MODELING OF DISPERSION OF SO_2 FROM Dr. NARLA TATA RAO THERMAL POWER PLANT USING AERMOD MODEL

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1. Introduction:

An air pollutant is known as a substance in the air that can cause harm to humans and the environment. Pollutants can be in the form of solid particles, liquid droplets, or gases. Power plants are the major sources of air pollution. Coal is the primary fuel used for generation of electricity in India and its usage is continually increasing to meet the growing energy demands of the country. Emissions of greenhouse gases and other pollutants such as Sulfur Dioxide (SO_2) are increasing parallel to the growing demands of electricity. Implications of power plant emissions on the environment depend on the concentration of SO_2 pollutant emitted and in the recent past they are at alarming levels. Therefore, it is necessary to predict the concentration of SO_2 pollutant for impact assessment.

The study was carried out in two levels. In Level 1 study, impact assessment was made by screening level dispersion modeling technique using worst case input data employing Gaussian formulae. Level 2 studies included an assessment by a refined dispersion modeling technique (AERMOD) using site-specific input data. Level 1 impact assessment would be more conservative and less specific than the result of Level 2 assessments. It is not intended that an assessment should routinely progress through the two levels. If the air quality impact is considered to be a significant issue from Level 1 assessment, there is a need to immediately conduct of Level 2 assessments.

2. Objectives:

Dr. Narla Tata Rao Thermal Power Plant (NTTP), Ibrahimpatnam, Vijayawada, Andhra Pradesh, is selected as a case-study in the present investigation for the assessment of air quality of the region.

The following are the objectives of the present study:

- To develop an emission inventory for the study area
- To evolve wind roses of the study area
- To predict concentration of primary pollutant namely Sulfur Dioxide (SO_2) using Gaussian formulae

- To assess ground level concentration of primary pollutant Sulfur Dioxide (SO_2) by using AERMOD (America Meteorological Environmental Protection Agency Regulatory Model)
- To evolve the Isopleths of the study area in AERMOD

3. Study Area:

The Dr. Narla Tata Rao Thermal Power Plant (NTTP) Vijayawada, of capacity 2x 210 MW and 1x500 MW of total 1760 MW is coal-fired based one. This thermal power station is predominantly government assigned land covering total area of 397.7Acres (167.7 Acres Existing Land & 230 Acres to be acquired).The proposed power plant location falls between **$16^0$35'27''N** Latitude and **$80^0$32'00''E** Longitude.

4. Methodology:

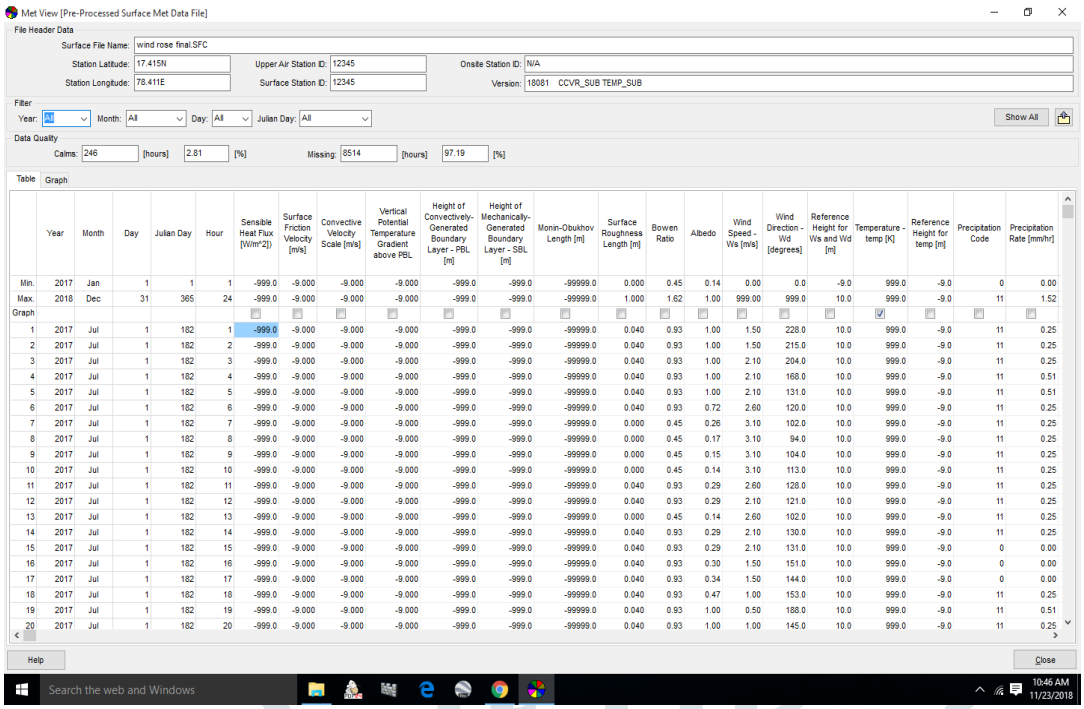
This chapter includes the following:

- Levels of Assessment
- Emissions inventory for the present case study
- Input of meteorological data
- Evolution of wind roses
- Prediction of primary pollutants by using Gaussian formulae
- AERMOD dispersion modeling methodology, Interpretation of dispersion Modeling results for SO_2

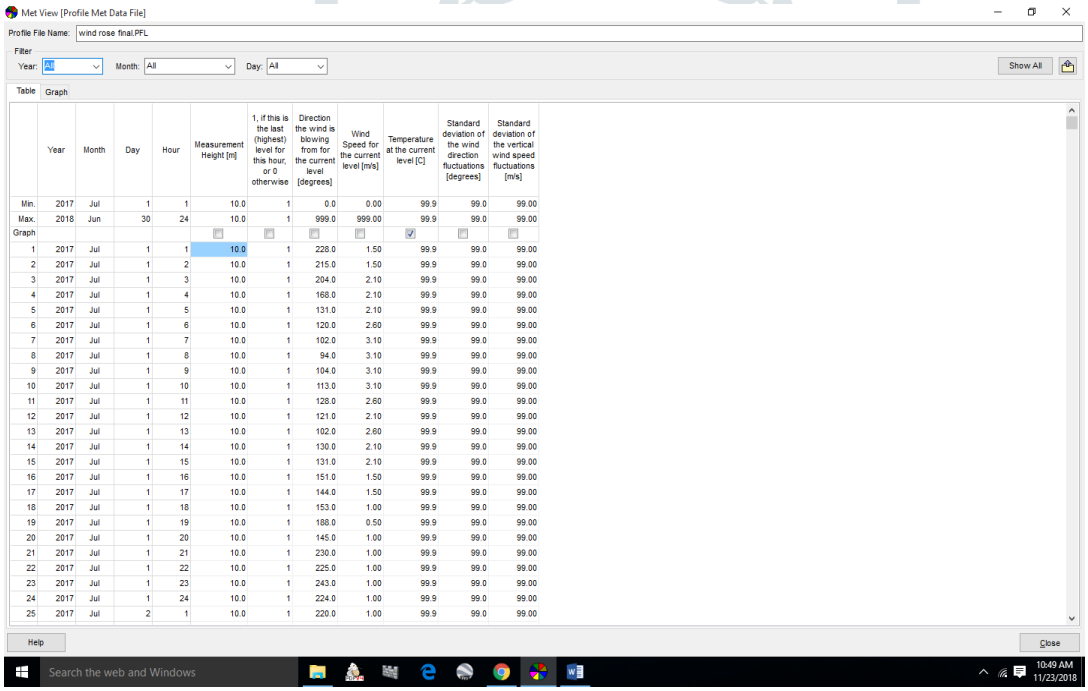
5. Results and Discussions:

The AERMOD model used in this study requires input information for an emission sources at the Dr.Narla Tata Rao Thermal Power Plant site-specific meteorological data of one complete year. The input data that describe both the emission source and meteorology provide a comprehensive set of information which can be used to run the AERMOD model and thus simulate the ground level concentration of Sulfur Dioxide (SO_2) from stationary sources of a thermal power plant.

In addition the model requires the site-specific meteorological information as input data. The local meteorological information that was to be given as input into the model were restricted to the Julian day of the year, the average wind flow vector, wind speed, height of the mixing layer, ambient Air temperature and the Pasquill stability category. The data were collected from Indian Meteorological Department, from web available by satellite data and from the website www.metcheck.com/IN/.

