EGU22-6269, updated on 11 Aug 2022
https://doi.org/10.5194/egusphere-egu22-6269
EGU General Assembly 2022

Dawn-dusk asymmetry of solar flare-driven ionospheric current at high latitudes

Pierre Cavarero[1], Masatoshi Yamauchi[2], Magnar G. Johnsen[3], Shin-Ichi. Ohtani[4], and Janet Machol[5]

[1]ESTACA, Engineering College, Paris Saclay Campus, France (pierre.cavarero@estaca.eu)
[2]Swedish Institute of Space Physics (IRF), Kiruna, Sweden
[3]Tromsø Geophysical Observatory (TGO), UiT the Arctic University of Norway, Tromsø, Norway
[4]Johns Hopkins University Applied Physics Laboratory, MD, USA
[5]National Oceanic and Atmospheric Administration

Solar flares are known to enhance the ionospheric electron density and thus influence the D- and E-region electric currents in the sunlit hemisphere. The resultant geomagnetic disturbances (called "crochet") are found at both low latitudes and high latitudes with a minimum in between. The subsolar response, with short-lived and symmetric changes around the subsolar region, is understood as a temporal re-distribution of the electron density. However, no systematic study has been made of the high-latitude responses, covering the auroral oval, the cusp, and the dayside sub-auroral region. Even global patterns are not well described or understood.

Using data from GOES satellites and SuperMAG, we made a statistical study of the high-latitude geomagnetic responses to X-class solar flares in the northern polar region. First, we needed to create a reliable X-flare database that we could use to get precise timings of when the flares start and when they stop. We merged XRS databases from different GOES satellites to create a X-class solar flare database between 1984 and 2017, gathering 331 X-flares over 34 years.

For all these X-flares, we plotted the geomagnetic disturbance (ΔB) on a polar map during the periods when the X-ray flux exceeds 1e-4 W/m2 (>X1 flare). Plots were made also for merged data, i.e., different events on the same map organized by geographic coordinates and local time to obtain the average disturbance pattern caused by the flares. Large events (ΔB >300 nT) were excluded to minimize the contamination from substorm events.

In these "merged" plots, we classify the data by season (summer - 4 months, equinox ±2 months, winter 4 months), flare intensity (X1-X2 flares and >X2 flares), and maximum ΔB among all stations > 65° GGlat (< 100 nT and 100-300 nT).

Except for winter, we found a large poleward ΔB which peaks at 13-16 LT, particularly for > X2 flares, but no enhancements in the pre-noon sector. This asymmetry, surprisingly, remains even

after we consider IMF By polarity. We do not have any plausible explanation for this result, and we will discuss it during the presentation.

[Acknowledgement: This work is resulted from a 2021 summer internship study at the Swedish Institute of Space Physics, Kiruna. The GOES X-ray data is provided by NOAA (USA). The geomagnetic data at high latitudes are obtained from SuperMAG and are originally provided by DTU (Denmark), TGO (Norway), FMI (Finland), SGO (Finland), SGU (Sweden), GSC (Canada), USGS (USA), AARI (Russia), PGI (Russia), IZMIRAN (Russia), BAS (UK), BGS (UK), IPGP (France), PAS (Poland), ZAMF (Austria), and ASCR (Czech)]