Environmental Physics Division
Fachverband Umweltphysik (UP)

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Übersicht der Hauptvorträge und Fachsitzungen

(Vorträge: G 1.011; Poster: Wassersaal;
Symposium Klimawandel – was nun?: RW HS)

Hauptvorträge

UP 2.1	Mon	10:45–11:15	G 1.011	**Remote Sensing of Greenhouse Gases from Ground and Space** — •André Butz
UP 4.2	Mon	14:15–14:45	G 1.011	**The response of the stratospheric circulation to climate change** — •Hella Garny
UP 6.1	Tue	16:30–17:00	G 1.011	**Simple relations for mixing in estuaries** — •Hans Burchard
UP 7.1	Tue	17:30–18:00	G 1.011	**Ice formation and crystallization in mesospheric clouds** — •Denis Duft, Mario Nachbar, Thomas Leisner

Hauptvorträge des fachübergreifenden Symposiums Klimawandel – was nun?

Das vollständige Programm dieses Symposiums ist unter SYKW aufgeführt.

SYKW 1.1	Tue	14:00–14:30	RW HS	**Das Ende der Eis-Zeit?** — •Dirk Notz
SYKW 1.2	Tue	14:30–15:00	RW HS	**Dekarbonisierung des globalen Energiesystems: Optionen und kosteneffiziente Strategien** — •Thomas Bruckner
SYKW 1.3	Tue	15:00–15:30	RW HS	**Retten die Klimaingenieure die Welt?** — •Jost Heintzenberg
SYKW 1.4	Tue	15:30–16:00	RW HS	**Anpassung an den Klimawandel: was kommt auf uns zu und wie müssen wir reagieren?** — •Daniela Jacob

Fachsitzungen

UP 1	Mon	10:30–10:45	G 1.011	**Begrüßung**
UP 2.1–2.6	Mon	10:45–12:30	G 1.011	**Atmosphere - trace gases, Methods - remote sensing**
UP 3	Mon	12:45–13:45	G 1.011	**Mitgliederversammlung mit Mittagsimbiss**
UP 4.1–4.2	Mon	14:00–14:45	G 1.011	**Climate modelling**
UP 5.1–5.9	Mon	14:45–17:30	G 1.011	**Atmosphere - trace gases, aerosols; Methods -measurement techniques**
UP 6.1–6.3	Tue	16:30–17:30	G 1.011	**Oceanography**
UP 7.1–7.2	Tue	17:30–18:15	G 1.011	**Atmosphere - lab studies**
UP 8.1–8.7	Wed	14:00–15:45	G 1.011	**Methods - measurement techniques; Atmosphere - trace gases, mesosphere**
UP 9.1–9.9	Wed	16:15–18:15	Orangerie	**Poster session**

Mitgliederversammlung des Fachverbands Umweltphysik

Montag 12:45 - 13:45 G 1.011
Mitgliederversammlung für alle Mitglieder des Fachverbandes mit Mittagsimbiss, Gäste willkommen

UP 1: Begrüßung

Time: Monday 10:30–10:45 Location: G 1.011

Begrüßung durch Prof. Christian von Savigny

UP 2: Atmosphere - trace gases, Methods - remote sensing

Time: Monday 10:45–12:30 Location: G 1.011

Invited Talk UP 2.1 Mon 10:45 G 1.011

Remote Sensing of Greenhouse Gases from Ground and Space — •André Butz — Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt e.V., Oberpfaffenhofen — Insitut für Umweltphysik, Universität Heidelberg

Understanding the sources and sinks of the greenhouse gases carbon dioxide and methane is key to projecting future climate. It is the respective man-made emissions that drive climate change and, it is the climate-carbon feedbacks that are among the largest uncertainties.

Here, I will review recent progress in ground-based and space-based remote sensing of carbon dioxide and methane. A particular focus will be on ground-based spectroscopic techniques that we deployed on mobile platforms at source regions such as the Mt. Etna volcano, Italy, and the Upper Silesian Coal Basin, Poland. Volcanic carbon dioxide emissions could be reliably detected at distance of 5-10 km from the crater at detection levels of about 1/1000 of the background concentration showcasing the excellent accuracy achievable in the field. Methane emissions from coal mining in Poland were found to be among the largest localized methane sources in Europe. Another focus will be on current and next-generation greenhouse gas satellite sounders and the challenges for reliable concentration retrievals. Current satellites such as GOSAT have been shown to provide robust information on climatically driven carbon cycle anomalies on sub-continental scales. Next-generation satellites will aim at improved sampling density and resolution to constrain regional-scale sources and sinks.

UP 2.2 Mon 11:15 G 1.011

Quantitative analysis of complex CH4 sources using airborne remote sensing and in-situ observations — •Sven Krautwurst, Konstantin Gerilowski, Thomas Krings, Jakob Borchardt, Michael Buchwitz, John P. Burrows, and Heinrich Bovensmann — Institute of Environmental Physics, University of Bremen, Germany

Methane (CH4) is the second most important anthropogenic greenhouse gas. However, its anthropogenic emissions, largely originating from localized sources such as fossil fuel exploitation and extraction sites or landfills, are often not readily assessed by current measurement systems and networks. A tool used to better understand and constrain emissions from these sources is the optical remote sensing instrument MAMAP (Methane Airborne MAPper), operated from aircraft. MAMAP delivers the background normalized column averaged dry air mole fractions for methane XCH4 derived from absorption spectroscopic measurements in the short-wave infrared with a precision of about 0.3%.

This talk presents MAMAP observations accompanied by airborne in-situ measurements by a Picarro greenhouse gas in-situ analyser aboard the same aircraft over oil fields and landfills in California in 2014. Based on the two data sets, independent emission rate estimates for an oil field complex in the San Joaquin Valley and a landfill in the Los Angeles Basin were derived and compared to inventory values.

UP 2.3 Mon 11:30 G 1.011

Methane retrieval and interpretation using high spatial resolution hyperspectral radiances obtained by aircraft measurements — •Jakob Borchardt, Konstantin Gerilowski, Sven Krautwurst, Michael Buchwitz, Thomas Krings, Heinrich Bovensmann, and John P. Burrows — Institute of Environmental Physics, University of Bremen, P.O. 330440, 28334 Bremen, Germany

Methane (CH_4) is an important greenhouse gas whose sources and sinks on regional scale are not well quantified. Science grade hyperspectral imaging spectrometers allow for source attribution with high spatial resolution ($\lesssim 4 \times 4\mathrm{m}^2$). The quantitative retrieval of methane (CH_4) total column variations with the "Weighting Function Modified - DOAS" algorithm (WFM-DOAS) originally developed for medium to high spectral resolution instruments ($\lesssim$ 1nm) was successfully applied to the lower spectral resolution ($\geq$ 5.5 nm) hyperspectral data. One source under investigation was a coal mine ventilation shaft located in the Four Corners region, which is known for it's high CH_4 emissions. In this talk, the adaptation of the WFM-DOAS algorithm to imaging spectroscopy measurements and the flux inversion using a mass balance approach for that source will be presented. Also a qualitative comparison with measurements taken with a commercial off-the-shelf hyperspectral sensor over coal mine ventilation shafts in silesia will be shown.

