The Influence of Corotating Interaction Regions on Jovian Electrons and Galactic Cosmic Rays

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Master Thesis

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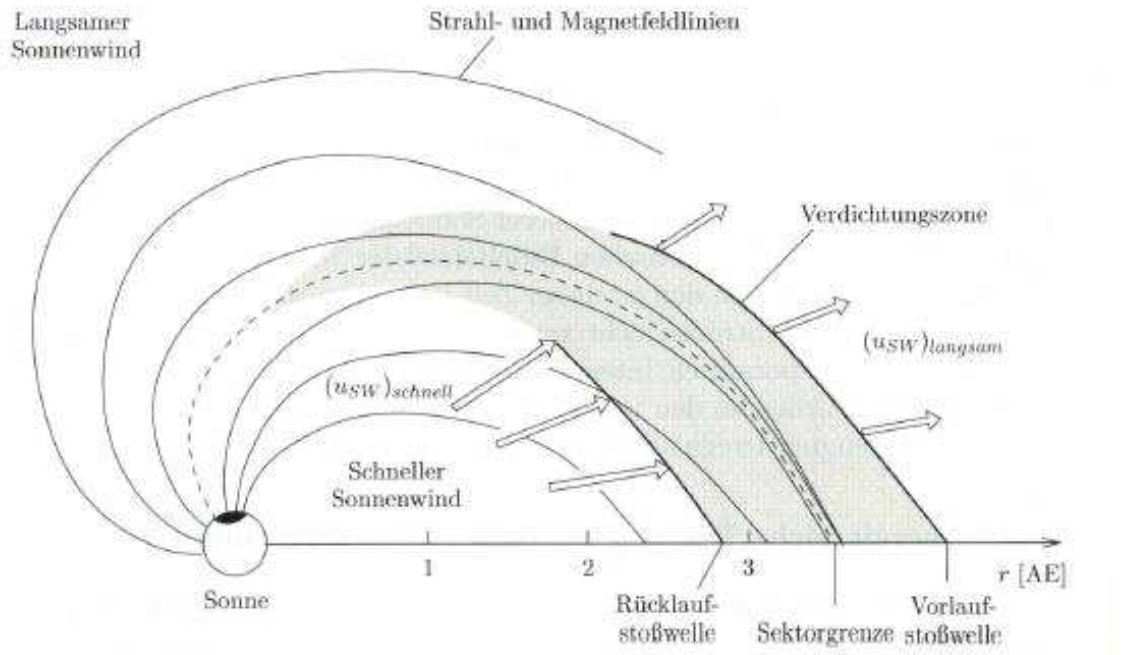
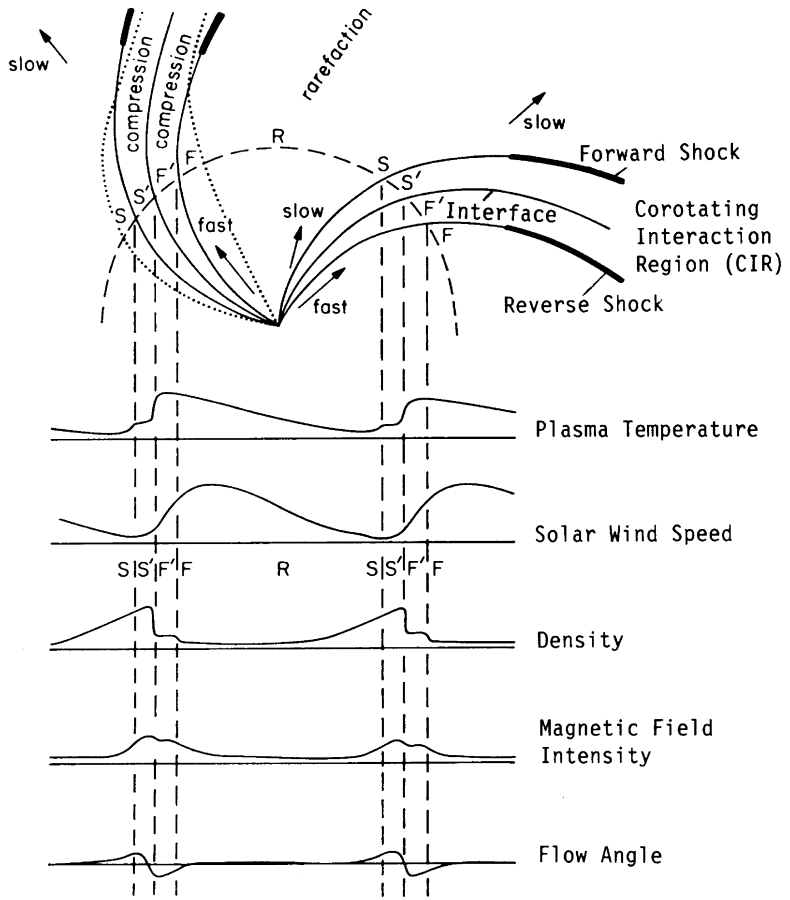
Corotating interaction regions (CIR)



Proelss, 2004

- interaction of slow and fast solar wind
- stream interface
- forward and reverse shock wave

CIR plasma signatures

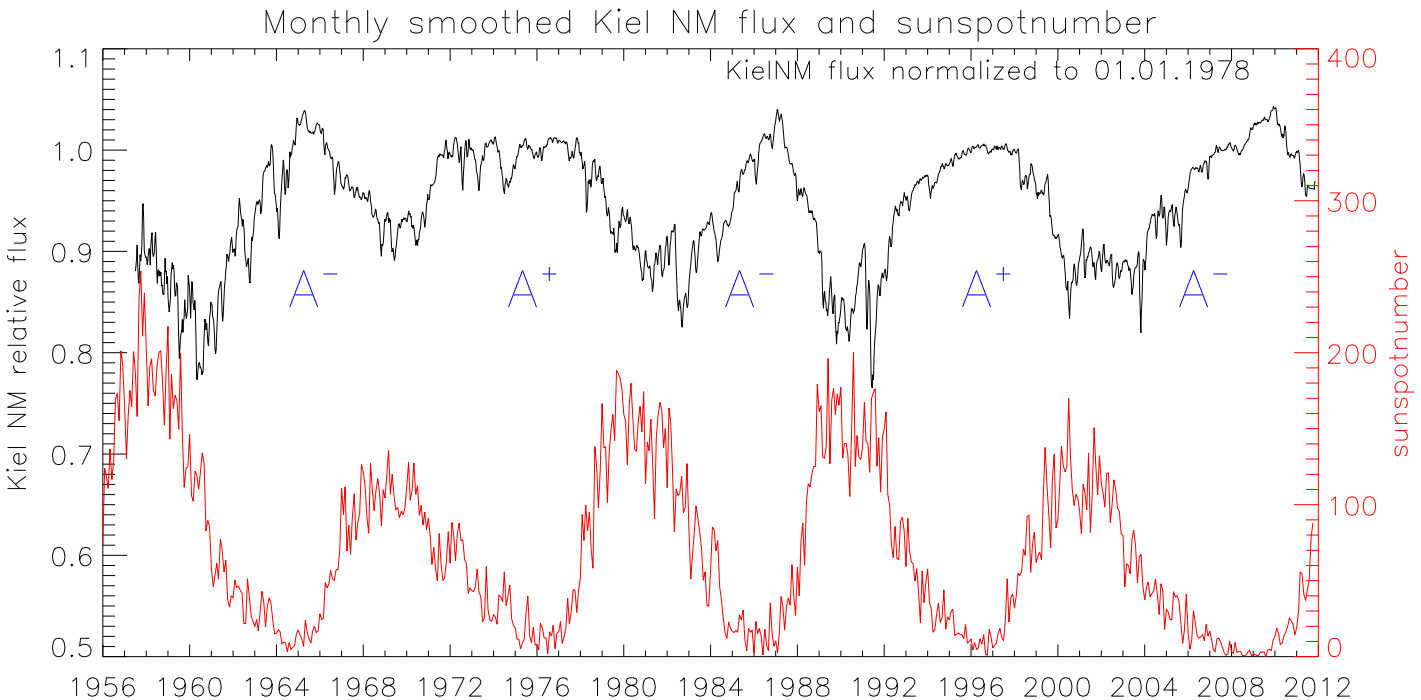


Richardson et al., 2004

typical plasma signatures:

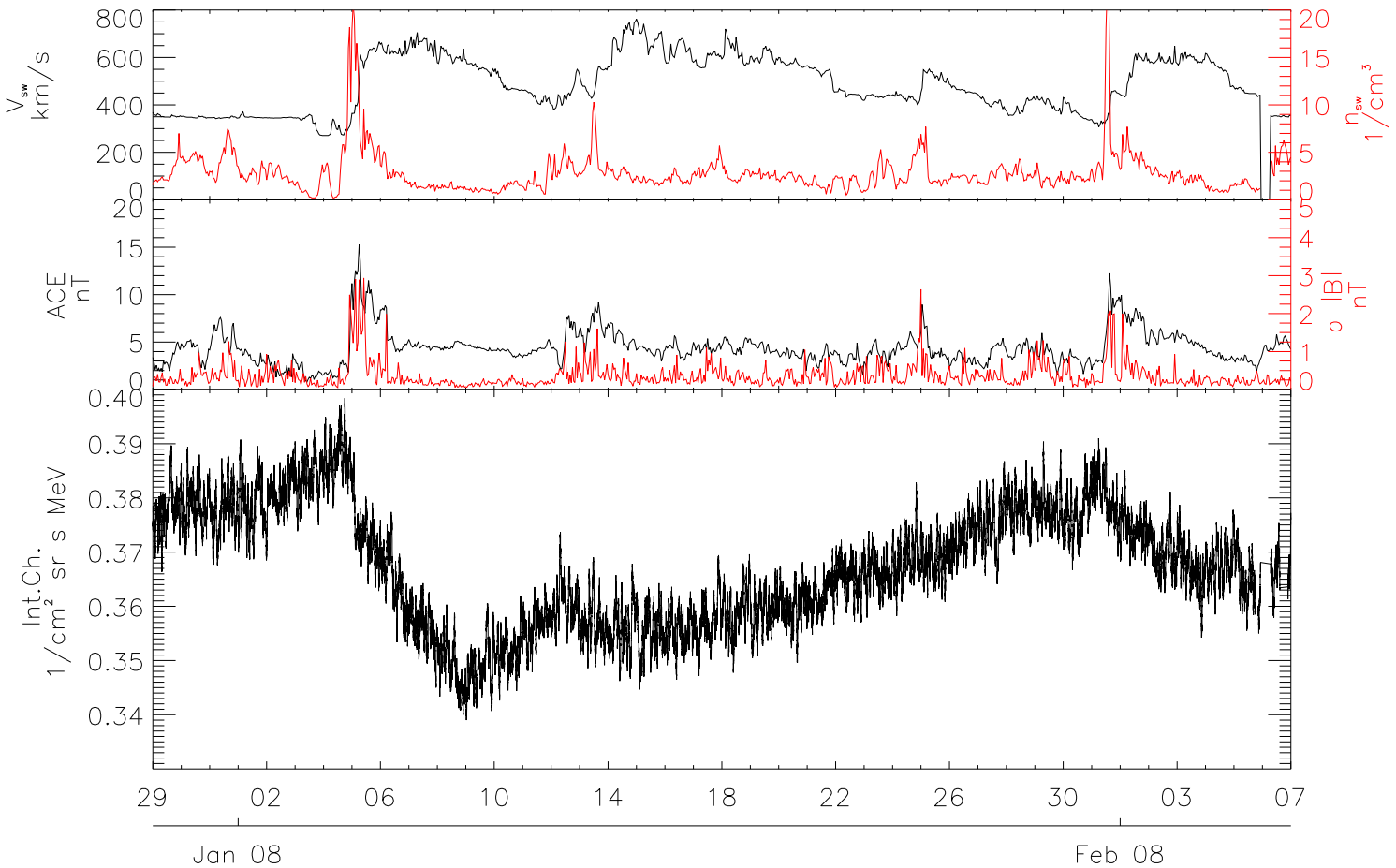
- increase of plasma temperature
- increase of solar wind speed
- decrease of particle density
- increase of magnetic field intensity
- change in flow angle

