Supporting Information for "Seasonal and hemispheric asymmetries in the cold ion outflow source region: Swarm and CHAMP observations of F-region polar cap plasma density"

S. M. Hatch[1] *, S. Haaland[1,2], K. M. Laundal[1], T. Moretto[1], A. W. Yau[3], L. Bjoland[4], J. P. Reistad[1], A. Ohma[1], K. Oksavik[1,4]

[1]Birkeland Centre for Space Science, University of Bergen, Norway

[2]Max-Planck Institute for Solar Systems Research, Göttingen, Germany

[3]Department of Physics and Astronomy, University of Calgary, Calgary, Alberta, Canada

[4]Department of Arctic Geophysics, University Centre in Svalbard, Longyearbyen, Norway

Contents of this file

Corresponding author: S. M. Hatch, Birkeland Centre for Space Science, University of Bergen, Allégaten 55, Bergen, Norway. (Spencer.Hatch@uib.no)

*Department of Physics and Technology,

Allégaten 55, N-5007 Bergen, Norway

Introduction In this Supporting Information we provide a plot of the ratio of the Northern and Southern Hemisphere polar cap areas and circumferences (Figure S1), and an alternative version of Figure 5 in the manuscript (Figure S2) that displays the "relative plasma density variation" [MAD(N_e^*)/median(N_e^*)] and the quantity std($\bar{q}$)/$\bar{q}$ from the plasma production model. These figures are respectively described in Text S1 and Text S2.

Text S1. Figure S1 displays the ratio of the Northern and Southern Hemisphere polar cap area (blue solid line) and circumference (orange dotted line) at 0-km altitude as a function of bounding Modified Apex magnetic latitude. Modified Apex coordinates are defined using a reference altitude of 110 km. Area and perimeter calculations are performed using the WGS84 ellipsoid and the `Geodesic` module of the `geographiclib` Python package (`https://geographiclib.sourceforge.io/html/python/`). Modified Apex coordinate conversions are performed using the `apexpy` Python package (see text).

Text S2. Daily average, minimum, and maximum of solar zenith angle χ (Figures S2a–b and g–h) and the plasma production model given by Equation (4) (Figures S2c–f and i–l) versus season parameter ϕ_s (season in the left panels and local season in the right panels; see section 3.1) in the Northern (blue) and Southern Hemisphere (red) geomagnetic polar caps (three upper rows, Figures S2a–f) and geocentric polar caps (three lower rows, Figures S2g–l). Tick marks in each panel precisely indicate the relevant equinox or solstice. The average (panels a–d and g–j) or relative deviation (standard deviation divided by the average) (panels e–f and k–l) of each quantity is indicated by a thick dotted line (NH) and thin dotted line (SH). The average plus or minus one standard deviation in panels a–d and g–j is indicated by cross and circle hatching for the Northern and Southern Hemisphere, respectively. The gray shading in the upper half of panels a–b and e–f indicates the range of χ values above the maximum solar zenith angle χ_m ($\chi_m \approx 108.6°$) at which the Sun is visible at 350-km altitude according to Equation (1). The solid blue (NH) and red (SH) lines in Figures S2c–f are median geomagnetic polar cap N_e^* (Figures S2c–d) and MAD(N_e^*)/median(N_e^*) (Figures S2e–f). The corresponding lines in Figures S2i–l are median geocentric polar cap N_e^* (Figures S2i–j) and MAD(N_e^*)/median(N_e^*) (Figures S2k–l).

