ISSN: 2229-6948(ONLINE)
DOI: 10.21917/ijct.2022.0396

ATMOSPHERIC EFFECTS ON ELECTROMAGNETIC RADIATION EXPOSURES FROM BASE STATION ANTENNA THROUGHOUT A SINGLE YEAR – A CASE STUDY

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Abstract

With the innovation of equipment and augmented needs of data on mobile networks it has been observed that a great amount of cell towers is constructed in metropolises and cities. We studied human exposure to EM radiation from base stations in an area of West Bengal state in India. In this research, measurements have been executed at a fixed location near the cell tower of this place. Here we have compared measured power densities, electric fields and magnetic fields among every day of each month throughout the year. At the moment atmospheric temperature, humidity, wind speed, pressure and precipitation were assessed for this exposure site near the base station. Results were given in terms of power density, electric field and magnetic field in relation to distinctive atmospheric factors. This paper illustrates an approach for the selection of measurement points in Metro city, urban, semi-urban and rural areas in order to evaluate amenableness with the restrictions for exposure to EMF. The amplitude of electromagnetic field exposure (EMF) is dependent on the various factors like antenna distance, base station tower heights, number of base station tower antennas, direction and different atmospheric parameters which are temperature, humidity, wind speed, pressure and precipitation.

Keywords:

Base Station Antenna, Electromagnetic Radiation, Atmospheric Effect, Power Density, Electric Field, Magnetic Field

1. INTRODUCTION

Throughout the preceding era it is discovered that cell phone equipment has raised very quickly. Massive proportion of towers is to be mounted for the necessity of the communication need. It is essential for human life of consuming wireless mobile communication networks as a component of it. Now it is realized that the intensity of electromagnetic environment all over the world is enhanced so there is a constant existence of electromagnetic radiation in the atmosphere. The unbelievable expansion in the utilization of cellular phone has resulted in incremental number of the Global System for Mobile communication (GSM) base stations being invented in extremely populated sector. As the utilization of mobile become expanded so the insertion of new base stations in the site of domiciles grows the public exposure to electromagnetic field. The domestic exposure occurs in authentic picture because of these established base stations in the domestic region. Since there will be the occupancy of EM field in all regions in the apartments for that reason individual human being from dwellings gathers subjected to EM field from cellular base station antennas. Normally, metropolitan areas have a massive inhabitant as a consequence cell size is diminished to enclose each and every part of the city. Hence there is a demand of enormous number of base stations. Considering the revelation of the practicable outcome of the EMF exposure from cellular base stations, distinct researches were conducted in the various divisions of EMF exposure assessment [1–5] and probable consequence of human exposure to EM fields from cellular base stations [6–10]. To evaluate the probable outcome of exposure to electromagnetic radiation from cellphone communications, researches have been executed in the surroundings of exposure field assessment [11–15] and probable consequence of human exposure to this kind of fields.

Atmospheric refractivity is the outcome of physical specification of air which are temperature, relative humidity, wind, pressure and precipitation. The base transceiver station (BTS) which can produce high frequency wavelengths cannot propagate well across water. Water can conduct electricity so radio waves are reflected by it. Also, the energy of radio signals is absorbed by water vapor, and converts into heat. In a basic sense water acts as a barrier for this radio signal between the tower and cellular device. The scattered cell signal will be more if the water drops are larger and more in amount. If there is a difference in air pressure between two points, then it will cause movement of air called wind. Atmospheric parameters especially temperature and wind are the predominant factors which affect cellular signal strength. In order to accomplish a good quality of service, wireless communication uses propagation of radio waves which re- quire a minimal variation in signal so that fading in receiver cannot happen. Recent studies show that the propagated radio signals undergo spatial and temporal changes because of fluctuations in the atmospheric conditions and environmental factors [16]. These variations occur in the troposphere because of refractivity changes in this region. It is noticed that at the troposphere region, temperature decreases largely with altitude at a rate nearly 10 degrees Celsius per kilometer [17, 18]. Wind is observed in troposphere when there is a consequent change in the atmospheric pressure which results movement of air from a lower to a higher part and arise winds of several speeds. Weather parameter measurements are taken for the improvement and up-gradation of network to minimize dropped calls happening, access failures and for finding the amount of fading expected at a given period of time in this environment. Radio waves are not directly affected by wind which affects the refraction (bending of the waves) capabilities of the medium so it leads to deviation in radio propagation. Refraction always exists in the atmosphere and therefore it is necessary to be considered for in radio propagation.

