Introduction

This is the fourth annual air quality report for the Central Interior Air Zone. Annual air zone reporting is a commitment under the national Air Quality Management System (AQMS). This report describes achievement of the Canadian Ambient Air Quality Standards (CAAQS) for ground-level ozone (O_3) and fine particulates ($PM_{2.5}$), the associated management levels and recent actions to improve air quality. A province-wide summary can be found at: http://www.env.gov.bc.ca/soe/indicators/air/.

Background

The AQMS is the national approach to managing air quality in Canada. Under the AQMS, the CAAQS are developed to drive action to protect human health and the environment. Air zones are areas that exhibit similar air quality characteristics, issues and trends, and that form the basis for monitoring, reporting and taking action on air quality. The Central Interior Air Zone (see Figure 1) is one of seven broad air zones across the province. Under the AQMS, progressively more rigorous actions are expected as air quality approaches or exceeds the CAAQS. The level of action is guided by the Air Zone Management Framework outlined in Table 1.

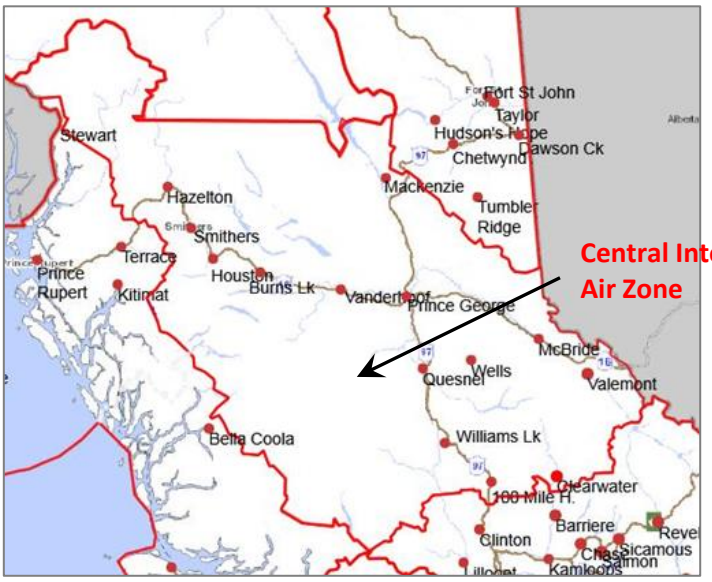

Figure 1. Central Interior Air Zone.

Table 1. Air zone management framework for ground-level ozone and $PM_{2.5}$. The CAAQS define the upper threshold, separating the "red" and "orange" management levels.

Management Level	O_3 (ppb)		$PM_{2.5}$ – Annual ($\mu g/m^3$)		$PM_{2.5}$ - 24h ($\mu g/m^3$)	
	2015	**2020**	**2015**	**2020**	**2015**	**2020**
Red	Actions for Achieving Air Zone CAAQS					
Threshold (CAAQS)	63	62	10	8.8	28	27
Orange	Actions for Preventing CAAQS Exceedance					
Threshold	56		6.4		19	
Yellow	Actions for Preventing Air Quality Deterioration					
Threshold	50		4		10	
Green	Actions for Keeping Clean Areas Clean					

Ozone Levels

Ozone measurements in the Central Interior Air Zone are summarized in Figure 2. Concentrations ranged from 47-53 ppb.[1] All sites achieved the national standard of 63 ppb.

Trends in ozone levels are shown in Figure 3.[2] Ozone concentrations have remained below the level of the national standard throughout this period.

