Bayesian monitoring with a generative approach:

Signal Envelope Model

- Propagating, and observed waveform envelopes, including event signals along with station background noise.

Phases Envelope Model

- Each phase is assigned a parameterized shape template, multiplied by a temporal modulation signal.

**Shape Parameter Models**

- Parameterized components are conditioned on an event hypothesis, by a combination of a joint and probabilistic model. The probabilistic model uses Markov Chain Monte Carlo (MCMC) sampling to refine the shape template by taking the observed envelope at each station as a reference envelope.

**Sensitivity**

- A model provides statistical evidence for an event if its signal is more probable under the hypothesis of that event than under a noise model.

**Localization: 2009 DPRK Event**

- Using a network of SIG-VISA stations, a relocated model (only P-phase, 2-5Hz frequency band, using only the reference station at each array) we infer a mean location of 128°E, 43.5°N for the 2009 DPRK event, 13 km from the epicenter.

**Probabilistic Waveform Matching**

- Waveform shape is known to be highly repeatable across events with the same location and source parameters, as seen in Shaff et al. (2004) and Waldhauser & Ellsworth (2000).

**Modeling Array Stations**

- Our standard model assumes that signals are independent at each station, conditioned on an event, but this model is far from realistic, as signals are not independent, which are empirically corrected. We remove the independence assumption by jointly modeling each template parameter across array elements with a single Gaussian process (GP), thus returning the existing 20 event location and velocity vectors.

**Conclusions**

- The signal envelope model makes a valuable contribution to a modular, joint-seismic monitoring system, integrating physical-based seismic models with probabilistic methods to understand and characterize the uncertainties.

**References**