Inverting magnetotelluric data with distortion correction – Stability, uniqueness and trade-off with model structure

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Abstract

Static distortion of magnetotelluric data is a common effect that can impede the reliable imaging of subsurface structures. Recently we presented an inversion approach that includes a mathematical description of the effect of static distortion as inversion parameters and demonstrated its efficiency with real data. We now systematically investigate the stability of this inversion approach with respect to different inversion strategies, starting models and model parametrizations. We utilize a dataset of 310 magnetotelluric sites that has been acquired for geothermal exploration. In addition, to impedance tensor estimates over a broad frequency range, the dataset also comprises transient electromagnetic measurements to determine near surface conductivity and estimates of distortion at each site. We therefore can compare our inversion approach to these distortion estimates and the resulting inversion models. Our experiments show that inversion with distortion correction produces stable results for various different inversion strategies and for different starting models. Compared to inversion without distortion correction, we can reproduce the observed data better and reduce subsurface artefacts. In contrast, shifting the impedance curves at high frequencies to match the transient electromagnetic measurements reduces the misfit of the starting model, but does not have a strong impact on the final results. Thus our results suggest that including a description of distortion in the inversion is more efficient and should become a standard approach for magnetotelluric inversion.