Victoria Ozone Trends

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National Ambient Air Quality Standard (NAAQS) for Ozone

- Previous (established 1997) primary and secondary NAAQS for ozone concentrations averaged over 8 hours was 0.08 parts per million (ppm).
  - Due to rounding, standard was effectively 85 ppb.
- On March 17, 2008, EPA revised the primary NAAQS for ozone concentrations averaged over 8 hours to 0.075 ppm (75 ppb). The secondary standard was set at a form and level identical to the primary standard.

Implementation Schedule for the Revised Ozone NAAQS

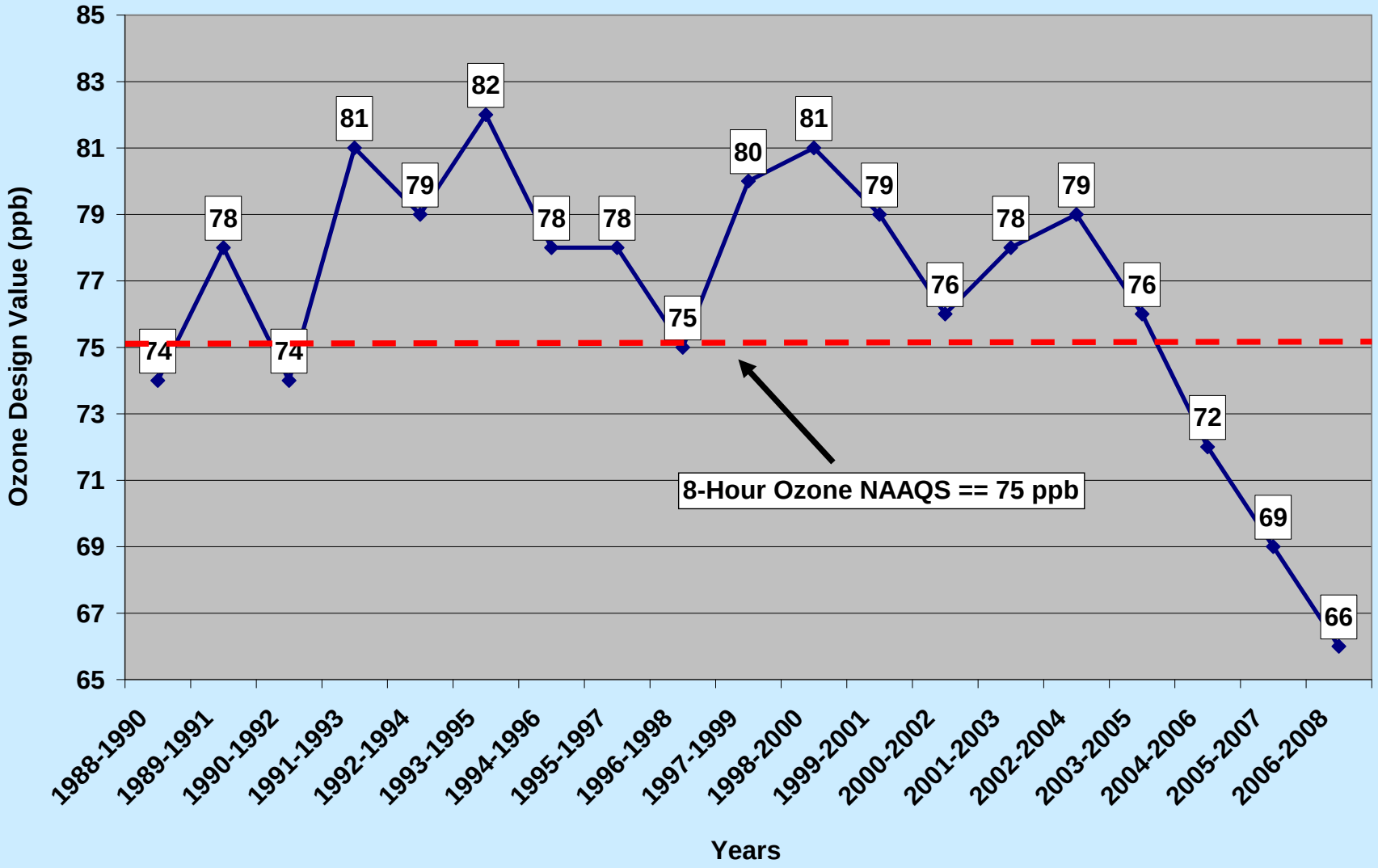
- EPA requires States to make designation recommendations no later than March 2009.
  - Designations to be based on monitoring during 2006 - 2008
- EPA will issue final designations no later than March 2010.
  - In cases of insufficient data, EPA will issue final designations no later than March 2011.
- If EPA issues designations in 2010, States must submit SIPs outlining how they will reduce pollution to meet the revised ozone NAAQS no later than 2013.
  - EPA will establish the attainment dates in a separate rule.

Ozone Design Values for 2006 – 2008 for Selected Texas Metropolitan Areas

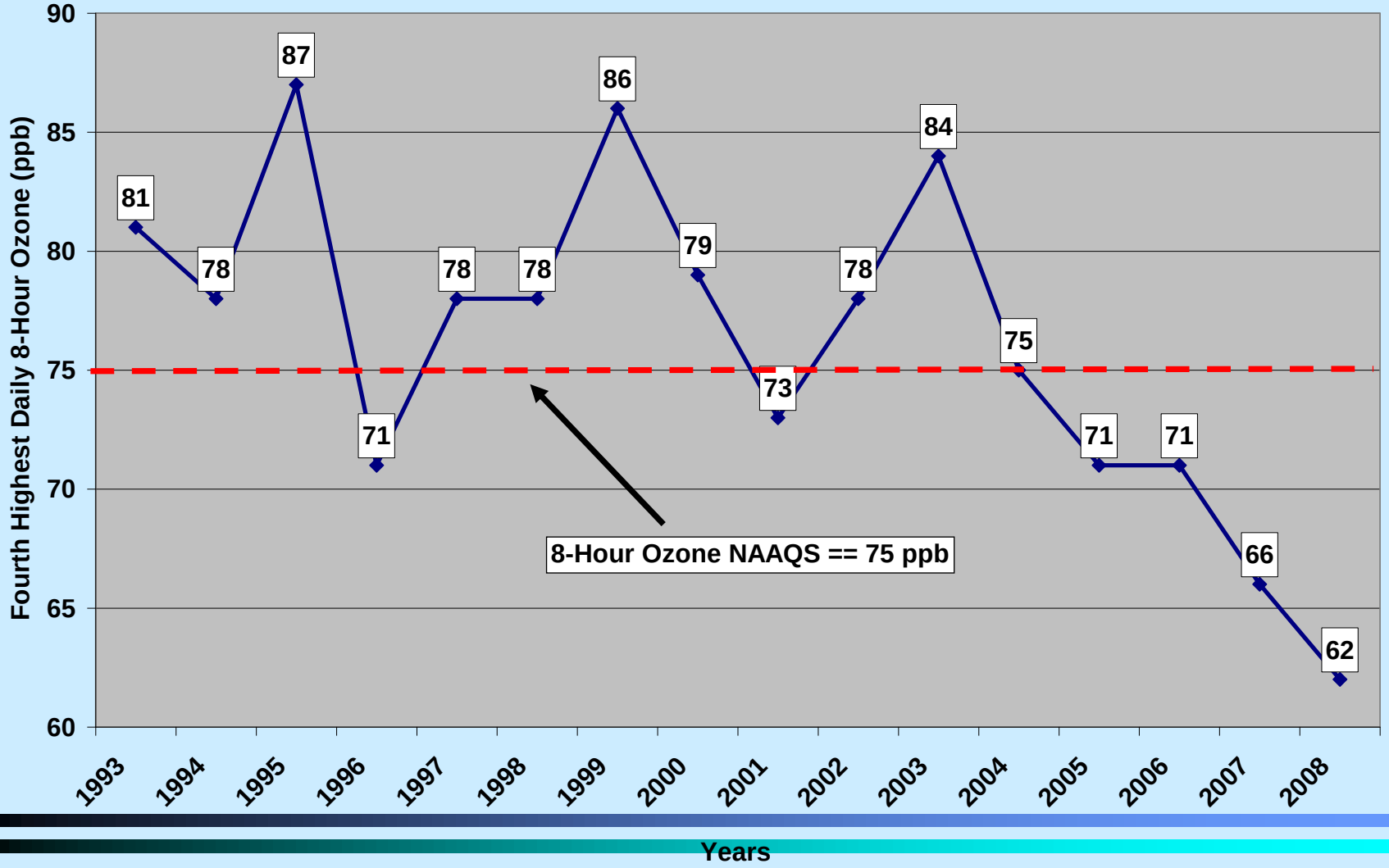
- DFW: 91 ppb
- HGB: 91 ppb
- BPA: 81 ppb
- TLM: 78 ppb
- El Paso: 78 ppb
- SA: 78 ppb
- AUS: 77 ppb
- CC: 71 ppb
- VCT: 66 ppb

- Source: http://www.tceq.state.tx.us/cgi-bin/compliance/monops/8hr_attainment.pl

