

1. Introduction

Particulate matter, abbreviated as PM, contains a mixture of microscopic solids and liquid droplets found in the air. Some particles are too small that they can get deep into people's lungs even bloodstream. Among these, PM_{2.5}, the general term for fine inhalable particles with 2.5 micrometers and smaller diameters, can cause higher risk of health[1-2]. Therefore, PM_{2.5} is a very important indicator in air quality standards.

Beijing is one of the most polluted cities in the world. Among the sources of PM_{2.5} in Beijing throughout the year, Motor vehicles, coal combustion and industrial production have become the main sources of PM_{2.5} in Beijing[3]. Scientists also analyzed the variability of PM_{2.5} through a heavy haze episode in Beijing, come up with a conclusion that wind speed is one of the major meteorological factors in causing the PM_{2.5} concentration[4].

This dataset comes from the hourly PM_{2.5} readings taken by the US Embassy in Beijing (116.47 E, 39.95 N) between January 1, 2010 and December 31, 2014. The number of instances is 43824. It contains thirteen attributes, including row number, year of data, month of data, hour of data, PM_{2.5} concentration ($\mu\text{g}/\text{m}^3$), dew Point ($^{\circ}\text{F}$), temperature ($^{\circ}\text{F}$), pressure (hPa), combined wind direction, cumulated wind speed (m/s), cumulated hours of snow and cumulated hours of rain[5].

Different countries have different standards for PM_{2.5}. This dataset is from Beijing, therefore I choose Chinese national standards(GB standards) to classify PM_{2.5} concentration. From GB 3095-2012, the 24-hour average value of PM_{2.5} lower than $75(\mu\text{g}/\text{m}^3)$ means the air quality is healthy, the 24-hour average value of PM_{2.5} higher than $75(\mu\text{g}/\text{m}^3)$ means the air quality is unhealthy[6].

2. Questions

Climate will affect PM_{2.5} concentration a lot. There are several questions that I am curious about this dataset:

1. What does the probability of air quality, under the standard of PM_{2.5}, looks like in winter(December-February) compared with the air quality in summer(June-August)?
2. What does the probability of air quality, under the standard of PM_{2.5}, looks like with different wind directions(CV, NE, NW, SW, SE)?
3. What does the probability of air quality looks like with different wind speed(10, 20, 50, 100) in four seasons?
4. What does the probability of air quality looks like with different rain hours(0, 1-3, 5-7, >9) in the same season?

Reference:

- [1]United States Environmental Protection Agency. 2020. Particulate Matter (PM) Basics. Retrieved from <https://www.epa.gov/pm-pollution/particulate-matter-pm-basics>
- [2]Pope CA, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K, Thurston GD. 2002. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 287, 1132–1141. DIO: <http://doi.org/10.1001/jama.287.9.1132>
- [3]Song Guo, Min Hu, Misti L. Zamora, Jianfei Peng, Dongjie Shang, Jing Zheng, Zhuofei Du, Zhijun Wu, Min Shao, Limin Zeng, Mario J. Molina, Renyi Zhang. Proceedings of the National Academy of Sciences, Dec. 2014, 111 (49) 17373-17378. DOI: <https://doi.org/10.1073/pnas.1419604111>
- [4] He H, Tie X, Zhang Q, Liu X, Gao Q, Li X, Gao Y. 2015. Analysis of the causes of heavy aerosol pollution in Beijing, China: a case study with the WRF-Chem model. Particuology 20, 32–40. DOI: <https://doi.org/10.1016/j.partic.2014.06.004>
- [5] Liang Xuan, Zou Tao, Guo Bin, Li Shuo, Zhang Haozhe, Zhang Shuyi, Huang Hui and Chen Song Xi. 2015. Assessing Beijing's PM_{2.5} pollution: severity, weather impact, APEC and winter heatingProc. R. Soc. A.47120150257. DOI: <http://doi.org/10.1098/rspa.2015.0257>
- [6] Ministry of Ecology and Environment of the People's Republic of China. 2012. Ambient air quality standards. Retrieved from <https://www.mee.gov.cn/>