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# Space radiation variations during solar energetic particle events and geomagnetic storms

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Energetic electron and proton flux variations have been observed by the Energetic Particle Telescope (EPT) from the launch of PROBA-V satellite on 7 May 2013 up to now. This detector that flies on a polar Low Earth Orbit (LEO) at an altitude of 820 km was designed to measure space radiations and provide uncontaminated spectra of electrons, protons and alpha particles.

Strong Solar Energetic Particle (SEP) events, like in January 2014, June 2015 and September 2017, inject energetic protons at high latitudes, but not in the inner belt where protons are trapped at long term at low L. Nevertheless, big geomagnetic storms, including those following SEP a few days after, can cause losses of protons at the outer border of the proton belt, due to magnetic field perturbations. At solar minimum, the proton fluxes are higher at low L corresponding to the northern border of the South Atlantic Anomaly. This solar cycle modulation of the inner belt is mainly due to losses by increased atmospheric interactions during solar maximum.

Electrons of the outer belt are very dynamic during geomagnetic storms. Electron flux dropout events are observed during the main phase of each storm and even during substorms: a rapid reduction of the electron flux is noted throughout the outer electron radiation belt at all energies above about 0.5 MeV on timescales of a few hours. The electron spectrograms measured by the EPT between 2013 and 2019 show that after each geomagnetic storm, dropout events are followed by a flux enhancement starting first at low L values, and reaching the slot or even the inner belt for the strongest storms. We have determined the link between Disturbed Storm Time (Dst) and the minimum value of the L-shell where the dropouts deplete the outer belt, as well as the non-linear relation between Dst and the minimum L-shell where the flux penetrates in the slot region or even the inner belt during the storms. Dropouts appear at all energies measured by EPT and penetrate down to L~3.5 for the strongest events. Dropouts are observed at LEO each time Dst has an inverted peak < -40 nT. Flux enhancements appear at lower L only for big storm events with Dst < -50 nT. They penetrate down to an impenetrable barrier with a minimum L-shell related to Dst and to the energy. For E > 1 MeV, this limit is also linked to the plasmapause position.

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