UNIVERSITY OF OSLO

COURSE NAME

Project Name

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ABSTRACT

[1]

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[1] FiXme Note: write abstract

CHAPTER

1 INTRODUCTION

This project in Space physics is for studying the dynamics ...

CHAPTER

2 METHOD AND THEORY

2.1 Instruments

2.1.1 Advanced Composition Explorer

The Advanced Composition Explorer (ACE) is a satellite that is positioned between the Earth and the sun, close to the first Lagrangian point (L1) and about 1.5 million km from the Earth. This gives the satellite a good view at the solar wind. It carries different systems with it including SWEPAM and MAG

The Magnetic Field experiment (MAG) Looks at the fluctuations of the interplanetary magnetic field(IMF).

The Solar Wind Electron Proton Alpha Monitor(SWEPAM) provides the bulk solar wind observations

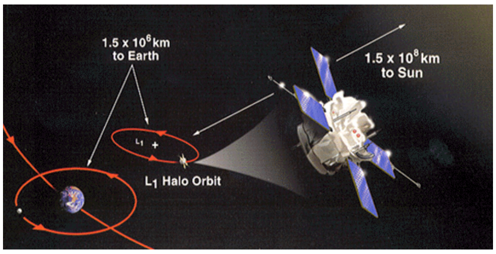

Figure 2.1. Placement of ACE between the Earth and Sun.

2.1.2 All-sky Imager

The All-sky imager consist of a fisheye lens, an optical filter and a photon counter.

The fisheye lens gives a 180° view, so that th entire sky is covered. The optical filter gives us a image of only the wavelengths that is wanted, so that the only source is the Aurora. And the photon counter gives the intensity of the aurora in the part of the sky that equals the pixel size. When there is daylight or the full moon is visible may the aurora be to week for the all-sky imager, so the data cuts.

The keograms are from the Ny Ålesund allsky imager as the Longyearbyen imager didn't provide

Figure 2.2. Allsky camera, Keo Scientific [1]

any data.

2.1.3 Super Dual Auroral Radar Network

Super Dual Auroral Radar Network (SuperDARN) is an international radar network used to map high latitude plasma convection in the F-region of the ionosphere, both in the northern and southern hemisphere.

In this project only the northern hemisphere is going to be studied.

SuperDARN consist of multiple radars that measures the movement of the plasma, adding these together gives a picture of how the convection is in the ionosphere at the moment.

2.1.4 Active Magnetosphere and Planetary Electrodynamics Response Experiment

Using 66 Irridium satellites in Low Earth Orbit at $\sim$ 780km altitude the Active Magnetosphere and Planetary Electrodynamics Response Experiment (AMPERE) is observing the Birkeland currents. This to create a map of the magnetic perturbation due to Field Aligned Currents.

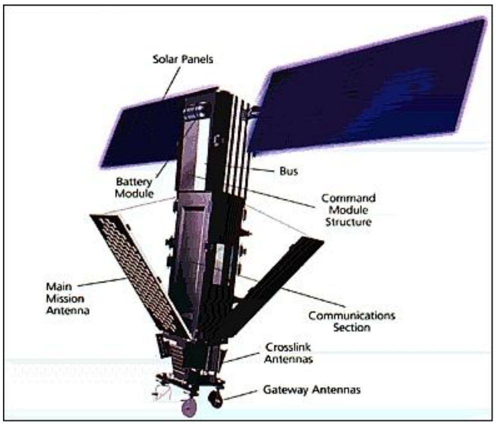

Figure 2.3. Irridium satellite.

Something awesome

even more

2.1.5 Ground-Based Magnetometer

International Monitor for Auroral Geomagnetic Effects (IMAGE) are studying auroral electrojets and two dimensional current systems. It consists of 35 magnetometer stations in Finland, Sweden, Estonia, Norway and Russia. And is covering latitudes from 54 to 79 degrees north.

2.2 Theory

Theorems that comes in handy

frozen-in flux

$E = -v \times B$

2.2.1 The Solar Wind and Interplanetary magnetic field

The solar wind can be modelled by the Parker Solar model. This model suggest that the Sun is not in hydrostatic equilibrium. Using Eq. (2.1) it is possible to show that plasma can stream out from the sun and hence create the solar wind.

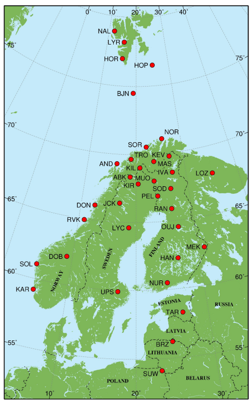

Figure 2.4. The locations of the Magnetogram stations.

$$\rho \frac{\partial v}{\partial t} + \rho(\vec{v} \cdot \nabla)\vec{v} = -\nabla p + \rho \vec{g} \tag{2.1}$$

As the pressure is dominating the particles must accelerate outward. This allows for two solutions for the problem. One that gives subsonic particle speeds at Earth and one that gives supersonic speeds at Earth. As the observed speeds are supersonic this only allows one solution.

