

# pyDARN

A Python Library for SuperDARN Data!

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[pydarn.readthedocs.io](https://pydarn.readthedocs.io)

# What is SuperDARN?

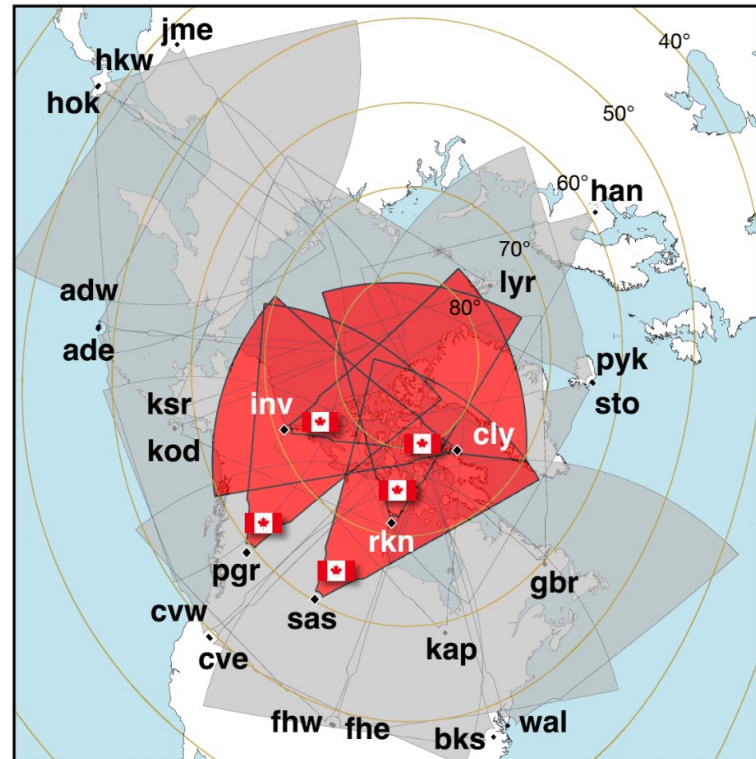


Worldwide array of 35+ radars measuring the ionosphere

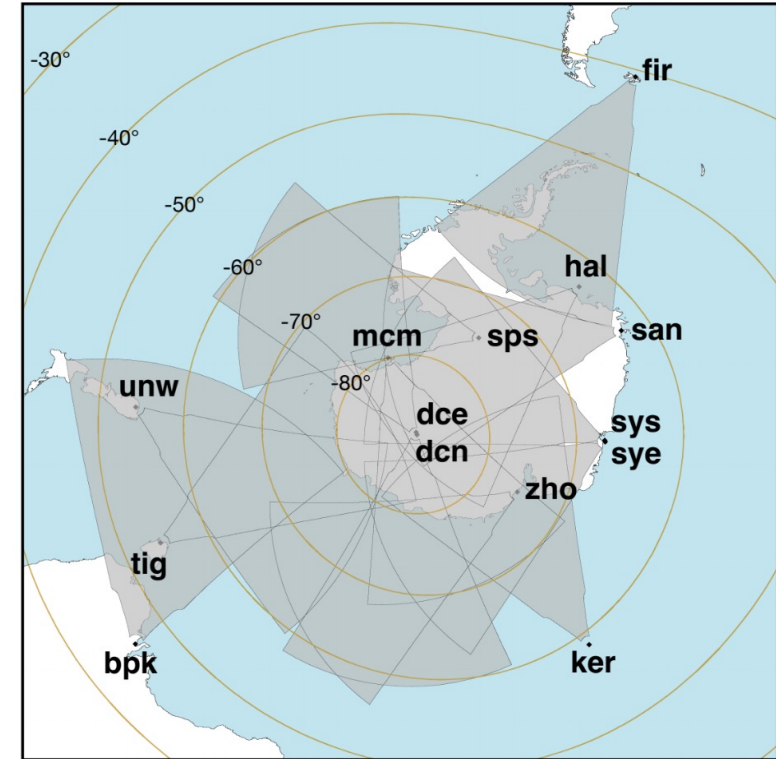


The northern lights seen over the Saskatoon SuperDARN radar site. (Credit: Ashton Reimer)

Northern Hemisphere Radars



Southern Hemisphere Radars

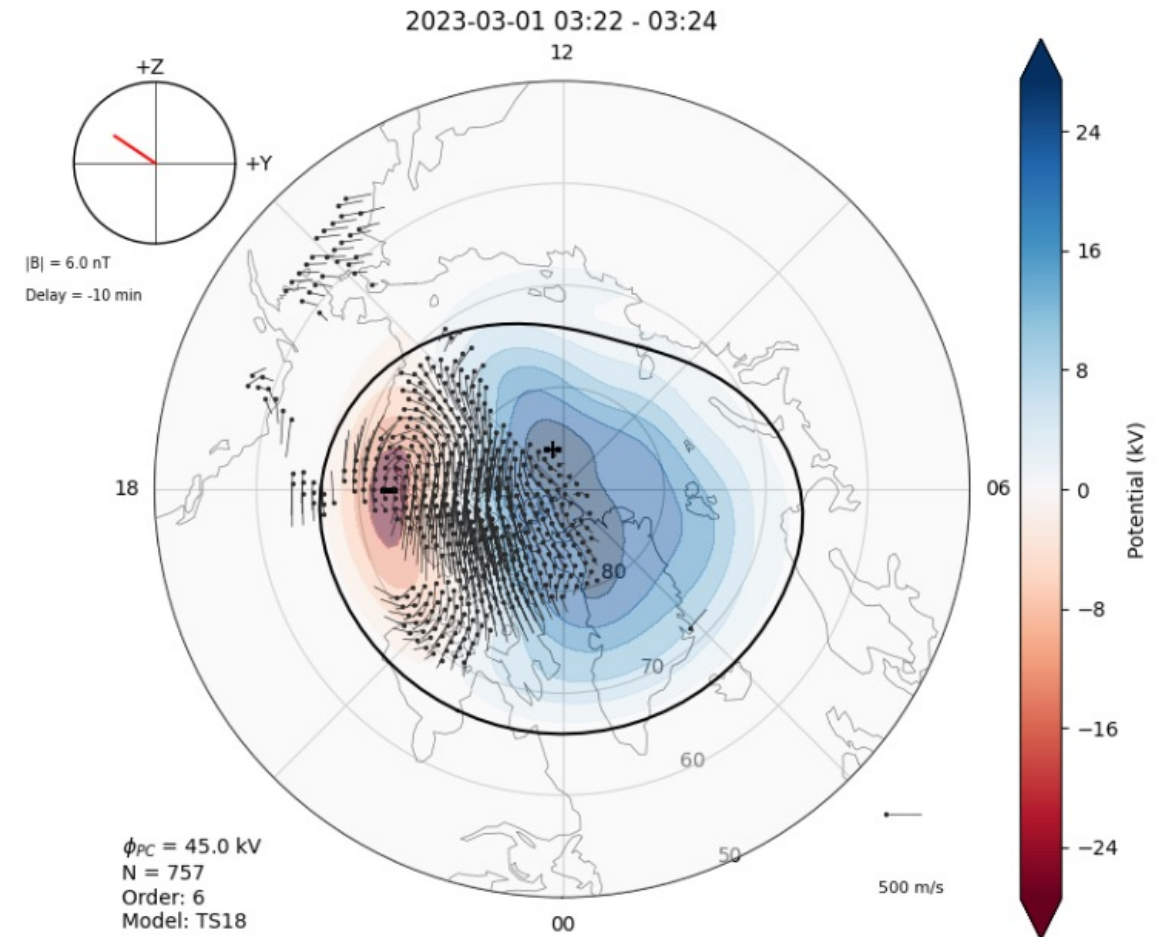


The above diagrams show field of view in grey for each radar in the Northern (left) and Southern (right) hemispheres. In the Northern hemisphere, SuperDARN Canada managed radars have a red field of view. Both diagrams are viewing Earth from above the corresponding geographic pole, where the concentric ovals are showing the geomagnetic latitude. Each black dot is a radar station, labeled by its unique 3 letter code. The landmasses are shown in white.

