

New Applications of MISR and VIIRS for Assessing Health Exposures

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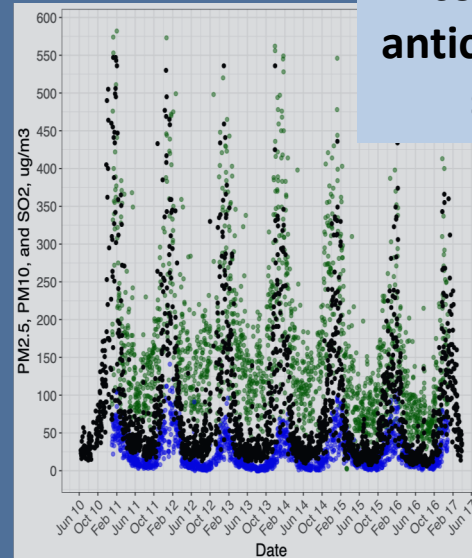


Air Pollution In Ulaanbaatar

- Ulaanbaatar, Mongolia is the coldest capital city and has some of the worst air pollution in the world.
- Concentrations $PM_{2.5}$ frequently reach $500 \mu\text{g}/\text{m}^3$ over 20 times the WHO guideline for daily concentrations.

WHO Global Urban Ambient Air Pollution Database

http://www.who.int/phe/health_topics/outdoorair/databases/cities/en/



**UB's poor air quality is exacerbated by:
geographic position of the city and mid-continental Siberian anticyclone that causes a strong inversion**

Air Pollution Sources in Ulaanbaatar

- The primary source of air pollution in the area comes from burning coal and biomass for heating and cooking in the outskirts Ger settlements. (*Guttikunda et al. Air Qual and Health, 2013*)

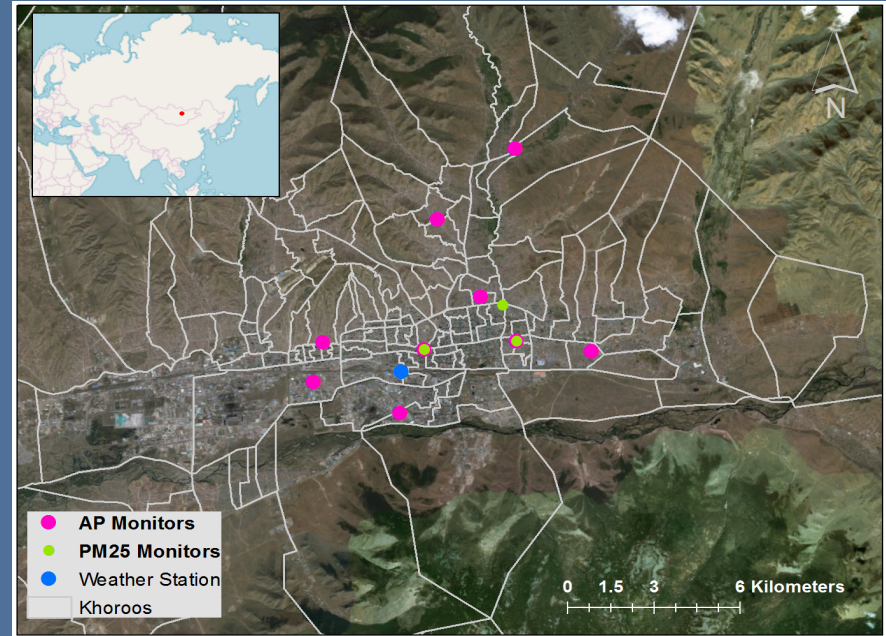


Photo credit: Lisa Gardner Children's Hospital Los Angeles

- ~ 60% of households are in the Ger district, and in winter, these households account for up to 70% of the PM_{2.5} emissions. (*World Bank, 2011*)
- Sulfates dominate PM chemical composition, particularly in winter. (*Hasenkopf et al. Atmos Environ, 2016*)

