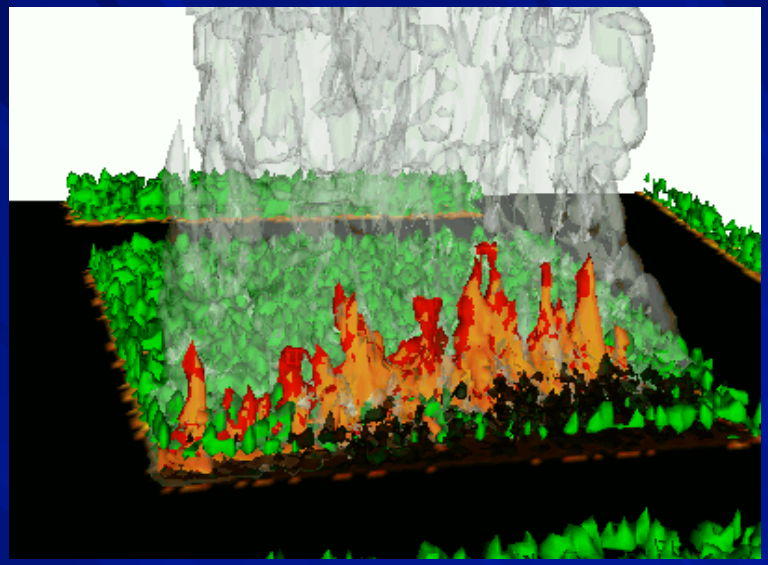

Using FIRETEC to Further our Understanding of Fire Science

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FIRETEC

FIRETEC is a wildfire behaviour model being developed at the Los Alamos National Laboratory in New Mexico.

FIRETEC is coupled to a computational atmospheric hydrodynamics model, HIGRAD, and is designed to represent the two-way interaction between wildfire and the surrounding atmosphere over a wide range of scales, from meters to kilometers.

This includes the effects of fuel heterogeneity and complex topography.

FIRETEC

Using FIRETEC, there is an opportunity to expand our understanding of fire science, thus improving our ability to predict critical aspects of fire behavior and its response to local environmental conditions.

Through this type of modeling, virtual experiments can be conducted that normally are difficult to plan or expensive to replicate.

Although these virtual experiments would not replace field work, they can help to expand what we learn from field studies and increase the value of experimental data.

FIRETEC

This presentation will describe the FIRETEC model, providing examples of past and current studies including topographic effects as well as fire behaviour in stands of varying density and conditions and stands affected by bark beetles.

Also, performance studies of the model will be presented based on observations from the International Crown Fire Modeling Experiment (ICFME).

Coupled Atmospheric Fire Models

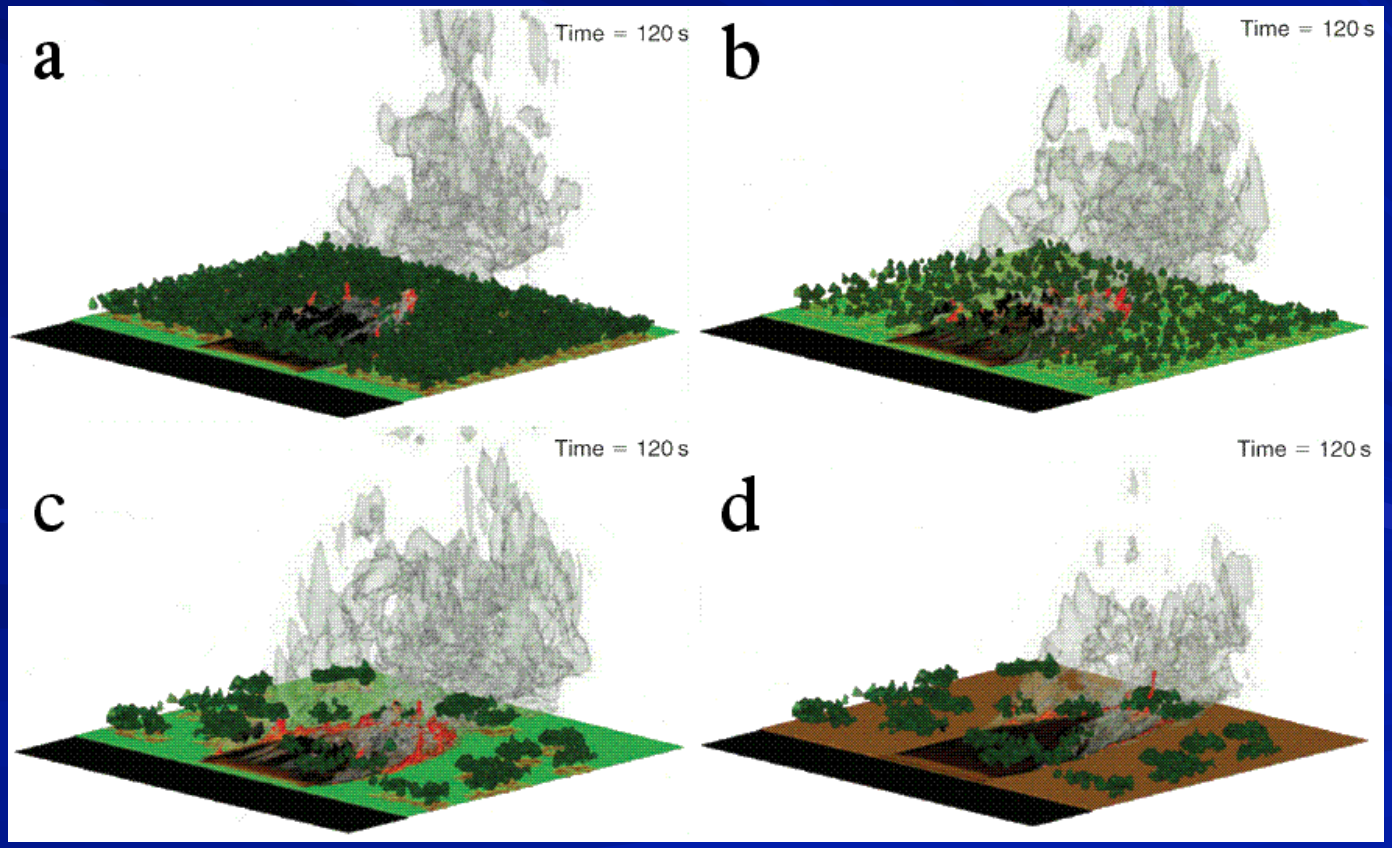
Coupled atmospheric fire models are micro- to meso-scaled numerical weather models that include vegetative fuel combustion (forest fires) in their parameterization.

