Local Agricultural Biomass Burning's Influence on Beijing Air Quality

by David Chorvinsky

Air quality

Buckley, Chris, and Adam Wu. "Amid Smog Wave, an Artist Molds a Potent Symbol of Beijing's Pollution." The New York Times. December 1, 2015.

Agricultural Burning

http://cojmc.webfactional.com/wp-content/uploads/2014/04/PrairieBurn.png

Is local agricultural biomass burning effecting Beijing air quality?

Methodology

Goal:

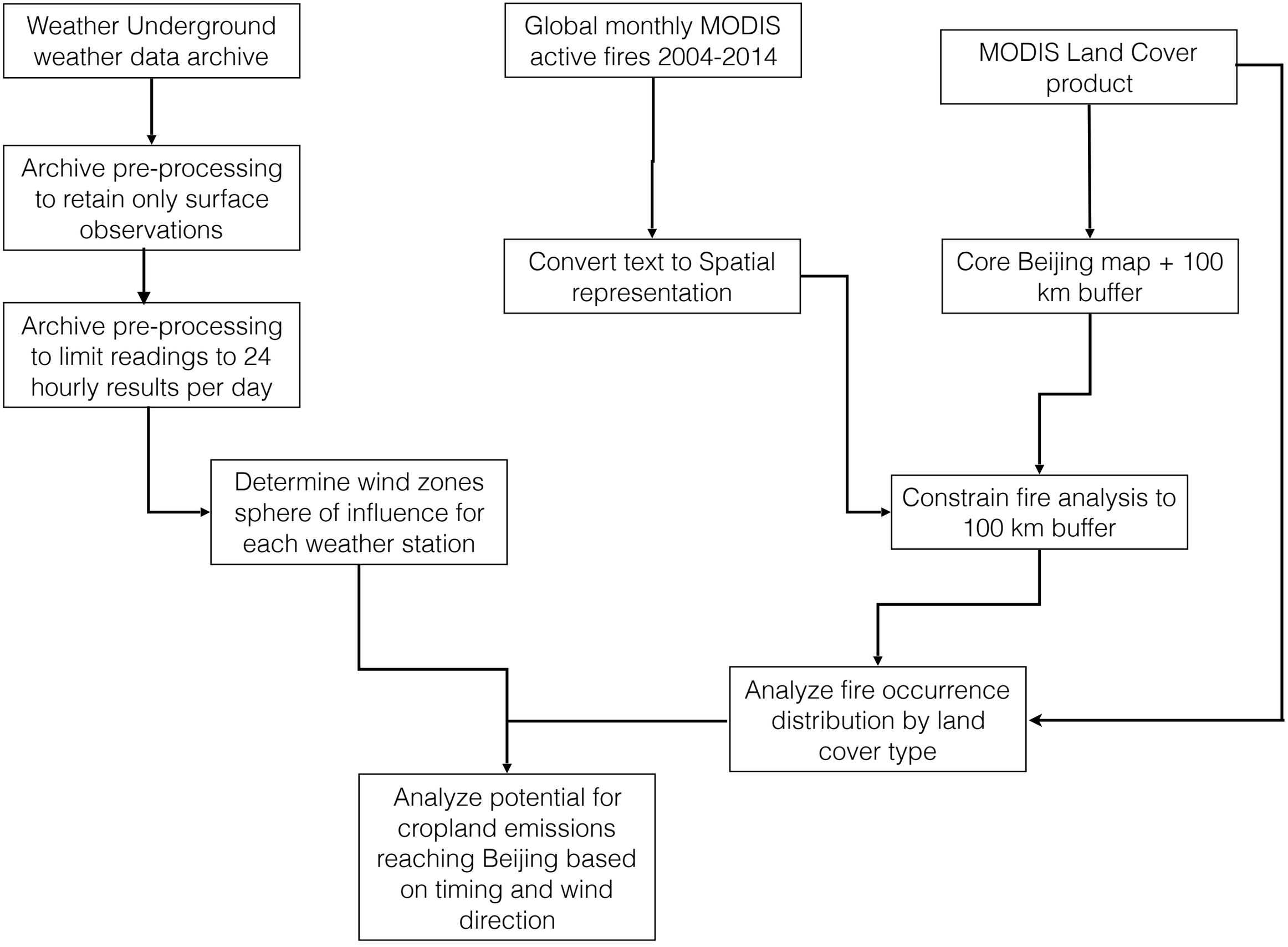
To quantify the possibility of local agricultural biomass burning having an influence on Beijing's air quality based on local wind data.

Steps:

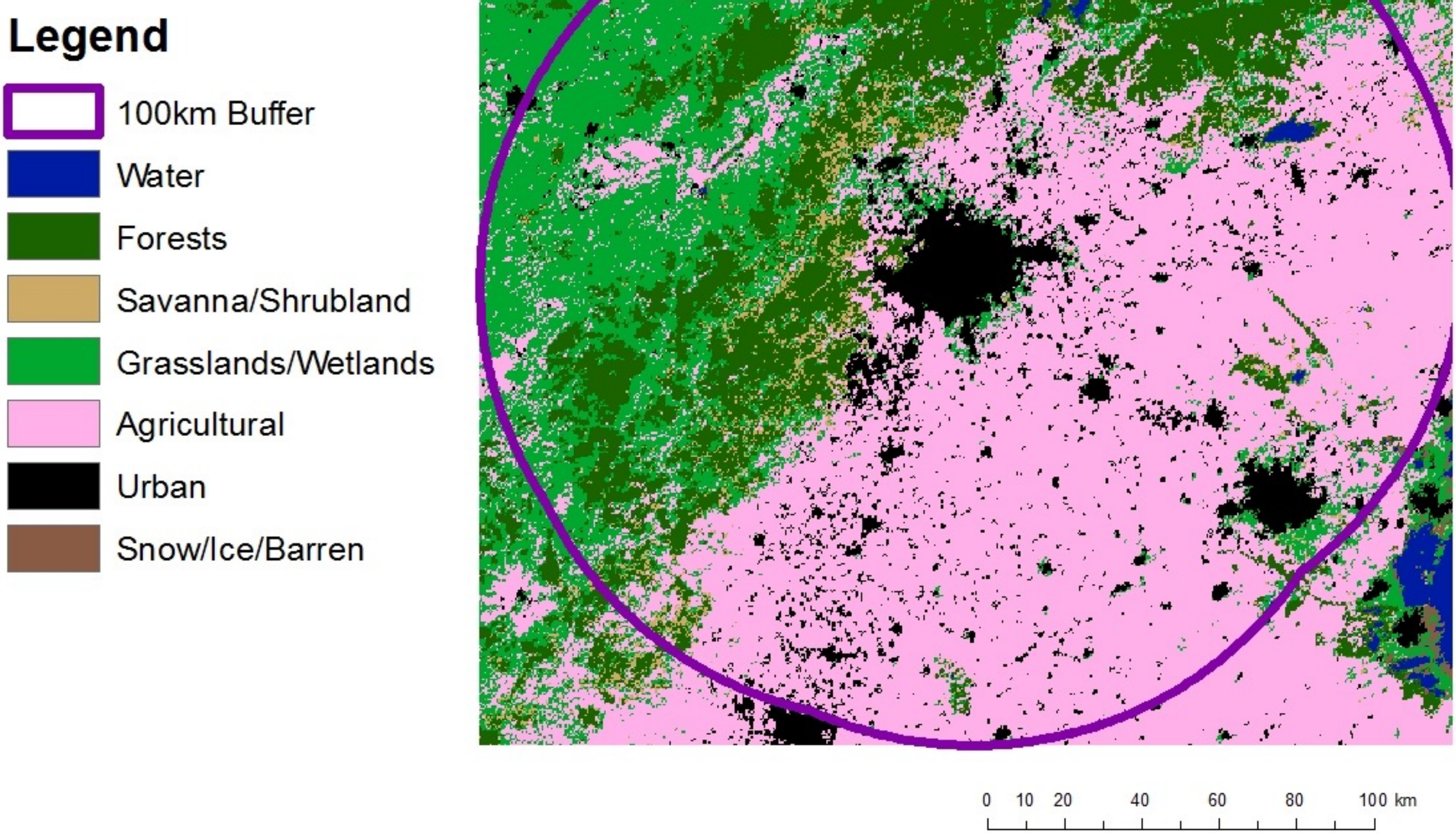
- Define wind patterns
- Locate fires in relation to Beijing
- Link wind patterns to fire events

Approach

Combine local weather data with satellite observations of fire to determine if cropland burning contributes to Beijing's air quality.


Weather Underground weather data archive
Archive pre-processing to retain only surface observations
Archive pre-processing to limit readings to 24 hourly results per day
Determine wind zones sphere of influence for each weather station
Global monthly MODIS active fires 2004-2014
Convert text to Spatial representation
MODIS Land Cover product
Core Beijing map + 100 km buffer
Constrain fire analysis to 100 km buffer
Analyze fire occurrence distribution by land cover type
Analyze potential for cropland emissions reaching Beijing based on timing and wind direction

Study Area


N
Legend
100km Buffer
Water
Forests
Savanna/Shrubland
Grasslands/Wetlands
Agricultural
Urban
Snow/Ice/Barren
0 10 20 40 60 80 100 km

