Comments on

Quantification of the Health and Economic Impacts of Air Pollution from Port-related Goods Movement and Port Activities in California (Appendix A of the Dec 1, 2005 Draft Emission Reduction Plan for Ports and International Goods Movement)

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The report presents results from a study, conducted by CARB, to estimate the impact of diesel particulate emissions from the ports of Los Angeles and Long Beach on surrounding communities. The study was conducted using the following steps: 1) Estimate diesel particulate matter (DPM) emissions from a variety of port activities, 2) Use these emissions as inputs to the Industrial Source Complex Model-Short Term (ISCST3) model to estimate ambient concentrations of DPM in the surrounding communities, 3) Convert these concentrations to risk levels for cancer and non-cancer health effects, and 4) Use population density information to convert risks to number of people likely to be affected by these health effects.

The second major objective of the study was to rank port related activities in terms of their impact on the surrounding communities. This ranking has allowed CARB to prioritize measures to reduce DPM emissions. CARB believes that this ranking of source impacts is more reliable than the concentration magnitudes, which are likely to be affected by inevitable uncertainties in emission estimates.

This review will focus on CARB's use of ISCST3 to estimate ambient DPM concentrations and rank the impacts of port sources on surrounding communities. CARB has assumed that because ISCST3 is a well established regulatory model, its application to this particular study requires little justification. The fact that ARB has used the model to "assess public health risk impacts of diesel PM emitted from the Roseville Railyard on nearby residential areas" does not constitute justification.

ISCST3 has been applied using meteorological information collected during 2001 at the Wilmington site located about 2 kilometers north of the port area. The report indicates that mixing heights were determined using EPA guidance although it is not specified which upper air station was used was used to derive these parameters. The dispersion parameters corresponded to the urban option in ISCST3. ARB has made reasonable assumptions about the characteristics of the sources associated with port emissions.

While this application of ISCST3 follows standard EPA guidance, the model estimates could be improved by using results from two field studies funded by CARB (See Yuan et al., 2005, see attached paper) to understand dispersion of surface and elevated releases in the Wilmington area. A conclusion from these field studies that is relevant to the current port impact study is that vertical dispersion is limited by the height of a shear generated boundary layer that is advected with the onshore flow.

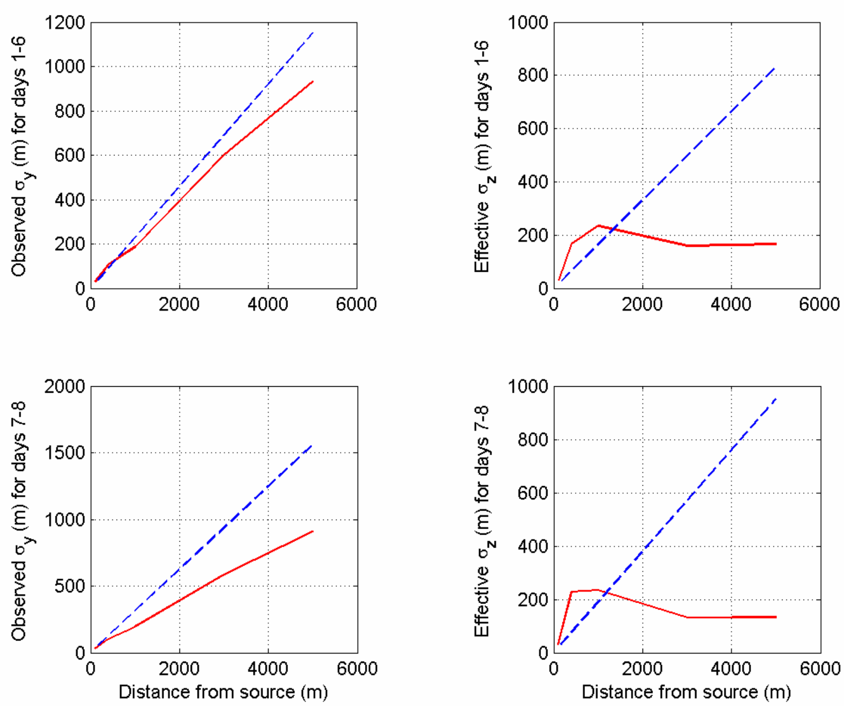

Figure 1: The variation of dispersion parameters as a function of downwind distance. The straight lines represent linear growth determined by turbulent intensities.

Figure 1, from the paper, shows that vertical dispersion is limited to about 200 m. It is unlikely that the ISCST3 dispersion curves or the mixed layer inputs would reflect this feature, which affects dispersion during onshore flows from the south; it is these flows, which occur primarily during the daytime, that bring pollutants from the port areas into the communities located to the north.

