Particle signatures in SphinX and STEP-F measurements possible new directions for common data analysis

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Sphinx is Polish X-ray spectrophotometer for measuring soft X-ray emission from the Sun in the energy range of 1 - 15 keV. The instrument operated from February to November 2009 on *CORONAS-Photon* satellite simultaneously with STEP-F instrument which is Ukrainian telescope for measuring electron and proton content and spectra at Low Earth Orbit. In addition to regular solar data SphinX has also provided particle related data of quite good quality. Preliminary comparison of STEP-F and SphinX particle data sets reveals their good correspondence. Based on the common data sets it is possible to carry out cross-calibration of SphinX particle registration channel.

SphinX

SphinX as the solar photometer provided big amount of excellent quality solar data. On top of these regular solar measurements additional particle related detector signal has been collected, mostly in the last of 256 SphinX energy channels which corresponds to the energies above 15 keV. It can be found that count rate in the last channel was significantly increased when spacecraft crossed through the South Atlantic Anomaly (SAA) and Radiation Belts (RB). This characteristic pattern was seen in data from both D1 and D2 SphinX detectors (Fig. 1). This figure shows that SphinX is able to take measurements of Earth's particle environment.

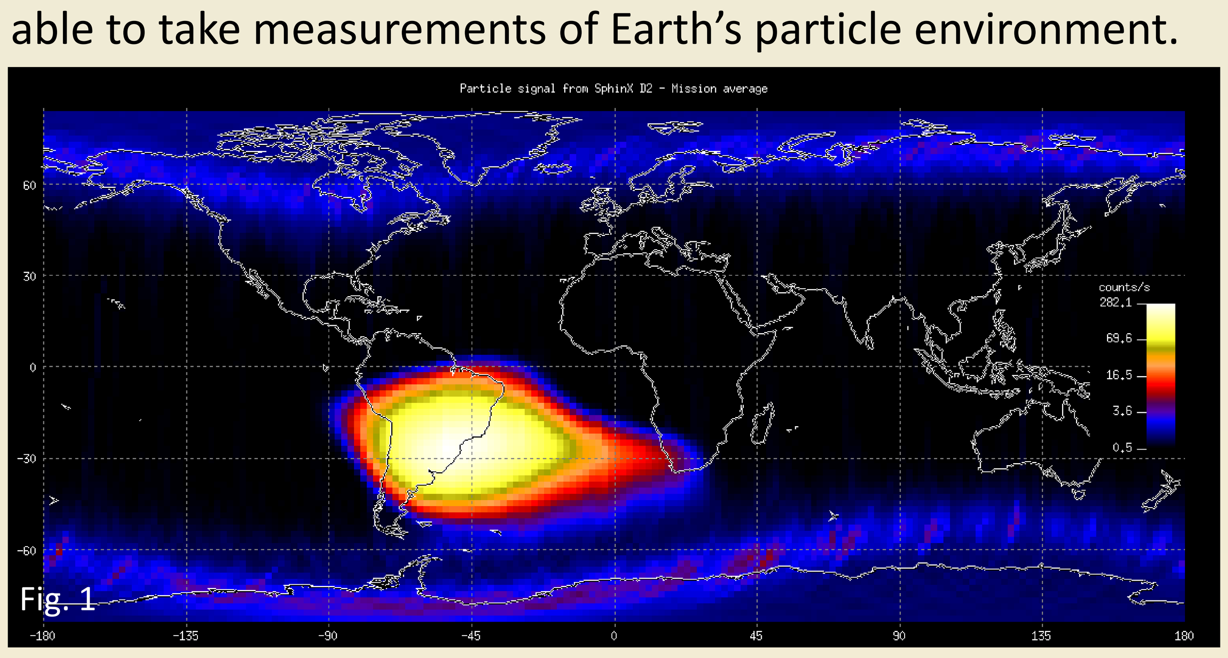


Fig. 1

In order to investigate SphinX sensitivity to the particle flux a ground test was performed using one of SphinX spare detectors and radioactive sources. The test result reveals that SphinX detector D2 is sensitive to electrons of energy up to 1.5 MeV as well as to gamma rays of energy up to 900 keV (Fig. 2).

