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Impacts of forward modelling operators on waveform inversion results: 2D elastic case

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We study the impact of forward modelling operators to seismic waveform inversion results. Since waveform inversion methods minimise the residual of synthetics and observed data, it is essential to obtain a high accuracy in the modelled synthetics as well as waveform Fréchet derivative calculation or gradient. However, little has been studied about error mapping of forward modelling operators onto final waveform inversion models. This study tries to formally describe the error propagation on Fréchet derivatives, which govern waveform inversion Fréchet derivatives, in a 2D elastic model, obtained with two operators, of which the accuracies are well known: conventional and optimally accurate collocated operators.

We use smoothed version of Marmousi-2 model in order to calculate Fréchet derivatives, since it is a model very often used for benchmark tests of full waveform inversion. Formal error analysis allows us to estimate the magnitude of the error propagation, which appears to be not ignorable. We then illustrate Fréchet kernels for a smoothed version of Marmousi-2 model, visualising the errors. Some long-offset features will not change but certainly there are numerical noises that would provoke misinterpretation of data during waveform inversion.