TOWARDS FUTURE RESEARCH ON SPACE WEATHER DRIVERS

2-7 July 2019, San Juan, Argentina

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- **Dynamic events determining space weather conditions**
- **Large scale corona and solar wind models**
- **Interplanetary counterparts of solar activity**
- **Tools and simulations for space weather forecasting**
- **Science with total solar eclipses**
- **Instrumentation with space weather applications**

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FReSWeD 2019

Towards Future Research on Space Weather Drivers

2 – 7 July 2019, San Juan - Argentina

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	Monday 1 July	Tuesday 2 July	Wednesday 3 July	Thursday 4 July	Friday 5 July	Saturday 6 July	Sunday 7 July
8:30				8:30 – 9:30 School at Venue	8:30 – 9:30 School at Venue		
9:00	9:00 – 11:00 Registration at University Residence	9:00 – 11:00 Registration at Venue				9:00 – 9:30 Teriaca	School at Electromechanics Engineering Department
9:30				9:30 – 10:00 Habbal	9:30 – 10:00 Richardson	9:30 - 9:50 Decker	
10:00			10:00 – 10:45 School & registration at venue	10:00 – 10:30 Green	10:00 – 10:45 3 contr. (Wu, Molina, Perez-Alanis)	9:50 – 10:10 Howard	
10:30				10:30 – 10:50 Veronig		10:10 – 10:40 Tripathi	
11:00		11:00 – 20:30 Eclipse Observation	10:45 – 11:15 School Coffee Break	10:50 – 11:15 Coffee Break	10:45 – 11:15 Coffee Break	10:40 – 11:15 Coffee Break	10:45 – 11:15 Coffee Break
11:30			11:15 – 12:00 School & registration at venue	11:15 – 12:30 5 contr. (Dissauer, Podladchikova, Webb, Sieyra, Lamy)	11:15 – 11:45 Dasso	11:15 – 12:00 3 contr. Golub, Hidalgo-Ramirez, Gulisano	School at Electromechanics Engineering Department
12:00			12:00 – 13:00 School Lunch Break		11:45 – 12:15 2 contr. (Janvier, Cecere) 12:15 - 12:35 Georgoulis	12:00 -12:20 Costta 12:20 – 12:30 Closing	
12:30				12:30 – 14:00 Lunch Break	12:35 – 14:00 Lunch Break	12:30 - 12:40 NSF SW prog. 12:40 - 13:10 Discussion SWx in Latin America	12:30 – 14:00 Lunch Break
13:00			13:00 – 13:30 Opening			13:10 – 14:30 Lunch Break	
13:30			13:30 – 14:00 Nandi				
14:00			14:00 – 14:30 Van Driel-Gesztelyi	14:00 – 14:20 Gibson	14:00 - 14:30 Collado-Vega		School at Electromechanics Engineering Department
14:30			14:30 – 15:30 4 contr. (Linan, Palacios, Yang, Buitrago-Casas)	14:20 – 15:05 3 contr. (Talpeanu, Nitta, O'Kane)	14:30 – 15:15 3 contr. (Amerstorfer, Desai, Glocer)	School at Venue	
15:00				15:05 - 15:35 Mierla	15:15 - 15:35 Zhukov		
15:30			15:30 – 16:00 Coffee Break	15:35 – 16:00 Coffee Break	15:35 – 16:00 Coffee Break	15:30 – 16:00 Coffee Break	15:30 – 16:00 Coffee Break
16:00	16:00 – 18:00 Registration at Venue		16:00 – 16:30 Vilmer	16:00 – 16:20 Gonzalez Esparza	16:00 – 16:30 Chamberlin	School at Venue	School at Electromechanics Engineering Department
16:30			16:30 – 16:45 1 contr. Musset 16:45 - 17:05 Raulin	16: 20 – 16:50 Klein 16:50 - 17:05 1 contr. Wijsen	16:30 - 16:50 Klimchuk 16:50 - 17:05 1 contr. Milligan		
17:00			17:05 – 17:20 1 contr. Valle Silva	17:05 - 17:35 Linker	17:05 - 17:25 Bong		
17:30			17:20 -17:50 Guo	17:35 – 17:50 1 contr. Vasquez	17:25 - 17:45 Hudson		
18:00			17:50 - 18:05 1 contr. Berger	17:50 - 18:10 Brooks	17:45 – 18:05 Young		
18:30							
19:00			19:00 – 20:00 Outreach Talk	19:00 – 20:00 Outreach Talk	19:00 – 20:00 Outreach Talk		
19:30							
20:30		Welcome reception			Closing dinner		

Session 1

Space Weather: An Approach from the Solar Interior to the Lower Solar Atmosphere

Forecasting Long-term Space Weather: A Dynamo Modeling Perspective

D. Nandi

Indian Institute of Science Education and Research Kolkata

Abstract. The Sun's magnetic cycle governs its radiation levels, particle flux output and the frequency of solar magnetic storms. Collectively these phenomena create space weather which impacts space- and ground-based technologies and drives Earths atmospheric dynamics. This has created the need to develop numerical model-based forecasting of solar activity. Successfully addressing this goal necessitates an understanding of the physics that governs high Reynolds number turbulent plasmas in the Suns interior, and building predictive dynamo models based on this understanding. This has remained an outstanding challenge for the community. In this talk, I will discuss the advances we have made in understanding the physics of solar cycle predictability over the last decade and present a physical model-based forecast for sunspot Cycle 25.

Invited talk

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Active Region Evolution and Dynamic Events

L. van Driel-Gesztelyi

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Observatoire de Paris, LESIA, France
Konkoly Observatory, Budapest, Hungary

Abstract. Solar activity is powered by free energy stored in magnetic fields and driven by evolving conditions. The strongest magnetic fields and highest amounts of free magnetic energy are present in solar active regions. Throughout their evolution, from their emergence through their decay, active regions are centres of magnetic activity, with the level and type of activity phenomena being dependent on the evolutionary stage of the active region. I will make an overview of typical dynamic events, which characterise specific evolutionary stages of active regions and also review how the magnetic evolution of active regions is reflected in the evolution of plasma parameters, coronal plasma composition and flows, which are also magnetically driven.

Invited talk

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Time Variations of the Non-potential and Volume-threading Magnetic Helicities

L. Linan[1], E. Pariat[1], K. Moraitis[1], G. Valori[2], J. Leake[3]

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[2]Mullard Space Science Laboratory, University College London, Holmbury St. Mary, Dorking, UK
[3]NASA Goddard Space Flight Center, USA

Abstract. Relative magnetic helicity is a gauge invariant quantity suitable for the study of the magnetic helicity content of heliospheric plasmas. Relative magnetic helicity can be decomposed uniquely into two gauge invariant quantities, the magnetic helicity of the non-potential component of the field, and a complementary volume-threading helicity. Recent analysis of numerical experiments simulating the generation of solar eruptions have shown that the ratio of the non-potential helicity to the total relative helicity is a clear marker of the eruptivity of the magnetic system, and that the high value of that quantity could be a sufficient condition for the onset of the instability generating the eruptions. This study introduces the first analytical examination of the time variations of these non-potential and volume-threading helicities. The validity of the analytical formulas derived are confirmed with analysis of three-dimensional (3D) magnetohydrodynamics (MHD) simulations of solar coronal dynamics. Both the analytical investigation, and the numerical application show that, unlike magnetic helicity, the non-potential and the volume-threading helicities are not conserved quantities, even in the ideal MHD regime. A term corresponding to the transformation between the non-potential and volume-threading helicities frequently dominates their dynamics. This finding has an important consequence for their estimation in the solar corona: unlike with relative helicity, their volume coronal evolution cannot be ascertained by the flux of these quantities through the boundaries of the volume. Only techniques extrapolating the 3D coronal field will enable both the proper study of the non-potential and volume-threading helicities, and the observational analysis of helicity-based solar-eruptivity proxies.

Contributed talk

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Coronal Hole Flux Emergence Evolution

J. Palacios[1], D. Utz[2,3]

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[2]IGAM, Institute of Physics, University of Graz, Austria
[3]Instituto de Astrofísica de Andalucía IAA-CSIC, Granada, Spain

Abstract. A joint campaign of different observatories, such as HINODE (named HOP 338), GREGOR and VTT, had a number of observing targets, such as pores, sunspots and coronal holes. Here we focus on the last target. On 2017 Sept 24, an equatorial coronal hole started developing flux emergence patches which contributed to decrease the area of the coronal hole. This contribution to the flux emergence is due to X-ray bright points appearance. Cancellation of coronal bright points is also reported. Other characteristics, such the EUV intensity, is studied with AIA data. The decrease of the area of the coronal hole may have implications on space weather.

Contributed talk

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Imaging Far-side Active Regions: A Possible Improvement by Porter-Bojarski Holography

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Abstract. Helioseismic holography numerically focuses the acoustic waves observed on the solar surface to any desired location of the Sun. It has been routinely used to detect active regions on the solar far-side, which is a valuable asset for accurate space weather forecast. Porter-Bojarski (PB) holography is a well-established method used in the field of acoustics to locate subsurface sources and scatterers. Numerical simulations with a realistic solar model suggest that PB holography can potentially improve the resolving power to image the solar far-side. We implement PB holography to the far-side imaging pipeline using line-of-sight velocities from SDO/HMI, and compare it with the current method.

Contributed talk

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On the Energetics of Seismically Active Solar Flares

J.C. Buitrago-Casas[1], J.C. Martínez-Oliveros[1], C. Lindsey[2], M.A. Abdallaoui[3], H. Bain[4], H. Hudson[1,5], S. Krucker[1,6]

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[6]University of Applied Sciences North-Western Switzerland, Windisch, Switzerland

Abstract. Some solar flares emit strong acoustic transients into the solar interior during their impulsive phases (Kosovichev and Zharkova, 1998). These transients penetrate thousands of kilometers beneath the active region photosphere and refract back to the surface, where they produce a characteristic helioseismic signature tens of thousands of kilometers from their origin over the succeeding hour. Several mechanisms of seismic excitation have been proposed, ranging from hydrodynamic shocks to Lorentz force perturbations.

However, regardless of the mechanism of generation, it is clear that not all flares induce an acoustic response in the interior of the Sun. A concrete hypothesis or theory about the nature of this is still a topic of ongoing investigations. For some particular flares, we present a comparative study between the energy deposited by the proposed mechanisms of seismic excitation and the acoustic energy deduced using holographic techniques.

Contributed talk

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Session 2

Energy Release in the Low Solar Atmosphere and its Consequences

Particle Acceleration in Solar Flares: X/Gamma-rays and Radio Diagnostics

N. Vilmer

LESIA-Paris Observatory, Paris, France

Abstract. Efficient particle acceleration is produced in association with solar flares. Energetic electrons and ions interact with the solar atmosphere and produce high-energy X-rays and Gamma-rays. Energetic particles can also escape to the corona and interplanetary medium, produce radio emissions (electrons) and may eventually reach the Earth's orbit. It is currently admitted that solar flares are powered by magnetic energy previously stored in the coronal magnetic field and that magnetic energy release is likely to occur on coronal current sheets along regions of strong gradient of magnetic connectivity. However, particle transport from the acceleration region to the emission sites still remains a challenging topic and has a crucial impact on the evaluation of the properties of accelerated particles from the observations of their radiation.

In this talk, I will present an overview of recent studies aiming at establishing a relationship between ribbons of electric currents observed at the photospheric level, and the flare energetic electrons traced by their X-ray emissions. I shall also present some recent results on the transport of energetic electrons in the solar corona obtained from X-ray imaging spectroscopy data in combination with observations of radio gyrosynchrotron emissions and will show how these observations support electron diffusive transport in the corona.

Radio emissions from electron beams produced in association with solar flares provide crucial information on the relationship and connections between energetic electrons in the corona and electrons measured *in situ* as well as information on flare acceleration sites and conditions. I will discuss some recent results based on the combination of radio observations with EUV and X-ray observations on the acceleration sites and on the relation between escaping electrons and electrons confined to the lower atmosphere of the Sun. I will finally describe how these studies can be continued in the future using measurements from the new solar and heliospheric missions.

Invited talk

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Energetic Electrons in Connection with Coronal Jets

S. Musset, M. Jeunon, L. Glesener

University of Minnesota, Minneapolis, USA

Abstract. Coronal EUV jets associated with flares offer the opportunity to study electron acceleration and transport to the high corona and interplanetary space in a relatively simple magnetic configuration. Coronal jets are generally thought to be produced due to interchange reconnection between a closed magnetic loop in the low corona and nearby open magnetic field along which coronal or chromospheric plasma escape towards the interplanetary space. Other jet models include the possibility that jets arise as small-scale filament eruptions.

Past studies have shown that energetic electrons and ions are also produced in relation with jets. These observations raise the question of the link between the flare and jet occurrence, as well as the role of energetic electron acceleration in such events. We present here a statistical study of the hard X-ray emitting energetic electrons in flare-related coronal jets, and the relation between flare and jet properties.

Contributed talk

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Recent Advances in Millimeter to Mid-Infrared Solar Physics

J.-P. Raulin

Centro de Rádio-Astronomia e Astrofísica Mackenzie, São Paulo, Brazil

Abstract. Since about 2000, solar flare observations at millimeter and submillimeter wavelengths have shown flux density spectra rising with increasing frequencies above 100 GHz, simultaneously with, but well separated from the well-known microwave synchrotron spectra. These results have raised important questions on the physical processes at work and the emission mechanism in this frequency range. Several possible mechanisms exist, although none is conclusive. Recent progresses on the production of synchrotron radiation by positrons during solar flares, as well as its relevance to the high-frequency radio spectrum will be discussed. The SOLAR-T experiment flew coupled to the U.C. Berkeley Gamma-Ray Imager/Polarimeter for Solar flares (GRIPS) experiment launched on a NASA CSBF stratospheric balloon. The main result obtained by these two photometers at 3 and 7 THz is the determination of the solar disk brightness temperature, which suggests an emission from the minimum temperature region. In the last few years, solar observations at even higher frequencies became available on a routine basis. Therefore, complete spectra up to 30 THz, combined with hard X-rays, and imaging information at EUV, H-alpha allowed to better describe the most energetic flare accelerated particles, and the energy transport processes from the energy release region to the chromosphere and photosphere. Then, it came out from recent analysis that thermal processes are likely to significantly contribute to the high frequency flare emission. Finally, we will present new instrumental developments at mid-infrared in order to achieve a better flare spectrum description.

Solicited talk

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Submillimeter Radiation as the Thermal Component of the Neupert Effect

J.F. Valle Silva[1], C.G. Giménez de Castro[1,2], P.J.A. Simões[1], J.-P. Raulin[1]

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Abstract. The Neupert effect is the empirical observation that the time evolution of non-thermal emission (e.g. hard X-rays) is frequently proportional to the time derivative of the thermal emission flux (soft X-rays), or, *vice versa*, that the time integrated non-thermal flux is proportional to the thermal flux. We analyzed the GOES M2.2 event SOL2011 02-14T17:25, and found that the 212 GHz emission plays quite well the role of the thermal component of the Neupert effect. We show that the maximum of the hard X-ray flux for energies above 50 keV is coincident in time with the time-derivative of the 212 GHz flux, within the uncertainties. In this event, the usual Neupert effect between hard and soft X-rays was not observed. The microwave flux density at 15.4 GHz, produced by optically thin gyrosynchrotron mechanism, and hard-X rays above 25 keV mark the typical impulsive phase, and have similar time evolution. On the other hand, the 212 GHz emission is delayed by about 25 seconds with respect to the microwave and hard X-ray peak. We argue that this delay cannot be explained by magnetic trapping of non-thermal electrons. With all the observational evidence, we suggest that the 212 GHz emission is produced by thermal bremsstrahlung, initially in the chromosphere, and shifting to optically thin emission from the hot coronal loops at the end of the gradual phase.

Contributed talk

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Solar Magnetic Flux Rope Eruption Simulated by a Data-driven Magnetohydrodynamic Model

Y. Guo[1], C. Xia[2], R. Keppens[2,3], M. D. Ding[1], P. F. Chen[1]

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Abstract. The combination of magnetohydrodynamic (MHD) simulations and multi-wavelength observations is an effective way to study the mechanisms of magnetic flux rope eruption. We develop a data-driven MHD model using the zero-beta approximation. The initial condition is provided by a nonlinear force-free field derived from the magnetofrictional method based on the vector magnetic field observed by the Helioseismic and Magnetic Imager on board the Solar Dynamics Observatory. The bottom boundary uses observed time series of the vector magnetic field and the vector velocity derived using the Differential Affine Velocity Estimator for Vector Magnetograms. We apply the data driven model to active region 11123 observed from 06:00 UT on 2010 November 11 to about 2 hr later. The evolution of the magnetic field topology coincides with the flare ribbons observed in the 304 and 1600 Å wavebands by the Atmospheric Imaging Assembly. The morphology, propagation path, and propagation range of the flux rope are comparable with the observations in 304 Å. We also find that a data constrained boundary condition, where the bottom boundary is fixed to the initial values, reproduces a similar simulation result. This model can reproduce the evolution of a magnetic flux rope in its dynamic eruptive phase.

Invited talk

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Solar Prominences: Plasma Trapping, Radiative Cooling, Rayleigh-Taylor Instabilities, and Gravitational Drainage in Non-potential Magnetic Field Configurations

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[3]University of St. Andrews, St. Andrews, UK

Abstract. We review the formation and dynamics of solar prominences with an emphasis on their origins in non-potential magnetic field configurations. Prominence plasma is not suspended by the magnetic field, but instead is constantly in motion with mass supply from radiatively cooled coronal plasma balanced by gravitational drainage from the field structure. Prominences are noteworthy from a space weather standpoint as the visible markers (aka "filaments") of non-potential magnetic field structures that eventually erupt, often forming coronal mass ejections that, if Earth-directed, can cause geomagnetic storms. In this talk we review the evolution of our understanding of solar prominence formation, dynamics, and eruption based on Hinode/Solar Optical Telescope (SOT) and Interface Region Imaging Spectrograph (IRIS) observations. We also compare and contrast solar prominences with the "coronal rain" phenomenon that is associated with more laminar flows guided by coronal loops. Finally, the phenomenon of structure formation by radiative cooling of partially ionized plasmas takes place in many astrophysical domains; we review some of the galaxy-scale examples such as large molecular clouds.

Contributed talk

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Anticipating Session 10

Sciences with Total Solar Eclipses

The Scientific Uniqueness of Total Solar Eclipse Observations

S.R. Habbal

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Abstract. Total solar eclipses offer unique opportunities for observing the corona, in particular the source regions of the solar wind and of dynamic events such as coronal mass ejections (CMEs), jets and prominence eruptions. The uniqueness of these opportunities stems from two main factors: (1) the possibility to observe the corona starting from the solar surface out to several solar radii, and (2) to capitalize on the important diagnostic potential of coronal forbidden lines best observed in the visible to the infrared wavelength range. Their properties are due to their excitation process, which is dominated by radiative excitation of minor ions in the corona. This implies that emission from these lines can be captured over much larger radial distances than possible with collisionally excited lines in extreme ultraviolet (EUV) such as observed by SDO/AIA. This talk will focus on scientific highlights from our recent eclipse observations, which consist of imaging in white light, in a suite of Fe lines, as well as imaging spectroscopy covering the visible wavelength range. I will also describe our observing plans to be executed on 2 July 2019, with a few preliminary highlights, if weather will allow us to be successful.

