Some phenomena in studies of transient luminous events measured by TATIANA2 satellite.

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On behalf of the TATIANA-2 science team

1.TATIANA2 microsatellite scientific instrument -principal investigator SINP MSU
Science team leader - Mikhail Panasyuk.

Co-executers
BUAP university, Mexico
EWHA university, Republic of Korea

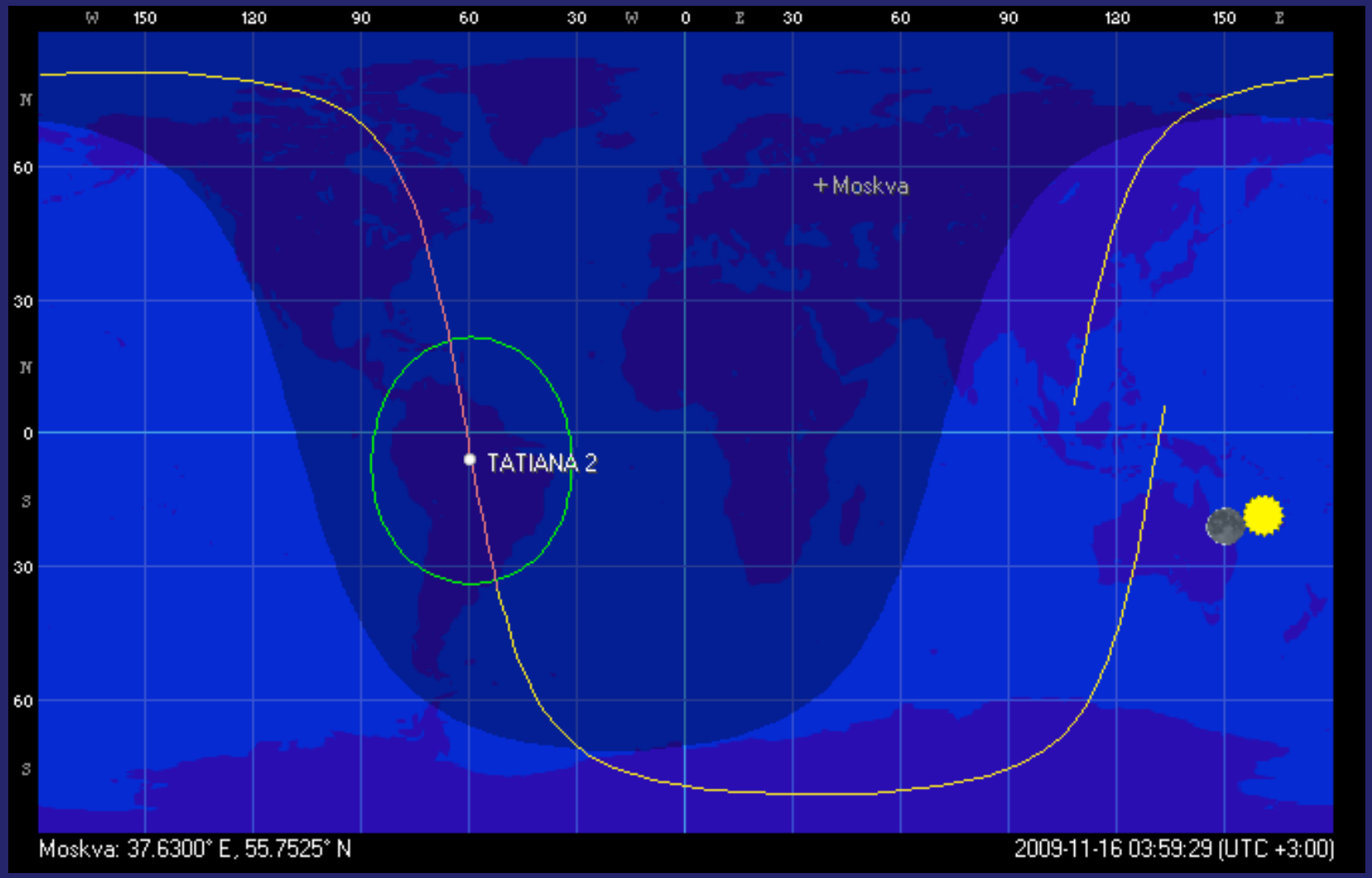
Speaker contribution to the science teams is design and manufacturing of detectors, development of research methods, on-line data processing and analysis

TATIANA-2 at the time of integration

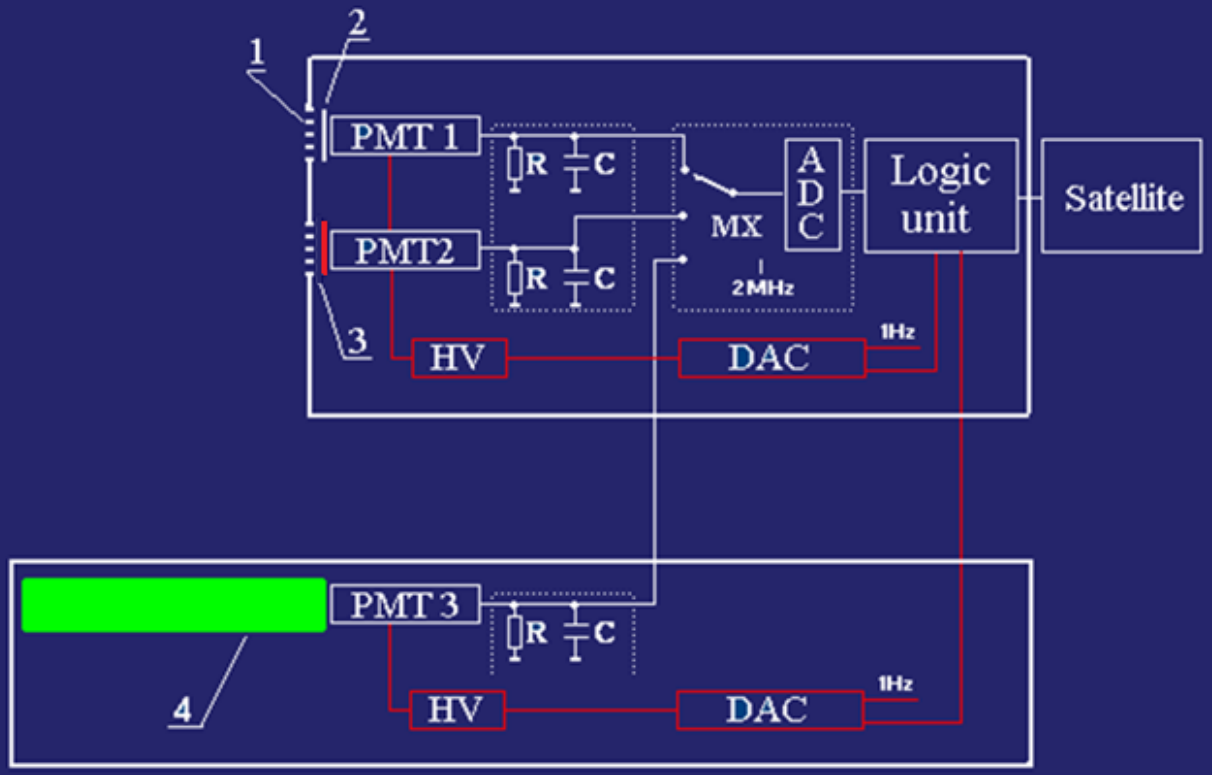
Carrier rocket: “Souz-2”
Upper-stage rocket “Frigate”

Operating orbit:
Polar Sun synchronous
Altitude : 800 – 850km
Inclination 98.8^0
Mass: 100kg
Power: 100W

