Estimating the Ionospheric and Plasmaspheric Total Electron Content (TEC) with GPS in a Kalman filter Approach

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We present a Kalman filter-based algorithm for estimating the ionospheric and plasmaspheric electron content (PEC) using GPS data and emphasize the importance of the plasmasphere in ionospheric studies, especially when deriving TEC estimates from GPS observations. To account for the plasmaspheric contribution to the total TEC along the GPS ray paths, the algorithm incorporates a plasmaspheric model and estimates an amplitude coefficient for the PEC predicted by the model. Furthermore, we investigate the diurnal, seasonal, and latitudinal variations of the estimated PEC by applying the algorithm at five GPS stations distributed over the 65°-90°W longitude range in both northern and southern hemispheres, for two periods in August and November 2007 characterized by low geomagnetic activity levels. At all stations, the PEC exhibits a diurnal variation with an evening plasma bulge and a daytime minimum, similar with the diurnal variation predicted by the model. In addition, our results indicate that the vertical PEC decreases with increasing geomagnetic latitude, whereas the slant PEC displays a latitudinal asymmetry with larger values on ray paths towards the equator than towards the poles. It is also shown that the estimated PEC follows a seasonal variation with smaller values in August than in November, and during both periods, the predicted PEC exhibits a hemispheric asymmetry, being of lesser significance to GPS observations in the northern than in the southern hemisphere. We interpret our results in terms of ionospheric-plasmapheric interactions in both local and conjugate hemispheres and in terms of geometry of the plasmaspheric flux tubes and tilt of the Earth's magnetic dipole.