2019 Space Weather Workshop Poster Abstracts
Embassy Suites Hotel Boulder
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Angling, Matthew (Spire)
Poster Number: I3
Poster - On a 4D Ionospheric Data Assimilation Model Using Spire Radio Occultation Data

Co-authors: F-X Bocquet, T. M. Duly, V. A. Nguyen, O. Nogues-Correig, L. Tan, T. Yuasa, D. Masters, J. Cappaert, J. Spark

Abstract: The ionosphere can affect a wide range of radio frequency (RF) systems operating below 2 GHz. One option for mitigating these effects is to produce assimilative models of the ionospheric density from which products can be derived for specific systems. Such models aim to optimally combine a background model of the ionospheric state with measurements of the ionosphere. This approach is analogous to the use of numerical weather prediction in the meteorological community, and has been evolving for ionospheric use for the last 10 to 15 years.

Published research has demonstrated to the utility of this approach. However, obstacles to providing effective data products remain due to the sparseness of ionospheric data over large parts of the world and the timeliness with which data is available. Spire is working to overcome these issues through the use of its large, and growing, constellation of satellites that can measure Total Electron Content (TEC) data in both zenith looking and radio occultation geometries, and its large ground station network that will allow low data latency. The Spire data will be combined with an innovative data assimilation model to provide accurate and actionable ionospheric products. This paper will describe the measurement collection and processing chain, the data assimilation model, and plans for the ongoing development of the combined system.

Angryk, Rafal (Georgia State University) *e-Poster
Poster Number: S29 - 10:00-10:15 & 3:30-3:45 on Screen 2
Poster - Multivariate Time Series Dataset for Space Weather Machine Learning

Co-authors: Petrus C. Martens, Berkay Aydin, Dustin Kempton, Sushant S. Mahajan, Sunitha Basodi, Azim Ahmadzadeh, Soukaina Filali Boubrahimi, Shah Muhammad Hamdi, Michael A. Schuh, Manolis K. Georgoulis

Abstract: We present a comprehensive, multivariate time series dataset extracted from solar photospheric vector magnetograms in Spaceweather HMI Active Region Patch (SHARP) series. Our dataset contains a cross-checked NOAA solar flare catalog. It is intended to simplify access to benchmark data for quantitatively comparative studies among machine learning experts and data scientists interested in solar flare prediction. We will present important aspects of data integration and cleaning for active regions and flares, and describe our data integration and sampling procedures.

Our dataset covers 4,075 multivariate time series data instances from active regions observed between May 2010 and August 2018. It includes 51 parameters and integrates over 10,000 flare reports.

Balikhin, Michael (The University of Sheffield)
Poster Number: G14
Poster - NARMAX Based Tools for Space Weather Forecast Resulting from the PROGRESS Project

Co-authors: Richard J. Boynton, Simon N. Walker

Abstract: The overall aim of the PROGRESS project was to develop novel systems science based tools for the forecast of geomagnetic indices and radiation environment of the geospace and to combine these tools with the forecast of solar wind parameters at L1 to increase the advance time of the forecast. NARMAX based models for Kp, AE and Dst indices, and advanced SNB3GEO-MLT model for the forecast of fluxes of energetic electrons at GEO that accounts for their MLT dependence. The online website that provides the forecast resulting from PROGRESS is also reviewed.

Baltzer, Tom (University of Colorado, LASP) *e-Poster
Poster Number: I36 - 10:15-10:30 & 3:05-3:20 on Screen 2
Poster - Web Applications and Services in Support of Science Data Access, 'Fusion', Visualization and Download

Co-authors: Doug Lindholm, Anne Wilson, Chris Pankratz, and the LASP Web Team

Abstract: In order to support easing dataset access for our user community, the University of Colorado's Laboratory for Atmospheric and Space Physics (LASP) Web Team has been building reusable tooling and applying it for use by scientists and mission operators. This poster will describe our LaTiS software library at a high level, and present front end capabilities that it has enabled for several different use cases the Team supports. LaTiS is a software library that implements a mathematical technique for

describing and manipulating scientific datasets. LASP has created numerous LaTiS services to provide unified access to disparate datasets easing the development of highly capable web applications which also will be described.

Baltzer, Tom (University of Colorado, LASP) *e-Poster
Poster Number: I38 - 10:30-10:45 & 3:20-3:35 on Screen 2
Poster - The University of Colorado Space Weather TREC Portal

Co-authors: Thomas E. Berger, Jennifer Knuth, Doug Lindholm, Anne Wilson, Chris Pankratz, and the LASP Web Team

Abstract: The Chancellor of the University of Colorado recently awarded a Grand Challenge grant to a group of departments and labs for the development of the Space Weather Technology, Research and Education Center (SWx-TREC https://www.colorado.edu/spaceweather/). As part of this effort, the Laboratory for Atmospheric and Space Physics (LASP) is developing a Space Weather (SWx) Data Portal to provide unified access to disparate datasets to help close the Research to Operations (R2O) and Operations to Research (O2R) gap. This poster shows the measurement instruments, providers, middleware and SWx TREC Portal prototype displays and how the capabilities being developed can be used to exemplify the 2015 St. Patrick's Day Storm.

Barani, Mohammad (West Virginia University)
Poster Number: G12
Poster - Azimuthal Mode Structure of ULF Waves Based on Multiple GOES Satellite Observations

Co-authors: Weichao Tu, Theodore Sarris

Abstract: The process of radial diffusion, due to the drift resonance between MeV electrons and Ultra Low Frequency (ULF) waves, plays an important role in the transport, acceleration, and loss of energetic electrons in the Earth's radiation belts. Characterizing the azimuthal mode structure of ULF waves and estimating the azimuthal wave (mode) number m is required for calculating the radial diffusion coefficient of radiation belt electrons. In this study, we make use of the five closely separated GOES satellites that are available during the 28-31 May 2010 storm, which is ideal to estimate the azimuthal mode structure of ULF waves. Specifically, a cross-spectral technique is applied to the compressional Pc5 ULF waves observed by multiple pairs of GOES satellites that cover a wide range of local time during the event to acquire the temporal and spatial variation of mode number. One new improvement in our analysis is that both positive and negative m values are allowed to provide a realistic estimate for the wave propagation direction. We find that during the storm commencement when the solar wind dynamic pressure was high, the ULF wave power is dominated by low mode numbers. Interesting change in the sign of m around noon is also found, with eastward propagation

in the noon to dusk sector (solid lines) and westward propagation in the noon to dawn sector (dashed lines). This is consistent with the external driving of ULF waves from the solar wind buffeting around noon, which creates anti-Sunward propagation of waves on both sides. In contrast, during the storm main phase and early recovery phase when the solar wind dynamic pressure dropped to a very low level and the AE index became very active, high mode number ULF waves become dominant. A new result we find is that the high m wave structure covers a wide range of local time, not only limited to midnight region as suggested by previous studies. In addition, new method and analysis is devised and performed to reduce the 2n ambiguities in the cross-phase and mode number calculation by comparing and reconciling the mode estimation results from two overlapping GOES pairs. In the future, the mode number estimation from this study will be used to quantify the role of radial diffusion to the observed enhancement of MeV electrons during the storm.

Barbrow, Seth (United States Military Academy)
Poster Number: I6
Poster - STK Scenario Development to Predict GPS and PFISR Beam Conjunctions for Periodic and On-demand Scintillation Research

Abstract: Using System Took Kit (STK), Global Positioning System (GPS) satellite conjunctions with Poker Flat Incoherent Scatter Radar (PFISR) beams were modeled to project experiments aimed at detecting ionospheric conditions associated with GPS L1 Scintillations. The GPS multi-beam mode has been used successfully at PFISR during the winters of 2017-18 and 2018-19 to detect ionospheric parameters associated with GPS L1 scintillation events. A series of central beams with an associated four beam cross pattern are matched to projected GPS signal ray paths using open source ephemerides, keeping the GPS line of site within +/- 2 degrees of the central beam. The resulting STK scenario will streamline existing PFISR experiment projections, and can be used in the future to develop on-demand conditions-based experiment requests.

Benson, Jennifer (Delta Solutions & Strategies, LLC)
Poster Number: G8
Poster - Relationship of >2 MeV Electron Fluence and Geomagnetic Storming Near Solar Minimum

Abstract: A study has been carried out to explore the relationship between >2 MeV electron fluence and geomagnetic storming during 2017 and 2018 in order to improve forecasting for the likelihood of internal charging in satellites. GOES geosynchronous satellites >2 MeV electron fluxes were used to calculate a 72-hour fluence, and USGS derived Ap index values determined geomagnetic storming. We used threshold criteria of Ap ? 30 to denote geomagnetic storming and 72-hour fluence ? 1.0E9 e/cm2/sr as an indicator of internal charging. During the study period, recurrent coronal holes (CHs) were the main driver of geomagnetic storms. We found that electron fluence exceeded 1.0E9 (‘charging’ threshold) primarily during the equinox periods with gaps during the

solstice periods. Charging followed geomagnetic storms from negative polarity CHs in the spring and positive polarity CHs in the fall. On average, electron fluence exceeded 1.0E9 three days after geomagnetic storming was first observed and remained above the threshold for six days.

Berger, Thomas (University of Colorado Boulder)
Poster Number: S22
Poster - The Solar Polar Observing Constellation (SPOC) Mission

Co-authors: Nicole Duncan, Natasha Bosanac, Thomas Smith, Ian Elliott, Chris Sullivan, Jeff Van Cleve, Mark Shannon, Lisa Upton

Abstract: We propose a novel constellation of small satellites called the Solar Polar Observing Constellation (SPOC) that will rapidly obtain magnetic field and doppler velocity measurements over the entire solar photosphere, including direct overhead measurements of the polar regions. The SPOC constellation consists of identical satellites placed into ~90-degree inclination circularized heliocentric orbits using Jupiter gravitational assist (JGA) trajectories. The SPOC magnetograph is a compact doppler imaging magnetograph instrument based on the Solar Dynamics Observatory (SDO) Helioseismic and Magnetic Imager (HMI) instrument. Additional baseline instrumentation includes a Compact Coronagraph (CCOR) and in-situ plasma and magnetic field measurements. The SPOC mission follows the model of ?hybrid operational-research? missions developed by the CU Space Weather Technology, Research, and Education (SWx-TREC) to enhance utility and collaboration by developing critical operational data sources for space weather forecasting that can also produce high-value exploratory science data.

Bernstein, Valerie (University of Colorado, Boulder)
Poster Number: I18
Poster - Investigating TIEGCM Sensitivities in Predictions of Low Earth Orbit Atmospheric Drag

Co-authors: Andrew Walker, Piyush Mehta, Delores Knipp

Abstract: Atmospheric drag describes the perturbing force of the atmosphere on the orbital trajectories of Low Earth Orbit (LEO) objects and depends primarily on the spacecraft drag coefficient and the atmospheric mass density of the space environment. Numerous physics-based and empirical models exist which estimate the variable atmospheric conditions that impact satellite drag with distinct advantages and errors. The Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIEGCM) is a physics-based model of the Earth's upper atmosphere that is unique in its ability to study the effects of including or neglecting atmospheric helium, a constituent that is typically considered to be a minor species with uncertain satellite drag effects that increases during solar minimum conditions, on atmospheric mass density and spacecraft drag coefficient

estimates. To examine the spatial and temporal effects of helium on satellite drag, we simulate TIEGCM atmospheres with and without helium along the orbital trajectories of two LEO satellites, the Challenging Minisatellite Payload (CHAMP) at 375 km altitude and the Gravity Recovery and Climate Experiment (GRACE) at 500 km altitude. TIEGCM simulations were performed for six one-week time periods including three active, moderate, and quiet geomagnetic activity time periods in both this past solar maximum and solar minimum. We compare TIEGCM atmospheric mass densities with and without helium with accelerometer-derived density estimates for CHAMP and GRACE revised based on newly-computed drag coefficients modeled for TIEGCM atmospheres with and without helium during these time periods to identify the strengths and weaknesses of TIEGCM estimates attributed to helium. Including helium in TIEGCM is found to increase TIEGCM density and drag coefficient predictions for GRACE during quiet solar minimum conditions at polar latitudes in the winter hemisphere. We additionally compare TIEGCM atmospheres with and without helium to atmospheres simulated by the Naval Research Laboratory's Mass Spectrometer and Incoherent Scatter Extended Model (MSIS), an empirical model of the atmosphere that includes helium, in order to assess trends in the variations in helium predicted from different atmospheric models. TIEGCM with helium consistently overestimates the densities and underestimates the drag coefficients compared to those associated with MSIS atmospheres during solar minimum. Differences between TIEGCM, MSIS, and CHAMP/GRACE newly revised densities will inform the ways in which composition differences impact density derivation and help to quantify and refine errors in MSIS.

Biesecker, Douglas (NOAA Space Weather Prediction Center)
Poster Number: S13
Poster - The Sunspot Number Was Corrected By 1.66? So What is SWPC Doing About It

Co-authors: Frederic Clette

Abstract: On July 1st, 2015 the sunspot number series was replaced by an improved version that corrects past inhomogeneities in the time series. The old and new versions are now referred to as Version 1 and Version 2. The most noticeable change has been the removal of a factor of 0.6 that was introduced by Wolf in 1893. Additional calibration factors and issues were resolved at the same time. However, as this was in the middle of the declining phase of the solar cycle, it was felt that SWPC customers would be impacted too greatly by the change. Therefore, SWPC chose to keep the 0.6 correction factor in place. Now that we are nearing solar minimum and we can expect a prediction for Cycle 25 in the near future, it is time for SWPC to begin to use the Version 2 sunspot number. SWPC plans to educate customers about this change through a variety of means in 2019 and will implement the change when it will have the least amount of disruption.

Boudouridis, Athanasios (University of Colorado Boulder)
Poster Number: G19
Poster - Calibration/Validation Efforts for Magnetospheric Plasma Sensor Low Energy, the New Plasma Instrument Onboard NOAA's GOES-16/-17 Satellites

Co-authors: Brian T. Kress, Juan V. Rodriguez

Abstract: The Space Environment In-Situ Suite (SEISS) on NOAA's GOES-16/-17 satellites includes a new instrument for measuring low-energy plasma populations, the Magnetospheric Particle Sensor - Low Energy (MPS-LO). MPS-LO is an electrostatic analyzer that measures electrons and protons in 15 energy channels between 0.03 and 30 keV, in 12 unique look directions. The first MPS-LO on GOES-16 has been returning real time data since January 8, 2017, and the second one on GOES-17 has been operating in real time since April 24, 2018. Extensive calibration/validation activities have been performed for both instruments to ensure instrument health and data quality. Here we discuss three major issues that have been investigated: (1) Contamination of the MPS-LO electron and proton channels by penetrating high-energy electrons. The high-energy electron population is monitored by the Magnetospheric Particle Sensor High Energy (MPS-HI) instrument, also onboard the GOES spacecraft. The MPS-HI electron channels cover the energy range 50 keV - 4 MeV. Various quantitative analyses have been performed, pointing to high correlations between the MPS-LO backgrounds and the MPS-HI 600-800 keV electron populations. The source of the contamination is still unknown. (2) Presence of negative electron and proton fluxes after the removal of backgrounds. The MPS-LO backgrounds are measured independently through 4 background channels not illuminated by the instrument aperture. Subtraction of these backgrounds from the in-band fluxes sometimes leads to negative fluxes. An empirical scheme has been developed to remove weighted background levels as to avoid negative fluxes. The background removal coefficients are calculated through this scheme for a specific time period, and are applied to accurately determine the true in-band fluxes. (3) Long term analysis of the in-band and background rates reveal a downward trend of both with time. It is the in-band rates, however, that decrease more rapidly leading to varying background removal coefficients with time, as calculated from the above technique. The source of the gradual decline in rates is still unknown.

