



Solar Shield Project - Updates and Future Challenges

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Solar Shield updates

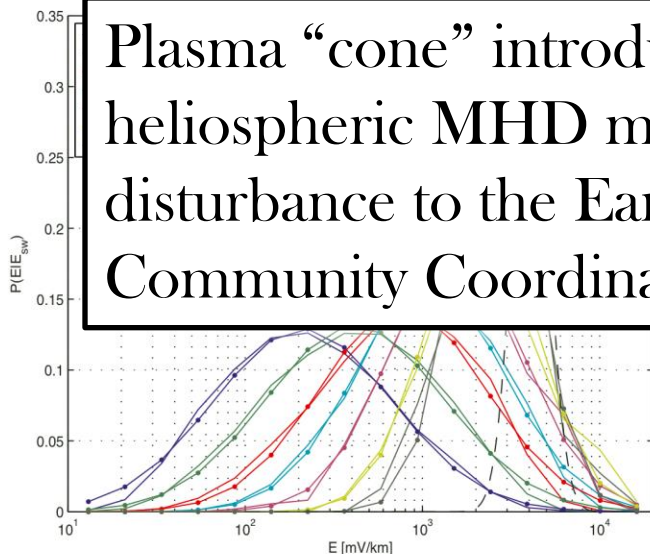
- Solar Shield leverages the forecasting carried out at NASA GSFC Space Weather Center.
- In Solar Shield, we developed a two-level experimental system to forecast space weather effects on the North American power grid; initial development funded by NASA's Applied Sciences Program.
- NASA GSFC and Electric Power Research Institute (EPRI) the key players.
- Pulkkinen et al. (*Natural Hazards*, 2009).

Level 1 forecasts

Solar observations of eruptive events are used to compute “cone model” parameters. NASA/ESA

SO MHD output at the Earth used in a statistical model providing probabilistic estimate for GIC at individual nodes of the power grid. GIC forecast file is generated.

Plasma “cone” introduced to the inner boundary of a heliospheric MHD model. Model propagates the disturbance to the Earth. Computations carried out at the Community Coordinated Modeling Center.



0 0 0 0 53.16 -99.29 45.39 -68.53
2006 12 14 14 6 76 15 153

LEVEL1

GIC2high ...

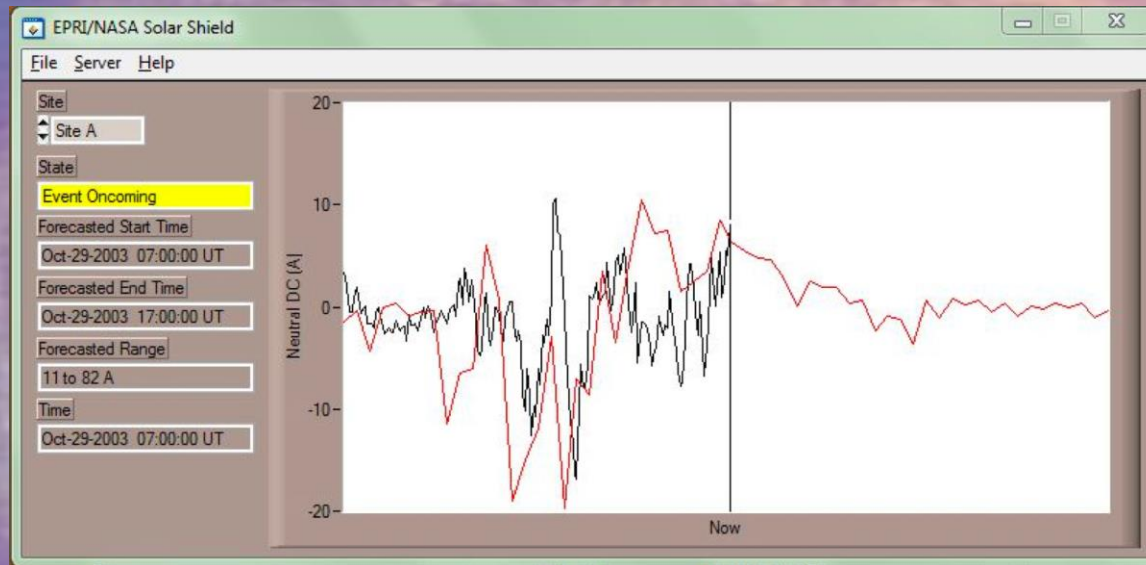
Level 2 forecasts

An abstract graphic featuring a series of wavy, overlapping lines in shades of blue and green. The lines originate from the left side and extend towards the right, creating a sense of movement and depth. The background is solid black, which makes the vibrant colors of the lines stand out. The lines vary in thickness and color intensity, with some appearing more saturated than others. The overall composition is dynamic and modern.

