AN APPROACH TO STUDY THE ATMOSPHERIC ELECTRIC FIELD USING EFM SYSTEM

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Abstract

The study of localized atmospheric electric field is expected to reflect upon the changes that take place in the near earth environment. The atmospheric earth electric field has been observed to serve as an important parameter which provides information about atmospheric – ionospheric coupling. The behavior of atmospheric electric field is reasonably different in normal weather condition and the condition due to perturbed climate state. In this paper, the authors intent to discuss the demonstration how the electric field mill perform and certain figure have been presented on a very basic level to reflect upon the kind of data being recorded by the field mill for complex analysis.

Keywords: Atmospheric - ionospheric coupling, thunderstorm, fair weather condition

INTRODUCTION:

In the recent times, the atmospheric dynamics have been a point of great interest to research community. When it comes to the exploration of the changes in the atmosphere, the vertical component of the localized electric field is observed to have played an important role towards characterizing the behavior of atmosphere. Under the "fair weather condition" electric field varies from 100V/m to 200V/m (Pulinets et al. 2006) but any kind of disturbance in atmosphere causes the variation in electric field due to movement of charges. Sometimes it is observed that even a greater degree of change in atmospheric electric field may indicate a severe weather condition. Atmospheric anomalies are interrelated with changes taking place in atmospheric electric field referred as global electric circuit. Global electric circuit is influenced by meteorological processes (Rycroft et al, 2000). The changes taking place in the atmosphere need to be monitored continuously as the atmospheric electric field is one of the major constituents of global electric circuit

(Bering III et al., 1988). The average value of vertical gradients of localized field has also been studied in this context for electrically calm days (Murri et al., 1973). The AEF is regulated by variation in climatic conditions such as rainfall and lightning, and produces a vertical potential gradient in non thunderstorm or normal weather regions (Harrison, 2005). AEF shows different pattern in turbulent condition (Bennett et al. 2008). Perturbation in atmospheric electric field has been witnessed in case of cloudy and meteorologically active region, even presence of air mass e.g. aerosols, pollutants etc. affect the atmospheric electric field (Datta et al., 2004). These variable patterns of atmospheric electric field corresponding to unusual climatic activities characterize the global as well as localized atmospheric electric field. Sometimes heavy lightning jump may not always constitute any turbulent or disturbed weather conditions at ground (Pawar et al. 2010). Non observance of severe weather may be due to the short duration of flash rate. Sudden rise and fall takes place immediately in very short span of time (Bressan et al., 2004).To characterize the fair weather condition, daily variation in three parameters namely the Earth electric field (E), vertical air earth current density, and atmospheric electrical conductivity (σ) are required. In normalized conditions it is found that the average values of above mentioned parameters are: Earth electric field (E) is 108 Vm^{-1}, air earth current density 1.85 Pam^{-2} and the average atmospheric electrical conductivity (σ) is 19.6 $FS\text{-}m^{-1}$(Guha et al, 2010).

METHOD AND MATERIAL:

To measure the localized electric field or vertical potential gradient an electric field meter (Mac Gorman et al. 1998) is used known as Electric Field Mill (EFM). EFM has been employed to observe and record the variation of the localized earth electric field regularly in Gwalior region. To avoid the interferences EFM is mounted on the roof top of the Madhav Institute of Technology and Science, Gwalior, Madhya Pradesh with the isolation.

In EFM, four electrodes are used to measure earth electric field. Two are exposed to near earth electric field and two are shielded from the field (Deshpande et al. 2000). These rotating electrodes come in contact with the earth electric field alternately (H. Bloemink, 2013). When exposed electrodes come in contact with the field, charges are induced on them and this induced charge moves back to the ground when shielded electrodes come in contact with the field (Ferro et al. 2011). Movement of charges from electrodes generates current which is found proportional to the strength of the electric field in contact.

