Long Term High Energy Electron Dynamics in The Inner Zone

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Outline

- Analysis of NOAA-POES measurements
- Salammbô simulation
- Conclusions and prospects

Rationale

There was always doubt about the presence of high energy electrons in the inner zone of the radiation belts:

Fennell et al. [2015], using MagEIS measurements on board the recent Van Allen Probes, claimed their absence, or at least the fact that their level must be below the background of their instrument.

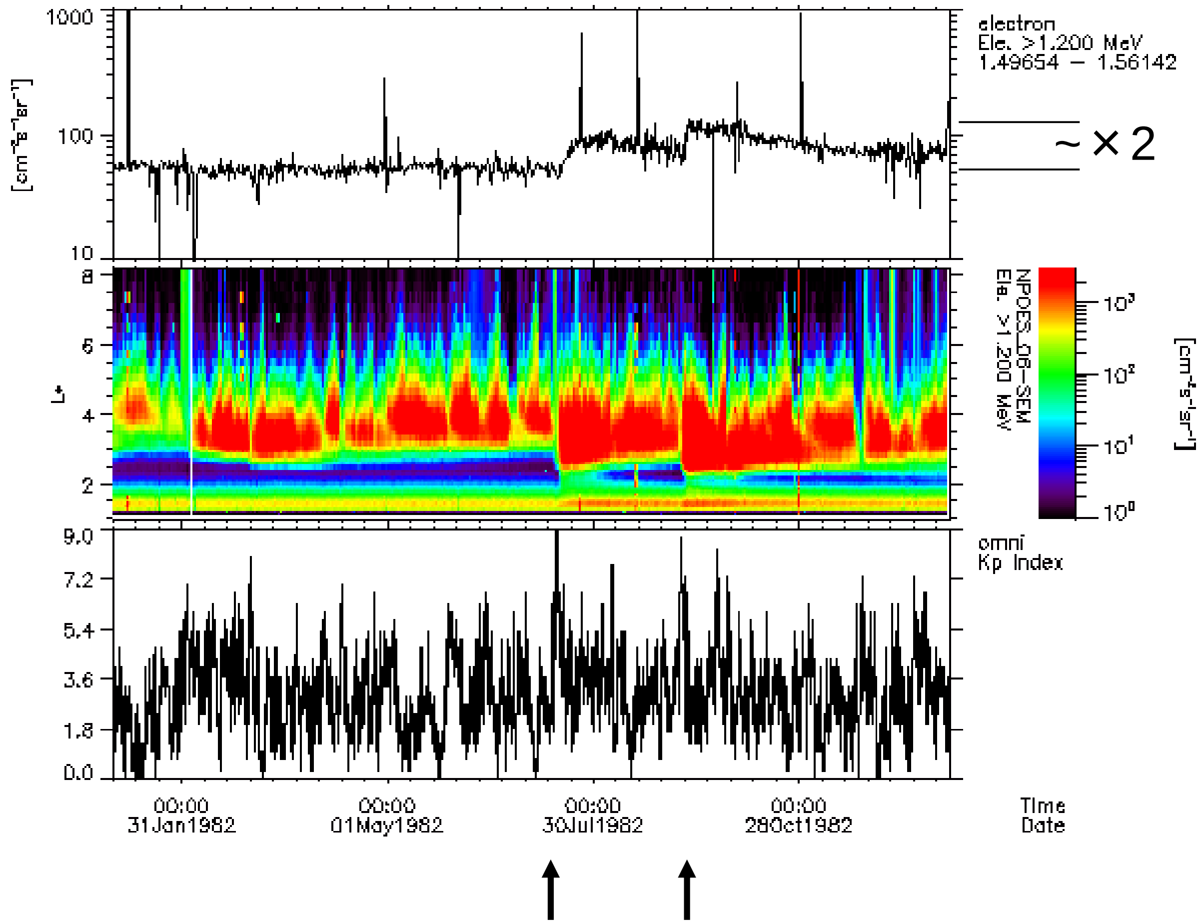
Selesnik [2015] replied months later, showing their presence during a limited period of time, as well as their variations from SAMPEX/PET

Recently, Claudepierre et al. [2017] improving the analysis of MagEIS instrument in the inner zone, amended the first conclusion about the absence of electrons, and showed that this zone can be filled with electrons, following strong magnetic storms.

In this work, we support the published findings of Claudepierre et al. [2017] and we extend the analysis to decades in order to try to improve radiation belt specification models.

