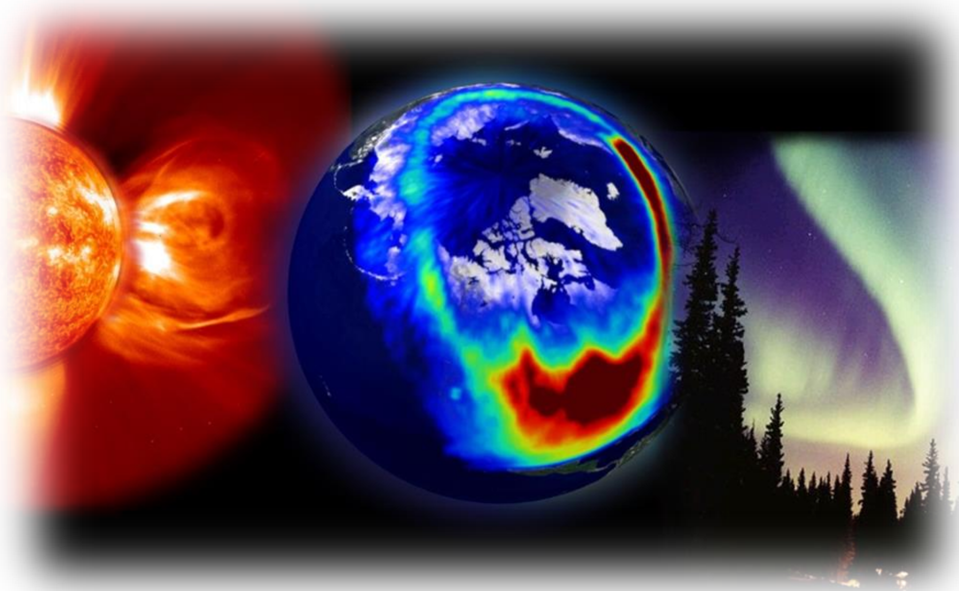
JOINT SPACE WEATHER SUMMER_CAMP 2016



21st June - 14th July, 2016

German Aerospace Center (DLR)

The University of Alabama in Huntsville

South African National Space Agency (SANSA)

THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

DLR Deutsches Zentrum für Luft- und Raumfahrt

sansa SOUTH AFRICAN NATIONAL SPACE AGENCY

LEIBNIZ-INSTITUT FÜR ATMOSPHÄREN PHYSIK IAP

Universität Rostock Traditio et Innovatio

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Welcome to the Joint Space Weather Summer_Camp 2016

The Joint Space Weather Summer Camp is a partnership between UAHuntsville and the DLR and SANSA.
Because of the considerable historical ties between Huntsville and the state of Mecklenburg-Vorpommern (Germany) in the development of rockets, missiles, and eventually manned space flight, the Joint Space Weather Summer Camp was created to forge ties and develop communication between these two regions that have had such an impact on the 20th century.

During the three week series of lectures, hands-on projects, experiments, and excursions you will be given an understanding of both the theoretical underpinnings and practical applications of Space Weather and solar and space physics.

For the first time, the South African National Space Agency will participate as a host. In the first half of the Summer_Camp in Hermanus (South Africa) the focus will on plasma physics, the source of space weather, the sun, and the near earth space. There will be the opportunity to participate in either data or practical-based project work, enabling you to gain a practical understanding of the topic.

In the second part in Northern Germany we will focus on the upper atmosphere and ionosphere. Besides the lectures there will also be practical project work and we will also visit the Leibniz-Institute of Atmospheric Physics (IAP) in Kühlungsborn.

The Joint Space Weather Summer Camp is much more than just lectures, projects and experiments. It also provides a wonderful opportunity for cultural exchanges between the US, South Africa and Germany in an academic setting. The visit of the 'Historical Technical Museum in Peenemünde' in the Northeast of Germany or whale watching in South Africa are just two further examples of a program that goes beyond.

We hope that the Joint Space Weather Summer Camp will be an interesting introduction to the theoretical and practical aspects of Space Weather combined with a cultural exchange between the US, South Africa and Germany!