# SuperDARN Data Products



- The SuperDARN community produces data at various processed levels for a large range of studies
- High bar for newcomers/users in other fields of study, to **make read/write and plotting code**, easily and quickly
- Solution: **pyDARN!**



# What is pyDARN?



"pyDARN is an open-source Python-based library developed specifically for visualizing SuperDARN radar data products. It provides various plotting functions of different types of SuperDARN data, including time series plot, range-time parameter plot, fields of view, full scan, and global convection map plots."

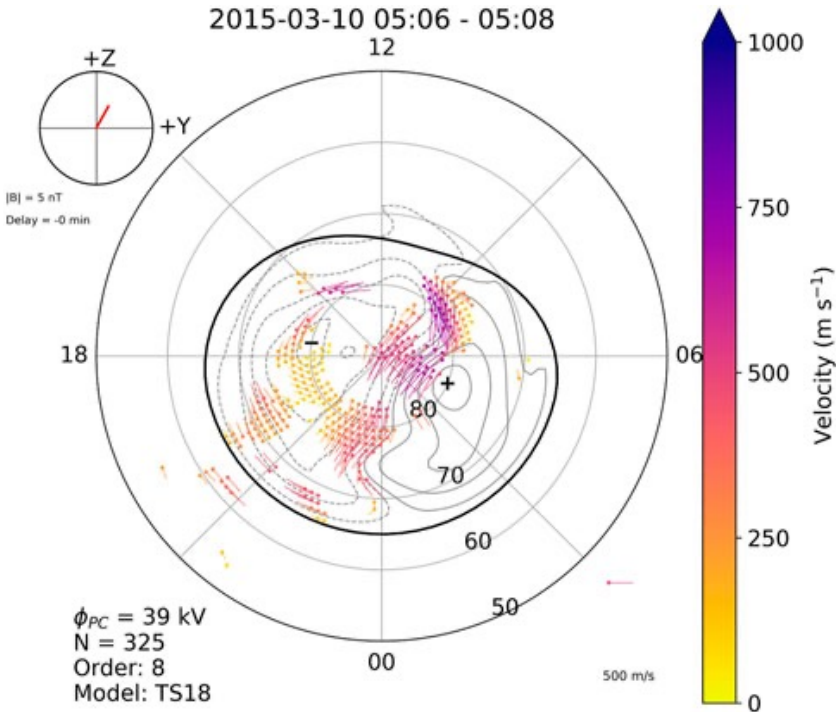
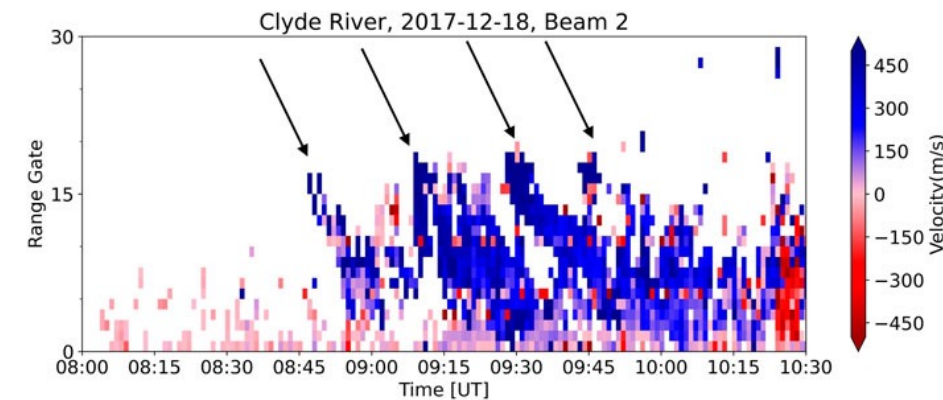


FIGURE 7 of Shi+ 2022 Ionospheric convection map with fitted velocities



FIGURE 3 of Shi+ (2022). Range-time-parameter (RTP) plot of the line-of-sight velocity. Arrows show ionospheric signatures of flux transfer events.

pyDARN: A Python software for visualizing SuperDARN radar data, Shi et al, (2022)



# How to get pyDARN?



- Installation as easy as:

```
pip3 install pydarn
```

- Installed in python virtual environment or conda environment
- Cartopy optional dependency needs installing separately

## Reading SuperDARN Files

Import pyDARN and set the file path then use **SuperDARNRead** to read the file

Depending on the type of file you are reading, use the **read\_filetype** method to unpack the file into a dictionary

Or you can use the **read\_dmap** which will read any dmap file into a dictionary

Use the dictionary to print data, or put it into one of our plotting functions!

```
import pyDARN

file = "path/to/file"
SDarn_read = pydarn.SuperDARNRead(file)

rawacf_data = SDarn_read.read_rawacf()
fitacf_data = SDarn_read.read_fitacf()
grid_data   = SDarn_read.read_grid()
map_data    = SDarn_read.read_map()

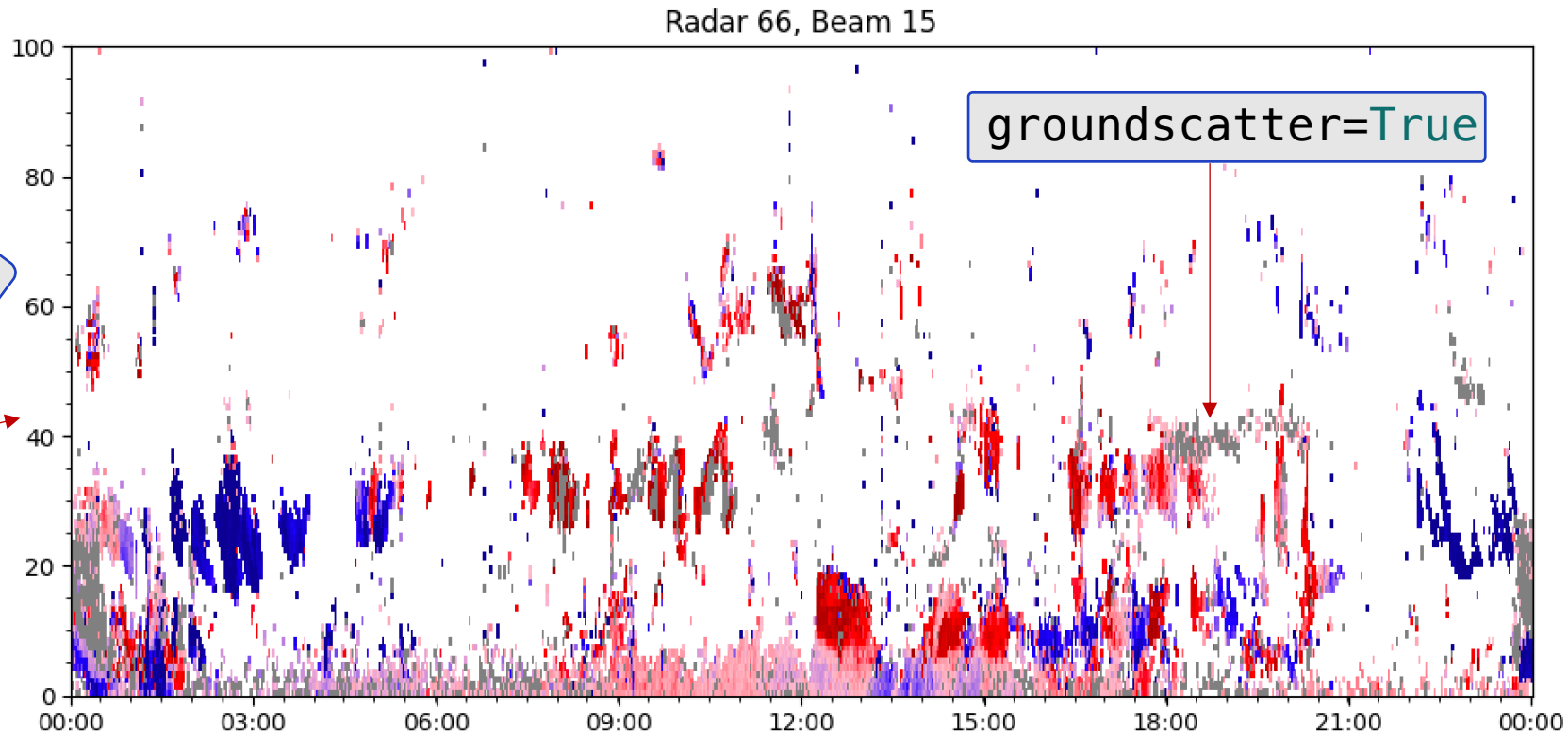
dmap_data   = SDarn_read.read_dmap()

print(fitacf_data[0].keys())
```