Air Pollution Monitoring in Ulaanbaatar

- There are 10 air pollution monitoring stations in Ulaanbaatar.
- All 10 measure SO_2 , NO_2 , CO , O_3
- Of these, 8 measure PM_{10} and only 2 measure $\text{PM}_{2.5}$
- In October 2015 the U.S. Embassy in Ulaanbaatar started measuring $\text{PM}_{2.5}$

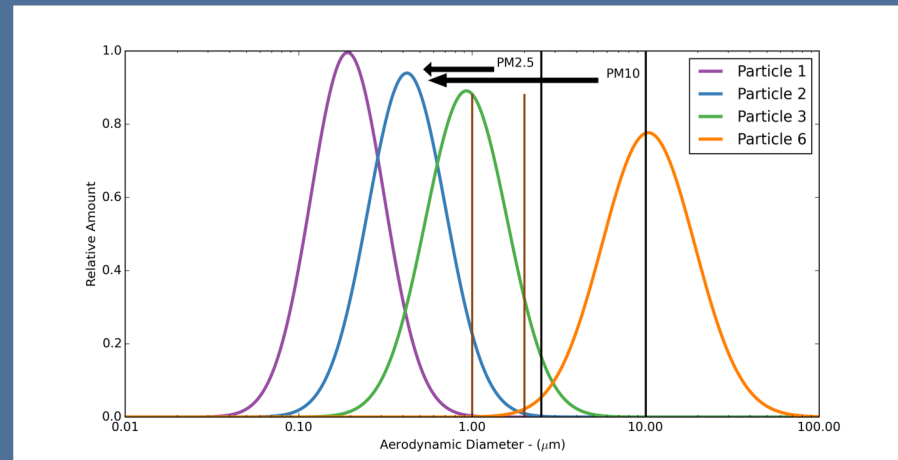


Insufficient PM data for exposure assessment for health effects studies

Multiangle Imaging SpectroRadiometer (MISR)

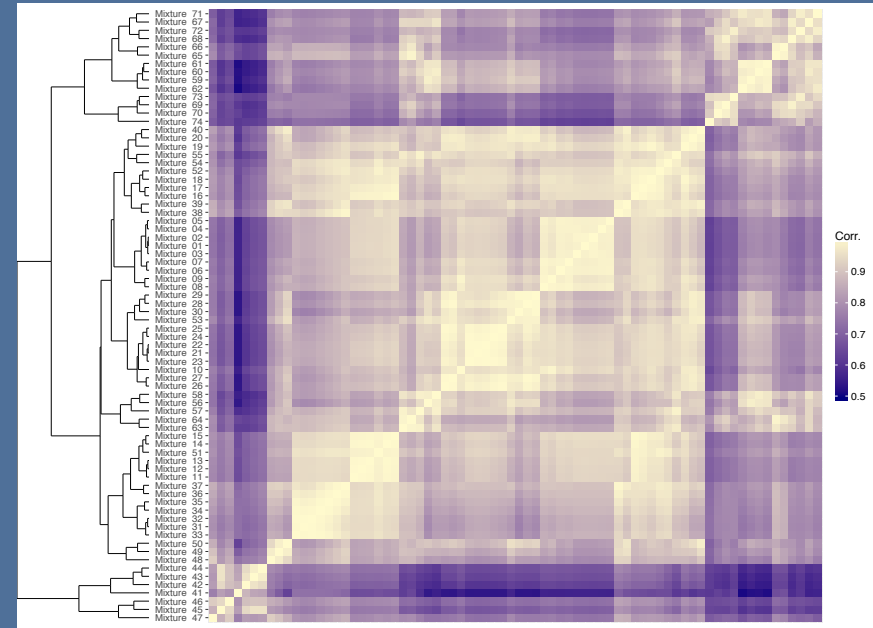
AOD in Air Quality Studies

- Linked new 4.4 km MISR AOD with monitoring data (*Garay et al ACP, 2017*)
- MISR total AOD as well as AOD particles provide:
 - Fractions to distinguish size (small, medium large) (*Franklin et al. RSE, 2017*)
 - Mixtures to distinguish size and type (spherical, non-spherical, absorbing, non-absorbing, dust) (*Kahn and Gaitley JGR, 2015*)
 - MISR AOD raw and additional data provide observations under bright surfaces (not available from MODIS/MAIAC)