Study Period

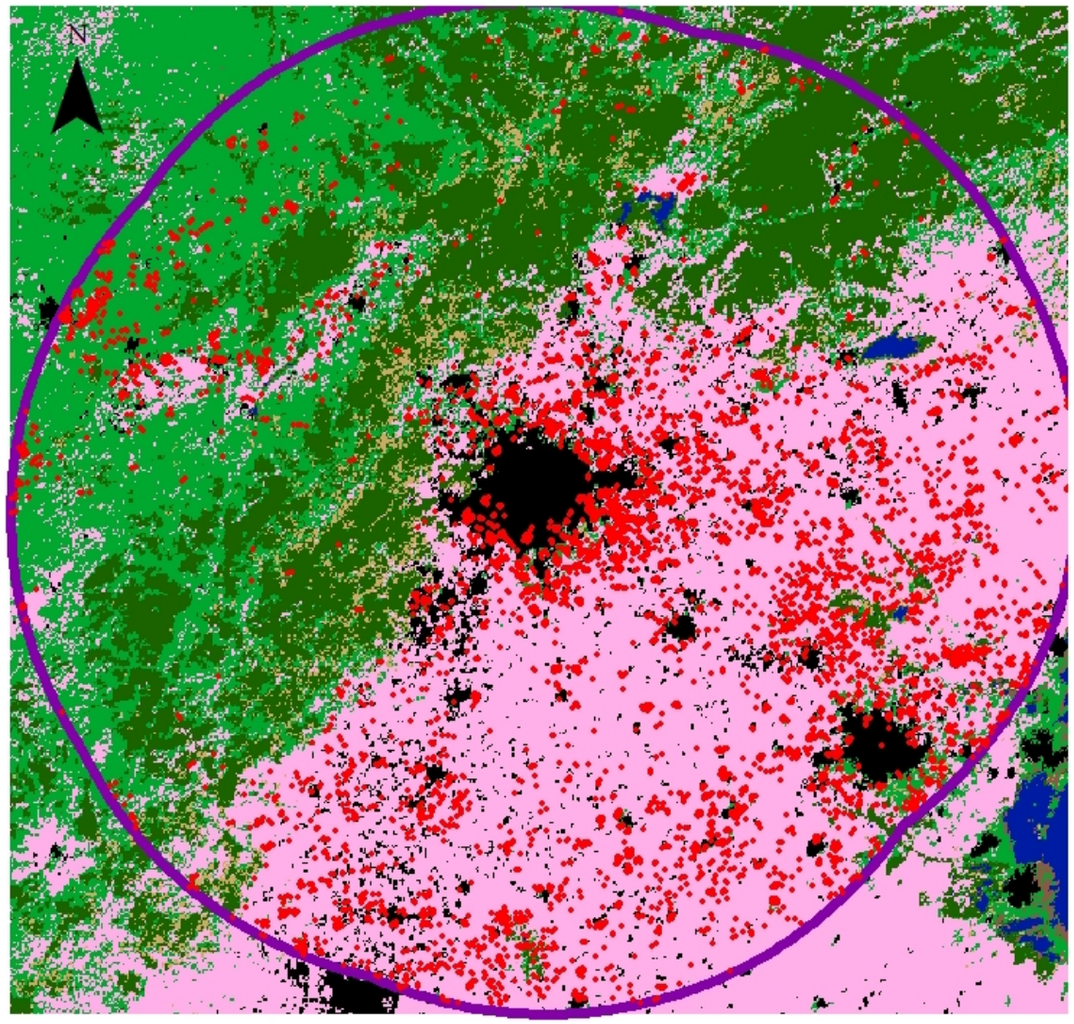
- 2/3/2004 to 12/31/2014

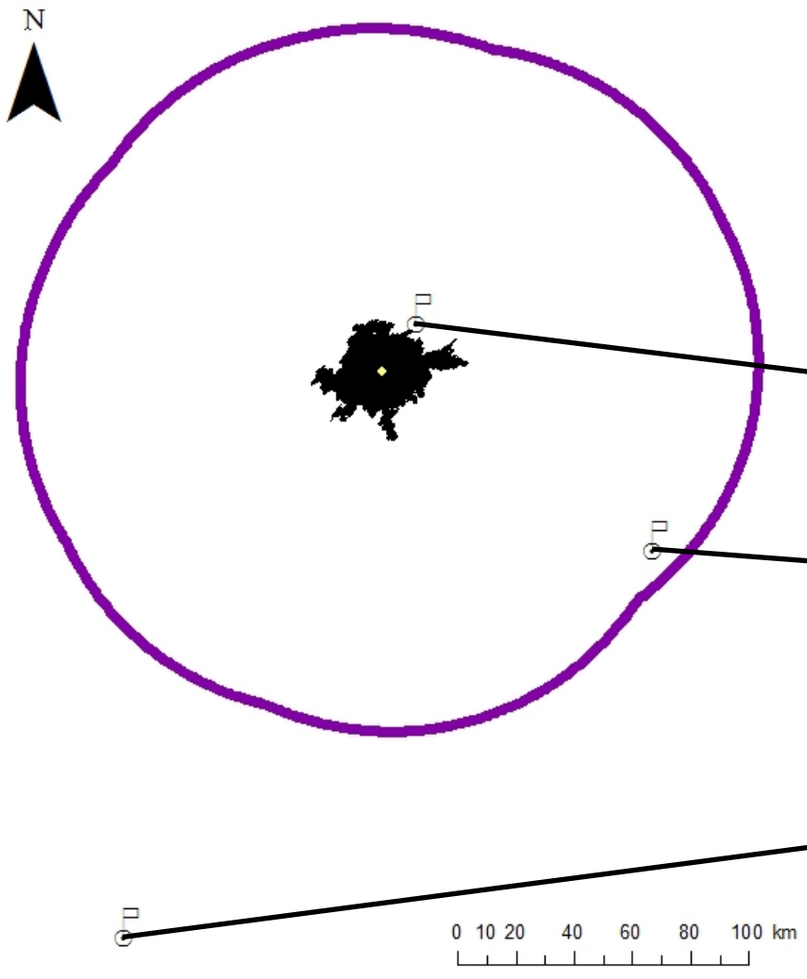
Active Fires:

- MODIS Active Fire Product

Land Cover:

- MODIS Land Cover Product

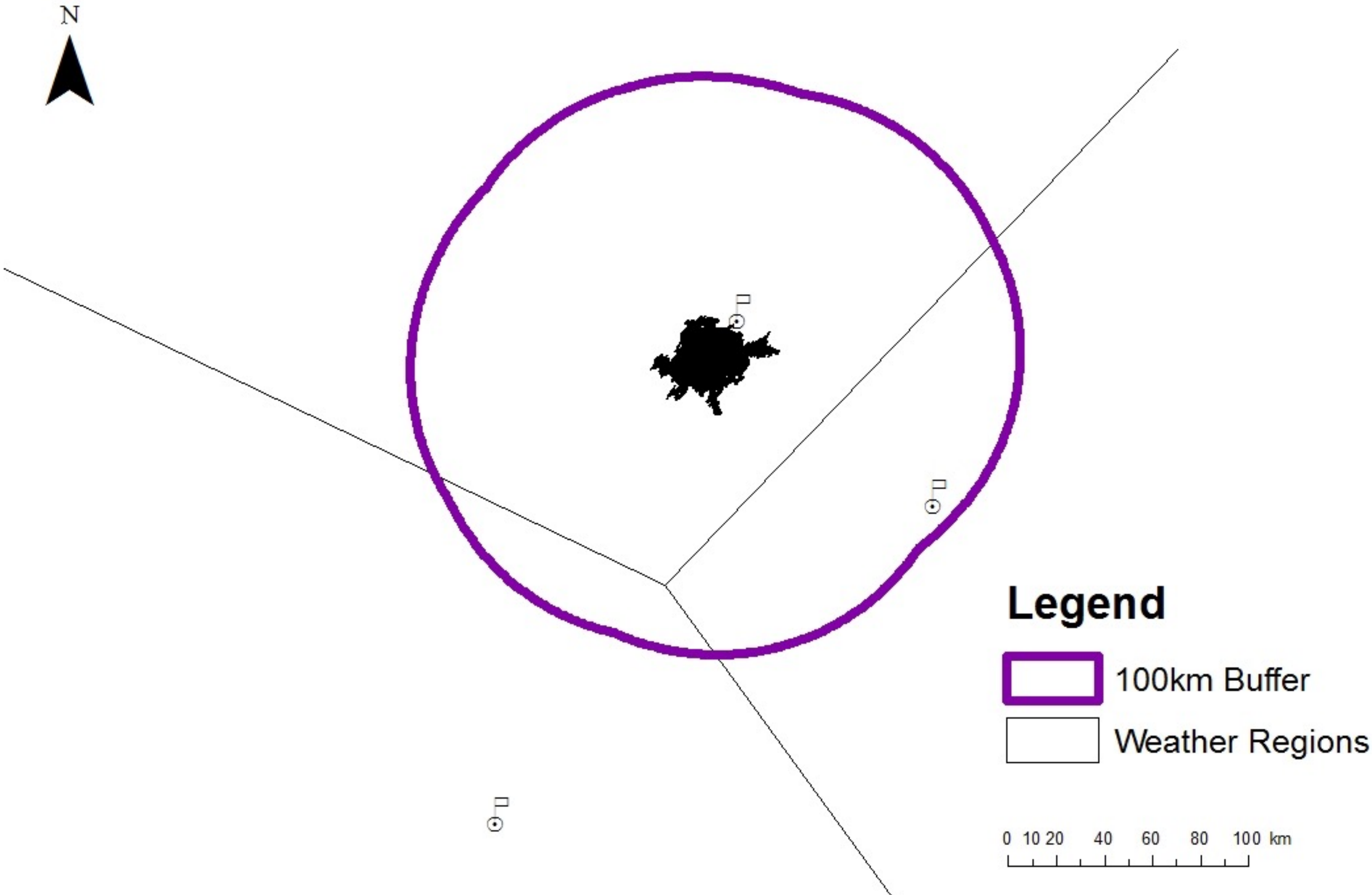




Weather Stations - Airports - Weather Underground Archives:

- Beijing Capital International Airport (ZBAA)
- Tianjin Binhai International Airport (ZBTJ)
- Shijiazhuang Zhengding International Airport (ZBSJ)

Defining Wind Zones



Locating Fires in Relation to Beijing

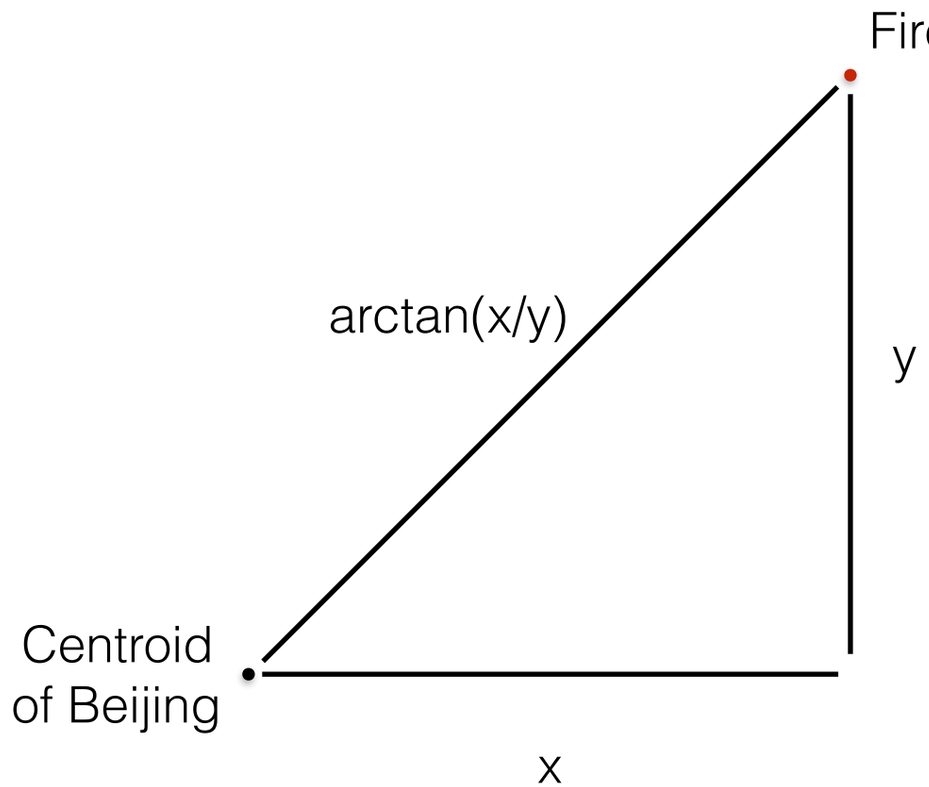
Goal:

Determine angle from centroid of Beijing to fire point

$x = x_{Beijing} - x_{Fire}$

$y = y_{Beijing} - y_{Fire}$

$$angle = \frac{180}{\pi}\left(\arctan\left(\frac{abs(x)}{abs(y)}\right)\right)$$



Linking Wind Patterns to Fire Events

Goal:

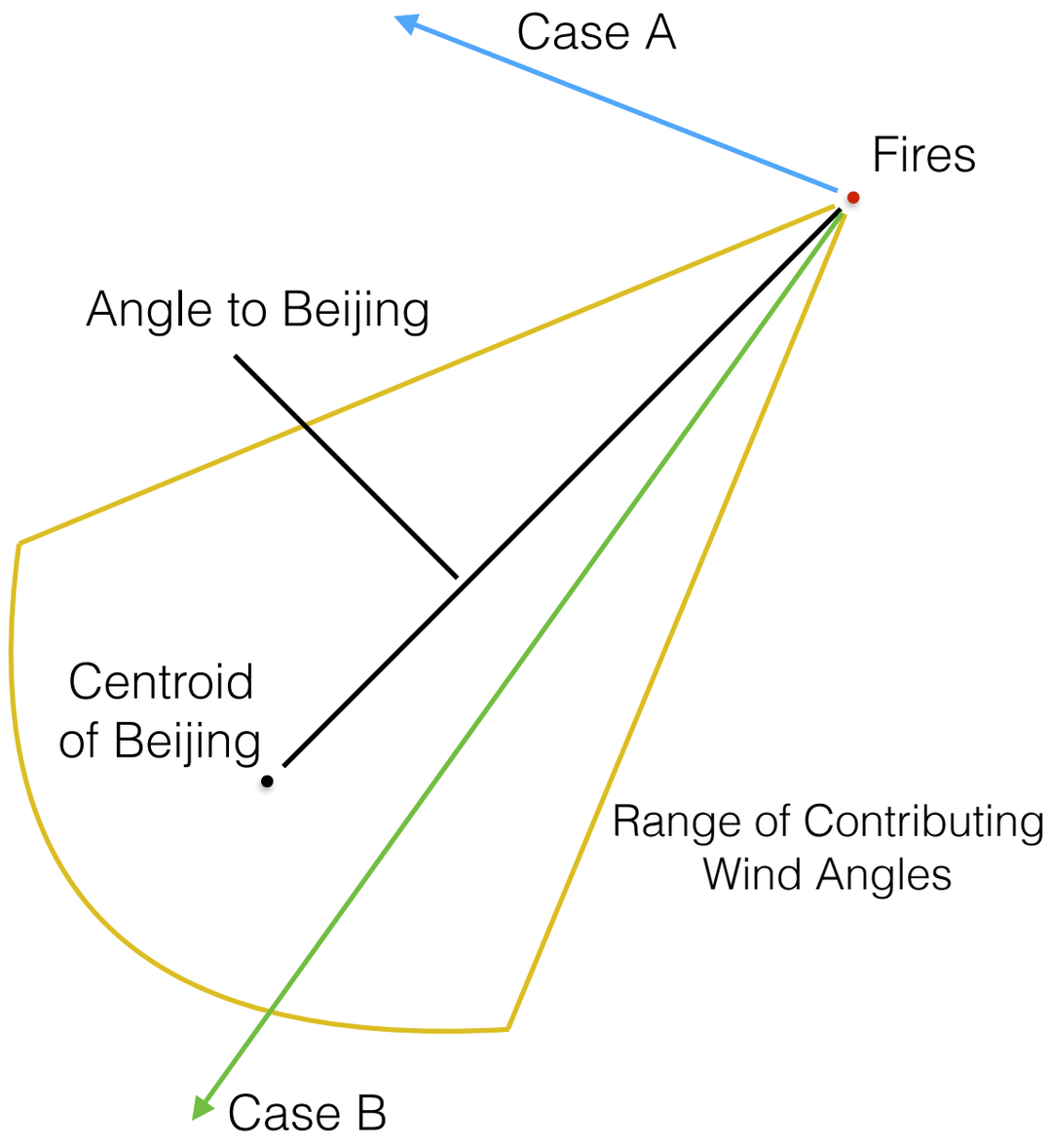
Determine if wind pattern is within a range around calculated angle between Beijing and fire point

