

# **Polar cap patches detection algorithm**

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# Is there any combination of parameters measured by SuperDARN that makes patches 'unique'?

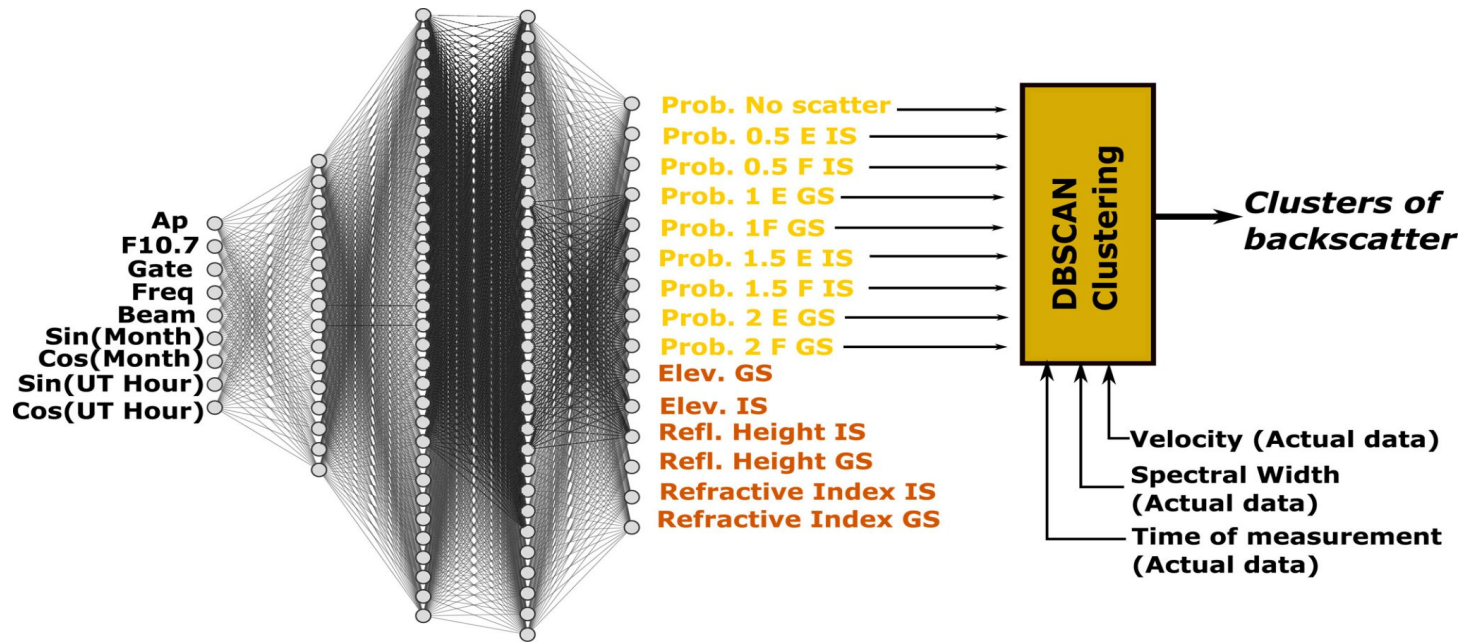
- Main requirements: decameter scale irregularities aligned with the geomagnetic field; transmitted EM wave has to reach the geomagnetic field line perpendicularly

Different instruments detect different processes, not overlapping

Within SuperDARN backscatter, we need to distinguish between different source regions - first step

# Kunduri et al, 2022: An Examination of SuperDARN Backscatter Modes Using Machine Learning Guided by Ray-Tracing

- Algorithm applied to mid-latitudes, to distinguish between ionospheric backscatter, groundscatter and meteor trails echo
- Includes predictions from ray-tracing (trained neural network), which are then combined with SuperDARN signal and clustered



# Distinguishing between different source regions of the signal

The screenshot shows a GitHub repository page for 'vtsuperdarn/clustering\_superdarn\_data'. The repository is public and has 156 commits, 9 stars, 8 watchers, and 6 forks. The main content is the README file, which describes the project's goal: classifying SuperDARN backscatter using machine learning algorithms. The README text is as follows:

**clustering\_superdarn\_data**

We are developing new models for classifying SuperDARN (Super Dual Auroral Radar Network) data using machine learning algorithms. In the past, this data has been classified point-by-point using a quadratic formula based on doppler velocity and spectral width. Recently, researchers successfully applied unsupervised clustering techniques to this data. These approaches improved on past methods, but they used a very limited set of features to create clusters and relied on simple methods (k-means, depth-first search) that do not easily capture non-linear relationships or subtle probability distributions.

