

**Q-1-Evaluate, the effects of solar activity, including sunspots, solar flares and coronal mass ejections, on the earth's atmosphere and its implications for human civilization.**

**Approach -**

A simple straightforward question where candidates need to write about effects of solar activity, sunspots, solar flares and coronal mass ejection on earth atmosphere and its effect on human civilization.

**Introduction -**

A solar storm is used to refer to the atmospheric effects that are visible on earth through certain events that occur on the surface of the Sun. Solar Storms happen when a Sun emits large bursts of energy in the form of solar flares and coronal mass ejections. An adverse effect of solar storms is the disruption of satellites and other electronic means of communications.

**Body -**

What are the effects of Solar Activity on Earth-

- Auroras: When charged particles from a CME reach areas near Earth, they can trigger intense lights in the sky, called auroras.
- Affects Electronics and Satellites: The energy, radiation and high-energy particles emitted by the flares can affect Earth-bound objects and life on Earth – it can affect the electronics within satellites and affect astronauts.
- Failure of Power Grids: Very powerful Earth-directed coronal mass ejections can cause the failure of power grids and affect oil pipelines and deep-sea cables.
- Sunspots, Solar Flares, Coronal Mass Ejections and their influence on Earth: Coronal Mass Ejection Coronal Mass Ejections (shown left) and solar flares are extremely large explosions on the photo-sphere.
- In just a few minutes, the flares heat to several million degrees F. and release as much energy as a billion megatons of TNT.
- They occur near sunspots, usually at the dividing line between areas of oppositely directed magnetic fields. Hot matter called plasma interacts with the magnetic field sending a burst of plasma up and away from the Sun in the form of a flare.
- Solar flares emit x-rays and magnetic fields which bombard the Earth as geomagnetic storms. If sunspots are active, more solar flares will result creating an increase in geomagnetic storm activity for Earth.
- Therefore during sunspot maximums, the Earth will see an increase in the Northern and Southern Lights and a possible disruption in radio transmissions and power grids. The storms can even change polarity in satellites which can damage sophisticated electronics.
- Therefore scientists will often times reposition satellites to a different orientation to protect them from increased solar radiation when a strong solar flare or coronal mass ejection has occurred.

### Impact of Solar Flares and CMEs on Earth-

- Not all solar flares reach Earth, but solar flares/storms, solar energetic particles (SEPs), high-speed solar winds, and coronal mass ejections (CMEs) that come close can impact space weather in near-Earth space and the upper atmosphere.
- Space-dependent services: Solar storms can hit operations of space-dependent services like global positioning systems (GPS), radio, and satellite communications.
- Radio communication: Geomagnetic storms interfere with high-frequency radio communications and GPS navigation systems.
- Magnetosphere: CMEs, with ejectiles loaded with matter travelling at millions of miles an hour, can potentially create disturbances in the magnetosphere, the protective shield surrounding the Earth.
- Astronauts: Astronauts on spacewalks face health risks from possible exposure to solar radiation outside the Earth's protective atmosphere.
- Other: Aircraft flights, power grids, and space exploration programmes are vulnerable.

### Effects of Interplanetary Coronal Mass Ejections on Earth-

- Geomagnetic Storm: caused by the shock wave of moving mass, which may also disturb Earth's magnetosphere.
- Aurora: In vast areas surrounding Earth's magnetic poles, solar energetic particles can create extremely powerful auroras. In the northern hemisphere, these are known as the Northern Lights (aurora borealis), whereas in the southern hemisphere, they are known as the Southern Lights (aurora australis).
- disruption of Radio Transmissions.
- damage to Satellites.
- damage to Electrical Transmission Line Facilities.

### Implication on human civilization -

- Very high-energy particles, such as those carried by Coronal Mass Ejections, can cause radiation poisoning to humans and other mammals.
- When a coronal mass ejection strikes Earth's atmosphere, it causes a temporary disturbance of the Earth's magnetic field.
- It can throw satellites off course and cause them to fall to the surface of the earth, putting many urban centers at risk.
- Some scientists have speculated that migrating animals which use magneto reception to navigate, such as birds and honey bees, might also be affected.
- Rapidly fluctuating geomagnetic fields can produce geomagnetically induced currents in pipelines. This can cause multiple problems for pipeline engineers. Pipeline flow meters can transmit erroneous flow information and the corrosion rate of the pipeline can be dramatically increased.

### Conclusion -

Fortunately, no matter what, flares do not have a significant effect on Earth. The Earth's atmosphere more or less acts as a shield to prevent the cosmic radiation from reaching the surface. There can be measurable effects at ground level, but the amount of radiation is pretty insignificant.

## **2. Evaluate the effects of global warming and its impact on the Earth's geophysical phenomena such as sea level rise, melting of glaciers and permafrost, and changes in precipitation patterns.**

### **Approach**

Candidates can start the answer with giving basic idea about global warming and then highlight how its impacting globally on different geophysical phenomena what changes has occurred due to it.

### **Introduction**

Global warming, also known as climate change, is the gradual increase of the Earth's average surface temperature due to burning of fossil fuels and other human activities. The effects of global warming can have a significant impact on the Earth's geophysical phenomena.

