

# The Corpus Christi Air Monitoring and Surveillance Camera Installation and Operation Project

THE UNIVERSITY OF TEXAS AT AUSTIN



Center for Energy & Environmental Resources

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# Outline

1. Monitoring network background
2. Additional alert and software tools
  - a) Alert system
  - b) Trajectory tool
3. Uses of the data collected
  - a) Effects screening: Auto-GC 2008 data summary
  - b) Events analysis
  - c) Source checking
4. Findings from data analyses
  - a) Concentrations vary by wind direction
  - b) Significant downward trends in benzene
  - c) How CC compares with other Texas cities
  - d) New & unexpected emission sources
5. Plans for the future
  - a) Neighborhood air toxics modeling
  - b) Infrared camera
  - c) Mobile monitoring
6. Summary

# 1. Monitoring Network Background

## Air Monitoring Sites, Locations, & Instrumentation

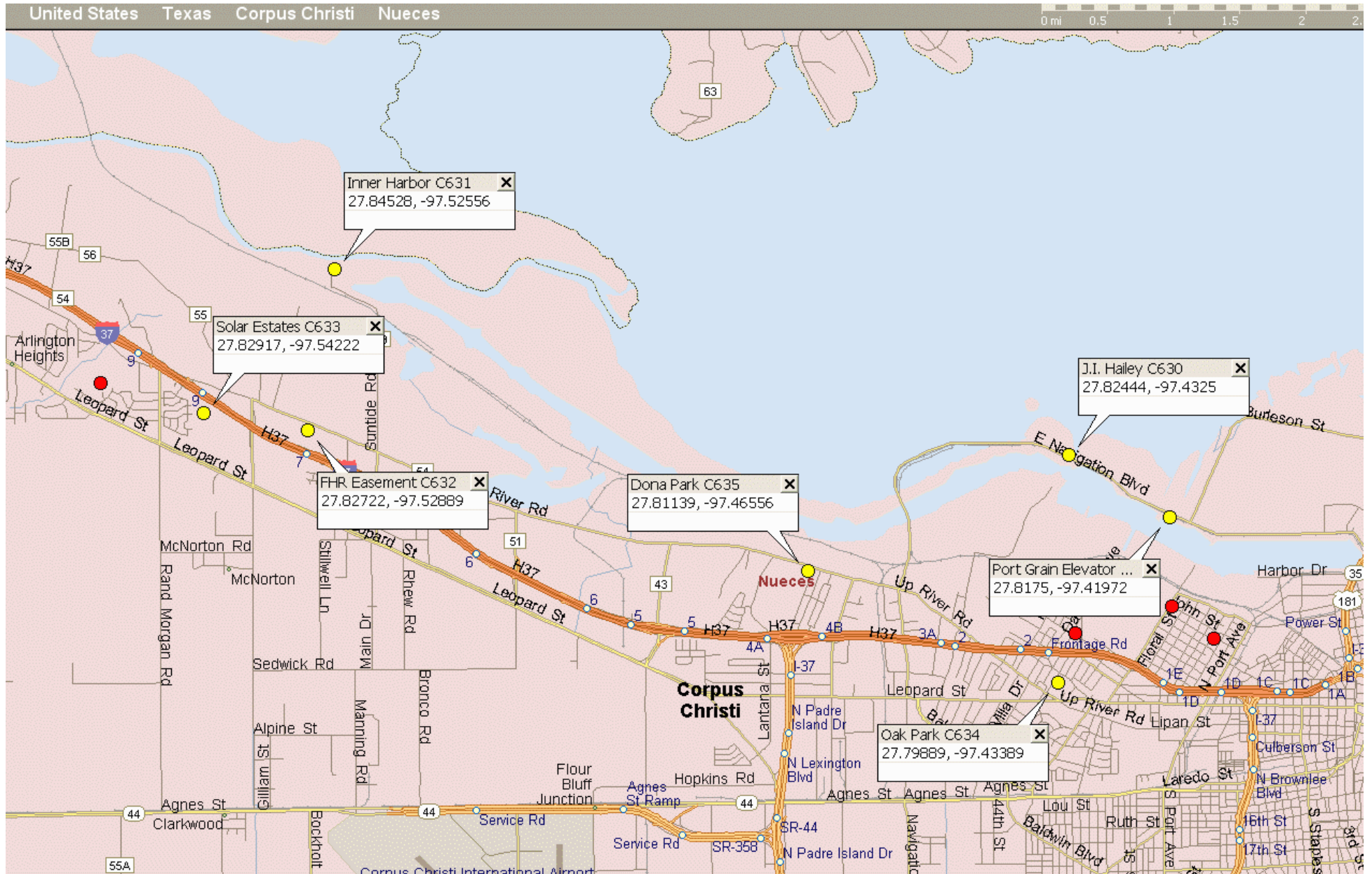
CAMS #	Site description	Auto-GC	TNMHC & Can	H <sub>2</sub> S & SO <sub>2</sub>	Met Station	Camera
634	Oak Park Recreation Center	Yes	T		Yes	
629	Grain Elevator POCC		T&C	Yes	Yes	
630	J. I. Hailey Site POCC		T&C	Yes	Yes	
635	TCEQ Monitoring Site @ Dona Park		T&C	Yes	Yes	Yes
631	West End Inner Harbor POCC		T&C	Yes	Yes	
632	Up River Road on FHR Easement		T&C	Yes	Yes	
633	Solar Estates Park, Sunshine Rd	Yes	T	Yes	Yes	Yes

# “Continuous Ambient Monitoring Station”

- See [http://www.tceq.state.tx.us/nav/eq/mon\\_sites.html](http://www.tceq.state.tx.us/nav/eq/mon_sites.html)



