New Research for the Texas SIP: A Science-Policy Synthesis

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November 14, 2005

Background Information

- Need for synthesis report identified during open discussions at June 1-2, 2005 SAC meeting.
- HARC instructed by TERC Board to produce synthesis report that would outline: 1) relevance to 8-hour ozone SIP of new research; 2) current gaps in knowledge; and 3) new projects to fill gaps.
- Authors of report: Jay Olaguer (HARC), Greg Yarwood (ENVIRON), Harvey Jeffries (UNC), Jim Smith (TCEQ), and Joe Pinto (EPA NCEA).
- Discussion of draft at EPA Region 6 on August 16, 2005.
- Report formally reviewed by SAC, DFW Roadmap Committee, TERC Research Team Committee, TERC Advisory Council, TCEQ, and EPA Region 6.

Key Dates for 8-Hour SIPs

SIP Revision	Proposal Documents Due	Adoption Documents Due
DFW	5/17/2006	11/15/2006
HGB	11/15/2006	6/16/2007
Regional Haze	5/2007	11/2007

External input should be submitted about 3 months prior to each official date.

Key Lessons Learned
Issue Categories

- Demonstrating Local Ozone Attainment
  - Various refinements in modeling needed to determine response of local O_3 to local control strategies.
- Assessing Regional Ozone and Transport
  - Regional background O_3 can be competitive with local O_3 production during 8-hour exceedances.
  - Regional strategies may be required to control intra-State and out-of-State transport.
- Deploying Effective New Control Strategies
  - Mobile NOx control needs greater emphasis.
  - Regional NOx reductions beyond CAIR are needed.
  - VOC controls in HGB deserve continued attention.

Demonstrating Local Ozone Attainment

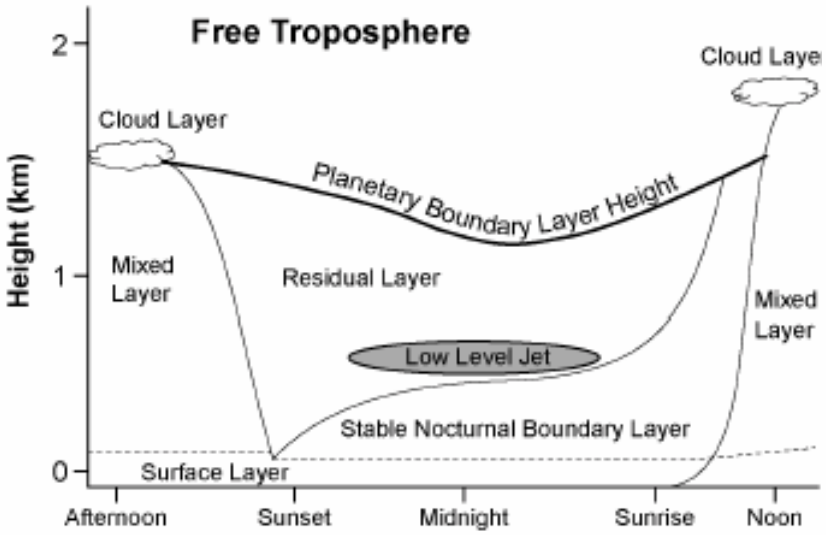
- Better EI data (speciation, quantity, timing)
  - HRVOCs, OVOCs, mobile NOx
- Updated LU/LC data and biogenic emissions
  - Tree speciation and counts, satellite data
- Improved meteorological modeling
  - PBL, sea breeze, stationary fronts
- Expanded chemical mechanisms
  - Urban sources and sinks of radicals, NOx
- More episodes to reflect 8-hr design values
  - Spring ozone exceedances in HGB