GCR modulation

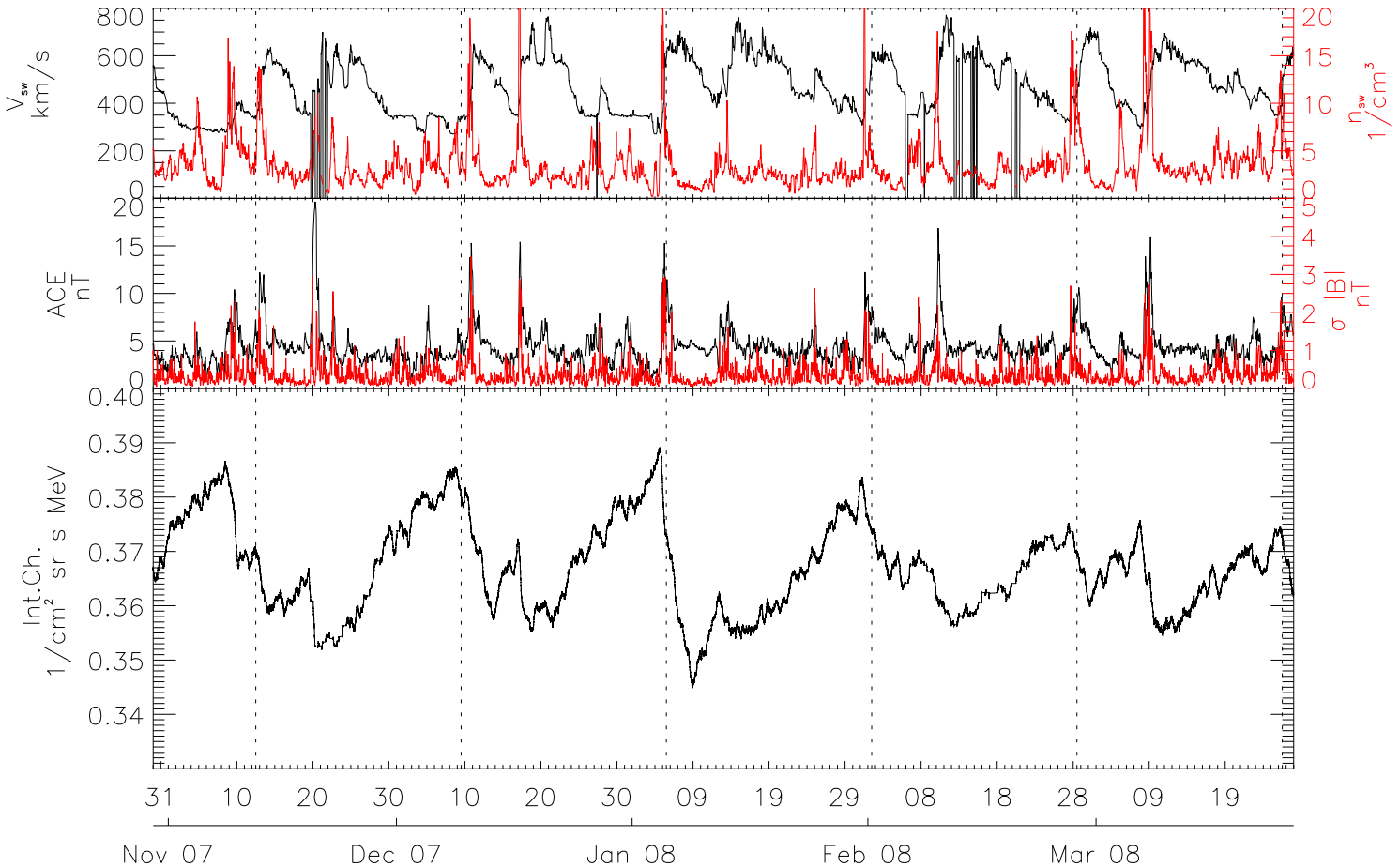


$$\frac{\partial U}{\partial t} = \underbrace{\nabla(\kappa^{(s)} \cdot \nabla U)}_{\textit{diffusion}} - \underbrace{\nabla \cdot (\vec{v_D} U)}_{\textit{drift}} - \underbrace{\nabla \cdot (\vec{V_W} U)}_{\textit{convection}} - \underbrace{\frac{1}{3}(\nabla \cdot \vec{V_W}) \frac{\partial}{\partial p}(pU)}_{\textit{adiabatic dezeleration}}$$

