

The impact of intense fluxes of 30 keV-energy electrons and protons on the low latitude ionosphere

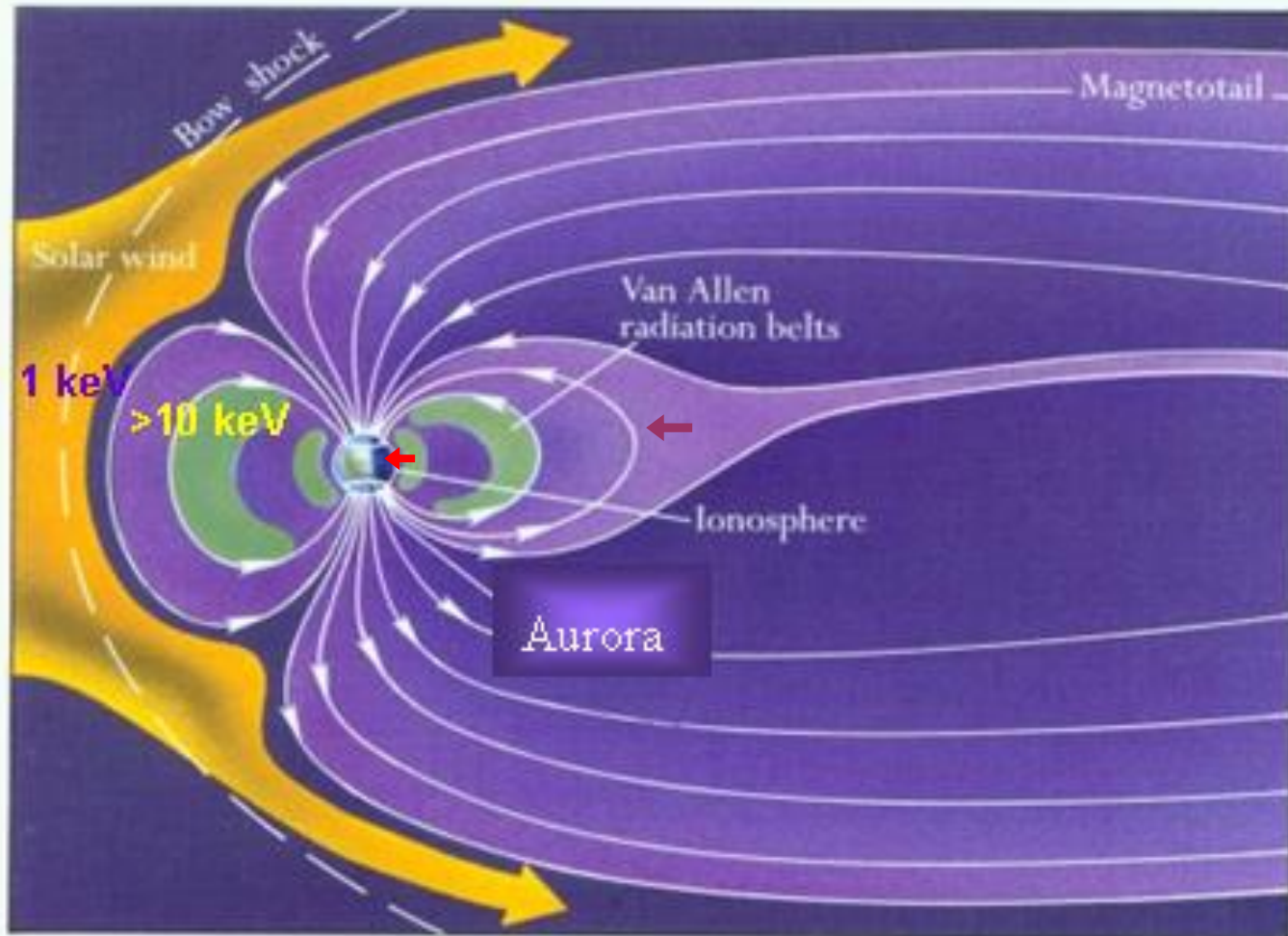
Suvorova A. V., Dmitriev A. V.

Воздействие интенсивных потоков >30 кэВ электронов и протонов на низкоширотную ионосферу

Суворова А.В., Дмитриев А.В.