In addition to affecting the magnitudes of concentration estimates, the internal boundary layer will affect the ranking of the sources of Diesel PM. If we assume that pollutants are well mixed through the depth of this boundary layer, the long-term concentration at a receptor at a distance r from the source is given approximately by

$$\frac{C(r, z=0)}{Q} = \frac{f_\theta}{2\pi r}\frac{1}{z_i U} \quad (1)$$

where r is the downwind distance from release, Q is the emission rate, U is the transport wind speed, z_i is the height of the internal boundary layer height, and f_θ is the relative frequency with which the wind blows towards the receptor. The relative frequency is calculated as follows. Assume that we use 8 sectors to quantify wind direction frequencies. If the probability of the wind blowing towards any sector is the same in all directions, then the absolute frequency in any one sector is 100/8 %=12.5 %. If the wind frequency in the NE sector is actually 20%, the relative frequency, f_θ, in that direction is 20/12.5=1.6.

What is important here is that the long-term concentration falls off as the distance, r, and is essentially independent of the source height if the source height is less than the internal boundary layer height. This means that the fact that the OGVs have a release height of 50 m has little bearing on the concentrations; the relative impact of a source at a receptor is governed by the source-receptor distance. Thus, not accounting for the existence of the internal boundary layer might lead to errors in both ranking of source impacts and magnitudes of concentrations.

CARB has followed EPA recommended procedures in estimating the impact of DPM sources in the ports of Los Angeles and Long Beach. However, following EPA procedures is necessary only for regulatory applications. It is clear that ISCST3 is not appropriate for estimating concentrations in this particular situation in which the internal boundary layer plays a crucial role. It is important to recall that the ISCST3 urban dispersion parameters were derived from tracer experiments conducted in downtown St. Louis in the 1960s (McElroy and Pooler, 1968), and might not be applicable to the Wilmington area.

CARB has focused on long-term concentration, which might be the most relevant variable for cancer risks. However, non-cancer health risks might be related to hourly or daily peak concentrations. It might be useful to present frequency distributions of short-term concentrations at selected receptors to assess health effects associated with short-term peak concentrations.

The report has a qualitative discussion of possible uncertainties in risk estimates. It is clearly possible to quantify these uncertainties by conducting sensitivity studies with plausible emission inventories and meteorological inputs.

Estimating concentrations associated with DPM emissions from the port areas requires in-depth understanding of the meteorology that governs dispersion. A great deal of this understanding has already been obtained through two major field studies, funded by CARB and CEC (Yuan et al., 2005). It is important to incorporate conclusions from these studies in future assessments of DPM emissions from port activities. CARB might consider using AERMOD (Cimorelli et al., 2005) in future assessments. EPA has recently proposed AERMOD as a replacement for ISCST3. AERMOD has the major advantage of being able to use on-site meteorology as inputs. For example, it can use on-site information on the internal boundary layer in estimating concentrations. CALPUFF might be useful for long-range transport studies. Note that invoking 'CALPUFF' or 'AERMOD' is not a substitute for in-depth understanding of the micrometeorology that controls dispersion.

CARB has also conducted a California wide risk assessment associated with DPM emissions. One of the steps in this assessment involved estimating the contribution of off-shore DPM emissions to total emissions from the air basin of interest. The next section provides comments on the method used by CARB to estimate this contribution.

Adjustment factors for Ship Emissions

I found it very difficult to understand the method used by CARB to estimate exposure because the description in the relevant document is too brief. Thus, my comments reflect my understanding of the method, which assumes that the basin wide averaged concentration, C, is related linearly to the corresponding emissions, Q, through

$$C = DQ, \tag{2}$$

where D is a dispersion function, the form of which is not required in the calculations if it is assumed that it does not change with time. Then, if C and Q are known, the concentration, C_f, corresponding to projected emissions, Q_f, is

$$C_f = Q_f D = Q_f \frac{C}{Q}. \tag{3}$$

The question that CARB addressed was: How do you include offshore emissions in Q? CARB has estimated that the total Q_T from a basin associated with offshore emissions can be expressed as

$$Q_T = Q + fQ_{off}, \tag{4}$$

where Q_{off} is offshore emissions, and 'f 'is a fraction. CARB estimates f=0.1 for the LA Basin, and f=0.25 for the San Diego and SF basins. I found it difficult to follow the qualitative arguments that justify these choices. I am also concerned that at least the LA fraction is based on ISCST3 estimates, which I believe are not credible.

Let me suggest one way of estimating f. To do so, we need to postulate a form for the dispersion function, D, in Equation (2). The simplest equation is

$$D = \frac{1}{2\pi R_b z_i U}, \tag{5}$$

where R_b is the radius of the air basin, and the other variables are defined in reference to Equation (1). If we take, R_b=15 km, z_i=200 m, and U=2 m/s, an emission of Q=2000 tons/year results in a basin wide averaged concentration, C= 1.5 μg/m^3.

If the contribution of offshore emissions is given by Equation (1), the fraction 'f' in Equation (4) is seen to be

$$f = \frac{f_\theta R_b}{R_{off}}, \tag{6}$$

where f_θ is the ***relative*** frequency with which the wind blows towards the air basin, and R_{off} is the effective distance of the offshore emissions from the center of the air basin. Because $R_{off} \geq R_b$, the fraction f is likely to be less than unity if $f_\theta \approx 1$. The point here is that there is a rational method to estimate the contribution of offshore emissions to basin emissions. The qualitative arguments presented in Appendix A need to be converted to equations that others can understand.

REFERENCES

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