Geophysical Research Abstracts
Vol. 17, EGU2015-10705, 2015
EGU General Assembly 2015

Probabilistic infrasound propagation using ensemble based atmospheric perturbations

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The state of the atmosphere is of utmost importance for infrasound propagation. In propagation modelling, still, the true state of the atmosphere is mainly represented by the analysis. The analysis is the best deterministic estimate of the atmosphere using a data assimilation system existing of a General Circulation Model (GCM). However, the analysis excludes error variances of both model and observations. In addition, the coarse resolution of GCM results in averaging of, e.g., clouds or gravity waves, over larger regions known as parameterisation. Consequentially, arrivals due to fine-scale structure in wind and temperature can be missing.

Therefore, infrasound propagation including the atmospheric best-estimate error variances based on the ensemble model is proposed. The ensemble system exists of model perturbations with an amplitude comparable to analysis error estimates to obtain a probability density function rather than one specific state as obtained from a deterministic system. The best-estimate analysis error variances are described by a set of perturbations using the European Centre for Medium-range Weather Forecasts (ECMWF) Ensemble Data Assimilation (EDA) system.

Probabilistic infrasound propagation using 3–D ray tracing is demonstrated by one year of mining activity, e.g., blasting, in Gällivare, northern Sweden, observed at infrasound array IS37 in Norway, part of the International Monitoring System (IMS) for verification of the Comprehensive Nuclear-Test-Ban Treaty (CTBT). Probabilistic infrasound propagation is compared with the standard deterministic result obtained using the analysis.