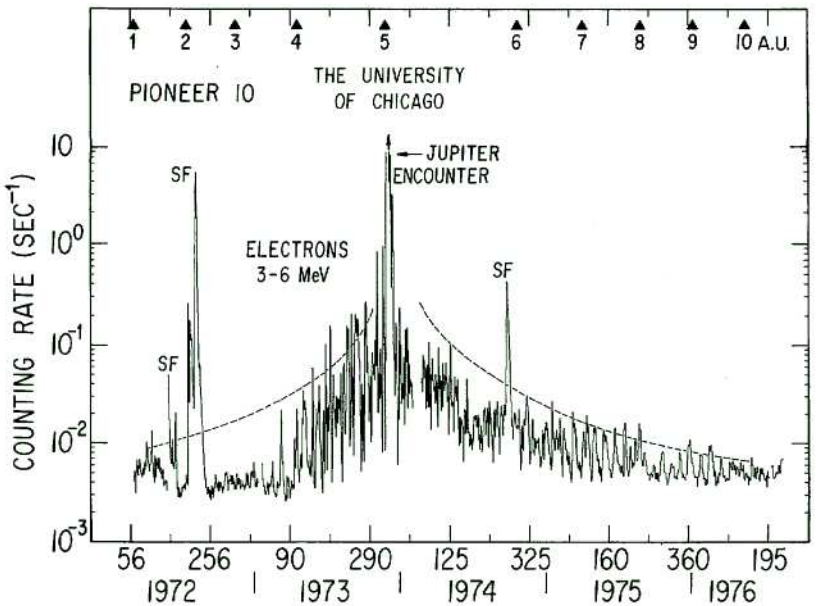
CIRs and GCRs



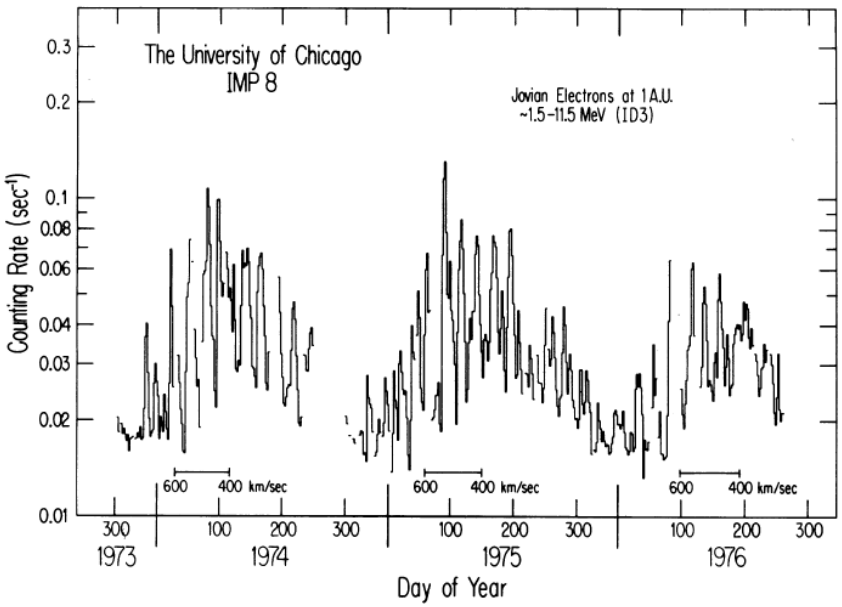
GCR recurrent modulation



Jovian electrons

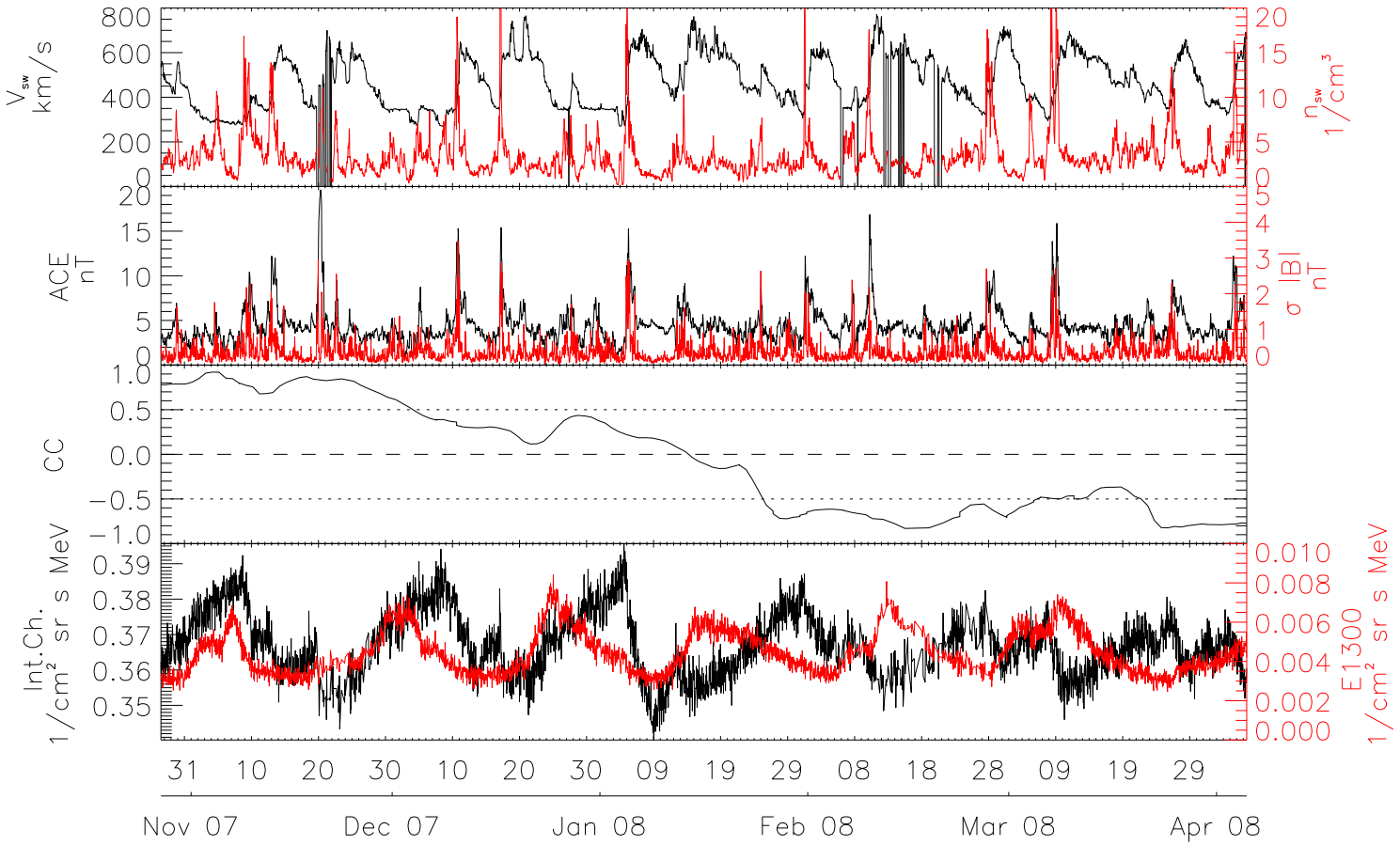


Pyle et al., 1977

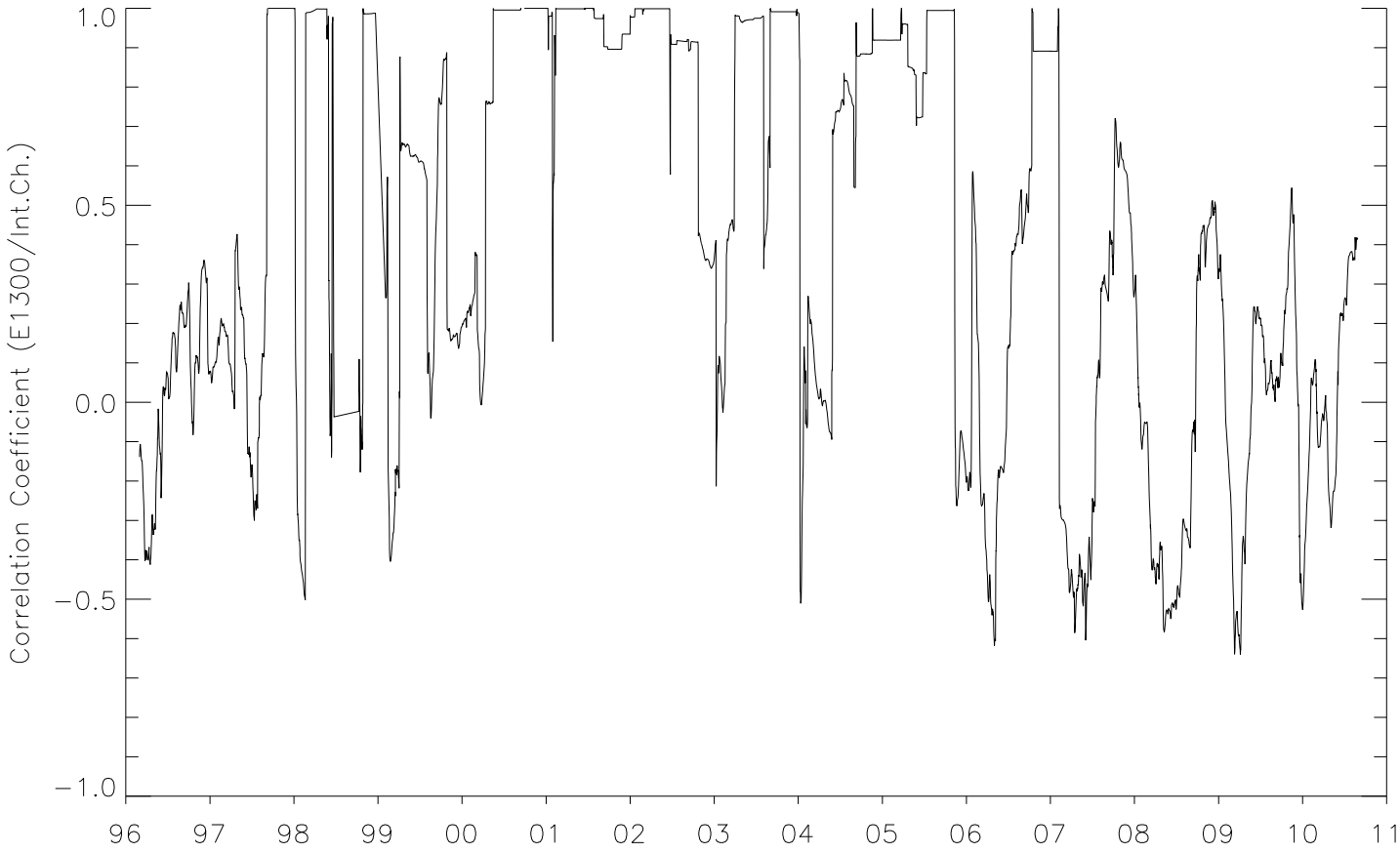


Chenette et al., 1977

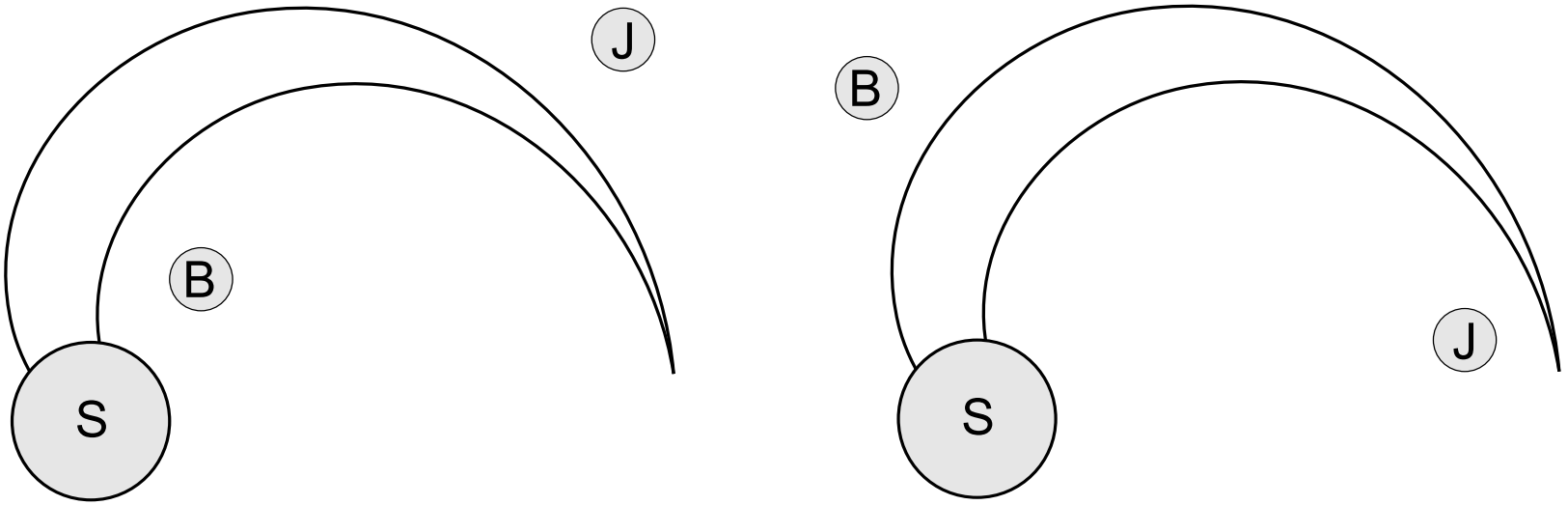
Comparison between GCR and Jovian electrons



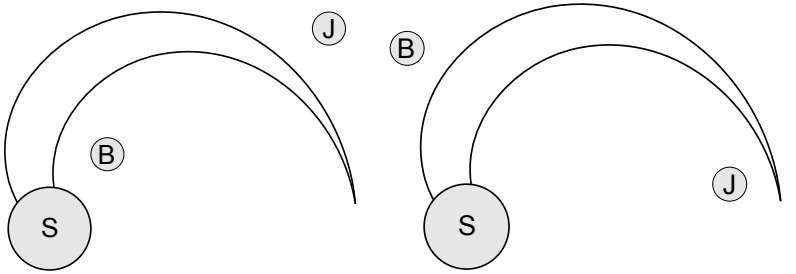
Correlation coefficient between GCR and Jovian electrons