45° range: angle ± 22.5°

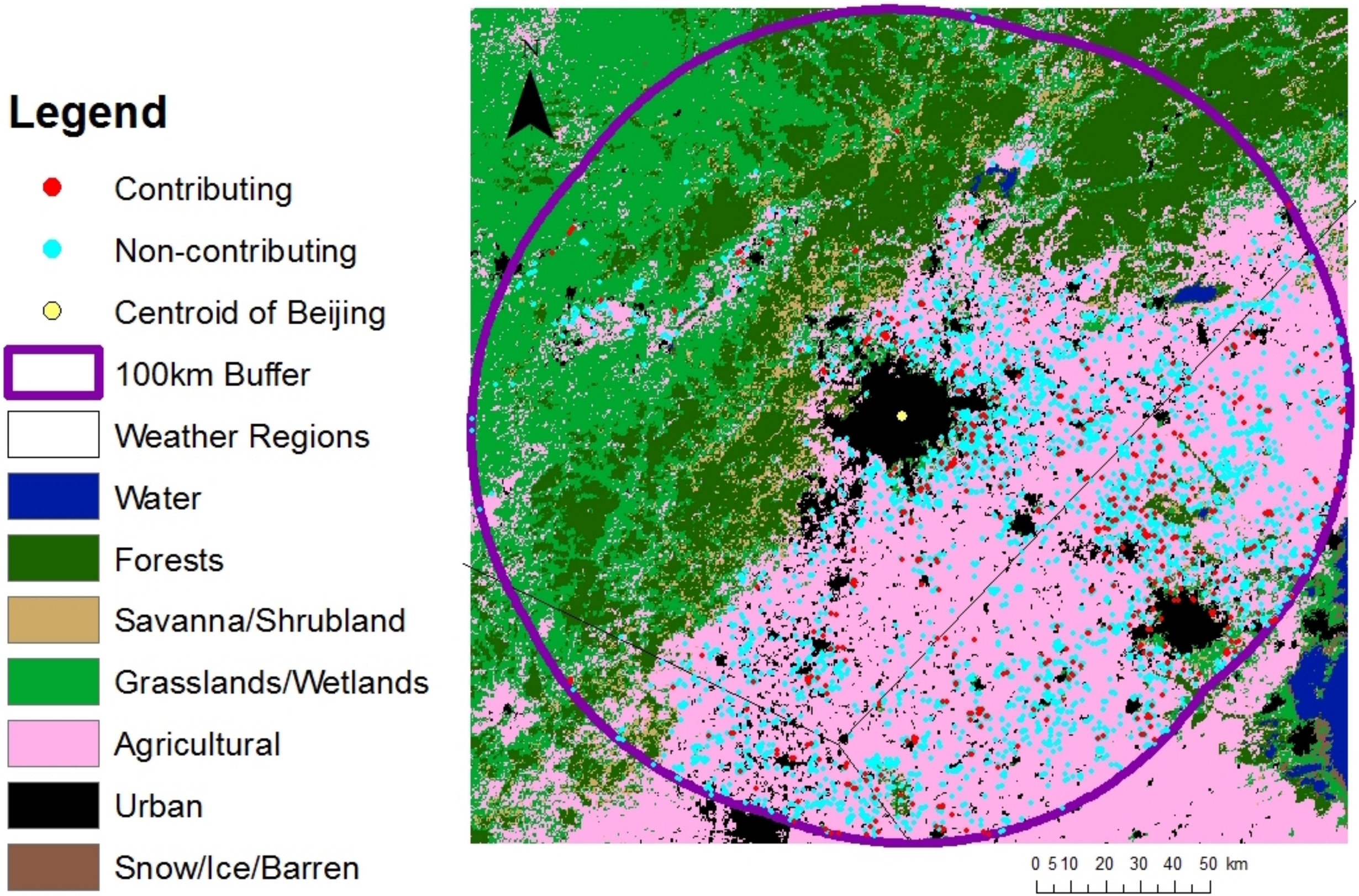
Range compared to wind direction at time