The reason of calculating the EMF exposure is to shield the individuals from extreme EM radiation from base stations, and from its unfavorable health consequences. At the present time cities are handling great extent of electromagnetic exposure due to GSM technology for wireless communication. In this regard, cities tackle the maximum degree of electromagnetic exposure in terms of non-ionizing radiation due to the existence of transmitters for mobile communication in congested regions. For practical reference level evaluation in far field region, extent of resultant magnitudes like electric field intensity, magnetic field intensity, or power density are adequate to certify that the basic margins are fulfilled [19]-[23]. This paper gives a methodology to approximate the probable location of maximum exposure to EMF associated with a base station antenna in urban areas as well as suburban or rural areas, fulfilling a gap not included by cur- rent international standards, which adopt preference of points of investigation, without comprising how to find locations of maximum exposure.

2. METHODOLOGY

We calculated the intensity of EM field and power density around portions close to the base station antennas situated at a fixed location throughout everyday of each month of a year. In our research, base station towers are fixed over the ground and average numbers of antennas on the towers were around 16 to 20. The average distance between base station antenna tower and our measuring point was approximate 18 m where maximum radiation will be observed. Seeing the typical height of the Indian people the EM field exposure was assessed at height 1.5 m by means of a three-axis electromagnetic field meter model KM-195 by KUSAM-MECO brand. The meter is a broadband device for observing high frequency radiation in the range from 50 MHz to 3.5 GHz which cover up complete frequency band worked for cellular mobile communication. Beside this measurement we have also measured the atmospheric temperature, humidity, wind speed, pressure and precipitation so that we have linked how these will be manipulating this EM radiation from base station antenna. Electric field was measured in V/m, magnetic field in mA/m and power density in μW/m^2.

3. RESULTS AND DISCUSSION

From Fig.1 to Fig.12, we obtained the results of power density in micro watts per square meter (μW/m^2) and electric field in mili volt per meter (mV/m) and magnetic field in mili ampere per meter (mA/m) for the base station antenna throughout everyday of each month of a single year. It is observed that radiation is very high in the month of March and April when temperature is very high and humidity is low and wind speed becomes high. Similarly, radiation is very low in the month of july when precipitation becomes high and also pressure is high. All the maximum values measured are below the ICNIRP limit.

The Fig.13 to Fig.15 show the maximum power density, electric field intensity and magnetic field intensity for this BTS and the same result is found in case of temperature, humidity, wind speed, pressure and precipitation variations.

The Fig.16 and Fig.17 depict the variation of power density, electric field and magnetic field when temperature is high and temperature is low respectively. It is seen that radiations become little high when temperature is high and radiation become little low when temperature is low.

