TCEQ

An Overview of NO_x and VOC Monitoring Data in Houston Area

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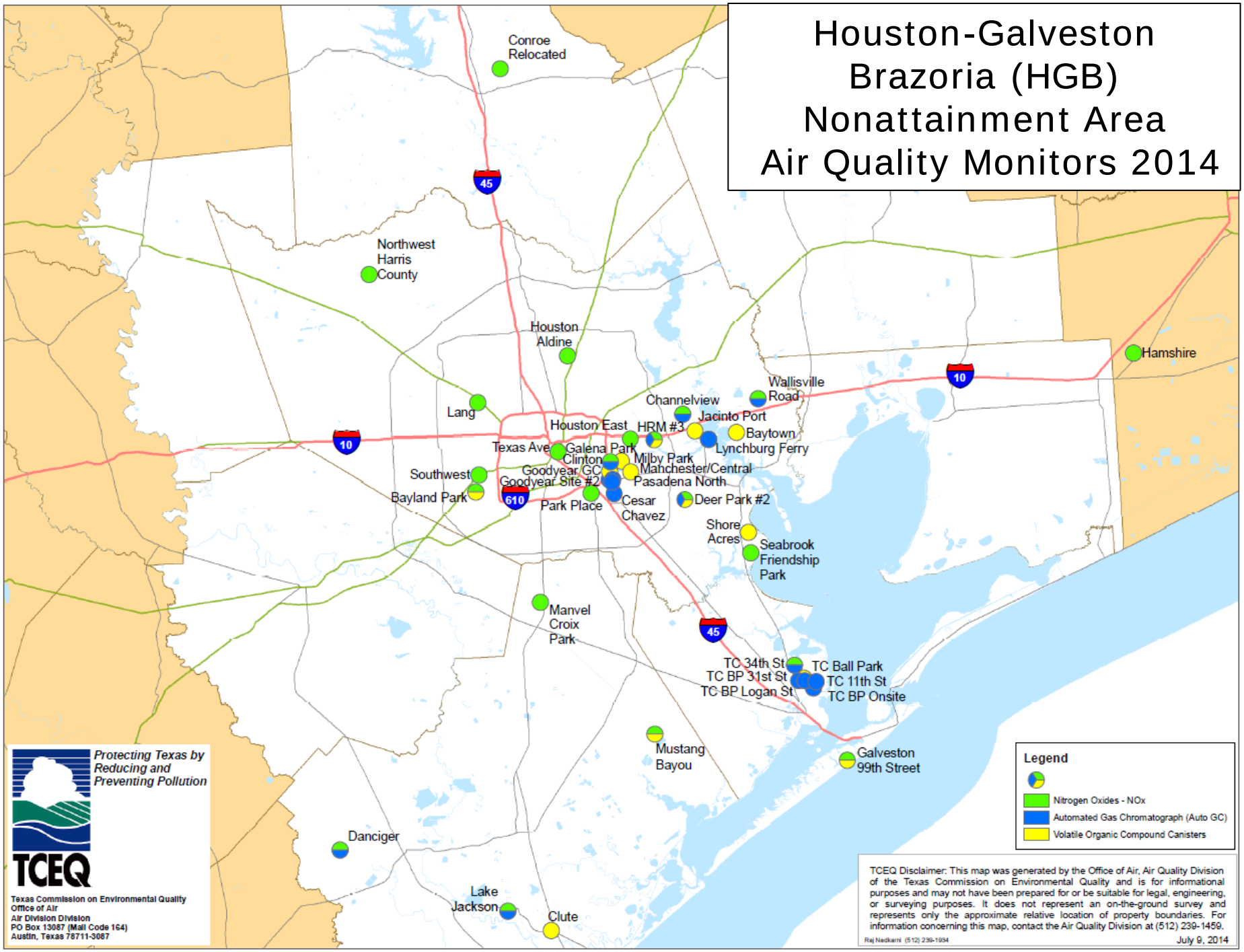
In this presentation

- NO_x
  - Qualitative and statistical evaluation of trends, including:
    - Overall concentration trends
    - Trends by wind direction at selected monitors
    - Trends by hour of day across the study period
- The same analyses performed for TNMOC and ethylene from VOC canisters, and TNMHC measurements from AutoGCs

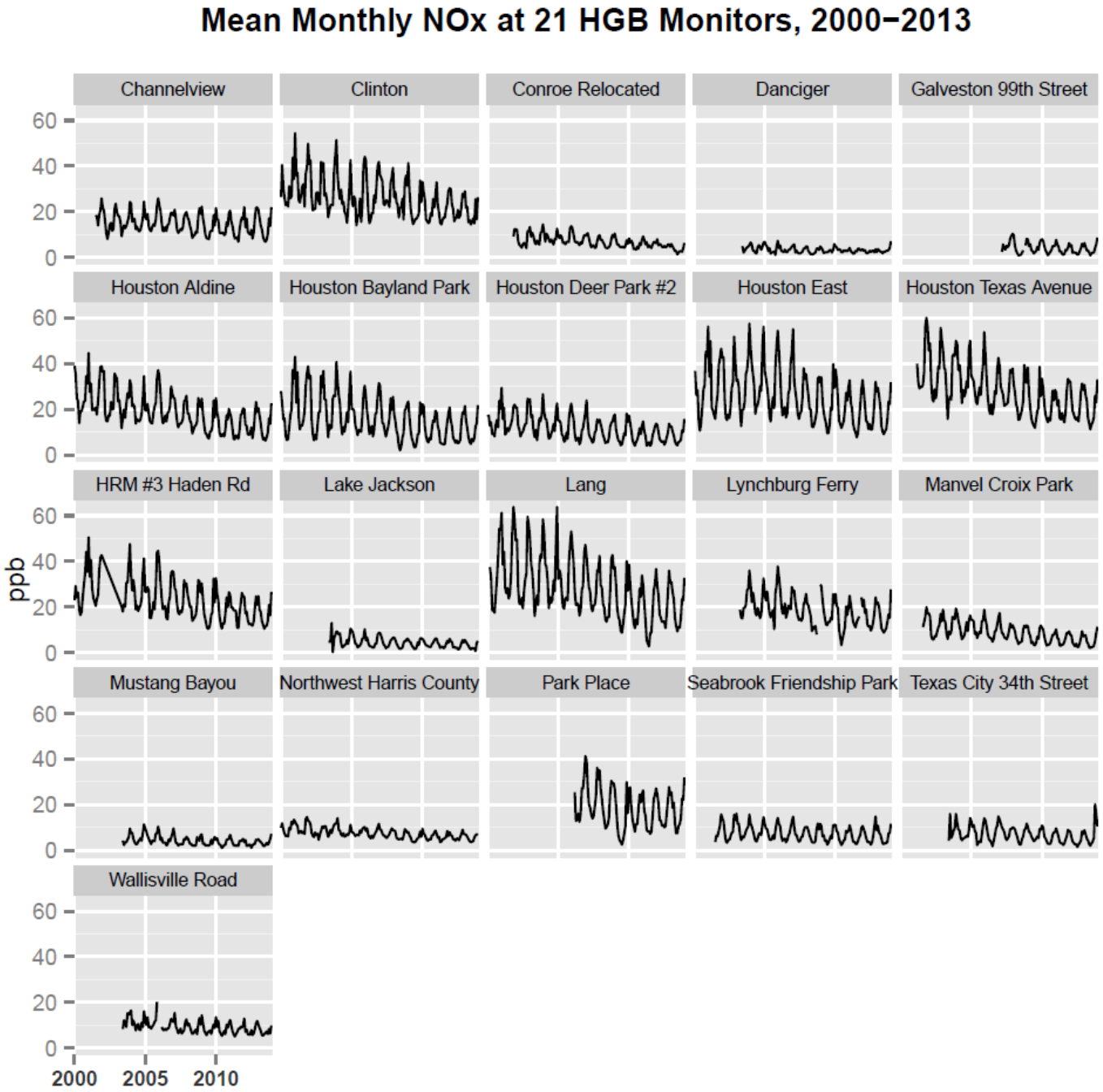
Houston-Galveston Brazoria (HGB) Nonattainment Area Air Quality Monitors 2014



1. NO_x

Seasonal trends are apparent at each of these monitors; NO_x is highest in winter, and lowest in summer.

