COMPARISON OF AERMOD TO EIAA WITH RESPECT TO THE LATEST TRACER FIELD DATA

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INTRODUCTION

The US EPA planned to promulgate AERMOD (U.S. EPA, 2002) in replacement of ISC3 (U.S. EPA 1995a, 1995b), which has been the workhorse of air dispersion model for decades in the United States. Both AERMOD and ISC3 utilize the PRIME building downwash algorithm (Schulman *et al*, 1997; Schulman *et al*, 1998) as an extended feature. The current Chinese regulatory model, EIAA (Ningbo Env. Sci. Academy, 1996), is a traditional Gaussian Plume model similar to ISC. In a similar trend, the state environmental agency of China is considering adoption of AERMOD as the regulatory short-range dispersion model. This report is part of a series of studies the State Environmental Protection Administration engaged in studying the merit and suitability of AERMOD for use as the regulatory model in China.

MODEL CONFIGURATIONS

We inter-compare the predicted hourly average ground level concentrations (GLC) from EIAA and AERMOD to the observed Alaska tracer field data (U.S. EPA, 2004). The Alaska site is flat and covered with ice and snow, with surface roughness of 0.01 m. Figure 1 shows the model set up, which consists of a source at (0,0) and a network of arc-ring receptors plus some outlying discrete receptors. Table 1 summarizes the source characteristics. The model computes the hourly average concentrations through the monitoring period between 23 October and 8 November, 1987, using conventional meteorological surface and upper air data collected at Barrow, AK. There are 153 arc-hour of records in total. For the sake of analysis, the arc-hour records are grouped according to the distance of receptors from the source (Table 2).

Table 5 ***Source parameters.***

X Coordinate (m)	Y Coordinate (m)	Emission Rate (g/s)	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Exit Temperature (^{0}C)
0	0	1.0	39.2	3.66	18.30	305.15

Table 6 ***The Alaska tracer field data records are grouped by downwind distances.***

Arc	1	2	3	4	5	6	7
Distance (m)	< 50.	140.	325.	545.	746.	939.	1890.<x<3292.
Number of records	4	35	38	32	24	9	11

Figure 12 ***AERMOD computation domain and discrete receptors.***

RESULTS

Figure 2 shows the scatter plots of the modeled concentrations versus the observed values. The straight lines in Figure 2 are computed by linear regression of the modeled concentrations according to the relations:

$$C_{MOD} = 0.0424\ C_{OBS} + 0.5784 \qquad \text{(EIAA)},$$

and

$$C_{MOD} = 0.8667\ C_{OBS} + 0.3095 \qquad \text{(AERMOD)},$$

where C_{MOD} and C_{OBS} are normalized modeled and observed concentrations, respectively, in μsm^{-3}. Figure 3 shows the quantile-quantile (QQ) plots of EIAA and AERMOD for the predicted versus observed concentrations. Table 3 summarizes statistical values for comparisons. We conclude that AERMOD is superior to EIAA according to the results presented. In particular, the EIAA results are severely biased: plagued with zero impacts and overestimating the GLCs.

Table 7 ***Statistics of model predicted concentrations against Alaska tracer data.***

Model	Normalized Correlation	Fraction of Factor 2	Root Mean Squared Error
EIAA	0.0320	10.4%	1.5468
AERMOD	0.7716	100%	0.8322

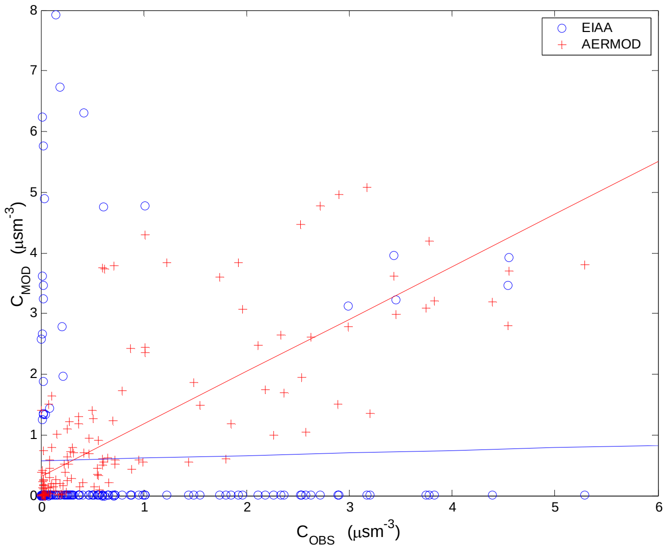

Figure 13 ***Modeled hourly ground level concentrations (EIAA; AERMOD) versus observed concentrations (normalized by the source strength) of the Alaska tracer field data.***