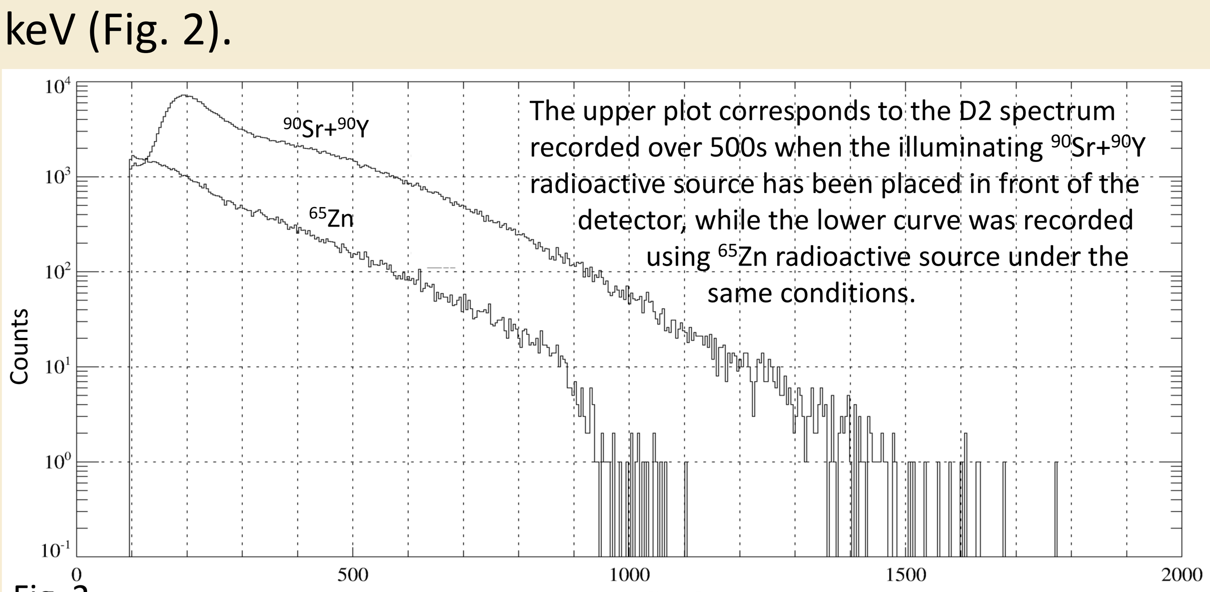


Fig. 2

Particle signals from SphinX D1 and D2 detectors recorded in SAA are very similar. In RB particle signal from D1 is significantly stronger than from D2 (Fig. 3). Different detector sensitivities arise from different dimensions of particular detectors and geometry of their optical entrances. There is also observed particle signal modulation while crossing RB which is most likely due to substantial particle flux anisotropy and narrow FOV of SphinX detectors. Besides primary electrons SphinX recorded also secondary gamma photons excited by primary particles on mechanical construction parts. The contribution of these two components in overall signal is different for D1 and D2.

