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Project ROSMIC

Article 1:

Introducing the NCAR Whole Atmosphere Community Climate Model with Thermosphere and Ionosphere Extension (WACCM-X 2.0)

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The Whole Atmosphere Community Climate Model with Thermosphere and Ionosphere Extension (WACCM-X) is a general circulation model (GCM) that

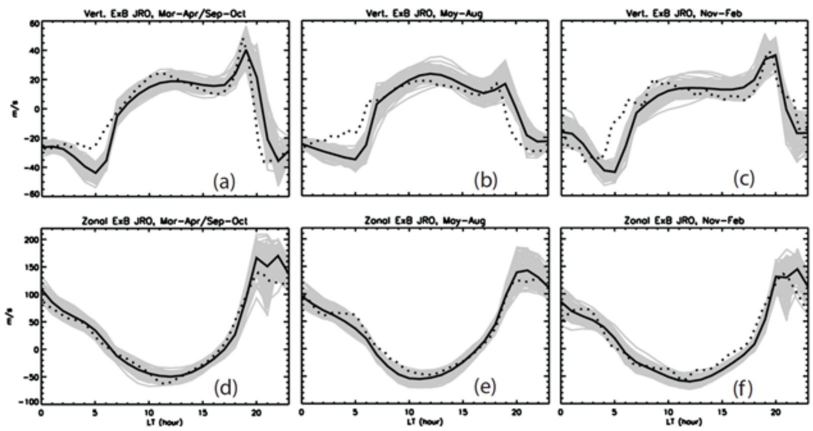

Figure 1. Vertical (a-c) and zonal (d-f) components of ExB drifts for the time periods of equinoxes (March-April and September-October), southern winter (May-August), and northern winter (November-February), respectively. Black/grey lines: average/daily model values over the respective time periods at 12.3°S/77.5°W and ~380 km. Dotted lines: climatological drift values obtained from Jicamarca Radio Observatory observations (Fejer et al., 1991). F10.7: 200 sfu for model simulations; 194, 174 and 168 sfu for JRO equinoctial, winter and summer observations, respectively [H.-L. Liu et al., 2018].

spans from the Earth's surface to the exobase. The main scientific goals of WACCM-X are to study the solar impacts on the Earth atmosphere system and to understand and quantify coupling processes between atmospheric layers on different temporal and spatial scales. Several key developments have recently been made to the model, including the self-consistent solution of ionospheric electrodynamics and F region O+ transport. Other ionosphere developments include time-dependent solution of electron/ion temperatures, metastable O+ chemistry, and high -cadence solar EUV capability. Additional developments of the thermospheric components are improvements to the momentum and energy equation solvers to account for variable mean molecular mass and specific heat, a new divergence damping scheme, and cooling by $O(^3P)$ fine structure. This new version of the model (WACCM-X 2.0) is described in a recent paper [H.-L. Liu et al., 2018]. Model results have been examined and compared with thermospheric and ionospheric observations under different solar conditions [H.-L. Liu et al., 2018; J. Liu et al., 2018], and general agreements have been found. For example, Figure 1 shows that the simulated ExB drifts in the equatorial region are in good agreement with the climatology from drift measurements made at Jicamarca Radio Observatory [Fejer et al, 1991]. The longitudinal and seasonal variations of the pre-reversal enhancement (PRE) from the model simulations also show good agreement with satellite observations, and the daily results of PRE reveal strong day-to-day variability (Figure 2).

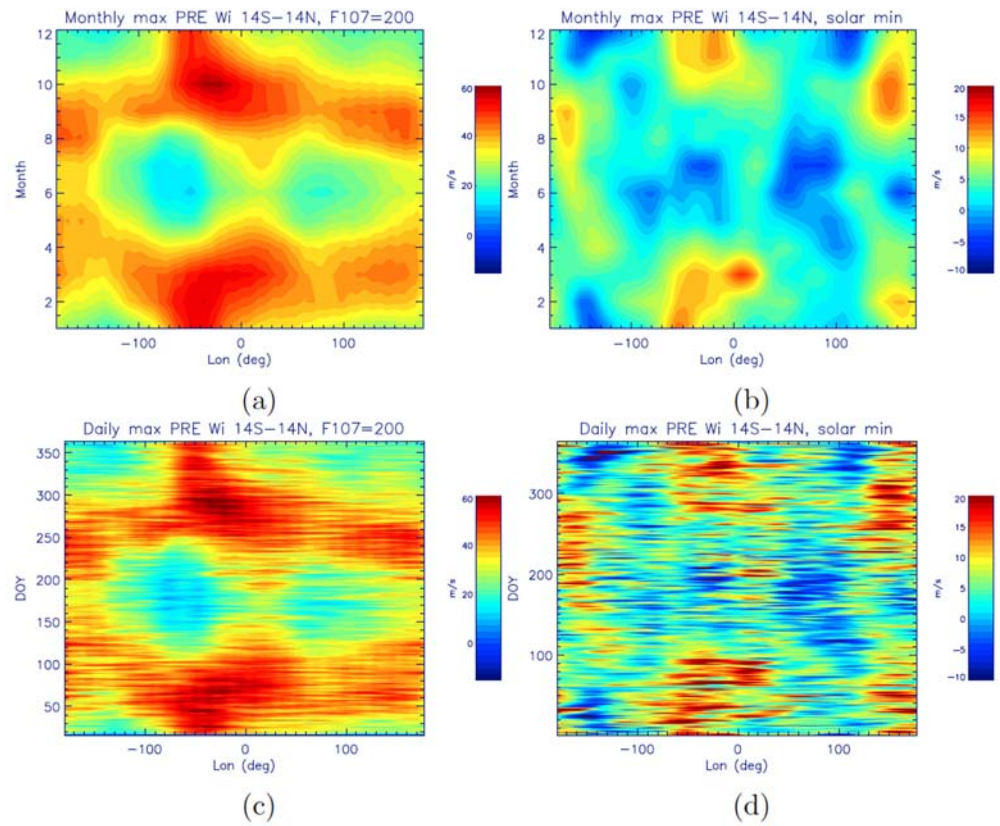

Figure 2. (a-b): Monthly averaged values of maximum pre-reveral enhancement (PRE) between 14°S—14°N from WACCM-X simulations under solar maximum and solar minimum conditions, respectively. (c-d) Similar to (a-b) but daily values of PRE [H.-L. Liu et al., 2018].

WACCM-X 2.0 has been used to simulate anthropogenic global change through the entire atmosphere under constant low solar activity conditions [Solomon et al., 2018]. The basic result was that even as the lower atmosphere gradually warms, the upper atmosphere rapidly cools. Global mean annual mean temperature increased at a rate of +0.2 K/decade at the surface and +0.4 K/decade in the upper troposphere, but decreased by about -1 K/decade in the stratosphere-mesosphere, and -2.8 K/decade in the thermosphere. Near the mesopause, temperature decreases were small compared to the interannual variation, so trends in that region are uncertain. Results were similar to previous modeling confined to specific atmospheric levels, and compared favorably with available measurements.

WACCM-X 2.0 has the option to constrain the troposphere and stratosphere by reanalysis (named specified-dynamics or SD configuration). This is particularly valuable for comparison with observations for a specific time period. SD-WACCM-X simulations for 2000-2012 can be accessed through Earth System Grid (https://www.earthsystemgrid.org/, then search fxsd).

Data assimilation capability has also been developed for WACCM-X, using the Data Assimilation Research Testbed (DART) ensemble adjustment Kalman filter [Pedatella et al., 2018]. The middle and upper atmosphere variability is well reproduced in WACCMX+DART reanalysis fields during the 2009 major sudden stratospheric warming (SSW). Hindcast experiments show that the model has good predictive skill, and can forecast the middle and upper atmosphere variability associated with the SSW ~10 days in advance.

WACCM-X 2.0 will be released for community use, as part of the NCAR Community Earth System Model version 2 (CESM 2). Once released, the model source code, as well as model documents, can be accessed from the CESM website (http://www.cesm.ucar.edu/). CESM tutorials are given each year, and the tutorial information can also be found under CESM Events (http://www.cesm.ucar.edu/events/tutorials/). A WACCM-X tutorial session was held during the 2017 NSF CEDAR Workshop, and the tutorial materials can be accessed at http://cedarweb.vsp.ucar.edu/wiki/index.php/2017_Workshop:WACCM_X_Users_Group.

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Project SPeCIMEN

Article 2:

Coordinated investigations of topside H^+ ions: new results for inner magnetosphere

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Atomic hydrogen (H) is a crucially important constituent of the Earth's atmosphere. These atoms form the geocorona which directly impacts the dissipation of the ring current during the recovery phase of magnetic storms [*Ilie et al*., 2013]. The H^+ ions, which are produced by the charge exchange reaction of H with ionospheric O^+, are primarily responsible for existence of the plasmasphere and its refilling after the emptying by severe storms [*Richards and Torr*, 1985].