$$\begin{array}{ccc} 0 & & \cdot \cdot \cdot \\ 0 & & \cdot \cdot \cdot \end{array}$$

2008 03 19 11 06 31	-0.02	0.00	0.04	0.00
2008 03 19 11 08 31	0.00	0.00	0.01	0.00
2008 03 19 11 10 31	0.01	0.00	-0.03	0.00
2008 03 19 11 12 31	0.00	0.00	0.02	0.00
2008 03 19 11 14 31	0.02	0.00	0.04	0.00
2008 03 19 11 16 31	-0.00	0.00	-0.05	0.00
2008 03 19 11 18 31	-0.01	0.00	-0.07	0.00
2008 03 19 11 20 31	0.03	0.00	0.00	0.00

Coupling to the SUNBURST research support tool



```
% Level 1 GIC forecast produced by REALTIMEGIC_LEVEL1
%
% The format of the data is as follows:
% 0 0 0 0 0 0 lat1 lon1 lat2 lon2 ...
% yy mm dd hh mi GIC1low GIC1high GIC2low GIC2high ...
%
0 0 0 0 53.16 -99.29 45.39 -68.53
2006 12 14 14 6 76 15 153
```

```
% Level 2 GIC forecast produced by REALTIMEGIC_LEVEL2
%
% The format of the data is as follows:
% 0 0 0 0 0 0 0 lat1 lon1 lat2 lon2 ...
%
0 0 0 0 0 0 53.16 -99.29 45.39 -68.53
2008 03 19 11 02 31 -0.11 0.00 0.13 0.00
2008 03 19 11 04 31 0.02 0.00 0.03 0.00
2008 03 19 11 06 31 -0.02 0.00 0.04 0.00
2008 03 19 11 08 31 0.00 0.00 0.01 0.00
```

