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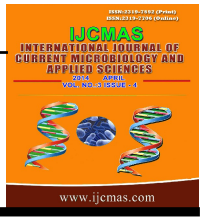

Original Research Article

An estimation of afternoon mixing heights by using gaussian box model-a case study

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A B S T R A C T

Horizontal wind speeds through the afternoon mixing heights are separately extended for the station to show how they differ from the average wind speeds through the morning mixing layer. The afternoon is subjected to a different sunshine regime when compared to morning. One can except the magnitude of wind speeds the afternoon mixing layers to be higher than the during morning. The separation of the two regimes of the day is very important from the point of air pollutant dispersal studies. A station subjected to strong ground based inversions in the morning hours will show higher concentration of pollution due to low winds. While the same station in the afternoon when the stability of the atmosphere is considerably reduced may lead to large mixing depths and moderate to large wind speeds. Subsequently low pollution concentrations will be present. In this article we present the concentrations of typical of the four seasons represented by four months namely January, April, August and October which are typical for the four seasons winter, summer, monsoon and post monsoon season respectively. October month recorded peak concentrations and where as April recorded low concentrations. If a comparison is made as season wise post monsoon season recorded maximum concentrations and followed by winter season, monsoon, and summer season respectively.

Keywords

Pollutant, dispersal, atmosphere, mixing heights.

Introduction

Mixing heights may be defined as the height above the ground to which releases pollutants will extend primarily through action of atmospheric turbulent (Stern 1976). Mixing height having time and space variations, which varies from one to several kilometers in thickness is of particular importance in vertical diffusion of pollutants (Munn,1976).Mixing height varies hourly, seasonally and annually. This is also influenced by the abnormal conditions of atmosphere like inversions

and isotherms. Holtzworth (1967) introduced the concept of mixing height, which is very useful in determining the pollution potential of a particular region. According to him the mixing height is that height in the atmosphere in to which the pollutants are stirred and mixed thoroughly, causing dilution of the pollutants. The more is the mixing height the less is the ground concentration of the pollutants. The mixing height is dependent upon the surface temperature, and the higher the temperature the greater the mixing. In urban areas because of their excessive heat the mixing height is greater than that in rural areas. Therefore, the mixing height is very important because it determines the dilution or building up of pollutants.

The importance of mixing height was brought to light by the pioneering work of Holtzworth. He calculated the mean maximum and minimum mixing heights for 62 stations in contiguous United States (Holtzworth, 1964a).The product of mixing height and mean wind speed through the mixing column is the ventilation coefficient. It indicates the advection of pollutants.

In India mixing heights were calculated by number of researchers (e.g., Padmanabhamurty and Mandal, 1979; Vittal Murthy et al., 1980).This kind of study was carried out for major urban centers in India by Vittal Murthy et al. (1980).Viswanadham (1980).Sadhuram (1982), Satyanarayana (1986) and Peddiraju and Vittal Murthy (1994).Sadhuram (1982) has computed mixing heights over Visakhapatnam and analyzed in detail. There estimated and procedure are according to Holtzworth (1964a).

Materials and Methods

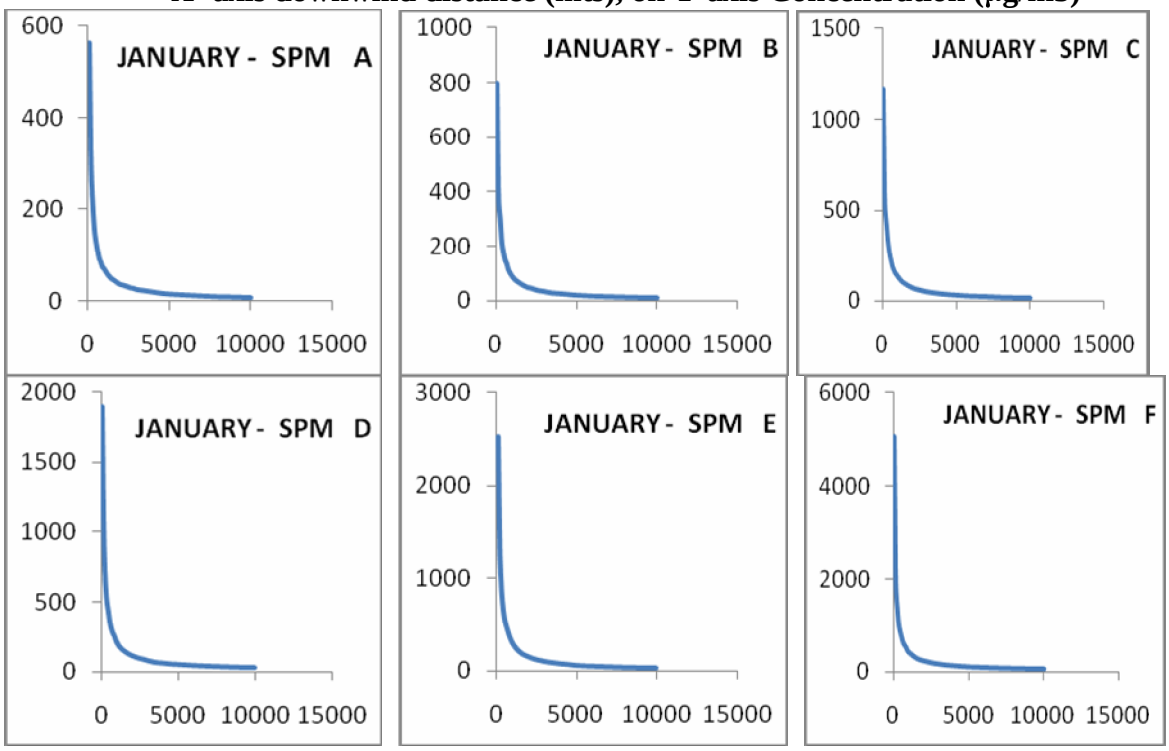
Unpleasant flumes and odors reduced visibility, injured to human health, crops and forms of vegetation by noxious pollutants and damage to property by dust particles and corrosive gases rank among the major environmental problems of urban and industrialized areas and their surroundings the fact was through with Visakhapatnam (17° 42'N: 82°18'E) a highly industrialized coastal metropolitan city on the east coast of India. Here in this study we taken major air pollutants are SPM (Suspended Particulate Matter), SO2 and NOx in different regions in the Visakhapatnam urban region those are Mindi (BHPV), IE Marripalem (Industrial), Police Barracks (Transportation), Gnanapuram (Industrial area), Veerabahu (INS- Kalinga) and Seetammadhara (Domestic area) in the year 2013. In this article data collected for typical month of the season such as January (winter), April (summer), August (monsoon) and October(post monsoon) for morning wind speeds with Gaussian Flume model (GPM- MMH- MWS).

