# Geomagnetically induced current (GIC) exercises

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The following exercises aim to estimate GIC at one of the nodes of the North American high-voltage power transmission system by using information about the state of the solar wind and the geomagnetic variations on the ground. The accompanied tutorial "Modeling of geomagnetically induced current flow in high-voltage power transmission systems" is needed for the completion of the exercises. The material located at the CCMC's summer school website that is associated with these exercises is as follows:

- "Modeled global geoelectric field" shows the global geoelectric modeled by using ionospheric output from global MHD and the methods described in Section 2 of the tutorial.

- "The global GIC proxy computed from the global geoelectric field" shows global proxy for the maximum GIC computed by using hypothetical power system parameters and the modeled global geoelectric field.

- "The GIC modeled to one of the North American power grid nodes" shows GIC modeled to the node of the North American power transmission system by using ionospheric output from global MHD and the methods described in Section 2 of the tutorial. Note that the temporal resolution of the data is 5 minutes.

- "The GIC observed at one of the North American power grid nodes" shows 5-minute averages of the observed GIC at the node of the North American power transmission system.

- "Tutorial on calculating GIC" contains PDF of the GIC tutorial.

# 1 (Advanced) Estimation of GIC based on the observed interplanetary shock strength

Use the Advanced Composition Explorer (ACE) observations of the solar wind magnetic field and the plasma parameters to estimate the strength of the interplanetary shock that was observed during the April 19, 2002 event. Apply the shock parameters to estimate the corresponding deflection of the magnetic on the ground at geomagnetic latitude of $56.09^o$ N (this corresponds to the geographic coordinates $45.4^o$N, $75.6^o$W of the Ottawa geomagnetic observatory used in the tutorial). Note that the information/material for carrying out the shock-related calculations is given elsewhere. Use the estimate for the deflection to estimate the time derivative of the magnetic field ($dB/dt$) at Ottawa and finally, feed the calculated $dB/dt$ to the empirical method described in Section 1 of the tutorial to estimate the corresponding GIC at the node of the North American power transmission system. Compare the GIC estimate to the observed GIC.

It may be stated that GIC of about 200 A would cause significant problems in operating the power transmission system at and around the node considered in the tutorial. As an additional task, estimate the strength of the interplanetary shock required to generate such high levels of GIC at the node. Have such shocks been observed?

# 2 (Intermediate) Estimation of GIC based on the observed geomagnetic field fluctuations

Use $dB/dt$ observed at the Ottawa geomagnetic observatory to estimate GIC by using the method described in Section 1 of the tutorial. The Ottawa data can be viewed via Natural Resources Canada website at http://gsc.nrcan.gc.ca/geomag/data/index_e.php. Once on the site, click "Rate of change (dB/dt)" and selected the correct station and the time period to access the $dB/dt$ data. Note that the unit for $dB/dt$ is on the website nT/min whereas in the tutorial nT/s. Compare the estimated GIC to the observed GIC. Discuss the possible reasons for the differences between the estimated and the observed GIC.

# 3 (Easy) Compare the simulated and the observed GIC

Compare GIC simulated by the methods described in the Section 2 of the tutorial to the observed GIC. Discuss the possible reasons for the differences between the predicted and the observed GIC.