Loss mechanisms in the radiation belts: comparing dropouts and flux decays simulated and observed by PROBA-V/EPT and Van Allen Probes/MagEIS

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Abstract

Test-particle and Fokker-Planck simulations of the energetic electrons trapped in the terrestrial magnetic field are used to study the outer radiation belt electron flux losses during and after geomagnetic storms. We compare the results with ESA PROBA-V observations of electron flux at LEO and with those from the NASA Van Allen Probes mostly at MEO. We find that loss mechanisms of trapped electrons can be very different depending on the geomagnetic activity. Dropouts are visible at all energy during each storm from both satellites. Test-particle simulations show that the Dst (Disturbance storm time) effect during the main phase of a geomagnetic storm results in an outward radial drift and a deceleration of the electrons. This outward drift motion is energy independent, pitch angle dependent, and represents a significant distance of about 1 L-shell at L=5 for moderate storms. At fixed L-shell, this causes a sharp decay of the LEO precipitating flux. The Dst effect, associated with magnetopause shadowing and radial diffusion can explain the main characteristics of outer radiation belt electron dropouts appearing at the beginning of storms. These instantaneous dropouts have to be distinguished from the gradual scattering that depopulates the slot region and the outer belt after storms. Fokker-Planck simulations with event-driven diffusion coefficients at high temporal resolution reproduce the slot formation and the gradual loss in the outer belt. The typical energy-dependence of these losses leads to the absence of scattering for relativistic and ultra-relativistic electrons in the outer belt, oppositely to dropouts. This work has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870437 for the SafeSpace (Radiation Belt Environmental Indicators for the Safety of Space Assets) project, and for the PITHIA-NRF project (funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007599).

LOSS MECHANISMS IN THE RADIATION BELTS: COMPARING DROPOUTS AND FLUX DECAYS SIMULATED AND OBSERVED BY PROBA-V/EPT AND VAN ALLEN PROBES/MAGEIS

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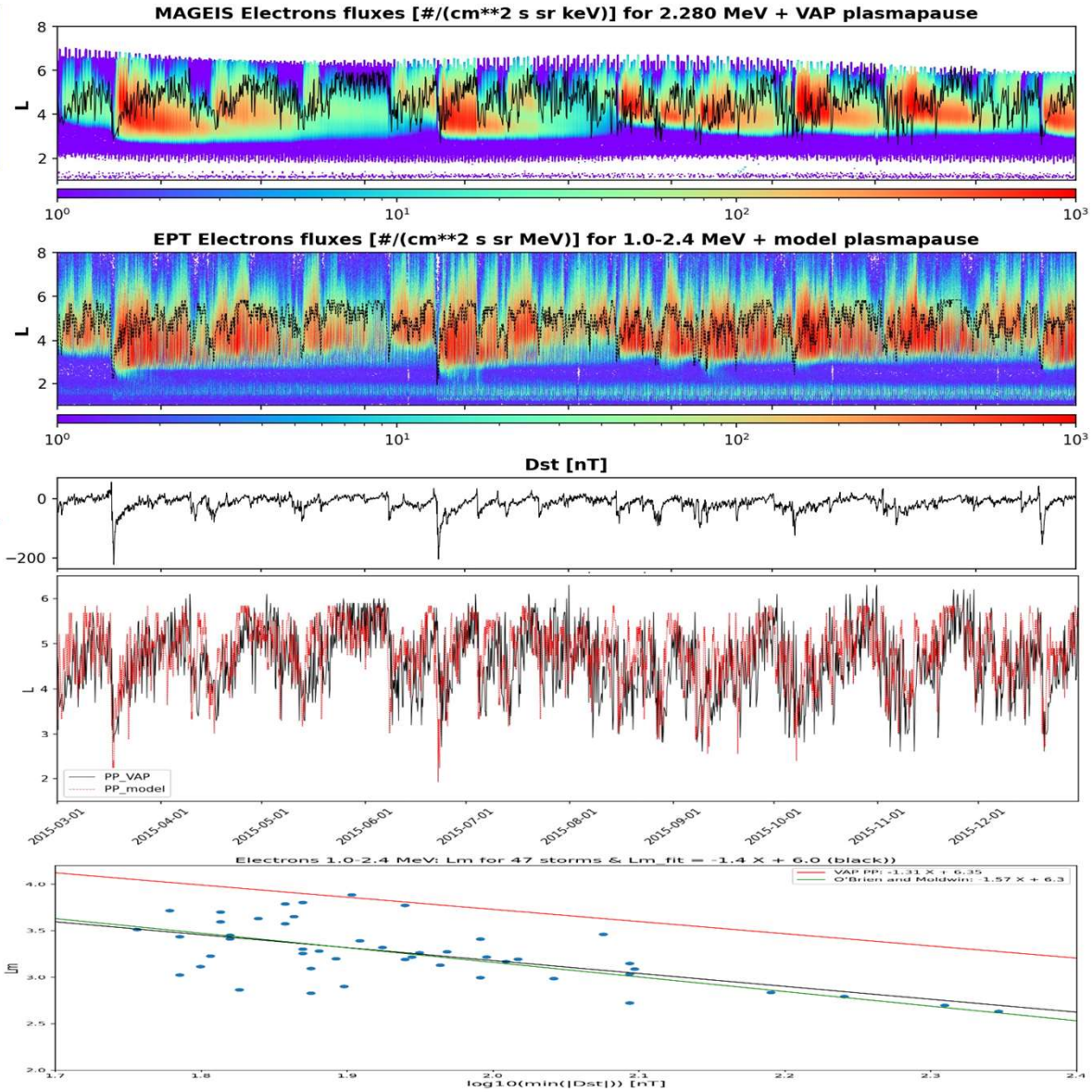
PIERRARD VIVIANE

