

Space Weather: Solar Storms and Their Effects on the Earth

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Since we are living in a high-tech environment, the facilities we all use depend on Earth's atmosphere to transfer the signals which is vulnerable by solar storms. These facilities include power lines that supply electricity to our homes, mobile phones, televisions, I-Pads, etc. that all need atmosphere to transport the signals from the source to the end use. Because these facilities have great importance to national security, a research program entitled "Space Weather" was created by the US National Science Foundation (NSF) in the 1990's. The European Union (EU), China, Taiwan, Japan quickly followed so that now it has become a world-wide program. Many countries around the world have satellites to observe the activity of the Sun and the responses of the Earth's environment.

In this presentation, we will describe these satellite missions to illustrate solar storm effect on our daily life. Firstly, the observations from the Solar Dynamics Observatory will show the Sun's activity. The STEREO satellites will show how these Sun's disturbances propagate to our Earth. A short video will illustrate the effects on our daily life.

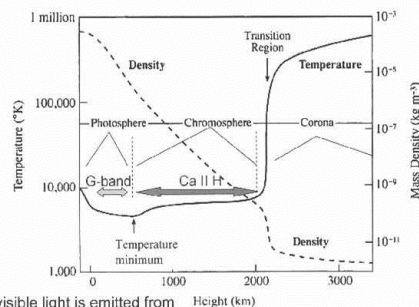
The birth of Space Weather can be counted back about two centuries ago. In 1859, there was a solar storm that hit Earth that set telegraph offices on fire and the Northern Lights were seen in the South Pacific. This event was named "Carrington Event" after the British astronomer Richard Carrington, who witnessed the instigating solar flare.

"Space Weather" is the magnetic disturbances and high radiation levels that result from solar storms.

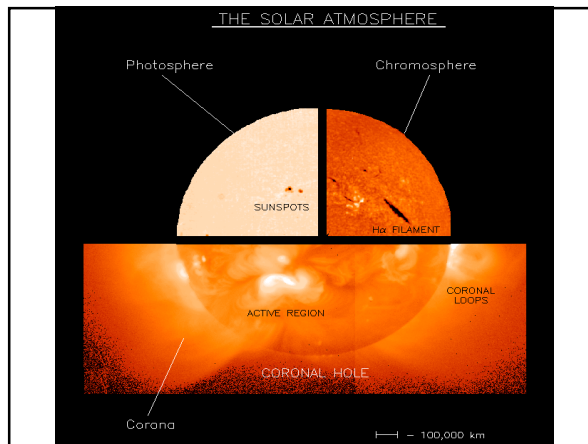
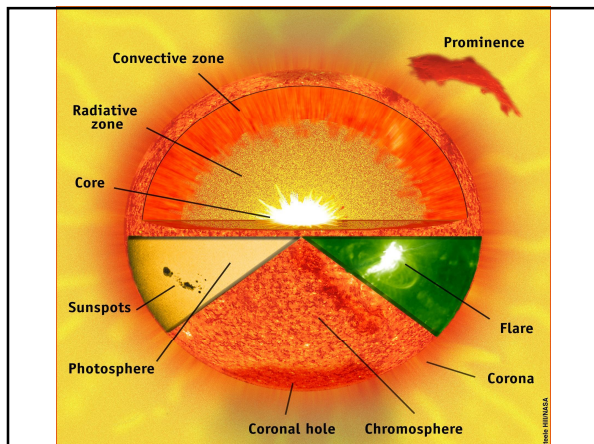
On Earth, we experience the auroras, power outages and communication blackouts which are all manifestation of space weather.

