SPACE CLIMATE 4

January 16-21, 2011

Goa, India

Space Climate Symposium 4

Sunday 16th		Monday 17th		Tuesday 18th		Wednesday 19th		Thursday 20th		Friday 21st	
				8:30	Schmutz	8:30	Beer	8:30	Tsurutani	8:30	Solomon
		9:00	Van Geel	9:15	Bhattacharjee	9:00	Bhattacharyya	9:15	Gopalswamy	9:15	Chakrabarty
		9:45	Martens	9:45	Chitre	9:30	Mursula	9:45	Subramanian	9:45	Lübken
		10:15	Hanslmeier	10:15	Coffee	10:00	Coffee	10:15	Manoharan	10:15	Asikainen
11:00	Registration	10:45	Coffee	11:00	Guhathakurta	10:30	Gibson	10:45	Coffee	10:35	Coffee
11:00	Posters	11:30	Ruzmaikin	11:30	Pesnell	11:00	Nandi	11:30	Schmieder	11:20	Korte
		12:00	Ramesh	12:00	Cirtain	11:30	Richardson	11:50	Lopez	11:50	Biktash
		12:30	Vaquero	12:30	Hassler	12:00	Miyahara	12:10	Banerjee	12:10	Rawat
13:00	Lunch	13:00	Lunch	12:50	Lunch	12:30	**Discussion**	12:30	Tlatov	12:30	Kuznetsova
		14:30	Choudhuri			13:00	Lunch	12:50	Lunch	12:50	Pustil'nik
14:30	**Beach Shuttle**	15:15	Turck-Chièze	14:20	Rozelot					13:10	Lunch
		15:35	Karak	14:50	Chiodo			15:00	Srivastava		
		15:55	Georgieva	15:10	Girish		**Sightseeing**	15:30	Kristjansson	15:00	SOC/LOC
17:30	**Return Beach**	16:25	Muñoz-Jaramillo	15:40	Beig		**Tour**	16:00	Tinsley		Meeting
	Shuttle	16:45	Coffee	16:10	Coffee			16:30	Coffee		
			Posters		Posters			17:10	Laken		
18:00	Posters			17:30	**Beach Shuttle**			17:30	Tjulin		
19:00	Reception	18:30	Ceremony	19:00	**Return Beach**						
	Dinner		Dinner		**Shuttle**			19:00	Banquet		

Keynote Talk	40 Minutes
Invited Talk	25 Minutes
Contributed Talk	15 Minutes
Focus Topic Talk	25 minutes

Space Climate Symposium 4

Sunday - 16th of January

11:00	Registration Opens Posters
13:00-14:30	Lunch
14:30	Shuttle to the beach
17:30	Return shuttle to hotel
18:00-19:00	Posters
19:00	Reception and Dinner

Monday - 17th of January

Session 1

9:00-9:45	Bas Van Geel	Climate change in historical and solar perspective
9:45-10:15	Petrus Martens	The Faint Young Sun Problem: A Solar Origin?
10:15-10:45	Arnold Hanslmeier	Space weather and space climate on extrasolar planetary systems

10:45-11:30 Coffee

Session 2

11:30-12:00	Alexander Ruzmaikin	Solar Influence on the Earth's Climate on global and regional scales
12:00-12:30	Ramesh Rengaswamy	Palaeomonsoon and Solar activity
12:30-13:00	José Vaquero	Space climate research using early solar observations: some recent progress

13:00-14:30 Lunch

Session 3

14:30-15:15	Arnab Rai Choudhuri	The solar dynamo and solar cycle predictions
15:15-15:35	Sylvaine Turck-Chièze	On the origin on long trend variation of the solar activity
15:35-15:55	Bidya Binay Karak	Modeling Solar Cycle Irregularities Using Flux Transport Dynamo Models
15:55-16:25	Katya Georgieva	Long-term variations of solar dynamo parameters and effects on terrestrial climate
16:25-16:45	Andrés Muñoz-Jaramillo	Are Active Regions as Relevant for the Solar Cycle as we Think?

16:45-18:30 Coffee & Posters

18:30 Opening Ceremony — Official conference opening: - Remarks by LOC and SOC
- Talk by Dr. Siraj Hasan "Solar and Space Science in India"
- **Dinner**

Tuesday - 18th of January

Session 4

8:30-9:15	Werner Schmutz	Total Solar Irradiance - Reconstruction and a new value from PREMOS/PICARD
9:15-9:45	Amitava Bhattacharjee	Fast and Impulsive Magnetic Reconnection: Mediator of Geomagnetic Activity
9:45-10:15	Shashikumar Chitre	Helioseismic View of the Sun

10:15-11:00 Coffee

Session 5

11:00-11:30	Madhulika Guhathakurta	Sun-Climate Research in LWS/ILWS (Invited)
11:30-12:00	W. Dean Pesnell	The Solar Dynamics Observatory: The First Six Months
12:00-12:30	Jonathan Cirtain	New Results from Hinode: A Systems Science Approach to Heliophysics
12:30-12:50	Don Hassler	Imaging Spectroscopy as a Tool to Understanding Solar & Heliospheric Processes

12:50-14:20 Lunch

Session 6

14:20-14:50	Jean Rozelot	Variations of solar dimensions and relation to solar activity
14:50-15:10	Gabriel Chiodo	Solar cycle effects in two coupled chemistry-climate models
15:10-15:40	Girish T.E	Solar magnetic flux amplification factor and upper limit to solar activity and space weather
15:40-16:10	Gufran Beig	Long-term changes and solar signal in the upper atmosphere

16:10-17:20 Coffee & Posters

17:30 Shuttle to the beach

19:00 Return shuttle to hotel

Wednesday - 19th of January

Session 7

8:30-9:00	Juerg Beer	Potential and Limitations of Cosmogenic Radionuclides in Space Climate
9:00-9:30	Archana Bhattacharyya	Long term geomagnetic variations at a low latitude observatory
9:30-10:00	Kalevi Mursula	Latest News about the Bashful Ballerina

10:00-10:30 Coffee

Focus Topic/Working Group on Solar Minimum 23-24 Panelists: Jurg Beer, Sarah Gibzon, Hiroko Miyahara, Kalevi Mursula and Dibyendu Nandi.

10:30-11:00	Sarah Gibson	WHI in the Context of a Long and Structured Solar Minimum: An Overview of Sun-to-Earth Observations
11:00-11:30	Dibyendu Nandi	Origin of the Unusual Minimum of Solar Cycle 23
11:30-12:00	John Richardson	The Solar Wind in the Recent Solar Minimum: Effects at 1 and 100 AU
12:00-12:30	Hiroko Miyahara	Variations of solar activity, cosmic rays, and climate during the Maunder Minimum

12:30-13:00 Discusions

13:00-19:30 Lunch and Sightseeing Tour

Thursday - 20th of January

Session 8

8:30-9:15	Bruce Tsurutani	Long-Term Changes in the Solar Wind and Heliospheric Magnetic Fields and Interaction with Geospace
9:15-9:45	Nat Gopalswamy	Solar cycle variation of CMEs and CIRs
9:45-10:15	Prasad Subramanian	Cosmic Rays, Forbush Decreases and CMEs
10:15-10:45	P.K. Manoharan	Peculiar Minimum of Solar Cycle 23 - Structure of Three-dimensional Heliosphere

10:45-11:30 Coffee

Session 9

11:30-11:50	Brigitte Schmieder	CMEs in the Sun Earth System: origins and interplanetary signatures
11:50-12:10	Ramon Lopez	Long-Term solar wind variations
12:10-12:30	Dipankar Banerjee	Detection of Alfven waves from Spectral line width variations
12:30-12:50	Andrey Tlatov	The centenary changes of the solar corona shape and variation of a global magnetic field of the Sun

12:50-15:00 Lunch

Session 10

15:00-15:30	Nandita Srivastava	STEREO observations of CMEs : Kinematics and influence on Space Weather
15:30-16:00	Jon Egill Kristjansson	Is there a link between cosmic rays, clouds and climate?
16:00-16:30	Brian Alfred Tinsley	The Effect of the Global Electric Circuit on Clouds and Climate: Observations and Theory for both So

16:30-17:10 Coffee

Session 11

17:10-17:30	Ben Laken	Forbush decreases and anomalous cloud changes detected over Antarctica
17:30-18:00	Anders Tjulin	EISCAT_3D: A European three-dimensional imaging radar for atmospheric and geospace research

19:00 Banquet

Friday - 21st of January

Session 12

8:30-9:15	Stanley Solomon	Solar, Geomagnetic, and Chemical Effects on the Climate of the Upper Atmosphere
9:15-9:45	Dibyendu Chakrabarty	On the coupling issues of low latitude ionosphere-thermosphere system during space weather events
9:45-10:15	Franz-Josef Lübken	Solar and terrestrial effects in the mesosphere/lower thermosphere
10:15-10:35	Timo Asikainen	The longest systematically calibrated series of magnetospheric energetic particle measurements

10:35-11:20 Coffee

Session 13

11:20-11:50	Monika Korte	Long term changes of the geomagnetic field
11:50-12:10	Lilia Biktash	Solar wind energy input to the magnetospheric ring current in the 22 and 23 solar cycles
12:10-12:30	Rashmi Rawat	Geomagnetic storm signatures at low-latitudes during descending phase of solar cycle 23
12:30-12:50	Tamara Kuznetsova	Characteristic manifestations of long-periodic solar cycles in climate changes
12:50-13:10	Lev Pustil'nik	Space Climate infunce on crop and wheat prices

13:10 Lunch

13:10 SOC/LOC Meeting

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LIST OF POSTERS ACCORDING TO RESPONSIBLE AUTHOR

P1 **Aggarwal, Malini**: Variation of Equatorial ionization anomaly of GPS-TEC during low solar activity period

P2 **Aslam, O. P. M.**: Cosmic-Ray Modulation During Unusually Long Minimum of Solar Cycle 23: Tilt of The Current Sheet

P3 **Badruddin**: Role of Solar/Cosmic-Ray Variabitity on Weather and Climate: Indian Perspective

P4 **Bal, Sourabh**: Atmosphere-Ocean Response in Idealized 11-year Solar Cycle Experiments

P5 **Belova, Evgenia**: to be communicated by email later

P6 **Calogovič, Jasa**: Cosmic Ray Modulation by Solar Wind Disturbances

P7 **Calogovič, Jasa**: Testing a link Between Solar Irradiance and Atmospheric Parameters

P8 **Chikaraishi, Yusuke**: Study of Climate Sensitivity on Cloud Droplet Size and the Number Of Aerosols Using a General Circulation Model

P9 **Chitta, Lakshmi Pradeep**: Oscillations and Heating of the Solar Chromosphere at the Sites of Fine Scale Features

P10 **Dwivedi, Vidya Charan**: Solar & Interplanetary Sources of Major Geomagnetic Event Observed During Unusual Period Of Cycle 23

P11 **Getko, Ryszarda**: Statistics of Activity Complexes

P12 **Gigolashvili, Marina**: About Strange Behavior of the Solar Spectral Irradiance During Extended Minimum of the Solar Cycle 23

P13 **Gosain, Sanjay**: Role of Activity Nests in Long Term Cosmic Ray Modulation

P14 **Gupta, Girjesh**: On the Nature of Propagating Waves in Polar Coronal Hole

P15 **Hegde, Manjunath**: Rotation Rates of Coronal Holes and Their Probable Origin

P16 **Hegde, Manjunath**: Daily Variation of Area and Photon Flux of the Coronal Holes

P17 **Holappa, Lauri**: Dcx index server: local Dst indices for an extended station network

P18 **Javaraiah, Javaraiah**: Long-term Variations in the Evolutions of Sunspot Groups

P19 **Karak, Bidya Binay**: Effect of Turbulent Pumping on Solar Cycles Memory: Investigations using a Kinematic Dynamo Model

P20 **Kaushik, Subhash**: Interplanetary Transient Plasma and their Associated Space weather Impacts

P21 **Kirkwood, Sheila**: A search for AGWs of Auroral Origin in the Lower Stratosphere

P22 **Kolláth, Zoltán**: Parallels Among the "Music Scores" of Solar Cycles, Space Weather and Earth's Climate

P23 **Kuznetsova, Tamara**: Distinctive Features of Solar Cycle 23

P24 **Lopes, Ilídio**: A Low Order Dynamo Model with Time Dependent Meridional Circulation

P25 **Michalek, Grzegorz**: Are Cone Models of CMEs Correct?