Califf, Sam (NOAA/NCEI)
Poster Number: G20
Poster - Arcjet Thruster Influence on Local Magnetic Field Measurements from the GOES-16 Magnetometer

Co-authors: Paul Loto'aniu, Derrick Early, Rob Redmon, Juan Rodriguez, Brian Kress, Mike Grotenhuis

Abstract: GOES-16 is the first satellite launched from NOAA's next-generation Geostationary Operational Environmental Satellite (GOES)-R series. Observations from GOES-16 are used by NOAA to provide terrestrial and space weather forecasts, warnings

and alerts. The magnetometer (MAG) on GOES-16, which monitors the geomagnetic field, consists of two tri-axial fluxgate magnetometers mounted on an 8.5 m boom. For stationkeeping, GOES-16 uses hydrazine arcjet thrusters. However, when the arcjets are fired a large magnetic field disturbance contaminates the MAG data. Here, the characteristics of the contamination are described and we suggest possible physical generation mechanisms for the magnetic field disturbance. The arcjet disturbances occur for ~90 minutes approximately every 4 days, and the contamination renders the MAG operationally useless to NOAA without a correction to the data. The contaminations are observed as step changes in the geomagnetic field observations of up to about 20 nT (~20% of the nominal field strength). We suggest two separate physical mechanisms: a large-scale diamagnetic effect caused by the dense plasma in the thruster plume, and a local current source near the spacecraft caused either by the current that drives the arcjet or by plasma pressure gradients near the thruster.

Caraballo, Ramon (Universidad Nacional Autonoma de Mexico) *e-Poster
Poster Number: G23 - 10:00-10:15 & 3:30-3:45 on Screen 1
Poster - First Estimates of Geomagnetically Induced Currents in the Mexican Power Grid

Co-authors: Americo Gonzalez Esparza

Abstract: The growing impact of Space Weather (SW) on technological systems in recent years, have compelled some governments to design new policies to address this kind of threat to its national security. This is the case of the Mexican government, where SW effects have been included in the revision of its civil protection law in 2014. The Mexican electrical power grid occupies a broad territory which covers 20 degrees in latitude, and in longitude and it has several connections with the US and Guatemala power grids. The most important power utility is operated by the Federal Commission of Electricity (CFE), a governmental company which ensures the energy supply all over the country. In 2018, a joint project between the CFE transmission management office and the Mexican Space Weather Service (SCIESMEX) at the Institute of Geophysics (UNAM), started with the aim to study the impact of geomagnetically induced currents (GIC) on the 400kV power grid in Mexico during the periods of intense geomagnetic storms. The objectives of the project are to assess and model GIC effects and to design mitigation protocols to ensure the integrity of the national power grid under disturbed geomagnetic conditions. We present, the preliminary estimates of GIC events associated with five intense geomagnetic storms from solar cycles 23 and 24. These initial results serve to plan the installation of GIC sensors at the most vulnerable CFE substations. A numerical model of 400kV grid was constructed in order to estimate the GIC levels at all substations. The first results suggest that terminal stations located at coastal regions are most affected by intense GIC ranging between 10 A and 40 A. The modeling shows that the Mexican power grid can be affected significantly during intense geomagnetic disturbances. The future work is to improve the model using the experimental data obtained directly from the GIC detectors at some substations.

Carlson, Samantha & Fleming, Rhiannon (Millersville University of Pennsylvania)
Poster Number: I24
Poster - Radiation Profiles During a Quiescent Sun

Co-authors: Samuel Reams, Noah Stitely

Abstract: The vertical profiles of high energy radiation will be investigated during a period of quiescent sun. New and previously obtained vertical profiles obtained during the extended solar minimum over southeastern Pennsylvania will be investigated in order to document that structure of the high energy radiation. Data will be collected during high altitude balloon ascents with onboard high energy probes and conventional meteorological sensors. The balloon can routinely attain altitudes of 30,000 - 40,000 meters. Balloons will be launched when sky conditions and clear to scattered conditions. The balloon carries a payload containing three probes, with two each measuring a bandwidths of ultraviolet radiation, UVA and UVB, and a third sensor measuring X-ray and gamma radiation. The data is archived using an onboard computer. Once the radiation package is retrieved, the data from the device is downloaded and processed through a python-based program to be studied and interpreted. Primarily, the research is conducted to understand radiation profiles over southeastern Pennsylvania with a secondary mission to develop research, data processing, and professional presentation skills in students.

Chen, Yanhong (National Space Science Center)
Poster Number: I2
Poster - The Derivation and Verification of a Regional Ionospheric TEC Disturbance Index

Co-authors: Yue Chen, Panfeng Li, Youzuo Lin, Geoffrey Reeves

Abstract: A regional ionospheric disturbance index (RIDI) derived from the regional TEC map was introduced in this paper. The RIDI index can give a clear description for the disturbed phase (positive or negative) and strength of the ionospheric perturbation. The comparison between indices and the regional TEC disturbance (TEC) suggested RIDI can represent the regional TEC well. Further verification using the multidimensional scaling suggested the RIDI is more correlated with TEC disturbance. The RIDI index can be used in global coverage. In addition, a Ns index was used to describe the disturbance range and it had a good relationship with Dst index. The RIDI and Ns can be used in space weather operational services to give the disturbance strength and influence range, which is convenient for users to know about ionospheric current conditions.

Chua, Damien (US Naval Research Laboratory)
Poster Number: S19
Poster - The Compact Heliospheric Imager (CHI): An R2O Instrument Concept for the NOAA SWFO L1 Mission

Co-authors: Clarence M. Korendyke, Dennis G. Socker, Arnaud Thernisien, Mario Noya

Abstract: The Compact Heliospheric Imager (CHI) is a dual-telescope instrument with 60 fields of view that will image interplanetary space in white light (500-700 nm) between 17.2 221.0 solar radii (RSun) or 4-64 elongation from both east and west limbs of the Sun. The CHI inner fields of view cutoff will overlap with the edge of the design-goal CCOR outer field of view. This will extend the ability of SWFO L1 to continuously track coronal mass ejections (CME) as they leave the CCOR FOV, improving CME trajectory determination, CME arrival time estimation, and ultimately the accuracy of geomagnetic storm forecasts.

Cook, Michael (University of North Dakota)
Poster Number: I30
Poster - Space Weather Policy and Citizen Science

Co-authors: Michael Dodge

Abstract: This research is from my Master's Thesis I am currently finishing and will examine current Space Weather Policy as well as Citizen Science Policy, discuss what ongoing Citizen Science projects have been able to accomplish and then talk about how to include Citizen Science in future Space Weather Policy. Space Weather and Citizen Science are two fields that continue to evolve with our ever-growing technology. With that, means new and evolving policy, whether it is in the Space Weather field or in Citizen Science. Citizen Science is when the public participates voluntarily in the scientific process, addressing real-world problems in ways that may include formulating research questions, conducting scientific experiments, collecting and analyzing data, interpreting results, making new discoveries, developing technologies and applications, and solving complex problems. Space Weather refers to the environmental conditions in Earth's magnetosphere, ionosphere and thermosphere due to the Sun and the solar wind that can influence the functioning and reliability of spaceborne and ground-based systems and services or endanger property or human health. As the field of Space Weather has continued to evolve, so has the policy surrounding the field. We've seen Space Weather pop up in our National Space Policy and be the focal point of a Presidential Executive order in recent years. Citizen Science has exploded over recent years with the abilities of smart phones and technology that is being made available to more and more people across the country and even the world. This field has already proven how valuable it can be in terms of public engagement and education, research and even international cooperation. All of which, are something Space Weather Policy is calling and asking for, from executive departments and agencies. After reviewing current Space Weather Policy,

it became obvious that this field along with Citizen Science could and should co-exist in future Space Weather Policy. It seems that so much of what Space Weather Policy addresses and wants, Citizen Science is already doing and proven its value.

Costa, Joaquim (National Institute for Space Research) *e-Poster
Poster Number: I33 - 10:00-10:15 & 2:50-3:05 on Screen 1
Poster - The EMBRACE (Brasilia) Services for Space Weather

Co-authors: C. Wrasse, M. Banik, C. De Nardin

Abstract: The program is structured to run a network of sensors on the ground that is organised in a structured data bank freely distributed through the EMBRACE web site. The program has already initiatives on space- based instruments (for ex. downlink system for COSMIC 2- NOAA, SPORT micro-satellite, NASA-INPE-ITA for 2020). Construction of daily indices, alerts and prediction (regional KSA for South America, burst alerter using GOES soft X ray flux, a version of Total Solar Irradiance prediction and prediction of Brazilian Ionosphere for 24 hours). For 2019 new products of night plasma bubbles will be shown in the web site (example shown here). We are working close to our authorities and users (workshop with users, meetings) to establish a chain of communications when needed. Our site is organised to offer a clear communication with users, we prompt the activity indices in the first page such as being done by other centres, we offer graphical user interface to play with and obtain the data. We work hard on our internal capacity building weekly with a meeting to discuss our operation. The EMBRACE is working in a cooperation agreement with other partners in Latin America to integrate our networking of sensors and cooperate within our expertises.

Covington, Jay (Cybersecurity and Infrastructure Security Agency, USDHS)
Poster Number: G5
Poster - Solar EMP Preparedness on the Homeland Security Information Network

Co-authors: Ben Sheppard, Edwin Martinez

Abstract: The Homeland Security Information Network (HSIN)- Critical Infrastructure (CI) website is a key resource to assist the public and private sectors to stay abreast of threats, best practices, programs, security, response, and recovery. The presentation will provide an overview of how HSIN-CI, maintained by the Cybersecurity and Infrastructure Security Agency (CISA), is playing a critical role by providing a forum to engage on solar events that impact critical infrastructure. Currently, power grid sector owners and operators are utilizing HSIN-CI to prepare and respond to solar electromagnetic pulse (EMP) events, and Federal, State, and local entities are utilizing the space to engage with and prepare their communities for possible significant power disruption. The presentation will also demonstrate ongoing EMP cross sector collaboration, and opportunities for further expansion in content and the range of users on

HSIN-CI (including international partners). HSIN is the primary mechanism that DHS shares intelligence and other sensitive information with vetted members.

Craft, James (Laboratory for Atmospheric and Space Physics)
Poster Number: I31
Poster - SWx TREC: An Open Space Weather (SWx) R2O Development and Testbed Environment

Co-authors: Chris Pankratz, Thomas Berger, Jeffrey Thayer, Thomas Baltzer, Daniel Baker

Abstract: The Chancellor of the University of Colorado recently awarded a Grand Challenge grant to a group of departments and labs for the development of the Space Weather Technology, Research and Education Center (https://www.colorado.edu/spaceweather/). As part of this effort, the Laboratory for Atmospheric and Space Physics (LASP) is developing a Space Weather Testbed to provide a platform to explore research and development models side-by-side with operational standards. The Space Weather Testbed is being built using technologies employed by LASP Data Systems for the Magnetospheric Multiscale Mission Science Data Center and the Emirates Mars Mission Science Data Center. These data centers provide a managed computational environment for independent science teams to deploy their processing software into the operational system. This poster will discuss the technologies that will be used in producing the Space Weather Testbed and how the exploration between
Operations to Research (O2R) and Research to Operations (R2O) will be supported.

Darnel, Jonathan (University of Colorado)
Poster Number: S23
Poster - Using the GOES SUVI to Observe the Solar Corona

Co-authors: D. B. Seaton, M. Tilton

Abstract: The GOES SUVI instruments are Extreme Ultra-Violet solar imaging telescopes observing the Sun and the solar corona in six primary wavelengths. There are four SUVI instruments in total; two already on-orbit on-board GOES-16 and -17, and two more hosted by GOES-T and -U. While SUVI has much in common with the AIA telescopes on SDO, SUVI boasts an extended field-of-view that spans 1.6 to 2 solar radii in some parts of the detector. We will present data from the current operating instruments and discuss the contributions that SUVI can make to investigate the mechanics and dynamics of the solar corona. We will also describe the SUVI datasets and products, and indicate where to access the data.

DeForest, Craig (Southwest Research Institute)
Poster Number: S7
Poster - Determining CME Leading Bz with Polarized Imaging

Co-authors: C. A. de Koning, H.A. Elliott, and S. E. Gibson

Abstract: We present a method of determining the leading direction of flux rope Bz in CMEs via visible-light imaging. The physics of Thomson scattering enables direct imaging of 3D structures in the corona and solar wind, via polarization effects. Measuring the 3D structure of a CME core reveals its chirality (direction of twist), which in turn relates the easily-measurable E/W direction of the source region's magnetic field to the all-important N/S component of the leading edge in interplanetary space. The technique requires low-noise polarized imaging. We present an actual measurement of CME 3D chirality using STEREO images, validated using in-situ encounter data from ACE; and demonstrate, with a forward model, what could be achieved with routine high-sensitivity polarimetry of CMEs as they erupt and propagate.

DeForest, Craig (Southwest Research Institute)
Poster Number: S8
Poster – PUNCH: A Mission for 3D Imaging of Space Weather in the Inner Heliosphere

Co-authors: The PUNCH Team

Abstract: Space weather prediction suffers from the difficulty of tracking CMEs and other disturbances across the inner heliosphere. The solar wind and interplanetary magnetic field modify and steer space weather events as they propagate, leading to well-known problems in predicting arrival at (or missing of) Earth, arrival time at Earth, and geoeffectiveness of solar disturbances if and when they do impact. These difficulties are only slightly mitigated by direct unpolarized heliospheric imaging, even from off the Earth-Sun line (as demonstrated by STEREO and conceived for L5). Polarized heliospheric imaging can yield direct 3D information without line-of-sight confusion effects that confound arrival prediction even with events seen by STEREO. We describe PUNCH, a polarimetric wide-field imaging space mission that will track CMEs across the inner solar system in 3D from near Earth.

De Koning, Curt (University of Colorado)
Poster Number: S6
Poster - In-Depth Analysis of the 2010 April 3 CME

Co-authors: Craig E. DeForest, Dusan Odstrcil

Den, Mitsue (National Institute of Information and Communications Technology)
Poster Number: S12
Poster - Forecast of Fast Solar Wind Using Global 3D MHD Simulation from the Sun to 1AU with an Empirical Coronal Heating Model

Co-authors: Takashi Tanaka, Yuki Kubo, Shinichi Watari

Abstract: Using our three-dimensional MHD simulation code, REPPU (REProduce Plasma Universe) code driven by solar magnetic field from the sun to 1AU, we are monitoring the global solar wind condition since 2016. Our model is able to reproduce both coronal holes and global solar wind structure, so it can connect fast solar wind observed at L1 point and that origin. We present our simulation results and discuss the effect of an empirical coronal heating model and solar wind acceleration region on reproduce of fast solar wind.

