Importance of Realistic Auroral Precipitation, Electrical Field Variability, and Model Resolution in Resolving the Storm-Time Neutral Temperature and Density

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Dramatic **N**eutral **T**emperature enhancement and an **I**nversion **L**ayer (NTIL) have been detected by the Fe Boltzmann lidar at McMurdo, Antarctica during a geomagnetic storm. None of empirical or default configurations of physical models capture these features. We use the Thermosphere-Ionosphere-Electrodynamics General Circulation Model (TIEGCM) with high-latitude drivers constrained by data to examine the mechanisms of NTIL. The auroral precipitation maps from DMSP/SSUSI are incorporated in the TIEGCM, which increase Pedersen conductivity significantly in the auroral region. Sub-grid electric field variabilities are implemented with regard to the spatial distribution of auroral activities. Thereby, the observed large temperature enhancement and NTIL are reproduced. The default model runs underestimate the neutral densities by 40% compared with GRACE measurements, which are resolved by incorporating observed auroral maps and sub-grid electric field variabilities. The mechanism to generate temperature inversion in the lower thermosphere is : strong local Joule heating due to the enhanced auroral precipitation and sub-grid electric field variability induces large upward vertical wind which leads to strong cooling around 200 km. Strong heating around 150 km, while cooling dominating above it, generates the inversion layer. The two different model resolutions are run for this event, and the contributions from the fine-scale auroral precipitation and electric field to the storm-time neutral atmosphere are examined.

Keywords: geomagnetic storm, auroral energetic particles, neutral ion coupling, electric field variability, DMSP/SSUSI, TIEGCM