AN INTEGRATED SYSTEM TO PROTECT AUSTRALIA FROM CATASTROPHIC BUSHFIRES

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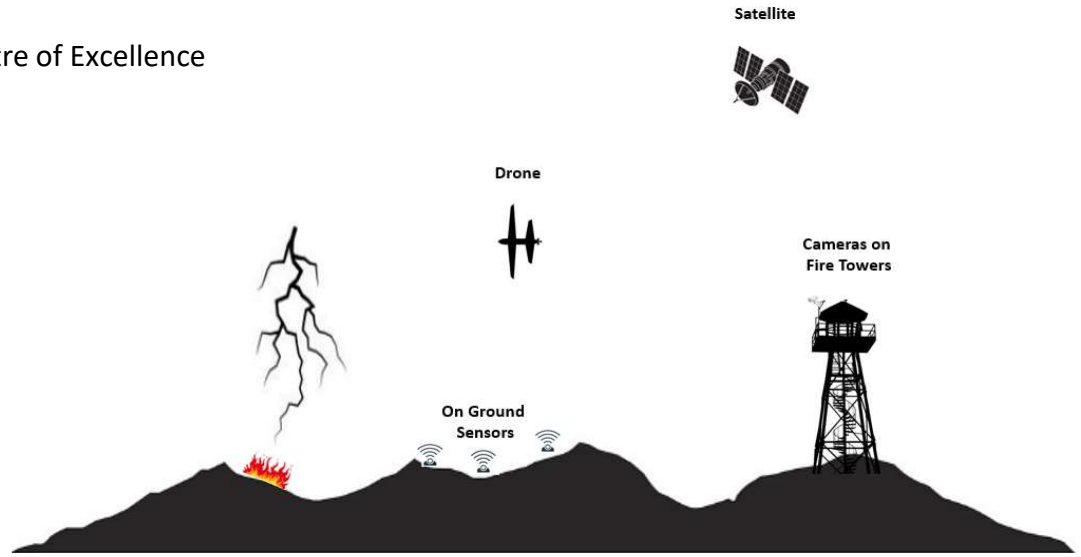
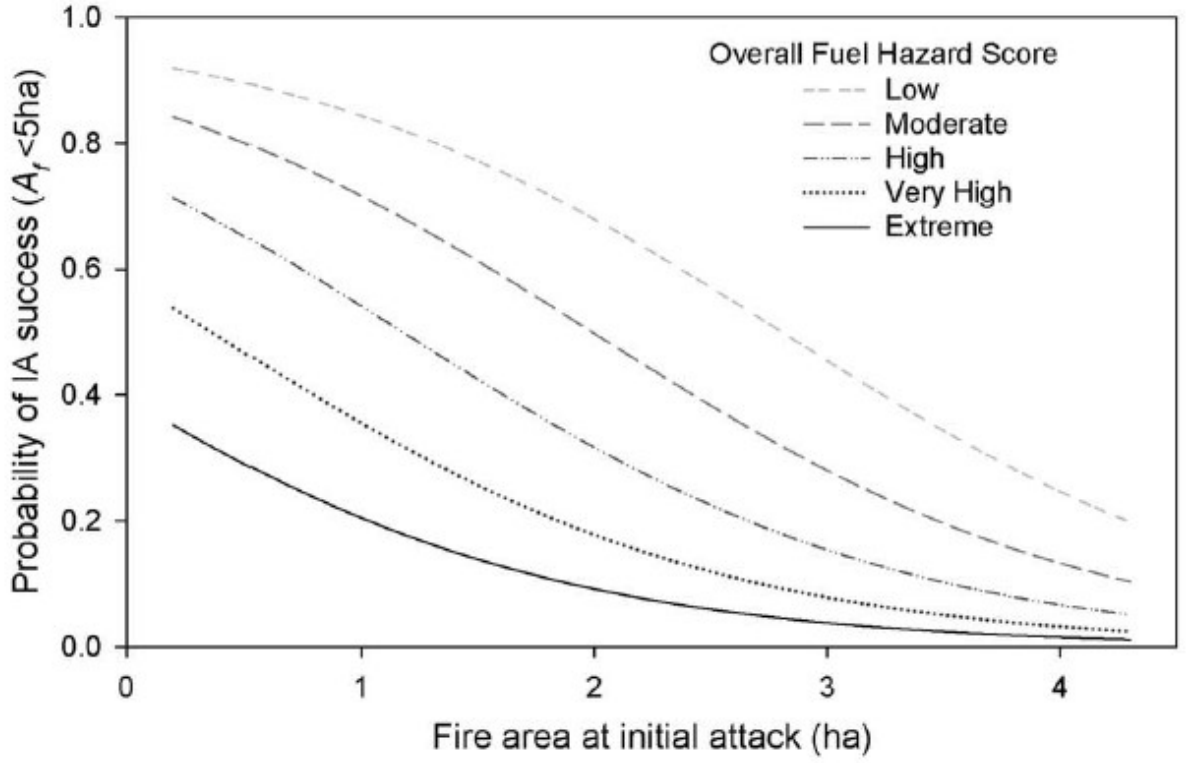


