Topical Discussion Meeting report

International Space Weather Action Teams (ISWAT): Community-driven effort to advance space weather capabilities
Conveners: Masha Kuznetsova, Rui Pinto, Suzy Bingham
Wednesday 26th October 2022, 1130-1245, Room: Water
Number of participants: ~50

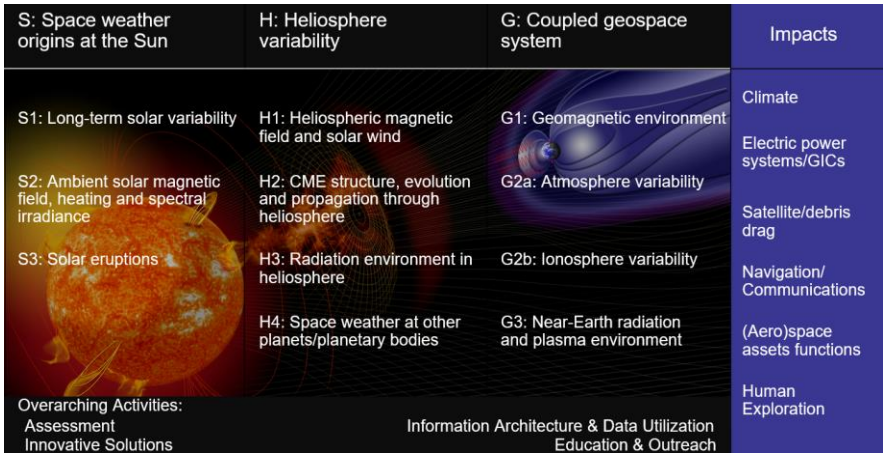
Presenters: Rui Pinto, Martin Reiss, Mario Bisi, Masha Kuznetsova. Chair/secretary: Suzy Bingham.

Objective of the TDM

The TDM's goals were to 1) update the space weather community on the recent ISWAT Working Meeting in September 2022, 2) update on recent activity including the Roadmap activity and progress made by some of the solar and heliosphere Teams, 3) discuss ISWAT way forward and 4) next future ISWAT Working Meeting.

Some discussion highlights

The meeting included a few slides (see Annex) with discussion encouraged throughout. The COSPAR ISWAT initiative is a global hub for collaborations addressing challenges across the field of space weather. Groups of Teams are arranged in ISWAT *Clusters (see schematic below)*.



The TDM began with Rui Pinto providing an overview of the ISWAT Working Meeting held in Coimbra, Portugal, from 26-30 September 2022. The Working Meeting was arranged for Teams to work on projects, coming together in plenary sessions, to provide updates at the start and end of the week.

Martin Reiss then gave an update on some of the progress in the solar and heliospheric domains. For each of the Teams, the following were presented: objective, why it matters, and progress made in Coimbra (please see Annex slides for more detail).

Next was Mario Bisi who provided an update on the ISWAT Roadmap status. Papers are currently in preparation; it was emphasised that there is transparency in the writing process. There will be two Special Issues of Advances in Space Research (ASR): Special Issue 1 (Science Research and Applications) and Issue 2 (Achievements and future goals).

Masha Kuzntesova gave an overview of a new topic to be addressed by ISWAT, 'World Modelling Challenge: Storms in Coupled Geospace System'. The importance of Essential Space Environment Quantities (ESEQs) was described, along with the link to Impact Quantities (IMPQs). A Geospace Scoreboard was also discussed (please see Annex slides for more description).

There was discussion on the benefit of joining ISWAT Teams and around the particular benefits to early career scientists. Martin Reiss explained how he had become involved with ISWAT, and other members present praised Martin on his commendable contributions.
Audience discussion included the importance of ensuring future ground-based networks (Carine Briand), in a similar manner as space-based observations are reviewed and planned. It was suggested that the source of observations could be identified specifically within discussion around ESEQs and IMPQs.
Great progress made by the Solar Teams was highlighted, and Manuela Temmer described the work in this area. On further topics to cover through ISWAT, it was suggested that Teams could be developed to focus on data assimilation, for example.
There was discussion on whether, when and where to hold the next large ISWAT meeting. It was agreed that a meeting in the US in February 2024 was of interest.
Thanks were given to those presenting at the ISWAT TDM, to the audience in-person in Zagreb, and to the online participants.