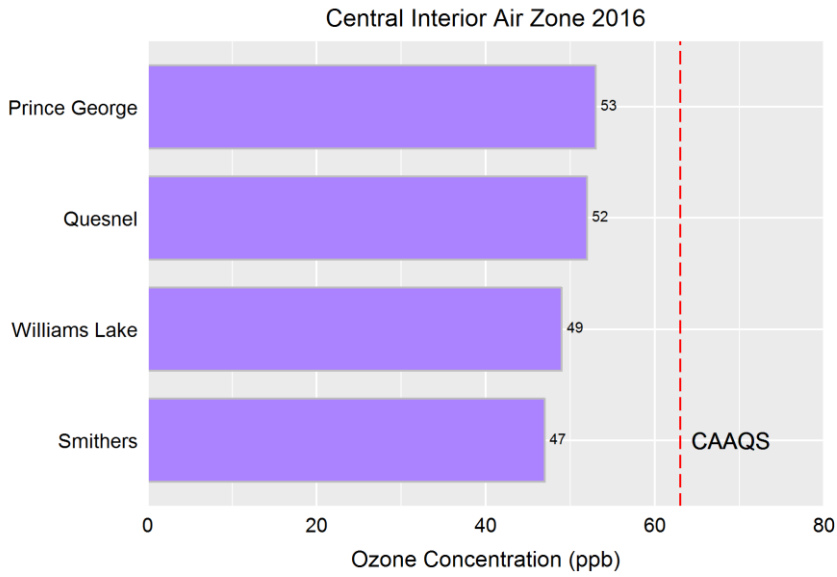

Figure 2. Ozone concentrations in the Central Interior Air Zone, based on annual 4th highest daily 8-hour maxima, averaged over 2014-2016. Red dashed line identifies the CAAQS of 63 ppb.

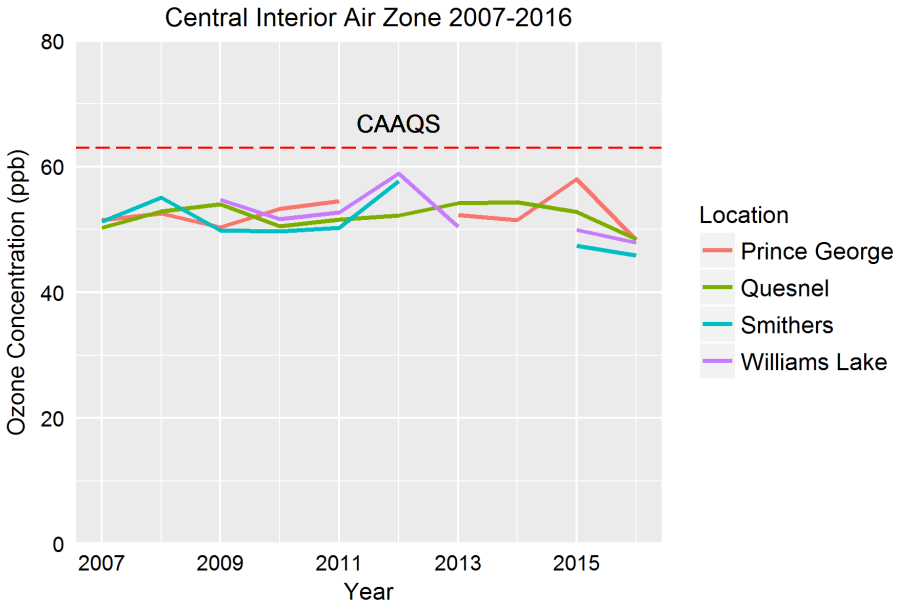

Figure 3. Trends in ozone concentrations (2007-2016), based on annual 4th highest daily 8-hour maxima over a single year. The red dashed line identifies the CAAQS level of 63 ppb.

[1] Concentrations based on 4th highest daily 8-hour maximum, averaged over three years (2014-2016).
[2] Concentrations based on 4th highest daily 8-hour maximum, over a single year.

$PM_{2.5}$ Levels

$PM_{2.5}$ refers to inhalable particles up to 2.5 micrometres in diameter. $PM_{2.5}$ measurements are summarized in Figure 4. All measurements for this reporting period were based on the Federal Equivalent Method (FEM), which provides a more complete measure of $PM_{2.5}$ than the older TEOM instruments.

