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Can anisotropic conductivity in the lower ionosphere and in the Earth's crust be studied by Schumann resonance transients?

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Schumann resonance transients (SRTs) are extremely low frequency (ELF, 3-3000 Hz) wave packets of high amplitude electromagnetic (EM) waves produced by intense lightning discharges worldwide. Near the lower end of the ELF band, frequencies are close to the lowest spherical eigenfrequencies of the closed EM waveguide formed by the surface of the Earth and the lower ionosphere. Therefore, these waves suffer little attenuation during their propagation and can be detected globally at any point on Earth.

SRTs detected both in the vertical electric and in the horizontal magnetic components of the atmospheric EM field at the Széchenyi István Geophysical Observatory (NCK, 16.7 E, 47.6 N) on 1st and 2nd August, 2012 have been analyzed. Azimuths of their parent lightning discharges were calculated from the horizontal components of the corresponding Poynting vector. Parent lightning strokes of the considered SRTs (342 and 245 events on the first and on the second day, respectively) have been identified in the records of the World Wide Lightning Location Network (WWLLN) using the detection times of the events in the two datasets.

It was found that the azimuths of the sources at NCK station deduced from ELF records systematically differ from source azimuths calculated using WWLLN provided lightning locations. The difference between the corresponding azimuth values from the two methods shows the same pattern on both examined days when it is plotted as function of the WWLLN data based source azimuth. The symmetry of this pattern agrees well with the symmetry of the conductivity variations of the Earth's crust determined by independent magnetotelluric methods at NCK station. The differences have similar diurnal variation, too, on the two days with the largest difference occurring near midnight, local time. Our results agree well with findings of Füllekrug and Sukhorukov (GRL, 1999) and support the idea that the azimuthal dependence of source azimuth differences can be related to anisotropic conductivity in the Earth's crust below the observatory. On the other hand, the diurnal variation of source azimuth deviations is rather due to different conductivities in the upper waveguide boundary (i.e. in the lower ionosphere) above the detection site during day and night.