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Cross-wind effects on infrasound waves partially reflected at stratospheric altitudes

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The cross-wind effect on infrasound propagation has been studied on the seismic array ARCES, Norway, utilizing 30 years of data from around 600 explosions at the Hukkakero military blast-site in Finland. The station is located at 178 km distance from the event site, which is within the classic shadow-zone range as confirmed by ray-tracing of infrasound through model atmospheres (ERA-Interim). However, infrasound signals from around 99% of the explosions are detected on the seismic sensors at ARCES as ground-coupled airwaves, indicating that the existence of a stratospheric infrasound propagation duct between the two sites is typical.

Our analysis supports a hypothesis that there are acoustic waves reflected at stratospheric altitudes which reach the station. In the wave-propagation simulations, we model this by introducing reflecting layers at all model altitudes. Then we select the rays that best match the observed travel time.

Moreover, the effect of atmospheric cross-winds on infrasound propagation has been quantified by averaging the cross-wind contributions along the partially reflected acoustic ray path, and comparing this to the predicted and observed backazimuth deviation at ARCES. There is a high degree of correlation between the estimated cross-wind effects and the observed backazimuth deviation. Our findings hence support the assumption that stratospheric reflecting structures, which are not resolved by the atmospheric models, are able to explain the observed signals.