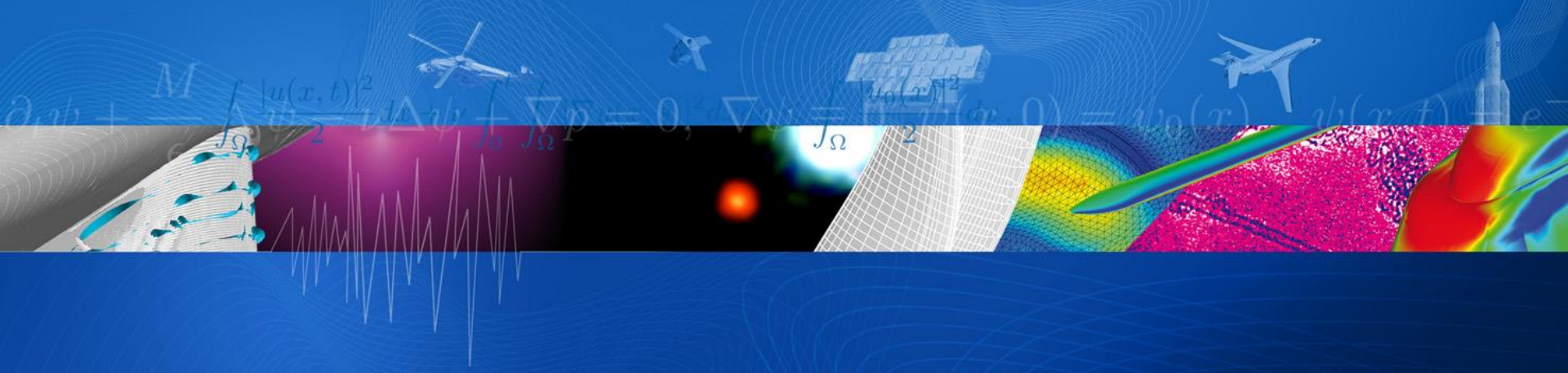

Validation of the Physical Model Salammbô-Protons with Van Allen Probes Data

A. Sicard, V. Maget, D. Boscher, D. Lazaro,

S. Bourdarie

Thanks to Van Allen Probes ECT Team (Harlan Spence and Geoff Reeves)

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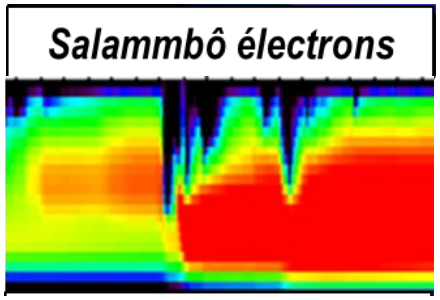
retour sur innovation

Salammbô: a physical model for electrons and protons

3D model ➔ E, y, L



Specificities e-

Wave-particle Interactions

A common architecture

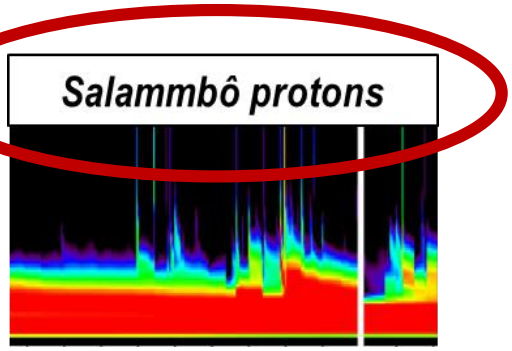
Radial Diffusion

Interaction between charged particles and other populations.

Boundary conditions

Drop out

Proxies (Kp, …)



Specificities p+

Sources *(CRAND and flares)*

Trapping boundaries *(Geomagnetic shielding)*

Nuclear Interactions and Charge Exchange *(losses)*

Salammbô for low energy protons

Simulation of protons from few keV to 1 MeV:

Radial Diffusion

➔Lejosne et al., 2013: magnetic field measurements at geostationary orbit

Interaction with atmosphere and exosphere:
- Friction
- Charge Exchange

➔Two models of atmosphere + exosphere are used:
- MSIS-86 model (Hedin, 1987, 1991) + exosphere model
- Hodges model (Hodges, 1994)