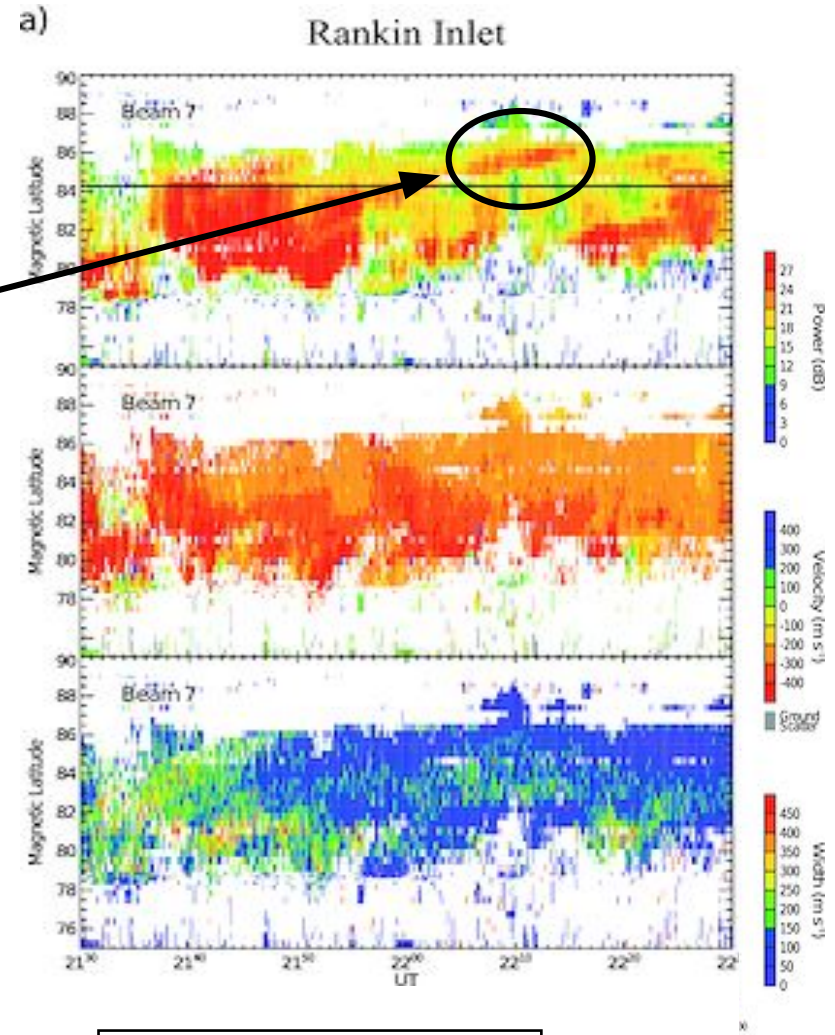
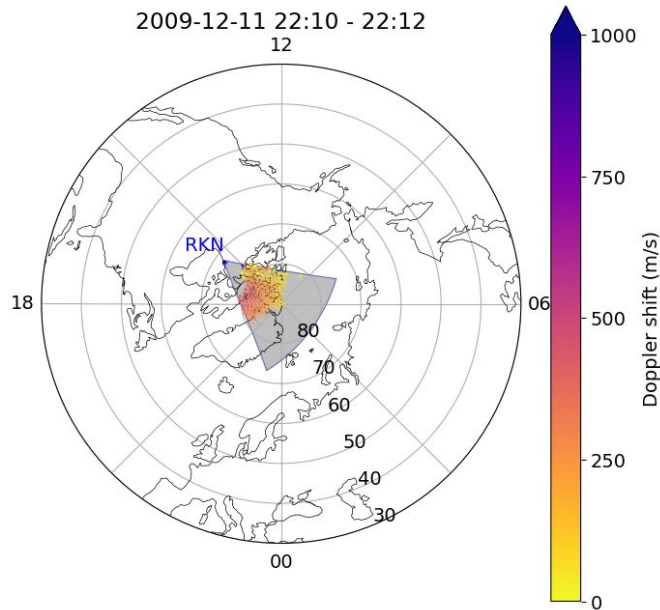
This project applies DBSCAN and Gaussian Mixture Model (GMM) to the data, and provides a library with different models and classification thresholds which can be used on SuperDARN data. Depending on characteristics of the data the user wants to study, different models, parameters, and thresholds may be suitable. For example, the Ribiero threshold is best for mid-latitude radars. and the Blanchard thresholds are best for high-latitude. See below for more

