



Extreme fire weather

Key Topics:

- communication [2]
- fire weather [3]
- severe weather [4]

Improved predictions of severe weather to reduce community impact [5]

This project is using high-resolution modelling, together with a range of meteorological data, to better understand and predict important meteorological natural hazards, including fire weather, tropical cyclones, severe thunderstorms and heavy rainfall. The outcomes from the project will contribute to reducing the impact and cost of these hazards on people, infrastructure, the economy and the environment.

Project: detail Notabs

Research team

Research leader

[6]




Dr Jeff Kepert
[6]
RESEARCH LEADER



[7]

Research team

[8]



Dr Kevin Tory
[8]
RESEARCH TEAM

[9]



Dr Dragana Zovko-Rajak
[9]
RESEARCH TEAM

[7]



[7]



[10]



David Wilke
[10]
RESEARCH TEAM



[7]

End User representatives

[11]



John Bally
[11]
END-USER



[12]

[13]



Paul Fox-Hughes
[13]
END-USER



[7]

[14]




Allen Gale
[14]
END-USER




[15]

[16]



Dr Simon Heemstra
[16]
END-USER



[17]

[18]




Andrew Grace
[18]
END-USER




[19]

[20]




Frank Crisci
[20]
END-USER




[21]

[22]



Dr Lachlan McCaw
[22]
END-USER



[23]

[24]



Alisa Schofield
[25]
END-USER



[26]

Description

This project used high-resolution modelling, together with a range of meteorological data, to better understand and predict important meteorological natural hazards, including fire weather, tropical cyclones, severe thunderstorms and heavy rainfall. The outcomes from the project are contributing to reducing the impact and cost of these hazards on people, infrastructure, the economy and the environment.

Specific case studies undertaken included the New South Wales Blue Mountains bushfires of 2013; ember transport by fire plumes; pyrocumulus cloud simulation and prediction, and the NSW April 2015 East Coast Low.

Ember transport

The study developed an understanding of how fire embers generated during bushfires can be lifted into the atmosphere and carried by winds ahead of a fire front, potentially starting new fires downwind. The team undertook simulations for ember transport for a wide range of wind speeds and ember fall speeds. It is important to consider a range of fall speeds, since different types of embers have different densities and aerodynamic properties which affect how far they are carried.

Pyrocumulonimbus

Plume modelling has also been utilised to study pyrocumulonimbus clouds (PyroCb). Intense fire plumes in suitably moist environments can lead to PyroCb development, with the possibility of strong downbursts which can exacerbate already extreme fire conditions. A survey of current understanding and forecast techniques was completed, and the team has worked towards developing improved techniques.

Blue Mountains bushfire

A detailed case study of the Blue Mountains fires of October 2013 was undertaken, focusing on 17 October when some 200 houses were destroyed. Analysis uncovered a weather phenomenon known as mountain waves which contributed to the severe fire behaviour. Mountain waves are atmospheric oscillations that occur due to air flowing over hills or mountains. They can arise in several different ways, some more predictable than others. Often they cause strong downslope winds on the lee slope of the hill or mountain.

April 2015 East Coast Low

Collectively, the ensemble weather simulations accurately predicted the position and intensity of the low, the strong winds and the rainfall. The differences between them give insight as to the forecast uncertainty, the overall envelope of areas at some risk, and the areas at highest risk. The ensemble also enables insight into the processes that lead to the rapid intensification of these systems. The team is continuing to learn from ensemble simulations about predictability of East Coast Lows and how to use this information to benefit both forecasters and the emergency services.

Specific outcomes of this project have:

- improved the scientific understanding of severe weather phenomena in Australia
- improved the knowledge of how to best predict these phenomena, including model configuration and interpretation
- contributed to the post-event analysis and lessons learned of selected severe events that occur during the course of the project
- informed the development of numerical weather prediction systems specifically for severe weather.