# Features Overview

## Range-Time Plots

```
pydarn.RTP.plot_range_time(fitacf_data, beam_num=15)
```



range\_estimation=  
pydarn.RangeEstimation  
- RANGE\_GATE

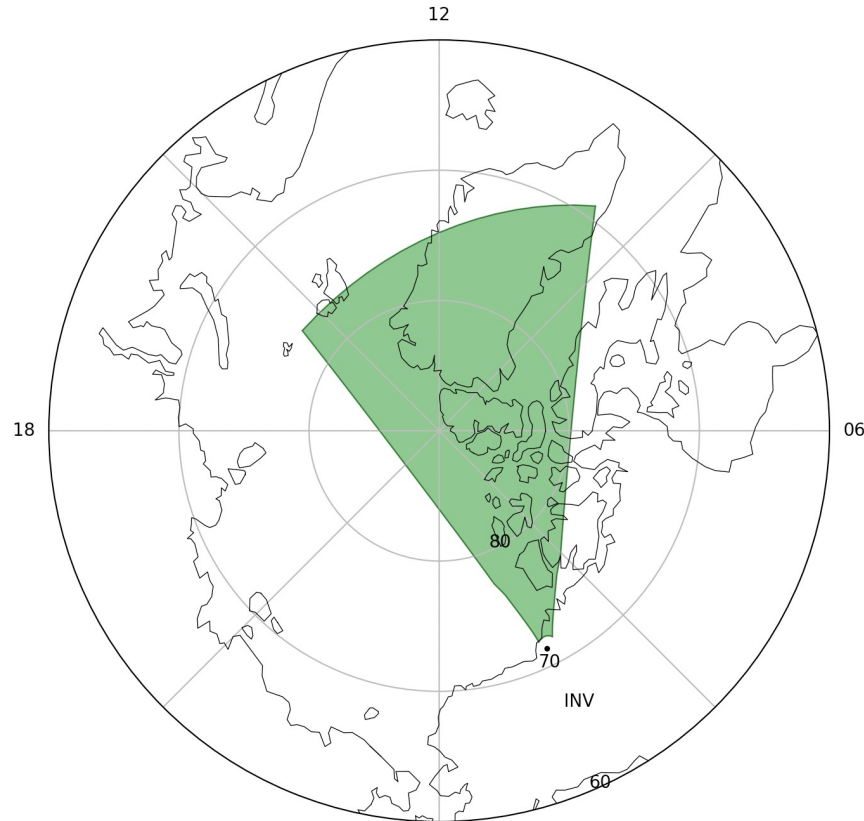
zmax=500  
zmin=-500

Line-of-Sight Velocity ( $\text{m s}^{-1}$ )

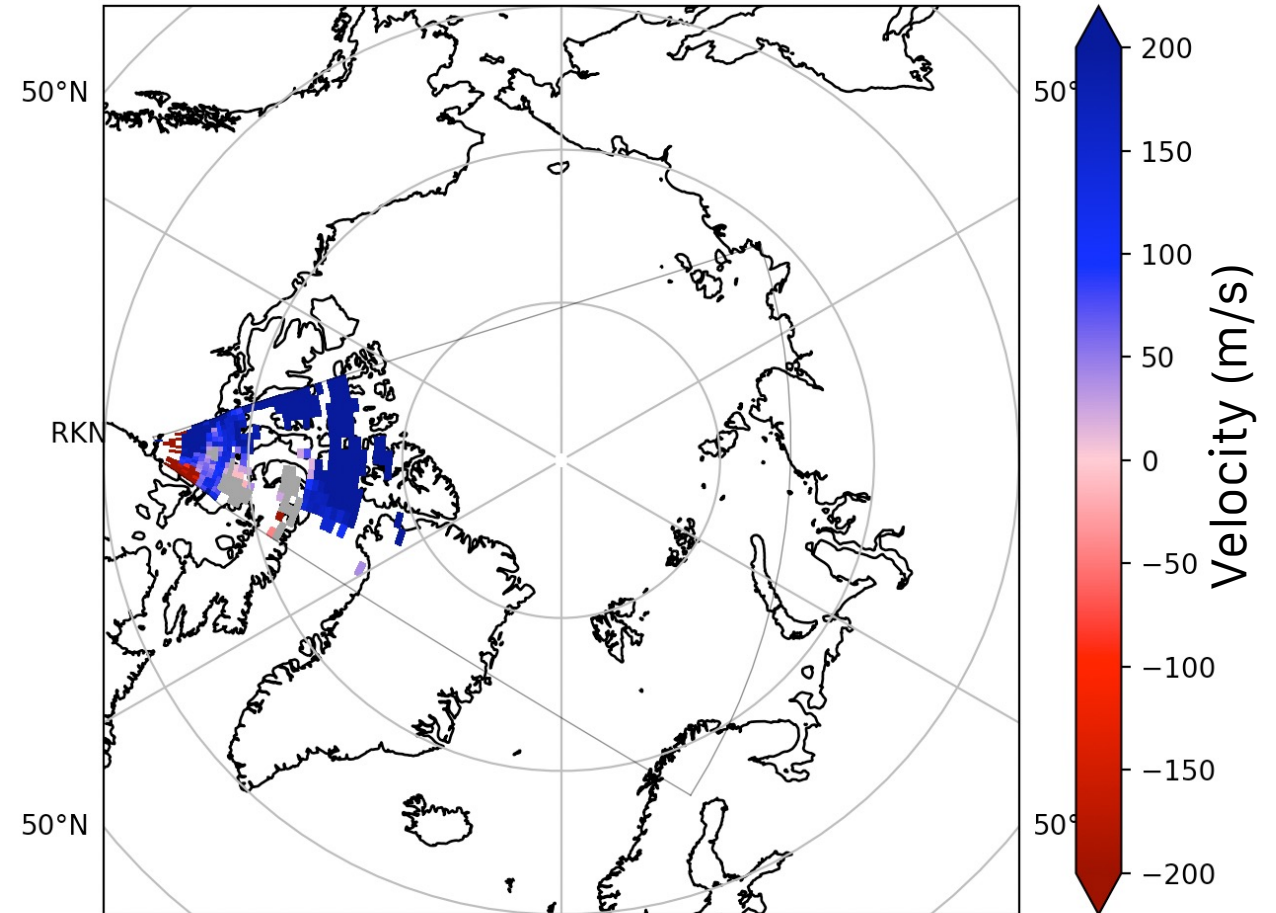
450  
300  
150  
0  
-150  
-300  
-450

