

Summary of TERC Research

Jay Olaguer

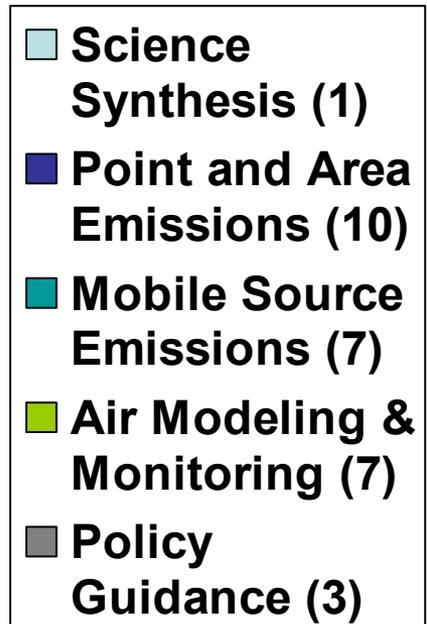
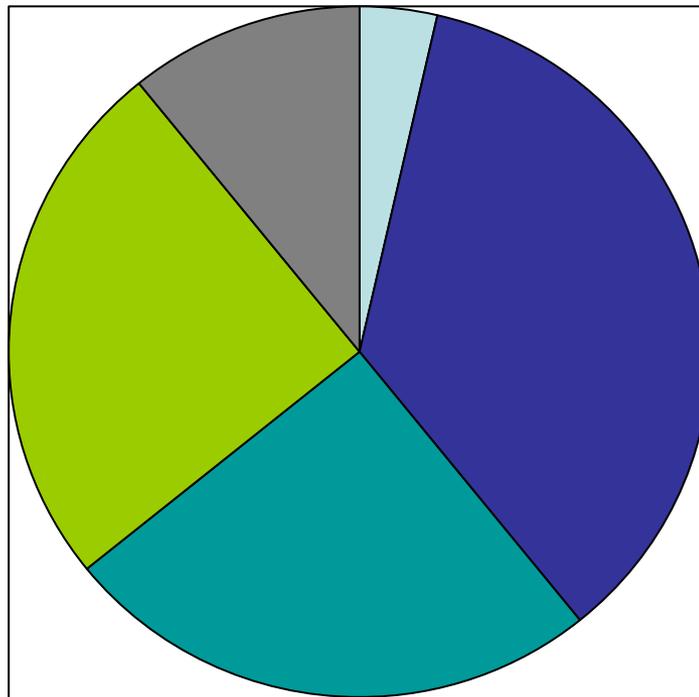
Houston Advanced Research Center

January 21, 2004

Strategic Research Plan

- Used to guide selection of TERC projects with input from Science Advisory Committee.
- Initial SRP identified improvement of emissions inventories as most pressing need.
- Priorities for 2004 include:
 - Identify emissions reductions most critical to meeting both 1 hr and 8 hr O₃ standards.
 - Evaluate role of regional transport.
 - Evaluate impact of ozone control strategies on PM and regional haze.

CIAP Project Distribution



Impact on Texas SIP

- Projects chosen primarily for impact on Mid Course Review.
- Some projects are designed to have intermediate results useful to SIP but will continue beyond 4/04 (e.g., Project H13).
- SIP impacts include:
 - better emissions inventories
 - better simulation of meteorology and transport
 - guidance on policy measures/implementation.

Research Highlights:

Point and Area Emissions

- Quantified emissions from fires (H3).
- Use of “top-down” methods to reconcile emissions with ambient observations (H6).
- Collected survey data from HGA plant sites to better characterize flare, cooling tower and fugitive emissions (H7A).
- Small-scale diesel generators found to be much more numerous (~30,000) than was previously estimated (<1000) in Houston region (H10).
- New methods for stochastic emissions (H13).

Research Highlights:

Mobile and Non-Road Emissions

- Projects H8 & H18 looked at cars, trucks, agricultural equipment, ships, and trains.
- Mileage rates in Harris County similar to MOBILE6 defaults for vehicles >11 years, but higher in new vehicles.
- High emitter fraction based on local data twice as high as MOBILE6 default.
- Agricultural emissions based on census data much higher than EPA model default.

Research Highlights:

Air Modeling

- Project H1 helped explain and alleviate problem of simulating the depth of the planetary boundary layer (PBL).
- Project H13 will develop efficient methods for modeling air impacts of highly intermittent emissions of HRVOCs.
- Project H17 improves simulation of the Urban Heat Island effect through better characterization of surface fluxes of moisture and energy.
- Project H19 provides TCEQ with better tools for computing back-trajectories of polluted air based on real-time data.