MISR AOD in Ulaanbaatar

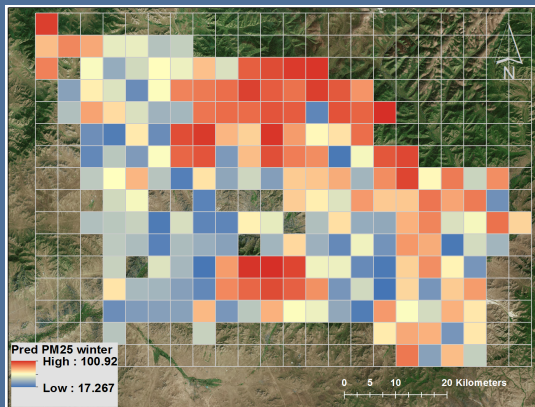
- MISR 74 AOD mixtures distinguish dominant particulate matter types
- Examination of 74 mixtures in Ulaanbaatar Mongolia showed:
- greater proportion of variability (~7%) in winter explained by small, spherical, non-absorbing particles (mixtures 1-20) (**sulfates from coal burning**)
- greater proportion of variability (~4%) in summer explained by medium and large non-spherical dust particles (mixtures 65–74) (**Gobi dust**)



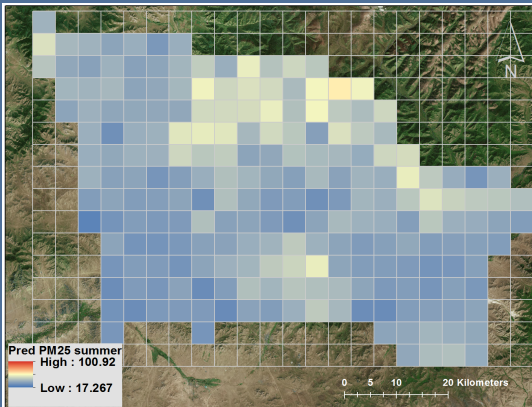
MISR AOD in Air Quality Studies

- Machine learning (SVM regression) on the high-dimensional set of 74 MISR AOD mixtures reliably estimated $\text{PM}_{2.5}$ ($R^2=0.46$) and sulfates ($R^2=0.51$)
 - No other data (e.g. meteorology) included, helpful for global studies where external data are sparse

Winter
2010-2017



Summer
2010-2017



Health Effects Study

- We are conducting a birth outcomes study, linking exposures to residential and Ger (Khoroo) addresses of pregnant mothers.
- **Stillbirth:** the birth of a fetus with ≥ 500 grams weight at or beyond 22 weeks gestation with no signs of life such as heartbeat, umbilical cord pulse, or muscle movement at birth) **N=1237**
 - Congenital anomalies (birth defects). Chromosomal abnormalities excluded. **N= 1625**
- Data were recorded from paper birth records obtained from four the maternity hospitals' archives.
 - Only subjects who had singleton birth and whose official residential address is in UB were included.
 - Case-crossover analysis of the association between air quality exposures and birth outcomes (acute, with lags).

