

# 1998 Ozone Field Study in Phoenix, AZ

S.R. Springston

Environmental Chemistry Division  
Brookhaven National Laboratory

## Description

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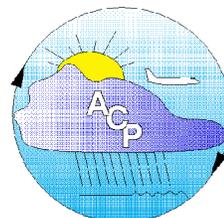
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### Phoenix 1998 Ozone Study

This multi-agency effort was designed to characterize the chemical and meteorological conditions associated with ozone episodes in the south west. In support of this program, the DOE/ACP Research Aircraft Facility flew 23 sampling missions from 5/17 to 6/10/98 in and around the Phoenix metropolitan area and the surrounding region. Morning and afternoon flights followed separate flight tracks to identify and map distributions of primary and secondary pollutants. Each flight included a circumnavigation of the urban center, transects of in-flow or out-flow regions and vertical profiles. A broad variety of instruments from numerous ACP investigators were flown on the aircraft. Data processing from all airborne systems is largely complete. These data are publically available and are being analyzed within the ACP community. Aircraft-based measurements were supplemented by an extensive array of ground sites. Ground sites included meteorological and chemical measurements, three radar wind profilers, radiosondes and a tethersonde.

A description of measurements made aboard the G-1 is presented here along with some preliminary observations.

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# Participants

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Argonne National Laboratory (ANL)

Arizona Department of Environmental Quality (ADEQ)

Arizona State University (ASU)

Brookhaven National Laboratory (BNL)

Pacific Northwest National Laboratory (PNNL)

State University of New York (SUNY) Old Westbury

Routine Aerometric Monitoring Sites Operated By:

University of Arizona (Arizona Meteorological Network)

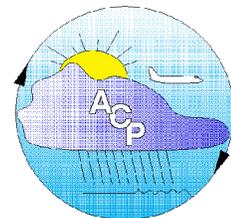
Maricopa County Department of Environmental Services, Air Quality Division

Maricopa County Flood Control District

National Weather Service

Phoenix Real-Time Instrumentation for Surface Meteorological Studies (PRISMS)

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# Objectives

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## Primary Goal

Understand the summertime atmospheric dynamics and chemical reactions governing the formation and transport of ozone and its precursors in the Phoenix metropolitan area.

## Atmospheric Chemistry Program Objectives

Determine the relative importance of natural and anthropogenic H.C. to ozone formation

Determine ozone production efficiencies vs.  $\text{NO}_x$  and H.C. as the urban plume moves down wind

Determine the contribution of upwind contributions to ozone concentrations during episodes

## Arizona DEQ Objectives

Measure vertical gradients of ozone and related compounds

Characterize meteorology associated with episodes

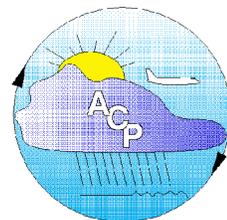
Measure the dispersion of elevated ozone levels

Assess potential for recirculation of ozone and precursors

## Application of Resulting Data

More accurate evaluations of ozone control strategies

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# Data Archive

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Data from G-1 available to public at <ftp://aerosol.das.bnl.gov/pub/phoenix98> at 10-s resolution. Data also available on CD-ROM by request (1-s and 10-s resolution)

ASCII Flat File (tab delimited)

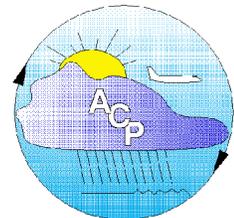
Processed data with only valid measurement periods reported

Uniform style across formats to facilitate retrieval

Row 1:	file name
Row 2:	date
Rows 4-6:	contact information
For each column:	
Row 7:	current revision
Rows 9-12:	instrument information
Rows 14-19:	free form comments on data
Rows 21-24:	available for calibration constants
Rows 35-36:	signal identification
Row 37:	units
Rows 40-end:	data (blanks for missing data)

Radar/Sodar profiler data and NEXRAD data available at:  
<http://www.atmos.anl.gov/ABLE/phoenix.html>

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# Measurements Aboard the G-1

