Non-Ionizing measures (1 Hz to 1kHz) using SpectranNF-5035 analyser in São José dos Campos, SP, Brazil

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Abstract

In a recent article, the author described a possible process of generating electromagnetic waves in the range of 1-12 Hz caused by diamagnetic currents originated by heat in ionosphere by high frequency waves (HF). The origin of the HF waves that reach the ionosphere can be sent from the Earth's surface or even solar phenomena. Through a SpectranNF-5035 detector, developed by German Aaronia with high sensitivity (1 µV) in a range of 1-12 Hz and low sampling time (5 ms), with specific external ELF antenna was possible to measure these waves and Schumann resonances. It was performed several measurements to detect these waves during very dry months of July and August 2016, away from electrical discharges in the region of São José dos Campos, SP, Brazil. These measurements it was also made during January 2017 that was a very wet period in the region. The positive results of these experimental observations as well as discussions and suggestions are presented in this paper.

Introduction

Non-ionizing radiation environment of a region has its intensity that can be measured in power (dBm) in milliwatts, in Volt/meter (V/m) corresponding the electric field or Volt (V) in the case of electrical potential relative to ground level. These values always vary with the frequency band [1] to be measured. General spectrum analyzers can observe this radiation in a particular frequency range, with continuous monitoring or discrete values of predetermined frequency. In general, analyzers covering the frequency range of 1 kHz to 26 GHz which are currently available on the international trade in addition to having high costs are used for measurements inside laboratories. They are not portable, and do not have sufficient sensitivity to observe radiation intensities in power with less than -90 dBm values which corresponds to 1×10^{-12} W of power [2]. These analyzers also require multiple sets of antennas to cover the entire frequency range to be used.

Non-ionizing radiations are those which do not produce direct ionization, that is, do not have sufficient energy to strip out electrons from atoms (< 12 eV), the means have enough power to dissociate molecules, or, break chemical bonds.

Non-ionizing radiations are always present in the environment [3]. Electromagnetic radiation also consists of waves that propagate through space. These waves can be ionizing or non-ionizing radiation and they are formed by composing an electric field (E) and magnetic field (B) which oscillates perpendicular to one another in the simplest case. The direction of propagation corresponds to the energy displacement (Poynting vector). These radiations include ultraviolet (near the visible), visible light, infrared, ELF (Extremely Low Frequency), LF (Low Frequency), VHF (Very High Frequency) and microwave. Some of this radiation is an electromagnetic spectrum band called Radio Frequency (RF) [4,5]. The alternating electric current also produces electromagnetic fields around the various conductors and equipment in any place and Brazil. For example, the oscillation frequency of the alternating current in Brazil is 60 Hz and its harmonics are as 120 Hz, 180 Hz and 240 Hz and more. Between 1 Hz and 40 Hz (ELF) are naturally Schumann waves determined by the resonances in 7.8 Hz, 14 - 16 Hz, 20.0 Hz and 33.0 Hz. Between 1 - 12 Hz, according to the recent theoretical work [6,7], waves formed in the ionosphere through HF wave and local ions interactions can exist.

These waves are extremely difficult to be measured given the low electric field values (E) and magnetic fields (B) by which they are transported [8, 9].

Method

It was used to collect the measures of non-ionizing radiation from 1 Hz to 1 MHz, one good commercial equipment purchased from Company Aaronia AG, Germany. A Spectran NF-5035 sensor works between the frequency (1 Hz to 1 kHz, and 1 kHz to 1 MHz) with a compact and omnidirectional antenna. The sampling time in the measurements may be chosen from 5 ms to 3000 ms. The resolution band width (RBW-Resolution Band Width) may range from 0.3 Hz to 1 MHz. The sensor is fully portable with its own batteries for 8 hours of continuous operation. Specific software provided by Aaronia AG writes the data on files (.ldt) and simultaneously generates graphics on screen display of computer that can save images. All details of the parameter settings and operation of the frequency spectrum analyzer can be found in the above-mentioned manufacturer's website [10]. It was used a laptop PC (Dell Vostro i5) for the acquisition and determination of the frequency spectra with the measured data files. Because the system is compact and portable, it is possible to carry out surveys of non-ionizing radiation field at any remote location. Figure 1 shows the lifting of the electric field (V/m) environment at ITA campus in São José dos Campos, SP, Brazil. It is observed in this graph that the electric transmission line on site (ITA campus) induces the electric field at 60 Hz and its harmonic 120 Hz, showing the proper functioning of Spectran NF-5053 sensor.