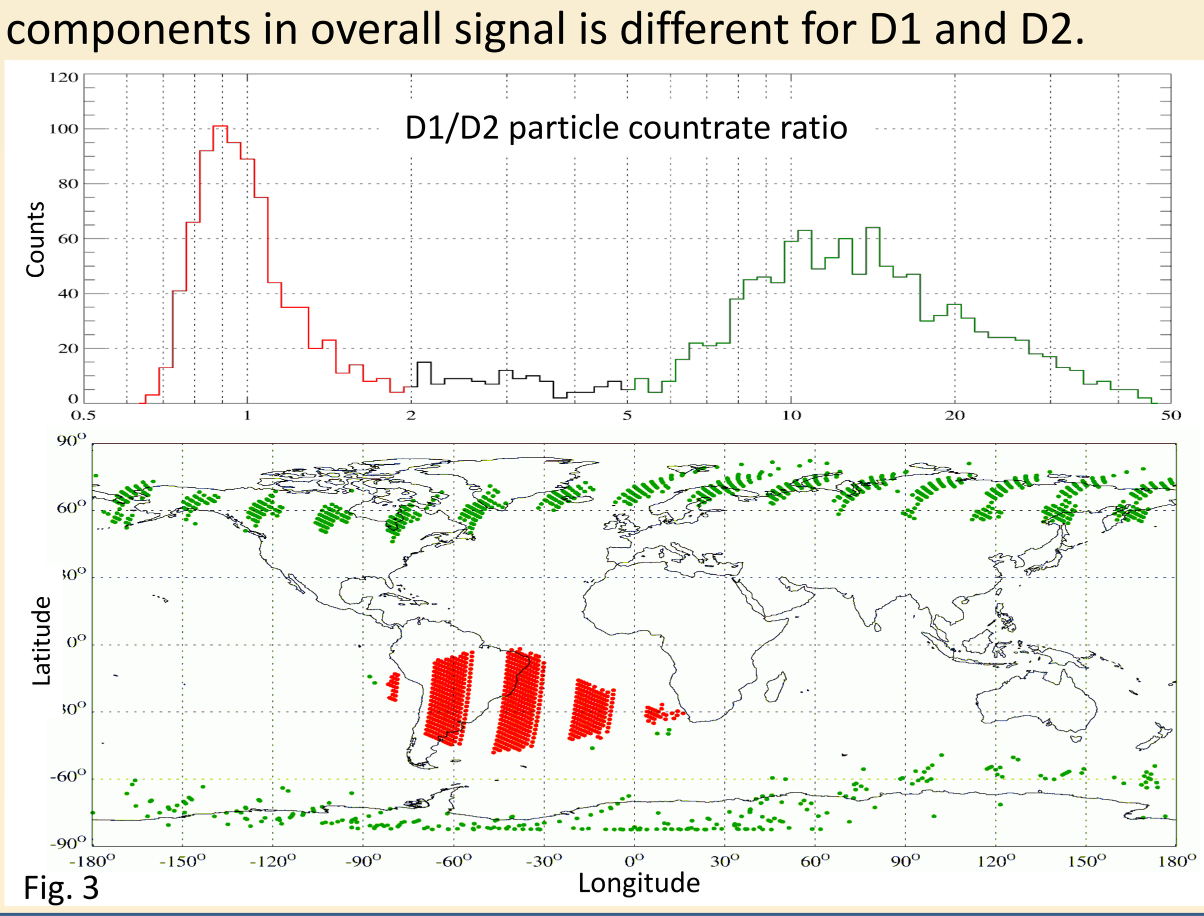
