CRPAQS Data Analysis Task 2.7

When and Where Does High O_3 Correspond to High $PM_{2.5}$?

How Much $PM_{2.5}$ Corresponds to Photochemical End Products?

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CRPAQS Data Analysis Workshop

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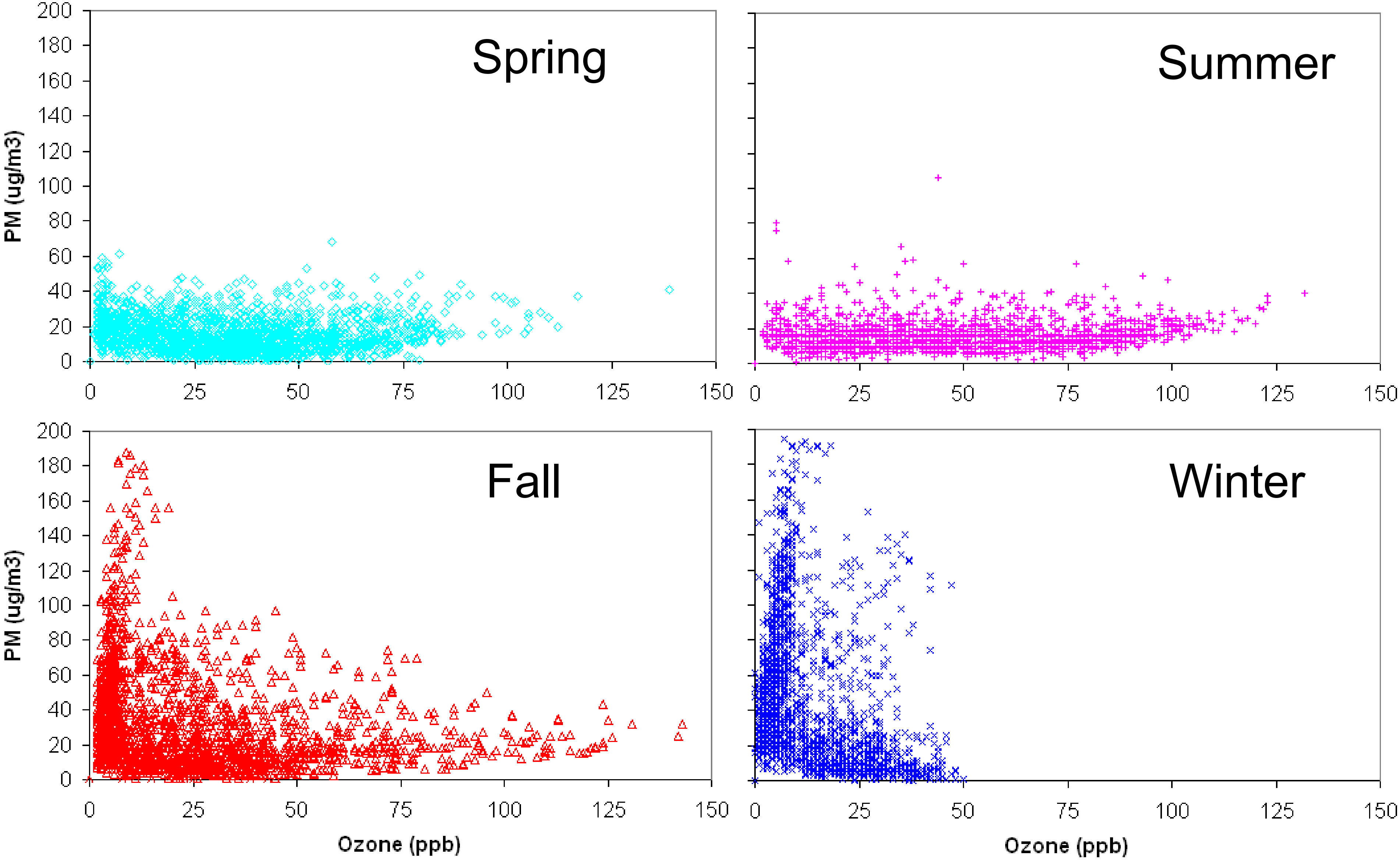
Discerning O_3-PM Relationships Hypotheses

