Learning space weather through the Astro Pi Project: the experience at a Secondary School

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Abstract

The European Astro Pi Challenge is a school project run by ESA. Through this Project, the AGUERE team, made up of Secondary School students and their teachers, developed a python code. The team run this code in one of the two Astro Pi computers to get from the sensors onboard the International Space Station (ISS) the temperature, the acceleration and the magnetic fields for three hours on April 4th, 2019 from 16:08:44 until 19:06:24. When plotting the data, the team discovered some anomalies that they were not able to understand by themselves. Then, they searched for the help of an expert in space weather. The final result of this experience was double: on one side we discovered a space weather disturbance observed by the ISS; on the other, the students learnt that doing research can be thrilling.

The ISS and the European Astro Pi Challenge

The International Space Station (ISS) is a joint project involving five participating space agencies: NASA, ESA, Roscosmos, JAXA and CSA. The ISS is a space station in low Earth orbit which provides a platform to conduct scientific research experiments.

The European Astro Pi Challenge is an ESA Education project run in collaboration with the Raspberry Pi Foundation. It offers students the opportunity to run scientific investigations in space, by writing computer programs that run on Raspberry Pi computers on board the ISS.

Figure 1. The International Space Station (*credits esa.int*)

The AGUERE experiment

The main objective of our experiment was to try to answer the following questions:

- Does the activity of the Sun influence the variation of some physical magnitudes?
- Does the value of the magnetic field vary depending on the face of the Earth, whether it is day or night?

To carry out this research, we first developed a code in the python language that allowed us to take the data that seemed appropriate to answer the questions posed. Our experiment consisted of taking data on temperature, acceleration and magnetic fields in the ISS for three hours on April 4th, 2019 from 16:08:44 until 19:06:24. We represented the data and then we analyzed if there was some important difference and we identified if it was related to solar activity.

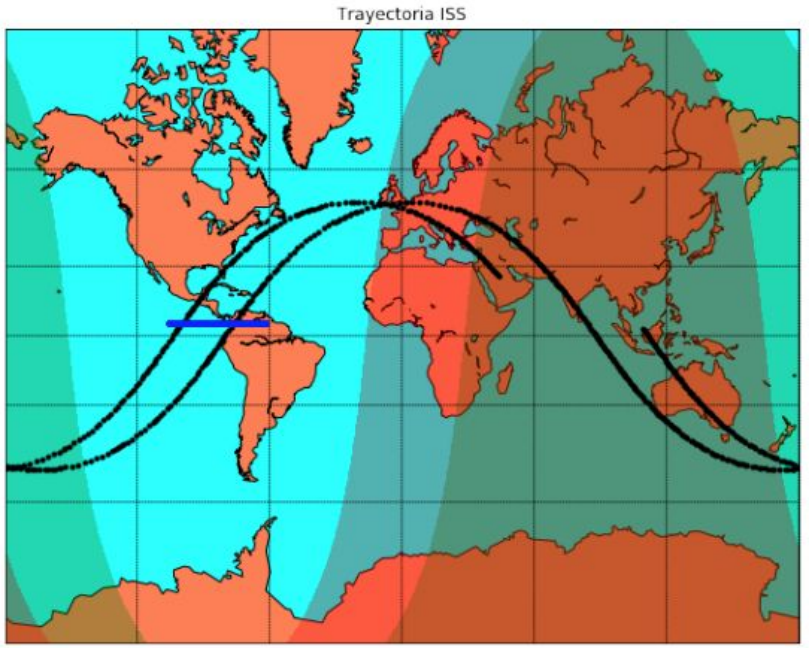


Figure 2. ISS Trayectory

The AGUERE experiment

We were struck by three discontinuities in the magnetic field at three points (Figure 3) and proceeded to study them. We identify the locations of the ISS at the time of the discontinuities (see Figure 4). We checked the ground magnetic field recorded by the geomagnetic observatories closest to these points through www.Intermagnet.org (MCQ in South Pacific, BEL in Poland, and CKI in Singapore). Effectively on April 4th, 2019 these observatories also detected a variation in the ground magnetic field from 16 to 18 UT.

