Predicting firestorm occurrence

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A firestorm results when the plume generated by the heat of a large wildfire develops characteristics akin to a thunderstorm. Indeed, the technical term for a firestorm is ‘pyrocumulonimbus’, which literally translates as ‘fire thunderstorm’. Firestorms should not be considered as surface fires, in the usual sense, as they involve significant coupling with the atmosphere, which can modify local weather patterns. For example, firestorm events can result in more erratic and unpredictable winds, mixing down of drier air from the upper levels of the atmosphere, increased potential for firebrand generation and transport, and dry lightning; all of which are unwelcome in the context of firefighting! Firestorm events consistently cause the greatest wildfire damage and pose an increasing challenge worldwide.

However, the complex processes that are required to combine to result in firestorm occurrence are still poorly understood, and we have only recently begun to be able to identify particular fires (amongst the many that may be burning on any given day) that are the most likely to develop firestorm characteristics. In this presentation, we present a summary of recent work conducted by UNSW, the ACT Emergency Services Agency and NSW Rural Fire Service, which has for the first time provided us with an operational capability to predict firestorm occurrence. We begin by formally defining the concept of an extreme wildfire as a fire that on one or more occasions couples with the atmosphere through development of blow-up fire events.

We then introduce the Blow-up Fire Outlook model, which draws upon recent scientific insights to ascertain the likelihood of a fire exhibiting deep or widespread flaming in an atmospheric setting conducive to strong plume development. In particular, the model combines information on wind, terrain, fuel moisture content and atmospheric instability, and incorporates new knowledge on dynamic modes of fire propagation to assess blow-up potential. The concepts will be illustrated with a number of historical examples.