Coupled modelling can provide the next level of value for fire danger forecasting, if it can be developed to be faster than real time, by enough to matter.

ACCESS-Fire: a case study
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This work examines fire spread and related weather phenomena in a large-scale high-intensity fire over complex topography using a coupled atmosphere and fire spread model ACCESS-Fire. The simulated fire occurred in 2016, igniting ~20 km east of Waroona WA, and behaviour diverged from forecast fire spread metrics. This is due to the fire generating its own weather systems revealed here by coupled modelling.

FINDINGS

Modelled PyroCB formation: clouds form due to massive heat output as the fire spreads. Updrafts are shown in red in the lower 2 km of atmosphere.

Pyrocumulonimbus (PyroCB)
The coupled model captured the formation of the PyroCB shown top-right. These often cause strong surface winds and lightning, both of which lead to unexpected fire spread. Strong winds lead to spotting when burning embers are transported in the elevated updrafts and turbulence. Waroona PyroCB or lightning were the most likely cause of downwind spotting on the first day of the fire.

The figure to the right shows PyroCB seen near Waroona, along with the formation seen in ACCESS-Fire output. The output is shown on 3D model levels up to 13.5 km altitude above ground level, over topography with the escarpment labelled in the top left panel. The cloud formation follows high energy output at a time when the fire front expands rapidly westwards. This matches what was seen in the field.

Discussion
Coupled modelling can clearly capture complex phenomena such as PCB and downslope fire spread. This is a step towards improved understanding and forecasting of these life threatening events.

- Fire spread is accurate but requires realistic estimation of potential downwind spotting.
- PyroCB formation and impacts could add value to danger warnings for fire suppression crews.
- Complex topography can lead to complex weather phenomena, which are difficult to accurately forecast using traditional fire danger indices.
- We can now run these simulations in better than real time, allowing, with the necessary infrastructure, for the possibility of operational use.