Correlating solar wind variation to the timing of field-aligned current flow

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Introduction

Field-aligned currents (FAC) provide information on solar wind, the magnetosphere, and the ionosphere. Refining auroral prediction includes determining correlation between the lag in solar wind and the timing of FAC flow. From an operational standpoint, radio frequencies used in GPS systems are affected by FACs. Knowing the lag time allows for greater continuity is system functions during solar events.

Problem Statement

The increased FAC flow are correlated to a strong southerly orientation of the magnetic field in the solar wind. It is contested whether these currents increase during subsolar magnetic merging or night-side magnetic reconnection.

Previous Work

Previous work regarding the timing and prediction of field-aligned currents concluded tail reconnection drives FAC flow rather than magnetic merging in the subsolar magnetopause [1]

Data of the interplanetary magnetic fields confirmed delays between changes in solar wind conditions with short lags occurring when solar wind speed was higher. This further suggests nightside tail reconnection drives FAC flow.

Acknowledgements

Solar wind data downloaded from NASA OMNIWeb at https://omniweb.gsfc.nasa.gov/form/omni_min.html, and https://sohoftp.nascom.nasa.gov/sdb/ace/daily/

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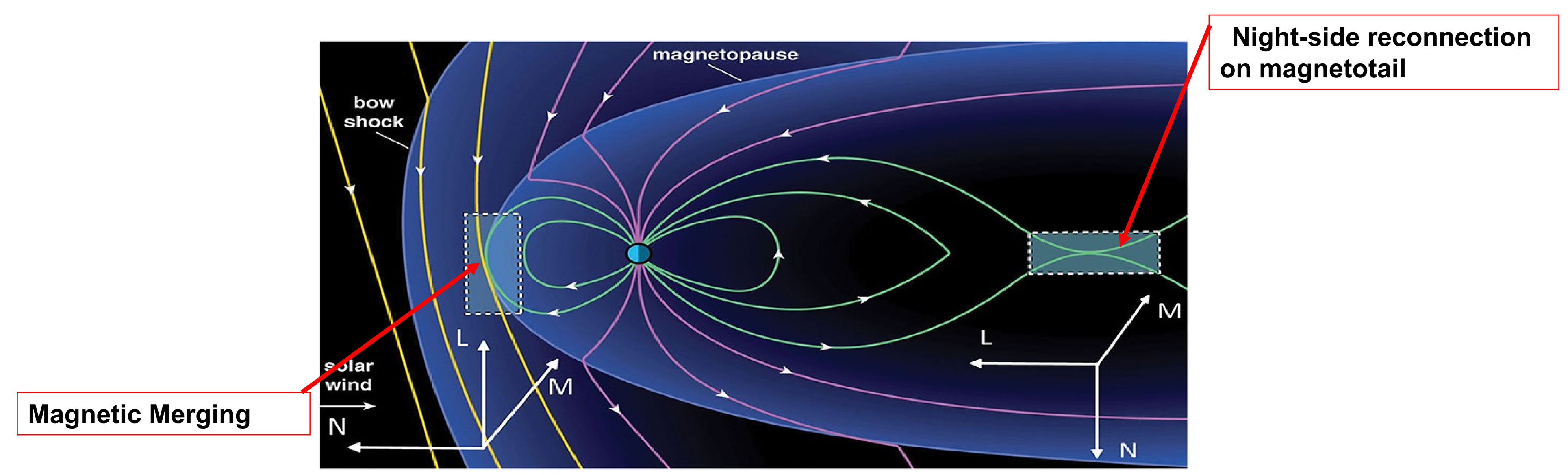
Environment

The sun's plasma embedded in magnetic fields form solar winds which interact with Earth's magnetic field. Earth's magnetosphere is compressed on the solar side and elongated on the night-side tail. Field-aligned currents are connected to the magnetosphere and ionosphere through magnetic merging and magnetic reconnection. [2] Currently, solar data from October 29th and 30th, 2014 is examined through this research.



Above: Dungey Cycle showing the interaction of Solar Wind with Earth's Magnetosphere [3]

Data Methods and Correlation

Solar wind data was taken from the Solar and Heliospheric Observatory, which is located at the L1 point between the Sun and Earth and compared to spectrographic measurements of diffuse aurora at 630 nm.[4] For the date, the KP index must be between 2 and 2+. A time series analysis was conducted using both sets of data in conjunction with a cross correlation function in order to determine the lag between changes in solar wind magnetic field properties conducive to aurora and terrestrial auroral detection. Once the lag was determined, the magnitude of the southern magnetic field component of the solar wind was compared to the solar wind speed and cross correlated as well.

