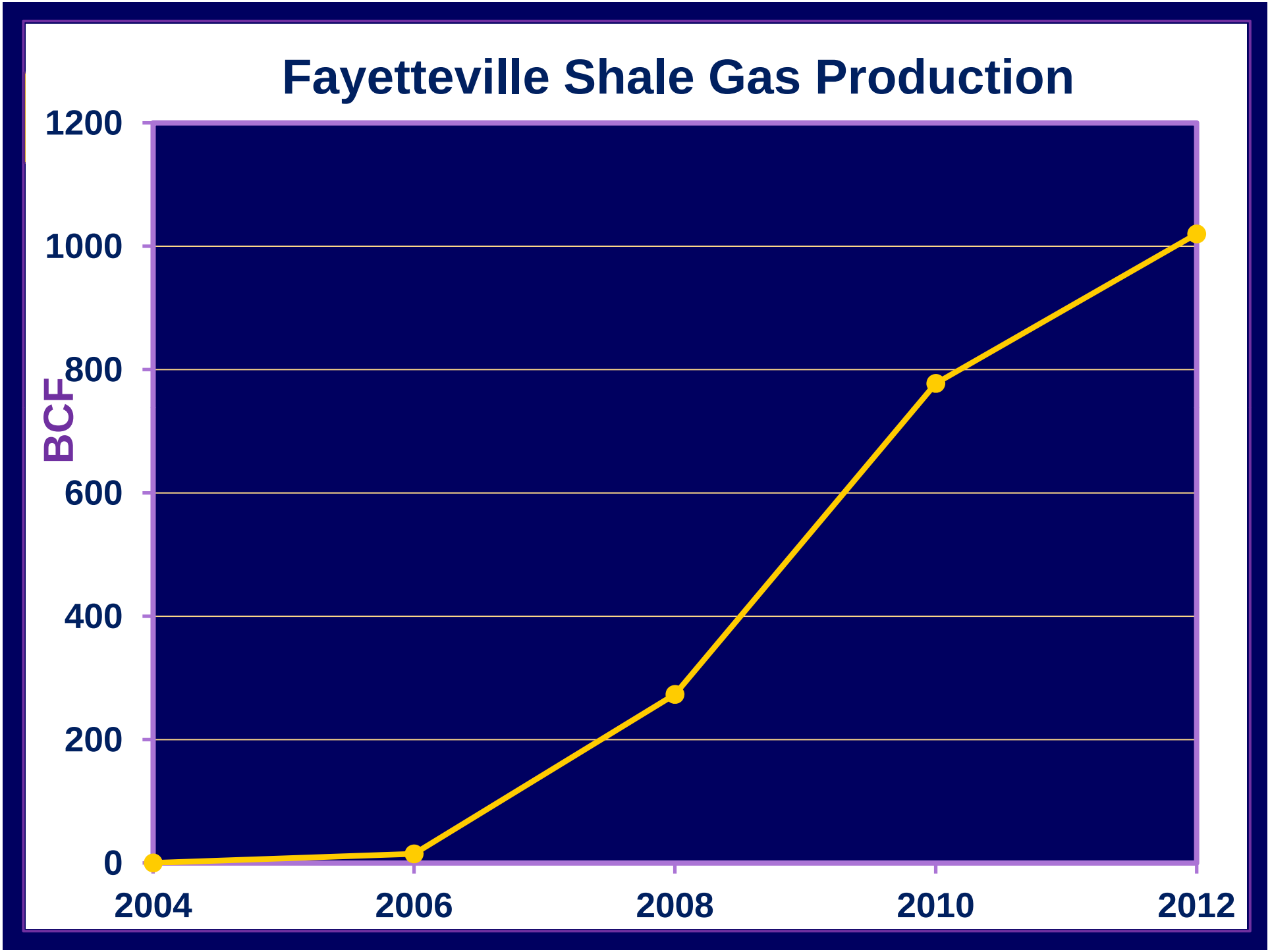
Emissions Inventory & Ambient Air Monitoring of Natural Gas Production in the Fayetteville Shale

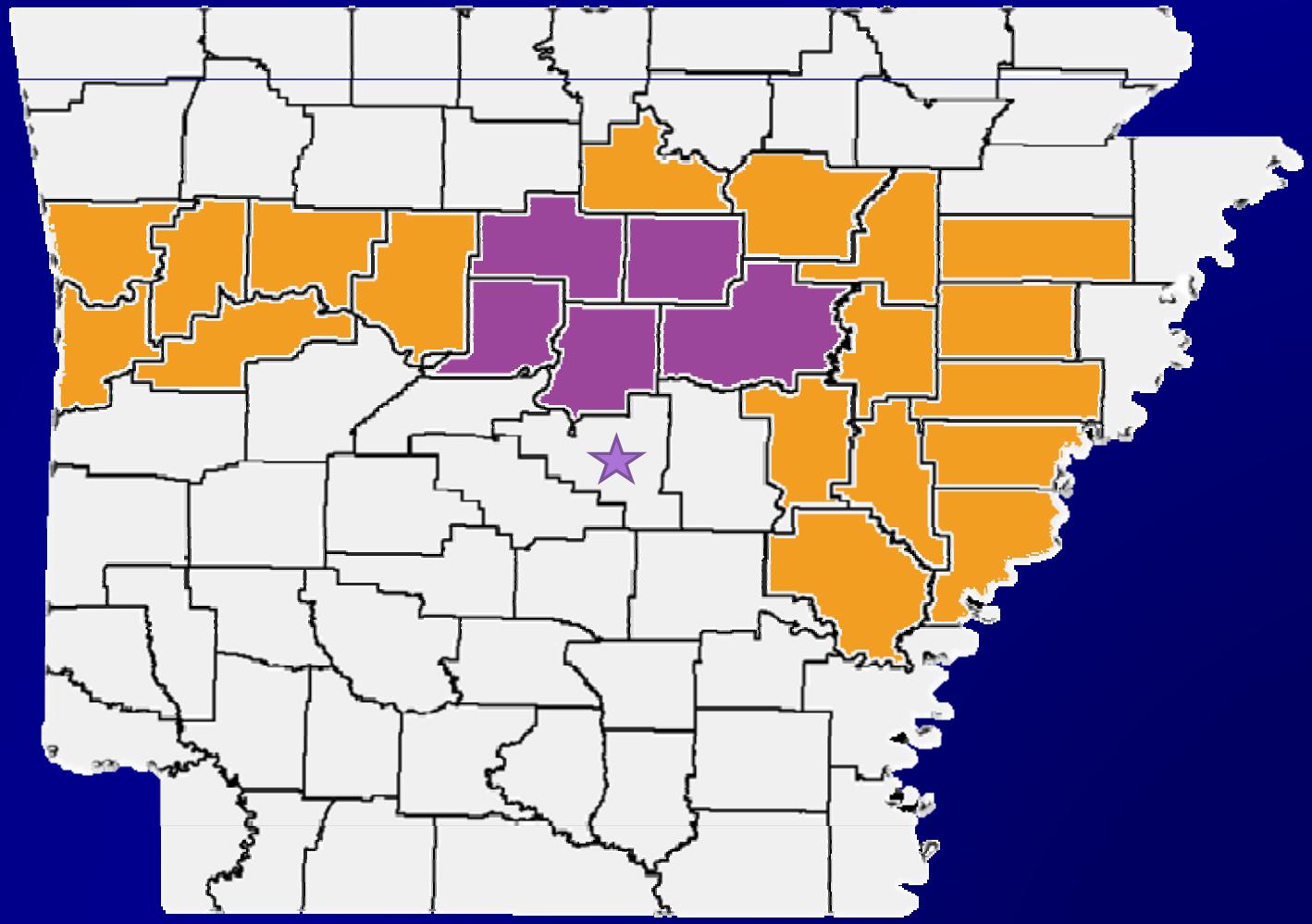
Toby Chu

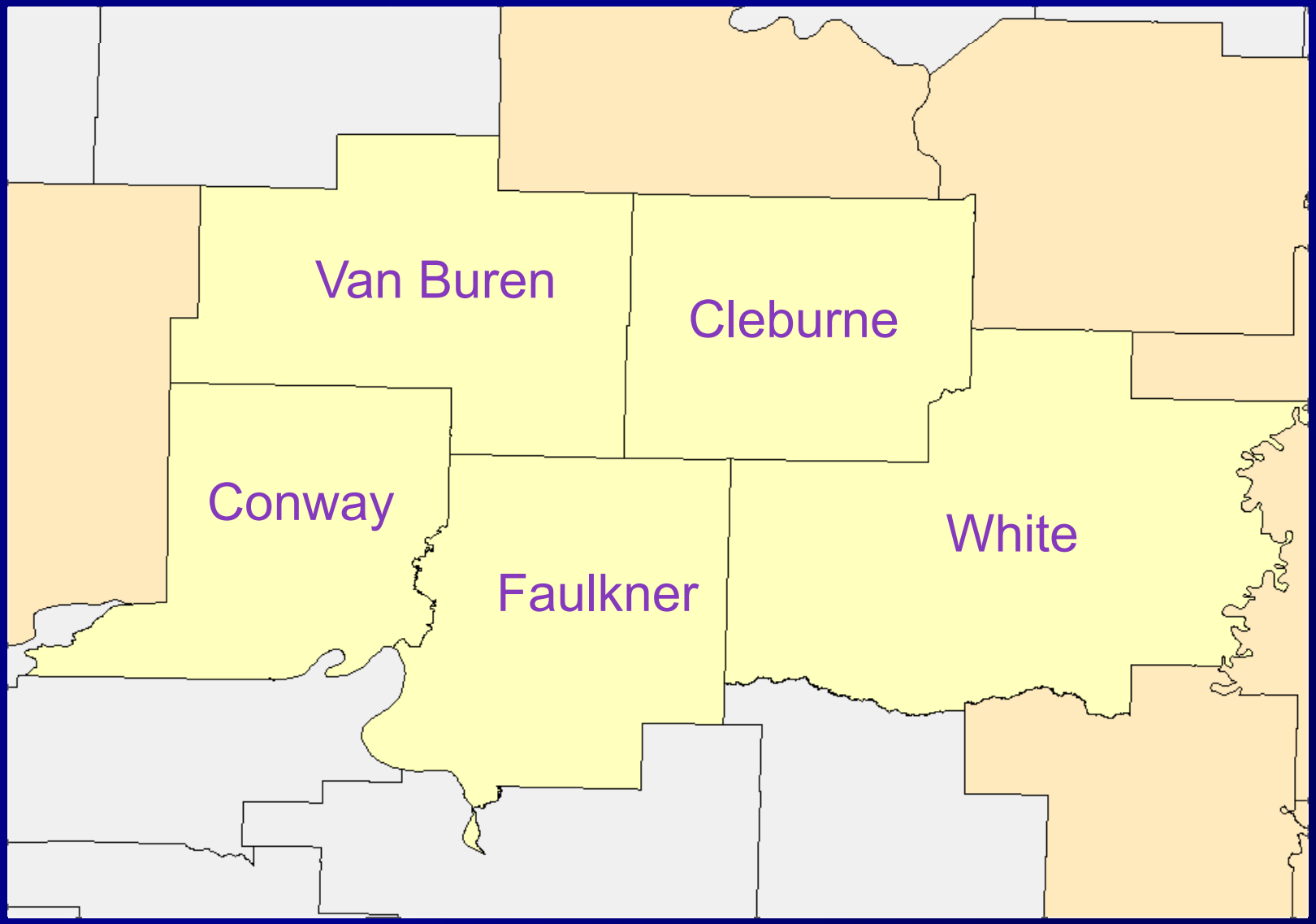
Arkansas Dept. of Environmental Quality

River
Muskwa-Otter Park
Montney
Doig Phosphate
Colorado Group
Niobrara
Bakken
Cody
Heath
Gammon
Mowry
Hilliard-Baxter-Mancos-Niobrara
Niobrara
Mancos
Monterey-Temblor
Hermosa
Lewis
Pierre-Niobrara
Monterey
Woodford
Excello-Mulky
Fayetteville
Bend
Avalon
Barnett
Barnett-Woodford
Eagle Ford, La Casita
Eagle Ford
Eagle Ford, Tithonian
Pimienta
Pimienta, Tamaulipas
Antrim
Devonian (Ohio)
Marcellus
Utica
New Albany
Floyd-Neal
Conasauga
Chattanooga
Haynesville-Bossier
Tuscaloosa
Utica
Frederick Brook
Horton Bluff
Current Shale Plays
Stacked Plays
Shallowest/Youngest
Intermediate Depth/Age
Deepest/Oldest
Prospective Shale Plays
Basins
Source: Energy Information Administration
www.usilp.com

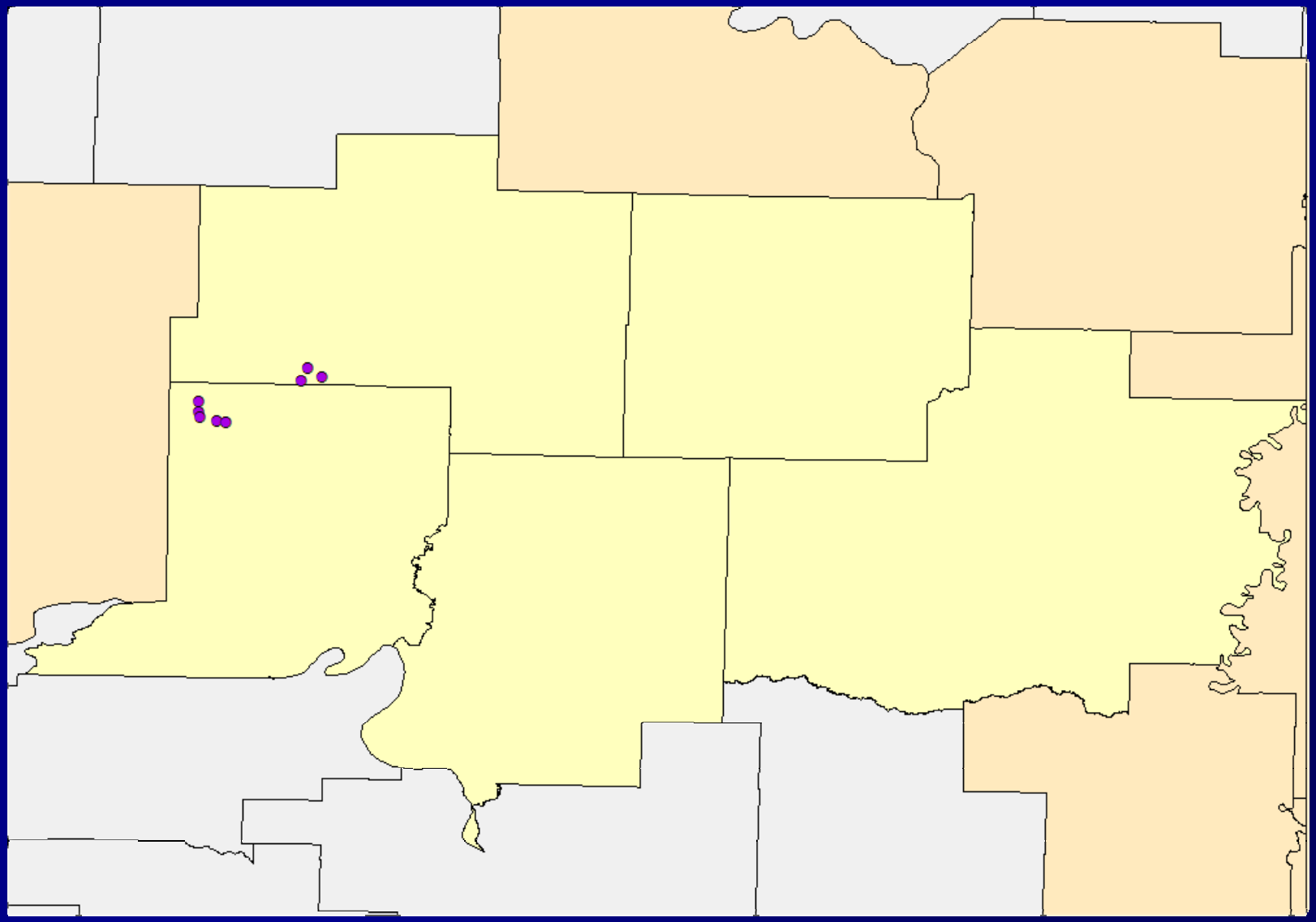
www.oilshalegas.com


Fayetteville Shale Gas Production
BCF
1200
1000
800
600
400
200
0
2004
2006
2008
2010
2012

