The rare exclusion of the July 2005 cosmic ray variations resulted from western and behind the limb solar activity

A. Papaioannou[1], A. Belov[2], H. Mavromichalaki[1],
E. Eroshenko[2], V. Oleneva[2]

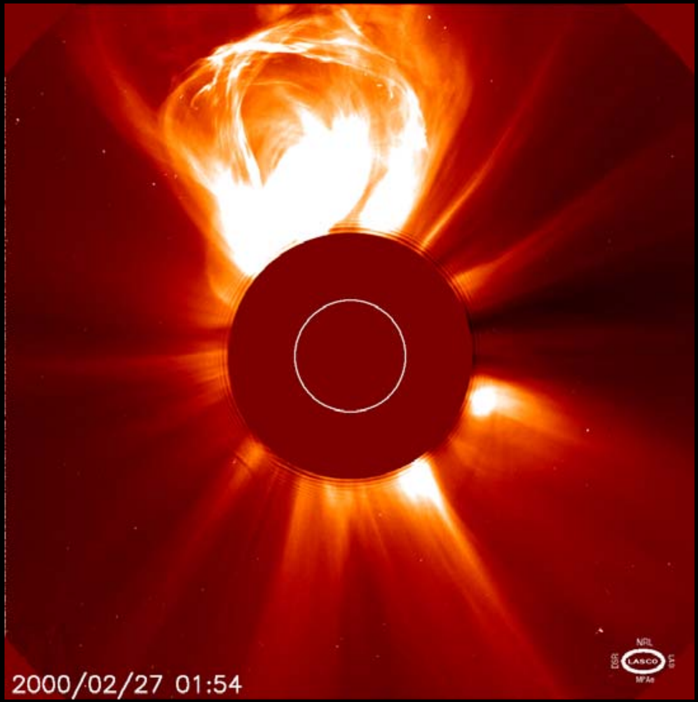
[1] *University of Athens, Physics Department, Section of Nuclear & Particle Physics (atpapaio@phys.uoa.gr)*

[2] *IZMIRAN, Russian Academy of Science, Moscow, Russia*

- Intro:
  - Solar Modulation and Solar Extreme Events
- July 2005:
  - Short description
  - Solar activity
  - Geomagnetic background
  - Results from ANMODAP Center
  - Cosmic Ray Anisotropy
  - Cosmic Ray Gradient
  - Conclusions

Solar Extreme Events

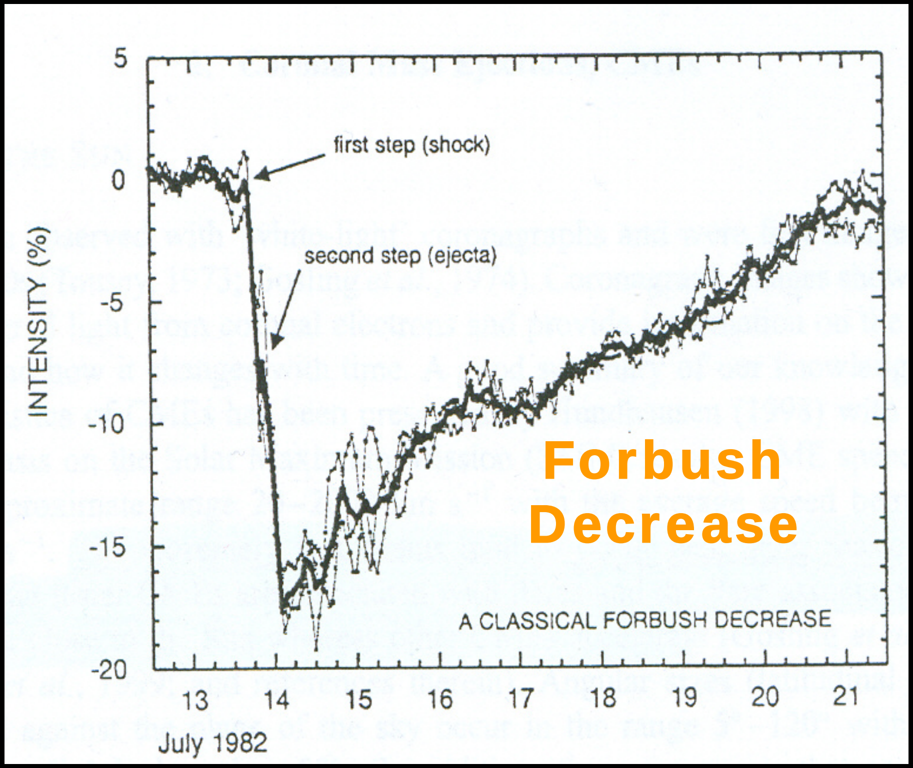
Solar Flares



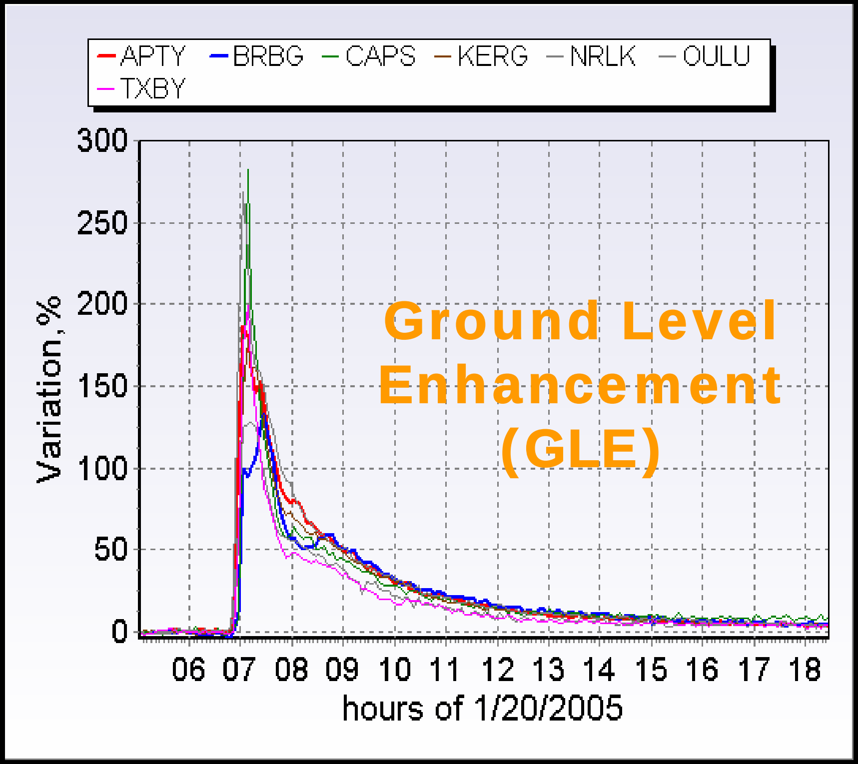
Coronal Mass Ejection (CME)