H6: Houston Inverse Modeling

(Greg Yarwood and Till Stoeckenius, ENVIRON)

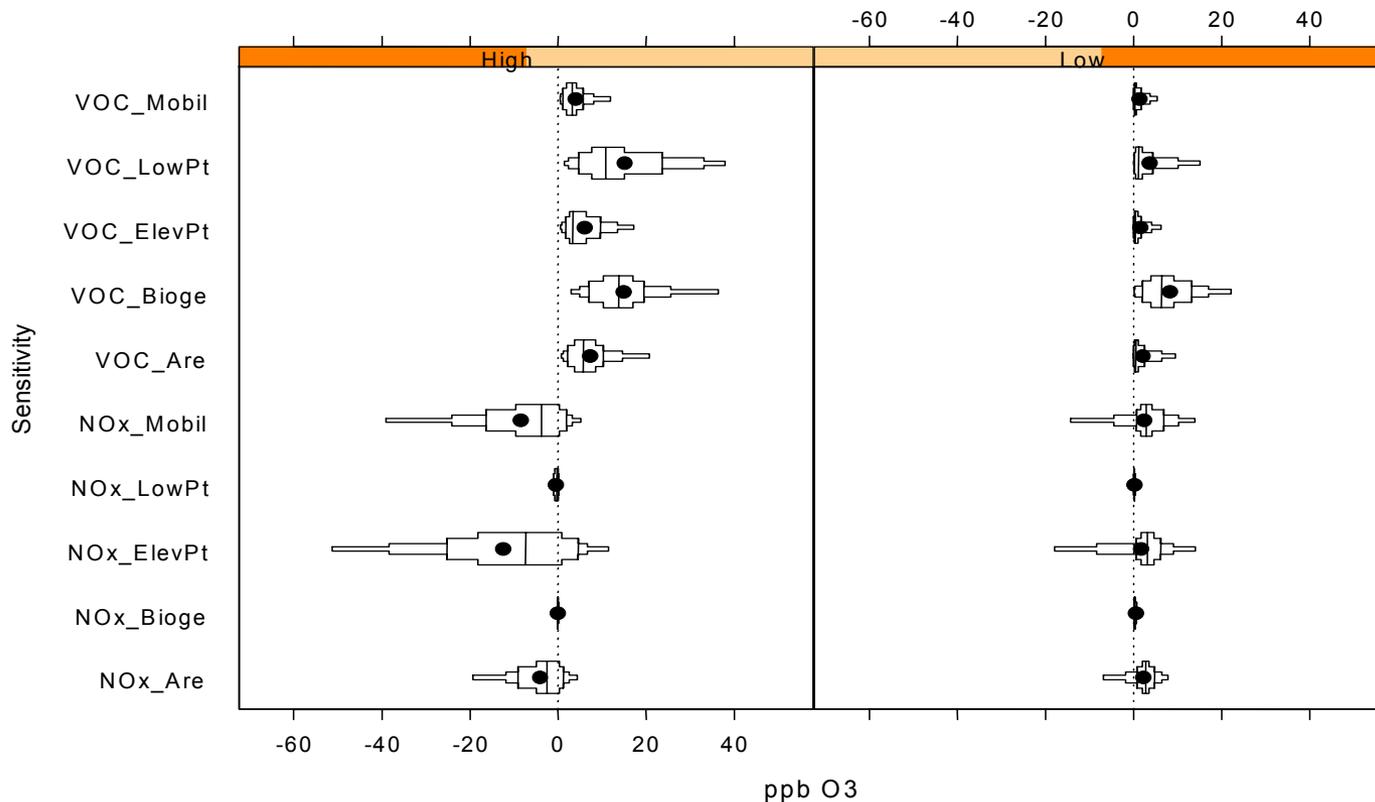
- CAMx DDM coefficients of sensitivity to emissions changes for O₃ , NO_y , HCHO
- NOAA and Brookhaven TxAQS aircraft data for August 27-31, 2000
- Adjust emissions by performing least squares minimization of prediction errors for O₃ , NO_y , HCHO according to:

$$\chi_{\text{obs}} - \chi_{\text{pred}} = \sum \beta_i S_i$$

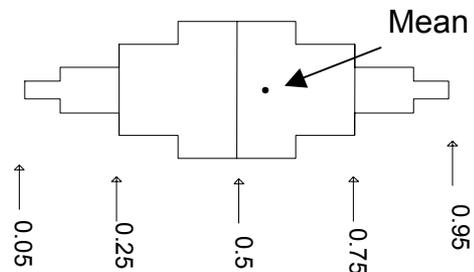
(S_i in ppb/fractional change in emissions)