Invited talk

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Session 3

Eruptive Phenomena Initiation and their Low Coronal Consequences

Flare Initiation and CMEs: Observations and Mechanisms

L.M. Green

UCL, Mullard Space Science Laboratory, Holmbury St. Mary, Dorking, RH5 6NT, UK

Abstract. The magnetic field configuration of coronal mass ejections (CMEs) as they leave the lower corona can be broadly decomposed into two components. One is the core field that is involved in the initiation of the eruption and which represents (at least part of) the pre-eruptive field configuration. The other is the field surrounding the core that is added to the core during the flare reconnection process and which acted to stabilise the core field prior to the eruption onset. This talk will look at the origin and evolution of the pre-eruptive magnetic field structure that goes on to form the core of the CME. In particular, we will utilise observations of EUV and soft X-ray emission structures to probe the atmospheric magnetic field configuration and how it evolves in the days before an eruption. The growing observational support for the importance of magnetic reconnection (which can produce a confined flare) will be discussed, as will the timescales over which eruptive structures form and flares occur. We will also address the wide range of mechanisms that have been proposed to occur in the time leading up to an eruption. The talk will conclude with a discussion on how to more effectively combine our observational, modelling and theoretical knowledge to progress our ability to forecast flares and CMEs.

Invited talk

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Large-scale Coronal Waves and Dimmings

A.M. Veronig[1,2]

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Abstract. Coronal mass ejections (CMEs) are often associated with coronal dimmings and large-scale waves propagating through the corona. Coronal dimmings are transient regions of strongly reduced emission, most prominently observed at EUV and soft X-ray wavelengths, resulting from the expansion and mass loss in the wake of the erupting CME. Large-scale coronal waves are generally interpreted as fast magnetosonic (shock) waves that are initiated by the fast lateral acceleration of the CME flanks. A small fraction of them is also associated with wave-like perturbations observed in the chromosphere, so-called Moreton waves. In the present talk, we will present recent progress on the study of CME-associated waves and dimmings, with particular focus on plasma diagnostics using differential emission measure analysis of the multi-band SDO/AIA EUV imagery and Hinode/EIS spectroscopy.

Solicited talk

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Can We Use Coronal Dimmings as Application for Space Weather Forecasting?

K. Dissauer[1], A.M. Veronig[1,2], M. Temmer[1], T. Podladchikova[3]

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[2]Kanzelhöhe Observatory, University of Graz, Treffen, Austria
[3]Skolkovo Institute of Science and Technology, Moscow, Russia

Abstract. Coronal dimmings are temporary regions of reduced extreme-ultraviolet emission that form in the wake of CMEs in the low corona due to plasma evacuation. As they are observed prior to the appearance of CMEs in white-light coronagraphs, coronal dimmings provide early information on the associated CME and build an important back-up in case no coronagraphic data are available. Especially, for Earth-directed events they are of interest because they provide immediate information whether a halo CME is front or back sided.

For a set of 62 Earth-directed events, we established the statistical relationship between coronal dimmings and their associated CMEs using optimized multi-point SDO and STEREO data. We found that the dimming area, its brightness and the total magnetic flux within the dimming region strongly correlate with the CME mass, while their corresponding derivatives (i.e. the area growth rate, the brightness change rate, and the total magnetic flux change rate) show the highest correlations with the CME speed (c = 0.6-0.7).

Based on these results we aim to provide early CME parameter estimates for real-time space weather forecasting based on observations of coronal dimmings. By applying a multiple linear regression model, we use our dataset to identify the best combinations of dimming parameters to calculate the CME mass and its maximal speed. We will also aim to derive coronal dimming cut-off relations to predict fast (>1000 km/s) and massive Earth-directed CMEs ($> 5 \times 10^{15}$ g).

Contributed talk

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Multiple EUV Wave Reflection from a Coronal Hole

T. Podladchikova[1], A.M. Veronig[2,3], O. Podladchikova[4], K. Dissauer[2], B. Vršnak[5], J. Saqri[2], I. Piantschitsch[2], M. Temmer[2]

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Abstract. EUV waves are large-scale propagating disturbances in the solar corona initiated by coronal mass ejections. We investigate the multiple EUV wave reflections at a coronal hole boundary, as observed by SDO/AIA on 1 April 2017. The EUV wave originates from active region (AR) 12645 close to the disk center and propagates toward the south polar coronal hole with an average velocity of 430 km/s. The interaction of the EUV wave with the coronal hole, which represents a region of high Alfvén speed, is observed as a splitting into two wave components: one continues propagation inside the coronal hole with an increased velocity of 850 km/s (transmitted wave), while the other one moves back toward the AR, also with an increased velocity of 600 km/s (reflected wave). The reflected EUV wave is subsequently reflected again from the AR and propagates toward the coronal hole with an average velocity of 350 km/s, where it is reflected for the second time at the coronal hole boundary and propagates again toward the AR with a velocity of 300 km/s. These events are observed over an interval of 40 minutes. The high cadence SDO imagery allows us to study in detail the kinematics of the direct and multiple times reflected EUV wave. In addition, its multi-wavelength EUV imagery allows us to derive the plasma properties of the corona and the EUV wave pulse via differential emission measure analysis. These results are used to compare the observed characteristics of the wave interaction with the coronal hole with simulations.

Contributed talk

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The Interplanetary Properties and Geoeffects of CME Events with Coronal Dimmings

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Abstract. Large regions of coronal dimming can accompany coronal mass ejections (CMEs). The dimmings may trace field lines locally opened during the CME and the mass and magnetic flux transported outward by it. Recent studies have established correspondences between the timing and slope of SDO/ EVE and AIA dimming regions and the mass and speeds of associated CMEs observed by the SOHO and STEREO coronagraphs. In this study we establish or confirm the relationships between dimming parameters and CMEs, and then extend comparisons of these events to their interplanetary counterparts (ICMEs) and geostorm occurrence and level. We have assembled a catalog of dimmings associated with CMEs that can be tracked from the Sun to L1/Earth. The data selected are flare/dimming events associated with Earthward CMEs during the SDO period 2010 2014 and when the STEREO spacecraft were at quadrature, allowing good IP tracking of CMEs from Sun to L1. ICME identifications are from the online Richardson and Cane list and composition and charge state data are from ACE/SWICS instrument.

Contributed talk

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Observational and Numerical Characterization of a Wave-like Front Propagating along Pseudo-open Field Lines above an Active Region

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Abstract. Early on the day, on July 6, 2011, high spatial resolution images of the solar corona recorded in the extreme ultraviolet (EUV) channels of the Atmospheric Imaging Assembly (AIA) instrument onboard the Solar Dynamics Observatory (SDO) detected a recurrent, arc-shaped intensity disturbance over a sunspot in NOAA AR 1243. The intensity fronts were observed to propagate along a coronal loop bundle rooted in a small area of the dark umbra of the sunspot. Neither signatures of flare activity nor of a coronal mass ejection event were observed in association with the phenomenon. A preliminary analysis suggests that the fronts 1) propagate with a projected, average phase velocity of about 50 km/sec, the exact value depending upon the EUV channel analyzed; 2) exhibit a pseudo-periodic recurrence with a period of about 3 minutes; and 3) appear to be rooted in an umbral dot. To shed light into the physical nature of the event, we performed numerical simulations based on a simple potential magnetic field configuration embedded in a gravitationally stratified atmosphere. In this presentation, we 1) report on the kinematical properties and frequency characterization of the event as observed at the different temperature regimes covered by the SDO/AIA images, and 2) compare them with the results from the numerical simulations carried out. The speed values obtained from numerical simulations are similar to those estimated from observations and we reproduce the periods observed in the corona. In brief, the analysis suggests that the wave-like, recurrent fronts are a signature of a propagating slow-mode magnetosonic wave.

Contributed talk

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Coronal Mass Ejections Over Two Solar Cycles (23 & 24)

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Abstract. We present a review of the properties of CMEs over two complete Solar Cycles (23 and 24) based on 23 years of quasi-continuous observations with the LASCO coronagraph and on five catalogs, one manual (CDAW) and four automated (ARTEMIS, CACTus, SEEDS, and CORIMP), in order to characterize their temporal evolution and the distributions of their properties: occurrence and mass rates, waiting times, periodicities, angular width, latitude, speed, acceleration and kinetic energy. The analysis points to inevitable discrepancies between catalogs due to the complex nature of CMEs and to the different techniques implemented to detect them, but also to large areas of convergence that are critically important to ascertain the reliability of the results. The temporal variations of these properties are compared to four indices/proxies of solar activity: the radio flux at 10.7 cm, the international sunspot number, the sunspot area, and the total magnetic field, either globally or separately in the northern and southern hemispheres when available.

The CME occurrence and mass rates are found to globally track the indices/proxies with no time lag, prominently the radio flux, but the linear relationships were different during the two cycles, implying that the CME rates were relatively larger during SC 24 than during SC 23. A pronounced divergence of the CME rates in the northern hemisphere during SC 24 is uncovered as these rates were substantially larger than predicted by the temporal variation of the sunspot number. Rather weak correlations are present among the various CME parameters and particularly none between speed and acceleration. The association of CMEs with flares and erupting prominences involves only a few percents of the overall population of CMEs but the associated CMEs have distinctly larger mass, speed, kinetic energy and angular width. A more pronounced association is found with active regions but the overwhelming one is with streamers, further confirmed by the similarity between the heliolatitudinal distribution of CMEs and that of the electron density reconstructed from time-dependent tomographic inversion. There is no evidence of bimodality in the distributions of physical parameters that would support the existence of two classes of CMEs. There exists an excess of narrows CMEs which however does not define a special class.

These narrow CMEs are likely associated with the ubiquitous mini-filaments eruptions and with mini-flux ropes originating from small magnetic bipoles, the disruption mechanisms being similar to those launching larger CMEs. This supports the concept that CMEs arise from closed-field coronal regions at both large and small scales.

Contributed talk

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Session 4

CMEs: Origin, Peculiarities and *in Situ* Signatures

Constraining the Origins and Evolution of Coronal Mass Ejections

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Abstract. The origins of coronal mass ejections (CMEs) lie in energized magnetic fields in the solar atmosphere, but their evolution between Sun and Earth affects their ultimate space-weather impact. It is therefore essential to quantify the coronal magnetic fields at their origins, but also to understand the physical processes that control interactions of the CME with the solar wind. I will present coordinated research from to projects: the Data-Optimized Coronal Field Model (DOCFM), and the Data-Optimized Interplanetary CME Model (DOICMEM). DOCFM is a model-data fitting method that combines a parametrized 3D magnetic field reconstruction model with forward modeling of coronal data. We show that such a framework provides a powerful means for including coronal polarization data in 3D reconstructions of the solar coronal magnetic field that also make use of the photospheric magnetic boundary. The goal of DOICMEM is to understand how factors such as the CME launch location and velocity, its positioning within the background solar wind, its mass, and its magnetic properties such as the orientation of its front with respect to the Earth's magnetic field and its internal magnetic topology affect its characteristics at the Earth. Our approach is to use an analytical flux rope model (Gibson & Low model) and a background solar wind boundary (Wang-Sheeley-Arge model) as inputs for a new MHD heliospheric simulation code (Gamera). We then carry out a large statistical study in the event parameter space. Further, Bayesian statistics are used along with large statistical databases of near-Sun and near-Earth observables, to infer statistical distributions of relevant CME input parameters, which are capable of yielding given distributions of observables, for a given stage of the solar cycle. Details of model coupling and early modeling results will be presented.

Solicited talk

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Stealth CME Initiation and *in Situ* Signatures: What Can We Learn from Numerical Modelling?

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Abstract. Coronal mass ejections (CMEs) are huge expulsions of magnetized plasma from the Sun into the interplanetary medium. A particular class of CMEs are the so-called stealth CMEs, i.e., solar eruptions that are clearly distinguished in coronagraph observations, but they do not have a clear source signature. Observational studies show that about 60% of stealth CMEs are preceded by another CME whose solar origin could be identified.

In order to determine the triggering mechanism for stealth CMEs we are using the MPI-AMRVAC code developed at KU Leuven. We simulate consecutive CMEs ejected from the southernmost part of an initial configuration constituted by three magnetic arcades embedded in a globally bipolar magnetic field. The first eruption is driven through shearing motions at the solar surface. The following eruption is a stealth CME resulting from the reconnection of the coronal magnetic field. Both CMEs are expelled into a bimodal solar wind. We analyse the parameters that contribute to the occurrence of the second CME. We obtain 3 different eruption scenarios and dynamics by changing the shearing speed by only 1%. The difference between the 3 cases consists in the characteristics of the second CME, which can be a failed eruption, a stealth CME, or a CME with a traceable source.

Furthermore, we compare the simulated signatures of the CMEs with the measured *in situ* data from Messenger and ACE spacecraft and obtain a good correlation in arrival time and magnetic field components.

This study aims to better understand the triggering mechanism of stealth eruptions and improve the forecasting of their geomagnetic impact.

Contributed talk

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ICMEs without Obvious Low Coronal Signatures

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Abstract. In order to predict non-recurrent geomagnetic storms, it is essential to understand how interplanetary coronal mass ejections (ICMEs) originate from eruptions in the solar corona. It is not a trivial exercise to relate an ICME *in situ* data with a solar eruption in remote-sensing data. We sometimes cannot find an eruption or even a CME (in Earth view) within the reasonable time range preceding the ICME. Specifically, the so-called stealth CME lacks on-disk low coronal signatures for the CME, as first brought to our attention by STEREO observations during the solar minimum between Cycles 23 and 24. Later, these CMEs were found to occur in all phases of a solar cycle. They give a major challenge to space weather prediction. Without the known origin of the CME, we would not be able to tell whether it will hit the Earth. It would also be more difficult to predict sustained southward magnetic field that is a major factor for strong geomagnetic storms. We present a recent progress in understanding stealthy CMEs by recategorizing them on the basis of how difficult it is to find low coronal signatures. These CMEs tend to occur close to coronal holes or open field regions. We discuss this in terms of their possibly unique origin and their enhanced geoeffectiveness.

Contributed talk

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Studying Stealth CMEs Using Advanced Imaging Analysis Techniques

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Abstract. Stealth coronal mass ejections (CMEs) are eruptions from the Sun that have no obvious low coronal signatures. These CMEs are characteristically slower events, but can still be geoeffective and affect the space weather at Earth. Therefore understanding the science underpinning these eruptions will greatly improve our ability to detect and, eventually, predict them. We present a study of two stealth CMEs analysed using advanced image processing techniques that reveal their faint signatures in observations from the EUV imagers onboard the SDO and STEREO spacecraft. The different viewpoints of the events given by these spacecraft provide the opportunity to study the eruption from above and the side contemporaneously. For each event, we combined EUV and magnetogram observations to reveal the coronal structure that erupted and find that both events originated in active regions. We discuss the physical processes that occurred in the time leading up to the onset of each stealth CME and comment on whether these eruptions are the low-energy and velocity tail of the distribution of CME events or whether they are a distinct phenomenon.

Contributed talk

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On the 3D Reconstruction and Propagation of Coronal Mass Ejections

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Abstract. Coronal mass ejections (CMEs) are huge eruptions of magnetised plasma from the Sun into the interplanetary space. They are very energetic, complex phenomena, which, when interacting with the Earth magnetic field can produce major disturbances. This is why it is important to know in advance their speed, their direction of propagation and their 3D shape.

The data from STEREO and from spacecraft near Earth helped us to get a better insight in the 3D complexity of CMEs. We will present in this talk an update of what was done so far on this topic. We will outline the constraints on reconstructing the CMEs and possible improvements with the next generation of space missions.

Invited talk

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Session 5

SEPs and Radio Emissions: Space Weather Connection

Solar and Interplanetary Radio Bursts, Including Scintillation Data, for Forecasting CMEs/Large-scale Solar Wind Structures

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Abstract. The study of solar transients and their evolution in the interplanetary medium requires the combination of different instruments. Solar and interplanetary radio bursts produce low frequency emissions that can be detected by radiotelescopes or satellites to track the evolution of shock waves near the Sun and in the interplanetary medium. The interplanetary scintillation (IPS) technique is a remote sensing measurement that uses radio observations of extragalactic sources to infer solar wind properties along the line of sight. If there is a good number of radio sources around the Sun detected by the radio telescope, then it is possible to infer solar wind speeds and changes in solar wind density along their lines of sight. Combining data from different remote sensing instruments, potentially can allow us to track the evolution of solar wind transients in the interplanetary medium. These remote sensing techniques of solar wind disturbances are useful tools for space weather studies and eventually for space weather forecasting.

Contributed talk

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Solar Energetic Particles (SEPs) Observations, Interpretation, and Space Weather Consequences

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Abstract. Solar energetic particles (SEPs) are nucleons and electrons of high, sometimes relativistic, energies that are accelerated during coronal eruptive events and escape to the interplanetary space, where they are measured *in situ*. SEPs have a twofold importance. On the one hand they present a unique means in astrophysics to combine detailed measurements of particle abundances, spectra, and angular distribution with remote sensing observations of the plasma environment where the particles are or might be accelerated. On the other hand the particles are relevant to space weather: they interact with the electronics aboard spacecraft and aircraft, ionise the polar atmosphere of the Earth with ensuing consequences for radio wave propagation, and, when the spectrum extends to relativistic energies, they produce additional radiation doses at aircraft altitudes. This talk will give an overview of SEP events and their association with flares and CMEs, address the question to which extent the observed associations give clues to the identification of relevant acceleration processes, and outline their space weather relevance. The upcoming observations of SEPs close to the Sun with Parker Solar Probe and Solar Orbiter will give us new tools to combine direct particle measurements, which will be much less affected by interplanetary propagation than traditional measurements near 1 AU, with remote sensing observations from space and ground to elucidate the wealth of physical processes that generate high-energy particles in solar eruptive events.

Invited talk

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Modelling the Transport of Solar Energetic Particles near a High-speed Solar Wind Stream

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Abstract. After being accelerated to high energies in the solar atmosphere, solar energetic particles (SEPs) escape their acceleration site and travel through the inner heliosphere, while spiralling around the interplanetary magnetic field (IMF). Upon impact, these SEPs have the potential to disrupt the microelectronics and software on board spacecraft, leading in some cases to permanent damage to the satellite.This is one of the many reasons why it is important to develop models capable of explaining and predicting the characteristics of SEP events.

In this work we focus on how the interplanetary transport of SEPs is affected by a solar wind stream that contains streams of plasma with different speeds. In particular, we discuss the effects of the presence of a corotating interaction region on the SEP distributions in the inner heliosphere. This is done by using a three-dimensional energetic particle transport model together with the data-driven heliospheric model, EUHFORIA. The latter model solves the ideal magnetohydrodynamic (MHD) equations, providing realistic solar wind configuration in the heliosphere. This solar wind is then used by our particle transport model to solve the focused transport equation in a stochastic manner, thereby providing SEP distributions in the entire heliosphere. We find that the presence of a high-speed solar wind stream affects both the energetics and spatial spreading of SEP events. In particular, particles are able to augment their energy at the two shock waves bounding the CIR. Also, the non-nominal IMF topology induces a strong dependency of the spatial width of the SEP event, both in latitude and longitude, on the location of the particle source region. We also look at how the SEP peak-intensity varies along a set of preselected magnetic field lines that are residing in varying solar wind conditions. To conclude, we also have explored the efficiency of the CIR pair of shocks at accelerating particles by injecting a seed population of 50 keV protons in the upstream region of both the forward and reverse shock waves.