Combustion acts as a heat source, which leads to buoyancies and shears and vortices that contribute to the development on winds.

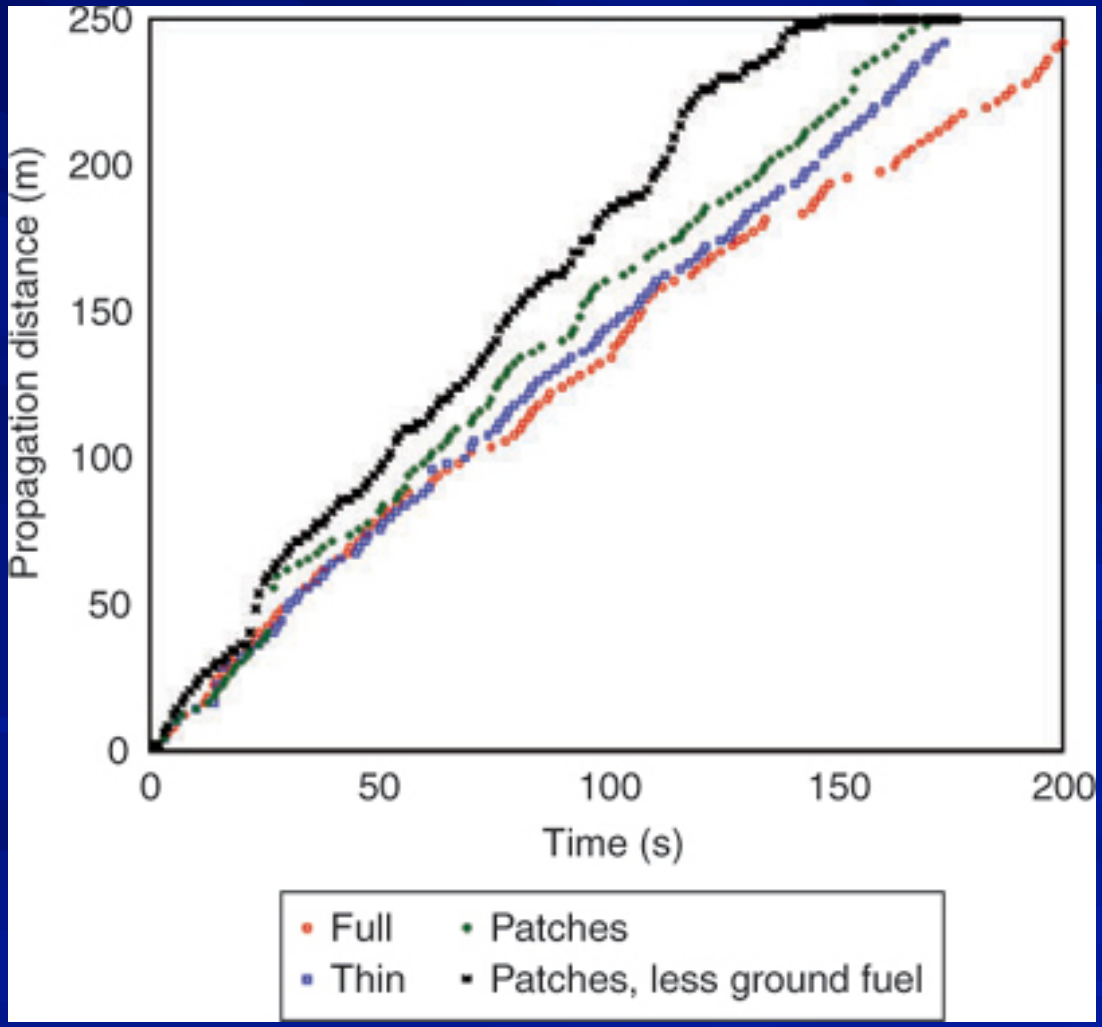
Applications

Stand Density

Linn et al. (2002) first tested the model on grass fuels and then Linn et al. (2005) conducted simulations varying the stand and surface fuel density.



Stand Density

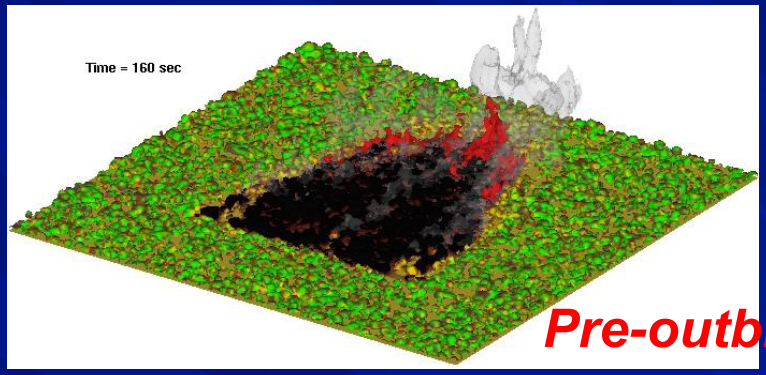


These factors varied the fire spread rate substantially.

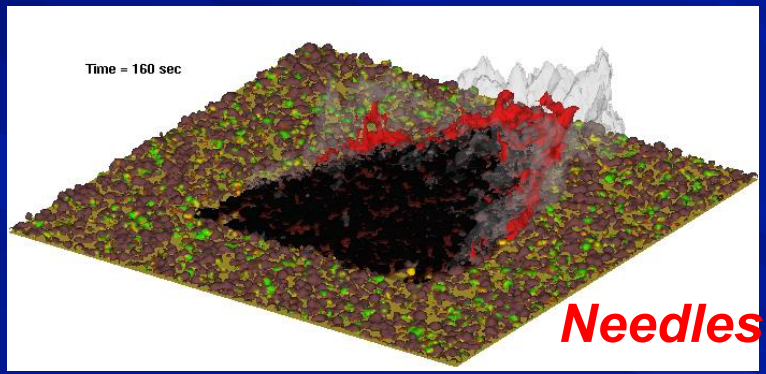
This illustrates the significance of stand characteristics on fire behaviour.