Drop out

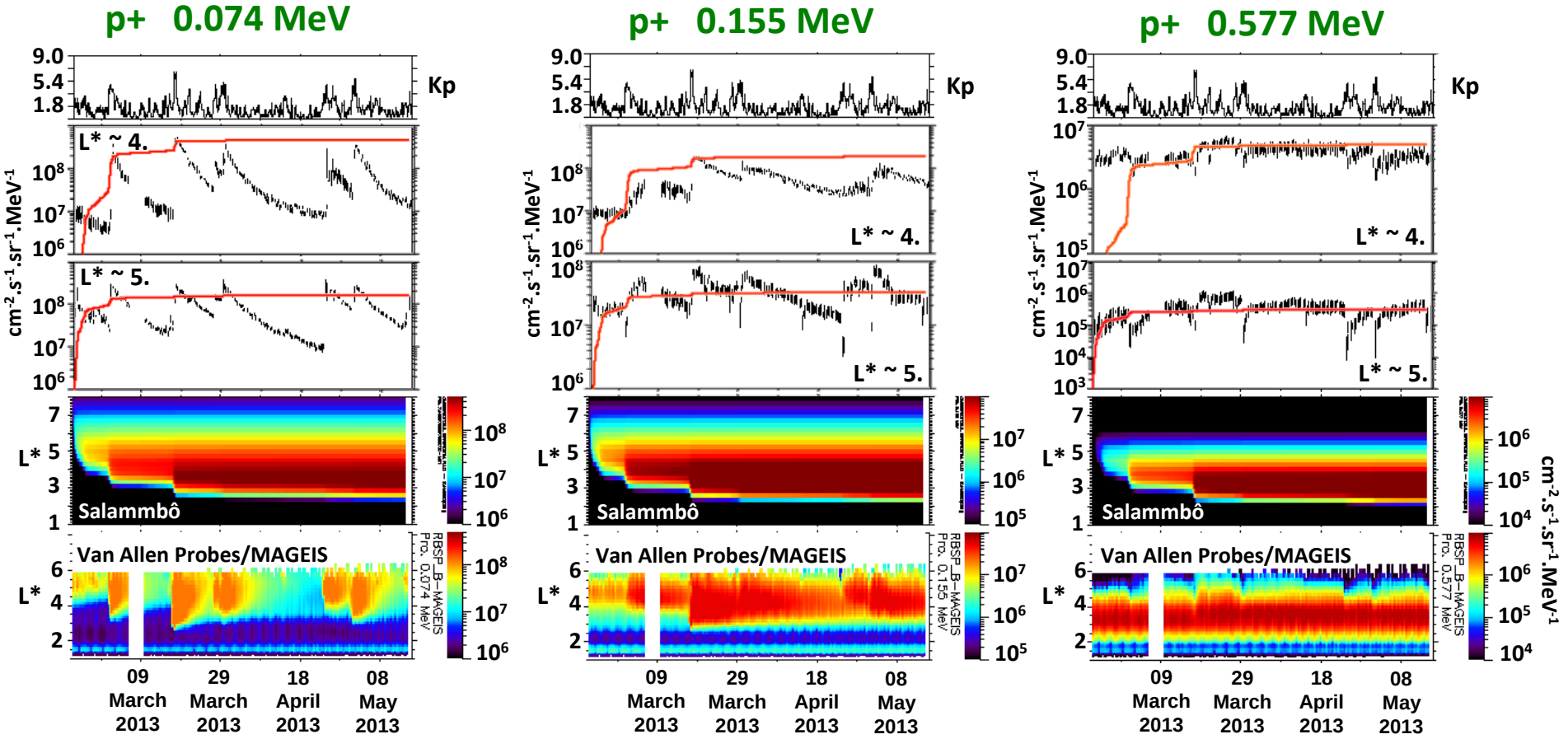
➔Herrera et al., 2016: model of magnetopause shadowing losses

Boundary conditions

➔ Boundary condition based on averaged geostationary LANL data (CPA and MPA)
➔ New boundary condition based on averaged NOAA POES data, depending on the magnetic activity