TATIANA-2 one orbit ground track on November 16 2009 which is discussed in this report



Block-diagram of the UV, IR & CP detector

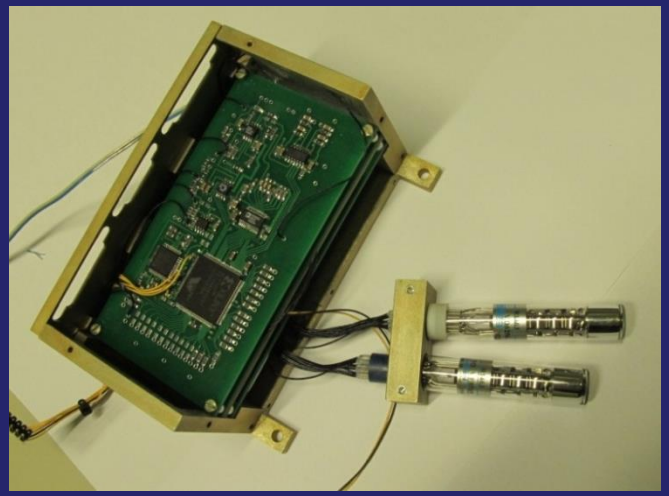


1.Signal finding algorithm of the brightest flashes in every 1min time interval.
2. Gain control algorithm to fix PMT anode current at a given level in the whole expected airglow range.
3.Interface algorithm for communication with the satellite board.

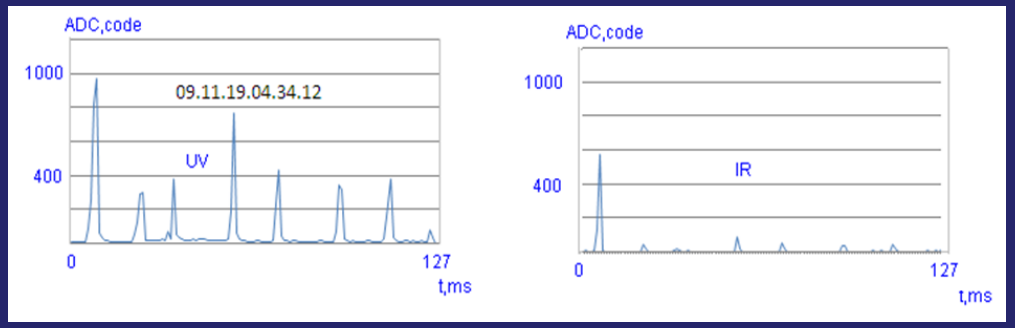
UV and IR detector comprises 2 PMT tubes and electronics block.
(first two tubes measure an optical radiation, third measures the charge particle background)

Two code are recorded and used in measurements:
M- PMT gain DAC code and N- the PMT anode current ADC code

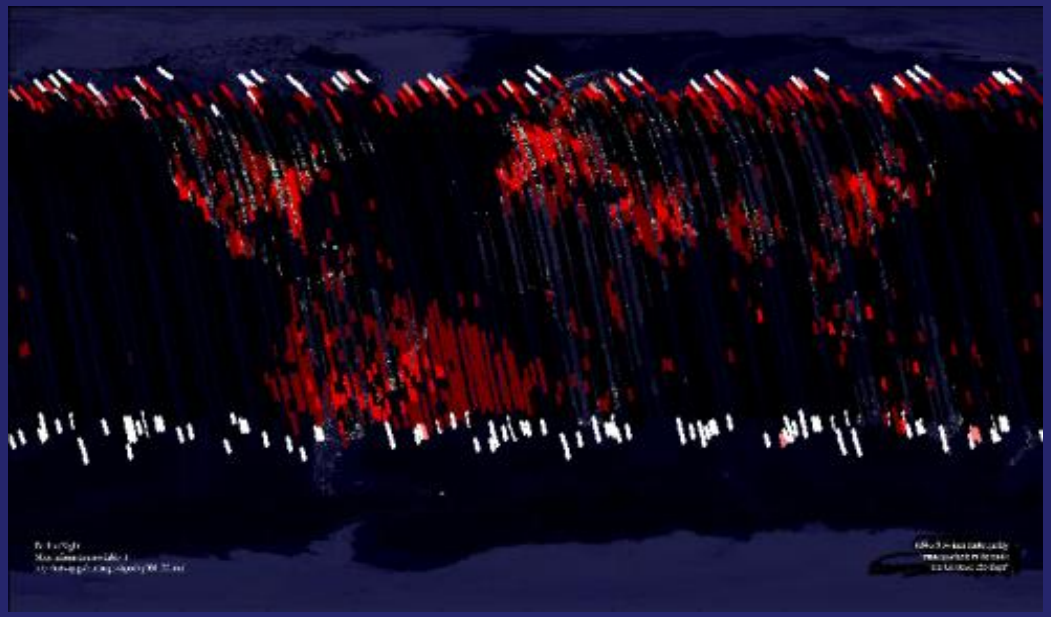
(1) collimator, (2) UV-1 filter, (3) IR filter, MX—multiplexor , HV—voltage supply for PM tubes, ADC and DAC—analog-digital and digital-analog convertors, Logic Unit-FPGA.
(4)Scintillate plastic.



UV 240-400nm
IR 610-800nm
Sensitive area ~ 0.5cm^2
Field of view ~ 15^0
Mass ~ 0.65kG
Power < 2.5Wt

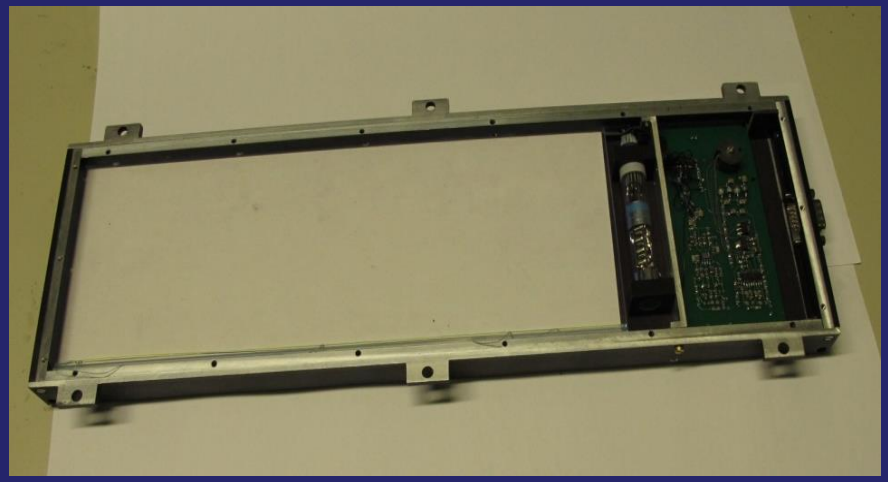


Example of one of the optical transient waveform registered by detector

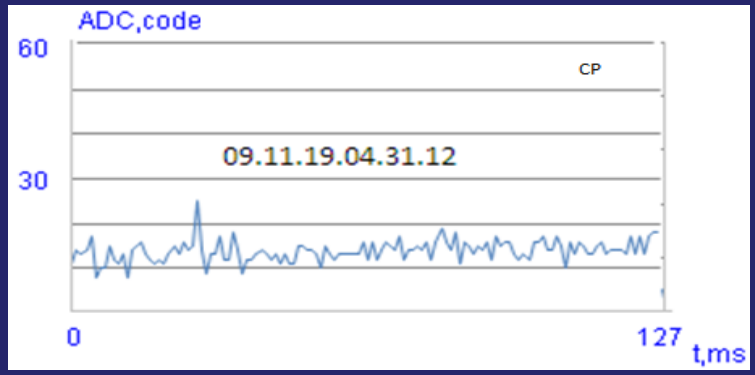


IR Earth night glow and light produced by charged particles in SAA region recorded by TATIANA -2

