Ozone Vertical Structure from IONS (INTEX Ozonesonde Network Study): "The Summer that Wasn't"

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Presentation

- IONS (INTEX Ozonesondes Network Study) Strategy

- Analyses, Activities to Date
  - 3-4 Papers at Fall 04 AGU
  - Mini-IONS Workshop (10 Mar 05, Boulder)

- Main Results
  - Thompson: The "Summer That Wasn't" – ***2004***
  - Cooper: Lagrangian view, IONS-MOZAIC
  - Morris: Houston Pollution & Alaskan Fires Case
  - Merrill: Closeup on Budgets (next talk)

- Goals for INTEX Workshop
  - Subtext - Rich dataset for multiple applications!

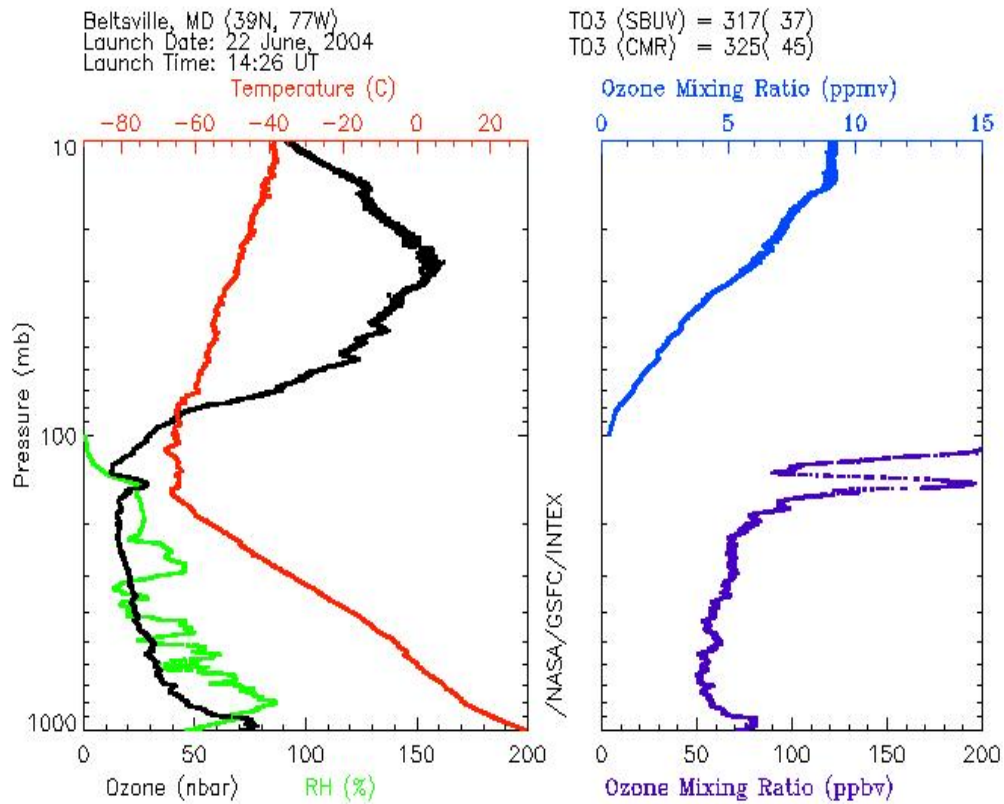
TROPOSPHERIC OZONE UNITS

Mixing ratio, ppbv; pollution > ~25 ppbv, 0 km

Column-integrated, DU; pollution > 25-30 DU

Ppmv – stratosphere; Total ozone w/ SBUV

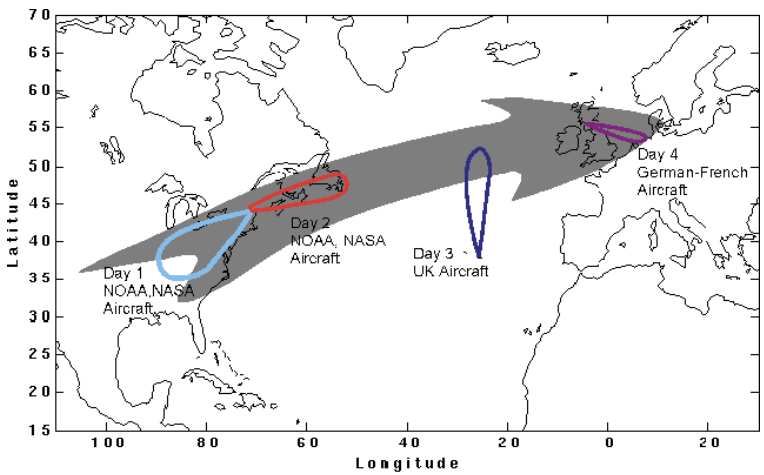
Free Trop = Climate, Long-range Impact BL = “Smog”

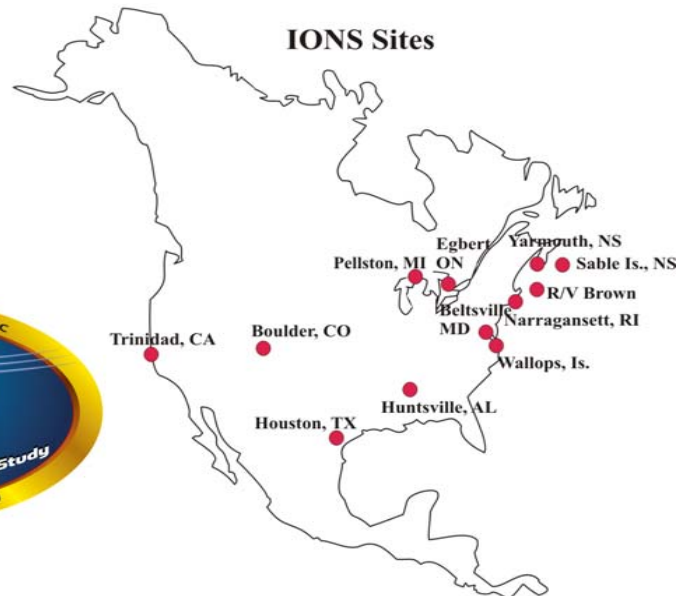


Define Ozone Network Requirements

Design No. American O_3 sonde network for INTEX (Intercontinental Transport Expt) to answer:

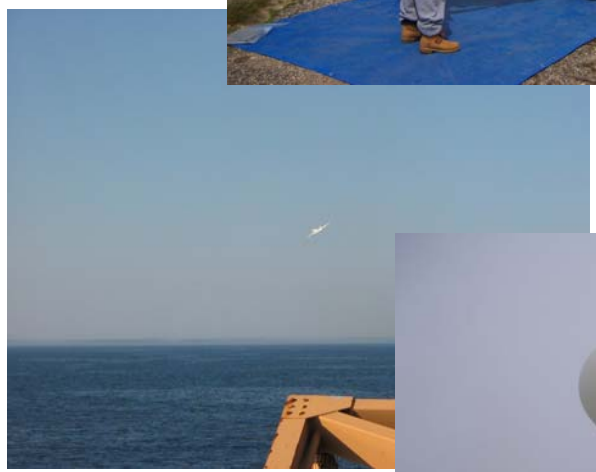
1. Can O_3 pollution be followed *during ICARTT?* √
2. What are O_3 transport patterns across NA? √
3. How much Asian O_3 reaches western NA? √
4. Can O_3 formation, transport in high pollution be: √
   Measured from satellite? Predicted?



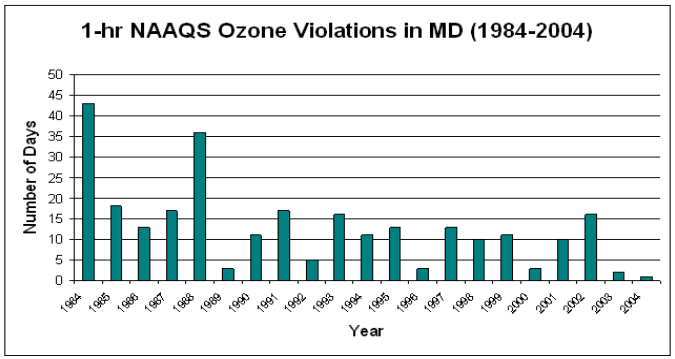


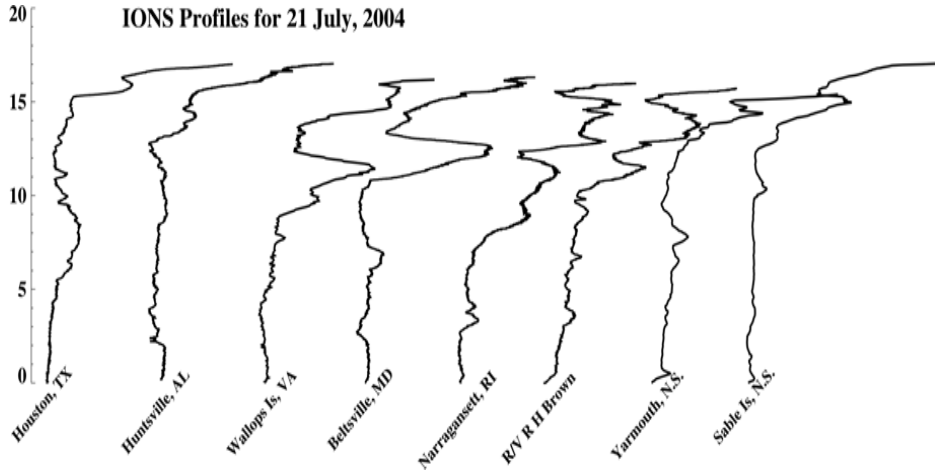
IONS – 2004: (INTEX Ozonesonde Network Study)
Design Responds to Scientific Requirements

- Design objectives met.
- Central US/Canada ➔ eastern outflow (MI, TO); SC to NE US/maritime flow
- Eight NE/NA sites, *R H Brown*
  - Lagrangian Flight Planning
  - Launch, aircraft coordination
- Operated 6 weeks, July-August, 6 sites daily: 290 sondes
- Images - http://croc.gsfc.nasa.gov/intex/ions.html. Data at ICARTT site – cloud1.arc.nasa.gov



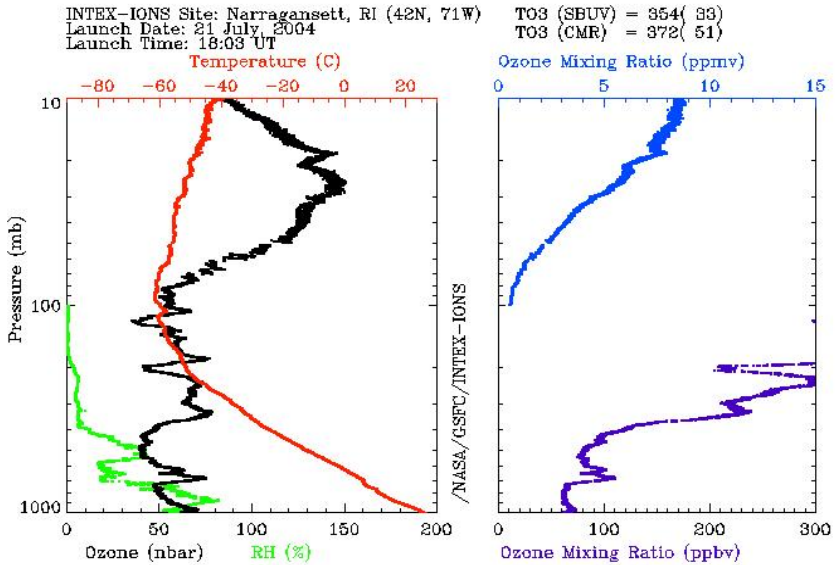
Summary of M-A/NE/NA O_3: "The Summer that Wasn't"

