Uses of Data from PAMS Measurements in the South Coast Basin

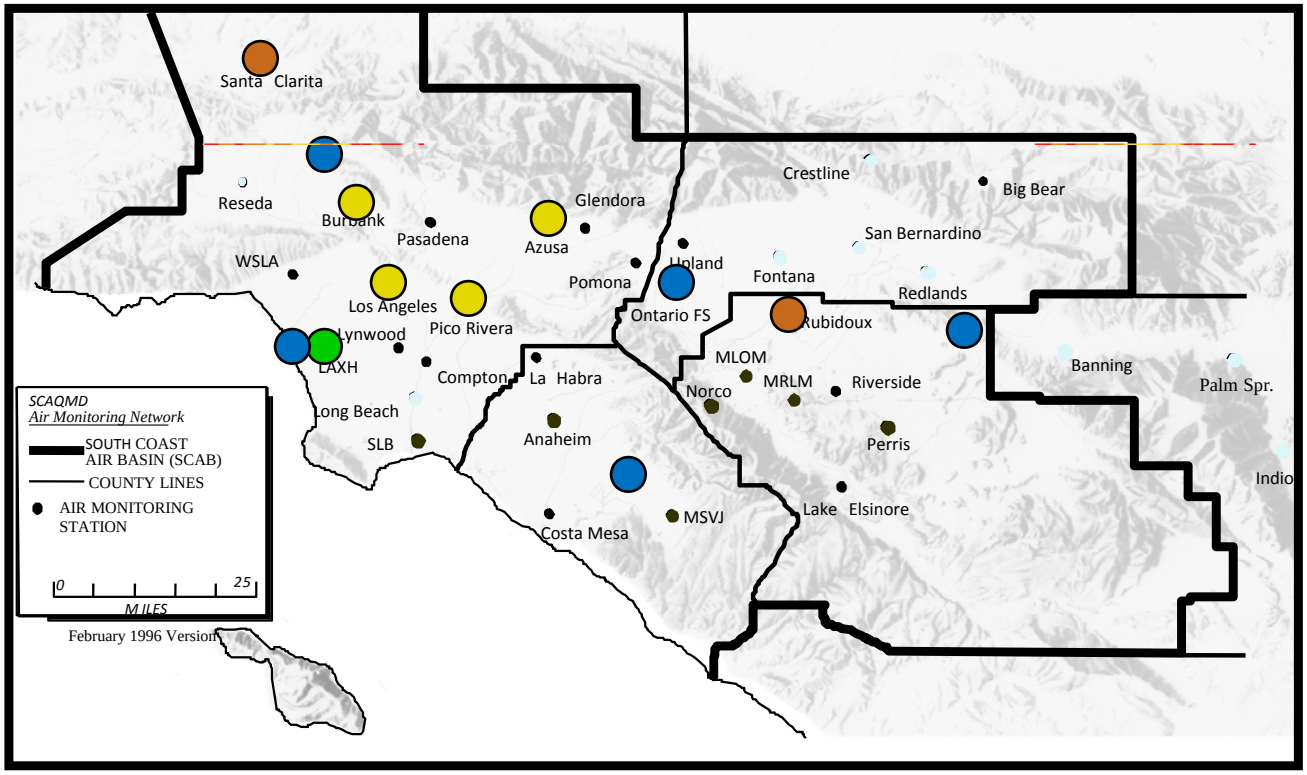
South Coast Air Quality Management
National Ambient Air Monitoring Conference
May 16th, 2012

South Coast Air Quality Management District

The South Coast Air Quality Management District includes all of Orange County and portions of Los Angeles, San Bernardino and Riverside Counties, an area of 10,743 square miles with 18 million people and 12 million vehicles.

SCAQMD PAMS Network Design

Type I Type II Type III Upper Air Meteorology



PAMS Measurements

- Ozone
- NO/ NO_2/ Noy
- CO
- Volatile Organic Hydrocarbons
  - 57 Hydrocarbons (C_2 through C_{10})
  - 2 *in-situ* measurement sites (Burbank and Pico Rivera)
- Carbonyl
- Meteorology (Surface and Upper Air)

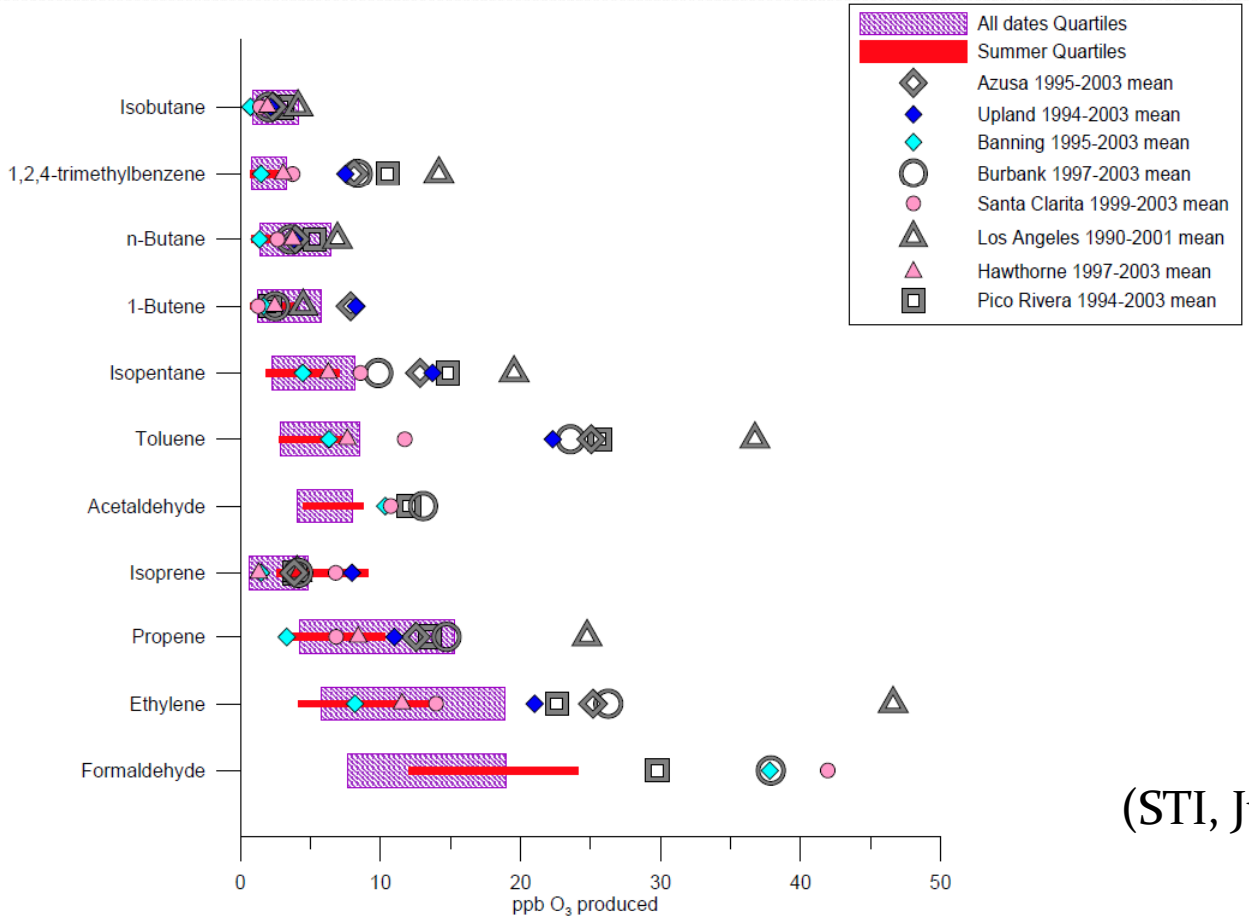
- Year-round Sampling Schedules:
  - October through June: Off Season
  - July through September: Intensive Season

PAMS Air Quality Measurement Analysis

- Ozone precursor assessment
  - Comparisons
  - Trends
  - Control evaluation
  - Source categories
- Source Apportionment
- Emission Inventory Evaluation/Reconciliation
- Scientific knowledge of regional ozone precursor interaction

Comparison of SCAQMD PAMS to National Averages

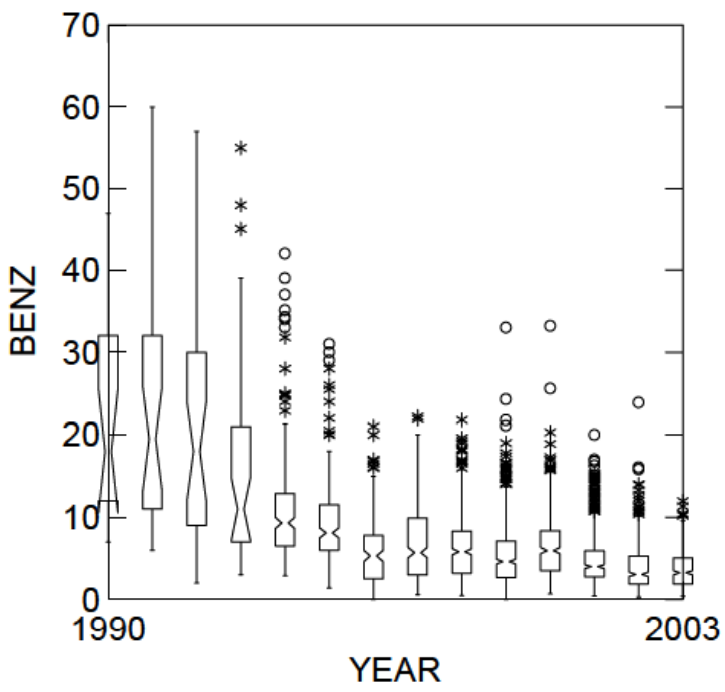
Hydrocarbons with highest reactivity-weighted ozone forming potential

