# TCEQ Staff Recommendations of Response to Comments for the Houston-Galveston-Brazoria SIP – Meteorology's Impact on Ozone Trends

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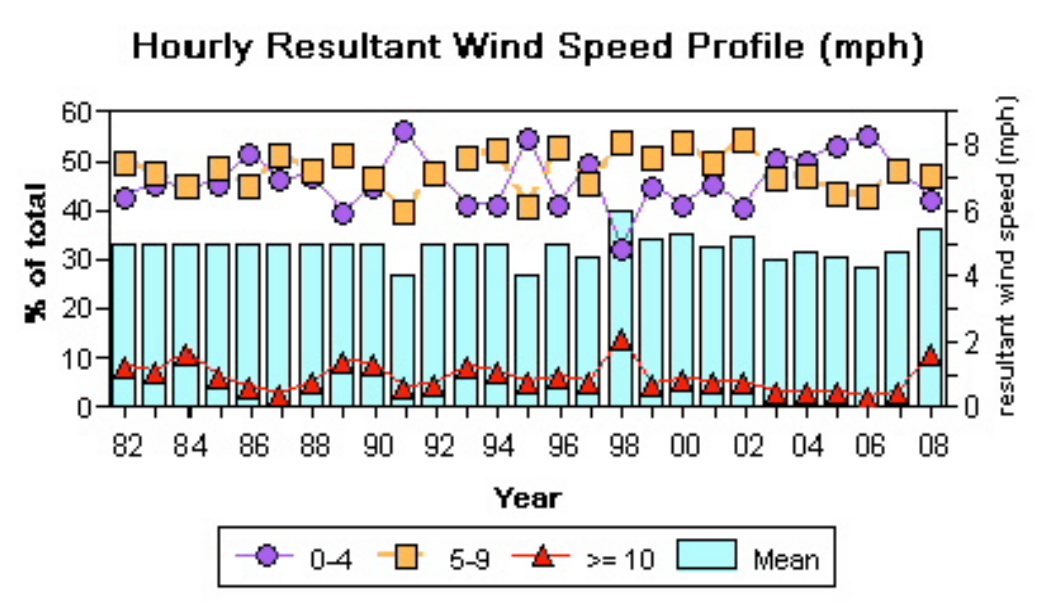
# Comments:
## Meteorology's Impact on Ozone Trends

- The weight of evidence analysis did not account for the effects of favorable meteorological conditions on reducing the 2007-2009 ozone design values.
- Favorable meteorological conditions may have played a greater role in reducing the ozone concentrations than the reduced emissions of ozone precursors.
- Meteorological conditions during the 2005 and 2006 modeled ozone episodes are more conducive to ozone formation than the 2007-2009 conditions leading to the current design values.
- Higher than average wind speeds occurred in both 2007 and 2008, leading to lower ozone concentrations.
- There was an unusually rainy and cool ozone season during 2007 and an unusually windy ozone season in 2009.

# TCEQ Staff Recommendations of Response to Comments:
## Meteorology's Impact on Ozone Trends

- Four analyses show that recent decreases in ozone cannot be attributed to meteorology alone:
  - Meteorological adjusted trends in Chapter 5 if the HGB SIP
  - EPA's meteorological adjusted trends
  - Ozone conducive day analysis from URS
  - Comparison of forecasted high ozone days to actual high ozone days
- Additional analysis of wind data by month and year show that winds in 2008 and 2009 were higher, but only during months when the highest ozone is not typically observed.

# Wind Data from Houston Aldine




Data is June through August, 05:00 to 19:00 LST, with a minimum of 65 percent data capture.

**Source:** This figure is copied from Sather and Snyder, *Region 6 "State of the Ozone" Report for 2008*, presented at the Southeast Texas Photochemical Modeling Technical Committee (SETPMTC) meeting, April 28, 2009

- Winds greater than or equal to 10 mph were more prevalent in 2008 compared to earlier years.
- The frequency of winds greater than or equal to 10 mph was similar in 1998 and 2008.
- 1998 had fewer winds less than 4 mph compared to 2008.
- 1998 had 48 eight-hour ozone exceedances (85 ppb) compared to 9 in 2008.
- The fourth-highest eight-hour ozone values ranged from 90 ppb to 117 ppb in 1998 and 68 ppb to 83 ppb in 2008.