Contributed talk

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Session 6

Coronal Large-scale Structure and Solar Wind Coupling

Prediction of the Structure of the Solar Corona for the July 2, 2019 Total Solar Eclipse

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Abstract. The Sun's magnetic field plays a crucial role in solar and heliospheric physics. It defines the structure of the solar corona, which in turn determines the position of the heliospheric current sheet and the regions of fast and slow solar wind. The geo-effectiveness of CMEs is in part determined by their interaction with the ambient magnetic field. The connection of the field to flares and CME-driven shocks determines where solar energetic particles propagate. In this talk, we describe progress and challenges in modeling the global thermodynamic and magnetic state of the solar corona, and illustrate the techniques with our prediction of the structure of the corona for the July 2, 2019 total solar eclipse. The key observational input to the model are measurements of the photospheric magnetic field. The model incorporates a wave-turbulence driven (WTD) description of coronal heating and solar wind acceleration, and shear/twist in the field at the expected location of filament channels. The prediction will include images of brightness, polarization brightness, EUV, and X-rays, which can be compared with ground-based observations of the eclipse, as well as observations from SDO/AIA, Hinode/XRT, and STEREO/EUVI.
Research supported by NASA and AFOSR.

Invited talk

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Using the Parker Solar Probe WISPR Instrument for Tomography of the Solar Corona

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Abstract. The Wide-field Imager for the Parker Solar Probe (PSP/WISPR) has two telescopes that record white-light total brightness [B] images of the solar corona. Over the 24 highly eccentric orbits planned for the mission, the fields of view of WISPR will cover a widely changing range of heliocentric heights. We investigate if the images provided by WISPR will be suitable for tomographic reconstruction of the electron density of the solar corona. Based on a three-dimensional magnetohydrodynamic model of the corona and the PSP orbital information, we compute synthetic images for the whole mission. For each orbit, the synthetic images are used to attempt the tomographic reconstruction of the electron density of the model. We report and discuss the results in detail.

Contributed talk

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Solar Sources of the Slow Solar Wind and Their Interplanetary Manifestations

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Abstract. The source regions of the slow solar wind, and its driver and acceleration mechanism, remain key topics of study in heliophysics with many open questions. The slow wind appears to originate from the equatorial regions, but the specific structures that contribute to the wind are still under active debate. In this talk I will focus on attempts to identify potential sources and their drivers from observations of the low corona by Hinode, IRIS, and the recently launched Hi-C sounding rocket; with a particular emphasis on plasma composition measurements from the Hinode EUV Imaging Spectrometer (EIS). These observations have revealed new insights on outflows from the edges of active regions and equatorial coronal holes. Furthermore, I will discuss ongoing efforts to explore the interplanetary manifestations of these flows by comparison with *in situ* measurements from ACE and Parker Solar Probe, which will also be relevant for the upcoming Solar Orbiter mission.

Solicited talk

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Session 7

Interplanetary Space Weather Drivers

Corotating High-speed Solar Wind Streams and Stream Interaction Regions

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Abstract. A solar wind stream interaction region (SIR) is formed by the interaction of a stream of high-speed solar wind originating in a coronal hole at the Sun with the preceding slower solar wind. The interaction forms a region of compressed plasma, the stream interaction region, along the leading edge of the stream, which, due to the rotation of the Sun, is twisted approximately into an Archimedean spiral. Since the source coronal holes tend to be long-lived, often persisting for many months, the interaction regions and high-speed streams tend to sweep past an observer at regular intervals of approximately the solar rotation period (∼27 days as viewed from Earth). Hence, the interaction regions are frequently referred to as corotating interaction regions (CIRs). This talk will briefly review the basic features of SIRs and high-speed streams include the formation of SIRs and their development with heliocentric distance, their geomagnetic effects including the intervals of enhanced geomagnetic activity recurring at the solar rotation period first identified by Maunder in 1905, acceleration of energetic particles by SIRs, their modulation of galactic cosmic rays, MHD modeling, and remote sensing. For a review of SIRs, see Richardson, I. G., Solar Wind Stream Interaction Regions Throughout the Heliosphere, Living Rev. Sol. Phys. (2018) 15:1, https://doi.org/10.1007/s41116-017-0011-z.

Invited talk

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The Solar Wind Speed Expansion Factor (v – fs) Relationship at the Inner Boundary (18 $R_\odot$) of the Heliosphere

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Abstract. The accuracy of current state-of-the-art data-driven magnetohydrodynamics (MHD) models depends highly on accurate initial, and boundary conditions specified at the inner heliosphere are probably the most important ones. However, all the MHD parameters (B, v, ρ, T) not measurable at the present time, except the total magnetic field (|B|) at the photosphere. The solar wind speed (v), which is probably most relevant to space weather forecasting, is often modeled by the standard Wang-Sheely-Arge (WSA) formula, which is based on the finding of an inverse relationship between the solar wind speed (v) at 1 AU and the expansion factor (fs) estimated at 2.5 solar radii ($R_\odot$), with the following generic form: $v = v_1 + v_2 \text{ fs}^{-\alpha}$ (where v is the solar wind speed at 18 $R_\odot$, fs is the magnetic field expansion factor, and v_1, v_2, and α are three free parameters to be determined). Because it uses the solar wind speed at 1 AU, the formula ignores the transport of solar wind in the heliosphere. While the WSA formula uses "source projection" to account for the transport of the solar wind, it does not treat the solar wind as plasma. The purpose of this study is to rectify this omission by using a numerical MHD simulation. In addition to the expansion factor, conservation of mass (ρv), magnetic flux (r^2 B), and total pressure along the stream line are assumed to obtain the solar wind mass density, magnetic field, and temperature at 18 $R_\odot$. These parameters are used as the inner boundary conditions of our G3DMHD code to simulate solar wind plasma and field parameters out to 1 AU. The simulation results are compared with the *in situ* data from Wind to assess the accuracy. Such a procedure is repeated (880 times) to cover the three parameter regimes ($100 < v_1 < 350$ km/s; $250 < v_2 < 700$ km/s; and $0.2 < \alpha < 0.9$) to find the optimal set. The simulation is performed for the period of CR2082. It is found that $v = 189 + 679 \text{ fs}^{-0.7}$ is the best formula to relate the solar wind speed at 18 $R_\odot$ to the expansion factor. Strictly speaking, this formula applies only to periods around solar minimum. This study is partial supported by Chief of Naval Research.

Contributed talk

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Causes and Consequences of a Possible CIR-ICME Driven Space Weather Event

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Abstract. The origin of Space Weather events can be initiated from tropospheric dynamical processes (e.g., gravity waves) or from solar sources (e.g., solar flares or solar transient perturbations to the solar wind conditions). In this study, we analyze the chain of coupled processes induced by a possible combination of two solar drivers: a co-rotating interaction region (CIR) and an interplanetary coronal mass ejection (ICME). In order to perform this survey, we analyze data acquired by space probes to unveil the solar/interplanetary origin of the observed perturbations to the geo-space conditions. The coupling between the solar wind and the Earth environment has been analyzed using geomagnetic data and proxies, combined with data acquired in the Tucumán Low Latitude Observatory for Upper Atmosphere (26°51' S, 65°12' W) to study consequences on the low latitude ionosphere. We observed the development of a combined CIR-ICME event occurred between 1-5 October, 2015. The interaction between the fast solar wind and terrestrial magnetosphere generated an intense geomagnetic storm on October 7th, 2015 having a sudden commencement in the early hours of that day. Two ionospheric storms have been observed at the low latitude station in Tucumán. We observe a negative ionospheric storm followed by a positive ionospheric storm, the last one in coincidence with the minimum value of Dst (-124 nT around 23 UTC). Preliminary results showed an enhancement of the total electron content due to prompt penetration electric field as the main mechanism involved in the positive ionospheric storm.

Contributed talk

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Variation of the Mean Shape of the ICME/shock Using *in Situ* Observations

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Abstract. The shock waves are solar phenomena closely related with interplanetary coronal mass ejections (ICMEs). The *in situ* observations offers a useful tool to study the propagation of these structures. However, they do not provide direct information about the morphology of ICMEs/shocks through the interplanetary medium.

The main aim of this work is to estimate and characterize the mean shape of ICMEs-shocks through a statistical study of shock orientations. We use a set of *in situ* observations of several spacecraft at different heliocentric distances. Using the technique of Janvier et al. (2014) we estimate the mean shape of ICMEs/shocks by comparing the normal distributions of the shocks with the synthetic distribution functions derived from an analytical model. Through these synthetic distribution functions we estimate the mean shape of the ICMEs/shocks derived from the cosine model.

We found similar shock shapes within the different sets of observations from the different spacecraft, also we compared the shock shape at 0.4 and 1 AU, where the mean angular width differs and study how its the variation of the mean shape of these structures with different spacecraft and several spacecraft.

This technique is an alternative way to study the global picture of these structures. Future solar missions as Solar Probe Plus and Solar Orbiter will be of great help to study the evolution of ICMEs and interplantery shocks in the inner heliosphere.

Contributed talk

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Main Physical Properties of Interplanetary Coronal Mass Ejections to Improve the Forecast of Space Weather

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Abstract. One of the major solar drivers of Space Weather events are the interplanetary manifestation of coronal mass ejections (ICMEs).

These solar eruptions are the result of magnetic instabilities, and they carry away in the heliosphere a huge amount of magnetic flux and helicity.

ICMEs contain different plasma and magnetic field properties, compared with those of the ambient solar wind, which can strongly perturb the geo-space. These transients are the most geo-effective heliospheric objects, with major consequences on new technologies and on life in space.

From the analysis and modeling of the huge number of observed ICMEs during the last years, the community has significantly increased the knowledge on key physical mechanisms determining their evolution and their impact on the space environment of Earth. These mechanisms include expansion, erosion, dynamics of fluctuations and turbulence, accretion of magnetic field, and drag. Other important progress on the knowledge of ICMEs has been done on the amount of magnetohydrodynamical quantities transported from the Sun, the identification of the composing sub-structures, their global 3D shape, as well as, how the plasma and magnetic field are typically distributed inside them.

In the present talk I will present a general review of these aspects of ICMEs. In particular I will focus on the recent observations and models.

The results presented here will help to better understand the interaction of ICMEs with planetary magnetic environments, and in particular to improve the forecast of the solar-terrestrial coupling.

Invited talk

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The Generic Magnetic Profiles of Interplanetary Coronal Mass Ejections at Mercury, Venus and Earth: Superposed Epoch Analyses

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Abstract. Coronal mass ejections (CMEs) are large disturbances emanating from the Sun and are mostly associated with flaring activity at our star. They transport solar plasma and magnetic field in the interplanetary medium and can interact with the space environments of planets. Known as one of the most important drivers of space weather, improving our understanding of how interplanetary CMEs (ICMEs) evolve, as well as their generic features, is critical to developing tools for predicting their effects in space.

ICMEs are routinely measured *in situ* by spacecraft dedicated to the monitoring of the solar wind (such as ACE or Wind), or as a by-product of planetary missions (e.g. MESSENGER, Venus Express). Then, ICMEs can be monitored at different heliospheric distances. On the other hand, statistical analyses such as superposed epoch studies can reveal generic features in the time series of *in situ* parameters. Here, by combining different catalogues of ICMEs detected at three spacecraft (MESSENGER at Mercury's orbit, Venus Express at Venus' orbit, and ACE at L1), we investigate the features of the superposed epochs for the magnetic field profiles of these events and how these features evolve with heliospheric distance. By using a proxy for the speed of these ICMEs (which is not readily available for all the missions), we find that slow and fast ICMEs have very different magnetic field profiles. At all spacecraft, slow ICMEs have a less intense sheath at the front of the magnetic ejecta and a magnetic profile inside the magnetic ejecta that is more symmetric, when compared with fast ICMEs, which have stronger field at their front than at their rear. This asymmetry increases with heliospheric distances, when comparing ICMEs at Mercury's orbit with those at L1.

We interpret the differences in the profiles of slow and fast ICMEs at different heliospheric distances as the result of the conditions of ICME ejections as well as propagation processes in the solar wind, in particular relaxation conditions. Such a study is important in providing a picture for how ICMEs propagate in the interplanetary medium.

Contributed talk

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Analysis of CME Deflections

M. Cécere[1,2], V. Sieyra[1,3,4], H. Cremades[3,4], M. Mierla[5], G. Stenborg[6], A. Sahade[1], A. Costa[1], PROBA-2 team[5],

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Abstract. Coronal mass ejections (CMEs) are the main drivers of geomagnetic storms. A comprehensive study of their direction of propagation throughout both the lower solar corona and interplanetary medium is a crucial first step to predict their potential geo-effectiveness. Since the early days of space-borne coronagraphy, the trajectory of CME events has been observed to be affected by the medium through which they propagate, deviations from their initial direction of propagation being the most easily noticeable effect. Therefore, to gain insight on the physical mechanisms at work as the CME events propagate through the coronal environment, it is of crucial importance the systematic study of both the kinematical and the morphological properties of the early CME development. In this talk we present a comprehensive morphological and kinematical analysis of CME events, with emphasis on the characterization of their early development. In particular, we study the deflection experienced by a selected set of events observed by different space telescopes covering an ample range of heliocentric distances and viewpoints (among them PROBA2/SWAP and SDO/AIA imagers, SOHO/LASCO coronagraphs, and STEREO-SECCHI instruments suite). The selected events cover the time period between October 2010 and October 2011.

Contributed talk

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A Comparative Evaluation of Solar Flare Prediction Models: Lessons Learned

M. K. Georgoulis[1,2] and the FLARECAST Consortium

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Abstract. The solar flare phenomenon is long-known to be stochastic in nature, at the same time exhibiting self-similarity in its manifestations. This is likely spawned by an underlying self-organized critical evolution in flaring solar active regions. The response of such nonlinear dynamical systems (active regions) to impulsive instabilities should be notoriously difficult to predict. However, spurred by its practical benefits and even more by the recent Research-to-Operations (R2O) trend, solar flare prediction has been humanity's first attempt to predict the adverse space weather at Earth and in other heliospheric locations. We will first give a brief comparative evaluation of several solar flare prediction methods, setting the stage and the rationale for the implementation of the EU Horizon 2020 FLARECAST project, entirely focused on the topic. We will then review the core findings of FLARECAST, arguably the largest-scale effort to date to predict solar flares. Despite its undisputed learning benefits, for example (a) that there is a clear distinction between a flare predictor and a flare prediction method; (b) that a single predictor is never enough and we need a large number of them, only to converge on a selected few that are most appropriate; (c) that selected predictors and prediction methods change for different prediction settings, and others, FLARECAST ultimately taught us that we have only scratched the surface of the problems complexity: first, conventional methods are not sufficient; machine- and deep-learning methods are necessary. Second, we need interpretable methods, namely those with traceable results and a feature ranking in terms of forecasting capability that will allow us to take the inverse, physical step of Operations-to-Research (O2R). Third, that the choice of the training dataset is crucial in terms of forecast capability and that correctly defined benchmark datasets are key for flare prediction. Fundamentally, even FLARECAST was unable to lift the stochasticity barrier in solar flare prediction, namely, unable to reach a reliable, binary (YES/NO) flare forecasting. Selected post-FLARECAST works confirm this and seem to converge that this stochasticity will continue to constrain our efforts in the foreseeable feature, if it is ever lifted. At the same time with this sobering conclusion, however, FLARECAST offered invaluable insight toward a vertical expansion of flare prediction methods, to include prediction of coronal mass ejections and solar energetic particle events, perhaps even with better accuracy than the prediction of flares themselves.

Contributed talk

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Session 8

Tools and Simulations for Space Weather Prediction

CCMC's Space Weather Tools Forecasting for NASA's Robotic Missions

Y.M. Collado-Vega, M. Kuznetsova, L. Mays, A. Chulaki, Y. Zheng, A. Taktakishvili, K. Muglach and the CCMC team

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Abstract. The Community Coordinated Modeling Center (CCMC) provides a variety of services to the space science community. The mission for the CCMC's Space Weather Forecasting team is to address the space weather needs of NASA's robotic missions by conducting customized space weather services to NASA end-users. The team leverages CCMC tools/resources, carries out prototyping activities for the next generation of space weather tools and follows communications/interactions with the users. We provide space weather forecasts, notifications, analysis and also education. This presentation will describe the team's concepts of operations, notification processes, anomaly analysis, and the tools used for space weather forecasting. The tools include a system that is completely open and available to the public use like the Integrated Space Weather Analysis (ISWA) tool and the Database of Notifications, Knowledge and Information (DONKI). We will also discuss the education and training activities and how events like solar eclipses are important for the improvement and validation of different space weather models.

Invited talk

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What is Needed for a Satisfying CME Arrival Prediction?

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Abstract. For the purpose of space weather prediction, many different kinds of data are available and even more different types of models are predicting the arrival times of CMEs. Despite the wide range of different approaches, there is not the one and only CME prediction model so far. When various models predict a CME arrival, the spread of arrival predictions often extends over ± 1.5 days or even more. In this presentation we raise the following questions: What influences the accuracy of CME arrival predictions? Is it the type or quality of the data used or the prediction model applied to these data? Is there a tendency for specific events, for which all or most of the prediction models fail?

With regard to a possible future space weather mission to L5, we are especially interested in models that use heliospheric imager data, enabling to trace a CME's path through interplanetary space. To answer the questions above we investigate a sample of CME-ICME pairs that were observed in white-light by STEREO's heliospheric imagers (HI) and detected *in situ* at L1. The time-elongation measurements were extracted from HI images using various tracking approaches. These time-elongation tracks are then used to perform arrival predictions by applying the ELEvoHI ensemble prediction tool as well as the self-similar expansion fitting method.

By comparing the prediction results we attempt to deduce a preferable approach for future real time predictions as soon as STEREO-A approaches the L5 point.

Contributed talk

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Global-MHD & Test-Particle Simulations of Radiation Belt Evolution During Shock-Driven Magnetospheric Compressions

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Abstract. The Van Allen radiation belts dynamically vary across timescales ranging from minutes to hours in response to varying solar wind conditions. Here, we employ the Gorgon global-MHD model and an integrated Van Allen radiation-belt model to simulate how extreme space weather events drive large-scale morphological changes to the global magnetosphere and how this affects radiation belt behaviour. Relativistic Lorentz and Guiding Centre test-particle integrators are implemented to sub-cycle beneath the MHD field solver, and a phase-space weighting is used to evolve radiation belt distributions. We focus our simulations on magnetospheric compressions driven by fast-forward interplanetary shocks which rapidly drive the magnetopause from > 10RE to < 6RE. As the shock-front propagates through the simulated magnetosphere, a magnetosonic pulse adiabatically accelerates protons and electrons to MeV energies and transports them radially inwards. This process is examined for varying dipole tilts and the drift orbits of electrons and protons constrained at various stages during the compression. In particular, enhanced magentopause currents on the day-side are shown to cause particles to execute Shabansky orbits as they become trapped within off-equatorial field-strength minima. This effect modulates particle fluxes across the outer radiation belt, including at distances encompassing geostationary orbit. These results demonstrate the relevance of this modelling technique for Space Weather forecasting.