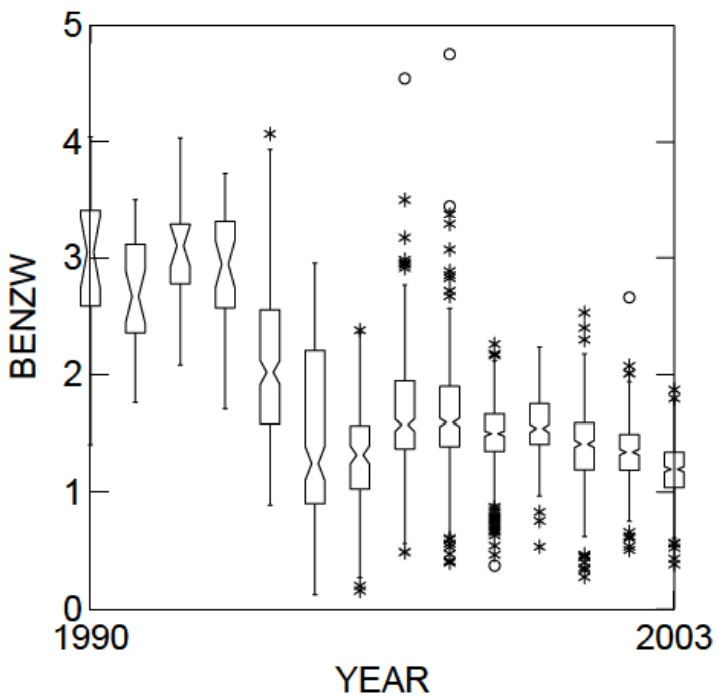


(STI, July 2005)

Assessing Annual VOC Trends

- Example shows morning ambient benzene concentrations and weight percent have declined since the mid-1990's

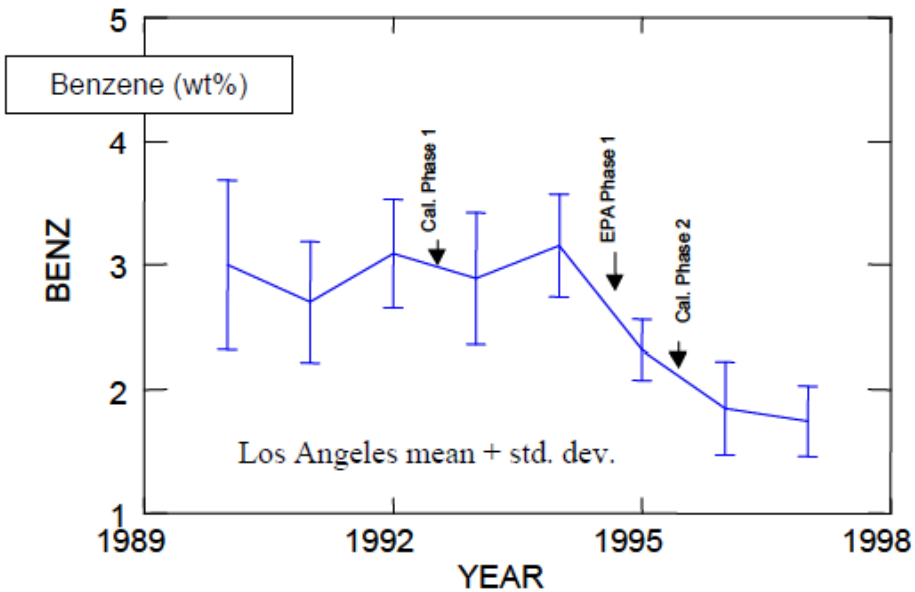




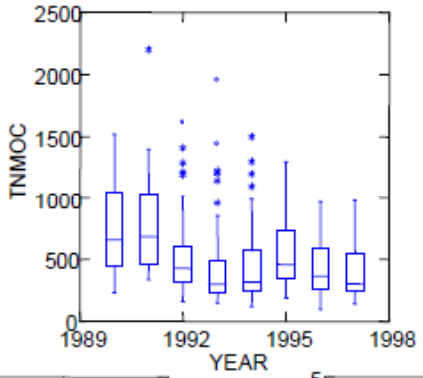
(STI, July 2005)

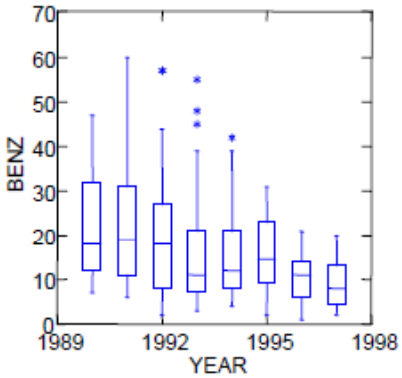
Control Evaluation Example: Reformulated Gasoline

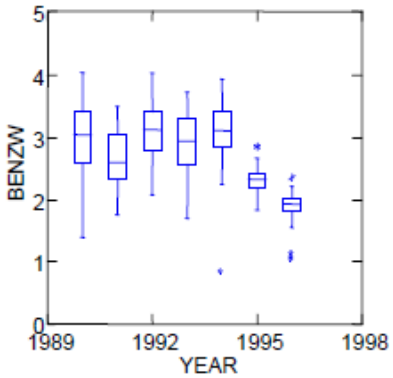
- Plots show annual ambient TNMOC (ppbC), benzene concentration (BENZ in ppbC), and benzene weight percent (BENZW) in Los Angeles
- Dramatic drop in Benzene between 1994 and 1995 with EPA Phase 1 RFG



Main et al., 1999

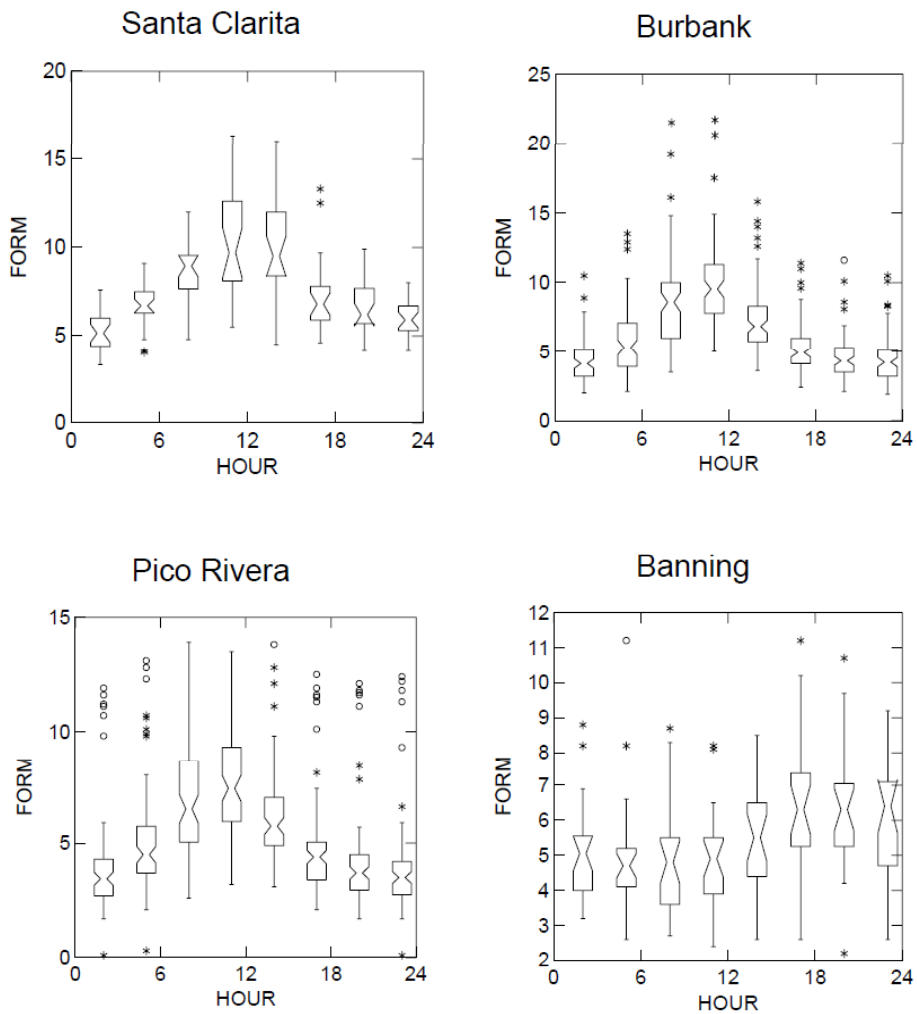






Diurnal Assessment

- Formaldehyde
  - highest during the late morning and midday at the most urban sites, consistent with the abundance of both fresh emissions and secondary formation
  - highest later in the day at Banning, consistent with the downwind location of this site.



(STI, July 2005) Figure 3-9. Notched box whisker plots of formaldehyde concentrations (ppb) by time of day in the SoCAB during 2003. Note that scales vary.