UP 2.4 Mon 11:45 G 1.011

Precise, direct, simultaneous spectroscopic measurements of CO_2 singly- and doubly-substituted isotopologues — •Ivan Prokhorov[1,2], Tobias Kluge[1], and Christof Janssen[1,2] — [1]Institute of Environmental Physics, Heidelberg University, Heidelberg, Germany — [2]LERMA-IPSL, Sorbonne University, UPMC Univ. Paris 06, CNRS, Observatoire de Paris, PSL Research University, Paris, France

The $^{17}O/^{18}O$ anomaly ($\Delta^{17}O$) and the "clumped isotope" composition $\Delta_{^{16}O^{13}C^{18}O}$ in CO_2 are new tools for quantification of temperature dependent equilibrium and non-equilibrium processes in a variety of environmental systems, requiring the analysis of multiple carbon dioxide isotopologues. Here, we present a laser-based measurement technique for precise, direct and simultaneous measurements of the six most abundant CO_2 isotopologues, including the two rare and doubly-substituted species $^{16}O^{13}C^{18}O$ and $^{16}O^{13}C^{17}O$. The prototype absorption spectrometer uses two intra-band cascade lasers (ICL) at 4.3 and 4.4 μm to detect CO_2 absorption lines in the fundamental ν_3 band. Dry pure carbon dioxide samples ($\leq$100 μmol) are analysed in a custom built multipass Herriot cell equipped with two optical path lengths of 9 cm and 9 m. A full operation cycle consists of several comparisons of the sample gas with the working reference (6–10 minutes per one comparison). Within one hour of measurements, a reproducibility at the level of 50 ppm (1SEM) is obtained. The performance of the instrument is comparable with the state of the art mass-spectrometers, but void of isobaric interferences.

UP 2.5 Mon 12:00 G 1.011

Retrieval advances of BrO/SO2 molar ratios from NOVAC — •Elsa Wilken[1], Florian Dinger[1,2], Nicole Bobrowski[1,2], Simon Warnach[1,2], and Ulrich Platt[1,2] — [1]IUP, University of Heidelberg — [2]Max-Planck Institute for Chemistry, Germany

Measurements of magnitude and composition of volcanic gas emissions allow insights in magmatic processes. Within the Network for Observation of Volcanic and Atmospheric Change(NOVAC) automatically scanning UV-spectrometers are monitoring gas emission at volcanoes. The emissions of BrO and SO2 can be retrieved from the recorded spectra by applying Differential Optical Absorption Spectroscopy(DOAS) and comparing the optical absorption of the volcanic plume to the background. Therefore, the background spectrum must not be affected by volcanic influence. Classically, the background spectrum is taken from the same scan but from a elevation angle which has been identified to be outside of the volcanic plume. However, experience shows those background spectra can still be contaminated by volcanic gases. Alternatively reference spectra can be derived from 1) a theoretical solar atlas spectrum or 2) a volcanic-gas-free reference spectrum recorded by the same instrument. 1) comes with a drawback of reduced precision, as the instrumental effects have to be modeled and added to the retrieval. For 2), the alternative reference spectrum should be recorded at similar conditions with respect to meteorology and radiation. We use 1) to check for contamination and 2) to evaluate the spectra to maintain a god fit quality. We present our approach and its results when applied on NOVAC data from Tungurahua and Nevado Del Ruiz.

UP 2.6 Mon 12:15 G 1.011

BrO/SO_2 variations in the volcanic gas plumes of Cotopaxi and Tungurahua — •Florian Dinger[1,2], Nicole Bobrowski[1,2], Simon Warnach[1,2], Stefan Bredemeyer[3], Silvana Hidalgo[4], Santiago Arellano[5], Bo Galle[5], Ulrich Platt[1,2], and Thomas Wagner[1] — [1]MPIC, Mainz, Germany — [2]IUP, Heidelberg, Germany — [3]GEOMAR, Kiel, Germany — [4]IGEPN, Quito, Ecuador — [5]CTH, Gothenburg, Sweden

Variations of the BrO/SO_2 ratio in volcanic gas plumes have been proposed as a proxy for volcanic activities. We present and discuss BrO/SO_2 data measured via remote sensing at Tungurahua and Cotopaxi. At Tungurahua, BrO/SO_2 ratios varied from $< 1 \cdot 10^{-5}$ to $16 \cdot 10^{-5}$ between 2007 and 2017. Lower ratios have been predominately observed at periods when the seismic activity elevated as it has been observed at other volcanoes, such as Nevado del Ruiz and Etna. In 2015, Cotopaxi awoke from a 72-years period of relative quiescence. The BrO/SO_2 ratios in Cotopaxi's gas plume were $< 1 \cdot 10^{-5}$ from May 2015 until the week after the phreatomagmatic explosions in August 2015 and increased to a mean value of $4 \cdot 10^{-5}$ in the period from September to December 2015. This change partially correlates with the evaporation of the hydrothermal system prior to October 2015. Further, during the period from September to December 2015 the BrO/SO_2 ratios oscillated between 2 and $8 \cdot 10^{-5}$ with a conspicuous periodic pattern of a period of 13.7 days. We found a partial correlation between BrO/SO_2 and the tide-induced surface displacement in North-South direction with a correlation coefficient of 47 %.

UP 3: Mitgliederversammlung mit Mittagsimbiss

Time: Monday 12:45–13:45 Location: G 1.011

60 min

UP 4: Climate modelling

Time: Monday 14:00–14:45 Location: G 1.011

UP 4.1 Mon 14:00 G 1.011

An explanation for the different climate sensitivities of land and ocean surfaces based on the diurnal cycle — •Axel Kleidon and Maik Renner — Max-Planck-Institut für Biogeochemie, Jena

Observations and climate model simulations consistently show a higher climate sensitivity of land surfaces compared to ocean surfaces, with the cause for this difference being still unclear. Here we show that this difference in temperature sensitivity can be explained by the different means by which the diurnal variation in solar radiation is buffered. While ocean surfaces buffer the diurnal variations by heat storage changes below the surface, land surfaces buffer it mostly by heat storage changes above the surface in the lower atmosphere that are reflected in the diurnal growth of a convective boundary layer. Storage changes below the surface allow the ocean surface-atmosphere system to maintain turbulent fluxes over day and night, while the land surface-atmosphere system maintains turbulent fluxes only during the daytime hours when the surface is heated by absorption of solar radiation. This shorter duration of turbulent fluxes on land then results in a greater sensitivity of the land surface-atmosphere system to changes in the greenhouse forcing because nighttime temperatures are then shaped by radiative exchange only, which are more sensitive to changes in greenhouse forcing. We use a simple, analytic energy balance model of the surface-atmosphere system to show that predictions compare very well with observations and CMIP 5 climate model simulations.

Invited Talk UP 4.2 Mon 14:15 G 1.011

The response of the stratospheric circulation to climate change — •Hella Garny — DLR Oberpfaffenhofen

The role of the stratosphere in the climate system is increasingly being appreciated, and it is known that the circulation of the stratosphere can significantly influence surface climate and weather. The fate of the large-scale circulation of the stratosphere in a changing climate is a much discussed topic in the last years. Progress has been made on the understanding of the mechanisms of the general acceleration of the circulation in response to climate change as simulated by models. However, observational evidence on circulation changes is still not reconciled with model simulations and with our mechanistic understanding. The key open questions on large-scale circulation changes and their possible impacts on the climate system, that will be discussed during this talk, are: (1) Process understanding: How is tracer transport (that is detectable from observations) coupled to the wave-driven mean mass circulation, the residual circulation? (2) Reconcile observations, models and reanalysis: Is decadal-scale variability causing the differences between observational records and models? Were different processes acting during the recent past compared to the long-term climate record typically analysed in global models?