Charged particles detector

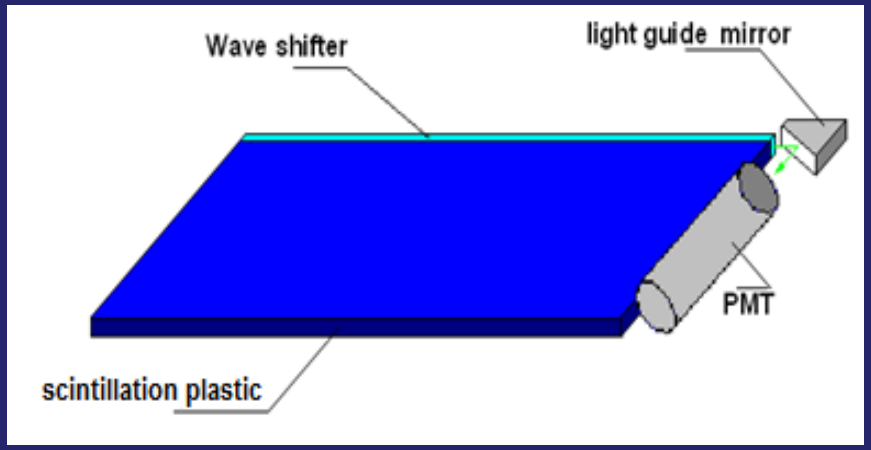


Sensitive area - 350cm²
Energy threshold for electrons -1MeV

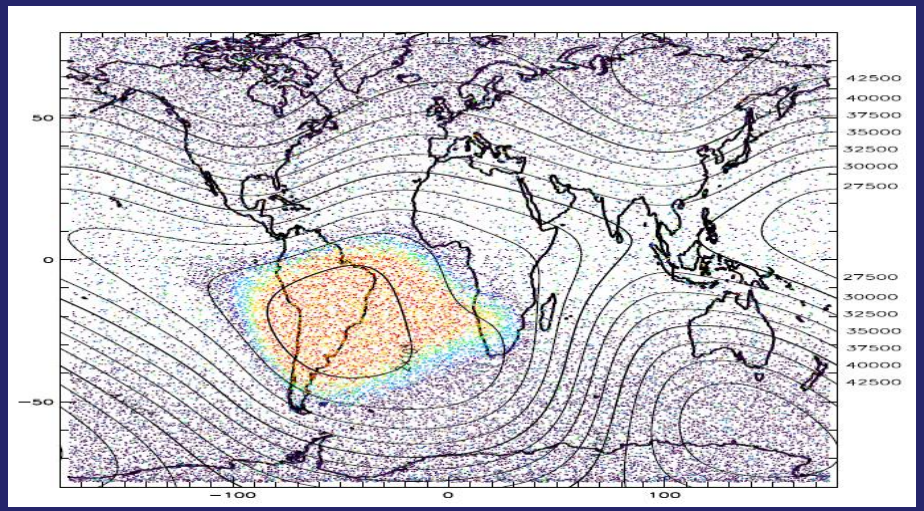


An example of charged particle flux waveform registered by detector

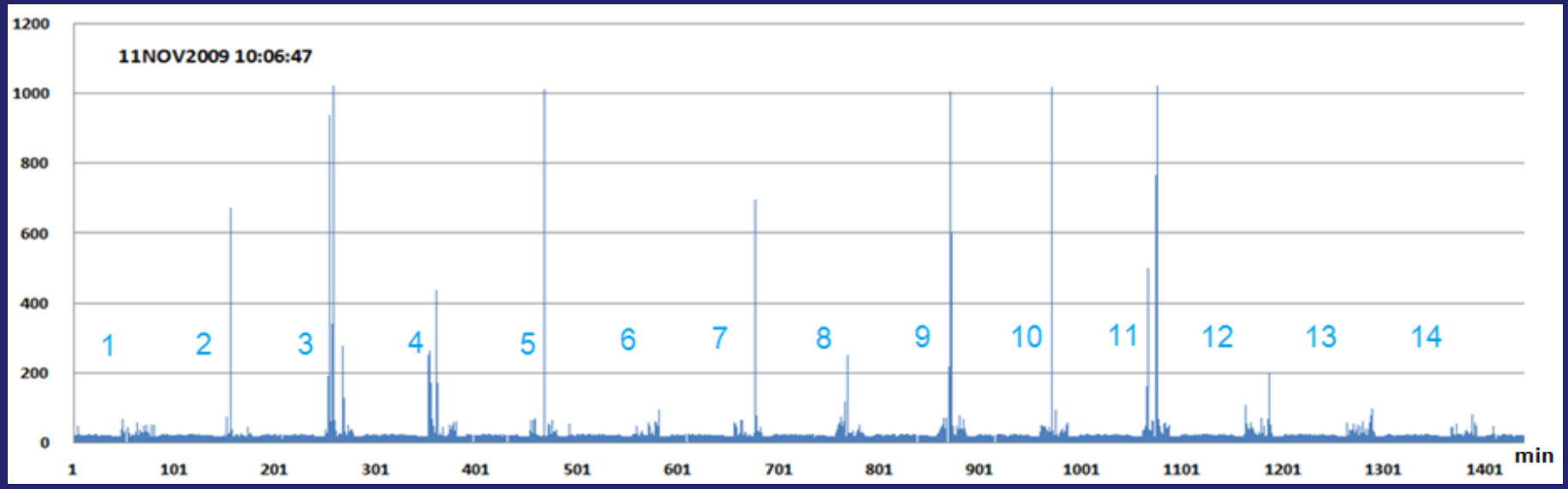
Detector structure



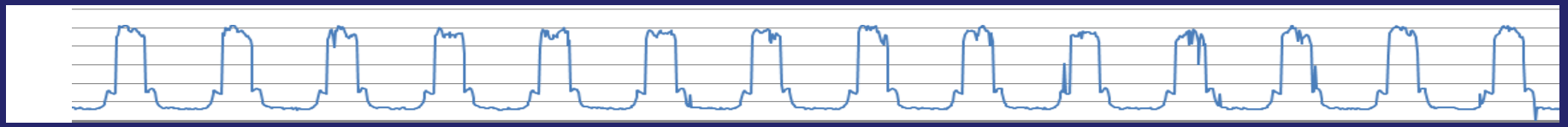
Global charged particles distribution recorded by TATIANA-2



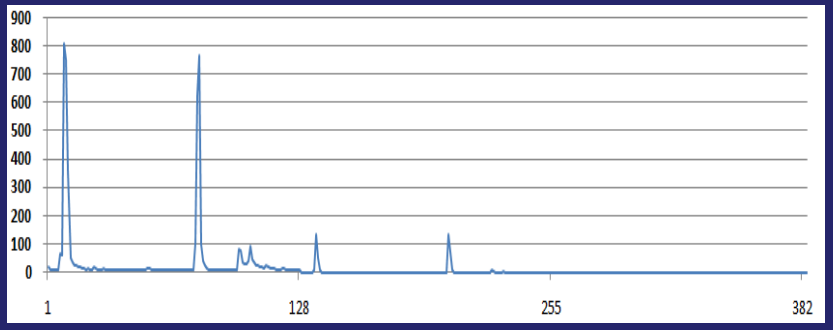
One day TLE signals altitudes distribution

