

## ***Interactive comment on “Unknown high-frequency (7–12 kHz) quasi-periodic VLF emissions observed on the ground at $L \sim 5.5$ ” by Jyrki Manninen et al.***

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General comments. This paper presents some comprehensive observations of newly discovered features in the dynamic spectra (spectrograms) of naturally occurring very low frequency (VLF) radio signals observed at a quiet site in Northern Finland ( $L \sim 5.5$ ). The presentation is worthwhile, as it contains valuable descriptions of these previously undreamed of whistler-mode signals occurring at remarkably high frequencies for the  $L$  value of the recording station. These weak signals are only revealed after the removal (by a digital filter) of strong signals from distant lightning discharges termed sferics. Two typical examples recorded on different days are shown in detail, and their characteristics are clearly discussed. There is an amazing amount of detailed novel information concerning these unexpected signals presented in Fig. 2a and in Fig. 5.

Fig. 6 clearly shows the very quiet geophysical situations under which these most strange whistler-mode emissions appear. The discussion of the features of these signals in Sections 2 and 3 is most valuable, even though some of the discussion is close to speculation; further research would be justified. I believe that this paper should be published, because it contains important new results which are discussed in a sensible way, once a few changes have been made.

Specific comments. In the title, I think that New would be preferable to Unknown. Also, there should be consistency in the stated upper frequency of these signals. Is it 11 kHz or 12 kHz? The appearance of naturally occurring VLF emissions at  $\sim 8$  kHz is quite remarkable (Fig. 1,2), but totally new (in my experience) is the extremely sharp termination (lines 75, 99, 165) of these signals, only a few seconds. How might this be explained? Has the flux of gyro-resonant electrons become zero? That is, have all such electrons trapped on the geomagnetic flux tube, where the wave-particle interaction is taking place, been depleted by the generation process? The diagram on the cover of the book by Trakhtengerts and Rycroft (2008) may be helpful in this regard. I consider that the papers listed in the References are entirely appropriate for this comparatively short paper.

Technical corrections. Line 20: we could not explain such a strange dynamic spectral shape of the waves. Line 34, and elsewhere: there should be a comma after e.g. e.g., Line 36: what is meant by a large spatial area? Would a large volume of geospace (latitude x longitude x distance along a geomagnetic flux tube) be a better expression? Line 61: sferics hide all other weaker waves Line 64: A rather similar event

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Discussion paper

