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Ray-tracing analysis of fractional-hop whistlers recorded by DEMETER in relation to the IRI model

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We use a backward ray-tracing technique to estimate the path and dispersion of fractional hop whistlers from the base of the ionosphere to the altitude of ~700 km. At this altitude, the wave polarization characteristics and propagation directions are obtained from multidimensional analysis of 3D waveforms of ELF electric and magnetic fields measured by the DEMETER spacecraft. We use a density profile based on the IRI model to obtain theoretical dispersion of group times of the rays at different frequencies. These model results are then compared to the observed spectrograms of fractional hop whistlers. The source lightning strokes are also identified by the EUCLID lightning detection network. We thus know what are the positions and parameters of the lightning sources of the whistler mode radiation observed by DEMETER. This allows us to characterize how the radiation penetrates through the ionosphere.