Fiori, Robyn (Natural Resources Canada)
Poster Number: I10
Poster - Characterizing Auroral Absorption Based on Geomagnetic Hourly Range

Co-authors: L. Trichtchenko, S. Groleau

Abstract: Energetic electron precipitation is a source of both ionospheric and geomagnetic disturbances. The resultant increased ionization in the auroral oval leads to the absorption of high frequency radio waves in the auroral zone, or auroral absorption, primarily localized in pre-noon and pre-midnight ionosphere lasting several hours. This poster examines the relationship between absorption and the geomagnetic hourly range in both the auroral and sub-auroral zones.

Forsyth, Jennifer (MITRE)
Poster Number: I14
Poster - Analytic and Experimentation Capabilities for Arctic Communications and Operations

Co-authors: Scott Bento

Abstract: Arctic situational awareness is increasingly important as arctic ice decreases and maritime transits increase. Key challenges include, as the DoD arctic strategy calls out, vast distances, obsolete or deteriorating polar communications architecture, limitations of geostationary communications satellites, harsh weather conditions, high-latitude ionic disturbances, and geomagnetic storms. These combine to make reliable, secure communications in the Arctic difficult. Arctic users have reported that current modeling tools for High Frequency (HF) communications are not consistently accurate in the arctic. This makes it difficult to operate reliably and to look forward to defining requirements for communications systems of the future. This presentation reviews recent

work that compares existing HF models performance in the arctic and looks at arctic parameters missing from existing communication modeling tools. The work uses several publicly available HF models as well as data from University of Massachusetts Lowell Digisonde database and NOAA. The intent is to improve arctic HF communication definitions for current capabilities, provide insight into arctic HF communications limitations, and drive decisions for investments and test planning. Future work is also presented.

Ganjushkina, Natalia (University of Michigan) *e-Poster
Poster Number: S33 - 10:30-10:45 & 4:00-4:15 on Screen 2
Poster - Operational Inner Magnetosphere Particle Transport and Acceleration Model for keV Electrons

Abstract: A series of anomalies at GEO have been attributed to electrons of energy below 100 keV, responsible for surface charging. The process at play is charge deposition on covering insulating surfaces and is directly linked to the space environment at a time scale of a few tens of seconds. Even though modern satellites benefited from the analysis of past flight anomalies and losses, it appears that surface charging remains a source of problems. Accurate specification of the space environment at different orbits is of a key importance. We present the operational model for low energy (< 200 keV) electrons in the inner magnetosphere, Inner Magnetosphere Particle Transport and Acceleration model (IMPTAM). This model has been operating online since March 2013 (http://citrine.engin.umich.edu/imptam/ and imptam.fmi.fi) and it is driven by the real time solar wind and IMF parameters and by the real time Dst index. The presented model provides the low energy electron flux at all L-shells and at all satellite orbits, when necessary. IMPTAM is used to simulate the fluxes of low energy electrons inside the Earth's magnetosphere at the time of severe events measured on LANL satellites at GEO. There is no easy way to say what will be the flux of keV electrons at MEO when surface charging events are detected at GEO than to use the model.

When an anomaly occurs, the radiation environment may be more extreme than that given by the specification models used for design. The existence of an operational model, validated and run in real-time is extremely important for determining the possible reason for that anomaly.

Garton, Tadhg (Trinity College Dublin)
Poster Number: S11
Poster - Expansion of High Speed Solar Wind Streams through the Inner Heliosphere and the Prediction of their Properties at L1

Co-authors: Sophie A. Murray, Peter T. Gallagher

Abstract: Coronal holes (CHs) are regions of open magnetic flux in the solar corona which are responsible for recurrent high speed solar wind (HSSW) streams. To date, it is

not clear which aspects of CHs are most influential on the observable properties of solar wind streams as they expand through the heliosphere. Here, we examine the connection between HSSW measurements at L1, taken from the ACE spacecraft, and the properties of their originating CH regions, extracted from Solar Dynamics Observatory's AIA instrument using the Coronal Hole Identification via Multi-thermal Emission Recognition Algorithm (CHIMERA). For narrow CHs, \Delta\theta_CH < 67 deg, peak SW velocity (v_max) is found to scale as v_max~330.8+5.7\Delta\theta_CH km/s. For wider CHs, (\Delta\theta_CH > 67 deg), v_max is found to tend to a constant value (~710 km/s). Furthermore, we find that the duration of HSSW streams (\Delta t) are directly related to the longitudinal width of CHs (\Delta t_SW ~ 0.09\Delta\theta_CH) and that their longitudinal expansion factor is f_SW ~ 1.2 +/- 0.1. We also derive an expression for the coronal hole flux-tube expansion factor, f_FT, which varies as $f_{SW} \gtrsim f_{FT} \gtrsim 0.8$. From these results it is now possible to estimate the peak speeds and durations of HSSW streams at L1 using the width of CHs identified in the solar corona.

Gary, Dale (New Jersey Institute of Technology) *e-Poster
Poster Number: G25 - 10:15-10:30 & 3:45-4:00 on Screen 1
Poster - Advances in Solar Radio Instrumentation for Space Weather

Co-authors: Bin Chen, Gregory Fleishman, Gelu Nita, Sijie Yu

Abstract: We introduce multi-frequency imaging from the Expanded Owens Valley Solar Array (EOVSA) and the Owens Valley Radio Observatory Long Wavelength Array (OVRO-LWA), both of which perform spatially-resolved imaging spectroscopy of solar flares and coronal mass ejections. The ability to perform imaging spectroscopy makes available for the first time unique diagnostics of plasma parameters in the source, including magnetic field strength, as well as energy distribution parameters of accelerated electrons. We illustrate the power of the technique with several well observed events, including SOL20150924, SOL20170904, and SOL20170910. The spectral diagnostics of these events are revolutionizing our understanding of the dynamics of the standard solar flare model.

Federico, Gasperini (University Corporation of Atmospheric Research)
Poster Number: I26
Poster - Preliminary Evidence of Madden-Julian Oscillation Effects onTropospheric Ultra-fast Kelvin Waves in the Thermosphere

Co-authors: Hanli Liu

Abstract: Mounting evidence has demonstrated that terrestrial weather significantly influences space weather. Much of this coupling is carried by waves that are excited by deep convection in the tropical troposphere and that propagate vertically into the thermosphere. Prominent among these waves are 'ultra-fast tropical waves' (UFTW) with periods between about 0.5 days to 3.5 days. By analogy with the need to understand

conditions on the Sun that translate to solar-driven space weather, it is also important to understand the meteorological conditions that give rise to waves that reach the thermosphere and the propagation conditions that make this possible. By taking advance of state-of-the-art numerical simulations (i.e., SD/WACCM-X) and satellite observations (i.e., CHAMP, GOCE, and TIMED/SABER), we present preliminary evidence of the effect of the Madden-Julian Oscillation (MJO) on two of the largest thermospheric UFTK: the diurnal eastward propagating tide with zonal wavenumber 3 (DE3) and the quasi-3-day ultra-fast Kelvin wave (UFKW). This study suggests that strong coupling between the troposphere and the thermosphere is occurring on intra-seasonal timescales, raising important questions including implications for the whole atmosphere system.

Gentile, Louise (Air Force Research Laboratory)
Poster Number: I11
Poster - The Kiritimati Equatorial Ionospheric Observatory (KEIO) Project

Co-authors: T. R. Pedersen, E. V. Dao, K. S. Obenberger, J. M. Holmes, J. W. Hines, R. F. Kelly, Z. T. Balint, K. Robinson, J. Moses, S. Kumar

Green, Janet (Space Hazards Applications, LLC)
Poster Number: G11
Poster - Applications for Satellite Anomaly Attribution

Co-authors: R. Quinn, T.P. O'Brien, Y. Shprits, J. Likar, A. Kellerman, S. Claudpierre, D. Turner, A. Boyd, P. Whelan, N. Reker

Abstract: The intense particle radiation that fills near Earth space has been an issue for satellites, causing them to behave in unexpected ways, since the first exploratory missions. Intense particle fluxes can damage electronic components, resulting in temporary malfunctions, degraded performance, or a complete system/mission loss. Every effort is made to design satellites that can withstand the harsh environment but on orbit issues still occur. When they do, it is necessary to understand and diagnose the cause in order to take the appropriate action needed to safeguard the asset and return to normal operations. However, diagnosing space weather related anomalies is currently challenging because it requires a wide range of environmental information, engineering knowledge, and specialized expertise. Our goal is to enable effective anomaly analysis and attribution by providing tools that bring together all the necessary components and simplify the analysis process for the end users.
Here we discuss our progress in developing models and anomaly attribution tools including the Satellite Charging Assessment tool (SatCAT) and a new model called Specifying High-altitude Electrons using Low-altitude LEO Systems (SHELLS). The SatCAT tool is an online system that allows users to create a timeline of the current and historical charging levels of a satellite on orbit for comparison with anomaly times. The tool is configurable and allows users to generate and view internal charging levels for their satellites and design parameters such as shielding thickness and materials. SHELLS

is a neural network model that maps energetic electron fluxes measured by the low altitude polar orbiting POES satellites to fluxes measured by the high altitude equatorial Van Allen Probes satellites. Once the mapping is established, global energetic electron fluxes can be specified in the past and out into the future using only the near real time POES data.

Halford, Alexa (The Aerospace Corporation)
Poster Number: I32
Poster - A Framework for Tracking Progress Towards Usability: Application Usability Levels

Co-authors: Adam Kellerman, Barbara Thompson, Antti Pulkkinen, Katherine Garcia-Sage, and the Assessment of Understanding and Quantifying Progress iLWS Working Group

Abstract: As our community continues to grow and become more intertwined with industry and other fields, there is a need for a framework that can allow researchers and end users to identify applications for the research, quantify metrics for each specific application, and enable communication between the researchers and end users. To this end, the Assessment of Understanding and Quantifying Progress iLWS Working group has developed the Application Usability Level (AUL) framework. The AUL framework was developed by implementing lessons learned from Technology Readiness Levels (TRLs) used by the instrument community and Application Readiness Levels (ARLs) used by the Applied Science program in NASA's Earth Science Division, as well as modifying the levels and their milestones to better suit the needs of the Space Weather and Heliophysics communities. In this talk we will introduce the AUL framework and show examples of how it can be applied to research for the Space Weather and Heliophysics communities. For more information on the AULs and other work being done by the Assessment of Understanding and Quantifying Progress iLWS working group, please see our website at the CCMC
https://ccmc.gsfc.nasa.gov/assessment/topics/trackprogress.php

Henney, Carl (Air Force Research Laboratory)
Poster Number: S1
Poster - ADAPT Global Solar Magnetic Maps with Reverse Active Region Modeling

Co-authors: Kathleen Shurkin, C. Nick Arge

Abstract: Global solar magnetic maps provide estimates of the solar photospheric magnetic field distribution and are typically utilized as the primary input data driver of heliospheric models. For over five years, the ADAPT (Air Force Data Assimilative Photospheric flux Transport) model has been operating continuously in a prototype mode at the National Solar Observatory (NSO), generating global photospheric magnetic maps in near real-time. Input to the ADAPT model includes photospheric magnetograms from

the NISP (NSO Integrated Synoptic Program) ground-based instruments, GONG (Global Oscillation Network Group) and VSM (Vector SpectroMagnetograph). In addition, the ADAPT model has been updated to utilize line-of-sight and vector magnetograms from HMI (Helioseismic and Magnetic Imager). Though full-disk solar magnetograms are now readily available with high temporal cadence, estimating the global magnetic field distribution continues to be a challenge since less than half of the solar surface is viewable with spectropolarimetric measurements at any given moment in time. The absence of solar far-side magnetic field observations and lack of quality polar data result in temporal and spatial discontinuities within global maps at the east-limb boundary and at the poles. Accounting for differential rotation, along with meridional and supergranulation flows, the flux transport component of ADAPT evolves an ensemble of realizations to match the observation time of magnetograph input data before assimilation. Progress toward generating smoothly evolving global solar magnetic maps will be presented, highlighting modifications to the ADAPT model to assimilate reverse-modeled far-side flux estimates for newly emerged active regions using east-limb HMI vector data. This presentation includes results generated by the WSA (Wang-Sheeley-Arge) model driven by ADAPT global maps that include reverse active region modeling.

Housseal, Sara (Millersville University of Pennsylvania)
Poster Number: I29
Poster - Analysis of Citizen Science Aurora Data Collected by Aurorasaurus in 2017

Abstract: Aurorasaurus is a citizen science project that uses Twitter as the foundation to report aurora from the ground up. Reports are sent in during auroral activity by citizen scientists, whether professionals or amateurs, allowing for a global range of involvement. The goal of the reports being to learn how far reaching aurora can be with different strength solar storms, and test our prediction of the intensity and viewing area of the storm that is displayed on the website. At the end of the year, direct reports and aurora-related tweets get collected from Twitter and sorted based on validation. We use this data for analysis to draw conclusions about the aurora and the reports made. The 2017 data will be used to show growth within the project and how the collaboration between the project and citizen scientists can be used to validate aurora-related space weather forecasts. Improvements within the project, such as ways to get more citizen scientist involvement, can be made from the yearly data that is collected from the tweets. The data can be showcased in ways such as showing the relationship between the number of reports received and the daily average Kp value. The analysis of the data will benefit citizen scientists, the field of space weather, and the Aurorasaurus project.

Hurlburt, Neal (Lockheed Martin ATC)
Poster Number: S9
Poster - Estimating Velocities in SUVI-ECI Data

Co-authors: Ralph Seguin

Abstract: The SUVI instrument on GOES-17 spent a month between August and September, 2018 conducting an extended coronal imaging campaign. Composite images constructed from interleaved image sets that scanned +/- 4 solar radii across the Sun every ~6 minutes were processed to create a consistent dataset for analysis. An optical flow method (opflow3d) was applied to this set to estimate velocities of moving features. The results were then compared to CMEs detected by the CACTUS algorithm operating on cotemporal LASCO images. While the peak speeds reported by opflow3d were significantly lower than the CMEs found further out in the corona by CACTUS, the time intervals of enhanced motions correlate well between the two sets. Here we present the data and discuss the processing, analysis and future work.