If within range, fire is contributing

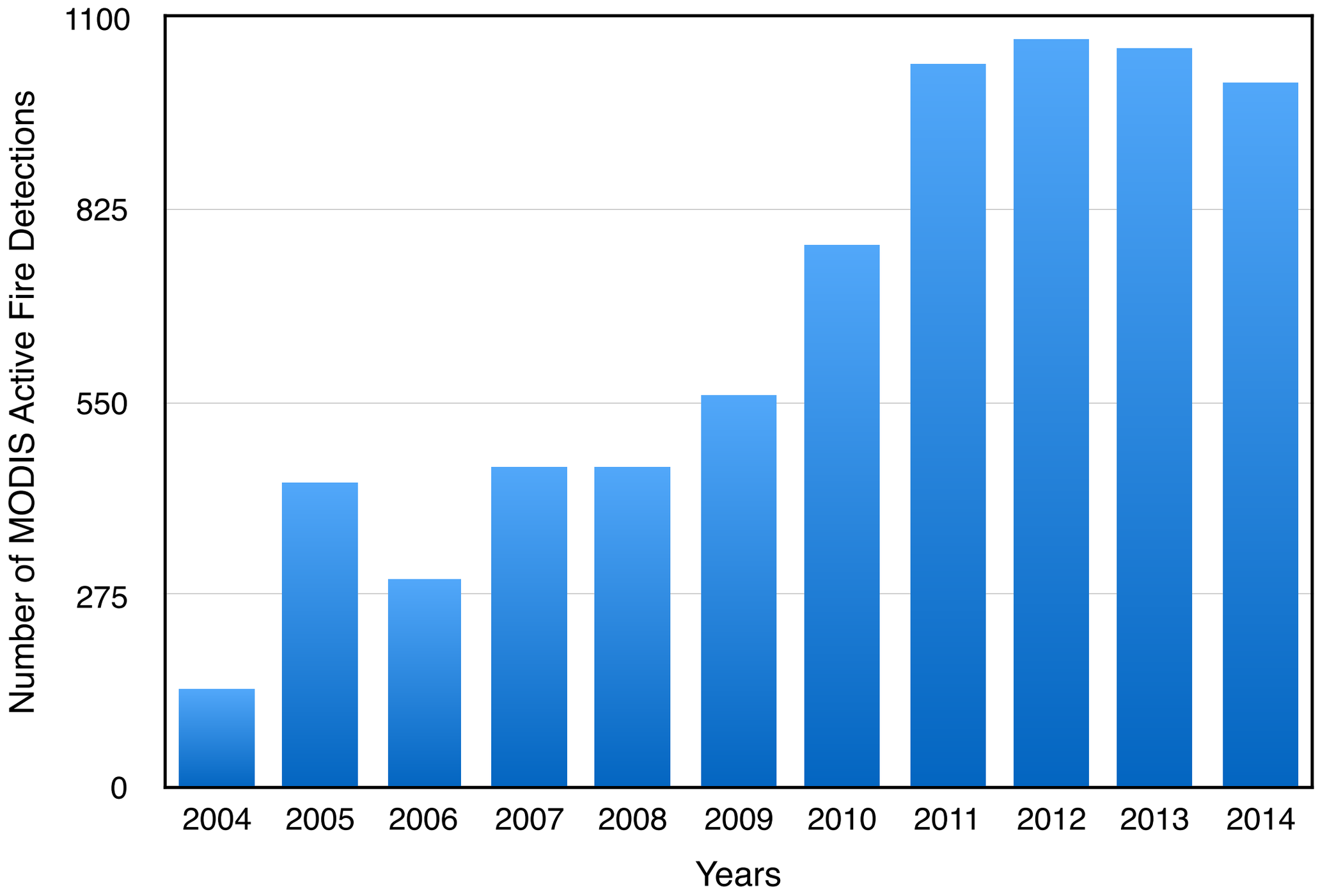
If outside of range, fire is non-contributing



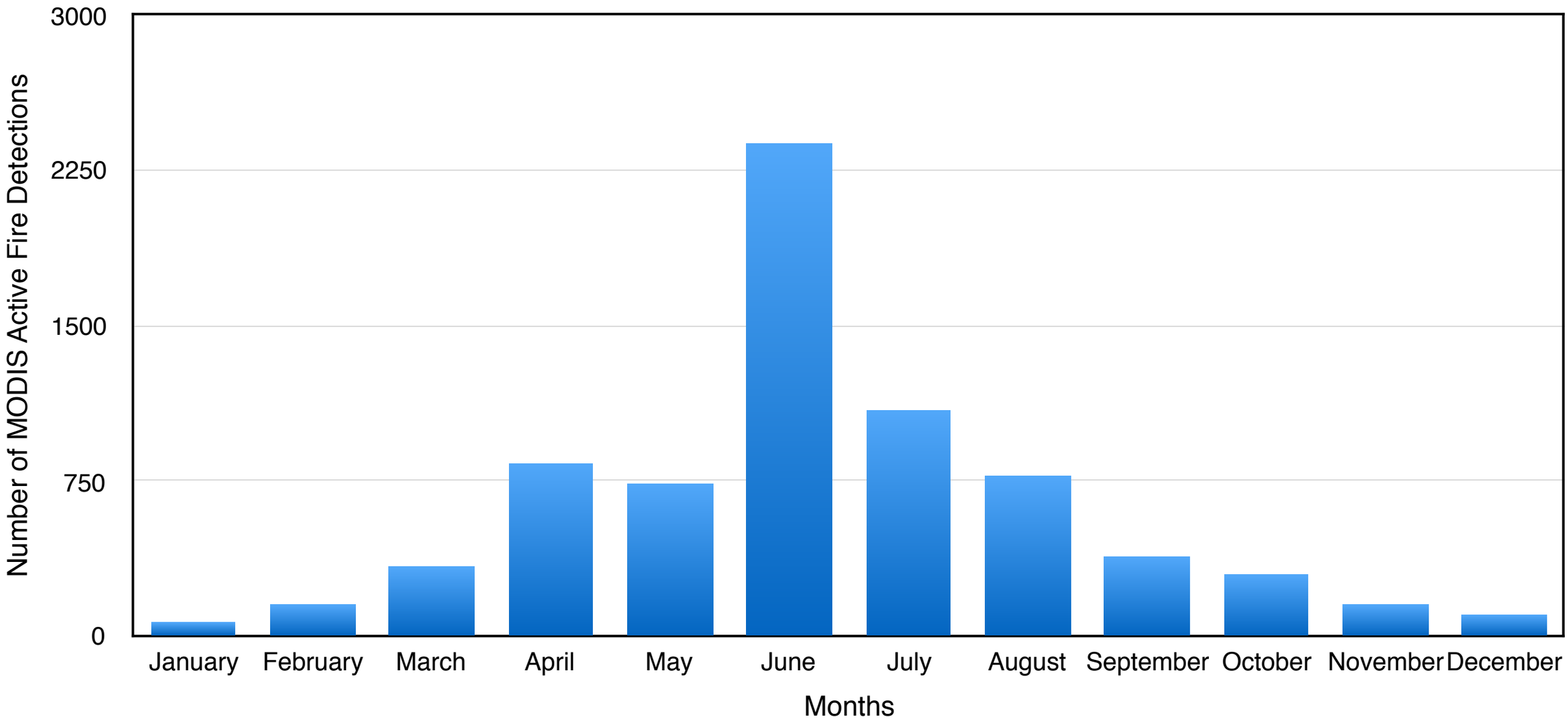
Contributing vs Non-contributing in Agricultural Areas