Cane 2000; Harisson 1995; Hundhausen 1999

Heliospheric phenomena recorded at Earth

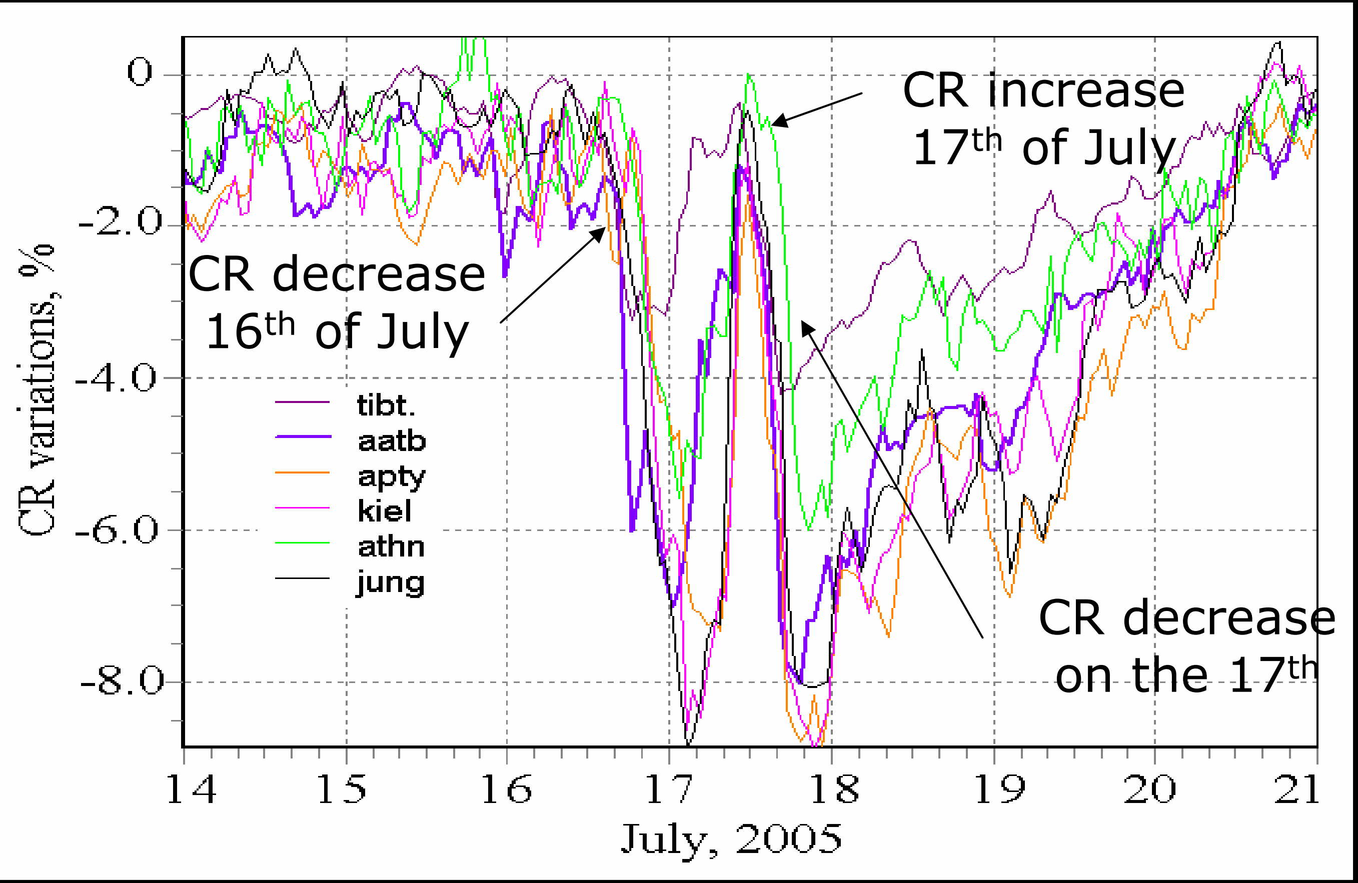


Forbush 1957; Belov 2001



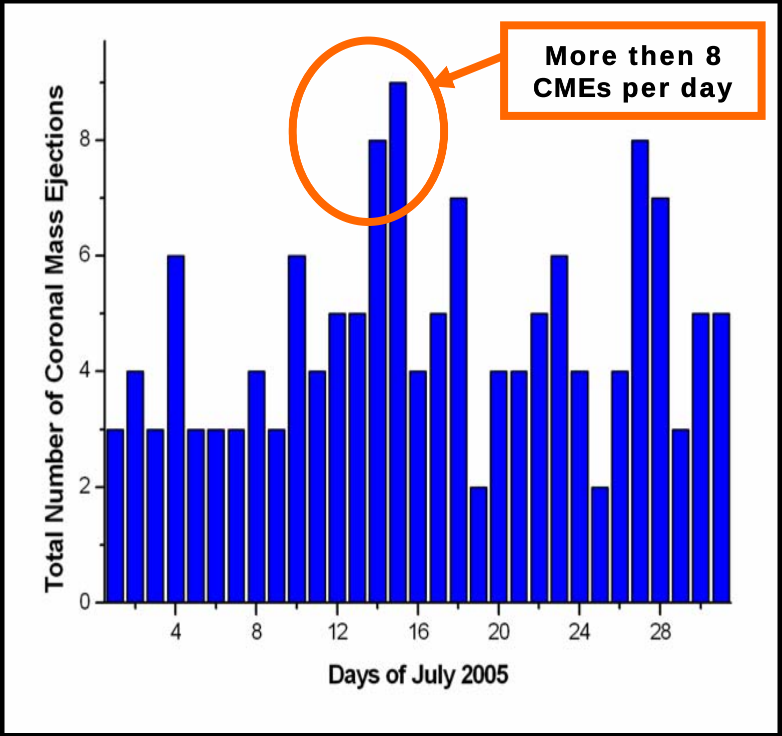
Plainaki et al 2006

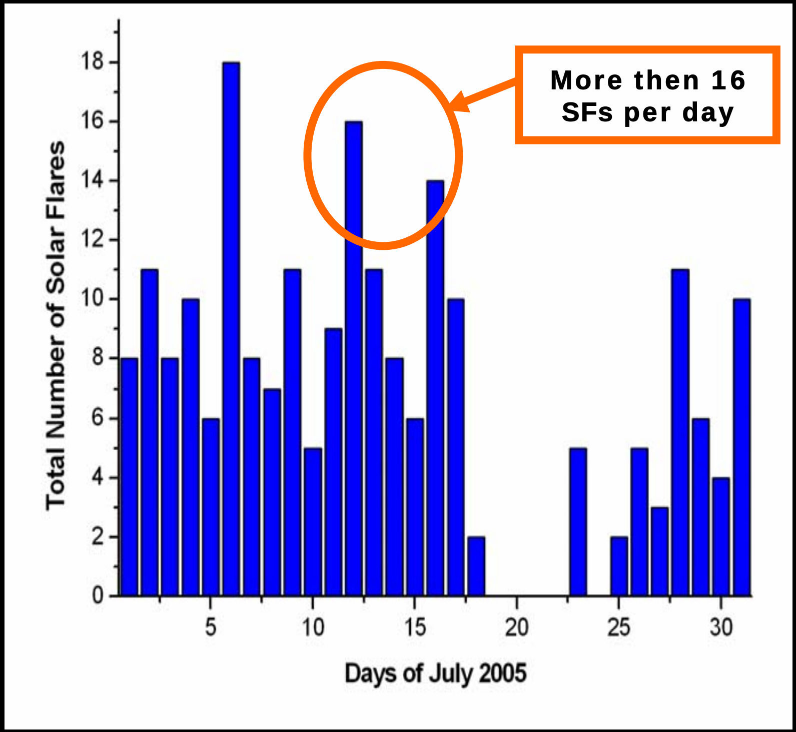
July 2005



Hofer et al, 2000; Mavromichalaki et al. 2007

Solar Events Background

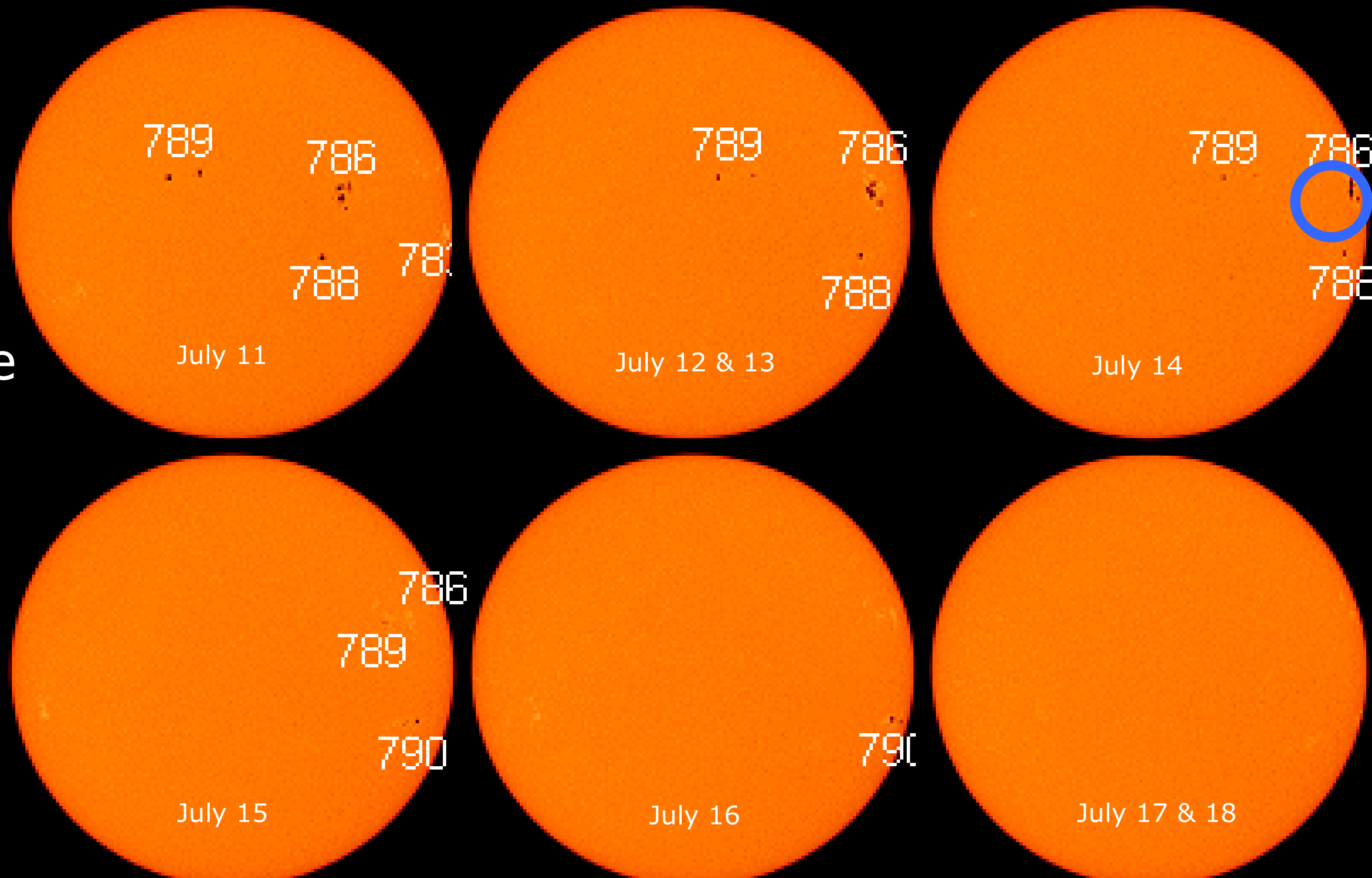