Analysis of NOAA measurements

P6 channel: mostly energetic protons but also sensitive to >1.2 MeV electrons

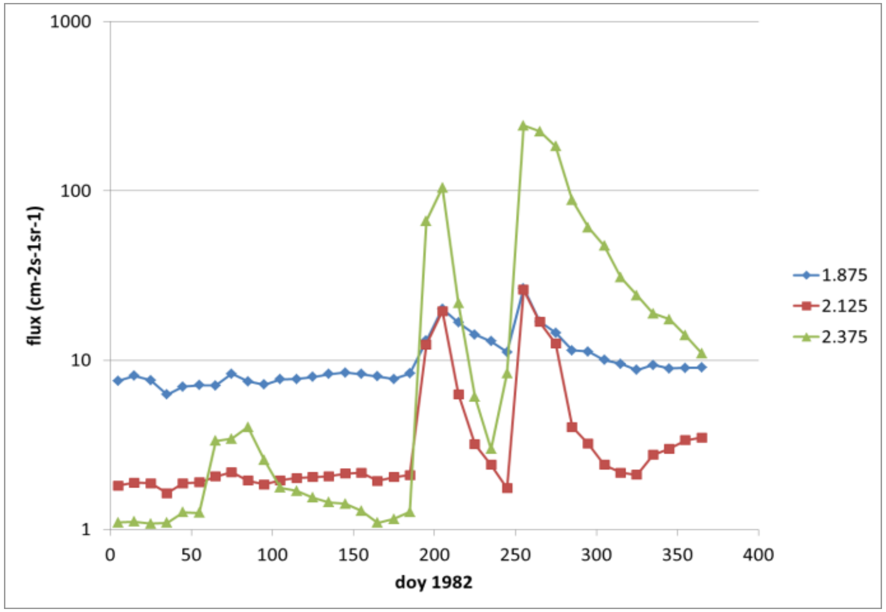


July 14th, 1982 storm

September 6th, 1982 storm

Analysis of NOAA measurements

P6: > 1.2 MeV electrons



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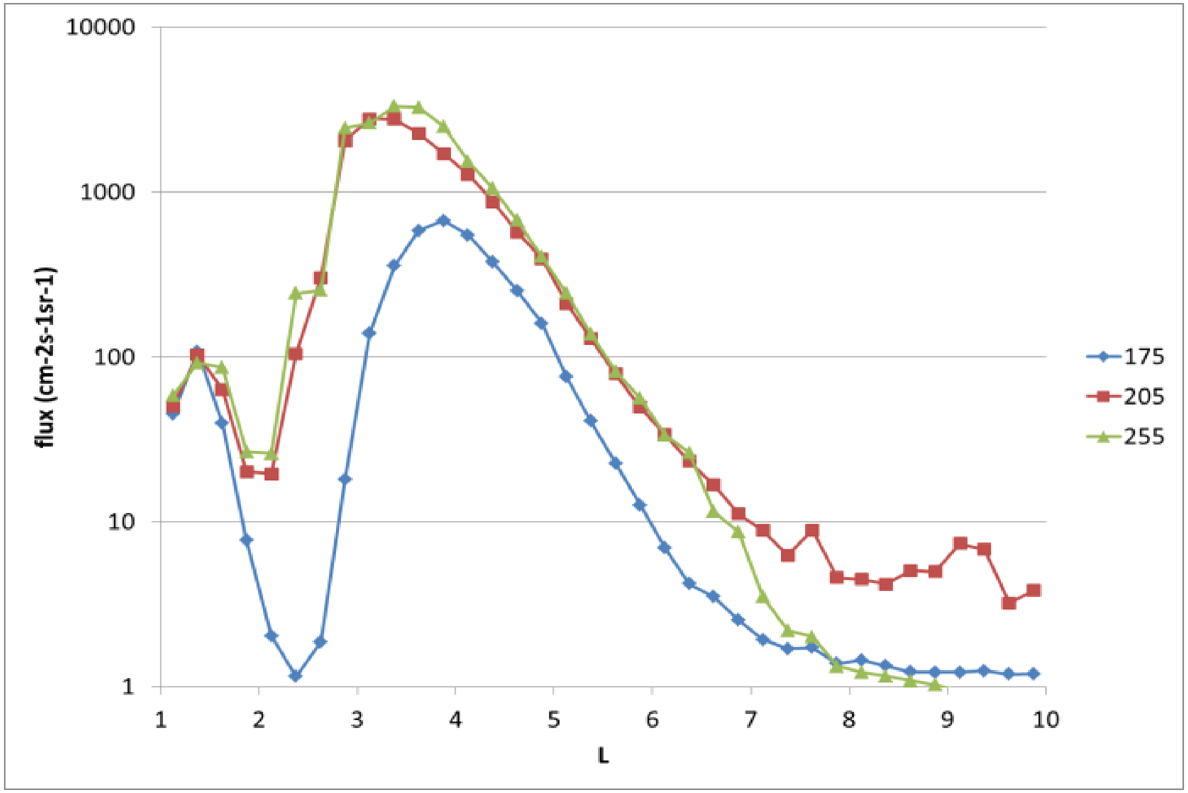
Analysis of NOAA measurements