# Features Overview

## Fan and FOV Plots



```
pydarn.Fan.plot_fov(64,  
                    fov_color='green',  
                    coastline=True)
```

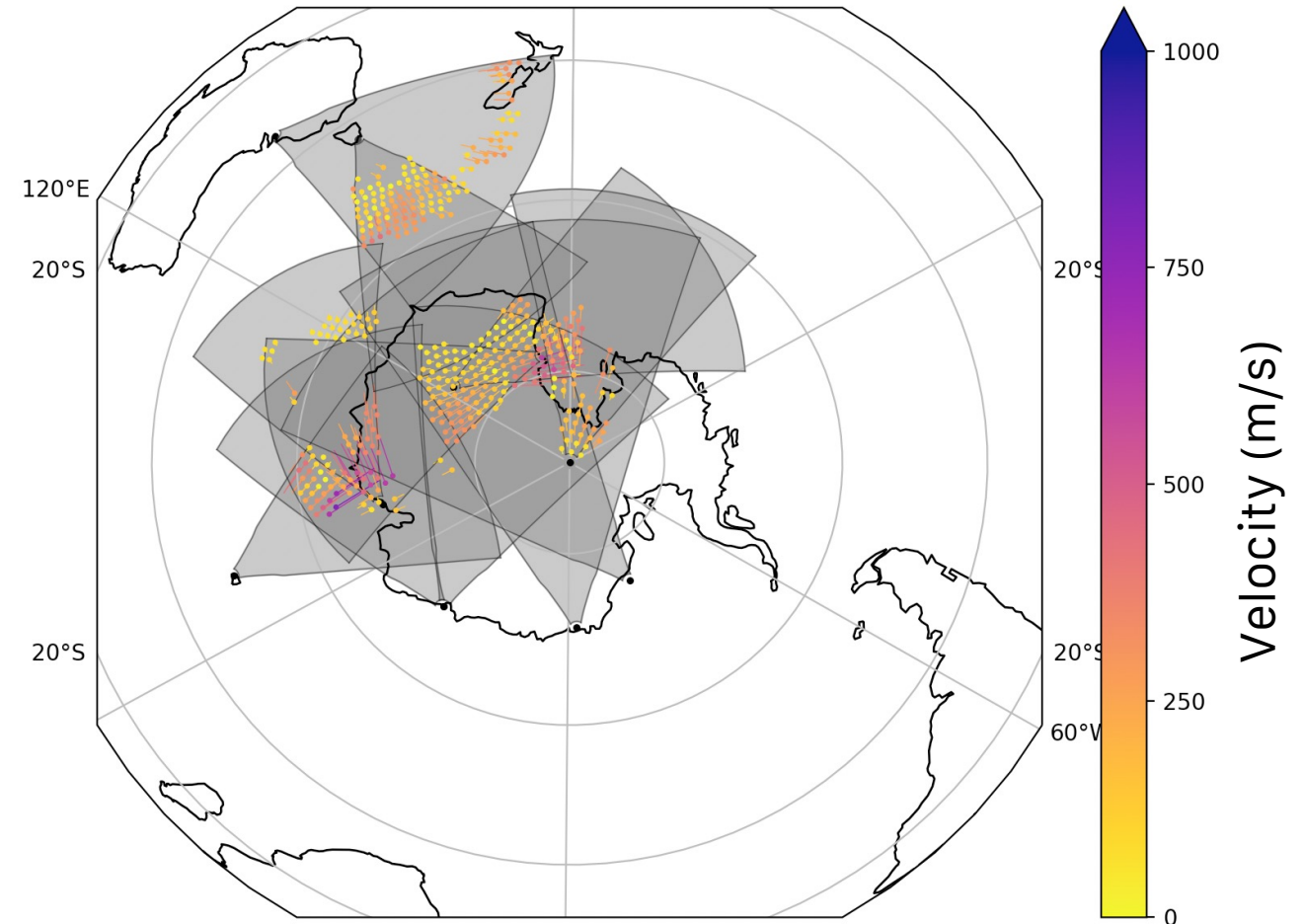
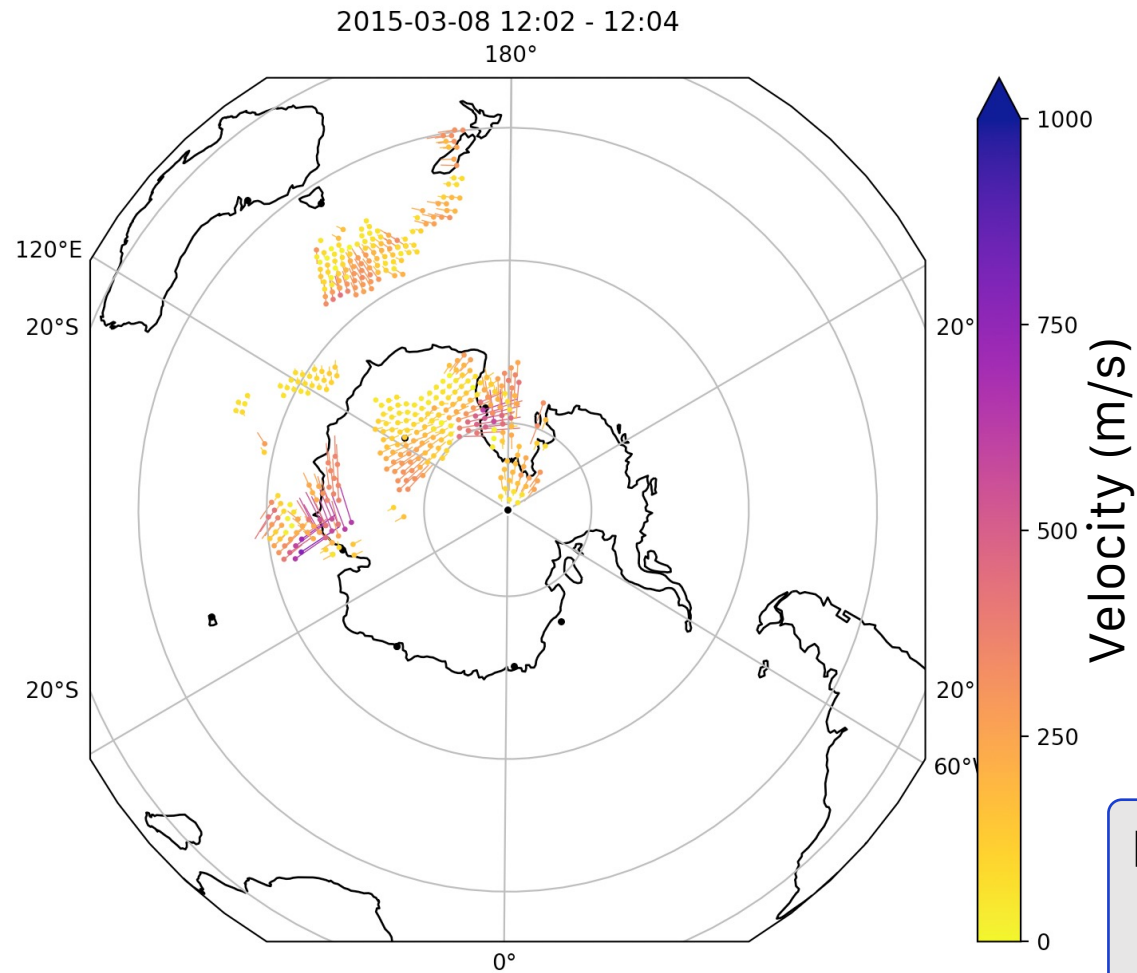


```
pydarn.Fan.plot_fan(fitacf_data, scan_index=1,  
                    coastline=True, lowlat=60,  
                    coords=pydarn.Coords.GEOGRAPHIC,  
                    projs=pydarn.Projs.GEO)
```