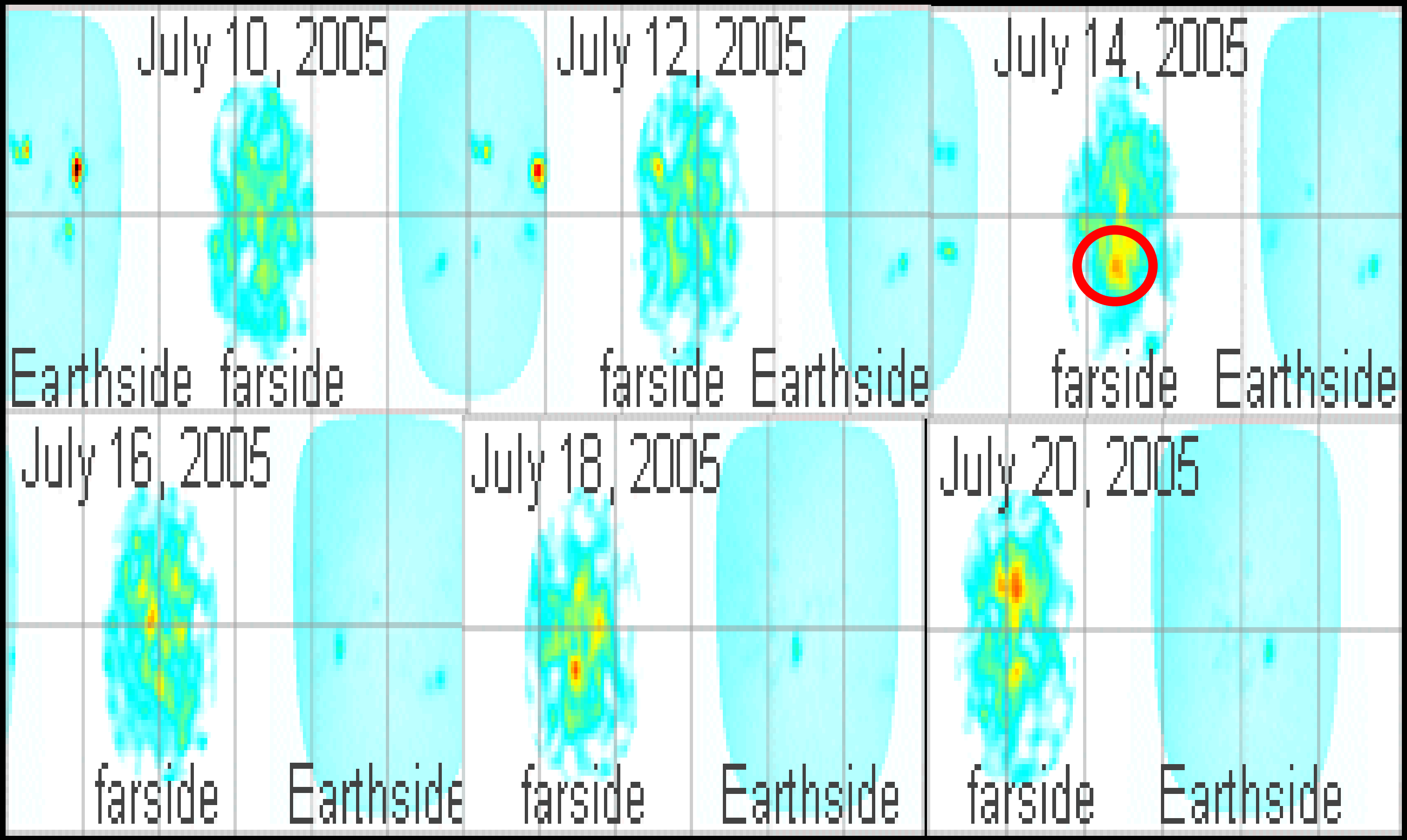
Days of July 2005	Location	X-ray	Active Region
07	N09E03	M 4.9	AR 786
09	N11W27	M 2.8	AR 786
12	N12W69	M 1.0	AR 786
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
13	N11W90	M 5.0	AR 786
13	N13W82	M 1.2	AR 786
13	N08W90	M 1.2	AR 786
14	N13W86	M 1.0	AR 786
14	N09W90	M 9.1	AR 786
14	N11W90	X 1.2	AR 786
14	N09W90	M 1.3	AR 786
14	N09W90	M 1.1	AR 786
16	S10W72	M 1.0	AR 790

