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On the testing of the electron density assimilative model (EDAM) with data from a globally distributed network of ionosondes

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Comprehensive, global and timely specifications of the earth's atmosphere (particularly refractivity profiles of the troposphere and ionosphere) are required to ensure the effective operation, planning and management of many radio frequency systems. In order to satisfy this requirement, there are currently a number of groups worldwide who are actively working on systems to provide 3D images of the ionosphere. Data for this ionospheric imaging may be provided by a range of measurement techniques. Of particular note is data from the International GNSS Service (IGS) GPS receiver network. Some IGS stations provide data in hourly files with low latency (˜90 minutes), which can be used to calculate near real-time slant TECs. Radio Occultation (RO) methods are also being increasingly investigated. RO measurements are made by monitoring transmissions from GPS satellites using receivers on Low Earth Orbiting (LEO) satellites and provide the potential of measuring refractivity profiles in regions where ground based sensors cannot easily be located, such as deep sea waters.

The Electron Density Assimilative Model (EDAM) has been developed to exploit such data sources. EDAM has been developed as a compromise solution to the ionospheric imaging problem that, in terms of complexity, lies between full physical model data assimilation systems and more data driven tomographic solutions. As such, it uses a median model for its background model, and uses a Gauss-Markov Kalman Filter assimilation technique.

Two major enhancements have been recently made to EDAM. First, IRI-2007 has been used instead of PIM as the background model. Although both these models produce similar foF2 results, IRI is significantly more accurate in terms of median vertical TEC (or, equivalently the median F region slab thickness). This is important to the assimilative model when it is only assimilating ground based GPS TEC - in this case it is difficult for the assimilation process to modify the slab thickness, so greater reliance must be made on the characteristics of the background model. Secondly, the model variable used within EDAM has been changed from the electron density to the log of the electron density. This results in the assimilation being significantly more stable - i.e. extreme positive or negative excursions from the background model are less frequent. This is due to the fact that the error characteristics of the log(electron density) model conform more closely to the Gaussian assumption that is made in the formulation of the Kalman filter.

In this paper, the EDAM enhancements will be described with reference to a test assimilation that has been validated using foF2 and M(3000)F2 measurements from a globally distributed set of ionosondes. Furthermore, EDAM results will be compared with published results from other ionospheric assimilative models that have been operated and validated using the same data sets.