"Dependence of radiation belt enhancements on the earthward propagation of Pc5 waves during magnetic storms"

Marina Georgiou
University of Athens

IAASARS

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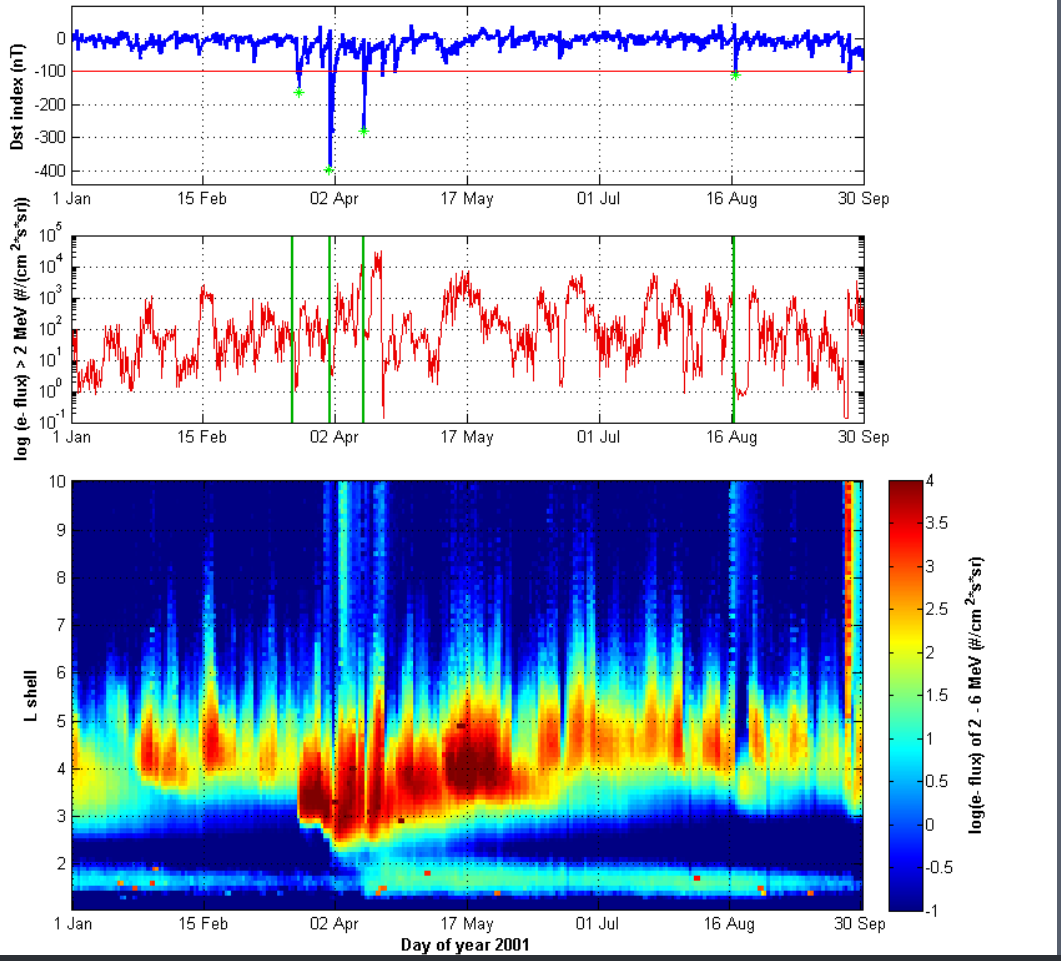
Overview

- Background information which provided motivation
- Data set compiled for the case studies
- Selected case studies
- Concluding remarks

Background

- Geospace magnetic storms are associated with either increases or decreases of the fluxes of outer radiation belt electrons (*Reeves et al. 2003*)
- Long-duration Pc5 wave activity during the recovery phase of a magnetic storm seems to be a discriminator (*O'Brien et al. 2001*)
- The peak of relativistic electron fluxes and penetration into the slot region is strongly correlated with the minimum Dst index value (*Zhao & Li, 2013*)
- ULF Pc5 waves have been observed at unusual depths during intense magnetic storms (Lee et al. 2007, Marin et al. 2014)

Data set: e- fluxes



Fluxes vary by > 5 orders of magnitude, while the electrons penetrate to lower L shells during periods of geomagnetic activity

Data set: ULF Pc5 waves

Observations of Pc5 waves from the IMAGE array as well as other ground-based magnetic observatories collaborating with SuperMAG

The continuous wavelet transform of the discrete sequence of ground-based measurements of the magnetic field:

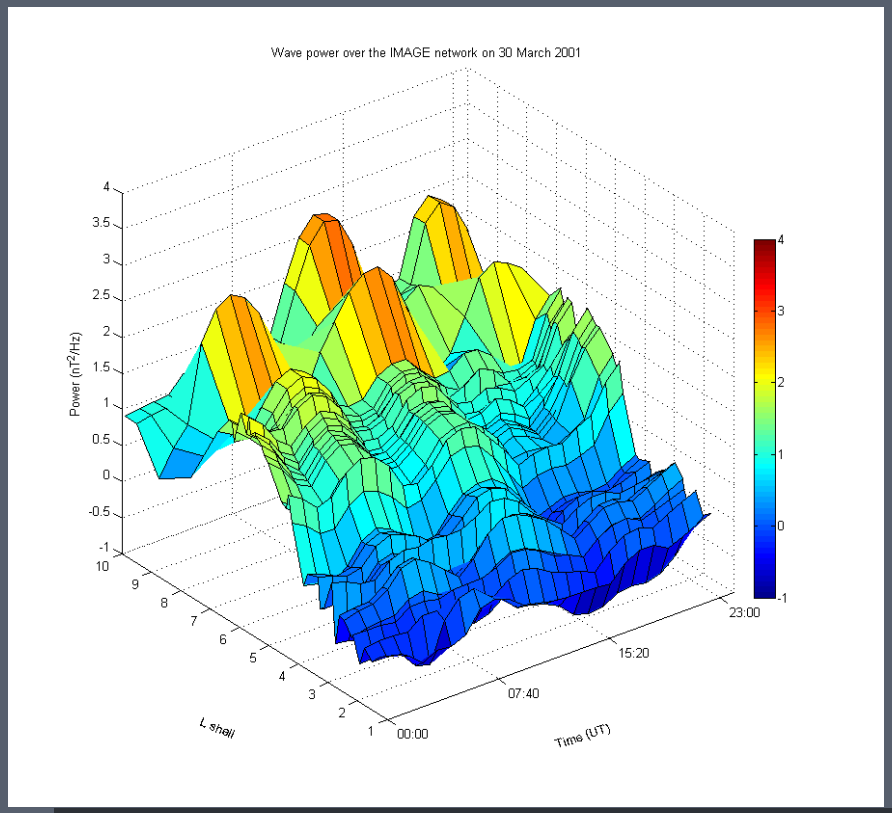
$$W_n(s) = \sum_{n'=0}^{N-1} x_{n'} \psi^* \left[\frac{(n'-n)\delta t}{s} \right],$$

The mean Pc5 wave power was calculated as the wavelet power averaged over scales corresponding to frequencies between 1 and 10 mHz:

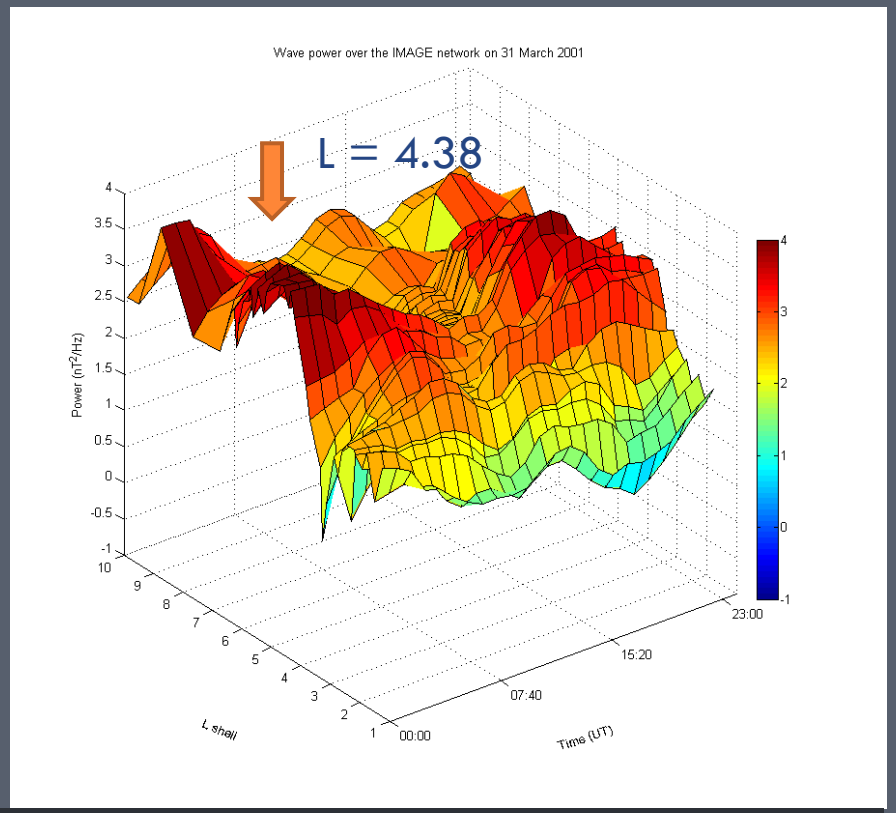
$$\overline{W}_n^2 = \frac{\delta j \delta t}{C_\delta} \sum_{j=j_1}^{j_2} \frac{\left| W_n(s_j) \right|^2}{s_j}.$$

