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Agenda Item: B.4
Discussed in Plenary

ANOMALIES FROM SOLAR EVENTS

In response to CGMS Permanent Action 02

NOAA-WP-04 provides an example of a new space weather product under development, the progression and prediction of the solar cycle, and a summary of significant space weather events. The new product is one that will serve customers, such as power utilities and those who depend on conditions in the ionosphere that affect communications and navigation. Predictions are given for the year and magnitude of Solar Cycle 24 maximum. The revised consensus prediction is that the new cycle will be smaller than recent cycles and reach maximum in May 2013. This prediction, of great importance for planning activities affected by solar activity, will be updated as needed. Information is provided that shows the lack of major space weather activity from August 2008 through July 2009. It is typical for energetic electron fluxes to increase during the declining phase of the solar cycle as recurrent coronal holes produce regular intervals of high-speed solar wind that interacts with the geomagnetic field. Electron fluxes reached high levels on 34% of days during the first half of the period, but only 8% of days during the second half of the period.

ANOMALIES FROM SOLAR EVENTS

1 INTRODUCTION

This paper documents significant space weather for the summary period AUG 2008 – JUL 2009. Previous CGMS papers have addressed in more detail the status of Cycle 23, and what follows is an update of CGMS XXXVI NOAA-WP-04.

2 SERVING CUSTOMERS WITH NEW PRODUCTS

The broad economic and societal impacts of solar disturbances have recently been reported in a US National Research Council report titled “Severe Space Weather Events—Understanding Societal and Economic Impacts: A Workshop Report.” The electric power industry as well as communication and navigation system users are among those affected by solar disturbances and the subsequent geomagnetic storms. These users will benefit from improved forecasts of solar disturbances that will impact their systems. With these customers in mind, NOAA’s Space Weather Prediction Center (SWPC), along with its partners, is embarking on the transition to operations of a solar wind disturbance prediction model to forecast (1-5 day predictions) the arrival time and intensity of solar disturbances that cause geomagnetic storms. This will be the first, large scale numerical model used in space weather operations.

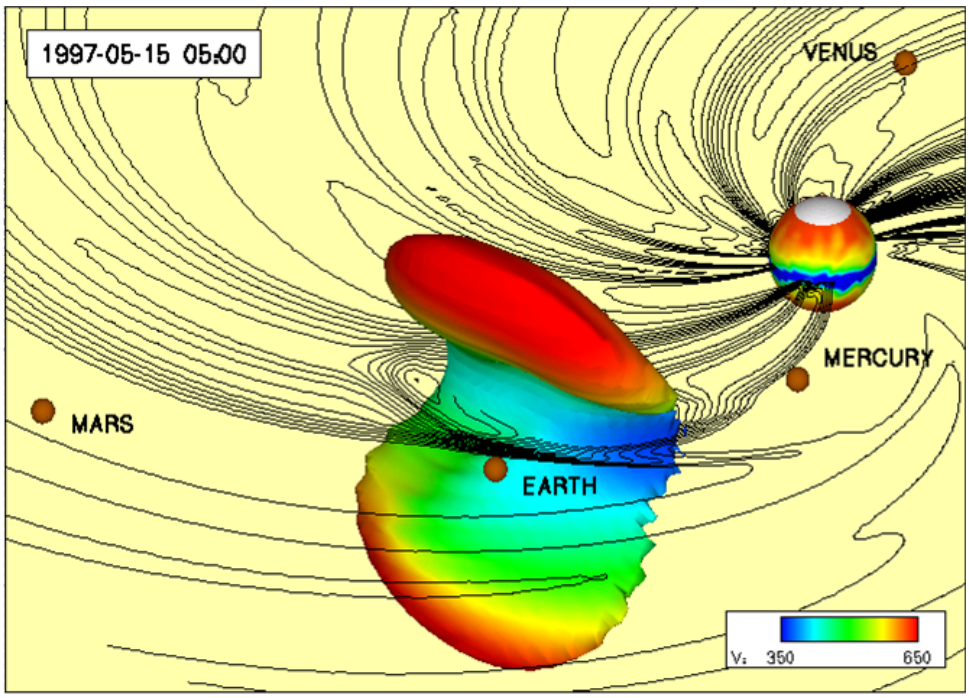

Figure 1: Output from the Wang-Sheeley-Arge Enlil model illustrating an interplanetary coronal mass ejection propagating from the Sun toward Earth. (Courtesy Dusan Odstrcil)

