Ozone Conceptual Model for the Victoria Area

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Update on Ozone NAAQS

- In 1997, EPA set primary and secondary NAAQS at 0.08 ppm for ozone concentrations averaged over 8 hours.
- In March 2008, EPA strengthened the 8-hour primary standard from 0.084 ppm to 0.075 ppm.
- In January 2010, EPA proposed to further strengthen the primary standard to between 0.060 – 0.070 ppm and to establish a new seasonal secondary standard.
- The revision of the standard is expected to be announced in October 2010.

TCEQ Conceptual Model Guidance for 2010

- NNAs were advised to develop conceptual models for three potential primary NAAQS: 60 ppb, 65 ppb, and 70 ppb
- The conceptual model should identify the necessary and sufficient conditions for high ozone concentrations.
  - In the past for Texas areas, it has not been technically feasible to develop a set of sufficient conditions for the formation of high ozone (i.e., conditions under which high ozone will always occur).

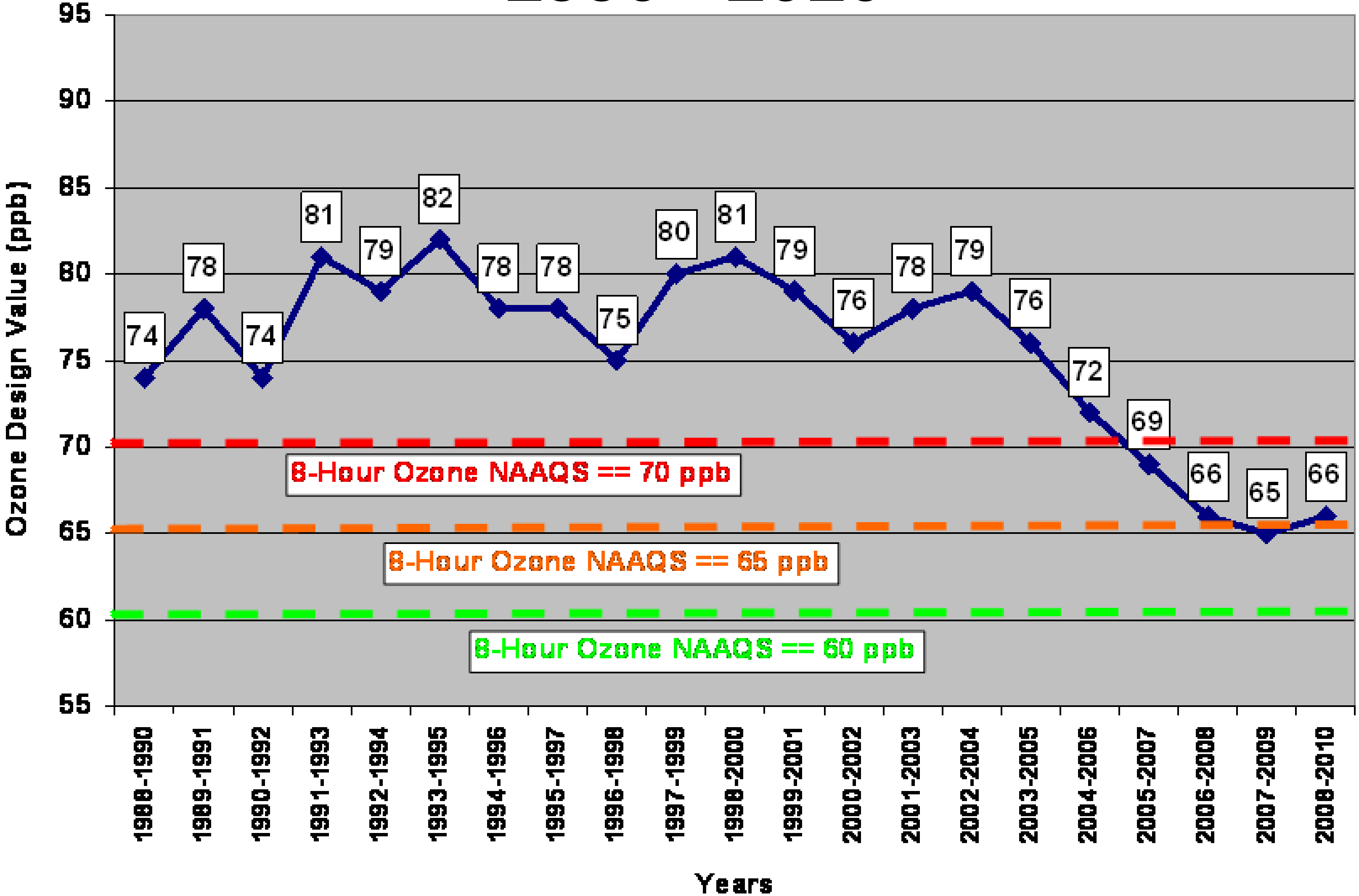
TCEQ Conceptual Model Guidance for 2010 (continued)

- TCEQ recommended that NNAs perform the following analyses in support of conceptual model development:
  - Evaluate the wind speeds, wind directions, and time of day associated with high ozone events.
  - Develop 24-hour back-trajectories to determine source regions most and least likely to affect local area ozone concentrations.
  - Conduct a weekday/weekend analysis.
  - Evaluate the range and average background ozone concentrations associated with local wind directions.
  - Investigate ozone and precursor trends and estimate the annual frequency of high ozone days at various proposed standard levels of 70 ppb, 65 ppb, and 60 ppb.