P26 **Mittal, Nishant**: On Some Properties of SEP Effective CMEs

P27 **Muñoz-Jaramillo, Andrés**: The Double-Ring Algorithm: A Better Way of Modeling Active Regions in Kinematic Dynamo Models

P28 **Munteanu, Costel**: Improved Estimation of Propagation Times of Short-Term Interplanetary Magnetic Field variations

P24 **Passos, Dário**: A Low Order Dynamo Model with Time Dependent Meridional Circulation

P29 **Preminger, Dora**: Solar Activity vs. Brightness: Implications for How Solar Radiative Variability may Affect Climate

P30 **Rangaiah, Kariyappa**: UV Irradiance Variability from Spatially Resolved Images

P31 **Samayamanthula, Krishna Prasad**: Study of Coronal line Width and Intensity Variations Using Norikura Coronagraph

P32 **Savani, Neel**: Estimates of a CME's Cross Sectional Area in Interplanetary Space

P33 **Sharma, Rahul**: Identification of Signatures of Solar Filaments in ICMEs Using in-situ Measurements by ACE and Wind

P34 **Sharma, Sonia**: GLEs and Their Space Weather Aspects with Solar, Interplanetary and Geophysical Parameters

P34 **Sharivastava, Ashutosh**: GLEs and Their Space Weather Aspects with Solar, Interplanetary and Geophysical Parameters

P35 **Uddin, Wahab**: Study of Eruptive Flares from NOAA 10486 on 25 October, 2003

P36 **Verma, Virendra**: On halo CMEs and its relation Solar Activity Phenomena and Coronal Holes observed during 1996-2007

P37 **Virtanen, Ilpo**: Heliosphere at high latitudes and far distance: Southward shift of the HCS

P38 **Wauters, Laurence**: Quality Control of Geomagnetic Disturbance

TALKS

The longest systematically calibrated series of magnetospheric energetic particle measurements

T. Asikainen, V. Maliniemi and K. Mursula

Department of Physics, University of Oulu, Finland

The low-altitude polar orbiting NOAA/POES satellites have measured fluxes of energetic particles nearly continuously from 1978 up to the present, covering almost three solar cycles. However, using these data for long-term studies includes several problems, most importantly due to the significant degradation of the MEPED proton detectors caused by radiation. Radiation damage tends to increase the effective energy thresholds of the instrument, leading to underestimated particle fluxes already a couple of years after satellite launch. While the electron detectors do not directly suffer from degradation, their measurements are significantly contaminated by energetic protons. This contamination is possible to remove but it requires a prior calibration of the measured proton fluxes. We have recently analyzed the radiation damage suffered by the MEPED proton detectors and calibrated the entire dataset for these effects. This provides us with currently the longest systematically calibrated series of magnetospheric energetic proton and electron measurements. Such a data base opens interesting possibilities to study more reliably, e.g., the long-term evolution of the ring current and radiation belts, the dynamics of the magnetotail current sheet as well as particle precipitation into the atmosphere. Here we discuss the calibration procedure and the method of correcting the energetic particle fluxes and present the particle fluxes covering more than 30 years.

Detection of Alfven waves from Spectral line width variations

D. Banerjee

Indian Institute of Astrophysics, Koramangala, Bangalore 560034

We attempt to detect whether Alfvén waves are present in the polar coronal holes through variations in EUV line widths. Using spectral observations performed over a polar coronal hole region with the EIS spectrometer on Hinode and SUMER on SoHO we study the variation in the line width and electron density as a function of height. We use the density sensitive line pairs of Fe xii 186.88 Å and 195.119 Å and Fe xiii 203.82 Å and 202.04 Å for EIS and compare with results from SUMER. For the polar region, the line width data show that the nonthermal line-of-sight velocity increases from 26 km/s at 10" above the limb to 42 km/s some 150" (i.e. 110 000 km) above the limb. The electron density shows a decrease from 3.3×10^9 cm^{-3} to 1.9×10^8 cm^{-3} over the same distance. These results imply that the nonthermal velocity is inversely proportional to the quadratic root of the electron density, in excellent agreement with what is predicted for undamped radially propagating linear Alfvén waves. Our data provide signatures of Alfvén waves in the polar coronal hole regions, which could be important for the acceleration of the solar wind.

Potential and Limitations of Cosmogenic Radionuclides in Space Climate

J. Beer, J. Abreu, F. Steinhilber

EAWAG, PO Box 611, CH-8600 Duebendorf, Switzerland

In recent years cosmogenic radionuclides have become a widely used tool to reconstruct long-term solar variability on centennial and millennial time scales. While this property is unique and has the potential to provide a much better understanding of the solar dynamo and the history of space climate it has also created expectations which cannot be fulfilled. First of all cosmogenic radionuclides act as some kind of natural neutron monitor by recording the intensity of the galactic cosmic radiation. In contrast to modern man-made neutron monitors they have a much lower temporal resolution which is mainly limited by the time it takes to transport the cosmogenic radionuclides from the atmosphere where they are produced to the archive where they are stored. This not only reduces the temporal resolution, but it also introduces some noise which, together with changes in the geomagnetic field, disturbs the solar signal. Approaches to circumvent these problems will be discussed. The 10Be and 14C data will then be used to discuss several important features of the variability of the space climate over the past 10,000 y

Long-term changes and solar signal in the upper atmosphere

G. Beig

Indian Institute of Tropical Meteorology, Pune, India

During the past decade, several attempts have been made to analyze different series of long-term observations and to deduce mesospheric temperature trends. The comparison of the results obtained by different observations separated by several decades is complicated. Nevertheless, there are a number of occasions where a majority of the temperature trend results indicate consistency and some of the differences are even understandable. There are a growing number of experimental results centered on, or consistent with zero temperature trends in the mesopause region. The most reliable data sets show no significant trend, but with an uncertainty of at least 2K/decade. It is also increasingly clear that until the solar-related changes in the long term temperature series are well understood and quantified in the mesosphere, there is little hope of separating out changes due to longer-term secular variability caused due to human induced changes at the surface, much less gaining any insight into their causes. Present investigations have revealed the presence of a solar component in mesospheric temperature in several data sets but not as strong as reported earlier and in some cases no significant solar signal is found. In this talk, an update of the long-term trend and solar signal in temperature of the region from 50-100 Km has been made based on available understanding. However, now the major challenge is in the interpretation of the various reported results. There appears to be latitudinal as well as seasonal variability in the linear and solar trends. These issues are briefly discussed.

Fast and Impulsive Magnetic Reconnection: Mediator of Geomagnetic Activity

A. Bhattacharjee

University of New Hampshire, Durham, USA

Magnetic reconnection is ubiquitous in space and astrophysical systems, and widely believed to be responsible for near-explosive magnetic events and particle acceleration. The onset of fast reconnection is studied extensively in the context of eruptive flares, substorms in the Earth's magnetosphere, and laboratory experiments. These observations place strong constraints on theory, which must explain not only a fast reconnection rate but also a sudden increase in the time-derivative of the reconnection rate. We will show by means of theory and high-resolution simulations that important features of such dynamics in systems of moderate size can be accounted for in one unifying framework by means of the Hall MHD model. The problem takes on additional complexity when it is applied to large systems, which have been the subject of considerable interest recently. Thin current sheets in systems of large size that exceed a critical value of the Lundquist number are unstable to a super-Alfvénic tearing instability, referred to as the plasmoid instability because it is a copious source of plasmoids (or magnetic islands). As a result of this instability, the system is shown to realize a fast nonlinear reconnection rate that is independent of the Lundquist number of the plasma. The possible role of this instability in accelerating particles is discussed in the context of in situ observations from spacecraft in space, especially Cluster.

Long term geomagnetic variations at a low latitude observatory

A. Bhattacharyya, S. Alex, and B. D. Kadam

Indian Institute of Geomagnetism, Navi Mumbai, India

Indices of geomagnetic activity have been used in several studies of past solar activity and evolution of the heliospheric magnetic field, over the last 100 years or even longer. Geomagnetic field variations recorded at the few observatories that have been in existence for such long periods of time, also include the secular variations on decadal and longer time scales, which originate in the fluid outer core of the Earth. While geomagnetic indices are designed to eliminate the secular variation of the geomagnetic field, there still remains a question of the extent to which changes in the main geomagnetic field influence the geomagnetic field variations of solar origin, through changes in the magnetospheric and ionospheric current systems. It is also necessary to consider the regular variations in geomagnetic field caused by quiet time ionospheric currents that are generated by an ionospheric dynamo, which in turn is controlled by both the geometry of the main geomagnetic field and solar EUV radiation, as distinct from the irregular variations forced by solar wind - magnetosphere interactions, where the heliospheric magnetic field plays an important role. We focus on these issues using the long series of geomagnetic data available from the low latitude (geomagnetic latitude 10.4^o N) observatory at Alibag.

Solar wind energy input to the magnetospheric ring current in the 22 and 23 solar cycles

L. Biktash

Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation, IZMIRAN, 142190, Troitsk, Russia

The geomagnetic storms and the solar wind parameters as elements of equation in Dst simulation are analyzed during the last two solar cycles (22-23) to calculate the solar wind energy input rate to the magnetospheric ring current. Previous calculations of the solar wind energy input rate to the magnetospheric ring current were carried out for values of the solar wind electric field limited up to 16 mV/m. To study the strong solar wind electric fields effect on the ring current formation the severe geomagnetic storms with the high-speed solar wind and great negative Bz IMF values were selected. The characteristics of large-scale solar corona and solar wind structures are inspected for its effects on the magnetospheric ring growth. The rate of energy input to the ring current in the main phase of geomagnetic storms for 60 selected intervals versus the solar wind electric field is presented. The rate energy input to the ring current near 30 mV/m Ey values for the geomagnetic storms in 2000, 2003 and 2004 is calculated. These storms are determined as CMEs events storms. Furthermore, there were a lot of small and moderate geomagnetic storms for calculation the energy input rate for Ey values between 0 and 20 mV/m. They were mainly caused by the CIRs. These calculations show us also that the relationship between rate change of the ring current and Ey-component of the solar wind remains linearly proportional to great Ey values as in the case of small and medium storms during the last solar minimum.

On the coupling issues of low latitude ionosphere-thermosphere system during space weather events

D. Chakrabarty

Physical Research Laboratory, Ahmedabad, India

In order to address the climatology of the environment in the near-earth space, it is necessary to comprehensively understand the complex aspects of different space weather phenomena. Impacts of space weather events on the high latitude ionosphere and thermosphere are mostly direct. However, over low latitudes , some of the space weather effects are known to be nearly instantaneous whereas some other effects are known to reach with a time delay. For example, the prompt penetration/overshielding effects of interplanetary electric field during storm time as well as the effects due to substorms affect the low latitude ionosphere nearly instantaneously. On the other hand, the disturbance dynamo effects due to altered meridional circulation during post-storm periods, propagation of travelling ionospheric disturbances (TID) from high to low latitudes, compositional disturbances involve finite time delay. More often than not, the presence of multiple facets of these disturbances makes the task of gauging the impact over low latitude difficult. In addition, there is a serious dearth of investigations that address the impact of these events on the ionosphere-thermosphere system in totality. In the present talk, an attempt will be made to highlight a few results that have been obtained in recent times that throw light on the complex ionosphere-thermosphere coupling over low latitudes during space weather events.

Solar cycle effects in two coupled chemistry-climate models

G. Chiodo(1), N. Calvo(1,2), H. Schmidt(3) and R. García-Herrera(1)

(1) Universidad Complutense de Madrid, Madrid Spain
(2) National Center for Atmospheric Research, Boulder USA
(3) Max-Planck Institute for Meteorology, Hamburg Germany

The atmospheric response to the 11-yr solar cycle (SC) and to the combined Quasi-Biennal-Oscillation (QBO)-SC variations were analysed in an ensemble of simulations from the two coupled chemistry climate models: the Whole Atmosphere Community Climate Model version 3.5 (WACCM-3.5), and the HAMburg Model of the Neutral and Ionized Atmosphere (HAMMONIA). Both ensembles were carried out with a full set of observed forcings, including a time-varying and spectrally-resolved solar forcing. Composite and multiple linear regression analysis on the ensemble mean fields allow for accurate detection of the signal. On the other hand, a comprehensive comparison of each one of the ensemble realizations is a valuable test for the signal robustness. The analysis focuses on the annual mean model response to the solar cycle, and on the evolution of the solar signal during the Northern Hemispheric (NH) winter. Since the HAMMONIA model can simulate an internally generated QBO, the full interaction between QBO and SC can be investigated. It is shown that WACCM-3.5 and HAMMONIA simulate a significantly warmer stratosphere under solar maximum conditions, and the vertical structure of the signal in the tropics matches observations. The results in the extratropics are less statistically significant, because of the seasonal dependence of the response and high dynamical variability. Both models reproduce reasonably well the observed downward propagation of the solar signal during winter-time in the NH as a result of changes in wave-mean flow interactions. These results certify the validity of WACCM-3.5 and HAMMONIA in SC studies, and confirm the plausibility of dynamical mechanisms proposed by other authors in driving the downward propagation of the signal.

Helioseismic View of the Sun

S. Chitre

UM-DAE Center for Basic Sciences, University of Mumbai, India

With the accumulation of helioseismic data generated by the Global Oscillation Network Group(GONG) and the Michelson Doppler Imager(MDI) on board the SOHO satellite for over the past solar cycle 23,it has now become possible to study the temporal variations taking place inside the Sun .The appearance and disappearance of spots on the solar surface is the most striking manifestation of this cyclical phenomenon.One of the outstanding problems in Solar Physics is to identify the nature and location of the underlying mechanism responsible for driving the Sun's cycle and also to account for the simultaneous variation of oscillation frequencies,rotation rate,magnetic field and total solar irradiance in phase with the activity cycle.

The Solar Dynamo and Solar Cycle Predictions

A. R. Choudhuri

Department of Physics Indian Institute of Science, Bangalore - 560012, India

It appears that the strength of the polar field during a sunspot minimum gives an indication of the strength of the forthcoming cycle, although the statistical evidence is still limited at the present time. The irregularities in the theoretical flux transport dynamo models arise primarily from the fluctuations in the Babcock-Leighton mechanism for production of the poloidal field. I shall discuss how these fluctuations can be incorporated in theoretical mean field models by feeding the observational data appropriately and show that the correlation between the polar field at the minimum and the next cycle is reproduced only if the turbulent diffusivity of the convection zone is sufficiently high. Apart from making predictions for forthcoming cycles, the high-diffusivity flux transport dynamo model can be applied to explain the various irregularities of the sunspot cycle – such as the occurrence of the grand minima and the Waldmeier effect. I shall also make some comments on the fluctuations of the meridional circulation as an additional source of irregularities in sunspot cycles in addition to the fluctuations in the Babcock-Leighton mechanism.

