EP 1: Near Earth Space

Zeit: Montag 16:30–19:00 Raum: BSZ - Pabel HS

Hauptvortrag EP 1.1 Mo 16:30 BSZ - Pabel HS

Recent Advances in Understanding of the Van Allen Radiation Belts — •Yuri Shprits — Helmholtz Centre Potsdam, GFZ German Centre for Geosciences, Potsdam, Germany — Institute for Physics and Astronomy, University of Potsdam, Potsdam, Germany

The Van Allen radiation belts consist of energetic electrons and ions at energies above 100 keV trapped by the Earth's magnetic field. These very energetic particles, often referred to as killer electrons, may be harmful to satellite electronics and humans in space. During geomagnetic storms, radiation in the near-Earth space can dramatically increase, and numerous anomalies are often reported by satellite operators. Since the discovery of the belts by the first US satellite over half a century ago, the origin of relativistic electrons in the radiation belts and physical mechanisms responsible for the dynamics of the belts has been a focus of extensive scientific research. We present an overview of recently discovered acceleration and loss mechanisms that determine the evolution of the belts, and an overview of the developed models of the space environment. We also present the real-time data assimilative framework based on the Versatile Radiation Belt Code (VERB). Using real-time streams from ACE, Van Allen Probes, GOES, and predictions of Kp index, we issue a highly accurate now-cast by assimilating all available data, and issue a forecast based on the now-cast.

EP 1.2 Mo 17:00 BSZ - Pabel HS

The Evolution of Turbulence behind the Terrestrial Bow Shock — •Gerrit Meinhardt, Joachim Saur, and Anne Schreiner — Institut für Geophysik und Meteorologie, Universität zu Köln

Using measurements from the Cluster spacecraft which investigate the Earth's magnetic environment and its interaction with the solar wind plasma, we study turbulence of magnetic fluctuations inside the Earth's magnetosheath. In the solar wind, power spectral densities of magnetic fluctuations follow a Kolmogorov scaling of $f^{-5/3}$ at MHD scales. Power spectral densities inside the magnetosheath were found to scale differently (close to f^{-1}) in most observations. We analyze 32 magnetosheath crossings of Cluster in different regions of the Earth's environment. We observe spectral slopes close to -1 as well as close to -5/3 which change with distance from the magnetosheath boundaries. We investigate the processes that lead to the evolution of turbulence in the inertial range of the turbulent cascade and the transition from a scaling with f^{-1} to a Kolmogorov scaling.

EP 1.3 Mo 17:15 BSZ - Pabel HS

The response of the middle and lower atmosphere to geomagnetic forcing in a coupled chemistry-climate model — •Miriam Sinnhuber, Sabine Barthlott, and Stefan Versick — Karlsruher Institut für Technologie, Karlsruhe, Germany

Precipitating electrons from the magnetosphere or the radiation belts accelerated in high-speed solar wind streams * called geomagnetic forcing * can affect atmospheric composition, temperatures and wind fields from the thermosphere down to at least the lower stratosphere. In a first instance, chemical composition is affected by impact ionization, which leads to the formation of nitric oxides in the upper mesosphere and thermosphere. Nitric oxide can then be transported down into the stratosphere during polar winter, and destroy ozone there in catalytic cycles. As ozone is one of the key species of radiative heating and cooling of the middle atmosphere, this has a direct impact on temperatures and the thermal wind balance.

We use a chemistry-climate model reaching from the surface up to the thermosphere (~220 km) to investigate the impact of high geomagnetic activity on composition, temperatures and wind fields in the middle and lower atmosphere.

EP 1.4 Mo 17:30 BSZ - Pabel HS

Impact of geomagnetic activity on thermospheric composition and circulation, and their coupling to the middle and upper atmosphere — •Sabine Barthlott[1], Miriam Sinnhuber[1], Thomas Reddmann[1], Stefan Versick[1], Holger Nieder[2], and Alexey Vlasov[2] — [1]Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany — [2]formerly KIT

External forcing by high-speed solar wind streams and solar coronal mass ejections (so-called geomagnetic forcing) incfluences composition and circulation of the lower thermosphere. Essential processes are photoionisation, particle ionisation and joule heating. Hereby produced changes in the thermosphere also effect other atmospheric layers. Enhanced nitrogen monoxide (NO) due to auroral ionisation subsides and influences atmospheric layers below (e. g. ozone layer). Gravity waves, excited in the lower thermosphere by e. g. geomagnetic storms, can propagate upwards and influence the environment of low-Earth orbit satellites.

To correctly reproduce this coupling with models, it is important, to describe these processes in the lower thermosphere as precisely as possible. We use and further develop the coupled chemistry-climate-model EMAC (used in an extended version up to ∼220 km) is further developed and processes mentioned above (e. g. photoionisation) are implemented. Using the example of winter 2008/2009, results of the further developed model will be compared with standard simulations and observations.