Sensitivities for High and Low Ozone

Sensitivities for O3 (High O3 is O3 > 125 ppb)



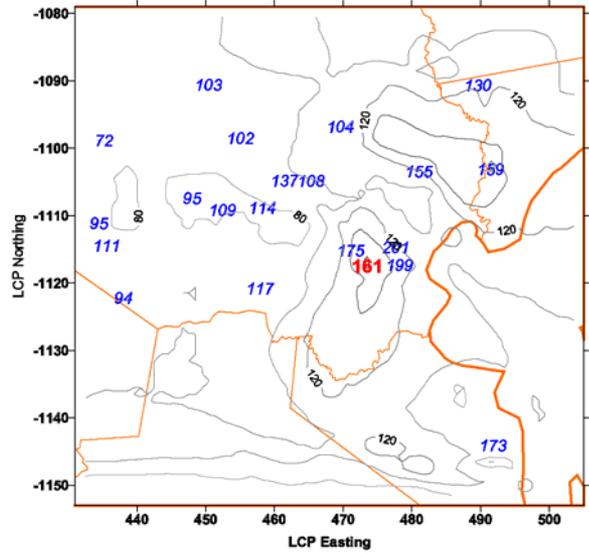
Run: summary.pt.o2n2.070pbl.1way.df



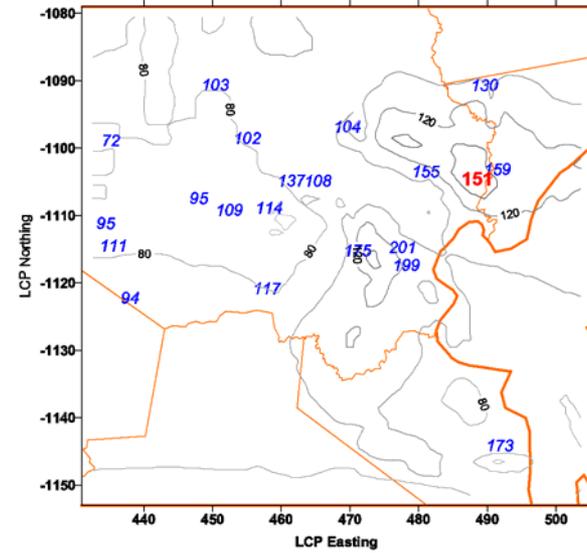
Adjustment Scenarios

			Adjustment Factors (1 = no adjustment)				
	Scenario	Description ¹	Relative to	On-Road Mobile + Area Sources	Biogenic	Low-Level Points	Elevated Points
VOC Scenarios	Base4a	Base case	--				
	PT_O2N2	Scale point source olefins to NOx	Base4a	1	1	Varies	Varies
	LPVOC	Increase Base4a low point VOCs	Base4a	1	1	4	1
	BioVOC	40% decrease in biogenics	PT_O2N2	1	0.6	1	1
	MABVOC	Increase mobile+area VOCs, decrease biogenics	PT_O2N2	3	0.3	1	1
NOx Scenario	NOxMAP	Decrease NOx from mobile+area and points	PT_O2N2	0.7	1	0.9	0.9

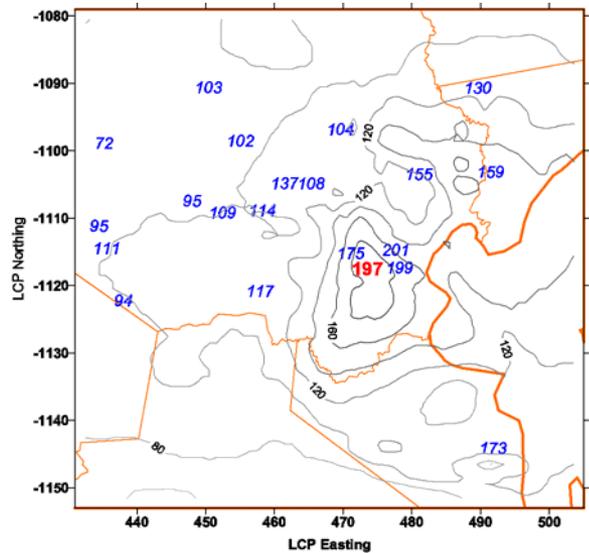
Surface Observed Vs. Predicted Ozone: 30 Aug 2000