New Results from Hinode: A Systems Science Approach to Heliophysics

J. W. Cirtain

NASA/MSFC, Huntsville, USA

Recent results from the analysis of Hinode data have been used to determine the origins of the fast and slow solar wind, possible heating sources for the solar corona, and onset locations for CMEs and polar x-ray jets. Using this information, and data collected by other observatories, major advances in the understanding of Heliophysics are now possible. These Hinode observation, and the techniques for analysis of the Hinode data will be discussed.

Long-term variations of solar dynamo parameters and effects on terrestrial climate

K. Georgieva, **B. Kirov**

Space and Solar-Terrestrial Research Institute, Bulgarian Academy of Sciences, Bulgaria

The relation between solar activity and terrestrial climate is not linear. Positive, negative or no correlations have been found for different periods, both in the 11-year sunspot cycle and on centennial time-scales. On the other hand, the relative importance of the different manifestations of solar activity also varies with time, apparently following a long-term cyclicity in the operation of solar dynamo. Here we study the long-term variations in the solar dynamo parameters, and their effects on the large-scale climatological phenomena and on global climate.

WHI in the Context of a Long and Structured Solar Minimum: An Overview of Sun-to-Earth Observations

S. Gibson

NCAR/HAO, Colorado, USA

Throughout months of extremely low solar activity during the recent extended solar cycle minimum, structural evolution continued to be observed from the Sun through the solar wind and to the Earth. In 2008, the presence of long-lived and large low-latitude coronal holes meant that geospace was periodically impacted by high-speed streams, even though solar irradiance, activity, and interplanetary magnetic fields had reached levels as low or lower than observed in past minima. This time period – of which the Whole Heliosphere Interval (WHI: CROT 2068) is typical – illustrates the effects of fast solar wind streams on the Earth in an otherwise quiet heliosphere. By the end of 2008 sunspots and solar irradiance had reached their lowest levels for this minima (e.g., CROT 2078), and continued solar magnetic flux evolution had led to a flattening of the heliospheric current sheet and the decay of the low-latitude coronal holes and associated Earth-intersecting high-speed solar wind streams. This simplified heliospheric morphology was associated with record levels of cosmic rays (high) and radiation belt flux (low). As the new solar cycle slowly began, solar wind and geospace observables stayed low or continued to decline, reaching a minimum in summer 2009 (e.g. CROT 2085) and a Sun-Earth system at its quietest. In this paper we will present an overview of observations that span the period 2008-2009, with highlighted discussion of CROTs 2068, 2078, and 2085. We will show side-by-side observables from the Sun's interior through its surface and atmosphere, through the solar wind and heliosphere and to the Earth's space environment and upper atmosphere, and reference detailed studies of these various regimes within this special issue and elsewhere.

Solar magnetic flux amplification factor and upper limit to solar activity and space weather

T. E. Girish and G. Gopkumar

Department of Physics, University College, Trivandrum, India

We have inferred poloidal to toroidal solar magnetic flux amplification factor (Af) during the past 400 years using proxy observations such as geomagnetic data and polar ice nitrate inferences of solar particle events. Inverse relation between Af and maximum sunspot number (Rm) during cycles 9-23 is used to estimate an upper limit for the sunspot activity (Rm ¡300). An upper limit to the extreme space weather activity is also inferred whose validity will be discussed using current physical models .

Solar cycle variation of CMEs and CIRs

N. Gopalswamy

NASA Goddard Space Flight Center, Maryland, USA

Coronal mass ejections (CMEs) and high-speed solar wind streams (HSS) are two solar phenomena that produce large-scale structures in the interplanetary (IP) medium. CMEs evolve into interplanetary CMEs (ICMEs) and the HSS result in corotating interaction regions (CIRs) when they interact with preceding slow solar wind. CMEs and CIRs originate from closed (active region and filament region) and open (coronal hole) magnetic field regions on the Sun, respectively. These two types of mass emissions from the Sun are responsible for the largest effects on the heliosphere, particularly on Earth's space environment. This paper discussed how these structures and their solar sources vary with the solar cycle and the consequent changes in the geospace impact.

Sun-Climate Research in LWS/ILWS (Invited)

M. Guhathakurta

NASA Headquarters, Washington D. C., USA

Space weather and space climate on extrasolar planetary systems

A. Hanslmeier

Institut f. Physik, Univ. Graz, Austria

We will present a study on space weather and climate on solar like and late type stars. The habitable zone around a central star strongly depends on the short and long term variation of the host star. Also factors that mitigate the influence of the host star on a planet have to be discussed: planetary magnetospheres, rotation, tidal locking, existence of giant planets etc. Finally, for the space climate, also local stellar environment in a galaxy plays a crucial role.

Imaging Spectroscopy as a Tool to Understanding Solar & Heliospheric Processes

D. M. Hassler

Southwest Research Institute, Boulder, USA

This talk will discuss the use of UV imaging spectroscopy as a tool to understanding Solar atmospheric processes and the flow of mass and energy from the solar surface into the heliosphere. These techniques are essential to fully understanding solar variability and the mechanisms responsible for both large and small scale solar activity. The role of UV imaging spectroscopy in current and future space missions, including the upcoming ESA/NASA Solar Orbiter mission will also be discussed.

Modeling Solar Cycle Irregularities Using Flux Transport Dynamo Models

B. B. Karak(1), D. Nandy(2) and Arnab Rai Choudhuri(1)

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The sunspot number varies roughly periodically with time. However the individual cycle durations and amplitudes are found to vary in an irregular way. It is observed that the stronger cycles are having less rise time and vice versa. This leads to an important effect know as Waldmeier effect. Another important feature of the solar cycle irregularity are the grand minima during which the activity level is strongly reduced. We explore whether these irregularities can be studied with the help of the flux transport dynamo model of the solar cycle. We show that with a suitable stochastic fluctuations in the regular dynamo model, we are able to reproduce many irregular features of solar cycle including the Waldmeier effect and grand minimum. However, we get all these results only if the value of turbulent diffusivity is reasonably high. We also discuss the effect of turbulent pumping on the solar cycle memory.

Long term changes of the geomagnetic field

M. Korte

Helmholtz-Centre Potsdam, GFZ German Research Centre for Geosciences

The geomagnetic core field varies on a broad range of time-scales, from years to millions of years. Changes during the past few hundred years are well known through data from magnetic observatories, satellite missions and historical field observations. Longer term field evolution can be reconstructed from the remanent magnetization preserved in rocks and archeological artifacts. Several spherical harmonic models describe the global magnetic field evolution over the past decades, centuries and a few millennia. For longer time spans, the global distribution and dating accuracy of available paleomagnetic data are not yet sufficient for global spherical harmonic modelling. Estimates of dipole moment evolution are obtained from averaging regional records. Here, an overview over the past geomagnetic field evolution as given by different models and reconstructions over various time intervals is presented and resolution and accuracy limitations are discussed.

Is there a link between cosmic rays, clouds and climate?

J. E. Kristjánsson(1), C. W. Stjern(1) and G. Myhre(2)

(1) University of Oslo, Norway
(2) Cicero, Oslo, Norway

Despite recent advances in climate research, there is still a large uncertainty concerning the role of solar activity for climate variations. In addition to variations in total solar irradiance (TSI), growing attention has recently been paid to possible mechanisms that might enhance the relatively weak signal from TSI. Among these is the suggestion of a modulation of clouds by galactic cosmic rays, either via cosmic ray induced ionization (CRII) or via electrical charges associated with clouds. Since clouds strongly influence the Earth's radiation budget through reflection of solar radiation and trapping of thermal infrared radiation, variations in cloud amount might exert a strong signal on the climate system. Such cosmic ray effects have been proposed on various time scales, ranging from days in the case of Forbush Decrease events via decades in the case of solar cycle variations to time scales of millions of years in the case of galaxy spiral band variations. Despite the controversy, climate models have now started accounting for CRII as a possible catalyst for aerosol formation in the presence of precursor gases. We will start by presenting a general overview of this complicated and contentious topic. We will then present some new results using the best available satellite data for cloud properties and radiative fluxes, applying them to recent Forbush Decrease events. The results will be interpreted in the context of global warming and climate sensitivity.

Characteristic manifestations of long-periodic solar cycles in climate changes

T. Kuznetsova

IZMIRAN, Russian Academy of Sciences, 142190 Moscow region, Troitsk, Russia

The observed substantial increase in the Earth's temperature since the beginning of the last century has attracted a great deal of attention to the problem of climate change. This study is an attempt to find answers to problem of climate change. The report presents results of our study concerning links between changes of solar activity (sunspot numbers W), Earth's global surface temperature (Tgl) to understand their connection on different time scales in the past, present and close future. We use W for the period 1700-2005 and proxy data of Tgl for the last 1000 yrs. In case of necessity we attract other geophysical and interplanetary data. We apply MGM method of spectral analysis elaborated by us that can quantitatively describe both trends and non-stationary variations to evaluate their input in data. Characteristics of cycles in Tgl and W with the same periods are discussed in detail. In particular, power trend in Tgl at period 1000 yr shows rise since Maunder minimum correlated with trend in W. High-amplitude 200-yr cycles in W and in Tgl have passed their maxima and show decrease of their parameters. The 200-yr variation in interplanetary magnetic field also shows decline. This 200-yr solar cycle contributed to the Tgl rise for to the last century. Based on analysis of components in the W and Tgl spectra (taking into account error bars) we suggest a possible interpretation periods in the Tgl spectrum by periods of solar-lunar origin. Long before the theories of the motions of the Sun and the Moon had reached development, astronomers noted that eclipses occurred at semi-regular intervals. Ancient astronomers used such eclipse cycles as Saros (18.0 yr) – similar solar eclipses spaced about 120^o apart in terrestrial longitude and Inex (28.9 yr) - similar solar eclipses at the same terrestrial longitude but opposite latitudes. Numerous eclipse cycles can be constructed by combining basic cycles such as Saros and Inex in different ways. Specifically, periods of 1040yr=36 Inex (so called Double Basic Period) and of 203yr=7 Inex in the Tgl spectrum can be periods of these eclipse cycles. Well-known 86.8-yr Gleisberg cycle in Tgl we interpret as triple Inex (Triad). Characteristics of the other cycles in Tgl and W with close periods are also discussed. Based on our results we discuss possible ways of the solar-lunar influence on atmospheric and geophysical processes.

Forbush decreases and anomalous cloud changes detected over Antarctica

B. Laken(1) and A. Wolfendale(2)

(1) Instituto de Astrofísica de Canarias, Tenerife, Spain
(2)Department of Physics, Durham University, UK

Changes in the galactic cosmic ray (GCR) flux due to variations in solar activity may provide an indirect connection between the Sun and Earth's climate. Epoch-superpositional (composite) analyses of high magnitude GCR fluctuations, known as Forbush decrease (FD) events, have been widely used to test this hypothesis, with varied results. This work provides new information regarding the interpretation of this approach, suggesting that FD events do not isolate the impacts of GCR variations from those of solar irradiance changes. On average, irradiance changes of 0.4 $W\ m^{-2}$ occur around two days in advance of FD-associated GCR decreases. Using this two-day gap to separate the effects of irradiance variations from GCR on cloud cover we demonstrate the presence of small, but statistically significant, anomalous cloud changes occurring over areas of the Antarctic plateau in association with the irradiance changes, which previous workers had attributed to GCR variations. This finding suggests that past FD-based studies may have ineffectively isolated the impacts of GCR variations on the Earth's atmosphere from changes in solar irradiance.

Long-Term solar wind variations

R. E. Lopez

Department of Physics, University of Texas, Arlington, USA

In this paper I will present an examination of long-term variations in solar wind mass, energy and momentum flux, as well as magnetic field as measured at 1 AU. For several solar cycles in the space age these quantities had been increasing. This changed after solar cycle 23, and all of the fluxes in the solar wind decreased to the very low values that marked the very deep solar minimum. Solar wind fluxes have still not recovered to overall values typical of previous solar minimums, even though the Sun is technically no longer at minimum. I will also discuss long-term variation in the relationships between solar wind temperature and velocity and momentum flux, which have been interpreted a signatures of the acceleration processes that produce the solar wind.

Solar and terrestrial effects in the mesosphere/lower thermosphere

F. J. Lübken

Leibniz Institute of Atmospheric Physics, Kühlungsborn, Germany

The mesosphere/lower thermosphere is located at the interface of the Earth's atmosphere and space. Therefore, solar and terrestrial processes are both important for the dynamical and thermal state of the MLT region. At the same time the relevance of basic physical phenomena changes at these heights since spatial and temporal scales of some molecular and macroscopic processes are of similar importance. The MLT region at polar latitudes is special: the lowest temperatures in the Earth's atmosphere are found here during summer in a condition of permanent sunshine. These low temperatures cause ice clouds known as, for example, noctilucent clouds (NLC). NLC are considered to be indicators of anthropogenic trends but are also sensitive to solar radiation. In this presentation new results on solar/terrestrial effects on NLC will be presented including new observations from ground based and satellite borne instruments as well as consequences from global and microphysical modeling. Solar influence on composition (mainly water vapor) and temperatures in the MLT region will be discussed. As will be shown the stratosphere significantly affects mesospheric ice cloud formation. Basically all models show that increasing greenhouse gases will enhanced cooling of the entire middle atmosphere, except for the summer mesopause region where the atmosphere warms. The potential role of mesospheric ice clouds for the detection of solar and terrestrial effects in the MLT region will be summarized.

