Near-Earth Particle Environment as Observed by CORONAS-F, CORONAS-PHOTON and PROBA2 Satellites

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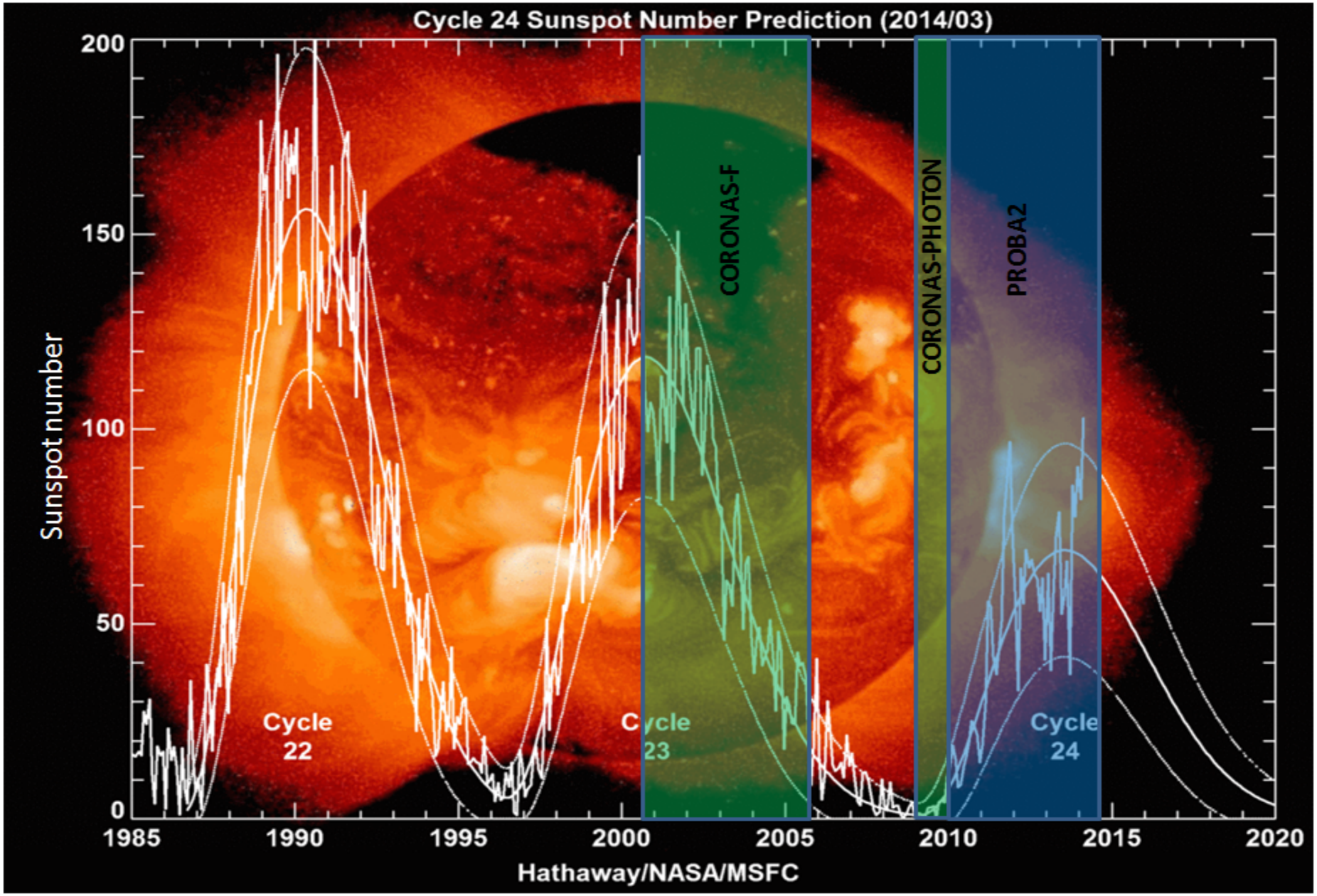
SRC-PAS

Involved eHEROES partners SRC-PAS, LPI, ROB

Satellites and periods of observations

SATELLITE	CORONAS-F	CORONAS-Photon	PROBA2
Mission duration	31.08.2001–05.12.2005	31.01-2009 – 30.11.2009	02.11.2009 - Present
LEO Orbit height [km]	550/500	575/550	728
Orbit inclination angle [deg]	82.5	82.5	98.3
Initial orbital period [min]	95	96	100

All spacecrafts on LEO, high inclination orbits



Mission lifetimes of CORONAS-F, CORONAS-Photon, PROBA2 satellites over solar activity cycle

Instruments

Instrument name	Short name	Satellite
SPRIT (Zhitnik et al. 2002),	SPRIT	CORONAS-F
DIagnostics Of Global ENErgy Sources and Sinks (Płocieniak et al., 2002; Siarkowski et al., 2002),	DIOGENESS	CORONAS-F
REntgenovsky Spektrometr s Izognutymi Kristalami (Sylwester et al., 2005)	RESIK	CORONAS-F
TElescopic Spectroheligraphic Imaging System telescope (Kuzin et al., 2011)	TESIS	CORONAS-PHOTON
Solar Photometer in X-rays (Sylwester et al., 2008; Gburek et al., 2013)	SphinX	CORONAS-PHOTON
The Sun Watcher with Active Pixel Sensor and Image Processing (Halain et al, 2010; Halain et al, 2013; Seaton et al, 2013)	SWAP	PROBA2
Lyman-Alpha Radiometer (Dominique et al., 2013)	LYRA	PROBA2