2.2.2 Bow Shock

When the Solar wind hits the Earth it is flowing at supersonic. Due to the magnetic field and the atmosphere of the Earth it need to slow down to subsonic speeds.This happens in a bow shock created in front of the magnetic field.

2.2.3 Reconnection

If the IMF is aligned in such a way that it is opposite the Earth's magnetic field reconnection is possible. [2] The reconnection of the magnetic field lines as shown in Fig. 2.5

Because there is a difference in field strength between the IMF and the Earth's magnetic field the Chapman-Ferraro current is set up to balance the sides. When there is enough pressure the diffusion processes starts which results in reconnection of the magnetic field lines.

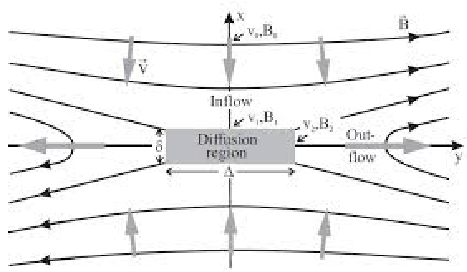

Figure 2.5. Sweet-Parker magnetic reconnection

2.2.4 Dungey cycles

As there is a reconnection on the day side the field line is stretched from the dayside to the nightside and therefore does also the plasma and field line foot move. As the fieldlines reconnects on the nightside the fieldlines and the plasma moves to the dayside again.

2.2.5 Hall, Pedersen and Birkeland currents

Birkeland currents or Field Aligned Currents are currents that flow along the magnetic field lines.

2.2.6 Magnetic Storms

The magnetic storm consists of two parts this is the main phase and the recovery phase.

In the main phase the magnetic field strength drops and the Kp rises.

While in the recovery phase the magnetic field strength slowly builds up again.

[2]FiXme Fatal: input figure for reconnection

CHAPTER

3 RESULTS

3.0.7 ACE

The magnetic field strength is shown in figure Fig. 3.1. Here it's possible to see when an outburst from the sun is passing before it hits Earth.

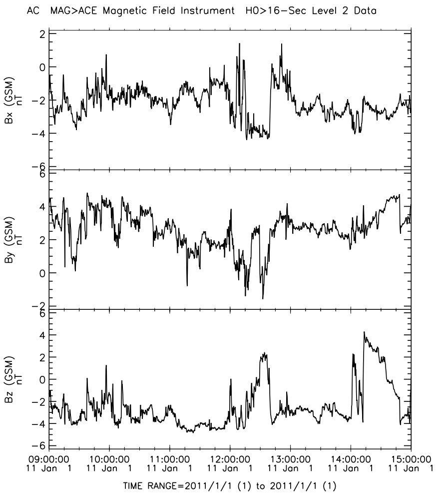

Figure 3.1. Magnetometer showing field strength from ACE

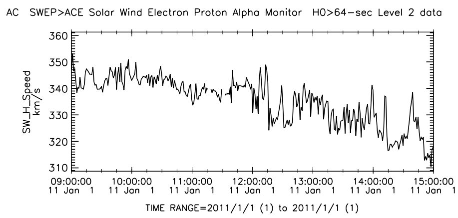

Figure 3.2. Bulk flow speed of the solar wind

The most interesting part is the Bz component that is the field aligned component of the IMF. When the component is negative over a period of time then reconnection can take place.

It is negative over the period between 9.00 and 12.00, and also between 12.30 and 14.00. As can be seen in Fig. 3.1.

From Fig. 3.2 the velocity at which the solar wind travels towards Earth can be seen This velocity is about 340 $\frac{\text{km}}{\text{s}}$ for the first period between 9.00 and 12.00. For the second period between 12.30 and 14.00 the wind velocity is slightly lower at about 330 $\frac{\text{km}}{\text{s}}$.

3.0.8 Ground-Based Magnetometers

The ground based magnetometers in Fig. 3.3 shows the magnetograms from the Svalbard area. In the magnetograms it's possible to see a decrease in the magnetic field strength starting at the station in Ny Ålesund and the moving south ending at Bjørn øya. It starts at around 10.00 in Ny Ålesund and goes down until 12.00, when it starts going back up before going down again between 14.00 and 15.30.

On Hopen (HOP) it starts decreasing at around 12.00 and decreases until 13.00, when it stays quite stable during the rest of the period.

On Bjørn øya it starts decreasing around 12.00 and continues until 14.00 when it gains a bit strength before it decreases from 15.00 until 15.30.