Our previous studies in 2015-2016 revealed that the NRLMSISE-00 neutral atmosphere model underestimated the H density by a factor of 2 to 3 during the period of extremely low solar activity 2006–2010 [*Kotov et al*., 2015, 2016]. We noted also that this finding was the key to explaining the lower than normal O^+-H^+ transition heights (height where H^+ becomes the dominant ion) as well as significant enhancements of the nighttime peak of the electron density (NmF_2).

Figure 1. The main antenna of Kharkiv incoherent scatter radar (diameter 100 meters).

Given the importance of the problem the question that we posed to solve was as follows:

'Is such a high neutral H density an attribute of the unique minimum of the solar cycle 23rd or this is usual situation when NRLMSISE-00 model underestimates hydrogen density for low solar activity?'

To answer the question, we proposed a new VarSITI campaign to continue thermospheric H density studies in the current solar minimum (2016–2017). In 2017, we carried out four observations (2–3 days duration) near the equinoxes and solstices with the Kharkiv incoherent scatter radar (49.6 N, 36.3 E) (Figure 1) to measure the H^+ ion density (see example in Figure 2) and another ionospheric plasma parameters. Then, we used the field line interhemispheric plasma (FLIP) model to perform the observational based simulation and, as the result, we estimated H density.

A meeting to analyze the results of the Campaign was supported by the VarSITI grant and it was organized in the Institute of Atmospheric Physics, Prague, Czech Republic in October 6-10, 2017.

The main conclusion follows from our investigations is that MRLMSISE-00 model underestimated hydrogen density during the period of 2016–2017. We are preparing a paper for peer-reviewed journal to summarize the results of the Campaign and we believe that our findings will be useful for all scientists who deal with studies of unresolved space weather problems. The results may be also especially interesting because the current solar minimum follows a much weaker solar maximum than the one that preceded the 2006–2009 solar minimum.

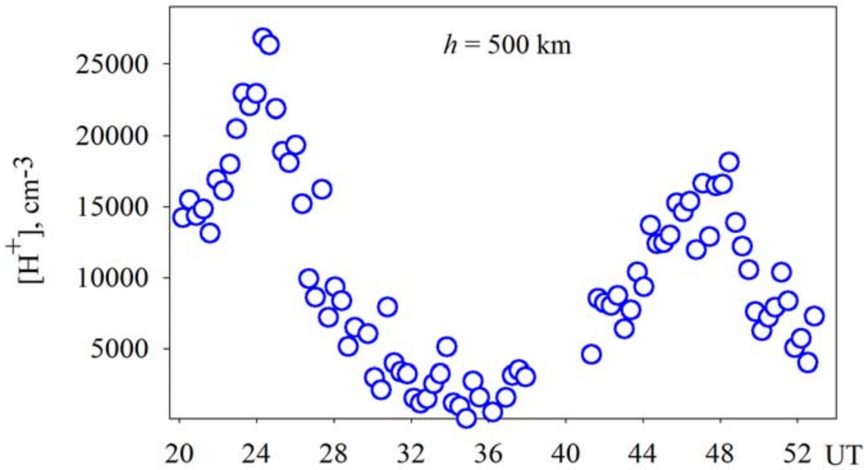

Figure 2. An example of H^+ ion density observed by Kharkiv IS radar during the VarSITI Campaign 2017: December 24-26, 2017, altitude 500 km.

Acknowledgements:

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Article 3:

Complex catalogue of high speed streams and geomagnetic storms during solar cycle 24 (2009 – 2016)

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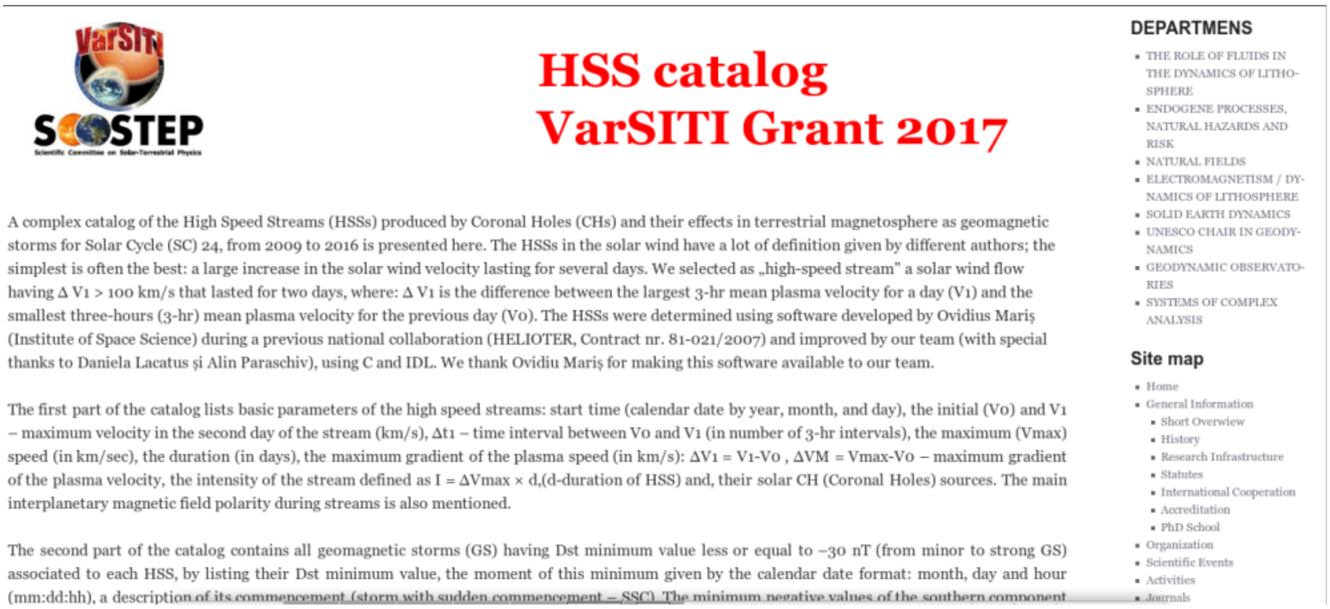
Georgeta Maris Muntean


Diana Besliu-Ionescu


Venera Dobrica

The High Speed Streams (HSSs) in the solar wind are travelling through the heliosphere towards the Earth's orbit and beyond, inducing a lot of interplanetary disturbances that could cause geomagnetic storms (GSs), polar auroras and even the geomagnetically induced currents in the large extent terrestrial technological systems. A series of previous works identified and analysed the HSSs during the solar cycles (SCs) nos. 20–23. Thus, the works of the Swedish team (1,2,3) or the Greek team (4,5) catalogued these currents in the solar wind for the period of three SCs, 1964-1996. HSSs during SC 23 were determined and published by other three co-authors teams (6,7,8).

It is known that geomagnetic activity and other associated phenomena are more influenced by the variation of the solar wind stream speed dV/dt rather than by the absolute value of the solar wind particles speed (1). For this reason in the attempts to define HSSs the criterion of speed variation rather than its absolute value has been used. We chose the same selection procedure of the streams as Swedish team because this one allows more precisely to determine the HSS beginning and end. So, we selected as HSS a solar wind flow having $\Delta V1 \geq$ 100 km/s that lasted for at least two days, where: $\Delta V1$ was the difference between the smallest three-hours (3-hr) mean plasma velocity for a given day ($V0$) and the largest 3-hr mean plasma velocity for the following day ($V1$). A complex catalogue for SC 24 (2009-2016) that includes HSSs produced by solar coronal holes (CHs) and their associated GSs is presented here. Two screenshots of this catalogue (http://www.geodin.ro/varsiti/) are shown in Fig. 1 (part of the main page) and Fig. 2 (HSSs during 2010).


HSS catalog
VarSITI Grant 2017

A complex catalog of the High Speed Streams (HSSs) produced by Coronal Holes (CHs) and their effects in terrestrial magnetosphere as geomagnetic storms for Solar Cycle (SC) 24, from 2009 to 2016 is presented here. The HSSs in the solar wind have a lot of definition given by different authors; the simplest is often the best: a large increase in the solar wind velocity lasting for several days. We selected as „high-speed stream" a solar wind flow having Δ V1 > 100 km/s that lasted for two days, where: Δ V1 is the difference between the largest 3-hr mean plasma velocity for a day (V1) and the smallest three-hours (3-hr) mean plasma velocity for the previous day (V0). The HSSs were determined using software developed by Ovidius Mariș (Institute of Space Science) during a previous national collaboration (HELIOTER, Contract nr. 81-021/2007) and improved by our team (with special thanks to Daniela Lacatus și Alin Paraschiv), using C and IDL. We thank Ovidiu Mariș for making this software available to our team.

