• The intensive studies: chemical data from aircraft cases of intra- and interstate export of pollution from:
  - Houston - Galveston (HGA)
  - Beaumont- Port Arthur (BPA)
  - Dallas - Fort Worth (DFW)

• A more continuous record: chemical data from the 500-meter-high KWKT television tower, Moody, TX
  - DFW plume example, September 2006

• A more general approach (?): evaluating models using chemical observations
  - comparison with Flexpart and profiler trajectories

A goal - a combination of thoroughly evaluated products that offers an accurate picture of transport in Texas
Intensive studies: Three transport examples from TexAQS 2000

#1: Sept. 1 - Houston plume transported east

GOES visible 4:45 PM CST
Intensive studies: Three transport examples from TexAQS 2000

**#1:** Sept. 1 - Houston plume transported east

- Plume \(O_3\) mixing ratios of 160 ppbv, or enhancements of 90 ppbv, were still encountered upwind of and above BPA

- Enhancements of longer-lived compounds and aerosol particles also observed in BPA
Intensive studies: Three transport examples from TexAQS 2000

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#2: Sept. 6 - Houston plume transported southwest

P-3 in situ

DC-3 lidar
Intensive studies: Three transport examples from TexAQS 2000

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- Enhancements of longer-lived compounds and aerosol particles also observed in BPA

**#2: Sept. 6 - Houston plume transported southwest**

- Plume $O_3$ mixing ratios of 140 ppbv, or enhancements of 60 ppbv, observed downwind nearly to Victoria, TX
- Enhancements of longer-lived compounds and aerosol particles also observed
**Intensive studies:** Three transport examples from TexAQS 2000

**#3:** Aug. 22-23 - Coastal plumes transported north

- Hysplit trajectories suggest general transport from SE Texas
Intensive studies: Three transport examples from TexAQS 2000

#3: Aug. 22-23 - Coastal plumes transported north

- Hysplit trajectories suggest general transport from SE Texas
- Chemical signatures from transect upwind of Dallas point to aged Houston plume - enhanced O₃, SO₂, CO, ethyne, benzene
Intensive studies: transport example from TexAQS 2006

2006: coastal plumes transported north

NOAA WP-3D track
09/16/2006
Intensive studies: transport example from TexAQS 2006

2006: coastal plumes transported north
Intensive studies: TexAQS 2006

NOAA WP-3D track
09/16/2006

Upwind

Downwind #1
Downwind #2
Downwind #3

SO2, ppbv

Longitude

Latitude

Monticello
Welsh
Martin Lake

AR
LA

Sulfate, ug/m³

Benzene, pptv

SO2, benzene, sulfate

WP-3D track
SO2 plumes
Intensive studies: TexAQS 2006

Noaa WP-3D track
09/16/2006

- chemical data illustrate transport of separate sulfate and benzene plumes
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Intensive studies: TexAQS 2006

- chemical data illustrate transport of separate sulfate and benzene plumes
- examine back-trajectories and retroplumes
Intensive studies: TexAQS 2006
Intensive studies: TexAQS 2006

NOAA WP-3D track
09/16/2006

24-hr back trajectories from point A on P-3 track

Trajectory data courtesy of NOAA ESRL PSD - C. Senff and A. White
Intensive studies: TexAQS 2006

NOAA WP-3D track
09/16/2006

24-hr back trajectories from point B on P-3 track

SO2 emissions, $10^{25}$ molec/sec

500-600m, 600-700m, 700-800m, 800-900m

Trajectory data courtesy of NOAA ESRL PSD - C. Senff and A. White
Intensive studies: TexAQS 2006

NOAA WP-3D track
09/16/2006

24-hr **back** trajectories from pts. A & B on P-3 track

24-hr **forward** trajectories from Beaumont-Port Arthur area

SO2 emissions, $10^{25}$ molec/sec

Trajectory data courtesy of NOAA ESRL PSD - C. Senff and A. White
Intensive studies: TexAQS 2006

Clear example of coastal plumes affecting northeast TX, LA, AR, OK
Transport signatures in a more continuous record:

The instrumented KWKT television tower, Moody, TX
\(\text{CO}_2, \text{CO}, \text{O}_3\), and met. at 30m, 122m, and 457m above ground level
Transport signatures in a more continuous record:

The instrumented KWKT television tower, Moody, TX
CO\textsubscript{2}, CO, O\textsubscript{3}, and met. at 30m, 122m, and 457m above ground level

KWKT example:
6 weeks in summer 2006
(data from 457m)

CO\textsubscript{2}
2001 to present

CO and O\textsubscript{3}
2003 to present

Instrumented by
NOAA ESRL GMD
Carbon Cycle Group
Transport signatures in a more continuous record:

The instrumented KWKT television tower, Moody, TX

**CO$_2$, CO, O$_3$, and met. at 30m, 122m, and 457m above ground level**

KWKT example:
6 weeks in summer 2006
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**CO$_2$**
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**CO and O$_3$**
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Instrumented by
NOAA ESRL GMD
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Transport signatures in a more continuous record:

The instrumented KWKT television tower, Moody, TX

\( \text{CO}_2, \text{CO}, \text{O}_3 \), and met. at 30m, 122m, and 457m above ground level

- Aircraft data confirm Dallas plume transported to KWKT on Sept. 13, 2006
- 2006 overflights tie continuous KWKT record to the TexAQS intensives
Transport signatures in a more continuous record:

The instrumented KWKT television tower, Moody, TX

CO₂, CO, O₃, and met. at 30m, 122m, and 457m above ground level

- Examine transport to KWKT tower for a 4-day period centered on 1st aircraft overflight using Flexpart (Andreas Stohl, NILU)

- Very similar conclusions from Flexpart and profiler trajectories for these particular transport cases
Intrastate transport on Sept. 12 - 16, 2006: 4 days of KWKT data from 457m AGL
**Intrastate transport on Sept. 12 - 16, 2006:** 4 days of KWKT data from 457m AGL

**Flexpart footprint emission sensitivity**
(retroplume time spent in lowest 100m)
Intrastate transport on Sept. 12 - 16, 2006: 4 days of KWKT data from 457m AGL

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Summary

• Airborne data sets from 2000 and 2006 intensives contain many examples of intra- and interstate transport.

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Identify source regions?
Quantify mixing ratios?
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Identify source regions? possibly - needs work
Quantify mixing ratios? not there yet
Acknowledgments

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A. White
C. Senff
R. Alvarez III
Intensive studies: TexAQS 2006

NOAA WP-3D track
09/16/2006

Flexpart footprint emission sensitivities
(retroplume time spent in lowest 100 m)

Flexpart model suggests Beaumont-Port Arthur for elevated benzene

Flexpart model suggests Houston-Galveston for elevated sulfate

• source regions identified using profiler-driven trajectories appear to be more consistent with WP-3D chemical data in this particular case

Flexpart model and output courtesy of Andreas Stohl, NILU