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Air Pollution Differences Between Nations with Different Economic Profiles

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China vs. U.S.

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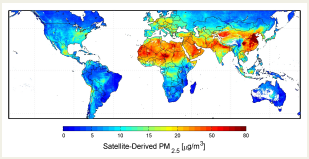
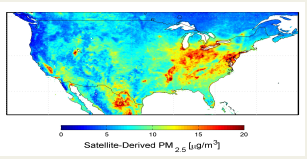
Introduction

A nation's economy plays an important role in determining what that country considers as its priorities. Developed countries that are more economically secure have the resources to focus on other prevailing matters, such as the environment. The impact of anthropogenic activities on climate change has been a topic under much debate. Air pollution, especially, remains a global issue. Air pollution can be largely attributed to the burning of fossil fuels as a result of industrialization and urbanization (Xia et al. 2011). This depicts a relationship between economic growth and environmental quality (Xia et al. 2011).

China is an example of a nation that is suffering greatly from poor air quality due to the increased rates of the manufacturing of goods (Lin et al. 2013). The densely populated cities exacerbates the air quality (Shao et al. 2006). China has emerged as the world's greatest emitter of air pollution (Dunbar, "NASA Satellite Measures"). Consequently, it leads the international economy in exporting industrialized products, prompting tremendous energy demands. China relies largely on coal as a source of its energy, which emits sulfur dioxide and particulate matter (Lin et al. 2013). Increases in motor vehicles has worsened the conditions in China by releasing more nitrogen oxide into the atmosphere (Shao et al. 2006). In this study, the pollutants we conducted our research on were methane (CH_4), carbon monoxide (CO), water vapor, and tropospheric ozone (O_3). All of these atmospheric components are useful indicators of the processes taking place on Earth's surface.





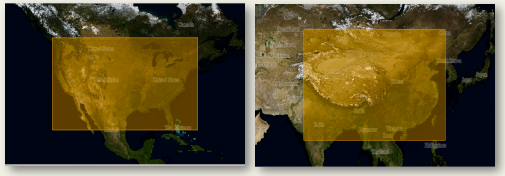
Global satellite image map of $PM_{2.5}$ averaged over 2001-2006. (Source: http://www.nasa.gov/topics/earth/features/healthsapping.html)

Research Questions

- This study compares the air pollution in a developing country (China) to a developed country (U.S.). It also expands further on the more densely populated areas of the U.S. (Los Angeles and eastern coast regions) and China (northeastern region) for comparison purposes by analyzing the distribution of pollutants in the atmospheric layer closest to Earth's surface.
- Is economic development worth the environmental and health implications that it inflicts on both a local and worldwide scale?

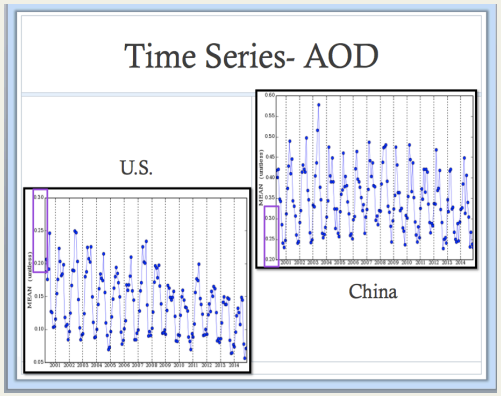
Study Site and Methods

- National Aeronautics and Space Administration's (NASA) Giovanni interactive visualization and analysis portals
- Moderate-resolution Imaging Spectroradiometer (MODIS), which is part of NASA's Terra satellite: Aerosol Optical Depth at 550 nm; monthly data
- "Time-series, Area statistics" format: a time-series plot accompanied by statistics (mean, pixel count, weighted standard deviation, maximum, and minimum); 14 year span



- Tropospheric Emission Spectrometer (TES): atmospheric vertical profiles of atmospheric constituents
- "Time Series": CH4 Total Column Density (Nadir), CO Total Column Density (Nadir), H2O Total Column Density (Nadir), O3 Tropospheric Total Column Density (Nadir); September 3, 2004 to December 27, 2010
- Cross Map, Latitude-Pressure: Air Temperature Profile (Nadir/Day), Air Temperature Profile (Nadir/Night), CH4 Profile (Nadir), CO Profile (Nadir), H2O Profile (Nadir), O3 Profile (Nadir); 215.444 hPa for the upper level to 825.402 hPa for the lower level; September 3, 2004 to January 1, 2006 and December 1, 2009 to December 27, 2010

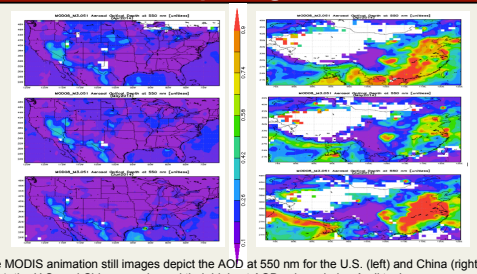
Graphs/figures



Time series of monthly mean Aerosol Optical Depth at 550 nm for the U.S. (left) and China (right) from MODIS-Terra for the period of April 2000 to December 2014. AOD is dimensionless.

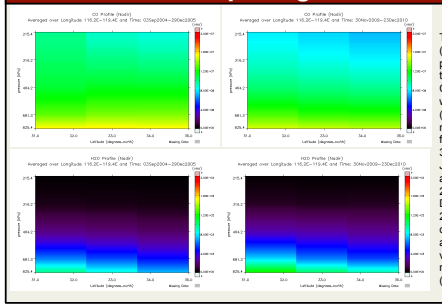
Acknowledgements:

Graphs/figures



The MODIS animation still images depict the AOD at 550 nm for the U.S. (left) and China (right). In 2014, the U.S. and China experienced their highest AOD values during April to June.

Graphs/figures



The cross-maps (latitude-pressure) show the variations in CO (top) and water vapor (bottom) in northeast China from September 3, 2004 to January 1, 2006 and December 1, 2009 to December 27, 2010. The concentrations are given as volume mixing ratios (dimensionless).

Conclusions

- China's air quality is significantly worse in comparison to that of the U.S.
- Areas undergoing industrialization showed the greatest accumulation of air pollutants.
- The amount of pollution, although detrimental to human health and the environment, is not showing much reduction in China.
- Analyzing the origin of the air pollutants (i.e. combustion of coal) could help propose standards aimed to improve the air quality in developing regions, such as the cities of northeast China.
- Methane, carbon monoxide, and water vapor were detected at high or increasing levels in China. If not monitored and lessened in the atmosphere, these greenhouses gases could result in unforeseen global climate phenomena.
- To improve this study using ground *in situ* data to compliment the remote sensing data could have increased the accuracy of this study. Also obtaining information from a larger temporal range would have yielded a more precise indication of air pollution patterns, and thus a better analysis of the air quality in the U.S. and China. Mathematic models to correct for lack of data could have also enhanced this study.