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The National Near-Road Mobile Source Air Toxics Study

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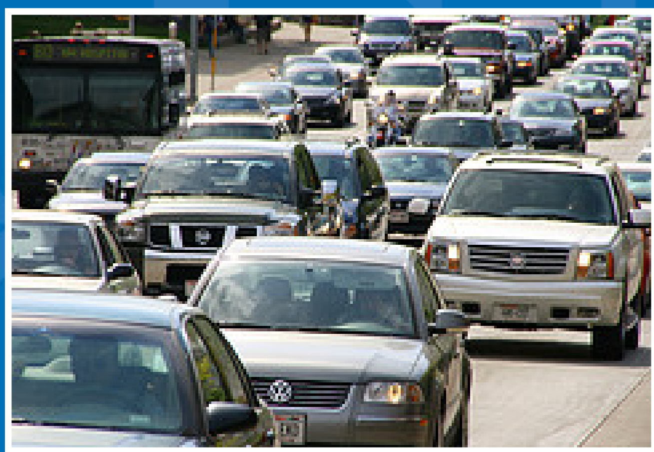

Office of Research and Development
RTP, NC

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Background – Identification of Research Problem

- OTAQ identified “near road health effects” as research need in 2001 Mobile Source Air Toxics Rule
  - Included as original PM Center RFA topic
  - Incorporated into HEI’s research program
  - OAR identified “near road” as the highest priority research need in the OAR/ORD “Voucher” Program
- Major focus in current ORD Air MYP

Near Road Air Quality

- Estimate over 35 million people live within 100 meters of a major transportation system including 4+ lane highways
- More than 1,000 compounds have been identified in exhaust and evaporative emissions from mobile sources
  - Regulated pollutants
  - Air toxics
  - Particulate matter
- Air quality measurements have indicated elevated pollutant concentrations near roads
  - CO and Pb the focus during the 70's
  - Recent studies indicate mixture of pollutants

Near-Road Health Effects

- Most “near road” health concerns based on epidemiology studies
- These studies typically use simple metrics to define “near roadway” exposure
  - Self-reported proximity to major roads
  - Distance from nearest highway (GIS)
  - Distance to nearest roadway weighted by the traffic volume on that road
- Some toxicological studies provide plausible biological mechanisms
- Limited air quality measurements available due to costs and current siting guidance restrictions for NAAQS monitors

Near Road Health Effects

- Living near major roadways has been associated with several health endpoints
  - Cardio-respiratory effects (e.g., asthma, bronchitis)
  - Adverse birth outcomes/developmental effects
  - Premature mortality
  - Cardiovascular effects
  - Childhood cancer
- Hundreds of studies published just since 2000
  - Account for varying fleets, engine technologies, etc.
  - OTAQ maintaining bibliography (over 50 pages and counting)
- Evidence not equally as strong for each of these health effects
- Most initial studies conducted in Europe, although similar results have been reported for all parts of the world including the U.S.

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What is the origin of the EPA/FHWA collaboration?

- Sierra Club sued FHWA over not accounting for near road impacts in NEPA assessments
  - ➢ US95 expansion in Las Vegas
  - ➢ Sierra Club sued over adequacy of NEPA document–did not include mobile source air toxics
  - ➢ Historically, NEPA only requires criteria pollutants.
- Settled in 2005
  - ➢ Agreed to conduct studies in "up to 5" cities in the U.S.
  - ➢ FHWA developed peer reviewed protocol for study implementation
    - ✓Peer review included representatives from EPA, DOE, industry, and NGOs
  - ➢ EPA/FHWA established partnership to conduct studies
    - ✓Based on success of pilot Raleigh Near Road Study and past successful collaboration on the Kansas City motor vehicle emissions study conducted by ORD staff.

Why are we involved in this project? --- Key Science Questions ---

- What is the spatial and temporal variability of traffic-related pollutants near roadways?
- How do traffic (volumes, speeds, fleet mix, etc.) and environmental (meteorology, topography, etc.) conditions affect vehicle emissions and near road air quality?
- What marker(s)/metric(s) can be used to identify exposures to traffic-related emissions?
- What tools are available, or can be produced, to identify the relationship between traffic emissions and: 1) population exposures; 2) adverse health effects for use in regulatory decision making and transportation planning?
- What are the concentration gradients at a fine(er) scale resolutions?
- How does urban topography and barriers impact these gradients?
- Are there mitigation techniques that can reduce exposures to susceptible populations?

Where are we in the project?

- IAG formed between EPA and FHWA
  - 3 one-year studies
  - Las Vegas, Detroit, Raleigh (possible)
- Las Vegas implementation
  - Select candidate site(s)
    - Site selection criteria
    - Weigh pros/cons of each site
    - Make site visit
    - Select suitable site
  - Acquire analytical equipment – contract awarded
  - Develop/Implement work assignment(s) – Site Infrastructure WA – In Place
  - Develop Quality Assurance Project Plan (QAPP)
  - **Started field measurements at selected site**
    - **December 15, 2008**

I-15 Monitoring Site: Trailer Locations Shown as Red Triangles.