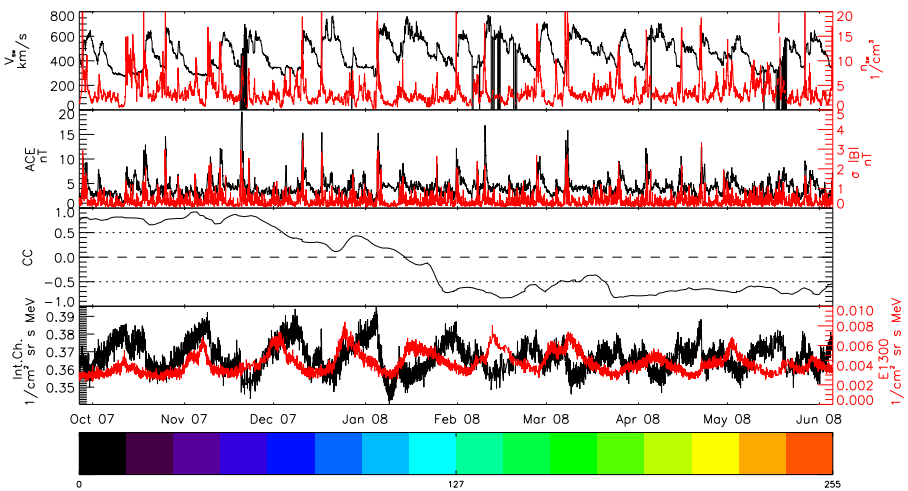


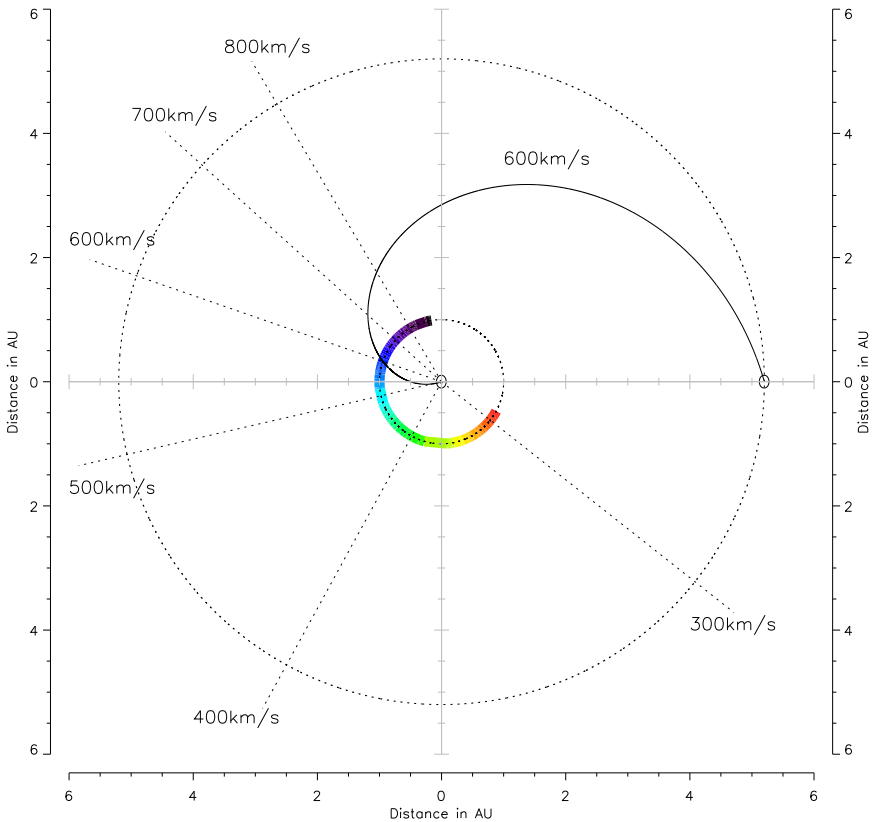
Schemes of positional influence



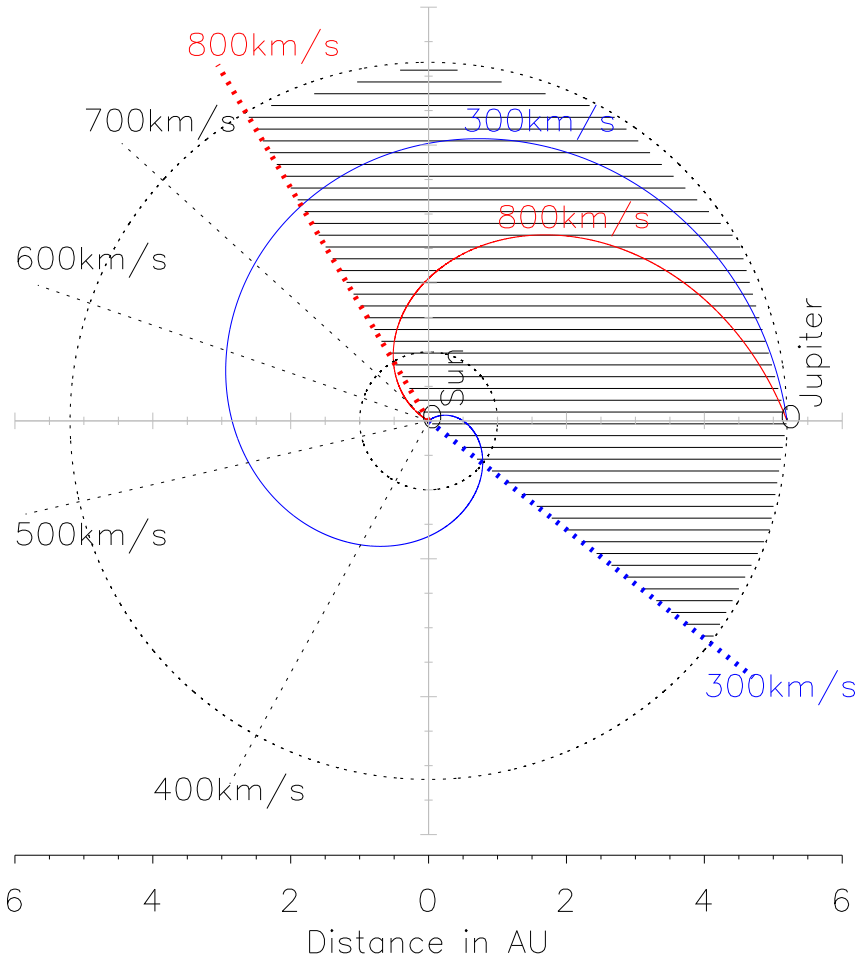
Comparison between GCR and Jovian electrons