Peculiar Minimum of Solar Cycle 23 - Structure of Three-dimensional Heliosphere

P. K. Manoharan

Radio Astronomy Centre, National Centre for Radio Astrophysics, Tata Institute of Fundamental Research, Udhagamandalam (Ooty), India

In this presentation, I review the results of three-dimensional evolution of the inner heliosphere over the solar cycle 23, based on Interplanetary Scintillation measurements made at 327 MHz using the Ooty Radio Telescope. The peculiar prolonged low solar activity eventually led to a heliosphere of low density, speed, and magnetic field. In this study, the large-scale features of the inner heliosphere obtained from a large number of solar wind measurements at each phase of the solar cycle 23 reveal a chaotic magnetic configuration than an expected nearly-dipole geometry at the minimum phase. The overall scattering diameter of the solar corona has significantly shrunk after about the year 2004 and resulting in a less turbulent heliosphere towards the end of the cycle. These findings may be related to the slowing down of the dynamo that generates the solar magnetic field.

The Faint Young Sun Problem: A Solar Origin?

P. C. H. Martens

Physics Department, Montana State University

While much (necessary) attention is being paid to the possible influence of the Sun on global climate variation in the last millennium, there is an even more astounding problem in the mismatch between solar luminosity and terrestrial climate in the first several billions of years of the Earth's existence, an issue known as the "Faint Young Sun Paradox". In brief the paradox is this: The geological and biological record support that the Earth's biosphere was considerably warmer than currently during the origin of life on Earth and for several billions of years thereafter. Yet, stellar evolution calculations support the Sun reaching the Zero Age Mean Sequence at about 75% of its present luminosity, and linearly increasing in time up to its current level. Climate models predict a "Snowball Earth"; for such a low solar constant, unless the greenhouse effect were much stronger than what it is now. However, there is no geological evidence for a hugely increased presence of greenhouse gasses in the early atmosphere. For possible solutions scientists have typically pointed fingers at other disciplines: Earth scientists suspect the Sun was much more luminous in the past than astronomers calculate. Solar scientists point to stronger geological activity on the early Earth, etc. As of now there is no theory, or even a credible scenario, to resolve this issue. However, recent observations point towards the Sun for a resolution of the paradox. Most important are the results from the Mars Rovers that show that Mars has had periods with a seeming abundance of liquid water over billions of years. If both Mars and Earth both have had liquid water over their history then it is reasonable to look for a common cause, i.e. a more luminous Sun than simulations indicate. One possibility for a brighter young Sun would be if the Sun had only about 5% more mass at its origin than it has now, and consequently, has lost the excess mass through the solar wind. Model calculations have been invoked to discard this possibility, but a comparison with observations of other Sun-like stars in earlier phases of their evolution indicates that their observed spin-down rates are consistent with much higher mass losses, potentially enough for a 5% mass loss over the Sun's almost five billion year lifespan. Calculations and simulations will be shown that tentatively support this hypothesis. The question remains what observations can be made to verify or discard the existence of a massive solar wind through much of the Sun's history.

Variations of solar activity, cosmic rays, and climate during the Maunder Minimum

H. Miyahara(1), Y. Yokoyama(1), Y. T. Yamaguchi(1), H. Matsuzaki(1) and T. Nakatsuka(2)

(1) The University of Tokyo, Japan
(2) Nagoya University, Japan

We review our results on the variations of solar activity, cosmic rays and climate change around the Maudner Minimum revealed by the measurements of cosmogenic and stable isotopes in tree rings as well as the cosmogenic isotope in ice cores. We have found that the solar cycles are lengthened not only at the Maunder Minimum but also at the two preceding solar cycles. It might help in understanding the mechanism of the occurrence of prolonged sunspot absence. We also find that the Hale cycle in cosmic ray variation is amplified at the Maunder Minimum, suggesting that the drift effect had played important role in solar modulation of cosmic rays at this period. The pattern of the cosmic ray variation is characteristic, suggesting the possibility of deriving the information on the structure of solar and heliospheric magnetic field at the sunspot absence. We also observe in reconstructed climate record the amplification of Hale cycle. The phase of this cycle is in synchronization with the Hale cycle of cosmic rays. It suggests that solar magnetic field had been playing important role in climate change possibly through modulating the galactic cosmic rays.

Are Active Regions as Relevant for the Solar Cycle as we Think?

A. Muñoz-Jaramillo(1,2) D. Nandy(3) and P. C. H. Martens(2,1)

(1) Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
(2) Montana State University, Bozeman, USA
(3) Indian Institute of Science Education and Research - Kolkata, India

The long and short term variability of the Sun is strongly determined by the evolution of the solar magnetic cycle, which is sustained through the action of a magneto-hydrodynamic dynamo. In our current understanding of the dynamo, the poloidal field (which acts as a starting point for the cycle) is recreated through the emergence and decay of active regions subjected to the collective effect of meridional circulation and turbulent diffusion; a process commonly referred to as the Babcock-Leighton mechanism. Dynamo models based on this mechanism have been quite successful in reproducing the different properties of the solar cycle and have also been used to make predictions of cycle 24. However, the question of whether the BL mechanism is enough to sustain the solar cycle has not yet been addressed quantitatively. By including real active region data in our state of the art kinematic dynamo model we find that the BL mechanisms is not enough to sustain the cycle both in terms of magnetic field amplitude and flux. Here we will show the results of this work. This work is funded by NASA Living With a Star grant NNG05GE47G.

Latest News about the Bashful Ballerina

K. Mursula, I. Virtanen, I. Usoskin and L. Zhang

University of Oulu, Oulu, Finland

It is known since long that solar activity is unevenly distributed over the solar surface, both along the solar longitude and between the two solar hemispheres. Related studies of hemispheric and longitudinal asymmetries have been pursued for long, using different methods and different activity parameters. Unfortunately, these studies have so far remained at a rather marginal status due to the rather inconclusive and sporadic occurrence of the asymmetries. However, it is known since recently that the solar hemispheric asymmetries depict a systematic long-term patterns that have prevailed for more than a century. Also, using a dynamic reference frame, more significant longitudinal asymmetries have been found that are quite similar for different solar parameters. Also, solar longitudinal asymmetries depict systematic long-term patterns that seem to be common for all cool stars. We review here these recent developments on solar hemispheric and longitudinal asymmetries and their role in improving our understanding solar activity and solar magnetic field generation. We also note that solar asymmetries affect the Earth's space environment and that the newly found patterns allow the possibility to make better long-term forecasts of solar related disturbances in near-Earth space.

Origin of the Unusual Minimum of Solar Cycle 23

D. Nandy(1), A. Muñoz-Jaramillo(2,3) and P. C. H. Martens(2,3)

(1) Indian Institute of Science Education and Research - Kolkata, India
(2) Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
(3) Montana State University, Bozeman, USA

The minimum of solar cycle 23 was characterized by very weak polar field strength and a large number of sunspot-less days that was unprecedented in the space age. This has had significant consequences in the heliospheric space environment in terms of record-high cosmic-ray flux and low levels of solar irradiance - which is the primary natural driver of the climate system. During this un-anticipated phase, there was some speculation as to whether the solar minimum could lead to a Maunder-like grand minimum which coincided with the Little Ice Age. In this talk we will present the first consistent explanation of the defining characteristics of this unusual minimum based on variations in the solar meridional plasma flows.

The Solar Dynamics Observatory: The First Six Months

W. D. Pesnell and the SDO Science Team

NASA GSFC, Maryland, USA

The Solar Dynamics Observatory (SDO) was launched on February 11, 2010 into the partly cloudy skies above Cape Canaveral, Florida. Over the next month SDO moved into a 28 degree inclined geosynchronous orbit at the longitude of the ground station in New Mexico. SDO is the first Space Weather Mission in NASA's Living With a Star Program. SDO's main goal is to understand and predict those solar variations that influence life on Earth and our technological systems. The SDO science investigations will determine how the Sun's magnetic field is generated and structured, how this stored magnetic energy is released into the heliosphere as the solar wind, energetic particles, and variations in the solar irradiance. The SDO mission consists of three scientific investigations (AIA, EVE, and HMI), a spacecraft bus, and a dedicated Ka-band ground station to handle the 150 Mbps data flow. SDO continues a long tradition of NASA missions providing calibrated solar spectral irradiance data, in this case using multiple measurements of the irradiance and rocket underflights of the spacecraft. The other instruments on SDO will be used to explain and develop predictive models of the solar spectral irradiance in the extreme ultraviolet. Science teams at LMSAL, LASP, and Stanford are responsible for processing, analyzing, distributing, and archiving the science data. We will talk about the launch of SDO and describe the data and science it is providing to NASA.

Space Climate infunce on crop and wheat prices

L. Pustil'nik(1) G. Yom Din(2)

(1) Israel Cosmic Ray and Space Weather Center, Mortimer and Raymond Sackler Institute of Advanced Study of Tel Aviv University, Israel
(2) Golan Research Institute, Haifa University, Israel

The model of possible influence of space weather on Earth wheat markets is described. The model is based on cause-sequence chain “space weather” - “earth weather” - “agriculture production-crop” - “price”. In the frame of the proposed approach, sensitivity of earth markets to space weather state are not universal phenomena, realized in any time and in any phase, but require for realization specific necessary conditions caused by critical state of atmosphere, agriculture production and wheat market. It is shown with high confidence level that this influence had place in of Middle Age England. It is shown that sensitivity of the European wheat markets to space weather factor (include signature of sensitivity) depend on location in corresponding climate zone. It is shown that even in modern epoch effect of dependence of market price on wheat had place in USA for wheat “durum”, produced in very compact region, sensitive to weather variation controlled by North Atlantic oscillation (NAO). It is shown coincidence of moments of mass mortality in Iceland in 18-19 centuries (caused by famines because reducing of livestock) with extremal phases of solar activity. All these observational facts are in good agreement with proposed model of possible space weather influence on wheat markets.

Palaeomonsoon and Solar activity

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(1) Physical Research Laboratory, Ahmedabad, India
(2) National Centre for Antarctic and Ocean research, Goa, India

We have used oxygen isotope ratios to reconstruct past monsoon variations with varying time resolutions during the past 20,000 years using a variety of natural proxies such as marine sediments and speleothems. We discuss the robustness and reliabilty of such paleomonsoon reonstructions and show that several important solar periodicities are present in all these records. We also discuss possible mechanisms for the solar-monsoon connection.

Geomagnetic storm signatures at low-latitudes during descending phase of solar cycle 23

R. Rawat and S. Alex

Indian Institute of Geomagnetism, Navi Mumbai, Maharashtra, India

Geomagnetic storms have been identified as the primary manifestation of the dynamic interaction between sporadic transient eruptions from the Sun, like coronal mass ejections, solar flares and fast wind streams from coronal holes, with the Earth's magnetosphere. Magnetic reconnection is the dominant process responsible for the energy transfer from solar wind into the magnetosphere. IMF Bz plays crucial role for occurrence of efficient reconnection mechanism. Solar cycle 23 witnessed numerous energetic solar eruptions in the descending phase (2002-2006) unlike the previous solar cycles. This period evidenced many intense geomagnetic storm events. Present work attempts for investigative analysis to ascertain the contribution of solar wind and interplanetary parameters like IMF By, Bz and dynamic pressure for the development of intense main phase for the storms that occurred between 2002 and 2006. Different interplanetary drivers like interplanetary coronal mass ejections (ICMEs) comprising magnetic cloud structures responsible for producing significant southward Bz are also discussed. Geoeffectiveness of the rapidly changing interplanetary conditions on the geomagnetic field variations are examined using the digital magnetic data from the chain of low-latitude geomagnetic observatories in the Indian longitude sector along with satellite observations of solar wind plasma and interplanetary parameters.

The Solar Wind in the Recent Solar Minimum: Effects at 1 and 100 AU

J. D. Richardson

Kavli Center for Astrophysics and Space Science, MIT, Cambridge, MA

The recent solar minimum was remarkable in that the solar wind magnetic field, plasma flux, and dynamic pressure all were at the lowest values ever observed. Although the magnetic field started to recover in 2010, the plasma flux and pressure continue to decrease and may do so until the next solar maximum. We present the latest solar wind results from the WIND spacecraft at 1 AU and from the Voyager spacecraft near 100 AU. The decreased magnetic field and solar wind flux and pressure decrease the cosmic ray modulation in the heliosphere and cause the heliosphere to contract. We discuss the effects of this contraction on the cosmic ray modulation. We will show how the flows, fluxes, particle intensities, and fields observed by the Voyager spacecraft continue to be affected by the unusual solar conditions.

Variations of solar dimensions and relation to solar activity

J. P. Rozelot

Nice University, Observatoire de la Cote d'Azur, France

Variations of the Sun's shape, its effective temperature and irradiance are ultimately related to solar activity. However, further investigations are needed on how a weak magnetic variation field might cause variations in the irradiance amplitude, combined with a shrinking or an expanding shape. We will here review the question of how the Sun's size may evolves in time by showing up to dated results from space (SOHO, RHESSI) or ground-based observations at the Pic du Midi Observatory in France. Indeed helioseismology results allow us to look at variations below the surface, where changes are not uniform, that puts in evidence a new shallow layer, the leptocline. Based on accurate space and ground-based observations, we will show that the oblateness of the Sun is time dependent, in phase with solar activity. We will propose a mechanism to explain this dependence. The concept will be extend to the asphericity-luminosity parameter which seems a key point to understand where the luminosity is produced. New dedicated space missions, such as SDO, already launched, or Dynamiccs (launch scheduled in a near future) will provide us a unique opportunity to study in detail changes of the global solar properties and their relationship to changes in the Sun's interior.