All instruments for observations of the Sun i X and EUV rays

Main components of Earth particle environment at LEO orbit

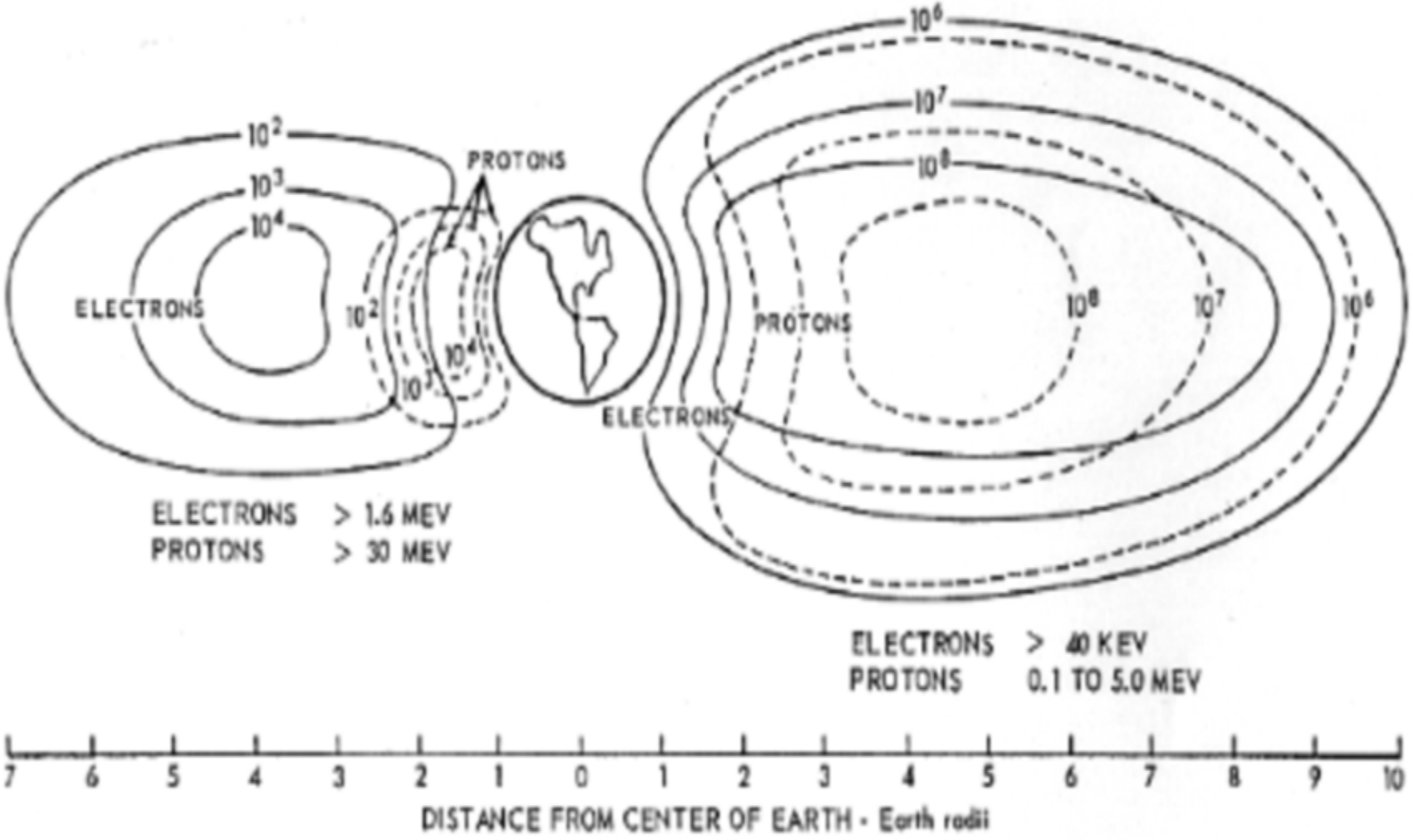
- Particles trapped in Earth radiation belts
- Transient events in solar wind (particles accelerated in flares and by coronal mass ejections)
- Fluxes of Galactic Cosmic Rays

The total radiation flux, as well as relative contributions of its components, depend on the position in orbit and vary with the level of the solar activity.

These particle fluxes disturb the measurements provided by on-board instruments, decrease a lifetime of sensors and may be a cause of sudden break-out.

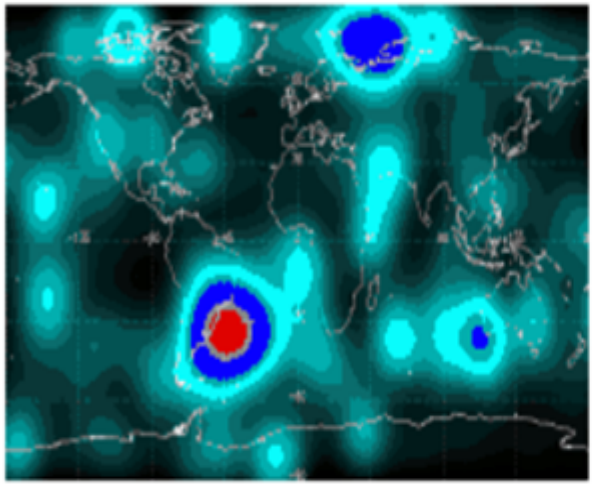
Important regions are South Atlantic Anomaly and polar caps.