Early detection of ignitions is critical to the prevention of large bushfires

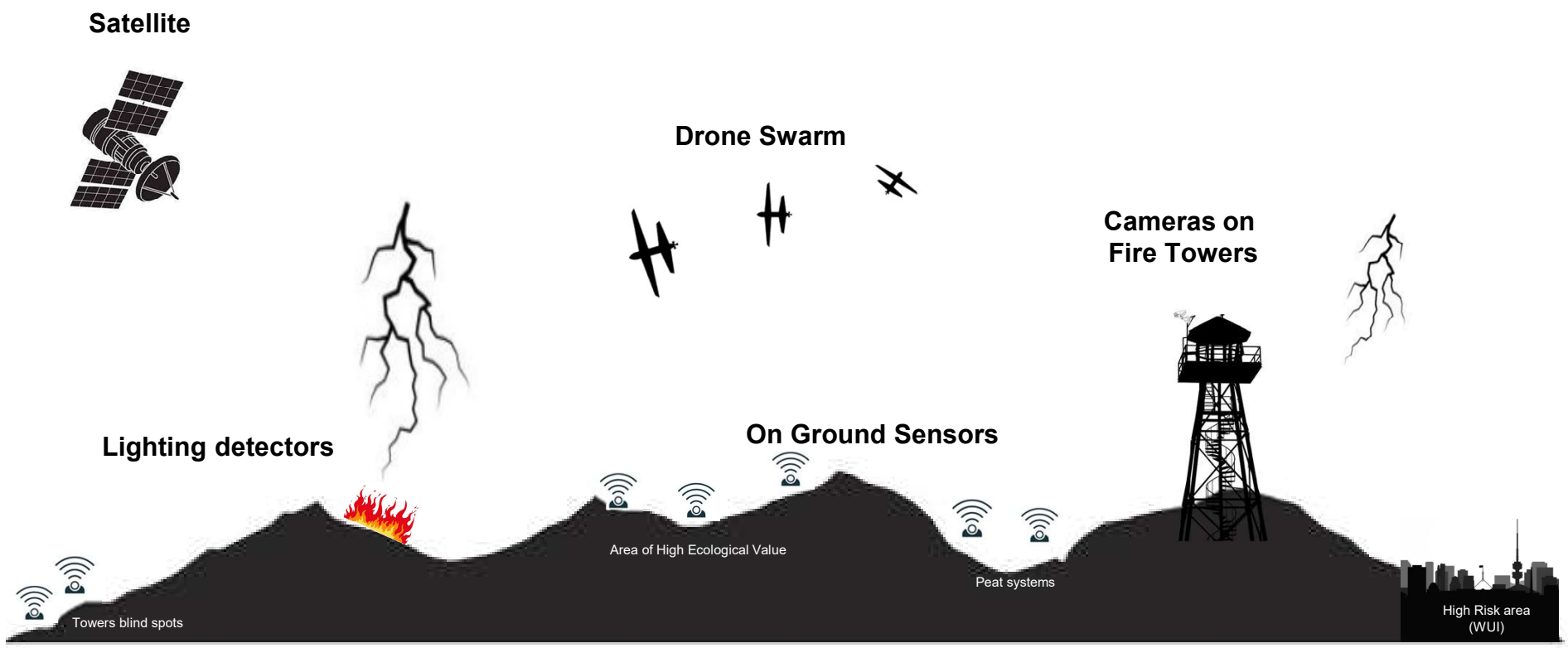


[2] (Plucinski, 2012)

Lightning ignitions

- Identified as a key cause of major bushfires.
- Occur across the landscape, often in remote, inaccessible bushland late in the day
- Individual thunderstorms may contain thousands of lightning strikes
- Checking and validating all possible ignitions after a dry lightning storm is a critical, time consuming and dangerous task.
- Crew fire-spotting aircraft may not be available until the next morning (resourcing/safety issues/restrictions on night flying)
- Fires can smoulder inside a tree or its root system, producing little if any smoke, for hours, days or even months