UP 5: Atmosphere - trace gases, aerosols; Methods -measurement techniques

Time: Monday 14:45–17:30 Location: G 1.011

UP 5.1 Mon 14:45 G 1.011

Signaturen der Madden-Julian-Oszillation in stratosphärischem Ozon — •Christoph Hoffmann, Christian von Savigny und Martin Rödiger — Ernst Moritz Arndt Universität Greifswald, Institut für Physik, Deutschland

Die Madden-Julian-Oszillation (MJO) beschreibt den dominierenden Teil der Variabilität der tropischen Troposphäre innerhalb einer Saison (Zeitskala 60 bis 90 Tage). Immer mehr Studien zeigen, dass diese troposphärische Variabilität auch verschiedene Parameter der Stratosphäre beeinflusst und von dort ggf. wieder auf die Troposphäre zurückwirkt. Viele dieser Studien basieren jedoch auf Reanalysedaten oder Modellexperimenten.

Wir untersuchen einen möglichen statistischen Zusammenhang zwischen der MJO und Ozon als einem der wesentlichen Parameter der Stratosphäre. Dafür greifen wir direkt auf Messdaten zurück, nämlich auf den globalen und mit mehr als 30 Jahren vergleichsweise langen Datensatz der Satelliteninstrumente Solar Backscatter Ultraviolet Radiometer (SBUV). Zunächst wurde besonders der Einfluss im tropischen Bereich Asiens untersucht, da dort in der Troposphäre das Zentrum der Variabilität ist. Darüber hinaus wurde auch global nach MJO-bedingter Ozon-Variabilität gesucht. Sowohl in Asien als auch in verschiedenen anderen Gebieten ist ein entsprechendes Signal in Ozon erkennbar. Während es über Asien weitestgehend robust erscheint, muss die Aussagekraft für andere Gebiete noch geklärt werden.

UP 5.2 Mon 15:00 G 1.011

The underestimated role of stratosphere-to-troposphere transport on tropospheric ozone - Two decades of lidar vertical sounding — •Thomas Trickl[1], Hannes Vogelmann[1], Ludwig Ries[2], Hans-Eckhart Scheel[1], and Michael Sprenger[3] — [1]Karlsruher Institut für Technologie, IMK-IFU, Garmisch-Partenkirchen — [2]Umweltbundesamt, Schneefernerhaus — [3]ETH Zürich, Institut für Atmosphäre und Klima

The atmospheric composition is strongly influenced by changing atmospheric dynamics, in potential relation to climate change. A prominent example is the doubling of the stratospheric ozone component at the Zugspitze summit (2962 m) between the mid-seventies and 2005. We present lidar studies of stratospheric air intrusions since 1996, since

2007 based on routine measurements ozone, water vapour and aerosol. Combined with in-situ and sonde data as well as trajectory calculations, we identified stratospheric influence in the free troposphere on more than 80 % of the measurement days. The pronounced seasonal cycle at Alpine summit stations exhibiting a summer minimum disappears if one looks at the entire free troposphere. Very long downward transport up to a full tour around the northern hemisphere dominates the stratospheric contributions in an altitude range above 4.5 km. It is interesting to note that, in recent years, most pronounced ozone maxima have been related to a stratospheric origin rather than to long-range transport from remote boundary layers. This fact could be caused by improving air quality in the most relevant source regions or changing transport patterns.

UP 5.3 Mon 15:15 G 1.011

Lidar observations of the stratospheric aerosol layer above Northern Norway — •Arvid Brand[1], Gerd Baumgarten[1], Franz Josef Lübken[1], Jens Fiedler[1], Christian von Savigny[2], and Jacob Zalach[2] — [1]Leibniz-Institut für Atmosphärenphysik, Kühlungsborn, Deutschland — [2]Ernst-Moritz-Arndt Universität, Greifswald, Deutschland

The Stratospheric sulfate aerosol (SSA) layer is of fundamental importance for the radiative balance of the atmosphere. The layer is found in altitudes between the tropopause and 30 km. The radiative effect is due to scattering of solar and absorption of thermal infrared radiation by the aerosol particles. We use the state of the art Doppler Rayleigh/Mie/Raman lidar at the ALOMAR research station located in Northern Norway (69N, 16E) to observe the aerosol layer and derive microphysical properties. The aerosol and molecular signal is therefore derived by using a multi wavelength approach and different scattering processes. The lidar is located at the edge of the polar vortex and allows the investigation of SSA from small spatial and temporal scales to decadal variatons.

In this work results of the observations of the SSA layer above ALOMAR for the time span 2000 to 2017 are presented and discussed.

Kaffeepause, 30 min

UP 5.4 Mon 16:00 G 1.011

Größenverteilung von stratosphärischen Aerosolen aus SCIAMACHY Limb Daten — •Elizaveta Malinina[1], Alexei Rozanov[1], Landon Rieger[2], Vladimir Rozanov[1], Patricia Liebing[1], Adam Bourassa[2], Doug Degenstein[2] und John P. Burrows[1] — [1]Institut für Umweltphysik, Universität Bremen, Bremen, Deutschland — [2]University of Saskatchewan, Saskatoon, Kanada

Stratosphärisches Aerosol spielt für den Klimawandel eine große Rolle: zum einen verändert es die Strahlungsbilanz der Atmosphäre und zum anderen beteiligen sich die Aerosole an chemischen Reaktionen und wirken beim Ozonabbau mit. Das stratosphärische Aerosol ist durch den Transport von OCS aus der Troposphäre reguliert, aber gelegentlich durch SO2 Emissionen von Vulkanausbrüchen gestört. Eine der wichtigsten Informationsquellen von stratosphärischem Aerosol ist die aus dem Weltraum gemessene gestreute Strahlung. SCIAMACHY war eines der Instrumente auf dem Envisat Satellit (2002 - 2012). Aus den SCIAMACHY Messdaten wurden zwei Parameter der Größenverteilung von Aerosolen abgeleitet: der Moderadius und die Verteilungsbreite. Die Aerosolteilchendichte blieb dabei unverändert. Der anzunehmende Fehler liegt bei 20% für den Moderadius und für die Verteilungsbreite bei 10%. Die Analyse der Ergebnisse zeigt, dass sich der Moderadius nach Vulkanausbrüchen erhöht, während die Verteilungsbreite kein regelmäßiges Verhalten zeigt. Bei den beiden Parametern wird eine deutliche QBO Signatur beobachtet. Die Vergleiche mit anderen Instrumenten haben sehr gute Übereinstimmung gezeigt.

UP 5.5 Mon 16:15 G 1.011

Effectiveness and impacts of stratospheric aerosol injection studied with a global atmosphere-aerosol model — •Christoph Kleinschmitt[1,2], Olivier Boucher[3], and Ulrich Platt[1] — [1]Institute of Environmental Physics, Heidelberg University, Germany — [2]Laboratoire de Météorologie Dynamique, Paris, France — [3]Institut Pierre-Simon Laplace, Paris, France

Climate engineering is currently being discussed as an option to prevent or at least reduce the magnitude of global warming. Stratospheric aerosol injection (SAI) in analogy to major volcanic eruptions is probably the most prominent of the proposed techniques. Numerous modelling studies on SAI have been published during recent years, mostly proving its power to reduce the global mean surface temperature significantly, but also revealing potential risks and undesirable side effects on the climate system.