Salammbô compared to Van Allen Probes (MagEIS) data

Radial diffusion only



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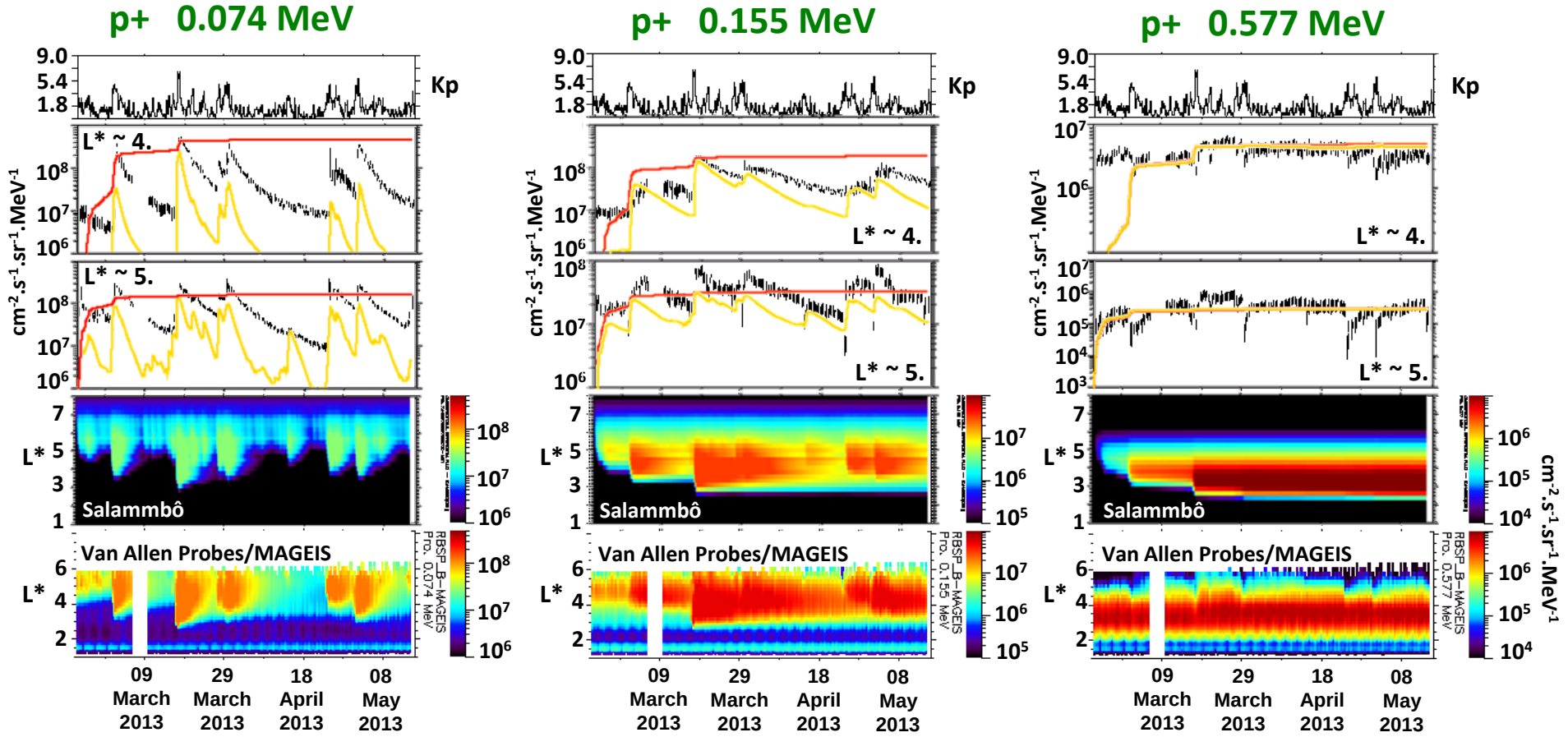
Salammbô compared to Van Allen Probes (MagEIS) data

Radial diffusion + Friction + Charge Exchange with neutral (MSIS + exosphere)



