

GEO-EFFECTIVE SOLAR FLARE EVENTS IN DECEMBER 2006 RECORDED CLOSE TO VENUS AND MARS

Y. Futaana, S. Barabash, M. Yamauchi, R. Lundin

Swedish Institute of Space Physics

&

Aspera-3 and -4 team

ASPERA-3 and -4 team

R. Lundin, H. Andersson, A. Grigoriev,
M. Holmström, M. Yamauchi, Y. Futaana
K. Asamura
W. Baumjohann, T. Zhang
P. Bochsler, P. Wurz
P. C:son Brandt, E. Roelof
A. Coates, D.R.Linder, D.O.Kataria
C. C. Curtis, K. C. Hsieh, B. R. Sandel
A. Fedorov, J.-J. Thocaven
R. Frahm, J. Sharber, D. Winningham
M. Grande
H. Koskinen, E. Kallio, P. Riihela, T. Säles
J. Kozyra
N. Krupp, J. Woch
J. Luhmann
S. McKenna-Lawlor
S. Orsini, R. Cerulli-Irelli, A. Mura, A. Milillo
K. Szego

IRF, Kiruna, Sweden

JAXA / ISAS, Sagamichara, Japan

SRI, Graz, Austria

UBe, Switzerland

APL /JHU, Laurel, USA

MSSL, UK

UA, Tucson, USA

CESR, Toulouse, France

SwRI, San Antonio, USA

RAL, Oxfordshire, UK

FMI, Helsinki, Finland

SPRL /U. of Michigan, Ann Arbor, USA

MPAe, Katlenburg-Lindau, Germany

SSL /U. of California in Berkeley, USA

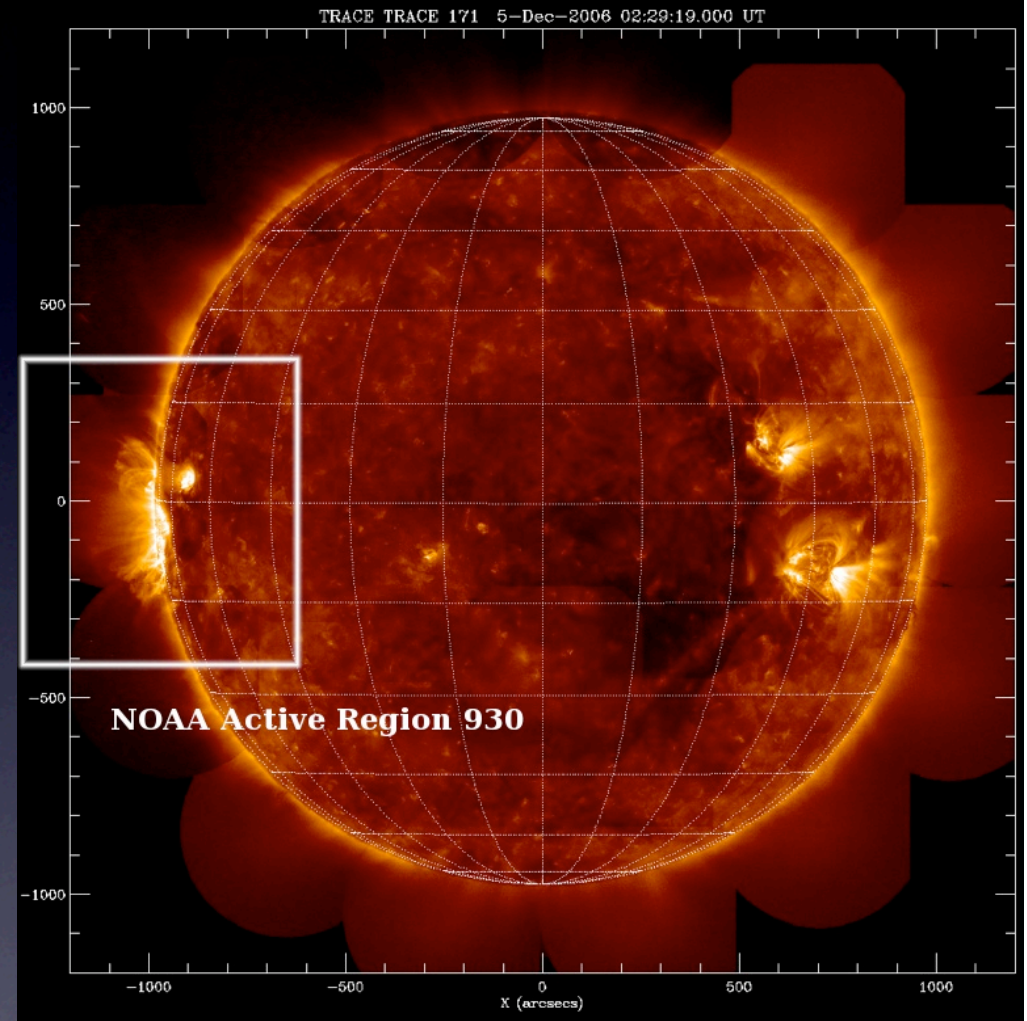
STIL, Ireland

IFSI, Rome, Italy

KFKI, Budapest, Hungary

SOLAR FLARE ON 5 DEC 2006

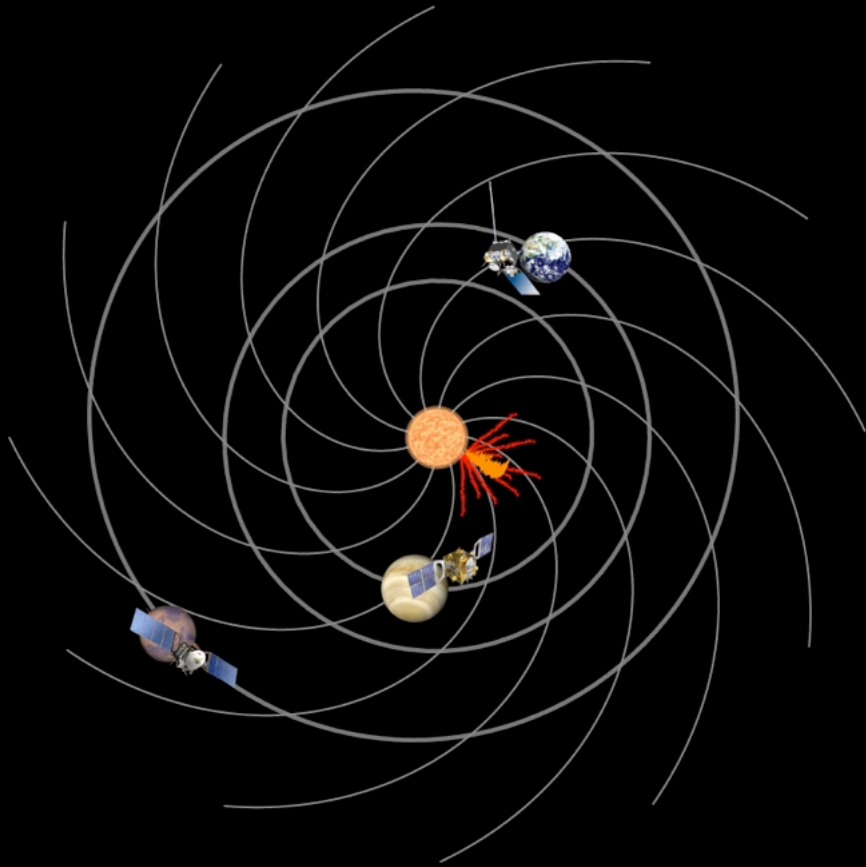
- An active region NOAA 0930 made series of X-class flares in December 2006
- X9.0 (December 5, 10:34UT) @ (E79, S07)
- X6.5 (December 6, 18:42 UT)
- X3.4 (December 13, 02:24 UT)
- X1.5 (December 14, 22:10 UT)