For a robust estimate of the cooling potential of SAI we developed a 3D aerosol model with a sectional approach fully coupled to the radiative scheme and other aspects of the IPSL climate model. This allows us to study physical effects limiting the radiative forcing, such as absorption and reemission of infrared radiation, particle growth through condensation and coagulation and changes in particle lifetime due to transport within the stratosphere.

We will present results of model simulations under various SAI scenarios and discuss the effectiveness and limitations of the method as well as its impacts on the atmosphere (e.g. stratospheric heating and circulation changes) and at the Earth's surface.

UP 5.6 Mon 16:30 G 1.011

Monitoring air quality in North and Baltic Sea with ship-borne MAX-DOAS — •André Seyler[1], Folkard Wittrock[1], Lisa Kattner[1,2], Barbara Mathieu-Üffing[3], Enno Peters[4], Andreas Richter[1], Stefan Schmolke[2], Andreas Weigelt[2], and John P. Burrows[1] — [1]Institut für Umweltphysik (IUP), Universität Bremen — [2]Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg — [3]Landesamt für Landwirtschaft, Umwelt und ländliche Räume des Landes Schleswig-Holstein, Itzehoe — [4]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Bremerhaven

The project MeSMarT (Measurements of Shipping Emissions in the Marine Troposphere) is a cooperation between the University of Bremen and the Federal Maritime and Hydrographic Agency (BSH).

The BSH conducts regular oceanographic and chemical surveys in North and Baltic Sea on-board the Irish research vessel Celtic Explorer for the assessment of the North Sea status. Atmospheric trace gas measurements with optical remote sensing (MAX-DOAS) and in situ gas analyzers have been performed on several cruises since 2012 by the MeSMarT-Team to additionally monitor the marine air quality.

Marine air pollution sources are mainly emissions from ships and oil rigs but also polluted air masses from land.

Here we present MAX-DOAS measurements of nitrogen dioxide (NO_2), sulfur dioxide (SO_2), formaldehyde (HCHO) and glyoxal (CHOCHO) in North and Baltic Sea, which have been evaluated and compared to simultaneous measurements from our in situ instruments as well as measurements from satellites.

UP 5.7 Mon 16:45 G 1.011

Mobile NOx-Emissionsmessungen an Stadtverkehrsbussen mit einem ICAD-Messinstrument — •Joscha Reber, Denis Pöhler und Ulrich Platt — Institut für Umweltphysik Heidelberg

Stickoxide (NOx), insbesondere Stickstoffdioxid (NO2), stellen aktuell die problematischste Schadstoffbelastung in deutschen Städten dar. Die größte Quelle bildet der Straßenverkehr, woran auch Linienbusse maßgeblich beteiligt sind. Um deren Einfluss genauer zu untersuchen, wurden die realen NOx Emissionen bei 30 Linienbussen in Reutlingen und 50 Linienbussen in der Region Heidelberg mittels *Plume Chasing* Verfahren bestimmt. Dabei wird mit dem ICAD-Messinstrument NOx und CO2 in der Abgasfahne gemessen. Die Ergebnisse zeigten eine große Spanne, vor allem zwischen modernen und älteren Fahrzeugen. Jedoch kamen vereinzelt auch EURO 6 Busse vor, die vermutlich durch defekte Abgasreinigungen weit über dem gesetzlichen Grenzwert für Stickoxide lagen. Somit können auch neue Busse erheblich zu der Schadstoffproblematik beitragen.

UP 5.8 Mon 17:00 G 1.011

Quartz Enhanced Photoacoustic Spectroscopy (QEPAS): Ein neuer Weg für die Messung von NO2 und SO2 mit kompakten Instrumenten? — Alexander Engeln, Jan-Lukas Tirpitz, •Jonas Kuhn, Nicole Bobrowski und Ulrich Platt — Universität Heidelberg, Institut für Umweltphysik, Heidelberg, Deutschland

Für das Verständnis vieler Prozesse, wie etwa vulkanischer Entgasung oder der Stickoxid (NO2) Emission von Fahrzeugen sind kompakte und preiswerte Messinstrumente, insbesondere für Schwefeldioxid (SO2) und (NO2), sehr nützlich. Trotz ihrer geläufigen Verwendung sind in-situ Messgeräte häufig unhandlich, teuer oder zeigen Querempfindlichkeiten. Mit QEPAS stellen wir ein alternatives Verfahren vor, welches auf photoakustischer Spektroskopie unter Verwendung eines Stimmgabel-Schwingquarzes mit 32,8 kHz Resonanzfrequenz (wie er in Quarzuhren verwendet wird) basiert. Neben dem kompakten Aufbau (möglicherweise weniger als 100 cm3 Volumen) sind die Signalverstärkung durch die hohe Güte (ca. 10000) der Mikro-Stimmgabel

und die geringen Kosten der Komponenten von großem Vorteil. An einem QEPAS-Laboraufbau für NO2 und SO2 wurden LEDs (285 nm bzw. 457 nm) und ein Halbleiter-Laser (439 nm) als Lichtquellen untersucht. Das Stimmgabelsignal wurde mittels Lock-In-Verstärker registriert. Während mit den LEDs bisher keine ausreichende Messempfindlichkeit erreicht wurde, konnte mit dem Laser (5 mW) eine Messgrenze von ca. 1 ppm für NO2 erreicht werden. Weitere Verbesserung z.B. durch Erhöhung der Laserleistung (prinzipiell sind > 1000mW möglich) oder akustische Resonatoren werden diskutiert.

UP 5.9 Mon 17:15 G 1.011

FTIR measurements of water vapour and cloud properties during Polarstern cruises PS106/PS107 — •Philipp Richter, Mathias Palm, Christine Weinzierl, and Justus Notholt — University of Bremen - Institute of Environmental Physics

The Arctic region experiences an much higher increase of the near-surface temperature than the rest of the earth, a phenomenon called the Arctic Amplification. A possible driver of this phenomenon could be the enhanced import of water vapour and clouds into the Arctic. To investigate this, we performed FTIR measurements onboard the RV Polarstern during the Arctic summer. The measurements were performed in solar absorption mode with the sun as light source to retrieve trace gases, water vapour and its isotopes (HDO, H2(16)O). In the emission mode, the FTIR spectrometer can be used to measure in the MIR for retrieving aerosols and cloud properties like the liquid water path (LWP) or the effective droplet radius from thin clouds. The acquired data will be provided for satellite validation, especially the LWP over the ice covered ocean. First results in retrieved trace gases and cloud properties will be shown.

UP 6: Oceanography

Time: Tuesday 16:30–17:30 Location: G 1.011

Invited Talk UP 6.1 Tue 16:30 G 1.011

Simple relations for mixing in estuaries — •Hans Burchard — Leibniz Institute for Baltic Sea Research Warnemünde, Rostock, Germany

The Knudsen and Total Exchange Flow (TEF) theories derived from the conservation laws of mass and salt by applying Gauss' theorem to the volume of a confined estuarine or marginal sea basin provide a quantitative understanding for estuarine physics. These theories represent exchange flows across an open boundary to the adjacent ocean in terms of bulk values (Knudsen theory: inflow and outflow volume or salinity) or with resolution in salinity space (TEF: profiles of volume and salt flux in salinity coordinates). Here, these theories are extended towards mixing of salinity, defined as the decay of salinity variance due to turbulent mixing. These new Knudsen and TEF relations for mixing are derived by applying Gauss' theorem to the salinity variance equation. As a result, long-term averaged mixing in estuaries and marginal seas can be estimated by simply considering inflowing and outflowing salinities at the open boundary as well as net freshwater run-off.