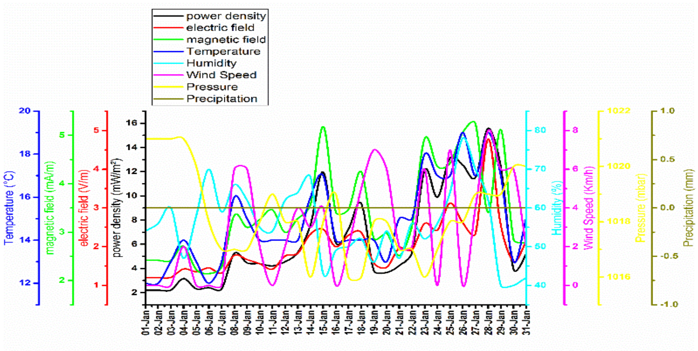

Fig.1. EMR exposure of base station antenna for the January month

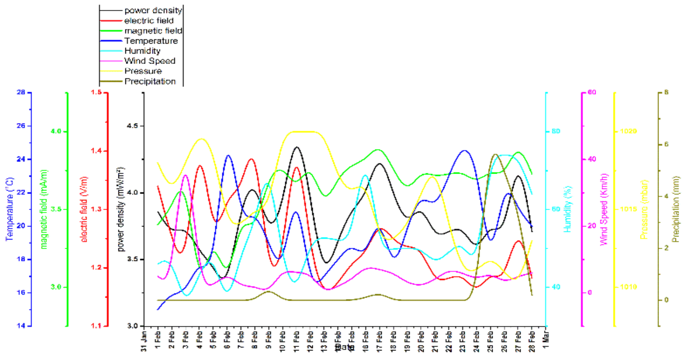

Fig.2. EMR exposure of base station antenna for the February month

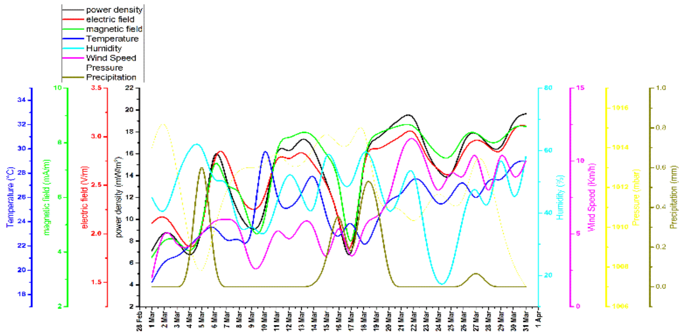

Fig.3. EMR exposure of base station antenna for the March month

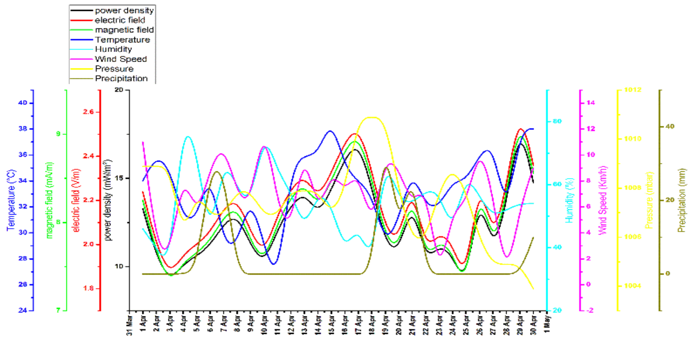

Fig.4. EMR exposure of base station antenna for the April month

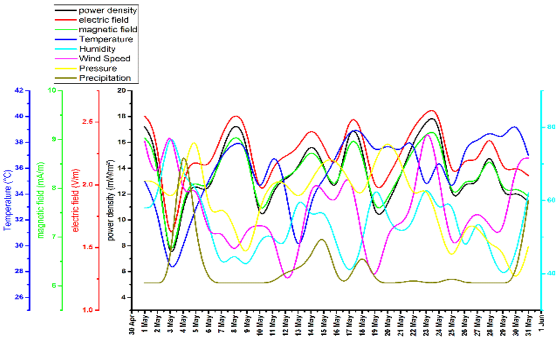

Fig.5. EMR exposure of base station antenna for the May month

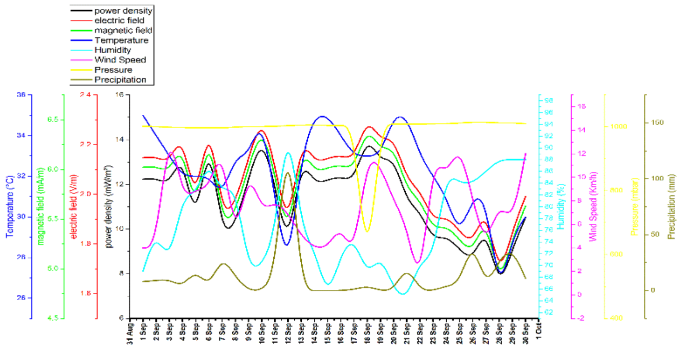

Fig.9. EMR exposure of base station antenna for the September month

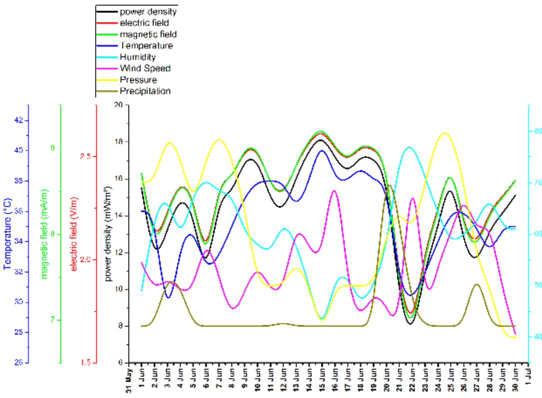

Fig.6. EMR exposure of base station antenna for the June month

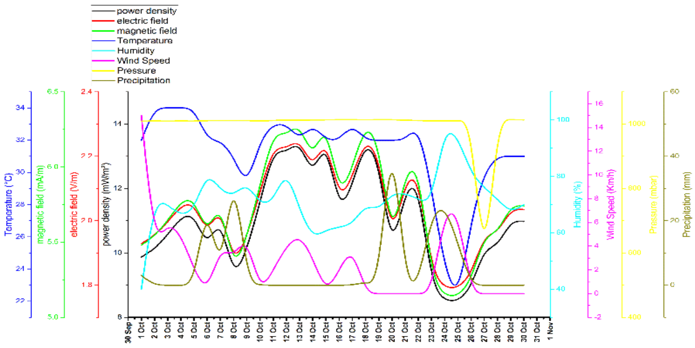

Fig.10. EMR exposure of base station antenna for the October month.