The Joint Space Weather Summer Camp 2016 Committee

Schedule Germany

	Saturday 02. Jul	Sunday 03. Jul	Monday 04. Jul	Tuesday 05. Jul	Wednesday 06. Jul	Thursday 07. Jul	Friday 08. Jul	Saturday 09. Jul	Sunday 10. Jul	Monday 11. Jul	Tuesday 12. Jul	Wednesday 13. Jul	Thursday 14. Jul
9:00-09:35	Departure from Africa	Arrival in Berlin	Welcoming	**E. Flückiger** (Cosmic Rays and Space Weather)	Discussion	**M. H. Pajares** (GPS for Flare Measurements)	Discussion	8-11:00 Departure to Peenemünde	Freetime	9-12:00 Departure to Kühlungsborn	9:30 IAP	9-11:00 Reichstag	
9:35-10:00			**G. Mann** (Radio Emission of the sun)								10:00-12:00 **R. Redmer** (Progress in warm dense matter…)		
10:00-10:15					Break		Break						
10:15-10:30					**B. Heber** (Cosmic rays in the Heliosphere)		**N. Jakowski** (Ionospheric Weather)						
10:30-10:55				Break		Break							
10:55-11:00			Break					11-15:30 Peenemünde Museum		12:00-12:50 Lunch	12:00-12:55 Lunch	Freetime	Departure
11:00-11:10				**B. Heber** (Cosmic rays in the Heliosphere)		**A. Morschhauser** (Magnetosphere)			13:00-14:30 Cafe	13:00-14:30 **F.-J. Lübken** (Introduction IAP)	13:00-14:30 **E. Becker** (Theoretical aspects of atmospheric dynamics and climate)		
11:10-11:15			**T. Wiegelmann** (Solar aspects of space weather)										
11:15-11:30					Break		Break		Sightseeing NZ				
11:30-12:30					**Y. Memarzadeh** (Space Weather and GNSS)		**I. Mann** (Incoherent Scatter)			14:35-15:00 **M. Gerding** (Ballon 1st)			
12:30-13:30			Lunch	Lunch	Lunch	Lunch	Lunch			15:05-15:45 **G. Stober** (Investigation of atmospheric dynamics using radars)	Freetime		
13:30 - 14:30			DLR-Tour	Projects	Projects	Projects	Projects						
14:30-17:00			Projects		BBQ (after 17:00)			Freetime Zinnowitz 19:00 to NZ	18:00 Dinner Orangerie	15:50-16:05 (Ballon 2nd) Break 16:15-18:00 (Round Tour) 19:00 Beachparty	18:00 Departure to Berlin	19:00 Dinner Alt-Berliner Wirtshaus	

Joint Space Weather Summer_Camp

Abstracts

Monday, 04th July

Welcome and Visit DLR Neustrelitz

Holger Maass
German Aerospace Center (DLR), Neustrelitz, Germany

The Neustrelitz site of the German Aerospace Center (DLR) is located in Mecklenburg-Vorpommern, approximately 100 km north of Berlin. More than 80 employees are working in three institutes the

- Earth Observation Centre
- Institute for Communications and Navigation
- Institute for Remote-Sensing Methods

and the Technology Marketing section. In addition a school-lab is just established for educating students in space sciences and related innovative technologies. DLR Neustrelitz site has access to modern technological systems suitable for the demands of a real-time data center for GMES and Galileo related research tasks.

The national ground segment is a department of the Earth observation center (EOC) and takes care for reception of numerous remote sensing and scientific satellites. Thus, DLR Neustrelitz, as one of the four stations belonging to the Real Time Solar Wind (RTSW) network of NOAA, contributes essentially to the permanent availability of solar wind data measured onboard NASA's ACE and DSCOVR satellite. Huge remote sensing data volume is success-fully managed in the EOC by using the Data Information Management System (DIMS).

Research activities in the Institute for Remote sensing Methods focus on studying scattering and radiative transfer in the Earth's atmosphere for improving atmospheric corrections of remote sensing data.

In the field of satellite navigation, the research is focused on developing algorithms for precise and safe navigation in particular in the maritime application sector. Thus, technological developments have been carried out for the Rostock Research Harbour.

To correct and the impact of space weather effects on GNSS applications, the ionosphere is permanently monitored and modelled in near real time. Research activities focus on developing methods to detect, forecast and mitigate ionospheric perturbations having the capability to degrade GNSS systems. Derived Data products are disseminated via the Space Weather Application Center Ionosphere (SWACI), a project which is essentially supported by the state government of Mecklenburg Vorpommern.

