A Field Campaign to Study Lightning that Ignites the Bush

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Lightning is the main natural cause of wildland fires

- *LIWs largely associated with continuing current (CC) flashes (Fuquay et al. 1972; Pérez-Invernón et al. 2023)*
- *Polarity and peak intensity of CG not likely factors in LIW (Schultz et al. 2024)*

Pre-Fire Weather

LIW DRIVING FACTORS	Flammable Vegetation	Lightning strike
	High air temperature Low air humidity Low soil moisture/rainfall Type of biomass	Thunderstorm Amount/duration of current *Electrical structure of cloud?*

Prob(LIW) ~ *f (fuel moisture, lightning current)*

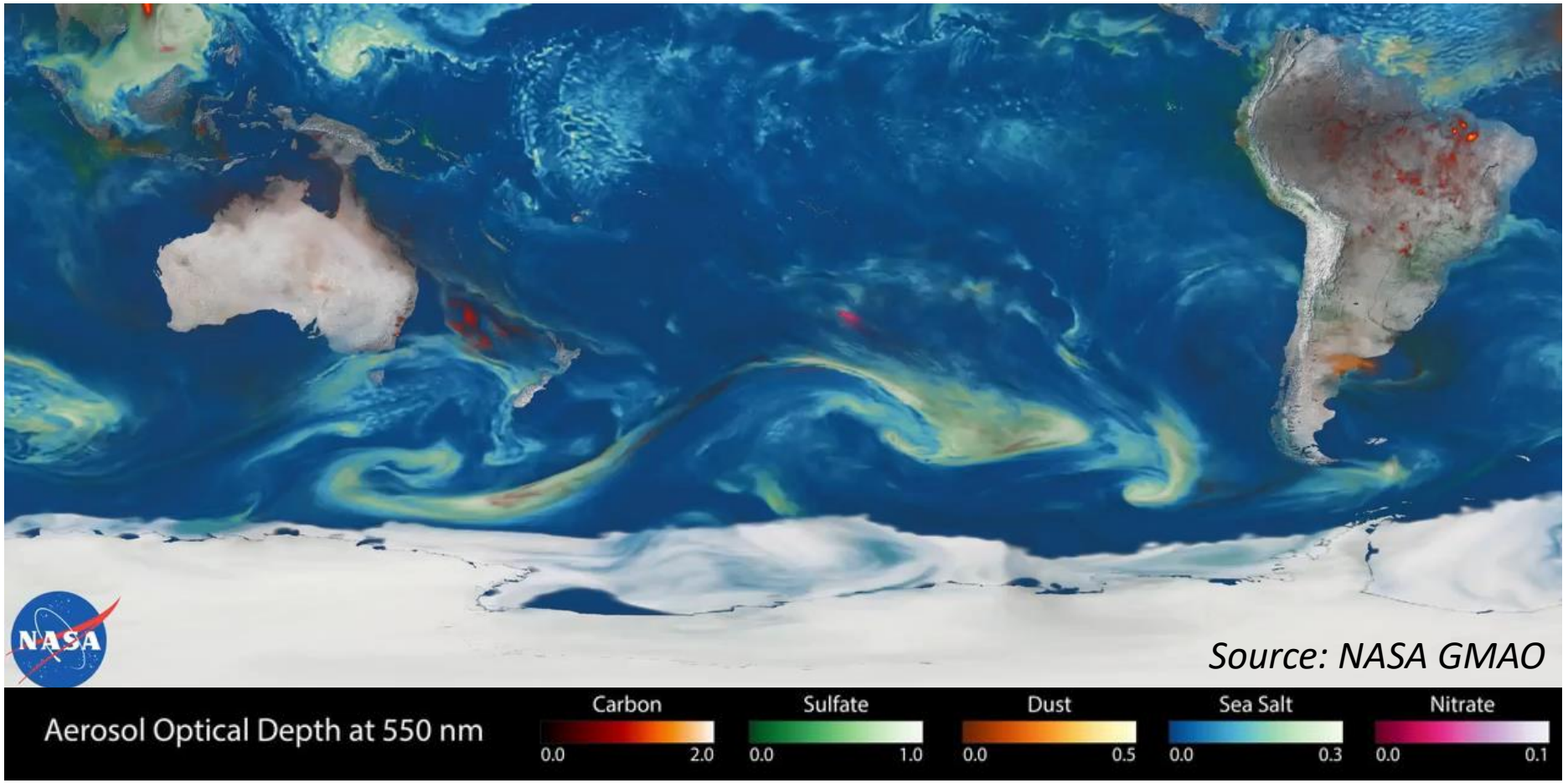
→ *Physical cause of CC flashes not well-understood*