Contributed talk

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Predicting Radiation Variability in Earth's Magnetosphere

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Abstract. The intensification of the radiation belts and ring current has significant impacts on the space environment and satellite assets. Moderate energy (10 to 100 keV) electrons can cause surface charging effects, and relativistic (0.1 to 3 MeV) electrons can cause deep-dielectric charging on space systems. While energetic ions do not cause substantial charging, they are indirect drivers of the radiation belts via wave generation, magnetic and electric field perturbations, etc. Therefore, understanding the physical processes that are controlling the dynamics of the radiation belts and ring current during active periods and being able to predict their variability have important space weather significance. A number of models have been established to simulate the radiation belt and ring current dynamics during magnetic storms. However, it is still a challenge to accurately predict the absolute intensities of energetic electron and ion fluxes. The user community therefore is often forced to rely on empirical models, which are limited to an averaged picture of the radiation environment, but are of limited utility in understanding a particular event. In this presentation, we will use coupled MHD and kinetic models together with spacecraft charging models to characterize the variability of the radiation environment, how that translates into particle fluxes and charging impacts, and to validate that the model performance.

Contributed talk

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Anticipating Session 11

Missions and Instrumentation with Space Weather Applications

PROBA-3/ASPIICS: a Giant Formation Flying Coronagraph, and its Contribution to the Studies of Coronal Mass Ejections

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Abstract. PROBA-3 is the next ESA mission in the PROBA line of small technology demonstration satellites. PROBA-3, to be launched in 2021, is a mission dedicated to the in-orbit demonstration of precise formation flying techniques and technologies. The PROBA-3 mission will place two small satellites in a highly elliptical orbit around the Earth. The two satellites will fly in a precise formation, producing a very long baseline solar coronagraph called ASPIICS (Association of Spacecraft for Polarimetric and Imaging Investigation of the Corona of the Sun). One spacecraft will carry the optical telescope, and the second spacecraft will carry the external occulter of the coronagraph. The inter-satellite distance of around 150 m will allow observing the inner corona close to the solar limb with very low straylight. The scientific objectives of PROBA-3/ASPIICS will be discussed. A special attention will be paid to the ASPIICS contribution to studies of coronal mass ejections (CMEs), which are the primary drivers of disturbed space weather at the Earth. In particular, due to low straylight and high spatio-temporal resolution, ASPIICS will measure CME kinematics and make detailed observations of the coronal restructuring during CMEs in the crucial region of the inner corona where the peak acceleration takes place. This will allow to determine the timing of occurrence of the fast eruption onset and the reconnection onset, which is necessary to distinguish between different mechanisms of the CME initiation, such as ideal (e.g. torus instability) and resistive (magnetic breakout) mechanisms. ASPIICS will also observe CME-driven shock waves in the region of their formation.

Solicited talk

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Session 9

Short Time-scale Radiation Variations and Space Weather Implications

Solar Irradiance Variability on Flare Time-scales: Measurements and Modeling

P.C. Chamberlin

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Abstract. One of the primary drivers of space weather, and the first to cause an impact, is the increased solar irradiance in Soft X-ray (0 – 10 nm) and Extreme Ultraviolet (EUV; 10 – 120 nm) wavelengths from solar flares. Until this past decade, measurements leading to the full understanding of irradiance variations has been limited due to the necessity to measure ultraviolet wavelengths in space. This presentation will focus on two missions to fully quantify the solar soft X-ray and EUV irradiance variability, the Miniature X-ray Solar Spectrometer (MinXSS) CubeSats and the Extreme ultraviolet Variability Experiment (EVE) onboard the Solar Dynamics Observatory (SDO), respectively. Concluding the talk will be a presentation of results from the Flare Irradiance Spectral Model (FISM2; 0 – 190 nm), an empirical model based on measurements from the aforementioned missions to help fill the gaps, both spectrally and temporally, in the ultraviolet irradiance when measurements are unavailable.

Invited talk

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Intermediate Timescale Solar Spectral Irradiance Variability and its Impacts

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Abstract. Variations in solar EUV and SXR radiation on timescales associated with the evolution of active regions and the rotation of active regions onto and off of the visible disk have important consequences for space weather. This radiation is the dominant energy input to the terrestrial upper atmosphere, controlling both its dynamics and ionization state. Variable heating changes the height profile of neutral density, which affects the drag experienced by satellites and space debris, thereby impacting orbit determination and collision avoidance maneuvers. Similarly, changes to the total number and profile of electrons adversely impacts multiple systems that rely on radio wave propagation through and reflection from the ionosphere. Being able to accurately nowcast and forecast the solar spectral irradiance is an important goal of the space weather community.

I will discuss efforts to construct physics-based models of solar active regions that can be used to determine the solar spectral irradiance. Coronal heating is a crucial ingredient of such models. Despite the great, long-standing interest in coronal heating, many of its basic properties are still not well established, including its spatial and temporal behavior. By comparing models with observations from missions such as the Solar Dynamics Observatory, we can better constrain the properties of the heating, which will allow us to: (1) better understand the physical mechanism responsible for the heating, a holy grail of space science, and (2) make better predictions of the solar spectral irradiance and its variability.

Solicited talk

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Statistical Study of Solar Flares Observed in Lyman-alpha Emission During Solar Cycle 24 Using GOES-15

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Abstract. The chromospheric Lyman-alpha line of hydrogen (Lyα; 1216 Å) is the strongest emission line in the solar spectrum. Fluctuations in Lyα are known to drive changes in the D-layer of Earths ionosphere ($>$ 70 km), and Lyα variations due to active region evolution and solar cycles have been extensively studied. However, there are very few studies in the literature that have investigated flare-related changes in Lyα, and those that do exist suggest that up to 10% of the energy deposited in the chromosphere by nonthermal electrons is radiated away by the Lyα line alone. This work presents a statistical study of almost 500 M- and X-class flares observed in Lyα emission by the EUVS instrument on GOES-15 during Solar Cycle 24. It was found that up to 100 times more energy is radiated by Lyα compared to X-rays (also a driver of D-layer fluctuations); that Lyα enhancements during flares are comparable to or greater than those measured due to solar rotation variability, albeit on much shorter timescales; and that center-to-limb variations appear to be negligible despite Lyα being optically thick.

Contributed talk

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Session 10

Science with Total Solar Eclipses

Total Eclipse Expedition of KASI

S.-c. Bong, Y.-d. Park, H. Yang, J.-O. Lee, Y.-B. Jeon, B. Jang, J. Kim, Y.-h. Kim, K. Cho

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Abstract. We, KASI (Korea Astronomy and Space Science Institute), have a project to install a new coronagraph on the International Space Station (ISS) with NASA. As part of the filter test work of this coronagraph, we have planned a Total Solar Eclipse (TSE) expedition in 2019 to El Jarillal, Las Flores, San Juan, Argentina. For the observation, we developed a spectrograph by using the microlenslet. Using the polarized spectrum of the corona, we will obtain the electron temperature and velocity distribution in the corona from the spectroscopic observation. In this talk, we will introduce the new spectrograph system which is using the microlenslet and few results of our total eclipse expedition.

Solicited talk

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Megamovie Programs for 2017 and 2024

H.S. Hudson[1,2] and the Megamovie Team

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Abstract. The Megamovie program engaged many amateur astronomers in a comprehensive program to document the total eclipse of August 21, 2017 across the U.S. The program enlisted 1,190 participants, whose contributions (50,016 images) helped to create a first-ever public archive of eclipse imagery. Volunteers used their own equipment but could participate in training and mutual education through Megamovie services. The outreach activity worked very well, thanks to the volunteers and to collaboration with Google, the Astronomical Society of the Pacific, and other institutions. The existing database is large (currently 0.77 TB) and quite heterogeneous; in principle it is a powerful scientific asset because of the dense sampling, covering the full (terrestrial) 90 minutes of the 2017 eclipse, and because most of the images included the bright star Regulus as a coalignment aid. This presentation will report on data acquisition and analysis, including citizen-science efforts.

I also comment on lessons learned, including mistakes en route; specifically the program did not build a strong scientific program, though broadly sourced data of this type could be quite valuable. This experience may help us to organize a similar but more ambitious program for the 2024 North American eclipse. The long totality of this event and its continental México-US-Canada breadth make it a very attractive opportunity.

Solicited talk

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The 2017 Great American Eclipse: NASA Efforts and Accomplishments

C.A. Young and the NASA Space Science Education Consortium Team (NSSEC)

NASA Goddard Space Flight Center

Abstract. Monday, August 21, 2017, marked the first total solar eclipse to cross the continental United States coast-to-coast in almost a century. NASA scientists and educators, working alongside many partners, were spread across the entire country, both inside and outside the path of totality. Like many other organizations, NASA prepared for this eclipse for several years. The August 21 2017 eclipse was NASA's biggest media event in history, and was made possible by the work of thousands of volunteers, collaborators and NASA employees. The agency supported science, outreach, and media communications activities along the path of totality and across the country. This culminated in a $3\frac{1}{2}$-hour NASA TV broadcast from Charleston, SC, a 4-hour NASA EDGE webcast from Southern Illinois University, Carbondale, and numerous other broadcast, webcast, and observing events across the country, showcasing the sights and sounds of the eclipse-starting with the view from a plane off the coast of Oregon and ending with images from the International Space Station as the Moon's umbral shadow left the US East Coast. Along the way, NASA shared experiments and research from different groups of scientists, including 11 NASA-supported studies, 50+ high-altitude balloon launches, and 12 NASA and partner space-based assets. In this presentation, we share the timeline of this momentous event from NASA's perspective, describing outreach successes and providing a glimpse at some of the science results available and yet to come. We will end with look at the total eclipses of 2019, 2020, 2021 and 2024, which will continue to add to this unprecedented time for eclipse science and outreach.

Solicited talk

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Session 11

Missions and Instrumentation with Space Weather Applications

Solar Orbiter: A Mission to Study the Sun and the Inner Heliosphere Space Weather Capabilities

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Abstract. Solar Orbiter, the first mission of the ESA Cosmic Vision Program, is an interplanetary probe devoted to the study of the Sun and of the inner heliosphere as a combined system.

Scheduled for launch in February 2020, after a 22 months cruise phase, the spacecraft will set on a 6 months elliptic orbit with perihelion as close as 0.28 AU to the Sun and with progressively higher inclination over the ecliptic plane so to achieve unprecedented (from up to 34 degrees heliocentric latitude) views of the solar poles. It carries six remote sensing and four *in situ* instruments, a payload designed and built to "connect" the plasma probed *in situ* by the spacecraft to its source regions on the Sun.

Although not specifically designed for space weather monitoring (because of the ever changing view point and of the constrained telemetry budget inherent to a deep space mission), Solar Orbiter will greatly contribute to space weather by improving our understanding of how the solar wind and occasional transient events propagate through the inner heliosphere.

Moreover, at selected occasions, Solar orbiter will have an unprecedented view of the Sun-Earth line (i.e., from away of the ecliptic plane), quadrature observations, alignment with Parker-spiral, providing a direct contribution to the understanding of geo-effective phenomena. This last opportunity is augmented by the recent decision to perform low-telemetry synoptic observations throughout the entire orbit.

In this contribution I will describe the mission, its payload and its scientific goals. I will then discuss the instruments and the observations that have more relevance in terms of space weather studies.

Invited talk

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Parker Solar Probe: Mission Status and Outlook After Two Solar Encounters

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Abstract. NASA's Parker Solar Probe, launched on 12 August 2018, is the first mission to fly into the Sun's lower atmosphere. Parker Solar Probe will advance our understanding of the lower solar corona by making measurements that directly address questions that have puzzled scientists for decades: how is the solar wind heated and accelerated, and how are solar energetic particles accelerated and transported throughout the heliosphere? Parker Solar Probe has already completed two solar encounters (periods when the spacecraft's elliptical orbit is within 0.25 AU of the Sun), and is heading toward the third (perihelion on 01 September 2019), all with perihelia of 35.6 solar radii. The second of seven Venus gravity assists will occur on 26 December 2019, after which the perihelion will decrease to 27.8 solar radii. Parker Solar Probe is primarily a mission of exploration. The potential for discovery is great. *In situ* measurements made by FIELDS, SWEAP, and ISIS science investigations and white-light images from WISPR show plasma features in the lower corona that have not been observed before. We provide an overview of the mission status after two solar encounters, science data collected since launch, and the outlook of the mission based on past performance.

Solicited talk

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The Parker Solar Probe WISPR Instrument: Status and Observations

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Abstract. The PSP mission was launched Aug 12, 2018 into orbit about the Sun. In Oct/Nov it performed its first perihelion pass at 0.16 AU (36 solar radii). We present the plans and first observations of the corona for the WISPR instrument on the PSP mission. Observing the corona/solar wind from 0.25 AU to the ultimate perihelion distance of 0.04 AU is absolutely unique, but presents new challenges due to the rapidly changing heliocentric distance. WISPR, a heliospheric imager type of instrument, consists of two telescopes, which together observe in the spacecraft ram direction along the ecliptic plane from 13.5 - 108 deg from the Sun. This range of elongations encompasses the Thomson circle (the locus of points of maximum Thomson scattering efficiency) thereby transitioning from remote observations of structures close to the Sun to local observations of structures close to the spacecraft. Three different types of observations are envisioned: synoptic full field, partial field high cadence shock studies and partial field turbulence studies. The last one is a sequence of images at a 10-second cadence for which a power spectrum of intensity or electron density will be generated at selected heights in the corona, to see where wave energy is being deposited. In these preliminary images we anticipate that the view will be quite different as PSP plunges into the corona than the view from 1 AU. The spatial resolution will be greatly increased as we fly through the coronal structures and will reveal fine-scale details such as fluctuations in the plasma sheet, perhaps indicating individual flux tubes or magnetic islands or maybe something totally unexpected. The vantage points will remove a large fraction of the circumsolar dust contributing to the F-corona, perhaps also revealing the first dust to sublimate. To prepare for the mission, techniques have been developed to determine the background, track features that are moving through the field of view, among others. Due to the relative positions of PSP, Earth and the Sun, only a small fraction of the data has been received on ground, but WISPR has worked well through the first perihelion. We gratefully acknowledge support from the NASA Parker Solar Probe Project.

Solicited talk

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Space Weather and Sun Climate with Aditya-L1

D. Tripathi

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Abstract. The Aditya-L1 is the first observatory of the Indian Space Research Organization (ISRO) in space dedicated to solar observations. The spacecraft will carry 7 payloads providing uninterrupted observations of the Sun using remote sensing as well as *in situ* measurements from the first Lagrangian point. There are four remote sensing instruments namely a coronagraph, an NUV imager, full-sun integrated soft X-ray and hard X-ray spectrometers. In addition, there are three instruments for *in situ* measurements including a magnetometer to study the magnetic field variations during energetic events. I will highlight some of the salient features of the mission and the important roles it will play in enhancing our knowledge in the science of space weather and sun-climate.

Invited talk

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Exploring the Transition Corona with the Coronal Spectrographic Imager in the EUV (COSIE)

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Abstract. The middle corona is a region rich in exploration opportunities for solar and space weather research. Current available instrumentation has resulted in a gap in our observational capability specifically in this regime where magnetic fields transition between the low solar atmosphere and extended interplanetary space, and where the main phase of acceleration for eruptive events (CMEs) occurs. The Coronal Spectrographic Imager in the EUV (COSIE) combines a wide-field solar coronal EUV imager (COSIE-C) and an on-disk EUV imaging spectrometer (COSIE-S) over the 186-205 Å spectral range, in a compact instrument designed to directly address this important observational gap. The COSIE-C channel makes use of a novel filter implementation allowing for observations from on-disk out to >3 solar radii, while the COSIE-S channel provides simultaneous imaging of the corona in multiple spectral lines. Proposed for mounting onto the International Space Station (ISS) with an independent pointing platform, the goal of the mission is to enhance our understanding of the dynamics of the Transition Corona (the region in which the coronal magnetic field transitions from closed to open), and to provide improved detection and tracking of solar eruptive events for space weather research. We will present scientific motivation for the mission based on inferred observations of the middle corona and the anticipated outputs from the COSIE mission.

Contributed talk

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The 7 GHz Solar Radio Polarimeter: Development of Tracking Automation and Acquisition Data Codes

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Abstract. Computer-based telescope automation and data acquisition system play an important role in astronomical observations. The solar tracking using a 7 GHz Solar Radio Polarimeter operating at the Center of Radio Astronomy and Astrophysics Mackenzie (São Paulo) is done using a Paramount MEII robotic equatorial mount, which is controlled by the SkyX Pro software. Here is presented the tracking automation procedure that was developed using the TheSkyX Professional Edition scripting, using scriptable objects that can be manipulated programmatically and allow a broad range of capabilities. The code was defined to automatically control the solar tracking each day, starting from connection to the positioner, point to the Sun and start tracking, do the flip at noon time and stops and home the mount at end of the day. In addition, it was developed a code in LabView to record the data using a NI USB-6221 module. The telescope automation and acquisition codes are distributed as open source in the JavaScript and LabView programming languages, respectively.

Contributed talk

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Results of the Installation of the Latin American Giant Observatory Space Weather Node at the last Antarctic Campaign

A.M. Gulisano[1,2,3], S. Dasso[2,4], O. Areso[2], M. Pereira[2], V.E. Lopez[5], V. Lanabere[4], M. Ramelli[2], U. Hereñú[2], H. Asorey[6], H. Ochoa[1], A. Niëmela[4,7] for the LAGO collaboration (lagoproject.org, see the full list of members and institutions at lagoproject.org/collab.html.)

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Abstract. Observations of the flux of cosmic rays at ground level is of major importance for Space Weather studies. Because the cut-off rigidity associated with the geomagnetic field is lower at high latitudes, the Antarctic continent has the unique advantage of combining a territory with proper infrastructure for the location of astroparticle detectors, and allowing the arrival of cosmic rays with low energies. It permits to bring a large amount of cosmic rays information, very rich and linked with physical processes in the Sun, the geo-space, and the interplanetary medium. In this work we will present the results of our campaign to Antarctic, developed for deploying and installing a Water radiation Cherenkov Detector (WCD) for making observations of solar and galactic energetic particles. The detector is planned to be installed during the beginning of 2019 at the Argentine Marambio Base of the Antarctic Peninsula, it is part of the first permanent Antarctic node of the LAGO collaboration (Latin American Giant Observatory), and was developed at IAFE (Instituto de Astronomía y Física del Espacio) by the LAMP group (Laboratorio Argentino de Meteorología del espacio, http://www.iafe.uba.ar/u/lamp/index.html). Particles arriving to this new LAGO node (node called NALBAM-LAMP, Nodo Antártico Lago Base Argentina Marambio) cannot reach ground level at other latitudes where LAGO already possesses detectors, since at those sites the arrival of particles are shielded by the geomagnetic shield. In particular, here we will present some details about the creation of the NALBAM-LAMP laboratory, associated with the telemetry and storage of the data, as well as the new thermal control and sensors telemetry tests, together with the calibration of the instruments. Data obtained by NALBAM-LAMP will allow the improve quantification of the time evolution of the flow of cosmic particles at ground level for space weather studies. These data will be also used for operative Space Weather activities of the LAMP group.

