



Laboratorio
Argentino de
Meteorología
del espacio

Energetic electrons in Van Allen radiation belts: A first approach towards a SWx product

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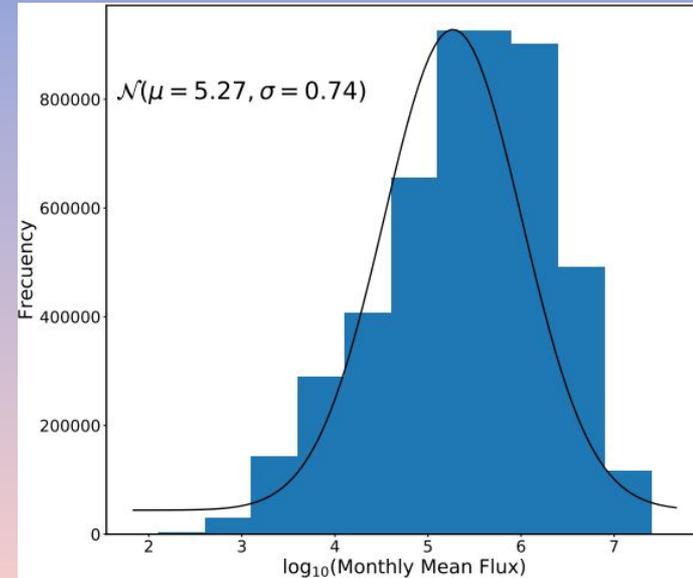
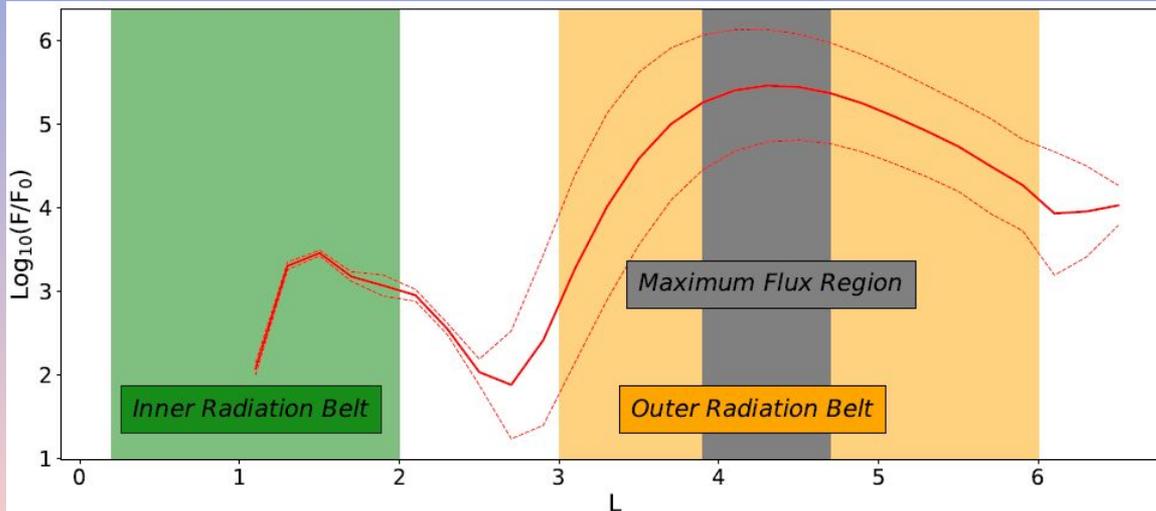
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Introduction

- The Van Allen Radiation Belts is populated by charged particles. Ultra-relativistic electrons with energies ranging from several keVs to several MeVs. They have a high time-space variability.
- These electrons can cause severe damage to humans and technologies in space. How? → Internal Charging.
- Internal charging is a phenomenon caused mainly by these type of electrons, also called “Killer electrons”. These can penetrate through shielding and accumulate charge inside, causing internal discharges that can lead to numerous adverse effects, with total loss of the satellite being one of them (and a catastrophic one) as explained in Lai [2018].
- Thus, due to the time-space variability of this electrons population and its impact (space health and technologies), it is crucial to understand dynamical evolution and to improve operative products to monitoring them and forecast severe conditions.

