COMPARISON OF ELF TRANSIENTS

OBSERVED AT TWO SEPARATE OBSERVATORIES

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ELF (Extremely Low Frequency: 3 Hz – 3 kHz) transient events are initiated by energetic lightning strokes. These ELF wave packages circumpropagate around the globe several times before decaying to background levels and can excite electromagnetic resonances, – known as Schumann resonances (SR) – , in the Earth-ionosphere cavity. These transient events appear as coherent signals in the vertical electric (E_Z) and horizontal magnetic (H_φ) field components and they are detectable over global distances. Such ELF transients recorded at two separate stations – Nagycenk (NCK; 47.6N , 16.7E), Hungary and Mitzpe Ramon (MR; 30.6N, 34.8E), Israel – have been studied from the point of view of the different propagation conditions along the great circle paths containing the source and each observer. Commonly observed transient events recorded on March 31, 2003 have been selected from the records of the two stations by utilizing GPS timing. Analyzing transient events coming from the same source (lightning stroke) and observed under different local ionospheric conditions can contribute to explain and resolve the contradictions between the background SR observations and the theoretical conclusions with respects to the day-night asymmetry of the Earth-ionosphere cavity. The background SR parameters at distant stations exhibit sharp variations starting/ending at ionospheric sunrise/ sunset in local time supporting the role of the ionospheric day-night asymmetry [1], while the theoretical interpretation [2] claims that the differences in the propagation conditions in the day-side and night-side of the cavity are compensated as the electromagnetic impulse initiated by a lightning stroke travels around the globe and crosses the day/night terminator twice in a circle.

The time difference of 1h 21m on March 31 between the ionospheric sunset time points at NCK and MR made possible to select three setups for receiving ELF transients: both observers on the day side, NCK still on the day-side while MR is on the night-side and both observers on the night-side of the cavity regarding the ionosphere. For each transient the current moment spectrum (CMS) of the ELF source (the lightning stroke) was derived from the recorded data in the 5-30Hz frequency range by dividing the measured field spectra with theoretical spectra corresponding to the source-observer distance (SOD). For evaluation of the theoretical spectra the model of Wait, Jones and Ishaq and Jones was used, which assumes a vertical electric dipole source and EM wave propagation in an idealized spherically symmetric earth-ionosphere cavity. The SOD was deduced by the spectral characteristics of SR transients which uniquely change with the SOD. Measured spectra of the E_Z, H_φ field components and their ratio (the wave impedance, Z) of an event was compared to a set of spectra calculated from the theoretical model. The distance was accepted at which the measured and the theoretical spectra were most similar. In addition to single station calculations geographical coordinates of the transient's source were determined from the intersection of the directions evaluated at the two stations from the horizontal components of the Poynting vector or the polarization plane of the H_φ field. (These calculations are described in details in [3] in connection with charge moment calculations.) When the CMS was evaluated at one station from locally measured data, the expected CMS for the same station was calculated from the CMS derived at the other station for the same transient considering the differences in the SODs. Differences of about 20% were found at each station between the directly derived CMS and the trans-calculated one when the two stations were on different sides of the ionospheric day-night terminator line. The differences indicate that the wave amplitudes change when the propagation path crosses the day-night terminator.

[1] A. Melnikov, C. Price, G Sátori, M. Füllekrug, "Influence of the Solar Terminator Passages on Schumann Resonance Parameters", *J. Atmos. Solar-Terr Phys.*, 66, pp. 1187-1194, 2004

[2] A. P. Nickolaenko and M. Hayakawa, "*Resonances in the Earth-ionosphere Cavity*", Kluwer Academic Publisher, 2002

[3] Huang, E., et al. "Criteria for sprites and elves based on Schumann resonance observations", *J. of Geophys. Res.*, 104, D14, pp. 16943-16964, 1999.