Solar Influence on the Earth's Climate on global and regional scales

A. Ruzmaikin

Jet Propulsion Laboratory, California Institute of Technology, USA

Global response of the Earth's climate system to solar variability appears to be weak and more strong responses are found in particular regions of the Earth such as near the poles and in the tropics. These responses are associated with the Earth's atmospheric and ocean dynamics (c.f. Hadley and Walker circulation in tropics, Brewer-Dobson circulation in the stratosphere). The Earth's dynamics generates large-scale spatial patterns. Examples of these patterns are the Northern and Southern Annular Oscillations and El Niño. In my talk I will discuss how solar variability influences these naturally produced climate patterns.

CMEs in the Sun Earth System: origins and interplanetary signatures

B. Schmieder(1), P. Demoulin(1), C. Mandrini(2), P. K. Manoharan(3), R. Chandra(4), P. Venketkrishnan(5) and W. Uddin(6)

(1) Observatoire de Paris, LESIA, Meudon, France
(2) IAFE, Buenos Aires, Argentina
(3) Radio Astronomy Centre, Tata Institute of Fundamental research, Udhagamandalam (Ooty), India
(4) Department of Science and Technology, Nainital, India
(5) Udaipur Solar Observatory, Udaipur, India
(6) ARIES, Manora Peak, Naininta l, India

During the maximum of the last Solar Cycle solar cycle 23, large active regions had a long life spanning several solar rotations and produced a large number of X-ray class flares, CMEs and Magnetic clouds (MC). This was the case for the Halloween active regions in 2003. The most geoeffective magnetic cloud of the cycle (Dst=-457) has its source in one passage of the active region (NOAA 10501) on November 18, 2003. Such an activity is presumably due to continuous emerging magnetic flux that was observed during this passage. Moreover, the region exhibited a complex topology with multiple domains of distinct magnetic helicities. The complexity is observed to reach such unprecedented levels that a detailed multi wavelength analysis is necessary to precisely identify the sources of CMEs and MCs. The identification of the clouds has been checked by in situ measurements and Interplanetary scintillation technique (IPS)

Total Solar Irradiance - Reconstruction and a new value from PREMOS/PICARD

W. Schmutz

Physical-Meteorological Observatory/World Radiation Center, Davos, Switzerland

PREMOS is a radiometer experiment on the French satellite PICARD build by PMOD/WRC. PREMOS measures Total Solar Irradiance and spectral solar irradiance in selected wavelength bands. PICARD was launched on June 15, and the experiment PREMOS is operational since July 27. PREMOS is the first fully SI-traceable space radiometer and its new value has decided which of the previous discrepant absolute TSI values from VIRGO/SOHO or TIM/SORCE is more correct. The initial sensitivity changes of PREMOS leads to a re-investigation of the early VIRGO/SOHO measurements and a new trend of the TSI between the solar minimum in 1996 and the recent mimimum in 2008 is derived. A new approach to the reconstruction TSI of the past by Shapiro et al. (submitted to A&AL) has brought back into the discussion a large TSI amplitude of the order of 6 W/m2 between the Maunder Minimum and the present. The basic assumption, which leads to this result, will be presented and discussed.

Solar, Geomagnetic, and Chemical Effects on the Climate of the Upper Atmosphere

S. C. Solomon

High Altitude Observatory, National Center for Atmospheric Research, Boulder, Colorado, USA

Thermospheric temperature and density respond primarily to forcing by solar ultraviolet radiation, which causes dramatic changes on solar-cycle and solar-rotational periodicities. This also controls the large-scale variability of the ionosphere. However, geomagnetic disturbances also play a role, so the variation of the solar magnetic field and energetic particle output, and their interaction with the evolving terrestrial magnetic field, is important to the thermosphere/ionosphere system on a wide range of time scales. Combined with these is the effect of changes in atmospheric composition, crucial to long-term evolution, thought to be fairly stable for the last few millennia, but now evolving rapidly again as the result of anthropogenic emissions. In addition, there is a large seasonal variation of major thermospheric composition. The confluence of all these effects with the recent long and deep solar minimum caused the terrestrial thermosphere to be colder and less dense during the summers of 2008 and 2009 than at any other times during the history of space exploration, and likely in the past several centuries.

STEREO observations of CMEs : Kinematics and influence on Space Weather

N. Srivastava

Udaipur Solar Observatory, Physical Research Laboratory, India

In this talk, I will present observations of a few CMEs obtained by SECCHI suite of instruments aboard STEREO spacecraft. These were observed by EUVI disk imager, COR1 and COR2 coronagraphs of the SECCHI package. The observations of CMEs were reconstructed in 3D using Tie-Point reconstruction and Forward Modeling techniques, and their kinematics were studied. This study yields information on true speeds of different features of CMEs viz. leading edge and prominence, and on their true direction of propagation in the interplanetary medium. The results of study of kinematics seems to have a direct bearing on the arrival time of the CMEs and hence the prediction of space weather. I will also compare the estimated arrival time of the CMEs at the earth obtained from 3D reconstruction of images obtained from two vantage points (STEREO) with those obtained by plane-of-sky observations from a single view point (SOHO). We find that arrival time estimated by STEREO observations are in much better agreement with the actual arrival time than those estimated by SoHO observations.

Cosmic Rays, Forbush Decreases and CMEs

P. Subramanian(1), K. P. Arun-Babu(1), S. Gupta(2) and H. M. Antia(2)

(1) Indian Institute of Science Education and Research, Pune, India
(2) Tata Institute of Fundamental Research, Mumbai, India

The physical properties of the near-earth manifestations of CMEs and their associated shocks are probed in a unique manner by transient decreases in the cosmic ray intensity. We use data from the GRAPES-3 cosmic ray telescope at Ooty, operated by the TIFR for this purpose. We are finding results that are changing our perceptions about the principal progenitors of Forbush decreases, and are also gaining insight into the perpendicular diffusion of charged particles in turbulent magnetic fields.

Two Centuries Space Weather and Climate

L. Svalgaard

Stanford University, California, USA

In the last decade we have learned how to interpret on a physical basis the 2 centuries long record of geomagnetic variations. We have learned how to reliably extract values and time variations for the magnetic field in the heliosphere, the solar wind speed, and to some extent the solar wind density back to the time of the beginning of geomagnetic observations. This talk describes our understanding of the physics of the interaction between the various elements of space weather and space climate, and the methods in which this understanding is brought to bear on assessing the long-term variations of the solar input to geospace. The past being a guide to the present, we speculate what the future might bring.

The Effect of the Global Electric Circuit on Clouds and Climate: Observations and Theory for both So

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The downward flow of current density (Jz) in the global electric circuit creates space charge in gradients of resistivity (due to gradients of droplet concentration and humidity) in clouds, in accordance with Ohm's Law and Gauss's Law. The gradients are found both within clouds and at the boundaries of clouds. The space charge is partitioned between aerosol particles and droplets, and the charges significantly affect scavenging rates and concentrations of cloud condensation nuclei (CCN) and ice-forming nuclei (IFN). Solar inputs that affect Jz include changes in the interplanetary electric field; solar energetic particles; relativistic electron precipitation, and in the cosmic ray flux. Atmospheric responses are observed for all four inputs. Since the first three do not change tropospheric ionization, ion-mediated nucleation cannot be responsible for these responses, and Jz changes can qualitatively account for all, via changes in aerosol scavenging. Corresponding atmospheric responses are found for Jz changes due to variations in the upward current to the ionosphere from thunderstorms and highly electrified clouds. The cloud microphysical responses to Jz produce changes in precipitation, cloud cover, and winter storm vorticity that can affect storm tracks and the advection of cold polar air in winter to lower latitudes. The present need is for the parameterization of CMAS (Charge Modulation of Aerosol Scavenging) and its use in models of clouds, which can then be inserted into GCMs

EISCAT_3D: A European three-dimensional imaging radar for atmospheric and geospace research

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EISCAT_3D is a next generation incoherent scatter radar system that will be built in northern Fenno-Scandinavia. This facility will provide better resolution and higher power than what is available today, combined with volumetric imaging and built-in interferometry capabilities as well as opportunities for continuous measurements. Several scientific areas will benefit from the capacities that EISCAT_3D will accommodate. These include studies of the solar-terrestrial energy input into the upper atmosphere coupling to the middle and lower atmosphere, the non-linear coupling dynamics, natural variability and long-term trends, the solar-terrestrial energy impact on climate change via atmospheric chemistry and electricity, and the development of predictive modelling capabilities. Fundamental space plasma physics research of turbulence, dusty plasmas, wave-plasma interactions, resonances, and plasma irregularities in the ionosphere will also be strengthened, and extended with the possibility to explore applications using the orbital angular momentum of the electromagnetic field. The interferometry capabilities can be used to study ionospheric and auroral phenomena, and their magnetospheric origin, on scales smaller than the beam-width, and the 3D volumetric imaging can be applied to ionospheric plasma convection, particle precipitation and mapped magnetospheric regions. The basic scientific purpose of the facilities will be complemented by service-type operation modes to support space debris and orbit detection, as well as navigation application support, with continuous direct ionospheric 3D imaging and geomagnetic disturbance detection service. EISCAT_3D, while functioning mainly as a scientific research radar, is also anticipated to have a substantial user community from the applied science sector, requiring data products relevant to a range of practical applications including long-term global climate change, human space flight, satellite operations, communications, position finding, terrestrial monitoring, long-distance energy transport and human health. It will also be used as a vehicle to advance all aspects of the incoherent scatter technique, including the development of new methods of radar coding, signal processing and data analysis. The Preparatory Phase of the EISCAT_3D project started in October 2010 and will continue for four years.

The centenary changes of the solar corona shape and variation of a global magnetic field of the Sun

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Analysis of the solar corona structure during the periods of minimum solar activity from 1878 till 2008 has been carried out. The comparative analysis of the solar corona during the minimum epoch in 12-24th activity cycles showed that the index has been smoothly changing during the last 130 years. The minimal value of the index occurred during activity cycles 17–19; this was the period when the solar corona most of all corresponded to the dipole configuration of the global magnetic field of the Sun. At the beginning of the 20th and the 21st centuries, the corona structure corresponded to the quadrupole configuration. The reasons for the variations in the solar corona structure and its relation with long-term variations of geomagnetic indices and Gleissberg cycle are discussed.

Long-Term Changes in the Solar Wind and Heliospheric Magnetic Fields and Interaction with Geospace

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The long-term change in the solar wind and the heliospheric magnetic field and the interaction with the geospace will be reviewed. Particular emphasis will be placed on the recent deep solar minimum. The effects on the near-Earth solar wind environment and resultant magnetospheric ionospheric and atmospheric environments will be discussed. In particular a suggestion for the lack of auroral sightings during the Maunder Minimum will be presented.

On the origin on long trend variation of the solar activity

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The long trend variation of the solar activity is not yet understood although helioseismology puts strong constraints on the rotation profile in the convective and radiative zones. It is now well established that young stars of solar type are more active and faster rotators than the Sun. It is why we begin to build models that include rotation history and compare the results with all the solar observations. The profiles of the rotation we get have interesting consequence for the introduction of a fossil magnetic field in the radiative zone. Moreover the impact of mass loss deduced from measured flux of young stars could have also a real impact on the planet formation history. We deduce from these studies some quantitative effect of the dynamical processes (rotation, magnetic field, mass loss) of these early stages on the present Sun which must be added to the effect of the dynamo of the convective zone for the long term variability of the solar activity. The interaction between fossil and dynamo fields could be a key ingredient to follow. This work is partly based on works done by Bouvier (2008), Ribas (2009) on young stars and on our recent publications on the solar radiative zone (Duez, Mathis & Turck-Chièze, 2010; Turck-Chièze et al., 2010a,b) plus some more recent studies not yet published. See ADS

Climate change in historical and solar perspective

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Was climate change during the 20th century anthropogenic, or did temperatures increase mainly because of increased solar activity? Climate has never been stable. Botanical and zoological remains and stable isotopes in peat deposits, lake sediments, marine deposits and stalagmites are important sources of information about natural climate change in the past. Major climate shifts during the last 11,000 years co-occurred with fluctuations of the cosmogenic isotopes 14C and 10Be that were caused by changes of the solar wind. Variations in solar activity were a major driving factor behind Holocene climate oscillations. Reconstructions of lake level changes in west-central Europe show major hydrological changes in response to Holocene climate cooling phases linked to changing solar activity. The transition from the dry-warm Subboreal to the cool-moist Subatlantic around 850 BC - as reflected in peat deposits - was caused by a considerable decline of solar activity. The effects of that climate shift for (a) Bronze Age people in the Netherlands and (b) the expanding Scythian culture in dry southern Siberian areas will be discussed. Detailed studies of this Subboreal-Subatlantic transition show that the climate shift started earlier than the sharp increase of the cosmic ray intensity. This phenomenon is not sufficiently understood and leads and lags needs to be studied by an interdisciplinary team. The hypersensitivity of the climate system to relatively small changes in solar activity points to the existence of amplification mechanisms in the atmosphere. The lack of accurate knowledge about such mechanisms hampers balanced evaluation and modeling of future climate. The deep and long minimum at the transition from solar cycle 23 to cycle 24 may be a signal for climate cooling in the near future and will also allow a better quantification of anthropogenic and natural climate change. The role of the sun is probably underestimated in climate models.

