EP 1: Near-Earth Space and Space Weather

Time: Monday 14:30–17:50 Location: ELP 1: HS 1.22

Invited Talk EP 1.1 Mon 14:30 ELP 1: HS 1.22

Gravity wave vertical coupling from the troposphere to the thermosphere — •Markus Rapp, Bernd Kaifler, Natalie Kaifler, Andreas Dörnbrack, Sonja Gisinger, Robert Reichert, Stefanie Knobloch, and Hella Garny — Deutsches Zentrum für Luft- und Raumfahrt, Institut für Physik der Atmosphäre, Oberpfaffenhofen, Germany

It is now well established that momentum and energy transport by gravity waves as well as its interaction with the mean flow is a key driver of middle atmospheric circulation. The latter in turn has important consequences for the middle atmospheric mean state. Unfortunately, though, gravity wave dynamics covers a very large range of spatial and temporal scales such that a comprehensive characterization both in terms of observations and modelling is still a major scientific challenge. This paper reviews efforts in both observations and modelling over the past 10 years during which ground based, airborne and satellite borne gravity wave observations were combined with models to shed light on several fundamental aspects of gravity wave dynamics and wave-mean flow interaction. Comprehensive data sets of gravity wave observations were collected from the Arctic to the South Pole which were used to characterize gravity wave processes and their role in climate. Examples will be presented and an outlook will be given how we plan to extend these studies into the thermosphere in order to gain better understanding of the role of neutral atmosphere vertical coupling for driving space weather phenomena.

EP 1.2 Mon 15:00 ELP 1: HS 1.22

A possible cause for the October effect in the D-region — •Vivien Wendt[1], Helen Schneider[1], Daniela Banys[1], Marc Hansen[1], Mark Clilverd[2], and Tero Raita[3] — [1]Institute of Solar-Terrestrial Physics, DLR, Neustrelitz, Germany — [2]British Antarctic Survey, Cambidge, UK — [3]Sodankylä Geophysical Observatory, University of Oulu, Sodankylä, Finland

Radar waves with very low frequency (VLF) are reflected in the D-region, the lower edge of the ionosphere. The D-region (60 - 90km) is influenced by the solar zenith angle and space weather from above and by the mesosphere's dynamic and chemical processes. During October there is a sharp decrease of the daytime VLF amplitude between transmitter and receiver combinations whose great circle paths lie in polar latitudes. Until now we do not know what causes the October effect. Space weather phenomena can be ruled out as a cause since their time scales are too short or too long. The solar zenith angle can also be ruled out as a similar behavior is not observed in spring. Thus, there is an assumption that dynamical processes in the mesosphere play a major role. Previous studies showed that a strong warming occurs in the lower mesosphere shortly before the October effect is observed. While the characteristics of this warming help us to explain why the October effect occurs during daytime only, the warming alone cannot explain the sharp decrease in the VLF daytime amplitude. We suspect and confirm that the water vapor in the lower mesosphere, having similar characteristics as the warming and the VLF amplitude decrease, plays a crucial role in the formation mechanism of the October effect.

EP 1.3 Mon 15:20 ELP 1: HS 1.22

The CHerenkov Atmospheric Observation System (CHAOS) for the 2024 Balloon Experiments for University Students (BEXUS) Campaign — •Hannes Ebeling, Ava Pohley, Pierre Bornfleth, Hannah Sophie Grimm, Janna Martens, Jasper Mess, Justus Mickausch, Clara Pittschellis, Nicolas Rohrbeck, and Tom Ruge — Christian-Albrechts-Universität, Kiel, Germany