File	Description	Updated
algorithms	add ability to save .csv output from clustering algs	5 years ago
data	Added new pickle files for all dates we have good data for. ...	6 years ago
plotters	Updated ipython plotters, added pickle for each one	6 years ago
utilities	add ability to save .csv output from clustering algs	5 years ago
website	Updated the website	6 years ago
LICENSE.txt	Update LICENSE.txt	6 years ago
README.md	Changed some function signatures	6 years ago
index.html	Update index.html	6 years ago
requirements.txt	update requirements.txt	6 years ago

**Contributors:** e-271 Esther Robb, MuhammadVT Muhammad Rafiq (Mai...)

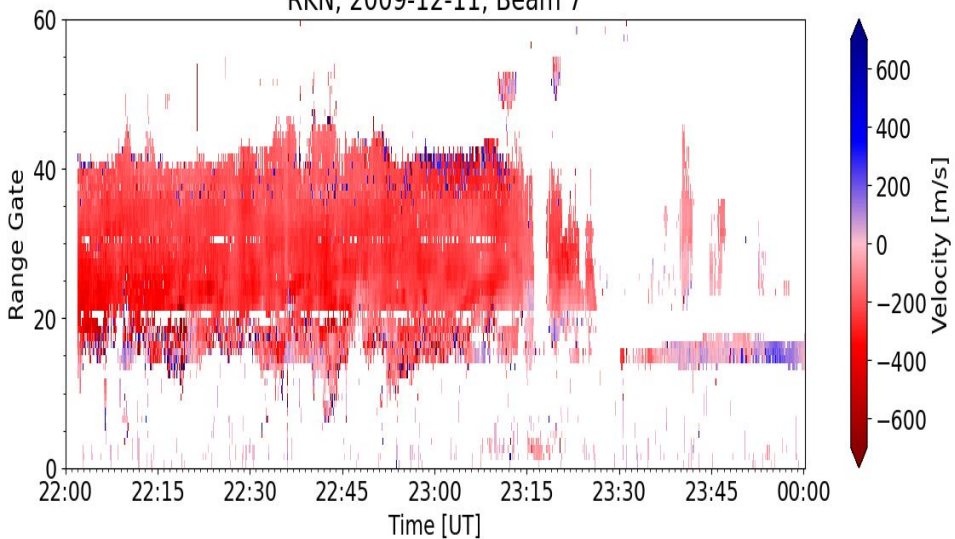
**Languages:** Jupyter Notebook 95.6%, Python 3.4%, Other 1.0%

- Since SuperDARN does not provide plasma density measurements, which other parameters are important for the polar cap detection?
- We use the same dataset as Dahlgren et al., (2012) – a patch is identified at around 22:13 UT