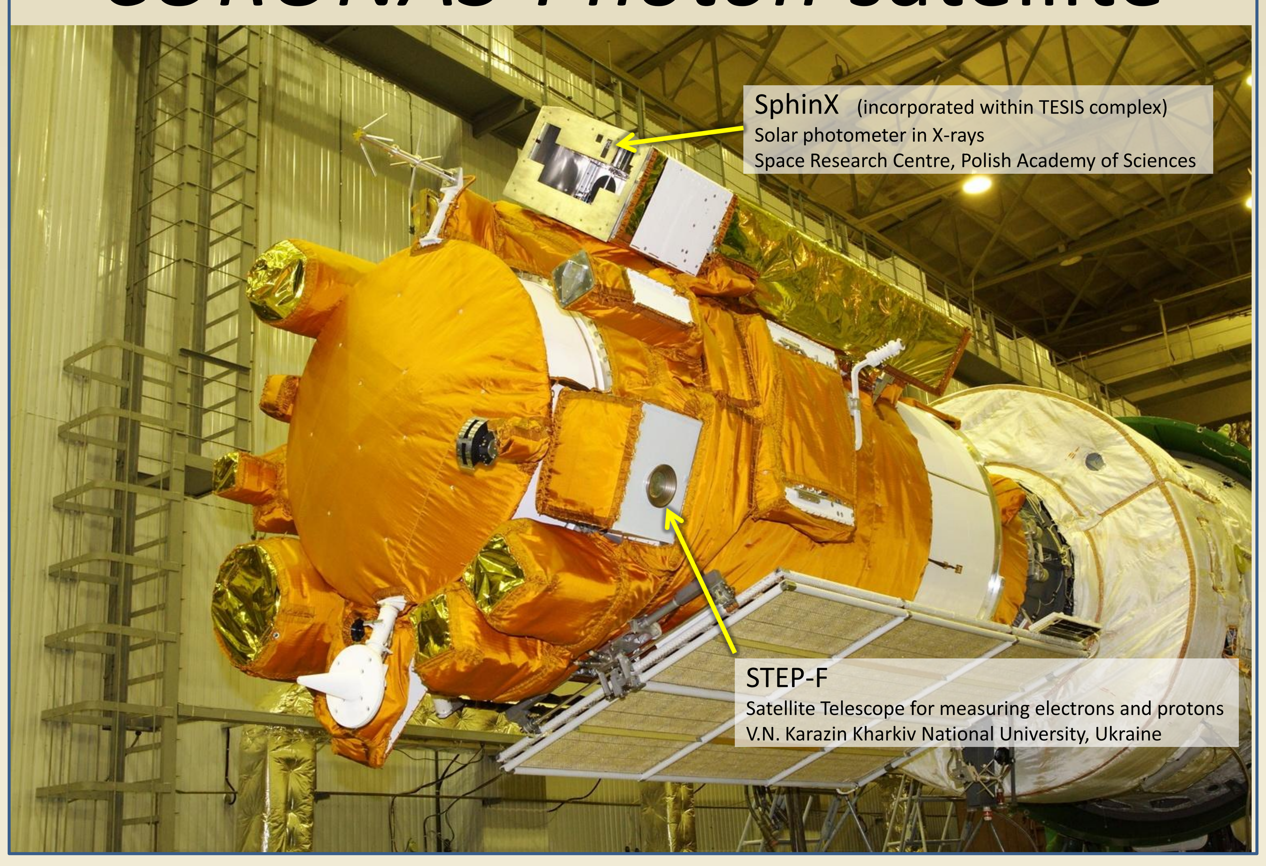