Comparing dropouts, flux decays and plasmapause observed by Van Allen Probes/MAGEIS and EMFISIS

and PROBA-V/EPT measurements

Loss mechanisms

- Dropouts (magnetopause shadowing)
- Flux decay (plasmaspheric hiss waves)



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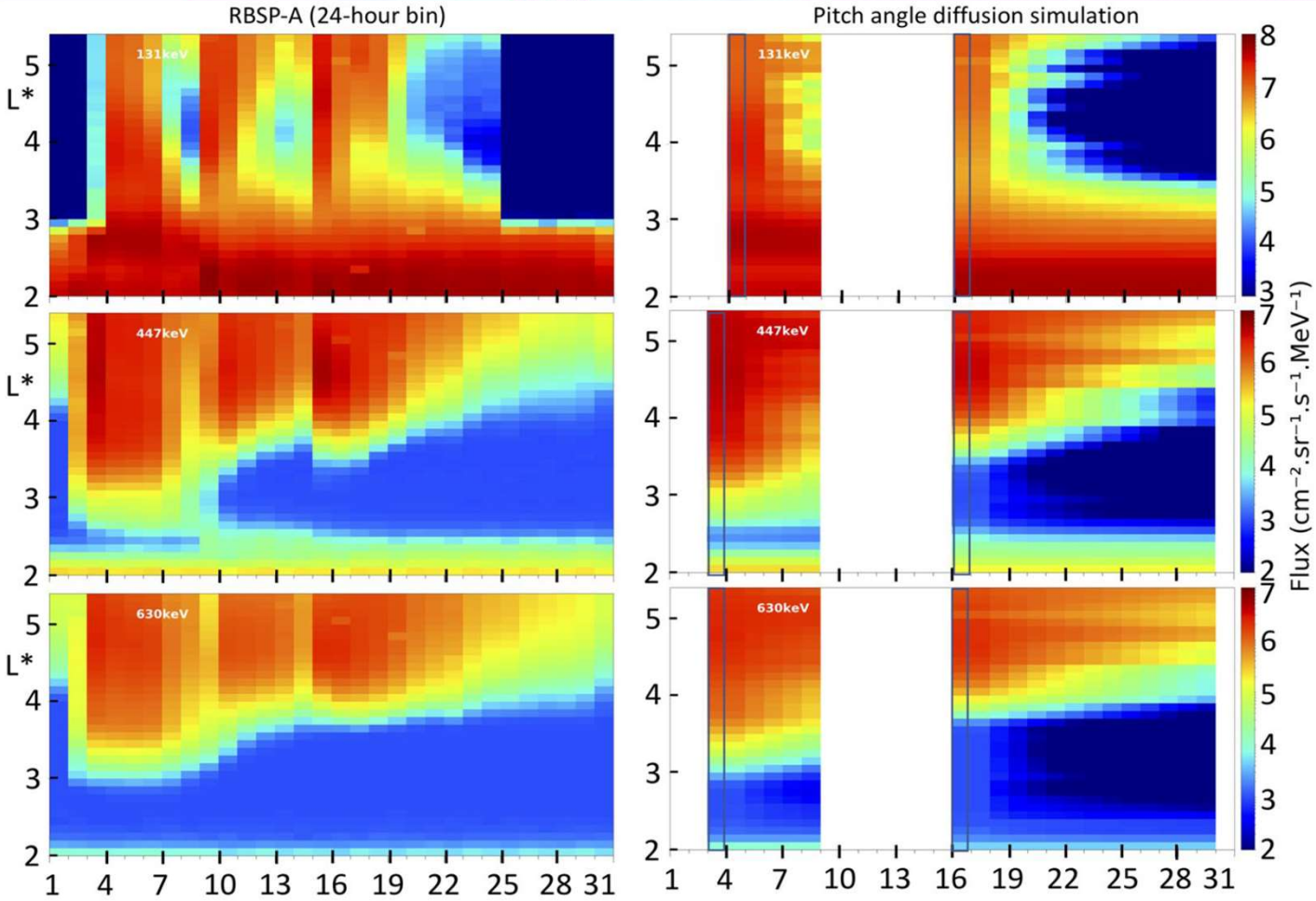
FLUX DECAY AFTER STORMS

RBSP observations (left)

compared to

Fokker-Planck simulations including plasmaspheric hiss



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