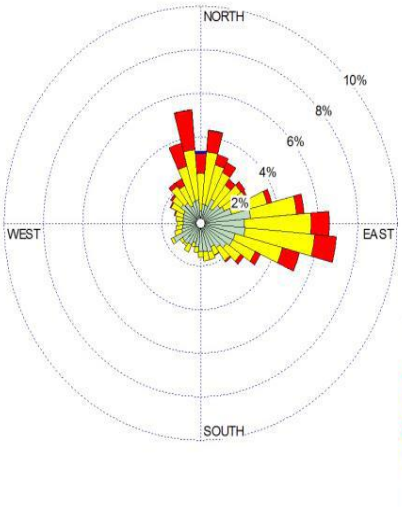


Meteorological data output surface file for AERMOD

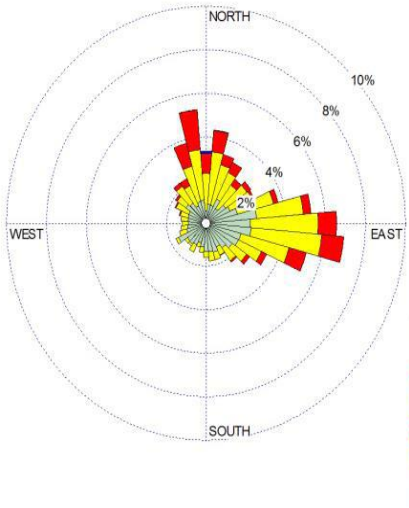


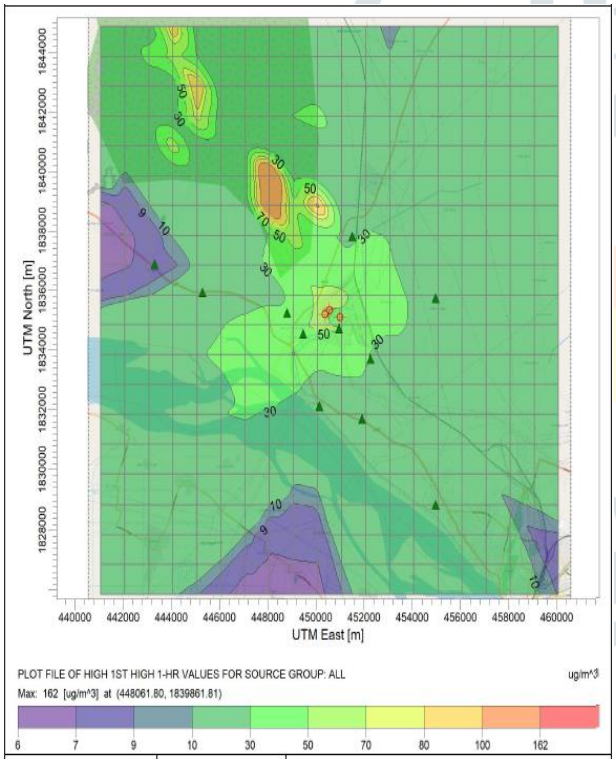
Meteorological data output profile file for AERMOD

