TCEQ Photochemical Modeling Update

Doug Boyer
Air Modeling & Data Analysis
Air Quality Division

Southeast Texas Photochemical Modeling Technical Committee Meeting
Houston-Galveston Area Council Offices

February 27, 2014
Texas Design Values by Area
2003-2013*

*2013 data is current as of 11/12/2013 and is subject to change.
Previous SIP Modeling Domains
Modeling Setup
HGB MVEB Update SIP (4/2013) vs Current TCEQ Modeling

CAMx Photochemical Model
- v4.53 → v6.00a
- CB05 → CB6 (additional explicit species and isoprene chem.)
- New inline photolysis rate adjustments
- MPI (CAMx 5+) – huge speed-up in run-time
- New dry deposition scheme w/ 26 landuse categories
- Improved Plume-In-Grid dynamics (vertical allocation of emissions)

Meteorological Model
- MM5 v3.7.3 → WRF v3.2
- Met-to-CAMx interface significantly improved
  - Speed-up, vertical mixing, convective cloud

Biogenic Emission Model
- GloBEIS3 → MEGAN v2.10
- MODIS Satellite-based Leaf Area Index (LAI)
MEGAN 2.10 vs GloBEIS3 Biogenic VOC Emissions
June 12th Episode Day

MEGAN 2.10

GloBEIS3

HGB: 1579 tons/day

HGB: 2117 tons/day
Modeling Setup
HGB MVEB Update SIP (4/2013) vs Current TCEQ Modeling

Point Sources
- Texas: latest 2006 State of Texas Air Reporting System (STARS)
- Non-Texas: 2002 NEI/CENRAP → 2008 NEI

Area/Non-road
- Shipping and Locomotives link-based

Oil and Gas
- Old: NEI/TexAER factors
- Now: Detailed county-based production and drilling from TX calculator and Railroad Commission of Texas
## 2006 HGB Area Anthropogenic Emissions Summary by Source Category

<table>
<thead>
<tr>
<th>2006 Summer Weekday Emissions (tons per day)</th>
<th>From 2013 MVEB SIP</th>
<th>Current TCEQ Modeling</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO\textsubscript{X}</td>
<td>VOC</td>
</tr>
<tr>
<td>On-Road</td>
<td>270.00</td>
<td>104.74</td>
</tr>
<tr>
<td>Non-Road</td>
<td>78.85</td>
<td>75.97</td>
</tr>
<tr>
<td>Area</td>
<td>36.35</td>
<td>528.99</td>
</tr>
<tr>
<td>Off-Road</td>
<td>73.55</td>
<td>6.05</td>
</tr>
<tr>
<td>Oil and Gas - Production</td>
<td>In Area</td>
<td>In Area</td>
</tr>
<tr>
<td>Oil and Gas - Drill Rigs</td>
<td>In Non-Road</td>
<td>In Non-road</td>
</tr>
<tr>
<td>Point Sources</td>
<td>170.82</td>
<td>222.33</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>629.57</strong></td>
<td><strong>938.08</strong></td>
</tr>
</tbody>
</table>

Note: Current TCEQ modeling emissions are preliminary
### 2018 DFW & HGB Area Anthropogenic Emissions Summary by Source Category

<table>
<thead>
<tr>
<th>2018 Summer Weekday Emissions (tons per day)</th>
<th>DFW</th>
<th>HGB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NO\textsubscript{X}</td>
<td>VOC</td>
</tr>
<tr>
<td>On-Road</td>
<td>113.21</td>
<td>55.61</td>
</tr>
<tr>
<td>Non-Road</td>
<td>39.87</td>
<td>32.77</td>
</tr>
<tr>
<td>Area (w/o Oil and Gas)</td>
<td>30.76</td>
<td>284.94</td>
</tr>
<tr>
<td>Off-Road</td>
<td>30.67</td>
<td>4.46</td>
</tr>
<tr>
<td>Oil and Gas - Production</td>
<td>12.21</td>
<td>43.68</td>
</tr>
<tr>
<td>Oil and Gas - Drill Rigs</td>
<td>5.83</td>
<td>0.01</td>
</tr>
<tr>
<td>Point Sources</td>
<td>57.57</td>
<td>47.09</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>290.12</strong></td>
<td><strong>468.56</strong></td>
</tr>
</tbody>
</table>

Note: Current TCEQ modeling emissions are preliminary
Tier 3 and 10 ppm Gasoline Sulfur Standards for Light-Duty On-Road Vehicles

- Current proposal by EPA ([http://www.epa.gov/otaq/tier3.htm](http://www.epa.gov/otaq/tier3.htm)) is to require:
  - more stringent Tier 3 standards for light-duty vehicles phasing in between the 2017-2025 model years; and
  - 10 parts per million (ppm) gasoline sulfur instead of the current 30 ppm level.