Radio Emissions of the sun

Gottfried Mann
German Aerospace Center (DLR), Neustrelitz, Germany

The Sun is the most intense radio source in sky. The Sun is an active star. That manifests not only in Sun spots and the famous 11-year cycle, but also in short term eruptions as flares. These eruptions are often accompanied with a strong enhancement of the Sun's emission of radio waves. With the novel European LOFAR (LOw Frequency ARray) we have the opportunity to observe these phenomena with a high accuracy.In the talk, we will present examples of radio phenomena of the active Sun as recently observed.

Solar aspects of space weather

Thomas Wiegelmann
Max Planck Institute for Solar System Research, Göttingen, Germany

The sources for space weather are active regions on the sun. They are called active regions because they are the origin of eruptive phenomena like coronal mass ejections and flares. These eruptions, which finally can cause space weather activity at Earth, occur due to instabilities in the higher solar atmosphere (chromosphere and corona). In these layers the solar magnetic field dominates over all other plasma forces (like pressure gradient and the gravity force) and consequently we need to study the magnetic field to investigate the physics of these eruptive phenomena.

While we cannot measure the magnetic field in the corona directly, there are two sources of information about the 3D magnetic field structure: 1.) coronal EUV-images which outline the magnetic field lines and 2.) measurements of the magnetic field vector in the solar atmosphere (ground based and space born vector magnetographs). Both information can be used to model the coronal and chromospheric magnetic field. With a subsequent analysis of the available free magnetic energy, helicity and the occurrence of strong current concentrations, we can estimate the probability and strength of space weather relevant eruptions.

Cosmic Rays and Space Weather

Erwin O. Flückiger
University of Bern, Switzerland

In all space weather scenarios cosmic ray measurements are included as a monitoring and alert instrument, as an additional forecasting tool, and as a provider of key input parameters for real time applications and post-event analysis. The energy input from cosmic rays into the system Earth is small, roughly the same as that of starlight. However, continuous galactic and sporadic solar cosmic rays have a multitude of effects on terrestrial, biological, and technological systems. The first part of the talk consists of a short summary of relevant fundamentals of cosmic rays and of their interaction with the geospace environment. Emphasis is given to the role of cosmic ray measurements taken by the global network of ground-based detectors, such as neutron monitors. The main part of the lecture gives a general overview of established and assumed cosmic ray space weather effects, and then illustrates with selected examples the significance of cosmic ray data within specific space weather programs. The examples include the role of real time ground based cosmic ray observations and advanced analysis methods as an alert and monitoring instrument for substantial changes in the Earth's particle radiation environment, as a forecasting tool for geomagnetic storms, and as a key element in the assessment of the radiation dose at aircraft altitude, in particular during intense solar particle events.

Cosmic rays in the heliosphere and on their route through the magneto and atmosphere – Theory and Experiment

Bernd Heber
Christian-Albrechts-University Kiel, Germany

Conditions on the Sun and in the helio-, magneto-, iono-, and atmosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health are subject to space weather research. Besides the understanding of the underlying physical processes a major objective is to forecast dangerous processes in the Earth's environment. The radiation field as measured in near Earth space and in the Earth atmosphere is determined by the primary distribution of energetic particles outside the Earth magnetosphere and the interactions of energetic particles with electromagnetic fields and matter.

This project is dedicated to shed some light on the different particle populations i.e. galactic and solar cosmic rays that dominates the near Earth environment, how these particles can be measured by different technologies and how the intensity spectrum is altered on their way through the Earth magneto- and atmosphere.

Cosmic rays coming from outside will due to the Lorentz force undergo complicated trajectories in the magnetic field and may even be prevented from getting access to the atmosphere. PLANETOCOSMICS is a GEANT 4 based tool that was developed to investigate the charged particle propagation in the near Earth space and their interaction with the atmosphere. After discussing the underlying physics we will make use of this program to calculate the altered galactic cosmic ray spectrum for different locations at a height of 600 km. The result will be compared to energy spectra measured with PAMELA from 2006 to 2010.

When energetic particles enter matter they interact with the atoms, losing energy and may even produce secondary particles. Based on the different processes, particle type, energy, and momentum can be derived. The second block of the project is thus dedicated to measurements of energetic particles in interplanetary space. We will analyze data from different instrumentation and learn how to identify different chemical elements and isotopes.

