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IONOTOMO: A new approach for ionospheric tomography using OTH radar

Corinna Roy (1,2), Giovanni Occhipinti (2,1), Lapo Boschi (3), and Jean-Philippe Moliné (1)

(1) L'Office national d'études et de recherches aérospatiales, (2) Institute de Physique du Globe de Paris - Université Paris Diderot - Sorbonne Paris Cité, (3) ETH-Zurich

Most of the recent methods in ionospheric tomography are based on the inversion of the Total Electron Content (TEC) measured by ground-based GPS receivers [e.g., Garcia et al. 2008]. As a consequence of the high frequency of the GPS, the electron density structure is principally well reconstructed at the F2 region, where the ionosphere reaches the maximum of ionization, neglecting the lower ionosphere. Here, we develop a new 3D ionospheric tomography method based on the full analysis of over-the-horizon (OTH) radar data.
Previous studies in ionospheric tomography by OTH radar (Fridman and Fridman, 1994; Ruelle and Landeau, 1994; Landeau et al., 1997; Fridman, 1998) are all based on the inversion of the leading edge echo curve, consequently an important amount of valuable information present in the data is necessarily neglected. To overcome this limit, we set up a new method, based on the ray-tracing tool TDR [Occhipinti, 2006], to invert the propagation time of electromagnetic waves emitted by monostatic OTH radars.
The major advance of our methodology is taking into account, numerically and jointly, not only the speed variation of EM wave induced by the electron density variation (solved analytically with a linear inversion) but also the perturbation in the raypath (nonlinear numerical method). As the present problem is an ill posed problem we calculate the matrix inversion numerically, using a regularisation method (Tikhonov, 1963). We determine the best regularisation parameter using the Lcurve method (Hansen, 2000).
We present here the originality and the advantage of our method with a full set of synthetic benchmark highlighting the sensitivity of our tomography to the plasma heterogeneities.
Some preliminary test on real data will be presented with a full coverage over Europe. Indeed, the ionospheric tomography by OTH radar, jointly with GPS, could open new exciting perspective in the plasma density estimation with a good resolution to the entire ionosphere.

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