2002 Seasonal Modeling for Victoria

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Background

- The existing September 15 – 20, 1999 episode has been used extensively for air quality planning in Victoria, for example to investigate:
  - sensitivity of ozone formation to reductions of VOC and NOx
  - response of ozone to various VOC and NOx control strategies
  - response of ozone to proposed new emissions sources
  - comparisons of model predictions with available observations
  - development of programs to perform VOC sampling
  - selection of locations for surface monitoring stations
  - sources contributing to ozone in Victoria and other Texas areas
  - role of long range point source impacts on local ozone formation
  - role of regional transport on local ozone formation.
- However, meteorological conditions and particularly regional ozone transport conditions vary between high ozone episodes.
- In 2007/2008, City of Victoria elected to develop an additional episode covering a full ozone season (May – September 2002).

2002 Seasonal Ozone Episode

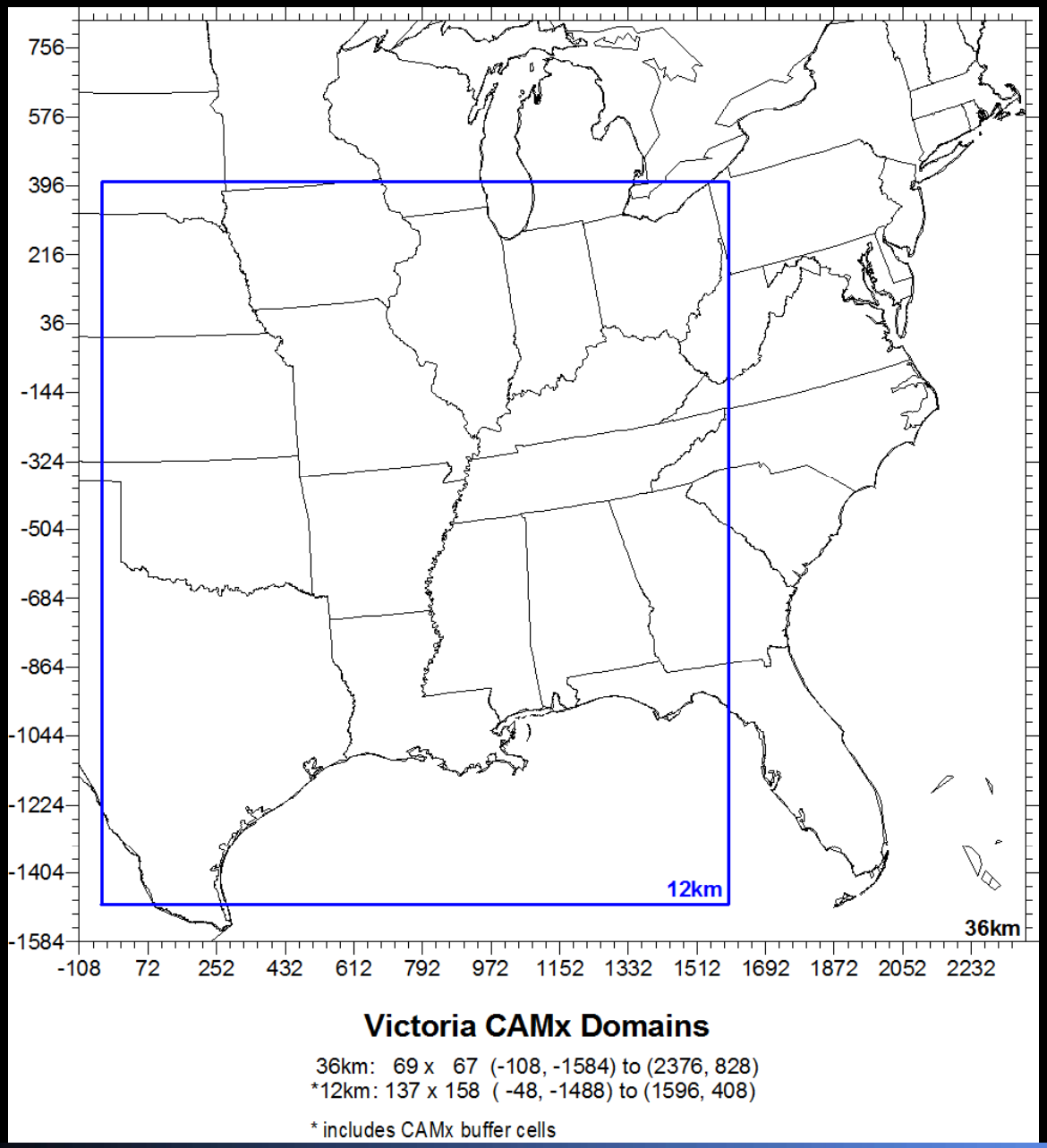
- The conceptual model was used to select year 2002 for ozone modeling.
  - 2002 was characterized by 12 days with daily maximum 8-hour ozone concentrations > 70 ppb at CAMS 87.
  - High ozone occurred during the climatologically favorable early and late summer periods.
  - 2002 high ozone events are representative of high ozone conditions during 2001 – 2009.
- Advantages of modeling a full ozone season include:
  - Capture a range of typical meteorological conditions and ozone transport patterns during an entire ozone season.
  - Changes in the 4th highest daily maximum ozone concentration can be predicted directly from model output.

Model Description

- Documented in *"Protocol for Seasonal Modeling, Victoria, June to September 2002 Episode"* submitted by City of Victoria and UT-Austin to TCEQ in 2008.
- Used Comprehensive Air Quality Model with Extensions (CAMx) version 4.51.
- Adapted from the Central Regional Air Planning Association (CENRAP) 2002 June – Sept modeling of regional haze and visibility but expanded to include ozone.
- Meteorological data originally developed by Iowa Department of Natural Resources (IDNR) using the PSU/NCAR Mesoscale Model Version 5 (MM5).