The first part of the catalog lists basic parameters of the high speed streams: start time (calendar date by year, month, and day), the initial (V0) and V1 – maximum velocity in the second day of the stream (km/s), Δt1 – time interval between V0 and V1 (in number of 3-hr intervals), the maximum (Vmax) speed (in km/sec), the duration (in days), the maximum gradient of the plasma speed (in km/s): ΔV1 = V1-V0 , ΔVM = Vmax-V0 – maximum gradient of the plasma velocity, the intensity of the stream defined as I = ΔVmax × d,(d-duration of HSS) and, their solar CH (Coronal Holes) sources. The main interplanetary magnetic field polarity during streams is also mentioned.

The second part of the catalog contains all geomagnetic storms (GS) having Dst minimum value less or equal to –30 nT (from minor to strong GS) associated to each HSS, by listing their Dst minimum value, the moment of this minimum given by the calendar date format: month, day and hour (mm:dd:hh), a description of its commencement (storm with sudden commencement – SSC). The minimum negative values of the southern component

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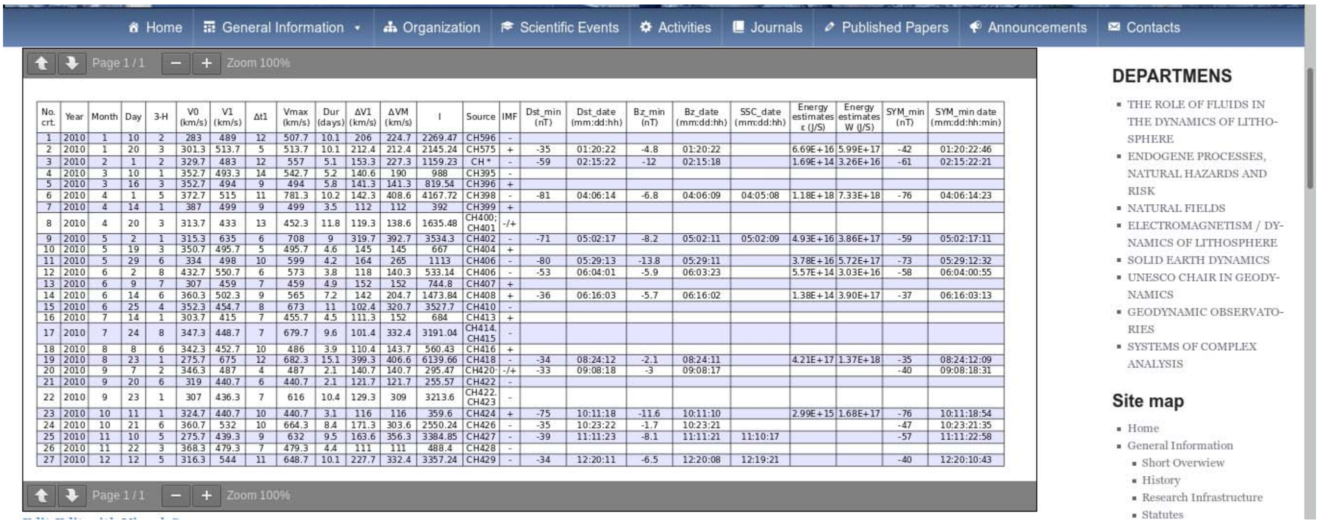
Figure 1. Screenshot of the main page of the complex catalogue of HSSs and GSs for SC 24.

The first part of the catalogue lists basic parameters of the HSSs (detailed presented on the main page). The second part of the catalogue contains all GSs having Dst min ≤ –30 nT (from minor to strong GS) associated to each HSS, by listing their Dst minimum value, the moment of this minimum given by the calendar date format: month, day and hour (mm:dd:hh), a description of its commencement (storm with sudden commencement, SSC). The minimum negative value of the southern component of the heliospheric magnetic field (Bz, in nT) registered just before the minimum Dst value and its time (mm:dd:hh) is also included. In order to give more information on the GS evolution and characteristics, our catalogue also includes estimated values for the energy deposited in the magnetosphere from solar wind (for GSs with Dst≤-50 nT), computed using the Akasofu parameter (9), ε, integrated over the main phase of the geomagnetic storms and an improved version of this formula given by Wang et al. (10), W. Generally, one single GS is induced by a HSS. However, there are some cases when, during a complex HSS, two or even more (minor) GSs are registered; in such cases, the parameters of the successive geomagnetic storms will appear on successive rows in the catalogue. Recently many scientists have begun to use the SYM-H geomagnetic index instead of classic index Dst. The last two columns of the monthly tables give the SYM-H value and its time (month, day, hour, minute). The main advantage is that SYM-H has 1-min time resolution compared to the 1-hour time resolution of Dst.



No. crt.	Year	Month	Day	3-H	V0 (km/s)	V1 (km/s)	Δt1	Vmax (km/s)	Dur (days)	ΔV1 (km/s)	ΔVM (km/s)	I	Source	IMF	Dst_min (nT)	Dst_date (mm:dd:hh)	Bz_min (nT)	Bz_date (mm:dd:hh)	SSC_date (mm:dd:hh)	Energy estimates ε (J/S)	Energy estimates W (J/S)	SYM_min (nT)	SYM_min date (mm:dd:hh:min)
1	2010	1	10	2	283	489	12	507.7	10.1	206	224.7	2269.47	CH596	-									
2	2010	1	20	3	301.3	513.7	5	513.7	10.1	212.4	212.4	2145.24	CH575	+	-35	01:20:22	-4.8	01:20:22		6.69E+16	5.99E+17	-42	01:20:22:46
3	2010	2	1	2	329.7	483	12	557	5.1	153.3	227.3	1159.23	CH *	-	-59	02:15:22	-12	02:15:18		1.69E+14	3.26E+16	-61	02:15:22:21
4	2010	3	10	1	352.7	493.3	14	542.7	5.2	140.6	190	988	CH395	-									
5	2010	3	16	3	352.7	494	9	494	5.8	141.3	141.3	819.54	CH396	+									
6	2010	4	1	5	372.7	515	11	781.3	10.2	142.3	408.6	4167.72	CH398	-	-81	04:06:14	-6.8	04:06:09	04:05:08	1.18E+18	7.33E+18	-76	04:06:14:23
7	2010	4	14	1	387	499	9	499	3.5	112	112	392	CH399	+									
8	2010	4	20	3	313.7	433	13	452.3	11.8	119.3	138.6	1635.48	CH400; CH401	-/+									
9	2010	5	2	1	315.3	635	6	708	9	319.7	392.7	3534.3	CH402	-	-71	05:02:17	-8.2	05:02:11	05:02:09	4.93E+16	3.86E+17	-59	05:02:17:11
10	2010	5	19	3	350.7	495.7	5	495.7	4.6	145	145	667	CH404	+									
11	2010	5	29	6	334	498	10	599	4.2	164	265	1113	CH406	-	-80	05:29:13	-13.8	05:29:11		3.78E+16	5.72E+17	-73	05:29:12:32
12	2010	6	2	8	432.7	550.7	6	573	3.8	118	140.3	533.14	CH406	-	-53	06:04:01	-5.9	06:03:23		5.57E+14	3.03E+16	-58	06:04:00:55
13	2010	6	9	7	307	459	7	459	4.9	152	152	744.8	CH407	+									
14	2010	6	14	6	360.3	502.3	9	565	7.2	142	204.7	1473.84	CH408	+	-36	06:16:03	-5.7	06:16:02		1.38E+14	3.90E+17	-37	06:16:03:13
15	2010	6	25	4	352.3	454.7	8	673	11	102.4	320.7	3527.7	CH410	-									
16	2010	7	14	1	303.7	415	7	455.7	4.5	111.3	152	684	CH413	+									
17	2010	7	24	8	347.3	448.7	7	679.7	9.6	101.4	332.4	3191.04	CH414. CH415	-									
18	2010	8	8	6	342.3	452.7	10	486	3.9	110.4	143.7	560.43	CH416	+									
19	2010	8	23	1	275.7	675	12	682.3	15.1	399.3	406.6	6139.66	CH418	-	-34	08:24:12	-2.1	08:24:11		4.21E+17	1.37E+18	-35	08:24:12:09
20	2010	9	7	2	346.3	487	4	487	2.1	140.7	140.7	295.47	CH420	-/+	-33	09:08:18	-3	09:08:17				-40	09:08:18:31
21	2010	9	20	6	319	440.7	6	440.7	2.1	121.7	121.7	255.57	CH422	-									
22	2010	9	23	1	307	436.3	7	616	10.4	129.3	309	3213.6	CH422. CH423	-									
23	2010	10	11	1	324.7	440.7	10	440.7	3.1	116	116	359.6	CH424	+	-75	10:11:18	-11.6	10:11:10		2.99E+15	1.68E+17	-76	10:11:18:54
24	2010	10	21	6	360.7	532	10	664.3	8.4	171.3	303.6	2550.24	CH426	-	-35	10:23:22	-1.7	10:23:21				-47	10:23:21:35
25	2010	11	10	5	275.7	439.3	9	632	9.5	163.6	356.3	3384.85	CH427	-	-39	11:11:23	-8.1	11:11:21	11:10:17			-57	11:11:22:58
26	2010	11	22	3	368.3	479.3	7	479.3	4.4	111	111	488.4	CH428	-									
27	2010	12	12	5	316.3	544	11	648.7	10.1	227.7	332.4	3357.24	CH429	-	-34	12:20:11	-6.5	12:20:08	12:19:21			-40	12:20:10:43

Figure 2. Screenshot of the HSSs and GSs during 2010.

