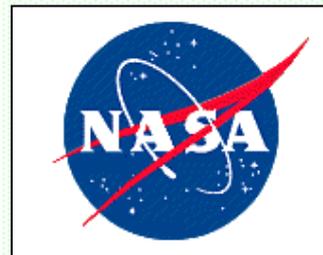


Stratospheric Intrusions Observed from Aircraft Profiles, Satellites and Ozonesondes during SEAC4RS

SEAC4RS Science Meeting, Pasadena, 29 Apr. 2015

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Thanks: D. Kollonige (UMD), S. Miller (PSU), J. C. Witte (SSAI, GSFC), J. Fishman & J. Wilkins (SLU)

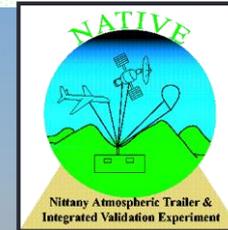
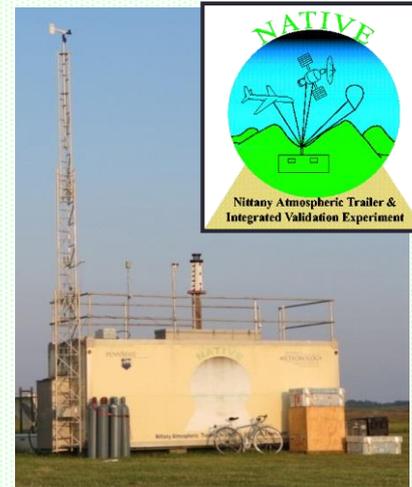




SEACIONS Basics



- **WHY/WHERE/HOW:** Coordinated launches for satellite overpass, aircraft rendezvous. West sites: fires; Central = NAM; East = mixed sources. > 170 profiles at <http://croc.nasa.gov/seacions>
- Houston sondes from 3 DISCOVER-AQ sites from 1 Sept 13 onward
- **ANALYZE STRATOSPHERIC INTRUSIONS (SI):** Houston, St Louis
 - Examine soundings & DC-8 tracers
 - Verify with tracer version of GEOS-5 model for 19 Aug., 22-23 Sept.
 - Add satellite views: AIRS water vapor; TES and OMI ozone
- **Right - SEACIONS map.**



