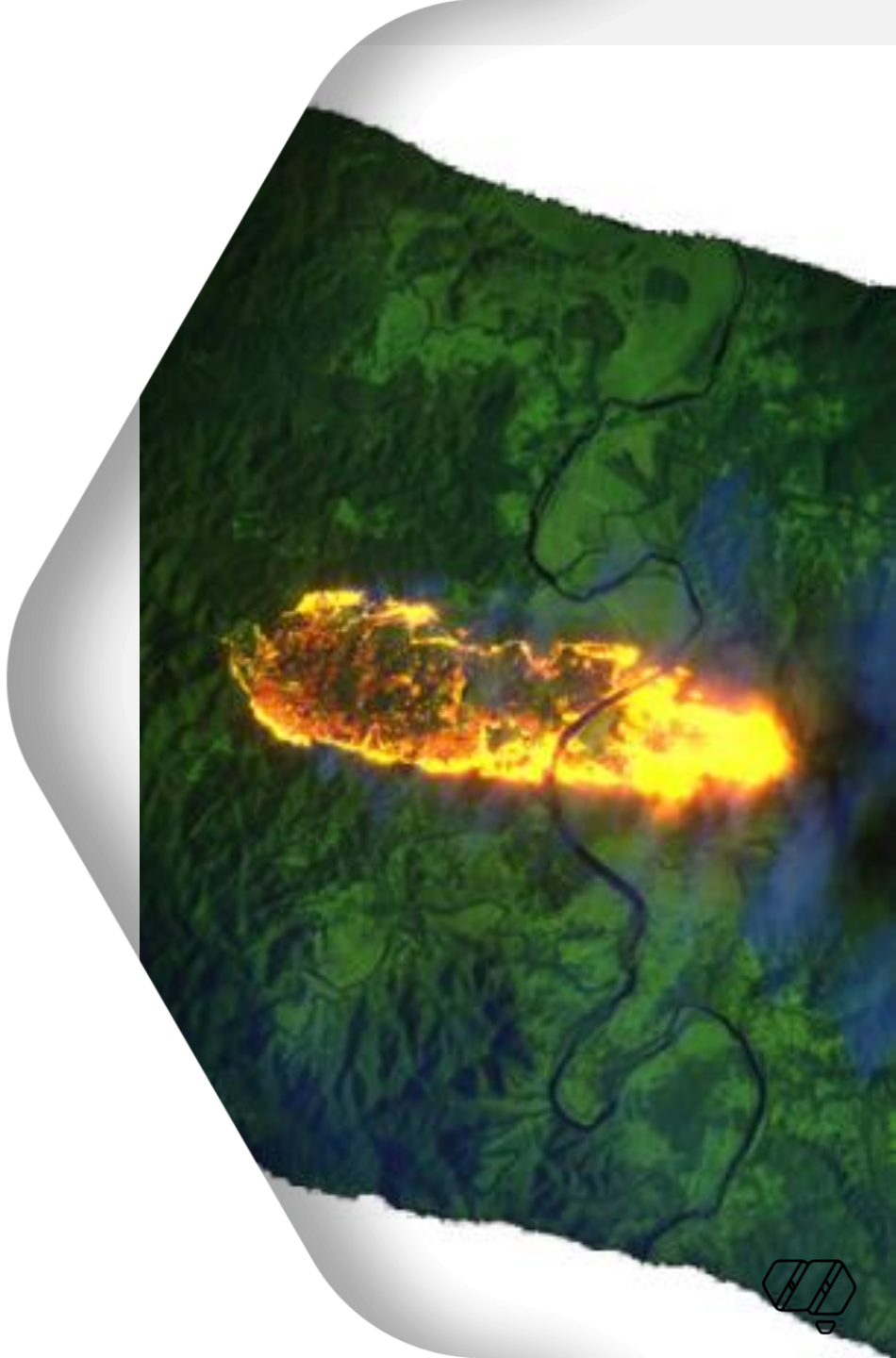
Natural Hazards Research Australia

T4-A2: Capturing uncertainty in bushfire spread prediction



Michael Storey
Associate Researcher
University of Wollongong

Capturing uncertainty in bushfire spread prediction

Goals

- A Bayesian probabilistic bushfire rate of spread model for operational use.
- Tools and approaches to generate and communicate probabilistic predictions.
- A rate of spread database and processing package