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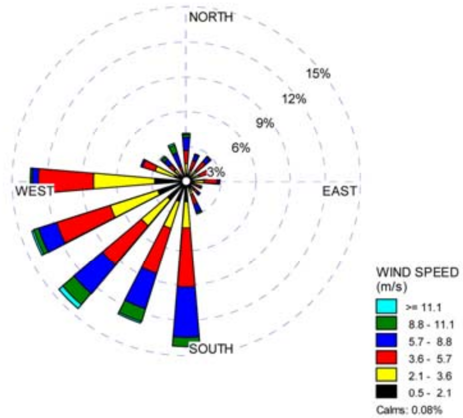
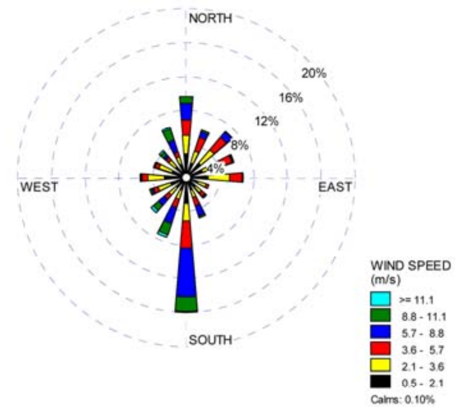
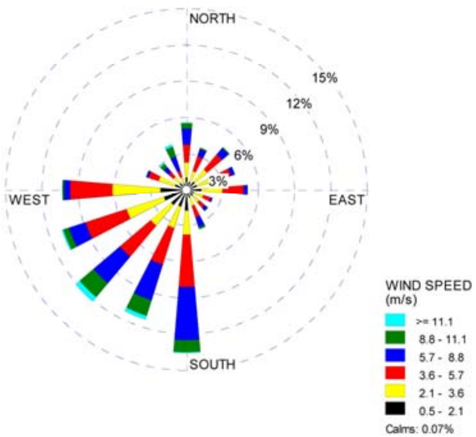
I-15 Site Windroses



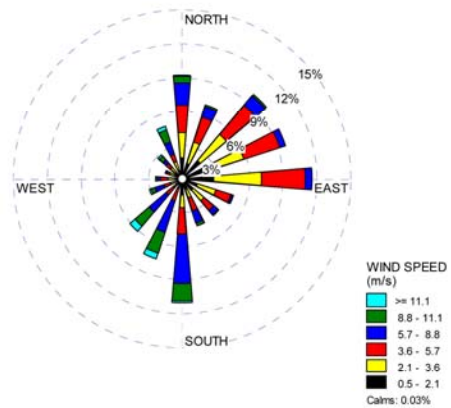
Hour 0 to Hour 15



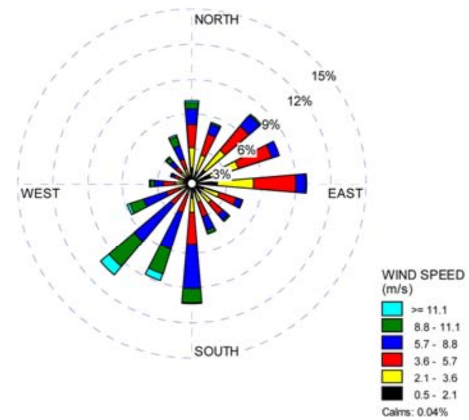
Hour 16 to Hour 17



24-Hour



Hour 18 to Hour 21



Hour 22 to Hour 23

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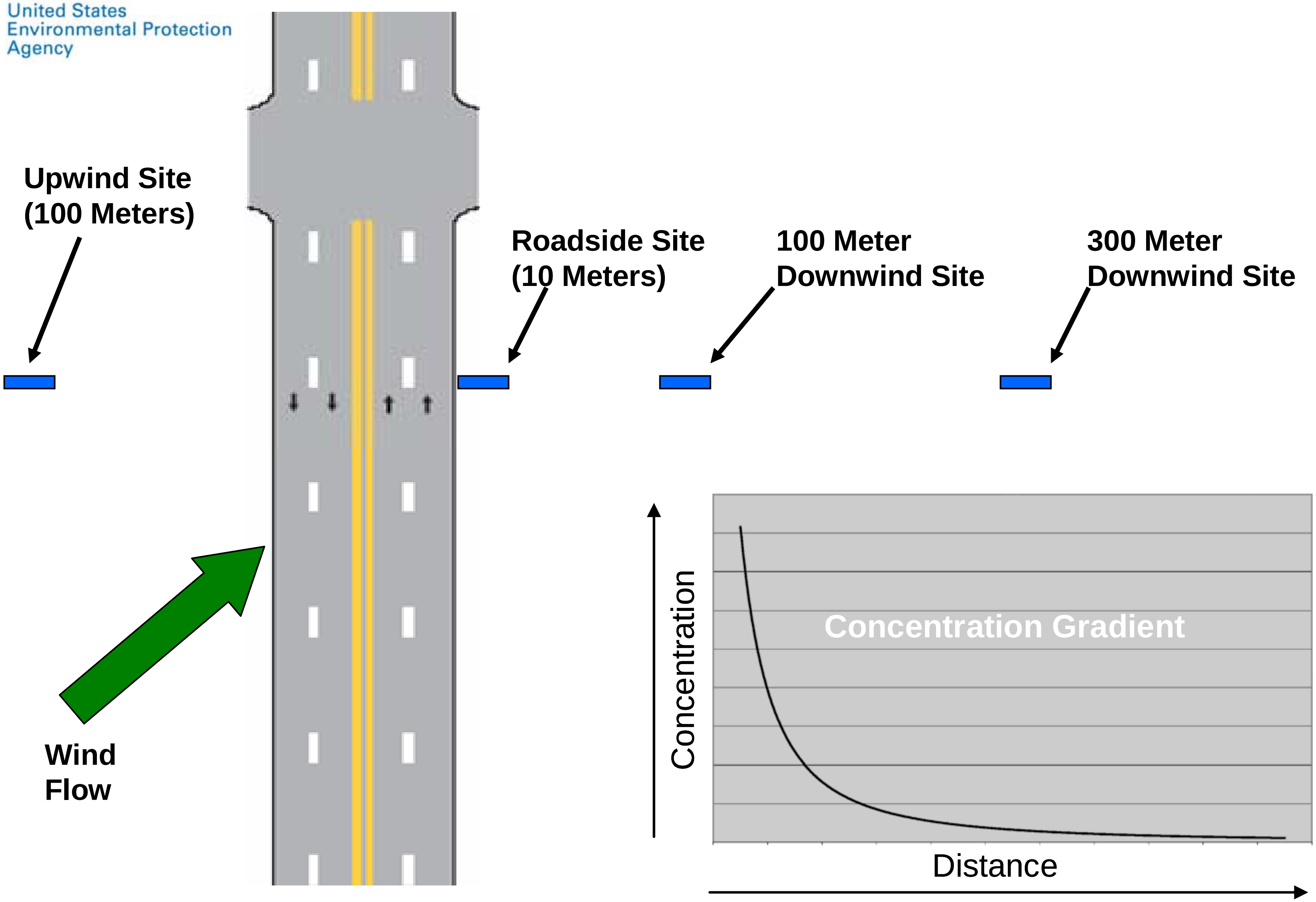