Results and Discussion

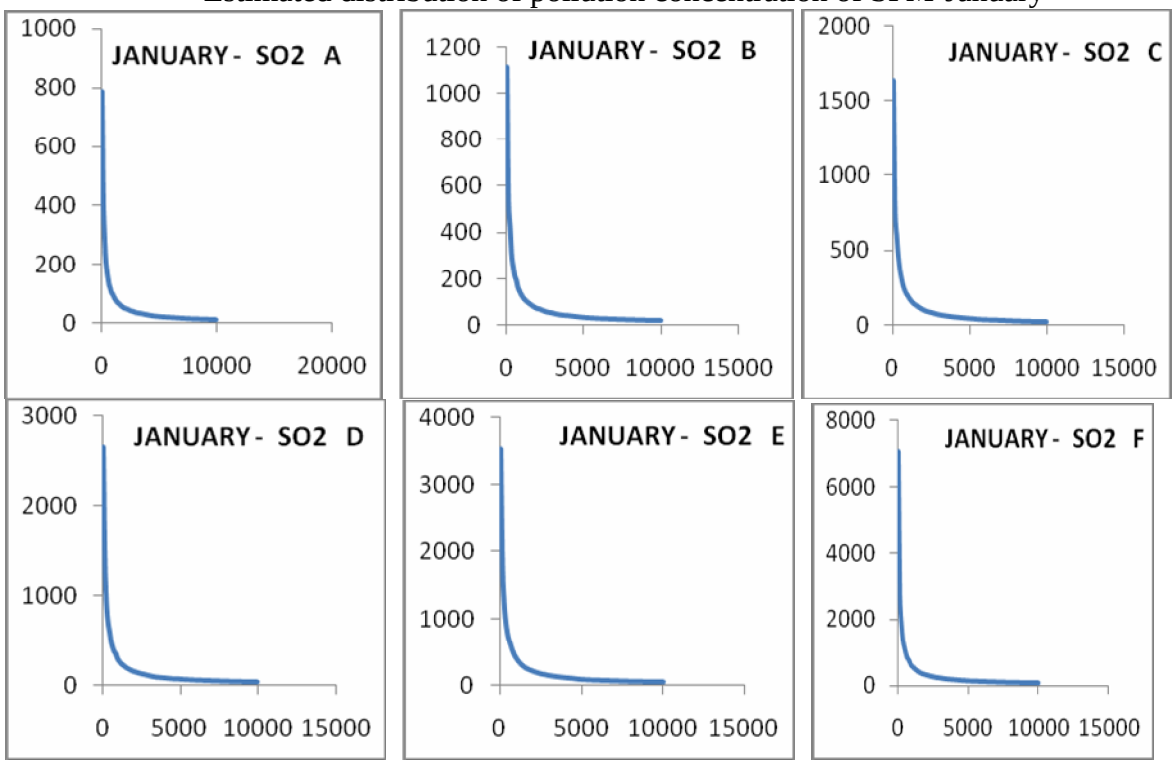
Gaussian Box Model- Afternoon Mixing Heights-Afternoon Wind Speeds (GBM-AMH-AWS)

In stability A, it is observed that the maximum concentrations are occurring within a distance of 100 m.There after, there is a drastic decrease in the concentration, when the downwind from the source is 200 m. The rapid decrease of concentration continued up to 800m.From 800 m to 2000 m, the concentration is decreasing at a slow rate. From 2000 m onwards the rata of decrease is small. The