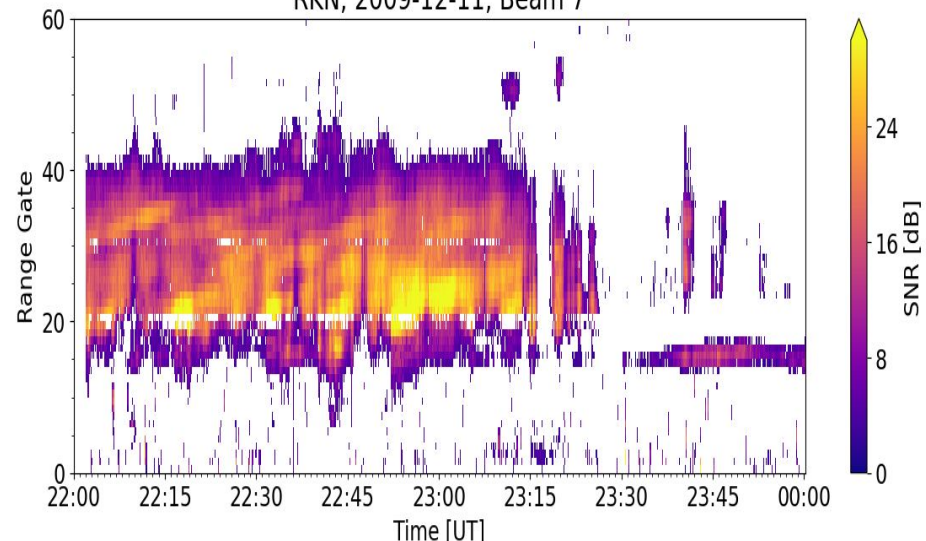


(Dahlgren et al., 2012)