## Nitrogen Species

Species	Importance	Technique	Instrument	Precision/ Time Response
NO	Primary pollutant, key to photochemical oxidant production	Chemiluminescence	Brookhaven 3-Channel Instrument	<10 pptv (@30 s) < 1 s response time
NO <sub>2</sub>	Principal O <sub>3</sub> precursor, major NO <sub>y</sub> constituent	UV-photolysis followed by chemiluminescence	Brookhaven 3-Channel Instrument	<50 pptv (@30 s) < 4 s response time
Total NO <sub>y</sub>	Quantifies total odd-nitrogen species	Heated Mo catalyst followed by chemiluminescence	Brookhaven 3-Channel Instrument	<50 pptv (@30 s) ~1 s response time
Aerosol NO <sub>3</sub> <sup>-</sup>	Removal species	Quartz filter	Brookhaven filter pack	~ 50 pptv, 30 min
HNO <sub>3</sub>	Dry deposition	NaCl filter	Brookhaven filter pack	~ 10 pptv, 30 min

Code

Data Status



Data available in archive



Data processed, awaiting inclusion in archive



Data awaiting processing

# Measurements Aboard the G-1

## Gaseous Species

Species	Importance	Technique	Instrument	Precision/ Time Response
O <sub>3</sub>	principal photo oxidant	UV photometry	TECO Model 49	~2 ppbv, 30 s
SO <sub>2</sub> (partial coverage)	primary pollutant	Pulsed fluorescence	TECO Model 42S, BNL modified	~200 pptv, 15 s
CO	Mobile emission source, tracer	Gas-filter correlation	TECO Model 48, BNL modified	~15 ppbv, ~30 s
Carbonyls	Rxn intermediates in HC oxidation	Glass scrubber/ HPLC of DNPH derivative	BNL Instrument	10 - 20 pptv, 3 min
H <sub>2</sub> O <sub>2</sub> , MHP, HMHP	Photochemical product	Glass scrubber/ selective derivatization/ fluorimetry	Kok Instrument/ BNL Chemistry	~60 pptv, 1 min
Hydrocarbons	Fuel for ozone production, primary anthropogenic and biogenic emission	Canister/ gas chromatography	Capillary GC	10 - 100 pptv

Code

Data Status



Data available in archive



Data processed, awaiting inclusion in archive



Data awaiting processing

# Measurements Aboard the G-1

## Aerosols

Species	Importance	Technique	Instrument	Precision/ Time Response
$D_p > 3 \text{ nm}$	Aerosol microphysics	Condensation particle counter	TSI 3025	$N^{1/2}$ , 1 s
$D_p > 10 \text{ nm}$	Aerosol microphysics	Condensation particle counter	TSI 3010	$N^{1/2}$ , 1 s
$D_p > 15 \text{ nm}$	Aerosol microphysics	Condensation particle counter after drying	TSI 3760	$N^{1/2}$ , 1 s
0.1 - 3 $\mu\text{m}$	Aerosols	Light scattering	PCASP probe	1 s
3 - 47 $\mu\text{m}$	Cloud droplets	Light scattering	FSSP probe	1 s
Soot	Carbonaceous aerosol	Light absorption	PSAP	1 s

