



Contribution ID: 185

Type: **Invited review talk**

## Connecting Sun to heliosphere over time and space: Extreme events

*Friday, January 24, 2025 11:00 AM (25 minutes)*

An extreme event can be defined as an event that falls on the tail of a distribution and characterized by its uniqueness either in its occurrence itself or in its consequences. In the case of the Sun, one talks about coronal mass ejections (CMEs) and flares of extreme energy. Taking one level deeper, one can think of the extremeness of the solar source of these events: active regions and their magnetic content/complexity. Ultimately, the energy that powers CMEs and flares are stored in active regions, so regions of extraordinary size and magnetic field strength have the potential to produce extreme events. The mass and magnetic field of CMEs and solar flare photons propagate into the heliosphere that can cause widespread impact on planets and human-made technological systems. Obvious examples of extreme consequences are super-intense geomagnetic storms caused by CME impact on Earth's magnetosphere and high energy/intensity solar energetic particle (SEP) events caused by CME-driven shocks in the corona and interplanetary medium. Geomagnetic storms and SEP events result in a number of effects in various layers of planetary environment, especially in geospace. Cumulative distribution of all available observations of event sizes can be used to identify the tail of the distribution and estimate the extremeness on various timescales (e.g., one-in-100-year events). I discuss cumulative distribution of CME kinetic energy, flare size, SEP fluence, and strength of geomagnetic storms and how historical space weather events fall on the tail of these distributions. If the mechanism that produces an extreme event is no different from the regular events, the extreme event is often referred to as a "black swan" event. On the other hand, if an extreme event deviates significantly from the tail, a different mechanism may be coming into play, making it a "dragon king" event. This talk summarizes some of these aspects of extreme events in the Sun-Earth system.

### Contribution Type

Poster

### Theme

Connecting Solar Corona to Heliosphere

**Primary author:** GOPALSWAMY, Nat (NASA Goddard Space Flight Center)

**Presenter:** GOPALSWAMY, Nat (NASA Goddard Space Flight Center)

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