Related News



Making better use of research
CAPABILITY, EMERGENCY MANAGEMENT

14 MAY 2021

[27]



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COMMUNITIES, FIRE WEATHER

18 MAR 2021

[28]



28 JAN 2021

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FIRE, FIRE IMPACTS

[29]



28 JAN 2021

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COMMUNICATION, EMERGENCY MANAGEMENT

[30]



28 OCT 2020

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COMMUNICATION, FIRE WEATHER

[31]



21 APR 2020

New online - April 2020
COMMUNICATION, EMERGENCY MANAGEMENT

[32]



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 COMMUNICATION, FIRE

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[33]



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11 DEC 2019

[34]



Severe weather research has impact
COINCIDENT EVENTS, FORECASTING

09 AUG 2019

[35]



New online - December 2018
EMERGENCY MANAGEMENT, MODELLING

18 DEC 2018

[36]



New online - November 2017

17 NOV 2017

[37]



New online - September 2017

13 SEP 2017

[38]



Floods and fires, volunteers and resilience
EMERGENCY MANAGEMENT, MULTI-HAZARD

02 JUN 2017

[39]



Mountain waves and extreme fire behaviour
COMMUNICATION, FIRE WEATHER

30 MAY 2017

[40]



New online - November 2016

17 NOV 2016

[41]



New online - September 2016

14 SEP 2016

[42]



07 OCT 2014

Mercury rising replay available
COMMUNITIES, FIRE SEVERITY

[43]

