SIMULATED RATE-OF-SPREAD OF A GRASSFIRE PROPAGATING UNDER A TREE CANOPY

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WHAT HAPPENS TO THE RATE-OF-SPREAD AS A GRASSFIRE PROPAGATES UNDER A CANOPY?

- Simulations of a fire entering, propagating under and leaving a tree canopy are conducted using FDS [1], a physics-based model.
- The presence of a tree canopy effects the wind speed, which in turn effects the rate-of-spread of a fire.
- From the simulated data we extract the average sub-canopy wind speeds in the absence of a fire and measure the rate-of-spread of a fire.
- This is the first step to testing the wind-reduction factor approach used in current operational models.

MODEL SETUP

The canopy is modelled following Mueller et al. [2]. The fuel, thermal degradation, and combustion are identical to Mell et al. [3]. The domain (figure 1) used is narrow but it captures the main features of the wind flow and reproduces realistic RoS in the absence of a tree canopy [4]. Six cases are considered, distinguished by the inlet wind speed at ten metres: $u_{10}(0)$=1, 2, 4, 6, 8, 10 ms^{-1}.

Data processing

For the wind only simulations, the wind field is averaged in time and in the y-direction. For fire simulations the front location (boundary temperature > 450 K) is averaged in the y-direction to obtain $x_*(t)$, then RoS=dx_*/dt

RESULTS AND CONCLUSIONS

The two- and ten-metre winds speeds across the domain are shown in figure 2. The wind reduction to due to the canopy is obvious. Two-metre winds in the $u_{10}(0)$=1 ms^{-1}. case are negative indicating the presence of a recirculation vortex [5].

The fire front position and RoS are shown in figure 3.)The key findings are:

- The $u_{10}(0)$=1 ms^{-1} case RoS is quasi-steady across the domain.
- The $u_{10}(0)$=2 ms^{-1} case RoS decreases inside the canopy and accelerates towards the canopy exit.
- The $u_{10}(0)$=4, 6, 8, and 10 ms^{-1} cases RoS decreases at some increasing distance within the canopy and all emerge from the canopy with approximately equal RoS.