The Earth is continuously exposed to high-energy charged particles, so-called Galactic Cosmic Rays (GCRs). When these particles hit the Earth's atmosphere, they create a cascade of secondary particles. CHAOS uses a new detector design developed at the Department of Extraterrestrial Physics at Kiel University by a team of students to measure the different particle species of the primary GCRs above the so-called Regener-Pfotzer Maximum. To perform these measurements a combination of multiple solid state detectors and a bismuth germanium oxide (BGO) scintillator is used to measure the energy depositions of the particles. The use of an additional Cherenkov aerogel scintillator allows to separate between electrons and protons. Because electrons are much lighter than ions, electrons with energies above ~ 1.1 MeV will trigger the Cherenkov detector whereas ions with the same energy are much slower and will not trigger the Cherenkov detector. In this talk we present the design and functionality of CHAOS as well as its current status. CHAOS is supposed to fly on a stratospheric balloon as part of the BEXUS program in fall 2024. More information about CHAOS can be found at `https://www.bexus.org/`.

EP 1.4 Mon 15:40 ELP 1: HS 1.22

EPP-climate link by reactive nitrogen polar winter descent revisited: MIPAS v8 reprocessing and future benefits by the EE11 candidate mission CAIRT — •S. Bender[1], B. Funke[1], M. López Puertas[1], M. Garcia-Comas[1], T. von Clarmann[2], M. Höpfner[2], B.-M. Sinnhuber[2], M. Sinnhuber[2], Q. Errera[3], G. Poli[4], and J. Ungermann[5] — [1]IAA-CSIC, Spain — [2]KIT, Germany — [3]BIRA, Belgium — [4]IAP "Nello Carrara", Italy — [5]FZJ, Germany

Polar winter descent of NOy produced by energetic particle precipitation (EPP) in the mesosphere and lower thermosphere affects polar stratospheric ozone by catalytic reactions. This, in turn, may affect regional climate via radiative and dynamical feedbacks. NOy observations by MIPAS/Envisat during 2002–2012 have provided observational constraints on the solar-activity modulated variability of stratospheric EPP-NOy. These constraints have been used to formulate a chemical upper boundary condition (UBC) for climate models in the context of solar forcing recommendations for CMIP6. Recently, a reprocessed MIPAS version 8 dataset has been released. We assess how the changes in this new data version impact the EPP-NOy quantification and the formulation of the UBC.

ESA's Earth Explorer 11 candidate Changing Atmosphere Infra-Red Tomography (CAIRT) will observe the atmosphere from about 5 to 115 km with an across-track resolution of 30 to 50 km within a 500 km wide field of view. CAIRT will provide NOy and tracer observations with unprecedented spatial resolution. We assess its potential to advance our understanding of the EPP-climate link in the future.

30 min break

EP 1.5 Mon 16:30 ELP 1: HS 1.22

Atmosphere-Magnetosphere Coupling During Geomagnetic Storms — •Alina Grishina[1,2], Yuri Shprits[1,2,3], Alexander Drozdov[3], Miriam Sinnhuber[4], Florian Haenel[4], Dedong Wang[1], Mátyás Szabó-Roberts[1], Jan Maik Wissing[5], and Stefan Bender[6] — [1]GFZ German Research Centre for Geosciences, Potsdam, Germany — [2]University of Potsdam, Potsdam, Germany — [3]University of California, Los Angeles, Los Angeles, CA, USA — [4]Karlsruhe Institute of Technology, Karlsruhe, Germany — [5]DLR German Aerospace Center Neustrelitz, Neustrelitz, Germany — [6]Instituto de Astrofísica de Andalucía, CSIC, Granada, Spain

The electron and ion flux in the near-Earth environment can change by orders of magnitude during geomagnetically active periods, which can lead to intensification of particle precipitation into the Earth's atmosphere. In our study, we concentrate on ring current electrons, and investigate precipitation mechanisms and their effect on the atmosphere using a numerical model. We validate our results against observations from the Polar Operational Environmental Satellites (POES) mission, as well as the Van Allen Probes. We calculate the altitude-dependent atmospheric ionization rates, and validate them against Atmospheric Ionization during Substorm (AIMOS 2.1-Aisstorm) and Special Sensor Ultraviolet Spectrographic Imagers (SSUSI) values, which shows good agreement at high geomagnetic latitudes during the storm time.