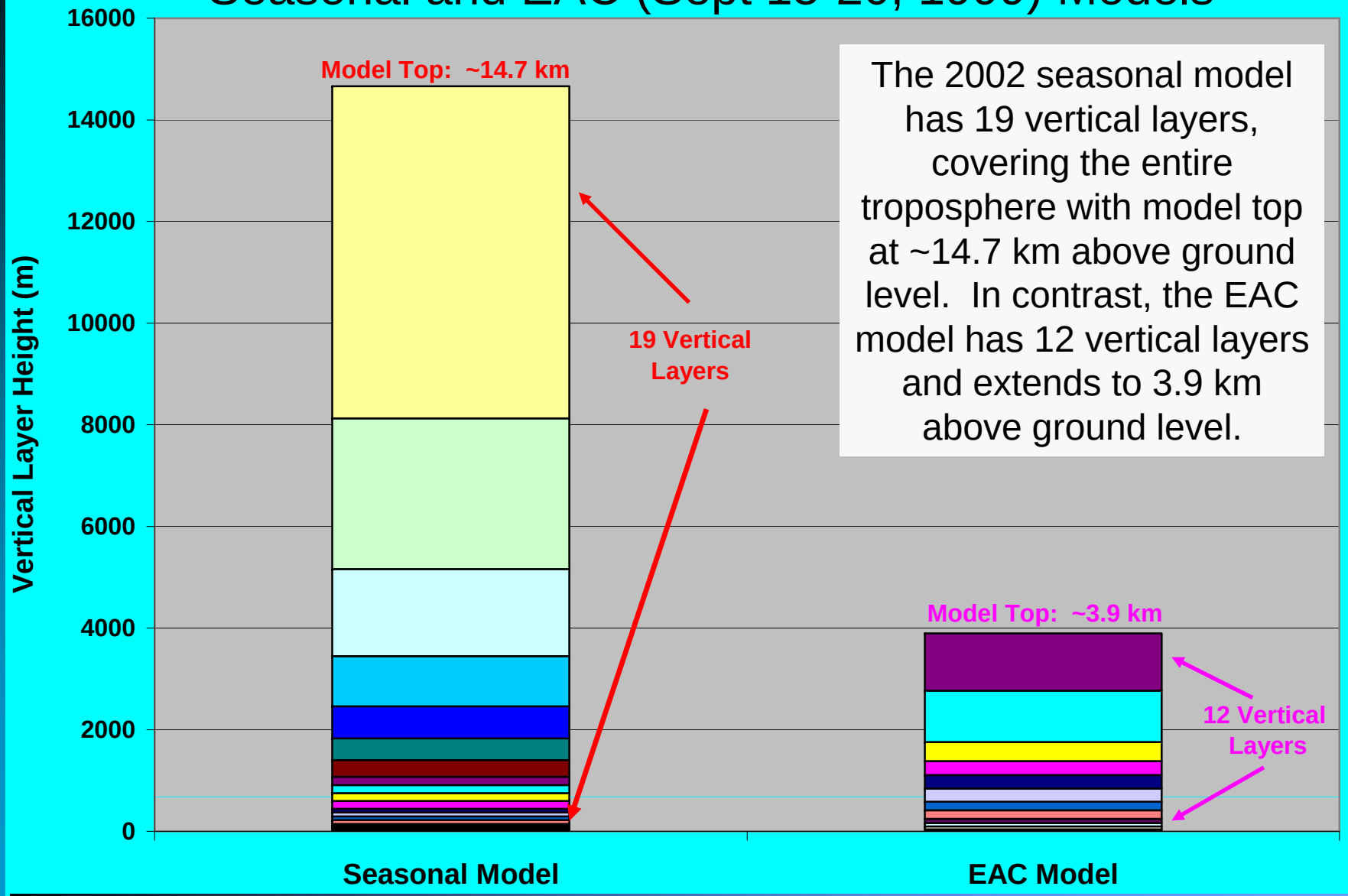
Model Emission Inventory

- National Emission Inventory (NEI) 2002v3 onroad mobile for the U.S.,Minerals Management Service (MMS)
- 2000 Gulf-wide Offshore Activities Data System (GOADS)
- Day-specific fire emissions from the National Center for Atmospheric Research (NCAR)
- Day-specific biogenic emissions generated with the Global Biosphere Emissions and Interactions System (GloBEIS) model version 3.3
- Hourly measured Continuous Emissions Monitoring (CEM) data for elevated point sources



The 36km outer and 12km inner (blue) horizontal grid domains.

Comparison of Vertical Grid Structures
Seasonal and EAC (Sept 15-20, 1999) Models



The 2002 seasonal model has 19 vertical layers, covering the entire troposphere with model top at ~14.7 km above ground level. In contrast, the EAC model has 12 vertical layers and extends to 3.9 km above ground level.

2002 Seasonal Model Ozone Performance Evaluation

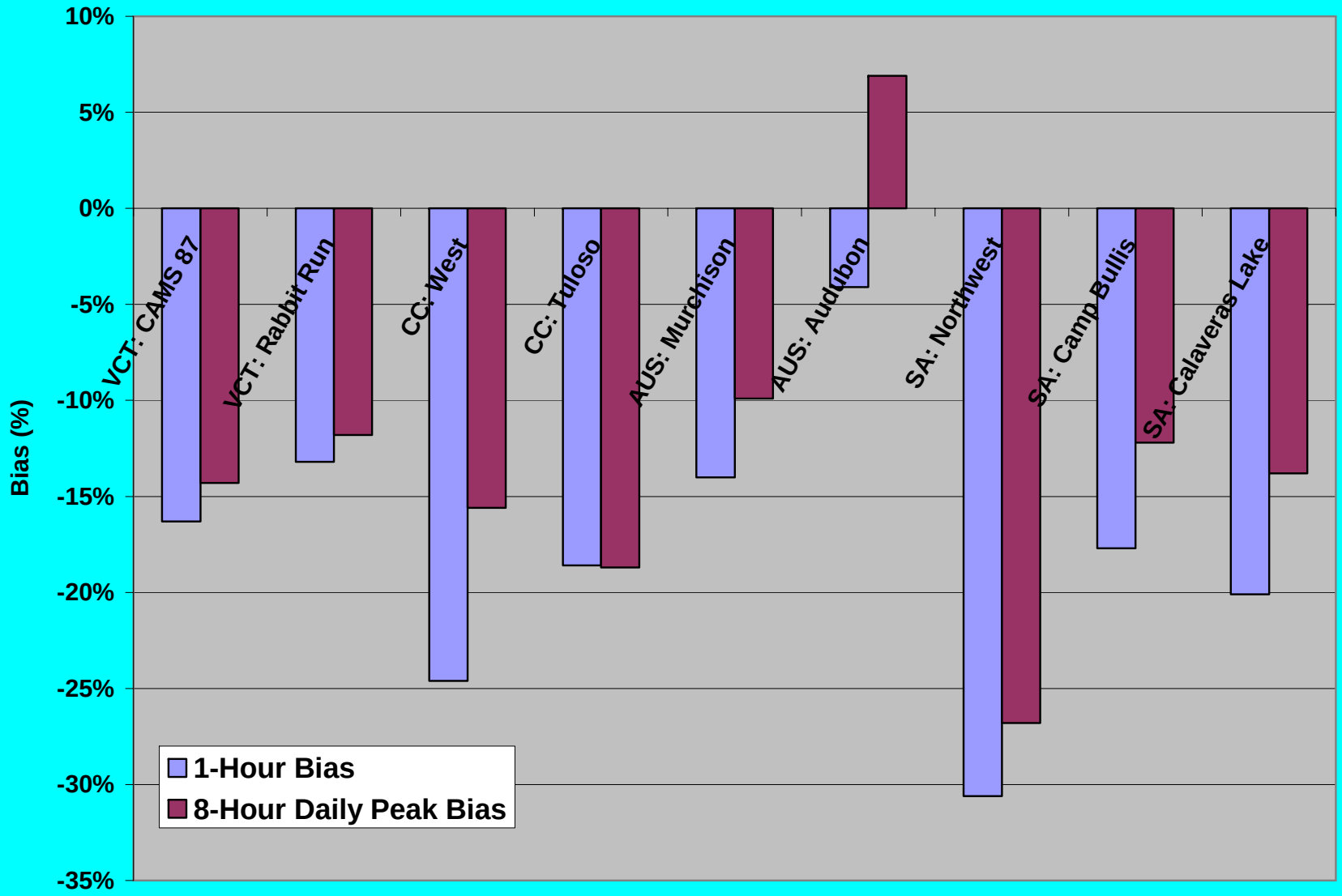
- Ozone performance evaluation was performed for NNA monitors based on EPA guidance.
  - Note: EPA guidance was originally developed for 1-2 week modeling of high ozone events. We are also investigating additional metrics for full season modeling not presented today.

- Statistical metrics (1) Bias and (2) Error

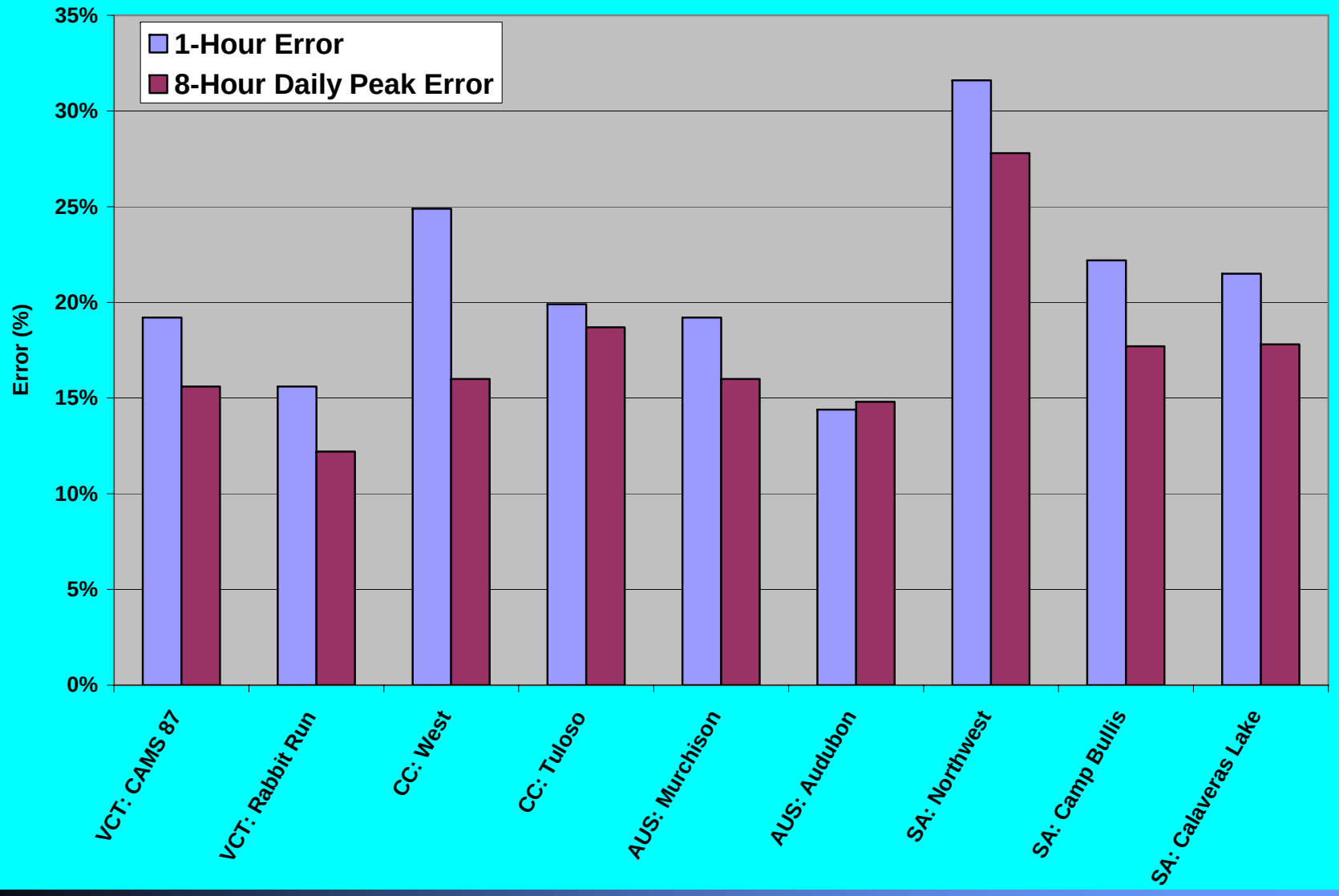
$$Bias = \frac{1}{N}\sum_{1}^{N}\left(\frac{(Model - Obs)}{Obs}\right) * 100\%$$

$$Error = \frac{1}{N}\sum_{1}^{N}\left(\frac{|Model - Obs|}{Obs}\right) * 100\%$$

