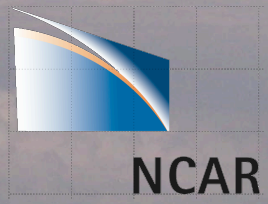
Stratosphere-Troposphere Analyses of Regional Transport Experiment 2008 (START08)

Scientific Concept and Initial Results

Laura L. Pan (NCAR), Elliot Atlas (U. Miami), Kenneth P. Bowman (TAMU)
&
The START08 Team



RF14, June 18, 2008

START08 Field Campaign

- April-June, 2008, operated from the Jeffco airport (Broomfield Colorado), using Gulfstream-V (GV, aka HIAPER)
- Participated by NCAR, TAMU, Univ. Miami, Univ. Colorado, Harvard U., and NOAA
- Joint operation with the PreHIPPO project
- Total 150 GV flight hours given, 123 flown in six flight weeks

Principal Investigators:

START08: Laura Pan, Elliot Atlas (Miami U), Kenneth Bowman (TAMU)
HIPPO: Steve Wofsy (Harvard)

RF01 Takeoff, April 18, 2008

START08 Team and Current Collaborators

Instruments, flight design and operations, data processing and analyses, modeling, satellite…

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Steve Wofsy (Harvard)
Bruce Daube (Harvard)
Eric Kort (Harvard)
Sun Y.Park (Harvard)
Rodrigo Jimenez (Harvard)
Linnea Avallone (CU)
Sean Davis (CU)
James Elkins (NOAA)
David Tarasick (WOUDC)
Emrys Hall (NOAA)

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Meng Zhang (TAMU)
Pavel Romanshkin
David Rogers
Al Cooper
Dale Hurst (CU)
Fred Moore (CU/NOAA)
Josh Ballard (NOAA)
Ru-shan Gao (NOAA)
Eric Ray (NOAA)
Britt Stephens
Jonathan Bent
Julie Haggarty
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Mark Zondlo (Princeton)

Laura Pan
Jim Bresch
Bill Hall
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Jasna Pittman
Bill Randel
Sue Schauffler
Brian Ridley
Mijeong Park
Steve Massie
Doug Kinnison
Jennifer Wei (NOAA)
Gloria Manney (JPL)
Mark Olsen (NASA)
Bärbel Vogel (FZJ, Germany)
Paul Konopka (FZJ, Germany)
Jack McConnell (York U. Canada)

Laura Pan, 12/16/08 **Group photo taken June 26, 2008, before RF17**

START08 Science Goals

- **Provide key chemical transport information for the new generation of chemistry-climate models**
- **Map major transport pathways that couple the UT and LS**
- **Characterize the behavior of the extratropical tropopause as a transport boundary using chemical tracers**

Scientific questions:

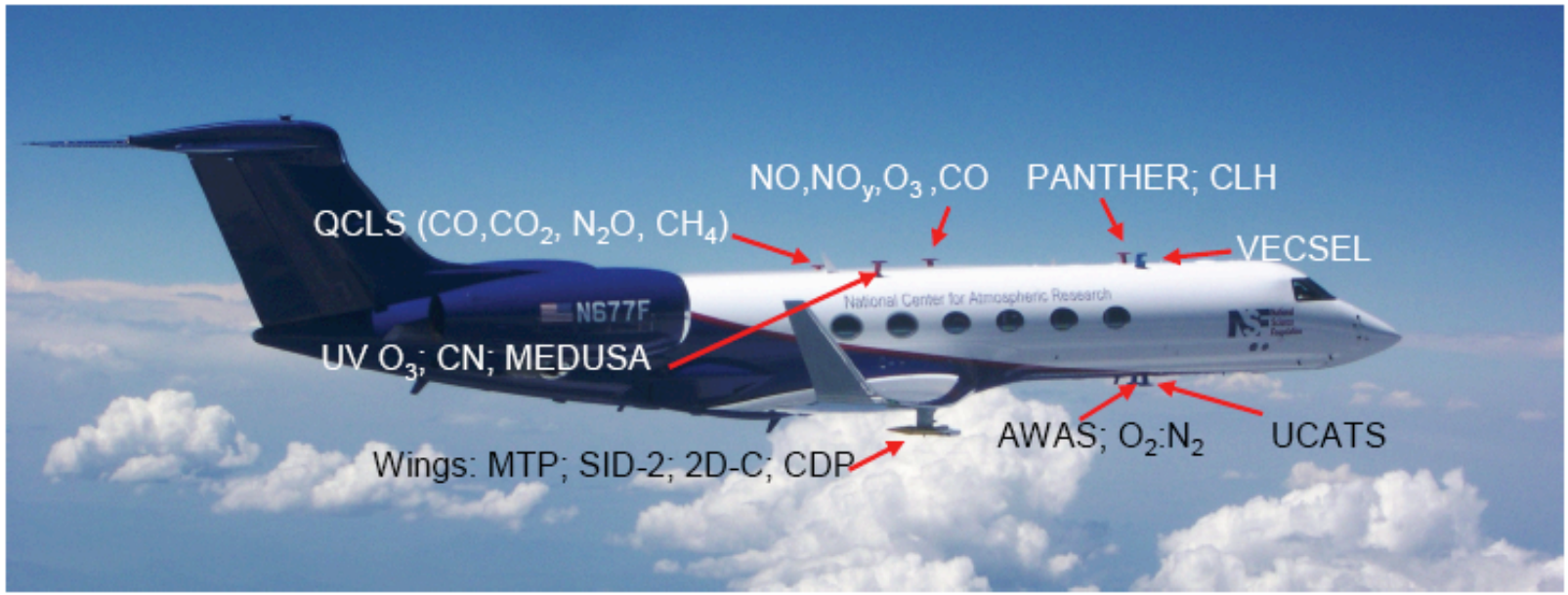
Behavior of the extratropical tropopause:

- Is the extratropical tropopause better characterized as a surface or a layer? ExTL?
- If a layer, how do we identify/define it? What controls its existence/depth?
- Does the subtropical tropopause break and the secondary tropopause derived from the WMO definition have physical meaning?

- **How is the chemical gradient across the tropopause related to the dynamical variables?**

- **Can we map out key dynamical processes in the Ex-UTLS using tracers and tracer correlations?**

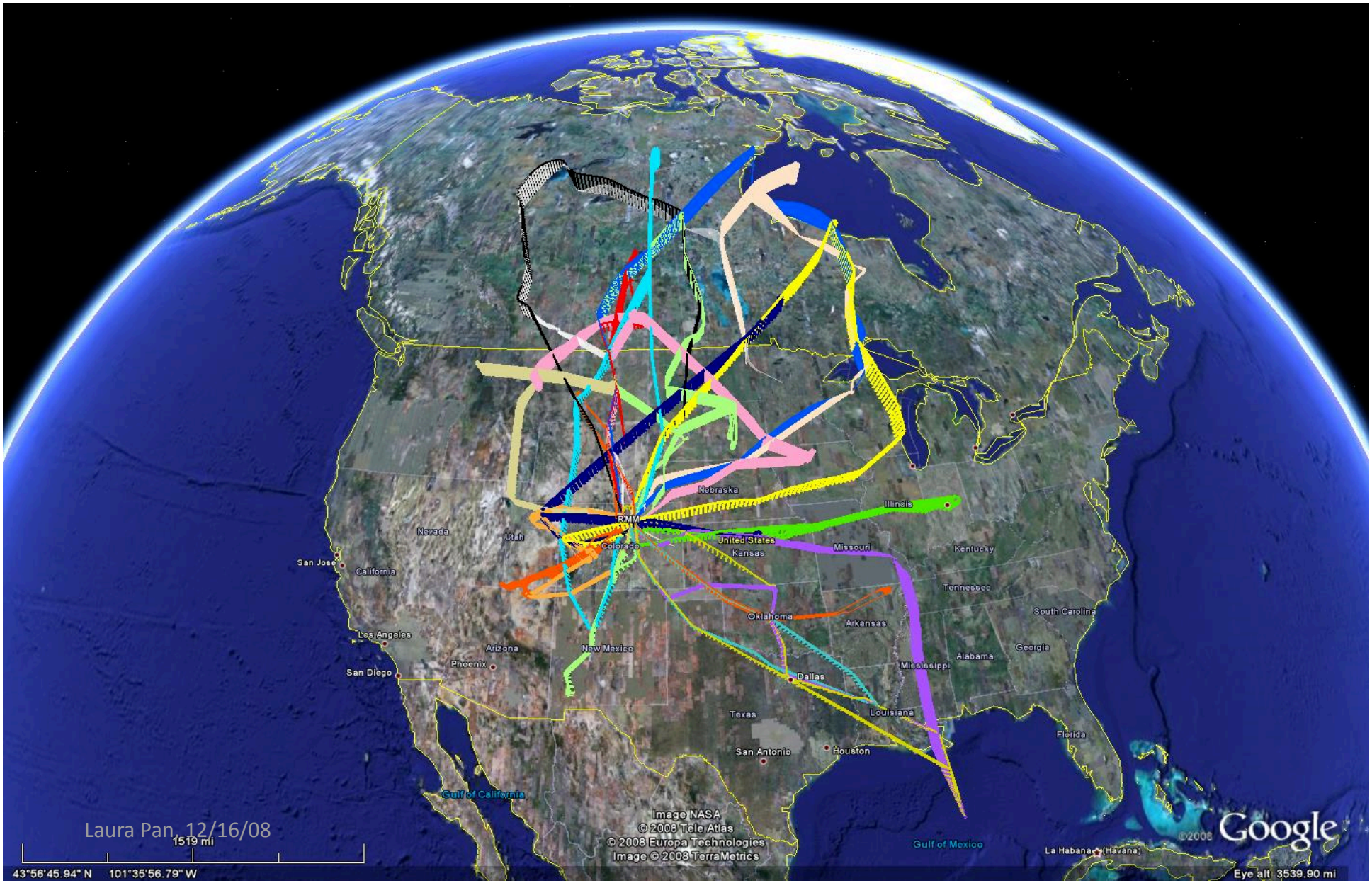
Breaking New Ground in GV Payload Complexity