Figure 3. From top to bottom: ISS eclipse information, magnetic field vector, aceleration and temperature measured by Aguere team

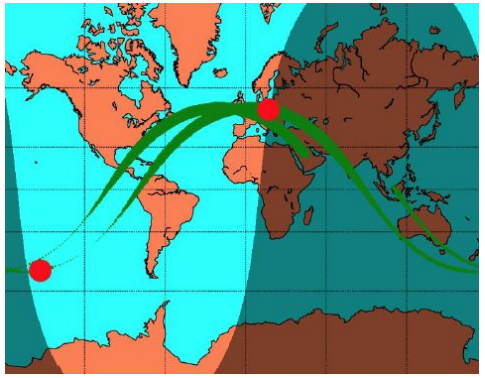


Figure 4. The location of the ISS while recording data for the Aguere experience

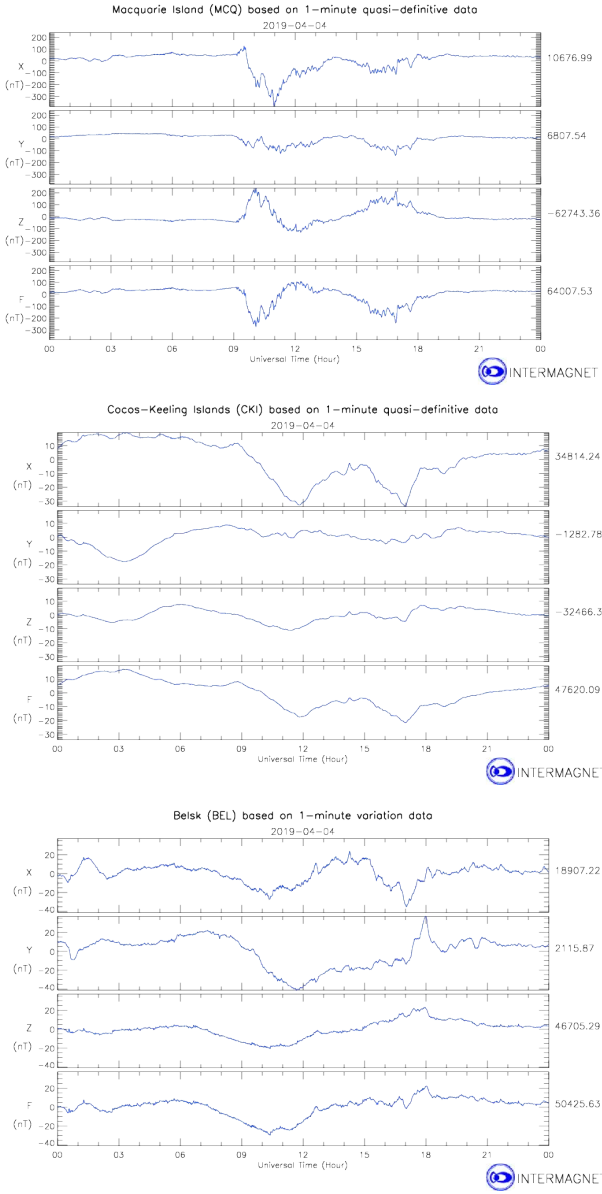
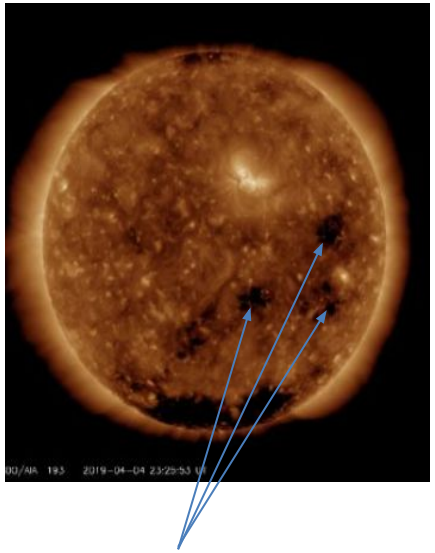