UP 6.2 Tue 17:00 G 1.011

^{39}Ar-dating with 5 litres ocean water samples — •Sven Ebser[1], Arne Kersting[2], Zhongyi Feng[1], Lisa Ringena[1], Maximilian Schmidt[1], Stefan Beyersdorfer[2], Emeline Mathouchanh[2], Florian Ritterbusch[2], Tim Stöven[3], Toste Tanhua[3], Werner Aeschbach[2], and Markus K. Oberthaler[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, Germany — [2]Institut für Umweltphysik, Universität Heidelberg, Germany — [3]GEOMAR - Helmholtz-Zentrum für Ozeanforschung Kiel, Germany

With a half-life of 269 years, ^{39}Ar is the only available dating tracer on the time scale of 50 to 1000 years, which makes it the perfect tool to investigate ocean ventilation. Up to now, Low-Level Counting was the only available technique for routine ^{39}Ar measurements. Requiring water sample volumes around one cubic meter and 6 weeks of counting, its application was limited to overall 125 ocean samples so far.

We will report the first ^{39}Ar measurements using only 5 litres of ocean water and taking only one day of analysis, based on the atom optical technique Argon Trap Trace Analysis. In 2015, three depth profiles at 8 samples each were taken during an east-west transect investigating the eastern tropical North Atlantic Oxygen Minimum Zone. The samples were further processed and analysed in Heidelberg. All three profiles show a rapid increase of the ^{39}Ar-age with depth in the upper 1500 m followed by a more homogeneous ^{39}Ar concentration down to 4000 m. The ^{39}Ar results are used in combination with CFC-12 and SF_6 data to constrain the Transit Time Distribution (TTD) method better, which is used to describe the ocean ventilation.

UP 6.3 Tue 17:15 G 1.011

Geophysical noise in L-band satellite observations for thin sea ice thickness retrieval — •Catalin Patilea and Georg Heygster — University of Bremen, Institute of Environmental Physics, Bremen, Germany

Thin sea ice thickness can be retrieved from the L-band radiometer Soil Moisture Ocean Salinity (SMOS) based on observations at 40-50° incidence angle. At L-band (1.4 GHz) the atmosphere has a low impact on the brightness temperatures but there are other potential sources of noise.

(1) Microwave radiation passing through the ionosphere can undergo a rotation of the polarization vectors (Faraday rotation) keeping the same intensity but changing the polarization difference. (2) The brightness temperatures recorded by SMOS over the same areas during ascending and descending overpasses can vary due to unequal RFI filtering or in zones with high brightness temperature gradient (e.g. ice edges). (3) Galactic radiation contains the uniform cosmic background radiation and the variable hydrogen emission lines and continuum radiation, thus the reflected radiation recorded by SMOS varies with day of the year and position of the satellite on the orbit.

An assessment of the impact of these noise sources on the sea ice thickness retrieval will be presented.

UP 7: Atmosphere - lab studies

Time: Tuesday 17:30–18:15 Location: G 1.011

Invited Talk UP 7.1 Tue 17:30 G 1.011

Ice formation and crystallization in mesospheric clouds — •Denis Duft[1], Mario Nachbar[2], and Thomas Leisner[1,2] — [1]Karlsruhe Insitute of Technology, Karlsruhe, Germany — [2]University of Heidelberg, Heidelberg, Germany

In this contribution we present results from a laboratory experiment designed to study the formation of ice at cold conditions. Specifically, we investigate the heterogeneous formation of ice on small aerosol particles which provide the surface for ice formation in the mesosphere. We show, that amorphous solid water, a highly viscous non-crystalline ice phase similar to supercooled liquid water, is the water ice phase which deposits from the gas phase below 160K, even though it is thermodynamically unstable and crystallizes above 120K. We also show, that amorphous solid water crystallizes to small nano-crystallites which greatly influence the properties of the ice phase. The nano-crystals are stable for hours below 160K and for even longer times at lower temperatures such that nano-crystalline ice can be regarded as a separate ice phase on atmospheric time scales. Only at temperatures above 160K the nano-crystalline ice transforms to micro-crystalline ice whose properties are typically given in textbooks.

UP 7.2 Tue 18:00 G 1.011

Precision measurements of the absolute ozone absorption cross section at the 325 nm HeCd laser line - the resolution of a long standing ozone puzzle ? — •Christof Janssen[1,2], Hadj Elandaloussi[1], and Julian Gröbner[3] — [1]LERMA-IPSL, Sorbonne Université, UPMC Univ. Paris 06, CNRS, Observatoire de Paris, PSL

Research Univ., Paris, France — [2]Institut für Umweltphysik, Universität Heidelberg, Heidelberg, Germany — [3]Phys. Meteorol. Observatorium Davos, WRC, Davos Dorf, Switzerland

Ozone is a key molecule in the Earth's atmosphere and the study of ozone hole recovery has become a major topic. Recovery rates being slow and depending on many factors, global and long-term observations of high accuracy are required to derive meaningful trends. While diverse observational platforms (from ground, balloons or satellites) provide such measurements, uncertainties and inconsistencies of the spectroscopic database being used for ozone retrieval are of considerable concern for the quantification of concentrations and trends.

In this talk, we will first introduce common measurement methods as well as currently used and recommended reference data in the UV and IR. We will discuss where and to which extent inconsistency problems exist. Then we present new highly accurate measurements of the absolute absorption cross section of ozone at the 325 nm wavelength of the HeCd laser. These measurements, as well as our previous work at 253.65 nm and in the IR shed new light on currently used absorption spectroscopic data used for ozone remote sensing, as they reveal potential biases in the UV and the IR spectral regions.

UP 8: Methods - measurement techniques; Atmosphere - trace gases, mesosphere

Time: Wednesday 14:00–15:45 Location: G 1.011

UP 8.1 Wed 14:00 G 1.011

New markets for an old tracer: Applications for ^{39}Ar dating with Argon Trap Trace Analysis (ArTTA) — •Arne Kersting[1], Sven Ebser[2], Zhongyi Feng[2], Lisa Ringena[2], Maximilian Schmidt[2], Florian Ritterbusch[2], Philip Hopkins[1], Viola Rädle[1], Stefan Beyersdorfer[1], Markus K. Oberthaler[2], and Werner Aeschbach[1] — [1]Institut für Umweltphysik, Heidelberg, Germany — [2]Kirchhoff-Institut für Physik, Heidelberg, Germany

The potential of ^{39}Ar as a dating tool has long been recognized in the geoscience community. As noble gas it is not influenced by chemical or biological processes and with a half-life of 269 years it closes the dating gap between young tracers (^{3}H, CFCs, SF_6) and ^{14}C. Still, its application was hindered by its extremely low isotopic abundance making the low-level counting laboratory in Bern the only facility performing routine measurements of ^{39}Ar. Requiring 1000 L of water this application is mainly restricted to groundwater studies. Recent developments in the atom counting method Argon Trap Trace Analysis (ArTTA), reduced the required sample size for ^{39}Ar analysis down to a minimum of 1 mL STP of pure argon corresponding to a few kg of water or ice. The measurement time per sample is one day and the current construction of a second apparatus will double the throughput soon. This apparatus will for the first time render applications of the tracer ^{39}Ar in oceanography, glaciology and limnology feasible, while reducing the effort for groundwater analysis significantly. In the scope of this talk an overview of already performed field campaigns is given as well as an outlook on the potential for future studies.

