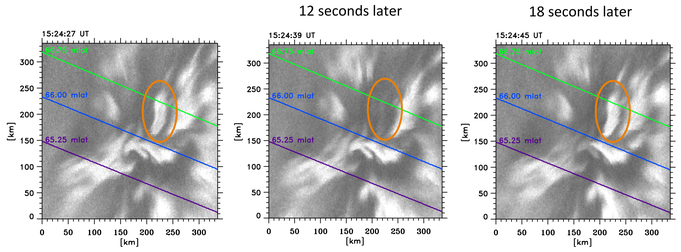
Untangling the space-time ambiguity of pulsating aurora

B. K. Humberset[1,2], J. W. Gjerloev[3,2], Robert Michell[4], Marilla Samara[4], Lessard, M., Ian Mann[5]

1: University of Bergen, Bergen, Norway.
2: Birkeland Centre for Space Science, Bergen, Norway
3: John Hopkins University-Applied Physics Laboratory, Laurel MD, USA.
4: Southwest Research Institute, Space Science Section, Texas, USA.
5: University of New Hampshire, Magnetosphere Ionosphere Research Lab, USA
6: University of Alberta, Alberta, Canada

Please write to beate.humberset@ift.uib.no for further discussion.

What are the spatiotemporal characteristics of pulsating aurora?



Motivation

Pulsating aurora (PA) often covers the entire sky with intermixed large and small-scale spatial (tens to hundereds of km) and quasi-periodic temporal variations (typically 2 to 20 seconds pulsations) [eg Lessard 2012].

A study of FAC indicated that the spatiotemporal characteristics of the magnetosphere-ionosphere system appear repeatable and utilizes all scale sizes [Gjerloev et. al. 2011]. Is this also the case for pulsating auroras, or is it only certain scale sizes which pulsate?

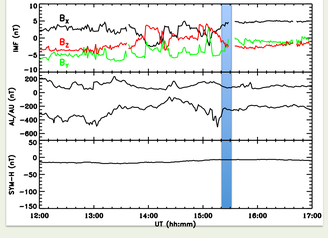
Pulsating Auroral Emissions - Δ/Δt From All-sky Imager

Data

All-sky imager data provides measurements at the same position, but separated in time allowing us to calculate Δf/Δt.

We investigate a 5 minutes case from a longer PA event 1 March 2012. We utilize 557.7 nm images obtained by a ground based all-sky imager (3.31 Hz) located at Poker Flat, Alaska.

Conditions

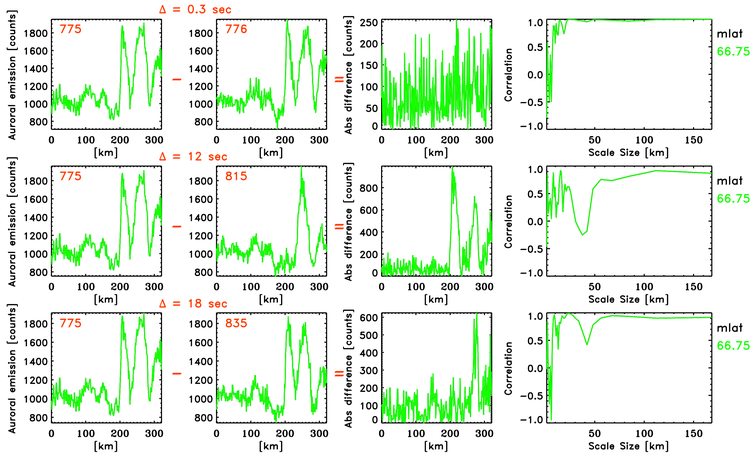


Technique

1) Transform fisheye images (512x512 pixels) onto an uniform grid.
2) Sample along a magnetic latitude to extract a 512 pixels mlat-vector or each image.
3) Perform a Fourier Transform for each mlat-vector; use a sweeping narrow Hanning type band pass filter and transform filtered mlat-vector back to produce 256 frequency filtered vectors.
4) Determine: C=C(f, Δt), where f is the frequency of the band pass filter and Δt is the image separation.
5) Define the scale size as $S = \Delta x = (1.3 \times 512)/f_x$

Typical Event

A closer look at the mlat-vector along 66.75° magnetic latitude.



