



Natural Resources  
Canada

Ressources naturelles  
Canada

# *Draft: Solar Radiation as an Input to FWI2025*

Last Updated: April 15<sup>th</sup>, 2026



# ***Draft: Solar Radiation as an Input to FWI2025***

Canadian Forest Service Fire Danger Group 2025

## **Disclaimer**

This document is a draft information note that describes the standards and options for sourcing solar radiation data required for the new grassland components in the updated Fire Weather Index System (FWI2025). This version is intended to be a living document and will be included as a part of the larger documentation describing the components of the Next Generation Canadian Forest Fire Danger Rating System (CFFDRS2025). Any feedback or questions from users regarding the information in this document are welcome and can be sent to the Fire Danger Group email:

[firedanger-dangerincendie@nrca-nrcan.gc.ca](mailto:firedanger-dangerincendie@nrca-nrcan.gc.ca)

## Introduction

The Canadian Forest Fire Danger Rating System is being updated to a new version as CFFDRS2025. This includes an update to the Fire Weather Index system (FWI2025) that calculates the impact of weather conditions on fuel moisture and fire behaviour on a broad, landscape-level scale. A major change in FWI2025 is the addition of standard grassland and peatland fuel types on top of the existing standard pine fuel type.

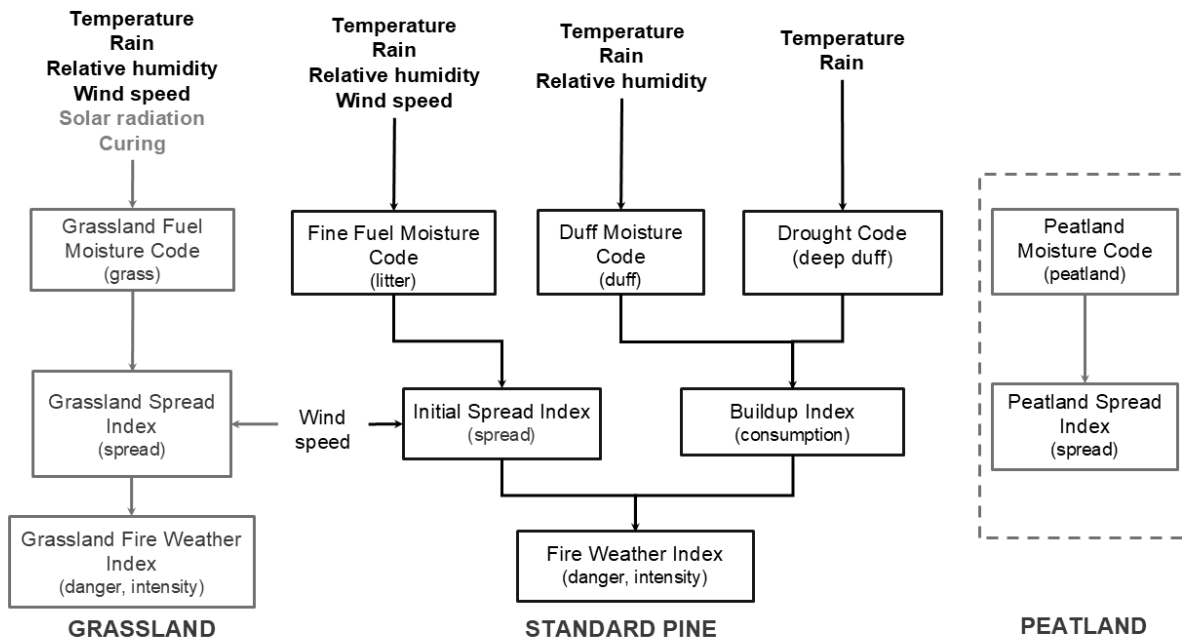


Figure 1: Diagram of FWI2025, showing the new standard grassland and peatland components beside the existing standard pine components. The peatland components are still under development.

The new moisture codes for the grassland and peatland fuel types are called the Grassland Fuel Moisture Code (GFMC) and Peatland Moisture Code (PMC) respectively. While the FWI system's standard pine fuel type represents a closed canopy forest, the standard grassland and peatland fuel types represent open and semi-open canopies. This means solar radiation is an important factor in order to accurately calculate drying, ignition likelihoods, and fire spread rates in these new fuel types.

The new solar radiation input in CFFDRS2025 represents the radiant power of the sun per unit area. It includes both direct as well as diffuse shortwave radiation that reaches fuels on the ground, and is expected in units of kilowatts per square metre ( $\text{kW}/\text{m}^2$ ).

This document covers three different methods to obtain solar radiation data. The first method is to measure it in-situ using sensors at weather stations (Method A). The second method is to get solar radiation from numerical weather models that output it (Method B). The last method is to use the default calculations provided in FWI2025 to estimate it from the other required weather variables (Method C). This last method can be considered a catchall in case a user has no solar radiation data.

However, we recommend fire agencies start thinking about upgrading their weather stations to get the most accurate solar radiation to use with CFFDRS2025. This document is meant as an introduction of solar radiation and an overview of the sourcing options available, for more details look forward to our upcoming CFFDRS2025 Weather Guide.