It appears that most monitors show decreases from their start year to 2013.



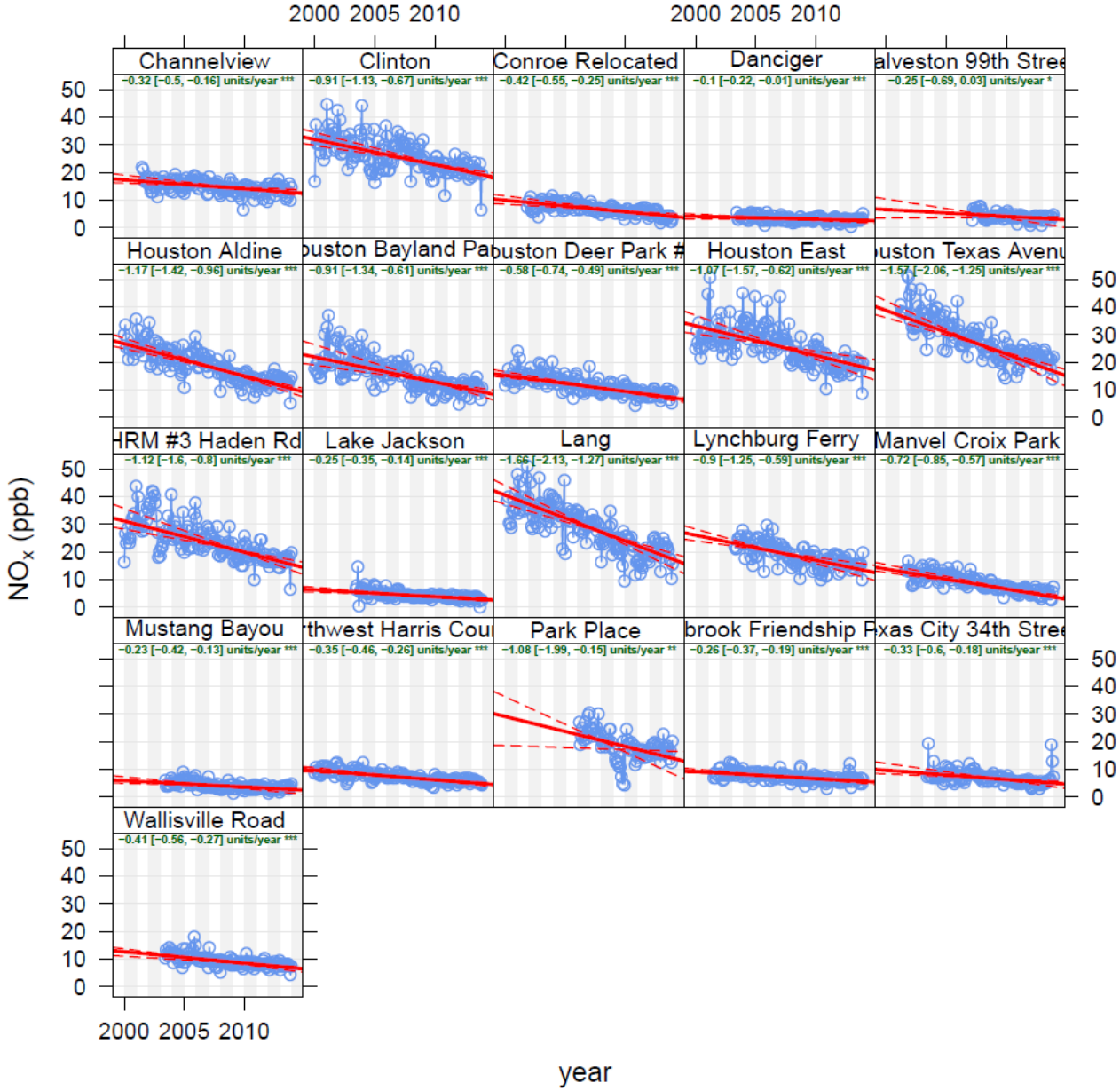
NO_x Statistical Trends Estimates at 21 Monitors

(Theil-Sen method)

In this slide, trends in the data seen in the previous slide are statistically estimated using the Theil-Sen method, with autocorrelation accounted for. Data are first "deseasonalized" (seasonal patterns are removed).

The trends estimates are depicted as solid red lines in each plot, with confidence intervals shown as dashed red lines.

All 21 of the monitors shown here had statistically significant decreases, with 19 having decreases significant at the .001 level. The decreases ranged from 0.1 ppb/yr to 1.66 ppb/yr; percent decreases ranged from 1.9 to 5.7% per year.



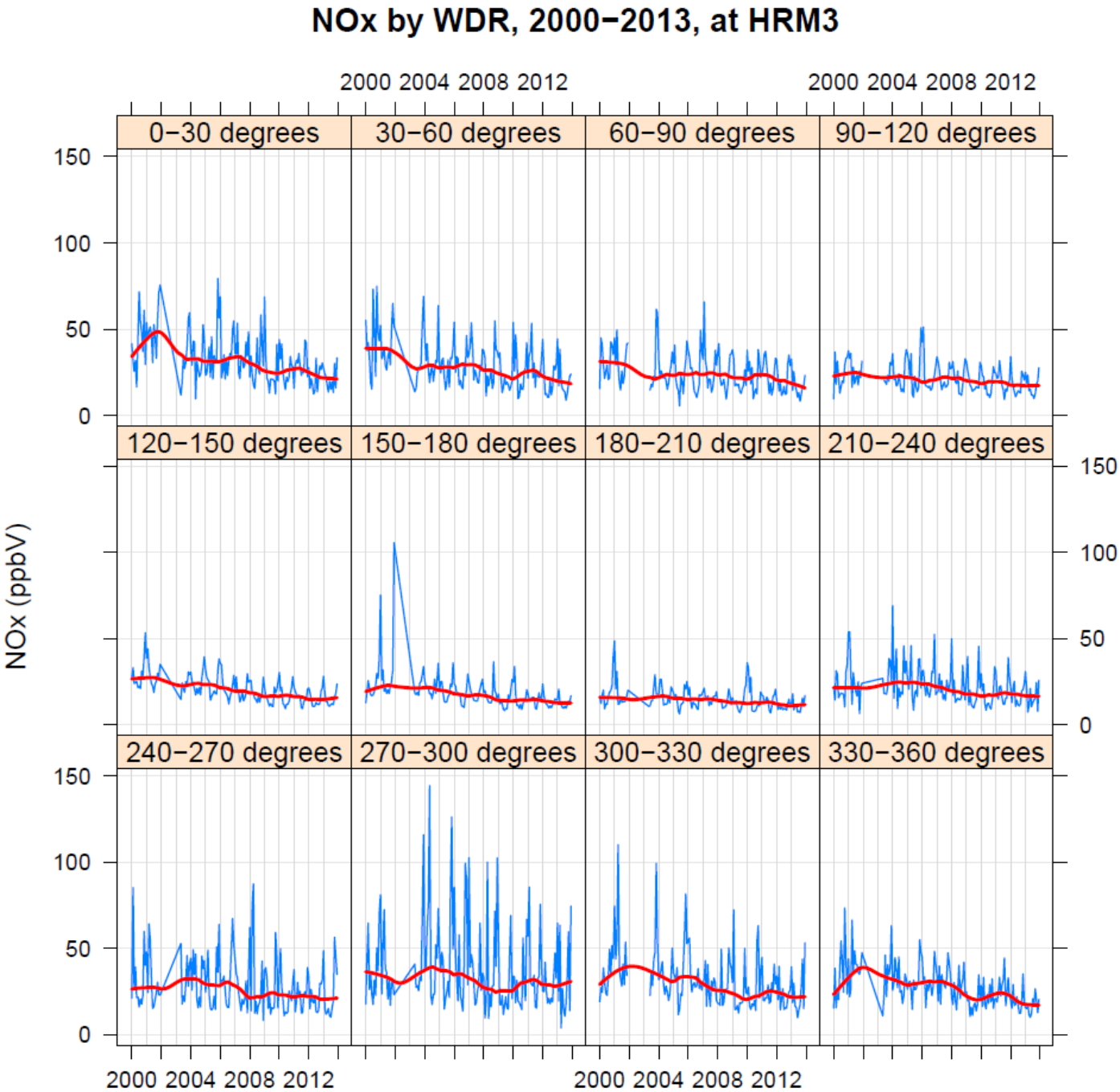
These are monthly mean NO_x concentrations by wind direction bin at HRM 3, a monitor located near IH-10 and the Ship Channel.

