Evidence of Light Alkane Transport from the Southwest During INTEX-NA

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Introduction

During the summer of 2004 we collected whole air samples aboard the NASA DC-8 flying laboratory as part of the Intercontinental Chemical Transport Experiment (INTEX-NA). The primary goal of INTEX was to understand the transport and processing of pollutants on transcontinental and intercontinental scales and their impact on air quality and climate. One concern was the quantification and characterization of pollutant transport over North America.

During several flights we were able to sample air masses which had originated in the Southwestern United States (Oklahoma, Texas). In a ground-based study conducted in May of 2002 we observed high levels of light alkanes (ethane, propane, n-butane, i-butane, n-pentane and i-pentane) being emitted in this region (Katzenstein et al., 2003). It is thought that these emissions come from the oil and natural gas production and storage in the region. We observed similarly elevated levels of light alkanes on those flights which sampled the Oklahoma/Texas plume.

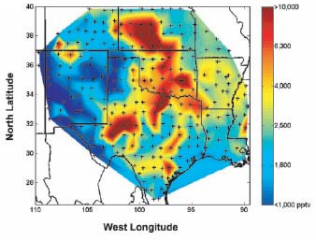
Methods

- For INTEX, whole air samples were collected in previously evacuated 2 L stainless steel canisters and pressurized to 40 psi. The ground study samples were collected in the same type of canister, but were not pressurized.
- Samples were returned to UC Irvine where they were analyzed using gas chromatography (GC).
- Hydrocarbons were measured using flame ionization detection (FID); alkyl nitrates by electron capture detection (ECD).

Results from Ground-Based Study

- April 27, 2002 – May 4, 2002.
- Collected 260 samples in a grid study fashion. Samples were 50 miles apart.
- Encountered high mixing ratios of light alkanes and C_2 - C_5 alkyl nitrates relative to compounds associated with combustion/urban emissions, such as ethyne and CO.
- The predominant source was found to be emissions from the oil and natural gas industries (Katzenstein *et al.*, 2003).

Ethane in SW Region

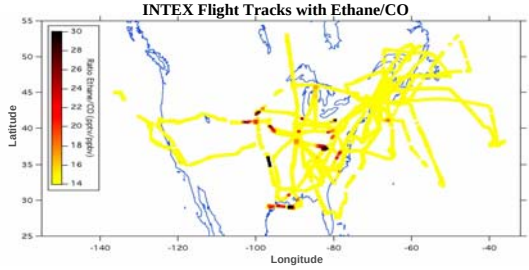


Map of Mid-Continent Oil Field

Results from INTEX-NA

- Collected 2900 samples aboard the NASA DC-8 aircraft.
- Numerous (> 15) INTEX flight legs on 10 flights encountered air masses that were enhanced in light alkanes (C_2 - C_5) compared to levels of typical combustion tracers such as CO (see Figure).
- Four INTEX flights (flights 5, 7, 19 and 20) show particularly strong evidence of enhancement in light alkanes (C_2 - C_5).

INTEX Flight Tracks with Ethane/CO

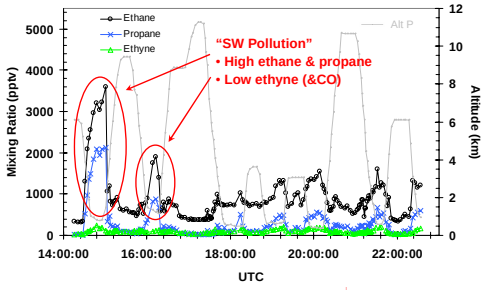


- Ratios of light alkane concentrations for legs in flights 5 and 7 influenced by SW pollution are similar to those ratios found in the ground-based study. Other legs show little similarity.

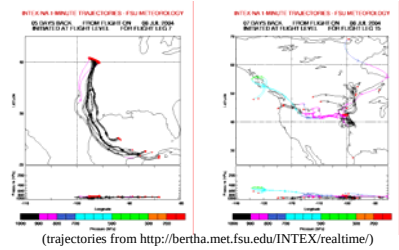
		SW Legs		Non-SW Legs	
Ratio (pptv/pptv)	Southwest	Flight 5	Flight 7	Flight 5	Flight 7
Ethane/Propane	1.7	1.7	1.6	7.5	6.2
Ethane/n-Butane	5.0	5.2	5.2	28.4	35.7
Ethane/i-Butane	11.4	12.6	13.0	49.4	54.0
Ethane/n-Pentane	20.9	23.4	20.5	80.9	112.8
Ethane/i-Pentane	24.5	17.3	14.9	50.7	85.3

Flight 5

- July 8, 2004, transit between Dryden in California and MidAmerica in St. Louis, Missouri.



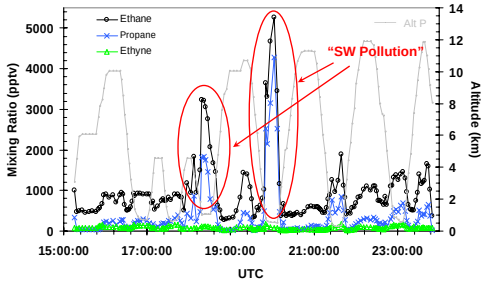
- Air mass sampled on legs 7 and 15 (about 1km AGL).
- High ethane and propane seen for SW legs. No corresponding increase in urban tracers (i.e. ethyne and CO).
- Back trajectories show air masses originating in the Oklahoma/Texas region.



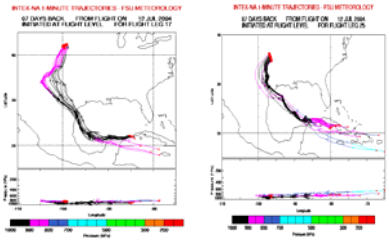
(trajectories from http://bertha.met.fsu.edu/INTEX/realtime/)

Flight 7

- July 12, 2004, local flight out of MidAmerica in St. Louis, Missouri.



- Air mass sampled on legs 17 and 25 (about 1km and 500m AGL, respectively)
- Similar air mass origin to flight 5, leg 7.
- Light alkanes enhanced, even greater absolute mixing ratios than in flight 5.



(trajectories from http://bertha.met.fsu.edu/INTEX/realtime/)

Conclusions/Future Work

- The influence from hydrocarbon emissions from non-urban US sources such as oil and gas fields including the Mid-continent Oil Field are surprisingly widespread.
- Used trajectory analysis to identify pollutants coming from the Oklahoma/Texas region (Southwest) in air sampled during INTEX-NA.
- These findings support our earlier ground-based work in the region.
- Need to further examine data to determine age, transport, evolution of air masses, etc.
- Need to compare with existing model emission inventories to see if these underestimate such emissions.