



HGB Ozone Trend

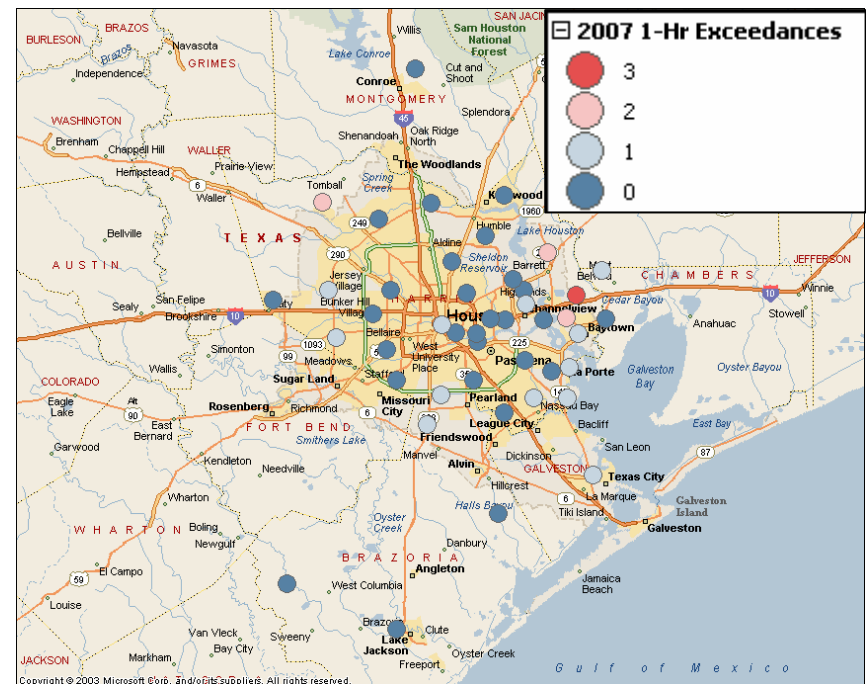
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Objective

- To evaluate whether ozone levels would have improved much from 2006 to 2007 if not for the mild temperatures and wet weather we had during this past summer
- Focus is on 8-hr averages but note how close 2007 1-hr levels came to achieving the modeled prediction of attainment – 40 of 44 monitors had ≤ 1 exceedance

1-Hr Exceedance Days for 2007



Approach (1 of 3)

- Define **ozone conducive day** in terms of routinely monitored weather variables
- Identify ozone conducive days during 1990-2007
- Determine how many ozone conducive days occurred in each year (***N***) and how many of them had 8-hr ozone > 84 ppb (***O***)
- Examine trend in $O \div N$, i.e., the fraction (or percentage) of ozone conducive days that had high ozone
- TCEQ performed a similar analysis in mid 1990s, using ozone forecast criteria to define ozone conducive day

Approach (2 of 3)

- **Classification and Regression Tree (CART)** used to define ozone conducive day
 - Multivariate data analysis technique
 - Splits dataset into groups of days based on a set of **predictor variables** (weather conditions)
 - CART software optimizes splits based on apparent relationships of the predictor variables to the **target variable** (ozone)
 - Output is binary tree with nodes representing groups of days that are each described by a unique set of weather conditions
 - Ozone conducive days are defined by the node having:
 - 1) The greatest number of high ozone days
 - 2) The greatest percentage of days in the node which have high ozone

Approach (3 of 3)

- CART analysis was performed for HRM near the end of the 2005 ozone season
 - Used surface weather conditions at HRM 1 and upper level data from the nearest NWS upper air station (Lake Charles)
 - Used ozone measurements from the HRM network
 - Used time series from January 1990 – October 2005
 - Results showed a downward trend in the fraction of ozone conducive days that had ozone greater than 124 ppb 1-hr max or 84 ppb 8-hr max in the HRM network
- CART analysis was updated for HRM in October 2007 without rerunning CART
 - Analyzed 2006 and 2007 HRM data using the earlier definition of ozone conducive days

