



Wildfires from Space: the end of MODIS Fire Data

An update on the status of the MODIS and WildFireSat missions

INTRODUCTION

Most decision making for wildland fire management starts with collecting the necessary fire intelligence needed to inform the decisions crucial for safe and effective field operations. Use of satellite-based Earth observation (EO) fire data in Canada for fire management has been established for decades and as is often complementary to other sources of fire intelligence (e.g., aircraft flights, field observations). While some fire management agencies rely heavily on EO fire data, to many, EO data are used to supplement rather than replace traditional methods.

Due to its northerly location, Canada does not fully benefit from geostationary satellite systems (e.g., GOES) that are used to monitor fires in temperate and tropical latitudes. Operational implementation of EO fire data has lagged and there is room to enhance its uptake by Canadian fire management agencies (McFayden et al. 2023).

The purpose of this report is to update fire management agencies on the status of MODIS data from NASA's Terra and Aqua missions and the upcoming CSA WildFireSat mission.

END OF THE MODIS MISSION

An instrument that is well known to fire managers in Canada, and in some cases is synonymous with all fire EO products — MODIS — is nearing end of life. During this end of life, the nature of the MODIS active fire observations is changing, and the satellites carrying these instruments will be 'switched off' soon. **We highly recommend that all users of MODIS active fire products (1) consider the impact of these changes in their specific use cases, and (2) transition to using other sources of active fire data within their workflows and operational systems as soon as possible.**

Data from NASA's MODIS instruments have been a resounding success, and critical to establishing the widespread and routine use of EO active fire data both for research and fire management purposes. The MODIS instrument has flown onboard both of NASA's polar orbiting satellites, Aqua and Terra, since the early 2000s, and typically provides four or more observations per day; Terra MODIS provides data in the late morning and evening (~10:30 & 22:30 mean local overpass time (MLT) at the equator), while Aqua provides data in the early afternoon and early morning (~13:30 & 01:30 MLT at the equator). Because of MODIS's wide field of view, at high

latitudes (e.g., northern Canada) many more than four MODIS observations are often available per day, and at a range of local times.

Despite its widespread integration into operational fire management tools, MODIS is not part of an 'operational' meteorological satellite programme (i.e., there are no plans for direct replacements of MODIS). Both Aqua and Terra are approaching their end of life, and, NASA is conducting a review of continued mission operations (Tsaoussi, 2022a; 2022b); in the best-case scenario, both satellites will cease to operate in 2026, although a sooner end is probable.

Aqua and Terra are running out of fuel and the manoeuvres to control the satellites' orbits and maintain strict fixed MLTs are no longer carried out. The satellites have started to drift in their orbits resulting in an earlier MLT for Terra and a later MLT for Aqua (see Figure 1). This drift in overpass times will get worse over time. Assuming that mission lifetimes are extended, Terra's MLT will be approximately 09:05 (and 21:05) and Aqua's MLT will be approximately 15:20 (and 03:20) by January 2026 (NASA 2022a; 2022b). Fire behaviour changes dramatically throughout the course of a day and the MODIS fire observations are becoming increasingly less comparable with past observations. Changes in the time that MODIS observes the Earth may influence the ability to generate active fire and burned area data products with comparable quality to the long-term data record. We expect this to have considerable implications for users of the MODIS active fire products who rely upon it for decision making in wildland fire management.

FILLING THE VOID LEFT BY MODIS

Several satellite EO systems offer opportunities for active fire monitoring in Canada (Frontline Express 93). Of these, the SLSTR and VIIRS instruments are the closest 'spiritual successors' to Terra and Aqua-MODIS and will provide similar or improved quality data. These instruments are also both part of long term, operational satellite missions and they should prove to be a reliable source of active fire information until at least the late 2030s. Data from other instruments, such as Sentinel-2 MSI, are also being exploited by Canadian fire management agencies (e.g. the BC Wildfire Service) using in-house data processing. VIIRS hotspot data have been openly accessible through NASA's Fire Information for Resource

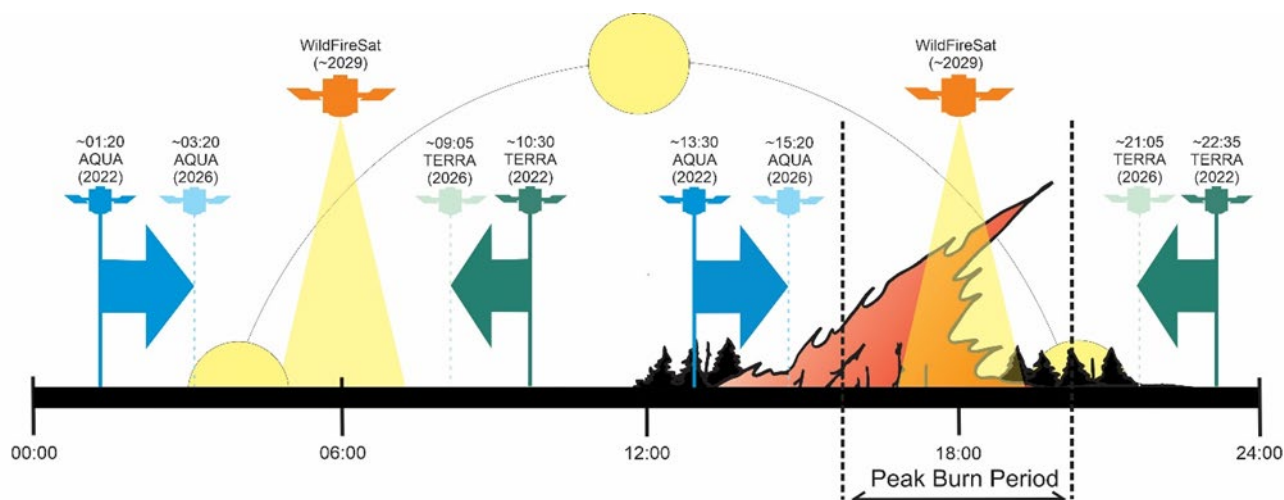


Figure 1. The effect of MODIS orbital drift on active fire monitoring. The mean local overpass time of Terra and Aqua is changing. If NASA extends their lifetime to 2026, Terra observations will be collected ~1.5 hours earlier, and Aqua observations ~2 hours later, than historic observations.