National Central University, Taiwan
НИИЯФ МГУ, Россия

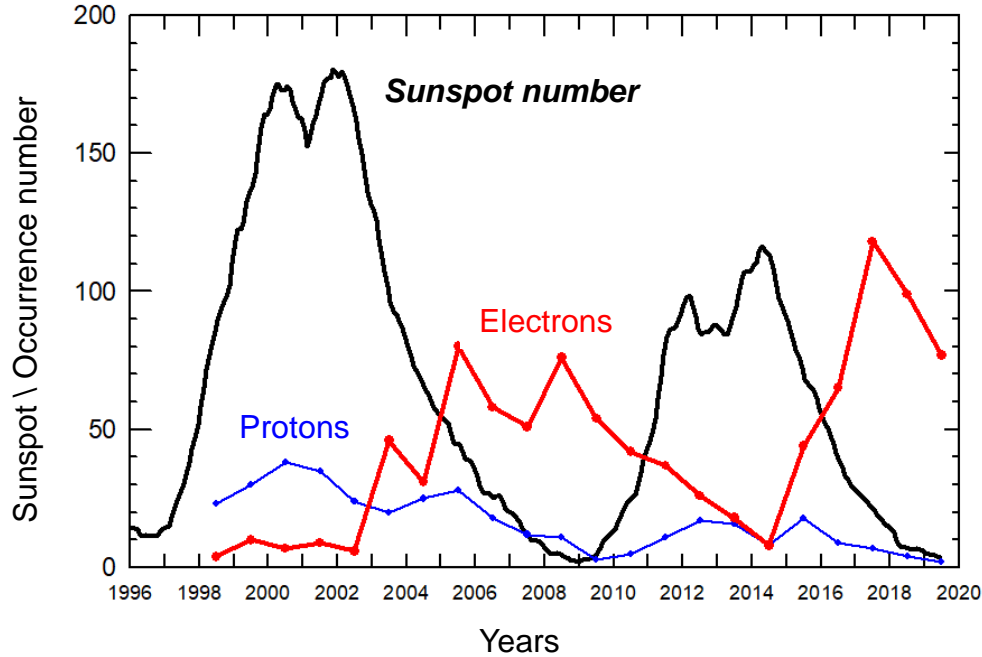
Experiments on board low-Earth orbit satellites show that energetic electrons and protons (tens of keV) of the Earth's radiation belt can penetrate to the equatorial ionosphere. We present the results of solar-cycle and annual variations of occurrence rate of electrons and protons injections into the ionosphere during the period from 1998 to 2019 years.



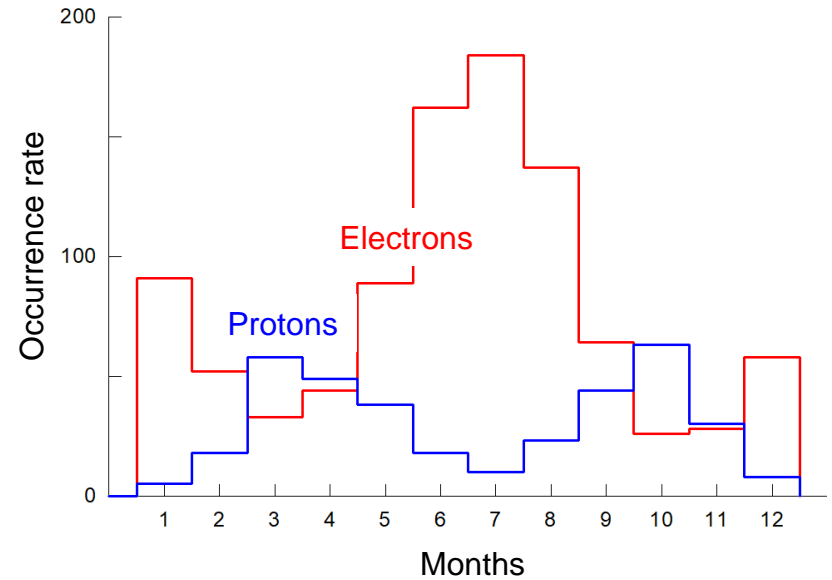
Statistics of particle injections (1998-2019)

low L-shells < 1.2

Solar cycle variations



Annual variations



Threshold of flux enhancement :