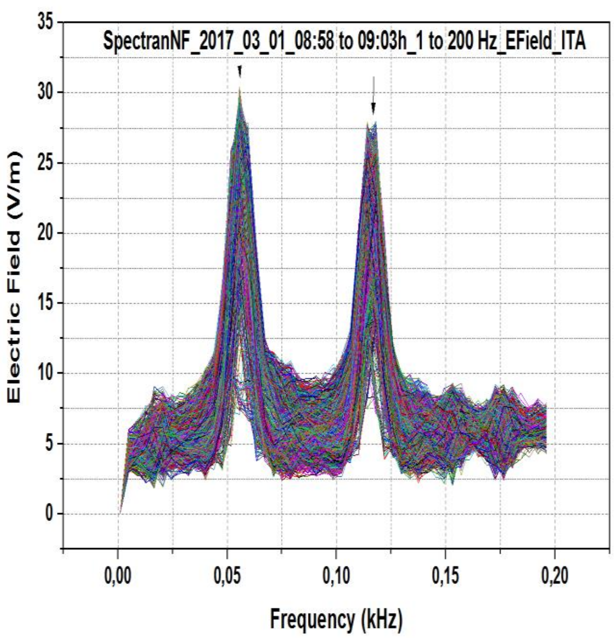

__Figure 1__ – Calibration of SpectranNF-5035 measuring electric field under electric power line of 220 V and 110 V. The 60 Hz are the frequency of transmissions line in Brazil giving maximum value of 3 mV/m.

Results

Measurements in São José dos Campos were made on the campus of the Department of Physics of the ITA (Technological Institute of Aeronautics) without direct interference from the local power grid. As a first result, it was found that the electric field spectrum (V/m) between 1 Hz and 1 kHz was repetitive and constant in region with an intensity of < 2 V/m. In the Figure 2 it is plotted this variation and the peaks in 60 Hz, 120 Hz, 180 Hz.., due to local power transmission line. In reference the local ground level and the the ionosphere it is plotted the electric potential in Volts shown in Figure 3. The background value due to all local emissions in same measurements site stay near value 2 microvolts.

The highest electric potential in 2.2 Hz, 4.3 Hz, 6.1 Hz and 7.6 Hz located peaks, was wavering between 40 and 50 microvolts and background noise with a lower value of 10 microvolts is as shown in Figure 4 below.

To this extent, the electric potential of the local site to that referring is already included local power network that contributes a maximum to 5 µV in August and September of 2016 and January of 2017.

