Conclusions

In this work, a number of techniques for magnetotelluric data processing known from the literature has been reprogrammed, i. e. the single-site approach, the remote reference technique, the signal-noise separation (Larsen et al. [1996]), and the extension of the latter by Oettinger et al. [2001].
These techniques differ by their nature in the equations that are solved during the processing. However, the “surrounding”procedure has been kept equal for all these techniques and as simple as possible (no time series preprocessing, no robust, but only least-square statistics, no smoothing over values of adjacent frequencies etc.) to ensure a comparableness of the results. The aim of this work was to clarify which relationship exists between the quality of transfer functions obtained with the remote reference, the signal-noise separation, and the extended signal-noise separation method due to the underlying equations in case of noisy data.
First, the efficiency of the least-square implementation is surprisingly good. In most cases, its results are not much worse than those obtained by the robust code of Egbert and Booker [1986], what might be unexpected in a time where robust processing tools are omnipresent and regarded as indispensable. In fact, there is only one situation in which robustness is superior to least-squares: if there is much uncorrelated noise present at the output channels. In order to obtain unbiased results when facing the other possible distributions of noise, i. e. uncorrelated noise on input channels and noise correlated between input and output channels, the best way is the remote reference technique. This method even tolerates a certain amount of noise in the remote data as long as this noise is not correlated to that of the local site.
Concerning the comparison with the implementations after Larsen et al. [1996] and Oettinger et al. [2001], the following could be stated:

- The least-square solution for the signal part of Larsen's two-source equation is formally identical to that of the remote reference equation, as it had been derived by Egbert before. Larsen's method is “better”only insofar as it yields smaller error bars, since a part of the data that cannot be correlated to the remote site goes into the correlated-noise transfer function instead of into the residual. In practice, the postulated identity can be confirmed, although there occur cases where the magnetotelluric transfer functions after Larsen are more affected by scattering and outliers than the remote reference results. I explain this with an enlarged sensitivity of Larsen's approach to numerical problems.

- Larsen et al. [1996] state that a noise-free reference is a condition *sine qua non* for their method. My results do not confirm this if it is about the main (the signal) part of the transfer functions. This follows already from its equality to the remote reference results which are, as mentioned above, quite insensitive to noisy remote data. However, the other transfer functions involved (the correlated-noise ones and the separation tensor) are, in fact, biased due to remote noise.

- Oettinger's extension is able to correct those biased transfer functions. However, the relevant ones for magnetotellurics are not improved hereby. They scatter even stronger than those after Larsen's equations.

On the other hand, MT workers who have used Larsen's original code and compared its output with that of other established algorithms observed that Larsen's method yielded more stable transfer functions (Müller and Haak [2004]). From this must be concluded that it is the special environment "independent of conditional equations", not the two-source equation in Larsen's code that causes such better results.

However, the special and reasoned equations used in Larsen's and Oettinger's techniques are instructive and of a certain practical use, even if they do not seem able to change standards in magnetotelluric data processing.
Correlated noise is a phenomenon that makes magnetotelluric work rather difficult, that demands to react on, and therefore, one must be able to recognize it. Larsen's method providing us with separated transfer functions sharpens the eye very much for this problem.
Oettinger's application of the remote reference technique to the estimation of the separation tensor is highly relevant, even if not in separation matters. It allows to correlate the horizontal magnetic field of one or more stations in an unbiased way to a reference that has noisy data. Moreover, that remote noise may be even correlated to the noise of other stations involved.