# Air Monitoring Network Site Locations



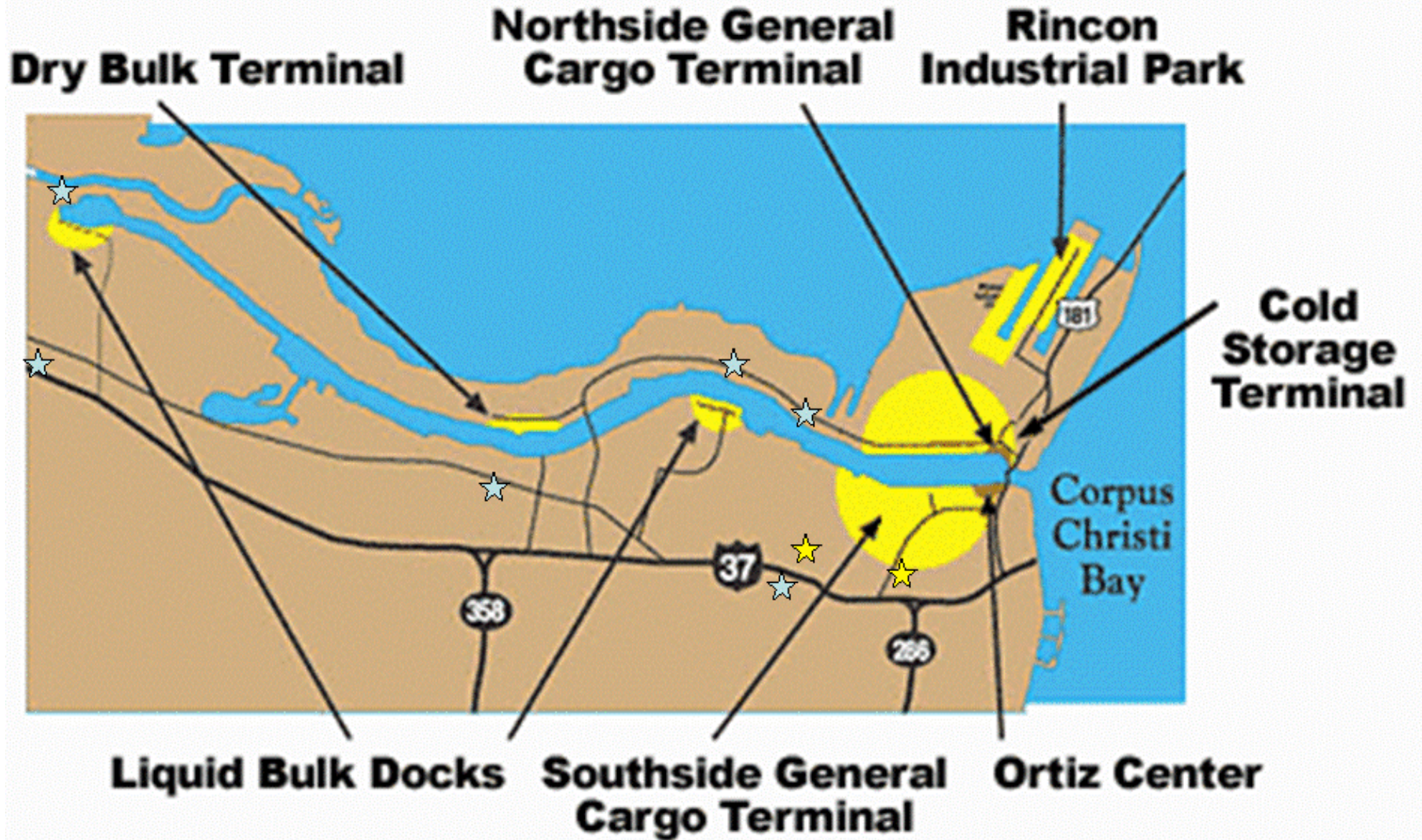


# Monitors and Emissions - Industry





# Monitors and Emissions - Shipping



☆ UT CAMS

★ TCEQ CAMS



# Small Emission Sources Eastern Network

## Legend and Overview

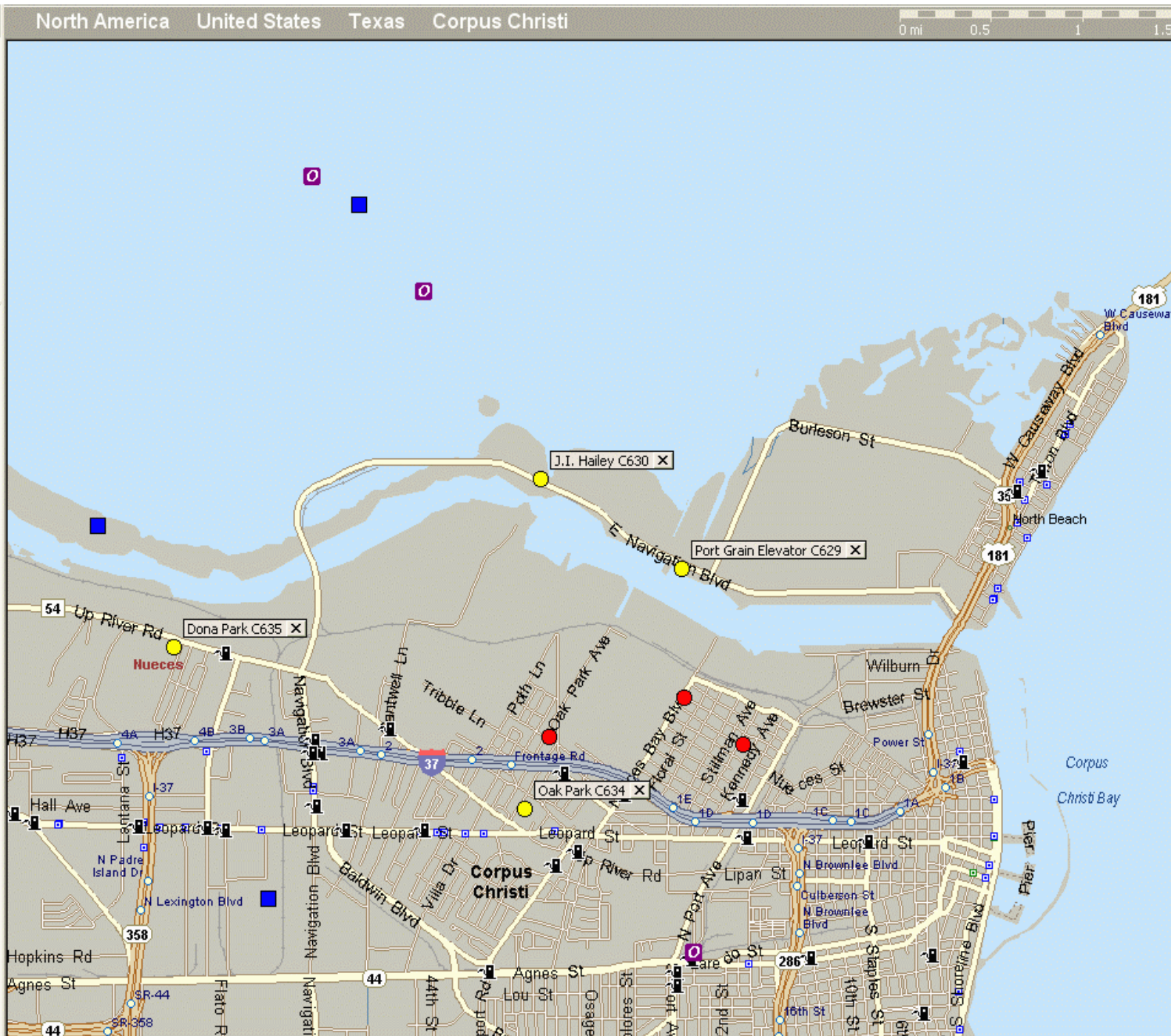


## Who by Latitude & Longitude

- TAMUK
- TCEQ
- UT
- UT/TCEQ

## Pushpins

- Gasoline Production (Nueces)
- Gasoline Production (San Pat)
- Oil Production (Nueces)
- Gasoline marketing





# Small Emission Sources Western Network

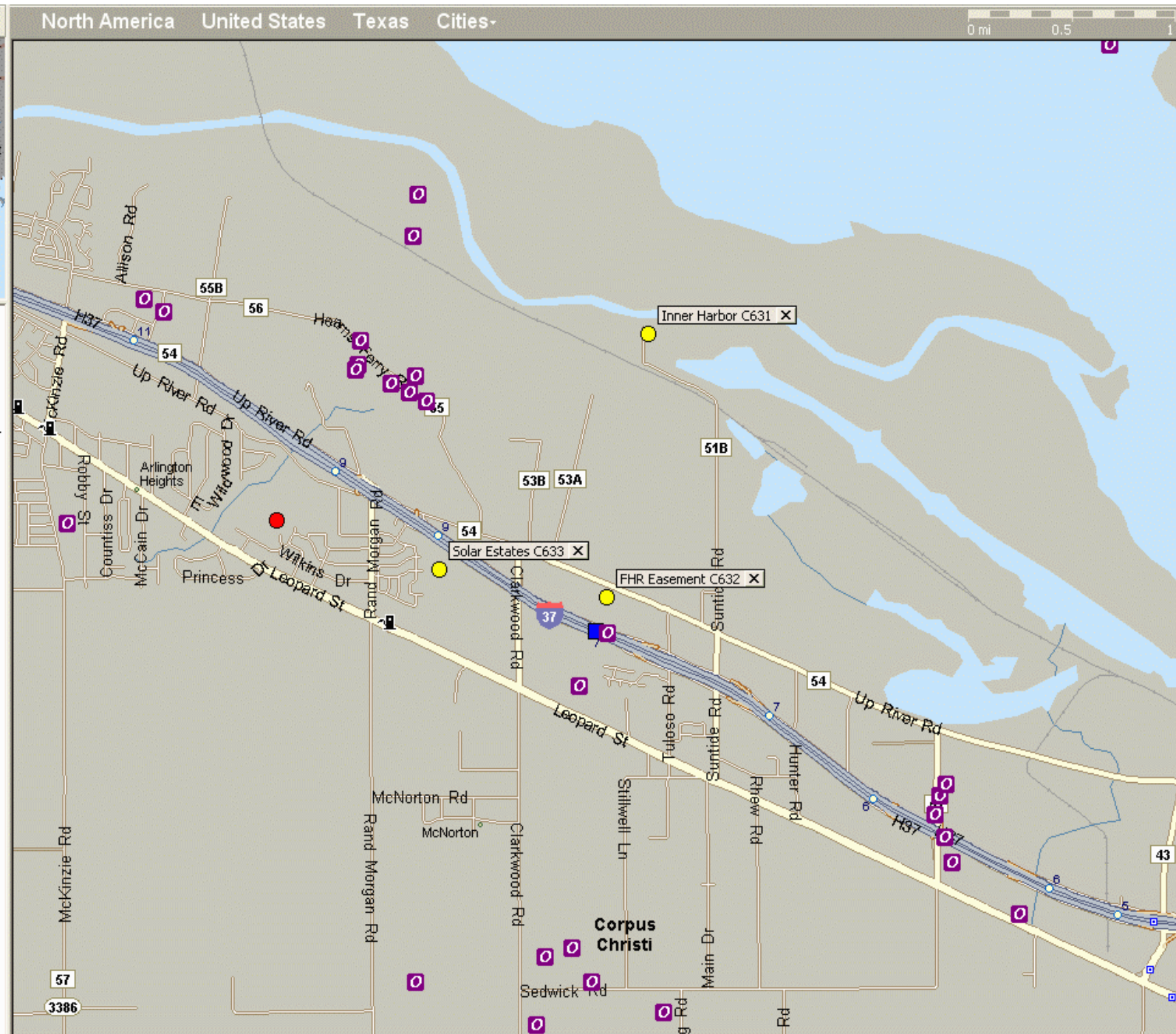


**Who by Latitude & Longitude**

- TAMUK
- TCEQ
- UT
- UT/TCEQ

**Pushpins**

- Gasoline Production (Nueces)
- Gasoline Production (San Pat)
- Oil Production (Nueces)
- Gasoline marketing



# Explanation of monitoring terms

- **Pollutant concentrations**
  - Gravimetric vs volumetric; ppbC vs ppbV
- **Auto-GC**
  - 40 min sample every hour, 47 hydrocarbons C<sub>2</sub>-C<sub>11</sub>
  - Carcinogens, photochemical compounds
  - In neighborhoods at Solar Estates & Oak Park.
- **Total non-methane hydrocarbons (TNMHC)**
  - 5 min time resolution, unspiciated
  - Operate at all 7 UT/CEER sites.
  - Sustained 2000 ppbC triggers canister samples.



# Explanation of monitoring terms

- **Canister**
  - Stainless steel cans filled when sensor detects elevated TNMHC.
  - 20 minute samples capture chemical make-up of air, 50 – 55 species.
  - Operated at 5 of 7 UT/CEER sites.
- **Sulfur Dioxide (SO<sub>2</sub>) and Hydrogen Sulfide (H<sub>2</sub>S)**
  - Two compounds associated with oil refining.
  - State limits on single source contributions to ambient levels.
- **“Elevated Concentrations”** – Colloquial term for pollutant > ESL or ReV (e.g., benzene), above a state standard (e.g., H<sub>2</sub>S), or above a triggering threshold (e.g., TNMHC)

# Explanation of monitoring terms

- **Effects Screening Levels (ESLs)** – “*used to evaluate potential for effects to occur as a result of exposure to concentrations of constituents in the air. ESLs based on data concerning health effects, potential for odors to be a nuisance, effects on vegetation, & corrosive effects. ... not ambient air standards. If ... levels of a constituent do not exceed screening level, adverse health or welfare effects are not expected. If ambient levels of constituents in air exceed screening levels, it does not necessarily indicate a problem but rather triggers a review in more depth.*” (emphasis added)

# Explanation of monitoring terms

- **Reference Values (ReVs)** - ReVs are health-based toxicity values used in evaluation of ambient air monitoring data and in calculation of health-based ESLs and source media cleanup levels.
- Benzene ReV = 180 ppbV for 1-hour
- Benzene long-term ESL used for long-term exposure = 1.4 ppbV



# Use of ReVs and ESLs

- Reference Values (ReVs) are used
  - to evaluate measured air toxics for potential to cause health/welfare effects, and
  - to help TCEQ prioritize resources in permitting, compliance, enforcement
- ESLs are used
  - in air permit reviews to evaluate predicted concentrations from proposed new emissions.

## 2. Additional Alert and Software Tools

Alert system

Trajectory tool

Additional analysis software

# Text Alerts, Email Alerts

- Text message received by TCEQ staff if measured concentrations > thresholds.
- Email message sent a couple of hours later with link to back-trajectory tool.

– From: the\_denz@mail.utexas.edu  
To: ...

Subject: (TEST)Corpus Christi Alert System Notice

The following alert has been received in the Corpus Christi Area:

emrs\_medium\_alert\_48355003743102\_20090501\_1420.txt

TNMOC MEDIUM trigger at site J.I. Hailey C630

21116.19 >= 2000.00 ppbC (trigger 2 of 3)

WD = 146 degrees

WS = 19.6 mph

time of trigger 14:20 (CST) 2009.05.01

20:20 (UTC) 2009.05.01

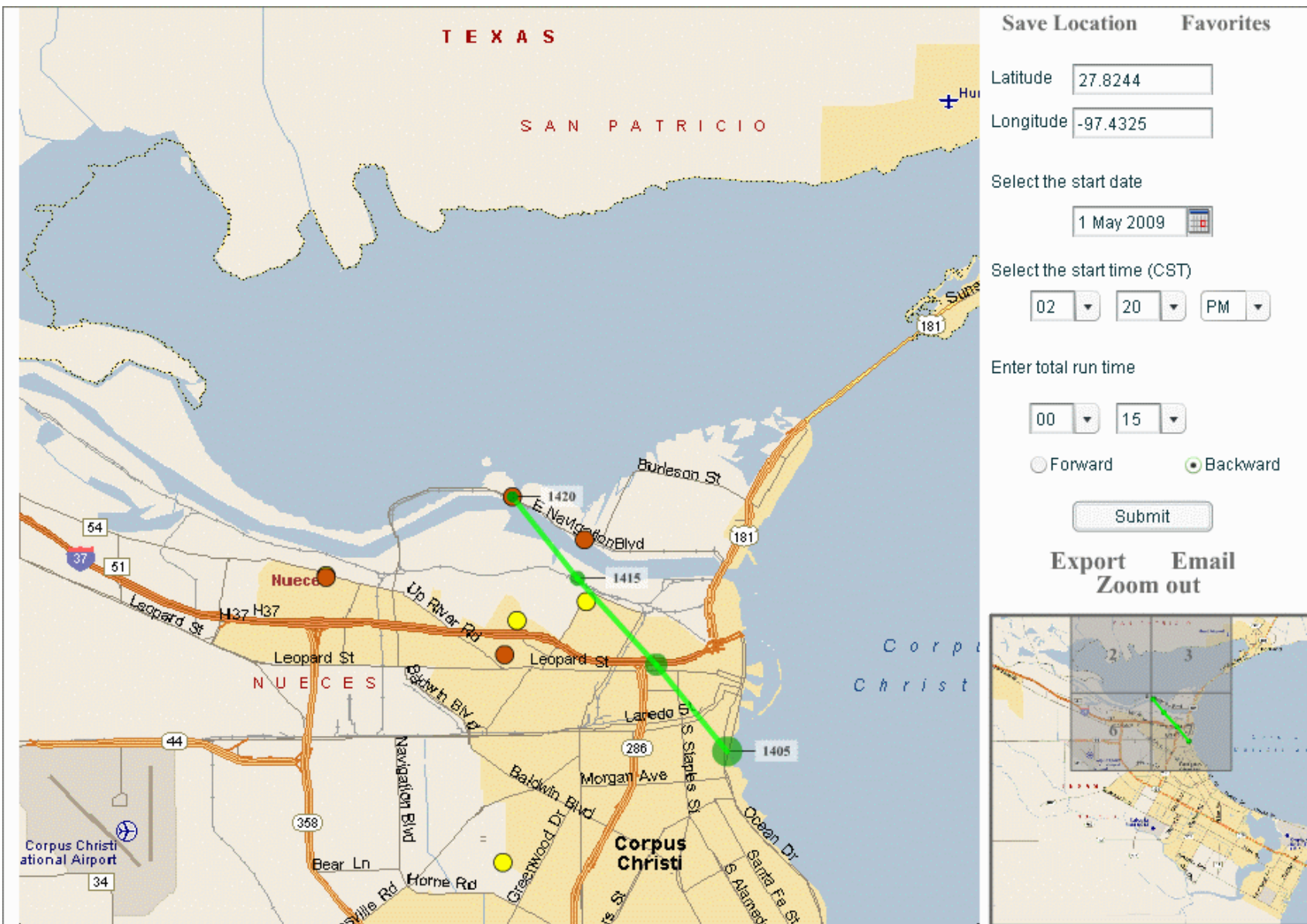
To see the graphical output from the Corpus Christi Trajectory Tool of this alert click the following link:

[Click Here](#)

Click this link to go to the Alert Archive to view other alerts in the Corpus Christi area:

[Click Here](#)





Alert ID: emrs\_medium\_alert\_48355003743102\_20090501\_1420

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 WD = 146 degrees  
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 time of trigger 14:20 (CST) 2009.05.01  
 20:20 (UTC) 2009.05.01

# Trajectory Tool

# Additional Analysis Software

- SAS 9.1 used for statistical analysis, graphs, quality assurance, etc. <http://www.sas.com/>
- Google Earth Pro 4.3 (beta) for plotting points <http://earth.google.com/>
- HYSPLIT 4.8 for long-distance trajectories <http://www.ready.noaa.gov/ready/open/hysplit4.html>
- TCEQ LEADS [http://www.tceq.state.tx.us/nav/data/aq\\_data.html](http://www.tceq.state.tx.us/nav/data/aq_data.html)
- TCEQ Emissions Events database <http://www11.tceq.state.tx.us/oce/eer/index.cfm>
- TCEQ STARS (point source emissions) [http://www.tceq.state.tx.us/nav/eq/eq\\_airstata\\_sources.html](http://www.tceq.state.tx.us/nav/eq/eq_airstata_sources.html)
- MS MapPoint, Excel, etc.

# 3. Uses of the Data

Assisting TCEQ Toxicology Section  
Event analysis & source checking for  
TCEQ Region



# TCEQ Toxicology Evaluation for 2007

- Neeraja K. Erraguntla, Ph.D., Toxicology Section, Chief Engineer's Office, October 16, 2008 Memo: Health Effects Review of the 2007 Ambient Air Network Monitoring Sites in Region 14 – Corpus Christi
- Addressed all data from UT and TCEQ monitors
- Conclusions
  - Concentrations of volatile organic compounds (VOCs) and metals monitored at TCEQ and Corpus Christi Air Quality Project sites in 2007 are not expected to cause chronic adverse health effects.
  - Benzene > short term Ref. Val. at JIH (twice), CCG (once)
  - Potentially-odorous VOC concentrations were measured at JIH (7 species)
  - Annual mean benzene ppbV below ESL

Site	Huisache	Hillcrest	Dona Park	Solar Estates	Oak Park
type	Canister	Canister	Canister	Auto-GC	Auto-GC
ppbV	1.4	0.85	0.34	0.32	0.61

# Toxicology: Oak Park 2008 Auto-GC & ESLs/ReVs

Species	Num Ambient Samples	Mean	Peak 1-Hour Value	Peak 24-Hour Value	Num > 1-Hr ESL	Num > Veg ESL	Num > Odor ESL	> Annual ESL?
Ethane	7,502	7.0	267.7	30.6	0			
Ethylene	7,502	0.7	56.3	9.0	0	0	0	No
Propane	7,501	4.5	346.7	32.8	0			No
Propylene	7,502	0.4	26.9	2.5	0			
Isobutane	7,502	1.9	80.5	10.2	0		0	No
n-Butane	7,502	3.1	255.7	42.6	0			No
t-2-Butene	7,502	0.1	7.1	1.7	0		0	
1-Butene	7,502	0.1	4.6	1.0	0		0	
c-2-Butene	7,502	0.1	7.9	1.6	0		0	
Isopentane	7,502	2.3	145.1	17.4	0			No
n-Pentane	7,502	1.3	88.9	12.6	0			No
1,3-Butadiene	7,502	0.0	2.5	0.2	0			No
t-2-Pentene	7,502	0.1	7.7	0.4	0		0	
1-Pentene	7,502	0.0	2.6	0.3	0		0	
c-2-Pentene	7,502	0.0	4.1	0.2	0		0	
n-Hexane	7,500	0.4	37.8	5.1	0		0	No
Benzene	7,501	0.4	20.9	3.0	0		0	No
Cyclohexane	7,501	0.2	15.4	1.6	0		0	No
Toluene	7,501	0.6	18.4	3.4	0		0	No
Ethyl Benzene	7,501	0.1	3.0	0.3	0		0	No
m&p-Xylene	7,501	0.2	7.7	1.4	0		0	No
o-Xylene	7,501	0.1	3.2	0.3	0		0	No
Isopropyl Benz	7,501	0.0	54.0	2.8	0		0	No
1,3,5-TMB	7,458	0.0	3.5	0.2	0			No
1,2,4-TMB	7,412	0.1	10.5	0.9	0			No
n-Decane	7,412	0.0	2.2	0.2	0			No
1,2,3-TMB	7,412	0.0	2.3	0.2	0			No

# Event analysis:

## 80 ppb 30-min. H<sub>2</sub>S FHR 1/22/07

- Operator & neighbor noticed odor: site operator arrived 10 a.m., reported intermittent odors consistent w sulfuric compounds. Adjacent storage business operator asked what the smell was and if it was monitored. He had smelled odor all morning.
- FHR & Solar Estates had daily peak readings close in time, so a hypothesis would be that the same source had affected both sites
- Concentrations much greater at FHR, so 2nd hypothesis would be that source was closer to FHR than Solar.

# 80 ppb 30-min. avg. H<sub>2</sub>S FHR 1/22/07

- Trajectory analysis showed air passed over refinery north of both FHR & Solar under fairly strong winds.
- FHR peaks
  - H<sub>2</sub>S at 1/22 5:00 CST of 168 ppb
  - TNMHC at 13,000 ppbC
- Solar peaks
  - H<sub>2</sub>S at 1/22 2:05 CST of 7.8 ppb
  - TNMHC at 722 ppbC
- Inner Harbor (upwind) peak on 1/22
  - 5-min H<sub>2</sub>S 0.7 ppb
  - SO<sub>2</sub> 1.2 ppb
  - TNMHC 436 ppbC

# Surface back-trajectory from FHR





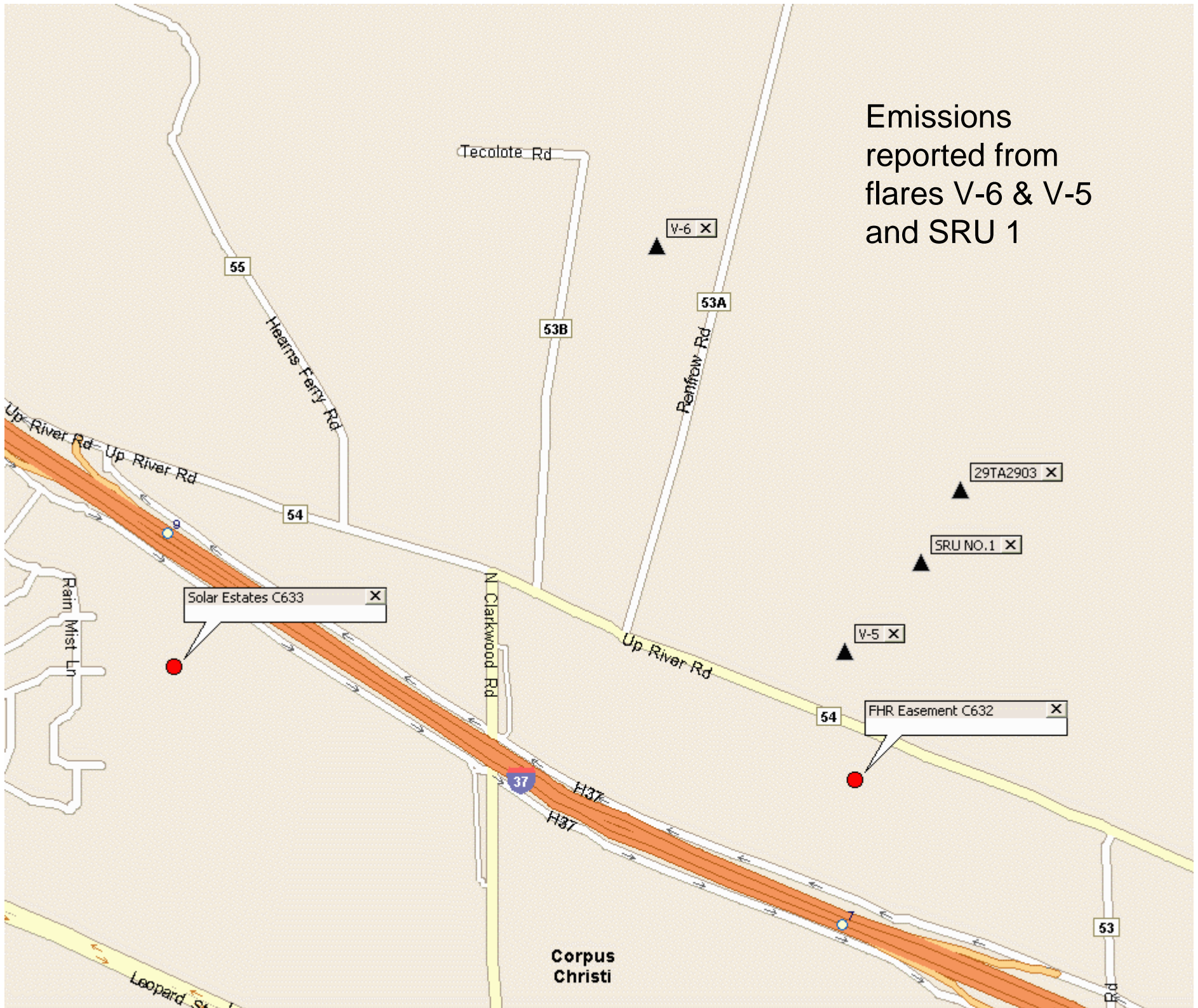
# Surface back-trajectory from SE



# Likely source

- Emission events records show the refinery north of FHR 632 reported emissions from a sulfur recovery unit on Jan. 21-23.
- H<sub>2</sub>S, NO<sub>x</sub>, and hydrocarbons are reported in the release.
- Emission event tracking number is 86263.
- Examination of the data led to TCEQ asking the refinery to correct the start time of the emission event.