Completion

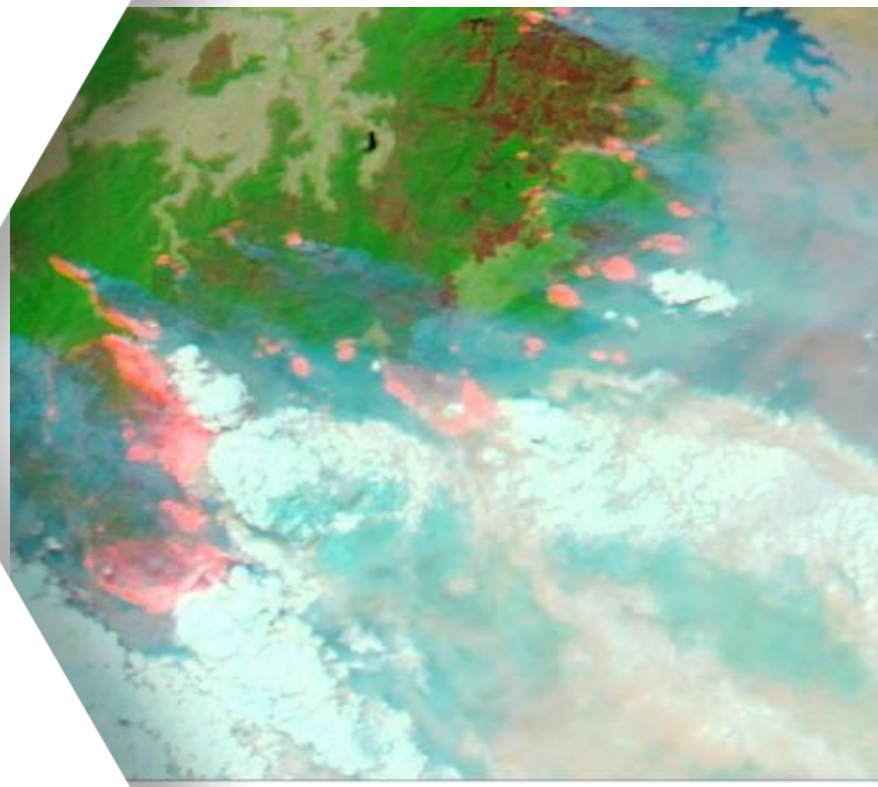
- Early 2027

Team

- University of Wollongong: Michael Storey, Michael Bedward and Owen Price

Contact

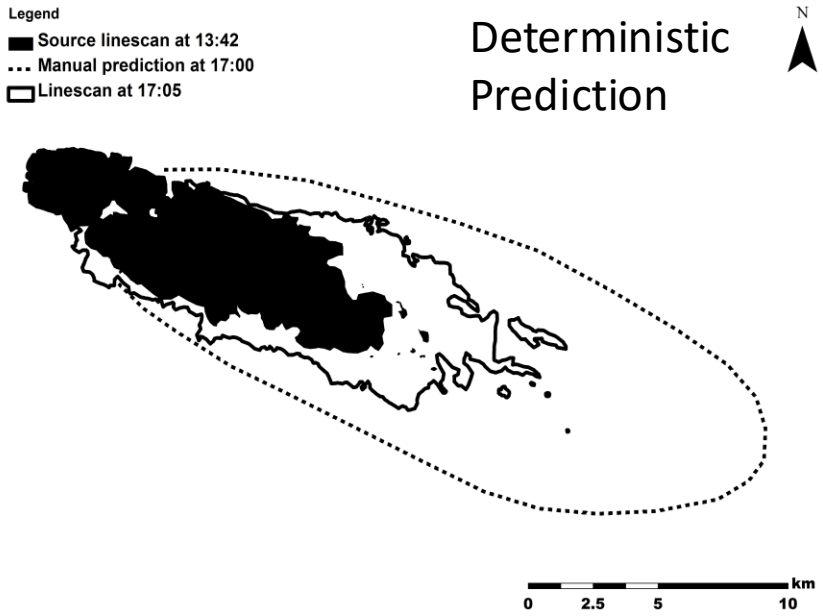
- mstorey@uow.edu.au



Why a Bayesian model for rate of spread?

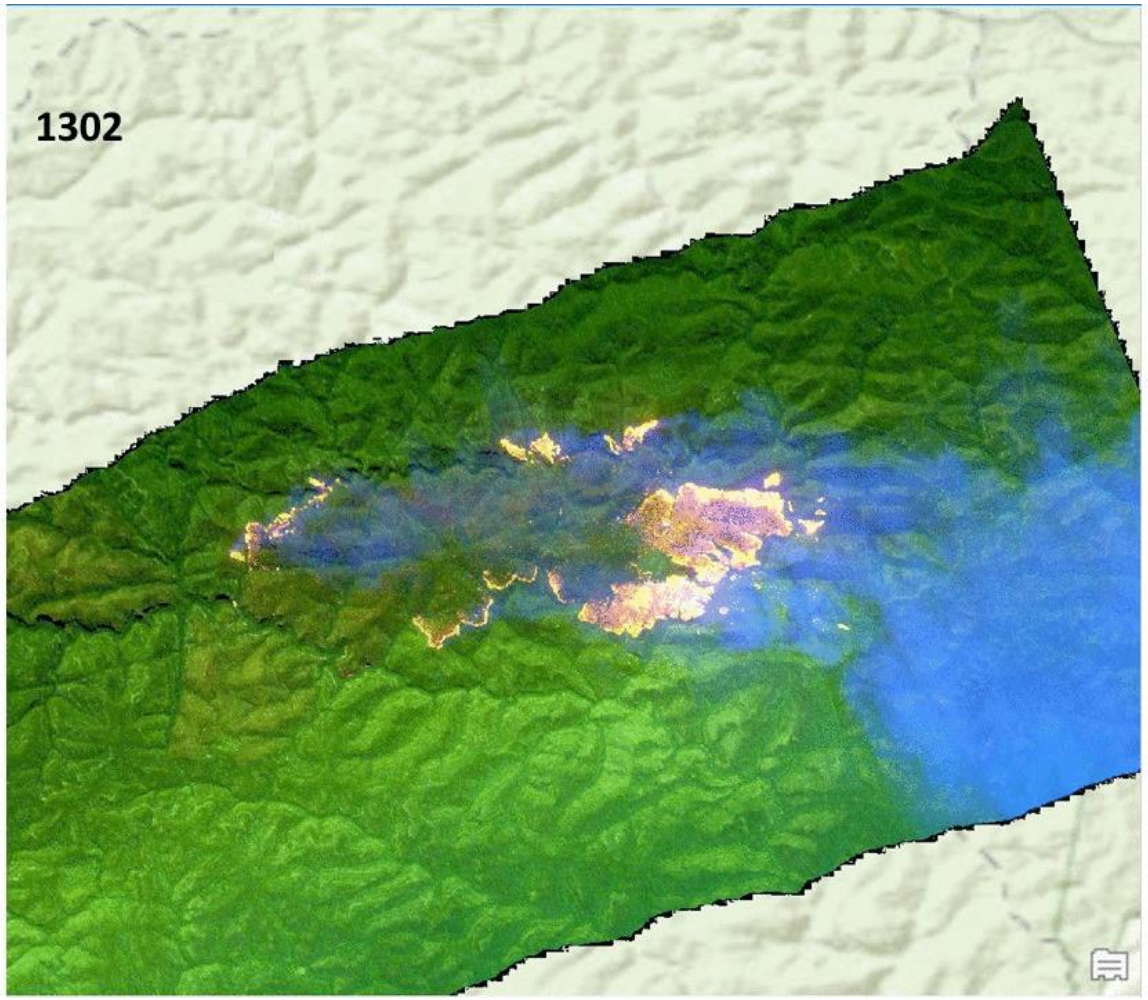
We usually predict spread based on a few variables. But bushfire spread complex:

- Topography variation
- Wind gusts
- Extreme fire behaviours
- Spotting interactions
- Atmospheric interaction