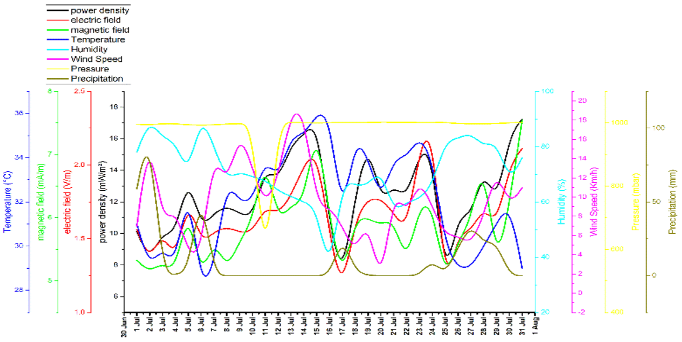

Fig.7. EMR exposure of base station antenna for the July month

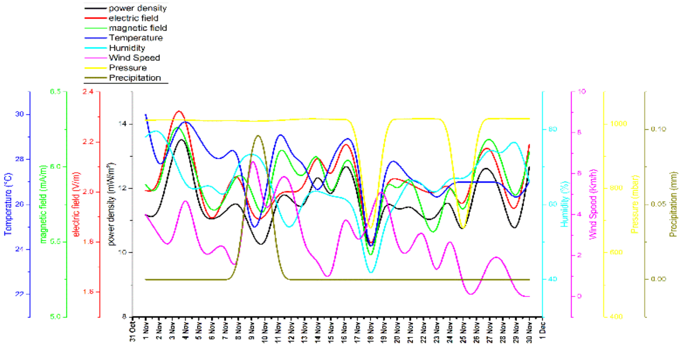

Fig.11. EMR exposure of base station antenna for the November month

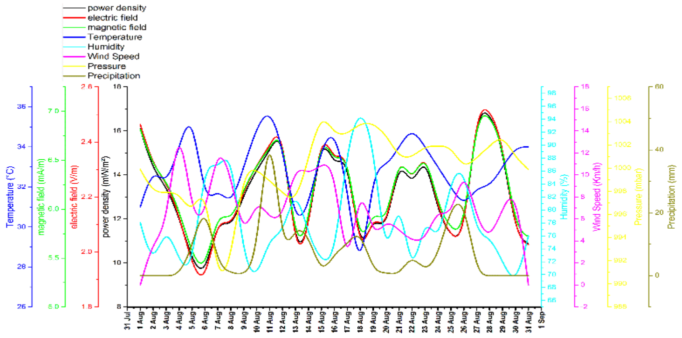

Fig.8. EMR exposure of base station antenna for the August month

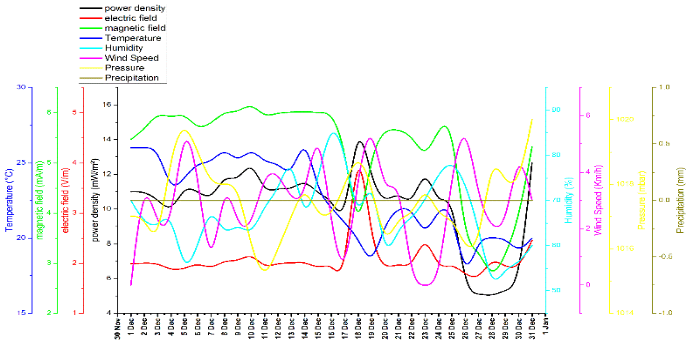

Fig.12. EMR exposure of base station antenna for the December month

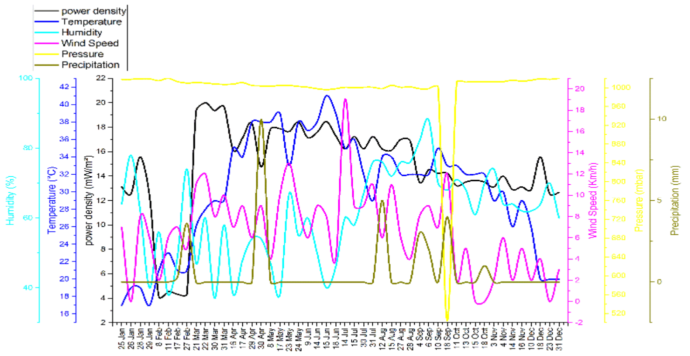