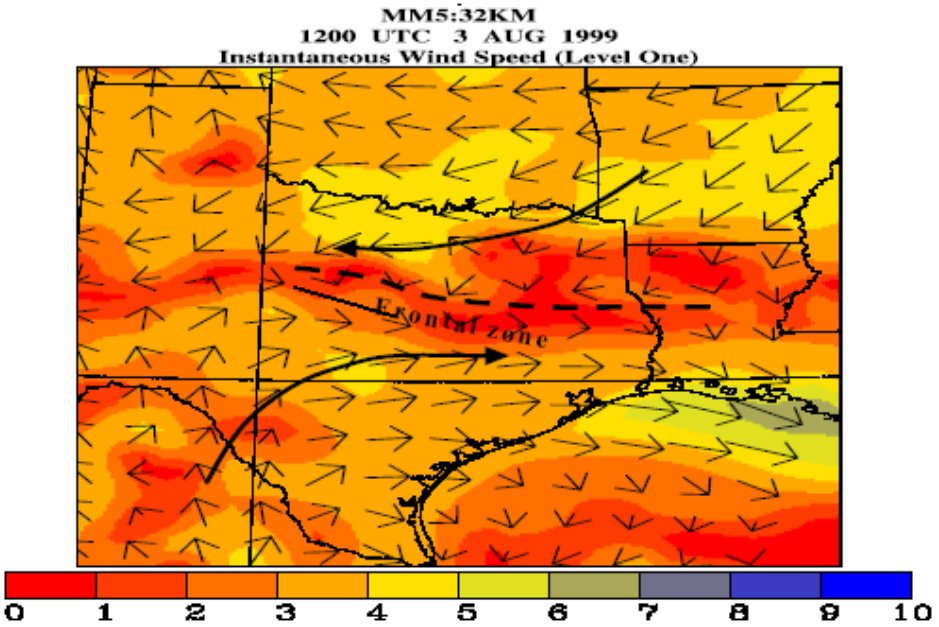
Assessing Regional Ozone and Transport

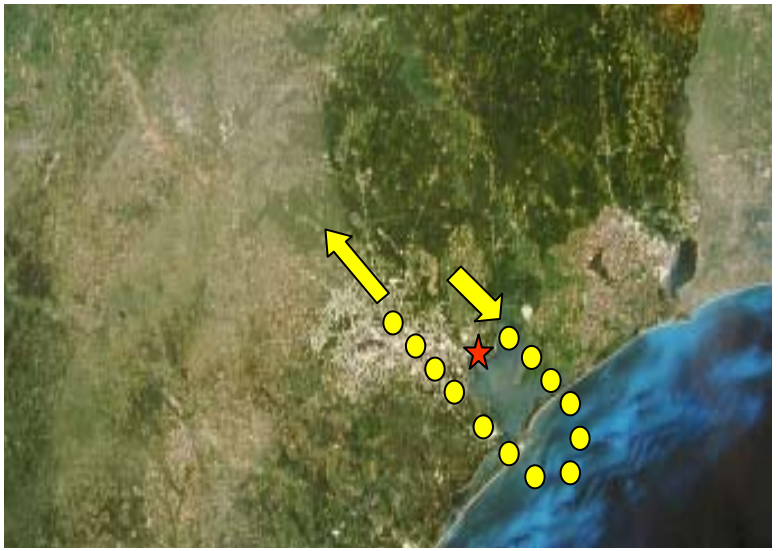
- Ozone apportionment to distant sources
- Seasonal evolution of background ozone
- Ozone transport and chemistry aloft, both at night and during the day
- Mechanisms of vertical exchange between surface and layers aloft

