WRF-FIRE SIMULATIONS OF THE KANGAROO ISLAND BUSHFIRES

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The Kangaroo Island bushfires

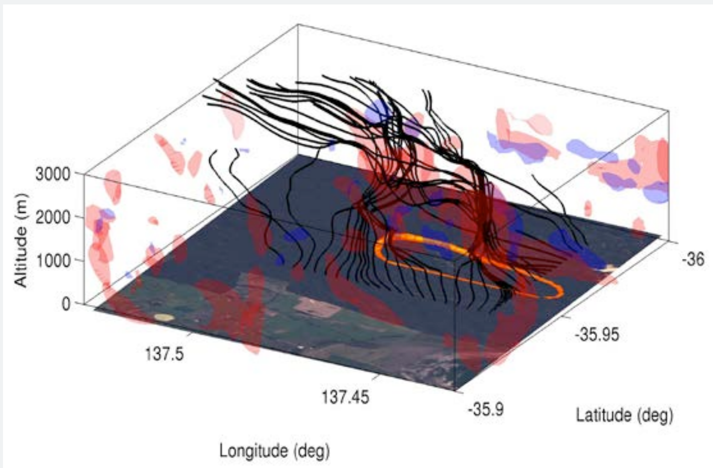
In December 2007, Kangaroo Island, off the coast of South Australia, was set ablaze by numerous dry lightning strikes. Four fires continued to burn for a two week period, consuming over 20% of the islands native vegetation. In a case study of the event, Peace and Mills (2012) attributed observed unusual fire behaviour to the local meteorology of the island.

At the Rocky River fire (above), experienced fire managers were shocked by the ferocity of the fire behaviour, in relatively benign conditions. The intense fire activity is believed to be due to convective plume entrainment of dry air from aloft, enhanced by topographic interactions as the fire moved up a gully in very dry, dense, open structured mallee fuels.

At the D'Estrees Bay fire (above) a spectacular convection column developed, sending a dense plume of smoke to the southeast. The satellite image shows the fire at the southeast corner of the island is much more intense than the other fires active on the island. Analysis of the meteorology showed the fire was located in a local sea breeze front convergence zone, overlain by an unstable atmosphere, which enabled an intense fire with a deep vertical column of smoke to develop.

Modelling the Kangaroo Island fires

Anticipating fire behaviour is critical for the fire management community to respond to events effectively. The aim of our research is to improve understanding of how the structure of the atmosphere, particularly in the vertical dimension, can impact fire behaviour. We believe that considering a wider range of factors than near surface temperature, relative humidity and wind, is key to understanding how the weather influences fires. Our approach has been in two phases. Firstly, we did a case study on the Kangaroo Island bushfires and described the local meteorology that produced unexpected fire-atmosphere interactions. Subsequently, we have simulated the event using WRF-fire.



Discussion of results and future work

The results here show our initial model simulations, with fire spread and vertical atmospheric structure around the fire well resolved. We are working on runs of the Kangaroo Island fires using high resolution topography and vegetation data and improved physics and dynamics options. Subsequent work will use WRF-fire in idealised mode in order to further understanding of the physical processes identified in the case study.

Further reading
Peace, M and Mills G. (2012) A case study of the Kangaroo Island bushfires. Technical Report, Centre for Atmospheric and Water Research.
http://www.cawcr.gov.au/publications/technicalreports.php
Mandel J, Beezley, J.D and Kochanski, A.K. (2011) Coupled Atmosphere-wildland fire modeling with WRF-fire version 3.3. Geoscience modeling development discussion.

Acknowledgements
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What is WRF-fire and why use it?

WRF-fire comprises of the Weather and Research Forecasting (WRF) atmospheric model coupled with a fire spread model. The coupling enables heat and moisture released by the simulated fire to be fed back into the atmospheric model, hence modifying the wind structure near the fire. WRF-fire allows us to explore how a fire can "create its own weather", which is an important process in understanding fire dynamics. The model can be run in real or idealised mode.

We have used WRF-fire to simulate the Rocky River and D'Estrees Bay fires on Kangaroo Island. Our simulations are the first run on a real event in Australia.

The WRF-fire simulations

The central graphic shows the vertical wind structure around the D'Estrees Bay fire. Black lines show the wind flow (streamlines) over the fire area (orange outline). Vertical motion around the fire is shown in red (2.5ms^{-1} upwards) and blue (2.5ms^{-1} downwards). This depiction of the wind above the fire is what sets WRF-fire apart from other fire behaviour models. By examining the vertical structure of the atmosphere around the fire using a coupled model, we can better understand how the fire and atmosphere interact and improve understanding of elements of fire behaviour apart from fire spread, such as convection column development.

The image below shows the isochrones (fire spread) for the D'Estrees Bay fire. The results are a reasonable match to the fire spread recorded during the event.