Fig.13. EMR exposure of base station antenna for the highest value of power density

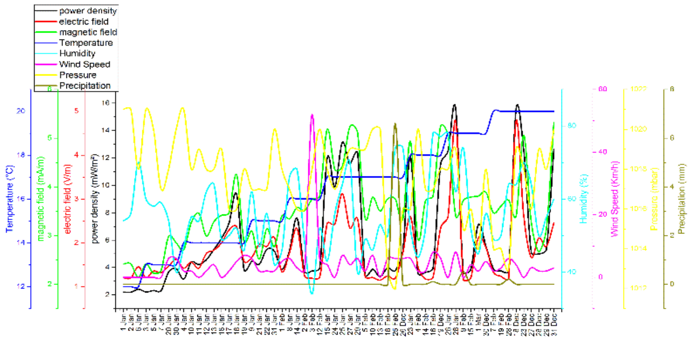

Fig.17. EMR exposure of base station antenna when temperature is low

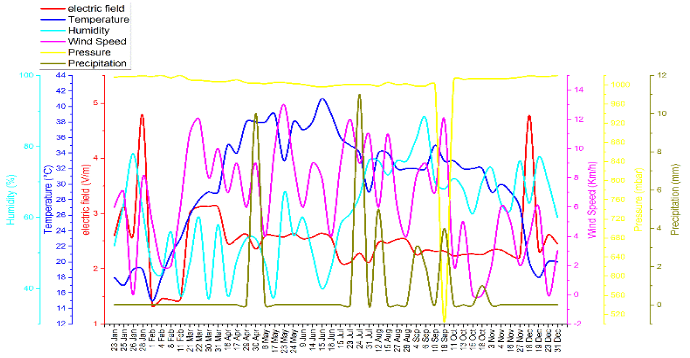

Fig.14. EMR exposure of base station antenna for the highest value of electric field

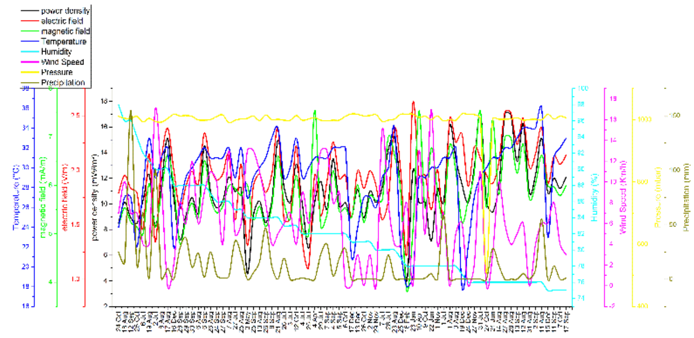

Fig.18. EMR exposure of base station antenna when humidity is high

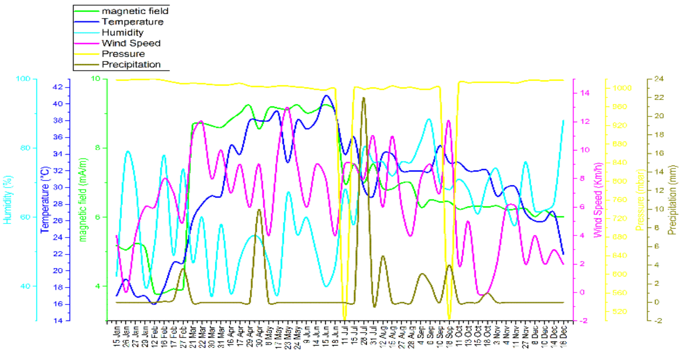

Fig.15. EMR exposure of base station antenna for the highest value of magnetic field