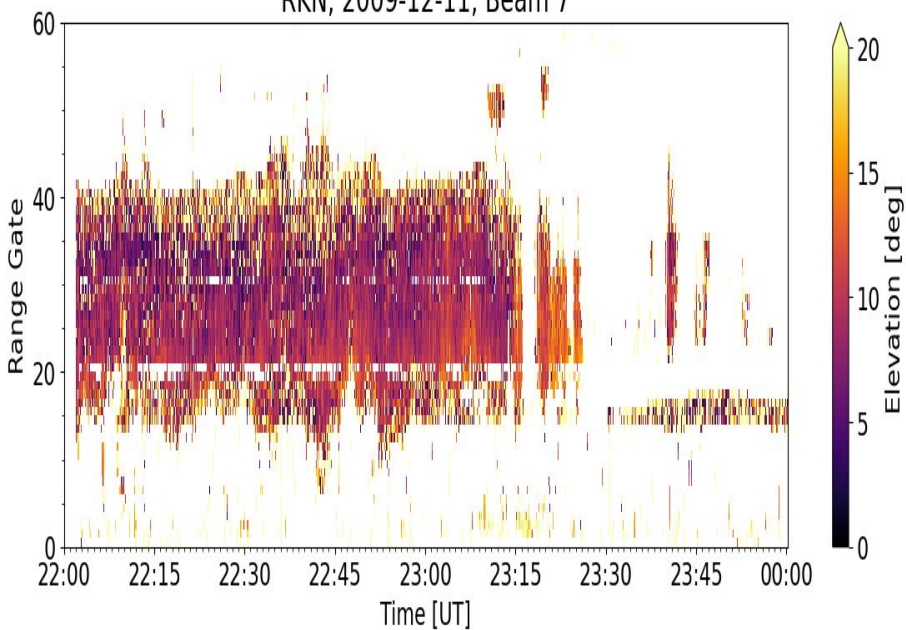
RKN, 2009-12-11, Beam 7



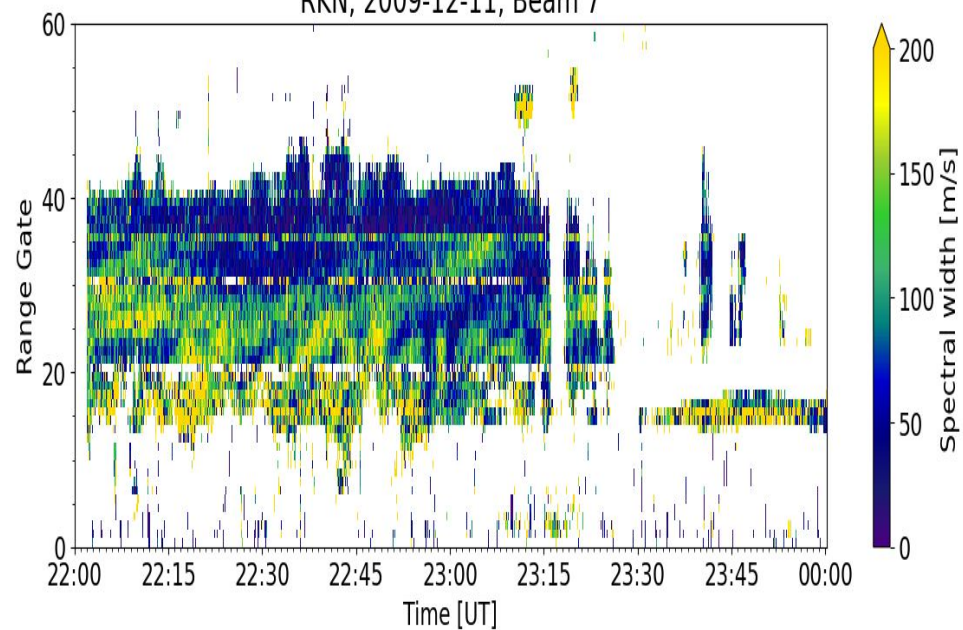
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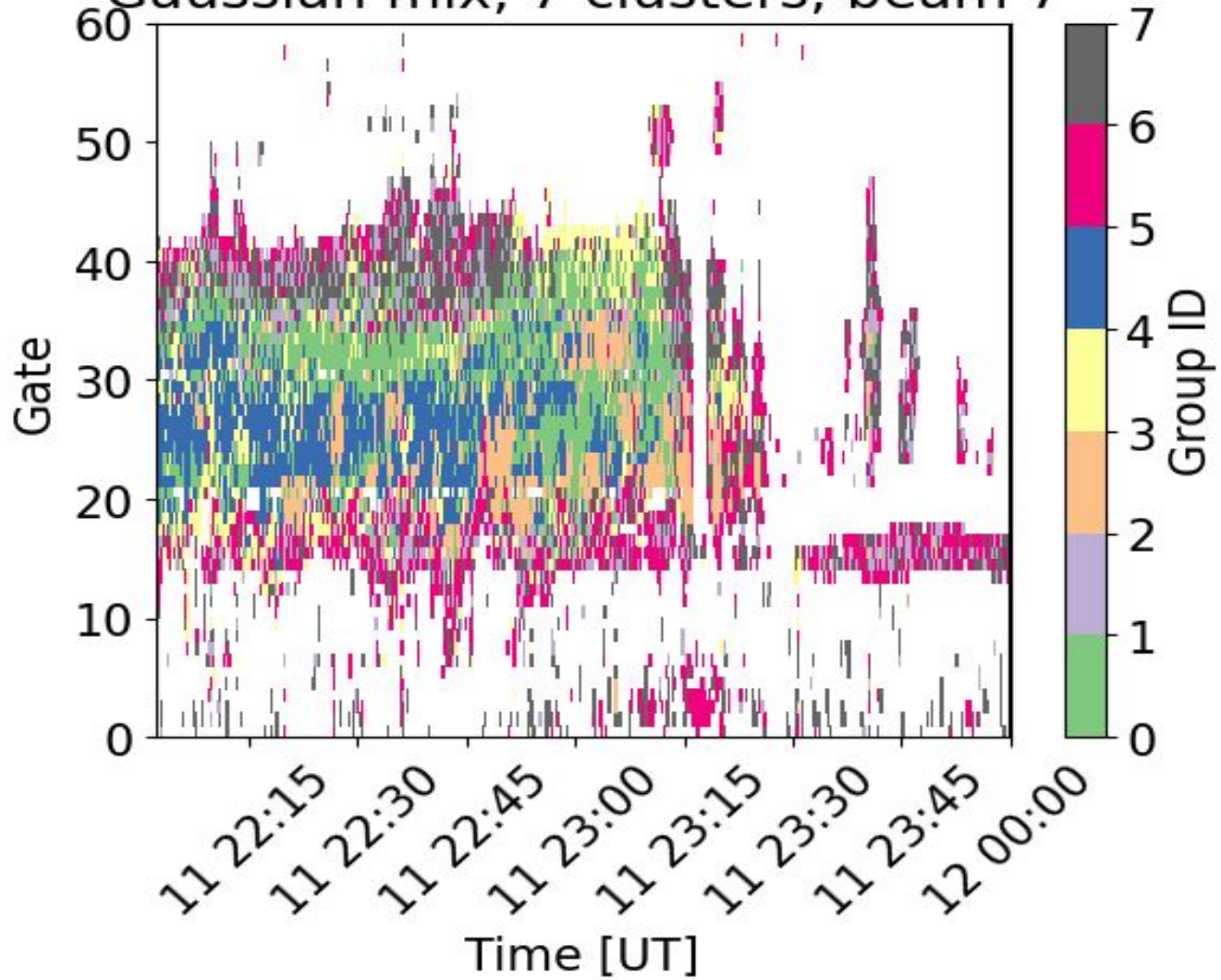
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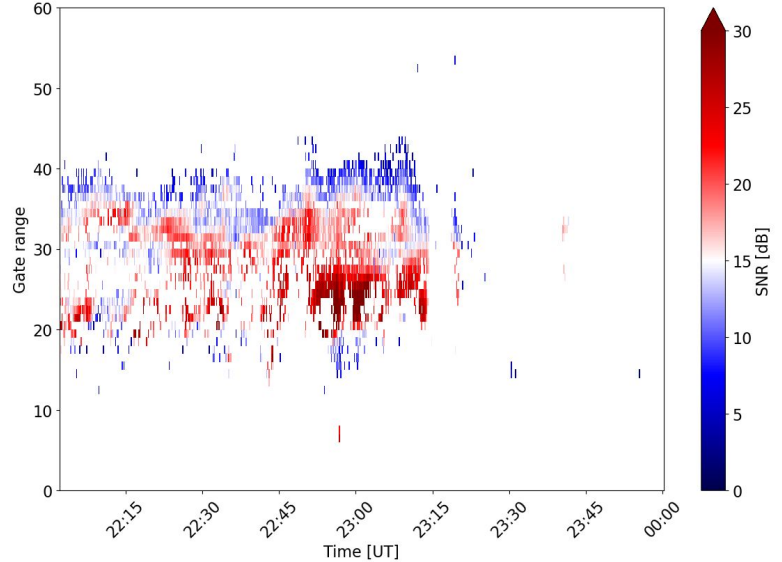