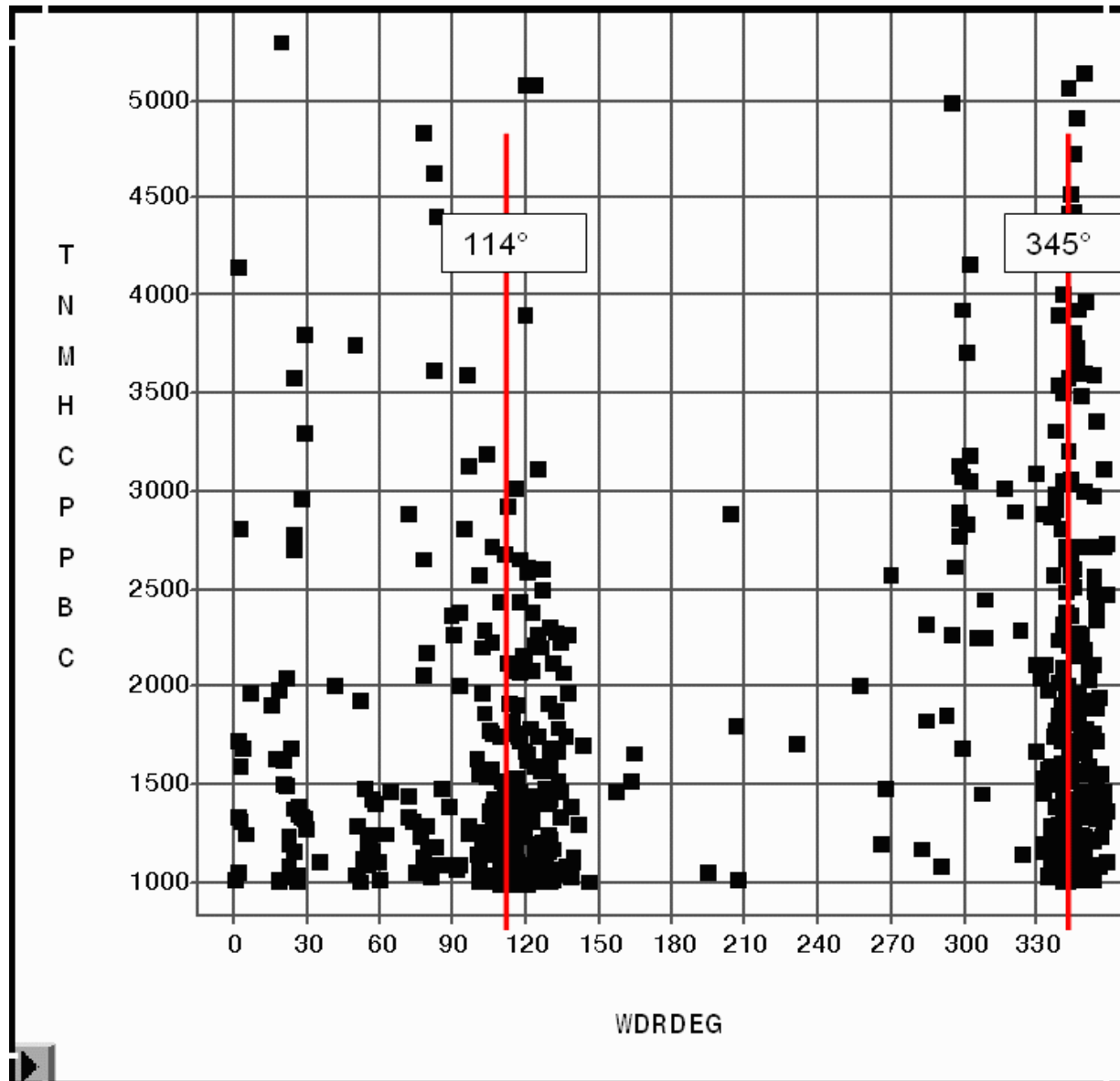
Emissions reported from flares V-6 & V-5 and SRU 1



# Source Checking

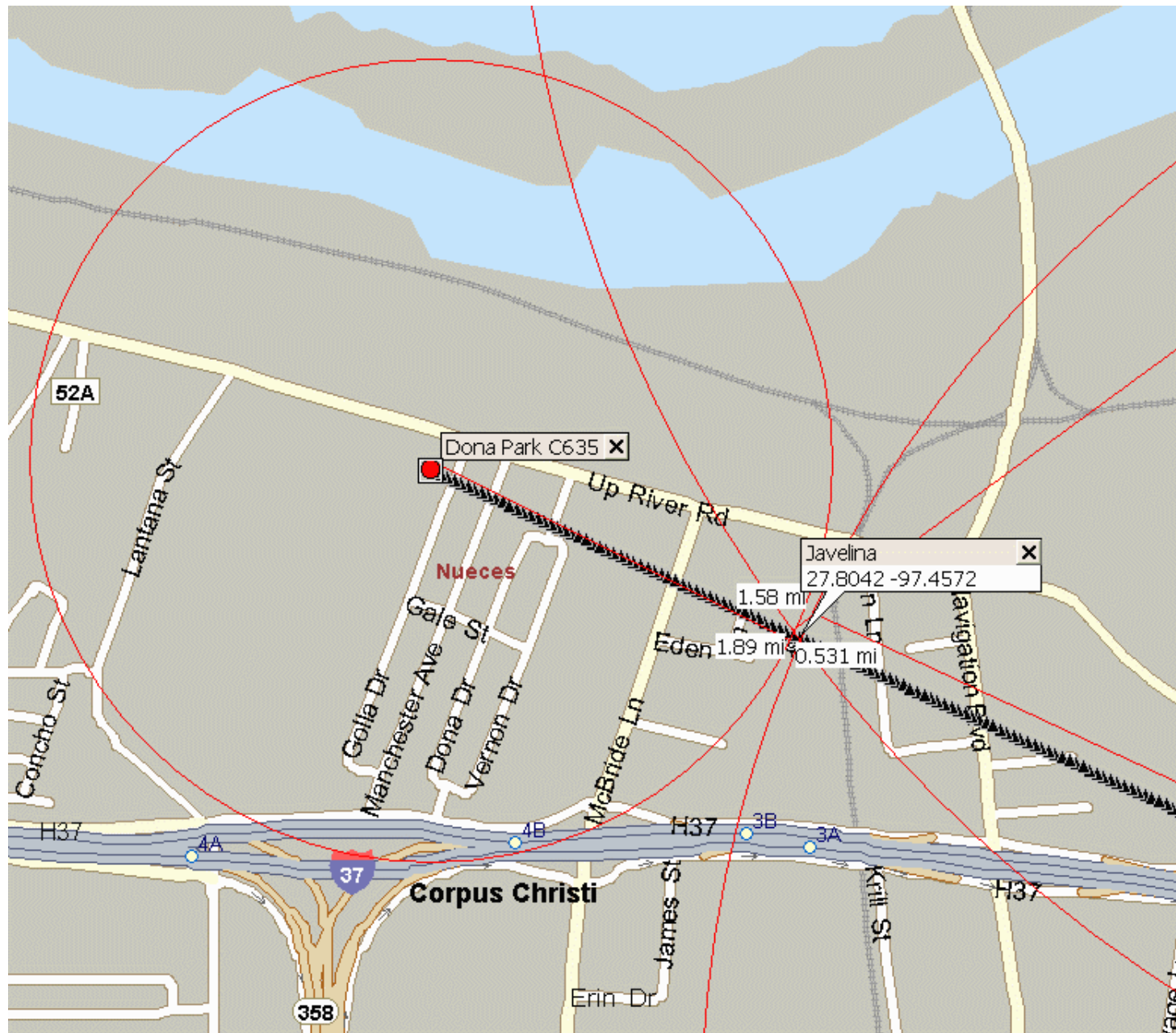
- TCEQ had concerns about flare on incinerator facility on IH 37 between Navigation and McBride.
- Emissions inventory records suggest emissions from the site would not be easily detectable.
- Examining data at Dona Park site showed noticeable effects.

# Dona Park TNMHC > 1000 ppbC (winds > 5 mph), vs wind direction 5/1/2006 – 4/30/2008





# Geometry of Monitor Locations and Incinerator Flare



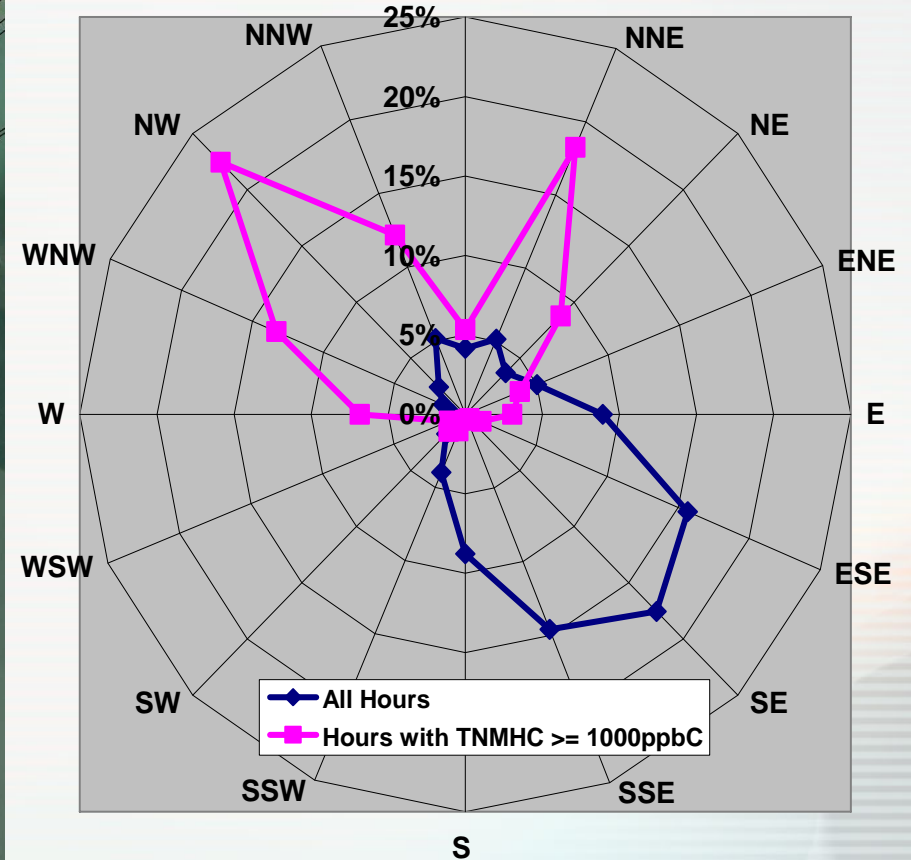
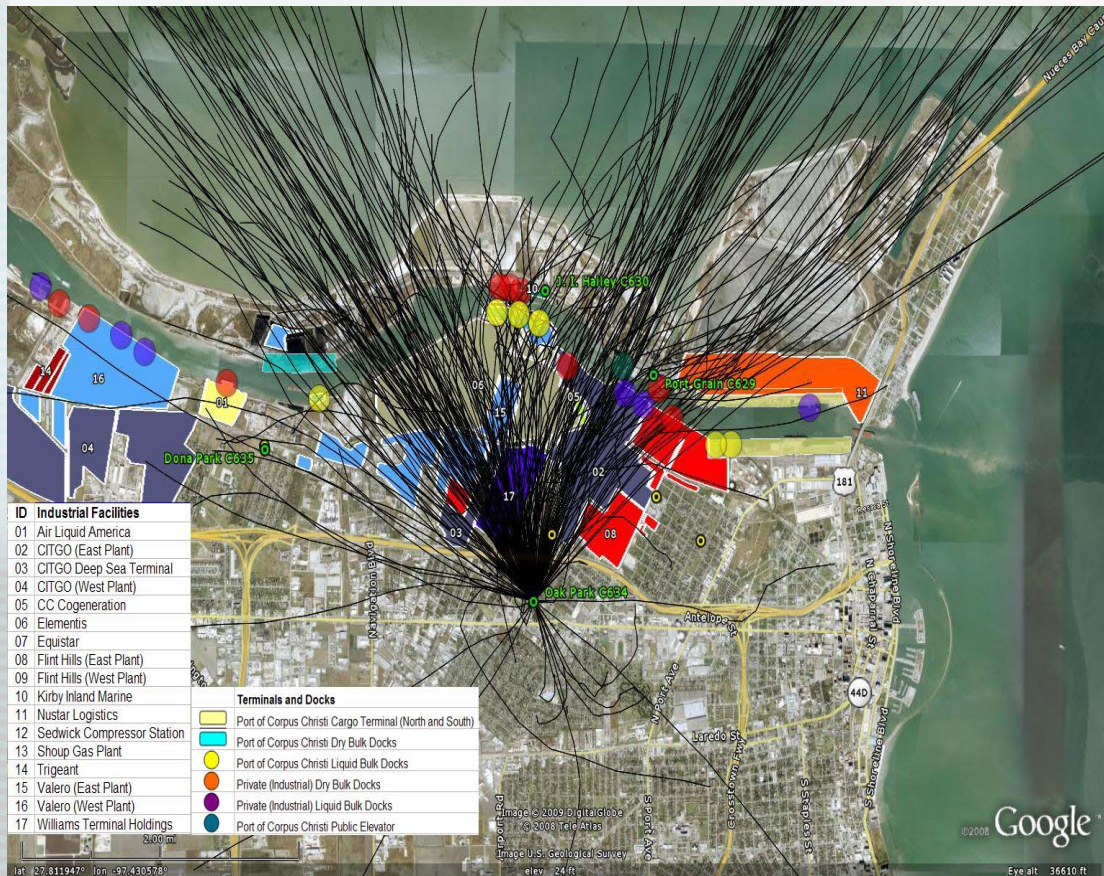
## 4. Findings from Data Analysis