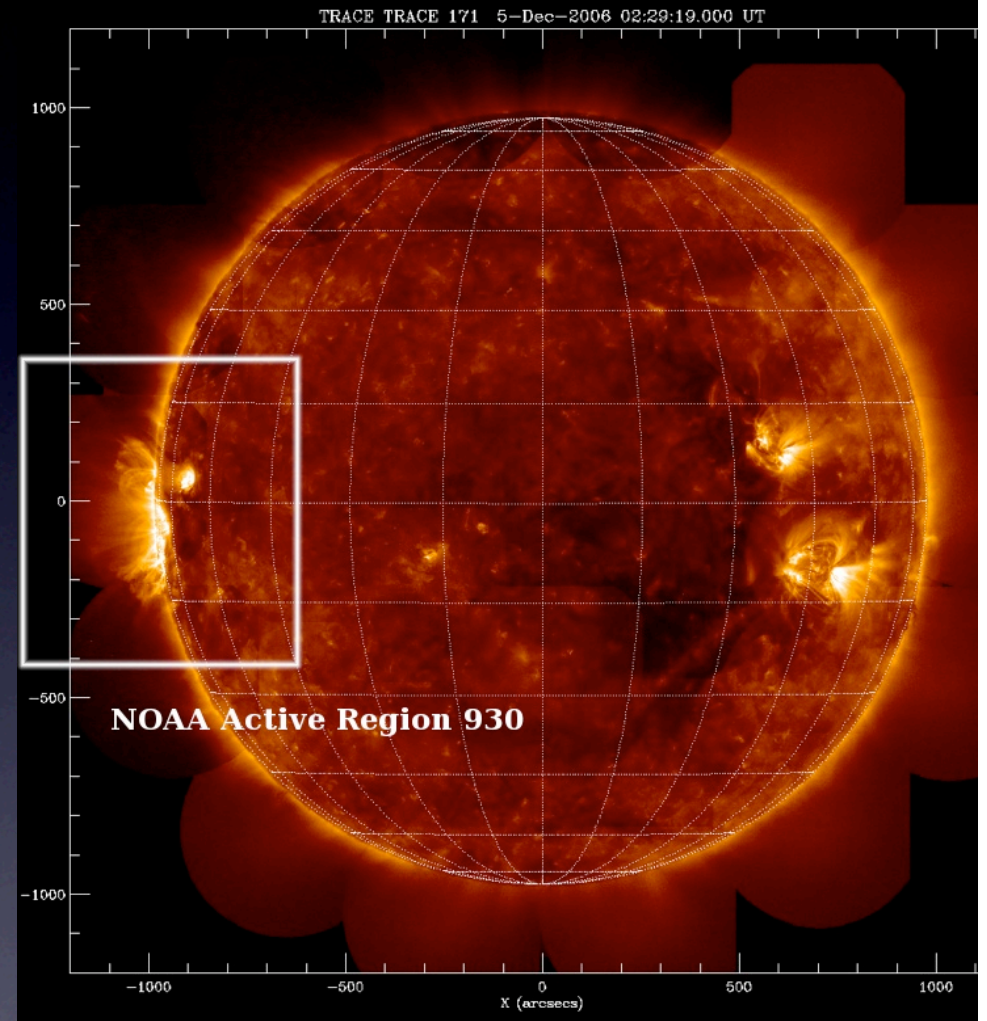
TRACE data
2006-12-05 02:29 UT

SOLAR FLARE ON 5 DEC 2006

2006-12-05 10:35 UT

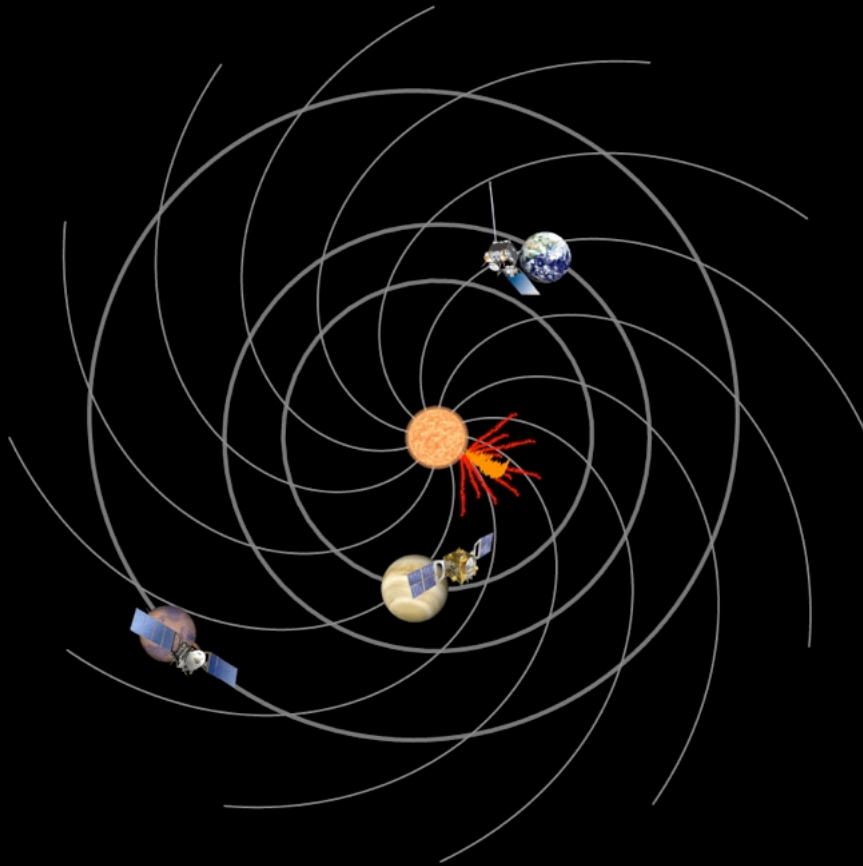


Large flare was erupted from the Sun



SOLAR FLARE ON 5 DEC 2006

2006-12-05 10:35 UT

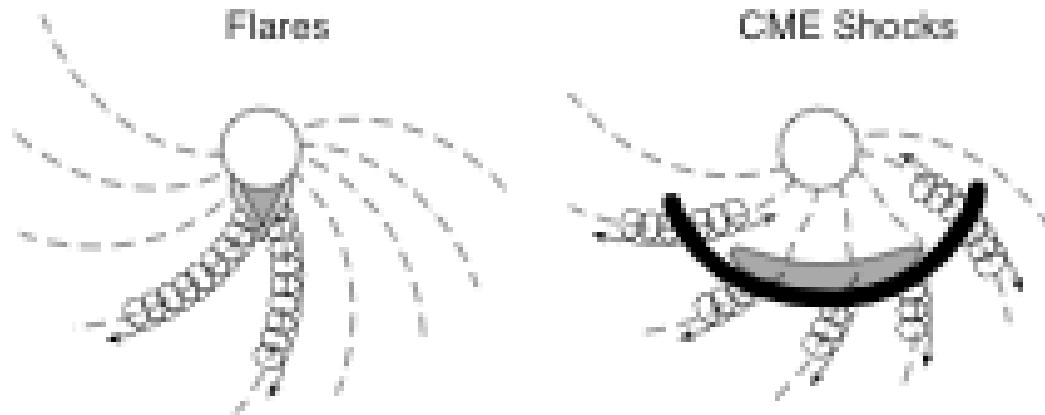


Large flare was erupted from the Sun

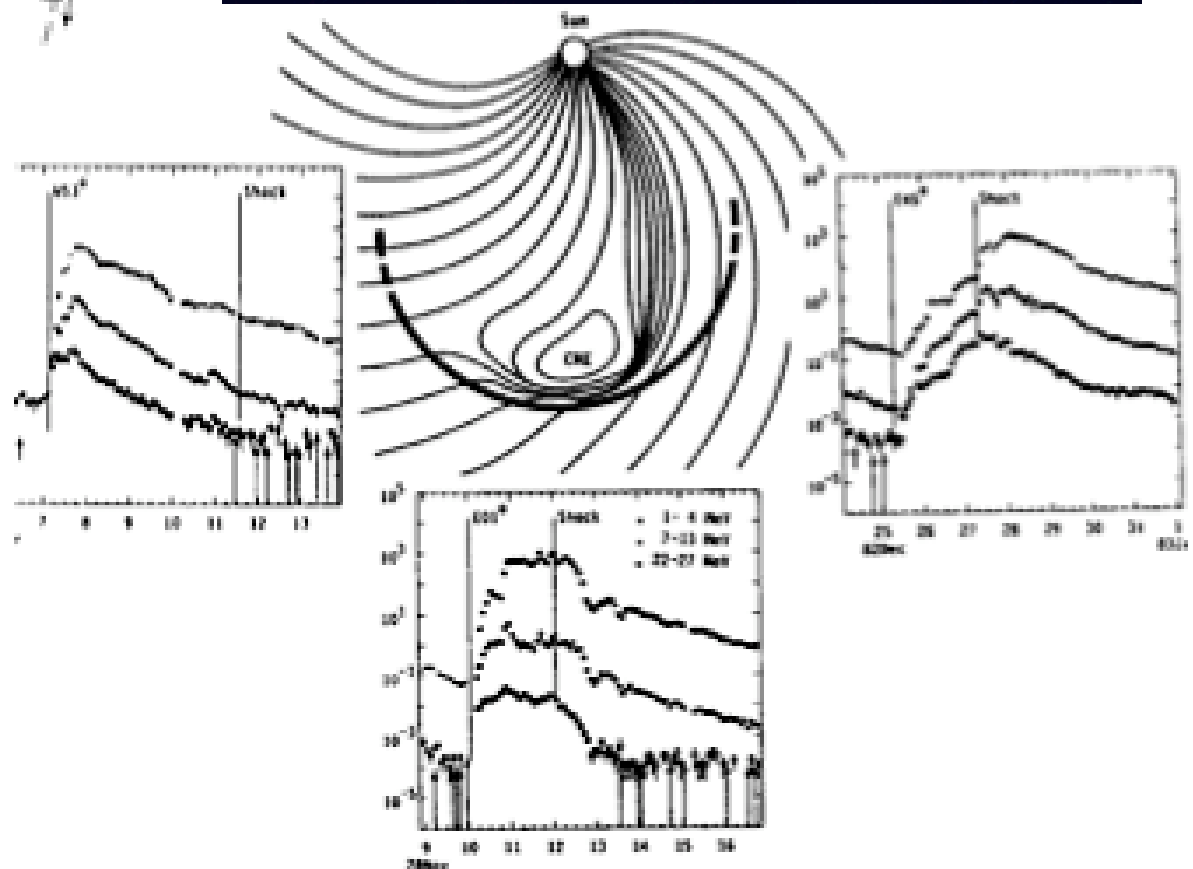
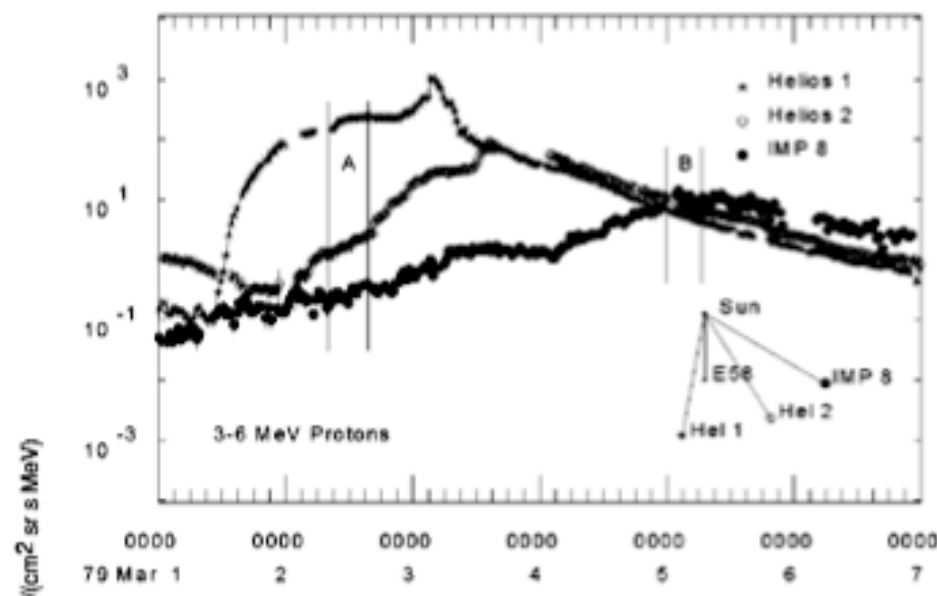
- Mars Express and Venus Express was operation in December 2006.
- From the largest flare location on 5th Dec., the Earth was $\sim 80^\circ$ westward, and Venus and Mars were $\sim 80^\circ$ and $\sim 125^\circ$ eastward, respectively.
- Venus and Mars was on the same Parker spiral.

SEP longitudinal extent (Reames' review, 1999)

New Picture:



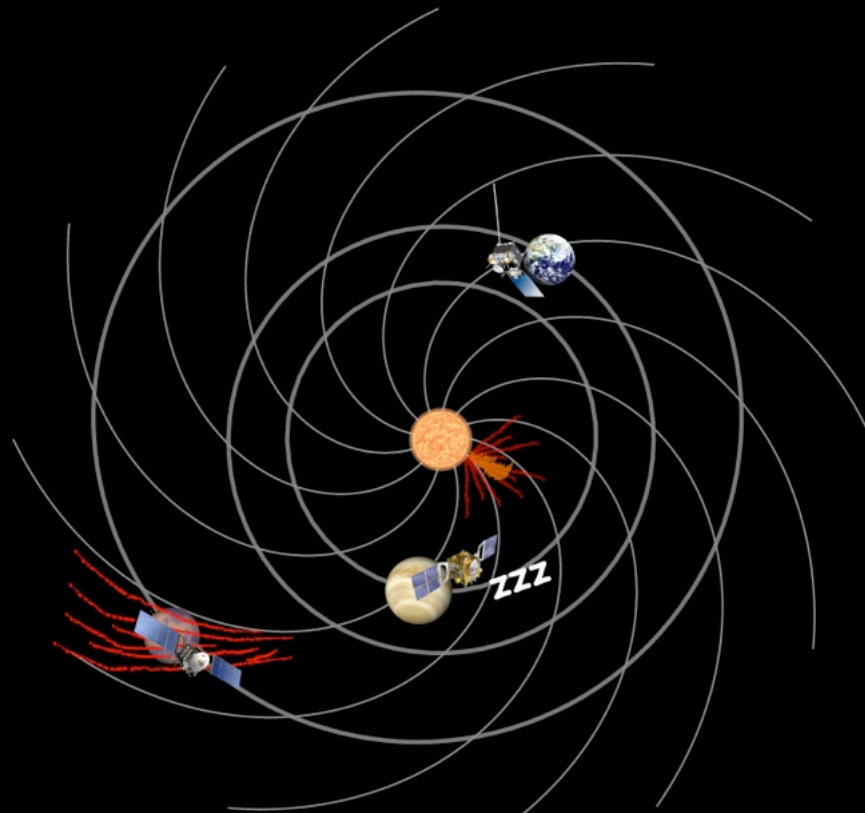
CME front is the source
Therefore, wide spread
but, never 180°