If we follow the path of energetic particles that enter the Earth’s atmosphere to the ground we recognize that collisions with the atmosphere atoms and molecules will create secondary particles of different energies. Some of the secondary particles in the atmosphere may reach the ground, where one can measure them by e.g. a neutron monitor or other detectors. Despite their decades of tradition, ground based neutron monitors (NMs) remain the state-of-the-art instrumentation for measuring cosmic rays, and they play a key role as a research tool in the field of space physics, solar-terrestrial relations, and space weather applications. A third block is dedicated to neutron monitor measurements and comparisons to measurements with our own device.

Cosmic rays in the heliosphere and on their route through the magneto and atmosphere – Theory and Experiment

Bernd Heber
Christian-Albrechts-University Kiel, Germany

2nd part

The effects of space weather on precise GNSS positioning

Yahya Memarzadeh
Fugro Intersite B.V., Netherlands

Fugro acquires and interprets earth and engineering data and provides associated consulting services to support clients with their design and construction of infrastructure and buildings. Fugro also supports clients with the installation, repair and maintenance of their subsea infrastructure. Fugro works around the globe, predominantly in energy and infrastructure markets offshore and onshore. These activities require precise and reliable real-time positioning. Therefore, Fugro provides a number of GNSS (Global Navigation Satellite System) positioning services, mainly for use offshore.

Fugro provides worldwide various differential GNSS and RTK positioning services. In April 2015, Fugro lunched an ultra-high accuracy positioning service called G2+ which provides worldwide 1-3 cm level accuracy in real time. Apart from the GNSS signals themselves, the services also rely on correction signals, broadcast e.g. by geostationary satellites, using L-band frequency (similar to GNSS).

Several space weather phenomena create disturbances in the Earth's magnetic field and ionosphere in the polar latitudes and equatorial areas e.g. Brazil, West Africa, Southeast Asia (where significant offshore oil exploration activities are). Ionospheric disturbances impact the performances of GNSS services e.g. degrading single-frequency services, L-band communication outages, and scintillating GNSS signals.

As a result, the GNSS and correction signals are often disturbed or even completely lost, due to e.g. ionospheric amplitude scintillations. Using more satellite systems, such as GPS, Glonass, Galileo and BeiDou, may help to mitigate the effects of scintillation. But phase scintillations still can be as a limiter for fixing ambiguities in the GNSS cm-level accuracy applications such as $G2^+$.

In 2015, Fugro developed a worldwide scintillation monitoring and prediction service, which can forecast scintillation for the next 24 hours. It could help Fugro's clients with the planning of large offshore operations such as rig moves around periods of strong scintillation.

It is not always possible to precisely predict the exact starting time or severity of forecast scintillation because of the dynamic nature characteristics of the solar wind and coronal mass ejection (CME) features which drive it. Recently, the service improved to issue an individual alert message (specific for the user) in near real-time in cases of: scintillation begins, scintillation ceases, and severity of scintillation increases at the user location.

In this presentation, after a brief introduction of Fugro's current and future positioning services, we will give an overview of the effects of the current solar maximum on precise GNSS positioning results in areas such as Brazil, Africa, India, Scandinavia and Alaska.

GPS for Flare Measurements

Manuel Hernández-Pajares
Universitat Politècnica De Catalunya, Barcelona, Spain

The development of the Global Positioning System, first, and the open civilian control segment after (the so called International GNSS Service, IGS), have dramatically improve the ionospheric sounding during the last 20 years. In this lecture a brief introduction, from the ionospheric monitoring with GPS to its recent new application to solar EUV flux monitoring, will be given. It will be supported by actual data, and validated with direct measurements from solar probes. Particular aspects of interest will be summarized as well, as the potential of GPS to provide as well an geophysical index of the solar flare intensity (mitigating the extinction effect of the solar atmosphere on EUV radiation), its advantages compared with direct measurements from solar probes, and its capability to characterize as well weak solar flares.

Magnetosphere

Achim Morschhauser
German Research Centre for Geosciences (GFZ), Potsdam, Germany

The Earth's magnetic field is continuously interacting with the solar wind and the interplanetary magnetic field. This interaction triggers a variety of processes and electric currents from up in the Earth's magnetosphere to down in the Earth's mantle. Hence, if we want to understand how space weather influences the system Earth, it is mandatory to observe and understand the Earth's magnetic field and its various sources.