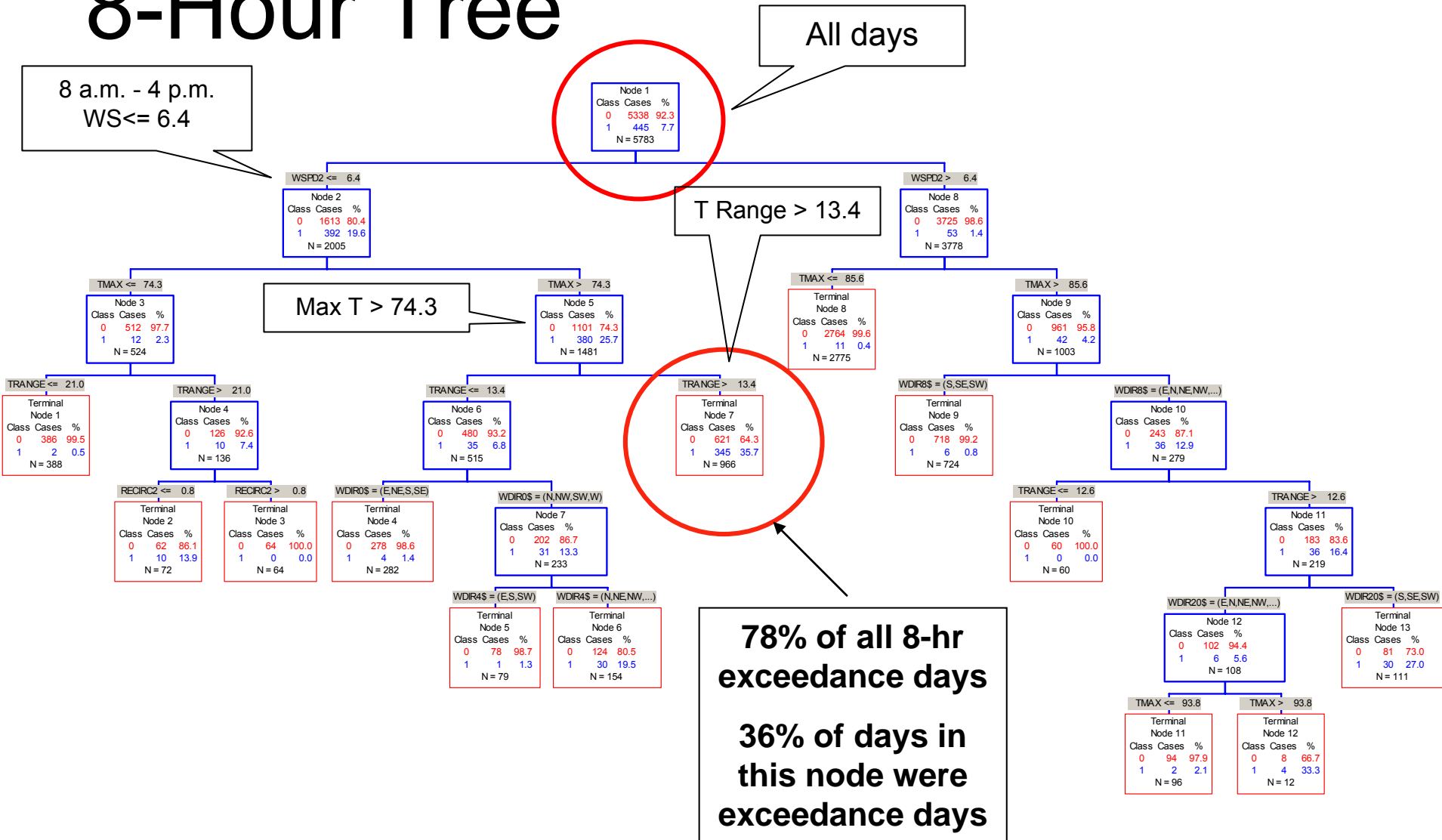
Weather Variables Used in CART Analysis

- Daily max temperature
- Daily min temperature
- Daily temperature range
- Average wind speed
 - 3 8-hour blocks
- Average wind direction
 - 6 4-hour blocks
- Recirculation factor
 - Vector WS/Scalar WS
 - 3 8-hour blocks
- Net Radiation
 - Daily max hourly average
- Rainfall
 - Daily max hourly total
- Upper level winds and surface heights from the Lake Charles NWS station

8-Hour Tree

8 a.m. - 4 p.m.
WS ≤ 6.4

All days



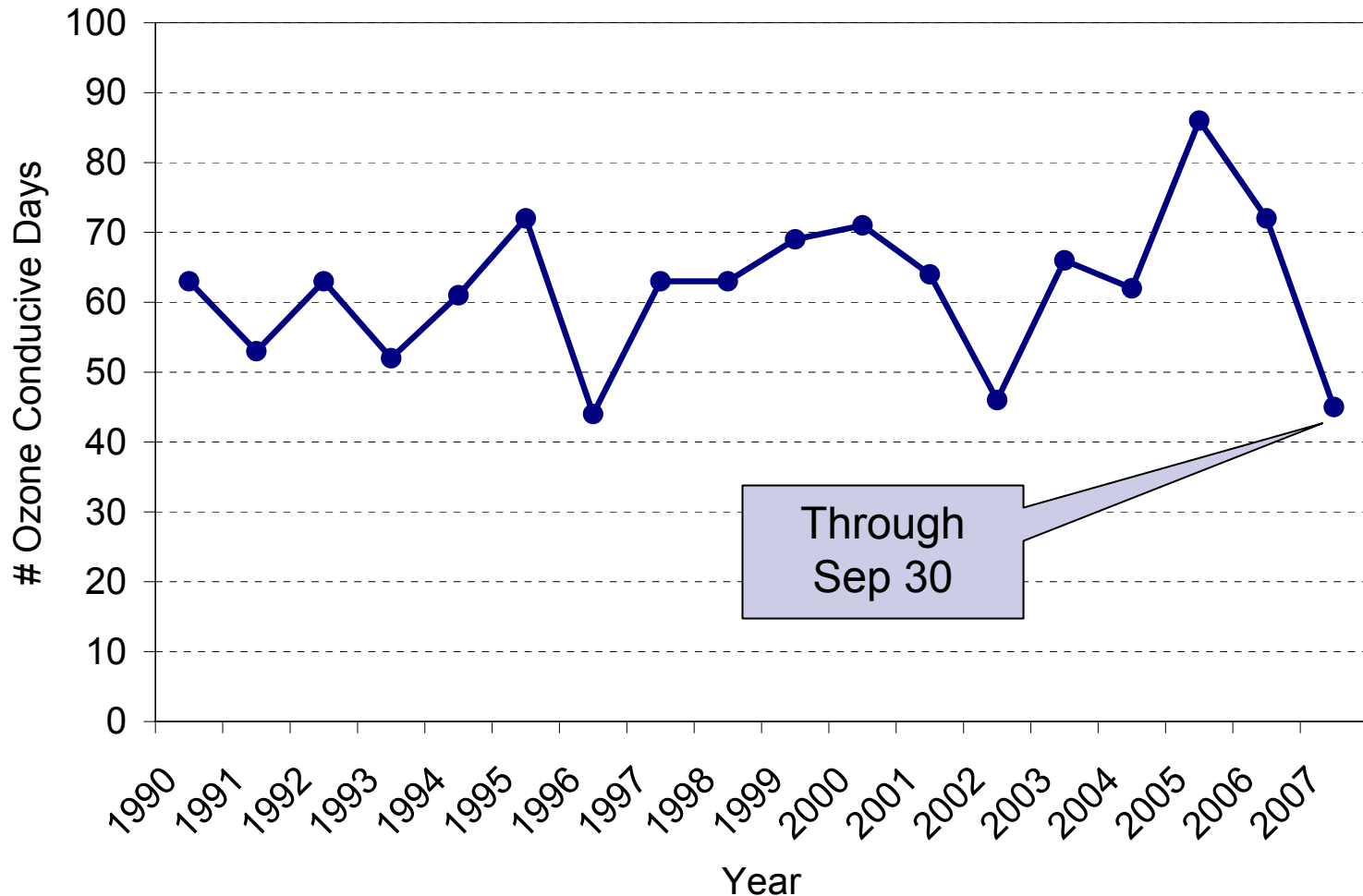
8-Hour Splitter Variables and Criteria

- 8 a.m. – 4 p.m. average wind speed less than 6.4 mph
- Maximum temperature greater than 74.3 degrees
- Temperature range greater than 13.4 degrees