Main conclusion of the meeting

The ISWAT TDM successfully updated the space weather community on recent ISWAT activities particularly on those at the Working Meeting in Coimbra in September 2022. Impressive progress in the Solar and Heliosphere Teams was highlighted. ISWAT Roadmap papers are in preparation, with the planned publication of Special Issues in ASR on track for next year. Once Roadmap papers are complete, Teams and Clusters will continue work towards Roadmap goals, along with newly established Teams to address topics identified during the Roadmap activity.

ISWAT is open to anyone in the community to join and work together; there's information on the [ISWAT webpages] to learn more about activities and all are very welcome to become involved.

Annex 1: Presentation slides

Topical Discussion Meeting

1130 - 1245 Wed 26th Oct

Room: 'Water'

International Space Weather Action Teams (ISWAT): Community-Driven Effort to Advance Space Weather Capabilities

COSPAR International Space Weather Action Teams (ISWAT) initiative with more than 500 active members includes 56 Action Teams working via self-guided topical collaborations addressing challenges across the field of space weather. Action Teams are organized into 15 SWAT Clusters by domain, phenomena, or overarching activity. The three regimes, Sun - Heliosphere - Geospace, cover chains of space weather phenomena linked to major space environment impacts on critical infrastructure (e.g., power grid systems, navigation/communications, (aero)space assets) and human health. ISWAT Clusters are enhancing our capabilities through shared resources forming partnerships to maximize return on investments to national and international space weather programs. The TDM will start with a scene setting introduction summarizing outcomes from the 3rd ISWAT Working Meeting (Coimbra, Portugal, 26-30 September 2022, https://iswat-cospar.org/wm2022) and status of Community-led COSPAR Space Weather Roadmap update efforts coordinated by ISWAT. The brief update will be followed by open discussion on Roadmap recommendations, high priority actions and community-wide campaigns, and approach to improving international coordination.

COSPAR ISWAT 2022 - Coimbra, Portugal (26 - 30 September)

ISWAT - International Space Weather Action Teams

https://www.iswat-cospar.org/iswat-cospar

5-10min Updates + **Discussion:**

- Overall Working Meeting – *Rui Pinto*
- Roadmap update – *Mario Bisi*
- Update on some of the solar-heliosphere sessions – *Martin Reiss*
- Coupled Geospace Modelling Challenge – *Masha*
- Next big meeting? – US, Feb '24?

PSW and ISWAT

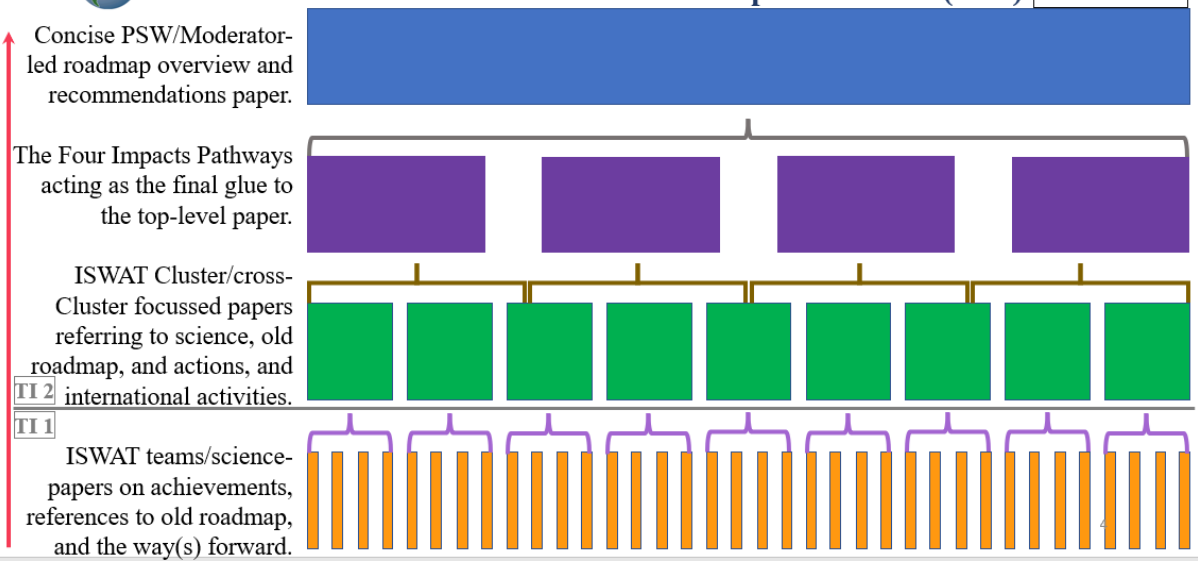
COSPAR PSW/ISWAT Roadmap Preparations, Updates, Next Steps, and Discussion?