Fig. 3

CORONAS-Photon satellite



Common analysis

Thanks to the STEP-F measurements taken in the same location and time as SphinX there is an excellent opportunity to carry out common data analysis. Using calibrated STEP-F data we can better understand SphinX particle observations and determine kind of recorded particles and energy thresholds.

A simple comparison of SphinX and STEP-F data sets for time period from May 1-st to 14-th 2009 shows quite good correspondence between both observations (Fig. 4). Slightly different timing and profile of RB crosses between SphinX and STEP-F arise from perpendicular orientation of SphinX and STEP-F detectors. In addition SphinX has much narrower FOV than STEP-F, thus anisotropy of particle flux in RB affected their profiles seen by SphinX. SAA profiles from D1 and D2 detectors match very well each other since particle flux in SAA is mostly isotropic.

By comparison of common data it can be found that SphinX was sensitive to electrons and secondary gamma rays while protons were rather not recorded.

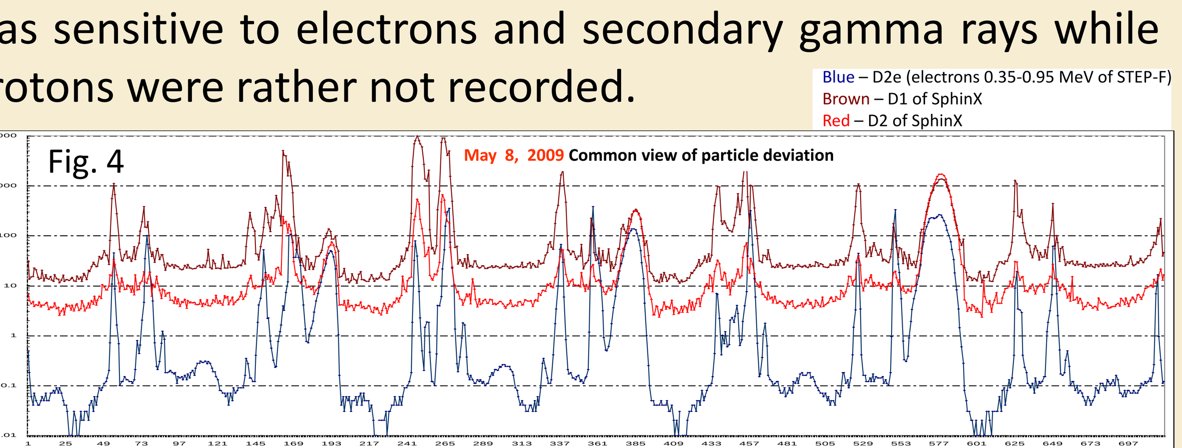


Fig. 4

By the analysis of RB and SAA profiles in L-shell domain we can determine effective energy thresholds for SphinX particle registration channels. SAA profiles recorded by SphinX are most similar to the profiles recorded by STEP-F D4e detector for registration of the secondary gamma rays (Fig. 5). The first results of common analysis are very promising and for the next steps we can also determine effective FOV for SphinX. Once a cross-calibration of SphinX measurements will be done a further scientific analysis can be carry out based on common data.

Possible direction for common analysis based on ShinX and STEP-F data:
- Analysis of anisotropy of particle flux in RB.
- Investigation of electrons lifetime in RB for few energy ranges.
- Analysis of radial diffusion during weak geomagnetic storm.

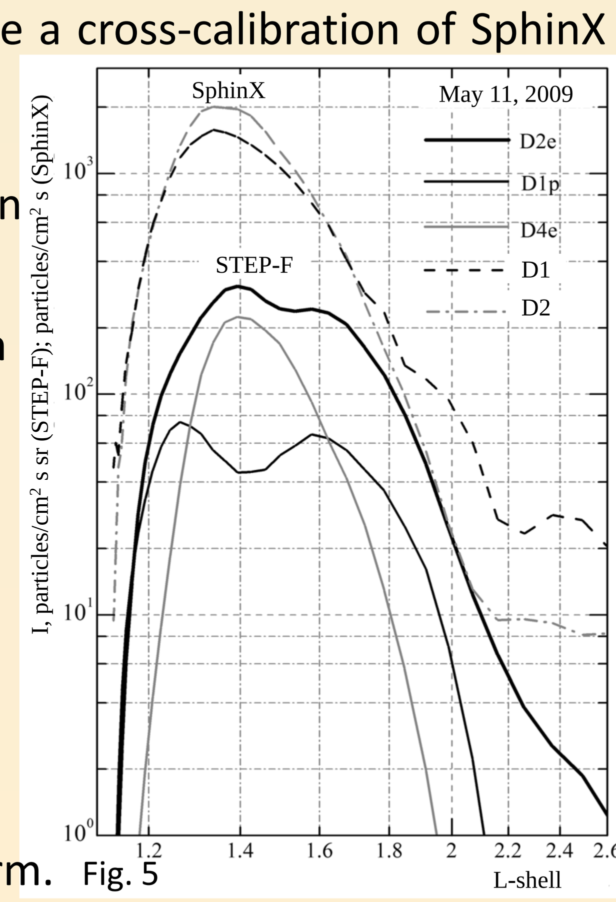


Fig. 5

STEP-F

STEP-F is Ukrainian telescope for measuring electron and proton fluxes aboard *CORONAS-Photon* satellite. Main scientific objectives of STEP-F is to study of energetic solar cosmic rays and their transport through interplanetary space as well as dynamics of Earth's radiation belts during the 23-rd cycle of solar activity.

