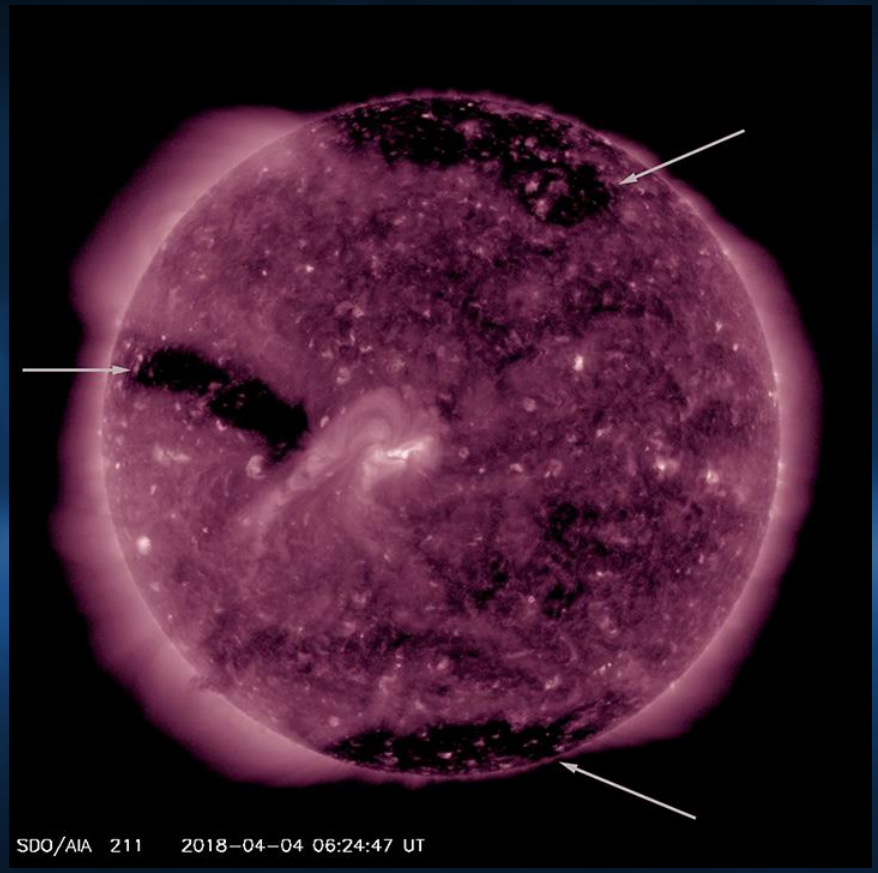
Solar Wind Streams and Co-latitude of Their Coronal Holes

Since the 1970s, solar coronal holes -- coronal regions with a reduced density and temperature compared to the ambient corona -- are known to be the source of high-speed solar wind streams. The supersonic plasma streams propagate radially away from the rotating Sun, compressing the preceding plasma of the slower solar wind and forming an interaction region. When the interaction region and the high-speed wind streams hit Earth, they compress the magnetosphere and can cause geomagnetic storms. Therefore, understanding the properties of such wind streams is key information to improve the space weather forecasts that can protect missions in space.

A recent study in the Journal of Geophysical Research: Space Physics analyzed the properties of 115 coronal holes observed by NASA's Solar Dynamics Observatory (SDO), Solar Terrestrial Relations Observatory (STEREO A and B) and Advanced Composition Explorer (ACE) between 2010 and 2017. For a subset of the 52 Earth-directed high-speed solar wind streams, the peak velocity and strength of geomagnetic storms induced by the high-speed solar wind streams was also measured.

The study found that when a coronal hole is located at the ecliptic, Earth is directly hit by the high-speed stream with stronger geomagnetic consequences. Higher latitudes result in Earth only being grazed, and the wind stream speed is lowered. When located at co-latitudes greater than 61.4◦, the corresponding high-speed solar wind stream does not expand down to the ecliptic and thus misses Earth entirely.



Three coronal holes appear as large dark areas which are identified with arrows in the still image. Credit: Solar Dynamics Observatory, NASA.

Hofmeister, S. J., Veronig, A., Temmer, M., Vennerstrom, S., Heber, B., & Vršnak, B. (2018). The dependence of the peak velocity of high-speed solar wind streams as measured in the ecliptic by ACE and the STEREO satellites on the area and co-latitude of their solar source coronal holes. Journal of Geophysical Research: Space Physics, 123. https://doi.org/10.1002/2017JA024586