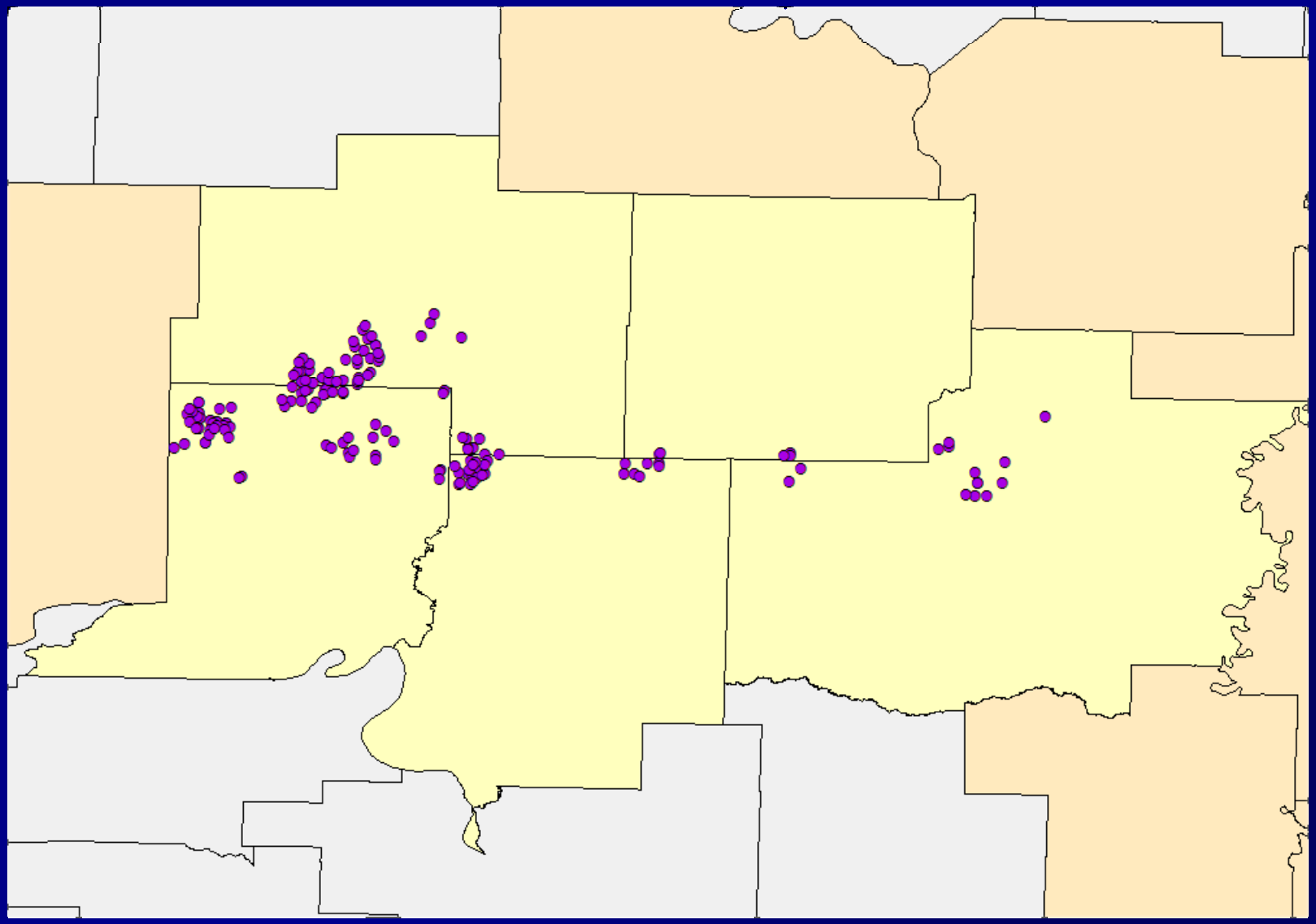



Van Buren
Cleburne
Conway
Faulkner
White

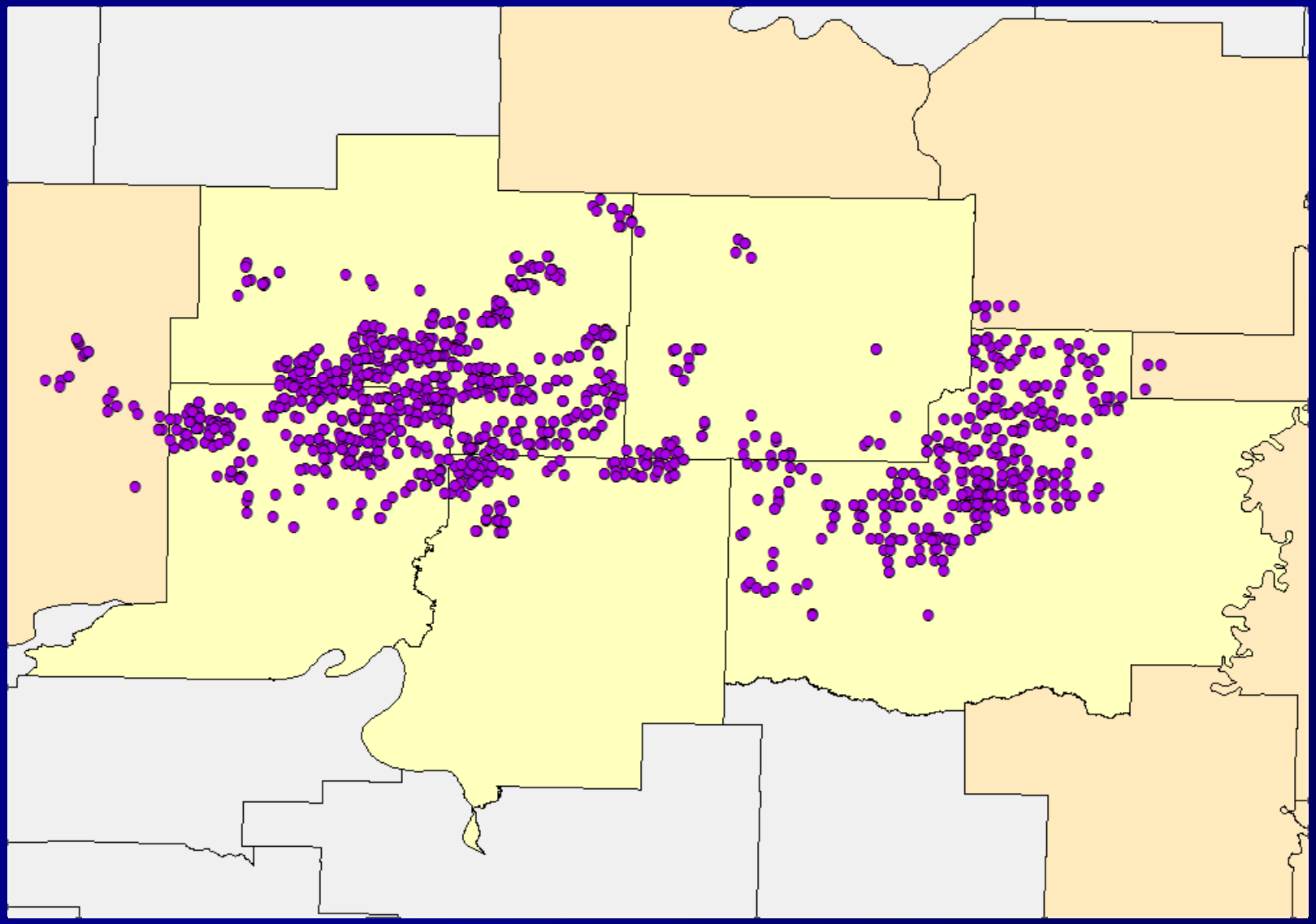
2004



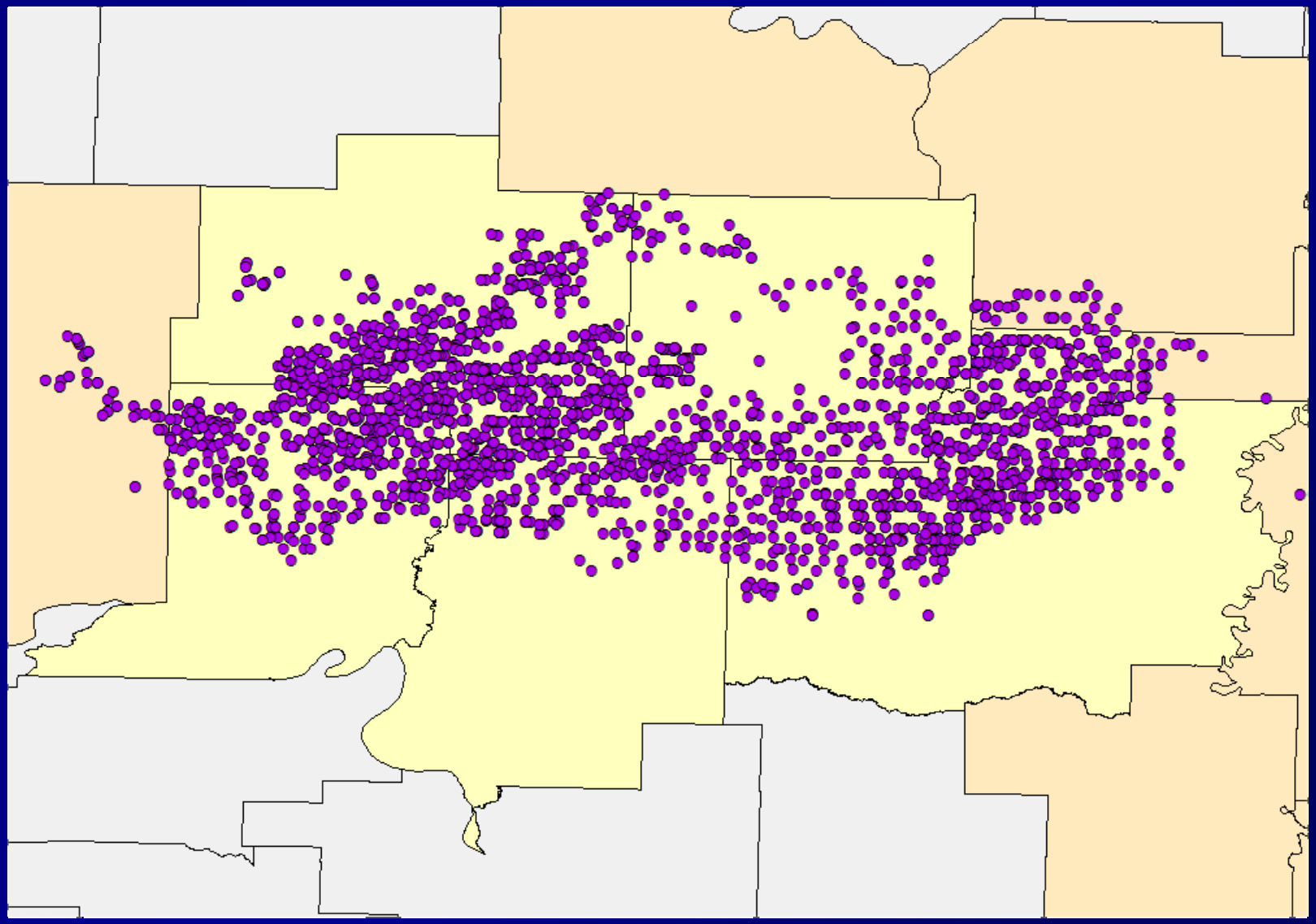
2006



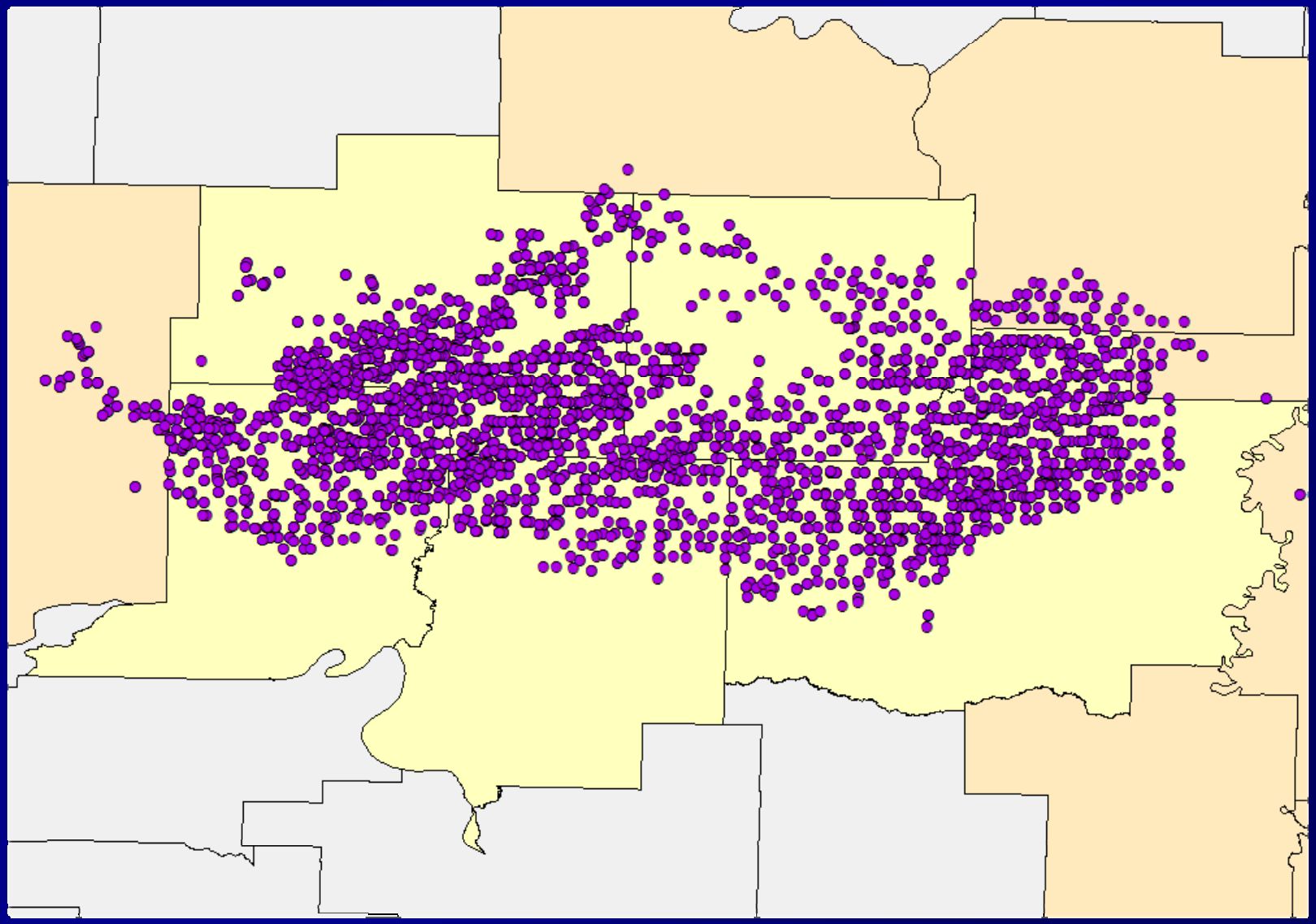
2008



2010



2012



two-prong study of Fayetteville Shale

Emissions Inventory

- Arkansas Oil & Gas Commission data
- emissions factors based on Armendariz
- Industry input
- Pollutants estimated: NOx, VOCs, PM, SO_2, CO_2, CO, CH_4