Bark Beetle

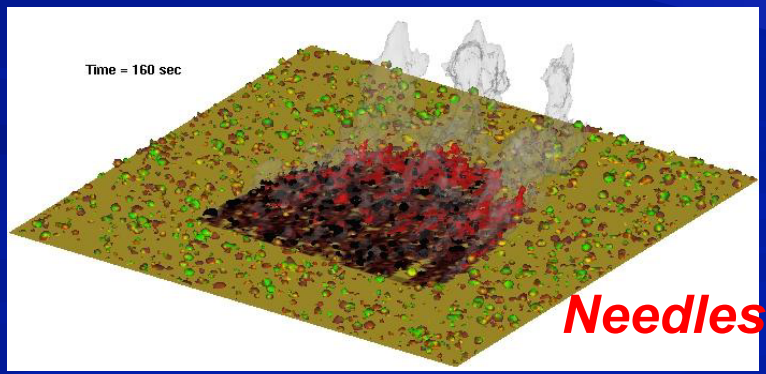
A collaborative effort between US Forest Service Rocky Mountain Research Station and Los Alamos National Laboratory is looking into levels of bark beetle-induced conditions that lead to drastic changes in fire behavior and how variable or erratic the behavior is likely to be.



Pre-outbreak

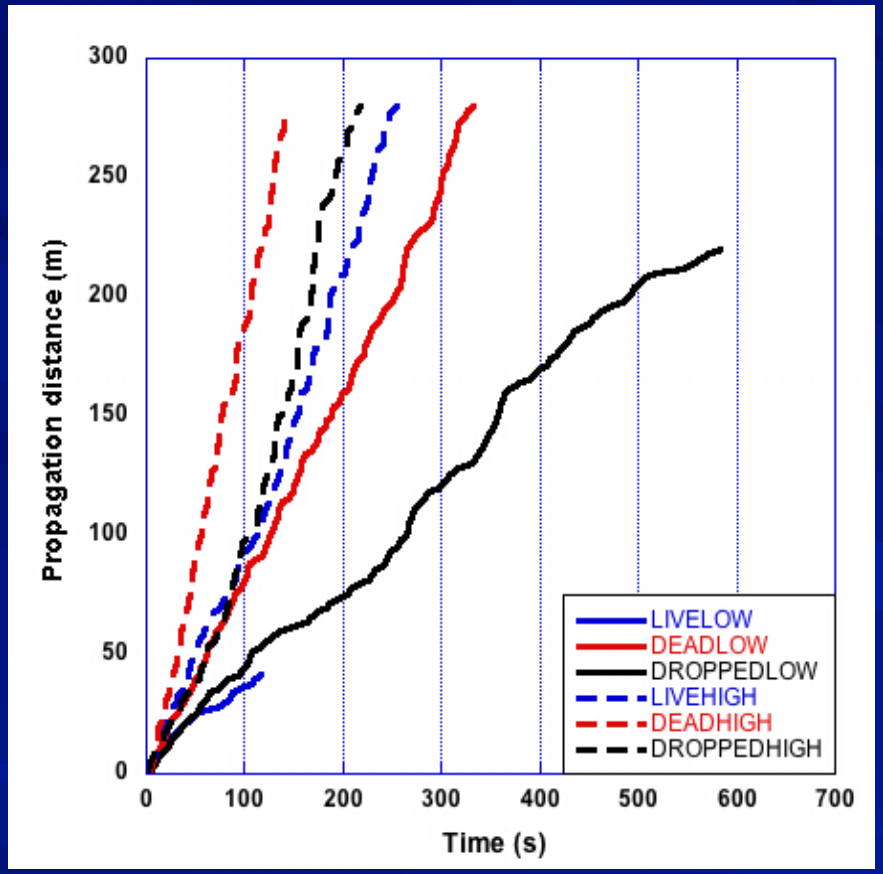


Needles on trees



Needles on ground

Bark Beetle



Simulation	ROS*/ROS*$_{LIVE}$
LIVELOW	1
DEADLOW	2.59
DROPPEDLOW	.882
LIVEHIGH	1
DEADHIGH	1.83
DROPPEDHIGH	.893

FIRETEC shows a two-fold increase in ROS while dead needles are on the tree, and a reduction after they fall.

