Geophysical Research Abstracts
Vol. 19, EGU2017-6329, 2017
EGU General Assembly 2017

The shifting zoom: new possibilities for inverse scattering on electrically large domains

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Inverse scattering is a subject of great interest in diagnostic problems, which are in their turn of interest for many applicative problems as investigation of cultural heritage, characterization of foundations or subservices, identification of unexploded ordnances and so on [1-4]. In particular, GPR data are usually focused by means of migration algorithms, essentially based on a linear approximation of the scattering phenomenon. Migration algorithms are popular because they are computationally efficient and do not require the inversion of a matrix, neither the calculation of the elements of a matrix. In fact, they are essentially based on the adjoint of the linearised scattering operator, which allows in the end to write the inversion formula as a suitably weighted integral of the data [5]. In particular, this makes a migration algorithm more suitable than a linear microwave tomography inversion algorithm for the reconstruction of an electrically large investigation domain. However, this computational challenge can be overcome by making use of investigation domains joined side by side, as proposed e.g. in ref. [3]. This allows to apply a microwave tomography algorithm even to large investigation domains. However, the joining side by side of sequential investigation domains introduces a problem of limited (and asymmetric) maximum view angle with regard to the targets occurring close to the edges between two adjacent domains, or possibly crossing these edges. The shifting zoom is a method that allows to overcome this difficulty by means of overlapped investigation and observation domains [6-7]. It requires more sequential inversion with respect to adjacent investigation domains, but the really required extra-time is minimal because the matrix to be inverted is calculated ones and for all, as well as its singular value decomposition: what is repeated more time is only a fast matrix-vector multiplication.

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