PREDICTION OF OZONE LEVELS IN URBAN AREAS USING MM5-CMAQ MODELING SYSTEM

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Introduction

Our Earth's troposphere layer is made up from various constituents and one of its major constituents is ozone. Ozone, unlike any other criteria pollutants, does not have a primary anthropogenic emission sources, but rather is produced by secondary reactions resulting from anthropogenic precursor emissions (predominantly hydrocarbons and oxides of nitrogen, NO_x) with the presence of sunlight radiation as catalyst. In Malaysia, formation of ozone in urban areas is of concern because as a developing nation, developments of industrial sectors and transportation usage have increased tremendously over the past few years and leads to the increase of ozone precursors (NO_x, VOCs). While agencies such as ASMA have been tasked in monitoring air quality in Malaysia, its monitoring stations are not available in all areas. This is where air quality models can be use to predict the concentration of pollutants while covering the whole place of interest in which the air quality prediction is applied.

Problem Statement

1. **Ozone precursors emission are increasing over the years.**
   This is due to the rapid increases in industrialization, motorized transport, urbanization and increase in the use of nitrogenous fertilizers (Schwela et al., 2006).
2. **Ozone has significant impact on human health and the ecosystem.**
   Ozone causes breathing irritation, triggers asthma symptoms, causes lung and heart diseases, and is associated with 21 000 premature death's per year (WHO, 2009).
3. **Current Air Quality Management in Malaysia only monitors air quality through monitoring stations, which are located at certain places in Malaysia.**
   Not all areas in Malaysia can be equipped with air quality monitoring stations due to cost, maintenance problem and unsuitable nature of the desired locations.
4. **Malaysia received continuous sunlight radiation throughout the year, unlike in some 4-season countries.**
   With continuous sunlight, it is highly likely that formation of ozone in Malaysia is higher and more frequent compared to other non-tropical countries.

Significance of the study

This study aims to further strengthen policy implementation on ozone concentration and also possibly stricter rules of emission of ozone precursors. Hopefully, this study can also help respective agencies that involve in air quality management in Malaysia find the best option to cope with the increasing ozone precursors concentration in the future.

Research objectives

1. To identify and quantify the sources of ozone precursors and microclimatic condition.
2. To conduct verification and sensitivity analysis of prediction using integrated PSU/NCAR Fifth generation Mesoscale Model (MM5) and Community Multiscale Air Quality Model (CMAQ) modeling system.
3. To predict the ozone concentration using integrated MM5-CMAQ modeling system.

Literature Review

The troposphere is the region of the Earth's atmosphere on which we live and into which chemical compounds are generally emitted by human activities. Pollutants emission affecting air quality in cities can be considered to have adverse impact on human health (Mazzeo et al., 2005). The sunlight-driven photochemical reactions of organic compounds in the presence of nitrogen oxides produce elevated concentrations of ozone almost all of countries of Europe (EEA, 2005). Air quality in megacities is of great concern because of continuing industrialization and migration toward urban centers (Shrestha et al., 2009). Urban areas are known for its excessive mobile and stationary-based emission. Sources of emissions come from vehicles, industries and to a lesser degree, vegetation and lightning. Ozone can accumulate where there are high temperatures, which enhance the rate of ozone formation and stagnant air. Some processes, such as those that lead to cloud formation, can disperse or transport ozone and its precursors (National Research Council). A report by Department of Environment Malaysia shows that 82% of 3000 tons of air pollutants were emitted by motor vehicles (DOE, 1996) while a study conducted by Chan in 2001 stated that 9% of air pollutants emitted in Malaysia were from power plants and 5% from industrial sectors. Malaysia emitted 388 kiloton's per year NO_x and 98 kiloton's per year NMVOC (T. Ohara et al., 2007).

Research methodology

Study area

The study area for this project is situated at the WestCoast of Malaysia, specifically the Southern region of Selangor which includes Klang Valley and parts of the Northern region of Negeri Sembilan. It includes several districts such as Hulu Langat, Klang, Petaling, Seremban, Nilai, Putrajaya, and Port Dickson. This area is chosen because its vast industrial developments and transportation usage which possibly contribute to the formation and concentration of ozone in that area.

Methodology Flow Chart