Hauptvortrag EP 1.5 Mo 17:45 BSZ - Pabel HS

Ionospheric research based on well-established and new monitoring methods — •Jens Berdermann — German Aerospace Center, Institute of Communication and Navigation, Neustrelitz, Germany

The ionosphere is an ionized layer ranging from about 50 km till 1000 km around the earth and is mainly generated by the solar irradiance. Ionospheric key parameters such as electron density, ion composition and plasma temperature are strongly dependent on geographic/geomagnetic location as well as on diurnal, seasonal, solar cycle and space weather effects. During the past decades a growing number of observations are available with the potential to significantly improve monitoring and modelling of the ionosphere. This is important since radio signals transmitted by modern communication, navigation and Earth observation systems are influenced during propagation through or by reflection at the ionosphere, depending on the used frequency. Therefore the combination of ground- and space-based data in combination with appropriate models can provide unique information about the ionosphere. We like to discuss how well established and new ionospheric measuring and modelling methods help to improve our understanding of the ionosphere and its dynamics.

EP 1.6 Mo 18:15 BSZ - Pabel HS

Mapping and Predicting Ionospheric Conditions based on Geodetic space-techniques and Solar Observations — •Andreas Goss[1], Eren Erdogan[1], Michael Schmidt[1], Denise Dettmering[1], Florian Seitz[1], Klaus Börger[2], Sylvia Brandert[2], Barbara Görres[3], Wilhelm Kersten[3], Volker Bothmer[4], Johannes Hinrichs[4], and Niclas Mrotzek[4] — [1]Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM) — [2]German Space Situational Awareness Center (GSSAC) — [3]Bundeswehr GeoInformation Centre (BGIC) — [4]Institute for Astrophysics at the University of Goettingen (IAG)

The project OPTIMAP is a joint initiative of the BGIC, the GSSAC, the DGFI-TUM and the IAG. The main goal of the project is the development of an operational tool for ionospheric mapping and prediction. The software uses geodetic observation techniques that are sensitive to the free electrons within the Earth*s ionosphere (GNSS, satellite altimetry, radio occultations, and DORIS) in order to provide representations of Vertical Total Electron Content (VTEC) with high spatial and spectral resolution. Since these observations are distributed rather unevenly over the globe, a so called Two-Level-Model (TLM) strategy has been developed, a combination of global and regional models. The additional incorporation of solar observations enables a reliable forecast for upcoming ionospheric conditions in terms of VTEC. In this contribution, we present the high-resolution VTEC products of the TLM, a correlation study of solar parameters and VTEC and the first results of the forecasted ionospheric conditions.

EP 1.7 Mo 18:30 BSZ - Pabel HS

Scaling thermospheric density of thermospheric empirical models using satellite laser ranging measurements to spherical low orbit Earth satellites — •Sergei Rudenko, Michael Schmidt, Mathis Blossfeld, and Eren Erdogan — Deutsches Geodätisches Forschungsinstitut der Technischen Universität München (DGFI-TUM), Arcisstrasse 21, 80333 Munich, Germany

Knowledge on the density of the Earth's thermosphere and exosphere is a prerequisite for planning of satellite missions, precise orbit determination, orbit and re-entry prediction, collision avoidance of artificial satellites orbiting the Earth at altitudes below 1000 km. Thermospheric density is usually given by empirical and physical models. Empirical models have been derived from observations, such as mass spectrometer, incoherent scatter radar, orbit and accelerometer data since 1961. Precise Satellite Laser Ranging (SLR) observations (with a precision of 1-3 mm for a normal point) to spherical satellites orbiting the Earth at an altitude below 1000 km can be used to validate and calibrate these models and, if necessary, scale the thermospheric density provided by the models. We present and discuss the results of the estimation of scaling factors of the thermospheric density given by four empirical thermospheric models CIRA86, NRLMSISE00, JB2008 and DTM2013 at the periods of low and high solar activity using SLR measurements to five low-altitude (350 to 425 km) satellites ANDE-RR Active and ANDE-RR Passive (2007), ANDE Castor and ANDE Pollux (2009-2010) and SpinSat (2015-2016).

EP 1.8 Mo 18:45 BSZ - Pabel HS

Empirical model of nitric oxide in the mesosphere from SCIAMACHY/Envisat satellite observations — •Stefan Bender[1], Miriam Sinnhuber[2], Patrick Espy[1], and John P. Burrows[3] — [1]Norwegian University of Science and Technology, Trondheim, Norway — [2]Karlsruhe Institute of Technology, Karlsruhe, Germany — [3]University of Bremen, Bremen, Germany

Solar, auroral, and radiation belt electrons as well as soft solar X-rays produce nitric oxide (NO) in the mesosphere and lower thermosphere (MLT, 50–150 km). NO downward transport, in particular during polar winters, influences the lower atmosphere by, for example, catalytically reducing ozone.

We present ten years of daily global NO number density measurements from 60 km to 90 km obtained by the satellite instrument SCIAMACHY on board Envisat. From this data set (from 08/2002 to 04/2012) we construct an empirical model of NO in the mesosphere. In particular, we link NO production and its lifetime to geomagnetic disturbances (given by the AE index) and to the solar UV radiation (using the Lyman-α index). The derived parameters constrain how solar and geomagnetic activity influence the NO content in the mesosphere. Our model will help to fill gaps in measurements and to validate and improve chemistry climate models.