Slides from Mario, Masha, and Martin…

Updating the COSPAR PSW Roadmap - Structure

PSW and ISWAT

Double Collection of COSPAR Advances in Space Research (ASR)



COSPAR PSW/ISWAT Roadmap Update Pathway – Brief Summary

PSW and ISWAT

- For TI 1:
  - 36 Submitted papers in total at close of submissions to ASR (but the possibility of some early Tier 2 submissions to be moved into TI 1 as appropriate).
  - 2 Rejected papers (but some content was merged into another paper).
  - 24 Accepted papers as of 23rd September 2022 (many of these are already available online from the ASR website).
- For TI 2:
  - A couple of submissions to date, but not submissions that we were necessarily expecting for TI 2.
  - Several of the Cluster-Moderator-led papers are ready/near-ready for submission!
    - Some work needs to be done still to reference the Tier 1 papers accordingly.
  - **Please COMPLETE your papers ASAP and don't wait for the 31st January 2023 extended deadline – thanks!**
- Final aim now is for a Mid-2023 release for the full publication and full collation of the double TI.

Community-Driven Space Weather Roadmap:
Where are we now? Where are we going? Where we want to be?

See: https://www.iswat-cospar.org/roadmap_update-pathway

PSW and ISWAT

- Set of two Roadmap Topical Issues in COSPAR 'Advances in Space Research':
  - **ASR-TI-1 : Science Research and Applications (Deadline: June 30, 2022); and**
  - **ASR-TI-2 : Achievements and Future Goals (Deadline: January 31, 2023).**
- ISWAT initiative is forming the backbone for the Roadmap with:
  - a set of science papers for ASR-TI-1 coordinated by Action Team Leads; and
  - a set of review papers mirroring the ISWAT Cluster structure for ASR-TI-2 coordinated by Cluster Moderators.
- PSW is leading papers on Interfacing with Users, International Space Weather Landscape, and the Road to Coordination to be submitted to ASR-TI-2.
- Everyone has opportunity to participate in this peer-reviewed endeavor by submitting papers to Roadmap Topical Issues and contributing to review paper:
  - Opportunities to submit to ASR-TI-2 even if there's a better fit to ASR-TI-1 as we can still move papers around before the finalization of the roadmap.
- The COSPAR Roadmap is planned to become a living document updated approximately every 5 years…
- The original COSPAR-ILWS Roadmap [Schrijver *et al*., 2015] is used as a point of reference (what have we achieved?).

Roadmap Topical Issue 2: Status & Plans

PSW and ISWAT

- Transparency in writing process. Roadmap Special Issue 2 preparation page: https://iswat-cospar.org/roadmap_preparation_si2
- Each paper intended for submission to ASR-SI-2 has a block with links to:
  - Tentative Title, Working Abstract, Author/Co-Authors; and
  - Paper outline, References, Supplementary material.

Tentative Title: **Prediction of Solar Eruptive Events Impacting Space Weather Conditions**

ISWAT Cluster(s): **S3**

First Author/POC: Manolis Georgoulis, manolis.georgoulis@academyofathe

First Author Affiliation: Research Center for Astronomy and Applied Mather

Possible co-authors: Toriumi, Wang, Yardley, Green, Chintzoglou, Leka, Bar Nishizuka, Ishii, Aydin, Angryk, Bobra, Kontogiannis, Falconer, Chen, Sadyk Bain, Patsourakos, Vourlidas, Antiochos, Kliem, Torok, Panos, Kleint, De Po Crosby, Malandraki, Richardson, Mays, Bloomfield, Camporeale, Bingham a more details)

Working Abstract:

Links:

[Paper Outline] [Paper Draft] [References] [Additional Information] [Summary]

CME Propagation Through Ambient Solar Wind - Observations and Model Development

ISWAT Cluster(s): **H1, H2**

First Author/POC: Manuela Temmer, manuela.temmer@uni-graz.at

First Author Affiliation: University of Graz, AUSTRIA

Co-authors: C. Scolini, I.G. Richardson, S.G. Heinemann, E. Paouris, A. Vourlidas, M. Bisi, and writing teams T. Amerstorfer, N. Al-Haddad, L. Barnard, D. Buresova, S. J. Hofmeister, K. Iwai, L. Jian, N. Lugaz, P.K. Manoharan, W. Mishra, M. Owens, B. Perri, R. Pinto, J. Pomoell, E. Samara, D. Sur, C. Verbeke, A.M. Veronig, B. Zhuang.