- Some relationship must exist between O_3 and $PM_{2.5}$ because O_3 and key secondary $PM_{2.5}$ components are governed by the same precursors (NO_x and VOC)
- Season-specific relationships: high O_3 predominantly occurs in summer, but high $PM_{2.5}$ occurs in winter

Do High O_3 and $PM_{2.5}$ Occur Together? Fresno, Hourly Data



Statistics at Fresno (January - December 2000)

	Annual	Spring[1]	Summer[1]	Fall[1]	Winter[1]
80th perc. O_3	50 ppb	52	74	41	24
80th perc. $PM_{2.5}$	39 $\mu g/m^3$	22	21	50	77
Tot. # samples	8028	2112	1817	2081	2018
# samples w/ high[2] O_3 & PM	68 (0.8%)	102 (4.8%)	113 (6.2%)	28 (1.3%)	36 (1.8%)
Conditional Probability[3]	0.04	0.24	0.31	0.07	0.09

(1) Spring: Mar to May; Summer: Jun to Aug; Fall: Sep to Nov; Winter: Dec to Feb
(2) Defined as the top 20th percentile
(3) P(high O_3 & PM | high O_3) = P(high O_3 & PM | high PM)

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Statistics at Bakersfield (January - December 2000)

	Annual	Spring[1]	Summer[1]	Fall[1]	Winter[1]
80th perc. O_3	57 ppb	57	76	45	23
80th perc. $PM_{2.5}$	29 $\mu g/m^3$	19	16	38	67
Tot. # samples	7080	1753	1982	1942	1368
# samples w/ high[2] O_3 & PM	70 (1.0%)	63 (3.6%)	98 (4.9%)	34 (1.8%)	39 (2.9%)
Conditional Probability[3]	0.05	0.18	0.25	0.09	0.14

(1) Spring: Mar to May; Summer: Jun to Aug; Fall: Sep to Nov; Winter: Dec to Feb
(2) Defined as the top 20th percentile
(3) P(high O_3 & PM | high O_3) = P(high O_3 & PM | high PM)

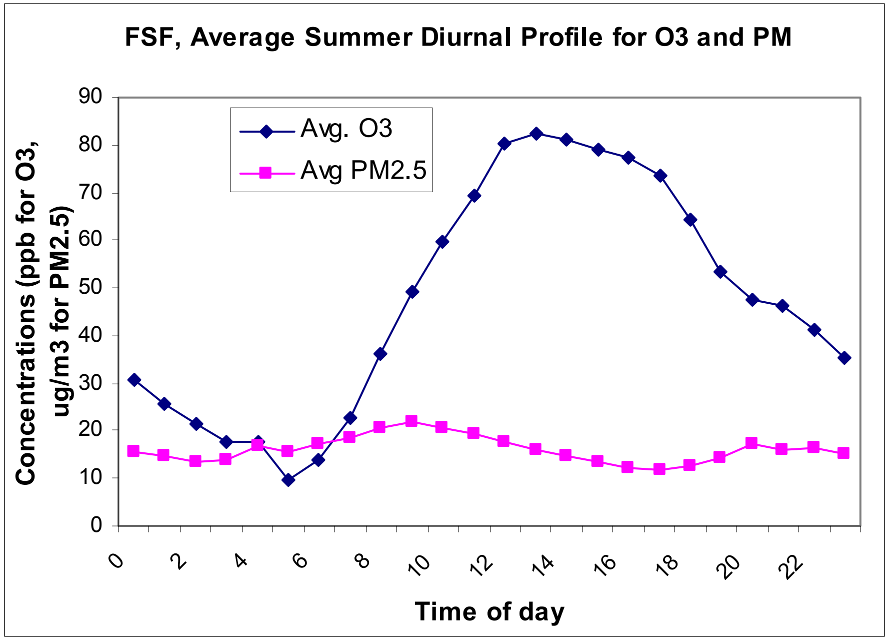
Statistics at Angiola (February 2000 - January 2001)