Fluxes of electrons and protons in Earth particle environments

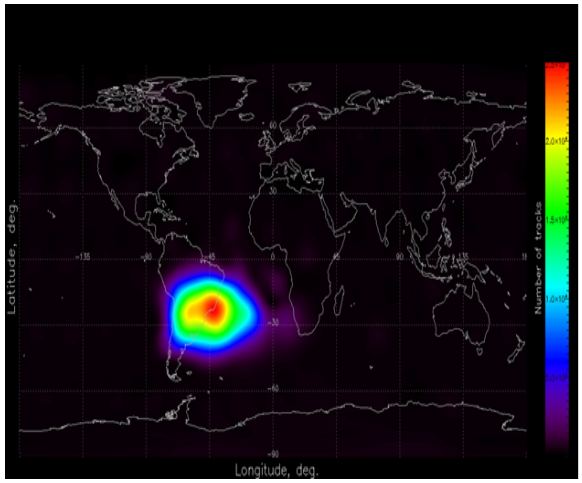


Examples of particle data obtained from different instruments

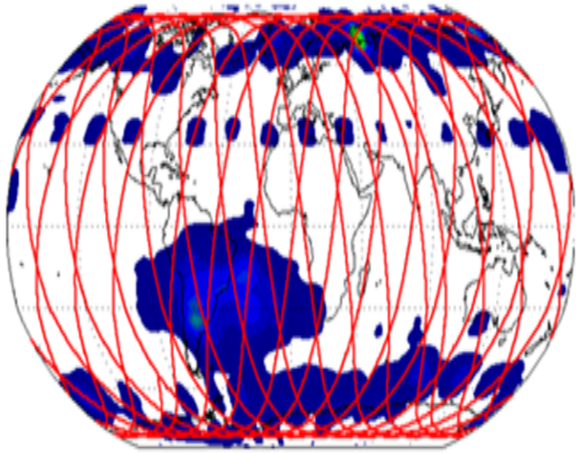
SPIRIT/CORONAS-F

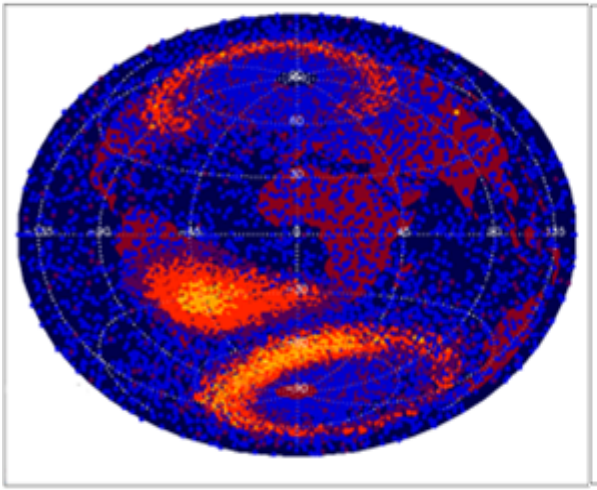


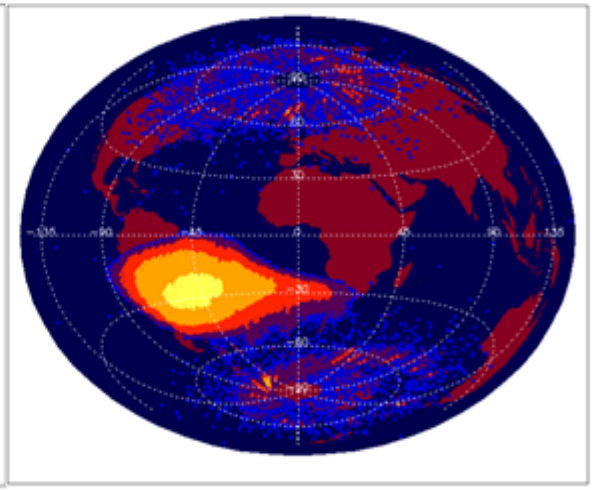
TESIS/CORONAS-PHOTON