Figure 1 shows a model view of a solar disturbance that originates on the Sun and propagates through the interplanetary medium before reaching Earth. In this figure, a spherical surface, with colored velocity contours, surrounds the Sun at 0.1 AU (21.5 Rs). This is the Wang-Sheeley-Arge model output that couples into the Enlil (Sumerian god of the wind) model that transports the solar wind to Earth and beyond. The colored iso-surface near Earth illustrates the velocity of a density structure called an Interplanetary Coronal Mass Ejection (ICME) that was ejected by the Sun. Black contour lines are in the ecliptic and show the background solar wind density. You can also see an interplanetary shock, generated by the ICME, as an arc-like structure of the compressed density in the ecliptic.

ICME's can contain a billion tons of matter and embedded magnetic fields that are the source of the largest geomagnetic storms at Earth. Depending on their speed, they can take as little as 18 hours or as much as five days to reach Earth. Satellite observations of the initiation of CMEs at the Sun are used as initial conditions for model runs that forecast the arrival time and intensity of these disturbances at Earth, and the subsequent geomagnetic storms that cause problems for space weather customers. Transition of this model into operations to support our customers is a high-priority for SWPC.

3 SOLAR CYCLE PROGRESSION

Monthly, the Space Weather Prediction Center updates the Solar Cycle Sunspot Number progression using the latest predictions from the International Space Environment Services (ISES). The official NOAA, NASA, and ISES Solar Cycle 24