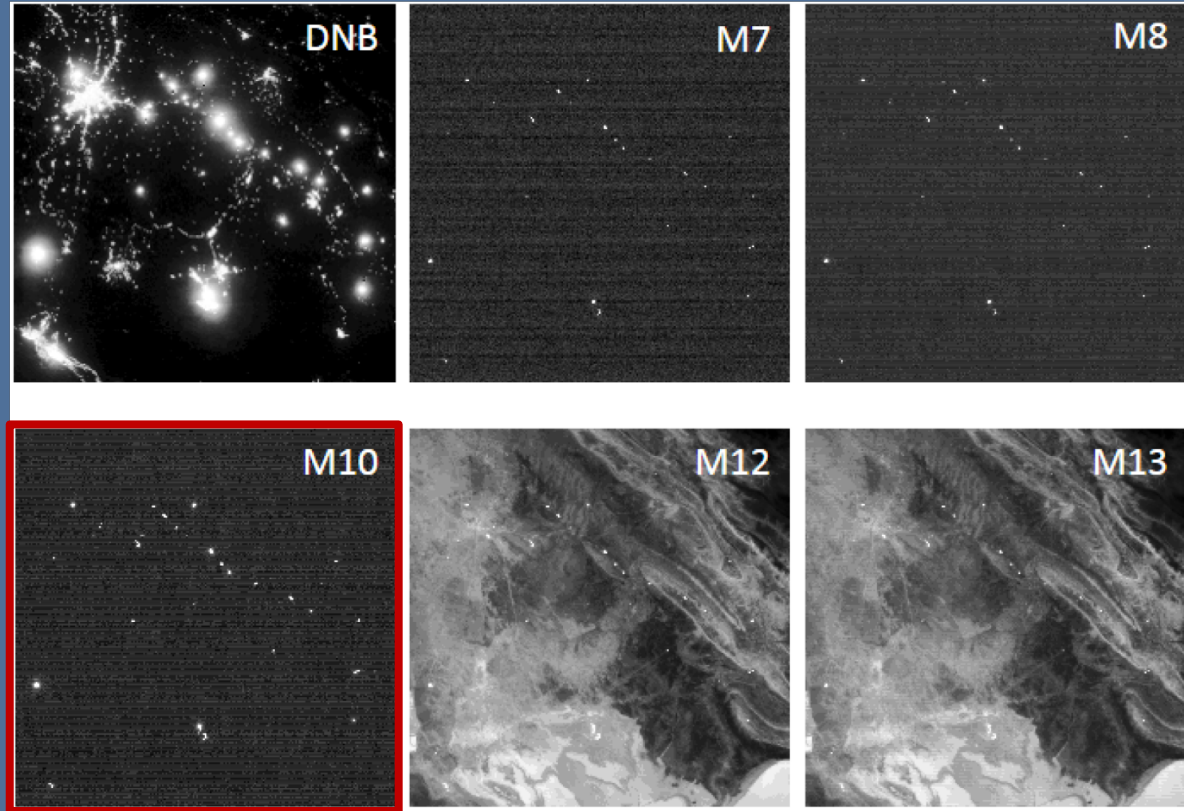
Exposure to Unconventional oil and gas (UOG aka “fracking”) operations in Texas

- Fracking has contributed to a rapid increase in natural gas (+35%) and oil (+75%) production in the U.S. over the last decade.