Space climate research using early solar observations: some recent progress

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During the last decades, an effort has been made to improve the sunspot number time-series, one of the more useful data set for space climate studies, using historical solar observations. Moreover, not only the sunspot number can be studied using these early solar records. During the last years, historical sources (i.e., sunspot drawings and solar radius measurements) have been also used to study the space climate. Here, I review some recent progress on these issues. In a hand, there are some periods with very few sunspot records and sunspot numbers are not so reliable in these intervals. I discuss the quality of sunspot records during these interesting periods: (a) 1610-1645, (b) 1721-1761, and (c) 1779-1795. On the other hand, I discuss the reliability of early sunspot drawings, sunspot position data, and solar diameter determinations to study long-term variations in our Sun.

POSTERS

Variation of Equatorial ionization anomaly of GPS-TEC during low solar activity period

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The Equatorial Ionization Anomaly (EIA) is a significant feature of the low-latitude ionosphere. The ionospheric total electron content (TEC) in the northern hemispheric EIA region is studied by analyzing dual-frequency signals of the Global Position System (GPS) acquired from Rajkot (geog.22.290N, 70.740E; geomag. 14.210N, 144.900E), India. The effect of solar and geomagnetic activity on the day-to-day, seasonal and latitudinal variability of TEC during low solar activity period (April 2005-March 2006) will be presented. It is found that the daily maximum TEC at the EIA crest yield their maximum values during the equinox months and is minimum during the winter months. The monthly averaged peak magnitude of TEC exhibits a clear semiannual variation with two maxima occurring in spring and autumn equinox. We found that the daily crest formed varies in a wide range of 7-160 N geomagnetic latitude at 1120-1620 IST with an annual mean at 110N around 1445 IST. The monthly magnitude of EIA crest, Ic is found negatively correlated with Dst index (r=0.57) but very less correlated with Kp index (r=0.25). The Ic and the latitude where the crest formed, Lc is found to be well correlated with electrojet (EEJ) strength (r=0.84 and 0.9) respectively. Our results favour the major role of EEJ, i.e. larger the electrojet strength, the greater the strength of the anomaly crest and the farther is its location.

Cosmic-Ray Modulation During Unusually Long Minimum of Solar Cycle 23: Tilt of the Current Sheet

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Study of variations in cosmic ray intensity, at different time scales, is useful to understand the physics of plasma/field interactions with charged particles, dynamics of the interplanetary structures responsible for these variations, and to understand the physical mechanisms playing important role in the modulation of galactic cosmic rays. Variability in cosmic ray intensity has been suggested to be a possible link, via cloud cover, to climate change; understanding the mechanisms of cosmic ray variations is important from this point of view also. We study the modulation of cosmic rays due to changes in tilt angle of the heliospheric current sheet (HCS) in the declining phase, including minimum, of solar cycle 23. In addition to HCS tilt, we utilize simultaneous solar (sunspot number, 10.7 cm solar flux, solar flare index) and interplanetary (solar wind velocity, magnetic and electric fields) data. As the sun rotates, the HCS crosses the earth and it remains immersed for some days alternatively in positive/negative polarity state of the IMF before/after each HCS crossing and vice versa. We perform analysis of cosmic ray neutron monitor data, and solar plasma/field data with respect to the days the HCS crosses the earth. We observe certain peculiar features in the cosmic ray modulation during this deep minimum of solar cycle 23. We compare these results with the results obtained during declining phases, including minima, of previous solar cycles 20, 21, and 22. We discuss these results in the light of existing models and theories of cosmic ray modulation.

Role of Solar/Cosmic-Ray Variabitity on Weather and Climate: Indian Perspective

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India is dominated by the monsoonal climate where summer monsoon rainfall is most important climate event for the country as a whole. It is generally believed that the Indian monsoon onset and intensity are driven/controlled by the land-sea temperature contrast, and large-scale atmospheric features like ENSO and QBO. However, role/influence of solar/cosmic-ray variability on monsoonal rainfall is controversial and worth debating. With its implication on global warming and associated climate changes, establishing (or rejecting) any significant role of solar/cosmic ray variability on monsoonal rainfall will be helpful not only to understand the monsoon dynamics but also for the prediction of monsoonal rainfall. Although there are a few evidences that suggest for some solar influence on monsoon rainfall on multi-decadal, centennial and millennial time scale, efforts are needed to look for evidence, if there is any, for solar/cosmic-ray variability on monsoonal climate at seasonal and even monthly scale. We use Indian monsoon (June-September) rainfall data and perform analysis using simultaneous solar, geomagnetic, interplanetary plasma/field, and cosmic ray data to look for this effect. We find evidence for the influence of cosmic ray variability on monsoon rainfall intensity, particularly during the extreme events of droughts and floods. We propose a plausible hypothesis that describes the sequence leading to the observed effects. We also discuss the implications of our results vis-à-vis the ongoing debate regarding the role of solar/cosmic ray variability on the Earth's climate.

Atmosphere-Ocean response in idealized 11-year solar cycle experiments

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The response of the climate system to the 11-year solar cycle is investigated in ensemble experiments performed with a global coupled atmosphere-ocean model. The model (EGMAM) includes a detailed representation of the middle atmosphere with 39 vertical levels and the top level located at 0.01 hPa. To account for changes in the short wave part of solar spectrum the model includes a sophisticated short wave radiation scheme (FUBRad) with 49 spectral intervals for the UV/visible part. The simulations are driven by an idealized sinusoidal forcing representing solar induced changes in irradiance and ozone. Three experiments are performed with ozone anomalies deduced from (i) offline calculations, (ii) observations and (iii) a combination of both. Each experiment contains a time interval of 231 years, comprising 21 solar cycles. The ensemble is used to assess the robustness of the solar signal in the stratosphere, troposphere and ocean. The focus is on the winter season (DJF). The stratospheric temperature response of solar maximum minus minimum for the ensemble mean shows a two peak structure in the tropical region with a warming around 0.6 K in the lower stratosphere and around 0.8 K in the stratopause region resembling observations. The dynamical response in the polar region shows a colder stratospheric polar vortex though not statistically significant. This signal becomes stronger after removing winters with sudden stratospheric warmings. Beside the stratospheric response we focus on the coupled atmosphere-ocean response in the tropical Pacific region. In general, a La Nina like response is found for solar maximum conditions but the amplitude of the ensemble mean response is underestimated in comparison to observations. Regarding periods of only 100 years the response is quite variable in terms of the amplitude. Some 100 year periods show similar amplitude of response to observation. The relevance of internal variability and differences in the ozone forcing for the robustness of the signal will be discussed.

Cosmic Ray modulation by Solar Wind Disturbances

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Compressions of interplanetary magnetic field (IMF) associated with interplanetary coronal mass ejections (ICMEs) and corotating interaction regions (CIRs) cause short-term decreases (so-called Forbush decreases, FDs) in galactic cosmic ray (CR) flux. The mechanism of this modulation is still a matter of research. In this report we analyze the influence of different parameters on the amplitude and the duration of Forbush decreases, using ground-based neutron monitor data and in situ solar wind data from the Advanced Composition Explorer (ACE). Solar wind disturbances were identified as increases of solar wind speed, IMF and magnetic field fluctuations and sorted by the type (ICME/CIR) and the association with a shock. Furthermore, FDs were treated separately for cases showing the over-recovery phase in CR flux. We analyzed correlations between CR depression amplitudes and solar wind speed, IMF and IMF fluctuations. Time profiles of the FDs and solar wind disturbances were also examined. An extensive statistical analysis was made regarding the delay of the depression after the onset of the IMF increase and also magnitude and the duration of the depression. The analysis of relative timing of CR depressions revealed that in the majority of cases the decrease follows the onset in IMF increase. Very high correlation between FD magnitude and IMF fluctuations is indicative of important role of reduced parallel diffusion as a modulation mechanism. Furthermore, the modulation effect was found to be more pronounced when proxies of time integrals are used. The differences obtained for the data sorted by type, shock association and presence of over-recovery are discussed regarding both FD magnitude and time profiles. These results can be used to test theoretical models.

Testing a link between solar irradiance and atmospheric parameters

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Although over long (centennial) timescales solar variability may be one of the most important natural causes of climate change, the extent to which solar activity may influence Earth's climate over shorter time periods is still poorly understood. It has been proposed that a solar-atmosphere link may influence climate variability. If such a link is operating, it is likely via one (or a combination) of the following three factors: total solar irradiance (TSI), ultraviolet (UV) spectral irradiance, or cosmic rays (CR). We present an analysis of the largest short-term TSI variations recorded by Active Cavity Radiometer Irradiance Monitor (ACRIM measurements), using an epoch-superposition (composite) approach, and test a possible link between TSI and several key atmospheric parameters. The statistical significance of these parameters is evaluated using Monte Carlo simulation techniques. Additionally, the relevance of our results will be discussed in relation to the CR-cloud connection hypothesis, as an extension to previous Forbush decreases studies and other related literature.

Study of Climate Sensitivity on Cloud Droplet Size and the Number Of Aerosols Using a General Circulation Model

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Since it was pointed out that the variation in galactic cosmic-ray intensity and the change in low-cloud amount are well correlated with each other, effects of cosmic rays on global environment have been discussed. Particularly a hypothesis that a higher intensity of galactic cosmic rays cools the global climate by enhancing nucleation of cloud particles through atmospheric ionization has attracted attention. According to this hypothesis, it is likely that the averaged size of cloud droplets becomes smaller as the galactic cosmic ray flux is increased, because the increase of number of cloud condensation nuclei may reduce the size of droplet when a constant amount of liquid water is present in the cloud. Then the Earth's albedo increases, and the earth surface temperature becomes cold as a result. In the present study, the influence that the diameter of the cloud droplet gives to the earth surface temperature is investigated by using a coupled atmosphere-ocean general circulation model. In this presentation, it will be discussed how the earth surface temperature and the albedo, among others, react when the radius of the cloud droplet is reduced. It will be shown that the temperature decreased about three degrees in ten years when the diameter of the cloud droplet is halved.

Oscillations and heating of the Solar Chromosphere at the sites of fine scale features

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Small scale bright magnetic features in photosphere and chromosphere show intensity oscillations. These features have one-to-one spatial correspondence and can be considered as a proxy for magnetic field. Our aim is to explore the temporal evolution of these spatially well connected bright features. Comparing the co-evolving intensity oscillations can give us insight into the temporal connection between these features. In this regard, Chitta & Kariyappa (2010) recently investigated oscillations over G-band bright points and their corresponding chromospheric bright points using dual band data obtained from Hinode/SOT. We performed a wavelet analysis to find the periods of these intensity oscillations and wavelet coherency test to check the coherence and phase relation of the combined intensity oscillations. The main goal of this program was to check how the intensity variation in photospheric bright feature influences its chromospheric counterpart. Interestingly, there is a negative phase relation between intensity oscillations at the two altitudes, indicating downward propagating waves; this result is surprising, because wave energy is expected to propagate outward from the solar interior through the chromosphere into the corona. Our observed inward phase delay from the Ca II H line to the G-band is 10 - 50 seconds depending on the bright point. While the signal appears clear and we have considered and eliminated many sources of potential systematic error, it is surprising enough that independent verification and more detailed measurements are needed. In this conference, we present and discuss the preliminary results of this analysis.

Solar & Interplanetary Sources of Major Geomagnetic Events Observed During Unusual Period Of Cycle 23

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In this study, we present the behaviour of the solar and interplanetary parameters of a very complex anomalous geomagnetic storm that is recorded on 15 December 2006, during the declining phase of the solar cycle 23. This was the last major geomagnetic event that occurred during the declining phase of solar cycle 23. This declining phase was persist for few more years up to 2009, although this period was expected to be the starting minimum phase of solar cycle 24. The observed event shows a very prominent and abrupt increase in He/proton density, and plasma dynamic pressure with a depressed alpha/proton ratio and low plasma beta, and more negative Bz at the stream interface of the event. Two days before of the event coronal hole associated high speed stream and 1 day before a halo earth-ward directed CME, with linear speed 1774 km/s at 2:54:04 on 13/12/2006 were observed. This CME was evolved as ICME, which pushed the forward shock as sheath region and producing ring current in equatorial region of the Earth's magnetic field. For the reported study which is under investigation, we use the hourly values of interplanetary plasma and magnetic field parameters as well as geomagnetic disturbance indices, for the period December 13-18, 2006. It is found that the major geomagnetic storm with a Dst -146 nT, occurred on 15 December, 2006, was associated with Storm Sudden Commencement, (SSC), and had a more complex interplanetary structure with a X- class Solar flare and an ICME + Sheath. This geomagnetic event recorded on the basis of the large Dst has peculiar characteristics with complexity in nature; particularly it is associated with CME and ICME, although it was expected to be associated with the CIR, because of its long recovery phase, The cause of the long recovery phase may be due to the another halo CME on 14 December 2006 with its linear speed 1042 km/ s [at 22:30:04 UT] from same active region, reported in SOHO LASCO CME list. The compositional anomalous characteristics of this particular major geomagnetic event through multi-instrument observations will be highlighted in this paper.

Statistics of Activity Complexes

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I utilize the Zubrzycki method to evaluate the activity complexes for all sunspot groups for the period 1874-2009. This method estimates the weighted areas of each activity complex. The weights depend on the correlation function of distances between sunspot groups created each complex. I also evaluate the weighted position of each structure. In addition I show the distribution of sunspot group numbers created each complex and the mean size of activity complexes within different phases of the 11-year cycle.