Left: Smith Point



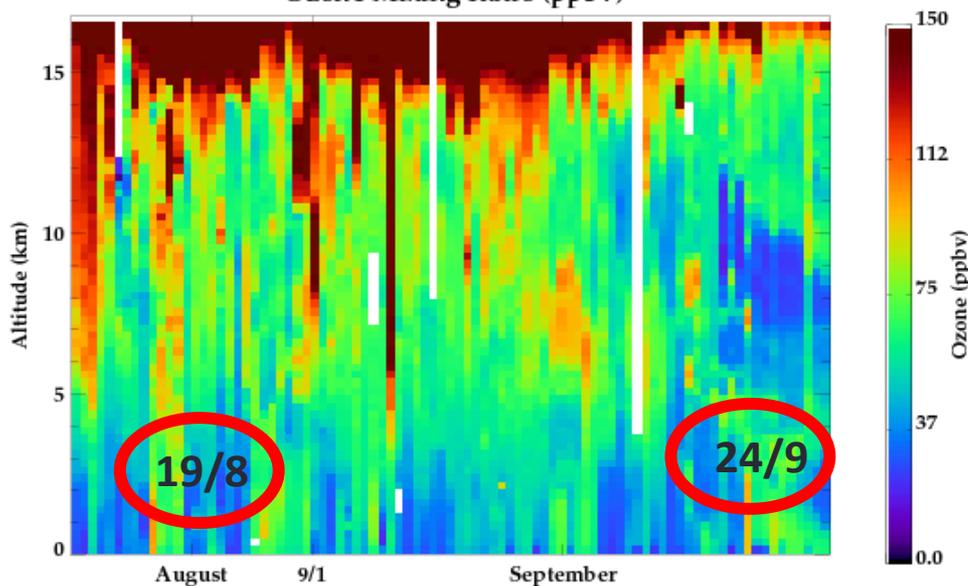


All-Houston Overview- SEAC4RS & DISCOVER-AQ



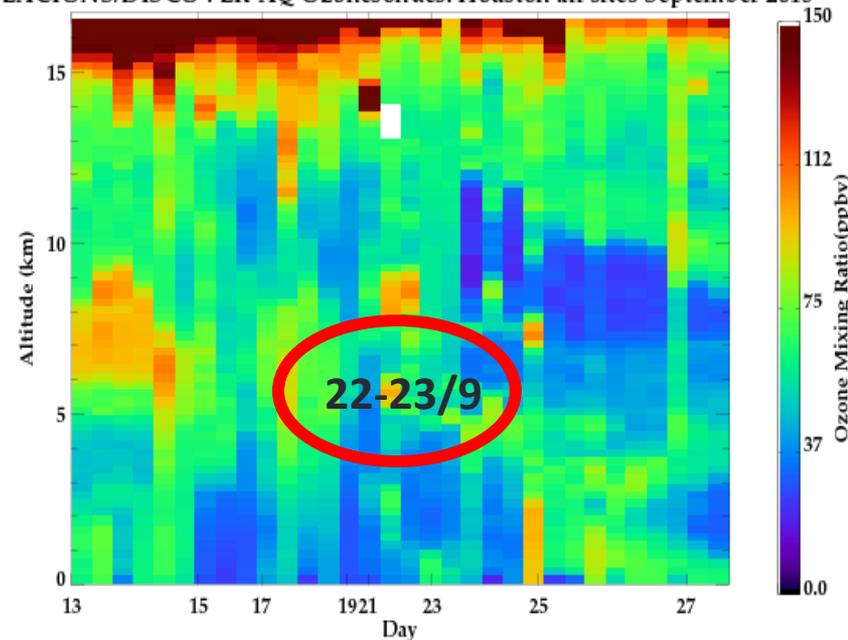
- Sonde curtain displays considerable FT & UT/LS variability
- Signatures of stratospheric intrusions (SI) inferred from laminae, H₂O-O₃ relation in sondes, aircraft tracers.
- STM #1: SI investigated with GEOS-5 for 19 Aug & 24 Sept 13. STM#2 - new GEOS-5 runs, satellite data. Focus on 19 Aug at Houston, St Louis; 22-23 Sept at Houston

SEACIONS Ozoneondes: Houston all sites August-September 2013
Ozone Mixing Ratio (ppbv)



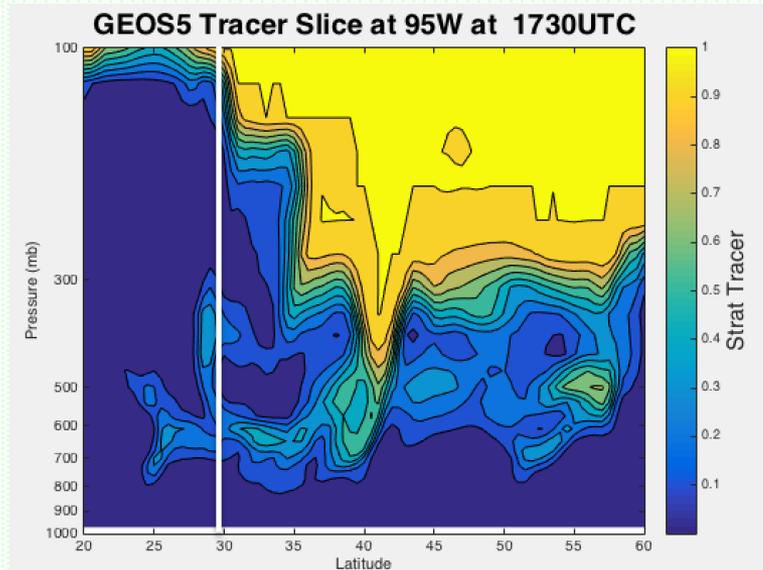
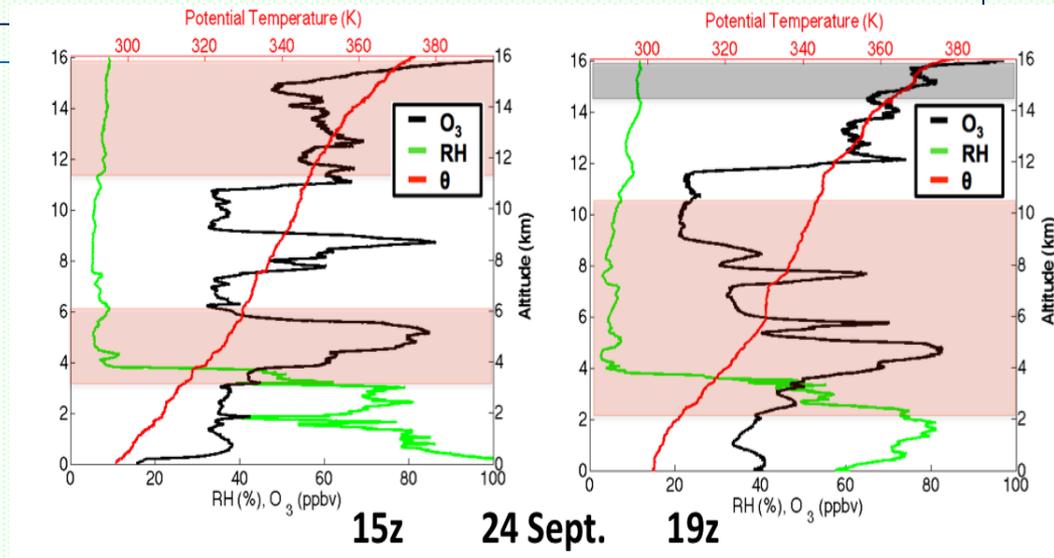
SEACIONS → |← SEAC4RS & DAQ → |← DISCOVER-AQ