>30 keV electrons

$FEE > 10^4 \text{ (cm}^2 \text{ s sr)}^{-1}$

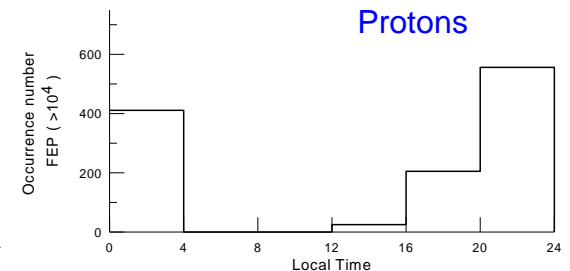
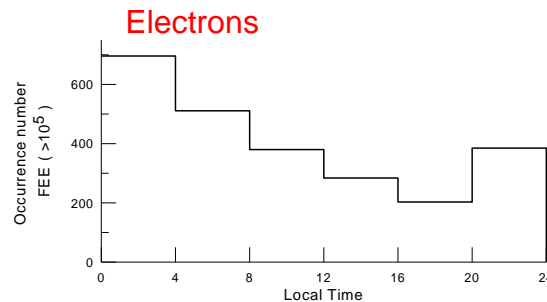
N =966 daily maps

30-80 keV protons

$FEP > 10^3 \text{ (cm}^2 \text{ s sr)}^{-1}$

N=364 daily maps

Diurnal variations



Local ion concentration in the low-latitude ionosphere

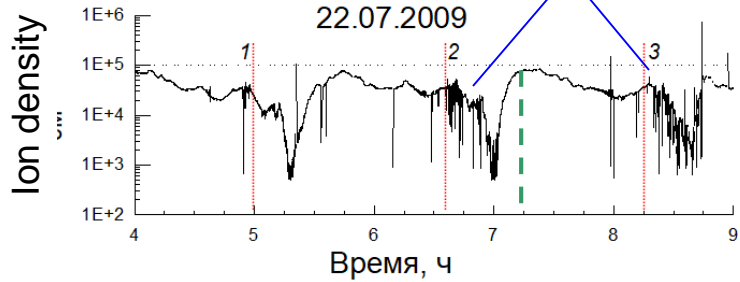
C/NOFS satellite
($h \sim 400-850$ km, $i \sim 13^\circ$)

Storm-time day

a

irregularity

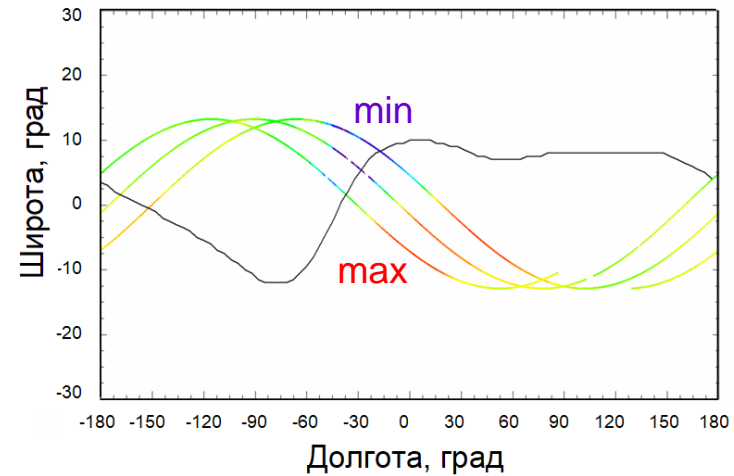
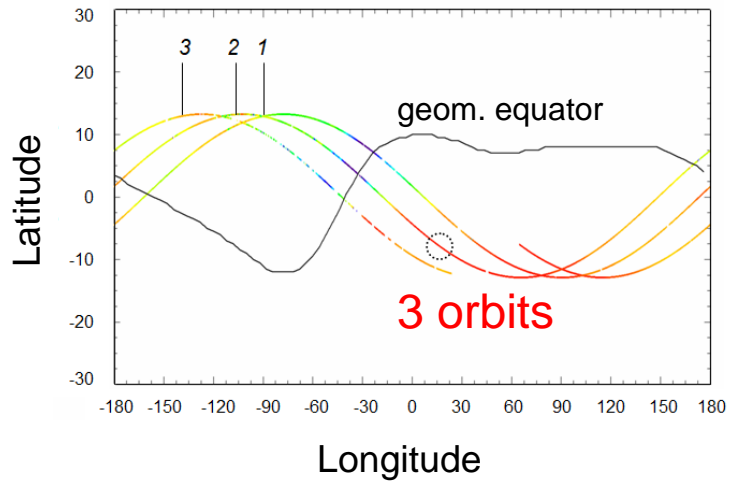
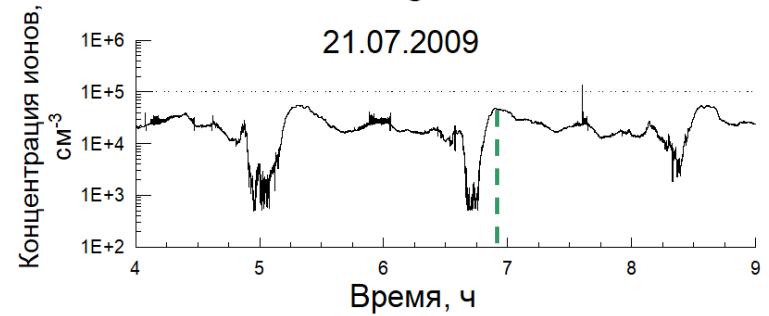
22.07.2009



