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Statistics of Small-Scale Ionospheric Waves in European Mid-Latitudes Observed Using LOFAR

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The LOw Frequency ARray (LOFAR) is a radio telescope centred in the Netherlands. The observed impact of the ionosphere on signals from astronomical radio sources can be used to derive differential Total Electron Content (dTEC) between the lines of sight from different LOFAR stations. The dTEC derived in calibration has extremely high precision (~1 mTECu) and is available at high temporal (~4s) and spatial (baselines from ~100 m to ~100 km) resolutions. These measurements provide a new means of studying ionospheric disturbances in the mid-latitudes.

A method for identifying wave signatures in the dTEC data has been developed and shown to be capable of identifying waves with amplitudes as low as a few mTECu (Boyde et al., 2023). This method has been used to analyse over 2,500 hours of observations made as part of an astronomical survey. The statistical characteristics of the identified waves and their dependence on time of day, season, and geomagnetic activity are discussed, such as variations in dominant propagation direction. These observations extend the range of ionospheric waves that can be identified to shorter wavelengths and lower amplitudes beyond what is currently detectable using GNSS derived TEC. This method complements established techniques for detecting ionospheric waves.

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