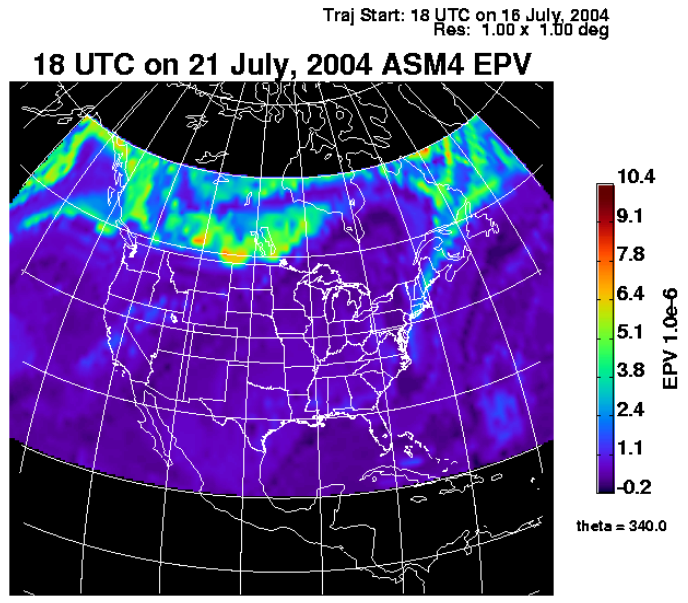


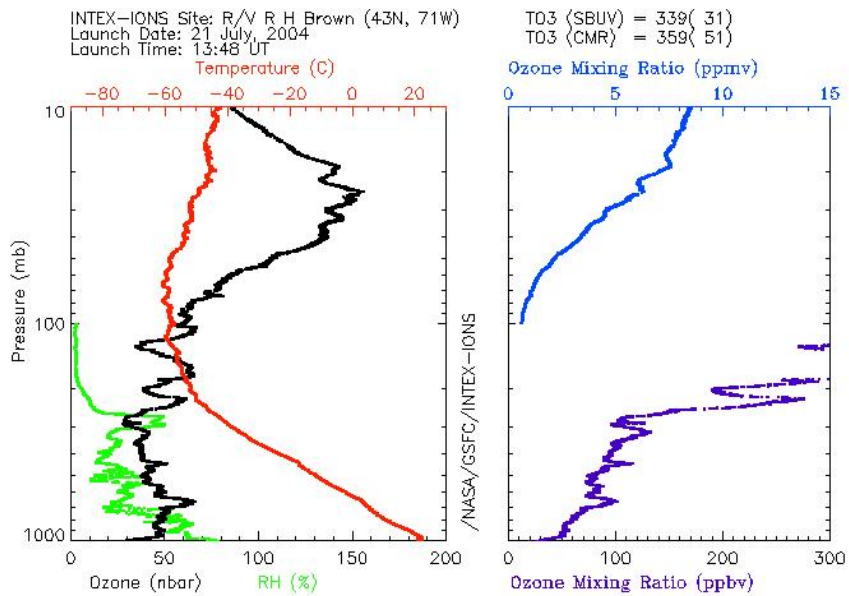


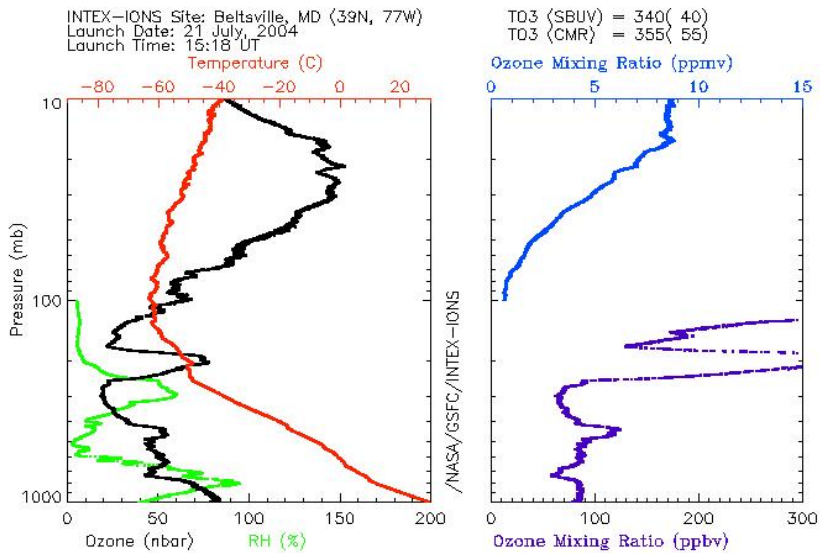
- Maryland 20-yr Air Quality "Best" typical for MA-NA region
- Note! Peaks on 21/7 WFF/Beltsville/RI/*R H* Brown/NS due to *stratospheric* ozone. Pollution (> 60 ppbv, 5-10 km) underneath
- Typical pattern with a few exceptions in early August

21 July 2004, "Summer That Wasn't:" RI, Beltsville **Profiles**; RDF (reverse-domain-fill) EPV. 1x1deg, 340K Back Air Parcel Trajectories.