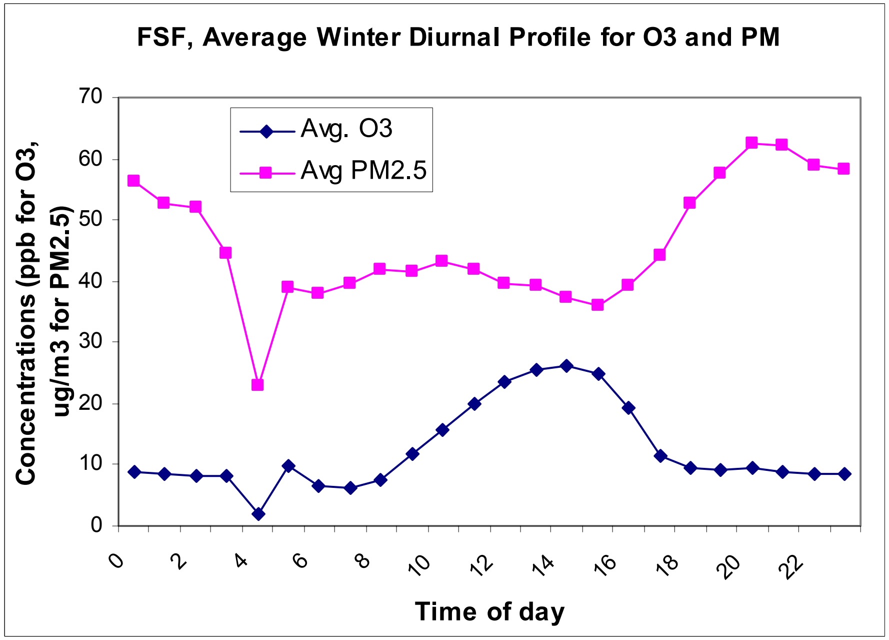
	Annual	Spring[1]	Summer[1]	Fall[1]	Winter[1]
80th perc. O_3	51 ppb	54	66	50	32
80th perc. $PM_{2.5}$	27 $\mu g/m^3$	16	15	32	66
Tot. # samples	6717	1766	1565	1744	1639
# samples w/ high[2] O_3 & PM	109 (1.6%)	99 (5.6%)	75 (4.8%)	47 (2.7%)	98 (6.0%)
Conditional Probability[3]	0.08	0.28	0.24	0.13	0.30

(1) Spring: Mar to May; Summer: Jun to Aug; Fall: Sep to Nov; Winter: Dec to Feb
(2) Defined as the top 20th percentile
(3) P(high O_3 & PM | high O_3) = P(high O_3 & PM | high PM)

High Hourly O_3 & PM Do Not Frequently Occur Together

- Seasonality: O_3 high in summer, PM high in winter
  - At all three sites, joint high O_3 and PM on an annual basis most frequently recorded in October
- Diurnal profile:





Spatial Differences in the O_3-PM Relationship

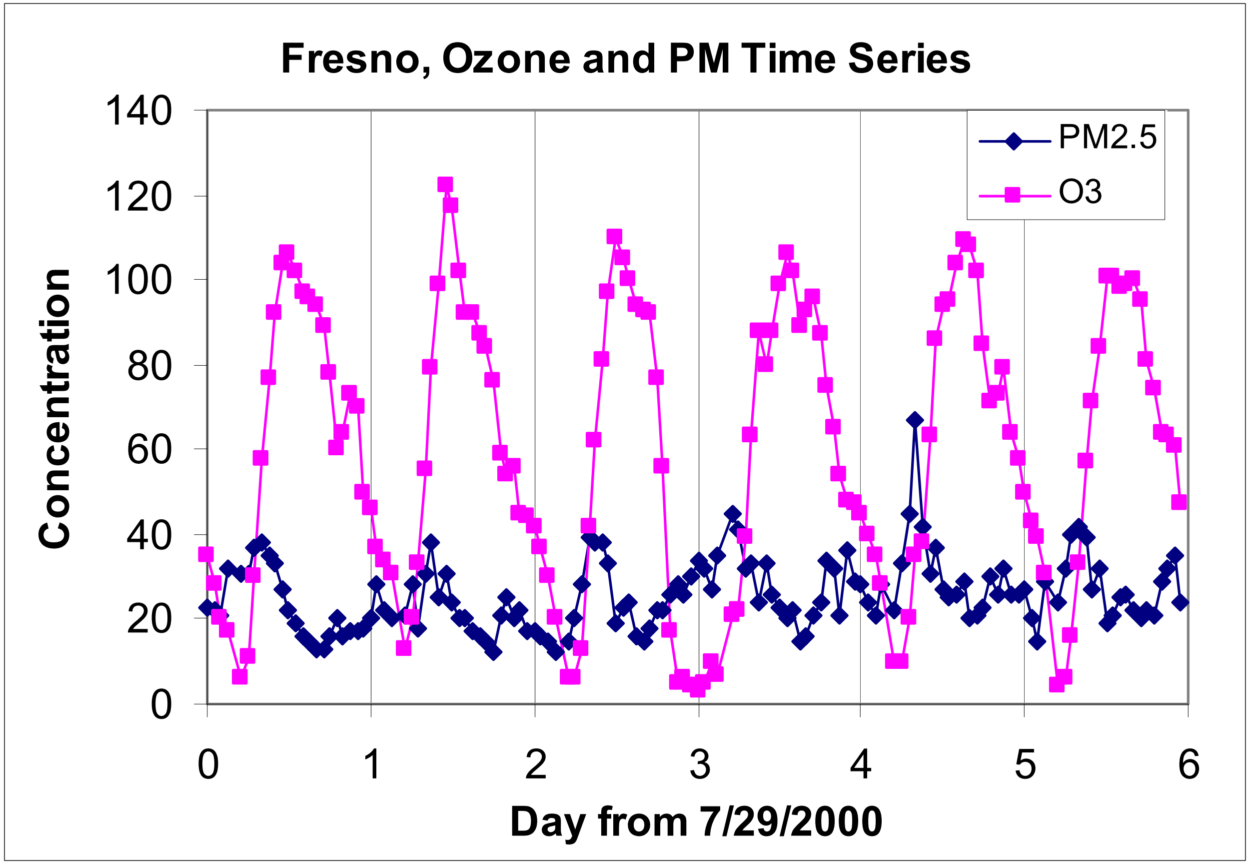
- Angiola: rural site
  - Winter > Spring > Summer > Fall > Annual
- Bakersfield and Fresno: urban sites
  - Summer > Spring > Winter > Fall > Annual

- High O_3 and PM occur together more frequently in Angiola than at Bakersfield and Fresno except during summer

Summer O_3-PM Relationship in Fresno

- Hypothesis: high O_3 and high PM both due to active day-time photochemistry
  – SOA formation accelerated due to availability of O_3 and other oxidants
  – Gas-phase HNO_3 formation increases due to availability of OH
- Expectation: Diurnal profile of both O_3 and PM show peak concentrations in the late afternoon when high O_3 and PM occur together

Diurnal Profiles of O_3 and PM



- PM concentrations peak during mid morning on days that record high O_3 and PM
- Afternoon PM typically lower

Diurnal profile inconsistent with hypothesis: Factor(s) other than local photochemical production drive high PM concentrations

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Winter O_3-PM Relationship in Angiola

- Hypothesis 1: high O_3 and high PM nitrate both due to active day-time photochemistry
- Hypothesis 2: high nighttime PM nitrate formation due to leftover high daytime O_3
- Expectation: For Hypothesis 1: diurnal profile of both O_3 and PM show peak concentrations in the late afternoon. For Hypothesis 2, out-of-phase diurnal profile.

