Exploring a Pollution Event

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A very important chemical reaction:

$$NO + O_3 \rightarrow NO_2^* + O_2$$

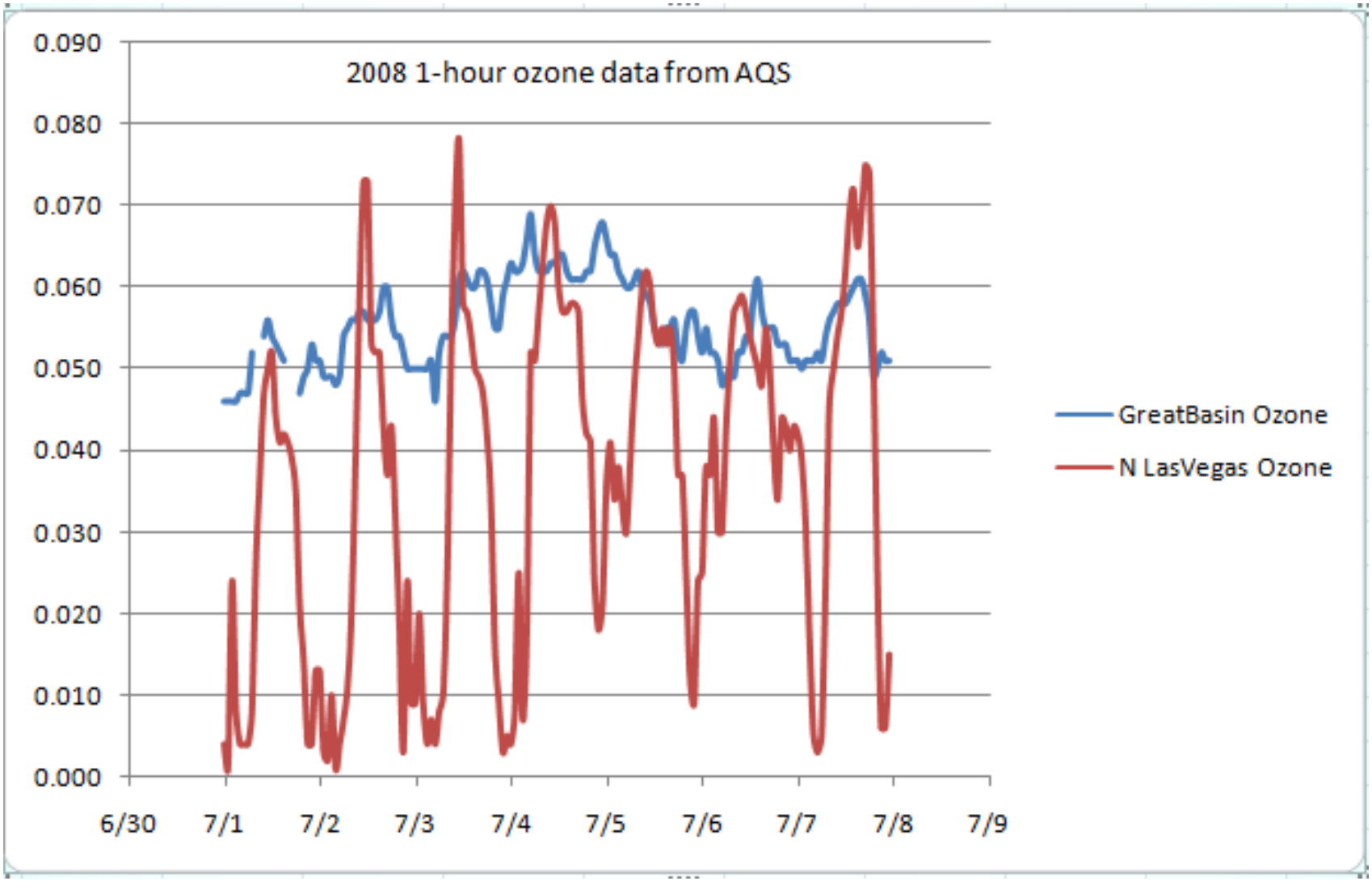
Notes:

NOx = NO + NO2

NOy = NOx + all other reactive oxides of nitrogen

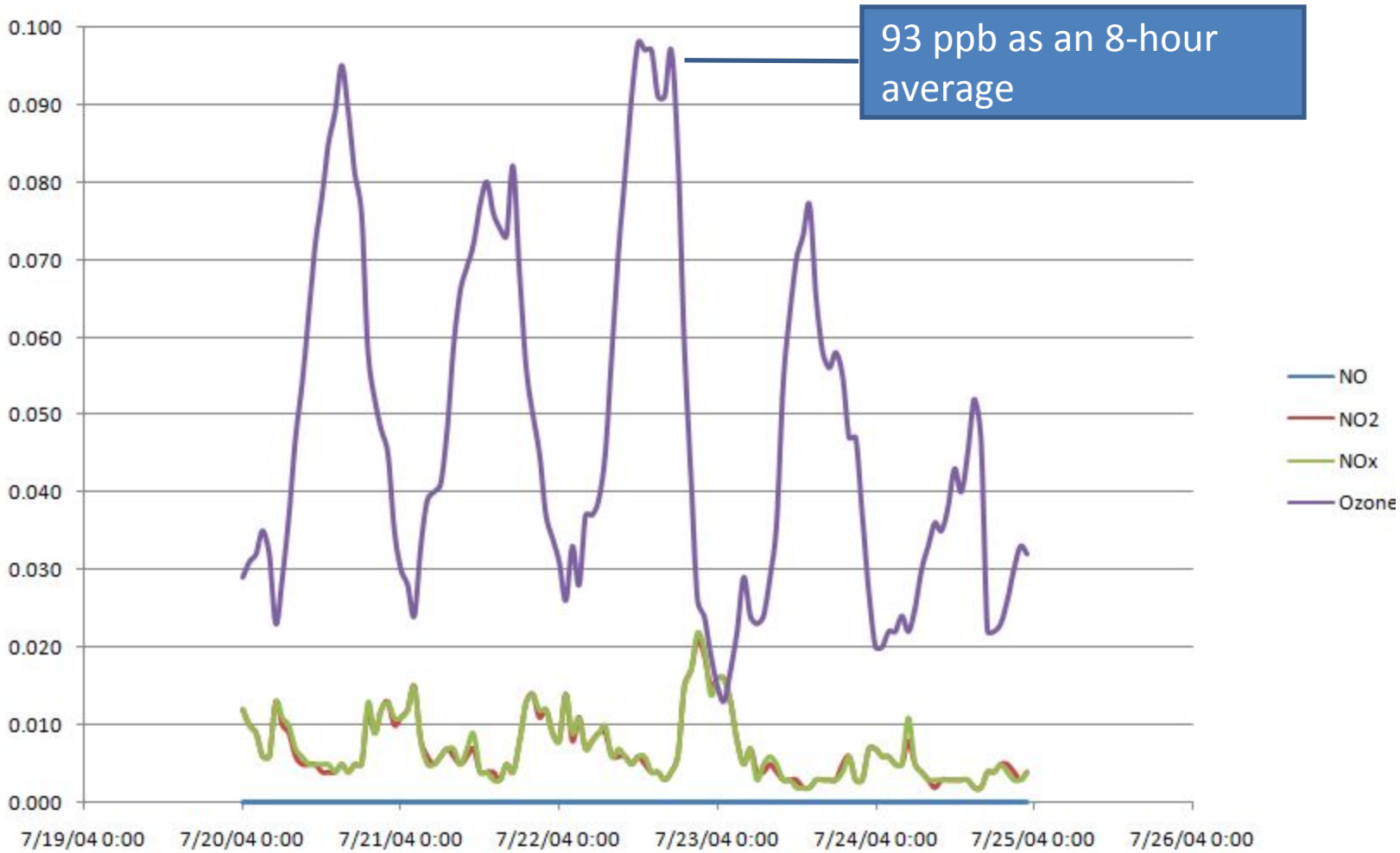
NO reacts with ozone driving ozone concentrations down

