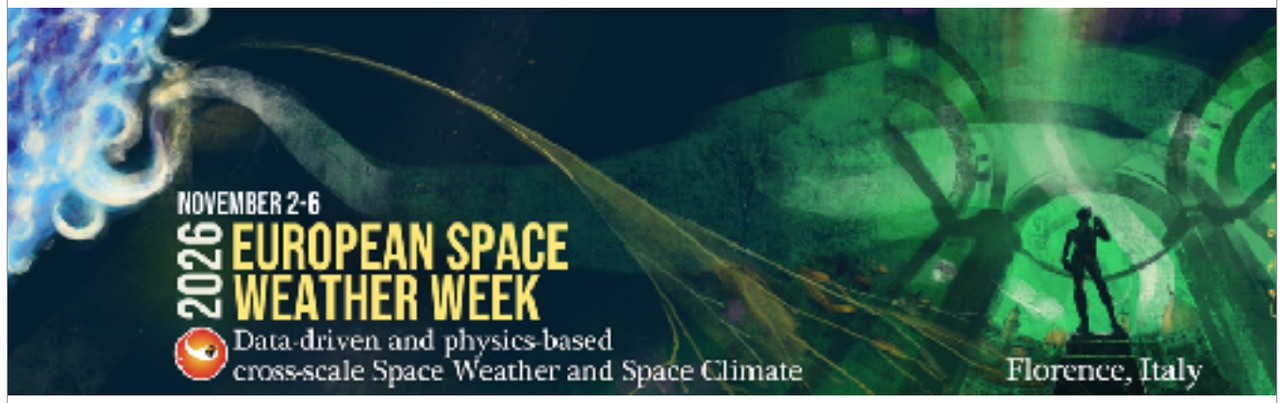
Space Weather Training Course



e-swan

SWEC
Space Weather Education Centre



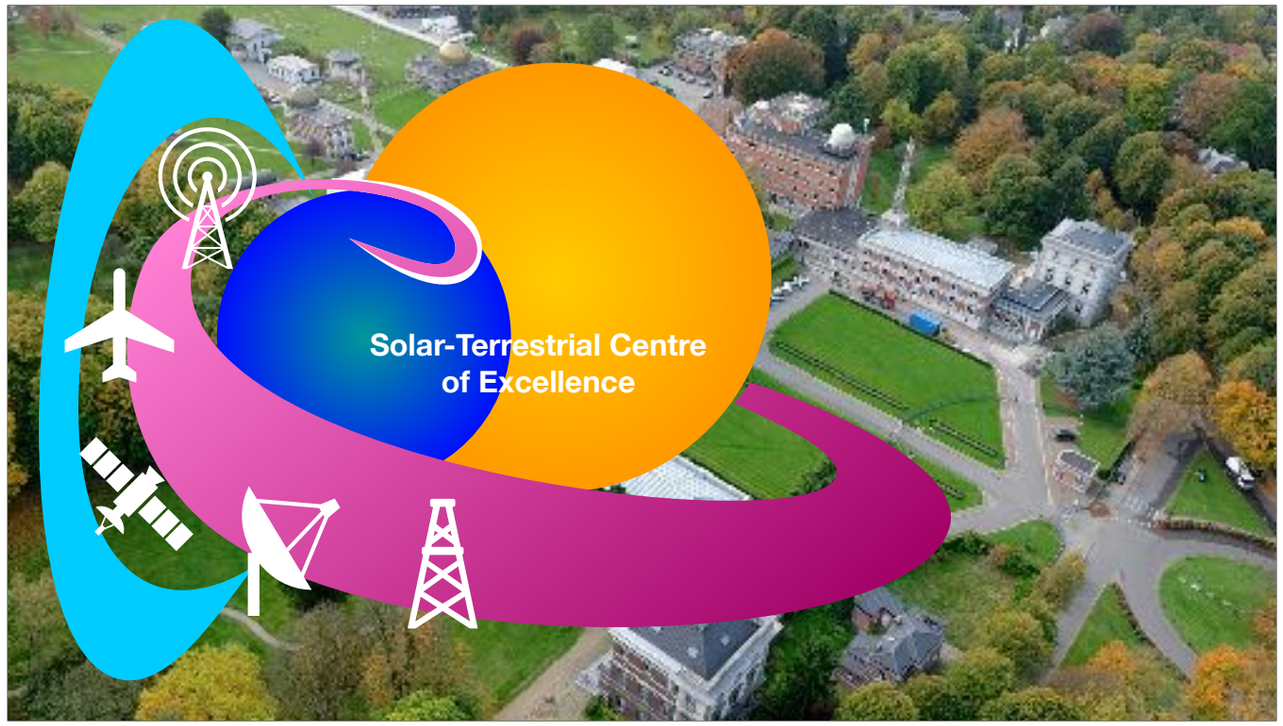
To recapitulate:
We are in the green outskirts of Brussels, Belgium



