systems are installed in 20 ft laboratory containers and can thus be easily shipped to places of interest. The lidars allow us to detect particles in the atmosphere with high vertical and temporal resolution.

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[2] F.Immler, R. Treffeisen, D. Engelbart, K. Krüger, O. Schrems, *Atmos. Chem. Phys.* 8, 1689 (2008)

Poster Session

9P-4 Radiative measurements at Thule, Greenland: factors affecting the cloud-free shortwave and longwave radiative budget in the Arctic

Claudia Di Biagio ENEA

Pietropaolo Bertagnolio INGV

Alcide di Sarra ENEA

Paul Eriksen DMI

Svend Erik Ascanius DMI

Giovanni Muscari INGV

The Arctic region plays a central role in the global climate system. Modifications in the Arctic radiative budget may strongly influence large scale atmospheric and oceanic circulation. The evaluation of the surface energy balance sensitivity to variations in several parameters, such as surface temperature, water vapour content, surface albedo, and atmospheric aerosols, is one of the main issues in assessing how the Arctic will respond to future climate changes. The NDACC station at Thule Air Base (76.5°N, 68.8°W) is equip ped with a variety of instruments for the measurement of the radiative fluxes at the surface, aerosol optical properties, water vapour atmospheric content, and meteorological parameters. A Yankee Environmental System Total Solar Pyranometer (YES-TSP) and an Eppley pyrgeometer (PIR) are installed at Thule for the measurement of the global shortwave and longwave downward irradiances at the surface. The TSP was installed in 2002, while the PIR in 2009. A Cimel Sunphotometer measures aerosol optical properties and water vapour columnar content; the Cimel is part of the Aerosol Robotic Network and was installed in 2007. In winter, the water vapour columnar content is also measured at Thule with a millimeter-wave spectrometer (GBMS) operating in the 230-280 GHz range. GBMS measurements have been carried out during several winters between 2002 and 2011. A meteorological station, which measures surface temperature and pressure, relative humidity, wind speed and direction is also continuously operational at Thule. Satellite observations of the surface shortwave albedo obtained from MODIS have been used together with ground-based measurements. Four years (2007 to 2010) of surface shortwave irradiance at the surface, aerosol optical properties, and water vapour have been combined with satellite observations of the surface albedo. Radiative transfer model calculations are used to reproduce the observed shortwave fluxes and to separate the effects of the different parameters in modulating the cloud-free downward shortwave radiation at the ground. Water vapour is the main factor affecting the cloud-free shortwave irradiance at the surface. Its column value varies between 0.1 and 1.4 cm during

the period spring to early autumn. Water vapour produces a reduction of the surface shortwave flux by -(2-12%). The surface albedo varies between 0.05 and 0.66 in the period March to September, with values larger than 0.5 in spring and smaller than 0.1 in summer. In spring the surface albedo induces an increase by +(2-4.5%) in the downward shortwave radiation. The aerosol optical depth at 500 nm is generally lower than 0.2; atmospheric aerosols produce a reduction in the shortwave radiation down to -5%. On annual base, the mean effects of water vapour and surface albedo are estimated to be –(10-11) Wm-2 and +(2-3) Wm-2, respectively. The temperature and humidity profiles in the troposphere have the strongest influence on the cloud-free downwelling longwave irradiance. In wintertime, in absence of solar radiation, the longwave fluxes dominate the surface radiation budget. GBMS water vapour measurements from winters 2009 to 2011 have been used, together with surface humidity and temperature, to investigate the relative influence of these factors in affecting the downwelling longwave irradiance.