Bias at NNA Monitors for (1) One-Hour Ozone >= 60 ppb and (2) Daily Peak 8-Hour >= 60 ppb



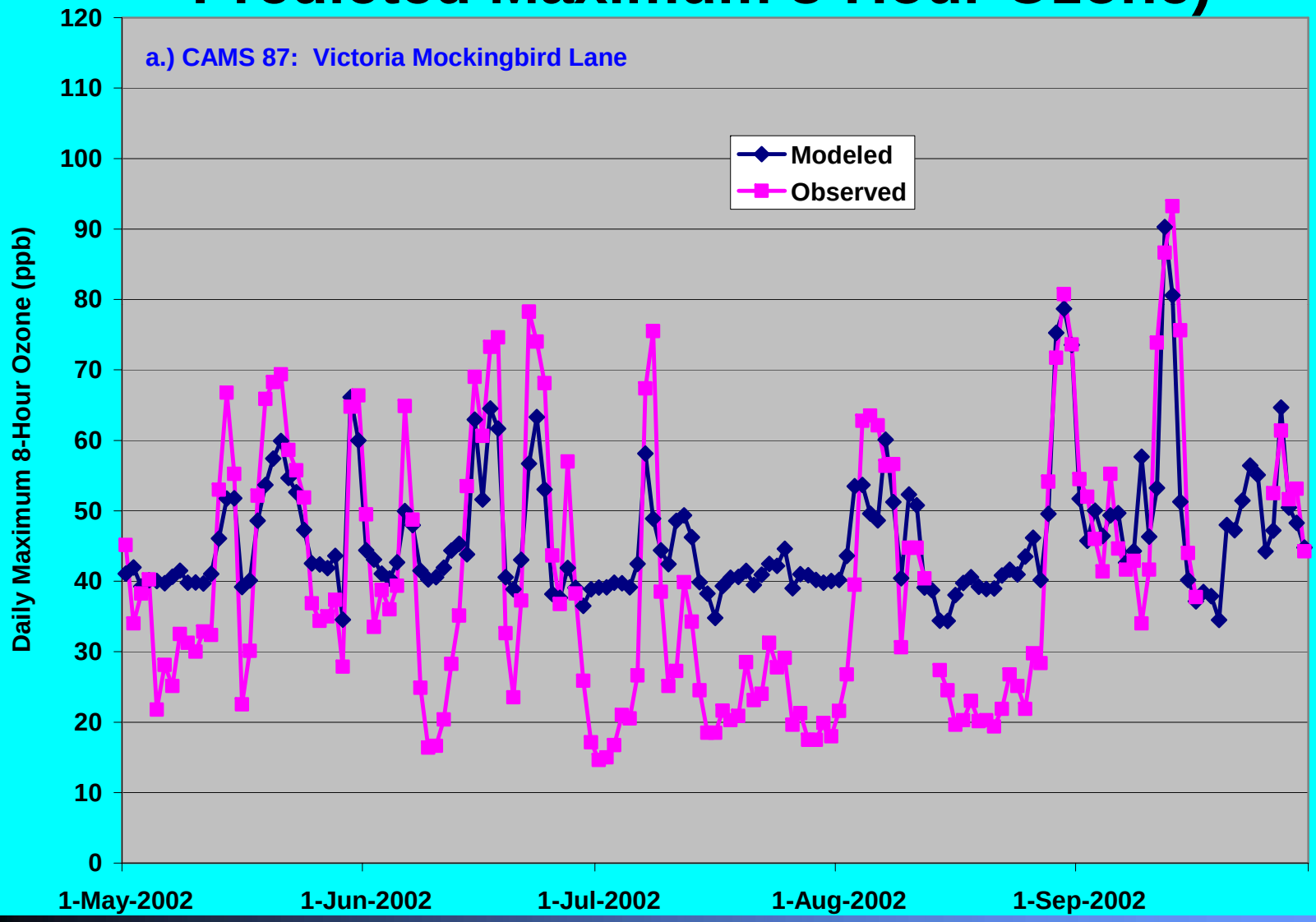
Error at NNA Monitors for (1) One-Hour Ozone >= 60 ppb and (2) Daily Peak 8-Hour >= 60 ppb



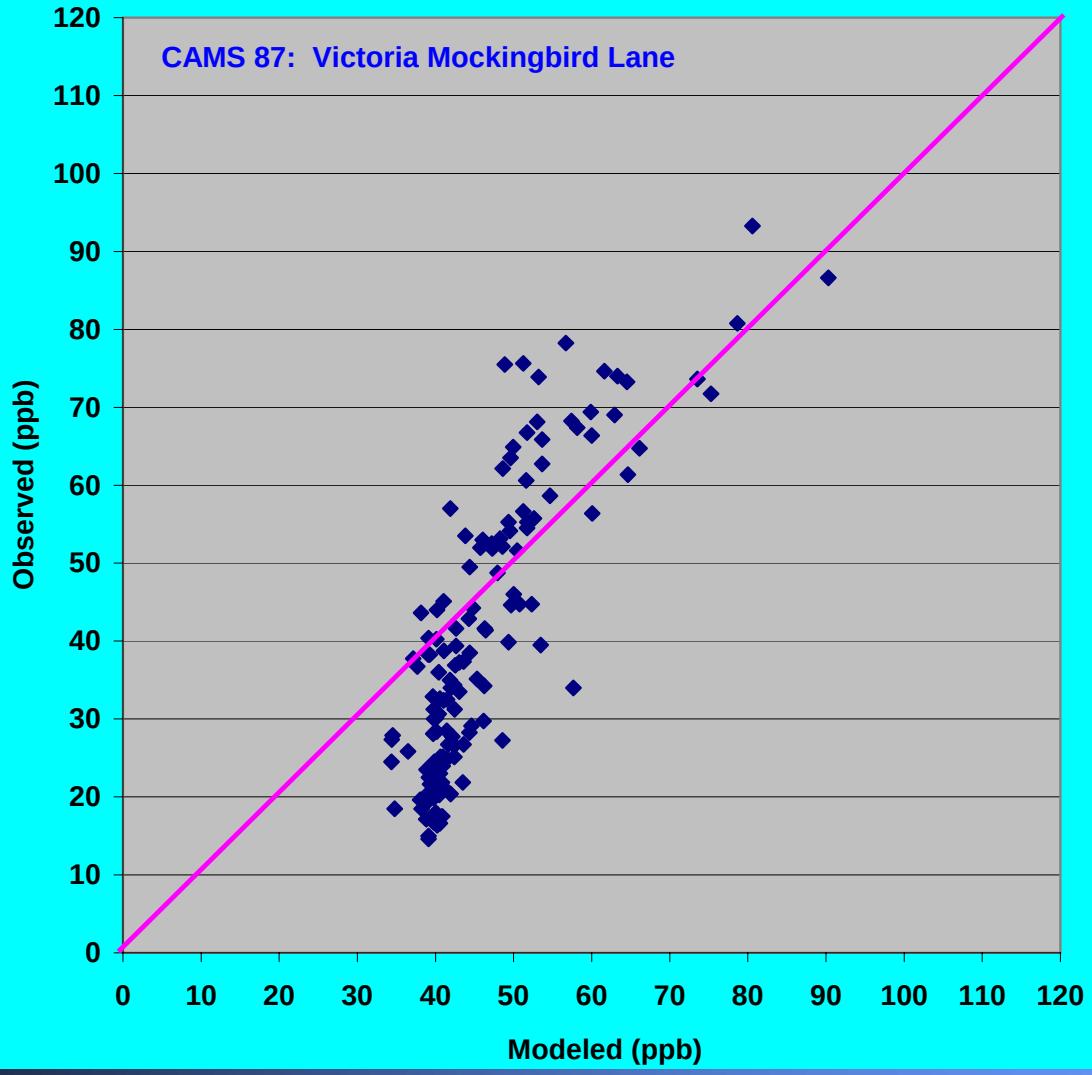
Graphical Analyses

- (1) Time series of daily observed and predicted 8-hour maximum ozone concentrations May – Sept.
- (2) Scatterplot of daily observed and predicted 8-hour maximum ozone concentrations May – Sept.