# Meteorological Adjustment of Ozone Trends

- Removing meteorological influences from ozone trends reveals whether observed ozone decreases result from:
  - variation in meteorology or
  - reductions in precursors.
- Two analyses remove meteorological influences from the ozone trends
  - Analysis from University of Texas, included in Chapter 5 of the HGB SIP, shows that ozone through 2007 would continue to be decreasing despite meteorological influences.
  - Analysis from the EPA shows that ozone in 2008 would have been lower when adjusted for the weather www.epa.gov/airtrends/weather/region06.pdf

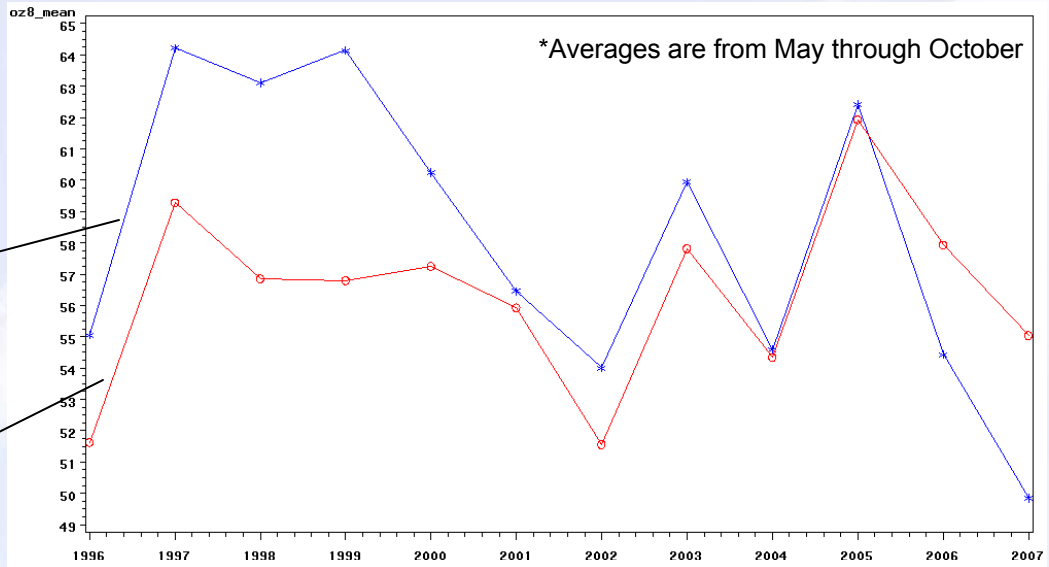
# Meteorologically-Adjusted Ozone Analysis from UT

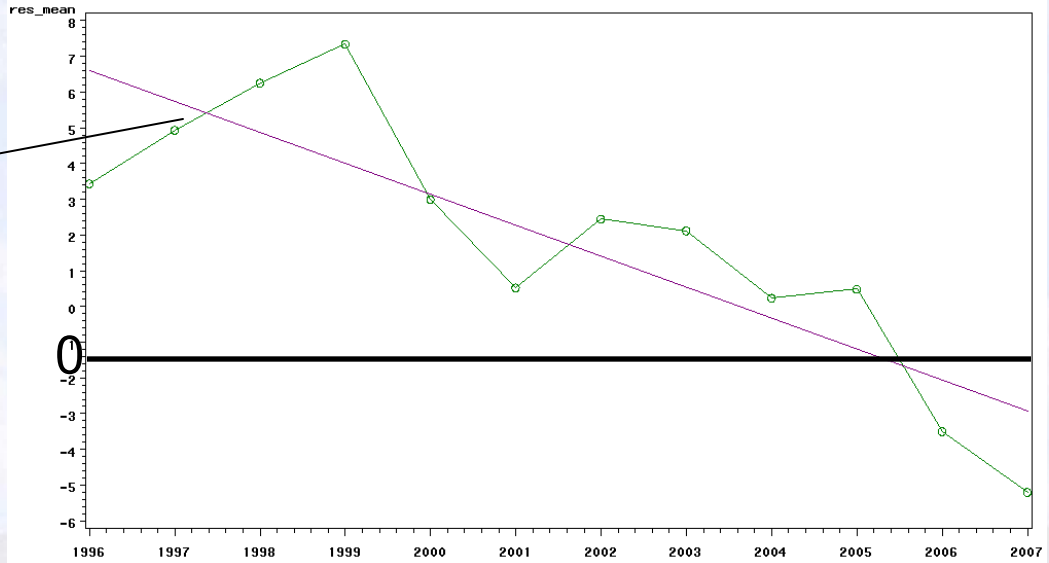
Since 1999, met adjusted ozone has dropped considerably.