Where we work on the interaction sun-earth, which we identify as space weather

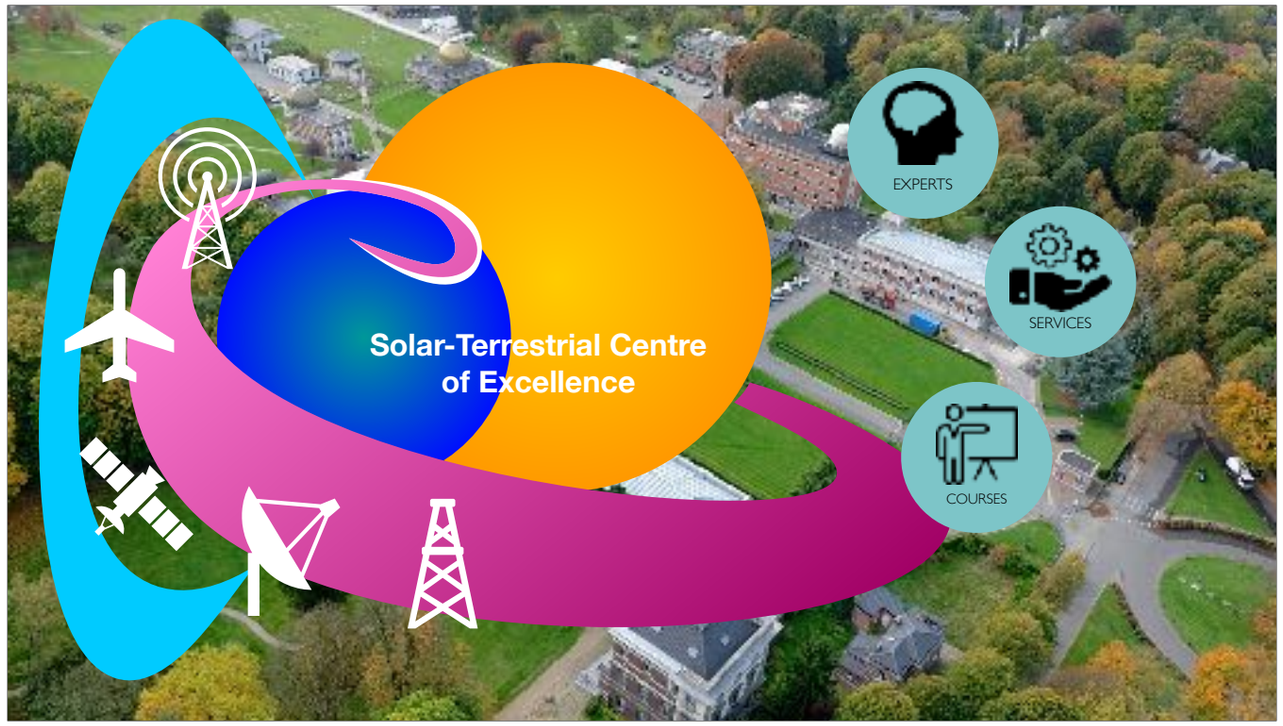


Consolidating the expertise, research and services provided by 3 scientific institutes on the interaction sun-earth, which we identify as space weather



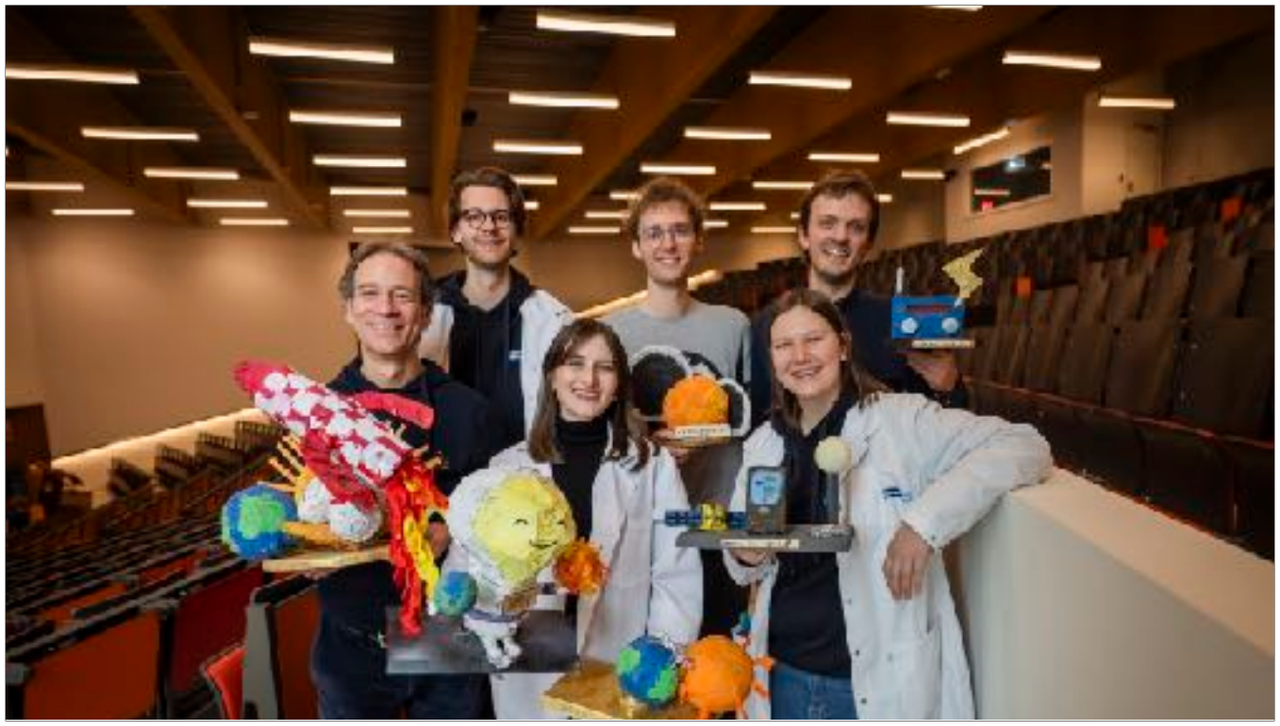
With space weather impacting technology, especially important for here: technology based upon e.m. waves, HF, GNSS, microwaves

Knowledge on space weather and solar activity helps to distinguish between
Human and natural interference in operations, e.g. surveillance systems



We have SWx experts
We offer client driven operational services and training courses


SPACE WEATHER
Why is this important?



This is a photo of the finalists of the ‘battle of scientists’



I want to present Dries.