In this talk, we will first discuss how the Earth's magnetic field is observed from ground and from space, what challenges are involved in measuring the Earth's magnetic field, and how space- and ground-based measurements complement each other. Then, we will look at the various sources of Earth's magnetic field by discussing their temporal variations and their typical signals in observations. These sources include the Earth's core dynamo, induced currents in the mantle and oceans, and the ionospheric and magnetospheric current systems. In the context of space weather, we will particularly focus on the dependency of these sources on solar activity. Further, geomagnetic indices and some of their applications in science and society will be discussed. These indices are derived from ground-based observatory data and provide an important tool to quantitatively characterize the strength and variations of most of these current systems.

Ionospheric weather – an integral part of space weather

Norbert Jakowski
German Aerospace Center (DLR), Neustrelitz, Germany

On the one hand the ionosphere directly responds to space weather events originating from the sun via electromagnetic and corpuscular radiation. On the other hand it is an integral part of space weather itself characterized by specific phenomena. The talk reviews some historical aspects related to the discovery and exploration of the ionosphere and considers its basic structure and dynamics including coupling processes in particular with thermospheric and magnetospheric processes. The use of dual frequency navigation signals from Global Navigation Satellite Signals (GNSS) for monitoring, exploring and modelling the ionosphere is emphasized because ground and space based GNSS measurements performed at DLR Neustrelitz since many years. Discussed are short- mid- and long- term effects caused by electromagnetic and corpuscular radiation from the sun associated with solar flares, solar rotation and solar cycle. As will be shown by selected case studies, Coronal Mass Ejections (CMEs) of the sun may heavily disturb regular ionospheric processes causing strong perturbations of the ionospheric structure and dynamics in particular at high latitudes.
It is shown that ground and space based GNSS measurements provide valuable data sets to model the ionosphere, to better understand generation and propagation of storm phenomena, to forecast them and to estimate their impact on modern telecommunication, navigation and radar systems. Degradation or even loss of their functionality caused by space weather hazards can be mitigated to some extent by ionospheric weather services as described in a separate talk.

Incoherent Scatter and EISCAT_3D

Ingrid Mann
European Incoherent Scatter Scientific Association (EISCAT), Kiruna, Sweden

Incoherent scatter observations are based on transmission of a high power radio signal and reception of a faint back-scattered signal. Incoherent scatter observations are made with high-power, large-aperture radar to (among other applications) study space weather events from the ground. The underlying physical mechanism is Thomson scattering of electromagnetic waves by ionospheric electrons. The back-scattered power is proportional to the number of scattering electrons. The spectrum of the back-scattered signal is shaped by wave-coupling to the ions, by Landau damping and by Dopplershift due to the ionospheric motion. As a result the incoherent scatter signal contains information on the ionospheric parameters electron density, electron temperature, ion temperature, ion drift velocity and sometimes velocity of neutrals. Incoherent scatter observations can be made at all space weather conditions. EISCAT Scientific Association is building a new multi-static phased radar EISCAT_3D with advanced measurement capabilities for measurements with high spatial and temporal resolutions and with the capability to derive velocity vectors. This presentation will address the basics of incoherent scatter, show measurements during space weather events and introduce the new EISCAT_3D.

Introduction to atmospheric science at IAP

Franz-Josef Lübken
Leibniz-Institute of Atmospheric Physics (IAP), Kühlungsborn, Germany

Incoherent scatter observations are based on transmission of a high power radio signal and reception of a faint back-scattered signal. Incoherent scatter observations are made with high-power, large-aperture radar to (among other applications) study space weather events from the ground. The underlying physical mechanism is Thomson scattering of electromagnetic waves by ionospheric electrons. The back-scattered power is proportional to the number of scattering electrons. The spectrum of the back-scattered signal is shaped by wave-coupling to the ions, by Landau damping and by Dopplershift due to the ionospheric motion. As a result the incoherent scatter signal contains information on the ionospheric parameters electron density, electron temperature, ion temperature, ion drift velocity and sometimes velocity of neutrals. Incoherent scatter observations can be made at all space weather conditions. EISCAT Scientific Association is building a new multi-static phased radar EISCAT_3D with advanced measurement capabilities for measurements with high spatial and temporal resolutions and with the capability to derive velocity vectors. This presentation will address the basics of incoherent scatter, show measurements during space weather events and introduce the new EISCAT_3D.

