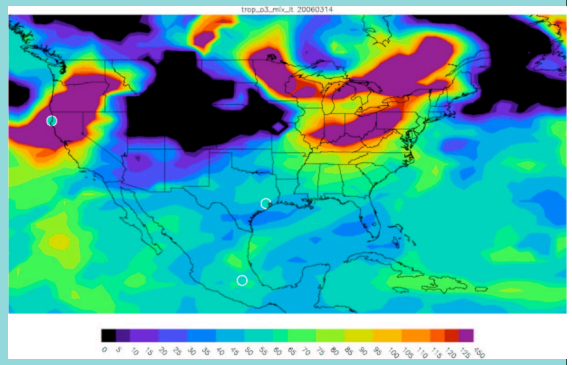
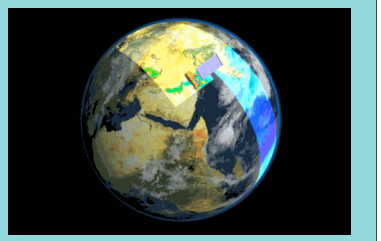
Robert B. Chatfield and Robert Esswein,
NASA Ames Research Ctr.;
Dennis Fitz, U.C. Riverside
Mark Schoeberl (GSFC), Greg Osterman (JPL)
IONS Ozonesonde Team
(J. B. Kumer, J. L. Mergenthaler, A. E. Roche, Lockheed Martin Advanced Technology Ctr)



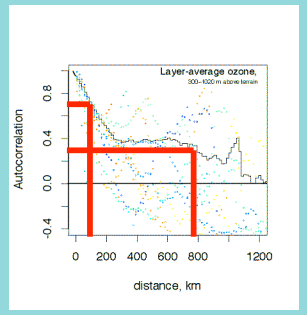
OMI-MLS
Mexican Plume

Tropospheric Ozone Relevant to Regional Smog — Synoptic Views and Validation

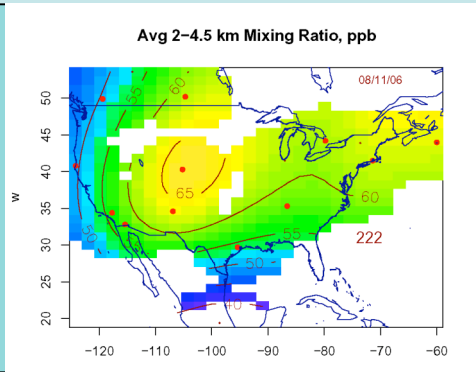
- *Views of the lower atmosphere accessible by current technology: How often and how close together do we need samples?*
- *What does the rich 2006 period tell us about <u>just-above-PBL ozone</u>?*
- *What does the tropospheric residual technique tell us, and why are sonde ozone amounts correlated, but show less range*
- *Under what other conditions can the partial success of OMI-MLS (for smog studies) be extended?*
- *How can we check TES - lower troposphere - within a broad continental context?*
- *Can we cross-validate TES and sondes while building a combined picture?*
- *What do we need to measure, understand, and forecast large-scale smog ozone ?*

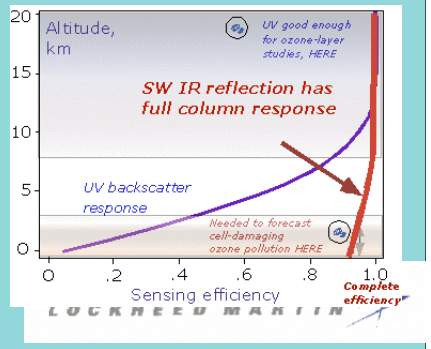


IR methods !



IONS — Regional consistency





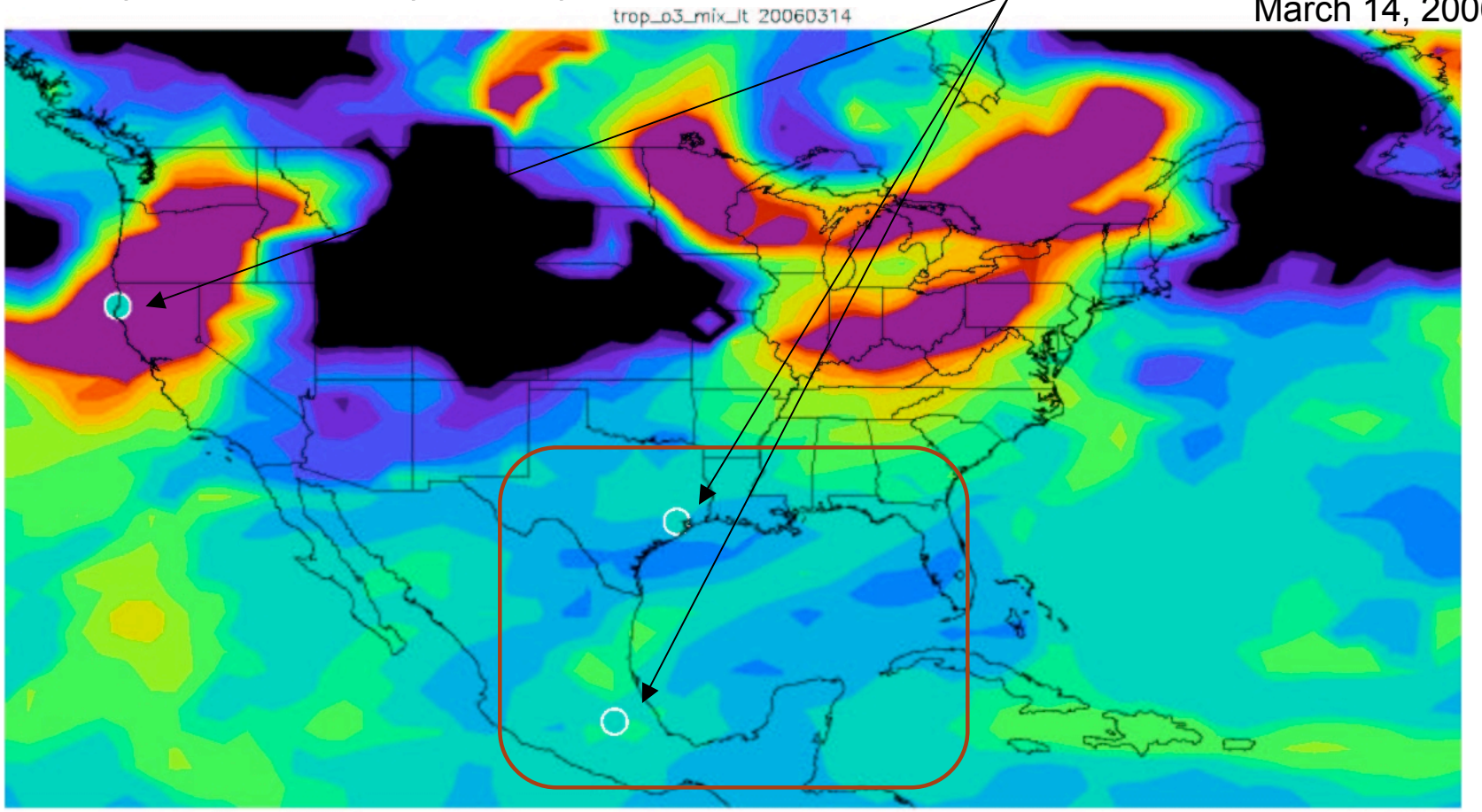
Total Tropospheric Ozone MR from Schoberl
OMI – MLS and Sondes capture
MexicoDF to US Plume event, Mar 13-15
with fair agreement of magnitudes

Schoeberl pre-Mar07 version

Subtropics easier to interpret, compare

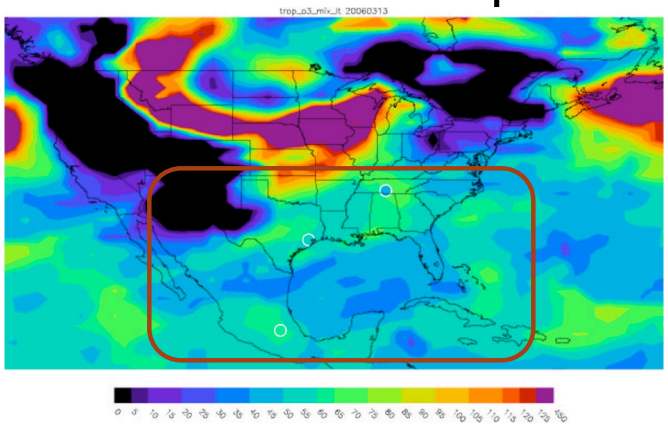
IONS Sondes *(best when they "disappear")*

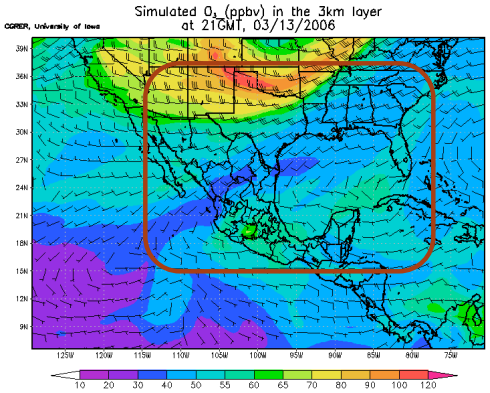
March 14, 2006



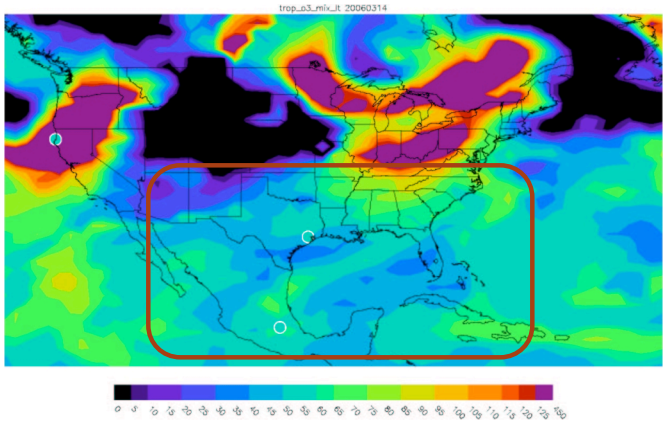
mean O_3, ppb

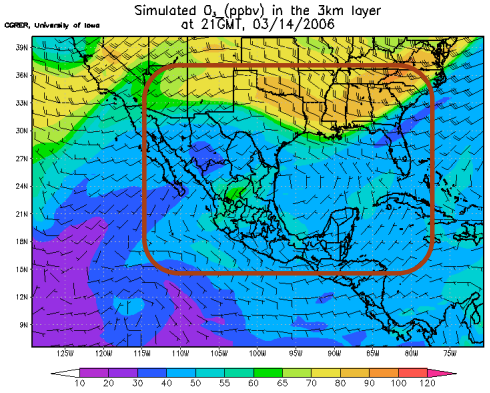
OMI – MLS and Sondes for Mar 13–15
compare well to Tang - CGRER 18-hr Forecasts



