Ionospheric Tomography with GPS Data from CHAMP and SAC-C

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Summary. Abel inversion offers a straightforward way to obtain the vertical distribution of electron density with low computational load. Nevertheless the treatment of the electron density above the LEO orbit must not be neglected, specially for satellites with very low orbit such as CHAMP. This work extends previous results obtained by inverting real GPS data from LEO data, coming from satellites such as CHAMP or SAC-C. In this work, the topside ionosphere is modelled using positive elevation data. To overcome the spherical symmetry assumption, occultations are processed with the aid of Vertical Total Electron Content, estimated from ground GPS data or models. The resulting electron density profiles are compared with external real data consisting basically on basic parameters or true-height vertical profiles obtained from ionosonde measurements.

Key words: GPS, LEO, Electron density, Occultations, Abel transform, Separability hypothesis

1 Introduction

As it is known, Abel inversion techniques are used to obtain high vertical resolution electron density profiles ([3],[4],[9]) which performance may vary between 10% and 20% for foF2 estimations. The assumption of spherical symmetry is not realistic in general, and in particular for occultations where high Vertical Total Electron Content (VTEC) gradients take place. For Low Earth Orbiters (LEO) such as GPS/MET or SAC-C (with nominal orbits of 700km approximately), an exponential extrapolation may be enough to account for the electron content above the LEO [7]. Nevertheless, a more accurate modeling for LEOs at very low orbit such as CHAMP (approx. 400km) is required in order to avoid this assumption leading to incorrect vertical profiles. Therefore, other approaches should be considered. For instance, a modelling of the topside ionosphere with an external model [8]. This work proposes to extend the performance study of two modifications on the classical approach in order to, first, overcome the assumption of spherical symmetry by using horizontal VTEC gradients and, second, model the electron content above the LEO satellite, which becomes crucial for LEOs such as CHAMP, by using LEO GPS observations associated to positive elevation.

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