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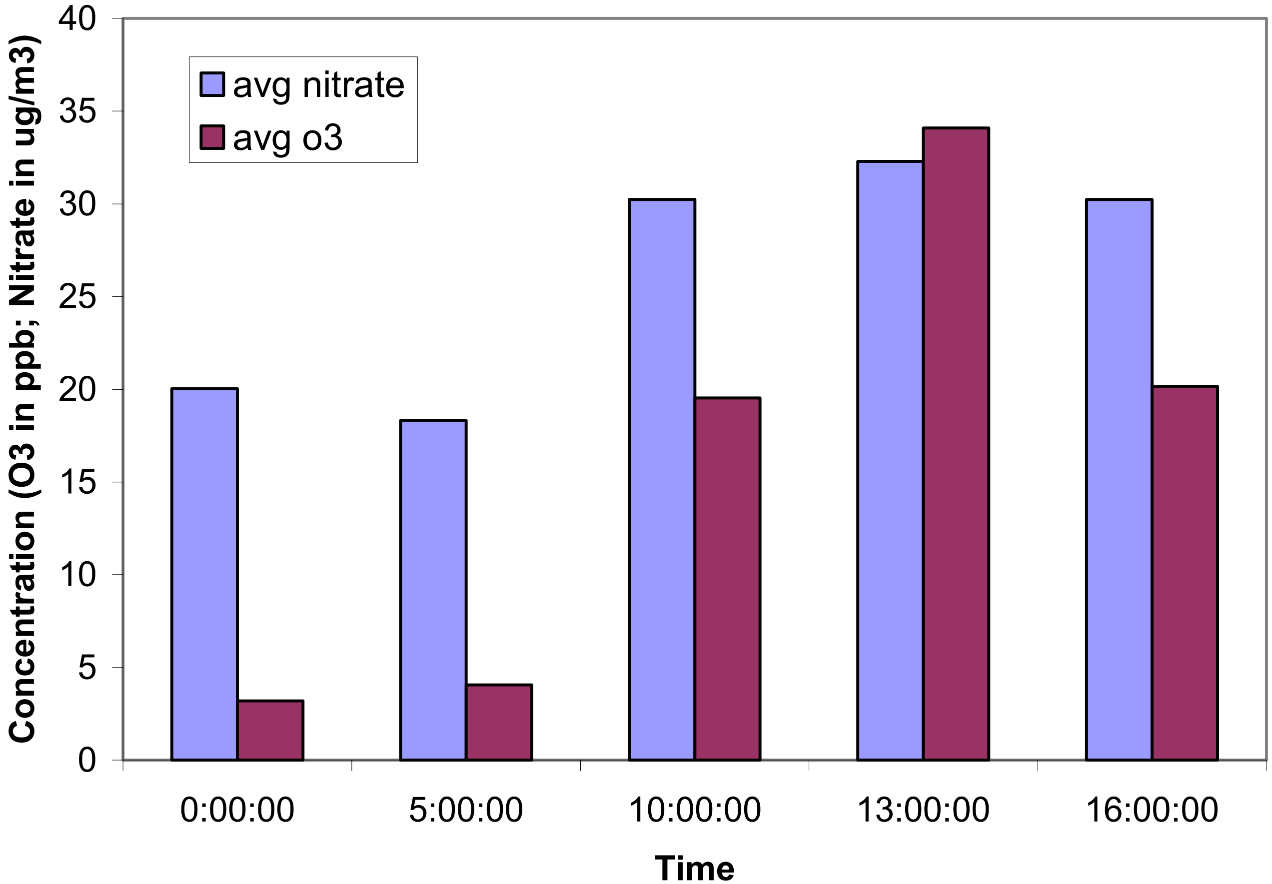
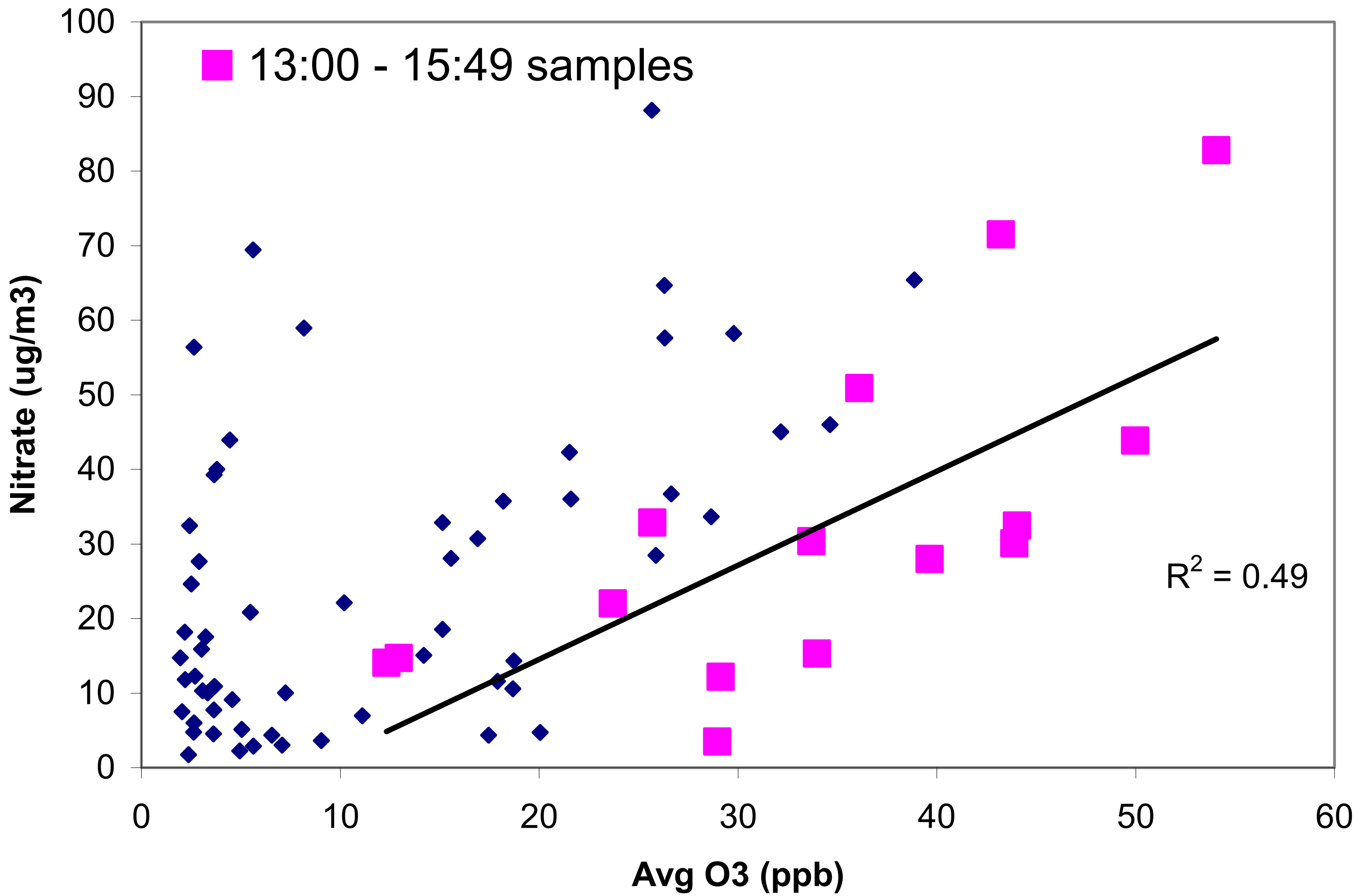
Diurnal Profile of O_3 and Nitrate Angiola, 15 Episode Days



Diurnal profile consistent with daytime nitrate formation hypothesis.

Formation may be local or regional

Do High O_3 Correlate with High Nitrate Formation in Angiola?



Correlation between Peak NO_3 and O_3 significant.

Correlation via OH or NO_2 + O_3 reaction?

On-going Work

- Obtain PM composition data for summer
- Analyze the relationship of individual secondary component with respect to ozone during fog episodes