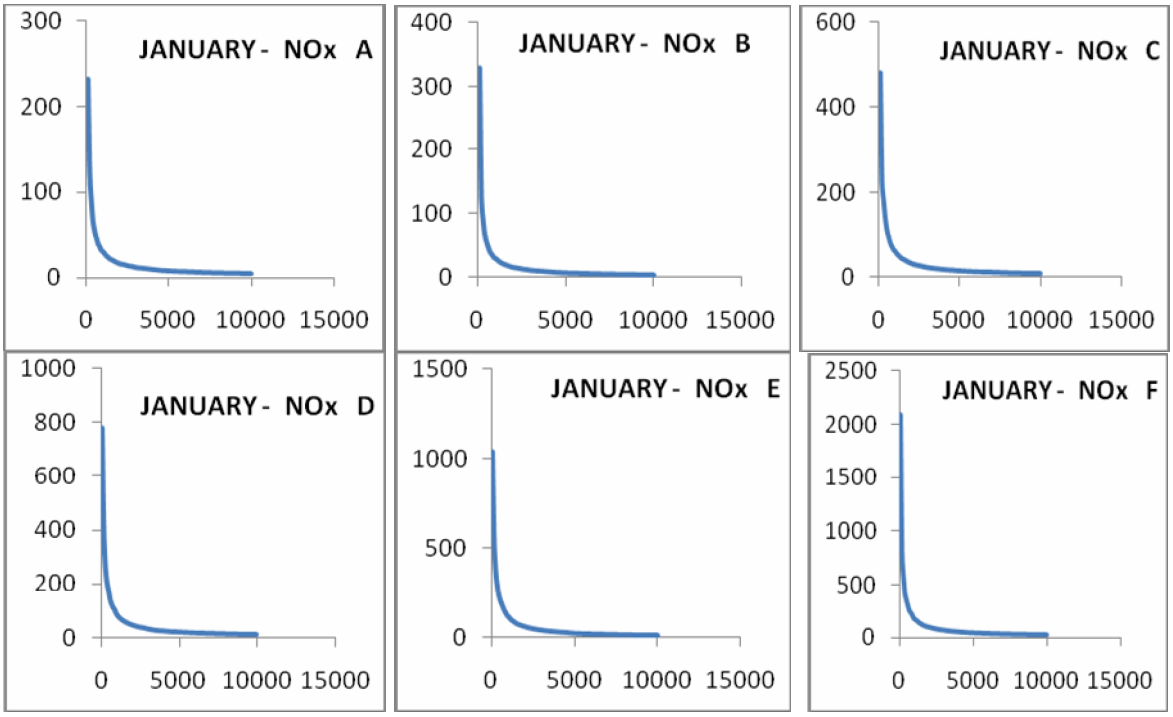
X- axis downwind distance (mts), on Y-axis Concentration (µg/m3)



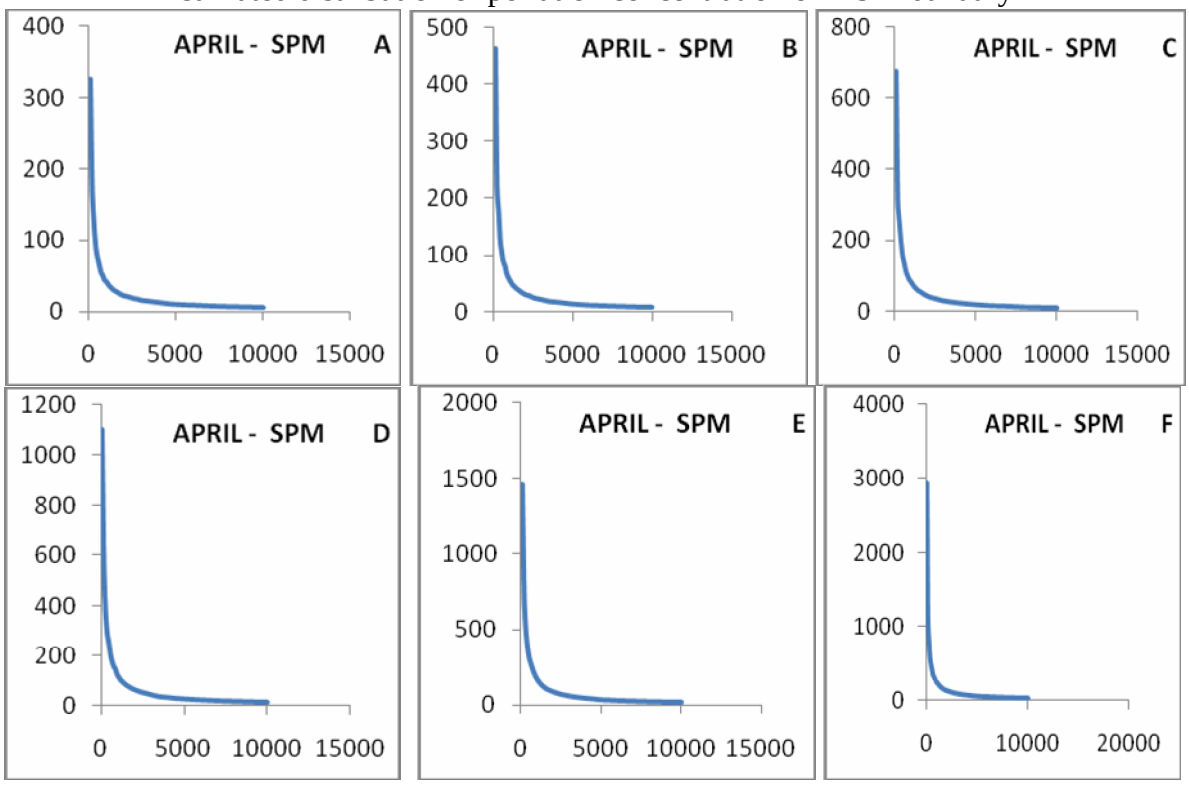
Estimated distribution of pollution concentration of SPM-January