Helios 1 Helios 2 IMP 8

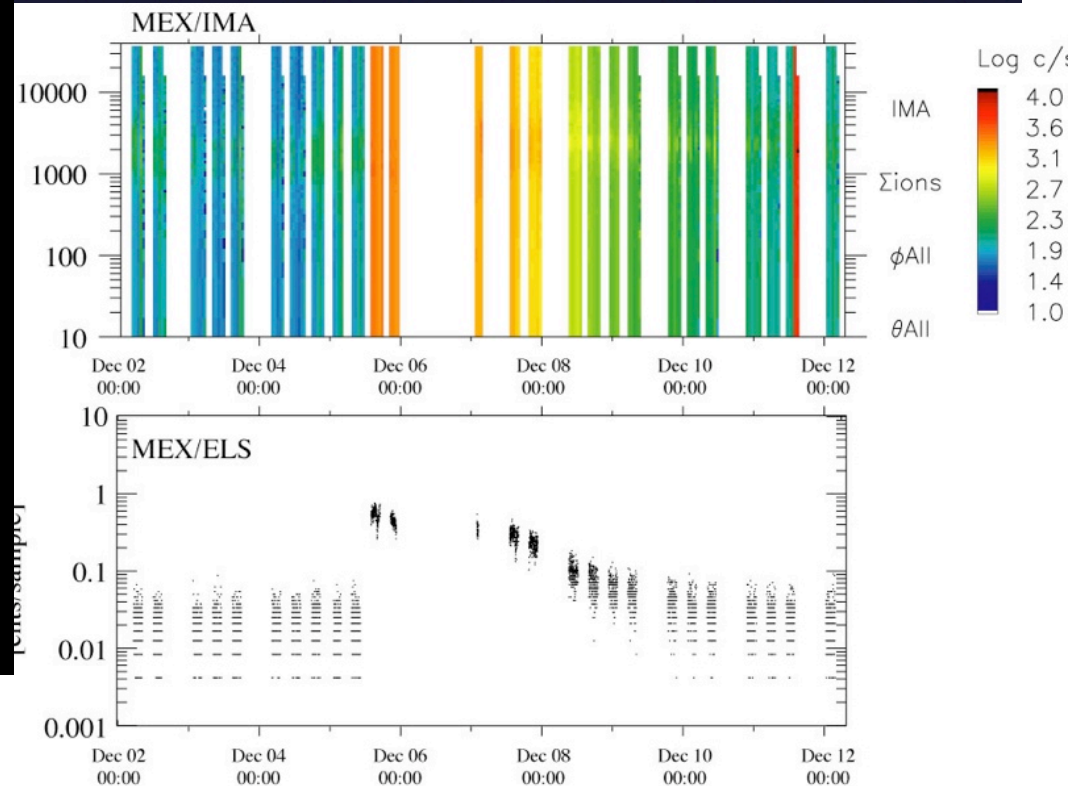
SEPs at Mars

2006-12-05 14:00 UT



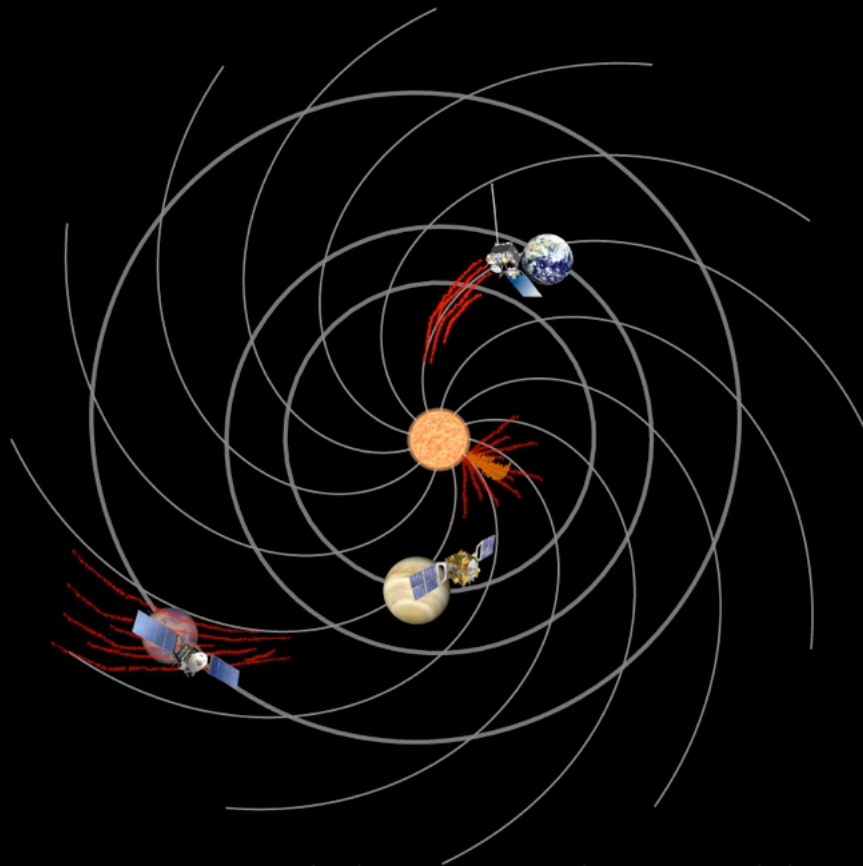
**High-energy particles had been arrived
Mars Express at Mars**

- SEPs (=increases of IMA/ELS background level) had been arrived before 14UT on 5 December
- SEPs flying time was less than 3.5 hrs. Corresponding energy is **>1.7 MeV/amu**



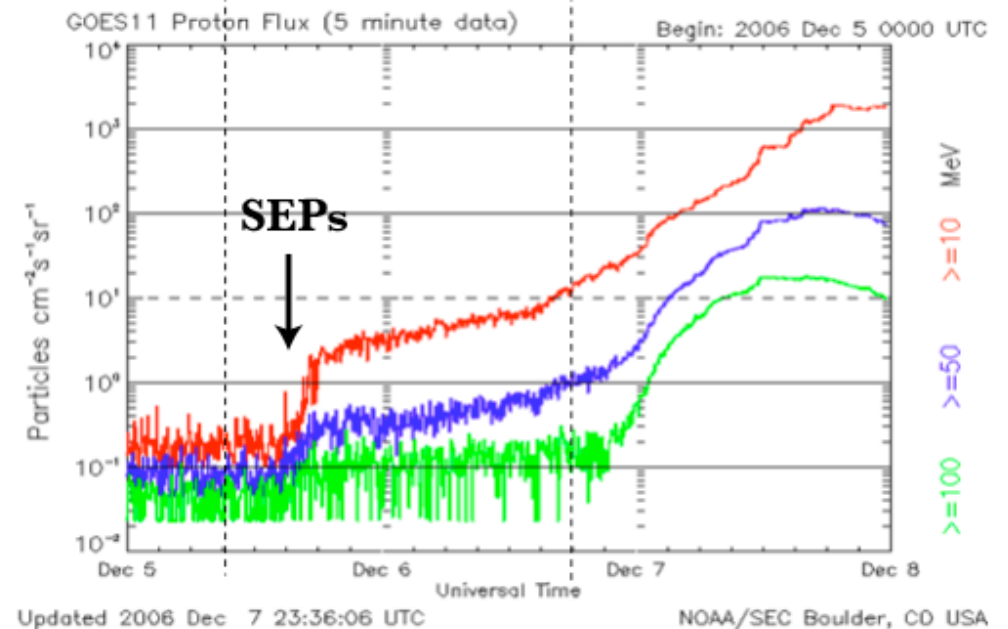
SEPs at Earth

2006-12-05 15:00 UT



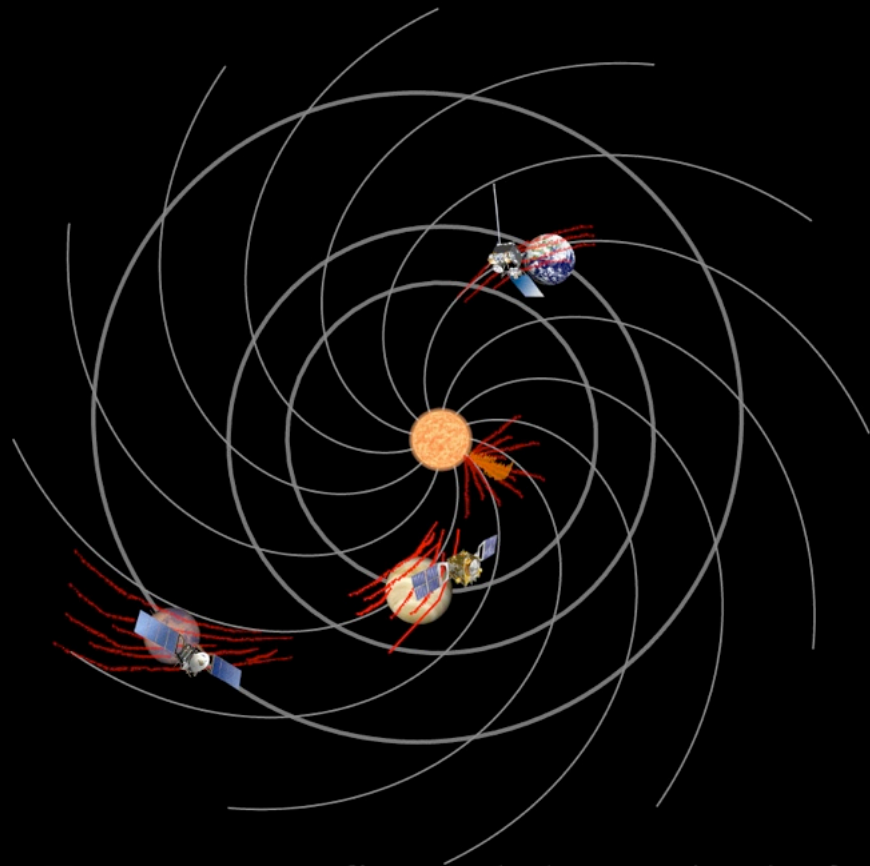
**High-energy particles were detected by
GEOS-11 at the Earth**