- Concentrations vary by wind direction
- Significant downward trends in benzene
- How CC compares with other Texas cities
- New & unexpected emission sources

# Total Non-Methane Hydrocarbon Concentrations

- Most frequent CC winds are SE. Highest concentrations come from specific source areas:
  - Refineries, Ship loading and unloading, Storage tanks, Oil & gas extraction and pipelines, Incinerators

Oak Park Hourly TNMHC Concentrations Frequency of Occurrence by Wind Direction Based on Observations during the June 2005 through May 2008 period.



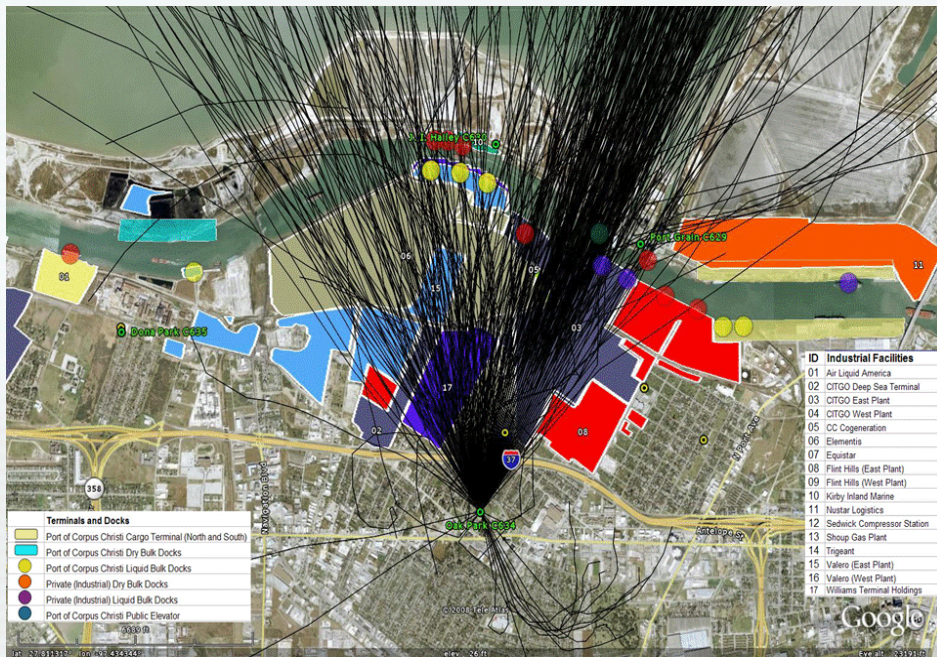
Example: Wind directionality and frequency of occurrence when TNMHC concentrations  $\geq 1000$  ppbC at Oak Park.



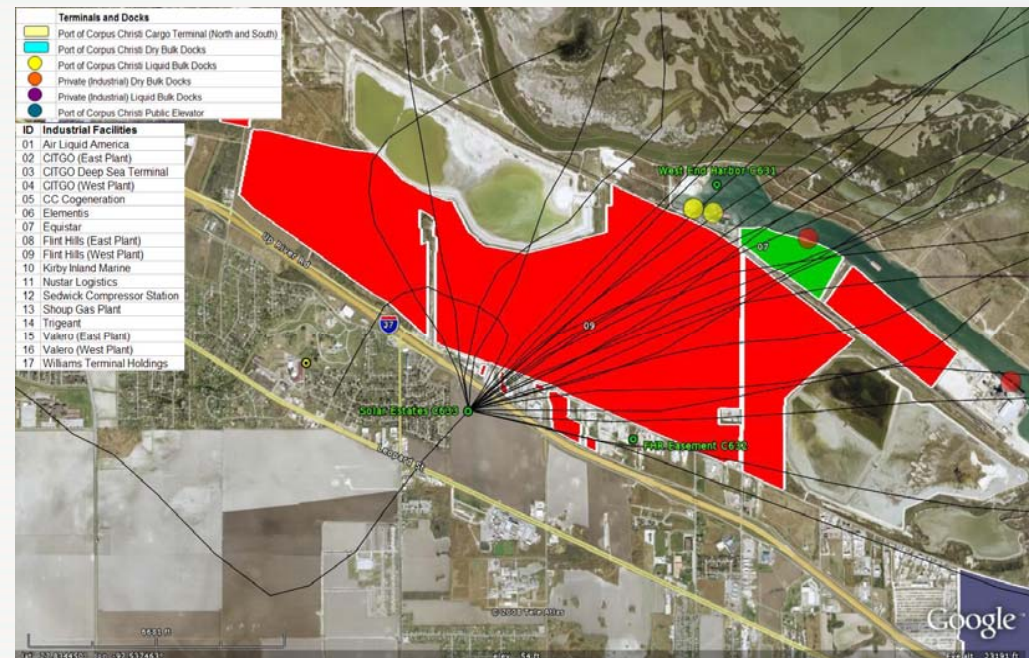
# Benzene Concentrations

- Consistent upwind geographic areas were identified during periods with higher benzene concentrations, suggesting site-specific emissions sources.

Oak Park: NW-NNE



Solar Estates: NE-E



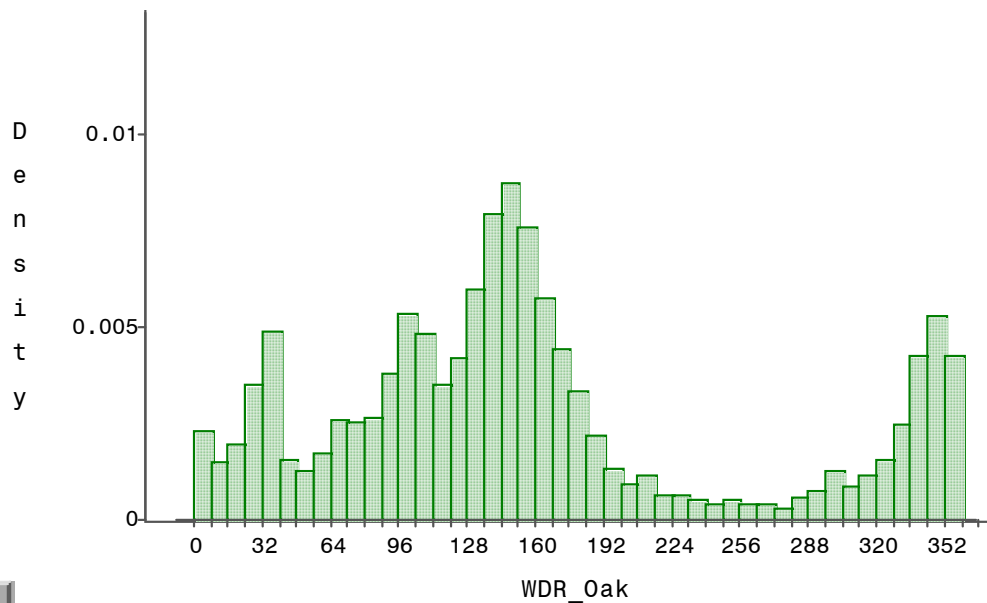
Wind directionality when benzene concentrations  $\geq 30$  ppbC at Oak Park and Solar Estates.