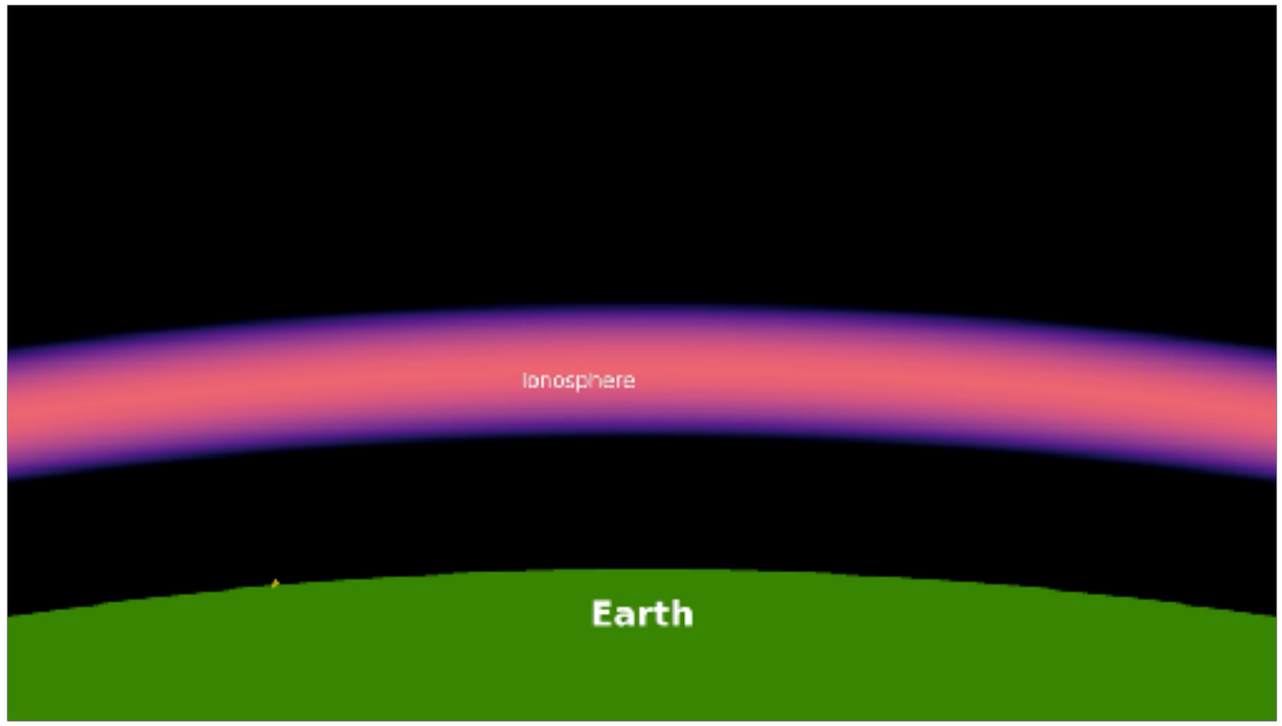


Dries works for the Belgian Defence, for an operational unit responsible for communication systems,

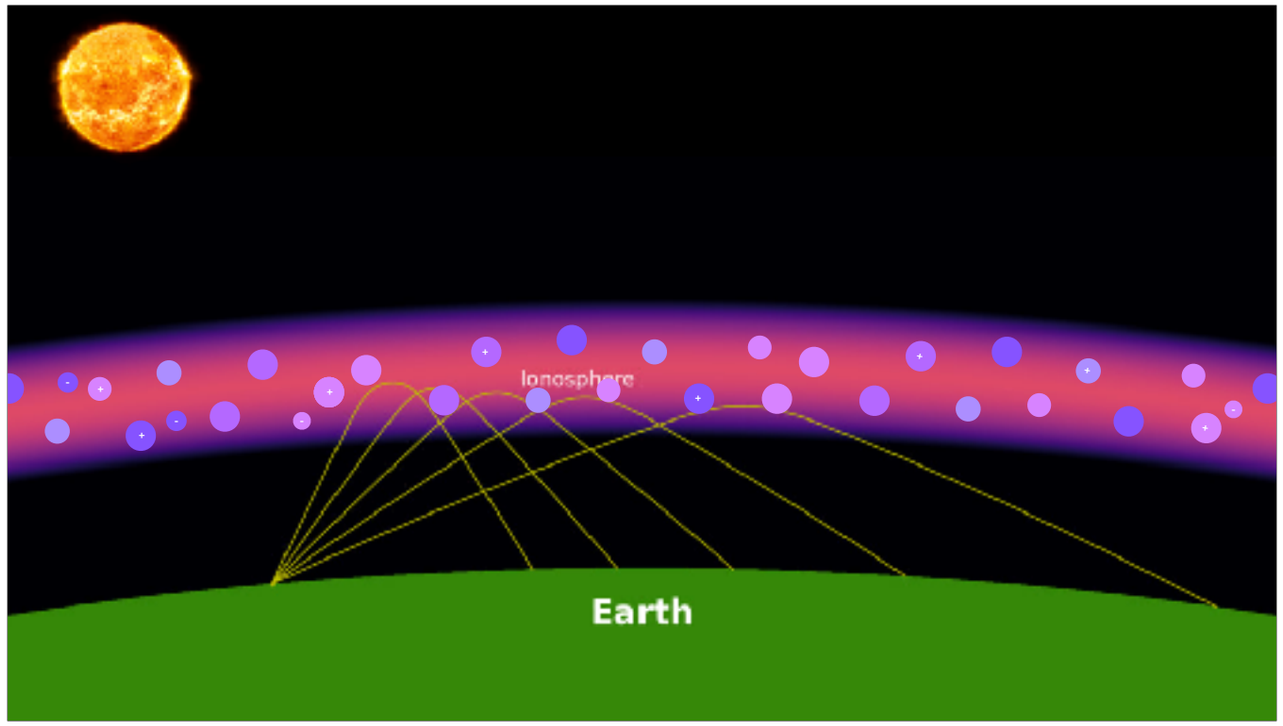


On May 15, 2024, Dries is doing an HF test with his Canadian colleagues.
But the signal doesn’t pass through

What happened?

