Auroral View Lines

This short paper is meant to be a summary of ***Using citizen science reports to define the equatorial extent of auroral visibility*** by *Case, N.A., et al.*

Introduction

An aurora may often be viewed hundreds of kilometers equatorward of the auroral oval owing to its altitude. As such, the NOAA Space Weather Prediction Center (SWPC) Aurora Forecast product provides a "view line" to demonstrate the equatorial extent of auroral visibility, assuming that it is sufficiently bright and high in altitude.

View lines can be calculated using the outputs of OP-13 multiple different ways (Here the OP-13 data is resampled into an array of 1024 bins in longitude and 512 bins in latitude, much like the CCMC sight). The precipitating energy flux of each auroral type is summed (Σj) and then scaled to a percentage probability of visible aurora or P(A) using the formula below.

$$P(A) = 10 + 8\Sigma j$$

This is not a view line or probability of where an aurora might be seen from but rather a probability of where there might be visible aurora geographically. This is very similar to what we have discussed doing so far.

SWPC View Line

The first equation used to generate a view line by SWPC is shown below and involve using the maximum probability of visible aurora.

The SWPC view line is determined independently for both hemispheres. Each of the 1024 geographic longitudinal arrays (spaced at 0.35° intervals) are split by hemisphere, and the maximum probability of visible aurora (P(A)max) in that longitudinal hemispheric array is determined. The latitude of the most equatorward bin, in that array, containing this maximum probability is then found (ϕP(A)max)

$$\phi_{VL}^{SWPC} = \phi_{P(A)max} \pm \left(\frac{P(A)_{max}}{20} + 3 \right)$$

Aurorasaurus View Line

The Aurorasaurus view line is calculated in a very similar way using $P(A)_{max}$ but with different constant values.

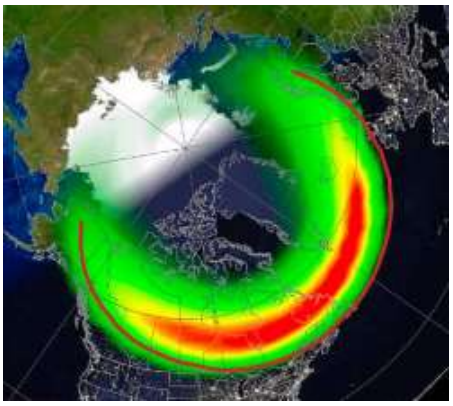
$$\phi_{VL}^{AS} = \phi_{P(A)max} \pm \left(\frac{P(A)_{max}}{16} + 8 \right)$$

Equatorial Boundary View Line

The third and final way to find a view line presented in this paper does not use $P(A)_{max}$ and instead bases the view line on the equatorward boundary of OP-13 or ϕ_{EB}. ϕ_{EB} is the boundary at which P(A) ≥ 18%, equal to Σj ≥ 1 erg cm^{-2} s^{-1}. This boundary is then used in the formula below to find the view line.

$$\phi_{VL}^{EB} = \phi_{EB} \pm 8$$

This view line was created specifically to avoid instances where the view line would overlap with the edges of the visible aurora prediction like below.



Additional Notes

The ± in the view line equations is to scale the latitude equatorward depending on which hemisphere you are looking at.

The accuracy as compared to Aurorasaurus data was calculated for each view line and resulted in the table below.

Table 1. A Summary of the View Lines and Their Accuracies

View Line	Equation	Accuracy (%)
Updated SWPC	$\phi_{VL}^{SWPC} = \phi_{P(A)max} \pm \left(\frac{P(A)_{max}}{20} + 3\right)$	43.9
Aurorasaurus	$\phi_{VL}^{AS} = \phi_{P(A)max} \pm \left(\frac{P(A)_{max}}{16} + 8\right)$	90.1
Equatorial boundary	$\phi_{VL}^{EB} = \phi_{EB} \pm 8$	91.2