# Features Overview

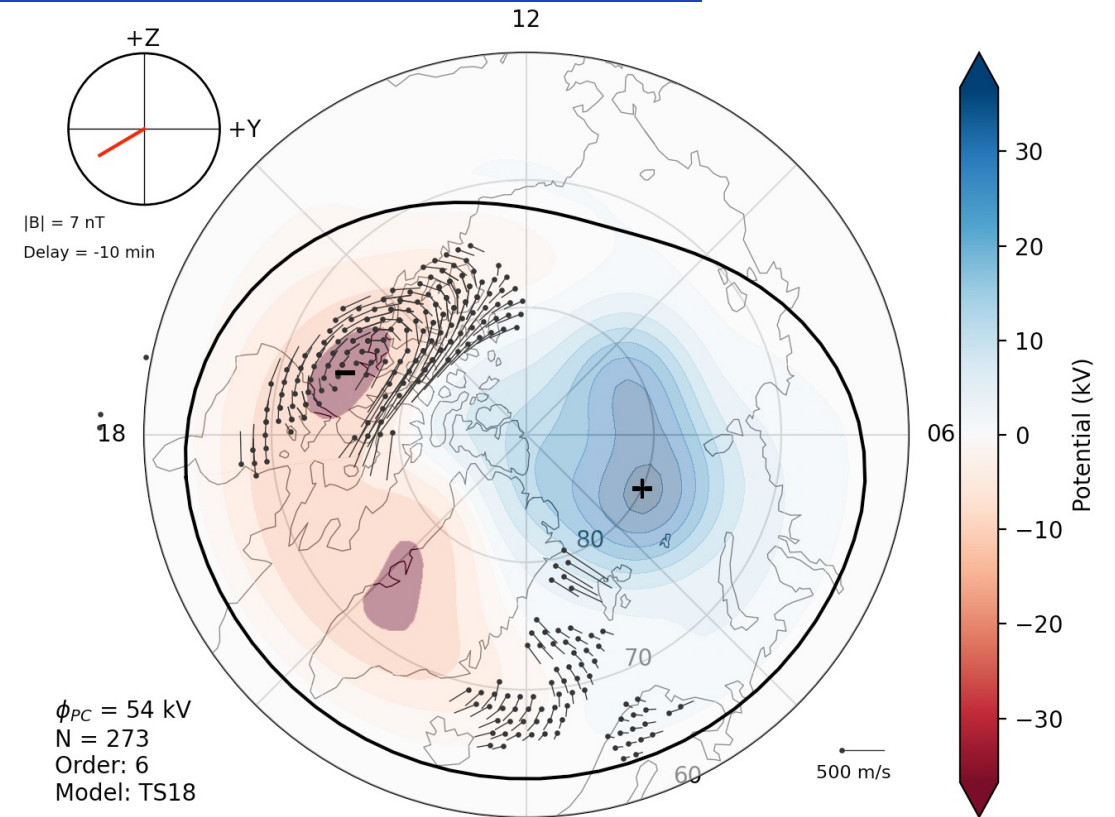
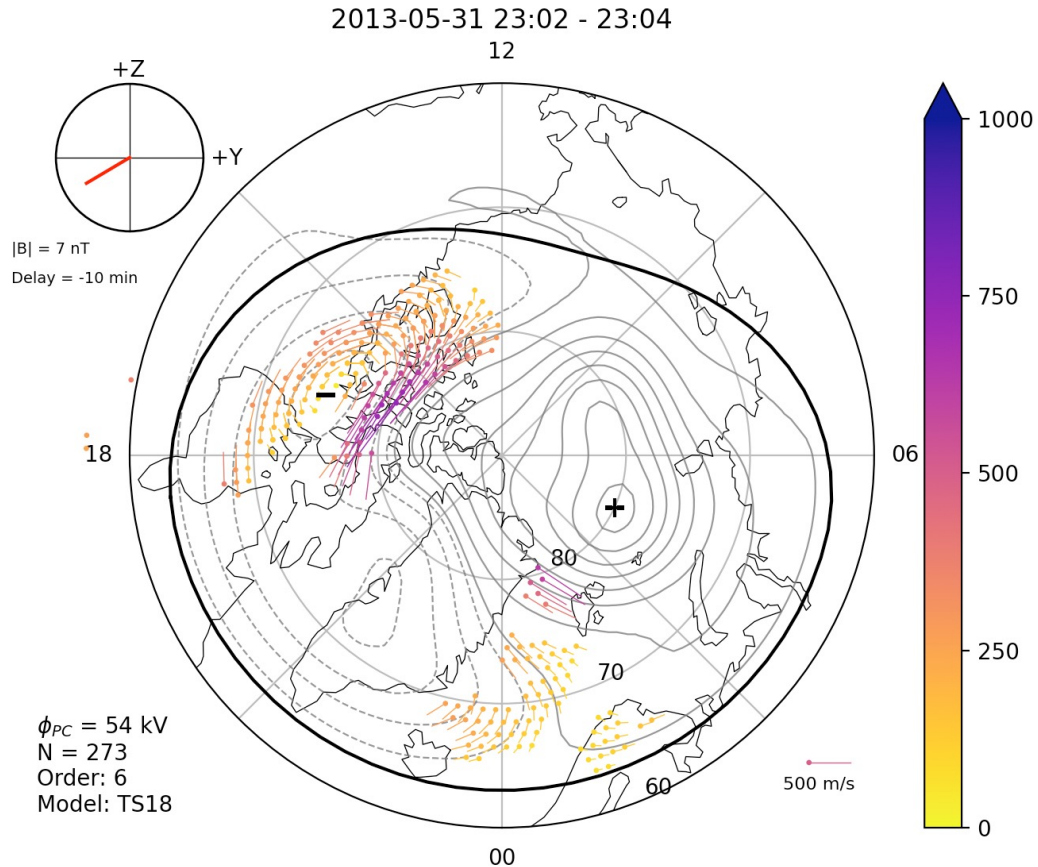
## Grid Plots



```
pydarn.Grid.plot_grid(grid_data, record=360,  
coastline=True,  
boundary=True, fov_color='grey')
```