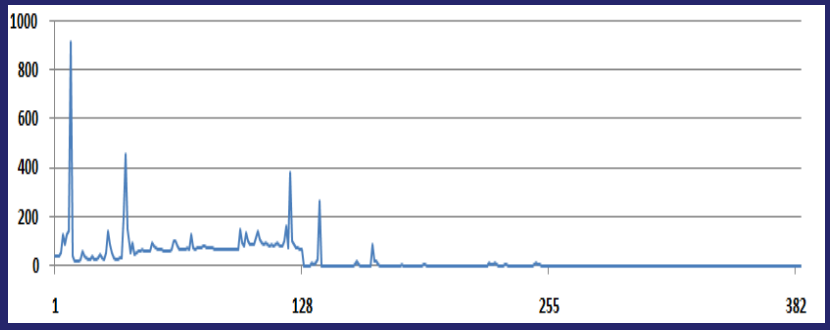


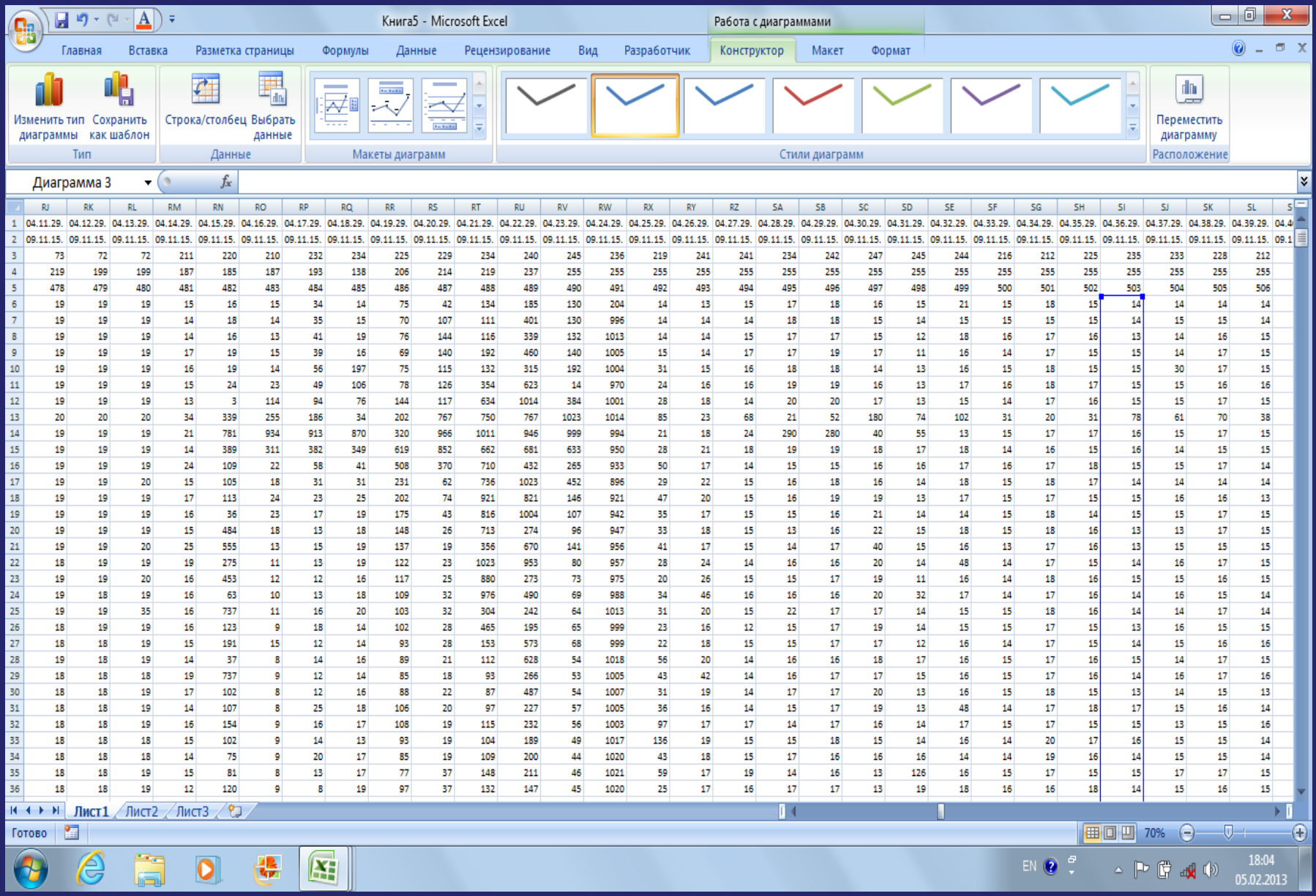
Example of gain changing during one day



Examples of two temporal profile recoded TLE






Книга5 - Microsoft Excel
Работа с диаграммами
Главная
Вставка
Разметка страницы
Формулы
Данные
Рецензирование
Вид
Разработчик
Конструктор
Макет
Формат
Изменить тип диаграммы
Сохранить как шаблон
Тип
Строка/столбец
Выбрать данные
Данные
Макеты диаграмм
Стили диаграмм
Переместить диаграмму
Расположение
Диаграмма 3
RJ RK RL RM RN RO RP RQ RR RS RT RU RV RW RX RY RZ SA SB SC SD SE SF SG SH SI SJ SK SL
04.11.29. 04.12.29. 04.13.29. 04.14.29. 04.15.29. 04.16.29. 04.17.29. 04.18.29. 04.19.29. 04.20.29. 04.21.29. 04.22.29. 04.23.29. 04.24.29. 04.25.29. 04.26.29. 04.27.29. 04.28.29. 04.29.29. 04.30.29. 04.31.29. 04.32.29. 04.33.29. 04.34.29. 04.35.29. 04.36.29. 04.37.29. 04.38.29. 04.39.29.
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19 19 19 17 19 15 39 16 69 140 192 460 140 1005 15 14 17 17 19 17 11 16 14 17 15 15 14 17 15
19 19 19 16 19 14 56 197 75 115 132 315 192 1004 31 15 16 18 18 14 13 16 15 18 15 15 30 17 15
19 19 19 15 24 23 49 106 78 126 354 623 14 970 24 16 16 19 19 16 13 17 16 18 17 15 15 16 16
19 19 19 13 3 114 94 76 144 117 634 1014 384 1001 28 18 14 20 20 17 13 15 14 17 16 15 15 17 15
20 20 20 34 339 255 186 34 202 767 750 767 1023 1014 85 23 68 21 52 180 74 102 31 20 31 78 61 70 38
19 19 19 21 781 934 913 870 320 966 1011 946 999 994 21 18 24 290 280 40 55 13 15 17 17 16 15 17 15
19 19 19 14 389 311 382 349 619 852 662 681 633 950 28 21 18 19 19 18 17 18 14 16 15 16 14 15 15
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19 19 20 15 105 18 31 31 231 62 736 1023 452 896 29 22 15 16 18 16 14 18 15 18 17 14 14 14 14
19 19 19 17 113 24 23 25 202 74 921 821 146 921 47 20 15 16 19 19 13 17 15 17 15 15 16 16 13
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19 19 20 16 453 12 12 16 117 25 880 273 73 975 20 26 15 15 17 19 11 16 14 18 16 15 15 16 15
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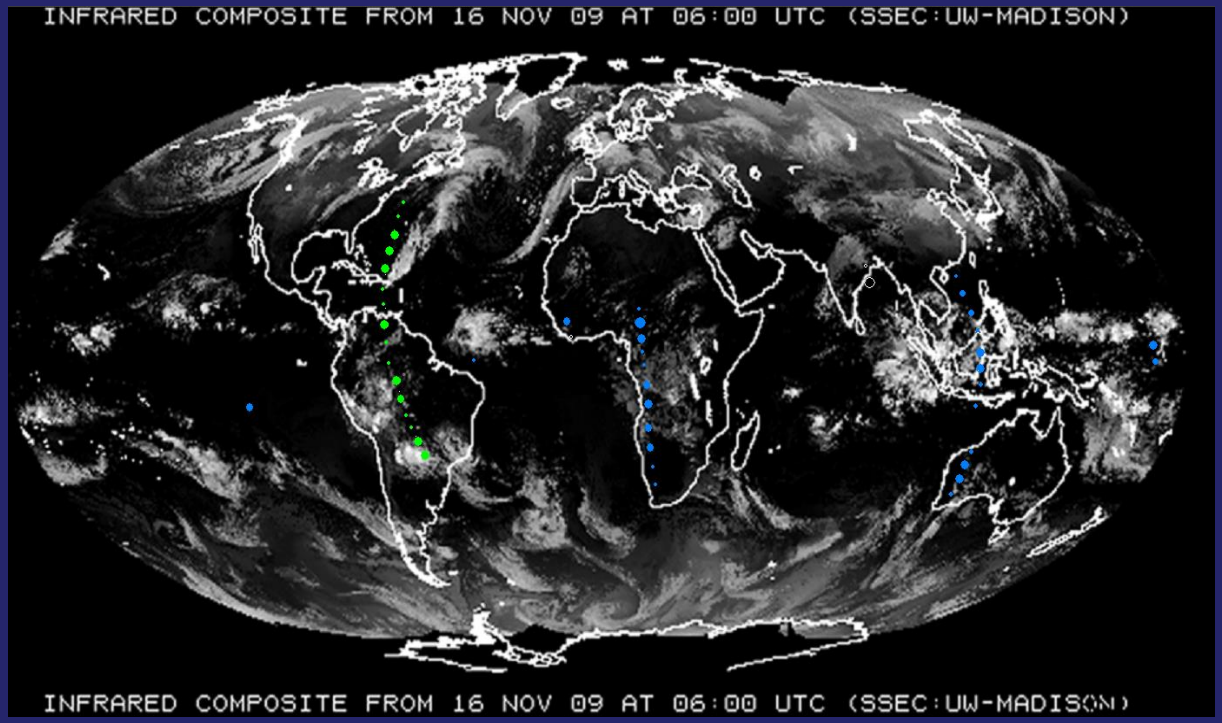
18 18 19 15 81 8 13 17 77 37 148 211 46 1021 59 17 19 14 16 13 126 16 15 17 15 15 17 17 15
18 18 19 12 120 9 8 19 97 37 132 147 45 1020 25 17 16 17 17 13 19 18 16 16 18 14 15 16 15
Лист1
Лист2
Лист3
Готово
70%
EN
18:04
05.02.2013

