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On the Use of the Low-Frequency Array for Ionospheric Diagnostics: A Case Study

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The Low-Frequency Array (LOFAR) [1] is primarily intended for radio astronomical observations in the interferometric mode. It provides excellent results due to its high sensitivity and space-and-time resolution capability over the 10 to 270 MHz frequency range. At the same time, the powerful performance characteristics of the LOFAR system make it a very suitable tool for the diagnostics of ionospheric plasma irregularities in a wide range of spatial and temporal scale sizes using radiation from various cosmic radio sources in the capacity of the probe signals. These can be, for example, strong, discrete cosmic radio sources like Cassiopeia A, Cygnus A, Taurus A and Virgo A whose scintillations, as observed on the Earth, contain valuable information about interplanetary and near-Earth plasma disturbances [2].

In this presentation, we demonstrate the LOFAR capability for ionospheric investigations using a case study of Cassiopeia A scintillation observations with 38 LOFAR stations on September 25, 2016, between 03:30 and 06:00 UT. This time interval corresponds to the recovery phase of a geomagnetic storm. The emphasis is made on analyzing specific features of scintillation data processing techniques to provide more accurate and efficient estimating parameters of ionospheric plasma irregularities of different kinds, including spatial and temporal scale-sizes, anisotropy, horizontal gradients, drift vectors, spatial correlation and spectra. The recovered parameters of plasma inhomogeneities have been found to vary with time, presumably following the geomagnetic storm evolution. The cross-correlation between fluctuations in the recovered parameters and the geomagnetic field should be analyzed to accept or reject this assumption.

Bibliography

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