## Method A: Direct Measurement

The best source of weather data is from instruments that are measuring real conditions on the ground. This is why our first recommendation is to use solar radiation data collected at weather stations. The type of sensor to directly measure solar radiation for CFFDRS2025 is the pyranometer. It should be a broad spectrum pyranometer and *not* one limited to the narrower range of Photosynthetically Active Radiation (PAR).

While there is a wide range in cost and quality across pyranometers, even a low-cost one provided by a standard supplier of weather instrumentation is sufficient for use with the CFFDRS2025. It is likely that any provider of fire weather stations will be able to add a pyranometer to existing stations and include solar radiation as a standard variable in the data stream. Existing automatic weather stations that measure solar radiation for other applications (e.g. monitoring of agriculture, avalanches, climate, or roadways) may also be a valid source and integrated into fire agency weather data processing systems.

Weather station location and procedures for CFFDRS2025 should continue to follow the same standards as for previous versions of the CFFDRS. For example, there should be no vegetation or structures near the weather station as it should be in an open area or clearing. Siting weather stations in clearings is particularly important when measuring solar radiation as shadows from nearby objects can lead to significant reductions observed solar radiation. Indeed, extra care should also be taken to ensure that the station mast or other instruments do not cast a shadow on the pyranometer. The pyranometer should be levelled with an internal spirit bubble or electronic levelling sensor towards the local zenith. See Volume I of the World Meteorological Organisation's *Guide to Instruments and Methods of Observation (WMO-No. 8)* for more details (WMO, 2024). Chapter 7 of the WMO guide includes a list of additional documents covering recommended practice and calibration of pyranometers. The measurement of global solar radiation is described in Chapter 7.3 which includes a list of characteristics for operational pyranometers in Table 7.4.

Hourly solar radiation data from pyranometers should be an average over the hour, or at least a 10 min average (like for wind speed data). If data is collected in the SI units of  $W/m^2$ , it needs to be converted to  $kW/m^2$  before use in CFFDRS2025.

## Method B: Numerical Weather Models

If data from physical sensors is not available, another option to obtain solar radiation is from numerical weather models. Weather models use equations representing Earth systems along with weather observations of initial conditions to predict weather on a regional or global scale. Model forecasts are also the only way to get predictions of future solar radiation. More information about sourcing solar

radiation from numerical models, what models are available, and the different model characteristics will be available in the upcoming CFFDRS2025 Weather Guide.

## Method C: Default FWI2025 Calculations

If solar radiation isn't directly measured and isn't available from numerical models, we provide a method to estimate solar radiation from other information as a part of prepping weather data for input into FWI2025. The method runs automatically when input data doesn't include solar radiation. The solar radiation values estimated from this method will be less accurate than by direct measurement (Method A) but can be used when nothing else is available. This can be especially useful for historical fire weather observations that did not include solar radiation.

The default method first calculates solar radiation at the top of the atmosphere (i.e. extraterrestrial) which only depends on the time and latitude. Then, an approximation needs to be made to account for the effects of atmospheric absorption and scattering by clouds and the air itself, which can significantly reduce the solar radiation that reaches fuels on the ground. This is done by scaling the top of atmosphere solar radiation by a factor based on the vapour pressure deficit, which is calculated using hourly temperature and relative humidity. This method works as a backstop because time, latitude, hourly temperature, and hourly relative humidity are already required inputs for FWI2025.

This method is similar to the process for determining effective solar radiation in the *Field Guide for Predicting Fire Behaviour in Ontario's Tallgrass Prairie* (Kidnie et al., 2010). This field guide was created to produce more accurate predictions in grasslands based on experience from prescribed burns where the FWI System's Fine Fuel Moisture Code (FFMC) tended to under-predict fire behaviour. It also starts with a top of atmosphere solar radiation but uses a physical check of the sky to determine the cloud condition (clear, scattered, broken, or overcast) that becomes the atmospheric factor to scale solar radiation. This works as a quick estimate in the field, for example during prescribed burns.

## Conclusion

If available, the best source of solar radiation data for CFFDRS2025 is direct measurement at weather stations with pyranometers. If direct solar radiation measurements are not available, values can be taken from numerical weather models or be left out of inputs to be calculated automatically. We are currently in the process of evaluating the effectiveness of different numerical weather models along with the default FWI2025 calculation. An analysis comparing them to directly measured solar radiation will be included in the upcoming CFFDRS2025 Weather Guide. However, no matter the method used to acquire solar radiation, it is an important piece of data when modelling fuel types that can be exposed to direct sunlight.

## References

Kidnie, S. M., Wotton, B. M., & Droog, W. N. (2010). *Field Guide for Predicting Fire Behaviour in Ontario's Tallgrass Prairie*. Elgin County Stewardship Council Special Publication. Ontario Ministry of Natural Resources, Aylmer, Ont. <https://ostrnrcan-dostrncan.canada.ca/handle/1845/246080>

World Meteorological Organization (WMO). *Guide to Instruments and Methods of Observation* (WMO-No. 8), Volume I. Geneva, 2024. <https://library.wmo.int/idurl/4/68695>

DRAFT