AMMONIA IN THE COLUMBIA RIVER GORGE

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ABSTRACT

Air in the Columbia River Gorge (CRG), a national monument, is impacting vegetation, haze and even rock hieroglyphs. Air quality in the CRG is derived from three geographical locations, the Gorge itself, West of the Cascades and East of the Cascade Mountains. Paper mills, power plants, wood burning stoves, forest fires, combustion engines, agriculture… all contribute to CRG haze. Ammonia is an important player in CRG haze. Ammonia combines with NOx and SOx to form ammonium sulfate and ammonium nitrate which both contribute to gorge haze. Because NOx is so prevalent in the air and is a minor contributor to haze on its own ammonia is considered one of the limiting factors to haze level in the CRG. Understanding the source of ammonia, NOx, SOx from agriculture has the potential to become more important in the future. How better to control ammonia release is a need for future research projects.

INTRODUCTION

The Columbia River Gorge (CRG) is where the Columbia River cuts through the Cascade Mountains. The Cascades Mountain Range is an air barrier between Western Oregon/Washington and Eastern Washington/Oregon with the Gorge being the weak spot where air moves through. The Cascades also create a climatic barrier. West of the Cascades climate is much wetter and generally milder than much of the area east of the Cascades. Air quality issues have been addressed by a multitude of groups including Oregon Department of Environmental Quality, U.S. Forest Service, Yakima Nation, Columbia River Gorge Commission and others. Much of what is presented in this article was presented a meeting in Hood River, OR and the information is available at: http://www.deq.state.or.us/aq/gorgeair/scienceday.htm.

THE PROBLEM

Smog has become a political issue in the CRG. Hieroglyphs created centuries ago by Native Americans have been degrading (Jaffe, 2006), lichens have increased nitrogen levels establishing a new species equilibrium (Fenn et al, 2007) and visibility (Gorge haze) is periodically severely degraded. All of the above are issues to a varying population that lives in or visits the CRG. Work on air quality in the CRG is termed the "Sacred Breath" project by the Yakima Nation. Who is responsible for creating the air quality issues in the Gorge is dependent on the direction of air flow through the Gorge. Wind in the Columbia River Gorge works similar to a windshield wiper. One day air flow moves from east to west the next day it can be west to east. There is some seasonality of the air flow. During the summer months air flow is predominantly west to east with strong winds and in the winter east to west with less dramatic wind speeds, but on any given day air can be flowing in either direction. Some days the air will flow one direction during the day and another at night. During spring and fall air flow varies in direction depending on pressures. Figure 1-3 (Adhikari and Nikolich, 2006) Shows air flow direction in the CRG and how it varies depending on Gorge location. Sauvie Island is the far western edge of the CRG and Towal Road the eastern. Notice that every location shows a dimodal pattern.

When air flow is from the west to the east decreased air quality in the Gorge is the result of what is happening in Western Washington and Western Oregon a largely populated (Portland and Vancouver) and industrial area which will only be discussed in a very limited capacity in this article. However, when wind is from the east moving west, Eastern Washington and Oregon are being tabbed as the source of the degraded air. November is the time of the year when haze is most prevalent in the CRG and the source of air is generally from east of the Cascades. With November being the worst time of year for CRG haze and wind direction being from the east, east of the cascades is possibly the major contributor to CRG haze. Table 3 (Jaffe, 2006) shows the source of poor air quality during the 50 worst haze events.

Air pollution takes on many forms, NOx (NO, NO2, NO3), SOx (SO2, SO4), ammonia (NH4) and a variety of other components such as particulates from wood smoke and forest fires. A large component of the smog issue is ammonia. Ammonia or NOx are not by themselves smog causing pollutants. When NOx combines with ammonia and ammonium nitrate is formed you get a smog causing air pollutant. Table 7-1 (Adhikari and Nikolich, 2006) shows the principle air pollutants present in the CRG, Mt Zion is the Western CRG edge and Wishram the eastern. Ammonia is the key because there is so much NOx in the air from a variety of sources that there is little motivation for making progress in reducing NOx as a way to reduce smog. NOx is in the air from a wide variety of combustion reaction including cars, trucks barges and trains. Since ammonia and NOx react in a one to one ratio, when NOx exists in e.g. a five fold concectration over ammonia, ammonia becomes the limiting factor to haze and both add nitrogen to the environment impacting flora such as lichens.

Pollution being derived from the east side has many sources including municipalities such as the tri-Cities, power plants, paper mills and agriculture. Two “poster child” generators are commonly mentioned in the common press. First, is the PGE coal fired power plant located just West of Boardman Oregon. This plant was recently labeled in the Portland Oregonian as “Oregon’s number one polluter” and a large emitter of SOx and NOx. The second poster child is Three Mile Canyon Farms, mostly characterized as a large industrial farm, where three dairies milk over a combined 20,000 cows and have a total heard nearing an estimated 50,000 cows. The feedlot next store to them (not part of three mile canyon farms) is rarely considered or mentioned. The aspect that if there were 10 individual 2000 cow dairies instead of what currently exists is never considered, just the negativity of “industrial farming”. Somehow the general press projects the impression that if these two entities disappeared the CRG would return to pristine conditions. However reality is never that simple.