Case study: 31 March 2001 (Dst_{min} = - 387 nT)

Pc5 wave power on 30 March 2001



Pc5 wave power on 31 March 2001

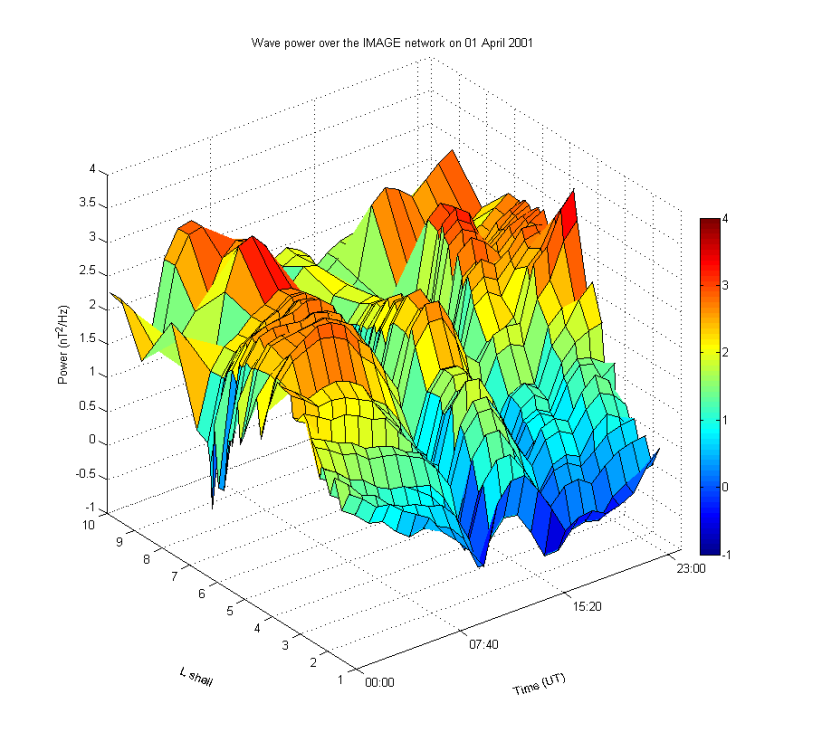


Latitudinal profile of Pc5 wave activity

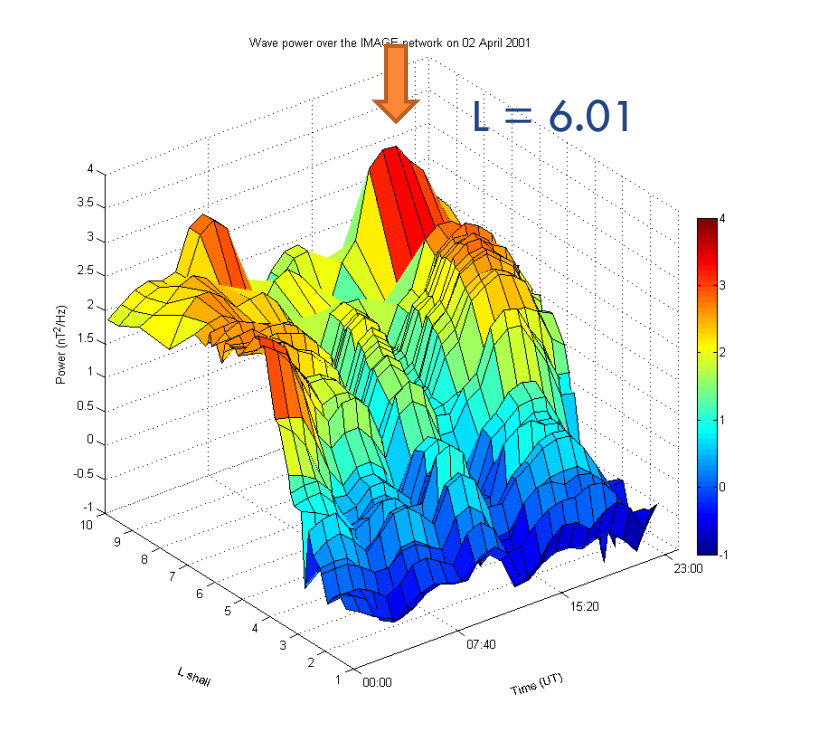
during the magnetic storm of 31 March 2001

