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Forecasting Convective Instability in the Equatorial Ionosphere using ICON

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Measurements from the Ionospheric Connections Explorer satellite (ICON) are used to forecast plasma convective instability in the equatorial *F*-region ionosphere and the attendant space-weather phenomena. Specifically, we examine data from the Ion Velocity Meter (IVM-A), Michelson Interferometer for Global High-resolution Thermospheric Imaging (MIGHTI), and Far Ultraviolet (FUV) instruments [1, 2, 3]. The data are used to initialize and force a direct numerical simulation (DNS). Forecasts made on the basis of data from one orbit are used to predict the appearance of irregularities at ICON's altitude by the subsequent orbit.

The study examines orbital segments where a) the ICON satellite was near the magnetic equator in a local-time window suitable for making measurements needed to initialize a forecast simulation and b) the satellite was again near the magnetic equator and able to detect irregularities when it revisited the same longitude approximately 104 min. later. The study concentrates on data from March equinox 2022.

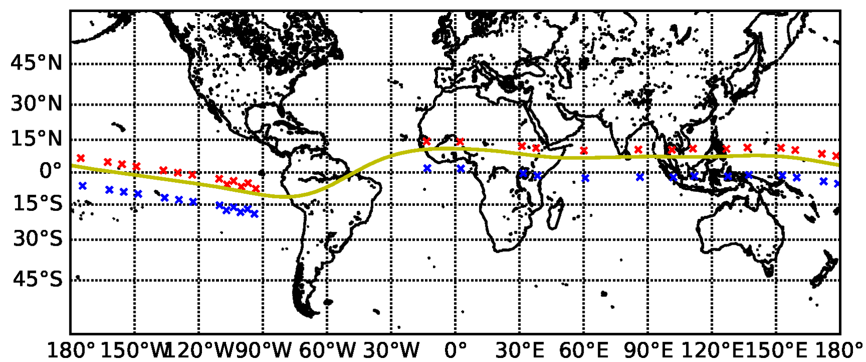

Figure 1. ICON orbital segments from the last week of March, 2022. Blue and red crosses represent segments (a) and (b), respectively, which are taken from subsequent orbits.

The numerical simulation solves the electrostatic potential completely in three dimensions along with the continuity and momentum equations for the dominant atomic and molecular ion species. It relies on a number of other physics-based and empirical models to estimate background atmospheric and ionospheric state parameters. Some state parameters are then nudged on the basis of parametrized ICON data.

In fourteen trials, the simulation produced twelve correct predictions, one false positive, and one false negative. The overall forecast strategy, its limitations, and practical avenues for improving it are discussed.

References

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