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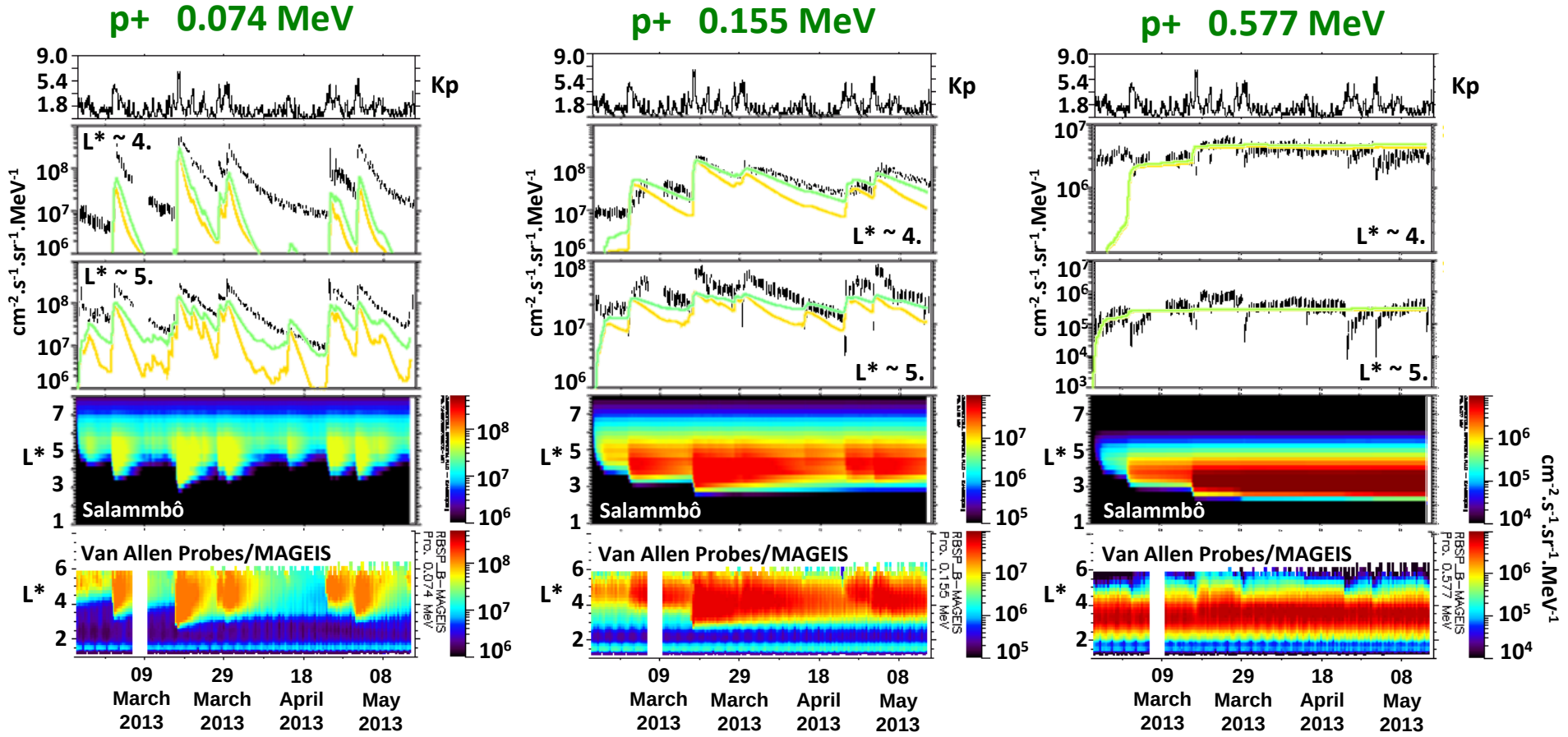
Salammbô compared to Van Allen Probes (MagEIS) data

Radial diffusion + Friction + Charge Exchange with neutral (Hodges model)