SEACIONS/DISCOVER-AQ Ozoneondes: Houston all sites September 2013



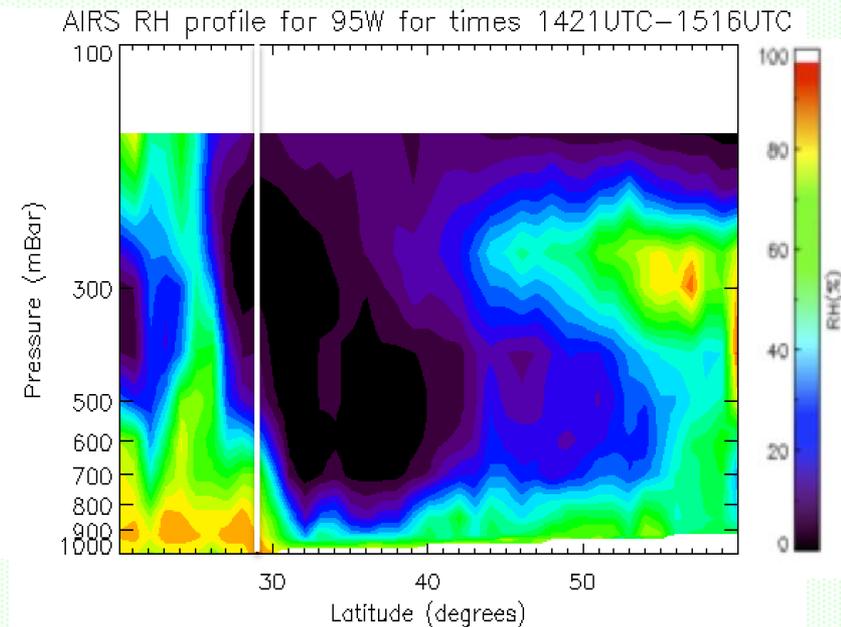
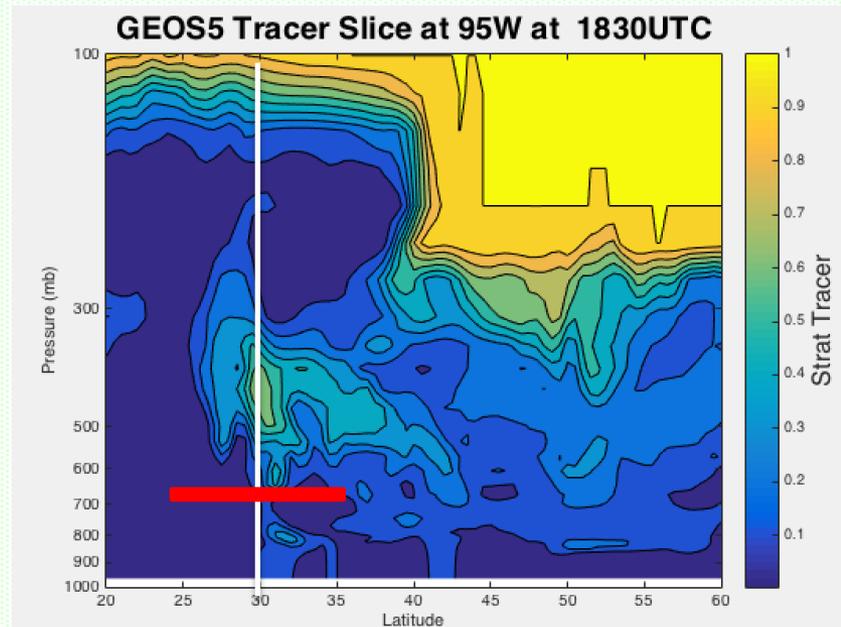
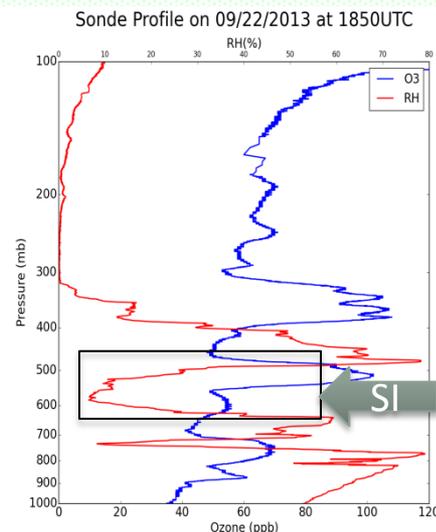
DAQ Houston Case Study – Day Before “the” Pollution Episode, 24/9: SI over Smith Point

- Dry air, elevated ozone, “Rossby Wave” (rose) label from Laminar analysis (Thompson et al., 2007 INTEX-A paper) signifies SI, especially in 2nd sounding
- P-3 corroboration near surface in O₃, suppressed NO_y (not shown)
- Below, **SI tracer (%) on 24 Sept.** Strat. tracer released in GEOS-5 DAS btn 19 and 24 Sept. White dashed line, location of Houston (30N, 95W). SI is clear from 800 to 300 hPa (~3-10 km)