Ishii, Mamoru (National Institute of Information and Communications Technology) *e-Poster
Poster Number: I37 - 10:30-10:45 & 3:20-3:35 on Screen 1
Poster - Update of Japanese Space Weather Research and Operation Activities

Abstract: Since September 6 2017, when X9.3 solar flare occured most of Japanese people were scared of it, the situation of Japanese spacw weather operation has been changed so much. The ionosphere observing network has been set more robustly with dual systems. A back up center of space weather information service has been installed at NICT Kobe branch. In addition, we will begin 24/7 operation of space weather forecast services in FY2019.We have been collaborating with academic researchers under the framework of PSTEP which will finish the end of FY2019. Through the activities, we have provided some applications for better service than before. A radio propagatoin simulator, HF-START, and the estimation system of human radiation on flight, WASAVIES will be up on our web soon. In addition, we continue to discuss hazardous map against severe space weather disasters, which will be published within a year.I would like to share our information and have close cooperation with Asia Oceania space weather researchers and operators.

Jackson, Bernard (University of California, San Diego) *e-Poster
Poster Number: S27 - 9:45-10:00 & 3:15-3:30 on Screen 2
Poster - The UCSD Iterative Interplanetary Scintillation (IPS) Analysis Operation Using an ENLIL 3-D MHD Model Kernel

Co-authors: Dusan Odstrcil, P. Paul Hick, Andrew Buffington, Munetoshi Tokumaru, Mario M. Bisi

Abstract: The University of California, San Diego (UCSD) has developed a time-dependent three-dimensional (3-D) reconstruction technique that provides volumetric maps of density and velocity by iteratively fitting 3-D MHD models to interplanetary scintillation (IPS) observations. We have applied a similar technique in near real time to the Institute for Space-Earth Environmental Research (ISEE), Japan IPS data for nearly 20 years. However, unlike the previous UCSD kinematic modeling, our new tomographic

analysis with a 3-D MHD kernel now includes shock processes and non-radial transport of structure from the inner-boundary source surface at 0.1 AU. Magnetic fields extrapolated outward from the solar surface, and in-situ spacecraft measurements near Earth are also included to support the iterative procedure. We now operate this modeling on the UCSD website in near real time and compare it with NOAA and NASA-provided in-situ measurements in order to validate its operation in all different types of conditions. This type programming will be especially important when more data become available from the Worldwide IPS Stations (WIPSS) network groups and both spatial and temporal coverage is increased. We also anticipate that the 3-D MHD modeling will be able to accept cone model inputs to provide fast CME onsets sometimes missed initially by the IPS, and then update these as they progress outward from the Sun. Our modeling system complements existing operating systems at the NOAA Space Weather Prediction Center based on NOAA/DSCOVR, NASA/SOHO, and NASA/STEREO spacecraft, and will ensure prediction robustness in case of their failure.

Jones, Shaela (Catholic University of America /NASA GSFC)
Poster Number: S2
Poster - Ranking ADAPT Model Maps

Co-authors: C. Nick Arge, Samantha Wallace, Carl J. Henney

Abstract: The Air Force Data Assimilative Photospheric flux Transport (ADAPT) model generates an ensemble of synchronic (i.e., globally instantaneous) photospheric magnetic field maps, which are used as input to coronal models such as the Wang-Sheeley-Arge (WSA) model. The output of the coronal models is then used to drive a variety of solar wind models of varying sophistication. Simple solar wind models like WSA's 1-D kinematic model can rapidly process large numbers of (ADAPT driven) WSA coronal runs and quickly provide solar wind predictions at any desired point in the inner heliosphere. For more advanced models like Enlil, Gamera-Helio, or MS-FLUKSS, processing so many solutions in a timely manner, especially for forecasting purposes, is highly demanding and generally impractical. A more efficient approach is to process all of the ADAPT maps through WSA and then rank the maps based on how well the resulting solar wind predictions match recent observations. A small subset of the ADAPT maps providing the best predicted values can then be run in the more advanced models. To achieve this objective, we have developed a metric for quantitatively ranking ADAPT maps. In this paper, we provide a general overview of the approach along with preliminary results demonstrating its utility.

Kelbert, Anna (United States Geological Survey)
Poster Number: G1
Poster - Geoelectric Field Maps: Data-driven and Model-driven Approaches to Real-time Geoelectric Field Estimation

Co-authors: Christopher C. Balch, Greg M. Lucas, Rui Sun

Abstract: Estimation of ground-level geoelectric fields has been identified by the electrical power industry as a key capability in assessment and mitigation of the impacts of space weather on electrical power infrastructure. An operational system to produce geoelectric field maps is being developed by the NOAA's Space Weather Prediction Center (SWPC) and the USGS Geomagnetism Program. The goal is to provide a close to real-time estimation of spatially variable ground-level geoelectric fields everywhere in the contiguous United States.

To this end, the ground-level geomagnetic fields are being interpolated, in a physics-based manner, from real-time geomagnetic observatory data collected by the USGS (Love & Finn, 2011) and Natural Resources, Canada (Newitt & Coles, 2007), using the method of spherical elementary currents (SECs; e.g., Amm & Viljanen, 1999; Pulkkinen et al., 2003). Using real-time geomagnetic data in conjunction with a map of magnetotelluric impedances that reflect the Earth's electrical conductivity structure, the geoelectric field maps can be computed in real-time.

Several alternative approaches are being explored within the framework of this collaboration. Here, we compare geoelectric field maps obtained with the empirical magnetotelluric impedances from the NSF's Earthscope USArray survey (Schultz et al., 2006-2018) with those obtained from the best available three-dimensional Earth conductivity models in the US that were derived using these data (Meqbel et al., 2014; Bedrosian, 2016; Murphy & Egbert, 2017 and others). The use of an electrical conductivity model provides a physics-based smoothing alternative to empirical data. We also discuss the effects of the data-driven and the model-driven approaches on the voltages in the electric power grids and compare to the more traditional formulation based on one-dimensional models.

Kim, Jiyoung (Korea Meteorological Administration) *e-Poster
Poster Number: G24 - 10:00-10:15 & 3:30-3:45 on Screen 2
Poster - Satellite-based Space Weather Observation by Korea Space Weather Monitor (KSEM)

Co-authors: Daehyeon Oh

Abstract: Satellite-based space weather monitoring is becoming more important than ever. This study describes the instruments and data applications of the Korea Space Weather Monitor (KSEM), which is a space weather payload of the GeoKompsat-2A (GK-2A) geostationary satellite. The KSEM payload consists of energetic particle detectors, magnetometers, and a satellite charging monitor. KSEM will provide accurate measurements of the energetic particle flux and three-axis magnetic field, which are the most essential elements of space weather events, and use sensors and external data such as GOES and DSCOVR to provide five essential space weather products. The longitude of GK-2A is 128.2 E, while those of the GOES satellite series are 75 W and 135 W. Multi-satellite measurements of a wide distribution of geostationary equatorial orbits by

KSEM/GK-2A and other satellites will enable the development, improvement, and verification of new space weather forecasting models. KSEM employs a service-oriented magnetometer designed by ESA to reduce magnetic noise from the satellite in real time with a very short boom (1 m), which demonstrates that a satellite-based magnetometer can be made simpler and more convenient without losing any performance.

Kim, Roksoon (Korea Astronomy and Space Science Institute) *e-Poster
Poster Number: S32 - 10:30-10:45 & 4:00-4:15 on Screen 1
Poster - Coronagraph on ISS

Abstract: KASI started a new 5-year space project to develop a next generation solar coronagraph on the International Space Station (ISS) in collaboration with NASA from 2017. Through this space project, KASI expects to produce the state-of-art research by our own, and to contribute for excellent scientific achievements in the research fields of solar corona and CMEs. And also, our research can help to protect the public safety and national space assets by space weather forecast and alert.

Kouassi, N'Guessan (Université Félix Houphouët-Boigny, Abidjan, Cote d'Ivoire)
Poster Number: G2
Poster - Geomagnetically Induction Effects Related to Impulsive Space Weather Events at Low Latitudes

Co-authors: Vafi Doumbia , Kouadio Boka

Abstract: Geomagnetically induced currents (GICs) regularly damage the technological infrastructures in high latitude regions. Its effects have also been observed in middle and low latitudes (South Africa, China.) (Gaunt and Coetzee, 2007). In view of these dangers, we study the GICs at low latitudes in order to determine the level of induction associated to the solar events which are the cause of these induced currents.

We estimate GIC intensity by two methods. Firstly, we use measured geoelectric data to infer GIC and secondly, we calculate geoelectric field data by geomagnetic field data and infer GIC.

Kress, Brian (University of Colorado Boulder)
Poster Number: G18
Poster - New Data from NOAA's First Plasma Instrument at Geosynchronous

Co-authors: A. Boudouridis, J. V. Rodriguez

Abstract: The GOES-R Series Space Environment In-Situ Suite (SEISS) includes the new Magnetospheric Particle Detector - Low Energy (MPS-LO), NOAA's first plasma instrument flown on-board GOES series spacecraft. MPS-LO was first launched on

GOES-R (now GOES-16) on November 19, 2016. A second MPS-LO was launched on GOES-S (now GOES-17) on March 1, 2018. Both MPS-LO instruments are returning data in real time. MPS-LO is an electrostatic analyzer that measures electrons and ions in 15 energy channels between 0.03 and 30 keV in 12 unique angular zones. Surface charging on spacecraft associated with <50 keV electrons is known to cause electrostatic discharge resulting in spacecraft anomalies, sometimes resulting in loss of mission. MPS-LO will be used by NOAA-SWPC to monitor plasma properties at geosynchronous and level of spacecraft charging. This presentation of new data from MPS-LO will include observations of plasma injections at geosynchronous, examples of ion line signatures of surface charging, and estimates of level of charging under eclipse and non-eclipse conditions.

Kubo, Yuki (National Institute of Information and Communications Technology)
Poster Number: I25
Poster - WASAVIES (WArning System for AVIatin Exposure to Solar energetic particles)

Co-authors: Tatsuhiko Sato, Ryuho Kataoka, Daikou Shiota, Mamoru Ishii, Hiroshi Yasuda, Syoko Miyake, InChun Park, Yoshizumi Miyoshi

Abstract: We have developed radiation dose assessment model for aviation called WASAVIES. The model development almost completed and test operation is in progress. It gives the dose rate at any flight altitude from the ground to 100km for all over the world. The dose rate is calculated based on the neutron monitor and GOES proton data. Development of WASAVIES web interface is in progress. The web interface gives world dose map for almost thirty flight altitude from the ground to 100km and dose rate graph along several real flight routes from Japan (TYO) to US (JFK), EU (LHR), and Oceania (SYD), and from Oceania (SYD) to south Africa (JNB) and south America (SCL). The information will be updated once a day in case of no GLE while updated every 5 minutes in case of GLE. The web site will be open in this year.

Lee, I-Te (Central Weather Bureau)
Poster Number: I13
Poster - Transited Products to Operation for Space Weather at CWB/SWOO in Taiwan

Co-authors: Mark Cheng, Jyun-Ying Huang, Hsu-Hui Ho

Abstract: In the past decade, many researchers in Taiwan have achieved remarkable results in the field of ionospheric physics and modeling. To improve space weather monitoring and forecasting operation, the Space Weather Operational Office (SWOO) of Central Weather Bureau (CWB) collaborated with the National Space Organization and science teams from different universities to transit mature scientific products to operations. During transitioning process, virtual machine and container technology is

used to develop transition procedures and interfaces between the system environment of operational center and science teams. In general, utilizing VM technology could increase the efficiency of transit process and software debugging as well as further maintenance efforts.

To date, several products have been successfully transferred from research to operation. These include the Global/Regional total electron content map, which not only is constructed by ground-based GNSS TEC but also includes FORMOSAT-3/COSMIC radio occultation data, the ionospheric scintillation model, and the assimilative Thermosphere-ionosphere coupled model. Details of these products and transition procedure with virtual machine at SWOO/CWB will be presented and discussed.

Leka, KD *(*NorthWest Research Associates and Nagoya University*)*
Poster Number: S31 - 10:15-10:30 & 3:45-4:00 on Screen 2
Poster - Photospheric Magnetic Field Properties of Flaring vs. Flare-quiet Active Regions, V: Results from HMI

Co-authors: Graham Barnes

Abstract: What constitutes the difference between those solar active regions that produce energetic events and those that do not? The answer no doubt lies in the state and ongoing evolution of the magnetic field. Extending this series of studies of the photospheric magnetic field as related to flare imminency, we consider daily evaluations of almost all HMI Active Region Patches (HARPS), including temporal evolution. Using the NWRA Classification Infrastructure based on NonParametric Discriminant Analysis, we evaluate not only the static characterization of the photospheric field (extending well beyond the SHARP parameters) but include coronal topology and time-series considerations, as well. Additionally, we extend the analysis beyond 'global' parametrizations to describe sub-area sites which may play roles in coronal energization and event triggering. We report here on those parametrizations which best distinguish imminent flaring from imminent quiet sunspot groups.
This material is based upon work supported by the National Science Foundation under Grant No. 1630454 and Nagoya University / ISEE.

Loper, Robert (Air Force Institute of Technology)
Poster Number: I27
Poster - Carrington-class Events as a Great Filter for Electronic Civilizations in the Drake Equation
Abstract: The Drake equation is a calculation providing an upper bound on the likely number of intelligent species in our galaxy. In order to reconcile a potentially high occurrence of intelligent extraterrestrial species with the current non-observation of them, we frequently resort to some Great Filter which represents some inevitable, cataclysmic fate (such as nuclear war, pandemic, or asteroid impact) that tends to await enough worlds to negate the expectation that the galaxy ought to be teeming with intelligent life.

This paper is intended to examine one potential Great Filter for electronic-based civilizations, the impact of a Carrington-class coronal mass ejection (CME) from the Sun. Carrington-class CMEs are classified as “once in a century” events caused by our Sun; this appears to place a time limit, following the development of a civilization dependent on electronic devices, either for hardening electronics against the geomagnetically induced currents that result from CMEs or for beginning interplanetary colonization.

Lucas, Greg (United States Geological Survey)
Poster Number: G3
Poster - Hazard Analysis of Geomagnetically Induced Voltages Throughout the US Power Grid

Co-authors: Jeffrey J. Love, Anna Kelbert, Paul A. Bedrosian, E. Joshua Rigler

Abstract: Storm-time geomagnetic disturbances induce significant geoelectric fields within the Earth that can adversely affect the operation of electric power grids. The recently completed magnetotelluric survey supported by the NSF EarthScope program (2006-2018) has produced a large public archive of impedance tensors across much of the continental United States (US). In this work, the EarthScope tensors are convolved with long time series of geomagnetic field variation recorded at USGS observatories to obtain estimated time series of historical geoelectric fields. Integrating these geoelectric fields across power transmission lines results in time series of geomagnetically induced voltages on each power line. These voltages are analyzed statistically to construct hazard maps of the maximum voltages that could be realized in transmission lines across the US for an extreme, once in one hundred-year, geomagnetic storm. In combination with grounding resistance data and network topology, these voltage estimates can be utilized by power companies to estimate extreme geomagnetically-induced currents within their networks. These voltage estimates can provide information on which power lines and substations are most vulnerable to geomagnetic storms and can guide power companies in assessments of where to install additional protections within their grid.

