

APPENDIX H

Sensitivity Studies – Wet and Dry Deposition Effects

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Overview

In the CALPUFF model simulations of diesel PM emissions, atmospheric dry and wet deposition processes were not considered because the particle size distribution and scavenging coefficients for diesel PM are not readily available for the types of diesel PM combustion sources evaluated in this study. However, ARB staff also believes these deposition processes are likely to have a small impact on the annual averaged diesel PM concentrations for the following reasons:

- The particle diameter and size distribution of diesel PM is generally very small, less than 2.5 μm , which results in diesel PM remaining suspended in the atmosphere for longer periods of time;
- Diesel PM has more organic components which make it less soluble in precipitation and lessens the extent that it is removed from the atmosphere by wet deposition; and
- Most of emission sources in this study are near-field sources, thus the effects of dry and wet deposition are minimized.

In order to assess the impact of not considering atmospheric dry and wet deposition processes, sensitivity studies were conducted. Port-related OGV transiting (Part I) emissions were used in the sensitivity studies since transiting ship emissions result in more regional impacts and dry and/or wet deposition processes may have a larger impact on transiting ship emissions that have elevated plumes that are further away from receptors as compared to sources nearer the community such as cargo handling equipment and on-road trucks.

Because the CALMET data set used for the West Oakland community study did not contain precipitation data, ARB staff developed a new CALMET data set containing precipitation data for the sensitivity studies. This new CALMET data set has the same modeling domain. However, because MM5 data (statewide 12 km resolution for year 2000) was available at the time the sensitivity studies were conducted, MM5 data were used as the initial wind field and then local topography and weather observations (30 surface, one upper air, and 3 buoy stations) were used to refine the wind field predetermined by MM5 data.

Impact of Dry Deposition

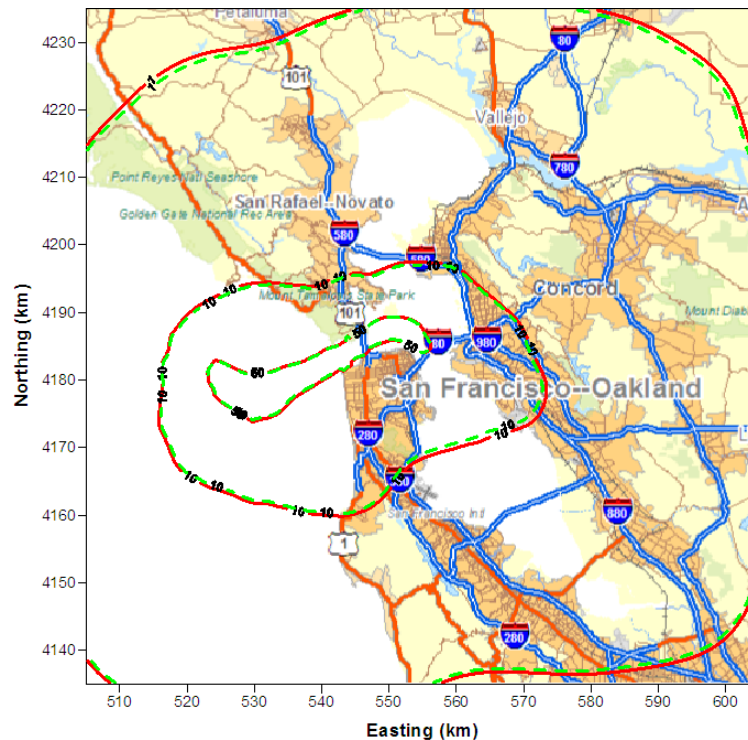
Dry deposition, the transport of suspended particles or gaseous contaminants from the atmosphere onto surfaces in the absence of precipitation, would reduce the airborne

concentration of primary diesel PM. Dry deposition is affected by several factors including the properties of the depositing species such as the chemical reactivity, solubility, diameter, surface charge and shape. It is important to have information on the particle size distribution as the deposition velocity is a function of the particle diameter. Because we do not have sufficient information regarding the diesel PM size distributions for the combustion sources used in this study (i.e., marine engine, harbor craft engines, heavy heavy-duty truck, cargo handling equipment, etc.), the air dispersion modeling performed for the HRA did not consider the impacts of dry deposition. To provide an indication of the impacts of not addressing diesel PM dry deposition, a sensitivity study was conducted that evaluated the effect of dry deposition using the CALPUFF dry deposition default for particle phase PM₁₀, i.e., geometric mass diameter of 0.48 μm, geometric standard deviation of 2.0 μm.

Figure H-1 compares the potential diesel PM cancer risk isopleths for port-related OGV transiting (Part I) diesel PM emissions in the regional domain with (CALPUFF default particle phase PM₁₀ particle size distribution) and without dry deposition. Based on an analysis of the population-weighted potential cancer risk we determined that the predicted population-weighted cancer risk within the domain is about 3 percent lower than that when dry deposition was not considered. For the West Oakland community, the impact is less than 2 percent.

