HGB Ozone SIP Modeling Overview

Zarena Post

Air Quality Division, TCEQ

Presented to

Houston-Galveston Area Council/
Regional Air Quality Planning Committee

July 31, 2008

Why Model Ozone?

- Section 182 of the 1990 Federal Clean Air Act Amendments lists SIP Requirements:

  For areas classified as "serious," develop an attainment demonstration SIP based on photochemical grid modeling

- EPA Guidance Documents
  - "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals…." (April 2007)

Ozone Formation

Ozone is a secondary pollutant

- Not emitted directly into atmosphere
- Forms via a complex chemical process

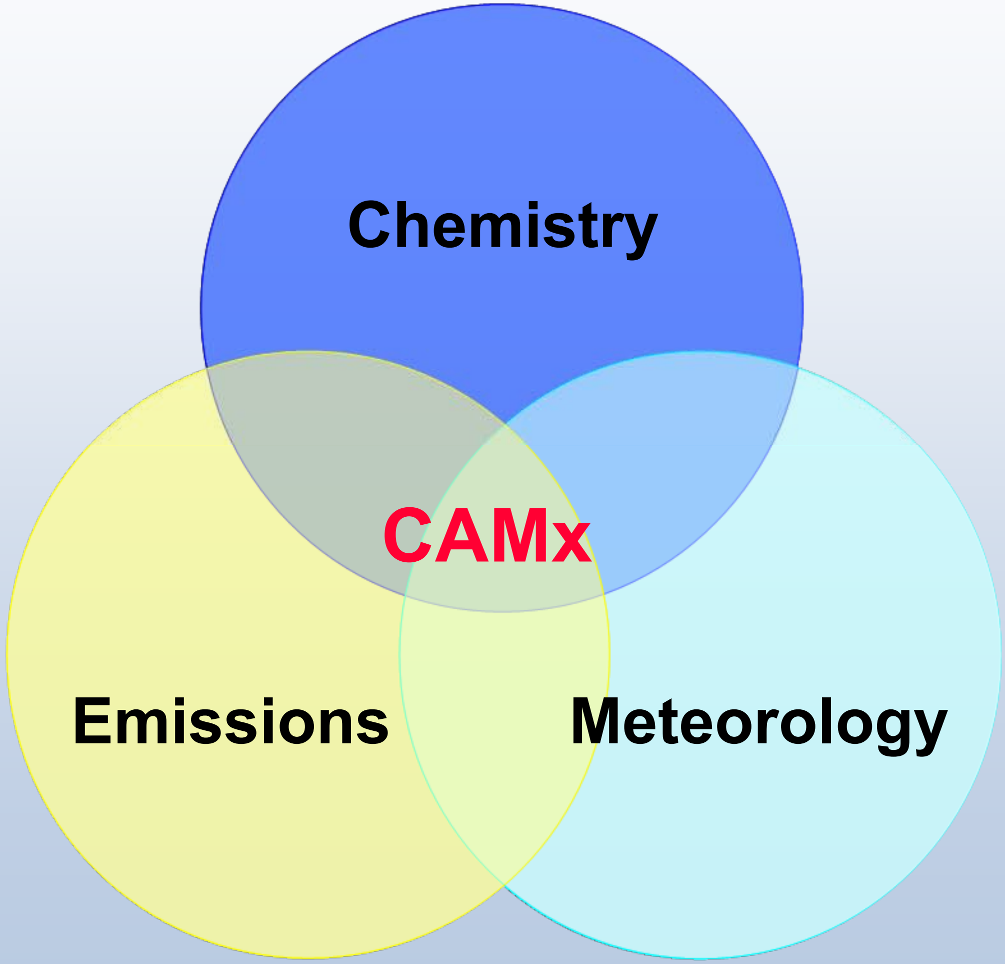
Photochemical reaction

- Requires UV energy from sunlight, so
- Ozone forms during daytime, decreases at night