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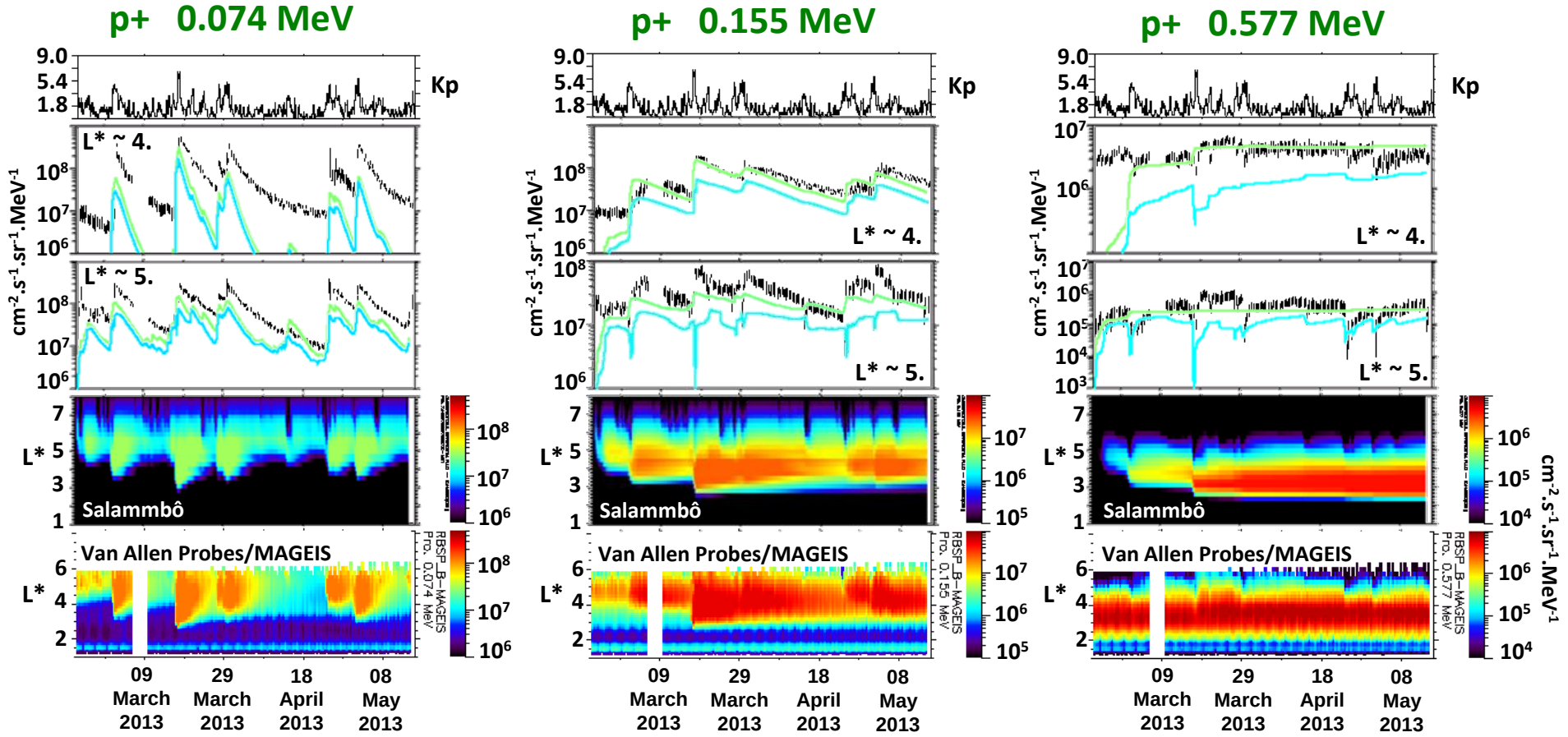
Salammbô compared to Van Allen Probes (MagEIS) data

Radial diffusion + Friction + Charge Exchange with neutral + Dropout



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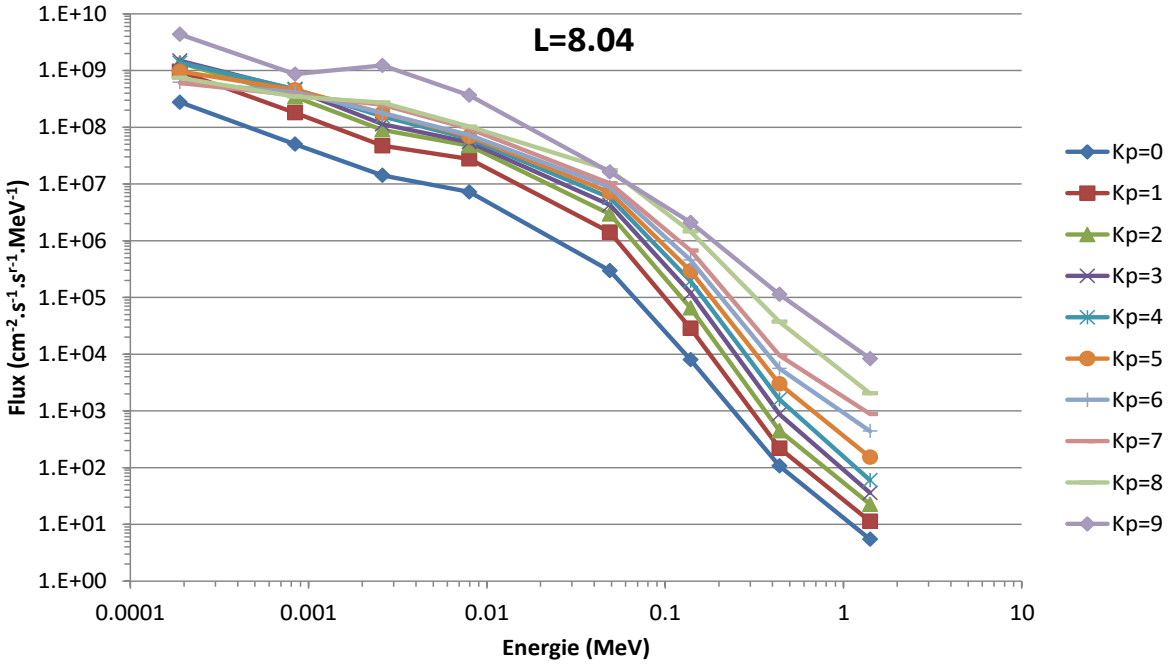
Boundary condition of Salammbô