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I-15 Site

Instrument Deployment - Overview

Core Instruments	10 Meters @ Roadside	100 Meter Downwind	300 Meter Downwind	100 Meter Upwind
TO-11A Cartridge sampling	X	X	X	X
TO-15 Canister sampling	X	X	X	X
Continuous GC	X	X	X	X
Continuous gas monitoring (CO, NO_x)	X	X	X	X
Continuous gas monitoring (SO_2)		X		X
Continuous black carbon monitoring (Aethalometer)	X	X	X	X
Continuous fine particle (TEOM)	X	X	X	X
Integrated $PM_{2.5}$ (FRM)	X	X	X	X
Continuous Particle Counts (TSI, 6nm – 3μm)	X	X	X	X
Wind speed/wind direction (sonic anemometer)	X	X	X	X
Meteorological monitoring (temp, RH, solar, etc.)		X		
Cut Section Monitoring (3-CO & 3-Aethalometers)	X			

Data Types, Methods, Frequency

Data Type	Pollutant or Covariate	Method	Sample Type and Frequency
Mobile Source Air Toxics	Benzene 1,3-butadiene	TO-15	1-hour integrated 1-in-12 day schedule 9 samples each day at each road-side location
	Formaldehyde Acetaldehyde Acrolein	TO-11A	
Mobile Source Related Air Pollutants	CO	NDIR	Continuous
	NO, NO_2, NOx	Chemiluminescence	
	SO_2	Fluorescence	
	Black carbon	Aethalometer	
	$PM_{2.5}$	TEOM	
	PM10		
	Particle count	CPC	
	$PM_{2.5}$	FRM	24-hour integrated 1-in-12 day schedule 1 sample each day at each road-side location
Traffic	Vehicle count Speed Length	Radar	Continuous
Meteorology	Wind speed/direction; Temperature Relative humidity	RM Young Sonic Anemometer; Vaisala Temp/Humidity	Continuous

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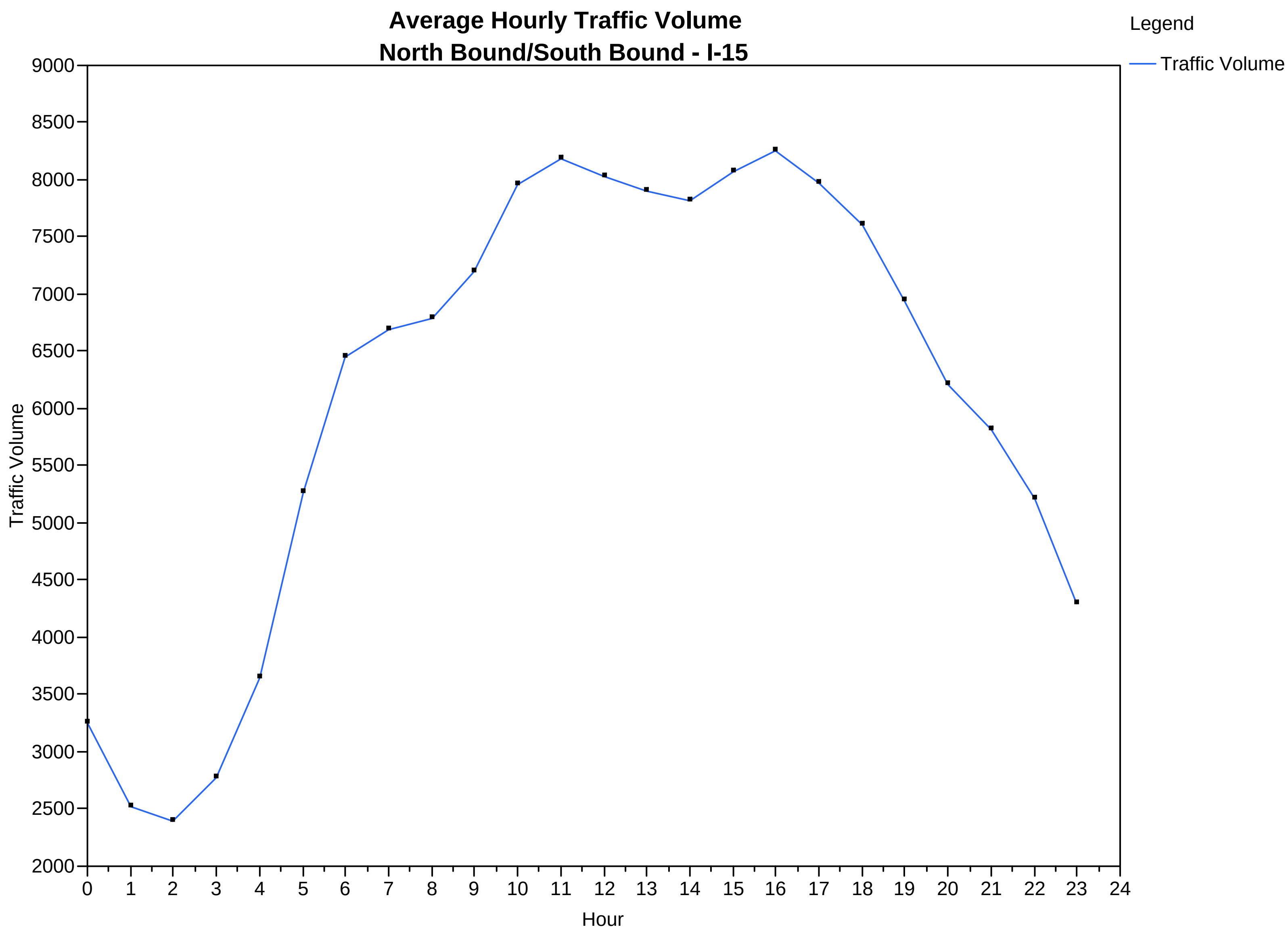
Data Capture Results