Performance Study

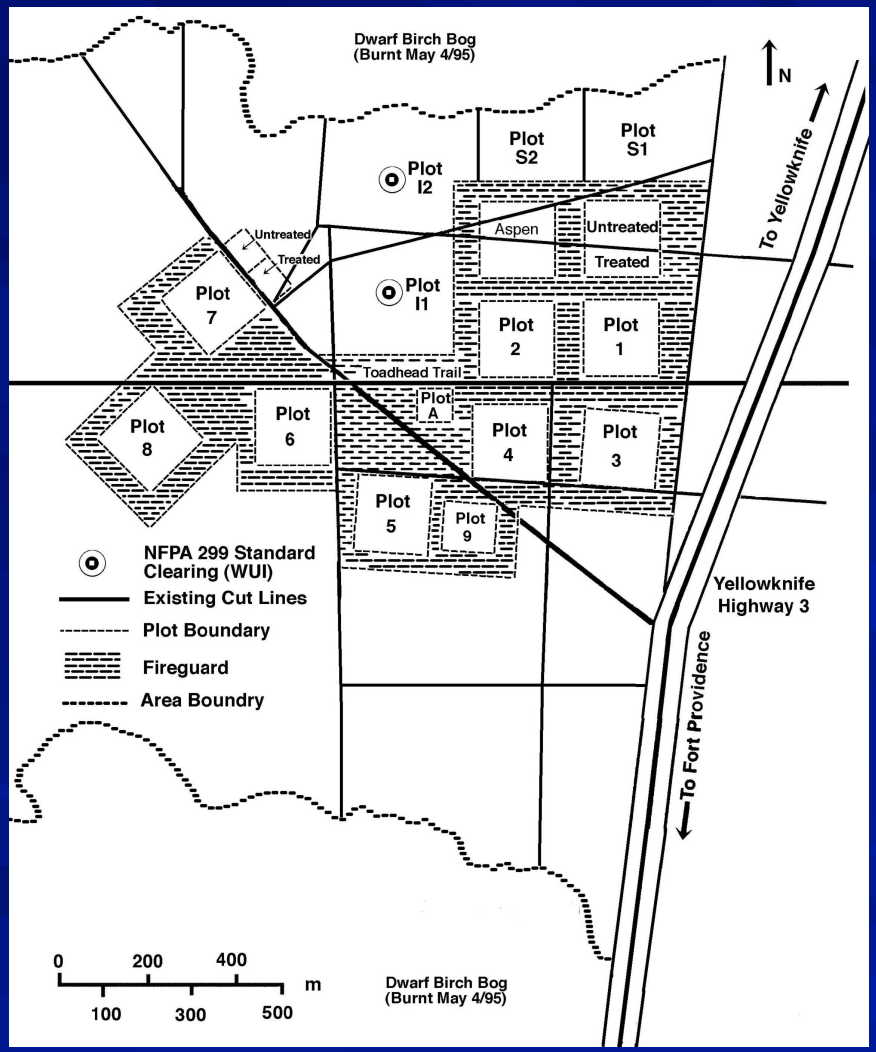
Testing FIRETEC with ICFME data

International Crown Fire Modelling Experiment

The International Crown Fire Modelling Experiment (ICFME) was a joint Canada-US fire research project carried out between 1995 and 2001 near Fort Providence NWT. More than 100 researchers from 30 organizations representing 14 countries participated in the experiments.

The goal of the experiment was to examine the nature and characteristics of crown fires, while facilitating research in other fire related studies.

ICFME plots



A series of 150 x 150 m plots were created out of a mixed spruce-pine forest.

Experimental Burns

Plots were ignited on the up-wind edge of the plot using a truck mounted Terra-Torch.

Ten experimental burns were conducted between 1997 and 2000.

Experimental Burns

Rates of spread varied between 0.4 and 1.2 m/s with frontal fire intensities as high as 93 000 kW/m.

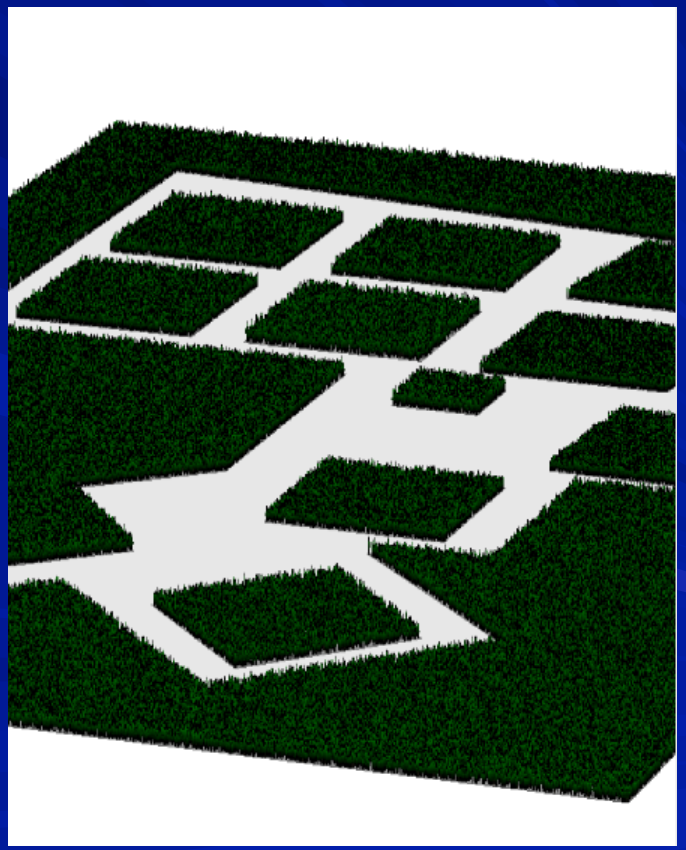
Most plots were burned in less than 3 minutes.

Performance Study

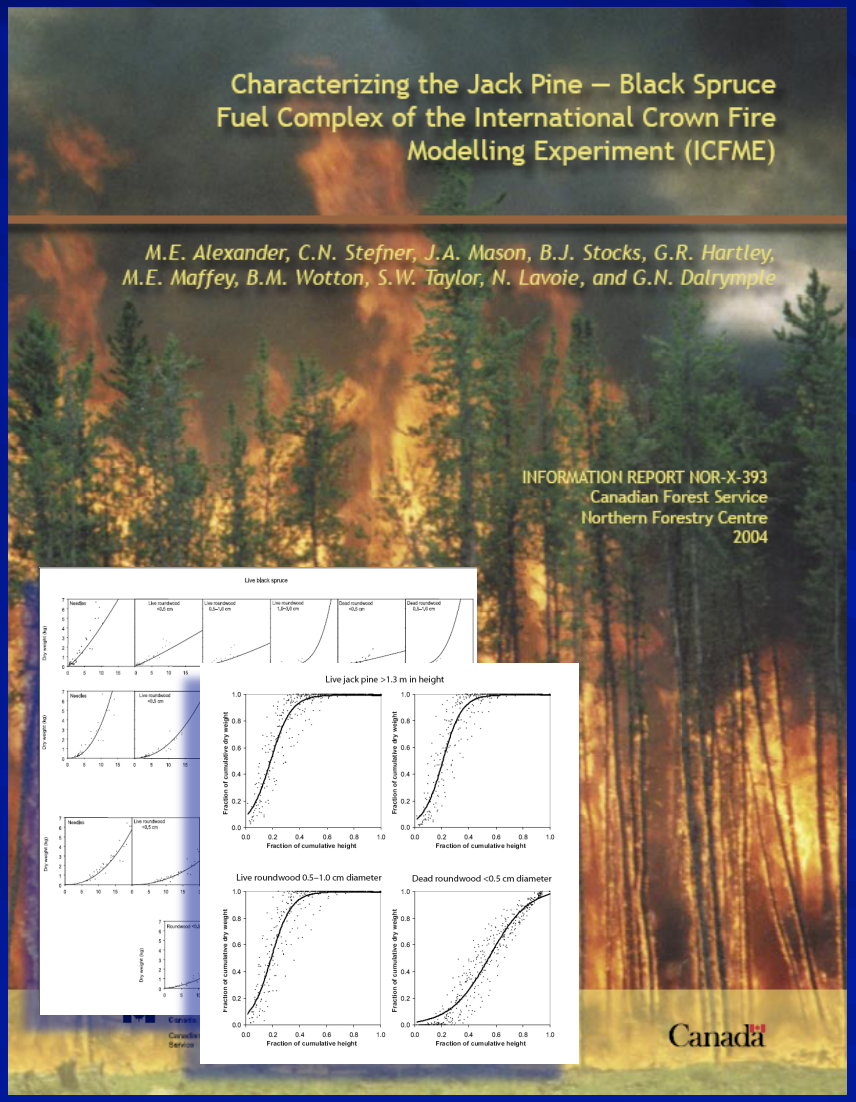
The ICFME data was used to test the FIRETEC model.