Complex chemical reaction between

- NO_X - Nitrogen Oxides (NO, NO_2)
- VOCs - Volatile Organic Compounds

CAMx Modeling Inputs



CAMx Ozone Modeling in SIP Development

Base Case	Day-specific emissions and meteorology; replicate what actually happened; 2005, 2006
Baseline Case	Typical emissions and day-specific meteorology; used as basis for calculating future design values
Future Base Case	Apply future growth and on-the-books controls to estimate future ozone; 2018
Project DV_{Future}	Use baseline design value and Future Base and Baseline modeling results
Test Control Strategies	Determine the control strategies and reductions that will effectively reduce ozone
Write SIP	Document modeling procedures, attainment demonstration, and weight of evidence

CAMx Ozone Modeling in SIP Development

Base Case – Historical Episode Replication

Meteorological Modeling

Winds, Mixing Depth, Temperature, Cloud Cover, etc.

Emissions Modeling

VOC, CO & NO_X
Point, Area, On- & Non-Road & Biogenic

CAMx Modeling

O_3, NO_X, VOC, CO, etc.
Chemical Mechanism (CBIV, CB05), "Mixing" schemes

Evaluate CAMx Performance

(How well does the model replicate the episode?)

Bias, Time Series, Contour Plots

Suitable Base Case

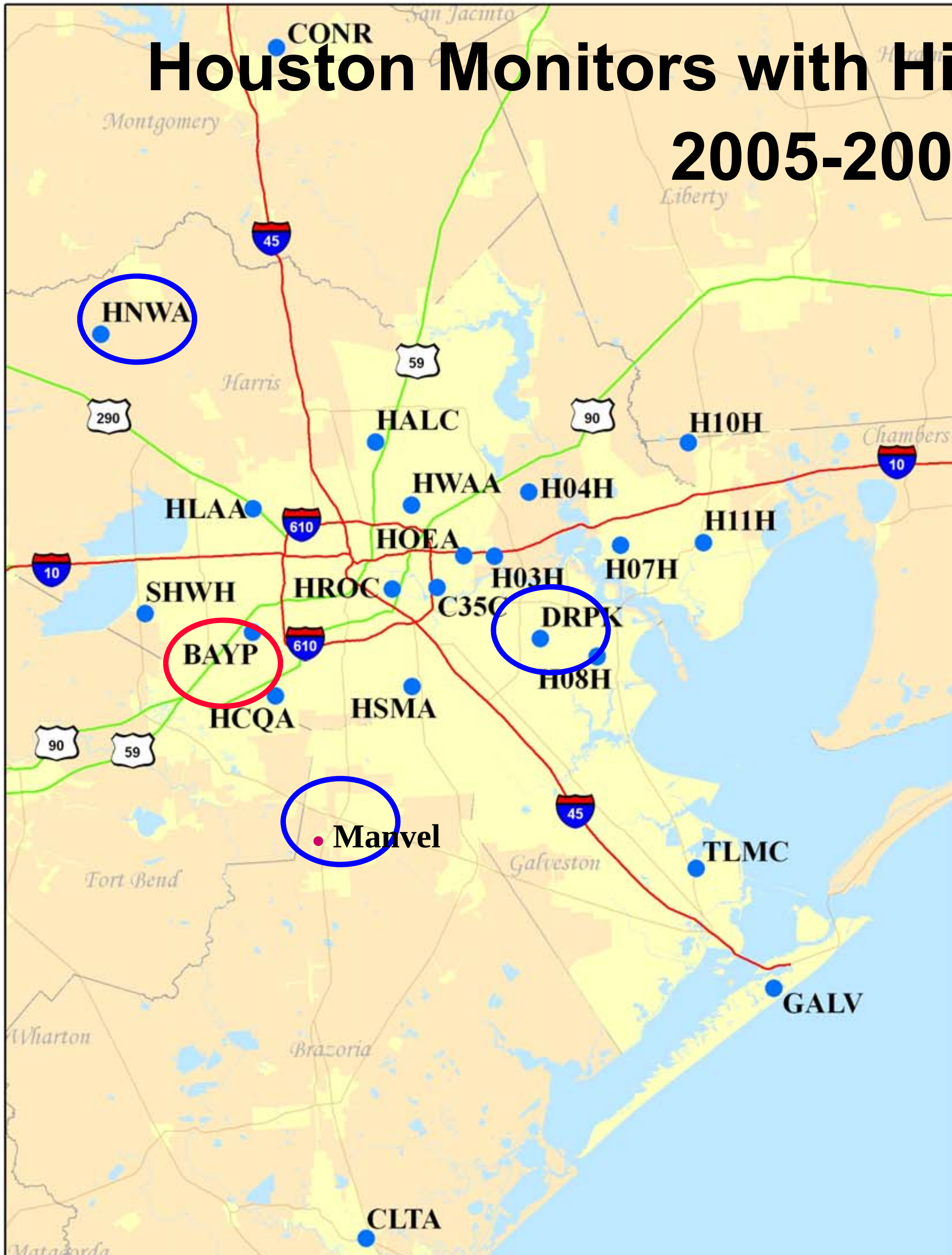
Features of 8-Hour Ozone Modeling

- Uses Relative Response Factor (RRF) approach to project future design value (DV_{Future})
  - Combines Future Base and Baseline modeling results
  - RRF = ratio of Future and Baseline modeling results
  - RRF represents predicted percent change
  - $DV_{Future} = DV_{Baseline} \times RRF$
- EPA recommends using a minimum number of 10 days ≥ 85 ppb be included in the RRF calculation for each monitoring site

Ozone Meteorology

- Clear (or partly cloudy) skies,