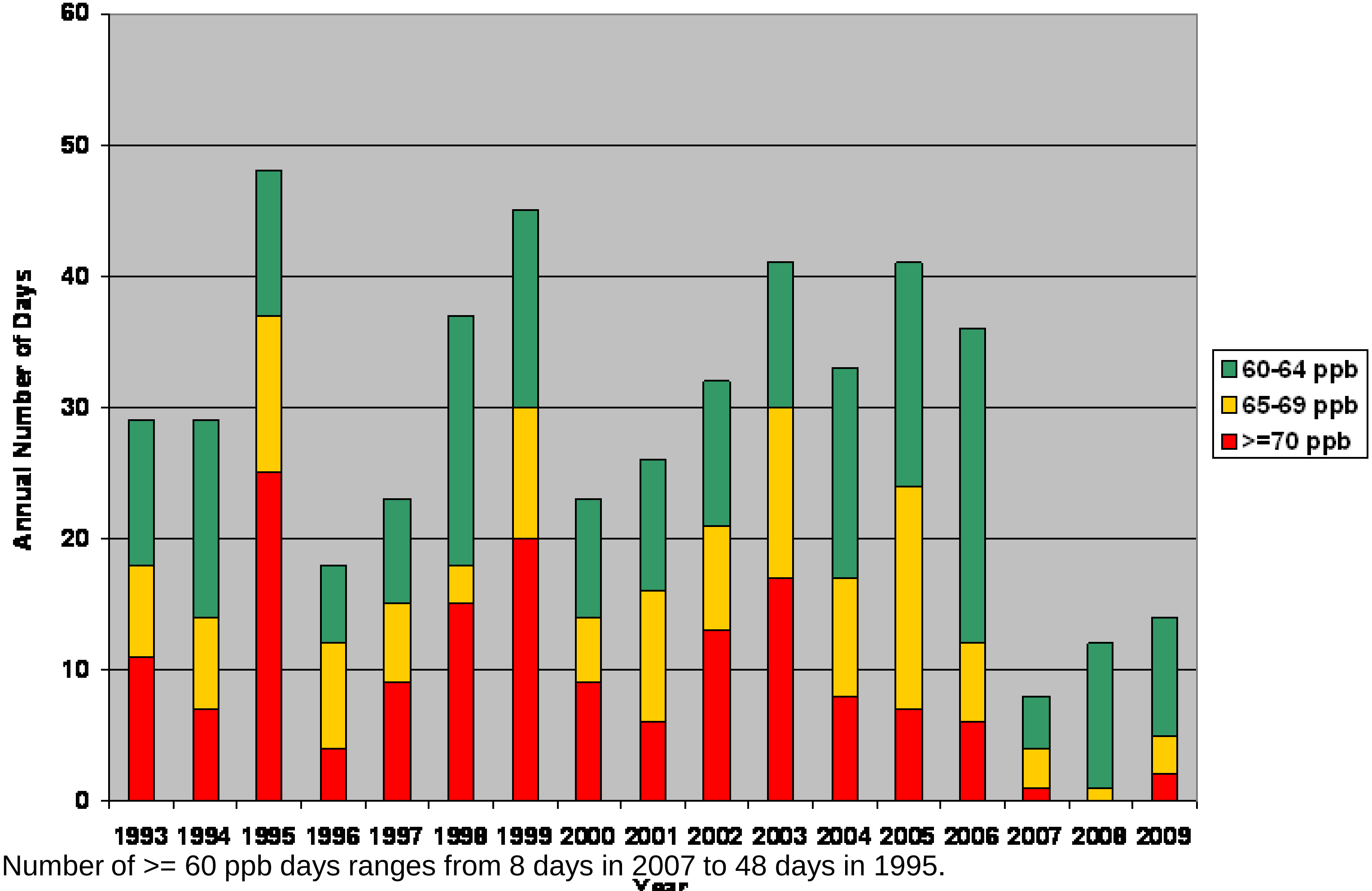
Conceptual Model Results for the Victoria Area

- Selected results are presented today.
- The full results are available in a recently completed report entitled “Ozone Conceptual Model for the Victoria Area”.
- The conceptual model originally developed in year 2000 and updated periodically has proven remarkably robust.

CAMS 87 Ozone Design Values 1990 - 2010

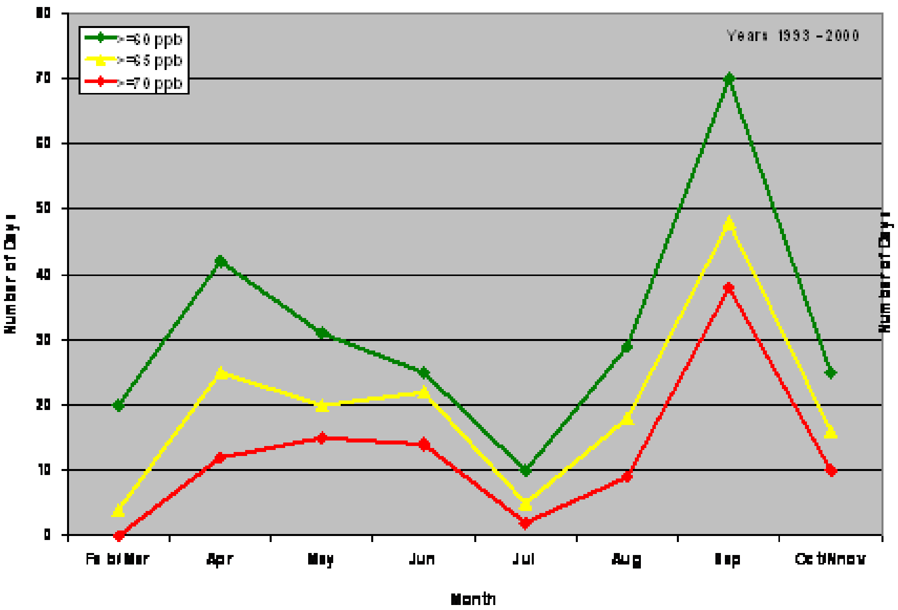


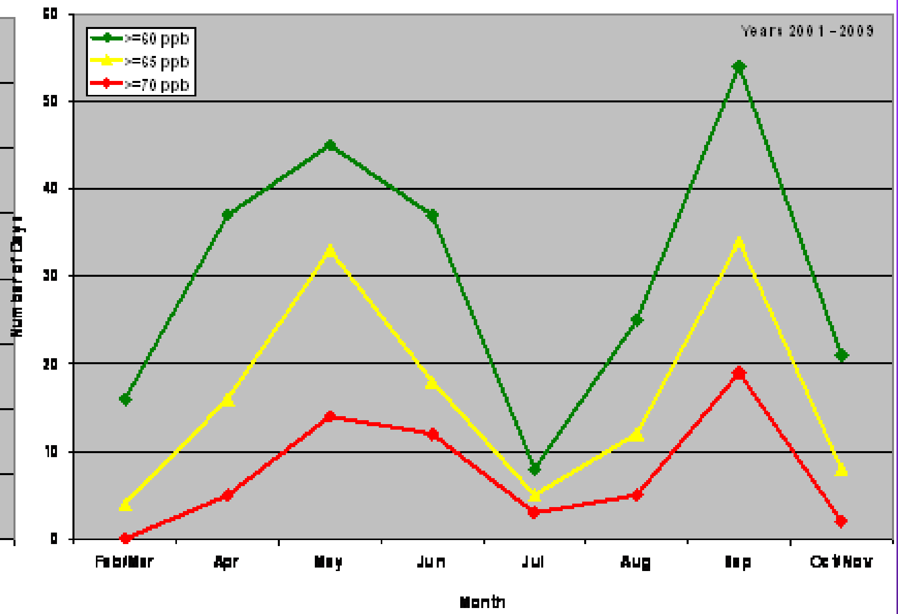
Annual Frequency of Occurrence



- Number of >= 60 ppb days ranges from 8 days in 2007 to 48 days in 1995.
- Number of >= 70 ppb days ranges from 0 days in 2008 to 25 days in 1995.
- 2007 – 2009 have relatively low numbers of high ozone days compared to previous years: Why? Hypotheses include (1) Changes in frequency of occurrence of conducive large-scale weather patterns, (2) decreasing levels of inter-state and/or intra-state ozone transport, and (3) emissions changes in local and/or upwind areas.