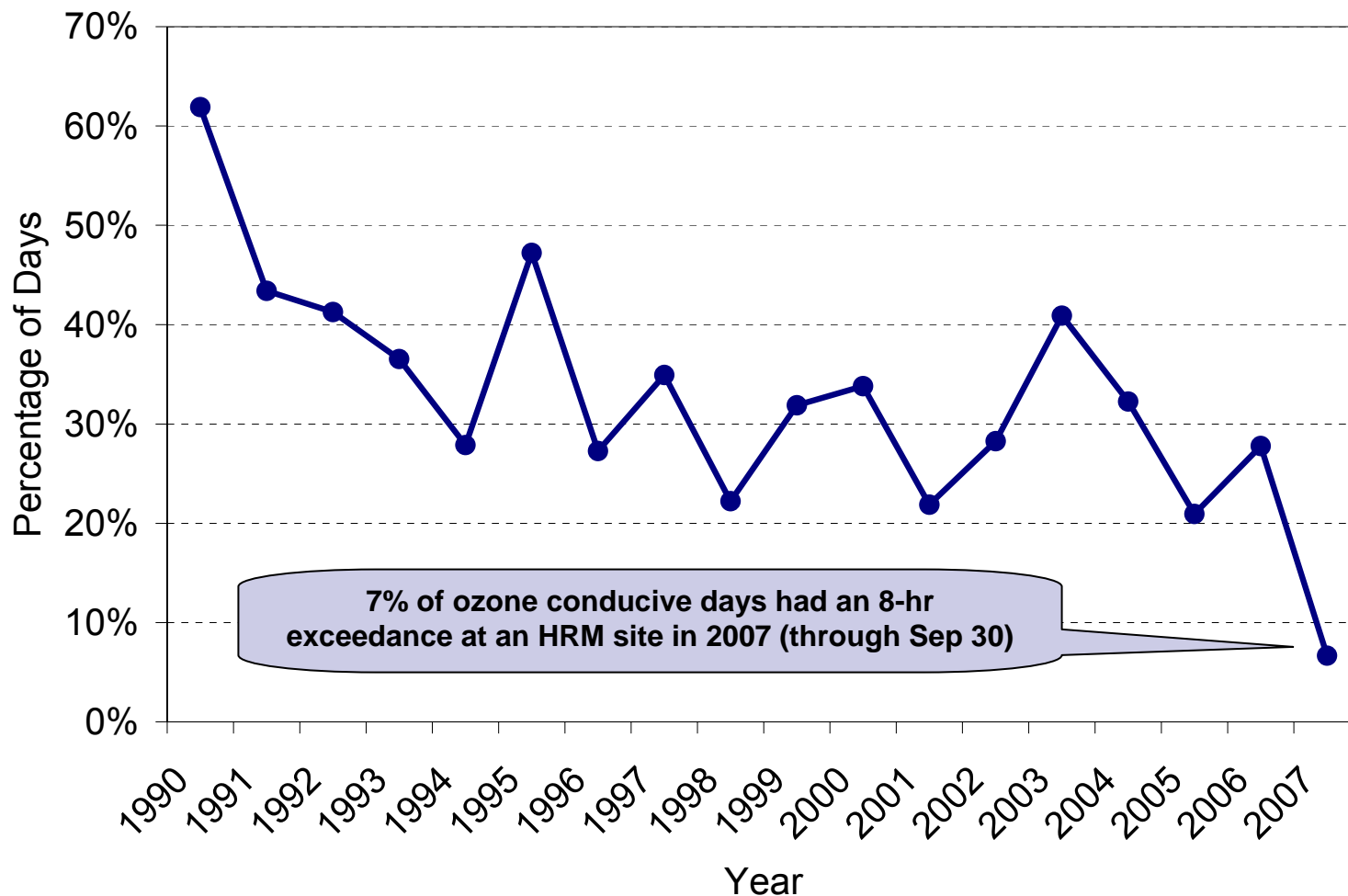
- 78% of all 8-hr ex days in the HRM network had these conditions
- 36% of days having these weather conditions were HRM 8-hr exceedance days

- ❖ How did this percentage change from year to year?

Annual Number of Ozone Conducive Days (through Sep 2007)



Annual Percentage of Ozone Conducive Days with 8-Hr Exceedances in the HRM Network (through Sep 2007)

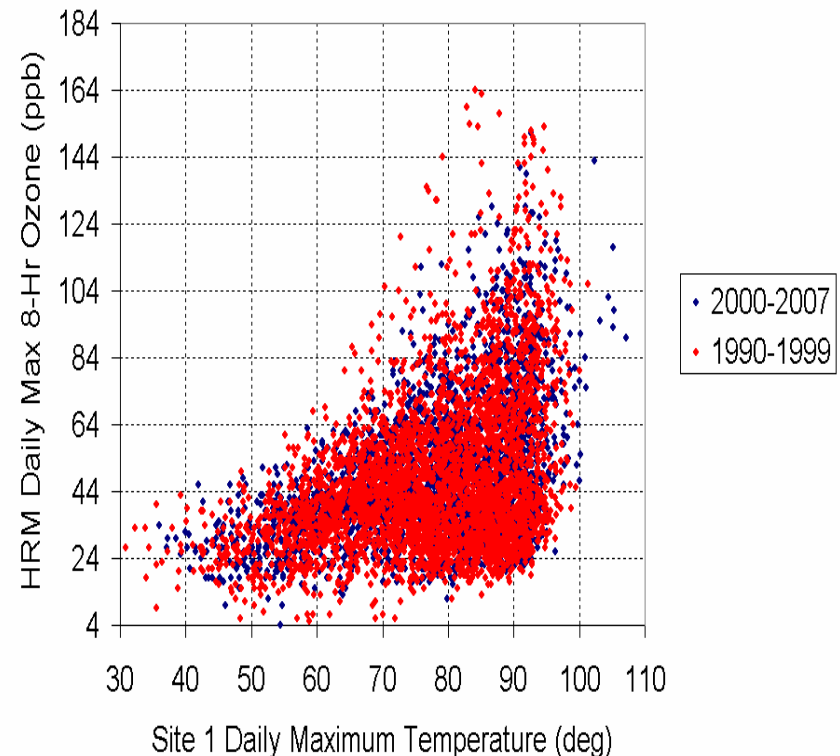


Caveats

- Broad definition of ozone conducive day draws in many days that did not have high ozone (64% over the long term)
- CART did not detect rainfall as a significant variable (2007 rainfall not addressed in this analysis)
- Just HRM sites taken into account