  - Limited clouds allows solar energy to reach the surface
  - Lots of Ultraviolet energy to make ozone
  - Strong surface heating
- High temperatures
  - Mix the air vertically
  - Accelerate the chemistry and
  - Speed up ozone formation
- Low wind speeds
  - Weak Winds → limited dispersion, dilution
  - Air stays in one place for a long time
  - Coastal areas get flow reversal

Houston Monitors with High Design Values 2005-2007



BAYP	BAYLAND PARK	96
C35C	CLINTON DRIVE	
CLTA	CLUTE	
CONR	CONROE	
DRPK	DEER PARK	93
GALV	GALVESTON	
HALC	ALDINE	
HCQA	CROQUET	
HLAA	LANG	
HNWA	NW HARRIS CO	91
HOEA	HOUSTON EAST	
HROC	HOUSTON REGIONAL OFFICE	
HSMA	SWISS & MONROE	
HWAA	NORTH WAYSIDE	
SHWH	SHELL WESTHOLLOW	
TLMC	TEXAS CITY/LA MARQUE	
H03H	HRM 3 HADEN ROAD	
H04H	HRM 4 SHEDLON ROAD	
H07H	HRM 7 WEST BAYTOWN	
H08H	HRM 8 LA PORTE	
H10H	HRM 10 MONT BELVIEU	
H11H	HRM 11 EAST BAYTOWN	
C84	Manvel-Croix	91

Protecting Texas by Reducing and Preventing Pollution

TCEQ

Texas Commission on Environmental Quality
Chief Engineer's Office
Air Quality Division
PO Box 13087 (Mail Code 164)
Austin, Texas 78711-3087

This map was generated by the Air Quality Division of the Texas Commission on Environmental Quality. No claims are made to the accuracy or completeness of the data or to the suitability for a particular use. For information concerning this map, contact the Air Quality Division at (512) 239-1459.

December 12, 2006 Raj Nadkarni (512) 239-1934

Sources of Precursor Chemicals

- Nitrogen Oxides come from combustion
  - Cars, trucks, boats, engines
  - Industrial smokestacks,
  - Electrical power plants
- VOCs come from evaporation and incomplete combustion
  - Industrial/petrochemical facilities
  - Solvents evaporation
  - Gasoline and other fuels
  - Plants, particularly oak trees