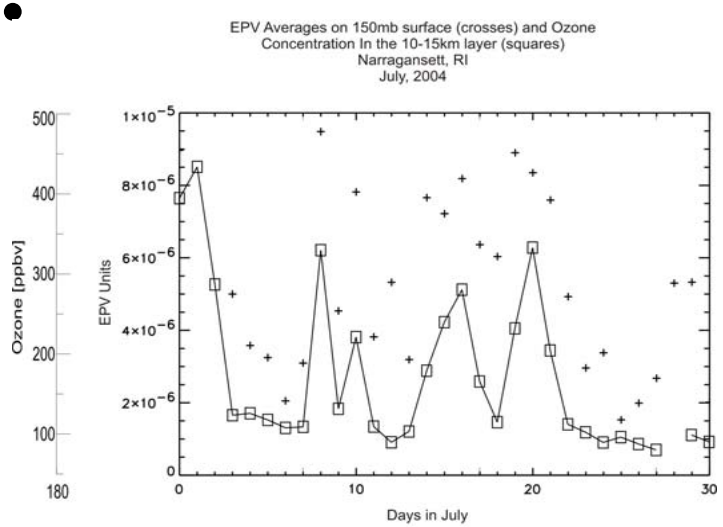


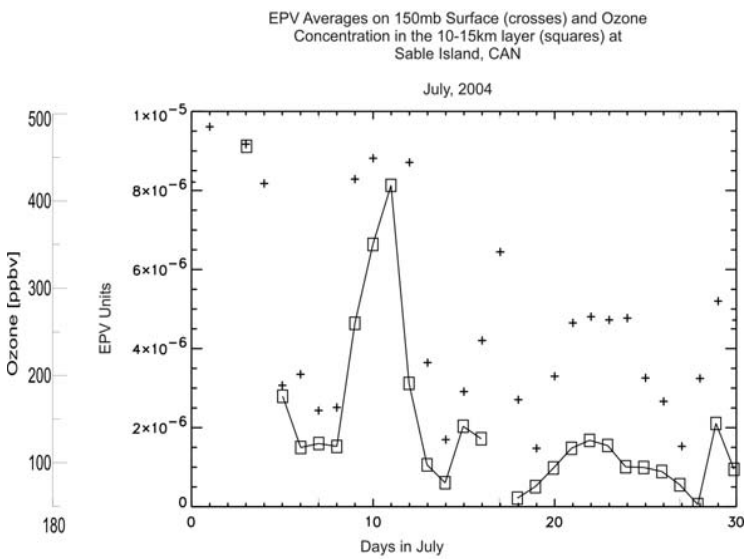


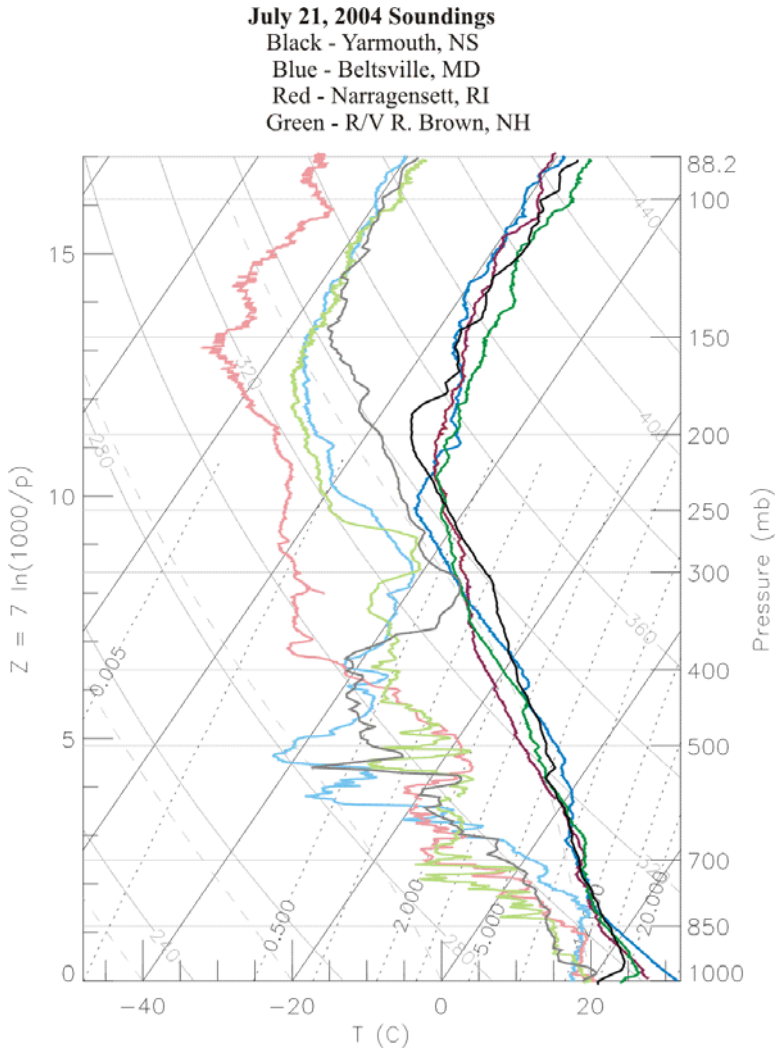




“Summer That Wasn’t” Study - I: Determine Upper Tropospheric Ozone from STE

- 

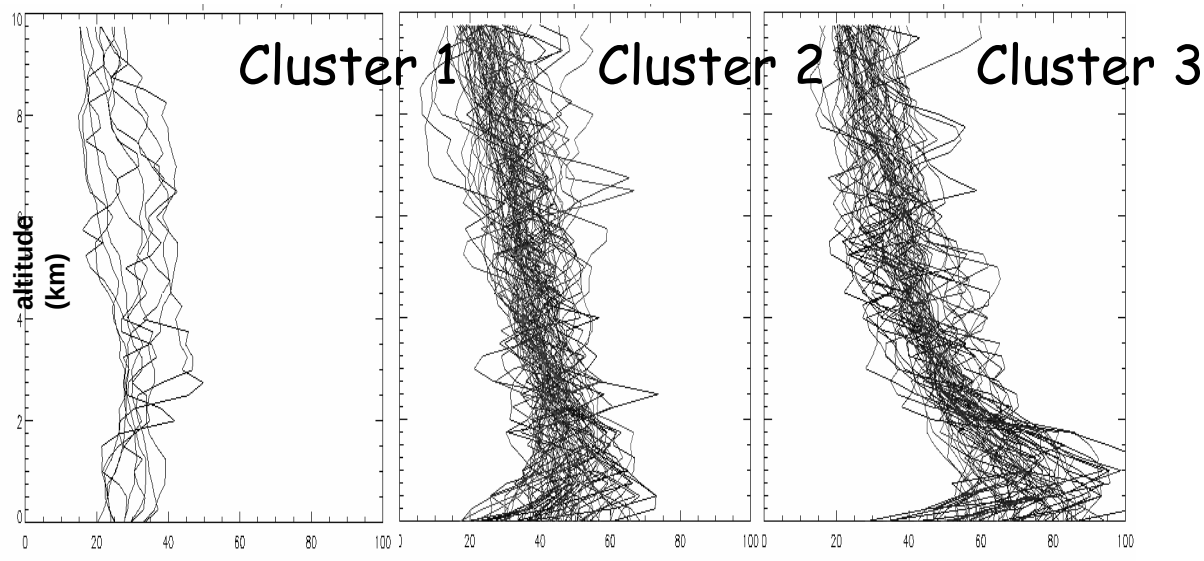


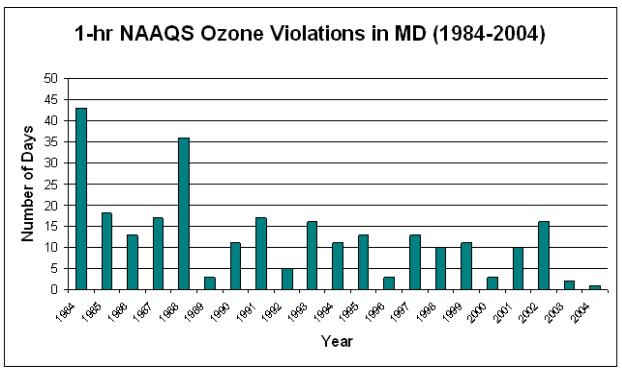


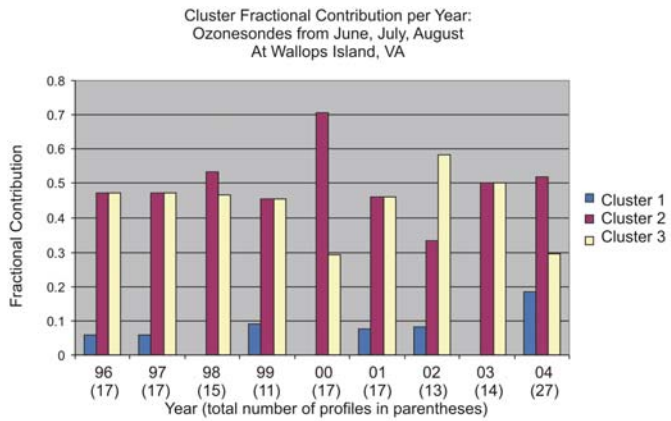
"Summer That Wasn't" Study - II: Statistics Confirm 2004 Stand-out in 10-year Wallops Record

Preliminary results - "Clustering" with 1995-2004 1-km data (nb).

