National Aeronautics and Space Administration

The Heliophysics Big Year

Solar Cycle/Max Investigations by Dr. Hilarie Davis 10/15/24

NASA Heliophysics Education Activation Team

Framework for Heliophysics Education (FHE)

Developed by NASA HEAT in 2022

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

Based on 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 NASA Questions and Big Ideas for Education

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)

Solar Cycle/Max Connections to FHE

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

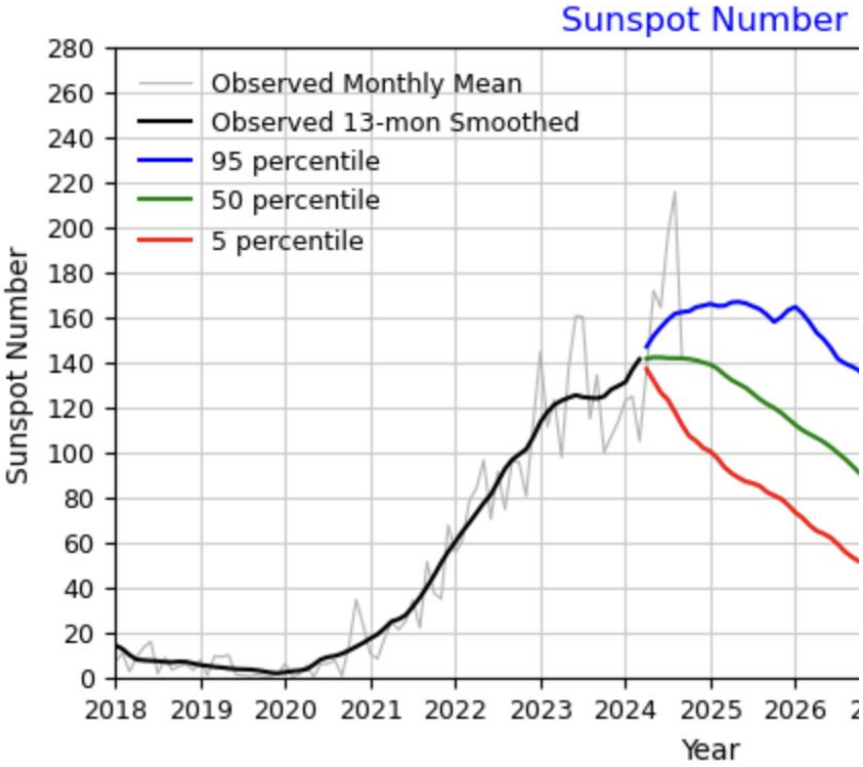
- Big idea 1.2 The Sun is active and can impact technology on Earth via Space Weather (PS1, PS2, PS4, ESS2, ESS3)

NASA Heliophysics Question **3: What causes the Sun to vary?**

- Big Idea 3.3 Our Sun, like all stars, has a life cycle. (PS1, LS1, ESS1)

Solar Cycle

For the past eight months, activity on the sun has steadily increased, indicating we transitioned to Solar Cycle 25. Solar Cycle 25 is forecast to be a fairly weak cycle, the same strength as cycle 24. Solar maximum is expected in July 2025, with a peak of 115 sunspots. Solar cycle prediction gives a rough idea of the frequency of space weather storms of all types, from radio blackouts to geomagnetic storms and solar radiation storms. See graph from 10/7/24 https://www.nasa.gov/solar-cycle-progression-and-forecast/

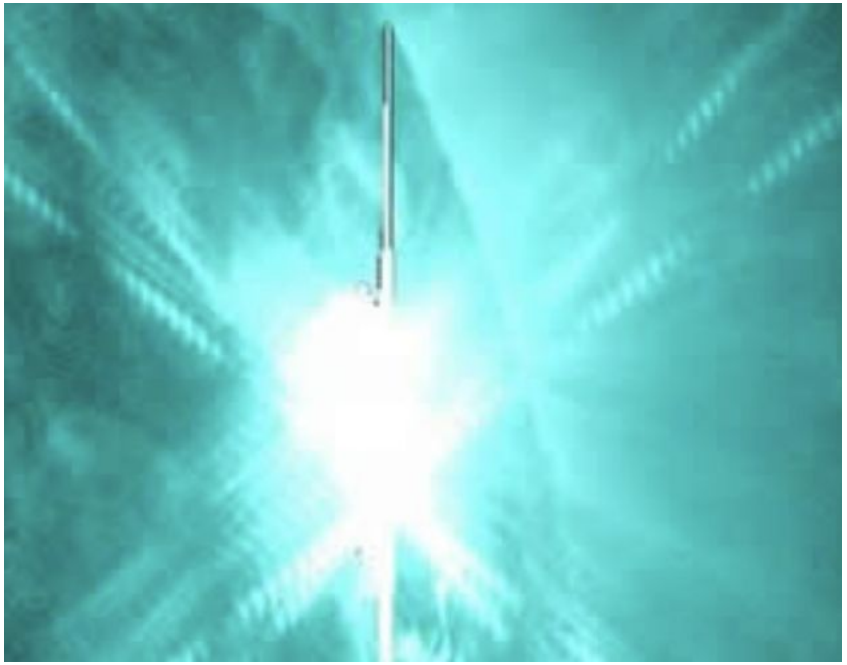


NASA HEAT

Solar Flares

"As the Sun rotates, magnetic fields loop back on themselves creating tangles. When the fields are twisted too far they snap like rubber bands in a spectacular explosion that releases a huge amounts of energy, light, heat, and material. The burst of light and energy is what we call a solar flare. The "stuff" (solar material and magnetic field) is called a coronal mass ejection. Solar flares happen multiple times a day during solar maximum and very infrequently during solar minimum."

https://nso.edu/for-public/sun-science/flares/



Introductory Level

How does the Earth keep us safe from the harmful effects of the Sun (including radiation and space weather)?

- What is space weather? https://www.youtube.com/watch?v=JNXzp3DxSLc
- Magnetic Earth https://culturalconnections.gi.alaska.edu/multimedia/magnet.html
- Earth's Magnetosphere: Protecting Our Planet from Harmful Space Energy https://science.nasa.gov/science-research/earth-science/earths-magnetosphere-protecting-our-planet-from-harmful-space-energy/

Intermediate Level

What is plasma? How does it contribute to sunspots, solar flares, and coronal mass ejections?

- Tales from Stanford SOLAR https://science.nasa.gov/learn/heat/resource/tales-from-stanford-solar/
- Space Weather Living History Podcast Featuring Plasma Physicist Dr. Robert Benson https://science.nasa.gov/learn/heat/resource/space-weather-living-history-podcast-featuring-plasma-physicist-dr-robert-benson/
- Solar Plasma Collage https://science.nasa.gov/learn/heat/resource/solar-plasma-collage/
- Plasma is … https://scied.ucar.edu/learning-zone/sun-space-weather/plasma
- Solar storms, the Hinode satellite video by Dr. Sten Odenwald, guest George Doschek https://www.youtube.com/watch?v=06jygaYE5eY

Advanced Level

What causes solar weather? How do we know?

- Tracking High-Energy Protons from Coronal Mass Ejections https://science.nasa.gov/learn/heat/resource/tracking-high-energy-protons-from-coronal-mass-ejections/
- Space Weather Math https://www.nasa.gov/wp-content/uploads/2013/05/574865main_SpaceWeather_Math.pdf
- Solar Wind: Mad Science at the Lunar Surface https://science.nasa.gov/learn/heat/resource/solar-wind-mad-science-at-the-lunar-surface/

For more information on the **Framework for Heliophysics Education**

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