Acknowledgements:

This work was supported by the VarSITI/SCOSTEP grant 2007.

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Highlight on Young Scientists 1:

Understanding Tidal “Weather”

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Jian Du

Although the importance of atmospheric tides is by now without dispute, the present understanding of their ionosphere/thermosphere (IT) impacts is limited to seasonal “climatological” timescales of variability. Figure 1 gives an example of the short-term tidal variability (periods < 30 days) of the migrating diurnal tide (DW1) from the extended Canadian Middle Atmosphere Model (eCMAM) [Fomichev et al., 2002] and the Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) satellite measurements in 2006. It is evident that tidal amplitudes vary by a factor of two or more within a few days.

Funded by NASA, we are currently investigating the short-term tidal variability with informational theory [Larson, 2012]. Figure 2 clearly shows the individual PDFs are Gaussian like but the shapes of the PDFs change with time. Broader PDFs indicate a larger range of tidal short-term variability, whereas narrower PDFs indicate a smaller range of tidal variability. A simple FFT on the peaks of the PDFs shows that there are long-term variations governing the shapes of the PDFs. There are 4-, 6-, 12- month peaks in the FFT and a peak associated with the quasi-biannual oscillation (QBO) period. We are currently investigating how and why these changes are present.

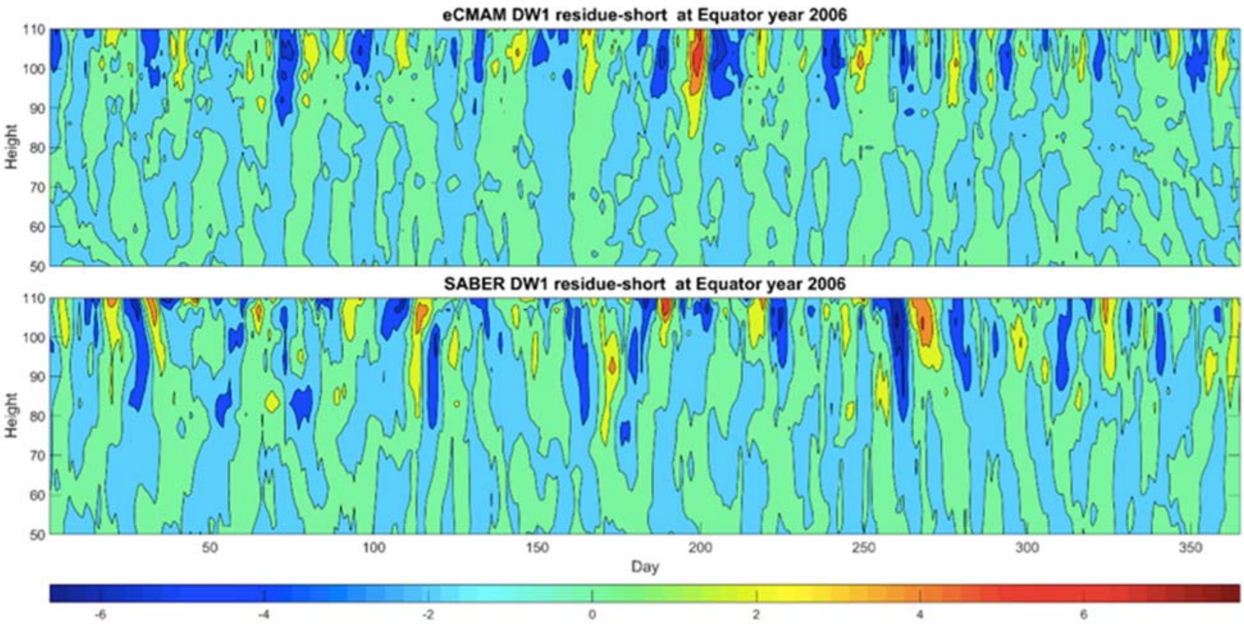

Figure 1. Short-term tidal variability (periods < 30 days) of the migrating diurnal tide (DW1) as a function of day in 2006 and height from the eCMAM (top) and SABER (bottom).

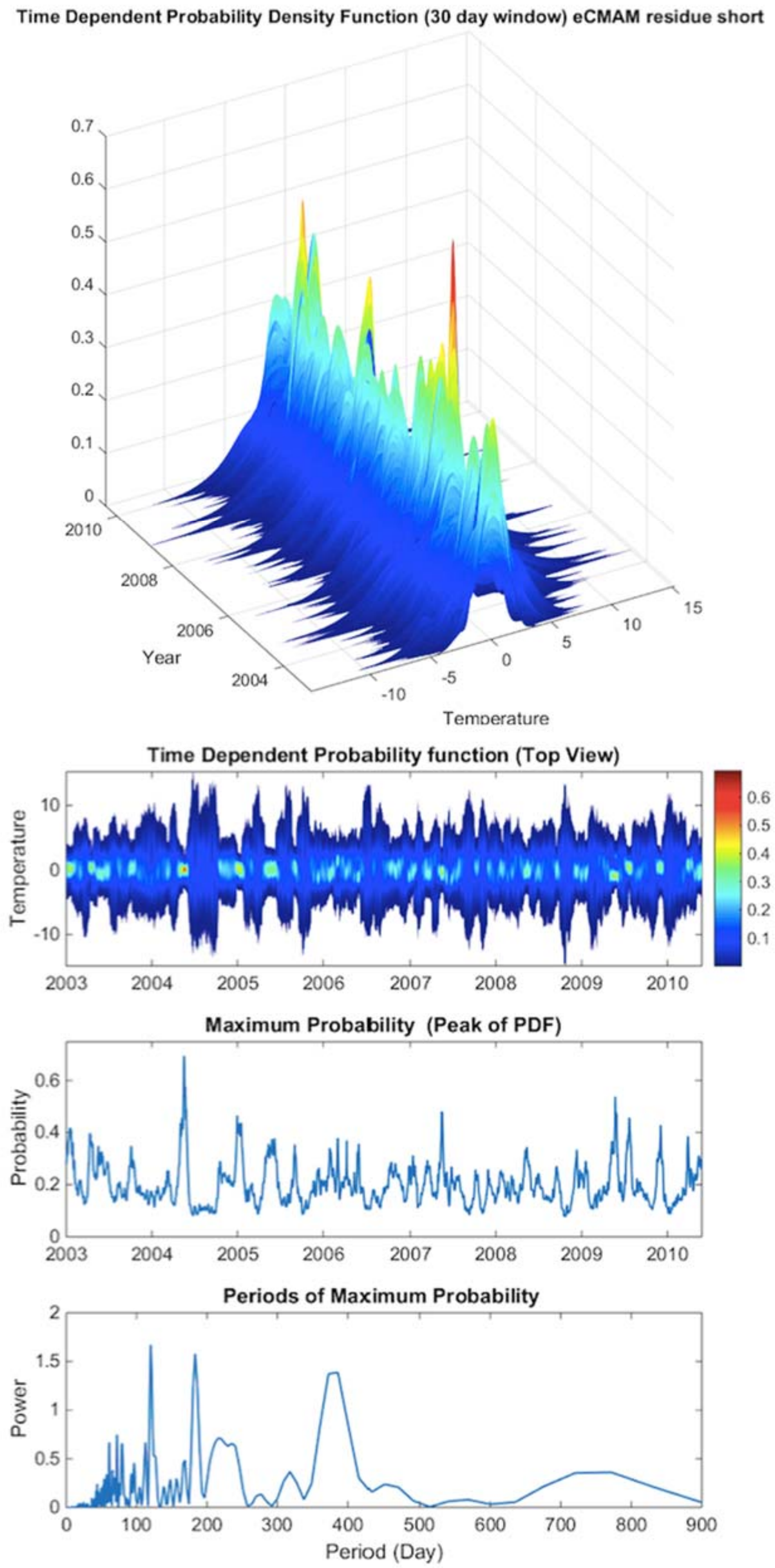

Figure 2. Top: Time dependent Probability Density Functions (PDFs) of the short-term DW1 variability (periods < 30 days) at 100 km and the equator from January 2003 and June 2010. Second from top: same as the Top figure but the top view. Second from bottom: the peak of the PDFs as a function of time. Bottom: Fourier transform of the maximum probability.