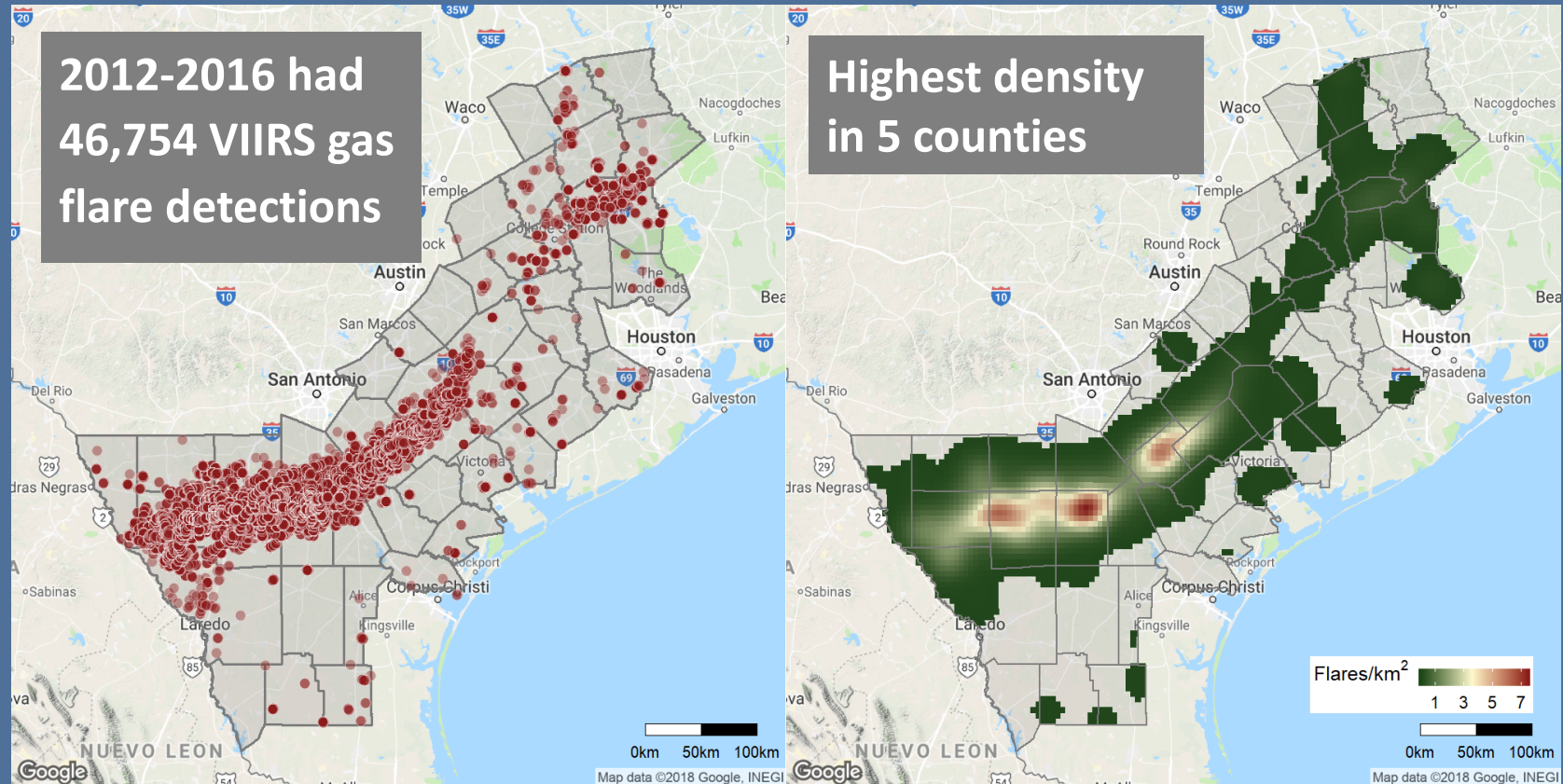


Visible Infrared Imaging Radiometer Suite (VIIRS)

- Suomi National Polar-orbiting Partnership (NPP) satellite (NASA and NOAA).
- It has 22 spectral bands, 9 at night.
- Nightfire product, developed by NOAA, detects heat (combustion) sources at night using **M10 band $\sim 1.6\mu\text{m}$** .

