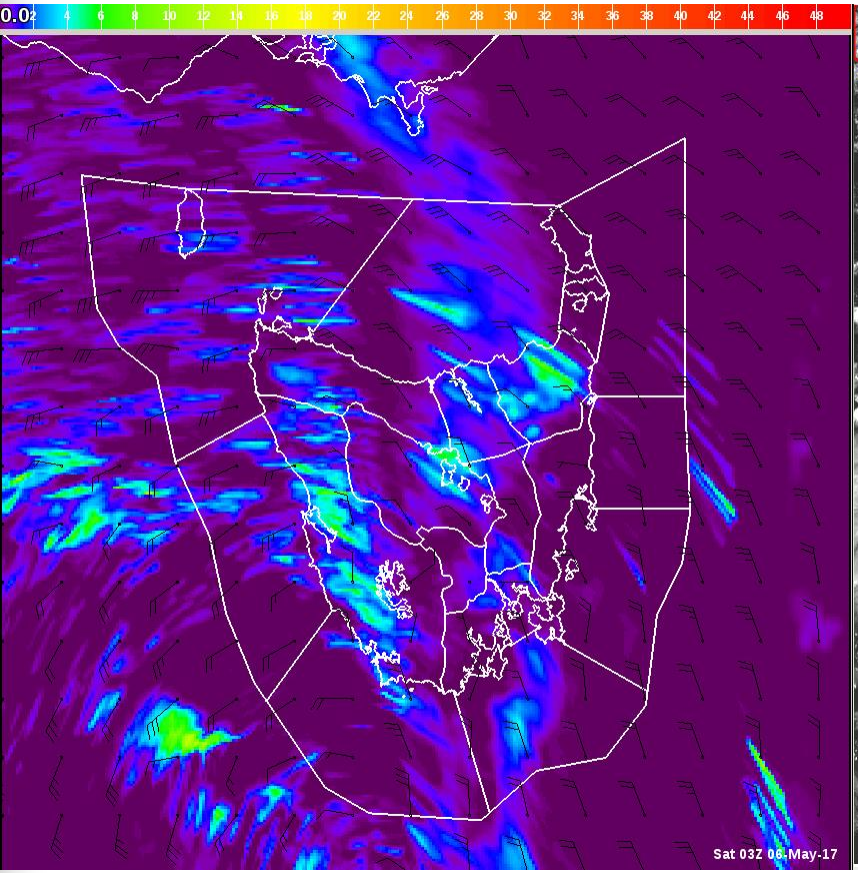
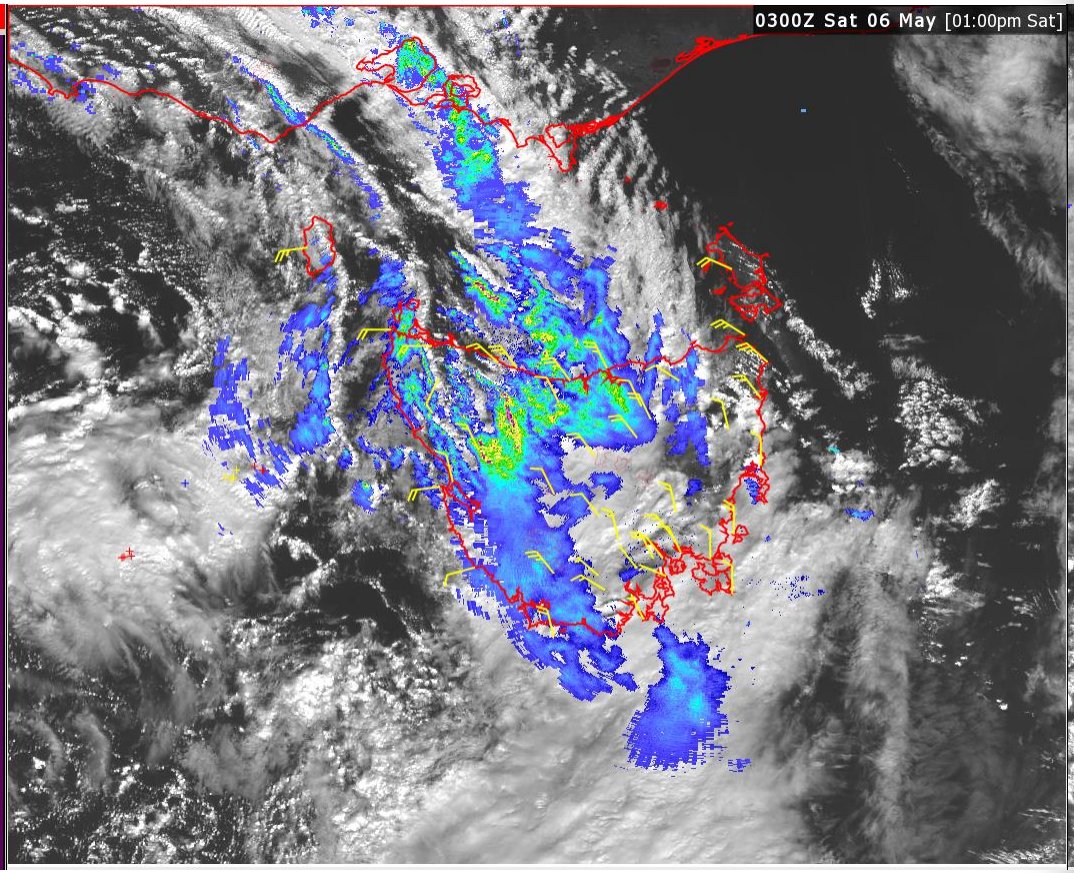
BUILDING BUSHFIRE PREDICTIVE SERVICES CAPABILITY

Dr Stuart Matthews – NSW Rural Fire Service
John Bally – Bureau of Meteorology
Dr Adam Leavesley – ACT Parks and Conservation Service
David Pearce – Country Fire Service South Australia
Simeon Telfer– Dept of Environment, Water and Natural Resources South Australia
Associate Prof Khalid Moinuddin– Bushfire and Natural Hazards CRC, Victoria University
Associate Prof Jason Sharples – Bushfire and Natural Hazards CRC, University of New South Wales
Dr Jeff Kepert – Bushfire and Natural Hazards CRC, Bureau of Meteorology
Dr Mika Peace– Bushfire and Natural Hazards CRC, Bureau of Meteorology
Dr Alex Filkov– Bushfire and Natural Hazards CRC, University of Melbourne

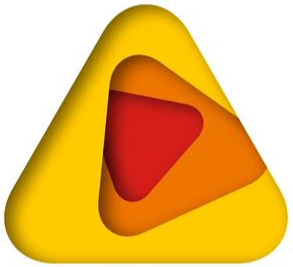
Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme

JOHN BALLY, BUREAU OF METEOROLOGY, LEAD END-USER


0.02 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Sat 03Z 06-May-17


0300Z Sat 06 May [01:00pm Sat]

VIDEO WITH DR SIMON HEEMSTRA, NSW RURAL FIRE SERVICE, LEAD END-USER

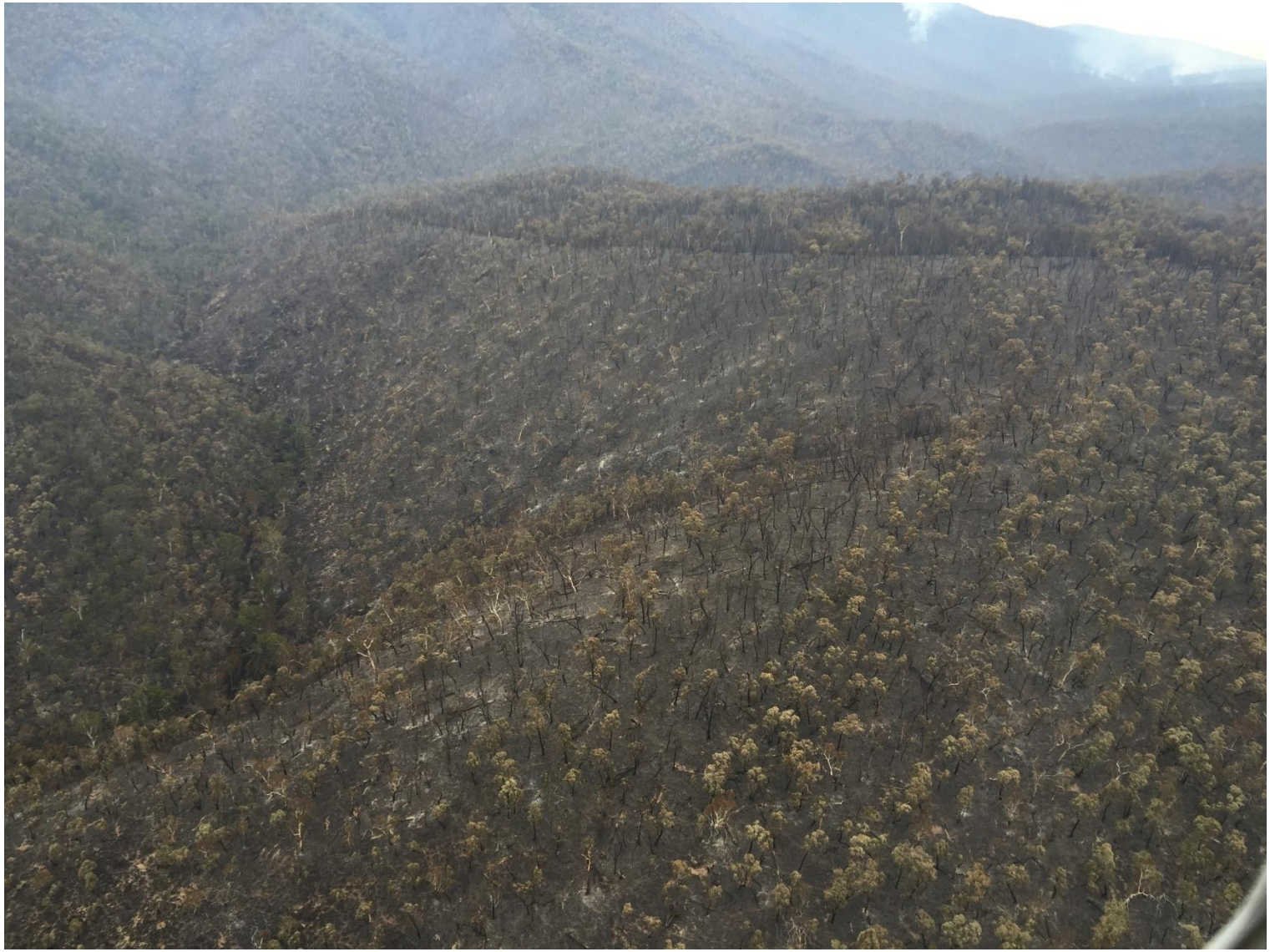


bushfire&natural
HAZARDSCRC

Building bushfire predictive services capability

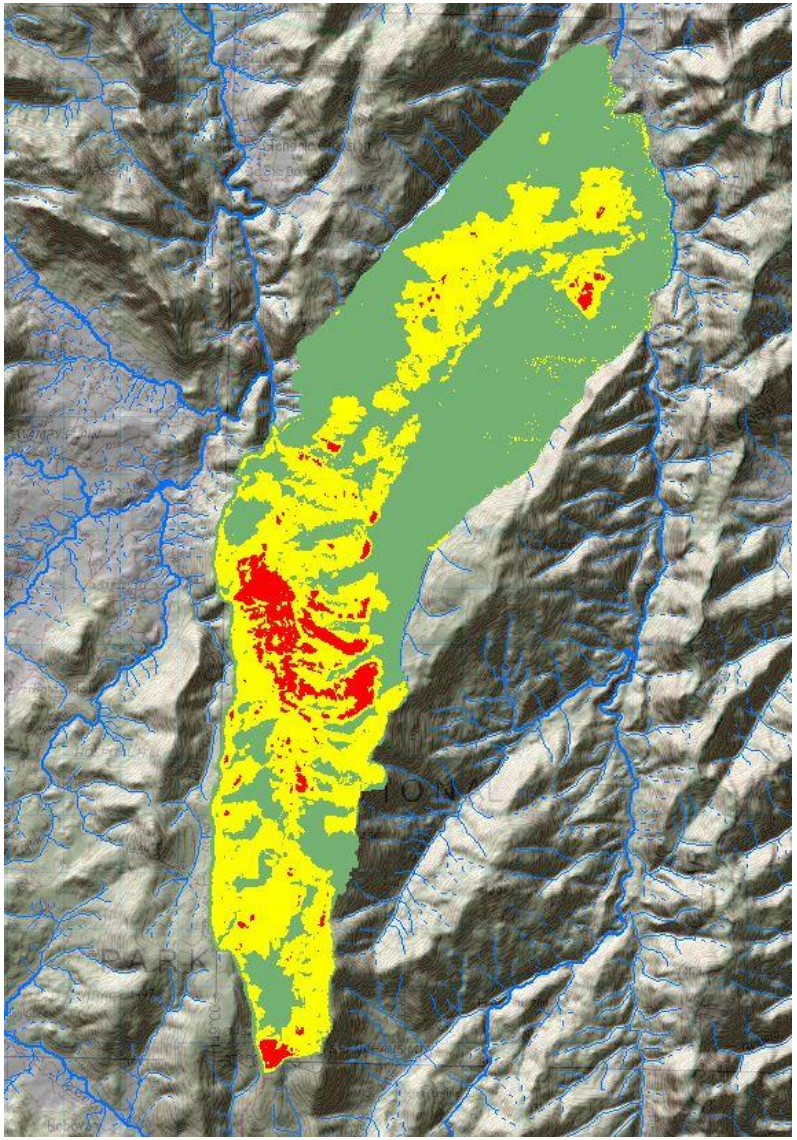
DR ADAM LEAVESLEY, ACT PARKS AND CONSERVATION SERVICE, END-USER

BNHCRC RESEARCH SHOWCASE IN PRESCRIBED BURNING



EVALUATION

Brandy Flat HRB fire severity assessment



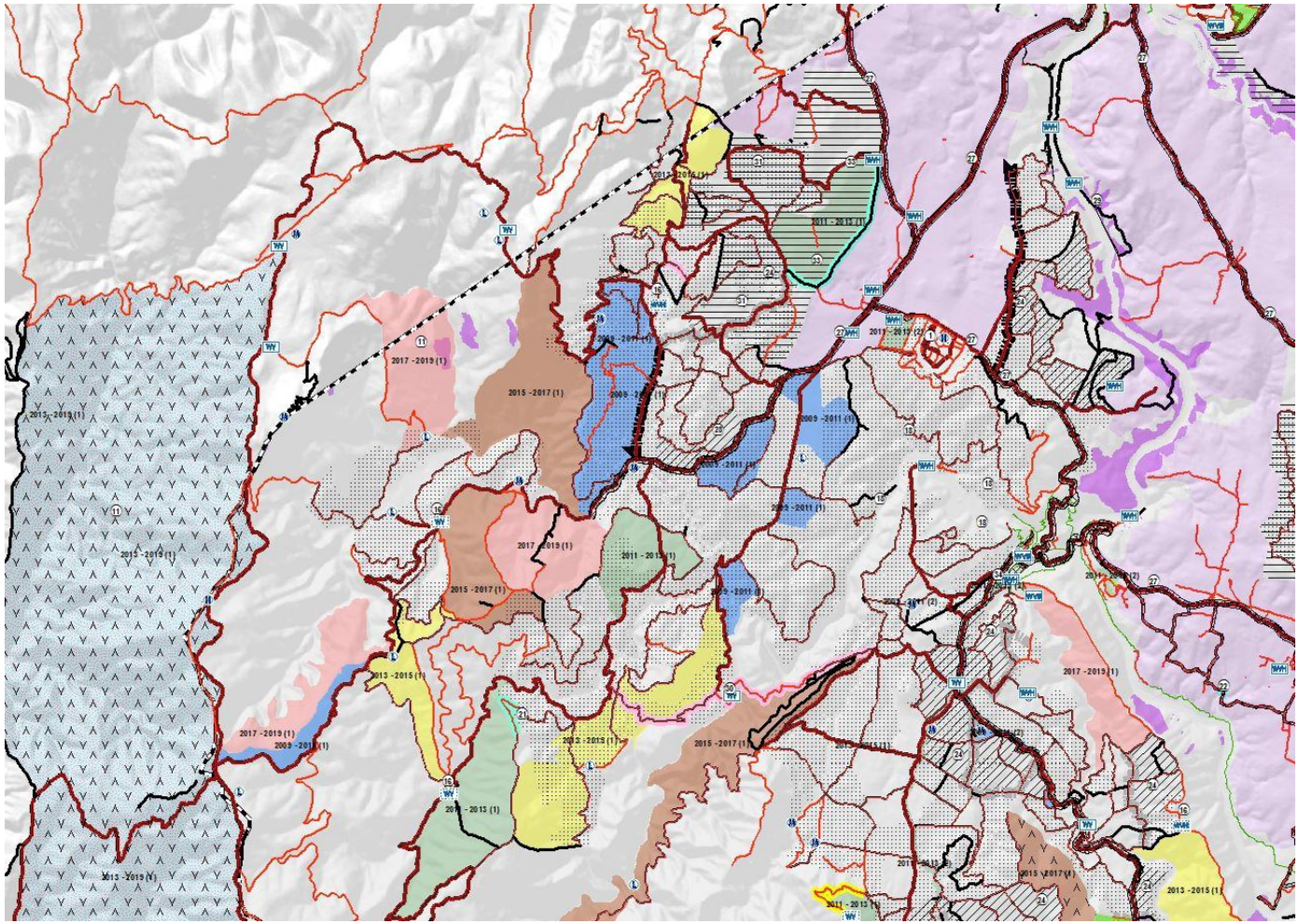
RESEARCH SHOWCASE IN PRESCRIBED BURNING

1) Planning: Bradstock group (UoW, UMelb)

