EP 3: Planetary Atmospheres (joint session EP/UP)

Zeit: Dienstag 16:30–18:45 Raum: HS 22

EP 3.1 Di 16:30 HS 22

Lidar-Messungen von extremen Schwerewellen an der Südspitze Südamerikas — •Natalie Kaifler, Bernd Kaifler, Andreas Dörnbrack und Markus Rapp — Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Deutschland

Mit dem CORAL-Rayleigh-Lidar befindet sich seit November 2017 ein vollautomatisches Lidar-System für Temperaturmessungen bis in 90 km Höhe in Rio Grande, Argentinien, an der Südspitze Südamerikas. Aufgrund der starken Winde und der Topographie treten in dieser Region die weltweit stärksten atmosphärischen Schwerewellen auf. Wir zeigen die Aktivität von Schwerewellen im Jahresverlauf, auch im Vergleich zu entsprechenden Messungen während der DEEPWAVE-Kampagne 2014 in Neuseeland. Anhand eines mehrere Tage anhaltenden, extremen Schwerewellen-Ereignisses im Juni 2018 mit Spitzenamplituden von 80 K wird die Ausbreitung der Wellen in der Atmosphäre und deren Einfluß auf die Hintergrundströmung anhand von Lidar-Messungen und ECMWF-Analysen erläutert. Die Messungen in Rio Grande dienen auch der Vorbereitung und Begleitung der SouthTRAC-Kampagne mit dem Forschungsflugzeug HALO, die im September 2019 in der Region stattfinden wird. Während SouthTRAC werden die Rolle von Schwerewellen und stratosphärischer Zirkulation für das Klima der Südhemisphäre untersucht.

EP 3.2 Di 16:45 HS 22

Validation of the Multiple Airglow Chemistry model applied on the basis of data sets from various sources — •Olexandr Lednyts'kyy[1], Miriam Sinnhuber[2], and Christian von Savigny[1] — [1]University of Greifswald, Greifswald, Germany — [2]Karlsruhe Institute of Technology, Karlsruhe, Germany

The Multiple Airglow Chemistry (MAC) model was proposed to couple electronically excited states of molecular (O_2, four states) and atomic (O, two states) oxygen with each other as well as with the O_2 and O ground states to represent the photochemistry in the upper Mesosphere and Lower Thermosphere region. Rate values of processes coupling seven O_2 and three O states considered in the extended MAC model were tuned on the basis of the in-situ measurements from the Energy Transfer in the Oxygen Nightglow campaign. Calculations with the MAC model are verified and validated on the basis of the in-situ measurements from the 2nd WAve propagation and DISsipation in the middle atmosphere campaign and the WAVes in airglow structures Experiment 2004 campaign. The MAC calculations are analyzed in various cases, in which some of these in-situ data sets are replaced with collocated remote measurements or data sets simulated with the NRLMSISE-00 (Naval Research Laboratory Mass Spectrometer Incoherent Scatter Extended, 2000) model. The level of self-consistency of the MAC input and output data sets varies from one case to another.

EP 3.3 Di 17:00 HS 22

Long-term evolution of MLT-temperatures above Europe as observed by the GRIPS spectrometers within the Network for the Detection of Mesospheric Change (NDMC) — •Carsten Schmidt[1], Lisa Küchelbacher[1], Sabine Wüst[1], and Michael Bittner[1,2] — [1]Deutsches Zentrum für Luft- und Raumfahrt, Oberpfaffenhofen — [2]Universität Augsburg

The German Aerospace Center (DLR) operates more than a dozen identical, so-called ground-based infrared p-branch spectrometers (GRIPS) in eight European countries to study excited hydroxyl-molecules in the upper mesosphere / lower thermosphere (MLT region). They contribute high quality observations to the Network for the Detection of Mesospheric Change (NDMC). Observations started at the Environmental Research Station Schneefernerhaus (UFS), Germany (47.42 N, 10.98 E) in October 2008.

Clearly, a long-term oscillation with a period of several years (ca. 8 years) modulates the OH temperatures. Maximum temperatures are reached during winters 2013 to 2015. This behavior implies a correlation with variations of solar activity (F10.7cm). However, the winter oscillation is not only more pronounced but it also precedes the variation in summer with a lead of 0.5 to 1.5 years. These variations can, at least in part, explain several remarkable seasonal patterns observed at all mid-latitude sites, e.g. between 2016 and 2018.