Mid-trop ozone (@ 1 km) hard to classify. Lower trop O3 leads to two main classes (2, 3)





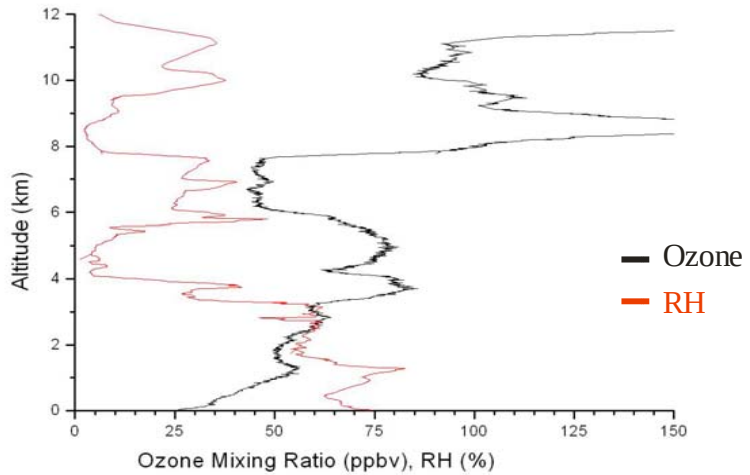


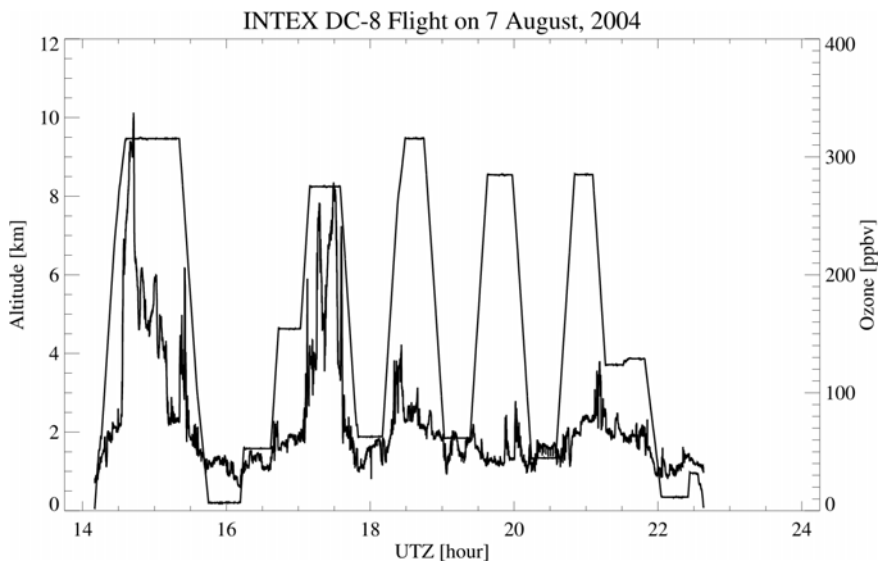
Other IONS Studies/Issues

From Mini-IONS Workshop (10 Mar 05, Boulder)

- Thompson: The "Summer That Wasn't" – ***2004*** √
  "Ozone Ambiguity" below. Resolve with DC-8
- Cooper: Lagrangian view, IONS-MOZAIC √
- Morris: Houston Pollution & Alaskan Fires Case √
- Merrill: Closeup on Budgets (next talk)