Contributed talk

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The Space Weather Efforts in Latin-America

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Abstract. Science related to modern space weather services known as solar terrestrial physics dates back to nineteen century with the discovery of the solar cycle. The service that was a spin-off of this science may have its beginning attributed to International URSIGRAM and World Day Service (IUWDS), started in 1959 as part of the International Geophysical Year (IGY). After the 1960s, the International Space Environment Service (ISES) was established as the leading organization involved in the international coordination of space weather services. Today twenty-three members, two of them in Latin America, compose ISES. This work will present some initiatives in Latin America based on a strong science existing in solar terrestrial physics being structured to become international services for the space weather. Among the difficulties are unstable economic conditions, the lack of concrete policies in the administration of sciences and the creation, maintenance and renewal of qualified Human Resources. The services of EMBRACE (Brazil) will be presented with its sensor's networks, some forecasts, user alert indexes and a database distributed free of charge by the site. We will discuss the involvement of Latin American countries in coordinating local scientists and facilities to initiate space weather programs across the continent.

Solicited talk

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Out of Schedule

Space Weather Programs

Present and Future Opportunities for Geospace Science Research at NSF

I. Roussev

National Science Foundation

Abstract. For over two decades, the Geospace Section within the Division of Atmospheric and Geospace Sciences of the USAs National Science Foundation has been providing outstanding opportunities for capacity building for the solar and space sciences communities of the Nation, such as the first National Space Weather Strategy (1995), Faculty Development in Space Sciences (2004), and CubeSats (2007), to name a few. In 2016, the Geospace Section completed a comprehensive Portfolio Review (ICCGS: Investments in Critical Capabilities for Geospace Science 2016 to 2025), which provides strategic guidance for present and future funding initiatives to be undertaken by the Section during 2016-2025. This includes the new Integrative Geospace Science Program and Grand Challenge Projects Program, which are to commence as early as 2020. This talk provides an overview of the present and future funding opportunities within the Section that support emerging areas of fundamental research in Geospace Science.

Contributed talk

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Discussion - Operative space weather in Latin America

J.E.R. Costa, S. Dasso, A. González-Esparza

Poster Contributions

Study of some Spectral Properties of Type II Radio Bursts

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Abstract. Interplanetary type II radio burst radiation results from the excitation of plasma waves in the ambient medium by shock waves driven by coronal mass ejections (CMEs). These radio emissions provide a means of remotely tracking CMEs/shocks. The aim of this work is to present an analysis of some events of type II radio bursts observed by the WAVES radio instrument onboard the WIND spacecraft. We focus our analysis on the spectral properties of the type II emissions and the speed evolution of CMEs/shocks. Linking remote sensing observations with *in situ* measurements provides a useful tool to track CMEs/shocks that move outward from the Sun to 1 AU.

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PREDSTORM - an Empirical Geomagnetic Storm Prediction System

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Abstract. We introduce PREDSTORM, an open source modeling package in python, which will allow to predict in real-time the solar wind at the Sun-Earth L1 point, the Dst index, the aurora location, and geomagnetically induced currents. Our main goal is to enhance the prediction lead time for geomagnetic storms. To this end, PREDSTORM is driven primarily by data from a spacecraft east of the Sun-Earth line such as STEREO-A or a possible future L5 mission, providing the background solar wind at L1 by a mapping technique. For modeling the coronal mass ejection signatures at L1, PREDSTORM will innovatively combine empirical flux rope modeling with machine learning algorithms applied to long-term solar wind data sets, and the usage of real-time L1 data as an ongoing constraint, to enhance the warning time of geomagnetic storms for up to 48 hours. This project is under development and we will provide insights into the specific parts of PREDSTORM. Finally, we will show first results.

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Characteristics of the Metis/Solar Orbiter Intensified Active Pixel Sensor Camera for Vacuum Ultraviolet Imaging

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Abstract. For astronomical observations from space, the acquisition of images in the Lyman Alpha line of hydrogen at 121.6 nm is of great interest. In particular for studies of the solar corona, imaging in this bright emission line allows diagnostics of the main component of the coronal plasma and of the solar wind.

To record the line with high efficiency and good suppression of the radiation emitted at longer wavelengths by our star, a preferred solution is to combine a microchannel plate intensifier, which carries a specific photocathode, with a CMOS sensor via a fiber optic coupler. We have built two such intensified active pixel sensor (IAPS) cameras for the Extreme Ultraviolet Imager (EUI) and for the Metis instrument of the ESA/NASA mission Solar Orbiter. Although conceptually very similar, those cameras use a different APS sensor and, thus, have different characteristics. Here we focus on the units built for the Metis instrument. The entirely new design of the coupling between the intensifier and the sensor involves a conversion and transfer of the image from the photocathode to the imaging device, which may affect the performance of the camera.

The qualification model and the flight and spare models of the Metis Lyman Alpha camera have been subjected to characterization campaigns at the Max Planck Institute for Solar System Research (MPS) and at the calibration facility of the Physikalisch-Technische Bundesanstalt (PTB) Berlin (Germany) in order to determine the camera response at different voltages applied to the intensifier, the camera intrinsic spatial resolution and the noise characteristics. Each unit under test was mounted inside a specifically built vacuum chamber that was connected to the beam line of the Metrology Light Source (MLS) at PTB for calibrated measurements and later attached to the reflectometer chamber at MPS for measurements in the VUV using a Lyman-Alpha light source producing a quasi-flat, monochromatic illumination, and a reference photodiode monitoring the intensity level of the lamp.

The calibrated measurements at PTB also allowed the determination of the spectral radiometric response of the camera. Measurements at MPS with a series of pinholes located as close as possible to the focal plane were performed in order to compare the expected diffraction pattern with the measured one to gain information on the intrinsic spatial resolution of our units. Additionally, measurements of the noise (dark thermal noise and MCP dark emission) were also performed.

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Visibility Function of the Coronal Mass Ejections from Modern Coronagraphs Observations

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Abstract. Coronal mass ejections (CMEs) are large-scale expulsions of magnetized plasma resulting from the explosive release of magnetic energy stored in the solar atmosphere. They are also the primary drivers of terrestrial and planetary space weather. It is, therefore, important to have a good understanding on CME properties (i.e. rates of occurrence, kinematic profiles, energy content, direction of propagation, etc.) to forecast and determine any likelihood of their impact on our planet. Because coronagraphs detect CMEs via the scattering of photospheric emission from the electrons in the CME plasma, the visibility of a given CME depends strongly on its direction of propagation. Moreover, the detection of a CME by a given coronagraph depends both on the event-observer geometry and on the instrumental sensitivity and stray-light level of the detecting instrument. This dependence is called the CME Visibility Function (VF), and is specific to a given coronagraph. Our goal is to provide a thorough analysis of CME detectability for all currently operating coronagraphs, over different phases of the solar cycle, and to interpret the VF results both in terms of instrument design, performance, and effects of projection. Here we present the first results from the CME observations over the 2007-2011 period from the SECCHI/COR1 and COR2 coronagraphs aboard STEREO-A and B, and the LASCO/C2 and C3 coronagraphs aboard the SOHO mission.

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Space Weather Studies from Aditya's Coronagraph

D. Banerjee and the Aditya team

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Abstract. ADITYA-L1 is the first Indian mission that is dedicated to study solar atmosphere with unprecedented spatial and temporal resolution. The satellite will carry seven payloads and is expected to be launched in 2020 by PSLV-XL from Sriharikota. The main payload is the Visible Emission Line Coronagraph (VELC), an internally occulted solar coronagraph capable of simultaneous imaging, spectroscopy and spectro-polarimetry close to the solar limb, with 3 visible and 1 infrared channels. In this presentation I will give an overview on the different payloads, with particular emphasis on the Coronagraph and how it will help in our understanding of the space weather studies. I will also emphasize the need for coordinated campaigns for space weather predictions.

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The local Interstellar Medium since 2012 at Voyager 1 Compared to that at Voyager 2

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Abstract. Examples of the magneto-matter compression as it is observed with both Voyager spacecraft in the LISM are presented. The work will focus on similarities and differences in the observations at the different locations. A priory it is fair to mention that the two regions differ in several aspects. Along the trajectory taken by Voyager 1 it appears like there is negligible compression, but signatures of reconnection appear to be present. This is well documented in Burlaga and Ness (2014). On the other hand, the recent entry (November 2018) of Voyager 2 into the LISM indicates substantial compression. Both features are illustrated and briefly discussed.

Burlaga L.F., and N. Ness, ApJ, 784, 146 (14pp), 2014.

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Aerodynamic Drag on CMEs and their Apparent Solid Body-like Behavior

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Abstract. Coronal mass ejections (CMEs) from the Sun are now recognized to be among the primary drivers of near-Earth space weather disturbances. The aerodynamic drag experienced by CMEs on their way from Sun to Earth is an important determinant of their dynamics and significantly influences their time and speed of arrival. Most observational studies seem to suggest that CMEs are subject to the so-called turbulent drag law, that is appropriate to a solid body moving at high Reynolds numbers. However, CMEs are well known to be deformable, bubble-like objects, and hardly appear like solid bodies. In order to investigate this apparent paradox, we use *in situ* (near-Earth) data for 25 well observed Earth directed CMEs to determine the ratio of the enthalpy density due to stagnation pressure to the enthalpy density due to ram pressure exerted on them by the solar wind. We find that this ratio considerably exceeds unity within the magnetic clouds, suggesting that the core of CMEs exhibits a solid body-like character. We also use the CME propagation data to compare their expansion speeds with the Alfven crossing speed, to determine if and how a CME can be considered to be a coherent object.

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Electromotive Force as a Tool to Detect ICME Events in Heliospheric Observations

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Abstract. The electromotive force is a quantity that stems from dynamo and turbulence research and can be obtained from magneto-hydrodynamic quantities, like the *in situ* measurements of the proton bulk flow and the magnetic field in the solar wind. We use the data of the HELIOS-1/-2 missions to scan automatically for iCME events. The probes recorded data between 0.3 and 1 au near the ecliptic. From this data we deduce the vorticity of plasma flows, the cross-helicity, and turbulent transport coefficients that allow us to compute the electromotive force in two alternative formulations. We compare our automatic detections of magneto-hydrodynamic shock fronts with a manually compiled list of iCME events. We find our method is capable of reproducing most of the known iCME events without any human interaction and gives additional that are not yet categorized. In a statistical study, we establish a scaling law of how the electromotive force decays with heliospheric distance from the Sun. For future missions flying the inner heliosphere, like Parker Solar Probe and SolarOrbiter, this method could be used to switch the spacecraft into a high-cadence observing mode once a threshold of the electromotive force is reached. This would allow to record the most interesting iCME passings in the highest possible resolution without contact to Earth control centers, which is necessary because an iCME typically passes a spacecraft typically within a few hours. Also for the data post-processing our method can be used to detect and analyze iCME events and to obtain the handedness of the magnetic helicity in the observed plasma structures.

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Quiet-Sun Study with Observations from the FOXSI Sounding Rocket

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Abstract. Observations of the Sun in hard X-rays provide insight into many solar phenomena, including clues on those mechanisms trying to explain coronal heating, such as nanoflares.

The FOXSI (Focusing Optics X-ray Solar Imager) is a solar dedicated instrument flown on three sounding rocket campaigns to observe the Sun in X-rays. FOXSI uses focusing optics for observations in the 4-20 keV range. An upgraded version of this experiment, FOXSI-3, was flown on September 11, 2018. Here we present an overview of the FOXSI-3 mission, detailing instrumental upgrades and describing how the enhanced capabilities of FOXSI-3 support a better understanding of small-scale and faint X-ray solar emissions. Additionally, we feature a preliminary analysis of observations from the FOXSI-3 flight.

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Wave Propagation in Magnetically Structured Plasmas

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Abstract. Our proximity to the Sun allows us to obtain high resolution images turning our star into a natural plasma laboratory. The reasons why the solar atmosphere is hotter than its surface are still a mystery. Recent observations have revealed that there is a large number and variety of oscillations in the solar atmosphere that lead to a new interest in the mechanisms of wave heating. One way to contribute to the understanding of coronal heating is to study these waves and oscillations that propagate in the solar corona, since they are capable of transporting energy and information. In this research we study the propagation of waves and coronal oscillations under a numerical approach comparing with direct observations.

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On the Nature of Extreme Ultraviolet (EUV) Waves

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Abstract. Extreme Ultraviolet (EUV) waves was first discovered by EUV Imaging Telescope (EIT) onboard SOHO satellite. After more than two decades of the discovery of EUV waves, their nature is still controversial. Different models proposed to explain their physical nature, which mainly includes wave, non-wave, and hybrid models. We will discuss here the different features of EUV waves namely fast-mode components, slow-mode components, stationary fronts, their mode conversions. For this purpose, we used the high spatial and temporal resolution data of Atmospheric Imaging Assembly (AIA) onboard Solar Dynamics Observatory (SDO) satellite.

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Cut-off Periods of Slow Magnetoacoustic Gravity Waves in a Stratified Solar Atmosphere Considering Changes in the Mean Atomic Weight

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Abstract. Assuming the thin flux tube approximation, we introduce an analytical model that contemplates the presence of: a non-isothermal temperature, a varying magnetic field, a non-uniform stratified medium in hydrostatic equilibrium due to a constant gravity acceleration and the variation of the mean atomic weight across solar spot temperature gradients.

This allows the study of slow magnetoacoustic cut-off periods across the solar transition region, from the base of the solar chromosphere to the lower corona. The temperature profile approaches the VAC solar atmospheric model. The periods obtained are consistent with observations. Similar to the acoustic cut-off periods, the resulting magnetoacoustic gravity ones follow the sharp temperature profile, but shifted towards larger heights. At a given height the magnetoacoustic cut-off period is significantly lower than the corresponding acoustic one.

We show that monochromatic oscillations of the solar atmosphere are the atmospheric response at its natural frequency to random or impulsive perturbations, and not a consequence of the forcing from the photosphere.

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Expansion of Coronal Mass Ejections from the Low to the Outer Corona

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Abstract. Coronal mass ejections (CMEs) constitute the most spectacular dynamic events in the solar system, and are key players in determining space weather conditions. Given that the ocurrence of a CME has so far been impossible to predict, the best attempt at forecasting is to assess their impact with the best possible accuracy. In this respect, understanding how magnetic fields are organized within CMEs, and how they evolve from the low corona into the heliosphere, is crucial. Exceptional ongoing solar missions, such as STEREO, SOHO, and SDO, provide a unique opportunity to shed light into this aspect. The stereoscopic-view images provided by the STEREO/SECCHI suite in combination with images from Earths perspective recorded by SDO/AIA and SOHO/LASCO enable the analysis of CME evolution from their birth in the low corona. The set of CMEs uder study arises from an appropriate combination of spacecraft vantage points and CME propagation direction, which is helpful to reduce uncertainties in their forward modeling. These events are carefully analyzed as they originate low in the corona by means of simultaneous observations of STEREO/EUVI and SDO/AIA, and followed up to the outer fields of view of the STEREO and SOHO coronagraphs. In particular, we examine the evolution of their global magnetic field configuration, and how CMEs expand along the direction of their main symmetry axis and orthogonal to it.

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Radio Spectra Fitting for Solar Events Exhibiting the THz Component

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Abstract. Flares are one of the most energetic transient phenomena in the Sun. Since the Solar Submillimeter Telescope installation (SST, Kaufmann et al., 2000 (a)) regular observations of the Sun at 212 and 405 GHz were made throughout the present millennium. In addition to SST observations, the KOSMA/BEMRAK telescope was operative from 2004 (Lüthi et al., 2004 (b)) at 210 and 230/340 GHz.

During solar flares the Sun can become very bright at the frequency range from 1 GHz to 100 GHz (microwaves). At these frequencies the burst emission is well explained by incoherent gyrosynchrotron radiation from mildly relativistic electrons moving through plasmas permeated by magnetic fields of 100-1000 G. Above 100 GHz some events exhibit an unexpected upturn towards the THz domain, during both impulsive and gradual phases, the so-called *THz component*.

A recent work (Kontar et al., 2018 (c)) shows that the spectral component rising with frequency can be explained by free-free emission from a plasma with temperatures between 10^4 and 10^6 K. Following Kontar et al., in this work we model the emission at 1-1000 GHz as gyrosynchrotron plus free-free emission due to inhomogeneous sources, trying to fit the observed spectra corresponding to events where the *THz component* was present.

(a) Kaufmann, P. et al., 2000, in High Energy Solar Physics Workshop Anticipating Hessi, ed. R. Ramaty, N. Mandzhavidze, 318, ASP Conf. Ser., 206.
(b) Lüthi, T. et al., 2004, A&A, 420, 361.
(c) Kontar, E. et al., 2018, A&A, 620, 95.

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Propagation of ICMEs to 1AU: Average Speed and CME Speed Uncertainty Estimates

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Abstract. Coronal mass ejections (CMEs) are among the main origins of geomagnetic disturbances. They change the properties of the near-earth interplanetary medium, enhancing some key parameters, such as the southward interplanetary magnetic field and the solar wind speed. Both quantities are known to be related to the energy transfer from the solar wind to the Earths magnetosphere via the magnetic reconnection process. Many attempts have been made to predict the magnetic field and the solar wind speed from coronagraph observations. However, we still have much to learn about the dynamic evolution of ICMEs as they propagate through the interplanetary space. Increased observation capability is probably needed. Among the several attempts to establish correlations between CME and ICME properties, it was found that the average CME propagation speed to 1AU is highly correlated to the ICME peak speed. In this work, we present an extended study of such correlation. Another aspect we would like to address is the uncertainty estimates in CME speed measurements. We present some results on the estimates of CME travel time to 1 AU with uncertainty estimates in the CME speed measurements.

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Radial Evolution of an Interplanetary Coronal Mass Ejection: ACE/WIND, Artemis and Juno Observations

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Abstract. Interplanetary coronal mass ejections, ICMEs, are the main drivers of space weather at Earth which can have severe effects on systems both in space and on the ground. ICMEs with a strong southward magnetic component are the most geo-effective, thus the strength and orientation of an ICME is important in forecasting space weather severity. Understanding their evolution as they propagate through the heliosphere is therefore essential. Relatively few studies have used multi-spacecraft observations to analyse ICME evolution as radial alignments between spacecraft are rare. While most such recent studies have focussed on the inner heliosphere, Juno cruise phase data provides a new opportunity to study ICME evolution beyond 1 AU.