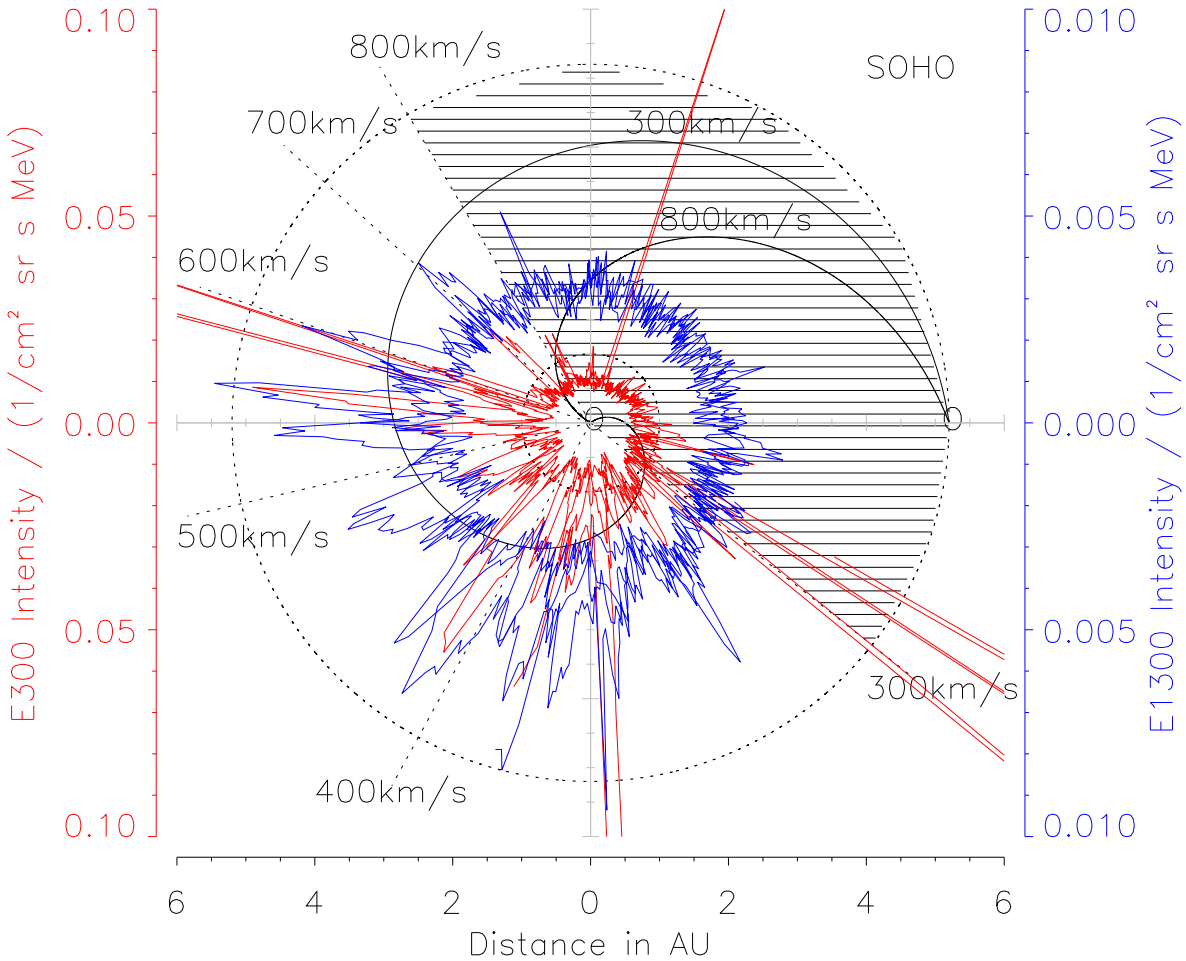




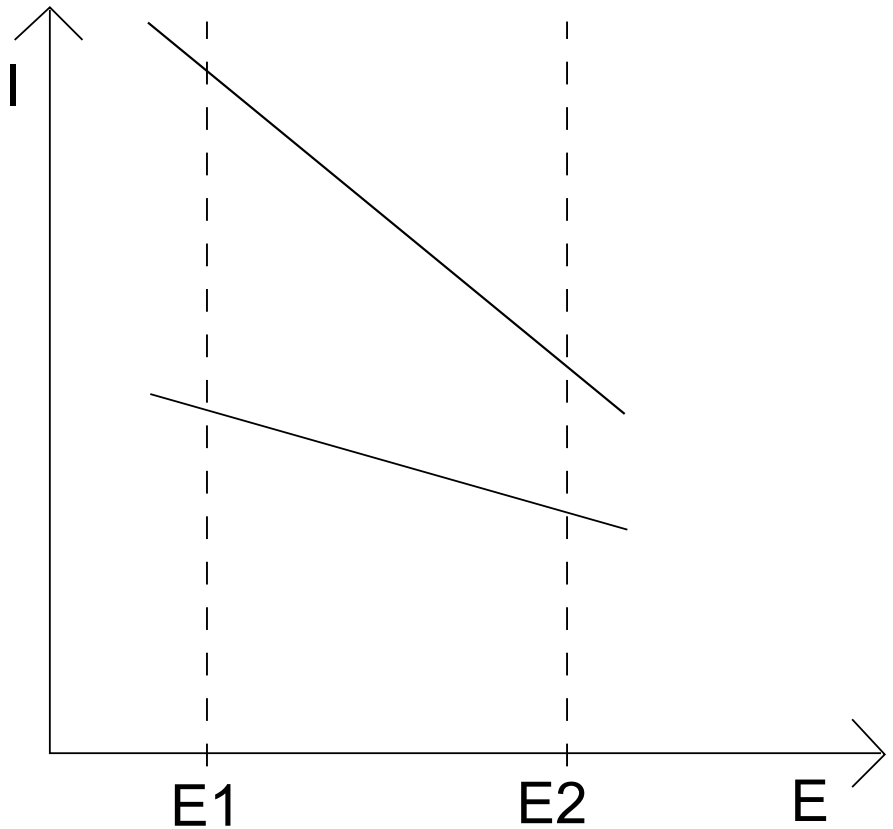
Magnetic connection



Magnetic connection and jovian electrons near earth



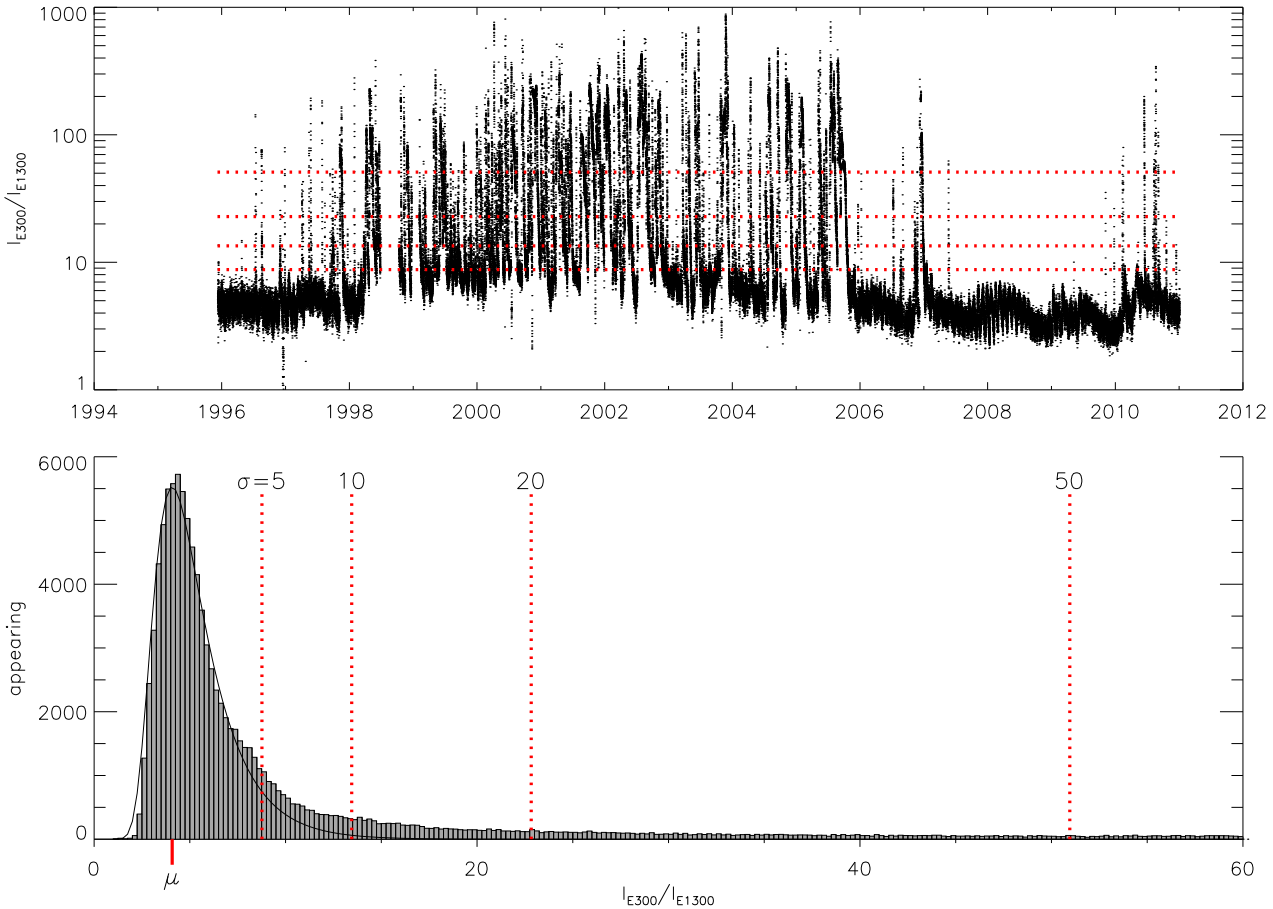
How to distinguish between solar and jovian electrons?