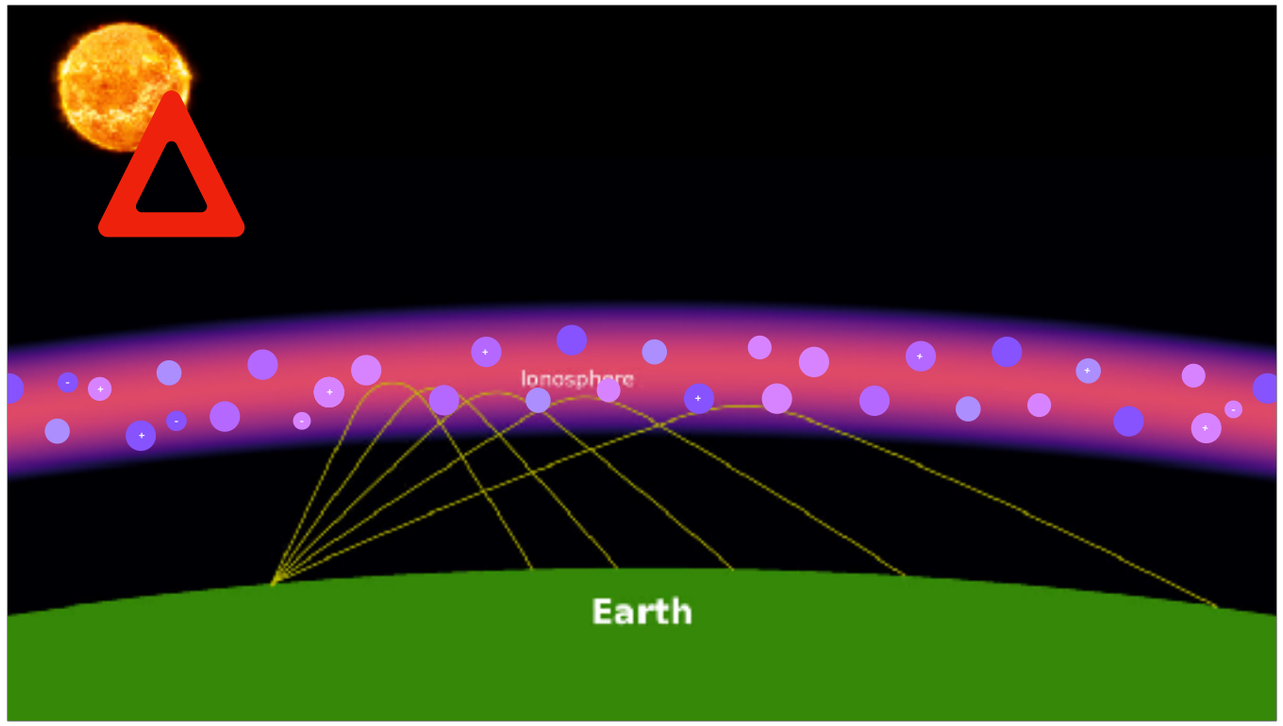


Dries uses the ionosphere to pass radio signals van Belgium to Canada.



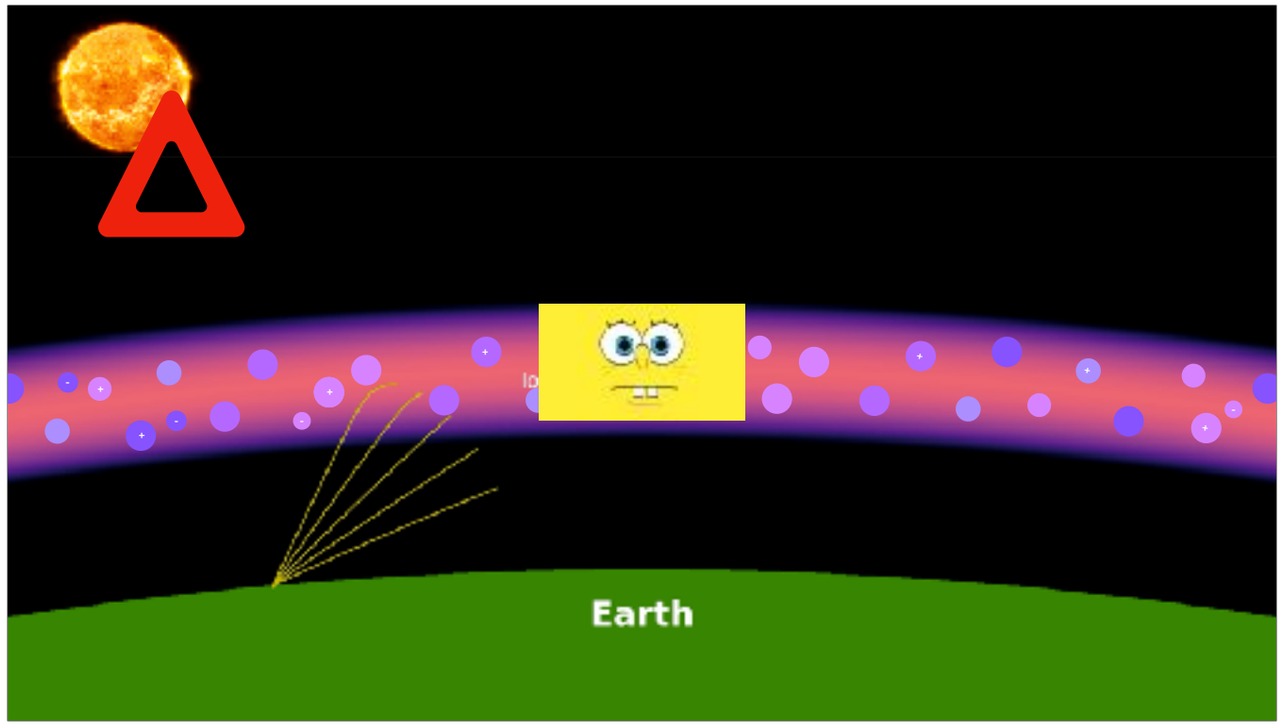
https://svs.gsfc.nasa.gov/5240

HF com - radio waves are being reflected in the ionosphere
The sun is the main factor/has a key role on the creation of the ionosphere.
Its energy can ionise the atmosphere.



https://svs.gsfc.nasa.gov/5240

This energy can evolve into storms busting down on Earth and the ionosphere.



https://svs.gsfc.nasa.gov/5240

This energy can evolve into storms busting down on Earth and the ionosphere.

In this case, the radio waves were being absorbed.

Sept 2017

During September 2017, a significant number of solar flares and geomagnetic activity occurred.
Simultaneously, major hurricanes, including Hurricane Irma and Hurricane Jose, caused situations in the Caribbean region **requiring the use of emergency HF communications,** often provided by ham (amateur) radio operators.

Ham radio hobbyists routinely volunteer to disseminate hazard information from the National Weather Service to island communities and ships during major storms, report real-time ground conditions and damages back to the National Hurricane Center, and assist the Red Cross with communications.

Even in the modern age of space-borne relays and widely distributed Internet availability, HF radio remains a key technology for long-distance communications.
It is actively used by aircraft, by ships at sea, in military operations, for disaster relief efforts, and by amateur radio operators. HF radio is particularly attractive in a backup or emergency communications role because of its ad hoc and agile nature, relatively low cost, and ability to communicate across large distances. In September 2017, HF amateur radio was called upon to provide emergency communications to the Caribbean Region in response to the devastation caused by Hurricanes Irma and Jose (American Radio Relay League, 2018).

https://news.agu.org/press-release/solar-flares-disrupted-radio-communications-during-september-2017-atlantic-hurricane-relief-effort/