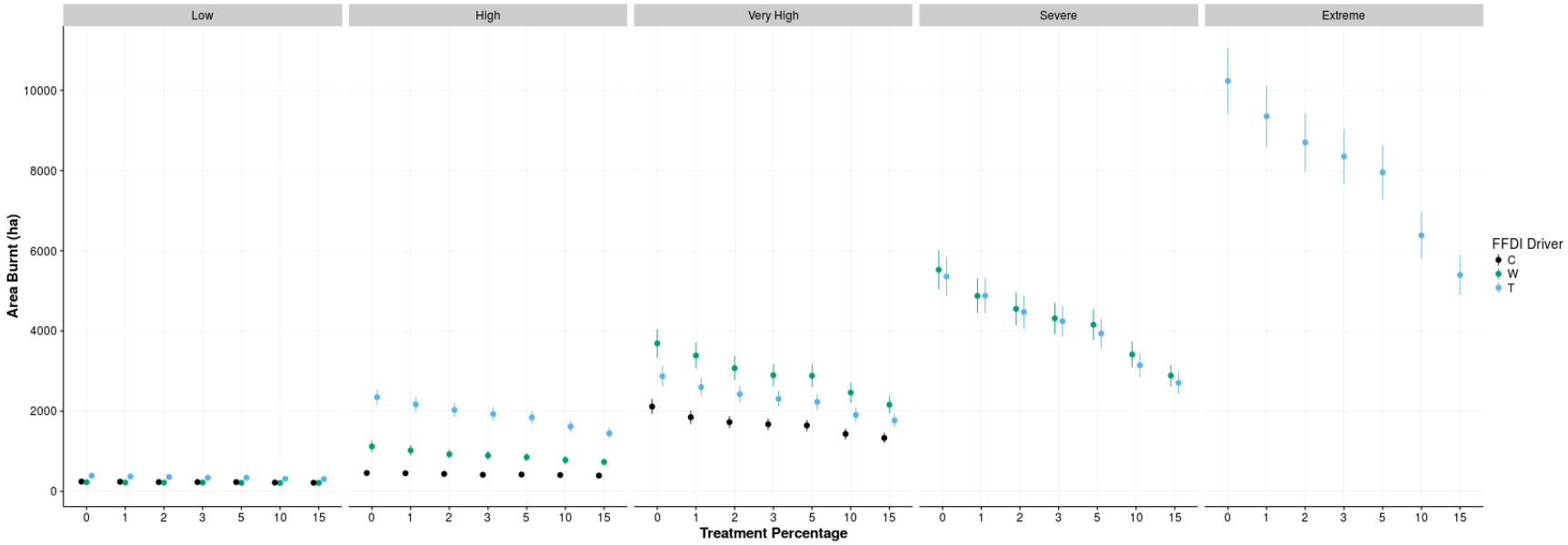
1) Implementation: Van Dijk, Yebra and Cary (ANU)

1) Evaluation: Adams, Bell and Gharun (USyd)