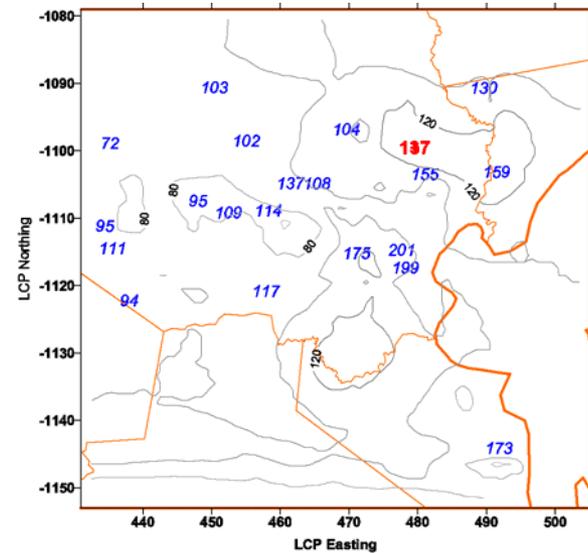
Daily Maximum 1-hour ozone for August 30, 2000
Run: PT_O2N2_070PBL



Daily Maximum 1-hour ozone for August 30, 2000
Run: BioVOC



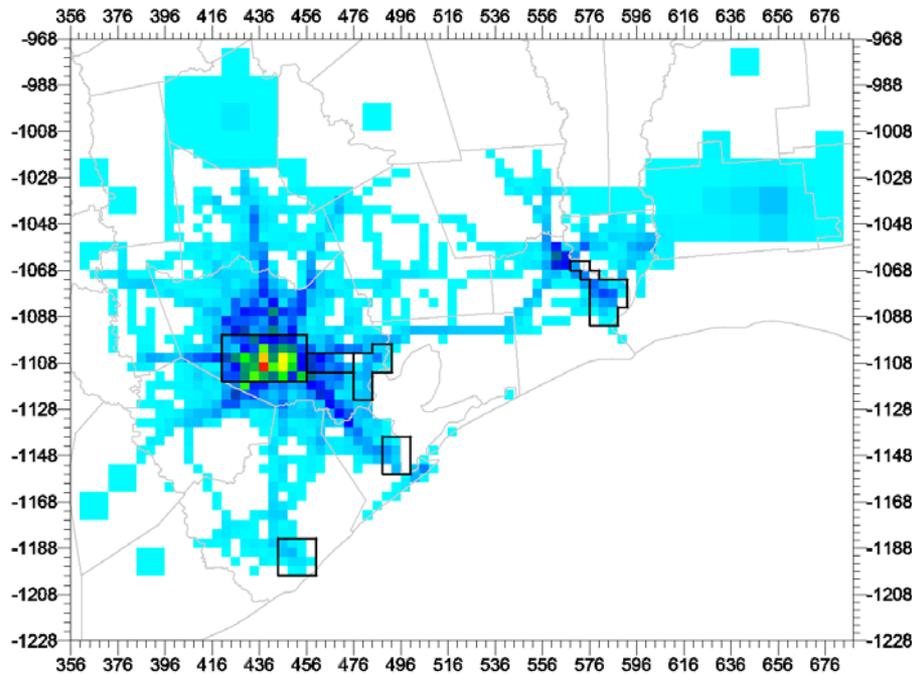
Daily Maximum 1-hour ozone for August 30, 2000
Run: MABVOC



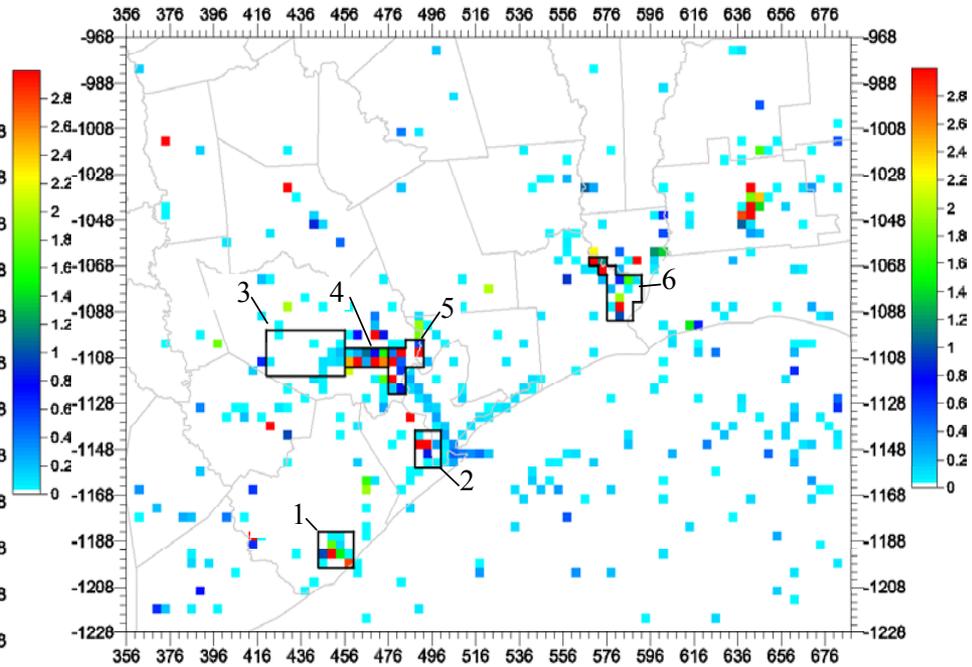
Daily Maximum 1-hour ozone for August 30, 2000
Run: LPVOC