Need more observations of continuing current lightning

- Basic characteristics (e.g., duration, intensity, polarity)
- In-cloud origin of CC flash and its path to ground
- Electrical, microphysical characteristics of parent storm

Global effects

Smoke from 2019 Bushfires in Australia

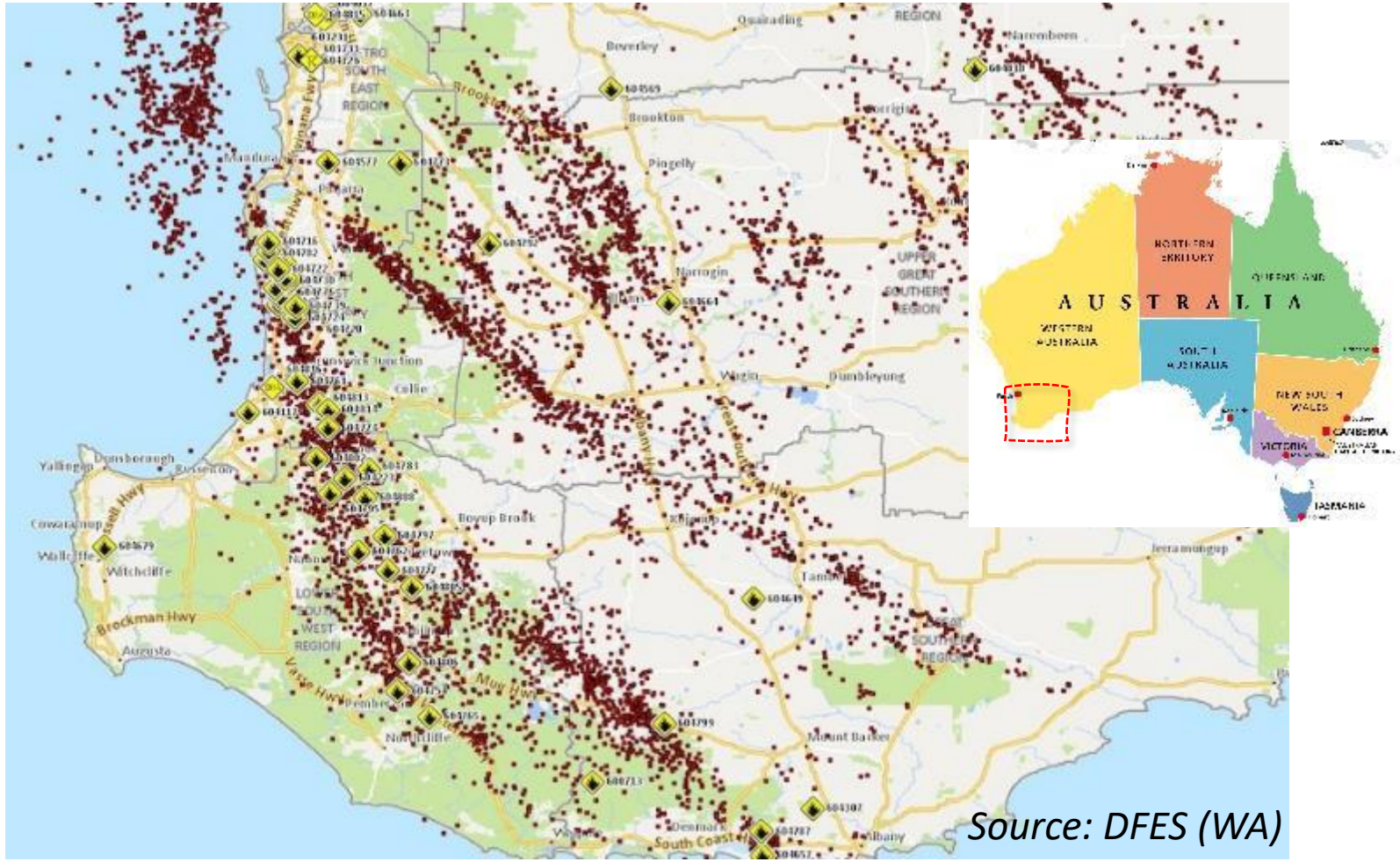


Why Australia?

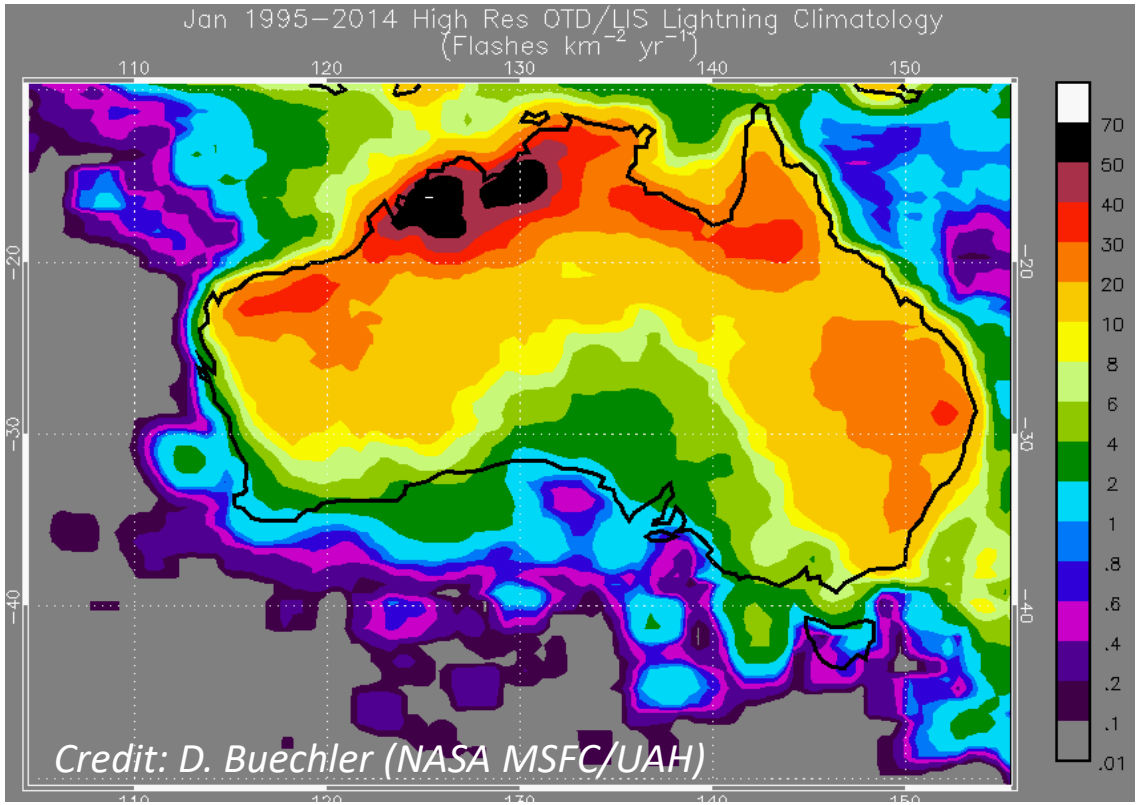
- Over 90% of Western Australia is Bushfire prone
- Bushfire season is October – April
- SW Australia is not known for large amount of lightning activity, but..
- Semi-arid/Mediterranean climate combined with occasional Spring/Summer storm systems
- Australia Bureau of Meteorology wanting to study continuing current national lightning detection capabilities