We attribute the different behavior to changes of northern middle atmospheric dynamics, having a larger impact on winter temperatures. Observations at the southern sites in Italy and Israel support this view.

EP 3.4 Di 17:15 HS 22

Solar heating rates derived from SCIAMACHY observations of the O_2 dayglow — •Miriam Sinnhuber[1], Stefan Bender[2], Thomas Reddmann[1], and Amirmahdi Zarboo[1] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]University of Trondheim, Trondheim, Norway

Solar heating by ozone absorption in the UV spectral range is an important contributor to radiative heating of the terrestrial stratosphere and mesosphere. At altitudes above about 60 km, the efficiency of the heating is reduced as part of the absorbed energy is transferred to excited species – $O_2(^1\Sigma)$, $O_2(^1\Delta)$ – and lost by emission.

We use observations of the $O_2(^1\Sigma)$ and $O_2(^1\Delta)$ dayglow in the mesosphere and lower thermosphere observed by SCIAMACHY on ENVISAT from 2008-2012 to derive ozone densities and the efficiency of the ozone solar heating. The heating efficiency decreases from 1 around 60 km to less than 0.6 at the mesopause depending on latitude and time of year. Resulting ozone heating rates vary from more than 10 K/day in the lower mesosphere to less than 1 K/day around 80 km, with a secondary maximum of up to 5 K/day around 90 km in the region of the second ozone maximum.

EP 3.5 Di 17:30 HS 22

The relativistic electron radiation belt response to CME- and CIR-driven geomagnetic storms — •Frederic Effenberger, Yuri Shprits, Nikita Aseev, Juan Sebastian Cervantes Villa, and Angelica Maria Castillo Tibocha — Helmholtz Zentrum Potsdam, Deutsches Geoforschungs Zentrum GFZ

The Earth's magnetosphere responds differently to storms driven by coronal mass ejections (CME) and co-rotating interaction regions (CIR). To understand the effects of geomagnetic activity on the inner and outer magnetosphere, CME- and CIR-driven storms should be considered separately. In this work, we investigate the impact of both types of storms on the radiation belt environment during the Van Allen Probe era, using the Versatile Electron Radiation Belt (VERB) code. We use the Kp index as a measure of geomagnetic activity to parameterize wave models, diffusion coefficients, and the plasmapause location. The electron population is considered to originate from the plasma sheet, and we set up the outer boundary conditions at geostationary orbit using GOES data. We model storm individually and with long-term simulations, and compare the simulation results with Van Allen Probes measurements to validate the model performance. We use data assimilation methods to assist with initial and boundary conditions and the validation and we utilize different performance metrics. The work shows, how well we understand the response of the belts to CME and CIR drivers and helps to identify the applicability of present wave models to CME- or CIR-driven storms.

EP 3.6 Di 17:45 HS 22

Middle atmosphere ionization from particle precipitation as observed by the SSUSI satellite instruments — •Stefan Bender and Patrick Espy — Norwegian University of Science and Technology, Trondheim, Norway

Solar, auroral, and radiation belt electrons enter the atmosphere at polar regions leading to ionization and affecting its chemistry. Climate models usually parameterize this ionization and the related changes in chemistry based on satellite particle measurements. Precise measurements of the particle and energy influx into the upper atmosphere are difficult because they vary substantially in location and time. Widely used particle data are derived from the POES and GOES satellite measurements which provide electron and proton spectra.

We present electron energy and flux measurements from the Special Sensor Ultraviolet Spectrographic Imagers (SSUSI) satellite instruments. This formation of satellites observes the auroral zone in the UV from which electron energies and fluxes are inferred. We use these observed electron energies and fluxes to calculate ionization rates and electron densities in the mesosphere. We also present an initial comparison of these rates to other models and compare the electron densities to those measured by the EISCAT radar.

EP 3.7 Di 18:00 HS 22

Spectropolarimetric Simulations of Earthshine — •Mihail Manev[1], Claudia Emde[1], Michael Sterzik[2], and Stefano Bagnulo[3] — [1]Meteorological Institute, Ludwig-Maximilians-University, Theresienstr. 37, D-80333 Munich, Germany — [2]European Southern Observatory, Karl-Schwarzschild-Str. 2, D-85748 Garching, Germany — [3]Armagh Observatory and Planetarium, College Hill, Armagh BT61 9DG, UK

Understanding exoplanet atmospheres and ultimately the remote detection of signatures of life from other worlds belong to the most important goals of modern astrophysics. Earth serves as a benchmark object to infer biosignatures of life as we know it today. One way to study Earth as an exoplanet is to observe Earthshine: sun-light scattered by Earth and back-reflected from the lunar surface to Earth.