Ronald H. Brown: July 16, 2004





IONS Workshop

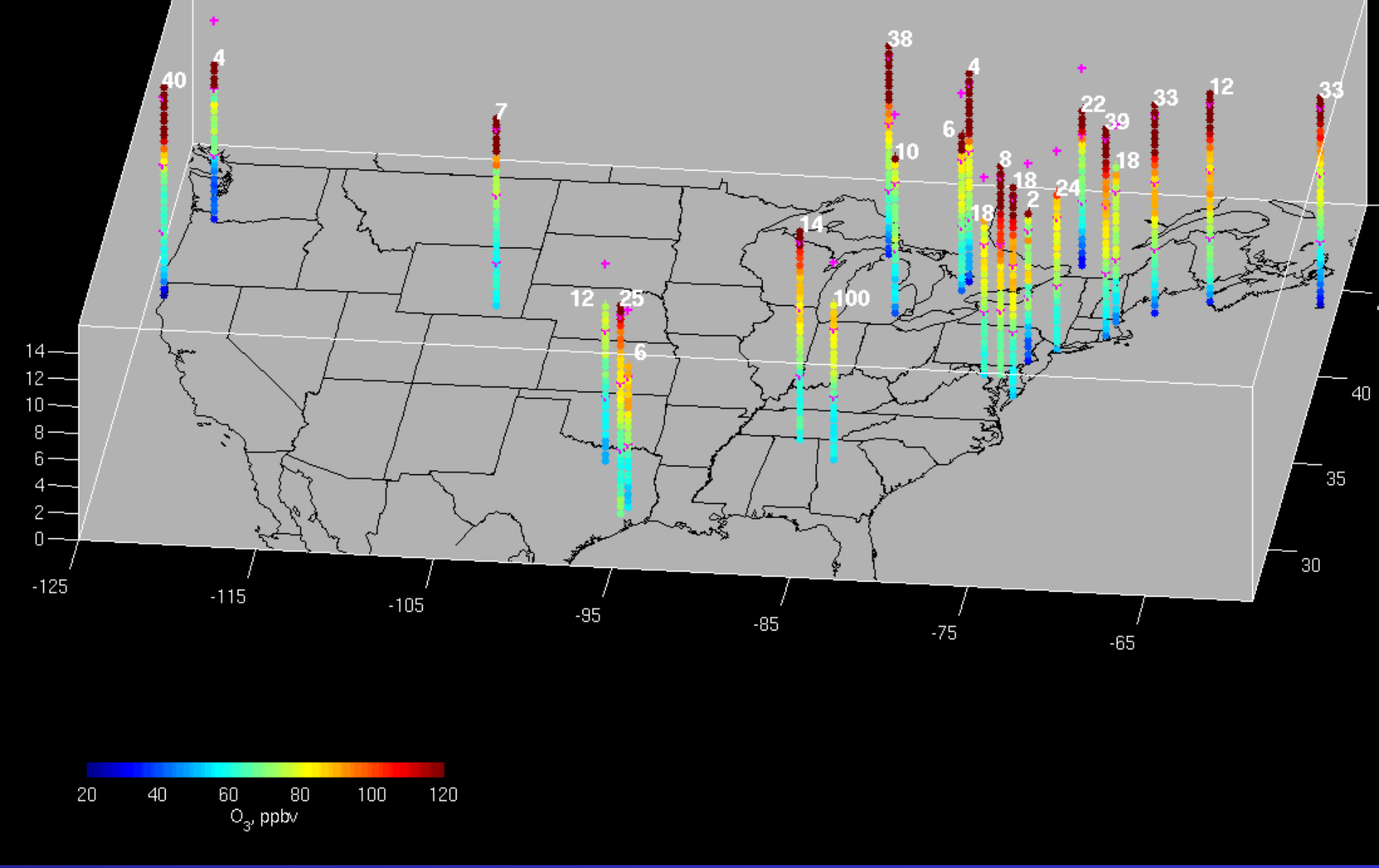
March 9, 2005, NOAA-CMDL, Boulder

Tropospheric ozone distribution across North America during July and August 2004

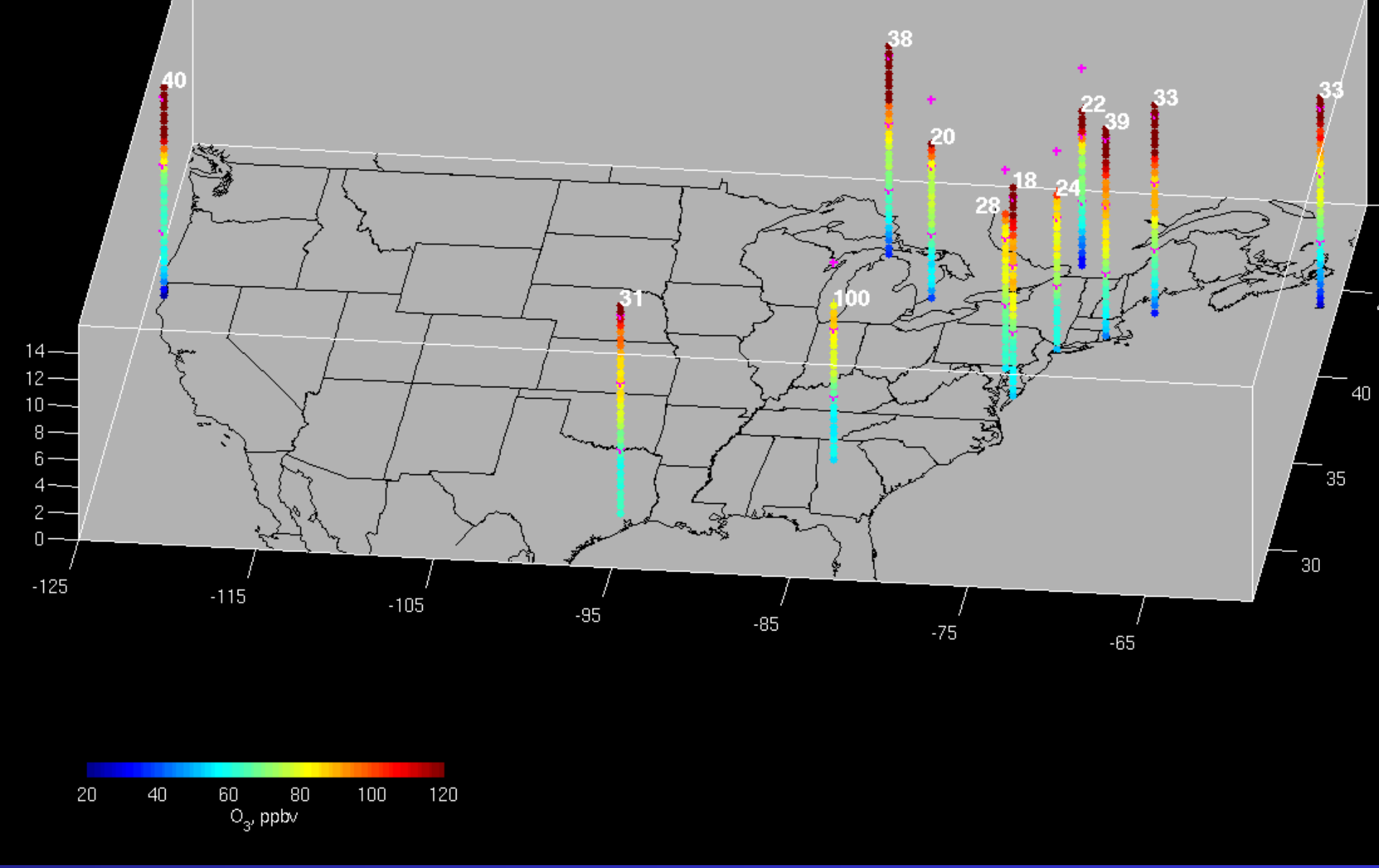
Owen Cooper

Cooperative Institute for Research in Environmental Sciences – University of Colorado/
NOAA Aeronomy Laboratory, Boulder

Two Objectives – (1) Lagrangian View & Ozone Budget – Cross-continental (2) Use MOZAIC data (1998-2003) to Put 2004 IONS/MOZAIC in Context



