

Analysis of data collected by the Tatyana II satellite

Rivera Liliana^a, Martínez Oscar^b, Mendoza-Torres Eduardo^c, Salazar Humberto^d

^{a,b,d}Benemérita Universidad Autónoma de Puebla, Puebla, México

^cInstituto Nacional de Astrofísica, Óptica y Electrónica, Puebla, México

E-mail: ^ataydarh@gmail.com, ^bmoscar70@gmail.com,

^cmend@inaoep.mx, ^dhsalazar@fismat1.fcfm.buap.mx

Abstract. The Tatyana II satellite is the second one of the University Satellite Program, which is led by the Moscow State University with the participation of the Benemérita Universidad Autónoma de Puebla. This satellite has ultraviolet, red-infrared and charged particles detectors. In this work preliminary results based on the data collected by these detectors on board the satellite over a period of ~ 3.5 months are presented.

1. Introduction

The study of the atmospheric background is important for studying Ultra High Energy Cosmic Rays (UHECR) from the space by satellites. The aim of this work is to analyze the ultraviolet (UV), red (R) and infrared (IR) radiation observed at the Earth's atmosphere. The atmosphere is a "transition" region of the earth, where the dynamics of the matter is determined by the earth gravity force, geomagnetic field and external fluxes of particles. In this region space particles and space radiation penetrate to the atmosphere but also there is an opposite process of electromagnetic radiation and emission of particles from it. The most known phenomenon in this "transition" region is the aurora glow at high latitudes of the Earth where the electrons and protons of the magnetosphere penetrate to the atmosphere along the magnetic lines. Charged Particles (CP) collide with the atmosphere molecules and atoms, excite them and resulting optical radiation is observed as "aurora" [1]. Also UV emission phenomena of very short duration known as Transient Luminous Events (TLE's) thought to be related to lightnings have been observed at this region of the Earth's atmosphere [2]. In the last years a region where also charged particles penetrate the atmosphere has been observed at the South Atlantic Ocean, called the South Atlantic Anomaly (SAA). At this region the magnetic field is weaker than at similar geographic latitudes and this seems to play an important role in the appearance of SAA.

2. About Tatyana II Satellite

Tatyana II Satellite was launched from the Baikonur cosmodrome using the Soyuz2.1B carrier rocket and the Fregat upper stage on September 17, 2009 [3].

Tatyana II has a polar Sun synchronous orbit with an inclination of 98.8° , a 800 – 850 km altitude, a mass ~ 100 kg and a power of 100 W [3]. The instruments constructed by the mexican participation, with the help of students, are:

- UV and R-IR detectors, at 300–400 nanometers (nm) and 600–850 nm ranges, respectively. Each detector has an aperture of $0.024 \text{ cm}^2 \text{ sr}$ and a temporal resolution of 1 millisecond (ms).
- Charged Particles (CP) detector, which works with an energy threshold of 1 MeV, 350 cm^2 of effective area and temporal resolution of 1 ms



Figure 1. Tayana 2 satellite. The solar panel was installed at an angle, such that it has the maximum efficiency in energy supply and the lower part of the satellite is available to install the scientific payload.

3. Data analysis

The observations were made to the nadir satellite because in this direction the absorption of the signal in the atmosphere is minimal, the field of view is clearer and more stable than to the limb direction.

Data taken in a period corresponding to 3.5 months (October 2009-January 2010) were analyzed. The Interactive Data Language (IDL) software for the data analysis was used.

The coordinates of the satellite were used to identify the time and location of the satellite when it was located over the recorded events.

4. Results

The geographic coordinates for different energies of UV and R-IR emissions and for CP detections were drawn over separated world maps. For low energies the UV distribution is more or less homogeneously spread over all the world. At high energies the locations of the events seem to be clumped over given regions. At low energies, the IR events are mainly above land. Remarkably, R-IR emissions as well as CP are seen at the South Atlantic Anomaly (SAA) (Figures 3 and 4). It is interesting to note that among the records over the SAA there is a clear difference between the distribution of low and high energies at R-IR events. The more energetic events are distributed over a large region that covers a considerably part of South America and extends to South Africa through the South Atlantic Ocean while the less energetic events lie over a smaller region and their amount is smaller than the more intense events.