Daily concentrations (upper plot) ranged from 20 to 32 μg/m^3.[3] Four sites exceeded the national standard of 28 μg/m^3: Vanderhoof, Prince George, Houston and Quesnel. Annual concentrations (lower plot) ranged from 7.2 to 9.8 μg/m^3. All monitoring sites achieved the annual standard of 10 μg/m^3, although Quesnel and Vanderhoof were within 5% of this level.[4]

Trends in annual mean concentrations between 2007 and 2016 are shown for a subset of sites in Figure 5.[5] A shift to higher reported concentrations is seen with the change from TEOM to FEM instruments from about 2010 onward.

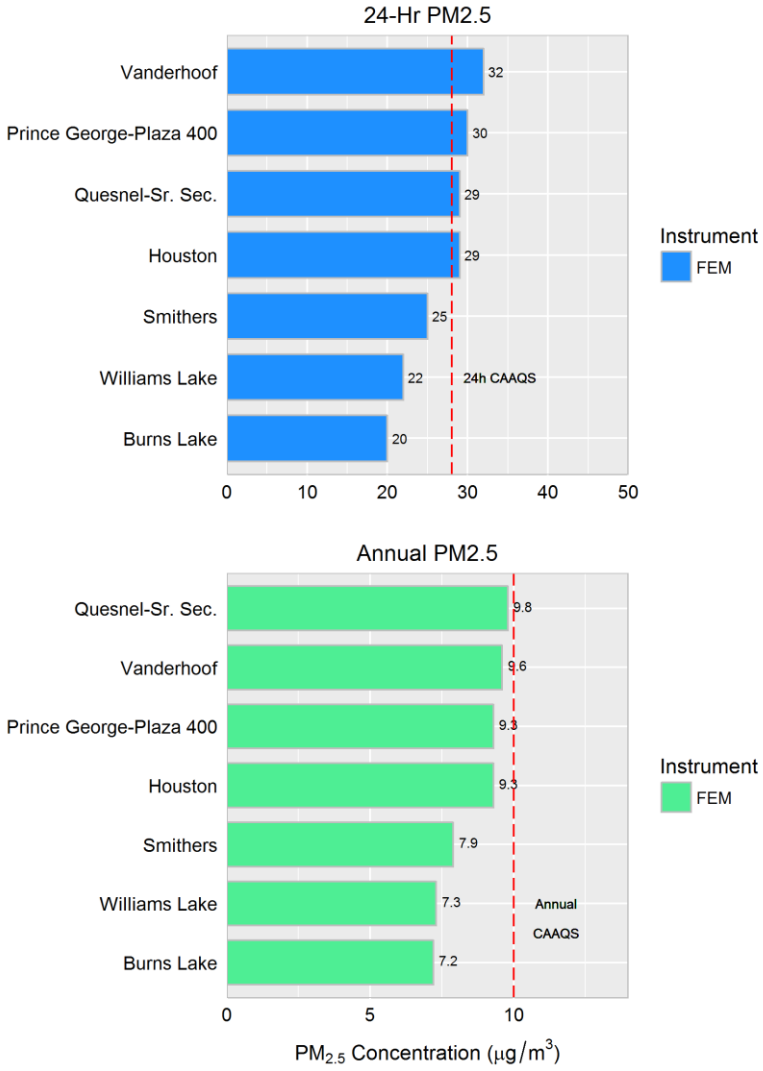

Figure 4. $PM_{2.5}$ concentrations in Central Interior Air Zone. Upper plot based on 24-hour concentration (annual 98th percentile, averaged over 2014-2016). Lower plot based on annual mean concentration (averaged over 2014-2016). The red dashed lines identify CAAQS of 28 μg/m^3 (upper plot) and 10 μg/m^3 (lower plot).

[3] Concentrations based on the annual 98th percentile of the 24-hour value, averaged over three years (2014-2016).
[4] Concentrations based on the annual average of 24-hour values, averaged over three years (2014-2016).
[5] Concentrations based on the annual average of 24-hour values over single year.

