



WIND ANALYSIS FOR THE 2024 SPRING WILDFIRE EVENT: POTENTIAL UTILIZATION OF RPAS DURING EXTREME EVENTS

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Alberta experienced intense and rapid burning in the spring of 2023. Use of remotely piloted aircraft systems (RPAS) can be helpful for situational awareness, hot spotting, and other operational tasks during these periods. However, the use of RPAS may be limited during such events due to the characteristically high wind speeds often associated with extreme fire behaviour. RPAS typically cannot fly in the same wind speeds as conventional aircraft, therefore an analysis of how often commonly available RPAS can be utilized in extreme wildfire events is beneficial for future decision-making and vendor RPAS development.

Types of RPAS

Micro Consumer (<250 g)

These RPAS do not require pilot certification to fly in Canada and are commonly available for a low price. The early versions of the DJI Mini had lower maximum wind resistance, but the newer versions can handle higher maximum wind speeds. The DJI Mini 3 Pro and 4 Pro can fly in gusts up to approximately 38.5 km/h. The RPAS could potentially fly in wind speeds higher than the specification at the risk of loss or damage to the aircraft.

The micro RPAS listed above cannot complete any mapping/programmed missions currently, as DJI has not released the appropriate code for third-party app developers. Furthermore, the current models only

have RGB cameras. Other manufacturers may have models that can be used for programmed missions.

Small Consumer (250 g – 25 kg)

The majority of RPAS sold to consumers and industry fall within this weight category and it includes popular models such as the DJI Phantom 4, DJI Mavic 3 series, DJI M30 series, and DJI M300/M350.

The newer DJI models such as the M350, M30, and Mavic 3 series of RPAS all have a manufacturer reported wind resistance of 43 km/h. The older M300 is reported to have a wind resistance of 54 km/h with a max flight speed in sport mode of 83 km/h. Max wind resistance is the wind speed the RPAS can remain stationary while hovering. The DJI M300 will start issuing high-speed wind warnings to its pilot when it detects wind speeds above 36 km/h. If the wind speeds exceed the wind resistance of the RPAS then it may not be able to fly programmed missions accurately or return to the launch location, in extreme cases it may cause the pilot to lose control of the RPAS.

Large Industrial (>25 kg)

Larger RPAS such as the Textron Systems Aerosonde Mk. 4.8 fixed-wing and the Insitu ScanEagle have cruising speeds of approximately 50 to 60 knots (92 – 111 km/h) and max takeoff weights above 25 kg. Neither of them lists maximum wind speeds for flight, however the ScanEagle specifies a maximum horizontal speed of 80 knots (148 km/h). The max wind resistance would likely depend on the stall speed and max

horizontal speed of the aircraft. Due to the efficiency of fixed-wing aircraft and the size of these RPAS, they likely have higher wind resistance than those mentioned in the micro and small consumer categories.

The fixed-wing platforms need to be larger to carry the same payloads as the multi-rotor RPAS, but they often have much longer flight times and can travel further distances per flight.

Wind Speeds between April 24, 2023, and June 11, 2023

The main limiting weather conditions that can influence RPAS operations are temperature, precipitation, and wind. High temperature can be a concern as some RPAS such as the DJI Mini 3 Pro have maximum operating temperatures of 40 °C. This is not usually a concern in Alberta even during extreme wildfire events because it could only occur during the hottest part of the day. Precipitation is not usually a concern during extreme wildfire events either as lack of rain is a primary cause of the extreme wildfire behaviour. Therefore, the primary concern for the deployment of RPAS during operations is wind.

The forest protection area is the area of the province where Alberta Wildfire conducts its operations and it is divided into 10 forest areas. The maximum wind speed recorded by Alberta Wildfire weather stations between April 24 and June 11 for each forest area can be seen below in Table 1. The dates were chosen based on the start and end of the extreme wildfire activity experienced in the spring of 2023. The constant wind and wind gusts were combined so that if the hourly data recorded gusts, then that value was used instead of the constant wind speed value. Therefore, it is likely that these values are somewhat conservative for how often RPAS could have been utilized, as a micro or small consumer RPAS may be able to cope with occasional gusts at or near its maximum wind resistance better than constant winds at that speed.

Table 1. Average and Maximum wind speeds by forest area from April 24 to June 11.

Area	Avg. (km/h)	Max. (km/h)
Calgary	11	86
Edson	12	82
Fort McMurray	14	74
Grande Prairie	13	77
High Level	13	59
Lac La Biche	12	71
Peace River	11	61
Rocky Mountain House	9	62
Slave Lake	12	83
Whitecourt	13	69

Calgary, Slave Lake, and Edson had the highest recorded wind speeds at 86, 83, and 82 km/h respectively. However, their averages are much lower than the maximum wind speeds recorded, indicating a significant portion of time when the wind speeds would have been manageable for most RPAS. The afternoons between 12:00 and 16:00 had the highest wind speeds, followed by the late afternoon/early evening between 16:00 and 20:00 (Figure 1). All RPAS that could be used for operations could have flown most of the time between 20:00 and 08:00 for all forest areas. Over 90% of hours in all forest areas had wind speeds below 30 km/h. However, Fort McMurray had a large percentage of wind speeds above 30 km/h at just under 30% between 12:00 and 16:00. On the other hand, Peace River and Rocky Mountain House had wind speeds above 30 km/h equal to or less than 10% of the day. A wind speed threshold of 30 km/h was chosen, as this is the wind speed that most consumer grade RPAS can still fly and it provides a buffer for increases in wind speeds that may be experienced at altitude.