Average peak daily ozone **(MEASURED)**

Average peak daily ozone attributable to meteorology alone **(PREDICTED)**

Meteorology-corrected ozone trend **(DIFFERENCE)**



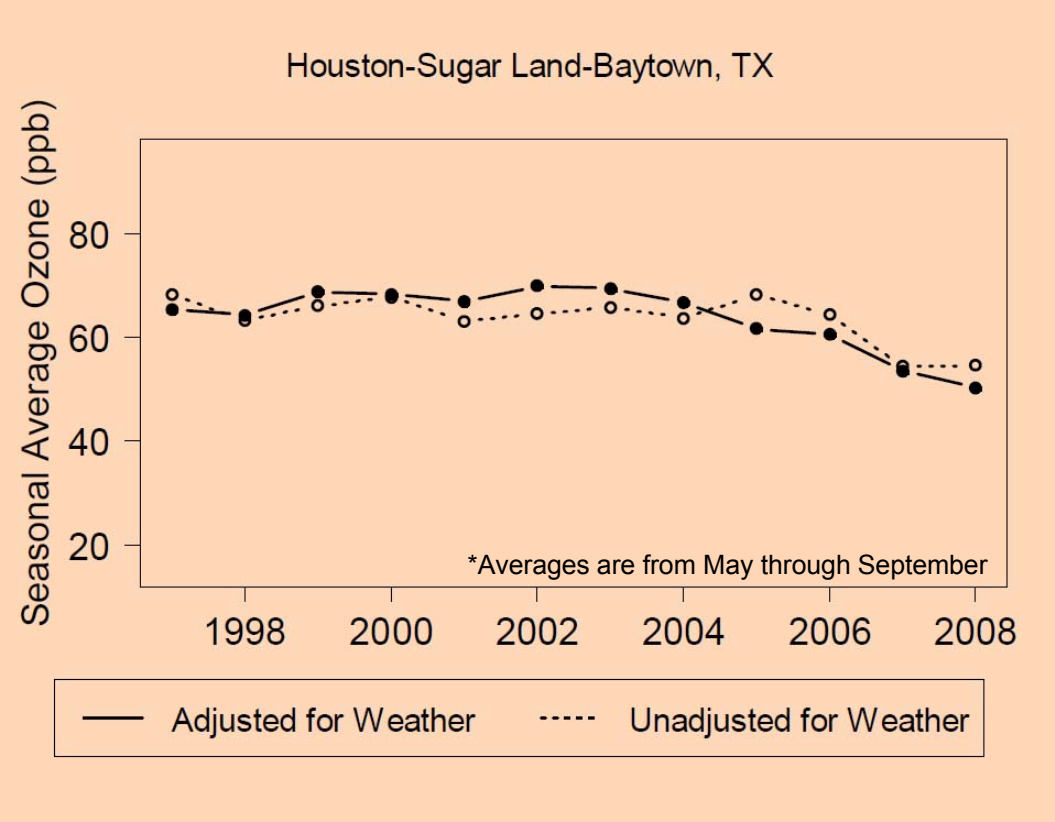

**Source**: Sullivan et al., 2009

**Parameter estimates for meteorologically-adjusted ozone trends, 1996-2007**

| Parameter | Value | t-stat |
|---|---|---|
| Intercept | 6.438 | |
| Slope | -0.86* | -4.20 |
| p-value | 0.00 | |
| lag 1 coefficient | -0.20 | -0.63 |