➔ Boundary condition based on averaged LANL data at L=6.5 adiabatically projected at L=8

➔ Definition of a new boundary condition depending on magnetic activity based on NOAA POES data at L=8:

SEM: - 0.19 keV, 0.84 keV, 2.6 keV and 7.98 keV on **TED**
- 49 keV, 139 keV, 438 keV and 1.41 MeV on **MEPED**



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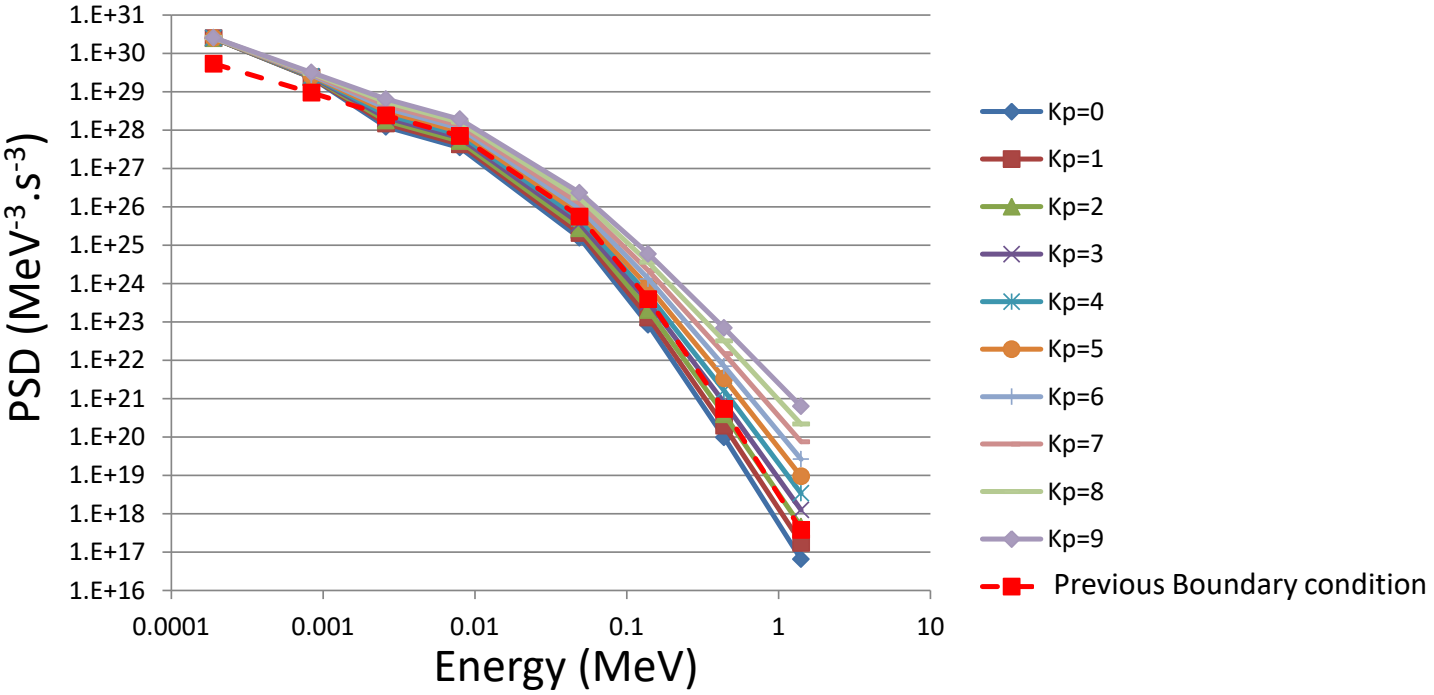
Boundary condition of Salammbô

