Background Ozone Levels

Sunil Kumar
MWAQC TAC
May 11, 2010

Introduction

- What is “Background ozone level”?
  - Ozone level of an area in absence of any anthropogenic influence.
  - True background ozone level existed before industrialization started. Not measurable now. So no true background ozone level known for an area.
- Is it fixed or does it vary?
  - Background ozone levels vary with time of day, month, and across large time spans (over a decade or more)
  - Natural and anthropogenic sources situated long distances influence local ozone levels due to long range atmospheric transport (overall 5-10 ppb increase, NRC report[1]).
  - Changes in these sources can lead to change in local background ozone levels.

[1] *Global Sources of Local Pollution: An Assessment of Long-Range Transport of Key Air Pollutants to and from the United States*, pp. 43, National Research Council, National Academy of Science, 2009

Global Contribution to Local Ozone
(Atmospheric Pollutant Transport Pathways)

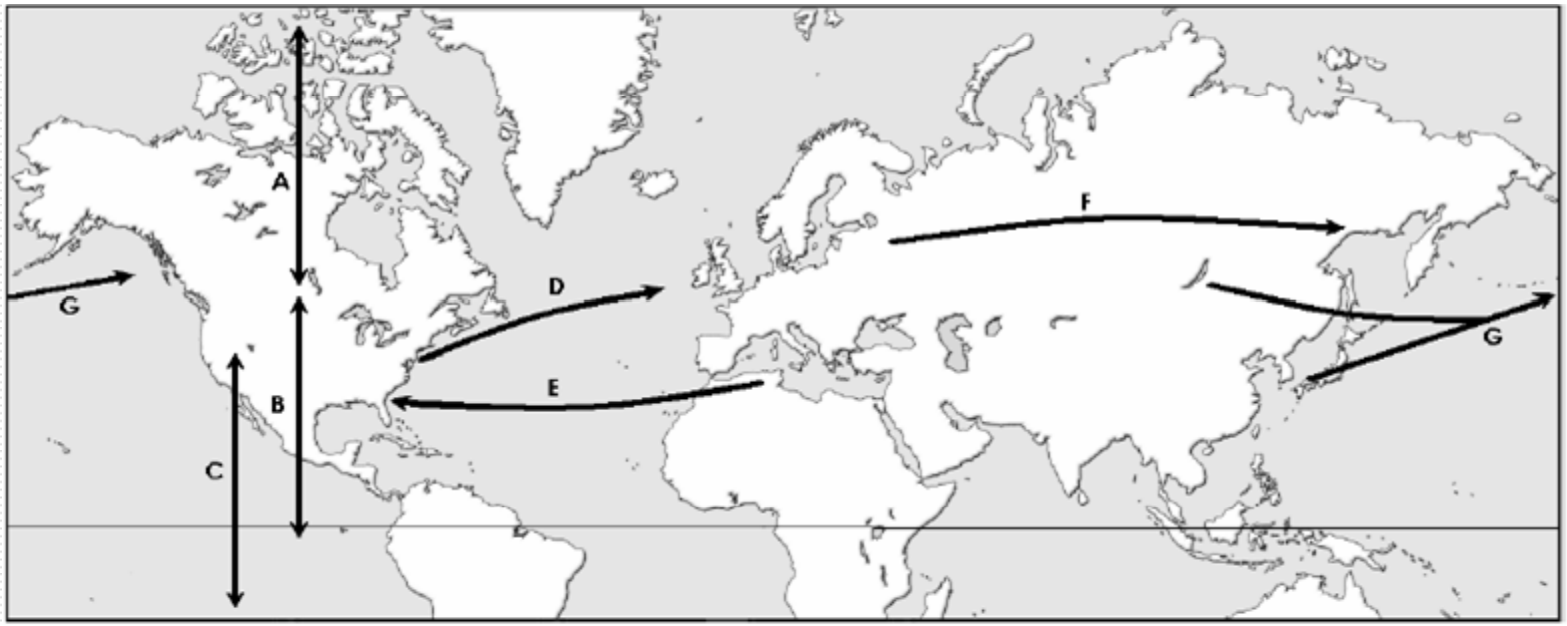

FIGURE 1.2 Major atmospheric transport pathways affecting North America. The general timescales of transport estimated by the committee from trajectory studies and other sources are: (A) Midlatitudes - Arctic exchange: 1-4 weeks. (B) Midlatitudes - Tropics exchange: 1-2 months. (C) Northern Hemisphere - Southern Hemisphere exchange: ~ 1 year. (D) North America to Western Europe: 3-13 days. (E) Northern Africa to North America: 1-2 weeks. (F) Eastern Europe to Asia: 1-2 weeks. (G) Eastern Asia to North America: 4-17 days. For (A), (B), and (C), transport occurs in both directions, depending on altitude.

