Lagrangian Analysis of Ozone Production in the Baltimore-Washington Metropolitan Area

Based on Air Parcel Trajectories and In Situ Airborne Measurements from the 2011 DISCOVER-AQ Campaign

Poster 283
Abstract 366003

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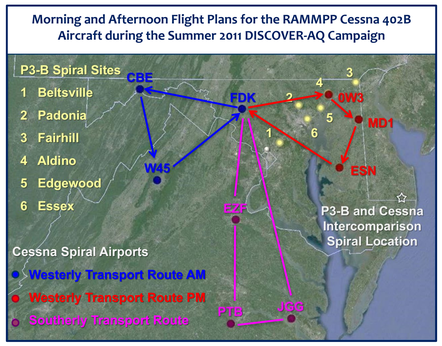
Objective Perform a Lagrangian analysis of in situ airborne measurements and air parcel trajectories to calculate ozone production rates and distinguish ozone derived from local photochemical generation versus regional transport.

Approach Analyze spatial and temporal patterns of ozone measured concurrently from two aircraft platforms over the Baltimore Washington corridor within the context of air parcel trajectories to empirically calculate ozone production rates.

Conclusion Dozens of cases were identified by examining data from overlapping flight days and corresponding air parcel trajectories and resulted in calculated ozone production rates ranging up to 13.5 ppbv hr^{-1} and 4.1 ppbv hr^{-1} on average.

RAMMPP Aircraft Program



RAMMPP
Regional Atmospheric Measurement Modeling and Prediction Program

Improve understanding of elements that control regional air quality

◊

Elucidate contributions by transport versus local sources over Mid-Atlantic

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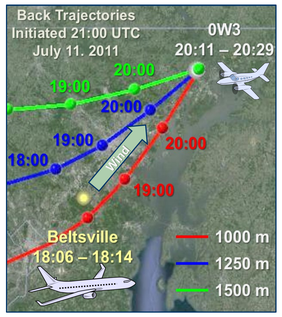
Integrated approach of air quality modeling and in situ measurements

Questions to Address

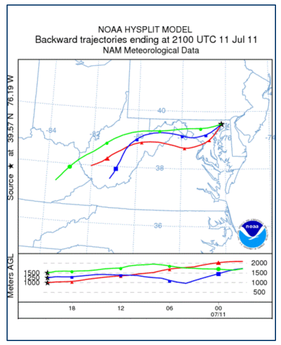
- How do tropospheric chemistry and dynamics affect the levels and vertical profiles of trace gas and aerosol species over the Mid-Atlantic region?
- How do the concentrations of trace gas and aerosol species evolve throughout the day in response to variations in transport, photochemistry, and emissions?
- Does regional transport have an effect on the levels of pollutants observed in the boundary layer based on in situ monitoring and air quality modeling?
- RAMMPP is a coordinated venture that combines efforts of Maryland Department of the Environment and the University of Maryland.

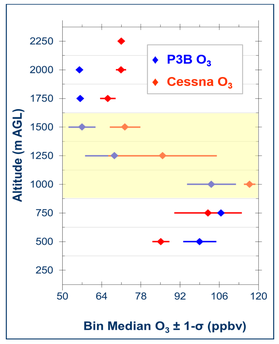
MDE

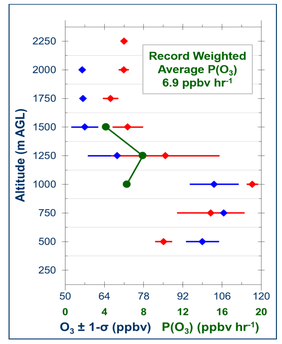
Lagrangian Analysis Methodology



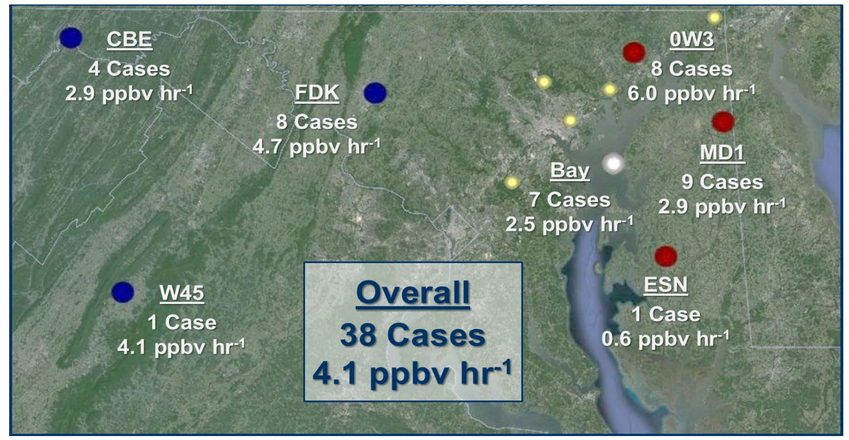
- The NASA P3B and RAMMPP Cessna 402B coordinated flights on 8 days in July 2011.
- Locations and times of individual spirals performed by each aircraft were evaluated with trajectories to identify transport analysis cases.
- The trajectory and profile figures illustrate a case with the P3B upwind of the Cessna on July 11th.
- The P3B Beltsville spiral was performed two hours before the Cessna 0W3 spiral and resulted in an average O_3 production rate of 6.9 ppbv hr^{-1}.