Parameter	Total	Station 1 (10 meter)	Stations 2 (100 meter)	Station 3 (300 meter)	Station 4 (Upwind)
CO	94	94	94	94	94
NO	96	96	97	96	96
NO_2	96	96	97	96	96
NO_X	96	96	97	96	96
PM_{10}	87	98	91	75	87
PM_{25}	87	98	96	73	82
PM Coarse	88	98	86	76	93
Black Carbon	91	95	75	97	98
Wind Speed	100	100	100	100	100
Wind Direction	98	99	96	99	99
SO_2	91		90		92
TO-15 canisters (VOCs)	95	97	84	97	100
TO-11 cartridges (aldehydes)	70	99	38	43	100
DNSH cartridges (aldehydes)	63	86	39	43	86
$PM_{2.5}$ Filters	86	86	86	86	86
Traffic (estimated)	>99	>99	>99	>99	>99
Continuous GC (estimated)	~40	~40			

Average Hourly Traffic Volume (Weekday/Weekend)

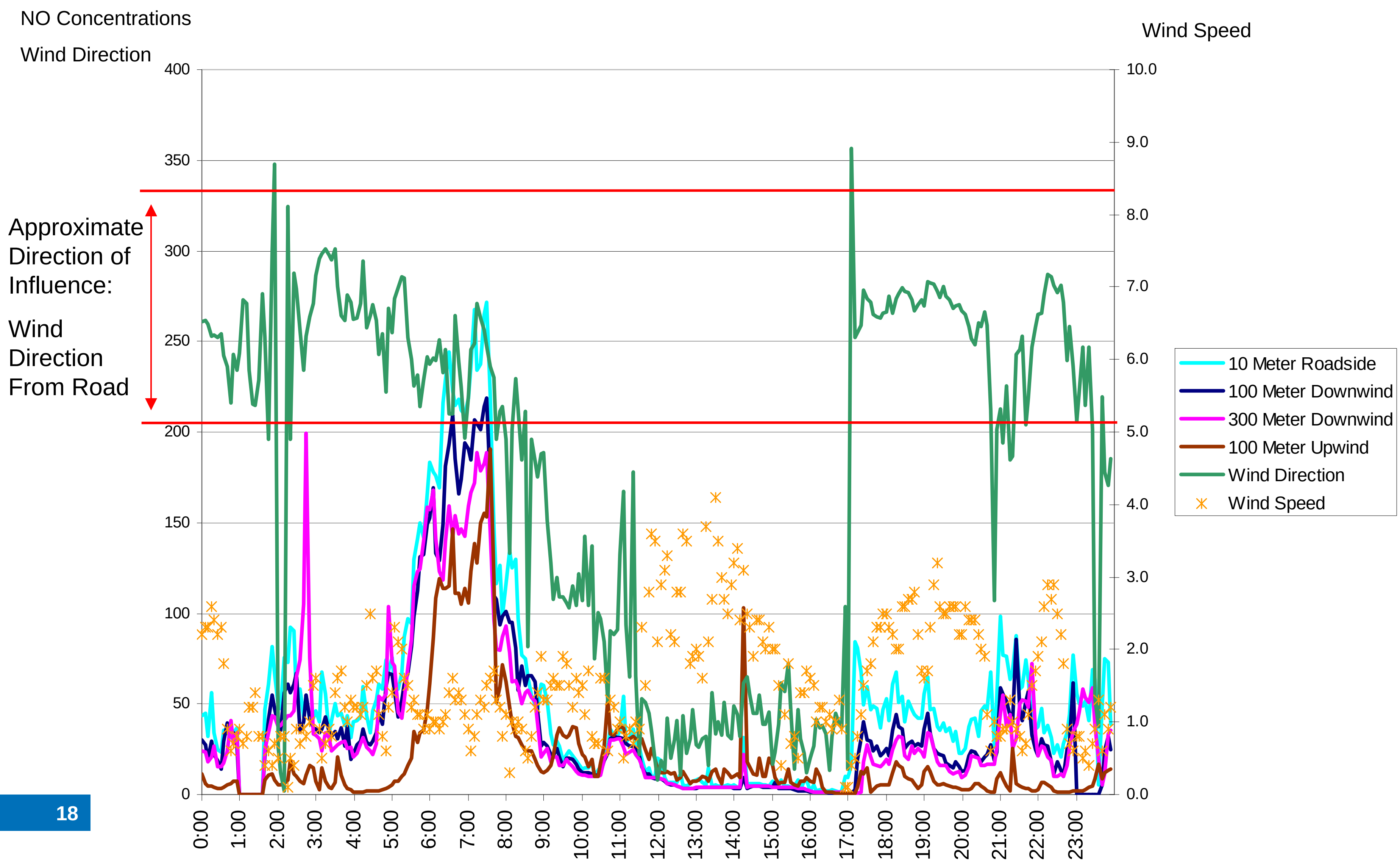


Tri-Modal Traffic Distribution

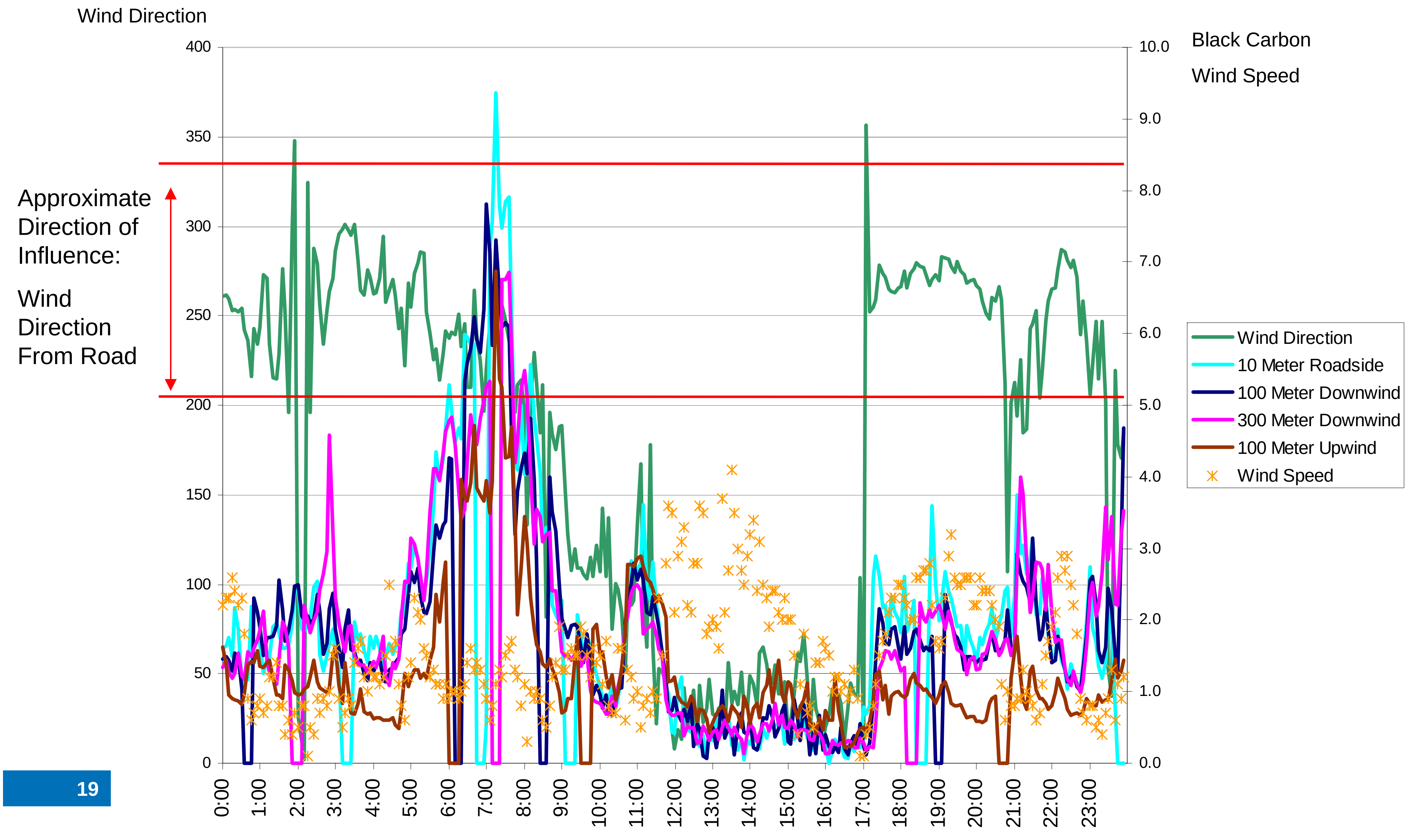
- Observe tri-modal traffic distribution as opposed to bi-modal
- This is believed to be the result of several factors:
  - Las Vegas is not typical commuter city;
  - Las Vegas is a recreation destination for many travelers;
  - Shift changes in Las Vegas are later or earlier in the day depending on the employer;
  - Study site is along an interstate that carries both inter- and intra- state traffic; and
  - I-15 is a North American Free Trade (NAFTA) corridor.