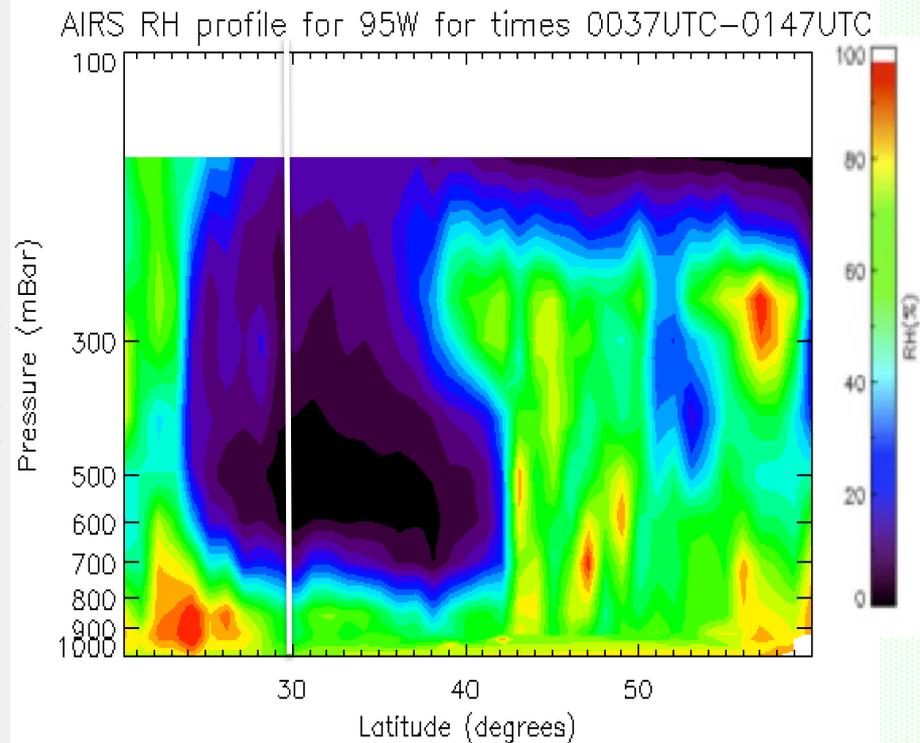
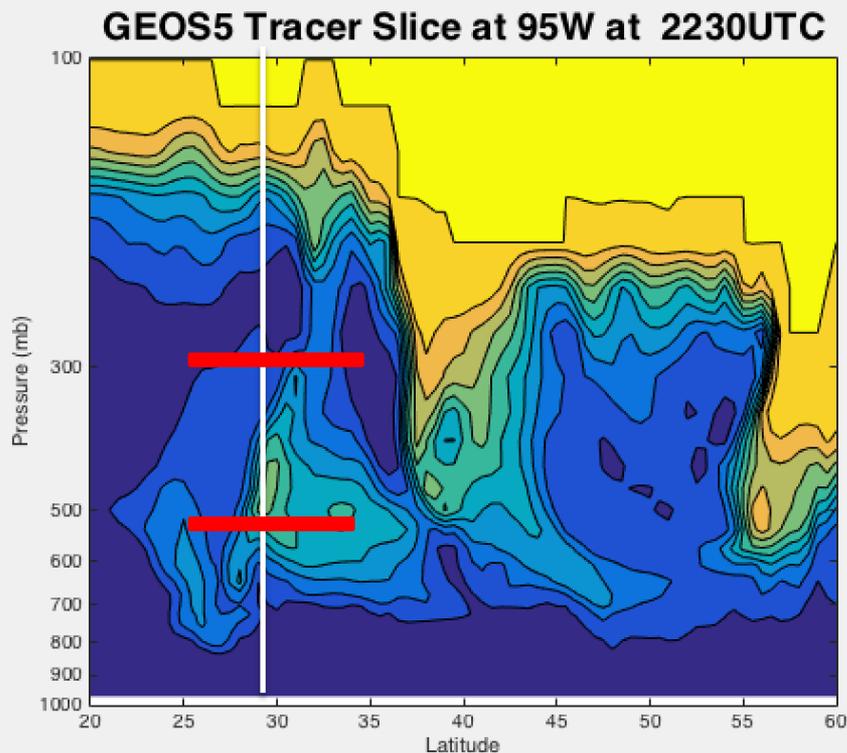
SEAC4RS: Houston, 22-23 Sept. 2013

- Frontal passage on September 21 (**Lower Left**) led to SI
- GEOS-5 model with strat. O₃ tracer (**Upper Right**) shows SI over Houston (~30 N, white line) in troposphere
- AIRS satellite RH (**Lower Right**) → stratospheric layer with RH < 20% from 800 hPa to top of profile
- SI present throughout troposphere with elevated ozone ~100 ppb, 22/9 sounding (**Center**)
- Stratospheric influence continued through 23 Sept before dissipation
- Subsequent SI 9/24-9/25 resulted from another front passing through on 9/24