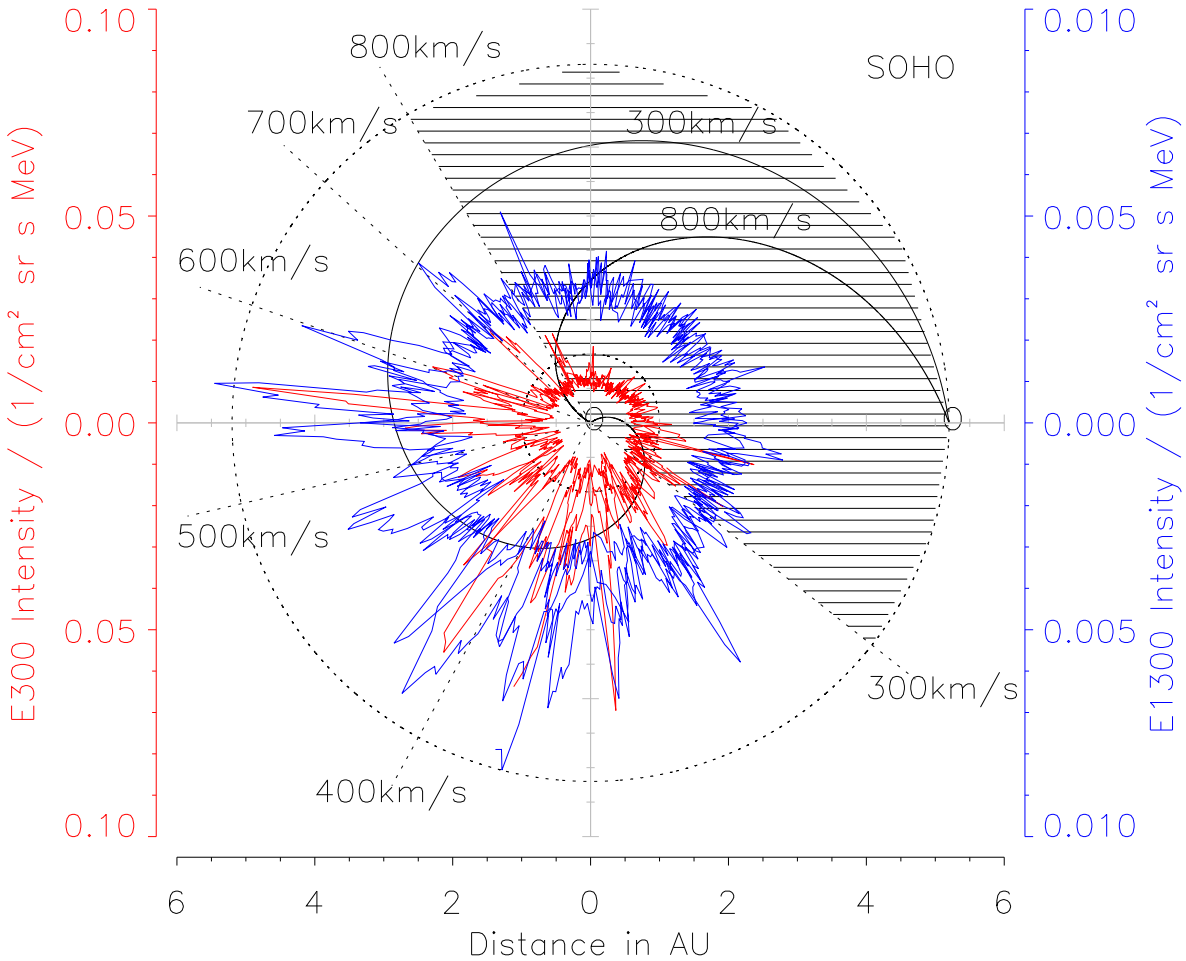
Spectral index

- is higher during events
- can be approximated by the ratio E1/E2

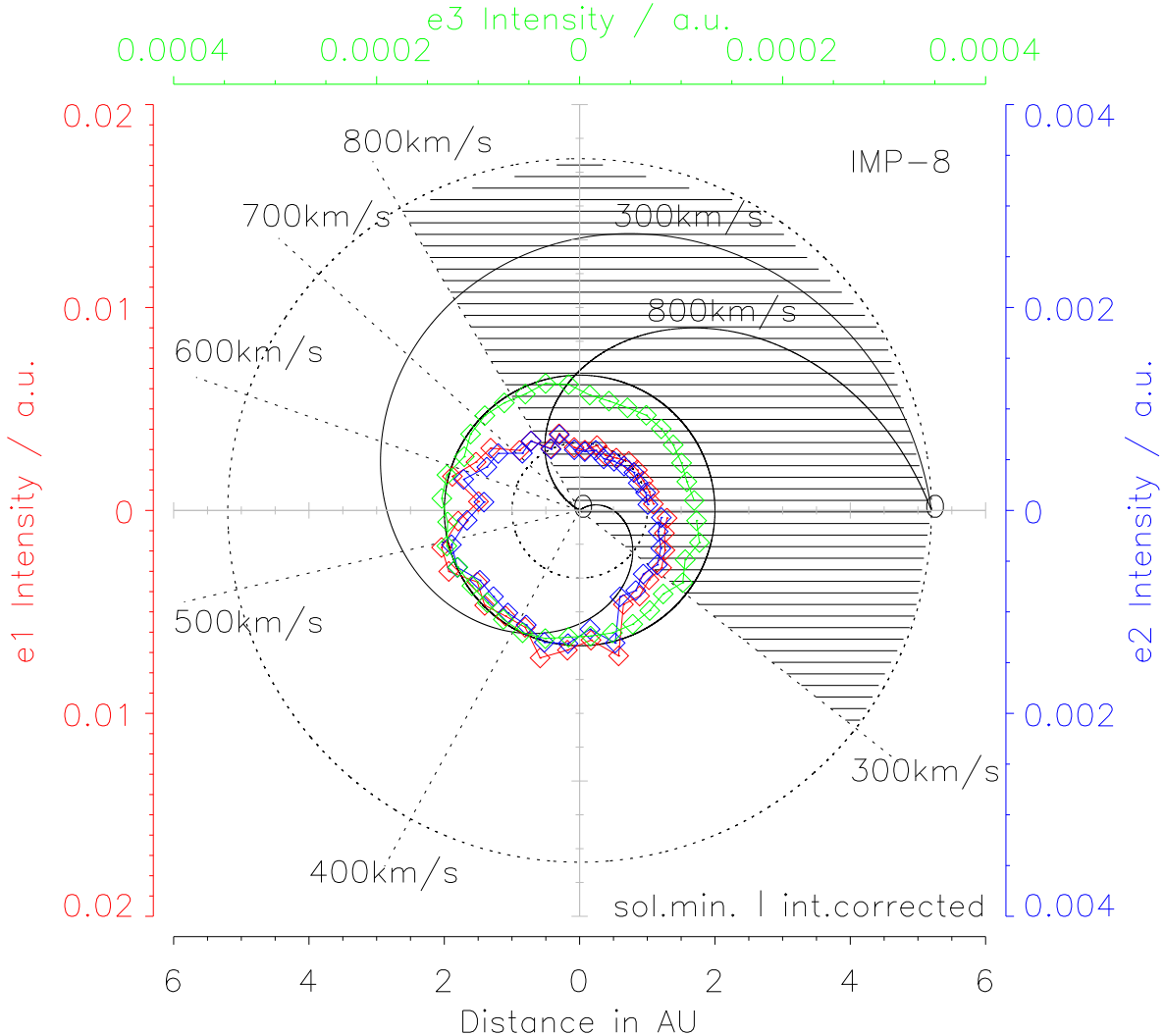
Filter of solar events



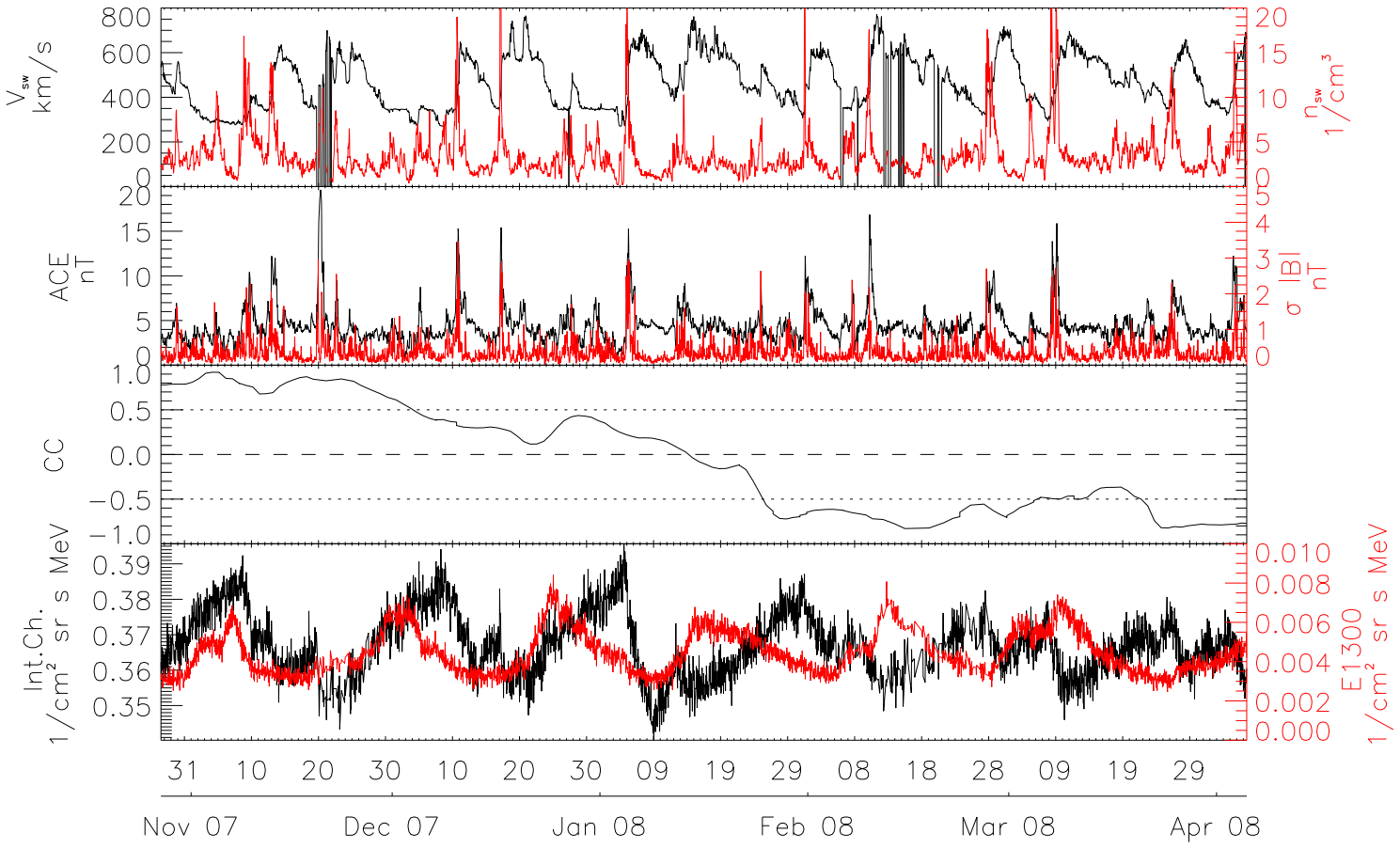
Corrected data



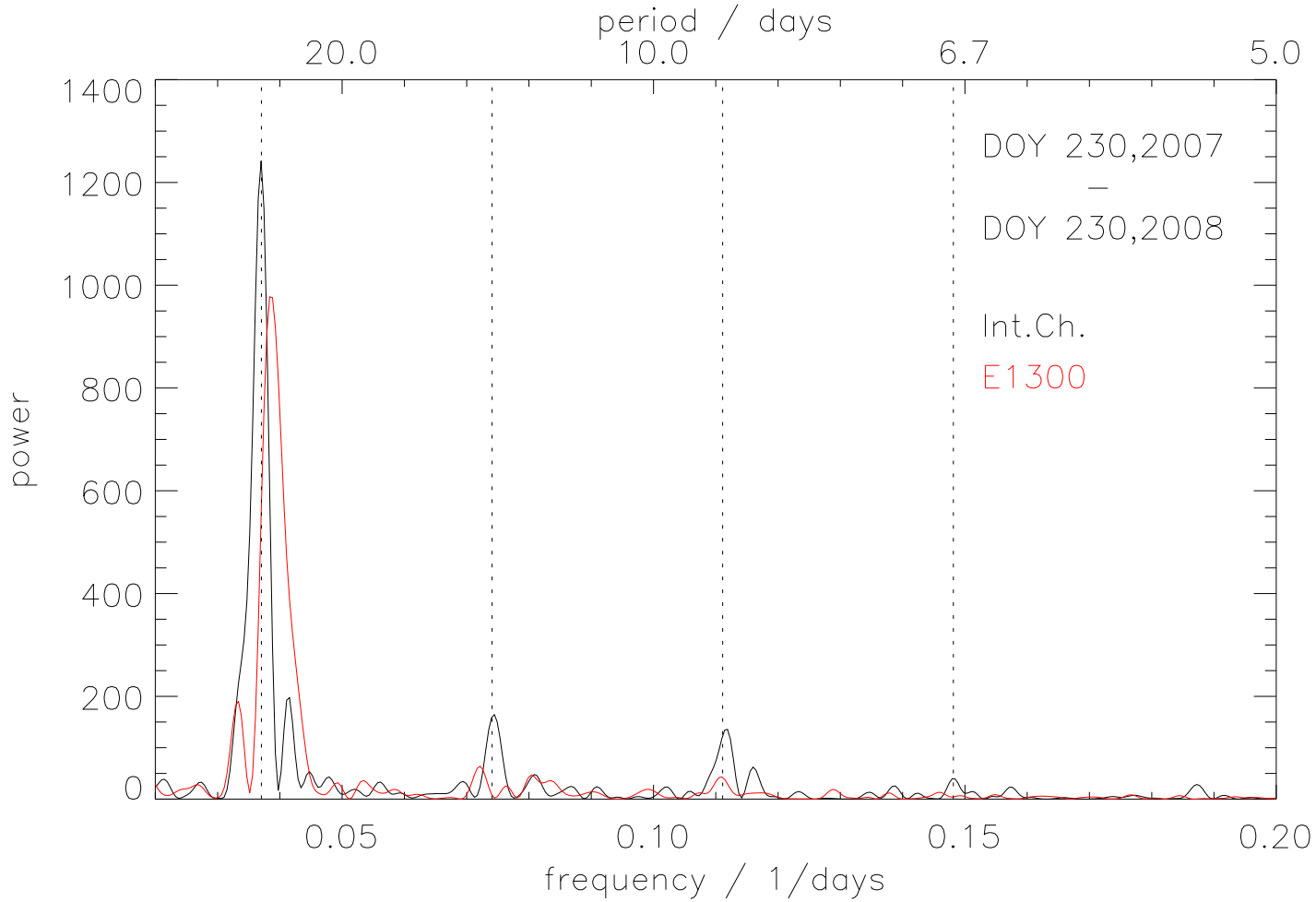
Magnetic connection



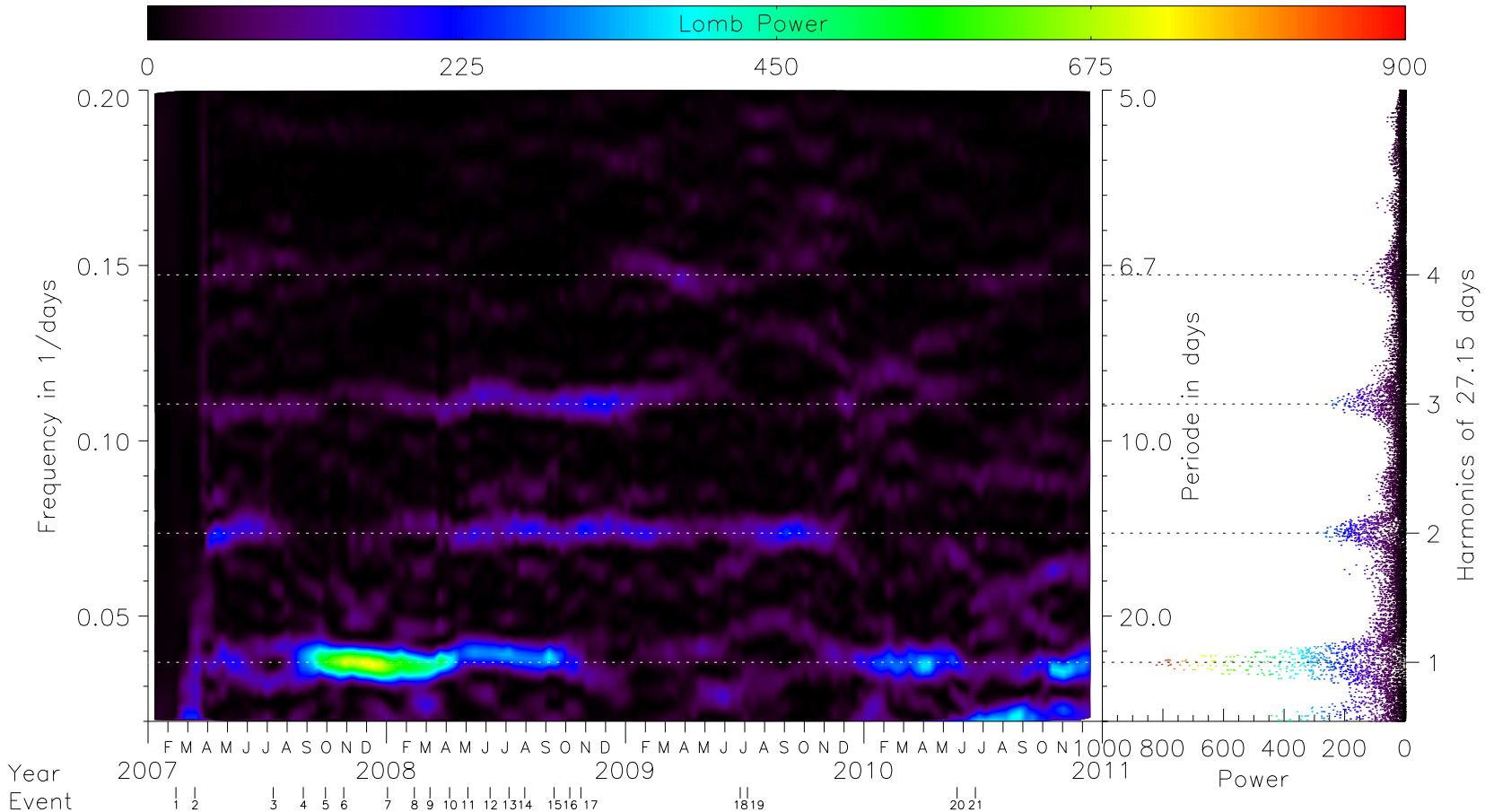
Frequency Analysis

