ABSTRACT

Air is one of the important life sustaining natural resources. Over the past 100 years, air quality is getting deteriorated due to rapid urbanization and industrialization in several parts of India. The concentrations of air pollutants depend not only on the quantities that are emitted from air pollution sources but also on the ability of the atmosphere to either absorb or disperse their emissions. The air pollution concentration varies spatially and temporally causing the air pollution pattern to change with different location and time due to changes in meteorological conditions.

Mathematical models are the best tools to quantitatively describe the cause effect relationship between source of pollution and different components of environment. The impact on air quality due to emissions from single source or group of sources is evaluated by the use of mathematical models. When air pollutants are emitted into the atmosphere, they are immediately diffused into surrounding atmosphere, transported and diluted due to winds. The air quality models are designed to simulate these processes mathematically and to relate emissions of primary pollutants to the resulting downwind air quality. The inputs include emission inventory, meteorology and surrounding topographic details to predict the impacts of conservative pollutants.

In the present study, a Gaussian plume model is developed to predict the concentration of pollutant emissions and applied for point sources
of Manali region in Chennai for validation and analysis. The present model is used to determine the hourly, daily and monthly concentrations of sulphur-dioxide, nitrogen-oxide and suspended particulate matter (SO$_2$, NO$_x$ and SPM) for three different seasons (winter, summer and monsoon). The seasonal variations of wind speed and mixing heights are analyzed in the study area. Also the assimilative capacity of the study area is determined through ventilation coefficient.

There are about six major industrial complexes situated in and around the Chennai Metropolitan area namely Manali, Guindy, Maraimalainagar, Ambattur, Perungudi and Thirumilisai. In the present study, 46 stacks situated within Manali are considered as point source emissions and their influence on the environment was studied.

The emission inventory of these industries consisting of stack height, stack diameter, exit gas velocity, ambient temperature and temperature of flue gas were collected from Tamilnadu Pollution Control Board (TNPCB) Manali. The hourly meteorological parameters such as cloud cover, cloud height, solar radiation, solar elevation and ambient temperature for the present study were collected for a period of 5 years, from Indian Meteorological department (IMD), Chennai. The data on wind speed, wind direction, ambient temperature and mixing height were also taken from Indian Meteorological Department (IMD), Pune.

Atmospheric stability is a simple method of classifying the turbulent conditions of the atmosphere. Atmospheric stability along with the
wind speed and direction is one of the useful meteorological parameters in air pollution studies. It affects both horizontal and vertical diffusion of pollutants, which in turn decide the ground level concentrations. In the present model, the three methods of determination of stability classes (Pasquilli-Turner method, Wind direction fluctuation method and Temperature profile method) were used.

The ability of the atmosphere to mix or allow vertical motion is influenced by the vertical temperature structure and to some extent by mechanically induced turbulence. In this study, the hourly mixing heights were determined using Holzworth Technique.

As per Central Pollution Control Board guidelines, for Air Quality Modeling works, three seasons need to be studied. Hence, Winter (December-March), Summer (April-May) and Monsoon (August-November) were taken and one representative month for each season (February, May and October) have been identified in each year and the study was carried out for a period of 5 years. The sixteen point wind rose diagram drawn for the three seasons indicate that the most prominent wind direction was from NW, W and N (Northwest, West, and North) during winter season, E, S and NE (East, South and Northeast) during summer season, followed by NW, ENE and E (Northwest, East-northeast and East) during monsoon season.

In the present work, the seasonal changes of sulphurdioxide (SO₂), nitrogen oxide (NOx) and suspended particulate matter (SPM) produced by 14 different Industries located in Manali region were predicted. Manali bus
stand was taken as the receptor point. It was found that the concentration was within the prescribed limits and varied with respect to different seasons. The model was validated using statistical techniques by comparing observed and predicted $SO_2$, $NO_X$ and SPM concentrations which indicated satisfactory performance of the present model. The model may also be applied to predict the concentrations of criteria pollutants for other industrial regions of Chennai.