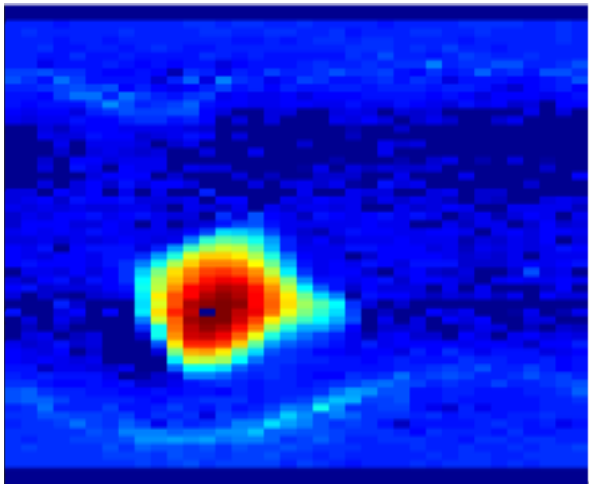


LYRA/PROBA2





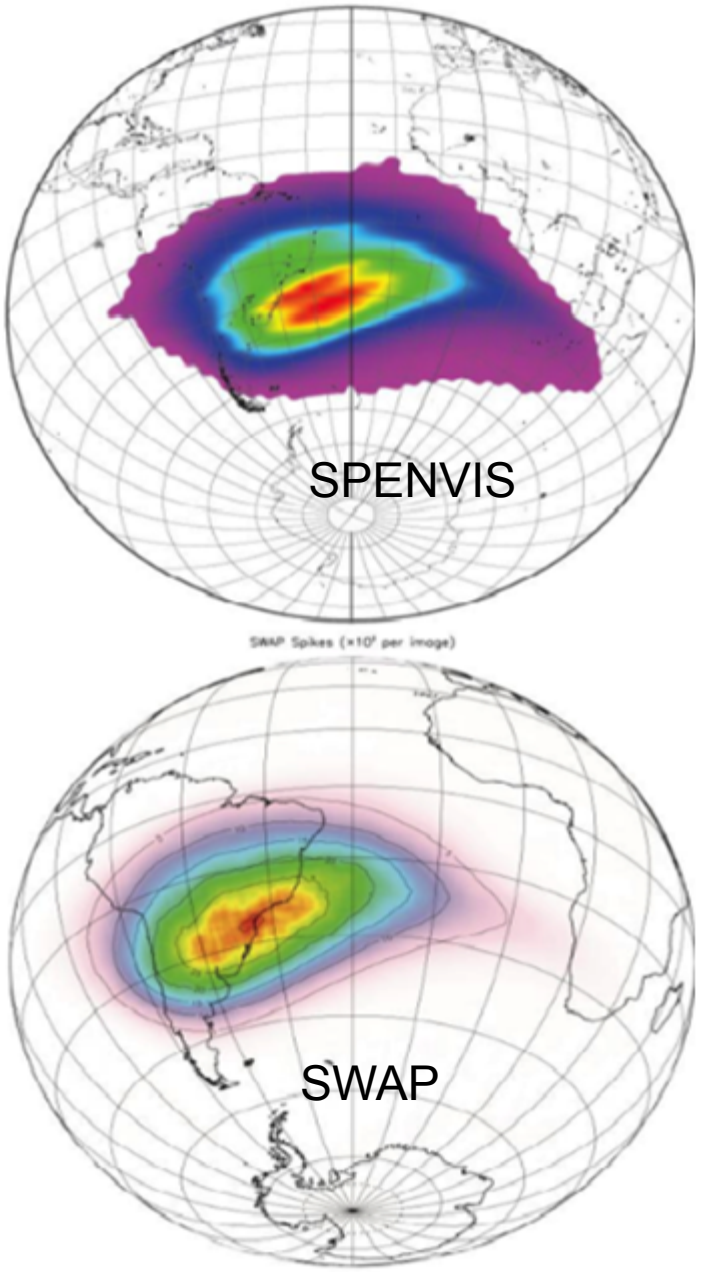




RESIK/CORONAS-F

SphinX/CORONAS-PHOTON

SWAP/PROBA2

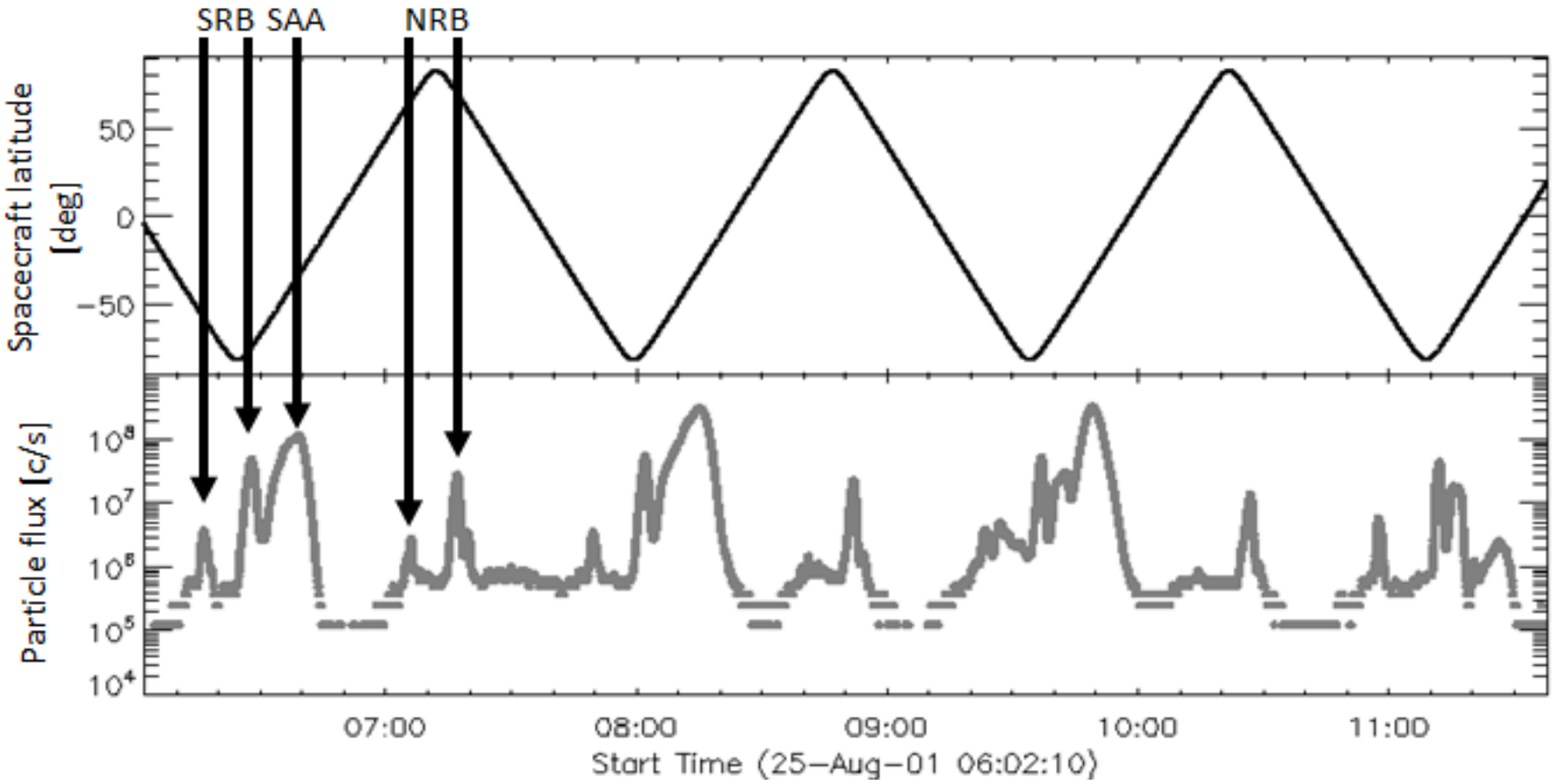


SAA shift

Comparison of the SWAP map
to the SPENVIS generated maps
reveals westward shift
of the SAA.

This is also seen
in other instrument maps.