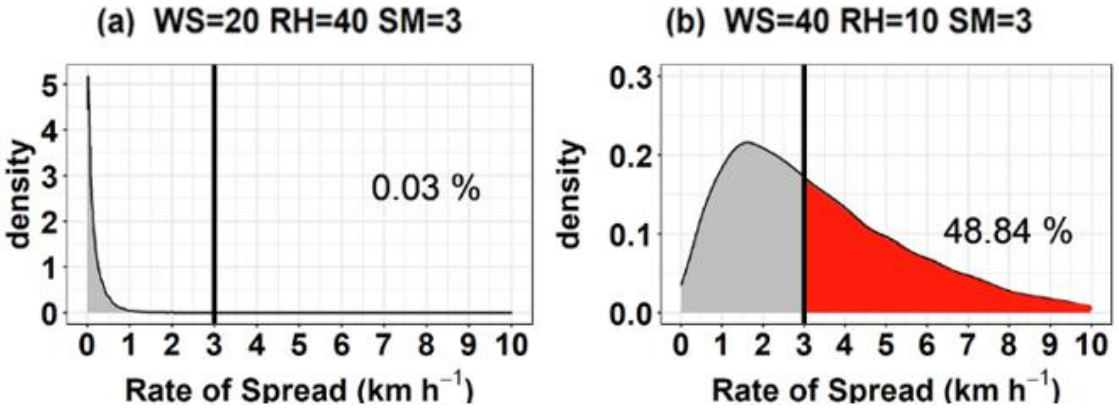
Deterministic Prediction

We need a way to represent this uncertainty in ROS predictions



Bayesian prediction example

Bayesian prediction examples



Based on all the examples of fire spread we have from line scans, and given these conditions, there is a ~49 % chance that fire ROS will be faster 3 kmh.