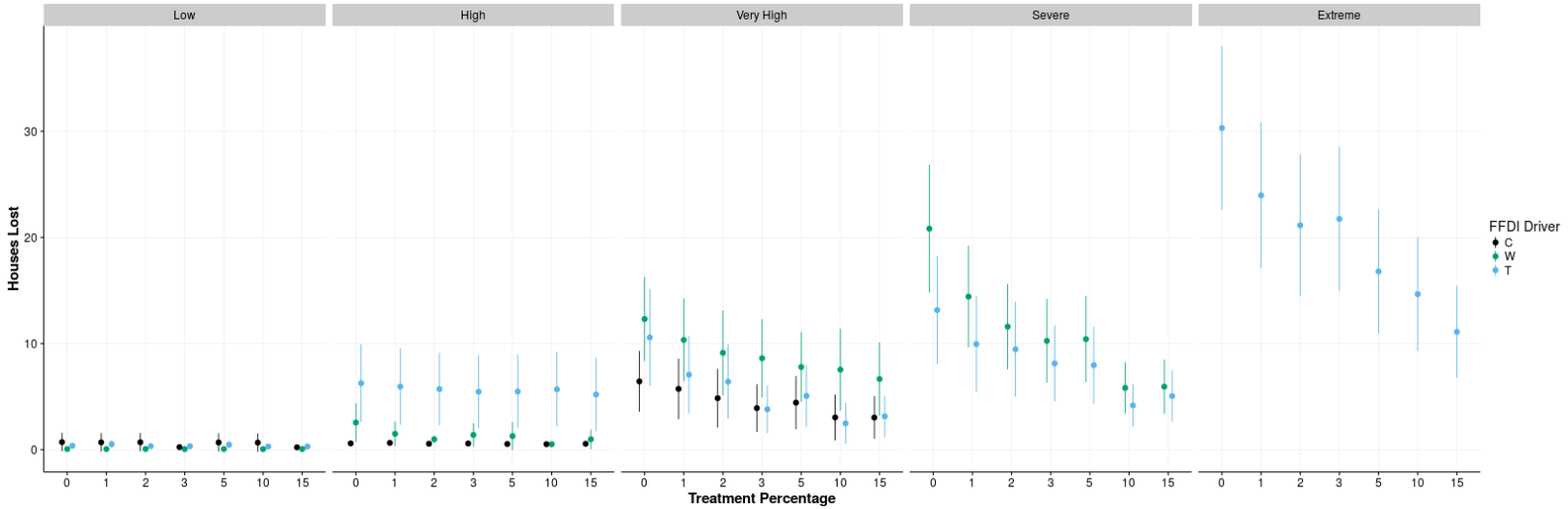
PRESCRIBED BURNING - PLANNING



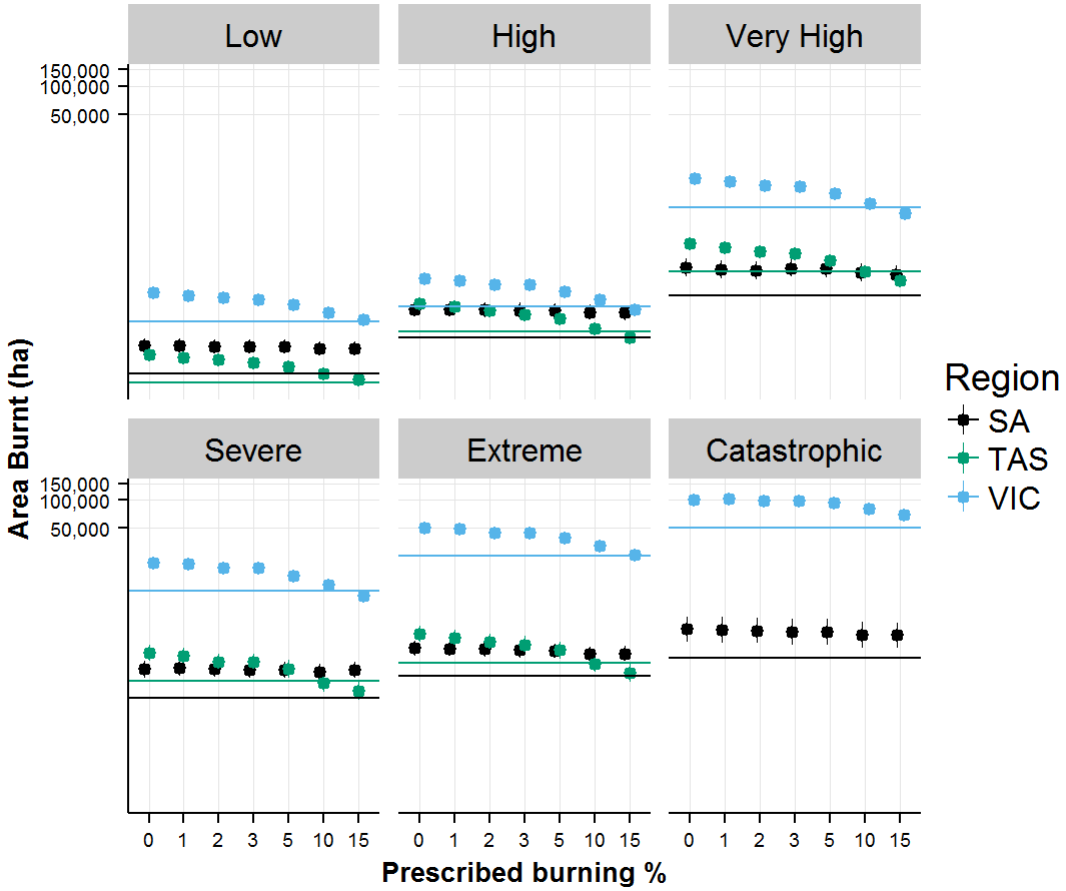
PRESCRIBED BURNING - PLANNING



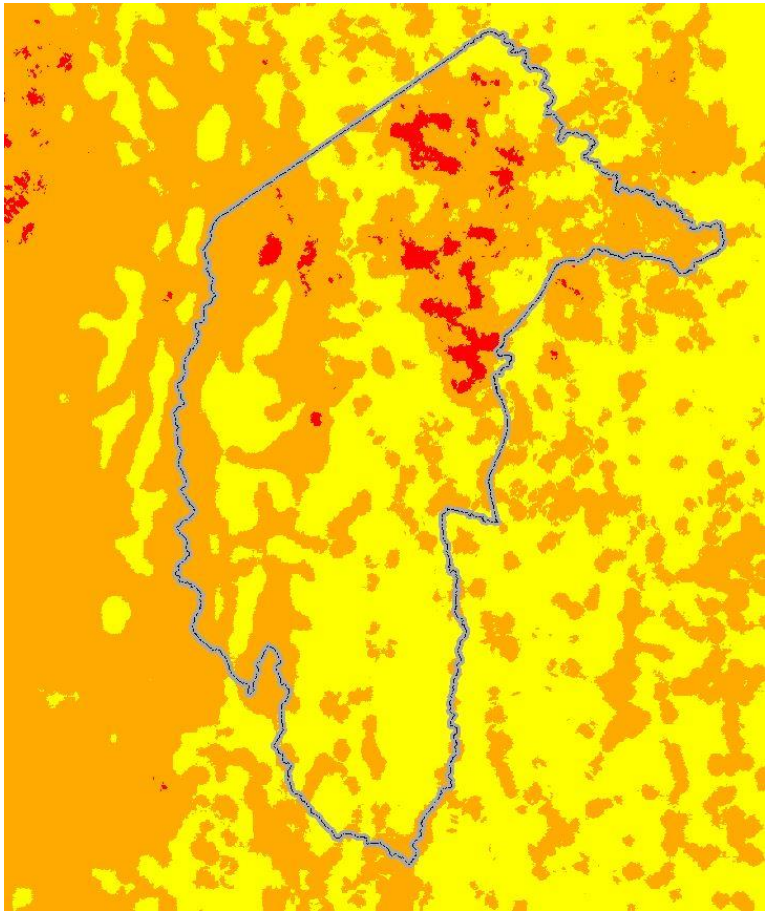
PRESCRIBED BURNING - PLANNING



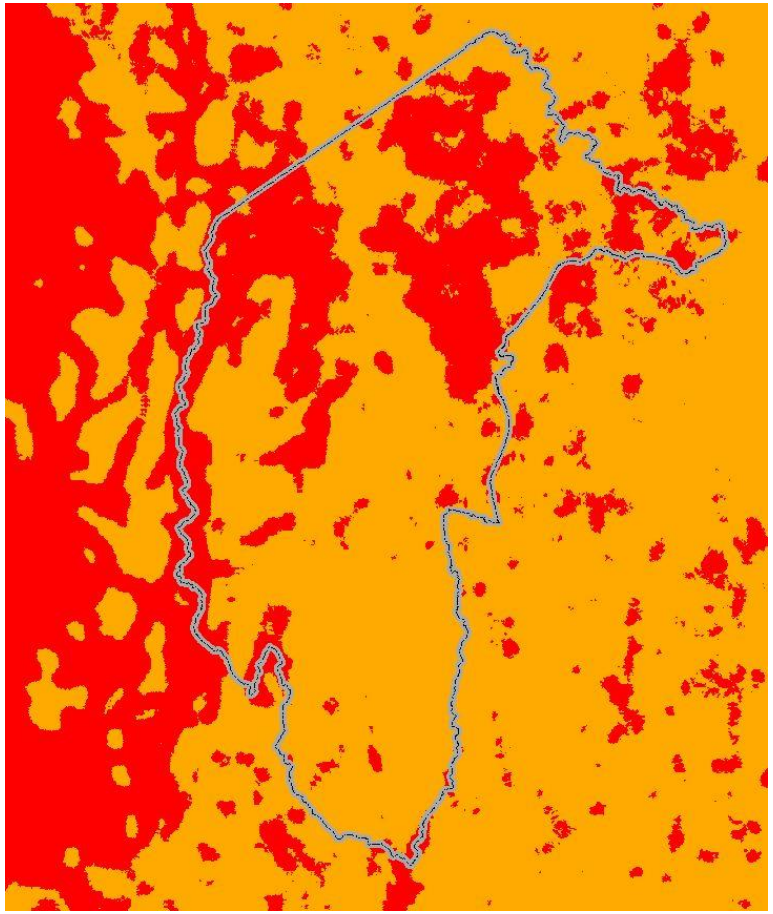
PRESCRIBED BURNING - PLANNING



PRESCRIBED BURNING - PLANNING



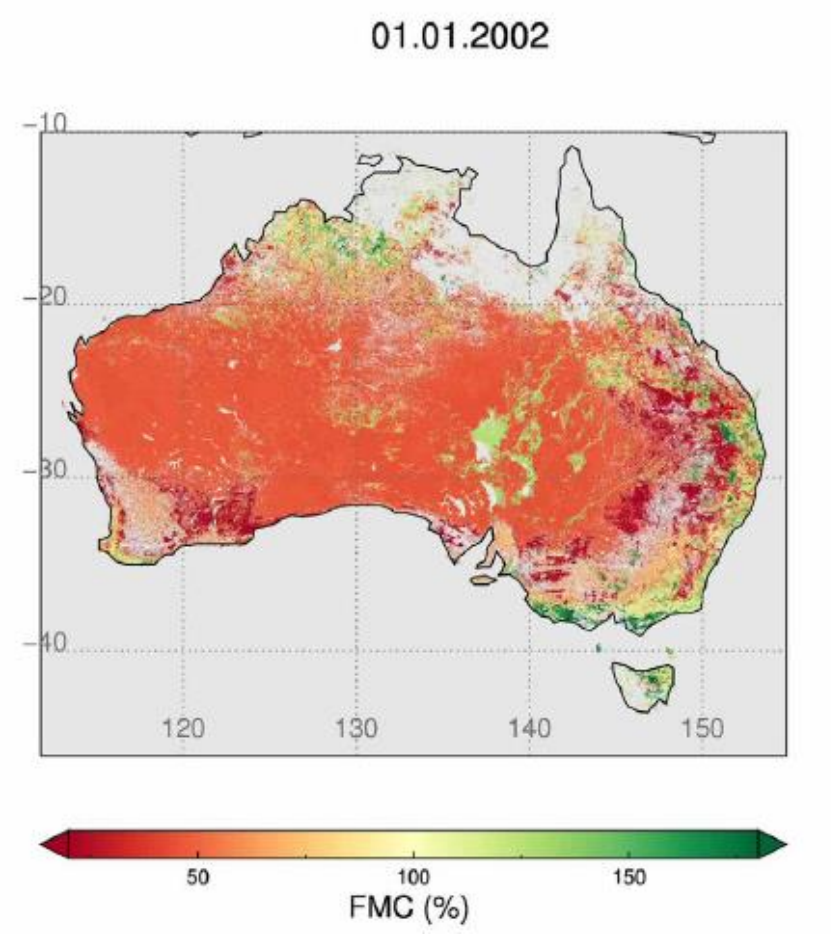
Ignition Probability – FFDI 25



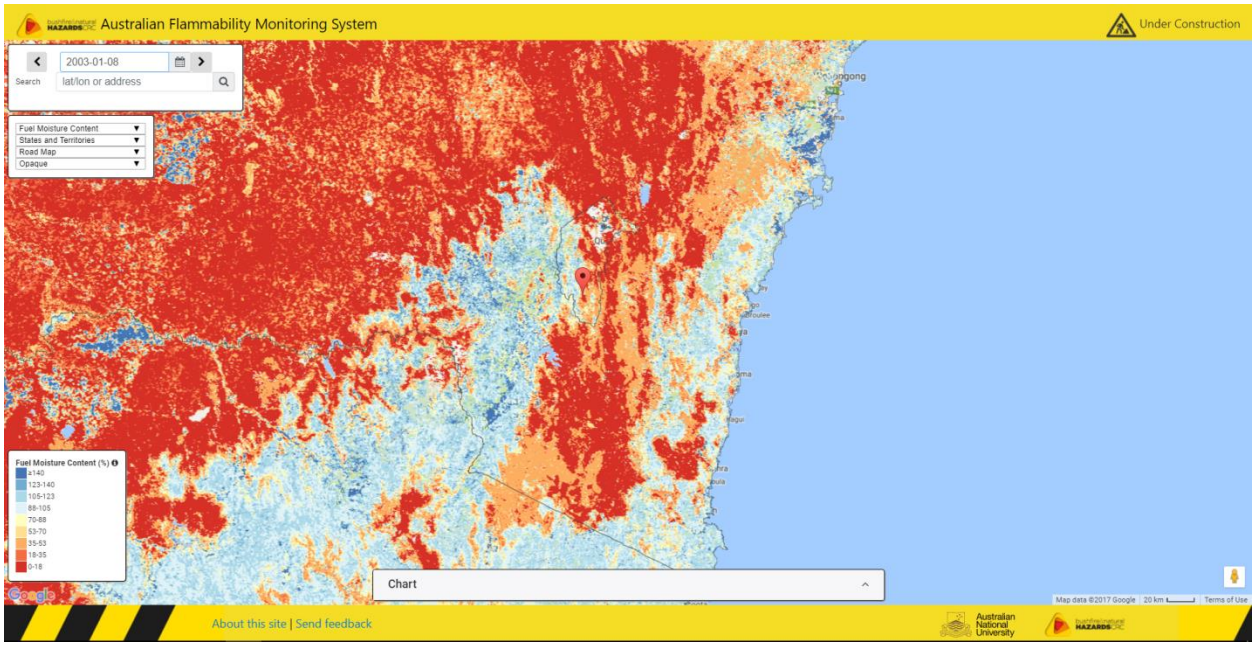
Ignition Probability – FFDI 135

PRESCRIBED BURNING - IMPLEMENTATION

Satellite-based fuel moisture content and flammability

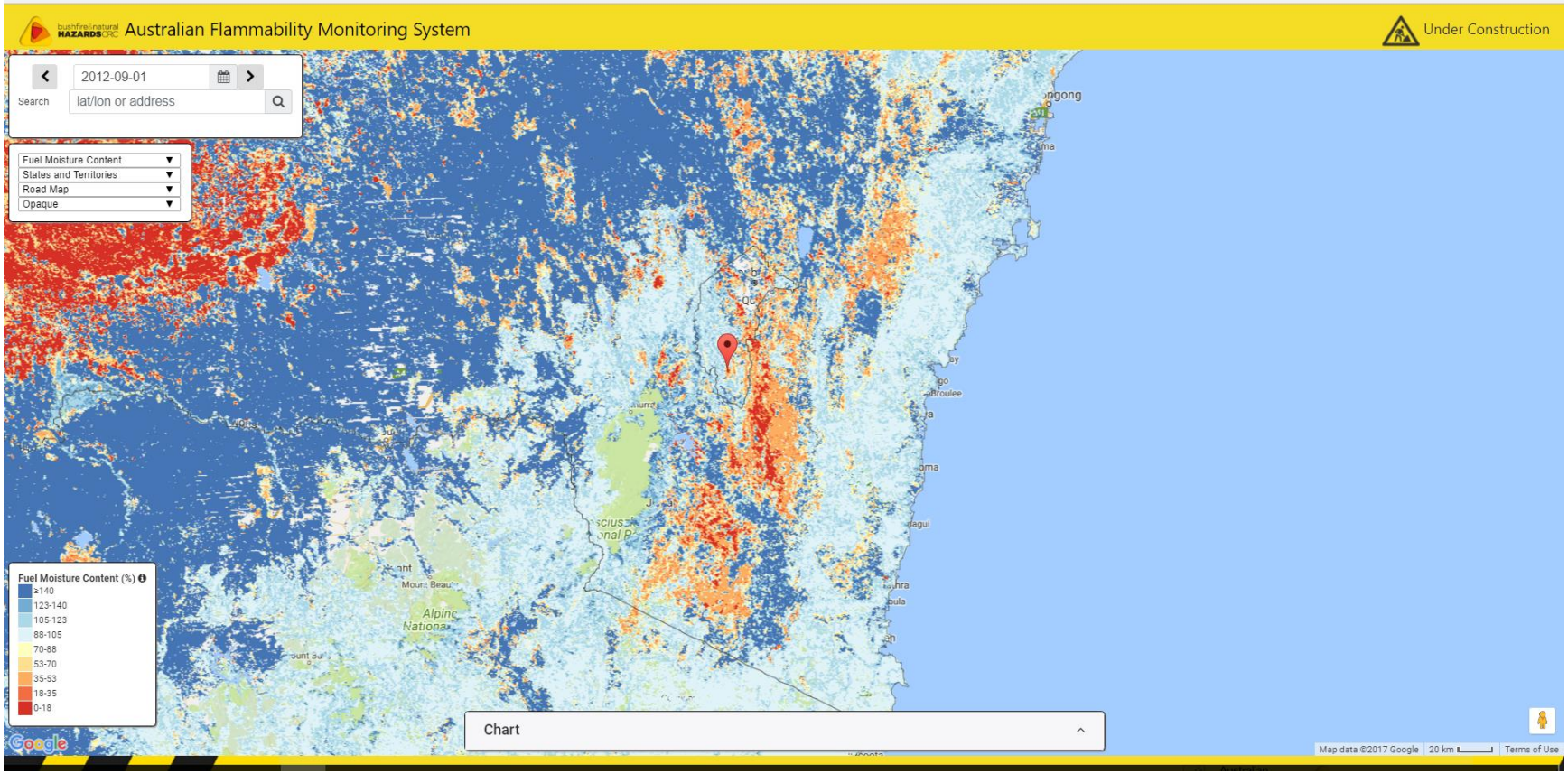


PRESCRIBED BURNING - IMPLEMENTATION



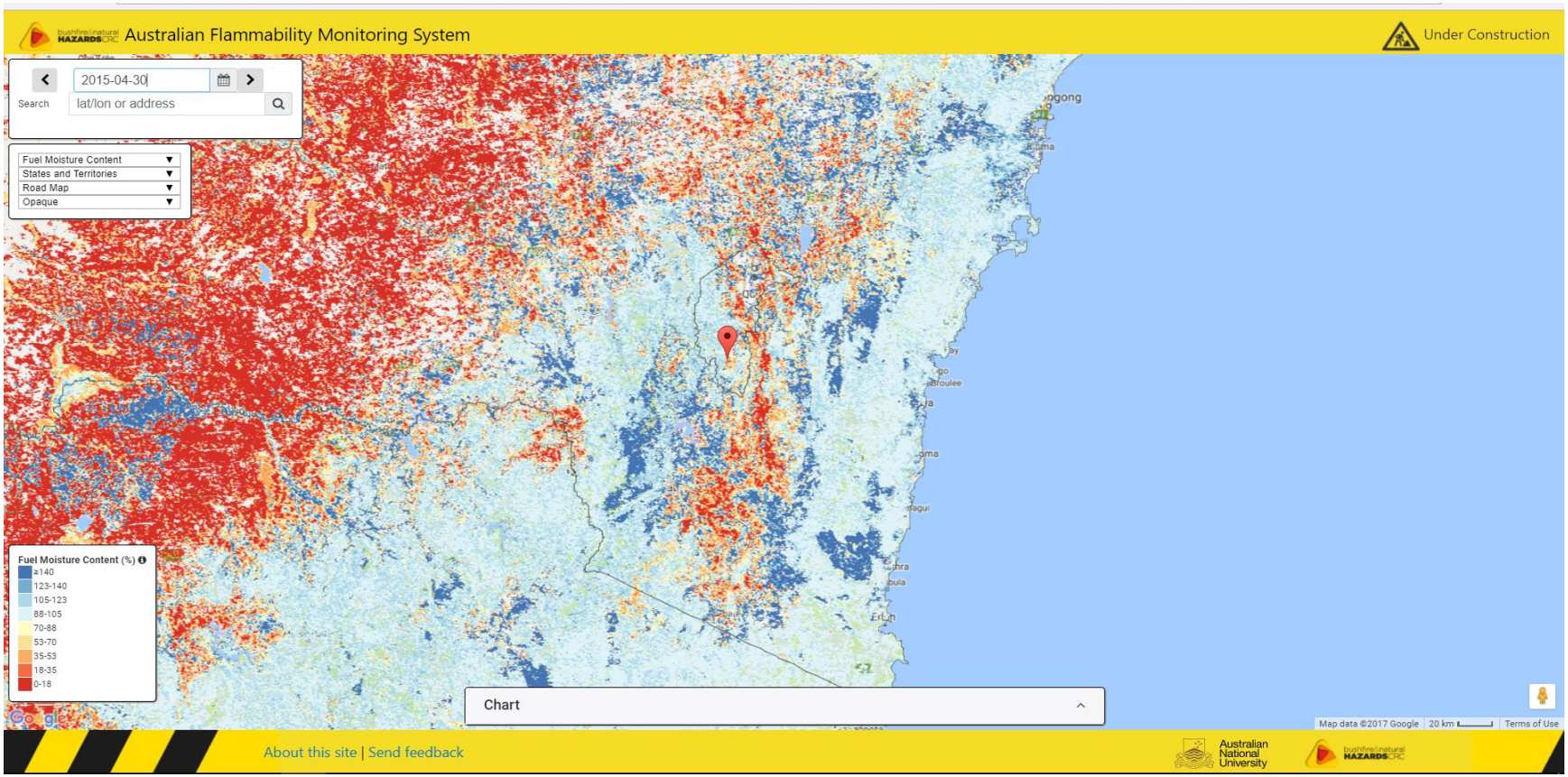
January 2003

PRESCRIBED BURNING - IMPLEMENTATION



October 2012

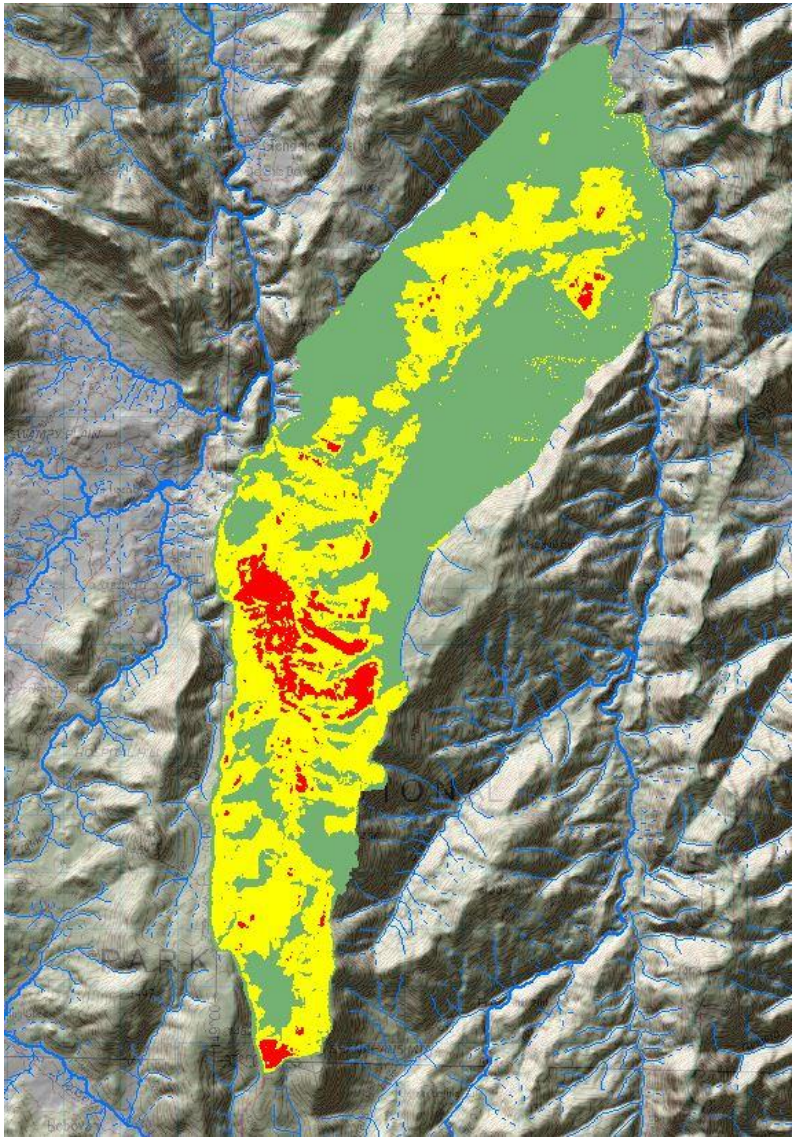
PRESCRIBED BURNING - IMPLEMENTATION



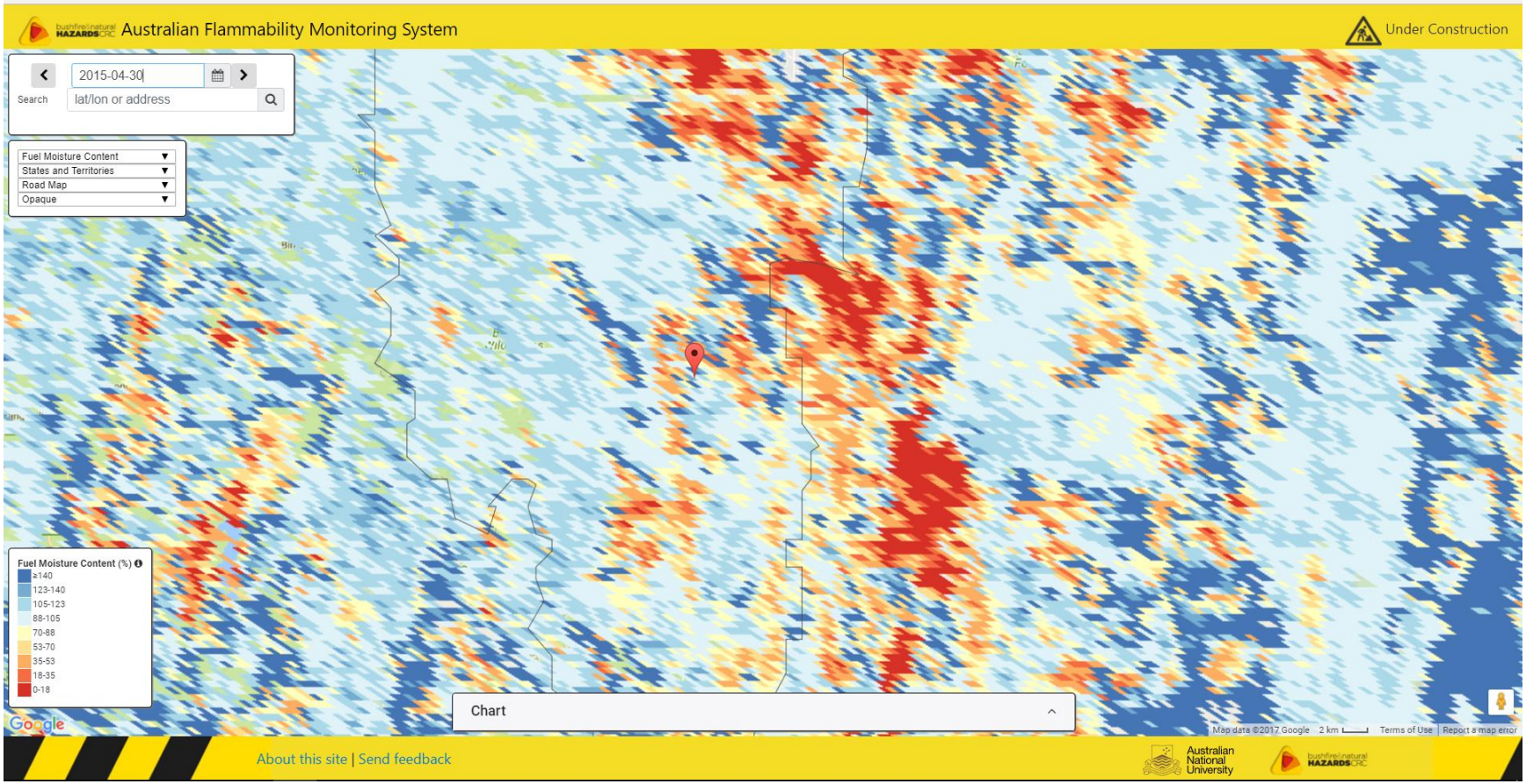
April 2015

IMPLEMENTATION

Brandy Flat HRB fire severity assessment



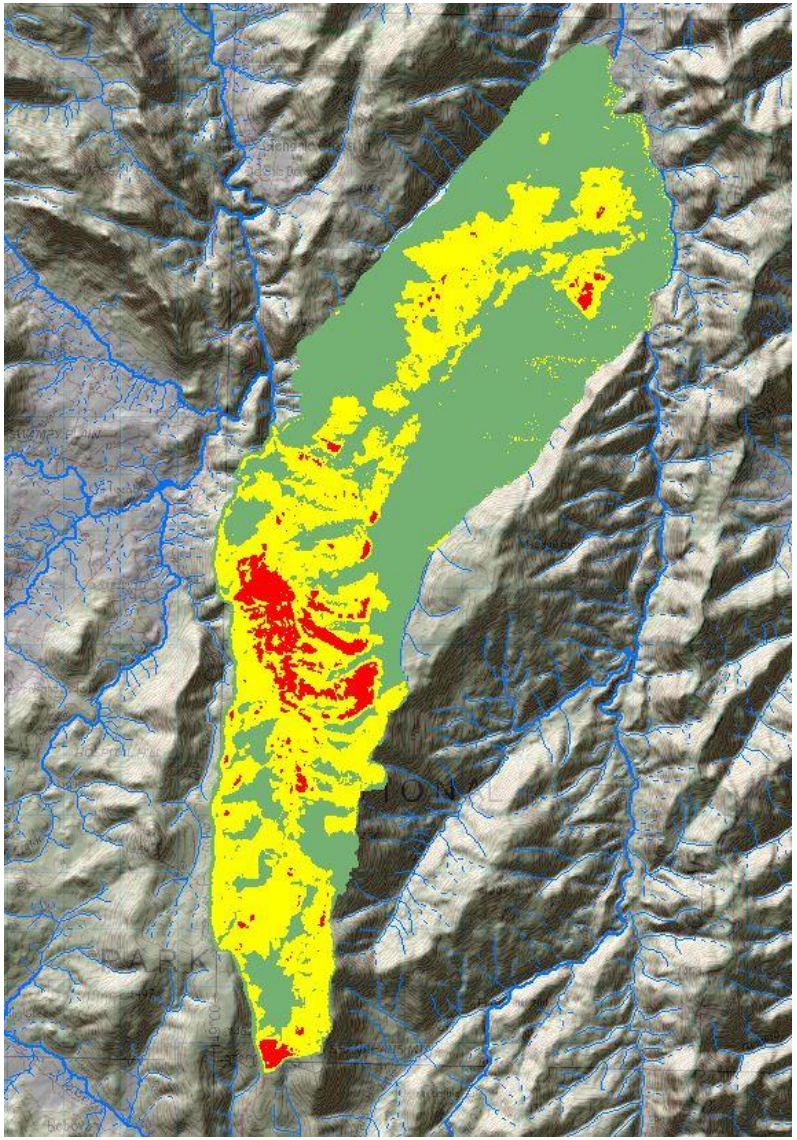
PRESCRIBED BURNING - IMPLEMENTATION



April 2015 – Brandy Flat Burn

