NON-BLANCED FINITE FINITE DIFFERENCES AND ADAPTIVE GRADIENT OPTIMIZERS: AN APPLICATION TO FULL WAVEFORM SEISMIC INVERSION

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Abstract. Full Waveform Inversion (FWI) has long been a straightforward and reliable tool in the field of geophysics for generating subsurface images. In this study, we integrate a highly efficient and innovative Non-balanced Finite Differences (NBFD) scheme for seismic wave propagations, coupled with robust adaptable gradient optimization methods with decay, to create a powerful and efficient FWI methodology.

Due to their structure the Non-balanced Finite Differences schemes, significantly reduce the computational time compared to traditional finite difference schemes and facilitate the computation of weights or coefficients for the Finite Diferences (FD) operators in the spatiotemporal domain, inducing a linear dispersion relationship in the frequency domain.

Furthermore, the adaptable gradient optimizers with decay have demonstrated high precision and performance when tested in Deep Learning. By employing them in conjunction with the frequency Multiscaling technique in our methodology, we aim to accelerate the convergence of FWI while maintaining stability and avoiding issues of local minima congestion.

The results obtained in this study are compared with those achieved through conventional FWI using standard stepped finite differences and various optimization methods. Our findings demonstrate that the utilization of an Non-balanced finite differences scheme in a stepped or staggered grid leads to significant improvements(with respect to time computation and accuracy) compared to the results of similar studies.

Keywords: Full-Waveform Inversion, Non-Balanced Finite Differences, Adaptive Weight Decay methods, Multiscaling, Dynamic simultaneous sources approach.

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