Quiet day

б

21.07.2009



Storm day

NOAA/POES satellites

Quiet day

($h \sim 850$ km, $i \sim 99^\circ$)

electrons
 $E > 30$ keV

4-8 UT

electrons
 $E > 30$ keV

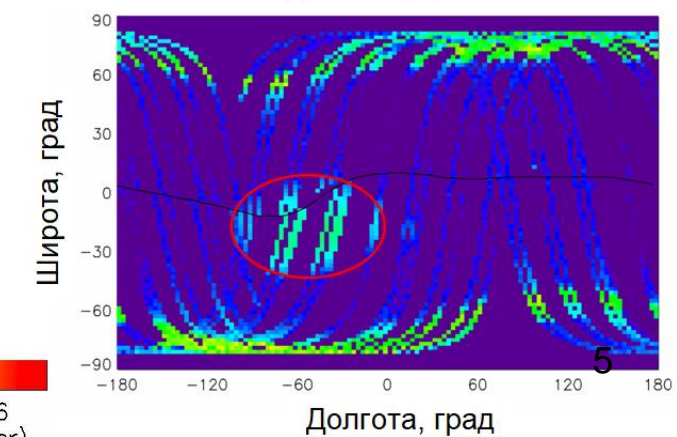
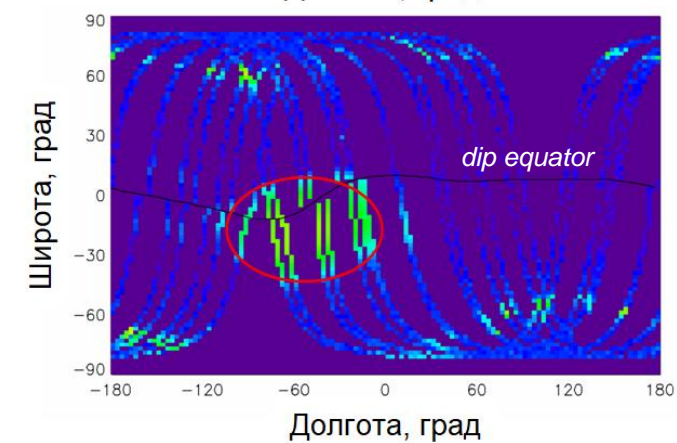