One day TLE distribution recorded by TATIANA-2 above clouds map 16 November 2009



Some of the flashes are observed in cloudless regions were not detected by WWLLN

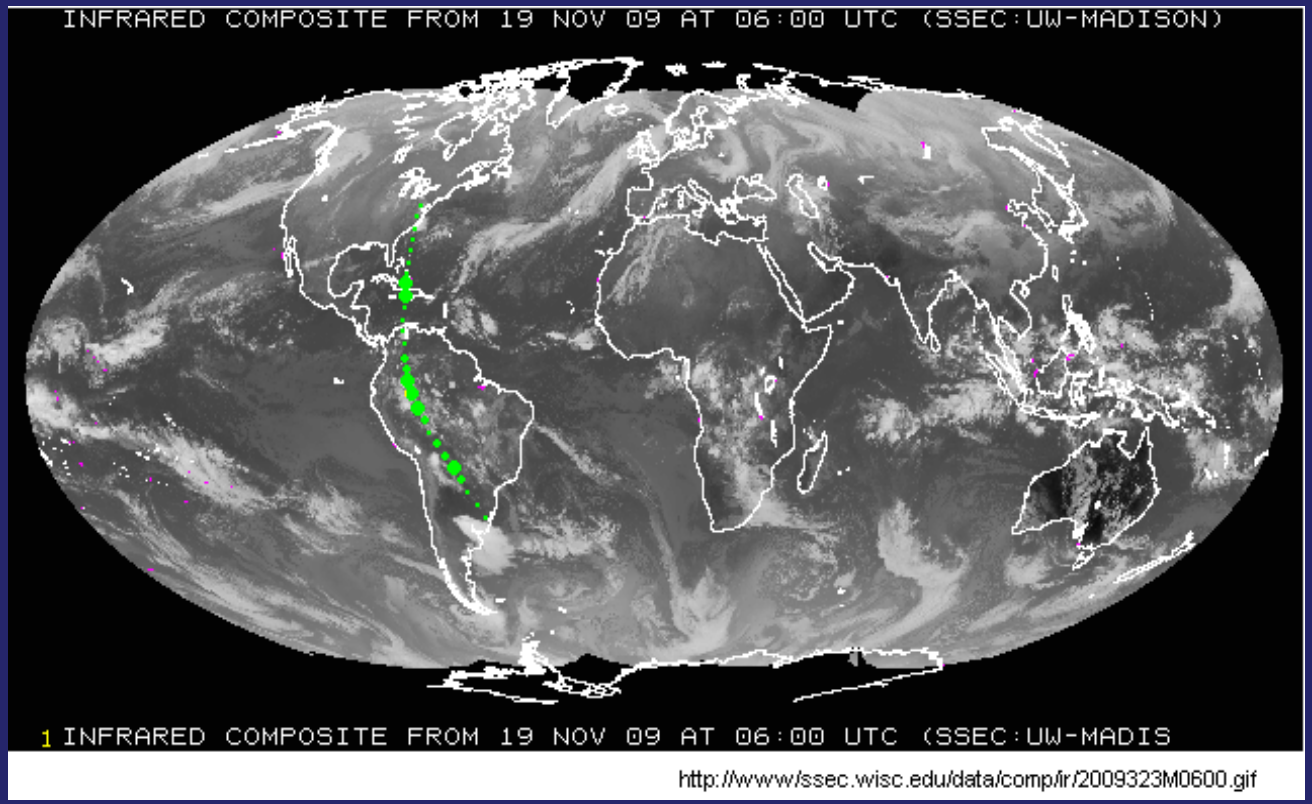
There are a lot of clouds above oceans but there are no registered events above them

Length of such series reach 10 thousand kilometers which is much more longer then expected thunderstorm or clouds area crossed by satellite

Efficiency of WWLLN is less then 30% so to miss 7 events which are out of clouds regions will be $(1-0.3)^7 \approx 0.08$.