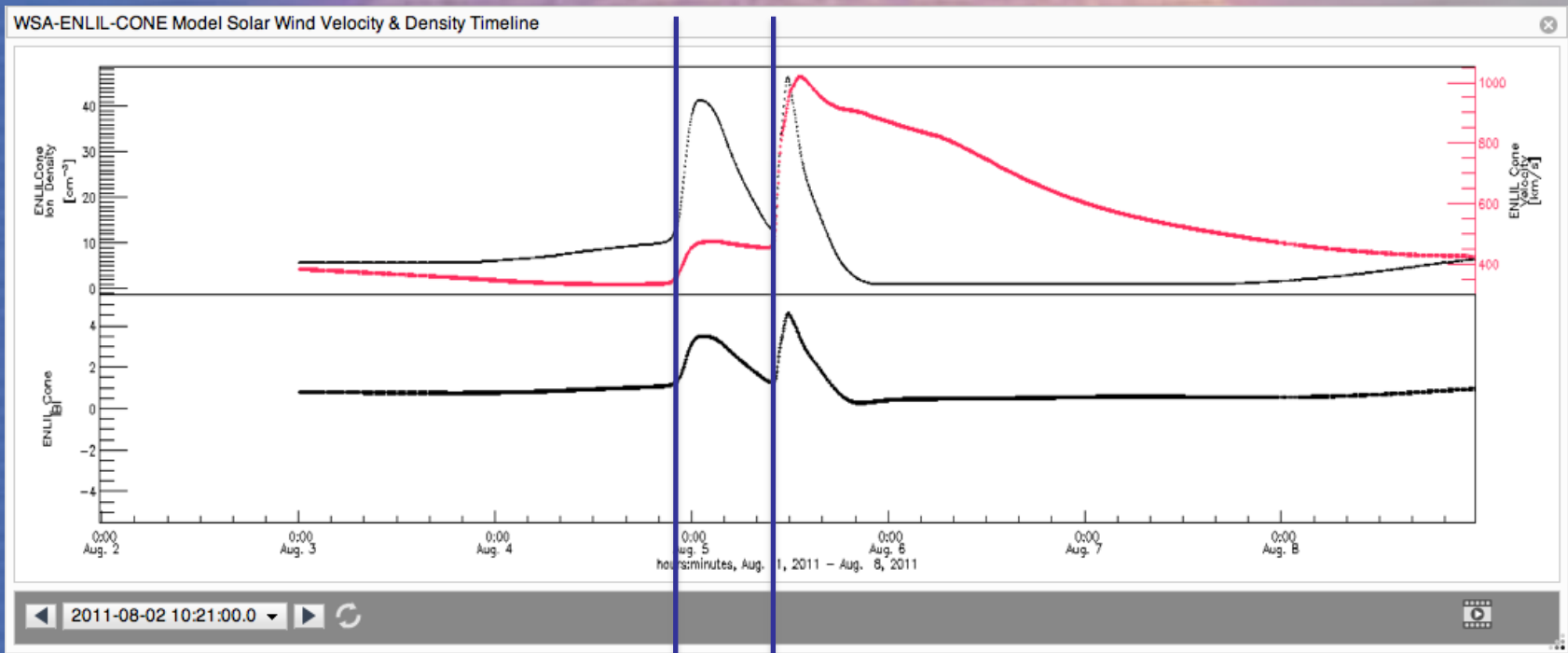
Solar Shield updates

- We are working on extension of the Level 2 part to cover also lower latitude locations.
- The system is being used for extreme GIC studies.
- Collaboration with EU FP7 EURISGIC activity.
- We have had the first good GIC events 2011-2012 and can now really start testing the system (no major GIC events so far).
- Ensemble CME simulations carried out at NASA GSFC Space Weather Center will be utilized in the system.

Aug 2-4, 2011 CME events

- Sequence of major CME events Aug 2-4, 2011.

Solar Shield Level 1 forecast



Predicted initial impact 2011-08-04 21:30Z

Predicted major impact 2011-08-05 10:00Z

Observed initial impact
2011-08-04 21:00Z

Observed major impact
2011-08-05 17:25Z

Predicted GIC range: 1-36 A

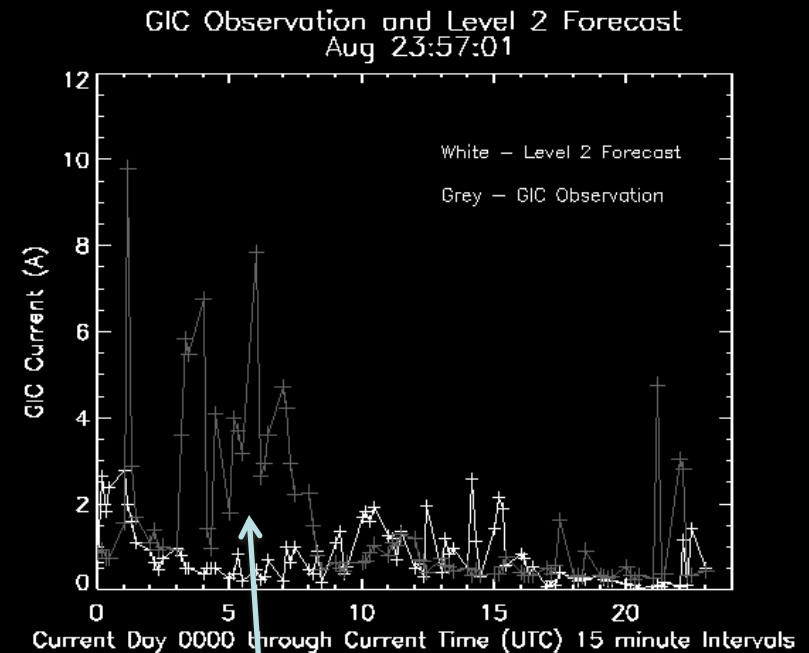
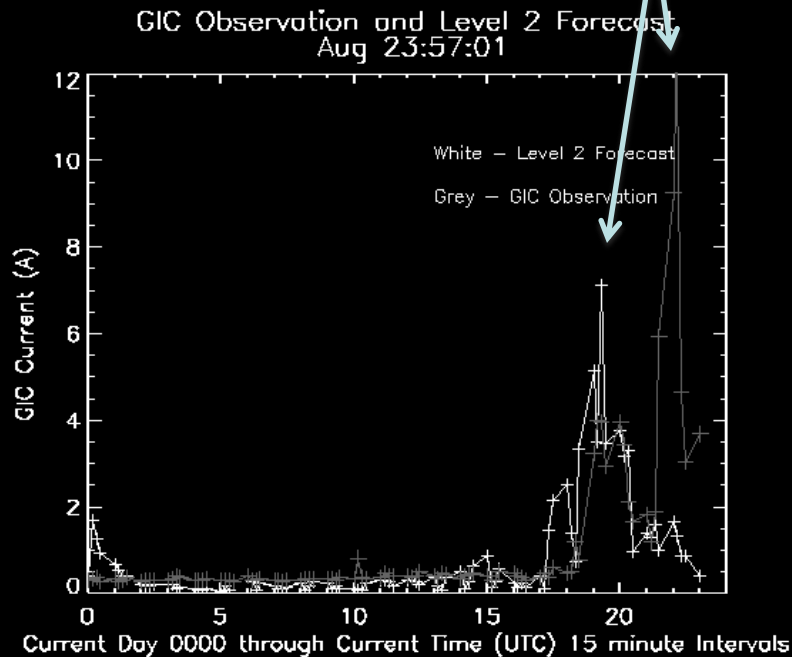
Observed max. GIC was 12 A