Poster Session

9P-5 Measurements of surface ultraviolet irradiance

Béatrice Sauvage Laboratoire d'Optique Atmosphérique

Colette Brogniez Laboratoire d'Optique Atmosphérique

Emilie Miot Météo France

Aline Peuch Météo France

Vincent-Henri Peuch Météo France

Frédérique Auriol Laboratoire d'Optique Atmosphérique

Christine Deroo Laboratoire d'Optique Atmosphérique

Jean-Marc Metzger Observatoire de Physique de l'Atmosphère de la Réunion

Guy Tournois Observatoire de Haute Provence

The intensity of the solar ultraviolet radiation at the surface depends on the geographical location, on date and time, on atmospheric factors and on environmental conditions. The main atmospheric factors are the cloud cover, scattering and absorbing gas (mostly ozone) and the aerosols. This radiation has both beneficial and deleterious effects on the biosphere and health. Consequently, following the discovery of the stratospheric ozone depletion in 1985, the monitoring of this radiation began in many countries in the early 1990's. Since the recovery of the ozone layer is only expected for the second half of the XXIst century, the continuation of the UV monitoring during the coming years is essential, particularly in locations with high UV radiation such as tropical regions. Satellite sensors provide global coverage while ground-based instruments provide local monitoring of the UV radiation. Besides, modeling provides forecasts over the whole globe. The consistency of all these products needs to be checked. The Laboratoire d'Optique Atmosphérique (LOA) operates spectroradiometers in Villeneuve d'Ascq (VdA), at the Observatoire de Haute Provence (OHP) and recently in the Observatoire de Physique de l'Atmosphère de la Réunion (OPAR). These instruments enable us to evaluate the biological effects of the UV radiation and to retrieve the total ozone column via modeling. The VdA and OHP instruments are affiliated to the NDACC since 2001. Their UV and ozone products have contributed to the validation of the spatial Ozone Monitoring Instrument (OMI/Aura) measurements. A similar work has been conducted for the new instrument in La Réunion. Such a validation is valuable because only few validations of the OMI products have been performed at low latitudes. Moreover, the topography of this site, a mountainous island, is specific. In addition, cross-comparisons with the UV index and total ozone column from the spatial Global Ozone Monitoring Experiment (GOME-2/MetOp-A) have also been conducted. Météo France carries out UV index forecasts, in order to inform populations on the risks of exposure to the UV solar radiation. Météo France uses ozone forecasts from MOCAGE

(Modèle de Chimie Atmosphérique à Grande Échelle) as input data of TUV (Tropospheric Ultraviolet and Visible radiation model) radiative transfer code. Validation of these forecasts is of course necessary. Comparisons between Météo France’s UVI forecasts and ground-based measurements have been conducted for all sky conditions. Simulations have also been performed at LOA with the radiative transfer code DISORT (DIScrete Ordinate Radiative Transfer) for clear sky conditions; the input data are aerosols characteristics coming from the sun photometer from AERONET/PHOTONS network, and the total ozone column retrieved by both OMI and the ground-based spectral measurements. Intercomparisons have also been conducted.

Poster Session

9P-6 Behavior of UV-B Dose, Total Ozone Column and Temperature at the Pacific Seaboard of the Republic of Panama

Alfonso Pino University of Panama

Sergio Guerra University of Panama

Alvaro Maturell University of Panama

Jorge Espinosa Panama Canal Authority

At the Republic of Panama, high levels of UV-B dose have been registered by the Laboratory of Atmospheric Physics of the University of Panama since 1998. It has been determined that at the tropics, cloud cover is a major factor for the attenuation of UV-B radiation. At the latitude of the Republic of Panama, a high anti-correlation between UV-B dose and cloud cover has been observed. During the 2005 and 2009, the cloud cover over the Republic of Panama decreased significantly. As a consequence of the predominance of clear sky conditions, the annual total dose, during the years mentioned before, increased with respect to the mean value of this parameter. This condition of low cloudiness could be linked to El Niño events 2004-2005 and 2009-2010. The broadband radiometers, 501 UV-Biometers, installed at the monitoring sites of the radiometric network managed by the University of Panama, have registered extreme UV Indexes during 87% of dry season period. Total ozone column shows an annual seasonal behavior with a minimum value during January (231 DU) and a maximum value during August (280 DU). Average total ozone column is 255 DU. Nevertheless, these values lie within the variability margin correspondent to the Panama City latitude. The oscillatory seasonal behavior which characterizes total ozone column could be modeled by means of a harmonic function. This presentation will emphasize an inter comparison of UV-B radiation levels at the monitoring sites as well as the correlation between normalized UV-B dose and cloudiness. In order to assess the evolution of Climate Change at the Republic of Panama, meteorological data provided by the National Hydrometeorological Center has been analyzed. This data was collected since 1979 to 2009 at six meteorological stations. These stations are located near the Pacific seaboard and one of them is located at a mountainous zone. The data analysis has permitted to establish that minimum temperature anomaly, measured in all these stations, shows a positive slope trend through all the time series. By means of a linear trend filter, applied to all the data, it was determined that, in all the stations, minimum temperature is increasing in an approximate rate of 0,25º C per decade.