At the same time in accordance to WWLLN data efficiency to detect event in cloud less regions is less then $\mathbf{10^{-2}}$ per min per detector field of view, so probability to detect 7 of the same kind events is about $(\mathbf{10^{-2}})^7$

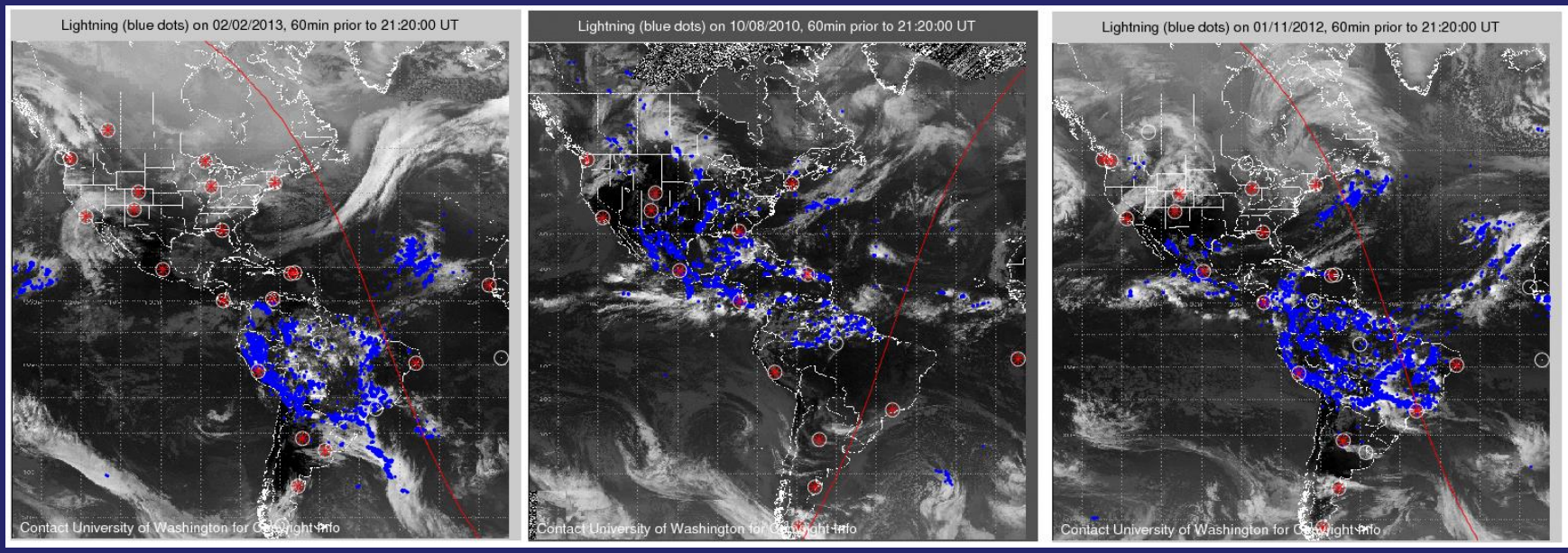
One orbit TLE distribution recorded by TATIANA-2 micro satellite above clouds map 19 NOVEMBER 2009



Distribution in number of flashes N_s in one series for various number of photons Q_a

Q_a/N_s	1	2	3	4	>4	Total number of flashes
10^{20}–10^{22}	202	59	48	18	49	372
10^{22}–10^{23}	118	146	128	85	222	699
$>10^{23}$	44	58	56	37	103	298

Typically only about 15 to 30% of strokes detected. These strokes are usually the stronger ones. Recent research indicates our detection efficiency for strokes about 30 kA is approximately 30% globally.



In these examples to be found less then 10 events out of clouds locations. Exposition time is 60 min, considering aria is about **$S=10^8$ km^2**

lightning detecting probability out of cloud region is less then **10^{-7} min^{-1}×km^2**

UV detector field of view **$s=10^5$ km^2**

Probability to detect one lightning out of cloud region by UV detector

less then **10^{-2}** per min

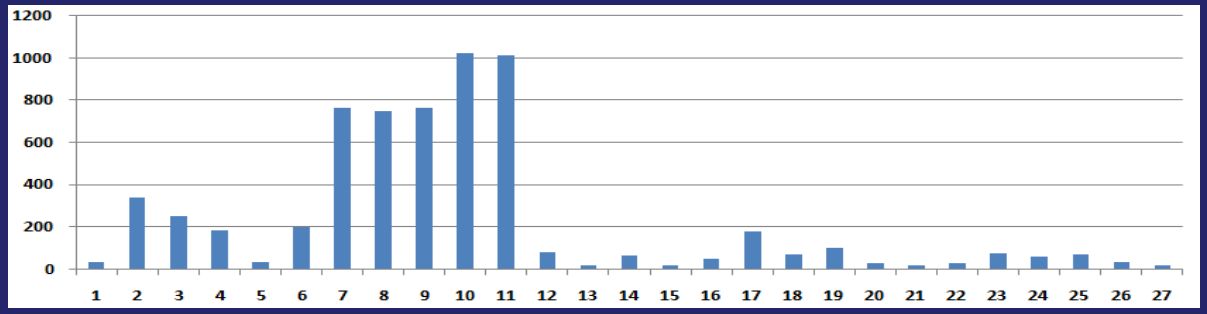
C11-0069-10 abstract to oral talk at 38th COSPAR Scientific Assembly, 2010

38th COSPAR Scientific Assembly 2010

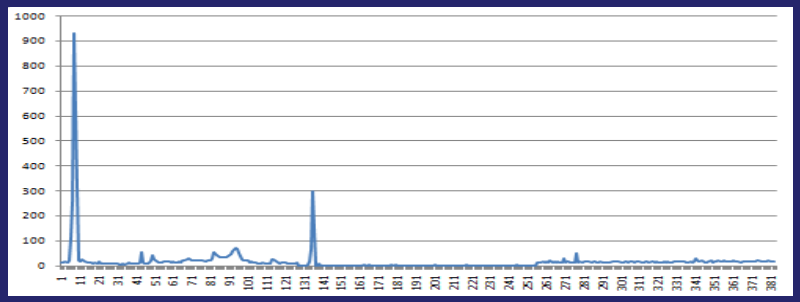
UV TRANSIENT FLASHES MEASURED BY "UNIVERSITETSKY-TATIANA-2" SATELLITE GEOGRAPHICAL DISTRIBUTION IN THE EQUATORIAL REGION AND THEIR PROBABLE IONOSPHERIC ORIGIN

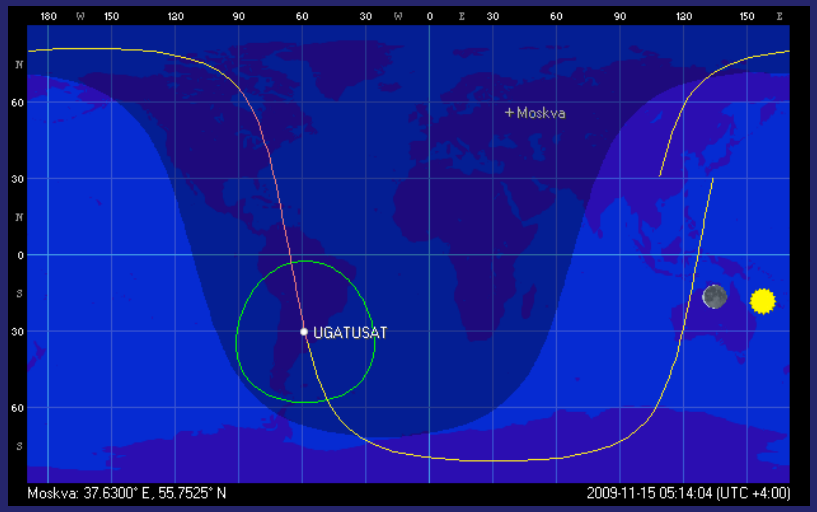
The set of scientific payload on-board "Universitetsky-Tatiana-2" satellite, launched on the 17 of September, 2009, measured transient (milliseconds) flashes in the atmosphere in two wavelength bands: UV (240-400 nm) and red (610-800 nm). Global distribution of the flashes is discussed in this work. Several characteristics of this distribution are against conventionally assumed lightning origin of the transient events. Transient flashes, measured from the satellite, are frequently detected in cloudless regions. Those events are not seen by the global net of lightning radio detectors. These evidences point to their upper ionosphere origin. At the same time flashes are mainly observed above continents stretching along magnetic meridians. This fact indicates the important role of geomagnetic field and the role of electrically active zones of the continents in formation of electric field in the ionosphere. The observed absence of transient events above the Sahara Desert stresses the role of water vapor in formation of electrically active zones not only in the troposphere but also in the ionosphere.

