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First Results from the ELF/VLF Receiver in Sri Lanka

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Abstract

In this work we present the first results from the low frequency receiver in Sri Lanka. The set-up was completed in November 2019 and it has been collecting data 24 x7 since then. The geographic location of this receiver makes it highly efficient in observing lighting and other lightning related ELF/VLF phenomenon. In the long run this station is about to be added into WWLLN network and provide ground-based data complementary to the TARANIS mission.

1 Introduction

Extremely Low Frequency (ELF: 300Hz – 3kHz) and Very Low Frequency (VLF: 3 – 30 kHz) waves have been a topic of interest within the scientific community since early1950s. Low attenuation and high penetration depth make these waves suitable for long distance and underwater communications. Low frequency waves can be guided between the Earth-Ionosphere Waveguide (EIW) and propagate longer compared to their high frequency counterparts [1].

Earth's ionosphere is at a plasma state and at these frequencies (< plasma frequency), ionosphere acts as a reflector. Hence, ELF/VLF waves incident on the ionosphere are bounced back to the Earth, instead of penetrating through. With this mechanism, low frequency waves can be guided between Earth and ionosphere, creating the Earth-Ionosphere Waveguide. Hence, studying the properties of ELF/VLF is of an engineering interest for over the globe communication and D region ionospheric studies.

In addition to these, ELF/VLF waves have been extensively studied in lightning research as well. Lightning acts as a source for waves within a large range of frequencies. Whistler waves are one type of low frequency waves emitted by lighting and leaked through the ionosphere. Those waves play a major role in space energy dynamics. Although whistlers are rarely observed on the equatorial region on Earth, the precursor to whistlers, 'sferics' are frequently observed. Hence, studying the equatorial ionospheric waves is an important aspect of space weather research [2].

In this work, we present first results from the ELF/VLF receiver implemented in Sri Lanka. Sri Lanka is an island in the Indian Ocean at latitude 7.87°N and longitude 80.77°E. Being close to the equator makes it very active in lightning and gives direct access to the equatorial electrojet.

Therefore, the objectives behind this receiver implementation were studying lightning statistics, lightning generated waves such as 'sferics', 'sprites' etc. In the long run this receiver is bound to supply data to the World Wide Lightning Location Network (WWLLN) [3] and also to provide ground based data to complement satellite observations from the French Tool for the analysis of Radiations from lightning and Sprites (TARANIS) mission [4].

22 Instrumentation

Figure 1shows the implemented receiver. It is in the Hantana mountain range and managed by University of Peradeniya. It was implemented in November 2019 and has been collecting data 24 x 7. The receiver antenna includes two magnetic loop antennas raised above ground and supported by cables. And the receiver electronics contains preamplifier, power supply and storage devices.
The VLF signal is sampled by 16bit at 200 kHz and stored in 10 millisecond long frames. Each frame header contains a timestamp with 80nanosecond accuracy.

Figure 1: ELF/VLF receiver in Sri Lanka. It is in the Hantana mountain range and managed by University of Peradeniya.

3 Data

As mentioned above, this receiver station is expected to observe lightning activity and other lightning related phenomenon such as ‘sferics’. Data analysis is currently in progress and so far, the site is operating smoothly collecting data 24 x 7. Once the receiver is officially added to the WWLLN network, data will be available online in real-time.

Figure 2 shows a spectrogram of data observed on November 27, 2019. It shows strong lightning strikes and ‘tweeks’.

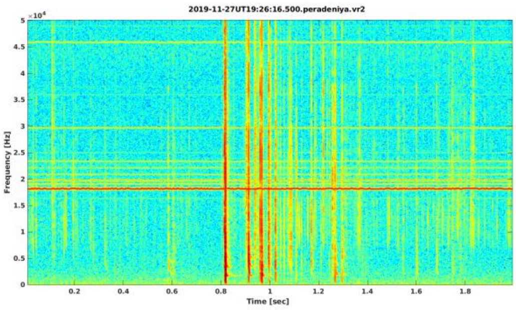

Figure 2: Spectrogram of data showing strong lightning strikes and tweeks. These were observed on November 27, 2019.

7 References

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