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Probability Distribution Functions of Ionospheric Peak Parameters

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One way to probabilistically assess systems that are impacted by the ionosphere (such as over the horizon radars) is to simulate that system through an ensemble of ionospheres. In order to perform an accurate assessment, an ensemble of *realistic* ionospheres is required. Such ionospheres can be generated using an ionospheric profiler (e.g. NeQuick) driven by representative 'anchor points' (NmF2, NmF1, NmE, hmF2, hmF1 and hmE). Probability distribution functions of these anchor points (parameters) can be estimated from long-term databases of scaled ionograms.

In this study we investigate ionosonde data over a period of 20 years (from January 1st 2000 to December 31st 2019) from 13 spatially distributed stations. Binning the data by region, time-of-day and geomagnetic activity levels Gaussian, Log-normal, Rayleigh and Weibull distributions have been fitted to the data, and the quality of the fit assessed using Jensen Shannon divergence (Figure 1).

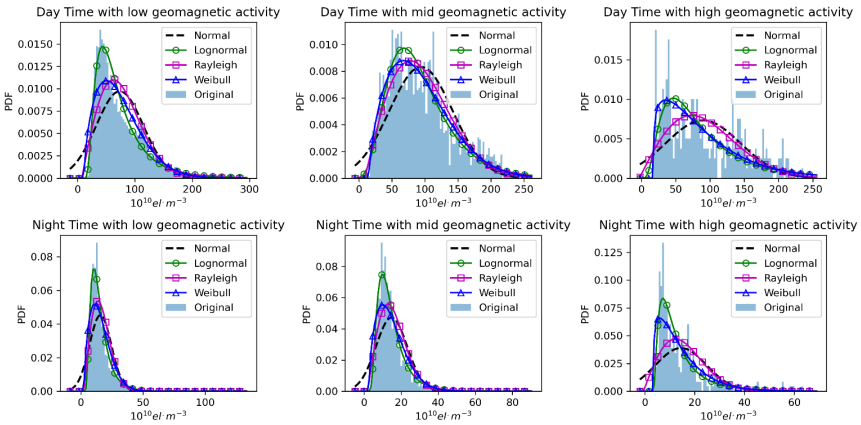

Figure 1. Examples of probability distribution function estimates for NmF2 at Grahamstown, RSA (GR13L).

The analysis demonstrates that in the vast majority of cases (~85%) a log-normal distribution fits the data best, and in the cases where it does not (and in those cases a Weibull distribution tends to) it usually ranks as "second-best". Overall, in 98% of cases a log-normal distributions ranks first or second according to the Jensen Shannon divergence.

By investigating the mean and standard deviations of the fitted log-normal PDFs, functions of these parameters are derived for each of the peak parameters. This paper presents these functional forms which can be used to generate probability distribution functions for each of the six anchor points at low, mid and high latitudes for low, mid or high levels of geomagnetic activity for day or night.