A total of 80 Coronal Mass Ejections (CMEs) – out of which 17 Halo and 11 Partial Halo- as well as 214 Solar Flares (SF), highlighted by 19 M class and 2 X class SF, recorded in July 2005

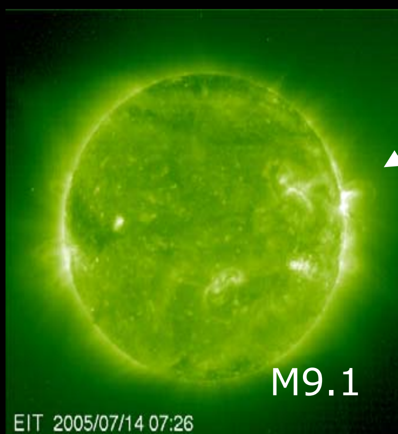
Development of sunspots at the visible side of the Sun from 11th until 18th of July 2005



Development of solar activity at the non visible side of the Sun

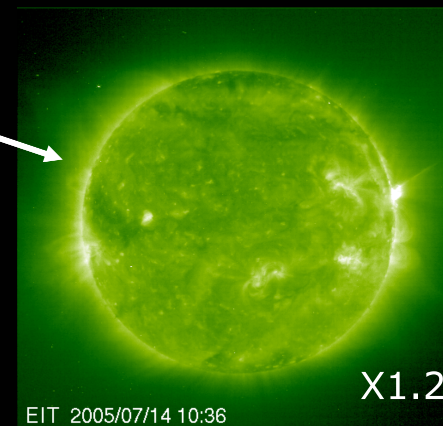


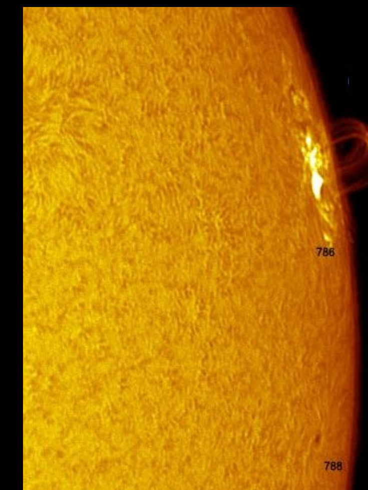