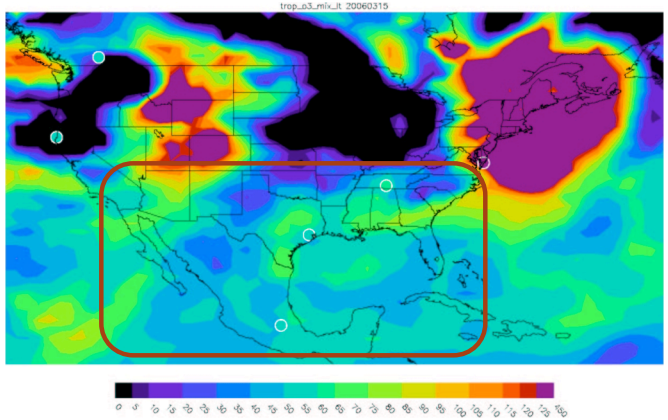


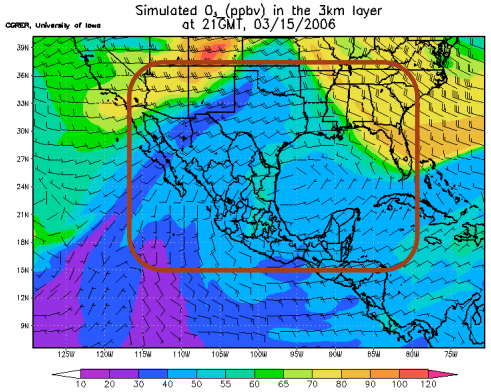
March 13, 2006





March 14, 2006

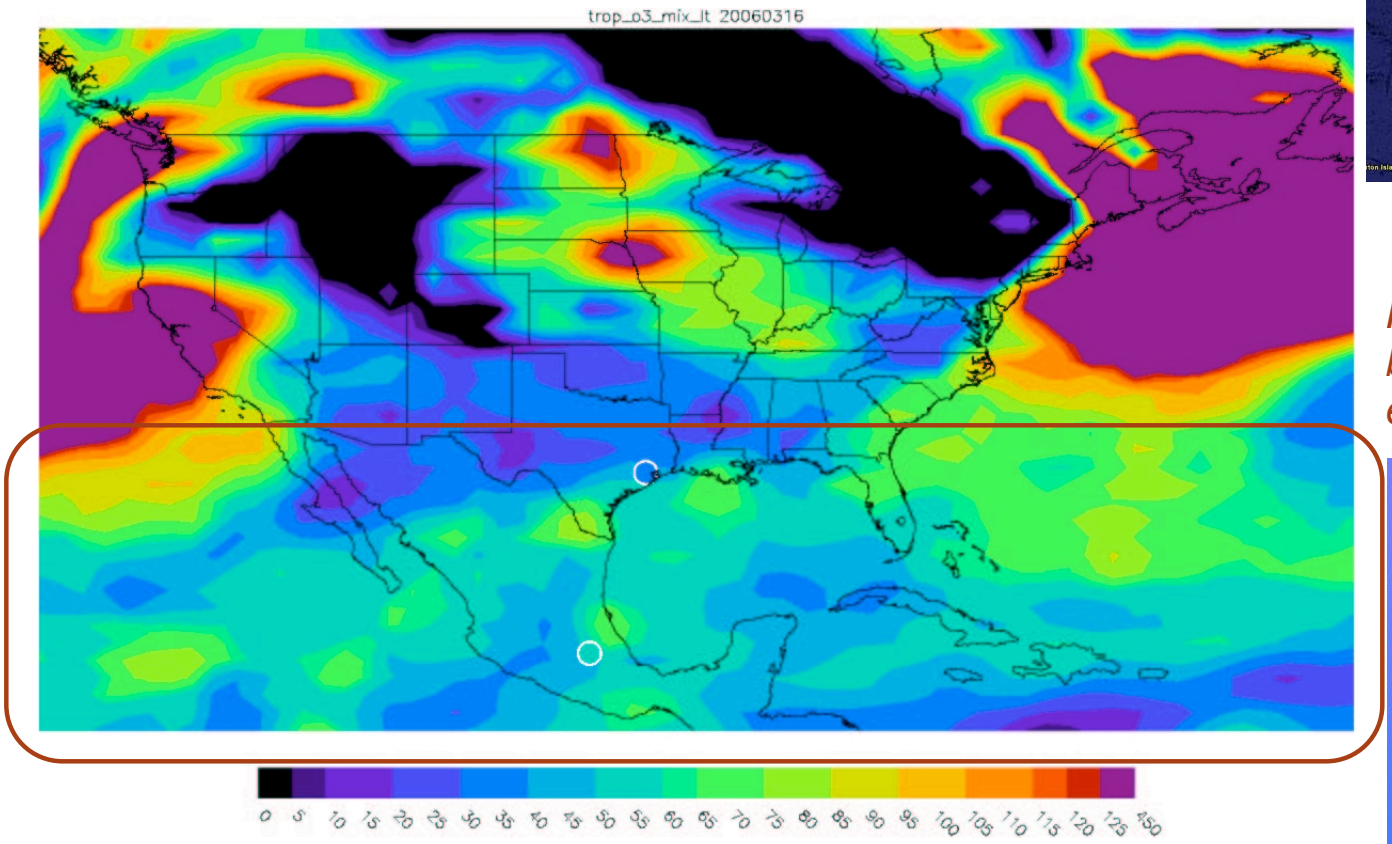


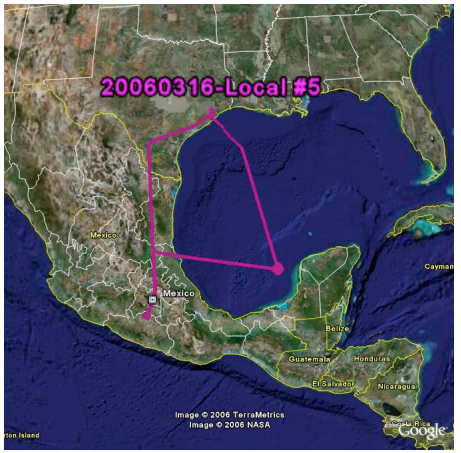


March 15, 2006

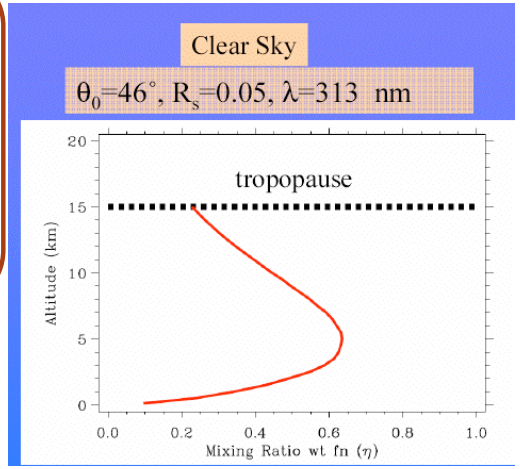
March 16 Mission shown passing through plume S of Louisiana

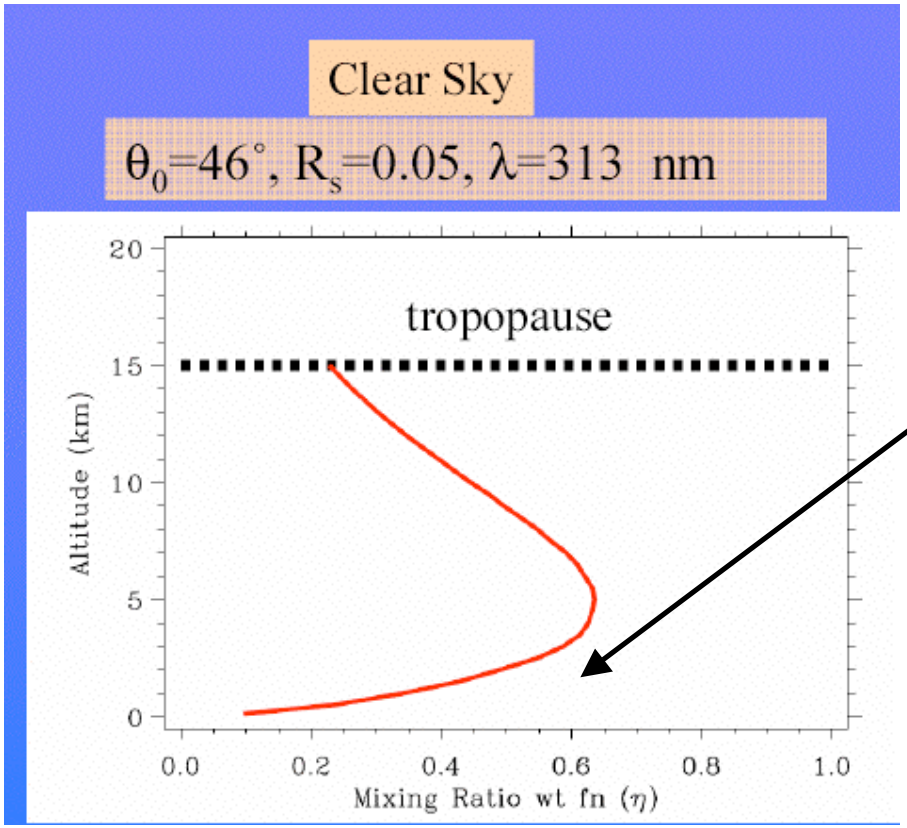
March 16, 2006





Region of better comparisons, easier interpretations.