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Data Status



Data available in archive



Data processed, awaiting inclusion in archive



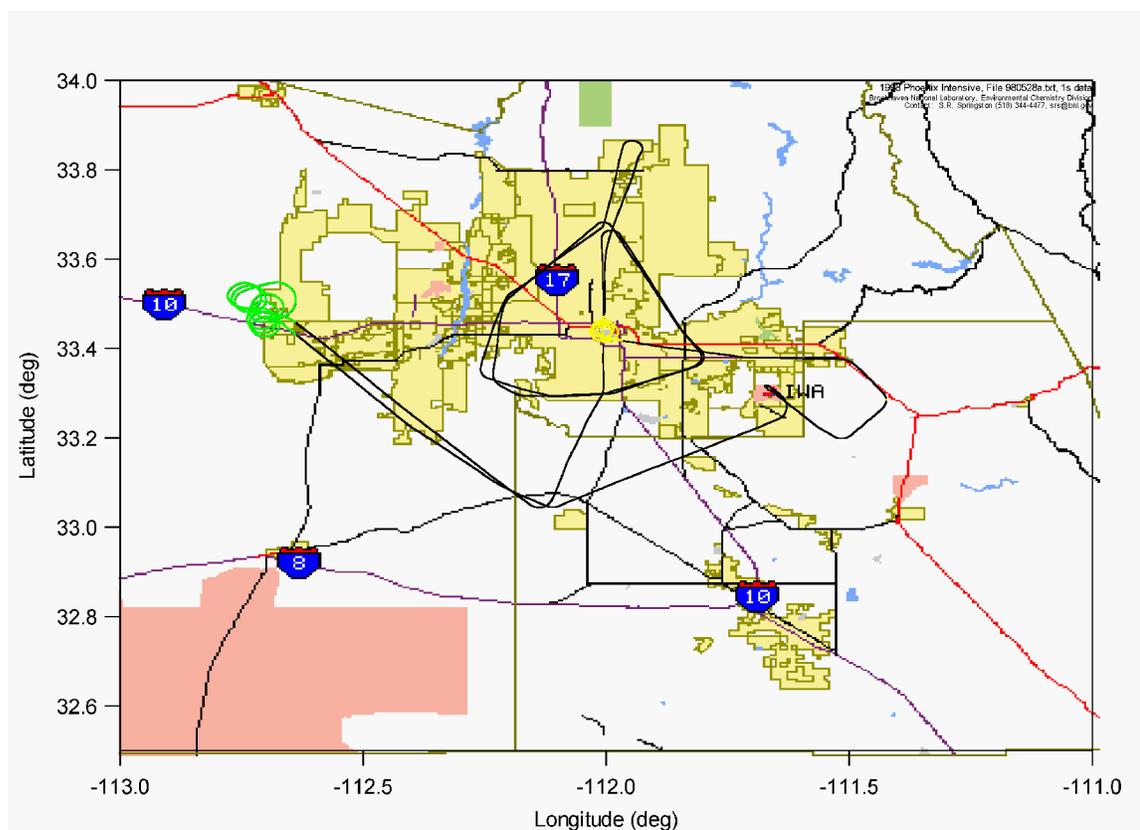
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# Measurements Aboard the G-1

## Other Measurements

Species	Importance	Technique	Instrument	Precision/ Time Response
Aerosol SO <sub>4</sub> <sup>=</sup>	SO <sub>2</sub> removal	Carbonate filter	Brookhaven filter pack	~20 pptv, 30 min
Total UV up and down	Photolytic driving force	Photometry	Eppley pyranometer	0.5 W/m <sup>2</sup> , 1 s
Meteorological parameters				
Winds aloft	Transport	Vector subtraction	Dynamic pressure & TANS-Vector GPS	~2 m/s, 1 s
Dewpoint	Water vapor concentration	Cooled mirror hygrometer	General Eastern	~0.2°C, 1 s
Static temperature	Reaction rates, air stability	Temperature sensor	Rosemount probe	~0.2°C, 1 s
Position	Flight track	LORAN-C, differential GPS		~50 m, 1 s (5 m differential)
Code	Data Status			
	Data available in archive			
	Data processed, awaiting inclusion in archive			
	Data awaiting processing			