Most Important Events of July 2005

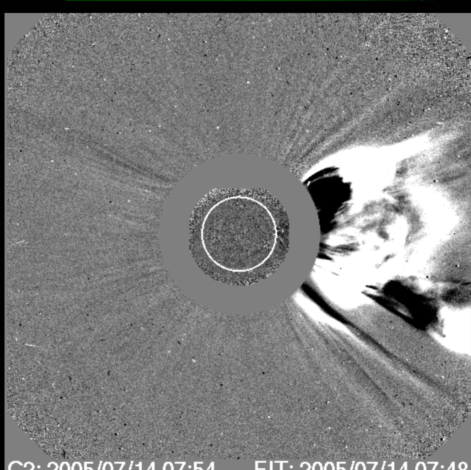


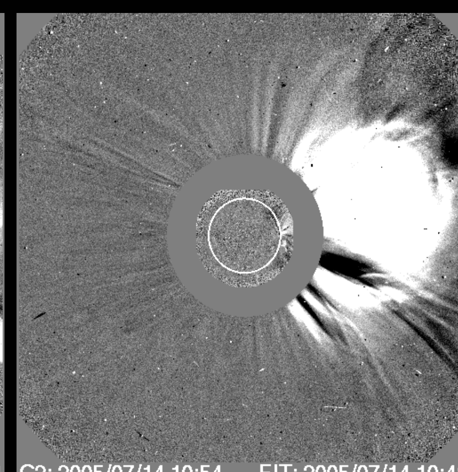
Intense western SF on the 14/07/05

& the associated series of CMEs

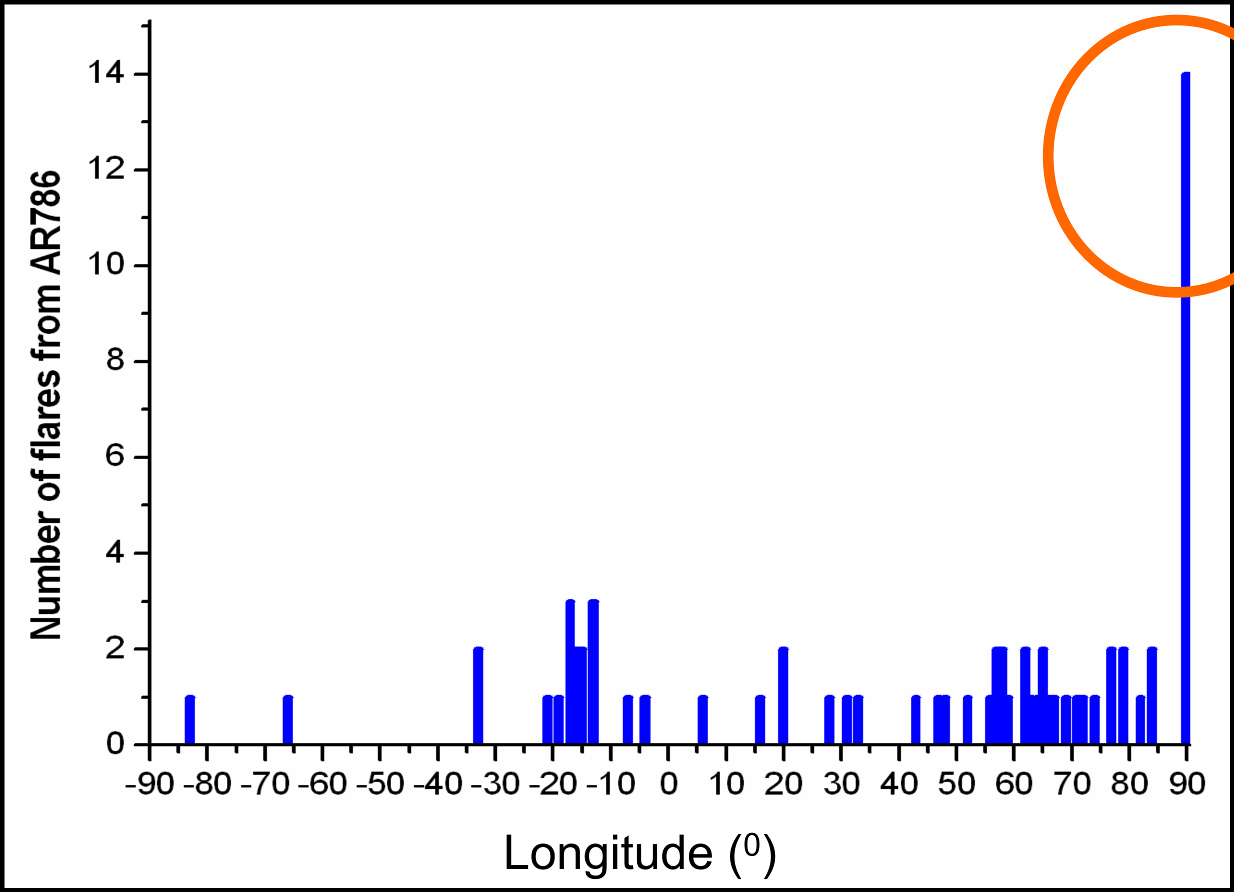






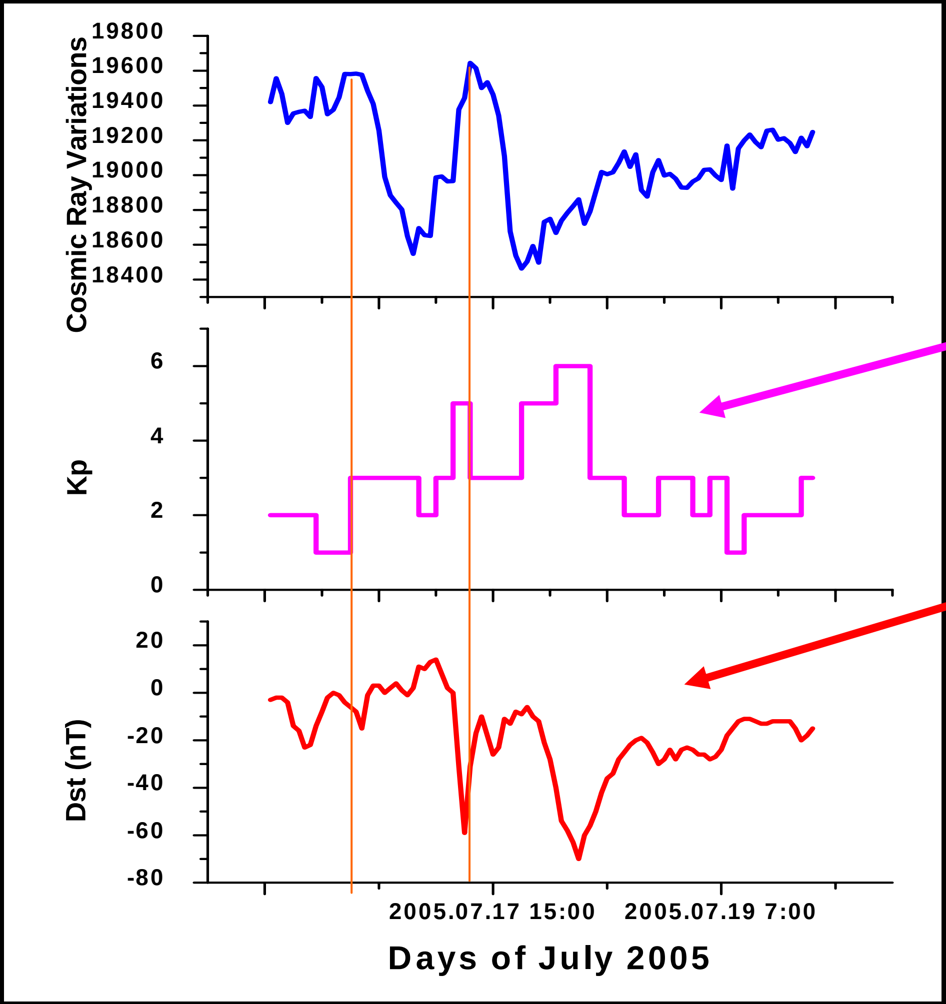


A representation of AR 786, just before its turning behind the limb



The majority of SF recorded at the limb of the Sun

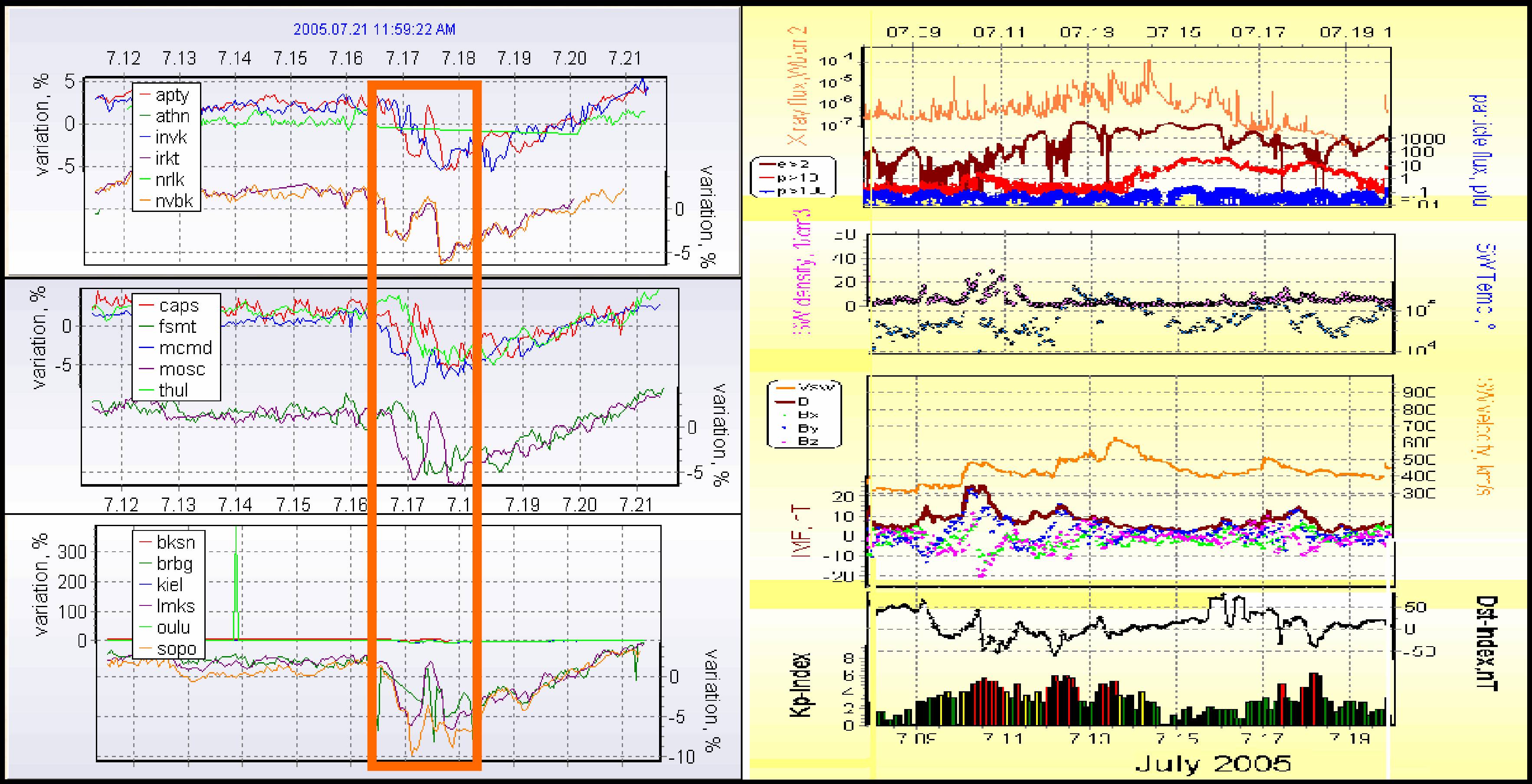