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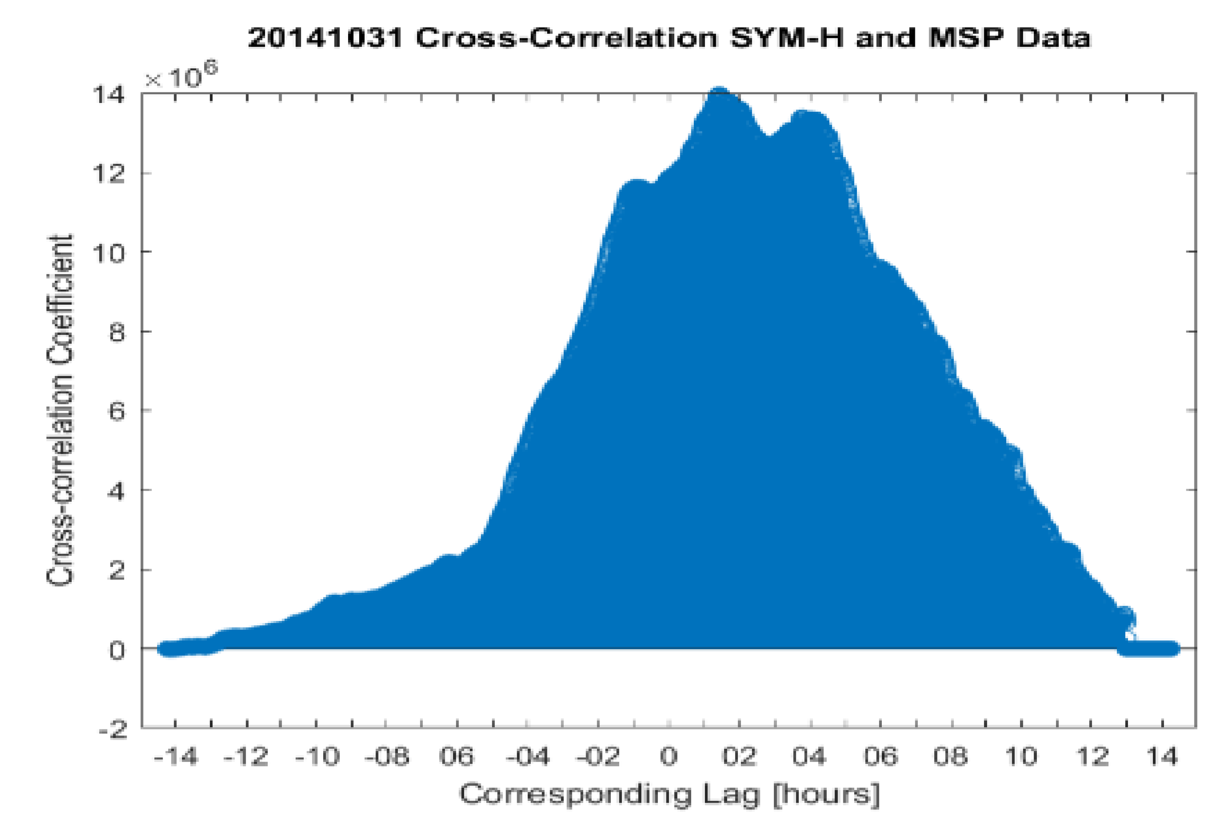
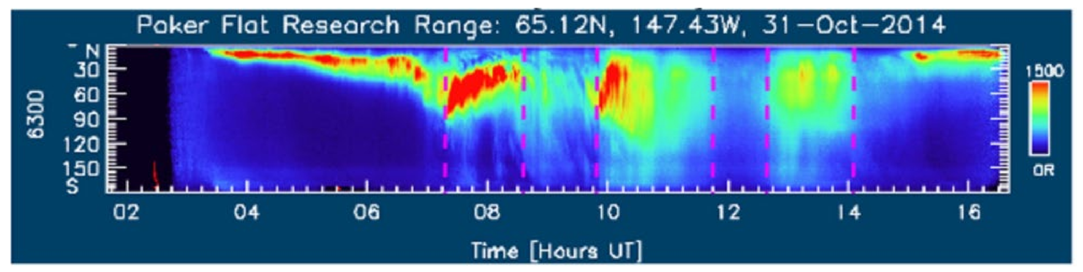
Results





Above is an example of the cross correlated data from October 31, 2014, and the corresponding Keogram.[5]

Future Work

This research can be expanded upon by incorporating aspects such as particle precipitation to better our auroral prediction. Expanding on the storm dataset will also allow for results to be better supported.

Abbreviated References*

[1] McPherron, R. L. (2016, 5). Where and when does reconnection occur in the tail?

. [2] Walach, M. -T., & Grocott, A. (2019). SuperDARN Observations During Geomagnetic Storms,

[3] NASA. Magnetospheric Multiscale Image.

[4] McPherron, R. L. (1970). Growth phase of magnetospheric substorms.

[5] Poker Flatt Digital All-Sky Camera Keograms. (2014). University of Alaska

*Full reference list available upon request