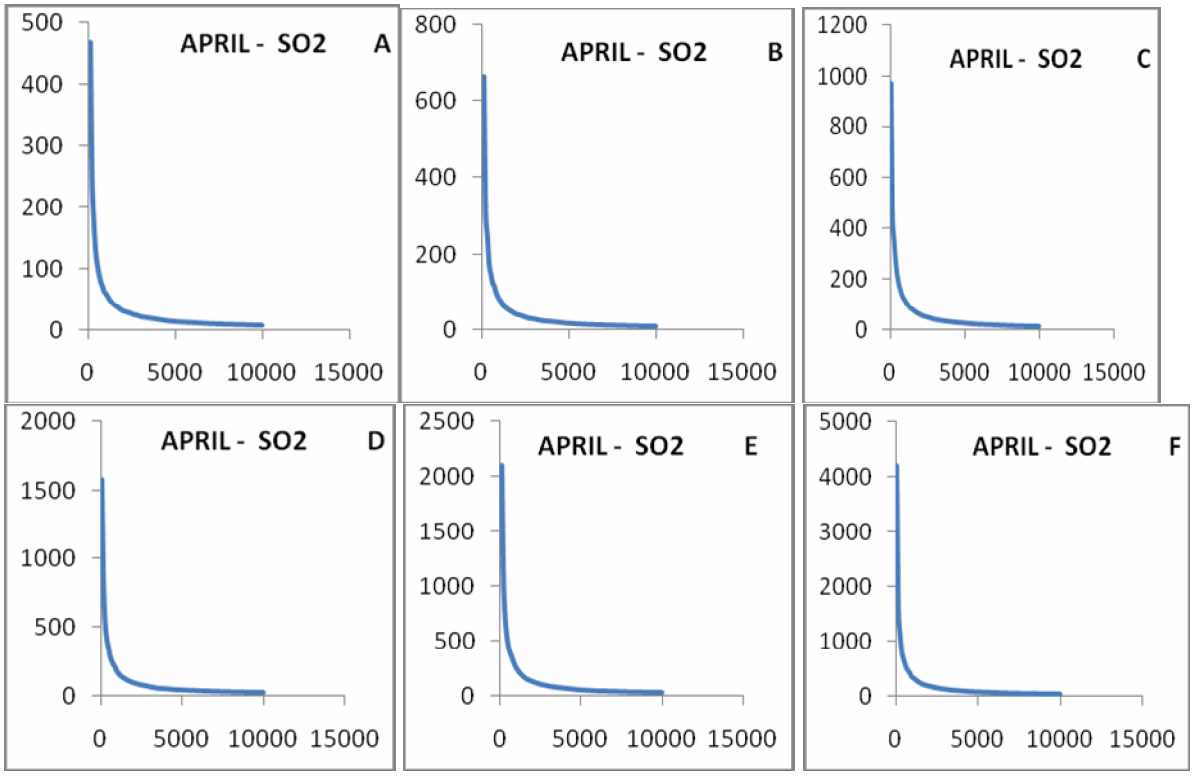
Estimated distribution of pollution concentration of SO2 –January