TLE altitudes distribution recorded by TATIANA-2 above South & North America

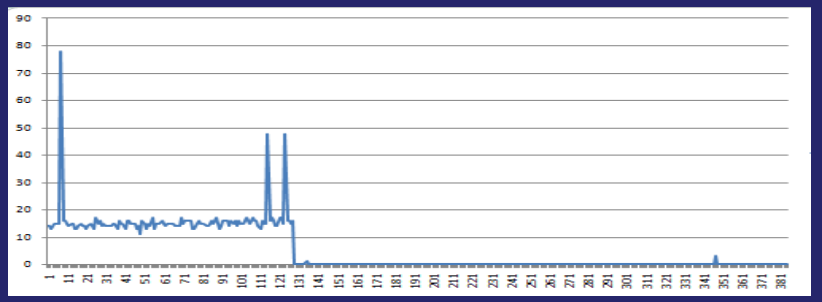


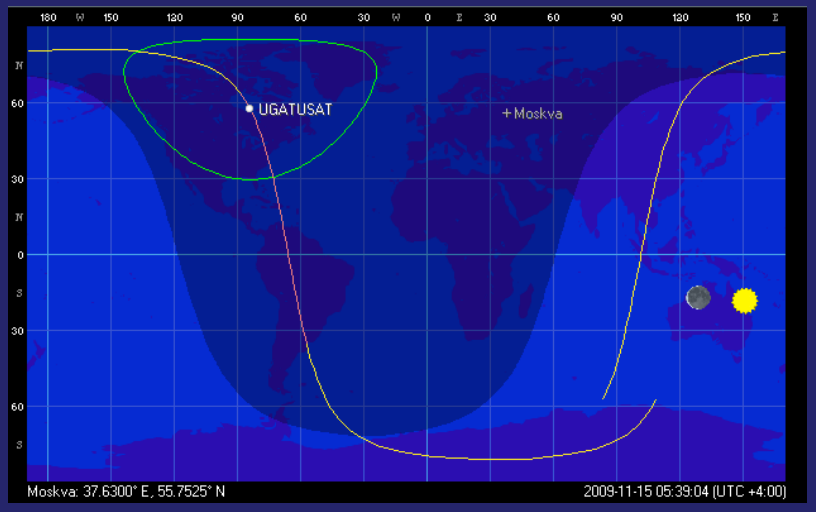
Example of temporal profile of TLE recoded at south age of trajectory



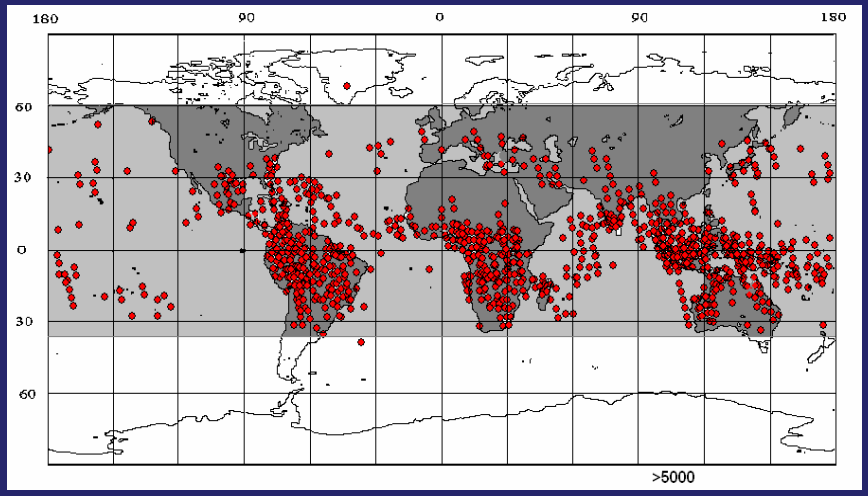


Example of temporal profile of TLE recoded at north age of the same trajectory

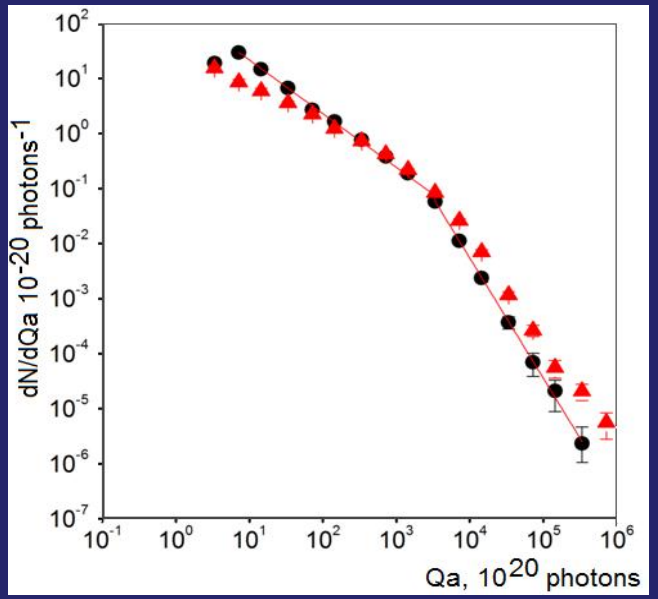




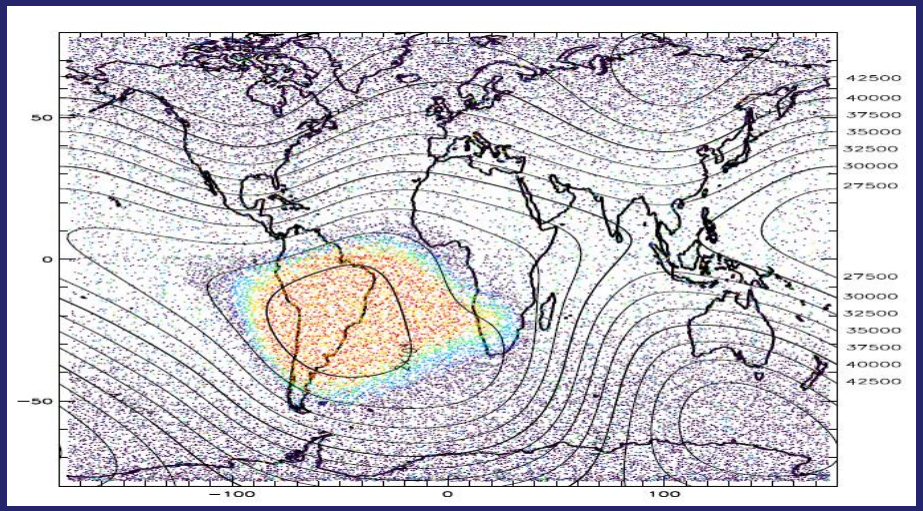
Global distribution of the TLE recorded by TATIANA -2



