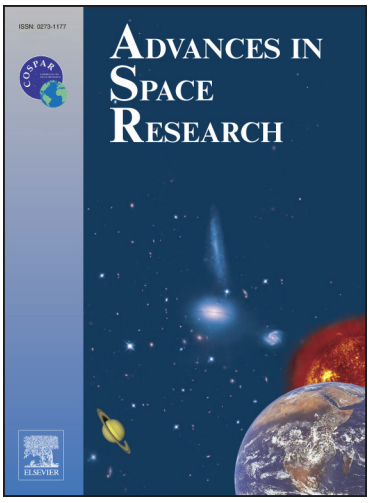

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A new inversion algorithm for HF sky-wave backscatter ionograms

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Abstract HF sky-wave backscatter sounding system is capable of measuring the large-scale, two-dimensional (2-D) distributions of ionospheric electron density. The leading edge (LE) of a backscatter ionogram (BSI) is widely used for ionospheric inversion since it is hardly affected by any factors other than ionospheric electron density. Traditional BSI inversion methods have failed to distinguish LEs associated with different ionospheric layers, and simply utilize the minimum group path of each operating frequency, which generally corresponds to the LE associated with the F_2 layer. Consequently, while the inversion results can provide accurate profiles of the F region below the F_2 peak, the diagnostics may not be so effective for other ionospheric layers. In order to resolve this issue, we present a new BSI inversion method using LEs associated with different layers, which can further improve the accuracy of electron density distribution, especially the profile of the ionospheric layers below the F_2 region. The efficiency of the algorithm is evaluated by computing the mean and the standard deviation of the differences between inverted parameter values and true values obtained from both vertical and oblique incidence sounding. Test results clearly manifest that the method we have developed outputs more accurate electron density profiles due to improvements to acquire the profiles of the layers below the F_2 region. Our study can further improve the current BSI inversion methods on the reconstruction of 2-D electron density distribution in a vertical plane aligned with the direction of sounding.

Keywords Backscatter, Ionogram, Ionosphere, Inversion, Reconstruction

1 Introduction

In the past decades, different observing instruments have been developed and used to gather information on the ionosphere, such as vertical sounders, oblique sounders, backscatter sounders, incoherent scatter radars, coherent scatter radars, satellite observations, LEO (Low Earth Orbit) GPS occultation measurements, imaging riometers, topside sounders onboard satellites and in situ rocket. However, to derive the 2-D ionospheric electron densities for heights which are crucial for HF radio wave propagation (below the F_2 peak), backscatter sounding is very important to determine height profile parameters at distances of 1000 km or more from the sounding station. Utilizing backscatter sounding systems with sweep frequency in a fixed direction, one can obtain three-dimensional graphics showing the relationship among working frequency, group path and echo energy, which are known as HF backscatter ionograms (BSIs). BSIs contain the media information of the ionosphere and land (or sea surface) in the sounding orientation. To invert the characteristics of these media according to the detected ionogram is called ionogram inversion.