Concentration Gradient Plots….

NO Concentration Gradient – Feb 3, 2009
Day with Low Wind Speed



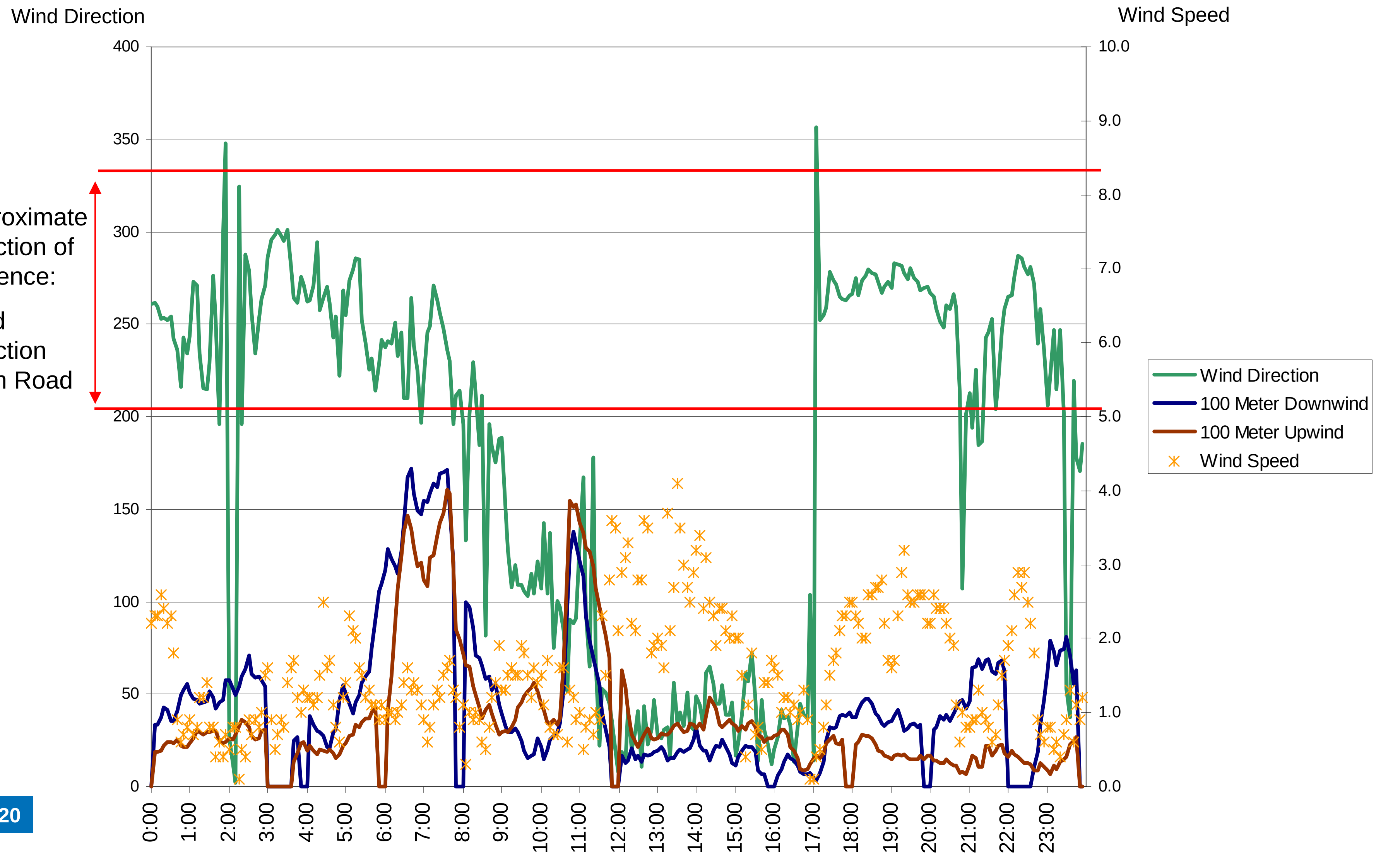
Black Carbon Concentration Gradient – Feb 3, 2009
Day with Low Wind Speed



SO_2 Concentration Gradient – Feb 3, 2009
Day with Low Wind Speed

Approximate Direction of Influence:

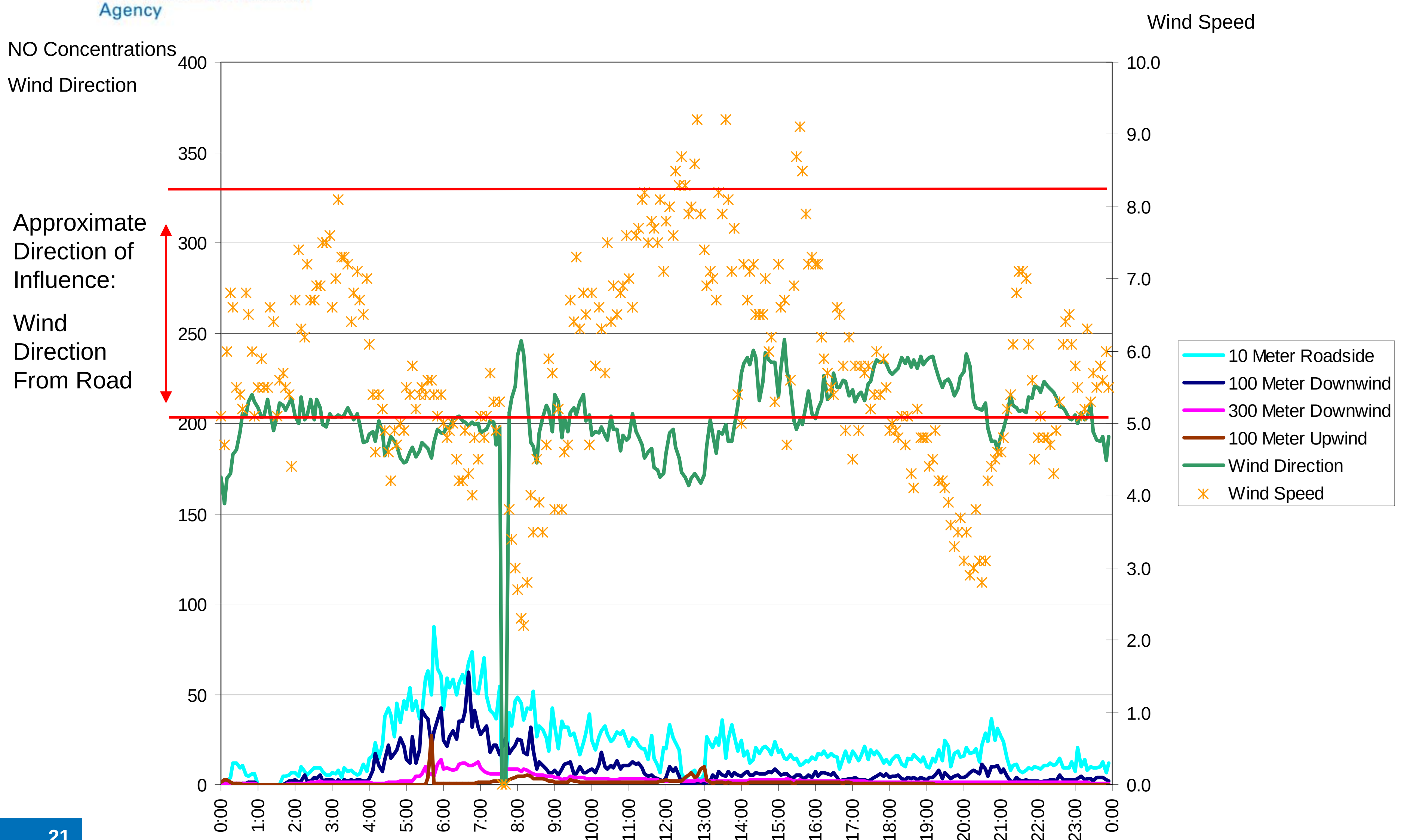
Wind Direction From Road



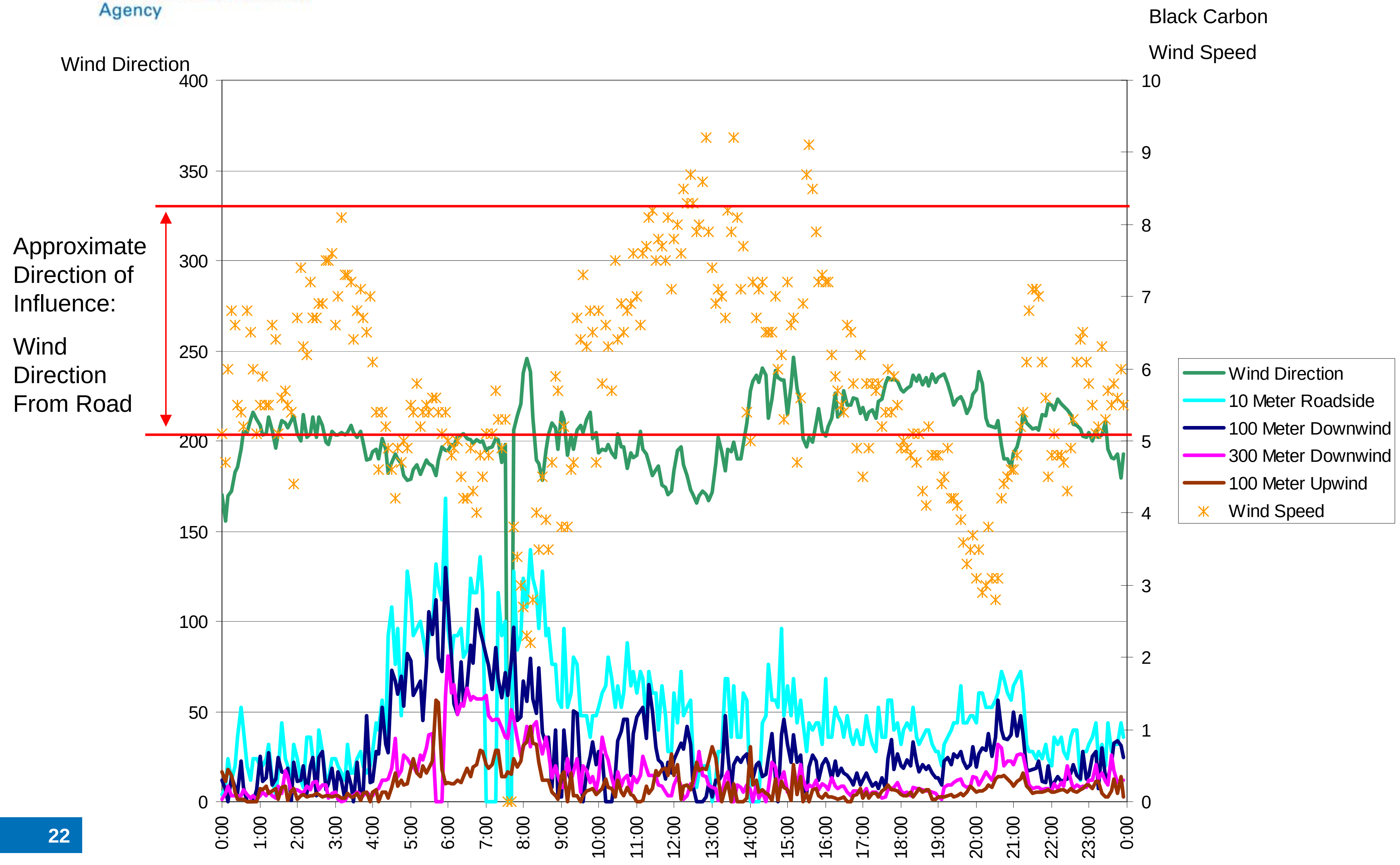
NO Concentration Gradient – March 3, 2009
Day with High Wind Speed

