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Analysis of LOFAR calibration data during quiet geomagnetic conditions

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Extended Abstract

Influence of the ionosphere on propagation of electromagnetic signal is the main environmental factor affecting the quality of radio observations acquired by the Low Frequency Array (LOFAR) interferometer. One of the key scientific projects conducted with LOFAR- Epoch of Reionization- aims at detection of faint signal of redshifted 21 cm hydrogen line. Retrieving such signal requires removal of foreground contamination due to ionosphere. Direction independent calibration solutions, which are a by-product of routinely conducted pre-processing of astronomical observations- provide information on horizontal gradients of Total Electron Content (differential TEC values) between the LOFAR core and remote stations. As a result of calibration of Epoch of Reionization project observations, we obtain dTEC solutions, with each time series spanning 6-8 hours during winter nighttime.

In this study we present analysis of differential TEC values for geomagnetically quiet conditions (Kp index <2) that have been obtained for 58 baselines. Making combinations of them increases their number to 1711, with length of the baselines ranging from 43 meters to 83 kilometers (ratio of number of baselines longer than 40 km to the shorter ones equals 1:14). Such geometry introduces various scales of ionospheric disturbances that can be detected (from small to medium scales) into statistical analysis and affects determination of drift velocity. Distinguishing between scales is especially important if one is interested in medium scale disturbances, as sensitivity of the network is shifted towards smaller scales. For this purpose, we use wavelet transform in our investigations and compare it to the results obtained with windowed Fourier transform analysis.