Case study: 31 March 2001 (Dst_{min} = - 387 nT)

Pc5 wave power on 1 April 2001

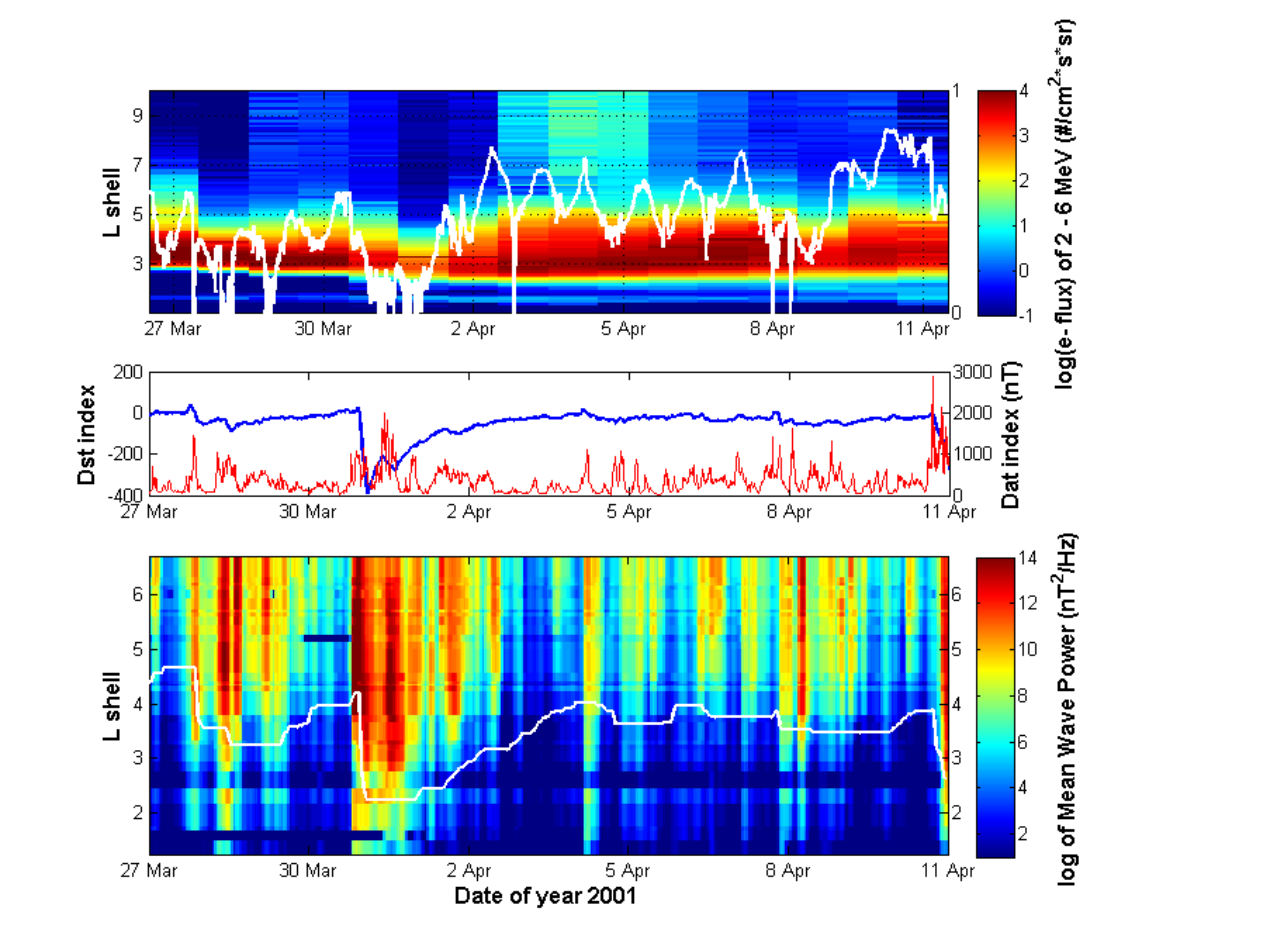


Pc5 wave power on 2 April 2001



Pc5 wave power vary >5 orders of magnitude as a magnetic storm evolves and penetrate to lower L shells during the main phase