EVALUATION

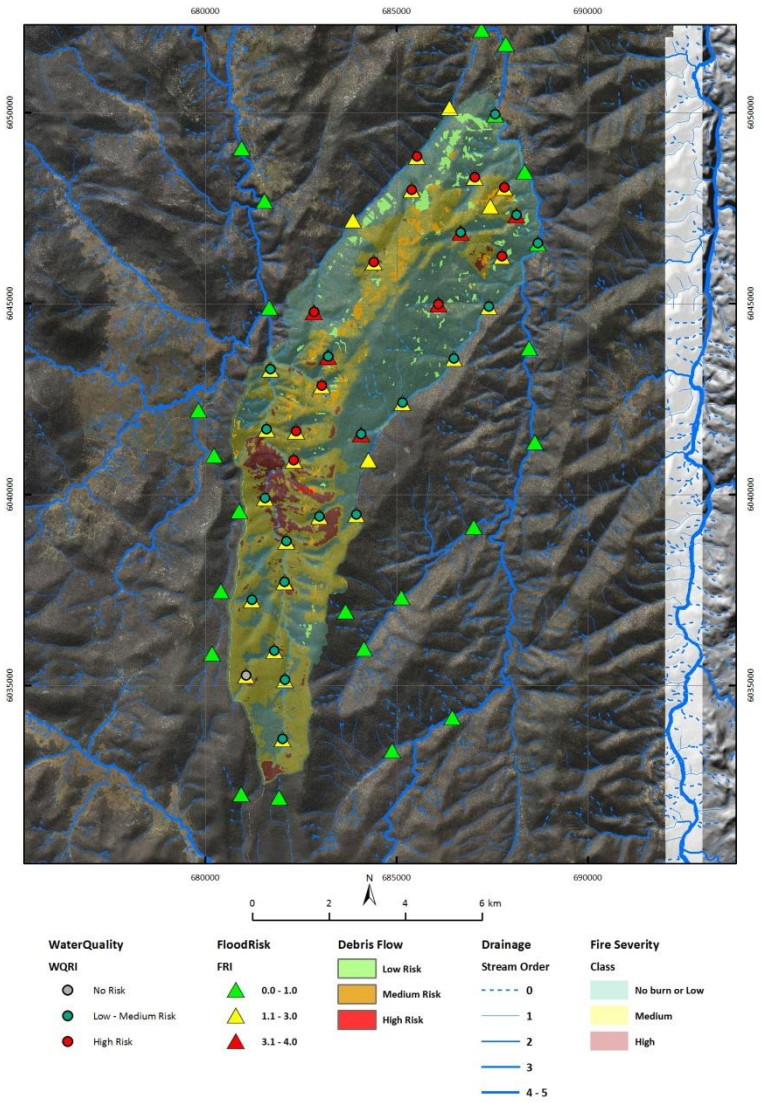
Brandy Flat HRB fire severity assessment

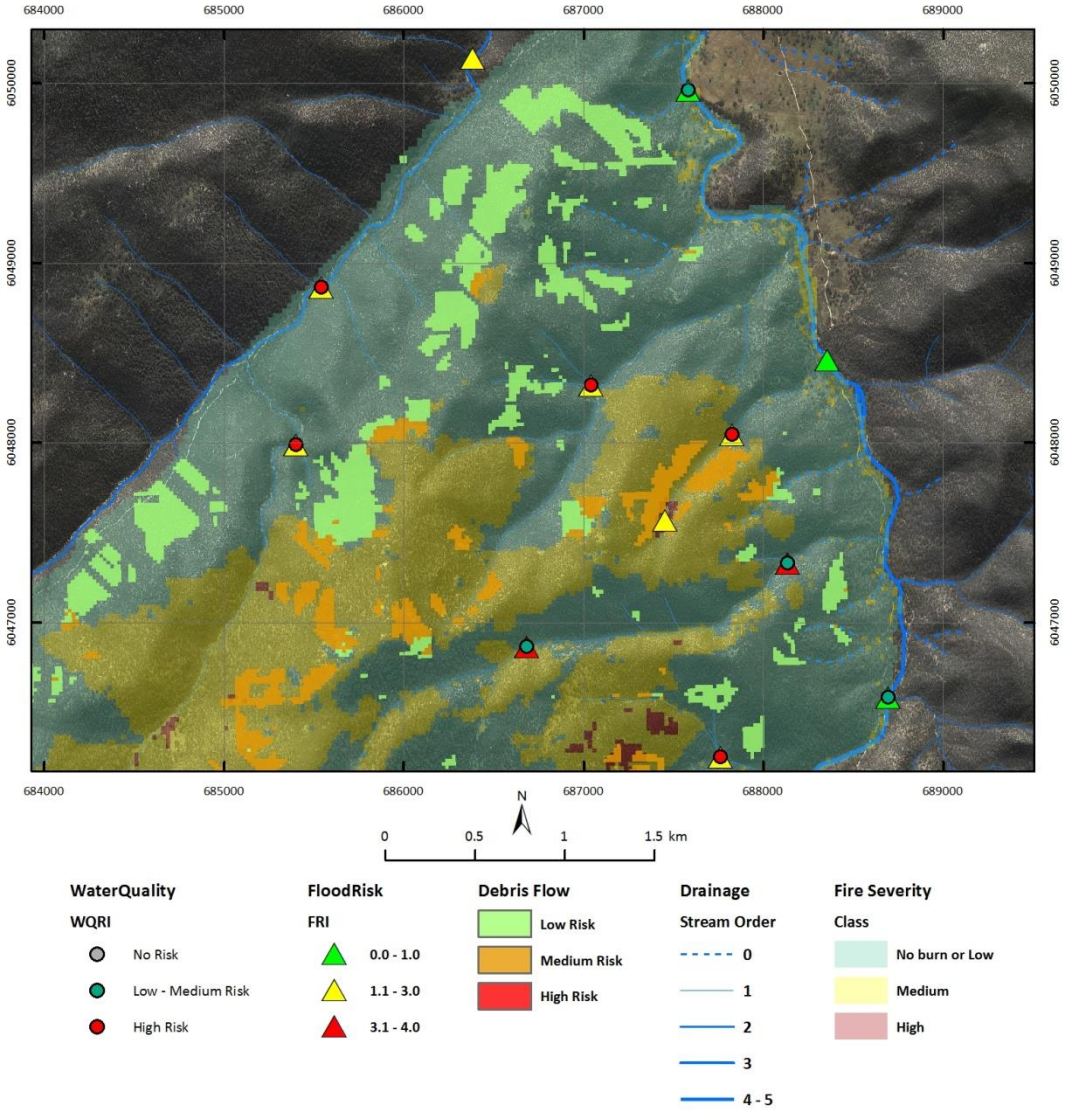


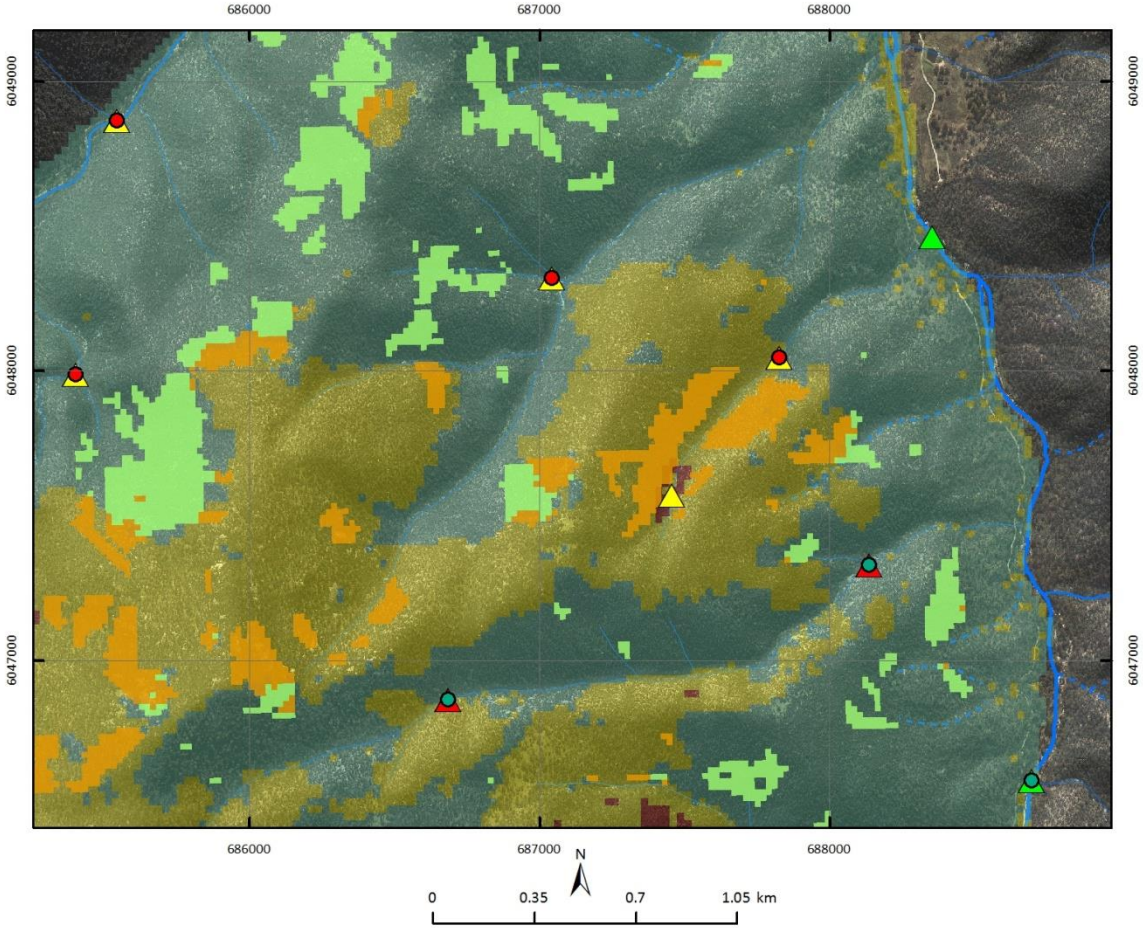
PRESCRIBED BURNING - EVALUATION

EVALUATION

Post-burn hydrological risk –
Brandy Flat HRB







DAVID PEARCE, COUNTRY FIRE SERVICE SOUTH AUSTRALIA, END-USER

AND

JOHN BALLY, BUREAU OF METEOROLOGY

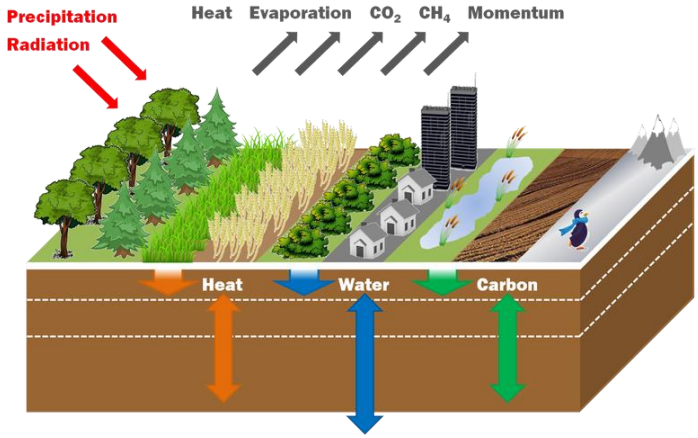
HISTORY

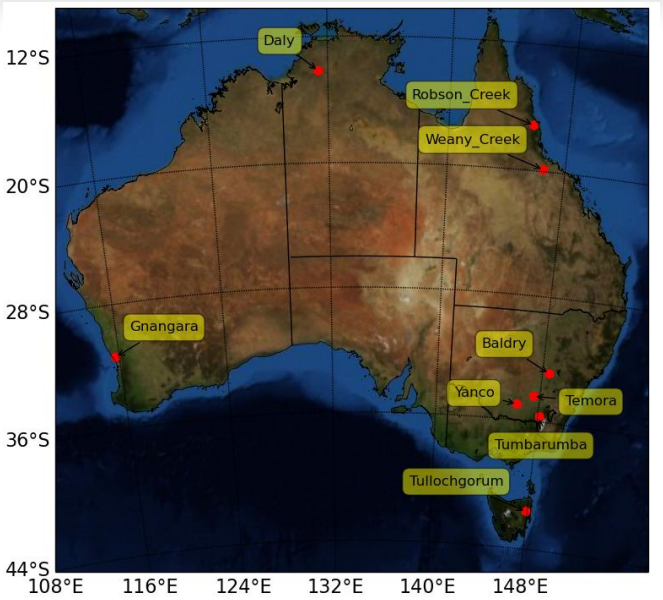
- "*From the standpoint of fire control, the significant moisture relationships are those which exists in an upper layer of soil and a covering layer of duff. ...*" **(Keetch & Byram, 1968, pp 24.)**

- KBDI / MSDI
  - >> single soil layer (~1 m)
  - Simple (very simple!) bucket model
  - 60's science

SOIL MOISTURE - 2016

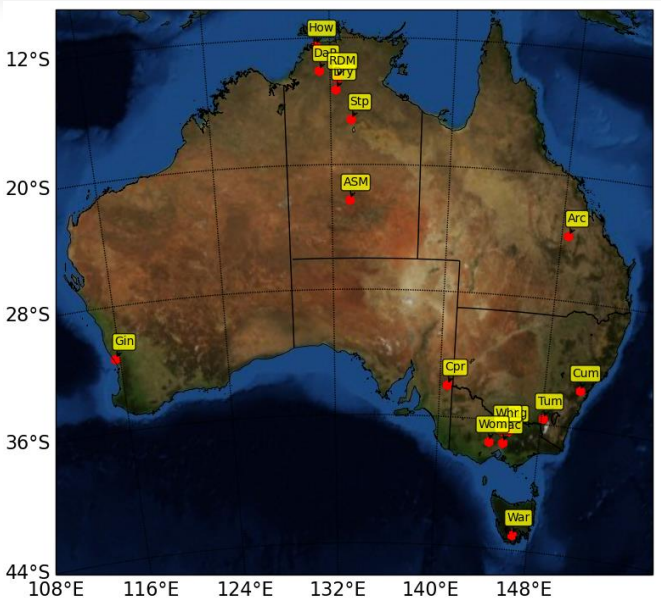
- Physics based land surface models.
  - Used in Numerical Weather Prediction & seasonal forecasting models.
  - JULES .... High resolution
  - Four soil layers, to 3 m deep.
  - 0~10; 10~35; 35~100; 100~300
  - Satellite remote sensing.

