



Global Ionosphere Specification and Forecast Using VISTA TEC Data

Shasha Zou⁽¹⁾, Yang Chen⁽²⁾, Hu Sun⁽²⁾, Zihan Wang⁽¹⁾, Yurui Chang⁽²⁾, Anthea Coster⁽³⁾

(1) Department of Climate and Space Sciences and Engineering, University of Michigan, Ann Arbor, MI, USA; shashaz@umich.edu; wzihan@umich.edu

(2) Department of Statistics, University of Michigan, Ann Arbor, MI, USA; ychenang@umich.edu; husun@umich.edu; yuruic@umich.edu

(3) MIT Haystack Observatory, Westford, MA, USA; costera@mit.edu

Ionospheric total electron content (TEC) derived from multi-frequency Global Navigation Satellite System (GNSS) signals and the relevant products have become one of the most utilized parameters in the space weather and ionospheric research community. However, there are a couple of challenges in using the TEC data, including large data gaps over oceans and the potential of losing meso-scale ionospheric structures when applying traditional reconstruction and smoothing algorithms. To overcome these shortcomings, we recently developed a novel video imputation algorithm called VISTA (Video Imputation with SoftImpute, Temporal smoothing and Auxiliary data)[1] to complete the TEC map and applied the VISTA algorithm to the Madrigal TEC data. The complete TEC maps reveal important large-scale TEC structures and preserve the observed meso-scale structures, such as equatorial plasma bubbles.

Furthermore, the constructed TEC dataset has been validated by comparing it with the JASON altimeter-derived TECs. In addition, we use the VISTA TEC dataset to develop ionospheric TEC specification and forecast models, including forecasting global TEC map using a modified U-Net model and matrix auto-regressive model, as well as characterization and forecasting of equatorial ionization anomaly.

References

- [1] Hu Sun, Zhijun Hua, Jiaen Ren, Shasha Zou, Yuekai Sun, Yang Chen. “Matrix completion methods for the total electron content video reconstruction.” Ann. Appl. Stat. 16 (3) 1333 – 1358, September 2022.
<https://doi.org/10.1214/21-AOAS1541>