Ambient air monitoring

- Well sites at different stages of completion
- Stationary/transect measurements
  - Pollutants measured: NOx, VOCs, CH_4

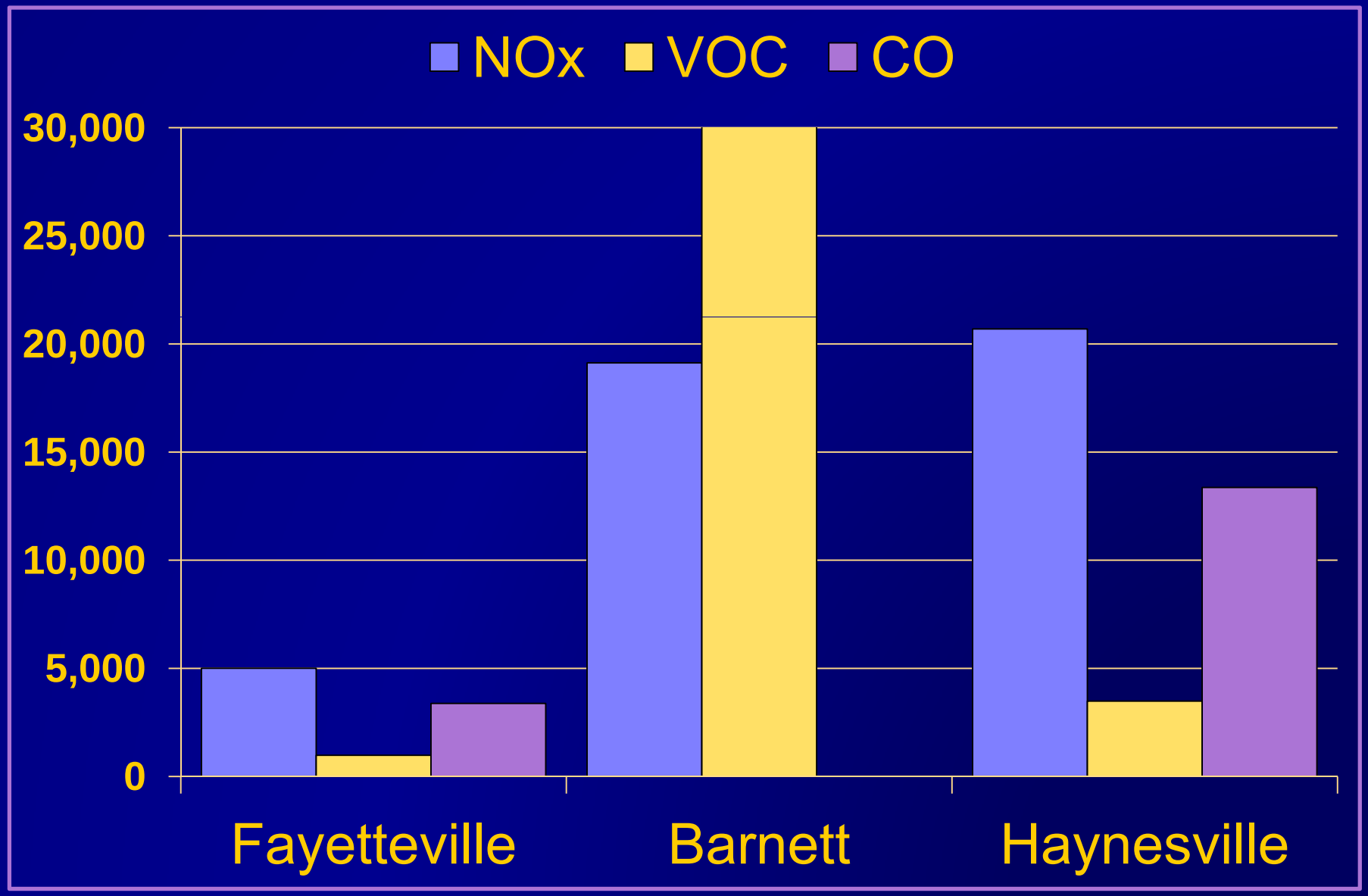
EPA-funded

Prong 1: Emissions Inventory

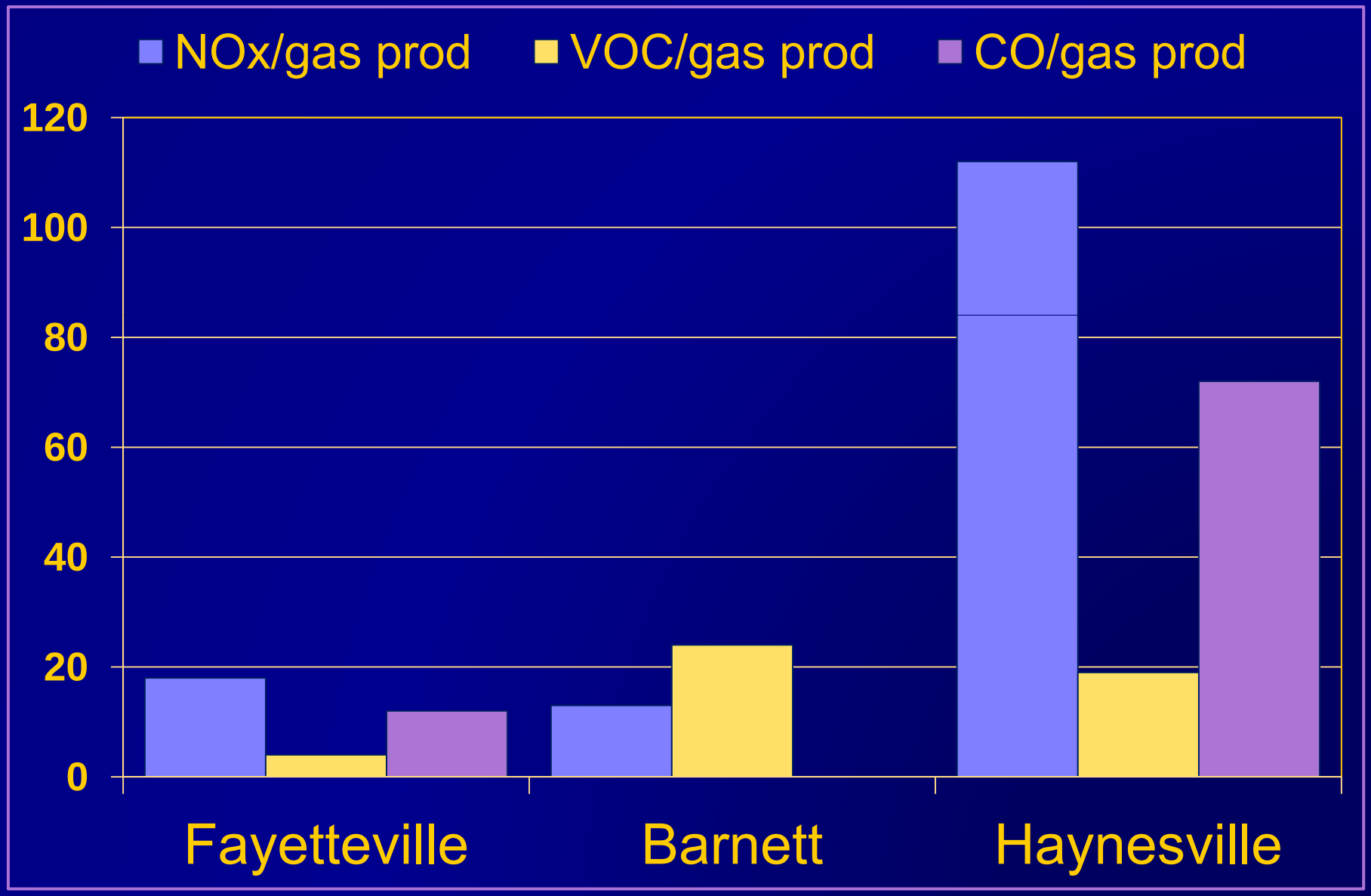
2008 emissions from the Fayetteville Shale

Source Category	NO_X	VOC	PM_{10}	CO	SO_2	CH_4	CO_2
Compressor Engines	3,381	787	79	3,258	106	13,833	1,225,643
Well Drilling & Completion	1,621	166	595	119	22	58,033	67,756
Fugitive Emissions		23				41,011	3,972
Total Emissions	5,002	977	674	3,377	128	112,877	1,297,371

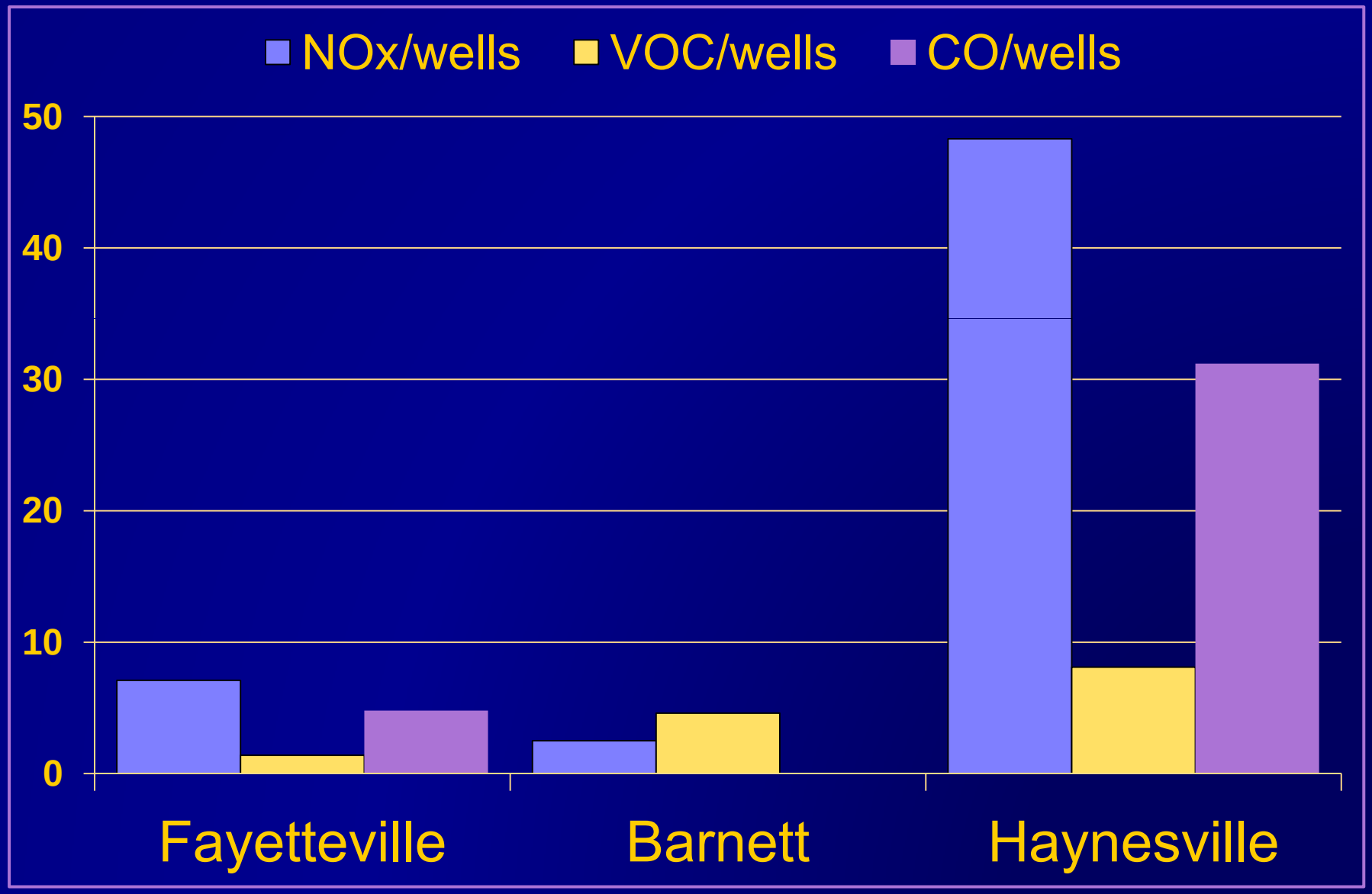
Emissions (tpy) by shale play



Emissions per gas production (tpy/bcf)