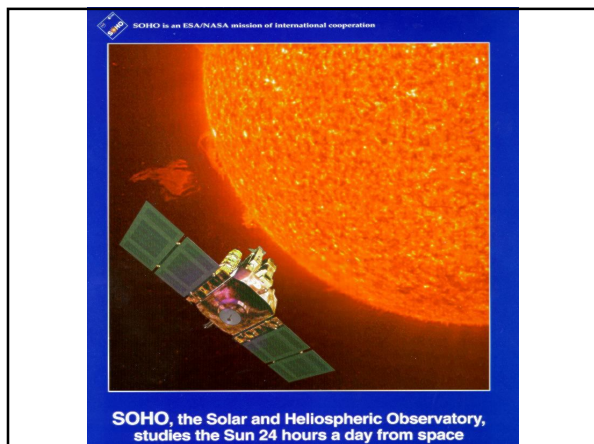
In space, high speed solar energetic particles strewn from the Sun can cause satellite damage and space radiation hazards not only to astronauts flying in space but also flying airline passengers health.

Temperature stratification of solar atmosphere



Most of visible light is emitted from the photosphere, 500-km thin layer around the surface of the Sun.





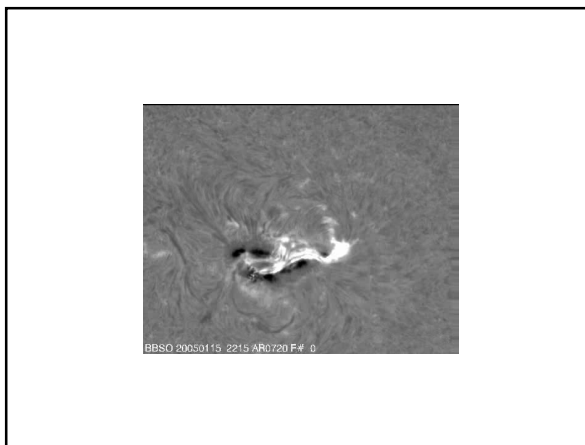
How do we view our Sun?

