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On the upper frequency limit of whistler mode waves observed by low-altitude spacecraft

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Frequency-latitude plots of electromagnetic wave intensity in the very low frequency range (VLF, up to about 20 kHz) observed by the low altitude DEMETER spacecraft are analyzed. Apart from electromagnetic waves generated by plasma instabilities in the magnetosphere, a significant portion of the detected wave intensity comes from ground-based lightning activity and VLF military transmitters. These whistler mode waves are observed not only close to source locations, but also close to their geomagnetically conjugated points. There appears to be an upper frequency limit of such emissions, where the wave intensity substantially decreases. Its frequency roughly corresponds to half of the equatorial electron cyclotron frequency at a respective magnetic field line, suggesting a relation to wave ducting in ducts with enhanced density. However, it seems to exhibit a non-negligible longitudinal dependence and it is different during the day than during the night. We use a realistic model of the Earth's magnetic field to explain the observed variations. We interpret the observations in terms of ducted/unducted wave propagation, and we compare the wave intensities in the source hemisphere with those measured in the hemisphere geomagnetically conjugated.