Geomagnetic Background



- Maximum Kp: 6
- Minimum Dst: - 70 nT

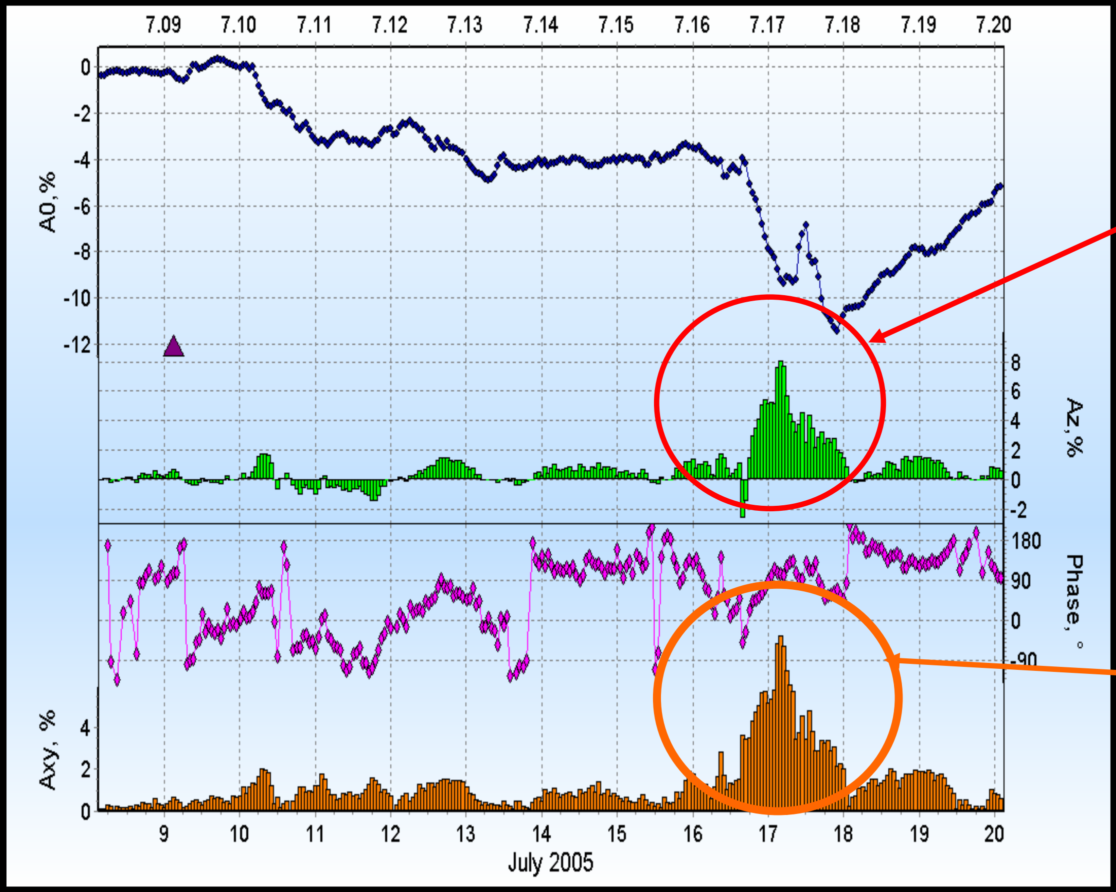
In order to characterize this as a Geomagnetic Effect
Dst < -80 nT
(Iyemori, T, et al. 1996)

The over all picture from ANMODAP Center



Mavromichalaki et al 2005a; 2005b

Cosmic Ray Anisotropy



Typical anisotropy response to a shock

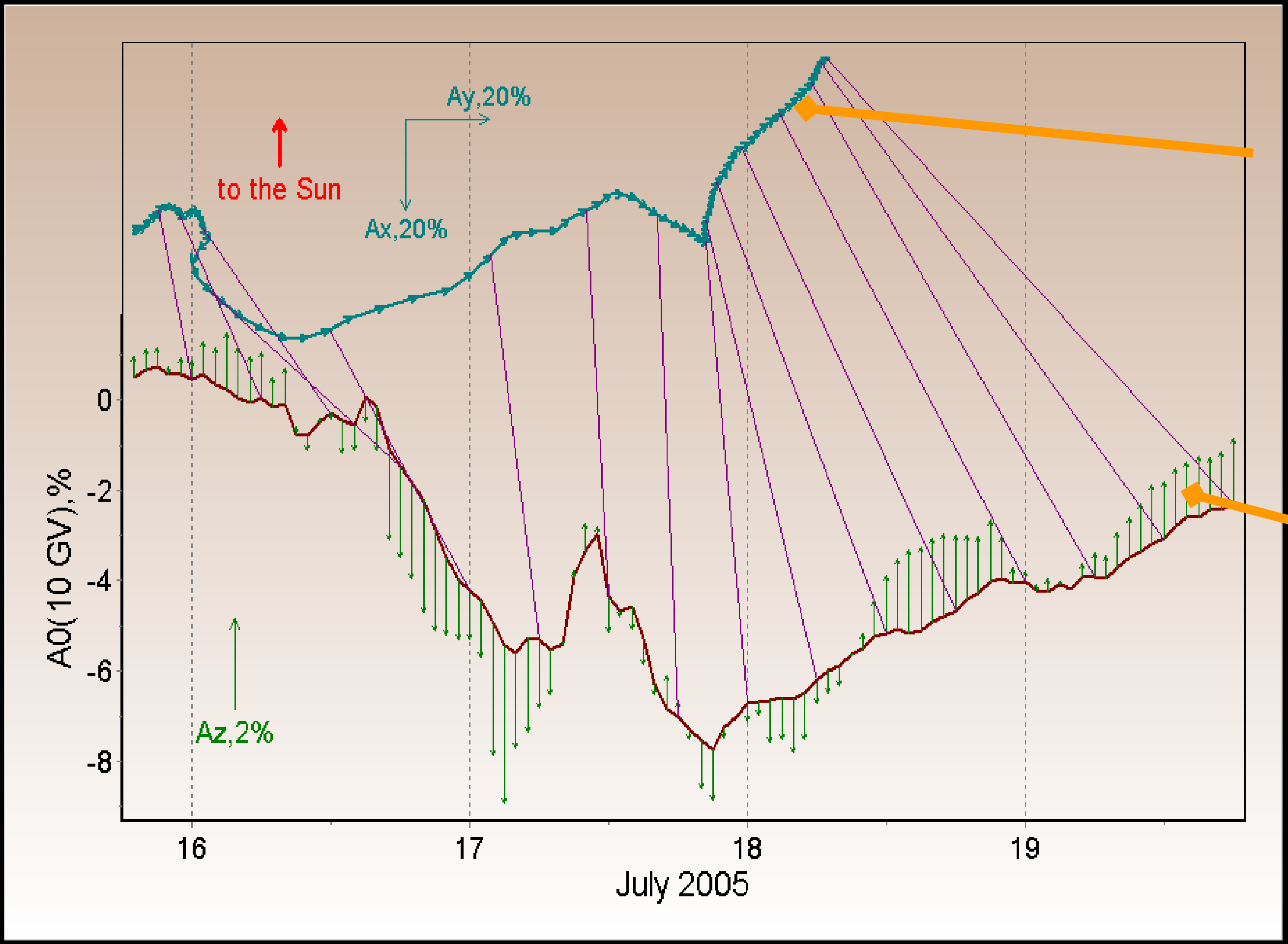
Direction inverse and increase of the North-South anisotropy component Az