Diurnal and Weekday Variation

- Used Data from Azusa, Central Los Angeles and Pico Rivera stations to source attribution of carryover of pollutants over time, and determining on-road versus other area sources in the VOC/ NOx ratios.
- Characterized NOx/VOC ratios from weekday to weekend
- Indicated urbanized areas VOC limited to suggest strategies to change fleet mix to reduce hydrocarbons
- Fujita, Campbell, Sagebiel, Bowen, Stockwell Lawson (2003)

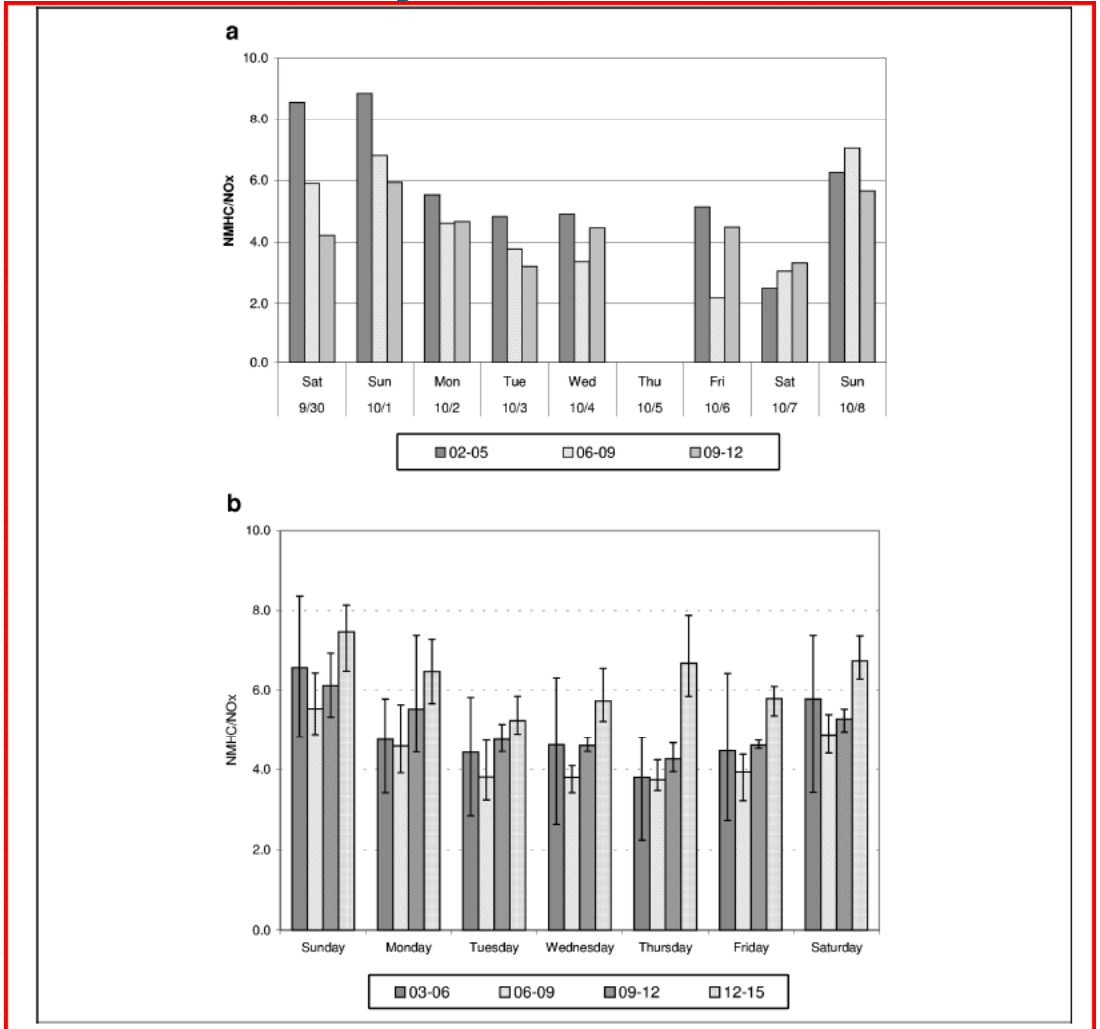
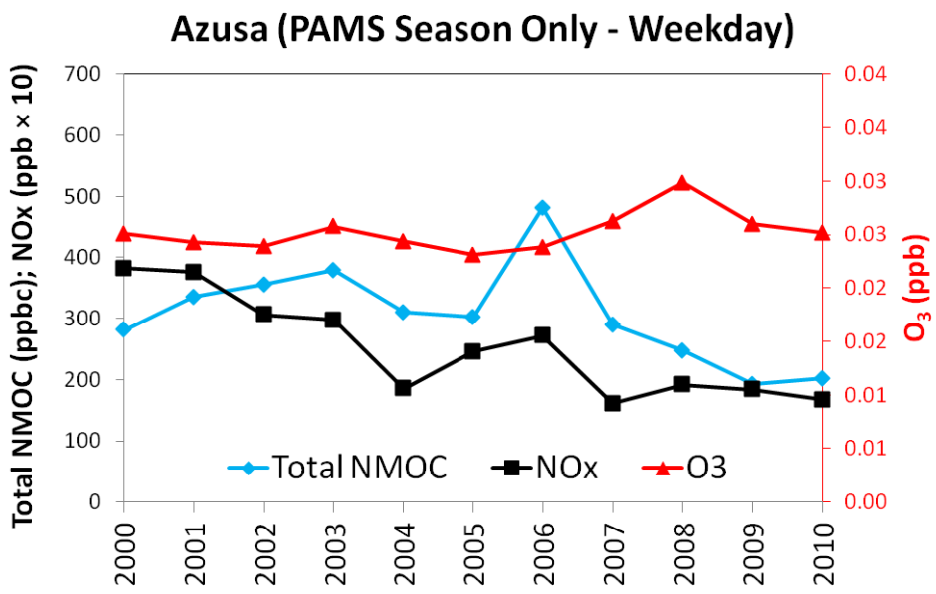
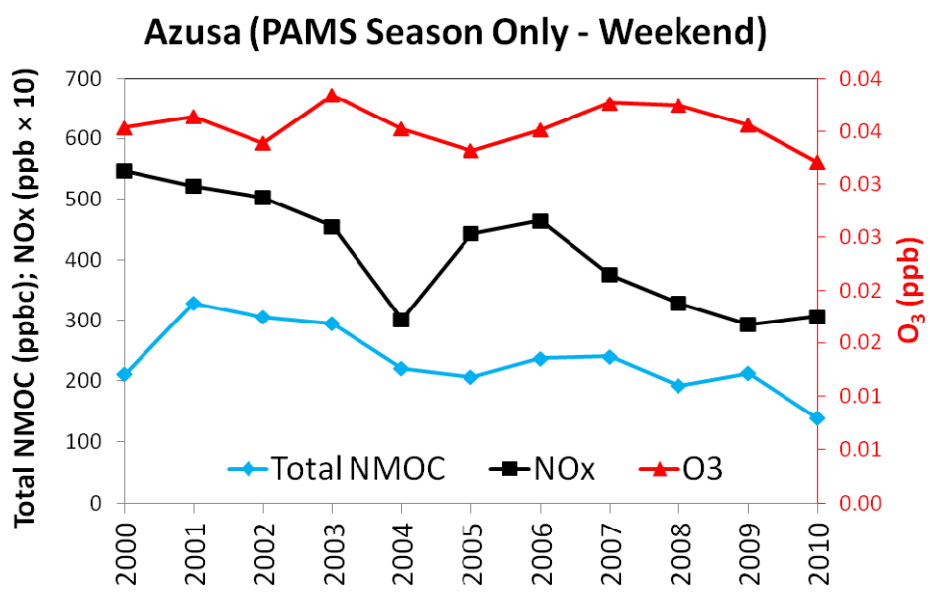


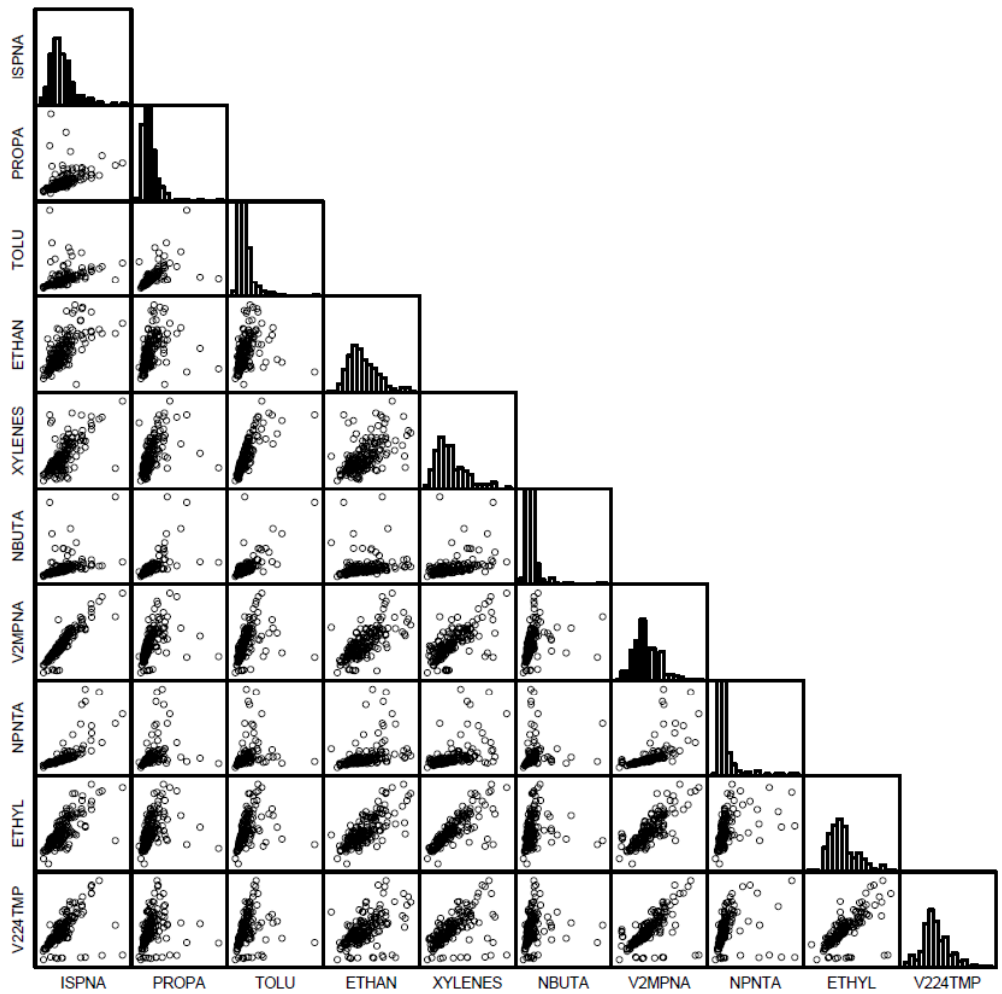
Figure 8. (a) NMHC/NO_x ratios during carryover (3:00–6:00 a.m.), O_3 inhibition (6:00–9:00 a.m.), and O_3 accumulation (9:00 a.m.–12:00 p.m.) at Azusa from September 30 to October 8, 2000. (b) Day-of-the-week variations in the mean NMHC/NO_x ratios during carryover (3:00–6:00 a.m.), O_3 inhibition (6:00–9:00 a.m.), O_3 accumulation (9:00 a.m.–12:00 p.m.), and O_3 peak (12:00–3:00 p.m.) at Los Angeles–North Main (data available only for the inhibition period), Azusa, Pico Rivera, and Upland during the summers (July–September) of 1999 and 2000. Error bars denote maximum and minimum ratios among the four sites.