- SEPs are detected by GOES 11 at the Earth at 15-18 UT on 5 Dec 2006



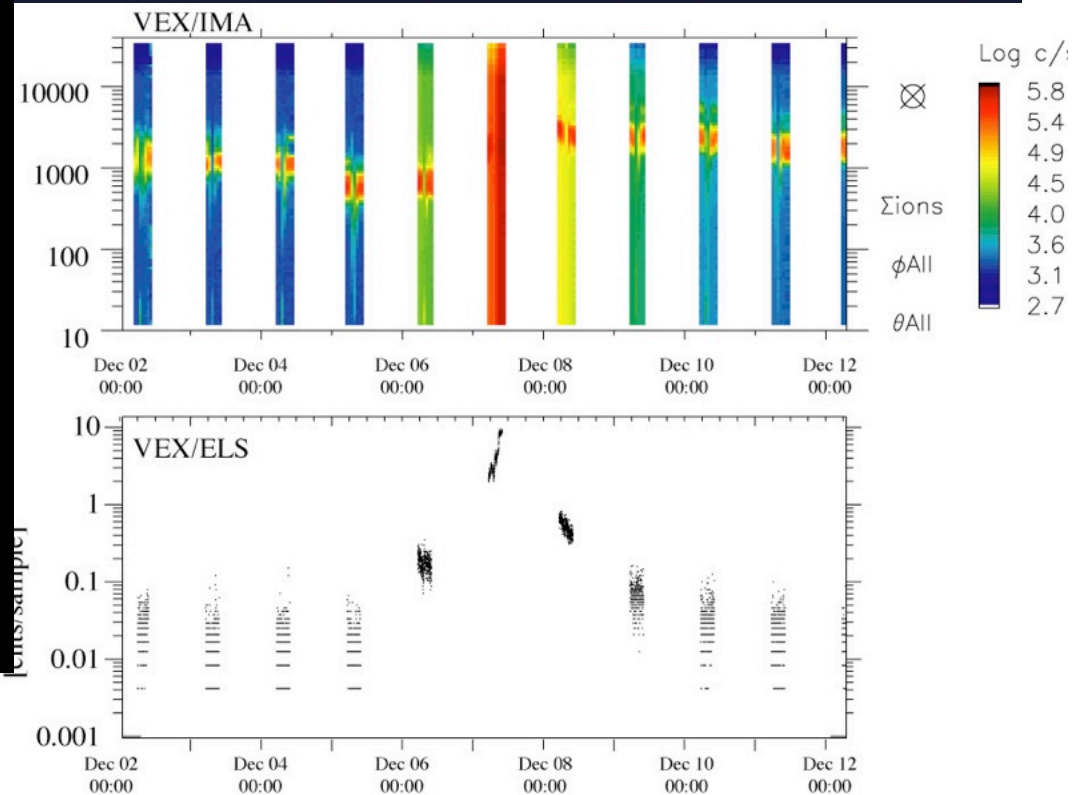
SEPs at Venus

2006-12-06 05:30 UT



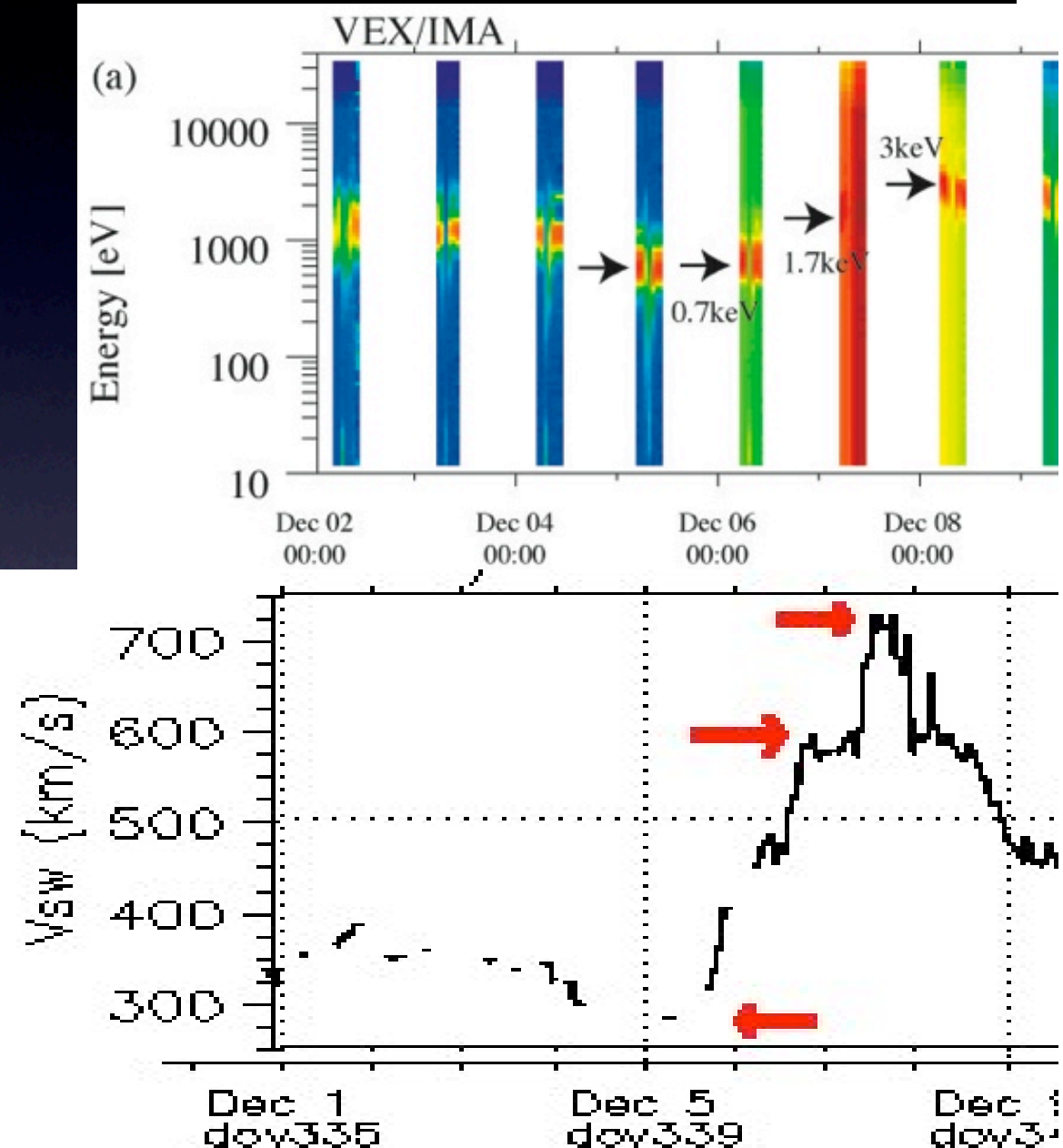
Venus Express confirmed the arrival of high-energy particles

- As soon as the operation of VEX/ASPERA-4 started at 05:30 UT on 6th Dec, SEPs were detected.



