APPLICATION OF NEWTON'S METHOD FOR INCOHERENT SCATTER INVERSE PROBLEM SOLVING

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Inverse problem solving in incoherent scatter (IS) technique is an estimation of such parameters of ionospheric plasma as ion and electron temperatures T_i and T_e as well as ion composition. It implies performing least squares fitting the measured IS signal autocorrelation functions (ACFs) with the ones calculated for different known values of plasma parameters in accordance with the theory of IS [1]. Despite Levenberg-Marquardt algorithm is commonly used for IS inverse problem solving [2, 3], full enumeration method is still in use in software for Kharkiv IS radar data processing [4]. This method gives reliable estimates of ionospheric plasma parameters, but its big disadvantage is a need of large (over 16Gb) library of precalculated ACFs. So, optimization techniques that need small number of evaluations should be used, gradient methods, for instance [5]. Newton's method could be also used for this purpose. It was implemented in UPRISE software package. This iterative method for IS inverse problem solving in case of single component plasma is $\begin{bmatrix} T_i \\ T_e \end{bmatrix}^{[k+1]} = \begin{bmatrix} T_i \\ T_e \end{bmatrix}^{[k]} - \mathbf{H}^{-1}\left(f\left(T_i, T_e\right)^{[k]}\right)\nabla f\left(T_i, T_e\right)^{[k]}$, where $f(T_i, T_e)$ is function for calculating ACF, $\mathbf{H} = \begin{bmatrix} \frac{\partial^2 f}{\partial T_i^2} & \frac{\partial^2 f}{\partial T_i\, \partial T_e} \\ \frac{\partial^2 f}{\partial T_e\, \partial T_i} & \frac{\partial^2 f}{\partial T_e^2} \end{bmatrix}$, $\nabla f\left(T_i, T_e\right) = \begin{bmatrix} \frac{\partial f}{\partial T_i} \\ \frac{\partial f}{\partial T_e} \end{bmatrix}$.

Peculiarities of implementation and application of Newton's method for incoherent scatter inverse problem solving were investigated.

References:

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