* Value is statistically significant. (Sullivan et al., 2009)

# Meteorologically Adjusted Ozone Analysis from EPA

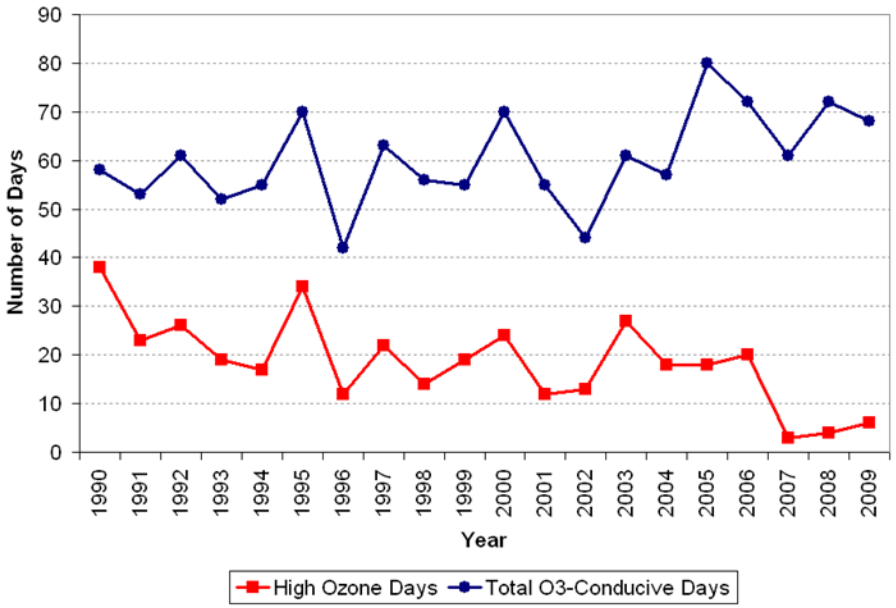



**Source**: EPA, www.epa.gov/airtrends/weather/region06.pdf

- Dotted line represents actual ozone trends.
- Solid line represents ozone trends expected under typical weather conditions.
- The trends adjusted for the weather show a downward trends since 2002.
- Ozone levels in 2008 were lower when adjusted for the weather.

# Ozone Conducive Day Analysis

Annual Number of O3-Conducive Days (OCDs) and the Number of OCDs with Max O3 > 84 ppb

