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Comparison of global lightning activity variations inferred from Q-bursts, Schumann resonances, and WWLLN-detected lightning strokes

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Measured time series of the extremely low frequency (ELF, 3 Hz-3 kHz) band electromagnetic field can be considered as a superposition of background and transient signals. Transient signals produced by exceptionally powerful lightning strokes far from the recording station are named Q-bursts. The direction of the source lightning stroke at the recording station can be calculated using the horizontal components of the Poynting vector. The source lightning stroke can be identified in the lightning database of the World Wide Lightning Location Network (WWLLN, wwlln.net) by the matching detection time and direction calculated from ELF measurements.

Schumann resonance (SR) peaks appear at ~8Hz, ~14Hz, ~20 Hz, etc., in the spectra computed from the background ELF timeseries. SRs are natural electromagnetic resonances with wavelengths comparable to the circumference of the Earth-ionosphere waveguide. Peak amplitudes and frequencies in the resonance spectrum detected in the ELF band at any given location on the Earth depend on the distribution and intensity of the global lightning activity which excites SR.

ELF measurements are routinely performed in the Széchenyi István Geophysical Observatory (NCK, 47°38' N, 16°43' E) near Nagycenk, Hungary. Vertical electric and the horizontal magnetic components of the atmospheric electromagnetic field are monitored by the Schumann resonance recording system. In this work, we study the variation of the number of lightning strokes with high charge moment change (CMC; indicated by the number of large amplitude Q-bursts recorded at NCK) and the variation of the number of lightning strokes with large peak current (indicated by the number of WWLLN-detected energetic lightning strokes). In addition to considering the total number of WWLLN-detected lightning strokes and Q-bursts, we analyze lightning strokes occurring only in west, south, east, and north directions from NCK, corresponding predominantly to the three main lightning producing regions of the tropical lands in America, Africa, and Indonesia as well as to the Pacific Ocean. Time variations of the number of high CMC and large

peak current lightning strokes during November, 2014 are compared with time variation of the cumulative SR intensity detected at NCK station in the vertical electric field component in the same month. Similarities and differences in the time variations of the considered quantities are discussed in order to show how these indicators mirror the changing distributions of the global lightning activity.