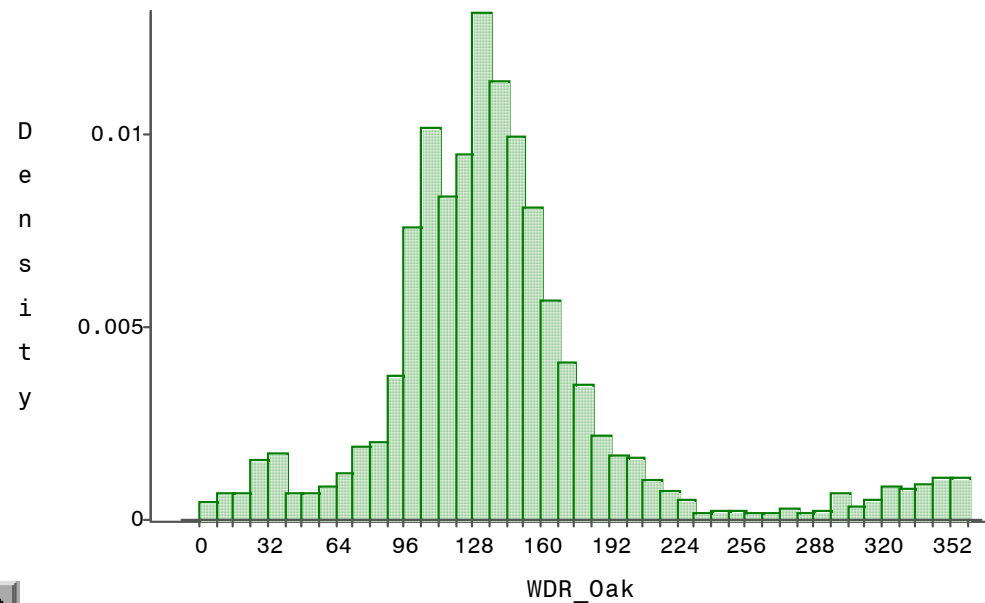
# Two Auto-GCs, peak benzene directions



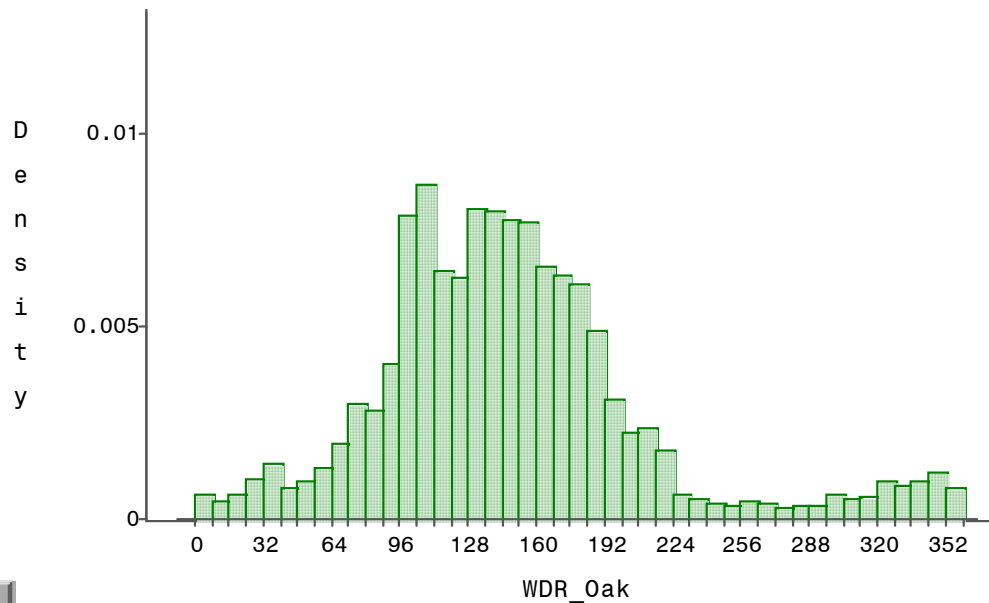
### Distribution of 1<sup>st</sup> Q wind directions



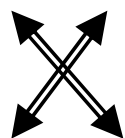
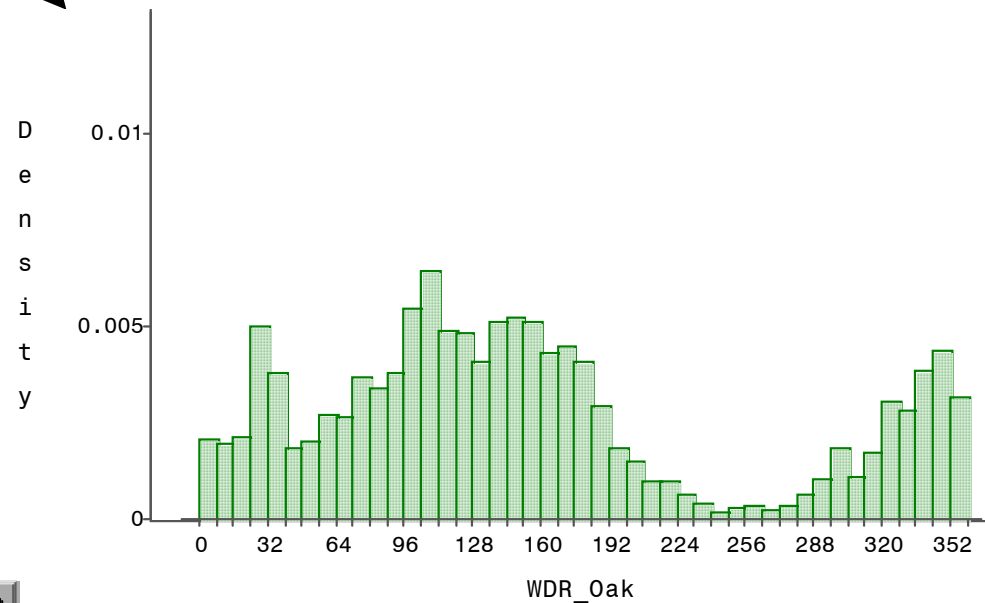
### Distribution of 2<sup>nd</sup> Q wind directions



### Distribution of 3<sup>rd</sup> Q wind directions



### Distribution of 4<sup>th</sup> Q wind directions



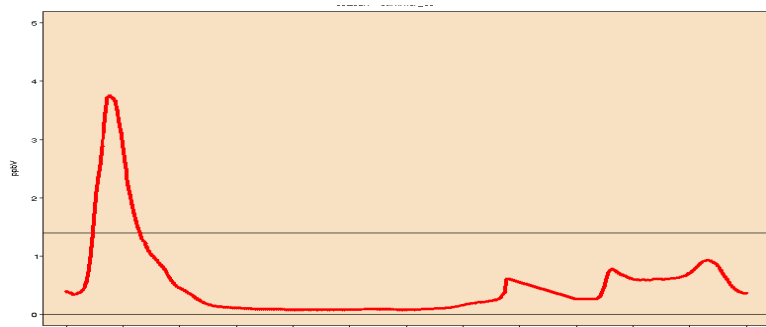
Trends:  
2005-2008  
Benzene  
from  
Auto-GCs  
in Corpus  
Christi

Site	Period	Num	Mean	Peak 1hr	Peak 24hr
Oak	2005	6312	0.59	48.17	5.52
Oak	2006	7394	0.70	51.15	7.78
Oak	2007	7628	0.62	120.16	8.95
Oak	2008	7501	0.36	20.93	2.97
Site	Period	Num	Mean	Peak 1hr	Peak 24hr
Solar	2005	5299	0.32	9.63	1.24
Solar	2006	6602	0.37	11.66	2.50
Solar	2007	6671	0.33	7.41	1.80
Solar	2008	7594	0.22	9.42	1.15
Site	Period	Num	Mean	Peak 1hr	Peak 24hr
Oak	4Q05	1972	1.30	48.17	5.52
Oak	4Q06	1915	1.14	26.32	5.65
Oak	4Q07	1900	0.68	38.15	6.41
Oak	4Q08	1912	0.63	16.31	2.97
Site	Period	Num	Mean	Peak 1hr	Peak 24hr
Solar	4Q05	1727	0.41	9.63	1.24
Solar	4Q06	1872	0.58	11.66	2.50
Solar	4Q07	1847	0.37	6.94	1.06
Solar	4Q08	1985	0.30	4.69	1.07

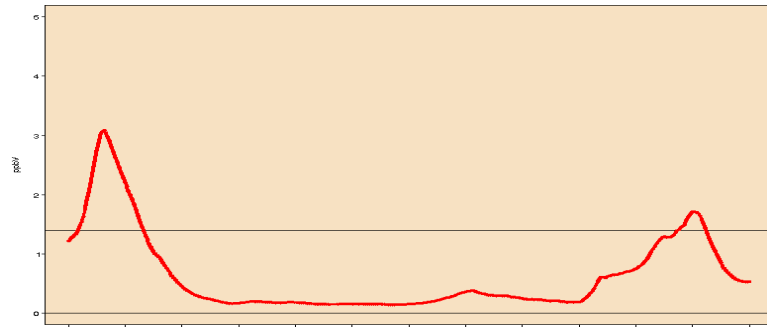
# Oak Park Benzene by Direction & Season

