

FULL-PROFILE ANALYSIS OF JICAMARCA INCOHERENT SCATTER TOPSIDE DATA

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An experiment employing alternating codes has been used at the Jicamarca Radio Observatory for incoherent scatter observations of the topside ionosphere since 2000. This experiment allows the simultaneous measurement of electron density, electron and ion temperature, and ion composition for altitudes up to about 1300 km during high solar activity. During periods of low solar activity, however, the sensitivity of this experiment decreases noticeably, and an alternative mode for topside observations becomes necessary.

As an alternative to the alternating code experiment, we are developing a new topside experiment which employs a long uncoded pulse together with a full-profile analysis [Holt et al., 1992; Lehtinen et al. 1996] for inversion of the ionospheric parameters. The long-pulse transmission scheme increases the sensitivity of the measurements, and the full-profile analysis mitigates the distorting effects of the 2-D long-pulse ambiguity function.

Topside observations using a 1.5 ms long uncoded pulse have been made at Jicamarca showing that reasonable autocorrelation functions (ACFs) can be measured up to 1600 km. In support to the long-pulse experiment, L/R circularly polarized double-pulse transmissions are interleaved with the long-pulse, allowing simultaneous measurements of ACFs at lower altitudes (≥ 450 km) along with Faraday rotation measurements for absolute electron density calibration.

A forward mathematical model of the long-pulse measurements has been developed for the numerical inversion of the ionospheric parameters. This model takes into account the effects of the radar ambiguity function. For the inversion process, we use a Levenberg-Marquadt algorithm which searches for altitude profiles of the ionospheric parameters that best fit the long-pulse measurements. Following Holt et al. [1992], we used a linear combination of B-Spline basis functions to represent the altitude profiles. Regularization techniques have also been used to constrain our search for the parameter profiles.

We have tested our inversion algorithm with simulated data, and the results show that it is possible to invert electron density, electron and ion temperature, and composition (2 ions: O⁺ and H⁺, or 3 ions: O⁺, H⁺ and He⁺ if $T_e = T_i$ is assumed) profiles simultaneously. Simulations were run with noise added, with flat profiles as initial guesses, and considering that ionospheric parameters below 450-km are known from the double-pulse measurements.

We will present topside measurements made with the long-pulse experiment and discuss details and results of our algorithm for full-profile analysis of the new experiment. Details include a derivation of the full error covariance matrix for the full-profile inversion algorithm.

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