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Extreme high-latitude activity from high-speed stream embedded Alfvén waves

Eija Tanskanen (1), Kalevi Mursula (2), Reko Hynönen (1), Kristian Snekvik (3), James Slavin (4), and Melvyn Goldstein (5)

(1) Finnish Meteorological Institute, ReSoLVE Centre of Excellence, Helsinki, Finland (eija.tanskanen@fmi.fi), (2) Oulu university, ReSoLVE Centre of Excellence, Helsinki, Finland, (3) University of Bergen, Birkeland Centre for Space Sciences, Norway, (4) University of Michigan, Ann Arbor, US, (5) Goddard Space Flight Center, Maryland, US

Geomagnetic activity is known to be driven by interplanetary coronal mass ejections (ICME), interaction regions and high-speed streams (HSS). Storm activity in low-latitudes is mainly driven by ICMEs while substorm activity in high-latitudes is strongly modulated by high-speed streams. In this work we explore what makes high-speed streams more powerful in modulating high-latitudes than ICMEs. We identified Alfvén waves from 1995 to 2011. Alfvén waves are found throughout the solar cycle, but they are fastest, most frequent and most geo-effective in the declining phase of the solar cycle 23, when the number of high-speed streams at the Earth′s vicinity increases rapidly. HSS embedded Alfvén waves were found to carry twice as much Alfvénicity than ICME embedded Alfvén waves. Furthermore, we found a rapid transition from predominance of slow Alfvén waves in 2002 to fast Alfvén waves in 2003, which coincide with the 40% increase in substorm number and 30% increase in substorm strength. We conclude that Alfvénic fluctuations embedded to high-speed streams make them more powerful in modulating high-latitudes than ICMEs, and thus cause largest threat to high-latitude infrastructure during declining solar cycle phases.