Luo, Bingxian (National Space Science Center, Chinese Academy of Sciences)
Poster Number: S16
Poster - Verification of Solar Wind Predictions by Different Empirical Models

Co-authors: Xuan Bu, Siqing Liu, Jiancun Gong

Abstract: High-speed solar wind streams (HSSs) which originate from solar coronal holes play an important role in space weather disturbances, especially during the declining phase of the solar cycle. Those coming from mid-to-low latitude, long-lived and rigidly rotating coronal holes are sources of recurrent geomagnetic storms. Space weather forecasters try to find good coronal hole indices which can be used to predict high speed streams several days in advance. Several indices with respect to coronal hole area, brightness, or magnetic field expansion factor have been reported in literature.

Based on these coronal indices, different empirical models have been constructed by relating the indices to solar wind velocities. In this study, we will do comprehensive verification of the prediction reliability using different coronal hole indices as input and with different algorithms in constructing the empirical forecasting function. Our verification is based on data from 2011 to 2018, covering almost the whole solar cycle 24. Performances of the models will be validated by comparing with in-situ solar wind observations from different perspectives, including continuous variable verification and High Speed Event based verification.

McCandless, Martin (Hollings SWPC)
Poster Number: G21
Poster - Modeling the Variability in Thermospheric Mass Density

Co-authors: Mariangel Fedrizzi, Tim Fuller-Rowell, Zhuxiao Li, Tzu-Wei Fang, Naomi Maruyama, Joseph Schoonover, George Millward, Rodney Viereck

Abstract: Recent accelerometer observations onboard Low Earth Orbit (LEO) spacecraft have revealed a considerable amount of variability in thermospheric neutral mass density on various temporal and spatial scales not only during periods of elevated geomagnetic activity but also during quiet times. Accurately predicting the upper atmosphere density is crucial for estimating the trajectory of LEO spacecraft since satellite drag introduces errors in orbit determination solutions for the rapidly increasing number of man-made objects. The purpose of this study is to quantify the degree of variability in the neutral mass density in the thermosphere and identify the possible causes by utilizing the coupled Whole Atmosphere Model and Ionosphere-Plasmasphere-Electrodynamics (WAM-IPE) that is running in real-time development mode in preparation for operations at NOAA/SWPC. In this presentation, the mass density variations for various geophysical conditions are compared between the WAM-IPE model, accelerometer satellite observations from GOCE, and the Coupled Thermosphere, Ionosphere, Plasmasphere, and electrodynamics (CTIPe) model that has been well established by continuous validation efforts for over a decade. The results comparing WAM-IPE with GOCE and CTIPe suggest that the WAM-IPE model can capture the normal diurnal/latitude neutral density structure as well as the response and recovery to geomagnetic storms. With appropriate parameters in place, the results yield reasonable agreement across the neutral mass density and temperature comparisons. Furthermore, the neutral composition and energy drivers are validated to improve the storm-time and recovery responses. Sensitivity analysis is carried out to quantify the neutral mass density variability toward improved predictions of satellite orbits.

Mehta, Piyush (West Virginia University) *e-Poster
Poster Number: I35 - 10:15-10:30 & 3:05-3:20 on Screen 1
Poster - Data-Driven Science and Engineering for Space Situational Awareness

Abstract: Data-driven discovery is revolutionizing the modeling, prediction, and control of complex systems. Data-driven science may be a legitimate, new scientific paradigm behind theory, experimentation, and computational science. It integrates machine learning, engineering mathematics, and mathematical physics for effective and efficient exploitation of data. It has been applied to a diverse range of complex systems, such as turbulence, the brain, climate, epidemiology, finance, robotics, and autonomy. It is rapidly taking center stage in our society and cannot be ignored, either by domain scientists or by researchers in applied mathematics who intend to develop algorithms that the community will use. This work will summarizes recent progress in application to the thermosphere and lay out plans for wider application in Space Situational Awareness.

Meier, Matthias M. (German Aerospace Center)
Poster Number: I20
Poster - First Steps Toward the Verification of Models for the Assessment of the Radiation Exposure at Aviation Altitudes During Quiet Space Weather Conditions

Co-authors: Kyle Copeland, Daniel Matthiae, Christopher J. Mertens, Kai Schennetten

Abstract: Space weather is an important driver of the exposure of aircrew and passengers to cosmic rays at flight altitudes. The assessment of the corresponding radiation doses can be realized by measurements or model calculations that cover the whole range of the radiation field in terms of geomagnetic shielding, atmospheric shielding, and the effects of space weather. Since the radiation field at aviation altitudes is very complex in terms of particle composition and energy distribution, the accurate experimental determination of doses at aviation altitudes is still a challenging task. Accordingly, the amount of data with comparatively small uncertainties is scarce. The Community Coordinated Modeling Center invited the Federal Aviation Administration, the German Aerospace Center, and the National Aeronautics and Space Administration to make their radiation models for aviation CARI-7A, PANDOCA, and NAIRAS available for interested users via the Community Coordinated Modeling Center web site. A concomitant comparison of model calculations with measuring data provided information on the predicting capabilities and the uncertainties of the current versions of these models under quiet space weather conditions.

Mertens, Christopher (NASA Langley Research Center)
Poster Number: I21
Poster - Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) Model Version 2: Preliminary Results

Abstract: The NASA Nowcast of Atmospheric Ionizing Radiation for Aviation Safety (NAIRAS) model is a real-time, global, physics-based model for predicting exposure to cosmic radiation to air travelers from both galactic and solar sources. Tabular and graphical data products from the prototype operational NAIRAS model are available via its public web site. The transport of cosmic radiation through the atmosphere is modeled

in NAIRAS using the High Charge (Z) and Energy Transport (HZETRN) code. The transport procedures in NAIRAS have been recently updated by transitioning from HZETRN version 2010 to version 2015. The most important update in HZETRN2015 for the application of the NAIRAS model is the inclusion of pion-initiated electromagnetic cascade processes. In addition to this update, a correction to the galactic cosmic ray primary proton flux was derived based on measurements from the satellite-borne Payload for Antimatter Exploration and Light-nuclei Astrophysics (PAMELA) experiment. These improvements included in NAIRAS Version 2 are quantified by comparing to reference aircraft radiation measurements compiled by the International Commission on Radiation Units and Measurements (ICRU) and the International Commission on Radiological Protection (ICRP).

Miao, Juan (National Space Science Center, Chinese Academy of Science)
Poster Number: S14
Poster - Is cycle 25 smaller than cycle 24?

Co-authors: LiuSiqing, LI Zhitao, Ren Tingling

Abstract: For many forecaster, solar cycle 24 is an unexpected cycle.Its activity is so low. Just a few large solar errupts: flares, CMEs, solar proton event ect. Prediction showed that solar cycle 24 will end in 2019 to 2020 and the next cycle will begin. What about the solar cycle 25? Is it active than cycle 24 or more calm than cycle 24? Based on World Data Center SILSO's new sunspot numbers, the correlation between various parameters of solar cycles 1-24 is investigated. The parameters include maximum, rising time and descending time. Two derived regression equations are given between maximum and rising time. Two derived regression equations are given between descending time and total of descending time and next rising time. Additionally, according to cycle periodicity of secular trend and the regularity of maximum between even cycles and following odd cycles, the beginning time and the sunspot number maximum of cycle 25 are predicted.

Miller, Scott (CFD Research Corporation)
Poster Number: S24
Poster - Novel Software Application to Forecast Solar Events and their Effects

Co-authors: Ashok Raman, Dan Howe, David Falconer, Igor Khazanov, Gang Li, Shuai Fu, Kevin Warren, Brian Sierawski, Robert Reed, Munther Hindi

Abstract: This effort describes the development and features of the SPE4 software application (Solar Particle Event and Effects Forecast). SPE4 is comprised of state-of-the-art modules (each being a self-contained code) that individually address important aspects of the overall problem of forecasting solar eruptive flares and their effects on space assets, thereby yielding a comprehensive event to effects prediction capability. This R&D effort was sponsored by the NASA STTR program and involved collaboration

between CFD Research Corporation, the University of Alabama in Huntsville, and Vanderbilt University. SPE4 includes a novel computational framework and offers capabilities for: (i) Forecasting the probability, severity/energy, and location of flares/CMEs, and associated SPEs (using the MAG4 code), (ii) Transport of emitted solar particles through the Heliosphere towards the Earth (using the PATH code), (iii) Subsequent transport through the geomagnetic field to yield spectra of energetic particles as a function of time at target locations (using a Geant4-based application), and (iv) Interface between particle spectra and downstream calculation tools to estimate single-event effects (SEEs) in electronic circuits/systems (using the CREME96 code).

A prototype of the SPE4 application has been developed and continues to be verified against selected prior solar events. This prototype allows for programmatic execution of the entire simulation flow including: running the individual modules, post-processing results and generating inputs for the next sequential module, storing calculated results in a local database, and presenting results to the end users via appropriate user interfaces. The paper will provide further details about the simulation flow, including the underlying software framework, anticipated modes of operation, and future applications. The goals of this overall effort include developing a modular toolkit framework to allow facile swapping of internal (research) modules for various heliospatial regimes. This capability will ultimately enable an R2O/O2R integrated effort where researchers AND operators can readily compare capabilities and impacts of different modules on a final integrated transport and effects analysis.

Mitchell, Elizabeth (Johns Hopkins University Applied Physics Laboratory)
Poster Number: G17
Poster - Sensitivity of OVATION Prime-2013 to Changes in the Solar Wind

Abstract: Aurora are the physical manifestation of one of the coupling mechanisms between the solar wind, the Earth's magnetic field and the ionosphere. Modeling the aurora and predicting its response to solar wind input has been a topic of great interest over the past decade. One of the premier auroral models, OVATION Prime-2013, nowcasts the auroral energy flux and number flux as a function of the solar wind conditions. As operational space weather works to predict the aurora, knowledge of how operational models respond to changes in solar wind conditions determines methods for forecasting the aurora. We present some of the sensitivity of the OVATION Prime-2013 model to changes in the solar wind.

Nugent, Luke (University of Birmingham)
Poster Number: I7
Poster - Probabilistic forecasting of low latitude ionospheric scintillation

Co-authors: Sean Elvidge, Matthew James Angling

Abstract: Radio transmissions which pass through or are refracted by the ionosphere (e.g. GPS, HF communications) are critical for a number of civil and military systems. In low latitude regions ionospheric bubbles or plumes of depleted plasma can form after sunset. Transmissions passing through these plasma irregularities are subject to interference caused by ionospheric scintillation (rapid fluctuations of amplitude or phase). In this work a new method to aid the mitigation of ionospheric scintillation effects is described. The Advanced Ensemble electron density (Ne) Assimilation System (AENeAS) is a state-of-the-art physics-based data assimilation ensemble model of the coupled ionosphere-thermosphere system. Output from each ensemble member contributes to the generation of probability density functions which are used to predict the probability of strong scintillation occurring. These probabilistic forecasts are performed at regularly spaced longitudinal intervals to provide a global early warning system for low latitude scintillation.

Odstrcil, Dusan (George Mason University) *e-Poster
Poster Number: S26 - 9:45-10:00 & 3:15-3:30 on Screen 1
Poster - Recent Enhancements of the WSA-ENLIL-Cone Modeling System

Abstract: The WSA-ENLIL-Cone modeling system enables faster-than-realtime simulations of corotating and transient heliospheric disturbances in the inner heliosphere. This 'hybrid' system does not simulate origin of coronal mass ejections (CMEs)but uses appearance in coronagraphs, fits geometric and kinematic parameters, and launches a CME-like hydrodynamic structure into the solar wind computed using a synoptic map produce by the Wang-Sheeley-Arge (WSA) coronal model. This modeling system provides global context and arrival times of the solar wind streams and CMEs to Earth, planets, and spacecraft, and it is used by various space weather agencies for operational predictions. In this presentation, we review recent improvements that address both issues and that enables continuous simulation of the evolving solar wind, launching of more realistic CME-like structures, providing data to SEP prediction models, and modeling support to heliospheric missions.

O'Neill, Andrew *(*Penn State University*)*
Poster Number: I5
Poster - Space Weather-Sondes: Development of Distributed Satellite Networks for F-Region Investigation

Co-authors: Sven Bilen, Julio Urbina, Tim Kane

Abstract: Space weather and related ionospheric variations have had an increased impact on society, affecting both individuals and corporations. As self-driving cars, the internet of things (IOT) and other autonomous technologies proliferate, this impact is felt at all levels of society. With this in mind, effective systems to continually monitor the ionosphere at all altitudes and scales are needed. Radars and conventional satellites have limits and to this end, new methods of measurements are needed to complement the

existing capabilities. A distributed sensor system built around board-scale, low cost satellites fills such gaps. In situ data collected via this mission, as well as measurements from ground based instrumentation, are used to improve current models of the ionosphere and provide more accurate predictions of spacecraft environment and impacts to terrestrial systems. The proposed mission takes relative electron density measurements of the ionosphere at a low cost per craft, with minimal orbital debris, and with high spatio-temporal resolution. At an altitude of approximately 300km the satellite lifetime is on the order of one lunar cycle. The majority of the constellation's lifetime will be spent in the F region and at the end of its life it will decay into the E region, acquiring data that was previously unattainable. A lifetime as short as this has low probability of creating orbital debris. A cluster of fifteen satellites could feasibly provide resolution on a scale of tens of meters over a track of 5km near instantaneously. The area contained within the snapshot taken by this cluster is based purely on the number of spacecraft on orbit and the separation between them. Once a constellation has deorbited, another is prepared for deployment to take its spot. This system does for space weather forecasting what radiosondes have done for forecasting terrestrial weather. Data assimilation techniques paired with spacecraft distributed over a wide area allows for both large and small scale ionospheric variations to be resolved. The development, necessity, and future implications of such a system is discussed.

Petersen, Alicia (University of Michigan)
Poster Number: S5
Poster - Now-Casting Interplanetary Coronal Mass Ejections Using Observations of Solar Wind Heavy Ions

Co-authors: Susan Lepri, Michael Liemohn, Abigail Azari

Abstract: Enhancements in high charge states of Fe, O and C ions have been shown to be frequently observed during Interplanetary Coronal Mass Ejections (ICME). The presence of these ions is a result of increased ionization attributed to enhanced heating at the Sun during the initiation and release of ICMEs. We present a retrospective study using in-situ data at L1 from the Solar Wind Ion Composition Spectrometer (SWICS) on the Advanced Composition Explorer (ACE) spacecraft. We analyze rates of event identification based on heavy ion charge state observations compared with published ICME databases using Heidke Skill Scores and Receiver Operating Characteristic (ROC) curves. Identifying events spanning 1998-2011, we evaluate a spread of thresholds to assess the feasibility of using solar wind measurements of Iron, Carbon and Oxygen ion charge state parameters, individually and in ensemble, to now-cast the arrival of ICME Space Weather events at Earth. We discuss future measurements of heavy ion charge states using the Solar wind and Pickup Ion Composition Energy Spectrometer (SPICES) on the upcoming IMAP mission, and the benefits of including ion charge state measurements in real-time space weather monitoring.