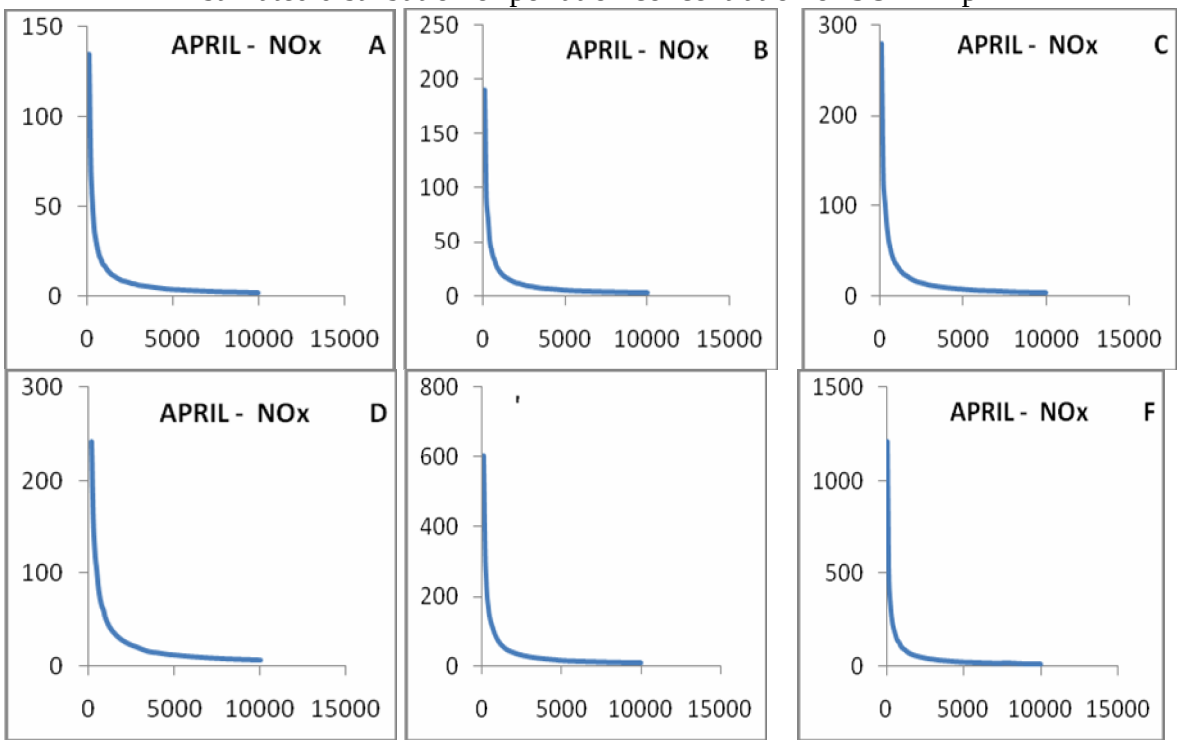
Estimated distribution of pollution concentration of NOx –January



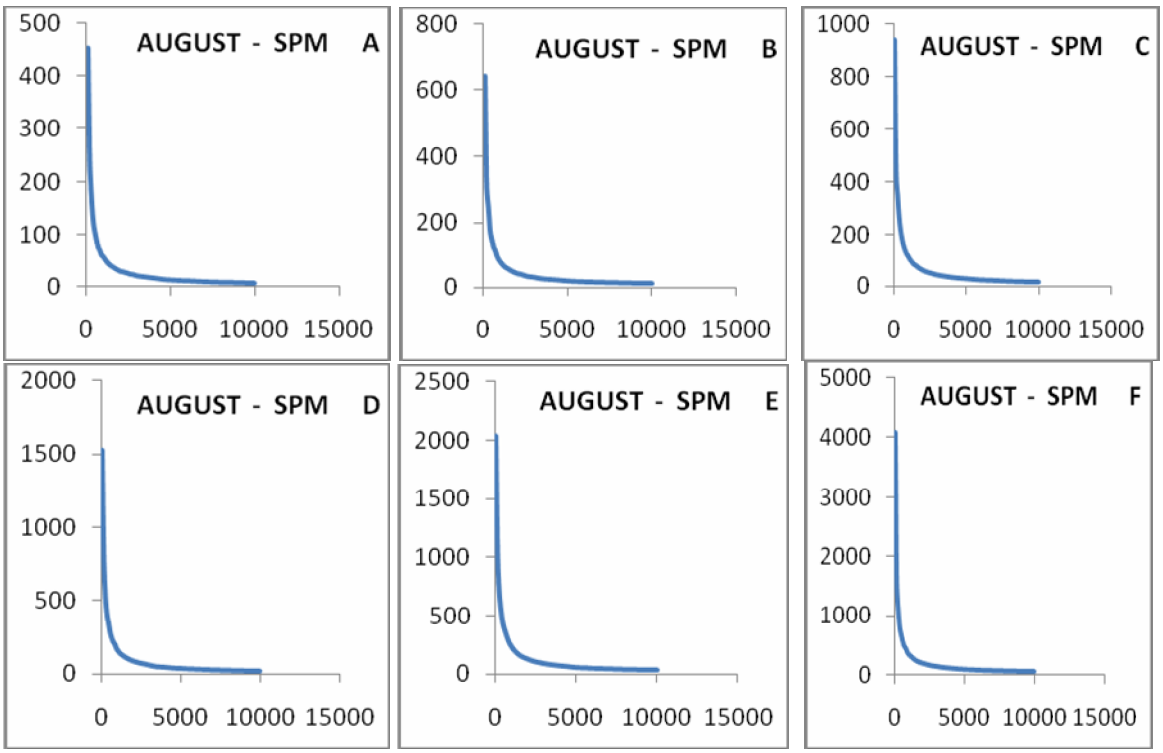
Estimated distribution of pollution concentration of SPM – April