~ 8 %

Inverse of Phase angle

Increase of the equatorial plane anisotropy component Axy

6-8%



Anisotropy Axy of the equatorial plane

North- South Anisotropy Az

Chen 1993; Hofer et al. 2000

Applying the Convection-Diffusion Approach

$$\vec{A}_c = c\frac{\vec{u}}{v} \qquad \vec{g}_{//} = \frac{\vec{A}_{xy}}{\lambda_{//}}$$

$$\kappa = \lambda_{\perp} / \lambda_{//} = (1+n^2)^{-1}$$

$$\vec{A} = \vec{A}_c - \lambda_{//}\vec{g}_{//} - \lambda_{\perp}\vec{g}_{\perp} - \lambda_h[\frac{\vec{H}}{H}\vec{g}]$$

$$\lambda_{//} = n\rho_o \qquad \lambda_{\perp} = n(1+n^2)^{-1}\rho_o \qquad \lambda_h = n^2(1+n^2)^{-1}\rho_o$$

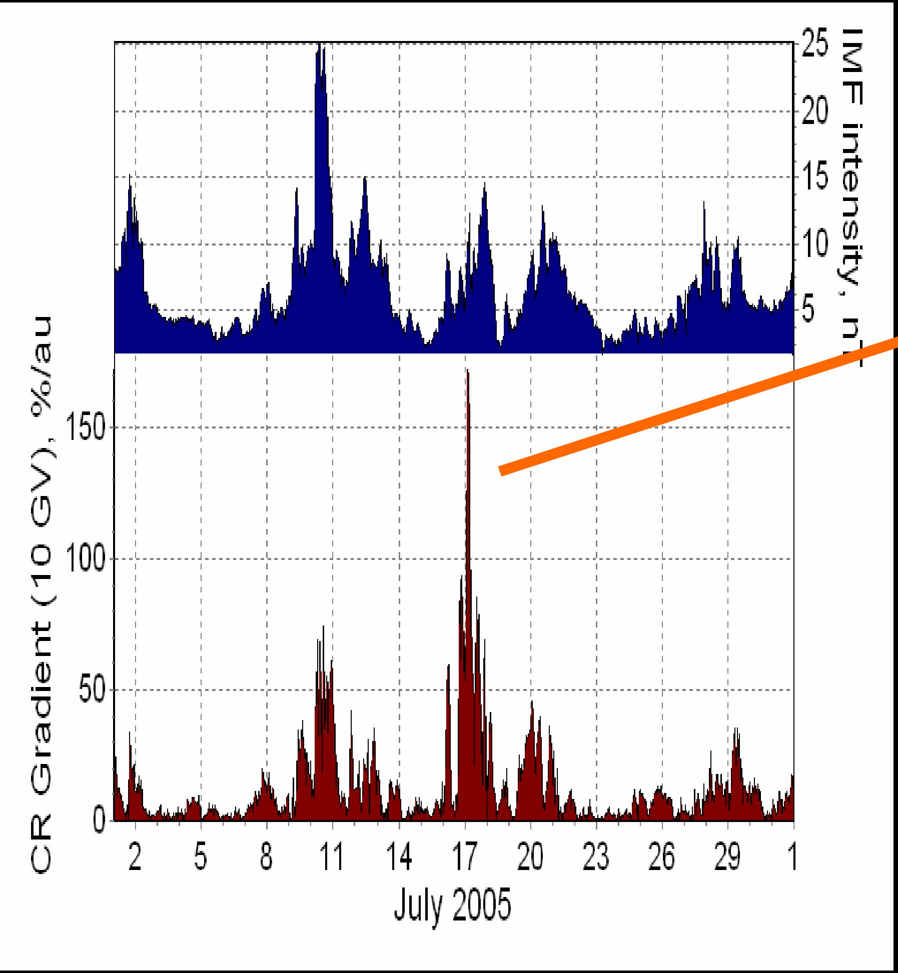
$$\vec{A} - \vec{A}_c = -\rho(\kappa^{\frac{-1}{2}}\vec{g}_{//} + \kappa^{\frac{1}{2}}\vec{g}_{\perp} + (1-\kappa)^{\frac{1}{2}}[\frac{\vec{H}}{H}\vec{g}])$$

Krymsky 1974; Belov, 1982

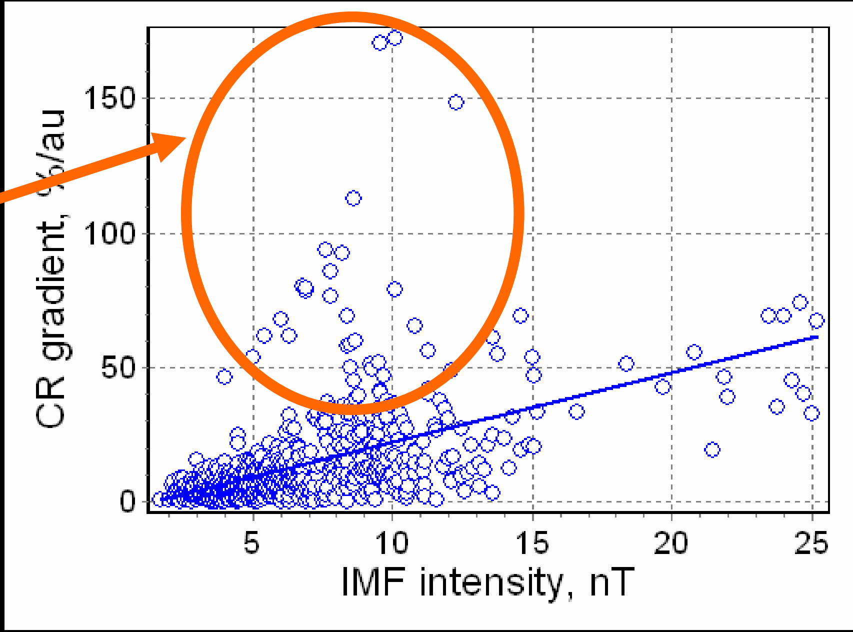
$$\vec{A}-\vec{A}_c = -\frac{1}{\sqrt{\kappa}}\begin{pmatrix} \cos^2\psi+\kappa\sin^2\psi & \cos\psi\sin\psi(1-\kappa) & -\sin\psi\sqrt{\kappa(1-\kappa)} \\ \cos\psi\sin\psi(1-\kappa) & \sin^2\psi+\kappa\cos^2\psi & \cos\psi\sqrt{\kappa(1-\kappa)} \\ \sin\psi\sqrt{\kappa(1-\kappa)} & -\cos\psi\sqrt{\kappa(1-\kappa)} & \kappa \end{pmatrix}\rho\vec{g}$$