NO2 reacts with VOCs in sunlight and produces ozone



The 5th and 6th is Saturday, Sunday

Quapaw Site on July 22, 2004 – Site's highest 8-hr Ozone



What were other 8-Hour ozone concentrations on July 22, 2004?

U.S. ENVIRONMENTAL PROTECTION AGENCY

AirExplorer

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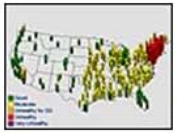
- Query Speciation Data

Air Explorer is a collection of user-friendly visualization tools for air quality analysts. The tools generate maps, graphs, and data tables dynamically. Currently, the tools access ambient concentration data from EPA's Air Quality System (AQS). The criteria pollutant data were last updated on April 17, 2008. PM2.5 speciation data were last updated on November 2, 2006.

UPDATE (8/22/2008) The PM2.5 speciation data were updated to include data through 2007.
UPDATE (7/3/2008) The AQI graphics now reflect the new ozone AQI break points.
UPDATE (4/17/2008) The criteria pollutant data were updated to provide complete years for 1997 to 2007.

MAPS

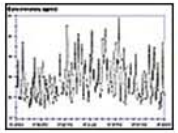


Map One Day
Generate a three-dimensional, interactive map of daily pollutant concentrations

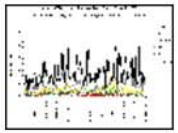
Map Several Days
Generate an animated series of daily concentration maps for a specific time period

Map Monitoring Sites

GRAPHS



Plot Concentrations
Generate a time series plot for a specific location and time period



Plot Speciation Data
Plot daily PM2.5 speciation data for a specific location and time period

Plot AQI Values

DATA

Query Concentrations
View or download daily concentrations for a specific location and time period

Query Speciation Data
View or download daily PM2.5 speciation data for a specific location and time period