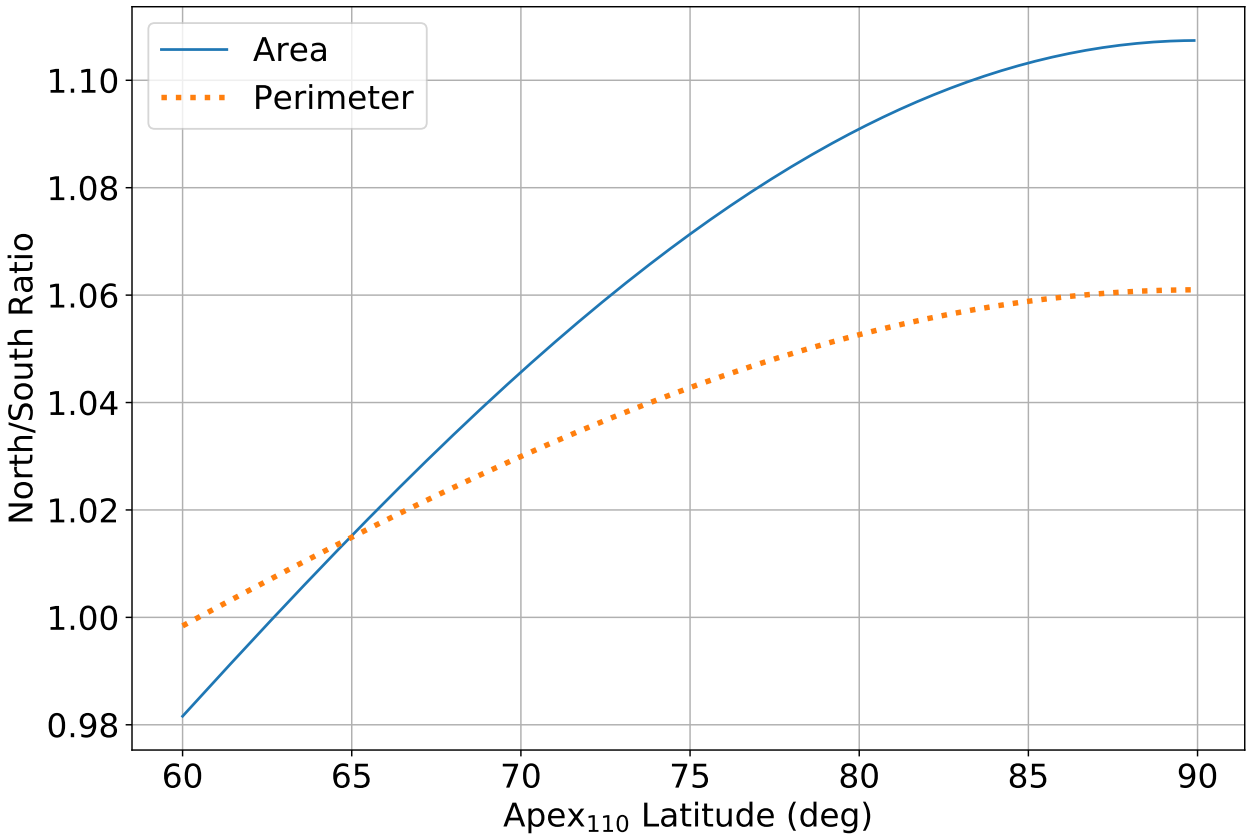

Figure S1. See Text S1.

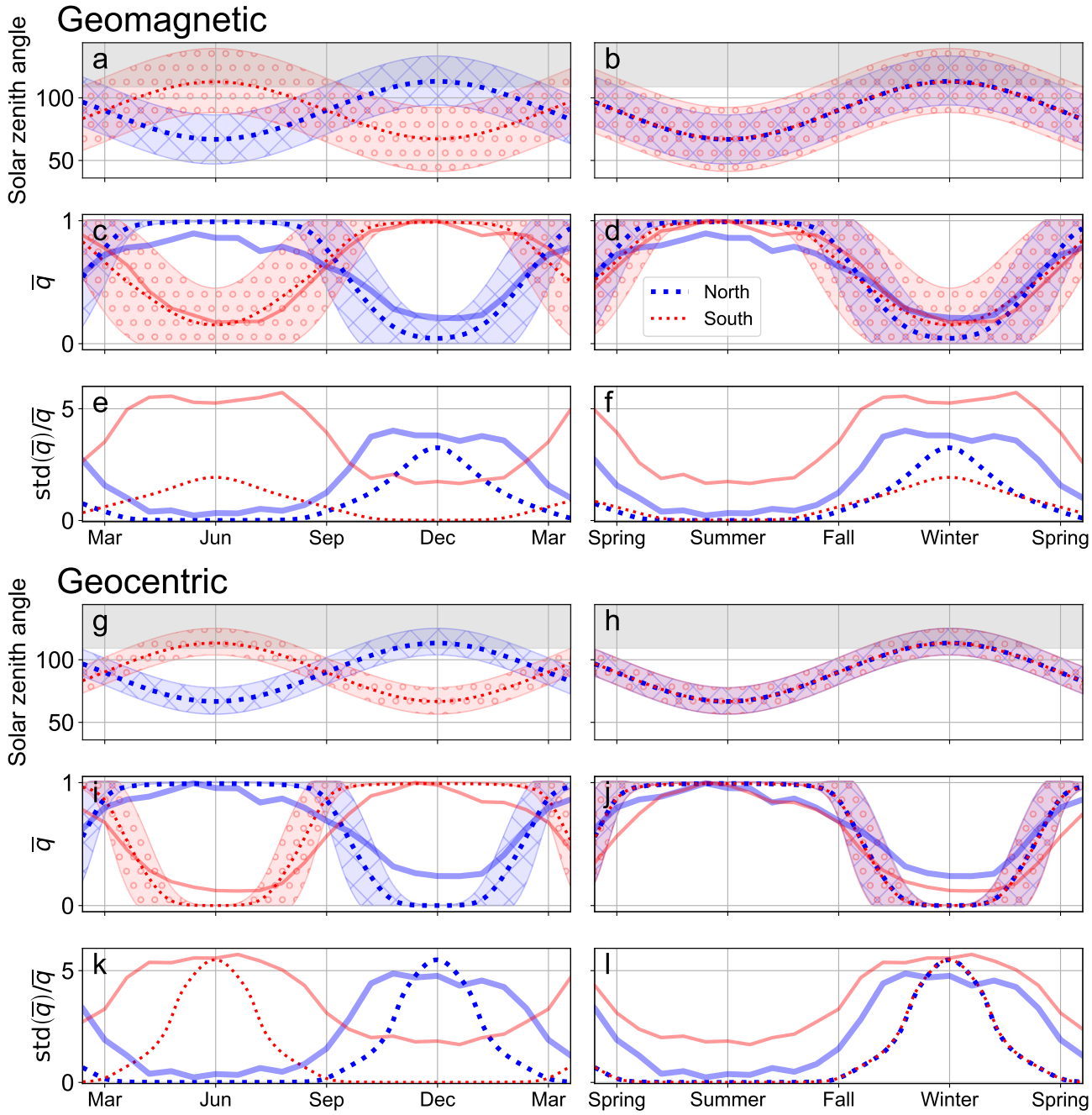

Figure S2. See Text S2.