# Seasonal Abundance of Wood Smoke Markers and Cholesterol in Fine Particles from the New York Metropolitan Area

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#### Introduction

Polar organic compounds are not well documented in U.S. urban airsheds. This study investigates the atmospheric abundance of wood smoke markers and cholesterol in the New York City (NYC) metropolitan area. Wood smoke originates from many sources including biomass burning due to human activities (home heating, campfires, agricultural burning, structural fires) and to wildfires. Cholesterol is a molecular marker for meat charbroiling, grilling and frying. The influence of wood smoke and cooking emissions on the PM2.5 mass in this high-population area is not well documented and, therefore may be important sources of fine particulate matter (PM) in the NYC area. This information is also valuable for source apportionment models such as the EPA CMB 8.2

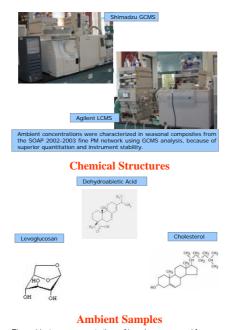
## Fine PM2.5 Collection



Fine PM samples were collected as part of the Speciation of Organic Compounds for Source Apportionment (SOAP) network. Samples were collected at 4 receptor sites over the period May 2002 through May 2003. Fine PM samples were obtained from two urban sites, (Queens, NY and U.S. EPA Supersite; Elizabeth, NJ), an upwind (Chester, NJ) and downwind site (Westport, CT) operating on the STN sampling schedule. Ten seasonal composites were generated for each site with 6 to 10 filters per composite.

#### Sample and Standard Analysis

Ambient fine particle samples were extracted with acetone and methylene chloride (1:1). Extracts were concentrated to dryness under a stream of  $\rm h_2$  gas. The samples were then derivatized with N,O-bis(trimethylsily)triflouroacetamide with trimethyl-chlorosilane (BSTFA-TMS) using hexane and pyridine as the solvents. The chemicals were added under a stream of  $\rm N_2$  gas. The samples were baked at 60  $^{\circ}$  C for 30-40 minutes to complete the reaction. Wood smoke markers and cholesterol standards were obtained from Sigma Aldrich. These were combined into a single standard solution that was derivatized and run as 5-level calibration standards. BSTFA with 1% TMS was purchased through Supelco. Ambient samples and the TMS derivatives were analyzed with a Shimadzu QP2010 GCMS.



The ambient mass concentrations of levoglucosan ranged from 2.36 ng/m³ to 149.5 ng/m³ for the NYC PM samples. Levoglucosan was typically highest in the fall and early winter, however significant levels were present also in the summer; the spring time had the lowest levels. The ambient mass concentrations of dehydroabietic acid ranged from 1.6 ng/m³ to 98.9 ng/m³. Dehydroabietic acid was present year-round and was particularly evident in the fall and early winter, however it was found also in the early spring. These data indicate that wood smoke and related OC and EC masses are a major contributor to fine PM mass in the NY metropolitan area.

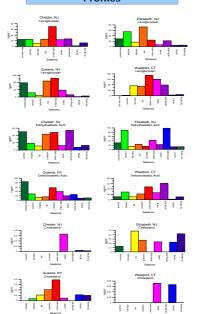
Cholesterol ranged from below the detection limit to 0.8 ng/m³. Cholesterol was present in Elizabeth, NJ and Queens, NY throughout the year indicating that meat cooking contributes to the fine PM mass. Cholesterol was detected only in winter in Chester, NJ and Westport, NY indicating meat charbroiling is not a major contaminant in these locations.

### **Profiles of Ambient Samples**

Distinct profiles of wood smoke markers, levoglucosan and dehydroabietic acid, and cholesterol are seen in the ambient samples taken from the NY metropolitan area. A summary of chemical characteristics of the compounds is given below. The following plots illustrate the concentrations of the targeted molecular markers at each site over the 2002-2003 year.



#### SOAP Polar PM Marker Profiles





Citation: Zheng, M., Russell, A.G., Schauer, J.J., Dong, M., Edgerton, E.S., and Cass, G.R. (2004) Source apportionment of fine organic carbon in the eastern United States. The 8th International Conference on Carbonaceous Particles in the Atmosphere. Vienna. Austria. September 14-16. 2004.

#### **Results & Discussion**

The analysis of the SOAP NY area 2002-2003 fine PM ambient samples indicate wood smoke markers and the associated OC and EC masses are present in the airshed throughout the year. Levoglucosan is a molecular marker for the combustion of cellulosic material: dehydroabietic acid is a molecular marker for the combustion of softwoods (conifers). The wood smoke markers typically are highest in the fall and early winter, particularly at the urban sites. This could be due to wood fireplaces and stoves used for heating. There also is a spike of wood smoke in the summer which could be due to charcoal burning in barbecue grills. Charcoal is produced by carbonization of hard-woods or softwoods in a kiln around 650 to 750 K. As shown in Zheng et al. (2004) levoglucosan is present in both the summer and winter in the NY area. Cholesterol is a molecular marker for meat cooking. mainly by commercial and residential charbroiling, grilling and frying operations. Cholesterol is present in the urban areas throughout the year. It is present in the upwind (Chester, NJ) and downwind (Westport, CT) sites in the winter and the spring.

At present wood smoke emissions and cooking emissions are unregulated sources in the tri-state metropolitan area. Our results suggest both sources are significant contributors to the total fine particle mass in the densely populated urban locations and also in the rural NJ background site and mixed urban/suburban CT downwind site. Improving the knowledge of polar organic compounds in the atmosphere has the potential to improve source apportionment models.

Disclaimer: Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official EPA policy.

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