Publications

| Year | Type | Citation |
|------|------------------|---|
| 2022 | Report | Kepernt, J. [6] <i>et al.</i> Improved predictions of severe weather to reduce community impact – final project report [44]. (Bushfire and Natural Hazards CRC, 2022). Google Scholar [45] BibTeX [46] EndNote XML [47] |
| 2020 | Journal Article | Tory, K. J. [8] & Kepernt, J. [6] Pyrocumulonimbus Firepower Threshold: Assessing the atmospheric potential for pyroCb [48]. <i>Weather and Forecasting</i> (2020). doi:https://doi.org/10.1175/WAF-D-19-0188.1 |
| 2020 | Report | Kepernt, J. [6], Tory, K. J. [8], Zovko-Rajak, D. [9], Wilke, D. [53] & Schroeter, S. [54] Improved predictions of severe weather to reduce community impact [55]. (Bushfire and Natural Hazards CRC, 2020). Google Scholar [56] BibTeX [57] EndNote XML [58] |
| 2020 | Report | Tory, K. J. [8] The real-time trial of the Pyrocumulonimbus Firepower Threshold [59]. (Bushfire and Natural Hazards CRC, 2020). Google Scholar [60] BibTeX [61] EndNote XML [62] |
| 2019 | Conference Paper | Tory, K. J. [8] Pyrocumulonimbus Firepower Threshold: a pyrocumulonimbus prediction tool [63]. <i>AFAC19 powered by INTERSCHUTZ - Bushfire and Natural Hazards CRC Research Forum</i> (Australia, 2019). Google Scholar [64] BibTeX [65] EndNote XML [66] |
| 2019 | Conference Paper | Zovko-Rajak, D. [9], Tory, K. J. [8] & Kepernt, J. [6] A case study of South Australia's severe thunderstorm and tornado outbreak [68]. <i>AFAC19 powered by INTERSCHUTZ - Bushfire and Natural Hazards CRC Research Forum</i> (Australia, 2019). Google Scholar [69] BibTeX [70] EndNote XML [71] |
| 2018 | Journal Article | Kepernt, J. [6] The boundary layer dynamics of tropical cyclone rainbands [72]. <i>Journal of the Atmospheric Sciences</i> 75 , (2018). DOI [73] Google Scholar [74] BibTeX [75] EndNote XML [76] |
| 2018 | Journal Article | Zieger, S. [77], Greenslade, D. [78] & Kepernt, J. [6] Wave ensemble forecasts for tropical cyclones in the Australian region [79]. <i>Ocean Dynamics</i> 68 , 603-625 (2018). DOI [80] Google Scholar [81] |
| 2018 | Report | Tory, K. J. [8] Models of buoyant plume rise [84]. (Bushfire and Natural Hazards CRC, 2018). Google Scholar [85] BibTeX [86] EndNote XML [87] |
| 2017 | Conference Paper | Rumsewicz, M. [88] Research proceedings from the 2017 Bushfire and Natural Hazards CRC and AFAC Conference [89]. <i>Bushfire and Natural Hazards CRC & AFAC annual conference 2017</i> (Bunbury, Australia, 2017). Google Scholar [90] BibTeX [91] EndNote XML [92] |
| 2017 | Conference Paper | Tory, K. J. [8], Thurston, W. [93] & Kepernt, J. [6] Thermodynamic considerations of pyrocumulus formation [94]. <i>AFAC17</i> (Bushfire and Natural Hazards CRC, 2017). Google Scholar [95] BibTeX [96] EndNote XML [97] |
| 2017 | Conference Paper | Kepernt, J. [6] Secondary eyewall formation in tropical cyclones [98]. <i>AFAC17</i> (Bushfire and Natural Hazards CRC, 2017). Google Scholar [99] BibTeX [100] EndNote XML [101] |
| 2017 | Journal Article | Thurston, W. [93], Kepernt, J. [6], Tory, K. J. [8] & Fawcett, R. [102] The contribution of turbulent plume dynamics to long-range spotting [103]. <i>International Journal of Wildland Fire</i> 26 , 317-330 (2017). doi:10.1071/ijwf16050 |
| 2017 | Journal Article | Kepernt, J. [6] Time and space scales in the tropical cyclone boundary layer, and the location of the eyewall updraft [108]. <i>Journal of the Atmospheric Sciences</i> (2017). doi:10.1175/JAS-D-17-0071.1 |
| 2017 | Report | Kepernt, J. [6] <i>et al.</i> Improved predictions of severe weather to reduce community impact: midterm report 2014-17 [113]. (Bushfire and Natural Hazards CRC, 2017). Google Scholar [114] BibTeX [115] EndNote XML [116] |
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| 2016 | Conference Paper | Ching, S. [121], Fawcett, R. [102], Thurston, W. [93], Tory, K. J. [8] & Kepernt, J. [6] Mesoscale features related to the Blue Mountains fires of 17 October 2013 revealed by high resolution Numerical Weather Prediction [122]. <i>AFAC16</i> (Bushfire and Natural Hazards CRC, 2016). Google Scholar [123] BibTeX [124] EndNote XML [125] |
| 2016 | Conference Paper | Thurston, W. [93], Tory, K. J. [8], Fawcett, R. [102] & Kepernt, J. [6] The effects of turbulent plume dynamics on long-range spotting [126]. <i>AFAC16</i> (Bushfire and Natural Hazards CRC, 2016). Google Scholar [127] BibTeX [128] EndNote XML [129] |
| 2016 | Conference Paper | Thurston, W. [93], Tory, K. J. [8], Fawcett, R. [102] & Kepernt, J. [6] Long-range spotting by bushfire plumes: The effects of plume dynamics and turbulence on firebrand trajectory [130]. <i>5th International Fire Behaviour and Fuels Conference</i> (Sydney, Australia, 2016). Google Scholar [131] BibTeX [132] EndNote XML [133] |
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| 2016 | Report | Kepernt, J. [6] <i>et al.</i> Improved predictions of severe weather to reduce community impact: Annual project report 2015-2016 [138]. (Bushfire and Natural Hazards CRC, 2016). Google Scholar [139] BibTeX [140] EndNote XML [141] |
| 2016 | Report | Tory, K. J. [8], Peace, M. [142] & Thurston, W. [93] Pyrocumulonimbus forecasting: needs and issues [143]. (Bushfire and Natural Hazards CRC, 2016). Google Scholar [144] BibTeX [145] EndNote XML [146] |
| 2015 | Conference Paper | Kepernt, J. [6], Naughton, M. [147] & Bally, J. [11] Managing Severe Weather - Progress and Opportunities Conference Paper 2014 [148]. <i>Bushfire and Natural Hazards CRC and AFAC Wellington Conference</i> (Wellington, New Zealand, 2015). Google Scholar [149] BibTeX [150] EndNote XML [151] |
| 2015 | Conference Paper | Fawcett, R. [102], Yeo, C. [152], Thurston, W. [93], Kepernt, J. [6] & Tory, K. J. [8] Modelling the Fire Weather of the Coonabarabran Fire of 13 January 2013 [153]. <i>Bushfire and Natural Hazards CRC and AFAC Wellington Conference</i> (Wellington, New Zealand, 2015). Google Scholar [154] BibTeX [155] EndNote XML [156] |
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| 2015 | Conference Paper | Thurston, W. [93], Tory, K. J. [8], Fawcett, R. [102] & Kepernt, J. [6] Large-eddy simulations of pyro-convection and its sensitivity to environmental conditions - peer viewed [161]. <i>Adelaide Conference on Fire Behaviour and Fuels</i> (Adelaide, Australia, 2015). Google Scholar [162] BibTeX [163] EndNote XML [164] |
| 2015 | Journal Article | Thurston, W. [93], Fawcett, R. [102], Tory, K. J. [8] & Kepernt, J. [6] Simulating boundary-layer rolls with a numerical weather prediction model [165]. <i>Quarterly Journal of the Royal Meteorological Society</i> 141 , 123-134 (2015). doi:10.1002/qj.2600 |
| 2015 | Presentation | Kepernt, J. [6], Thurston, W. [93], Ching, S. [121], Tory, K. J. [8] & Fawcett, R. [102] Improved predictions of severe weather to reduce community risk [170]. (2015). Google Scholar [171] BibTeX [172] EndNote XML [173] |
| 2015 | Report | Tory, K. J. [8] & Thurston, W. [93] Pyrocumulonimbus: A Literature Review [174]. (2015). Google Scholar [175] BibTeX [176] EndNote XML [177] |
| 2015 | Report | Kepernt, J. [6], Tory, K. J. [8], Thurston, W. [93], Ching, S. [121] & Fawcett, R. [102] Improved predictions of severe weather to reduce community impact: Annual project report 2014-2015 [178]. (2015). Google Scholar [179] BibTeX [180] EndNote XML [181] |

