

PROGRESS & PROSPECTS: SESSION #9 SEP MODEL VALIDATION CHALLENGE

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NASA JSC Space Radiation Analysis Group

SHINE Workshop

June 27, 2022

SEP MODEL VALIDATION CHALLENGE: PAST, PRESENT, AND FUTURE

Completed

First Phase –
quantitative comparisons with observations

SHINE 2019 & ISWAT 2021
Collect forecasts for 10
Challenge SEP Events

Current

Second Phase –
test for false alarms & correct negatives

SHINE 2022
Collect forecasts for 14
periods when no SEP
was observed

Next

Third Phase –
Statistically significant metrics and cross-model comparisons

Validation with statistically significant number of SEP events and non-events using standardized set of inputs and strict requirements

Final validation code product – *Integrated into CAMEL with assistance from CCMC*

- Third phase – ISWAT team will provide:
 - List of challenge events and non-events (~solar cycle 24)
 - CME and other input parameters
 - Time stamps after which no data may be used
- Incentive!!!!
- **Organizing a conference dedicated to the final results with travel support for challenge participants**

False Alarms in the Forecasting of SEP Events

Bill Swalwell

baswalwell@uclan.ac.uk

Part I: Scene Setter #1

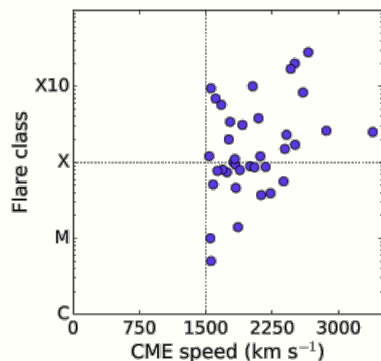
Two simple SEP forecasting algorithms

Two simple SEP forecasting algorithms:

1. A western Coronal Mass Ejection with a reported plane-of-the-sky speed of $1,500 \text{ km s}^{-1}$ or greater (a “fast CME”)
 2. A western X-class flare
- will result in an SEP event being detected at Earth

4

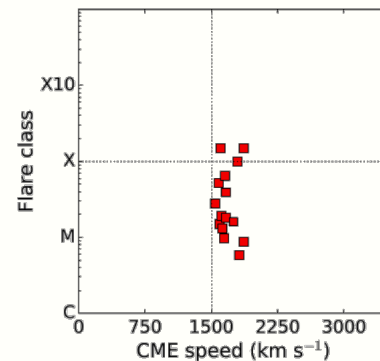
Fast, western CMEs



The algorithm is good at forecasting SEP events: 37/52 or 71.2% of such events produced SEPs at Earth

5

Fast, western CMEs



But that means that 28.8% (15/52) of fast, western CMEs were false alarms

Many of the false alarms were CMEs associated with less energetic flares, but it is notable that 3 were associated with a flare of class X1 or above.

6

PART I DISCUSSION

- Bill Swalwell presented that eruptive region latitude and longitude, CME speed, CME width, flare class, flare duration, and location with respect to the current sheet are all key factors for limiting false alarms
- Following discussion:
 - Measurements of shock low in corona – good coronagraph with small occlusion radius
 - Radio data reduces false alarm (e.g. SEPSTER paper)
 - Connectivity plays a role – large event with intermittent connectivity
 - CME speed very important – artifacts in catalogs an issue
- Presentation from Subhamoy Chatterjee about MEMPSEP Machine Learning model

Part II: Scene Setter #2

Human Exploration Operations

Why Model
Validation is Needed

Philip Quinn
NASA/JSC/SRAG (Leidos)



Background Image from ISS Expedition 65

Questions from the FCT

What they ask

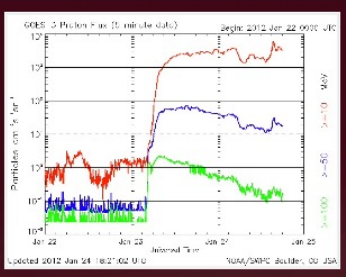
- 1 Will an event occur?
- 2 How intense will the event be?
- 3 When will the event end?