Bayesian

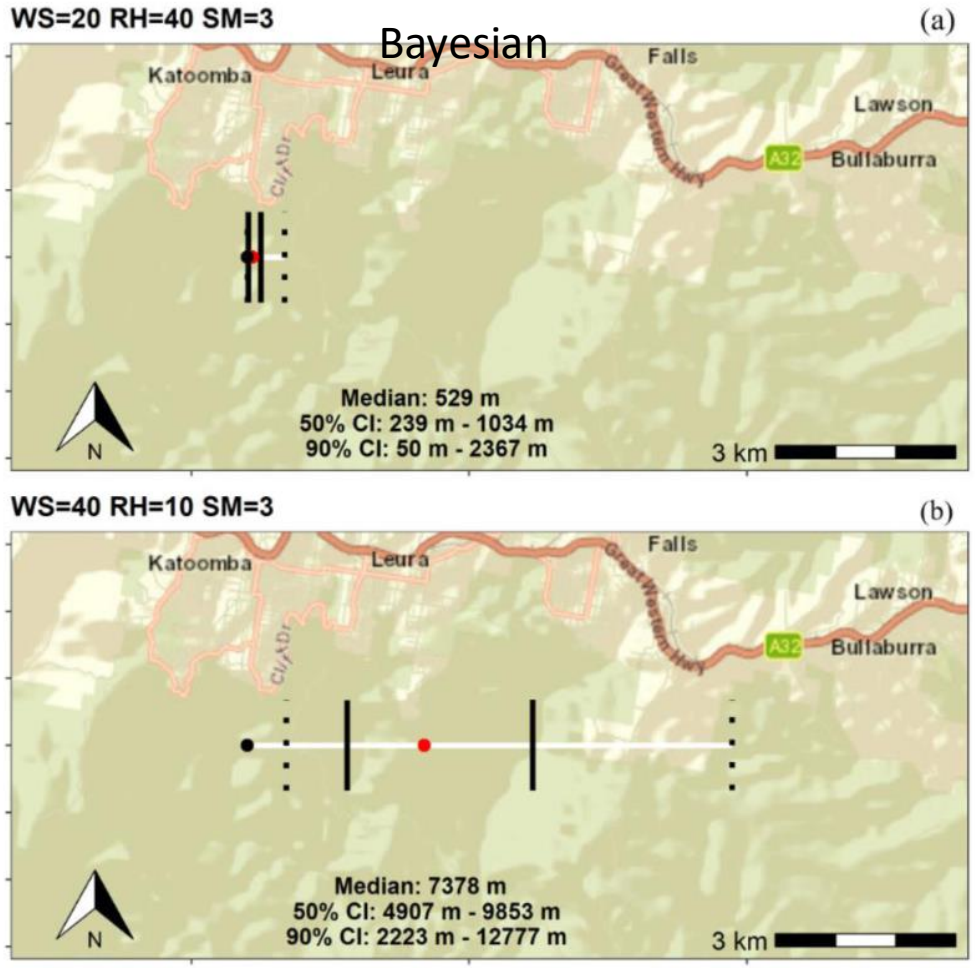


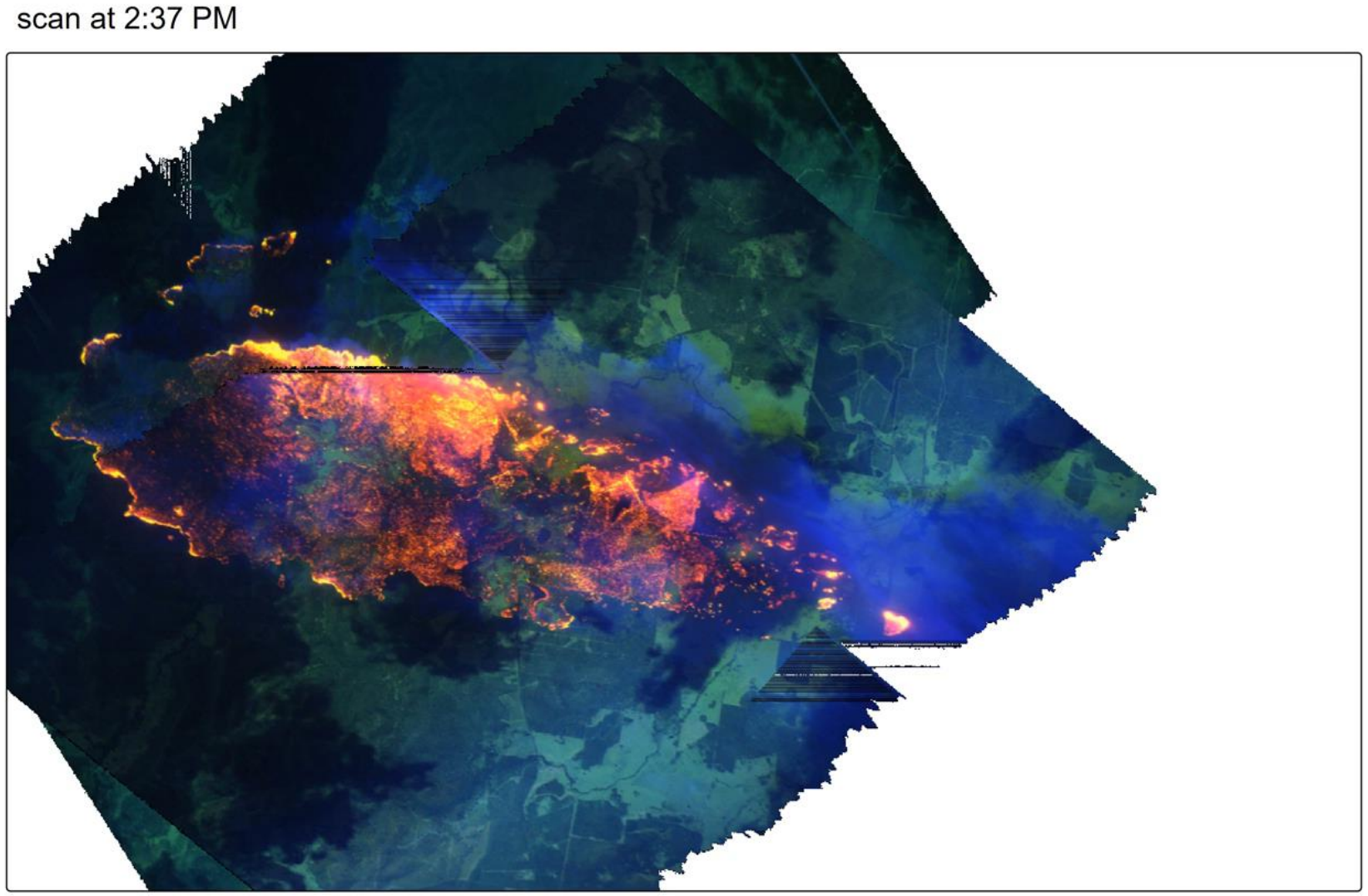
Fig. 8. Map representation of predicted spread distance over 1 h derived from the Bayesian model predictive distributions for different weather conditions (a = mild, b = more extreme), as in Fig. 7. Black dot is start point, red dot is median predicted distance, black lines show the 50% credible interval (CI), black dotted lines show the 90% CI. Fire path (represented by white line) is simply based on a spread bearing of 90°. Location for this example is in the Blue Mountains area, NSW, Australia. WS, wind speed (km h^{-1}); RH, relative humidity (%); SM, soil moisture (kg m^{-2}).

After one hour, the fire will most likely end up somewhere between the black lines. If the fire has extreme behaviour, there is a small chance it could spread as far as the black dotted line.

Fire progression data

→ Work to date

- Collating data from agencies and previous work (Thanks RFS, CFA, DEECA, DFES)
- Collating data from previous work at UOW
- Mapping fire progressions
- Building prototype processing package
- Building prototype database



Approach to mapping progressions and measuring ROS

Fire progression data

→ Work to date

- Collating data from agencies and previous work (Thanks CFA, DEECA, RFS, DFES)
- Collating data from previous work at UOW.
- Mapping fire progressions
- Building prototype processing package
- Building prototype database

20 min – 5 hour timesteps.

Processing package

→ Prototype package

- Search data online and search prototype database
- Download to one place
- Speed up mapping + ROS measurement
- Manage database

Landsat & Sentinel 2 images

(Online: GA STAC)

Daily VIIRS\MODIS hotspots & images

(Online: NASA GIBS)

Aircraft line scans

(UOW Database. Originals from RFS, DEECA, DFES)

Progression polygons (UOW Database)

BARRA weather

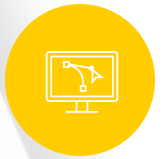
(Online: BOM NCI)

Himawari 8/9 images

(Online: BOM NCI)

