Maryland Ozone Forecasts in 2013

NOAA Air Quality Forecaster Focus Group Workshop
September 26 – 27, 2013

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Joel Dreessen
Meteorologists
Ozone Season 2013

- 9 Maryland exceedance days, > 75 ppb 8-hour daily max
  - 9 Unhealthy for Sensitive Groups (USG), or Orange, days
  - 0 Unhealthy, or Red, days
- Well below the 5-year average of 29 Maryland exceedance days
  - 6 out of 9 days were 76 – 78 ppb for the 8-hour daily max
  - 7 out of 9 days were only measured by 1 monitor
- July 19, 2013, Maryland’s worst day of the season
  - 83 ppb at the Fairhill monitor was the highest 8-hour daily max
  - Total of 3 monitors observed this exceedance day

Notes: 2013 data are preliminary. Information above is based on Maryland only monitors.
Forecast verification statistics to follow are based on monitors shown on slide 3.
Statistics are online at: [http://public.tableausoftware.com/views/ForecastVerification2013/O3VerifPPB2](http://public.tableausoftware.com/views/ForecastVerification2013/O3VerifPPB2)
Forecast Regions & Monitors

Air Quality Forecast Regions
- Metro Baltimore
- Metro Washington
- Eastern Shore
- Western Maryland

Ozone Monitor
*Piney Run is a mountaintop monitor
Maryland & Washington Ozone (O3) Forecast Verification
April - September 2013

Comparison of Observed to Forecast Ozone

Forecast Difference from Observed Ozone

Forecast Statistics at USG Threshold

<table>
<thead>
<tr>
<th>Agency</th>
<th>% Correct</th>
<th>POD</th>
<th>FAR</th>
<th>Bias</th>
<th>MAE (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Official</td>
<td>97</td>
<td>67</td>
<td>73</td>
<td>43</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.17</td>
<td>6.7</td>
</tr>
<tr>
<td>NOAA 06z</td>
<td>91</td>
<td>33</td>
<td>68</td>
<td>82</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.83</td>
<td>8.9</td>
</tr>
<tr>
<td>NOAA 12z</td>
<td>91</td>
<td>17</td>
<td>71</td>
<td>90</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.67</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Estimated concentrations are within ±2 ppb, derived from AQS.
Data: MD, VA DEQ, MDMOS, AirNow-NEAG

2012

Observed/Forecast

Region
- Eastern Shore
- Metro Baltimore
- Metro Washington
- Western Maryland

MD had below average O3 with 9 days >75 ppb statewide compared to the 5-year average of 29 days.
Maryland & Washington Ozone (O3) Forecast Verification
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</tr>
</thead>
<tbody>
<tr>
<td>Official</td>
<td>97</td>
<td>50</td>
<td>72</td>
<td>50</td>
<td>38</td>
</tr>
<tr>
<td>NOAA 06z</td>
<td>93</td>
<td>40</td>
<td>67</td>
<td>75</td>
<td>56</td>
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<tr>
<td>NOAA 12z</td>
<td>93</td>
<td>40</td>
<td>71</td>
<td>80</td>
<td>54</td>
</tr>
</tbody>
</table>

| Region      |          |     |     |     |           |           |
|-------------|----------|-----|-----|-----|-----------|
| Eastern Shore|         |     |     |     |           |           |
| Metro Baltimore|      |     |     |     |           |           |
| Metro Washington|    |     |     |     |           |           |
| Western Maryland|   |     |     |     |           |           |

2012

Observed/Forecast

- Observed
- Official
- NOAA 06z
- NOAA 12z

MD had below average O3 with 9 days >75ppb statewide compared to the 5-year average of 29 days.

Est. concentrations are within ±2ppb, derived from AQI.

Data: MD, VA, DEQ, MNNCC, AirNow-Tech
Comparison of Observed to Forecast Ozone

Forecast Difference from Observed Ozone

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<th>POD</th>
<th>FAR</th>
<th>Bias</th>
<th>MAE (ppb)</th>
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<tbody>
<tr>
<td>Official</td>
<td>97</td>
<td>0</td>
<td>100</td>
<td>22</td>
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<tr>
<td>NOAA 06z</td>
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<td>100</td>
<td>26</td>
<td>5</td>
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<tr>
<td>NOAA 12z</td>
<td>95</td>
<td>0</td>
<td>100</td>
<td>19</td>
<td>6</td>
</tr>
</tbody>
</table>

2012

Observed/Forecast

- Observed
- Official
- NOAA 06z
- NOAA 12z

Region

- Eastern Shore
- Metro Baltimore
- Metro Washington
- Western Maryland

MD had below average O3 with 9 days >75ppb statewide compared to the 5-year average of 29 days.

Est. concentrations are within +/-2ppb, derived from AQI.

