Blue Sky Olympics: Satellite Observations of Air Quality During the 2008 Beijing Olympics

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Introduction

China imposed short-term emission control regulations on industry and transportation to quickly improve air quality during certain events, including the 2008 Summer Olympic Games. During the 2008 Beijing Olympics, heavy polluting factories were shut down from July 20th to September 20th and driving restrictions banned vehicles with even or odd license plates on alternating days. The study area is the Beijing-Tianjin-Hebei economic region (Figure. 1). This study uses Aerosol Optical Depth (AOD) as an indicator of air quality. AOD is the degree to which aerosols block the transmission of light (Radcliff et. al. 2013). This study seeks to answer the following research questions:

1. Were there air quality benefits beyond the borders of the pollution ban?
2. Did air quality benefits last after the ban was lifted?

I hypothesize that emission regulation during the 2008 Beijing Olympics temporarily reduced the levels of emissions, providing temporary benefits throughout the Beijing-Tianjin-Hebei region, the temporary reduction in AOD will return to estimated levels following the lifting of the ban.

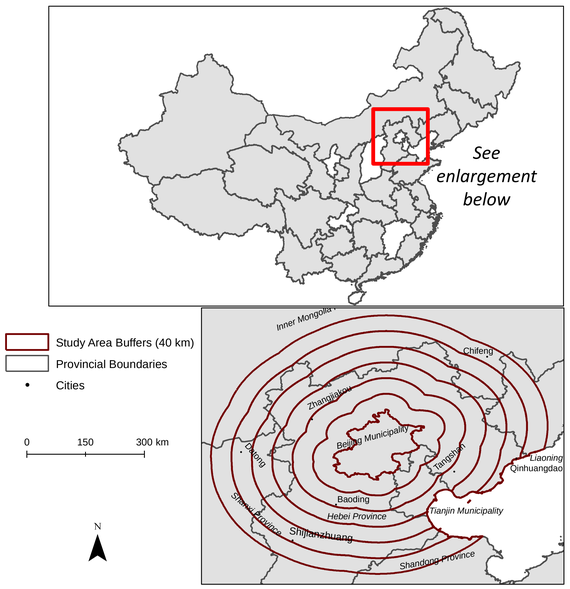

Figure 1. Study Area: the Beijing-Tianjin-Hebei economic region in northeast China.

Methods

- MODIS Aqua Level 2 Dark Target imagery (MYD04_L2) downloaded from Level-1 and Atmosphere Archive & Distribution System Distributed Active Archive Center.
- Images from 2003-2013, excluding 2008, were used to create a 10 year reference period organized by year and a 9-day period. MYD04_L2 was validated using AERONET observations R-squared = 0.509 p= 0.031 (Figure 2).
- All images in the 9-day period were used to create a raster with the period's median values.
- Zonal Statistics were calculated to find the median per zone.
- The reference period was created by averaging the median value per band within a 9-day period for all 10 years.

Results

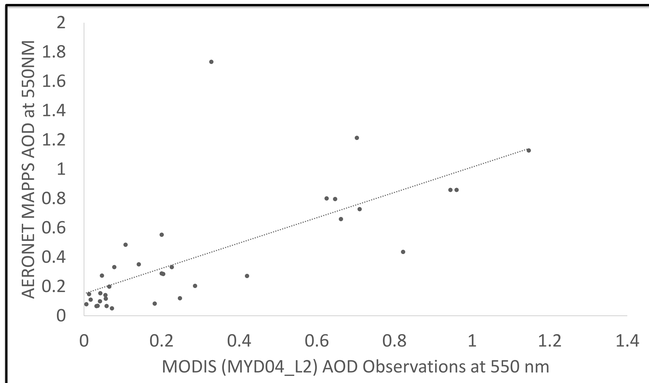

Figure 2. Comparison of Modis AOD to AERONET ground observations.

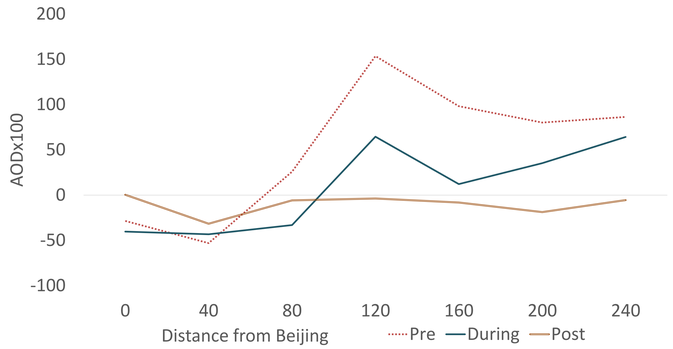

Figure 3. AOD spatial deviation by regulation period. Pre-regulation: 6/23-7/19, During: 8/7-9/20, and Post-regulation: 9/21-10/26.