SW Australia Jan 9 2023

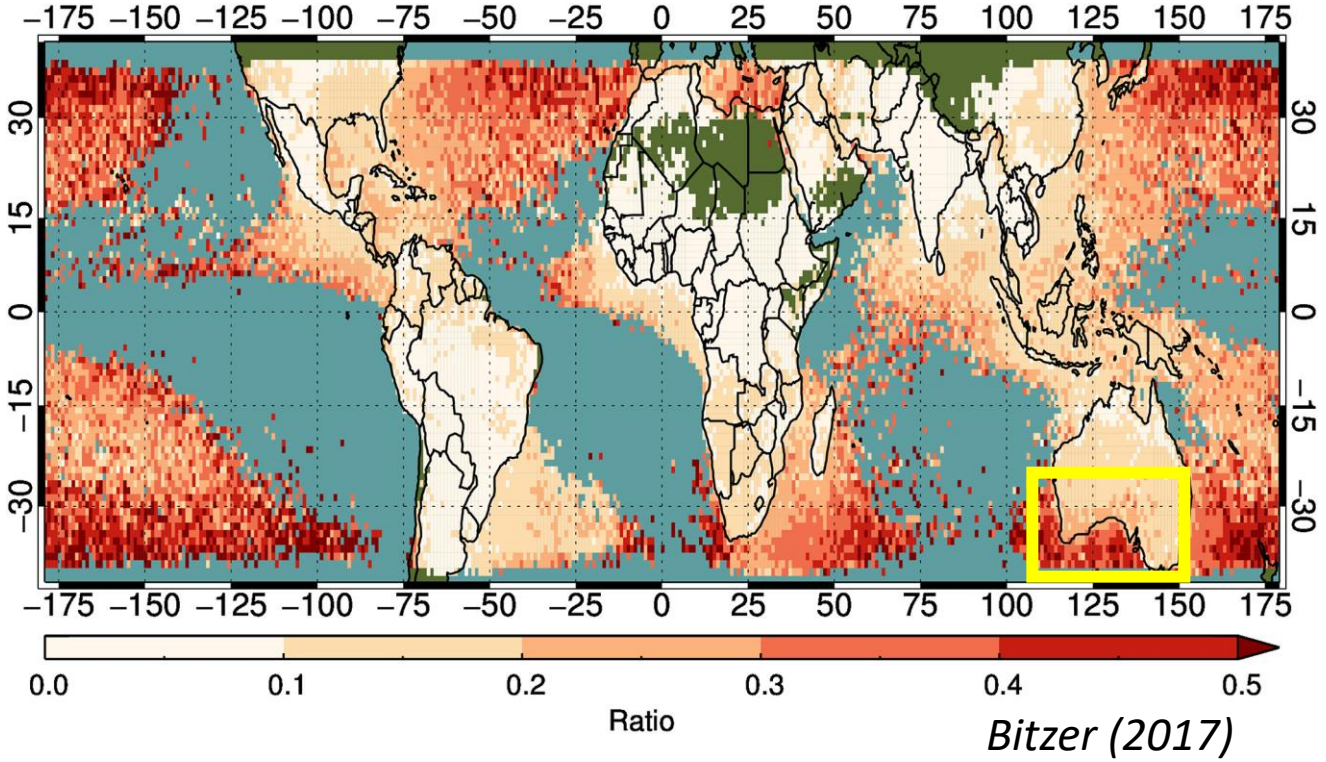
>300,000 Lightning strikes, multiple fires reported



