IBERIAN SPACE SCIENCE SUMMER SCHOOL 2022, June 6-10, 2022, Alcalá de Henares, Madrid, SPAIN

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Introduction

As part of my PhD program, I attended and participated in the the second Iberian Space Science Summer School held in Alcalá de Henares, Madrid, Spain from the 6th of June 2022 to the 10th of June 2022.

Modern society, industry, and science rely much on technology that may in one way or another be affected by space weather, ie: solar activity and Sun-Earth interactions. The study of space weather has therefore become an important practical task in addition to the intellectual value of understanding the physical processes involved. There still a small number of doctoral and master programs focusing on pace weather studies and Sun-Earth interactions. The school provided professional development for young researchers in the domain of space weather, with an emphasis on the fundamental science of the Sun-Earth system, modeling and forecasting.

The school was attended by 30 PhD and Post-Doctoral students from different countries (Rwanda, France, Spain, UK, US, Croatia, Finland, Germany, Italy, Greece, Portugal, Japan, Argentina, India, Indonesia, Ghana).

Engagement with the summer school programme

At the beginning of the school, participants (students) were divided in five groups and each group had at least five or six members. The aim was to work on different projects distributed as follow:

Group 1 : Starlink February 2022,
Group 2 : Solar Extreme Event in September 2017,
Group 3: Solar Extreme Event on June 2015 ,
Group 4: March 2015, St. Patrick's Day Event ,
Group 5: April 2010, Galaxy 15 Anomaly.

Organizers allocated time to work on projects from Monday (6th June) to Thursday (9th June) and Friday was the day to present the obtained results. Each group had a facilitator depending on the type of analysis being done.

- Monday (6th June) session started with welcome remarks, registration and opening of the school, we had courses on solar activity, solar eruptions and space weather. We were given time to interact with lecturers and asked them related questions.

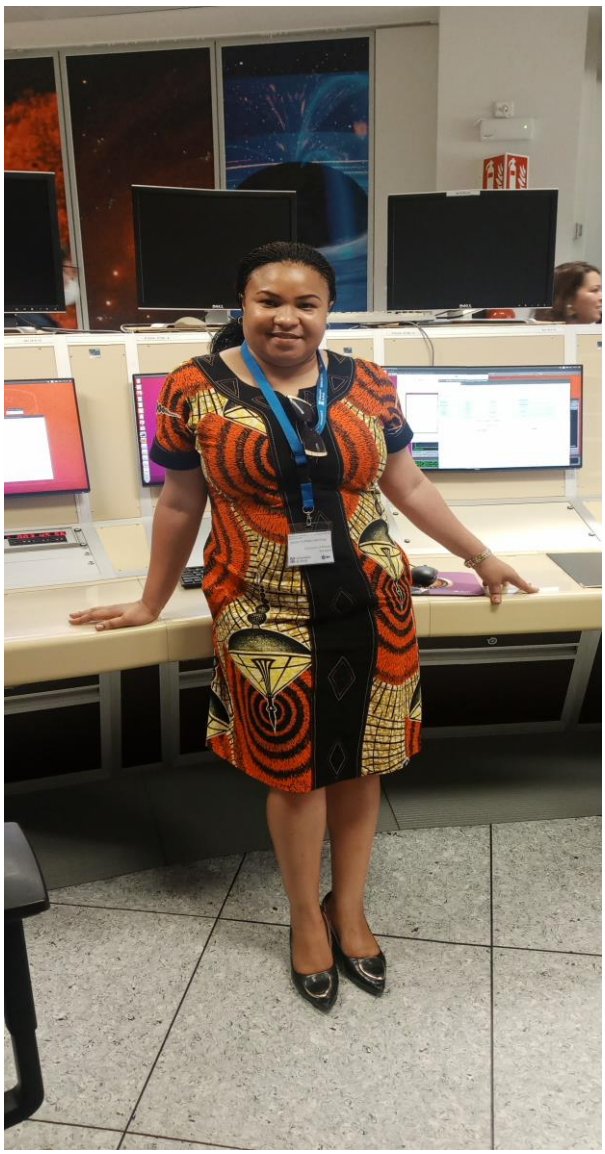
- On Tuesday (7th June), we attended a course on Interplanetary medium and magnetosphere. In the afternoon, we worked on our group projects.

- On Wednesday (8th June), we attended the course on Solar Wind-Magnetosphere and Geomagnetic field. In the afternoon, students presented their research works (talks and posters)

- On Thursday (8th June), we had course on Ionosphere and low-thermosphere. In the afternoon, we were given time to prepare our final projects. We also visited the European Space Agency (ESA). More details on the visit will be discussed in the next section.

Visit at the European Space Agency premises in Madrid

On June 9th, 2022, students, lecturers and organizers visited the the European Space Agency (ESA). The activity was organized by the UAH (University of Alcala de Henares). We walked through the ionic places of ESAC facilities. CESAR and ESAC experts described the European Space Agency, the Astronomy Center in Madrid, and provided insights on some of the key science missions and results.



More information about the visit can be found at : https://cesar.esa.int/index.php?Section=News&Id=249

- On Friday (9th June), the morning session covered the course on low-cost instrumentation and we concluded the school with final group projects

Group 1 Project

Group 1 discussed the Starlink February 2022 event. They first checked what happened on the Sun, Propagation through the interplanetary medium, Effects on the geomagnetic field -Dst index, Effects on the ionosphere -TEC and socio economic impacts. After discussion and analysis from the Sun to the Earth, they realized that the SpaceX lost 40 satellites to the geomagnetic storm a day after launch and this could be due to the atmospheric drag exerted on satellites by changing their orbit.