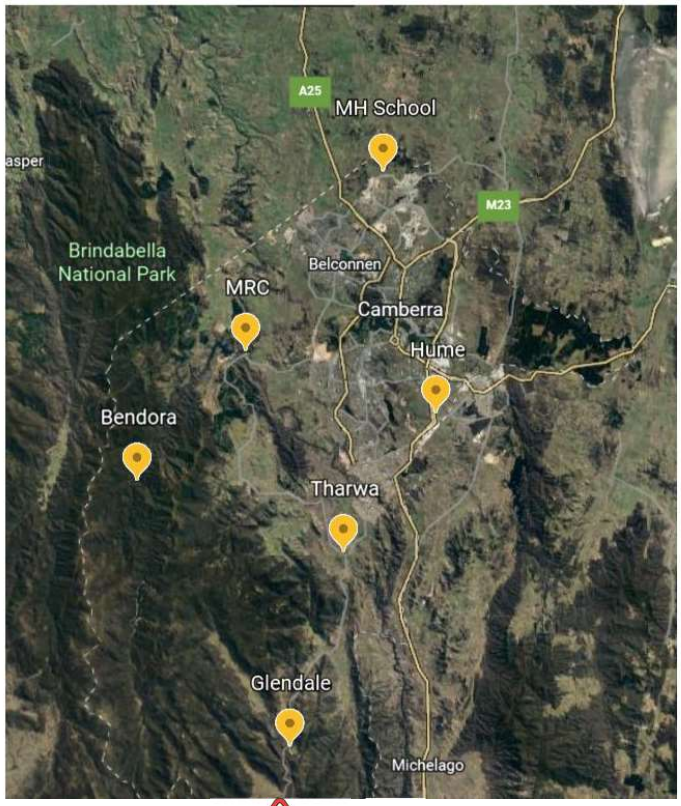
Layers of situational awareness for ignition detection



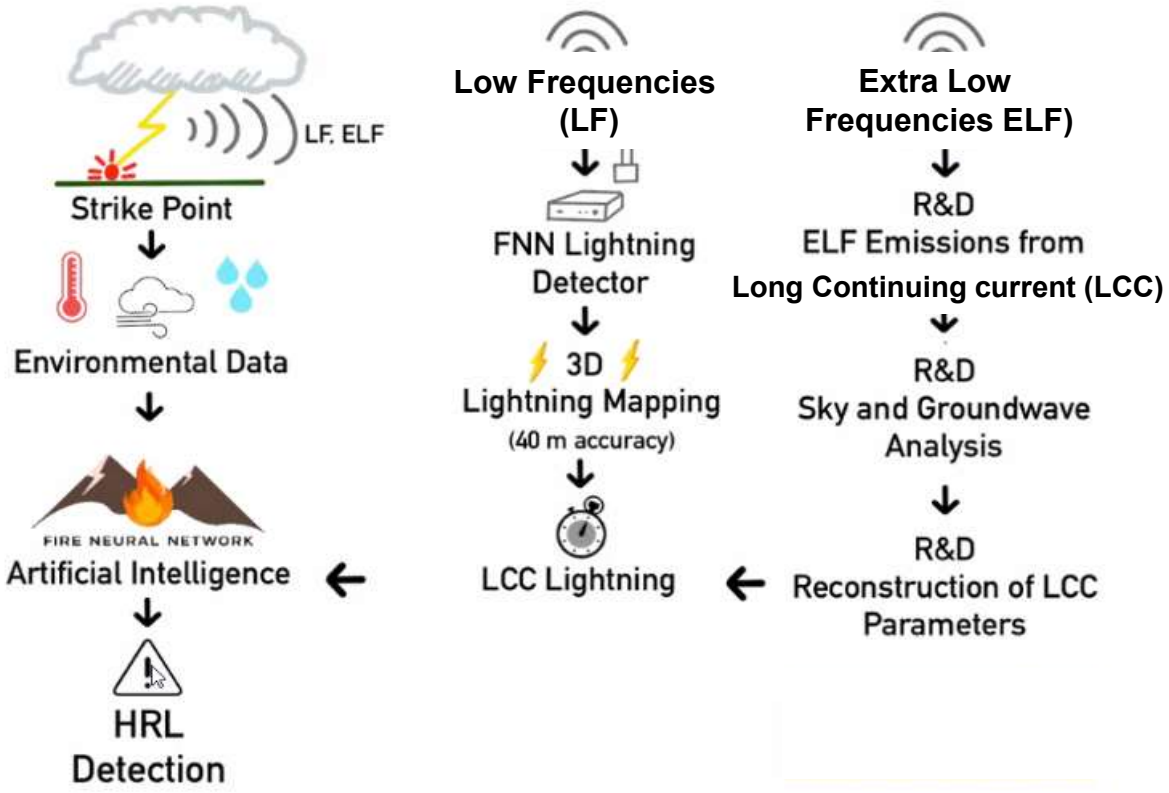
Trailing technologies in the **Australian Capital Territory**