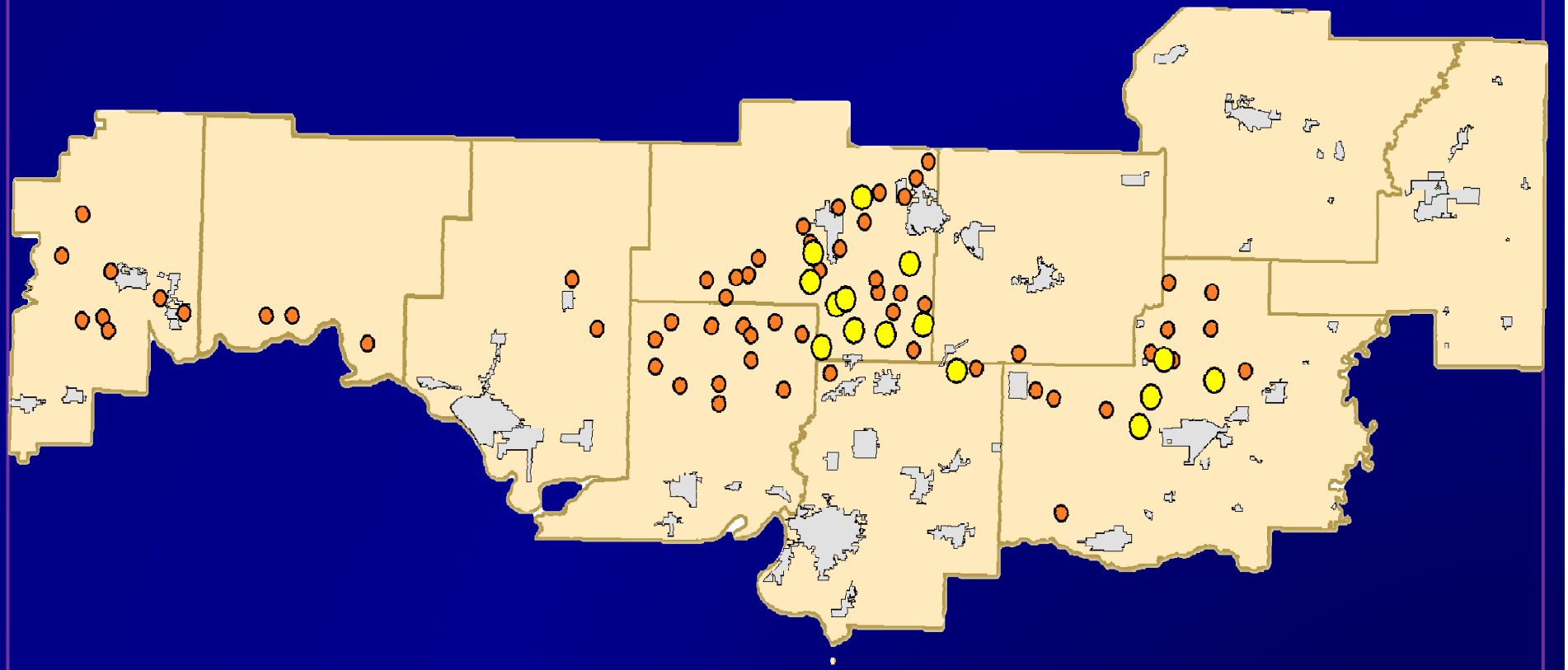


Emissions per number of wells (tpy/wells)



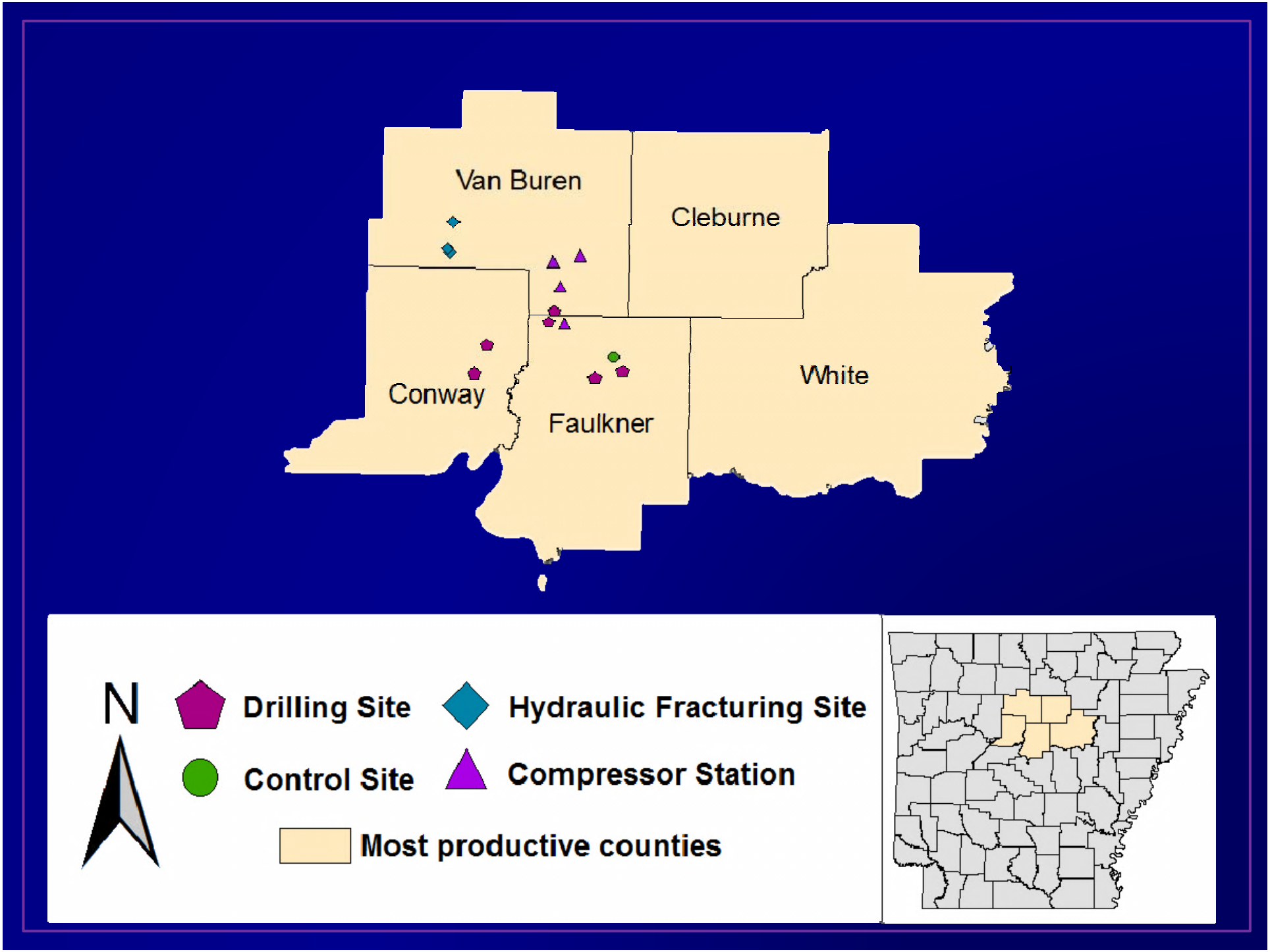
Prong 2:
Air monitoring

Choosing Compressor Stations



- Compressor Station (≥4 engines + dehydrator)
- Compressor Station (<4 engines or no dehydrator)
- City Limits
- County Line

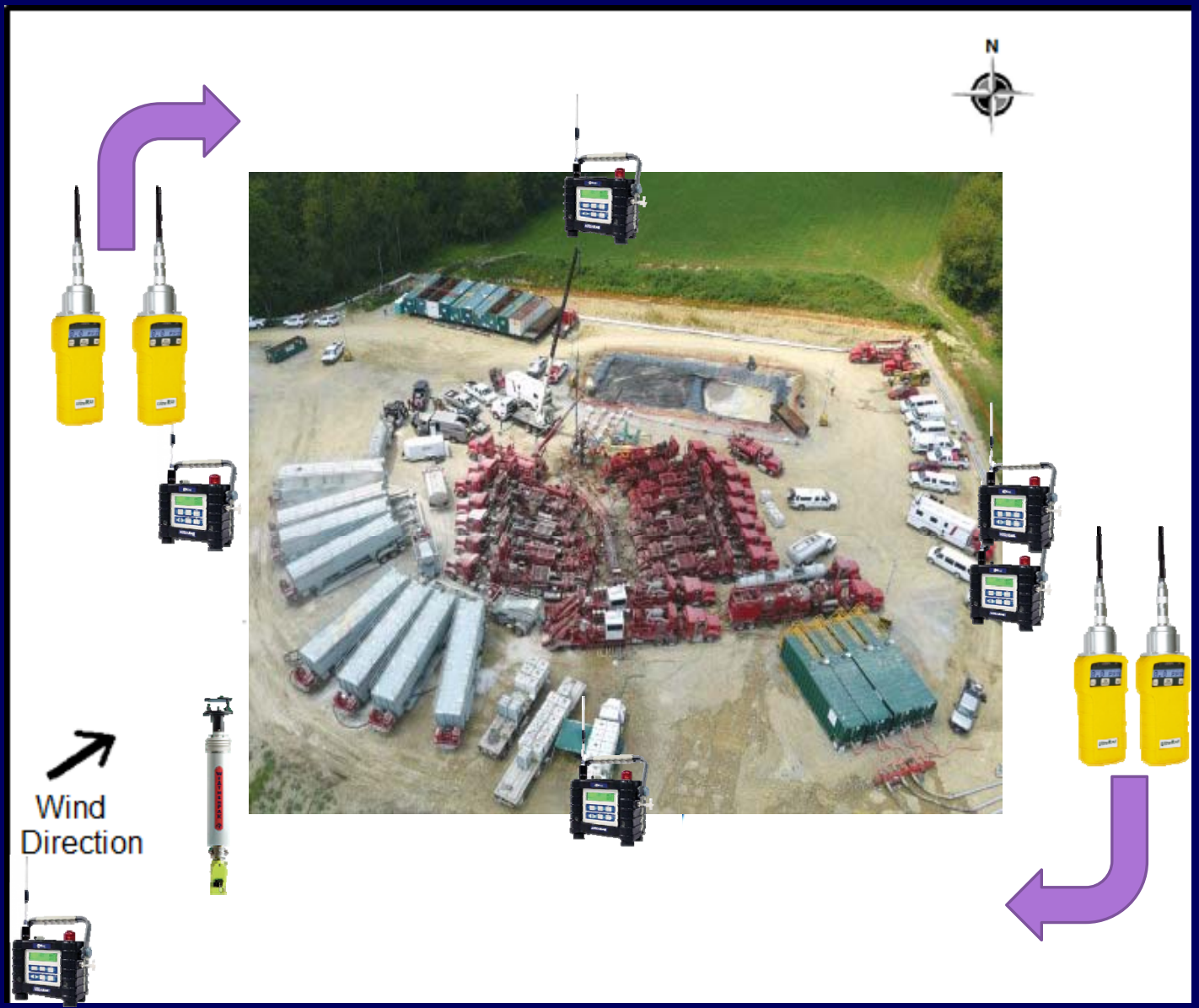
Stages of Well Completion Studied


Van Buren
Cleburne
Conway
Faulkner
White
N
Drilling Site
Hydraulic Fracturing Site
Control Site
Compressor Station
Most productive counties

Portable Air Monitoring Equipment

Monitoring Method

Monitoring Method



Monitoring Method

Toby Chu

Toby Chu

Study Results

- Which site type had the highest NOx recorded?
- Which site type had the highest CH4 recorded?
- Which site type had the highest VOC recorded?

Study Results

- Which site type had the highest NOx & CH4 recorded?
  - Trick question – nothing was recorded above Minimum Detection Limits
- Which site type had the highest VOC recorded?
  - Drilling site monitors measured up to 678 ppb daily avg. & 13 ppm 5-sec avg.

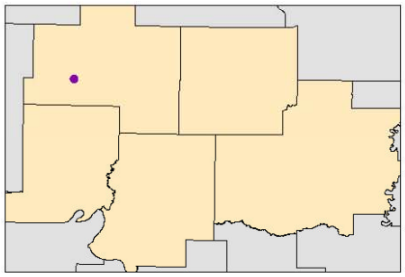
AFGC
5/26/2011

N

AGFC 10-16 1-2H11
(35.5449069, -92.6540498)
Van Buren County
Monitored during Hydraulic Fracturing
BHP (formerly Chesapeake)