- AWAS (Advanced Whole Air Sampler) [HAIS/U Miami]
- QCLS airborne laser spectrometers (CH_4, N_2O, CO, CO_2) [HAIS/Harvard],
- AO2 (Continuous O_2/N_2 ratio) [NCAR/EOL],
- Fast O_3 and NO/NOy [NCAR/ACD],
- MTP (T profile, tropopause) [HAIS/JPL],
- TDL-Total Water [CU]
- SID2 (small ice detector) [HAIS],
- VCSEL (H_2O) [HAIS],
- TDL-H_2O, VUV CO [NCAR/RAF],
- UV Ozone (NOAA),
- PANTHER-UCATS gas chromatographs [NOAA] (CO, CH_4, N_2O, H_2, PAN, halocarbons, COS), with ozone and MayCom H_2O.

Flight Tracks of START08/PreHIPPO (18 flights)

Phase I: April 18-May 16, Phase II: June 16-27



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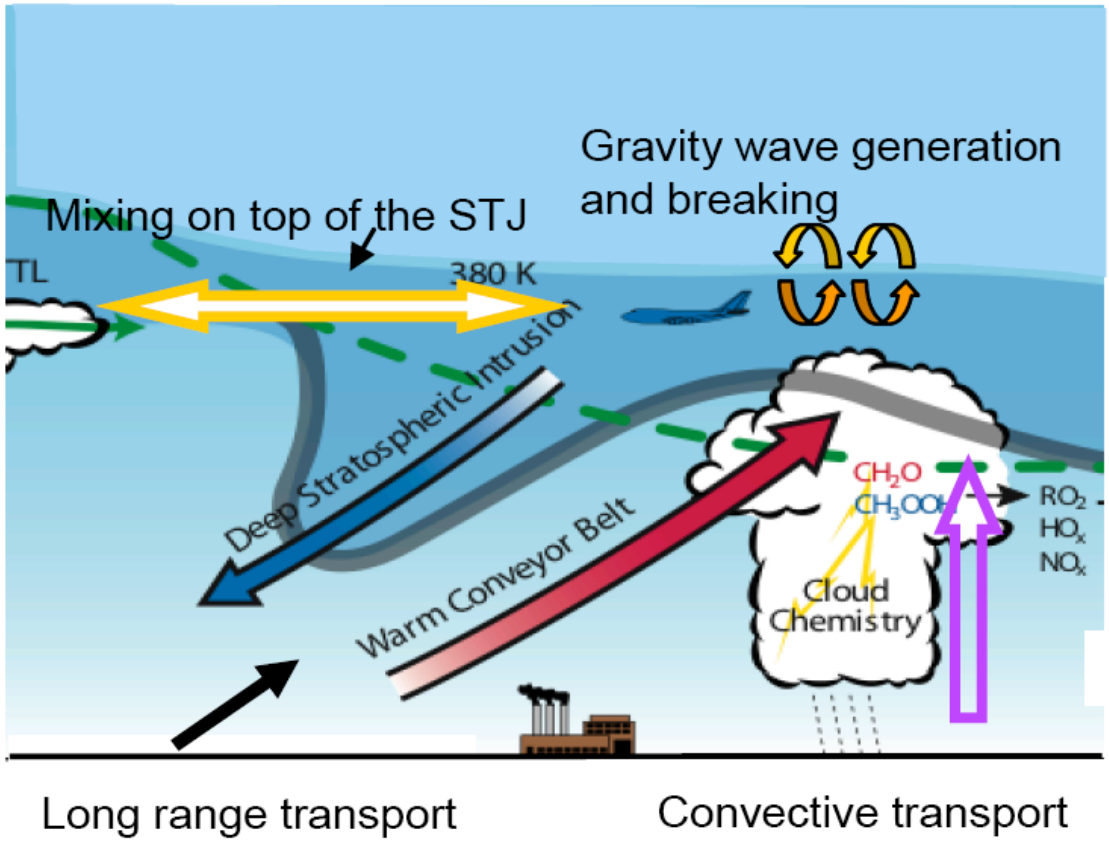
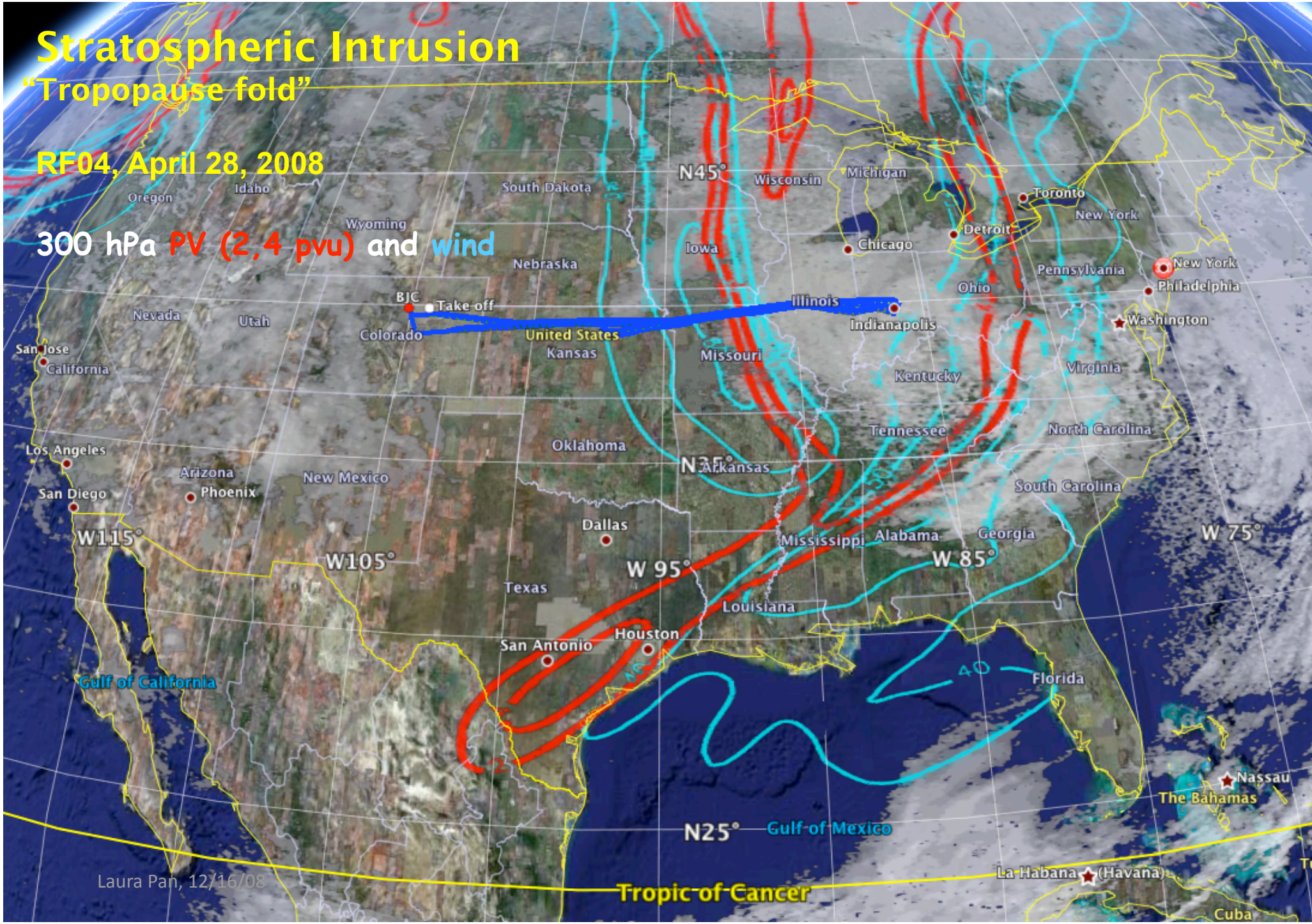
Sampling Strategy: Targeting Major Transport Pathways in the Ex-UTLS



1. **Extratropical UT/LS Survey (including cirrus clouds) (RF 03, 09, 14, 17, 18)**
2. **Stratospheric Intrusion (Tropopause Fold) (RF 04, 06, 11, 12)**
3. **Tropospheric Intrusion (RF 01, 07, 08, 09, 14)**
4. **Convective Influence (RF 08, 13, 14, 18)**
5. **Gravity Wave (RF 02)**
6. **HIPPO (RF 05, 07, 08, 10, 13, 15, 16)**