P6: > 1.2 MeV electrons



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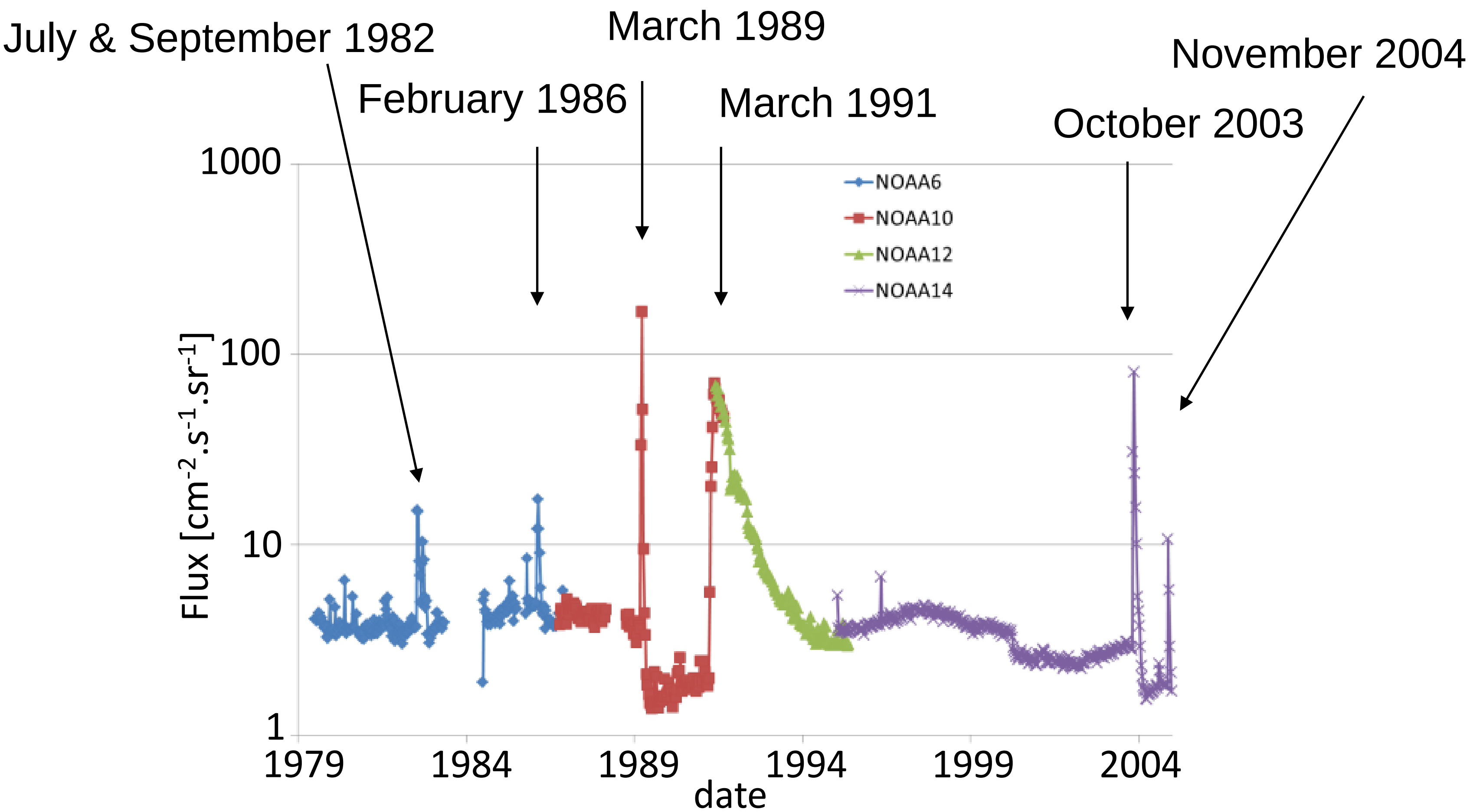
Analysis of NOAA measurements