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Query Concentrations

Step 1: Select Pollutant

Ozone

Step 2: Select a County, MSA, or State

County: Select a County

MSA: Select an MSA

State: OK

Step 3: Select a Site

400170101
400190296
400190297
400219002

Step 4: Select Dates

From

JUL 22 2004

To

JUL 22 2004

Step 5: Select Options

Include Exceptional Events? Yes No

Download or View Online? Download View Online

Step 6: Submit Selections

Submit

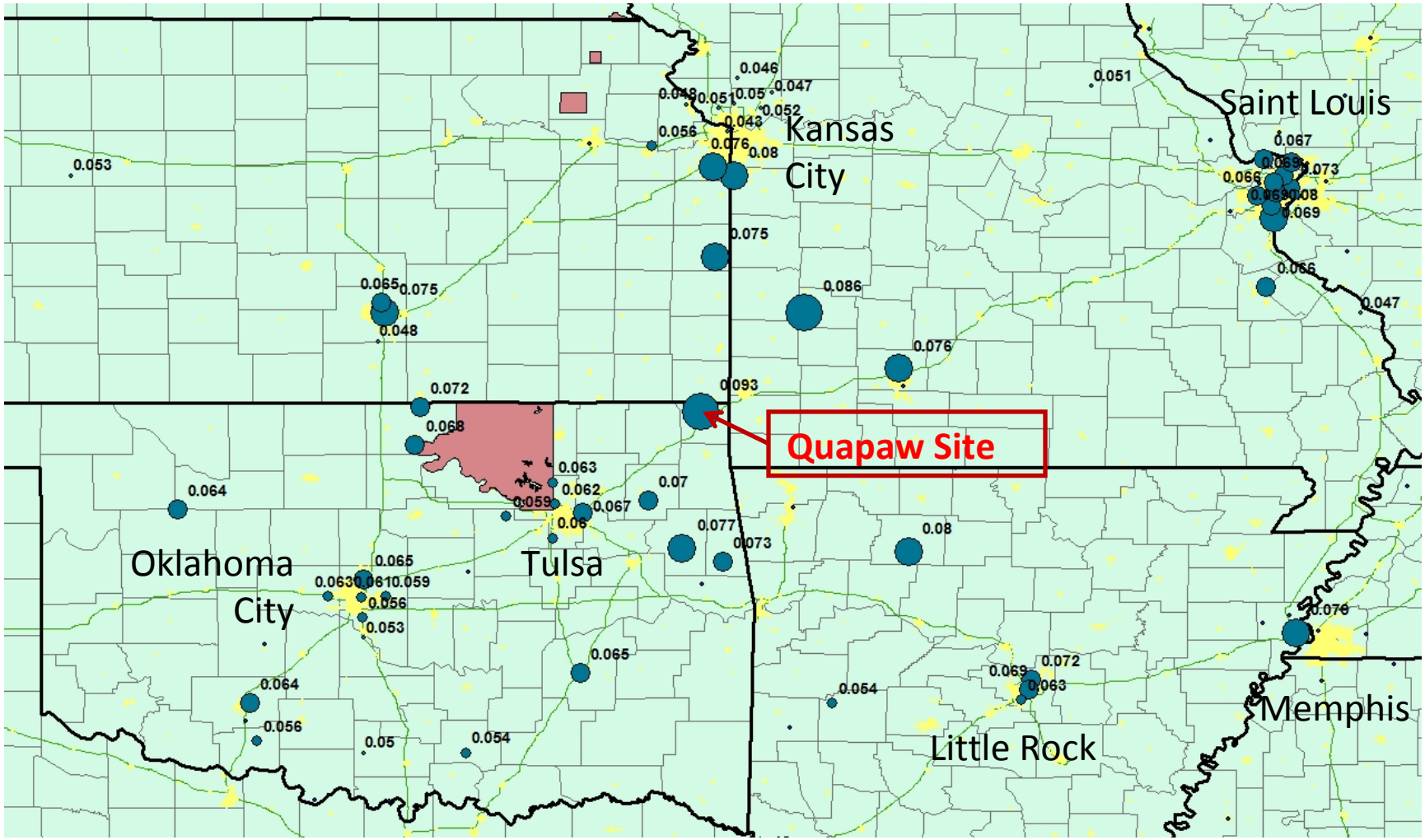
I selected ozone for one state at a time and merged the resulting data in a spreadsheet.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y
Date	SITE	POC	Concentra	FLAG	NOBS	PCTOBS	STATE_NA	COUNTY_I	CITY	CITY_NAM	ADDRESS	AQCR	AQCR_NAI	UAR	UAR_NAM	LAND_USE	LOCATION	LATITUDE	LONGITUD	UTM_ZON	UTM_NOR	UTM_EAS	ELEVATIOI	REGION
7/22/2004	400019009	1	0.073	0	24	100	Oklahomi	Adair	13775	Cherry Tre	8 MILES S	17	METROPO	0	NOT IN AI	AGRICULT	RURAL	35.75074	-94.6697	.	.	.	330	6
7/22/2004	400170101	1	0.063	0	24	100	Oklahomi	Canadian	82950	Yukon	12575 NW	184	CENTRAL (	5880	OKLAHOM	COMMERC	SUBURBA	35.47922	-97.7515	.	.	.	422.21	6
7/22/2004	400190297	1	0.05	0	24	100	Oklahomi	Carter	33350	Healdton	1800 AIRP	188	SOUTHEA	0	NOT IN AI	AGRICULT	RURAL	34.25713	-97.4743	14	3791524	640474.7	289.66	6
7/22/2004	400219002	1	0.077	0	24	100	Oklahomi	Cherokee	57300	Park Hill	P.O. BOX 9	17	METROPO	0	NOT IN AI	RESIDENT	RURAL	35.85408	-94.986	.	.	.	238	6
7/22/2004	400270049	1	0.056	0	24	100	Oklahomi	Clevelanc	49200	Moore	S. E. 19TH	184	CENTRAL (	5880	OKLAHOM	RESIDENT	SUBURBA	35.32011	-97.4841	.	.	.	372.36	6
7/22/2004	400310647	1	0.064	0	24	100	Oklahomi	Comanch	41850	Lawton	1515 NE L	189	SOUTHWE	4200	LAWTON,	RESIDENT	RURAL	34.62642	-98.3832	.	.	.	344.65	6
7/22/2004	400330680	1	0.056	0	24	100	Oklahomi	Cotton	78150	Walters	3RD STREI	189	SOUTHWE	0	NOT IN AI	RESIDENT	RURAL	34.34863	-98.3076	.	.	.	310	6
7/22/2004	400370144	1	0.059	0	24	100	Oklahomi	Creek	46200	Mannforc	MANNFOF	186	NORTHEA	0	NOT IN AI	COMMERC	RURAL	36.10548	-96.3612	14	3998672	737543.6	239	6
7/22/2004	400430860	1	0.064	0	24	100	Oklahomi	Dewey	66250	Seiling	SEILING M	187	NORTHWE	0	NOT IN AI	AGRICULT	RURAL	36.15841	-98.932	.	.	.	532.9	6
7/22/2004	400690323	1	0.054	0	24	100	Oklahomi	Johnston	73900	Tishomin	TISHOMIN	188	SOUTHEA	0	NOT IN AI	COMMERC	RURAL	34.26003	-96.6805	14	3793237	713572	220	6
7/22/2004	400719003	1	0.068	0	24	100	Oklahomi	Kay	59850	Ponca Cit	RT 1, BOX	185	NORTH CE	0	NOT IN AI	RESIDENT	RURAL	36.66278	-97.0744	14	4058958	672096	335	6
7/22/2004	400719010	1	0.072	0	24	100	Oklahomi	Kay	0	Not in a c	NORTH OF	185	NORTH CE	0	NOT IN AI	AGRICULT	RURAL	36.95622	-97.0314	.	.	.	334	6
7/22/2004	400871073	1	0.053	0	24	100	Oklahomi	McClain	29850	Goldsby	310 E. BUF	184	CENTRAL (	5880	OKLAHOM	AGRICULT	RURAL	35.15965	-97.4738	14	3891616	639006.6	355.67	6
7/22/2004	400979014	1	0.07	0	24	100	Oklahomi	Mayes	0	Not in a c	CHEROKEE	186	NORTHEA	0	NOT IN AI	AGRICULT	RURAL	36.22841	-95.2499	.	.	.	190	6
7/22/2004	401090033	1	0.061	0	24	100	Oklahomi	Oklahomi	55000	Oklahomi	NE 10TH &	184	CENTRAL (	5880	OKLAHOM	COMMERC	URBAN AI	35.47704	-97.4943	14	3926790	636603	397.51	6
7/22/2004	401090096	1	0.059	0	24	100	Oklahomi	Oklahomi	14200	Choctaw	12880 A N	184	CENTRAL (	5880	OKLAHOM	RESIDENT	SUBURBA	35.4778	-97.303	14	3927156	653955.6	374.76	6
7/22/2004	401091037	1	0.065	0	24	100	Oklahomi	Oklahomi	55000	Oklahomi	2501 E. M	184	CENTRAL (	5880	OKLAHOM	RESIDENT	SUBURBA	35.61413	-97.4751	.	.	.	353.84	6
7/22/2004	401159004	1	0.093	0	24	100	Oklahomi	Ottawa	48000	Miami	QUAPAW	186	NORTHEA	0	NOT IN AI	RESIDENT	RURAL	36.92222	-94.8389	15	4087621	336205	247	6
7/22/2004	401210415	1	0.065	0	24	100	Oklahomi	Pittsburg	44800	McAleste	104 AIRPC	188	SOUTHEA	0	NOT IN AI	INDUSTRI	RURAL	34.90227	-95.7844	.	.	.	231.14	6
7/22/2004	401430137	1	0.063	0	24	100	Oklahomi	Tulsa	67850	Skiatook	900 SOUT	186	NORTHEA	8560	TULSA, OK	RESIDENT	SUBURBA	36.35744	-95.9992	15	4027571	230866.8	194.95	6
7/22/2004	401430174	1	0.06	0	24	100	Oklahomi	Tulsa	29600	Glenpool	502 EAST	186	NORTHEA	8560	TULSA, OK	AGRICULT	RURAL	35.95371	-96.005	14	3982761	770137.1	223.01	6
7/22/2004	401430178	1	0.067	0	24	100	Oklahomi	Tulsa	75000	Tulsa	18707 E. 2	186	NORTHEA	8560	TULSA, OK	RESIDENT	SUBURBA	36.1338	-95.7645	15	4002129	251224.8	199.13	6
7/22/2004	401431127	1	0.062	0	24	100	Oklahomi	Tulsa	75000	Tulsa	3520 1/2 N	186	NORTHEA	8560	TULSA, OK	RESIDENT	URBAN AI	36.2049	-95.9765	.	.	.	198.12	6

Since these data have spatial references for each monitoring site (lat, long) I can easily put this data into GIS software. Then I can use gradients to make higher concentrations appear as larger circles on the map.

