SWWT Topical Group "Drivers of Space Weather" Subgroup "Solar Storms"

Nicole Vilmer
LESIA
Paris Observatory
Olga E. Malandraki
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Restructuring of the

SWWT TWG “Fundamental Research:

Spokesperson
Henrik Lundstedt
(Swedish Institute of Space Physics)”

To:

SWWT TWG
'Drivers of Space Weather
(e.g. solar, Solar-Terrestrial, including future missions and instrumentation)'

Subgroup 1: Solar Magnetic Energy

Spokesperson:
Henrik Lundstedt
(IRF)

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

Spokespersons:
Nicole Vilmer (Paris Observatory)
&
Olga E. Malandraki (NOA)

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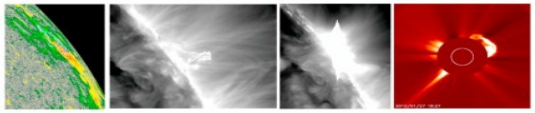
SWWT Topical Group "Drivers of Space Weather", Subgroup "Solar Magnetic Energy"

Submitted by Stijn Calders on Wed, 05/23/2012 - 09:23.

Solar storms (Solar Flares, CMEs, SEP Events) are a result of a conversion of stored magnetic energy. Stretching, twisting and folding of the magnetic field increase the energy.

Solar Storm 27 January, 2012



SDO HMI/AIA 193 and SOHO LASCO C2

Mission Statement

The main objectives of the subgroup are:

- Develop a collaboration between solar physicists and mathematicians on applying topology for better understanding solar storms.
- Define generally a solar storm (magnetic energy conversion) topologically. Investigate limits of intensity.
- Study the relationship between solar storms (and global) and the solar dynamo topologically.
- Compare observations of historical extreme solar storm events with most recent observations by e.g. Solar Dynamics Observatory (SDO).

Composition

Spokesperson:
Henrik Lundstedt
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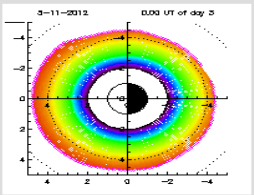
223 70 Lund
Sweden
E.mail: henrik@lund.irf.se
http://www.lund.irf.se/henrik/

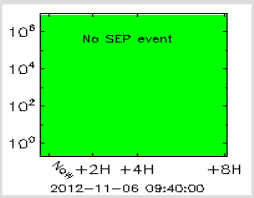
News

A workshop on "Solar Magnetic Activity and Topology" is planned for May/June, 2014 in Lund, Sweden.

Plasmasphere density



SEP event forecast



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Subgroup 1: Solar Magnetic Energy

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SWWT Topical Group "Drivers of Space Weather" Subgroup "Solar Storms"

Submitted by Stijn Calders on Wed, 05/23/2012 - 15:32.

Solar flares & CMEs and geomagnetic activity

Solar flares are the most powerful explosions in the solar system. Radiation and particles emitted during flares may strongly interact with the Earth's ionosphere. The monitoring of the extreme and far ultraviolet irradiance variations is essential to characterize the Earth's upper atmosphere. The impact of flares on the Earth's atmosphere is still a field under development.

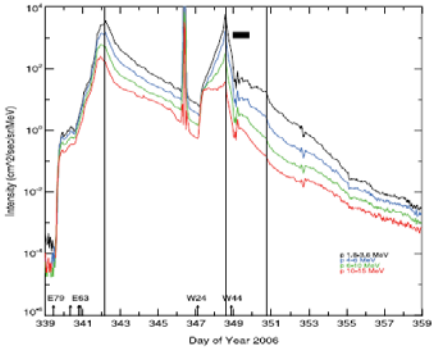
The main drivers of geomagnetic storms at Earth are Coronal mass ejections associated with solar flares or solar filament eruptions and co-rotating regions formed by the interaction between two solar wind streams which produce recurrent storms.

The coronal mass ejections (CMEs) and their interplanetary counterparts (ICMEs) are the main sources of the interplanetary transient events and shocks that produce the strongest geomagnetic storms. To be able to forecast the arrival of these magnetic structures at the Earth, it is necessary to develop tools to investigate their origin and onset at the solar atmosphere as well as their further propagation in the interplanetary medium and subsequent interaction with the Earth's magnetosphere. Space-borne observations as well as numerical simulations are needed to significantly enhance our knowledge about the onset of flares/CMEs, their 3D structure and impact on the Earth's magnetosphere. Understanding the solar wind-magnetosphere-ionosphere coupling through modeling, simulations and data analysis is also crucial to understand the development of the geomagnetic activity.