CAMS 87 Time Series (Daily Observed and Predicted Maximum 8-Hour Ozone)



CAMS 87 Scatterplot (Daily Observed and Predicted Maximum 8-Hour Ozone)



Summary of Performance Evaluation Results (Victoria and Corpus Christi)

- Over-prediction on low ozone (< 40 ppb) days
  - Observed lowest daily maximum ozone concentrations are often 20-30 ppb but the model predicts 40 ppb.
  - The over-prediction on low ozone days is likely associated with the southern boundary condition used in the seasonal model of 40 ppb. This default value should be replaced by measured values.

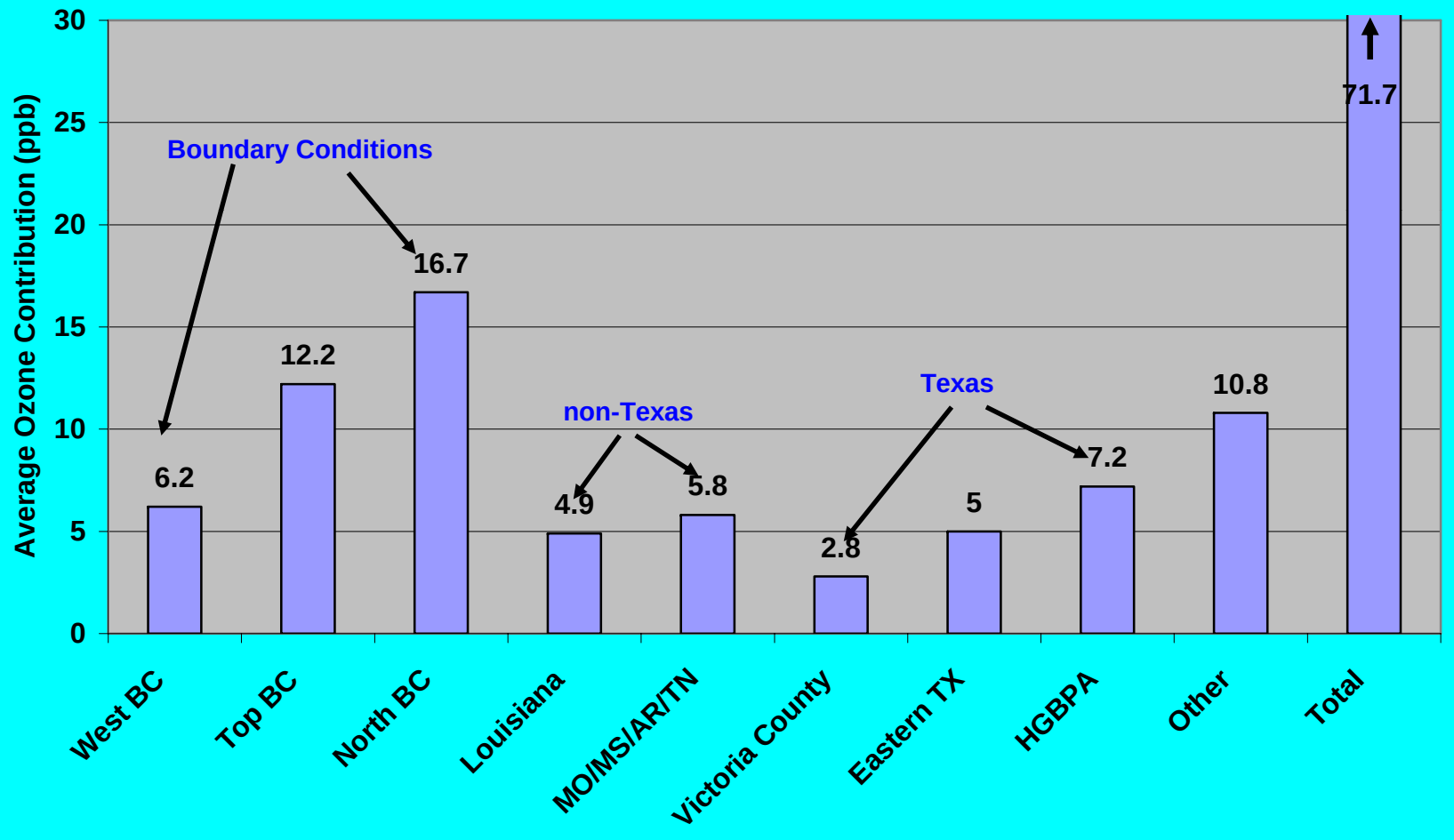
Summary of Performance Evaluation Results (Victoria and Corpus Christi) -- Continued

- Under-prediction on high ozone (> 60 ppb) days
  - 8-Hour Peak Bias
    - CAMS 87: -14.3%,
    - Rabbit Run: -11.8%,
    - Corpus Christi West: -15.6%,
    - Tuloso: -18.7%
- May – July characterized by larger under-prediction compared to Aug – Sep in both Victoria and Corpus Christi. For example, at CAMS 87:
  - Early summer Bias is -17.8%
  - Late summer Bias is -9.6%

Using APCA to Study Ozone Transport

- APCA is a variation of Ozone Source Apportionment Technology (OSAT) and provides a method for estimating contributions to ozone concentrations from source groups within and outside a receptor region of interest.
  - APCA uses ozone reaction tracers to track ozone precursor emissions of VOC and NOx as well as ozone formed from these emissions.
  - APCA assigns ozone source contributions to either VOC or NOx.
  - APCA assigns tracers to biogenic emission sources only resulting from the interaction of biogenic VOC with biogenic NOx. Compared to OSAT, APCA results are more relevant to the design of emissions control strategies.

Average Victoria County APCA Ozone Contributions using the September 15 – 20, 1999 Episode