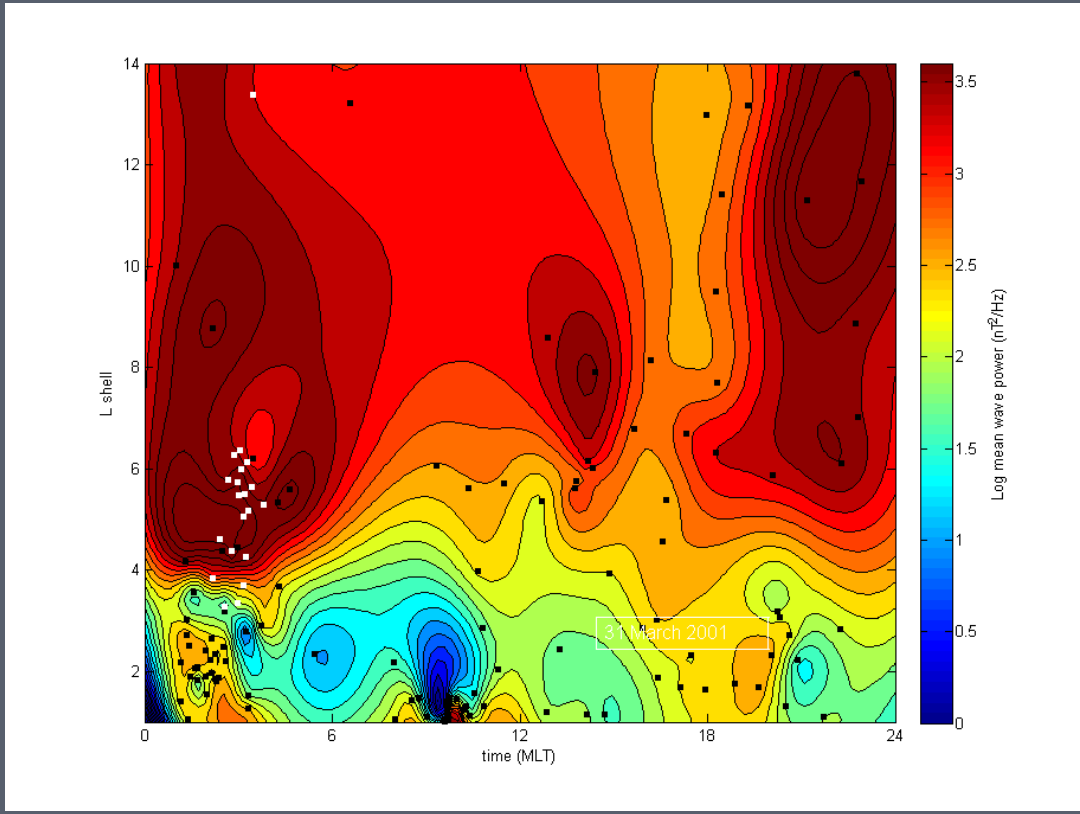
Case study: 31 March 2001 (Dst_{min} = - 387 nT)



Latitudinal profile of Pc5 wave activity

during the magnetic storm of 31 March 2001

Case study: 31 March 2001 (Dst_{min} = - 387 nT)