Van Allen Probes - Time range: 2012-2018

We analyze data from the Relativistic Electron Proton Telescope (REPT), corresponding to the energy range between 1.6 MeV and 2.0 MeV. Due to the orbit, inner and outer radiation belts are observed. The observed flux vs L (bins of XXX) was fitted using a log-normal distribution. Then, an in-house algorithm of particle storm selection was generated using a metric associated with this distribution.

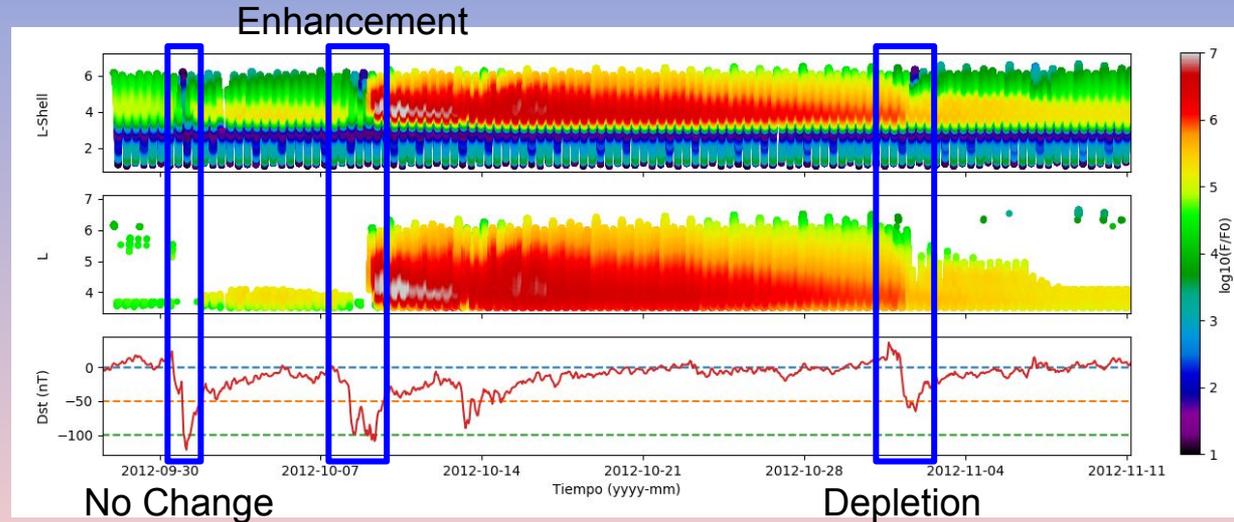


Van Allen Probes Analysis

Results seen by Reeves et al. [2003] can be observed throughout the whole period of study. Moderate and severe Geomagnetic storms can cause either an enhancement, a depletion or almost no change, as shown in the blue boxes.

The particle storm periods were successfully identified with the algorithm, but in order to obtain a fully comprehensive and more robust analysis, other metrics would need to be used.

Percentiles resulted as one of the best compromises between computational time and statistical robustness.

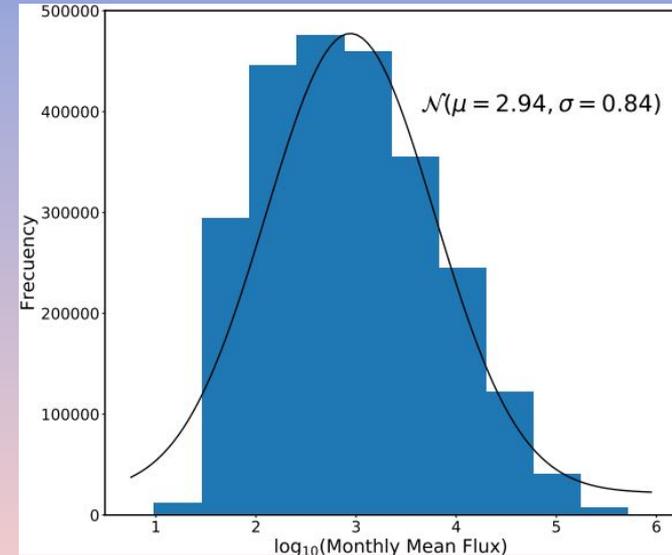
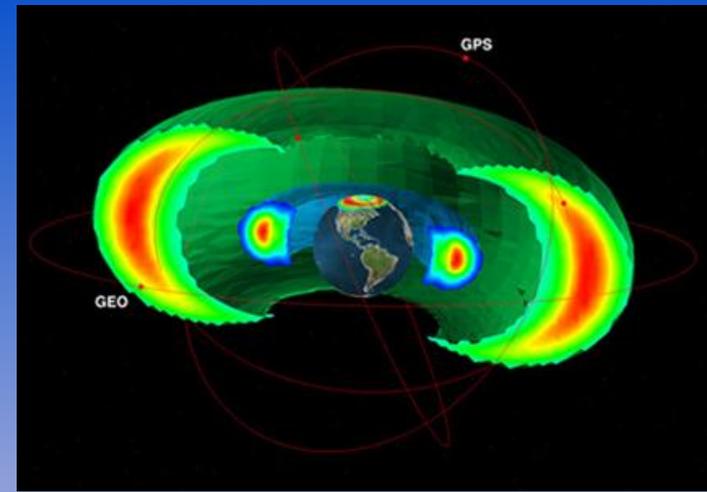


