Meteorological Aspects of the Margaret River Fires on 23 November 2011

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Introduction: Early in the morning of 23 November 2011, a fuel-reduction burn near Margaret River in southwest WA increased dramatically in activity. The fire escaped control lines and burnt southwards along the coastal fringe, subsequently destroying some 47 homes, including the historic Wallcliffe House. Satellite imagery showed a smoke plume of vastly greater extent than other fires in the area.

Here, we present an analysis of the meteorology of the event, based mainly on very high resolution (400 m) simulations with the Bureau of Meteorology's ACCESS weather forecasting system. The fields shown are from an experimental very high resolution version of the model, similar to that described in the poster "Modelling the fire weather of the Eyre Peninsula fire of January 2005".

Vertical Atmospheric Structure: The marked change in the surface characteristics from land to sea resulted in a complex boundary-layer structure. Over the sea, a shallow moist stable boundary layer was surmounted by a marked maximum in the low level wind of about 24 m s^{-1} at a height of 600 to 700 m, which extended inland at least 100 km, and overlay light surface winds associated with a nocturnal inversion (Fig. 1). During the day, a well-mixed boundary layer up to 800 m deep developed over the land, while the jet weakened inland, probably due to this mixing.

Examination of the vertical wind component showed clear evidence of mountain-wave activity throughout the period, which led to marked downslope winds on the lee slopes in the early morning (see next section). During the day, turbulence generated by heating of the land surface would have mixed momentum from the jet down to the surface, and contributed to the strong gusty winds observed near the fire. Mechanical mixing from the topography, particularly in the vicinity of the coast, would have contributed further to this process.

Horizontal Atmospheric Structure: During the night of the 22nd, the wind direction backed from southeasterly to northeasterly. Marked drying was evident over the northern part of the Leeuwin-Naturaliste block from about 3 am WST on the 23rd, which extended southwards and strengthened over the next few hours (Fig. 2). The winds likewise strengthened, and marked downslope flow was evident along the coastal hills. According to the model, the strongest downslope winds at this time occurred near the Ellensbrook fire, with secondary maxima on some other hills (Fig. 3).

The winds continued to tend northerly during the morning, and the topographic enhancement shifted from being a maximum on the lee slopes, to the hilltops, due largely to the daytime reduction in stability.

Discussion: The following meteorological factors likely contributed to the fire becoming active from the early morning of the 23rd onwards:

- Dry air over the fire ground from about 3 am.
- Strong downslope winds in the lee of the hills over the prescribed burn areas.
- The development of a marked low level wind maximum (jet) during the night, which persisted through much of the day.
- Transfer of the jet momentum down to the surface, initially by mountain wave activity and mechanical turbulence, and after sunrise by heating-induced turbulence also.

The simulations show that the Ellensbrook prescribed burn area may have been meteorologically the worst location along that coast to have a fire that morning, due to the combination of the overnight drying and the strong downslope winds.

While high-resolution modelling such as that used here shows considerable potential, it is at present highly experimental and considerably more research, as well as more powerful computing, is needed before it could be made operational.

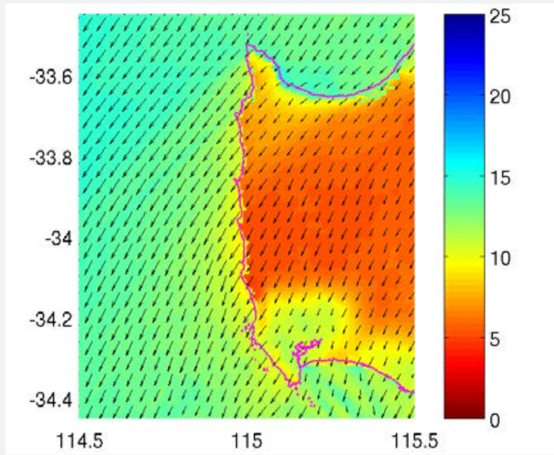

Figure 2: Surface dewpoint temperature (ºC) and winds (arrows) at 8 am WST over southwest WA. Warmer colours indicate drier air.