The first attempt was to simulate Plot 1 (June 17, 2000). This was chosen because of its symmetry.

The second plot studied was Plot 6.



Stand Structure

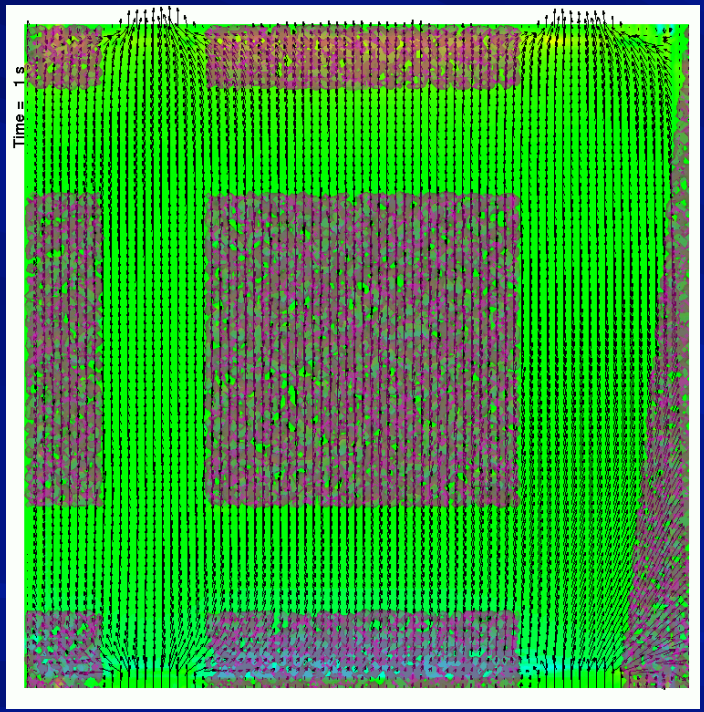


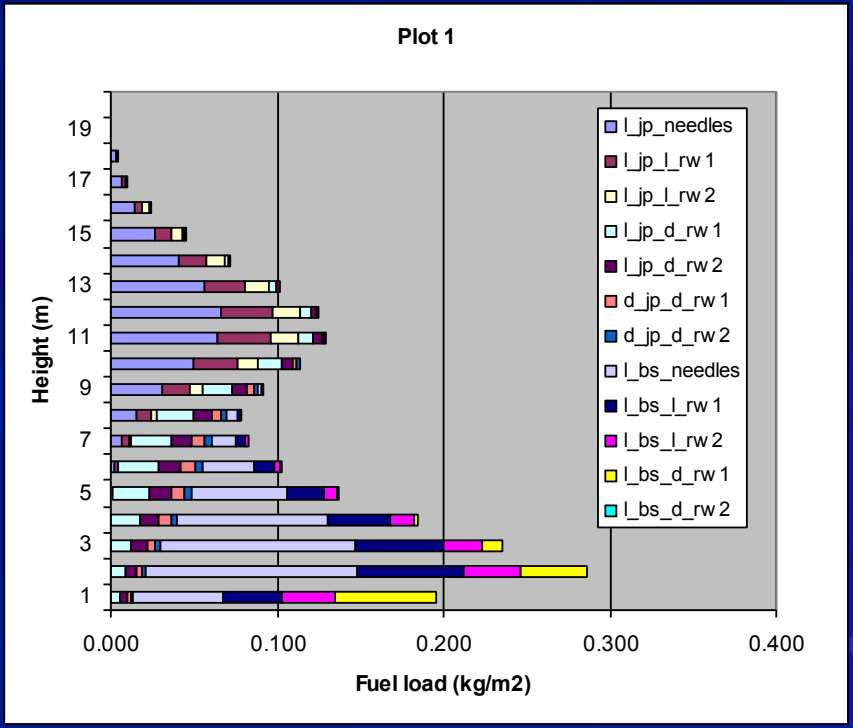
Stand structure for each plot has been replicated based on the regression curves provided in Alexander et al 2004.

FIRETEC is now designed to handle multiple fuels components (e.g. needles, branches, etc.)