Concentrations are depicted as blue lines; the red lines represented a “smoothed” estimate of overall concentration with seasonality minimized.

The highest concentrations occur when winds are from northerly directions (0 – 60, and 270 – 360, degrees), which points to IH-10, as well as a railyard.

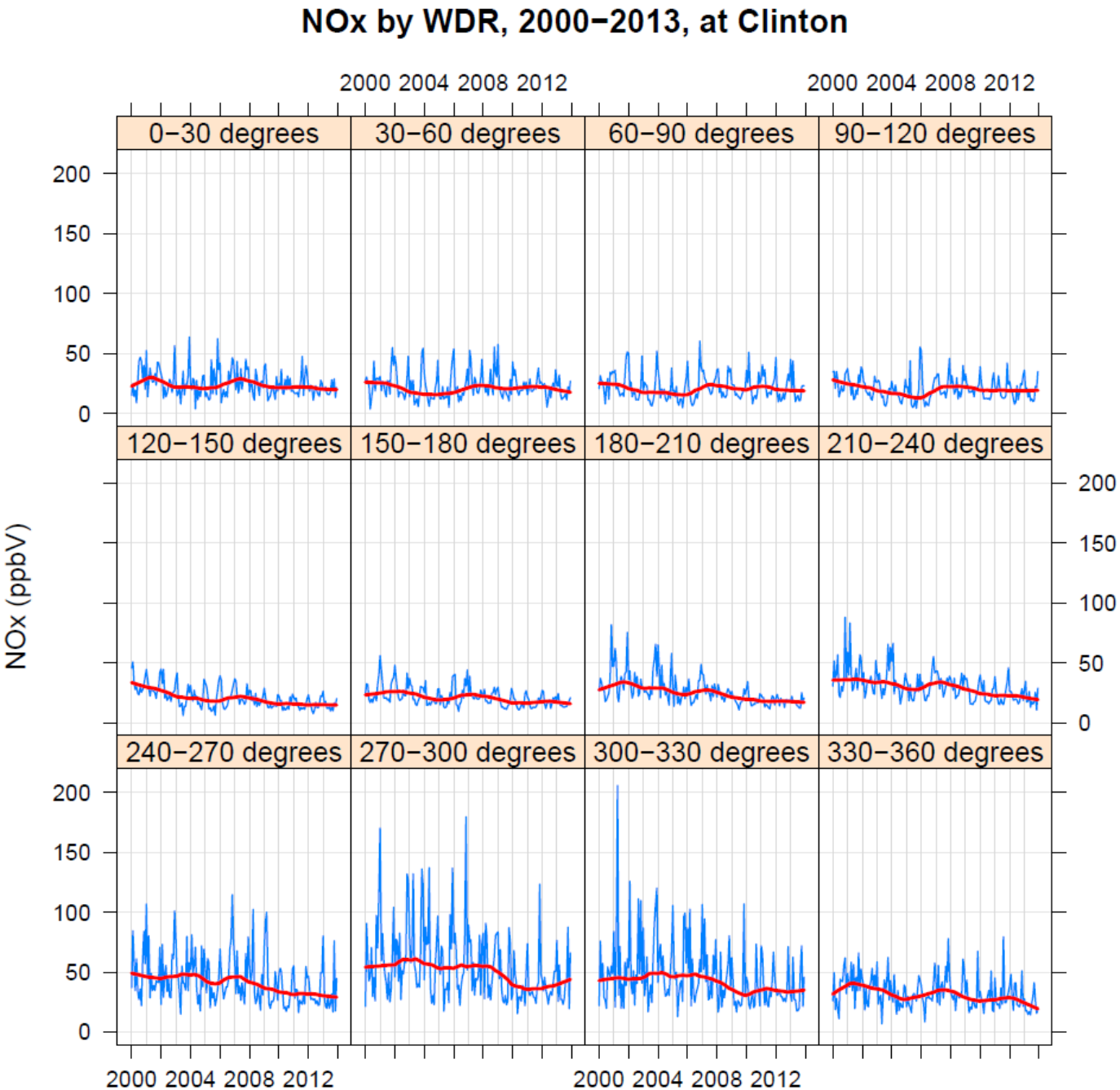
NO_x from the direction of industrial sources is lower, but the relative distances from sources (the freeway and the industrial sources), along with emissions rates from these sources, were not evaluated.

Based on the smoothed estimates, it appears that NO_x from all directions has declined, implying that both vehicle and industrial emissions of this pollutant have declined.



This is mean monthly NO_x by wind direction bin at Clinton, across the entire 14-year study period. Clinton is located close to some major industrial sources, a railyard, and Loop 610.

When air is arriving from between zero and 240 degrees – where it would have passed over both industrial sources and vehicles – nearly all of the monthly mean concentrations were below 50 ppb. However, when winds were between 240 and 330 degrees – the direction of IH-610, plus an adjacent railyard – mean concentrations were considerably greater.