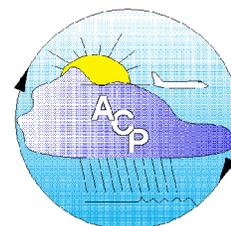
# Morning Flight Track



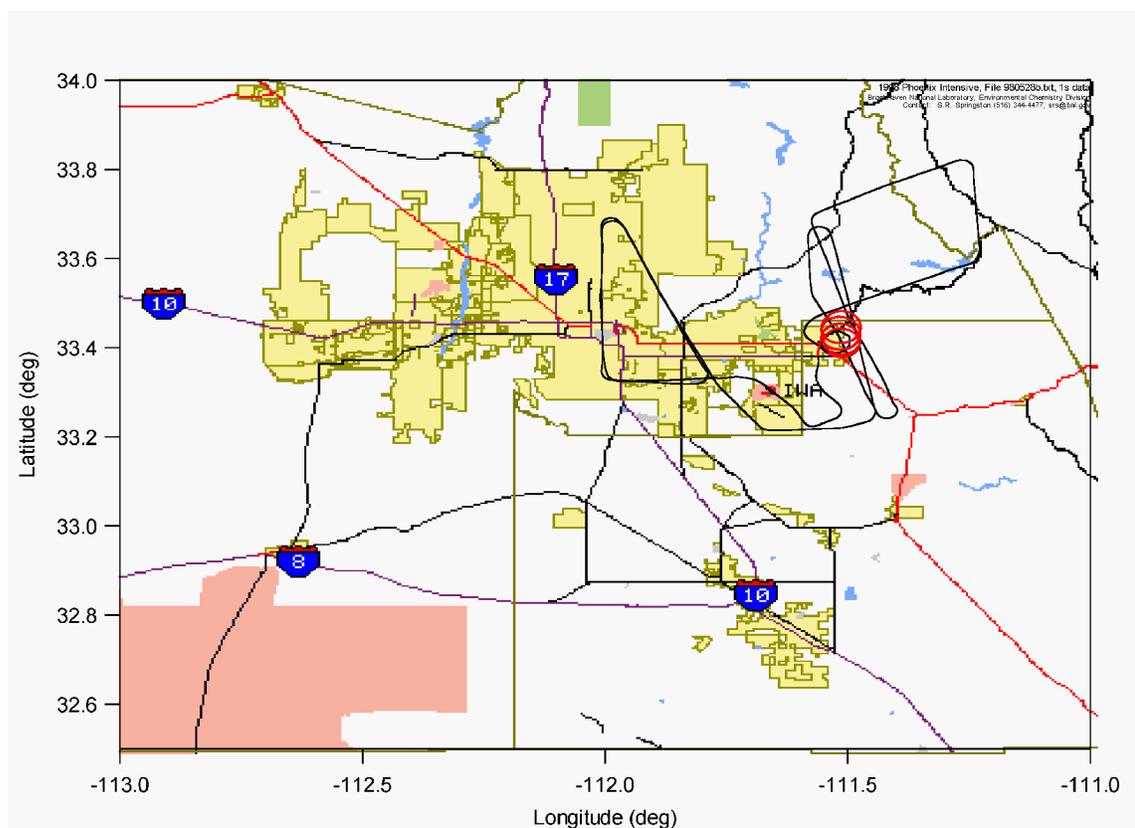
Typical morning flight track (11 flights)  
Take off 7:30 - 9:30 am local time, 2.5 - 3 h duration

Transect upwind of the city with a vertical profile to ~10,000' at the furthest point (green section of track). Two circuits of the city center and a second profile over the city center (yellow section of track).

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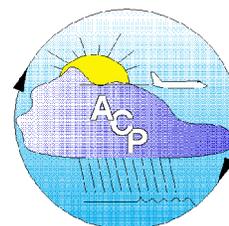
# Afternoon Flight Track



Typical afternoon flight track (12 flights)  
Take off 2:00 - 4:00 pm local time, ~2 h duration

Two circuits of eastern half of the city. Three transects at different altitudes to the east of the city and a longer leg further east. A single profile downwind of the city before landing (red section of track).

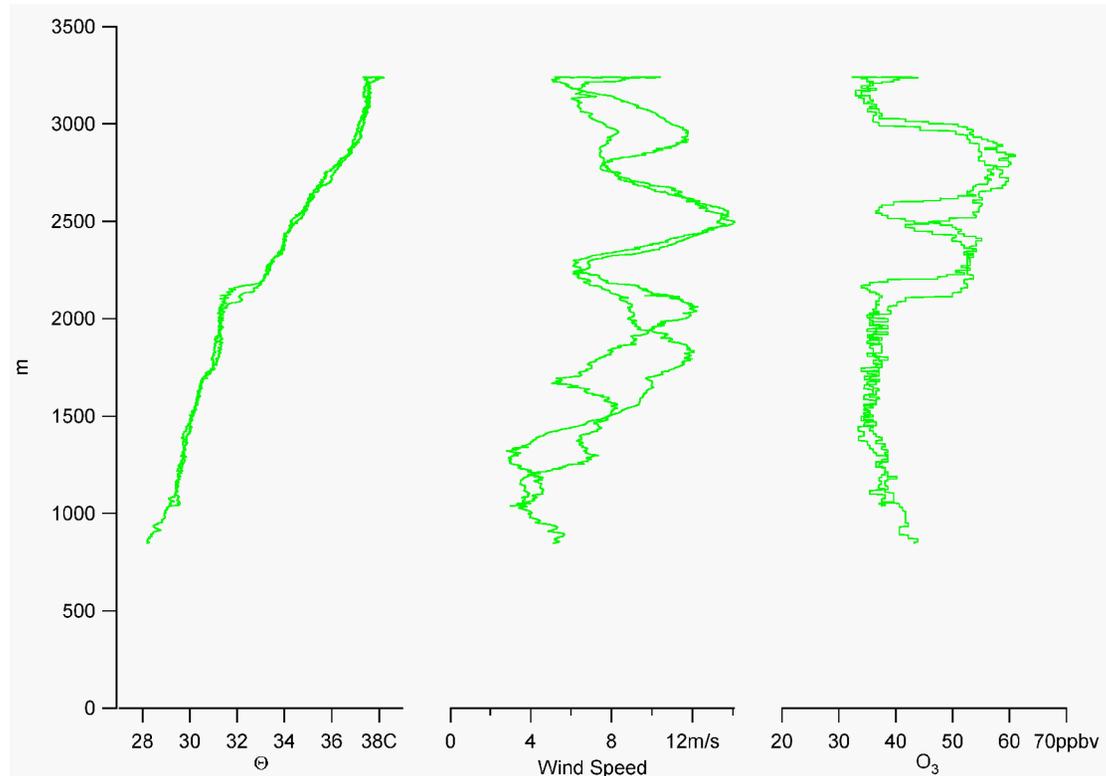
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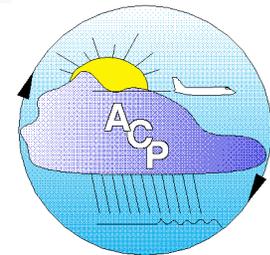
# Sounding 1, 11:00, Upwind