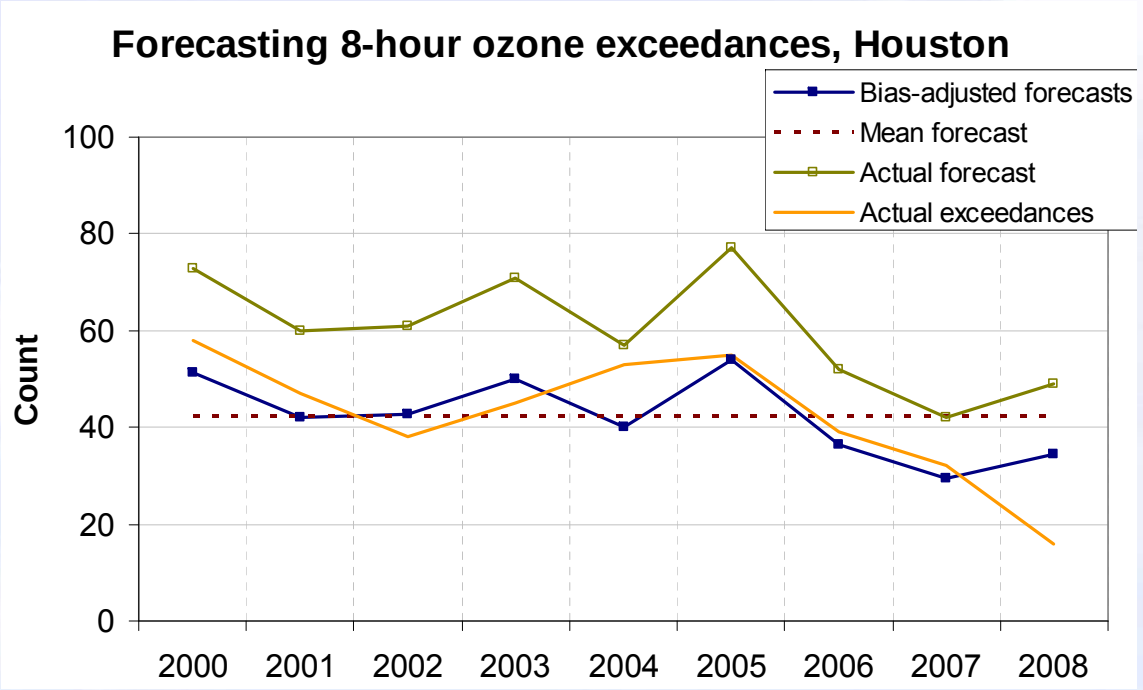



**Source**: URS Corporation

- Analysis uses a Classification and Regression Tree (CART) method to:
  - Classify ozone season days according to meteorological conditions, and
  - Determine whether those conditions are conducive to high ozone in Houston.
- Number of ozone conducive days is compared to the number of ozone exceedance days.
- The past three ozone seasons (2007, 2008, 2009) appear to be just as conducive to high ozone formation as previous years.
- Since 2005, there appear to be more ozone-conducive days, but fewer eight-hour ozone exceedance days.
- 2005 had the largest number of ozone-conducive days since 1990, but there were fewer exceedance days in 2005 than during previous years with a lower number of ozone-conducive days (1995, 2000, 2003).

