Unusual attenuation events in the VLF range observed by the DEMETER spacecraft

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Results of a systematic study of unusual attenuation events observed by the DEMETER spacecraft in the VLF range are presented. In the frequency-time spectrograms of wave intensity, these attenuation events consist of several lines with significantly lower intensity. Detailed analysis of the events shows that they are formed by consecutive lightning generated whistlers. These whistlers are attenuated at some specific frequencies which vary continuously during the event, resulting in lines of lower intensity. We inspected all available DEMETER data for the presence of these attenuation events. Altogether, 1580 events have been identified. They occur exclusively during the nighttime. We compare the overall geographic distribution of the total event duration with the geographic distribution of the mean lightning occurrence. It is found that the event locations are closely related to the areas of enhanced lightning activity, but they are shifted by about 30 degrees westward. We present a simple model of a possible event formation based on a basic theory of wave propagation in the Earth-ionosphere waveguide. This model, however, does not explain the observed longitudinal shift. We believe that the shift is due to an azimuthal dependence of the wave attenuation in the Earth-ionosphere waveguide, which is not considered in the used simplified waveguide theory.