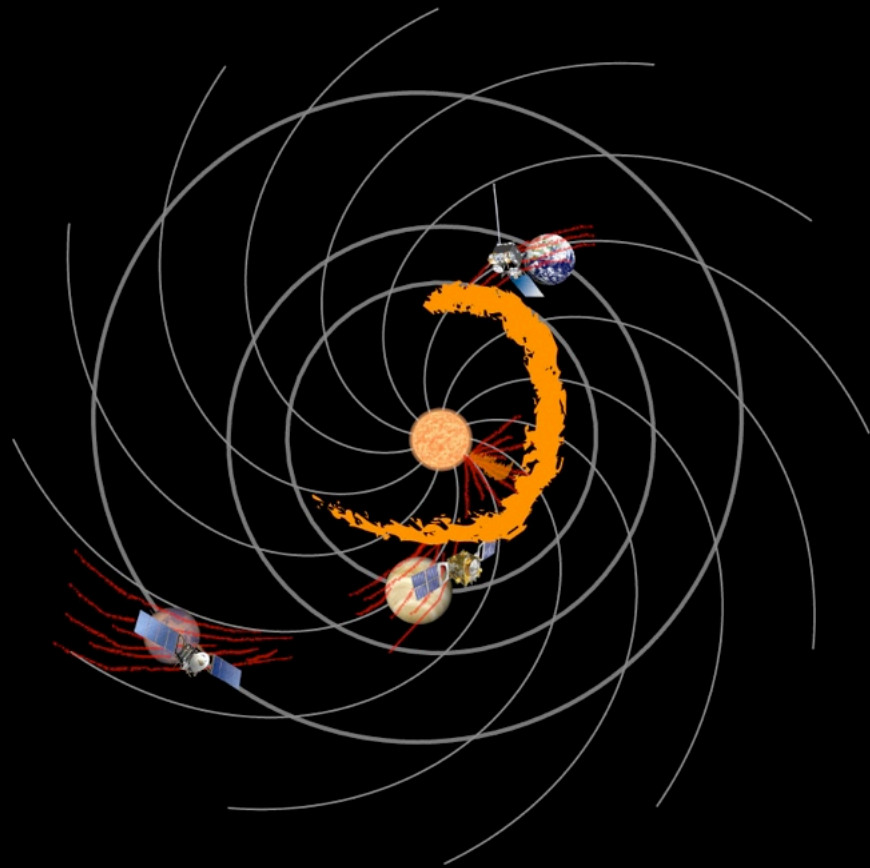
CMEs at Venus and the Earth

- Change of solar wind energy at Venus, which is very similar signature observed at the Earth by SOHO.
- 0.7 keV (350 km/s) on Dec 6
- 1.7 keV (550 km/s) on Dec 7
- 3 keV (750 km/s) on Dec 8
- Extents of CMES are

