Modeling of the 2006 HGB SIP
Basecase Episodes

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Acknowledgement

- Thank you to TCEQ Staff for their time and effort in delivering modeling files and answering questions.
General Summary

- Ongoing emissions and ozone modeling analyses will inform public comments on the proposed HGB SIP submitted this autumn.
- Corroborative modeling indicates that we can replicate TCEQs basecase ozone results using agency CAMx input files.
- Emissions differences (mass, speciation, temporal/spatial allocation) between EPS and SMOKE are generally small.
- There are several unresolved and potentially important emissions concerns with the TCEQ 2006 basecase data.
- Discontinuous grid nesting, when compared with standard full-nest (36/12/4/2) modeling for all 2006 episode days, reveals unusually large and unexplained ozone differences. This suggests model replicates high ozone periods better than lower ozone periods.
- Sensitivity experiments reveal that CAMx basecase peak 8-hr ozone estimates are sensitive to changes in emissions and model configuration (e.g. grid nesting scheme).
CAMx Base10 Corroboration

**Left:**
- Max value: 1.23E+02 at (35, 56)
- Min value: 5.78E-04 at (35, 105)
- Avg value: 8.20E+01 non zero cells only
- Grid Total: 1.674E+06

**Right:**
- Max value: 1.29E+02 at (15, 25)
- Min value: 5.70E-01 at (20, 65)
- Avg value: 8.19E+01 non zero cells only
- Grid Total: 4.154E+05

**Legend:**
- Daily Max: O3 Concentration (ppb)
- reg10si.grell.tceq : 060817
- 8 Hour Average

**Files:**
- LEFT: base10\06aug15-06aug22\reg10si.grell.tceq\O3.AQS\tommap\02\8hr\060817.99
- RIGHT: base10\06aug15-06aug22\reg10si.grell.ag\O3.AQS\tommap\04\8hr\060817.99

**Resolution:**
- TCEQ (2 km: 130x166)
- AG (4 km: 65x83)
CAMx Base10 Corroboration

Top: base10\06oct03-06oct11\reg10si.grell.tceq\O3.AQS\maps\02\8hr\CHANNEL
Bottom: base10\06oct03-06oct11\reg10si.grell.ag\O3.AQS\maps\02\8hr\CHANNEL
**Emissions Model Comparisons**

8-hr Ozone Fractional Bias, (%).

<table>
<thead>
<tr>
<th>Date</th>
<th>Fractional Bias, %</th>
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<tr>
<td>5-Oct</td>
<td>15.0</td>
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<tr>
<td>6-Oct</td>
<td>11.0</td>
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<tr>
<td>7-Oct</td>
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<tr>
<td>11-Oct</td>
<td>20.0</td>
</tr>
<tr>
<td>Average</td>
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**Legend:**
- **TCEQ EPS3 Base**
- **AG SMOKE Base**

TCEQ Results: reg10si.tceq 3-11 Oct '06_o3.AQS.2km.8hr.CHANNEL.60.allhrs.allsite.oneday
AG Results: reg10si.2006Bca1a.ag 3-11 Oct '06_o3.AQS.2km.8hr.CHANNEL.60.allhrs.allsite.oneday
How is $O_3$ Affected by Choice of Emissions Model?

Average Daily Maximum 8-hr Ozone (MDA8), ppb.

- **TCEQ EPS3 Base**
- **AG SMOKE Base**

TCEQ Results: reg10si.tceq 3-11 Oct ‘06_o3.AQS.2km.8hr.CHANNEL.60.allhrs.allsite.oneday

AG Results: reg10si.2006BCa1a.ag 3-11 Oct ‘06_o3.AQS.2km.8hr.CHANNEL.60.allhrs.allsite.oneday
Example of Emissions Issues

- EPS vs. SMOKE – two different models with same emissions inputs should result in only minor differences in emissions mass, which we do see.
- Greater concerns are not in emissions masses, but in the underlying data themselves:
  - Where are fire emissions outside TX?
  - Why 24/7 temporal profile for railroad?
  - Why differences in Plume in Grid (PinG) outcome using same criteria (i.e., 240+ TCEQ vs. 1,077 AG PinG sources)?
Discontinuous Modeling versus Full-nest Modeling

- Examine differences in day to day 8-hr peak ozone mixing ratios due to discontinuous use of the 4 km and 2 km fine nests versus continuous CAMx modeling with full 36/12/4/2 km nesting of all days.