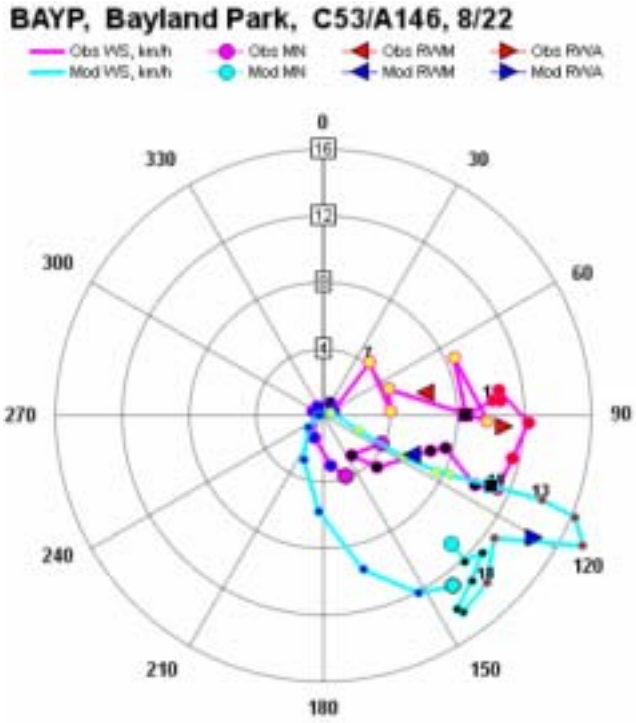
Meteorological Mechanisms

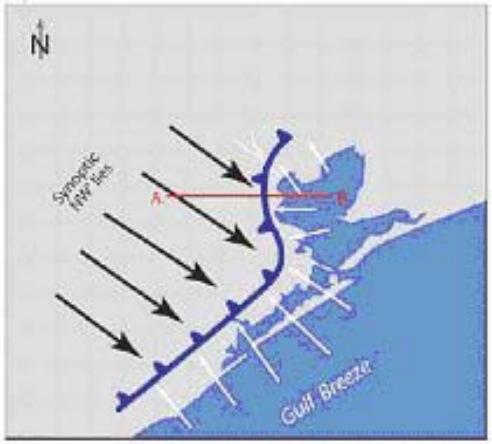
Mechanism	Importance to Air Quality
Sea Breeze	Slow wind rotation traps pollution over Houston. Stalled sea breeze front traps and uplifts pollution.
Nocturnal Jet	A fast night-time wind near the surface can spew pollution large distances downwind.
PBL Evolution	PBL height helps determine the concentration of O_3 precursors and the efficiency of O_3 formation.
Cumulus Convection	Cumulus towers rapidly vent pollution to free troposphere where it can be transported long distances. Slow subsidence around cumulus towers can also entrain pollution back into PBL.
Vertical Diffusion	Transfers pollution from surface to higher levels, raising O_3 (high NOx) or diluting O_3 (low NOx).
Stationary Front	Causes “dead zones” allowing O_3 to “cook” longer or bring pollution down from free troposphere.