What they mean

- 1 Do we need to worry?
- 2 Will we need to stop mission activities so crew can shelter?
- 3 When can we resume mission activities? When can we stop worrying?

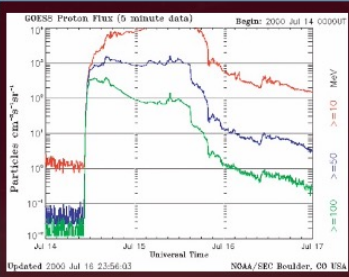
Recommendations

Low Intensity Event



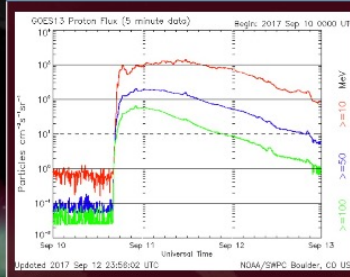
- GOES >100 MeV proton intensity barely crosses 1 pfu
- Recommendation is easy. No impact to crew

High Intensity Event



- GOES >100 MeV proton intensity crosses 100 pfu
- Recommendation is easy. Crew needs to shelter

Middling Intensity Event



- GOES >100 MeV proton intensity near 50 pfu and showing little or no sign of turning over
- Recommendation is difficult. Will 100 pfu be crossed or not?

Model Validation

- Accuracy** How close are model predictions to observations?
- Bias** Does the model tend to overpredict or underpredict?
- False Alarm Rate** How often does the model predict a false alarm?
- Any Caveats** Does the model perform better or worse for different conditions?

Having quantitative validation metrics and a list of caveats for a model provides confidence to our console operators when giving recommendations to Surgeon for crew – without them, model predictions cannot be trusted

Presentation of Challenge Results

SEP MODEL VALIDATION

Kathryn Whitman

NASA JSC Space Radiation Analysis Group

SHINE Workshop

June 27, 2022

SEP MODEL COMMUNITY VALIDATION EFFORT 2021 TO 2022

SHINE 2021

Request to forecast 10 SEP events
Results submitted by 13 models

PARTICIPATING MODELS:

- ASPECS (Papaioannou et. al.)
- COMESEP (Dierckxsens et al.)
- HESPERIA REleASE (Posner, Kuhl, Malandraki)
- IPATH + ZEUS (Li, Hu)
- MAG4 SEP (Falconer, Khazanov)
- M-FLAMPA (Sokolov, Zhao)
- SEPMOD + ENLIL (Luhmann)
- SEPCaster (IPATH + AWSoM) (Li, Jin)
- SEPSTER (Richardson, I.)
- SEPSTER2D (Bruno)
- SPARX (Marsh, Dalla, Swalwell)
- STAT (MAS + EPREM) (Linker, Schwadron)
- UMASEP (Núñez)

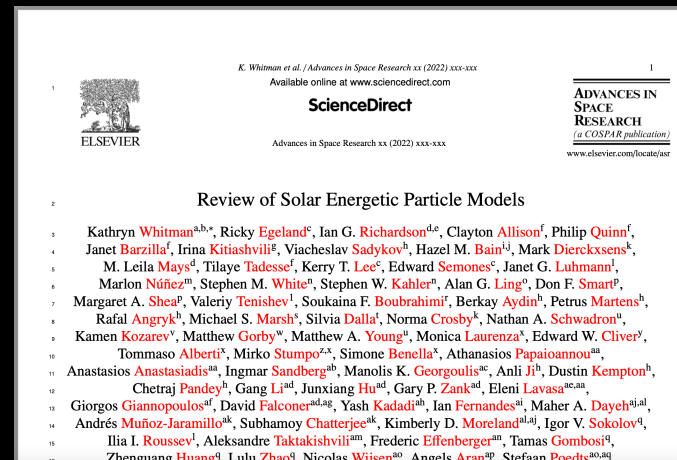
SHINE 2022

Request to forecast 14 non-events
Results submitted by 14 models

PARTICIPATING MODELS:

- ASPECS (Papaioannou et. al.)
- COMESEP (Dierckxsens et al.)
- HESPERIA REleASE (Posner, Kuhl, Malandraki)
- IPATH + ZEUS (Li, Hu)
- MAG4 SEP (Falconer, Khazanov)
- MagPy (Tidesse, Falconer et al.)
- MEMPSEP (Dayeh et al.)
- PHSVM (Hosseinzadeh)
- PPS (AFRL)
- SEPMOD + ENLIL (Luhmann)
- SEPSTER (Richardson, I.)
- SEPSTER2D (Bruno)
- SPRINTS (Engell et al.)
- STAT (MAS + EPREM) (Linker, Schwadron)

REVIEW OF SOLAR ENERGETIC PARTICLE MODELS



- Whitman et al. submitted to special issue of Advances in Space Research for the ISWAT-COSPAR heliophysics roadmap effort
- Summarize 35 SEP models in the community with over 100 coauthors
 - Inputs/Outputs
 - Caveats
 - Validation
- Emphasize critical observations required to run and validate SEP models and their limitations
- Compile outputs of each model to understand forecasting coverage and identify gaps

ALL CLEAR FORECASTS

Lavasa Model >10 MeV, 10 pfu
Forecasts only for 10 non-events

Contingency Table		
	Observed Yes	Observed No
Forecast Yes	0	1
Forecast No	0	9

SEPMOD >10 MeV, 10 pfu
9 events + 14 non-events

Contingency Table		
	Observed Yes	Observed No
Forecast Yes	6	0
Forecast No	3	14

SAWS-ASPECS Flare 50%>10 MeV, 10 pfu
9 events + 11 non-events

Contingency Table		
	Observed Yes	Observed No
Forecast Yes	8	1
Forecast No	1	10

PHSVM5 >100 MeV, 1 pfu
4 events + 10 non-events

Contingency Table		
	Observed Yes	Observed No
Forecast Yes	2	0
Forecast No	2	10

PART II DISCUSSION

- Significance of All Clear forecast –
 - Ops can't act on a pre-eruption model, particularly due to the prevalence of false alarms
 - Better to use post-eruptive all clear or model like REleASE
- SRAG Ops Preference – false alarms or missed events?
 - Observations are always available for nowcasting, so missed events are less problematic than false alarms
- SEP Scoreboard currently showing forecasts – will there be validation results as well?
 - That's what the work through these sessions is leading towards!
- Are physics-based models with limited or no lead time useful?
 - Need forecasts for event onset, peak, and end – forecasts coming in after threshold crossing are still useful for Ops
- Presentation by Junxiang Hu about iPATH results for non-events
- Discussed terminology for “non-events” or negative events – SEP quiet?

H3-01: SEP MODEL VALIDATION

Team title: SEP Validation

Team ID: H3-01

Team Leads:

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Keywords (impact): Human exploration

Keywords (activity type): Forecasting, Assessment,

- **Please join our ISWAT Validation Team**
- **This effort continues at ISWAT in Portugal Sept 26 – 20, 2022**
- ISWAT: <https://iswat-cospar.org/H3-01>
- CCMC: <https://ccmc.gsfc.nasa.gov/challenges/sep/>
- SHINE 2022 Events: <https://helioshine.org/sep-model-validation-challenge/>

[Home](#) > [Community Challenges](#)

Last Updated: 05/18/2022

SHINE/ISWAT/ESWW SEP Model Validation Challenge

Organizers

Organizers: Katie Whitman (NASA JSC SRAG/University of Houston), Hazel Bain (NOAA SWPC/CU Boulder CIRES), Leila Mays (NASA Goddard), Phil Quinn (NASA JSC SRAG), Ian Richardson (NASA Goddard/University of Maryland), Mark Dierckxsens (BIRA-IASB)

Introduction

This website was created to provide SEP modelers with all the information needed to participate in the SHINE/ISWAT/ESWW SEP Model Validation

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