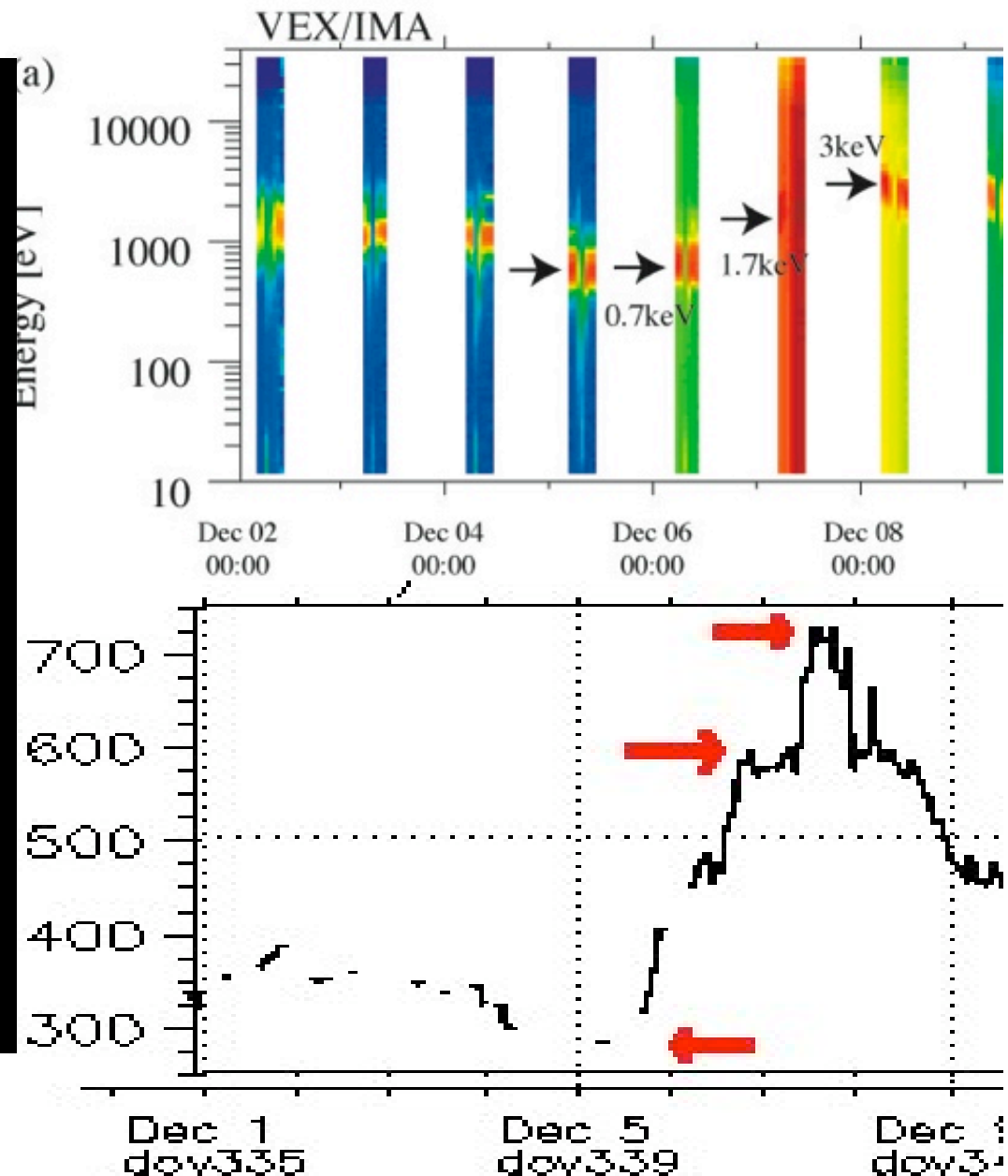


CMEs at Venus and the Earth

2006-12-06 15:00UT

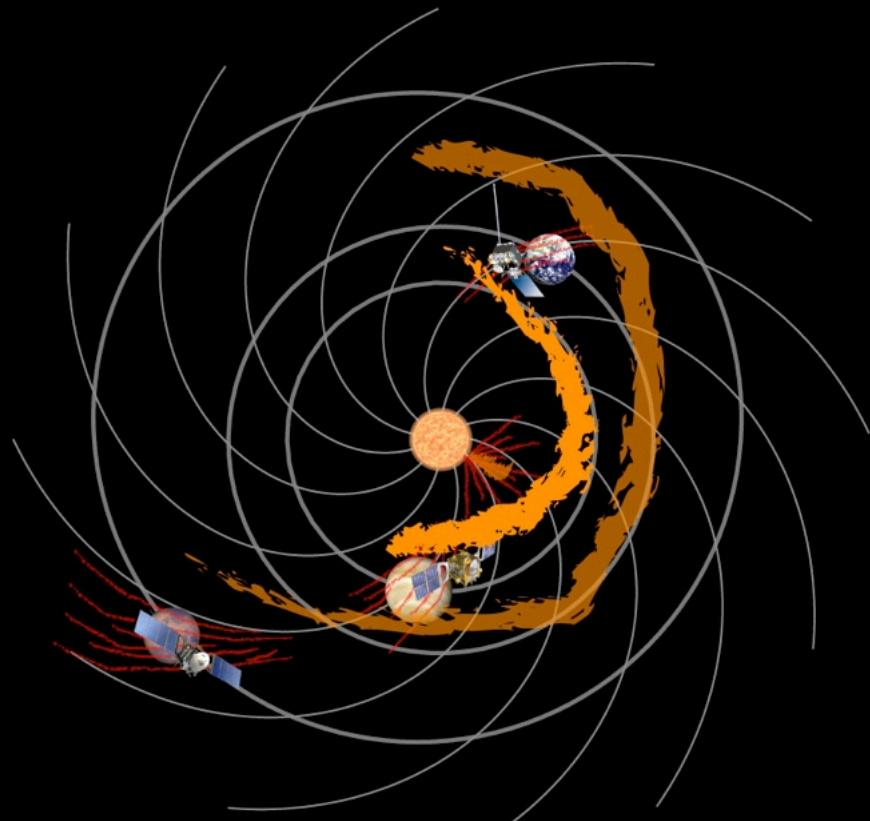


First CME arrived at Venus and the Earth