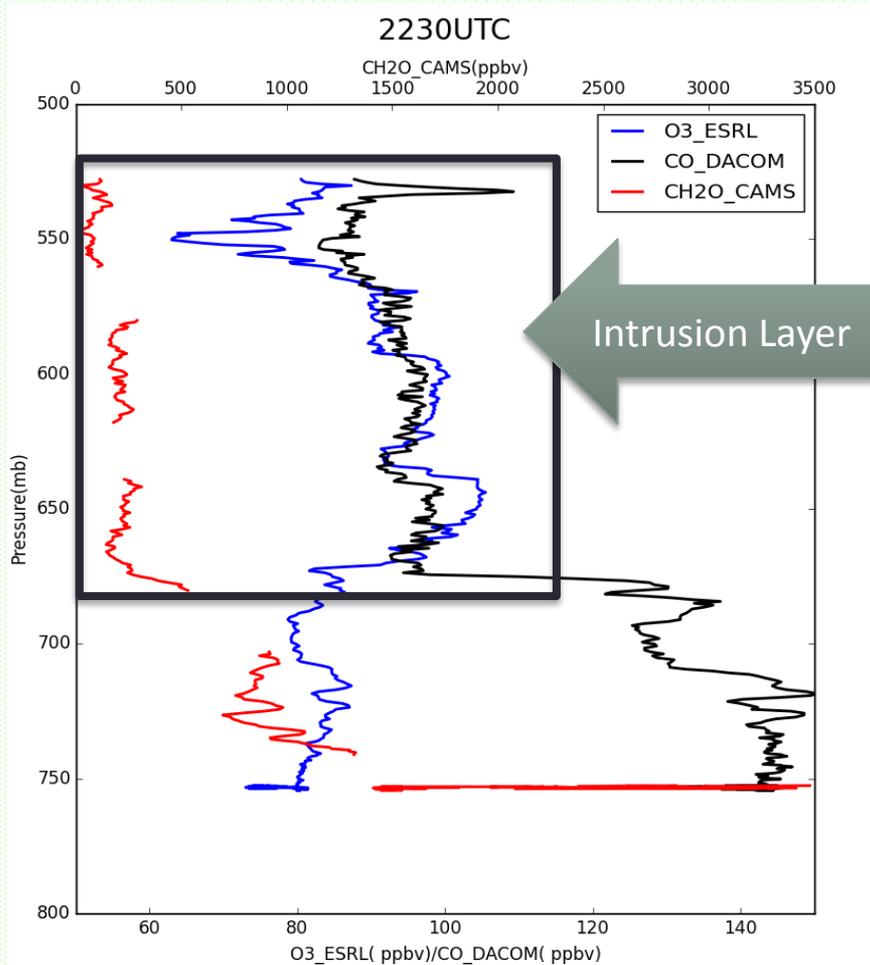


Houston, Model & AIRS RH, 19 August 2013

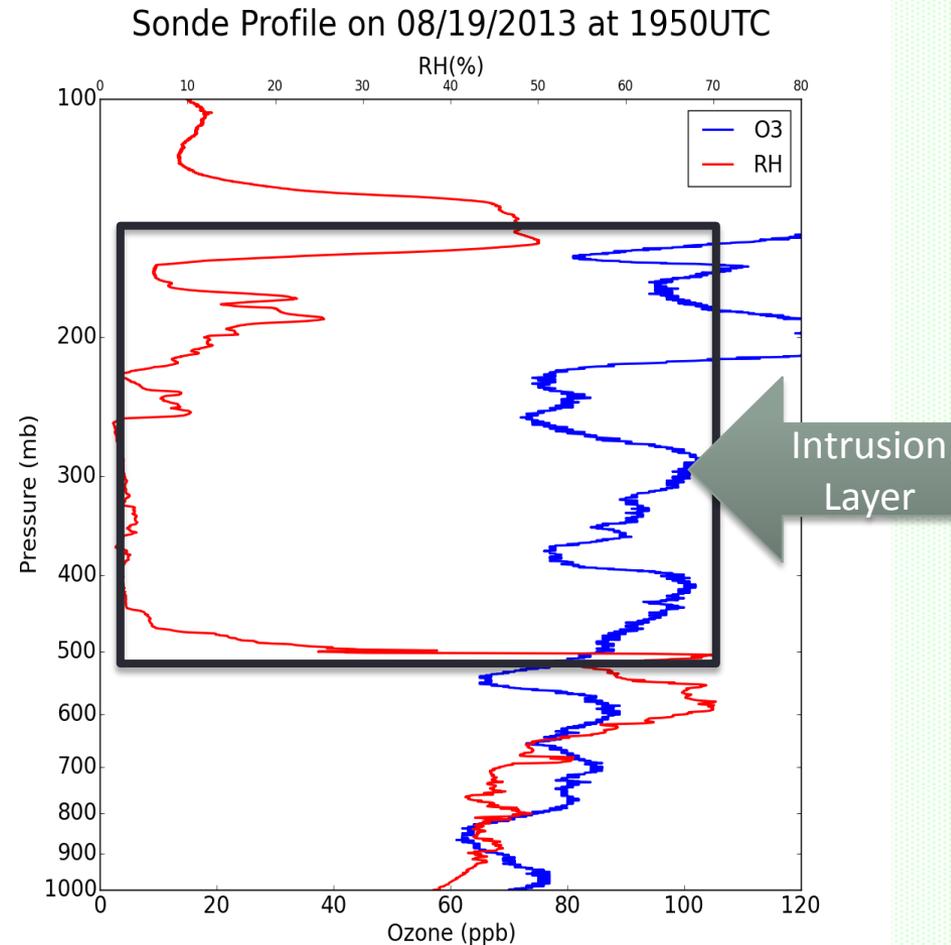
- Frontal passage on 17 August led to SI across central US
- GEOS-5 model with stratospheric tracer (**Left**) shows stratospheric influence over Houston (~30 N, noted by white line) from ~750-300 hPa
- AIRS satellite RH (**Right**) displays stratospheric layer as RH < 20% from 700 hPa through top of profile
- SI influenced mid- to upper trop in Houston sounding: O₃ ~ 100 ppbv at 300 hPa, > 120 ppbv at 200 hPa. Also at 500-600 hPa, seen by DC-8 descent to EFD. (**Next Slide**)



