Geophysical Research Abstracts
Vol. 18, EGU2016-1362, 2016
EGU General Assembly 2016
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Atmospheric infrasound propagation modelling using the reflectivity method with a direct formulation of the wind effect

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We recently advocated using the reflectivity method, also known as the wavenumber integration method or fast-field program, to model atmospheric infrasound propagation at regional distances. The advantage of the reflectivity method is its ability to model the full wavefield, including diffractive effects with head waves and shadow zone arrivals, in a broad frequency range but still at a relatively low computational cost. Attenuation can easily be included, giving the possibility to analyse relative amplitudes and frequency content of the different arrivals. It has clear advantages compared with ray theory in terms of predicting phases considering the particular frequent occurrence of shadow zone arrivals in infrasound observations. Its main limitation, at least in the traditional form of the method, lies in the fact that it can only handle range-independent models. We presented earlier some reflectivity method simulations of an observed accidental explosion in Norway. Wind intensity and direction are non-negligible parameters for infrasound propagation and these are appropriately taken into account in most infrasound ray-tracing codes. On the other hand, in the previous reflectivity simulations wind was taken into account only through the effective sound speed approximation where the horizontal projection of the wind field is added to the adiabatic sound speed profiles. This approximation is appropriate for dominantly horizontal propagation but can give incorrect arrival times and shadow zone locations for waves which have a significant portion of their propagation path at more vertical incidence, like thermospheric arrivals. We present here how we have modified the original reflectivity algorithm in order to take the wind into account in a more correct fashion, and how this improvement influences the synthetics.