Automated rate of spread measurement

Database functions



Meta/Facebook AI model based mapping

Prototype bushfire progression database

-9000 line scans
(DEECA/RFS/DFES)
-Satellite images

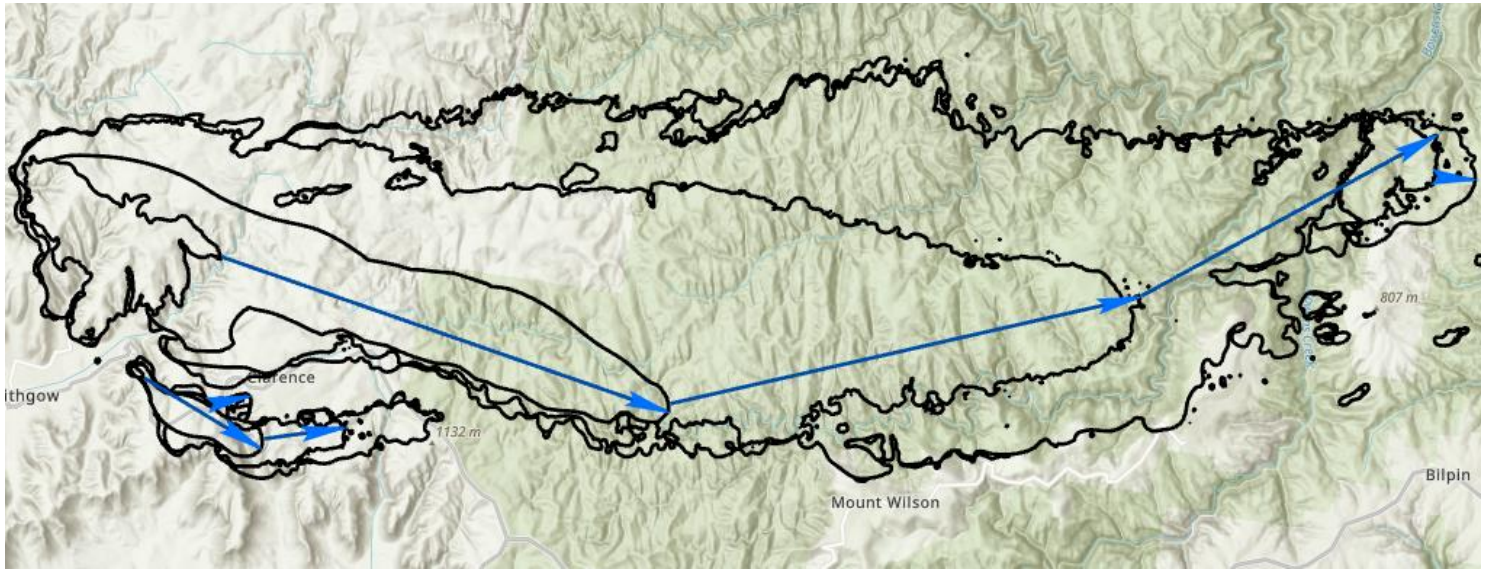
3300 progressions

Progressions linked to images

727 ROS lines

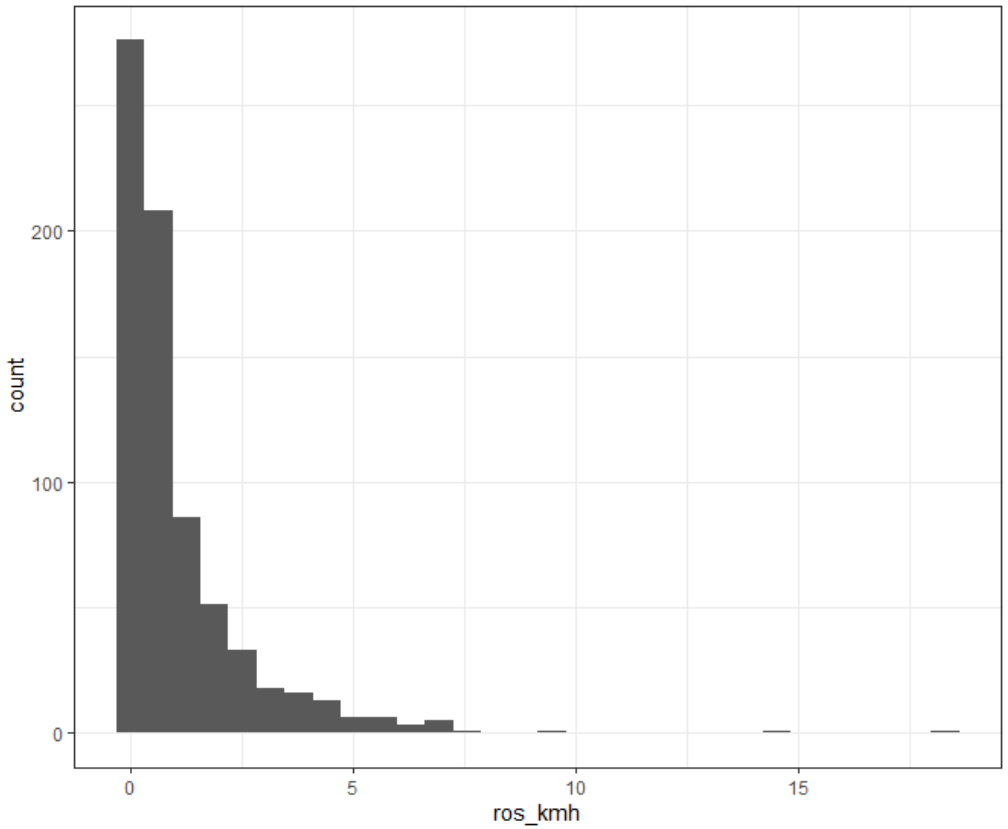
→ Advantages

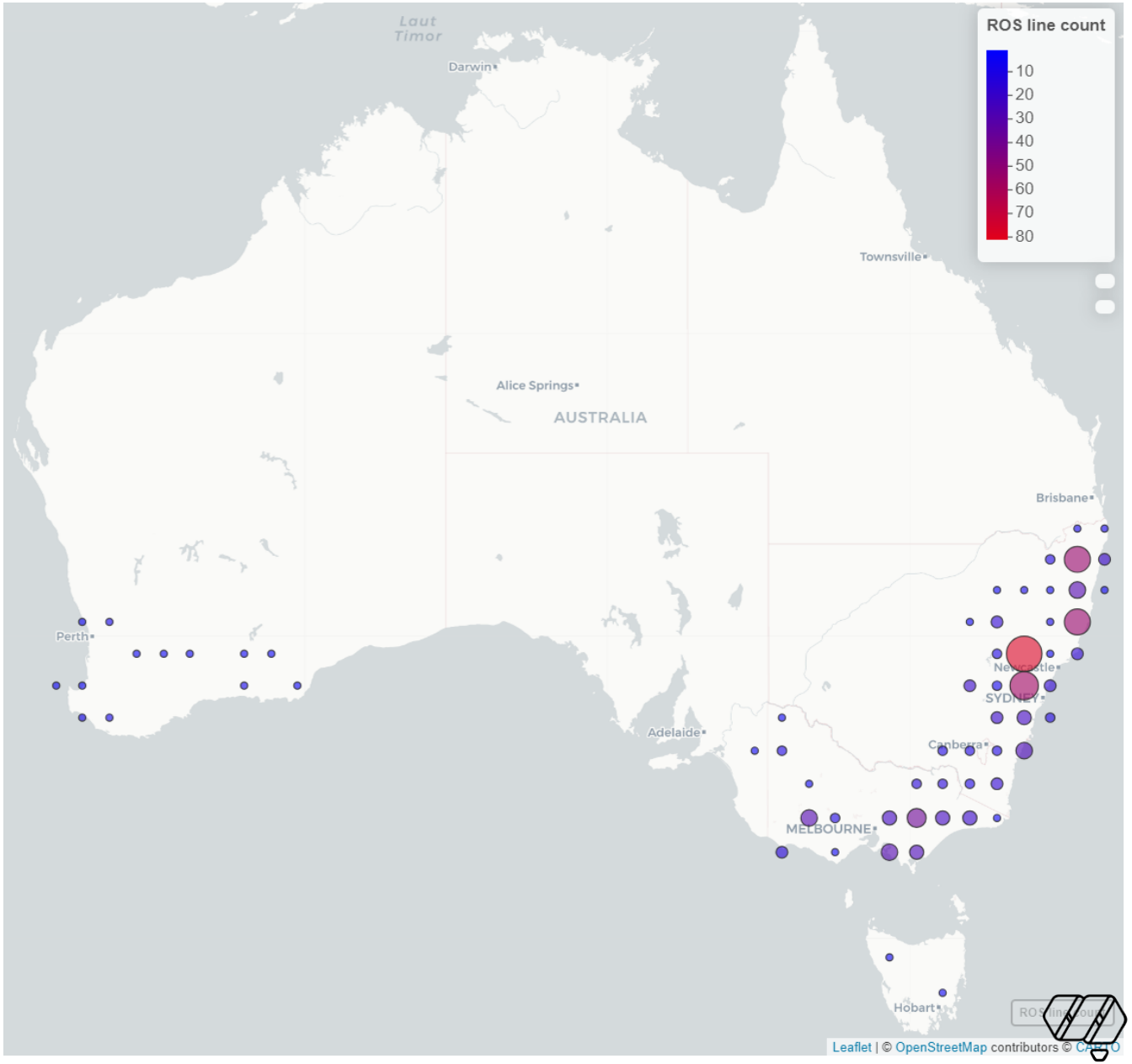
- Consistent polygon attributes.
- Easily searchable by time & location.
- Links to other data/other data can be added.
- Substantially speed up data collection phase of research.
- Continually assess ROS model performance (+ update models)