Yebra et al. 2021 AJEM

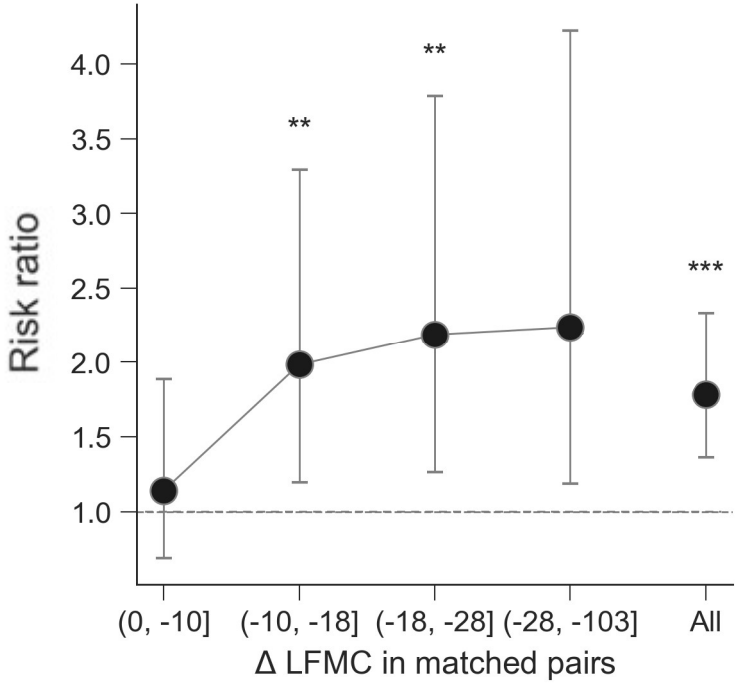
Six lightning detectors installed in the ACT



Rapid identification of High Risk Lightning (HRL)



Live Fuel Moisture Content increases the likelihood of a lightning-caused wildfire



* p < 0.05
** p < 0.01
*** p < 0.001

Rao et al., (Under review)

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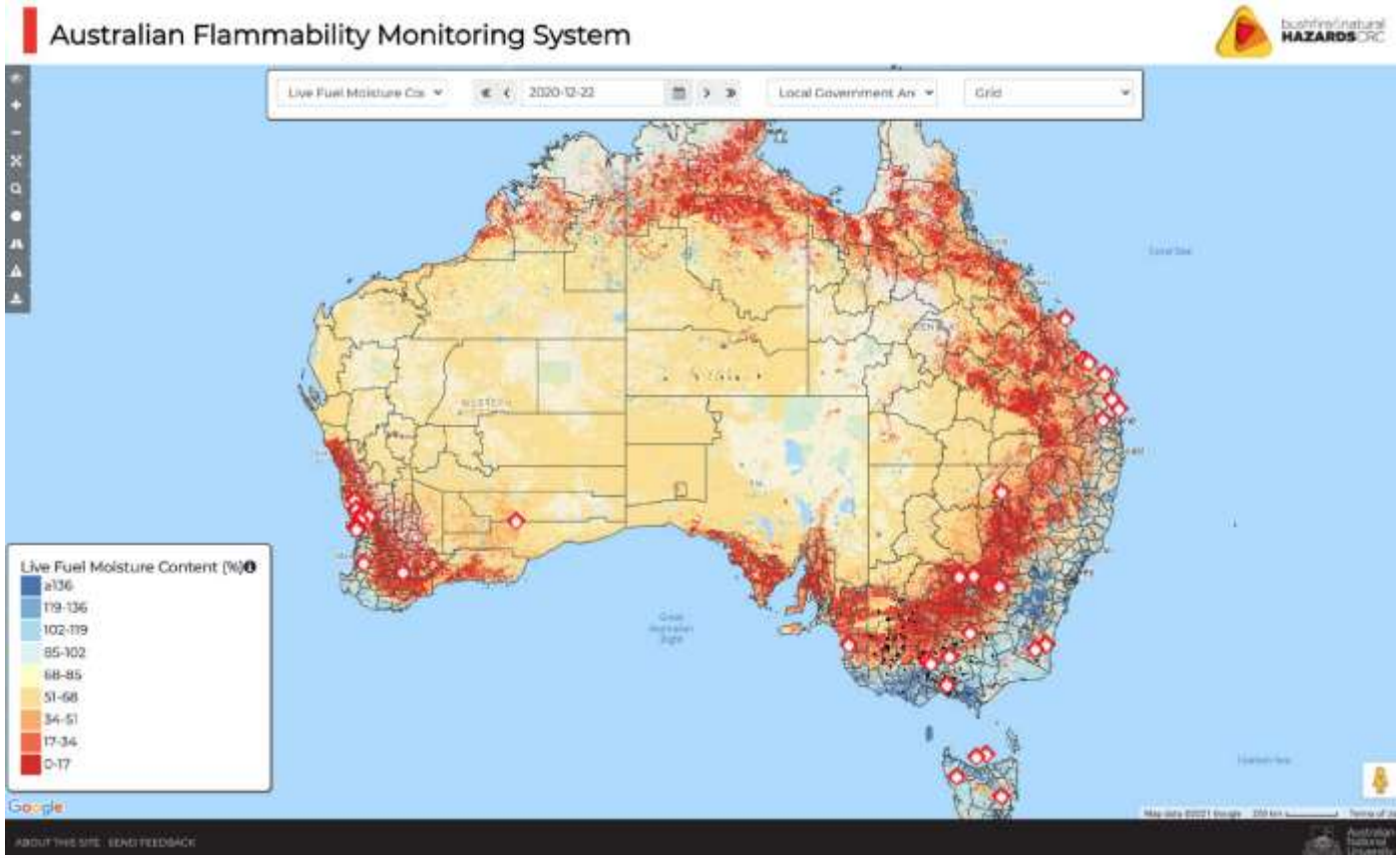
Landscape flammability