Here we interpret spectropolarimertic observations of Earthshine carried out at the VLT (Sterzik et al., Spectral and Temporal Variability of Earth Observed in Polarization, accepted at A&A on 28-Nov-2018, https://arxiv.org/abs/1811.12079) utilizing the Monte Carlo radiative transfer model MYSTIC and employing meteorological and satellite data as an input (Emde et al., Influence of aerosols, clouds, and sunglint on polarization spectra of Earthshine, A&A, Vol. 605, A2, 2017). The results reveal the contributions of the major components of the Earth system to the spectropolarimetric signal: water and land surfaces, vegetation, atmospheric gases, water and ice clouds.

We think that similar simulations will become an important tool for the interpretation of observations of exo-Earth type planets.

EP 3.8 Di 18:15 HS 22

Atmospheric Characterization via Broadband Color Filters on the PLAnetary Transits and Oscillations of stars Mission — •John Lee Grenfell[1], Mareike Godolt[2], Juan Cabrera[1], Ludmila Carone[3], Antonio Garcia Muñoz[2], Daniel Kitzmann[4], and Heike Rauer[1,2,5] — [1]Department of Extrasolar Planets and Atmospheres (EPA), German Aerospace Centre (DLR), Berlin, Germany — [2]Centre for Astronomy und Astrophysics (ZAA), Berlin Institute of Technology (TUB), Germany — [3]Max-Planck-Institute for Astronomy (MPIA), Heidelberg, Germany — [4]Centre for Space and Habitability (CSH), Bern, Switzerland — [5]Institute for Geological Sciences, Free University Berlin (FUB), Germany

We assess broadband color filters for the two fast cameras on the PLAnetary Transits and Oscillations of stars space mission with respect to the characterization of exoplanetary atmospheric composition, haze and geometric albedo. We focus on Ultra Hot Jupiters and Hot Jupiters placed 25pc and 100pc away from the Earth and low mass low density planets placed 10pc and 25pc away. Our analysis takes as input literature values for the difference in transit depth between the broadband lower (500-675nm) wavelength interval (hereafter referred to as blue) and the upper (675-1125nm) broadband wavelength interval (hereafter referred to as red) for transmission, reflection and occultation spectroscopy. Planets orbiting main sequence central stars with stellar classes F, G, K and M are investigated. We calculate the signal-to-noise ratio with respect to photon and instrument noise for detecting the difference in the blue and red spectral intervals.

EP 3.9 Di 18:30 HS 22

Modeling the Formation of super-Earth Atmospheres — Nicolas Cimerman[1], •Rolf Kuiper[1], and Chris Ormel[2] — [1]University of Tübingen — [2]University of Amsterdam

In the core accretion paradigm of planet formation, gas giants form a massive atmosphere via run-away gas accretion once their progenitors exceed a threshold mass: the critical core mass. On the one hand, the majority of observed exo-planets never crossed this line. On the other hand, these exo-planets have accreted substantial amounts of gas from the circumstellar disk during their embedded formation epoch.

We investigate the hydrodynamical and thermodynamical properties of proto-planetary atmospheres by direct numerical modeling of their formation phase. Our studies cover one-dimensional (1D) spherically symmetric, two-dimensional (2D) axially symmetric, and three-dimensional (3D) simulations with and without radiation transport.

In terms of hydrodynamic evolution, no clear boundary demarcates bound atmospheric gas from disk material in a 3D scenario in contrast to 1D and 2D computations. The atmospheres denote open systems where gas enters and leaves the Bondi sphere in both directions. In terms of thermodynamics, we compare the gravitational contraction of the forming atmospheres with its radiative cooling and advection of thermal energy, as well as the interplay of these processes. The coaction of radiative cooling of atmospheric gas and advection of atmospheric-disk gas prevents the proto-planets to undergo run-away gas accretion. Hence, this scenario provides a natural explanation for the preponderance of super-Earth like planets.