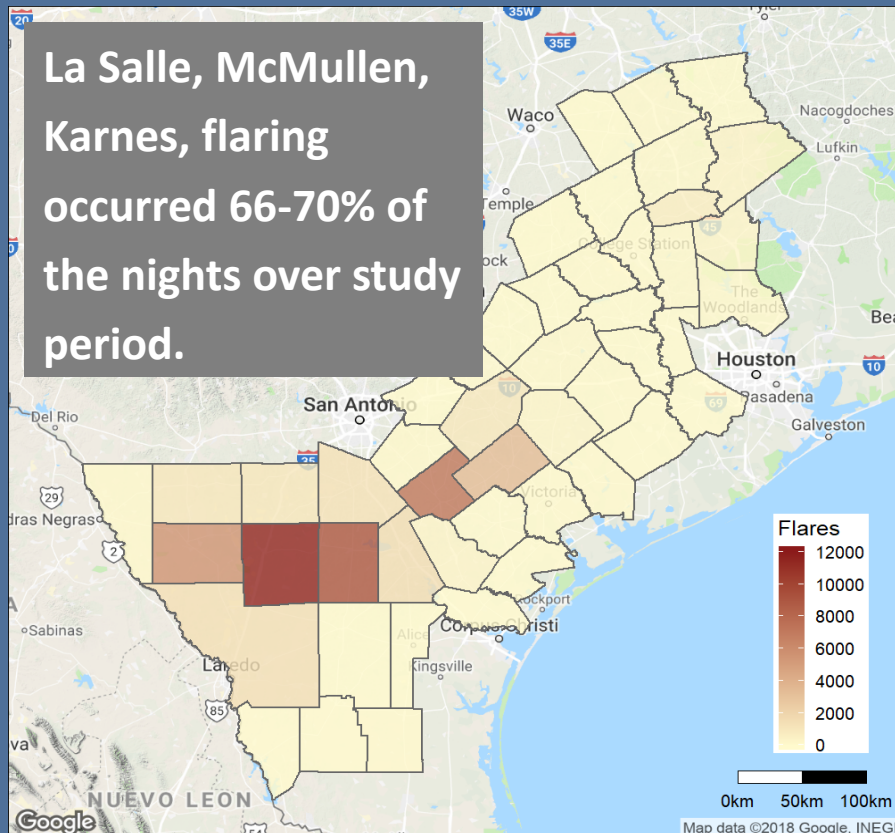


VIIRS Nightfire for Gas Flare Detection

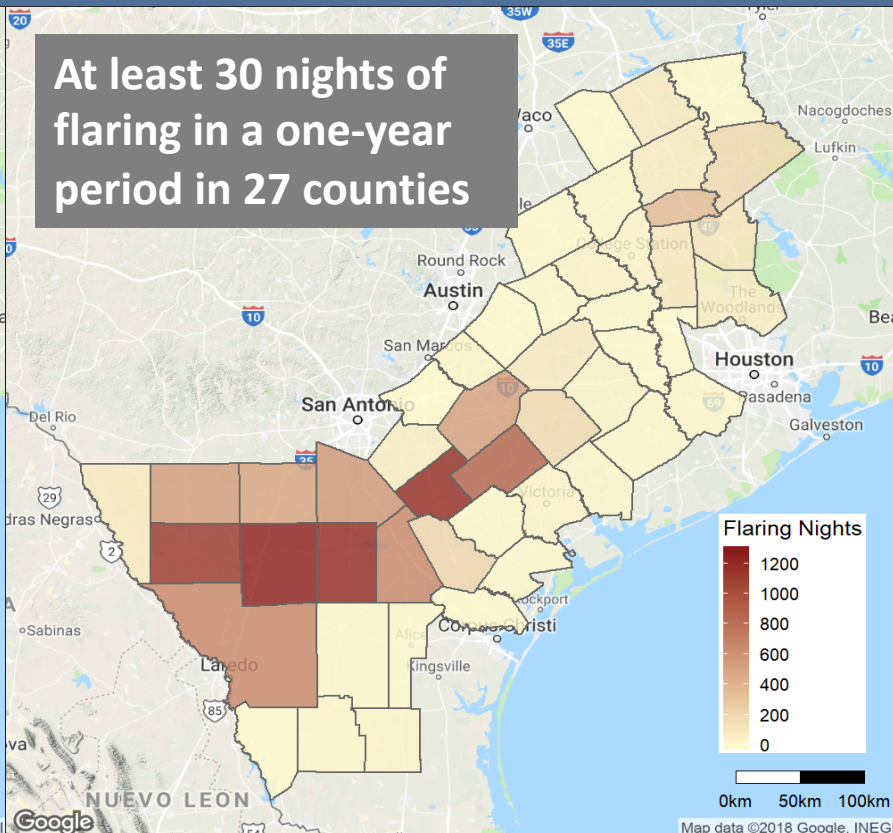


VIIRS Nightfire for Gas Flare Detection

La Salle, McMullen, Karnes, flaring occurred 66-70% of the nights over study period.



At least 30 nights of flaring in a one-year period in 27 counties



Estimating Gas Flare Volume from VIIRS

- Linked VIIRS to county-level reporting data, and developed a simple model to estimate gas volume from flare temperature and source area.
- Enables conversion of individual flare properties (temperature and area) to a volumetric exposure.

$$\text{Flare Vol (BCM)} = 0.0052 + 0.31 \times \text{Temp} - 0.01 \times \text{Temp}^2 - 0.016 \times \text{Temp}^3 - 1.63 \times 10^{-5} \times \text{Area}$$

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