➔ New boundary condition: Kappa function + exponential function

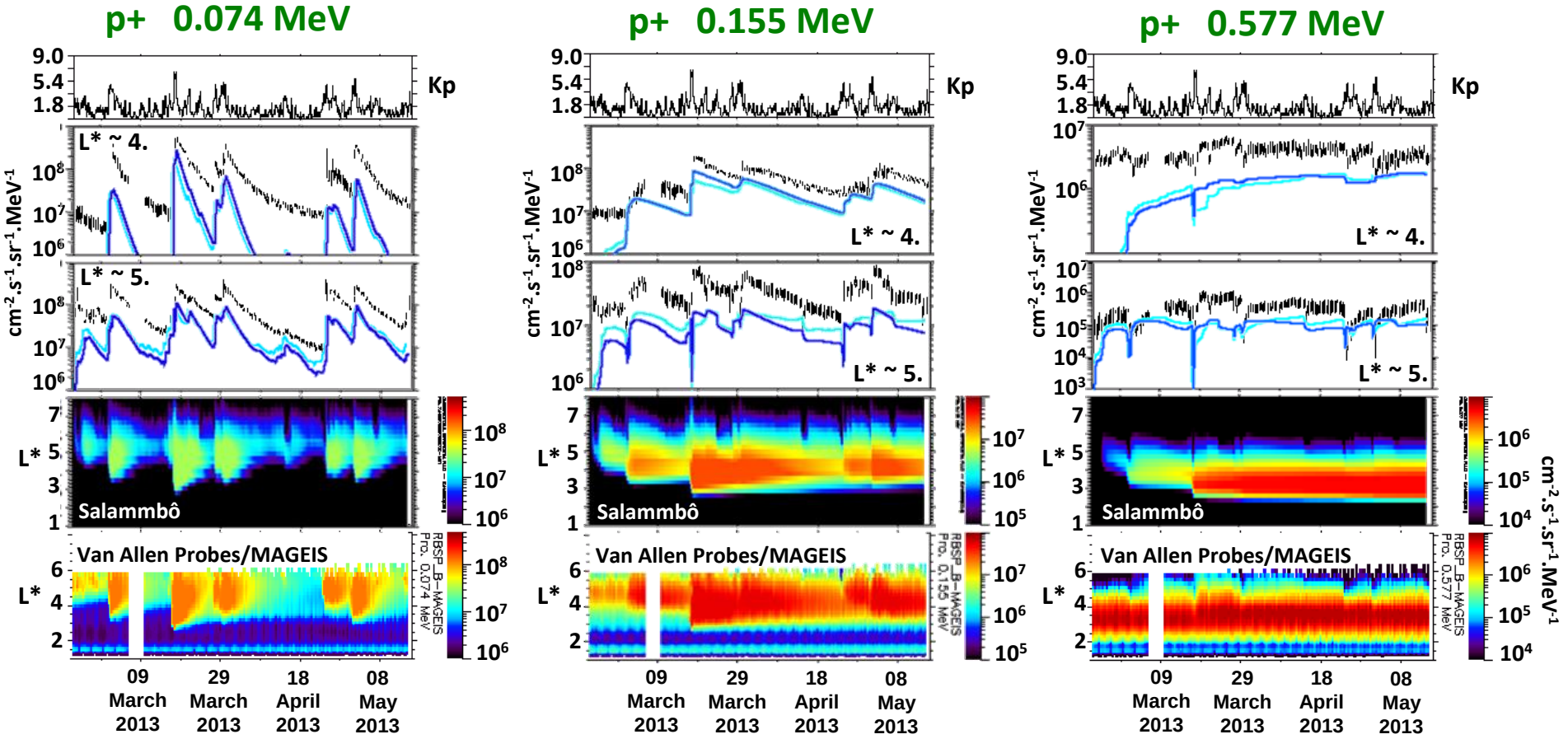
$$\text{PSD}\ (MeV^{-3}.s^{-3}) = \frac{5{,}01.10^{30}}{E}.\exp\left(\frac{-E}{0{,}000265}\right) + \text{F0}.\left(1+\frac{E}{\kappa.T}\right)^{-\kappa-1}$$

$$\kappa = -0{,}2623\ Kp + 5{,}4558$$
$$T[MeV] = 0{,}00425$$
$$F0\ [MeV^{-3}.s^{-3}] = \exp(0{,}1927Kp + 65{,}33)$$