Management System (FIRMS) for several years, and similar products for **SLSTR should be available via FIRMS around 2024**. We highly recommend that all users of MODIS active fire products consider the impact of these changes in their specific use cases, and transition to using other sources of active fire data as soon as possible (see Figure 2).

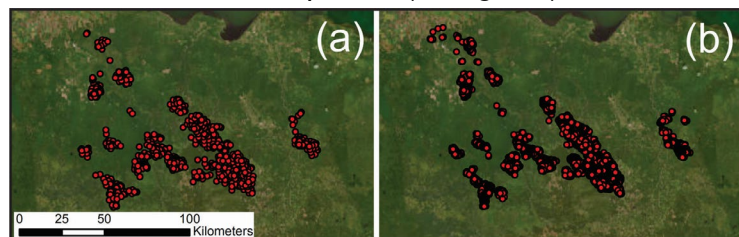


Figure 2. MODIS (a) and VIIRS(b) in 2023 Alberta. Instruments such as VIIRS (b) provide similar (and often better) monitoring capability to MODIS (a).

WILDFIRESAT: THE WORLD'S FIRST PURPOSE-BUILT OPERATIONAL SATELLITE SYSTEM FOR MONITORING WILDFIRES

The forthcoming WildFireSat mission (Johnston et al., 2020) will offer additional, novel active fire-derived intelligence products to Canadian fire management users and is planned for operation in the 2029 fire season. WildFireSat is a Government of Canada funded (Budget 2022) collaboration between Natural Resources Canada (NRCan), the Canadian Space Agency (CSA), Environment and Climate Change Canada (ECCC), fire management stakeholders, and academia. The design of WildFireSat has been driven by user needs provided by provincial and territorial fire management agencies (e.g., McFayden et al., 2023). The mission will deliver fire intelligence products twice daily for the entire Canadian landmass in within 30 minutes of collection, providing fire managers and decision makers with unprecedented strategic intelligence for situational awareness. WildFireSat will allow new insights into how fires are burning at the hottest time of the day, including their intensity, growth rate and direction, and the probability of success for different firefighting approaches. Additionally, the mission will support smoke and air quality monitoring and forecasting, and downstream carbon emission monitoring. For more information on the WildFireSat mission, visit <https://www.asc-csa.gc.ca/eng/satellites/wildfiresat/>.

COMMERCIAL SPACE OPTIONS

In addition to the civil (government) space agency-lead missions there has been a rapid expansion of the private EO satellite sector in recent years, and this trend is likely to continue for the foreseeable future (Denis et al., 2017). Such commercial ventures may provide active fire intelligence that supplements, or even surpasses, that provided by civil space missions, albeit with an associated direct financial cost to fire management agencies.

CONCLUSION

Satellite EO data and active fire products have contributed to the fire intelligence required by fire managers in Canada and around the world to support their decision making for several decades. We are now at an important inflection point, as the widely used MODIS instruments will be switched off in the next few years. The data they produce during the period of orbital drift may have lower reliability. Fire management users are encouraged to adopt newer alternative sources of EO active fire data as soon as possible. For now, for afternoon observations this shift will likely mean using data from the VIIRS instruments flown on the Suomi-NPP and NOAA/JPSs satellites. The newer SLSTR instruments flown on the Sentinel-3 satellites will provide additional morning observations once these data become widely accessible (~2024). Several other current and future missions may suit specific active fire management use cases (Frontline Express 93). Notably, WildFireSat is uniquely designed for the needs of Canadian fire managers. Commercial

satellite operators and data providers are also increasingly likely to provide a viable solution to some fire management needs. Researchers at the Canadian Forest Service, Great Lakes Forestry Centre are available to discuss active fire EO capabilities with fire managers interested in further information.

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Authors: Mark C. de Jong and Colin McFayden

Reviewers and Contributors:

Natural Resources Canada, Canadian Forest Service - Alan S. Cantin; Morgan A. Crowley; Timothy J. Lynham; Joshua M. Johnston; Lynn Johnston; Dan Thompson; Anna Turbelin; **British Columbia Ministry of Forests, Wildfire Service** - Ash Richardson; **Yukon, Wildland Fire Management Branch** - Mike Smith; **Canadian Space Agency** - Denis Dufour; **NASA** - Douglas Morton.

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- Figure 2 data source: MODIS Collection 6 Hotspot / Active Fire Detections MCD14ML and NRT VIIRS 375 m Active Fire product VNP14IMG1 and VNP14IMG2 distributed from NASA FIRMS.
- CONTACT INFORMATION**
Great Lakes Forestry Centre
1219 Queen Street East
Sault Ste. Marie, ON P6A 2E5 Canada
Telephone: 705-949-9461
E-mail: wildfiresat-gardefeu@nrcan-rncan.gc.ca
Web site: nrcan.gc.ca/forests/research-centres/glfc/13459