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Estimation of DCB bias error term for ground and space-based observations using the Spire TEC Environment Assimilation Model (STEAM)

Spire Global develops and maintains its own in-house ionospheric data assimilation (DA) model called STEAM. STEAM assimilates ground and space-based Slant Total Electron Content (STEC) observations generated from global navigation satellite system (GNSS) signals and combines these with a background model to produce estimates of the 3D electron density field. The production of the STEC observations requires a number of pre-processing steps including applying differential code bias (DCB) corrections for both receiver and transmitter to obtain absolute/calibrated STEC observations. However, good knowledge of the DCB values (and errors) are not known/available for all ground-based receivers. In practice, data from approximately half of the ground stations at each assimilation window are not being assimilated because their DCBs are unknown. Further, whilst DCBs for ground stations are usually expected to be stable for days and even weeks, the variability of DCBs for space-based data is expected to be much greater though this has not yet been explored for Spire data. One way to allow assimilation of uncalibrated STEC observations as well as potentially understand the variability of space based DCBs is to use an augmented state DA approach, thus simultaneously estimate the DCBs along with the electron density. Our initial work concentrates on estimating DCBs for ground stations. Our results using three ground stations with known and accurate DCBs show that it is possible to estimate the DCB values using the augmented state. However, our estimates show much more variability than DCBs provided the Chinese Academy of Sciences (CAS). We will present the details of these results and further trials with space data, discuss the reasons for the variability and the impact this has on the analysis electron density field.

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