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POLYNOMIAL SURROGATES FOR BAYESIAN TRAVELTIME TOMOGRAPHY

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This talk is about the issue of the computational load encountered in seismic imaging by Bayesian traveltime inversion. In Bayesian inference, the exploration of the posterior distribution of the velocity model parameters requires extensive sampling. The computational cost of this sampling step can be prohibitive when the first arrival traveltime prediction involves the resolution of an expensive number of forward models based on the eikonal equation. We propose to rely on polynomial chaos surrogates [1] of the traveltimes between sources and receivers to alleviate the computational burden of solving the eikonal equation [2] during the sampling stage. The numerical tests for canonical problems (simple layered media, microseismic and seismic refraction configurations) illustrate that a moderate number of evaluations of the eikonal solver suffices to build traveltime surrogates with an error less than the typical observation noise. When constructed, the surrogates of the traveltimes enable the extensive sampling of the posterior distribution with Markov Chain Monte Carlo methods. Our experiments show that the posterior uncertainty in the velocity model parameters depends on the observations available and the structural dependencies between the parameters and the traveltimes. The seismic refraction configuration also highlights the potential of relying on advanced surrogate construction methods, suited to the posterior distribution, through an iterative adaptation. The adaptive approach can drastically improve the precision of the inference while reducing the overall construction cost [3].

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