First Successful Measurements of the Small-Scale Irregularity Spectrum Parameters by Dynasonde Data Analyses at Jicamarca

N.A. Zabotin* [1,2], J. W. Wright [1,2]
(1) University of Colorado at Boulder, USA
(2) Dynasonde Solutions Ltd., Longmont, CO, USA

The first ionosonde system belonging to the NSF-MRI 'LISN' Project, built by Scion Associates Inc., is being tested at Jicamarca. We report first results of analysis of data obtained by this system by the Dynasonde 21 Software Suite.

The Phase Structure Function method of irregularity diagnostics employs statistics of temporal variations of the phase of the ionospherically reflected signal to determine the spectral index and the irregularity amplitude for scale lengths 0.1-2 km (Zabotin N.A. and J.W. Wright, Radio Sci., 2001, Vol.36 , No.4 , p.757-772). This is the last and most demanding of all existing Dynasonde processing steps, as it depends upon nearly all the others: the vertical plasma density profile inversion NeXtYz, vector velocity calculations, phase stringing over the time intervals of the 'B-mode' sounding pattern, echo classification into 'traces', echo recognition and parameterization. An inversion of the Phase Structure Function yields parameters of the irregularity spectrum. Since the method is based on the principle of total reflection of a radio signal, it is characterized by high sensitivity, allowing to detect km-scale irregularities as low as $\Delta N / N \sim 0.001$.

The HF-radar installation at Jicamarca provides 8 identical, parallel digital receivers to service each antenna of a spaced array. This new feature for Dynasonde practice allows full separation of the spatial and temporal physical variables that characterize radio echoes. These basic echo variables are obtained in a least squares solution for each pulse set. We show how this approach provides more accurate input information for the Phase Structure Function method, and eventually allows characterizing parameters of the irregularity spectrum with higher confidence.

This new capability is particularly important for low-latitude detection of irregularities at early stages of their development, for example, those responsible for GPS scintillations. The LISN Project includes an extensive array of GPS sites with which the Phase Structure Function results can be merged in future studies of this kind.

We confirm our theoretical estimates with practical results of application of the adapted Phase Structure Function method to recordings obtained on 4 and 6 August 2008. We are grateful for the data obtained by staff of the Jicamarca Radio Observatory, Institute of Geophysics, Peru, and provided to us by the LISN project leader C. Valladares.