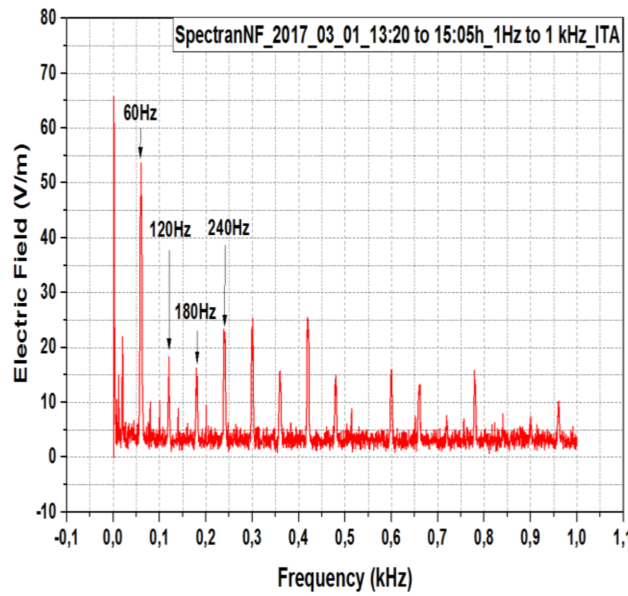

__Figure 2__ – The local electric field background and peaks from electric power line in Hz, giving 3 mV/m in 60 Hz.

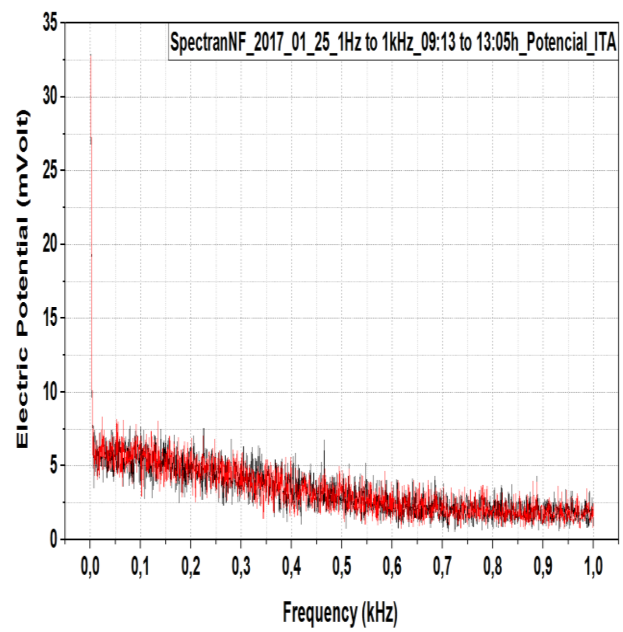

***Figure 3 –** Electric Potential (µV) variation with frequency in the region with maximum of 6 µV.*

Figure 3 gives the electric potential variation from 1 Hz to 1000 Hz. The intensity stay near 5 µV constant in the frequency range 1 - 40 Hz.

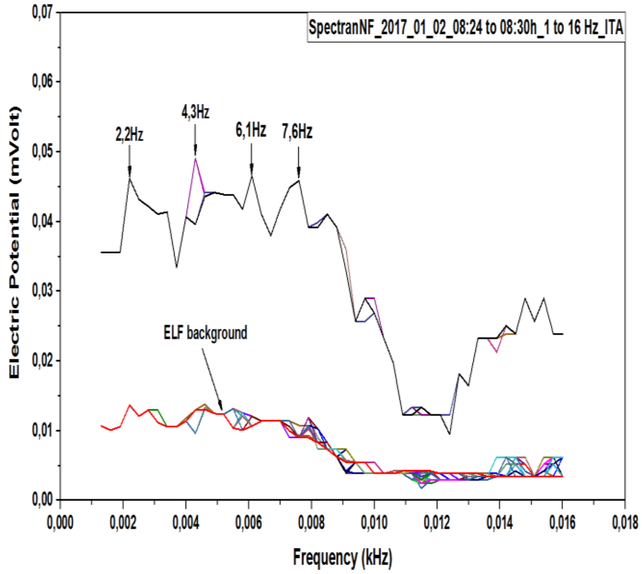

Figure 4 *– Measurement of ELF background and ionosphere peaks due to diamagnetic currents.*

Measurements in Figure 4 were made with monitoring obtained on 2017/02/01 from 08:24 to 08:30 local time it shows that the values are already the maximum of the region. Generally nocturnal measures and periods are until 07:00 local time, and the intensity of this wave of 1-12 Hz is a minimum of 10 microvolts order, that it is call the ELF background in that Figure 4.