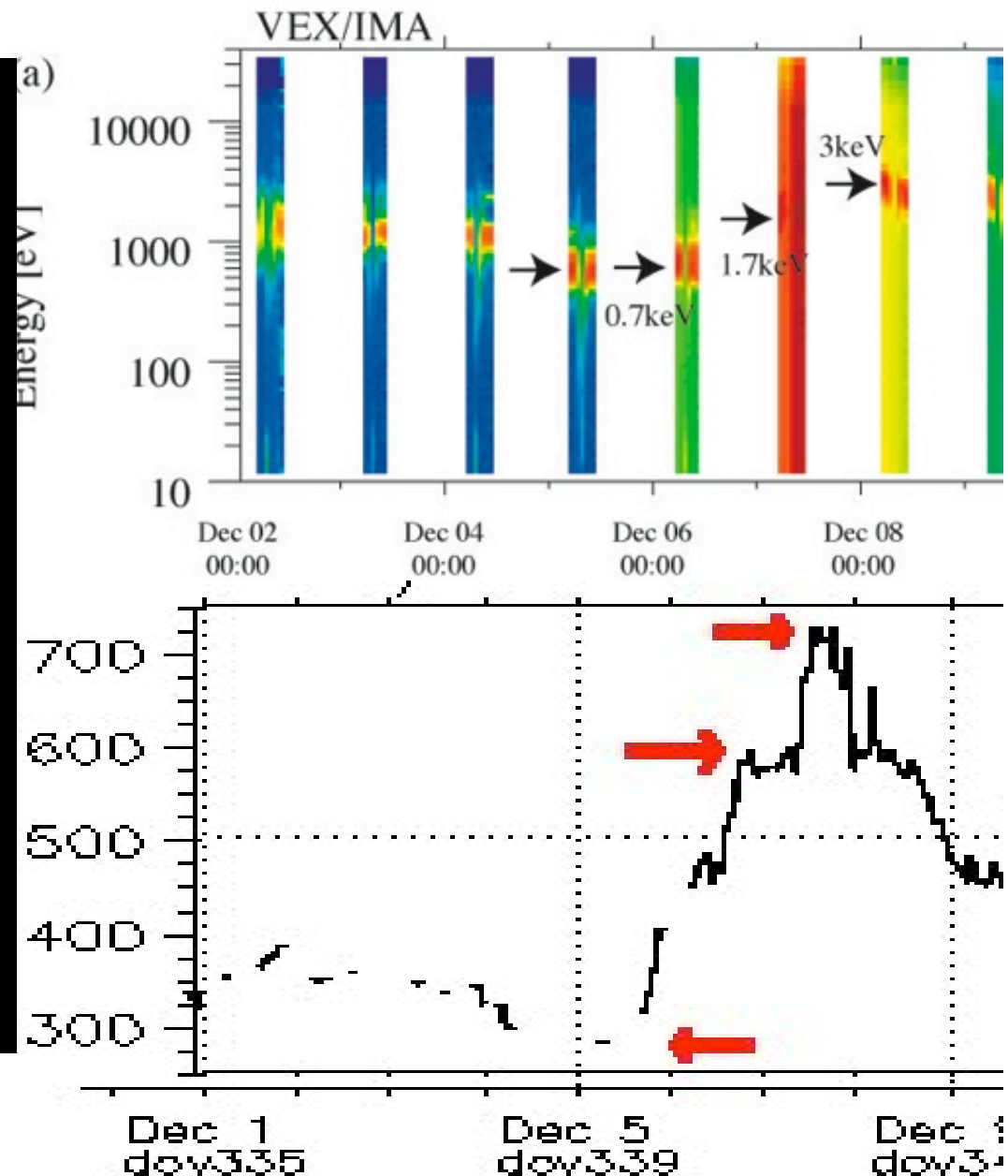


CMEs at Venus and the Earth

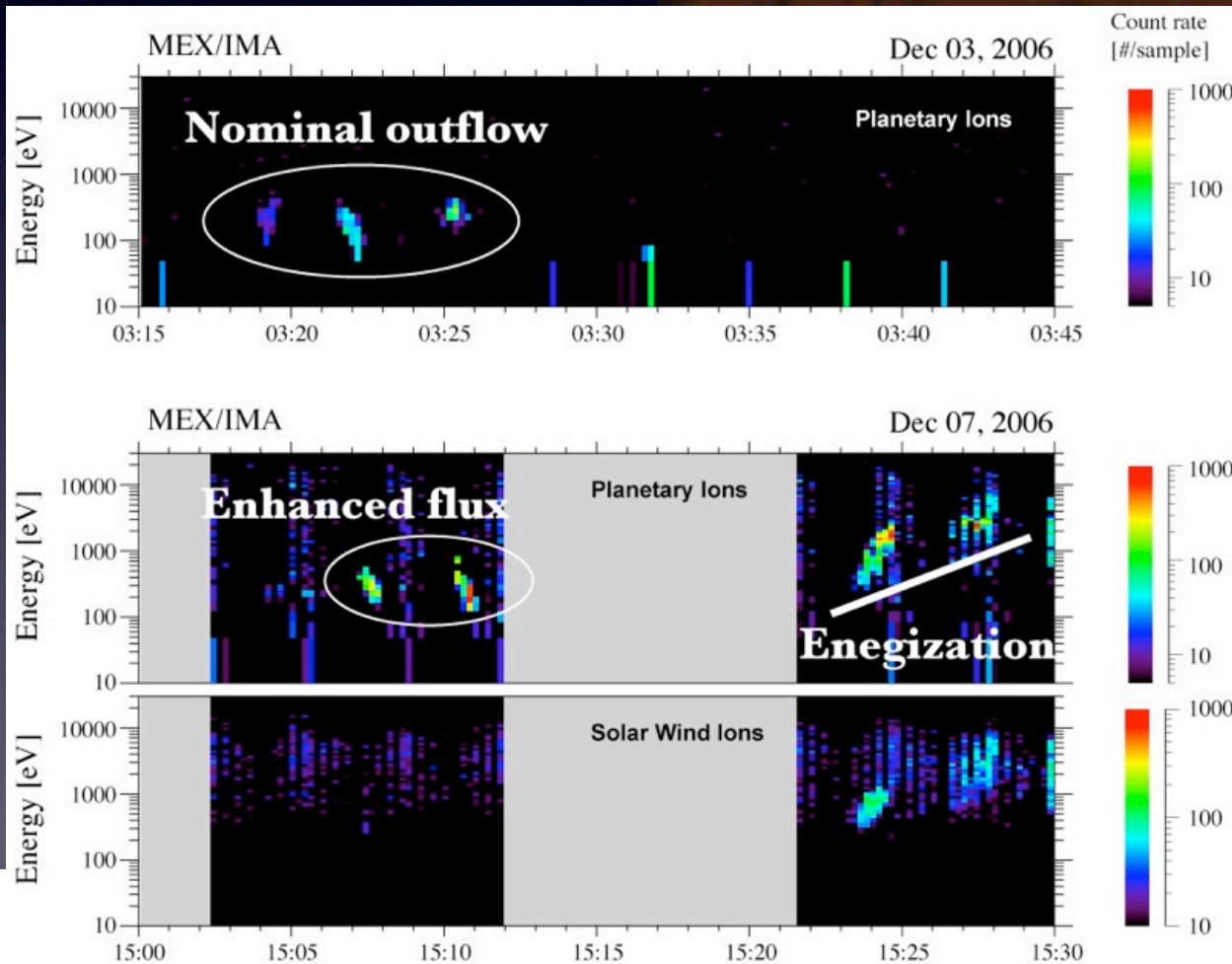
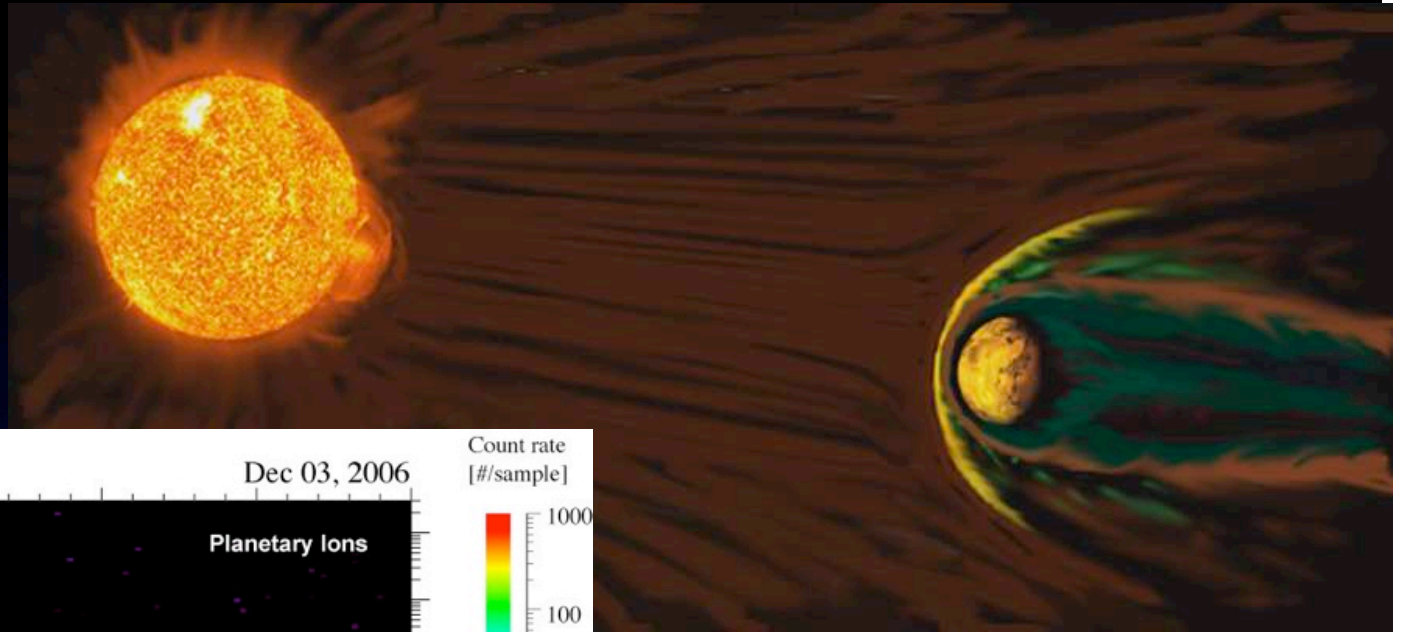
2006-12-07 11:00UT