Investigation of atmospheric dynamics using radars

Gunter Stober
Leibniz-Institute of Atmospheric Physics (IAP), Kühlungsborn, Germany

The investigation of atmospheric dynamics from the troposphere up to the mesosphere/lower thermosphere is rather challenging for remote sensing instruments. Radars provide the opportunity to observe, independent of the weather conditions, continuously the troposphere/lower stratosphere as well as the mesosphere/lower thermosphere. At IAP we operate unique radar instruments to study atmospheric dynamics at high spatial and temporal resolution at mid- and high-latitudes. We present recent results on two specific research topics: (a) Investigation of small scale GW and ripples using the Middle Atmosphere Alomar Radar System (MAARSY), and (b) the MMARIA concept, radar networks to resolve horizontal wind structures at regional scales.

Progress in warm dense matter and planetary physics

Ronald Redmer
University of Rostock, Rostock, Germany

The behavior of matter under extreme conditions (megabar pressures, temperatures of several 1000 K up to about 100.000 K) is important for interior models of giant planets. Surprisingly, the high-pressure phase diagram of even the simplest and most abundant elements hydrogen and helium is not well known (Jupiter, Saturn). Interesting phenomena such as proton conduction and demixing are expected when studying the behavior of oxygen, carbon, nitrogen, their hydrides and mixtures at high pressures (Uranus, Neptune). A large number of planets has been found around other stars since 1995 which show a strong variation in mass, chemical composition, and distance to their parent star so that solar and extrasolar giant planets are perfect laboratories for the study of matter under extreme conditions. In the first part we will review the main properties of the solar planets and introduce detection methods for extrasolar planets and their properties.

In the second part we will give an introduction into the physics of matter under extreme conditions. Because simple plasma models based on perturbation theory fail to describe strongly correlated systems, ab initio methods have been applied to derive physical properties. For instance, molecular dynamics simulations based on finite-temperature density functional theory were used to calculate the equation of state, the electrical and thermal conductivity of H, He, their mixtures, and of molecular systems such as H2O for a wide range of densities and temperatures. Most interestingly, the equation of state data for hydrogen predict a first-order liquid-liquid phase transition with a critical point at 1400 K, 1.32 Mbar and 0.79 g/cm3 which is connected with a nonmetal-to-metal transition. The behavior of the electrical and thermal conductivity and of their ratio (Lorenz number) is analyzed along this transition, especially the deviations from the well-known Wiedemann-Franz relation which might be important for the operation of planetary dynamos. Furthermore, we have identified the parameters for demixing of helium from hydrogen which match the conditions in the interior of Saturn as long has been predicted. Finally, we have calculated the interior structure and composition of solar and some extrasolar planets within three-layer models. We will give exemplary results for the density and temperature profile, the metallicity and size of the planetary cores, and for the slope of the material properties along planetary isentropes.

Theoretical aspects of atmospheric dynamics and climate

Erich Becker
Leibniz-Institute of Atmospheric Physics (IAP), Kühlungsborn, Germany

We present an overview of the major concepts that allow us to understand the general circulation of the atmosphere. We define the different layers of the atmosphere and discuss the governing equations of motion that are solved numerically in global climate models. We shall explain the substantially different aspects of the seasonal variations in the lower and middle atmosphere using the concept of wave-mean flow interaction. Exemplary model results for the role of different types of waves in the atmosphere (in particular, gravity waves and Rossby waves) will be presented. In a second part we discuss the basic concepts of climate physics in the global-mean equilibrium. This picture is extended by the Lorenz energy cycle and the meridional energy exchanges by the atmosphere and the ocean, leading to the latitude-dependent global radiation budget at the top of the atmosphere.