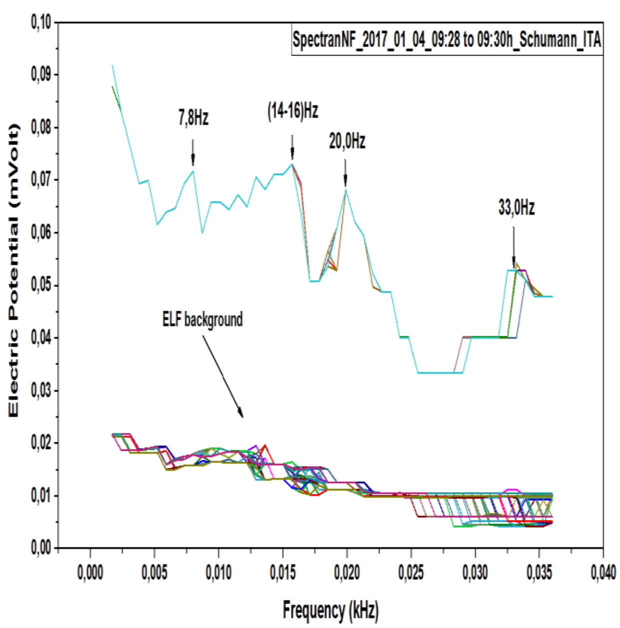

Figure 5 *– Measurements of Schumann's resonances peaks and local ELF background.*

Conclusions

Measurements were made in São José dos Campos on the campus of the Department of Physics of the ITA (Technological Institute of Aeronautics) without direct interference from the local power grid. As a first result, it was found that the electric field spectrum (V/m) between 1 Hz and 16 Hz was repetitive and constant in region with an intensity of < 2 miliVolt/m. The highest electric potential in 2.2 Hz, 4.3 Hz, 6.1 Hz and 7.6 Hz located peaks, was wavering between 40 and 50 microvolts and background noise with a lower value of 10 microvolts is as shown in Figure 2 below. To this extent, the electric potential of the local site to that referring is already included local power network that contributes a maximum to 5 microvolts in August and September of 2016. Measures in Figure 4 made with monitoring obtained 2017/02/01 from 08:24 to 08:30 local time show that the values are already the maximum of the region. Generally nocturnal measures and periods are until 07:00 local time, and the intensity of this wave of 1 - 12 Hz is a minimum of 10 microvolts order. In the period of August to September in 2016, and in 2017/02/01 from 08:24 to 08:30 local time the spectrum in frequency from 1 Hz to 16 Hz was measured through a Spectran NF-5035 sensor developed by a German company, Aaronia Ag. This spectrum showed electric potential peaks (V) at 2.2 Hz, 4.3 Hz, 6.1 Hz and 7.6 Hz ranging from 40 to 50 microvolts maximum in the period from 10:00 to 20:00 local time. At night until 07:00 morning in the local time, this reached near 10 microvolts in the same frequency range. Between 07:00 and 10:00 local time, values are minimum passing unstable (~ 10 μV) to the maximum (~ 50 μV) as shown in Figure 4, in the text. It was found that in the morning hours before 10:00 local time, the electric potential of the signal becomes maximum when there is an increase of X-rays flux in wavelength from 0.5 to 4.0 Å and in wavelength from 1 to 8 Å; shown by satellite Goes series 13 and 15 measurements. It was concluded that through diamagnetic currents in the ionosphere, it is more or less ionized creating electromagnetic waves between 1 Hz and 12 Hz, and visible peaks with intensities and frequencies described above. In the same way it is measured for the period the Schumann resonance showing peaks of 8.0 Hz; (15-16) Hz, 20.0 Hz and 33.0 Hz. Maximum value in intensity of peaks ranging in 65 μV and minimum calling the ELF local background of 10μV. So it is measured the ionospheric diamagnetic currents and also the Schumann resonance's using the SpectranNF-5035 and one external antenna.

Acknowledgments

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