# Features Overview

## Convection Maps



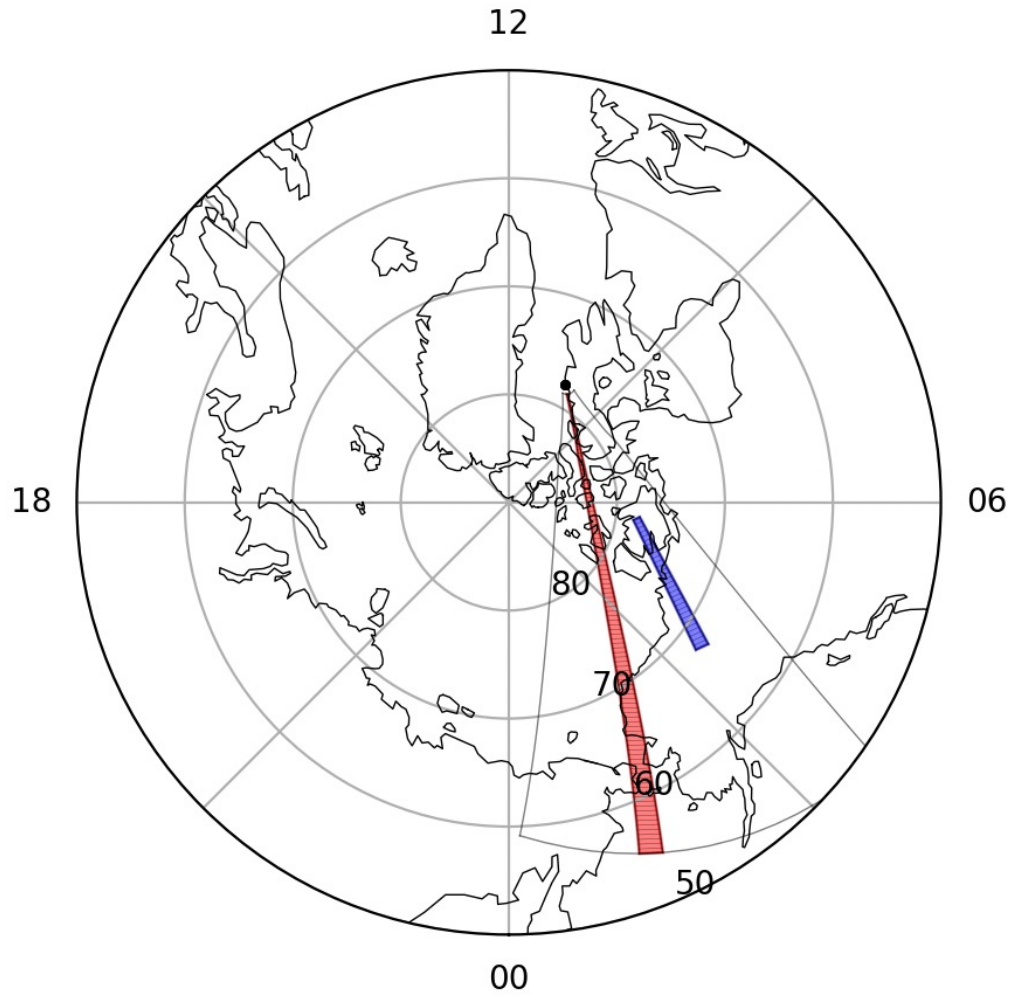
```
pydarn.Maps.plot_mapdata(map_data, record=690,  
parameter=pydarn.MapParams.FITTED_VELOCITY,  
lowlat=50, contour_fill=True,  
color_vectors=False, coastline=True)
```

[superdarn.ca/convection-maps](http://superdarn.ca/convection-maps)

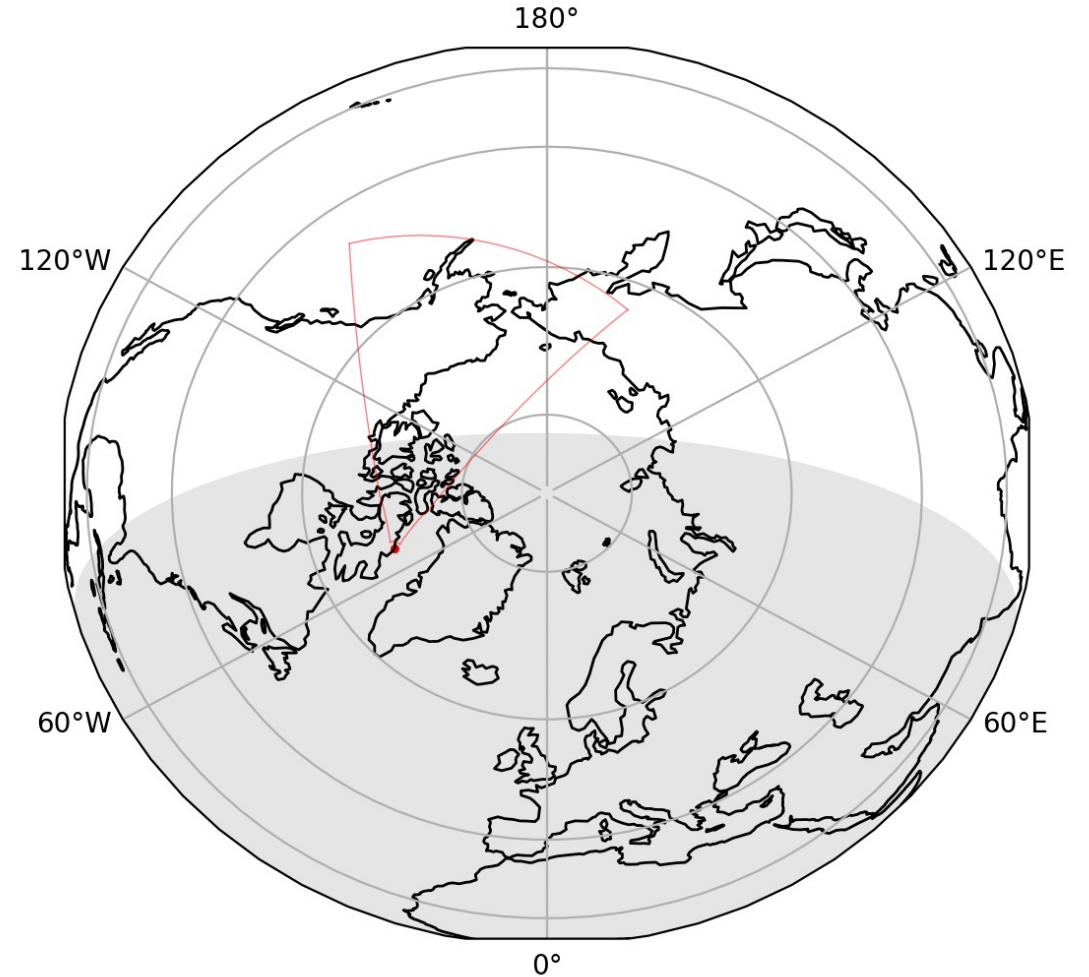
# Coming soon...