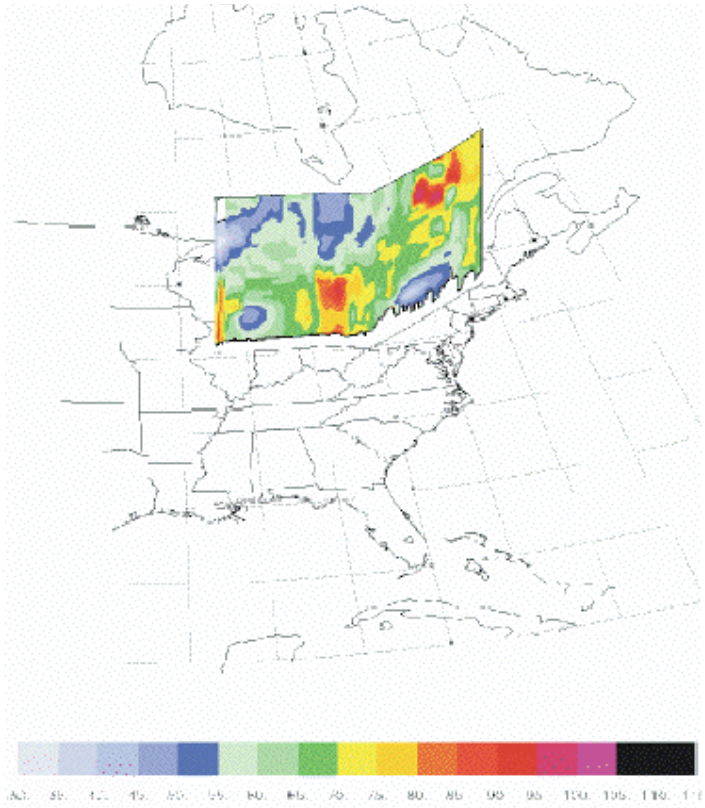
Tropospheric ozone sensitivity poor in lower troposphere;

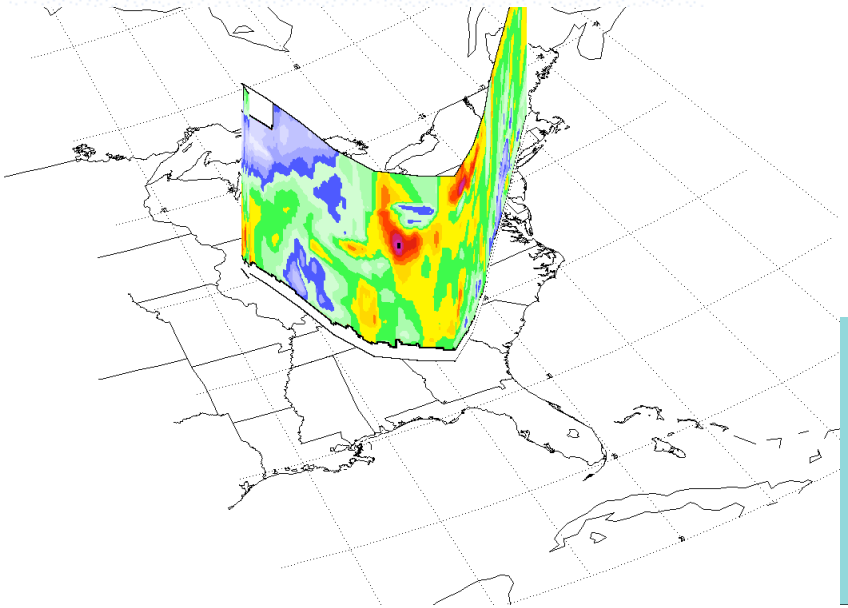
likely greater at border latitudes:
high surface albedo, less slant path

- wt fn is indep. of trace gas profile, depends weakly on λ, SZA and SatZA, and aerosols, but strongly affected by clouds and sfc albedo.
- no unmeasured component.
- insensitive to terrain ht.
- insensitive to trop ht. (if above >15 km)
- concept can be adapted to trace gases in PBL

This mixing ratio measure adapts easily to terrain and presence of clouds;
still: be careful about which levels are sampled!

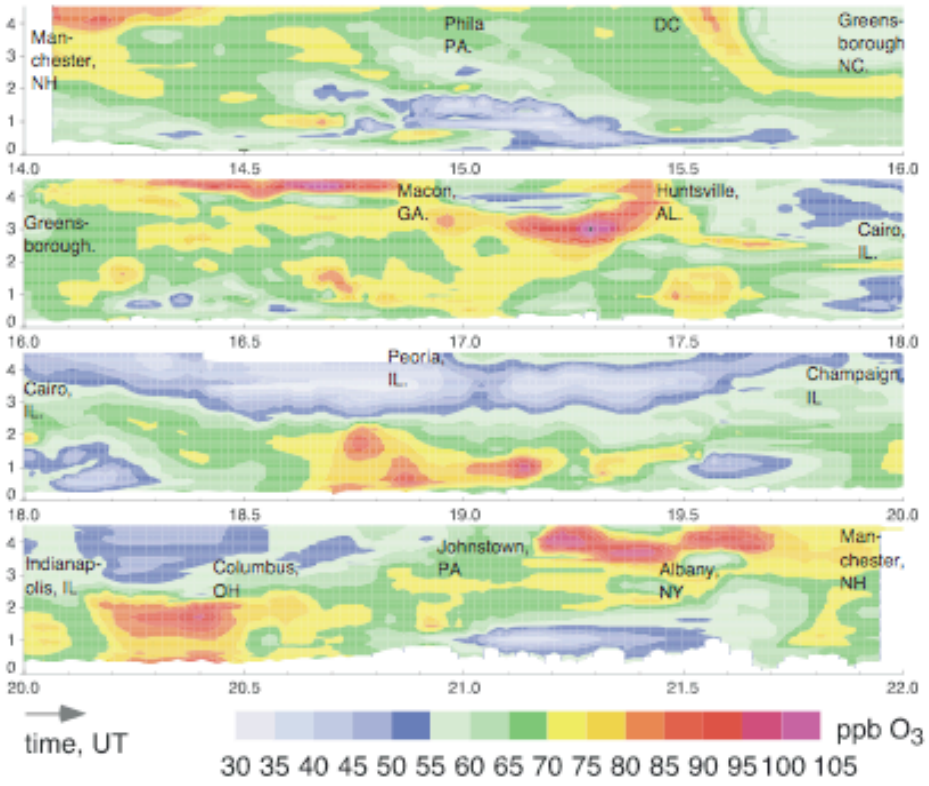
- *P.K. Bhartia, GSFC, progress report presentation, November, 2005*





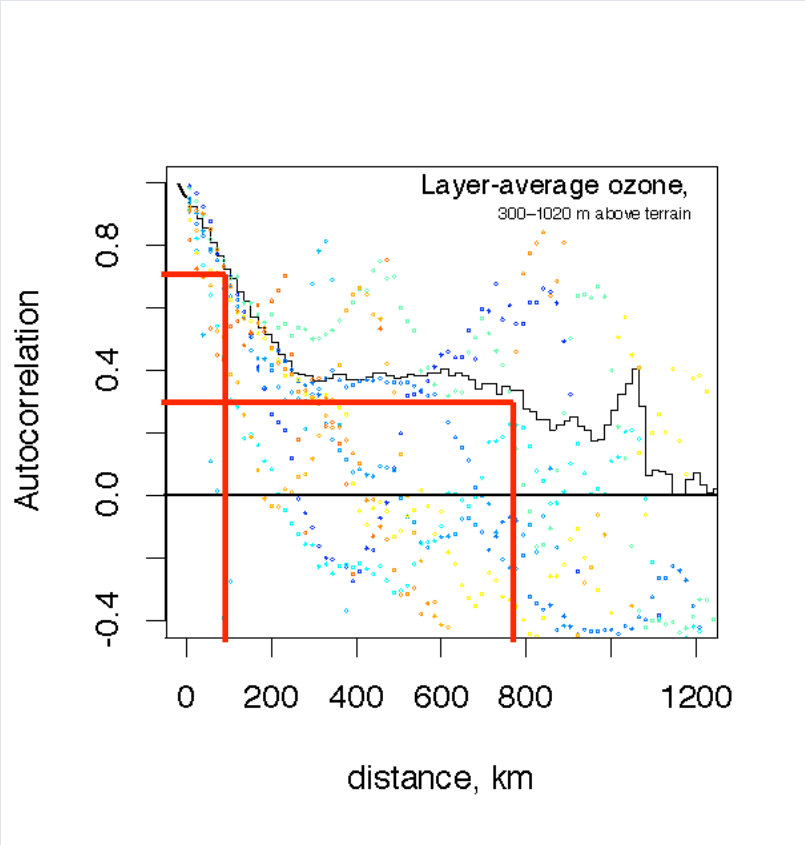
Ozone's variability

DIAL Differential Absorption LIDAR, …by Ed Browell and the Langley LIDAR team See: Chatfield et al., 2006a



Note layering 0–1.3(?) km, 1.3m–3 km, similarity of values, and signs of interaction (via clouds?)