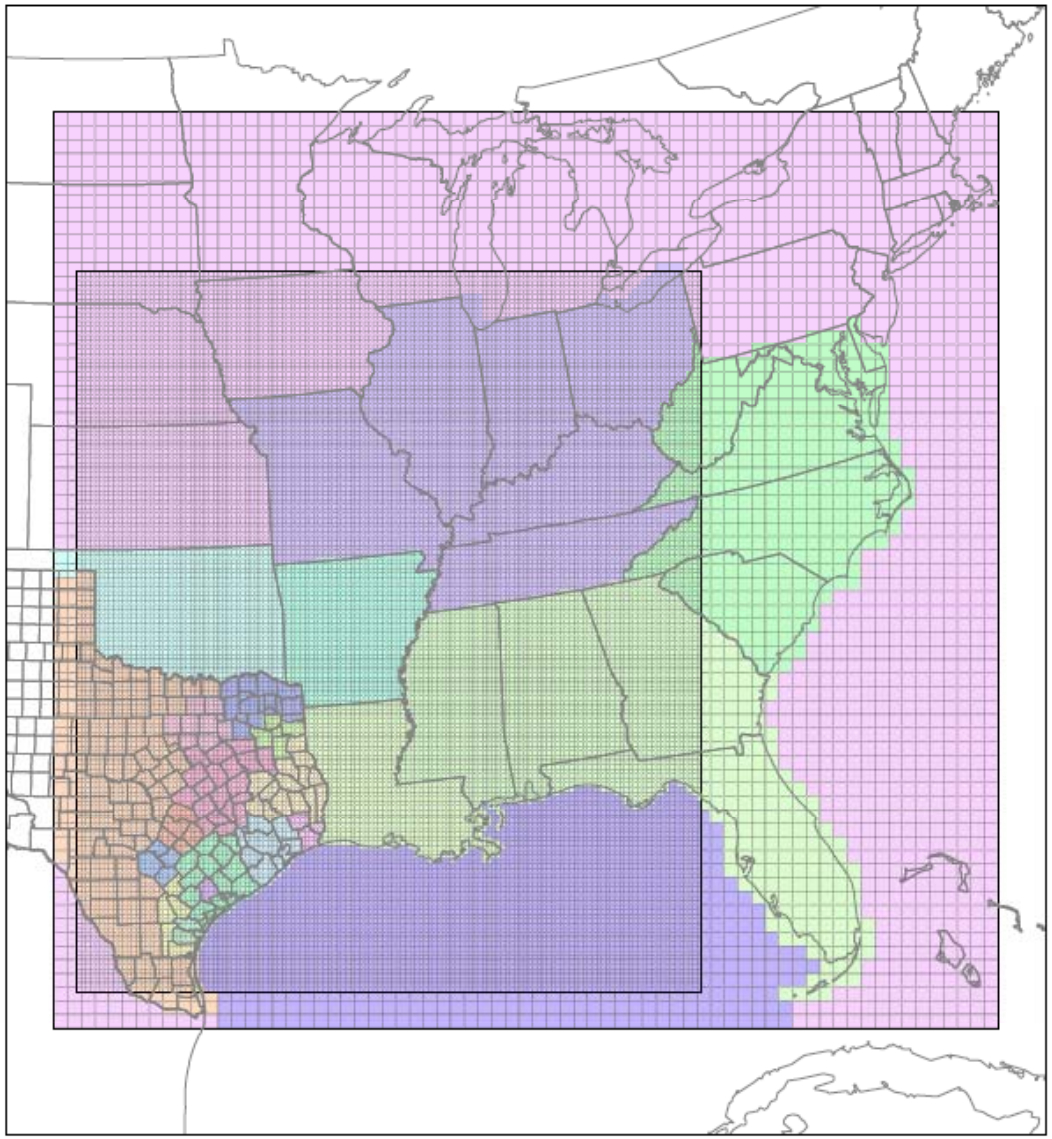


Work In-Progress
APCA Seasonal Modeling

One of the primary goals of the seasonal model is to investigate the role of ozone transport on Victoria air quality.

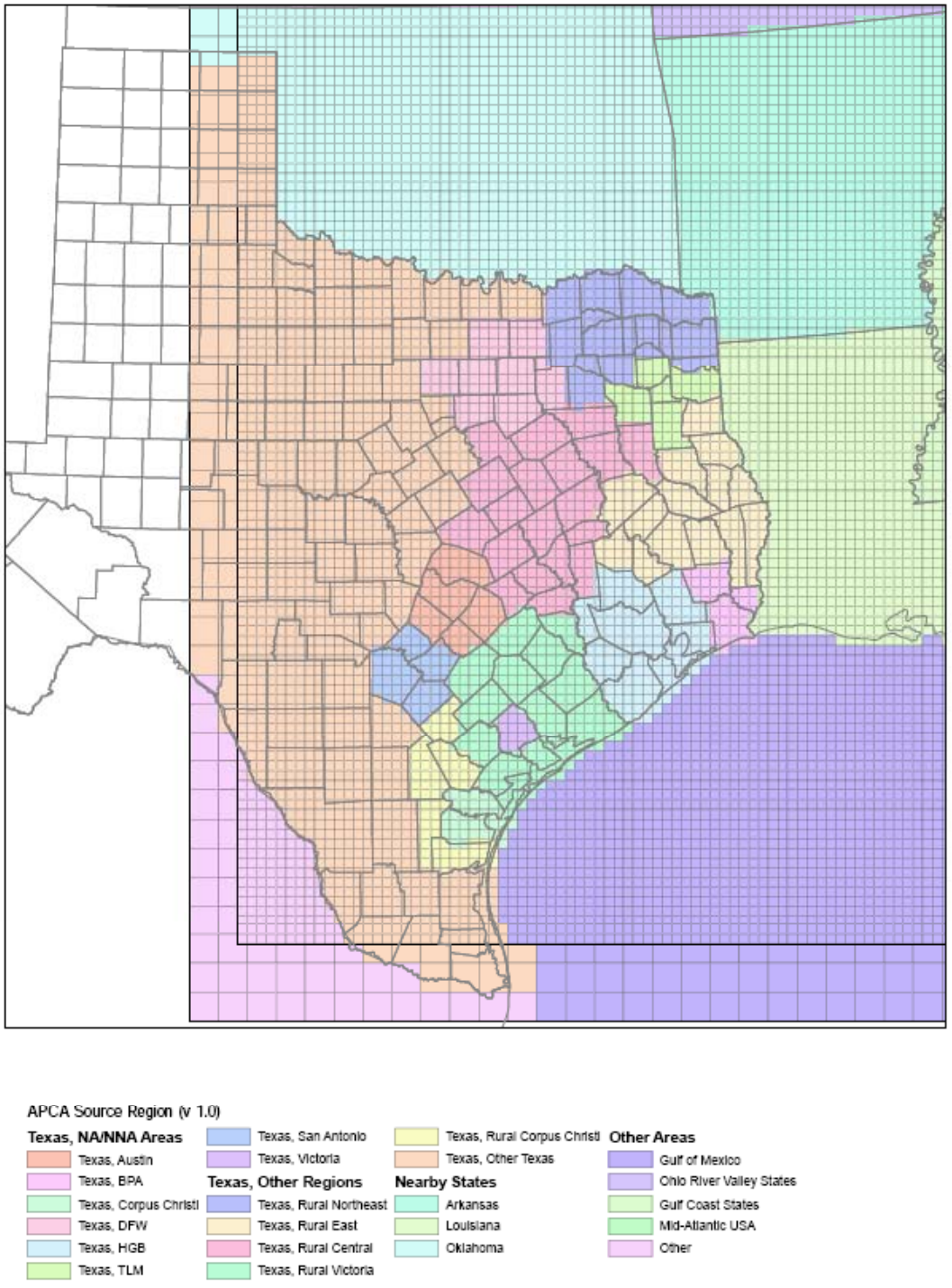
APCA Source Groups:

- Initial conditions (1 group)
- Boundary conditions (5 groups)
  - Each lateral boundary North, East, South, and West
  - Top boundary
- 8 Non-Texas Geographic Regions
- 8 Texas NA/NNA Areas
- 6 Other Texas Regions
- 28 Source Groups Above
  - Each individual source group further tracked by:
    - Anthropogenic or Biogenic
    - VOC or NOx



APCA Geographic Source Areas

8 Texas NNA/NA Areas
6 Other Texas Areas
Louisiana
Arkansas
Oklahoma
Gulf Coast States
Ohio River Valley
mid-Atlantic States
Gulf of Mexico
Other