NO_x by Hour, Month, and Year, at Clinton C403

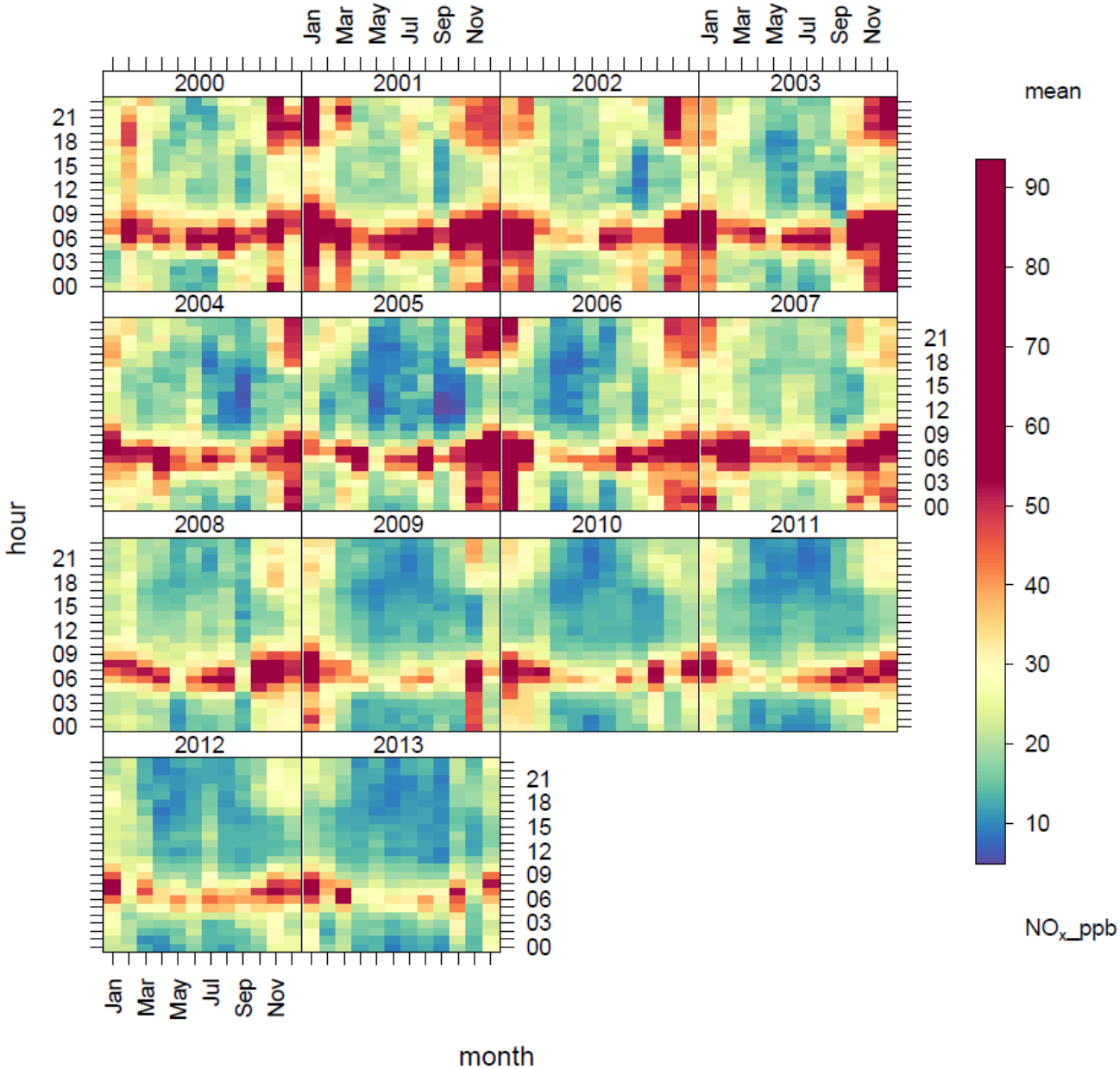
The plot for Clinton shows average monthly NO_x, by hour of day, for 14 years.

There are two patterns evident that are most clearly seen in the plots in the top two rows:

1. NO_x between about 0500 and 0800 is greater than most other hours, suggesting that vehicle emissions are a very important source, and

2. During the winter months, concentrations are frequently high in the overnight hours; this suggests that wintertime meteorology (i.e. overnight inversions) are the cause of this.

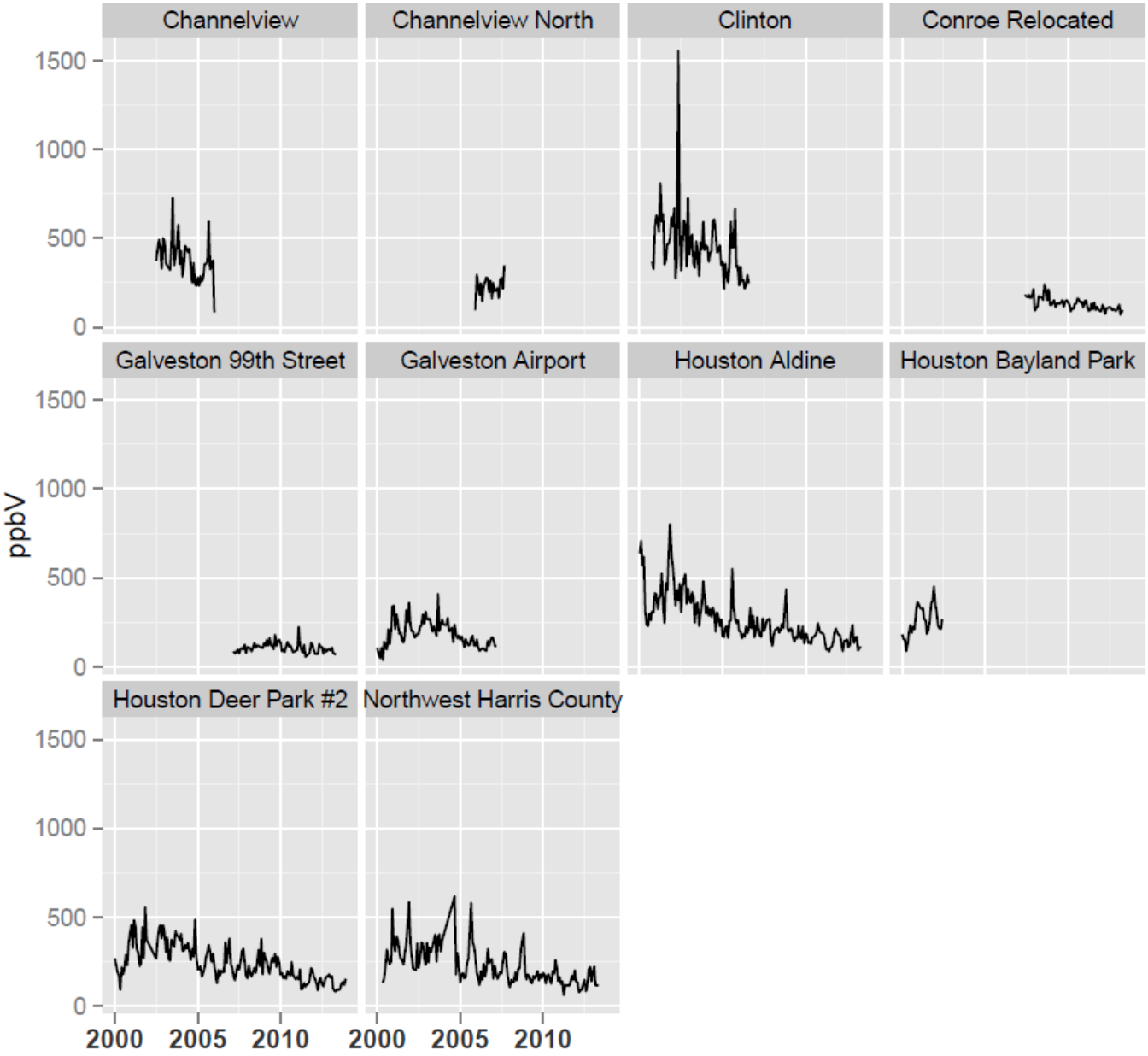
It is evident that concentrations are decreasing during these two sets of hours; they are likely doing so during other hours (note increase in blue tiles).



