



Statistics of unusual VLF bursty-patches detected at Kannuslehto, Finland.

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VLF bursty-patches are a relatively recent type of differently structured very low frequency (VLF) radio waves [1]. Their main characteristic is their detection at frequencies above the half and full electron gyrofrequency in the equatorial plane for the L-shell of observation (f_{ce}). In this study, we used data from the VLF receiver of Kannuslehto, Finland (KAN, MLAT=64.4°N, L=5.5) where VLF bursty-patches are commonly detected (>60% of campaign days). The average f_{ce} at KAN is close to 6 kHz.

We analyzed data from the winter campaigns of 2017 (~8 months) separating the observations by spectral type, periodicity, number of bursts, and observed frequency. We also noted the presence or absence of other usual VLF emissions simultaneously detected at lower frequencies ($f < f_{ce}$).

Our results show that the overall highest occurrence rate is in the morning (05 - 12 MLT, with MLT=UT+1.5 hrs) correlating with general VLF occurrence rates at KAN (07 - 13 MLT) [2]. If we consider usual VLF emissions ($f < 6$ kHz) and VLF bursty-patches with similar spectral features, this relationship becomes clearer. These results confirm that both groups of emissions are generated by the same mechanisms, most likely temperature anisotropy. However, unlike usual VLF emissions at lower frequencies, daily occurrence of bursty-patches did not show a distinct relationship with AE index. Using a superposed epoch analysis of the magnetic components from a magnetometer located 35 km from KAN we found that VLF bursty-patches are detected when the magnetic field is at a local minimum. This indicates that even though bursty-patches could be generated in the magnetosphere, their propagation to the ground relies on localized low magnetic activity.

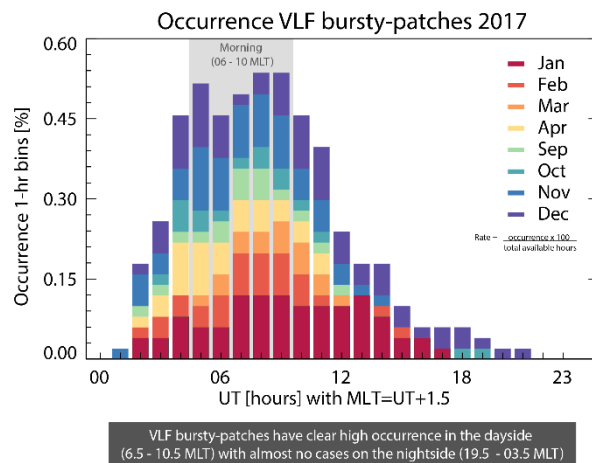


Figure 1. Occurrence of VLF bursty-patches at KAN during the 2017 campaigns.

1. Martinez-Calderon, C., Manninen, J.K., Manninen, J.T. et al. A review of unusual VLF bursty-patches observed in Northern Finland for Earth, Planets and Space. *Earth Planets Space* 73, 191 (2021). <https://doi.org/10.1186/s40623-021-01516-y>

2. Takeshita, Y., Shiokawa, K., Ozaki, M., Manninen, J., Oyama, S.-I., Connors, M., et al. (2019). Longitudinal extent of magnetospheric ELF/VLF waves using multipoint PWING ground stations at subauroral latitudes. *Journal of Geophysical Research: Space Physics*, 124, 9881–9892. <https://doi.org/10.1029/2019JA026810>