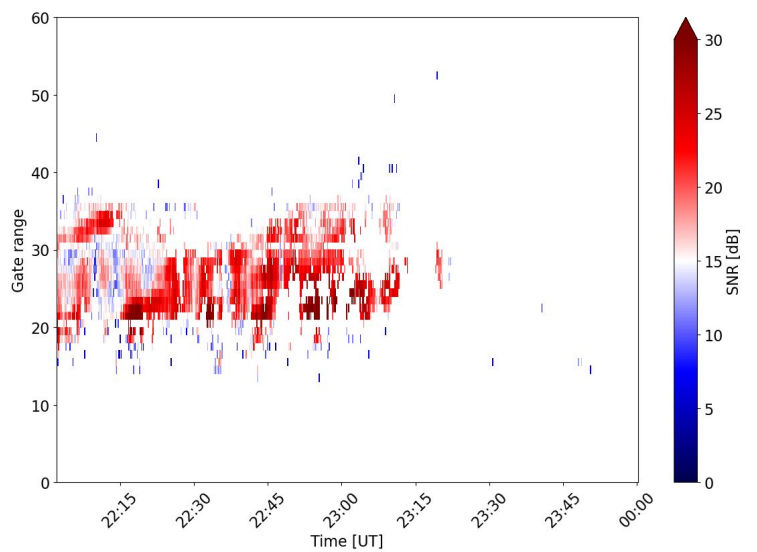
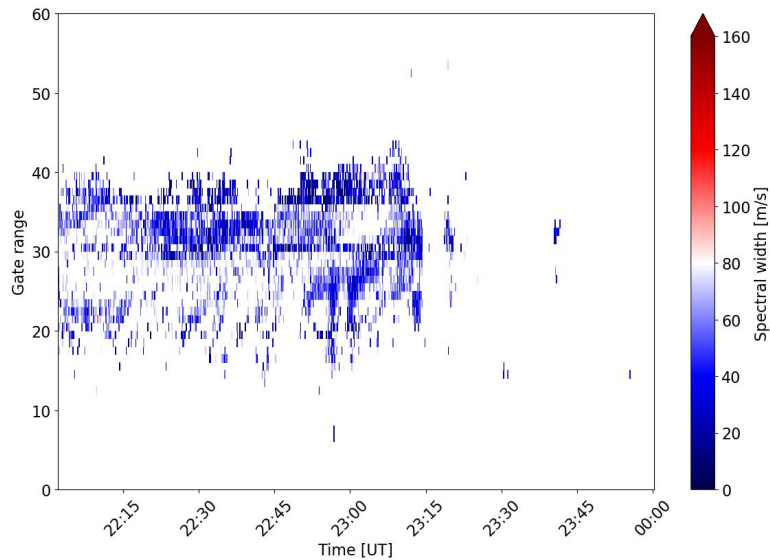
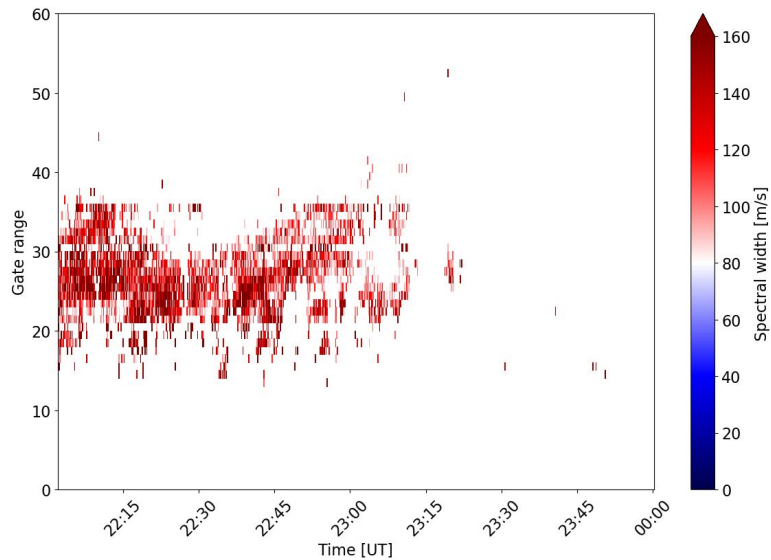
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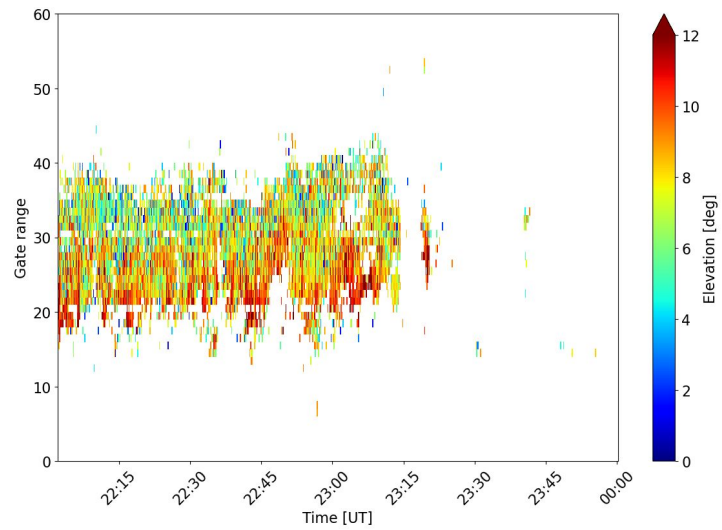
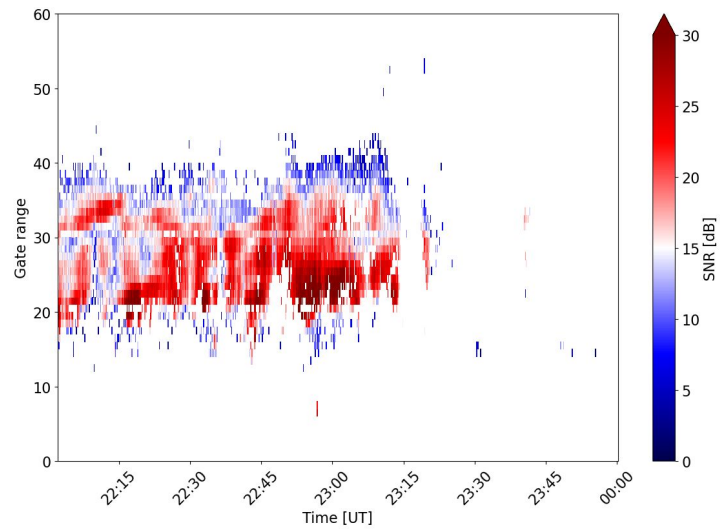