19 August 13 Houston DC-8 Descent/Sonde Profiles



Profile from DC-8 Dallas-Houston during descent, layer at ~675-525 hPa shows high O₃ with suppressed HCHO and CO, latter to 80 ppbv

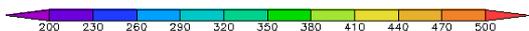
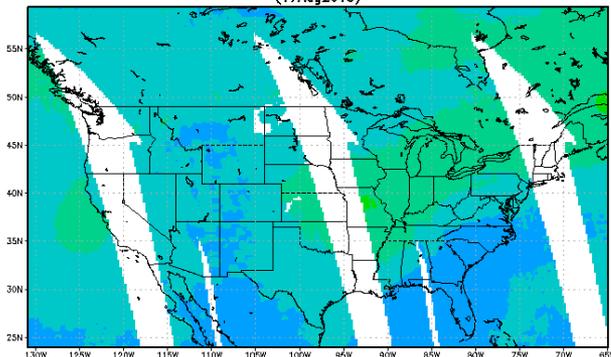


Sonde profiles at Houston a few hours earlier than aircraft profile shows elevated O₃ & decreased RH from ~ **500-175mb**

Satellite Ozone 17-21 Aug. 2013: OMI Total Ozone & TES "Step and Stare" Operation

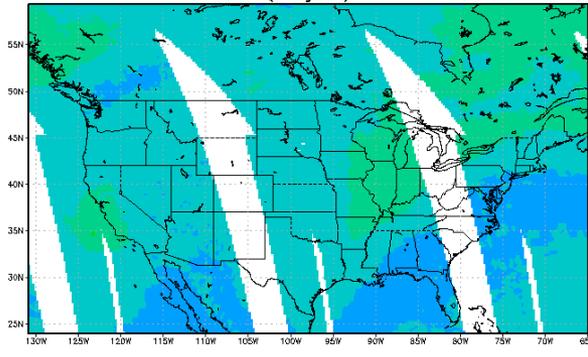
17/8

OMT03e.003 Column Amount Ozone [DU]
(17 Aug 2013)



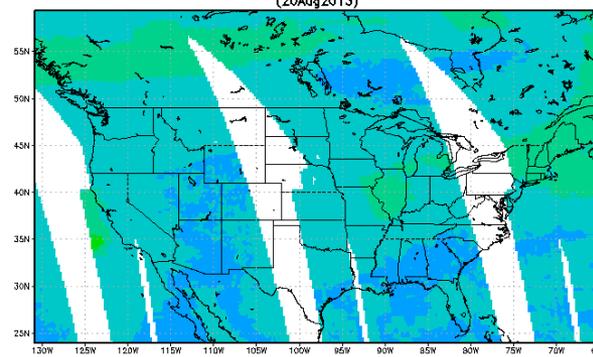
18/8

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(18 Aug 2013)