Weekend Effect Trend Assessment





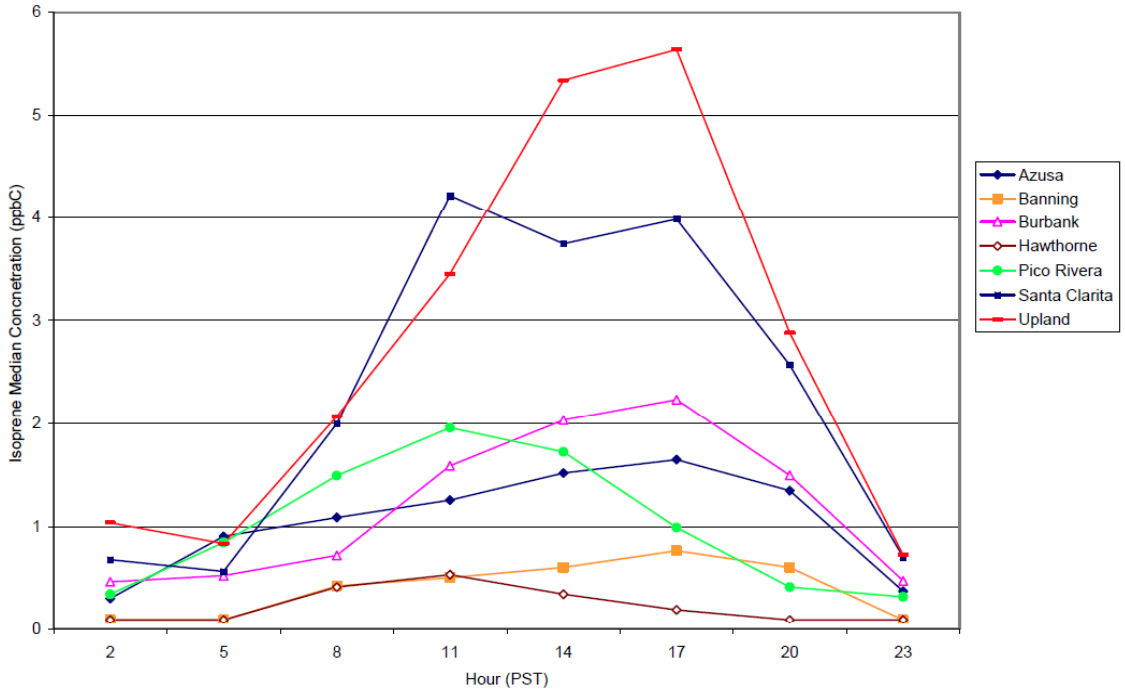
Assessing Relationships between PAMS Species



(STI, July 2005)

- Azusa 2003 Scatter Plot Matrix
  - Combustion species (ethene, acetylene) correlate well
  - Gasoline components correlate well
  - NOx & CO likely have common sources
  - TNMOC sources are more complex
  - Generally less correlation at upwind or downwind sites

Assessing Biogenic Contribution



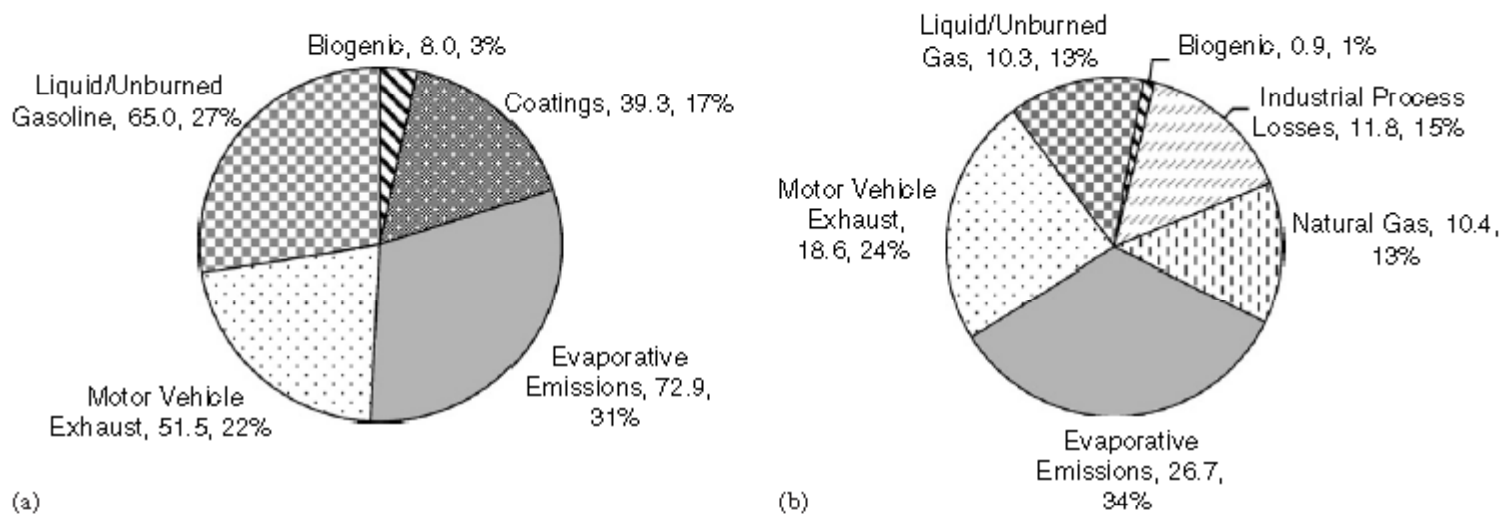
(STI, July 2005)

- Mean Diurnal Concentrations of Isoprene
- Upland and Azusa higher due to proximity to Angeles National Forest
- Shows temperature & sunlight impact on biogenics

Source Apportionment

- Principal Component Analysis – Central Los Angeles
  - Key Species listed in order of significance
  - 91.6% of variance accounted for in this case

Fig. 3. Factor profiles (% of species) for PAMS data collected in 2001–03 at Hawthorne.