2. TNMOC and Ethylene at VOC Canisters

Mean Monthly TNMOC at 10 HGB canisters, 2000−2013

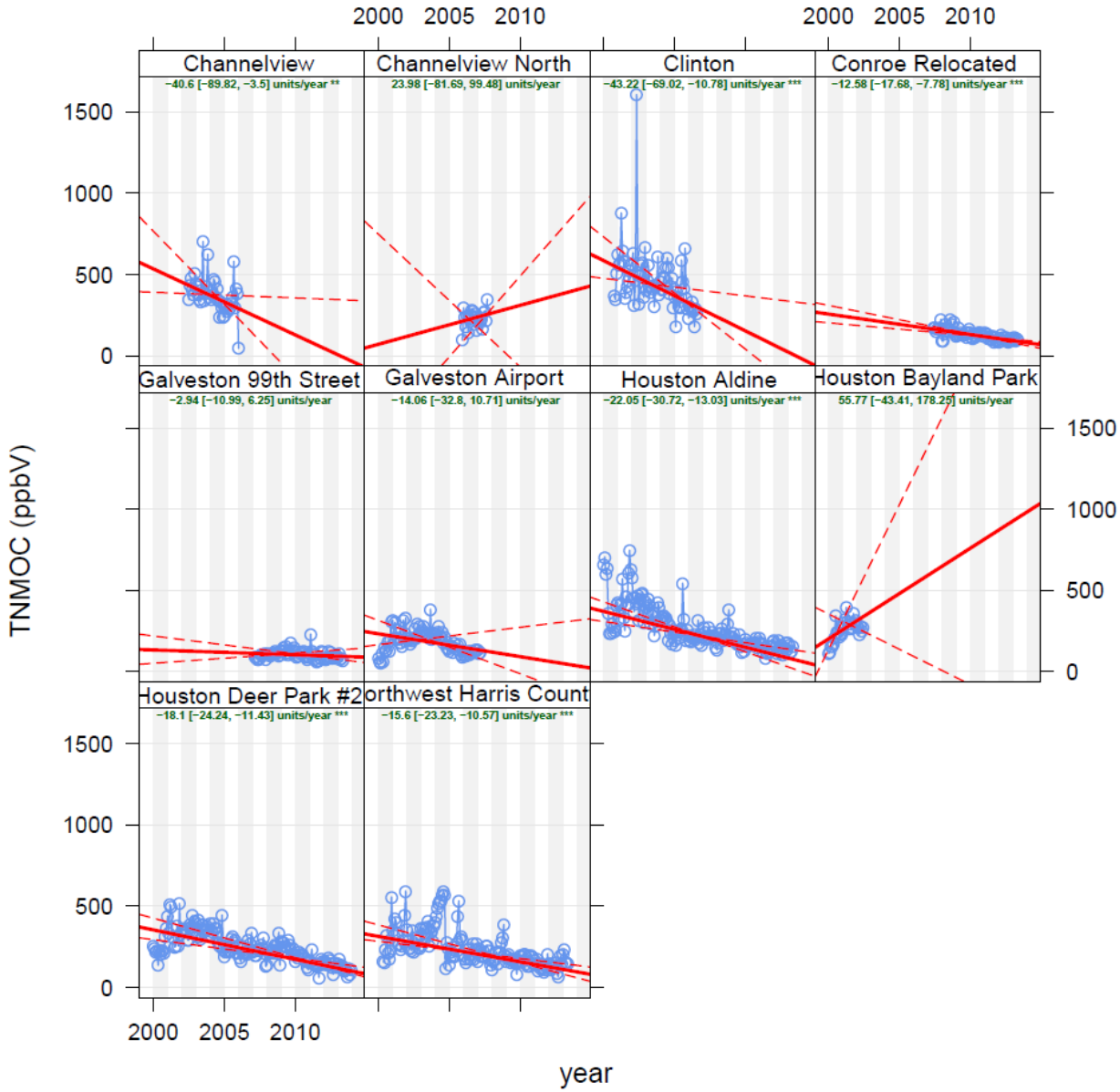
This shows mean TNMOC at the 10 VOC canister monitors that measured it during all or part of the study period. Due to lack of data, it can be difficult to discern trends at some monitors.



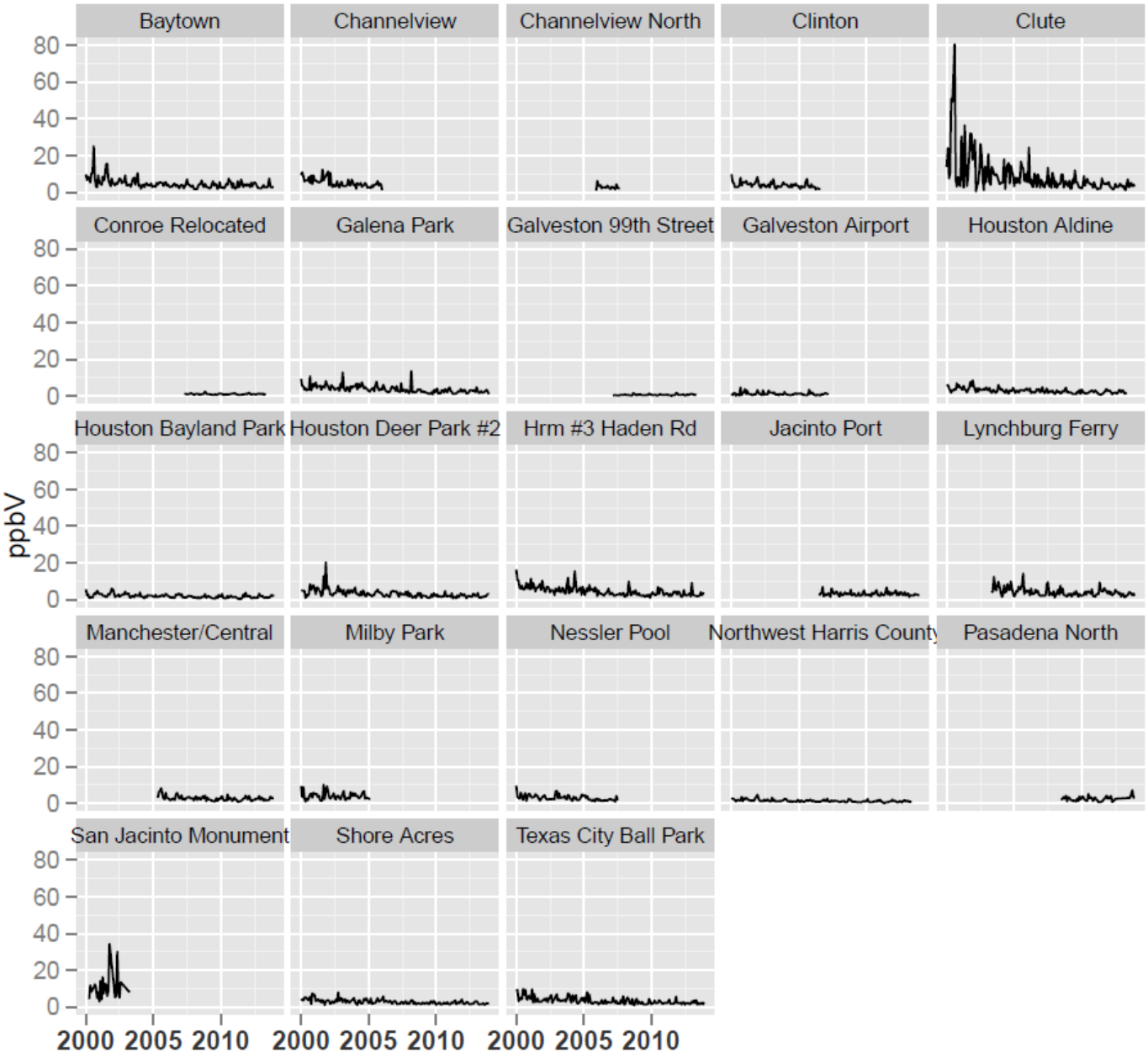
TNMOC Statistical Trends Estimates at 10 Monitors

This is similar to the plot of Theil-Sen statistical estimates for NO_x. It can be seen that the monitors with more complete data generally have more robust trends (i.e. they have "tighter" confidence bounds than do most of the others).

