Lake Tahoe Source Attribution Study (LTSAS): Receptor Modeling Study to Determine the Sources of Observed Ambient Particulate Matter in the Lake Tahoe Basin

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Deposition of ambient particulate matter (PM) has been implicated as a major source of nitrogen (N), phosphorus (P) and sediment to Lake Tahoe. Therefore, knowledge of the sources contributing to the observed PM is crucial if we are to develop an approach to reduce the impact of atmospheric deposition on water quality in the lake.

To address the issue of atmospheric particulate matter deposition we applied a number of source-receptor modeling techniques to chemically speciated PM data collected as part of Lake Tahoe Atmospheric Deposition Study (LTADS) and source profiles information obtained from the Lake Tahoe Source Characterization Study.

As part of the proposal for this work, a set of twelve hypotheses related to the impact of different sources on air quality and deposition in the basin were put forth. Using the source apportionment findings, we can address these previously identified issues. The results are as follows:

1. *Re-suspended paved road dust is the major source of PM_{10} in the basin*. The results supported this hypothesis. This was best seen at the two high traffic sampling sites in the densely populated areas (South Lake Tahoe and Sandy Way) and the near-roadway site.

2. *Wood burning is an important source of $PM_{2.5}$ during the winter months*. The results supported this hypothesis. The receptor models demonstrated that residential wood combustion, with possible contributions from wildfires and controlled burns are the major $PM_{2.5}$ sources of pollution during the fall and winter months.

3. *Motor vehicle tailpipe emissions is the major source of $PM_{2.5}$ in the basin*. The results do not support this hypothesis. This is an important source but as a percentage of $PM_{2.5}$ mass the chemical mass balance (CMB) receptor model derived value varied from 23 to 33%.

4. *Secondary pollutants from outside the basin are minor sources of $PM_{2.5}$ and PM_{10}*. The results supported this hypothesis. The maximum predicted contributions from secondary sources to $PM_{2.5}$ were found to vary from 8 to 12%.

5. *Emissions from controlled burns inside the basin, and wildfires outside the basin are minor sources of the observed PM*. The results are inconclusive in supporting this hypothesis. Due to the smoke from residential wood burning during the fall and winter, the contributions from wildfires and controlled burns in or outside the basin could not be assessed.

6. *Emissions from restaurants can be an important source of PM at some locations*. This could not be determined. In the absence of measured meat and other cooking markers in the ambient samples, or chemical source profiles, this source could not be identified or modeled.

7. *Overall, the most important sources to control are emissions from light-duty gasoline vehicles*. The results did not support this hypothesis. As stated under 1, 2, and 3 above, the most important sources to control are road dust, followed by wood smoke and mobile sources.

