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Simultaneous optimization of resistivity structure and electrode locations in ERT

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Electric Resistivity Tomography (ERT) is to visualize subsurface structure in terms of electric conductivity, and is categorized as a geometric sounding using the variations of measured potentials associated with the changes of the locations of current and potential electrodes. Accordingly, accurate coordinates of electrodes are essential in ERT, and electrode mislocation or inaccurate information on electrode positions inescapably results in crucial distortions of the subsurface images. These problems caused by the discrepancy between known coordinates and the true ones of electrodes are much more probable in an ERT monitoring especially performed in an area where ground deformations are expected, such as in landslide monitoring. Without careful considerations of possible movements of electrodes over time, in this case, interpretations may fail to evaluate the ground condition changes. To address these problems, we develop an inversion algorithm that resistivity distribution and electrode coordinates are simultaneously optimized. Using the developed algorithm, we performed numerical experiments based on several scenarios. Firstly, we tested a special case that the subsurface resistivity distribution was known, and almost exact electrode coordinates were calculated. When electrode positions and a resistivity structure are completely unknown and simultaneously inverted, the calculated electrode coordinates are much more erroneous compared to the case when the resistivity distribution is known, but they are reasonably close to the true positions. Furthermore, the reconstructed resistivity image well resembles the ground truth even though the inverted electrode coordinates are still erroneous to some extents. All the numerical experiments show that even with erroneous information on electrode locations, we are able to reconstruct a subsurface image that is close to the ground truth. The developed algorithm will be further combined with a 4-dimensional inversion scheme to precisely evaluate ground condition changes over time particularly when ground deformations cannot be ignored.