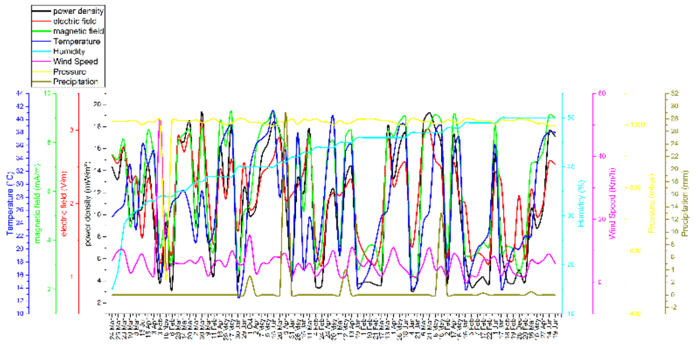

Fig.19. EMR exposure of base station antenna when humidity is low

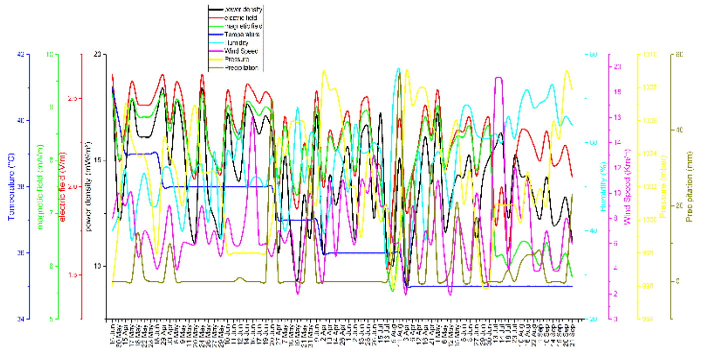

Fig.16. EMR exposure of base station antenna when temperature is high

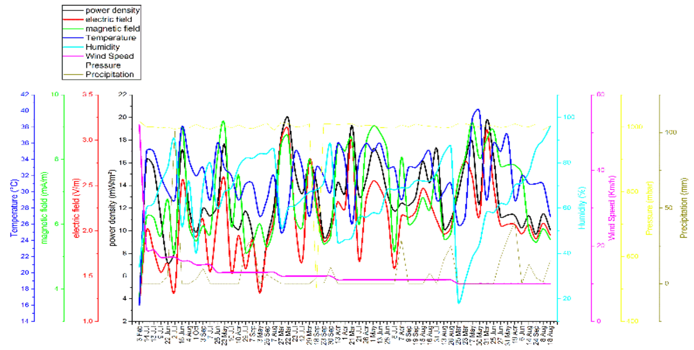

Fig.20. EMR exposure of base station antenna when wind speed is high.

