# The Problem:

Based on my experience living in the greater Denver, Colorado metropolitan area for more than thirty years, a nagging question has been lying in the recesses of my mind for a considerable time. Have our pollutants changed over the years?

When I arrived in the Denver area in 1983, it was known for the infamous “brown cloud.” It was generally present all year long, but in the Winter, it became much worse. One could travel out of the Denver valley and look back to get a perspective. The brown cloud would have the appearance of a huge disc-shaped “flying saucer” that had descended upon the city. I was told at the time that the vast majority of the pollutants consisted of noxious gasses from vehicle exhaust. The governor of the state proposed that large fans could be placed on the foothills to blow the cloud away to the east. This was idea discarded as impractical.

Later, in the ‘90s, the pollution content seemed to change. The cloud was no longer a grayish-brown, but instead, a lighter tan, and noticeably less dense, especially in the summer. I read an article claiming that vehicle exhaust had become only ten percent of the content of the “tan cloud.” Approximately thirty percent—in the winter—consisted of fine, airborne sand and gravel particles. Sand and gravel is commonly put on the streets and roads to make winter driving manageable. The vehicle tires, crushing the sand and gravel into the street, generate the fine particles which then become airborne.

Up to another thirty percent of the tan cloud was, believe it or not, *meat particles* from restaurant exhaust or perhaps simply restaurant exhaust in general, and up to another thirty percent consisted of gasses and particulate matter from cigarette smoke. Smokers were quick to reject that line of thought, but it does give one pause. If the sources of previous pollution are being reduced, it stands to reason any remaining pollution will share a greater percent in the overall content.

Time passed, and in the first decade of this millennium, the cloud was often not even visible. However, upon returning from a three-year absence from the Denver area, I noticed that the cloud is once again evident.

For this project, I propose an analysis of air quality data to determine whether the content of pollutants has changed over the years. I hope to identify whether either particulate matter or gasses are increasing or decreasing, and if so, is the change relative to overall percent or is it quantitative?

# Audience:

In general, the audience for this study is anyone who might be interested in trends in clean air. However, it is directed primarily to those who are charged with reducing air pollution in the human environment; those who might be interested to know whether old methods and goals have been successful and whether new methods and goals are in order or even necessary.

# Data:

I located a collection of air quality data that spans the years of 1990-2016 for multiple cities in the United States. From this collection, I plan to select five cities, each from a different geographical region, and analyze the data to determine whether there is a trend of increasing or decreasing tendency for specific pollutants. In order to keep this study to a manageable scope, I intend to compare particulate matter to gasses to determine their relative proportions throughout these years.

# Deliverables:

With this study, I will include the code I wrote to extract the data from the annual datasets, the extracted dataset, along with charts and graphs in a PowerPoint presentation to demonstrate the question, the analysis, and the conclusion.

# Process:

* Download and extract each year’s data into a .csv
* Assess the tidiness of the data
* Determine the columns of data that will be useful for the analysis
  + City Name, State Name, State Code, Site Number, Parameter Name [pollutant], Units of Measure, Observation Count [in ppm], Observation Percent, Sample Duration, Pollutant Standard
* Identify the pollutants to be considered across the five cities and group them according to the elements that use the same metrics.
* Merge the data from individual year datasets into a single dataset
* Plot the data for the two categories of pollutants on dot/line charts for each year.

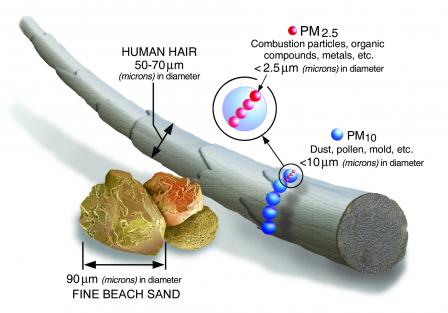
# Definitions:

Particulate Matter (PM)

<http://www.tceq.state.tx.us/airquality/sip/criteria-pollutants/sip-pm>

Particulate matter (PM) is a mix of small particles and liquid droplets. These particles can be made up of acids, organic chemicals, metal, dust, or soil. Particulates are different in several ways including size. Federal definitions for PM based on particle size can be found in [40 CFR §58.1](http://www.ecfr.gov/cgi-bin/retrieveECFR?n=40y6.0.1.1.6#se40.6.58_11).

PM10 is sometimes referred to as coarse particles. They consist of particles that are less than or equal to 10 micrometers in diameter.

PM2.5 are fine particles and are the smallest particles that are regulated. They consist of particles that are less than or equal to 2.5 micrometers in diameter. By comparison, the average diameter of human hair is 70 micrometers.

<https://www.epa.gov/pm-pollution/particulate-matter-pm-basics#PM>

Size and Composition Distribution of Fine Particulate Matter Emitted…:

<http://authors.library.caltech.edu/67782/>

[Review of recent advances in detection of organic markers in fine - NCBI](http://www.ncbi.nlm.nih.gov/pubmed/20102032)

[Toxicity of Polycyclic Aromatic Hydrocarbons (PAHs): Routes of](http://www.atsdr.cdc.gov/csem/csem.asp?csem=13&po=6)

[Sources of Fine Organic Aerosol. 6. Cigarette](http://pubs.acs.org/doi/pdf/10.1021/es00056a030)