Yebra et al. 2018, RSE http://wenfo.org/afms/

Landscape flammability forecast

SCIENTIFIC DATA

OPEN

DATA DESCRIPTOR

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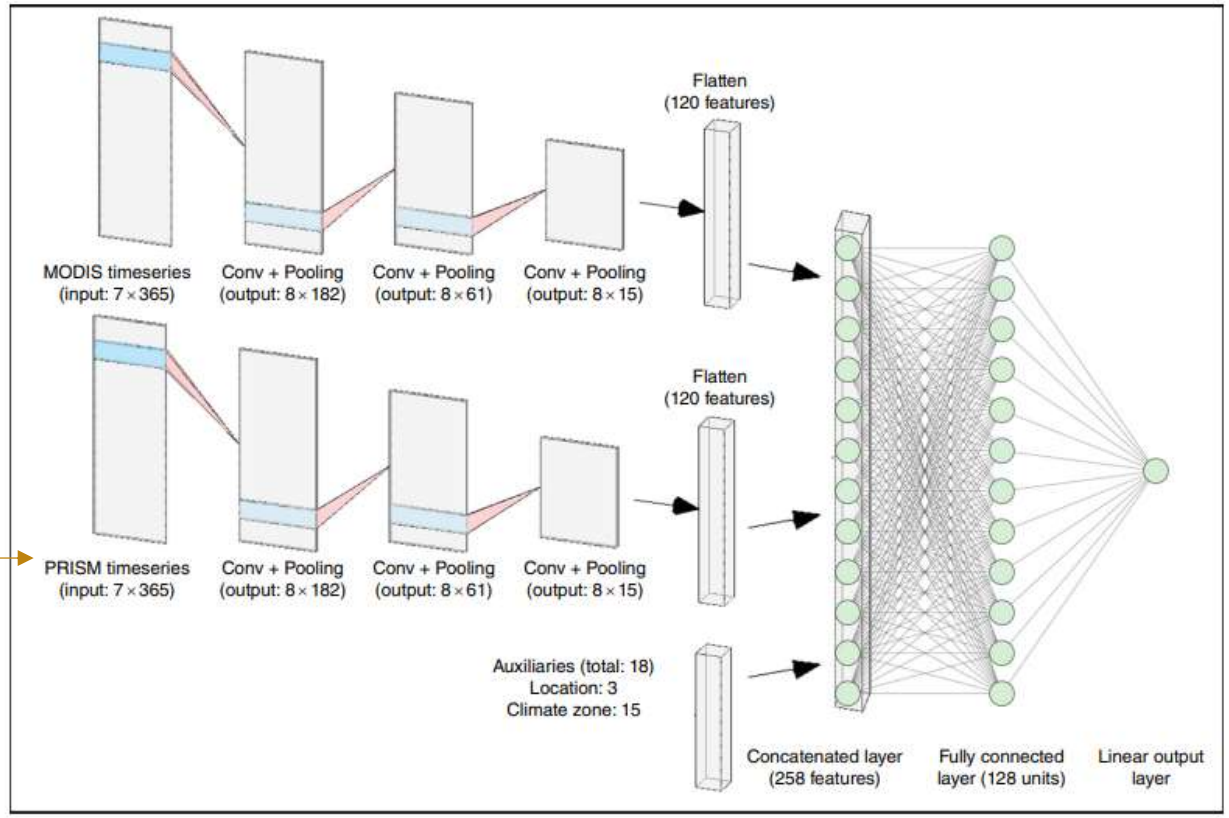
Globe-LFMC, a global plant water status database for vegetation ecophysiology and wildfire applications

