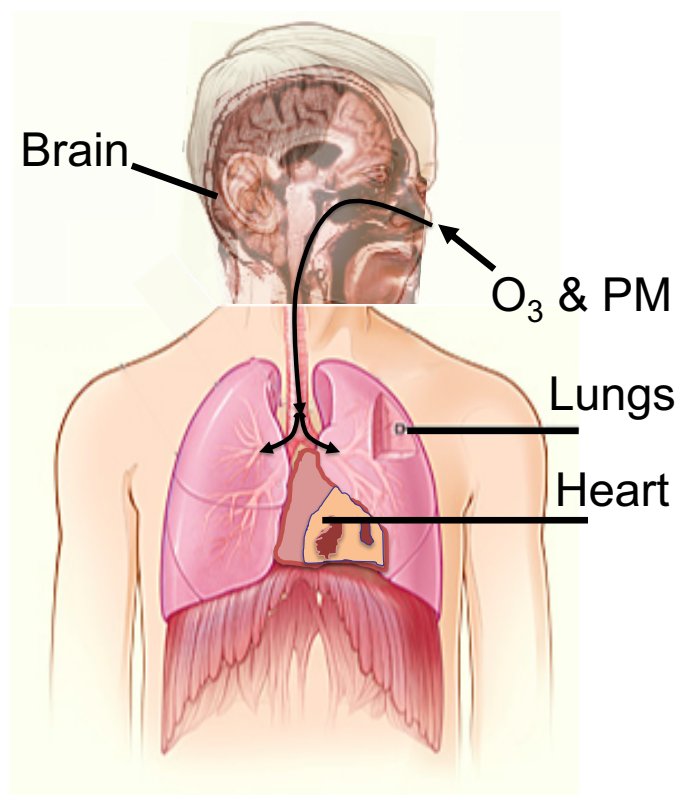


**Beltsville PBL Air Quality Modeling – Atmospheric Chemistry**  
**Applications of 3-D Air Quality Models to Estimate Health Impacts –**  
**Linking to Health Effects Codes**  
**William Stockwell, Rosa Fitzgerald**

**Objective:** Students will learn why is air quality in an Important factor in human health and how modeling tools may be applied to inform the development of public policy.

**Air Quality Health Effects**

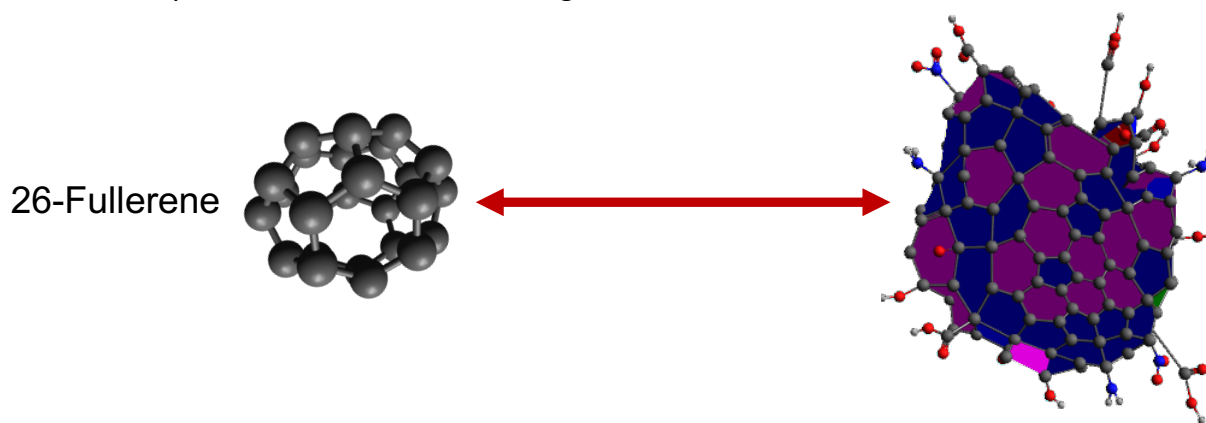
National Ambient Air Quality Standards in the U.S. Clean Air Act. These are defined by the EPA for six principal pollutants also known as "criteria air pollutants". Criteria Air Pollutants all have health effects and may damage animals, crops, vegetation and buildings. The Criteria Air Pollutants are ozone ( $O_3$ ), particle matter (PM), nitrogen dioxide ( $NO_2$ ), carbon monoxide (CO), sulfur dioxide ( $SO_2$ ) and lead (Pb). Particulate matter has two subgroups, the first group is known as  $PM_{2.5}$  whose particles have an aerodynamic diameter of  $\leq 2.5 \mu m$  and  $PM_{10}$  whose particles have an aerodynamic diameter of  $\leq 10 \mu m$ . Under current conditions  $PM_{2.5}$ ,  $PM_{10}$  and ozone have the most significant human health effects, Figure 1.