https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2018SW001897

https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2018SW002008

Sept 2017 - Hurricane train



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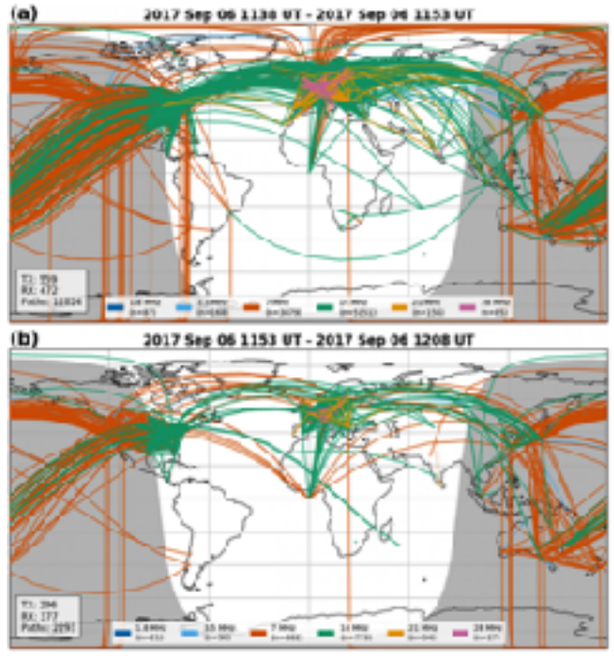
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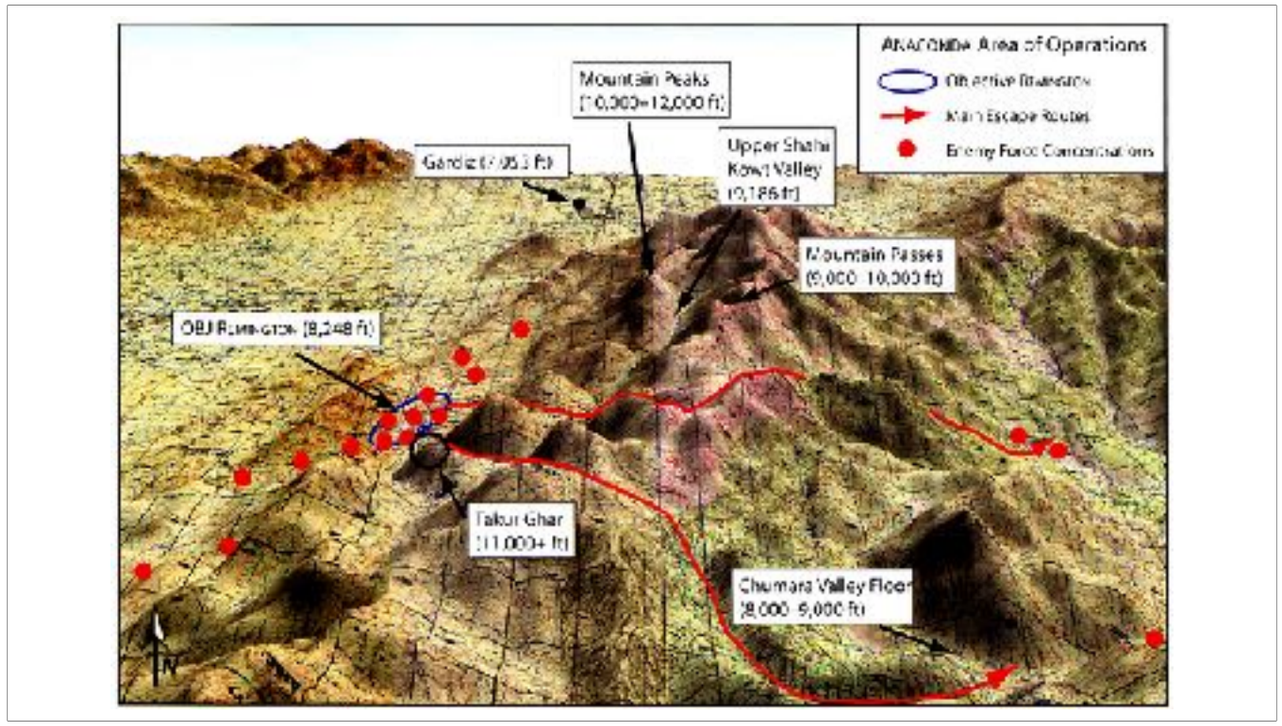
Amateur radio reporting network results for the (a) 15 min prior to and (b) 15 min following the X9.3 solar flare on 6 September 2017 1153 UT. The propagation paths are color-coded based on the amateur radio frequency on which the report occurred. The gray and white background shows the diurnal boundary. A reduction in reports can be seen across all frequencies with 7 MHz (dark orange), 14 MHz (bluish green), and 21 MHz (light orange) being the most affected across Europe. (Figure from Frissell et al. 2019)

Sept 2017 - Earth and space storms were aligned



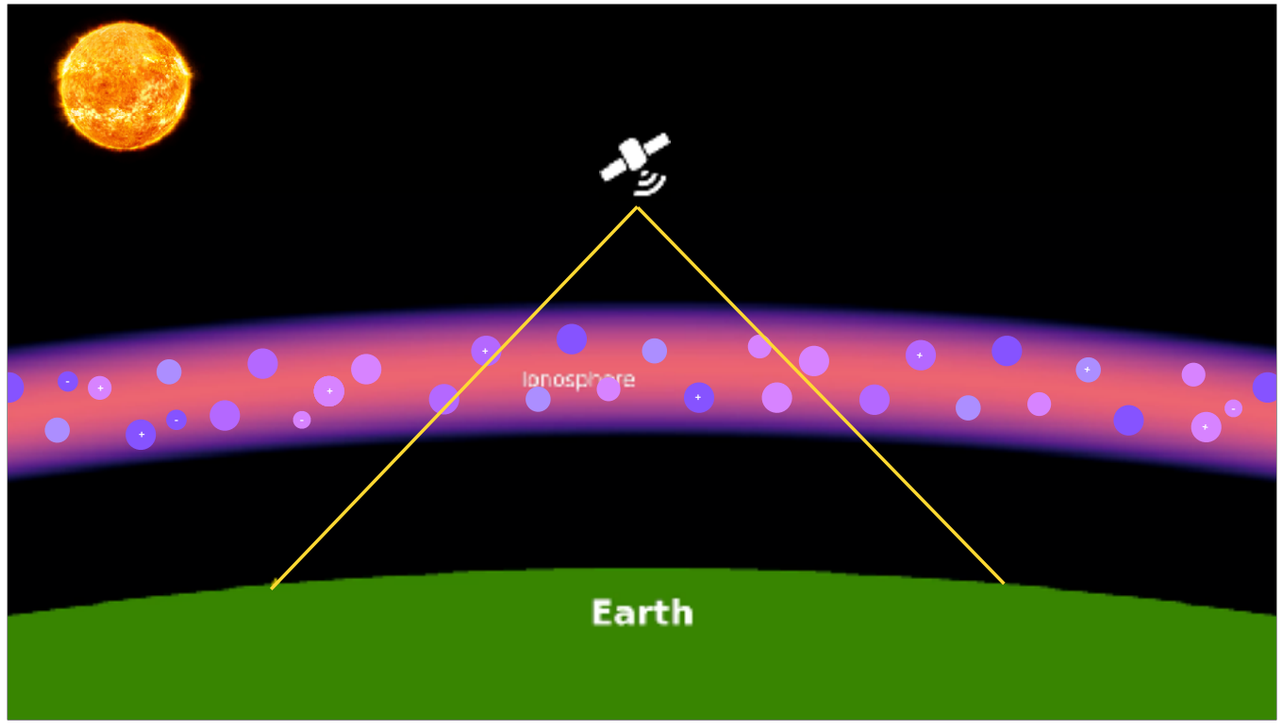
The coincidental timing of both the space weather activity and hurricanes was unfortunate, as HF radio was needed for emergency communications.

