*3rd URSI AT-AP-RASC, Gran Canaria, 29 May – 3 June 2022*

# Space Weather Effects on Satellite-based Technology

Patricia H. Doherty
Institute for Scientific Research, Boston College, Chestnut Hill, MA 02467
e-mail: Patricia.Doherty@bc.edu

Space Weather is the field of space science that studies how the Sun influences the Earth's space environment and the impacts of those interactions on technology and society. Some of the most intense interactions can damage our Earth-orbiting commercial and scientific satellites; threaten astronaut safety; introduce high levels of radiation for crews and passengers in flights crossing over the poles; disrupt High Frequency (HF) communication for aircraft flying at high and polar latitudes; interrupt electric power grids, oil pipelines and the reliability and accuracy of global communications and navigation systems, including Global Navigation Satellite Systems (GNSS). This presentation will introduce the physical concepts of the source of Space Weather. This includes information on the Sun, solar wind, eruptive solar phenomena, magnetosphere, ionosphere and geomagnetic induction. The presentation will continue with a view of the impacts of Space Weather on technological systems in space and on the ground. With society's ever-increasing dependence on space-based technology, it is important to enhance public awareness of Space Weather, its potential impacts and what governments are doing to enhance forecasting and mitigation of its most damaging effects.

One of the most critical systems that is affected by space weather is satellite communication. There are over 2200 communications satellites in Earth orbit today. They are used for numerous applications including television, telephone, radio broadcasting, amateur radio, internet, military, data collection, airline communications and many more. It is well known that all radio signals propagating to and from a satellite are affected by the environmental conditions along the propagation path. In a vacuum, radio signals propagate at the speed of light, but trans-ionospheric radio propagation affects the speed of the signal via group delay and phase advance of the signal. In addition, the signals can be attenuated and further refracted and diffracted by ionospheric scintillation, especially during significant space weather events.. Scintillation occurs when a radio signal traverses a region of small scale irregularities in the ionosphere. It is observed as a rapid fluctuation of the received phase and amplitude of a radio signal. Scintillation effects are frequency dependent with lesser effects observed at higher frequencies. However, it does have effects on radio signals up to a few GHz in frequency and as such it can have deleterious effects on satellite-based communication and navigation systems (such as GNSS-based systems). Due to the high degree of ionospheric variability, the effects on propagating signals are also highly variable with the most intense effects occurring due to high levels of scintillation observed in the near equatorial regions and in the high and polar latitudes.

This presentation will review Space Weather effects on satellite communications and navigation.

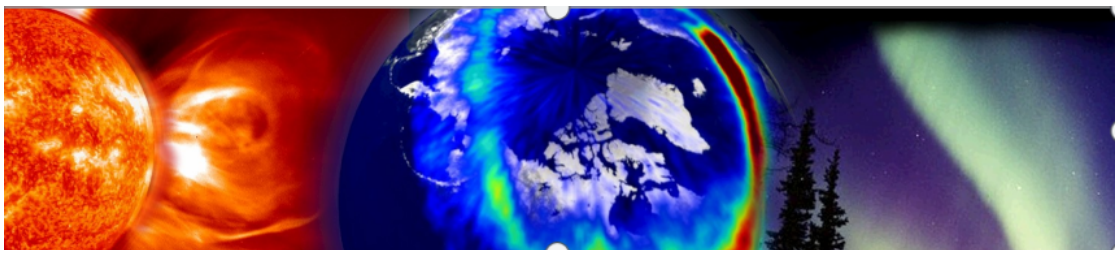

**Image Credit: NASA**