Emission Sub-Regions

Mobile VOC
Date: Aug 28, 2000



Elevated and Low Point NO_x (PTO2N2)
Date: Aug 28, 2000



Summary of H6 Results

- Biogenics may be overestimated (drought)
- Olefin adjustment (PT_O2N2) optimal for point source VOC (β_{LPVOC} near zero).
- NOx reduction equivalent to VOC increase (NOx disbenefit)
- Sub-regional analysis results still being analyzed

New CIAP Project Requests from TCEQ

- TCEQ staff generated a list of desirable research projects.
- TCEQ's Science Coordinating Committee (SCC) evaluated suggested projects.
- Several SCC members are also on SAC.
- TCEQ asked TERC to fund several most highly rated projects (quality rank 5).
- HARC chose 5 projects from TCEQ list with SAC consultation.

New Project H22: Permit Data for VOC/NOx

- Need to look at difference between maximum allowable and reported emissions.
- SIP development also needs data on emissions permitted after construction of 2000 base case inventory to project future emissions.
- State permits (e.g., NSR) can yield info on maximum allowed release levels for VOC/NOx.
- Project will convert data from hardcopy to digital format.

New Project H23: **Model Use of Satellite Data**

- Met models have difficulty in simulating surface heating and moisture.
- This deficiency has major adverse impacts on wind flow and pollutant dispersion.
- Incorporation of GOES satellite data significantly improves model performance.
- Project will continue testing and evaluation of new data assimilation technique.

New Project H24: **Ensemble Kalman Filter (EnKF)**

- Basic problem of deciding best model representations and parameter values.
- Data assimilation uses observations to drive models toward correct behavior.
- EnKF is a rigorous data assimilation technique used in global change research.
- Project will apply EnKF in a novel way to a met model with simple chemistry.
- Project will also use EnKF to identify optimal timing and location of adaptive (e.g. aircraft) measurements (useful for TxAQS 2005-2006).

New Project H25: Nighttime Reservoirs of NO_x

- Air quality models have difficulty in simulating cycling of NO_x involving temporary reservoirs such as HNO₃, HONO, HO₂NO₂, and N₂O₅.
- Nighttime chemistry can influence daytime NO_x availability.
- Total reactive nitrogen = NO_x + reservoirs
- Export of total reactive nitrogen (NO_y) at all hours can influence NO_x in remote areas.
- Project will use novel analytical technique (ion drift chemical ionization mass spectrometry) to measure nitrogen reservoirs at night.

New Project H26: **Modeling of Industrial Plumes**

- Extension of on-going work involving perfluorocarbon tracers by BNL (H6A).
- Project will make use of aircraft data for highly reactive olefins.
- Project will use two different dispersion/chemistry models (LES-chem and LRPM) to model industrial plumes from Sweeny ethylene plant.

Additional CIAP Project: **Unusual Hydrocarbons**

- Examine aircraft data from TxAQS 2000 to evaluate the role of different classes of VOC in rapid ozone formation.
- DOE G-1, Baylor Twin Otter, DC-3 aircraft
- Examine and explain (using trajectory analysis) aircraft samples with anomalous hydrocarbon signatures.
- Case study analysis of August 31, 2000.

New DFW Projects Funded by TCEQ

- Extensions of current CIAP-funded emissions inventory and policy projects:
 - H10: Small scale diesel generators
 - H18: Locomotive emissions
 - H20: TERP diesel technology assessment
- Survey of NO_x abatement technology for Ellis County point sources
- Impact of transport on Dallas-Ft. Worth

DFW Transport Project

- Evaluate contribution of point sources outside DFW to ozone non-attainment.
- Information sources: aircraft data, SIP model runs, regional & trajectory modeling.
- Regions of influence considered:
 - 8 outlying counties in DFW CSMA
 - Counties adjacent to DFW CSMA
 - Counties in East Texas east of I-35, north of I-37
- Evaluate contribution of new power plants (after 1997) outside DFW non-attainment area.