- Overall on-road fleet benefits accrue from both:
  - introduction of tighter standards with the 2017 model year; and
  - lower sulfur levels increasing catalytic converter effectiveness, which reduces emissions from in-use vehicles.

  - “The maximum projected decrease in an eight-hour ozone design value in 2017 is 1.09 ppb in Tarrant County, Texas…”

- Estimating Tier 3 on-road emission benefits for the 2018 attainment year:
  - the current MOVES2010b model does not include Tier 3 benefits;
  - MOVES2013 will include them and is scheduled for release after Tier 3 rule finalization;
  - TCEQ obtained the MOVEST3NPRM database available from EPA as part of the Tier 3 proposed rulemaking;
  - TCEQ ran 2018 gasoline scenarios for the current 30 ppm and the proposed 10 ppm levels; and
  - TCEQ applied ratios of the results by vehicle type, pollutant, and emission process (e.g., running exhaust versus start exhaust) to the 2018 on-road inventories based on 30 ppm.
## Preliminary 2018 DFW Future Design Values for 10 and 30 ppm Sulfur Gasoline Scenarios

<table>
<thead>
<tr>
<th>DFW Area Monitor and CAMS Code</th>
<th>2018 Future Design Values (ppb)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Current 30 ppm Sulfur Gasoline</td>
<td>Proposed 10 ppm Sulfur Gasoline</td>
</tr>
<tr>
<td>Denton Airport South - C56</td>
<td>77.09</td>
<td>76.29</td>
</tr>
<tr>
<td>Eagle Mountain Lake - C75</td>
<td>76.38</td>
<td>75.64</td>
</tr>
<tr>
<td>Grapevine Fairway - C70</td>
<td>76.12</td>
<td>75.38</td>
</tr>
<tr>
<td>Keller - C17</td>
<td>75.31</td>
<td>74.55</td>
</tr>
<tr>
<td>Fort Worth Northwest - C13</td>
<td>74.07</td>
<td>73.37</td>
</tr>
<tr>
<td>Frisco - C31</td>
<td>73.33</td>
<td>72.59</td>
</tr>
<tr>
<td>Dallas North #2 - C63</td>
<td>71.82</td>
<td>71.18</td>
</tr>
<tr>
<td>Parker County - C76</td>
<td>71.75</td>
<td>71.12</td>
</tr>
<tr>
<td>Dallas Executive Airport - C402</td>
<td>71.41</td>
<td>70.82</td>
</tr>
<tr>
<td>Cleburne Airport - C77</td>
<td>70.91</td>
<td>70.36</td>
</tr>
<tr>
<td>Arlington Municipal Airport - C61</td>
<td>69.92</td>
<td>69.32</td>
</tr>
<tr>
<td>Dallas Hinton Street - C401</td>
<td>68.85</td>
<td>68.24</td>
</tr>
<tr>
<td>Granbury - C73</td>
<td>68.56</td>
<td>68.06</td>
</tr>
<tr>
<td>Midlothian Tower - C94</td>
<td>68.09</td>
<td>67.60</td>
</tr>
<tr>
<td>Pilot Point - C1032</td>
<td>66.91</td>
<td>66.22</td>
</tr>
<tr>
<td>Rockwall Heath - C69</td>
<td>65.82</td>
<td>65.33</td>
</tr>
<tr>
<td>Greenville - C1006</td>
<td>63.40</td>
<td>62.98</td>
</tr>
<tr>
<td>Midlothian OFW - C52</td>
<td>63.38</td>
<td>62.93</td>
</tr>
<tr>
<td>Kaufman - C71</td>
<td>63.10</td>
<td>62.71</td>
</tr>
</tbody>
</table>
Gasoline Passenger Car Running Exhaust NO\textsubscript{X} Emission Rates in 2018 for 10 and 30 ppm Sulfur Gasoline

1988-1993 model year Tier 0
NO\textsubscript{X} reduction of 2%

1994-2000 model year Tier 1
NO\textsubscript{X} reduction of 2%

2001-2003 model year NLEV
NO\textsubscript{X} reduction of 14%

2004-2018 model year Tier 2/3
NO\textsubscript{X} reduction of 49%

1988-2018 model year weighted average NO\textsubscript{X} reduction of 29% from 0.1647 to 0.1163 gpm

Source: 2018 Dallas County default runs of MOVES2010b by model year with the T3NPRM database. Refer to Updates to MOVES for the Tier 3 NPRM Analysis, U.S. EPA Office of Transportation and Air Quality, March 2013.
## Estimated 10 ppm Sulfur Gasoline Reductions to 2018 Summer Weekday On-Road Emissions