Bulk Density and Wind Profiles

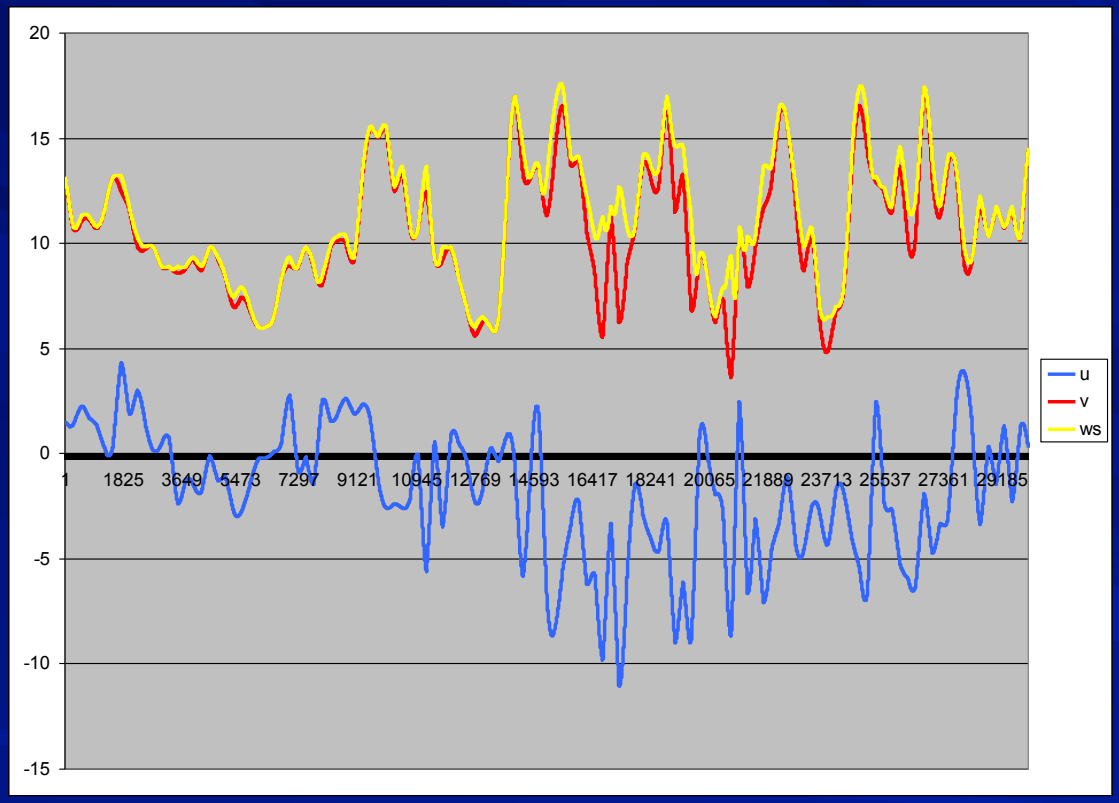
The HIGRAD/FIRETEC model was run at a 2m x 2m x 1.5m resolution at the surface with 0.002 sec time steps.





HIGRAD was run until a profile approximating the in-stand observed wind profile prior to burn was obtained.

Wind Data



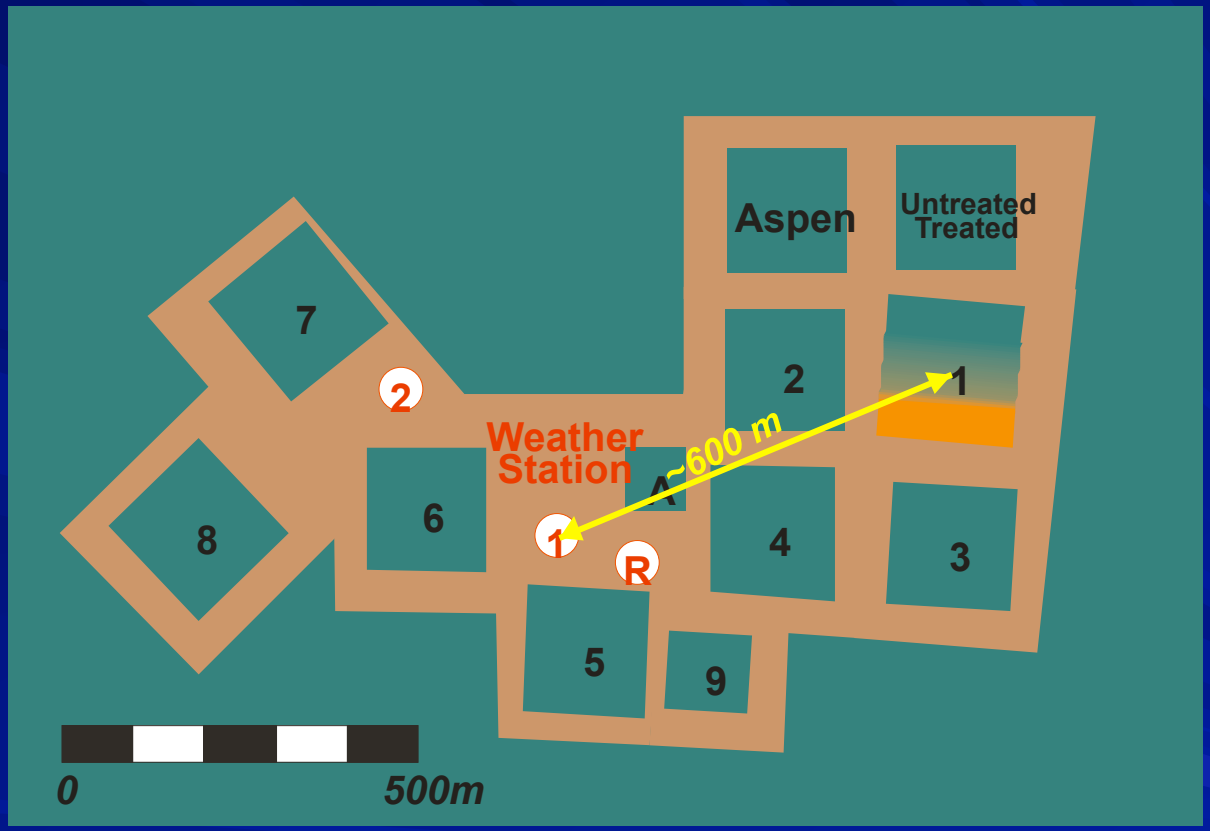
u_{10}=-ws_{10} *sin*(wd_{10} *pi / 180*)

v_{10}=-ws_{10} *cos*(wd_{10} *pi / 180*)

10-m control tower wind data with 5 second sampling was used to derive the wind field.