Australia lightning climatology



Fraction of flashes with continuing current (>10 ms)



Bitzer (2017)

→ ~1/4 lightning flashes in SW Australia have continuing current

Australian-led Field Campaign (IGNIS) to Study Lightning-Ignited Wildfires

- Motivating Science Question: What are the characteristics of a lightning flash that starts a wildfire?
- Partners: Consortium of Australian Univ. led by Edith Cowan Univ. (W. Australia), *BoM, NASA MSFC/GSFC*
- Deploy ground-based lightning instruments to bushfire-prone region of SW Australia (Feb 2025-Mar 2026)
  - NASA's deployable Lightning Mapping Array (LMA) → 3-D structure of flash (in-cloud source/path to ground)
  - UAH's VLF/LF electric field change meters → current duration (> 20 ms)
  - Neuromorphic cameras → propagation and duration of optical lightning events (µs-timescale)
  - Australia Bureau of Meteorology (BoM) lightning detection network → location and polarity of CG
  - Existing weather stations and soil moisture probes → fuel moisture

- Planning for airborne campaign in Oct 2025 in SW Australia
  - Australian low-altitude aircraft (Airvan) that supports Fire Management operations and can host science payloads
  - High-speed cameras to measure shorter duration CGs (Fire Ignition) and side-cloud illumination (GLM parallax)
  - Thermal IR camera to measure fire temperature

→ *Goal: Inform design of a future satellite mission*

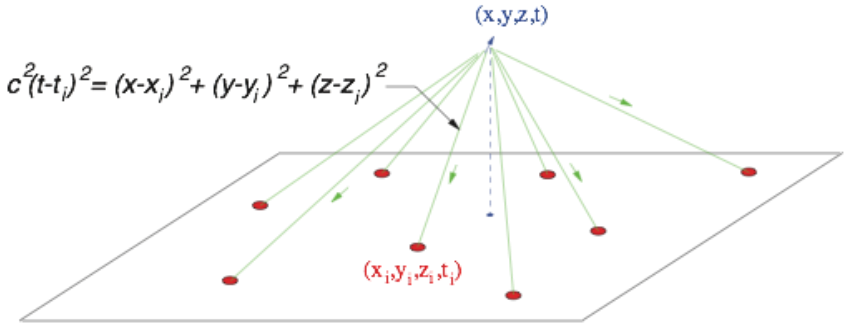
>90% of WA prone to bushfires from Oct-Apr