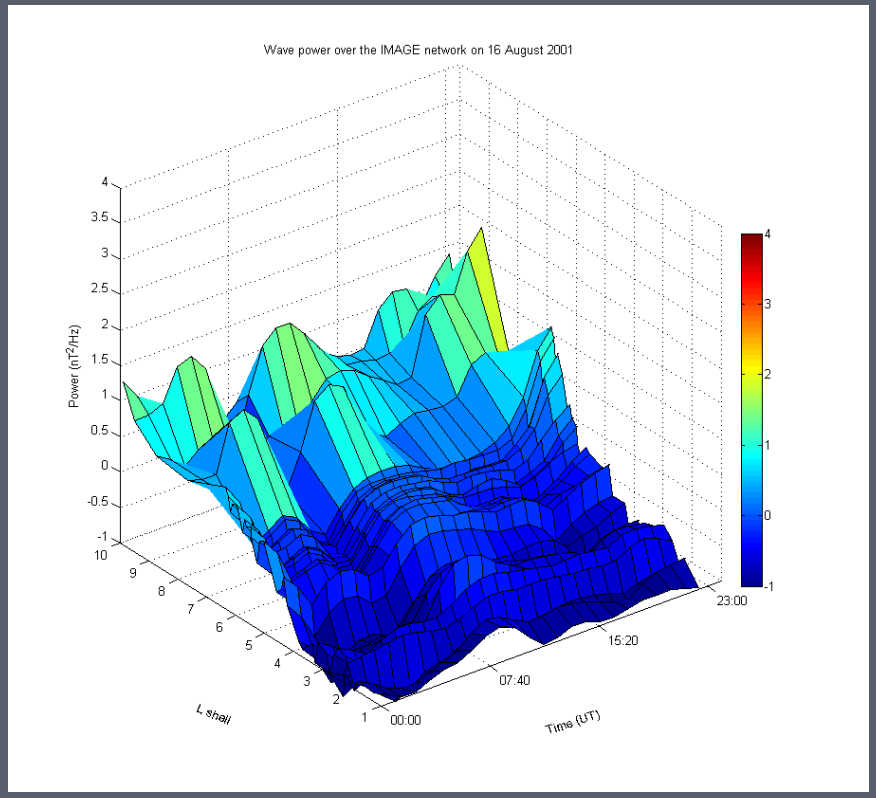


Global profile of Pc5 wave activity

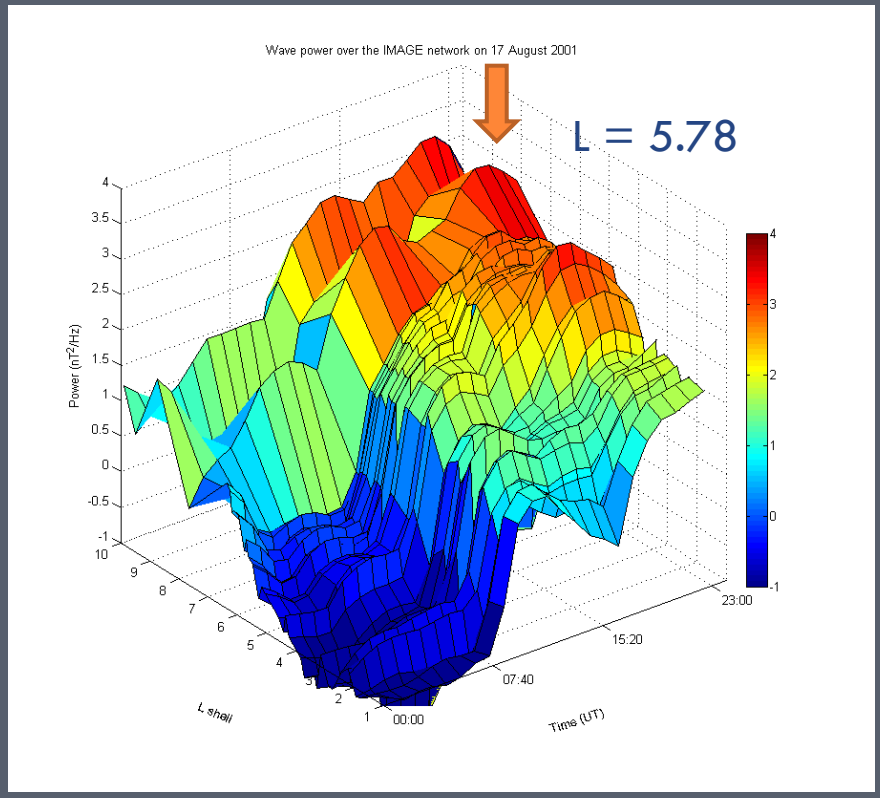
during the magnetic storm of 31 March 2001

Case study: 17 August 2001 (Dst_{min} = - 104 nT)