GOES-15 - Time range: 2012-2018

GOES satellites are at GEO orbit, which is at the edge of the core of the outer radiation belt. Killer electrons are more present in this region than in any other region of space, so monitoring them becomes crucial.

Energetic Particle Sensor (EPS) integral electron fluxes with energies higher than 0.8 MeV and higher than 2 MeV data were analyzed, with the same methodology as Van Allen data.

The same behaviour as with Van Allen Probes data was observed. In this case the Log-normal distribution has $\mu=2.94$ and $\sigma=0.84$.

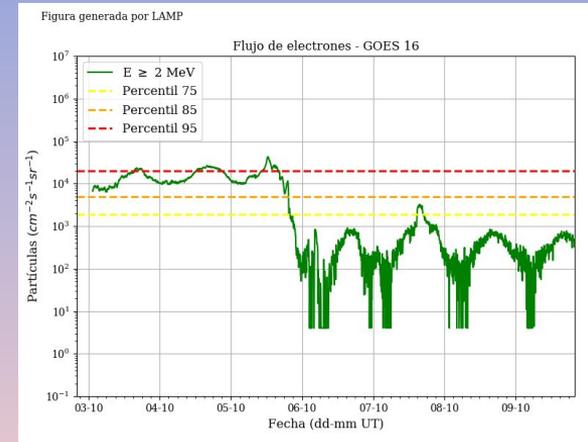
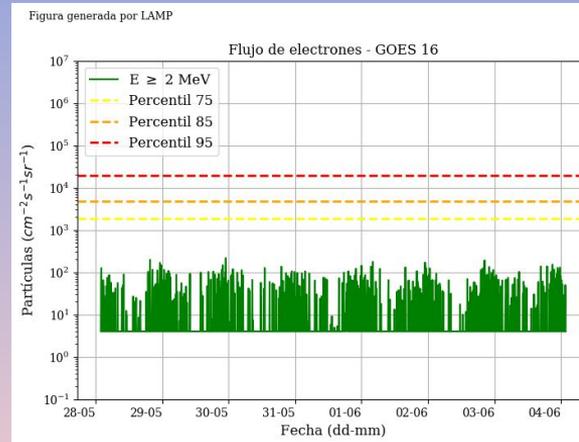


GOES-15 Results

GOES-15 data have daily variation due to its orbit. During strong geomagnetic storms flux levels are enhanced, and can last over the threshold several days after the event.