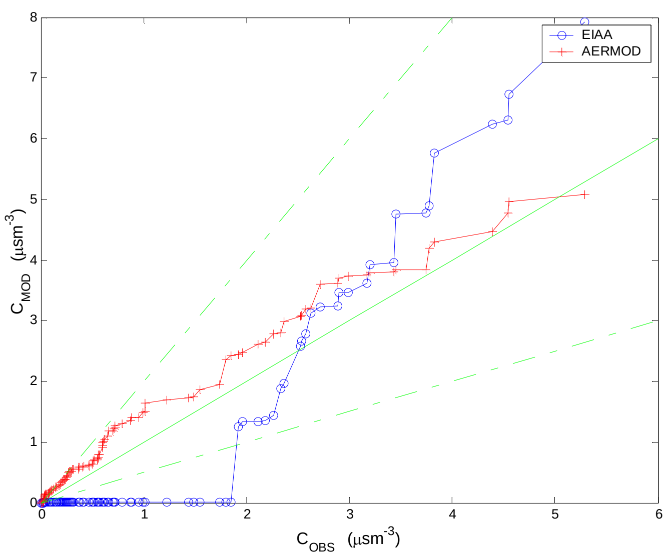

Figure 14 ***Quantile-quantile plots of modeled hourly ground level concentrations (EIAA; AERMOD) versus observed concentrations (normalized by source strength) of the Alaska tracer field data.***

We further examine the box plots of residual, defined as C_{MOD}/C_{OBS}, grouped by arc order (see Figure 4). The box and whiskers indicate the percentiles at 10%, 25%, 50%, 75%, and, 90% within each partition of data. The near-field impacts predicted by EIAA are flat zero except for a single outliner at downwind distance 26 m (within arc order 1). At further downwind distances, the predicted impacts are either zero or overestimation by several hundreds times.

In contrast, the AERMOD predictions generally fall within the range of factor two, although the near-field impacts (arc order 1) are overestimated by an average of 6 times.

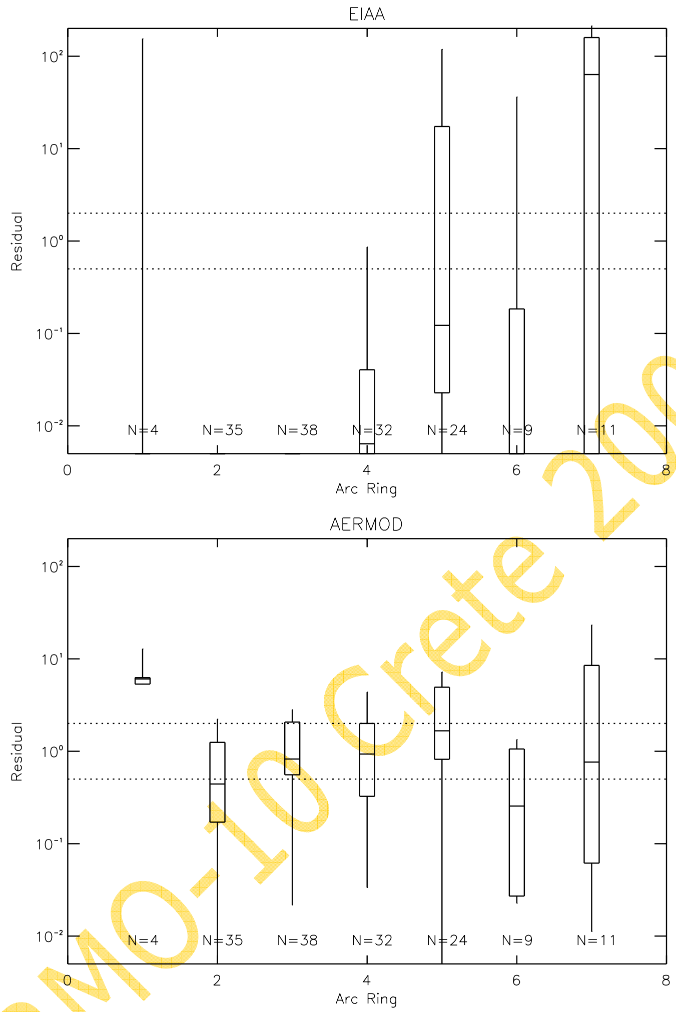

Figure 15 ***Residual plots of EIAA and AERMOD predictions grouped by arc-ring order. Arc ring order increases with downwind distance from the source (see Table 2).***

CONCLUSION

The EIAA model does not consider effects from building downwash in accordance to the air dispersion guideline of China, HJ/T 2.2-93 (SEPA, 1993). The plume rise is overestimated in the absence of building downwash. The plume quickly ascends from the source and then rapidly touches the ground at further downwind distance, as it is evident from the box plot (Figure 4). The impacts near the source are zero, while overestimating the ground level concentrations at far downwind distances. This results in a poor space-time correlation (Figure 2) and a skewed distribution of the model concentrations (Figure 3). The atmospheric condition is stable during the Alaska tracer field experiment. We there conclude that EIAA underestimates the near-field concentrations influenced by building downwash under stable atmospheric conditions, and EIAA overestimates the concentrations at further downwind distance by more than a factor of 2. It is therefore necessary to include building downwash program in the future dispersion guideline of China.

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