Simulation of electric field and current during the June 11, 1993, disturbance dynamo event: comparison with the observations

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During high geomagnetic activity periods, disturbance winds from high latitude regions may influence the low latitude ionosphere. These dynamo effects have been associated with mid-latitude winds driven by the high latitude Joule heating and with fossil winds accelerated by strong ion convection in the auroral regions. The ionospheric disturbance dynamo mechanism has been proposed to explain these electric field disturbances observed at the end of magnetic storms, generated by the disturbed thermospheric wind actions (M. Blanc and A. D. Richmond, *J. Geophys. Res.*, **85(A4)**, 1980, pp. 1669-1686, doi: 10.1029/JA085iA04p01669).

The influence of geomagnetic activity on mid and low latitude thermospheric winds and ionospheric electric field has been investigated using the National Center for Atmospheric Research Thermosphere-Ionosphere-Electrodynamics General Circulation Model (NCAR TIE-GCM)

The NCAR TIE-GCM is a three-dimensional, time-dependent model which solves the full dynamical equations of the coupled thermosphere and ionosphere self-consistently. It is designed to calculate the coupled dynamics, chemistry, energetic, and electrodynamics of the global thermosphere-ionosphere system between about 97 km and 500 km altitude. In particular, the TIE-GCM calculates the ionospheric electric fields and currents and their associated magnetic perturbations. With a specified day number of the year, $F_{10.7}$ solar flux, high-latitude hemispheric power of precipitating auroral particles, cross-polar-cap electric potential and tides specified at the lower boundary, the model calculates global electric fields and currents, ion and neutral densities, temperatures, compositions, and velocities.

The model results are tested against reference magnetically quiet time observations on June 21, 1993, and disturbance dynamo effects observed on June 11, 1993. The model qualitatively reproduces the observed diurnal and latitude variations of the geomagnetic horizontal intensity and declination for the reference quiet day in middle and low latitude regions, but underestimates their amplitudes. The patterns of the disturbance dynamo signature and its source "anti-Sq" current system are well reproduced in the northern hemisphere. However, the model significantly underestimates the amplitude of disturbance dynamo effects when compared with observations. Furthermore the amplitude maxima occur at different local times than the observations. The discrepancies suggest that the assumed high-latitude storm-time energy inputs in the model were underestimated.