P6 @ L=2 ±0.1

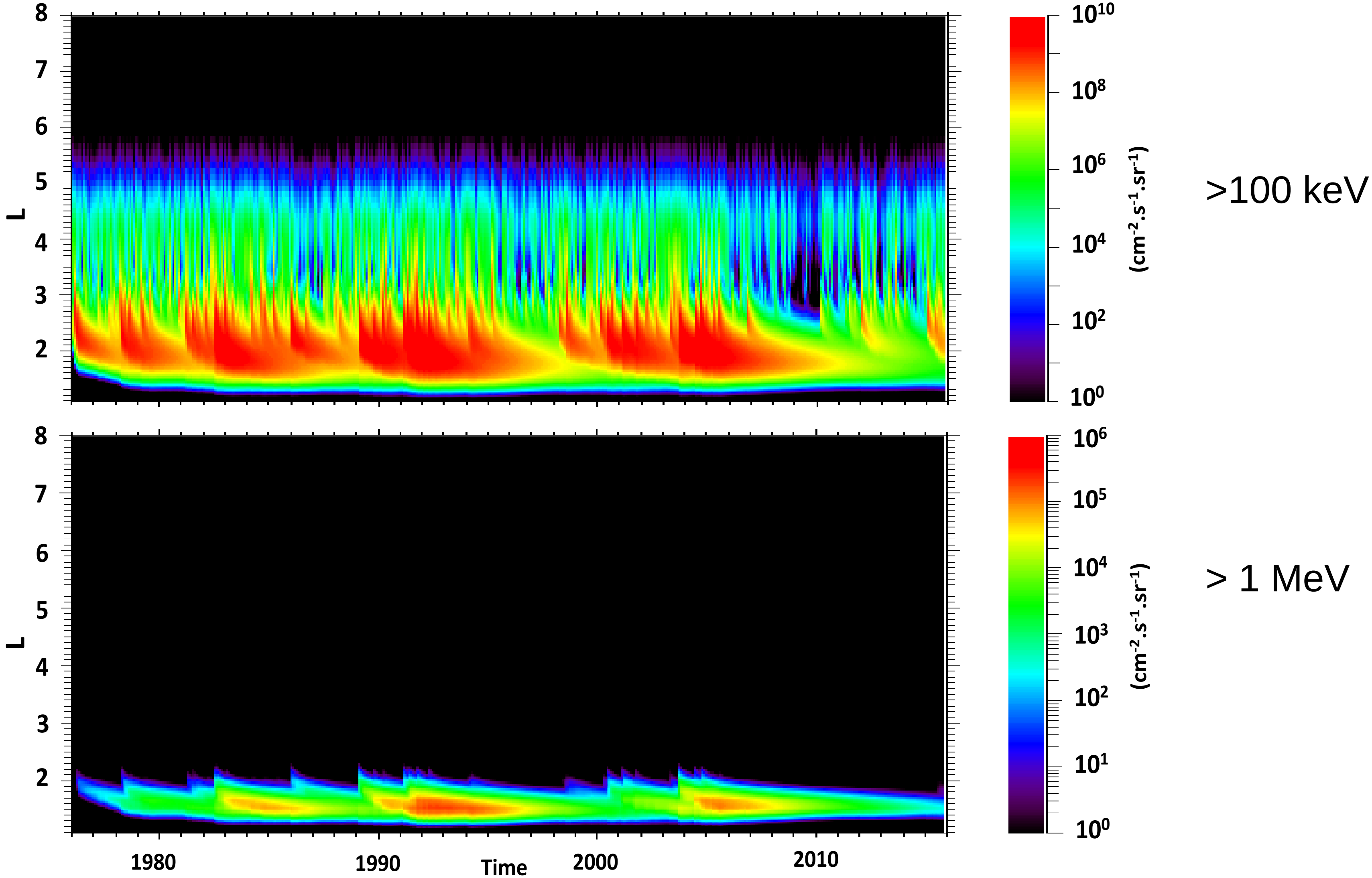


Salammbô simulation

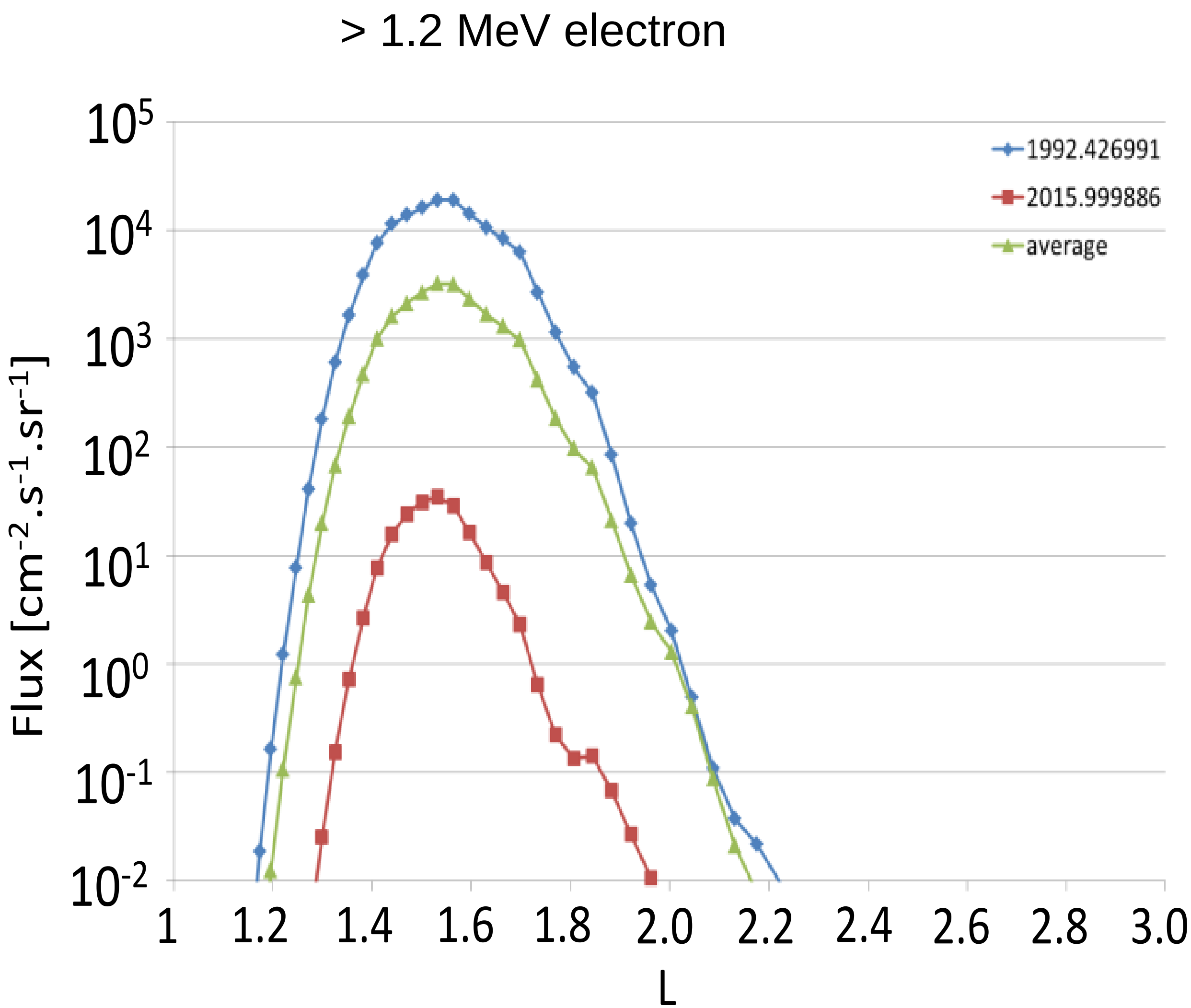
Simplified version of Salammbô: 2D i.e. for equatorial electrons (2D=µ & L)

- Constant boundary condition: unidirectional flux at the external boundary L=8 is given by $J\ [MeV^{-1}cm^{-2}s^{-1}sr^{-1}] = 4.3195.\,10^{10}exp^{-E[MeV]/0.002085}$.
- Radial diffusion coefficients which depend on L and magnetic activity through the Kp magnetic index $D_{LL}[s^{-1}] = 1.198.\,10^{-14}exp^{1.0362Kp}L^{10.2}$
- Losses due to waves and interactions with neutrals and plasma from the thermosphere-exosphere and the ionosphere. Following the works of Lyons and Thorne [1973], a life time was deduced from pitch angle diffusion coefficients
- energy diffusion coefficients are not taken into account in this work.