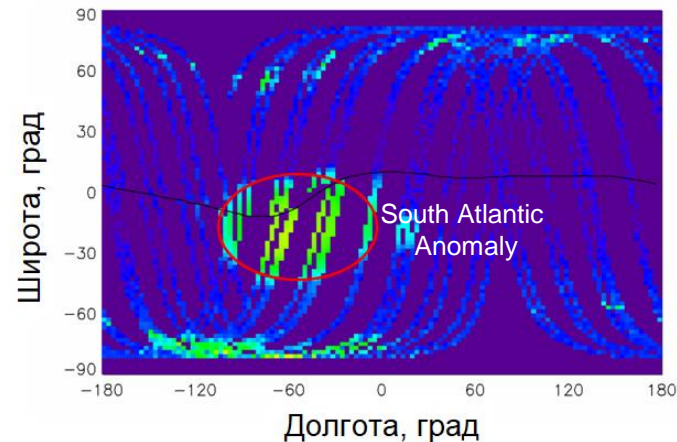
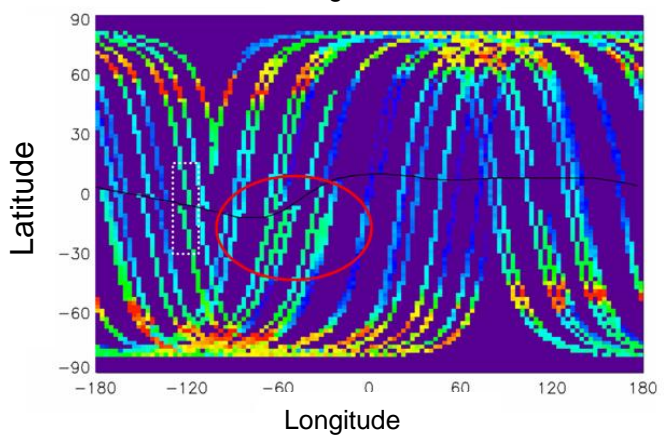
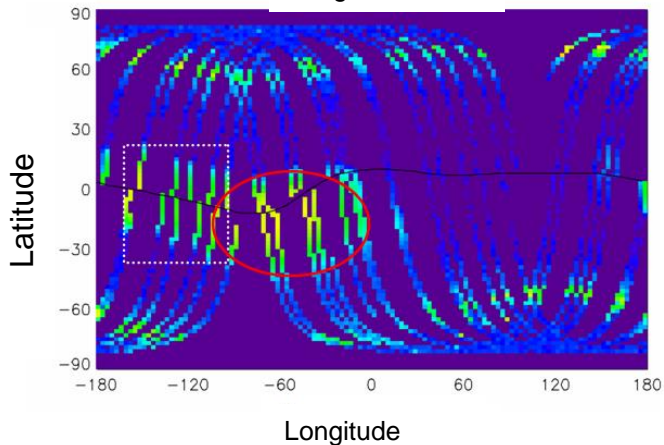
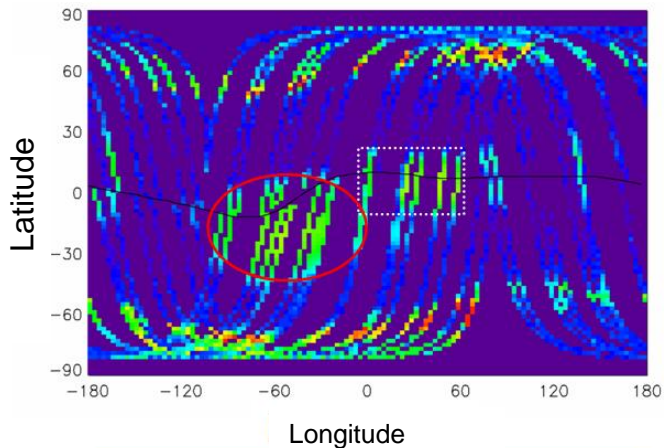
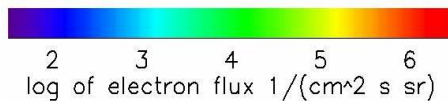
15-19 UT