Stratospheric Intrusion
"Tropopause fold"
RF04, April 28, 2008
300 hPa PV (2,4 pvu) and wind
BJC
Take-off
Illinois
Indianapolis
Colorado
United States
Kansas
Missouri
Nebraska
Iowa
Chicago
Detroit
Toronto
New York
Pennsylvania
Philadelphia
Washington
Ohio
Wisconsin
Michigan
South Dakota
Wyoming
Oregon
Idaho
Nevada
Utah
San Jose
California
Los Angeles
San Diego
Arizona
Phoenix
New Mexico
Oklahoma
Texas
Dallas
San Antonio
Houston
Louisiana
Mississippi
Alabama
Georgia
South Carolina
North Carolina
Tennessee
Kentucky
Virginia
Arkansas
Florida
Gulf of California
Gulf of Mexico
The Bahamas
Nassau
La Habana (Havana)
Cuba
Tropic of Cancer
N45°
N25°
W115°
W105°
W 95°
W 85°
W 75°
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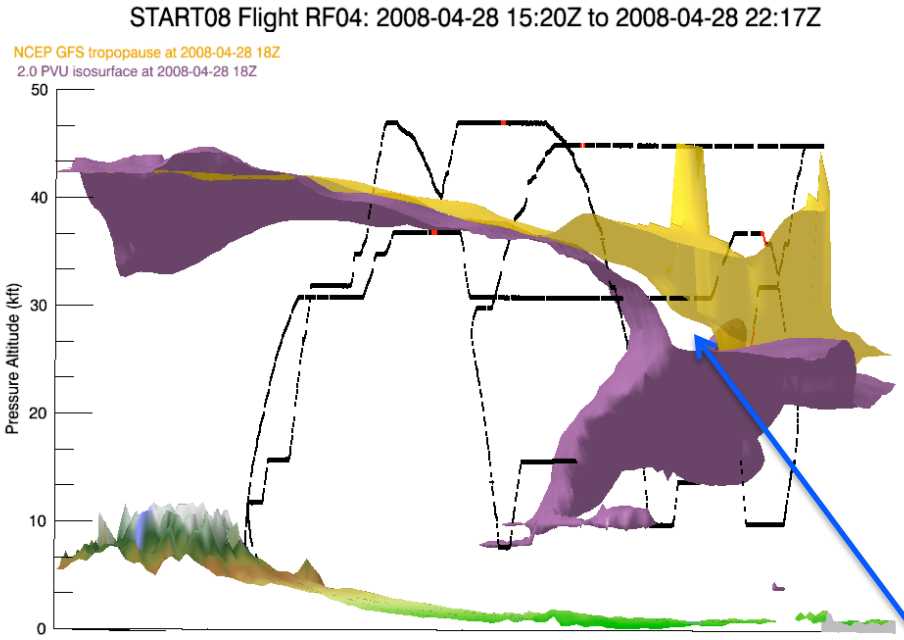
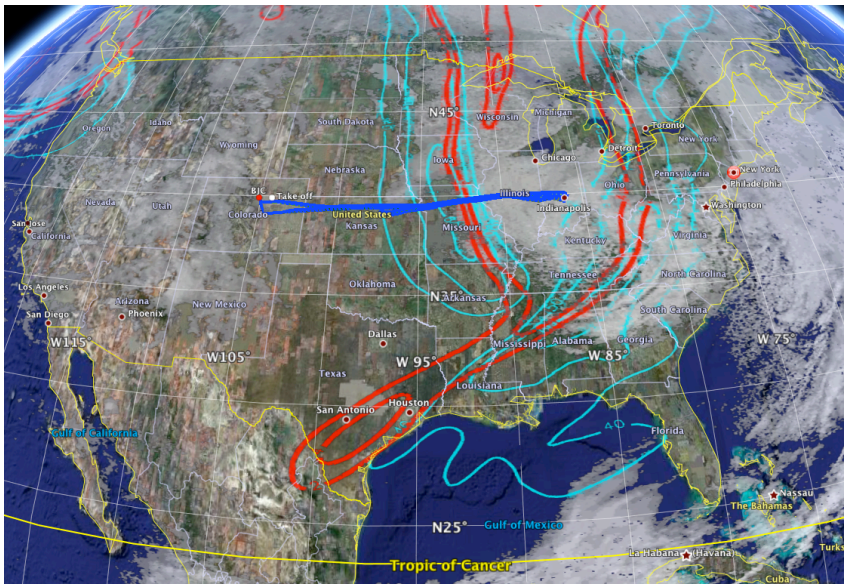
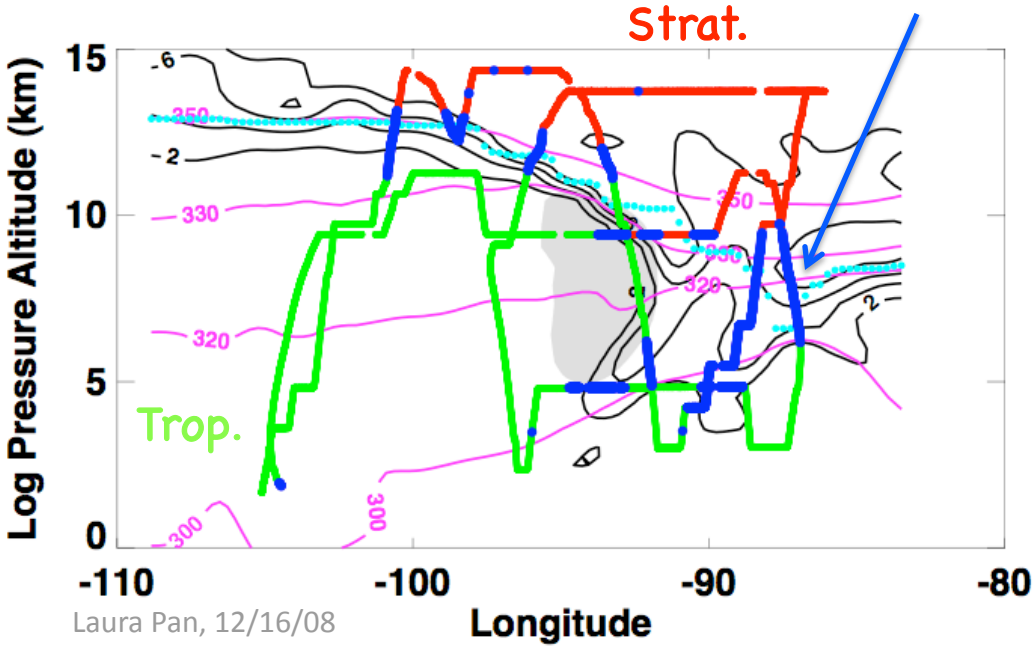
“Flat” vs. “Structured” Tropopause