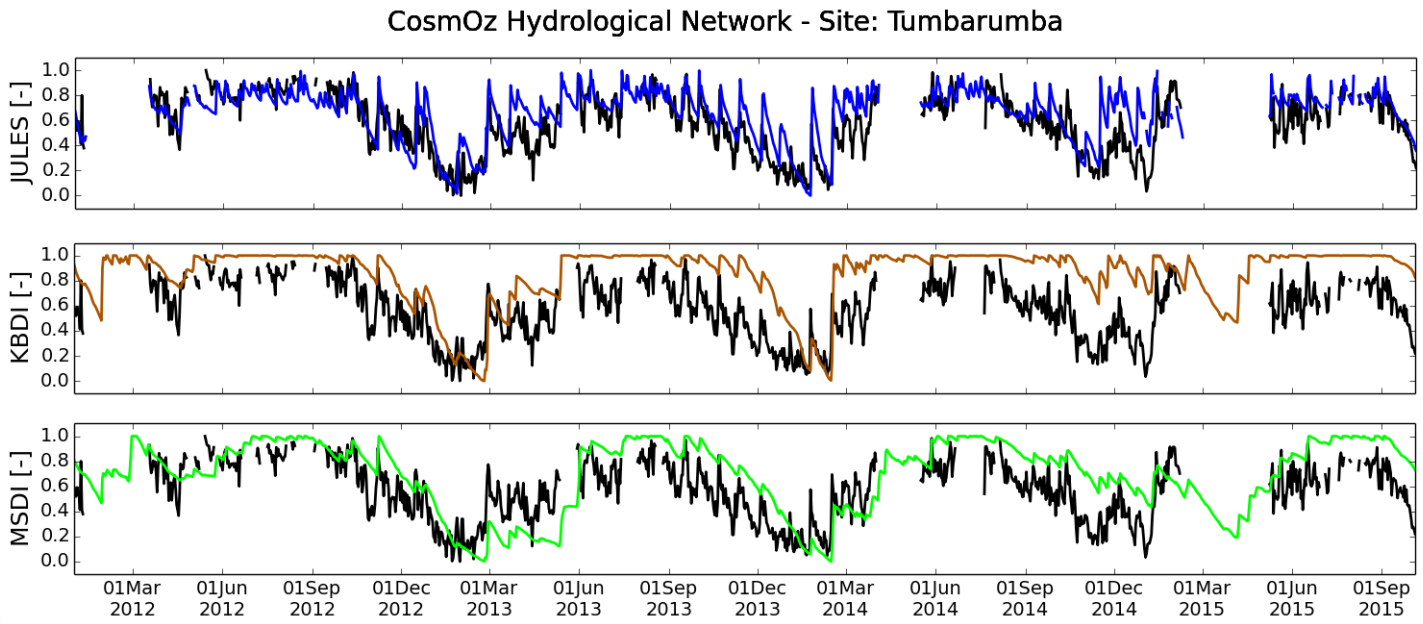




CosmOz

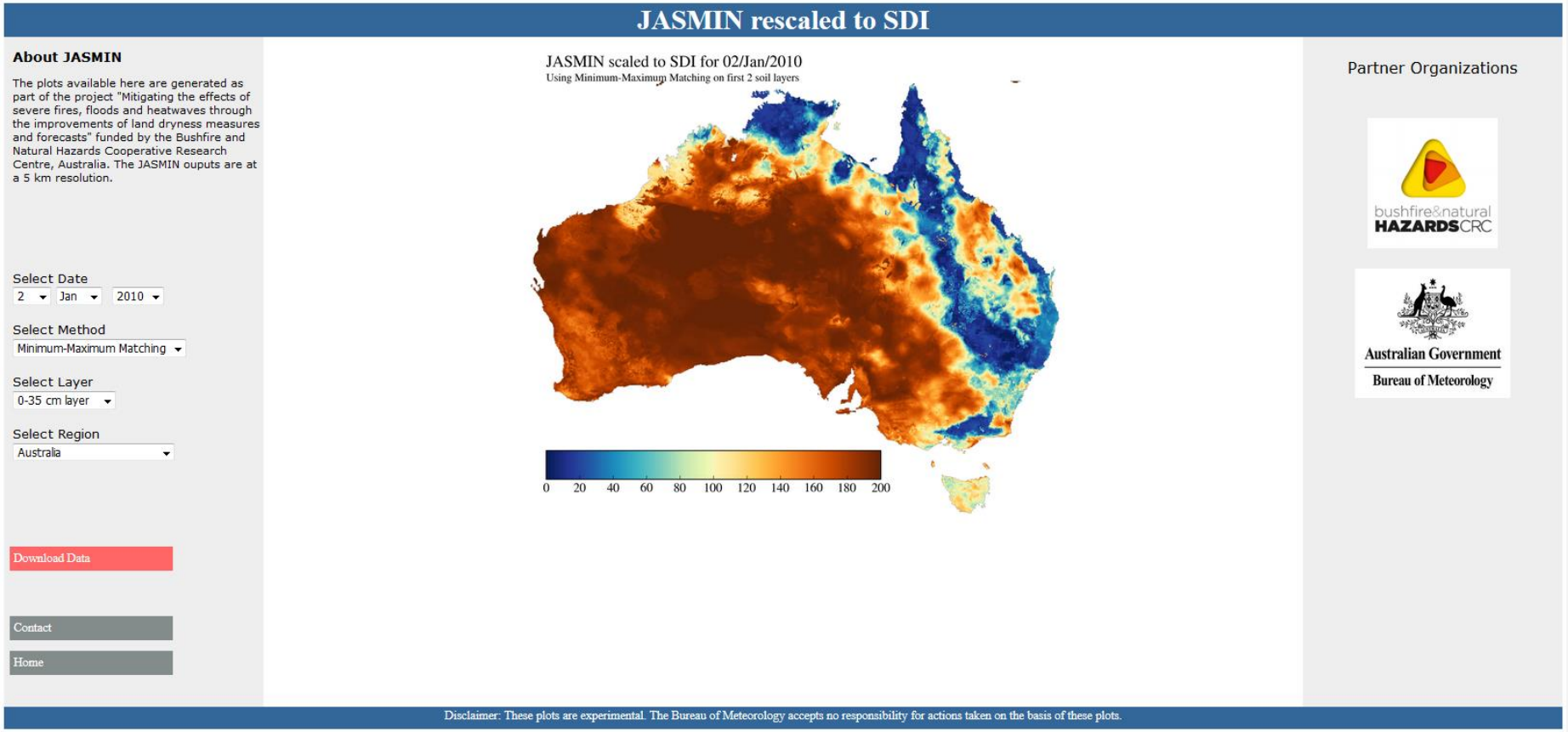
OzFlux



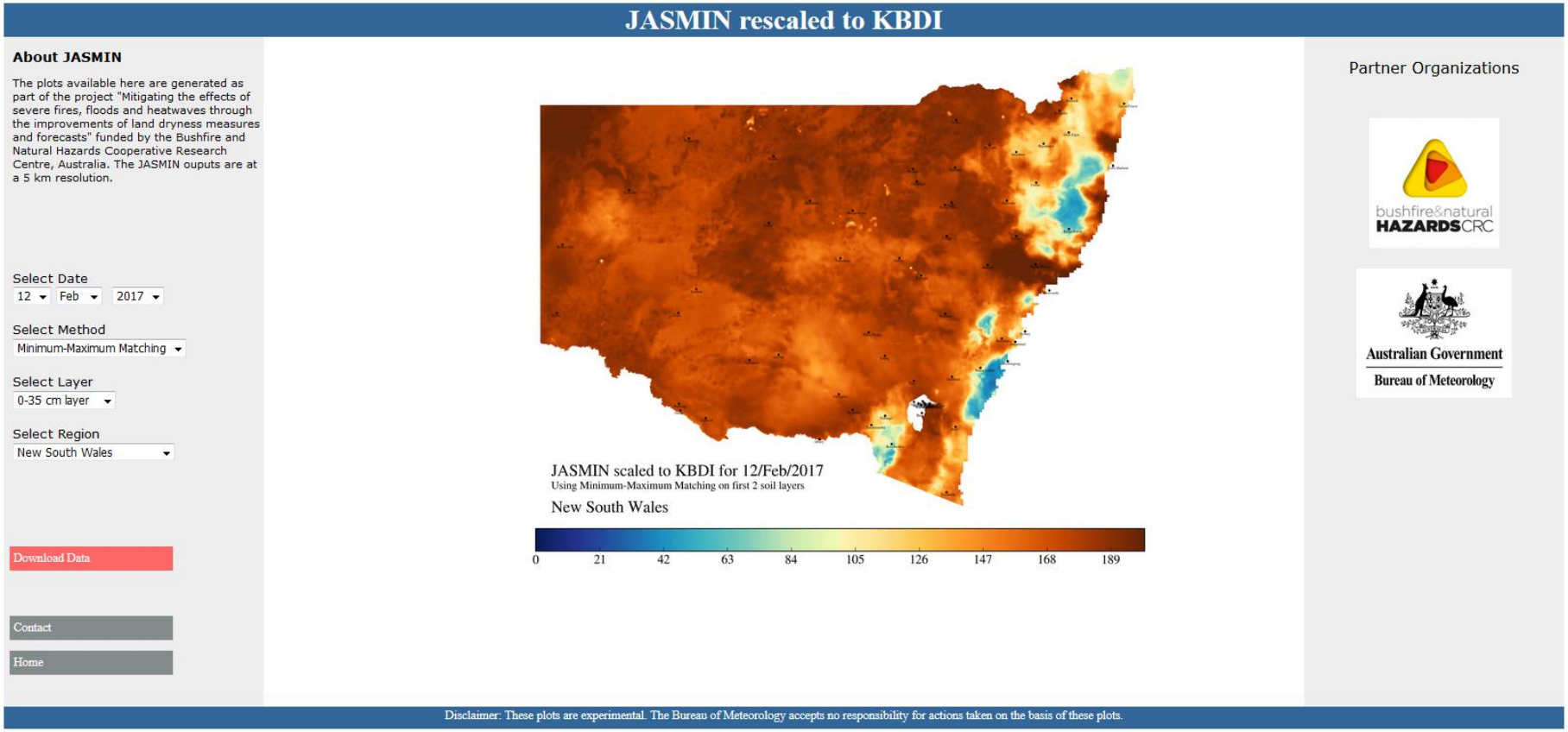


Comparison to In-situ Observations

Website in preparation - SDI



Website in preparation - KBDI

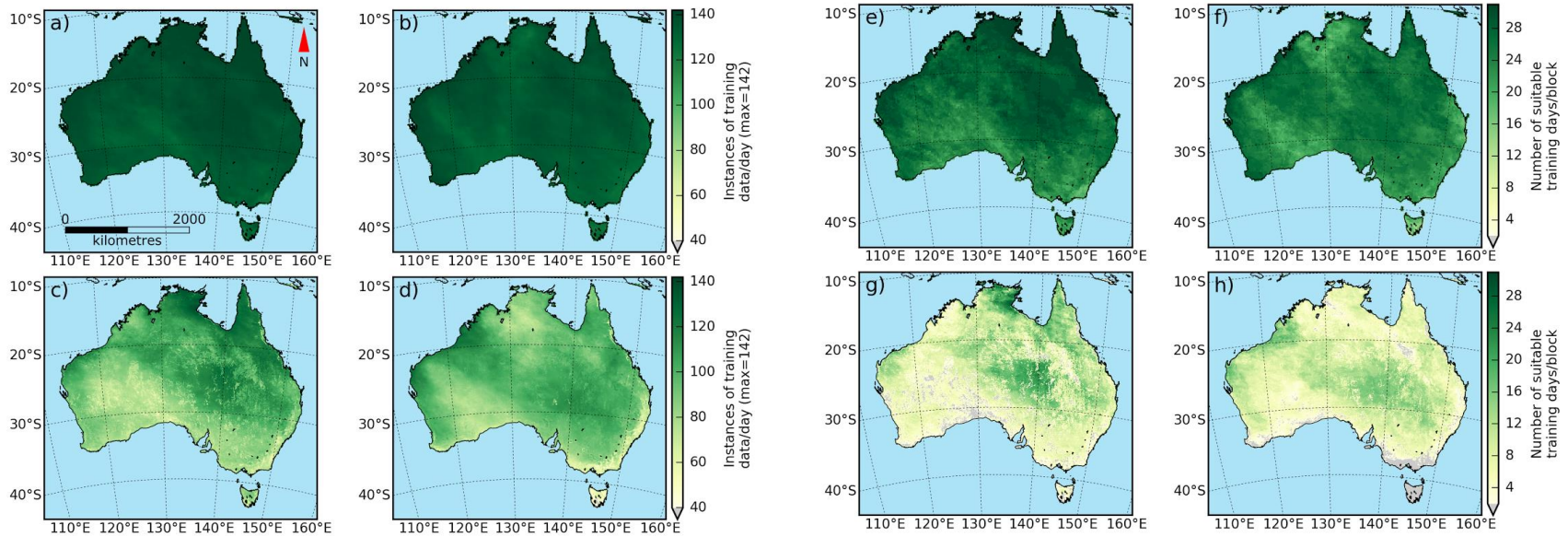


SIMEON TELFER, DEPARTMENT OF ENVIRONMENT, WATER AND NATURAL RESOURCES SOUTH AUSTRALIA, END-USER

ACTIVE FIRE SURVEILLANCE - DETECTION

BA
T

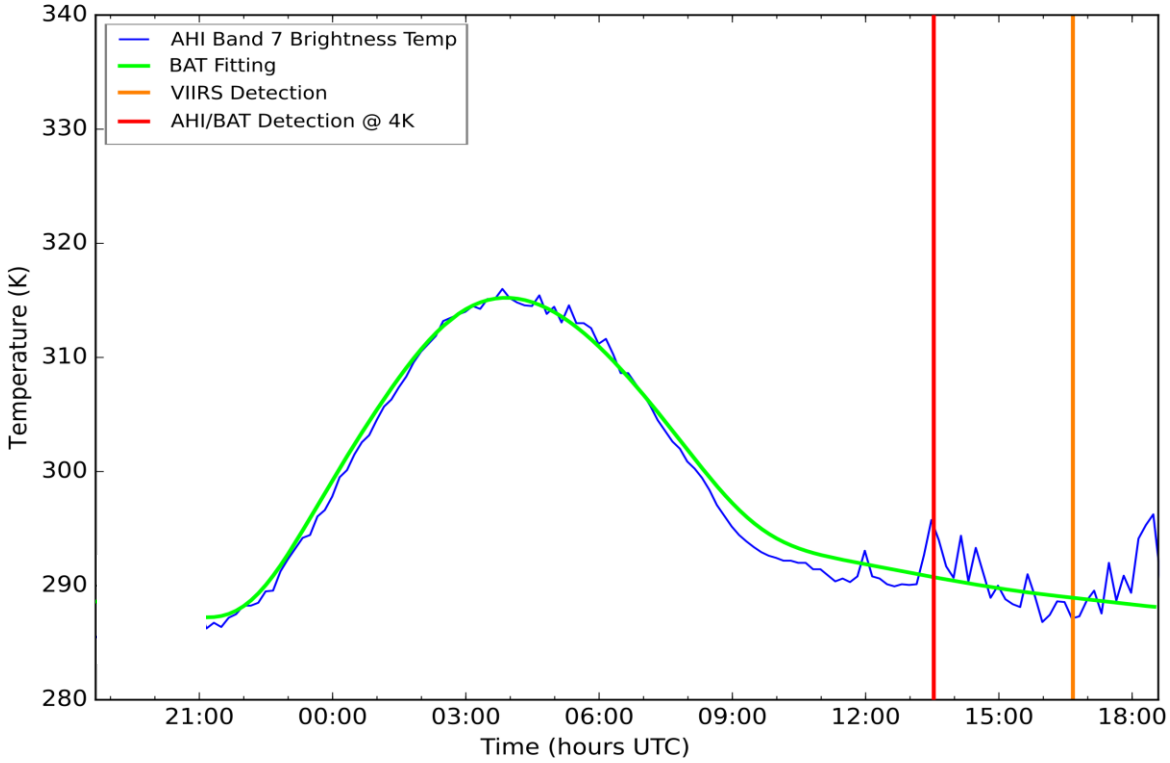
pix
el



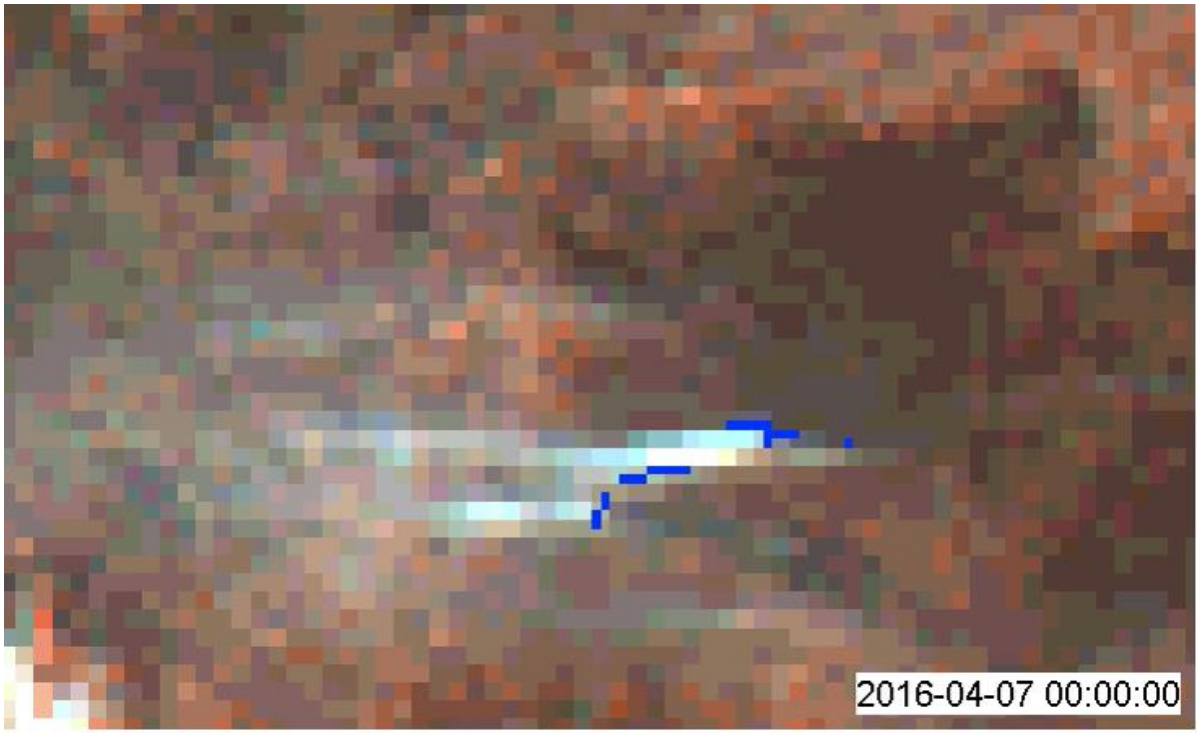
Advantages over pixel-based training data include increased availability of data for fitting, reduced error of fitting through periods of cloud and reduced processing load

ACTIVE FIRE SURVEILLANCE - DETECTION

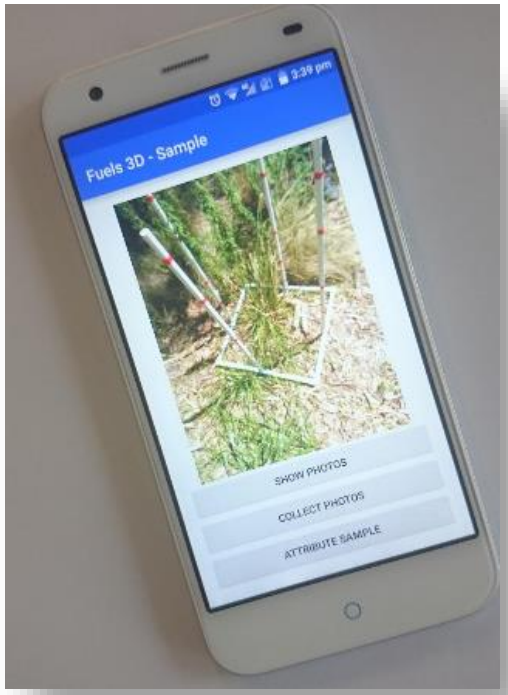
Example showing fire detected in band 7 AHI Himawari-8 at least 3 hours earlier than the first detection by LEO fire products



