

## Calculating the Absorption of HF Radio Waves in the Ionosphere

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High Frequency (HF) radio waves experience absorption during ionospheric propagation which can significantly influence the received signal strength. The calculation of ionospheric absorption is thus vital for many HF applications, including Over the Horizon Radar (OTHR) and satellite signal propagation through the ionosphere. It has long been known that the ionospheric absorption of HF radio waves is dependent on the electron density in the ionosphere, but the impact of the ray trace formulation and electron collision frequency used to calculate the absorption is less clear. The Sen Wyller ray trace formulation has been assumed to provide more realistic estimates of absorption, especially in the D- and E-regions of the ionosphere as it assumes the electron collision frequency is proportional to the square of the electron velocity. In this paper the two formulations are outlined and compared to each other. In addition, the correct collision frequency specifications for use in each formulation are examined. Comparisons of the two absorption calculations show that the two formulations are effectively equivalent, with maximum errors only in the range of 5%, if the correct collision frequency specifications are utilized. These errors are significantly smaller than the 30% errors predicted in the Sen Wyller paper (H.K. Sen and A.A. Wyller (1960), On the generalization of the Appleton-Hartree magnetoionic formulas, *J. Geophys. Res.*, 65, 3931–3950, doi:10.1029/JZ065i012p03931). Finally, the dependence of the ionospheric absorption on seasonal and daily variations of the collision frequency is examined and found to be significant enough to warrant inclusion in future ionospheric absorption models.