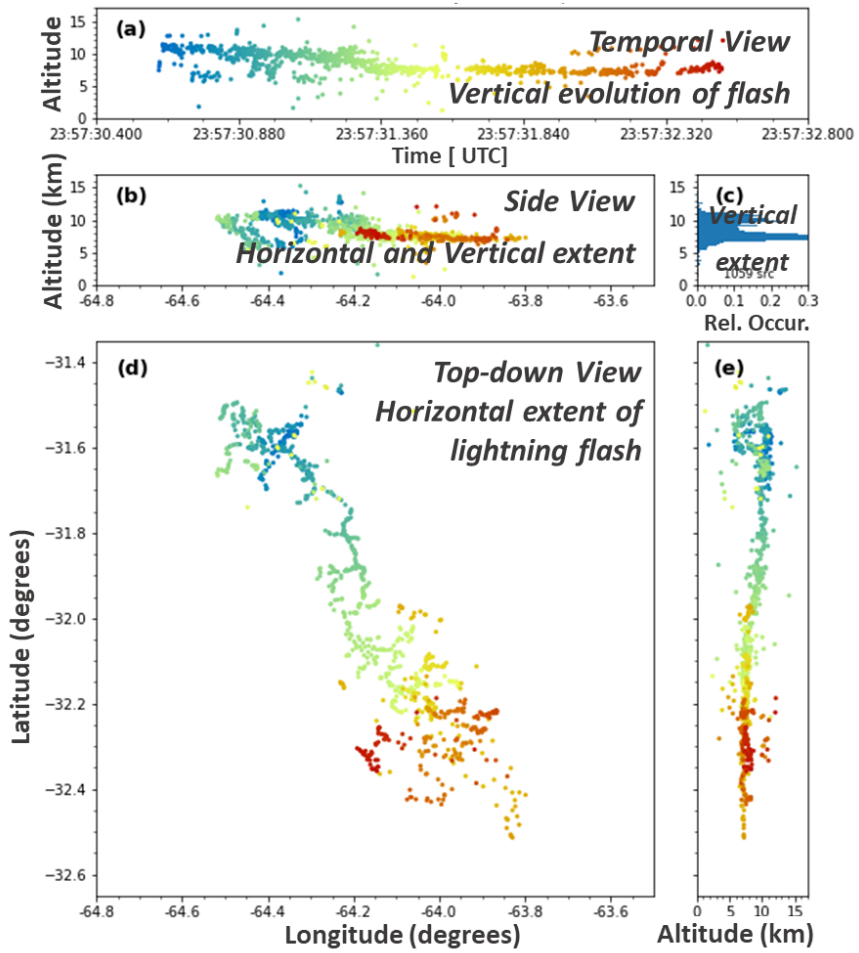
Lightning Mapping Array

LMA station

- 10 portable stations
- VHF emissions (60-66 MHz)
- Revion-5 LMA boards
- RMS timing error: < 50 ns
- Location accuracy: <~10-20 m

Time-of-Arrival technique→4-D location
(Thomas et al. 2004; Koshak et al. 2004)