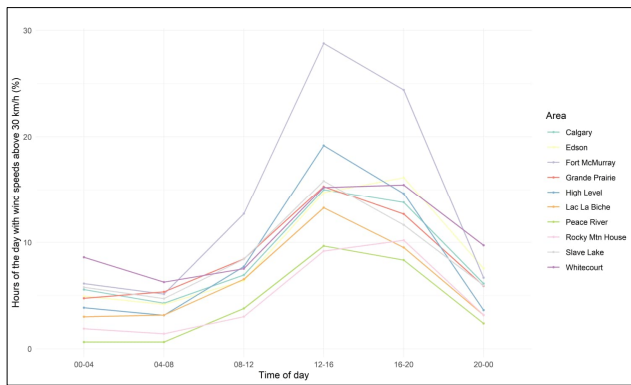


Figure 1. Percent of hours for each four-hour period of the day with wind speeds above 30 km/h between April 24 and June 11 per forest area. This figure is high resolution and can be zoomed for more detail.

The percentage of hours with recorded wind speeds above 30 km/h was also analyzed per week and time of day for each forest area (Figure 2). Similar to the percentage of hours for the entire period of concern, the Fort McMurray area had the highest percentage of hours with wind speeds above 30 km/h. However, even weeks 17 and 18, which had the highest percentage of hours with wind speeds above 30 km/h across all forest areas, had reduced wind speeds during the same periods observed previously. Weeks 17 and 18 exhibited a large reduction in wind speeds during the time between 20:00 and 08:00. Week 18 had slightly more hours with wind speeds above 30 km/h than week 17 in all forest areas with the lowest percentage of hours observed in the Calgary forest area. RPAS could have been utilized during most of the nighttime hours (20:00 to 08:00) and less during the daytime hours (08:00 to 20:00). However, even the daytime periods in Fort McMurray, which had the highest percentage of wind speeds above 30 km/h, did not get above 50%.

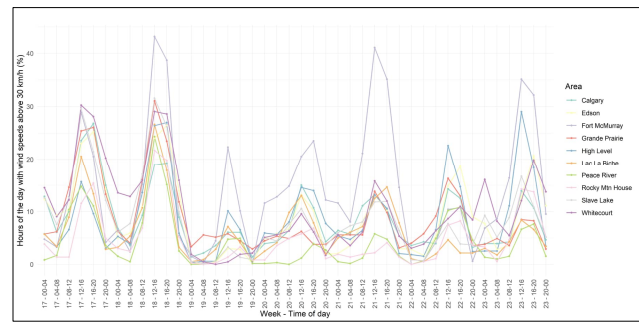


Figure 2. Percent of hours by week and four-hour period of the day with wind speeds above 30 km/h between April 24 and June 11 per forest area. This figure is high definition and can be zoomed for more detail.

To determine if there were any particular stations where wind speeds were not conducive to RPAS flights for a majority of the day, stations were plotted individually per day when they recorded wind speeds over 40 km/h for over 50% of the daily hours (Figure 3). The threshold increase from 30 km/h to 40 km/h was chosen since this is the wind speed where a majority of consumer grade RPAS can no longer fly. The Beaverlodge Cs and Marten Mountain Auto stations had the most days above these thresholds with 18 and 9 respectively, all other stations had below 4 days. Fifty-two percent of stations that met the thresholds only had 1 day (2% of the 48 days between April 24 and June 11) where micro and small consumer RPAS likely could not have been deployed for most of the day (Table 2). Micro and small consumer RPAS likely could not have been deployed for the majority of 38% and 19% of the days in the areas surrounding the Beaverlodge Cs and Marten Mountain Auto stations respectively, between April 24 and June 11.

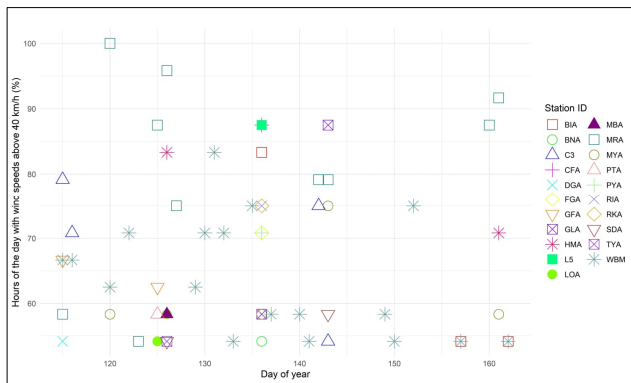


Figure 3. Alberta Wildfire weather stations with over 50% of the daily hourly wind speeds above 40 km/h between April 24 and June 11. This figure is high definition and can be zoomed for more detail.