RF04, April 28, 2008





Kenneth P. Bowman
Texas A&M University



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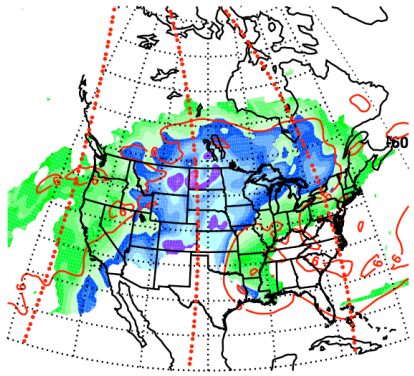
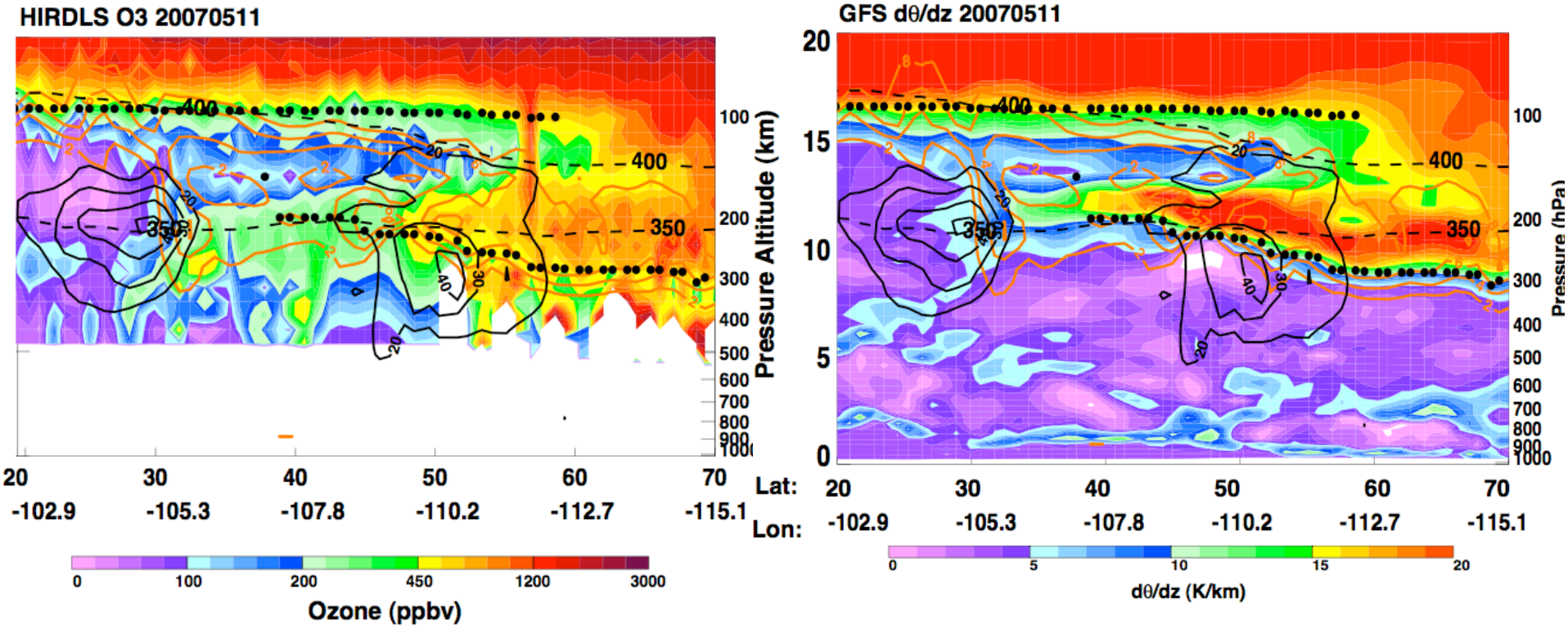
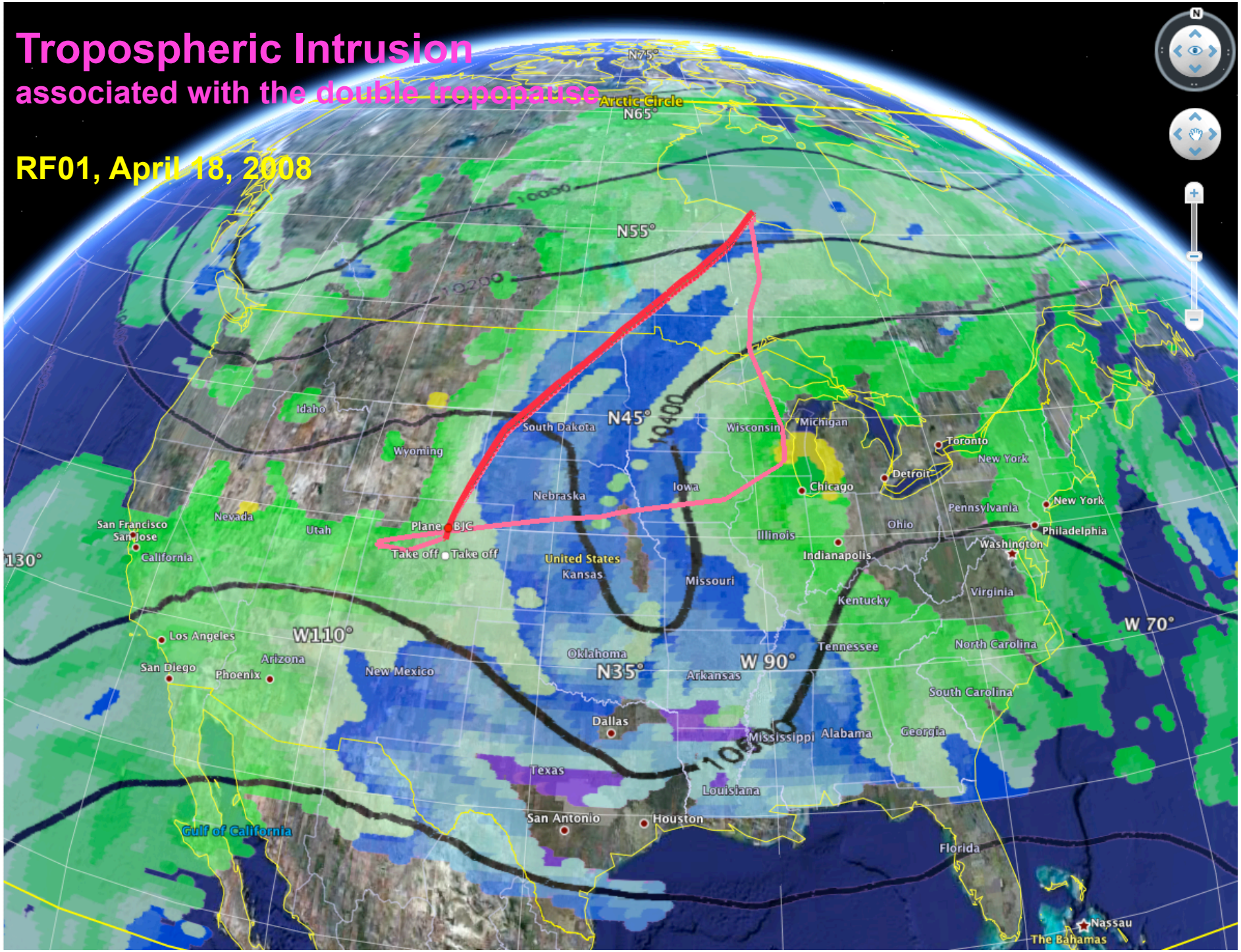
Diagnostic and forecast for intrusion of tropospheric air above the subtropical jet



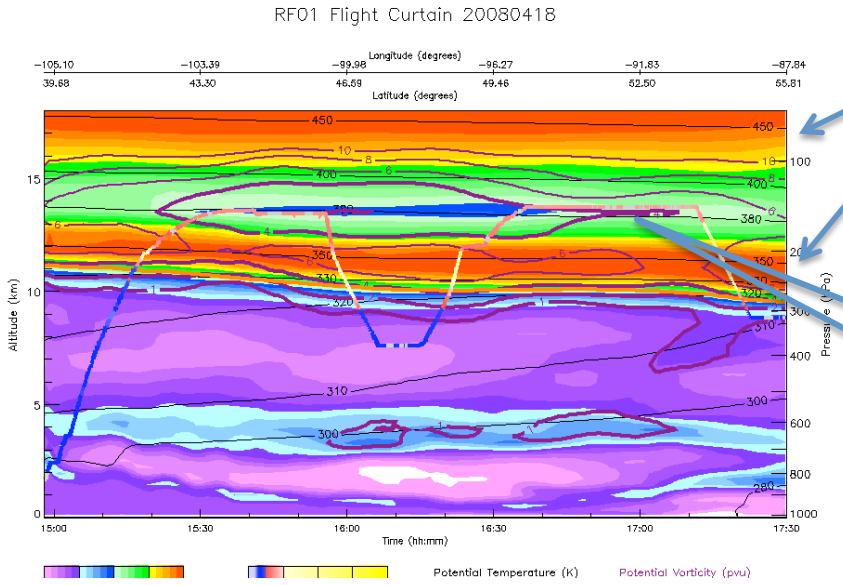
HIRDLS O_3 and GFS $d\theta/dz$, May 11, 2007

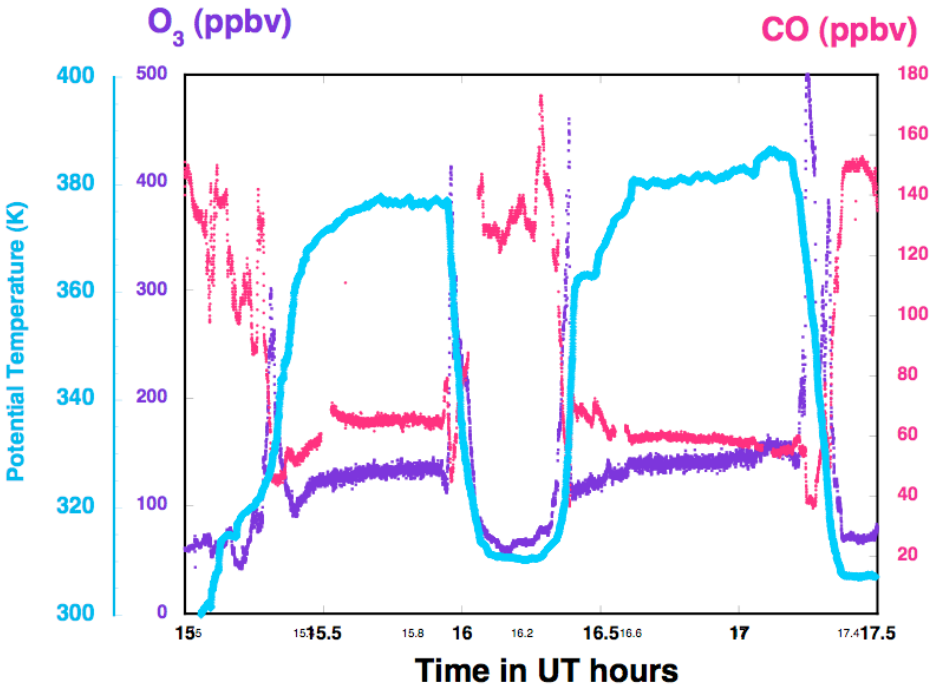


Pan et al., submitted 2008


Tropospheric Intrusion
associated with the double tropopause
RF01, April 18, 2008
N75°
Arctic Circle
N65°
N55°
10000
10200
10400
10600
N45°
N35°
W110°
W 90°
W 70°
130°
Idaho
South Dakota
Wyoming
Nebraska
Nevada
Utah
California
San Francisco
San Jose
Los Angeles
San Diego
Arizona
Phoenix
New Mexico
Plane
BJC
Take off
Take off
United States
Kansas
Missouri
Oklahoma
Arkansas
Texas
Louisiana
Dallas
San Antonio
Houston
Gulf of California
Iowa
Illinois
Wisconsin
Michigan
Chicago
Indianapolis
Ohio
Kentucky
Tennessee
Mississippi
Alabama
Georgia
Florida
South Carolina
North Carolina
Virginia
Pennsylvania
Washington
Philadelphia
New York
Toronto
Detroit
New York
Nassau
The Bahamas

RF01, April 18, 2008





Sandwiched stratosphere?