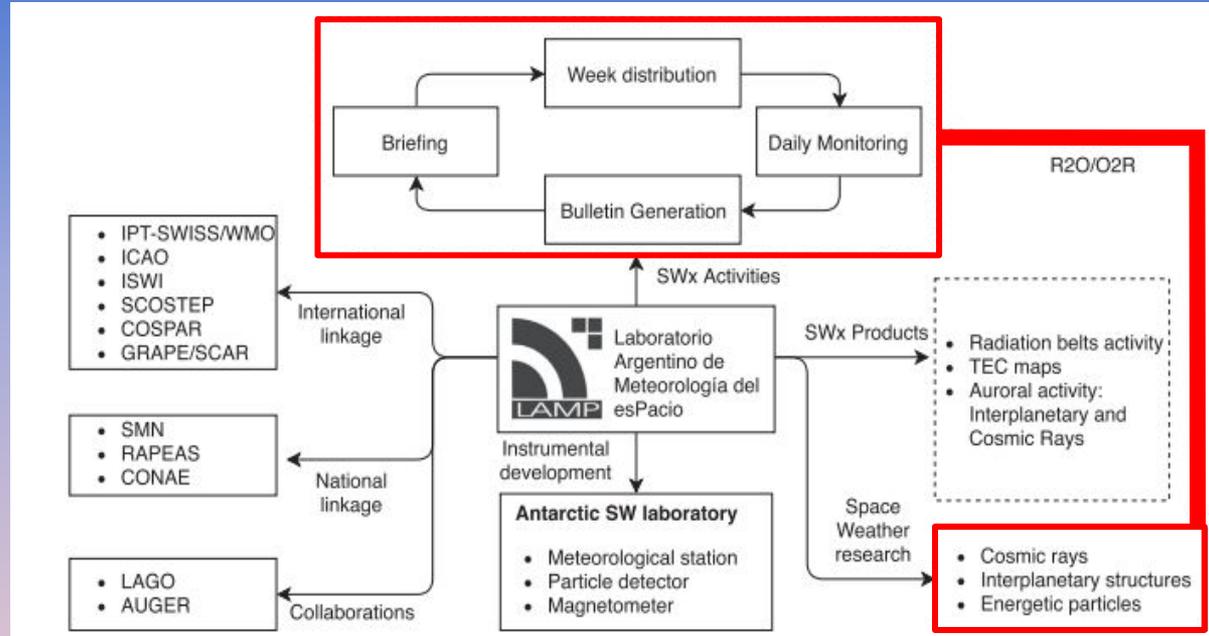
SWPC threshold is fixed at a level at which these particles can penetrate through shielding and cause internal discharges, as shown in Frederickson [1996].

New thresholds were developed, and associated with severe (P75), very severe (P85) and Extreme (P95) particle storms. This refinement can be used to describe different effects on technologies.



LAMP activities

In QV - R20 and development of services (30926) Space weather services in Argentina: Argentine Space Weather Laboratory (LAMP) activities there is a more complete overview at Weekly reports of the Space Weather conditions available at <http://spaceweather.at.fcen.uba.ar/2/boletines.html> .



As in [Lanabere+20]

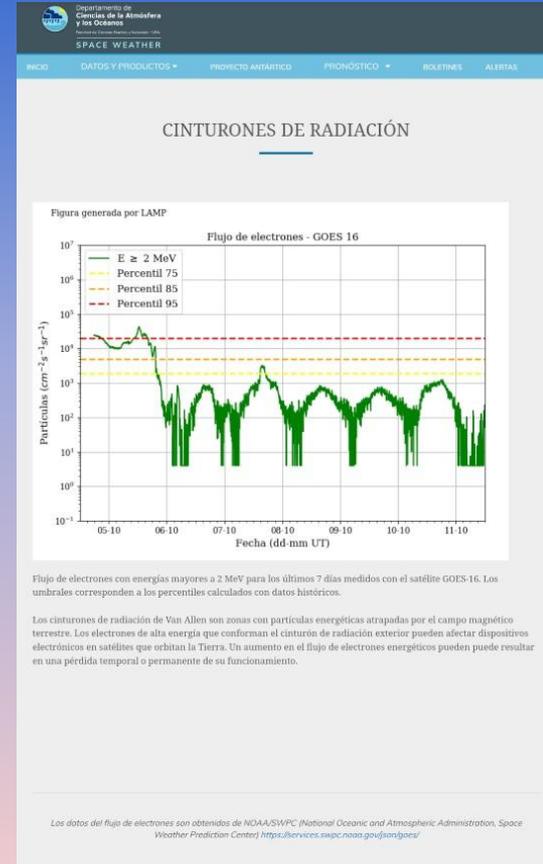
Operative Product

As GOES-15 went out of service, GOES-16 data is used to generate this realtime product.

Constant validation through the weekly monitoring and discussion sessions.

Percentile values are associated with different particle storms intensities, although a more interdisciplinary approach needs to be made in order to associate them to different levels of risk.

Future work: extend this whole procedure to other relevant quantities.



References

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Thank you for your attention

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