5/28/98 - 11:00 local  
Sounding west of city

Profile shows strong inversion at 2100 m.  $O_3$  is low and uniformly distributed below the inversion (build up has not yet started). Above the inversion,  $O_3$  decreases with higher winds (winds from SSW). Conjecture:  $O_3$  aloft is left over from previous day's local production. Sounding was conducted at the western edge of the bubble over Phoenix where winds are sloshing in cleaner air.



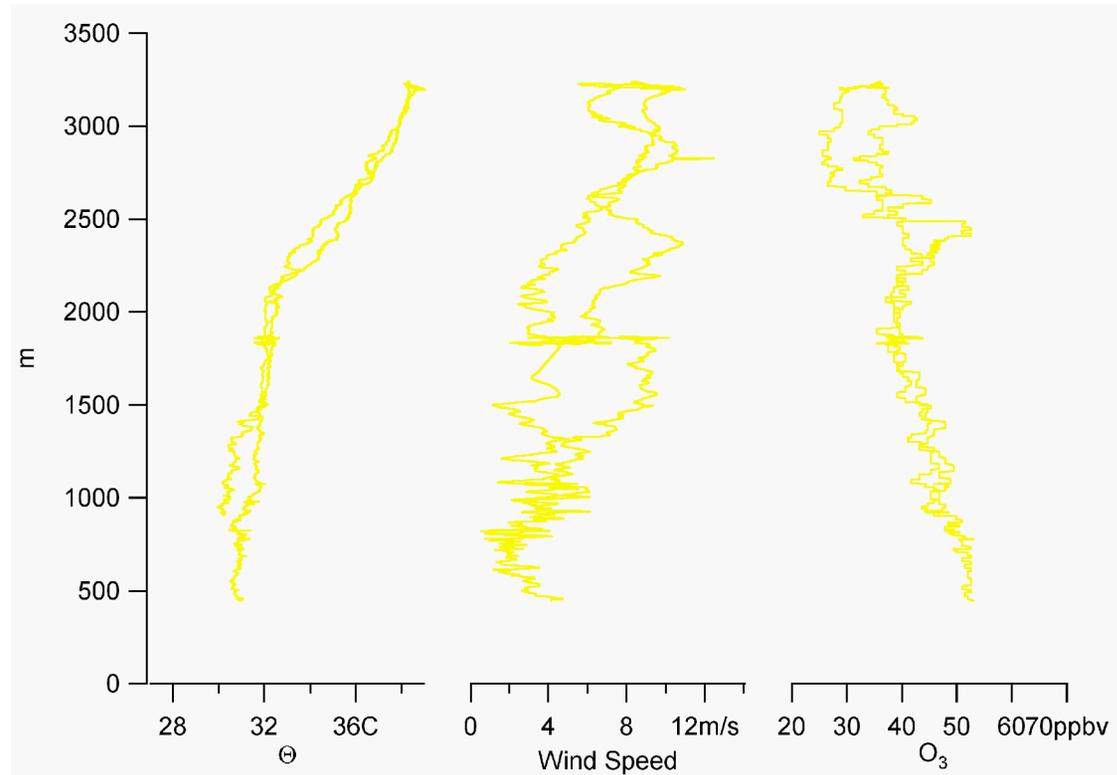
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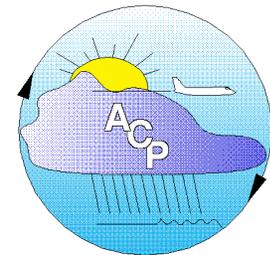
## Sounding 2, 12:30, City Center

5/28/98 - 12:30 local  
Sounding over Sky Harbor  
(center of city)

Profile still shows inversion at 2100 m. Boundary layer is beginning to mix.  $O_3$  production is commencing in boundary layer. Above the inversion,  $O_3$  is less than below and also less than earlier sounding at the same level.