We present analysis of the sheath and flux rope of a halo ICME registered *in situ* by Juno on 25th October 2011 that is of particular interest, firstly, due to its large maximum magnitude field strength which caused a strong geomagnetic storm at Earth and, secondly, due to partially merging with a slower preceding halo ICME. The spacecraft is close to radial alignment with near Earth spacecraft, however, we find that the slight longitude separation causes clear differences in the signatures observed by the Juno spacecraft in comparison to the near Earth spacecraft. This case study illustrates the utility of studying ICMEs from the Juno cruise phase towards understanding the chain of evolution from spacecraft in the inner heliosphere, to Earth and beyond into the outer heliosphere.

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Testing the Validity of a Model of Propagation and Expansion of Coronal Mass Ejections from Near the Sun to 1 AU

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Abstract. Understanding the evolution of coronal mass ejections (CMEs) from the Sun to the Earth and the underlying mechanisms is of vital importance, given that they are considered the main drivers of severe space weather.

Here we study the propagation and expansion of a CME from the Sun to 1 AU. The kinematics of the CME in the inner and outer solar corona are first determined via 3D forward modeling from STEREO observations. These measurements are then contrasted with the FRIS (Flux Rope Internal State, Wang et al. 2009; Mishra & Wang 2018) model which describes the evolution of the internal thermodynamic properties of CMEs. The model assumes that CMEs behave self-similarly and provides the variation of the polytropic index of the CME plasma, the average Lorentz force and the thermal pressure force inside CMEs during their propagation. We further extrapolate the derived properties to 1 AU and compare them with *in situ* measurements to evaluate the validity of the assumptions.

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Long-term Space Weather Data Sets from SOHO

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Abstract. SOHO, launched on 2 December 1995, has provided a nearly continuous record of solar and heliospheric phenomena over more than a full 22-year magnetic cycle. SOHOs long-term data sets include measurements of total and spectral solar irradiance, He II 304 Å and integrated (1-500) EUV solar output, low-frequency global velocity oscillations (including frequency tables), solar wind parameters (proton speed, density, thermal speed and arrival direction), energetic particles (electrons, protons, He), full disk EUV images in He II 304 Å, Fe IX/X 171 Å, Fe XII 195 Å, and Fe XV 284 Å, white light images and thus electron densities in the range from 2.5 to 30 solar radii, full-sky Ly-alpha flux, and for the first 15 years of the mission also medium-l helioseismology data and full disk magnetograms at 96 min cadence. This presentation will give an overview of the SOHO long-term data sets with a particular emphasis on their use in space weather research.

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Multi Instrument Tomography of the Solar Corona

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Abstract. Solar rotational tomography (SRT) was originally developed to be applied to coronal white light images, allowing reconstruction of the three-dimensional (3D) distribution of the coronal electron density. More recently SRT was extended to be applied to coronal EUV narrowband images, producing 3D maps of the EUV emissivity in each band. These are in turn used to compute 3D maps the differential emission measure (DEM), from which the coronal electron density and temperature can be obtained. In this work, we introduce a new tomographic methodology of the solar corona capable in principle of simultaneously determining the 3D distribution of the electron density and temperature, the filling factor, and the coronal iron abundance. The technique, dubbed multi instrument tomography (MIT), involves joint analysis of tomographic products based on data provided by multiple instruments: white-light coronagraphs, EUV telescopes, and visible emission line coronagraphs. MIT is currently under development to combine data from KCOR, AIA, and the (soon to be operative) Upgraded Coronal Multichannel Polarimeter (UCoMP) instrument. For a specific target Carrington rotation, we show examples of the tomographic products based on the different types of data sets required, and discuss the capabilities of the technique as well as the challenges involved in its implementation.

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Geomagnetic Storm Effects on Spread-F Occurrence at Low Latitudes

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Abstract. This work presents an analysis of the SF occurrence during the intense geomagnetic storm of May 28, 2017 from ionospheric sounding observations at two geomagnetic conjugate stations at South America: Campo Grande (-20.43; 305; dip: -22.3) and Boa Vista (2.81, 299.3; dip: 22) and a low latitude station in the chenise longitude sector, Sanya (18.34, 109.4; dip: 12.8). It was found that: A) Campo Grande and Boa Vista presents RSF on May 28, 00:40UT - 04:00UT (20:40LT 0LT) caused by eastward prompt penetration electric fields. B) There is also RSF during the recovery phase on May 29 from 00:50 UT to 07:50 UT (May 28 20:50LT-May 29 3:30LT) at Boa Vista related to the Joule heating at high latitudes that drive traveling atmospheric disturbances (TADs). C) No range spread F was observed during the period of the storm at Sanya but the presence of TADs was detected. D) Vertical plasma drifts are the most important contributor to the initial storm time response of the low latitude F region. E) Neutral composition changes (increase in the molecular species, mainly N2) play a predominant role in the decrease of electron density at Boa Vista during the recovery phase of the geomagnetic storm.

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Space Weather Studies in Mexico

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Abstract. In the recent years Mexico has been developing a scientific team and ground based instrumental infrastructure to perform space weather studies, and to analyze the particular effects in the Mexican territory. The instrumental network includes: solar telescope, three CALLISTO stations, the MEXART radiotelescope for solar wind studies applying the interplanetary scintillation (IPS) technique, cosmic rays observatory, a new network of magnetometers, a new network of ionosondes, and a network of GPS receivers for maps of the total electron content (TEC). These new observational and analytical capabilities are used by the Mexican Space Weather Service (SCIESMEX) to perform studies and warnings for the National Civil Protection System. We present the results of some space weather events combining international data with our own instrumental network. These events illuminate particular geomagnetic and ionospheric effects in the Mexican territory. We also comment on the new studies that we are initiating, including the geomagnetic induced currents (GIC) in the national electric grid.

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Analytical Model of Particle Acceleration that Results in Power-Law Energy Spectra

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Abstract. The mechanism that accelerates particles to the energies required to produce the observed spectra in solar flares is not well understood. Here, we propose a simple fully analytical, first-principle-based model, which produces energy spectra with power-laws at high energies. This model is based on ideas from our previous semi-analytical model (Guidoni et al. 2016), which uses large-scale contracting magnetic islands (accelerators) formed during fast reconnection in simulated solar flares to accelerate electrons, as similarly proposed by Drake et al. (2006) for kinetic-scale plasmoids. The goal of this simple model is to develop physical insight into the development of spectrum power-laws not to reproduce observed events in detail. We model particles visiting a small number of accelerators, each of which increases the temperature of its initial Maxwellian distribution. We assume that only a small fraction of the particles in one accelerator is transferred to another accelerator. For simplicity, all accelerators have the same properties. We deduced the spectral index of the final particle distribution as function of parameters of the model. We find that our model (with very few physical parameters) reproduces typical observed spectral indices for flare hard X-ray emissions with as few as five passages through different accelerators.

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Space Weather at Mars: Impact of the September 2017 Solar Particle Events

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Abstract. Although solar activity is declining as the Sun approaches solar minimum, a series of large solar storms occurred in September 2017 that impacted both Earth and Mars. This was the largest event seen on the surface of Mars since the landing of the Mars Science Laboratory (MSL) in 2012, and was also observed as GLE72 on Earth, making it the first event observed to produce a ground level enhancement (GLE) on 2 planets at the same time! Due to the modulating effect of the Martian atmosphere and the magnetic cloud associated with the coronal mass ejection (CME), the structure and intensity of the spectra observed at the surface are complex. We present the observations of this event obtained with the Radiation Assessment Detector (RAD) on MSL and discuss the implications for our understanding of such events and for mitigating the risk of space radiation and space weather for future human exploration.

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Development of a 21cm Multi-Element Phased Array Solar Radio Interferometer

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Abstract. Solar radio emissions account for different emission processes and the medium in which these are generated in the Solar Atmosphere. For a better understanding of this radio emission is essential to observe and study the different solar phenomena and how their physical processes affect the Interplanetary Medium. Additionally, Radio Astronomy is a field that is gradually growing in Colombia thanks to several projects aiming to a more viable way of performing astronomical studies in a country whose climate conditions are predominantly cloudy, as well as the contribution it presumes to the scientific and technological development that can have an impact on future generations of Colombian astronomers, scientists and engineers. This work presents the first development stage of a Solar Radio Interferometer with a novel antenna design, consisting of the implementation results for one element (Antenna and Reflector Dish) and the proposed configuration for the full interferometric array, as well as a time correlation system implemented with a Reconfigurable Open Architecture Computing Hardware (ROACH) electronic system, in order to study Solar Radio emissions at the frequency of 1.42 GHz, corresponding to the 21cm emission line, generated by gyro-resonance mechanisms, as well as the type III radio bursts observed in the interplanetary medium.

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CME Arrival Prediction Based on L5 HI Observations Using ELEvoHI Ensemble Modeling

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Abstract. Accurate predictions of CME arrival time and speed have become of increasing importance. In this study, we perform post-event prediction of CME arrivals using ELEvoHI (ELlipse Evolution model based on Heliospheric Imager observations) ensemble modeling. ELEvoHI is the current state-of-the-art HI fitting method that makes use of heliospheric imager data obtained by one of the STEREO (Solar TErrestrial RElations Observatory) twin spacecraft. The model assumes that the drag force exerted by the ambient solar wind is the dominant force influencing the CME propagation in the IP-space. The HI time-elongation profiles needed by ELEvoHI as well as the *in situ* data for validating the results are taken from the EU FP7 HELCATS project. We apply GCS (Graduated Cylindrical Shell) fitting, based on coronagraph images, to each CME separately and perform a cut in the ecliptic plane to derive the initial values needed for the ELEvoHI ensemble modeling. In this study, we select CMEs occurring between June 2009 to June 2010, corresponding to a location of STEREO-B close to Lagrange point 5 (60° trailing Earth). Therefore, the model results are valuable for future studies (STEREO-A near L5 in mid-2020) and for a planned L5 mission. Our validation analysis consists of two parts: First, a contingency table (hits/false alarms/misses) with the corresponding skill scores and second, the times and speeds for the predicted and observed events arriving at Earth. We compare the statistical results to other studies and will use them as a benchmark for future enhanced ELEvoHI versions.

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Correlation Between Activity Indicators: Hα and Ca II Lines in dMe Stars

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Abstract. The magnetic fields responsible for the stellar activity are generated by the stellar dynamo mechanism. Several late-type stars present activity cycles similar to the 11-year solar.

The standard stellar activity indicator used is the Mount Wilson S-index, essentially the ratio of the Ca II H&K line-core fluxes to the continuum nearby. However, due to the low intrinsic luminosity of dM stars the S-index is not always suitable for studying the chromospheric activity on these fainter stars. Therefore, it is necessary to explore redder activity indicators in late-type stars (eg. Balmer lines, Na lines or Ca IRT). It is well known that the correlation between the the Ca II and H line-core fluxes is positive in the solar case for the whole solar-cycle. However, during the last decade, this correlation has been revised for solar-type stars. The main conclusion is that this relation is not always valid for single stars.

Since 1999, the HKα Project is operating in the Argentinian observatory CASLEO. Our group, systematically observe more than 150 main-sequence stars from F3 to M5.5. To date, we have more than 5000 mid-resolution spectra, ranging from 389 to 669 nm, which constitute an ideal dataset to study different chromospheric activity indicators at different heights of the stellar atmosphere. In this work, we present a particular study of the relation between H and Ca II in a set of 10 southern dMe stars for different level of activity.

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Analysis of a Flare and Accompanying Eruption in NOAA AR 12127: Magnetic Field Topology and Comparison with Observations

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Abstract. During August 2014 an M1.5 flare took place in AR 12127 followed by a filament eruption, observed by several instruments including the H-alpha Solar Telescope for Argentina, HASTA, and a coronal mass ejection (CME). We report on a preliminary study of the coronal magnetic field topology obtained by a linear force-free field (LFFF) extrapolation of the photospheric field measured by the Heliospheric and Magnetic Imager. The determination of quasi-separatrix layers suggests a breakout and a quadrupolar reconnection as the main triggering mechanisms of the observed flare and eruption. LFFF extrapolations, however, have known limitations in the estimation of some important magnetic field parameters associated to eruptive events, e.g. free magnetic energy and magnetic helicity. These and other disadvantages can be overcome by employing more sophisticated, non-linear force free field extrapolations (NLFFFE) that require, however, a more complex pre-processing of the input vector magnetograms used as boundary condition. We also report on the preliminary results of a NLFFF extrapolation of AR 12127 that can better model key pre-eruptive, coronal field topological features.

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Segmentation of Coronal Holes with a Convolutional Neural Network

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Abstract. Coronal holes (CHs) are regions of open magnetic fields in the solar corona. They are typically associated with high speed solar wind streams and provide an estimation of solar wind parameters and corresponding geomagnetic effects. An accurate CHs segmentation procedure is essential for more detailed investigation of this relationship and implementation of space weather forecasting routines. Current CHs segmentation methods typically rely on image thresholding and require non-trivial image pre- and post-processing. We have trained a neural network that accurately isolates CHs from SDO/AIA 193 Angstrom solar disk images without additional complicated steps. We compare results with publicly available catalogues of CHs and demonstrate stability of the neural network approach. In our opinion, this approach can outperform hand-engineered solar image analysis and will have a wide application to solar data. In particular, we investigate long-term variations of CH indices within the solar cycle 24 and observe increasing of CH areas in about three times from minimal values in the maximum of the solar cycle to maximal values during the declining phase of the solar cycle.

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The Fractal Properties of the Interplanetary Magnetic Field Measured by ACE and CLUSTER

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Abstract. The solar wind displays similar characteristics to fluid turbulence, namely, power spectra with inertial subranges, non-Gaussian probability distribution functions, and small-scale intermittency. Here we analyze data of the interplanetary magnetic field collected by Cluster and ACE near and far upstream of the Earth's bow shock,respectively. We start with a statistical analysis of the magnetic field using tools such as probability distribution functions and high-order structure functions. Then, the singularity spectrum is obtained using a formalism which relates the Hausdorff dimension and the scaling exponent obtained from the structure functions. Our results can contribute to understanding the fractal nature of the turbulent magnetic field near and far the Earth's bow shock.

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Solar Jets Observed by the Solar Dynamics Observatory

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Abstract. Solar jets are small scale mass eruption from sun as the collimated beams at different heights from solar chromosphere to coronal heights. These are observed at different wavelengths, such as H-alpha, UV, EUV, and X-rays. Magnetic reconnection is widely accepted mechanism for their generation. Several magnetic topological features have been observed at the jet locations like: emerging, converging, cancelling magnetic flux, quasi-separatrix layers (QSLs). Here, we present the recurrent solar jets from two different active regions i.e. NOAA AR 12297 and 12644. These jets were observed by Atmospheric Imaging Assembly (AIA) onboard Solar Dynamics Observatory (SDO) in UV and EUV channels. For the magnetic configuration, we have used the Heliospheric magnetic Imager (HMI) data. We have computed the different physical parameters of these jets like: velocity, heights, life-times. These physical parameters have been compared with previous results. It is inferred from the magnetic field analysis that the flux cancellation and emergence and presence of null-point are responsible for the production of these jets.

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Measuring Characteristics and Performance of a BITSE (Balloon-borne Investigation of Temperature and Speed of Electrons in the corona) CCD Detector

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Abstract. KASI have been developing a Balloon-borne Investigation of Temperature and Speed of Electrons in the corona (BITSE) system for observing the corona and testing of technology. We have tested the characteristics and performance of the BITSE CCD detector. For this we have used KASIs photoelectron detector performance test system. (1) Using a lambertian light source flatted by integrating sphere, we were able to get the image signal value dependent on the exposure time. We have analyzed these images and measured dark noise, intensity and linearity. Using a Photon Transfer Curve (PTC) method, we have obtained CCDs Conversion Gain(CG) for each channel and full well capacity. (2) Using a monochromator that make light of a specific wavelength band, we have measured the quantum efficiency (200 nm-1100 nm). As a result, we found that each channel has almost the same CG value (Channel 1 and 3: 2.439e$^-$/ADU, Channel 2 and 4: 2.5e$^-$/ADU). In particular, the channels connected to each ADC have the same CG value. And in the quantum efficiency measurement, it was confirmed that the peak value of the quantum efficiency is 50% and measured quantum efficiency was similar to the KAI-04070 manual made by On-Semiconductor.

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Research to Operations Initiatives at LAMP (Argentinean Space Weather Laboratory Group)

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Abstract. Since more than one decade ago, several institutions started to offer a large variety of Operative Space Weather (SWx) products. This is of major importance because Space Weather events can affect aviation communications, global positioning systems, grid electric power, satellite technologies, and human health in space. The scientific potential on solar-terrestrial physics in Argentina motivated the creation of an interdisciplinary Argentine Laboratory of Space Weather. The Argentinean Space Weather Laboratory (in Spanish Laboratorio Argentino de Meteorología del esPacio, LAMP) was initiated in 2016 by researchers from the following institutions: Departamento de Ciencias de la Atmósfera y los Océanos & Departamento de Física at Universidad de Buenos Aires (DCAO/DF-UBA), Instituto de Astronomía y Física del Espacio (IAFE), Instituto Antártico Argentino (IAA), and Servicio Meteorologico Nacional (SMN).

LAMP carries out daily monitoring of real-time information (space and ground based instruments) on SWx conditions. In particular, it analyzes Total Electron Content maps in the Argetinean region, which was developed by LAMP in collaboration with INPE-EMBRACE. The information is synthesized on a weekly bulletin as a summary of the space weather activity, and it is posted on a website (spaceweather.at.fcen.uba.ar). We also analyze and discuss the information later on, during monthly briefings.

LAMP also plans to extend the set of analyzed observations, in particular data from a water Cherenkov radiation particle detectors will be monitored. One of this detectors is being installed in the Antarctic Peninsula during this campaign (January-March, 2019), at a LAMP group site, which is in the Argentinean Marambio base and it is dedicated to Antarctic Space Weather studies. In this work, we present all these LAMP activities and an example of the conditions analyzed from 06 to 10 September 2017.

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Finding the Distribution of the Twist Profile in Magnetic Clouds Using a Superposed Epoch Analysis

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Abstract. Coronal Mass Ejections (CMEs) are the most massive transient structures expelled from the Sun. They have a magnetic field configuration with elevated magnetic field intensities that can produce an important perturbation in the solar wind conditions and planetary environments. In particular, Magnetic Clouds (MCs) are a sub-set of the interplanetary manifestation of CMEs, and they are essential drivers for geomagnetic storms. The magnetic field configuration in MCs presents properties consistent with the presence of a flux rope. To gain a better understanding of the magnetic configuration in MCs is of major importance for improving methods and models of Space Weather forecast. In this work we study a sample of MCs with statistical significance, presenting an analysis of plasma and magnetic field *in situ* observations at 1 AU. Consistently with previous studies, we found that fastest MCs (V>600 km/s) present a strong asymmetry in their magnetic field profile; we limited our present study to the symmetric events (slow MCs with V<600 km/s). In order to acquire the most common features of the magnetic configuration of MCs, we applied a statistical technique known as "superposed epoch analysis", and applied it to the components of the magnetic field inside the MCs in the flux rope frame. We will present a quantification of the typical magnetic twist profile and their implications for Space Weather.