References:

Fomichev, V. I., W. E. Ward, S. R. Beagley, C. McLandress, J. C. McConnell, N. A. McFarlane, and T. G. Shepherd (2002), Extended Canadian Middle Atmosphere Model: Zonal mean climatology and physical parameterizations, J. Geophys. Res., 107 (D10), 4087, doi:10.1029/2001JD000479.

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Highlight on Young Scientists 2:

The Journey of a CME in the heliosphere in June 2015

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Diana Besliu-Ionescu

Studying the solar-terrestrial connections is of a great importance for applications in everyday life as well as in scientific research. Therefore, understanding the consequences of a coronal mass ejection (CME) upon the Earth's magnetosphere can be a relevant contribution to this connection.

On June 22, 2015 a large active region of βγδ complexity was situated at N13W14 (223",183") on the solar disk. An M6.6-class solar flare started to be recorded by GOES around 17:39 UT, at heliographic coordinates N12W08. It lasted for 44 minutes and peaked at 18:23 UT.

A Halo CME was registered by the SOHO/LASCO coronograph (https://cdaw.gsfc.nasa.gov/CME_list/) at 18:36:05 UT. Although all its measured velocities exceeded 1000 km/s, this was not the fastest CME during that month. With a linear speed of 1209 km/s and a final height speed of 1147 km/s, it decelerated by 25.1 m/s^2. Figure 1 shows the evolution of the CME as seen in LASCO-C2 running difference images.

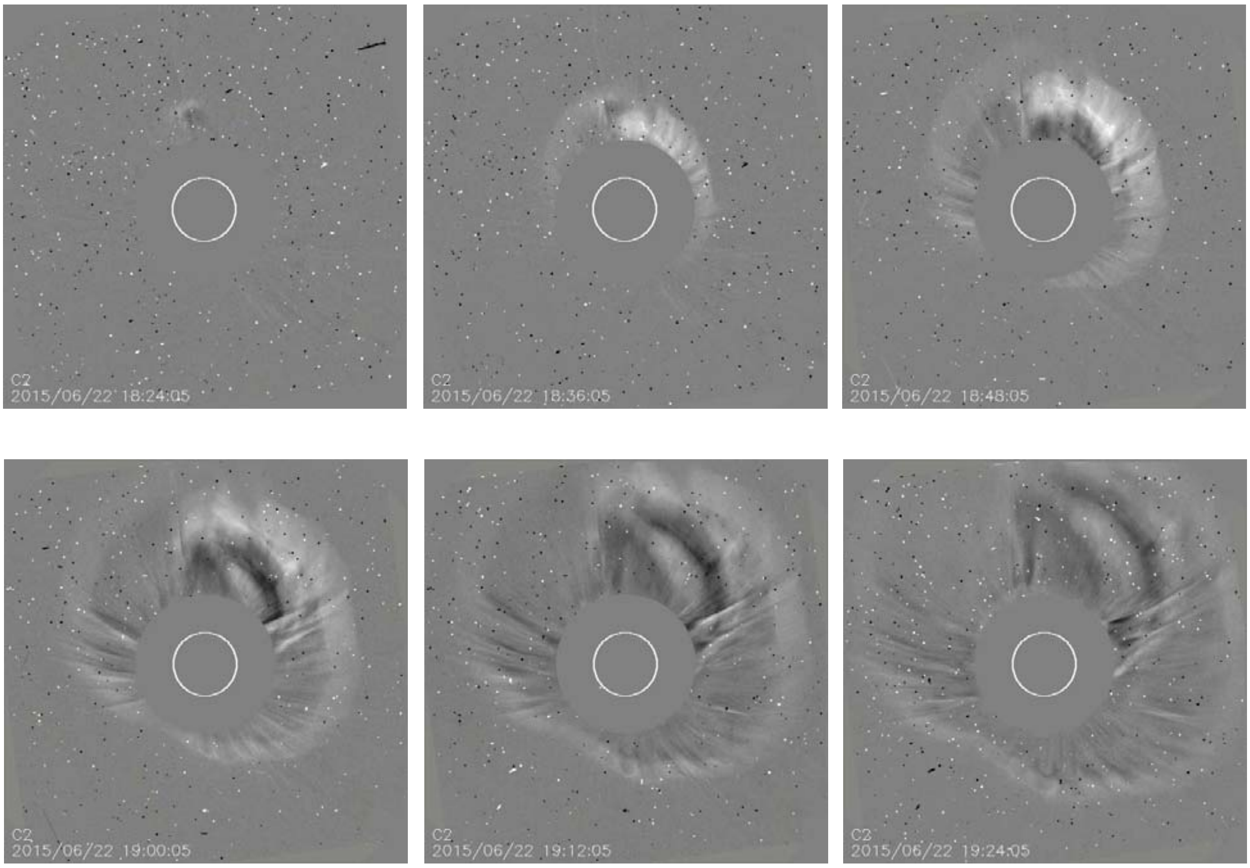

Figure 1. CME evolution as seen in LASCO-C2 running difference images. (credits: https://lasco-www.nrl.navy.mil)

The associated interplanetary CME (ICME) was reported on the online catalogue available at http://www.srl.caltech.edu/ACE/ASC/DATA/level3/icmetable2.htm. It caused a geomagnetic disturbance on June 24 at 13:29 UT without a sudden commencement (SSC) detected, ~43 hours after the first appearance of the CME. The ICME started at 10:00 UT on June 25 and ended on June 26, at 06:00 UT.

From the online high speed streams (HSS) catalogue available at http://www.geodin.ro/varsiti/, we can observe that a HSS was detected during this period starting on June 24, 2015 in the fourth 3-h interval and lasted for 4.5 days.

Following this combination of ICME and HSS the geomagnetic index Dst showed a significant decrease to a minimum value of -86 nT. The temporal profile of Dst index along with the interplanetary magnetic field evolution (total intensity and Bz component) are shown in Figure 2 (left panel) where the red straight line represents the starting time of the disturbance, the two dotted red lines represent the main phase of the geomagnetic storm, while the black dashed lines mark the ICME start and end time.

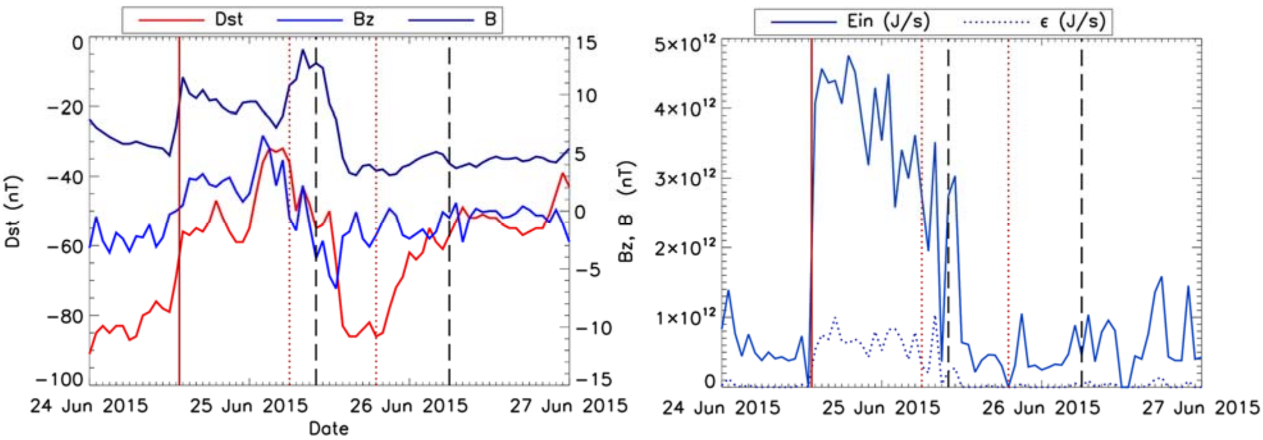

Figure 2. Time series of the geomagnetic index Dst, total and southern component of the interplanetary magnetic field (left panel) and of energy values (Akasofu parameter and Wang formula) variations (right panel).

