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Testing the role of Dispersion Relation & Collision Frequency Formulations on Estimation of Shortwave-Fadeout (SWF)

S. Chakraborty*(1), J. B. H. Baker(1), R. Fiori(2), J. M. Ruohoniemi(1), K. Zawdie(3)
(1) Virginia Tech, USA
(2) Natural Resources Canada, Canada
(3) Naval Research Laboratory, DC, USA

Over-the-Horizon (OTH) communication is strongly dependent on the state of the ionosphere which is susceptible to solar flares [1]. Trans-ionospheric high frequency (HF) signals on the dayside of the Earth can experience strong attenuation ($\geq$1dB on 30 MHz) following a solar flare (M-class or stronger) that lasts typically for an hour, a phenomenon commonly referred to as Shortwave-Fadeout (SWF). In this study, we examine the role of dispersion relation-collision frequency formulations on estimation of SWF in riometer observations using a data assimilation framework. The framework first uses modified solar irradiance models (such as EUVAC, FISM) [2], which incorporate high-resolution solar flux data from GOES satellite X-ray sensors, to compute the enhanced ionization produced during a flare event. The framework then uses different dispersion relation-collision frequency formulations [3] to estimate the enhanced HF absorption. Finally, the modelled HF absorption is compared with the data to determine which dispersion relation-collision frequency formulation best reproduces the observations. We find that the Appleton-Hartree dispersion relation in combination with Schunk-Nagy collision frequency [4] profile results in the best performance among the four formulations under consideration with an RMSE on attenuation of less than 0.25 dB over the lifetime of the event. We anticipate application of this formulation will lead to improve space weather forecast of solar flare impacts on HF propagation.

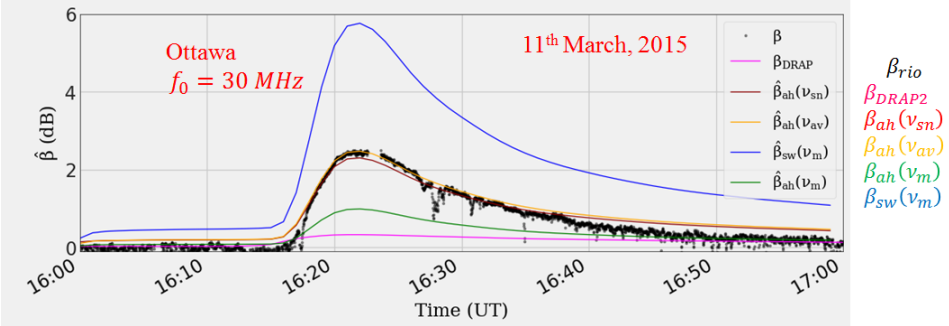

Figure 1. Data–model comparison between Ottawa riometer measurements and outputs from three different model formulations during a solar flare event on 11 March, 2015. Five colored curves represent four different formulations and DRAP2 model (in magenta) outputs.

References

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