Monitoring Site / Shale Pad

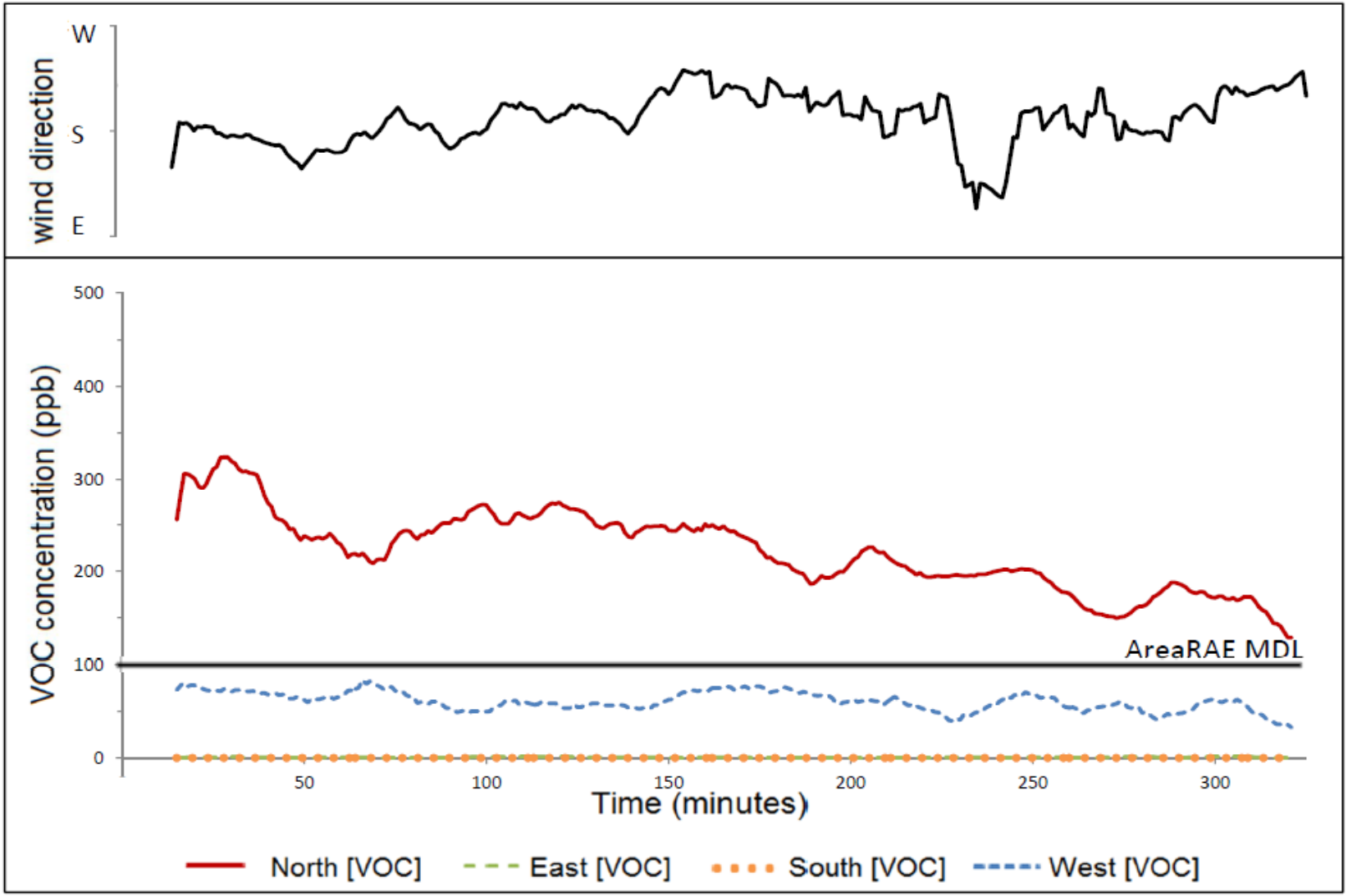
Background Point



Toby Chu

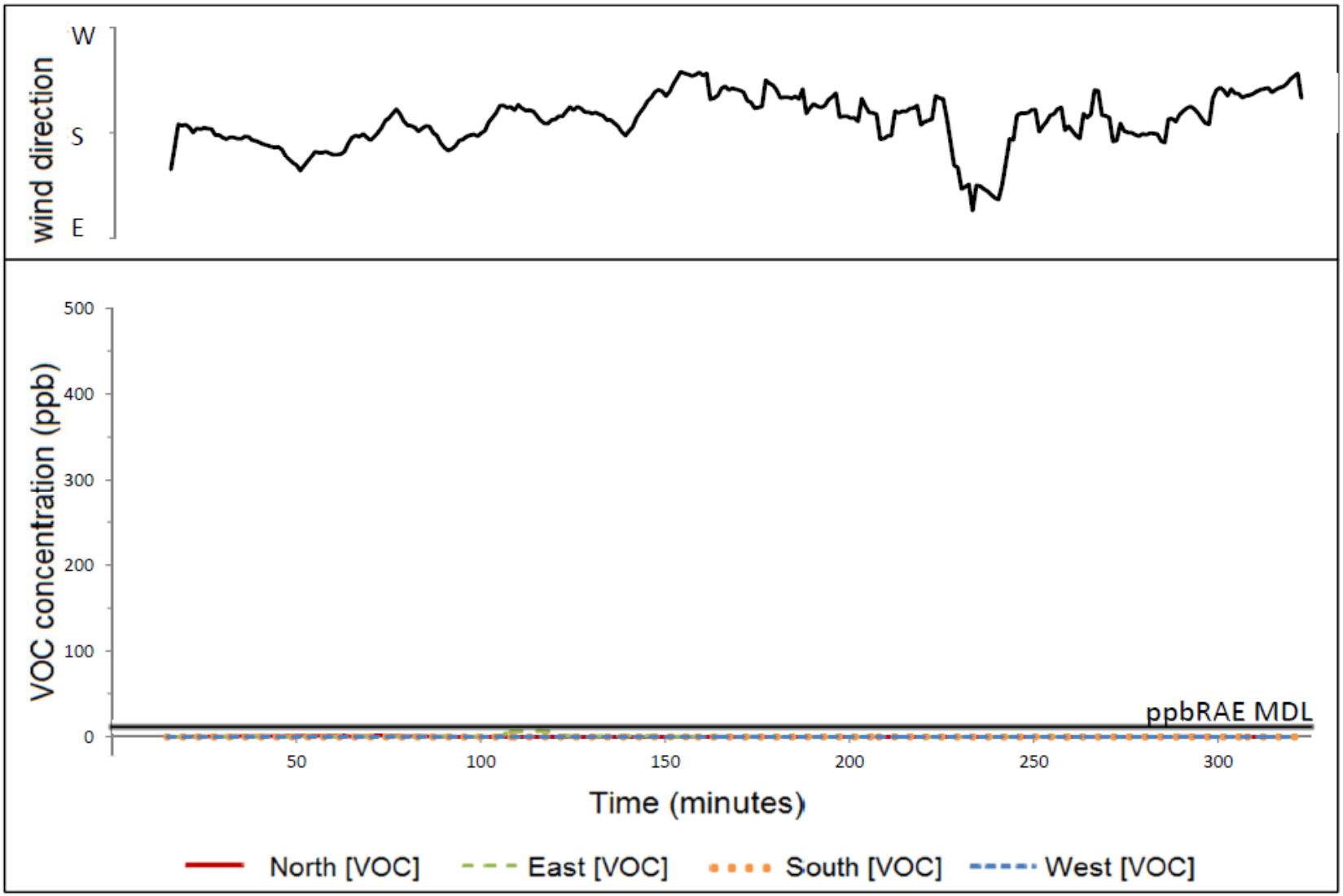
AGFC 5/26/2011

15 minute moving average of wind direction and VOC concentration of AreaRAE monitors



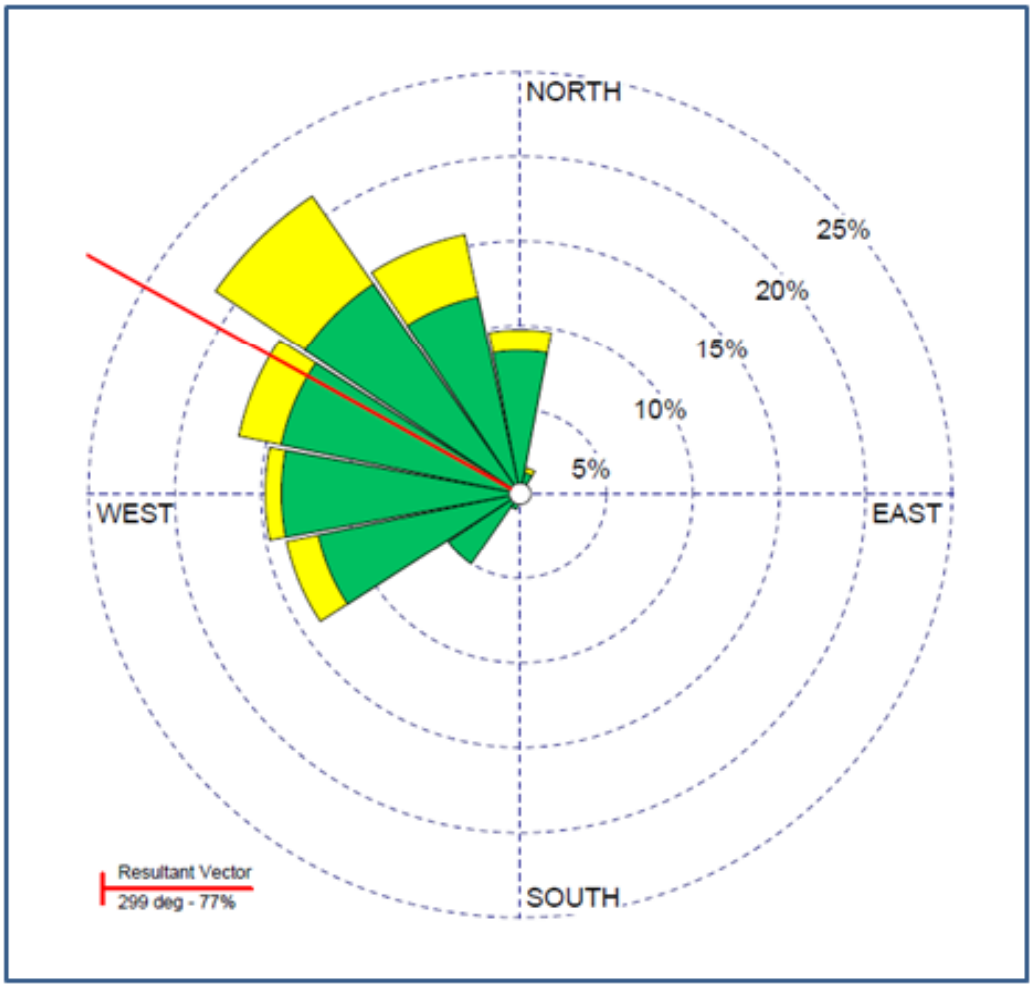
AGFC 5/26/2011

15 minute moving average of wind direction and VOC concentration of ppbRAE monitors



AGFC 5/26/2011

30	0.5



0	0

5	0.2

34	1

Wind Rose Plot (blowing from) and Maximum & Average Values of ppbRAE Transects by Perimeter Side

Max[VOC]	Avg.[VOC]

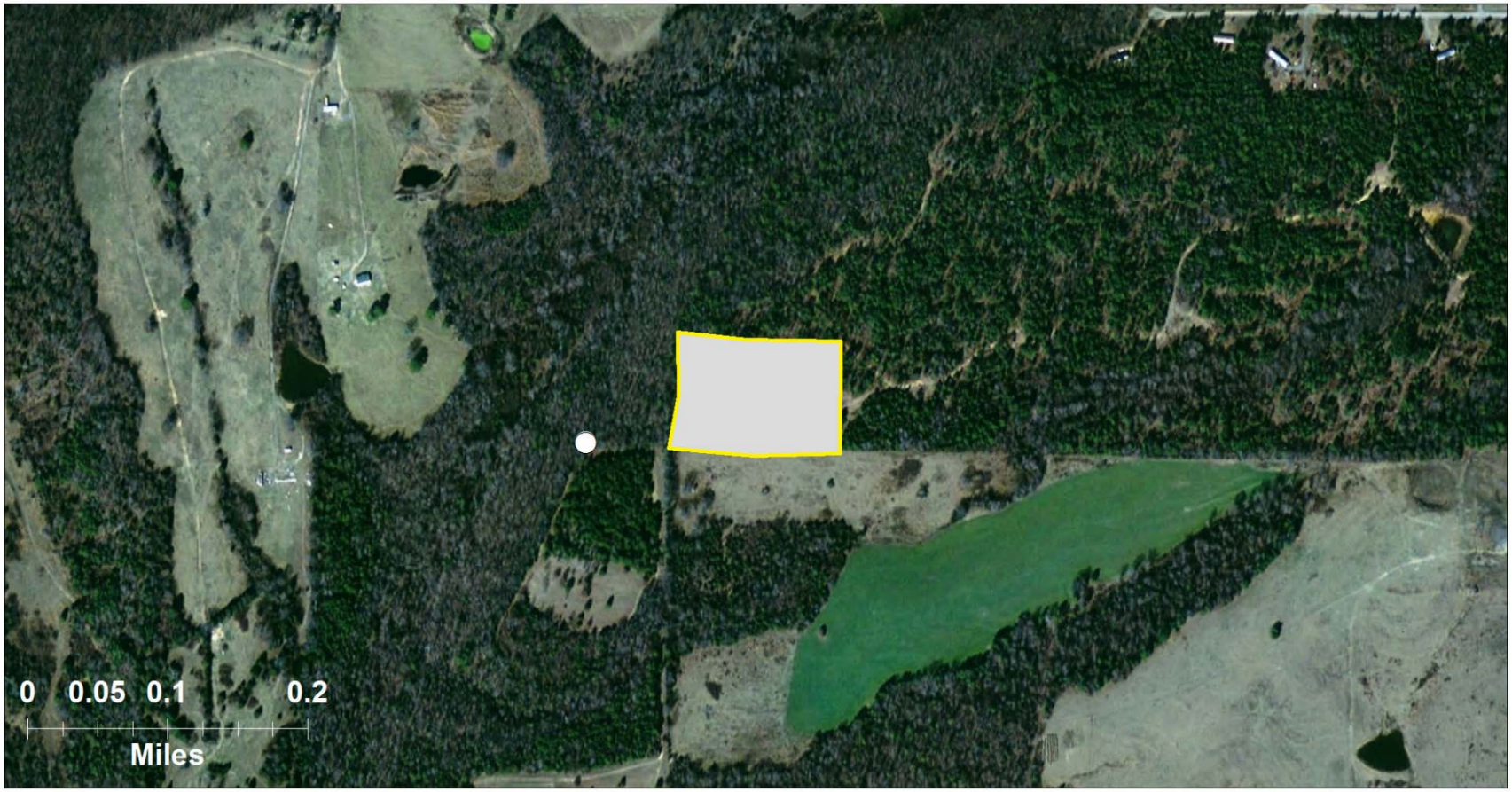
(Values in ppb)

WIND SPEED (Knots)

- >= 15
- 10 - 15
- 5 - 10
- 0 - 5

Calms: 0.00%

Cove Creek
4/5/2011



N

Cove Creek CPF-4
(35.349136, -92.399876)
Van Buren County
Compressor Station
DeSoto, SWN