Figure H-1: Impact of Dry Deposition on Potential Diesel PM Cancer Risks in the Regional Domain from Due to Exposures to Part I OGV Transiting Diesel PM Emissions

(Solid Red – Without Dry Deposition; Dashed Green – With Dry Deposition)



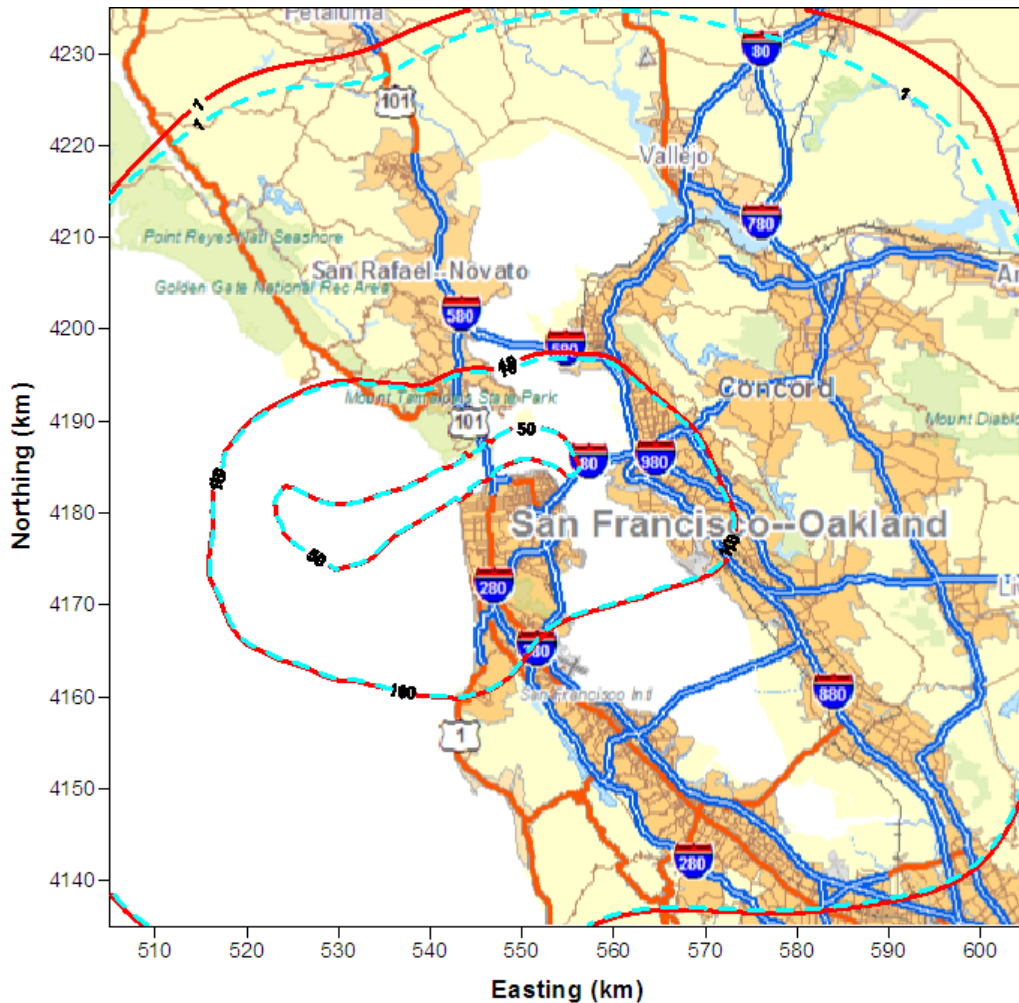
Impact of Wet Deposition

Wet deposition occurs when atmospheric suspended particles or gases are dissolved in water droplets and deposited to the earth. Wet deposition of particles is impacted by several variables including the amount of precipitation, the concentration of particles in the air, solubility, and particle size. Because the precipitation statistics from the Western Regional Climate Center shows that about 3 – 4 percent of the annual hours had measurable precipitation in the San Francisco Bay area during the time period of 1948 through 1999, it is expected that the effect of wet deposition on primary diesel PM air concentrations is small. To provide an indication of the impacts of not addressing diesel PM wet deposition, a sensitivity study was conducted that evaluated the effect of wet deposition using the CALPUFF wet deposition defaults for particle phase PM₁₀, i.e., 1.0E-4 (1/s) and 3.0E-5 (1/s) for liquid precipitation and frozen precipitation, respectively. The default values for particle phase PM₁₀ were used because a scavenging coefficient for diesel PM is not available.

Figure H-2 compares the potential diesel PM cancer risk isopleths for port-related OGV transiting (Part I) diesel PM emissions in the regional domain with (CALPUFF default scavenging coefficients values for particle phase PM₁₀ wet deposition) and without wet deposition. Based on an analysis of the population-weighted potential cancer risk we determined that the predicted population-weighted cancer risk within the domain is about 2 percent lower than that when wet deposition was not considered. For the West Oakland community, the impact is less than 1 percent.