The Solar Storms Topical sub-group is a forum of discussion and exchange of ideas to enhance the understanding of the triggering of flares and CMEs at the Sun, the further propagation of CMEs in the interplanetary medium and their impact on the Earth's magnetosphere. The sub-group also deals with critical aspects of modeling and forecasting of geomagnetic activity.

Solar Energetic Particle (SEP) events

SEP events form one of the key elements of Space Weather. SEPs are accelerated either by the magnetic energy released in solar flares or by shock waves driven by Coronal Mass Ejections (CMEs). A long-standing debate within the solar and heliospheric community concerns the relative roles that flares and CMEs play in the acceleration and release of SEPs. SEP events are much more frequent during the active phase of a solar cycle. The maximum energy reached in SEP events is typically 10-100 MeV, although CME-driven shocks can accelerate particles up to 20 GeV. Large Solar Proton events (SPEs), which constitute a sub-group of SEPs, are extremely hazardous to astronauts outside the Earth's atmosphere and magnetosphere. To mitigate the hazard SPEs pose, it is necessary to develop the capability to predict when and where they will occur on the Sun, and to provide adequate shielding from them.



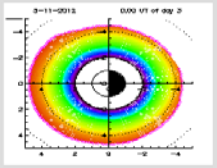
The SEP events in December 2006 as observed by the IMPACT/LET instrument onboard the STEREO-B spacecraft. Upward vertical arrows indicate the intense flares that occurred during this period. Vertical solid lines denote the passage of shocks. (Adapted from Malandraki et al. 2009, Astrophys. J., 704, 469, 2009).

The Solar Storms Topical sub-group is a forum of discussion and exchange of ideas to enhance the understanding of the particle acceleration and transport processes at the Sun and in the inner heliosphere that lead to SEP events. The sub-group also deals with critical aspects of modeling and forecasting of SEP events.

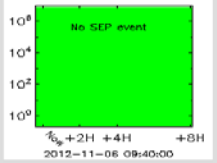
Composition

Spokesperson:
Nicole Vilmer (Solar Flares/ CMEs)
Olga Malandraki (SEP events)

Plasmasphere density



SEP event forecast



[Add your forecast]

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http://spaceweather.eu/swwt/solarstorms

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

Splinter - Solar Storms: Solar Energetic Particle (SEP) events

O. Malandraki (NOA)

Thursday, Nov 8, 14:00-16:00

This splinter meeting will cover topics that fit in the SWWT Topical Working Group *Drivers of Space Weather*, Subgroup 2 *Solar Storms*. The emphasis of this Splinter will be on Solar Energetic Particle (SEP) events which are the key element of Space Weather. During the splinter, recent advancesin the understanding of the particle acceleration and transport processes at the Sun and in the inner heliosphere that lead to SEP events will be presented and discussed, also in terms of the relative toles of flares and CMEs in the acceleration and release of the SEPs. Advances on the modeling and forecasting of SEP events, mitigation strategies as well as results on these issues of current relevant FP7 projects will be highlighted during this splinter. Participants are welcome to present their data and analysis of particular aspects on SEP events that is of interest for them. Please contact Dr. Olga Malandraki, omaland at astro.noa.gr, spokesperson, subgroup 2.

Organization of a splinter session at ESSW9

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

'Open Questions' in the SEP field

- **What is the origin of SEPs?**

- **Long-standing debate within the solar-heliospheric community:**

What are the relative roles that flares and CME-driven shocks play in the acceleration and release of SEPs?

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

'Open Questions' in the SEP field *(cntd.)*

- **Modeling of SEP events: What are the acceleration and transport processes in the inner heliosphere that lead to SEPs?**

- **Forecasting SPEs (Solar Proton Events): When and where will they occur at the Sun? (critical for the mitigation of hazardous SPEs)**

Invited Short Presentations (+ Discussion)

- Rami Vainio for the SEPServer Consortium, UH
  SEPServer - A tool for solar energetic particle research

- Karl-Ludwig Klein, LESIA, Observatoire de Paris
  The origin of solar energetic particle events – evidence from joint observations of SEP and radiative signatures

Invited Short Presentations (+ Discussion) *cntd.*

- Norma Crosby, BIRA-IASB, Belgium
  COMESEP: the SEP side of the Project
- Marlon Nunez, Universidad de Málaga, Spain
  New functionalities and improvements of the UMASEP forecaster
- Olga Malandraki, National Observatory of Athens (NOA) ***Initial Fe/O enhancements in Large, Gradual, SEP events: Observations from Wind and Ulysses***

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

Splinter Main Conclusions

'Open Questions' in the SEP field

- What is the origin of SEPs?
- What are the relative roles that flares and CME-driven shocks play in the acceleration and release of SEPs?