Cosmic Ray Gradient

$$\begin{cases} g_x = \frac{1}{\rho}[-\sqrt{\kappa}(A_x - A_c) - \sin\psi\sqrt{1-\kappa}] \\ g_y = \frac{1}{\rho}[-\sqrt{\kappa}A_y + \cos\psi\sqrt{1-\kappa}A_z] \\ g_z = \frac{1}{\rho}[\sin\psi\sqrt{1-\kappa}(A_x - A_c) - \cos\psi\sqrt{1-\kappa}A_y - \sqrt{\kappa}A_z] \end{cases}$$



July 16 – 17, 2005



Summarizing:

I. The intense solar activity that forehanded the Forbush decrease on the 16th of July could justify the recorded variation

II. The high equatorial anisotropy shows that an intense flux from Western particles arrived at Earth on the 17th and can explain the sudden increase of CRs

III. The recorded increase is in no case a Ground level one (GLE)

IV. The geomagnetic indices Dst & Kp did not reach values that could justify a geomagnetic effect

V. The Convection-Diffusion approach revealed a unique situation which evolved at a more or less quiescent background

VI. Overall the complexity that dominated interplanetary space and evolved at the Western part of inner heliosphere after the series of CMEs at 14/07/05

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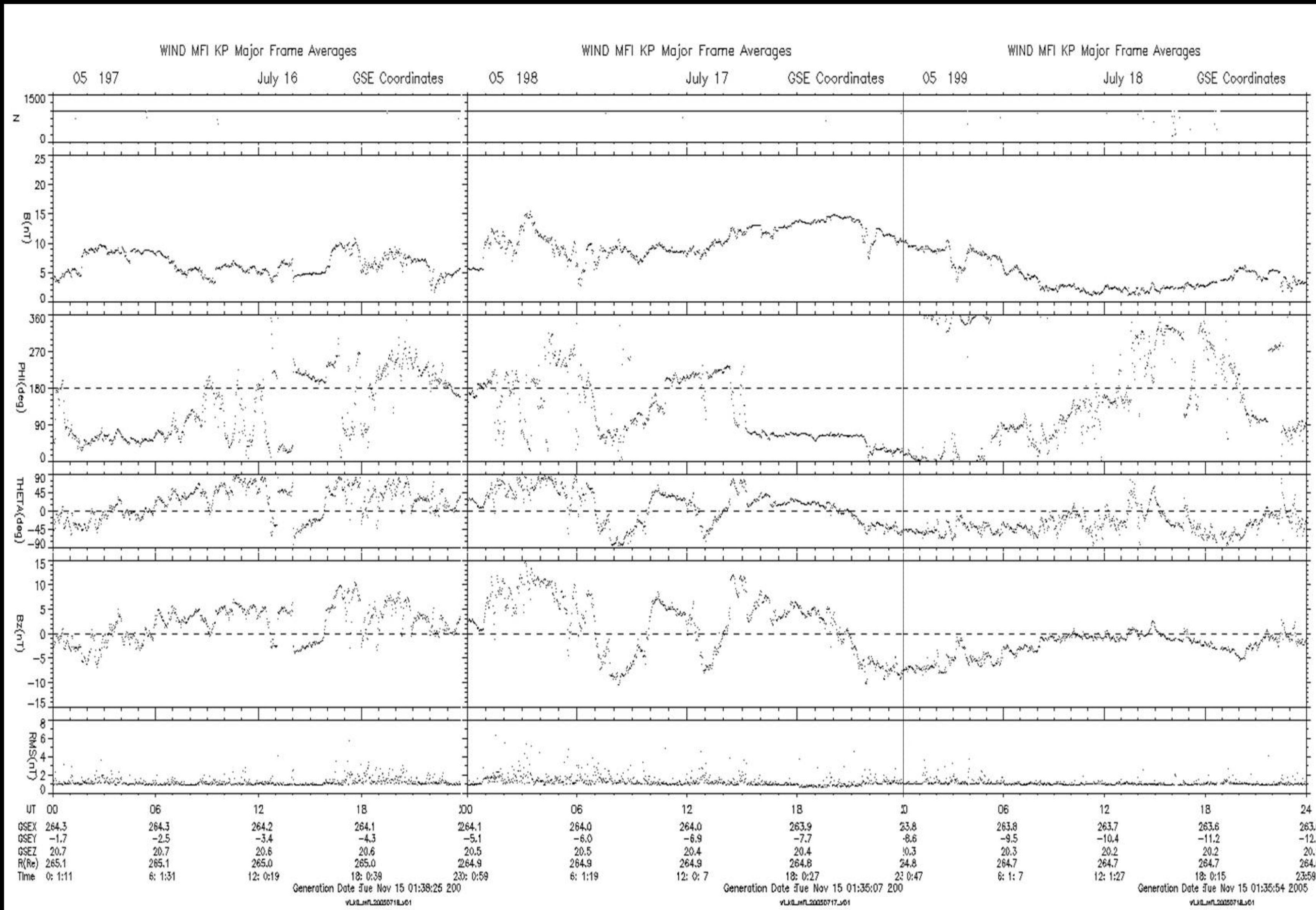
We would like to thank all colleagues providing the data of their stations

Thank you for your attention


WIND MFI KP Major Frame Averages
05 197
July 16
GSE Coordinates
WIND MFI KP Major Frame Averages
05 198
July 17
GSE Coordinates
WIND MFI KP Major Frame Averages
05 199
July 18
GSE Coordinates
N
B(nT)
PHI(deg)
THETA(deg)
Bz(nT)
RMS(nT)
UT 00 06 12 18 00 06 12 18 00 06 12 18 24
GSEX 264.3 264.3 264.2 264.1 264.1 264.0 264.0 263.9 263.8 263.8 263.7 263.6 263.6
GSEY −1.7 −2.5 −3.4 −4.3 −5.1 −6.0 −6.9 −7.7 −8.6 −9.5 −10.4 −11.2 −12.1
GSEZ 20.7 20.7 20.6 20.6 20.5 20.5 20.4 20.4 20.3 20.3 20.2 20.2 20.1
R(Re) 265.1 265.1 265.0 265.0 264.9 264.9 264.9 264.8 264.8 264.7 264.7 264.7 264.6
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