Variational Methods in Ionospheric Ray Tracing

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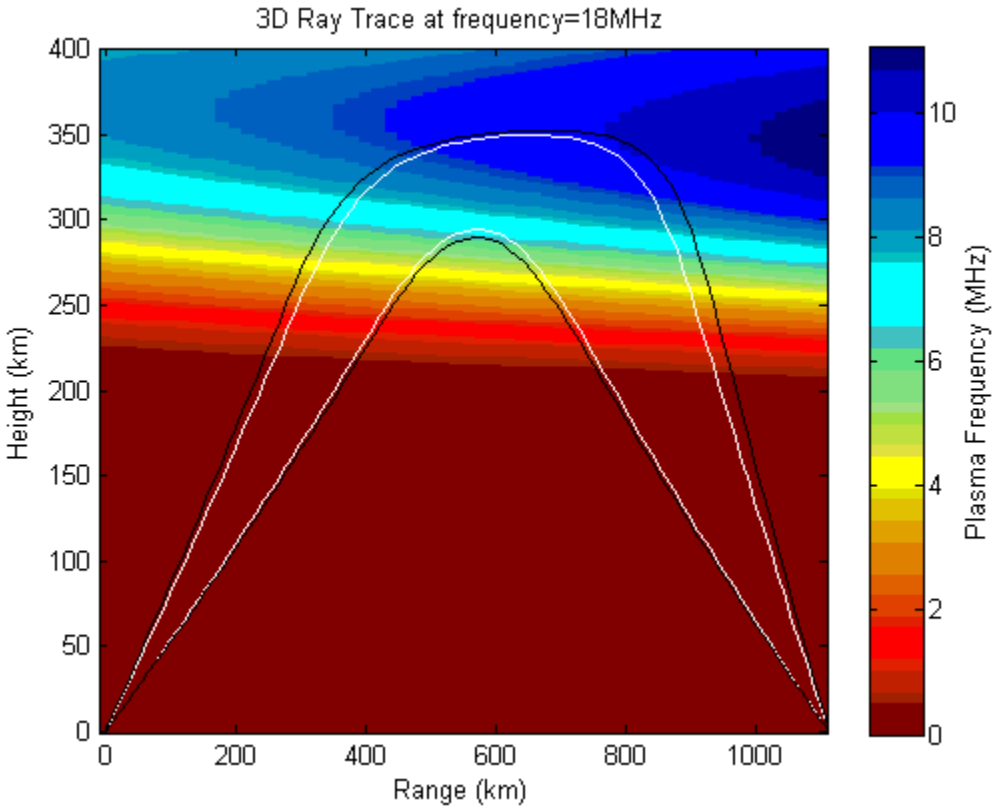
Abstract

Ray tracing is an important tool in the study of radio wave propagation. In particular, numerical solutions to the Haselgrove ray equations have proven to be one of the most useful techniques for ray tracing in the ionosphere. In their basic form, the equations allow the user to find the rays that are launched from a particular point in a variety of directions. Many important propagation problems, however, require the study of rays that start at a particular point and end at a particular point. In order to solve such problems with the Haselgrove equations, one must shoot out rays in numerous directions in order to find the ray that ends at a desired point. The iterative refinement of such a process is known as 'homing in' and is the basis of the Haselgrove approach to point to point ray tracing. Importantly, it will be noted that the Haselgrove equations are differential equations that are derived from Fermats principle. This principle provides a variational equation for ray tracing and such equations are better suited to the solution of point to point ray tracing problems. The present paper will discuss the problems of directly solving Fermats principle and describe some recent work that has led to a successful variational approach to ionospheric ray tracing with magneto-ionic effects included. The figure below shows a typical example of point to point ray tracing using this new approach.



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