Data for Machine Learning Algorithm: Predicting Ion Velocity from Auroral Imagery

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Introduction

- Electric Field Instruments (EFI) on satellites like Swarm measure horizontal ion velocity to increase understanding of ionospheric electrodynamics near auroral arcs
- Can only compare data to ground-based imagery on rare occasions
- Goal: train a neural network to recreate Swarm EFI horizontal ion velocity plots from ground-based observatories (GBOs) in THEMIS All-Sky Imager Array
- Find a set of conjunctions between the THEMIS GBOs and Swarm A and B satellites and store the images and relevant Swarm data together

Footpointing

- Satellites are at different altitudes than arc imaged, so need to adjust satellite coordinates when mapping over image
- All satellite coordinates footpointed to altitude 110 km using python script written by Jules Van Irsel using SpacePy

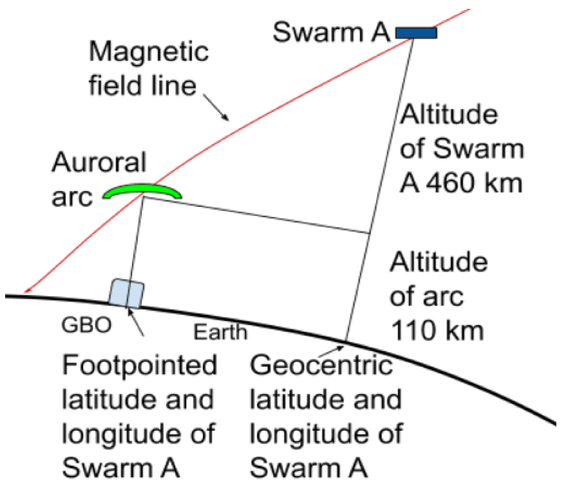

Figure 1. Diagram of footpointing

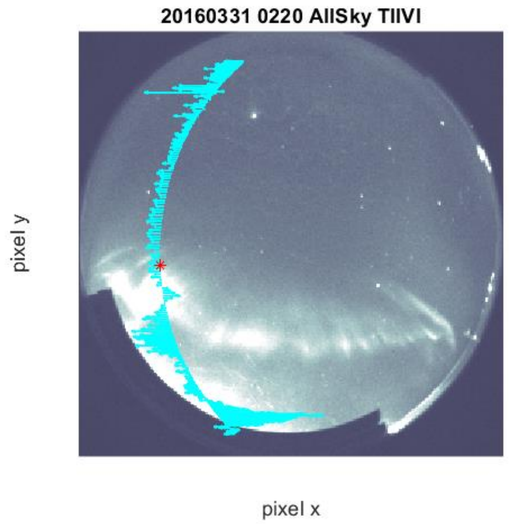

Figure 5. Horizontal ion velocity along satellite path in GBO fisheye view

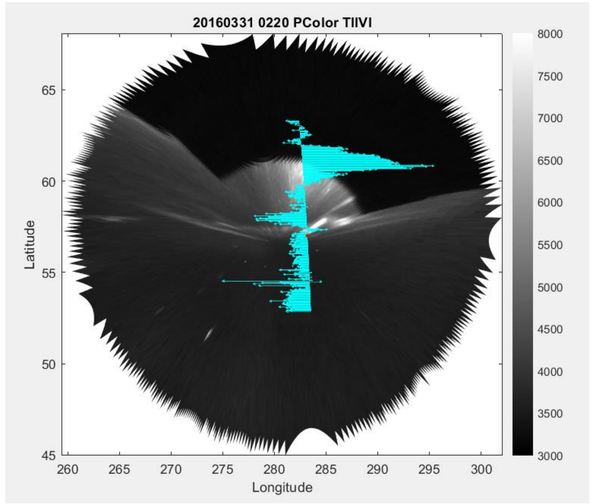

Figure 6. Horizontal ion velocity along satellite path with physical latitude and longitude

Conjunctions

- Python script found times when satellite over GBO at night and EFI data available
- Looked for defined arc in GBO keogram and change in field aligned current (FAC)
- Found 108 conjunctions from 12/2013 to 12/2018

