An improved procedure for estimation of propagation distance of tweek atmospherics

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Tweek atmospherics are very low frequency (VLF) / extremely low frequency (ELF) waves radiated from lightning discharge and propagate in the Earth-ionosphere waveguide for a long distance over 1000 - 12000 km. The tweeks have frequency dispersion that the frequency rapidly falls down from 10 kHz to 2 kHz during several tens of milliseconds. The occurrence rate of the tweeks are 50-60 per minute during nighttime in Japan [Ohya et al., JGR, 2015]. By analyzing tweeks, location of lightning in wide area and their reflection height in the D-region ionosphere can be estimated. However, it is difficult to estimate the horizontal propagation distance of tweeks with high accuracy, because of the rapid frequency variation of tweeks in frequency-time spectra and overlapping multiple tweeks. The accuracy of the lightning location estimated from tweek atmospherics has been estimated as less than 60 km in Europe [Santolik and Kolmasova, Sci. Rep, 2017]. The accuracy of lightning location for the lightning discharges of world-wide lightning location (WWLLN) data is less than 10 km [Rodger et al., 2004]. So far, the reflection height and the horizontal propagation distance of tweeks have been estimated by curve fitting on tweek dynamic spectra by the maximum entropy method (MEM). In this study, we improved our procedure to estimate the tweek propagation distances. The new procedure is based on conversion of non-linear dispersion equation to a linear equation. The linear equation would be more useful for estimating the propagation distance, even if attenuation around the cut-off frequency is significant. As a result of evaluation by pseudo-tweeks which have propagation distances in the range of 2000 –10000 km, the error of the propagation distance was estimated to be 6.7% by the new procedure and 13.8% by the previous method. In particular, the new procedure showed a great improvement for tweeks with propagation distances of less than 6000 km. In this presentation, we show the new procedure for tweek propagation distance in detail and discuss its accuracy.