Pokhrel, Santosh (University of Utah)
Poster Number: G4
Poster - Regional FDTD Modeling of GICs during Solar Storms

Co-authors: Jamesina J. Simpson, Anna Kelbert, Daniel Welling, Michael Liemohn

Abstract: Geomagnetically induced currents (GICs) are generated in the ground and in any grounded conductors during geomagnetic storms. Using 3-D Maxwell's equations finite-difference time-domain (FDTD) models, we are simulating the near-Earth environment (< ~110 km altitude). Specifically, disturbed ionospheric electric current density vectors (J_x, J_y and J_z) calculated from the block-adaptive-tree-solarwind-Roe-upwind-Scheme (BATS-R-US) model and occurring during the 2003 Halloween solar storm are used as input to the FDTD models. Realistic 3-D regional ground conductivity data from the U.S. Geological Survey (USGS) is used, based on a compilation of inverse models informed by the National Science Foundation's EarthScope magnetotelluric survey. The northwestern US coast, northeastern US coast, southern Canada and Europe are the initial regions of interest. The primary output from the models are ground-level electromagnetic field variations sampled at the Earth's surface. A very high amplification of the surface electric field is observed along peninsulas and peninsula-like ground regions. The amplitude of magnetic field intensity (B) and the rate of geomagnetic field variations (dB/dt) is compared with measured data recorded at several USGS magnetic observatories. The performance of the FDTD models are quantified using the probability of detection (POD) and false alarm rate. Advantages of FDTD include its ability to model realistic source current density time waveforms, as well as 3-D spatial variations of the ground topography, lithosphere conductivity, and ionospheric current densities. This research is a component of the NSF PREEVENTS Track 2 project: Comprehensive Hazard analysis for Resilience to Geomagnetic Extreme Disturbances (CHARGED).

Redmon, Robert (NOAA/NCEI) *e-Poster
Poster Number: I34 - 10:00-10:15 & 2:50-3:05 on Screen 2
Poster – Metop-C Space Environment Monitor (SEM-2)

Co-authors: Juan Rodriguez, Sam Tsui

Abstract: NOAA's latest SEM-2 instrument has captured initial measurements of the space radiation environment from its low Earth, polar-orbiting platform on the EUMETSAT Metop-C satellite. Metop-C was launched on 7 November 2018. The SEM-2 instrument was activated on 23 November 2018. NOAA has been observing high energy electrons and ions from satellites in polar low Earth orbits (LEO) since TIROS-N was placed into operations in 1978. The Space Environment Monitor (SEM-2) instrument has 2 components, covering low to high energy measurements of electrons and protons: the Total Energy Detector (TED) and the Medium Energy Proton and Electron Detector (MEPED). TED telescopes observe the lowest energy electrons and protons which are responsible for generating the aurora borealis and australis and are consequential for

charging up the surfaces of satellites such as solar panel arrays, possibly resulting in damage and even total loss. MEPED telescopes observe medium energy electrons and protons known to cause charging of sub-surface satellite elements such as solar arrays and integrated circuits deep within the satellite bus. Discharges of built up electric charge can be disastrous. TED and MEPED telescopes enable relating these radiation measurements to the orientation of Earth's magnetic field, critical for capturing dynamics. Finally, MEPED's four omni-directional detectors provide observations of the highest energy protons, which have sufficient energy to penetrate most spacecraft materials, potentially causing upsets in integrated circuits. Humans and satellites in LEO are bathed in this radiation environment, with some regions containing potentially dangerous levels of charged particle populations, depending on the location and storm condition of the near Earth space environment. Near real-time observations are regularly used by satellite operators to address on-orbit anomalies and to avoid conducting non-essential activities during elevated radiation conditions. The research community relies heavily on the multi-decadal archive from POES and Metop satellites to develop and advance physical data assimilative models and metrics of the location, frequency and strength of the worst-case radiation environments, critical for future mission planning activities. This presentation reports on the initial findings of the ongoing Metop-C SEM-2 calibration and validation activities.

Renfroe, Kyle (University of Alabama in Huntsville)
Poster Number: S17
Poster – Bulk Properties of Interstellar Pickup Ions in the Solar Wind Derived from Ulysses Measurements

Co-authors: Nikolai Pogorelov, Tae Kim

Abstract: Integrating the velocity space distribution of ions in the solar wind allows for the determination of the bulk plasma properties such as the density and pressure of interstellar pickup ions. The particle spectra are generated from measurements taken by the Solar Wind Ion Composition Spectrometer (SWICS) instrument on the Ulysses spacecraft, and are provided for many different time periods. The particle velocities are originally given in the spacecraft frame and have been converted to the frame of reference moving with the solar wind. The distribution function is scaled by a factor of the velocity squared. The interstellar pickup ions in the velocity space distribution are distinguishable by the plateau that they cause in what would otherwise be a shifted Maxwellian distribution. This plateau determines the limits of integration necessary to find the bulk properties of the interstellar pickup ions. The upper limit of the plateau is nearly a hard cutoff at the solar wind speed, but the lower limit of the plateau is not so well-defined. The lower limit of the plateau merges with the shifted Maxwellian distribution, which complicates the determination of its exact location. A comparison of the velocity space distributions for all provided time periods may be used to find a consistent method of defining the lower limit of the interstellar pickup ion plateau. The integration of the velocity space distribution with these limits is then performed to determine the plasma moments (e.g. density and pressure) of the interstellar pickup ions.

Roeder, James (The Aerospace Corporation)
Poster Number: G10
Poster – Long Term Charge Buildup and Dissipation in Spacecraft Materials

Co-authors: Colby Lemon, Joe Fennell

Abstract: Bulk charging of insulators inside spacecraft, and the subsequent risk of electrostatic discharge (ESD), is a major concern for on-orbit anomalies. Quantitative understanding of this risk is valuable both for on-orbit anomaly assessment and for consideration of tradeoffs during satellite design. Laboratory testing is critical for evaluating ESD risk, but poses some challenges: 1) it is difficult to create a realistic space-like electron spectrum in the laboratory, 2) assessing the long term risk of ESD on-orbit requires accelerated testing, which may not be helpful for materials with long dissipation time constants that are of the greatest concern for charging, and 3) testing at MeV electron beam facilities can be costly and time consuming. Simulations using radiation transport codes can addresses these problems, and are therefore complementary to laboratory testing. We have simulated the charging of materials during long missions in geostationary orbit, with GOES electron data providing the radiation environment to drive the simulations. Our results show that even deep inside spacecraft, where energetic electron fluxes remain low, extremely resistive insulators such as PTFE could accumulate charge over many years. We show that substantial accumulation can occur in some years (such as 2016-2017) and almost complete dissipation in others (2009). However, the likelihood of ESD in any given situation remains difficult to predict due to uncertainty in material properties, and we have found it necessary to run parametric simulations using a range of material parameters. Another uncertainty is how electron flux will vary in future years, or in non-GEO orbits where energetic electron data are sparse. Despite these challenges, simulations of long missions are proving to be a valuable tool for assessing ESD risk and anomalies due to bulk charging of dielectric materials used in spacecraft components.

Roelant, Patrick (Millersville University of Pennsylvania)
Poster Number: I23
Poster – Relationship Between High Energy Actinic Flux and Particle Number Density

Co-authors: Tony Iampitro, Gabriela Himmele

Abstract: The primary purpose of this experiment is to study the relation of actinic flux of gamma and x-ray radiation to the density of dry air in the upper atmosphere. Calculating the density of dry air in the upper atmosphere (200 mb +), using the dry air equation and scale height to compare with the actinic flux. This equation will then be compared with data that was received by launching a high altitude weather balloon with a high energy radiation sensor onboard. The graphed difference of air density to amount of radiation will show how accurate the equation is in its predictions of high energy

radiation is with density. Finding a relation of radiation flux and the density would help future predictions for high altitude high energy.

Rose, Randy (SouthWest Research Institute)
Poster Number: S18
Poster – Combining New Space and Old Space for a Revolutionary SWFO-L1 Solution

Co-authors: Peter Roming

Abstract: SwRI is a world-class developer of successful space flight hardware and missions of all classes; from CubeSats to billion dollar mission explorations of our solar system's furthest reaches. We are an industry leader in mission design and management, flight avionics and instruments, with full lifecycle development capabilities and all test facilities onsite. Since our inception in 1977, the SwRI Division of Space Science and Engineering has participated in over 85 missions without a mission failure. Our approach to mission development starts with understanding the mission requirements and progresses to completion of innovative, mission-centric solutions. Because SwRI is an independent, not-for-profit organization, we are not encumbered by selling a product line; our focus is on the success of the mission.

SwRI is world-renowned for developing Heliophysics missions and instruments. We understand the science and engineering necessary to implement these missions. Historically, science spacecraft have been custom-designed to specific mission sets with lengthy design and/or enhancement cycles at a high cost per spacecraft. SwRI recognized early the science potential of the commercial SmallSat New Space revolution that has led to breakthrough mission costs and development schedules with little to no loss of mission reliability. SwRI's development of the NASA CYGNSS mission, AIAA's 2017 Mission of the Year, is proof of our commitment to doing major science within the New Space arena. SwRI is a leader in leveraging these advances to achieve cost-effective major science missions that offer short design cycles and opportunity for frequent technology upgrades.

This poster highlights our approach of melding the revolutionary opportunity of New Space development, SwRI's Heliophysics mission and instrument heritage, and the SWFO-L1 mission requirements to create a SWFO-L1 solution at a fraction of the cost and schedule achievable only a few years ago.

Sadykov, Viacheslav (New Jersey Institute of Technology)
Poster Number: S10
Poster – Enhancement of Binary and Probabilistic SWPC NOAA Flare Forecast by Using Machine Learning Algorithms

Co-authors: Alexander G Kosovichev, Irina N Kitiashvili

Abstract: In this study we investigate the possibility of enhancing the daily operational flare forecast performed at the NOAA Space Weather Prediction Center (SWPC NOAA) by integrating the standard operational flare probabilities with daily whole-Sun descriptors obtained from routine observations of photospheric magnetic fields by SDO/HMI and soft X-ray (SXR) observations by XRS/GOES. The magnetic field descriptors are automatically constructed from properties of the Polarity Inversion Lines of Active Regions (PIL, previously tested by Sadykov and Kosovichev 2017) and the Space weather HMI Active Region Patches (SHARP, Bobra et al. 2014). The SXR descriptors include the flare history of the Sun and properties of its SXR 1-8 emission. For each day in 2010-2017, we define a vector of PIL, SHARP, and SXR descriptors, and optionally include the operational SWPC NOAA next-day flare probability as an additional descriptor. We subdivide the data set into 10 train-validation subsets and compare the performance of various machine learning classification algorithms. Our results indicate that it is possible to enhance the binary forecast of M-class and X-class flares by considering jointly PIL, SHARP, and SXR characteristics. In particular, the Brier Skill Score (BSS) of probabilistic forecast of M-class flares based on the Support Vector Machine results (BSS=0.29/0.04) is higher than for the SWPC NOAA operational forecasts (BSS=0.09/0.04) and indicates an enhancement of the machine-learning probabilistic forecast with respect to flare climatology.

Schaefer, Robert (Johns Hopkins University Applied Physics Lab)
Poster Number: I16
Poster – Full Spectrographic Ultraviolet Observations of the Upper Atmosphere

Co-authors: Y. Zhang, L. Paxton, H. Kil, B. Wolven, G. Romeo, P. Dandenault

Abstract: The Far UltraViolet (FUV) spectrographic imagers onboard NASA's TIMED (Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics) mission and DMSP (Defense Meteorological Satellite Program) satellites F16-F19 are known for 5 color UV images of the emission from the ionosphere, thermosphere, and aurora. These instruments observe a full UV spectrum ~ 170 individual wavelength bins between 115 and 180 nm, but due to telemetry limitations, the full spectrum is only downloaded in staring mode. The Global UltraViolet Imager (GUVI) on NASA's TIMED mission has been in full spectrograph stare mode since 2008. Recently (August 2016) the SSUSI instrument on DMSP F16 was also put in spectrographic stare mode. These observations can be mined to reveal new information about properties and dynamics of the upper atmosphere, e. g., Lyman Birge Hopfield band ratios measuring global thermospheric temperatures and nitric oxide emission indicative of polar cooling flows. In addition, the (30x) longer exposures enable a better signal to noise ratio, which allows us to detect some surprising early morning equatorial ionosphere emission. In this poster, we review the spectrographic mode data and show examples of recent discoveries. We then point to novel strategies that can be employed by new FUV instrument designs like GUVI-plus and SSUSI-Lite which can take advantage of the full hyperspectral capabilities and custom exposure times in the future.

Schonfeld, Samuel (USRA/NASA)
Poster Number: S3
Poster – Correcting F10.7 for Use in Ionosphere/Thermosphere Models

Co-authors: Stephen White, Rachel Hock-Mysliwiec, Carl Henney, James McAteer

Abstract: We investigate the multiple sources of solar F10.7 emission and the implications they have on its use as an EUV proxy. Using full-Sun integrated spectra from the EUV Variability Experiment (EVE) MEGS-A instrument we construct daily coronal differential emission measures (DEMs) during the rising phase of solar cycle 24 and isolate the bremsstrahlung emission component of F10.7. We find that this EUV related component correlates with observed EUV irradiance as effectively as the Mg II index and better than the commonly used 81-day averaged F10.7 while requiring only a single ground-based F10.7 measurement. Additionally, we investigate the relative contribution from the coronal bremsstrahlung and magnetic field induced gyroresonance emission and the possibility of chromospheric variability. We find that the bremsstrahlung component typically contributes more to the total F10.7 than the gyroresonance component, but that the rotational modulation tends to be dominated by gyroresonance. This explains both the long timescale correlation and the short duration deviations between EUV and F10.7.

Seki, Daikichi (Kyoto University)
Poster Number: G22
Poster – Small-scale Motions in Solar Filaments as the Precursors of Eruptions

Co-authors: Kenichi Otsuji, Hiroaki Isobe, Takako T. Ishii, Kiyoshi Ichimoto, Kazunari Shibata

Abstract: In this study, 12 solar filaments that disappeared in H-alpha line center images were analyzed in a manner similar to our previous work (Seki et al. 2017, ApJL); these included two quiescent filaments, four active region filaments, and six intermediate filaments. We verified that in all the 12 events, the standard deviation of the line-of-sight velocities of solar filaments increased before the solar filaments disappeared. Moreover, we observed that the quiescent filaments had approximately 10 times longer duration of an increase in the standard deviation than the other types of filaments. We concluded that the standard deviation of the LOS velocities of the small-scale motions in a solar filament can potentially be used as the precursor of a filament eruption.

Shifrin, Caleb (United States Military Academy)
Poster Number: I4
Poster – PFISR Electron Density Visualization analysis for GPS Scintillation experienced at Poker Flat Research Range

Abstract: The focus of this research is the analysis of electron densities reported by the Poker Flat Incoherent Scatter Radar (PFISR) from multi-beam Global Positioning System (GPS) mode experiments. Those experiments where GPS L1 scintillations were seen by ground receivers at Poker Flat Research Range (PFRR) are visualized in order to aid attribution of the scintillations to their driving phenomena. PFISR has collected and stored multi-beam data over the course of the winter seasons of 2017-18 and 2018-19 for scintillation research. This project analyzes that data using Systems Tool Kit (STK) in order to visualize in the associated ionospheric variations. The model is being applied to times both with and without geomagnetic activity for comparison purposes.