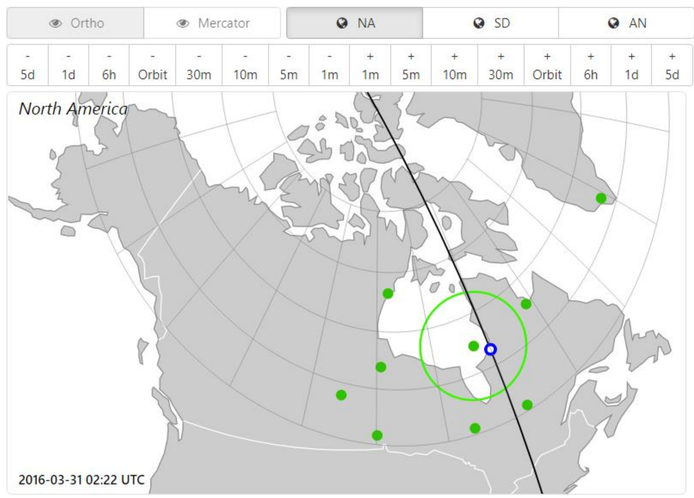

Figure 2. Swarm A satellite and Sanikiluaq GBO.

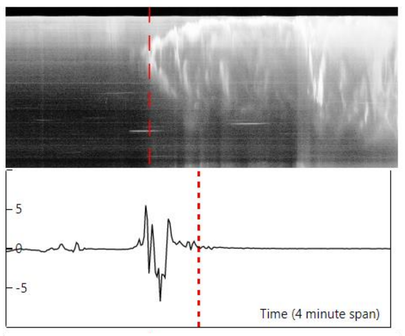

Figure 3 (top). Sanikiluaq GBO keogram indicates defined arc and mostly clear skies.
Figure 4 (bottom). Swarm A FAC displays change.

Next Steps

- Build structure with all 108 events
- Train machine learning algorithm to recreate horizontal ion velocity plots for known dataset
- Test algorithm's accuracy with a different dataset

Plotting Ion Velocity

- Using a MATLAB script written by Caitlin Bowers, overlaid horizontal ion velocity along path of satellite on GBO image
- Created plots of image brightness and horizontal ion velocity along the path of the satellite

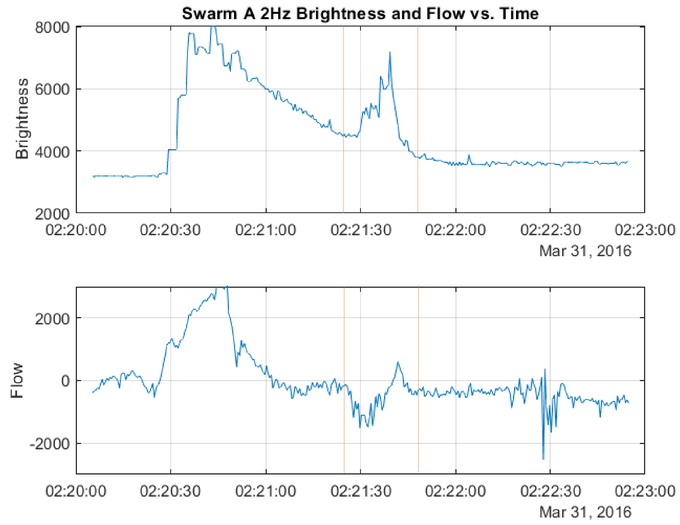

Figure 7. Plots of Sanikiluaq image brightness along the path of the satellite (top) and horizontal ion velocity along the path of the satellite (bottom).

Acknowledgments

This is a continuation of Caitlin Bowers and Ruthie Nordhoff's WISP project. I would like to thank Dr. Kristina Lynch and Jules Van Irsel for helping me.

References

Conjunctions:
https://swarm-aurora.com/conjunction Finder/
CDFs: swarm-diss.eo.esa.int/#swarm/Advanced/Plasma_Data/2Hz_TII_Cross-track_Dataset/
Skymaps and Images:
http://data.phys.ucalgary.ca/sort_by_project/THEMIS/
Caitlin Bowers: MATLAB/IDL scripts (create structure)
Jules Van Irsel: Python scripts (footpointing and conjunction finder)