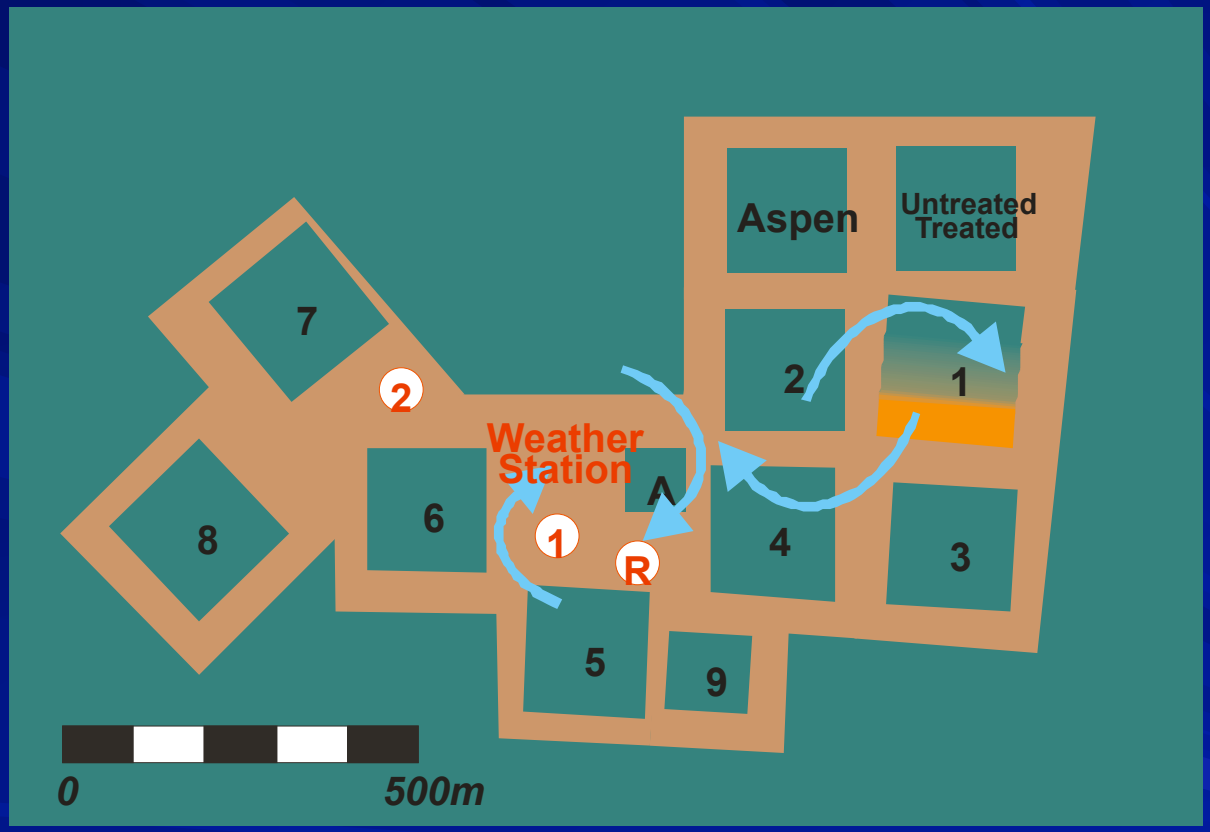
This was interpolated to 0.02 sec time steps for the model.

Wind Data



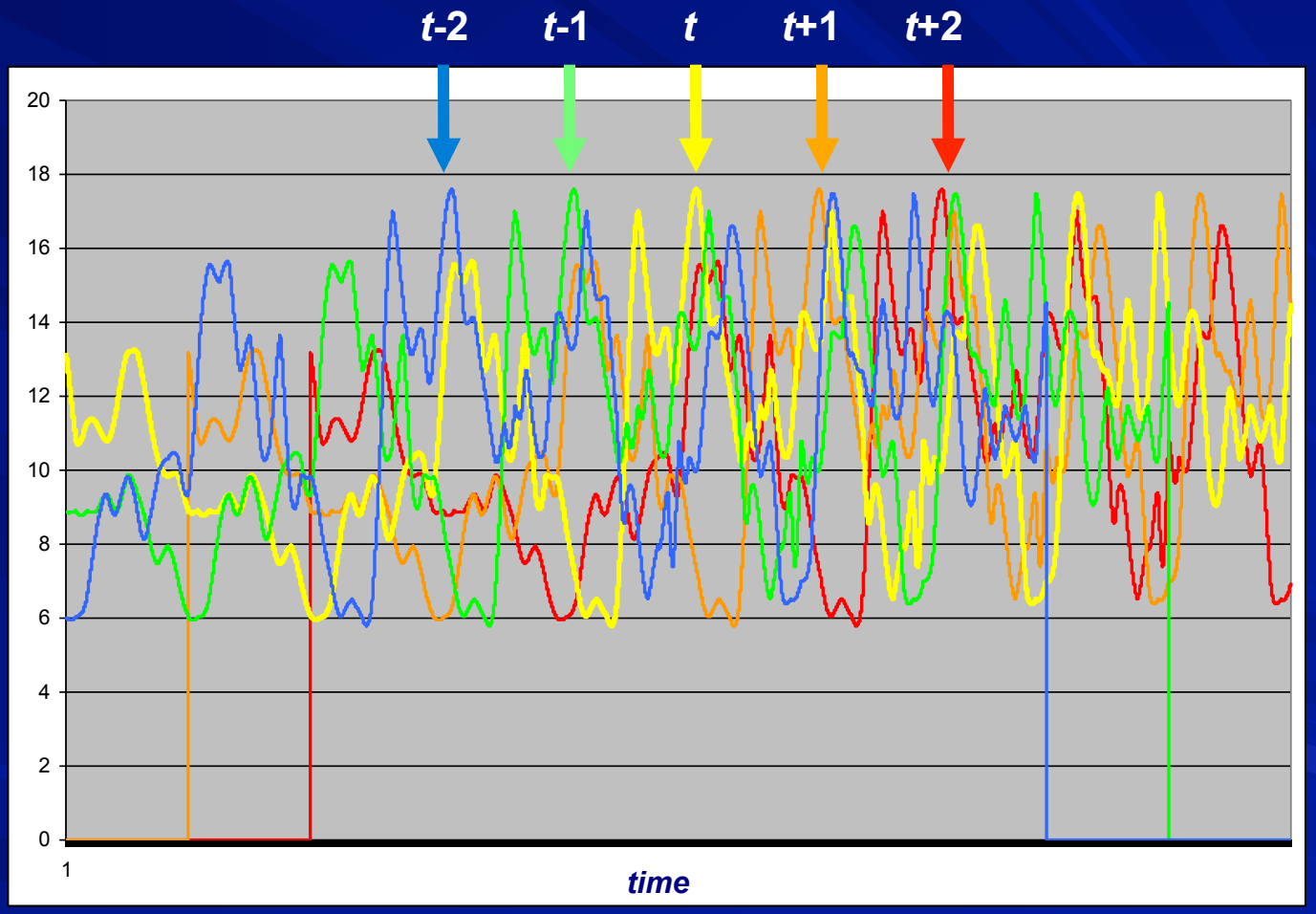
An unanticipated issue turned out to be the distance from the weather station to the plot.