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>2018 Summer Weekday On-Road Emissions (tpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Use of Current 30 ppm Sulfur Gasoline for In-Use Fleet</td>
</tr>
<tr>
<td>Ten-County DFW</td>
<td>95.80</td>
</tr>
<tr>
<td>Eight-County HGB</td>
<td>87.01</td>
</tr>
<tr>
<td>236 Attainment Counties</td>
<td>344.32</td>
</tr>
<tr>
<td>Texas Total (254 Counties)</td>
<td>527.13</td>
</tr>
<tr>
<td>Non-Texas U.S. (2,856 Counties)</td>
<td>7,173.34</td>
</tr>
<tr>
<td>Southern Canada (10 Provinces)</td>
<td>406.42</td>
</tr>
<tr>
<td>Northern Mexico (562 Municipios)</td>
<td>91.77</td>
</tr>
<tr>
<td>Grand Total</td>
<td>8,198.65</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Geographic Area</th>
<th>2018 Summer Weekday On-Road Emission Reductions (tpd)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Use of Proposed 10 ppm Sulfur Gasoline for In-Use Fleet</td>
</tr>
<tr>
<td>Ten-County DFW</td>
<td>8.46</td>
</tr>
<tr>
<td>Eight-County HGB</td>
<td>7.79</td>
</tr>
<tr>
<td>236 Attainment Counties</td>
<td>22.89</td>
</tr>
<tr>
<td>Texas Total (254 Counties)</td>
<td>39.14</td>
</tr>
<tr>
<td>Non-Texas U.S. (2,856 Counties)</td>
<td>588.39</td>
</tr>
<tr>
<td>Southern Canada (10 Provinces)</td>
<td>0.00</td>
</tr>
<tr>
<td>Northern Mexico (562 Municipios)</td>
<td>0.00</td>
</tr>
<tr>
<td>Grand Total</td>
<td>627.54</td>
</tr>
</tbody>
</table>
## EPA’s Estimated Ozone Reduction Benefits in 2017 from Tier 3/10 ppm Sulfur Rule Proposal

<table>
<thead>
<tr>
<th>Metropolitan Area</th>
<th>Texas County</th>
<th>2017 Future Design Value</th>
<th>Ozone Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Without Tier 3</td>
<td>With Tier 3</td>
</tr>
<tr>
<td><strong>Austin</strong></td>
<td>Travis</td>
<td>67.77</td>
<td>67.06</td>
</tr>
<tr>
<td>Beaumont-Port Arthur</td>
<td>Jefferson</td>
<td>75.14</td>
<td>74.86</td>
</tr>
<tr>
<td></td>
<td>Orange</td>
<td>68.09</td>
<td>67.80</td>
</tr>
<tr>
<td><strong>Dallas-Fort Worth</strong></td>
<td>Collin</td>
<td>75.35</td>
<td>74.46</td>
</tr>
<tr>
<td></td>
<td>Dallas</td>
<td>76.92</td>
<td>76.02</td>
</tr>
<tr>
<td></td>
<td>Denton</td>
<td>75.80</td>
<td>74.73</td>
</tr>
<tr>
<td></td>
<td>Ellis</td>
<td>67.53</td>
<td>66.67</td>
</tr>
<tr>
<td></td>
<td>Hood</td>
<td>65.82</td>
<td>64.80</td>
</tr>
<tr>
<td></td>
<td>Hunt</td>
<td>66.40</td>
<td>65.94</td>
</tr>
<tr>
<td></td>
<td>Johnson</td>
<td>68.73</td>
<td>67.85</td>
</tr>
<tr>
<td></td>
<td>Kaufman</td>
<td>63.93</td>
<td>63.48</td>
</tr>
<tr>
<td></td>
<td>Parker</td>
<td>69.66</td>
<td>68.65</td>
</tr>
<tr>
<td></td>
<td>Rockwall</td>
<td>67.66</td>
<td>67.12</td>
</tr>
<tr>
<td></td>
<td><strong>Tarrant</strong></td>
<td>77.34</td>
<td>76.25</td>
</tr>
<tr>
<td>El Paso</td>
<td>El Paso</td>
<td>68.37</td>
<td>67.95</td>
</tr>
<tr>
<td>Houston-Galveston-Brazoria</td>
<td>Brazoria</td>
<td>83.33</td>
<td>82.80</td>
</tr>
<tr>
<td></td>
<td>Galveston</td>
<td>75.38</td>
<td>75.12</td>
</tr>
<tr>
<td></td>
<td>Harris</td>
<td>90.22</td>
<td>89.68</td>
</tr>
<tr>
<td></td>
<td>Montgomery</td>
<td>73.00</td>
<td>72.41</td>
</tr>
<tr>
<td>Northeast Texas</td>
<td>Gregg</td>
<td>74.18</td>
<td>73.88</td>
</tr>
<tr>
<td></td>
<td>Harrison</td>
<td>66.93</td>
<td>66.51</td>
</tr>
<tr>
<td></td>
<td>Smith</td>
<td>69.81</td>
<td>69.44</td>
</tr>
<tr>
<td>San Antonio</td>
<td>Bexar</td>
<td>72.36</td>
<td>71.76</td>
</tr>
</tbody>
</table>