8-Hour Ozone Design Values at CAMS 87
Years 1990 - 2008



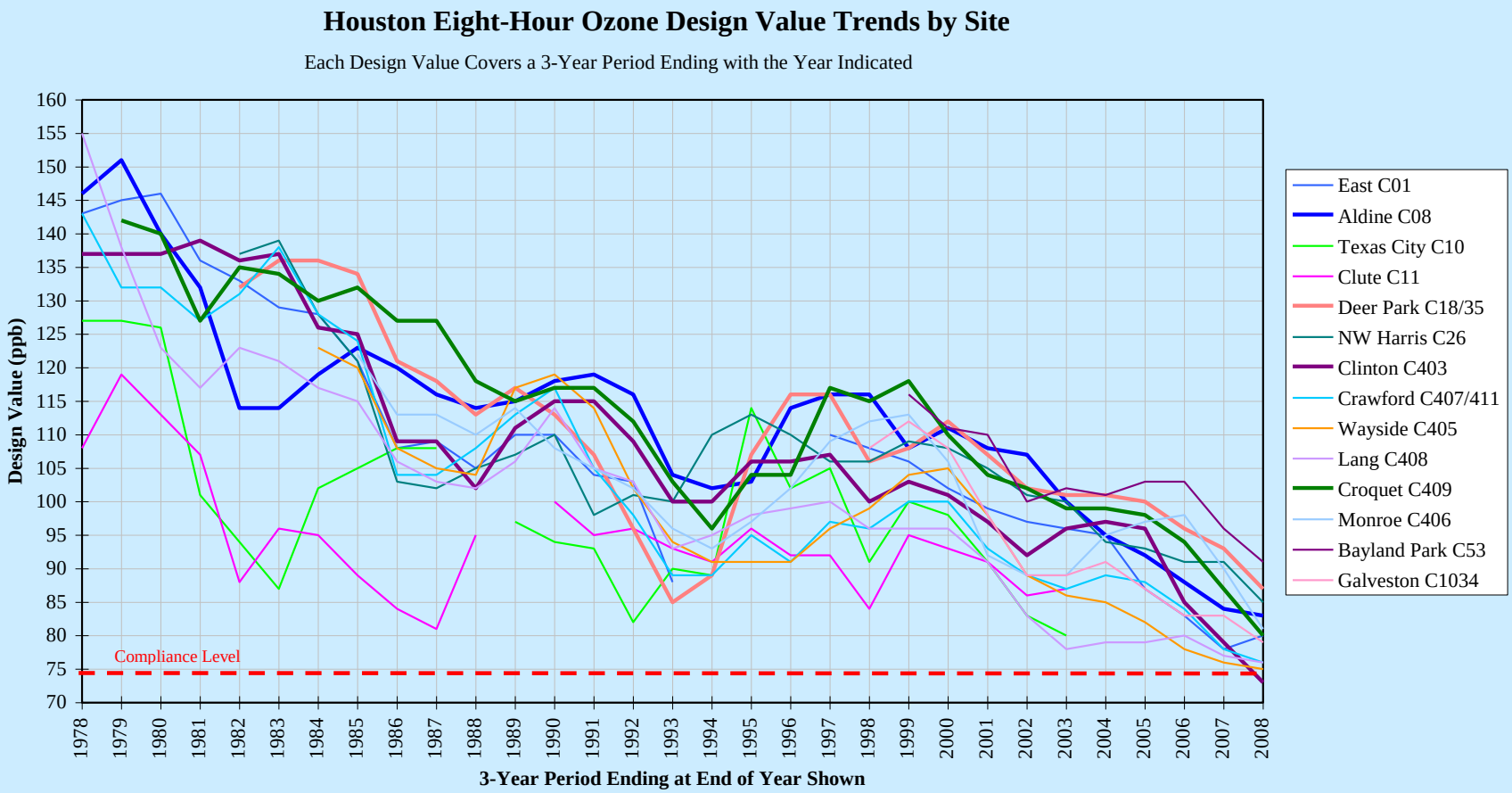
Annual Fourth Highest Daily 8-Hour Ozone Concentration at CAMS 87 Years 1993 - 2008



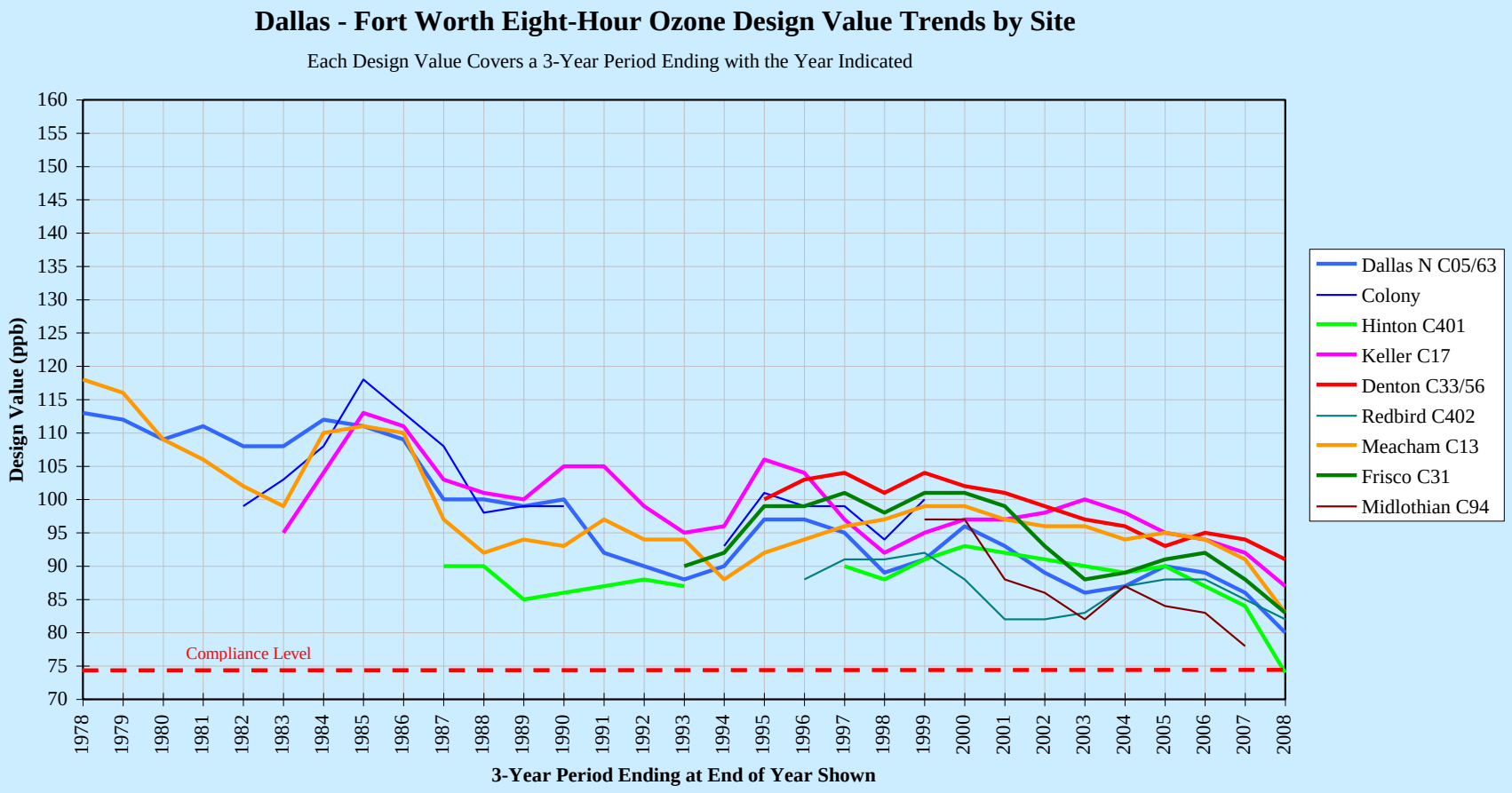
Why the Recent Downward Trend in Ozone Concentrations at CAMS 87?

- Potential Factors:
  - Unfavorable meteorological conditions for ozone formation
  - Decreased background concentrations
  - Decreased ozone formation associated with local source emissions
  - Combination of above?

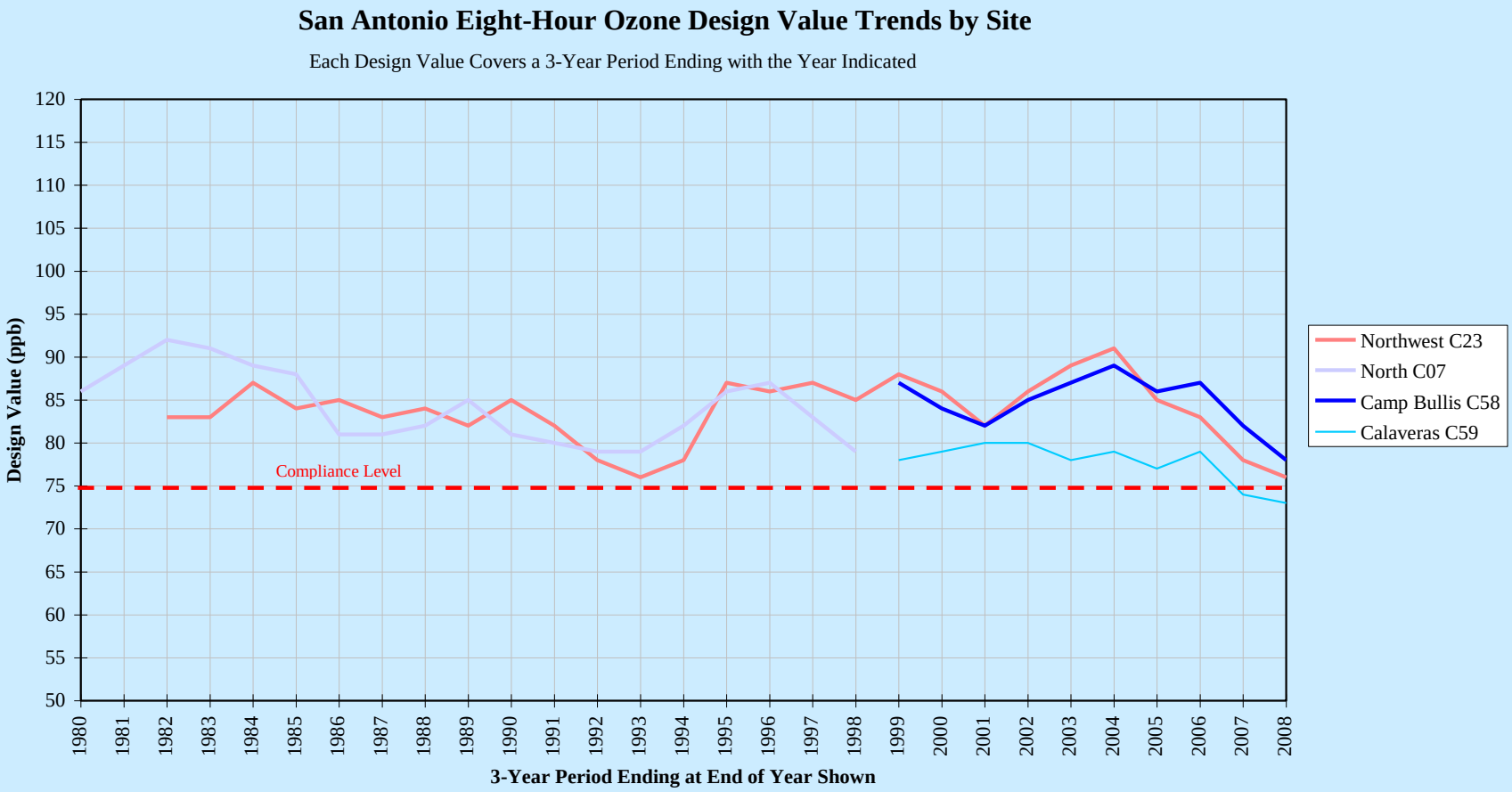
Design Value Trends at HGB Monitoring Stations