Wind Data



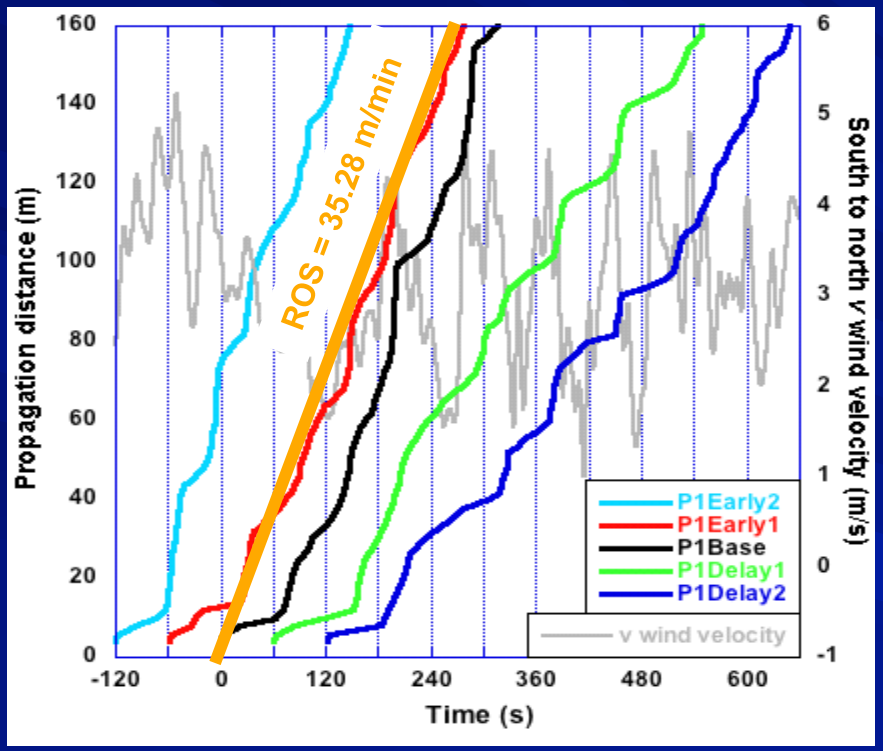
These distances are the scale of wind eddies so the timing of wind events was brought into question.

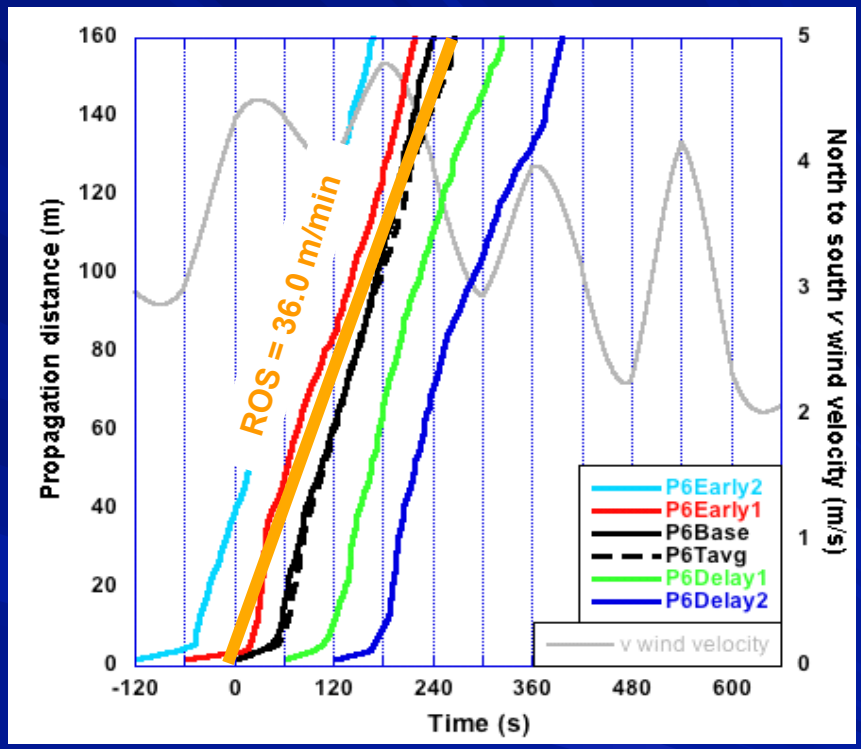
Wind Data



To address this issue, an ensemble approach was used, staggering the ignition time by 1 and 2 minutes each way

Results





Plot 1

5 sec wind data

ROS = 35.28 m/min

(0.588 m/s)

Plot 6

60 sec wind data

ROS =36.0 m/min

(0.600 m/s)

Conclusion

It is difficult to measure the accuracy of a model such as FIRETEC when considering the sensitivity to external input data. Issues with the wind, ignition method, documentation, etc, prevent such a rigorous study.

With that said, the model clearly shows behaviour appropriate to the burns with rates of spread closely matching those observed, showing that FIRETEC is valuable at modelling fire behaviour.

Thank You