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Trans-dimensional and hierarchical Bayesian approaches toward rigorous estimation of seismic sources and structures in the Northeast Asia

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A framework is presented within which we provide rigorous estimations for seismic sources and structures in the Northeast Asia. We use Bayesian inversion methods, which enable statistical estimations of models and their uncertainties based on data information. Ambiguities in error statistics and model parameterizations are addressed by hierarchical and trans-dimensional (trans-D) techniques, which can be inherently implemented in the Bayesian inversions. Hence reliable estimation of model parameters and their uncertainties is possible, thus avoiding arbitrary regularizations and parameterizations. Hierarchical and trans-D inversions are performed to develop a three-dimensional velocity model using ambient noise data. To further improve the model, we perform joint inversions with receiver function data using a newly developed Bayesian method. For the source estimation, a novel moment tensor inversion method is presented and applied to regional waveform data of the North Korean nuclear explosion tests. By the combination of new Bayesian techniques and the structural model, coupled with meaningful uncertainties related to each of the processes, more quantitative monitoring and discrimination of seismic events is possible.