geometric mean, kernel smoothing, wind speed > 4mph

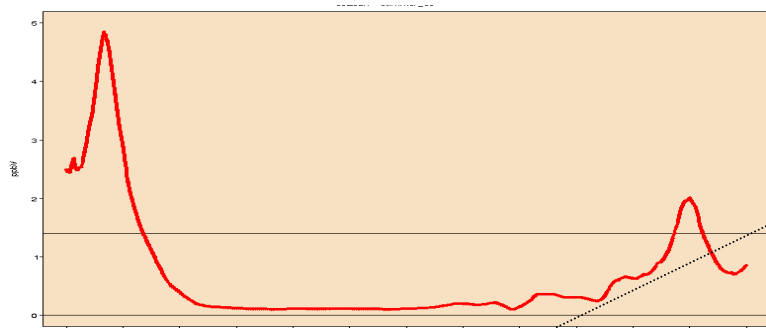
S05



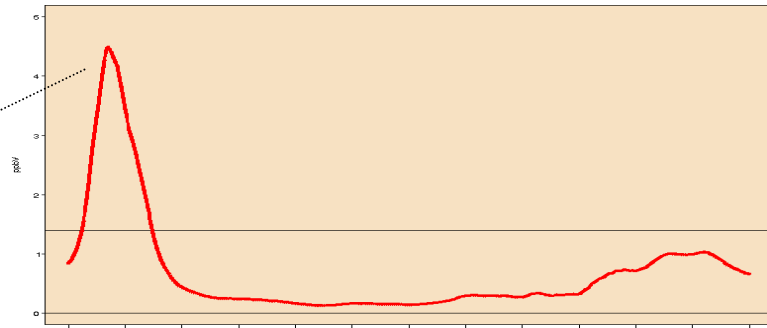
W05-06



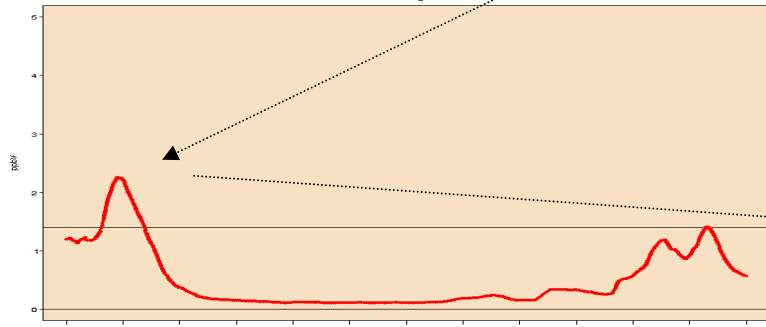
S06



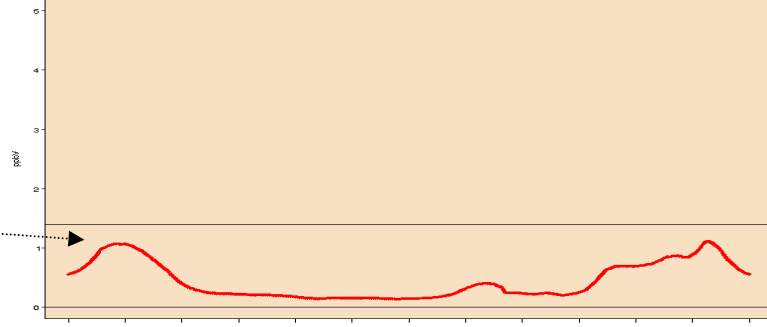
W06-07



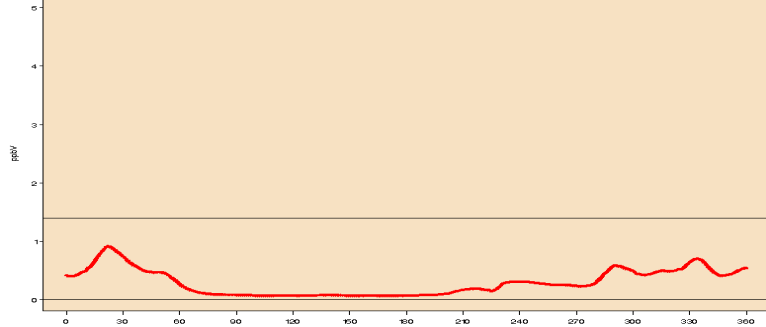
S07



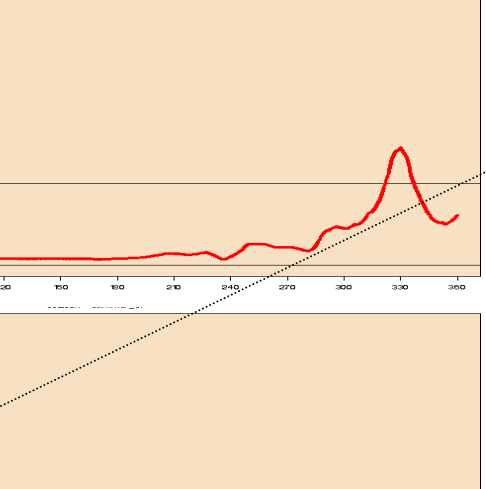
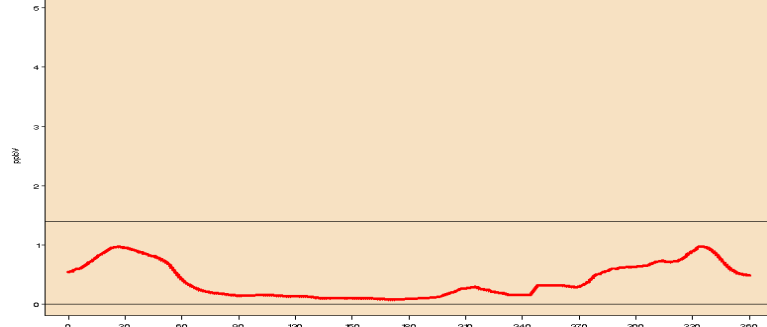
W07-08



S08



W08-09





# 2008 Benzene from Auto-GCs in Texas

Site	Where	Num Samples	Mean	1-hr max	24-hr max
Lynchburg Ferry	Houston	6,771	1.10	777.09	38.32
Channelview	Houston	7,235	0.63	94.04	6.72
Chamizal	El Paso	5,959	0.49	16.17	3.81
Odessa Hays	Odessa	7,377	0.45	679.02	61.73
Cesar Chavez	Houston	7,150	0.43	7.73	2.00
Clinton Dr.	Houston	6,151	0.40	8.15	1.44
HRM 3 Haden Rd	Houston	7,109	0.40	14.60	2.25
Beaumont-Lamar	Beaumont	7,025	0.40	14.00	2.07
Deer Park	Houston	7,091	0.39	20.55	2.06
<b>Oak Park</b>	<b>Corpus Christi</b>	<b>7,501</b>	<b>0.36</b>	<b>20.93</b>	<b>2.97</b>
Nederland HS	Beaumont	6,947	0.34	12.39	2.13
Milby Park	Houston	6,341	0.30	14.83	2.10
Mustang Bayou	Brazoria Co	7,104	0.30	12.42	2.07
Odessa Gonzales	Odessa	7,578	0.26	4.62	0.89
Wallisville Rd	Houston	7,365	0.24	9.85	1.70
<b>Solar Estates</b>	<b>Corpus Christi</b>	<b>7,594</b>	<b>0.22</b>	<b>9.42</b>	<b>1.15</b>
Texas City	Texas City	7,163	0.20	8.43	0.98
Fort Worth	Fort Worth	7,318	0.20	2.79	0.72
Dallas Hinton	Dallas	7,334	0.17	2.05	1.66
Lake Jackson	Brazoria Co	7,253	0.14	32.81	1.67
Dancinger	Brazoria Co	6,480	0.13	7.53	0.58

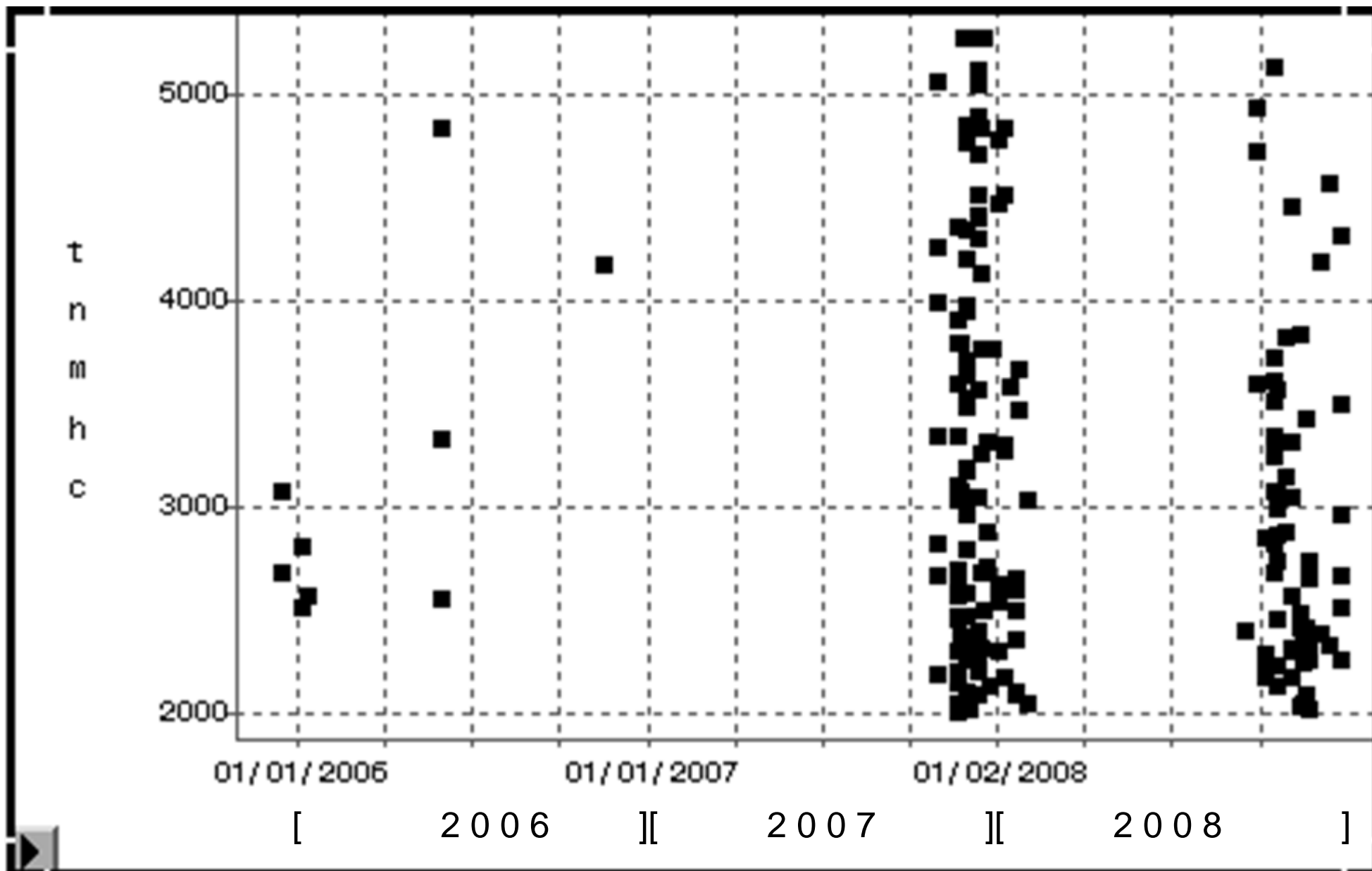
Site	Mean 2006	Mean 2008	Difference
Lynchburg Ferry	2.38	1.10	-54%
Texas City	0.41	0.20	-51%
<b>Oak Park</b>	<b>0.70</b>	<b>0.36</b>	<b>-49%</b>
<b>Solar Estates</b>	<b>0.37</b>	<b>0.22</b>	<b>-41%</b>
HRM 3 Haden Rd	0.61	0.40	-34%
Chamizal	0.67	0.49	-27%
Clinton Dr.	0.53	0.40	-25%
Deer Park	0.51	0.39	-24%
Wallisville Rd	0.30	0.24	-20%
Danciger	0.16	0.13	-19%
Dallas Hinton	0.20	0.17	-15%
Milby Park	0.33	0.30	-9%
Mustang Bayou	0.33	0.30	-9%
Cesar Chavez	0.47	0.43	-9%
Lake Jackson	0.15	0.14	-7%
Channelview	0.67	0.63	-6%
Fort Worth NW	0.18	0.20	11%
Odessa Gonzales	0.22	0.26	18%
Odessa Hays	0.24	0.45	88%

2006 vs  
2008  
Benzene  
from  
Auto-GCs  
in Texas

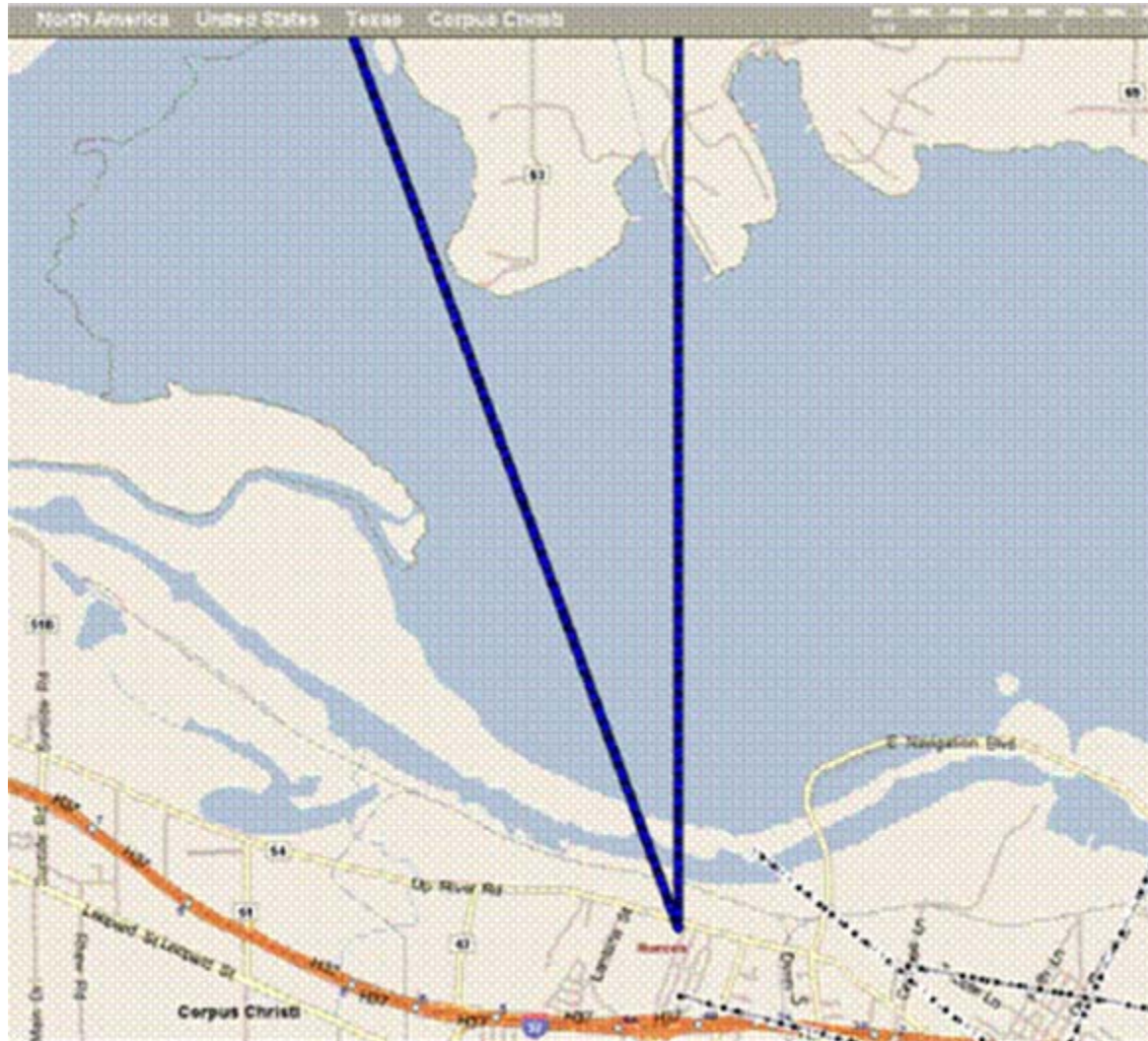
## New & unexpected emission source: Oil & Gas Operations on White Point

- Noticed increasing number of alerts and associated back-trajectories with north winds at Dona Park, WEH, and other sites
- TCEQ Region reported oil & natural gas extraction had started up on White Point peninsula on north side of Nueces Bay
- Ensemble of back-trajectory analysis added evidence, although back-trajs “leave” the network.