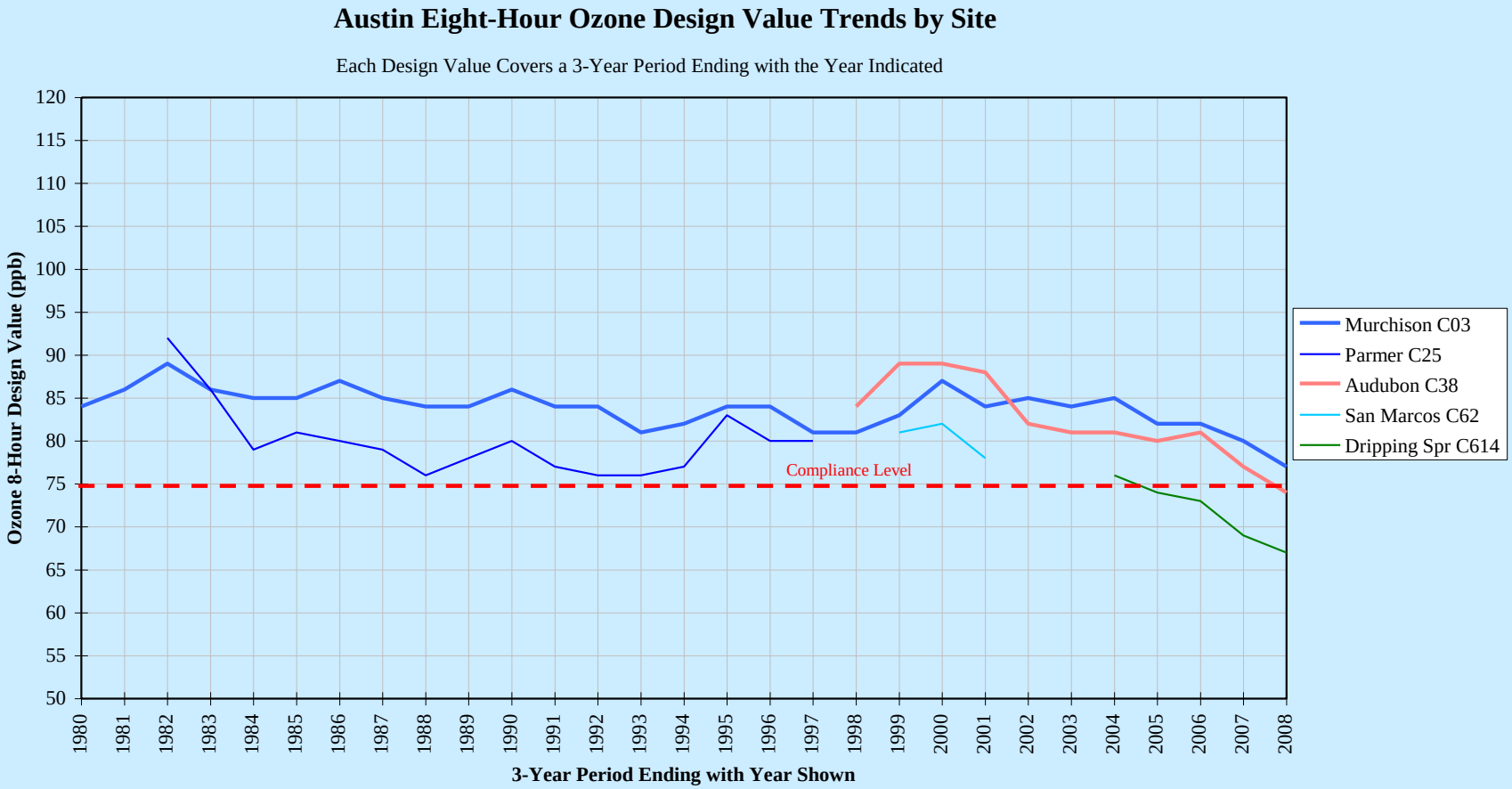
Design Value Trends at DFW Monitoring Stations



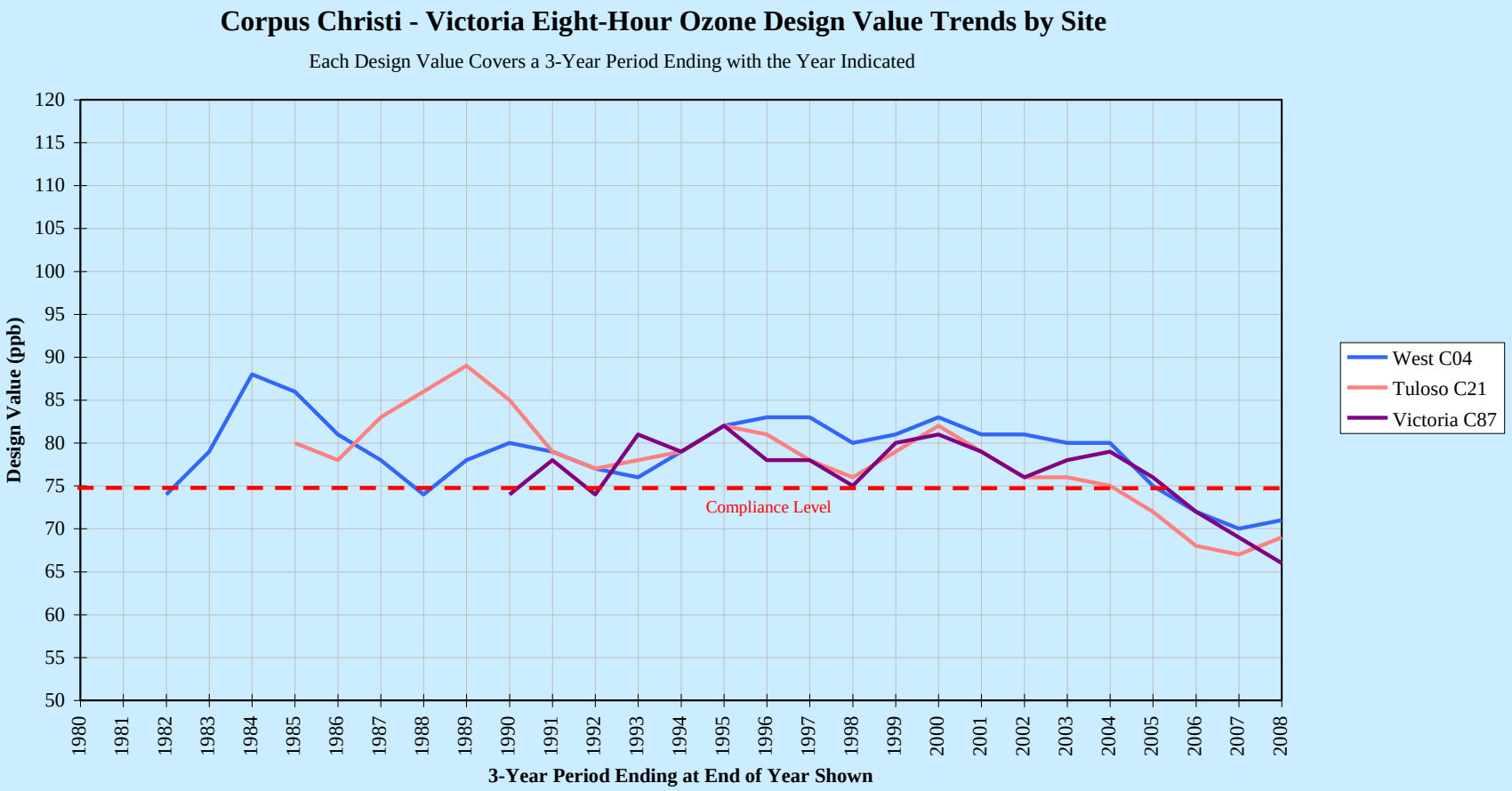
Design Value Trends at SA Monitoring Stations



