1. Executive Summary

Fairbanks, AK experiences very high levels of ambient $PM_{2.5}$ during the winter months. Studies are currently under way to determine the sources of the $PM_{2.5}$ so that the issue might be addressed. Possible sources of the $PM_{2.5}$ include residential heating (wood, fuel oil, and/or natural gas combustion), transportation (diesel and gasoline engines), and coal combustion.

The current project is to provide a more complete characterization of the organic chemical composition of $PM_{2.5}$ from Fairbanks with the goal of identifying and quantifying chemical species that can be used to calculate and apportion ambient $PM_{2.5}$, particularly from wood and fossil fuel combustion.

Comprehensive chemical analyses for levoglucosan, hopanes, steranes and PAHs have been performed on up to33 ambient $PM_{2.5}$ samples from Fairbanks. Analyses have also been performed on $PM_{2.5}$ generated at OMNI scientific using representative fuels and devices. The results of these analyses have been examined with special attention to compounds reported by previous authors as emissions from wood (levoglucosan) and fossil fuel sources. Emphasis has been placed on sulfur-containing compounds (dibenzothiophene and benzonaphthothiophene) which are known emissions of diesel vehicles and were hypothesized to be markers of residential oil burners and a polynuclear aromatic hydrocarbon (picene) which has been reported as a unique marker for coal combustion. A second polynuclear aromatic hydrocarbon, bibenzyl, has been identified as a potential marker for residential oil combustion.

In general, the results show that the ambient levels of levoglucosan and selected hopanes, steranes, picene and thiophenes, measured either as a concentration in air or as a fraction of $PM_{2.5}$, are high relative to previous studies. Levoglucosan results provide a reasonable estimate of the wood smoke contribution to ambient $PM_{2.5}$, and other markers provide a sense of upper bounds for the contribution of residential oil burners and coal combustion.

Levoglucosan results indicate that wood smoke contributes 26-35% of the $PM_{2.5}$ at the State Building site, 42-62% at the North Pole site, and 20-30% at the Peger Road site. These values are significantly lower than those reported by CMB analysis and similar to somewhat lower than those determined by ^{14}C analysis. The results show that wood smoke is a substantial contributor to ambient $PM_{2.5}$. The contribution of wood smoke to ambient $PM_{2.5}$ varies substantially within a season, but has had a fairly constant seasonal average or median over the past three seasons.

Polynuclear aromatic hydrocarbon results indicate that residential oil combustion is likely a minor contributor to ambient $PM_{2.5}$ levels with a median contribution of less than 1%. Sterane analysis indicates that the upper bound for the contribution from residential oil combustion is 15%, but this is likely to be an overestimate. There is significant but unquantifiable uncertainty in these results, which rely on a single sample of no. 2 fuel oil $PM_{2.5}$.

Analysis of picene levels indicates that coal combustion also contributes a minor fraction to ambient $PM_{2.5}$ of 2.7% or less. Analysis of hopanes suggests an upper bound for coal contribution of 13%, which is likely to be an overestimate. The picene and hopane shares of coal $PM_{2.5}$ are highly variable with device, however, and the contribution of coal combustion to ambient $PM_{2.5}$ could be less than 1% from coal stoves or much higher if from HH systems.

Thiophene analysis shows that these compounds are not present in residential oil emissions, and thus cannot be used as markers of residential oil combustion. The compounds do appear in the emissions from coal combustion at shares that result in estimated coal contributions to ambient $PM_{2.5}$ of 6.7% to over 100%. It is clear from this analysis that there is another significant source of thiophenes, particularly dibenzothiophene, other than residential heating. The most likely source is transportation, since thiophenes have been reported at significant levels in diesel fuel and gasoline emissions.