Emissions Inventory Categories

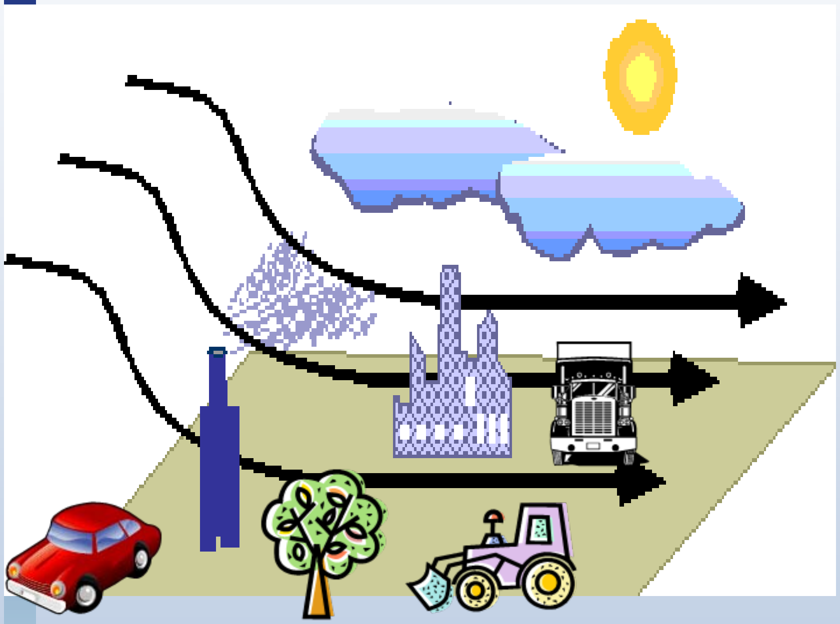
- Point Sources
  - Industrial sources (Petrochemical and Electric Generating)
- On-Road Mobile sources
  - Cars, trucks, buses, motor cycles, 18 wheelers
- Non-Road sources
  - Trains, planes, boats, construction equipment, pumps etc
- Area Sources
  - Dry Cleaners, Gas stations, Bakeries
- Biogenic Sources
  - Oak and Pine Trees, Vegetation, Farming

Inputs Combined into One Model

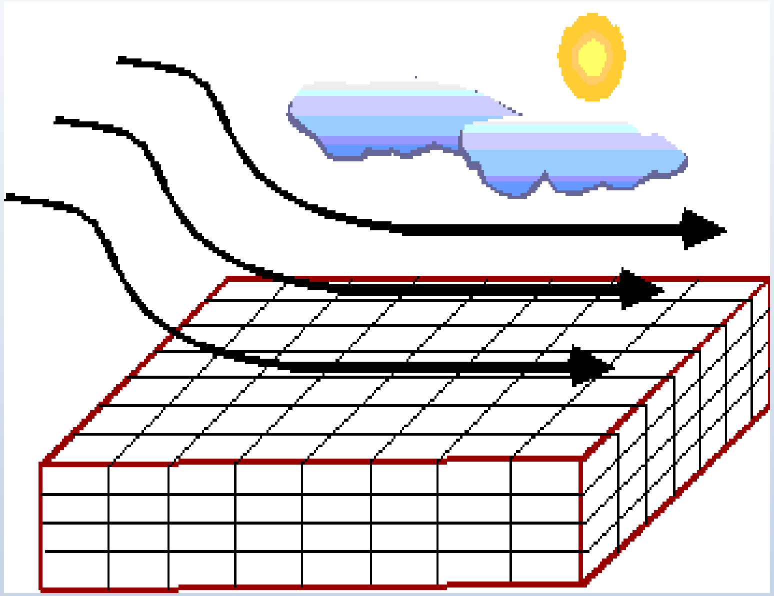
- Chemistry Equations
  - Chemistry changes during day and night
  - 51 chemical groups, 156 reactions
  - Complex system of differential equations
- Meteorological Data
  - Wind transports and mixes pollutants
  - Temperature affects reaction rates
  - Sunlight provides energy (ultraviolet radiation)
- Emissions Inventory
  - Emissions from cars, planes, factories, power plants
  - Nitrogen Oxides and Volatile Organic Compounds
  - Speciation - Break VOC emissions down into chemical components