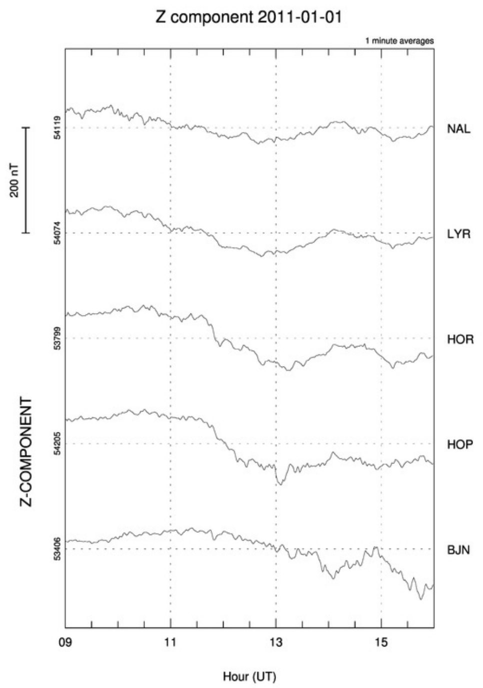

Figure 3.3. Magnetogram from Svalbard area

3.0.9 SuperDARN

In Fig. 3.4 the motion of plasma in the F-region is mapped at the time 14.15 UT. Here it's possible to see that there is a movement going eastward above Svalbard and across the polar cap from Russia to Canada. There is a twin cell pattern in the movement.

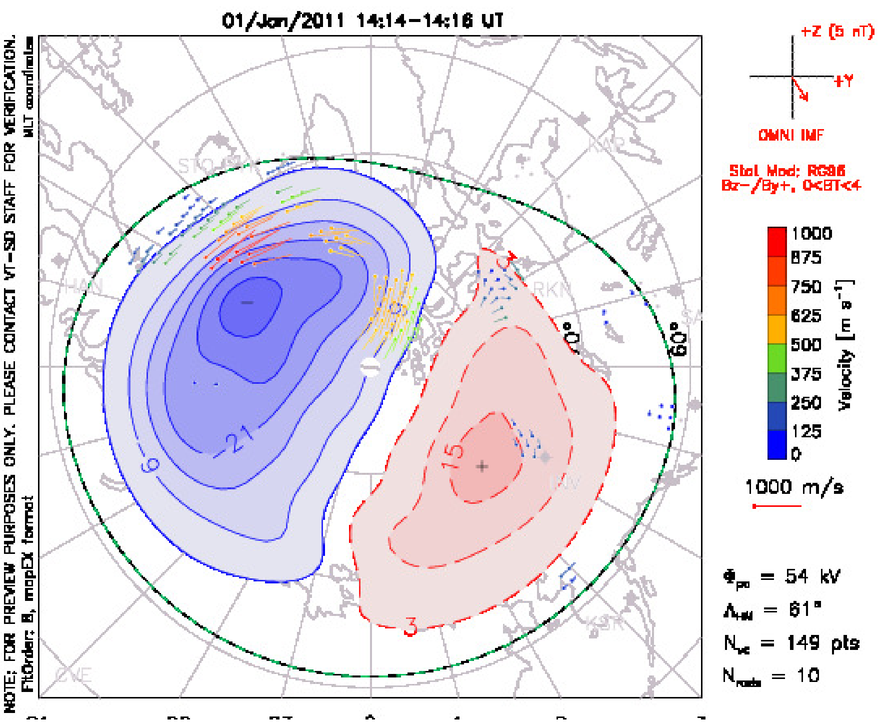

Figure 3.4. SuperDARN at 14.15

3.0.10 Current densities (AMPERE)

In Fig. 3.11 the current densities from January 1st 2011 between 11.00 to 15.00 calculated from the Irridium satellites are shown. Here the most interesting time is around 14.00 as this is the time with the highest densities.