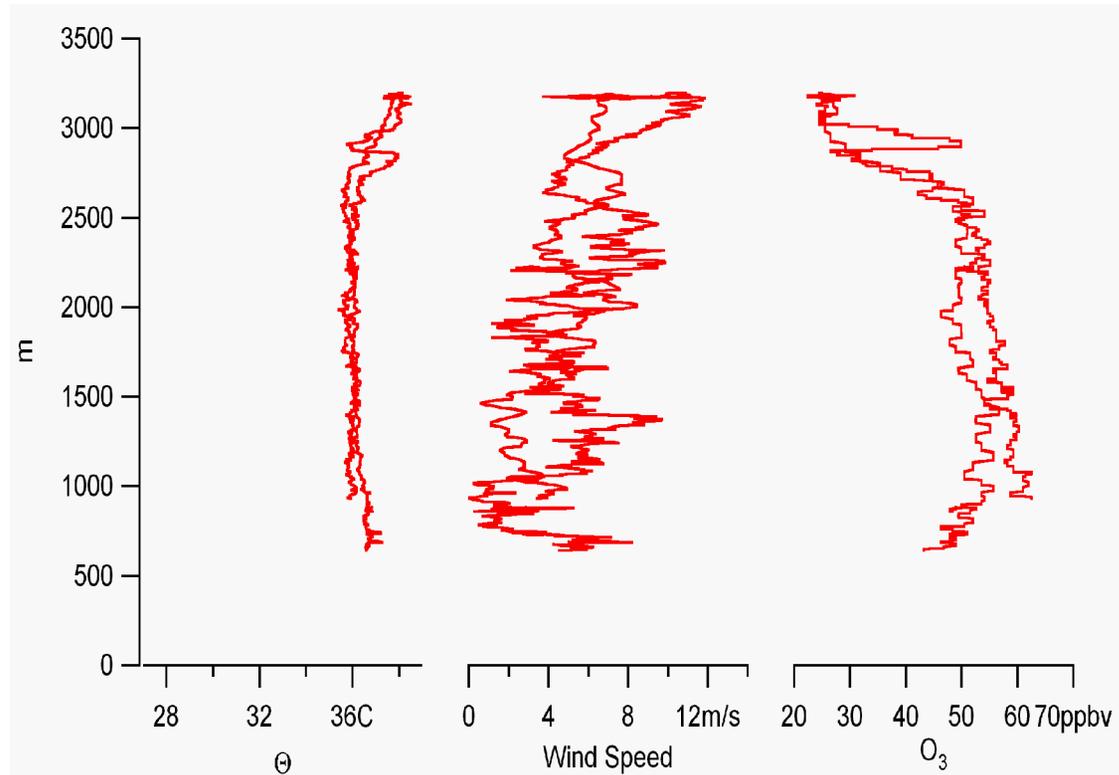
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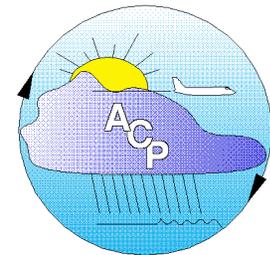
## Sounding 3, 16:30, Down Wind

5/28/98 - 16:30 local  
Sounding east of city

Profile shows weakening inversion raising to 2800 m and breaking up. Boundary layer is well mixed.  $O_3$  production is perking along in boundary layer. Above the inversion,  $O_3$  is less than below and also less than earlier soundings at the same level. Convective activity is pumping  $O_3$  aloft.



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## View of Phoenix from Utery Pass

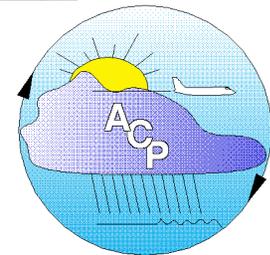
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Note bubble of haze over city  
6/9/98, 13:20 local time

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## G-1 on Tarmac

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