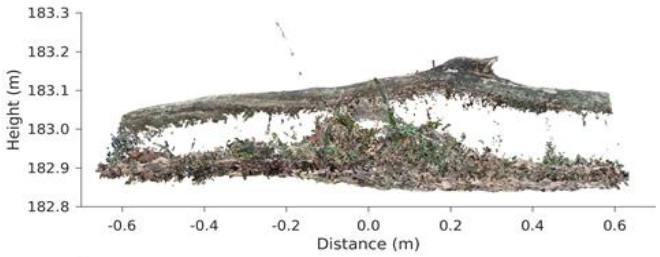
ACTIVE FIRE SURVEILLANCE - MAPPING

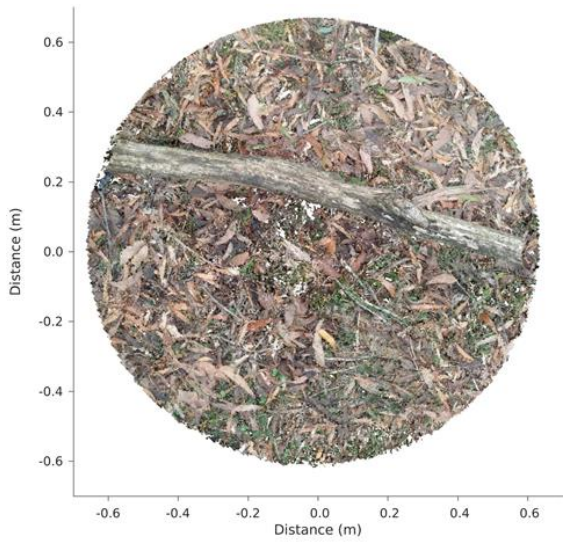


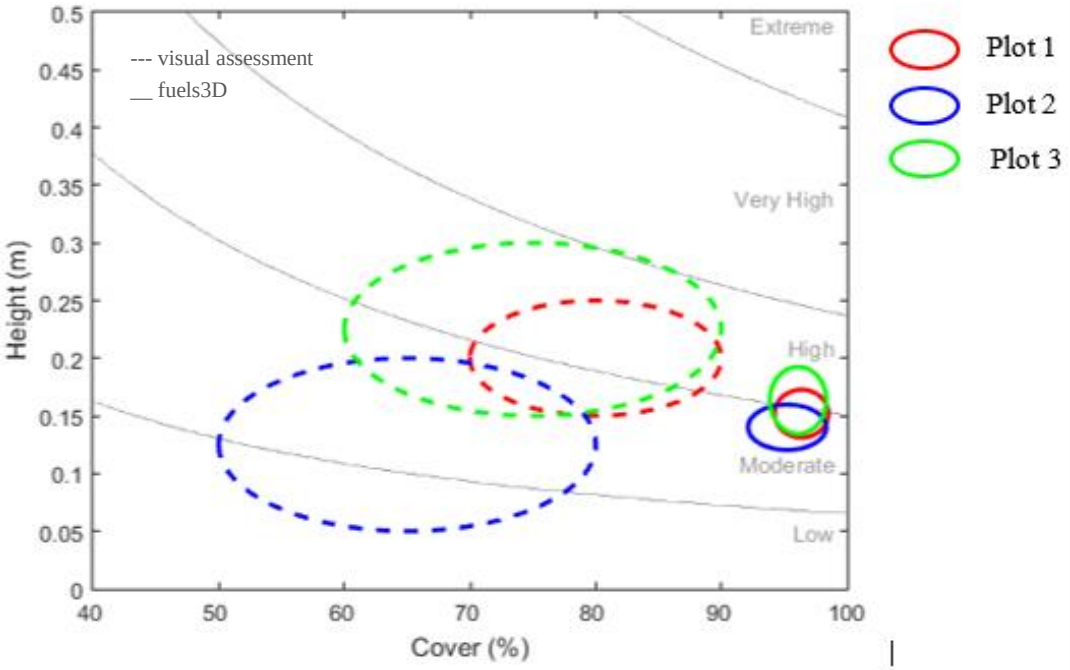
FUEL HAZARD FIELD ASSESSMENTS - FUELS3D



FUEL HAZARD FIELD ASSESSMENTS - FUELS3D

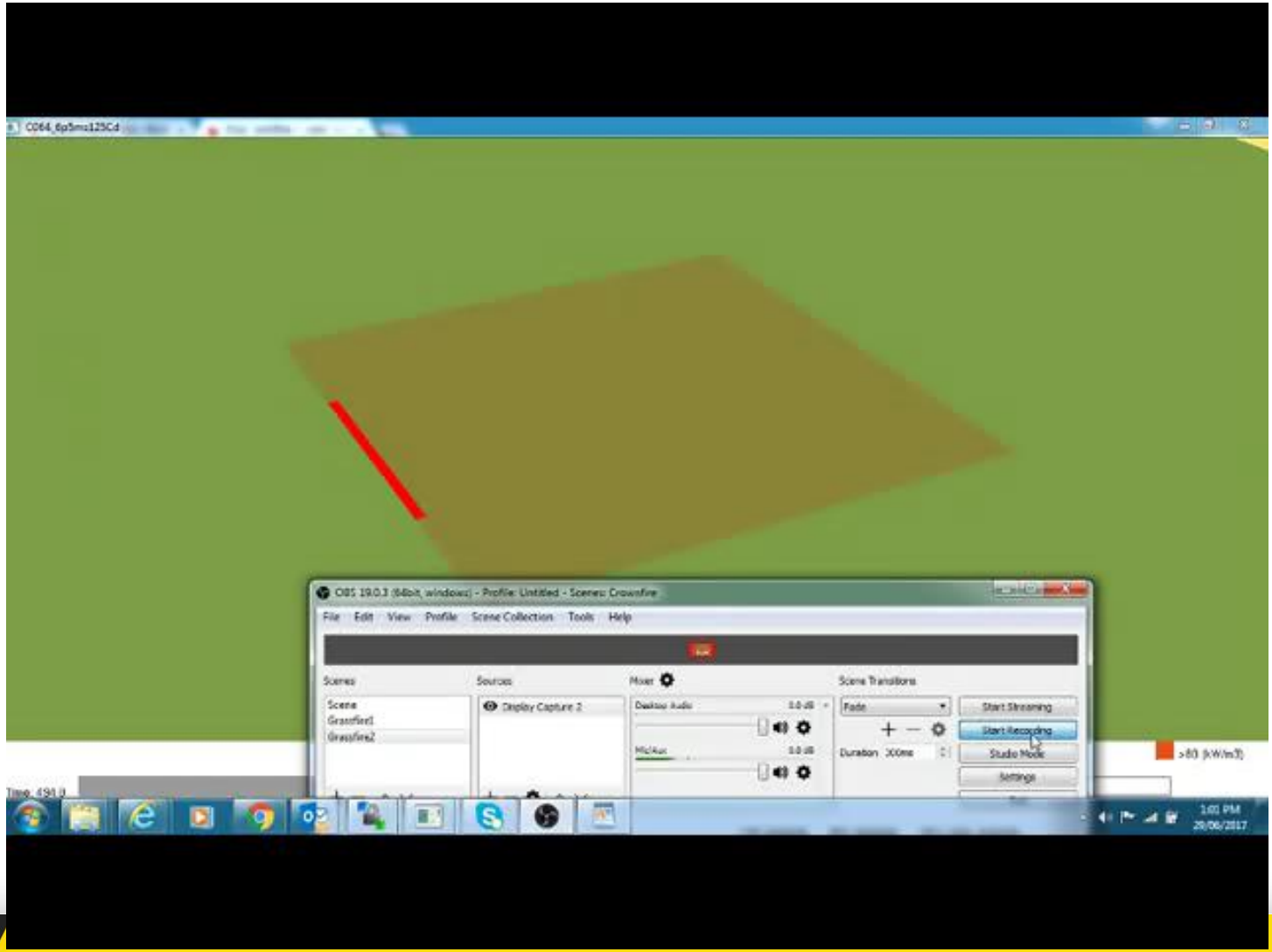






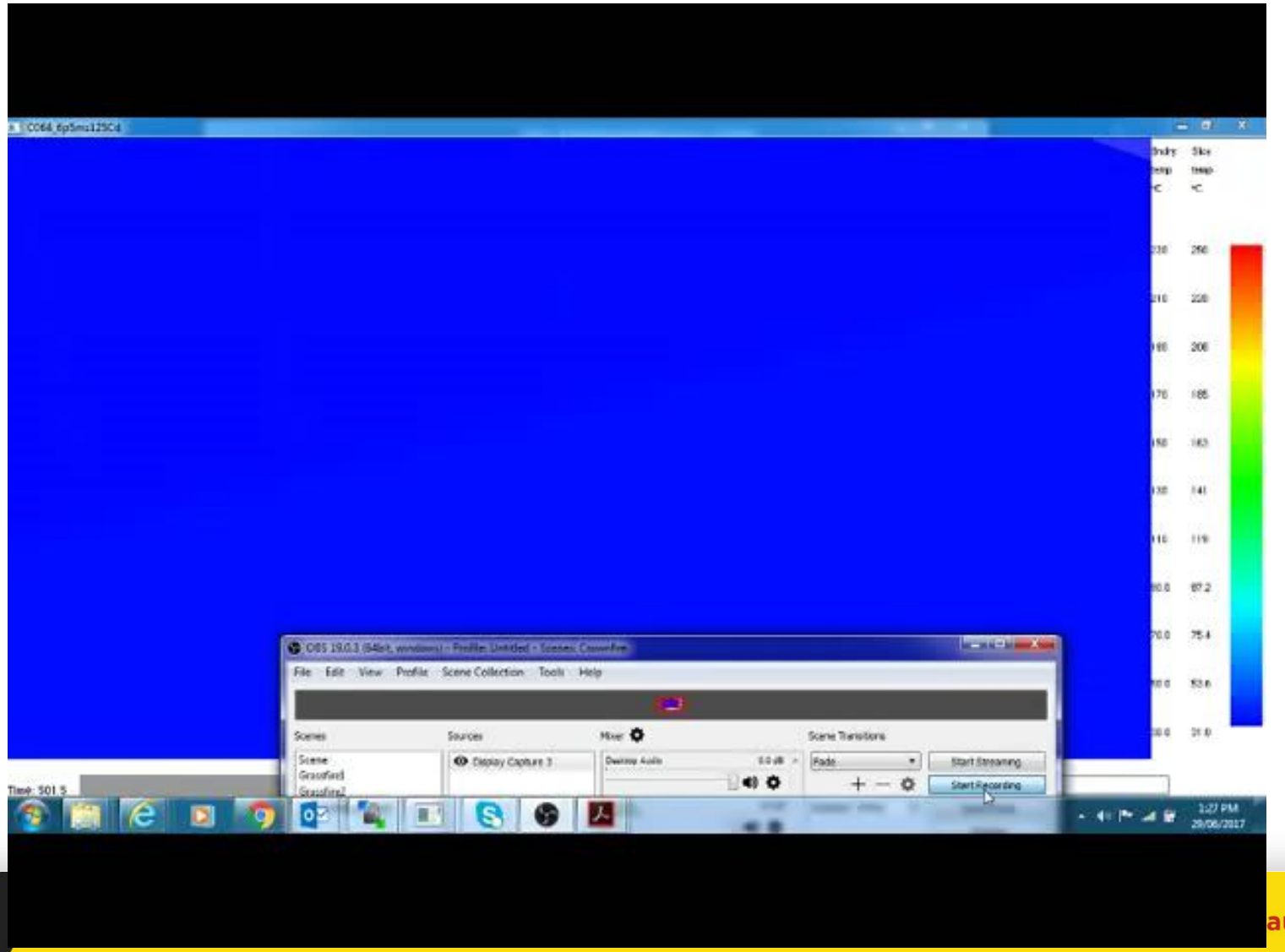
ASSOCIATE PROF KHALID MOINUDDIN, PROJECT LEADER, VICTORIA UNIVERSITY

CAPABILITY OF PHYSICS-BASED MODELLING
GRASSFIRE AND SMOKE PROPAGATION



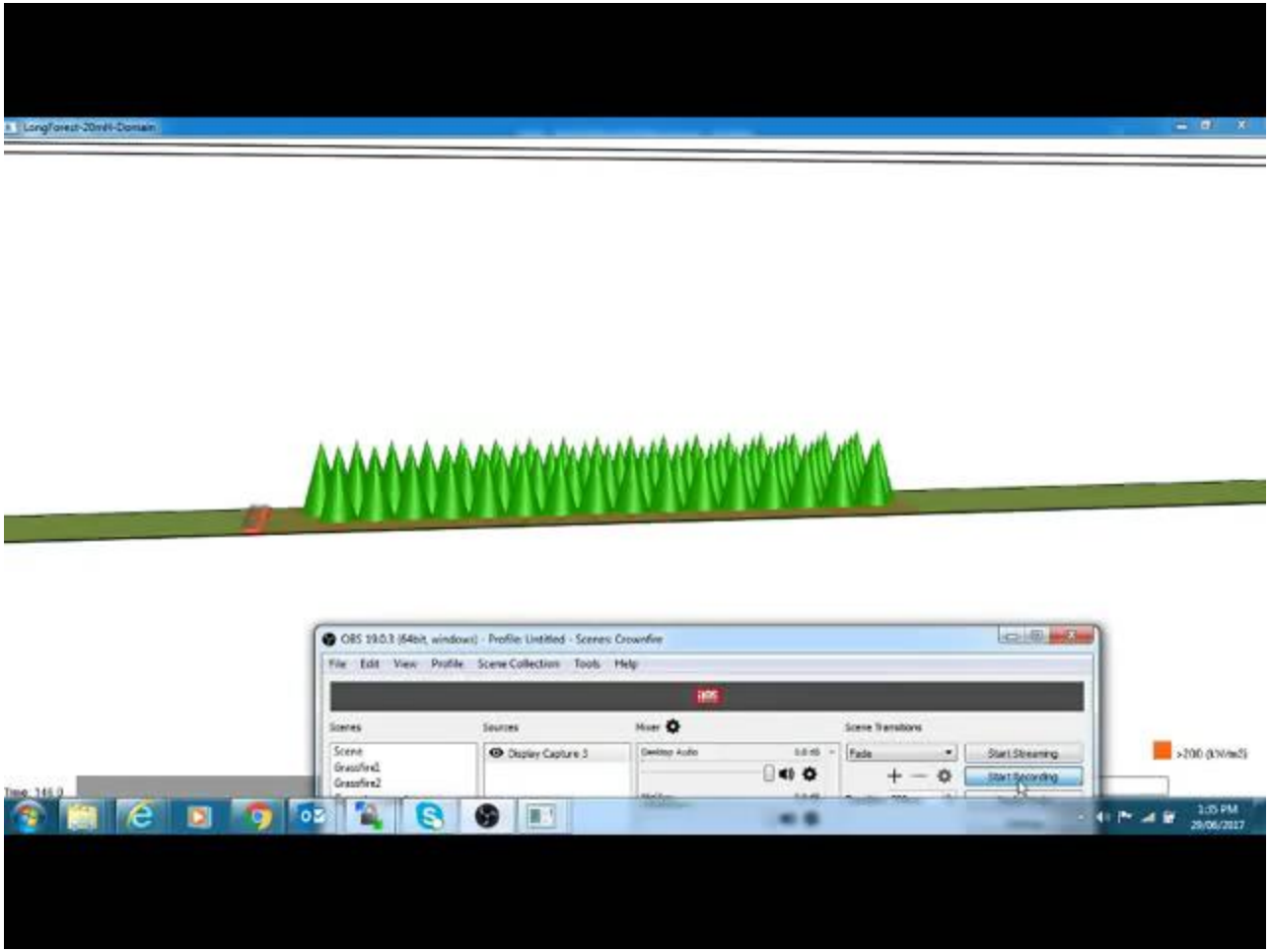
CAPABILITY OF PHYSICS-BASED MODELLING

GRASSFIRE – GAS & SURFACE TEMPERATURE



CAPABILITY OF PHYSICS-BASED MODELLING

CROWNFIRE AND SMOKE PROPAGATION



Benefits

- Can develop improved operational model and provide insight into them
- Assessment of heat and ember loading on homes; appraisal of AS3959
- Facility siting (including power poles, bridges, shelters etc), estimation of fire breaks, planning prescribed burning etc

DETERMINING THRESHOLD CONDITIONS FOR EXTREME FIRE BEHAVIOUR

Alex Filkov, Tom Duff, Trent Penman
The University of Melbourne

Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme
THE UNIVERSITY OF MELBOURNE
bnhcrc.com.au

EXTREME FIRE BEHAVIOURS

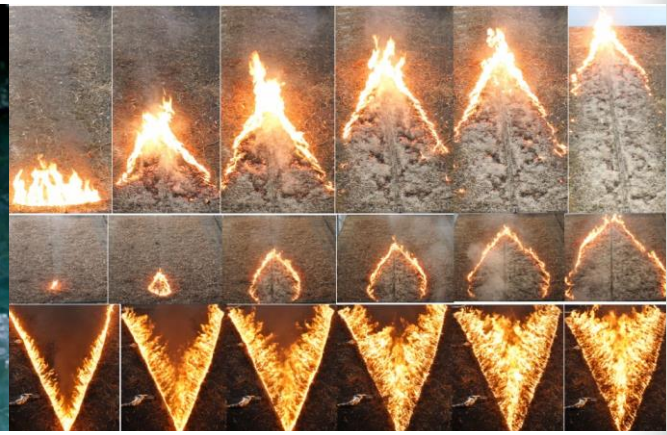
Spotting/fire storm

Fire tornado/whirls

Pyro-convective events

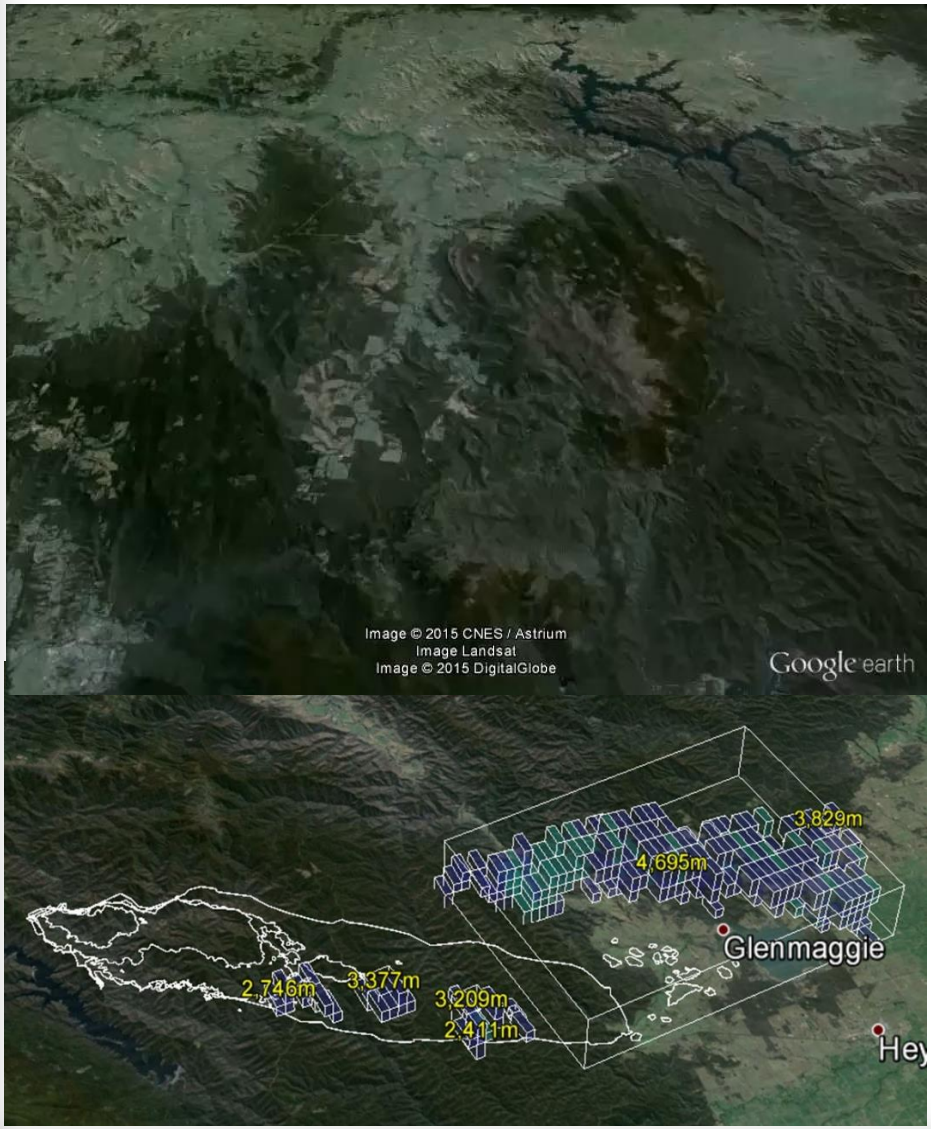
Crown fires

Conflagrations



Junction zones/Eruptive fires

STANDARDISING BUSHFIRE DATA



INNOVATION IN DATA COLLECTION

There are a wide range of sources of information in relation to fires, however, as a starting point we recommend a focus on particular categories:

- Ground observations and operational information;
- Linescans;
- Forward Looking IR;
- Aerial observers;
- Satellites;
- Remote weather observations
- UAV observations;
- Vehicle/aircraft GPS tracks; and
- suppression strategies.

