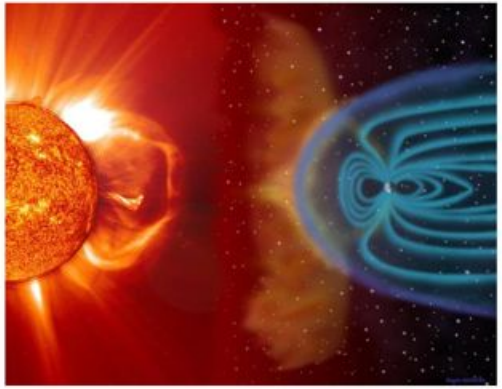
National Aeronautics and Space Administration



Air Force Space Weather Models

Heliophysics Investigations by Dr. Hilarie Davis

9/2/25 Heliophysics Education Community Meeting

NASA Heliophysics Education Activation Team

Air Force Research Laboratory ADAPT, SIFT & WSA Models

Dr. Schonfeld works at the Air Force Research Laboratory with the ADAPT (Air Force Data Assimilative Photospheric flux Transport) model of the Sun's magnetic field and uses it to drive SIFT (Solar Indices Forecasting Tool) solar activity and WSA (Wang-Sheeley-Arge) solar wind modeling. The SIFT forecasts are critical for other space weather models that predict the conditions of the ionosphere and thermosphere, which in turn impact modern technology.

- **Satellite operations**: The forecasts help predict atmospheric drag on satellites, which is crucial for orbit planning and lifetime analysis.
- **Radio communication**: Forecasted solar activity helps predict disruptions to radio transmissions, including those used by GPS.
- **Power grids**: Intense solar storms can induce currents that damage power grids, and accurate forecasts are needed for mitigation.

Framework for Heliophysics Education (FHE)

Developed by NASA HEAT in 2022

https://science.nasa.gov/learn/heat/big-ideas/

Structured around NASA's Big Heliophysics Questions

1. What are the impacts of the Sun on humanity?
2. How do the Earth, the solar system, and heliosphere respond to changes on the Sun?
3. What causes the Sun to vary?

FHE has Developed Big Ideas for the NASA Questions

1. What are the impacts of the Sun on humanity?

1.1 The Sun is really big and its gravity influences all objects in the solar system. (PS2, ESS1)

1.2 The Sun is active and can impact technology on Earth via space weather. (PS1, PS2, PS4, ESS2, ESS3)

1.3 The Sun's energy drives Earth's climate, but the climate is in a delicate balance and is changing due to human activity. (PS1, PS2, PS3, LS4, ESS2, ESS3)

2. How do the Earth, the solar system, and heliosphere respond to changes on the Sun?

2.1 Life on Earth has evolved with complex diversity because of our location near the Sun. It is just right! (PS3, PS4, LS1, LS2, ESS2)

2.2 The Sun defines the space around it, which is different from interstellar space. (PS2, ESS1, ESS2)

2.3 The Sun is the primary source of light in our solar system. (PS1, PS2, PS3,PS4, ESS1)

3. What causes the Sun to vary?

3.1 The Sun is made of churning plasma, causing the surface to be made of complex, tangled magnetic fields. (PS1, PS2, ESS1, ESS2)

3.2 Energy from the Sun is created in the core and travels outward through the Sun and into the heliosphere. (PS1, PS3, PS4, ESS1, ESS2, ESS3)

Space Weather in the FHE with NGSS

Question 1: What are the impacts of the Sun on humanity?

1.2 The Sun is active and can impact technology on Earth via space weather. (PS1, PS2, PS4, ESS2, ESS3)

Question 2: How do the Earth, the solar system, and heliosphere respond to changes on the Sun?

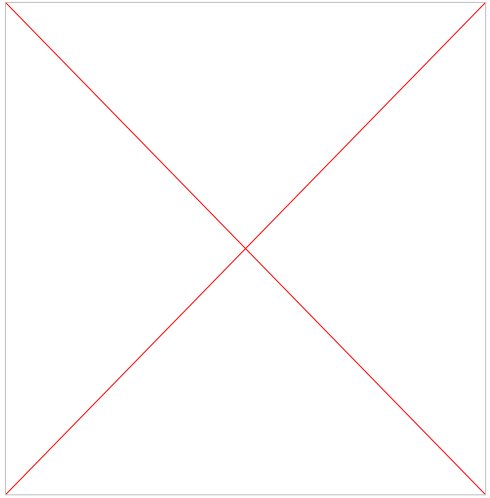
2.1 Life on Earth has evolved with complex diversity because of our location near the Sun. It is just right! (PS3, PS4, LS1, LS2, ESS2)

Question 3: What causes the Sun to vary?

3.1 The Sun is made of churning plasma, causing the surface to be made of complex, tangled magnetic fields. (PS1, PS2, ESS1, ESS2)

Intermediate Level Investigation (no introductory)

How do solar storms affect power grids? Can we predict them and protect our grids?

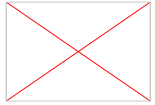


Resources

Space Weather Forecasting Presentation How solar activity affects Earth technologies and how scientists use math and physics principles to make predictive models.

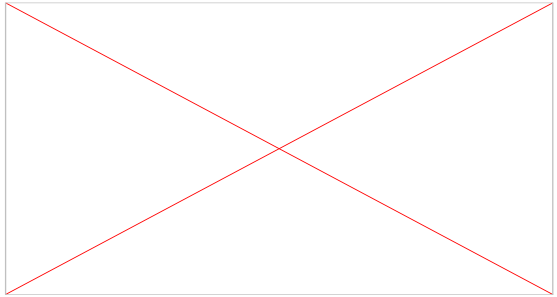
Solar Storms How solar storms cause geomagnetic storms on Earth that affect technology

Effects of Space Weather on the US Power Grid How Geomagnetically Induced Currents (GIC) are introduced into the grid.



Intermediate Level Investigation

How are satellite operations affected by solar storms?

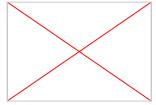


Resources

Satellite Drag Why the drag force on satellites increases during times when the Sun is active.

UND Satellite Tracking System The system is designed to predict the satellites' location at any given time

Hazards of Geomagnetic Storms Our technology-based infrastructure can be adversely affected by rapid magnetic field variations



Advanced Level Investigation

Solar storms disrupt radio communication. Is forecasting possible?

What can be done when a storm is predicted?

Resources

Solar Flares (Radio Blackouts) The sudden outburst of electromagnetic energy travels at the speed of light, therefore any effect upon the sunlit side of Earth's exposed outer atmosphere occurs at the same time the event is observed.

Health, Safety, and Commercial Needs Many communication systems use the ionosphere, an outer layer of our atmosphere, to reflect radio signals over long distances.

Space Weather Conditions 24 hour observed maximums, latest observed, and predicted.

NASA HEAT

For more information

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Framework for Heliophysics Education

https://science.nasa.gov/learn/heat/big-ideas/