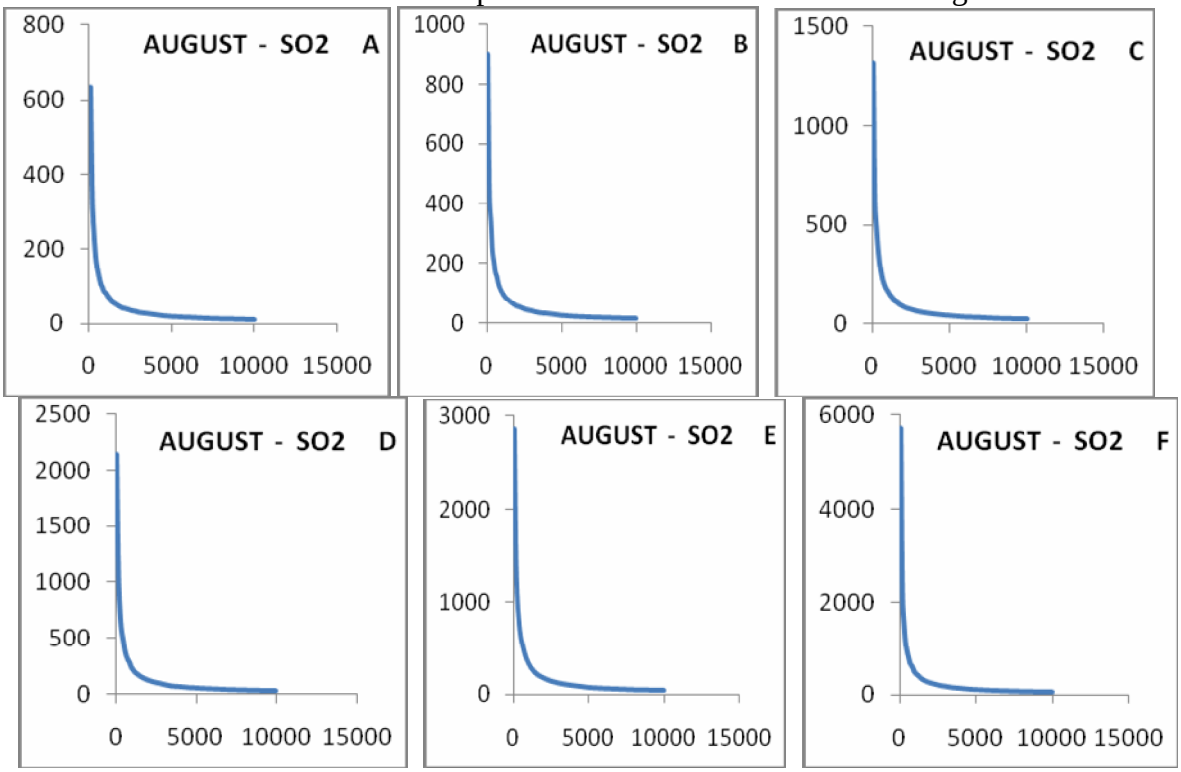
Estimated distribution of pollution concentration of SO2 – April



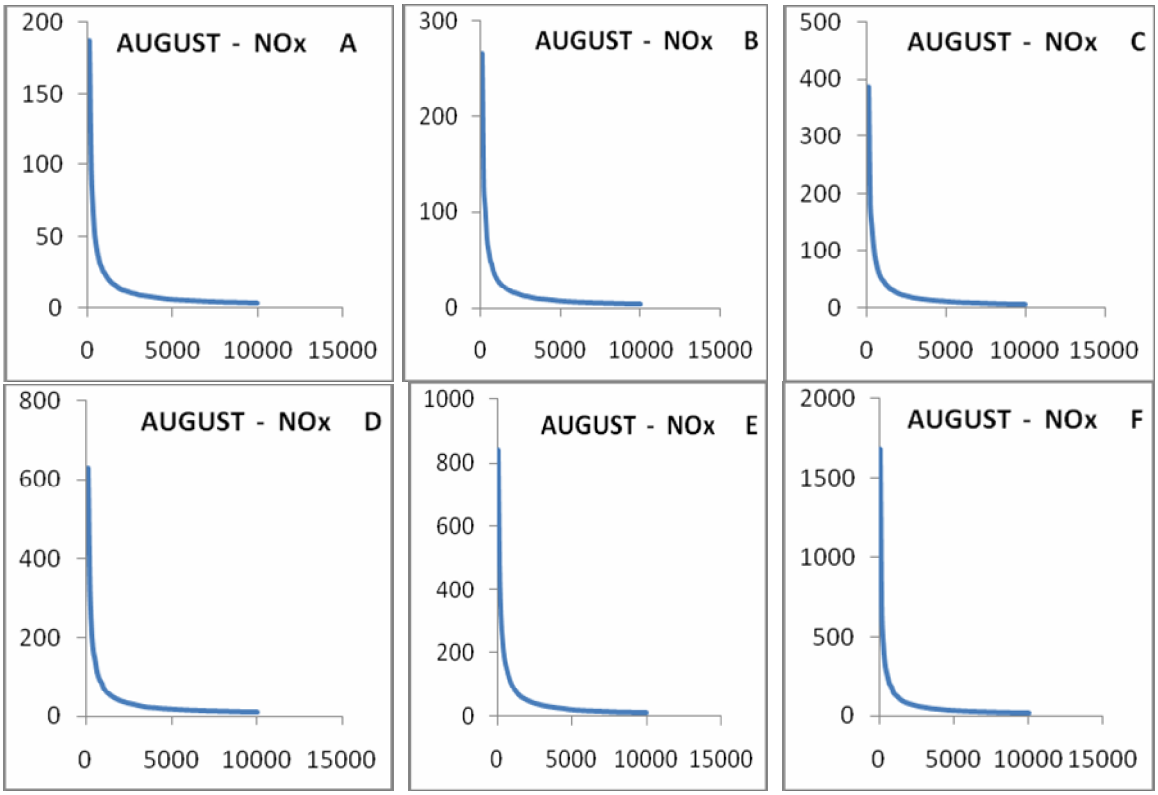
Estimated distribution of pollution concentration of NOx – April