Approximate Direction of Influence:

Wind Direction From Road



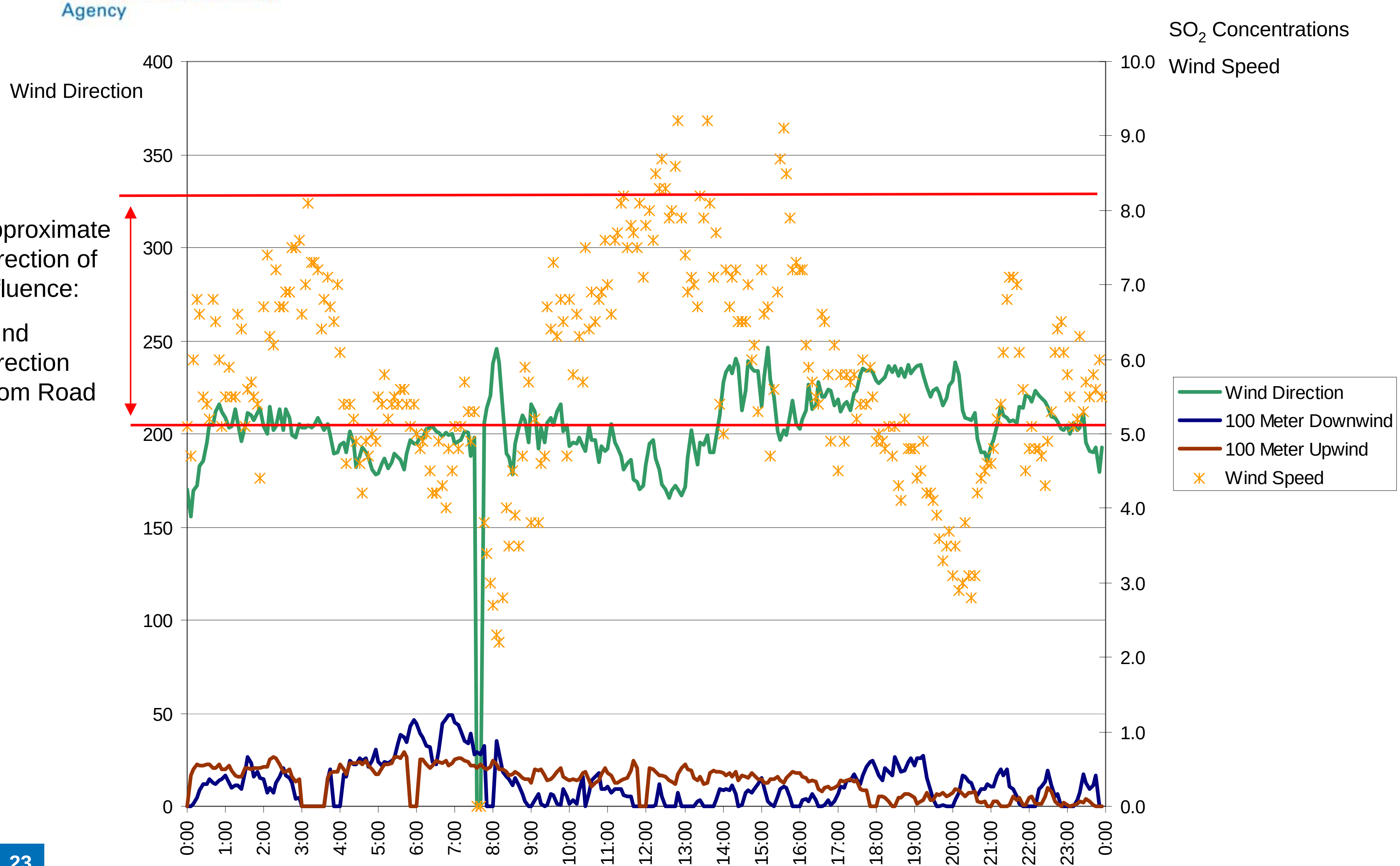
Black Carbon Concentration Gradient – March 3, 2009
Day with High Wind Speed



SO_2 Concentration Gradient – March 3, 2009
Day with High Wind Speed

Approximate Direction of Influence:

Wind Direction From Road



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