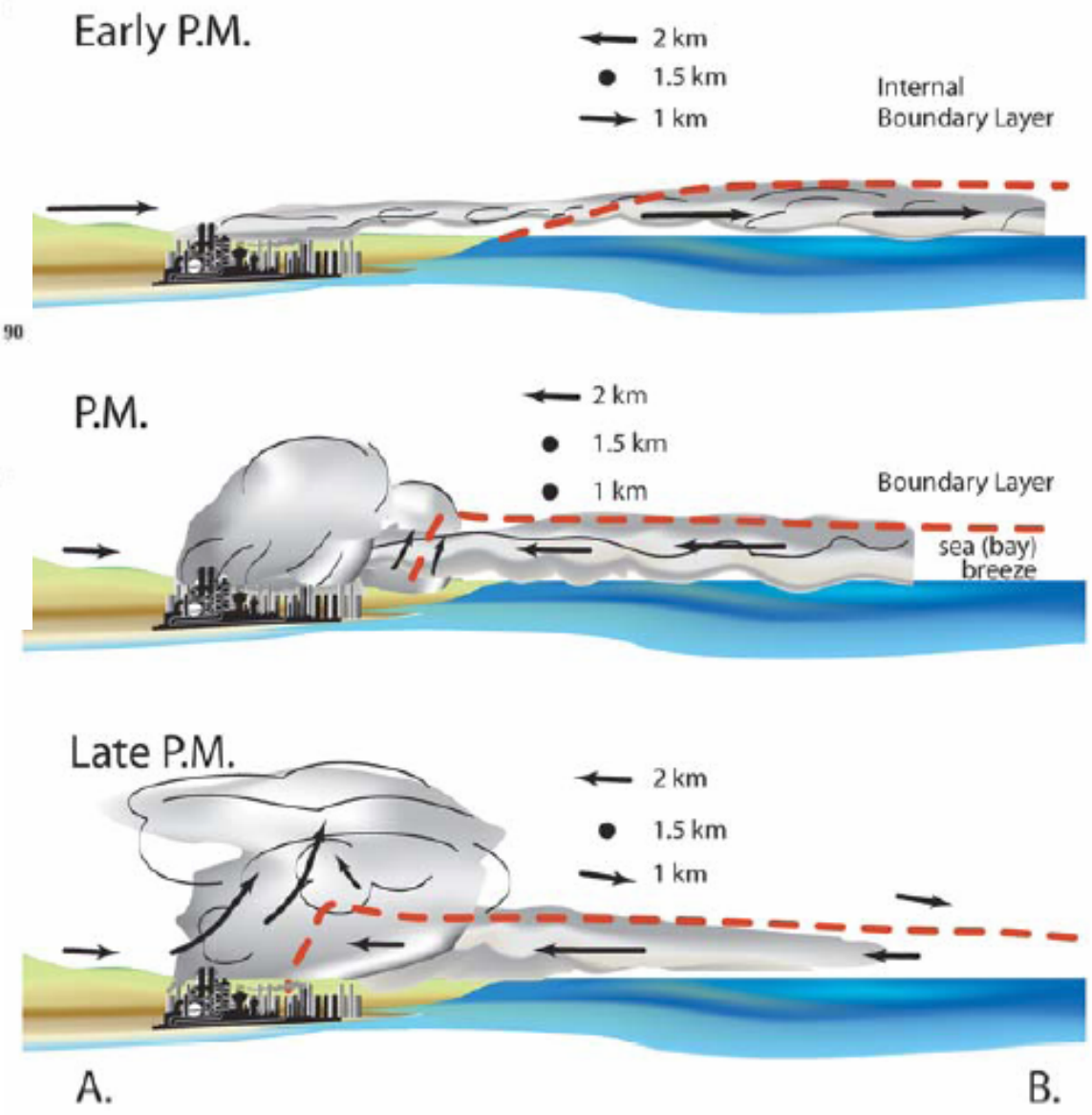

Free Troposphere
Height (km)
2
1
0
Cloud Laye
Cloud Layer
Planetary Boundary Layer Height
Mixed Layer
Residual Layer
Mixed Layer
Low Level Jet
Stable Nocturnal Boundary Layer
Surface Layer
Afternoon
Sunset
Midnight
Sunrise
Noon

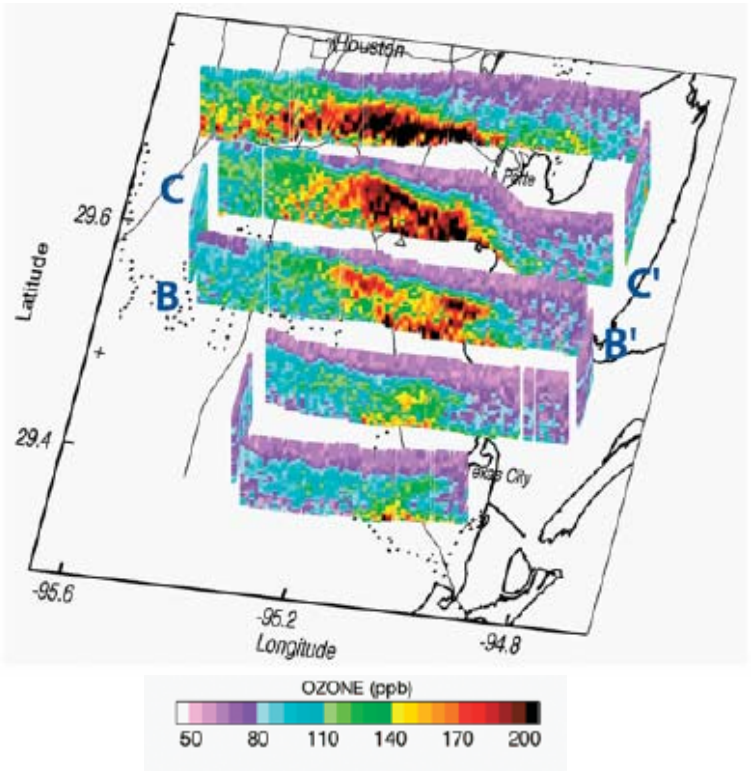

MM5:32KM
1200 UTC 3 AUG 1999
Instantaneous Wind Speed (Level One)
Frontal zone
0 1 2 3 4 5 6 7 8 9 10