protons
 $E = 30-80$ keV

15-19 UT

South Atlantic
Anomaly

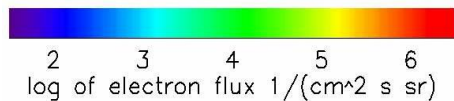
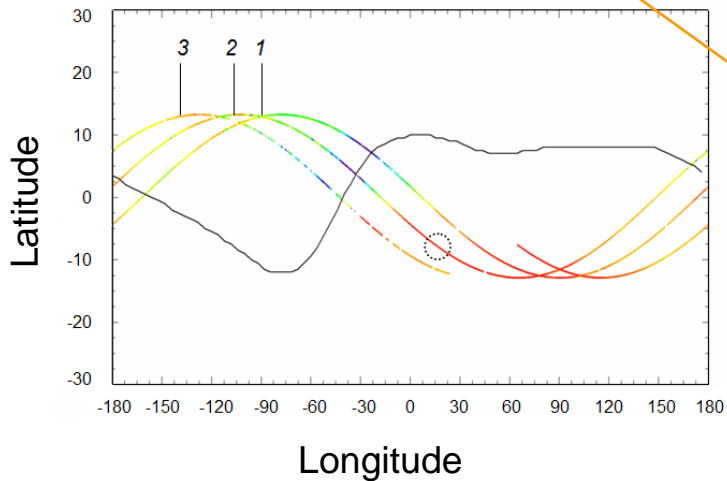
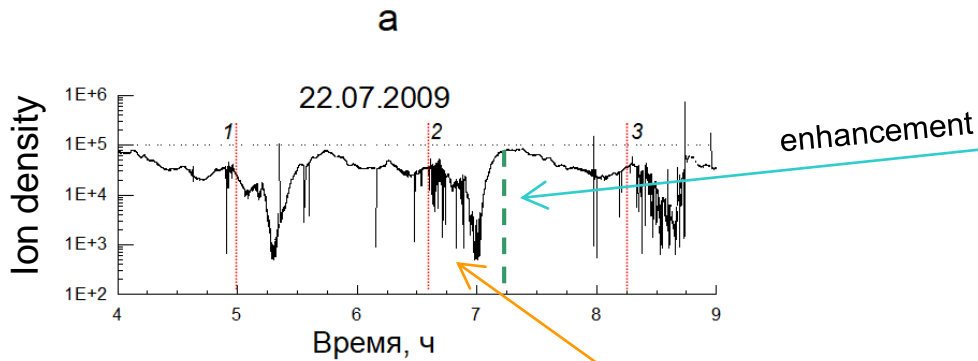
dip equator



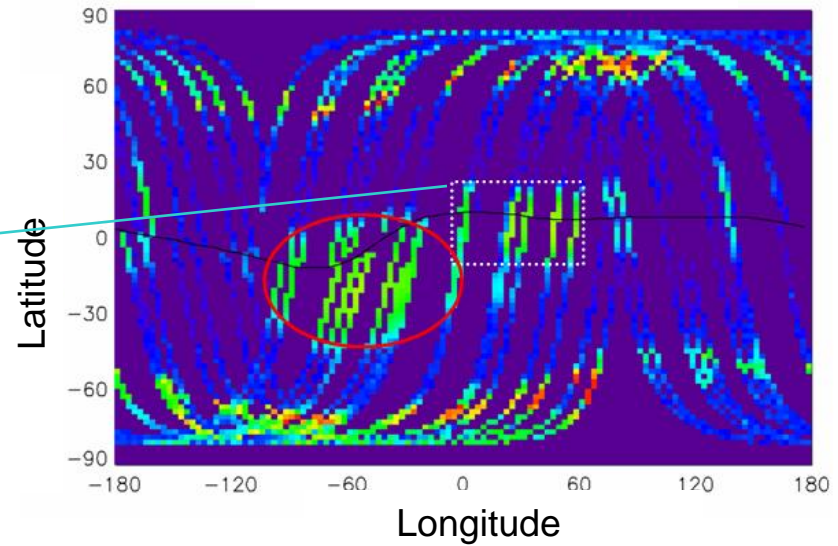
Ionizing effects of particles in the low-latitude ionosphere