Autocorrelations Spatial Scales Drawn from DIAL LIDAR samples, INTEX-NA (ICARTT), July-Aug. 2004



Layer average, 300–1020 m

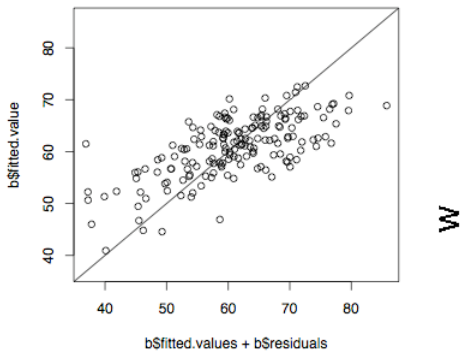
c = 0.7 … 50% variance explained

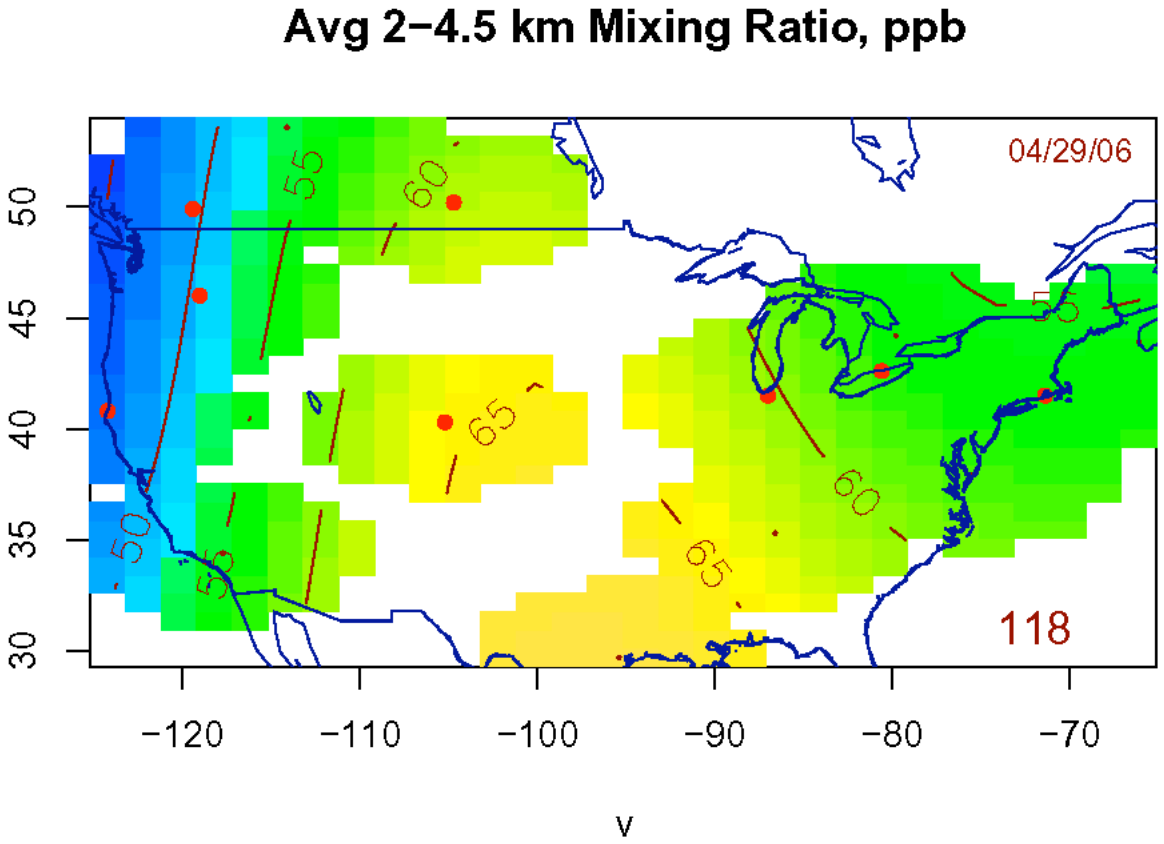
c = 0.36 defines "spatial scale"

What's going on: local (plume/antiplume effects) vs regional tendencies?)

LT Ozone May (IMPEX Period) … North America

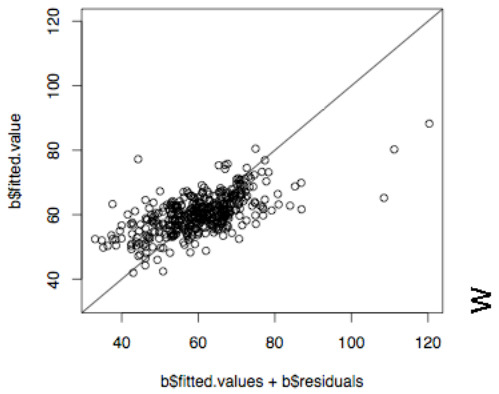
- The April-May period captured more LT ozone in the time-space smoothe

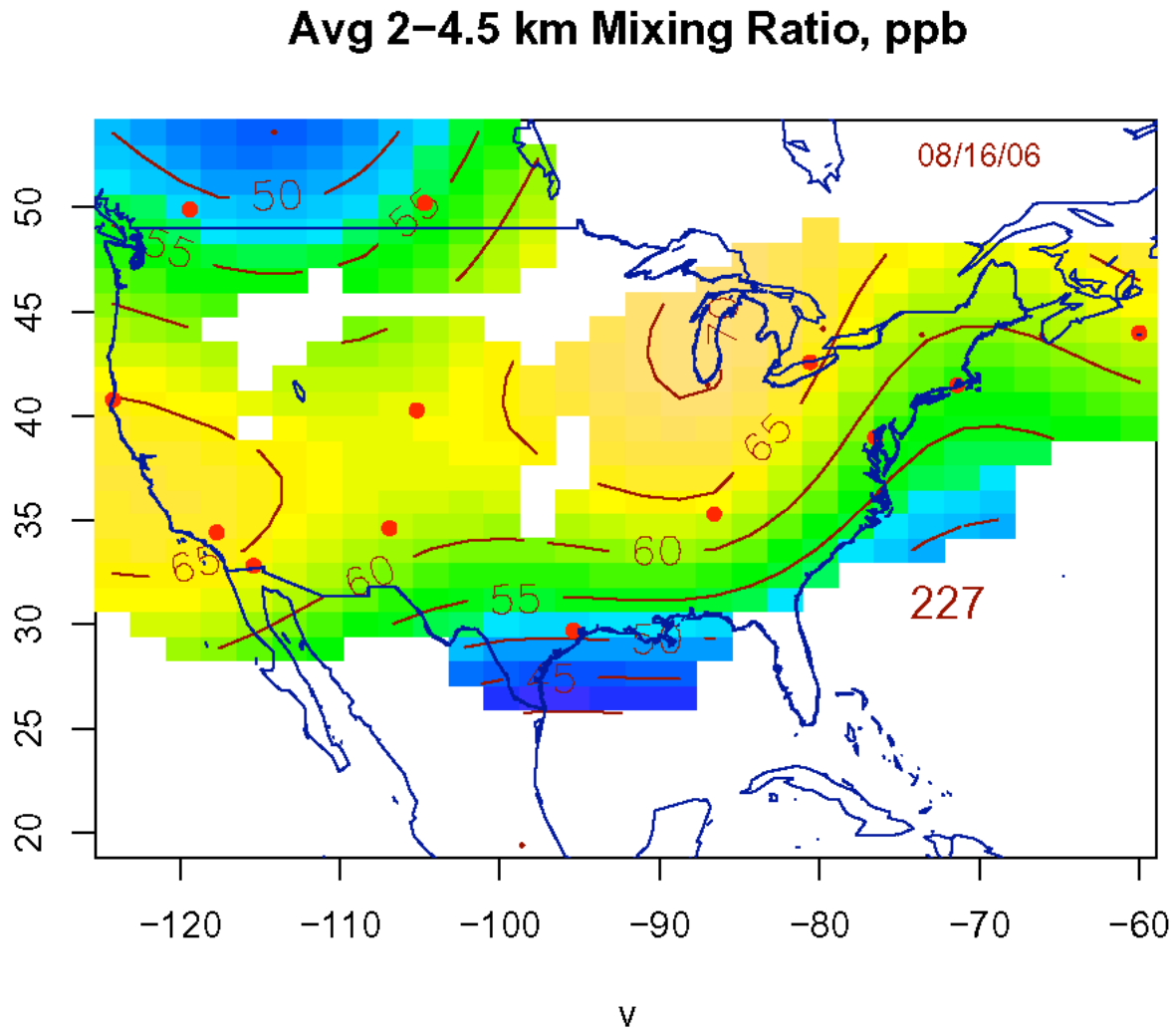




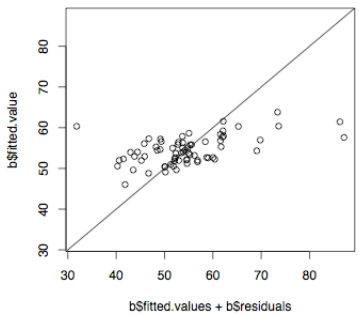
LT Ozone August (TexAQS Period)

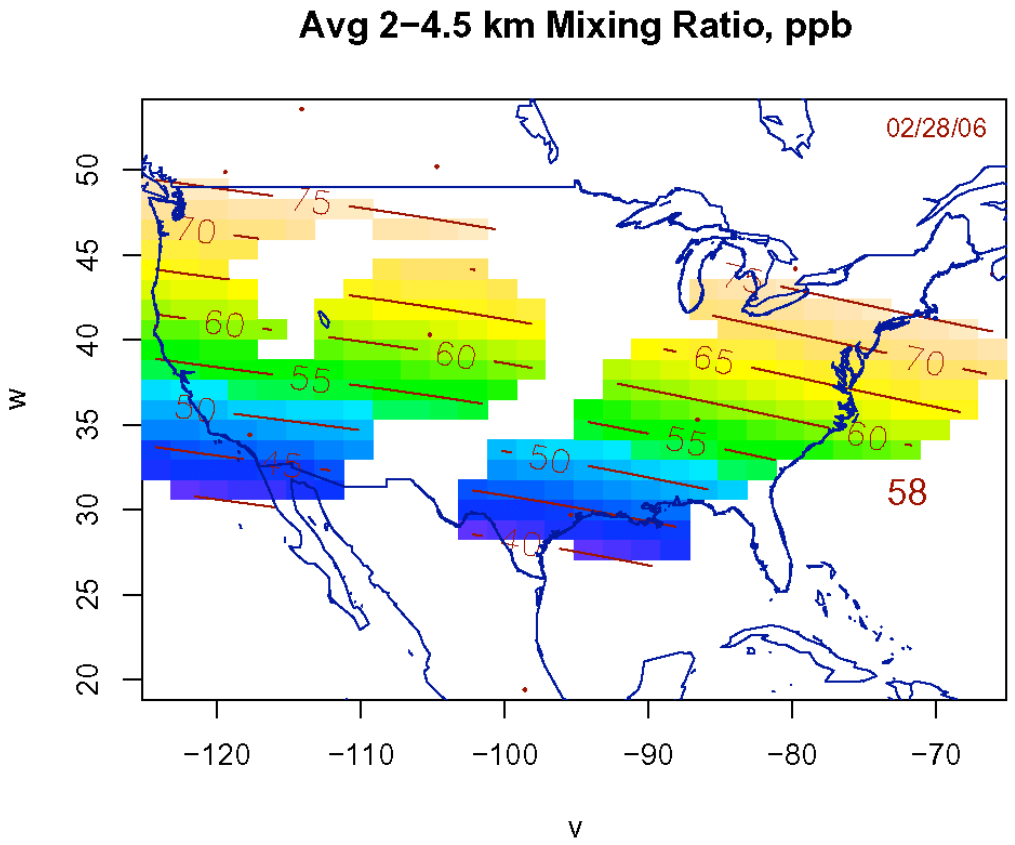
- The August period modestly well captured more LT ozone in the time-space smoothe





