PROBABILISTIC JOINT-INVERSION AND UNCERTAINTY ANALYSIS

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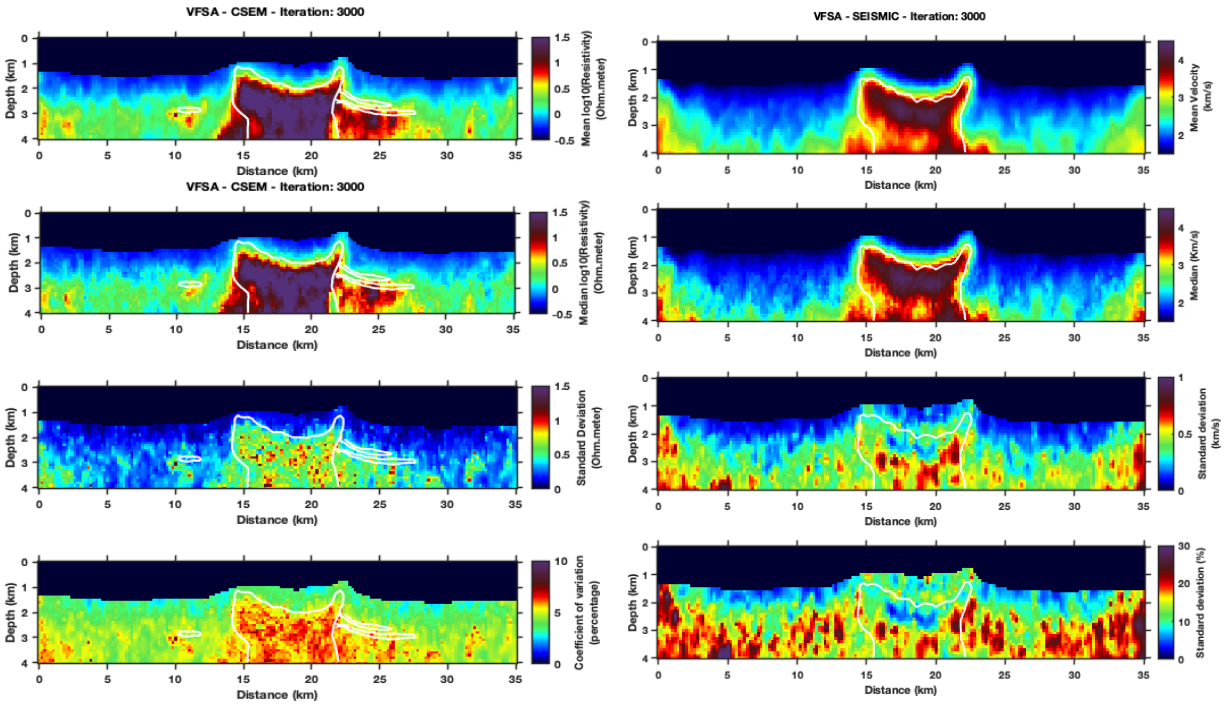
ABSTRACT

Nonlinear sampling methods like Monte-Carlo (MC) algorithm require testing a large number of proposal models, which makes their computational cost a vital concern. Implementing a probabilistic joint-inversion, therefore, indispensably requires an affordable alternative. In this paper, we propose a joint-inversion framework combining the Very Fast Simulated Annealing (VFSA) method with a generalized fuzzy c-means clustering approach for parameter coupling. We report that the intrinsic bias of the VFSA towards the peak of the derived posterior probability density (PPD) function can be efficiently reduced by using a sparse parameterization and running multiple chains of VFSA with different starting models. Moreover, we discuss how petrophysical and geological constraints can be integrated into the proposed joint-inversion framework. Finally, we demonstrate our proposed method by jointly-inverting first-arrival seismic traveltimes and controlled-source electromagnetic data for velocity and vertical resistivity of a 2D slice of the SEAM-Phase-1 model. We report that mean models, model parameter uncertainties, and petrophysical relationships derived from our joint-inversion framework provide a good description of the true synthetic model.



Results from the joint-inversion of controlled-source electromagnetic and traveltime seismic data for a 2D slice of SEG SEAM Phase 1 model. The figure shows mean, median, coefficient of variation, and percentage coefficient of variation for the estimated resistivity model (left) and mean, median, standard deviation, and percentage standard deviation for the estimated velocity model (right), from 15 chains of joint-inversion