Data: MD, VA, DEQ, MNNCG, AirNow-Tech
Early Season: May 15, 2013

Forecast 5-14-2013 Valid 5-15-2013

Official Forecast

58 59
56 59

All concentrations are parts per billion (ppb)

Verification 5-15-2013

77 66
72 67

All concentrations are parts per billion (ppb)

<table>
<thead>
<tr>
<th>Region</th>
<th>Official</th>
<th>NOAA 12z</th>
<th>Actual</th>
<th>NOAA Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMD</td>
<td>58</td>
<td>58</td>
<td>77</td>
<td>-19</td>
</tr>
<tr>
<td>DC</td>
<td>56</td>
<td>59</td>
<td>72</td>
<td>-13</td>
</tr>
<tr>
<td>Balt.</td>
<td>59</td>
<td>58</td>
<td>66</td>
<td>-8</td>
</tr>
<tr>
<td>E.S.</td>
<td>59</td>
<td>60</td>
<td>67</td>
<td>-7</td>
</tr>
</tbody>
</table>

Source: Airnow; NCEP; MDE
Meteorological Conditions

- Warm front and associated trough along the Appalachians
- Strong westerly flow aloft
- Temperatures near 90°F at Piney Run, upper 70s elsewhere
- Some rain and clouds over eastern MD, dry and clear over Piney Run.

Daily Peak Ozone AQI
Wednesday, May 15, 2013

Source: WPC, HYSPLIT, AirNow
Mid Season: July 19, 2013

Forecast 7-18-2013  Valid 7-19-2013

All concentrations are parts per billion (ppb)

Verification 7-19-2013

<table>
<thead>
<tr>
<th>Region</th>
<th>Official</th>
<th>NOAA 12z</th>
<th>Actual</th>
<th>NOAA Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMD</td>
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<td>58</td>
<td>54</td>
<td>+4</td>
</tr>
<tr>
<td>DC</td>
<td>74</td>
<td>68</td>
<td>77</td>
<td>-9</td>
</tr>
<tr>
<td>Balt.</td>
<td>76</td>
<td>71</td>
<td>83</td>
<td>-12</td>
</tr>
<tr>
<td>E.S.</td>
<td>75</td>
<td>75</td>
<td>62</td>
<td>+13</td>
</tr>
</tbody>
</table>

Source: Airnow; NCEP; MDE
Mid Season: July 19, 2013

Meteorological Conditions

- High pressure over the Mid-West had moved southeast
- Light south-westerly winds
- Temperatures near 96°F at BWI with isolated afternoon thunderstorms

Source: WPC, HYSPLIT, AirNow
Late Season: September 11, 2013

**Forecast 9-10-2013 Valid 9-11-2013**

<table>
<thead>
<tr>
<th>Region</th>
<th>Official</th>
<th>NOAA 12z</th>
<th>Actual</th>
<th>NOAA Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMD</td>
<td>61</td>
<td>70</td>
<td>63</td>
<td>+7</td>
</tr>
<tr>
<td>DC</td>
<td>71</td>
<td>78</td>
<td>72</td>
<td>+6</td>
</tr>
<tr>
<td>Balt.</td>
<td>72</td>
<td>83</td>
<td>71</td>
<td>+12</td>
</tr>
<tr>
<td>E.S.</td>
<td>65</td>
<td>69</td>
<td>62</td>
<td>+7</td>
</tr>
</tbody>
</table>

All concentrations are parts per billion (ppb)

Source: Airnow; NCEP; MDE
Late Season: September 11, 2013

- Meteorological Conditions
  - High pressure with Appalachian Lee-side trough
  - Stagnation aloft; southerly sfc. winds
  - Temperatures near 95°F at BWI
  - Afternoon thunderstorms over the mountains only

Source: WPC, HYSPLIT, AirNow
2013 Ozone Season NOAA Model USG False Alarms, Misses and Success in Maryland

<table>
<thead>
<tr>
<th>Regional</th>
<th>Official</th>
<th>NOAA</th>
</tr>
</thead>
<tbody>
<tr>
<td>USG Forecasts</td>
<td>15</td>
<td>30</td>
</tr>
<tr>
<td>False Alarms</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>Misses</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Success</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>
The clean year of 2013 altered forecast statistics from previous years

- All forecasts were fairly similar in skill level, except for Metro Baltimore and Washington where official forecasts were better than the NOAA model.
- The small sample size of USG days skewed verification statistics.
- 8-hr maximum ozone on USG days ranged 76-78ppb 75% per regional verification (9 of 12) and 66% (6 of 9) Maryland-wide USG days.

On the whole, the model did well finding trends but:

- Had trouble catching the early season event.
- False alarms were an issue, especially late season.
  - NOAA model’s first false alarm was June 20th with increasing frequency towards the end of the season.
Contacts

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Laura.Warren@maryland.gov

Ambient Air Monitoring Program
Air and Radiation Management Administration
www.mde.maryland.gov/air
Appendix
# Forecast Statistics

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Units</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent Correct</td>
<td>%</td>
<td>Percent of forecasts correctly predicted for event or non-event.</td>
</tr>
<tr>
<td>Probability of Detection (POD)</td>
<td>%</td>
<td>Percent of times a forecast of higher pollution verified.</td>
</tr>
<tr>
<td>False Alarm Rate (FAR)</td>
<td>%</td>
<td>Percent of times a forecast of higher pollution did not verify.</td>
</tr>
<tr>
<td>Bias</td>
<td>AQI</td>
<td>Indicates, on average, if the forecasts are underpredicted or overpredicted. Value closer to 1 are best where values &lt; 1 are underprediction.</td>
</tr>
<tr>
<td>Mean Absolute Error (MAE)</td>
<td>ppb</td>
<td>Average “closeness” between the forecast and observed values.</td>
</tr>
</tbody>
</table>

Source: EPA Guidelines for Developing an Air Quality (Ozone and PM2.5) Forecasting Program