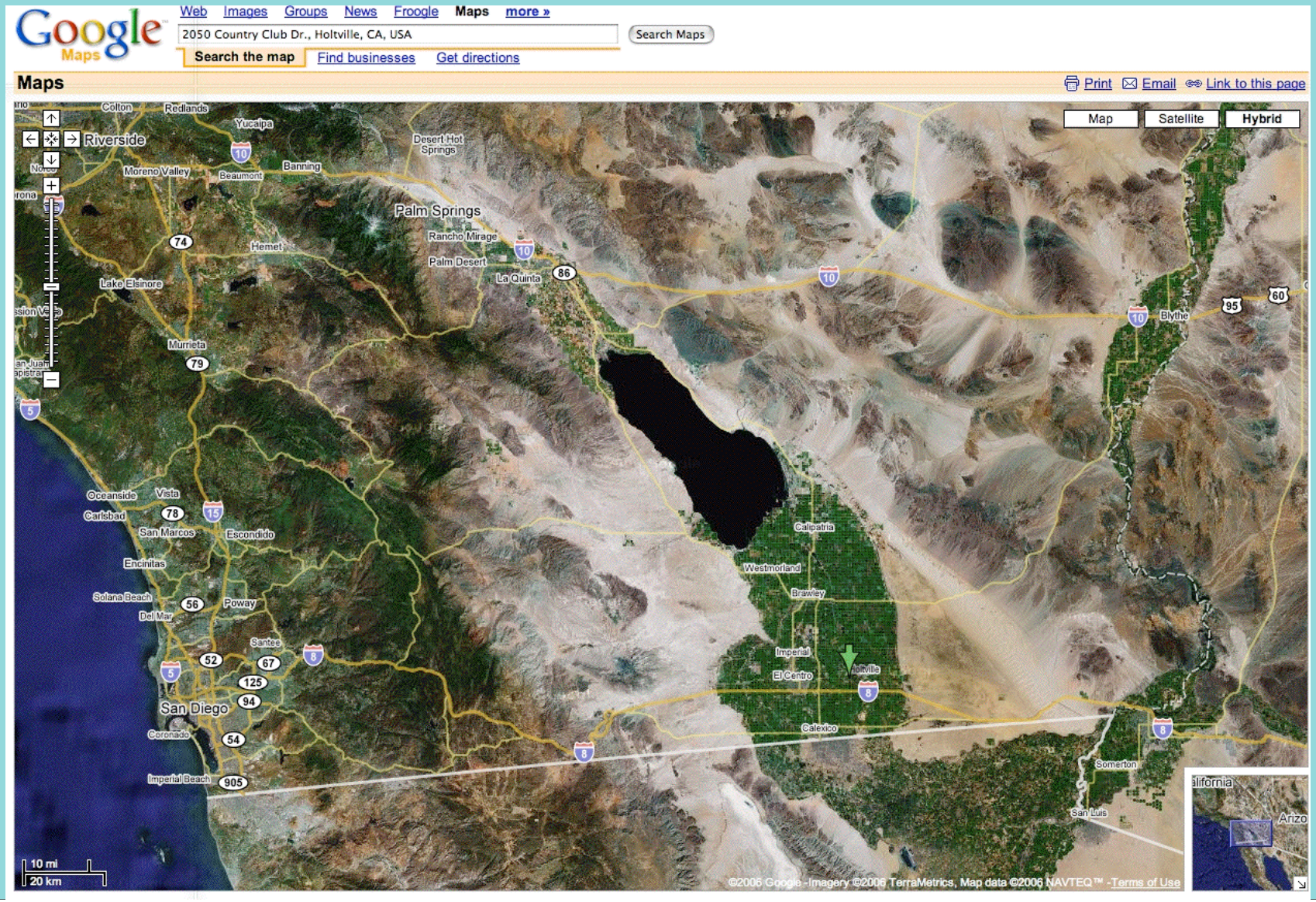
LT Ozone March-MILAGRO Period



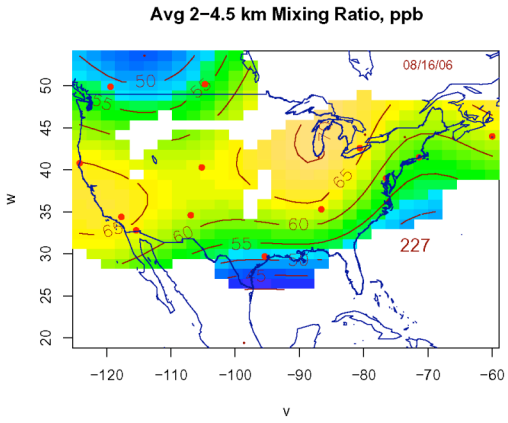


NOT Shown … but poor ability to fit (large variability, few sondes) mentioned

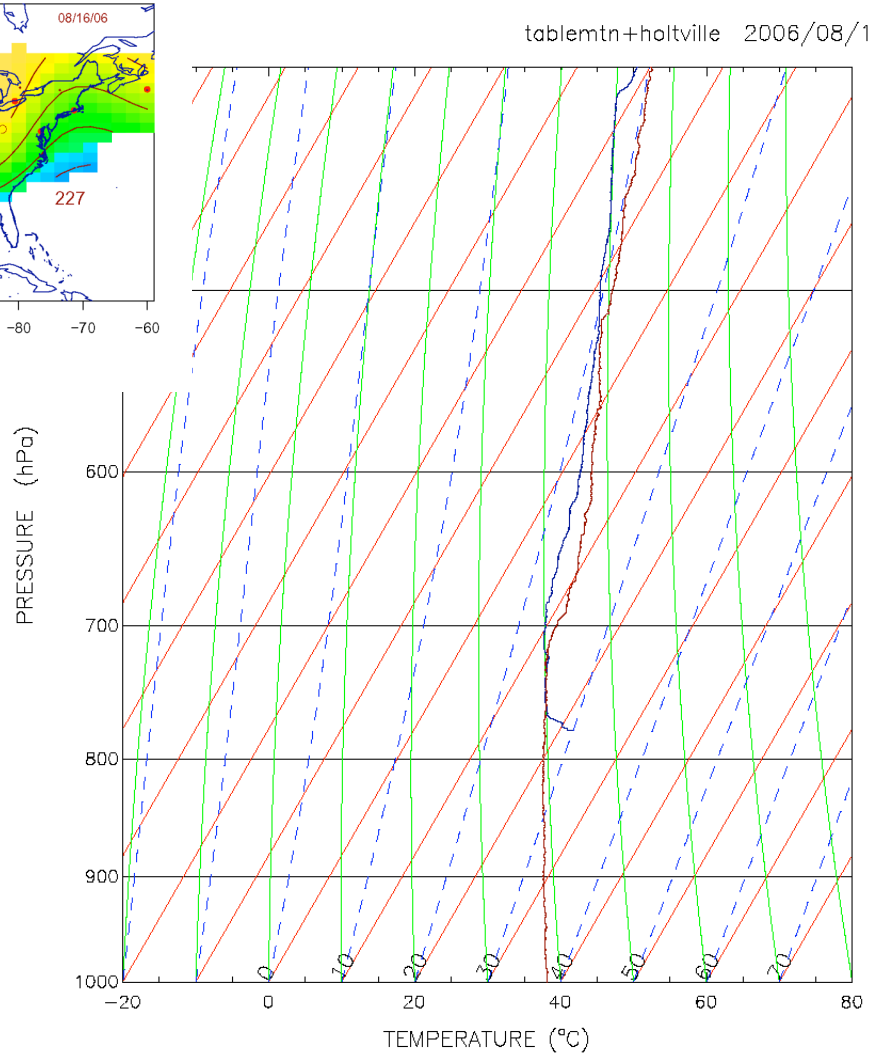
Using satellite data to understand smog ozone: a very current example

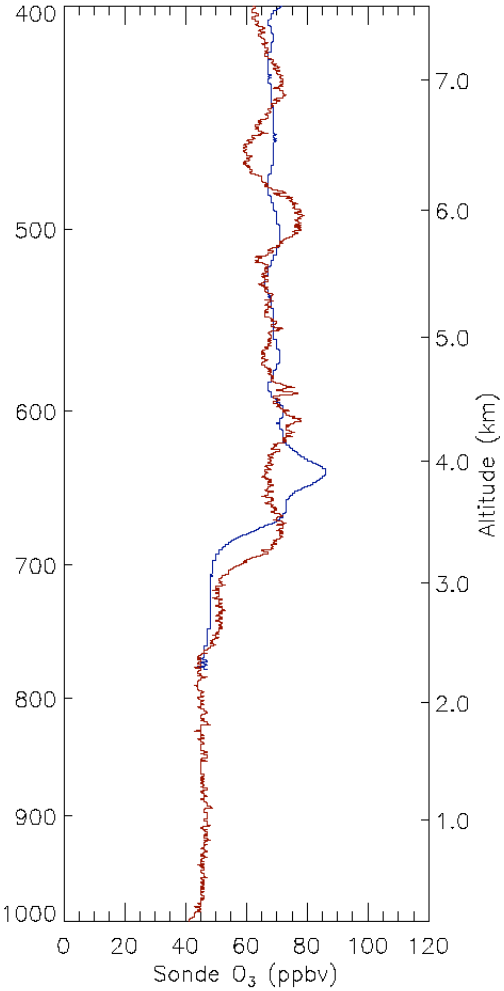


Holtville and Table Mountain in Southern California
Close correlation of nearby sondes … sometimes

