Master thesis project in space plasma physics

Analysis of ionospheric currents structures to better understand and predict power outages

Supervisor: Audrey Schillings
Contact: audrey.schillings@umu.se

Figure 1: Space weather effects. Credits: ESA.

Aims & Purpose

The Sun continuously emits solar wind, which interacts with the Earth's magnetosphere. When solar eruptions occur and once the solar wind reaches the Earth, it creates geomagnetic storms and substorms. They provoke perturbations in the Earth's magnetic field, which can be measured on the ground with magnetometers. Such geomagnetic disturbances (GMDs) induce electric currents on the ground called the geomagnetically induced currents (GICs). These GMDs find signatures in the ionosphere and are associated with a brightening of the auroral emission and some current enhancements. If the enhancement is isolated, we called it a wedgelet (see Figure 2).
The aims of the project is to establish a statistical study of these ionospheric structure called wedgelets and try to understand their roles in the global picture of geomagnetic storms and substorms.

Why would you care about this?

The GICs are one of the signatures of space weather (see Figure 1) and our modern society relies on more and more sensitive technological systems (e.g. power, telecommunication, and navigation), which are very vulnerable to GMDs. It is therefore important that we better understand GMDs causes and consequences so that we can predict their occurrence and protect our technological systems.

Methodology & Tasks

In this project, you will use magnetometers data and All-Sky Camera images (upon availability) from Scandinavia and Greenland to look at the Earth's magnetic field in combination with auroral images. You will also learn about a software that estimate the so-called ionospheric equivalent currents, a proxy of the ionospheric currents at about 100 km altitude. In the B field, you will look for rapid and short-lived GMDs in 2021-2022, estimate the equivalent currents, look for corresponding auroral images and try to identify wedgelets. Depending on your interests, we can look at satellites data such as THEMIS or MMS to find signatures in the Earth's magnetosphere (more scientific oriented) or investigate the roles of wedgelets in comparison with GICs (more engineer oriented).

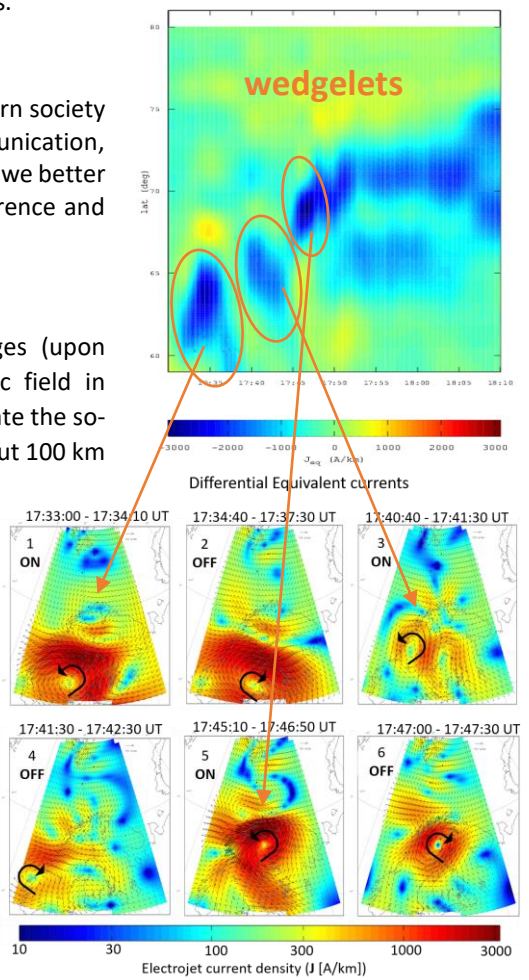

Figure 2: Signatures of wedgelets and associated ionospheric equivalents currents. Credits: Schillings A.

Requirements

Basic understanding on space plasma and magnetospheric/ionospheric physics is essential to conduct this project. The project is based on data analysis, so one computer programming language e.g. Matlab, Python is beneficial, however, if you are pro-active and willing to learn you can learn it from scratch.
Language of the thesis will be English.

Contact information

The project will be supervised by myself, a postdoctoral fellow at the space plasma group at the Physics Department. We will partially collaborate with DTU Space in Denmark as well as FMI in Finland for the analysis of the magnetic field data and the auroral images. If you have any questions or are interested in the project, do not hesitate to contact me for more information at audrey.schillings@umu.se .