Design Value Trends at AUS Monitoring Stations



Design Value Trends at CC/VCT Monitoring Stations



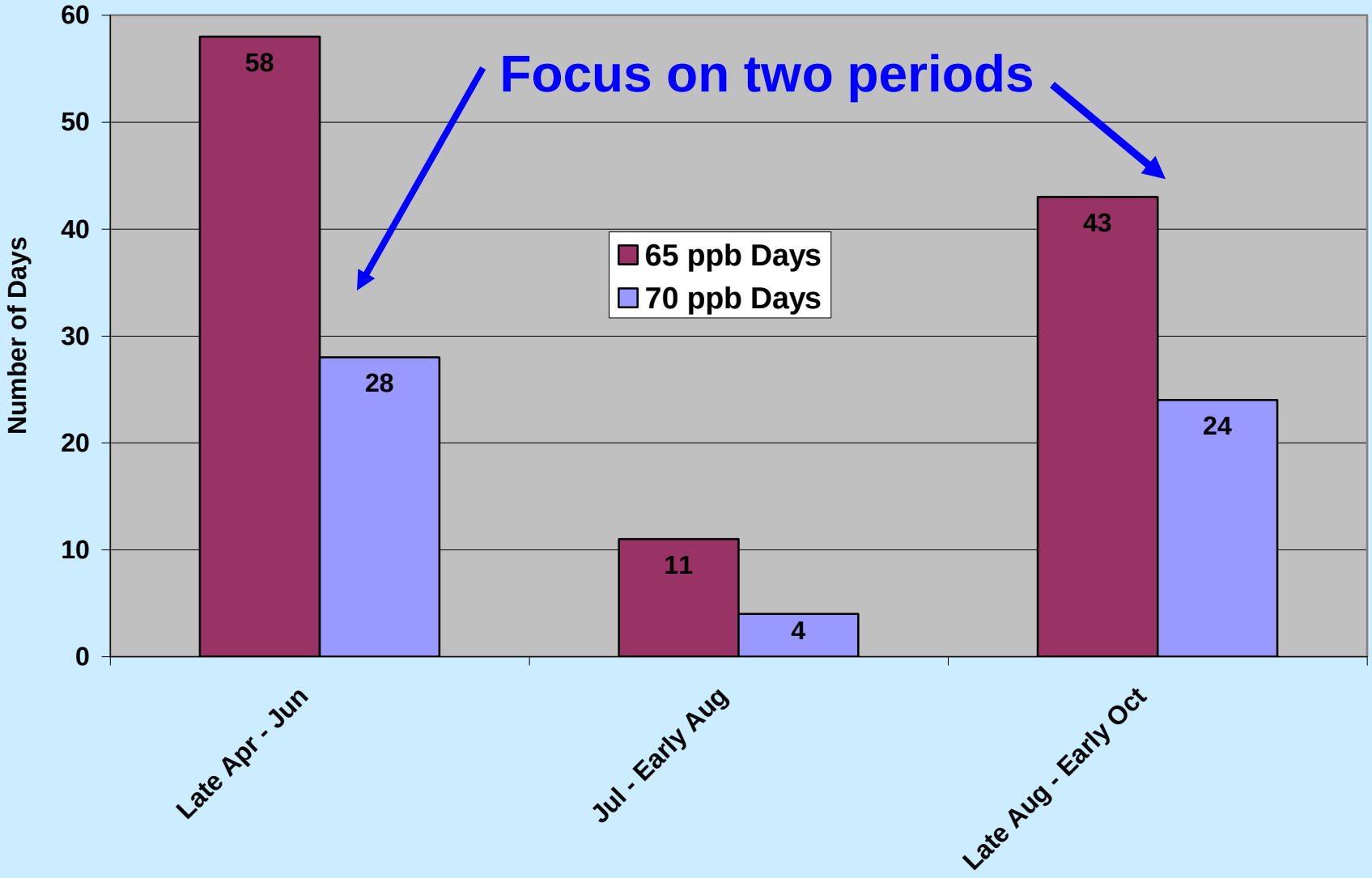
Ozone Trends in Texas

- Design values have decreased over the past couple of years in most eastern Texas metropolitan areas.
- For most areas, 2008 was characterized by the lowest design values over the history of monitoring.
- The design values (3-year average) suggest that years 2007 and 2008 were relatively “clean” compared to previous years.

Goal for Remainder of Presentation

- Hypothesis: Meteorological conditions alone are sufficient to explain the recent decline in the number of high ozone days at CAMS 87.
- Method to test hypothesis:
  - Using the available surface and upper air meteorological observations during years 2001 - 2008, develop the criteria to define meteorologically favorable days for high ozone concentrations at CAMS 87.
  - High ozone days are defined as those days characterized by maximum 8-hour concentrations of 70 ppb or greater at CAMS 87.
  - Do the numbers of annual meteorologically favorable days and observed high ozone days correlate?

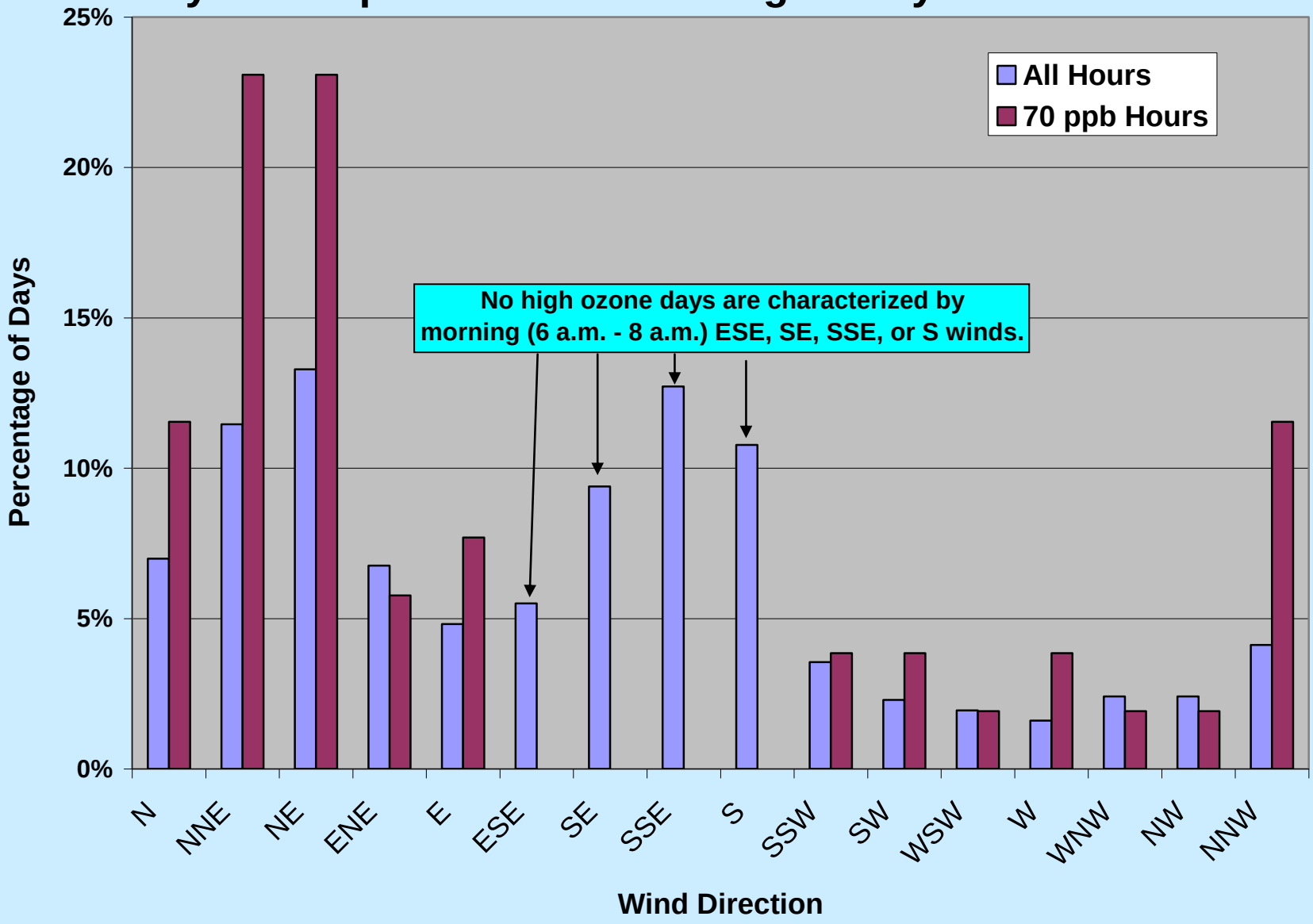
Number of High Ozone Days by Period at CAMS 87 Years 2001 - 2008



Surface Meteorological Measurements at CAMS 87 on 70 ppb days

- Daily maximum temperature ranges between 77 F and 95 F
  - 52 of 52 high ozone days meet this criteria.
- Daily minimum temperature ranges between 56 F and 78 F
  - 52 of 52 high ozone days meet this criteria.
- Daily average wind speed was 2.5 m/s or less.
  - 48 of 50 high ozone days meet this criteria. (Wind data missing at CAMS 87 for 2 of 52 days.)

Morning (6 a.m. – 8 a.m. CST) Surface WD at CAMS 87
All days late Apr – Jun and late Aug – early Oct: 2001 - 2008



Surface Meteorological Measurements at CAMS 87 on 70 ppb days (cont.)

- Morning resultant wind direction (6 a.m. – 8 a.m. CST) is NOT S, SSE, SE or ESE.
  - 52 of 52 high ozone days meet this criteria.
- Remove all rain days (as measured at Victoria Regional Airport NWS station).
- Other NWS surface-based parameters investigated but not used:
  - Cloud cover
  - Relative humidity
  - Sea level pressure