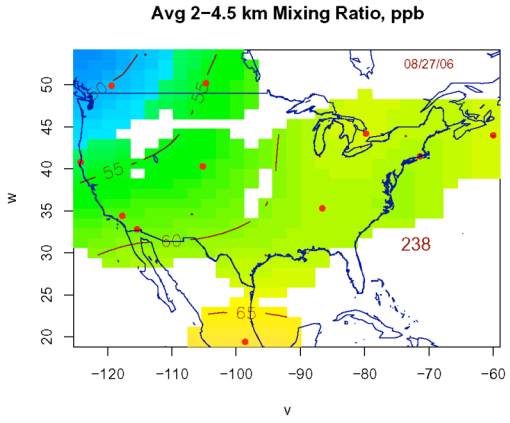


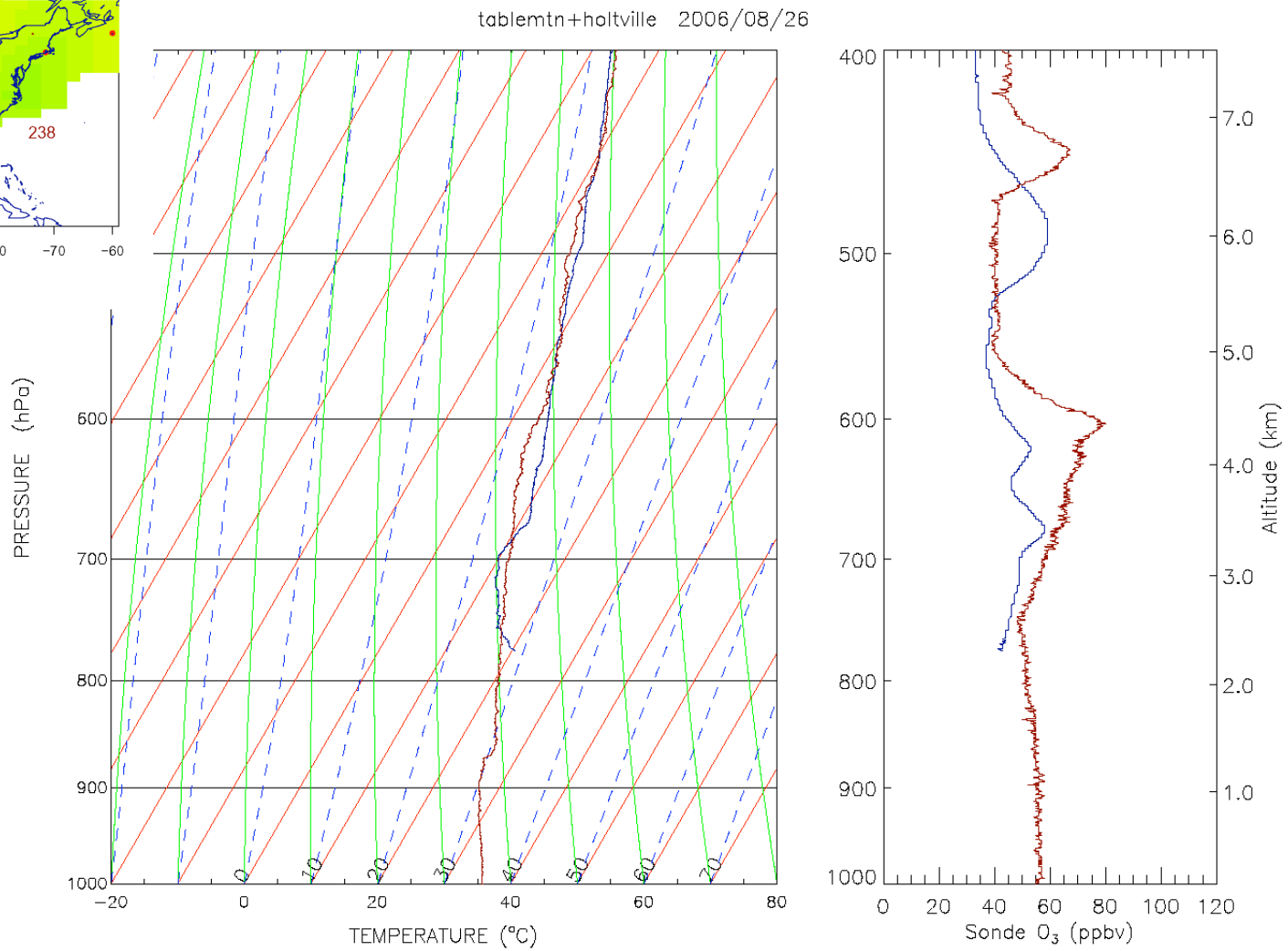
Holtville Launches
UC Riverside /
Dennis Fitz &
James Bristow



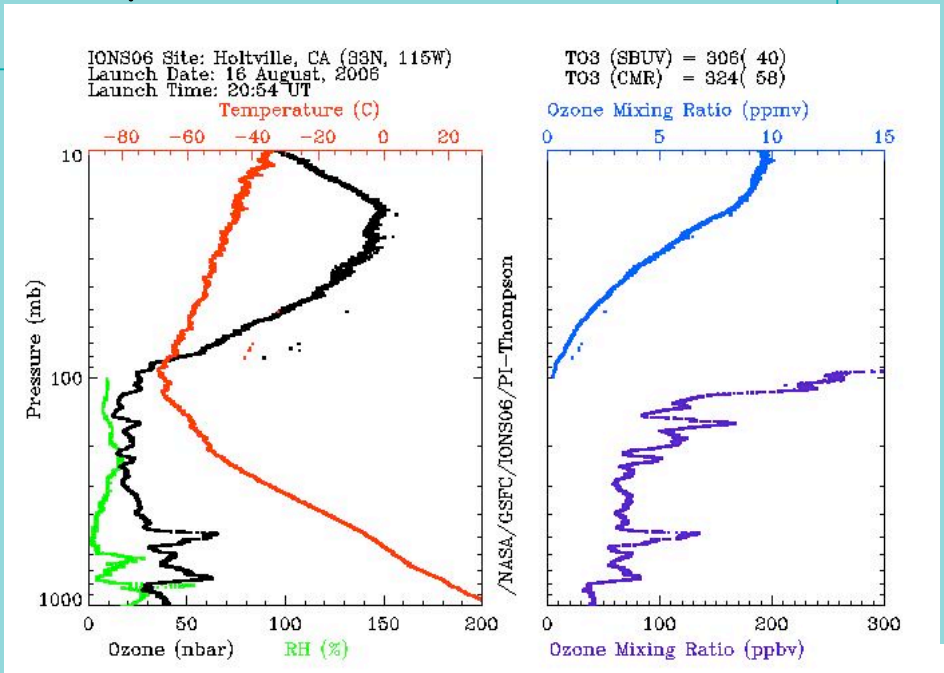


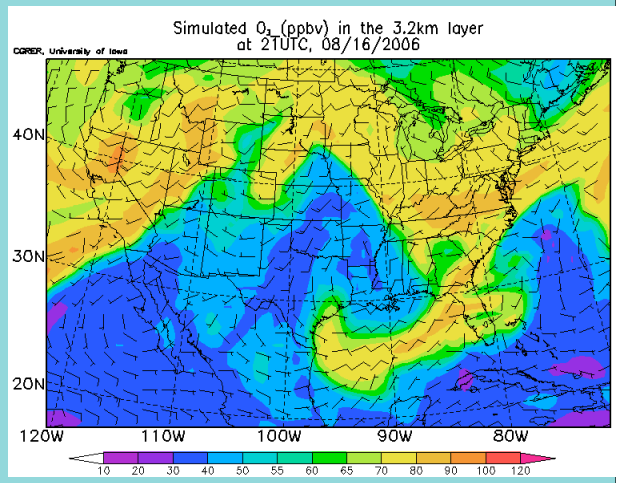
Holtville and Table Mountain in Southern California Sometimes less correlation

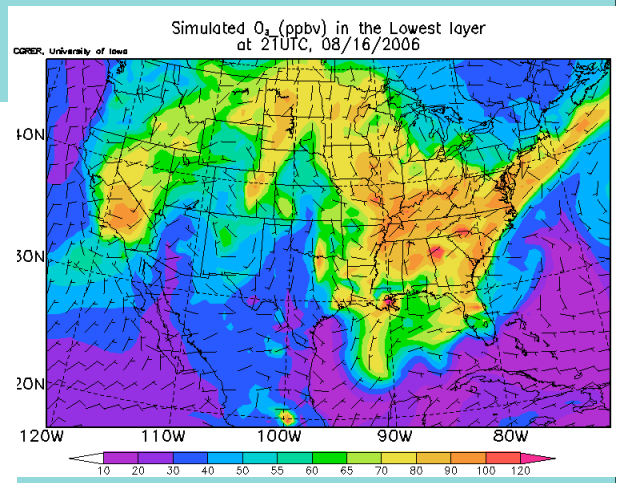




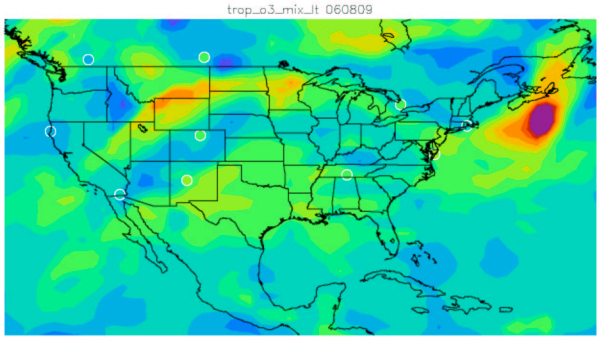
- Layering of ozone in PBL and elevated layers often confound lower-tropospheric interpretations