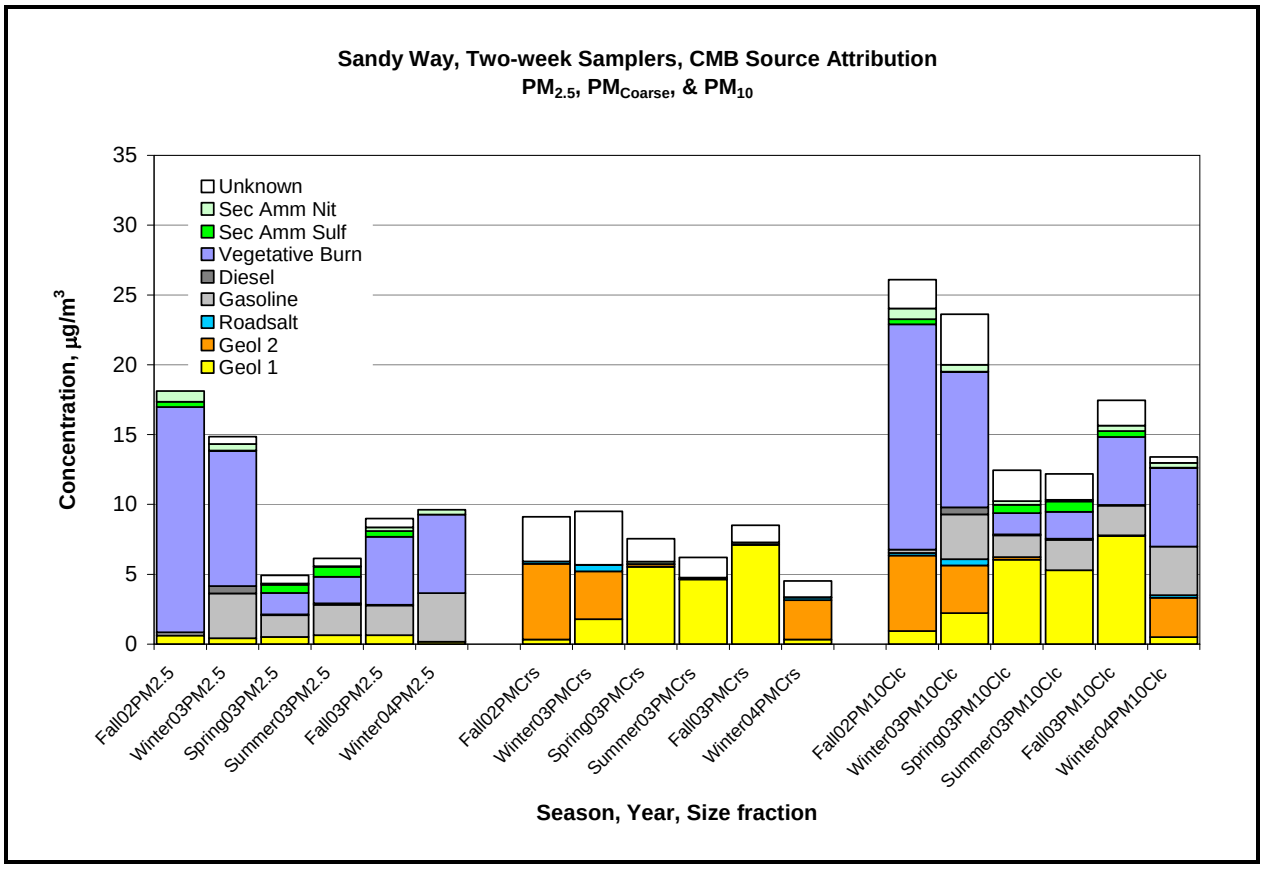
8. *The major source of phosphorous is soils, while the contributions from wood burning are small*. The results supported this hypothesis. Initial data analysis, including the calculation of correlation coefficients did not confirm any relationship of phosphorus with wood combustion. Phosphorus was highly correlated with all soil species in PM_{10}.

9. *Phosphorous concentrations in the coarse fraction are elevated and are therefore indicative of mechanically re-suspended soil*. The results supported this hypothesis. PCA and subsequent data analysis revealed that phosphorus occurs as individual mineral grains in the coarse geological fraction, as re-suspended road dust.

10. *Phosphorous from mobile source tailpipe emissions is small*. The results supported this hypothesis. Phosphorus from motor vehicle emissions as measured in $PM_{2.5}$ was very low for all cases. If phosphorus had been in motor vehicle emissions in measureable concentrations, it would have occurred evenly distributed in all the South Lake Tahoe, Sandy Way, and Lake Forest samples, which was not the case.

11. *Nitrogen is a minor component of the coarse PM fraction. Hence the PM contribution to the atmospheric deposition of N is small*. The results supported this hypothesis. On average about 0.30 $\mu g/m^3$ nitrate occurs in the TSP fraction, with about 0.26 $\mu g/m^3$ in PM_{10} and 0.15 $\mu g/m^3$ in $PM_{2.5}$. Deposition in the lake from aerosol nitrate will therefore be small.

12. *Soil is the major contributor to atmospheric sediment deposition in the lake*. The results supported this hypothesis. The receptor modeling show that road dust in the PM_{Coarse} size fraction, partly from de-icing procedures during winter months is an important source to control. Road dust accounted for as much as 60% of PM_{10} and, based on its size, has the potential to be deposited in Lake Tahoe.



Two week samplers, Sandy Way site: Summary of seasonal average CMB modeled source contributions for measured $PM_{2.5}$, PM_{Coarse}, and calculated PM_{10}.