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Improving Ionospheric Imaging Via the Incorporation of Direct Ionosonde Observations Into GPS Tomography over South Africa

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The Multi Instrument Data Analysis System (MIDAS) developed by (Mitchell & Spencer, 2003) images the ionosphere in four dimensions (three spatial dimensions over time) using a variety of data inputs. These sources include measurements from GPS satellites, values from the International Reference Ionosphere (IRI) and observations from ground based ionosondes (Bilitza, 1997; Chartier, Smith, Mitchell, Jackson, & Patilongo, 2012). The MIDAS model uses the process of tomography to generate values of the total electron content (TEC) along a path through the ionosphere. The direct assimilation of data from a single ionosonde into MIDAS was successfully undertaken by (Chartier et al., 2012). The results from this study showed that image resolution was significantly improved in the vertical dimension; and that local TEC values were also more accurate. The addition of ionosonde data allows for a better assessment of the strengths and weaknesses of TEC estimates made using GPS data.

In this study ionosonde observations from three ionosondes are used as absolute values to correct the peak electron density suggested by IRI for each ionosonde location. The ratios between the original IRI values and the ionosonde observations are then used as a scaling factor to adjust the IRI model values for electron density across the entire grid. This forces the model values to comply with observations. The ratio between MIDAS and IRI values of TEC is then used to adjust the topside shape modeled by IRI. The new method is applied over a region extending across 30 degrees in latitude and longitude centered around -30° latitude and 24° longitude; and uses data from three South African ionosondes, located at Grahamstown, Hermanus, and Louisvale. Here, we present results for a range of trial periods and verify them against data from a fourth ionosonde at Madimbo.

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