UP 8.2 Wed 14:15 G 1.011

Soil moisture measurement at the hectometer scale using CRNS for mobile applications — •Markus Köhli[1,2], Jannis Weimar[1], Martin Schrön[3], and Ulrich Schmidt[1] — [1]Physikalisches Institut, Universität Heidelberg, Heidelberg, Germany — [2]Im Neuenheimer Feld 226 — [3]Helmholtz Zentrum für Umweltforschung, UFZ, Leipzig

The method of cosmic ray neutron sensing (CRNS) - soil moisture measurement at the hectometer scale non-invasively has turned out to be feasible by detecting environmental albedo neutron density. The key feature of the method is the exceptionally different behavior of hydrogen in its reflection power of neutrons generated by cosmic rays. It slows down fast neutrons whereas any other heavier element independent of the chemical composition rather reflects them. In the recent years the understanding of neutron transport by Monte-Carlo simulations led to major advancements in precision, which have been successfully targeted meanwhile by a manifold of experiments. Whereas the homogeneous conditions are well understood, inhomogeneous topologies are now in the focus of research. In our case these are applications for partial snow cover and mobile surveys, where the influence of the road material, which biased results towards lower soil moisture values, could be calculated, measured and analytically understood. Here we present the actual status of the method especially with respect to inhomogeneous terrain.

UP 8.3 Wed 14:30 G 1.011

Night-time atomic oxygen in the mesopause region derived from satellite observations of atmospheric airglow — •Tilo Fytterer[1], Miriam Sinnhuber[1], and Christian von Savigny[2] — [1]Institute for Meteorology and Climate Research, Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany — [2]Institute of Physics, Ernst-Moritz-Arndt-Universität Greifswald, Greifswald, Germany

Atomic oxygen in its ground state [O(3P)] is involved in several exothermic reactions and collisions with CO2 and contributes to both heating and cooling rates in the mesopause region (80-100 km). Therefore, O(3P) has a strong impact on the general energy budget of the mesopause region, eventually affecting further quantities like air temperature and the wind. However, direct observations of O(3P) are relatively rare, and consequently O(3P) had to be indirectly derived from the atmospheric light emissions which are known as airglow and are observable by satellite instruments. Here, we present results of nighttime O(3P) in the mesopause region by using a zero dimensional model which was adapted to match atmospheric OH airglow observations from 2003 to 2011. The measured OH transitions are obtained from the satellite/instrument configuration TIMED/SABER [OH(9-7)+OH(8-6) and OH(5-3)+OH(4-2)] and ENVISAT/SCIAMACHY [OH(6-2) and OH(3-1)].

UP 8.4 Wed 14:45 G 1.011

Retrieval of the $O_2(^1\Sigma)$ and $O_2(^1\Delta)$ volume emission rate and temperature in the mesosphere and lower thermosphere using SCIAMACHY MLT limb scans — •Amirmahdi Zarboo[1], Stefan Bender[2], Miriam Sinnhuber[1], John P. Burrows[3], and Johannes Orphal[1] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]Norwegian University of Science and Technology, Trondheim, Norway — [3]University of Bremen, Bremen, Germany

We present the retrieved volume emission rates (VERs) from airglow of the daytime and twilight $O_2(^1\Sigma)$ and $O_2(^1\Delta)$ band emissions in the visible (811–595 nm) and near infrared (1200–1360 nm) and the retrieved temperature from daytime $O_2(^1\Sigma)$ emission in the mesosphere and lower thermosphere (MLT). SCanning Imaging Absorption spectroMeter for Atmospheric CHartographY (SCIAMACHY) on-board European Space Agency Envisat satellite observes up-welling radiation in the limb viewing geometry with its special MLT mode in the 50 to 150 km altitude range. We analyze the daily averaged latitude distributions and the time series of the retrieved VERs in the altitude range from 53 to 149 km and the retrieved temperatures in the altitude range from 80 to 120 km. The $O_2(^1\Sigma)$ VER peaks are observed at about 90 km altitude, while $O_2(^1\Delta)$ VER emissions are observed to decrease with altitude, with the largest values at the lowest edge of the observations (about 53 km). Comparisons of the temperature retrievals with other satellite instruments are made. We do some sensitivity tests of the temperature retrievals in order to investigate the variations due to different parameters as well.

UP 8.5 Wed 15:00 G 1.011

Validation of the extended Multiple Airglow Chemistry model with in-situ measurements of the Energy Transfer in the Oxygen Nightglow campaign — •Olexandr Lednyts'kyy[1], Christian von Savigny[1], and Edward Llewellyn[2] — [1]Ernst-Moritz-Arndt-University of Greifswald, Greifswald, Germany — [2]University of Saskatchewan, Saskatoon, Canada

Coupling of electronically excited states of molecular and atomic oxygen (O_2 and O) with each other through collisions was implemented in the Multiple Airglow Chemistry (MAC) model to reflect the photochemistry in the upper Mesosphere and Lower Thermosphere (MLT) region. Additionally, temperature, concentrations of O_2 and molecular nitrogen were simulated with the NRLMSISE-00 model and used in the MAC model to retrieve concentrations of MLT minor species based on airglow emissions. The MAC model was extended with two upper

Herzberg states that allowed the excitation of the green line emission to be explained and refuted the concept of integrity of identity of the O_2 electronic states. The photochemical models of McDade *et al.* were tuned using *in-situ* measurements of the Energy Transfer in the Oxygen Nightglow (ETON) campaign conducted in March 1982. The developed, and verified, extended cubic equation (ECE) was based on quenching processes that were in addition to those of McDade *et al.* The ECE results in overestimated [O], the McDade *et al.* models result in underestimated [O] while the extended MAC model results in [O] in the best agreement with ETON *in-situ* [O].

UP 8.6 Wed 15:15 G 1.011

Wave driven dynamical processes to couple the lower and the middle atmosphere over the year — •Kathrin Baumgarten, Michael Gerding, and Franz-Josef Lübken — Leibniz-Institute of Atmospheric Physics at the University of Rostock , Kühlungsborn, Germany

Atmospheric waves, e.g., gravity and tidal waves, play a key role for our understanding of the circulation in the Earth's atmosphere. Due to the propagation and interaction of these waves, they couple different atmospheric layers from the troposphere to the mesosphere by the transport of momentum and energy over a wide range of scales. The propagation of gravity waves is strongly affected by tides as they modulate the mean background wind field. Since 2010 a daylight capable RMR lidar for high resolution density and temperature measurements at Kühlungsborn (54° N, 12° E) is in operation to investigate wave phenomena in the middle atmosphere between 30 and 75 km altitude. An extensive data set of about 7500 hours is used to derive the seasonal variation of different gravity and tidal waves. Therefore, a 1-dimensional spectral filtering technique is used to separate gravity and tidal waves. Inertia gravity waves and tides show a reduced activity during summer as theoretically expected due to the mean prevailing winds. Gravity waves with periods of only a few hours or less behave contrary to this. This is presumably caused by large horizontal phase speeds allowing these gravity waves to propagate into the mesosphere. We will present the seasonal variation of gravity waves as well as tides to demonstrate their particular influence in different regions of the middle atmosphere.

