

## Denver CAMx-MM5 Modeling Comments for June-July 2006

The following summary highlights the major comments Denver has for the draft 2006 base case CAMx-MM5 model results.

Denver has several recommendations for the final 2006 base case model runs that would help us gain a better understanding of the MM5-CAMx model performance.

With model output files, we are offering staff assistance to perform more in-depth evaluations of MM5 and CAMx inputs and outputs (i.e. wind vector plots, gridded emissions). The intent is to better understand conditions along the Front Range and the impact of predicted ozone concentrations. The wind speed index of agreement, averaged across the entire 4-km domain, while useful, does not provide specific insight into how MM5 is performing along the Front Range.

### CAMx Chapter 1

Section 1.4.6., Table 1-5 –

- Plume in Grid for major NO<sub>x</sub> sources in the final run was said to be considered. This was in the original scope of work as well. PiG will not be run as apparently the integration with CB05 occurred while the final 2006 base case was being run and there is not time/resources to develop a revised base case.
- RECOMMENDATION: PiG is potentially important in understanding NO<sub>x</sub> controls at major sources. We understand the resource constraints, so an alternate would be to describe an example of PiG impacts in other MSAs (i.e. Dallas-Fort Worth). Graphics demonstrating the effects of PiG should be included. [Some description of PiG effects needs to be included in the final report.](#)

### CAMx Chapter 3

Section 3.1.1 –

- RECOMMENDATION: A table should be included that lists the Boundary Conditions that were used in the final model runs, perhaps not in this section but elsewhere.
  - It would be helpful to see the 4- or 12-km grid BCs for the 3 episodes. They can change slightly from day to day. If the OSAT source apportionment shows the BC contribution that would also suffice.

### CAMx Chapter 4

Section 4.4.2, Tables 4-8, 4-10 and last paragraph on pg 4-50 –

- The VOC-to-NO<sub>x</sub> ratios in Tables 4-8 and 4-10 are incorrect (see tables below). The 6-9am reported observed NO<sub>x</sub> conc. is really the 5-8am avg whereas the VOC sample was collected from 6-9am (local Daylight time). The ratios need to reflect this. This likely carries over to all days where VOC to NO<sub>x</sub> ratios are graphed. In many cases, the lower

NOx avg translates to better predicted-to-observed ratios as well as higher VOC-to-NOx ratios. In any case, the VOC-NOx ratio for CAMP is incorrect.

- **RECOMMENDATION:** Please provide gridded output files of predicted CB05 lumped species that can be matched with APCD 2006 air toxics monitoring data. An initial attempt was performed for Ethane in the 2006 final base case.

**Measurements for CAMP on 06/19/06**

HOUR (MST)	O3 (ppb)	NO (ppm)	NO2 (ppm)	CO (ppm)
1	35	0.002	0.024	0.3
2	30	0	0.02	0.3
3	18	0	0.025	0.3
4	11	0.006	0.032	0.4
5	12	0.007	0.027	0.4
6	14	0.016	0.029	0.5
7	7	0.065	0.041	0.9
8	7	0.079	0.046	1.2
9	9	0.069	0.049	1.1
10	16	0.044	0.051	0.9
11	28	0.022	0.044	0.7
12	40	0.013	0.043	0.7
13	45	0.009	0.044	0.6
14	46	0.005	0.039	0.6
15	46	0.014	0.042	0.7
16	41	0.014	0.046	0.7
17	41	0.01	0.029	0.5
18	43	0.003	0.021	0.4
19	38	0.007	0.028	0.5
20	35	0.002	0.026	0.4
21	44	0	0.017	0.4
22	23	0.011	0.035	0.5
23	25	0.008	0.031	0.4
24	27	N/A	N/A	0.3

NOx (ppm)

0.045  
0.106

0.125  
0.118

5-8am  
avg  
**0.116** 6-9am avg (Daylight time)  
0.216 Environ observed value

**Measurements for WBX on 06/19/06**

HOUR (MST)	O3 (ppb)	NO (ppm)	NO2 (ppm)	CO (ppm)
1	43	0	0.003	0.4
2	34	0	0.002	0.3
3	27	0	0.002	0.4