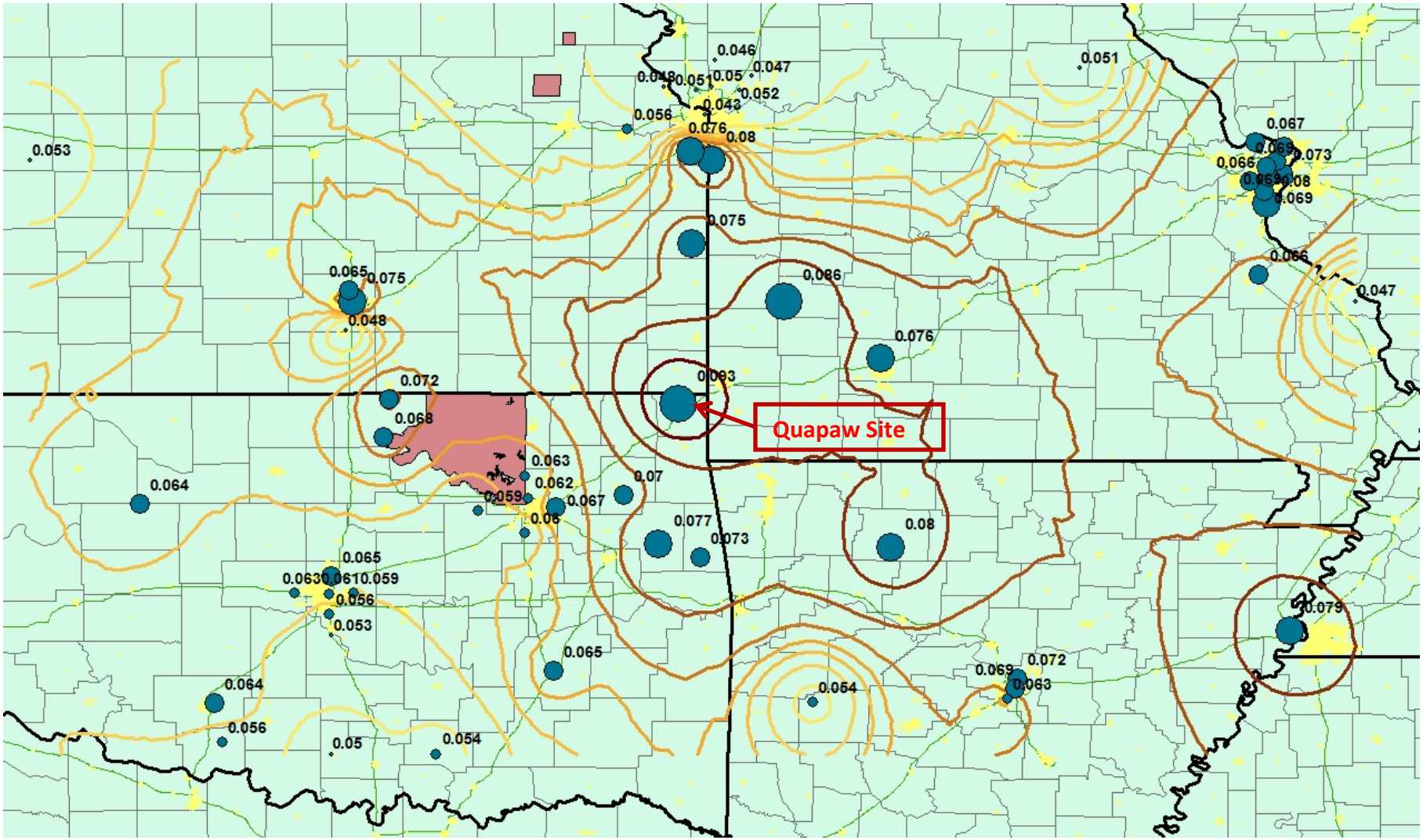
S	T
LATITUDE	LONGITUDE
35.750735	-94.669697
35.479215	-97.751503
34.257125	-97.474341
35.85408	-94.985964