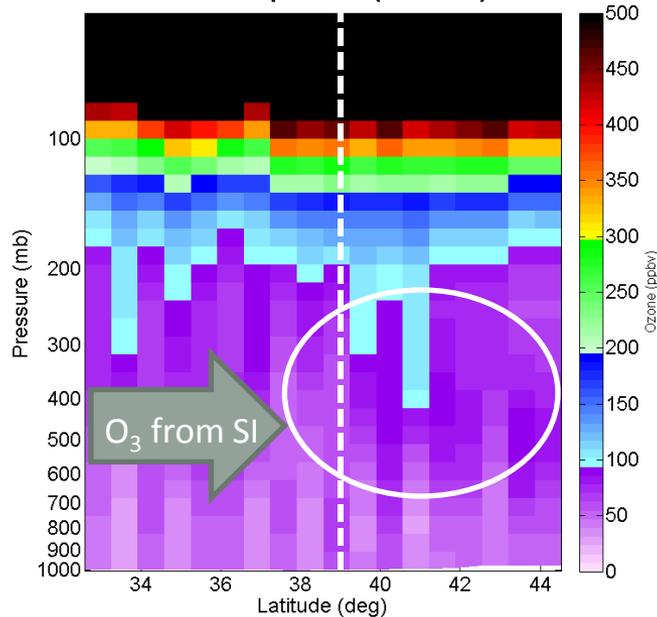
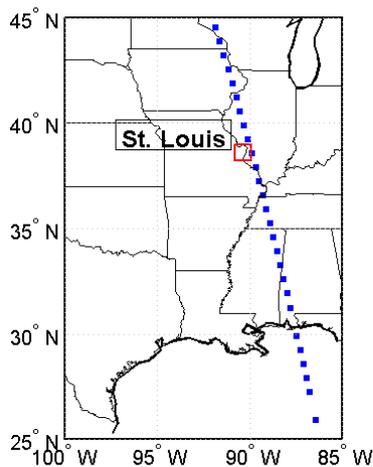


20/8

OMT03e.003 Column Amount Ozone [DU]
(20 Aug 2013)



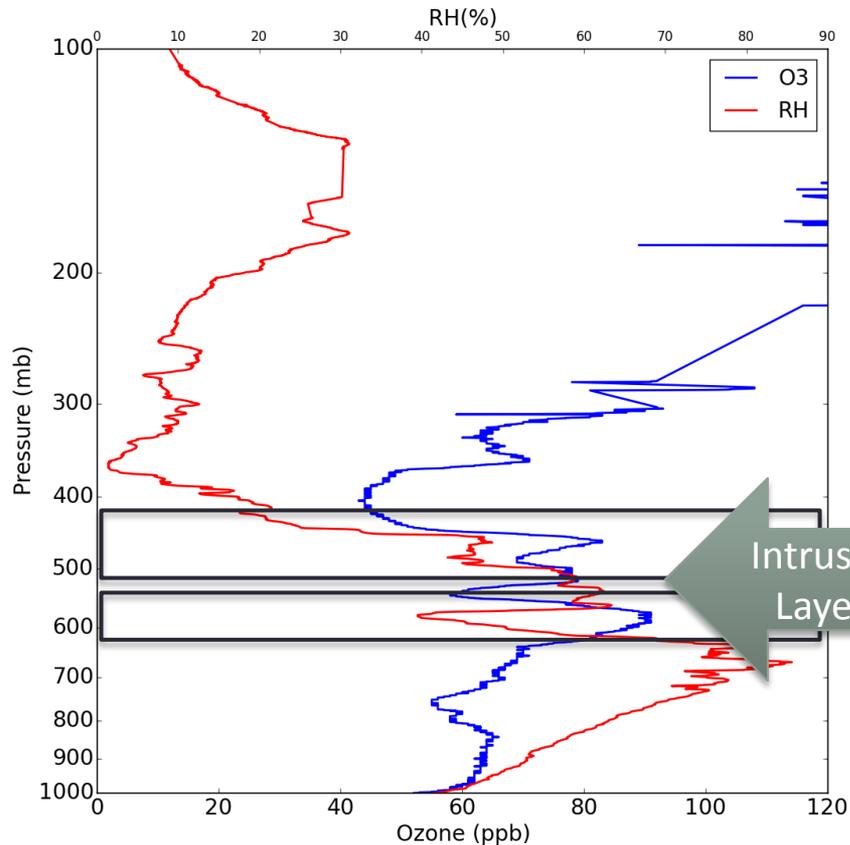
TES O3 Step & Stare (run18178)



