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Time-domain CSEM modelling using frequency- and Laplace-domain computations

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Summary

Modelling time-domain electromagnetic data with a frequency-domain code requires the computation of many frequencies for the Fourier transform. This can make it computationally very expensive when compared with time-domain codes. However, it has been shown that frequency-domain codes can be competitive if frequency-dependent modelling grids and clever frequency selection are used. We improve existing schemes by focusing on (a) minimizing the dimension of the required grid and (b) minimizing the required frequencies with logarithmically-spaced Fourier transforms and interpolation. These two changes result in a significant speed-up over previous results. We also tried to further speed-up the computation by using the real-valued Laplace domain instead of the complex-valued frequency domain. Computation in the Laplace domain results in a speed-up of roughly 30 % over computation in the frequency domain. Although there is no analytical transformation from the Laplace to the time domain we were able to derive a digital linear filter for it. While this filter works fine for exact analytical responses it turned out that it is very susceptible to the smallest error. This makes it unfortunately unsuitable for iterative 3D solvers which approximate the solution to a certain tolerance.