Surface file wind rose

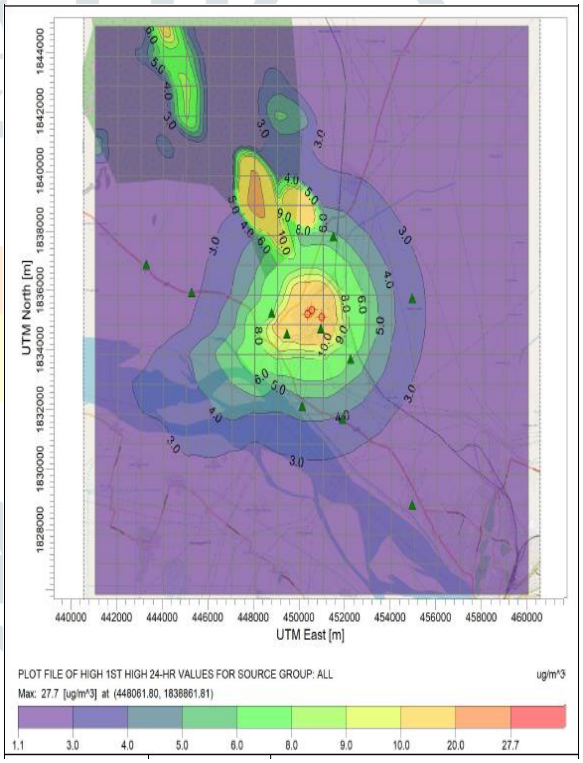


Profile file wind rose

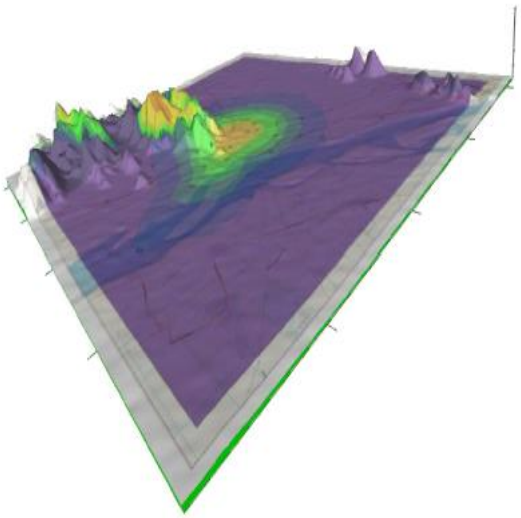


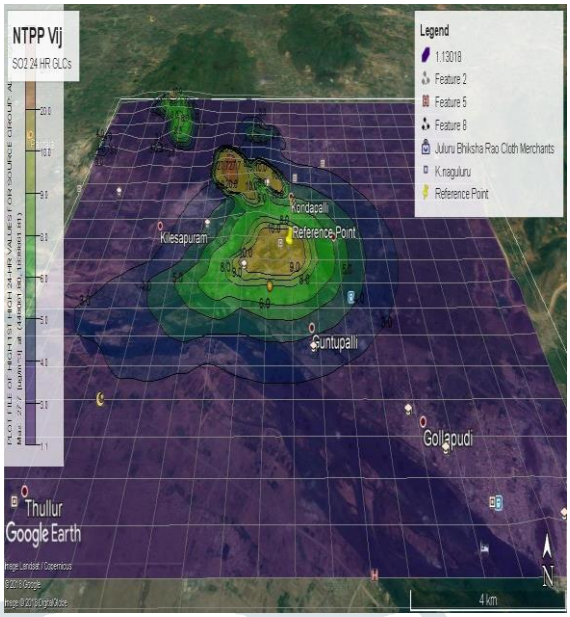


Isopleths for 1hr SO_2 concentration



Isopleths for 24hr SO_2 concentration





Isopleths for 3D SO_2 concentration **Spatial Distribution of SO_2 over Study Area**

VALIDATION OF AERMOD

Source/ Monitoring Station	Location	Latitude	Longitude
Source Points	Stack 1	16.5887^0N	80.5542^0E
	Stack 2	16.5907^0N	80.5632^0E
	Stack 3	16.5967^0N	80.5232^0E
Monitoring Stations	AAQMS 1	16.58707^0N	80.5332^0E
	AAQMS 2	16.5927^0N	80.5632^0E
	AAQMS 3	16.5807^0N	80.6332^0E

The Predicted values of criteria pollutants SO_2 from output files of AERMOD with background concentrations are as shown in table.6.5.

Predicted Values of SO_2 Pollutant from Output Files of AERMOD

Months	Pollutant concentration (µg/m^3)
	Background concentration is 33 (µg/m^3)
	SO_2
July 2017	48.80
August 2017	46.30
September 2017	44.50
October 2017	43.28
November 2017	41.52
December2017	40.24
January 2018	42.74
February 2018	47.10
March 2018	51.20
April 2018	36.30
May 2018	44.50
June 2018	43.28

The Predicted and Measured concentrations of Sulfur Dioxide (SO_2) are as shown in table

Predicted and Measured Concentrations of SO_2

MONTHS	AAQMS 1 (Project site)		AAQMS 2 (Ibrahimpatnam)		AAQMS 3 (Hill point)	
	P ($\mu g/m^3$)	M ($\mu g/m^3$)	P ($\mu g/m^3$)	M ($\mu g/m^3$)	P ($\mu g/m^3$)	M ($\mu g/m^3$)
July 2017	48.80	41.68	48.80	48.3	48.80	50.3
August 2017	46.30	42.9	46.30	39.6	46.30	41.59
September 2017	44.50	48.6	44.50	45.23	44.50	39.6
October 2017	43.28	42.6	43.28	36 .78	43.28	30.6
November 2017	41.52	44.65	41.52	44.36	41.52	38.4
December 2017	40.24	38.48	40.24	34.6	40.24	44.5
January 2018	42.74	46.9	42.74	35.2	42.74	35.36
February 2018	47.10	47.5	47.10	48.3	47.10	48.6
March 2018	51.20	53.5	51.20	50.35	51.20	47.2
April 2018	36.30	29.36	36.30	40.5	36.30	39.6
May 2018	44.50	37.48	44.50	38.6	44.50	37.6
June 2018	43.28	45.36	43.28	38.7	43.28	39.6

Statistical Performance Measures of AERMOD Model:

Parameter	Monitoring station	R^2	Inference
SO_2	AAQMS 1	0.94	Strong positive correlation
	AAQMS 2	0.81	Strong positive correlation
	AAQMS 3	078.	Moderate positive correlation

6. CONCLUSION REMARKS

From level 1 assessment, it was noticed that SO_2 concentration were high and exceeding National Ambient Air Quality Standards, prescribed by the Central Pollution Control Board. In Level – 2 assessments, replication of pollutant SO_2 dispersion from Dr.Narla Tata Rao Thermal Power Plant was obtained by applying an AERMOD model and the results of predicted values were compared with the measured concentrations at the NTTP site from July 2017 to June 2018 made available by APPCB.

Sulphur Dioxide (SO_2) varies from 40.24µg/m^3 to 48.80µg/m^3 from the month of July 2017 to June 2018.using AERMOD model. Value of R^2 at AAQMS 1 project site is 0.94 which is strong positive correlation, AAQMS 2 ibrahimpatanam is 0.81 which is strong positive correlation and AAQMS 3 hill station is 0.78 which is moderate positive correlation.

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