DIOGENESS particle observations during quiet magnetosphere

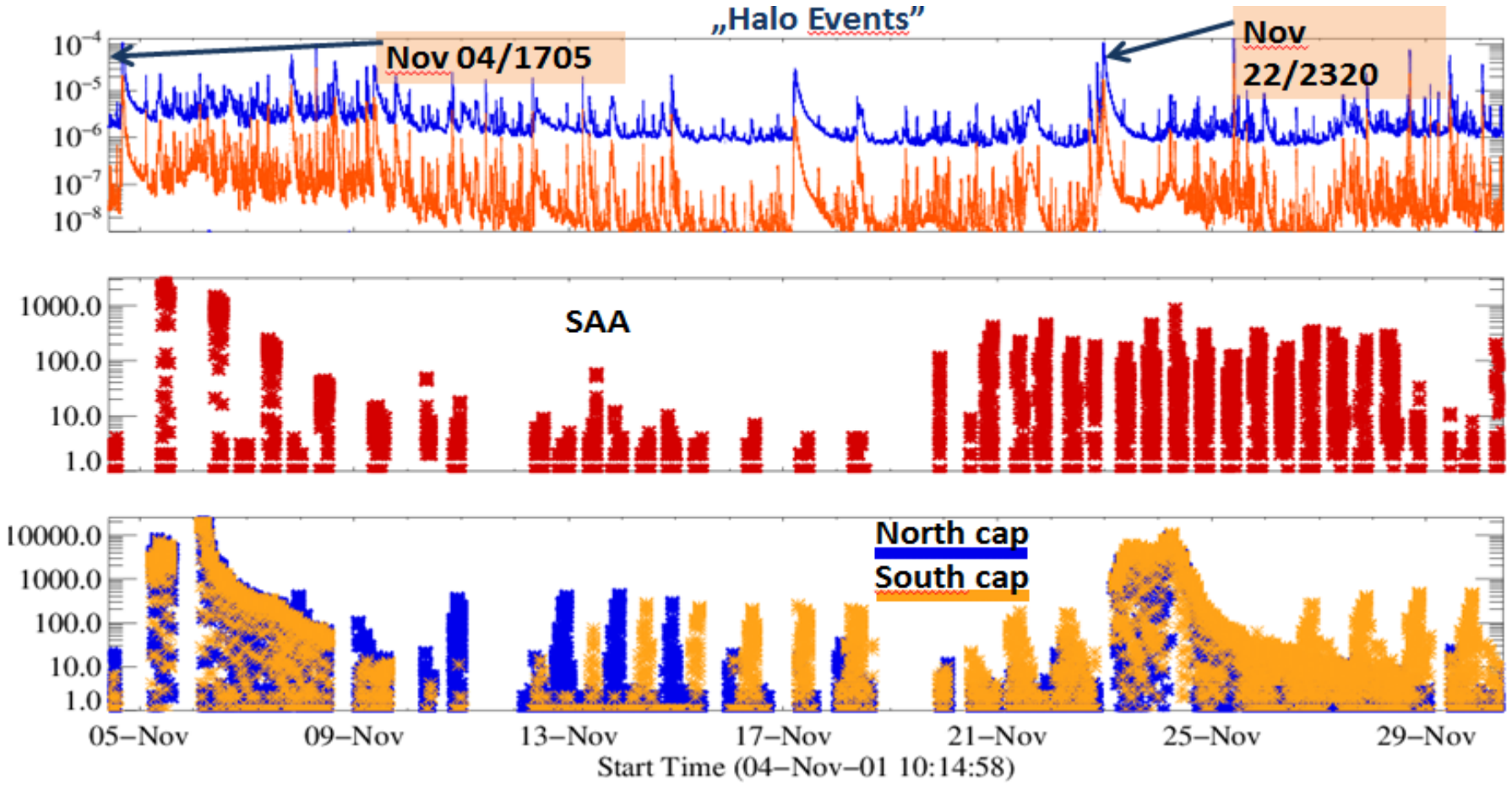


SRB, NRB - southern and northern portion of radiation belts.

SAA - South Atlantic Anomaly.

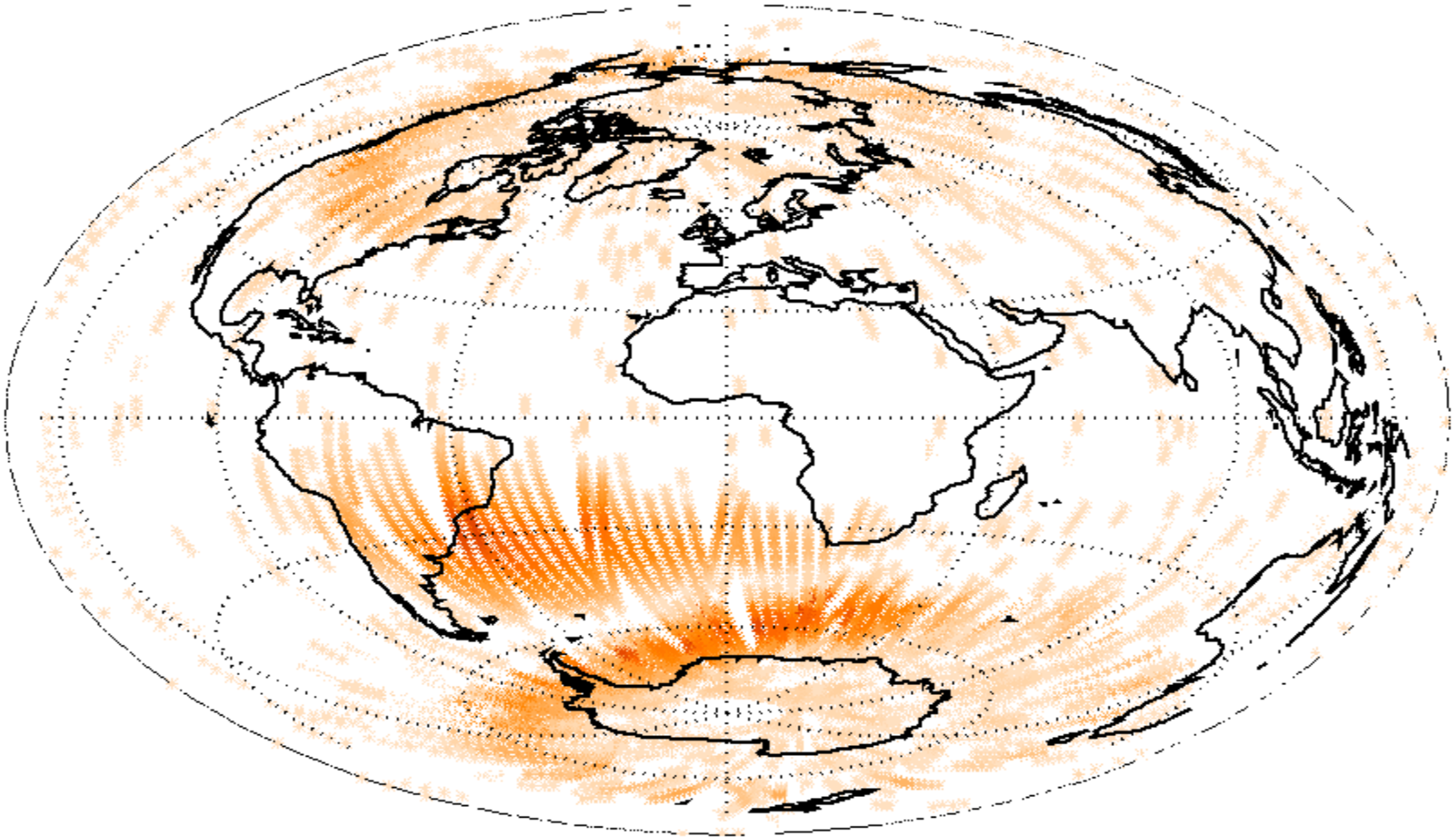
Particle signal in polar caps is similar in intensity to equatorial regions.