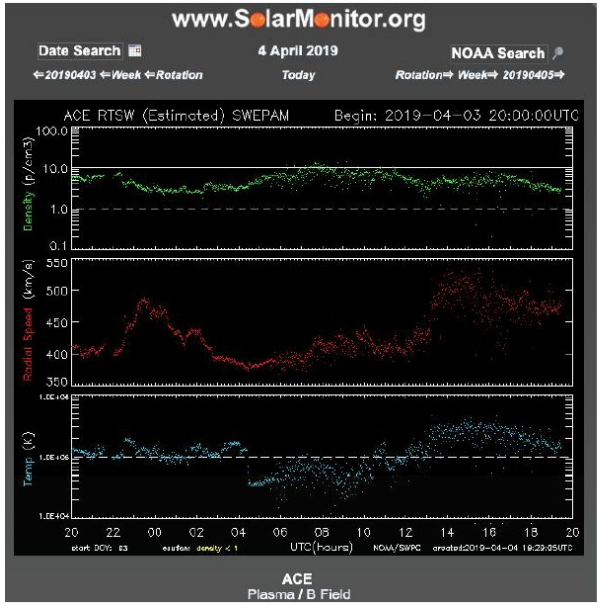
Figure 5. Magnetic field recorded by the magnetometers at MCQ, BEL, and CKI on April 4th, 2019 (*credits, INTERMAGNET*)

Space Weather as the trigger of the anomalies

We studied the possibility of whether this variation was related to the solar activity of this day. For this purpose we checked solar wind parameters from ACE spacecraft through www.SolarMonitor.org from April 1st to April 6th, 2019. We find that on April 4th and 5th, 2019, the radial speed had reached values around 550 km/s and it is usually below 400 km/s, and also that the components of the magnetic field had undergone changes. Investigating the activity of the Sun in those days, we discovered that these variations were due to the existence of coronal holes.



Coronal holes



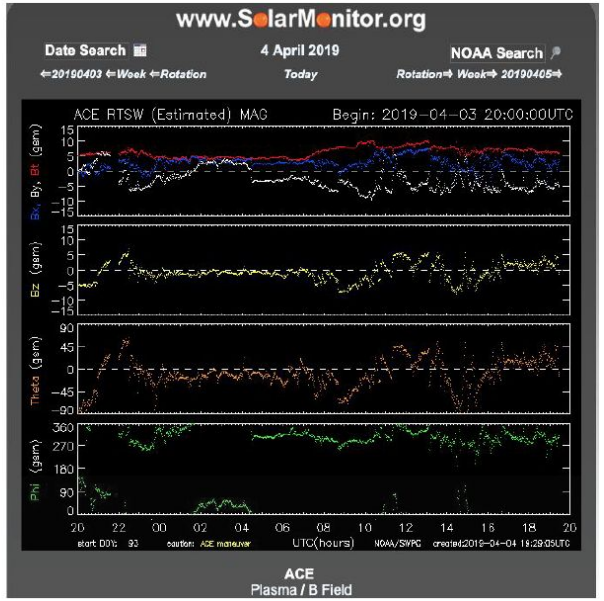


Figure 6. Solar wind plasma and magnetic field measured by ACE spacecraft (left panels) and solar disk image from SDO/AIA 193 Å (rigth panel) obtained from www.solarmonitor.org

Impact and prospects for the future

We can say that the value of the magnetic field of the ISS varies according to the face of the Earth, depending on whether it is in the eclipsed area or not and that it can also be affected by solar activity. Answering these questions, we consider that we have achieved the objective of our experiment.

Thanks to this project, students have had the opportunity to carry out scientific work, becoming researchers, with real data, looking for answers to their initial questions and formulating new unknowns. They discovered that the main path of study led to new questions, which increased their curiosity and interest in science.