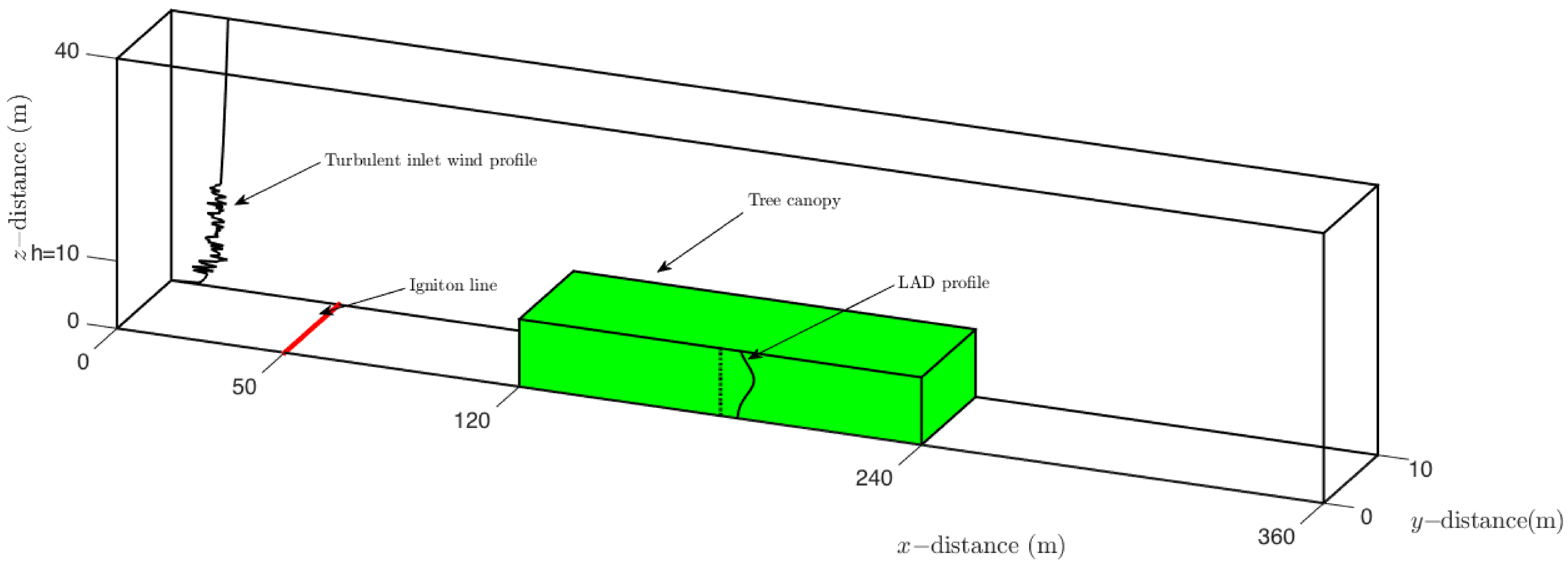


Figure 1: Simulation domain. The LAD profile has been exaggerated for