Urban Emissions and Nightlights

Theme: Health

Daniel L. Mendoza,[1,2] John C. Lin,[2] and Robert Paine[1]

[1] *Pulmonary Division, School of Medicine, University of Utah, Salt Lake City, U.S.A.*
[2] *Department of Atmospheric Sciences, University of Utah, Salt Lake City, U.S.A.*
daniel.mendoza@utah.edu

Introduction

Nightlights have been used as a proxy to characterize a region's economic activities. Multiple metrics have been derived from nightlight satellite imagery, including population density, electricity consumption (Proville, Zavala-Araiza, & Wagner, 2017), and carbon dioxide (CO_2) emissions (Oda & Maksyutov, 2011). However, there has been limited work focusing on the association between night lights and health related criteria pollutants at a high resolution.

The Hestia emissions data product (Gurney et al., 2012) was developed to resolve CO_2 emissions at a high resolution (hourly and building, road segment, and individual point source scale) for multiple U.S. cities. Patarasuk et al. (2016) described the development of Hestia for Salt Lake County. Further recent work has developed a similarly-scaled emissions inventory for nitrogen oxides (NO_x) (Figure 1), fine particulate matter ($PM_{2.5}$) (Figure 2), and carbon monoxide (CO).

In this study we compared the annual spatial distribution of Hestia 2015 $PM_{2.5}$ and NO_x emissions to the radiance obtained from the Visible Infrared Imaging Radiometer Suite (VIIRS) Day Night Band (DNB) product (Wang, Qiu, NOAA Ocean Color Team, & Office, 2012) for 2015.

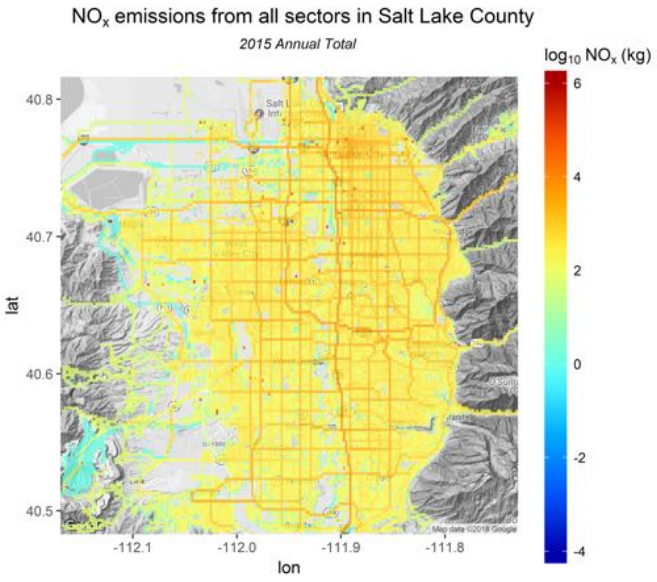

Figure 1. Salt Lake County nitrogen oxides emissions

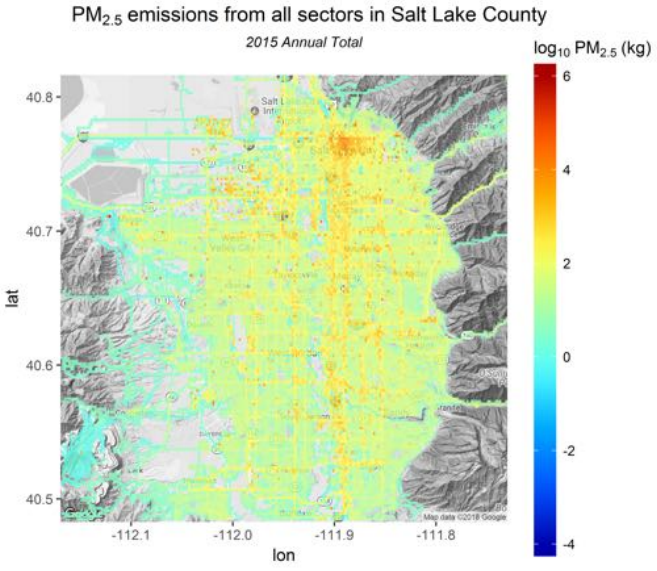

Figure 2. Salt Lake County fine particulate matter emissions

We found a spatial association between the patterns of radiance and emissions. Since NO_x is primarily emitted by mobile (onroad and nonroad) sources, and $PM_{2.5}$ is primarily emitted by point sources, their different, but complementary spatial patterns, resulted in a composite comparable to the observed nightlights. Furthermore, the magnitude of emissions corresponded well with the radiance magnitude. These results will provide guidance for the use of nightlights as additional indicators of health-related pollutants and pollution hotspots.

Future work will focus on the comparison of nightlight radiance with emissions of other criteria pollutants including CO and coarse particulate matter (PM_{10}). Further time disaggregation will include a comparison of monthly radiance and emissions products to determine the impact of seasonality. Lastly, the atmospheric transport of emissions will be included to account for dispersion effects of pollutants.

References

Gurney, K. R., Razlivanov, I., Song, Y., Zhou, Y., Benes, B., & Abdul-Massih, M. (2012). Quantification of Fossil Fuel CO_2 Emissions on the Building/Street Scale for a Large US City. *Environmental Science & Technology, 46*(21), 12194-12202. doi:10.1021/es3011282

Oda, T., & Maksyutov, S. (2011). A very high-resolution (1 km×1 km) global fossil fuel CO_2 emission inventory derived using a point source database and satellite observations of nighttime lights. *Atmospheric Chemistry and Physics, 11*(2), 543-556. doi:10.5194/acp-11-543-2011

Patarasuk, R., Gurney, K. R., O'Keeffe, D., Song, Y., Huang, J., Rao, P., . . . Ehleringer, J. R. (2016). Urban high-resolution fossil fuel CO_2 emissions quantification and exploration of emission drivers for potential policy applications. *Urban Ecosystems*, 1-27. doi:10.1007/s11252-016-0553-1

Proville, J., Zavala-Araiza, D., & Wagner, G. (2017). Night-time lights: A global, long term look at links to socio-economic trends. *Plos One, 12*(3), e0174610. doi:10.1371/journal.pone.0174610

Wang, M., Qiu, S., NOAA Ocean Color Team, & Office, N. J. P. (2012). *NOAA JPSS Visible Infrared Imaging Radiometer Suite (VIIRS) Ocean Color/Chlorophyll (OCC) Environmental Data Record (EDR) from IDPS [VIIRS]*.