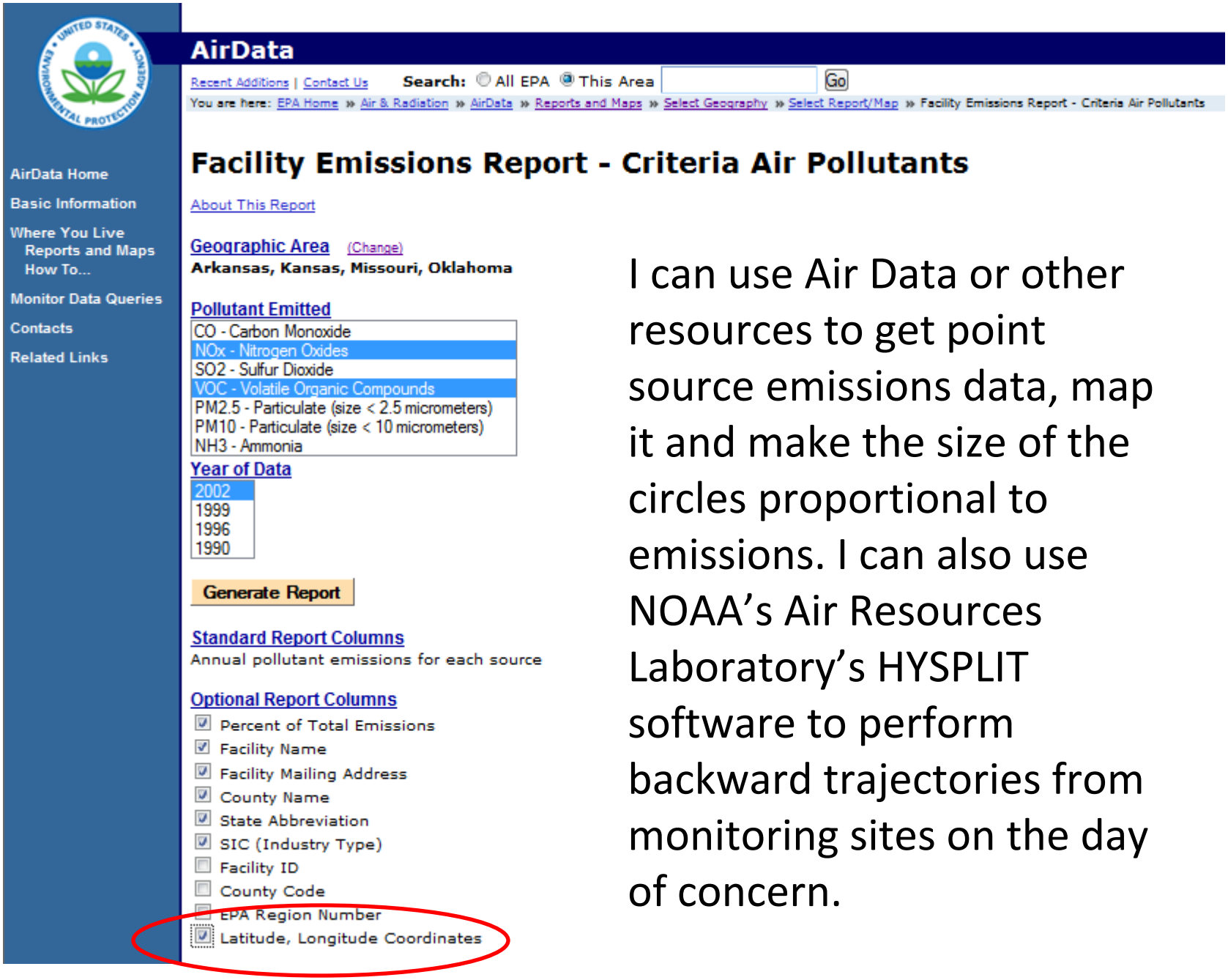
Area 8-hr Ozone on July 22, 2004



I can also use GIS extensions to help illustrate.

8-hr Ozone on July 22, 2004 with Prediction Contours (ESRI Geostatistical Analyst)





I can use Air Data or other resources to get point source emissions data, map it and make the size of the circles proportional to emissions. I can also use NOAA's Air Resources Laboratory's HYSPLIT software to perform backward trajectories from monitoring sites on the day of concern.

ARL
Air Resources Laboratory
READY

ARL Home > READY > Transport & Dispersion Modeling > HYSPLIT > HYSPLIT Trajectory Model

HYSPLIT Trajectory Model

Model Run Details

Meteorology: EDAS40

Source Location: Lat: 36.922222 Lon: -94.838889

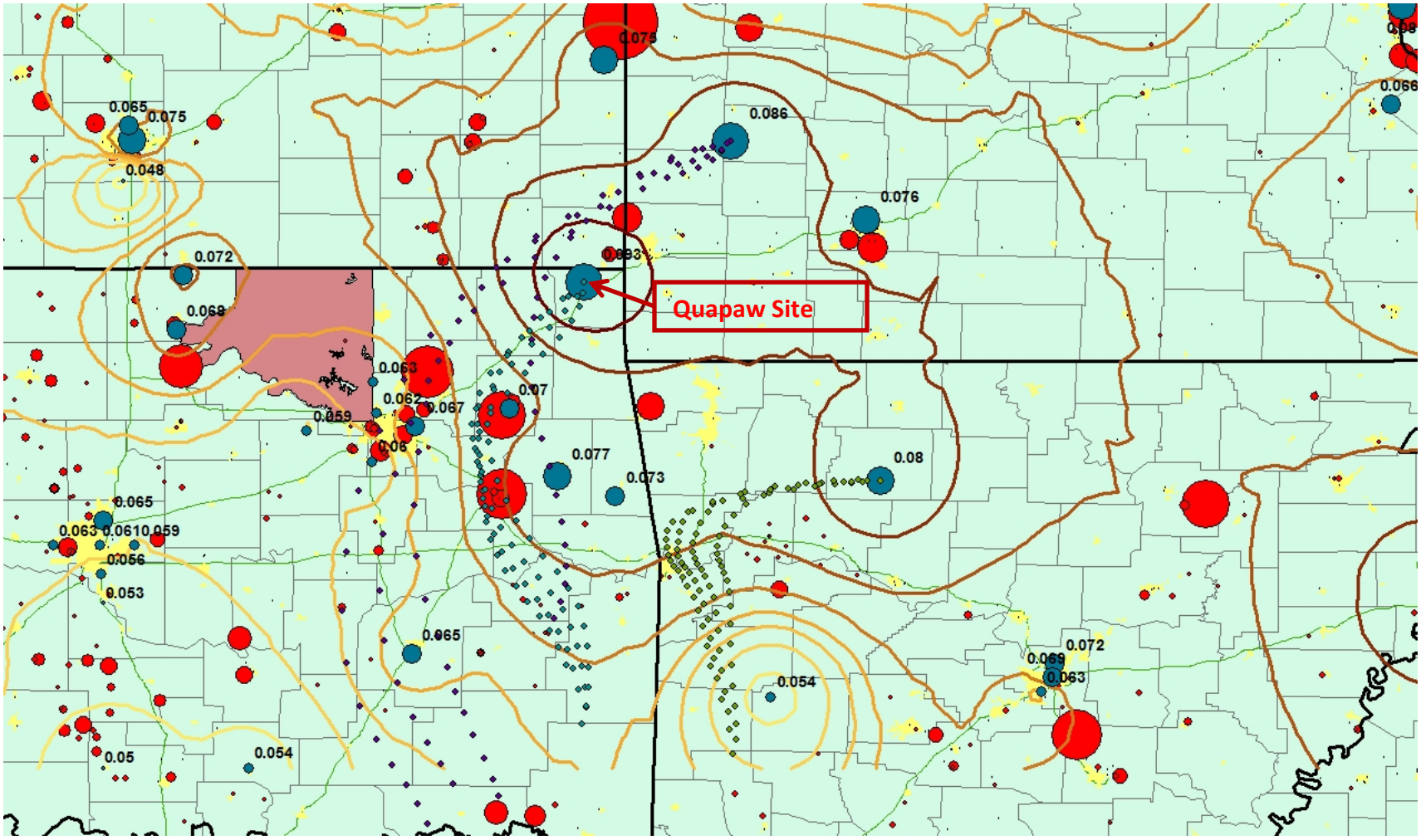
The EDAS40 archive file contains data beginning at 0000 UTC 7/16/04.