Summary & Conclusion

We have addressed the spatiotemporal characteristics of a short period of pulsating aurora (PA) 1 March 2013 using an ASI movie. To determine the scale size dependent variability we used a simple, yet robust, FT technique.

We find indication that PA has these spatiotemporal characteristics:
- ✓ Only certain scale sizes pulsate.
- ✓ The period of the pulsation is variable.
- ✓ The PA source mechanism is drifting eastward.

References

Gjerloev J. W. et. al. (2011), Characteristics of the field-aligned current system, *Ann. Geophys.*, 29, 1713–1729, 2011

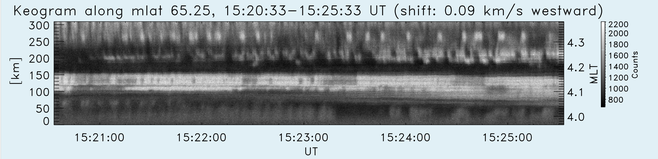
Lessard, M. R. (2012), A review of pulsating aurora, Auroral Phenomenology and Magnetospheric Processes: Earth and Other Planets, *Geophys. Monogr. Ser.*, vol. 197, edited by A. Keiling et al. 55–68, AGU, doi:10.1029/2011GM001187.

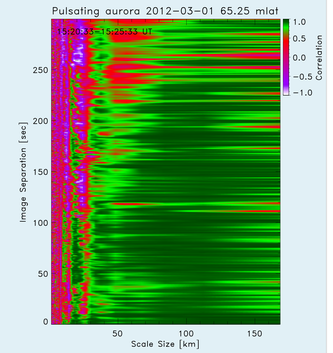
Lew J. A. (1961), Drift rate in a dipole field, *J. Geophys. Res.*, 66, 2681-2685.

Spatiotemporal Characteristics

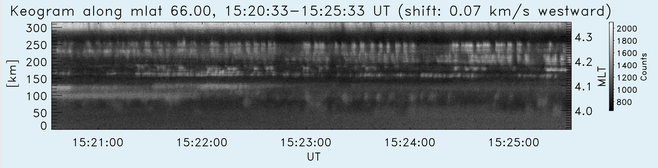
Keograms along a fixed magnetic latitude.

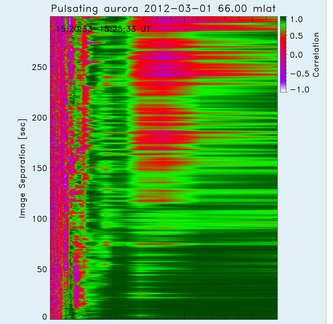
65.25° magnetic latitude:



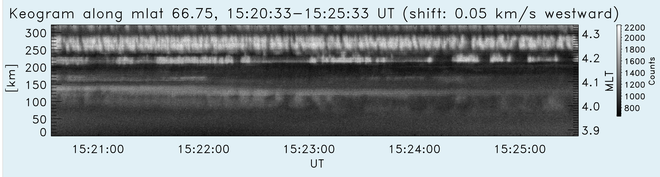


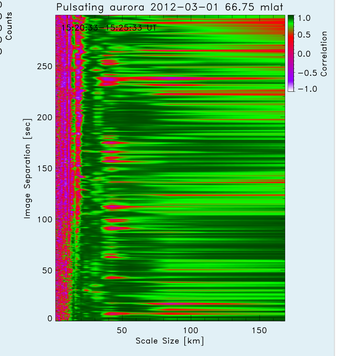
66.00° magnetic latitude:





66.75° magnetic latitude:





Magnetic latitude dependence

From visual inspection of the keograms, it is found indication of a mlat dependence in the PA eastward drift:
65.25 deg: 0.170 km/s, 66 deg: 0.176 km/s, 66.75 deg: 0.183 km/s.
Such a signature should also be seen in the magnetic electron drift. However, using a simple technique for drift time calculation [Lew, 1961] we find that these drifts correspond to ~ 0.4 keV electrons, not 30-60 keV producing PA.