Application of bounded influence remote reference processing and 1-D simulated annealing inversion to MT data at Mt. Fuji area

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Abstract

The capability of conventional robust response function estimators is limited to down-weight the extreme values in the electric field (outliers) i.e. they are too sensitive to the extreme values in the magnetic field (leverage points). Chave and Thomson (2004) proposed a bounded influence robust estimator that can reduce the influence of both outliers and leverage points by combining the robust M-estimator weight and hat matrix diagonal weight. We used the estimator to process MT data obtained in the Mt. Fuji area and examined the performance by comparing the result to a non-robust estimate.

MT data acquisition training was conducted on 14-16th September 2020 in a very localized area located at the northeast of Mt. Fuji. We measured the horizontal and vertical magnetic field at two sites (s001 and s005) and measured two electric fields in the same direction at three sites (s002, s003, and s004) with the dipole spacings of 30m. The 6 dipoles were alligned without gaps. We used the MT instruments ADU07e (Metronix) for both of the electric and magnetic field measurements. The basic sampling rates are 32Hz, 1kHz, 65kHz, and 524kHz. The MT response functions were estimated by two alternatives: the bounded influence estimator and a non-robust estimator. The responses estimated by the former are more stable and have significantly smaller error estimates than their non-robust counterpart. This reflects the downweighing of the outliers and leverage points by the bounded influence estimator.

The one-dimensional modeling was done with the aid of a simulated annealing scheme that provides a guided random search of the global minimum (Grandis, 2009). We inferred that the bounded influence estimator performed better than the non-robust estimator in that the spatial variation of the 1-D structures after the bounded influence estimator was much smoother than that after the non-robust estimator. In addition, the RMS misfits for the former responses were much smaller than those for the latter responses.

Inversion results show that the study area is a 3-layered high-resistivity structure with the most resistive anomaly at depth of 100-1000m approximately. We then compared the 2020 models with the models obtained from 2019 data. The overall structure is in good agreement. The surface moderately conductive layers of the 2019 model, however, are several times thinner and more conductive than those obtained in 2020. This difference results from difference in apparent resistivity and phase values in the highest frequency bands from 10 to several 10's kHz.

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References

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