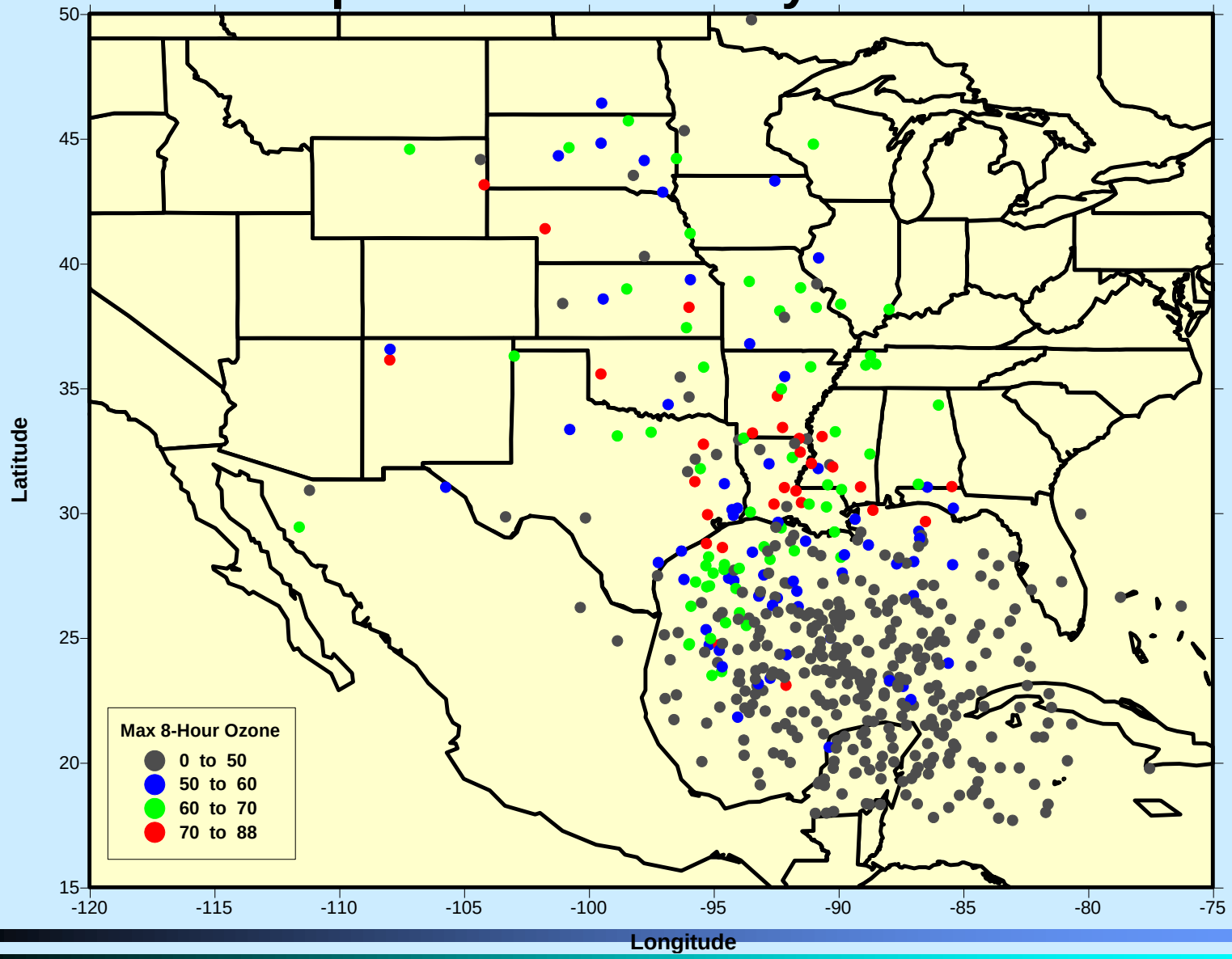
Upper Air Meteorological Measurements

- Investigated relationship between the daily maximum CAMS 87 ozone concentrations and twice-daily rawinsonde sounding data collected at the Lake Charles and Corpus Christi NWS stations.
  - No strong correlation with temperature or dewpoint
  - Most high ozone days were characterized by winds with a northerly component at 850 mb the previous evening.
  - Did not use rawinsonde data in favor of HYSPLIT results presented on next slides.

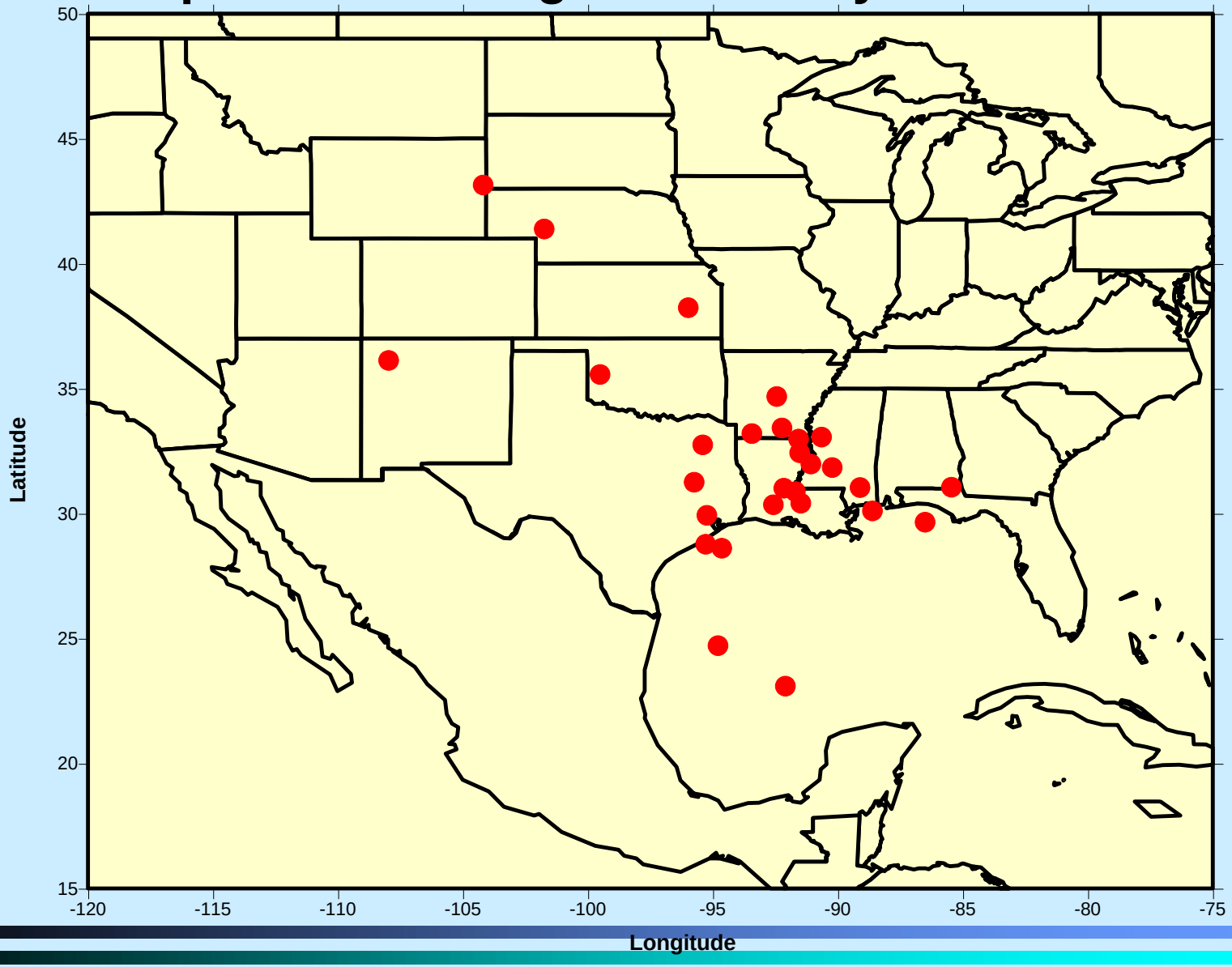
Regional Transport and Background Ozone

- We know background ozone transported into Victoria is important to measured ozone concentrations at CAMS 87.
  - Conceptual model
  - APCA modeling using September 1999 episode
- 48-Hour HYSPLIT back-trajectories were generated for each day during years 2001 – 2008 for the two distinct seasonal periods:
  - Late April – June
  - Late August – Early October
- The 48-hour HYSPLIT back-trajectory results were used to define the upwind geographic areas prior to high ozone events at CAMS 87.

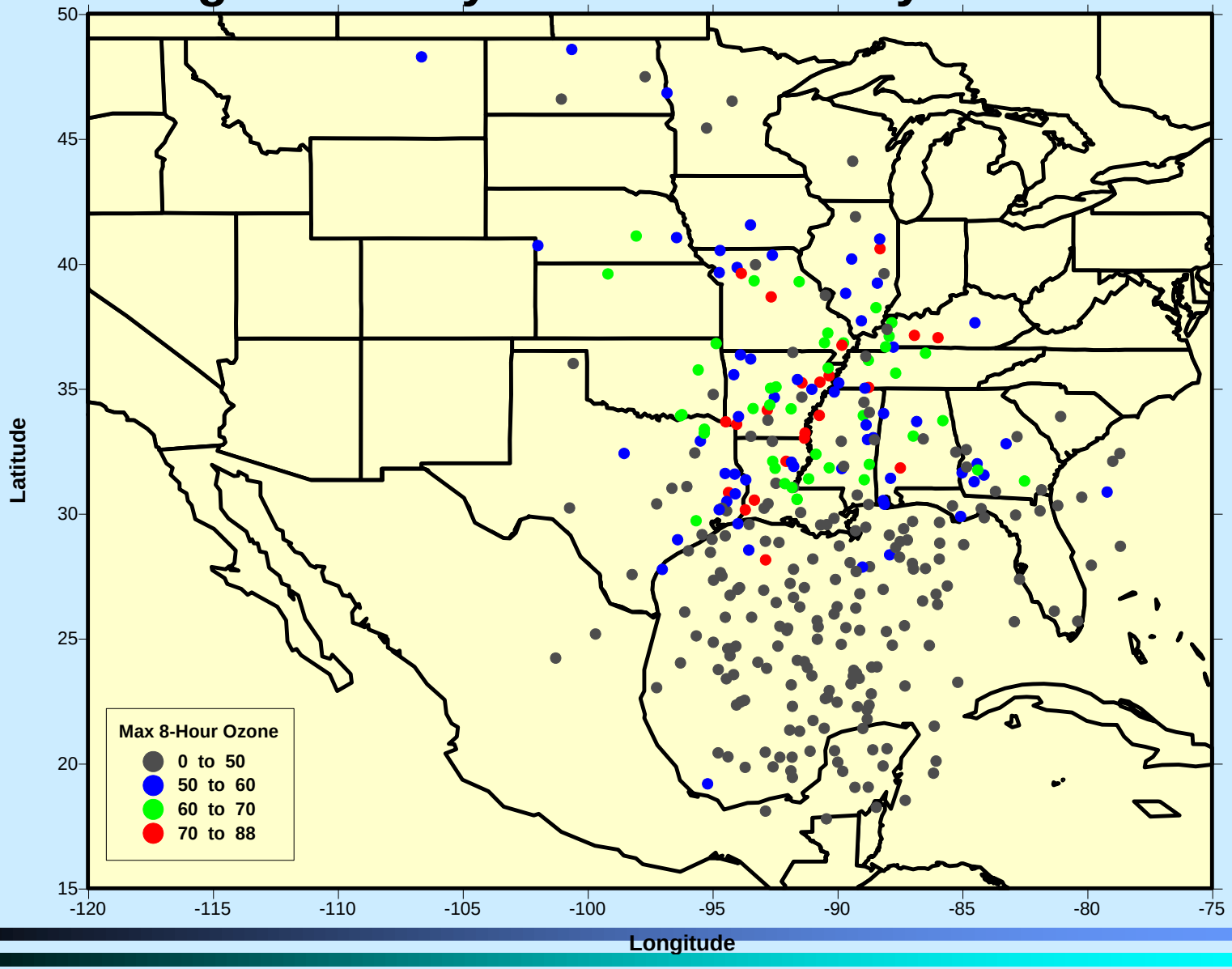
48-Hour Back-Trajectory Endpoints: Late April – June: All Days 2001 - 2008



