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Chosen theme: Life in Space/Life on Earth
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Researching the Effects of Solar Winds on the Earth's Magnetic Field

Introduction:

Our team aimed to research the magnetic field of the Earth. We thought this would be interesting because we wanted to discover the magnetic shape of the earth as there may be external factors.

Our hypothesis was that the graph would be basically sinusoidal but with some kinks in our data on the sunlit side of the Earth due to the solar wind. We expected to see that the ISS should perform two full orbits, passing over (near) 4 poles, which would give four maxima to the magnetic field.

Method:

We wrote a code that took the average magnetic data over 10 seconds. We exported this in a text file including the current time and the longitude and latitude of the ISS.

We measured the magnetic field data in microteslas in the x, y and z orientation using the built-in magnetometer. For the time we imported the datetime module into python. And for the longitude and latitude we imported the ephem module. For the average over 10 seconds, we wrote a For Loop which took the data every second and added to a variable which was then averaged. We did this so we would have reliable results and eliminate any anomalous readings.

We tested the run time of the code to ensure that the code ran for 10 seconds before being averaged. We also added a flashing red light that would help the astronauts to see that the code was being run. We also decreased the level of light so it would not be irritating to the astronauts.

Results:

From the y and z graph (figure 2 and 3 respectively) we can see a more or less sinusoidal relationship. In the x graph (figure 1) is very hard to find a clear correlation, and the variation in field is significantly less. We think therefore that the orientation of Raspberry Pi is such that the x axis is always more or less perpendicular to the magnetic field lines and so there is less of a clear trend. However, there is a clear dip in the y component of the field and a rise in the z component, along with a dip in x component at 2000 seconds into the experiment and at 8000 seconds.

We used the given longitude and latitude (figure 4 and 5) to find the location of ISS at this point. At 2000 seconds the ISS is at 33º S, 14º E (just off coast of South Africa). This occurs at 23:00 GMT - the local time there is 1:00am which is close to midnight (the sun is behind the earth from ISS point of view) (figure 7). The same event occurs more or less in the same place at 8000 seconds except at a different latitude (43ºS, 14ºE) this is also encouraging because the ISS does a complete orbit of the earth between 2000 and 8000 seconds and continues to plot a sinusoidal relationship until it passes the point where the sun is behind the earth. We see a change in the field at these points because the solar winds push the magnetic field away from the space station (figure 6).

Knowing that the Raspberry Pi is fastened to an observation window facing the Earth, we can deduce that the z-component of the field it measures is radial, ie parallel to a line from the Earth's centre. Because of the solar wind, we should see an increase in z but a decrease in y because the magnetic field lines are pushed further out so more magnetic field lines are parallel to the radius of the earth, the z orientation will then get an increase during these points as shown by the graph. However y, which is perpendicular to the radius of the earth and parallel to the magnetic field lines, will get a decrease because fewer magnetic field lines will cross the y axis.

We see 4 poles, two strong positive poles and two slightly weaker negative poles. From the collected longitude and latitude we see that the reason for the difference is that the ISS passes much closer to the magnetic south pole (currently at 80.65ºS, 106.83 ºE) compared to the north pole.

Conclusion

We expected to see a sinusoidal graph with kinks on the sunlit side of the Earth, whereas we got a kink on the 'dark' side. These changes can nevertheless be explained by the effects of solar wind. If we were to do this again we would write the code so that the results would be easier to manipulate, and perhaps take photographs to decorate this report.