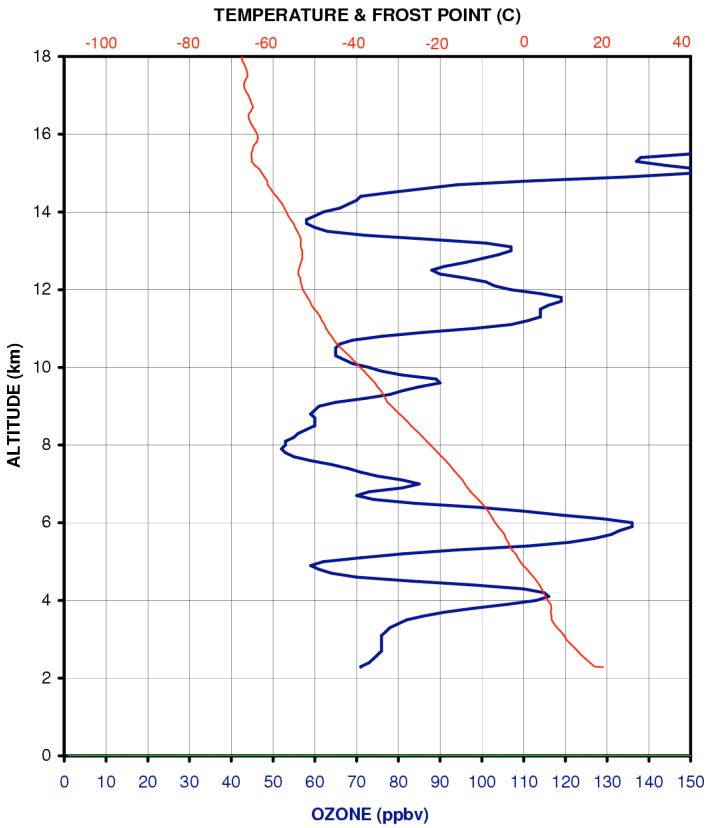


Holtville Launches
UC Riverside /
Dennis Fitz &
James Bristow

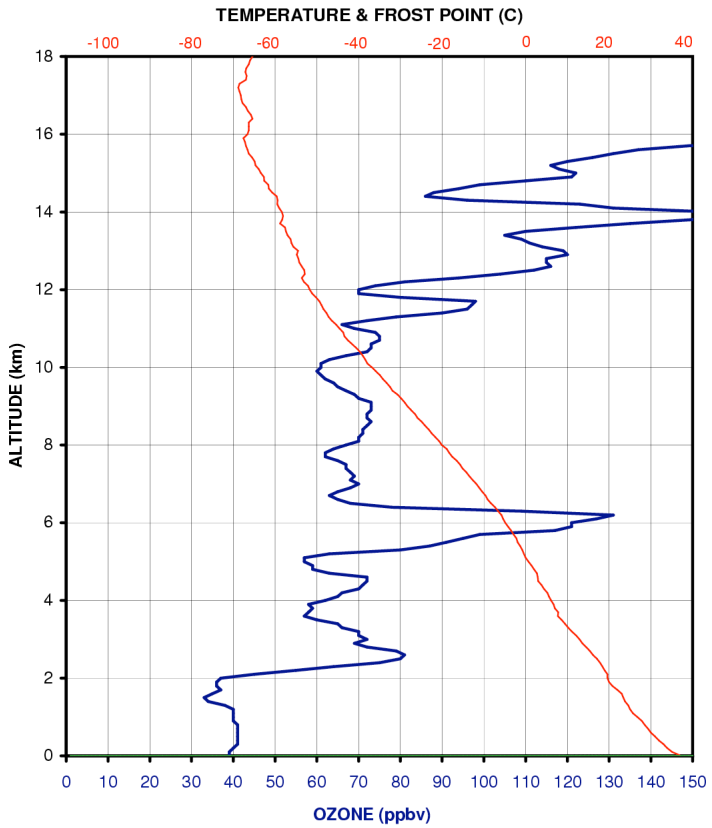


... Oltmans slide

Ozone Vertical Profile at Table Mountain, California
August 17, 2006 2005 GMT

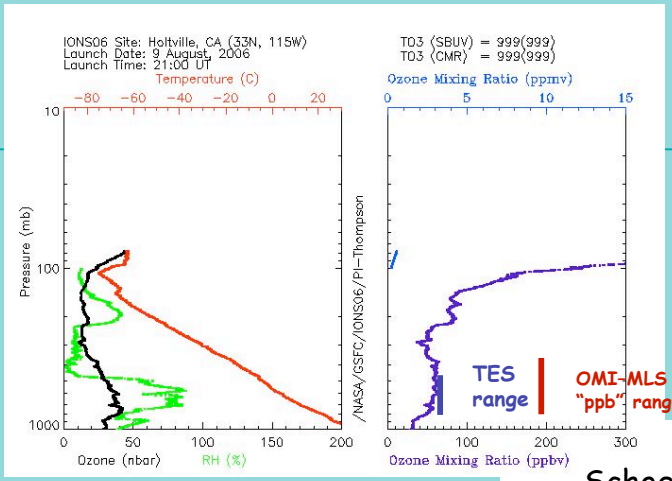


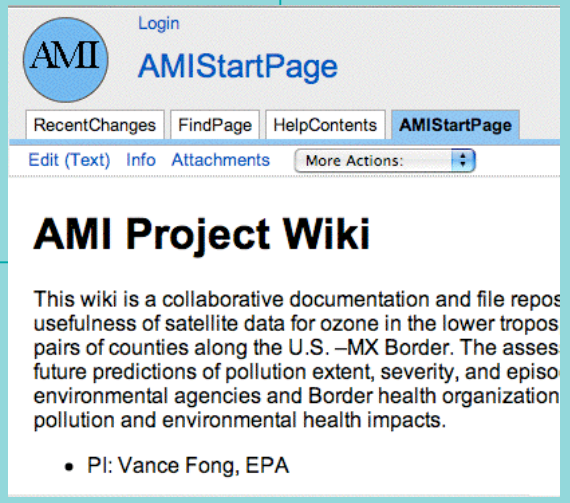
Ozone Vertical Profile at Holtville, California
August 16, 2006 2054 GMT



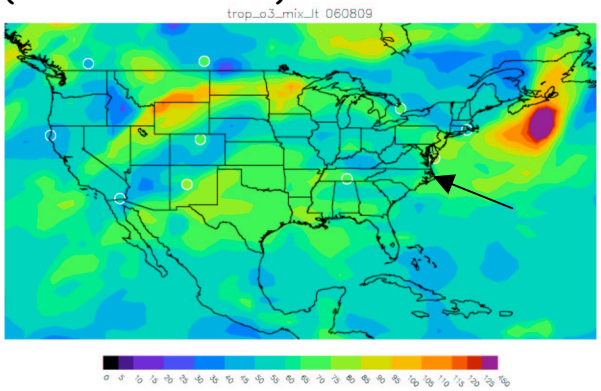
Looking for LT influences

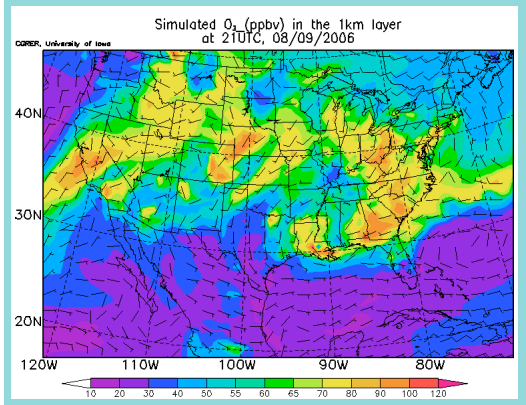
- Largely funded by an Environmental Protection Agency Advanced Measurements Initiative (AMI) project





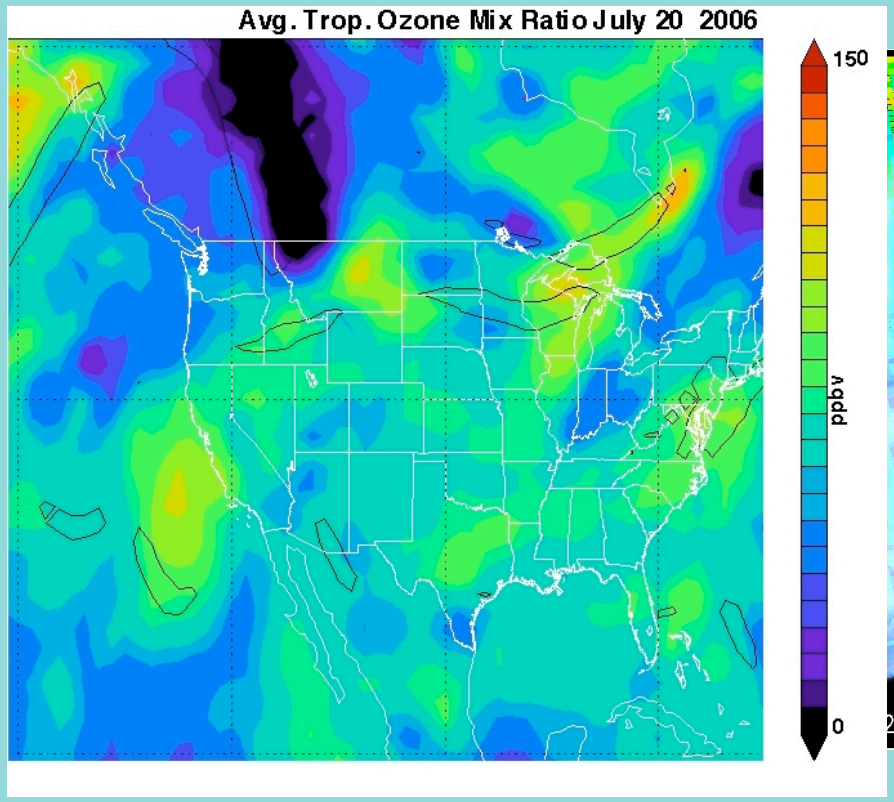
Schoeberl OMI-MLS tropopause technique (March 07 version)