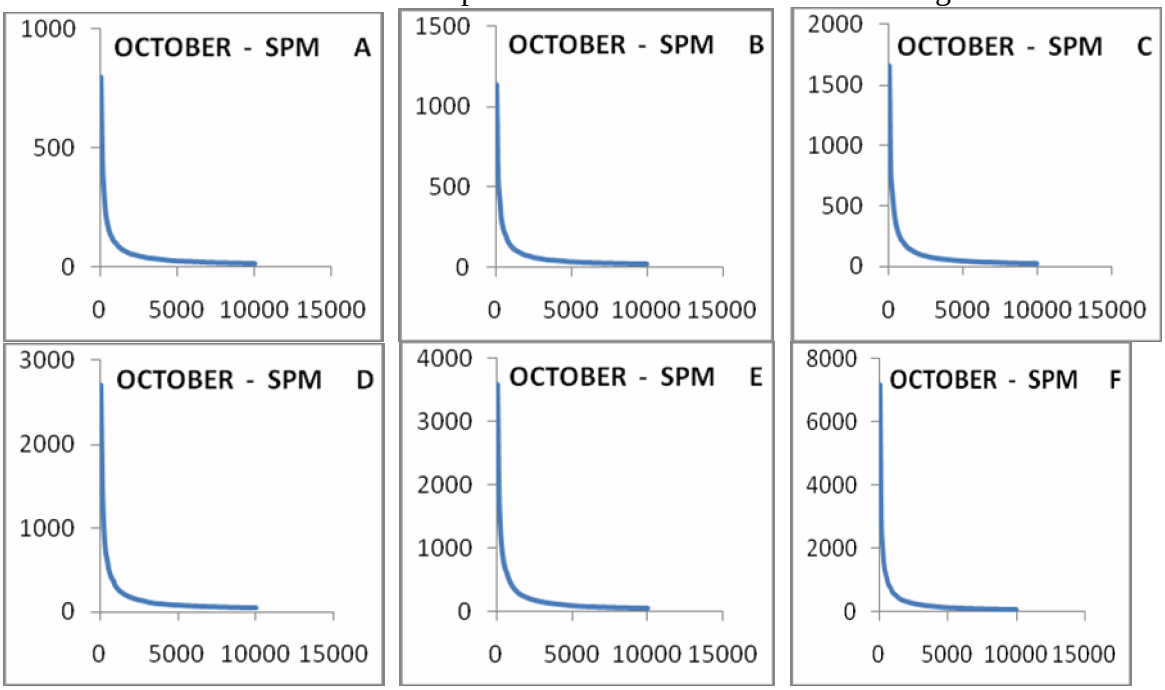
Estimated distribution of pollution concentration of SPM – August



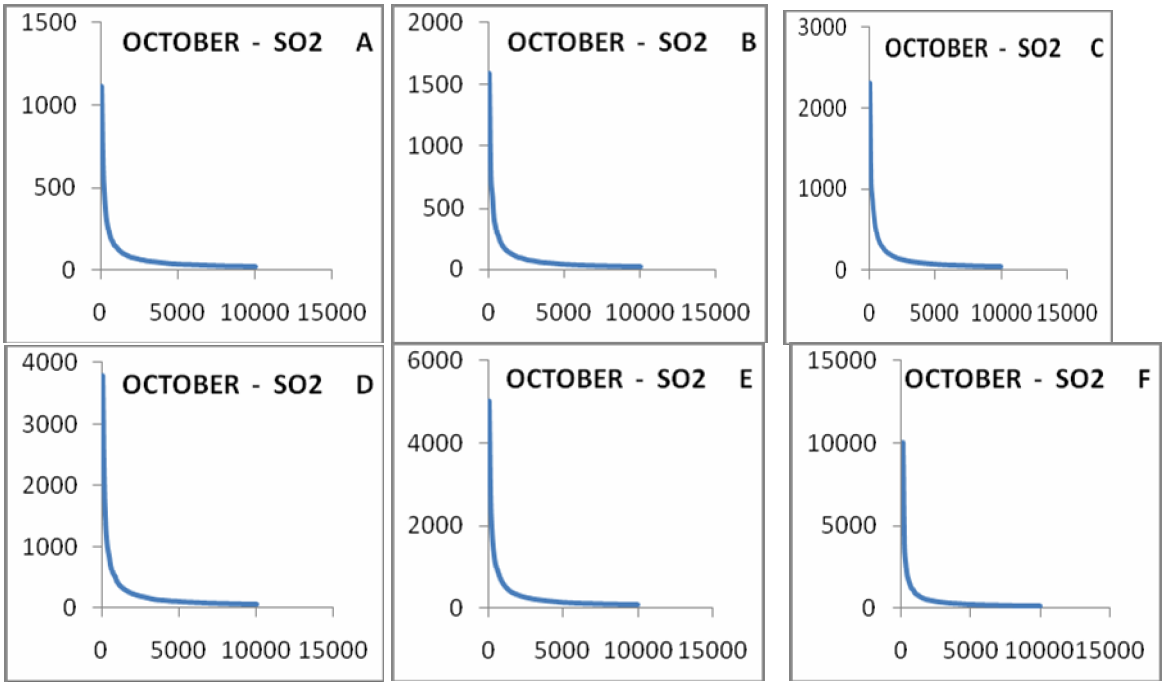
Estimated distribution of pollution concentration of SO2 – August



