Review of: "Annealed Stein Variational Gradient Descent for Improved Uncertainty Estimation in Full-Waveform Inversion"

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Potential competing interests: No potential competing interests to declare.

This paper explores the annealed Stein Variational Gradient Descent (SVGD) optimization algorithm in Bayesian full-waveform inversion. The authors quantitatively compare the performance of annealed SVGD and other optimization algorithms through synthetic inversions. The presented work is novel because it explores the use of annealed SVGD in FWI for the first time. Also, they use a clever methodology to analyze the performance of the optimization process.

The experiments and results are explained in detail, and the manuscript is well-written. However, I have a few suggestions that can improve the manuscript:

- Discuss the applicability of the method to 3-D inversions: The work presents only 2-D inversions, which are widely used in seismic exploration studies. However, the authors should discuss the challenges of applying the proposed method to 3-D inversions, which have considerably more model parameters.

- Discuss the application of the method to multiparameter inversions: Similar to my previous suggestion, it would be beneficial to discuss the challenges of using the proposed method in multiparameter inversions (e.g., Vp, Vs, anisotropy, etc.)

- Discuss the computational benefits of SVGD: Maybe I missed it, but the paper does not specify the computational advantage of using SVGD compared to Markov Chain Monte Carlo methods. Is the computational cost reduced in half? More? Mentioning this can increase the appeal of the proposed method.

- Add more tests using a different experimental setup: The authors only evaluate the performance of the optimization algorithms using the Marmousi model. I understand that the Marmousi model is a standard model for benchmarking methodologies. However, including another set of experiments involving a different subsurface model and acquisition geometry could be interesting (although I understand this involves a considerable amount of work).