GRASSP Instrument: Status and First Results

M. Passas[1], J. Sánchez[2], F.C. Parra-Rojas[1], A. Luque[1], F.J. Gordillo-Vázquez[1]

[1] *Solar System Department, IAA - CSIC, Glorieta de la Astronomía s/n Granada, Spain*
[2] *Instrumental and Technology Development Unit, IAA - CSIC, Glorieta de la Astronomía s/n Granada, Spain*

GRanada Sprite Spectrograph and Polarimeter instrument is being designed and developed by TRAPPA Group (IAA-CSIC, Spain) and consists of a medium-high resolution spectrograph and a polarimeter (currently under development) both installed on a telescope mount to study the influence of TLE over the Earth mesosphere by analyzing the emitted spectrum. This mount moves automatically by consulting lightning databases and aims to the region where TLE are most likely to appear. It is currently installed at CAHA Observatory, in Almería, Spain, place from where we can observe the west Mediterranean Sea zone (37º-45ºN; 2ºW-14ºE) with an elevation of 10º-35º above the horizon. In this abstract we report GRASSP main characteristics, several TLE images recorded from CAHA Observatory and a lightning spectra recently captured by GRASSP instrument.

1. Introduction

Transient luminous events (TLE) were observed accidentally for the first time in 1989 [1] and since then, several spectroscopic measurements have been performed [2]-[4] to understand the influence of them over the Earth mesosphere. However, so far, the best spectral resolution used is $R = \lambda/\Delta\lambda = 215$ ($\Delta\lambda = 3$ nm) [4].

Granada Sprite Spectrograph and Polarimeter (GRASSP) is being designed and developed by TRAPPA Group at IAA – CSIC, Spain. It is thought to record TLE optical emissions spectrum with high spectral resolution and to characterize TLE polarization, if there is any. We attempt to combine theoretical models predictions [5]-[8] with the data collected by GRASSP to study the kinetics and electrodynamics of the air plasmas generated by TLEs.

GRASSP instrument is currently installed at CAHA Observatory 2.2 m dome since 21st November 2012 and since then several TLE and lightning images have been recorded.

2. GRASSP Spectrograph Main Characteristics

GRASSP Spectrograph uses a 1440-lines/mm grating and presents a variable free spectral range of 110 nm (655 nm to 765 nm), with a spectral resolution of $R = \lambda/\Delta\lambda = 1500$; $\Delta\lambda = 0.45$ nm. It uses an ICCD camera of 1360 x 1024 pixels with a FOV of 4º x 0.03º and 0.01 mm/px. The entrance slit (~100 microns) is oriented parallel to the horizon to optimize the likelihood of TLE detection. GRASSP conversion factor spectral sensitivity has been calculated according to [9] and it is shown in figure 1. After calibration and regarding to check the instrument reliability, we have compared the spectrum of the same air plasma obtained with different measurement systems: GRASSP and commercial Jobin Yvon - HORIBA FHR1000 spectrometer at 0.45 nm. Comparison is shown in figure 2.

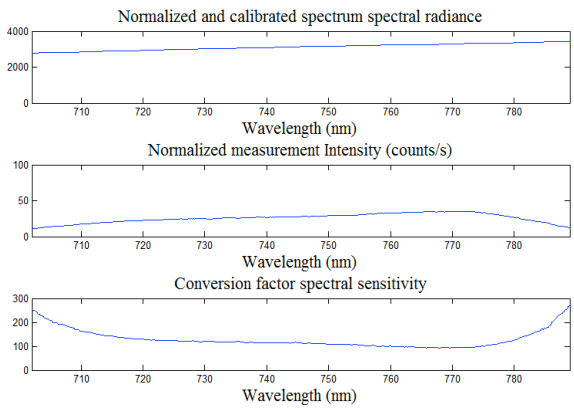

Figure 1: GRASSP conversion factor spectral sensitivity.

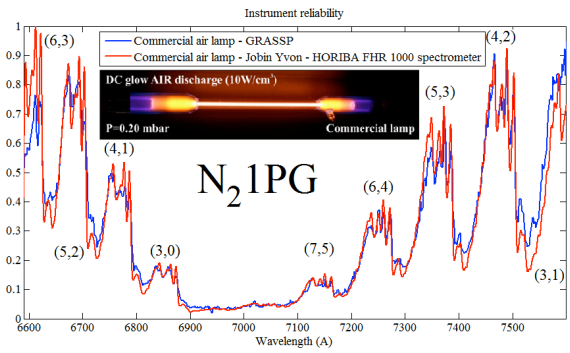

Figure 2: GRASSP reliability.

3. First results

The night of 9th July 2013 there were up to 1065 positive and 1430 negative lightning strokes in the area between 37º-45ºN and 2ºW-14ºE (figure 3), and GRASSP instrument captured 49 spectra of them (figures 4 and 5). We also present in figure 6 a sample of TLE images captured with GRASSP in 2013.