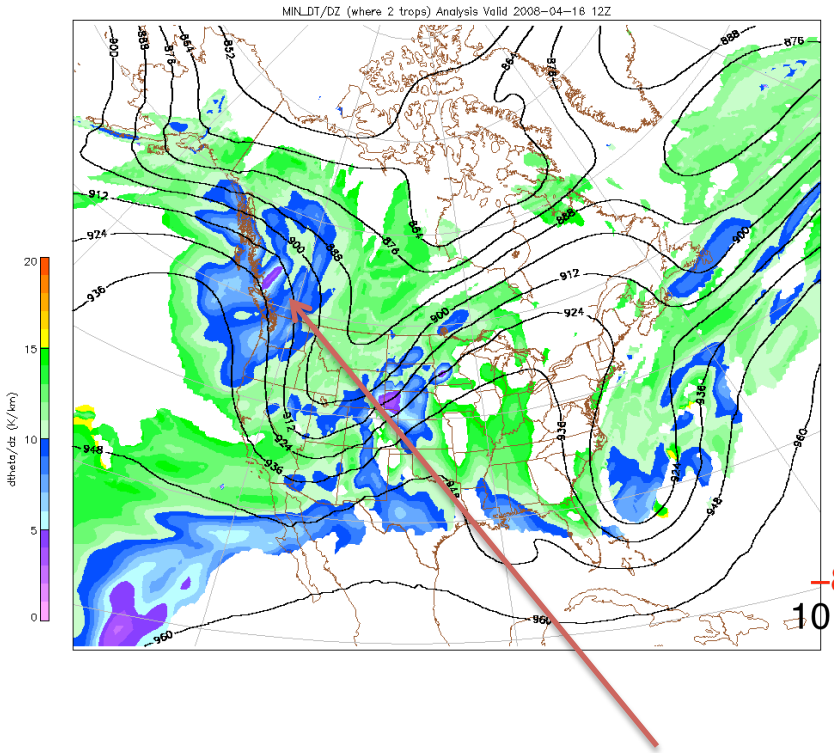
Latitudes: > 50° N

PT: ~ 380 K

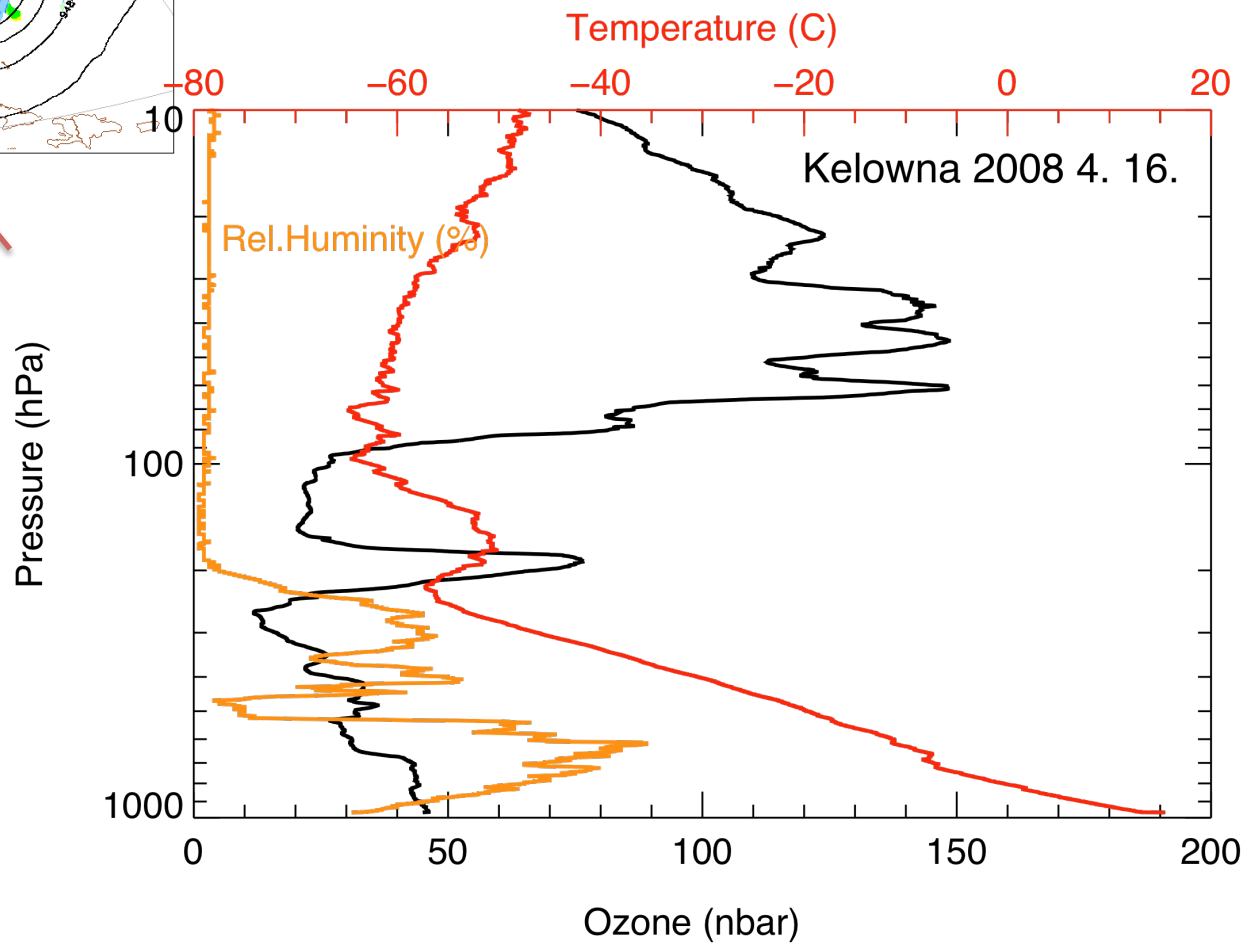
PV: < 4 pvu

O3: <150 ppbv

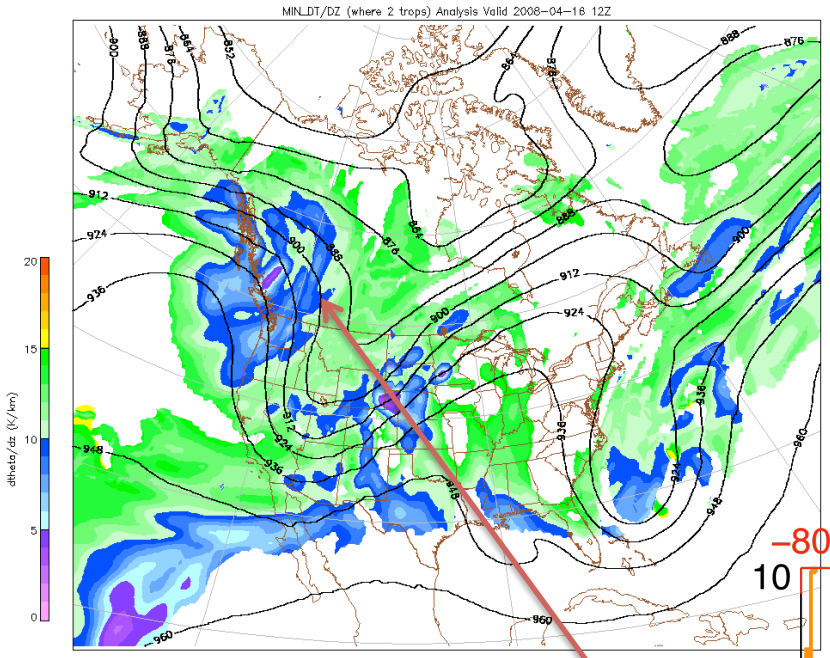
CO: ~ 50 ppbv

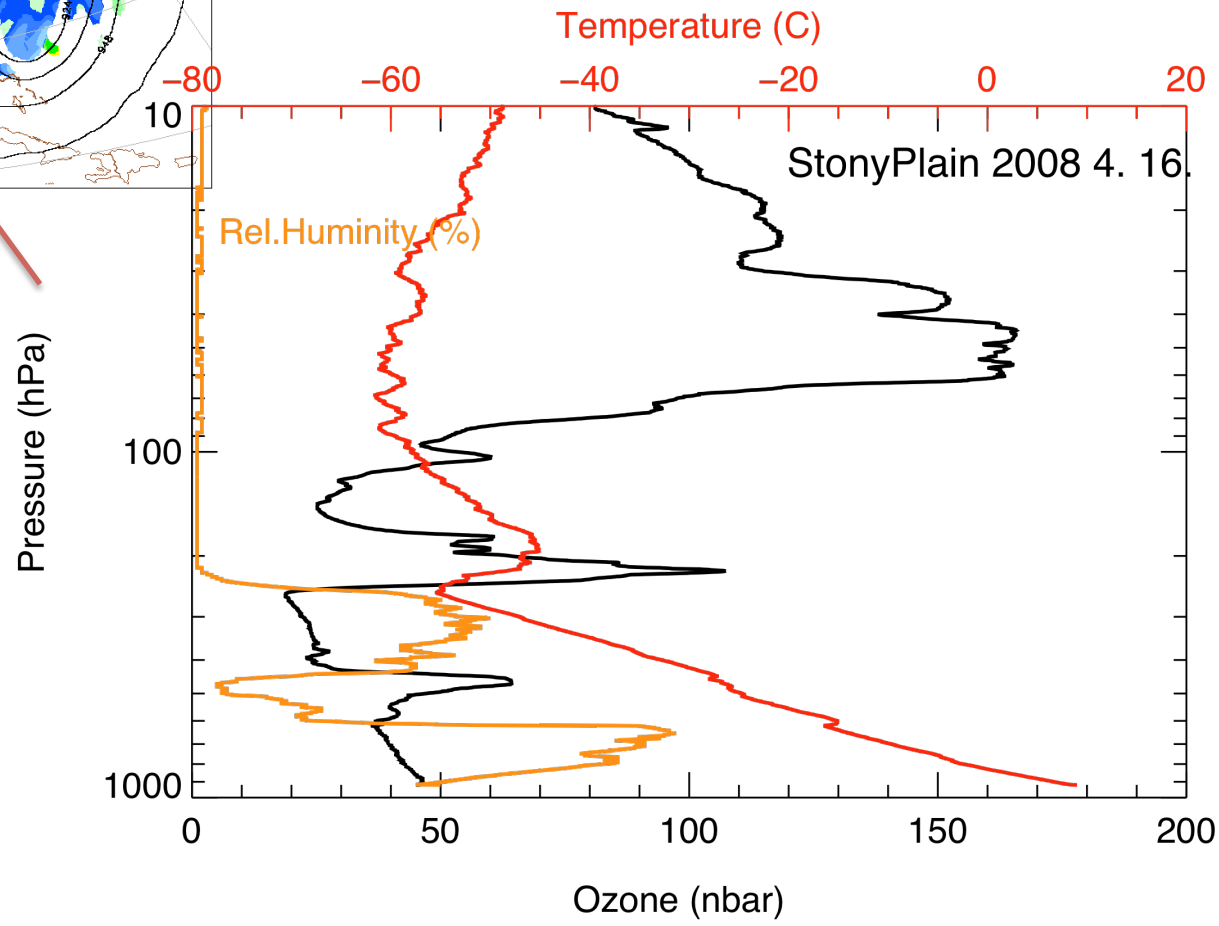


Kelowna, April 16, 2008