Salammbô simulation



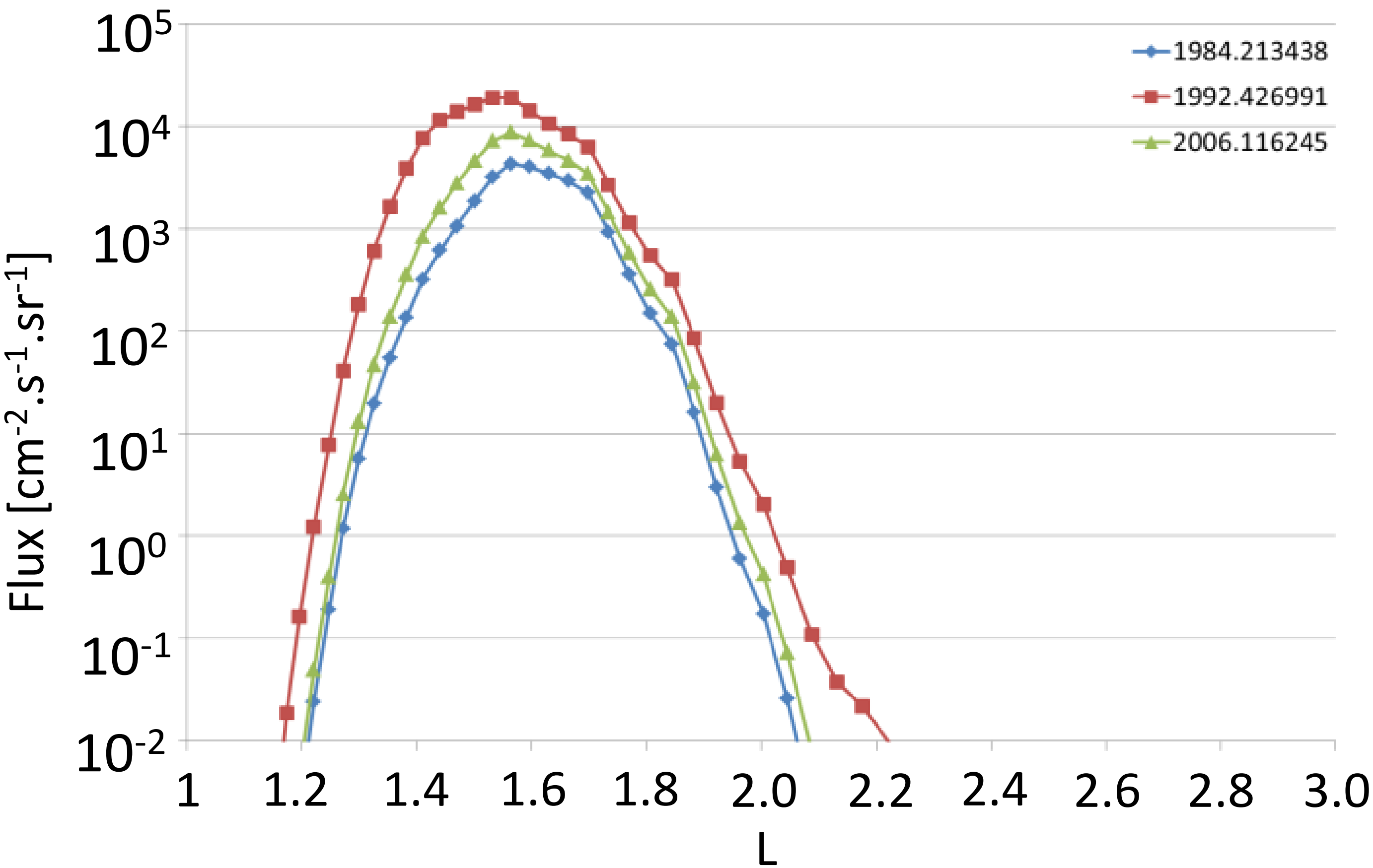
Salammbô simulation



Salammbô simulation

>1.2 MeV electron

3 highest profiles calculated in solar cycles 21, 22 and 23.



Conclusions

- MeV electrons can fill the region below L=2 following intense and extreme magnetic storms
  - Evidence from NOAA-MEPPED, SAMPEX-PET and RBSP-MagEIS
- A simple physical model of the electron belt (Salammbô 2D), without taking into account wave-based energization of trapped electrons, provides crucial elements on the dynamics of these electrons
  - succession of storms during solar maximum activity increase MeV electron flux by important factors at low L
  - Their decay timescales during the decrease of magnetic activity in solar minimum.
  - the conjunction of the last long solar minimum and the weak solar maximum currently observed induce very low flux level of MeV electrons in the inner belt