NOx (ppm)

4	14	0	0.016	0.4
5	0	0.049	0.036	0.5
6	0	0.09	0.039	0.8
7	2	0.07	0.044	0.7
8	8	0.033	0.039	0.6
9	25	0.009	0.024	0.5
10	42	0.003	0.014	0.4
11	58	0.002	0.013	0.4
12	64	0.002	0.014	0.4
13	66	0.001	0.011	0.4
14	69	0	0.006	0.4
15	62	0.001	0.004	0.3
16	68	0.001	0.006	0.4
17	54	0	0.008	0.3
18	56	0	0.002	0.3
19	53	0	0	0.3
20	43	0	0.007	0.3
21	32	0	0.017	0.4
22	31	0	0.023	0.4
23	22	0	0.026	0.4
24	8	N/A	N/A	0.5

0.129  
0.114

0.072  
0.033

5-8am  
avg  
**0.073** 6-9am avg (Daylight time)  
0.105 Environ observed value

**Measurements for CAMP on 07/13/06**

HOUR (MST)	O3 (ppb)	NO (ppm)	NO2 (ppm)	CO (ppm)
1	29	0	0.017	0.4
2	21	0	0.023	0.4
3	34	0	0.014	0.3
4	18	0.005	0.029	0.3
5	6	0.028	0.044	0.5
6	5	0.05	0.045	0.7
7	7	0.063	0.044	0.8
8	15	0.03	0.036	0.7
9	19	0.027	0.038	0.6
10	36	0.014	0.033	0.5
11	49	0.007	0.028	0.4
12	57	0.008	0.028	0.4
13	56	0.008	0.029	0.4
14	59	0.007	0.025	0.3
15	52	0.01	0.031	0.4
16	48	0.017	0.036	0.4
17	47	0.014	0.04	0.6

NOx (ppm)

0.095  
0.107

0.066  
0.065

5-8am  
avg  
**0.079** 6-9am avg (Daylight time)  
0.089 Environ observed value

18	44	0.009	0.043	0.6
19	45	0.008	0.042	0.4
20	22	0.015	0.062	0.9
21	12	0.035	0.07	0.9
22	2	0.085	0.076	1.6
23	6	0.06	0.064	1.4
24	26	N/A	N/A	0.6

**Measurements for WBY on 07/13/06**

HOUR (MST)	O3 (ppb)	NO (ppm)	NO2 (ppm)	CO (ppm)
1	0	0.033	0.048	0.6
2	0	0.019	0.044	0.5
3	0	0.018	0.043	0.4
4	8	0.008	0.031	0.3
5	5	0.004	0.031	0.3
6	0	0.101	0.042	0.9
7	0	0.166	0.052	1.2
8	5	0.038	0.043	0.6
9	N/A	0.019	0.033	0.2
10	36	0.007	0.023	0.2
11	65	0	0.003	0.2
12	68	0	0.003	0.2
13	70	0	0.002	0.2
14	70	0	0.002	0.1
15	69	0	0.002	0.1
16	75	0	0.002	0.2
17	74	0	0.003	0.2
18	60	0	0.011	0.3
19	23	0.005	0.039	0.7
20	17	0.002	0.045	0.8
21	3	0.006	0.058	1
22	0	0.039	0.064	1.4
23	0	0.059	0.059	1.5
24	0	N/A	N/A	0.9

NOx (ppm)

0.143  
0.218

0.081  
0.052

5-8am  
avg

0.147  
**0.117** 6-9am avg (Daylight time)  
0.147 Environ observed value

**Measurements for CAMP on 07/28/06**

HOUR (MST)	O3 (ppb)	NO (ppm)	NO2 (ppm)	CO (ppm)
1	42	0.001	0.018	0.3
2	47	0	0.01	0.4

