Ambient Nitrogen Oxide Concentrations During Peak Tourist Season in Yosemite National Park

2011 School of Science Summer Research Proposal

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My proposed research for the summer of 2011 under the supervision of Dr. Joel Burley involves the measurement of ambient nitrogen oxide concentrations in the Valley region of Yosemite National Park. The data collected by the nitrogen oxide and ozone monitors will be used to assess the air quality in and around Yosemite Valley during peak tourist season in Yosemite National Park.

Ozone monitors in locations throughout California compile data to determine if air quality standards are met and to allow comparisons between different regions. According to data from the California Air Resource Board, air quality in Yosemite National Park can register similar and even greater ozone levels than the San Francisco Bay Area. For example, ozone readings on July 4, 2000 from a monitor stationed in Concord (Contra Costa County), a densely populated region in California's East Bay, indicated a daily maximum of approximately 0.04 ppm with a noticeable increase in ozone from eight am until noon and subsequent decrease until about seven pm; meanwhile, a monitor in Turtleback Dome, located just outside Yosemite Valley, recorded a significantly higher maximum of 0.06 ppm with little variation in ozone values throughout the day (Air Quality Data, 2000).

The National Park Service is interested in understanding what causes these unforeseen levels of air pollution in Parks such as Yosemite. One hypothesized explanation suggests that nitrogen oxide emissions from sources including campfires and vehicle traffic cause increased levels of ozone (O_3). With sufficient research, data collection, and data analysis, the question they hope to answer is whether or not this is occurring to a significant extent in Yosemite Valley.

During the summer months - primarily May, June, July, August, and September - Yosemite National Park experiences a dramatic increase in visitors. For instance, in 2009,

nearly 70% of the total annual guest count visited between May and September, with a peak of 643,300 guests in the month of August alone (Newburger, et al., 2010). High visit totals correlate to elevated vehicular traffic in the greatly travelled area of Yosemite Valley, which in turn is likely to raise the overall concentration of combustion emissions released into the atmosphere.

Combustion of gasoline in automobiles contributes nitrogen oxide compounds (NO and NO_2, often denoted as NO_X), which may elevate surface ozone (O_3) levels by the subsequent reaction of NO_2 molecules and volatile organic compounds (VOCs) in the presence of sunlight ("Air Quality"). It is known that these processes vary within a diurnal cycle. In the daytime, fresh NO emissions titrate O_3, eliminating ozone from the atmosphere. NO that does not react with O_3 immediately, is usually converted to NO_2 on a timescale of a few hours. The NO_2 molecules formed in this manner can later react with VOCs to form O_3. In the nighttime, NO titrates and removes O_3 from the atmosphere.

Previous studies conducted in 2003 and 2005 by my mentor, Dr. Joel Burley, have measured surface ozone concentrations in multiple locations throughout Yosemite National Park; monitored locations include Turtleback Dome, Crane Lookout Flat, El Portal, Tuolumne Meadows, Tioga Pass, etc. (Burley et al., 2007). However, data on ambient nitrogen oxide concentrations in and around Yosemite Valley exist only for a couple of years from a single mid-Valley site along the Merced River. This proposed research will gather data from multiple sites in the Valley region, expanding the volume of data that can be used to assess the impacts of nitrogen oxides on air pollution in Yosemite National Park.

The data will be collected via portable, solar powered 2B Technologies nitrogen oxide and ozone monitors (2B Technologies). The monitors will be mounted on a mobile

trailer, and the trailer will be moved every one to two weeks to allow for data collection at multiple sites in Yosemite Valley. Proper set-up and calibration of the monitors will be performed each time the instrumentation is moved to ensure accurate readings. The locations will include areas such as turnouts alongside the main road, close enough to allow the monitors to collect accurate atmospheric samples from each specific location. The data will be downloaded directly to portable computers for subsequent analysis using computer programs such as Microsoft Excel and JMP (JMP 8). These programs will be used to organize the data and view them as graphs in order to examine trends.

This research is a top priority for the Air Resource Division of the National Park Service in Yosemite. Dr. Lee Tarnay, the full time Air Quality Specialist for Yosemite, is prepared to move forward with this project in the spring of 2011. The mobile trailer and monitors that will be used for collecting measurements are already in existence, and measurements may commence as early as May 2011, continuing into early fall. This research will likely become a year-round undertaking to allow analysis of ambient nitrogen oxide concentrations during all four seasons.

References

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