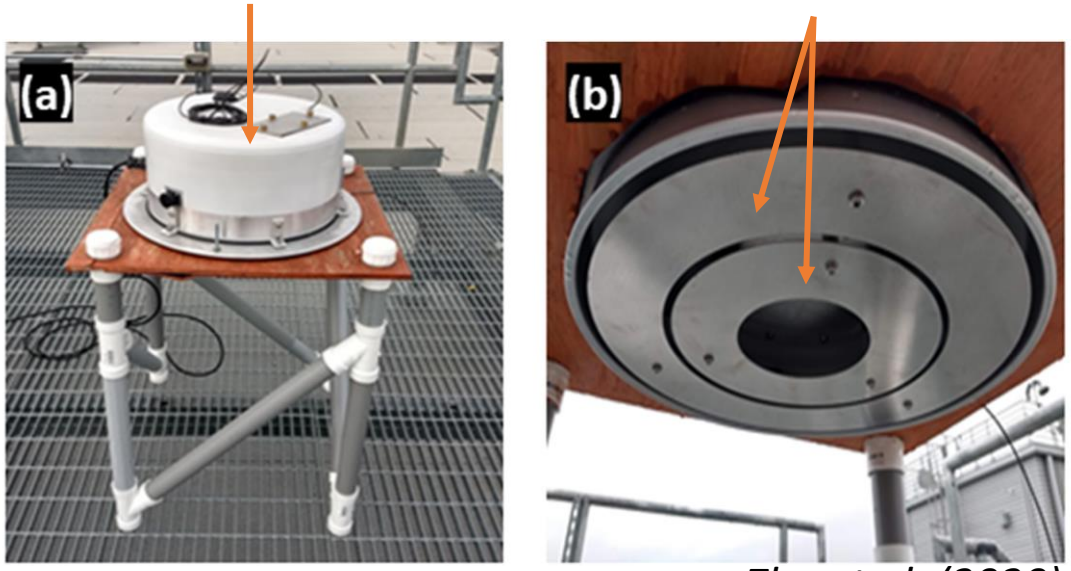


Electric Field Change Meters

HAMMA 2 Sensors

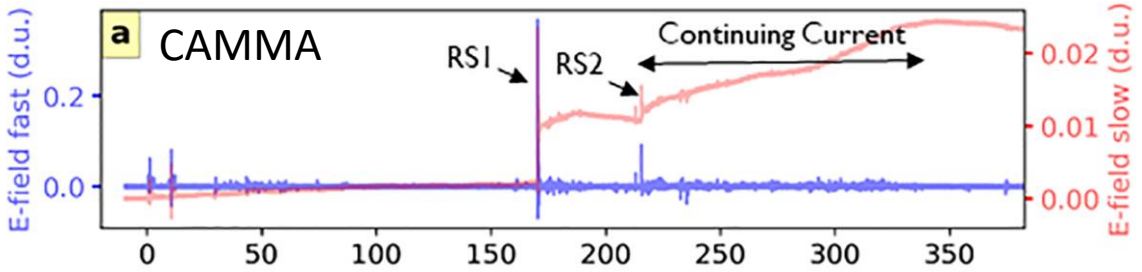
Electronics (FPGA, GPS, Computer)

Slow and Fast Plate Antennas



Zhu et al. (2020)

- Slow Channel: 1Hz – 57 kHz, 100 ms
- Fast Channel: 1.6 kHz – 2.5 MHz, 100 µs
- RMS timing error: < 50 ns