The STEP-F instrument provides registration of electron fluxes and energy spectra in the energy ranges Ee = 0,18 – 15,0 MeV (Fig. 6), proton fluxes and energy spectra in the energy range Ep = 3,5 - 61,0 MeV, proton fluxes in integral range Ep > 61,0 MeV, alpha-particle fluxes and energy spectra in the energy range Ea = 15,9 - 246,0 MeV.

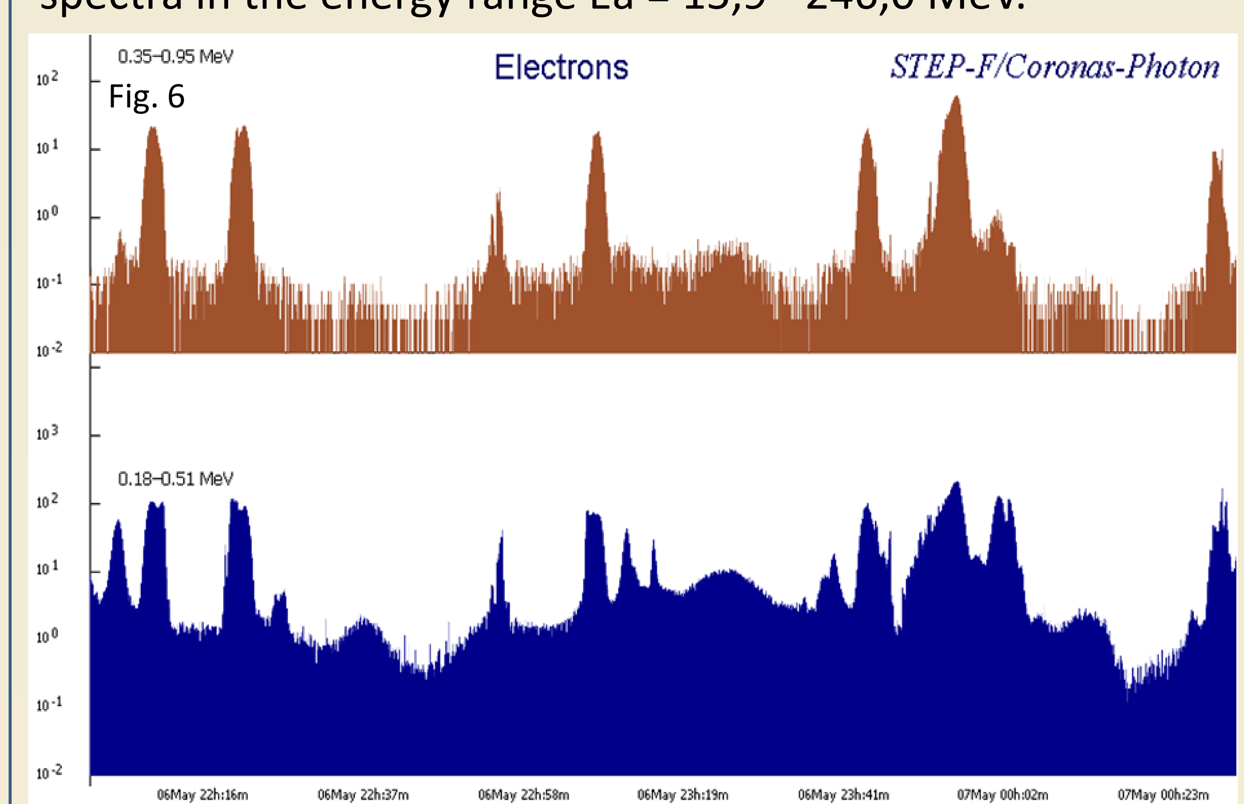


Fig. 6

Excellent sensitivity of STEP-F instrument allow to study fine changes in Earth's particle environment during weak geomagnetic storm on May 8, 2009 (Fig. 7, 8). These unique observations will be also used for common analysis.