NOx (ppm)

3	47	0	0.009	0.4
4	43	0	0.011	0.4
5	35	0.001	0.019	0.4
6	21	0.009	0.033	0.6
7	8	0.051	0.048	0.9
8	8	0.067	0.051	1
9	24	0.026	0.04	0.8
10	44	0.006	0.03	0.5
11	54	0.004	0.028	0.6
12	56	0.006	0.026	0.4
13	63	0.004	0.021	0.4
14	61	0.007	0.028	0.5
15	50	0.01	0.032	0.4
16	51	0.008	0.033	0.4
17	47	0.01	0.034	0.4
18	48	0.005	0.025	0.2
19	44	0.005	0.025	0.2
20	45	0.003	0.021	0.2
21	40	0.004	0.023	0.3
22	32	0.005	0.021	0.3
23	34	0.004	0.017	0.3
24	31	N/A	N/A	0.4

0.042  
0.099  
0.118  
0.066

5-8am  
avg  
**0.094** 6-9am avg (Daylight time)  
0.086 Environ observed value

Section 4.4.2, Page 4-38, last paragraph –

- **Why do you speculate mobile source VOC is underestimated July 13 (Friday) and July 28 (Saturday), but not June 19 (Tuesday)?**
- **RECOMMENDATION:** An analysis of the wind obs on June 19 indicated an earlier shift to N-NE winds (6-8am) at all sites south of Greeley, 3-4 hrs earlier than normal. Winds veered from SW to NE that morning. Normal diurnal winds typically back SW to SE then E-NE in the afternoon. A closer inspection of hourly predicted morning wind patterns (5-10am) during the three episodes is warranted.

## CAMx Chapter 5

Section 5.4, page 5-27 –

**Doubling of mobile source VOC does not change ozone much (in the maximum but increases the area of influence).**

- **RECOMMENDATION:** Has ENVIRON conducted or seen a similar effect in cities with more advanced ozone SIP modeling efforts? If so, ENVIRON should reference these effects in the Denver documents. Understanding the mechanisms or rationale in CAMx behind such changes would be of much value when the SIP is brought forward to the RAQC Board and the AQCC.

## General, MM5, Appendices

**MM5 – CAMx: The July 27-29 episode is the best performing episode. Comparisons of MM5 outputs with the other episodes may reveal why other episodes don't perform as well as this one.**

- **RECOMMENDATION:** Detailed diurnal (every 3<sup>rd</sup>-hr) MM5 flow field analyses (using vector plots for 4km domain) for the three episodes would likely reveal why there are differences between the episodes. Also, statistics on wind direction bias and gross error at monitored locations in the Front Range would prove useful, at least for the three high ozone episodes. Alpine had agreed to provide this info at the March meeting.
- If the raw model input and output files could be made available to interested stakeholders, this would help facilitate additional analyses to understand the model strengths/weaknesses. Denver is willing to assist with this effort and does not require guidance from the contractor.
- Full outputs and guidance will be available with the Technical Support Documents scheduled for August. This is too late for any analysis of raw data to occur as we seek to better understand the models performance, hence the request above.

**At the urban periphery and mountain sites, why does CAMx not seem to capture the apparent ozone minimums during the overnight and morning hours? This is especially apparent at Academy (Colo Spgs), Welch, Chatfield, and Niwot Ridge.**

- **RECOMMENDATION:** What explains the frequent late evening/midnight occurrence of predicted increases in ozone, that frequently do not match observed conditions? This appears to be a downslope or down-valley effect that predicts too much ozone returning to sites in the urban core overnight (and for too long). While there is some evidence of this in the observed data at certain sites/days, it is usually much less pronounced. A better understanding of the MM5 overnight flow fields would help to clarify this issue during high ozone episodes.
- **RECOMMENDATION:** Please also output or list predicted diurnal PBL heights for certain grid cells in the Front Range (urban and rural).

Thank you for accepting these comments. Please contact me if you have any questions.

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