Drafts of summary sections including recommendations due on **09/11/22**

COSPAR PSW/ISWAT Roadmap S-H Summaries

PSW and ISWAT

At A Glance: Tier 2 Paper Status in the Solar & Heliospheric Domains

	Cluster	Title	Keywords	Coordinators	Status	Submission
Solar	S1	Long-term Solar Variability	Historical time series; Extreme solar events; Physical Understanding of Long-Term Variability; Data Curation	Alexei Pevtsov	?	?
Solar	S2	Ambient Solar Magnetic Field, Heating, and Spectral Irradiance	Global solar magnetic field; Coronal Holes; Magnetic Connectivity; Solar Spectral Irradiance	Nick Arge, Martin Reiss	revising	Nov/Dec 2022
Solar	S3	Prediction of Solar Eruptive Events Impacting Space Weather Conditions	Pre-flare/pre-eruption situation; Solar Flare Prediction; Framework of solar weather prediction	Manolis Georgoulis	planning / drafting	January 2023
Solar	S3	Recent Progress on Understanding Coronal Mass Ejection/Flare Onset by a NASA Living with a Star Focused Science Team	MHD simulations of solar eruptions; Magnetic reconnection and the onset of solar eruptions	Mark Linton	revising	January 2023
Heliospheric	H1, H2	CME Propagation Through Ambient Solar Wind	SIRs/CIRs formation and propagation; ICME propagation; Improving heliospheric modeling	Manuela Temmer, Mario Bisi, Camilla Scolini	revising	January 2023
Heliospheric	H3	Current Understanding and Future Perspectives of the Radiation Environment in Heliosphere	SEP observations; SEP model validation; GCRs fluxes; Radiation forecasting for future missions	Jingnan Guo	drafting	January 2023

COSPAR PSW/ISWAT Roadmap Update – Key Next Steps – Discussion…?

PSW and ISWAT

- The intent of the TI 2 papers is to focus more widely on current/future capabilities:
  - What has been achieved from the previous roadmap?
  - What has not been achieved and is it still relevant?
  - What do end users really need and value?
  - A comprehensive view on international activities/missions where some strategies will be covered.
  - A set of papers covering the key impacts from space weather.
  - Overarching and international papers from the Clusters/Cross-Clusters of the ISWAT structure with referencing both down and across the chain highlighting key TI 1 developments and the links across clusters…
  - To pull together the initial pathways forward to the future, but especially in pulling out key recommendations for the future; this is especially important for the foundations of the overarching paper at the top of the tiered set of papers…

COSPAR ISWAT 2022 Meeting: Progress in the Solar & Heliospheric Domains

Martin Reiss[1,2], Karin Muglach[3], Carl Henney[4], Nick Arge[3]; Rui Pinto[4,5], Jon Linker[6], Katie Whitman[7], Claudio Corti[1], and parallel session leads

[1]CCMC, NASA Goddard, Greenbelt, USA; [2]Austrian Space Weather Office, Graz, Austria; [3]NASA Goddard, Greenbelt, United States; [4]Air Force Research Laboratory (AFRL), USA; [5]LDE3, CEA SAclay, DAp/AIM, University of Paris-Saclay, France; [6]IRAP, OMP/CNRS, CNES, University of Toulouse, France; [6]Predictive Science Inc., USA; [7]NASA JSC SRAG, Wyle, USA

Solar Domain	Heliospheric Domain
S1: Long-term solar variability	H1: Heliospheric magnetic field and solar wind
S2: Ambient solar magnetic field, heating and spectral irradiance	H2: CME structure, evolution and propagation through heliosphere
S3: Solar eruptions	H3: Radiation environment in heliosphere
	H4: Space weather at other planets/planetary bodies

Seven action team sessions in the Solar and Heliosphere Domain were held during the COSPAR ISWAT Working Meeting in Coimbra, Portugal.