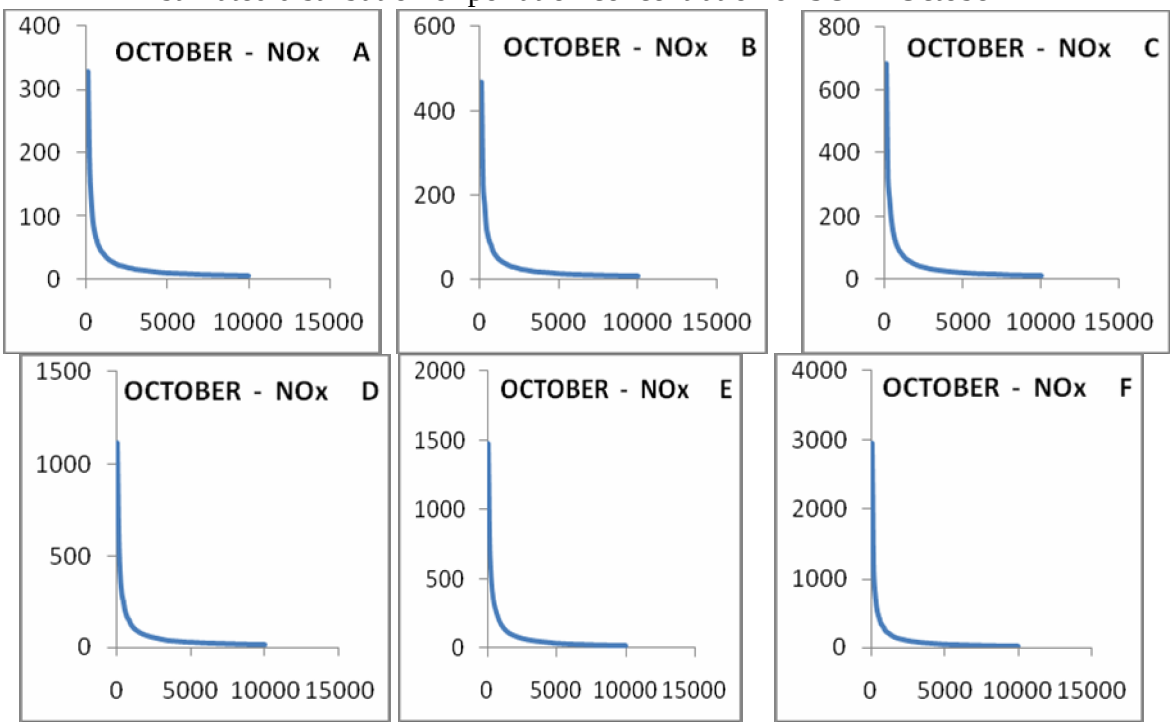
Estimated distribution of pollution concentration of NOx – August



Estimated distribution of pollution concentration of SPM – October



Estimated distribution of pollution concentration of SO2 – October



Estimated distribution of pollution concentration of NOx – October

peak concentrations for SPM in the month of January in stability A, is around 562.For the same month B stability, the peak concentration is 798, which is greater than the concentration of A stability. In C stability, the peak concentration increase further to a value of 1167.D, E, F, stabilities showed peak concentration 1897, 2529, and 5058 respectively. From this example, one can easily infer that the peak concentration increase in their value from A to F stability. This gradual

increase with minimum mixing heights i.e., in the afternoon was observed in all the months February to December.

It is equally interesting to note that the distance downwind from the source where the ground concentrations shows a peak value is constant irrespective of the pollutant for which we estimated the value (SO2, NOx, or SPM) and the concentration occur within first 100 m unlike Gaussian Plume Model .When a comparison is made within the concentrations, October recorded peak concentration and April recorded minimum value. If a comparison is made as season wise post monsoon season recorded maximum concentrations and followed by winter season, monsoon, and summer season respectively. The peak concentrations in the descending order of the twelve months are as follows October,Sptember,November,January,Febr uary,December,August,May,June,July,Ma rch,April. The similar trend is followed for the pollutants SO2 and NOx in all the stabilities for all the twelve months. The estimated concentrations for the pollutants SPM, SO2 and NOx in different stabilities (A, B, C, D, E, F) for all the twelve months.

The estimated concentrations in the GBM-AMH-AWS are lesser than the estimated GBM-MMH-MWS. This can be attributed to the higher values of mixing heights in the afternoon. The pollutants mix to greater heights, the volume is more and the concentrations are naturally less. On the contrary, the morning mixing heights are smaller compared to the afternoon mixing heights. So, the pollutants are mixed in a smaller vertical extent and as consequence the concentrations are more. This is reflected in the estimated concentrations utilizing morning mixing heights and afternoon mixing heights. The concentrations are more in the former and less in the later.

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