APCA Texas Regions

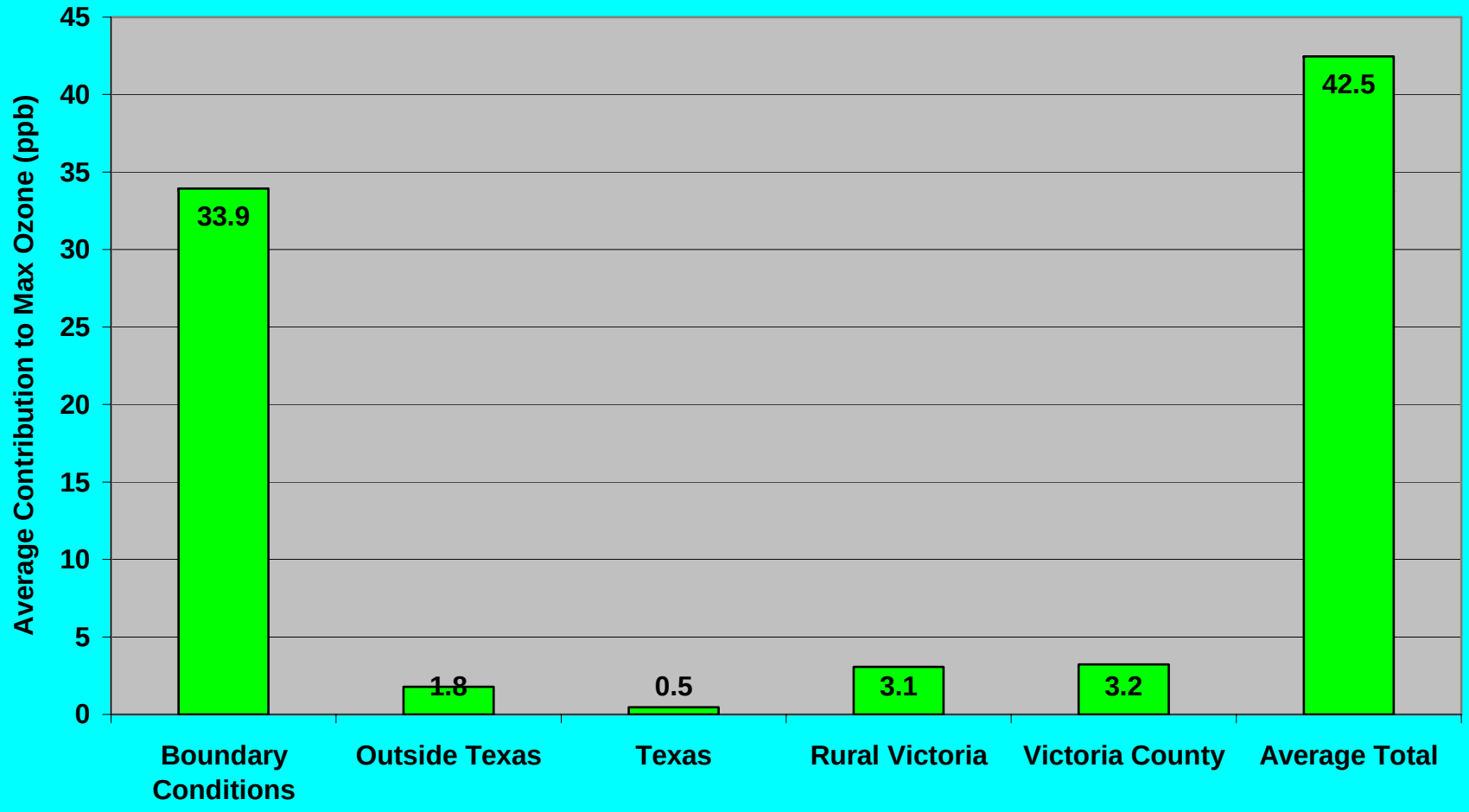
Ozone NA Areas
HGB, DFW, BPA

Ozone NNA Areas
Victoria, Corpus Christi, Austin, San Antonio

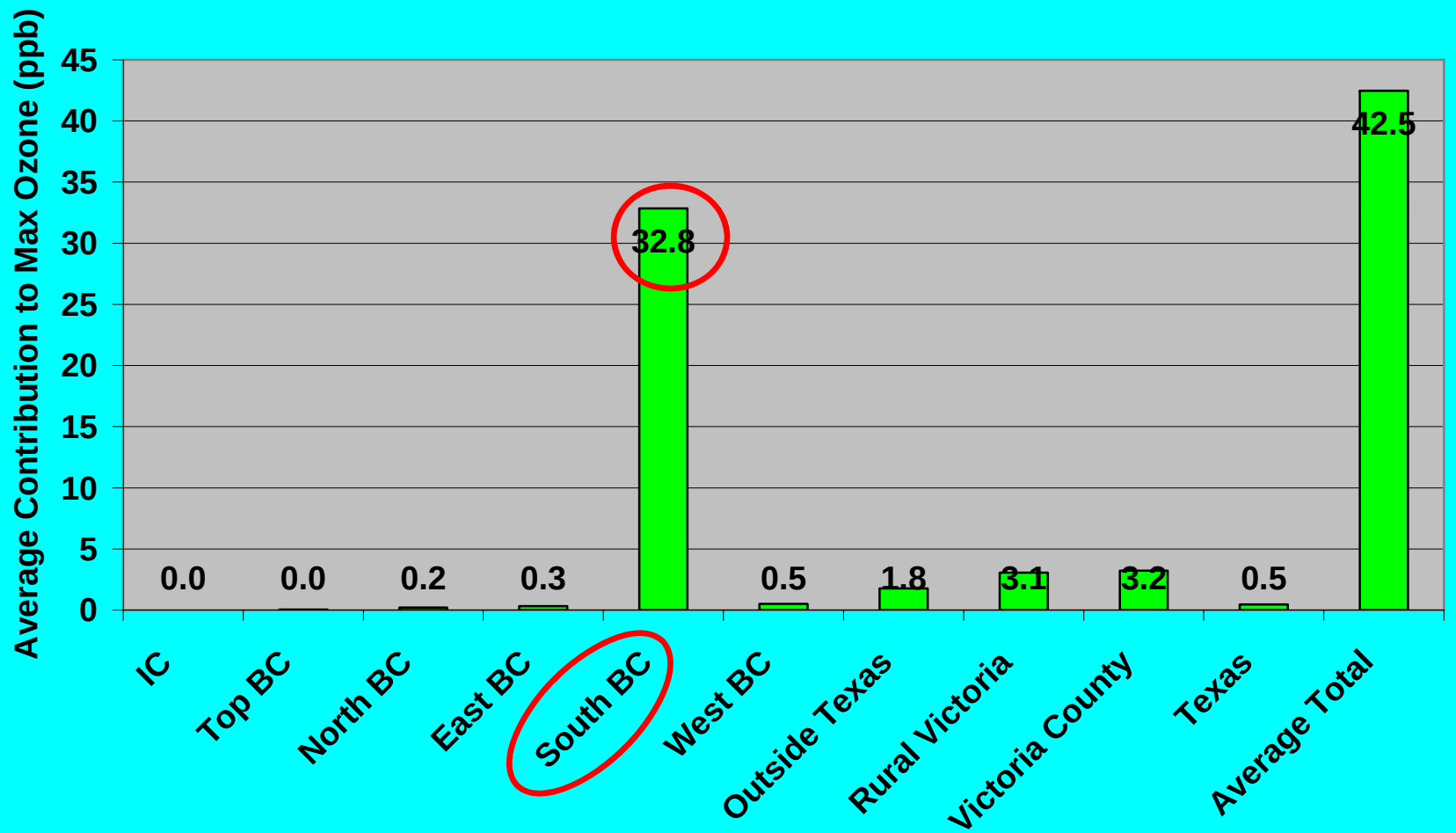
5 East Texas Rural Regions
Northeast, East, Central, Victoria, Corpus Christi

All Other Texas

Preliminary Victoria County Results -- Average ozone contributions by broad APCA category for low ozone days



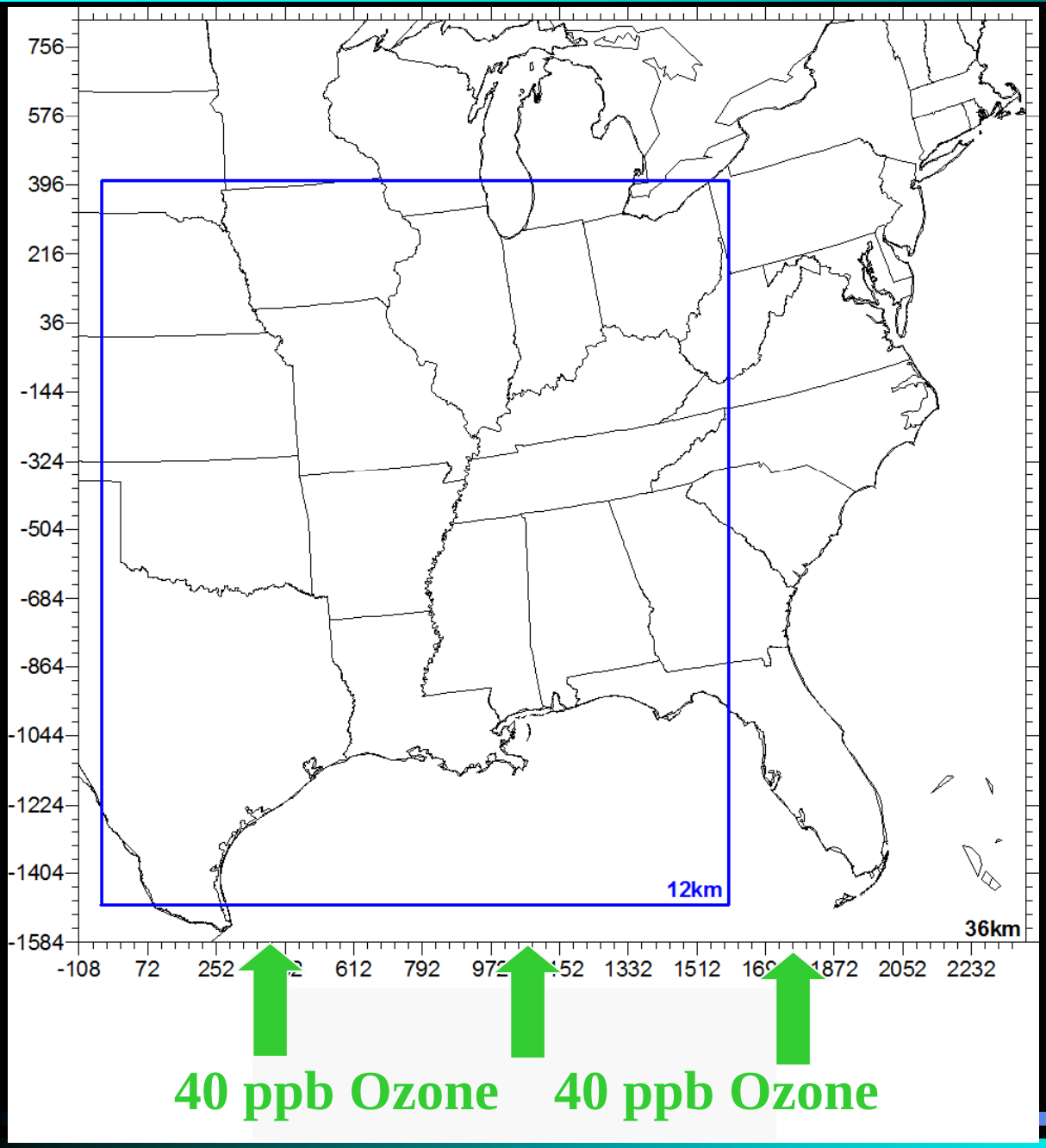
Preliminary Victoria County Results -- Average ozone contributions by detailed boundary condition category for low ozone days



APCA Results on Low Ozone Days

- Rural Victoria and Victoria contribute 7.3% and 7.5%, respectively, to Victoria County ozone.
- Victoria County ozone dominated by contribution from southern boundary condition (77%).