Prototype bushfire progression database

- Some ROS stats
  - 727 ROS lines (so far)
  - 33% > 1 km/h
  - 9% > 3km/h
  - Mean 1.1 km/h, max. 18.3 km/h





Faster progression mapping

→ Testing a process to create polygons

- Mostly automated with some manual input and oversight.
- Meta “Segment Anything” model
- Time is saved by:

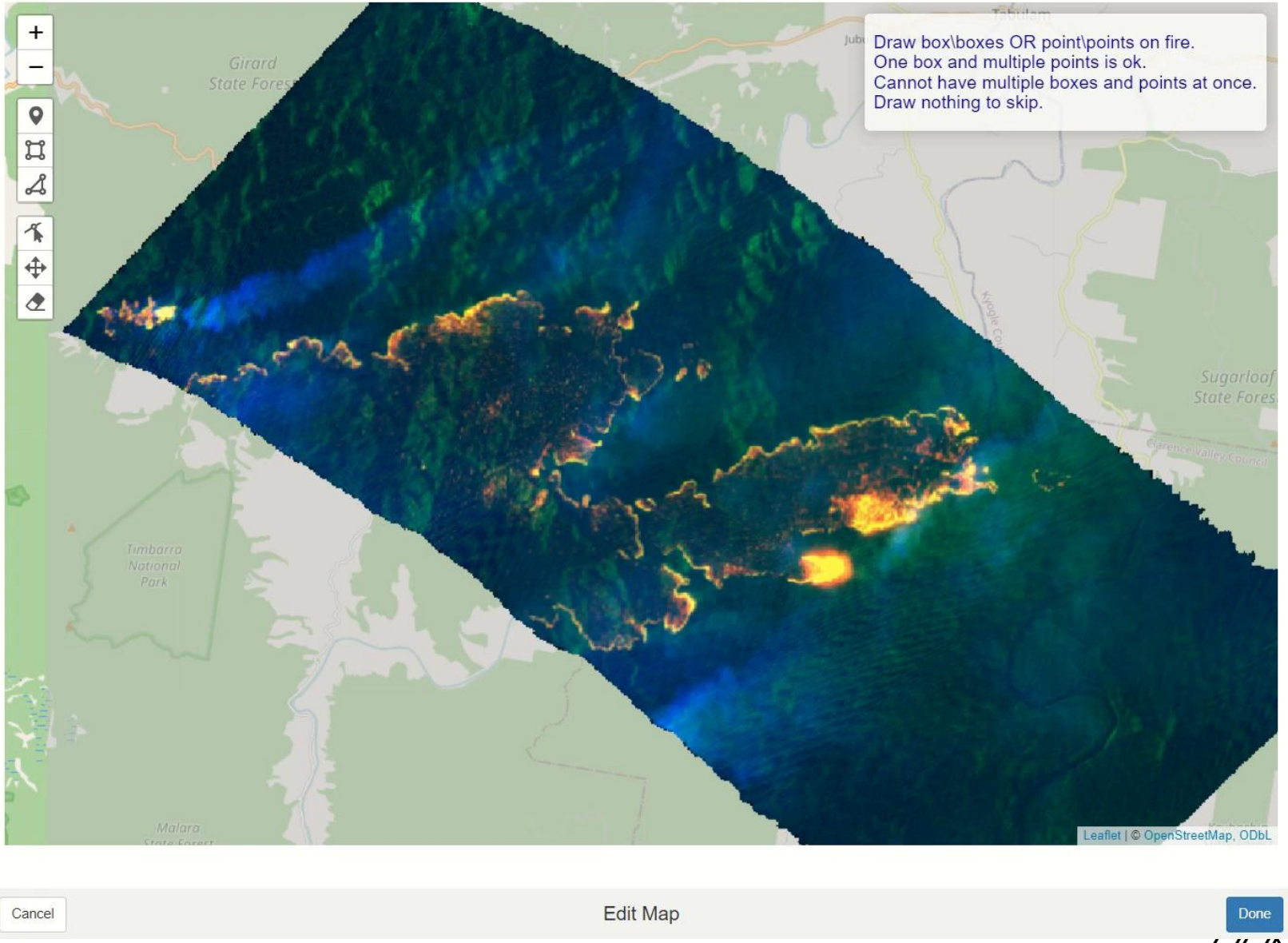
-automatically loading scans

-auto creation of initial fire polygon via Meta model.

-auto adding of attributes (e.g. scan time)

-auto save to file (shp or gpkg)

- Works best where edge is clear



Database and processing package future?