Spectrographic Imagery

- H α
- UV
- EUV
- X-Ray
- Coronagraph: Scattering Light

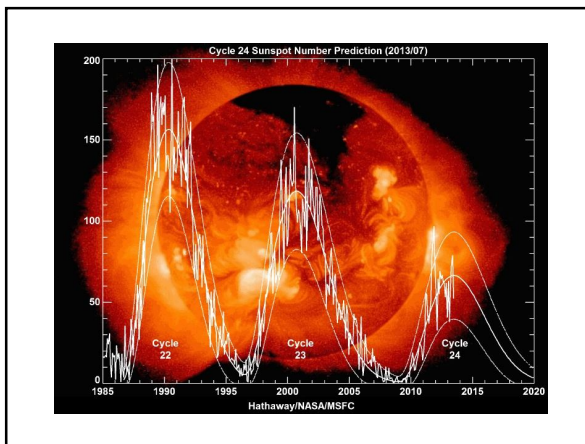
H α Images

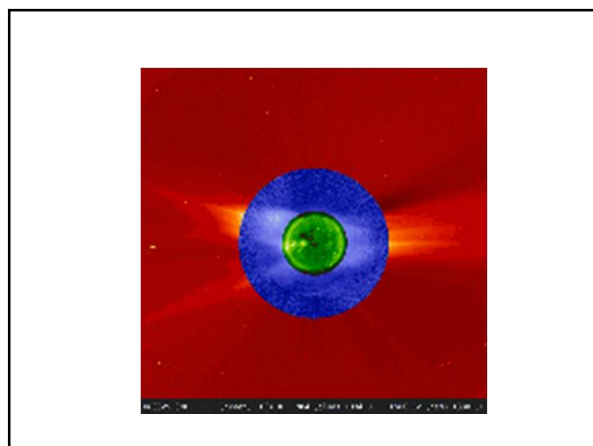
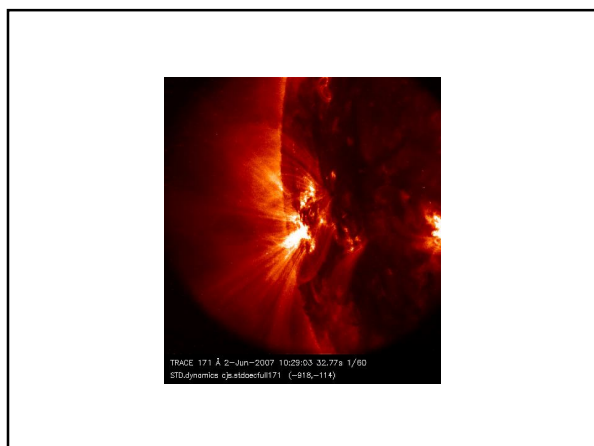
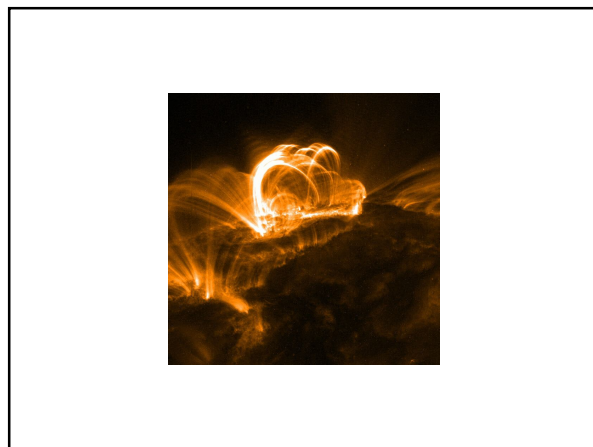
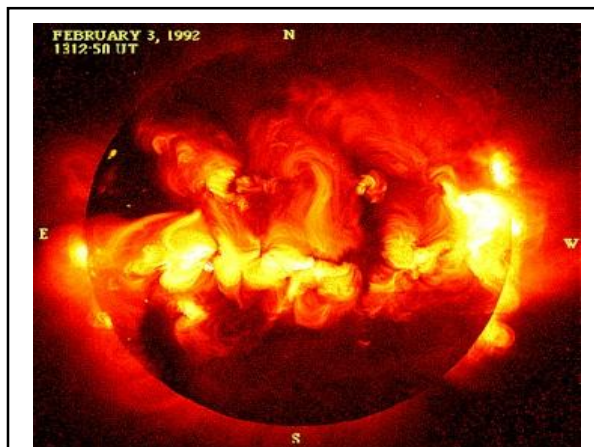
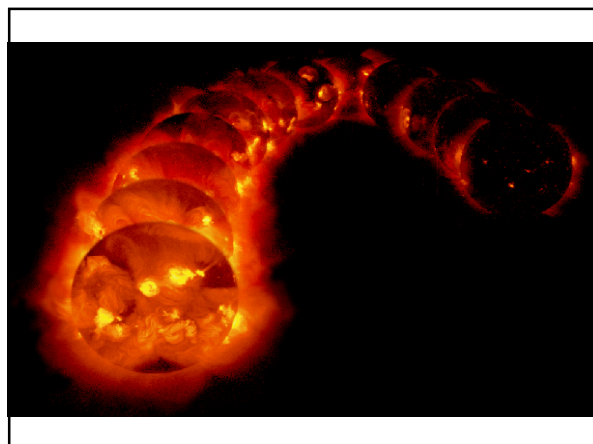
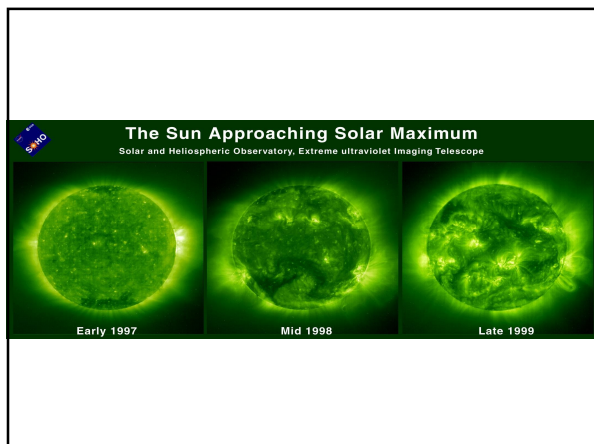
- Flares and Others
- Sunspots

