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Seismo-acoustic analysis of explosions observed in Norway and the temporal variations in the state of the upper atmosphere

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The ARCES seismic array in Norway has been observing seismic and infrasound signals from explosions in Finland over tens of years. The source location is known and the seismic signals provide the origin time and estimates of event magnitude. The observation of infrasound from these well-constrained explosive sources provides an excellent opportunity to evaluate models of atmospheric sound propagation.

Old ammunition is destroyed in Finland during August and September every year at a distance of 180 km from ARCES. The similarity of the seismic signals from event to event indicates an almost repeating source. The enormous variation observed in the infrasound waveforms, amplitudes and arrival times, must therefore be dominated by atmospheric fluctuations. This dataset is an intriguing subject of research due to both the source-receiver distance and the time of year. At 180 km, ARCES is only just capable of receiving stratospheric arrivals and is on the edge of the acoustic shadow zone. The time of year is of interest due to the change in direction of the polar vortex which, at an altitude of around 50 km in the stratosphere, largely controls long range sound propagation.

In this presentation, the results of 8 years of observations from 2001 to 2008 will be discussed. Stratospheric arrivals are continually observed at ARCES, while propagation modelling (raytracing, PE and normal modes) rarely predicts any. By modifying the ECMWF atmospheric specifications, stratospheric arrivals at ARCES can be modelled which correspond well with the observations. However, the changes in the ECMWF specifications necessary to match the observations involve a large increase in temperature and/or wind speed. Therefore, an alternative hypothesis is tested which assumes that the observed arrivals are the result of partial reflection.