C/NOFS vs NOAA/POES

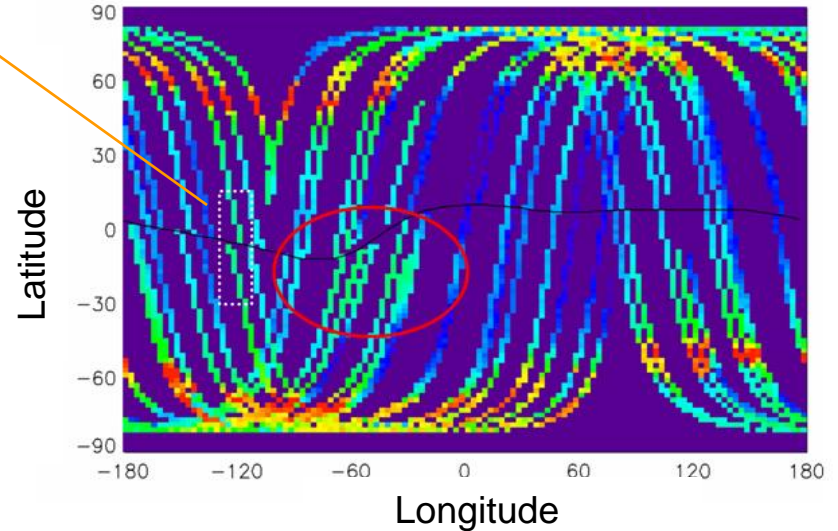
4-9 UT



electrons $E > 30 \text{ keV}$



protons $E = 30-80 \text{ keV}$

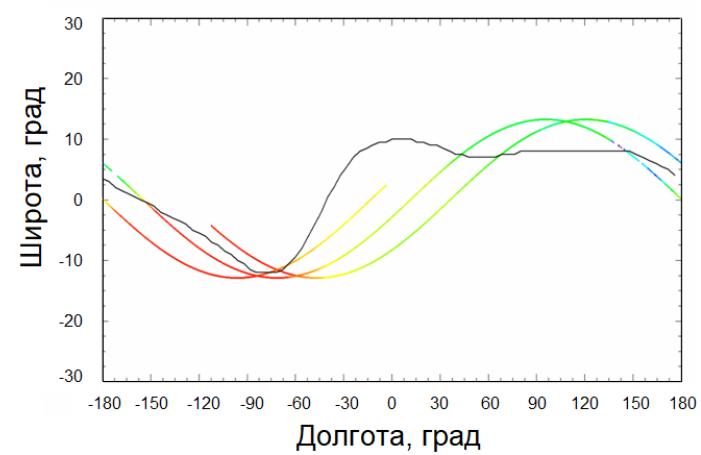
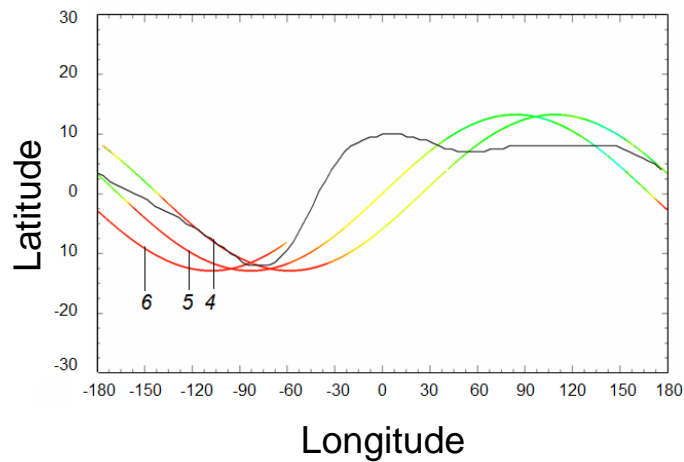
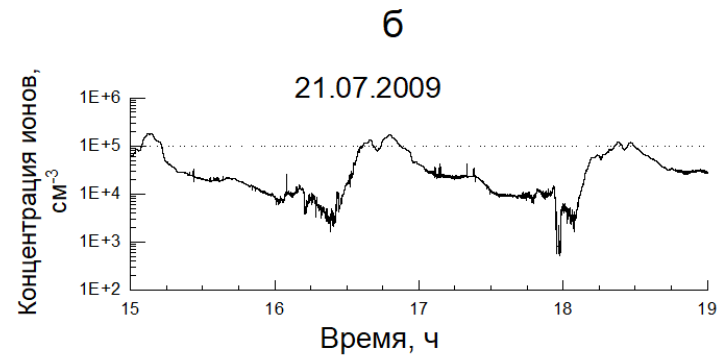
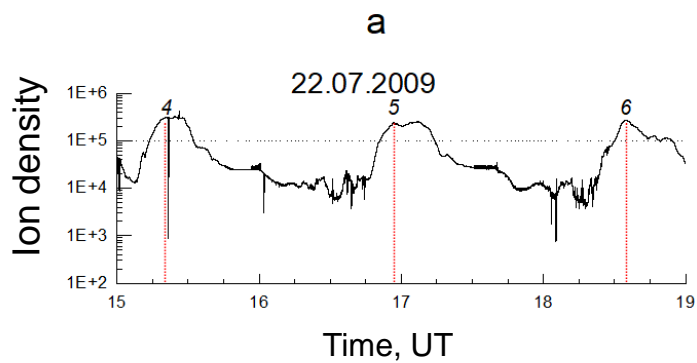