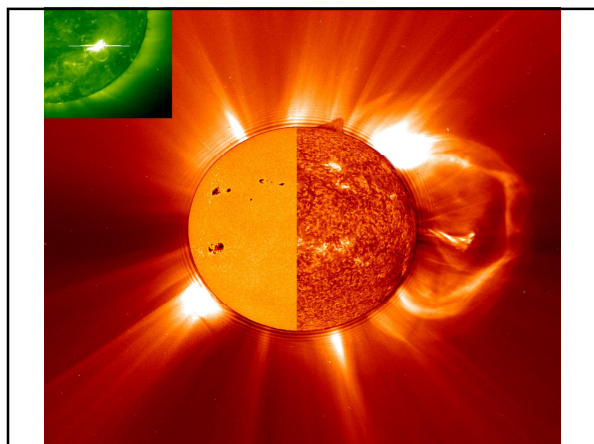


EUV/UV Images

- X-Ray – Hinoda
- TRACE
- Chromosphere







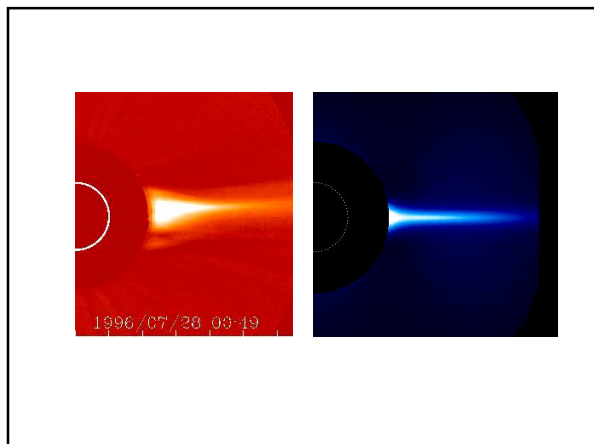
Properties of CMEs

- Velocities 20-2500 kms
- Mass 10^{14-15} grams (i.e. $10^9 - 10^9$ metric tons)
- Energy 10^{31-32} ergs (i.e. $10^{24} - 10^{25}$ joules)
- Power $2 \times 10^{27-28}$ watts
- Frequency 1/3 day to 3/day
- Homologous one active region can produce 2 dozen CMEs
- Source regions range from a few $\times 10^4 - 10^6$ kms
- Originate from regions of high magnetic shear (electric current)

