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: Stochastic propagation models for decision analysis

While long-range infrasound propagation modeling is a useful tool in geophysics and nuclear treaty verification, the inherent unpredictability of subgrid-scale atmosphere dynamics results in a poorly constrained propagation medium. This work reports on the project FLOWS (Fast Low Order Wave Simulation) that begun in 2013 and whose aim is to reformulate the problem in a probabilistic framework by using stochastic reduced models. Signal statistics are obtained by computing a few propagating modes over large ranges of frequencies, along with probabilistic inference to incorporate atmospheric data. Such a probabilistic model enables integrating the uncertainties associated with a hypothesized event and the atmosphere. A stochastic parameterization of gravity waves (GWs), currently in use in a general circulation model, is adapted to estimate the GW field unresolved in the large-scale atmospheric specifications. By examining how the GW field manifests statistically within the waveforms, it is shown how we can update the numerically obtained signals from the underlying probabilistic GW field. Applied in the context of the International Monitoring System (IMS), FLOWS achieves uncertainty quantification of the continuous stream of recorded signals and enables associations based on a Bayesian framework. It also predicts signals that are missed by the classical high-frequency techniques.

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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