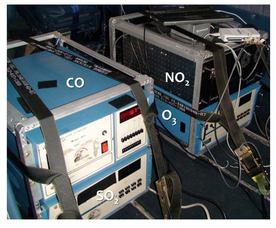


Ozone Production Rates



Cessna Spiral	Cases	P(O_3) (ppbv hr^{-1}) Weighted Avg	Standard Dev
Upwind	20	3.4	3.5
Downwind	18	4.9	3.5
Overall	**38**	**4.1**	**3.5**

RAMMPP Aircraft Payload



- RAMMPP Cessna 402B flew a total of 65 spirals during 23 flights over 13 days in Summer 2011.
- Of those, 40 spirals during 14 flights over 8 days coincided with DISCOVER-AQ P3B flight days.
- One wingtip-to-wingtip comparison flight was performed between the P3B and the Cessna.
- Factors derived from comparison flight data were applied to adjust Cessna RH and T data for inlet ram effects and scattering data for ambient RH.

Cessna Payload	Technique (*Instrument*)
Carbon Monoxide	Non-Dispersive Infrared Radiation Gas Filter Correlation (*TEI 48C*)*
Nitrogen Dioxide	Cavity Ring-Down Spectroscopy (*Los Gatos Research RMT-200*)*
Ozone	Dual Cell Ultraviolet Photometry (*TEI 49C*)*
Sulfur Dioxide	Modified Pulsed Fluorescence (*TEI 43C*)
Aerosol Absorption	7-Wavelength Aethalometer (*Magee Scientific*)
Particle Counts	Condensation Particle Counter (*TSI 3007*)
Aerosol Scattering	Integrating Nephelometer (*TSI 3563*)*
Particle Size	Particle Profiler (*Met One 9012*)
Pressure	Capacitance Barometer (*Vaisala PTU300*)*
Relative Humidity	Thin Film Capacitance (*Vaisala PTU300*)*
Temperature	Platinum Resistance (*Vaisala PTU300*)*
Position	Global Positioning System (*Garmin*)*

CPC

*Parameters available for comparison between the NASA P3B and the Cessna 402B

DISCOVER-AQ Field Campaign

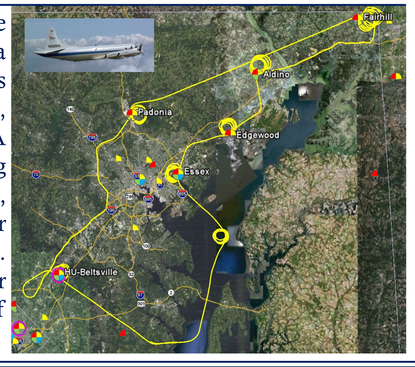
Deriving Information on Surface Conditions from COlumn and VERtically Resolved Observations Relevant to Air Quality

DISCOVER-AQ NASA Langley Research Center

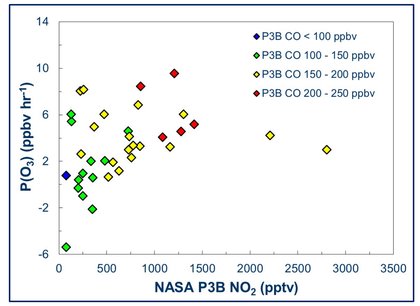
Science Goals

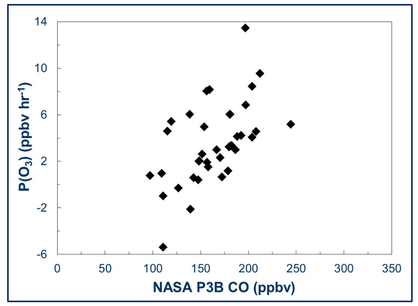
- Investigate relation between column observations and surface conditions to explore the diagnostic potential of remote sensing column observations
- Examine horizontal scales of variability that affect satellite and model calculations to improve interpretation and assimilation of data
- Characterize differences in diurnal variability of column observations and surface conditions to better understand the influence of variability on interpretation of satellite observations

This campaign was conducted in the Baltimore Washington Metropolitan Area in July 2011. Coordinated observations were performed from ground, aircraft, and remote sensing platforms. The NASA P3B flew over the I-95 corridor, spiraling to 1000 ft over selected ground stations, while the NASA King Air flew higher altitude transects over the P3B circuit. The RAMMPP Cessna 402B spiraled over airports located upwind and downwind of the corridor to provide regional context.



Ozone Production Results





- Calculated O_3 production rates increased at higher NO_2 concentrations with an average of 2.3 ppbv O_3 hr^{-1} for measured NO_2 less than 500 pptv to an average of 5.9 ppbv O_3 hr^{-1} for measured NO_2 greater than 1000 pptv.
- Calculated O_3 production rates continued to increase with NO_2 concentrations up to 1500 pptv then fell slightly at higher NO_2 concentrations suggesting a pattern of increasing O_3 production with NO_2 to that turnover point.
- Calculated O_3 production rates increased with increasing CO concentrations. The patterns of increasing calculated O_3 production rate with CO and with NO_2 up to a turnover point are consistent with kinetic model predictions.

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