Comparison between operation and research simulations with CTIPe model during geomagnetic storm conditions

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Introduction
The perturbations in the magnetosphere-ionosphere-thermosphere system are significant during geomagnetic storm conditions. The response in the ionosphere-thermosphere (IT) system to these conditions can be analyzed with the Coupled Thermosphere Ionosphere Plasmasphere (CTIPe) model.

We perform simulations using first the model inputs available in real-time (operational run) and second with the best estimate obtained after the event (research run), and compare the results.

CTIPe Model and Observations
CTIPe is a global non linear physics based model that solves the equations of momentum, energy and composition for neutral and ionized atmosphere.

Comparing CTIPe results with GPS TEC and CHAMP satellite neutral mass density observations allows validating the CTIPe results and complete the interpretation of the physical mechanisms behind the perturbations during the event.

Storm Morphology: 20th November 2003

CTIPe operational real-time (red) and research (blue) model input for 19-20 November 2003. Solar wind particles can introduce noise in the ACE detector and make the signal fluctuate ($B_1$, $B_2$, $v_y$, and $p_o$).

Hemispheric power in GW and Activity level (PI), derived from TIROS/NOAA, does not differ between real time and research runs.

Thermosphere response
Changes in the thermosphere are evaluated using CHAMP satellite neutral mass density (black), and compared with CTIPe operational (red) and research (blue) model results.

Neutral mass density operational – research discrepancies during maximum peak of the storm with measurements are not larger than 8.4%. The research results are closer to observations and a good representation of the thermosphere can be assumed.

Ionosphere response
Changes in the ionosphere during storm conditions are evaluated using GNSS TEC, and compared with CTIPe operation and research model results.

19-20 November 2003 storm TEC differences for a fixed location of 40°N latitude and 10°E longitude.

Significant differences between operational and research runs can be identified. The deviation from the TEC observations are considerable in the operational, while research is closer to measurements with a 17% deviation.

Storm Dynamics
Strong Joule heating in the auroral region driving storm wind cell is visible in the CTIPe research run and it is suggested to be the main driver of the positive ionospheric storm over Europe.

Conclusions
- CTIPe simulations show input dependent global changes in neutral winds, temperature, and composition which are reflected in the global electron density structure.
- Comparing the research run results with GNSS and CHAMP satellite observations allows validating the CTIPe results and complete the interpretation of the physical mechanisms behind the perturbations during the event.

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