

Earth receives triple hit on 8 December 2013 ~ Observation by Whitham D. Reeve

Coronal hole high-speed streams (CHSS) are pummeling Earth's magnetosphere on a regular basis. Coronal holes are large areas on the Sun's corona that have less dense and colder plasma and through which the magnetic field escapes, carrying with it charged particles (plasma) at high speed, thus it is called a coronal hole high-speed stream (CHSS). When a CHSS is geoeffective, Earth's magnetosphere can be disturbed by it.

The high- and low-speed solar wind components from coronal holes form alternating streams in the solar wind flow. They move outward into inter-planetary space in a spiral due to the Sun's rotation. As the streams travel away from the Sun, the high-speed flows overtake the slow-speed flows and create regions of enhanced density and magnetic field called corotating interaction regions. When these regions encounter Earth, they can trigger geomagnetic disturbances and storms that can recur with a 27-day period. Coronal holes can last for several rotations of the Sun so they are not transient events like flares.

Coronal mass ejections (CME) are huge clouds of charged particles ejected from the Sun and which carry a portion of Sun's magnetic field. CMEs often are linked to solar flares and other transient events that release a great amount of energy but not all flares result in a CME and not all CMEs are related to flares. When a CME is directed at Earth and the CME's embedded magnetic field has a southward component, it connects and reconnects with Earth's field causing a disturbance as energy builds up and is released in the magnetosphere.

On 8 December 2013, Earth was hit by all three – CHSS, CIR and CME, causing highly disturbed conditions throughout the day as seen on the magnetogram recorded at Anchorage, Alaska USA. The magnetogram has been annotated with details from the Space Weather Prediction Center's (SWPC) twice-daily *Forecast Discussion* (<http://www.swpc.noaa.gov/ftpmenu/forecasts/discussion.html>). The times given for various events are when they occurred at the Advanced Composition Explorer (ACE) spacecraft. ACE is 1.5 million km from Earth in line with the Sun so, if the event causes a disturbance on Earth, it usually is about 40 to 50 minutes later.