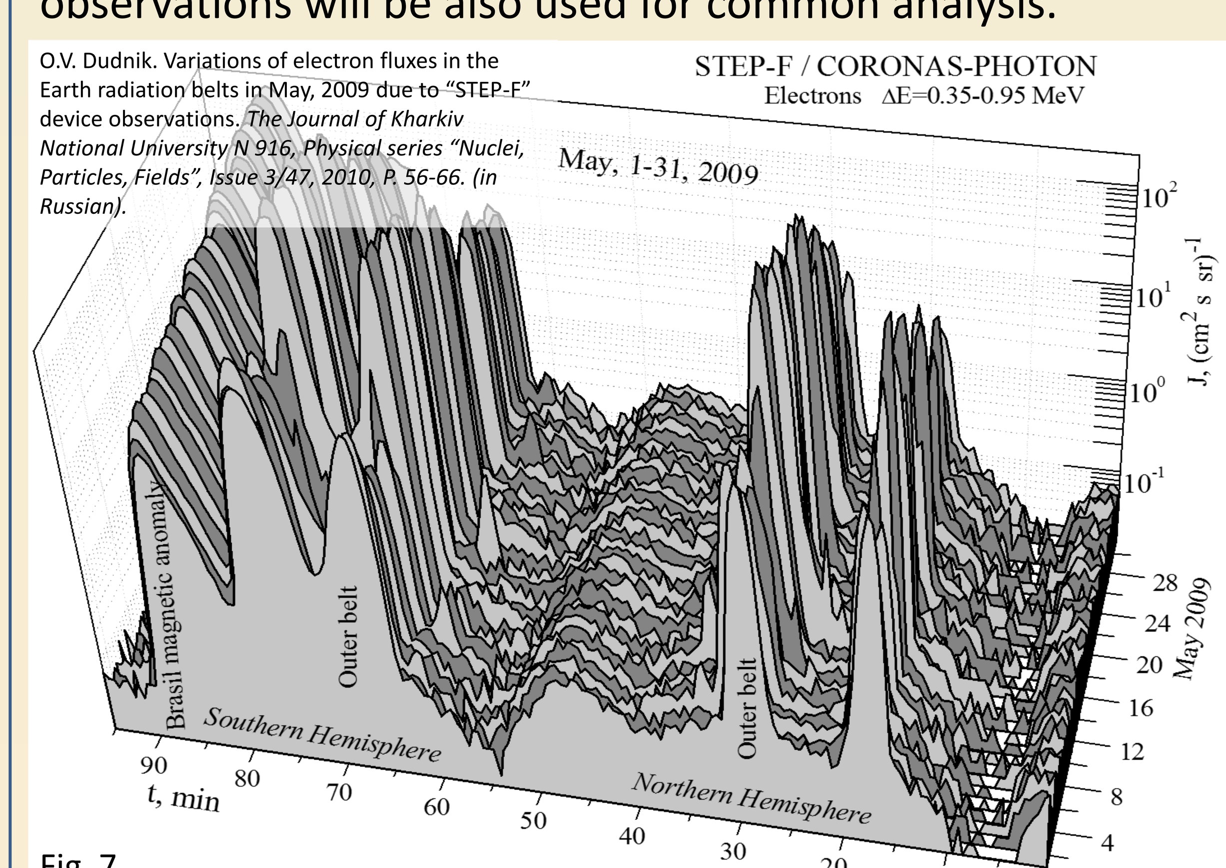


Fig. 7

The time period selected for scientific analysis is very interesting because it covers quiet conditions as well as weak geomagnetic storm which affected Earth's particle environment.