Table 2. Full-weather station names and number of days with over 50% of the hourly wind speeds above 40 km/h for weather stations found in Figure 3.

Station ID	Station name	Number of days
BIA	Birch Mountain Auto	3
BNA	Buckton Auto	1
C3	Poll Haven Auto	4
CFA	Cambrian Auto	1
DGA	Doig Auto	1
FGA	Foggy Mountain Auto	1
GFA	Grave Flats Auto	2
GLA	Gordon Lake Auto	2
HMA	House Mountain Auto	2
L5	Keane Auto	1
LOA	Lovett Auto	2
MBA	Mayberne Auto	1
MRA	Marten Mountain Auto	9
MYA	May Raws	4
PTA	Pinto Env Auto	1
PYA	Fort Chipewyan Auto	1
RIA	Richardson Auto	1
RKA	Rock Island Lake Auto	1
SDA	Swan Dive Auto	2
TYA	Tony Auto	1
WBM	Beaverlodge Cs	18

Stations that met the 50% and 40 km/h thresholds were clustered in the north-east, and central areas of the province (Figure 4). The Beaverlodge Cs station is located west of Grande Prairie and the Marten Mountain Auto station is located just east of Lesser Slave Lake.

Much of the extreme wildfire activity in the spring of 2023 occurred in the central region of the province. Furthermore, most of the weather stations with days when micro and small consumer RPAS could not have been utilized for most of the hours were located away from the areas where the main fires were burning, south of Edson and south-west of Lesser Slave Lake. Therefore, it is likely that micro and small consumer RPAS could have been well utilized on these fires especially between the hours of 20:00 and 08:00 when there were lower wind speeds.

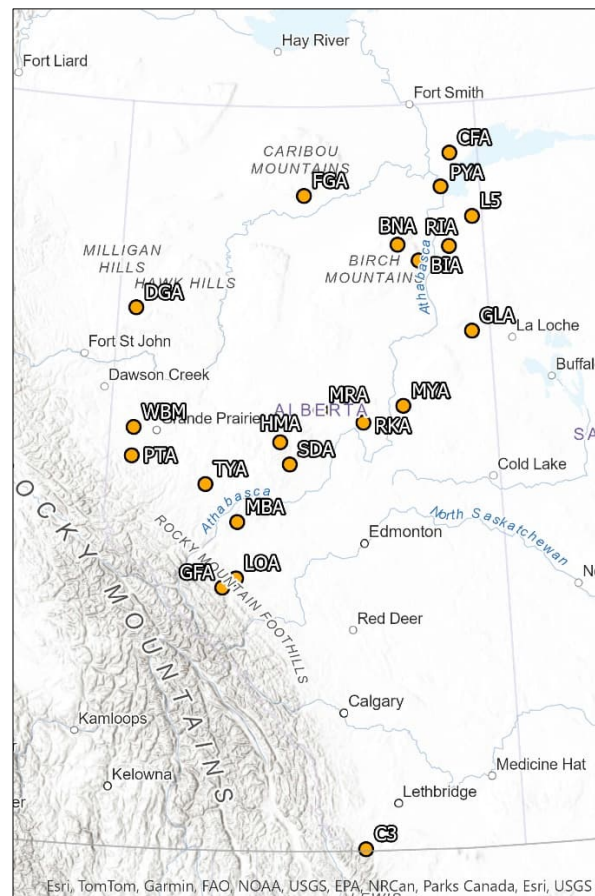


Figure 4. Weather station locations for stations that had days where over 50% of the hourly wind speeds were above 40 km/h.

Conclusion

RPAS offer an economical means of collecting more intelligence information and assisting in wildfire operations, such as hot spotting and collection of wildfire burning intensity imagery. The currently available micro and small consumer grade RPAS can reliably fly in wind speeds below 30 km/h to 35 km/h (depending on the model) and as seen in the analysis, could be utilized for a majority of the hours on fires in Alberta. The analysis was exclusively based on the wind speeds recorded between April 24 and June 11, 2023, but should be indicative of general trends in other years and periods of the wildfire season.

Between wind speeds of 30 km/h and 40 km/h many of the smaller RPAS cannot continue to fly safely. DJIs

industry targeted RPAS, such as the M300 and M30 series can continue to fly in wind speeds up to 54 km/h and 43 km/h respectively, can be utilized in a wider range of situations. If the large industrial RPAS (maximum wind speeds not stated by the manufacturer) or any RPAS can fly in gusts above 86 km/h, they could have been fully utilized during the spring of 2023.

This InfoNote serves to inform wildfire practitioners where and when they can best utilize RPAS in operations. Vendors can utilize this information to guide future development of aircraft and ensure they will be able to fly in most weather conditions present during extreme wildfire events.

For more information

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