Marta Yebra[1,2], Gianluca Scortechini[1], Abdulbaset Badi[3], Maria Eugenia Beget[4], Matthias M. Boer[5], Ross Bradstock[6], Emilio Chuvieco[7], F. Mark Danson[3], Philip Dennison[8], Victor Resco de Dios[9], Carlos M. Di Bella[4], Greg Forsyth[10], Philip Frost[11], Mariano Garcia[7], Abdelaziz Hamdi[12], Binbin He[13], Matt Jolly[14], Tineke Kraaij[15], M. Pilar Martin[16], Florent Mouillot[17], Glenn Newnham[18], Rachael H. Nolan[5], Grazia Pellizzaro[19], Yi Qi[20], Xingwen Quan[13], David Riaño[16,21], Dar Roberts[22], Momadou Sow[23] & Susan Ustin[21]

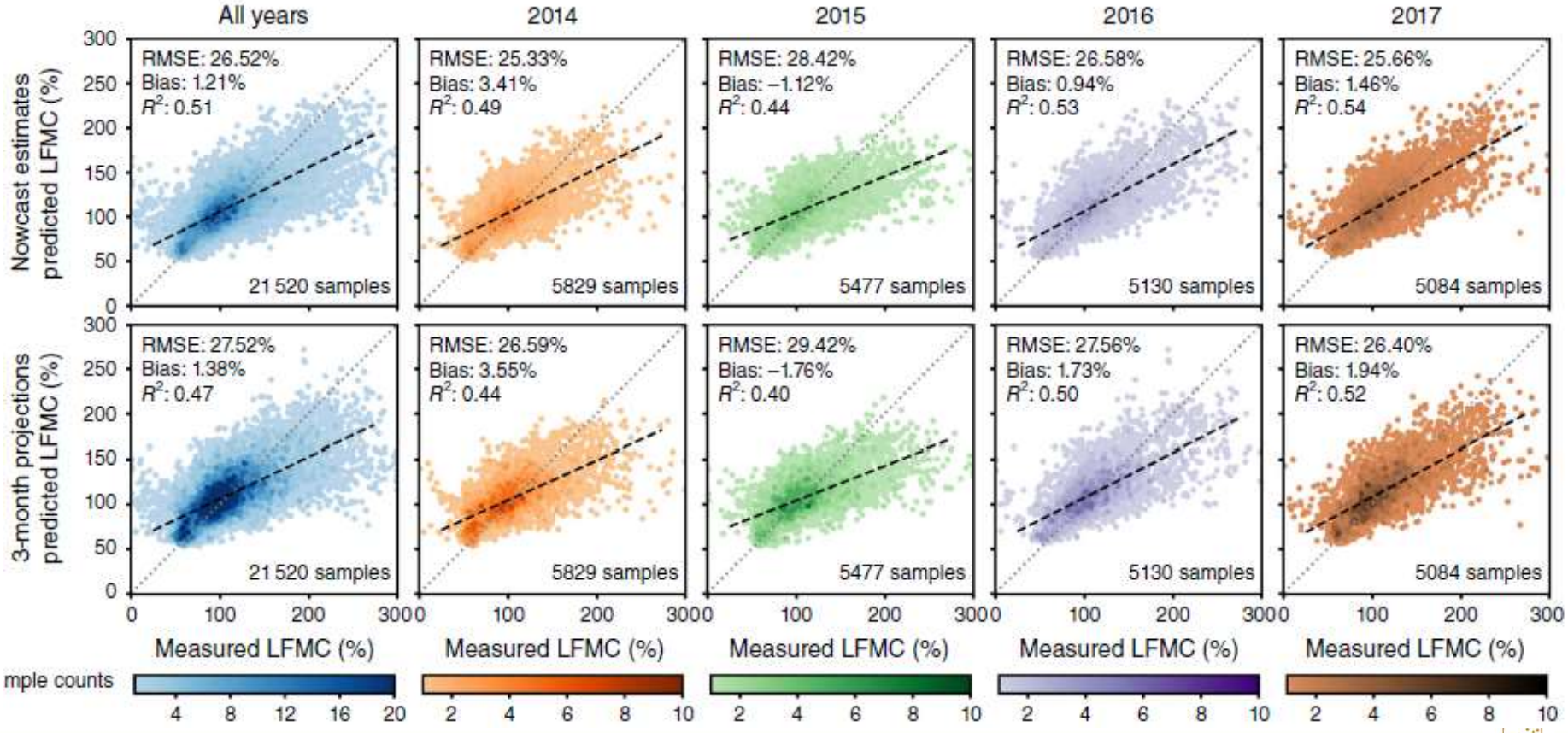
(Yebra et al, 2019)

Meteorological data



(Miller et a., 2023, Projecting live fuel moisture content via deep learning, IJWF)