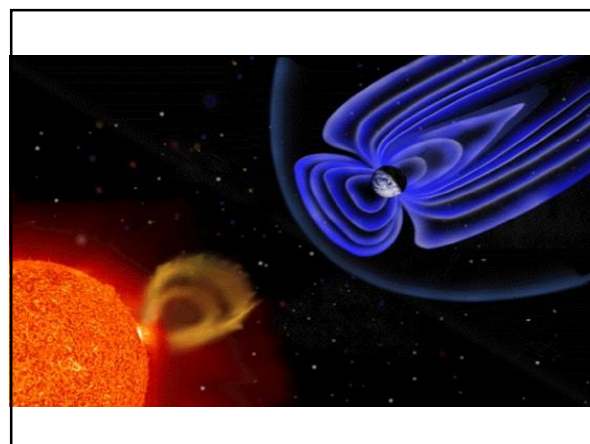
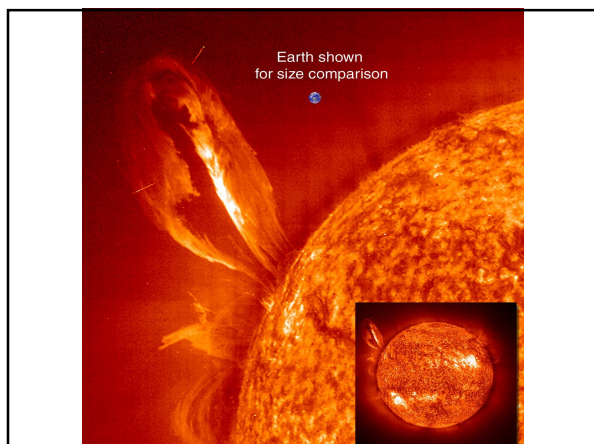
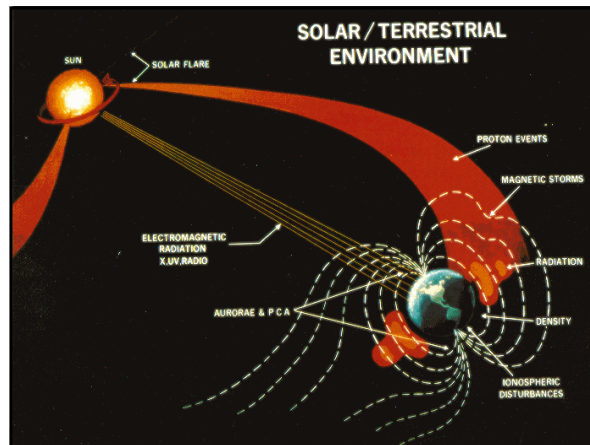
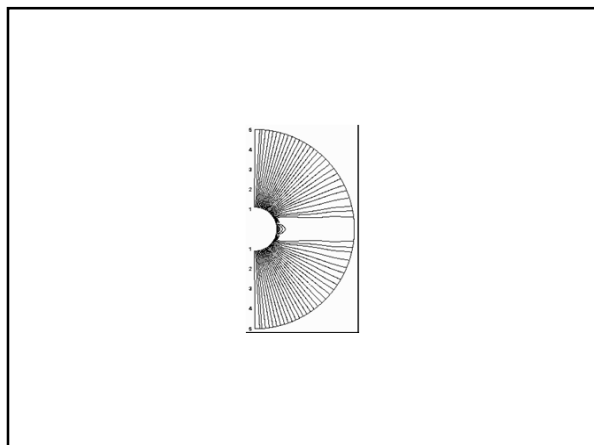
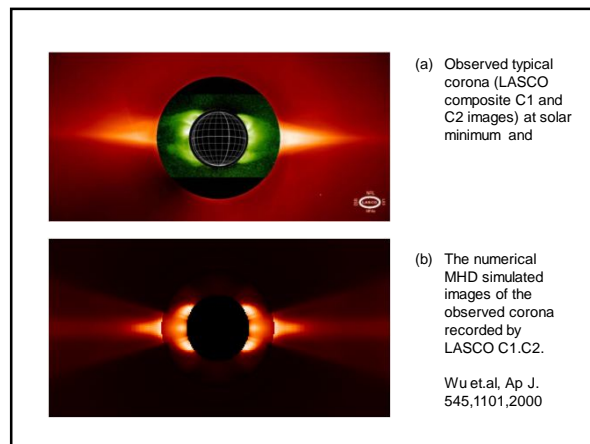
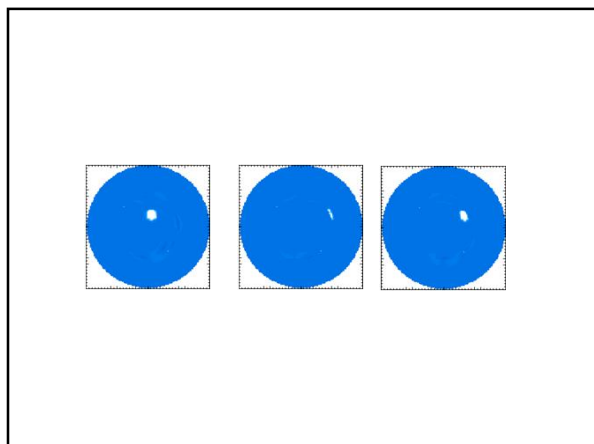
Coronagraph
Pictures & Movie