Source- *Global Sources of Local Pollution: An Assessment of Long-Range Transport of Key Air Pollutants to and from the United States*, pp. 20, National Research Council, National Academy of Science, 2009

“Policy Relevant Background” Ozone Level

- What is “PRB ozone level” and why it is needed?
  - PRB ozone level is the background ozone level used for purposes of informing decisions about NAAQS.
  - EPA defines PRB ozone level as background ozone level in absence of continental North American anthropogenic emissions. These are calculated using a chemical transport model.
  - Emissions control possible only within US territory and in Canada and Mexico through agreements (North American Agreement on Environmental Cooperation ,NAAEC). No control over other locations in the world contributing to ozone in US.
  - EPA assesses risks to human health and environmental effects from Ozone levels in excess of PRB concentrations.

"Policy Relevant Background" Ozone Level

- What is "PRB ozone level" and why it is needed?
  - PRB varies with seasons and altitude (higher in spring and higher altitudes).
  - Identifying PRB ozone level allows us to know the minimum ozone level that can be achieved for an area through possible emissions control measures.
  - PRB used by EPA as a floor for estimating risk associated with alternative NAAQS levels.
- PRB ozone level : 1-hour Vs 8-hour
  - Averaging period of ozone standard changed from 1-hour to 8-hour
  - So 8-hour PRB ozone level is more important than 1-hour level from the standpoint of attaining the new 8-hour standard.

"Policy Relevant Background" Ozone Level
(Summary of Findings)

Table 3-2. Previous Estimates of Background O_3 in Surface Air Over the United States

Study	Method	Time Period	Region	Background Estimate (ppbv)
Trainer et al. (1993)	y-intercept of O_3 vs. NO_y-NO_x regression line[a]	Summer 1988	Eastern United States	30-40[b]
Hirsch et al. (1996)	y-intercept of O_3 vs. NO_y-NO_x regression line	May-Sep 1990-1994	Harvard Forest[c]	25 (Sept) – 40 (May)[d]
Altshuller and Lefohn (1996)	y-intercept of O_3 vs. NO_y regression line, and observations at remote/rural sites	Apr-Oct 1988-1993	Continental United States	25-45 (inland)[e] 25-35 (coastal)
Liang et al. (1998)	Sensitivity simulation in a 3-D model with anthropogenic NO_x emissions in the continental U.S. set to zero	Full year	Continental United States	20-30 (East)[f] 20-40 (West) (spring maximum)
Lin et al. (2000)	Median O_3 values for the lowest 25th percentiles of CO and NO_y concentrations	1990-1998	Harvard Forest	35 (fall) – 45 (spring)[g]
Fiore et al. (2002)	O_3 produced outside of the North American boundary layer in a global 3-D model	Summer 1995	Continental United States	15-30 (East)[h] 25-35 (West)

[a] NO_y is the chemical family including NO_x and its oxidation products; NO_y-NO_x denotes the chemically processed component of NO_y.
[b] 1300-1700 local time (LT) in flatland and valley sites; all daytime measurements at elevated sites.
[c] rural site in central Massachusetts.
[d] 1100-1700 EST hourly means.
[e] seasonal 7-h (0900-1559) daylight average.
[f] 1300-1600 LT monthly mean.
[g] daily max 8-h averages.
[h] 1300-1700 average.

Source- *Air Quality Criteria for Ozone and Related Photochemical Oxidants, Volume I*, pp. 3-48, EPA 2006

"Policy Relevant Background" Ozone Level (Estimates)

- PRB concentrations in the United States are generally 0.015 ppm to 0.035 ppm (between 1300-1700 local time).
- They decline from spring to summer and are generally <0.025 ppm under conditions conducive to high O3 episodes.
- Stratospheric ozone intrusions elevate surface ozone at high-altitude sites on rare occasions only, not a major concern for the Washington region.

References

- *Air Quality Criteria for Ozone and Related Photochemical Oxidants,* Volume I, 2006, EPA
- *Global Sources of Local Pollution: An Assessment of Long-Range Transport of Key Air Pollutants to and from the United States*, 2009, Committee on the Significance of International Transport of Air Pollutants; National Research Council, National Academy of Science
- *Background Ozone*, 2009, http://www.asl-associates.com/back.htm, Lefohn A.S.
- *Variability in surface ozone background over the United States: Implications for air quality policy*, 2003, A. Fiore,1 D. J. Jacob, H. Liu,2 R. M. Yantosca, T. D. Fairlie,2 and Q. Li, Department of Earth and Planetary Sciences and Division of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts, USA
- *Background ozone over the United States in summer: Origin, trend, and contribution to pollution episodes,* 2002, Arlene M. Fiore, Daniel J. Jacob, Isabelle Bey,1 Robert M. Yantosca, Brendan D. Field, and Andrew C. Fusco, Department of Earth and Planetary Sciences and Division of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts, USA & James G. Wilkinson, School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, Georgia, USA