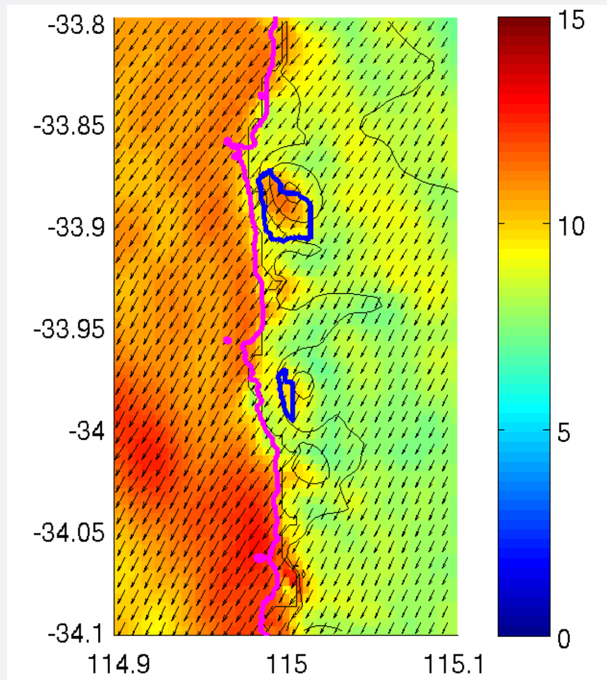

Figure 3: Surface wind speed (shading, m s^{-1}) and vector (arrows) in the Ellensbrook – Margaret River area at 8 am WST. The blue curves show the planned burn areas and the thin black lines are topographic contours at 50-m intervals.

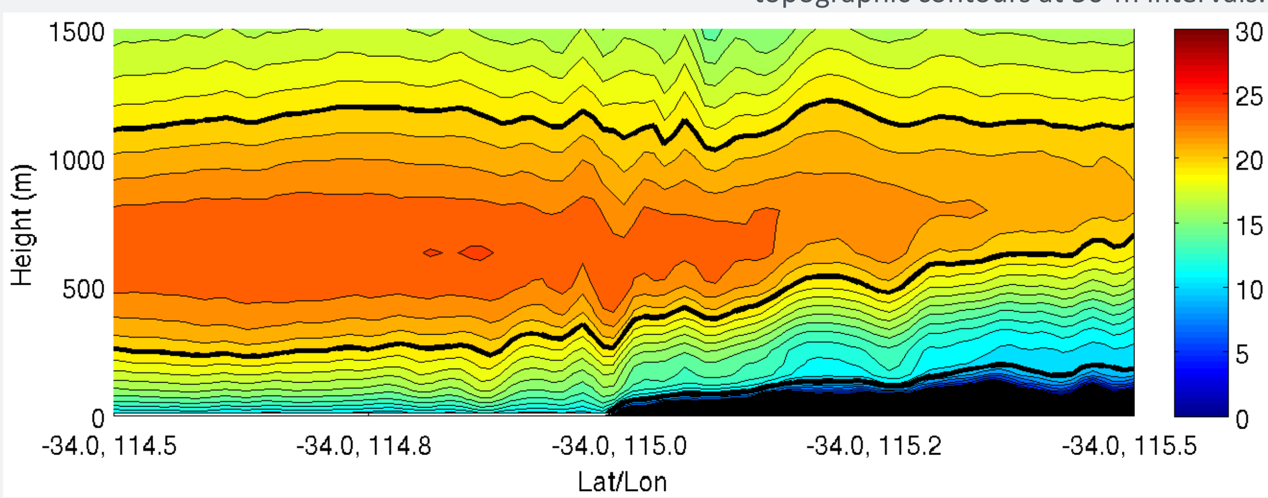

Figure 1: East-west cross-section of the wind speed at 8 am WST along latitude 34ºS. The wind speed is in m s^{-1}, contoured at 1 m s^{-1} with multiples of 10 shown bold.

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