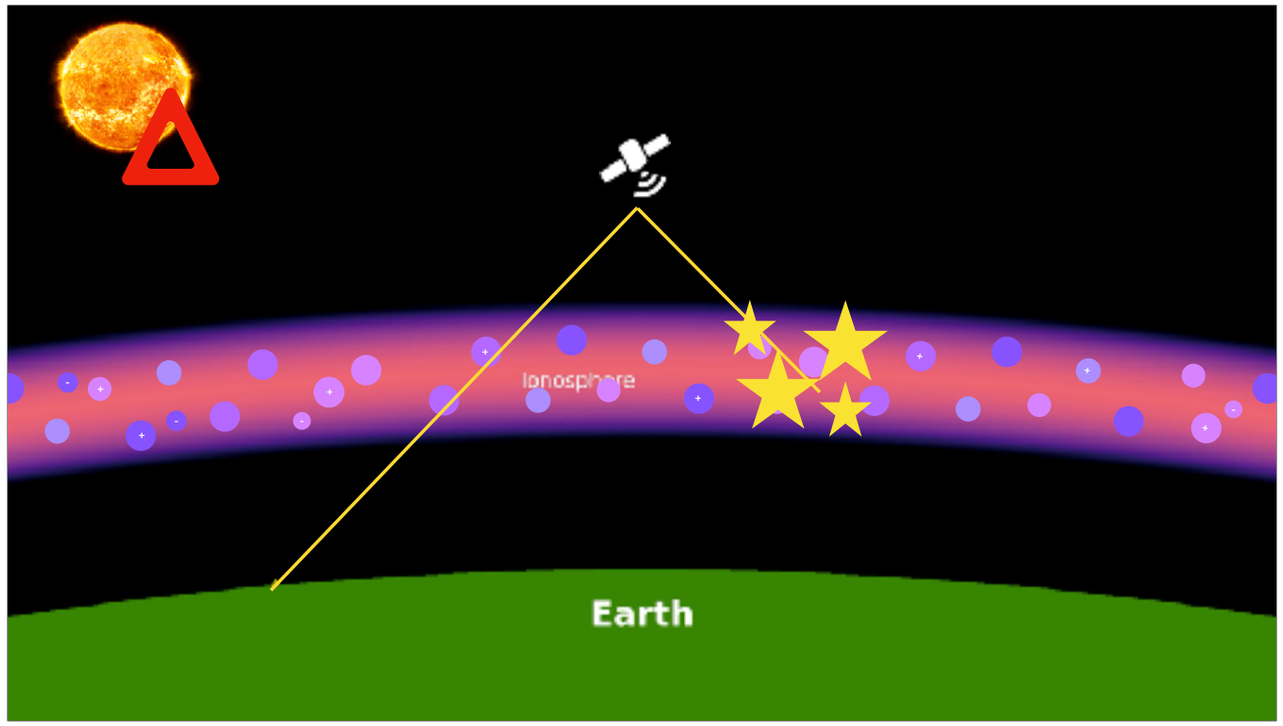
Specifically, X-class flares on 6, 7, and 10 September caused acute radio blackouts during the day in the Caribbean with recovery times of tens of minutes to hours, based on the decay time of the flare. **A severe geomagnetic storm** with Kpmax = 8+ and SYM-Hmin = −146 nT **occurring 7–10 September wiped out ionospheric communications first on 14 MHz and then on 7 MHz starting at ~1200 UT 8 September.** This storm, combined with effects from additional flare and geomagnetic activity, contributed to a significant **suppression of effective HF propagation** bands both globally and in the Caribbean **for a period of 12 to 15 days**.



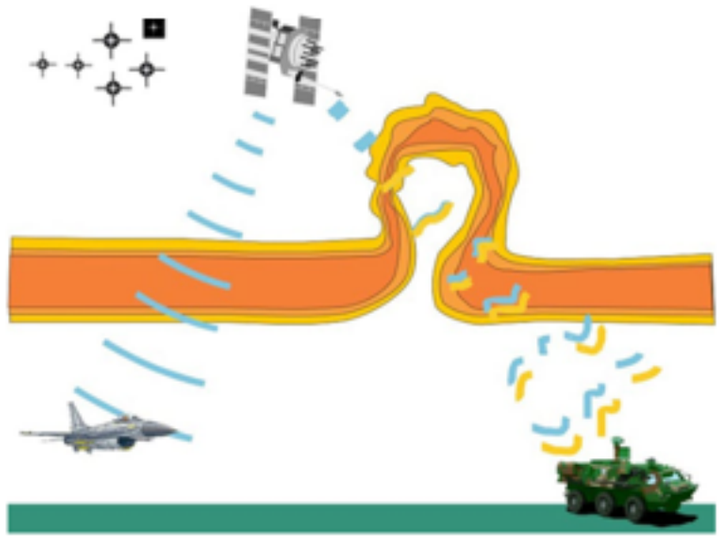
Outage due to ionospheric scintillation

Battle of Takur GHar - Afghanistan - little above the equator
Tactical impact of SWx
Navy seals were under fire in mountainous region. A chinook heli was sent to rescue them. To avoid hot landing a **UHF message** was sent but never received by the chinook.


Ionosphere
Earth



The ionospheric scintillation during the Battle of Takur Ghar was caused by upper-atmospheric plasma bubbles—low-density pockets of charged gas that rise through the denser plasma in the ionosphere at night.



Source: U.S. Air Force Research Laboratory (AFRL)

The radio was blamed but after investigation, this wasn’t the only reason. Ionospheric perturbation led to the loss of the signal due to plasma bubbles in the ionosphere.
Causing scintillation of the radio signal — twinkling of the radio signal

April 2010



As you are aware there was a very interesting geomagnetic storm period over the Easter period this year, this period was particularly significant as the disturbed space environment caused a number of spacecraft anomalies, including the well publicised Galaxy 15 failure suffered by our competitor Intelsat. The Presto Alerts and Daily Bulletins ('URSIGRAM') issued by SIDC at the time were superior to alternative products issued by NOAA SWPC, both in terms of timeliness and content.