Change Default Model Parameters and Display Options

Trajectory direction:	help	(●) Forward			
		( ) Backward			
Vertical Motion:	help	(●) Model vertical velocity			
		( ) Isobaric			
		( ) Isentropic			
Start time (UTC):	help	year 04	month 07	day 16	hour 00
Total run time (hours):	help	24			
Start a new trajectory every:	help	0 hrs	Maximum number of trajectories: 24		

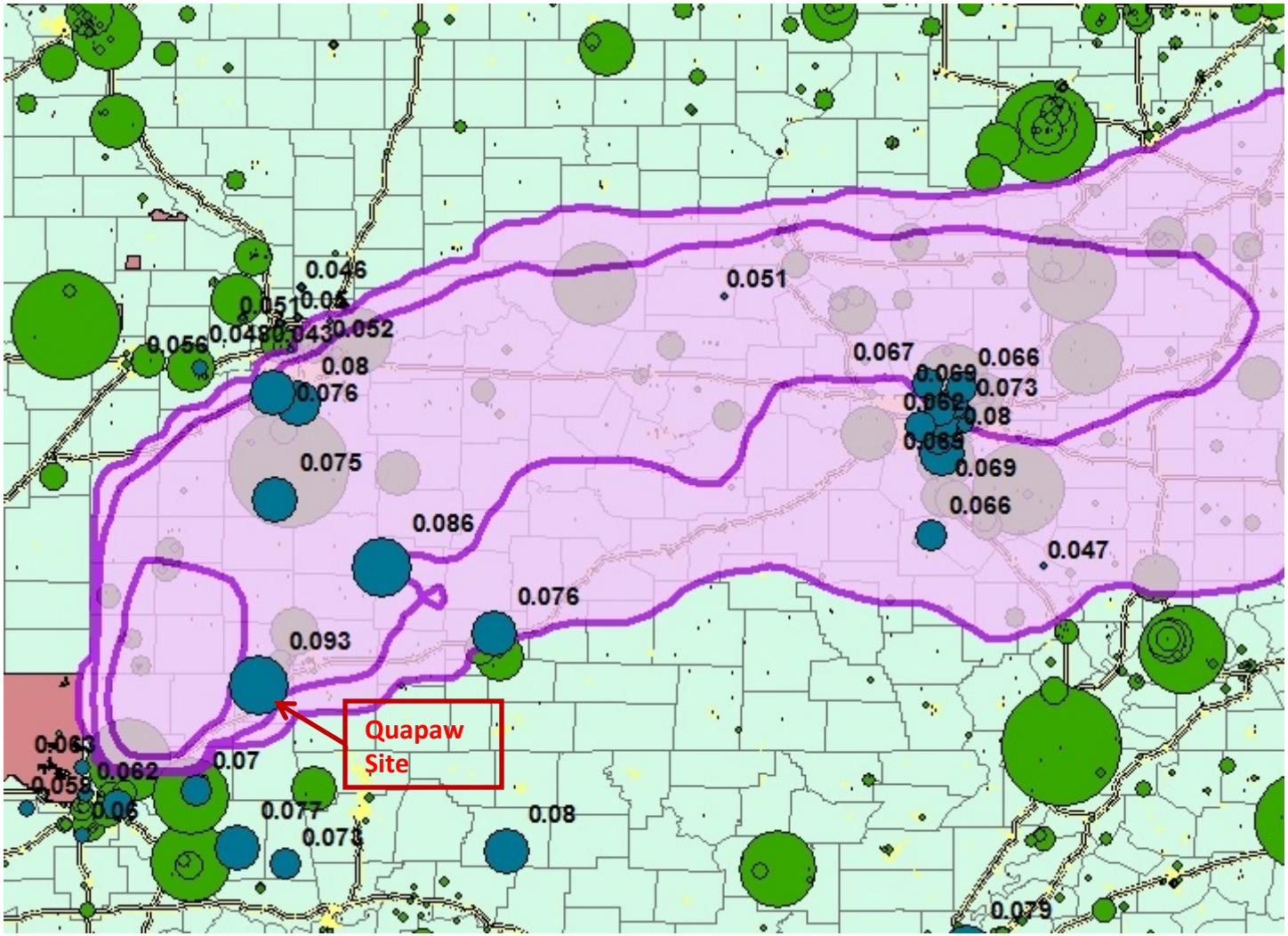
July 22, 2004, 24-hour Backward Trajectories
(NOAA Air Resource Laboratory HYSPLIT Model)