Eight of these show downward trends, with 5 of them statistically significant at the 99.9% confidence interval. Of the significant ones, the decreases range from 13 to 43 ppb/yr.



Mean Monthly Ethylene at 23 HGB canisters, 2000−2013



This shows mean ethylene at the 23 VOC canister monitors that measured it during all or part of the study period.

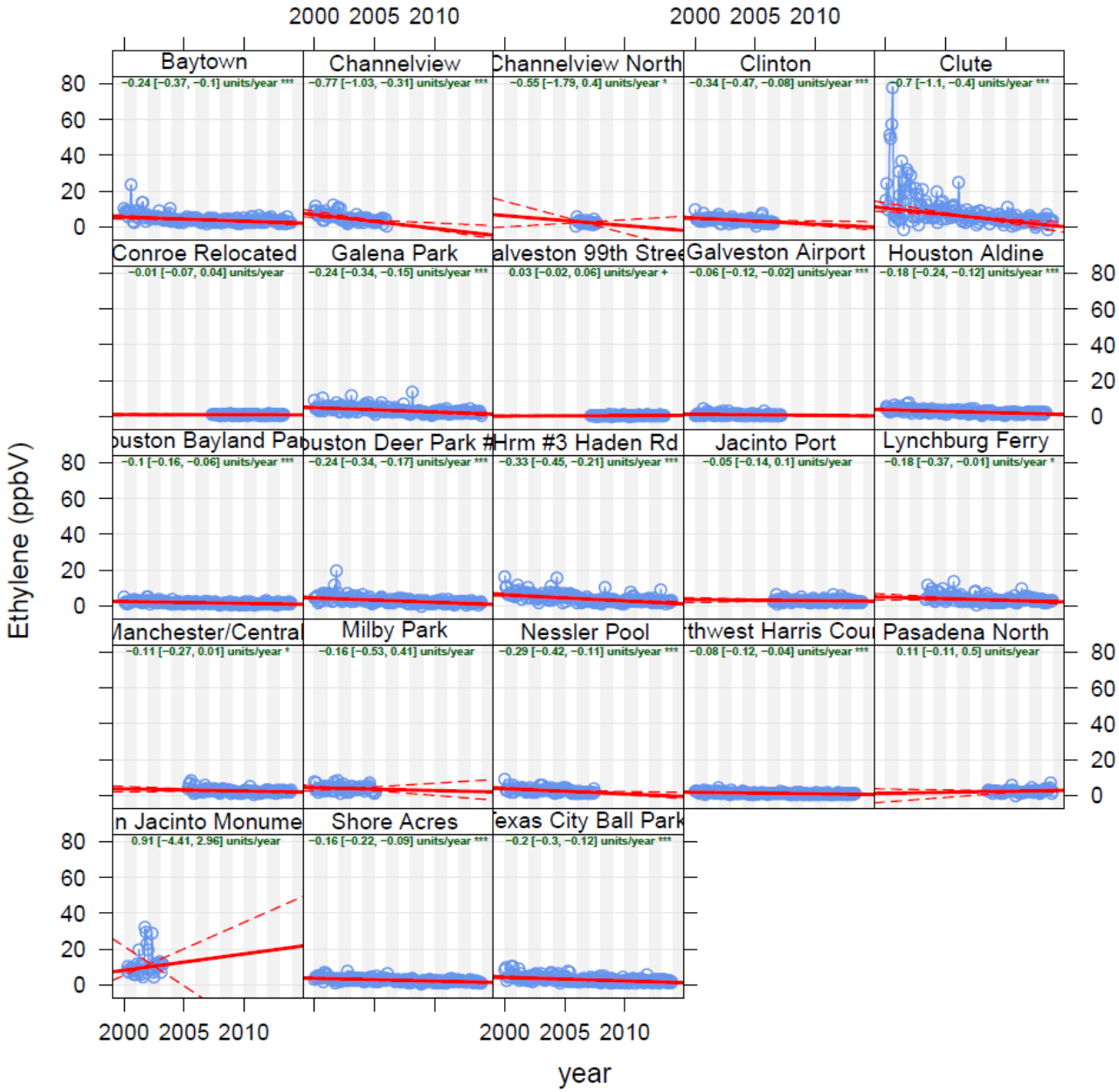
(While there are 23 canister monitors in the area, just 10 measure TNMOC, hence the difference in the number of plots for these two pollutants.)

Concentrations at Clute in the early 2000s dwarf those at any other monitor, making it difficult to interpret the other monitors' trends. In the next slide the trends are statistically evaluated.

Ethylene Statistical Trends Estimates at 23 Monitors

These are Theil-Sen statistical estimates for ethylene from VOC canisters.

A strong majority – 20 of the 23 monitors – have downward trends, with 17 of these decreases being statistically significant at least at the .05 level.