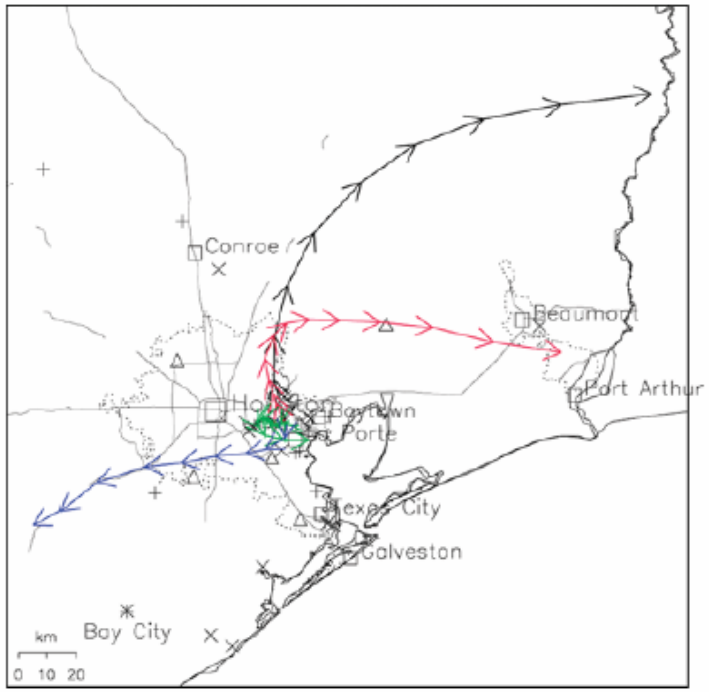

BAYP, Bayland Park, C53/A146, 8/22
Obs WS, km/h
Mod WS, km/h
Obs MN
Mod MN
Obs RWM
Mod RWM
Obs RWA
Mod RWA
0
30
60
90
120
150
180
210
240
270
300
330
16
12
8
4


N
Synoptic flow lines
A
B
Gulf Breeze


Early P.M.
2 km
1.5 km
1 km
Internal
Boundary Layer
P.M.
2 km
1.5 km
1 km
Boundary Layer
sea (bay)
breeze
Late P.M.
2 km
1.5 km
1 km
A.
B.



Left. 3-D distribution of O_3 measured by airborne lidar in the Houston-Galveston area in late afternoon (16:53 to 18:11 CST), August 30, 2000. Flight tracks began south and ended north. Measurements extend from 300 to 2000 m. O_3 concentrations of nearly 200 ppb penetrate to almost 2 km. Trajectory analysis indicates that the air in the high-pollution band along the coast passed over the Ship Channel (after Banta et al., 2005).



