Using Flow Charts to Visualize the Decision Process in Space Weather Forecasting

Myo Thu Ya Aung,1 Tun Myat1, Yihua Zheng2,3, Chigomezyo Ngwira2, M. Chantale Damas1

1Queensborough Community College (City University of New York)
2Community Coordinated Modeling Center, NASA Goddard Space Flight Center
3Department of Physics, Colorado State University of America

Abstract

Our society today relies heavily on technological systems such as satellites, navigation systems, power grids, and aviation. These systems are very sensitive to space weather disturbances. When Earth-directed space weather driven by the Sun arrives at the Earth, it causes changes in the Earth's radiation environment and the magnetosphere. Solar Energetic Particles from the Sun can endanger life in outer space, and geomagnetic storms can severely impact critical infrastructure near and on Earth, such as the power grid and satellites. These adverse effects can be lessened through the early warnings sent by space weather forecasters. A space weather forecaster's duty is to send advanced warnings to technicians in industries and NASA missions so that they can take extra measures for protection. Decisions are made by following certain steps and processes to the time an event occurs at the Sun, all the way to the impacts on the locations. These decision making processes are complex, thus a flow chart is created to help forecasters visualize the decision making processes. This flowchart provides basic knowledge of space weather and can be used to train future space weather forecasters. There is also a great reference for people who are already familiar with space weather.

Forecasting Methodology

Space weather forecasters use various space weather event models developed at the Community Coordinated Modeling Center (CCMC, http://ccmc.gsfc.nasa.gov/) such as:

- iSWA (Intelligent Solar Weather Analysis) - allows forecasters to observe various graphs and models called ‘cygnets’. (http://iswa.gsfc.nasa.gov/)
- SWRC (SWP/ENLIL+Cone Analysis Tools) - measures parameters of Coronal Mass Ejections (CMEs) to be entered into simulations.
- SWRC-ENLIL+Cone - Models CMEs and predicts impacts at various locations.

SWRC Space Weather Forecasting Process Flow Chart

Space Weather Impacts

- Solar Flares can produce intense brightening events on the surface of the Sun with different X-ray fluxes.
- CMEs can produce Solar Energetic Particle (SEP) events that can endanger life in outer space.
- Geomagnetic Storms cause changes in the Earth's radiation environment and the magnetosphere.
- Geomagnetic Storms cause Satellite Drag that can affect spacecrafts at low Earth Orbit.
- Solar flares are classified by X-ray flux and detected using the GOES Primary X-ray Flux Monitor.

Conclusion

Space Weather is increasingly important for today's society. We rely heavily on high-tech systems that are easily disturbed and damaged by space weather. It is important to predict the next generation of space weather forecasters, who will develop forecasting procedures and sophisticated models that will ultimately enable them to predict solar storms accurately. This flowchart can help forecasters visualize the decision making processes from the time an event occurs at the Sun, all the way to the impact locations.

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References

- Adding event into Space Weather Database of Notification, Knowledge, Information (DONKI)
- DONKI is used to send space weather notifications.

Contact Info & Download Link

Myo Thu Ya Aung, aungmtn@gmail.com
Tun Myat, TunMyat423@gmail.com

Flowchart download link: (http://iswa.gsfc.nasa.gov/iswa/iSWA.html)