Pc5 wave power on 16 August 2001



Pc5 wave power on 17 August 2001

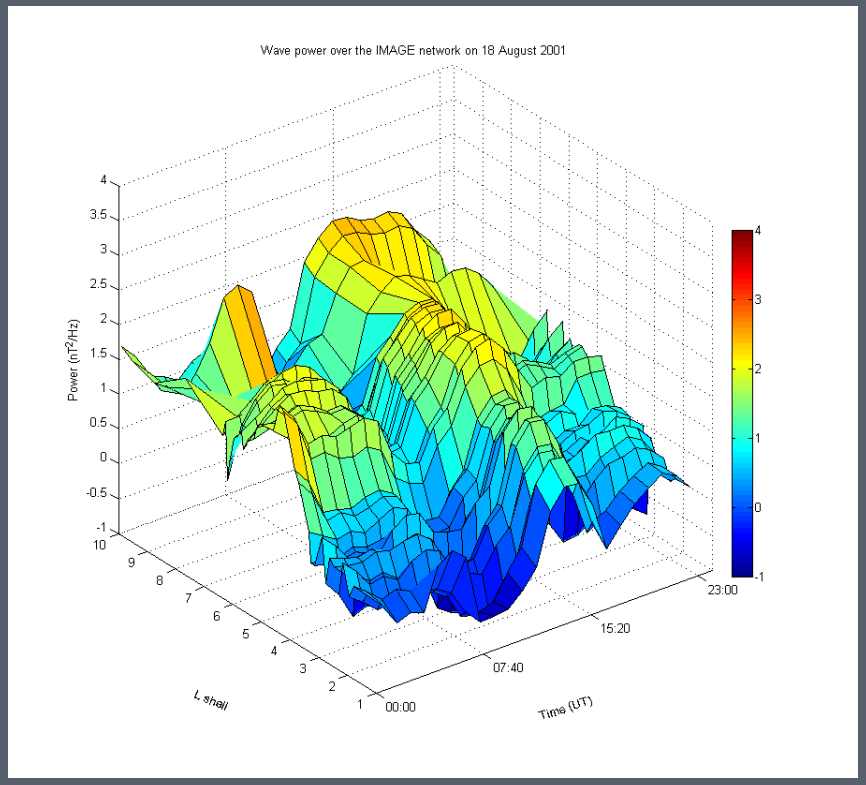


Latitudinal profile of Pc5 wave activity

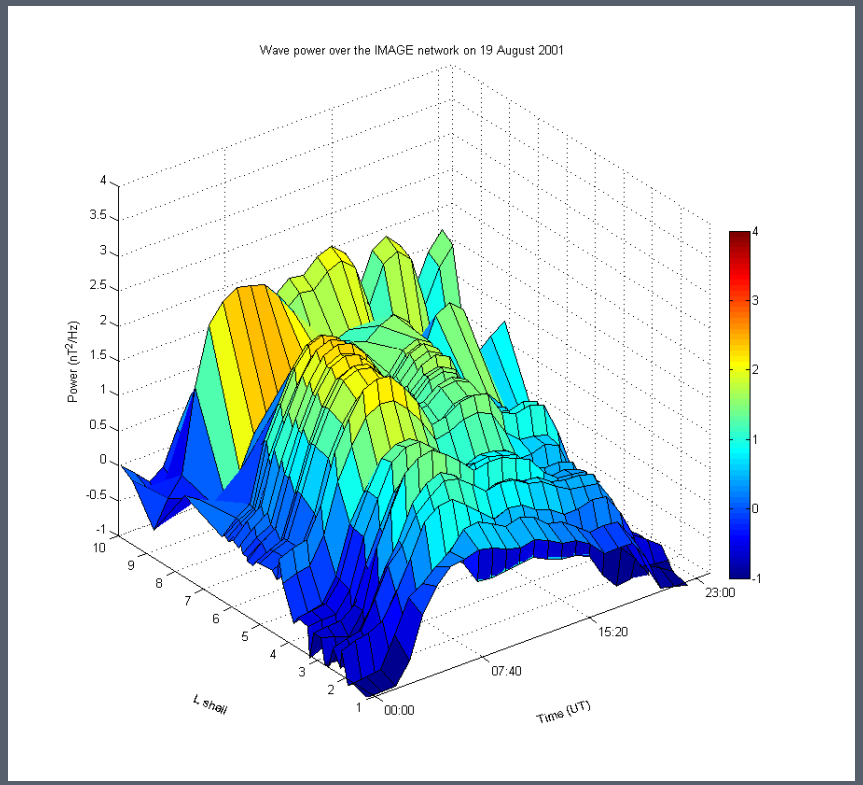
during the magnetic storm of 17 August 2001

Case study: 17 August 2001 (Dst_{min} = - 104 nT)

