

# Tropospheric Ozone Regimes in the Semi-Arid Interior of Southern British Columbia

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## Executive Summary

Traditional ozone summaries (1-hour, 24-hour, and annual mean) reveal very little about the differences between sites with different ozone regimes. For example, using traditional ozone summaries it may be impossible to distinguish large urban areas from areas affected by transport from large urban areas. Medium sized urban areas may be indistinguishable from remote rural sites. These regimes are easily discerned utilizing the concept of diurnal-curve space.

Three scientific papers by Bohm, McCune and Vandetta (1991, 1995a, 1995b) outline a novel approach to classifying ozone regimes utilizing the concept of diurnal-curve space. Unlike traditional summaries this method involves examining both the 24-mean ozone value (y-axis or magnitude) and the shape of the daily curve (x-axis or standard deviation). Bohm, McCune and Vandetta (1991) used a variety of multivariate statistics to discerned 17 characteristic patterns of diurnal ozone exposure at numerous sites in the western United States. The study reported on herein replicates their analysis on ozone data from southern British Columbia.

In this study individual days consisting of 24 hourly ozone values from Kelowna and Kamloops were run through a pattern-matching algorithm to classify each day as one of 17 characteristic diurnal curves. Each curve falls into one of 6 general 'categories', and it is the relative mix of these categories that determine which of 8 larger 'regimes' that site represents. It was determined that overall both Kelowna and Kamloops most closely fit the "Urban-Small" regime. This regime is dominated by urban/small categories (25% to 55%), (Kelowna is 39.5%, Kamloops is 40.0%), but have some urban/large, urban/medium and urban/transport categories (less than 5%). Remote categories occur frequently (30% to 50%), (Kelowna is 48.1%, Kamloops is 41.0%). Ozone maxima occur during summer.

To provide a larger context the analysis was repeated on 2 coastal sites in southeastern British Columbia; Surrey East and Victoria. Surprisingly, Surrey East, Kelowna and Kamloops differed very little. Both fit within the "Urban-Small" regime. The main difference between them is the absence of the urban/large category in Kelowna (Surrey is 0.2%), and a doubling of the urban/transport category in Surrey (Kelowna is 0.3%, Surrey is 0.8%). The difference between the two boils down to the diurnal ozone behavior for approximately 0.7% (1.3 days per year) of the May-October 'ozone season'. Victoria, on the other hand, fits the "Remote" regime description (74.8% Remote, 24.4% Urban Small).

While Kelowna, Kamloops and Surrey are all classified as 'Urban Small', Surrey has the ozone precursors to produce a far greater number of urban/large curves, but the meteorology is ideal for the formation of excess ozone. The populations of Kelowna and Kamloops is quite small compared to Surrey, but given the current level of growth and expected climate changes these interior cities may be consistently producing urban/medium curves in the not-too-distant future.

By consulting Bohm, McCune and Vandetta (1995a) and (1995b) it was possible to determine which sites in the Western United States which most closely approximate the regimes experienced in Kelowna and Kamloops. These are Marion County, Medford, and Eugene, all in the State of Oregon. Marion

County, Eugene and Medford are all located some distance inland along the I-5 corridor. There are some interesting geographic, climatic and demographic similarities between Kamloops/Kelowna and this region. Contacts with land managers responsible for implementing air quality management measures in Oregon may be instructive.

Through this work a great deal has been learned about the ozone exposure regimes in the semi-arid interior of southern British Columbia, and how they compare with other sites in western North America. This analysis and the subsequent findings could form the means and basis for initiating pro-active ozone abatement and control strategies. It is recommended that airshed management planning activities be initiated in the southern interior similar to those completed by the Greater Vancouver Regional District. Initially, a detailed emission inventory must be compiled. Following completion of the inventory modeling of the respective airsheds can commence. There is also a need to intensively study airshed dynamics with respect to precursor availability, ozone production, and transport phenomenon.