Singh, Talwinder (University of Alabama, Huntsville)
Poster Number: S4
Poster – MHD simulation of Gibson-Low flux-rope Based CME Constrained Using Observations

Abstract: Coronal Mass Ejections (CMEs) are major sources of extreme space weather events. These events can have several negative impacts on our technologically advanced society, so we must develop accurate prediction models for their arrival time and properties at 1 AU. MHD simulation of flux-rope based CMEs models, such as Gibson-Low (GL) flux rope model, are increasingly gaining importance in space weather predictions. Here, we demonstrate how the parameters of a Gibson-Low flux-rope-based CME can be constrained using remote observations. Our Multi Scale Fluid-Kinetic Simulation Suite (MS-FLUKSS) has been used to simulate the propagation of a CME in a data-driven solar corona background computed using the photospheric magnetogram data. We constrain the CME model parameters using the observations of such key CME properties as its speed, orientation, and poloidal flux. The speed and orientation are estimated using multi-viewpoint, white-light coronagraph images. The reconnected magnetic flux in the area covered by the post eruption arcade (PEA) is used to estimate the poloidal flux in the CME flux rope. We simulate the partial halo CME on 7 March 2011 and demonstrate the efficiency of our approach. This CME erupted with the speed of 812 km/s and its poloidal flux, as estimated from source active region data, was 4.9?1021 Mx. Using our approach, we were able to simulate this CME with the speed 840 km/s and the poloidal flux of 5.1?1021 Mx, in a remarkable agreement with the observations.

Sokolova, Olga (Peter the Great St. Petersburg Polytechnic University)
Poster Number: G6
Poster – Thirty Years after Hydro-Quebec Blackout, Current Activities in Support of Russian Critical Infrastructure Protection to Space Weather Effects

Co-authors: Yaroslav Sakharov, Vasilii Selivanov

Abstract: Though space weather phenomenon is known for a long time, there was no request for a detailed research from various stakeholders until 1989. The Hydro-Quebec

blackout in 1989 was the tipping point that changed the status of research in this area from a curiosity to a necessity. Federal programs were established in the US and Canada and the issue was identified as a principal one. Contrary to North America, space weather problem didn't receive the status of a principal one in Russia. Several scattered activities have taken place in the last years. The first attempt happened in 1994, when an informal research group among leading research centers in the field of geophysics was founded in Leningrad Polytechnic Institute. The group focused on the study of the space weather impact on power grid in the N-W Russia. Later in 2003, the scientists of Polar Geophysical Institute of Russian Academy of Science started a research about the space weather impact on high voltage power transformers. Geomagnetically induced current (GIC) registration equipment was installed in the power transformer neutrals. The participation in EURISGIC project allowed to integrate the results of GIC registration in the European model and analyze the space weather impact on power grid operation on the continental level. Currently, the measurement equipment is installed on the five substations, which are located along the 340 longitude, approximately between 620 and 690 latitudes. The measurement results are transferred to Polar Geophysical Institute on the hourly basis and analyzed there.

Risk engineers characterize devastating space weather impact on critical infrastructure as a super-storm (black swan). The authors propose to classify it as a perfect storm. In the case of a perfect storm, multiple forces join to create a disaster greater than the sum of its parts. These forces can be assessed in a systematic way before the event, since they have been observed in the past, though they are rare. The critical infrastructure vulnerability to space weather avenues is determined by interrelated critical factors. Moreover, space weather can cause adverse simultaneous effects on different critical infrastructures. The space weather impact on Russian power grid and railway was registered and studied. This presentation gives an overview of the current activities in the field, present the study results and their interpretation and provides an outlook on the mitigation efforts.

Sultan, Peter (The MITRE Corporation)
Poster Number: I15
Poster - A Parameterized Model of X-Ray Solar Flare Effects on the Lower Ionosphere and HF Propagation

Co-authors: Edlyn Levine, Lucien Teig

Abstract: We present a parameterized X-ray solar flare effects model relating the physics of radiation transport to the observable impact of solar flares on low-altitude ionospheric absorption of High Frequency (HF) signals. Tunable parameters of time-varying flare spectral energy density and characteristic flare temperature provide a novel capability to simulate HF experiments over a wide range of X-ray solar flare behavior. Results from our model are consistent with HF propagation data collected over a period of heightened solar flare activity during 5?7 September 2017, including M and X class solar flares. Our predictions and measurements are compared with results from D Region Absorption Prediction (Akmaev et al., 2010, https://www.ngdc.noaa.gov/stp/drap/DRAP-

V-Report1.pdf) and the Wait Very Low Frequency (VLF)-driven model (Wait & Spies, 1964).

Tilton, Meg (Cooperative Institute for Research in Environmental Sciences)
Poster Number: I28
Poster – Accessing NOAA's Space Weather Satellite Data: POES, GOES, and DSCOVR Products

Co-authors: Stefan Codrescu, Rob Redmon, Dan Seaton, William Rowland

Abstract: NOAA's assets for monitoring space weather range from the low-earth orbiting Polar Operational Environmental Satellites (POES) all the way out to the Deep Space Climate Observatory (DSCOVR), located a million miles from the Earth at Lagrange Point 1. Observations provided by POES and DSCOVR, along with data from the Geostationary Operational Environmental Satellite R-Series (GOES-R), give a comprehensive picture of space weather in the near-Earth environment. This poster provides an overview of available POES, GOES, and DSCOVR data products. It describes both current access mechanisms and future plans for enhancing data discoverability and visualization.

Tobiska, W. Kent (Space Environment Technologies)
Poster Number: I22
Poster – ARMAS and RADIAN: Progress Towards Operational Aviation Radiation Monitoring and Forecasting

Co-authors: The ARMAS Team

Abstract: The objective of the Automated Radiation Measurements for Aerospace Safety (ARMAS) project is to develop cost-effective management of space weather radiation risks at aviation altitudes. ARMAS measurements now include over a half-million one-minute global data records between 2013-2019 during nearly 600 flights in aircraft, stratospheric balloons, and commercial suborbital spacecraft from the surface to 90 km. ARMAS has shown that it is possible to monitor the radiation environment in real-time. Its data are setting the stage for aviation radiation environment forecasting. The project called RADIation environment using ARMAS data in the NAIRAS model (RADIAN) is building the framework to assimilate ARMAS data into the Nowcast of Atmospheric Ionizing RAdiation System (NAIRAS) physics-based radiation model using a continuous, real-time data stream. We present the status of ARMAS measurements and RADIAN data assimilation in this poster.

Tsui, Chiwa (Assurance Technology Corporation)
Poster Number: I12
Poster – First Light for Metop-C Space Environment Monitor (SEM-2)

Co-authors: Rob Redmon, Juan Rodriguez, Sam Tsui, Bronek Dichter

Vassiliadis, Dimitris (NOAA/NESDIS)
Poster Number: S21
Poster – The NOAA Coronal Mass Ejection Imager for Space Weather Forecasting

Co-authors: Kevin Tewey, Dan Mamula, Marco Vargas, Larry Zanetti , Jacob Inskeep, MaryKae Lockwood, Richard Ullman, Elsayed Talaat

Abstract: NOAA/NESDIS is developing a solar coronagraph to obtain coronal mass ejection (CME) imagery suitable for the estimation of CME velocity and mass near the sun. The near-Sun CME velocity and mass estimates will be applied as transient inputs to the inner boundary of a 3-D magnetohydrodynamic (MHD) model describing the ambient heliospheric solar wind, such as ENLIL. The model output at earth will enable the National Weather Service's (NWS) Space Weather Prediction Center (SWPC) to forecast CME related geomagnetic storm threat conditions with 1-4 day lead times.

The solar coronagraph, referred to as the Compact Coronagraph (CCOR), employs an innovative optical design and an active pixel sensor detector to yield a small envelope, low mass, low power, and low cost CME imager capable of operation on various small platforms such as the GOES-U Sun-Pointing Platform (SPP) and on small satellites.

We describe the innovative aspects of the CCOR optical design, its performance, and the concept of operations.

Vogt, Cornelius (Airbus Defense and Space)
Poster Number: S20
Poster – The Lagrange Space Weather Mission to L5
Co-authors: Vasco Pesquita, Bettina Oexl, Airbus Project Team

Current satellite missions essential for space weather forecasting are nearing the end of their mission life. Europe and the US are pushing forward on complementary operational space weather and solar monitoring missions. ESA plans to position a spacecraft at L5 with a 24/7 monitoring capability and a comprehensive suite of remote sensing and in-situ instruments. Airbus and its partners are preparing this mission to be launched in 2025.

Wang, Jingjing (National Space Science Center, CAS)
Poster Number: S15
Poster – An Operational Solar Wind Prediction System Transitioning Fundamental Science to Operations

Co-authors: X. Ao, Y. Wang, C. Wang, Y. Cai, B. Luo, S. Liu, C. Shen, B. Zhuang, X. Xue, and J. Gong

Abstract: We present in this paper an operational solar wind prediction system. The system is an outcome of the collaborative efforts between scientists in research communities and forecasters at Space Environment Prediction Center (SEPC) in China. This system is mainly composed of three modules: 1) a photospheric magnetic field extrapolation module, along with the Wang-Sheeley-Arge (WSA) empirical method, to obtain the background solar wind speed and the magnetic field strength on the source surface; 2) a modified Hakamada-Akasofu-Fry (HAF) kinematic module for simulating the propagation of solar wind structures in the interplanetary space; and 3) a coronal mass ejection (CME) detection module, which derives CME parameters using the ice-cream cone model based on coronagraph images. By bridging the gap between fundamental science and operational requirements, our system is finally capable of predicting solar wind conditions near Earth, especially the arrival times of the co-rotating interaction regions (CIRs) and CMEs. Our test against historical solar wind data from 2007 to 2016 shows that the hit rate (HR) of the high-speed enhancements (HSEs) is 0.60 and the false alarm rate (FAR) is 0.30. The mean error (ME) and the mean absolute error (MAE) of the maximum speed for the same period are -73.9 kms-1 and 101.2 kms-1, respectively. Meanwhile, the ME and MAE of the arrival time of the maximum speed are 0.15 days and 1.27 days, respectively. There are 25 CMEs simulated and the MAE of the arrival time is 18.0 hours.

Wold, Alexandra (University of Colorado Boulder)
Poster Number: G16
Poster – Measuring Geomagnetic Cutoff with GPS Energetic Proton Data

Co-authors: Matthew R. Carver, Steven K. Morley

Abstract: The magnetosphere effectively shields low latitudes from most energetic protons. This shielding is dependent upon both the energy and angle of arrival of protons, and the latitude at which a particular energy of proton cannot reach is referred to as the cutoff latitude. The newly available Global Positioning System (GPS) energetic particle data presents an exciting opportunity to study solar energetic particle (SEP) events and cutoff latitude. With more than 20 satellites in 6 orbital planes at MEO covering a wide range of L-shells for a 16 year period (over 190 satellite years), this data set covers a longer time span and greater spatial distribution than most science missions. We present a study of geomagnetic cutoff evaluated with energetic proton measurements from the Combined X-ray and Dosimeter (CXD) instruments onboard the GPS satellites. At a four minute cadence, the CXD instrument detects protons with energies ranging from 10 MeV to >100 MeV on five channels and have been recently cross-calibrated with the NOAA GOES Energetic Particle Sensor. Cutoff latitude can be defined in multiple ways, and we investigate previously used and novel methods of cutoff determination from data. For several SEP events we calculate the GPS observed cutoff using different heuristics and

compare to previous studies of cutoff variation during these events. We further compare the GPS-derived cutoff latitudes to modeled cutoffs.

Woods, Thomas (University of Colorado)
Poster Number: S25
Poster – Community Input Solicited for Heliophysics Decadal Survey Midterm Assessment Committee

Co-authors: Robyn Millan, Art Charo, Tim Bastian, Monica Bobra, Anthea Coster, Ed DeLuca, Scott England, Stephen Fuselier, Ramon Lopez, Janet Luhmann, Katariina Nykyri, Jens Oberheide, Merav Opher, Karel Schrijver, Josh Semeter, Jeff Thayer, Alan Title

Abstract: The National Academies of Sciences, Engineering, and Medicine has convened a committee to review the progress towards implementing the 2013 Heliophysics Decadal Survey, titled Solar and Space Physics: a Science for a Technological Society. This review serves as a midterm assessment before the next Heliophysics Decadal Survey committee would begin its formulation. This committee is interested to receive input from the heliophysics and space weather communities about the 2013-2018 progress realizing the 15 recommendations and applications specified in the 2013 Heliophysics Decadal Survey, about any suggested actions to optimize the science value during 2019-2023, about any suggestions to improve the process for the next Heliophysics Decadal Survey, and about any suggested actions to enhance all stages of careers for scientists and engineers in the solar and space physics community. This poster will outline the Heliophysics Decadal Survey recommendations and recent progress, and it will also summarize the tasks for this midterm assessment committee. There will be an opportunity to discuss your inputs with a few of the Committee members during the Space Weather Week workshop, and web-based community-input survey opportunities are anticipated to be available sometime later this spring.

Wu, Chin-Chun (Naval Research Laboratory) *e-Poster
Poster Number: S28 - 10:00-10:15 & 3:30-3:45 on Screen 1
Poster – Modeling Inner Boundary Values at 18 Solar Radii During Solar Quiet time for Global Three-dimensional Time-Dependent Magnetohydrodynamic Numerical Simulation

Co-authors: Kan Liou, Simon Plunkett, Dennis Socker, Y.M. Wang, Brian Wood, S. T. Wu, Murray Dryer, and Christopher Kung

Abstract: The solar wind speed plays a key role in the transport of coronal mass ejections (CME) out of the Sun and ultimately determines the arrival time of CME-driven shocks in the heliosphere. Here, we develop an empirical model of the solar wind parameters at the inner boundary (18 solar radii, Rs) used in our global, three-dimensional (3D) magnetohydrodynamic (MHD) model (G3DMHD) or other equivalent

ones. The model takes solar magnetic field maps at 2.5 Rs (which is based on the Potential Field Source Surface, PFSS model) and interpolates the solar wind plasma and field out to 18 Rs using the algorithm of Wang and Sheeley [1990a]. A formula V18Rs = V1 + V2 fs is used to calculate the solar wind speed at 18 Rs, where V1 is in a range of 150-350 km/s, V2 is in the range of 250-500 km/s, and fs is an expansion factor, which was derived from the Wang and Sheeley (WS) algorithm at 2.5 Rs. To estimate the solar wind density and temperature at 18 Rs, we assume an incompressible solar wind and a constant total pressure. The three free parameters are obtained by adjusting simulation results to match in-situ observations (Wind) for more than 54 combination of V1, V2 and during a quiet solar wind interval, Carrington Rotation (CR) 2082. We found V18Rs = (150?50) + (500?100) fs^-0.4 km/s performs reasonably well in predicting solar wind parameters at 1 AU not just for CR 2082 but other quiet solar period. Comparing results from the present study with those from WSA [Arge et al. 2000; 2004] we conclude that i) Results of using V18Rs with the full rotation data (FR) as input to drive 3DMHD model is better than the results of WSA using FR, or daily updated. ii) When using a modified daily updated 4-day-advanced solar wind speed predictions WSA performs slightly better than our WSW-3DMHD. iii) When using V18Rs as input, 3DMHD model performs much better than the WSA formula. We argue the necessity of the extra angular width (?b) parameter used in WSA.