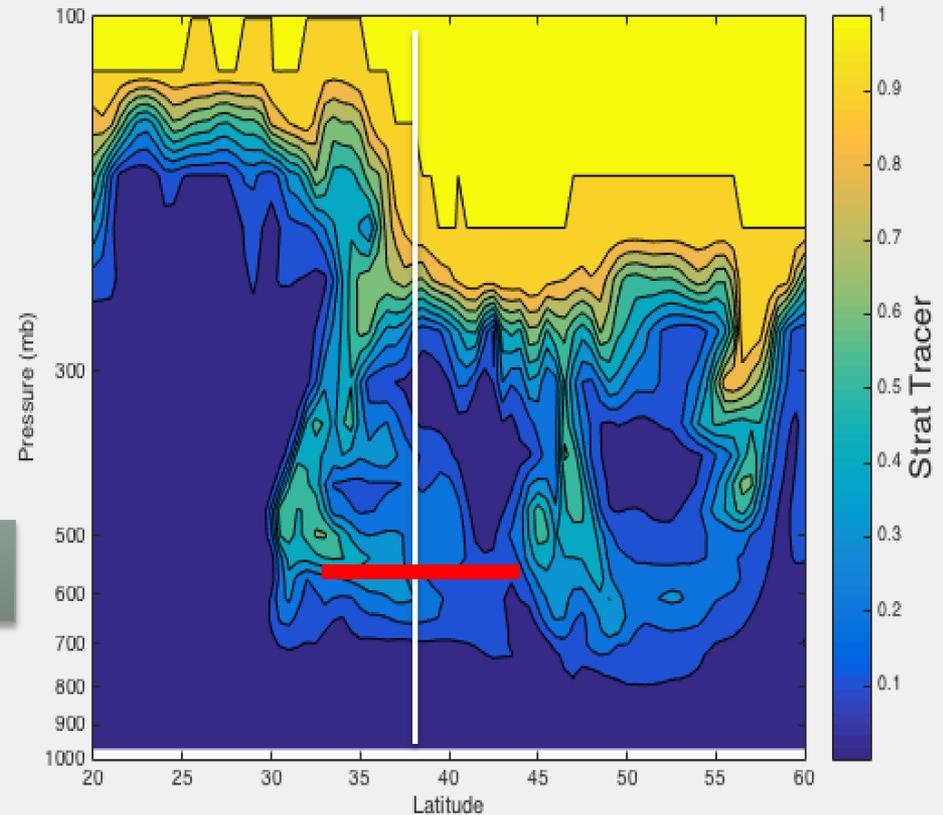
TES Step & Stare
21 Aug. 2013
Over St. Louis
(white dashed line)

19 August 2013 - St Louis Sounding & Model

Sonde Profile on 08/19/2013 at 1820UTC



GEOS5 Tracer Slice at 90W at 2230UTC



Ozonesonde profile from St Louis showing stratospheric influence (~625-575 hPa, ~525-475 hPa). Note: no DC-8 flights to St Louis

GEOS-5 model with stratospheric tracer slice over St. Louis (-90 W) showing stratospheric influence also present at St. Louis 38.5N (noted by white line)



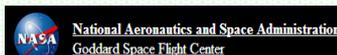
Summary & Looking Ahead



- **Ubiquity of Summer SI over US inferred in INTEX-A, B confirmed in SEAC4RS!**
- SEACIONS Team preparing an paper: “Overview of Ozone Variability in SEAC4RS from the SEACIONS Ozone sonde Network: Stratospheric Influences”
- Also SEACIONS: (1) Selkirk et al., Prior Talk; (2) J. Wilkins et al., *Thursday* Poster on St Louis Sondes

Thanks to Tropospheric Chem Program & UARP for SEACIONS Support & to all Partners For Launches, especially P. Cullis @ NOAA for supplies to new stations.

<http://croc.gsfc.nasa.gov/seacions>



SEACIONS: SouthEast American Consortium for Intensive Ozone sonde Network Study

HOME PI CONTACTS DATA ARCHIVE PRESENTATIONS LINKS

SEACIONS Principal Investigators

[Dr. Anne M. Thompson \(NASA/GSFC\)](#)

[Dr. Henry B. Selkirk \(NASA/GSFC & USRA\)](#)

SEACIONS (SouthEast American Consortium for Intensive Ozone sonde Network Study) during summer 2013: A strategic approach to determining convective impacts on Tropospheric Ozone and TTL gravity waves

Our scientific foci address SEAC4RS goals of satellite product validation (cf IONS-06, Doughty et al., 2011), convective and wave signatures in ozone [Morris et al., 2010a; Selkirk et al., 2010; Thompson et al., 2010], interaction of urban pollution with convection, and empirically derived tropospheric ozone budgets (Thompson et al., 2011a,b; see also Oltmans et al., 2010).



Operational Sites	
Boulder, CO (40.0N, 105.2W)	PI: Samuel Oltmans (NOAA ESRL), Bryan Johnson (NOAA ESRL)
OSU Kiamichi Forestry Research Station, Idabel, OK (33.90N, 94.75W)	PI: Gary Morris (Valparaiso University)
Houston Ellington Field, TX (29.6N, 95.2W)	PI: Anne Thompson (NASA GSFC) & Henry Selkirk (NASA GSFC & USRA)
Huntsville, AL (35.3N, 86.6W)	PI: Mike Newchurch (University of Alabama in Huntsville)
Smith Point, TX (29.55N, 94.78W)	PI: Anne Thompson (NASA GSFC)
Socorro, NM (34.6N, 106.9W)	PI: Ken Minschwaner (New Mexico Tech)
St. Louis, MO (38.6N, 90.2W)	PI: Jack Fishman (Saint Louis University) & Gary Morris (Valparaiso University)
Tallahassee, FL (30.4N, 84.3W)	PI: Henry Fuelberg (Florida State University)