Solar Shield Level 2 forecast

Max. amplitudes captured fairly well

Aug 5, 2011

Aug 6, 2011



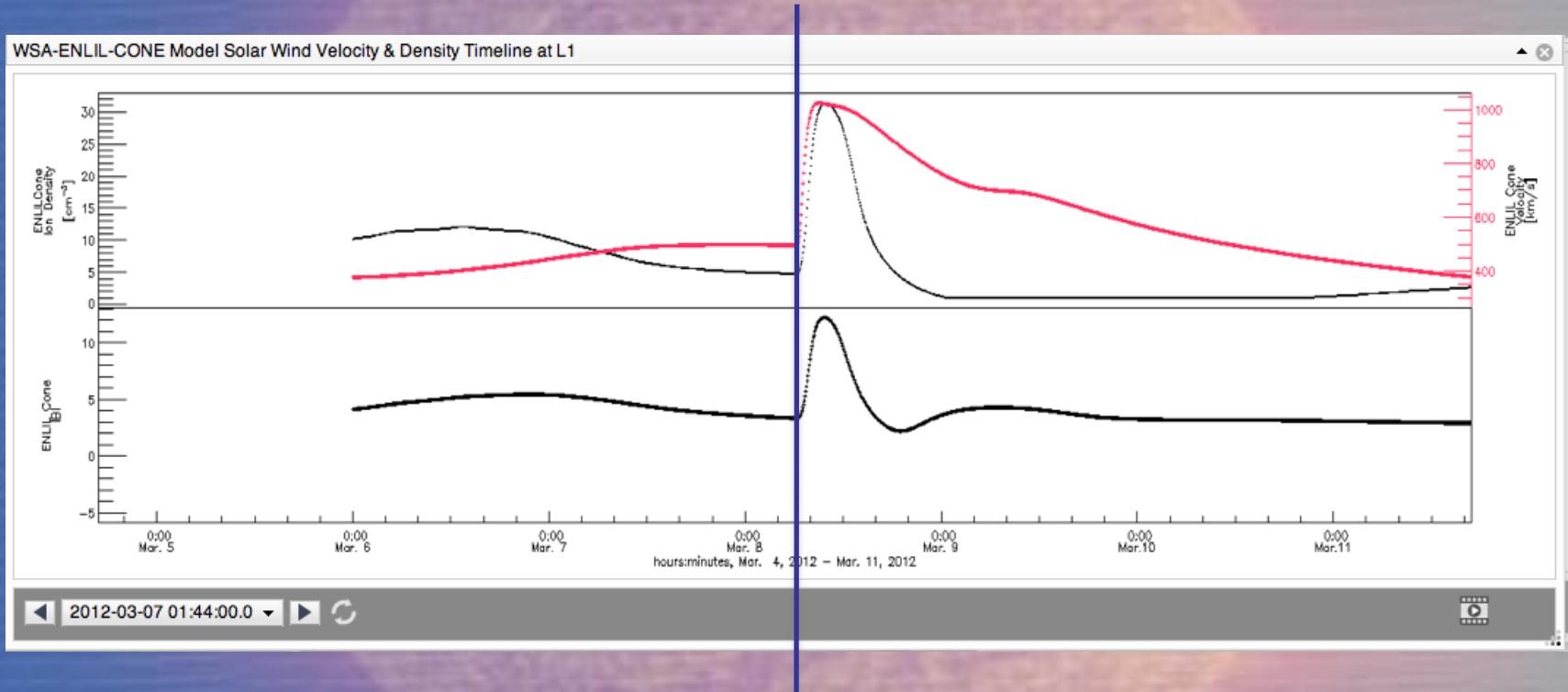
Beginning of the event was captured fairly well