Salammbô compared to Van Allen Probes (MagEIS) data

Radial diffusion + Inter. with atm. + Dropouts + New Boundary condition



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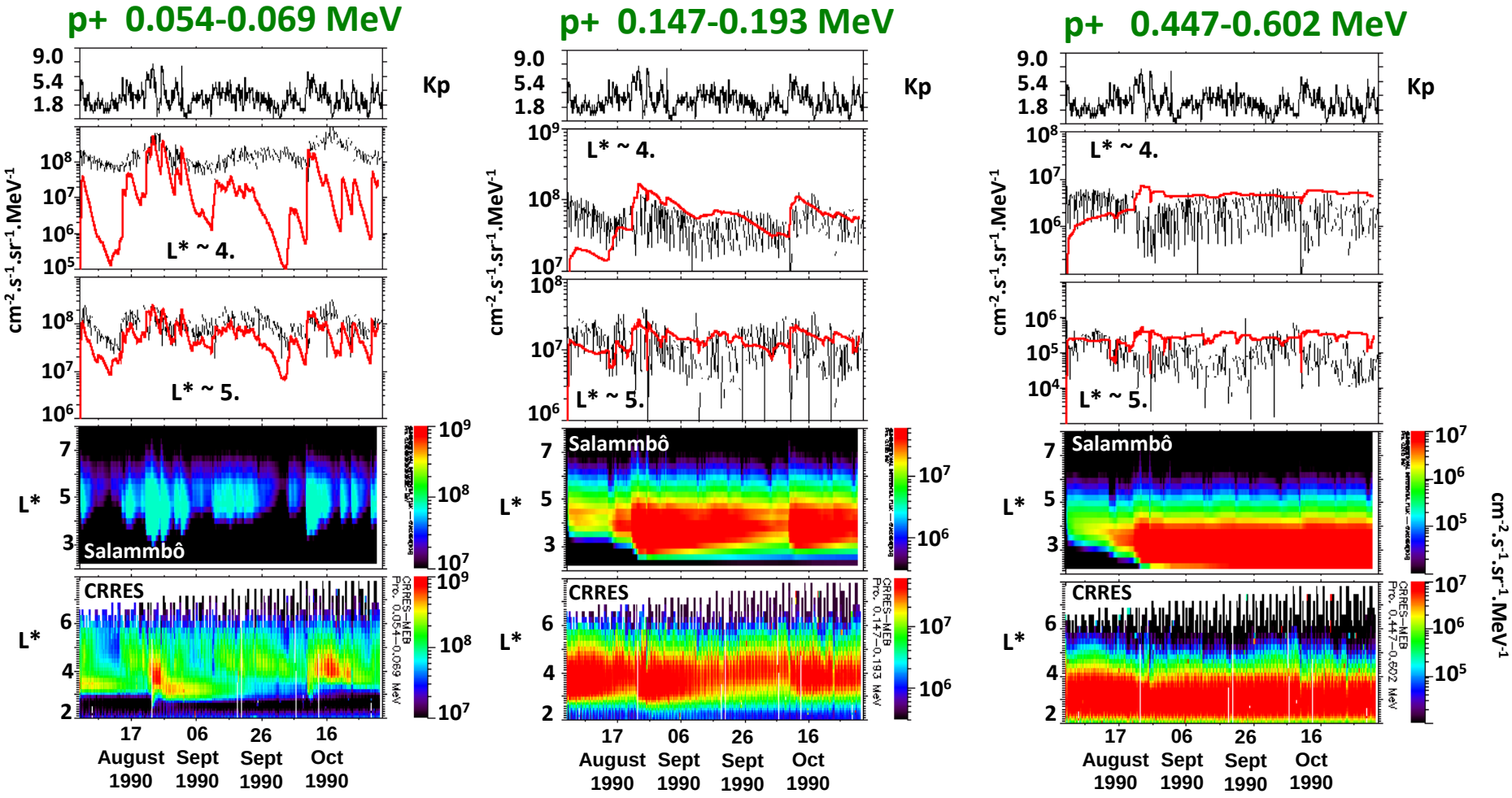
Salammbô compared to CRRES (MEB) data

Radial diffusion + Inter. with atm. + Dropouts + New Boundary condition



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Summary

➔ Salammbô-3D allows reproducing quite well few tens of keV to 1 MeV protons fluxes in the radiation belts, compared to Van Allen Probes-MagEis measurements

➔ Major physical processes have been integrated in Salammbô: radial diffusion, dropout, friction and charge exchange with atmosphere and exosphere

➔ Salammbô simulation seems to be better using Hodges model rather than MSIS model

➔ However, few tens of keV protons dynamics for $L^* < 5$ can not be reproduced by a pure diffusive code like Salammbô-3D because convection processes dominate diffusion processes at those energies.

➔ A new boundary condition, depending on magnetic activity, based on NOAA POES data has been developed but does not change significantly Salammbô simulation

➔ Comparison with CRRES/MEB measurements leads to the same conclusions than those with Van Allen probes/MagEis data

➔ Radial diffusion and dropout are common processes for electrons and protons (independent of the species). The coefficients for these processes are exactly the same for protons and electrons . These common processes reenforce the validity of radial diffusion coefficients in Salammbô.