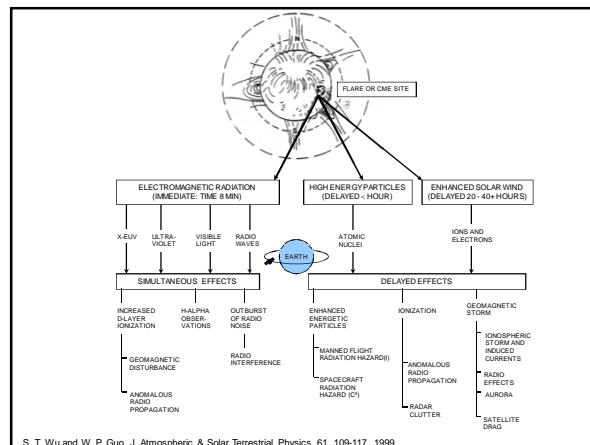
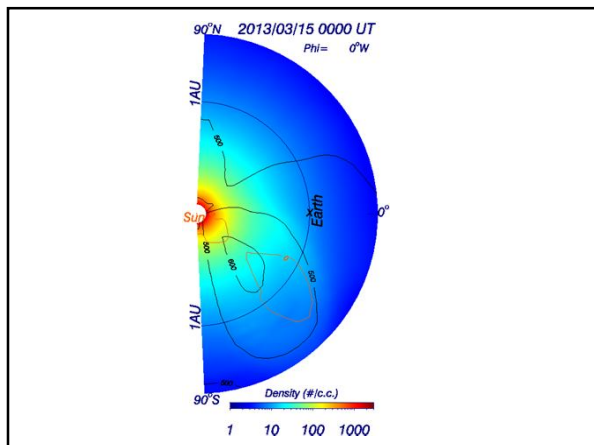
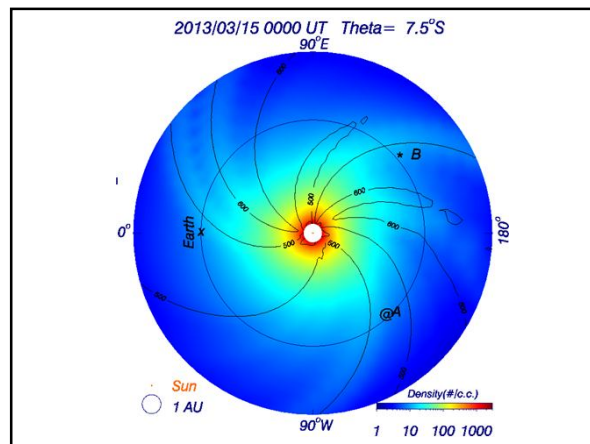
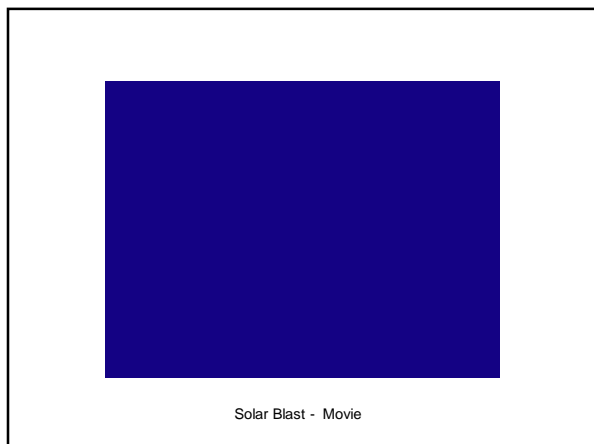
The sun and its extended corona
from February 09 to March 16, 2000

A time lapse movie using
EIT and LASCO data from the
Solar and Heliospheric Observatory (SOHO),
a bilateral space mission of ESA and NASA



Wu et al. JGR, 106 (A11), 25089, 2001





THANK YOU