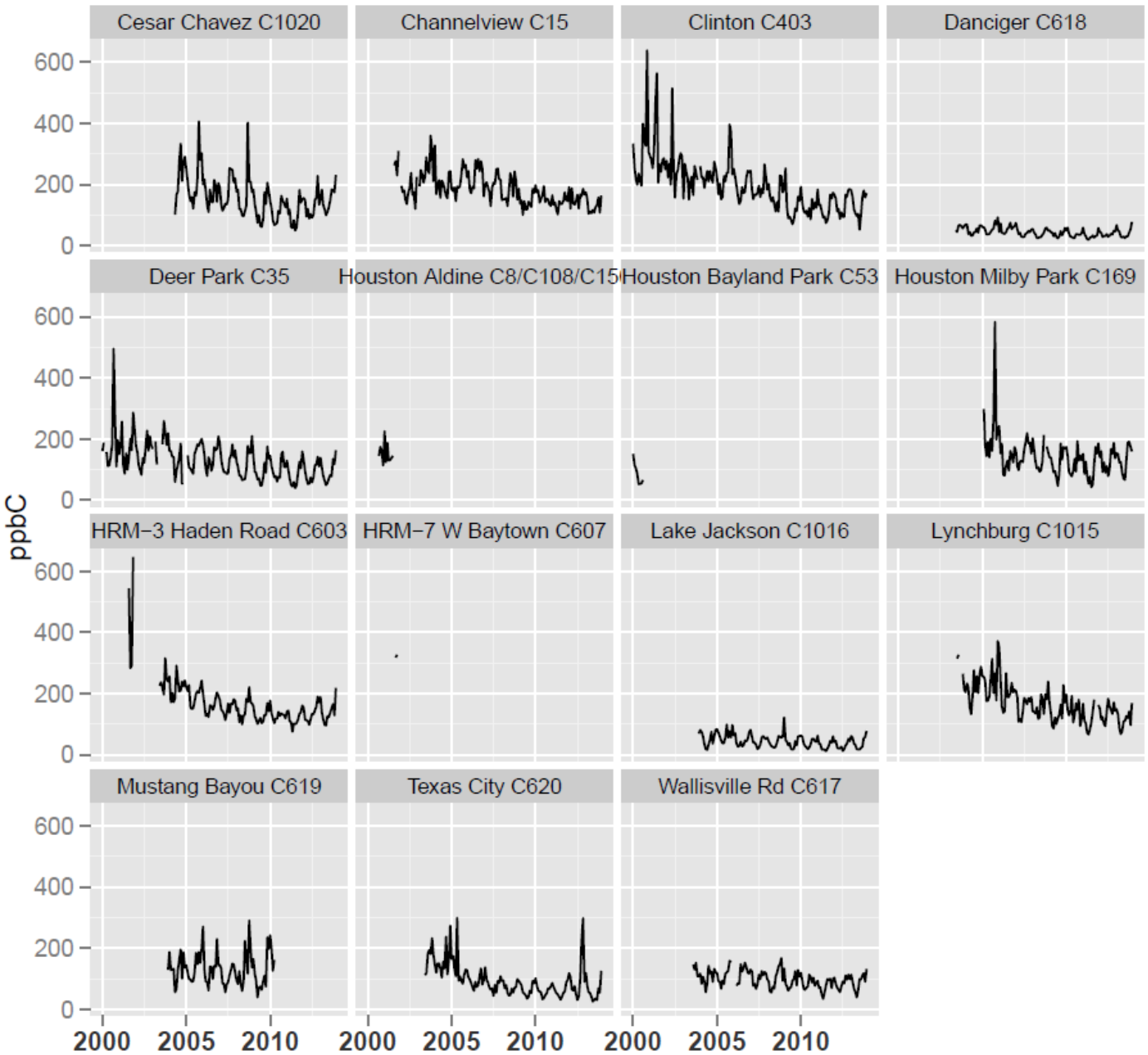


3. TNMHC at AutoGCs

Mean Monthly TNMHC at 15 HGB AutoGCs, 2000−2013

For comparison with TNMOC measured from canisters, we also analyzed TNMHC from AutoGCs. It can be seen that there are more AutoGCs than canisters (that measure total hydrocarbons), and the AGCs typically have more years of data than the canisters.

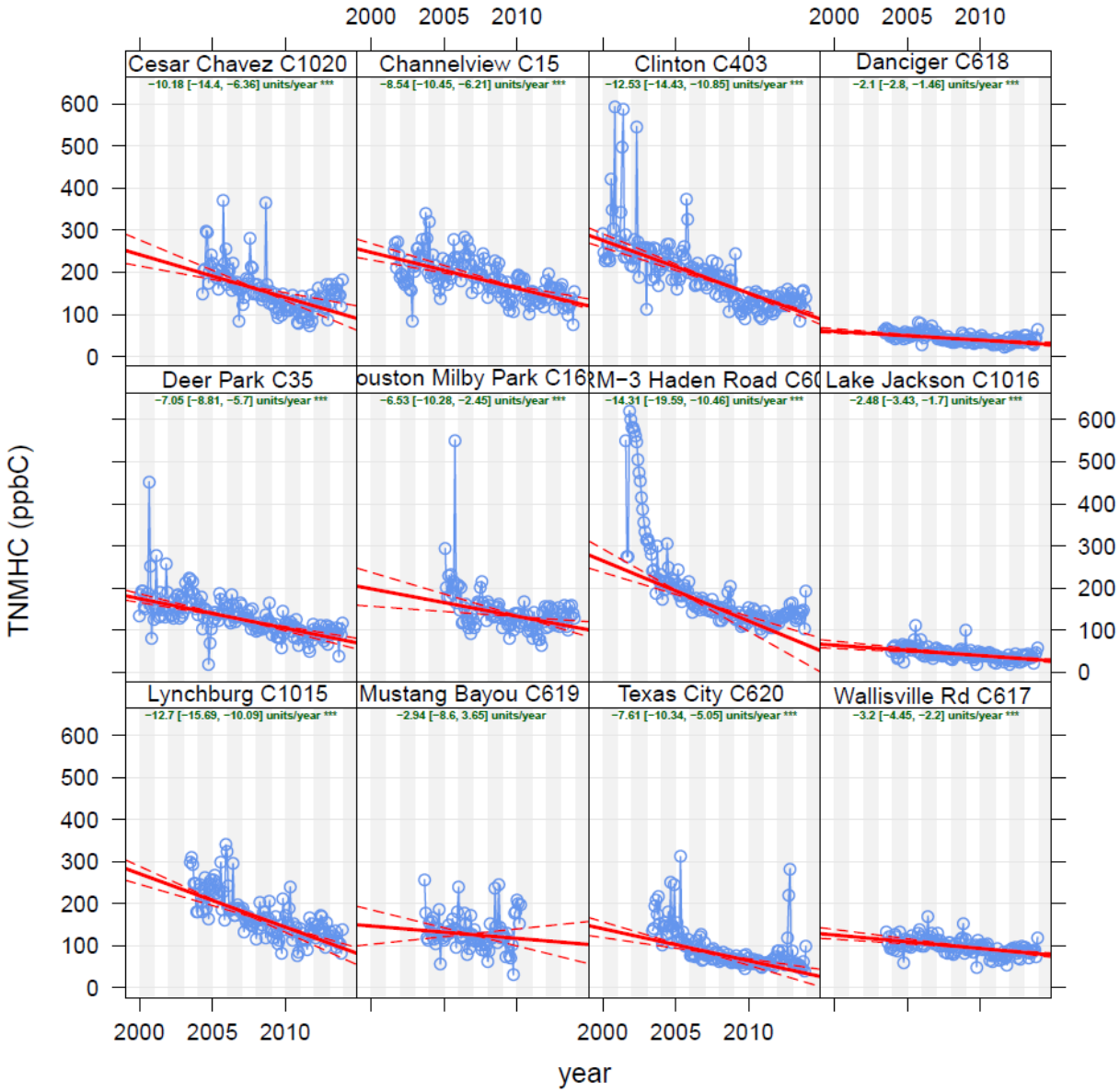
As with NO_x and TNMOC, TNMHC concentrations generally vary by season. In the next slide we evaluate them statistically.



TNMHC Statistical Trends Estimates at 12 Monitors

These are Theil-Sen statistical estimates for TNMHC from Auto-GCs. (Three of the 15 AutoGCs did not have enough data to analyze statistically, and are not shown here.)

All 12 of these exhibit downward trends, with 11 of them statistically significant at the .001 level. Decreases range from 2.1 ppb/yr to 14.3 ppb/yr.

