Air Quality as an Indicator for Climatology Forecasting: A Case Study of Northern Utah

Jaemin Eun
University of Maryland, College Park

Abstract

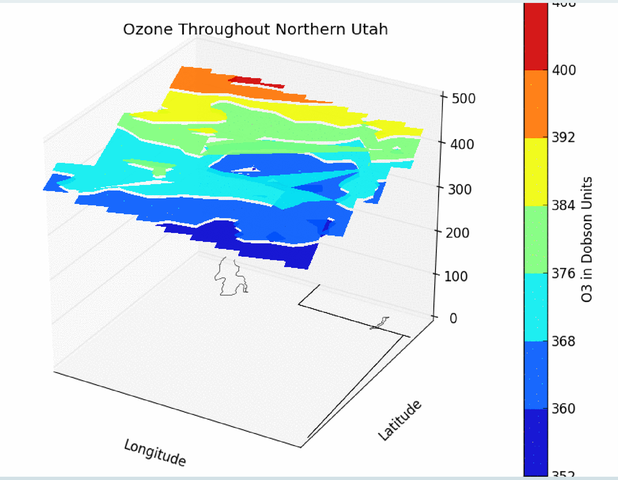
Air quality is typically considered in terms of local environmental issues. However, with recent interest in climatology study, a global phenomenon, it has been shown that a relationship exists between the two, whereby climate patterns influence and drive air pollution. Typically, in the environment, we observe that global events explain local episodes, but can the inverse manifest itself in this situation? Can data from air pollution in a local region be subtended to a much more global scale of climatology forecasting? This is a major concern when considering that "swings" in climate patterns such as the North Atlantic Oscillation (NAO) are prime drivers of intensifying extreme weather events (hurricanes, flooding, etc.). By taking advantage of mathematical concepts, we can explore the foundations of producing a valid 'basis' of such a forecast model by studying air pollution episodes seen in Northern Utah.

Introduction

- Primary concerns lie within **geographic** and **meteorological** features.
- Northern Utah is unique in that air pollution is a winter phenomena.
- Temperature inversions can occur during the winter due to geographic valleys.
- Presence of snow reflects sunlight and causes additional photochemical pollution.
- Regions of the Intermountain West experience circulation stagnation.
- Such areas experience continual regions of stable high pressure, causing further entrapment of polluted air.
- Shifts in climate patterns determine strength and frequency of inversion break-up mechanisms.

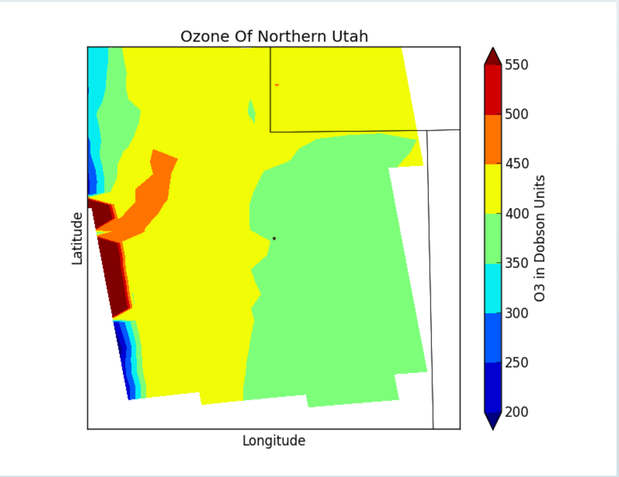
Methodology

- **Instrument**: NASA AURA OMI (Ozone Monitoring Instrument)
- **Data**: NASA EOSDIS (Earth Observing System Data and Information System)
- **Spatial Subset**: (-114.302, 38.165, -108.853, 42.296)
- **Variable**: 'Best Total Ozone Solution' (Dobson Units)
- Dobson Units measures a **vertical** column **throughout** atmosphere
- NASA AURA OMI partitions regions by grids **not** coordinates
- Areas analyzed by given grid cells



Results

- Episodes were most severe during the mid-winter period.
- 'Clear' periods were not uncommon.
- 'Swaths' typically captured in early and late evenings.
- Effects of photochemical pollution not fully realized.
- Ozone concentrations differed across heights.
- Different responses across the valley regions were not uncommon.
- The North Atlantic Oscillation (**NAO**) appeared to modulate inversion intensities in 6 year cycles (Wang et al., 2015).



Conclusions

- NAO measures fluctuations between the Azores High and the Icelandic Low.

$$NAO\ Index = \frac{P_{south} - \bar{P}_{south_{30yrs}}}{std(P_{south})_{30yrs}} - \frac{P_{north} - \bar{P}_{north_{30yrs}}}{std(P_{north})_{30yrs}}$$

- Affects the strength and direction of Westerly Winds.
- Determines storm tracks across the Atlantic.
- Significantly important in determining severity of ecological effects such as fisheries.
- The NAO can affect the climate across Northern Europe.

Inversions are typically removed by Cold Fronts which can break up regions of high pressure. In this regard, the transport of air is very important in the removal of such air pollution in environment with strong inversions. The NAO not only affects the weather experienced in the continental U.S., but is also a key factor in extreme weather events across the U.S. Atlantic coast. In future study, the relationship between air pollution and the NAO can be used to produce climate forecasts. It could be possible to create a forecast basis by orthonormalizing such data and produce a similar Empirical Orthonormal Function as applied in methods of Numerical Weather Prediction.

References & Acknowledgements

- Wang et al., 2015. Long-term winter inversion properties in a mountain valley of the Western United States and implications on air quality. J. Appl. Meteorol. Climatol. 54:2339-2352.
- Boström, P. 2014. NAO index: An extreme pressure approach. *Examensarbete vid Institutionen för geovetenskaper , ISSN 1650-6553 Nr 283.*
- Special thanks to Jeffery Henrikson and the Department of Atmospheric and Oceanic Science at UMD.