Low ozone days in Victoria most often occur during periods characterized by deep southerly to southeasterly near-surface flow associated with transport of relatively clean maritime air from the Gulf of Mexico into Texas.



During southerly flow, 40 ppb ozone transported northward along southern grid boundary.

APCA Results on Low Ozone Days (continued)

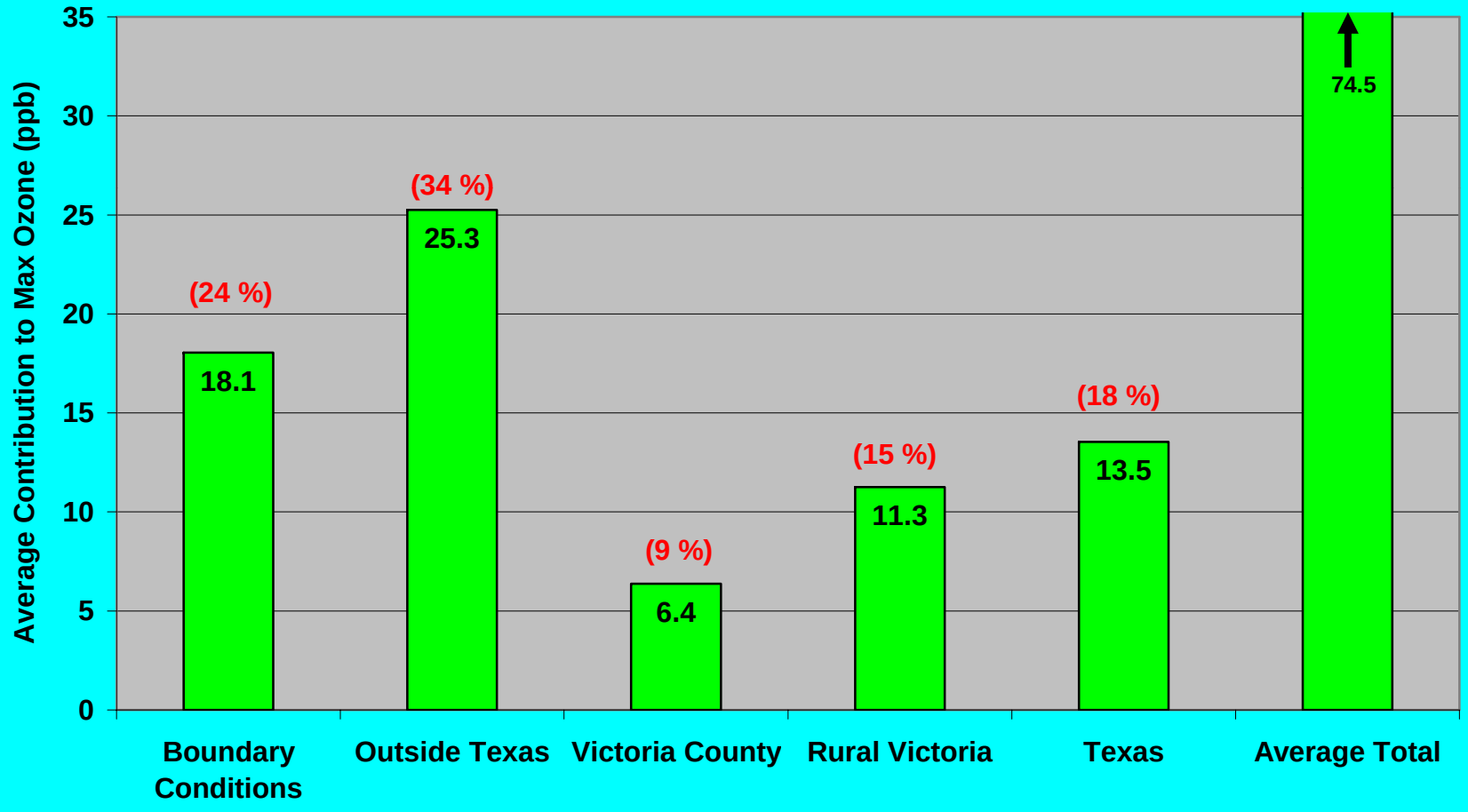
In the model, the simulated ozone concentrations during onshore (low background ozone) flow patterns are likely dominated by the southern grid boundary condition of 40 ppb.

- The relatively greater simulated near-surface ozone concentrations compared to the observed values suggests that the assumed value of 40 ppb is too high during low ozone events and should be replaced by actual measured values.

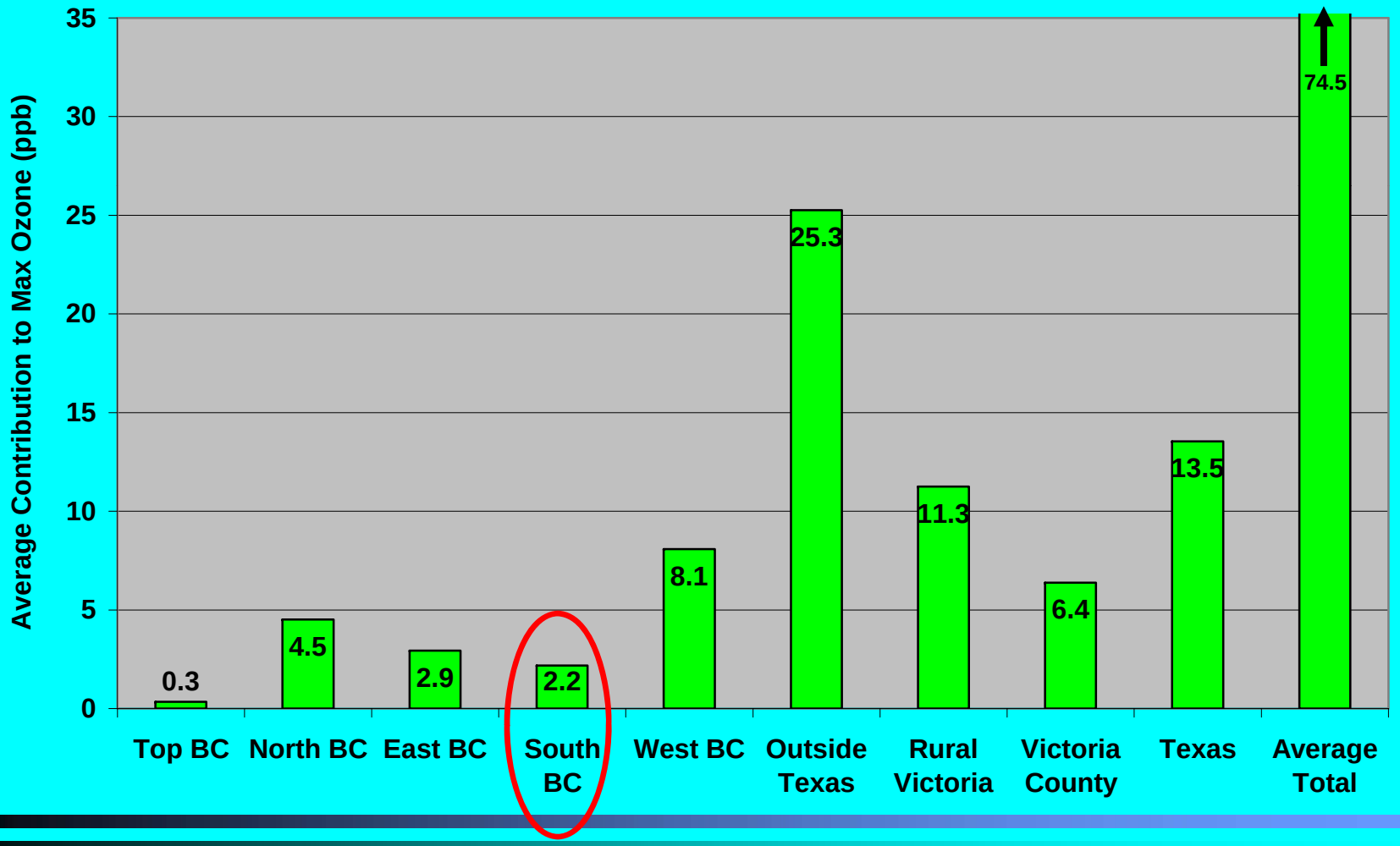
Preliminary APCA Results for High Ozone Days (in-progress work)