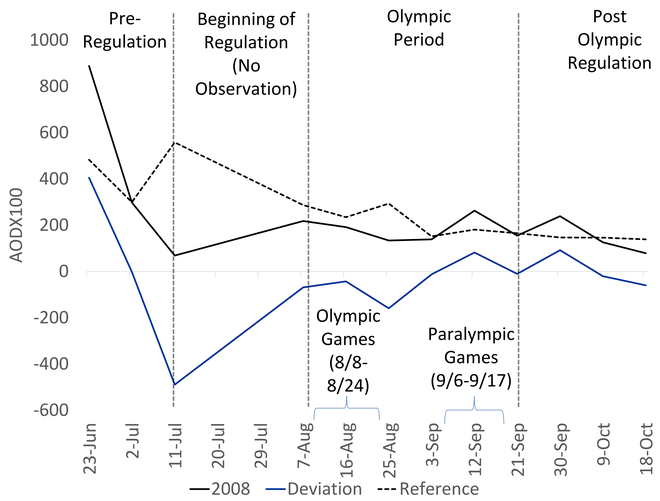

Figure 4. AOD difference from reference over time, Inner Beijing.

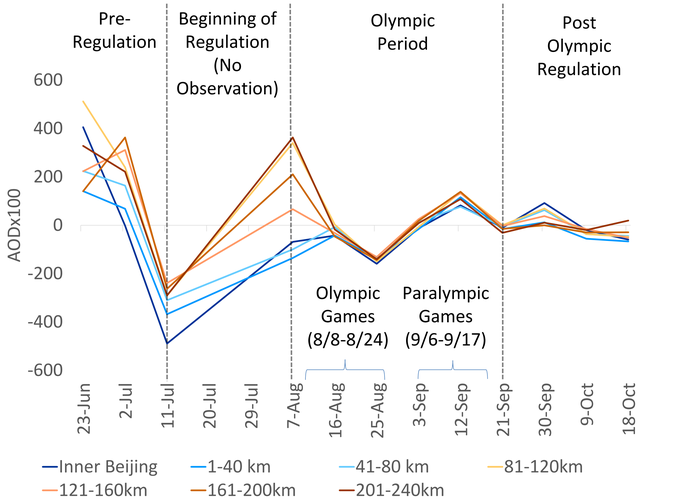

Figure 5. AOD difference from reference over time.

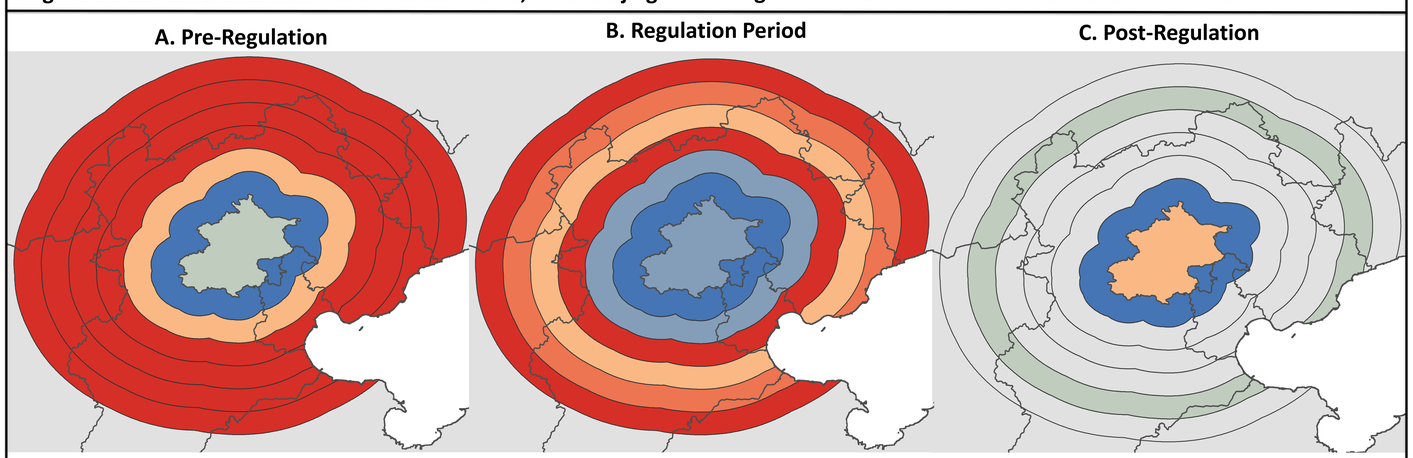

Figure 6. AOD difference from reference across distance zones.

Results Continued

- AOD values during the Pre-regulation and regulation periods increased with distance. Post-Olympic regulation values remained constant with distance (Figure 3).
- 2008 AOD observations dropped to below reference period levels before the start of the Olympic regulation period. Observations rebounded back to reference period levels before the end of the regulation program, remaining around reference period levels after the end of the Olympic period (Figure 4-5).
- Pollution regulations proved beneficial for regions within 80km of Beijing, where there was higher air quality standards, represented by AOD. Regions 81-240km outside of Beijing experienced lower air quality (Figure 6).

Discussion

- The results of this study indicate that government pollution regulation programs were successful, consistent with previous studies (Liu et. al. 2012 and Chen et. al., 2013).
- Benefits were only observed in regions within 80km of Beijing.
- Air quality benefits were only temporary, and not an effective form of long term regulation, consistent with findings from studies on the APEC summit (Huang et. al., 2015).

Limitations:

- MYD04_L2 has smaller sample sizes during periods of bad weather.
- This study does not take into account the location of industry outside of Beijing.

Literature Cited

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For more information…
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