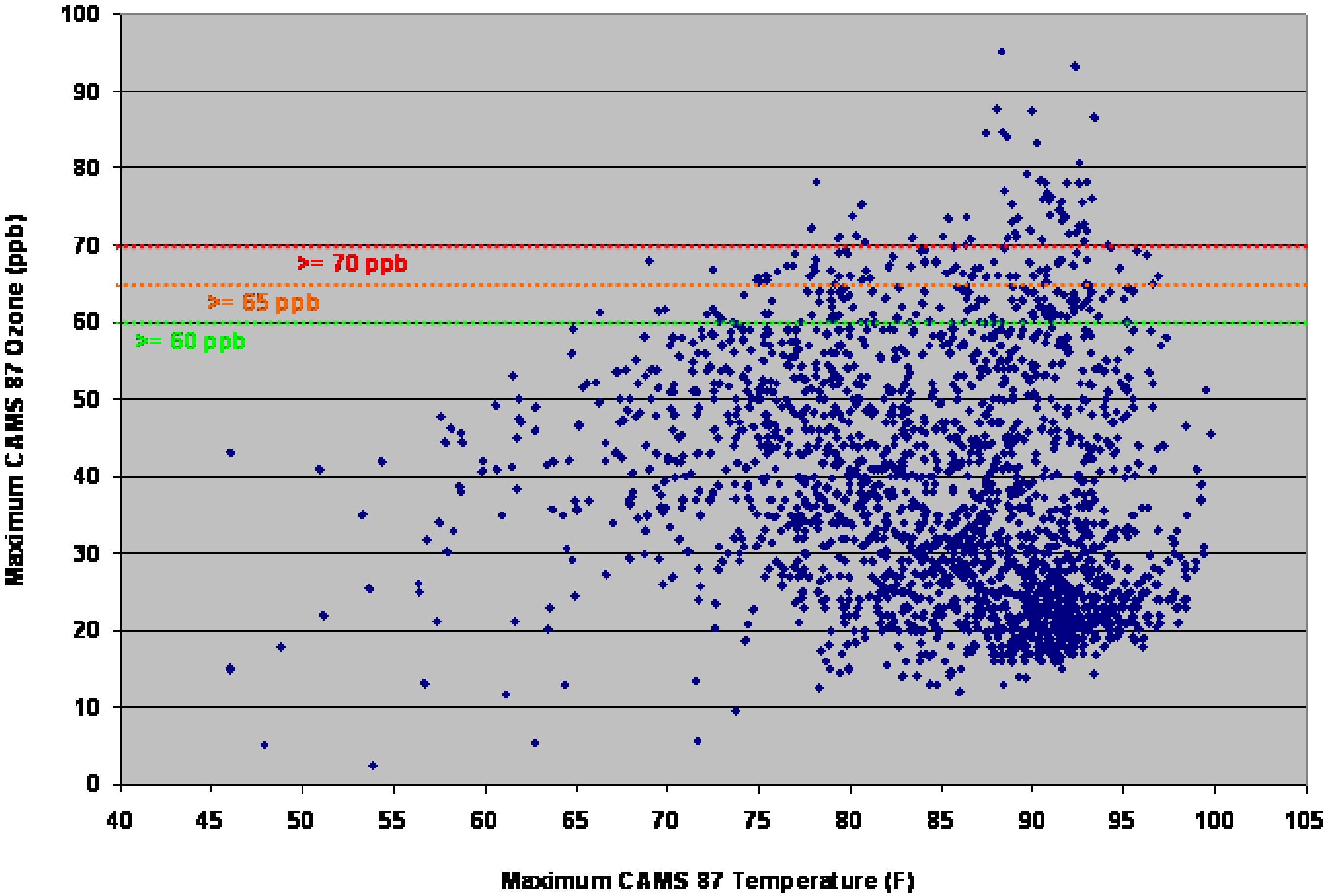
Monthly Frequency of Occurrence
Years 1993 – 2000 (left) and 2001 – 2009 (right)