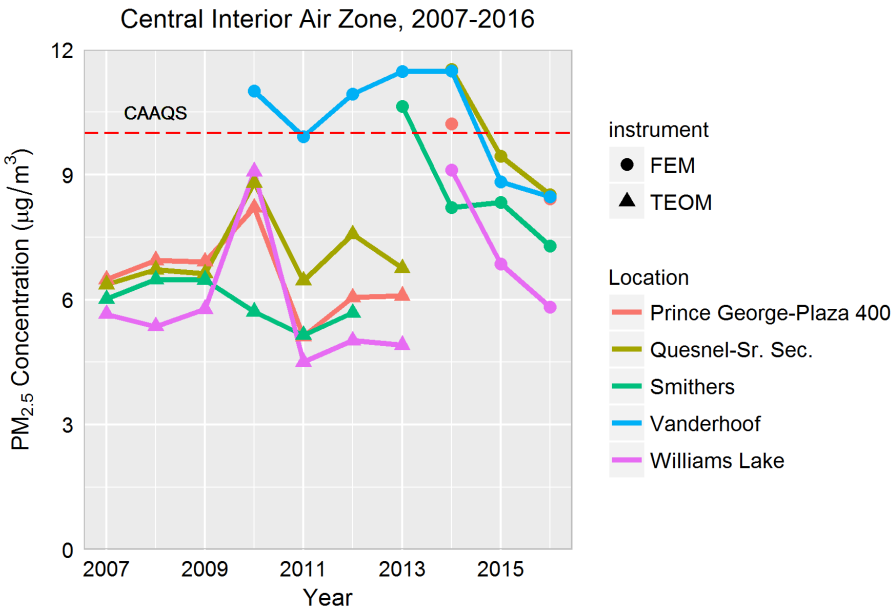

Figure 5. Trends in $PM_{2.5}$ concentrations (2007-2016), based on annual mean concentrations from a single year. The CAAQS value of 10 µg/m^3 is shown by the dashed line. $PM_{2.5}$ measurements prior to 2011 are reported at 25^{o}C and 1 atm. From 2011 onward, measurements are reported at local conditions.

Air Zone Management Levels

Air zone management levels are assigned on the basis of the highest concentrations within an air zone, excluding contributions from transboundary flows (TF) and exceptional events (EE) such as wildfires. This is done so that long-term management strategies are not developed on the basis of events that are beyond local or provincial control.

In the Central Interior Air Zone, wildfires are the primary contributor to TF/EE. The methodology for identifying wildfire-influenced data is provided in Appendix I and excluded data are summarized in Appendix II. For the period of 2014-2016, wildfire influences were primarily restricted to the summer of 2014, when hot, dry conditions led to an above-average number of hectares burned in the province and periods of elevated $PM_{2.5}$ levels.

Table 2 summarizes ozone concentrations as measured and after consideration of any TF/EE influences. No TF/EE influences were identified. Consequently, the Central Interior Air Zone is assigned a “yellow” management level based on concentrations in Prince George and Quesnel. This indicates that any ozone-related actions should focus on preventing further air quality deterioration.

Table 2. Summary of ozone concentrations as measured and air zone management levels for the Central Interior Air Zone (based on 2014-2016 data).

Location	No. Valid Years	4th Highest Daily 8-hour Maxima (ppb)		Air Zone Management Level
		As Measured	TF/EE Influences Removed	
Prince George	3	53	53	Goal: Preventing Further Deterioration
Quesnel	3	52	52	
Smithers	2	47	47	
Williams Lake	2	49	49	

Table 3 summarizes $PM_{2.5}$ concentrations as measured and with TF/EE influences removed for each monitoring site. Overall, the Central Air Zone is assigned a "red" management level based on elevated $PM_{2.5}$ levels in Houston and Vanderhoof. This indicates that $PM_{2.5}$-related actions, particularly in these two communities, should focus on activities to achieve the CAAQS. Although as-measured $PM_{2.5}$ concentrations in Prince George and Quesnel also exceeded the CAAQS level, this was determined to be a result of wildfire influence. For more information on these analyses, see Appendix II.

Table 3. Summary of $PM_{2.5}$ concentrations as measured and air zone management levels for the Central Interior Air Zone (based on 2014-2016 data).