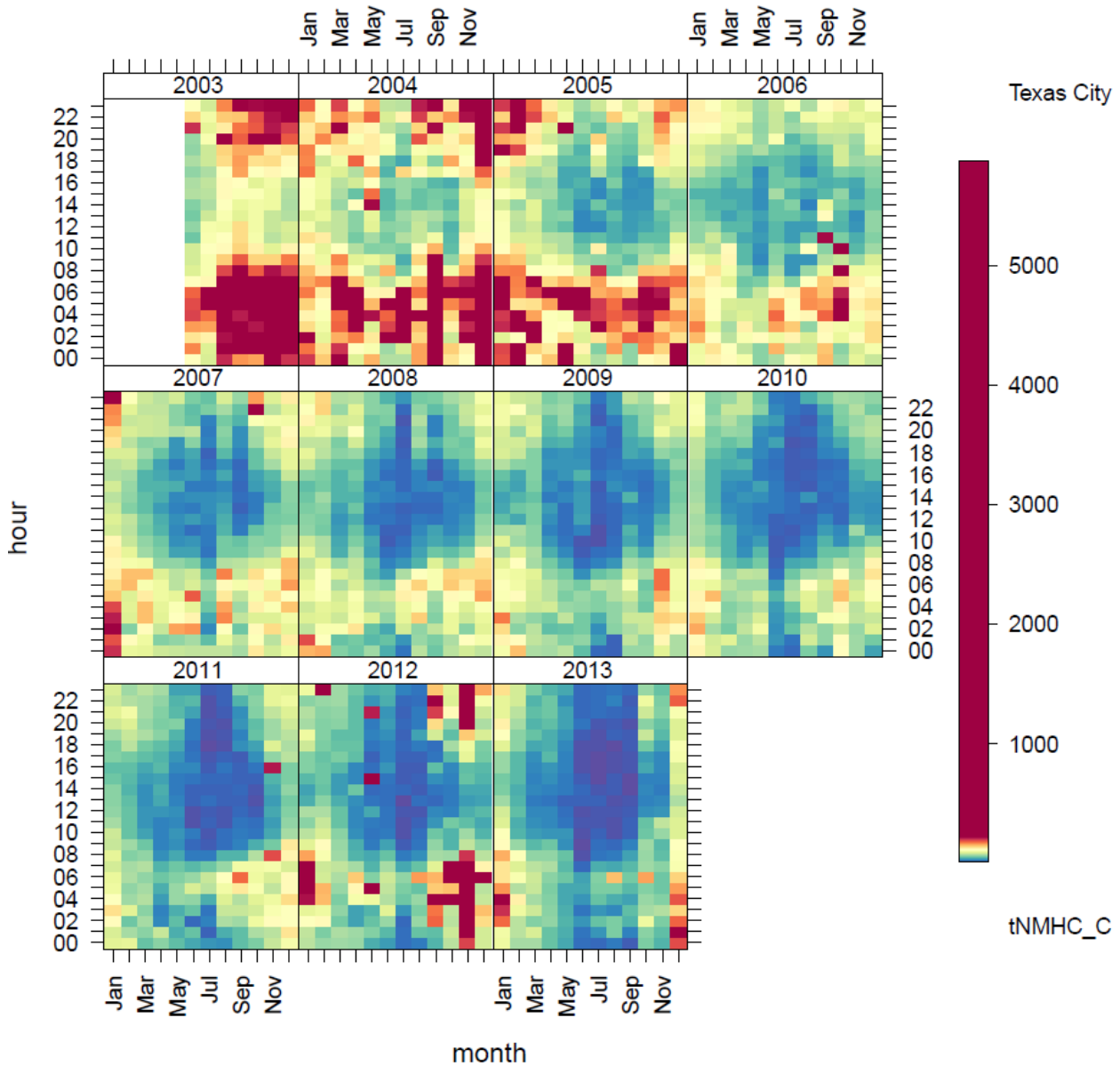


TNMHC by Hour, Month, and Year, at Texas City C620

This plot shows average monthly TNMHC, by hour of day, for 14 years at Texas City.

Like the similar plot for NO_x at Clinton, TNMHC was much higher during overnight hours, except this occurred both in summer and winter, and only for the first three years. Texas City C620 was one of eight AGCs in the HGB area that started in 2003; early analysis of data from these monitors showed unexpectedly high concentrations of many VOCs, indicating much greater emissions than expected. The data was presented to industry representatives, the EMRS program was implemented, HRVOC rules were enacted and concentrations declined.

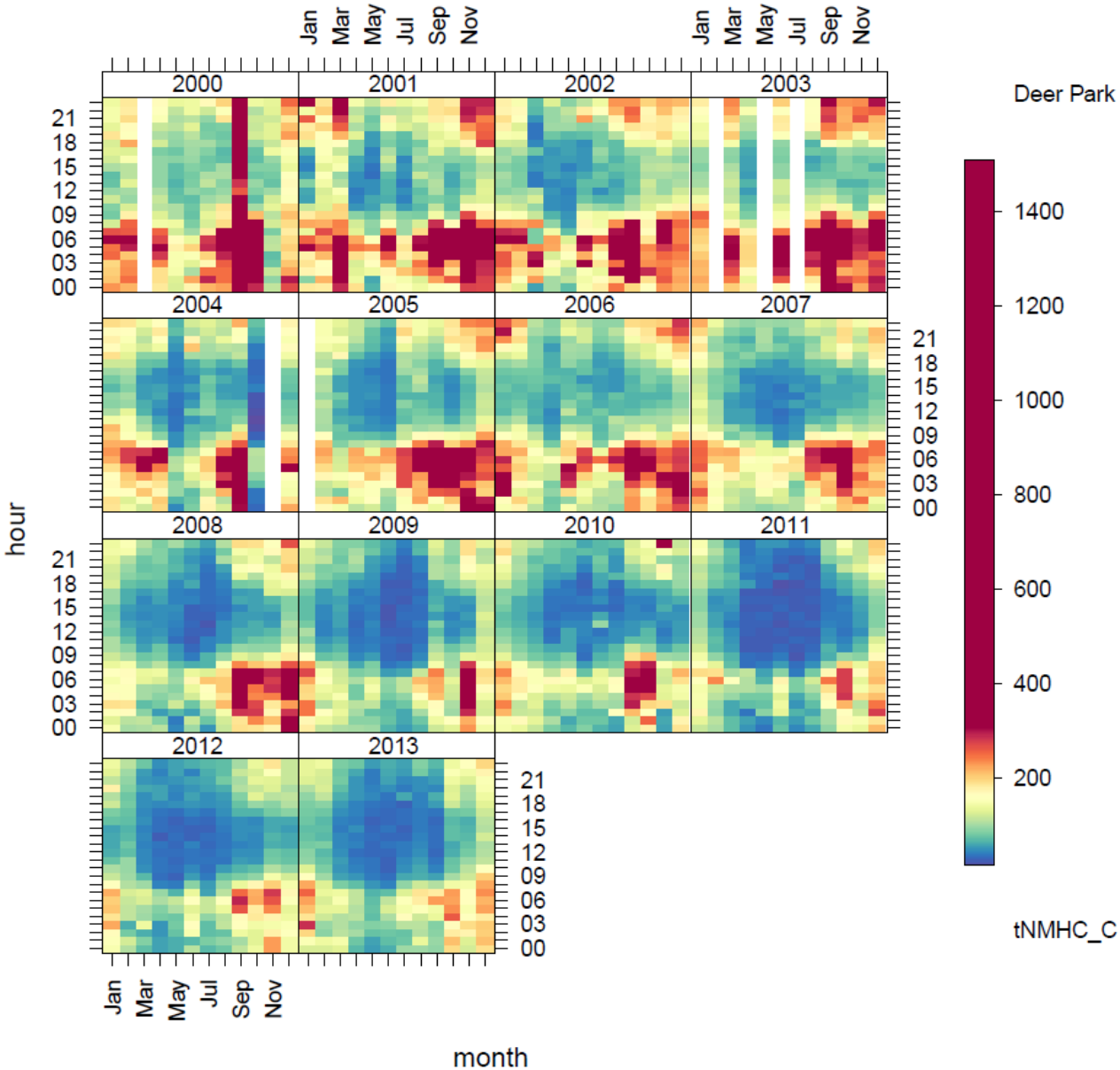
Note that while concentrations are decreasing, some months in recent years have high concentrations; this may be due to nonroutine emissions releases from area plants.



TNMHC by Hour, Month, and Year, at Deer Park C35

As with the previous plot, this shows average monthly TNMHC, by hour of day, for 14 years but for the Deer Park monitor.

Like at Texas City, this monitor shows higher concentrations during overnight hours, with less seasonal variation than NO_x at Clinton. However, Deer Park does not show a considerable decrease from 2005 through 2006. Texas City is very near to several plants that emit large amounts of VOCs; it may be that Deer Park's greater distance from area industry, as well as it having more roadways nearby, are the reasons that no such dropoff is seen.



Summary / Next Steps

- Concentrations of NO_x and VOCs (TNMOC, TNMHC, and ethylene) decreased considerably, and nearly uniformly, at HGB monitors during the period 2000 – 2013.
- It is apparent based on 2000-13 plots of average by hr/mo/year that vehicle emissions have decreased, and from wind direction plots that industry emissions have decreased.
- Upcoming analysis: evaluate the role of, and trends in, vehicle, rail, and industry emissions across this period, and compare with concentration patterns seen at monitors affected by both sources.