KLK: Findings suggest that flare-accelerated particles are bound to contribute to large SEP events when the s/c is magnetically connected to the parent active region. But also observed at several tens of heliocentric deg away from it in longitude due to the super-radial expansion of open magnetic field lines from ARs. Transient IMF configurations may also play an important role.

OM: Given that initial Fe/O enhancements are seen at widely-separated s/c even when one or both is not magnetically well-connected to the flare site it is likely that the initial Fe/O enhancement is generally a transport effect. Future Fe charge state measurements could be used to address the issue of a direct flare contribution component.

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

'Open Questions' in the SEP field *(cntd.)*

➢ **Modeling of SEP events: What are the acceleration and transport processes in the inner heliosphere that lead to SEPs?**

RV: Comprehensive coverage of data on solar energetic particles (SEPs) and related electromagnetic (EM) observations has been ingested in a database, to be released to the community in 2013

New analysis methods, based on simulations of charged-particle transport, have been developed and will be released to the community together with the data

SEPServer has performed a systematic scan of the SEP events of the 23rd solar cycle and provides catalogues of the major SEP events of that time period

Analysis on the early development of more than a hundred SEP events and detailed analyses of a selected events have been performed

Data analysis efforts have shown the potential of SEPServer to be the tool of choice of the SEP research community to tackle the problems of energetic solar eruptions also in the aftermath of the project

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

➢ Modeling of SEP events: What are the acceleration and transport processes in the inner heliosphere that lead to SEPs?

NC: (COMESEP, SEPs) Particle confinement mechanisms occurring in individual flux tubes were investigated to understand the conditions that enhance the duration of high-energy proton intensities in different magnetic topologies. (Tan et al., 2012)

Consistency of Path Lengths Traveled by Solar Electrons and Ions in Ground-Level Enhancement Events

A test particle model for the study of SEP propagation from the Sun to e.g. near-Earth regions was developed

- Allows diffusion of particles across the magnetic field to be taken into account
- Easily enables one to study different types of interplanetary turbulence and their effect on the particle profiles.

Subgroup 2: Solar Storms (Solar Flares, CMEs, SEP events)

- **Forecasting SPEs (Solar Proton Events): When and where will they occur at the Sun? (critical for the mitigation of hazardous SPEs)**

NC: COMESEP: An operational "*European Space Weather Alert system*" to forecast SEP radiation storms and magnetic storms will be established.

The alerts and forecasts will be disseminated to the space weather vulnerable industries and other users using existing media on European and national level thereby complementing the ESA Space Situational Awareness space weather observational programme

MN: New UMASEP version 1.1. in August 2012 available.

It is yielding satisfactory results in terms of the probability of detection (POD) and False Alarm Ratio (FAR) taking into account solar data from 1986 and presents additional inferences about the forecasted situation (e.g. energy range of protons involved in the forecast) . UMASEP 1.1 is now able to predict a well-connected SEP event during another particle storm

ESSW10

Proposal of a splinter:

- Solar Storms: Flares, CMEs and Solar Energetic Particle (SEP) events

This splinter meeting will cover topics from the SWWT Topical Working Group Drivers of Space Weather, Subgroup 2 SolarStorms.

(spokespersons: N. Vilmer (LESIA, Paris Observatory) and O. Malandraki (NOA) During the splinter, recent advances in the understanding of

1- particle acceleration and transport processes at the Sun and in the inner heliosphere that lead to SEP events will be presented and discussed. The presentation from results from relevant FP7 projects will be highlighted during the splinter.

2- the onset of CMES, propagation in the interplanetary medium and subsequent interactions with the Earth's magnetosphere. The splinter will address both results from observations and from numerical simulations. Presentation from relevant FP7 projects will also be highlighted.

3- the impact of flares (UV radiation, particles) on the Earth’s atmosphere which is still a field under development.

Expected number of participants: 50