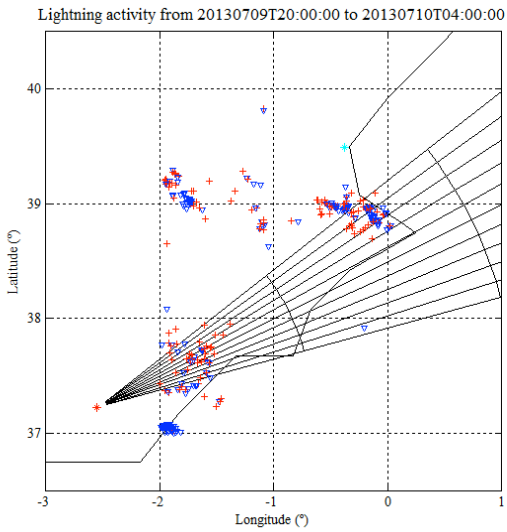

Figure 3: 9th July 2013 lightning activity.

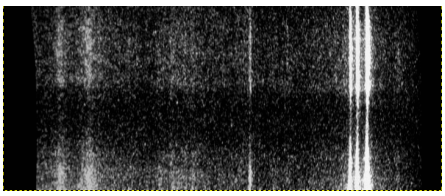

Figure 4: iCCD image of a lightning spectrum.

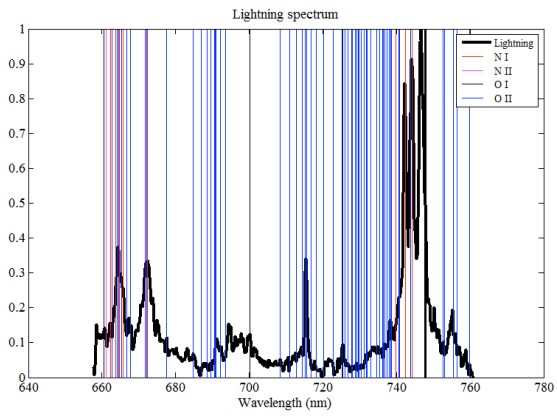

Figure 5: Lightning spectrum corrected by GRASSP conversion factor spectral sensitivity and overlapped atomic lines.

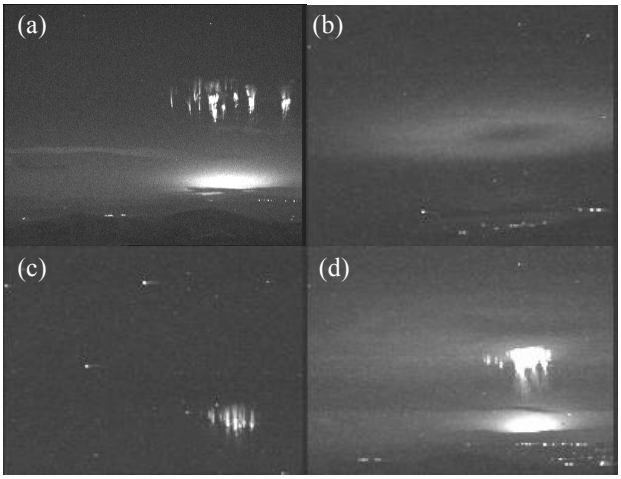

Figure 6: TLE images captured with GRASSP in 2013. Carrot sprites (a), elve (b), column sprites (c) and carrot sprites with halo (d).

4. Acknowledgement

This work was supported by the Spanish MINECO Ministry under project AYA2011-29936-C05-02 and by the Junta de Andalucía, Proyecto de Excelencia FQM-5965. Also, we kindly acknowledge lightning data provided by the Spanish Meteorological Service (AEMET).

5. References

[1] R. C. Franz, *et al.*, Science 249, 48 (1990).

[2] S. B. Mende, *et al.*, Geophys. Res. Lett. **22**, 2633 (1995).

[3] D. L. Hampton, *et al.*, Geophys. Res. Lett. **22**, 89 (1996).

[4] T. Kanmae, *et al.*, Geophys. Res. Lett. **34**, L07810 (2007).

[5] F. J. Gordillo-Vázquez, Journal of Physics D: Applied Physics **41**, 234016 (2008).

[6] A. Luque, and F. J. Gordillo-Vázquez, J. Geophys. Res.: Space Physics, **116**, A02306, (2011).

[7] A. Luque, A. F. J. Gordillo-Vázquez, Geophys. Res. Lett. **38**, L04808, (2011).

[8] F. J. Gordillo-Vázquez, and A. Luque, J. Geophysical Research: Space Physics **116**, A09319, doi: 10.1029/2011JA016652, (2011).

[9] U. Fantz, Plasma Sources Sci. Technol. **15**, S137-S147 doi: 10.1088/0963,0252/15/4/S01, (2006).