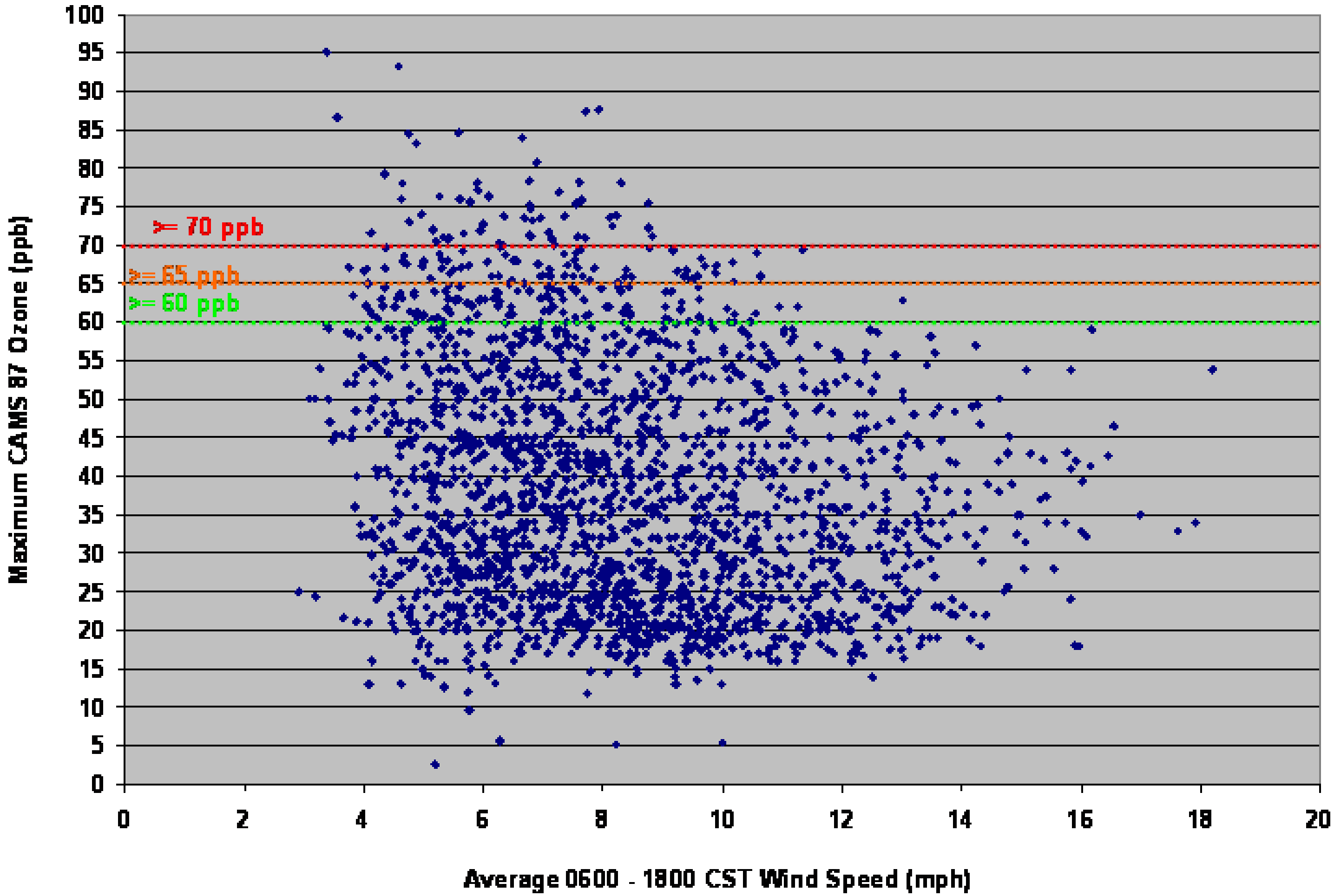
- Seasonal frequency of occurrence of high ozone days has a bi-modal distribution with a relative minimum during July.
- During 1993 – 2000, Aug – Oct was the primary peak; during 2001 – 2009, the numbers of high ozone days during Apr – Jun and Aug – Oct were more evenly balanced.
- Hypothesis (untested): Transport of background ozone into Victoria is more important for the late ozone season compared to the early ozone season and ozone concentrations transported into (and potentially within) Texas have decreased.

Daily Max Temperature vs. Daily Max 8-Hour Ozone at CAMS 87



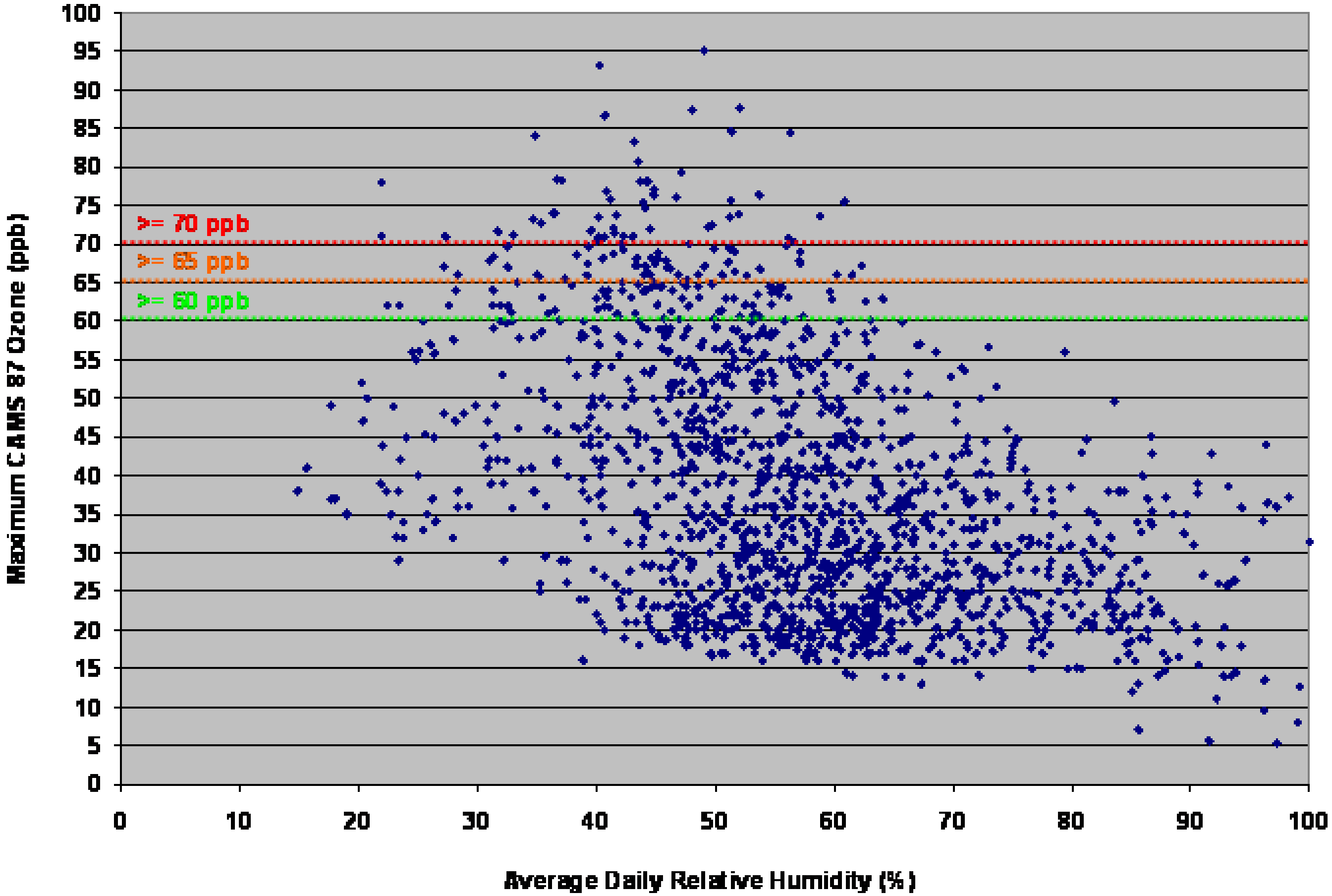
- There is an obvious tendency to observe higher max ozone at higher temperatures; however, high daily peak temperatures are not a sufficient condition for high ozone.
- For 60 – 64 ppb days, 95% have a peak T > 72.7 ºF; For 65 – 69 ppb days, 95% have a peak T > 74.9 ºF; For >= 70 ppb days, 95% have a peak T > 75.6 ºF.
- High T is correlated with (1) conducive met for ozone formation and accumulation near the surface, (2) sunshine necessary to drive ozone formation, and (3) potentially higher emissions of ozone precursor compounds and/or atmospheric reactivity.