Find out more at www.iswat-cospar.org/

S2-03: Global Solar Magnetic Field Team

Leads: Carl Henney[1], and Nick Arge[2]

[1] Air Force Research Laboratory (AFRL), USA; [2] NASA Goddard, Greenbelt, United States

What is the objective?

Answer the question of how best to address the challenges and limitations of creating global solar magnetic field maps.

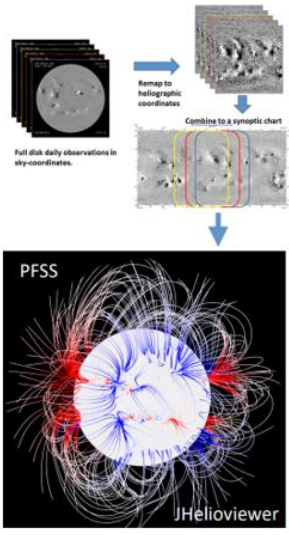
Why does it matter?

Global magnetic maps are the primary input to almost all state-of-the-art coronal, solar wind, and irradiance prediction models.

What progress has been made in Coimbra?

- Great attendance! Large fraction of groups that generate magnetic field maps represented at session.
- Discussed possible methods for quantitatively validating and comparing photosphere magnetic field maps including direct and indirect methods.
- Planned to create a Community Dashboard that will provide publicly available comparisons in retrospective and real-time.

Content based on slides by Nick Arge (ISWAT Meeting 2022)

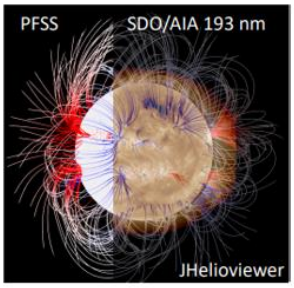


Find out more at www.iswat-cospar.org/s2-03

S2-01: Coronal Hole Boundary Working Team

Leads: Martin Reiss[1], and Karin Muglach[2]

[1] CCMC, NASA Goddard, Greenbelt, USA; [2] NASA Goddard, Greenbelt, United States



What is the objective?

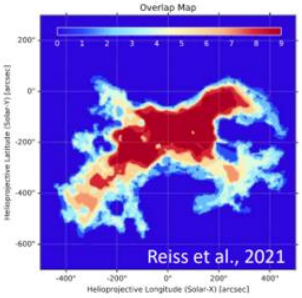
Coronal holes are the part of the solar magnetic field that is open to the heliosphere. We want to learn more about the uncertainties of their boundaries when observed in SDO AIA images of the Sun.

Why does it matter?

The observational uncertainties of coronal hole boundaries are valuable constraints in solar research, solar wind modeling, and space weather prediction.

What progress has been made in Coimbra?

- Identified strengths and weaknesses of automated coronal hole detection schemes.
- Collected feedback on our next research paper that builds on our previous work in Reiss et al., (2021).
- Follow-up study: Use synoptic maps (not single full disk images) and connect this to coronal and solar wind models.



Find out more at
www.iswat-cospar.org/s2-01

S2-05: Sun-Spacecraft and Sun-Earth Magnetic Connectivity

Leads: Rui Pinto[1,2], and Jon Linker[2]

[1] LDE3, CEA SAclay, DAp/AIM, University of Paris-Saclay, France; [2] IRAP, OMP/CNRS, CNES, University of Toulouse, France; [3] Predictive Science Inc., USA

What is the objective?

Determining the effects of Solar phenomena on Earth or on spacecraft requires understanding the propagation of the perturbations they generate across the heliosphere. The objective is to assess the accuracy of tools that establish magnetic connectivity from the solar surface to any point in space.

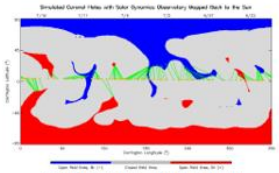
Why does it matter?

Relating remote observations to in-situ data from one or more spacecraft requires tools and methods that establish connectivity systematically. Space explorers require a priori knowledge of the regions of the observed solar disk and corona that will either be connected magnetically to the spacecraft within at least few-days lead time, or be the source of solar wind flows and particles that are likely to be detected in-situ.

What progress has been made in Coimbra?