UP 8.7 Wed 15:30 G 1.011

About 27-day signatures in standard phase height measurements above Europe — •Christian von Savigny[1], Dieter H. W. Peters[2], Günter Entzian[2], and Georg Teiser[1] — [1]Ernst-Moritz-Arndt-University of Greifswald, Greifswald, Germany — [2]Leibniz-Institute of Atmospheric Physics, University of Rostock, Kühlungsborn, Germany

We report on 27-day signatures in standard phase height measurements performed using a radio transmitter in central France and a receiver in Kühlungsborn (54° N, 12° E, Mecklenburg, Germany). Using the superposed epoch analysis technique solar 27-day signatures with amplitudes of several tens of meters are found. The statistical significance of the obtained results was tested with a Monte-Carlo approach and the solar 27-day signatures are found to be highly significant. The sensitivity parameter for the 27-day solar response of standard phase height is in good agreement with the sensitivity parameter for the 11-year solar cycle. Surprisingly, the amplitude of the 27-day signature is larger during solar minimum than during solar maximum. In addition, distinct differences in the signature's amplitude with season exist. These findings indicate that the observed effects are not exclusively driven by photochemical effects, but that dynamical processes play an important role, especially in winter.

UP 9: Poster session

Time: Wednesday 16:15–18:15 Location: Orangerie

UP 9.1 Wed 16:15 Orangerie

Berechnung von Aerosolparametern aus Lidarmessungen der Alomar Station — •Jacob Zalach[1], Christian von Savigny[1], Arvid Brand[2], Gerd Baumgarten[2] und Franz Josef Lübken[2] — [1]Universität Greifswald — [2]Institut für Atmosphärenphysik, Kühlungsborn

Stratosphärische Aerosole sind von großer Bedeutung für die atmosphärische Strahlungsbilanz. In den letzten 15 Jahren zeigte die Aerosolbefrachtung eine deutliche Variabilität. Bisherige Lidar-Langzeitbeobachtungen stratosphärischer Aerosole konzentrierten sich auf mittlere geografische Breiten, diese Arbeit wertet Lidardaten der Alomar Station bei 69°N aus.

Im Rahmen dieser Arbeit werden bei verschiedenen Wellenlängen gemessene Rückstreuverhältnisse benutzt, um auf Partikelradien und Extinktionskoeffizienten zu schließen. Zunächst wird aus den gemessenen Rückstreuverhältnissen ein Verhältnis gebildet und mit theoretischen, auf der Mie-Theorie basierenden Werten verglichen. Da für eine angenommene Lognormalverteilung mit einer festen Verteilungsbreite dieses Verhältnis über einem weiten Radiusintervall nur vom mittleren Radius der Verteilung abhängt, kann so dem Messwert ein Radius zugeordnet werden. Damit kann die Mie-Phasenfunktion der betrachteten Wellenlängen und der Extinktionskoeffizient berechnet werden. Der Beitrag erläutert das Vorgehen und zeigt die Entwicklung der Partikelradien und Extinktionskoeffizienten ab 1994 über der Alomar Station.

UP 9.2 Wed 16:15 Orangerie

Argon purification system for ^{39}Ar measurements with Argon Trap Trace Analysis (ArTTA) — •Viola Rädle[1], Philip Hopkins[1], Arne Kersting[1], Maximilian Schmidt[1,2], Lisa Ringena[2], Zhongyi Feng[2], Emeline Mathouchanh[1], Sven Ebser[2], Markus K. Oberthaler[2], Werner Aeschbach[1], and Stefan Beyersdorfer[1] — [1]Institut für Umweltphysik, Heidelberg, Deutschland — [2]Kirchhoff-Institut für Physik, Heidelberg, Deutschland

Noble gas radioisotopes are ideal environmental tracers because of their chemical inertness. In particular, ^{39}Ar is of great importance as it is the only tracer covering the age range of 50 to 1000 years. However, measuring the ^{39}Ar/^{40}Ar ratio is challenging due to an extremely low isotopic abundance in the order of 10^{-16} and a long half-life of 269 years. In order to apply the emerging technique ArTTA, approx. 1 mL of pure argon are required, corresponding to about 5 L of water or 2-5 kg of ice. Large amounts of water (e.g. groundwater) can already be degassed in the field using a portable device based on a membrane contactor. Smaller samples are transported to the laboratory and are processed by a newly developed argon purification setup. Here, the gas dissolved in water or enclosed in ice is extracted. In a second step, it is purified by removing the reactive gases on titanium sponge getters at 900 °C and 20 °C, leaving only noble gases, hence resulting in an argon purity of >99 %. Finally, the argon is frozen on an activated charcoal trap and can be measured using ArTTA. The new setup can purify one ice sample or up to three water samples per day with a yield >95 %.

UP 9.3 Wed 16:15 Orangerie

MAX-DOAS measurements of African continental pollution outflow over the Atlantic Ocean — •Lisa K. Behrens[1], Hilboll Andreas[1,2], Peters Enno[1,3], Richter Andreas[1], Alvarado Leonardo[1], Wittrock Folkard[1], Burrows John P.[1], and Vrekoussis Mihalis[1,2] — [1]IUP, Bremen, Germany — [2]MARUM, Bremen, Germany — [3]DLR, Bremerhaven, Germany

Trace gas global maps retrieved from satellite measurements revealed enhanced levels of atmospheric key pollutants, namely nitrogen dioxide (NO_2), formaldehyde (HCHO) and glyoxal (CHOCHO) over the Atlantic Ocean. To validate the spatial distribution of the continental outflow, we conducted ship-based measurements during the DFG project COPMAR (Continental outflow of pollutants towards the marine troposphere). A multi-axis differential optical absorption spectrometer (MAX-DOAS) was installed on board the research vessel Maria S. Merian for the cruise MSM58/2. This cruise was conducted in October 2016 and went from Ponta Delgada (Azores) to Cape Town (South Africa), crossing between Cape Verde and the African continent. The instrument was continuously scanning the horizon looking towards the African continent. We investigated the temporal variability of the above three species, and identified their spatial gradients over the Atlantic Ocean. The observed spatial gradients of HCHO and CHOCHO along the cruise track have a similar spatial distribu-

tion as satellite measurements and as model simulations. Furthermore, possible sources of the discrepancies are discussed.

UP 9.4 Wed 16:15 Orangerie

Measurements of ship emissions of NO_2 and SO_2 using LP-DOAS near Hamburg harbour, Germany — •Stefan Schmitt[1], Andreas Weigelt[3], Barbara Mathieu-Üffing[2,3,4], Lisa Kattner[2,3], André Seyler[2], Folkard Wittrock[2], Johannes Lampel[1], Denis Pöhler[1], and Ulrich Platt[1] — [1]Institut für Umweltphysik, Heidelberg — [2]Institut für Umweltphysik, Bremen — [3]Bundesamt für Seeschifffahrt und Hydrographie — [4]Landesamt für Landwirtschaft, Umwelt und ländliche Räume Lufthygienische Überwachung Schleswig-Holstein

Within a 6 week measurement campaign in July and August 2016, ship emissions were measured at the river Elbe in Hamburg, Germany using the Long Path(LP)-DOAS technique. The measurements were carried out within the framework of the project MESMART (Measurements of shipping emissions in the marine troposphere) which investigates the influence of ship emissions on chemical processes in the atmosphere and monitors the correct use of low sulphur ship fuel.