Assembling and testing of a SOFIE receiver

Lutz Heinrich
DLR_Project_Lab, Neustrelitz, Germany

SOFIE (Solar flares detected by Ionospheric effects) is a German student project related to space weather. Target is the detection of solar flares by using of ionospheric propagation effects on radio waves. These effects are measurable with a suitable receiver, the SOFIE receiver. The SOFIE receiver measures constantly the field strength of a military VLF transmitter. By this it is possible to observe the activity of the sun independently of satellites and with relatively simple means.
This project offers participants to set up their own receiver (at max 4 receivers) with professional guidance and supervision. Each component of the receiver and its specific use will be presented in detail. One main point is the proper integration of all the components to the printed circuit board (PC-board) of the receiver. The required solder techniques will be trained and applied. After all components are adjusted, the whole instrument is put into operation.

Radiation Protection in Aviation

Tomas Forkert
German Aerospace Center (DLR), Cologne, Germany

The determination of the radiation exposure of aircrew at aviation altitudes, generated by interactions of primary high-energetic particles of cosmic origin with atoms in upper layers of the Earth's atmosphere, has been part of the radiation protection standards in the EU for more than ten years. The corresponding radiation field is very complex in both particle composition and energy distribution. The corresponding intensity depends on altitude, geomagnetic latitude and solar activity. Furthermore, Solar Particle Events (SPEs) can temporarily lead to increased dose rates at aviation altitudes, as well. Today, the radiation field and its modulating parameters can be represented by numerical models very well and, therefore, the operational dose assessment of aircrews relies on numerical calculations. Nevertheless, the results of these calculations need to be verified and improved regularly by concomitant measuring flights that allow spot checks of the calculated doses by measuring the actual radiation field with different types of detectors.

This project work will give an insight into the measurement of radiation fields in aviation by evaluating the data of a real measurement flight. The students learn which dosimetric quantities can be measured by various detectors and determine the relevant characteristics of the radiation field at cruising altitudes. Finally, the space weather situation during the flight is to be considered.

Interplanetary HD and MHD Shocks – Theory and application to data

Klaus Scherer
Ruhr-University, Bochum, Germany

The project aims on the understanding of interplanetary shocks and their geo-effectivity, in the first part the theoretical framework hydrodynamic and magneto-hydrodynamic (MHD) shocks will be presented in general. The first task will be to formulate the Rankine-Hugoniot relations.

In the next step the MHD shocks will analyzed, which have a much richer structure. In that course we will introduce fast and slow magneto sonic waves and study their role in MHD shocks.

In the second task spacecraft data will be analyzed. In the presented example data fast and slow shocks, rotational discontinuities etc., shall be identified and analyzed. Additionally a simple error analysis of the fluctuating spacecraft data shall be performed.

The Effect of Ionospheric Scintillations on Global Navigation Satellite Systems (GNSS) Receivers

Felix Antreich
German Aerospace Center (DLR), Oberpfaffenhofen, Germany

Ionospheric scintillations are rapid variations in the amplitude and phase of radio signals propagation through the ionosphere. These rapid variations of the amplitude and the phase of a signal are resulting from electron density irregularities in the ionosphere. Scintillations are therefore directly linked to the underlying physical processes in the ionosphere that give rise to irregularities.

Scintillation activity is most severe and frequent in and around the equatorial regions (geomagnetic equator), particularly in the hours just after sunset. In high latitude regions, scintillation is frequent but less severe in magnitude than that of the equatorial regions. Scintillation is rarely experienced in the mid-latitude regions. However, it can influence GNSS operation during very intense magnetic storm periods when the geophysical environment is temporarily altered and high latitude phenomena are extended into the mid-latitudes.

Amplitude scintillation, or short-term fading, can be so severe that signal levels drop below a GNSS receiver's lock threshold, requiring the receiver to attempt reacquisition of the satellite signal. Phase scintillation, characterized by rapid carrier-phase changes, can produce cycle slips and sometimes challenge a receiver's ability to hold lock on a signal. The impacts of scintillation cannot be mitigated by the same dual-frequency technique that is effective at mitigating the ionospheric delay. For these reasons, ionospheric scintillation is one of the most significant threats for GNSS users in the near equatorial and polar latitudes.

The students will study the functionality of a GNSS receiver. They will use a software GNSS receiver to process recorded/simulated GNSS signals in order to understand the impact of ionospheric scintillations on GNSS receivers.