Transient particle events as observed by RESIK



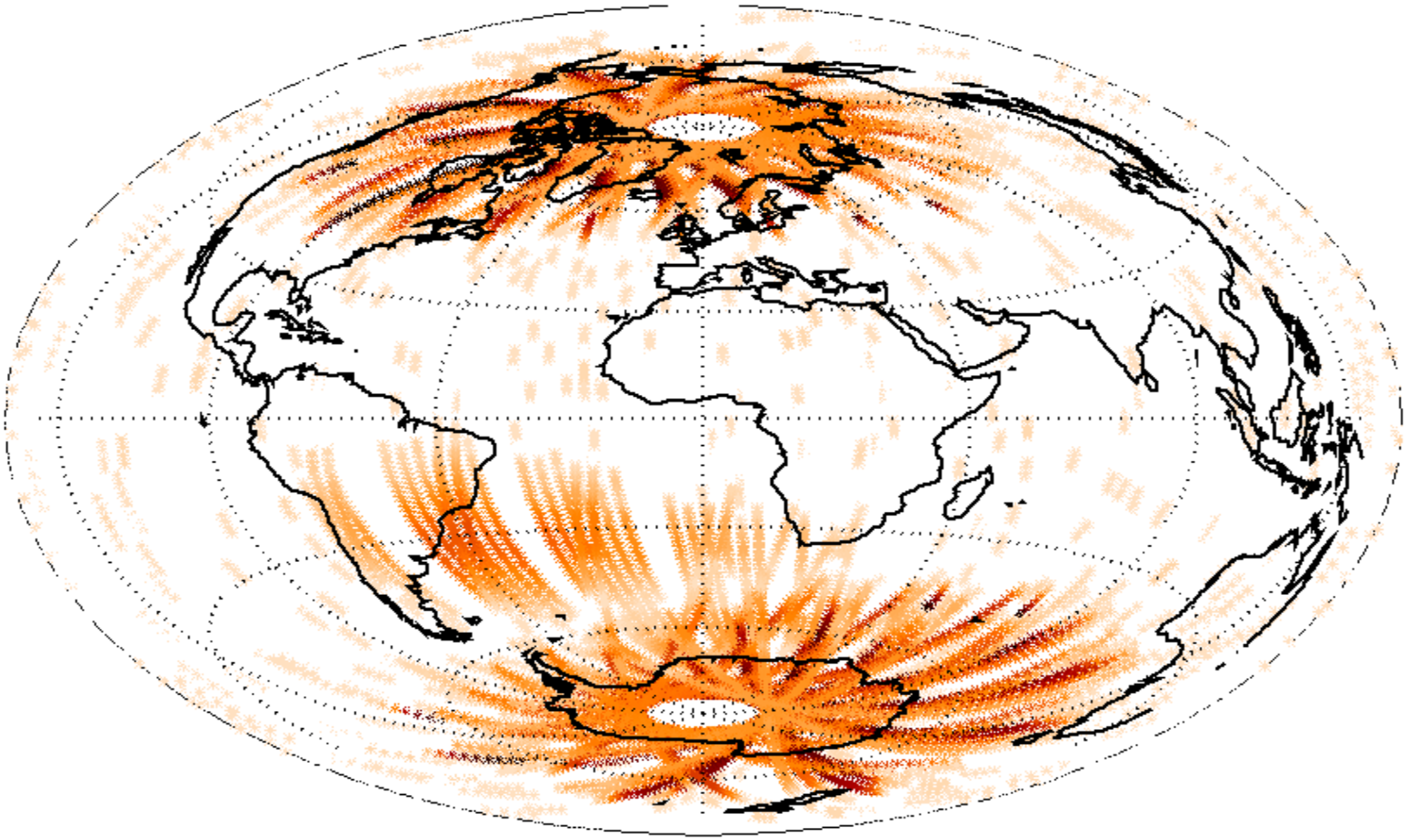
PARTICLE EVENT			ASSOCIATED CME, FLARE, AND ACTIVE REGION				
Start	Maximum	Proton Flux pfu @ >10 MeV	CME	Maximum	Importance	Location	NOAA SEC AR
Nov 04/1705	Nov 06/0215	31 700	halo /04 1635	Nov 04/1620	X1/3B	N06W18	9684
Nov 19/1230	Nov 20/0010	34	halo /17 0530	Nov 17/0525	M2/1N	S13E42	9704
Nov 22/2320	Nov 24/0555	18 900	halo /22 2330	Nov 22/2330	M9/2N	S15W34	9704

RESIK particle environment during quiet period 13-19 Nov 2001



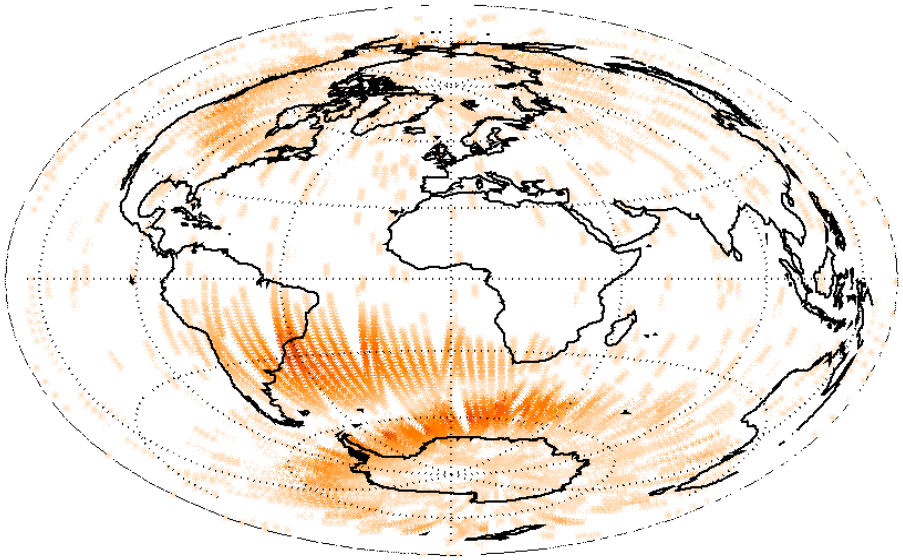
Kp < 4

RESIK particle environment during disturbed period 13-19 Nov 2001

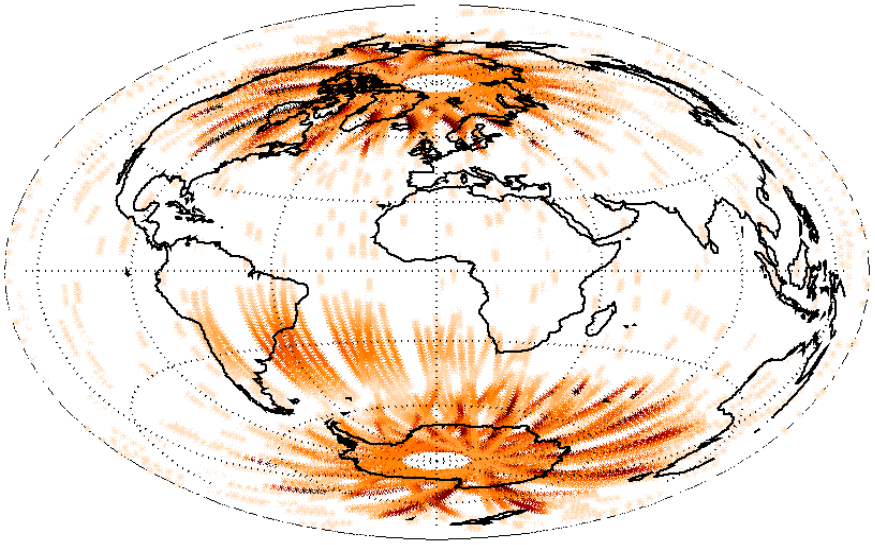


max Kp = 9, SEP event

Comparison of RESIK particle observations during quiet and perturbed magnetospheric conditions