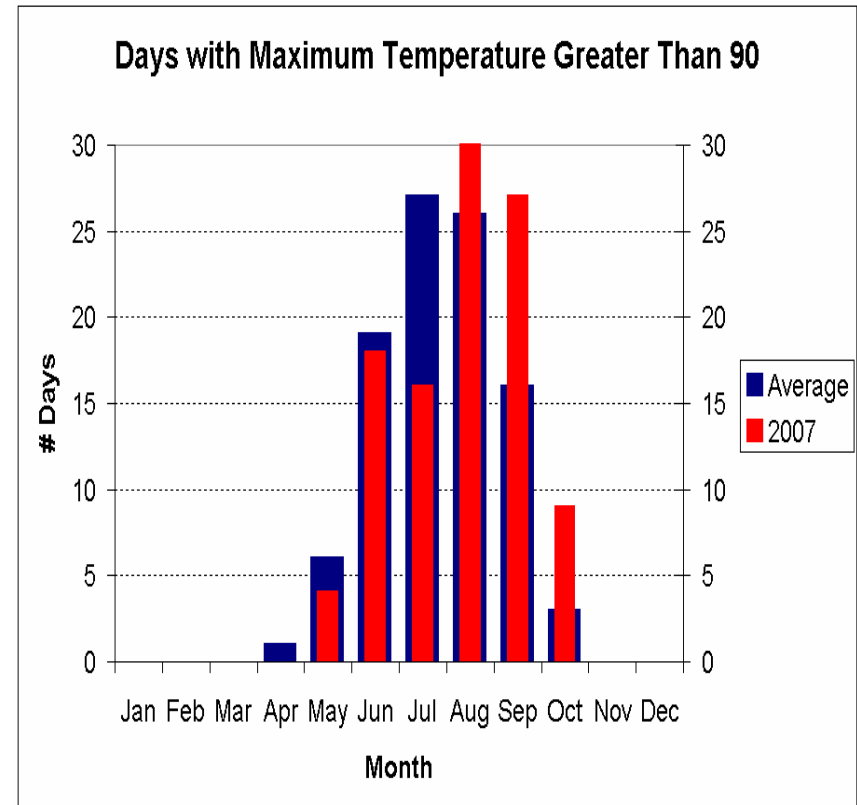
Caveat 1: Broad definition of ozone conducive day

- Higher temperatures usually found on high ozone days during 2000-2007 compared with the 1990s
- Criteria for ozone conducive day has become more exclusive – shows that air quality improvements have been made independently of weather
- Reanalysis focusing just on more recent data may produce a higher temperature split and have a better signal/noise ratio



Monthly # Days with Max Temperature > 90 Degrees at Intercontinental Airport

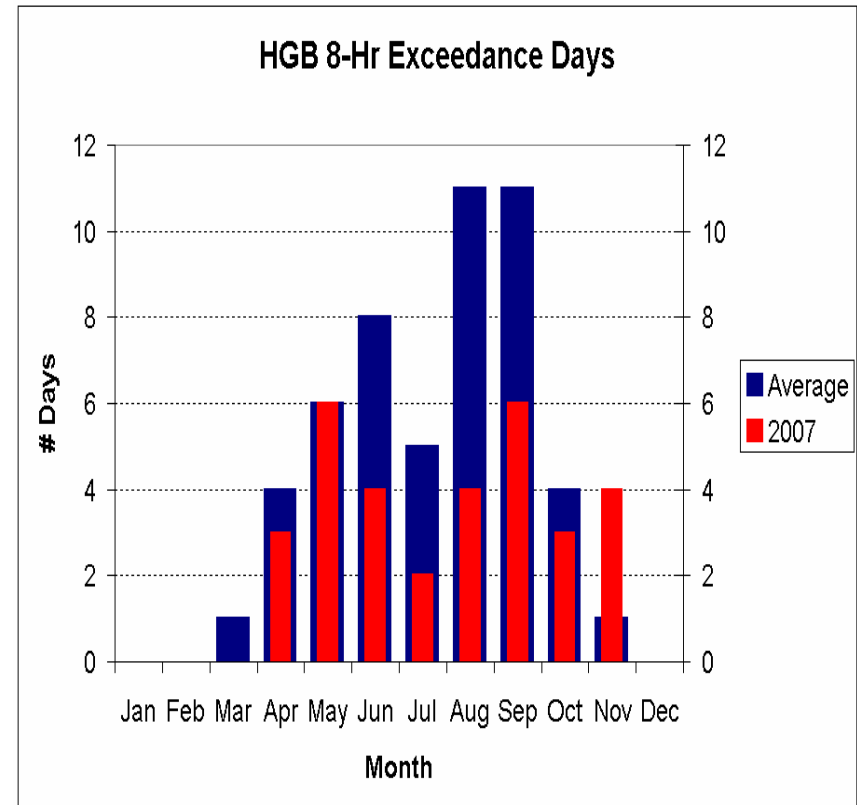
- August, September, and October 2007 had above normal number of days with maximum temperature above 90 degrees
- July was the only month with significantly fewer than normal 90 degree days
- July typically has few high ozone days compared with other summer months (next slide)