## Plot a Single Beam/ Selected Ranges



## Terminator

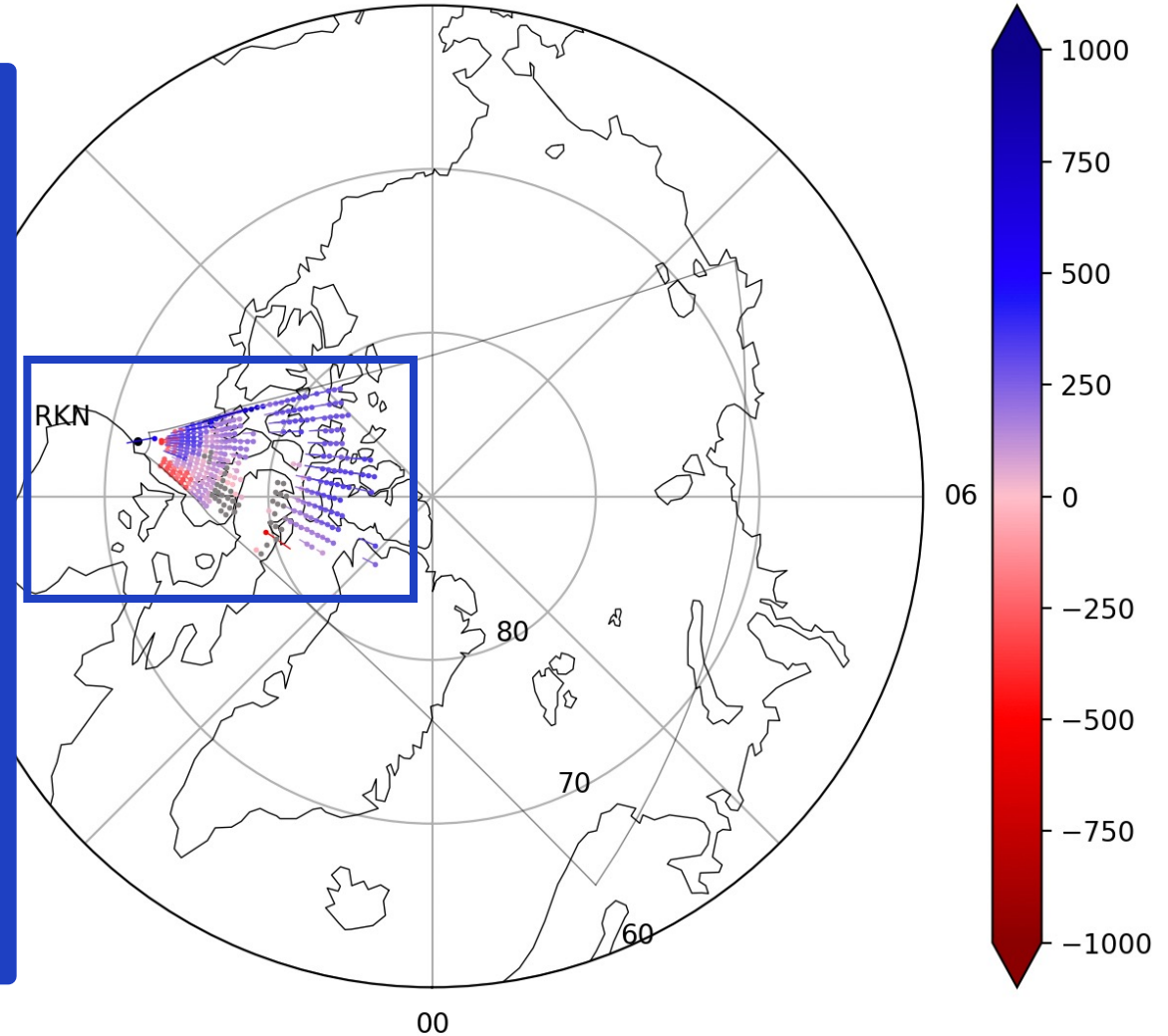
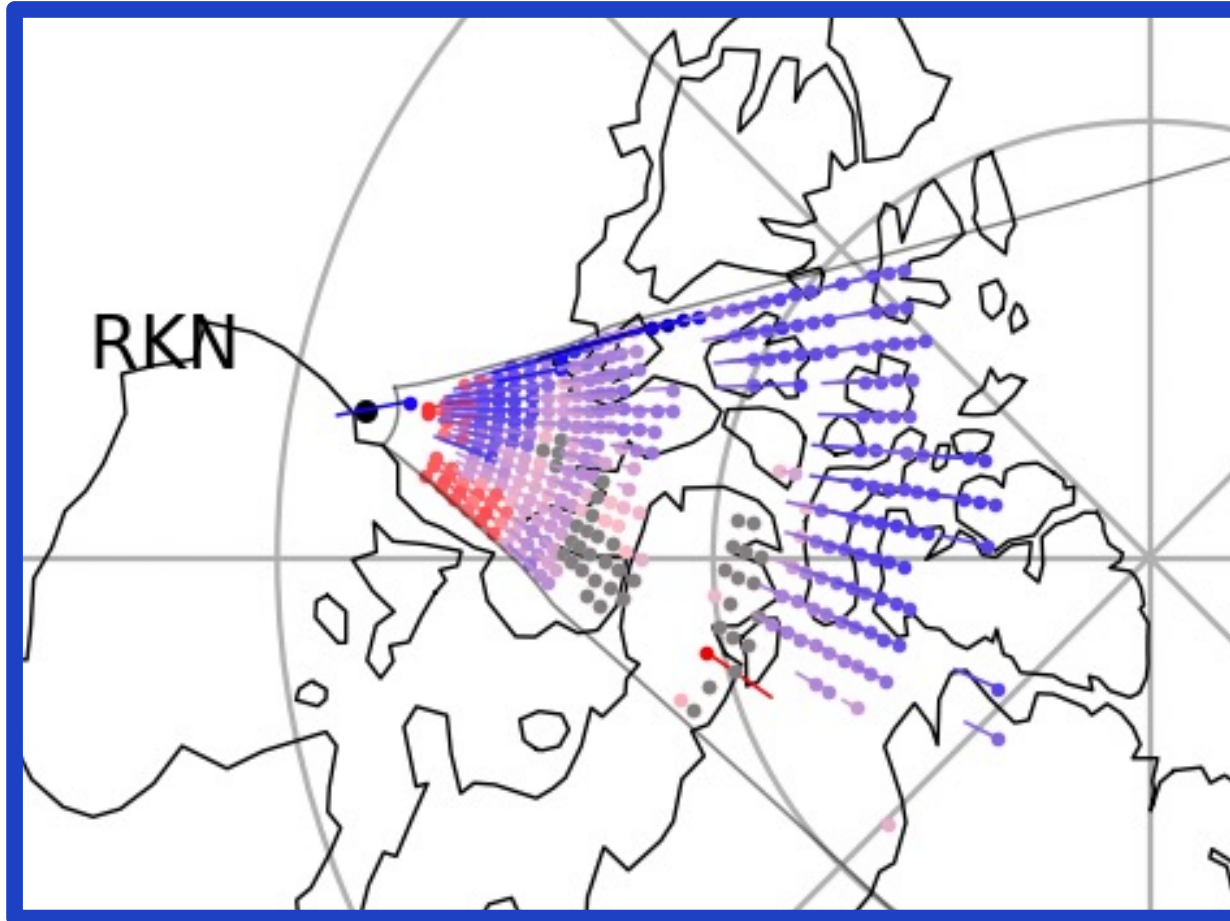


# Coming soon...

## Ball and Stick Plots

2018-01-01 00:00:01 - 00:00:53

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# pyDARN Online

[superdarn.ca/pydarn](https://superdarn.ca/pydarn)