Presentations & Resources

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| 02 Sep 2015 | The Sydney 2014 Forecasting Demonstration Project A Step from Research to Operations [203] | 1.27 MB | [204] (1.27 MB) [197], fire weather [3], severe weat |
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| 03 Apr 2016 | Monitoring and prediction - cluster overview [208] | 0 bytes | [209] (0 bytes) [202], multi-hazard [210], scenario |
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| 30 May 2017 | Fire Australia Issue Two 2017 [223] | 5.11 MB | [224] (5.11 MB) severe weather [4], volunteering [2 |
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| 18 Jun 2019 | Forecasting the Impacts of Severe Weather: How does our work reduce the impacts of natural disasters? [243] | 648.54 KB | [244] (648.54 KB) [240], severe weather [4] |
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| 30 Jul 2019 | Improved predictions of severe weather to reduce community risk [247] | 2.76 MB | [248] (2.76 MB) [240], severe weather [4] |
| 27 Aug 2019 | The PyroCb Firepower Threshold: A pyrocumulonimbus prediction tool [249] | 9.16 MB | [250] (9.16 MB) [3], severe weather [4] |
| 27 Aug 2019 | A case study of South Australia's severe thunderstorm and tornado outbreak (28 September 2016) [251] | 4.84 MB | [252] (4.84 MB) [2] [2], flood [225] |
| 02 Jul 2020 | The PyroCb Firepower Threshold (PFT): a tool for pyrocumulonimbus prediction by Kevin Tory [253] | 0 bytes | [254] (0 bytes) [3], severe weather [4], storm surg |
| 07 Dec 2020 | Severe thunderstorm and tornado outbreak in South Australia [256] | | coastal [257], risk management [186], storm su |
| 08 Dec 2020 | Forecasting fire-generated thunderstorms [258] | | fire weather [3], severe weather [4], storm surg |
| 18 Mar 2021 | Fire Australia Issue One 2021 [259] | 5.2 MB | [260] (5.2 MB) [1], communities [240], severe weath |
| 17 May 2021 | Fire Australia Issue Two 2021 [262] | 11.74 MB | [263] (11.74 MB) [264], emergency management [265] |

Posters



[267]
Improved predictions of severe weather to help reduce community impact
 [267]

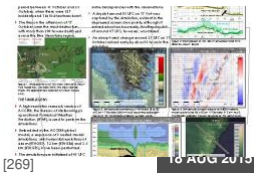
To improve our understanding of and ability to predict severe weather, including for bush fires, tropical...



[268]
Weather Science to Societal Impact: Opportunities for Australia in the World Meteorological Organisation's High Impact Weather Project
 [268]

COMMUNICATION [2], FIRE WEATHER [3]

The Bureau of Meteorology seeks Australian collaborators to participate in a new 10-year international high...

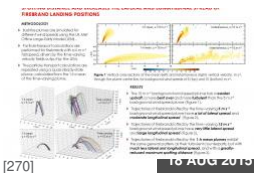


[269] 18 AUG 2013

Modelling the Fire Weather of the Blue Mountains Fires of October 2013

[269]
 COMMUNICATION [2], FIRE WEATHER [3]

High resolution simulations over the Blue Mountains Region on 17 October 2013 show several interesting...