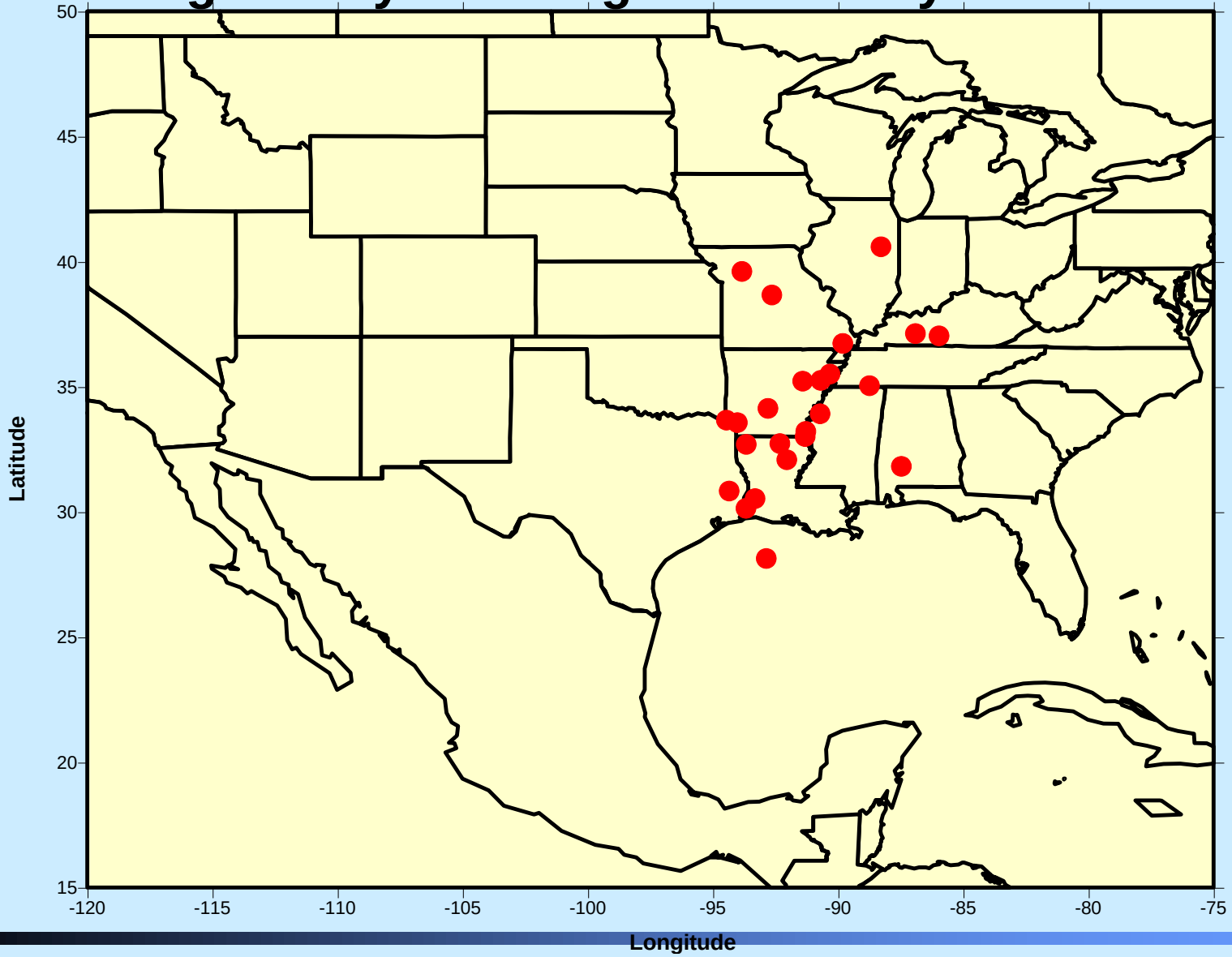
48-Hour Back-Trajectory Endpoints: Late April – June: High Ozone Days 2001 - 2008



48-Hour Back-Trajectory Endpoints:
Late August – Early October: All Days 2001 - 2008



48-Hour Back-Trajectory Endpoints: Late Aug – Early Oct: High Ozone Days 2001 - 2008



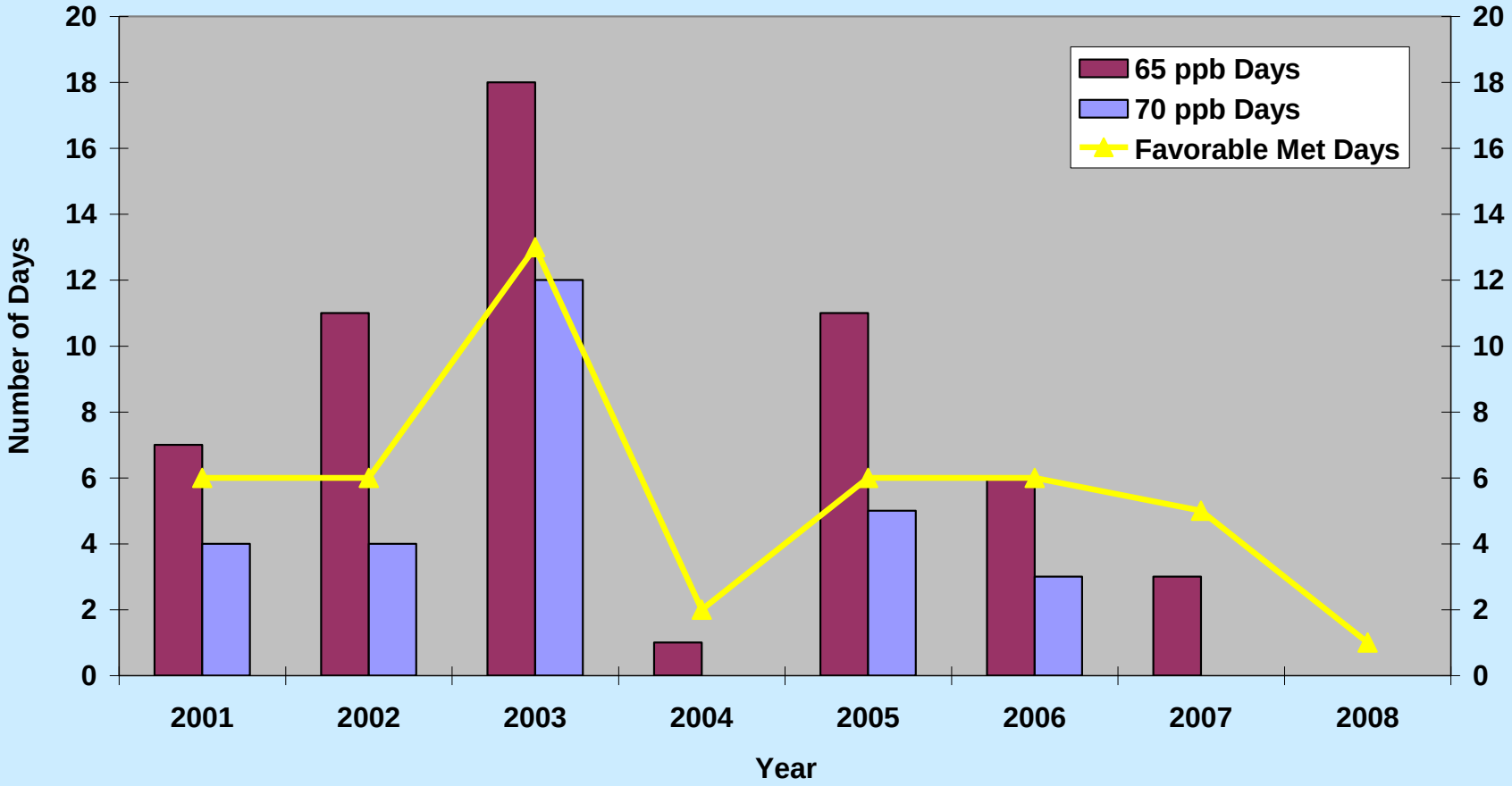
Upwind Geographic Areas

- Use the geographic footprint of 48-hour back-trajectory endpoints on 70 ppb ozone days to define the required upwind geographic areas prior to high ozone at CAMS 87.
- The upwind geographic areas are different between the late April – June and Late August – Early October high ozone periods.