**Plot Option** ▾ Fan Plot

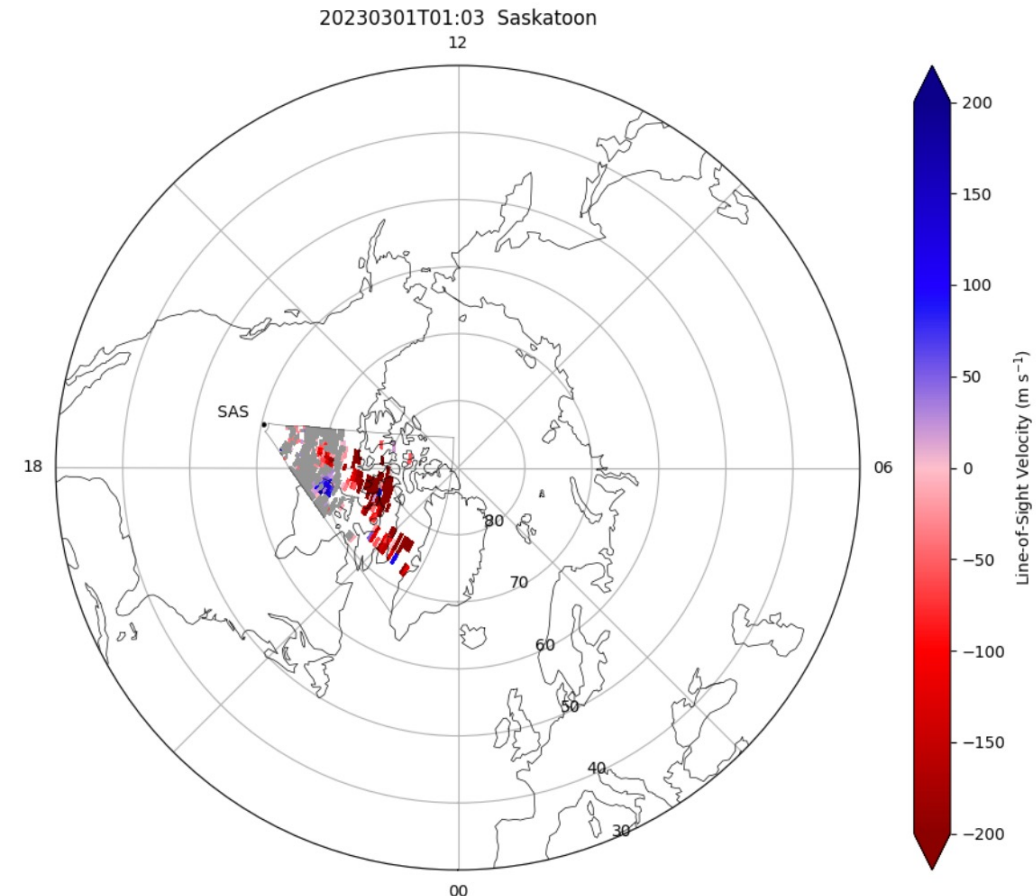
Date | Time 2023-03-01

Radar Saskatoon

Parameter Line-of-Sight Velocity (m/s)

Advanced Options  Check Inventory

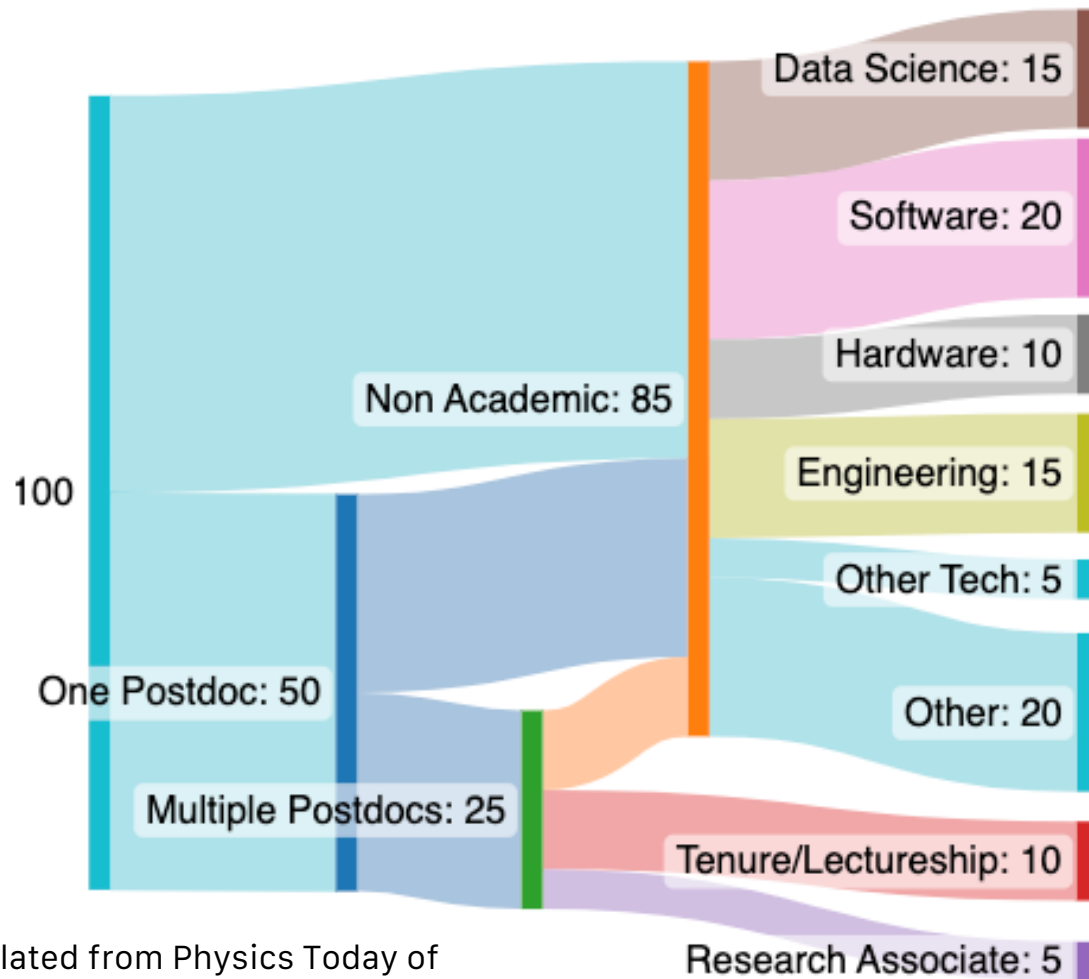
**Create Plot**



# Why you should be developing



Physics  
graduate  
students:



Data collated from Physics Today of PhD students from 1970-2018 and American Institute of Physics studies on graduate careers in 2017-2018 (rounded numbers)

\*APS estimates as low as 3-5% tenure rate

65% of graduate students end up in career requiring some knowledge of software or computing outside academia

75-90% of active programming time is spent debugging

Getting experience in coding now will:

- Save you **time**
- Give you better **career prospects**
- Make your colleagues like working with you more (!!)
- Make your research conclusions more **reliable**
- Make scientific code more **respected** in industry

More respect for SuperDARN internationally and outside academia === **Getting that funding money**



# Summary

- pyDARN makes it easier for new students and scientists not in the SuperDARN community easily produce plots and read data
- pyDARN is always growing with **new tools** and **plotting features**
- We are always looking for **help testing and developing**
- Email Carley to get involved!  
**[carley.martin@usask.ca](mailto:carley.martin@usask.ca)**
- Check out our publication: **pyDARN: A Python software for visualizing SuperDARN radar data**  
**[DOI:10.3389/fspas.2022.1022690](https://doi.org/10.3389/fspas.2022.1022690)**