### Comparing DFW Area Ozone Modeling from EPA for 2017 and TCEQ for 2018

#### EPA Modeling – 2005 Base Case, 2017 Future Year, 12 km Resolution

<table>
<thead>
<tr>
<th>Scenario Description</th>
<th>2017 Future Year Ozone Design Values (ppb)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum – Kaufman</td>
<td>Maximum - Tarrant</td>
<td></td>
</tr>
<tr>
<td>With 30 ppm Sulfur Gasoline</td>
<td>63.93</td>
<td>77.34</td>
<td></td>
</tr>
<tr>
<td>With 10 ppm Sulfur Gasoline</td>
<td>63.48</td>
<td>76.25</td>
<td></td>
</tr>
<tr>
<td>Net Ozone Reduction</td>
<td>0.45</td>
<td>1.09</td>
<td></td>
</tr>
</tbody>
</table>

#### TCEQ Modeling – 2006 Base Case, 2018 Future Year, 4 km Resolution

<table>
<thead>
<tr>
<th>Scenario Description</th>
<th>2018 Future Year Ozone Design Values (ppb)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum – Kaufman</td>
<td>Maximum – Denton Airport</td>
<td></td>
</tr>
<tr>
<td>With 30 ppm Sulfur Gasoline</td>
<td>63.10</td>
<td>77.09</td>
<td></td>
</tr>
<tr>
<td>With 10 ppm Sulfur Gasoline</td>
<td>62.71</td>
<td>76.29</td>
<td></td>
</tr>
<tr>
<td>Net Ozone Reduction</td>
<td>0.39</td>
<td>0.80</td>
<td></td>
</tr>
</tbody>
</table>
Current Ozone Modeling Plans and Known Future Changes

- Emission estimate updates:
  - 2018 (and maybe 2006) on-road emissions after MOVES2013 is released by EPA, which is scheduled to occur in 2014. Currently relying on emission estimates from MOVES2010a and MOVES2010b.
  - 2018 point source emission projections based on 2013 acid rain database (ARD) for electric generating utilities (EGUs) and 2012 State of Texas Air Reporting System (STARS) database for non-EGUs (NEGUs). Currently using 2012 ARD and 2011 STARS.
  - 2018 oil and gas emissions based on recently received 2012 production data from the Railroad Commission of Texas. Currently projecting from 2011 production data.
  - If version 2 of the 2011 National Emissions Inventory (NEI) is released by EPA, update 2018 future projections for non-Texas areas. Version 1 of the 2011 NEI was recently released and is currently being used.

- Chemical mechanism:
  - Implement any CB6 improvements that result in improved base case performance.
  - Currently using the “revision 2” option for CB6 in CAMx to estimate ozone.
  - 2006 base case CAMx runs showed that both the initial version of CB6 and “revision 1” caused significant over estimation of ozone.
  - CB05 was an improvement over its predecessor (CBIV), but still had under estimation problems.

- Meteorological modeling:
  - Implement any WRF improvements that result in improved base case performance.
  - Currently using WRF 3.2 output.
  - The recently released WRF 3.5 has been run for the 2006 episodes and the output is currently undergoing quality assurance review.
Modeling Web Sites

- SET PMTC: Presentations and past meeting information

- Interactive Air Quality Modeling Results (New)
  http://www.tceq.texas.gov/airquality/airmod/data/results

- Proposed HGB and DFW EI SIP Revision for the 2008 Eight-Hour Ozone Standard (12/11/2013)

- Current Eight-Hour Ozone SIP Modeling Details
  http://www.tceq.texas.gov/airquality/airmod/rider8/rider8Modeling

- Current Modeling File FTP Site
  ftp://amdaftp.tceq.texas.gov/pub/TX/
Questions?

Doug Boyer – HGB Modeling Project Manager
doug.boyer@tceq.texas.gov
512 239-1523

The Air Modeling & Data Analysis Section contributed to these results.

Contact: amda@tceq.texas.gov