Quiet period
13-19 Nov 2001



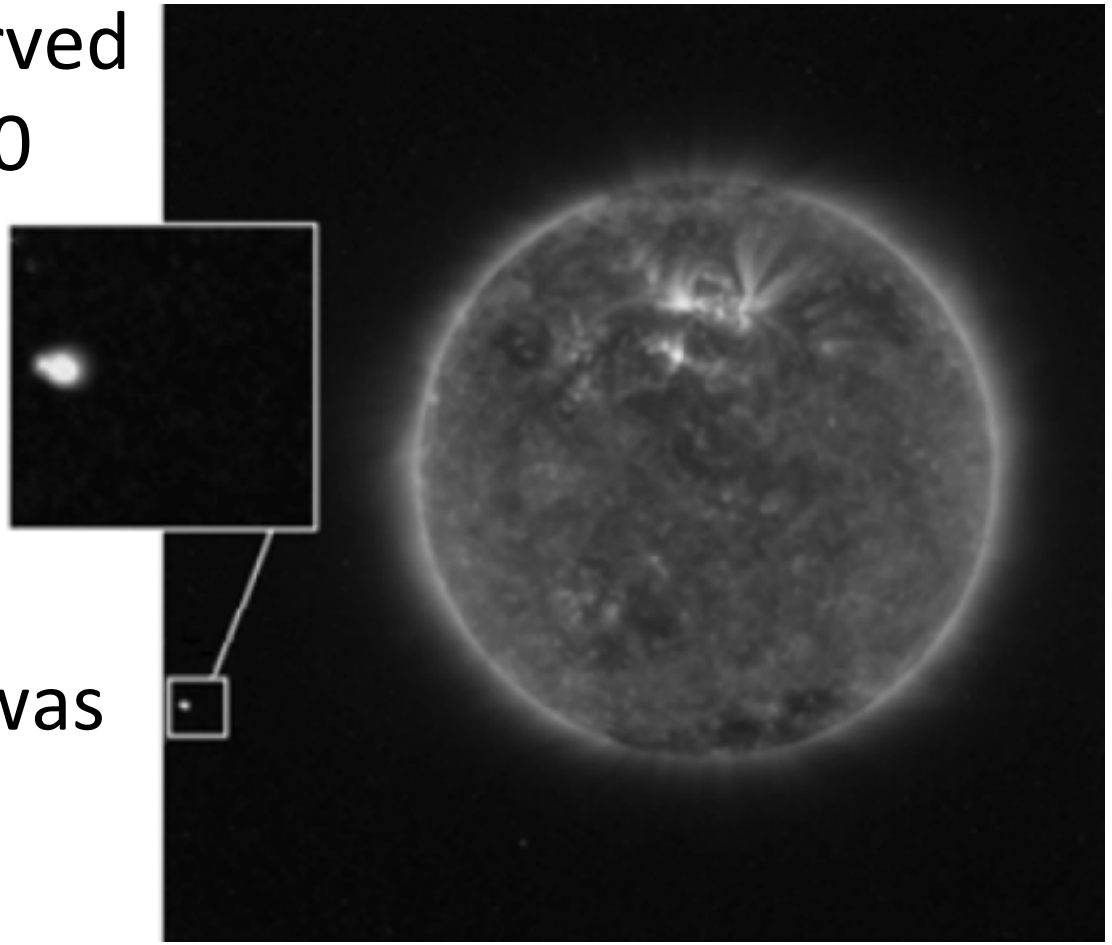
Disturbed period
03-09 Nov 2001

Galactic Cosmic Rays

Particular event observed on 13 January 2010

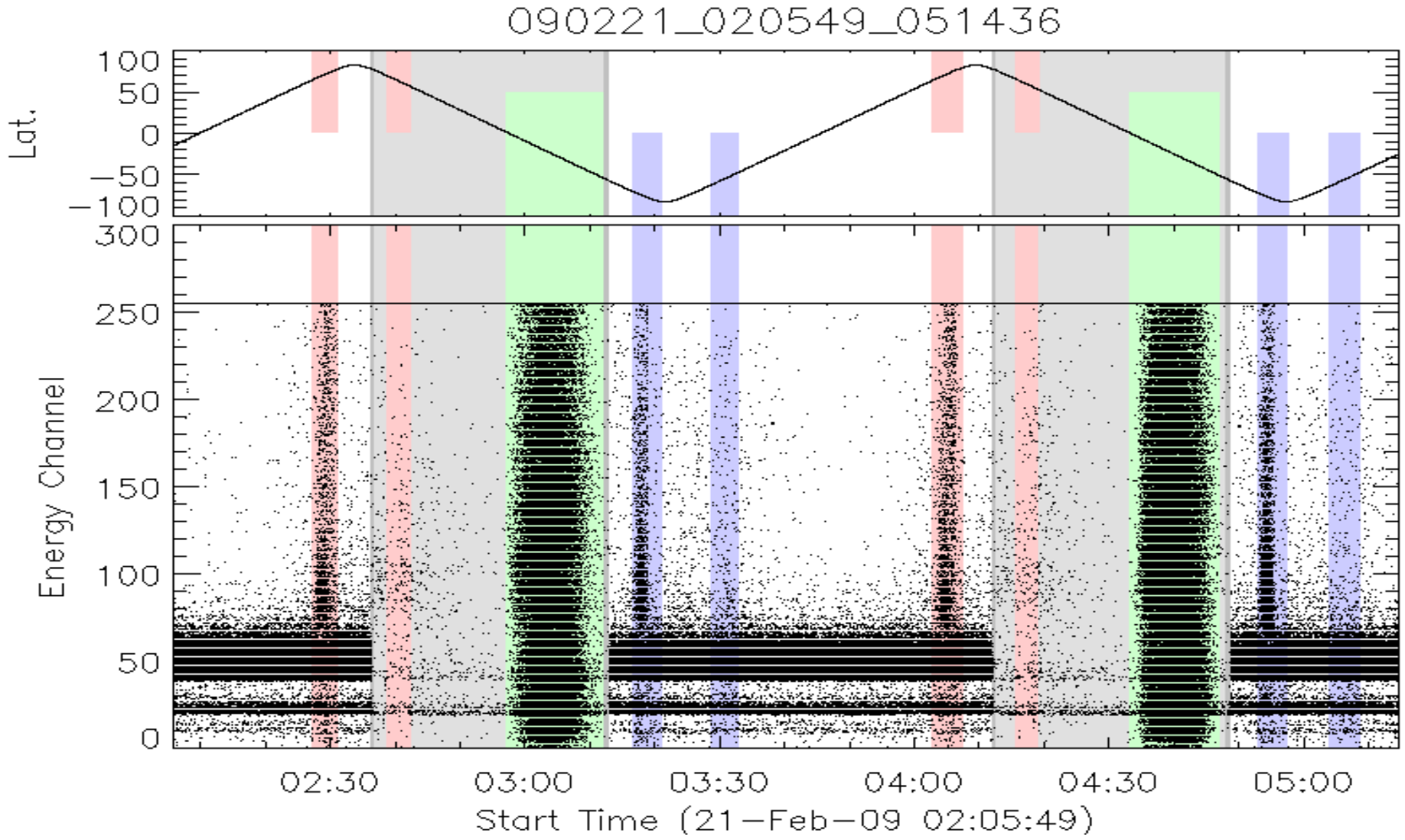
May be of GCR origin

SWAP APS detector was not damaged by this event

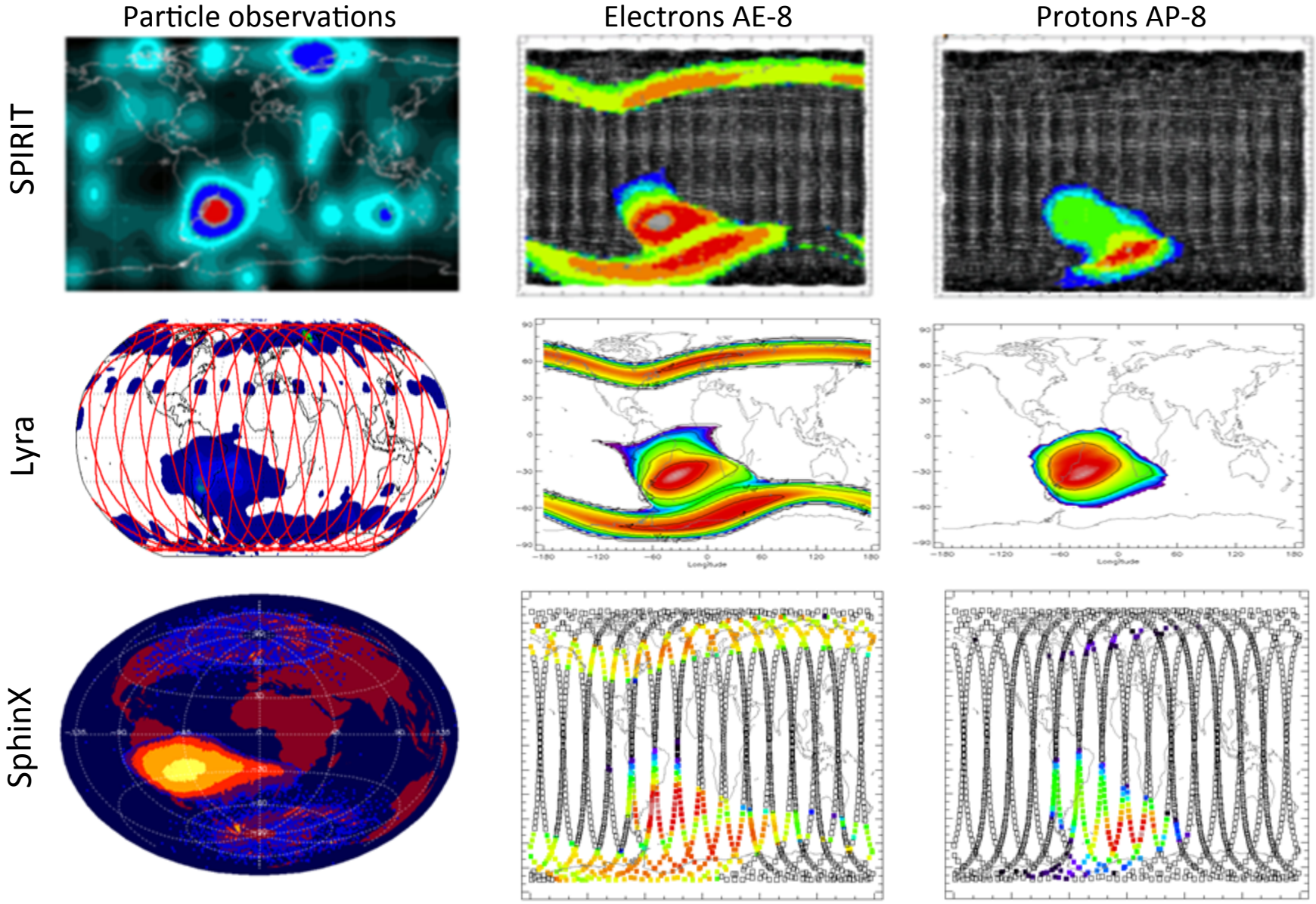


Halain *et al*., 2011, First light of SWAP on-board PROBA2, Proceedings of the SPIE, Volume 7732, article id. 77320P, 11 pp. 2010, DOI: 10.1117/12.857979

SphinX particle observations during quiet magnetosphere



Comparison of particle observations with AE-8 and AP-8 models



The spatial distribution of particle data differs from that predicted by AE-8 and AP-8 models due to enhancements produced by transient effects.

CONCLUSIONS

Identified particle contributions to the data have typically forms of spiky structures (and tracks for pixelized detectors) for all instruments.

This signal may be caused by primary energetic particles on spacecraft orbits and secondary particles produced in instrument/satellite construction elements.

All instruments saw/see particle signal in SAA.

Shape of SAA is different in maps obtained from observations (different detectors, shielding).

Comparison the particle map to the SPENVIS-generated maps reveals shift of SAA. It is seen in maps from all instrument.

For quiet magnetospheric conditions the instrument fall into two categories:
1) TESIS, LYRA, SWAP – do not see/saw additional contribution to the signal in auroral zones,
2) SPIRIT, SphinX, RESIK and DIOGENESS saw additional contribution in auroral zones.

All instruments see some additional contribution to the signal in auroral zones during magnetospheric disturbances.

Obtained data can be useful in studies of transient component of the Earth particle environment which is not available in AE-8 and AP-8 its models.

All the instruments appeared robust against particle during their missions. No particle caused damages were observed.

THANK YOU

More about particle effects on LYRA by

Thanassis Katsiyannis

on January 9