Landscape flammability



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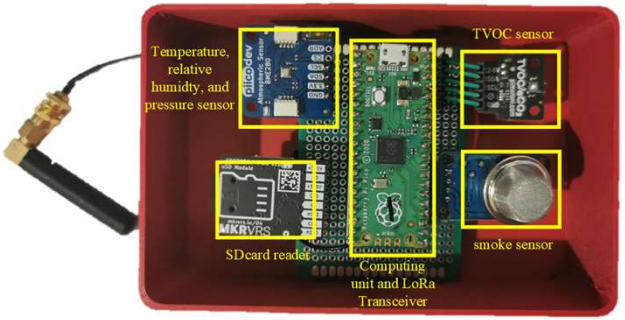
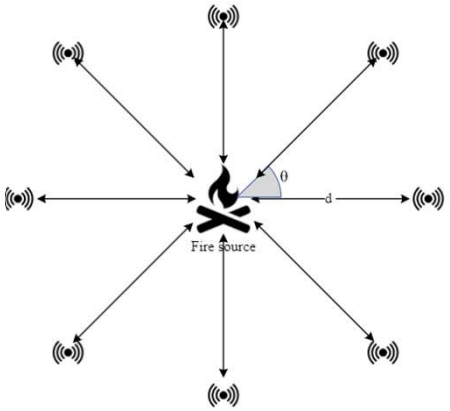
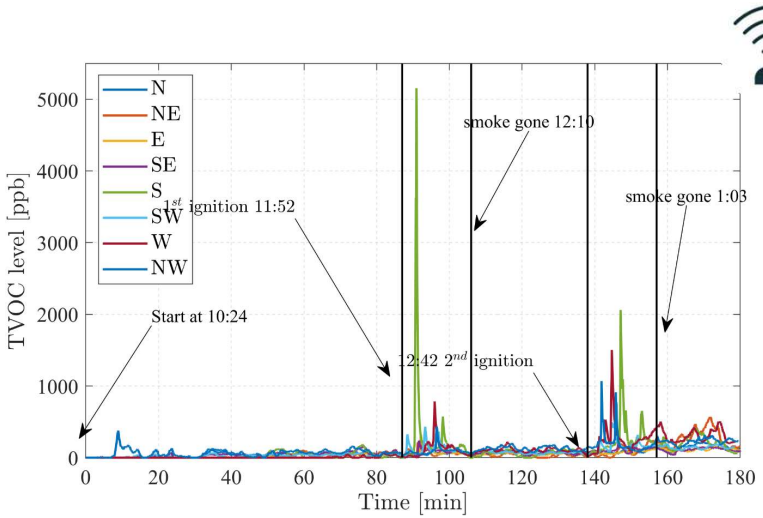
Early Bushfire Detection using IoT

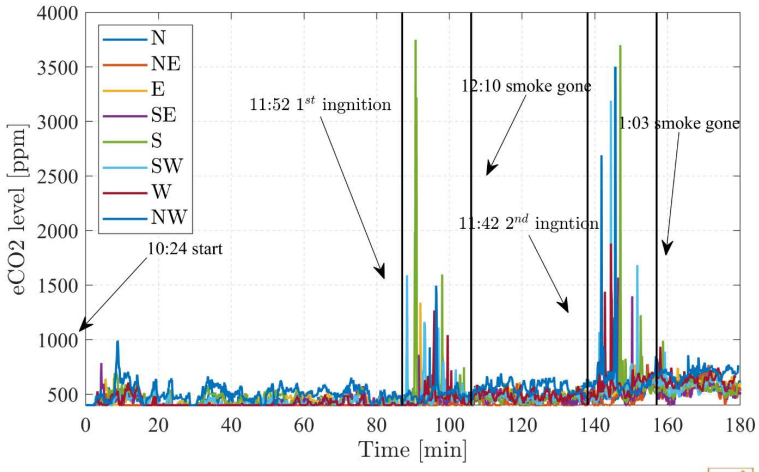
Experimental/Prescribe Burns

- Clear spikes in TVOC/eCO2 reading
- Can tell if there is fire by setting a threshold
- Ongoing research on better detection algorithm using AI









Fire Tower camera based Smoke detection

- Identify the pixels that are smoke in an image using a novel Convolutional Neural Network
- Allows finding the source (rather than just there is smoke, or rough location) 24/7
- Overperforms other existing algorithms in the literature
- Need to generate a publicly available dataset of smoke-detecting camera imagery

Input Image | hand pixel label | Our detection | Detection only label

[12] S Yan, J Zhang, N Barnes, 2022. Transmission-Guided Bayesian Generative Model for Smoke Segmentation, AAAI

Long range uncrewed vehicles

Carbonix partnership on development of Remotely Piloted Aircraft System (RPAS) technology.