Wu, Chin-Chun (Naval Research Laboratory) *e-Poster
Poster Number: S30 - 10:15-10:30 & 3:45-4:00 on Screen 1
Poster – The 04-10 September 2017 Sun-Earth connection events: Solar Flares, Coronal Mass Ejections/Magnetic Clouds, and Geomagnetic Storms

Co-authors: Kan Liou, Ronald P. Lepping, and Lynn Hutting

Abstract: In early September of 2017, a series of solar flares and coronal mass ejections (CMEs) erupted from the Sun. The Cor2a coronagraph, a unit of the Sun Earth Connection Coronal and Heliospheric Investigation (SECCHI), onboard the Solar Terrestrial Relations Observatory (STEREO)-A spacecraft recorded two Sun-Earth directed CMEs on September 4 (referred to as CME04) and 6 (referred to as CME06). A few days later, The Wind spacecraft (~212.839 solar radii, Rs) recorded two interplanetary shocks, presumably driven by CME04 and CME06, at ~22:41UT on 6-09-2017 (referred to as Shock06) and at ~22:48UT on 7-09-2017 (referred to as Shock07), respectively. The traveling time of the CME04/Shock06 (tshock-CME@18Rs) and CME06/Shock07 from 18 Rs to the Wind spacecraft was 41.52 hours and 32.47 hours, respectively. The propagating speed (VCME) of the CME04 and CME06 at ~18 Rs were determined with SECCHI/Cor2a as ~886 km/s and ~1368 km/s, respectively. Assuming a constant velocity after 18 Rs, the estimated tshock-CME@18Rs is 42.45, and 27.5 hours for CME04 and CME06, respectively. This simple estimate of the CME propagation speed provides a satisfactory result for the CME04 event (error ~8%) but not for the CME06 event (error ~15.3%). The second event, CME06 was delayed due to an interaction with the preceding event (CME04). It is suggested that the CME speed estimated near the Sun with coronagraph images can be a good estimator for the

interplanetary CME (ICME) transit time when there is no pre-event. A three-dimensional magnetohydrodynamic simulation is performed to address this issue by providing a panoramic view of the entire process not available from the observations. A southward interplanetary magnetic field (Bs) increased sharply to -31.6 nT on 7 September at Wind, followed by a severe geomagnetic storm (Dst = -124 nT). The sharp increase of the IMF Bs was a result of the interaction between Shock07 and the driver of Shock06 (CME04). This study suggests that a severe geomagnetic storm can be caused by the interaction between a MC, with an impinging IP shock from behind, and the Earth's magnetosphere. The intensity of a geomagnetic storm will likely be stronger for an event associated with ICME-ICME interaction than by a geomagnetic event caused by only a single ICME.

Wu, Qian (National Center for Atmospheric Research)
Poster Number: I17
Poster – New Thermospheric Wind Observations at NCAR

Co-authors: Delores Knipp, Wenbin Wang, J. Liu

Abstract: NCAR/HAO has been operating ground-based Fabry Perot interferometers (FPI) to observe thermospheric winds over many years from high to low latitudes. In June 2018, NCAR HIWIND (High altitude Interferometer WIND experiment) balloon-borne FPI successfully made a 5-day flight from Kiruna, Sweden to Northern Canada. Along the way, it made daytime thermospheric wind observations from auroral zone into the polar cap. By combining the HIWIND thermospheric and incoherent scatter radar ionospheric observations along the balloon flight path, we examine the thermosphere ionosphere interaction in the high latitudes. Thermospheric winds are a critically important parameter for understanding the ionosphere and space weather. Lack of thermospheric winds has hampered further progress on the space weather forecast capability. To meet the needs of future space weather and ionosphere studies, NCAR is also developing a CubeSat version of the FPI, which will have global thermospheric wind coverage. The new instrument will be able to provide data sources for assimilation and validation to ionosphere and space weather modeling efforts.

Yang, Xiaochao (National Space Science Center, Chinese Academy of Sciences)
Poster Number: G15
Poster – A Statistical Study of Commonly Used Magnetic Models Performances in the Region of MEOs

Abstract: The accuracy of geomagnetic field models is of significance from both practical and theoretical perspectives, since they are employed widely in a variety of studies of space science, such as the forecasting of geomagnetic storms, the interactions of magnetosphere with both solar wind and thermosphere/ionosphere and the dynamics of magnetospheric particle populations. For example, the acceleration/loss mechanisms of radiation belt energetic particle populations, which are critical issues of space science,

heavily rely on the accurate geomagnetic field models.

Due to the shortage of in situ measurements, the assessment of external field models in the area of medium earth orbits (MEOs) is very insufficient. However, it is important for the studies of space science because of the reasons as follows: first, the contribution of external field is prominent in this area so that the performance of external models affects the accuracy of the geomagnetic field description; second, since MEOs cover the center context of the outer radiation belt with dramatic energetic electron dynamic changes, the accurate description of MEOs magnetic field is critical for the investigation of electron's acceleration/loss mechanisms which relies on the energetic electrons PSD distribution on PSC; third, MEOs are operational orbits for numerous operational satellites such as GPS constellation and Beidou constellation, so that the precise understanding of the environment in MEOs is of practical significances.

By taking advantage of magnetic field measurements from Van Allen Probes over a period of more than five years, we focus on comprehensive investigation of performances of widely used external field models in MEOs. We expect to determine how accurate these models are in this magnetospheric context. And because of these models involved different assumptions about magnetospheric current systems, the results of our work would shed a light on how accurate the assumptions of current system under different conditions.

Yi, Wonhyeong (Korea Meteorological Administration)
Poster Number: G13
Poster – How Well Planetary Geomagnetic Disturbance Index (Kp) is Correlated with the Local Indices at North America and East Asia?

Co-authors: Jiyoung Kim

Abstract: Accurate monitoring of geomagnetic storms in a timely manner is needed to mitigate their potential adverse impacts on modern society. This study investigates that how planetary geomagnetic disturbance index (Kp) is correlated with local indices (e.g., Fredericksburg of U.S.A. and Kakioka of Japan). And the real-time estimated local K indices at Kakioka of Japan and Cheongyang of South Korea are validated with observed indices. The result shows that the Kp index and the local K indices at both stations have usually similar correlations. However, the local K was smaller than the observed Kp even when planetary geomagnetic storms are observed. This implies that simultaneous monitoring of Kp and local K would be needed when a geomagnetic storm occurs at Earth. When the local K is greater than 3, the probability of estimated local K within an error range of 1 is greater than 98%. This suggests that the estimation method in this study can be operationally used to monitor local geomagnetic disturbances.

Young, Shawn (Air Force Research Laboratory)
Poster Number: G7
Poster – A Comparison of the Magnetospheric Specification Model and the Magnetospheric Specification and Forecast Model as Possible Inputs for a Surface Charging Specification

Co-authors: Robert V. Hilmer, Steven O'Malley

Abstract: Differential surface charging is a potential hazard for spacecraft. It is the result of electron charge accumulation in the skin of the spacecraft and occurs when there is an imbalance between the inbound and outbound currents. It becomes hazardous if the charge buildup is substantially different on nearby surfaces, creating significant voltages and the potential for arcing. Because of this it is important to have some measure of the local plasma properties when analyzing the environmental hazard for a spacecraft. This is best done using a plasma monitor located on the satellite, but for those satellites that don't have a monitor, a model is the next best thing. Here we report on a comparison of the Magnetospheric Specification Model (MSM) and the Magnetospheric Specification and Forecast Model (MSFM) to satellite data.

Yuan, Tianjiao (National Space Science Center, Chinese Academy of Sciences)
Poster Number: I1
Poster – Prediction Model for Ionospheric Total Electron Content Based on Deep Learning Recurrent Neural Network

Co-authors: Yanhong Chen, Siqing Liu, Jiancun Gong

Abstract: A 24 h ahead forecasting model for ionospheric total electron content (TEC) at Beijing station is established based on the deep learning recurrent neural network (RNN). The model implementation requires solar 10.7 cm flux index, geomagnetic index ap, grid map of TEC, solar wind speed and the southward components of interplanetary magnetic field. The predicting results for Beijing station (40?N, 115?E) show that the root mean square error (RMSE) of the disturbed ionosphere TEC predicted by RNN model is lower than that of BPNN (Back Propagation Neural Network) model by 0.49~1.46 TECU. The forecasting accuracy of ionospheric positive storm by RNN model is increased by 16.8% with solar wind parameters. Furthermore, we established a 24 h ahead forecasting model of 55 grids TEC map and its RMSE is at the same level with single station RNN model. The results indicate that RNN model is more reliable than BP model for short-term forecasting of TEC. Moreover, the add of interplanetary solar wind parameters are helpful for predicting TEC positive storm.

Yudin, Valery (University of Colorado Boulder)
Poster Number: I19
Poster – Longitudinal Variability of Wave Dynamics and its Representation in Weather Models Extended into the Mesosphere and Thermosphere

Co-authors: S. I. Karol, R. A. Akmaev, T. J. Fuller-Rowell, D. Kleist, J. Wang, J. Alpert, A. Kubaryk, C. Thompson

Abstract: Paper presents overview of current developments of the vertically extended global atmosphere models at NOAA and CU/CIRES with accents on the prediction of the longitudinal variability of tides, planetary waves and gravity waves. We will highlight uncertainties in the data analysis and Whole Atmosphere Model (WAM) predictions of tidal dynamics and representations of mesoscale gravity waves, resolved by dynamical cores and parameterized by model physics on the sub-grid scales. Capability to resolve mesoscale waves by non-hydrostatic FV3GFS dynamical core in the strato-mesosphere at enhanced horizontal and vertical resolutions will be discussed including its potential impacts on the gravity wave dynamics in the future FV3WAM forecasts. We also discuss recent progress for the SABER and MLS data analysis (20-100 km) in the WAM with spectral dynamical core and GFS-workflow of 2017/18 and its transition to FV3GFS.

Zakharenkova, Irina (University of Warmia and Mazury)
Poster Number: I8
Poster – Advances of Ground and Space-based GPS Measurements for Specification of Storm-induced Ionospheric Irregularities

Co-authors: Iurii Cherniak, Andrzej Krankowski

Abstract: Rapid growth of the ground-based segment of GNSS provides an opportunity to monitor and investigate the ionospheric plasma density irregularities occurrence with an unprecedented detail and on the global scale. The space-borne GPS measurements, as a by-product of LEO satellite missions with GPS receiver for Precise Orbit Determination and up-looking antenna, offers advantages for direct probing ionospheric irregularities in the topside ionosphere, above LEO orbit altitude. During space weather events, the strong storm-induced ionospheric irregularities occur at polar and equatorial regions, and further extension of these zones can seriously affect middle latitudes. Prompt penetrating electric fields can cause plasma bite-outs and super plasma bubbles development toward mid-latitudes leading to the performance degradation for ground-based GNSS receivers, SBAS systems, and GPS receivers onboard LEO satellites. We present results of a joint analysis of the ground-based GNSS observations from ~6000 stations together with up-looking GPS measurements onboard three satellites of the ESA's Swarm mission and COSMIC GPS RO measurements for several case-studies of equatorial super plasma bubbles occurrence and their impact on GNSS performance degradation. The research is supported by the Polish National Science Centre grant 2017/25/B/ST10/00479.

Zakharenkova, Irina (University of Warmia and Mazury)
Poster Number: I9
Poster – Large Scale Traveling Ionospheric Disturbances: Origin and Propagation

Co-authors: Iurii Cherniak

Abstract: On the case of 19021 December 2015 geomagnetic storm, we demonstrate advantages on how combination of ground-based GPS and GLONASS observations with space-borne magnetic and plasma measurements allows investigate an origin, occurrence, and propagation of large-scale traveling ionospheric disturbances (LSTIDs). Based on high spatio-temporal resolution mapping approach of the total electron content (TEC) perturbation component deduced from the ground-based GNSS observations, we revealed the ionospheric small- to large-scale disturbances associated with two major sources of the LSTIDs generation: the solar terminator passage during the quiet time and auroral activity caused by auroral particle precipitation and field-aligned currents (FACs) intensification during geomagnetic disturbances. Location of ionospheric irregularities associated with auroral particle precipitation was deduced from multi-site ground-based GNSS measurements by rate of TEC index (ROTI) technique, and AMPERE and Swarm data products were used to estimate FACs intensity and location. We found that an equatorward expansion of the strong ionospheric irregularities zone and an increase of the FACs magnitude led to a simultaneous intensification of the LSTIDs occurrence at high latitudes. COSMIC RO observations confirmed the E-layer conductivity enhancement due to particles precipitation that can lead to Joule heating intensification and TADs/TIDs excitation. The research is partially supported by the Polish National Science Centre grant 2017/27/B/ST10/02190.

Zhong, Qiuzhen (National Space Science Center, Chinese Academy of Sciences)
Poster Number: G9
Poster – Quantitative Prediction of High-Energy Electron Integral Flux at Geostationary Orbit Based on Deep Learning

Co-authors: LIhang Wei, Ruilin Lin, Jingjing Wang, Siqing Liu

Abstract: The deep learning method of long short-term memory (LSTM) is applied to develop a model to predict the daily >2-MeV electron integral flux 1 day ahead at geostationary orbit. The inputs to the model include geomagnetic and solar wind parameters such as Kp, Ap, Dst, solar wind speed, magnetopause subsolar distance, and the value of >2-MeV electron integral flux itself over the previous five consecutive days. The model is trained on the data from the periods 1999-2007 and 2011-2016, and the efficiency of the model is tested on the 2008-2010 period. We experiment with different input combinations and find that when the model takes daily >2-MeV electron integral flux, daily averaged magnetopause subsolar distance, and daily summed Kp index as inputs, the prediction efficiencies for 2008, 2009, and 2010 are 0.833, 0.896, and 0.911, respectively. This value reaches 0.900 for 2008, when hourly >2-MeV electron integral flux, hourly magnetopause subsolar distance, and daily summed Kp index are taken as inputs, with training on the remaining data from 19 June 2003 to 13 April 2010. The prediction efficiencies of the persistence model and the 27-order autoregressive model for the same tested time period are 0.679 and 0.743, respectively. Therefore, the model developed based on the LSTM method can improve the prediction efficiency significantly for daily >2-MeV electron integral flux 1 day ahead at geostationary orbit.