Group members found that on 3 February 2022, there was an increase in atmospheric density at 210 km, 38/49 satellites were lost and tens of millions of dollars (~ $ 80) were lost.

Group 2 Project

Group 2 analyzed the Solar Extreme Event in September 2017. They observed the active regions such as solar flares, their location and intensity within the month of September. They also determined an Earth directed CME and their arrival time. Parameters such as Dst and Bz were determined to check their variation within the interplanetary medium. Inside the flux rope, the solar wind speed was also measured.

Using the observations from the coronagraph images from SOHO/LASCO the analysis found that ~ 83 flares and ~ 20 CMEs were observed from 2017 September 4 to 2017 September 12. Also an intense geomagnetic storm occurred in 2017 September 8 with a minimum value 0f ~ -172 nT resulted from the compression at the IP shock's plasma sheath. These events impacted HF radio links for ground and aviation communication.

The French Civil Aviation authorities reported that the HF radio contact was lost with one non-controller pilot data link communication (CPDLC) equipped aircraft off the coasts of Brazil and French Guyana for approximately 90 minutes, triggering an alert phase until a position report was received by New York radio (NOAA/SWPC). The hurricane Watch Net also reported about the event (www.hwn.org)

Group 3 Project

The project involved the Solar activity and Earth connections in June 2015. They first distinguished 5 features that occurred on the Sun: west limb eruption observed on June 18, 2021, AR eruption on the same day. The Filament eruption was observed on June 19, 2021 with a speed of 600 km/s with the AR on June 21, 2021. In addition a coronal hole was also observed. A CME observed by C2 and C3 on June 18, 2021 had a speed of 1700 km/s. The early warning of related events shows that the shock arrival time was at 18:00 on June 22, 2012. The in-situ data shows that the shock arrival time could be at 18:33.

News released at 2015 June 22 at 7:00 after the shock hit the Earth was reported as “the consecutively arriving solar storms in the upcoming few days may cause power grid fluctuations, and our high latitude region is especially vulnerable. Also, loss of GPS lock, issues for amateur radio and GNSS operators may be observed”. The Goddard Media Studios at NASA also provided an early warning of related events. Using the radio data, the ICME could be analyzed as well.

Conclusively, the group 3 members proposed methods of societal risks mitigation including Nowcasting, alternate communication methods, flight diversions and backup power.

Group 4 project

Group 4 discussed and analysed the March 2015, St. Patrick's Day event. They observed the solar transients events such as Solar flares and CMEs from the Sun, Interplanetary medium, Magnetosphere, ionosphere and the Earth. On March 15, a long duration with a partial halo CME with a speed of ~ 606 km/s corresponding to 2-3 days arrival time. The enhancement in the southward magnetic field was observed with the IMF. A strong Dst (-50 nT) compression on 17th indicating the shock reaching magnetosphere. The magnetic storm took place on 17th with an index

of -223 nT showing generation of strong ring current."The recovery phase of the storm was slow" the group members added.

The St. Patrick's day storm induced currents in the power grids of Britain and Ireland, however , no significant effect was reported. As mitigation methods, there would be warning systems, GNSS interference Detection Analysis System (GIDAS) which detects and classifies GNSS in real time. Also there would be the backup systems.

Group 5 project

Group 5 discussed the April 2010, Galaxy 15 Anomaly. Galaxy 15 is a Geostationary Earth Orbit (GEO) communications satellite built by Orbital Sciences Corporation (OSC) and operated by Intelsat. Galaxy 15 was primarily used to relay Direct TV signals to millions of customers with North America. It was launched in 2005. Its anomaly occurred on April 5, 2010 and ended its usefl life.

At the beginning the Group 5 members provided an overview on what may have caused the malfunction. The internal charging is caused by high energy electrons (> 100 keV). The electrons penetrate into the satellite, giving a negative charging of floating conductors and dielectrics materials. The high energy electrons are most likely found in Earth's van Allen radiation belts. High energy electrons penetrate into the spacecraft and cause negative charging of dielectric materials and floating conductors.

On April 3, 2010 at 10:33:58 a halo CME with a linear speed of 668 km/s was observed in both STEREO A and LASCO C2. Simultaneously a B7.0 flare was observed by GOEs. Its image could be seen in SOHO-EIT located at S25W03 on the solar disk. The ICME observed in the IP medium occurred at ~ 8:30 UT. Analysis shows that during the time in which Galaxy 15 was in eclipse during its orbit, the ICME had just arrived to the bowshock. While during the eclipse and during the time of the anomaly, IMF BZ was negative meaning that there was the classic case of dayside and nightside reconnection.

Operational Timeline

April 3, 2010

09:54 B7 solar flare
10:33 CME first visible
22:04 Daily Forecast issued
April 4, 2010

22:01 Daily Forecast issued
April 5, 2010

05:30 Warning issued: K=4
05:44 Alert issued : K= 4
08:04 Warning issued K= 5
09:16 Warning issued K=5
09:17 Alert issued : K=6
09:48 GALAXY 15 anomaly
09:56 Alert issued : K = 7

ACKNOWLEDGEMENT

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