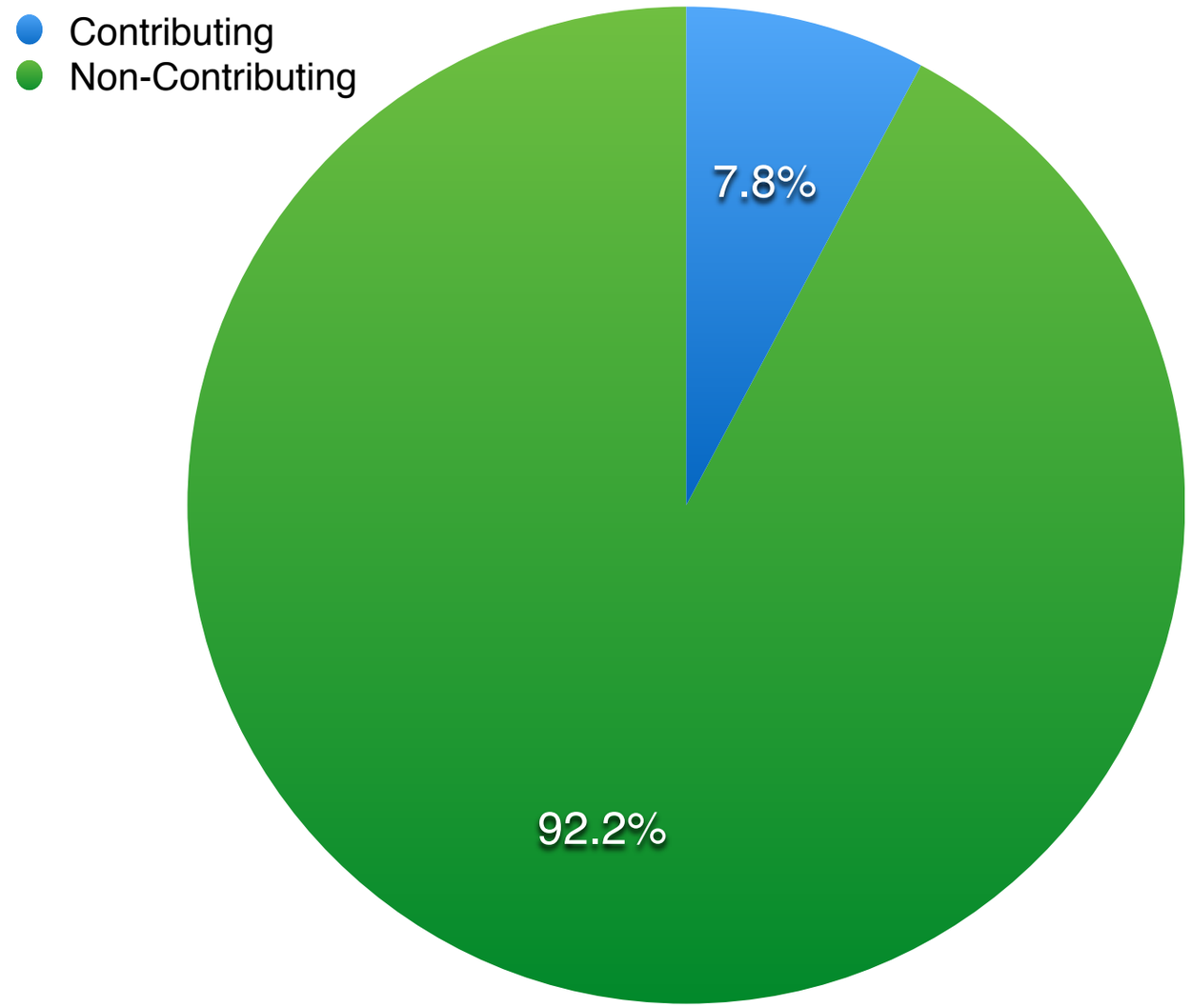
Interannual Agricultural Fire Activity



Monthly Agricultural Fire Activity



Contributing vs Non-contributing Agricultural Fires vs All Fires



Study limitations

- Fire data limited to overpass times
- Wind zones
- Lack of distance and wind speed analysis
- Lack of data on particulate matter dispersal

Conclusion:

Based on prevailing wind patters only 8% of agricultural fires likely contribute to Beijing air quality.

Further Work

Expansion of modeling:

wind data and zones of influence

particulate matter distribution

Reverse gravity model to introduce distance and wind speed data into analysis

Questions?