● proportional NOx point source emissions – 2002 EI

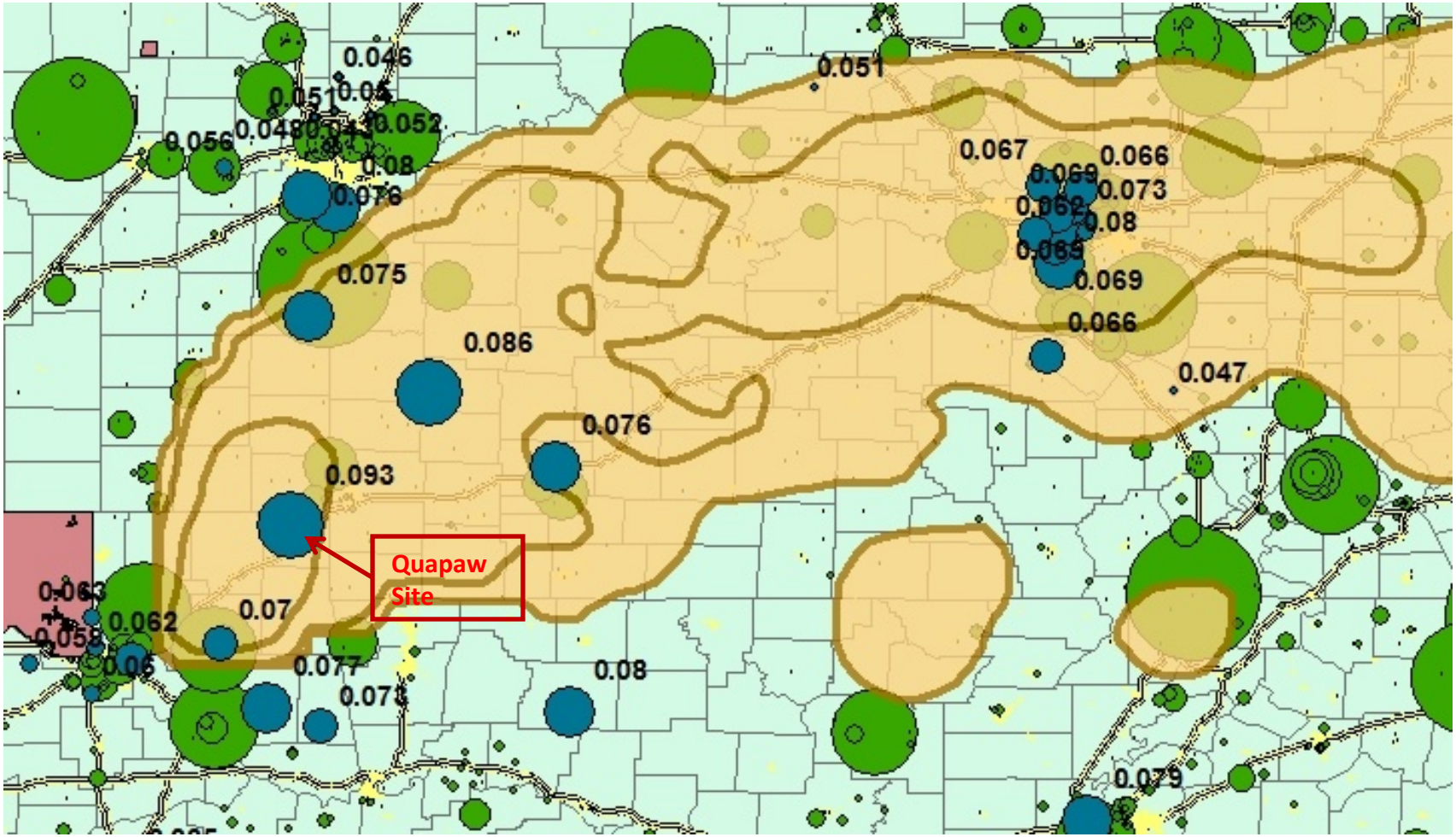


Now I have some suspect areas that may have contributed to the problem (something near the three coal-fired power plants). I can use ARL's HYSPLIT software to run forward dispersions from the power plants to see where the model indicates their emissions were when I had the high concentration. In this example I set the model to average concentrations from 100 m to ground level and set it for a 48-hour release beginning 48-hours prior to the high concentration at the Quapaw site.

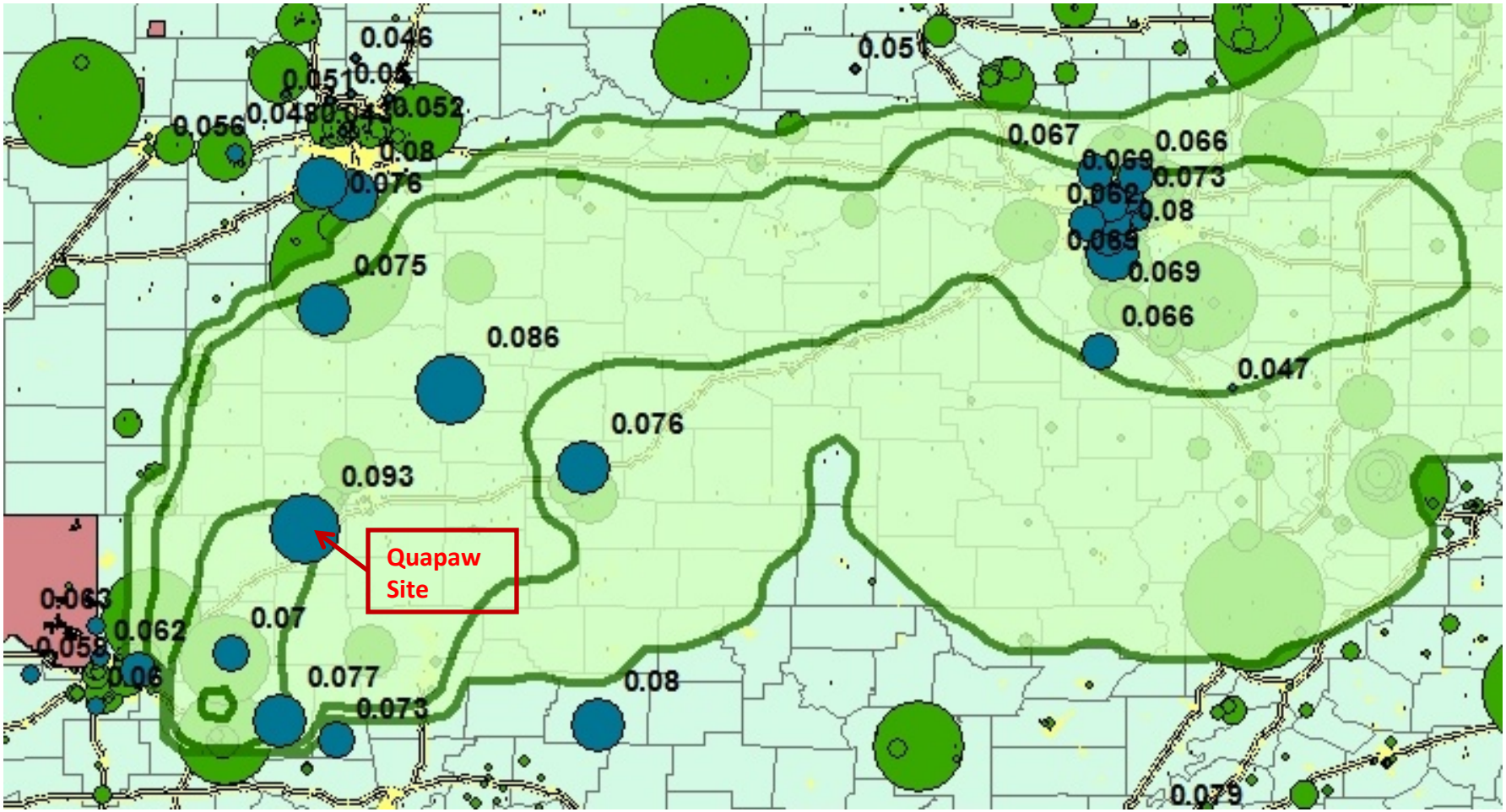
Oologah Power Plant 48-hr dispersion
(NOAA Air Resource Laboratory HYSPLIT Model)



