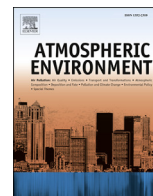




Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

A study of the effects of vehicle emissions on the atmosphere of Sultan Qaboos University in Oman



Sabah A. Abdul-Wahab*, Sulaiman O. Fadlallah

Department of Mechanical and Industrial Engineering, Sultan Qaboos University, P.O. Box 33, PC 123, Sultanate of Oman

HIGHLIGHTS

- Predicting concentrations of CO, NO_x, and CO₂ released from traffic using CALPUFF.
- Sultan Qaboos University was selected as study domain.
- Simulation results demonstrate the violation in the concentrations of pollutants.

ARTICLE INFO

Article history:

Received 9 July 2014

Received in revised form

20 August 2014

Accepted 21 August 2014

Available online 23 August 2014

Keywords:

Vehicle-emitted pollutants

Model

Dispersion

Sultanate of Oman

Line source

Area source

ABSTRACT

Traffic jams have become a serious matter at Sultan Qaboos University (SQU) in Muscat, Oman due to an increase in student numbers. Therefore, the main objective of this research study is to apply the information gained by running CALPUFF software to model and investigate the concentration dispersion of the three most dominant vehicle emissions carbon monoxide (CO), mononitrogen oxides (NO_x), and carbon dioxide (CO₂) at SQU. The study was divided into two main parts: a line source study focused on investigating the dispersion of CO, NO_x, and CO₂ for a street located within the university's boundaries, and a study of the university domain as an area source. The study was based on statistical data collected on April 2, 2014, between 00h00 and 23h00 Local Standard Time (LST). Information related to both surface and upper air quality was obtained and processed into data files which were used to activate CALMET. For selecting vehicle emission factors, a comparison between different studies was conducted. CALPUFF line source case study simulation results showed that CO levels were within the allowable concentrations assigned by the United States' Environmental Protection Agency (EPA) standards. On the other hand, the NO_x and CO₂ simulated results were higher than the allowable amounts according to the EPA emission standards. Moving to the area source study, results demonstrated that the three pollutants significantly exceeded the allowable standards. The top five maximum concentrations were located near the origin of the study domain for both line and area source measurements. At the times that maximum concentrations were recorded, the wind was blowing from the sea toward the land. As a result, the greatest accumulation of pollutants was located close to the domain of the area of study.

© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

CALPUFF is considered one of the most powerful environmental modeling programs. It has been used by many researchers to investigate and model pollutant concentrations as well as to simulate the effect of the meteorological and geophysical

conditions on the dispersion of a targeted pollutant. CALPUFF can be run for any specific location around the world and for any modeling type period selected by the user. Due to its flexibility, CALPUFF has been used in several research studies.

Over the past years, several CALPUFF-aided case studies have been published. Abdul-Wahab et al. (2011a) used CALPUFF software to measure and simulate the dispersion of sulfur dioxide (SO₂) at the Mina Al-Fahal Refinery in the Sultanate of Oman. The study compared the application of this modeling system with Abdul-Wahab's (2003) study of the same location using the Industrial Source Complex Short Term (ISCST) model. Abdul-Wahab et al. (2011b) conducted another case study simulating the dispersion of sulfur dioxide (SO₂) at Sohar Refinery in the Sultanate of Oman.

Abbreviations: SQU, Sultan Qaboos University; CALPUFF, California Puff; U.S., United States; LST, Local Standard Time; ID, identifier; UTM, universal transverse mercator; WMO, World Meteorological Organization; LCC, Lambert conformal conic; UTC, universal time coordinates; WGS, world geodetic system.

* Corresponding author.

E-mail address: sabah1@squ.edu.om (S.A. Abdul-Wahab).

Abdul-Wahab et al. (2012) evaluated the impacts of a SO₂ release on workplace and ambient air quality at Al-Noor Production Station located in the southern desert of the Sultanate of Oman.