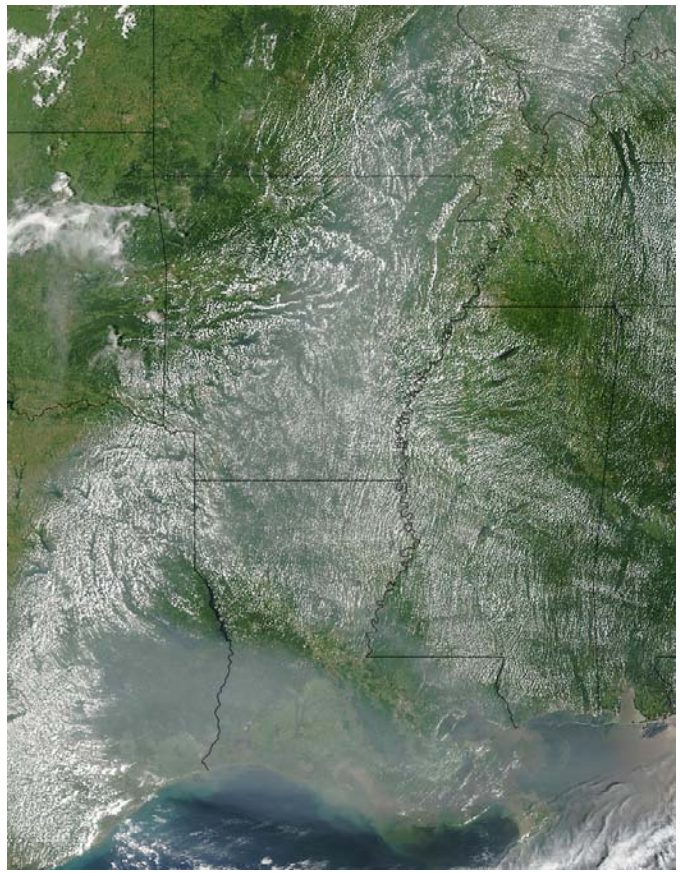
Median ozone profiles at all IONS and MOZAIC sites, July 1 – August 15, 2004



IONS and MOZAIC sites to be used in determining the trans-North America ozone distribution, July 1 – August 15, 2004

Smoke from Alaskan Wildfires Arrives in Southeast Texas and Louisiana

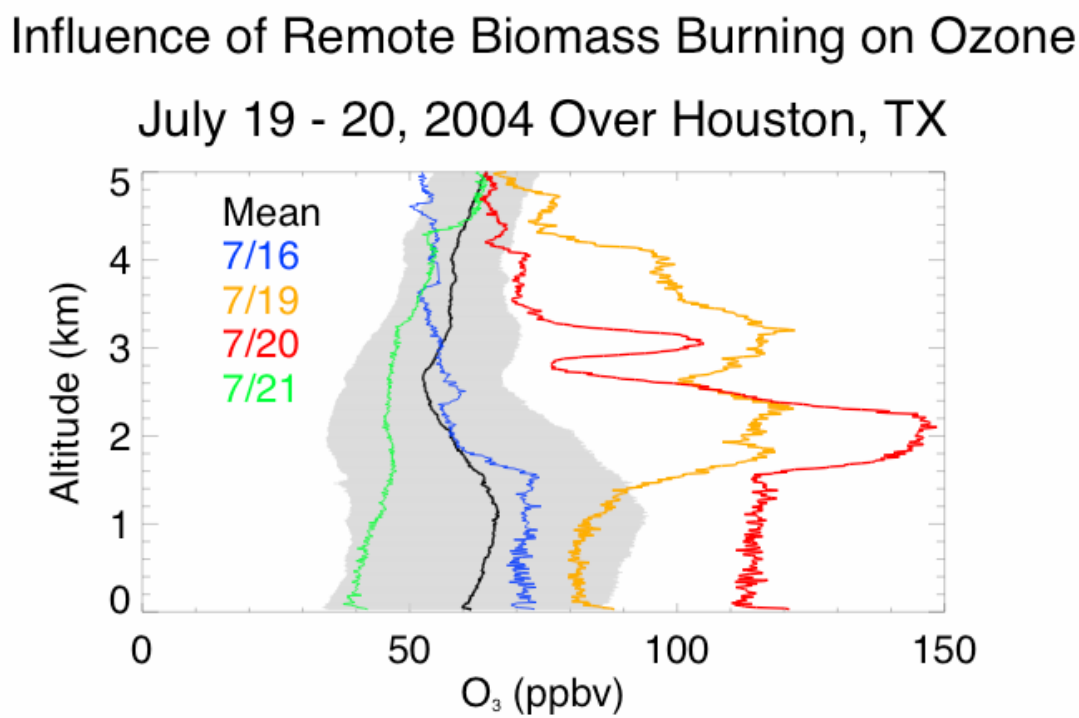
- Smoke from Alaska/Western Canada a week before arrives in Houston July 19 and 20, 2004.
- MODIS image



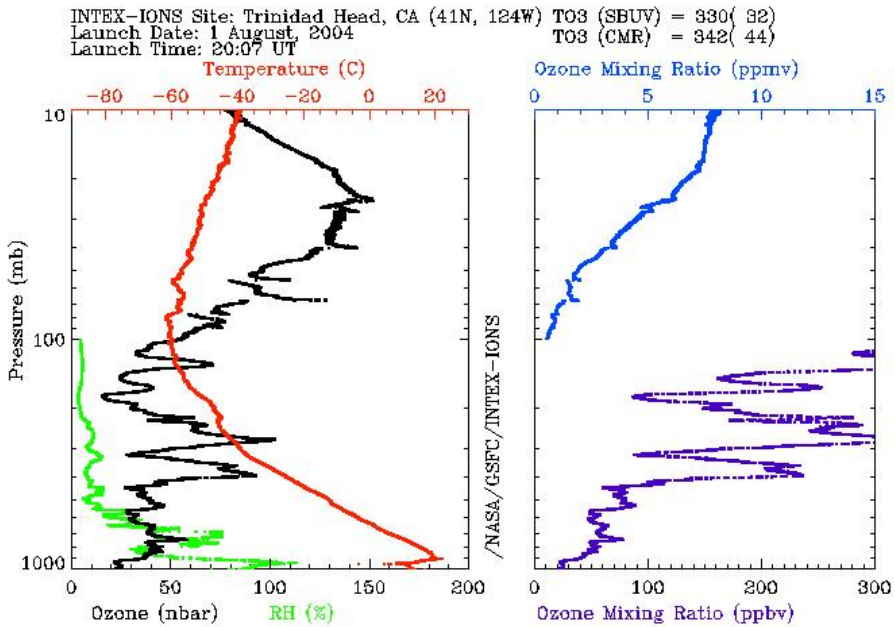
NASA MODIS

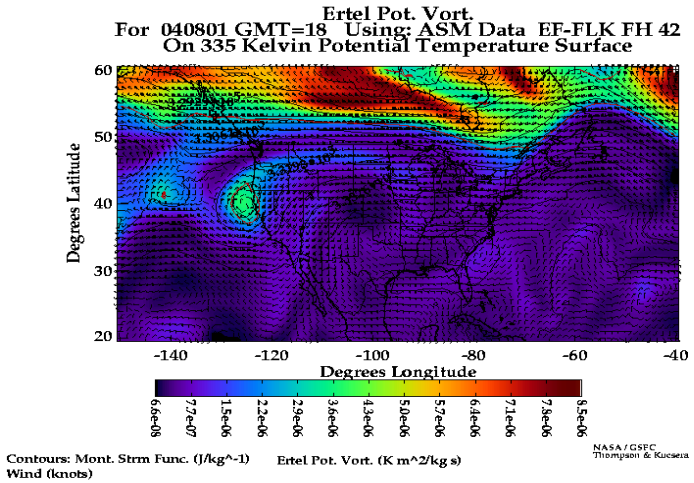
Arrival of Forest Fire Smoke Affects Ozone Levels Over Houston

