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

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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
  – Add satellite views: AIRS water vapor; TES and OMI ozone

• Right - SEACIONS map.
• Sonde curtain displays considerable FT & UT/LS variability
• Signatures of stratospheric intrusions (SI) inferred from laminae, $\text{H}_2\text{O}-\text{O}_3$ 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
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 NOₓ (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)
Frontal passage on September 21 (Lower Left) led to SI
GEOS-5 model with strat. O\textsubscript{3} tracer (Upper Right) shows SI over Houston (~30 N, white line) in troposphere
AIRS satellite RH (Lower Right)\rightarrow 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
• 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: O$_3$ ~ 100 ppbv at 300 hPa, > 120 ppbv at 200 hPa. Also at 500-600 hPa, seen by DC-8 descent to EFD. (Next Slide)
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

OMI35e.003 Column Amount Ozone [DU]
(17Aug2013)

18/8

OMI35e.003 Column Amount Ozone [DU]
(18Aug2013)

20/8

OMI35e.003 Column Amount Ozone [DU]
(20Aug2013)

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

TES O3 Step & Stare (run18178)

O3 from SI

TES Step & Stare
21 Aug. 2013
Over St. Louis
(white dashed line)
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 Ozonesonde Network: Stratospheric Influences”
- Also SEACIONS: (1) Selkirk et al., Prior Talk; (2) J. Wilkins et al., Thursday Poster on St Louis Sondes

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