Understanding agricultures contribution to NOx, Sox and ammonia has become important with the haze issue in the CRG. The use of anhydrous ammonia, fertigating with ammonia containing products, denitrification and other issues need to be better understood so they can be managed to both improve efficiency and help improve air quality.

SUMMARY

Life in and next to the CRG has become more interesting. Understanding the contributions to CRG haze will help agriculture better manage their emissions.

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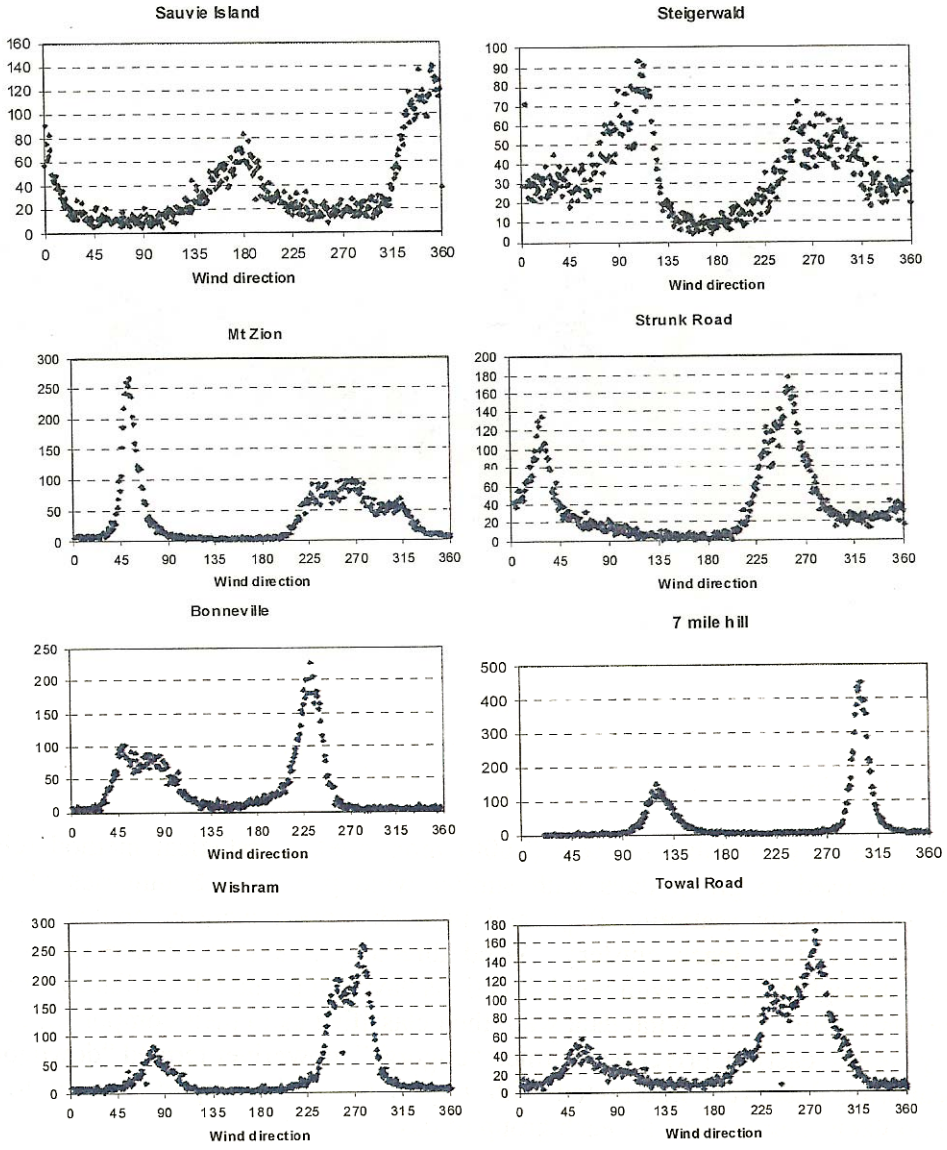

Figure 1-3. Frequency distribution of wind direction by site. X-axis is direction from which wind is blowing (meteorological convention; y-axis is number of hours with wind from each one-degree increment in direction. Period of record is July 1, 2003 to February 28, 2005.

Table 7-1. Component contributions to reconstructed extinction using the new IMPROVE protocol at Mt . Zion and Wishram.

Component	Mt. Zion	Wishram
Organic mass	35%	35%
Ammonium sulfate	24%	17%
Ammonium nitrate	16%	17%
Coarse mass	12%	15%
Light absorbing carbon	9%	10%
Sea salt	3%	3%
Fine soil	1%	3%

Table 3. Distribution by category for the 50 highest PM2.5 days.

Category	Number	Average PM2.5 (ug/m^3)
1- West Gorge	5	14.8
2-West Gorge possible	4	17.7
3-Unassigned or other	22	17.5
4-East Gorge possible	4	20.1
5-East Gorge	15	20.5
All others	1089	5.3

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