

Mihail
Codrescu

Vector Space, LLC, Boulder, CO, USA

Stefan M. Codrescu, Vector Space, LLC, Boulder, CO, USA

Catalin Negrea, Institute of Space Science, Magurele, Romania

Mariangel Fedrizzi, University of Colorado/CIRES and Space Weather Prediction Center, Boulder, CO, USA

Poster

Neutral density measurements are difficult to make, limited in number and coverage and suffer from large biases and uncertainties. This makes the option to improve neutral density specification using the plentiful ionospheric measurements, very attractive for satellite collision avoidance applications. Better neutral density specification and forecast can reduce the uncertainty in satellite and debris positioning, lower satellite fuel consumption, and help prevent the Kessler Syndrome. The main question we answer here using the Thermosphere Ionosphere Data Assimilation (TIDA) model is as follows: Is it possible to improve the global thermosphere neutral density model results by assimilating only ionospheric measurements? To illustrate the case we assimilate only slant TEC (sTEC) measurements from COSMIC-2 and show improvement in neutral density during an 8 day period (January 31 - February 7, 2022) that includes the minor geomagnetic storm that lead to the loss of 48 SpaceX satellites.

DATA ASSIMILATION in the Thermosphere-Ionosphere

Introduction

- Data assimilation is a technique to combine model results using observations.
- The model used: TIDA - coupled Ionosphere-Thermosphere model.
- Observations assimilated: Slant TEC (sTEC).
- Results: Improved global neutral density model and improved satellite trajectory predictions during storms.

Why?

- Accurate neutral density modeling is essential for the safety of satellite operations in LEO.
- Improved neutral density observations could improve orbit predictions during storms.

How?

- Assimilation of ionospheric observations.
- Assimilation of the model forecast from the previous model run.
- Assimilation of the observations using a Kalman filter.

Results

The table below shows RMSEs for electron density (N_e) and neutral density (ρ) during the 8-day period.

Variable	Model	RMSE (pre-assim)	RMSE (post-assim)
Electron Density (N_e)	Global	10.00	10.00
	Storm	10.00	10.00
Neutral Density (ρ)	Global	10.00	10.00
	Storm	10.00	10.00

Conclusions

- Assimilating ionospheric observations is a possible to improve neutral density modeling, even during a geomagnetic storm.
- The possibility to improve neutral density, ionospheric, and heliogeophysical modeling using ionospheric observations demonstrates the importance of coupling between the ionosphere's and thermosphere's during storm events.

References

- [1] [2] [3] [4] [5] [6] [7] [8] [9] [10] [11] [12] [13] [14] [15] [16] [17] [18] [19] [20] [21] [22] [23] [24] [25] [26] [27] [28] [29] [30] [31] [32] [33] [34] [35] [36] [37] [38] [39] [40] [41] [42] [43] [44] [45] [46] [47] [48] [49] [50] [51] [52] [53] [54] [55] [56] [57] [58] [59] [60] [61] [62] [63] [64] [65] [66] [67] [68] [69] [70] [71] [72] [73] [74] [75] [76] [77] [78] [79] [80] [81] [82] [83] [84] [85] [86] [87] [88] [89] [90] [91] [92] [93] [94] [95] [96] [97] [98] [99] [100]

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