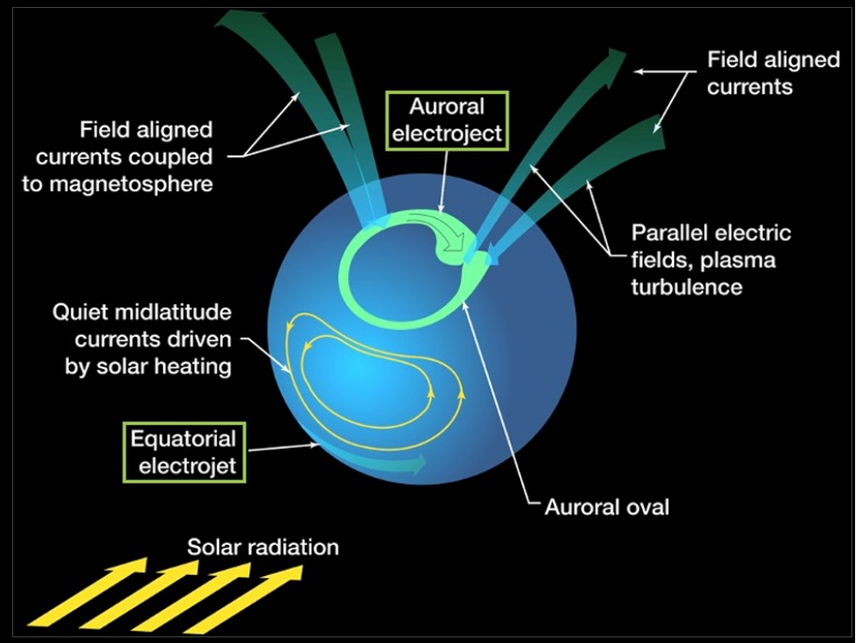
Understanding Magnetosphere/Ionosphere Coupling

The solar wind is a continuous stream of charged particles blowing from the Sun. The Earth's magnetic field forms a protective shield around our planet, called the magnetosphere, which deflects most of the solar wind particles away from the Earth.

Disturbances in the solar wind can interact with the magnetosphere and impact the Earth's upper atmosphere (ionosphere). The interaction creates electric fields forcing charged particles to move in the magnetosphere, which creates electric currents flowing along the magnetic field lines connecting to the high-latitude ionosphere and drives the movement of charged particles there. The low-latitude ionosphere is generally shielded from these electric fields.

Sudden changes in the solar wind can break such balance, leading to the electric field penetration to low latitudes. We examined how the magnetosphere and ionosphere interacted during the 23 March 2023 geomagnetic storm, focusing on what happened when the solar wind dynamic pressure suddenly decreased.

We found the pressure drop caused a sudden decrease of the high-latitude electric field, resulting in a brief period of overshielding and the electric field in the equatorial ionosphere reversed its direction. This changed the direction of the equatorial electrojet, a major electric current in the ionosphere at the magnetic equator. These findings are a step forward in the improvement of global magnetosphere and ionosphere-thermosphere models that ultimately will help the development of forecasting capabilities for space weather.



A diagram of the electrojet circuit in the ionosphere and shows the currents aligned with Earth's magnetic field and couple to the magnetosphere. This system is driven by input from the Sun.

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