Ionosphere Plasma Density Estimation by Ray Tracing Optimization

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Abstract:

In recent years, several studies have tried to estimate volumetric electron density by methods of refraction tomography on an HF network. These methods involve a dynamic optimization problem where the ray tracing equations have to be solved in every optimization step [1]. Furthermore, to improve the estimates, data from incoherent scatter radars and GPS can also be assimilated. However, the computational complexity involved in these estimates is considerable. Even though some efforts have been implemented to reduce this complexity, it is clear that new methods have to be explored.

Furthermore, to our knowledge, the possibility of using the frequency sweep capability of ionosondes has not been considered. This work simplifies the dispersion relation to an unmagnetized collisionless plasma to focus our efforts on the inverse process. Instead of using sensitivity analysis, we propose a direct collocation approach, where the points on the transmitter and receiver can be fixed, therefore, eliminating the chances of the extreme misfire.

References:

[1] Hysell, D. L., Rojas, E., Goldberg, H., Milla, M. A., Kuyeng, K., Valdez, A. (2021). Mapping irregularities in the postsunset equatorial ionosphere with an expanded network of HF beacons. Journal of Geophysical Research: Space Physics, 126.

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