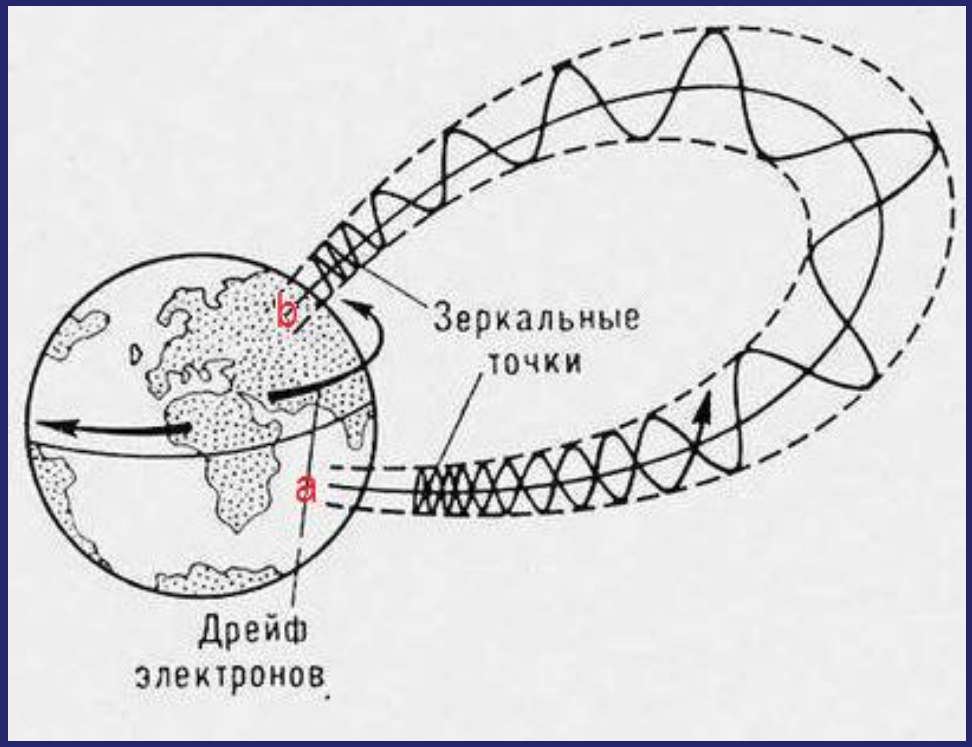
Transient optical phenomena differential photon number distribution in discharge point



Charged particles global distribution recorded by TATIANA -2



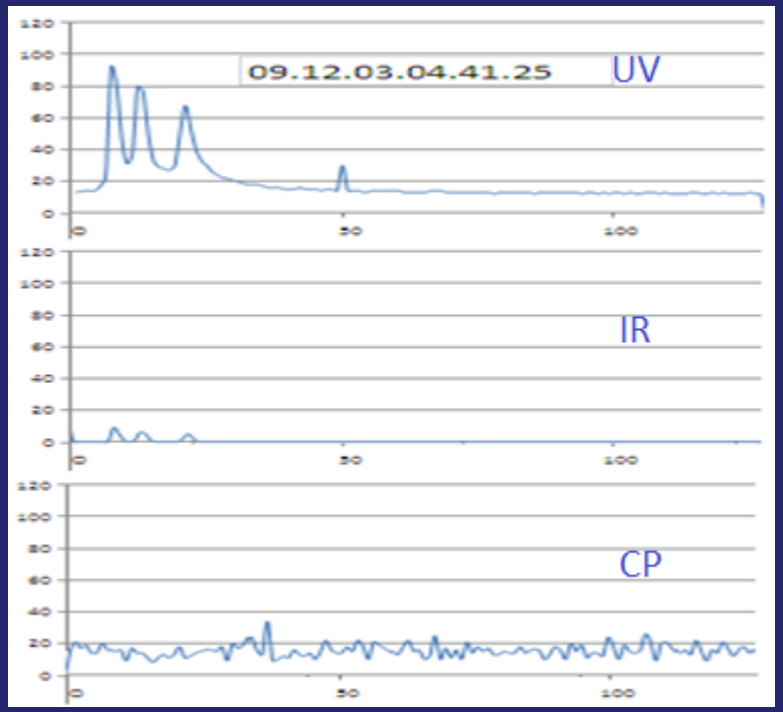
Conjugate points: connection points Brazil &Canada



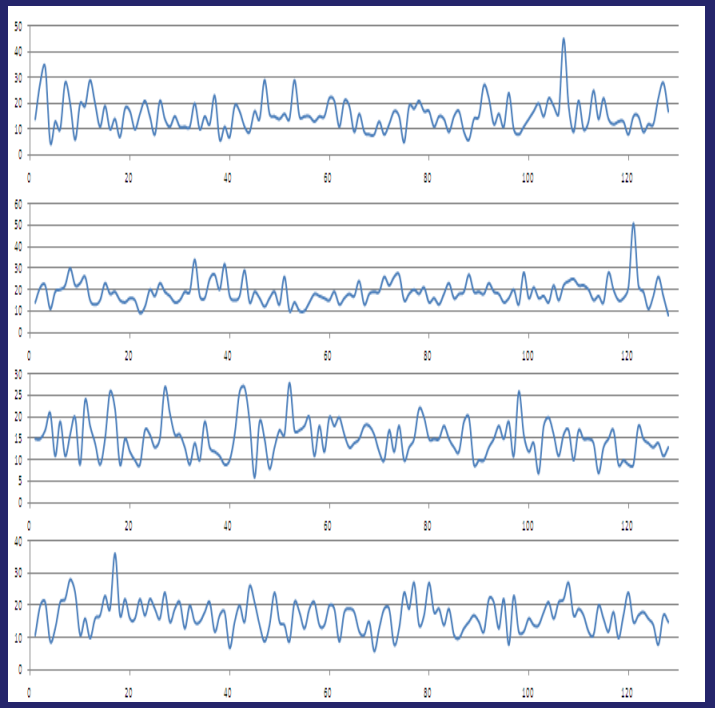
Conjugate points:
Connection Brazil and Canada

1.At the time of the flash there was not detected response of electrons in SAA. In all temporal profile of the charge particle detector recoded above Brazil there were not detected any kind of bursts in the particles flux.

Example of optical signals records in UV and IR range together with signals from charge particle detector during TATIANA-2 mission



Examples of signals of charge particle detector recorded during TATIANA-2 mission in SAA



Conjugate points: connection from Brazil to Canada (downward electrons)

2.At high latitudes above the north Canada registered several flashes which emit at least W> 10^{20} photons . In this region the Earth magnetic field has vertical direction and electrons move downward. Lets estimate the possibility of generation of these flashes by the flow of relativistic penetrating electrons.

Efficiency of electron to produce light is about η ~ 5 photons / m

With the average path length of ~30 kilometers each electron is emits P = 30 × 5 × 1000 = 1.5 × 10^5 photons. In our case 10^{20} photons can be produced by n = W / p = 10^{20} /1.5 × 6 × 10^5 = 10^{14} electrons.

Density of the electrons in this beam with diameter of about 500 km and corresponded area S~ 10^{11} /m^2 will be ρ=10^{14}/ 10^{11} = 10^3 m^{-2} .

Delay time between electrons and photons from flash for satellite orbit with altitude 1000 km. will be in range 1000km × 3.3 km/msec. = 3.3ms for electrons moving along magnetic field and ~ 33 ms for electrons moving in a spiral trajectory are in range of detector recording time trace

Expected signal for such flashes in charge particle detector with area a=0.05m2 will be ρ×a = 0.05m^2 × 10^3 m^{-2} = 50 particles, which exceeds the detector sensitivity at list two time.

But during measurement there were not find candidates for such model.

Conclusions

1. In Sun-synchronous orbit measurements along satellite trajectory observed series of the flashes which observed every day
2. Series of flashes are observed not only above clouds in thunderstorm regions, but also over cloudless ones
3. Number of flashes in series increase with increasing number of photons in flashes
4. Flashes were not observed above Sahara desert.

Also

Measurements provide:

1.No evidence find for synchronous occurrence of flashes and expected electrons generated in lighting discharge.
2.No evidence finds for influence of electric field of lighting discharge on electrons with energy greater than 1MeV in near Earth space.
3.No evidence find for flashes generated by downward electrons in conjugate points.

THANKS!