Overview of IONS – Strategy, Accomplishments and Views from “The Summer that Wasn’t”

Anne Thompson
PSU Meteorology, anne@met.psu.edu

J. B. Stone, B. F. Taubman, PSU
J. C. Witte, T. L. Kucsera, SSAI at NASA/GSFC

E. Joseph, Howard Univ., Washington, DC
J. T. Merrill, Univ of Rhode Island, Narragansett, RI
G. Morris, Valparaiso Univ, IN
M. J. Newchurch, U Alabama – Huntsville, AL
S. J. Oltmans, NOAA/CMDL, Boulder, CO
F. J. Schmidlin, NASA/Wallops Flight Facility, VA
D. J. Tarasick, EC-MSC, Downsview, ONT
IONS (INTEX Ozonesondes Network Study)

- ICARTT**/INTEX/NEAQS science from sondes
- Sequence
  * Overview of IONS approach to ICARTT goals
  * IONS Results in context of INTEX issues
  * Early analysis of mid-Atlantic-NE O₃ budgets, climatology in “Summer That Wasn’t” - 2004

Subtexts

- Ozonesondes – Strategic design of network raises traditional method to “state-of-art” for integrating models, in-situ, satellite data
- Rich dataset for primary analysis, other applications

**ICARTT = Intl Consortium for Atmospheric Research on Transport & Transformation
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
  - Data at ICARTT site – cloud1.arc.nasa.gov
1. Can O₃ pollution be followed during ICARTT? √

Lagrangian Operational Design

Ozone at 500 hPa from Beltsville predicted to arrive at RH Brown two days later, and did so.
2. What are $O_3$ transport patterns across NA? √

Lagrangian View – Surprise – less ozone than expected!

- 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
3. How much Asian $O_3$ reaches western NA?

- 21/7 example shows *some* of $O_3$ pollution from Asia.
- Longer back-trajectories to be run, based on kinematic Schoeberl model & GMAO GEOS-4.
- Further analysis will use met. fields (RDF-pv, pot. Temp).
21 July 2004, “Summer That Wasn’t:” RI, Beltsville Profiles; RDF (reverse-domain-fill) EPV. 1x1deg, 340K Back Air Parcel Trajectories.
• **Budgets:** How much ozone from:
  • Local-regional photochemistry, interaction of pollutant sources with convection, lightning?
  • Long-range transport, advection of pollution?
  • Stratosphere?

**Approaches:**
• Correlate \( O_3 \) with meteorological, chemical tracers √
• Illustrate with UT/LS \( O_3 \) and pv, water vapor √

Images at ICARTT archive.
Date POC – tlk@croc.gsfc.nasa.gov
Evaluate Stratospheric Impact in UT Ozone

Select 10-15 km Ozone Layer (mean mixing ratio) for Analysis

July 2004 – Compare daily EPV (GMAO, 150 hPa) & ozone.

Most stratospheric influence - Pellston, Narragansett (below).

Less influence - R H Brown, Sable Island (below)

- Site comparison consistent with overall meteorology
Ron Brown UT Ozone Intermediate in NE-NA

10-15 km Ozone Layer & July 2004 EPV

Left – R H Brown. Right – Pellston. Latter more consistently in low pressure area, lower tropopause, higher pv, ie strat. influence
Ongoing Analysis: Mid-Tropospheric 2004 Ozone Budget

- **Challenge:** Separate pollution from aged UT/LS sonde O₃
- **Approaches:**
  - Statistics with sonde data (H₂O-O₃), trajectories
  - Interpret O₃ with tracers (eg CO, NOₓ) from satellite, DC-8, P-3

√ RHB Data, Images at cruise website. All IONS images, GSFC Met images: <croc.gsfc.nasa.gov/intex>. All data, images at ICARTT archive

IONS/Sondes Emphasis: Micro-Workshop on 10 Mar, c/o CMDL Sam Oltmans, Anne Thompson [tentative papers]

- **IONS Overview – AMT**
- **Analyses to Date -**
  - URI/Narragansett – episodic NOx titrating out surface ozone– J Merrill
  - Trans continental flow – O Cooper, S Oltmans
Mid-trop. “Ozone Ambiguity” (4-12 km)

Plan $\text{O}_3$-RH correlations with high resolution data. Case studies & aircraft tracer comparisons when possible.
• 8 - 10 km peaks in $O_3 > 150$ ppbv
  ->> matching elevated aircraft measurements.
• GPS/trajectories show origins from South/West Region.
• Elevated upper level $O_3$ found previous day at Wallops Is.
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.
Date POC – tlk@croc.gsfc.nasa.gov
STATUS – COLLABORATIONS – PUB PLANS

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  • Trans-continental flow – O Cooper, S Oltmans
  • Alaskan fires double Houston pollution – G Morris

Workshop, Collaborations, Potential Papers:
• Ozone variability over entire cruise – (RHB & RI/Maritime)
• Episodes – Ozone lidar plumes (Senff) 22 July; 30/7-1/8
  stability (Angevine); Others ? 16-19 July, 21 July, early August

Resource – Use ozone. trajectories. met data