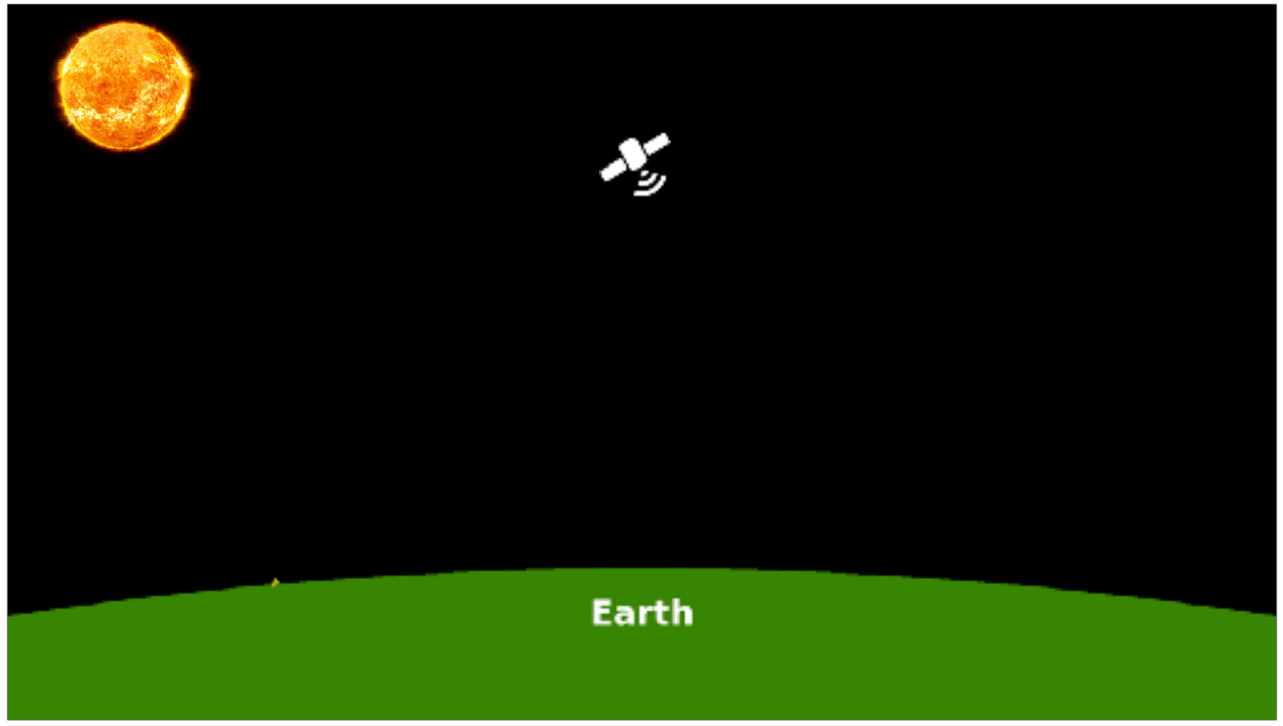
In general I find that the level of technical content and commentary included in your Daily Bulletins and other products are exactly what we need as a spacecraft operator, and I find that these products compare very favourably with the alternative products issued by NOAA SWPC. You are tending to include greater detail in your commentary regarding events observed on the sun and the effects likely to be experience at earth, we value this additional detail.

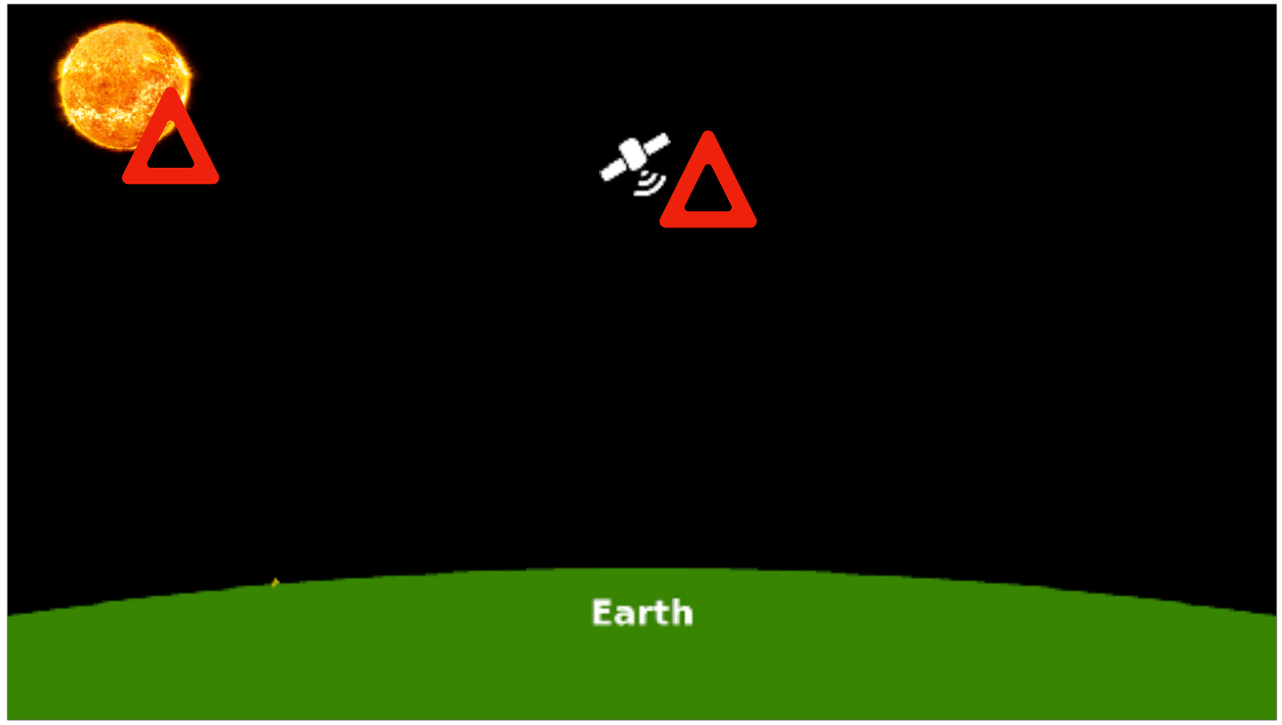
I hope these comments are of use and trust that your team will keep up the good work!