Stony Plain, April 16, 2008





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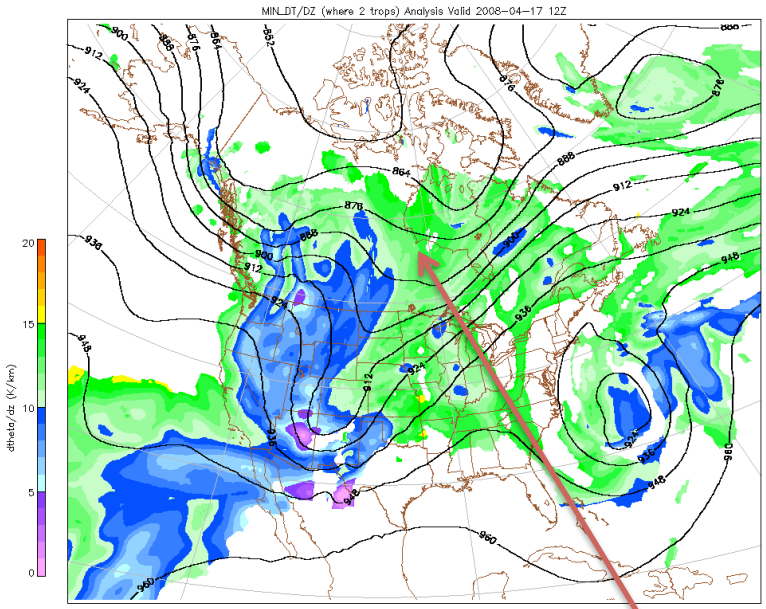
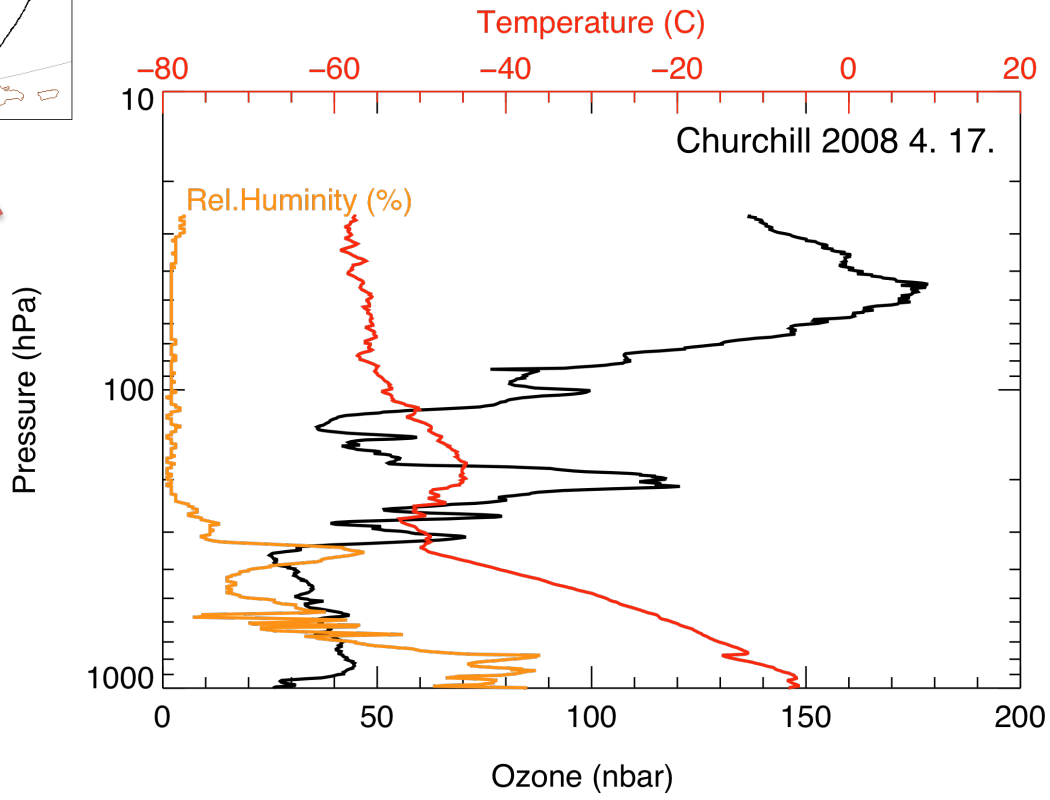
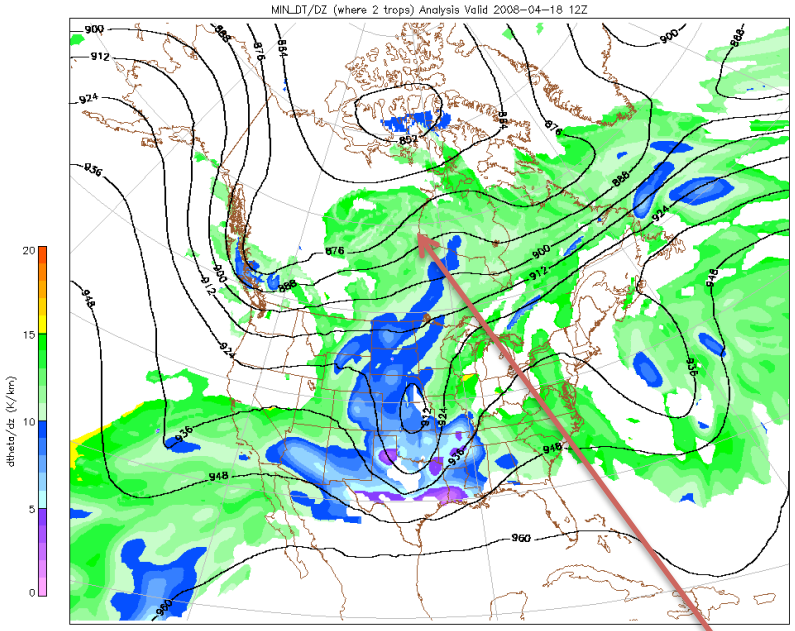
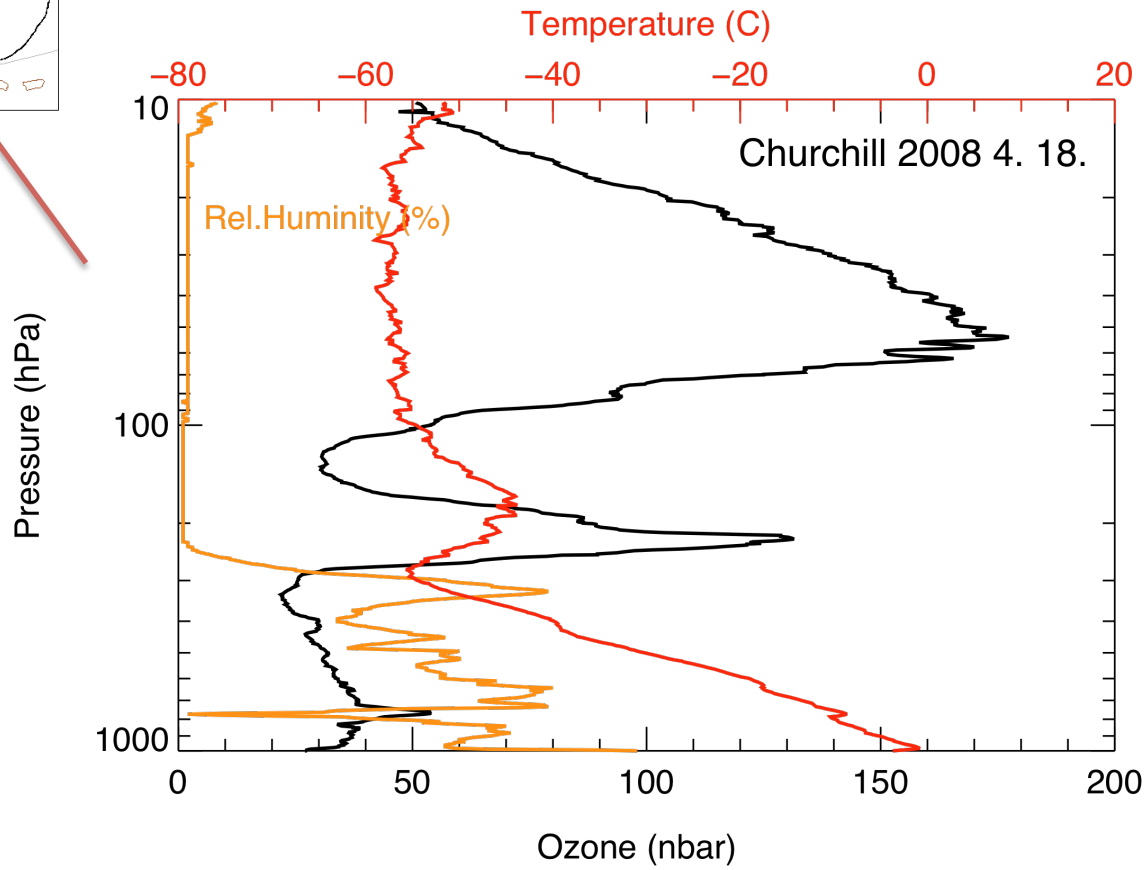
Churchill, April 17, 2008