→ Feedback on this idea is welcome

- What aspects are useful in fire agencies?
- What is already being used in fire agencies?
- What's missing?
- Any feedback/ideas for development?
- mstorey@uow.edu.au

A national database of wildfire progression and wildfire scans. Publicly available (?) and **updated yearly.**

Further development of R package functions including developing a web app.

Deploy R package and app and agree on process to update database.

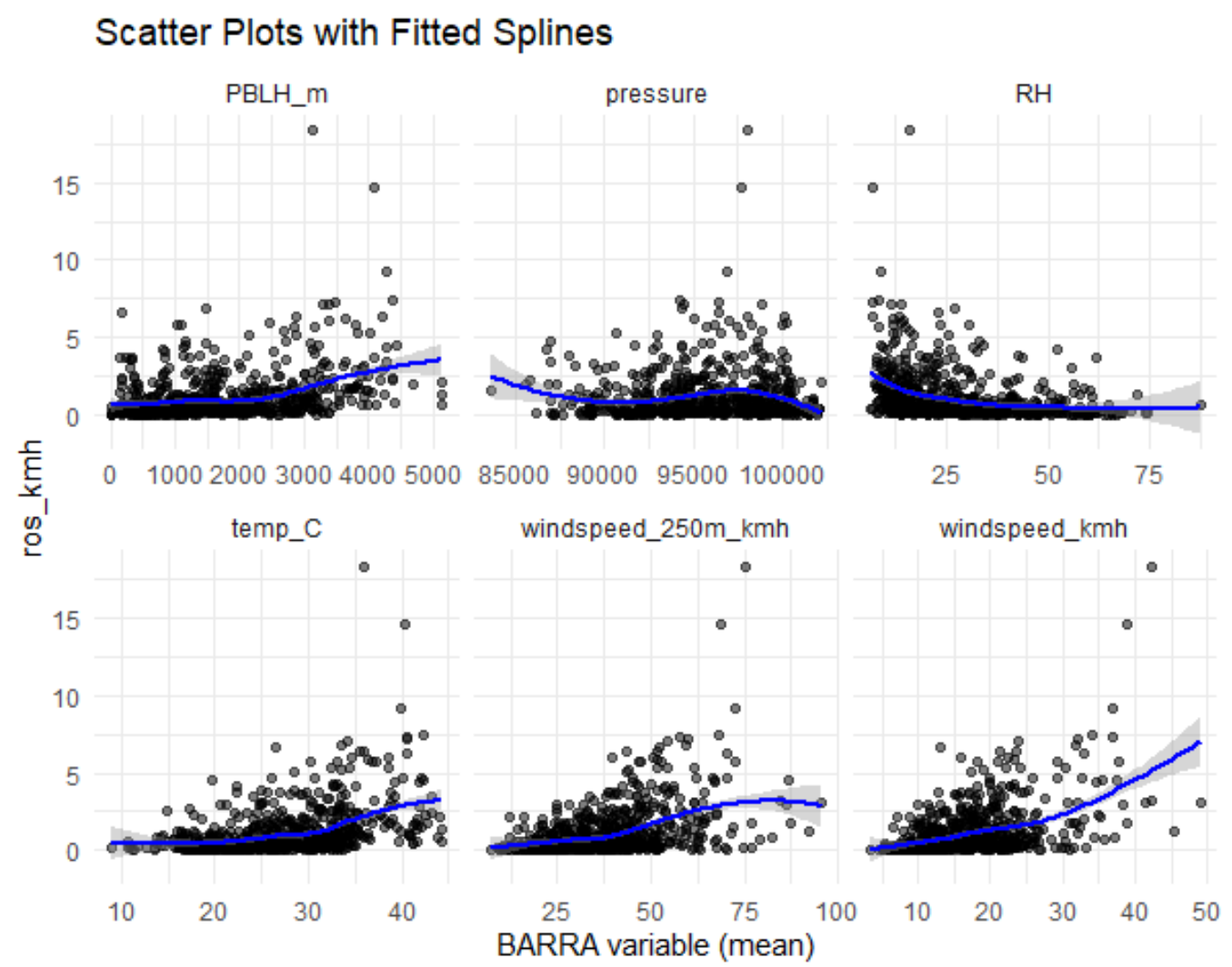
Add other selected data for fire reconstructions/ research (ICON/Emap records, PM2.5, fuel moisture records, weather, water drops, FLIR images etc).

Add tables linking fire spread and line scans to extreme fire behaviours, e.g. VLS, pyroCB.