A LP-DOAS instrument was set up side by side to a MESMART in situ measurement station at the river Elbe at Wedel (15 km downriver of Hamburg harbour). Emission signatures of NO_2 and SO_2 of about 4000 passing ships were monitored and combined with AIS data. The study shows that the LP-DOAS measurements are well suited to monitor ship emissions and the correct use of low sulfur ship diesel. An overview of observed emission factors for different ship types will be presented.

UP 9.5 Wed 16:15 Orangerie

What can we learn from polarised MAX-DOAS measurements? — Andrés G. Bernal Samacá, •Andreas Richter, André Seyler, Vladimir Rozanov, and John P. Burrows — Institut für Umweltphysik, Universität Bremen, Bremen, Deutschland

Most modern Multi Axis Differential Optical Absorption Spectroscopy (MAX-DOAS) instruments use fibre optics between telescope and spectrometer which are long enough to efficiently mix polarisation states of the collected light. Therefore, polarisation sensitivity of the spectrometer is usually not a problem in MAX-DOAS observations. However, sky-light can be strongly polarised, and even if the instrument is not sensitive to the polarisation of the light, the light paths through the atmosphere vary between photons having different polarisation direction. Therefore, at least in principle, having an instrument that measures the polarisation in addition to the intensity of the incoming light should provide additional information on the vertical distribution of absorbers and also on aerosol loading.

In this presentation, results from one month of polarised MAX-DOAS test measurements in Bremen are reported. The measurements include normal horizon scans as well as scans in the principal plane and in the Almucantar. The measurements for several clear sky episodes are compared to radiative transfer calculations with SCIATRAN and the potential and limitations for improving the information content of MAX-DOAS observations are discussed.

UP 9.6 Wed 16:15 Orangerie

Optimierung optischer Kalibrierungsmethoden für Resonatoren zur Spurengasmessung — •Sebastian Sontag, Johannes Lampel, Denis Pöhler, Henning Finkenzeller, Miriam Reh und Ulrich Platt — Institut für Umweltphysik Heidelberg

Niedrige Konzentrationen von Schadstoffe in der Atmosphäre (z.B. Stickoxide) können mit Hilfe der Cavity-Enhanced-DOAS (CE-DOAS) Methode verlässlich bestimmt werden. Bei diesem optischen Messverfahren wird das Licht vor der Detektion im Spektrometer mehrere Male in einem optischen Resonator reflektiert, was zu Lichtwegen bis zu mehreren km führt und somit zu einer genaueren Messung auch bei geringen Schadstoffkonzentrationen. Für die Berechnung der Konzentration muss die Weglänge des Lichts im Resonator genau bestimmt werden. ICOM stellt eine neuartige direkte Weglängenkalibration für diese Resonatoren dar. Dabei wird mittels phasenmodulierter Messung einer gepulsten LED und eines Choppers die Weglänge simultan zur eigentlichen Messung bestimmt. Notwendig für das ICOM Verfahren ist eine LED-Pulselektronik mit möglichst steilen Anstiegs- bzw. Abfallflanken und ein geeigneter Chopper (z.B. Stimmgabel- oder Flüssigkristall-Chopper). Das Kalibrationsverfahren und die Optimierung dieser notwendigen Parameter werden präsentiert.

UP 9.7 Wed 16:15 Orangerie

Detektion leuchtender Nachtwolken in GOME-2 Satelliten Messungen — •Julia Koch, Martin Langowski und Christian von Savigny — Institut für Physik, Ernst-Moritz-Arndt Universität Greifswald, Deutschland

Leuchtende Nachtwolken (engl.: Noctilucent Clouds, NLC) sind die höchsten Wolken der Erdatmosphäre. Da sie sehr empfindlich auf ihre Umgebungsbedingungen reagieren, sind sie schon länger im Verdacht ein guter Indikator für Veränderungen, ob natürliche oder menschengemachte, in der Atmosphäre zu sein. Es soll nun ihre Auftretensrate (engl.: Occurrence Frequency) in der Nordhemisphäre über einen Zeitraum von zehn Jahren untersucht werden. Hierzu wird eine Datenreihe von 2007 bis 2016 ausgewertet, die von zwei GOME-2 Geräten (engl.: Global Ozone Monitoring Experiment), die sich auf den Satelliten Metop-A und Metop-B befinden, stammt. Zur Auswertung wurden die NLC Auftretensraten eines jeden Tages im Nordsommer in Abhängigkeit vom Breitengrad ermittelt. Es stellte sich heraus, dass die Methode zwar für die ersten Betriebsjahre der GOME-2 Instrumente gut funktioniert, es dann aber zu einer Degradation des Instrumentes kam, sodass für die späteren Jahre keine zuverlässige Aussage mehr getroffen werden kann.

UP 9.8 Wed 16:15 Orangerie

The formation of ice in noctilucent clouds — Mario Nachbar[1], Denis Duft[2], and •Thomas Leisner[1,2] — [1]University of Heidelberg, Heidelberg, Germany — [2]Karlsruhe Institute of Technology, Karlsruhe, Germany

Noctilucent clouds are the highest occurring clouds in the terrestrial atmosphere. They form heterogeneously on sub-2nm meteor smoke particles at about 86km height in the polar summer mesopause, the coldest and also one of the dryest regions of the atmosphere. It is for these extreme conditions and the difficulty of in-situ measurements that the formation process of noctilucent clouds is still not well understood. In this contribution we present laboratory measurements on the ice formation at mesopause conditions on small metal oxide nanoparticles as a substitute for meteor smoke particles. We show that, in contrast to the current assumption of crystalline ice nucleation, amorphous solid water forms on the nanoparticle surface and that ice growth is activated above the equilibrium saturation for amorphous ice. The experimental method is based on the analysis of ice particle growth rates which also allows to measure the saturation vapor pressure over the amorphous ice phase between 130K and 160K. We show that the saturation vapor pressure was underestimated by more than a factor of two in the past.

UP 9.9 Wed 16:15 Orangerie

Ice nucleation on mesospheric nanoparticles: the first three monolayers — Mario Nachbar[2], Denis Duft[1], •Thomas Dresch[2], and Thomas Leisner[1,2] — [1]Institute for Meteorology and Climate Research - AAF, Karlsruhe Institute of Technology, Germany — [2]Institute of Environmental Physics, Ruprecht-Karls-University of Heidelberg, Germany

Heterogeneous ice formation on meteoric smoke nanoparticles in the upper atmosphere is critical for the formation of mesospheric ice clouds, also known as noctilucent clouds. A better understanding of the microscopic dynamics of the condensation mechanisms is important for modeling the growth of ice particles and cloud formations in the mesosphere. All heterogeneous nucleation starts with the adsorption of single molecules from the vapor phase followed by the formation of the first few monolayers, where the influence of the core particle is still felt by the adsorbed water molecules. We present experimental data for the nucleation of 0.5 to 3.5 monolayers of water ice on Fe3O4 nanoparticles with diameters of 4 to 6 nm at temperatures between 150 to 160 K. By laser irradiation of the nanoparticles in a linear quadrupole ion trap under well controlled super-saturation conditions we precisely control the particle temperature. For each particle temperature the particle growth and the equilibrium number of adsorbed water molecules is directly measured in a Time-of-Flight mass spectrometer. From the measurements we obtain H2O sublimation rates as a function of particle temperature and relative desorption free enthalpies as a function of surface coverage.