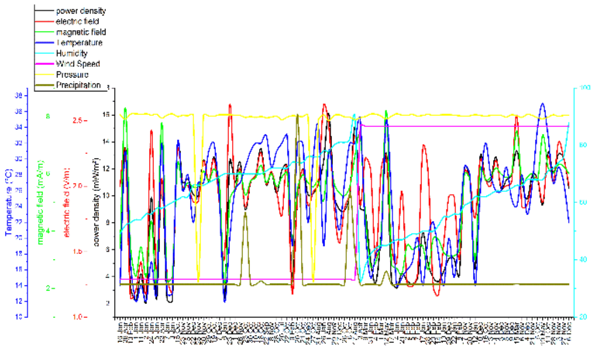

Fig.21. EMR exposure of base station antenna when wind speed is low

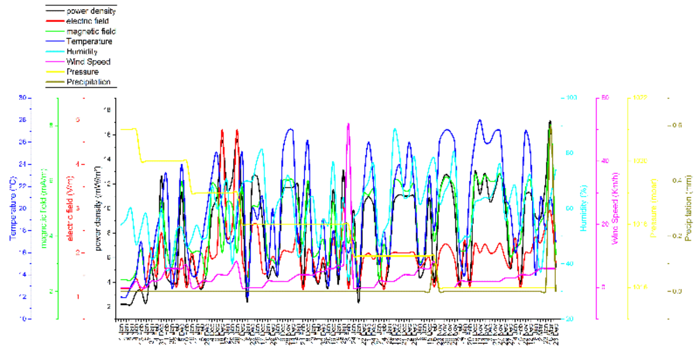

Fig.22. EMR exposure of base station antenna when pressure is high

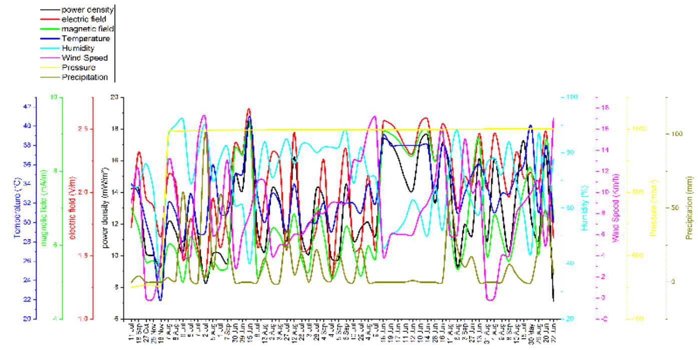

Fig.23. EMR exposure of base station antenna when pressure is low

The Fig.18 and Fig.19 represent the variation of power density, electric field and magnetic field when humidity is high and humidity is low respectively. It is seen that radiation become low when humidity is high and radiation become high when humidity is low. Fig.20 and Fig.21 show the variation of power density, electric field and magnetic field when wind speed is high and wind speed is low respectively. It is seen that radiation become high when wind speed is high and radiation become low when wind speed is low. Fig.22 and Fig.23 indicate the variation of power density, electric field and magnetic field when pressure is high and pressure is low respectively. It is seen that radiation become low when pressure is high and radiation become high when pressure is low. Fig.24 and Fig.25 demonstrate the variation of power density, electric field and magnetic field when precipitation is high and precipitation is low respectively. It is seen that radiation become low when precipitation is high and radiation become high when precipitation is low. It was found that power densities varied both in space and time. There were large differences between the maximum and the minimum values at every base station antenna. In most of the cases the measured field exposure is well below the reference level.

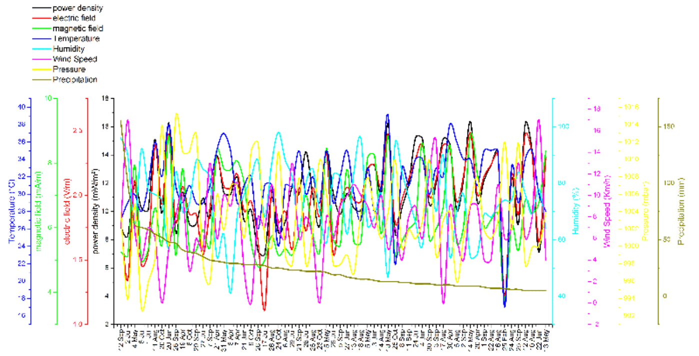

Fig.24. EMR exposure of base station antenna when precipitation is high

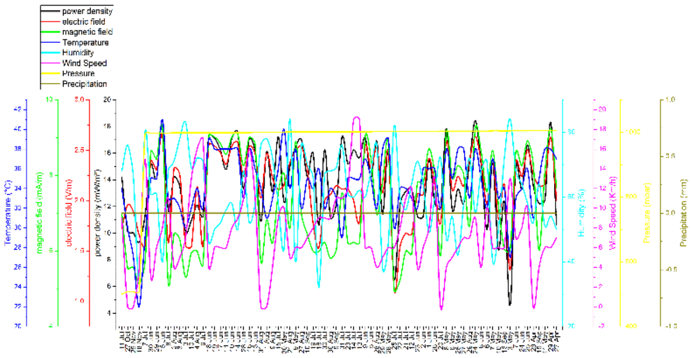

Fig.25. EMR exposure of base station antenna when precipitation is low

4. CONCLUSION

From this paper we come to an end that atmospheric parameters like temperature, humidity, wind speed, pressure and precipitation greatly influence this EM exposure. It is also found that there is more power density, electric field and magnetic field intensity when temperature is high, humidity and wind speed are low and there is less power density, electric field and magnetic field intensity when precipitation is high and pressure is low. Finally, it is seen that by the increase of temperature this EM radiation is increased and by the increase of humidity this EM radiation is decreased but not as a great extent. But it is found that by the increase of pressure this EM radiation is decreased and by the increase of precipitation this EM radiation is decreased as a great amount. So we can conclude that the pressure and precipitation play major role to control this EM exposure level and on the other hand the temperature, humidity and wind speed play medium role to control this EM exposure level.

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