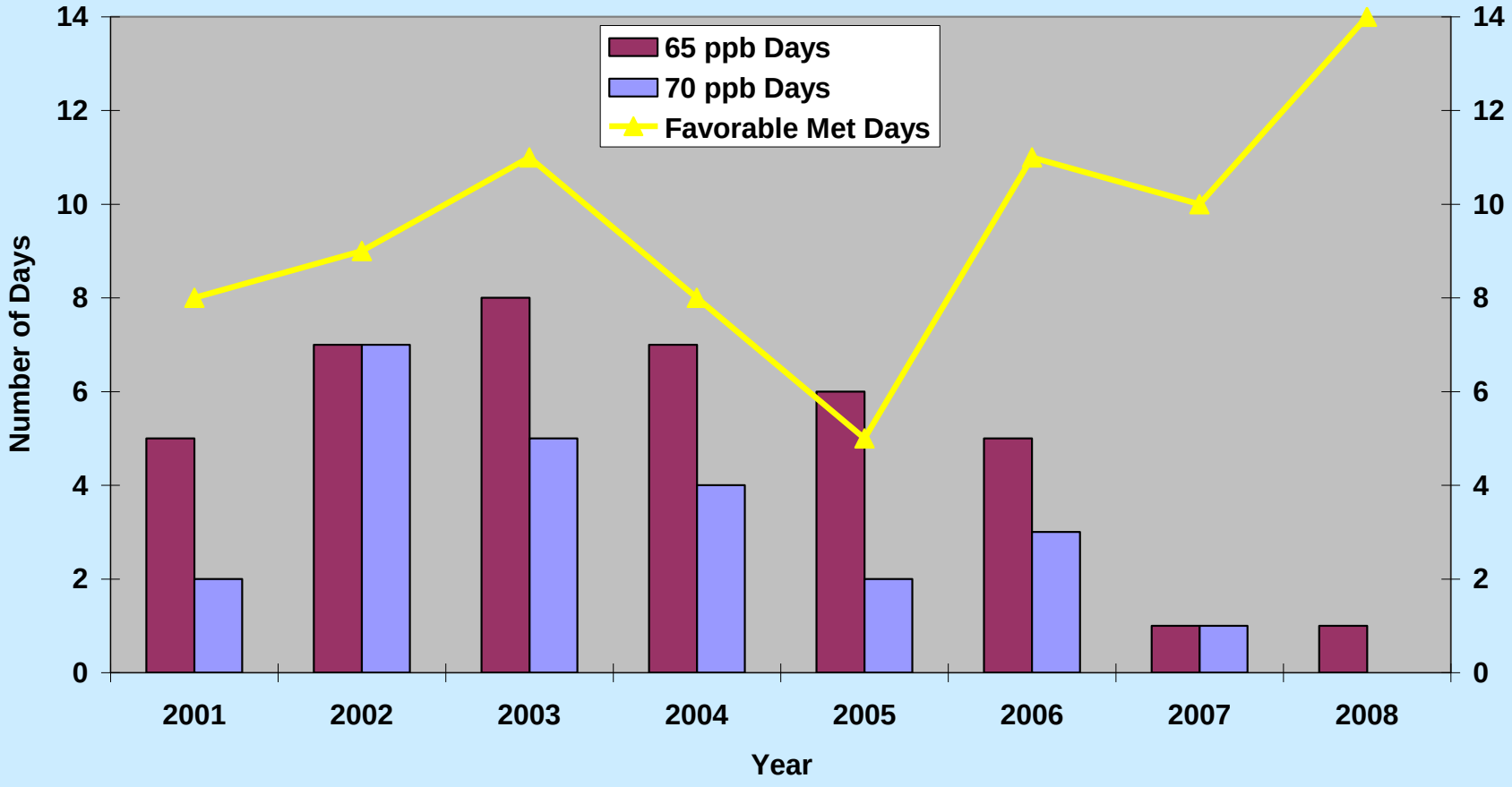
Summary of Meteorological Criteria for Days Favorable to High Ozone at CAMS 87

- Max T between 77 F and 95 F
- Min T between 56 F and 78 F
- Daily Avg WS < 2.5 m/s
- Morning WD not S, SSE, SE, or ESE
- No measurable 24-hour precipitation
- 48-hour back-trajectory endpoints located in specific upwind geographic regions
  - Identifies the typical background ozone source regions and associated large-scale flow patterns

Results: Met Favorable Days
Late April – June
2001 - 2008



Results: Met Favorable Days
Late August – Early October
2001 - 2008

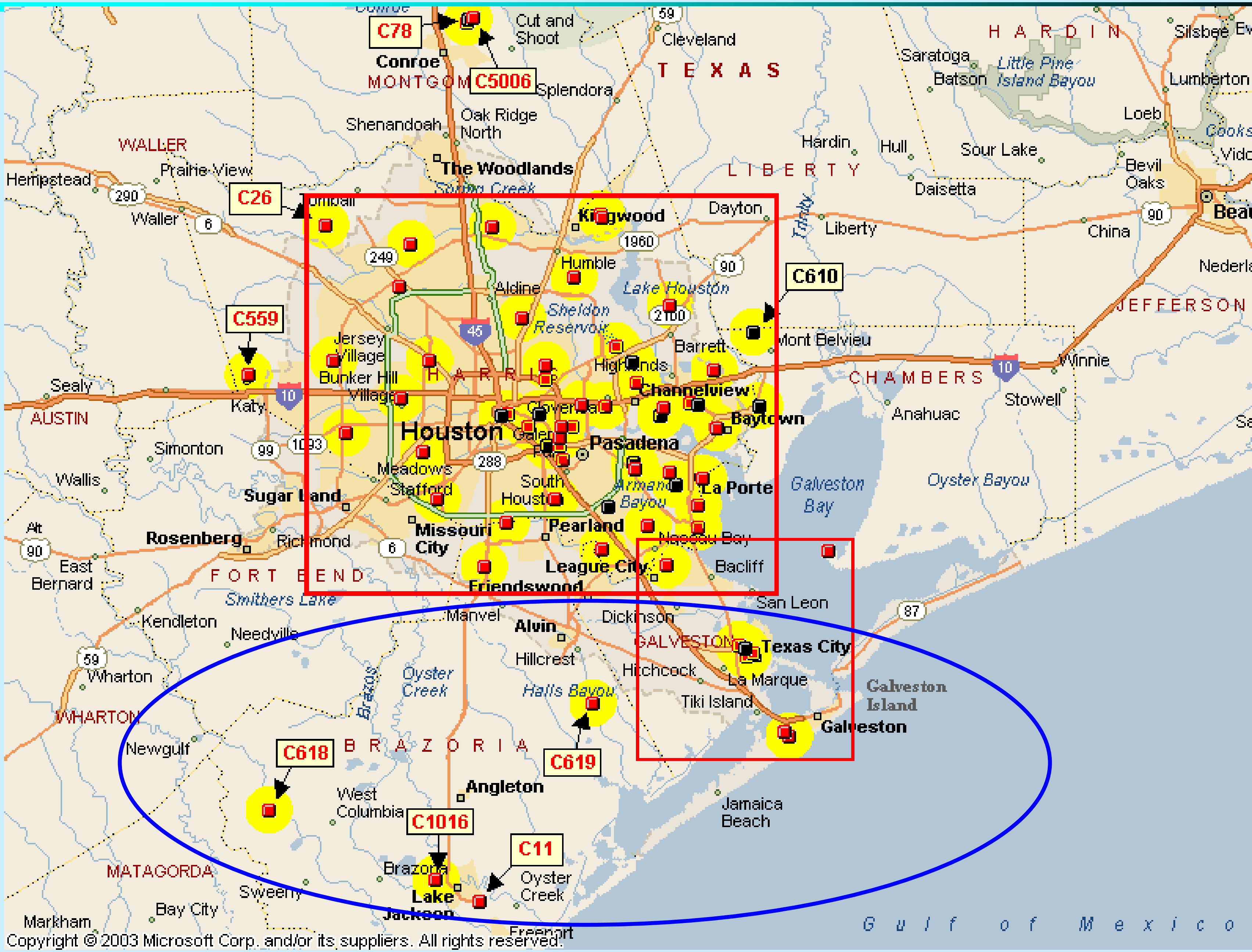


Favorable Meteorological Days Results

- Excellent agreement between the annual trends of meteorological favorable days and high ozone days at CAMS 87 for the late April – June period.
  - Hypothesis: Meteorological conditions alone may explain the annual variation in high ozone days during the spring and early summer period.
- Good agreement between the annual trends of meteorologically favorable days and high ozone days at CAMS 87 for the late August – early October period but relatively poor agreement during recent years.
  - Hypothesis One: The necessary meteorological conditions for high ozone at CAMS 87 have not been captured.
  - Hypothesis Two: The number of meteorologically favorable days have not decreased in recent years. Instead, background concentrations have declined.

Background Ozone Concentrations

- Houston/Galveston/Brazoria is often upwind of Victoria prior to high ozone concentrations at CAMS 87.
- Use the ozone concentrations measured at HGB monitoring stations located on the south side of Houston as an estimate of potential background ozone concentrations entering Victoria.
- Monitoring stations:
  - 480390618: Danciger (618)
    480391016: Lake Jackson (1016)
    480391003: Clute (11)
    480390619 : Mustang Bayou (619)
    481670056: Texas City (620)
    481671034: Galveston (1034)
- Caveat: We recognize that measurements collected south of HGB are not necessarily representative of background ozone concentrations entering Victoria on any given day.



C78
Conroe
Cut and Shoot
C5006
MONTGOM
Splendora
Cleveland
59
T E X A S
Saratoga
Batson
Little Pine Island Bayou
H A R D I N
Silsbee
Lumberton
Loeb
Cooks
Vidor
Bevil Oaks
Beau
Shenandoah
Oak Ridge North
The Woodlands
Spring Creek
WALLER
Prairie View
Hempstead
290
Waller
6
C26
Tomball
Kingwood
Dayton
1960
Hardin
Hull
Sour Lake
L I B E R T Y
Daisetta
Liberty
Trinity
China
90
Nederland
J E F F E R S O N
249
Humble
Aldine
Lake Houston
C610
2100
Sheldon Reservoir
45
C559
Jersey Village
Bunker Hill Village
H A R R I S
Barrett
Highlands
Channelview
Mont Belvieu
Winnie
C H A M B E R S
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Sealy
Katy
AUSTIN
Houston
Galena Park
Cloverleaf
Baytown
Pasadena
Anahuac
Stowell
Simonton
99
1093
288
Meadows
Stafford
Sugar Land
South Houston
Armand Bayou
La Porte
Galveston Bay
Oyster Bayou
Wallis
Alt 90
Rosenberg
Richmond
Missouri City
Pearland
Nassau Bay
East Bernard
F O R T B E N D
Smithers Lake
Friendswood
League City
Bacliff
San Leon
Kendleton
Needville
Manvel
Alvin
Dickinson
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59
Wharton
GALVESTON
Texas City
Hillcrest
Hitchcock
La Marque
Oyster Creek
Brazos
Halls Bayou
Tiki Island
Galveston Island
Galveston
WHARTON
Newgulf
C618
B R A Z O R I A
C619
West Columbia
Angleton
Jamaica Beach
C1016
C11
MATAGORDA
Brazoria
Lake Jackson
Oyster Creek
Sweeny
Bay City
Markham
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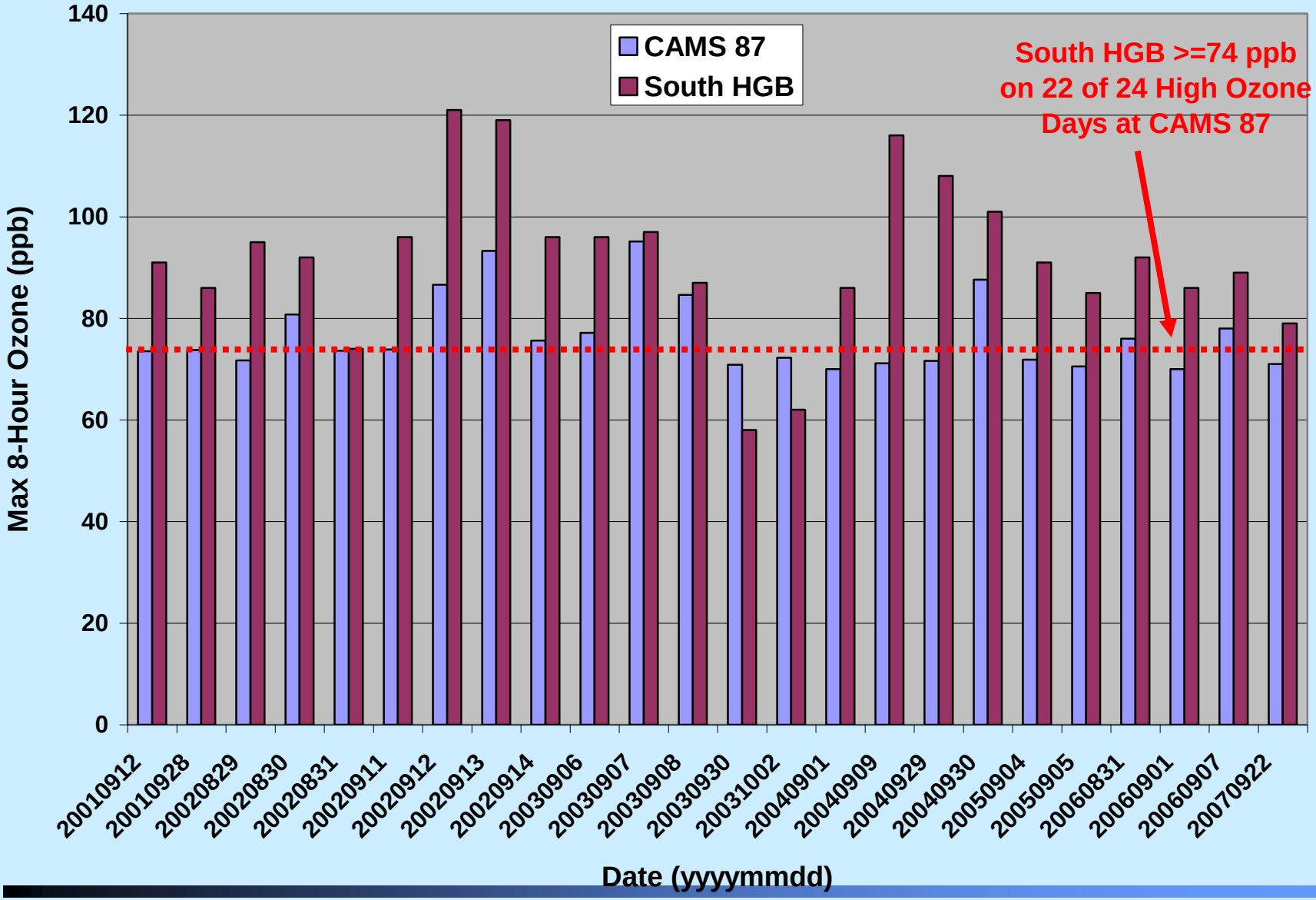
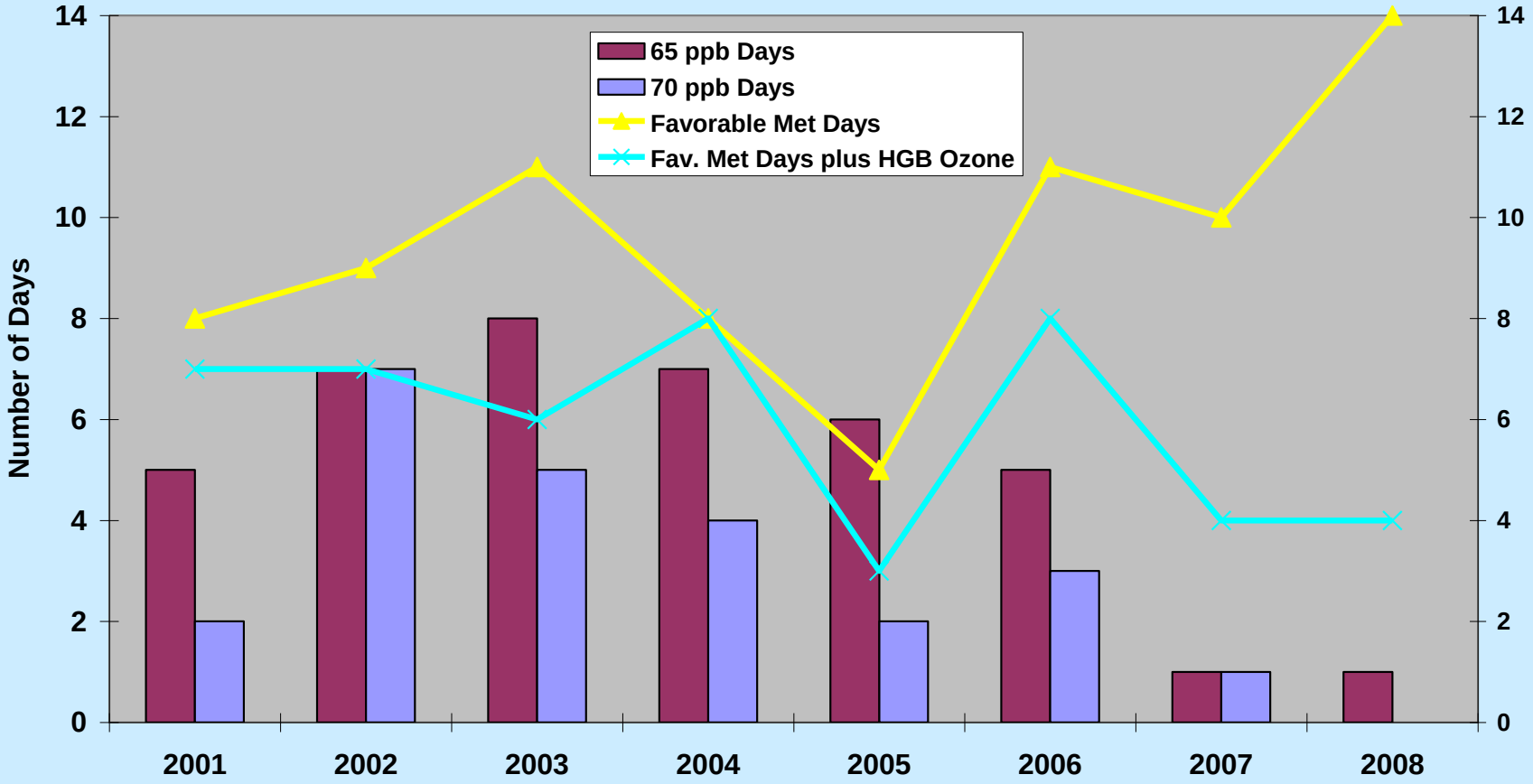
Max 8-Hour Ozone at CAMS 87 and South HGB stations
Days with CAMS 87 >= 70 ppb: Late August – Early October



Revised Late Aug – Early Oct Criteria for Days Favorable to High Ozone at CAMS 87

- Max T between 77 F and 95 F
- Min T between 56 F and 78 F
- Daily Avg WS < 2.5 m/s
- Morning WD not S, SSE, SE, or ESE
- No measurable 24-hour precipitation
- 48-hour back-trajectory endpoints located in specific upwind geographic regions
  - Identifies the typical background ozone source regions and associated large-scale flow patterns
- Maximum 8-Hour Ozone at South HGB Stations >= 74 ppb

Results: Met Favorable Days and South HGB Max >= 74 ppb Late August – Early October



Conclusions

- **Caveat: Work-In-Progress Analysis**
- Annual ozone concentrations in Texas metropolitan areas have decreased during recent years.
- At CAMS 87, years 2007 and (especially) 2008 were characterized by exceptionally low ozone concentrations compared to previous years.
- A relatively simple method was used to define meteorologically favorable days for high ozone concentrations at CAMS 87 using surface observations and 48-hour HYSPLIT back-trajectories.

Conclusions (continued)

- Working Hypotheses:
  - Meteorological conditions alone may explain the annual variation in the numbers of late spring and early summer high ozone days at CAMS 87 during the 2001 – 2008 period.
  - In contrast, the late summer and early autumn period is not characterized by a decrease in the frequency of occurrence of meteorologically favorable days during recent years.
  - This latter finding (combined with trends in measured ozone concentrations at monitoring stations located south of HGB) suggests that relatively lower background concentrations may have played a role in the lower numbers of high ozone days at CAMS 87 for years 2007 and 2008.

Conclusions (continued)

- Additional analysis:
  - Use complete set of NWS observations to refine the criteria used to define meteorologically favorable days for high ozone concentrations at CAMS 87 during the late August – early October period.
  - The above should include a detailed comparison of weather patterns during currently defined meteorologically favorable days during 2007 and 2008 with those of previous years.