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The Origin of White Light Plasma Blobs Formed in Post-CME Current Sheets

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Abstract. We investigate the origins of localized plasma density enhancements (plasma blobs) in the post-CME current sheets observed by the COronal Solar Magnetism Observatory (COSMO) K-coronagraph (K-Cor) on 2017 September 10 from 17:11 UT to 19:25 UT. For this, we use K-Cor level-1.5 data, which is fully calibrated polarization brightness (pB) intensity, and make K-Cor intensity and running difference images in order to find white light plasma blobs. By the visual inspection of the intensity and running difference images, we classify the white light plasma blobs into three groups: (1) 41 white light plasma blobs located on the flare arcade regions that are observed temporaily, and might be generated by the collision of the sunward magnetic reconnection jet with the flare arcade plasma. Their observational projected heights range from 1.10 to 1.14 solar radii. (2) 32 white light plasma blobs located in the post-CME current sheets that are observed consecutively, propagate outward, and might be formed by the tearing mode instability. Their observational projected heights range from 1.15 to 1.86 solar radii. (3) 8 white light plasma blobs above the tips of post-CME current sheets that are observed consecutively, propagate outward, and might be formed by either the tearing mode instability or loop pinches off at an X-type neutral point. Their observational projected heights range from 1.6 to 2.29 solar radii. Among 8 outward-moving plasma blobs above the tips of post-CME rays, only 2 blobs might be associated with the 2 post-CME blobs in LASCO-C2 FOV and their formation heights are below or near the 1.93 and 1.79 solar radii, respectively. Our results demonstrate that K-Cor observations are very useful to determine the formation heights of post-CME blobs and their kinematics.

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Towards an Improved Combination of Sunspot Areas Databases

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Abstract. Sunspot areas are an important indicator of solar activity used in a wealth of applications. They are useful not only to reconstruct the past behaviour of the Sunś magnetic field but also to help understand the operation of the underlying solar dynamo. Sunspot areas can also be used in solar cycle forecasting, which is important to determine the general conditions of the Sun that might have an impact in space weather.

Different studies reveal that the sunspot size observations made by SOON (Solar Optical Observing Network), differ from those made by other observatories such as RGO (Royal Greenwich Observatory). However, there is no consensus as to the magnitude of this difference. The comparison with more recently available data becomes necessary. In order to have a better understanding of the causes that give rise to these discrepancies, we present the preliminary results of the comparison of the daily and group sunspot size records from SOON with those provided by the Debrecen observatory.

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An Introduction to the International Meridian Circle Program and China-Brazil Joint Laboratory for Space Weather

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Abstract. International Space Weather Meridian Circle Programme (IMCP) is designated to connect 120E and 60W meridian chains of ground-based observatories and enhance the ability of monitoring and studying for space environment worldwide to understand the relationship between spatial weather regional characteristics and global changes.

China-Brazil Joint Laboratory for Space Weather (CBJLSW), as the first step of IMCP, was jointly constructed by National Space Science Center (NSSC), Chinese Academy of Sciences (CAS) and Brazilian National Institute for Space Research (INPE). The CBJLSW is responsible for the space environment exploration and research.

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Thermodynamics of the Inner Solar Corona: A Tomographic Validation Study of the AWSoM Model

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Abstract. To advance the understanding of the physics of the solar corona, magnetohydrodynamic (MHD) three-dimensional (3D) models need to be validated with observations. To that end, differential emission measure tomography (DEMT) provides global 3D maps of the electron density and temperature in the inner corona (1.0-1.25 Rsun). In combination with models of the coronal magnetic field, it allows estimating the energy input flux required at the coronal base to maintain thermodynamically stable coronal structures. Hence, the DEMT analysis can be useful to tune up the modelś Alfven wave amplitudes and dissipation rates. Here, a DEMT validation study of the latest version of the Alfven Wave Solar Model (AWSoM) of the Space Weather Modeling Framework (SWMF) is reported. The analysis is carried out for Carrington rotations selected from the previous solar minimum and the current declining phase of solar cycle 24. The capability of the model to reproduce the tomographic products is discussed, and the need for improvements in the model is evaluated.

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Estimating the Mass of CMEs from the Analysis of EUV Dimmings

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Abstract. The determination of the mass of coronal mass ejections (CMEs) is usually performed using white-light coronagraphic data, by the Thomson scattering formulation. In this work, we propose a new methodology to estimate the mass of CMEs based on the analysis of mass loss from the associated dimming regions in the extreme ultraviolet (EUV) low corona. Our work builds upon the combination of the temporal evolution of the mass of 32 white-light CMEs, with that of the mass evacuated from the associated dimmings. The mass of the CMEs in white-light is determined from COR2 coronagraphic data, while the mass evacuated in the EUV low corona is estimated using a differential emission measured (DEM) technique. The combined white-light and EUV analyses allows the quantification of an empirical function that describes the evolution of CME mass with height. We quantify the success of the method by calculating the relative error with respect to the mass of CMEs determined from white-light STEREO data, where the CMEs propagate close to the plane of sky. The median for the relative error in absolute values is around 30%. The proposed method does not rely on assumptions regarding CME size or distance to the observerś plane of sky and is solely based on the determination of the mass evacuated in the low corona. Therefore, it represents a valuable tool to estimate the mass of Earth-directed events.

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Study of the Variability of Temperature and Ozone in the Lower-middle Stratosphere of the Antarctic Peninsula During Significant Disturbances of AE and Dst Indexes

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Abstract. Geomagnetic storms are caused by solar and interplanetary events that generate disturbances in various regions of the terrestrial space environment; these events can last hours or days. Magnetospheric substorms are episodes of transport and dissipation of energy in the ionosphere and the magnetosphere, in time lapses of the order of 10 minutes to 3 hours, and are much more frequent than geomagnetic storms.

The aim of this work is to study the variability of temperature and ozone partial pressure profiles in the lower-middle stratosphere of the Antarctic region during severe Space Weather events. Vertical profiles of these atmospheric parameters are analysed at the Marambio station (-64.2S, -56.6W), among solar cycles 23 and 24 (1998-2018). The data are obtained by ozone-sounding balloons, and are provided by the National Meteorological Service of Argentina and the Meteorological Institute of Finland.

The spatial and temporal variation of the studied quantities in the stratospheric region is quantified during periods of intense and moderate storms and substorms, defined from the Dst geomagnetic index, which provides a measure of the intensity of the energy contained in the ring current, and the index AE, useful for the analysis of individual substorms, which quantitatively measures the auroral magnetic activity. The results of this study will be useful to better understand the possible impact of Space Weather events on the Antarctic atmosphere.

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EUV Spectral Lines and the Nanoflare Model of Coronal Heating

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Abstract. The mechanism of coronal heating by nanoflares has been proposed to explain a diversity of coronal observations. The theory is based on the idea that coronal loops are formed by unresolved elementary magnetic strands that are stressed by photospheric motions, generating conditions for magnetic reconnection and consequent plasma heating. It is expected that this heating process also produce conspicuous plasma flows along individual strands. We explore some observational consequences of these flows, particularly, their effect on EUV spectral lines, such as broadenings and Doppler shifts. In order to simulate the evolution of a large number of heated strands, in previous works (see e.g., López-Fuentes and Klimchuk, 2016, ApJ, 828, 86) we used the 0D model *Enthalpy Based Thermal Evolution of Loops* (EBTEL, Cargill et al., 2012, ApJ, 752, 161), which is much less demanding numerically than more sophisticated full hydrodynamic models. In this work, we compare the results obtained with this model and with a 1D hydrodynamic code (HYDRAD, Bradshaw et al., 2012, ApJ, 758, 53), by analysing the effect that they have on synthetic spectral lines constructed from the emission produced by individual nanoflares.

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Analysis of Historical Ionospheric Data Taken from Colombia During the Intense Solar Cycle Number 19

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Abstract. In June 1957 the Universidad Javeriana in Bogotá (Colombia) received a C4 Ionosonde aimed at analyzing the behavior of the ionosphere over the city. This study was part of the International Geophysical Year and was carried out continuously for ten years with the sponsorship of the National Bureau of Standards of the United States. The ionospheric soundings were based on pulses that lasted 50 microseconds in frequencies between 1 and 25 MHz every 15 minutes. The results of this study, although performed in Bogotá, were never known by the Colombian scientific community, with the exception of data obtained between 1957 and 1958 and published by Wladimiro Escobar S. J. (1960). The study carried out between 1957 and 1964 is very important because it allowed collecting information about the behavior of the local ionosphere during the maximum and the decline of the solar cycle number 19, the most active since we have records of solar activity at the beginning of the XVII century. The initial results were very interesting since they showed that the sporadic layer in Bogota was 81 kilometers high, a distance much lower than the average of other areas of the Earth that are rarely lower than 100 kilometers. It was also established that the critical frequencies in Bogotá were very high, more than in most stations at that time, due to a higher concentration of ions in the ionosphere. The main objective of this work is to reconstruct the information obtained through the Ionosonde C4 and to deepen in the knowledge that we have about the ionosphere, in particular to study its behavior in moments of great solar activity that will give more inputs on how it would affect communication and GPS systems. Another objective of this research is to look for the data obtained between 1959 and 1964 which are not currently available in Colombia.

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Slip-running Reconnection Signatures in Solar-flare Ribbons

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Abstract. Solar flares are one of the most explosive phenomena in the solar atmosphere. In this work, we study the evolution of the X1.6 class solar flare that occurred in the active region NOAA 12205 on 7 November 2014. We analyze data obtained with satellite instruments and ground-based telescopes (AIA/SDO, HMI/SDO, and the Halpha Solar Telescope for Argentina (HASTA)). We describe the flare evolution in the optical and EUV ranges.

We observe the slipping motions of small kernels located along flare ribbons and we interpret them as a signature of slip-running reconnection occurring at coronal heights. We estimate the velocity of the kernel displacement and compare it with an average coronal Alfvén speed.

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Study of Scaling Laws in Quiet-Sun Coronal Loops

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Abstract. Different theoretical studies of active region (AR) plasmas provide relations between the physical parameters of coronal loops, such as temperature, density, loop length and magnetic field. These relations predict particular scaling laws that can be compared with observations (see Mandrini, Demoulin and Klimchuk 2000, ApJ, 530, 999). This task is specially difficult in the case of quiet-Sun loops, since they are not identifiable in observations. In a series of works in recent years (see the review by Vásquez 2016, AdSpR, 57, 1286), a novel coronal tomography procedure was developed that provides, integrated from EUV observations over a solar rotation, the three-dimensional distribution of the mean temperature and density in the coronal volume between 1.02 and 1.225 solar radii. The tomographic results are combined with magnetic field extrapolations to obtain average temperature and density of the plasma along model field lines. In this work, we study the relation between observed and inferred parameters of quiet-Sun coronal loops to obtain scaling laws. These laws are compared with expected relations according to the most known models of coronal heating.

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On Fine Structures in the Solar Corona

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Abstract. Coronal loops, the enigmatic features of the solar corona, have been a subject of study for decades. It is generally agreed that they are elongated strands of emitting plasma, which are oriented along magnetic field lines. Pretty much everything else about them is subject to intense debate. A number of explanations exist for why loops do not appear to expand with height like magnetic flux tubes do, or why loops appear overdense, and a number of models have been proposed that address the size of individual strands, the plasma composition and temperature, loop heating and cooling, oscillations of associated flux tubes, etc. Many properties of coronal plasma and the coronal magnetic field can be derived from comparing the observations to theoretical models. However, most of the current models have one point in common, their concept of a loop.

It is this concept that, our study shows, might need to be reconsidered.In this work, we study a 3D MHD simulation of the solar corona generated with MURaM code (Rempel 2017). The synthetic Extreme Ultraviolet (EUV) images constructed from this simulation are remarkably realistic. The overall structure and evolution of the synthetic corona was recently shown to reproduce many important aspects of solar observations (Cheung et al, 2018). In particular, the synthetic EUV images contain bundles of realistic coronal loops. We analyze individual loops in these bundles, and attempt to identify features in the volume of the model responsible for generating these loops in the line-of-sight integrated plane-of-sky images. Based on the results of our study, we propose a new explanation for the entire phenomenon of strands seen in the EUV images of the solar corona. The explanation is strongly supported by observations of loops on the Sun, explaining some properties of loops that are challenging to address otherwise. At the same time, this explanation is not in agreement with the current interpretation of individual loops as plasma emission from individual, well-defined and spatially coherent magnetic flux tubes. Our study may lead to substantial changes in how loop observations are interpreted, challenging currently used techniques and models.

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Type-II Kilometric Radio Emissions Driven by CMEs: Associated Interplanetary Structures and Geo-effectiveness

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Abstract. To study which conditions are favorable for a shock to produce detectable kilometric radio emission, and what are the characteristics of this radio burst, we perform a statistical study of type II kilometric radio waves associated with the occurrence of coronal mass ejections (CMEs) and interplanetary shock waves. We analize type II radio emission events occurred between the years 2000 and 2012, using data provided by the Radio and Plasma Wave Investigation (WAVES) on the Wind Spacecraft, supported by the Wind/WAVES Type II Catalog and by the sets of events compiled by Cremades et al. (Space Weather 5, S08001, 2007 and Sol. Phys. 290, 2455, 2015). Wind/WAVES dynamic spectra from the TNR receiver (256 – 4 kHz) are examined in depth to register all kilometric radio emissions. These emissions have not been surveyed before, except those associated with metric radio bursts. For the same time interval, we register the occurrence of all ICMEs and magnetic clouds (MC) from on-line catalogs. For a reduced number of events, for which the radio emission could be unambiguously associated to a CME, CME fundamental properties are determined from white-light coronagraphic data. This work, enables the joint analysis of interplanetary radio data, *in situ* detections, and coronal imaging, to investigate which conditions are most favorable for the production and detection of type II low-frequency emissions. In addition, we consider the indices of magnetic storm intensity Dst and Kp, to investigate the relationships between the geoeffectiveness of an ICME or MC and the characteristics of their associated metric or kilometric type II radio emissions.

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Understanding the Ejective Behavior of an Active Region throughout Five Solar Rotations

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Abstract. On 2010 a long-duration active region emerged and persisted through five months from July until its decay in November. The quadrature situation of the STEREO spacecraft enabled continuous tracking of the region and identification of the coronal mass ejections originating in it. Using data from the STEREO SECCHI instrument suite, as well as from the Atmospheric Imaging Assembly and the Helioseismic and Magnetic Imager instruments onboard the Solar Dynamics Observatory, we investigate the conditions that gave rise to specific periods of ejective activity in this active region. We determine the locations from which mass ejections originated, and measure the ejection's angular widths, speed, and mass. The active region behavior, during front-disk passages, is analyzed by following the spatial distribution and evolution of current density, current helicity, and other parameters extracted from customized HMI-SHARP data. The correlations found between the active region photospheric evolution and periods of intense ejective activity, is encouraging to understand the physical mechanisms at work and to improve space weather forecasting.

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3D Visualization of Solar Data: Preparing for Solar Orbiter and Parker Solar Probe

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Abstract. Solar Orbiter and the recently launched Parker Solar Probe will focus on exploring the linkage between the Sun and the heliosphere. These new missions will collect unique data that will allow us to study, e.g., the coupling between macroscopic physical processes to those on kinetic scales, the generation of solar energetic particles and their propagation into the heliosphere and the origin and acceleration of solar wind plasma. Combined with the several petabytes of data from NASA's Solar Dynamics Observatory, the scientific community will soon have access to multi-dimensional remote-sensing and complex it in situ observations from different vantage points, complemented by petabytes of simulation data. Answering overarching science questions like "How do solar transients drive heliospheric variability and space weather?" will only be possible if the community has the necessary tools at hand. In this contribution, we will present recent progress in vizualising the Sun and its magnetic field in 3D using the open-source JHelioviewer framework, which is part of the ESA/NASA Helioviewer Project.

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A Solar Eclipse Challenge: Predicting the Sun's Large-scale Coronal Structure

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Abstract. The Sun's coronal structure is notoriously difficult to observe except during solar eclipses; thus theoretical models must be relied upon for inferring the underlying magnetic structure of the Sun's outer atmosphere. These models are necessary for understanding the role of magnetic fields in the heating of the corona to a million degrees and generation of severe space weather. We present a methodology for predicting the structure of the coronal field based on model forward-runs of a solar surface flux transport model whose predicted surface field is utilized to extrapolate future coronal magnetic field structures. This prescription was applied to the 21 August 2017 Great American solar eclipse. Post-eclipse analysis shows good agreement between model simulated and observed coronal structures and their locations on the limb. We demonstrate that slow changes in the Sun's surface magnetic field distribution driven by long-term flux emergence and evolution, govern large-scale coronal structures with a (plausibly cycle-phase dependent) dynamical memory timescale on the order of a few solar rotations. Our work opens up the possibility of large-scale, global corona predictions at least a month in advance. Using the same methodology, we shall attempt to predict the coronal structure of the eclipse that will sweep South America on 2 July, 2019 and present the results in the conference "Towards Future Research on Space Weather Drivers" in San Juan, Argentina (if we manage to do this in time).

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Analysis of High-energy Electron Fluxes in the Radiation Belt: *in Situ* Measurements from the Van Allen Probes

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Abstract. It is well known that the electrons population in the outer radiation belt can reach energies larger than several MeVs. In certain occasions, for example during magnetospheric storms, the flux of these particles present large time-space variability. It is crucial to study and understand these events, mainly due to their impact on technologies and human activities in space. With this information the satellite design teams will be able to develop technologies in order to preserve the integrity of such valuable devices.

The purpose of this work is to characterize the electron population in the outer radiation belt, for energies ranging from 1.6 to 18.9 MeV, by analysing the measurements made by the Relativistic Electron-Proton Telescope (REPT) instrument on-board the Van Allen probes, launched into orbit in August 2012. These probes have a highly elliptical orbit, with a perigee of 618 km and an apogee of 30414 km, making them cover a wide range of distances in the Earth environment, from the inner to the outer radiation belt.

In particular, we study the behaviour of the electron flux in the outer radiation belt during several strong geomagnetic storms and compare them with several geospheric properties (e.g., interplanetary, geomagnetic and ionospheric conditions).

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Deciphering the Internal Magnetic Field Structure of Earth-directed ICMEs

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Abstract. The magnetic field configurations associated with interplanetary coronal mass ejections (ICMEs) are the *in situ* manifestations of the entrained magnetic structure associated with the coronal mass ejections (CMEs). The prediction of such configurations is essential to Space Weather in order to forecast any resulting geomagnetic disturbances. The main hypothesis in such predictions is to assume that such structure is a flux rope. We present a comprehensive study of the internal magnetic field configurations of ICMEs observed at 1 AU in the period 1995-2015 in order to unravel the internal magnetic structure associated with the CMEs and establish under what signatures a flux rope model is valid. In the first part of the presentation, we examine the expected magnetic field configurations by simulating various spacecraft trajectories within an ICME. This simulation is based on the assumption of a flux rope with the simplest flux rope geometry, i.e. circular-cylindrical helical magnetic field configuration. In the second part of the paper, we reconstruct the flux ropes by using the technique described on Nieves-Chinchilla et al. 2016. We examine the orientation and geometrical properties during the solar activity levels at the end of solar cycle 22, solar cycle 23 and part of solar cycle 24.