The impact of nitrogen oxides (NO_x) has attracted the attention of several researchers, including Abdul-Wahab et al. (2013). The main focus of that study was to examine the impact of a region's geophysical and meteorological conditions on the dispersion of NO₂ from a proposed refinery located in Canada. Another study for similar pollutant was done by Yu and Stuart (2013). Ghannam and El-Fadel (2013a, b) and Tian et al. (2013) considered as examples of studies for which CALPUFF software was used to study concentrations of multiple pollutants. Recently, Abdul-Wahab et al. (2014) used CALPUFF to study the effect of meteorological conditions on the dispersion of an accidental release of hydrogen sulfide (H₂S).

Although a significant amount of research related to CALPUFF modeling software has been published, few studies have considered the effect of vehicle emissions or investigated the dispersion of CO, NO_x, and CO₂ concentrations for line sources. The James Bay AirQuality Study Team (2009) and Rosemont Copper Company (2011) considered line source emissions in their research, but this most recent research paper concentrates on applying the knowledge gained by running CALPUFF modeling software to model the dispersion of CO, NO_x, and CO₂ concentrations. Despite the fact that traffic jams have become a serious matter there, the main aim of this study was to investigate the effect of vehicle emissions on the Sultan Qaboos University (SQU) environment.

This study has been divided into two main parts: a line source study which focuses on investigating the dispersion of CO, NO_x, and CO₂ for a street located within the university boundary, and a study which consider SQU as an area source of pollutants.

2. Materials and methods

2.1. Description of the study area

Located in Muscat, the capital city of Sultanate of Oman, SQU was the first public university in the Sultanate. Fig. 1 shows a map of Oman with the location of the university, the study domain, highlighted. The construction of SQU commenced in 1982 in a total area



Fig. 1. Location of Sultan Qaboos University on the map of Oman.

of 6.8 km²; the first batch of students enrolled in 1986. The university initially started with five main colleges: Engineering, Medicine, Education, Agriculture, and Science. A year later, the College of Arts was established, with the College of Commerce and Economics joining in 1993. Finally, in 2006, the Colleges of Law and Nursing were established. Fig. 2 shows an aerial view of SQU.

The SQU Hospital, initiated by His Majesty Sultan Qaboos Bin Said in 1990, is also located within the boundaries of the study area. The hospital, with a total area of 40,000 m², is considered an educational as well as medical institution and tertiary medical care; acts as a teaching center for undergraduate and postgraduate medical students; and serves as a research facility (<http://www.squh.edu.om/default.aspx>).

SQU's student body has grown significantly throughout the years. The university started with 557 students but currently has around 15,000 students. Due to this rapid increase and university policies regard housing, the number of vehicles within SQU's boundaries also has significantly increased resulting in traffic jams. It is worth mentioning that some populations at SQU do not contribute directly to automobile emissions: female students who come from a long distance to attend the university are provided with on-campus university housing. Additionally, many academic staff live on campus. In contrast, a number of staff live off campus, and male students are required to live off campus. The daily commute of these populations contributes to daily traffic jams. Between 7:30 and 8:30 in the morning, SQU suffers from a massive influx of traffic due to the number of cars entering the school through the university's three main gates. Of equal concern is that the university suffers from general congestion and an outflow of traffic at the end of each teaching session throughout each week-day. For example, if a class starts at 10:00 am and ends at noon, male and female students congregate within the streets from noon as they cycle out of classrooms, as shown in Fig. 3. Therefore, traffic flow is interrupted and congestion becomes heavier.

The study will consider the following areas: first, the SQU street where most students congregate at the end of each class session will be examined as a line source. Second, the university as a whole will be considered as an area source.



Fig. 2. An upper view of the domain of study.

Download English Version:

<https://daneshyari.com/en/article/6338920>

Download Persian Version:

<https://daneshyari.com/article/6338920>

[Daneshyari.com](https://daneshyari.com)