### **Body**

Global warming can have a wide range of impacts on the Earth's geophysical phenomena, including:

- **Sea level rise:** As the Earth's temperature increases, ice and snow in the polar regions begin to melt, causing sea levels to rise. This can have a significant impact on coastal areas, as it can lead to flooding and erosion.
- **Extreme weather:** Global warming can lead to an increase in the frequency and severity of extreme weather events such as heat waves, droughts, and heavy precipitation. This can have a significant impact on agriculture and food production, as well as human health and well-being.
- **Ocean acidification:** As carbon dioxide (CO<sub>2</sub>) is absorbed by the ocean, it can lead to a decrease in the pH level of seawater, a process known as ocean acidification. This can have a significant impact on marine life, as it can make it more difficult for shellfish and other organisms to form and maintain their shells.
- **Wildfires:** Global warming can lead to an increase in the frequency and severity of wildfires. This can have a significant impact on human communities, as well as wildlife and their habitats.
- **Climate-induced migration:** Climate change can lead to the displacement of people due to extreme weather events, sea-level rise and other impacts. This can lead to increased pressure on infrastructure and resources in receiving areas and can lead to conflicts.
- **Glacier retreat:** As the Earth's temperature increases, glaciers and ice sheets begin to melt, causing them to retreat. This can have a significant impact on freshwater availability and flooding in downstream areas that rely on glacier meltwater.

- Changes in precipitation patterns: Global warming can lead to changes in precipitation patterns, such as increased droughts in some regions, also heavy cloud burst with flash floods.
- Climate variability: Global warming can cause changes in precipitation patterns, leading to more extreme weather events such as floods and droughts.
- Loss of biodiversity: Global warming can cause changes in temperature and precipitation patterns, which can lead to the loss of habitats for many plant and animal species.
- Natural disasters: Global warming can increase the frequency and severity of natural disasters such as wildfires, hurricanes and typhoons, which can cause significant damage to infrastructure and communities.

### Conclusion

Humankind has become dependent on the burning of fossil fuels to support our way of life, but it increases global warming at an unnatural rate that led to melting of glaciers. To restore the glaciers we need to utilize alternative energy sources, increase our energy efficiency and decrease our individual carbon footprints.

### 3. Discuss the causes and consequences of El Niño and La Niña, two of the most important geophysical phenomena that affect the global climate.

#### Approach

Candidates can start the answer with giving basic idea of El Nino and La Nina with its formation. And then simply explain what are its causes and different consequences

#### Introduction

El Niño and La Niña are two natural climate phenomena occurring across the tropical Pacific Ocean and influence the weather they are two opposing weather patterns that can have significant impacts on weather patterns around the world.

#### Body

- El Niño is caused by a warming of the surface waters in the eastern Pacific Ocean, which leads to a shift in the prevailing winds and a change in the location and strength of the jet stream.
- This can lead to increased rainfall in the western Pacific and drought in the eastern Pacific. El Niño can also result in increased storm activity in the eastern Pacific, and can have a range of impacts on weather patterns around the world, such as increased rainfall in some regions and drought in others.
- La Niña is the opposite of El Niño, and is caused by a cooling of the surface waters in the eastern Pacific Ocean. This leads to a shift in the prevailing

winds and a change in the location and strength of the jet stream, which can lead to drought in the western Pacific and increased rainfall in the eastern Pacific.

- La Niña can also result in decreased storm activity in the eastern Pacific, and can have a range of impacts on weather patterns around the world, such as increased drought in some regions and increased rainfall in others.

Impact on global climate:

- During an El Niño event, the trade winds that usually blow from east to west across the Pacific weaken or even reverse. This allows warm water from the western Pacific to move eastward towards the coast of South America, leading to an increase in temperature and a shift in weather patterns.
- El Niño can result in increased rainfall in some regions, such as the southern United States, and drought in others, such as Australia and Indonesia.
- It can also lead to increased storm activity in the eastern Pacific, and can have a range of impacts on weather patterns around the world, such as increased flooding in some regions and drought in others.
- La Niña, on the other hand, is characterized by a cooling of the surface waters in the eastern Pacific Ocean, which leads to a strengthening of the trade winds and a shift in weather patterns.
- La Niña can result in increased rainfall in some regions, such as the western Pacific, and drought in others, such as the southern United States.
- It can also lead to decreased storm activity in the eastern Pacific, and can have a range of impacts on weather patterns around the world, such as increased drought in some regions and increased flooding in others.

El Nino impacts India:

- El Nino and Indian monsoons are inversely related. The most prominent droughts in India – six of them – since 1871 have been El Nino droughts, including the recent ones in 2002 and 2009
- However, not all El Nino years led to a drought in India. For instance, 1997/98 was a strong El Nino year but there was no drought (Because of IOD).
- El Nino directly impacts India's agrarian economy as it tends to lower the production of summer crops such as rice, sugarcane, cotton, and oilseeds.

La Nina impacting India:

- Winter rainfall is less than normal in North India.
- Snowfall over Western Himalayas is less than normal.
- Winter temperatures in the plains are less than normal.

### Conclusion

Both El Niño and La Niña can have significant impacts on agriculture, freshwater resources, and human settlements, as well as on the timing and distribution of plant and animal species. They can also impact the fishing and tourism industries, as well as global economy and trade.