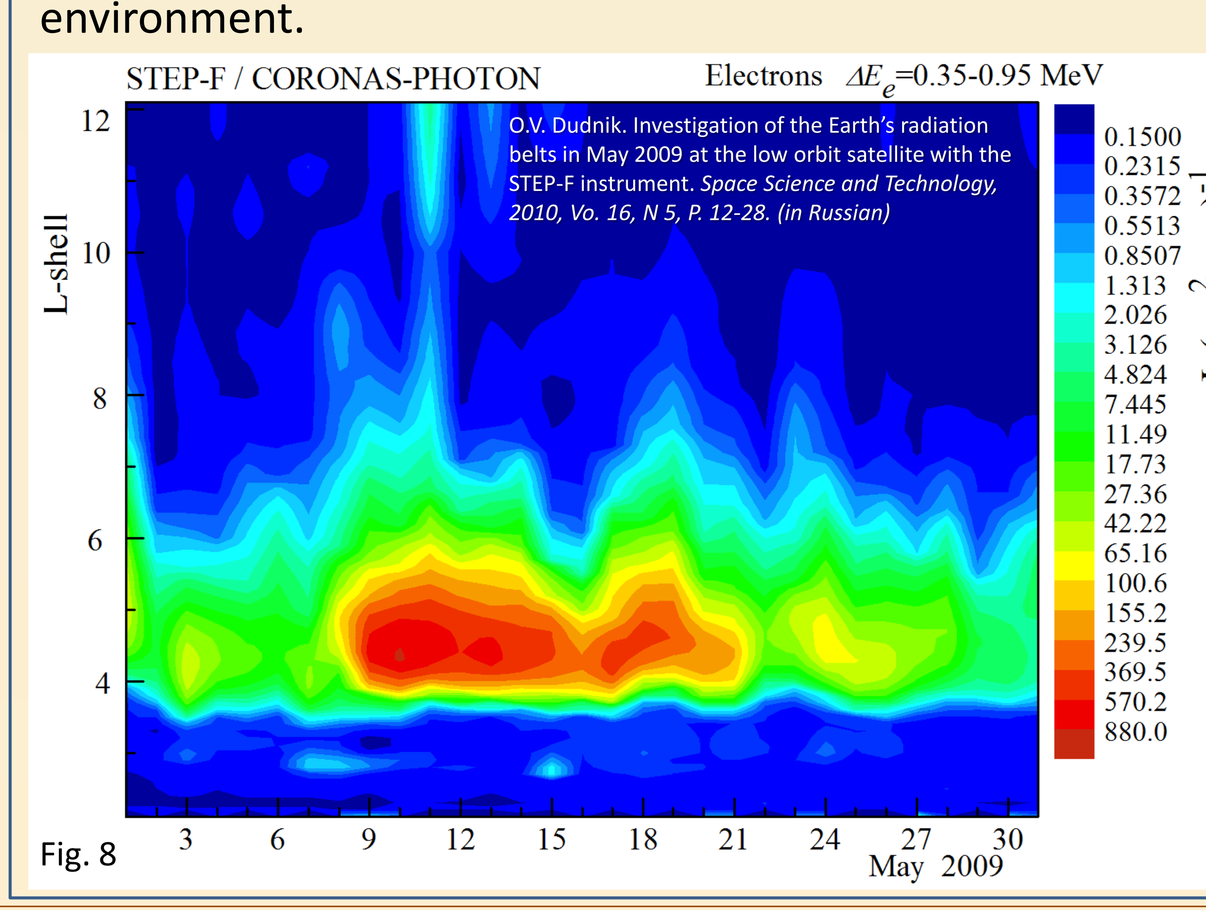


Fig. 8

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