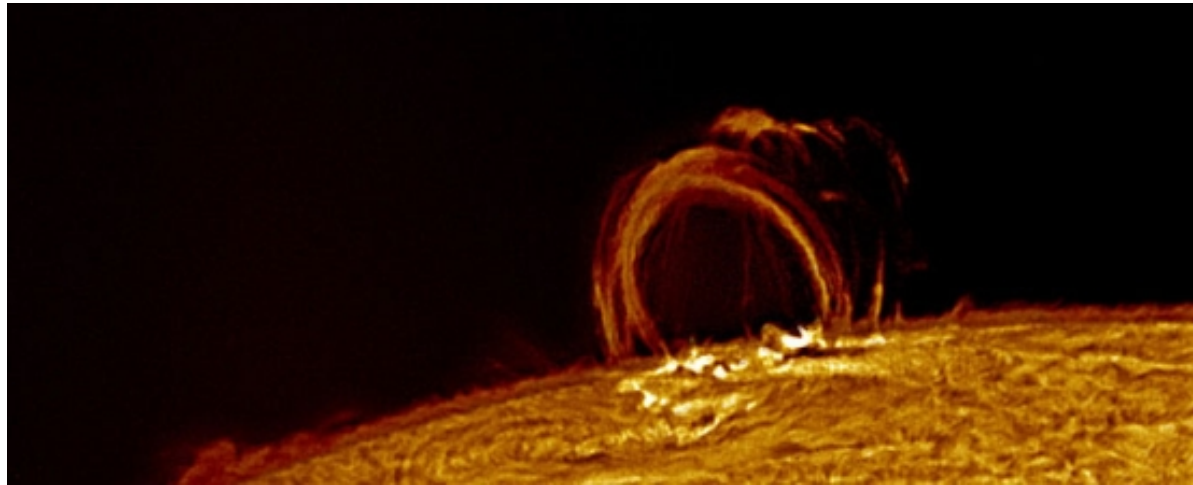


PROMETHEUS COUNCIL

Solar Flare Radiation



Solar flares are intense, temporary releases of energy from the sun. They can be the equivalent to approximately 40 billion Hiroshima-size atomic bombs. The primary energy source for flares is the tearing and reconnection of strong magnetic fields. They radiate throughout the electromagnetic spectrum, from gamma rays to x-rays, through visible light out to kilometer-long radio waves.

Energetic protons can reach Earth within 30 minutes of a major flare's peak. During this event, Earth is showered by the protons released from the flare site. Some of these particles spiral down Earth's magnetic field lines, penetrating the upper layers of the atmosphere where they produce additional ionization any can produce a significant increase in the radiation environment. If, these protons enter through ozone holes in the upper atmosphere, the effects are substantially increased.

Many communications systems utilize the ionosphere to reflect radio signals over long distances. Solar flares affect communications systems in all latitudes that utilize this part of the atmosphere for signal propagation. Some radio frequencies are absorbed and others are reflected, leading to rapidly fluctuating signals and unexpected broadcast paths. TV and commercial radio stations are little affected by this solar activity, but ground-to-air, ship-to-shore and amateur radios are frequently disrupted.

Some detection or early-warning systems are also affected by solar flares. Over-the-Horizon radar bounces signals off the ionosphere in order to monitor the launch of aircraft and missiles from long distances. These systems are severely hampered by radio clutter. Detection systems using magnetic signatures as the input to locating schemes will be masked and distorted.

When an aircraft and a ground station are aligned with the Sun, as well as an Earth based station, a satellite and the Sun is aligned, jamming of the radio frequencies can occur. Navigation systems such as GPS, LORAN and OMEGA are severely hampered by the solar flare and can give navigators information that

is inaccurate by as much as several miles.

The solar flare increases the amount of ultraviolet emission heat over the Earth's upper atmosphere, causing it to expand. The heated air rises, and the density at the orbit of satellites up to about 600 miles (1000km) increases significantly. This results in increased drag on satellites in space, causing them to slow and change orbit slightly. Unless low-Earth-orbit satellites are routinely boosted to higher orbits, they slowly fall, and eventually burn up in Earth's atmosphere.