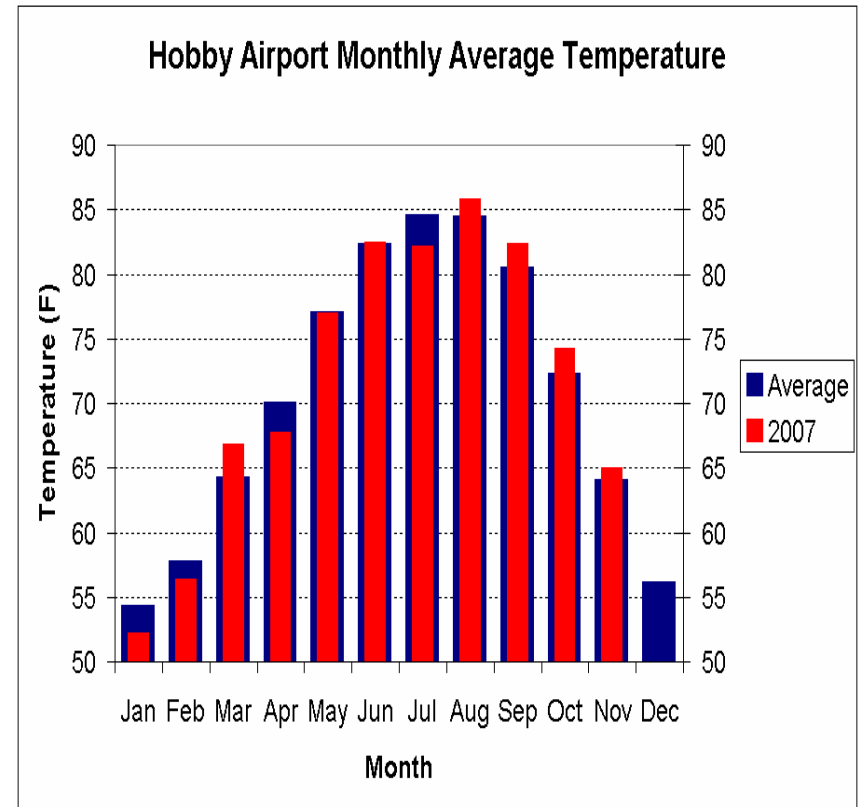
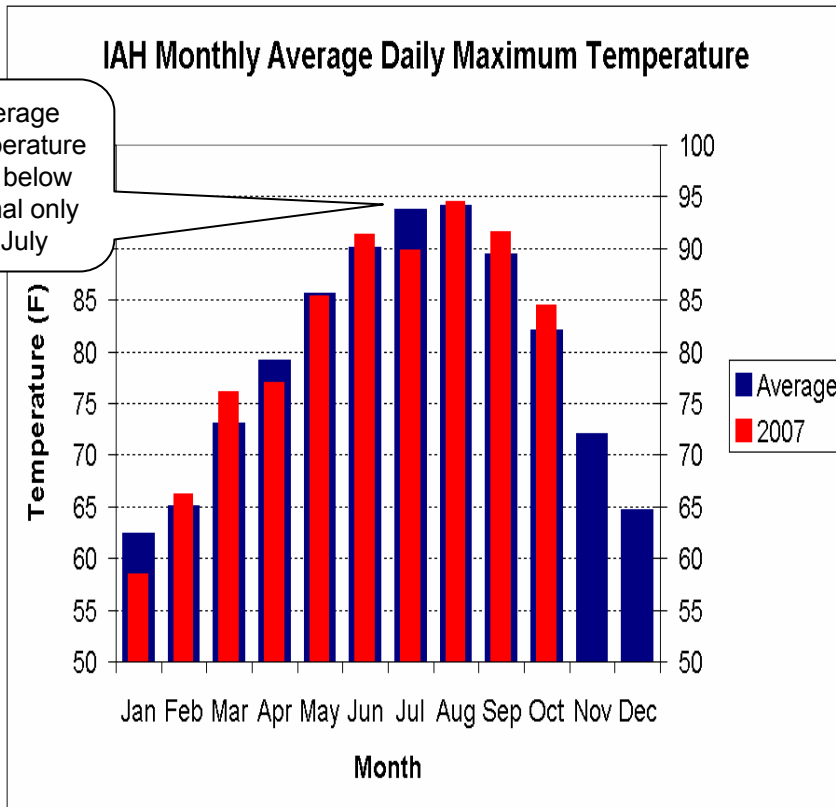
Source: Preliminary Climatology Data. Published online by the National Weather Service.
<http://www.weather.gov/climate/index.php?wfo=hgx>

Monthly 8-Hr Exceedance Days in HGB

- July typically has few high ozone days compared with other summer months
- 2007 had fewer than average 8-hr exceedance days during June-October
- Only July had below average temperatures



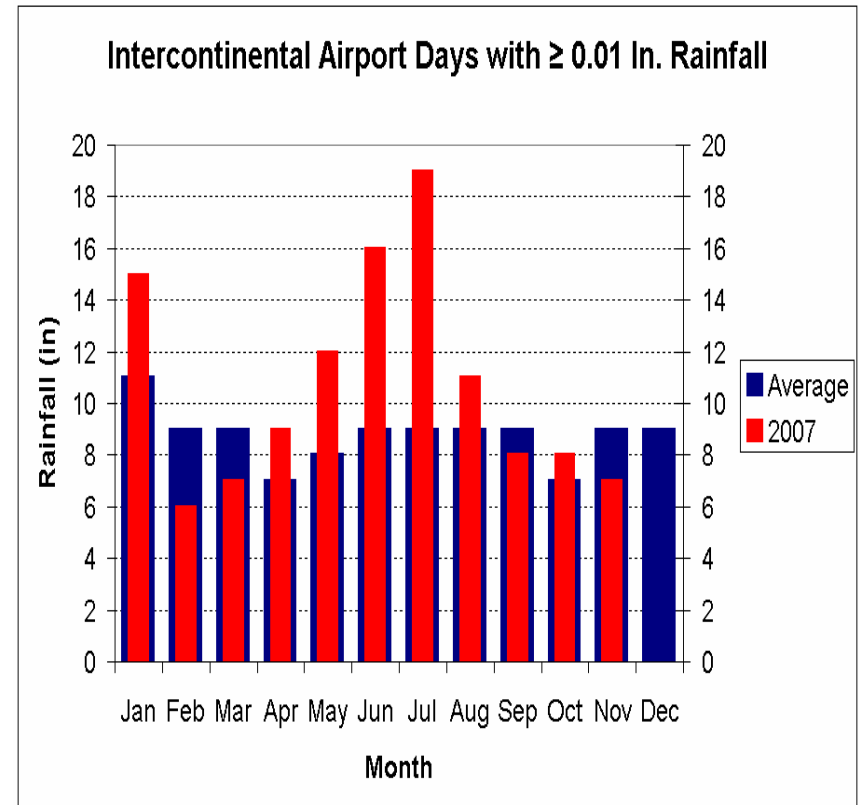
Monthly Average Temperature



Source: Preliminary Climatology Data. Published online by the National Weather Service.
<http://www.weather.gov/climate/index.php?wfo=hgx>