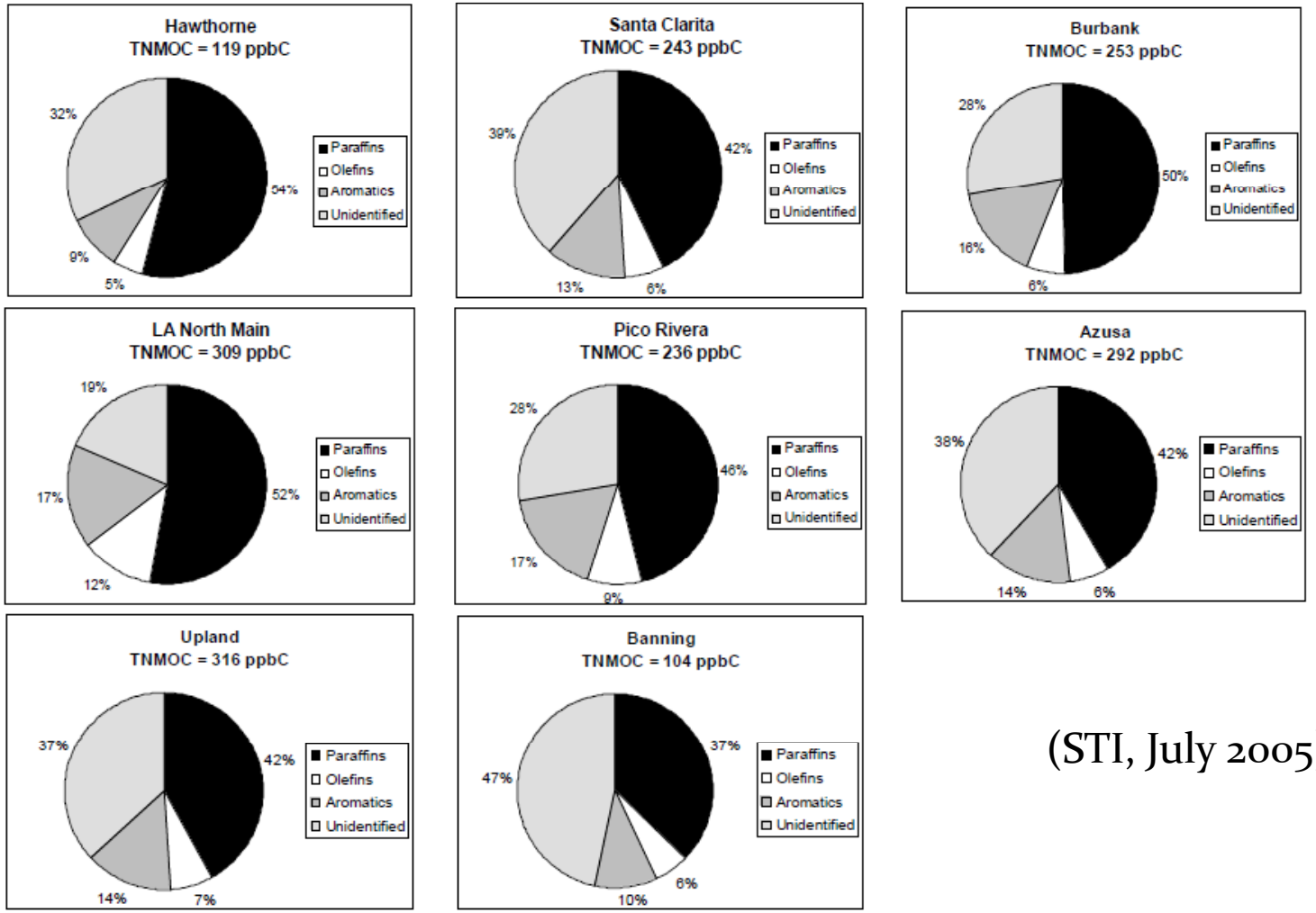


		ethane, isobutene, 1,3,5-trimethylbenzene, ethylbenzene, 2-methylhexane)	
3	Industrial	p-diethylbenzene, 1-hexene	5.5
4	Diesel	n-octane, unidentified VOCs, n-nonane	10.5

- Brown, Hankel, Hafner (2007)

Emission Inventory

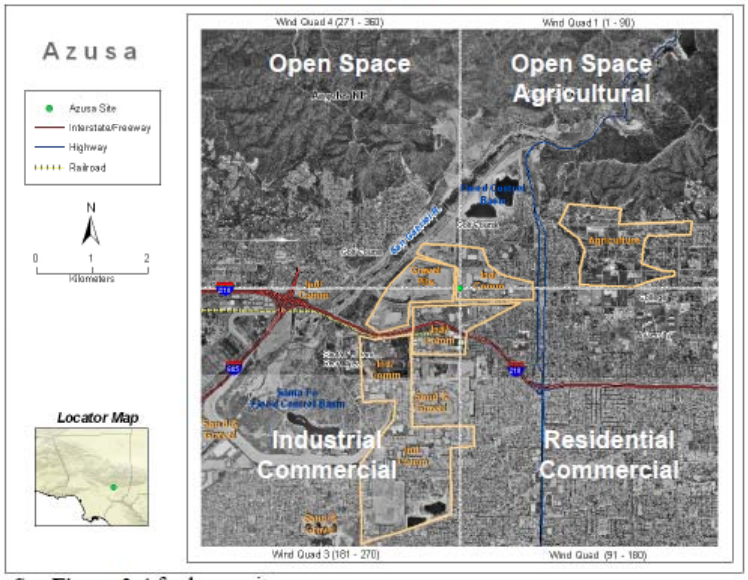
Median Composition by species group and PAMS Stations



(STI, July 2005)

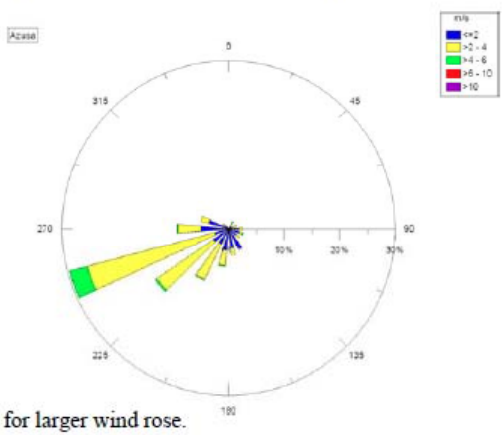
Emission Inventory Reconciliation (1 of 2)

Azusa Site Characterization



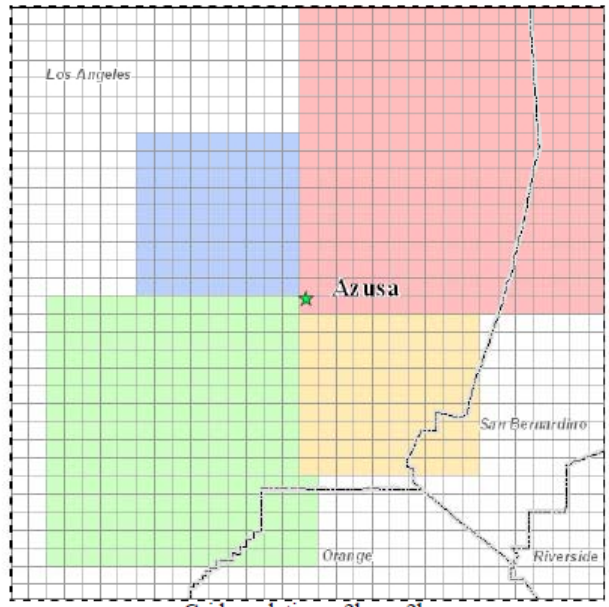
See **Figure 2-4** for larger site map.

Azusa prevailing wind direction and speed (0500-1000 PST).



See **Figure 2-16** for larger wind rose.

Azusa analysis zone grid extent (33 x 33 grid cells).

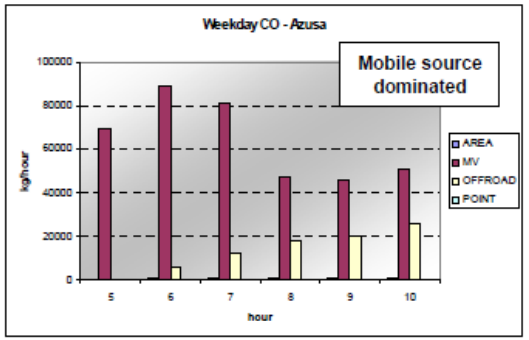


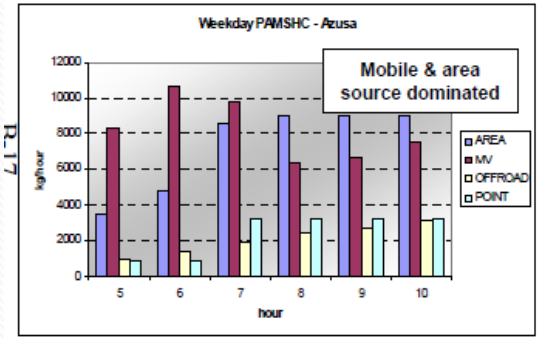
Grid resolution = 2km x 2km

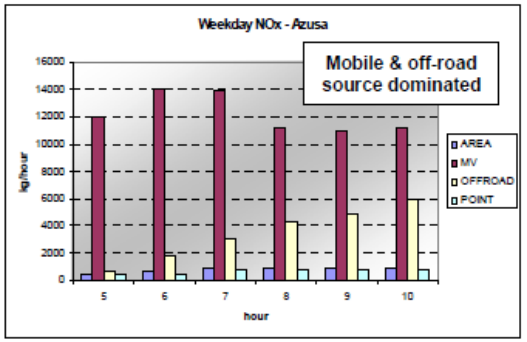
(STI, August 2005)

Emission Inventory Reconciliation (2 of 2)

Azusa hourly weekday emission rates by major source category and pollutant for full grid extent.

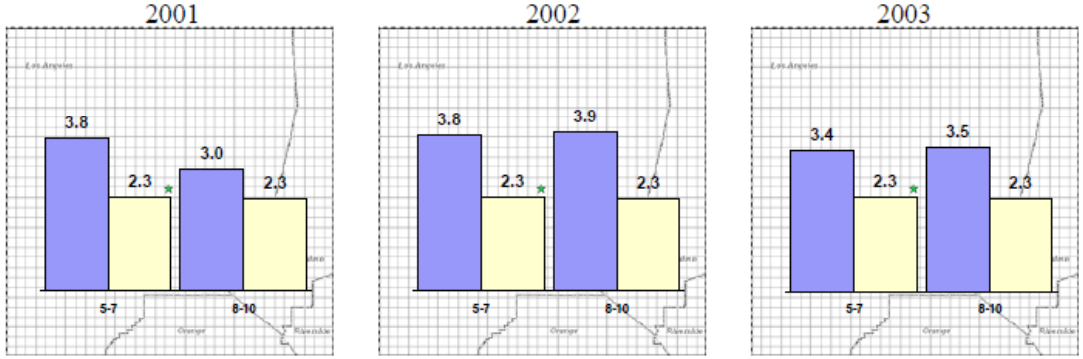




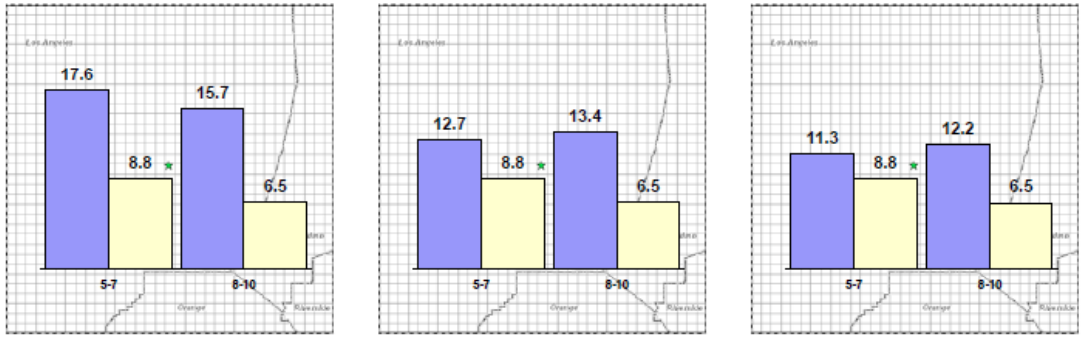


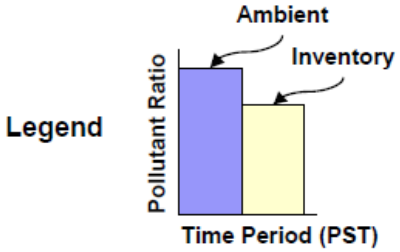
MV = motor vehicles

Azusa ambient- and emissions-derived PAMSHC/NO_x ratios for the full analysis zone extent from 0500-0700 and 0800-1000 PST.