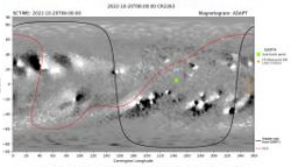
- Discussed validation approaches and metrics for connectivity tools.
- Developed future action plan based on two parallel science objectives, namely event studies of SEPs and Coronal Holes.

Magnetic Connectivity Products
from Predictive Science Inc.



https://www.predsci.com/hmi/spacecraft_mapping.php.

Magnetic Connectivity Products
from IRAP, University of Toulouse



http://connect-tool.irap.omp.eu/

Find out more at
www.iswat-cospar.org/s2-05

H3-01: SEP Model Validation

Leads: Katie Whitman[1], Phil Quinn[1], Hazel Bain[2], Ian Richardson[3], Leila Mays[4], and Mark Dierckxsens[5]

[1]NASA JSC SRAG, Wyle, USA; [2]NOAA SWPC, CIRES, USA; [3]NASA Goddard, Greenbelt, United States; [4]CCMC, NASA Goddard, Greenbelt, USA; [5]BIRA-IASB, Belgium;

What is the objective?

The goal is to develop a framework to validate SEP models. This effort is being carried out in the form of community participation in challenges through SHINE and ISWAT, as well as through validation of forecasts produced for the SEP Scoreboard.

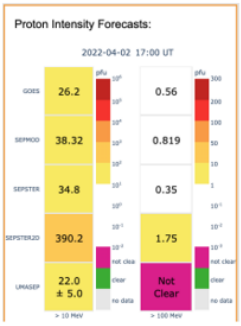
Why does it matter?

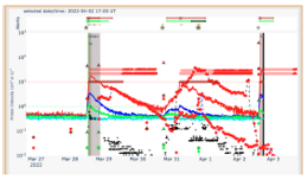
Quantitative model validation is important for assessing whether a model is capturing the critical physics of the system or whether additional research is needed.

What progress has been made in Coimbra?

- Team lead Kathryn Whitman (NASA) presented an overview of the current capabilities of the validation code and received valuable feedback.
- Team lead Mark Dierckxsens (BIRA-IASB) showed SEP model validation work being done for ESA purposes.
- H3-01 met with H3-02 (suprathermal seed particles; Maher Dayeh) to discuss the latest results from ACE, PSP, and SolO and how they are relevant to SEP models.
- Planned the next phase of the validation challenge effort.

SEP Scoreboard
https://sep.ccmc.gsfc.nasa.gov/intensity/





Find out more at
www.iswat-cospar.org/h3-01

TDM on Thursday!

H1-01: The Ambient Solar Wind Validation Team

Leads: Martin Reiss[1], Karin Muglach[2], Barbara Perri[3]

[1] CCMC, NASA Goddard, Greenbelt, USA; [2] NASA Goddard, Greenbelt, United States; [3]Astronome-Adjointe au CNAP (OSUPS), Saclay, France

What is the objective?

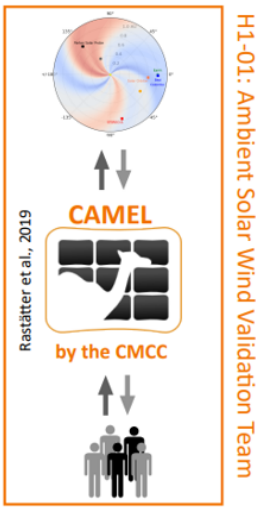
Develop an online platform for the validation of ambient solar wind models in a bottom-up approach from the space weather community.

Why does it matter?

Ambient solar wind models are a key part of space weather research and forecasting. But tracing their progress over time needs community-wide metrics and goals.

What progress has been made in Coimbra?

- Collected feedback from the community on the alpha version of the platform that will be included in future versions.
- Identified community needs (metrics, forecasting goals) that we need to address.
- Discussion during the meeting lead to the development of the future action plan focusing on „historical“ and „real-time“ validation.



Find out more at
www.iswat-cospar.org/h1-01

S1-01: Long-term Solar Variability

Leads: Ilya Usoskin[1]; Claudio Corti[2]

[1] University of Oulu, Finland; [2] CCMC, NASA Goddard, Greenbelt, USA

What is the objective?

The objective is to estimate the past long-term solar variability (e.g., sunspots, irradiance, open magnetic flux) on time scales of solar cycles and longer including uncertainty assessments. The team also aims to develop new methods of data analysis to predict the long-term solar variability.