Caveat 2: CART Reanalysis did not take account of 2007 above average rainfall

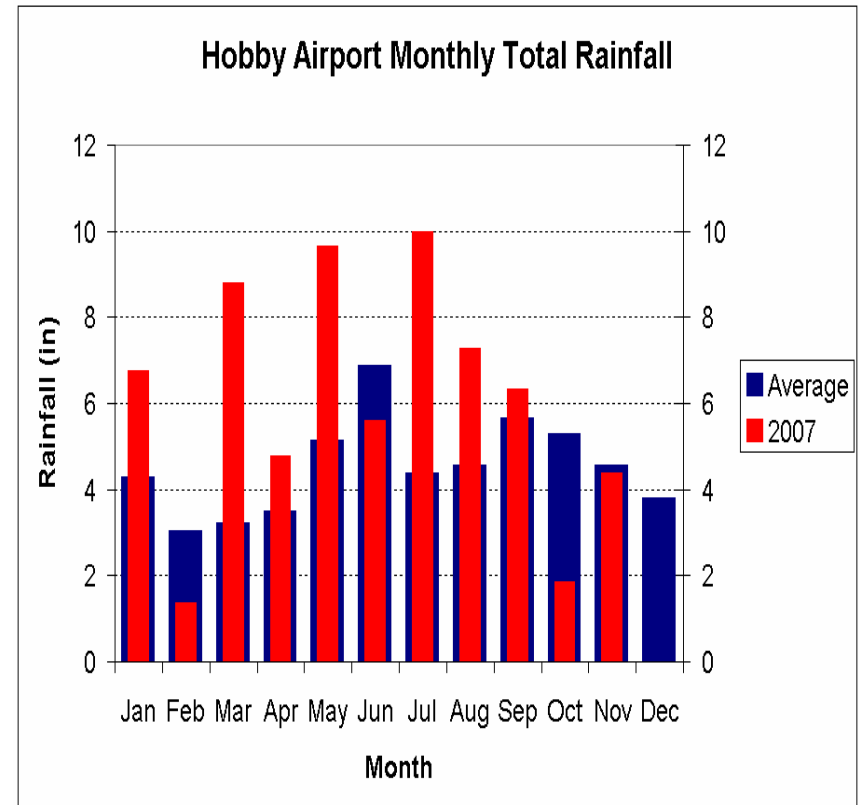
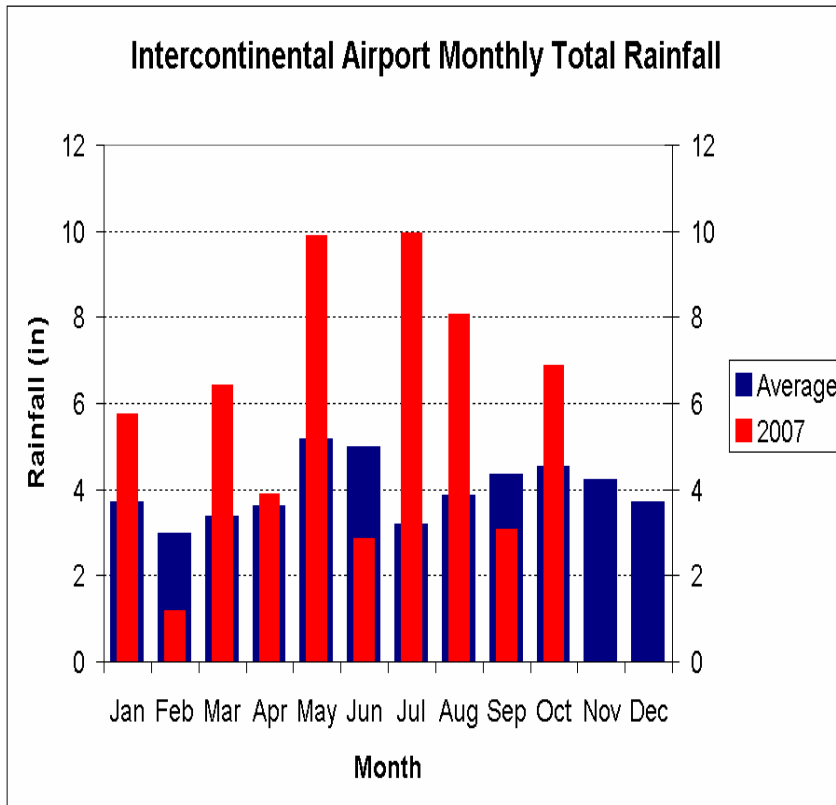
- # of days with rainfall ≥ 0.01 in. was above normal during April-August but near normal during September and October
- Greatest departure from normal was in July
- Significance of 0.01 in. rainfall is unclear
 - 4 of 7 ozone conducive days in June had rainfall ≥ 0.01 in. at either IAH or HOU
 - 2 of the 4 were HGB 8-hour exceedance days
- Only 4 of 45 ozone conducive days in 2007 (Jan-Sep) had ≥ 0.1 in. rainfall at any HRM site



Source: Preliminary Climatology Data. Published online by the National Weather Service.
<http://www.weather.gov/climate/index.php?wfo=hgx>