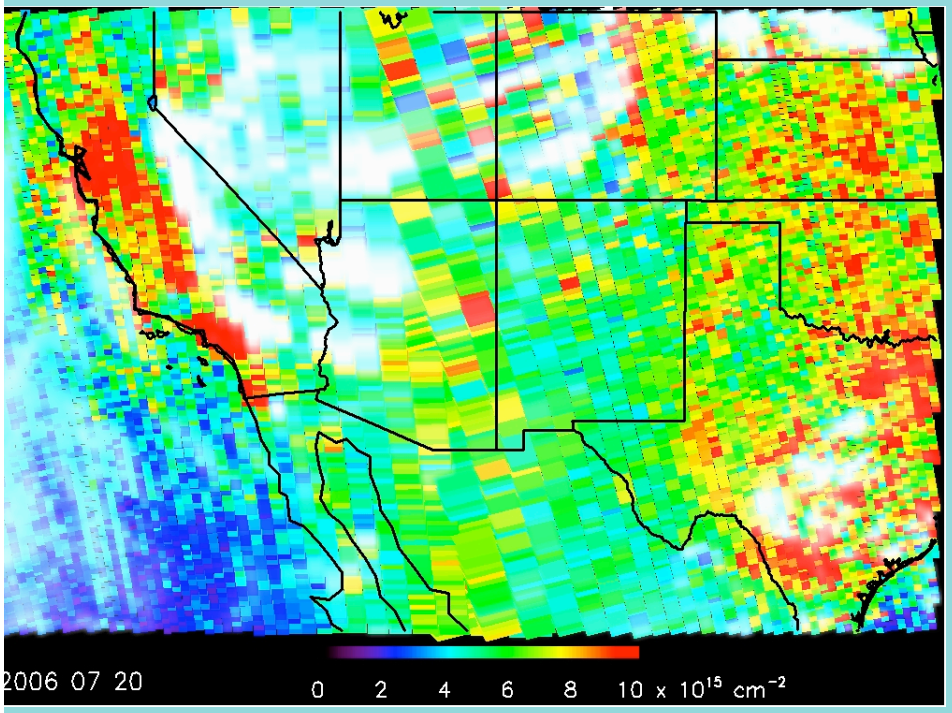




Northern/Western California Heat Wave and Smog Episode

Note footprint width towards limb



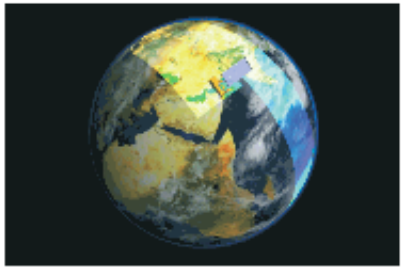


- **OMI tropospheric O_3 sees some effects: Mark Schoeberl, GSFC (Contours are front/stratosphere indicators)**

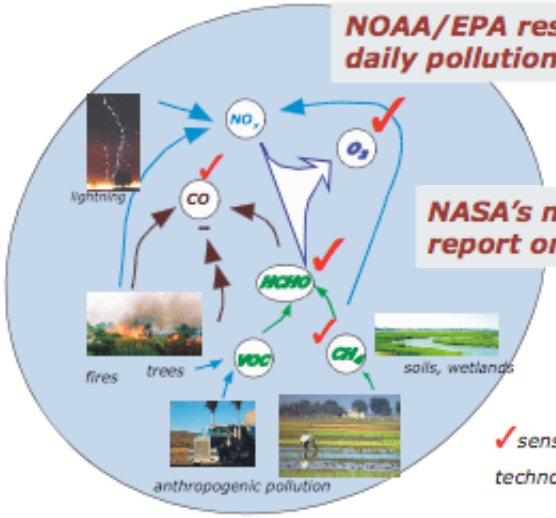
- OMI tropospheric NO_2 sees clearly, but describes O_3 generation, not O_3 (Gleason/Bucsela, GSFC).

Robust Infrared Mapping for Tropospheric Ozone Prediction

R. Chatfield / Ames, J. Kumer, A.Roche, J. Mergenthaler / L-M ATC Palo Alto,
L. Strowe / UM BC, ... K. Chance / Harvard-Smithsonian Astrophysics



NOAA/EPA responsiblity for daily pollution forecasts



NASA's mandate to report on Earth's ozone

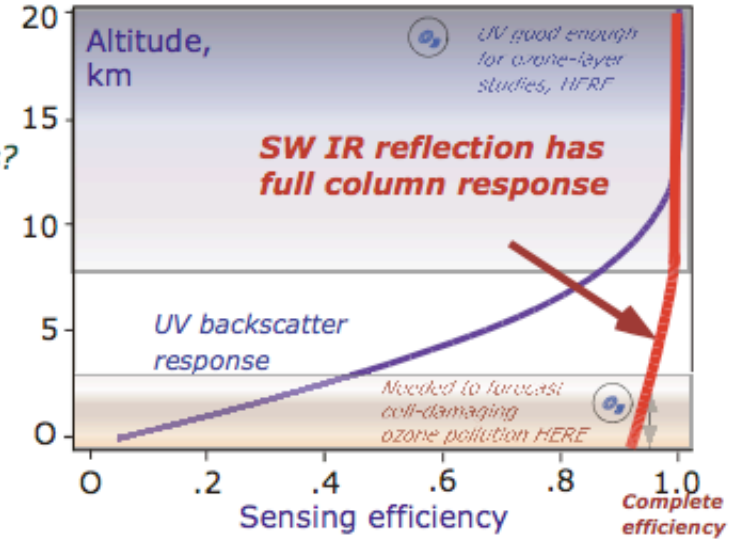
✓ *sensed by this technology !*

Tropospheric Infrared Mapping Spectrometry

- ***Elegant, small, robust, cheap: Grating Mapping Spectrometers have ONE MOVING PART, vis: Cal On/Off ... ~20 kg + radiative cooling, etc.***
- *Daily, global maps to highlight regional and long-distance pollution threats.*

- *UNEXPLORED reflective IR wavelengths usable with new detector technology: complement or supplant limited UV techniques?*

TIMS adds tropospheric information allowing 0–2 km O3 to ~15% per area



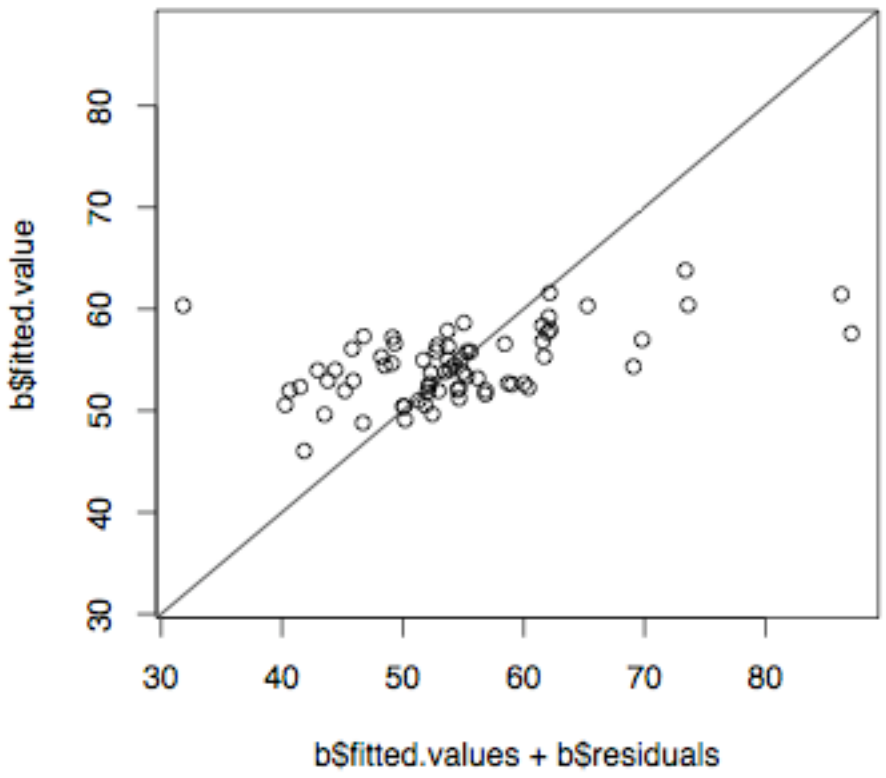
A Basic Demonstration Sensor Set: O_3 and HCHO

Spectral Region	Approx. λ	Frequency resolution	Nadir ELF [1]	Primary Measurement (potential measurement)	Consequent Additional Benefits
SWIR	3.56 μm	< 0.35 cm^{-1}	3.2 km	HCHO, CH_4, N_2O, and maybe some O_3 info	HCHO summarizes pollution Volatile Organic Carbon compound smog-activity; high precision column info and some vertical info for HCHO, CH_4 & N_2O
SWIR	3.3 μm	< 0.35 cm^{-1}	3.2 km	O_3, CH_4 Good reflectivity	Adding 2nd slit gives more O_3 sensitivity

1- ELF: Elemental (smallest sampled) footprint
2- BL: Planetary Boundary Layer

LT Ozone March-MILAGRO Period

- Time-space technique variability over North
- Spring is complex



Overview

- *What can current satellite retrievals tell about smog ozone and its orgins? Our experience: a current field study: What do we need?*
- *Problem 1: Near "Full Column" Tropospheric ozone sampling*
  - *Limitations of UV: full column has many MT/UT "distractions*
  - *UV information useful for Mexico-City / Central Mexico ozone plume*
    - *Subtropical and lofted plume*
- *Problem 2: Intermittency in time and space of current measurements: we're tantatilizing close to 1.5 – 4.5 km ozone*
  - *Very helpful delineation from INTEX-B and TexAQS:*
  - *combining and "cross-validating" TES and Sondes for special periods will give us clear empirical coverage*
  - *What continuity of ozone should we expect?*
  - *PBL and just-above has considerable day-to-day persistence and spatial correlation, … with notable sharp exceptions.*
- *SWIR/MWIR Technology: What we can get … at small-sat. launch costing!*
  - *Advantages of UV + MWIR + Thermal IR*

FIN