visibility. The maximum LAD=0.2 m^{-1}.

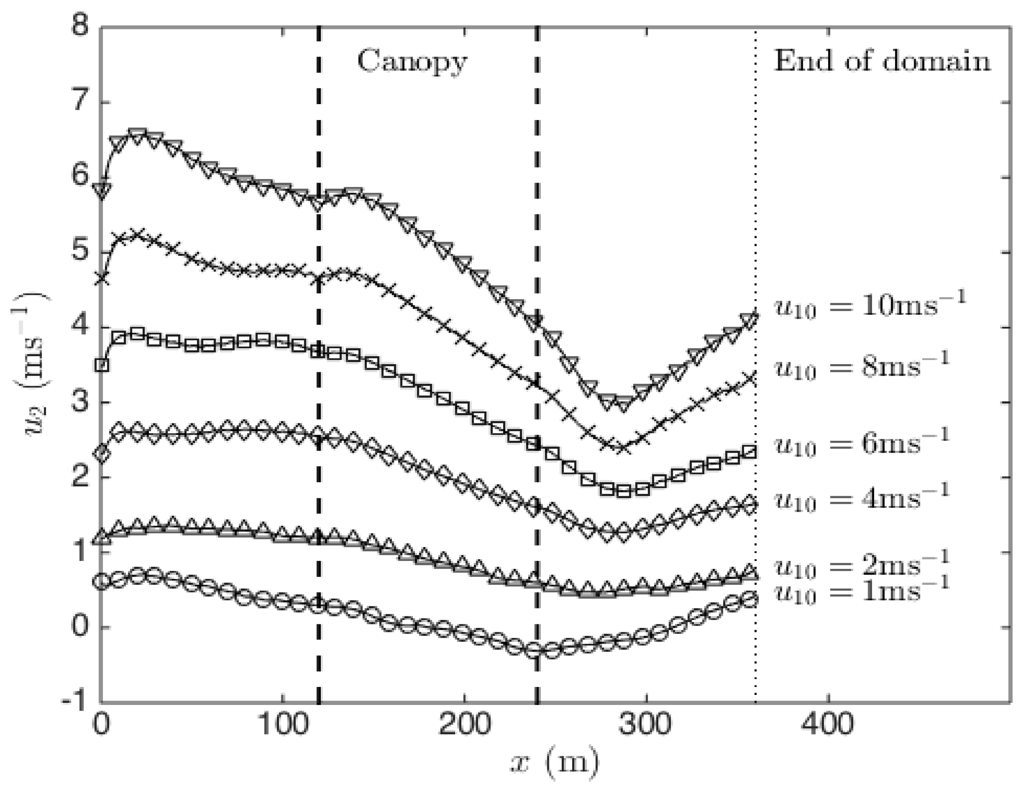
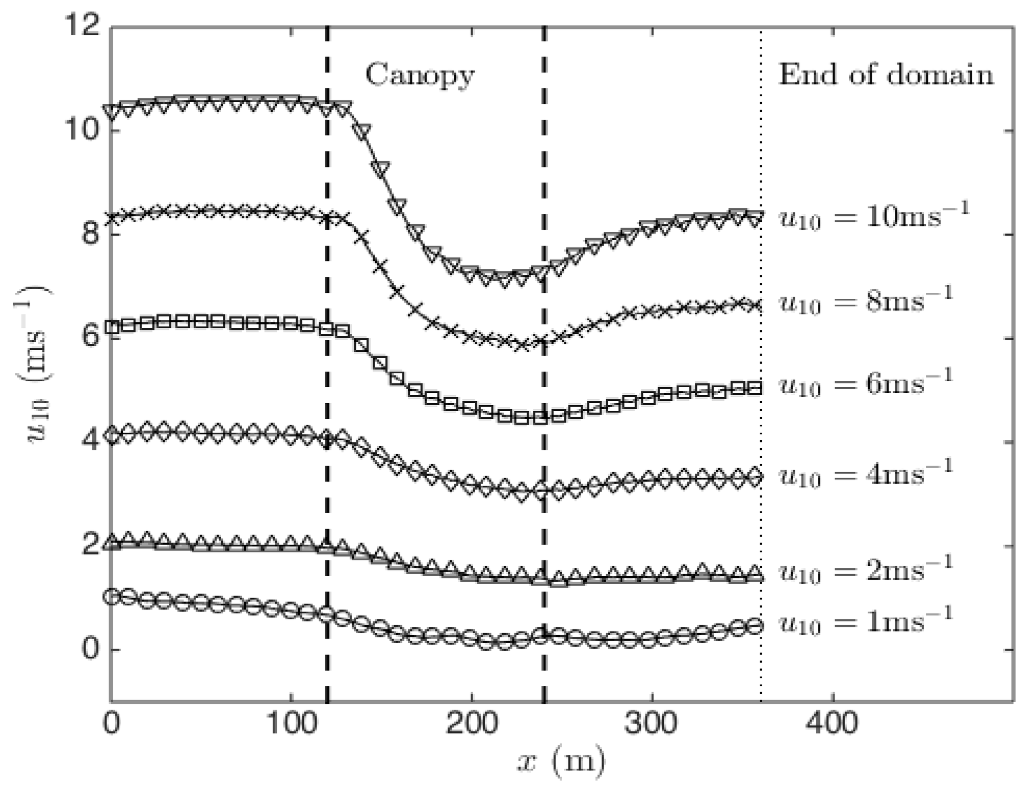