Total Monthly Rainfall

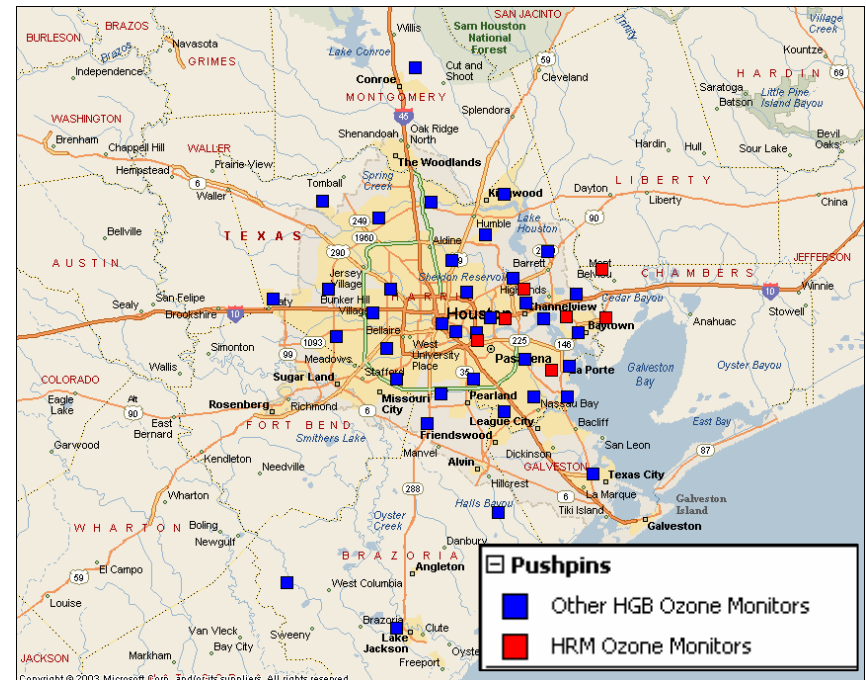
Note that total rainfall was actually below normal in June and about average in September



Source: Preliminary Climatology Data. Published online by the National Weather Service.
<http://www.weather.gov/climate/index.php?wfo=hgx>

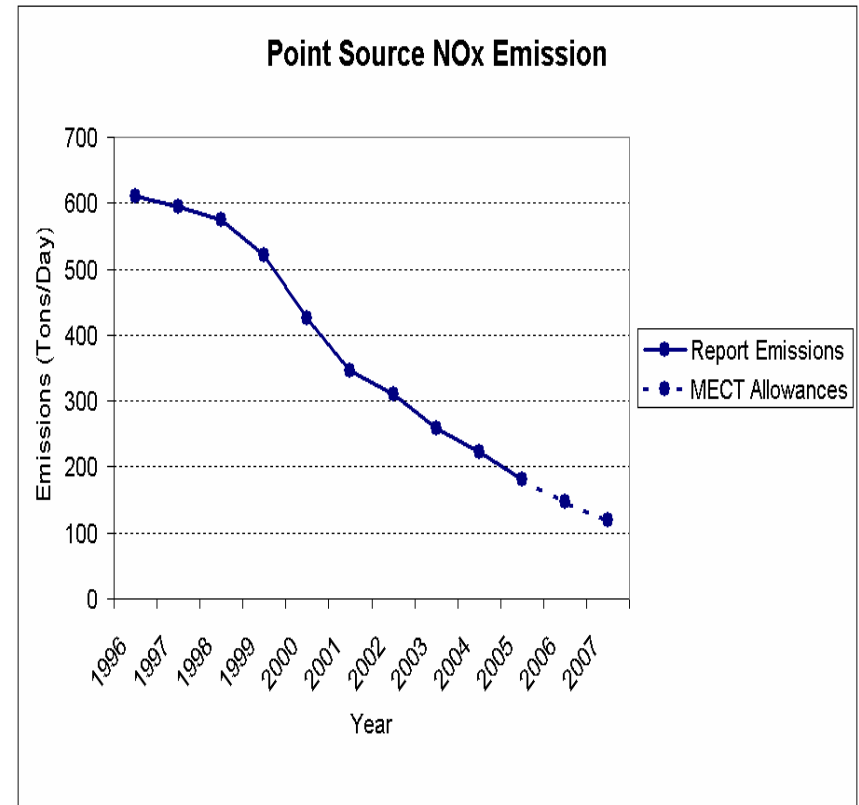
Caveat 3: Analysis only considers HRM monitors

- HRM sites are concentrated near the Houston Ship Channel
- Possible that other subregions of the HGB may have different ozone conducive days and trends
 - wind direction may also be a greater factor in other subregions