Why does it matter?

Knowledge of past solar variability can inform us about the range of possible solar activity fluctuations, and about worst-case scenarios. This is relevant to better understand the near-Earth space environment, planetary atmospheres and climate, and exoplanets orbiting Sun-like stars.

What progress has been made in Coimbra?

- Discussed the need for global heliospheric modeling, from the Sun's surface to the heliopause, to further our understanding of particle transport and solar dynamo processes during grand minima periods.

- Working on improving the outline of the roadmap paper.

Find out more at
www.iswat-cospar.org/s1-01

On the Web:

Roadmap Preparation Page
https://www.iswat-cospar.org/roadmap_preparation

COSWAR ISWAT Activities
https://www.iswat-cospar.org

ISWAT

World Modeling Challenge:
Storms in Coupled Geospace System

(past and on-going/recent storms)

Evaluate capability to model geomagnetic and ionosphere/thermosphere storms in *coupled geospace system* and

- to reproduce essential space environment quantities (**ESEQs),** that are
  - indicative of phenomena of interest,.
  - linked to space environment impacts,
  - utilized by forecasters as a base for alerts and warnings or utilized as inputs for models of impacts
  - ***can be derived from model outputs and available/accessible observational data.***
- to reproduce Impact Quantities (**ImpQs**) at selected locations for a set of time intervals where/when space environment observations and impact information are reliably available
- to quantify and demonstrate potential improvements in space weather predictive capabilities due to new understanding, new models, and new measurements
- to quantify and assess what we start modeling right, what we are consistently getting wrong, to identify targets for further developments, and to trace progress over time.
- to design Display Systems and Scorecards for evaluation results
- to enable online analysis and download through API

Examples ESEQs and ImpQs

User Groups and Impacts	**ESEQs**	**ImpQs**	Observational Data, Models of Impact
Electric power systems, GICs	**Ground Magnetic Perturbations at** SuperMAG magnetometer stations (10 sec - 1 min): Delta-B, dB/dt at instrument locations binned by latitude and/or by local time. **Geomagnetic activity indices:** Dst, Kp. Ap, AE, Sym-H	GICs, Geoelectric field	Ground conductivity, models of geoelectric fields, and GICs.
Communications	**foF2** and **foF2** anomaly dfoF2(%)=[(foF2obs-foF2median)/foF2median]*100. 3D plasma density	MUF, MUF_anomaly Difference between predicted and actual HF signal propagation	Ionosods, ISR Ray tracing for signal propagation (e.g., PHaRLAP)
Satellite drag	**Neutral density along satellite orbits**. 3D outputs from neutral density models.	Difference between predicted and actual satellite position	Orbit propagators (e.g., GEODYN) satellite tracking information (GNSS, laser ranging, etc), details on satellite orientation and other properties

Pre-Event Forecasting Methods Scoreboards

Active

(focus on solar drivers)

- Scoreboards organized by ISWAT Action Teams
  - Flare Scoreboard (**S3-01**)
  - CME Scoreboard (**S3-02, H2-01**)
  - SEP Scoreboard (**H3-01**, *inspired by NASA Space Radiation Analysis Group*)
- Scoreboards collect forecasts from the community before event is observed
- Allows a consistent **real-time** comparison of various operational and research forecasts
- Over time enough statistics are collected for validation studies. Opportunity to download all forecasts for research.
- Provides valuable feedback for model developers to make improvements
- Scoreboard infrastructure is developed and maintained by the CCMC

https://ccmc.gsfc.nasa.gov/scoreboards/

Pre-Event Source-to-Impact Geospace Storm Scoreboard

Planning

Goal:

- Community Ensemble Forecast for ESEQs to exceed certain thresholds

Tasks:

- Agree on **type of forecasts**, e.g., probability, peak, duration.
- Agree on **quantities, thresholds, displays** for each user group.
- Initiate **inventory** of available models, data, products, displays.
- Take advantage of CME and Flare Scoreboards, and initial work done with IMF Bz Scoreboard.
- Agree on **formats** for forecast submissions

Challenge and Scoreboard Planning Folder
https://drive.google.com/drive/folders/1rwQCyZJyjm681cvJoKNcQwLivyOipYug

CCMC is building and maintaining infrastructure for Challenges and Scoreboards