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Modeling the Magnetic Field in Active Regions: LFFF *versus* NLFFF

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Abstract. The knowledge of the three-dimensional coronal magnetic field ($\mathbf{B}$) at high-resolution is key to better understand the physical mechanisms that trigger eruptive phenomena in the inner corona, the ultimate drivers of space weather conditions. High-resolution, direct coronal measurements of $\mathbf{B}$ are not available, so we must rely on suitable coronal field models based on the available photospheric field measurements (magnetograms). For active region's (ARs) field, where $\beta \ll 1$, the force-free regime ($\nabla \times \mathbf{B} = \alpha\mathbf{B}$) is the simplest approximation. If α is taken to be constant across field lines, then the model field is called a linear force-free field (LFFF), while if α depends on position, then the model field is a non-linear force free field (NLFFF). While LFFF models are fully determined by the line-of-sight magnetograms as boundary condition, NLFFF models require information from the full vector magnetogram. In ARs with a high degree of non-potentiality, currents are observed to be concentrated in limited region of coronal space. The observational determination of α using vector magnetograms confirms that this quantity is not constant in complex ARs. In such cases, large variations of α are expected that cannot be accomodated for by LFFF models. In this work we test and compare specific numerical implementations of both LFFF and NLFFF models applied to two ARs exhibiting different levels of non-potentiality. We first compare the small-scale and the large-scale structure of the field, using observed coronal loops as proxies for the field-line tracing. Then, we compare the amount of magnetic free energy and helicity obtained with both models for the same integration box, and discuss the implications of our results for the determination of the characteristics of active phenomena with impact on Space Weather conditions. We also analyze the convenience of using one method over the other for different applications.

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Arecibo Observatory Solar/Heliospheric Program (AO-SOL): Status and First Results

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Abstract. The Arecibo Observatory (AO) has served the scientific community since 1963 by providing high-quality space data and enabling important discoveries, mainly in the areas of Radio Astronomy, Planetary Radar and Aeronomy. After 55 years and recent upgrades and repairs (related to hurricanes), the aforementioned areas constitute the 3 consolidated AO Science Divisions. Science studies currently make use of the big cluster of active and passive instruments, including the 305m famous single dish the world's most sensitive Incoherent Scattering Radar (ISR), most powerful planetary radar and one of the largest aperture radio-telescope in operation.

A new program has been created in 2018: the Arecibo Observatory SOLar/heliospheric Program (AO-SOL) to extend the utility of the facility with new work that aims to (a) explore the full potential of the AO technical capability, (b) promote internal cross-disciplinary studies, (c) expand the team of external collaborators/users and (d) strengthen the connection with the Latin-American and Puerto Rican academic/scientific communities. Although a few experiments were performed individually at the AO in the past (like solar active and passive radio observations and measurements of the Interplanetary Scintillation caused by solar wind fluctuations) this is the first time in the history of AO that an internal effort is being made to establish a permanent solar/heliospheric program that can be integrated with the international solar/helio-community. Here, we present the status of the new AO-SOL program and discuss its first science results and the new collaborative opportunities for science, education and public outreach associated with it.

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Onboard Automated CME Detection Algorithm for the Visible Emission Line Coronagraph on ADITYA-L1

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Abstract. ADITYA-L1 is India's first space mission to study the Sun from the Lagrange 1 position. The Visible Emission Line Coronagraph (VELC) is one of seven payloads on the ADITYA-L1 mission, which is scheduled to be launched around 2020. One of the primary objectives of the VELC is to study the dynamics of coronal mass ejections (CMEs) in the inner corona. This will be accomplished by taking high-resolution ($\approx$2.51 arcsecpixel^{-1}) images of the corona from 1.05 $R_\odot$–3 $R_\odot$ at a high cadence of 1 s in the 10 Åpassband centered at 5000 Å. Because telemetry at the Lagrangian 1 position is limited, we plan to implement an onboard automated CME detection algorithm. The detection algorithm is based on intensity thresholding followed by area thresholding in successive difference images that are spatially rebinned to improve the signal-to-noise ratio. We present the results of the application of this algorithm on the data from existing coronagraphs such as STEREO/SECCHI COR-1, which is a space-based coronagraph, and K-Cor, a ground-based coronagraph, because they have a field of view (FOV) that is most similar to that of VELC. Since no existing space-based coronagraph has a FOV similar to VELC, we have created synthetic coronal images for the VELC FOV after including photon noise and injected CMEs of different types. The performance of the CME detection algorithm was tested on these images. We found that for VELC images, the telemetry can be reduced by a factor of 85% or more while maintaining a CME detection rate of 70% or higher at the same time. Finally, we discuss the advantages and disadvantages of this algorithm. The application of such an onboard algorithm in future will enable us to take higher resolution images with an improved cadence from space and simultaneously reduce the load on limited telemetry. This will help understanding CMEs better by studying their characteristics with improved spatial and temporal resolution.

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Improving Atomic Models to Improve the Synthetic Spectral Irradiance in the Sun and Stars

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Abstract. In this work I present the current progress on the study of the NUV region spectral lines. Atomic models are essential to compute the populations in full NLTE. In this case, it is tested how changes in the atomic model of neutral magnesium influences the formation of different important lines in the NUV region, in the Sun and in different stars. Given the relevance of the spectral features formed by Mg I in the stellar spectrum of late type stars, and because there is a need to improve the Mg I atomic model mainly in the NUV range (e.g. 285.2 nm inverted line), the populations and the spectra of 52 species were recalculated using the Solar-Stellar Radiation Physical Modeling (SSRPM) code using different atomic models for Mg I. Then we compared the numerical results in the populations and the effects in the synthetic spectra. The main goal is to improve the modelling of the atmosphere of the Sun and stars with planets, in order to obtain more reliable synthetic spectra compared to observations. As it is known, if the atmospheric model is physically consistent, this often open the possibility to infer physical properties impossible to obtain from observations.

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Computing the Tilt Angle of Solar Active Regions

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Abstract. The tilt angle of an active region (AR) is defined as the acute angle between the segment that joints the magnetic barycenters of the main AR polarities and E-W solar direction. Current methods to estimate the tilt angle rely on the magnetic flux distribution of the AR obtained from line-of-sight (LOS) magnetograms. However, the LOS projection of magnetic field in twisted emerging structures forming ARs produces an elongation of the magnetic polarities known as magnetic tongues. In Poisson et al. (2016, Solar Phys., 291, 1625-1646) we have shown that magnetic tongues affect the photospheric field distribution in LOS magnetograms and, consequently, impact on the determination of the tilt angle. As a first approach, we use a simple flux emergence model to test a method to isolate and remove the flux associated with the tongues from the tilt angle estimation. Then, with our experience gained from the model, we develop a new procedure to determine the tilt angle of solar ARs. We apply this method to 150 ARs observed by the Michelson Doppler Imager. We compute the evolution of the corrected tilt during the emergence the ARs and we quantify the effect of the magnetic tongues in the determination of the tilt. Finally, using this method we correct the mean size of the ARs and we estimate the intrinsic rotation of the emerging bipoles. Knowledge of an AR intrinsic rotation can be a good proxy for the free magnetic energy stored during the AR emergence.

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20 Years of ACE Data: How Superposed Epoch Analyses Reveal Generic Features in Interplanetary CME Profiles

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Abstract. Interplanetary Coronal Mass Ejections (ICMEs) result from solar flares occuring in our star's atmosphere. These large-scale magnetised structures propagate in the interplanetary medium where they can be probed by spacecraft. Depending on their speed, ICMEs may accumulate enough solar wind plasma to form a turbulent sheath ahead of them. They therefore consist of two main substructures, a sheath and a magnetic ejecta (ME), with the magnetic ejecta being the main body of an ICME where the magnetic field intensity is larger, and its variance smaller, than that of the ambient solar wind. We present a statistical study using the superposed epoch analysis technique, of a little less than 300 ICME parameter profiles (the magnetic field intensity, the speed, temperature, etc.) seen at 1 AU by the ACE spacecraft. In particular, we investigate different possible classifications of ICMEs, for example based on their speeds, when they are detected during the solar cycle, the detection of a magnetic clouds (MCs, a subset of ME with a clear rotation of the magnetic field as well as a low plasma temperature compared with the solar wind), and finally the distance of the spacecraft from the ICMEs main axis. We find that slow ICMEs have a more symmetric profile than fast ICMEs, therefore generalising the work made on a sample of 44 ICMEs with clearly identified magnetic clouds by Masias-Meza et al. (2016). We also find that ICMEs ejected during the maximum of the solar cycle are also more asymmetric and faster than their solar-minimum counterpart. . This analysis provides a better understanding of the interplay between the solar wind and ICMEs, in particular on the relaxation process taking place for slow/slowed-down ICMEs compared with fast ICMEs. Furthermore, the superposed epoch analysis on ICMEs with no clear-detection of MCs show similar tendencies for all the parameters expected for the magnetic profiles as those with an identified MC, suggesting that ICMEs with no detected MCs are either probed further away from the core of the MC, or with a strongly degraded MC.

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Using a Simple Algorithm Based on CME Speed and Direction and Observations of Associated Solar Phenomena to Predict Solar Energetic Particle Event Peak Proton Intensity (SEPSTER)

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Abstract. We assess whether a formula obtained by Richardson et al. (2014, https://doi.org/10.1007-/s11207-014-0524-8) relating the peak intensity of 14- to 24-MeV protons in a solar energetic particle (SEP) event at 1 AU to the solar event location and the speed of the associated coronal mass ejection (CME) may be used in a scheme to predict the intensity of an SEP event at any location at this heliocentric distance. Starting with all 334 CMEs in the CCMC/SWRC DONKI database in October 2011 to July 2012, we use the CME speed and direction to predict the proton intensity at Earth and the two Solar Terrestrial Relations Observatory spacecraft using this formula. Since most (≈85%) of these CMEs were not in fact associated with SEP events, many SEP events are predicted that are not actually observed. Such cases may be reduced by considering whether type II or type III radio emissions accompany the CMEs, or by selecting faster, wider CMEs. This method is also applied to predict the SEP intensities associated with ≈100 CMEs observed by the LASCO Coronagraph during 19972006 in solar cycle 23. Various skill scores are calculated. We conclude that the Richardson et al. (2014) formula has potential as a simple empirical SEP intensity prediction tool which we call SEPSTER- SEP predictions based on STeReO observations.

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Solar Observations in H-Alpha (6562.8A) and CaII-K to be Used in a Space Weather Context

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Abstract. In the early 2015 year, the Laboratory of GeoSpatial Sciences (Laboratorio de Ciencias GeoEspaciales, LACIGE, www.lacige.unam.mx) was created belonging to the National School of Higher Studies (Escuela Nacional de Estudios Superiores, ENES), UNAM Morelia, México. This Laboratory also has an observatory dedicated to solar and space weather studies. The main motivation to have in México an observatory like this is to monitor daily the Sun for three main reasons: a) to conduct research on solar activity through H-alpha (6562.8 A) and CaII-k images, b) to monitor this activity daily by generating images of the Sun that allow to make own reports, and c) to give support for the teaching and training of bachelors degree in Geosciences and graduate students in Earth Sciences (Space Physics), both cases belonging to UNAM. In this way, our interest is to generate scientific products for our country and establish collaboration with other countries in this context. In addition, the LACIGE has a direct collaboration with the National Laboratory of Space Weather (LANCE, www.lance.unam.mx), also in UNAM Morelia. The LANCE is the academic instance in our country responsible for studying space weather together with the Autonomous University of Nuevo Leon (UANL). In this work, we will present advances particularly focused on solar images obtained from the Solar Observatory of ENES-UNAM Morelia, as well as advances on making of a solar images catalog for the use in Space Weather in México. As a complementary information, we will present a quantitative analysis to characterize scales or sizes for structures observed in that images.

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Simulated Deflections of the CMEs

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Abstract. Coronal mass ejections are eruptive events in which large amounts of solar mass are released into the interplanetary medium. If the CME travels to Earth, the plasma particles cross our magnetosphere and generate significant geomagnetic storms. These storms are capable of causing disruptions in global communication and navigation networks, or satellite failures or commercial energy systems, so these types of events are of great interest.

It is known that not all CMEs evolve radially and the deviations are mainly attributed to the distribution of magnetic energy surrounding the coronal mass ejection formation area. For this reason, to study the cases in which a deviation occurs, it is necessary to characterize the coronal environment during the first evolutionary stages of the ejection.

In the present work, we show preliminary results of the numerical analysis of several simulated magnetic scenarios where a deviation of a CME can occur.

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Predicting Extreme Flare Events Using Lu & Hamilton Avalanche Model

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Abstract. Solar flares are the most powerful events in the solar atmosphere, releasing a huge amount of energy in a few minutes. Any progress in the direction of predicting when a flare of a big magnitude will occur is extremely important to evaluate the risk related to space weather.

The Lu & Hamilton SOC model for solar flares is the most conspicuous amongst the several avalanche model for flares that have been developed in the last 30 years. It has been very succesful in reproducing some of the characterisc features of observed flares (e.g., probability density function of flares energy) and in the last years have been explored as a way of predicting extreme flaring events.

In this work we will study the predicting capabilities of Lu & Hamilton model by assesing the proximity to stability the 2D lattice and will investigate the importance of lattice configuration in the generation of extreme avalanches.

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Sun to Earth MHD Simulation of a Gibson-Low Flux Rope Based CME Constrained by Observations

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Abstract. We use a data-constrained Gibson-Low (GL) flux-rope model to simulate a coronal mass ejection (CME) using Multi Scale Fluid Kinetic Simulation Suite (MS-FLUKSS). This CME is propagated through a realistic solar wind background modeled by our data-driven magnetohydrodynamics (MHD) model for corona and inner heliosphere. We propose a method to constrain GL parameters to match speed and poloidal flux of the simulated CME with the observations. Poloidal flux in the observed CME is estimated from reconnected flux in its post eruption arcade. De-projected speed, direction and tilt of the CME are found using multiple viewpoints of STEREO A & B and SOHO white light coronagraphs by the Graduated Cylindrical Shell (GCS) method. The CME is simulated till 1 AU and the arrival time is compared with the observations. We compare the CME properties such as magnetic field, speed and density observed by the ACE spacecraft with our simulated CME. We show how data constrained flux rope CME models can be used as a tool for space weather prediction.

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On the Eruptiveness of Major Solar Flares

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Abstract. Major solar flares are often, but not always accompanied by coronal mass ejections (CMEs). The cause and consequence are not completely understood. Here, using a moderate active region (AR) sample hosting major flares of Cycle 24, we study the correlation between AR surface magnetic features and their association with CMEs (eruptiveness). Contrary to our earlier hypothesis, none of the investigated features or their combinations serves as an effective discriminator between flares with and with out CMEs. Further, the post-flare surface field changes (magnetic imprints) in these two classes are not distinctively different, either. We discuss the behavior of a previously discovered AR "main sequence", the role of electric-current neutralization, and the implication on space weather prediction.

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Effects of Energetic Particles on the Global Atmospheric Electric Circuit

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Abstract. Events of energetic particles are potential candidates to affect the Global Atmospheric Electric Circuit. This is supported by theoretical models proposing that these events can modify the atmospheric conductivity profile above thunderstorms. If very strong events occur, they are able to change the atmospheric conductivity at low altitudes. These effects can be studied through measurements of the atmospheric electric field (AEF) in fair weather regions. In this work, we investigate the AEF daily curve departures from the monthly curve during solar proton events and Forbush decrease applying the superposed epoch analysis. AEF data corresponds to the period between January 2010 - December 2017, and were recorded at Complejo Astronomico El Leoncito (CASLEO) at 2550 masl. The results show possible ionization effects in regions of disturbed and fair weather regions, which alters the global electric circuit.

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Some Remarks about the Observed Solar Abundances

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Abstract. The present determination of the solar abundances, obtained by using 3D simulations of the solar convective zone, leads to values that are not compatible with helioseismology. In this poster, I will discuss the present situation for the solar abundance problem.

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Solar Cycle Variation of the Heliospheric Plasma Sheet Thickness

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Abstract. Past independent studies of the heliospheric plasma sheet (HPS) have shown that the thickness is highly variable, ranging from 3.8×10^5 to 8.9×10^6 km. Here we conduct a survey of the previous results and found a solar cycle dependence where the width of the HPS tends to be wider during solar minimum years and narrower during solar maximum years. The HPS is thicker near solar minimum than near solar maximum by a factor of 1.6 (in solar cycle 23) 8 (in solar cycle 24). We also found that the averaged HPS thickness in 2007 (near minimum of solar cycle 23/24) was almost ten times larger than that in 1995 (near minimum of solar cycle 22/23), and was associated with a weak polar magnetic field in 2007. Based on the solar surface field measurements, we found that the average solar magnetic field strength ($|B|$) at 2.5 solar radii (Rs) were ∼40% larger in 1995 than in 2007 (0.22 gauss vs 0.16 gauss). We also found a larger (∼27%) magnetic gradient force in 1995 than in 2007. Because this gradient force points toward the equator in a low-beta coronal plasma (which is also probably true outward of the Sun), a wider HPS is expected to occur in 2007 than in 1995, at least close to the Sun. This result supports the so-called heliospheric plasma sheet inflation hypothesis i.e. the HPS is wider if Suns polar field is weaker, and narrower if Suns polar field is stronger.

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Development of Coronal Integral Field Spectrograph (CIFS)

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Abstract. Various observations have been done to measure the density of the solar K-corona in decades, but no other physical parameters. CODEX ([1]) plans to measure temperature and velocity of the electron of the K-corona using the filter ratio in UV wavelengths, suggested by Dr.Cram. The Cram method is based on the characteristics of the spectra variation caused by electron temperature and velocity. The range of the maximum variation of the spectra is located UV, however, spectra variation is also expected in 550nm range. Coronal Integral Field Spectrograph (CIFS) records the spectrum of the corona using a 20x20 microlenslet and a grism. CIFS is specialized for the total solar eclipse, because it measures the spectrum for 2D image plane at an exposure. We plan to test the CIFS in the 2019 total solar eclipse, and the completed CIFS will be used in 2020 total solar eclipse.

[1] KASI-NASA joint project developing the coronagraph . The coronagraph plan to be installed at International Space Station at the end of 2021.

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Moreton Waves and Flux Rope Winking Intensity

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Abstract. Moreton waves are uncommon large-scale propagating perturbations at solar chromospheric level, travelling distances of ≈500 Mm with speeds in the range of [500 – 2000]km/s. After the occurrence of a Moreton event, some observations have reported great intensity oscillations emitted by surrounding flux ropes (Francile et al. 2013, A&A 552, A3); also, observations have suggested this flux rope wink is coincident with the passage of a Moreton wavefront not detectable at coronal heights. In a previous work, we have examined the capability of a CME to drive a Moreton event by means of an unstable initial flux rope magnetic configuration (Krause et al. 2018, MNRAS 474); now we study whether surrounding flux ropes variable intensities are compatible with perturbations exerted by a Moreton wavefront passage, and whether this oscillating emissions are either caused by the flux rope oscillatory motions or by changes in their internal plasma-parameters. By means of 2D MHD simulations considering the chromosphere and a stratified corona, we model an initial pseudo-equilibrium flux rope magnetic configuration, where observationally constrained different plasma-parameters' values and Moreton wavefront are analysed. The obtained results and comparison with observations are presented.

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