During a solar flare, the number and energy of electrons and ions increase. When a satellite travels through this energized environment, the charges particles striking the spacecraft cause different portions of the spacecraft or satellite to be differentially charged. Eventually, electrical discharges will arc across satellite components, harming or destroying them. Bulk charging (also called deep charging) occurs when energetic particles, primarily electrons, penetrate the outer covering of a satellite and deposit their charge in its internal parts. As this charge builds, it will ultimately overload and attempt to discharge to other components.

This discharge is very hazardous to the satellite's electronic systems, as well as household computers, and is very similar to static electricity.

Technology has allowed components to become smaller; their miniaturized systems have become increasingly vulnerable to the more energetic solar particles.

These particles can cause physical damage to microchips and can change software command in satellite borne computers.

Intense solar flares release very-high-energy particles that can be as injurious to humans and other life forms as the low-energy radiation from nuclear blasts. Earth's atmosphere and magnetosphere often allow adequate protection for us on the ground at the lower latitudes. Individuals who are in spacecraft, commercial aircraft or even in the higher latitudes of the earth can be exposed to does up to 100 times that of an x-ray machine. The penetration of high-energy particles into living cells, measured as radiation dose, leads to chromosome damage and potentially, cancer. Large doses can be fatal immediately.

The solar cycle has been nearly regular during the last 300 years; there was a period of 70 years during the 1600 and 1700's when very few sunspots were seen. This drop in sunspot number coincided with the timing of the little ice age in Europe, when canal froze over, as they never had before. Stratospheric winds near the equator blow in opposite different directions, depending on the time in the solar cycle, and these may affect the global circulation patterns and weather.

During solar storms and high proton events, many more energetic particles reach Earth's middle atmosphere. There they cause molecular ionization, creating chemicals that destroy atmospheric ozone (fluorocarbons) and allow increased amounts of harmful solar ultraviolet radiation to reach Earth's surface. These have resulted in a temporary 70% decrease in ozone densities.

Geomagnetic fields affect biological systems of life forms, including humans and respond to fluctuations in the geomagnetic field. Migratory animals, such as dolphins, whales and pigeons have been severely affected and been unable to properly navigate. Chemical processes are ultimately controlled in biological life forms that directly affect the thought process of humans and their ability to reason. During intense solar flares, humans and other life forms can act in seemingly irrational ways that defy common sense and logic.

The National Oceanic and Atmospheric Administration (NOAA) have developed a five level classification system to standardize the possible events of solar flares.

Solar Radiation Storms

Scale Descriptor Events

Duration of event will influence severity of effects

Number of events per one 11-years solar cycle

S5 Extreme

Biological: Unavoidable high radiation to astronauts; high radiation exposure to passengers and crew in commercial jets and people in high latitudes (100 chest x-rays)

HF Radio: Complete HF radio blackout on entire sunlit side of Earth lasting a number of hours

Navigation: Low-frequency navigation signal used will experience outage on the sunlit side of the Earth for many hours, and may transition into the night
Satellite: May be rendered useless, memory impacts can cause loss of control, permanent damage to solar panels, serious noise in image data, star tracker unable to locate sources

Other: Complete blackout of HF communications, and position errors make navigation operations extremely difficult
Fewer than 1 per cycle

S4 Severe

Biological: Unavoidable high radiation to astronauts; elevated radiation exposure to passengers and crew in commercial jets and high latitudes (10 chest x-rays)

HF Radio: One to two hour HF communication blackout on sunlit side of Earth

Navigation: Increased error in positioning for one to two hours on sunlit side of Earth

Satellite: Experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency degraded.

