Modeling the spread of wildfire

What is Prometheus, and how was it developed?

Prometheus is a spatially explicit fire growth simulation model that provides operational and strategic assessments of fire behaviour potential over time and space. Alberta Sustainable Resource Development led the development of this new state-of-the-art national tool in collaboration with fire management agencies across Canada. Prometheus simulates the spread of one or more fires across a landscape with heterogeneous fuels and topography based on daily, hourly or sub-hourly weather data. Spatial wind grids (wind speed and wind direction) produced by WindWizard or WindNinja, and multiple weather stations can also be used in Prometheus to create more spatially accurate fire growth simulations.

The foundation of Prometheus' model is the Canadian Forest Fire Behaviour Prediction (FBP) System and the most recent wave propagation algorithms that were developed with input from various university research teams. The FBP System is a complex, semi-empirical system that mathematically expresses and integrates many of the fuels, weather and topographic features that influence fire behaviour. The FBP System is used across Canada and in other parts of the world to predict fire behaviour in a quantitative and structured manner. It produces outputs that describe the physical characteristics of a wildfire such as rate of spread, fuel consumption, head fire intensity and degree of crowning.

Prometheus was developed through a collaborative effort involving an integrated, multi-disciplinary team of researchers and managers from governments, universities and the private sector. Technical sub-committees were established to address various aspects of the model to ensure the best science and technology was adopted. The development and structure of Prometheus are described in the report entitled "Development and Structure of Prometheus: the Canadian Wildland Fire Growth Simulation Model" (1)

Has Prometheus been validated?

The accuracy of Prometheus is limited to the accuracy of the FBP and Fire Weather Index (FWI) Systems, which are best approximations of reality. Wotton et al. (2009) reported validation of the FBP System (i.e., predictions versus observations) and also considered some of the assumptions made during its development. (2) Further validation was conducted through independent comparisons of Prometheus outputs against a stand-alone FBP and FWI tester suite program (generated from FBP source code). The results of the validation testing indicate that the propagation methods used in Prometheus are working correctly. (1)

Case studies are used to identify data gaps, as well as the limitations of the model for a particular simulation. The model inputs can be changed and the projected fire growth compared to actual fire growth to help assess the relative importance and accuracy of the variables and parameters influencing fire behavior. (1) A primary source for case studies is the 32-hour Prometheus course. Work is underway to establish a case study library available on the firegrowthmodel.ca website.

The pending release of Prometheus 5.3 includes a spatial weather modeling component. Validation of spatial weather modeling is currently underway and will incorporate the expertise of a beta-test team comprised of fire behaviour specialists, fire modeling specialists, and university researchers. Test results will be reported and incorporated into user documentation.

How is Prometheus used to manage wildfire?

Fire growth simulation can be a valuable tool in today's wildfire manager's tool box to provide decision support to suppress fires, plan for the use of prescribed fire, and design future desired FireSmart communities and landscapes. Prometheus can be used by not only fire management agencies across Canada, but also by other interested stakeholders such as landscape modellers, university fire researchers, forest management planners, municipal planners, and educators. As a result, the program is open and flexible, and easy to use and integrate with other applications.

Prometheus provides operational decision support by predicting wildfire behaviour during escape fire situations. This is important when the fire load exceeds the resource availability to fight all of the fires. Fires are assigned a priority based on values-at-risk and the potential fire behaviour. Prometheus allows users to complete single or multi-day fire spread simulations. The potential threat that a wildfire poses to a community or other important values-at-risk can be evaluated using Prometheus. This includes the amount of time available to evacuate if a change in weather occurs.

Prometheus also provides decision support for wildfires that are not fully suppressed (i.e. modified suppression). Wildfire managers can then suppress these fires more cost effectively by focusing on the portions of the fire perimeter that need resources.

1 Tymstra, C., Bryce, R. W., Wotton, B. M., Tayalor, S.W., and O. B. Armitage. 2010. Development and Structure of Prometheus: the Canadian Wildland Fire Growth Simulation Model. tion Model. Nat. Resour. Can., Can. For. Serv., North. For. Cent., Edmonton, AB. Inf. Rep. NOR-X-417. 88 p.

2 Wotton, B.M.; Alexander, M.E.; Taylor, S.W. 2009. Updates and revisions to the 1992 Canadian Forest Fire Behavior Prediction System. Nat. Resour. Can., Can. For. Serv., Great Lakes For. Cent., Sault Ste. Marie, ON. Inf. Rep. GL-X-10. 45 p.