CAMx Photochemical Model

Photochemical Grid Models



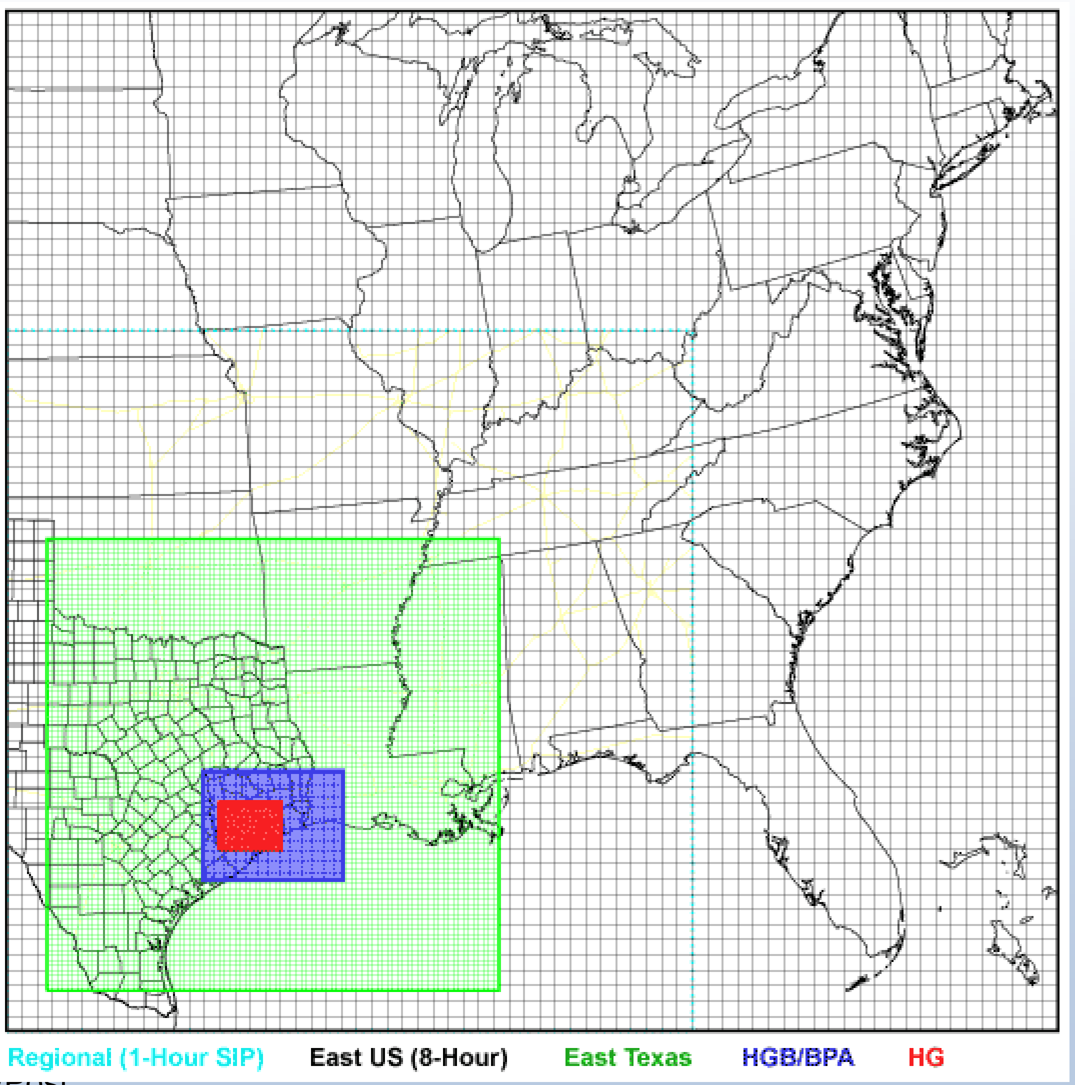
Real World Situation



Computer Grid Simulation

CAMx Modeling Domain

Horizontal Grid Structure



Grid Size	
Black	36 k
Green	12 k
Blue	4 k
Red	2 k

TexAQS II Modeling Episodes

- 2005
  - Episode0: May 19 - June 3, 2005
  - Episode1: June 17 - June 30, 2005
  - Episode2: July 27 - August 8, 2005
- 2006
  - Episode 0: May 31-June 15, 2006
  - Episode 1: August 13- September 15, 2006
  - Episode 2: October 3 – October 11, 2006

Goal of Ozone Modeling

- Get the right ozone concentrations at:
  - The right time
  - The right place
  - For the right reasons
- Get enough valid modeling days so the results are reliable
- Serves as a directional tool to provide information about what control strategies are expected to be helpful