Azusa ambient- and emissions-derived CO/NO_x ratios for the full analysis zone extent from 0500-0700 and 0800-1000 PST.





(STI, August 2005)

SCAQMD PAMS Meteorology

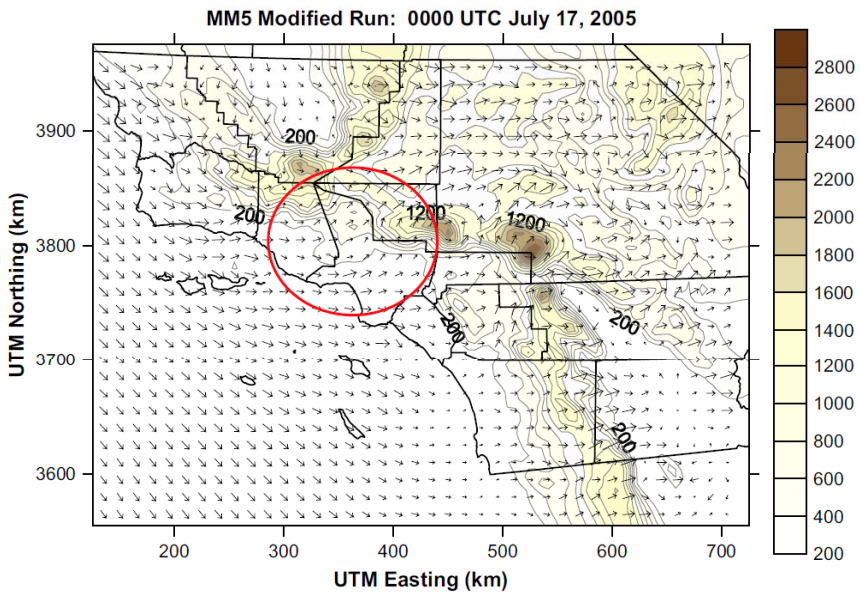
- Surface Measurements
  - Winds
  - Solar Radiation
  - UV Radiation
  - Relative Temperature/ Humidity
  - Barometric Pressure

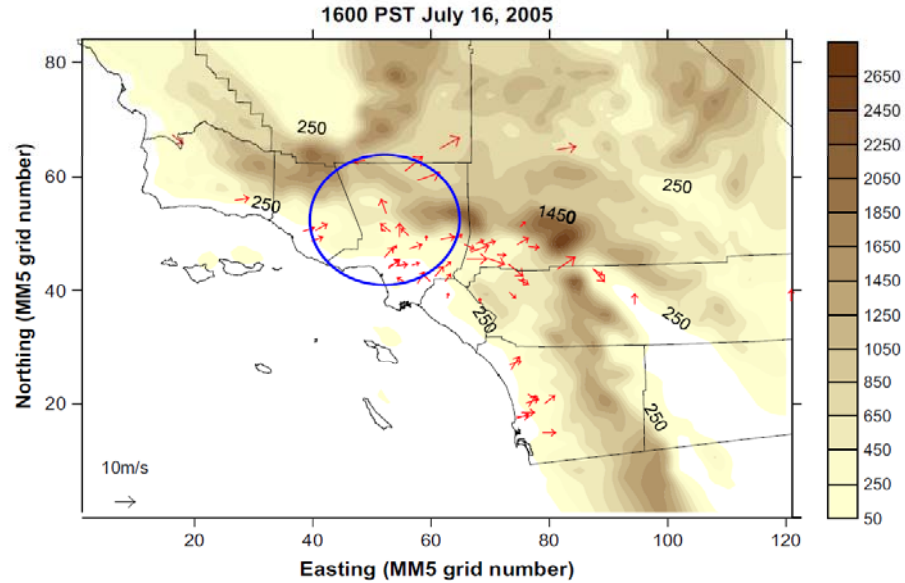
- Upper Air Measurements (5 Stations)
  - Radar Wind Profiler (RWP) – winds to 4 km
  - Radio Acoustic Sounding System (RASS) – T_v to 1.5 km
  - MiniSodar Acoustic Wind Profilers – winds to 200 m
  - Microwave Radiometer (T & RH to 10 km)
    - (new at LAX, cooperative project with industry)

PAMS Meteorology Data Analysis

- Meteorological model performance evaluation
- Regional and point source models (Meteorological model data assimilation)
- Analysis of episodic air quality events (including exceptional event analysis)
- Meteorological adjustment of air quality trends
- Vertical Profiles
- Climatology of regional atmospheric properties
- Air Quality Forecasting
- Other Applications

Comparison of Meteorological Model Winds to Observations



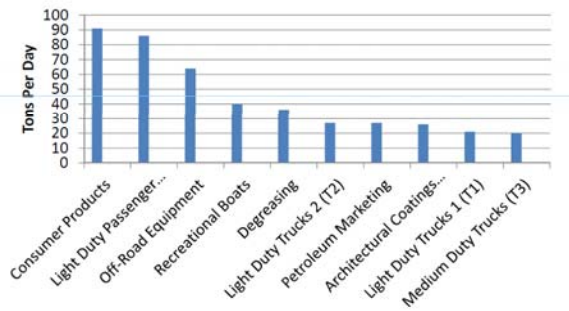


Lee, et. al, *Atmospheric Measurements* (2009)

Regional Modeling

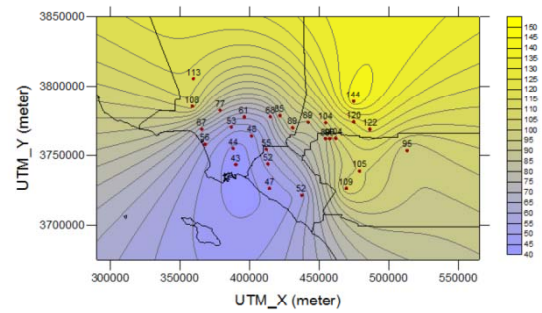
Evaluating Meteorological & Air Quality Simulations

