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Global 4D modeling of electron density from GNSS, using spherical harmonics

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Ionosphere is a dispersive medium with respect to microwave signals. Since most of the space geodetic techniques operate in microwave band, they are capable of providing information about the parameters of the ionosphere in terms of the electron density (Ne), or the Total Electron Content (TEC). In the last decade space geodetic techniques, such as the Global Navigation Satellite Systems (GNSS), satellite altimetry missions, and Low Earth Orbiting (LEO) satellites have turned into a promising tool in remote sensing of the ionosphere.
This study aims at developing a global multi-dimensional model of the electron density, using measurements from GNSS data. This multi-dimensional model represents the height-dependency of the electron density by a modified Chapman function. The parameters of the modified Chapman function, namely the maximum electron density and its corresponding height act as a scaling factor and a profile parameter, respectively. These two parameters are modeled in longitude and latitude by two spherical harmonics expansions. The unknowns of each of the expansions are estimated using least-squares adjustment of the observations. In order to take the time dependency into account, the temporal variation of the spherical harmonics coefficients is modeled by a one-dimensional Fourier series expansion.