Monitoring Site / Shale Pad

Background Point

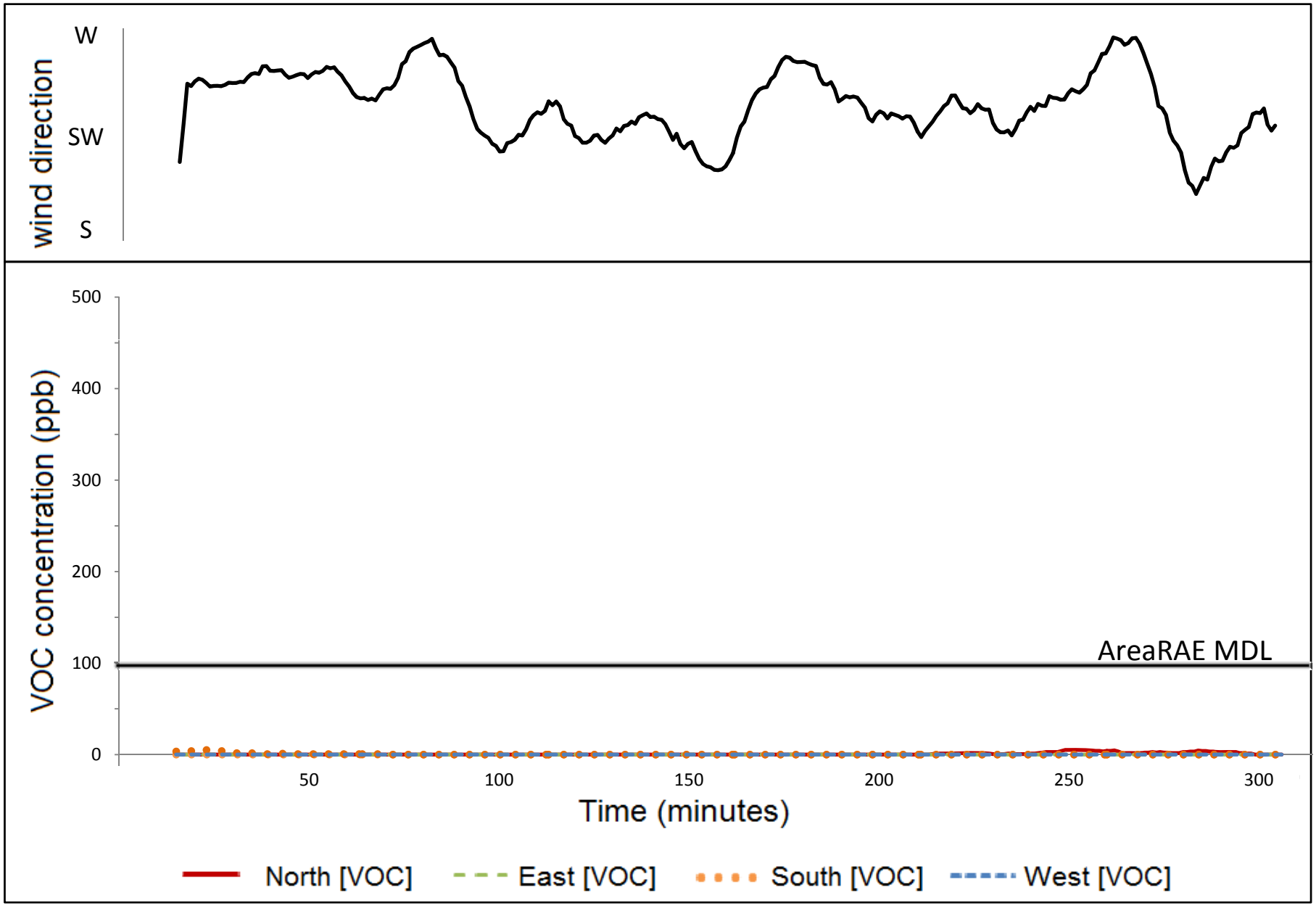
Toby Chu

Toby Chu

Toby Chu

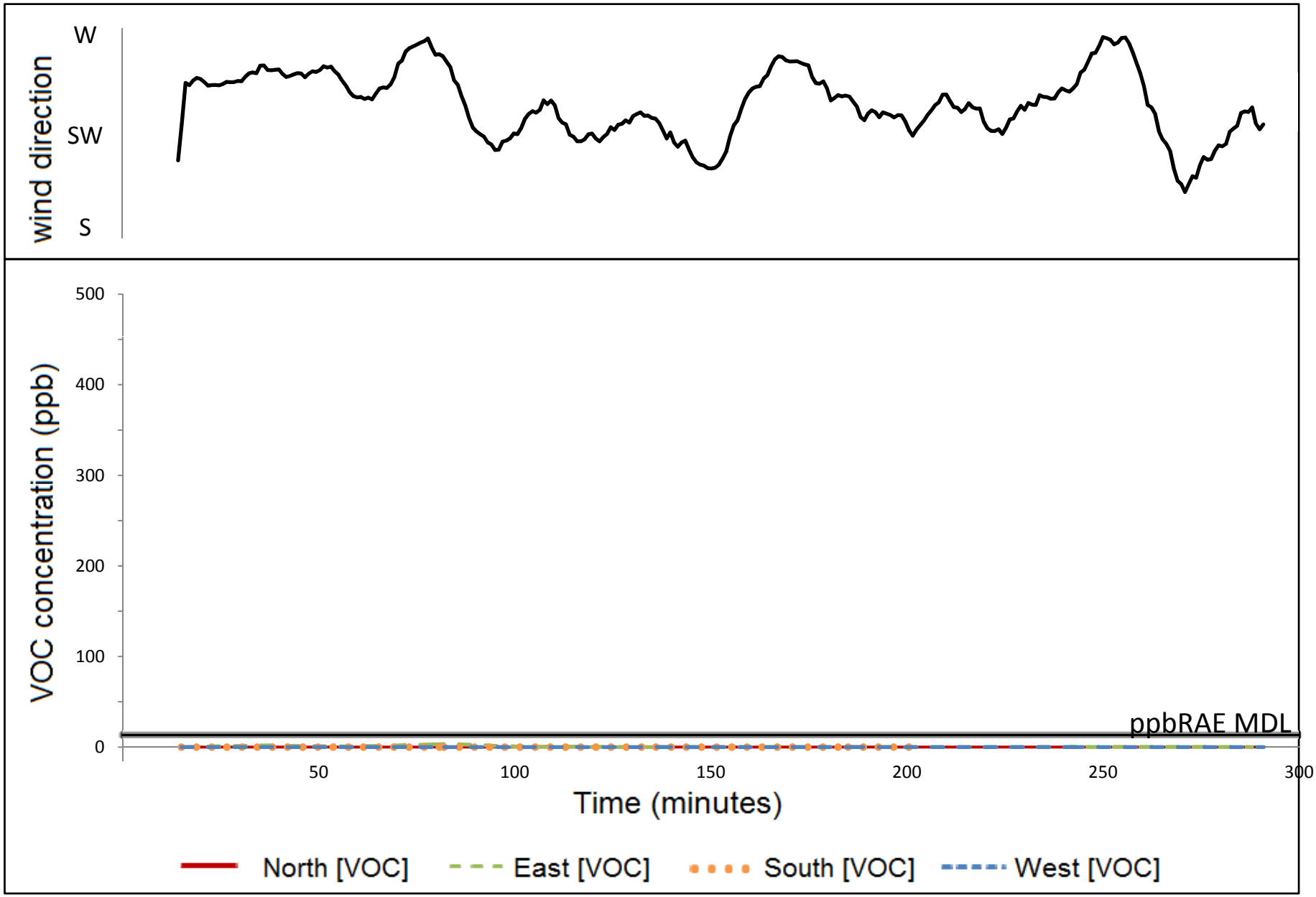
Cove Creek 4/5/2011

15 minute moving average of wind direction and VOC concentration of AreaRAE monitors



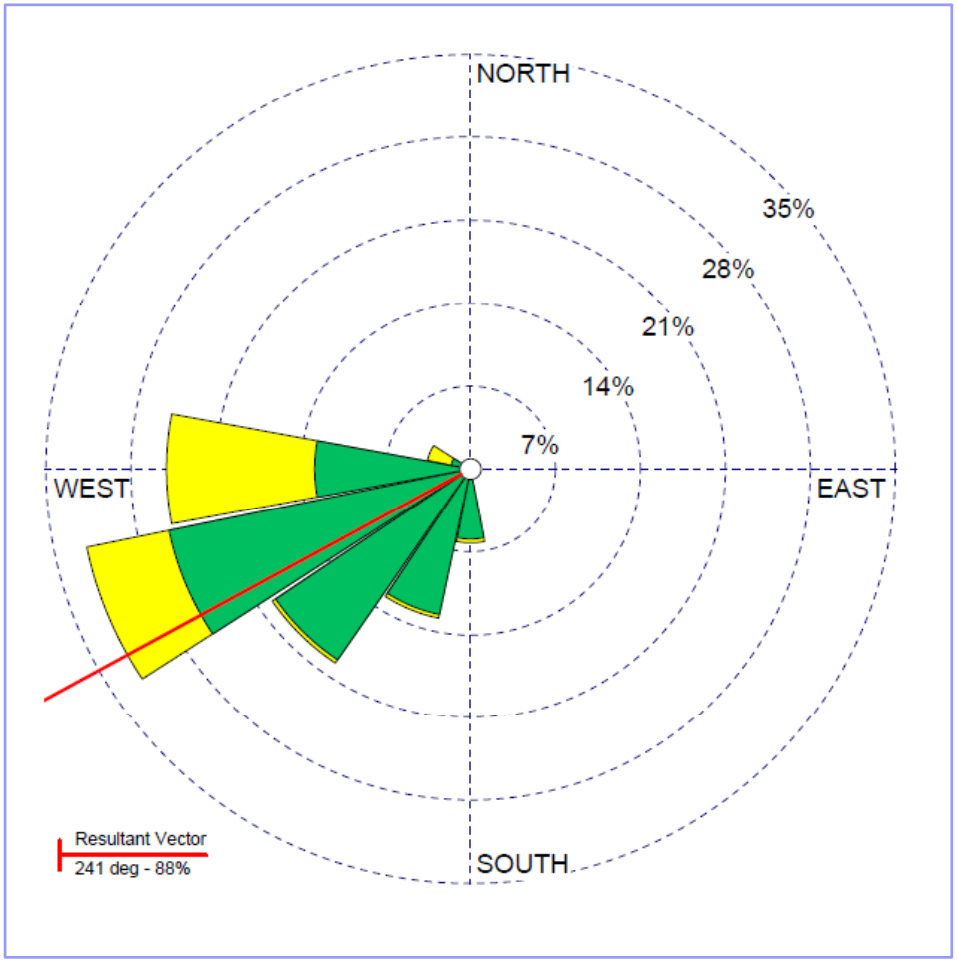
Cove Creek 4/5/2011

15 minute moving average of wind direction and VOC concentration of ppbRAE monitors



Cove Creek 4/5/2011

13	0.4



1	16

29	2

6	0.3

Wind Rose Plot (blowing from) and Maximum & Average Values of ppbRAE Transects by Perimeter Side

Max[VOC]	Avg.[VOC]

(Values in ppb)

WIND SPEED (Knots)

- >= 15
- 10 - 15
- 5 - 10
- 0 - 5

Calms: 0.00%

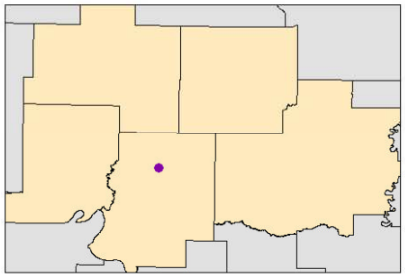
Cockrell
4/29/2011

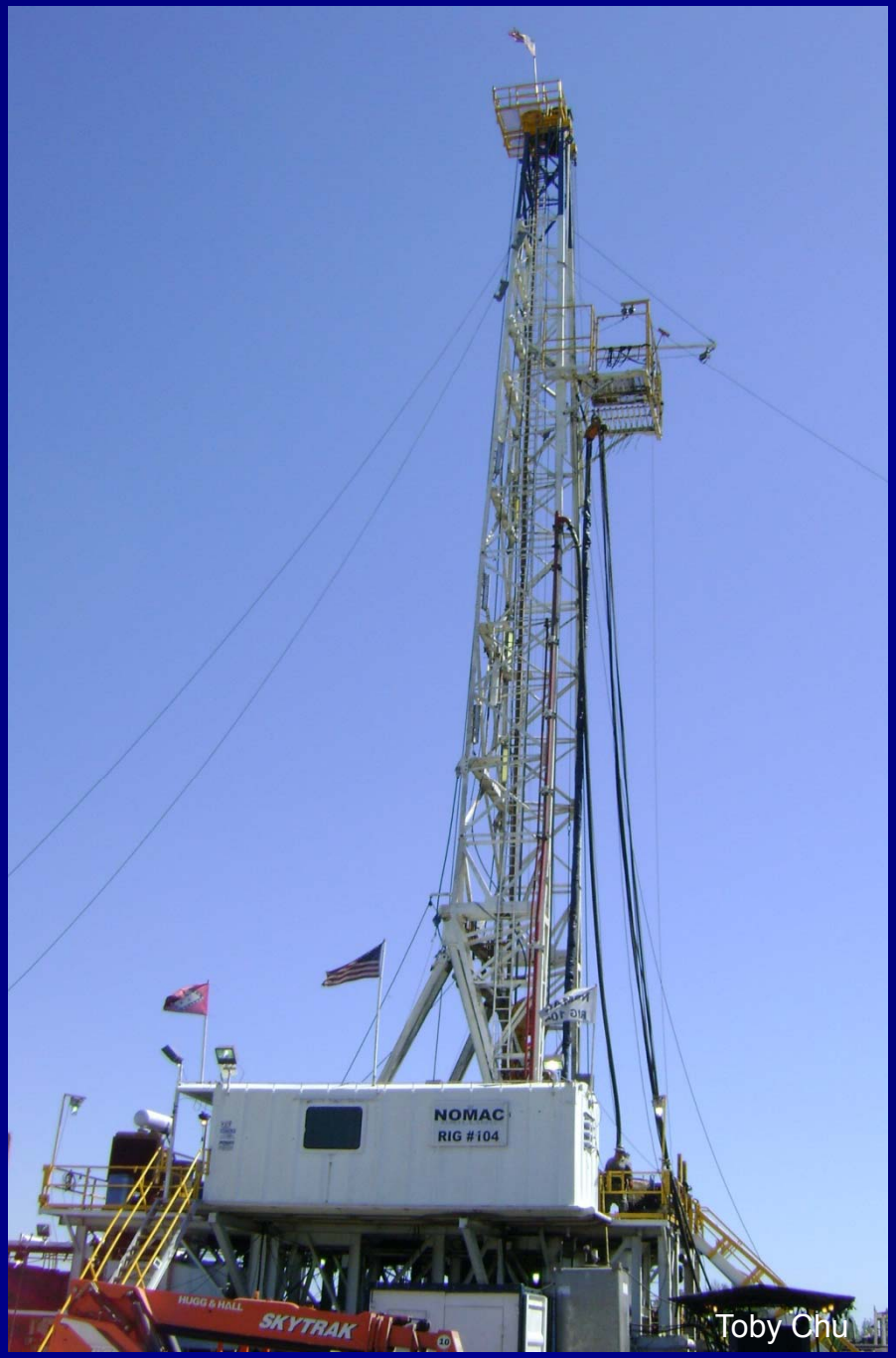
N

Cockrell 7-13 1-12H
(35.249596, -92.330398)
Faulkner County
Monitored during Drilling
Nomac Rig 104, BHP