Local ion concentration in the low-latitude ionosphere

Storm day

Quiet day

15-19 UT

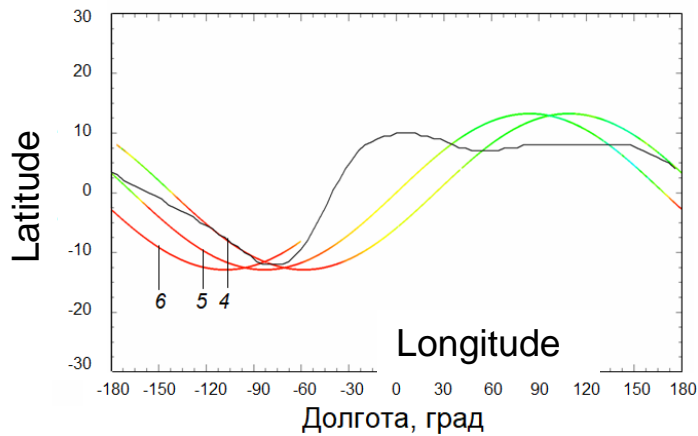
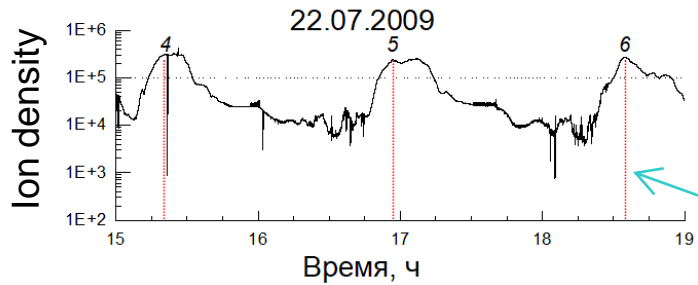


Ionizing effects of electrons in the low-latitude ionosphere

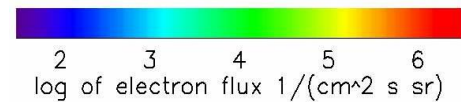
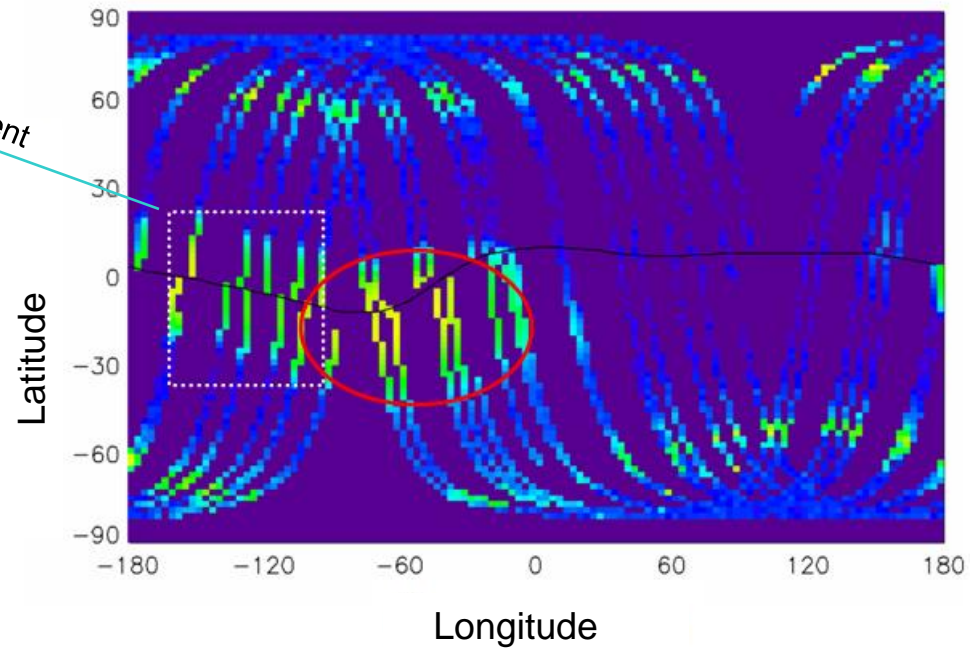
C/NOFS vs NOAA/POES

15-19 UT

a



electrons $E > 30$ keV



Summary

We have found that local ion concentration changed in the regions of penetration of the >30 keV electrons and 30-80 keV protons into the low latitude ionosphere. We showed that increase of ion concentration in the F layer at dawn related with additional ionization of neutral gas by energetic electrons. Ionospheric irregularities at night can be caused by effect of energetic protons.

Thank you for attention !