Capturing the mid-storm evolution needs improvement

March 7, 2012 CME events

- Sequence of two major CME events March 7, 2011.

Solar Shield Level 1 forecast



Predicted impact
2012-03-08 06:10Z

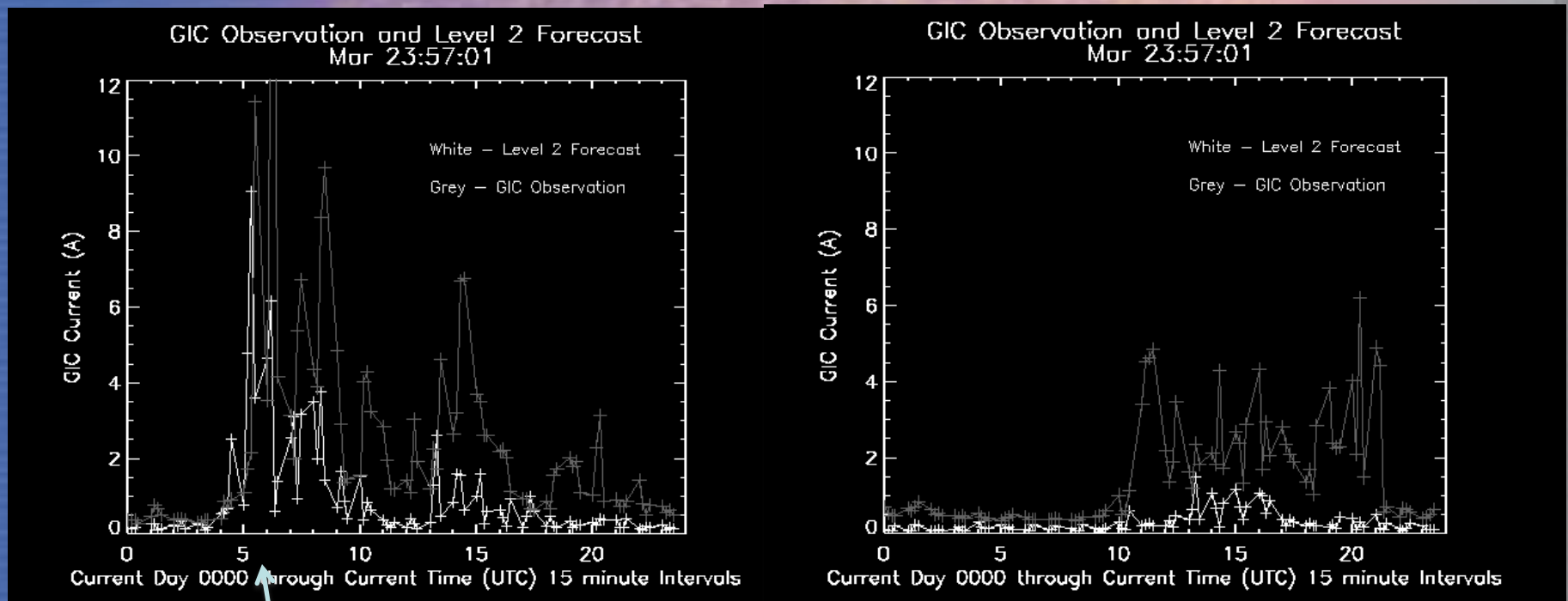
Observed impact
2011-03-08 11:00Z

Predicted GIC range: 8-80 A Observed max. GIC 20 A

Solar Shield Level 2 forecast

March 7, 2011

March 8, 2011

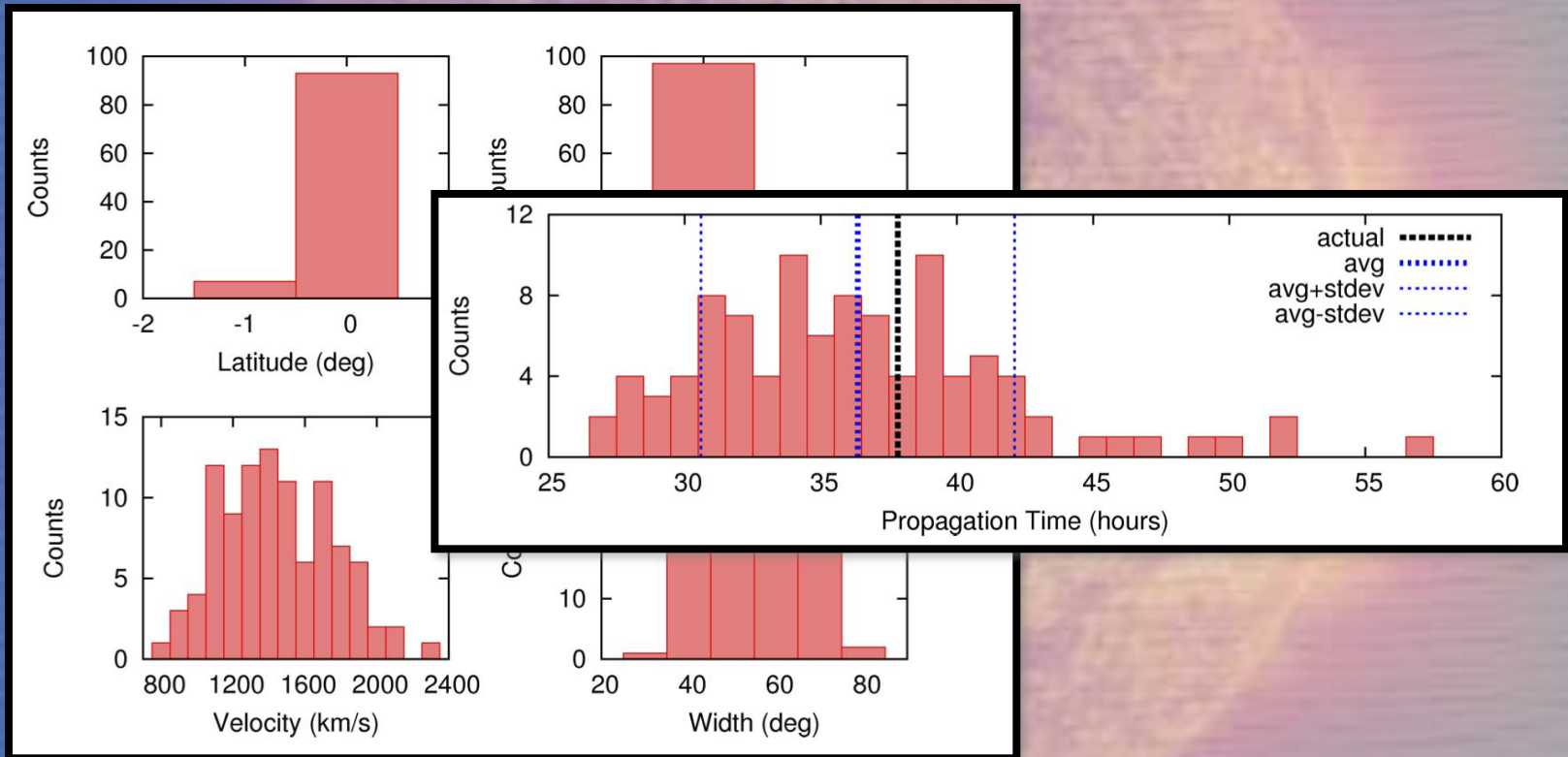


Earlier low-level activity captured well

ACE plasma data out

Ensemble CME forecasts

March 29, 2001 event



D. Emmons and A. Acebal, Air
Force Institute of Technology



Summary

- Solar Shield system has been up and running since February 2008.
- With the approaching solar maximum we can now start to test the true capabilities of the system.
- Extension of the system underway.
- Utilization of the system in extreme event studies underway.