The Response Of Equivalent Ionospheric Currents To The External Drivers Using A Machine Learning Method

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It is well known that geomagnetic field disturbances can be generated at high latitudes due to strong ionospheric electrojet currents during substorms and geomagnetic storms. These large magnetic disturbances, usually accompanied by a large rate-of-change in the magnetic field dB/dt, will also produce geoelectric fields and geomagnetically induced currents (GIC).

In order to study the variations of ionospheric currents (i.e., the Equivalent Ionospheric Currents (EICs) and the Spherical Elementary Current (SEC) amplitudes) and its response to upstream solar wind and the magnetospheric activities, we developed an ANN-SEC model based on the feedforward neural network to reproduce the ionospheric current obtained from the SEC technique. The conventional statistical analysis is incapable of providing a quantitative prediction and reproduction of the EICs and SEC amplitudes with relatively high accuracy due to the high nonlinearity of this system. Understanding how the upstream solar wind, the magnetospheric dynamics, and the Earth’s ionosphere coupled with each other is essential. The data utilized are measured by multiple spacecraft and ground-based observations, and the target values of the ANN-SEC model are the ionospheric currents obtained from the SEC technique, including both components of the EICs and the SEC amplitudes. The input parameters include the locations of the measurements (longitude and latitude), solar wind parameters (e.g., solar wind velocity, magnetic field, dynamic pressure), and geomagnetic indices (e.g., AL, AU, AE, SYM-H, ASY-H). Based on the result of our ANN-SEC model, we found that our model is promising in predicting the Earth’s ionospheric currents using the driving mechanism of the solar wind and the magnetosphere. Our model can provide spatial and temporal reconstruction of the ionospheric currents whenever and wherever they are not directly available from the SEC current system.

![Figure 1. The data-model comparison (left) and the global prediction contour map (right).](image-url)