### **Conclusions and Recommendations**

Prior to conducting this study the main source of insight into ozone regimes in Kelowna and Kamloops was gained by counting the number times a year the Federal 1-hour Level B guideline was exceeded. No hourly exceedances of the 160-ug/m<sup>3</sup> threshold meant no problem with ozone. This guideline was also the main means of comparing from one year to the next, or between widely scattered sites. This simple technique provides a very limited insight into a regions' ozone regime, and does not allow for a proactive approach to managing urban air quality. In contrast, the application of the diurnal-curve space technique has proven to be an extremely insightful exercise. It has provided a new perspective on historic data, and yielded an important insight into the future. Through this study the following can be concluded:

- Ozone regimes in the semi-arid interior of southern British Columbia are very similar to those experienced in the lower Fraser Valley. Kelowna, Kamloops and Surrey all share the same “Urban Small” designation despite some major difference between the interior and coast in terms of climate, geography, population and quantity of ozone precursors.
- Kelowna and Kamloops share a virtually identical ozone exposure regime. They appear to be behaving as expected given their climate, geography, population and quantity of ozone precursors. As these regions grow the ozone exposure regimes can be expected to change accordingly. Interior climate and geography are better suited to ozone production compare to the coastal regions.
- The lower Fraser Valley (Surrey) on the other hand appears to be behaving in a manner inconsistent with the quantity of ozone precursors available. This is due mainly to the prevailing cool, moist climate which prevents the region from producing ozone in line with its potential. The Surrey site only behaves as expected during very warm and stagnant conditions, which occur infrequently.
- Given these findings and present population growth trends it is reasonable to expect that ozone levels in the semi-arid interior of British Columbia will eventually surpass those of the coastal region. Determining exactly when ozone levels of the southern interior surpass those of the lower Fraser Valley requires further research.
- Climate change may exacerbate this situation by increasing the frequency and duration of high amplitude ridges, leading to an increase in the number of days with hot, dry and stagnant conditions. This increase in ozone production potential adds to the pressures wrought by the expected population growth.

Recommendations for future actions fall into two categories: i) emission control measures (actions which reduce ozone precursors), and ii) airshed management planning (actions to develop priorities with future air quality on mind). The emission control measures include:

- A variety of measures to prevent substantial growth on emissions of NO<sub>x</sub>, CO and VOCs. This will likely take the form of an Air Care program, as is in effect in the lower Fraser Valley. Other means of controlling emissions must also be considered, with the most effective (e.g. dollars spent per ton of emission avoided) being implemented first.
- Development of alternatives to the automobile as the prime means of transportation in interior communities. These measures include: travel demand management, public transit, rideshare programs, tele-commuting, increasing core density and co-locating work, shopping and living spaces to reduce the need to commute.

The airshed management planning activities include:

- Developing a means of considering the air quality consequences of regional development as a whole. Such an exercise is usually called an Air Quality Management Plan or an Airshed Management Plan. The Greater Vancouver Regional Districts' Plan is an excellent model for Interior communities to consider. To be effective these plans must be implemented on a airshed (valley-wide) basis, and this often means traversing existing Municipal and Regional District boundaries.
- The assembly of a very finely detailed emission inventory for each airshed. This is of primary importance as it provides a means of discerning significant from insignificant sources, and of evaluating the proposed emission control strategies. A detailed emission inventory is also required to do any computer modeling of the airshed behavior. Another valuable tool in any airshed planning exercise.
- The initiation of a summertime intensive research project to study the spatial and temporal aspects of several ozone episodes in 1999. Conducted over a single ozone season the multi-agency study would discern the spatial distribution of ozone and precursors (NO<sub>x</sub>, VOC). With the meteorological resources available transport phenomenon (lake breeze) could also be resolved.

**For more information on this report, contact the Ministry of Environment, Lands and Parks, Kamloops Branch phone: (250) 371-6200**