- Continuous versus discontinuous nesting can increase or decrease daily maximum ozone concentrations.
Full-nest Spatial Mean Ozone (08Aug-15Sep)

- **Observed**: XXXX
- **Modeled**: OOO

- **TCEQ analysis period**
- **TCEQ does not model**
- **Use of TCEQ 04 km met**
- **Flexi-nest of TCEQ 12km met**

Overestimating Lower Ozone Periods
Full-nest Spatial Mean Ozone (16Sep-11Oct)

***Observed  XXXX  TCEQ analysis period
---
Modeled  OOO  TCEQ does not model

MMM  TCEQ did not use 04 km met
TTTT  Use of TCEQ 04 km met
WWW  Flexi-nest of TCEQ 12km met
Mixed changes in performance. "Full-nest" modeling results in generally higher peaks. Neither "full-nest" nor "discontinuous" modeling is the consistent better predictor of minima ozone.
Note that though the peak during the period is higher in “full-nest” modeling, the peaks for other days are better modeled in “full-nest” than they are in “discontinuous.”
"Full-nest" modeling results in slightly better peak prediction and definitely better prediction of minima ozone.
Sensitivity & Bias at Deer Park

Peak 8-hr Ozone Performance at Deer Park: All Days

Peak 8-hr Ozone Mixing Ratio, ppbv

Fractional Bias, %

CAMx (1a1)  Measured  Fractional Bias

SIP Modeling Day (Julian)
Sensitivity & Bias at Deer Park

At Deer Park, daily fractional bias ranges from -31.2% to 37.1% (mean of 8.2%)
Sensitivity & Bias at Wallisville

Peak 8-hr Ozone Performance at Wallisville: All Days

Peak 8-hr Ozone Mixing Ratio, ppbv

CAMx (1a1)
Measured
Fractional Bias

SIP Modeling Day (Julian)
Sensitivity & Bias at Wallisville

At Wallisville, daily fractional bias ranges from -10.8% to 57.5% (mean of 16.1%)
CAMx Sensitivity Experiments

- Incremental emissions
  - 2006BCa1a - Initial 2006 basecase emissions
  - 2006BCa1-mobilidlea - Addition of idling emissions from HDDV
  - 2006BCa1-landlossa - Addition of tank landing loss emissions
  - 2006BCa1-pscfa - Addition of emissions from PSCF analysis

- No change in CAMx inputs (e.g., meteorology, BC/IC) other than in emissions

- Purpose of experiments
  - To ascertain changes in predicted ozone due to incremental additions of emissions from specific sources
  - Does CAMx model performance change?
# Summary of Emissions Over 2 km Domain by Sensitivity Experiment

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<th></th>
<th>NOX</th>
<th>CO</th>
<th>VOC</th>
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<th>NOX</th>
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<td>116.0</td>
<td>435.7</td>
<td>Basecase + Mobile Idle (included in onroad)</td>
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<td>Basecase + Mobile Idle + Landing Loss (included in point)</td>
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2006BCa1-moblidlea: Mobile Idle (HDDV) minus Basecase

- Showing hour of maximum impact
- Other days/hours show +3 ppb difference
- Impact is unexpectedly large

Layer 1 O3c-O3b

Mobile Idle NOx Emissions (summer-Sunday)
2006BCa1-landloss: Landing Loss minus Basecase + Mobile Idle

- Showing hour of maximum impact
- Other days/hours no impact (i.e., 0 ppb)

(landloss-bc+mobidle)
2006BCa1-pscfa: PSCF minus Basecase+Mobile Idle+Landing Loss

- Potential Source Contribution Factor (PSCF) emissions
- Showing hour of maximum impact
- Other days/hours no impact (i.e., 0 ppb)

(pscf-bc+mobidle+landloss)
Specific Summary

- Baseline CAMx Performance Testing Shows:
  - Full-nest modeling results suggest model better able to replicate high ozone periods, but overestimates lower ozone periods. Neither “full-nest” nor “discontinuous” modeling is the consistent better predictor of minima ozone.
  - Understanding the model at all ozone levels increases confidence the model is getting the right concentrations for the right reasons.
  - This becomes increasingly important as ambient ozone levels continue to decrease.
Specific Summary (con’t)

- Substantial over-prediction bias exists in the SIP model at the key 2018 nonattainment monitors. For days with measured $O_3 > 50$ ppb:
  - At Lynchburg, daily fractional bias ranges from -36.7% to 24.5% (mean of 1.8%)
  - At Deer Park, daily fractional bias ranges from -31.2% to 37.1% (mean of 8.2%)
  - At Wallisville, daily fractional bias ranges from -10.8% to 57.5% (mean of 16.1%)
Specific Summary (cont.)

- CAMx Sensitivity Experiments Reveal
  - SMOKE produces *4.5 times* as many PinG sources (1,077) across the 36 km SIP modeling domain compared to EPS2 (~240).
Recommendations 1 & 2

- The unresolved and potentially important emissions concerns with the TCEQ 2006 basecase data warrant additional scrutiny.

- The implications of and justification for discontinuous grid nesting in the SIP model warrants investigation of why modeling system can better replicate high ozone periods than lower ozone periods.
Recommendation 3

- Reliance on ozone increments in the range of 'a few tenths of a ppb' to a 'few ppbs' should be examined because of inherent uncertainties in the model.

- Therefore, other relevant analyses must be used to support and enhance the usefulness of modeling results.
Science Team Activities

- The Coalition will continue science activities relevant to current and future SIPs. Areas of investigation include:
  - OSAT and related analyses to assist with a monitor-by-monitor approach
  - Approaches to include emissions from the 2006 special EI in the future case
  - Analysis of ozone effects of the IR camera and other emission reduction programs