Daytime (0600 – 1800 CST) Avg WS (mph) vs. Daily Max 8-Hour Ozone at CAMS 87



- There is an obvious tendency to observe higher max ozone at lower wind speeds; however, low wind speed is not a sufficient condition for high ozone.
- The average March – October daytime wind speeds for < 60 ppb days, 60 – 64 ppb days, 65 – 69 ppb days, and >= 70 ppb days were 8.5 mph, 7.0 mph, 7.1 and 6.4 mph, respectively.
- Low WS is associated with decreased atmospheric dispersion of pollutants such as ozone. High WS may sometimes be associated with weather that is not conducive to high ozone near the surface (e.g., rain showers, clouds, lower temperatures associated with strong fronts or low pressure systems.)

Midday Relative Humidity (1000 – 1600 CST) vs. Daily Max 8-Hour Ozone at CAMS 87



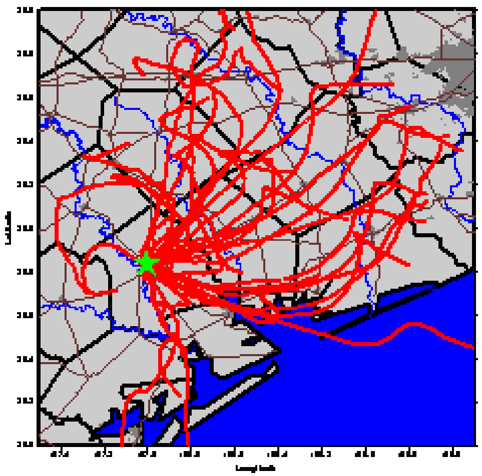
- There is an obvious tendency to observe higher max ozone at low RH; however, low RH is not a sufficient condition for high ozone.
- The average May – October RH on < 60 ppb days is 59.6%, compared to 45.5%, 44.9%, and 43.4% for 60 – 64 ppb days, 65 – 69 ppb days, and >= 70 ppb days, respectively.
- These data demonstrate that high ozone days occur predominantly during periods characterized by low atmospheric moisture levels.
- Why?: (1) Most importantly, low RH is a signature of air of recent continental origin as opposed to relatively moister air that originated over the Gulf of Mexico, (2) Low RH may enhance the atmospheric chemistry that forms ozone, and (3) High RH may sometimes be associated with overall weather conditions that are not conducive to high ozone concentrations (e.g., clouds, rain, low pressure systems).

Back-Trajectory Analyses

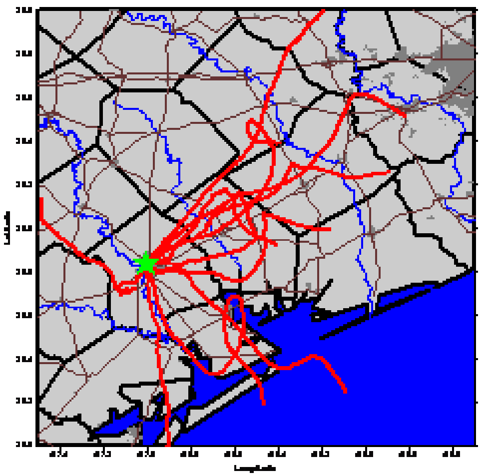
- Back-trajectories can be used: (1) to investigate potential geographic source regions of ozone entering the Victoria Area, and (2) to investigate wind flow patterns.
- Three types of back trajectories (local, intra-state, and inter-state) were generated with a start time of 1700 CST and CAMS 87 as the start location.
- One-day (local) back-trajectories used 5-minute averaged surface wind data collected at ground monitors in the Greater Victoria Area.
- Three-day (intra-state) back-trajectories were generated using HYSPLIT to investigate potential Texas geographic source areas of background ozone.
- Five-day (inter-state) back-trajectories were generated using HYSPLIT to investigate potential US source areas of background ozone.

Local Back-Trajectory Results

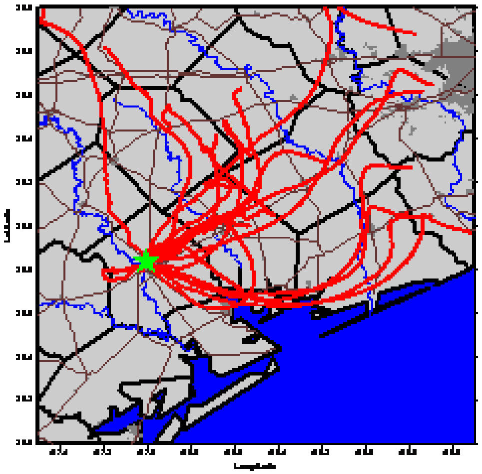
60 – 64 ppb Days



70 ppb Days



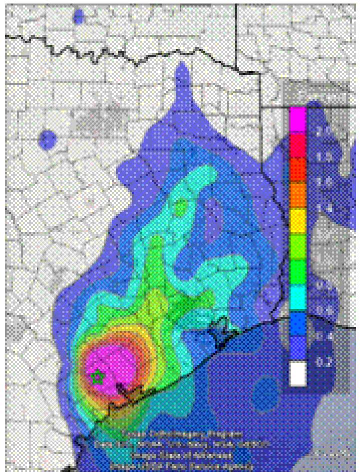
65 - 69 ppb Days



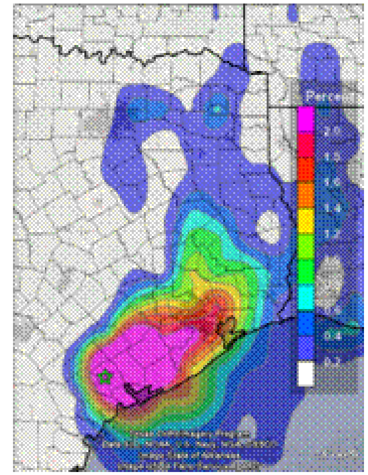
- Two common upwind flow patterns: Winds from the ESE and NE.
- For all days, the counties of Calhoun, Jackson, Wharton, and Matagorda are most commonly in the upwind region.
- For 60 – 64 ppb days, the more northerly back-trajectories pass over Lavaca and Colorado counties.

Intra-State Back-Trajectory Results

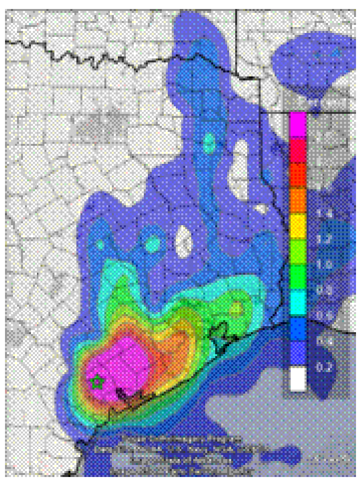
60 – 64 ppb Days



70 ppb Days



65 - 69 ppb Days

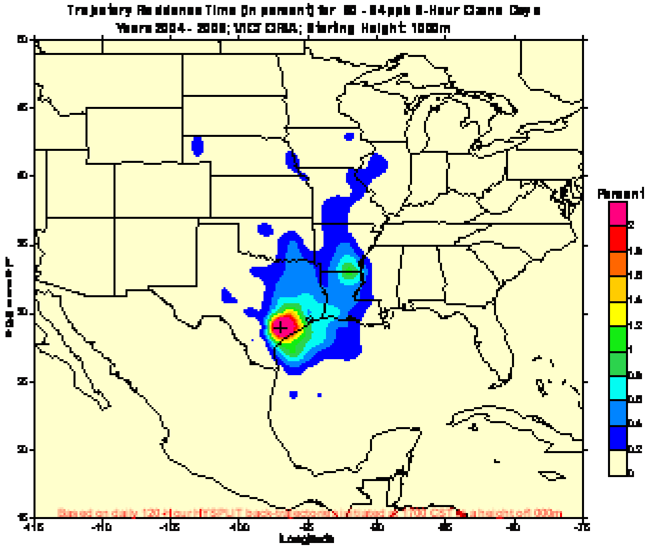


•In general, the overall spatial coverage of potential ozone source regions is similar for the three ozone ranges and is consistent with long-range flow from the northeast.

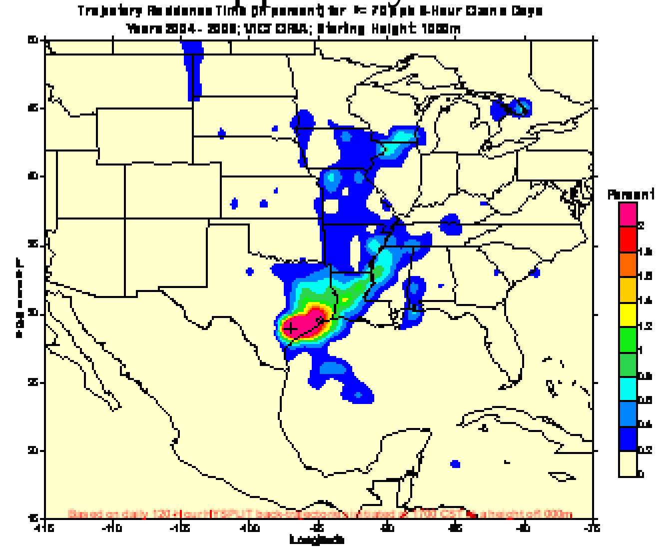
•For the two higher ozone categories, the most common upwind area includes a region that extends roughly 100 miles inland between Victoria and southeast Texas. The upwind region extends directly into the HGB and BPA areas.

Inter-State Back-Trajectory Results

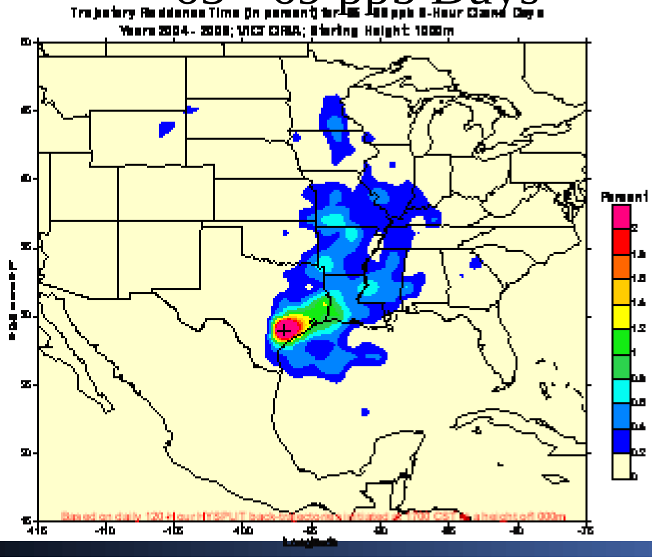
60 – 64 ppb Days



70 ppb Days



65 - 69 ppb Days



- In general, the overall spatial coverage of potential ozone source regions is similar for all three ozone ranges and is consistent with long-range flow from the northeast.

- Upwind states include Louisiana and Arkansas. For the two higher ozone categories, the upwind region expands to include Missouri and portions of the Mississippi River Valley.

Large-Scale Weather Patterns

- The conditions conducive to the transport, formation, and accumulation of ozone are dependent on the prevailing large-scale weather patterns.

- Previous conceptual models have found the following common large-scale weather features:
  - A surface ridge of high pressure ridge extends south or southwest into Texas. High pressure is often dominant at upper levels over Texas as well.
  - High pressure is often associated with conditions favorable for high ozone concentrations (e.g., light wind speed, clear skies, sinking air).
  - The clockwise flow of air around the high pressure ridge brings continental air, likely containing elevated ozone and/or its precursor compounds, into Texas. This flow pattern is also consistent with transport of ozone from HGB and BPA into Victoria.

Large-Scale Weather Patterns (continued)

- Previous conceptual models have found the following common large-scale weather features:
  - Most often, high ozone episodes began after the passage of a cold front through Texas. Sometimes high ozone days began immediately; other episodes began several days after the front passed through Victoria.
  - A second category of high ozone episodes episodes began during periods of regional stagnation with high pressure entrenched over Texas at the surface and upper levels. Importantly, the long-range transport patterns are consistent with flow of continental air into Texas and Victoria.
  - As the high pressure system over Texas weakened or moved eastward, southeasterly or southerly winds sometimes continued to move air of recent continental air into Texas from over the Gulf of Mexico and conditions over coastal Texas remained favorable for high ozone concentrations near the surface.

Example Days during June 2006

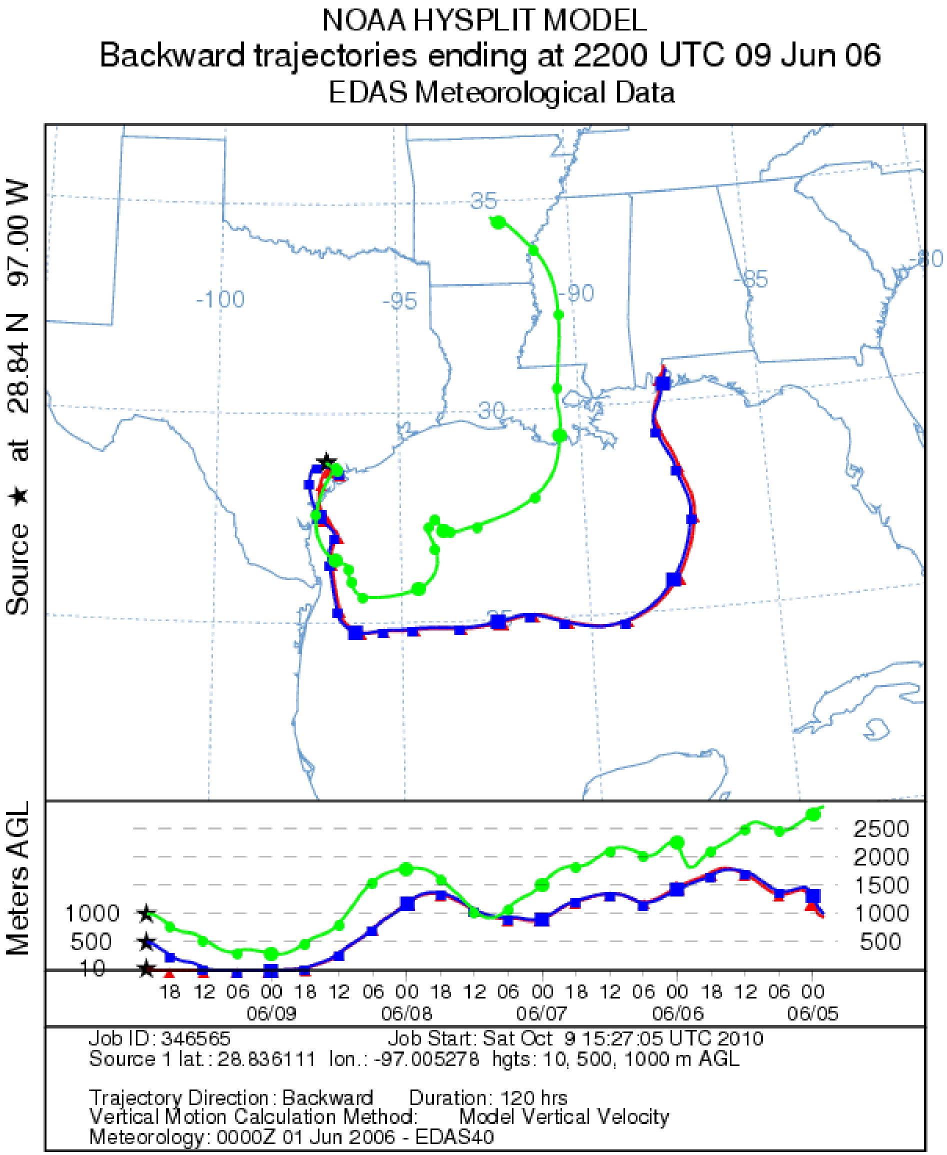
- June 2006 had high ozone concentrations across much of eastern Texas.
- June 2006 is being developed for the Dallas SIP and TCEQ is encouraging NNAs to develop the episode in support of possible SIPs as well.
- The large-scale weather patterns during the first half of June had high pressure over Texas at both the surface and upper levels (stagnation).
- The large-scale weather pattern after June 24th was dominated by the after-effects of the passage of a cold front through Texas.
- Table below shows the daily maximum 8-hour ozone concentrations for each day for selected Texas areas (60 – 64 ppb in green, 65 – 69 ppb in yellow, >= 70 ppb in red)

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DFW	68	74	88	87	76	92	93	96	106	86	74	101	98	107	89
TLM	66	62	78	75	65	78	82	79	83	77	75	90	78	82	81
Temple	52	66	68	68	62	60	64	69	78	70	56	62	79	71	64
BPA	54	69	68	93	85	89	77	81	84	81	78	69	80	90	71
Austin	51	65	81	72	64	67	73	88	81	76	60	71	82	83	69
HGB	48	94	84	105	103	110	83	122	106	95	79	101	90	119	93
San Antonio	56	66	80	73	63	68	76	84	77	71	64	70	93	90	69
CAMS 87	34	35	62	44	56	63	58	61	65	63	50	45	60	50	63

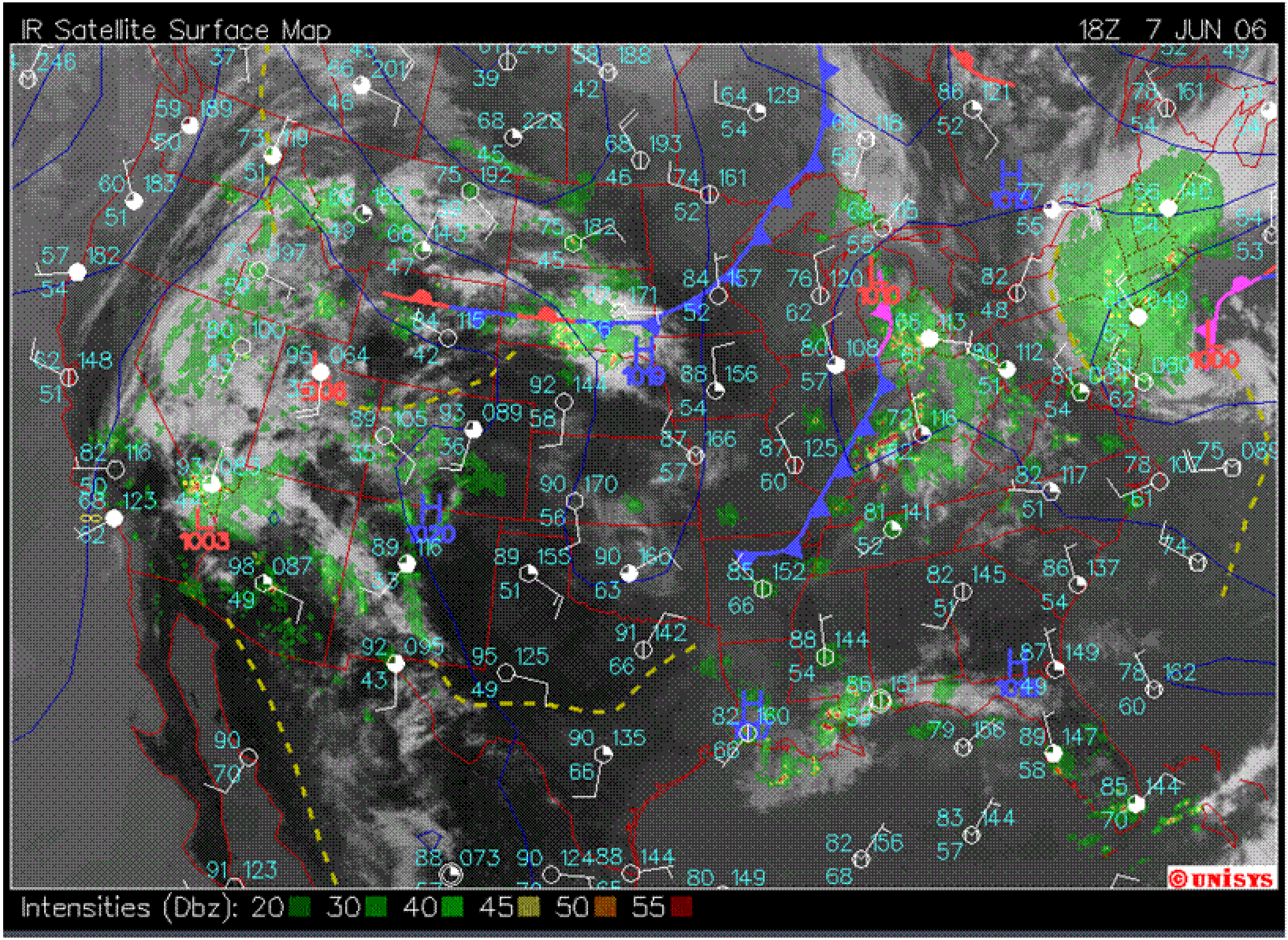
Day	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
DFW	45	70	97	76	42	41	48	55	73	68	66	91	98	91	102
TLM	41	38	68	51	57	50	31	58	50	73	67	64	79	84	85
Temple	30	50	68	50	27	25	29	38	48	69	67	63	69	73	74
BPA	31	39	41	33	36	30	33	56	65	62	67	82	82	95	91
Austin	35	60	77	65	28	29	36	45	45	69	71	72	79	91	89
HGB	35	38	44	49	36	47	39	71	88	73	83	94	108	121	85
San Antonio	35	44	71	65	29	32	36	50	45	65	78	88	90	91	71
CAMS 87	16	24	36	32	21	18	22	30	31	52	62	62	72	64	NV

•The maximum CAMS 87 ozone concentration during the first half of June was 65 ppb on June 9th.
•The maximum CAMS 87 ozone during late June was 72 ppb on June 28th.
•The next few slides investigate the large-scale weather features during June 7 – 9 and June 26 – 28.

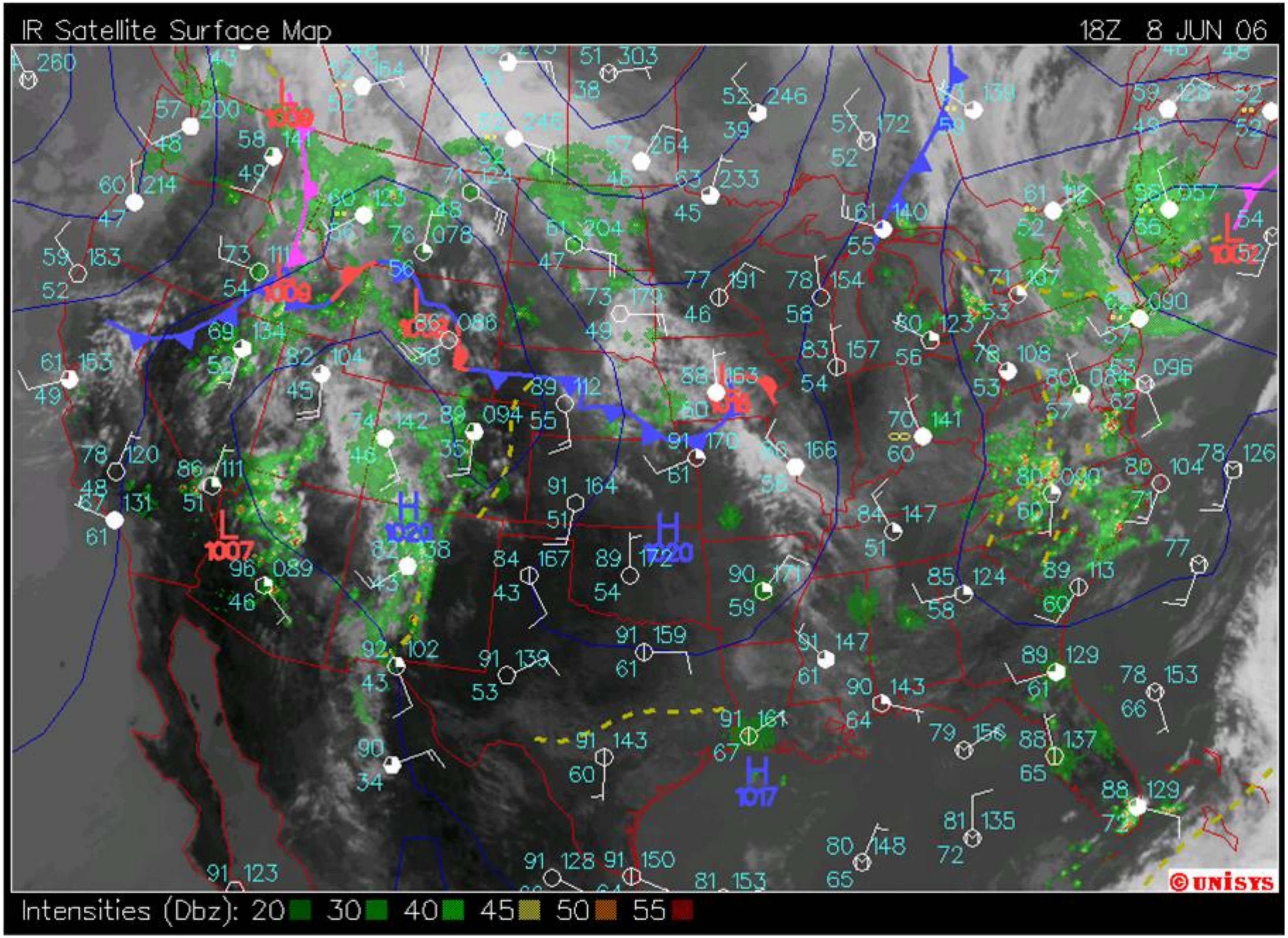
HYSPLIT Back-Trajectories for June 9th



June 7 Surface Weather



June 8 Surface Weather



June 8 Upper Air Analysis