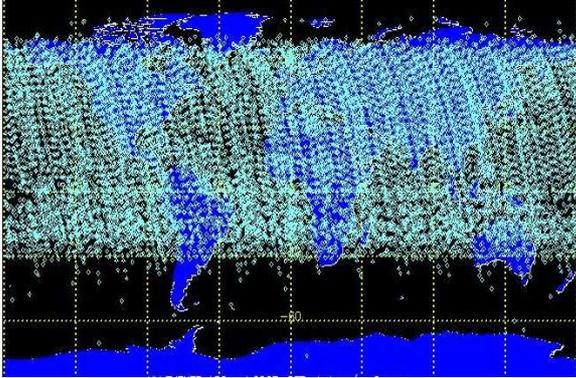


Figure 2. Distribution of UV flashes at low energies. The distribution is more or less homogeneous over the world.

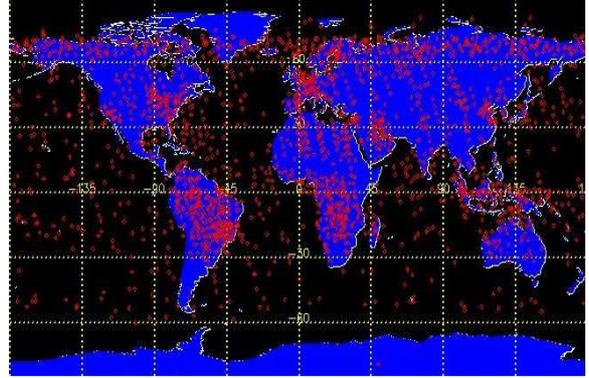


Figure 3. Distribution of R-IR flashes at low energies, most events are over SAA and above land.

In the Figures 4 and 5 we have a comparison of charged particles detected zones in the Earth by Tatyana II and Along Track Scanning Radiometer (ATSR) [4]. We can see that both distributions show the South Atlantic Anomaly.

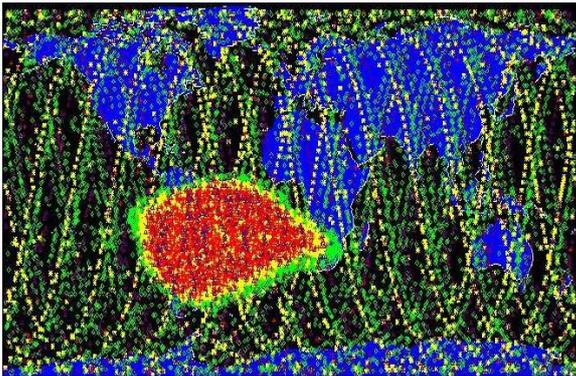


Figure 4. World Map of charged particles detected by Tatyana II satellite.

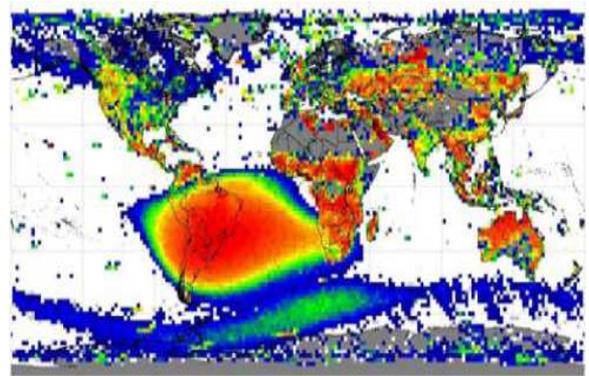


Figure 5. Charged particles distribution by Along Track Scanning Radiometer (ATSR).