Other: Blackout of HF radio in polar regions and increased navigation errors over several days likely
3 per 11-year cycle

S3 Strong

Biological: Radiation hazard avoidance recommended for astronauts; passengers and crew in commercial jets and high latitudes receive some exposure (1 chest x-ray)

HF Radio: Wide area blackout for one hour on sunlit side of Earth

Navigation: Signals degraded for about an hour

Satellite: Single event upsets, noise in imaging systems and slight reduction of efficiency in solar panels are likely

Other: Degraded HF radio propagation through the polar regions and navigation position errors likely
10 per 11-year cycle

S2 Moderate

Biological: None

HF Radio: Loss of radio contact for about 10 minutes on sunlit side of Earth

Navigation: Degradation of signals for tens of minutes

Satellite: Infrequent single-event upsets possible

Other: Small effects on HF propagation through the polar regions and navigation at polar cap locations possibly affected:
25 per 11-year cycle

S1 Minor

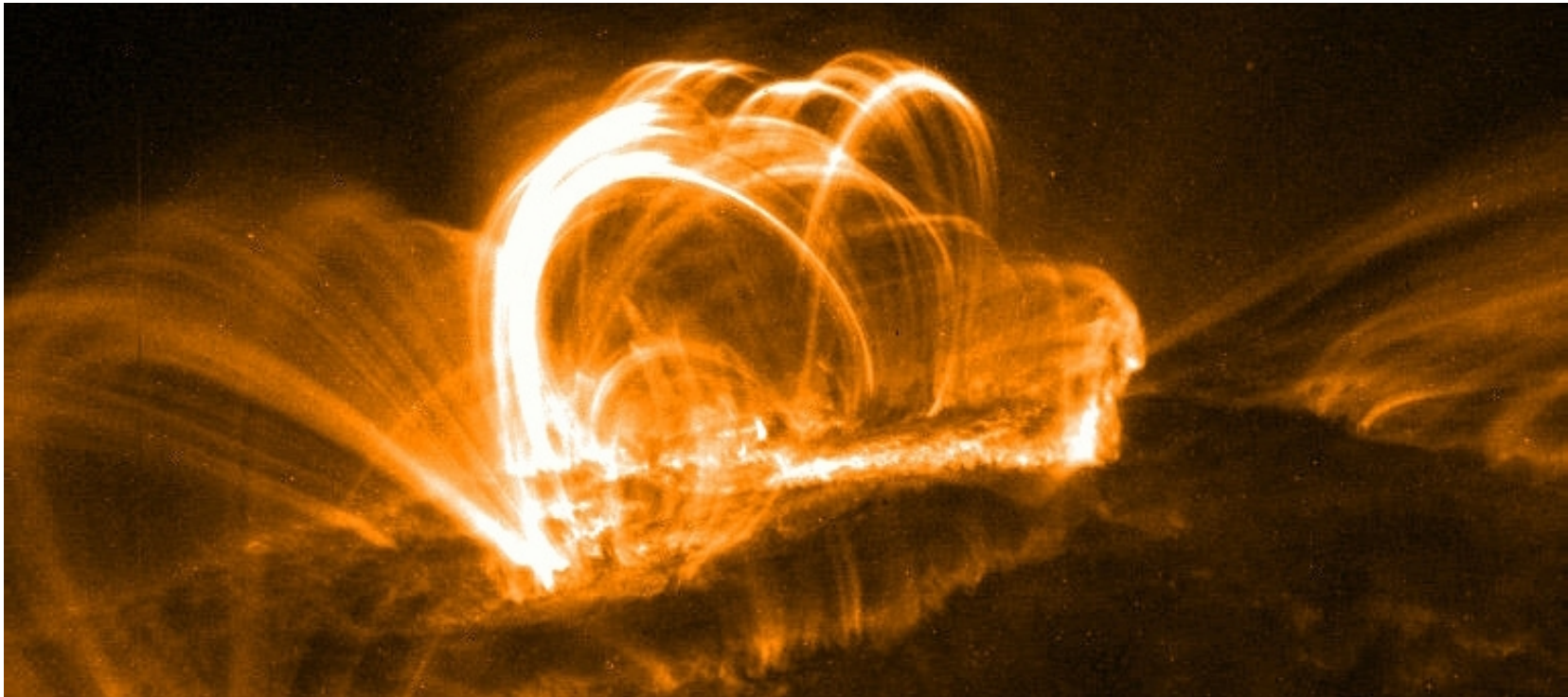
Biological: None

HF Radio: Weak or minor degradation of radio communication on sunlit side, occasional loss of radio contact

Navigation: Signals degraded for brief intervals

Satellite: None

Other: Minor impacts on HF radio in the polar regions
50 per 11-year cycle



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