Information

Locations – Neustrelitz

Kornspeicher am Hafen (Café)

Am Stadthafen 5,17235 Neustrelitz - 53°21'54.9"N 13°03'18.1"E

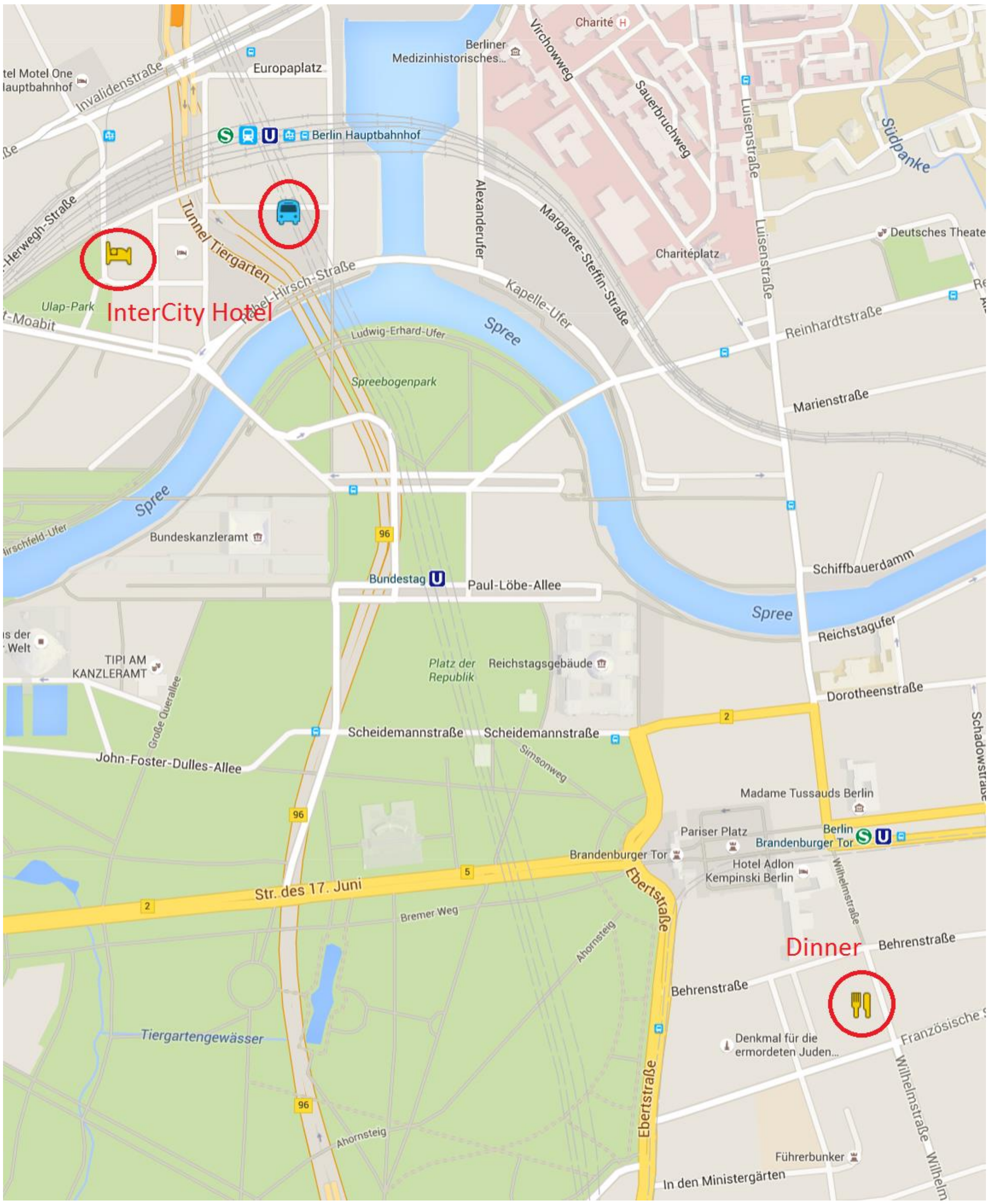
Locations – Berlin

InterCityHotel Berlin Hauptbahnhof

Katharina-Paulus-Straße 5, 10557 Berlin - 52°31'25.0"N 13°22'00.3"E

Alt-Berliner Wirtshaus (Dinner)

Wilhelmstr. 77, 10117 Berlin - 52°30'52.0"N 13°22'53.1"E



Phone Numbers

Emergency numbers

110 ← police

Or

112 ←ambulance service

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