Second CME arrived at Venus and the Earth



Influence to Martian ion outflow

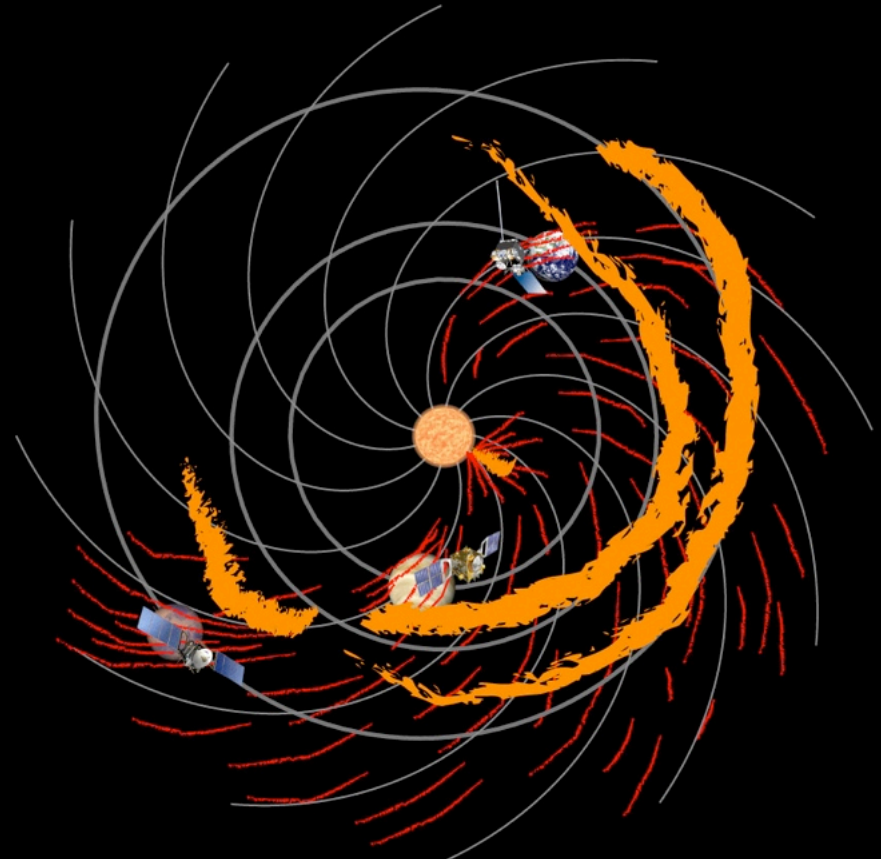


- During the SEP event, MEX/ASPERA-3 recorded energization (up to several keV) and enhancement of ion outflow flux (~5-10 times).

Summary (I)

- An active region NOAA 0930 made series of **geo**-effective X-class flares in December 2006.
- At **Venus** and **Mars**, VEX and MEX made observations, and detected associated SEPs by measuring increases of background level of ASPERA sensors.
- **VEX** recorded CMEs, whose signatures resemble those recorded around the **Earth**
- The SEPs and CMEs associated with the active region 0930

SUMMARY Dec '06



The flare influenced wide area of the inner solar system

Summary (2)



- During this violent SEP event, MEX/ASPERA-3 recorded energization (up to several keV) and enhancement of ion outflow flux (~ 5 -10 times).
- While this result is predicted by theoretical investigations and model calculations, this is the first observation.
- As a next step, statistical analysis of the correlation between the background SEPs or UV flux and outflow flux has been just started. This work will provide the role of the solar wind to evolution of

- FLARES FROM THE FAR SIDE OF THE SUN MAY AFFECT SPACE WEATHER OF INNER PLANETS
PRESS RELEASED FROM EUROPLANET!
- http://www.europlanet-eu.org/index.php?option=com_content&task=view&id=105&Itemid=32
- Some articles show this result!
 - DentalPlans.com, FL - Aug 24, 2007
<http://www.dentalplans.com/articles/23722/>
 - Science Daily (press release) - Aug 24, 2007
<http://www.sciencedaily.com/releases/2007/08/070824131445.htm>
 - MSNBC - USA - Aug 23, 2007
<http://www.msnbc.msn.com/id/20410979/>
 - Mars Today (press release) - Aug 23, 2007
<http://www.marstoday.com/news/viewpr.html?pid=23322>
 - Space Ref (press release) - Aug 23, 2007
<http://www.spaceref.com/news/viewpr.html?pid=23322>
 - innovations report, Germany - Aug 23, 2007
http://www.innovations-report.de/html/berichte/physik_astronomie/bericht-89330.html
 - LiveScience.com, NY - Aug 22, 2007
http://www.livescience.com/space/scienceastronomy/070822_solar_flares.html
 - Space.com - Aug 22, 2007
http://www.space.com/scienceastronomy/070822_solar_flares.html

SEP longitudinal extent (Reames, 1999)

New Picture:

