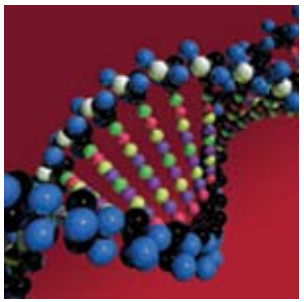
Background Ozone


Presentation to the NETAC Technical and Policy Committees

March 12, 2010

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Presentation Outline

- Sources of background ozone (O3)
- Terminology
  - Natural Background
  - Policy Relevant Background
- Background experienced in NE Texas
  - Aircraft data
  - Surface monitoring at TCEQ sites

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Sources of Background Ozone

- Natural background
  - Stratospheric ozone
    - Ozone concentrations in the lower stratosphere are many hundreds of ppb
    - Stratospheric air can be mixed down to ground level by powerful weather events
    - Ozone pollution episodes don't coincide with powerful weather events
  - Ground level ozone from natural sources
    - Biogenic VOC emissions
    - Natural methane emissions (e.g., swamps)
    - Lightning NOx
    - Wildfires – source of VOCs and NOx
- Additional ground level comes ozone from human activities

Policy Relevant Background (PRB)

- "defined as the distribution of O3 concentrations that would be observed in the U.S. in the absence of anthropogenic (man-made) emissions of precursor emissions (e.g., VOC, NOx, and CO) in the U.S., Canada, and Mexico."
  - From the EPA OAQPS "Staff Paper" - Review of the National Ambient Air Quality Standards for Ozone: Policy Assessment of Scientific and Technical Information

- What is the significance of PRB?
  - The lowest O3 that could possibly be achieved by air quality management efforts within the US

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How low is PRB?

- Impossible to measure – need to use models
- The GEOS-CHEM model shows "PRB O3 concentrations at the surface are generally predicted to be in the range of **15 to 35 ppb** in the afternoon"
  - GEOS-CHEM global model evaluated and considered to be "within 5 ppb" for simulating current conditions
  - Simulations of PRB conditions impossible to evaluate directly
  - Model consistent with observations at remote locations
- PRB O3 concentrations are related to season, altitude and total surface O3 concentration
  - Tend to decline under conditions conducive to high O3 episodes
  - Tend to be highest during spring and decline into summer
  - Higher values tend to occur at higher elevations during spring
- EPA had previously assumed 40 ppb

GEOS-CHEM model PRB for 1995

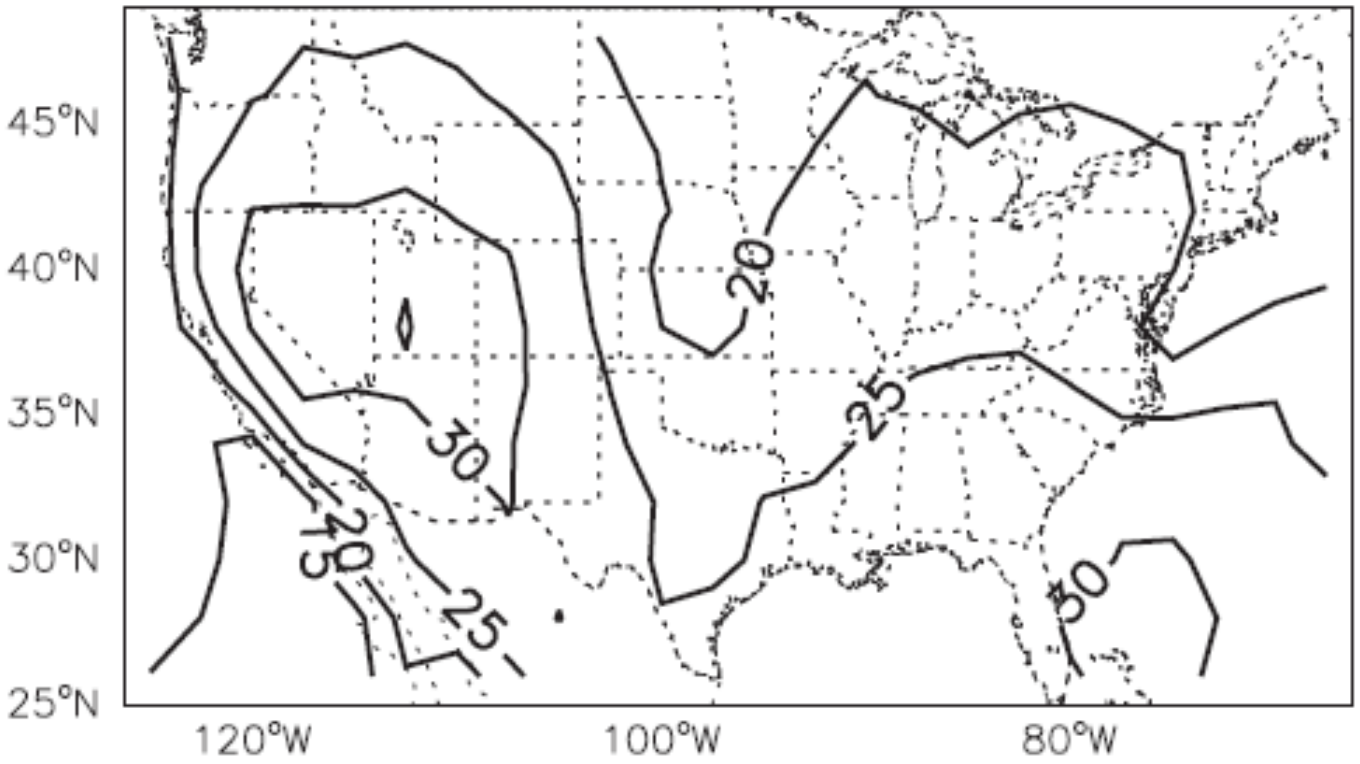

Figure 10. Mean afternoon (1300–1700 LT) background O_3 concentration (ppbv) in surface air in the GEOS-CHEM model for the summer of 1995. The background is defined as O_3 produced outside the North American boundary layer (surface to 700 hPa).

PRB contribution from Asia and Europe

GEOS-CHEM result for all of US in 1995

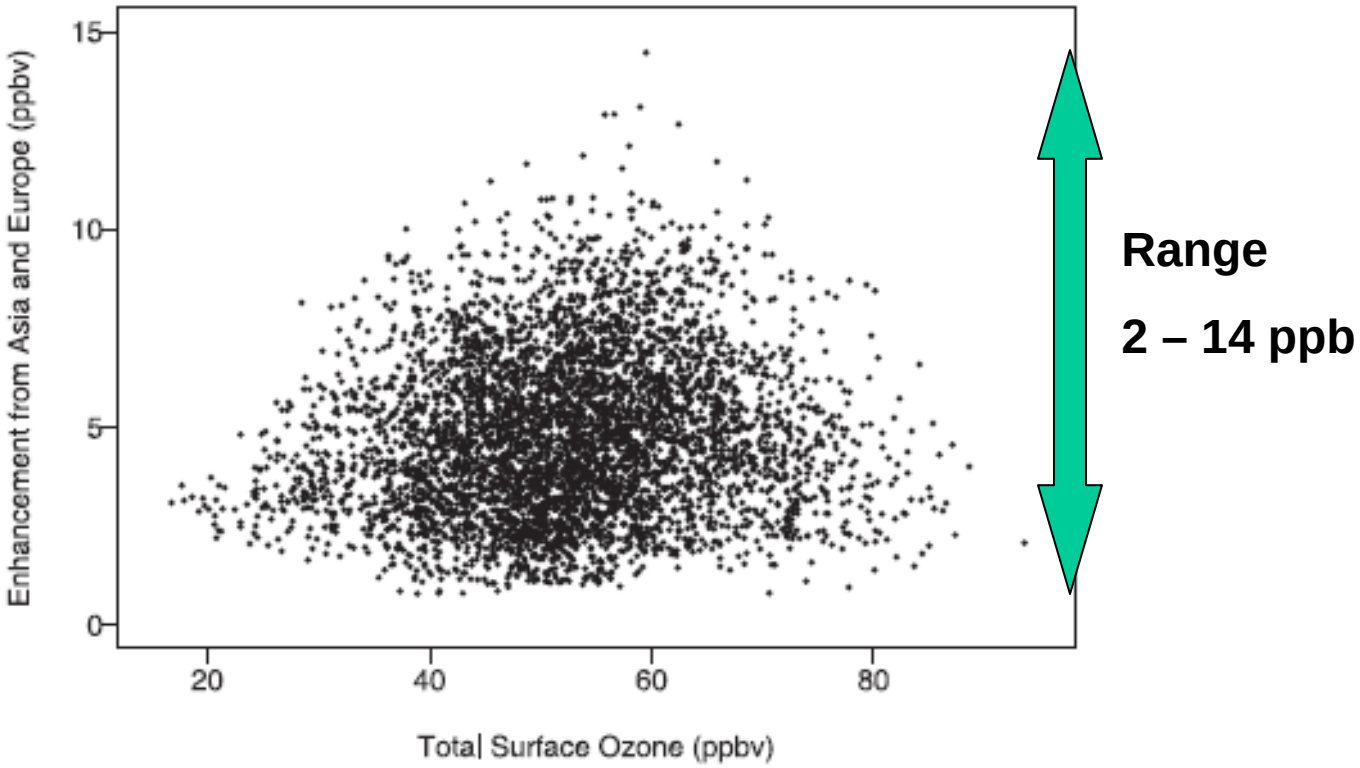

Figure 15. Enhancement to afternoon background O_3 in surface air over the United States due to anthropogenic emissions in Asia and Europe, plotted as a function of total O_3 concentrations in the model surface layer. Points represent daily afternoon (1300–1700 LT) model values for the ensemble of days in June–August 1995 for all U.S. grid squares.

Is PRB Constant or Changing?

- **Work just published analyzed trends in ozone crossing the Pacific Ocean to the west coasts of North America**
  - "An effective method is presented for determining the ozone (O3) mixing ratio in the onshore flow of marine air at the North American west coast"
  - "The average trend in mean annual ozone is 0.34±0.09 ppbv/yr"
  - Published Atmos. Chem. Phys., 9, 1303–1323, 2009
- Ozone concentrations at the West Coast have been increasing at 3.4 ppb per decade due to emissions in Asia

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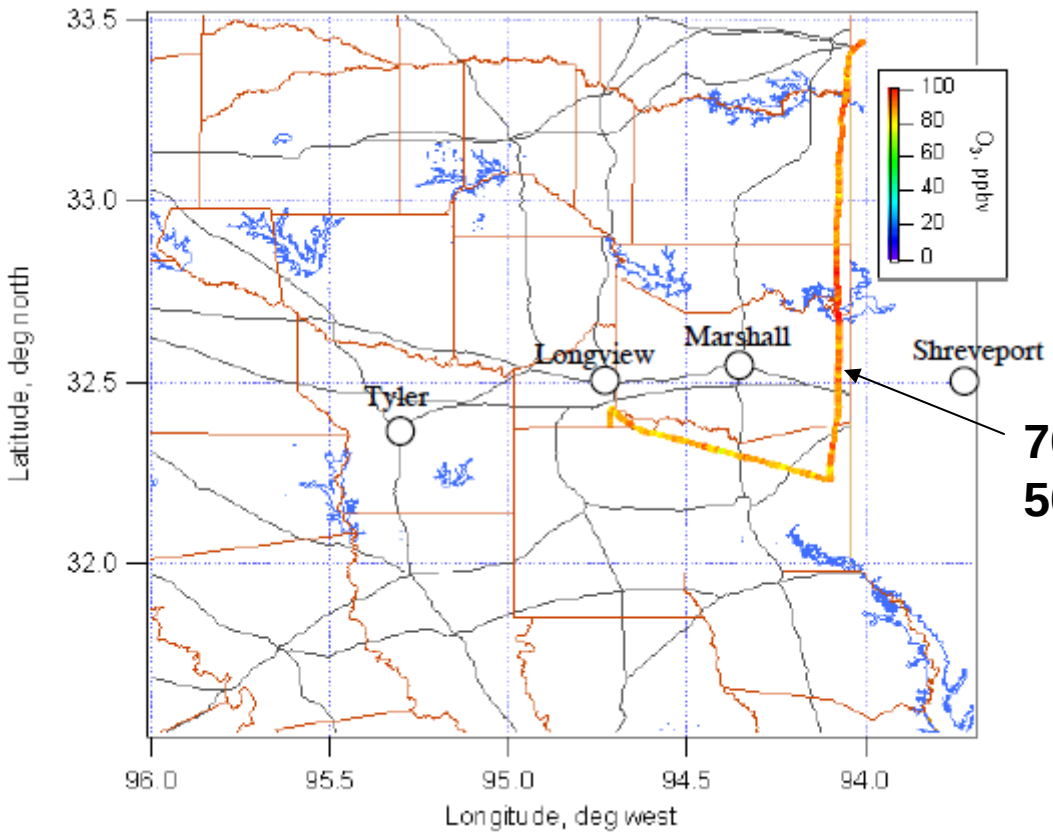
Ozone Background in NE Texas

- Varies widely between clean and polluted conditions
- Aircraft lights have characterized some days with very high background
- Can estimate from TCEQ monitors in NE Texas, especially Karnack

August 29, 2002: Background Ozone

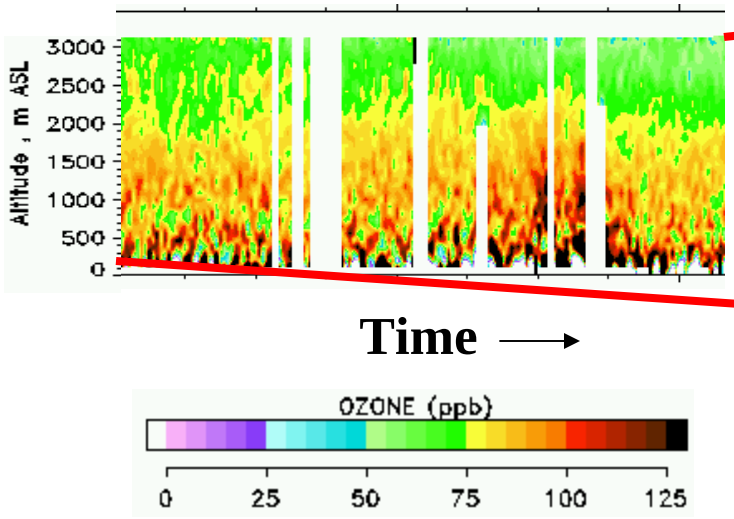


70-85 ppb measured 500-600 m aloft

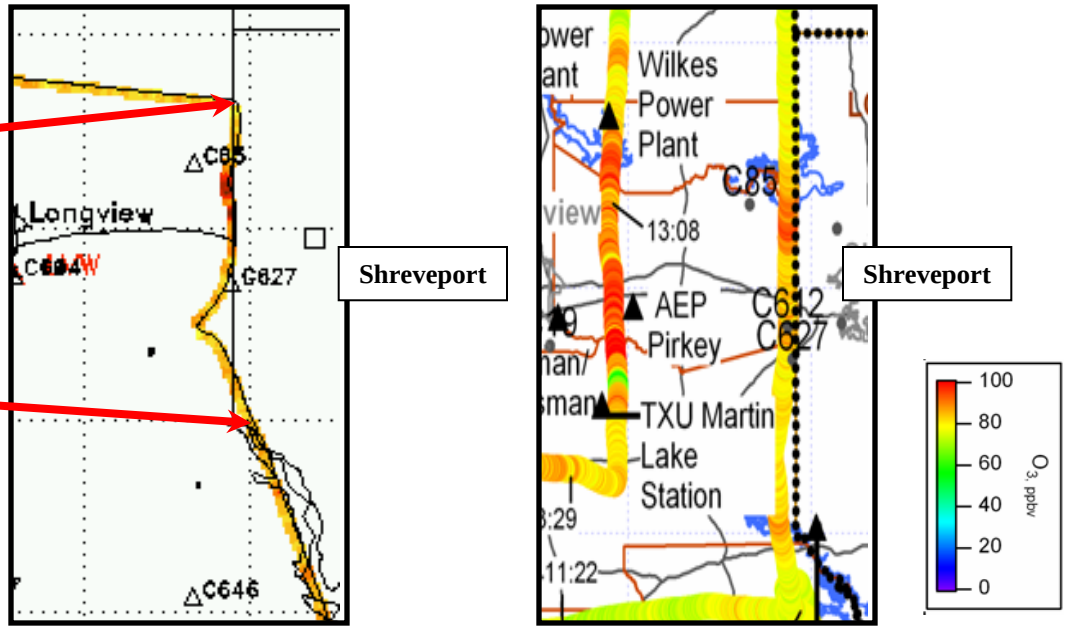
- Baylor aircraft flight, northeasterly winds
- 8-hour daily max ozone ranged from 76 ppb at Tyler to 88 ppb at Karnack

September 8, 2006: Background Ozone

NOAA Twin Otter

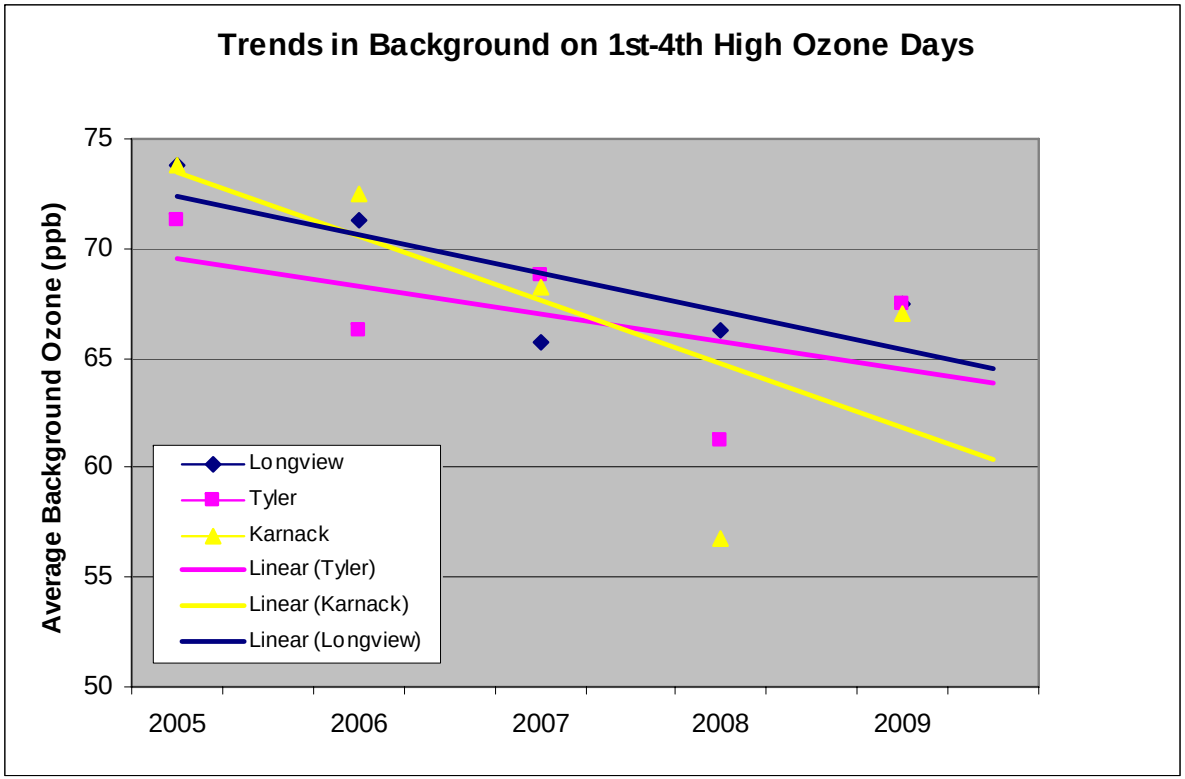


Baylor Aircraft



- Baylor and NOAA aircraft find 75-80 ppb ozone along LA border
- Both detect ozone enhancement in Shreveport urban plume

Trends in Diagnosed Background Ozone



- Background ozone declining, ~4-7 ppb decrease from 2005-2009

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End