**Figure 1.** Ozone inflames lung tissue and  $PM_{2.5}$  and  $PM_{10}$  particles may lodge in lungs. Particles may travel to the heart and brain where they can cause more damage. Lead (Hg), and Mercury (Hg) and strong neurological effects.

Particulate air pollution inflames the brain, sparking reactions that lead to diseases such as dementia and autism (Pelley). Atmospheric lead is less of a problem after its removal from gasoline. But note that some aviation gasolines continue to contain lead! Mercury is a strong neurotoxin that is transported globally and is deposited to bodies of water where it may be taken up into fish.

Soot and secondary organic aerosol (SOA) are major health concerns. Soot particles may have some similarity to carbon nanostructures, Figure 2.



**Figure 2.** Soot particles may have some similarity to carbon nanostructures. Note that reactive sites (bright red and blue) in the figure that may influence health effects (Medina et al., 2018).

Stewart et al. (2017) used the Community Multiscale Air Quality (CMAQ) model to simulate air quality for the year 2008 and the effects of proposed air quality control strategies on particulate matter in the year 2030 for the South Coast Air Basin (including Los Angeles, California). The CMAQ air quality simulations were used as input to the Environmental Benefits Mapping and Analysis Program—Community Edition (BenMAP-CE) program that was used to estimate health and economic impacts of the various control strategies. BenMAP-CE is based on epidemiologic studies that link human health and air quality. This modeling approach allows better evaluation of proposed public policies to improve air quality because it addresses directly how concentration changes affect human health.

## Assignment

Download the Stewart et al. (2017) paper at:  
<https://journals.sagepub.com/doi/10.1177/1178630217737551>

Examine the paper and we will discuss it during our workshop meeting. Our discussion will include the following questions:

1. What is the assumed relationship between the concentration of an air pollutant and the incidence of an adverse health effect? Does the assumed relationship seem valid; what are the strengths and weaknesses?
2. What are the large data files required to run BenMAP-CE?
3. How was the CMAQ base simulation evaluated? Comment on the normalized mean error and the normalized mean bias for PM<sub>2.5</sub>? How much would you rely on these CMAQ simulations.
4. What are the major chemical components of the simulated PM<sub>2.5</sub>?
5. Discuss the projected economic and health benefits. Do you think benefits are worth the costs?

## References

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- Stewart, D.R., E. Saunders, R.A. Perea, R. Fitzgerald, D.E. Campbell and W.R. Stockwell (2017) Linking Air Quality and Human Health Effects Models: An Application to the Los Angeles Air Basin, *Environmental Health Insights*, 11, 1–13, doi: 10.1177/1178630217737551
- Stewart, D.R., E. Saunders, R. Perea, R. Fitzgerald, D.E. Campbell and W.R. Stockwell (2019) Projected Changes in Particulate Matter Concentrations in the South Coast Air Basin Due to Basin-Wide Reductions in Nitrogen Oxides, Volatile Organic Compounds and Ammonia Emissions, *J. Air Waste Manage. Assoc.*, 69, 192–208,. doi: 10.1080/10962247.2018.1531795