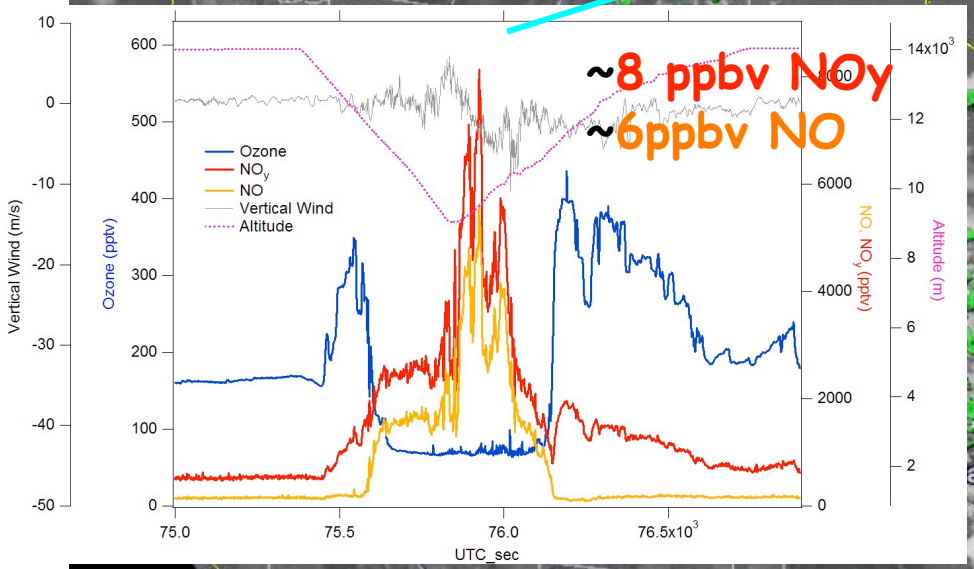
Churchill, April 18, 2008





Convective transport and lightning NOx-

RF14, June 18, 2008

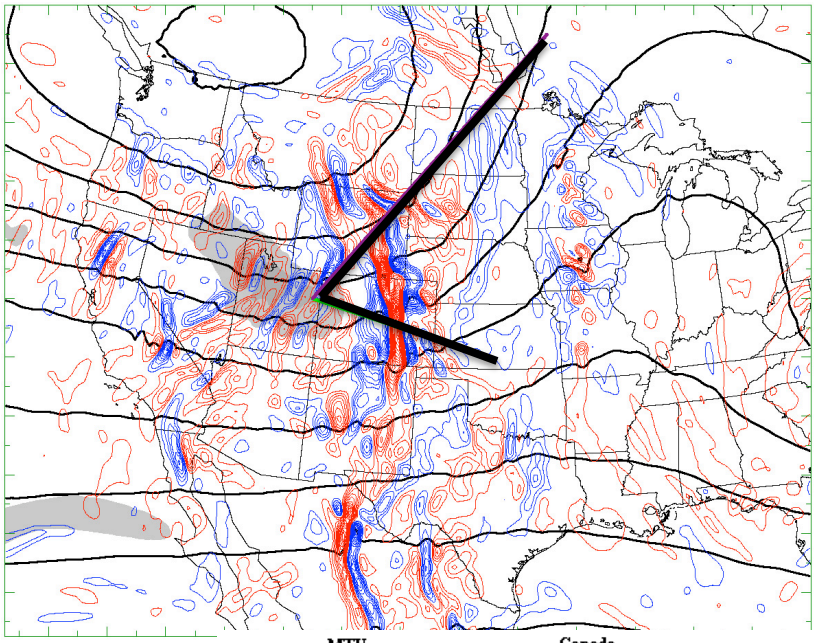


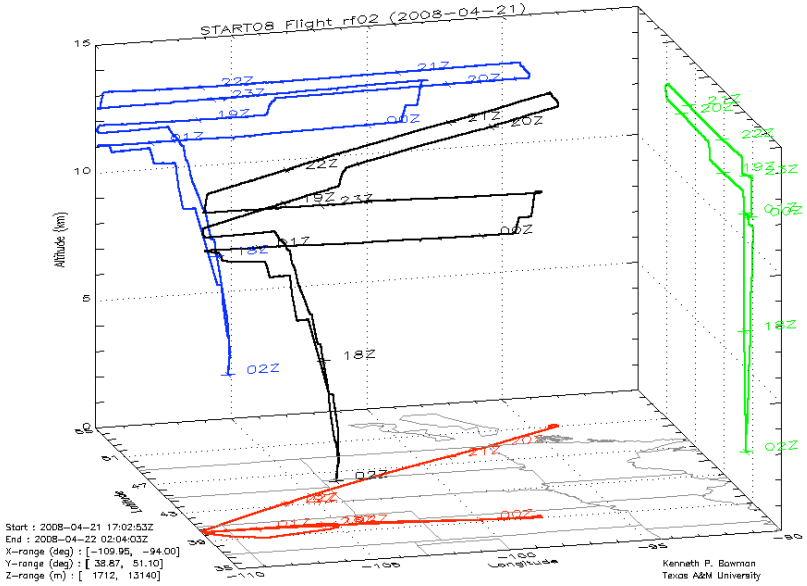
Laura Pan, 12/18/08

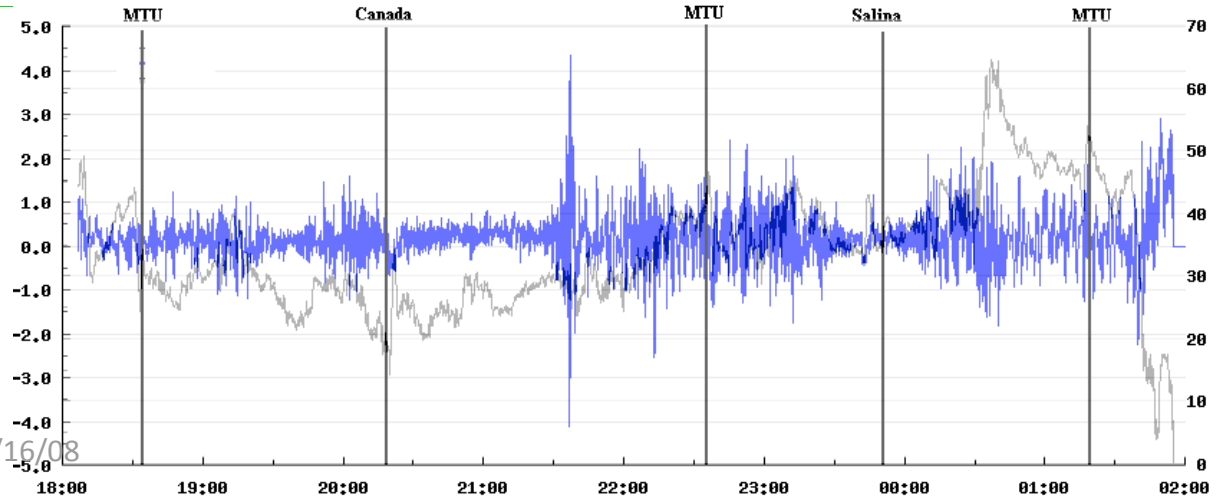
Gravity wave flight

Fuqing Zhang (TAMU/PSU)

RF02, April 24, 2008 : Jet/Mountain interaction







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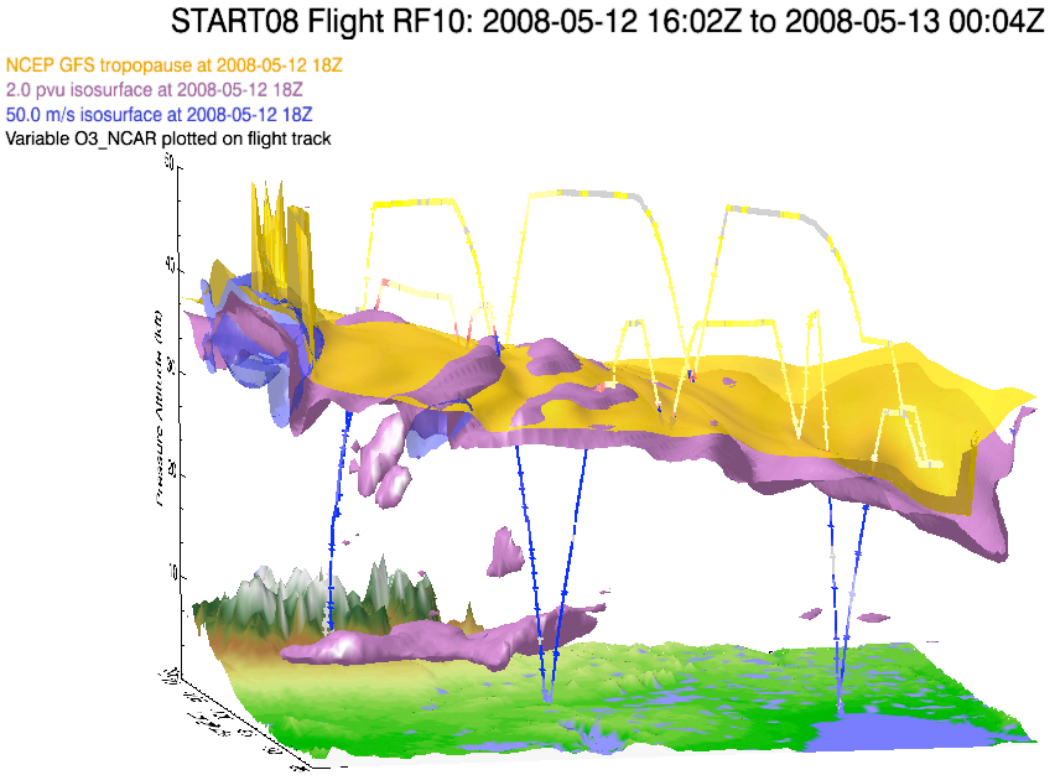
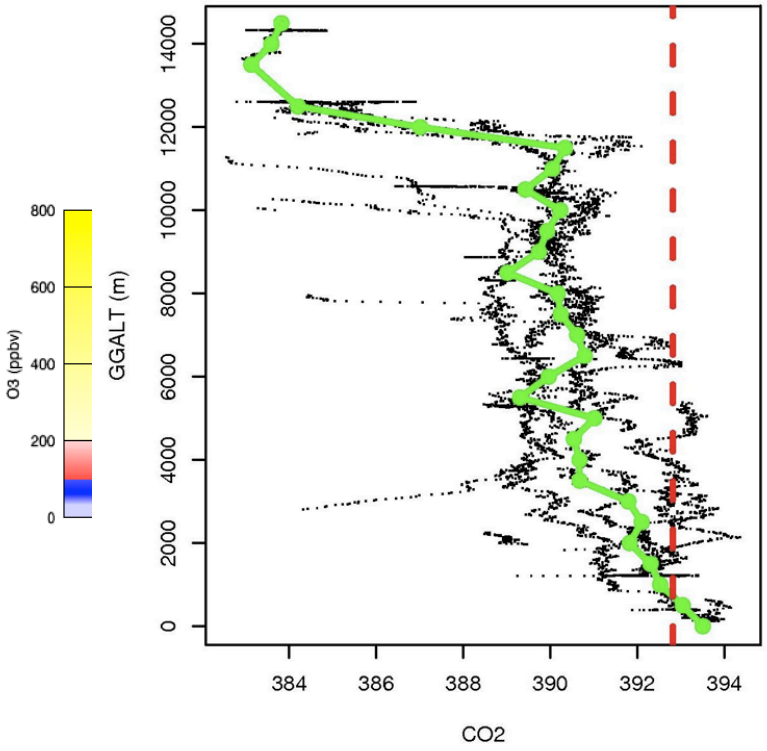
PreHIPPO Flights:

Cross section of CO_2 and other greenhouse gases from surface to stratosphere

RF10, May 12, 2008

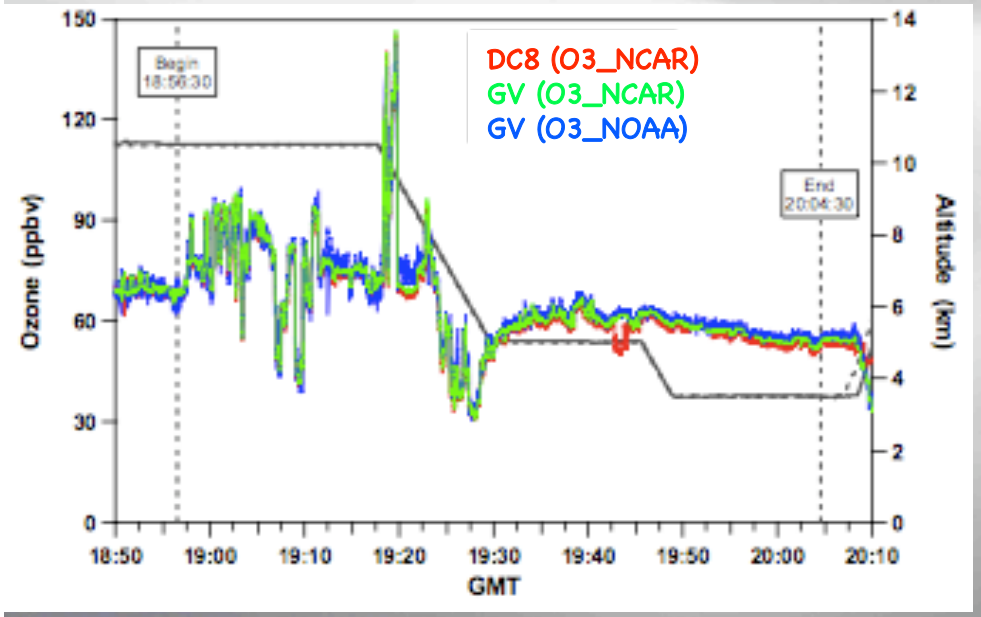




Steve Wofsy (Harvard)

Wing tip-to-wing tip inter-comparison with NASA DC-8

RF17, June 26, 2008



Expected Scientific Results

- **Climate relevant UTLS processes**
  - Transport and mixing,
  - Behavior of the tropopause,
  - UTLS chemical gradients and Age Spectra
- **Modeling chemistry-climate interaction**
  - diagnostics for CCM
  - quantifying mixing – Lagrangian vs. Eulerian
- **Design for future campaigns**
  - GV as a powerful tool for UTLS studies
  - Targeting thunderstorms use GV over continental US with IFR
- **Satellite data evaluation**
  - MLS, OMI, AIRS, IASI, ACE…


Thank You !
Data become public July 1 2009
For collaboration, see mailing list subscription at:
http://www.acd.ucar.edu/start/