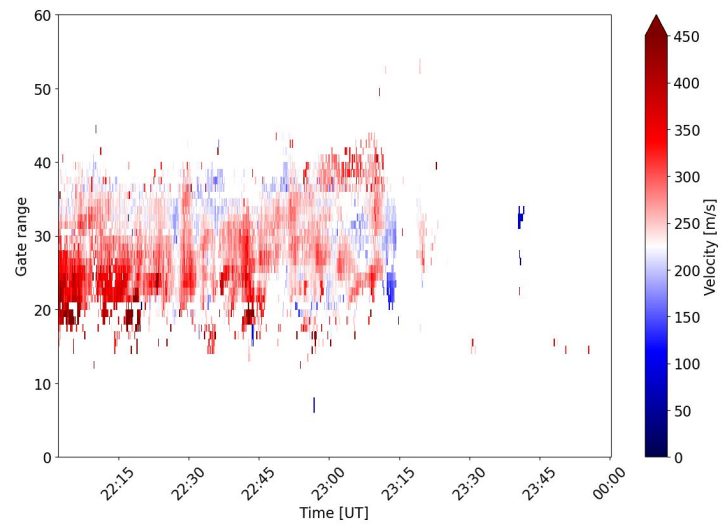
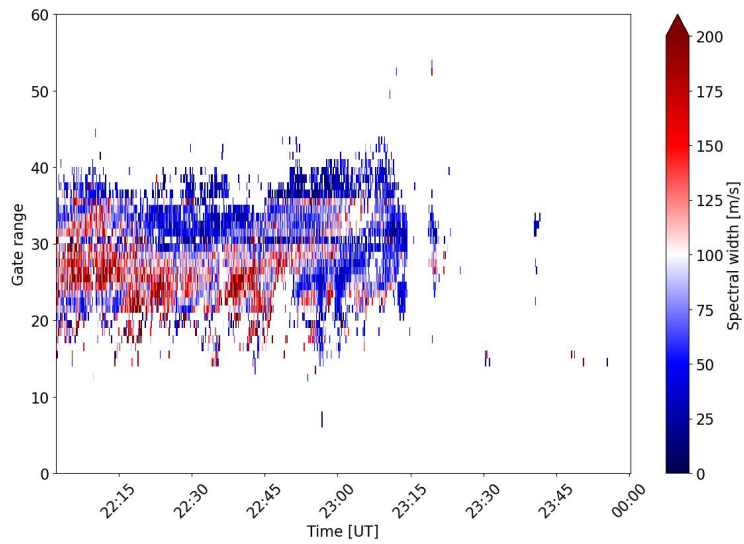
# Gaussian mix, 7 clusters, beam 7



Number of clusters estimated from the BIC score test







# Conclusions

- Case studies are helpful for constraints used in automatic detections
- Statistical study requires automatic approach
- There are already tools to differentiate between different source regions, but still we need to investigate the properties of patches themselves

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