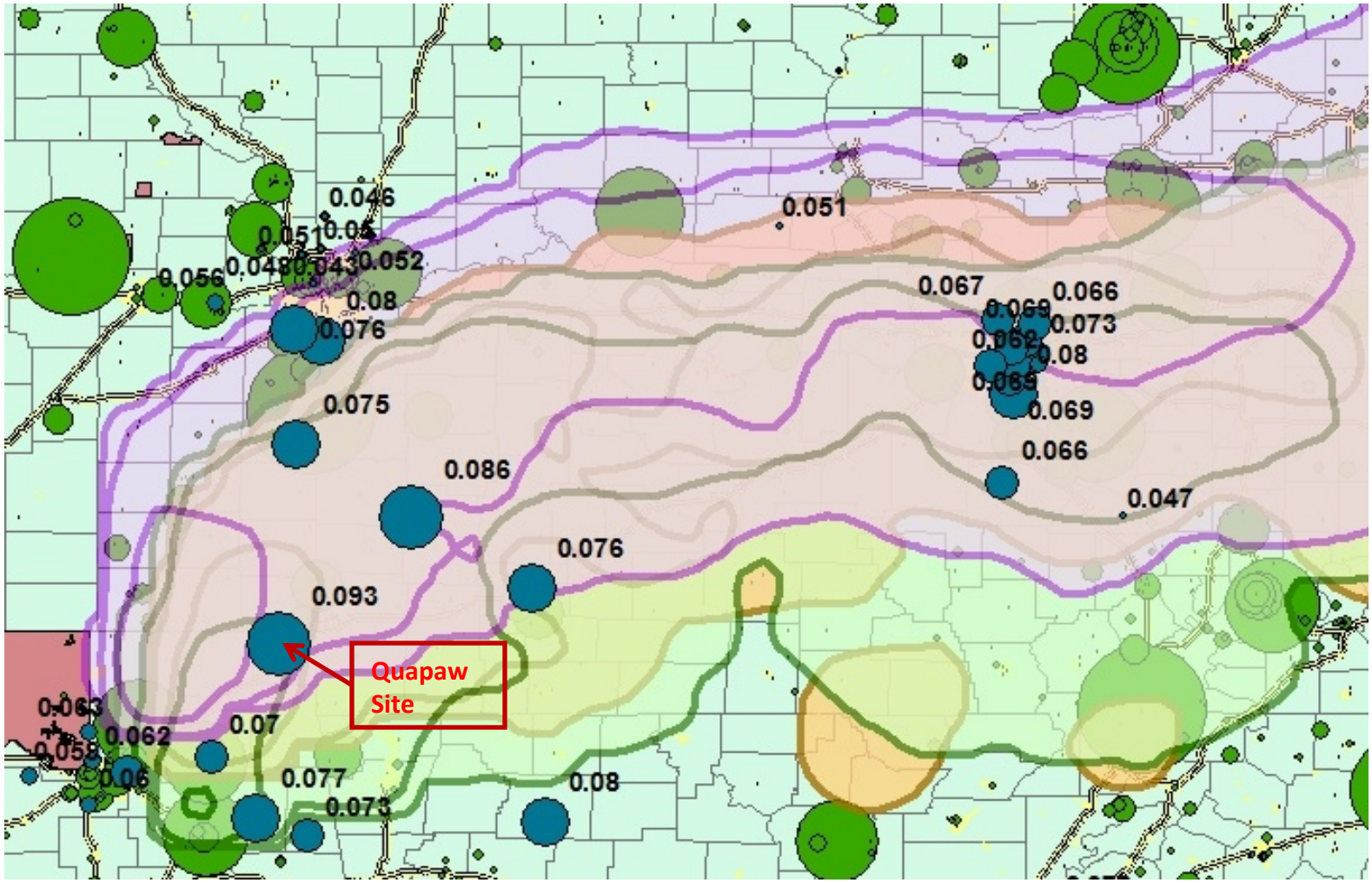
GRDA Power Plant 48-hr dispersion
(NOAA Air Resource Laboratory HYSPLIT Model)



Muskogee Power Plant 48-hr dispersion
(NOAA Air Resource Laboratory HYSPLIT Model)



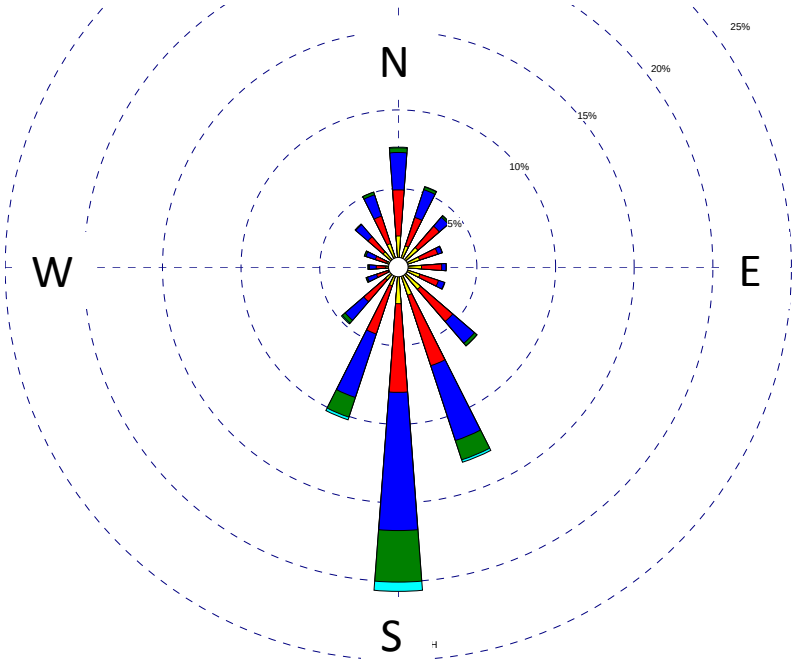
Combined 48-hr dispersion
(NOAA Air Resource Laboratory HYSPLIT Model)



Most Relevant Winds for Ozone

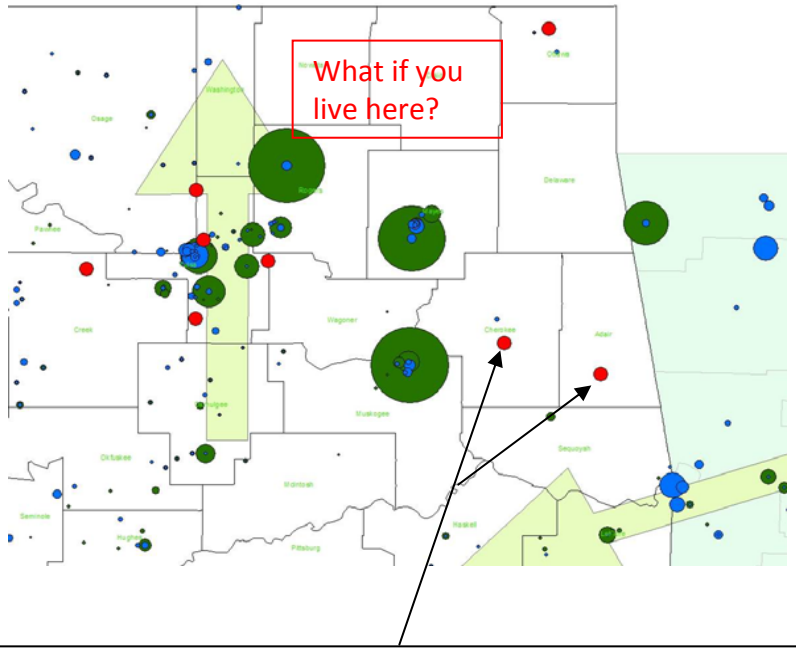
WIND ROSE PLOT

Tulsa Ozone Season Wind Rose,
Lines Indicate the Direction the Wind Came **FROM**, and Colors Indicate Wind Speed
(1984-1992, March 1 to October 31, from 8 AM to 6 PM)



NE Oklahoma Coal-Fired Power Plant NOx Emissions

Source: EPA AirData (1999 EI)



2003 Ozone Monitoring Locations (Red Dots)

26.5% of Oklahoma facility NOx emissions are from Muskogee, Mayes and Rogers Counties (1999)

22.9% of Oklahoma facility NOx emissions are from three NE Oklahoma coal-fired power plants (1999)

A tutorial is being developed with step-by-step screen shots using this example. Every step in GIS software will be included. If you would like a copy when it is completed please email me at:
glenn.gehring@nau.edu