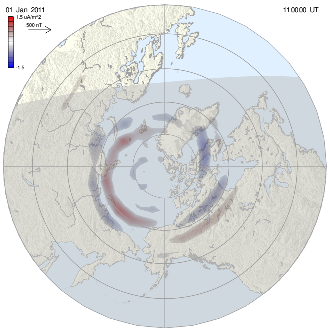

Figure 3.5. 11.00

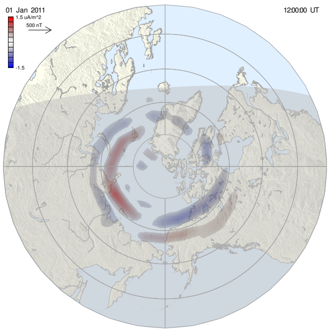

Figure 3.6. 12.00

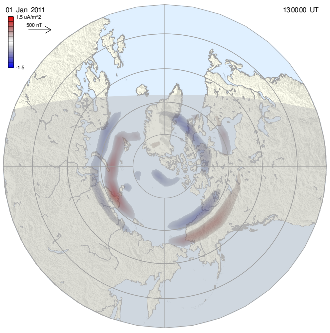

Figure 3.7. 13.00

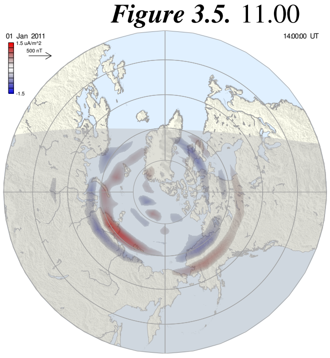

Figure 3.8. 14.00

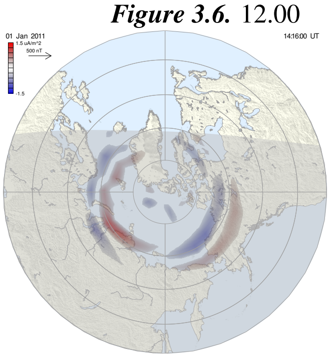

Figure 3.9. 14.16

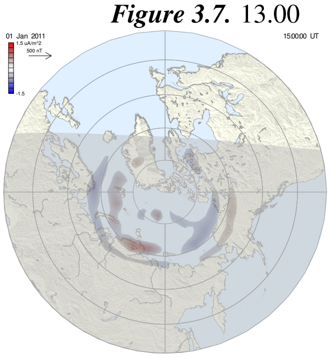

Figure 3.10. 15.00

Figure 3.11. Current densities from 11.00 to 16.00 on January 1st 2011, scale from -1.5 $\frac{uA}{m^2}$ to 1.5 $\frac{uA}{m^2}$, one figure for each hour and an extra for 14.16

At 14.00 the current is up above Svalbard which is the most interesting place to study due to the all-sky camera. And down a bit further south. On the Canadian side there is down furthest north and out further south. At 12.00 there also is a higher density of outward current above Svalbard.

3.0.11 Aurora

When looking at the Keograms during the day then there is most activity between 11.00 and 15.00. So these will be the ones considered. Starting in the time period between 11.00 and 12.00 then it's possible to see some activity???????

In the keograms the

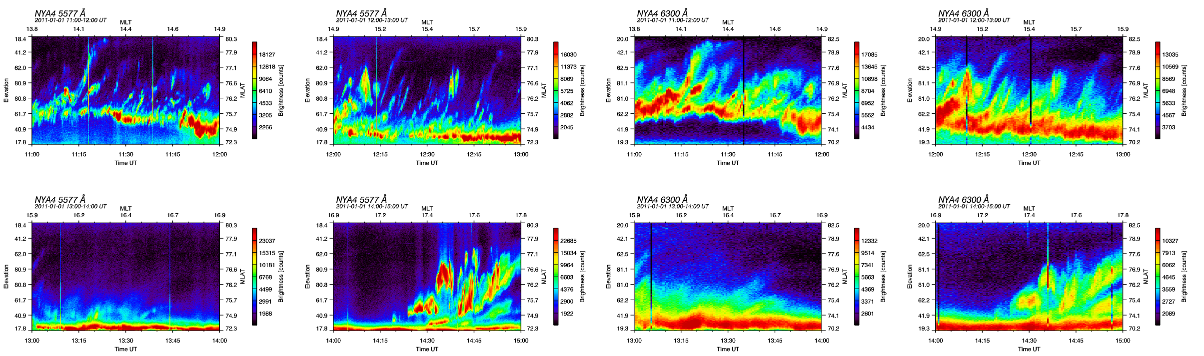

Figure 3.12. Keograms for the time period between 11.00 and 15.00. The four on the left side is in the 5577Åand the four on the right is in 6300 Å

CHAPTER

4 DISCUSSION

4.1 Interplanetary magnetic field and interaction with Earth's magnetic field.

As observed on the satellite ACE there is a change in the magnetic field strength, this change to a negative direction is connected to the southward IMF. So there is a burst of plasma coming towards Earth, that will lead to reconnection and an auroral storm. This also means that there are plasma flowing that causes aurora. That there is reconnection is supported by the magnetograms from Svalbard and Bjørn øya. They show a change in the magnetic field strength a bit more than an hour later. So the solar wind has moved the IMF so that there can be reconnection and it from the data given by the ground-based magnetometers it also seems like that is whats happening.

This reconnection causes the opened magnetic field lines to move back into the tail. When these magnetic field lines reconnect in the tail again and becomes closed field lines then the plasma can rush down the field lines and cause aurora. Also the magnetic field lines then move to the day side again as a part of the Dungey cycle.

CHAPTER

5

CONCLUSION

Conclude!!!!