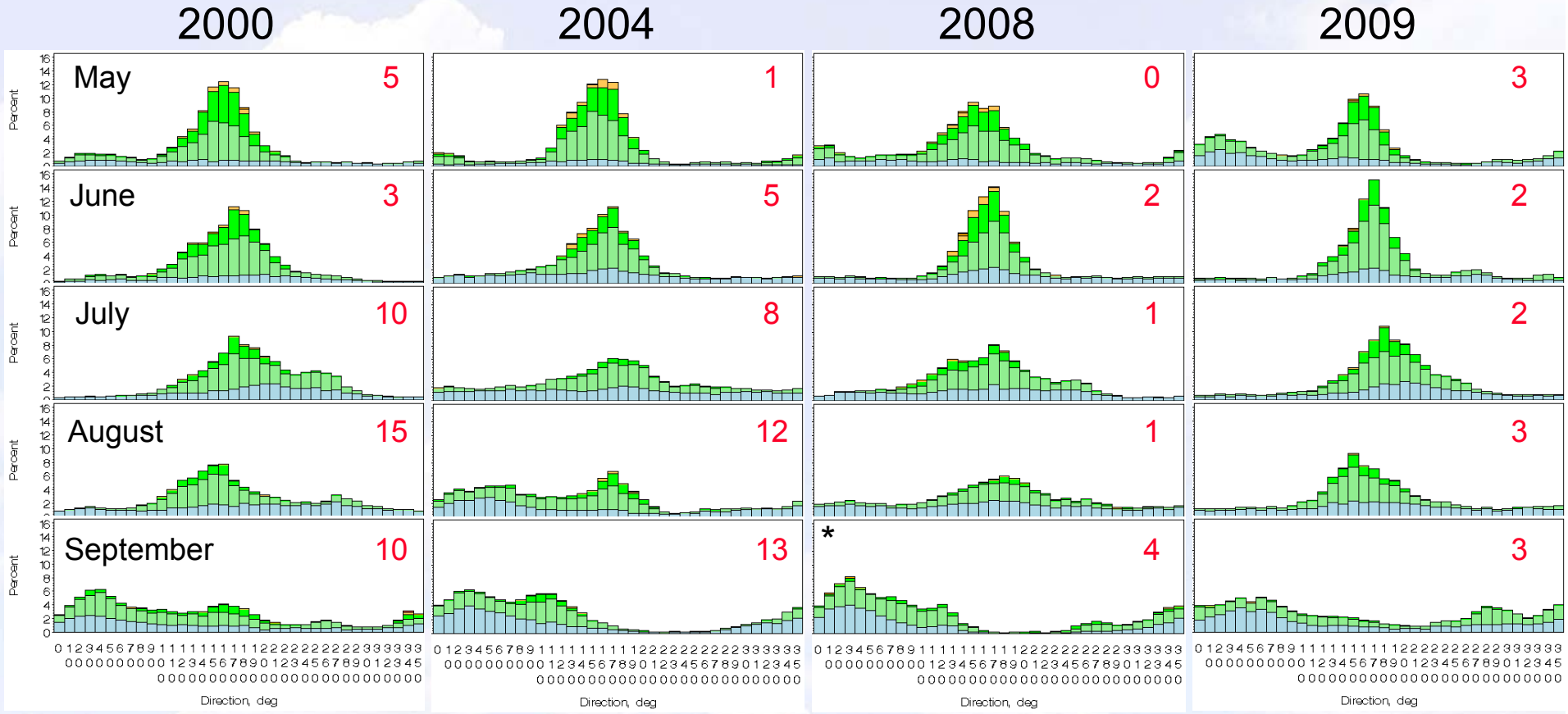
# Forecasted Ozone Exceedance Days

- The number of TCEQ-forecasted eight-hour ozone exceedance days is used as a surrogate for the number of ozone-conducive days.
- To adjust for the bias in forecasted ozone days, the average percent of false negative days was added to the number of forecasted ozone exceedance days, and the average percent of false positive days was subtracted.
- The 2008 bias-adjusted forecast of ozone exceedance days was much higher than the actual number of eight-hour ozone exceedance days – indicates decreases due to factors other than meteorology.
- The number of forecasted ozone days in 2008 approximately matched the number in 2006, but there were about half as many actual exceedance days in 2008 as in 2006.
- Although there are uncertainties in this analysis, it is consistent with previous analysis.



# Wind Speed and Direction

## Eight-Hour Ozone Exceedance Days (≥ 85 ppb) in Red




## Winds are from 05:00 to 19:00 LST

Wind Speed, mph

< 5 | 5 - 10 | 10 - 15 | 15 - 20 | 20 - 25 | > 25

*September winds incomplete due to the passage of hurricane Ike.

# Wind Speed and Direction

- May 2000 and 2004 were less conducive to ozone formation based upon wind speeds but had more exceedances than May 2008 and 2009.
- May 2009 was more conducive based upon wind direction yet had fewer exceedances than May 2000 or 2004.
- For all years, June was dominated by southerly winds, which are not conducive to ozone formation. The low number of exceedances each year reflects how unfavorable southerly winds are to ozone exceedances; therefore, the slightly greater frequency of high winds in June 2008 was unlikely to affect the number of exceedances in that month.
- July winds were very similar in 2000 and 2009, but there were only two exceedance days in July 2009 compared to 10 exceedance days in July 2000.
- August 2008 was more conducive to high ozone than August 2000, based upon wind speeds, but had far fewer exceedances.
- September 2009 was more conducive to high ozone, but had far fewer exceedances than September 2000 or 2004.

# Summary

- Evidence provided in the proposed attainment demonstration SIP revision, along with additional analyses presented, show that favorable meteorology is not adequate to explain the decreases in ozone observed in 2007, 2008, and 2009.
  - Ozone concentrations continue to decrease, even when adjusted for meteorology
  - The number of ozone conducive days appears to be higher, while the number of ozone exceedances continues to decrease
  - The number of exceedance days in 2008 were lower than what was forecasted
  - High winds from the past few seasons occur in months which do not typically observe the highest ozone concentrations.
- Evidence presented in Chapter 5: *Weight of Evidence* of this attainment demonstration SIP revision shows that decreases in ozone precursor emissions played a significant role in the recent decreases in ozone.