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FINDINGS

Our new method for calculating **bushfire ember transport** is **accurate** and **very fast.**

Improved Predictions of Severe Weather: Ember Transport

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This project has explored several aspects of severe weather, including fire, severe thunderstorms and tropical cyclones. This component aims to develop a computationally efficient way of predicting long-range ember transport within bushfire plumes.

Introduction

Embers accelerate fire spread and make it less predictable. They contribute to fires breaking control lines and are a major factor in house loss.

This poster describes a new, rapid method for predicting how far bushfire embers will travel.

Ingredients

The plume model
We use the bulk equations for plume rise, similar to but more sophisticated than the Briggs model used in our pyrocumulonimbus firepower threshold work. These tell us the plume structure, rise and updraft strength, depending on the fire strength, environmental winds and stability.

Plume turbulence
The flow in plumes is naturally unsteady (turbulent), and these fluctuations increase the maximum transport distance. Two quantities matter – the strength, and the spatial scale, of the fluctuations. We have developed statistical models for both, based on over 40 simulations of plumes in a large-eddy model.

Ember shedding from the plume
At each step along the plume, the probability that an ember falls is proportional to the probability that the total updraft (mean + turbulence) is less than the ember fall velocity, divided by the spatial scale of the turbulence. We integrate this quantity along the plume to get the fall-out distribution

Ember fallout
Once embers fall out of the plume, they are advected by the winds below as they fall.

Results

The figures to the right compare the ember landing patterns simulated at very high resolution, using a large-eddy model and explicit ember transport, by Thurston et al (2017), to those with the new method. Good agreement is apparent, except that the parameterization presently overpredicts ember density at long range, especially for the high fall velocity case.

Thurston et al.'s simulations each required **thousands of CPU hours** on a supercomputer. The new method takes **less than a second** on a desktop PC.

Next steps

We need to complete our validation of the method against Thurston et al.'s simulations, improve the long-range performance, and extend the method to work when the wind direction changes with height.

Then, we will implement it in a fire spread model, and examine how it performs in some chosen fire events.

Finally, we will document the method so that it is useable by others.

Thurston, W., Kepert, J. D., Tory, K. J. and Fawcett, R. J. B., 2017: The contribution of turbulent plume dynamics to long-range spotting. *Int. J. Wildland Fire*, **26**, 317–330, doi:10.1071/WF16142

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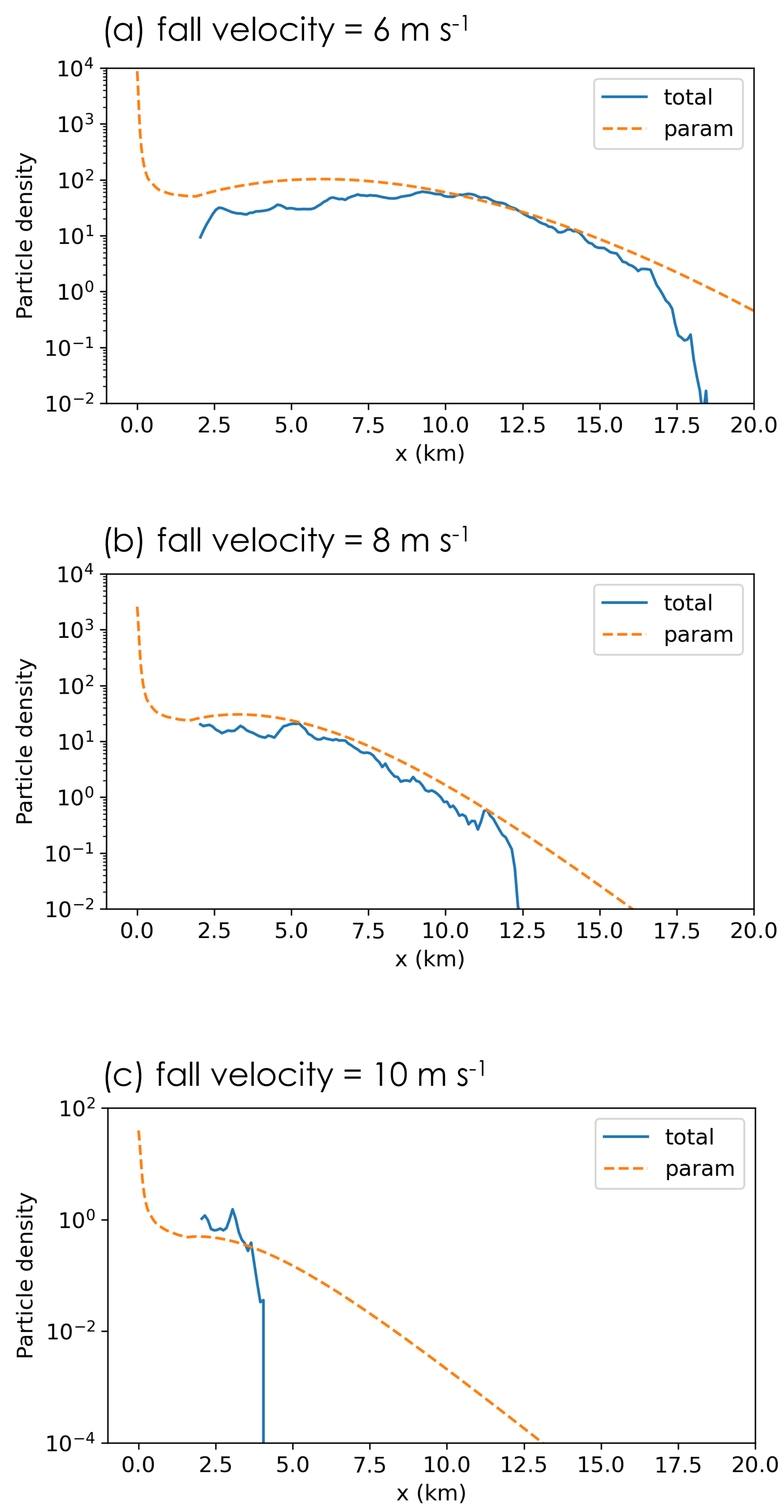

Figure1: Results from the ember transport parameterization. All cases are for a 250-m radius fire with heat flux 100 kW m^{-2}, in a turbulent boundary layer with gradient wind speed 15 m s^{-1}. The blue curves show the data from Thurston et al (2017), and the orange dashed curves are the parameterization. Data are plotted against downwind distance, and are the total number of embers, summed across the wind direction. Ember fall velocity is (a) 6 m s^{-1}. (b) 8 m s^{-1} and (c) 10 m s^{-1}.

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