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Atmospheric Infrasound Propagation Modelling Using the Reflectivity Method

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We demonstrate that the reflectivity method can be applied to the modelling of infrasound propagation. The reflectivity method is a slowness (or wavenumber) integration method widely applied in the seismological community to generate synthetic seismograms in layered media. The integrated function essentially describes the reflection coefficients between the layers. The method models P- and S-wave propagation and includes refractions and reflections, multiples, caustics, mode conversion, absorption and dispersion. Some limitations of conventional ray tracing are circumvented since head waves are represented and shadow zones are more correctly modelled.

We apply a 2.5-D ray-tracing engine and a slightly modified version of Müller's reflectivity code to the atmospheric wind and temperature conditions at the time of the Drevja accidental explosion on December 17, 2013, in Northern Norway. The infrasound modelling results are compared with signals observed at the IS37 array station in Bardufoss, situated around 400 km north-east of the event. The effective sound speed approximation is applied, where the altitude-varying and range-independent sound speed is given by sum of the adiabatic sound speed and the wind projected in the horizontal propagation direction.

An important observation is that an infrasound arrival, clearly observed in the IS37 data approximately 20 minutes after the explosion time, is predicted by the reflectivity method and not by ray-tracing, even for very densely sampled ray emission elevation angles. However at shorter ranges ($\sim$300 km), the corresponding phase is predicted by both modelling methods. There, the ray tracing shows this arrival as resulting from of a ray turning once in the stratosphere.