Briefing for Policy Practitioners

Improving Air Quality Monitoring for Future Wildfire Smoke Events

Wildfires and associated smoke episodes are the leading cause for poor air quality during wildfire season (March to October) in Alberta.

As wildfire pollutants can quickly degrade air quality over large areas, affecting local communities and the province at large, a responsive air quality monitoring program is in place to monitor, evaluate and report, including near real-time, on air quality during wildfire events. To continuously improve Alberta's air monitoring program, successes and recommendations from the 2016 Horse River Wildfire air monitoring efforts are presented in this briefing.

Highlights

- Smoke from the Horse River Wildfire had the largest impact on air quality in Fort McMurray in May 2016, with higher pollutant concentrations observed within the wildfire boundary compared to downwind areas.
- The mobile monitoring platforms that were deployed during the Horse River Wildfire are suitable for emergency response monitoring during wildfires.
- Recommendations for improvement:
  1) Displaying near real-time data from mobile platforms publicly
  2) Assessing existing monitoring network for gaps to detect smoke
  3) Minimizing the relocation of mobile monitoring platforms
  4) Comparing data from Beta-attenuation Particulate Monitors (EBAMs) with continuous monitoring stations to support future data interpretation.

Wildfire trends in Alberta

The area burned due to wildfires in Alberta and British Columbia has been increasing since 1990, and nearly doubled in 2017 and 2018 compared to 2015 and 2016[1] due to back-to-back record-breaking fire seasons in British Columbia. Large fires in Alberta, such as the 2016 Horse River Wildfire (~590,000 hectares) and the 2011 Richardson Backcountry Fire (~577,000 hectares), also contributed to this trend. The annual burn area is predicted to further increase, particularly across north-eastern Alberta[2].

2016 Horse River Wildfire

One of the largest recorded wildfires in Alberta, the Horse River Wildfire, burned an area of ~590,000 hectares across northern Alberta and Saskatchewan. The fire started on May 1st and was declared under control on July 4th. The wildfire entered Fort McMurray and burned in close proximity to several Indigenous communities and major oil sands mining operations, resulting in the largest wildfire evacuation in Alberta's history of roughly 80,000 people. The fire also led to the loss of 2,400 structures and was the costliest disaster in Canadian history with a total $3.6 billion (CAD) of insured losses. Smoke from the fire significantly degraded air quality in Fort McMurray and surrounding areas. To inform health and safety decisions for emergency response personnel and the public,

[1] For information on trend analysis using annual fire data from Alberta Agriculture & Forestry and National Forestry Database for 1990-2017, refer to the factsheet on wildfire smoke.

[2] Boulanger et al. (2014). A refinement of models projecting future Canadian fire regimes using homogeneous fire regime zones. Canadian Journal of Forest Research, 44(4), 365–376.

Alberta

Alberta Environment and Parks (AEP) worked together with the Wood Buffalo Environmental Association (WBEA) to monitor air quality during the fire.

How was air quality measured?

The close proximity of the 2016 Horse River Wildfire to existing permanent air monitoring stations (Appendix 1) was a rare circumstance that resulted in the collection of air quality data for the duration of the fire. Additionally, AEP and WBEA deployed mobile monitoring platforms to Fort McMurray and surrounding areas to provide air quality information for areas without existing monitoring stations, including four Beta-attenuation Particulate Monitors (EBAMs, Figure 1) and one Mobile Air Monitoring Laboratory (MAML, Figure 2). EBAMs measure fine particulate matter continuously and can be deployed quickly to multiple locations. The MAML provides data on supplementary air parameters, such as carbon monoxide and ammonia, in addition to fine particulate matter, but requires more time to be deployed.

Figure 1. Beta-attenuation Particulate Monitors (EBAM). Source: Marty Collins

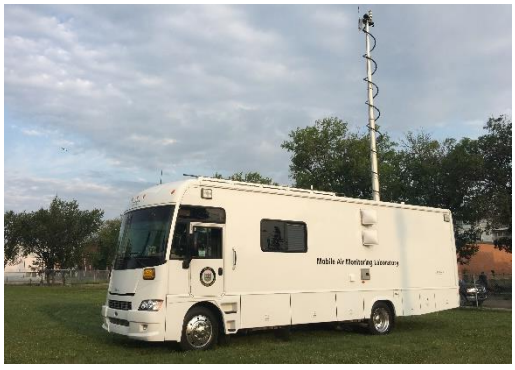

Figure 2. Mobile Air Monitoring Laboratory (MAML). Source: Shane Taylor

What do monitoring results show?

Both permanent and mobile monitoring stations observed the largest air quality impact from wildfire smoke in May 2016 at locations within the Horse River Wildfire boundary (Appendix 1), including Fort McMurray. Wildfire smoke dispersed as the fire moved eastward, and pollutant concentrations in June, July and August of 2016 were similar to non-wildfire impacted periods (April to August in 2013-2015 and 2017). Table 1 summarizes exceedances of Alberta Ambient Air Quality Objectives (AAAQOs) for five air parameters commonly emitted during wildfires that are of concern to human health and that were measured by permanent and mobile stations.

Table 1 Exceedances of Alberta Ambient Air Quality Objectives (AAAQOs). Red indicates high number of exceedances of longer duration, yellow indicates elevated concentration levels or short-term exceedances and green indicates no exceedances.

Air parameter	Key findings from permanent monitoring stations	Key findings from mobile monitoring stations
Fine particulate matter ($PM_{2.5}$)	All six permanent stations measured 24 hour AAAQO exceedances of fine particulate matter. The largest number of exceedances were recorded at the two stations within Fort McMurray, Athabasca Valley and Patricia McInnes, with 18 and 17 days of exceedances. This finding is similar to the 20 days of AAAQO exceedances observed at the nearby community of Fort McKay during the 2011 Richardson Wildland Fire.	The MAML and EBAMs also measured elevated fine particulate matter concentrations during the wildfire and exceedances of AAAQOs.