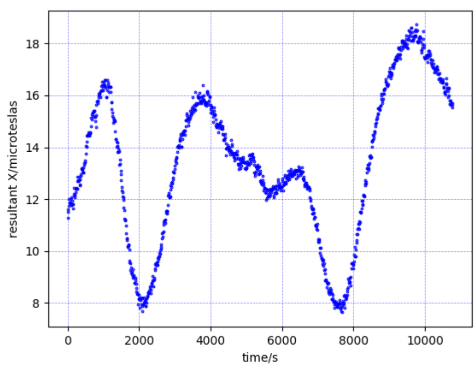

Figure 1

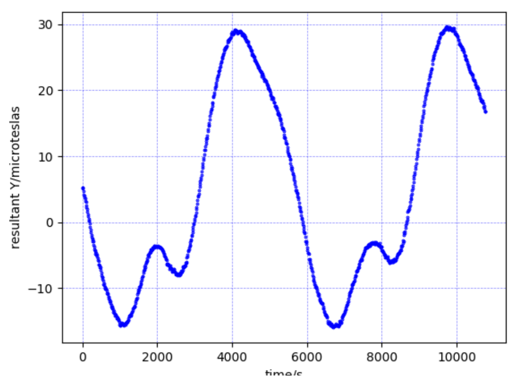

Figure 2

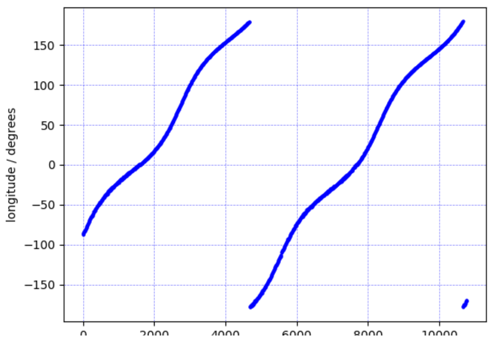

Figure 3

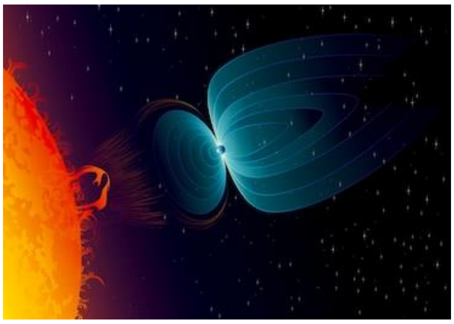

Figure 4

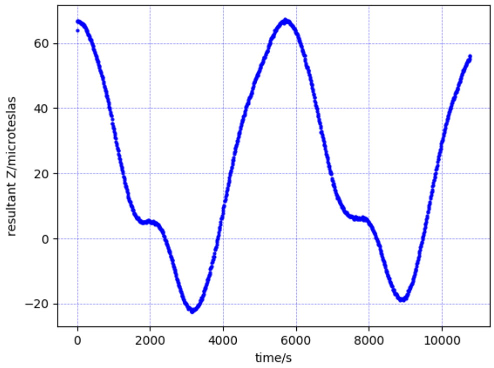

Figure 5

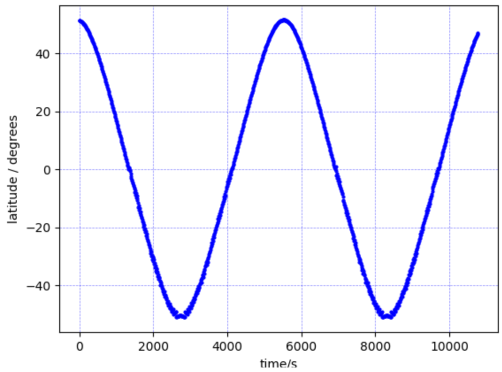

Figure 6

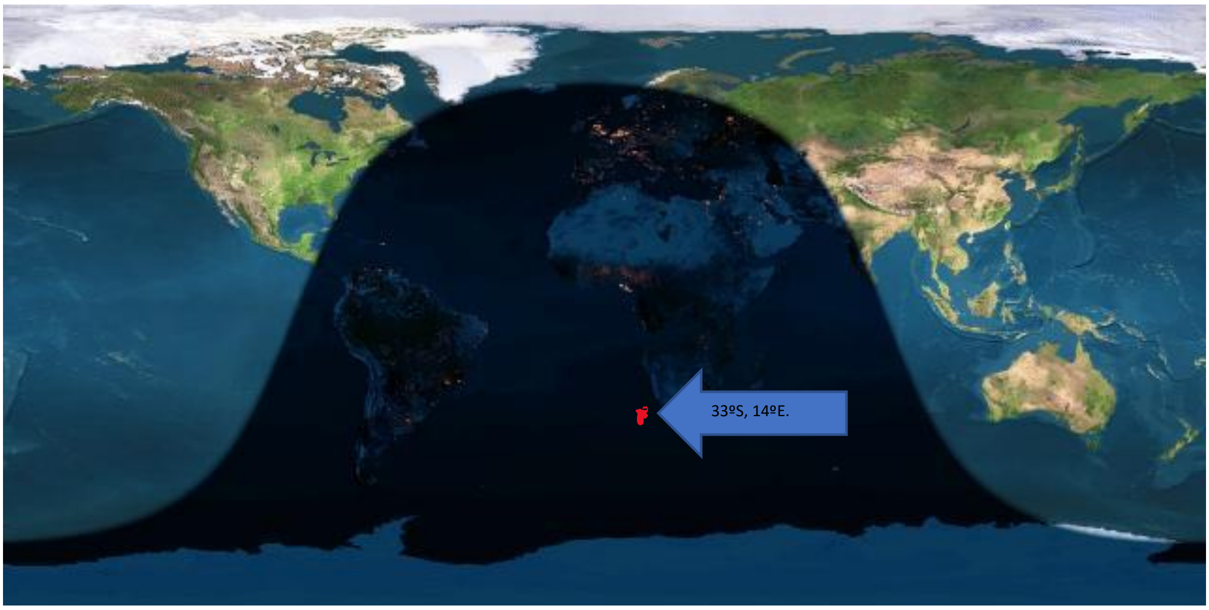

Figure 7

Sources:

- day/night map (figure 7):
  http://conroyandtheman.blogspot.com/2011/09/day-and-night.html

- magnetic field photo (figure 6):
  https://depositphotos.com/7689306/stock-illustration-earths-magnetic-field-and-solar.html