Pc5 wave power on 18 August 2001

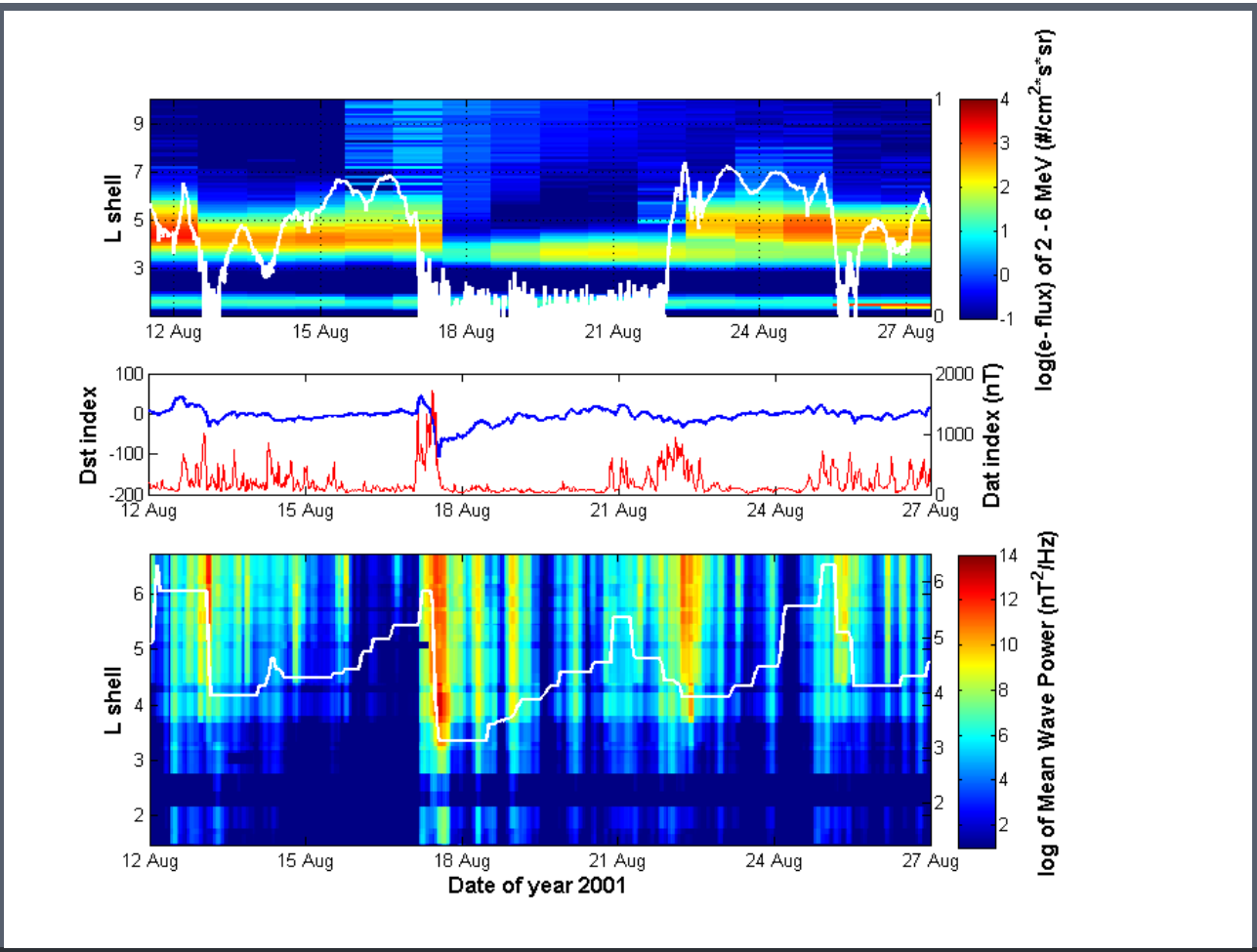


Pc5 wave power on 19 August 2001



Pc5 wave power vary >4 orders of magnitude as a magnetic storm evolves and penetrate to lower L shells during the main phase

Case study: 17 August 2001 (Dst_{min} = - 104 nT)



Latitudinal profile of Pc5 wave activity

during the magnetic storm of 17 August 2001

Case studies: March-August 2001

- The response of the outer electron radiation belt to intense magnetic storms, which occurred in 2001

Date & Time	Min Dst	SW structure
20 March 2001, 14:00 UT	-149 nT	SH+MC
31 March 2001, 09:00 UT	-387 nT	SH+ICME
12 April 2001, 00:00 UT	-271 nT	SH+MC
17 August 2001, 22:00 UT	-104 nT	SH+MC

- Observations of the relativistic electron population is compared with concurrent observations of Pc5 waves from the IMAGE magnetometer array and other ground-based magnetic stations along the same magnetic meridian

Concluding remarks

- Pc5 wave power was enhanced during the main phase and slowly weakened throughout the recovery phase.
- The duration of enhanced Pc5 wave activity was longer for the most intense magnetic storm.
- Pc5 wave activity penetrated in the inner magnetosphere at L shells so low as 2.
- Plasmapause defined the innermost location that Pc5 wave activity penetrated.
- The intensification and penetration of Pc 5 wave activity in the inner magnetosphere is followed by enhancements of relativistic electron fluxes.

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European Union

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Thank you!