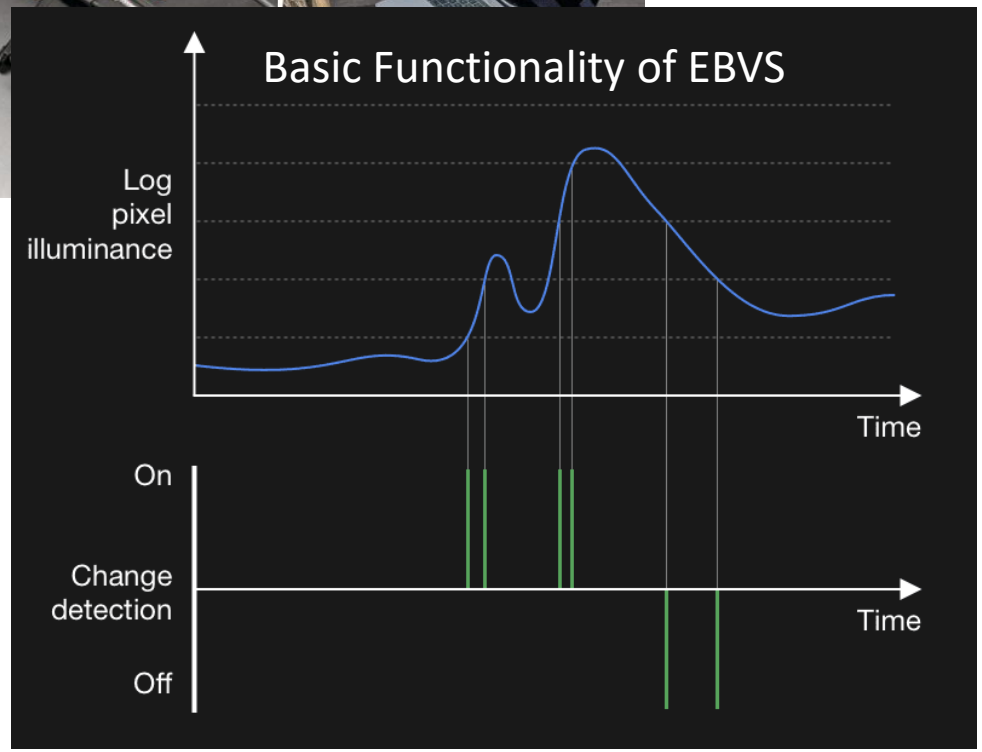


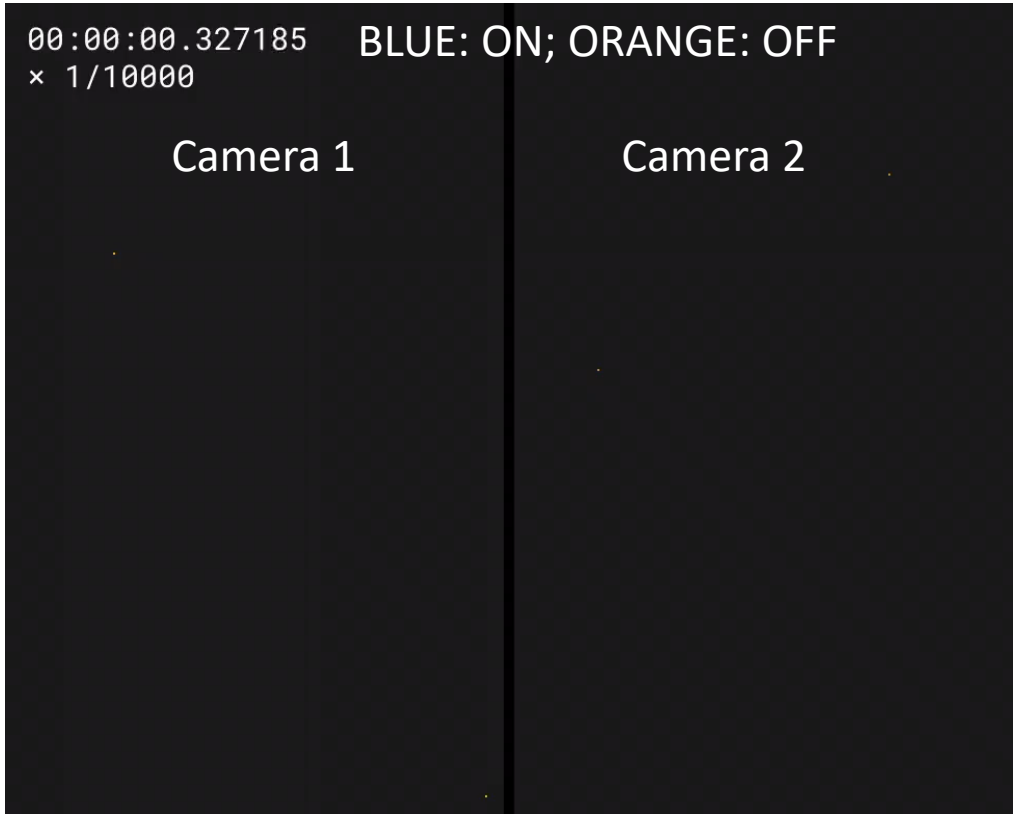
Zhu et al. (2021)

Event-Based Vision System (Neuromorphic Camera)

Provided by G. Cohen, A. Marcireau, N. Ralph, Western Sydney Univ.

- Detect log-change in pixel illuminance
- Temporal resolution: 1-100 µs
- 1280 x 720 pixels (Prophesee Gen4 EBVS)
- WSU to deploy ≥3 for IGNIS campaign





Summary

- IGNIS campaign will observe lightning characteristics in bushfire prone region
- Timeframe: Oct 2025 to Feb 2026
- Location: Southwest Australia
- 3-D maps of RF and optical characteristics of lightning
- Electrical source and pathway of continuing current flashes

IGNIS Steering Committee

- Paulo de Souza (PI), Murray Terwey, Edith Cowan Univ.
- Fred Mink, Univ. of Newcastle
- Jason Sharples, Ed Kruzins, Univ. of New South Wales
- Derek Abbott, Alex Dinoviser, Said Al-Sarawi, Adelaide Univ
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- Doug Morton, Murzy Jhabvala, Julie Breed, NASA Goddard
- Patrick Gatlin, Mason Quick, Neil Martin, NASA Marshall