Charges flowing on to and off of the sense electrodes will develop a voltage across the sense resistor. This voltage is amplified and fed into an analog switch along with an out of phase version of the signal.

Block diagram of Field Mill is shown below.

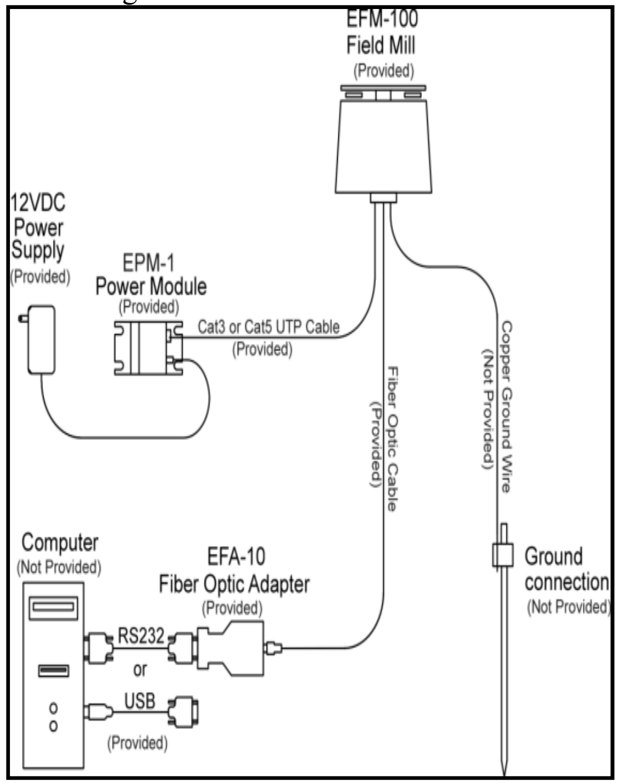

Figure 1 Block Diagram of Electric Field Mill

RESULTS AND DISCUSSION:

In this section the authors have presented the pattern how the electric fields are recorded with the data logger with initial diagram. The plot shows the variation of AEF along with the time of the day. Here four different pattern of AEF has been taken to compare and understand the variability of AEF pattern under different climatic (Turbulent to normal) conditions. Figure 2(a) shows the sudden variation in AEF on April 02, 2013 at 16:00 hrs which is termed as turbulent condition in which electric field attains the value about 6.47kV/m, which is the indication of heavy rain fall and lightning activity. Heavy rainfall and lightning activity has been recorded at the same day (data taken by data server of climatic data centre). Figure 2(b) shows the phase transition in AEF pattern after the heavy rain fall and lightning activity. Phase transition in AEF pattern depicts the gradual normalization in climate on the same day. Followed the phase transition gradually normalization in localized AEF has been observed on the same day April02, 2013 in Figure 2(c). Figure 2(d) evinces the quiet period, referred as fair weather day on April 03, 2013.

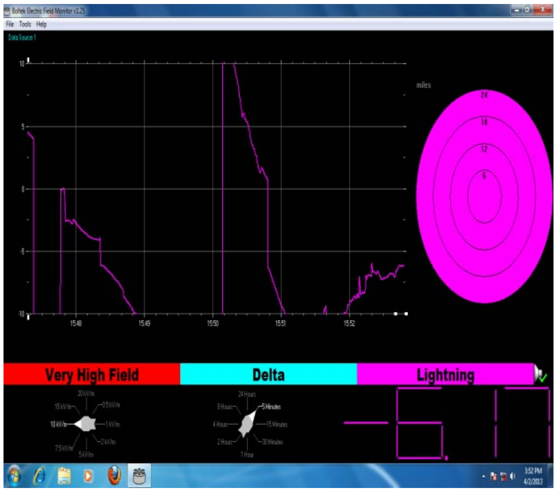

Figure 2(a) depict the occurrence of heavy rainfall and lightning activity on April 02, 2013 at 16:00 hrs

