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Order Reduction for Infrasound Propagation in Range-Dependent Atmospheres

The usual approach to study infrasound propagation is to compute the acoustic component superimposed to a mean atmospheric state. The justification of such an approach is questionable given that meteorological uncertainties may affect the waveforms in such a way that some arrivals may literally disappear. In the present work, we perform a sensitivity analysis to estimate the role of atmospheric uncertainties in the signal predictions at large distances from the source. The atmospheric structures are obtained through a wavelet decomposition of ECMWF data with the sensitivy of signals being analysed through a perturbative approach. Our approach provides statistical insight into the waveform analysis by mode-based reduced-order models. Very accurate low CPU time models are obtained by retaining only few eigenvalues/modes, thereby leading to better converged statistics. We consider the case of the Fukushima power plant explosion (March 2011) for which an infrasound signal was recorded 250 km away from the power plant. It is shown that several commonly made simplifications can lead to 2 or 3 arrivals, depending on the profile datasets. The signals obtained with the range-dependent normal mode code are in very good agreement with those obtained with the finite element method.

Primary author: MILLET, Christophe (Commissariat à l'énergie atomique et aux énergies alternatives (CEA))

Presenter: MILLET, Christophe (Commissariat à l'énergie atomique et aux énergies alternatives (CEA))

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