Figure 2: (a) Two-metre winds



(b) Ten-metre winds

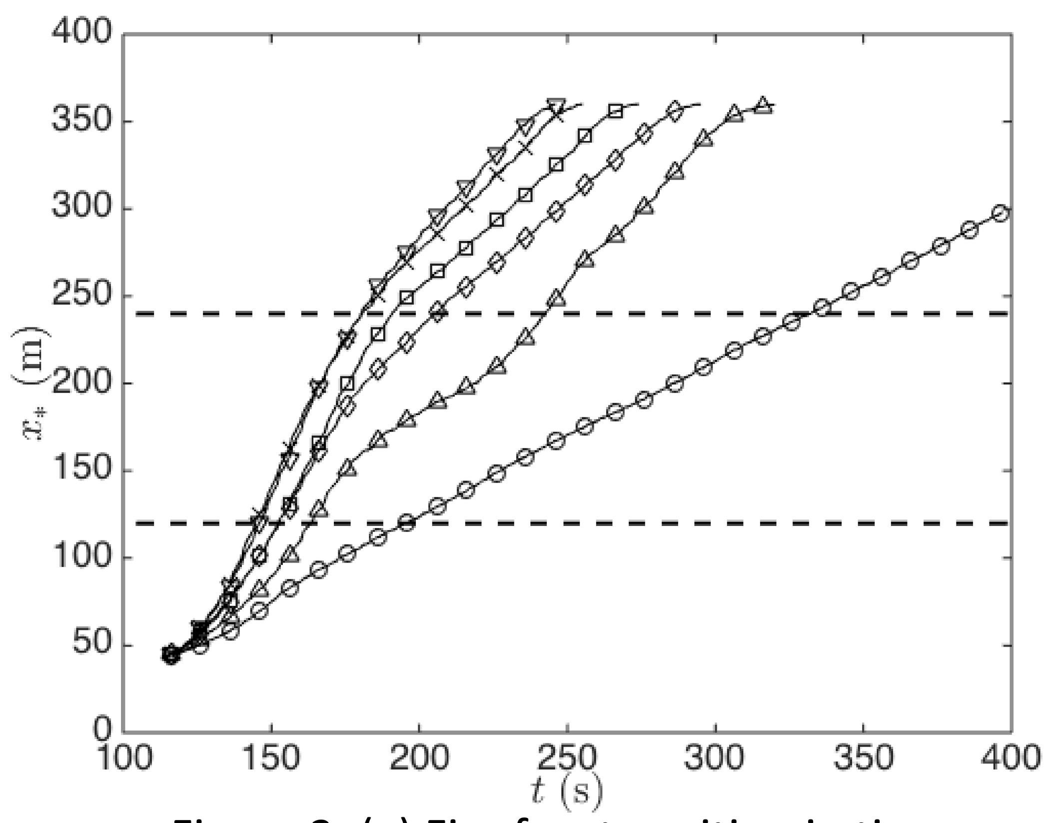
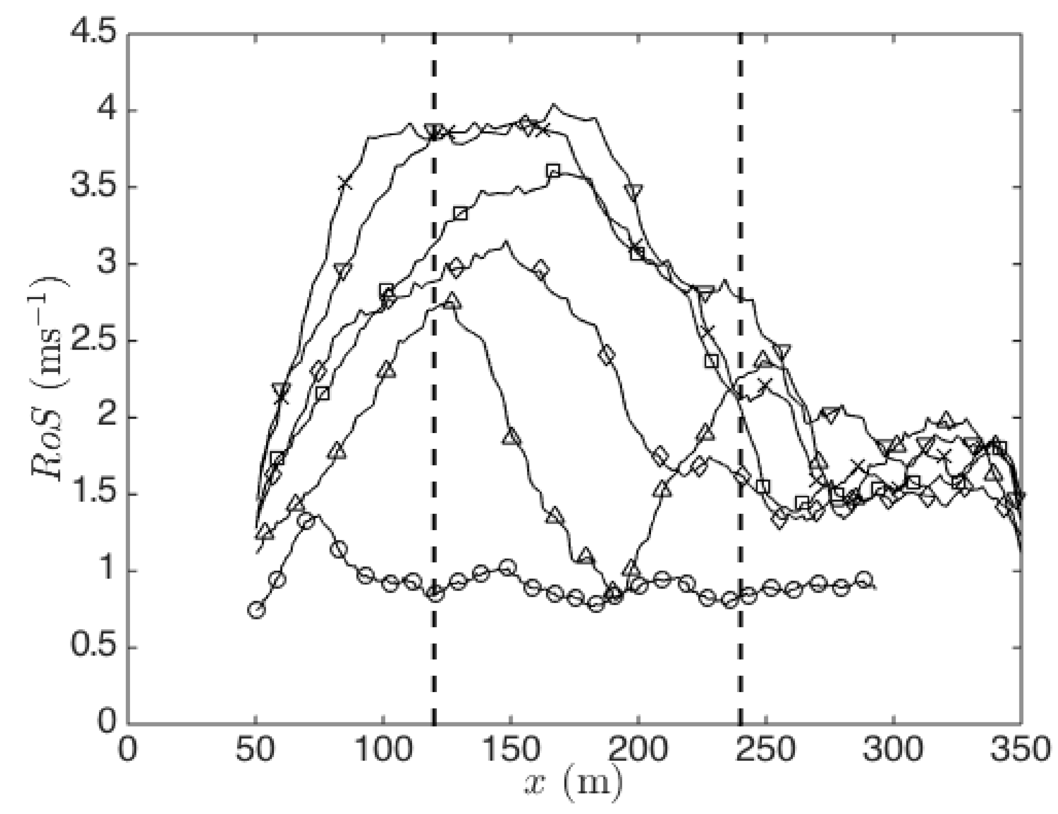


Figure 3: (a) Fire front position in time



(b) Rate-of-spread vs fire position

End user comment

Understanding the behaviour of wind profiles both within and downstream of canopies and disruptions is necessary in order to improve our application of wind modification factors in modeling. It is envisaged that the products of this work, when linked with other relevant projects, will improve the future accuracy of predictive fire behaviour modeling.

Dr Simon Heemstra, Manager Community Planning, NSW Rural Fire Service

References:

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[3] W. Mell et al. International Journal of Wildland Fire (2007) [4] D. Sutherland et al. (in preparation 2017) [5] M. Cassiani et al. Boundary Layer Meteorology (2008)

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