Preliminary 2012 AQMP
2008 Baseline VOC Inventory

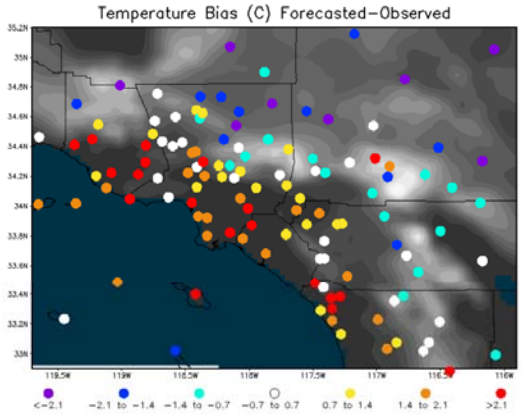


July 18 Fri

July 18 Max 1-hr O3

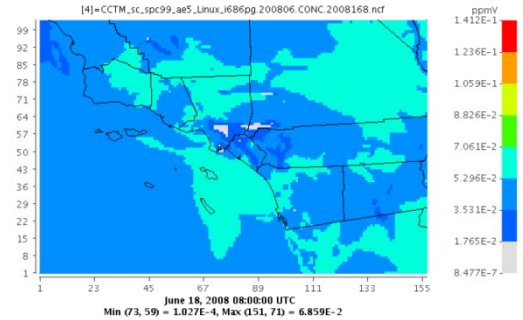


Surface Temperature Bias by Station
WRF Model



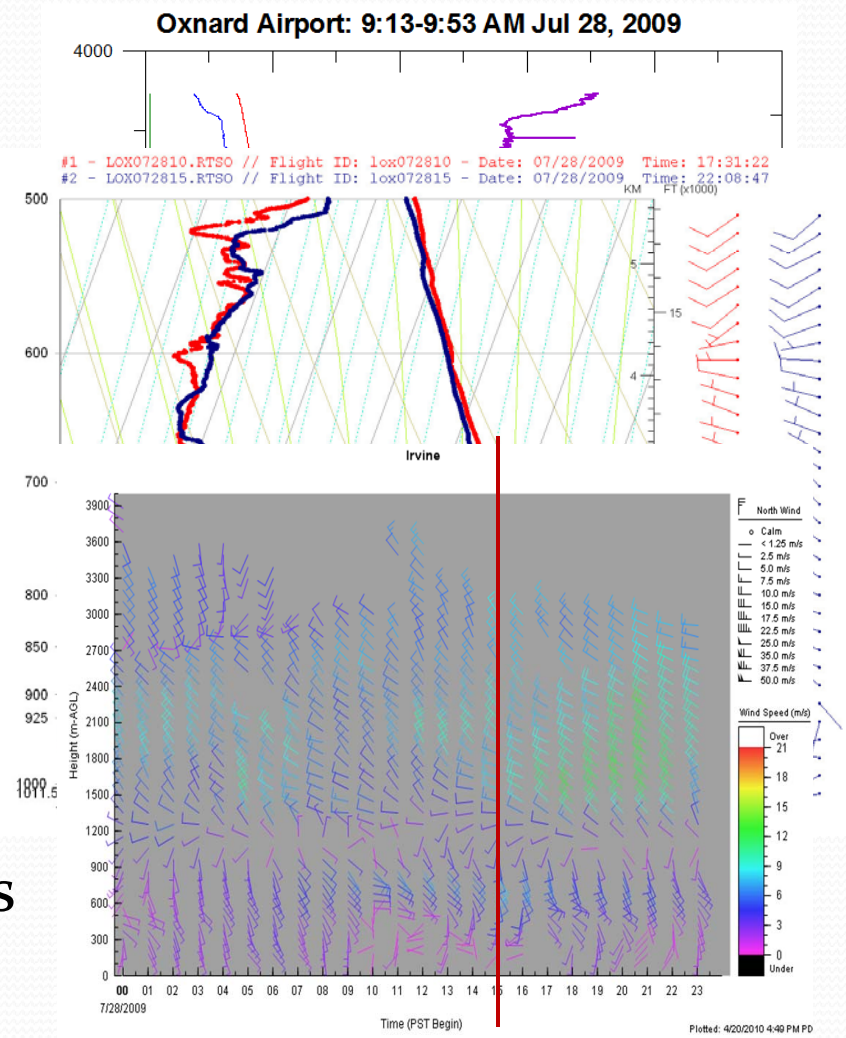
1-hr Ozone during June 18-20, 2008

Layer 1 O3[4]

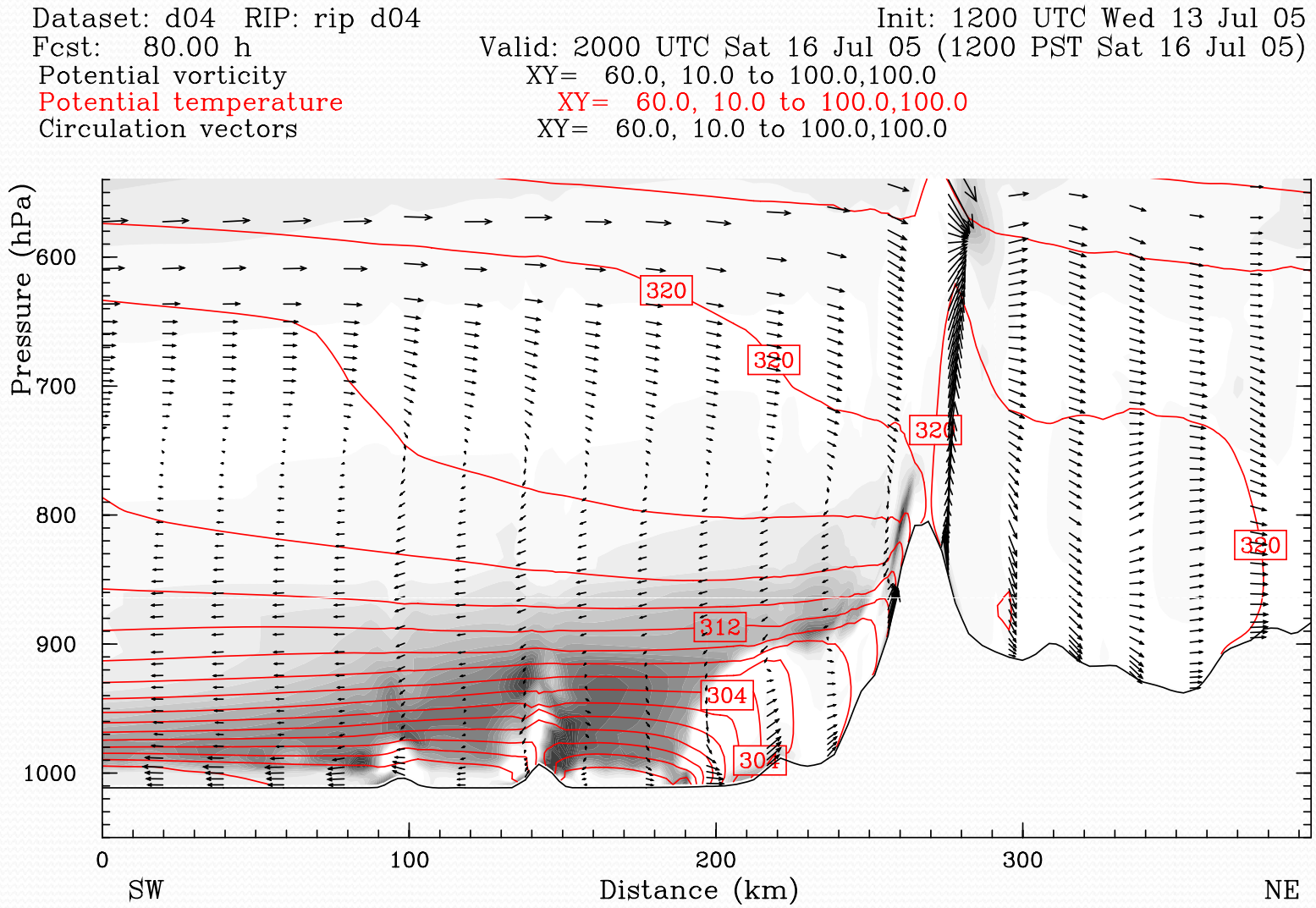


Ozone Profiles in Vertically Layered Structure in Southern California

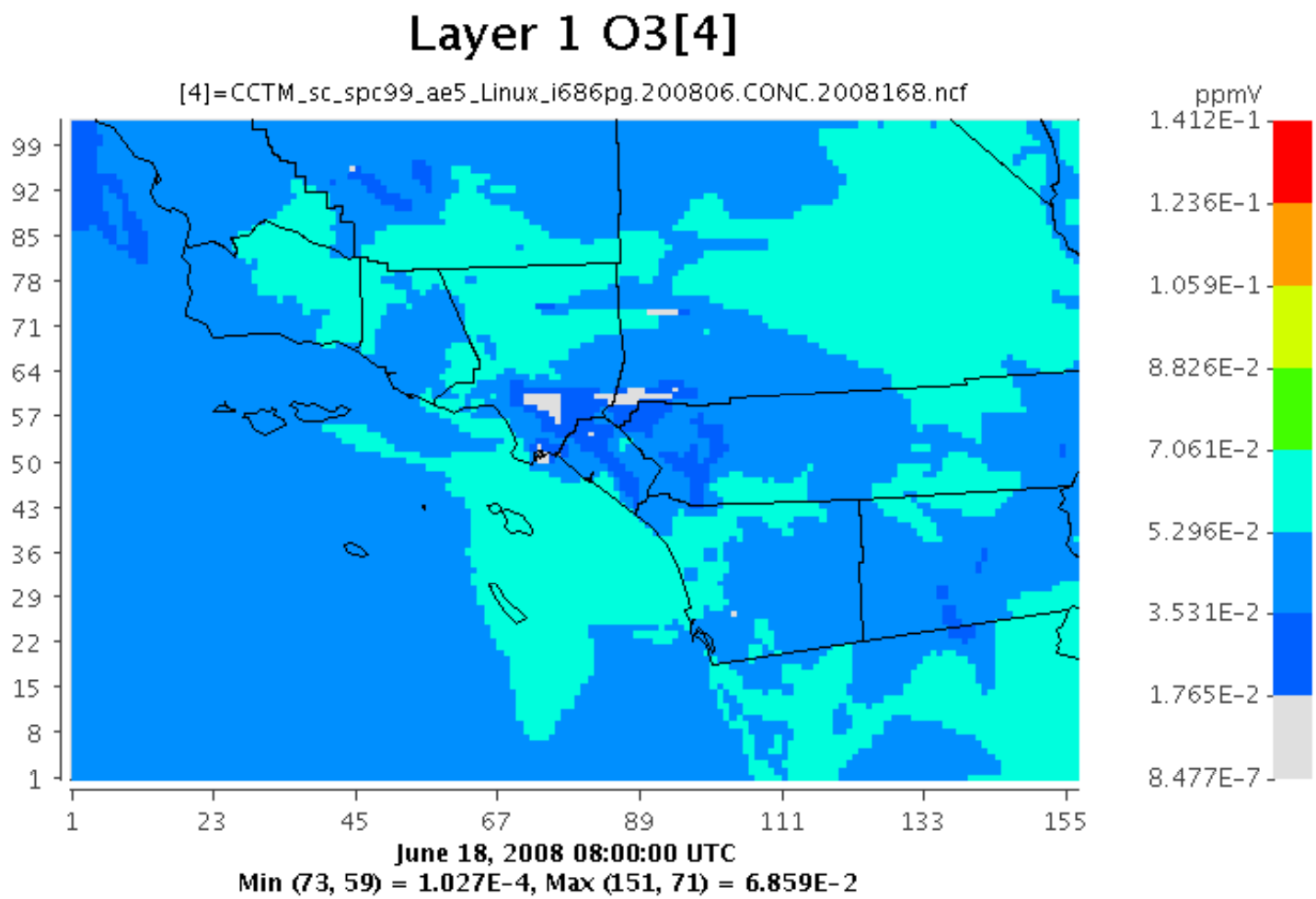
- Ozone, PM and Meteorology Sounding at Oxnard airport
- RADAR Wind Profiler at Irvine site
- Weather Research Forecast (WRF) meteorological modeling was run to validate the vertical layered structure
- Community Multi-scale Air Quality (CMAQ) chemical transport model was tested with the aircraft measured O3 profiles