- Analyze results using the daily maximum 8-hour ozone concentrations in Victoria County during May – Sep 2002.
- For each day, choose the 12km grid cell in Victoria County with the maximum 8-hour ozone concentration.
- High ozone days are defined by max 8-hour concentration >= 65 ppb.
  - 14 total high ozone days (1 May days, 3 June days, 1 July days, 4 August days, and 5 September days)

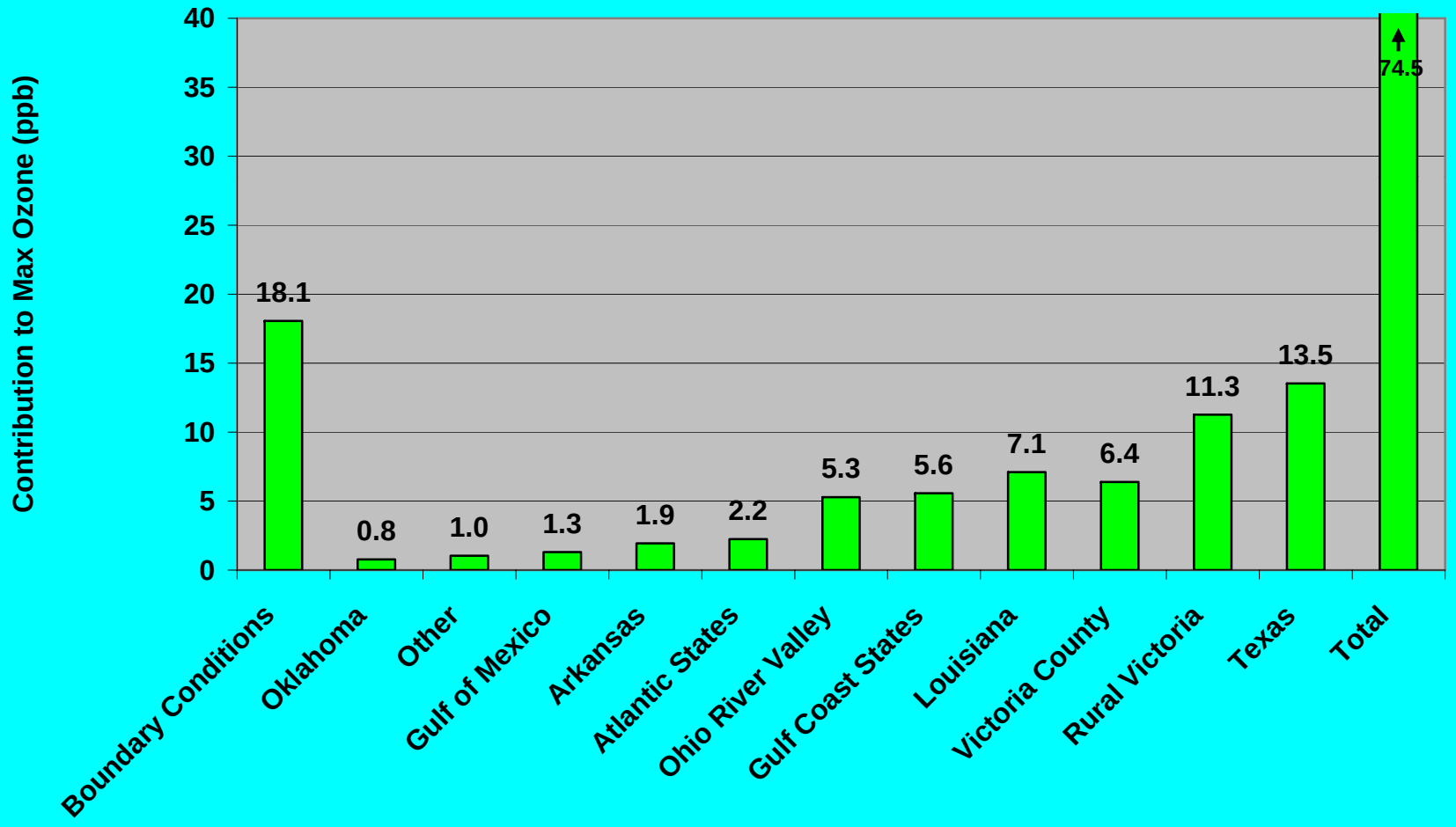
Preliminary Victoria County Results -- Average ozone contributions by broad APCA category for high ozone days



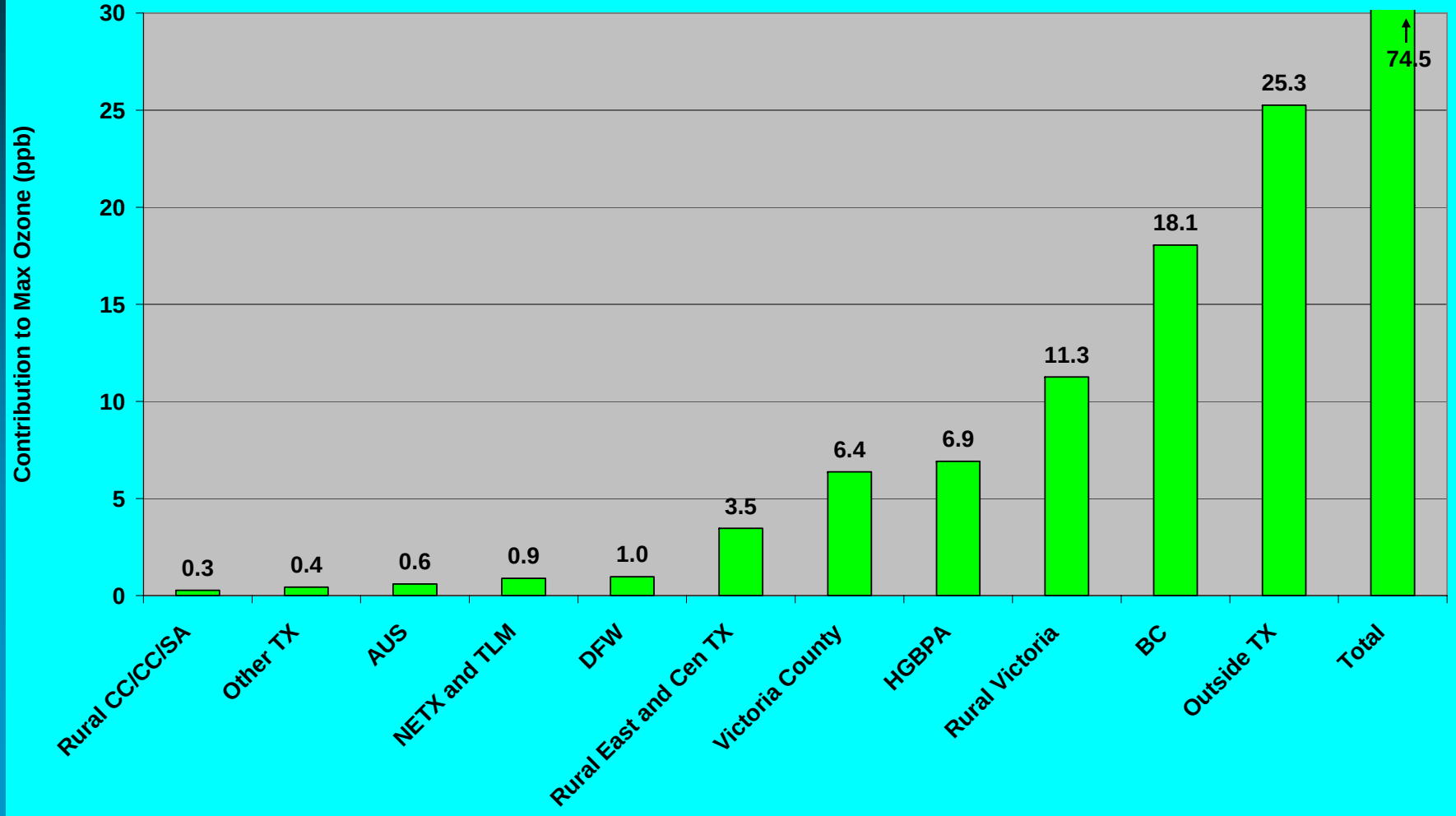
Preliminary Victoria County Results -- Average ozone contributions by detailed boundary conditions for high ozone days



Preliminary Victoria County Results -- Average ozone contributions by detailed non-Texas regions for high ozone days



Preliminary Victoria County Results -- Average ozone contributions by detailed Texas regions for high ozone days



Next Steps (APCA analyses)

- Quality Assurance.
- Investigate day-to-day variability on high ozone days.
- Characterize contributions from source groups as anthropogenic vs. biogenic and NOx-limited vs. VOC-limited.
  - Initial results for the geographic source groups demonstrate all sources are dominated by ozone associated with anthropogenic NOx emissions.