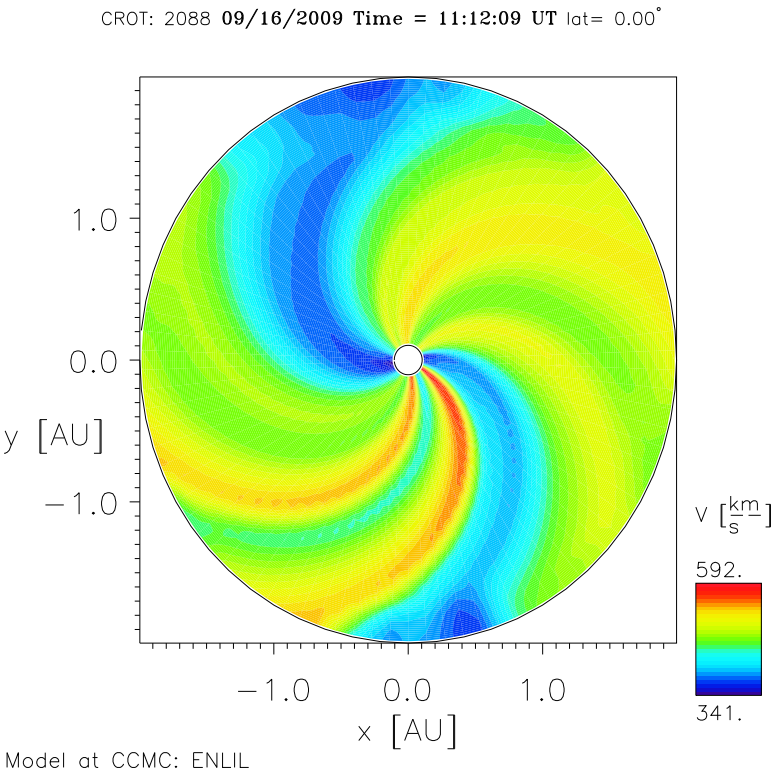


Lomb analysis indicating the occuring frequencies



Sliding lomb analysis

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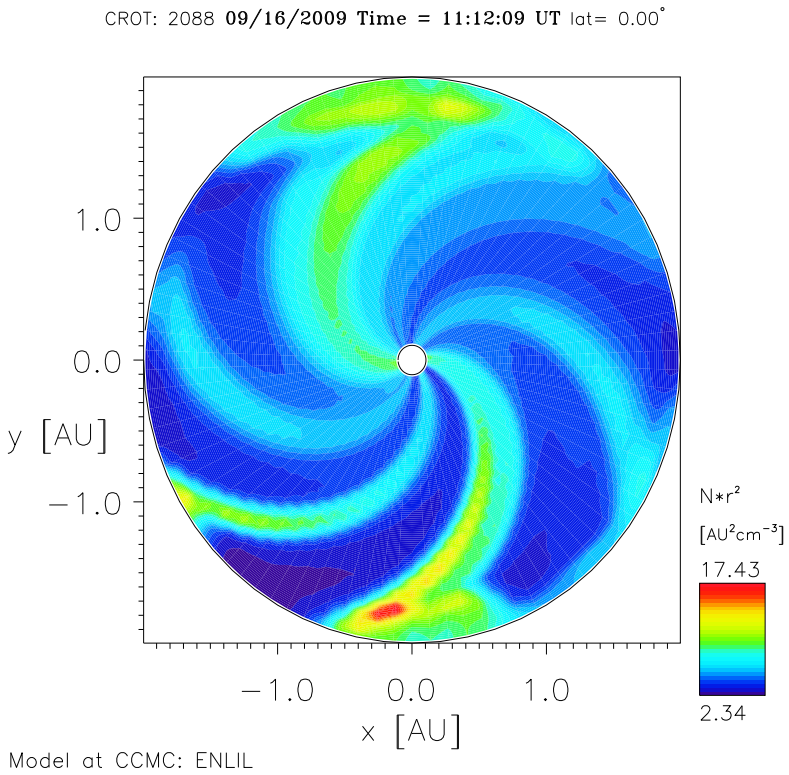
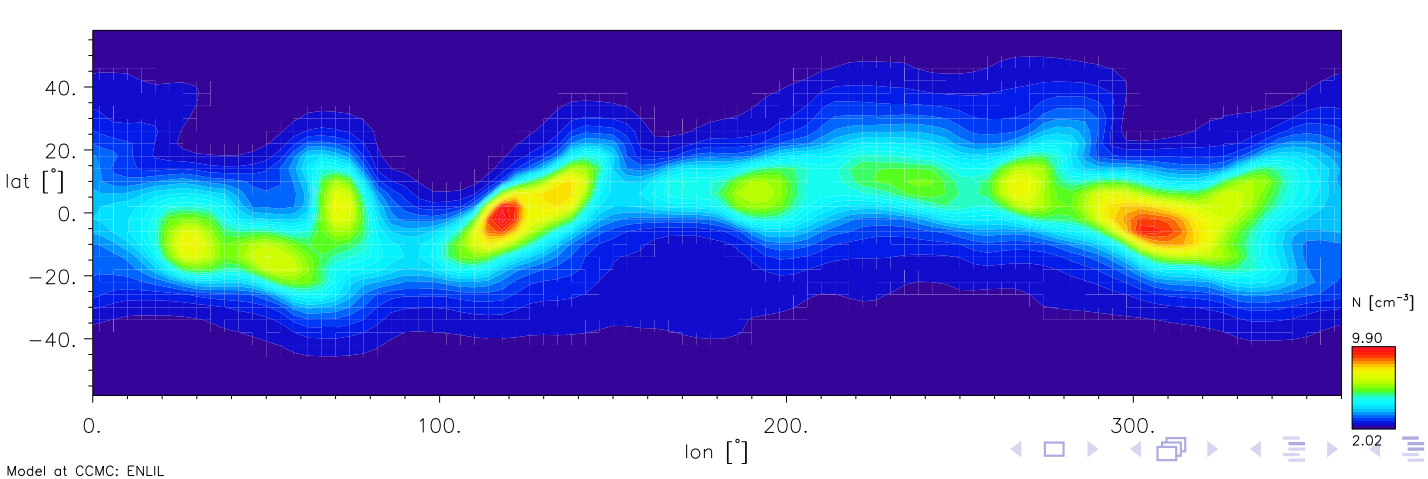
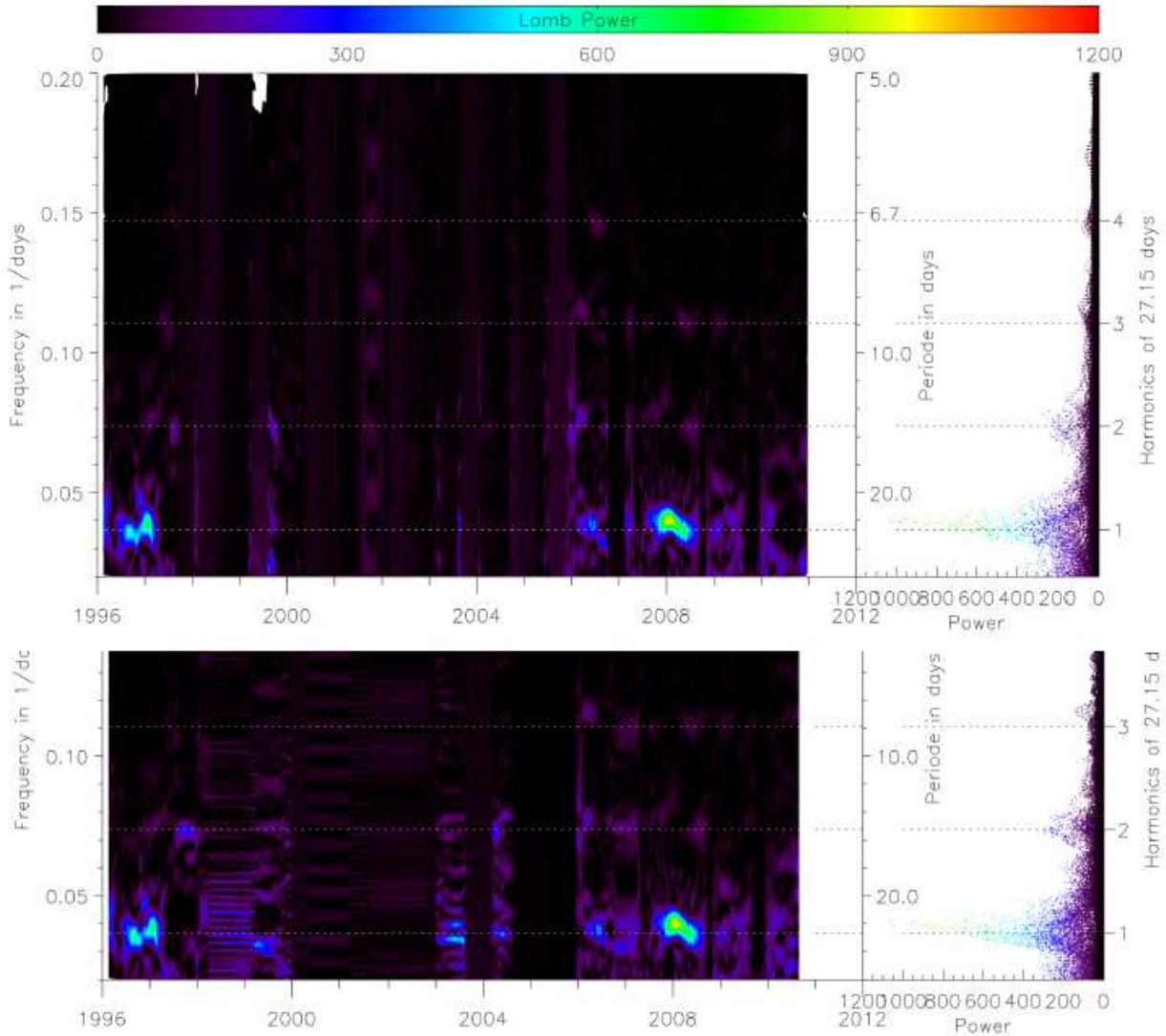
1.0
0.0
−1.0
y [AU]
−1.0
0.0
1.0
x [AU]
V [km/s]
592.
341.
Model at CCMC: ENLIL