Location	Monitor Type	No. Valid Years	Daily Mean (98th Percentile, µg/m³)		Annual Mean (µg/m³)		Air Zone Management Level
			As Measured	TF/EE Removed	As Measured	TF/EE Removed	
Burns Lake	FEM	3	20	20	7.2	7.2	Goal: Achieving the CAAQS
Houston	FEM	3*	29	29	9.3	9.3	
Prince George-Plaza 400	FEM	2	30	24	9.3	8.8	
Quesnel-Sr. Sec.	FEM	3	29	24	9.8	9.3	
Smithers	FEM	3	25	25	7.9	7.9	
Vanderhoof	FEM	3	32	32	9.6	9.4	
Williams Lake	TEOM/ FEM	3	22	20	7.3	7.0	

* Incomplete year of data in 2014 was included in the calculation of the daily mean value but did not meet data requirements for inclusion in the annual mean.

Actions to Protect Air Quality

The reduction of $PM_{2.5}$ emissions has been a top air quality priority across the Central Interior Air Zone over the past several years. Strategies and actions to reduce $PM_{2.5}$ emissions have been documented in local airshed plans that have been developed and implemented for the Bulkley Valley-Lakes District,[6] Prince George,[7] Quesnel[8,9] and Williams Lake[10].

The Provincial Wood Stove Exchange Program encourages residents to change out their older, smoky wood stoves for low-emission appliances including new CSA-/EPA-certified clean-burning wood stoves. Between 2014 and 2016, wood stove change-out programs were supported in the Bulkley Valley and Prince George. Additional funding support is being provided in 2017.

A description of other activities underway in B.C. air zones can be found in the "Air Zone Management Response for British Columbia" (see: www.gov.bc.ca/bcairquality).

[6] http://www.cleanairplan.ca/cleanairplan2012.pdf
[7] http://www.pgairquality.com/uploads/PGAIR_PhaseIII.pdf
[8] http://www.quesnelairshed.org/wp-content/uploads/2012/09/airshed_management_plan2.pdf
[9] http://www.env.gov.bc.ca/epd/bcairquality/reports/pdfs/airshed_review_2011.pdf
[10] https://breatheasywilliamslake.files.wordpress.com/2015/03/wlairshed_mgt_plan_final.pdf

Appendix I – Approach to Identify Wildfire-influenced Data

Summertime air quality in British Columbia is periodically influenced by wildfire smoke – from local fires as well as long-range transport from outside of the province. The wildfire season in B.C. typically occurs between May and September, when warm and dry conditions prevail.

A myriad of different pollutants are emitted from wildfires, including $PM_{2.5}$ and gases that include nitrogen oxides and volatile organic compounds (VOCs) that can react in the atmosphere to form ground-level ozone and additional $PM_{2.5}$.

Given that smoke-affected areas may be extensive, and that smoke may linger for days before being fully dispersed from an airshed, the current analysis has focussed on those periods when wildfire smoke may have contributed to an exceedance of the CAAQS levels for $PM_{2.5}$ levels. Criteria used to flag and evaluate wildfire-influenced data included the following:

- 24-hour $PM_{2.5}$ concentrations exceeded the CAAQS level of 28 $\mu g/m^3$ or 8-hour daily maximum ozone levels exceeded the CAAQS level of 63 ppb between May and September,
- Wildfires of interest were identified based on data from B.C. Wildfire Management Branch,
- Wildfire smoke advisories had been issued by the Ministry of Environment & Climate Change Strategy during the period of interest,
- MODIS satellite images indicated smoke impacts over the region,
- Multiple monitoring sites in the area of concern exhibited similar air quality characteristics, suggesting a common source or contributing source, and
- Modelling studies identify enhanced pollutant concentrations due to wildfire smoke.

Wildfire-influenced data were excluded from the calculation of air zone management levels. Excluded data are as summarized in Appendix II.