Figure H-2: Impact of Wet Deposition on Potential Diesel PM Cancer Risks in the Regional Domain from Due to Exposures to Part I OGV Transiting Diesel PM Emissions

(Solid Red – Without Wet Deposition; Dashed Blue – With Wet Deposition)



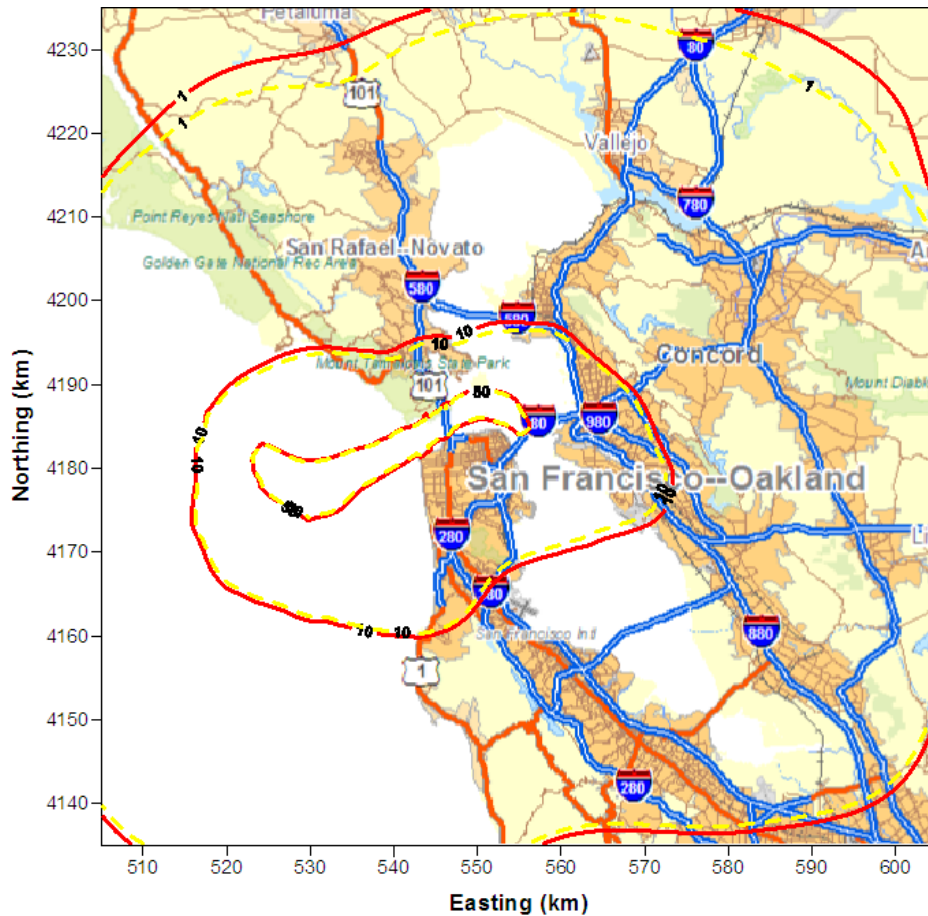
Impact of Combined Dry and Wet Deposition

To estimate the combined effects of dry and wet deposition on ambient diesel PM concentrations, a sensitivity simulation using the CALPUFF defaults for particle phase PM₁₀ particle size distribution for dry deposition and the scavenging coefficient for wet deposition was conducted. Figure H-3 compares the potential diesel PM cancer risk isopleths for port-related OGV transiting (Part I) diesel PM emissions in the regional domain with and without dry and wet depositions. Based on an analysis of the population-weighted potential cancer risk we determined that the predicted population-weighted cancer risk within the domain is about 5 percent lower than that when both dry

and wet depositions were not considered. For the West Oakland community, the impact is less than 3 percent.

Figure H-3: Impact of Dry and Wet Deposition on Potential Diesel PM Cancer Risks in the Regional Domain from Due to Exposures to Part I OGV Transiting Diesel PM Emissions

(Solid Red – Without Any Deposition, Dashed Yellow – With Dry and Wet Deposition)



Summary

From the sensitivity simulations presented above, we can conclude that the impacts of dry and/or wet deposition on diesel PM air concentrations are not significant and are expected to be less than that simulated in the model runs using the default values for particle phase PM₁₀. This is because the actual size distribution of diesel PM is likely smaller than the default in CALPUFF and the actual scavenging coefficients of diesel PM are probably much smaller than those defined in the CALPUFF. In addition, the impacts of wet and dry deposition on ambient diesel PM concentrations are a function of the distance from the emission sources to the receptors. Of the emission sources evaluated in the West Oakland HRA, diesel PM emissions from transiting OGV, which occur at greater distances from the community, can be considered as a “worse case”

i.e. due to the regional nature of the emissions, OGV transiting emissions should be impacted to the greatest extent by wet or dry deposition as compared to those emissions sources, such as trucks, locomotives, and cargo handling equipment, that are located nearer the community.