Poster Session

9P-7 Surface UV at polar and mid-latitude "Ozone in the Atmosphere"

Adil Hakeem Khan Govt. Kasturba Girls College Jiwaji University Guna M.P. India

Ozone is the magical part of the Earth atmosphere It absorbs solar radiation at wave lengths shorter than 200-300 nanometers that is not absorbed by other mean gases particles like Oxygen and Nitrogen . Ozone play a major role to control the Sun rays ultra violet to protect the DNA in our Life .Life on Earth is thus directly dependent on the existence of the ozone layer. In addition, the absorption of UV radiation by ozone between 10 and 50 kilometers releases heat and thus creates a positive temperature gradient in the atmospheric layer which called stratosphere .In other word we can say temperature increases with height .In the parallel condition stratosphere from the troposphere where declining temperature with height promotes vertical circulation.

Ozone is a powerful anti oxidant(At Present Low Concentration limit 10-50 PPB) and Its beneficial role in the stratosphere, ozone in the troposphere interacts directly with living matter, with potential detrimental effects on ecosystems and human health. The harmful effects of ozone on forest & Agriculture production have been completely destroyed. ozone can directly affect human health. Also, ozone in the troposphere is a greenhouse gas with an efficiency on a per molecule basis in the atmosphere 1,200 times larger than that of carbon dioxide, the main contributor to the greenhouse effect. Ozone is thus responsible, directly and indirectly in the green house gases.

Poster Session

9P-8 An Introduction to the WCRP/GEWEX Baseline Surface Radiation Network (BSRN), a New NDACC Cooperating Network

Dutton Haefflin Institut Pierre Simon Laplace, Palaiseau Cedex, France

Originally initiated as a project of the World Climate Research Program (WCRP) in 1988, BSRN began field-data gathering activities on 1 January 1992 after organizational and observational specification requirements had been established and met. The original need for the BSRN was recognized primarily from the lack of high-quality, globally-remote, surface-based thermal infrared (IR) irradiance observations to which planned satellite surface radiation budget products could be compared for validation. It was soon also recognized that there was a need for more extensive and improved ground-based observations of solar surface radiation budget components for multiple applications in climate research. Subsequently, BSRN data have been used for radiative transfer and related climate model comparisons as well as for providing valuable detailed observational records of local and regional surface radiation climatology. Solar and IR irradiance data were accumulated from five field sites in 1992, then five more in 1993, four more in 1994 and so on until by 2010 fifty-two worldwide sites had provided data to the network archive, which is currently located at the Alfred Wegener Institute in Bremerhaven Germany. Forty-one of those sites have continued to submit routine high-time resolution data since they began, while only three sites have discontinued operations. Data submissions have lag times of up to about three years, although more rapid submission is encouraged and some sites update their records monthly. Several additional "candidate" sites have been approved for participation in BSRN, but which have not yet submitted data. The archived data are extensively used for satellite validation and in various climate modeling studies as well as providing observational records of inter- and intra-annual variability. Related contributions have been made to the assessment of possible worldwide inter-annual variations in both solar and IR. The success and proliferation of the network relied on the reduction in observational uncertainty that included instrumentation improvements and the development of international-consensus absolute-calibration reference standards for irradiance quantities for which such standards did not previously exist. The overall effort also required advanced data handling and archival capabilities. This presentation covers major activities and accomplishments of the BSRN along with the status of current progress and participation in climate research activities. The BSRN became a Cooperating Network of NDACC in the summer of 2011, and had been previously enlisted as the Global Climate Observing System (GCOS) Global Baseline Surface Radiation Network in 2004. BSRN was incorporated into the WCRP GEWEX project in 1996.

Note: All participation in, and contributions to, BSRN have been voluntarily provided by individuals and their sponsoring governments and/or institutions. Major contributions, such as: five or more field sites, providing for the physical data archive and web services, or providing extensive documentation, have been made by Switzerland, Germany, Canada, Brazil, Japan, and the United States. The Authors wish to acknowledge all those who have worked to contribution time, expertise, and data to the BSRN, which includes more than 70 individuals from more than 20 countries.