Email from a satellite operator to Ronald
Subject SIDC URSIGRAMS / GEOALERTS & PRESTO ALERTS - SOME FEEDBACK

Galaxy is owned by Intelsat - Geostationary satellite
Did not respond anymore to commands from the ground and it began to drift away from its intended orbit.
The spacecraft failure was most likely caused by the spacecraft charging which is induced by the solar wind.

SES (Société Européenne des Satellites) company Satellite Communications Service Provider


Earth

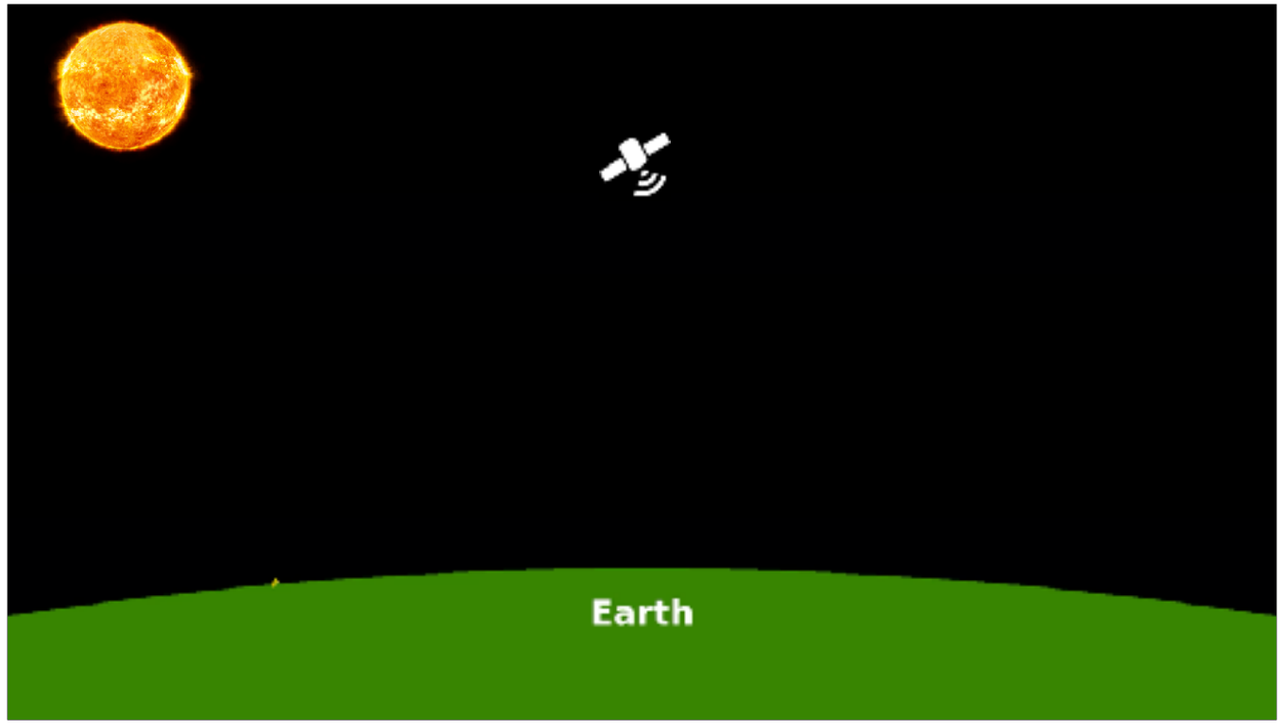


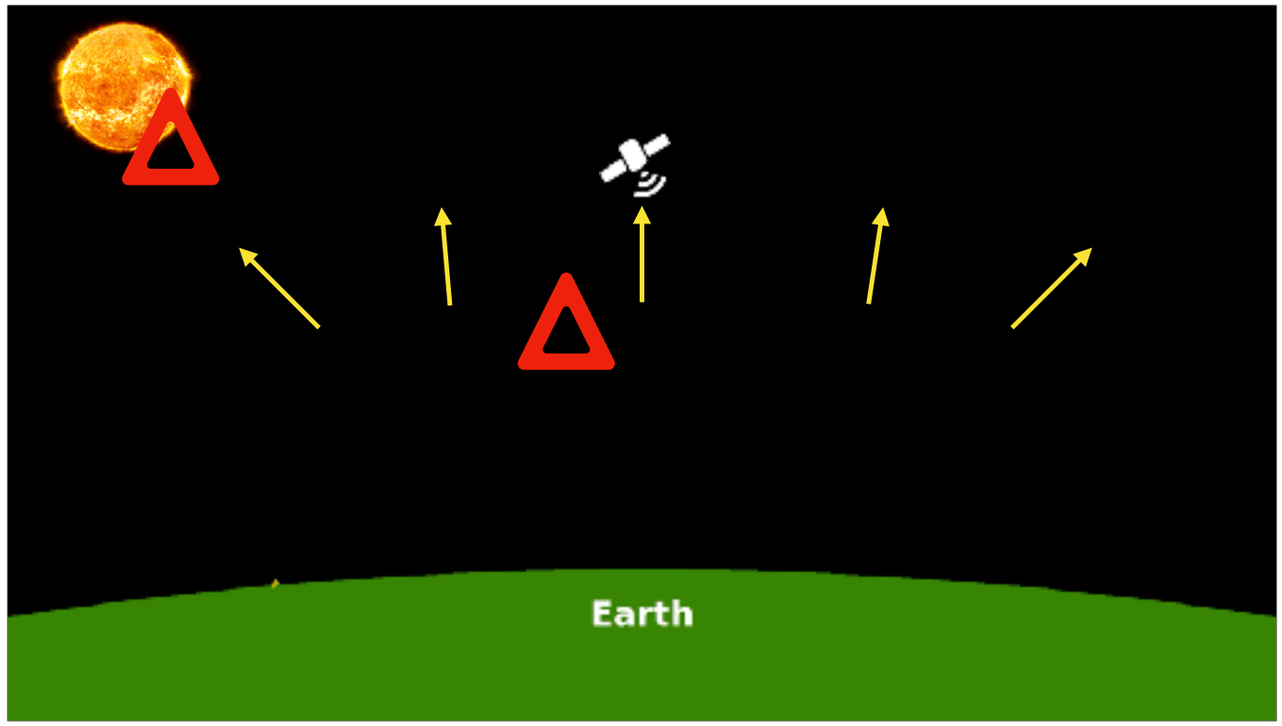
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Los of altitude due to drag




Earth



Satellite drag

Things are not always what they seem.



Knowledge on space weather and solar activity helps to distinguish between
Human and natural interference in operations, e.g. surveillance systems

Geopolitics

We have to realise that we are living in the backyard of the Sun.