Appendix II – Wildfire-influenced Data in the Central Interior Air Zone (2014-2016)

$PM_{2.5}$ data from 2014-2016 for the Central Interior Air Zone were evaluated based on the criteria set out in Appendix I for TF/EE influences.[11] Wildfire-influenced data are summarized in Table II-1. These data were excluded from the calculation of management levels, and resulted in a change in management levels for the monitoring sites at Prince George Plaza 400 and Quesnel Senior Secondary from "red" to "orange". Supporting evidence included the following:

- Elevated $PM_{2.5}$ concentrations that coincided or overlapped with wildfire smoke advisories issued by the Ministry of Environment & Climate Change Strategy (see Table II-1);
- Coincidently high $PM_{2.5}$ concentrations at multiple sites across a broad area;
- The number of very large wildfires exceeding 20,000 ha in central/northern B.C. that burned for weeks (see Table II-2);
- MODIS satellite images that showed smoke plumes in the vicinity of affected monitoring locations (see Figures II-1 and II-2 for examples).

Table II-1. Wildfire-influenced $PM_{2.5}$ data.

Location	Date	24-Hr $PM_{2.5}$ ($\mu g/m^3$)	Wildfire Smoke-related Air Quality Advisory
Prince George Plaza 400	2014-07-11	39.2	Y
Quesnel Maple Drive	2014-07-11	32.5	
Quesnel West Correlieu School	2014-07-11	28.1	
Prince George Gladstone School	2014-07-15	86.7	Y
Prince George Plaza 400	2014-07-15	79.8	Y
Quesnel Maple Drive	2014-07-15	39.9	Y
Quesnel Senior Secondary	2014-07-15	36.5	Y
Quesnel West Correlieu School	2014-07-15	53.5	Y
Williams Lake Columneetza School	2014-07-15	36	Y
Quesnel Maple Drive	2014-07-16	67.7	Y
Quesnel Senior Secondary	2014-07-16	66.9	Y
Quesnel West Correlieu School	2014-07-16	90.3	Y
Williams Lake Columneetza School	2014-07-16	79.3	Y
Quesnel Maple Drive	2014-07-17	101.4	Y
Quesnel Senior Secondary	2014-07-17	105.8	Y
Quesnel West Correlieu School	2014-07-17	121	Y
Williams Lake Columneetza School	2014-07-17	59.9	Y
Quesnel Senior Secondary	2014-07-18	57.7	Y
Quesnel West Correlieu School	2014-07-18	75.2	Y
Williams Lake Columneetza School	2014-07-18	42.8	Y

[11] Wildfire influences on ozone concentrations were not assessed given that as-measured concentrations were well below the CAAQS.

Table II-1 (continued)

Location	Date	24-Hr $PM_{2.5}$ ($\mu g/m^3$)	Wildfire Smoke-related Air Quality Advisory?
Prince George Gladstone School	2014-08-03	41.6	Y
Prince George Plaza 400	2014-08-03	52.1	Y
Quesnel Maple Drive	2014-08-03	56.5	Y
Quesnel Senior Secondary	2014-08-03	45.3	Y
Vanderhoof Courthouse	2014-08-03	28.3	
Prince George Gladstone School	2014-08-04	39.4	Y
Prince George Plaza 400	2014-08-04	47.6	Y
Quesnel Maple Drive	2014-08-04	44	Y
Quesnel Senior Secondary	2014-08-04	37.2	Y
Vanderhoof Courthouse	2014-08-04	68.7	
Prince George Plaza 400	2014-08-05	29.6	Y
Quesnel Maple Drive	2014-08-05	42.8	Y
Quesnel Senior Secondary	2014-08-05	43.2	Y
Vanderhoof Courthouse	2014-08-05	37	
Quesnel Maple Drive	2014-08-06	40.4	Y
Quesnel Senior Secondary	2014-08-06	41.7	Y
Williams Lake Columneetza School	2014-08-06	42.6	Y
Prince George Gladstone School	2014-08-12	31.1	Y
Prince George Plaza 400	2014-08-12	50.5	Y
Prince George Plaza 400	2014-08-13	34.1	Y
Quesnel Senior Secondary	2014-08-13	29.1	Y
Prince George Plaza 400	2014-08-15	38.2	Y
Quesnel Senior Secondary	2014-08-15	35.1	Y
Vanderhoof Courthouse	2014-08-15	45	Y
Quesnel Maple Drive	2014-08-16	40.6	Y
Quesnel Senior Secondary	2014-08-16	34.5	Y
Quesnel Maple Drive	2014-08-17	39.1	Y
Quesnel Senior Secondary	2014-08-17	52.1	Y
Williams Lake Columneetza School	2014-08-17	29.6	Y
Prince George Gladstone School	2014-08-18	40	Y
Prince George Plaza 400	2014-08-18	43.6	Y
Quesnel Maple Drive	2014-08-18	39	Y
Quesnel Senior Secondary	2014-08-18	43.3	Y
Vanderhoof Courthouse	2014-08-18	34.6	y
Prince George Plaza 400	2014-08-25	33.2	
Vanderhoof Courthouse	2015-05-13	28.6	
Vanderhoof Courthouse	2015-05-15	31.7	
Quesnel Senior Secondary	2015-05-17	34	
Williams Lake Columneetza School	2015-07-11	39.9	