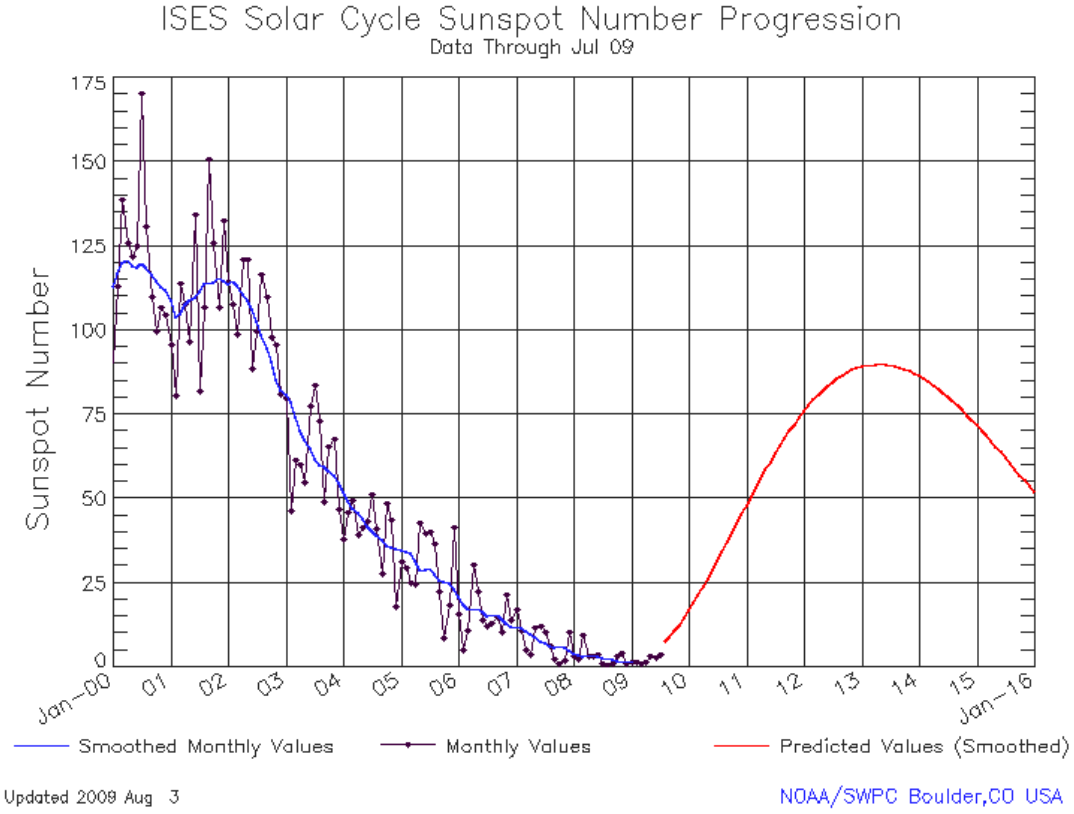

Figure 2: Solar Cycle Sunspot Number Progression and Prediction

prediction was released by the Solar Cycle 24 Prediction Panel on April 25, 2007 and most recently updated on May 8, 2009. The Prediction Panel included members from NOAA, NASA, ISES and other US and international representatives. As shown in Figure 2, the most recent panel consensus predicts solar cycle minimum in December 2008 and solar cycle maximum in May 2013. The predicted maximum sunspot number of 90 is below average. The Panel issues this prediction as needed to serve our many customers who make economic decisions based on the level of solar activity and its affect on human and technological systems.

4 SIGNIFICANT LATE-CYCLE EVENTS

There were no significant space weather events as we approached solar minimum.

Table 1: Summary of Space Weather Events

	X-ray Events		>2 MeV Events		Proton Events		Geomagnetic Storms		
	M-class	X-class	Days > 1.0E+03	F10.7	>10 SPE	>100 SPE	Ap	Major	Severe
AUG 2008	0	0	14	66.3	0	0	4.9	0	0
SEP	0	0	13	67.1	0	0	5.6	0	0
OCT	0	0	17	68.3	0	0	6.5	0	0
NOV	0	0	13	68.6	0	0	4.1	0	0
DEC	0	0	5	69.2	0	0	4.5	0	0
JAN 2009	0	0	0	69.8	0	0	4.2	0	0
FEB	0	0	4	70.0	0	0	4.5	0	0
MAR	0	0	5	69.2	0	0	5.2	0	0
APR	0	0	4	69.7	0	0	4.4	0	0
MAY	0	0	0	70.5	0	0	3.8	0	0
JUN	0	0	0	68.6	0	0	4.1	0	0
JUL	0	0	2	68.2	0	0	4.4	0	0

5 ENERGETIC ELECTRON ACTIVITY

It is typical for energetic electron fluxes to increase during the declining phase of the solar cycle as recurrent coronal holes produce regular intervals of high-speed solar wind that interacts with the geomagnetic field. Electron fluxes reached high levels (1.0E+3 pfu, where pfu means particles per square centimeter second steradian) at geosynchronous orbit on about 21% of the days during the period. This is a 66% decrease in high flux level days relative to last year's summary period. More specifically, electron fluxes reached high levels on 34% of days during the first half of the period, but only 8% of days during the second half of the period. Very high flux levels (5.0E+04 pfu) did not occur during the summary period.

6 REFERENCES

NOAA/NCEP/SWPC Preliminary Report and Forecast of Solar Geophysical Data (PRF):PRF 1718, 05 AUG 2008 – PRF 1770, 04 AUG 2009.

Severe Space Weather Events—Understanding Societal and Economic Impacts: A Workshop Report, Committee on the Societal and Economic Impacts of Severe Space Weather Events: A Workshop, Space Studies Board Division on Engineering and Physical Sciences, NATIONAL RESEARCH COUNCIL OF THE NATIONAL ACADEMIES, THE NATIONAL ACADEMIES PRESS, Washington, D.C. www.nap.edu, 2008.