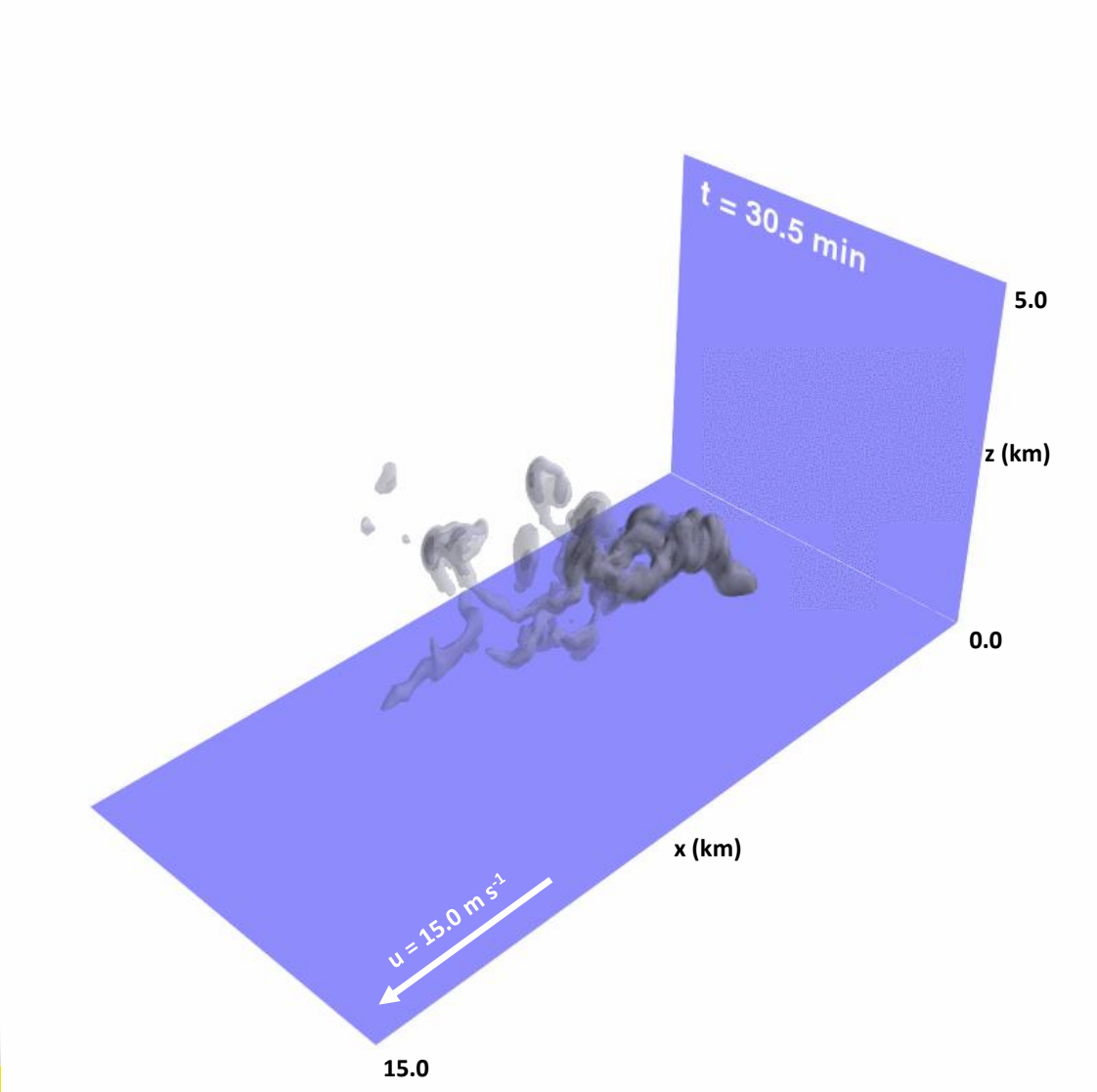
FUTURE RESEARCH

- Analyse the frequency and importance of extreme fire behaviours (Dec 2017)
- Examine environmental contribution to landscape scale fire behaviour (2018 +)
- Evaluate influence of dynamic radiant heat on fire front propagation and structure ignition (2018 +)

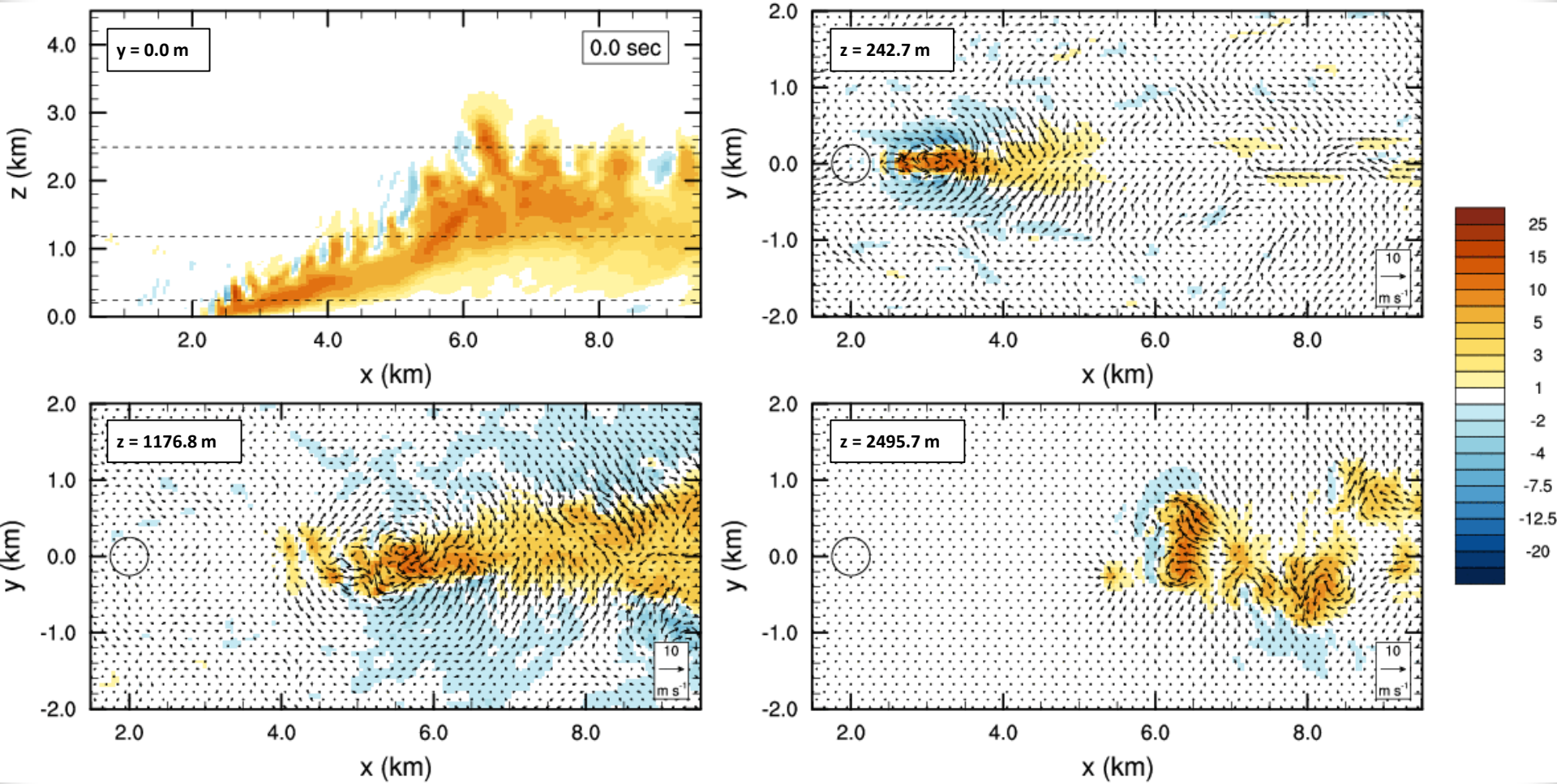
THANK YOU!

DR JEFF KEPERT, CRC PROJECT LEADER, BUREAU OF METEOROLOGY

SIMULATED FIRE PLUME, 56 KM/HR WIND



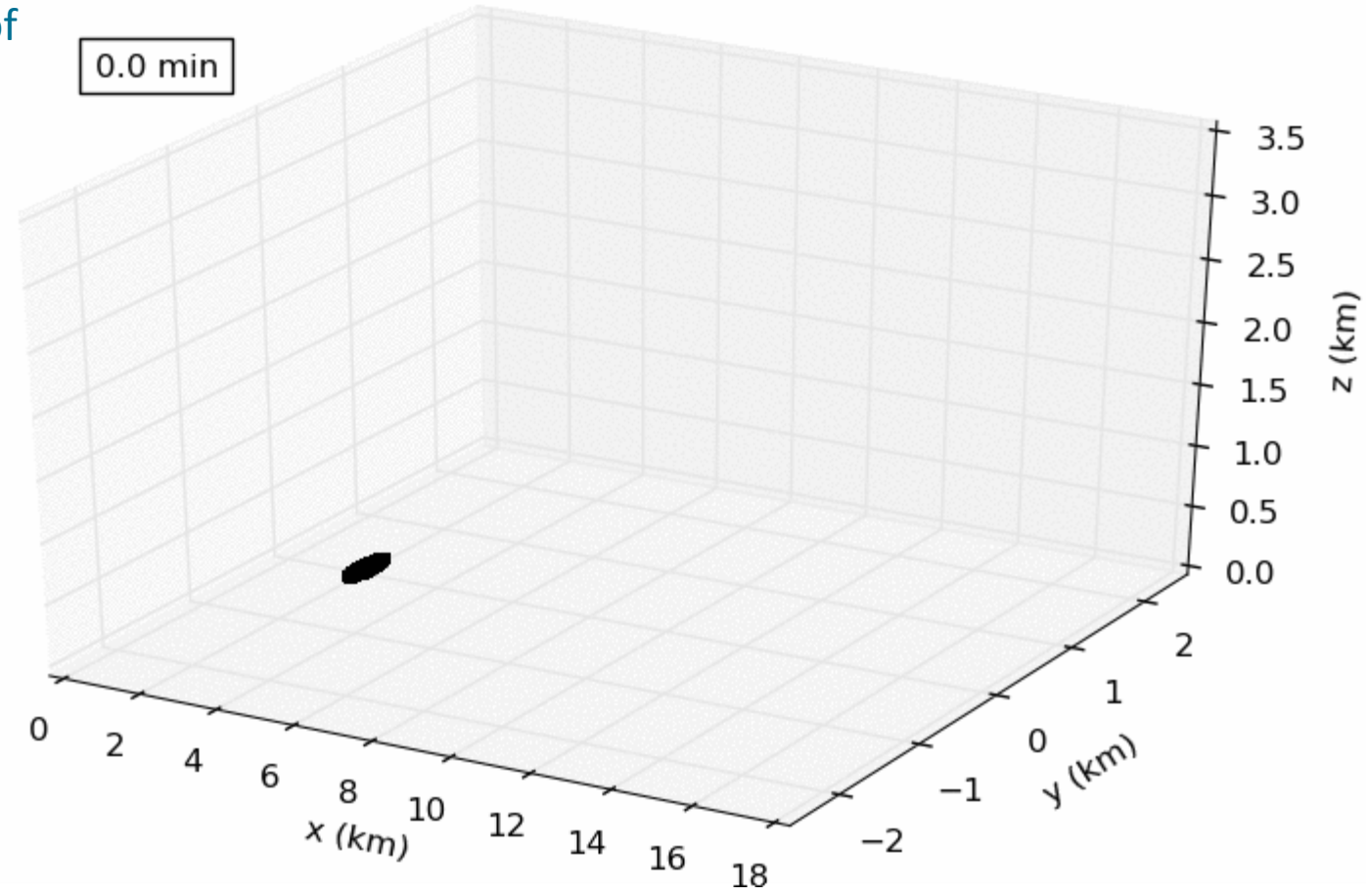
WINDS IN AND NEAR THE SMOKE COLUMN



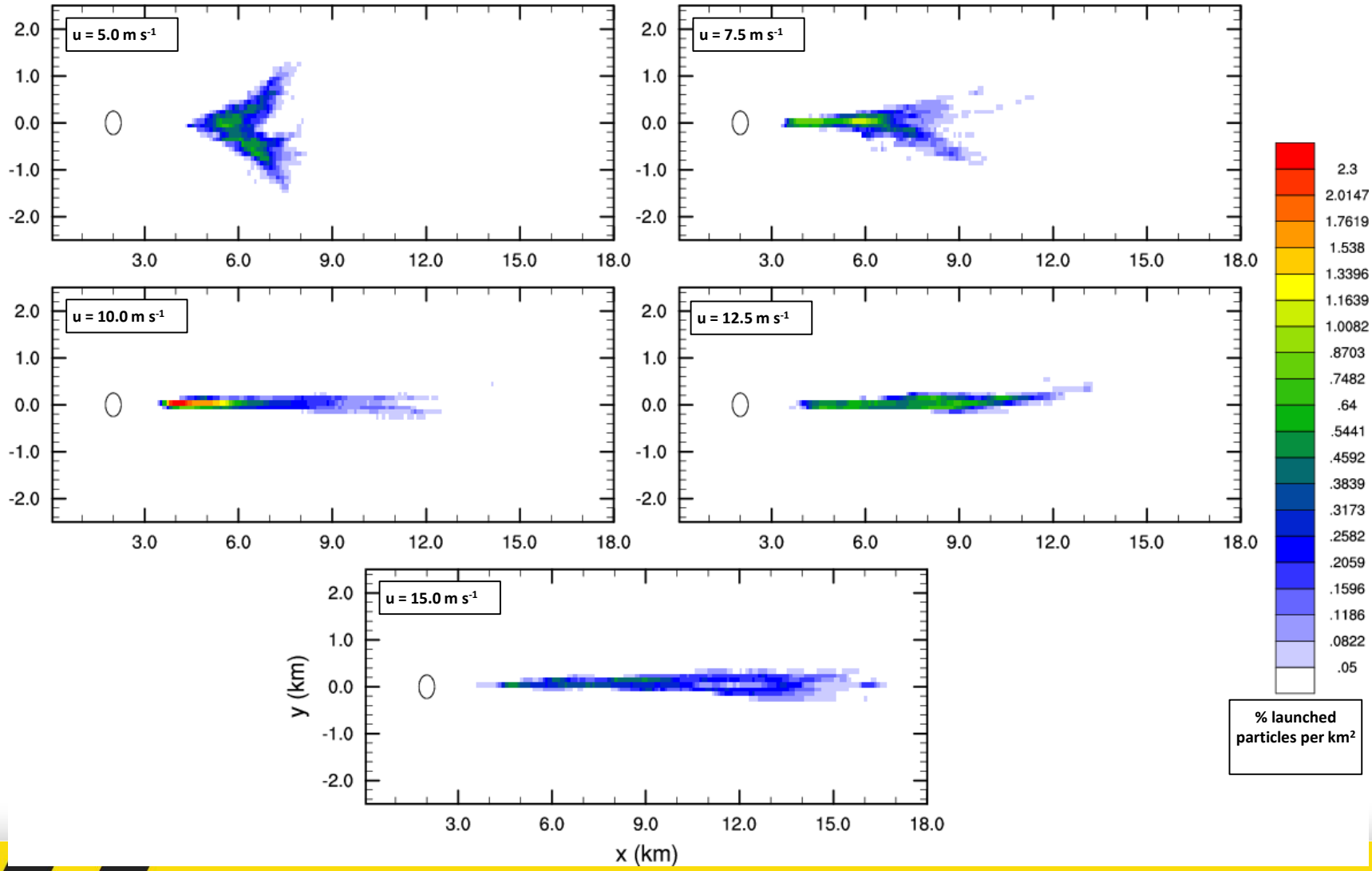
FIREBRAND TRANSPORT – 56 KM/HR WIND

Studied the path of nearly 1.5 million embers (only 1% are shown here)

Almost 33% travel more than 1 km in this case



WHERE DO THE EMBERS END UP?