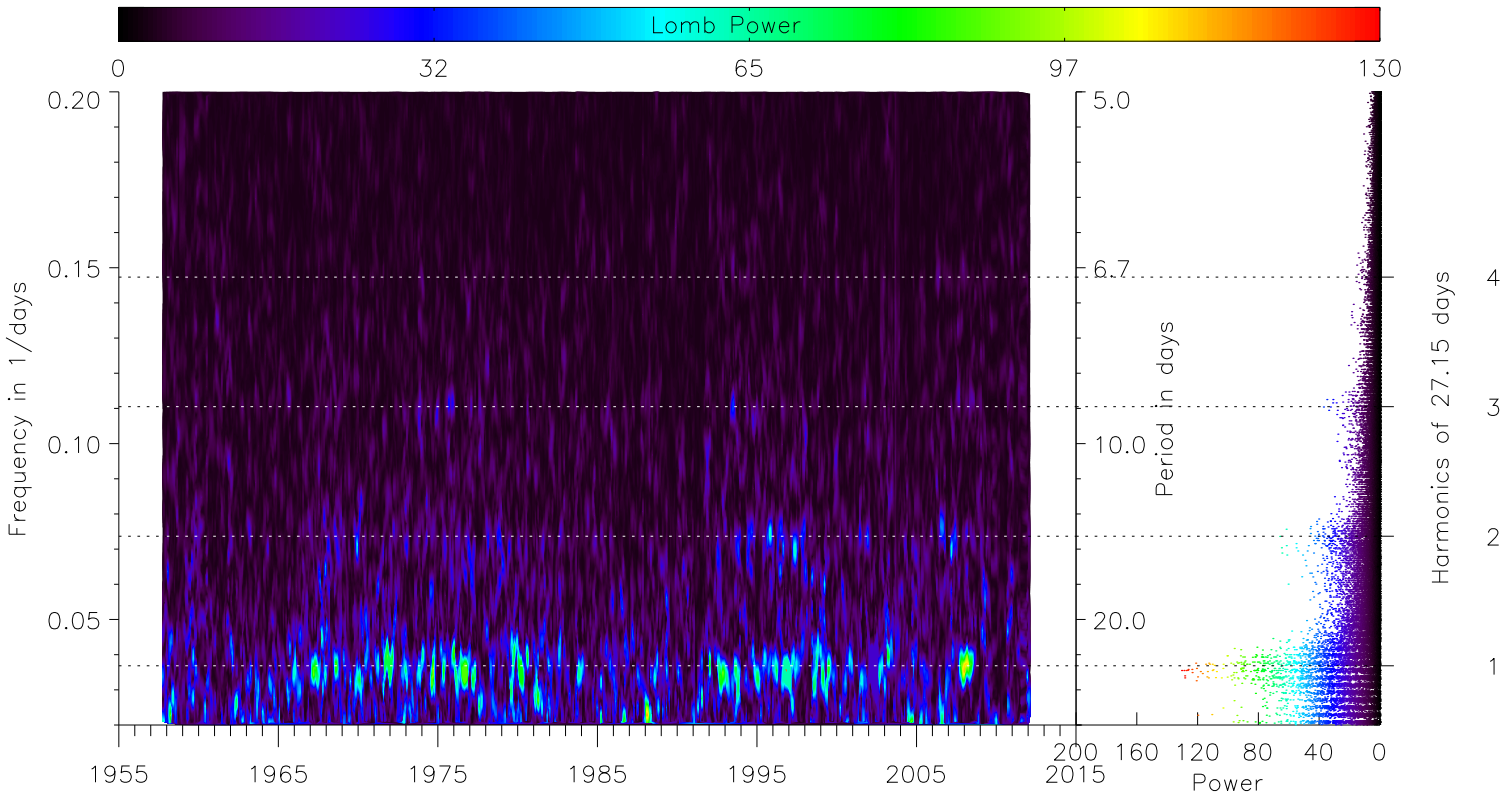

CROT: 2088 09/16/2009 Time = 11:12:09 UT lat= 0.00°
1.0
0.0
−1.0
y [AU]
−1.0
0.0
1.0
x [AU]
N*r²
[AU²cm⁻³]
17.43
2.34
Model at CCMC: ENLIL


CROT: 2088 09/16/2009 Time = 11:12:09 UT r= 1.05AU
40.
20.
lat [°]
0.
−20.
−40.
0.
100.
200.
300.
lon [°]
N [cm⁻³]
9.90
2.02
Model at CCMC: ENLIL

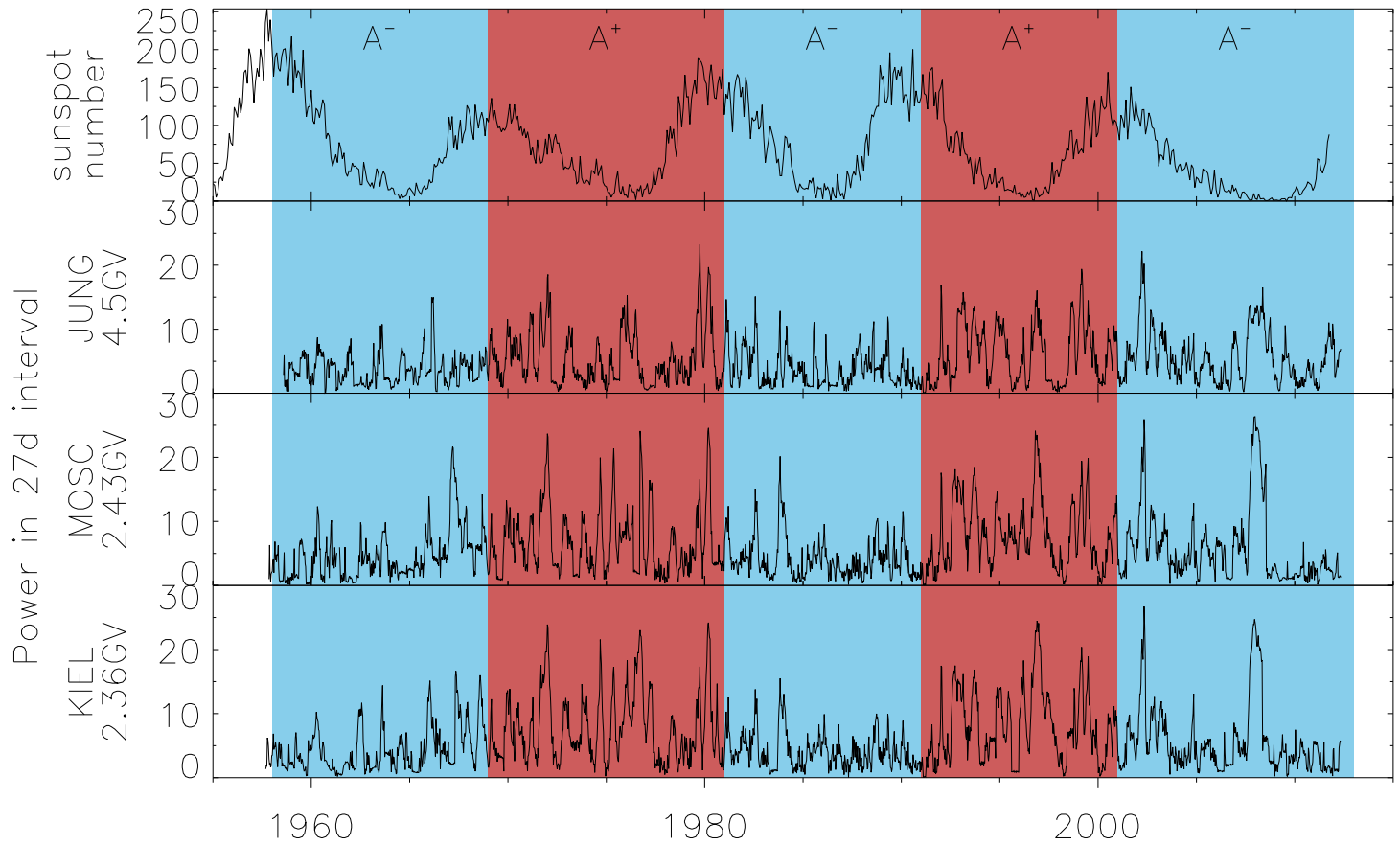
Sliding lomb analysis during solar maximum



Long term variations of the spectrum



Difference between A^+- and A^--epochs



Summary

- CIRs influence the propagation of GCRs and jovian electrons
- phaseshift between GCRs and jovian electrons can be explained by CIRs crossing either Earth or Jupiter first
- intensity of MeV-electrons near Earth depends on magnetic connection
- frequency analysis delivers insights on coronal structures
- GCR modulation is more prominent in A^+- than in A^--epochs
- ratio of electron channels allows identification of solar events