In order to understand the variation of the geomagnetic index we studied the energy transfer from the solar wind into the magnetosphere using the Akasofu parameter – ε (Akasofu, 1981) and an improved version of its formula denoted here by EIN calculated by Wang et al. (2014). We computed the two quantities using the OMNI data (https://omniweb.gsfc.nasa.gov/form/dx1.html) as input in an IDL program. The two quantities are shown in Figure 2 right panel, ε being represented by a blue dotted line, while E_{IN} is represented by a blue continuous line. We can observe that the energy transfer starts at exactly the same time as the disturbance preceding the ICME.

It is evident that the energy input is not limited to the main phase of the storm. The energy transfer from the solar wind into the magnetosphere is considered to happen only during the main phase of the storm. We computed the total energies transferred during the main phase as being ε_{tot}=1.46e16 J/s and $E_{IN\text{-}TOT}$=2.13e17 J/s.

References:

Akasofu, S.I.: 1981, Energy coupling between the solar wind and the magnetosphere. Space Sci. Rev. 28, 121.

Wang, C., Han, J.P., Li, H., Peng, Z., Richardson, J.D.: 2014, Solar wind-magnetosphere energy coupling function fitting: Results from a global MHD simulation. Journal of Geophysical Research (Space Physics) 119, 6199.

Highlight on Young Scientists 3:

Properties of Relativistic Electron Microbursts


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Relativistic electron microbursts are intense short-duration (< 1 s) precipitation events of > 1 MeV electrons from the outer radiation belt into the atmosphere [1].

The net flux in the Van Allen radiation belts which surround the Earth is a delicate balance between loss and energization [2], with relativistic electron microbursts likely significant contributors to radiation belt losses. Therefore, we must understand the conditions under which relativistic microbursts occur, and moreover, the physical processes in space driving this type of precipitation.

There are multiple theoretical studies demonstrating how either EMIC [3] or whistler mode chorus waves [4] are the drivers of relativistic microbursts. Recent experimental evidence has shown relativistic microbursts occurring simultaneously with whistler mode chorus waves [5, 6], however this does not rule out EMIC waves as an additional scattering wave capable of causing microbursts.

We statistically processed a satellite dataset of relativistic microburst events in order to describe the conditions characteristic to relativistic microbursts occurrence [7] and the wave activity present on the ground during these events [8]. With this information we hope to help answer the question of which plasma wave is driving relativistic microbursts. We have also used the observed properties to test the likely atmospheric impact [9].

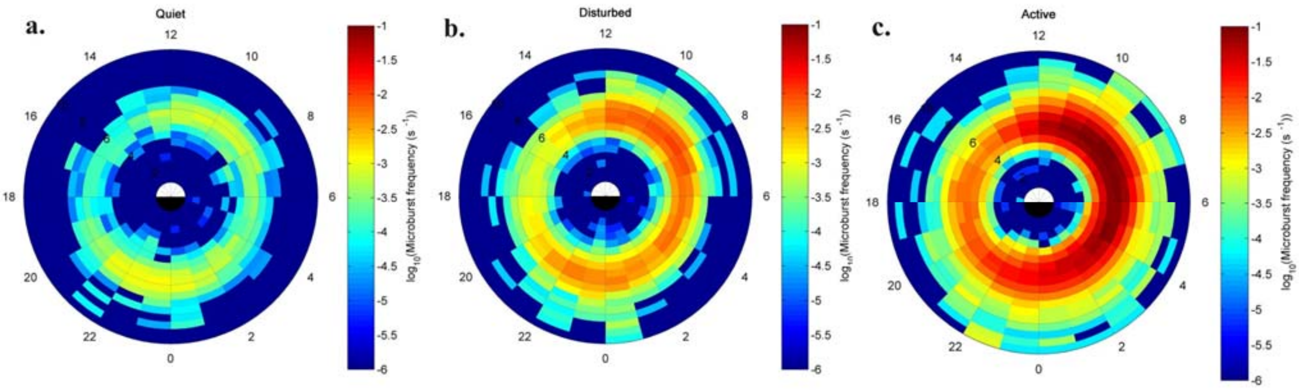

Figure 1. The global distribution of relativistic microbursts reproduced from Douma et al. [2017, Figure 6]. The L and MLT distribution of the frequency of relativistic microbursts during three levels of geomagnetic activity as measured by AE*. (a) Quiet conditions, defined as AE* ≤ 100 nT, (b) disturbed conditions, defined as 100 < AE* ≤ 300 nT, and (c) active conditions, defined as AE* > 300 nT. Note that all three panels have the same log color scale.

References:

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[3] Omura, Y., and Zhao, Q. (2013), Relativistic electron microbursts due to nonlinear pitch angle scattering by EMIC triggered emissions, *Journal of Geophysical Research Space Physics*, 118, 5008–5020, doi:10.1002/jgra.50477.

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ic storms, *Journal of Geophysical Research*, 110, A09202, doi:10.1029/2004JA010882.

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[7] Douma, E., Rodger, C. J., Blum, L. W., and Clilverd, M. A. (2017). Occurrence characteristics of relativistic electron microbursts from SAMPEX observations, *Journal of Geophysical Research Space Physics*, 122, 8096–8107, doi:10.1002/2017JA024067.

[8] Douma, E., Rodger, C. J., Clilverd, M. A., Hendry, A. T., Engebretson, M. J., and Lessard, M. R. (2018), Comparison of Relativistic Microburst Activity Seen by SAMPEX With Ground-Based Wave Measurements at Halley, Antarctica, *Journal of Geophysical Research: Space Physics*, doi:10.1002/2017JA024754.

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Project SEE / ROSMIC

Highlight on Young Scientists 4:

Centennial evolution of solar wind and solar magnetic field reconstructed from geomagnetic activity

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[2]NASA Goddard Space Flight Center, Greenbelt, MD, USA

Lauri Holappa

Geomagnetic activity has been measured at ground-based magnetic observatories since the mid-nineteenth century. The two most important solar wind structures driving geomagnetic activity are coronal mass ejections (CMEs) and high-speed streams (HSSs). These two solar wind structures originate from different sources in the Sun. While CMEs are closely associated with active regions and their occurrence closely follows the solar cycle, HSSs originate from coronal holes maximizing during the declining phase of the solar cycle. Because active regions and coronal holes are related to distinct components of the large-scale solar magnetic field, knowledge of their long-term evolution is critical, e.g., for studies on solar dynamo.

We have recently developed novel methods for extracting information on the occurrence of CMEs and HSSs in solar wind from long-term measures of geomagnetic activity [1-4]. These methods exploit the fact that there are latitudinal differences between CME- and HSS-driven geomagnetic activity (Figure 1). Using auroral region geomagnetic activity we can reconstruct, e.g., annual solar wind

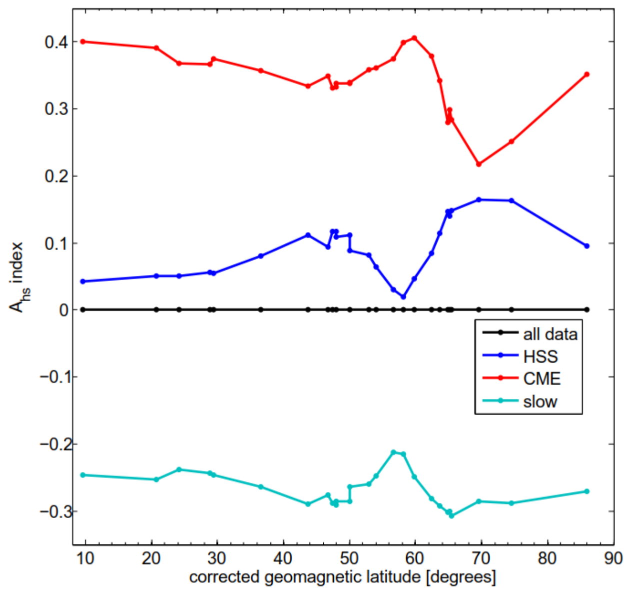

Figure 1. Latitudinal distribution of standardized A_h indices (A_{hs}) during CMEs, HSSs and slow solar wind in 1966-2009 [1]. While HSS-driven geomagnetic activity maximizes in the auroral region (about 65°-70°), CME-driven geomagnetic activity maximizes in subauroral (about 60°) and low latitudes.

speeds for the last century (Figure 2). Figure 2 shows that, interestingly, solar wind speeds (and polar coronal holes) maximized during the declining phase of solar cycle 18, preceding the highest solar cycle 19. This also indicates that the strongest solar polar fields preceded the highest solar cycle 19, giving support for the dynamo theory.

