Spatial and energy distributions of high energy electron bursts caused by precipitations from the inner radiation belt.

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Abstract. This work is devoted to the analysis of experimental data of high-energy electron flux in the near-Earth space. The data were obtained during the ARINA and VSPLESK satellite experiments. The ARINA and VSPLESK spectrometers measured the fluxes of electrons and protons with energies of 3-30 MeV and 30-100 MeV respectively. The ARINA was carried out since 2006 till 2016 on board the Resurs-DK1 satellite. The VSPLESK was carried out since 2008 till 2013 on board the International Space Station. The goal of these experiments was to study the physics origin of high-energy charged particle variations and bursts (short term increases of fluxes). Spatial distributions and energy spectra of high-energy electron bursts caused by various local geophysical phenomena were analyzed.

ARINA and VSPLESK satellite experiments

<table>
<thead>
<tr>
<th>Acceptance</th>
<th>10 sm^2sr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aperture</td>
<td>±30 degrees</td>
</tr>
<tr>
<td>Energy range</td>
<td>protons 30 – 100 MeV</td>
</tr>
<tr>
<td>Energy resolution</td>
<td>protons 10%</td>
</tr>
<tr>
<td>Time resolution</td>
<td>100 ns</td>
</tr>
<tr>
<td>Mass</td>
<td>8.6 kg</td>
</tr>
<tr>
<td>Power consumption</td>
<td>13.5 W</td>
</tr>
</tbody>
</table>

Physical layout of ARINA and VSPLESK

The dependence of cloud duration (Tc) on longitude (ΔL) traveled by drifting electrons (3-30 MeV).

In drift processing, a cloud of precipitating electrons expands in longitude. So the duration (and size) of this cloud increases. The dependence of cloud duration Tc, containing electrons in 3-30 MeV range, on longitude distance ΔL travelled by electrons is presented in Figure

Comparison modeling and experimental results
(The electron burst of August 24, 2009, ARINA)

The electron burst and determine region of precipitation

The red asterisk at 29° N, 2° E is the electron burst of August 24, 2009. The black line denotes the L-shell corresponding to the place at which the burst was registered. Yellow zone is region of electron precipitation by previous calculation. Dark yellow zone is region of electron precipitation by present calculation.

Table 1 presents values of y2 versus longitude distance traveled by drifting electrons (ΔL). Region of electron precipitation from the radiation belts determined in this work matches with [S.Yu. Aleksandrin, A.M. Galper, T. R. Zharaspayev, and S.V. Koldashov Bulletin of the NRC. Physics, 2015 Vol. 78, No. 5, pp. 646-649]. It is important to note that approach considered in present paper increases the reliability of the results because does not require utilization of complex mathematical methods under low statistics.

The depletion of high-energy part (a) and low energy part (b) of spectrum of drifting electrons (3-30 MeV).

Physical model

It is important to note that crossing time of L shell corresponding inner radiation belt (L=1-2) is about one minute for low orbit satellite with inclination more 40 degree. This time is smaller than cloud duration. In this case there are two different cases of electron burst registration by satellite. The first case is the cross of a head part of drifting electron cloud and the second one is the cross of a tail part of drifting electron cloud. A tail of electron cloud is depleted high-energy part of energy spectrum because of high velocity of longitudinal drift of high-energy electrons. So the tail of electron cloud is enriched with low energy electrons during the drift in difference of a head part of cloud (Figure b).

And for longitudinal distance travelled by electrons of cloud greater than 40-50 degree low energy part of registering electron spectrum at crossing L shell of cloud head by satellite will be depleted. In (Figure a) this effect (depletion of low energy part of electron spectrum) is shown.

Conclusion.

Numerical modeling results considered in this work show the changing energy spectrum of bursts of electrons generated by precipitation of electrons under local disturbances of the inner radiation belt with subsequent drift of electrons along L-shell around the Earth. Energy spectrum of bursts of drifting electrons depends on the longitudinal distance travelled by drifting cloud of electrons. So it is possible to determine the place of precipitation of particles from the radiation belt with using comparison of energy spectrum of electron burst, observed in satellite experiment, and modeled one. This technique has been used for electron bursts observed on 24 August 2009 and result determined for longitudinal distance matched the previously obtained by another method.