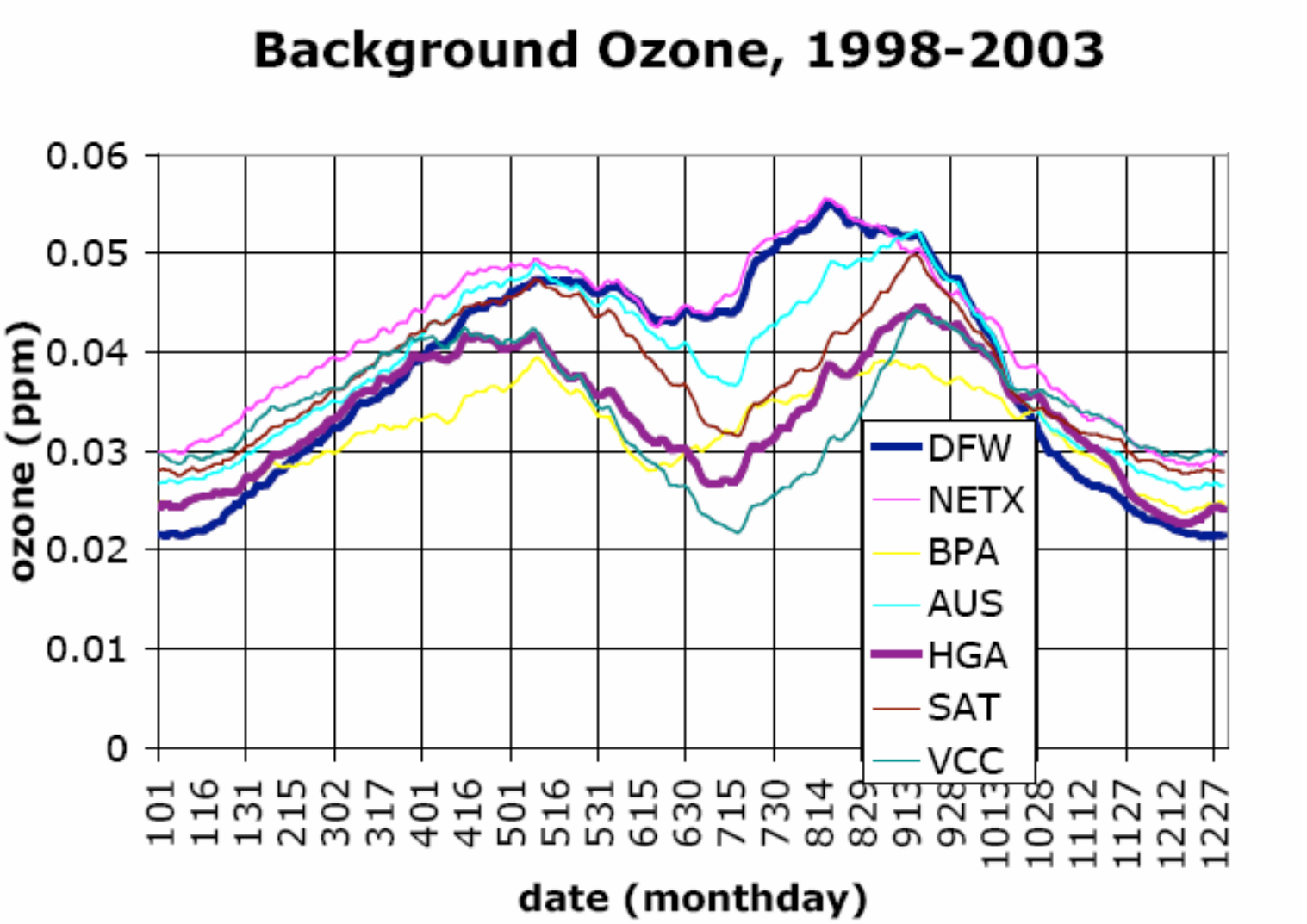
Right. Estimated 12-hr forward trajectories showing overnight transport from Houston starting at 1800 CST on August 30, 2000 and ending at 0600 CST on August 31, 2000. Red is for 200-500 m layer, black is for 500-800m layer, green is for 800-1100m layer, and blue is for 1100-1400m layer (after Banta et al., 2005). Note how Houston pollution is transported in complex ways to various areas in East Texas overnight.