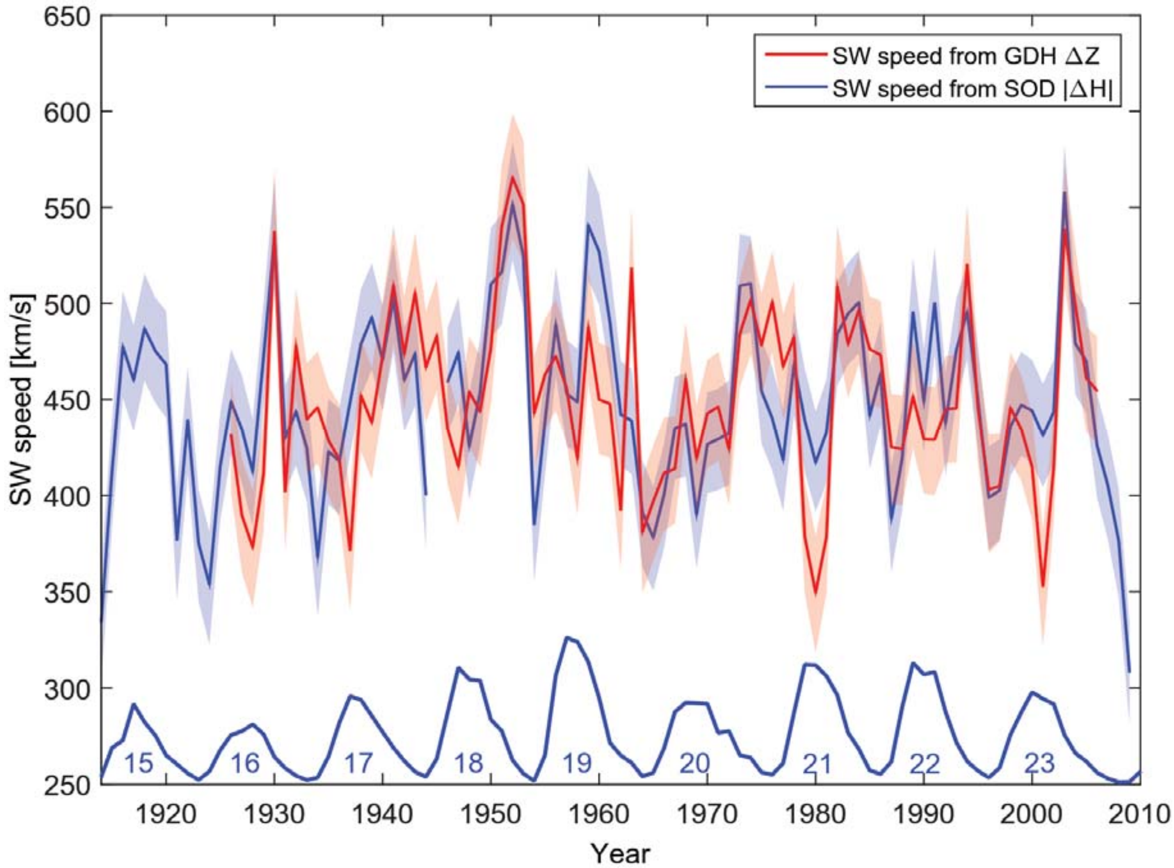

Figure 2. Annual solar winds speeds reconstructed from geomagnetic activity measured at two high-latitude observatories (Godhavn, Greenland and Sodankylä, Finland) [3]. Annual sunspot number (arbitrary scale) and solar cycle numbers are included for reference.

References:

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[3] Mursula, K., R. Lukianova, and L. Holappa, Occurrence of high-speed solar wind streams over the Grand Modern Maximum, *Astrophys. J.*, 801, 30, 2015.

[4] Mursula, K., L. Holappa and R. Lukianova, Seasonal solar wind speeds for the last 100 years: Unique coronal hole structures during the peak and demise of the Grand Modern Maximum, *Geophys. Res. Lett.*, 44, 30-36, 2017.

Project ISEST / SPeCIMEN

Meeting Report 1:

Promoting a new generation of Chinese-American collaboration in space

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Boulder, CO, USA

Ryan McGranaghan

On January 23-24 the National Space Science Center of the Chinese Academy of Sciences (CAS) and the Space Studies Board of the U.S. National Academies of Sciences, Engineering, and Medicine convened the 7th New Leaders in Space Science Forum (NLISSF) in Guangzhou, China. The purpose of these Forums is to provide opportunities for a highly select group of young space and Earth scientists (i.e., *New Leaders*) to discuss their research activities in intimate and collegial environments in both China and the United States.

New leaders are chosen annually by an international program committee (link to the list of

Figure 1. Participants in the 7th Forum for New Leaders in Space Science.

2018 leaders (http://sites.nationalacademies.org/cs/groups/ssbsite/documents/webpage/ssb_184134.pdf) and are invited to participate in a pair of Forums, one held in China and the other in the United States. In 2018, the 7th and 8th Forums are devoted to astronomy and astrophysics and solar and space physics. The 7th Forum, occurring over two days, featured presentations and discussions led by each New Leader and several members of the CAS and NAS . Culminating conversations were held to outline new collaborations and important future directions.

The 8th Forum will be held in July 2018 in Pasadena, California. Each of the invitees to the 7th Forum are charged with presenting novel research, independent of the work they shared in Guangzhou.

Project ISEST / ROSMIC

Meeting Report 2:

13-th conference "Plasma Physics in the Solar System"

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Moscow, Russia

Yuri Yermolaev

The 13-th conference "Plasma Physics in the Solar System" was organized by Space Research Institute (IKI), Moscow, Russia and held in IKI on 12-16 February, 2018. The program of the Conference included the following main traditional sections: 1. Theory and observations of the Sun, 2. Solar wind and heliosphere, 3. Ionosphere, 4. Magnetosphere, 5.Theory of space plasma, 6.Theory and observation of current layers, 7.Turbulence and chaos, as well as Special sections:

Figure 1. Photograph of the 13-th conference "Plasma Physics in the Solar System".

S1. Space weather forecast and applied questions of physics of the magnetosphere and ionosphere,
S2. Wave phenomena in space plasma,
S3. The impact of space factors on the Earth's atmosphere and climate (see conference web-site: https://plasma2018.cosmos.ru/en). There were more 300 participants from 6 countries. A large part of presentations were translated in real time in https://www.youtube.com/watch?v=Zl3PD_d9sJA. The conference was supported by VarSITI grant.

Meeting Report

Project SEE / ISEST

Meeting Report 3:

Dynamic Sun II: Solar Magnetism from Interior to the Corona

V. Fedun[1], S. Shelyag[2], E. Scullion[2], and A. K. Srivastava[3]
[1]University of Sheffield, Sheffield, UK
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[3]Indian Institute of Technology (BHU), Varanasi, India


Viktor Fedun


Sergiu Shelyag


Eamon Scullion


Abhishek K. Srivastava


Figure 1. Group Photo of the Dynamic Sun II.

'Dynamic Sun' is a new conference series, which provides a highly visible platform for the observers, theoreticians, numerical modellers and instrumentation experts in solar physics and space science to discuss cutting edge scientific challenges. The Dynamic Sun II meeting, which focused on the recent achievements in understanding photospheric, chromospheric and coronal dynamics, energy transport between the solar interior and the solar atmosphere, and dynamical processes in the confined solar transients, took place on 12-16 February 2018 in Siem Reap, Cambodia. This meeting, supported by VarSITI and AOARD, was highly successful with more than 60 attendees from more than 10 countries.

Special attention was paid to the key goals of the proposed high-altitude and ground-based instruments, e.g., DKIST, EST, Sunrise III, and Aditya-I. To disseminate the results reported during the conference the refereed proceedings will be published as a special issue of Annales Geophysicae journal.

Project ISEST / ROSMIC

Meeting Report 4:

International School on Equatorial and low-latitude ionosphere (ISELION 2018)

C. Y. Yatini[1] and K. Shiokawa[2]
[1]Space Science Center, National Institute of Aeronautics and Space of Indonesia (LAPAN), Jakarta, Indonesia
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Clara Y. Yatini


Kazuo Shiokawa

Figure 1. Participants of ISELION2018.

The International School on Equatorial and low-latitude ionosphere (ISELION2018) was held at Bandung, Indonesia on 5-9 March 2018. Participants are 39 students and young scientists from 7 countries of Egypt, India, Indonesia, Malaysia, Nepal, Philippines, and Vietnam. Six lecturers (Nurul Shazana Abdul Hamid, Buldan Muslim, Kazuo Shiokawa, Yoshimasa Tanaka, Mamoru Yamamoto, and Tatsuhiro Yokoyama) introduced ionospheric dynamics, measurement techniques including radars, Spread-F/plasma bubbles, and space weather for four days of Mon-Wed and Fri. A visit of Sumedang Observatory of LAPAN and practice of ionogram processing was held on Thursday. Participants enjoyed lively discussions with the lecturers and mutual communications during this one-week school. Details of the school are available at http://pussainsa.sains.lapan.go.id/event/iselion2018/. This school was supported by LAPAN, ISEE/Nagoya University, JSPS core-to-core program B. Asia-Africa Science Platforms, PSTEP project, National Institute of Information and Communications Technology (NICT), and SCOSTEP.