Vertical Cross Section on 12 PST, 7/16/2005

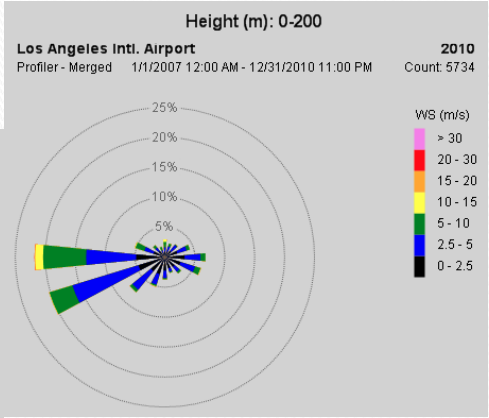


CMAQ Sensitivity Runs

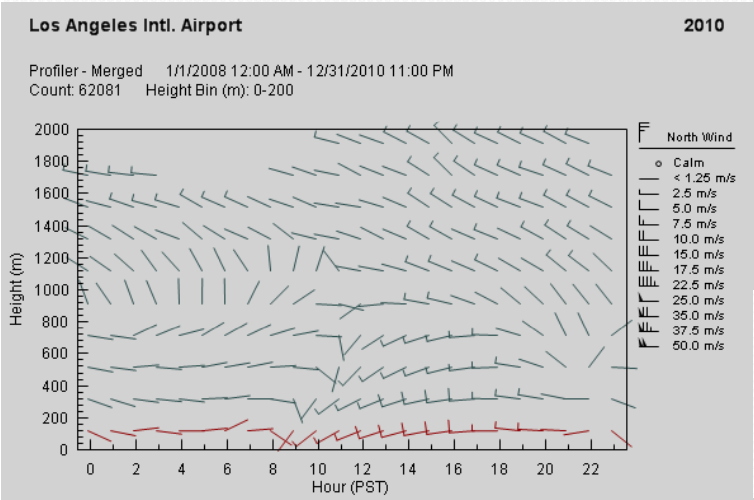


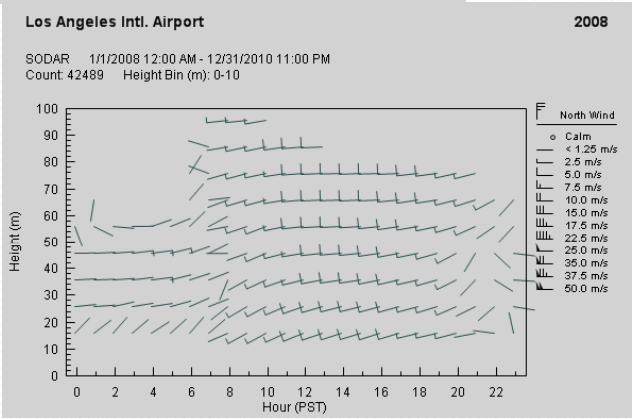
Climatology – Using PAMS Upper Air Stations

Average diurnal wind profiles & wind roses by height (Radar & Sodar winds)

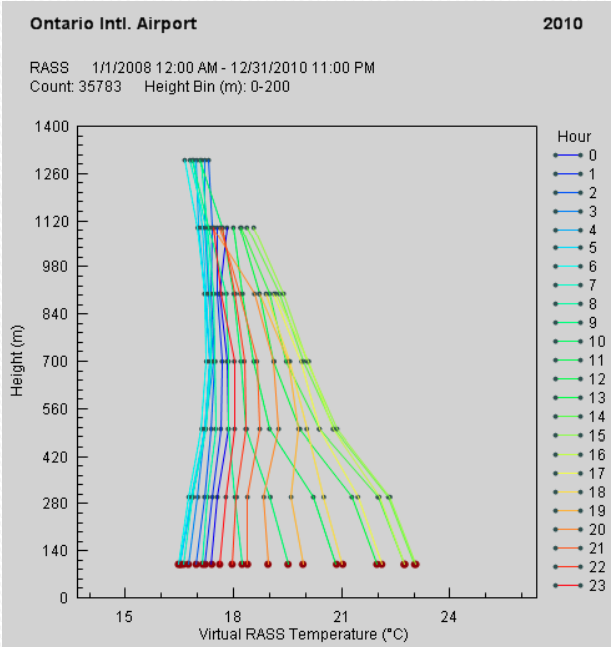


(STI, August 2011)



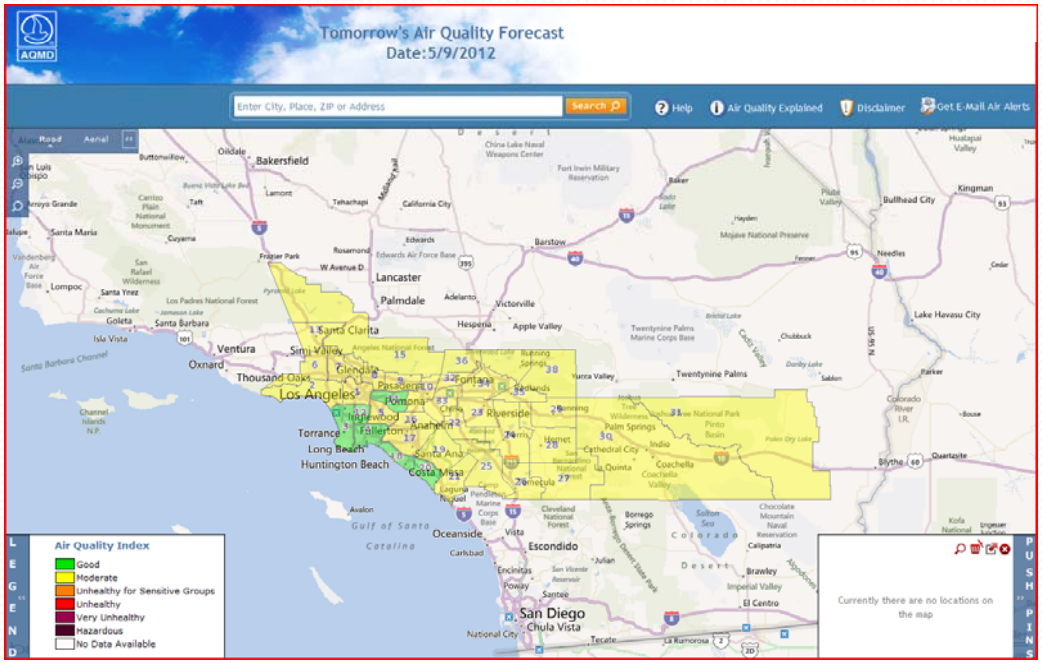


Average diurnal temperature profiles (RASS)



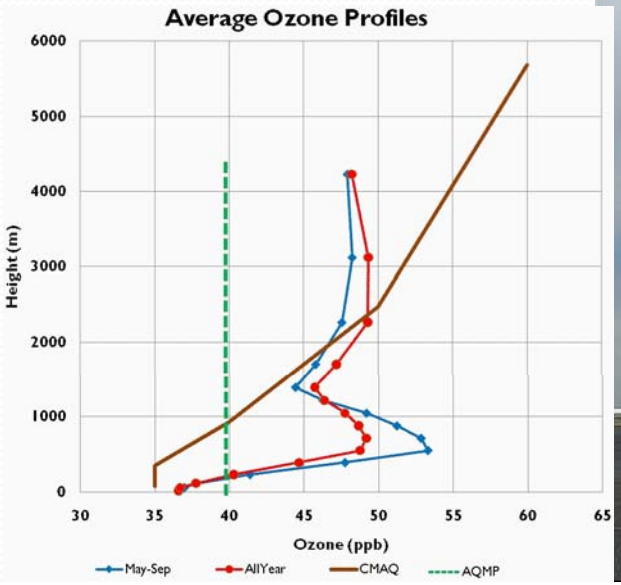
Air Quality Forecasting

- PAMS meteorological and air quality data is used in the development of improved air quality forecast models
  - Improves daily inputs (surface and upper air measurements)
  - Improves scientific understanding of air pollution (e.g., transport, stability, ventilation, stagnation, recirculation)
  - Helps to assess changing emissions trends adjusted for weather conditions



Aloft Air Pollutant Study

- Ozonesondes and Aircraft Measurements
  - Evaluated portable monitoring platform on light, unmodified aircraft (relatively low cost)
  - Aloft Ozone, Hydrocarbons, Sulfur Compounds, PM and Met throughout a year
    - 24 Flights
  - Evaluated offshore regional air quality model boundary conditions
  - Shipping lane emissions assessment
  - Catalina Island ozone transport assessment



Applications of AQMD PAMS Meteorological Data from Other Agencies

- PAMS meteorological data is used by National Weather Service for forecasting
- PAMS upper air data has been used in numerous field measurement programs and research studies (SCOS97, ARCTAS, CALNEX, Pac-Jet, …)
- PAMS meteorological and air quality data is used for point source modeling
- NOAA ingests upper air profiler data to improve the Rapid Update Cycle (RUC) model
- Utilities use PAMS meteorological data (surface & upper air) to improve load demand forecasts