Air parameter	Key findings from permanent monitoring stations	Key findings from mobile monitoring stations
Carbon Monoxide (CO)	A total of 13 episodes of 1-hour carbon monoxide concentrations exceeding the AAAQOs were recorded in Fort McMurray in May 2016.	The MAML measured higher carbon monoxide concentrations in mid-May, while no AAAQO exceedances were observed by the MAML.
Nitrogen Dioxide (NO_2)	Only one AAAQO exceedance was observed for nitrogen dioxide on May 5th, 2016, when the fire was in close proximity to the Anzac station.	The MAML did not record exceedances of the AAAQO for nitrogen dioxide.
Ammonia (NH_3)	Elevated ammonia concentrations were detected at stations within the wildfire boundary, including in Fort McMurray and Fort McKay, compared to downwind locations, without exceedances of hourly AAAQOs.	The MAML recorded elevated NH_3 concentrations in Fort McMurray and Fort McKay in May 2016 but no exceedances of 1-hour AAAQO concentrations were recorded.
Sulphur Dioxide (SO_2)	Sulphur dioxide levels were not strongly affected and no AAAQOs exceedances were recorded at the permanent monitoring stations – a finding similar to the 2011 Richardson Wildland Fire observations.	The MAML did not record exceedances of the AAAQO for sulphur dioxide.

Steps to improve air monitoring and reporting during wildfire events

Data from permanent and mobile air monitoring platforms informed health and safety decisions for emergency response personnel and the public re-entry to Fort McMurray and surrounding areas. Learnings, limitations and recommendations based on data evaluation and stakeholder conversations are outlined below.

Improving air quality data reporting

Hourly, near real-time data from mobile air monitoring platforms were only available to limited government personnel, while daily summaries of the data were posted publicly. As air quality during the wildfire changed rapidly in the course of a day, the daily data summaries were often out-of-date by the time data was released. Therefore, it is proposed to publicly share near real-time data from mobile monitoring platforms, similar to the public posting of near real-time data from permanent stations at http://airquality.alberta.ca/map. This would enable the public and external organizations to access time-sensitive data, for example, to inform Environment and Climate Change Canada's Wildfire Smoke Prediction System.

Optimizing usage of mobile air monitoring platforms

Beta-attenuation Particulate Monitors (EBAMs): EBAMs can be transported and deployed rapidly at multiple locations and therefore are suitable tools for emergency monitoring. During the 2016 wildfire, EBAMs were relocated several times due to security reasons, which could be limited during future wildfire events through upfront assessment of the suitability of sites. One limitation of using EBAMs is that they use different analyzers

than traditional air monitoring stations[3], and therefore the data is not directly comparable. AEP is leading a study to quantify differences between data collected by EBAMs and traditional air monitoring stations to support future interpretation of data from EBAMs.

Mobile Air Monitoring Laboratory (MAML): The MAML supported the emergency response by providing data on multiple air parameters. The MAML was moved to multiple locations to measure spatial variation of air quality, however, rapidly changing conditions did not allow for the assessment of spatial variation. It is recommended to locate the MAML in a single location that lacks current monitors, throughout the duration of a wildfire.

Filling gaps in Alberta's existing air monitoring network

Due to logistical issues, mobile monitoring equipment was not deployed until several days after the evacuation of Fort McMurray on May 3rd. This delay was not critical, however, since numerous permanent air monitoring stations collected data continuously in the affected areas, including Fort McMurray, several Indigenous communities and oil sands industry. By contrast, many smaller communities impacted by wildfires have insufficient or no existing air quality monitoring instruments in place. It is therefore proposed to assess Alberta's air monitoring network for its ability to detect and characterize wildfire smoke, with a focus on identification of gaps in wildfire smoke monitoring in (1) smaller communities possibly affected directly by wildfires, and (2) regional monitoring across the province. AEP will publish identified gaps and opportunities to address these gaps as part of the Five-Year Air Quality and Deposition Monitoring Plan in 2020.

More information

Tam, N. and Adams, C. 2019. Characterization of Air Quality During the 2016 Horse River Wildfire using Permanent and Portable Monitoring. Ministry of Environment and Parks. ISBN: 978-1-4601-4477-0. Available at: open.alberta.ca/publications/9781460144770.

Interested in key facts on Alberta's wildfire trends, monitoring and smoke forecasting? See the summary Fact Sheet.

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Landis, M. S., Edgerton, E. S., White, E. M., Wentowrth, G. R., Sullivan, A. P., Dillner, A. M. 2018. The impact of the 2016 Fort McMurray Horse River Wildfire on ambient air pollution levels in the Athabasca Oil Sands Region, Alberta, Canada. Science of the Total Environment, 618, 1665–1676.

Wentworth, G. R., Aklilu, Y., Landis, M. S., and Hsu Y-M. 2018. Impacts of a large boreal wildfire on ground level atmospheric concentrations of PAHs, VOCs and ozone. Atmospheric Environment, 178, 19–30.

Government of Alberta. 2017. Horse River Wildfire May 2016 - Updated Preliminary Air Quality Assessment.

Government of Alberta geospatial wildfire data is available at: https://wildfire.alberta.ca/resources/historical-data/spatial-wildfire-data.aspx

[3] Alberta's permanent air monitoring stations and the Mobile Air Monitoring Laboratory (MAML) use designated Federal Reference Method (FRM) monitors used for regulatory reporting, whereas the mobile Beta-attenuation Particulate Monitors (EBAMs) are not FRM-designated.

Appendix 1. Location of the Horse River Wildfire and monitoring sites