Background Ozone and Transport

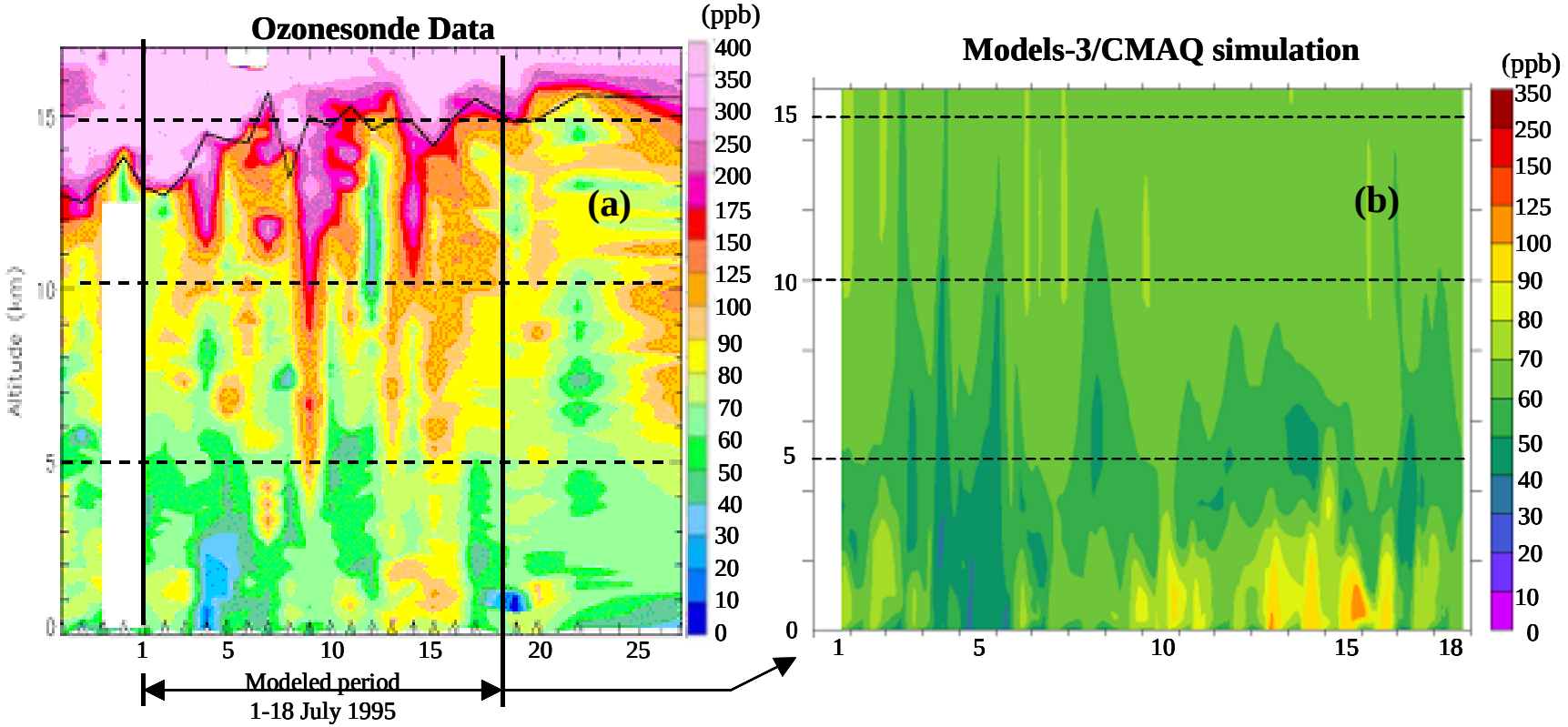
- Episode Average APCA Contributions to 8-Hr O_3 Exceedances in DFW during August 1999 (Stoeckenius and Yarwood, 2004)

Source Category	**Ozone Contribution**
Intra-State Transport	12 ppb
Out-of-State Transport	11 ppb
Model Boundary Conditions	31 ppb
Total Background	**54 ppb**
Local Production	**40 ppb**

- EPA Policy Relevant (continental) Background ozone (~25 ppb) vs. Anthropogenic regional/continental background ozone (~29 ppb) vs. Local ozone contribution (~40 ppb)
- Houston contribution to DFW high ozone: 3-5 ppb (Tai et al., 2005)