- Working with multiple RPAS platforms
  - Volanti (electric, 2-hour)
  - Domani (petrol, 6-8 hours)
- Thermal camera (NextVision NightHawk2-UZ)
- Silvus mesh radio
  - Beyond Visual Line Of Sight (BVLOS) flight
  - Enable us to stream thermal Imagery directly to ACT RFS

Carbonix Volanti RPAS in flight over the ANU field robotics site at Spring Valley

CARBONIX

Evaluation of detection techniques: What are we testing?

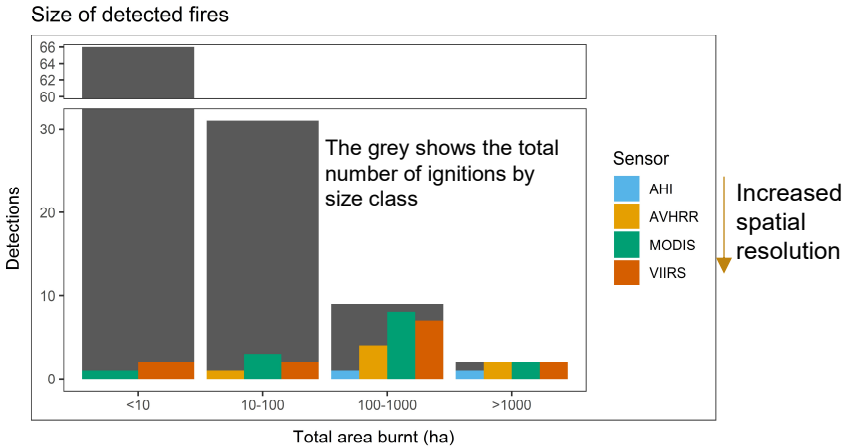
Detection techniques

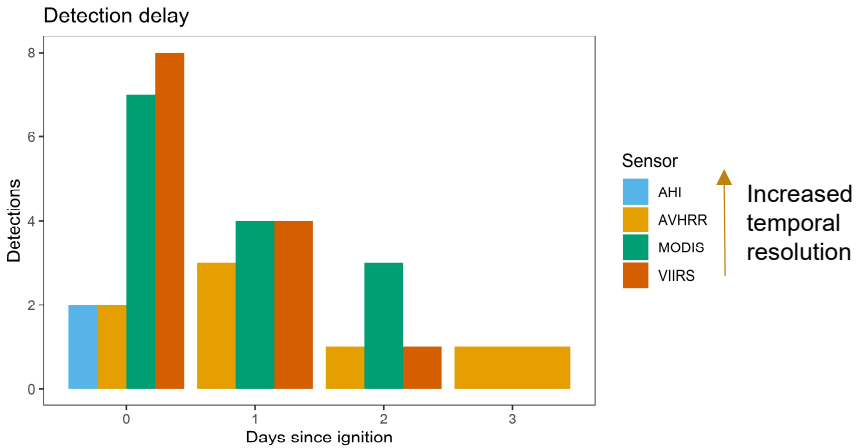
1. 000
2. Fire lookout observers
3. Ground sensors
4. Cameras
   - Fire observer operator looking at the screen in a control centre
   - Automatic AI algorithm
3. Drone detection
4. Existing satellite capability

Performance metrics

1. Fire detection rate
2. Time to report (only possible with experimental or prescribed fires)
3. Location accuracy
4. Fire size and shape at the time of registering (from drone footage)
5. Indicator of fire intensity (radiative power or colour of the smoke)

Evaluation of Hotspot detection from existing satellites





- Most satellites can detect the biggest fires but the smaller fires are mainly detected by those satellites with better ground.
- Most small fires are missed.

- Most satellites able to detect ignitions within <1 day since ignition
- AHI is the only satellite that provides sub daily images but has the worst spatial resolution what explain the low detection rate

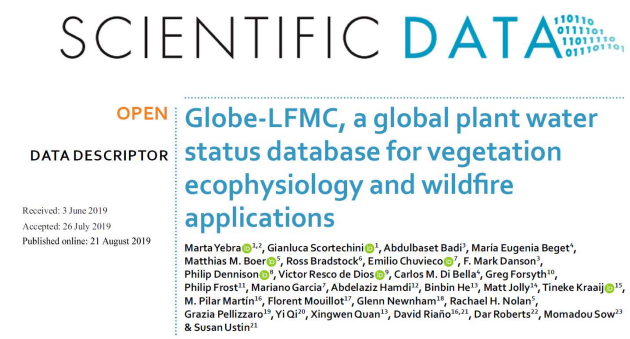
The are 108 fires in the database

Take home message

Current ignition detection approaches are not always effective, especially during extreme weather and in remote, unpopulated locations.

Novel technologies, some powered by AI may offer more efficient detection of ignitions.

Access to more data can enhance the accuracy of algorithms. We should work together to create publicly available datasets!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(Yebra et al, 2019)

OpenWildFire
2191 images
bounding box
annotations
(Wei et al. 2020)

THANKS

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