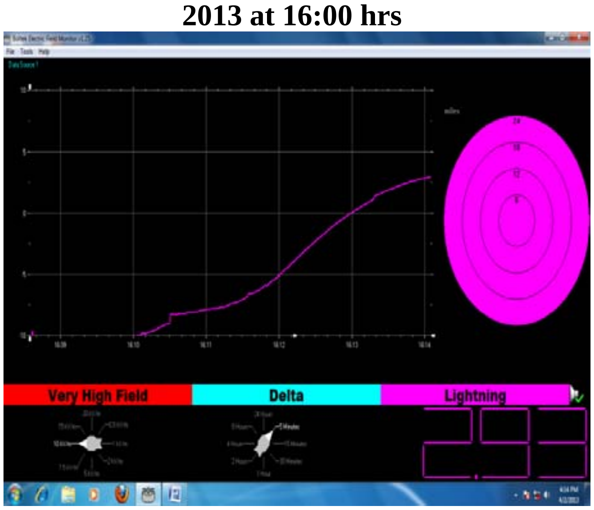

Figure 2(b) expresses the phase transition in AEF of April 02, 2013 after 16:10 hrs

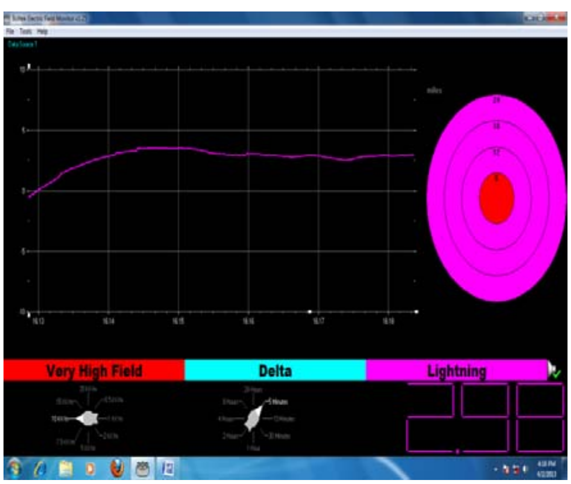

Figure 2(c) Gradually normalization in AEF on April 02, 2013

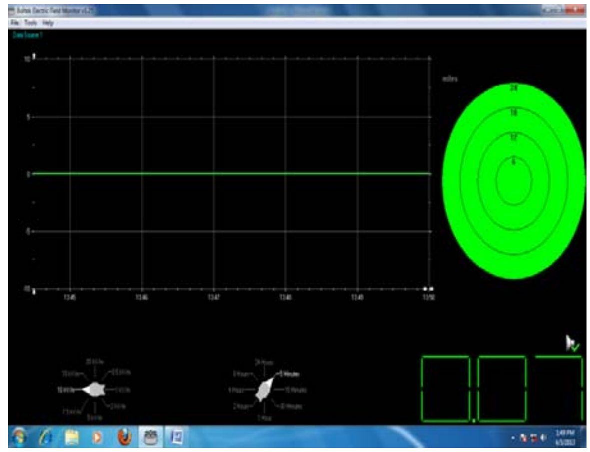

Figure 2(d) shows the pattern of AEF in fair weather condition on April 03, 2013

CONCLUSION:

In this paper, authors have presented the conditions of atmospheric electric field pattern which is measured using the locally set up electric field mill. The conditions refer to heavy rain fall, lightning activity to normal condition, which definitely is expected to help us characterize and understand the variability of atmospheric electric field pattern. The response of atmospheric electric field with unusual climatic condition can be seen clearly, which leaves an impression about the tendency of AEF in different climatic conditions, normal as well as disturbed.

ACKNOWLEDGEMENTS:

The authors sincerely thank the All India Council for Technical Education (AICTE), New Delhi, India and Madhav Institute of Technology and Science (MITS), Gwalior, India for providing necessary support.

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