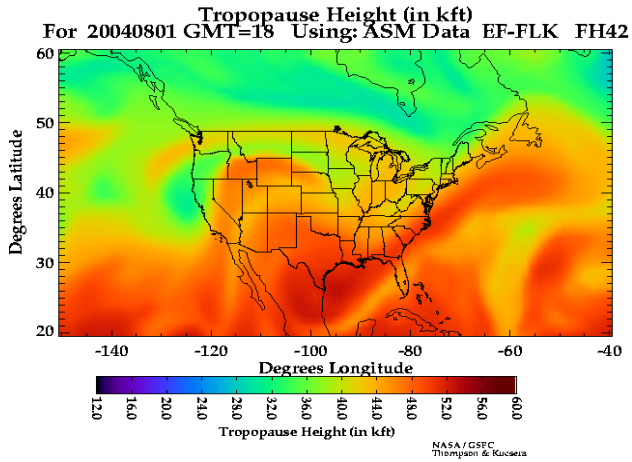
- Mean
- 1σ variability
- Before (22 DU)
- After (12 DU)
- July 19 (34 DU)
- July 20 (36 DU)
- 75 - 100% increase in ozone below 5 km



Meteorological Fields from GMAO – EPV (335K), Trop. Height – 1 August STE – Cutoff Low – Trinidad Head







Analyze with INTEX GMAO fields:

http://croc.gsfc.nasa.gov/intex

Images at ICARTT archive.

Data POC – tlk@croc.gsfc.nasa.gov

Summary – Pub Plans -- Issues for Workshop

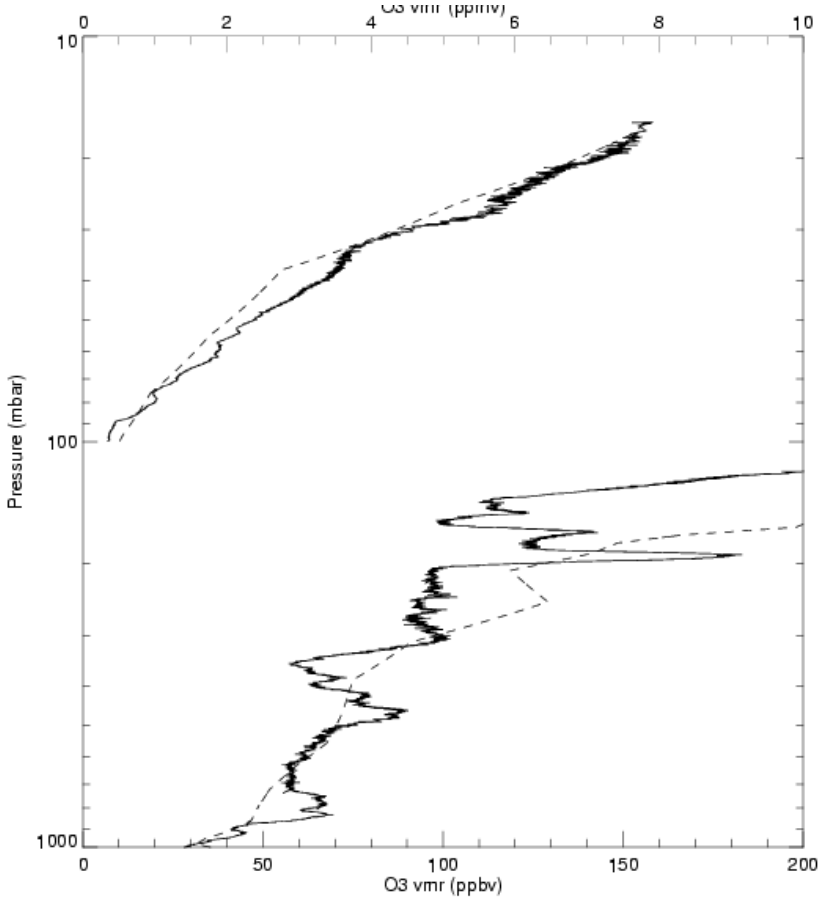
- IONS strategy successful – Intriguing "Summer that Wasn't"

- Short Format Papers (Tentative)
  - Thompson: The "Summer That Wasn't" – ***2004***
  - Cooper: Lagrangian view, IONS-MOZAIC
  - Morris: Houston Pollution & Alaskan Fires Case
  - Tarasick: Model Comparisons – Caveats with IONS data

- Other Papers (Tentative)
  - Oltmans: Multiple Site Overview/Climatology
  - Merrill: Ozone Variability, Budgets
  - ? Pierce: Model-Assimilation Comparisons
  - ? Chatfield -

- Issues - UT/LS definition (models, satellite retrievals)
- "Ozone Ambiguity" in UT/LS – distinctive IONS feature

4. Can Pollution Ozone be Measured from Satellite? Predicted? Test Assimilation √



- **TOMS satellite ozone in Regional Air Quality Model System (B Pierce, NASA-LaRC) 8 July *Ron Brown* Sounding & RAQMS**
- **Lower tropospheric (LT) ozone and UT/LS not correct**
- **Will IONS assimilation improve agreement?**
  - **Give better tropospheric ozone from satellite?**
  - **Predict pollution transport?**

Conclusion- Acknowledgments

All **IONS images,** GSFC Met images: <croc.gsfc.nasa.gov/intex>. **All data, images** at ICARTT archive

IONS - Proved Concept of Sondes as Element of **Integrated Observing & Model-Prediction Strategies**

- Rich Data Set for Multiple applications
- **2006 INTEX-B, TEXAQS-2, MIRAGE next opportunity**

Thanks to: Howard U, UMCP, *R/V RH Brown* Chief Scientist T. Bates, Crew, Fellow Scientists
Students – V Davis, O Hylton, J Liesch, M Taylor, L Zamora
Sponsors: NASA/TCP, GSFC/DDF; NOAA; EC-MSC