FIRE COALESCENCE AND MASS SPOT FIRE DYNAMICS

Experimentation, modelling and simulation

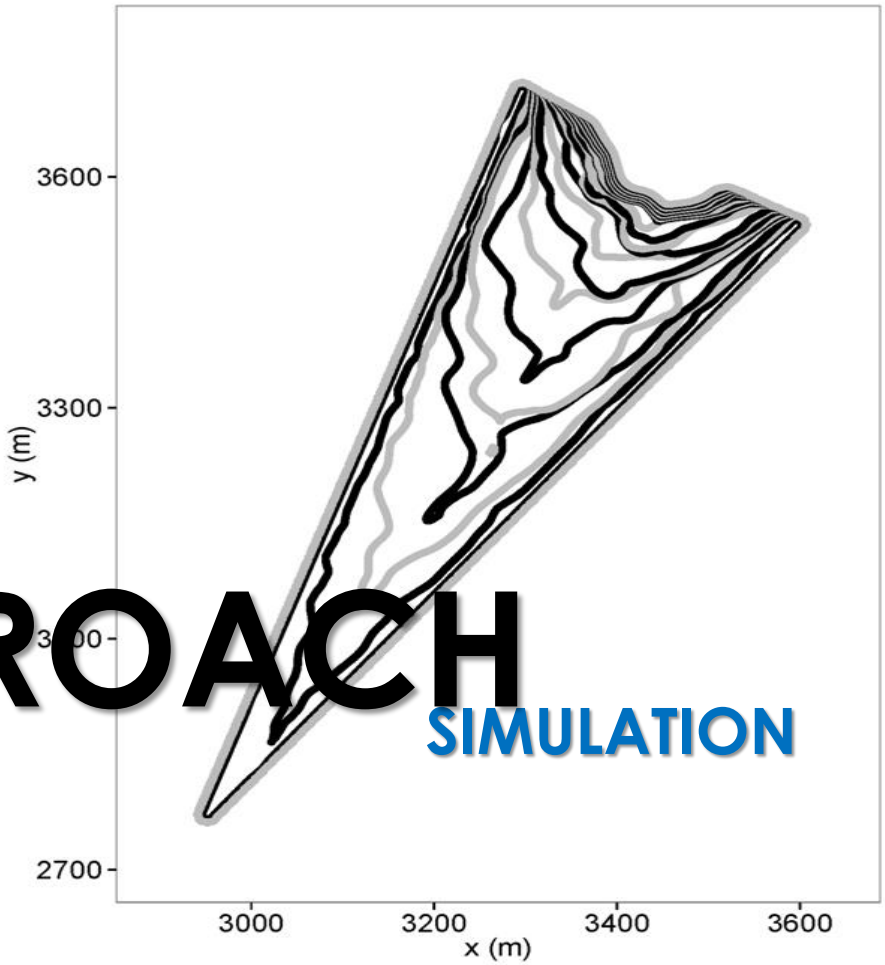
Jason Sharples[1], James Hilton[2], Andrew Sullivan[3]

1. Computational Science Initiative,
   School of Physical, Environmental and Mathematical Sciences, UNSW Canberra
2. CSIRO Data 61
3. CSIRO Land and Water

Australian Government
Department of Industry, Innovation and Science
Business Cooperative Research Centres Programme
UNSW AUSTRALIA Canberra
DATA 61
CSIRO
SPOTFIRE PROJECT

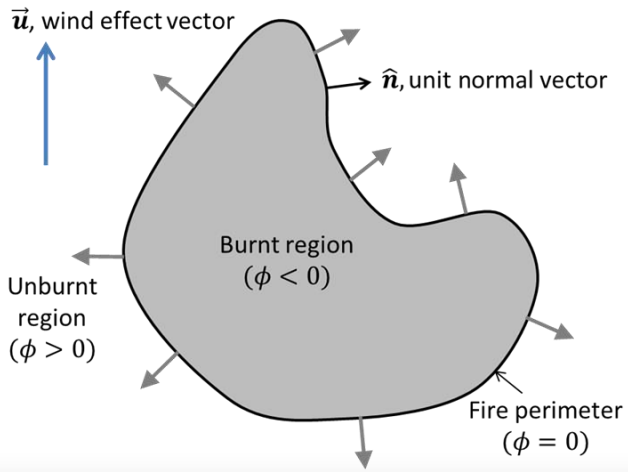
UNDERSTANDING SPOT FIRE DYNAMICS…

EXPERIMENTATION



OUR APPROACH

MATHEMATICAL MODELLING



SIMULATION

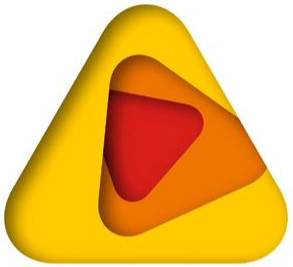
$$\frac{\partial \phi}{\partial t} + \beta \left\| \nabla \phi \right\| + \left(\mathbf{u}_a(\gamma) + \nabla \psi \right) \cdot \nabla \phi = 0$$

$$\nabla^2 \psi = \rho \int \delta(\mathbf{x} - \mathbf{x}_\Omega)\, d\mathbf{x} = \begin{cases} \rho & \mathbf{x} \in \Omega \\ 0 & \mathbf{x} \notin \Omega \end{cases}$$

AN END-TO-END FIRE SPREAD SIMULATOR INCORPORATING SPOTTING EFFECTS

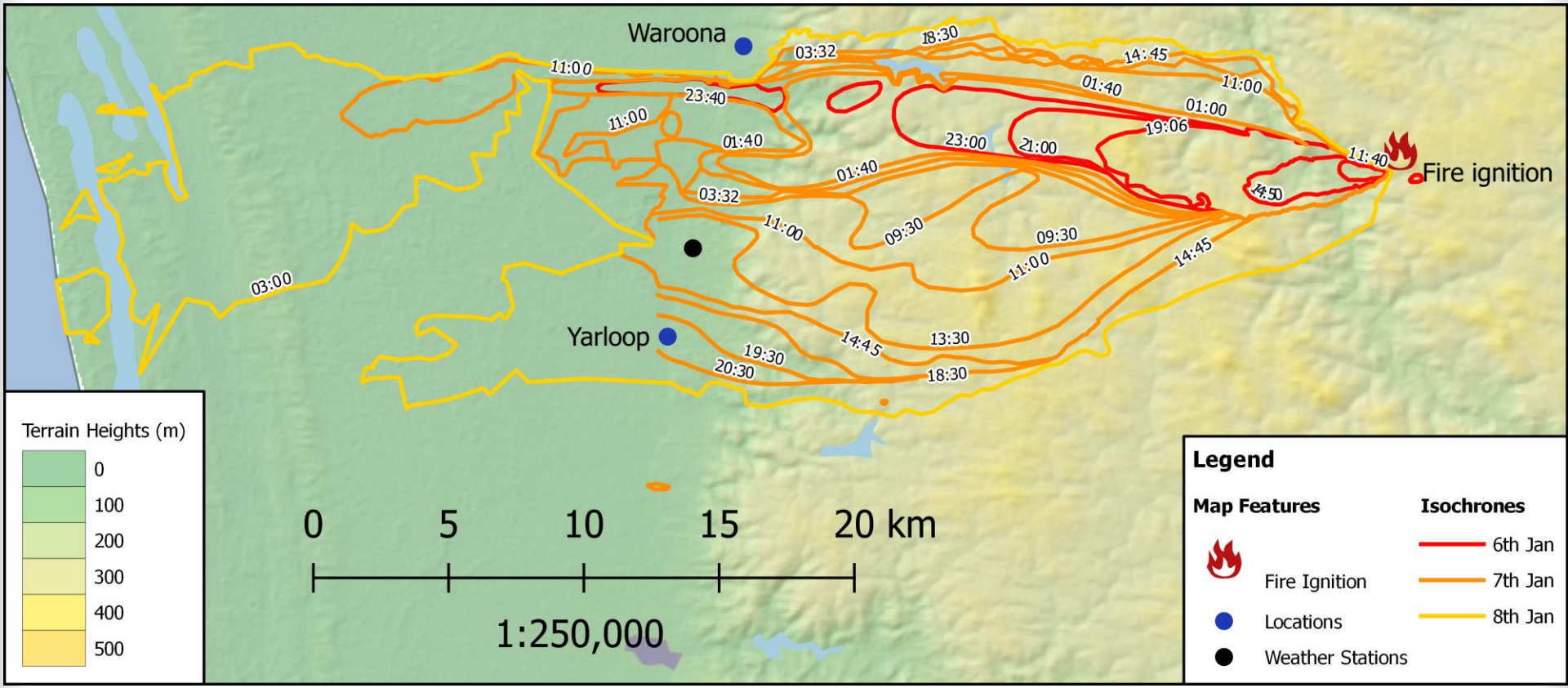
DR MIKA PEACE, CRC RESEARCHER, BUREAU OF METEOROLOGY

VIDEO WITH DR LACHIE MCCAW, DEPARTMENT OF PARKS AND WILDLIFE WA, END-USER



bushfire&natural
HAZARDSCRC

Coupled fire-atmosphere modelling



Fire isochrones from reconstruction by Department of Parks and Wildlife, WA

PYROCB EVENT 1, WEDNESDAY AFTERNOON

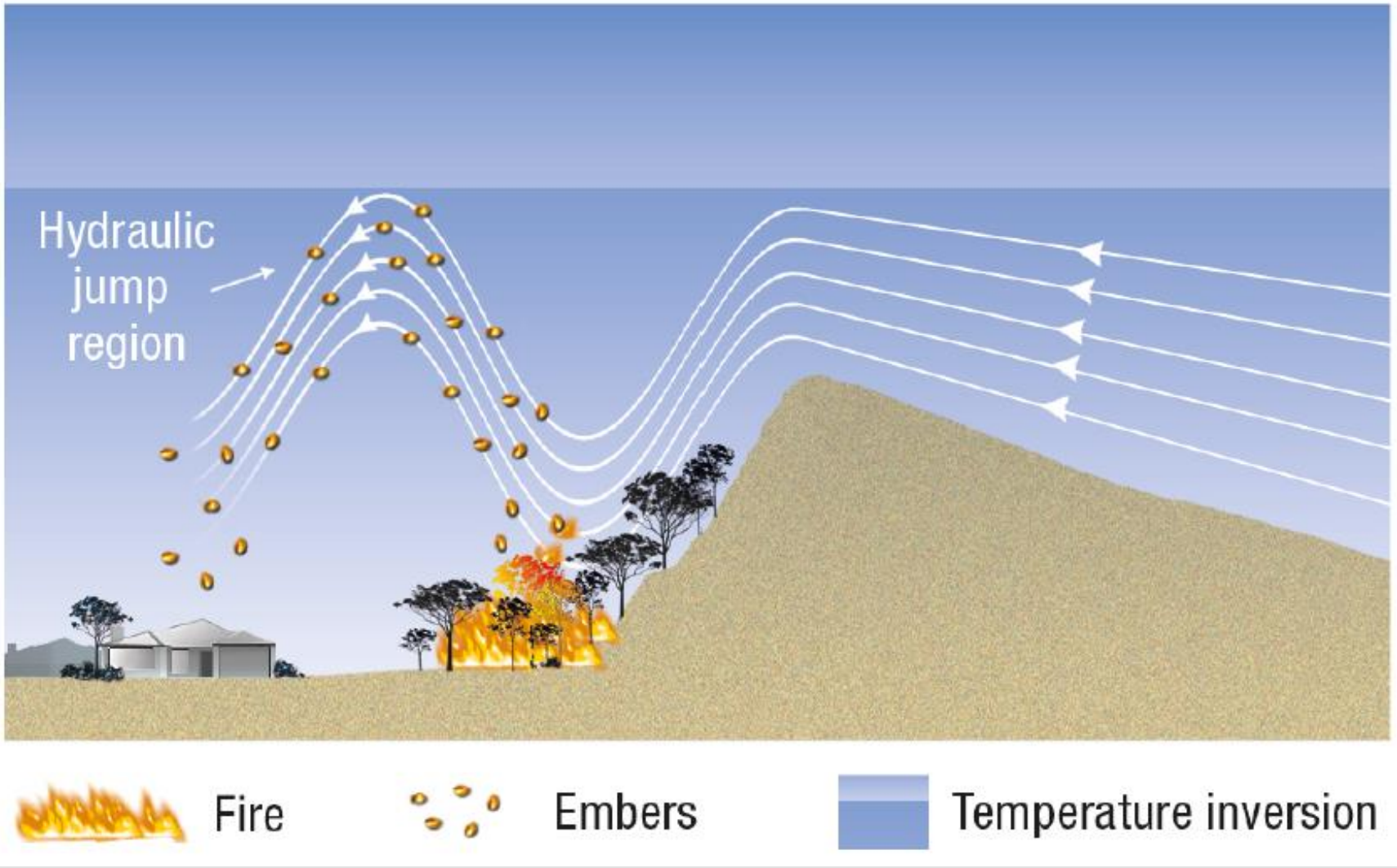
Still from video taken by Darren McCagh of Farmhouse Films

PYROCB EVENT 2, THURSDAY MORNING

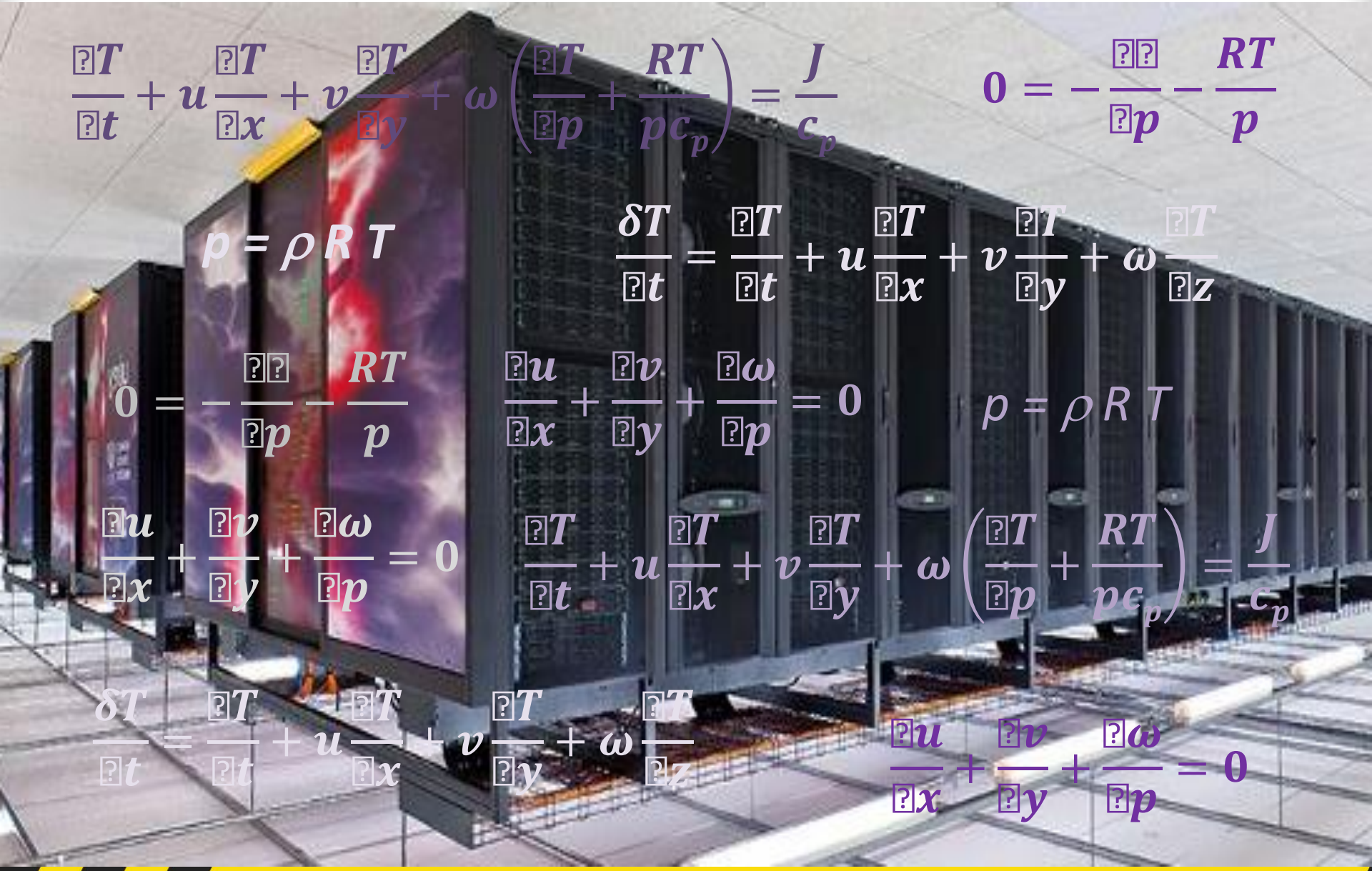
FFDI "Very High" from Dwellingup AWS observations

'…at one stage every single boundary was a head fire …
Like, the whole thing just exploded in a massive downdraft.'

(Operations manager quote from Ferguson report)



SUPERCOMPUTER (NCI)



DR STUART MATTHEWS, NSW RURAL FIRE SERVICE

NATIONAL FIRE DANGER RATING SYSTEM

Q AND A