Table II-2. Summary of notable wildfires in central/northern B.C. between 2014 and 2016.[12]

Discovered	Size (ha)	Geographic Location	Description
01 Jun 2014	33,068	Forres Mountain	50 km NW of Williston Lake
08 Jul 2014	61,285	Tenakihi - Mesilinka	50 km west of Williston Lake
N/A	21,518	Euchiniko Lakes	120 km west of Quesnel
08 Jul 2014	133,100	Chelaslie River	7 km south of Chelaslie River, including sections of Entiako Provincial Park
NULL	26,281	Mount McAllister	56 km west of Chetwynd
09 May 2015	25,569	Little Bobtail Lake	70 km southwest of Prince George
08 Jul 2015	8,078	Puntzi Lake	~180 km west of Williams Lake

No smoke-related advisories were available for periods of elevated $PM_{2.5}$ observed in Quesnel and Vanderhoof from May 13-17, 2015, and in Williams Lake on July 11, 2015. However, major wildfires were burning in the air zone during these periods and likely influenced $PM_{2.5}$ levels. These included the Little Bobtail Lake and Puntzi Lake wildfires.

Figure II-1. MODIS image over B.C. on July 16, 2014. (Source: NASA GSFC).

[12] http://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-statistics/wildfire-season-summary).

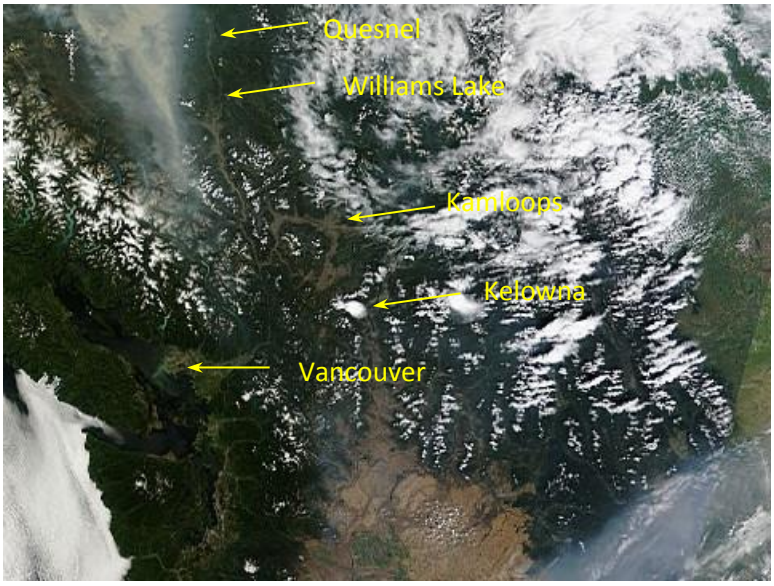

Figure II-2. MODIS image over B.C. on Aug. 4, 2014. (Source: NASA GSFC).