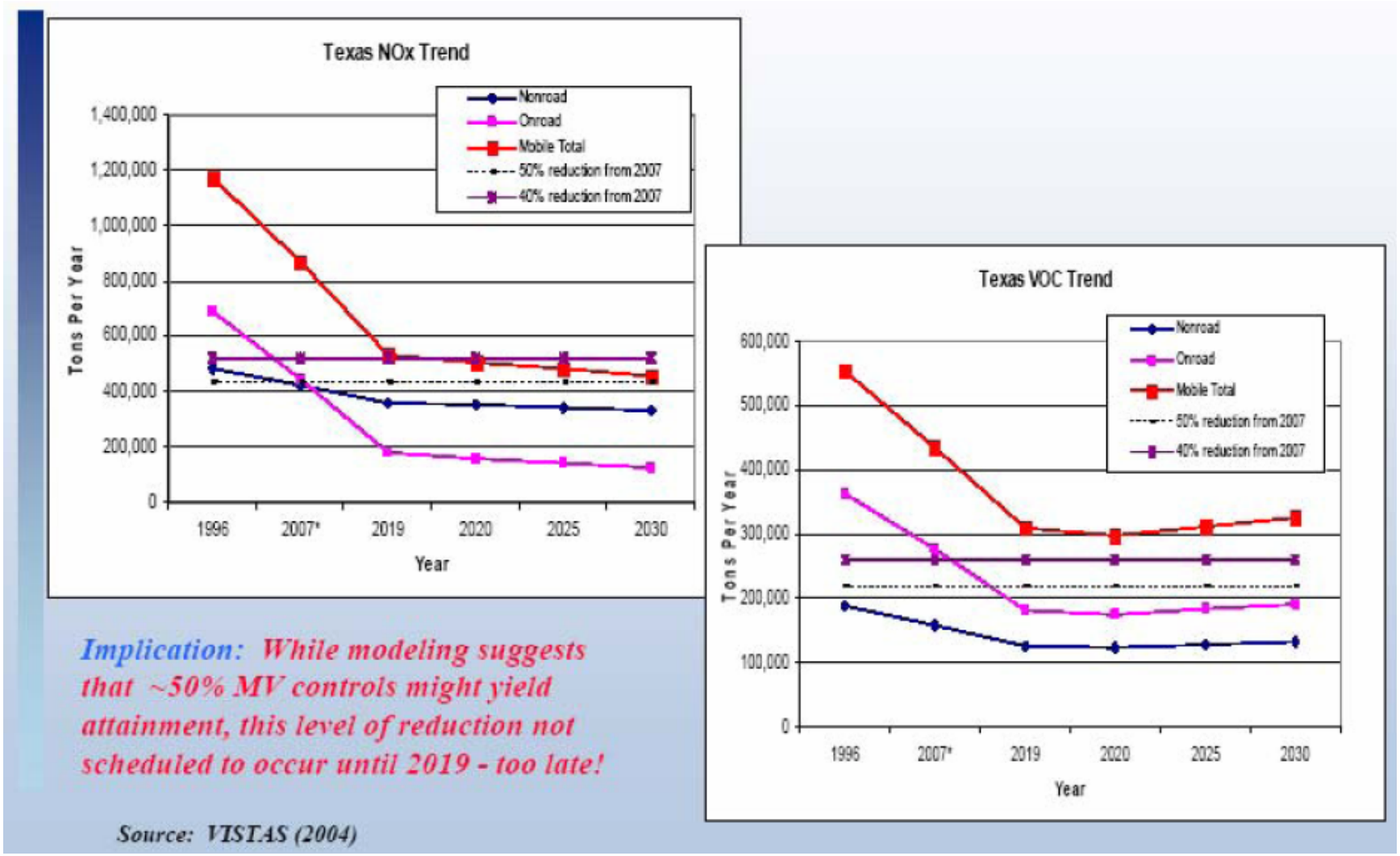
Six year average 8-hour background ozone in in East Texas regions (after Nielsen-Gammon et al., 2005).



A comparison of a CMAQ simulation of tropospheric ozone over Nashville, TN for the period 1-18 July 1995 with daily local ozonesonde data collected at noon. Observations indicate high O_3 concentrations above 10 km that are missing from the model simulation. Note high surface ozone observed on July 15 (after Gillani, 2005).

Deploying Effective New Control Strategies

- Mobile Sources
  - Improve voluntary measures (TERP, LIRAP)
  - Consider adoption of CA LEV II standards
  - Reduce NOx trom trains, ships, barges
- Regional NOx Controls
  - Control NOx from compressor engines used in gas production
  - Tighten controls on point sources outside non-attainment areas
  - Seek out-of-State reductions beyond CAIR
- HRVOCs and OVOCs in Houston
  - Expand monitoring for detection and enforcement
  - Track and anticipate impacts of emission events
  - Incorporate reactivity-based strategies
  - Control storage tank and wastewater emissions



Impact of federally mandated motor vehicle controls in Texas

(after Lubertino, 2005)

Research Recommendations

- Recommended projects include:
  - SAC-reviewed projects from June 2, 2005
  - TCEQ-suggested control strategy projects
  - Additional transport projects
- Short-term priorities for 8-hr SIP
  - Identify and assess effective new local controls
  - Assess strategy for controling regional O_3
- Longer-term priorities
  - Observational and modeling projects for TexAQS II 2006 intensive