About Strange Behavior of the Solar Spectral Irradiance During Extended Minimum of the Solar Cycle 23

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We have investigated the solar spectral irradiance (SSI) during 2003-2008, using the daily spectra of FUV recorded by the TIMED/SEE satellite. Using the software developed by us, we choose discrete wavelengths in the range of 122-420 nm. We have noticed a peculiar behavior among some regions of FUV spectral narrow-band differ with usual behavior from other ranges. We found that the same solar spectral narrow-band emissions not agree equally well also with other indices of the solar activity during descending phase of the solar activity. In this connection, we have compared our results of descending phase of solar cycle 23 with behavior of the solar activities for the descending phases of cycles 21 and 22, as well as ascending phases in the same solar cycles. We found that only in the cycle 23 is take place the anti-correlation in some narrow bands of spectral lines with other indices of solar activity. Revealed by us anti-correlation with solar activity is not the error of changes of optical characteristics of measuring instruments. We have tried to find what the reason of such results is. By our opinion, the reason of it there is magnetic fields. However, investigated by us data set have covered period's more than full magnetic cycle in 22 years. Alternatively, maybe emission of different molecules or other different reason takes place. We hope further investigations will resolve these problems.

Role of Activity Nests in long term Cosmic Ray Modulation

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The long term modulation of cosmic ray flux is generally associated with the solar magnetic field. It has been suggested, based on cosmic ray data, that the solar magnetic field has doubled in last 100 years. We evaluate the role of activity complexes in long term cosmic ray modulation. It is suggested that cycles with higher nesting lead to more CMEs. The solar cycles with larger number of CMEs may lead to stronger IMF causing decrease in cosmic ray flux. Thus, long term variation in cosmic ray flux could also be due to cycle to cycle variation in nesting activity.

On the nature of propagating waves in polar coronal hole

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Waves play an important role in the heating of the solar corona and in the acceleration of the fast solar wind from polar Coronal Holes (pCHs). Recently using EIS/Hinode and SUMER/SoHO, we have reported the presence of accelerating waves in polar region (Gupta et al. 2010, ApJ, 718, 11). These waves appeared to be originating from a bright location on-disk, presumably the footpoint of the coronal funnels. These waves were interpreted in terms of either propagating Alfvén waves or fast magneto-acoustic waves. The new sets of observations are obtained from the EIS/Hinode 2" slit and imaging data from AIA/SDO in various filters over plume and inter-plume regions as HOP175 program. The combination of spectroscopic and imaging data will provide further details on mode identification and properties of these waves and will help in the energy calculations. In this presentation, preliminary results obtained from these observations in terms of different nature of propagating waves in plume and inter-plume regions and energy carried by these waves will be presented.

Rotation Rates of Coronal Holes and their probable origin

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Compared to the ambient medium in the corona, coronal holes are the low density and intensity regions that emit high speed solar wind into the inter planetary space. Recent overwhelming evidences show that they also affect earth's environment and climate. Hence understanding of their origin and evolution is one of the mystery in solar physics. In the present study, using SOHO/EIT 195 A calibrated images, for their different life times, on the observed solar disk, we measure heliographic coordinates of the coronal holes with respect to different latitude zones and rotation rates also are computed. Preliminary results are as follows : (i) for all the latitude zones, coronal holes rotate rigidly yielding a rigid body rotation law from the least square fit, (ii) for different latitude zones, it is found that there is a slowly decreasing trend of rotation rates for majority of the coronal holes with respect to their life times. From these two important results it is estimated that all the coronal holes probably might be originated below base of the convection zone.

Daily Variation of Area and Photon Flux of the Coronal Holes

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From the SOHO/EIT 195 A calibrated images, coronal holes are detected and, day to day variations of area and average photon fluxes are measured. Preliminary results are as follows : (i) shape of the coronal hole area-time curve is almost similar to the shape of the sun-spot area time curve, (ii) without taking into account the projectional effects, area-time curve is fitted to a law of the form $A(T) = (3.22+/-1.2)*104+(2.23+/-0.60)*104*T-(0.25+/-0.05)*104*T2$ square arc seconds, where T is time in days and, (iii) average photon flux emitted by the coronal holes during their day to day variations is different for different latitude zones.

Dcx index server: local Dst indices for an extended station network

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The Dst index is one of the most used geomagnetic indices that is constructed to monitor the most dramatic events in the near-Earth space, the geomagnetic storms. The Dst index is calculated as an average of disturbances observed at four low-latitude stations, roughly equally distributed in longitude. However, in addition to the ring current, other current systems like the tail current, magnetopause current and partial ring current contribute to the Dst index, leading to the fact that the local disturbances at the four stations are very often quite different. Moreover, it has been found that the Dst index includes some random and systematic errors. E.g., the different Dst stations contribute to the Dst index with systematically different weights. We have calculated a revised version of the Dst index, the so called Dcx index, correcting all known errors. Moreover, we have increased the number of stations used to calculate the Dcx index to 16 stations. Also the time coverage of some of the local Dcx indices is extended significantly longer than the traditional Dst index. Within the European FP7 SOTERIA project both the global and the local Dcx indices observed at each contributing station will be made available on public server (http://dcx.oulu.fi). This offers a large range of new possibilities for detailed studies of storm time disturbances and currents on a long time interval.

Long-term variations in the evolutions of sunspot groups

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Using the combined Greenwich (1874-1976) and Solar Optical Observatories Network (1977-2009) data on sunspot groups, we studied the long-term variations in the mean daily rates of growth (increase in area) and decay (decrease in area) of sunspot groups. We find that the average value (over the period 1874-2009) of the growth rate is about 70% more than that of the decay rate. The growth rate varies by about 35% on a 60-year time-scale, whereas the decay rate varies by about 13% on a similar time-scale.From the beginning of cycle 23 the growth rate is substantially decreased and near the end (2007-2008) the growth rate is lowest in the past about 100 years. In the extended part of the declining phase of this cycle, the decay rate steeply increased and it is largest in the beginning of the current cycle 24. These unusual properties of the growth and the decay rates during cycle 23 may be related to cause of the very long declining phase of this cycle with the unusually deep and prolonged current minimum. Long-term increasing and decreasing trends in the growth and the decay rates indicate that the next 2-3 solar cycles will be relatively weak cycles.

Effect of Turbulent Pumping on Solar Cycles Memory: Investigations using a Kinematic Dynamo Model

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In the flux transport Babcock-Leighton dynamo model, the transport of poloidal field from the source region near the solar surface to the base of the convection zone introduces a time delay in the solar cycle. This process can be dominated by advection mediated through meridional circulation, or by turbulent diffusion. It is known that in the advection-dominated regime, the memory of previous cycles persists for up to three cycles, whereas in the diffusion-dominated regime this memory is present only for one cycle. However, none of these scenarios take account of turbulent flux pumping – a process which full MHD simulations have shown to be impportant in the downward pumping of magnetic flux. We include turbulent flux pumping in a stochastically forced dynamo model and show that with the effects of downward flux pumping included, the diffusion dominated regime and advection dominated regime behave similarly – with cycle memory reduced to just one cycle.

UV Irradiance Variability from Spatially Resolved Images

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We segregated the different chromospheric features, namely, (i) plages, (ii) magnetic network, and (iii) intranetwork + the background (hereafter IN + BG) regions from the CaII K spectroheliograms for the years: 1980 and 1992, observed at the National Solar Observatory at Sacramento Peak, using their histograms taken for the full-disk. The various parameters like the intensity and area of the chromospheric features, the full-disk intensity (called spatial K index), the intensity of quiet-Sun, and the full width at half maximum (hereafter FWHM) of the histograms have been derived from the images. The spatial K index, FWHM, and the intensity of various features have been compared to the UV irradiance measured in the MgII h and k lines by the Nimbus7 and NOAA9 satellites and found that they are correlated with the MgII h and k c/w ratio. We established, for the first time, from the results of 1980 and 1992 images that the FWHM can be used as a good index for measuring and describing the chromospheric activity in the K-line. The results of both 1980 and 1992 images show an anticorrelation between the intensity and area of the network elements, which confirm the earlier findings derived from Kodaikanal CaII K spectroheliograms analyzed for the center of the solar disc in a quiet regions for the time interval 1957–1983. During solar minimum the network is fainter but covers a larger area than during solar maximum. These results suggest that the variations in both the intensity and area of the various chromospheric features have to be taken into account in irradiance models. The results indicate that the intensity values of the intranetwork + background (IN + BG) regions are not constant as assumed in the current irradiance models. On the contrary, they are changing in a fashion similar to the plages and the magnetic network. We estimated the contribution of various chromospheric features to the total CaII K flux from the intensity time series data and found that about 50% of the CaII K solar cycle variability results from plages, about 32% from network, and about 18% from intranetwork + background features.

Interplanetary Transient Plasma and their Associated Space weather Impacts

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Previous studies have indicated the association of space weather activities like, geomagnetic storms with various solar and interplanetary features. In the present study two types of solar wind plasma structures namely Magnetic cloud events and Bidirectional electron heat flux events have been taken to study the short-term changes and analyzed taking in to consideration their association with coronal holes selecting these events occurred during solar maximum and soar minimum period of cycle 23. Analysis reveals distinctly different effects of these two signatures on ionospheric/magnetospheric geo-effective events. Magnetic cloud events are found more effective comparing to bidirectional events on short-term basis.

A search for AGWs of Auroral Origin in the Lower Stratosphere

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Acoustic gravity waves (AGWs) launched by auroral disturbances in the lower thermosphere have been proposed as a possible way to transmit disturbances down to tropospheric heights. If such waves are to have a significant impact on tropospheric weather systems they should affect e.g. vorticity by amounts which are comparable to the ever-present background of fluctuations due to tropospheric processes. MST radars have been widely used in the past to detect the wind perturbations associated with the whole spectrum of gravity waves, from the acoustic to the inertial ranges. Here we show that MST radar can also be used to directly monitor perturbations in static stability, which, at high latitudes, constitutes the main contribution to potential vorticity. Using two 50 MHz radars, ESRAD in Arctic Sweden and MARA in Queen Maud Land, Antarctica, we demonstrate the typical signatures of wave-related and other perturbations in the lowermost stratosphere. Large perturbations due to inertial gravity waves generated by orographic flow and to the movement of upper-troposphere jet streams dominate. Filtering techniques are used to extract the shorter period AGWs and to search for evidence of any significant contribution from auroral sources.

Parallels among the "music scores" of solar cycles, space weather and Earth's climate

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Solar variability and its effects on the physical variability of our (space) environment produce complex signals. In the indicators of solar activity at least four independent cyclic components can be identified, all of them with temporal variations in their timescales. Time-frequency distributions are perfect tools to disclose the "music scores" in these complex time series. Special features in the time-frequency distributions, like frequency splitting, or modulations on different timescales provide clues, which can reveal similar trends among different indices like sunspot numbers, interplanetary magnetic field strength in the Earth's neighborhood and climate data. Parallels and differences of the different periodic components within the same dataset, like modulations of the harmonics of the frequency of the 11-year solar cycle, provide additional clues for understanding processes like the Waldmeier-effect. Analyzing long-term data with such "music scores" can bring to light recurrent structures hidden in other data representations. These recurrent "tunes", due to their regular nature, can be used for forecasting the phenomena. The long-term modulation of solar activity went over a frequency shift (a glissando) around 1700, most probably in connection with a frequency split in the Gleissberg cycle. This frequency shift event is strongly related to the termination of the Maunder minimum. We identify a very similar structure in the "scores" of recent solar activity, starting around 1950. We ask the question whether or not this frequency shift can be a precursor of the behavior of the recent solar cycle.

Distinctive features of solar cycle 23

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The aim of our report is to present special features of the 23-d cycle of solar activity. We use results of our analysis of spectra of sunspot numbers W, Interplanetary Magnetic Field (IMF), the solar wind velocity (V) calculated on the basis of spaced measurements near the Earth's orbit for the time intervals of 1964-1997 and for 1996-2005 (interval of cycle 23). The IMF and W spectra for the period 1964- 1997 both show the solar cycle at period of T=10.8 yr and its higher harmonics. But spectrum of sunspot number W for the period 1996-2005 (time interval of the 23-d cycle) has not spectral component at T=10.8 yr (at confidence statistical level 95%). Instead we see T=16.56 yr, which can be interpreted as period of asymmetric component of perturbed tide force connected with the Sun motion around the mass center of the solar system caused by pair Jupiter-Uranus (1st planet determines shift of mass center of the Sun, the 2nd planet determines perturbed tide force acting on the Sun). The fact that spectrum of W during the cycle of 23 has the most power spectral components at T=16.56 yr and T=1.83 yr (9-th harmonics of the 16.56-yr cycle) determined by pair Jupiter-Uranus points to change of condition for sunspot formation during the cycle of 23 and to possible length of solar cycle 23. Such long cycle length was observed for interval 1619-1626 in the past. Moreover, spectrum of V demonstrates power components of the 16.56 yr oscillation and its higher harmonics.We show also that development of the 23d solar cycle will be accompanied by temporal decreasing the long-term components both in the IMF strength (200-yr cycle) and in the value V (54-yr cycle). In addition, we described all parameters of the 47-yr oscillation in the solar spectrum and detected their connection with generation of toroidal component in sunspot activity. Sharp phase shifts of the 47-yr solar oscillation (influencing on all parameters of main solar cycle) occurred in 1743 and 1913 (Ät= 170 yr), close to minima of the 0-th and the 15-th cycles. The result points to the fact that such phase shift did not lead to a Grand minimum in solar activity. Based on our results we discuss other characteristics of the 23-d solar cycle.

Are Cone Models of CMEs Correct?

