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Vespagram-based approach for microbarom radiation and propagation model assessment using infrasound recordings

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This study investigates a vespagram-based approach as a tool for multi-direction comparison between simulated microbarom soundscapes and infrasound data recorded at ground-based stations. The used microbarom radiation model takes into consideration both finite ocean-depth and the source radiation dependence on elevation and azimuth angles, while the effects of the atmospheric ducting from the source regions to the station are estimated using a semi-empirical attenuation law. The infrasound data recorded at the IS37 station in northern Norway during 2014-2019 are processed in the framework of the velocity spectrum analysis to generate vespagrams presenting signal power depending on time and back-azimuth direction. The analysis is performed for five frequency bands distributed between 0.1 and 0.6 Hz. The processed infrasound data and the modelled microbarom soundscapes are compared in three different aspects: i) azimuthal distribution of dominating signal, ii) signal amplitude and iii) ability to track atmospheric changes during extreme events such as sudden stratospheric warmings (SSW). The back-azimuth resolution between the vespagrams and the microbarom model output is harmonized by smoothing the modelled soundscapes along the back-azimuth axis with a kernel corresponding to the frequency-dependent array resolution. The time-dependent similarity between the model output and the processed infrasound data is estimated using the image processing approach of mean-square difference. The results reveal good agreement between the model and the infrasound data and demonstrate the ability of vespagrams to monitor the time-dependent microbaroms azimuth distribution, amplitude, and frequency on a seasonal scale, as well as changes during SSWs. The presented vespagram-based approach is computationally low-cost and can uncover microbarom source variability. There is also a potential for near-real-time diagnostics of atmospheric model products and microbarom radiation models, especially when applied to multiple stations, e.g. exploiting the CTBTO International Monitoring System network.