Just as weather affects air operations, atmospheric and space weather can directly impact space systems and the intelligence, surveillance, and reconnaissance (ISR); navigation; and communication services these space systems are expected to provide.

Weather Effects on Space Operations
Weather affects space support operations (launch, recovery, ground sites). For example, a hurricane approaching the Eastern Range launch sites at Cape Canaveral Air Force Station can delay a satellite’s launch or damage the rocket on the launch pad. Global space mission operations and space control can also be affected. For example, rain may cause signal attenuation (due to absorption of the radio signals by water vapor), hindering satellite communication (SATCOM) in the higher frequency ranges (C-band and above).¹

Space Weather
Space weather is defined as “the conditions and phenomena in space and specifically in the near-Earth environment that may affect space assets or space operations.”² The Air Force is responsible for conducting space environmental (space weather) operations in support of all elements of the Department of Defense.³

Specially trained Air Force weather personnel monitor the sun’s solar activity. They pay particular attention to sunspots, which are good indicators of periods of increased solar activity and help with solar forecasting. These space weather forecasts can be of critical importance during the planning and execution of military operations. Space-based satellites and ground-based systems that observe the sun and space environment assist forecasters in their characterization and exploitation of solar activity. When an event such as solar flare or coronal mass ejection (CME) occurs, weather personnel and systems provide notifications via alert messages to commanders.

Space Weather Effects on Air and Ground Operations
Having the proper understanding of space weather is critical when planning and conducting military operations. It also helps contribute to good space situational

¹ For more information, see Annex 3-14, Space Operations.
² JP 3-59.
³ Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3810.01D Meteorological and Oceanographic Operations.
awareness (SSA), which is crucial when air and ground operators experience interference and degradation to radio signals, SATCOM, Global Positioning System (GPS) signals, or radar operations. Knowledge of the space environment can help personnel mitigate the effects of space weather, and help differentiate between equipment malfunctions, natural interference, and man-made interference (purposeful and non-purposeful). Being able to distinguish between purposeful interference and natural sources of interference on space systems (whether on the ground or in space) enables the COMAFFOR or the functional air operations center (AOC) for space to identify threat trends to better protect the United States and its allies’ space center of gravity.

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**Space Weather Effects on Space and Cyberspace Operations**

Space weather has a direct impact on space operations. Space weather such as a proton event (high-energy charged particles released from the sun) can disable satellite subsystems or even an entire spacecraft (temporarily or permanently). By extension, space weather interference on space systems also affects operations in the cyberspace domain since a great deal of cyberspace mission data transits the space domain.

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4 For more detail on space weather effects see the space weather tutorials on the Air Force Weather Web Services site
https://weather.af.mil/confluence/display/AFWWEBSTBT/Space+Weather+Main+Page
Increased solar activity can also cause an expansion of Earth’s atmosphere, increasing atmospheric drag, which can shorten the operational life of low-orbiting satellites by causing their orbits to decay more rapidly. It can also hamper the tracking of space-based objects by the space surveillance network, since the spacecraft may be in a different position than expected due to the increase in atmospheric drag. A positive effect of an increase in atmospheric drag is a reduction in the amount of space debris (man-made and natural) due to the speeding-up of atmospheric re-entry of objects in low Earth orbit.