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A set of 106 limb CMEs which are wide and could be possible halo events, when directed towards Earth, are used to check for the asymmetric cone model accuracy. For this purpose characteristics of CMEs (widths and radial speeds) measured for the possible halo CMEs are compared with these obtained for halo CMEs using the asymmetric cone model (Michalek, 2006). It was shown that the width and speed distributions for both datasets are very similar and with probability ($p>0.93$ using the Kolmogorov-Smirnov test) were drawn from the same distribution of events. We also determined the accurate relationship between radial (V_{mrad}) and expansion (V_{mexp}) speeds of halo CMEs. This relation for the halo CMEs is very simple $V_{mrad} = V_{mexp}$ and could be very useful for space weather application.

On some properties of SEP effective CMEs

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Solar energetic particles (SEP) are believed to originate from two different sources, solar flares and coronal mass ejections (CMEs). These two sources are the most energetic particle accelerators in the heliosphere, as they can accelerate electrons from 10 keV to a few MeV and protons from a few MeV to a few GeV. The large SEP events that constitute a serious radiation hazard, particles are accelerated at shock waves driven out from the Sun by CMEs. In this paper the high-energy solar proton data obtained from NOAA SPACE ENVIRONMENT SERVICES CENTER are used to investigate some statistical properties such as speed, apparent width, acceleration, latitude, mass, kinetic energy and occurrence rate of SEP effective CMEs observed during the period 1996-2006 covering the solar cycle 23.

The Double-Ring Algorithm: A Better Way of Modeling Active Regions in Kinematic Dynamo Models

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The emergence of tilted bipolar active regions and the dispersal of their flux, mediated via processes such as diffusion, differential rotation and meridional circulation is believed to be responsible for the reversal of the Sun's polar field. This process (commonly known as the Babcock-Leighton mechanism) is usually modeled as a near-surface, spatially distributed α-effect in kinematic mean-field dynamo models. However, this formulation leads to a relationship between polar field strength and meridional flow speed which is opposite to that suggested by physical insight and predicted by surface flux-transport simulations. With this in mind, we present an improved double-ring algorithm for modeling the Babcock-Leighton mechanism based on active region eruption, within the framework of an axisymmetric dynamo model. We demonstrate that our treatment of the Babcock-Leighton mechanism through double-ring eruption leads to an inverse relationship between polar field strength and meridional flow speed as expected, reconciling the discrepancy between surface flux-transport simulations and kinematic dynamo models and how this formulation paves the way for direct active region data assimilation.

Improved Estimation of Propagation Times of Short-Term Interplanetary Magnetic Field Variations

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Short-term variations of the Interplanetary Magnetic Field (IMF), like southward turnings for example, are often associated with disturbances in the geomagnetic field. A challenge in this connection is that solar wind measurements are usually taken at large distances from the Earth, and need to be time shifted in order to be representative for the Earth's magnetopause. Most time shifting methods are based on the assumption that the variations of the IMF are often contained in planar structures, and by using variance analysis to determine the normal of these structures, one can calculate the time delay between a solar wind monitor and a target (in our case: the magnetopause). A drawback with this approach is that the presence of Alfvénic structures or magnetic islands embedded in the solar wind plasma has a negative influence on the resulting normal. By using a wavelet de-noising technique we can minimize this influence without losing the sharp IMF variations, and without loss of time resolution (like in the usual de-noising methods). Variance analysis of the IMF is already used in time shifting studies (see NASA's OMNI-database), and we will show that the results are improved if we de-noise the IMF time series before applying the variance analysis. We will also present a comparative study of the results obtained by using different wavelet basis functions, and different threshold levels.

A Low Order Dynamo Model with Time Dependent Meridional Circulation

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Based on flux transport dynamo theory we develop a low order model in which the meridional circulation is time dependent (Vp(t)). Afterward we substitute Vp(t) by an analytical function based on observations of the variation of the meridional flow during a complete solar cycle and we study how several types of variations in Vp(t) influence the amplitude of the cycle.

Solar Activity vs. Brightness: Implications for How Solar Radiative Variability May Affect Climate

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Two solar cycles' worth of photometric solar data from the San Fernando Observatory, including full-disk observations at red and blue continuum wavelengths and in the Ca II K spectral line, reveal the correlations that exist between brightness and activity for the Sun. We use the data to model TSI, and show that, to a first approximation, TSI variations can be explained by 2 variable components, a visible continuum component and a spectral line component. This study focuses on the long-term variability of TSI and the two components. The visible continuum component, which can pass through the Earth's atmosphere, warming the ground and oceans directly, exhibits a maximum decrease of 0.5 Wm-2 during cycle 22 and 0.25 Wm-2 during cycle 23 – i.e. it is out of phase with solar activity. If high solar activity is associated with high global temperatures, then this component cannot be the cause. However, the spectral line component is directly correlated with solar activity, and varies more than the TSI itself. The maximum increase in the spectral line component is 1.5 Wm-2 during cycle 22 and 1 Wm-2 during cycle 23. Solar spectral lines are concentrated at ultraviolet wavelengths, which are absorbed in the Earth's atmosphere and could provide a radiative forcing mechanism in phase with solar activity.

Study of coronal line width and intensity variations using Norikura coronagraph

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Spectroscopic observations of off-limb corona had been done using 25 cm coronagraph of National Astronomical Observatory, Norikura, Japan. Raster scans were made using forbidden iron lines in optical regime, namely [Fe X] 6374 A0 (red line), [Fe XI] 7892 A0, [Fe XIII] 10747 A0 and [Fe XIV] 5303 A0 (green line), with two lines simultaneous. Using those scans from polar regions taken in September 2004, the variation of intensity ratios and spectral line widths with height and from structure to structure are studied. The results indicate that the line width of green line decreases with height whereas that of red line increases and the other two lines show intermediate behaviour irrespective of the structure. Also the intensity ratio of green line to red line decreases with height whereas that of other two increase with respect to red line. These complex variations are in agreement to that reported by Singh et al. (2004, 2006) from equatorial regions, though they differ quantitatively. The possible explanation for this complex behaviour and the comparison of the gradients from structure to structure and also with the earlier equatorial region results will be discussed.

Estimates of a CME's Cross Sectional Area in Interplanetary Space

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For a case study event observed in situ, Russell and Mulligan [2002] analysed the sheath region between the shock front and the obstacle to the flow presented by the CME. They then compared this region to the sheath found around Earth's magnetosphere. By measuring the sheath distance and modifying the work of Spreiter et al. [1966], they were able to infer a height of an ICME in a direction that is perpendicular to the solar wind flow. We present a similar analysis for 45 events varying between 0.5AU to 5.5AU; thus greatly expanding on previous studies. We find the average ratio of the inferred height to measured radial width, otherwise called the aspect ratio, of an ICME is 2.6 +- 1.4. We also compare the results to geometrical predictions that forecast an aspect ratio between 3 and 6. We find that instead of the results following the predictions, they appear to be bounded by the theoretical maximum. We also find that if a simple constant expansion rate of an ICME is assumed the geometry predicts the aspect ratio of an ICME would converge to a fixed value as it propagates out into the heliosphere; and thereby making the morphology scale invariant and not undergo further "pancaking".

GLEs and Their Space Weather Aspects with Solar, Interplanetary and Geophysical Parameters

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Studies have indicated the association of space weather activities like, geomagnetic storms with various solar and interplanetary features and also with the Cosmic rays. Whilst the intensities of the cosmic rays are observed to be enhanced with sudden, sharp and short-lived increases, they are termed as ground level enhancements (GLEs). They are the occurrences in solar cosmic ray intensity variations on short-term basis, so different solar factors erupted from the Sun can be responsible for causing them. In this context, an attempt has been made to determine quantitative relationships of the GLEs with solar / interplanetary and Geophysical Parameters. We have taken the data for solar cycle 23. Results suggest that GLE peaks might be caused by solar energetic particle fluxes and solar flares. The proton fluxes which seemed to cause GLE peaks were also supported by their corresponding fluences. Coronal mass ejection presumably causes geomagnetic disturbances characterized by geomagnetic indices and polarities of interplanetary magnetic fields. Analysis reveals distinctly different effects of these two signatures on ionospheric / magnetospheric geo-effective events on short-term basis.

Identification of Signatures Of Solar Filaments in ICMEs Using in-situ Measurements by ACE and Wind

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Solar filaments are often associated with Coronal Mass ejections (CMEs) and they travel through interplanetary medium as a part of large magnetic clouds which interact with the medium. In rare cases, filament material retains their "freezed-in" thermal and compositional properties which could be identified in-situ. Interplanetary Coronal Mass Ejections (ICMEs) or magnetic clouds when sampled by the spacecrafts (ACE/Wind) at L1 points, provide crucial information about their properties and associated solar wind and filament material, if present. Observations of these associated prominences (cold) material is rare in an ICME and are not reported in many studies. We report on three cases of ICMEs where cold material is identified as a direct consequence of an eruptive filament. Prominence material is identified in ICME by using plasma (low plasma beta and proton temperatures) and magnetic field (high magnitude) parameters. Also, compositional signatures were used to identify the prominence material such as high proton and ion densities along with charge state ratios. It is found that quiescent filaments can be identified at 1AU as cold material.

Study of Eruptive Flares from NOAA 10486 on 25 October, 2003

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We present multi-wavelength analysis of the two M1.2 and M1.7 class flares that occurred on 25 October 2003 from active region NOAA 10486. The flares observed in H-alpha (ARIES, Nainital), TRACE UV/EUV, RHESSI X-rays and by SOHO. The active region was one of the most complex magnetic configuration of the solar cycle. Flares show multiple eruptive centers i.e. kernels/ribbons. Both the flares seems to be initiated with different mechanisms. First flare started with the eruption of huge sigmoid filament in the south-west direction, while the second flare started by the interaction and eruption of complex loop systems and the sigmoid filament in the northern side of the active region. Temporally the flares shows long duration events (LDEs). Both the flares are eruptive in nature and associated with CMEs and different type of radio bursts. Using the co-alignment of different instruments data, we compare the spatial locations of flare sources. We interpret our results in the light of existing theories.

On Halo CMEs and its Relation to Solar Activity Phenomena and Coronal Holes Observed During 1996-2007

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In the present paper we have studied the reconnection of chromospheric active regions events and uni-polar regions (Coronal Holes/CH) leading to the production of solar coronal mass ejections (H-CMEs). To carry out this study we have used H-CMEs data for the period April 1996 and December 2007 observed by LASCO/ SOHO and the daily solar 10830 image observed at KPNO for the same period. We also used solar activity events data recorded by EIT instruments aboard SOHO, X-ray images of Sun recorded by Yohkoh mission, solar activity events recorded in H- Alpha emission from various ground based-based observatories and solar CH maps in 10830 A emissions recorded by KPNO, USA. To understand the role of CH maps in 10830 A and Chromospheric solar active region events we first matched time of onset of H-CMEs with time of solar events in H-alpha or EIT data. Secondly we looked for the spatial location of solar activity phenomena and CH maps on the solar disk. From this study we find that 45% H-CMEs were observed when there were CHs within 10 degree of flares locations, 25% H-CMEs were observed when there were CHs within 20 degree of flares locations, and 18% H-CMEs were observed when there were CHs within ¿ 20 and ¡ 40 degree of flares locations. The flares locations are identified from H-alpha flares data or EIT activity phenomena. We are of the view that the H-CMEs are perhaps have been produced by some mechanism, in which the mass ejected by some solar flares or active prominences, gets connected with the open magnetic lines of CHs (source of high speed solar wind streams) and moves along them to appear as suggested earlier by Verma and Pande (1989) and Verma (1998). In the present papers we will show reconnection between chromospheric flares or EIT activity phenomena and solar coronal holes area on the Sun.

Heliosphere at High Latitudes and Far Distance: Southward Shift of the HCS

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We have studied the hemispheric asymmetry of the high-latitude heliospheric magnetic field and the related latitudinal shift of the heliospheric current sheet using Ulysses observations during the perihelion passes in 1994-1995, 2001-2002 and 2007. Using the cumulative flux density at the high-latitude sections of the orbit in the two hemispheres, we find that the average intensity of the high-latitude radial field of the southern hemisphere is larger than in the north during the two solar minimum time scans in 1994-1995 and 2007. This implies that the northern field area is some 5-10% larger than the southern area and that the HCS is shifted southward by about 2^o during both orbits. The results resolve the discrepancy between earlier results and verify that the southward shift of the HCS was roughly the same as earlier even though the polar fields were much weaker during the exceptionally weak solar cycle 23.

We have also reanalyzed the observations made by Pioneer 10 and 11 and Voyager 1 and 2 probes in the outer heliosphere from the point of view of hemispheric differences. The fact that these probes are outside the ecliptic plane, mostly in one hemisphere, makes the determination of the possible shift of the heliospheric current sheet more difficult. However, comparison of simultaneous measurements in the two hemispheres gives significant information about the HCS location. Voyager 1 is in the northern hemisphere, and the northern hemisphere field dominates there very strongly. Voyager 2 is flying at the equatorial region in 1980's, but still observes a strong dominance of the northern polarity. In 1990's Voyager 2 is in the southern hemisphere, but still sees a significant amount of the northern field. These results verify that the HCS was shifted southward even as far as about 45 AU, at least.

Quality control of geomagnetic disturbance

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Space weather forecasts are done every day by the SIDC, the Solar Influences Data analysis Center. The SIDC forecasts the flare and proton event probabilities, the 3 days prediction for the 10.7 cm radio flux and for the geomagnetic disturbance (Kp/Ap index). We present a statistical study of the accuracy of the forecasted geomagnetic Kp/Ap index

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