Dona Park TNMHC 5-min data  $\geq 2000$  ppbC,  
wind direction 340 – 360 deg (NNW)



# Wind direction “cone” from Dona Park points to “White Point”





# WEH 11/11/07 ; J.I. Hailey 12/10/08



Alert ID: emrs\_medium\_alert\_48355003843102\_20081107\_2345

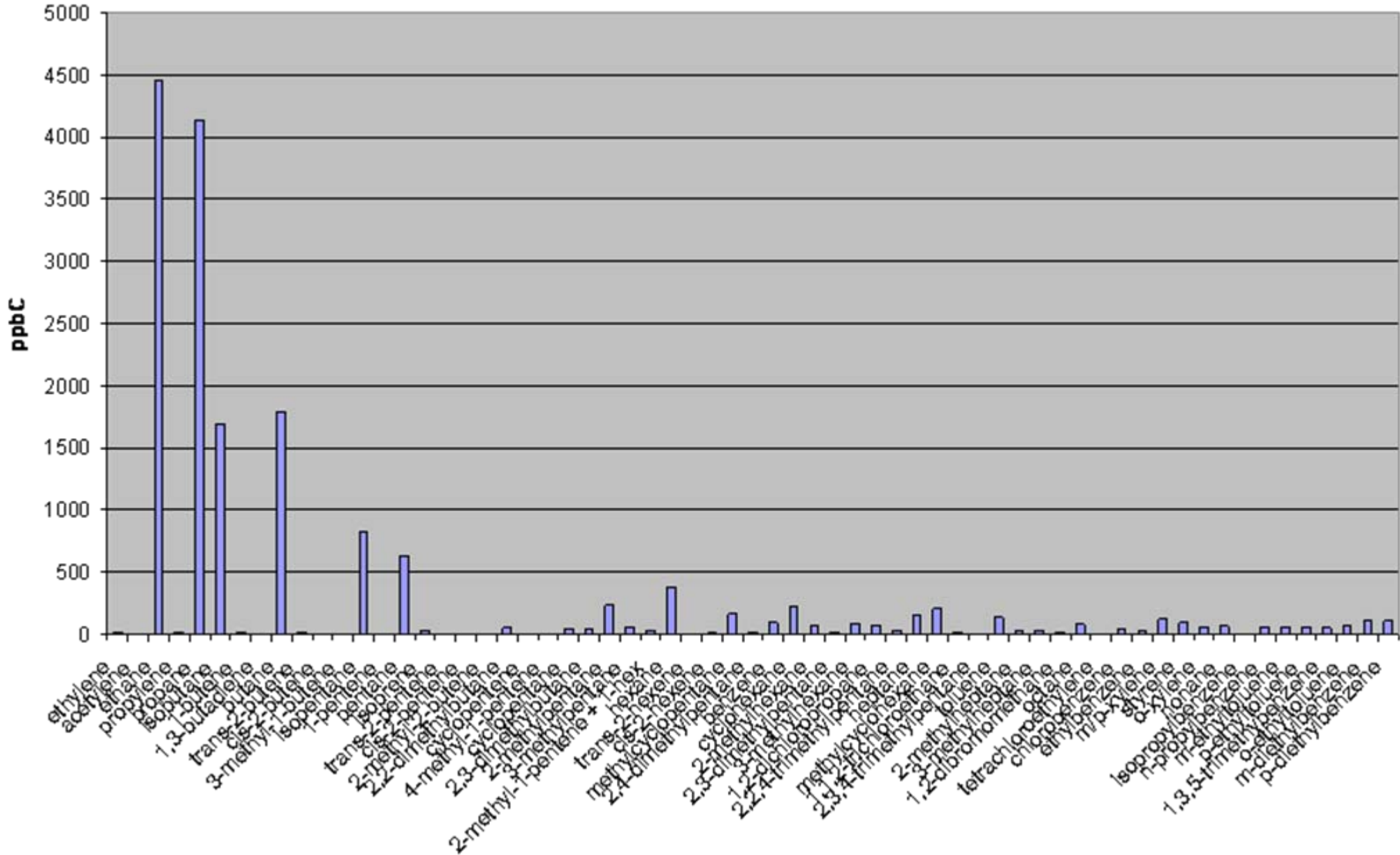
TNMOC MEDIUM trigger at site Inner Harbor C631  
4171.16 >= 2000.00 ppbC (no previous trigger)  
WD = 78 degrees  
WS = 4.0 mph  
time of trigger 23:45 (CST) 2008.11.07

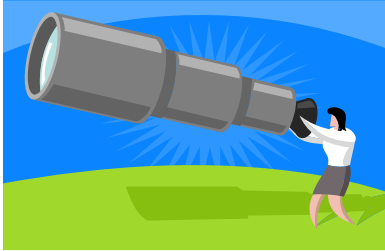


Alert ID: emrs\_medium\_alert\_48355003743102\_20081210\_1835

TNMOC MEDIUM trigger at site J.I. Hailey C630  
4820.92 >= 2000.00 ppbC (trigger 2 of 3)  
WD = 316 degrees  
WS = 8.4 mph  
time of trigger 18:35 (CST) 2008.12.10

# JIH Can 12/10/08 18:43 CST, White Point upwind





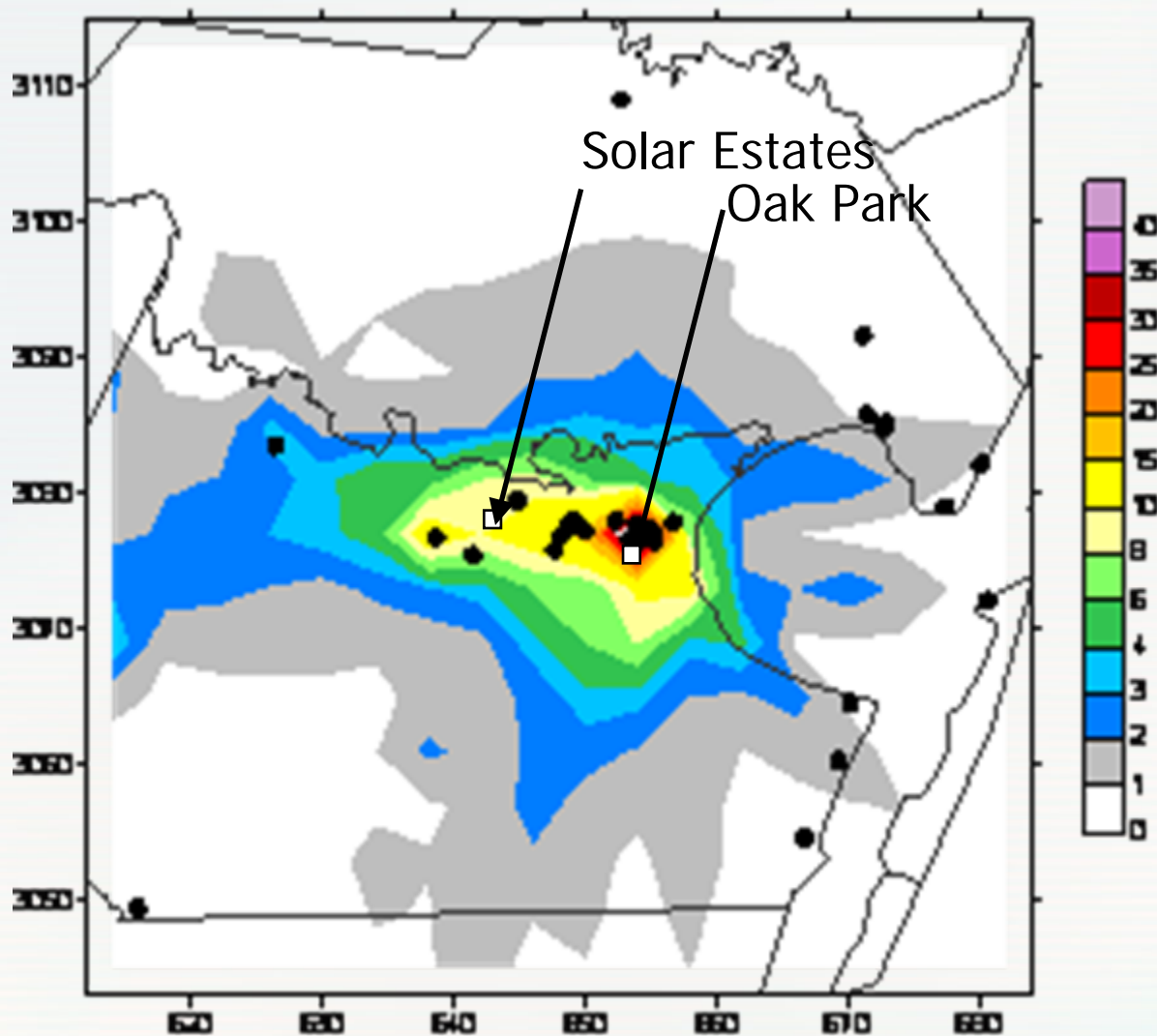
## 5. Plans for the Future

Neighborhood air toxics modeling

Infrared camera

Mobile monitoring

# Neighborhood Air Toxics Example: Preliminary Predicted Max 1-hour Benzene ppbV for Modeled Time Period



**All Sources**

**Maximum concentration: 43.537 ppb**

# Infrared Camera



# Mobile Monitoring

- Contingent on receiving second stage of funding from Federal Court.
- Would create mobile monitoring vehicle similar to that in use for current UT CEER projects and TCEQ Monitoring Operations.
- Would allow for tracking of plumes, better characterization of concentrations between CAMS sites for comparisons with simulations.

# 6. Summary

- Monitoring has helped
  - Assess air toxics exposure
  - Show trends – in particular, decline in Benzene
  - Detect new emission sources – oil & gas operations, incinerator emissions
  - Confirm some emission events
- Future monitoring will help
  - Expand knowledge of emissions and concentrations
- Future modeling will help
  - Assess human exposure
  - Check existing emissions inventory
  - Test new emission sources
  - Suggest improvements to monitoring network