Monitoring Site / Shale Pad

Background Point





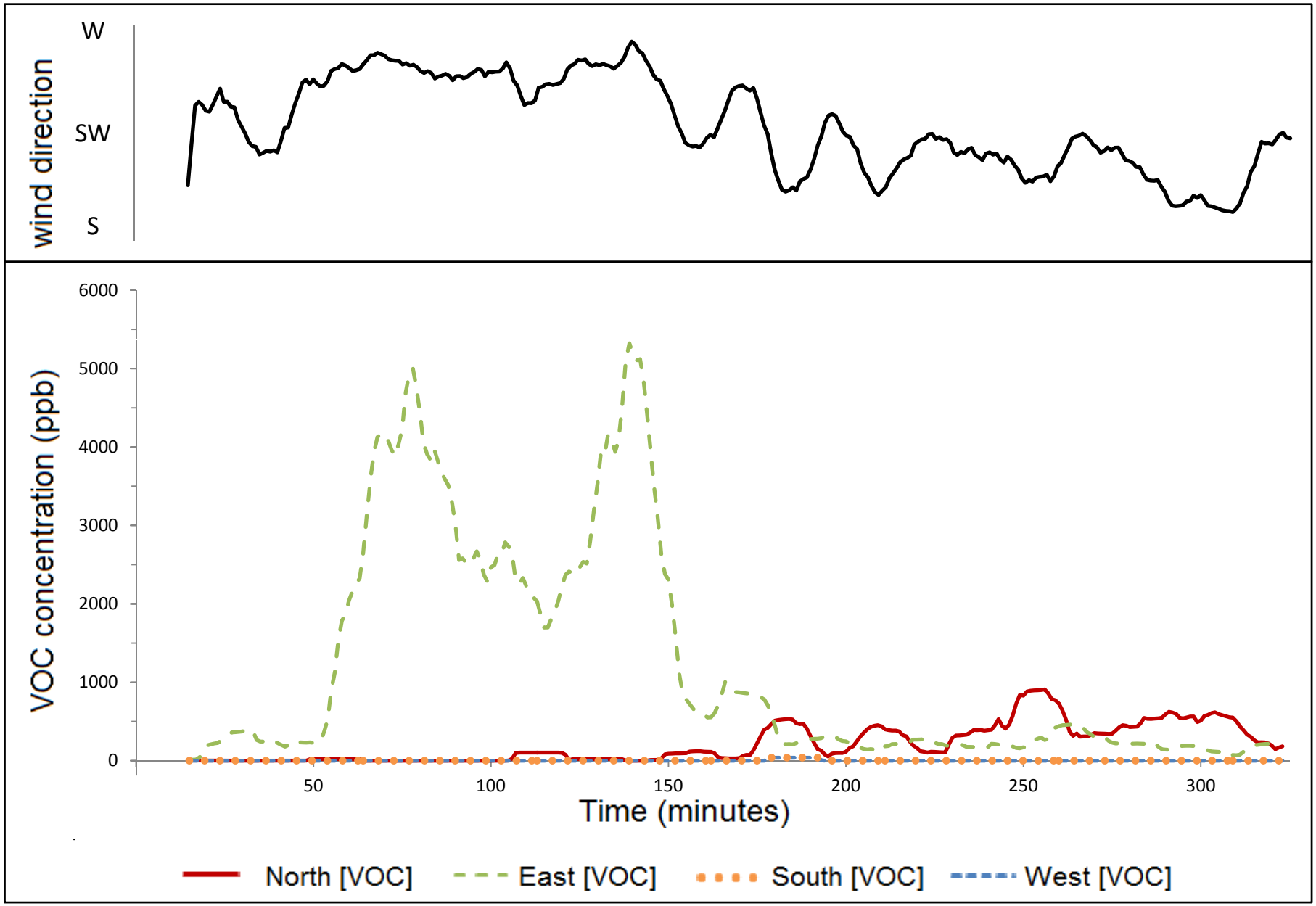
Toby Chu

Toby Chu

Toby Chu

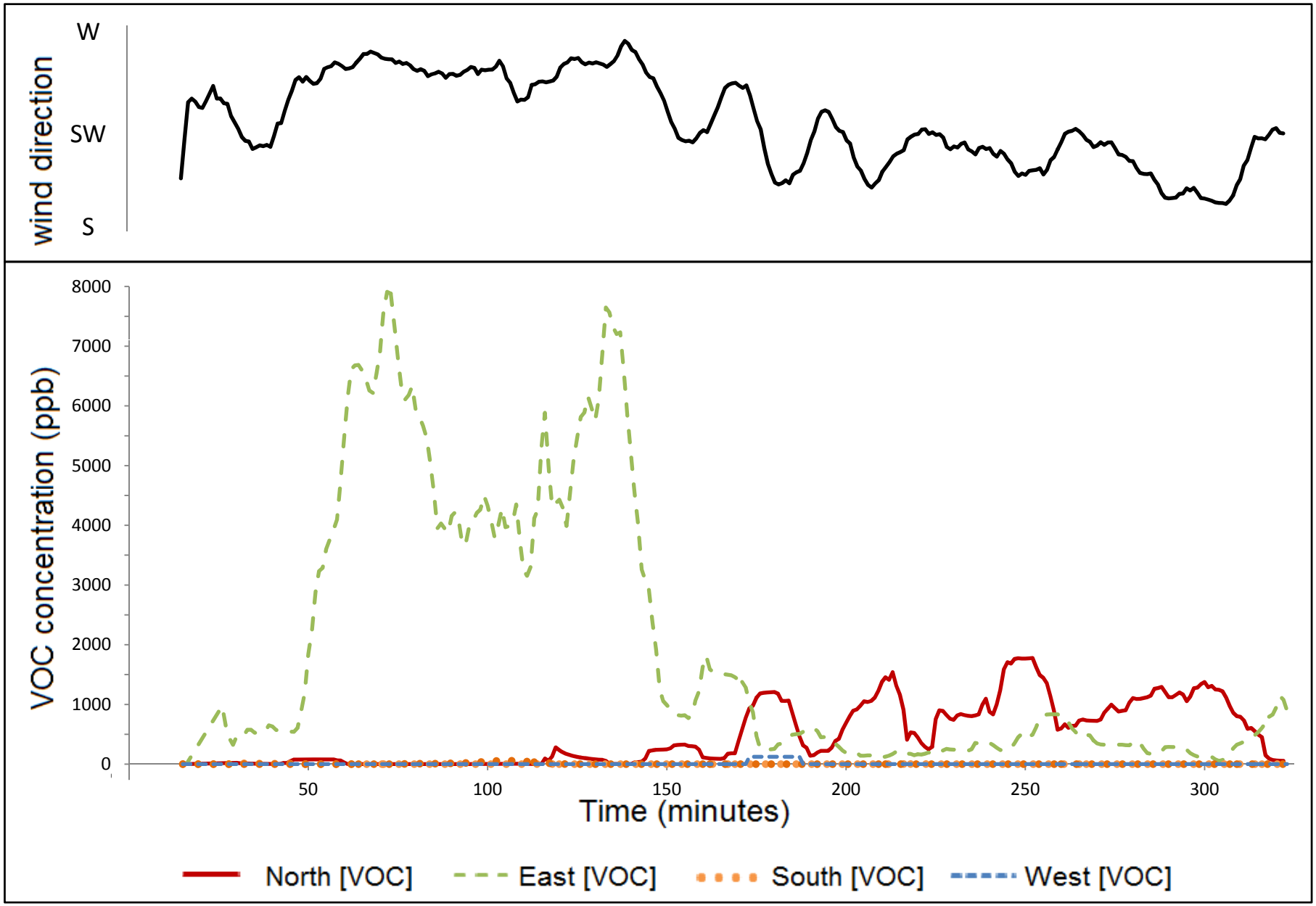
Cockrell 4/29/2011

15 minute moving average of wind direction and VOC concentration of AreaRAE monitors



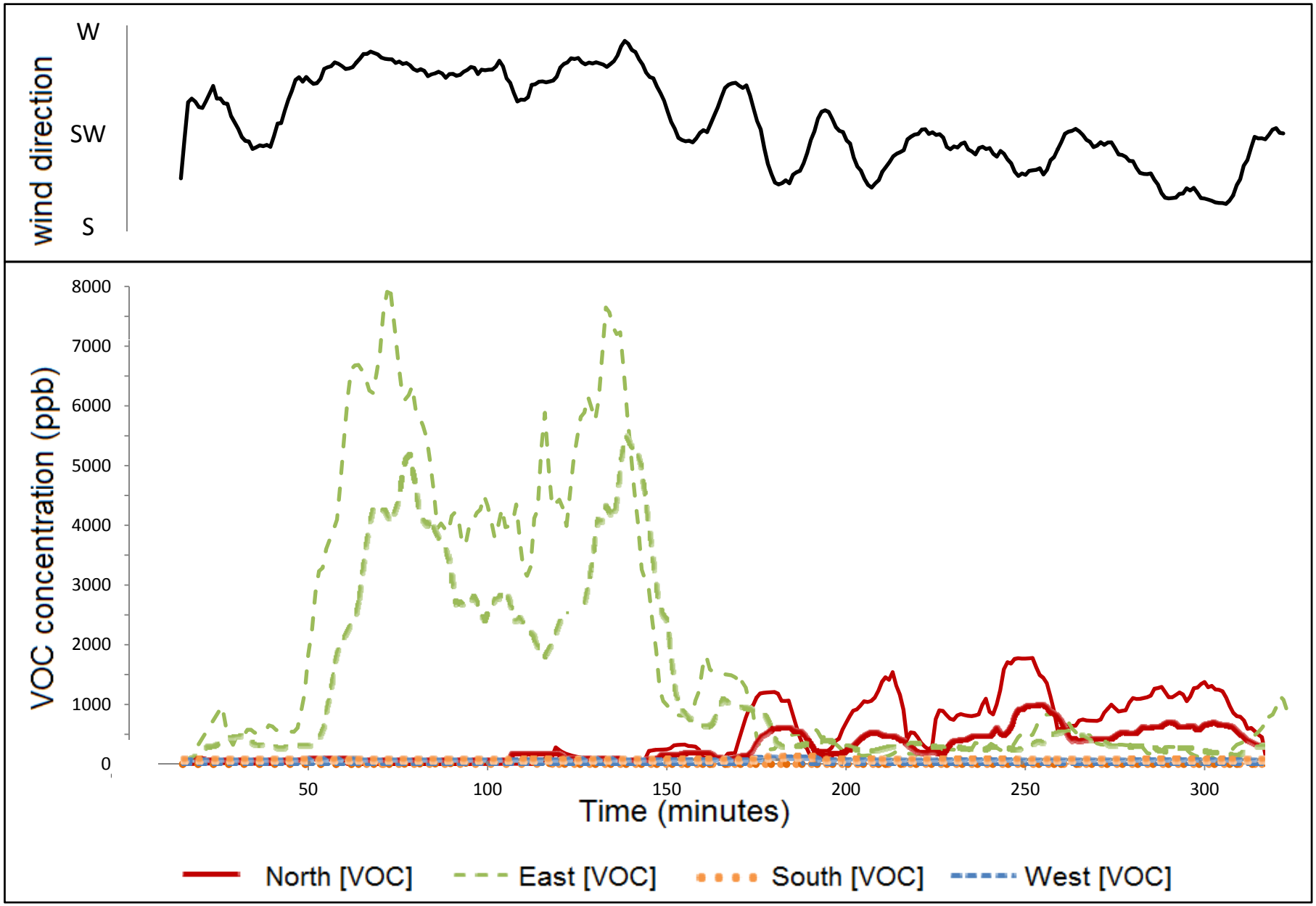
Cockrell 4/29/2011

15 minute moving average of wind direction and VOC concentration of ppbRAE monitors



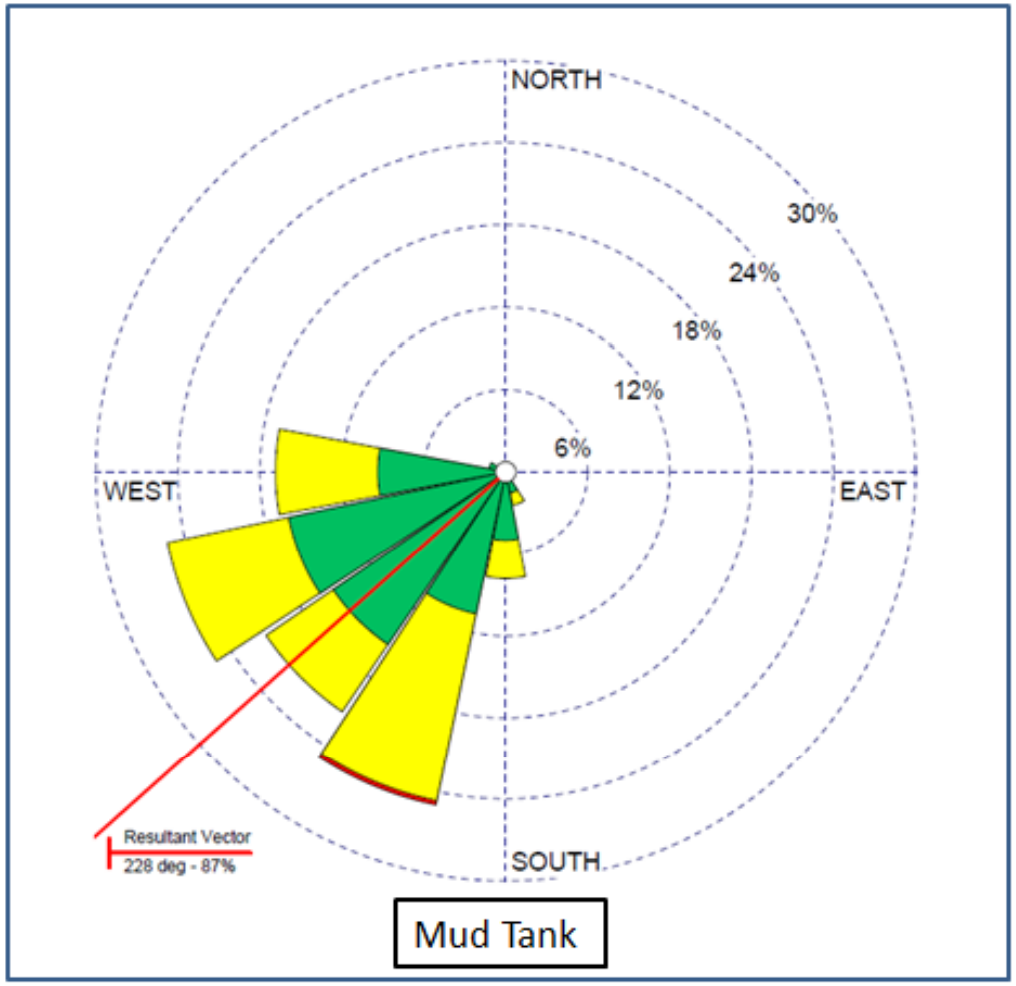
Cockrell 4/29/2011

15 minute moving average of wind direction and VOC concentration of ppbRAE & AreaRAE monitors