Meeting Report

VarSITI

Meeting Report 5:

IAU Symposium 340

Dipankar Banerjee

Dipankar Banerjee
Indian Institute of Astrophysics,
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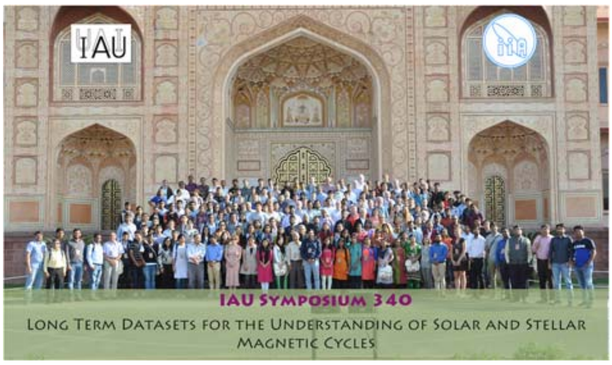

Figure 1. Group Photo of the IAU Symposium 340.

IAU Symposium 340 on "Long term datasets for the understanding of solar and stellar magnetic cycles" was held in Jaipur, India – February 18 - 24, 2018. The symposium provided an ideal opportunity for scientists from diverse, interdisciplinary areas such as solar, stellar, space and heliospheric physics to review the status of the different long-term datasets available across the globe. The symposium provided an excellent platform to exchange ideas on the understanding of solar long-term behavior, its effects and prediction. The Kodaikanal Observatory has observed the sun at wavelengths WL, Ca-II K, H-alpha since 1904. The digitization process has been completed recently and raw and calibrated data was made available to the global community through an announcement during the meeting. IAU Symposium 340 enabled a comparison of recent results from a wide variety of scientific disciplines. There were eight sessions with 25 invited talks and 46 contributed presentations. There were 153 poser presentations and dedicated poster sessions were allotted each day. Each session also attracted poster awards for young scientists. A total number of 233 registered participants attended the symposium, with 157 male and 69 female candidates from 26 different countries across the globe. All the presentations are now posted at the conference website at https://www.iiap.res.in/iaus340/Home. There were several education and outreach programs conducted during the conference, including a visit for the conference delegates to the Jantar Mantar, a world heritage site. There were workshops organized for the tourist guides with the theme of understanding the usage of the historical observatory instruments through Positional Astronomy observations. A full day workshop on computer based data analysis on long term solar data sets was also organized for undergraduate and graduate students on the last day of the conference. 90 students attended this workshop. Nat Gopalswamy also delivered a public lecture titled "Our life-giving star, the Sun and its dark side".

Project SPeCIMEN

Meeting Report 6:

Particle Dynamics in the Earth's Radiation Belts

Seth Claudepierre

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In March of 2018, radiation belt scientists descended upon the beautiful, seaside town of Cascais, Portugal, to discuss and debate the current state of the field. The week-long meeting, *Particle Dynamics in the Earth's Radiation Belts*, was organized under the auspices of the American Geophysical Union (AGU) Chapman Conference program. The conference was well attended, with roughly 100 attendees representing 14 countries. There was a strong contingent (~25%) of students and early career researchers who were supported by generous travel grants from the United States National Science Foundation (NSF) and the VarSITI program of SCOSTEP. Of particular note is that over half of the invited speakers (https://chapman.agu.org/particle-dynamics/program-and-invited-speakers/) were from underrepresented groups. The conference website (https://chapman.agu.org/particle-dynamics/) details the full scientific program (https://agu.confex.com/agu/18chapman2/webprogram/start.html) and includes .pdf files of nearly all of the oral and poster presentations given at the conference. A special issue of the Journal of Geophysical Research – Space Physics is currently being planned.

Upcoming meetings related to VarSITI

Conference	Date	Location	Contact Information
EGU General Assembly 2018	Apr. 8-13, 2018	Vienna, Austria	https://www.egu2018.eu/
DKIST Critical Science Plan Workshop 5: Wave generation and propagation	Apr. 9-11, 2018	Newcastle upon Thyne, UK	http://eclipse2017.nso.edu/science/dkist/dkist-critical-science-plan/workshop-5/
4th International ANGWIN workshop: Exploration of High-latitude Upper Atmosphere Wave Dynamics	Apr. 24-26, 2018	São José dos Campos, Brazil	http://www.inpe.br/angwin/
10th International Workshop on "Long-Term Changes and Trends in the Atmosphere"	May 14-19, 2018	Hefei, China	http://trends2018.ustc.edu.cn/home.html
Japan Geoscience Union (JpGU) Meeting 2018	May 20-24, 2018	Makuhari, Japan	http://www.jpgu.org/meeting_e2018/
COSPAR Capacity-Building Workshop Coronal and Interplanetary Shocks: Analysis of Data from SOHO, Wind, and e-CALLISTO	May 21-Jun. 1, 2018	Mekelle, Ethiopia	http://www.e-callisto.org/cospar2018/COSPAR2018workshopEthiopia.html
10th Workshop "Solar Influences on the Magnetosphere, Ionosphere and Atmosphere"	May 30-Jun. 3, 2018	Sunny Beach, Bulgaria	http://ws-sozopol.stil.bas.bg/
15th AOGS Annual Meeting	Jun. 3-8, 2018	Honolulu, Hawaii, USA	http://www.asiaoceania.org/aogs2018/public.asp?page=home.htm
6th International conference "Atmosphere, ionosphere, safety"	Jun. 3-9, 2018	Kaliningrad, Russia	http://www.ais2018.ru/
2018 GEM Workshop	Jun. 17-23, 2018	Santa Fe, NM, USA	http://www.cpe.vt.edu/gem/index.html
7th IAGA/ICMA/SCOSTEP workshop on Vertical Coupling in the Atmosphere-Ionosphere System	Jul. 2-6, 2018	Potsdam, Germany	https://www.gfz-potsdam.de/en/section/space-geodetic-techniques/topics/vcais-2018/vcais-2018/
SCOSTEP 14th Quadrennial Solar-Terrestrial Physics Symposium	Jul. 9-13, 2018	Toronto, Canada	http://www.scostepevents.ca/
42nd COSPAR Scientific Assembly	Jul. 14-22, 2018	Pasadena, CA, USA	https://www.cospar-assembly.org/
7th Symposium of Brazilian Space Geophysics and Aeronomy Society (SBGEA)	Aug. 6-10, 2018	Santa Maria-RS, Brazil	http://www.sbgea.org.br/vii-sbgea/
45th Annual Meeting on Atmospheric Studies by Optical Methods	Aug. 27-31, 2018	Kiruna, Sweden	http://45am.irf.se/
Annual African Geophysical Society (AGS) Conference on Space Weather	Sep. 24-27, 2018	Cairo, Egypt	http://www.spaceweather.edu.eg/AGS2018.html
ISEST 2018 Workshop XVIth Hvar Astrophysical Colloquium	Sep. 24-28, 2018	Hvar, Croatia	http://oh.geof.unizg.hr/index.php/en/meetings/184-isest-2018
15th International Symposium on Equatorial Aeronomy	Oct. 22-26, 2018	Ahmedabad, India	http://www.prl.res.in/isea15

The purpose of the VarSITI newsletter is to promote communication among scientists related to the four VarSITI Projects (SEE, ISEST/MiniMax24, SPeCIMEN, and ROSMIC).

<u>The editors would like to ask you to submit the following articles to the VarSITI newsletter.</u>

Our newsletter has five categories of the articles:

1. Articles— Each article has a maximum of 500 words length and four figures/photos (at least two figures/photos).
   With the writer's approval, the small face photo will be also added.
   On campaign, ground observations, satellite observations, modeling, etc.
2. Meeting reports—Each meeting report has a maximum of 150 words length and one photo from the meeting.
   With the writer's approval, the small face photo will be also added.
   On workshop/conference/ symposium report related to VarSITI
3. Highlights on young scientists— Each highlight has a maximum of 200 words length and two figures.
   With the writer's approval, the small face photo will be also added.
   On the young scientist's own work related to VarSITI
4. Short news— Each short news has a maximum of 100 words length.
   Announcements of campaign, workshop, etc.
5. Meeting schedule

Category 3 (Highlights on young scientists) helps both young scientists and VarSITI members to know each other. Please contact the editors if you know any recommended young scientists who are willing to write an article on this category.

TO SUBMIT AN ARTICLE

Articles/figures/photos can be emailed to the Newsletter Secretary, Ms. Ayumi Asai (a-asai_at_isee.nagoya-u.ac.jp). If you have any questions or problem, please do not hesitate to ask us.

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