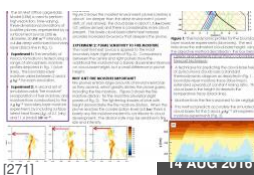


[270] 18 AUG 2013

Long-Range Spotting by Bushfire Plumes: The Effects of In-Plume Turbulence on Firebrand Trajectory

[270]
 COMMUNICATION [2], FIRE WEATHER [3]

Large-eddy simulations of bushfire plumes are combined with firebrand trajectory calculations to estimate the...

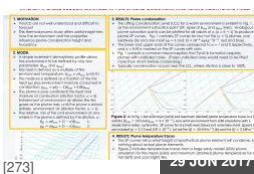


[271] 14 AUG 2016

Is fire moisture importance for pyrocumulimbus development?

[271] REMOTE
 FIRE SEVERITY [216], SENSING [272]

Pyrocumulimbus clouds have been linked to highly dangerous fire behaviour.

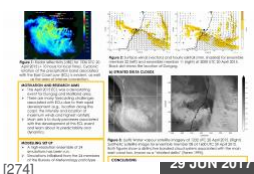


[273] 23 JUN 2017

Thermodynamics of pyrocumulimbus formation

[273]
 COMMUNICATION [2], FIRE WEATHER [3]

In favourable atmospheric conditions, large hot fires can produce pyrocumulimbus cloud: deep convective columns...

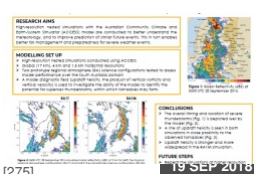


[274] 29 JUN 2017

Ensemble prediction of the East Coast Low of April 2015

[274]
 COMMUNICATION [2], FLOOD [225]

Between 20-23 April 2015 the eastern coast of Australia was affected by a low-pressure system, known as an...



[275] 19 SEP 2018

A case study of South Australia's severe thunderstorm and tornado outbreak (28 September 2016)

[275]
 COMMUNICATION [2], FIRE WEATHER [3]

One of the most significant thunderstorm outbreaks recorded in South Australia impacted central and eastern...

27 AUG 2019

A fast, physically based scheme for predicting long-range spotting potential

[276]
 COMMUNICATION [2], SEVERE WEATHER [4]

In extreme cases, embers transported in a bushfire plume have started new fires over thirty kilometres away...



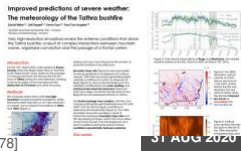
[277] 27 AUG 2019

Pyrocumulonimbus Firepower Threshold: A pyroCb prediction tool.

[277]

COMMUNICATION [2], FIRE WEATHER [3]

Pyrocumulonimbus (fire-induced thunderstorms, pyroCb) are associated with unpredictable changes in fire...



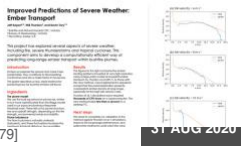
[278]

Improved predictions of severe weather: The meteorology of the Tathra bushfire

[278]

COMMUNITIES [240], SEVERE WEATHER [4]

Key findings: High-resolution simulations provide valuable insight into the meteorology of the Tathra bushfire.



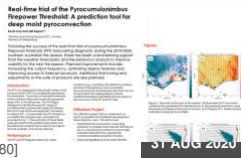
[279]

Improved Predictions of Severe Weather: Ember Transport

[279]

COMMUNITIES [240], SEVERE WEATHER [4]

Key findings: Our new method for calculating bushfire ember transport is accurate and very fast.



[280]

Real-time trial of the Pyrocumulonimbus Firepower Threshold: A prediction tool for deep moist pyroconvection

[280]

COMMUNITIES [240], SEVERE WEATHER [4]

Key findings: "The PFT provided very useful guidance to forecasters briefing emergency services."

Linked Projects

Resilience to clustered disaster events on the coast - storm surge

[281]

FLOOD AND COASTAL MANAGEMENT [282]

Dr Scott Nichol
Geoscience Australia [283]



[283]

Fire spread prediction across fuel types

[284]

BUSHFIRE PREDICTIVE SERVICES [285]

A/Prof Khalid Moinuddin
Victoria University [286]



[286]

Improved predictions of severe weather to reduce community impact

[5]

SEVERE AND HIGH IMPACT WEATHER [287]

Dr Jeff Kepert
Bureau of Meteorology [7]



[7]

Improving land dryness measures and forecasts

[288]

SEVERE AND HIGH IMPACT WEATHER [287]

Dr Imtiaz Dharssi
Bureau of Meteorology [7]



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