Cockrell 4/29/2011

5425	582



Mud Tank

9	7335
44	887

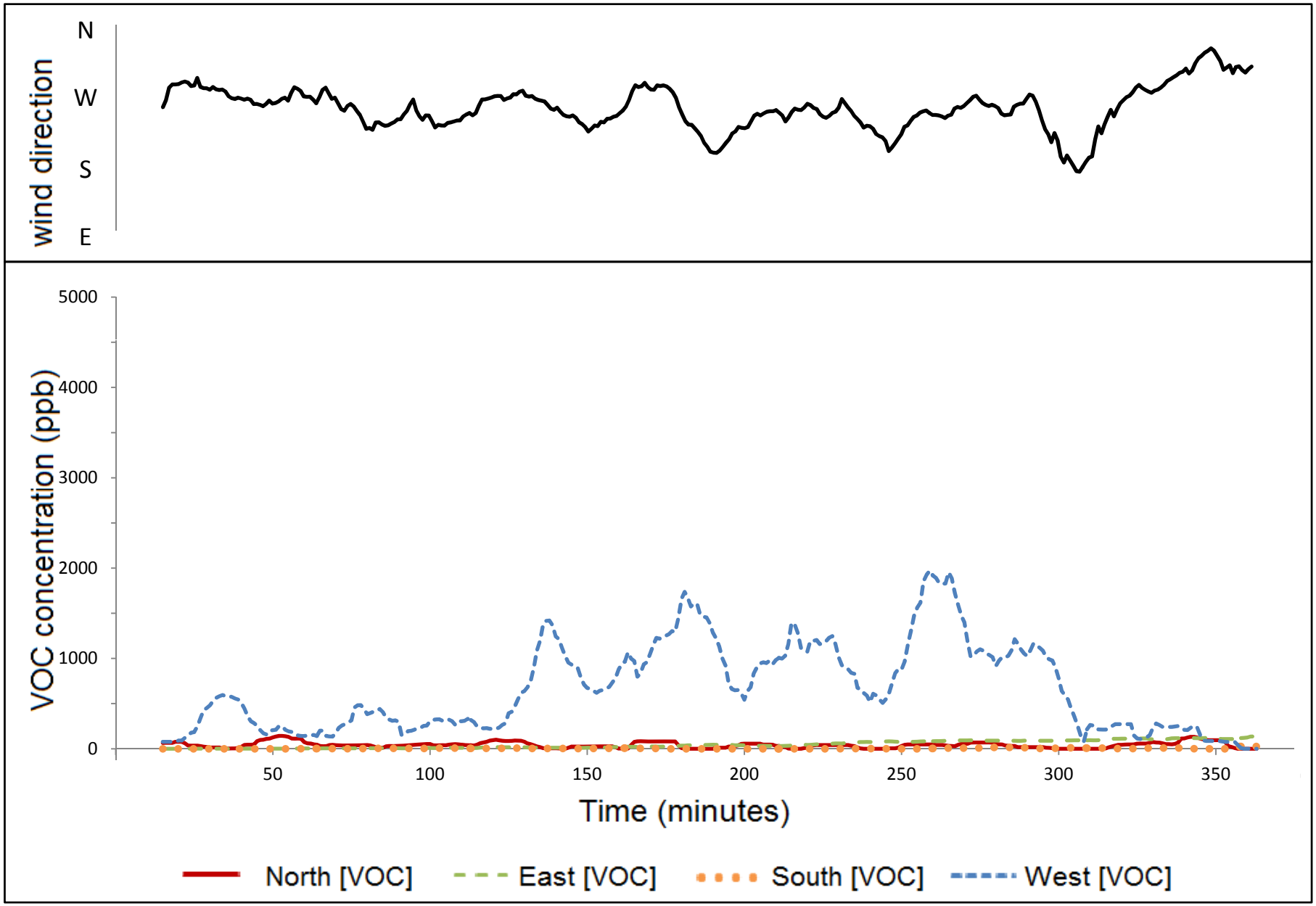
12831	233

Mud tanks
RAE
3
Toby Chu

Toby Chu

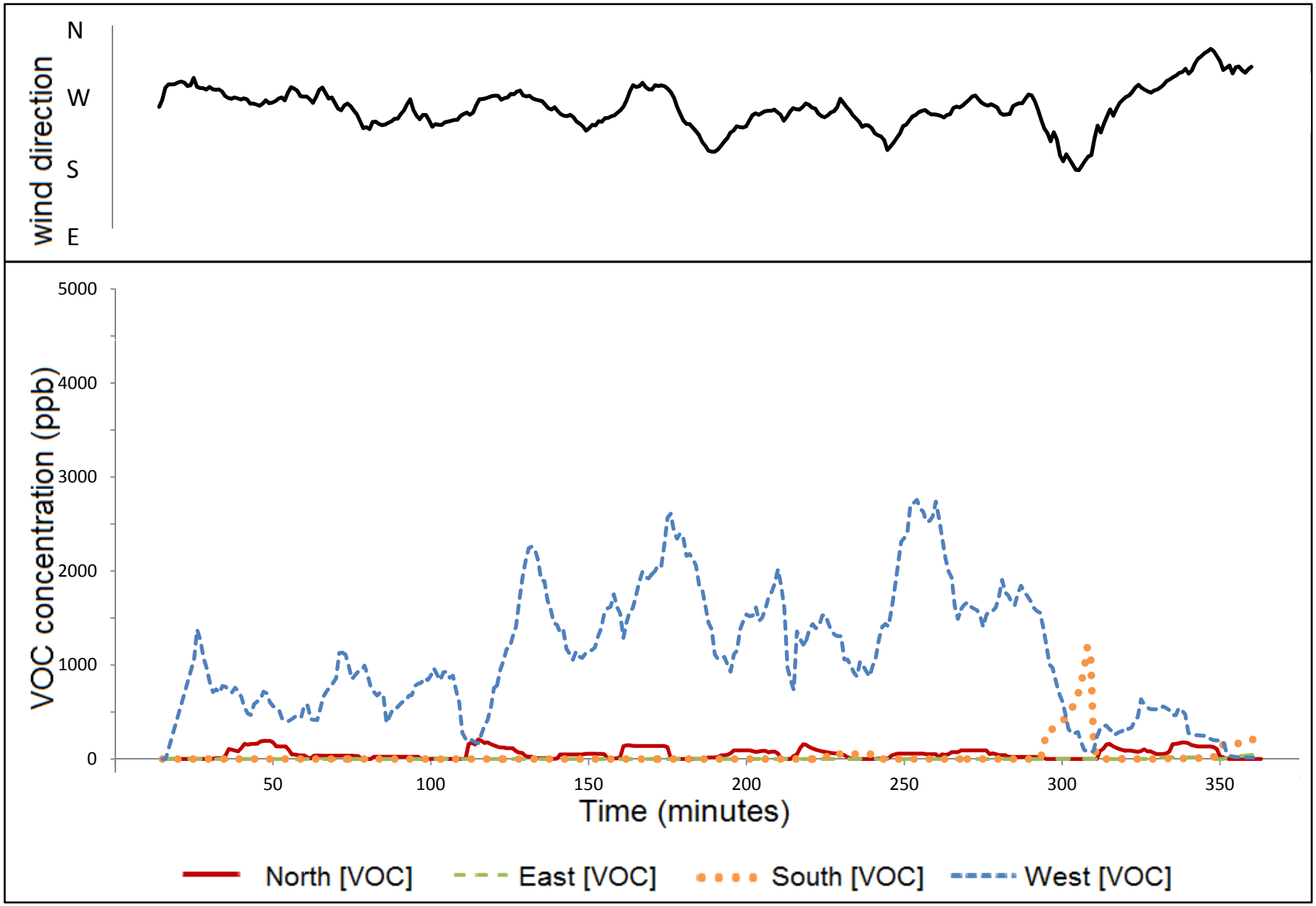
Wilcox 4/13/2011

15 minute moving average of wind direction and VOC concentration of AreaRAE monitors



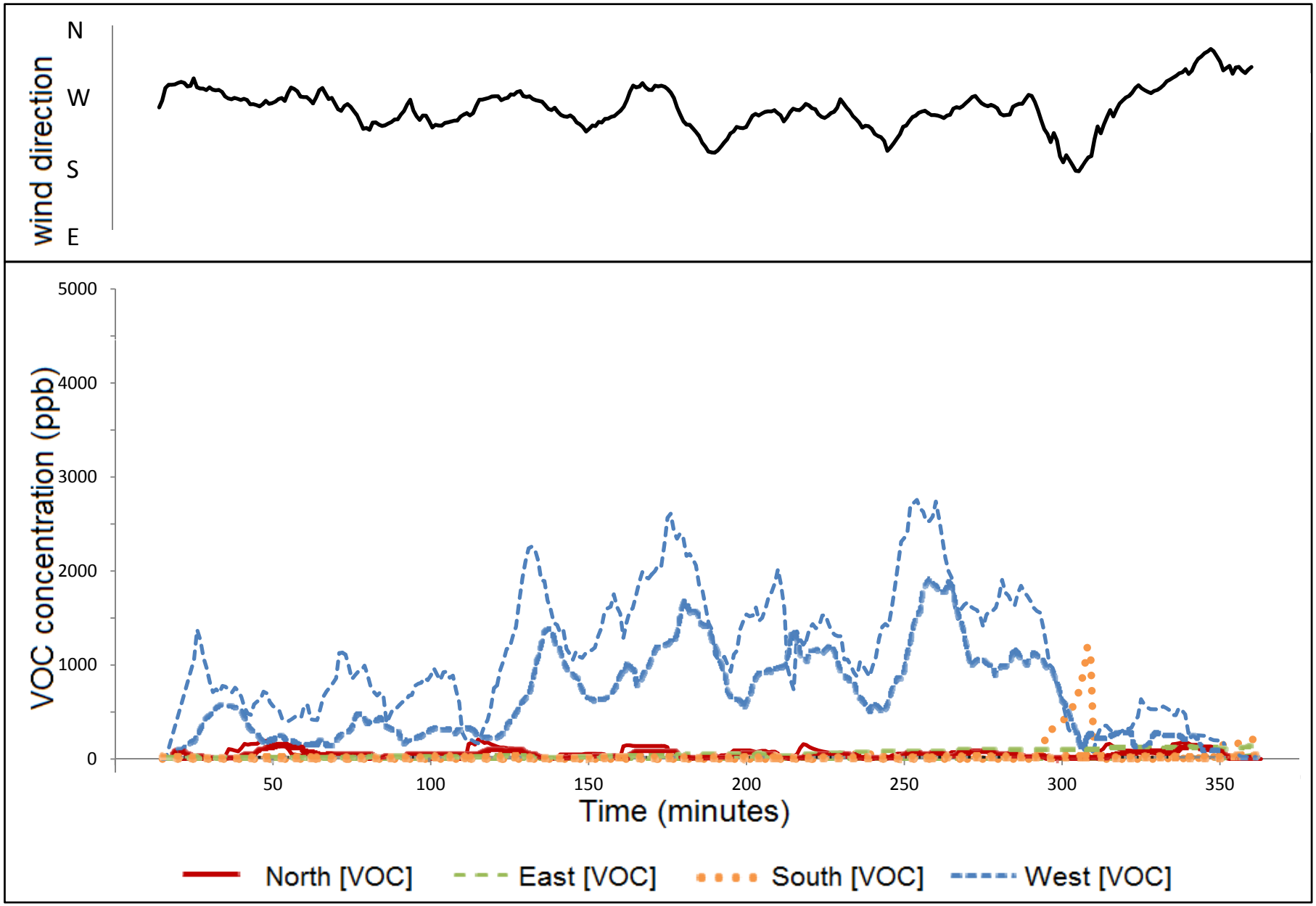
Wilcox 4/13/2011

15 minute moving average of wind direction and VOC concentration of ppbRAE monitors



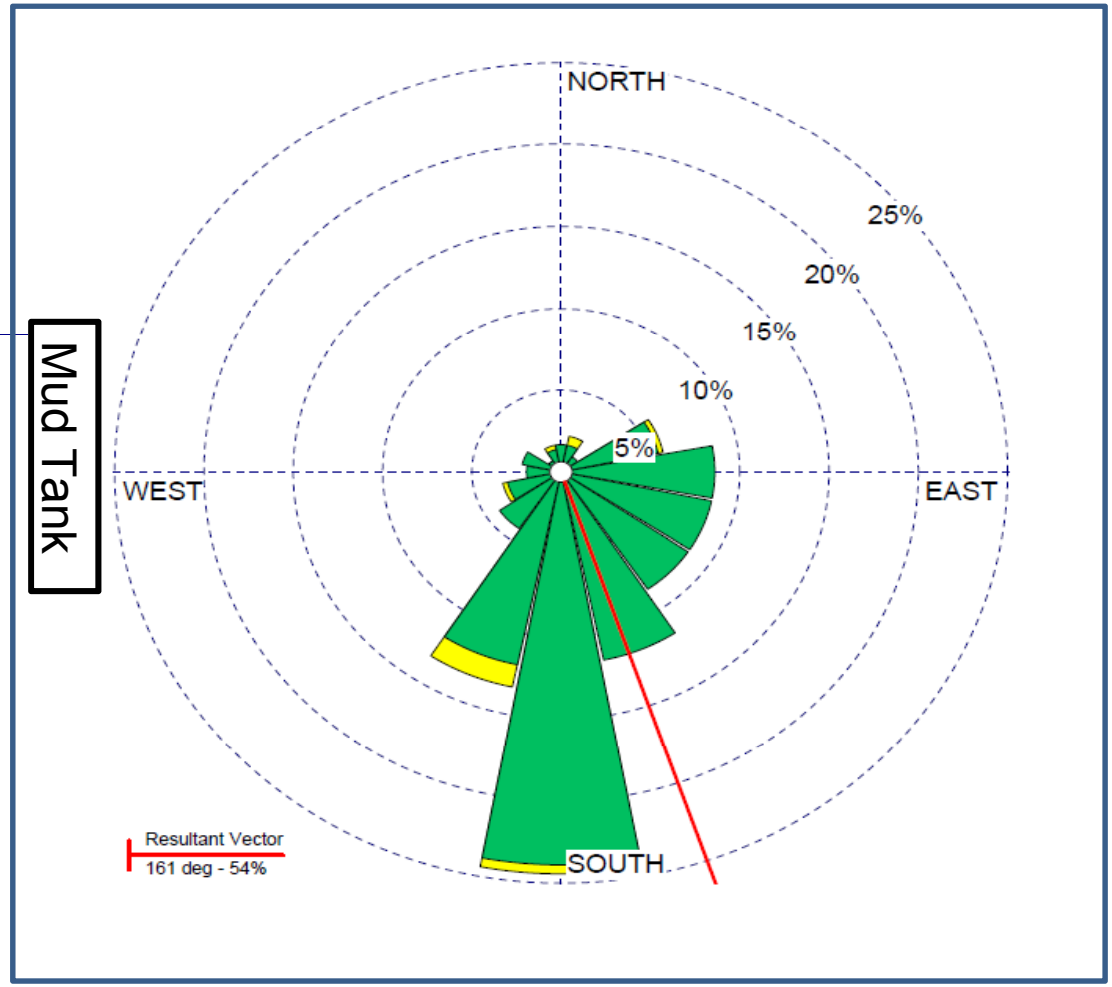
Wilcox 4/13/2011

15 minute moving average of wind direction and VOC concentration of ppbRAE & AreaRAE monitors



Wilcox 4/13/2011

893	67



389	
7616	

Mud Tank

91	
11	

2851	93

Conclusions (Lessons Learned)

Emissions – Elevated VOC at drilling sites

Equipment – CH_4 & NOx concentrations were lower than MDLs

Mud Tanks – Probable source of VOCs

Future studies – Lower detection limits & VOC speciation; more representative sample including flowback venting

Acknowledgements

David Lyon

Jay Justice

Mark McCorkle & Jane Hurley

Chesapeake Energy

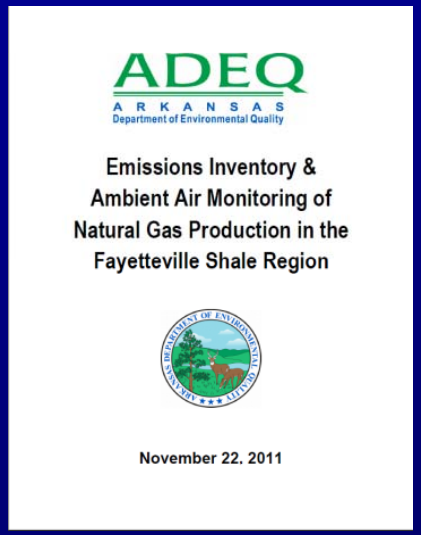
Scott Stinson

EPA Region 6

SWN Energy

For the full report:

www.adeq.state.ar.us/air/pdfs/fayetteville_shale_air_quality_report.pdf


ADEQ
ARKANSAS
Department of Environmental Quality

Emissions Inventory & Ambient Air Monitoring of Natural Gas Production in the Fayetteville Shale Region

November 22, 2011

Contact info:

Toby Chu

chu@adeq.state.ar.us

501-682-0064