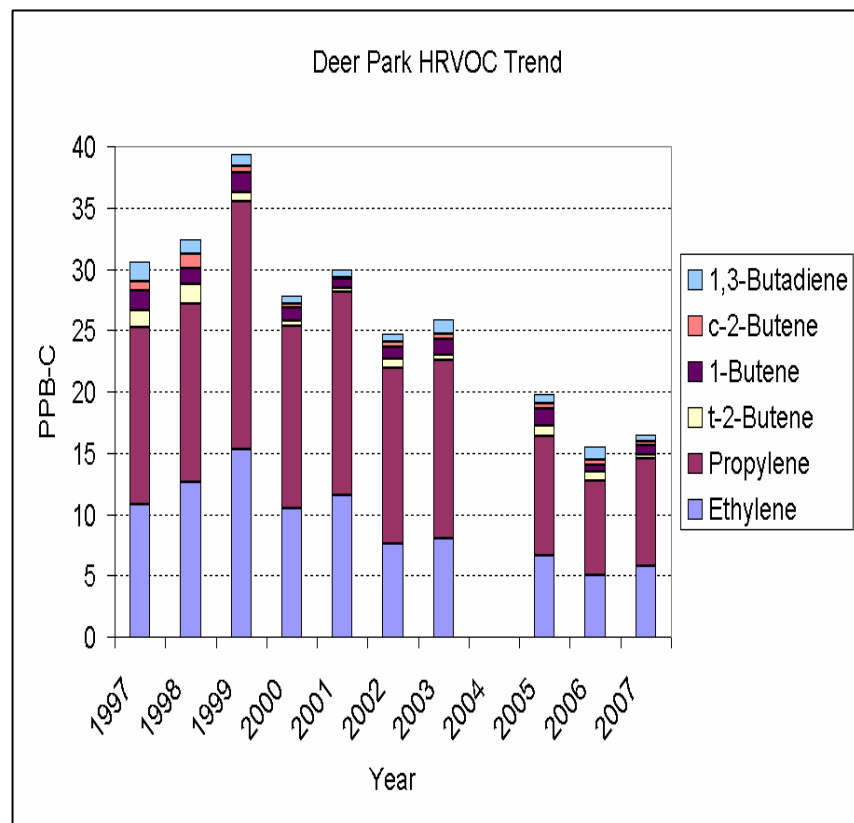
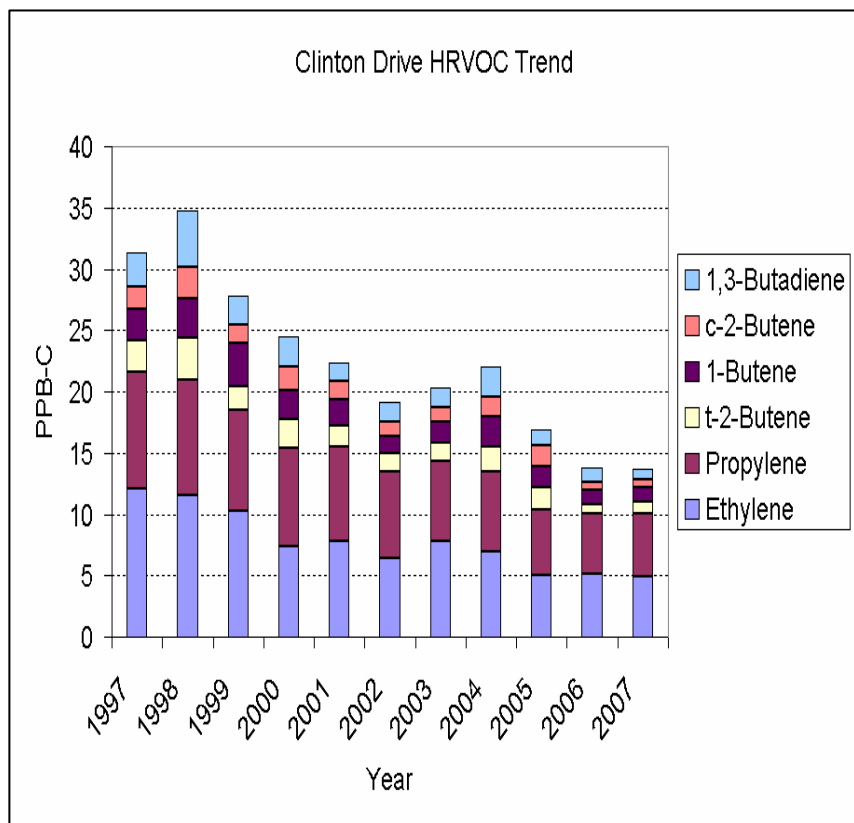


Other Factors

- 1-hr SIP provided for sufficient emission reductions to model attainment by 2007
- Reported point source NO_x emission were reduced by 70% in 2005 compared with 1996
 - Estimated reduction is 80% by 2007 based on MECT allowances

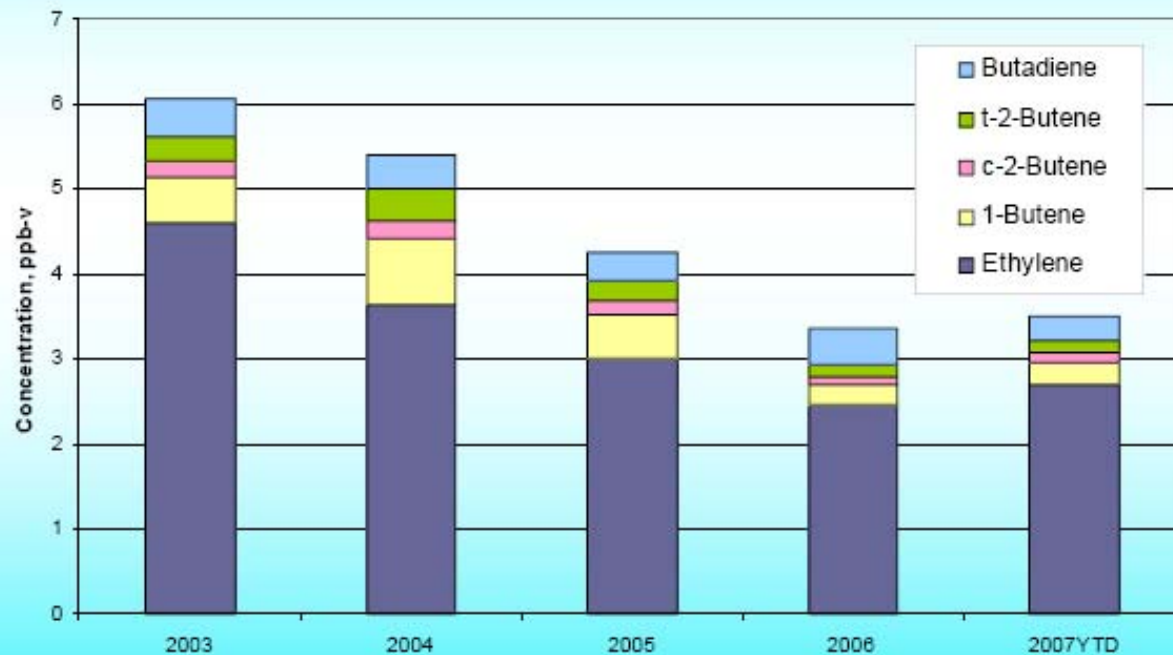


HRVOC Levels were Reduced by About 50% at TCEQ's Long-Term Monitors (through Nov 2007)



Total HRVOC Network Concentrations at Houston Ship Channel GC Monitors (June to November)

*2007 data is as of 11/7/2007



Houston Regional Monitoring



Conclusions

- 40 of 44 ozone monitors operating in HGB had ≤ 1 exceedance of the 1-hr standard in 2007
 - Nearly consistent with modeled predictions of attainment
- About half of all monitors now have 8-hour design values ≤ 84 ppb
- Point source NO_x emissions were reduced by 70-80% over the last decade
- Ambient HRVOC levels were reduced by about 50%
- Temperature was above normal most of the 2007 summer
- Rainfall was below normal in June 2007 and near or below normal in September 2007
- It appears likely that significant air quality improvements would have been achieved independent of the above average rainfall that persisted during other parts of the summer