The Figures 6 and 7 are compared for show the Earth's zone where the geomagnetic field intensity is lower than another regions [5]. That region corresponds at South Atlantic Anomaly.

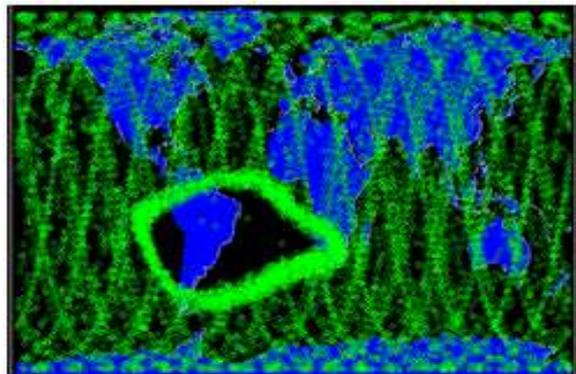


Figure 6. SAA detected by Tatyana II in the range of low energy charged particles.

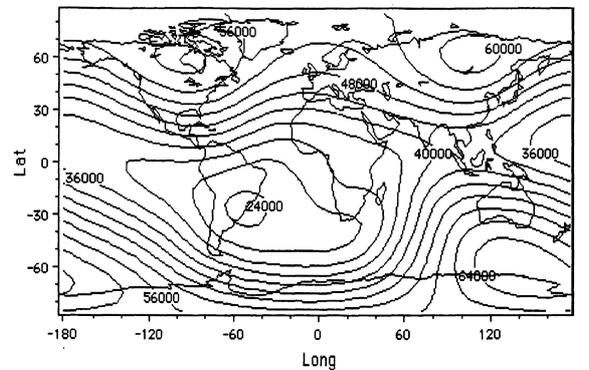


Figure 7. Contours of total field intensity at Earth's surface. It may be seen that in SAA the geomagnetic field intensity is low.

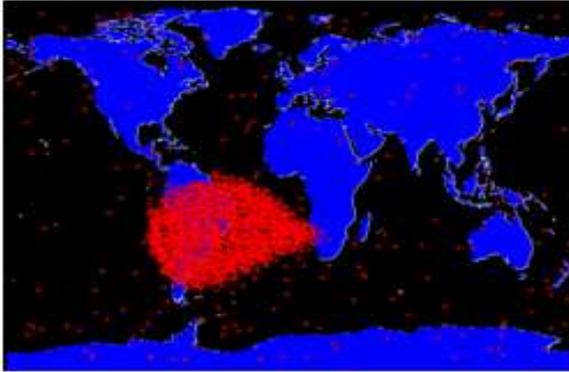


Figure 8. SAA zone in the range of high energy charged particles detected by Tatyana II satellite.

5. Conclusions

- (i) We have obtained maps of UV-R-IR flashes in different ranges of energies from Tatyana II data. The distribution of flashes shows clearly a tendency in determined regions. The IR events are mainly above land. R-IR emissions are seen at the South Atlantic Anomaly (SAA).
- (ii) Maps of charge particles were also obtained. The SAA was detected by Tatyana II satellite as the zone with most particle flux, so the detector works properly.

6. Acknowledgements

L.R. would like to thank the organizers of the XVI Mexican School of Particles and Fields for their support for assisting that event. This work has been supported in part by CONACyT México 106901 and VIEP, BUAP 0088.

References

- [1] Program of transient uv event research at tatyana-2 satellite 2010 *Journal of Geophysical Research* **115**
- [2] M. I. Panasyuk et al, Energetic particles impacting the upper atmosphere in connection with transient luminous event phenomena: Russian space experiment programs 2009 *AIP Conf. Proc.* **1118** 108-115
- [3] M. I. Panasyuk, Lomonosov Moscow State University Satellite Program 2010 *Universat/LRT*
- [4] S. Casadio, O. Arino and D. Serpe, Monitoring the South Atlantic Anomaly using ATSR
- [5] J.R. Heirtzler, The geomagnetic field and radiation in near-Earth orbits 1999 *NASA*