EP 1.6 Mon 16:50 ELP 1: HS 1.22

Atmospheric impact of extreme solar eruptions — •Miriam Sinnhuber[1], Thomas Reddmann[1], Jan Maik Wissing[2], and Ilya Usoskin[3] — [1]Karlsruher Institut für Technologie — [2]DLR Neustrelitz — [3]University of Oulu, Finland

Large solar eruption - solar flares and coronal mass ejections - can have a significant impact on the chemical composition and dynamics of the polar middle atmosphere. For solar events of the space age since 1957, this is well quantified and understood. However, evidence for much larger events has been derived from paleonuclide records within the last 10000 years. Here, we show results from model experiments comparing the well-known "Halloween" solar storm of October 2003 with an extreme event of AD774/775. Both events had a significant impact on atmospheric composition which lasted for several months. Due to its harder spectrum and larger fluxes, this impact affected lower atmospheric layers during and after the AD774 event. Due to radiative-dynamical feedbacks, both events affected atmospheric temperatures and dynamics as well with larger changes during the event and during polar summer for the stronger AD774 event. However, during polar winter, the preconditioning of the atmosphere seems to play a role as well.

EP 1.7 Mon 17:10 ELP 1: HS 1.22

The Atmospheric Ionization during Substorm Model (AISstorm 2.1) — •Jan Maik Wissing[1] and Olesya Yakovchuk[2] — [1]DLR Neustrelitz — [2]Universität Rostock

AISstorm derives the global atmospheric ionization due to particle precipitation based on in-situ particle measurements. The model covers auroral precipitation as well as solar particle events on an altitude range of about 250km down to 16km for protons and down to 70km for electrons. Alpha particle ionization is included as well but on a smaller altitude range. The overall structure splits up into an empirical model that determines the 2D precipitating particle flux and a numerical model that determines the ionization profile of single particles. The combination of these two results in a high resolution 3D particle ionization rate pattern. The AISstorm is the successor of the Atmospheric Ionization Module Osnabrück (AIMOS).

The main benefit of the updated ionization rates are higher dynamics during substorms and during the onset of geomagnetic storms in particular in the mesosphere - in agreement with observations.

The internal structure of the model has been completely revised in AISstorm with the main aspects being: a) an internal magnetic coordinate system, b) including substorms characteristics, c) higher time resolution, d) higher spatial resolution, e) energy specific separate handling of auroral precipitation, polar cap precipitation and crosstalk affected areas, f) better MLT resolution.

The contribution will compare the new ionization rates to AIMOS 1.6, AISstorm 2.0 and the HEPPA III multi-model study.

EP 1.8 Mon 17:30 ELP 1: HS 1.22

Solar Wind monitoring for Space Weather impact prediction — •Jens Berdermann[1], Erik Schmölter[1], Martin Kriegel[1], and Henrike Barkmann[2] — [1]German Aerospace Center (DLR), Institute for Solar-Terrestrial Physics — [2]German Aerospace Center (DLR), German Remote Sensing Data Center

Applications in safety-critical communication, precise navigation and remote sensing require comprehensive information on the current and future state of the ionosphere. Of particular interest are monitoring and prediction of solar activity driven disturbances, which significantly impact the operation of these services. This in turn requires a sufficiently good database as well as powerful models and simulation tools. Additionally, early knowledge of the relevant sources of ionospheric disturbances, primarily solar radiation and wind, are necessary for forecasting. Therefore, near real time solar wind data are crucial for assessing and predicting the impact of space weather on the ionosphere and on technical systems. DLR is part of the Real Time Solar Wind network coordinated by the US National Oceanic and Atmospheric Administration, and therefore responsible for receiving the DSCOVR satellite in the European sector. We will provide information about the solar wind receiving facility, data acquisition and the product processing at the Ionosphere Monitoring and Prediction Center of DLR in Neustrelitz. In addition, we present storm events from the current space weather situation near solar maximum and their effects on the ionosphere and technical systems. Finally, we give a brief outlook on upcoming solar wind missions and future forecasting products.