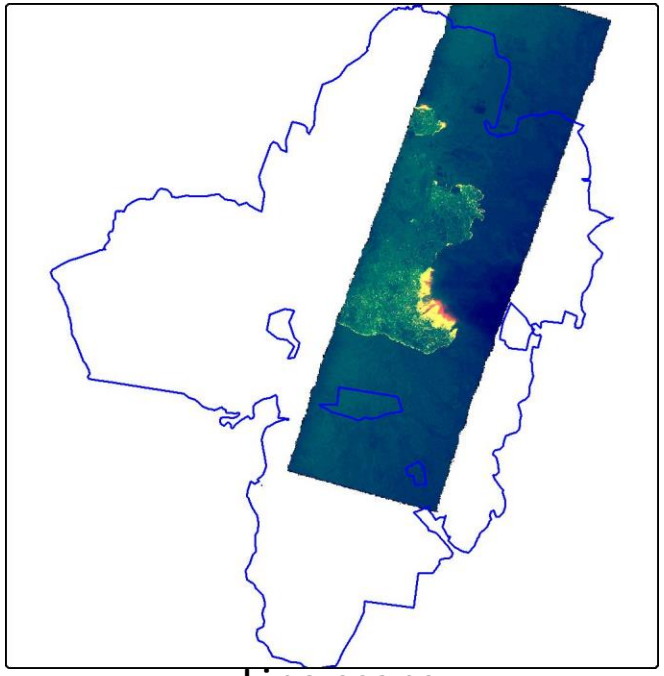
Next steps

→ Project completion early 2027

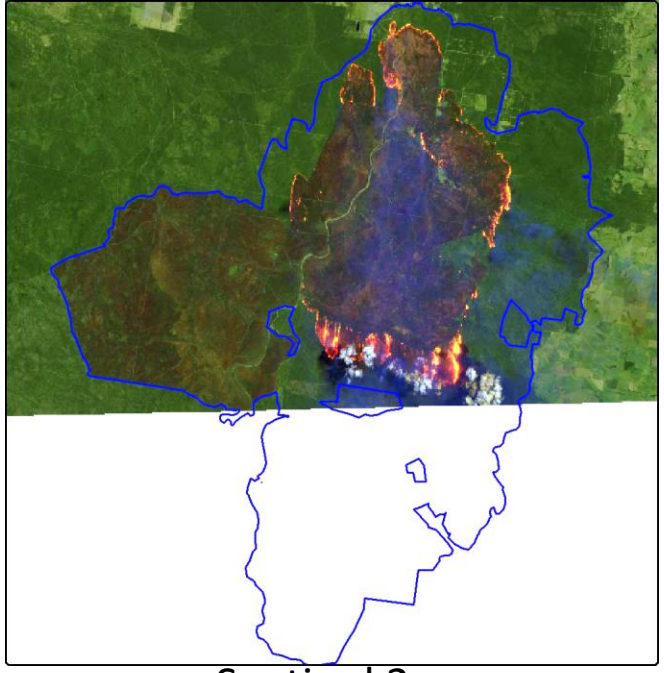
- Add more progressions?
- Sampling fuel and weather
- Fitting and testing models
- Working with RFS and other agencies to develop prototype operational tool
- Develop database + processing package???



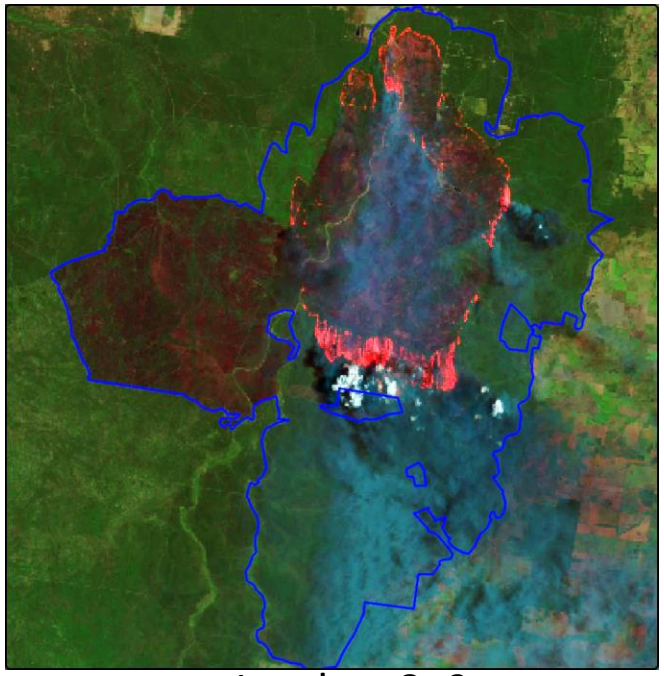
Contact:
Michael Storey
University of Wollongong
mstorey@uow.edu.au



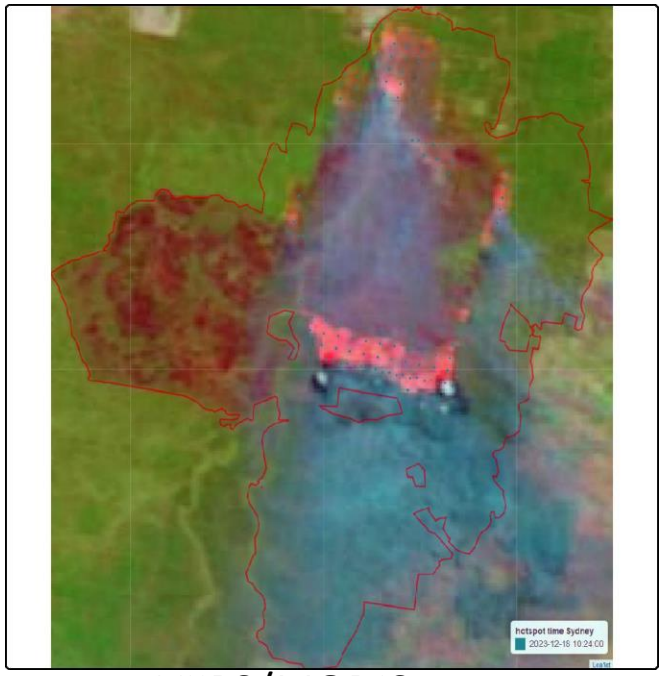
Line scans



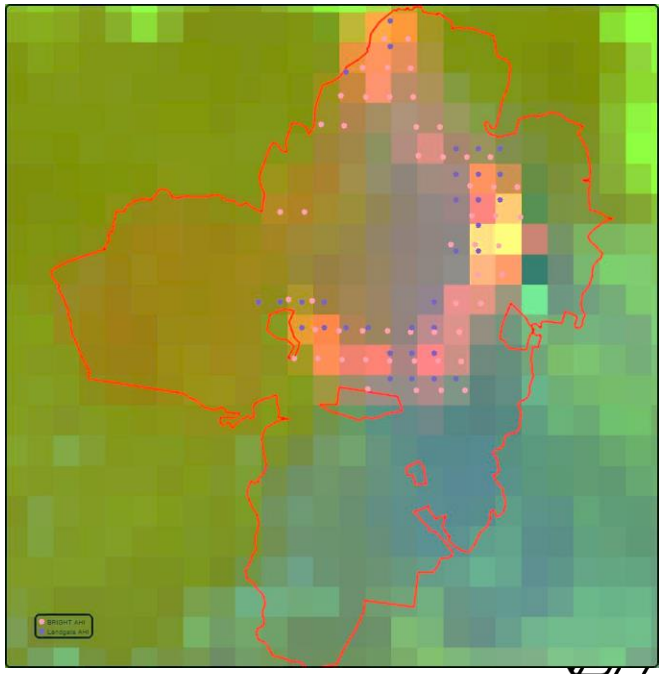
Sentinel 2



Landsat 8, 9



VIIRS/MODIS



Himawari 8, 9