

Fire pixels, a multi-layered approach to derive smoke emission fluxes and enhance skills in smoke forecasting

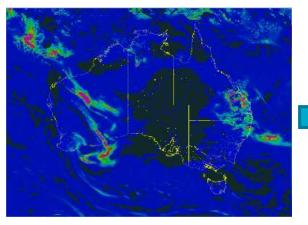
Fabienne Reisen, Martin Cope, Julie Noonan, Paul Ryan 7th International Fire Behaviour and Fuels Conference Canberra, 18 April 2024



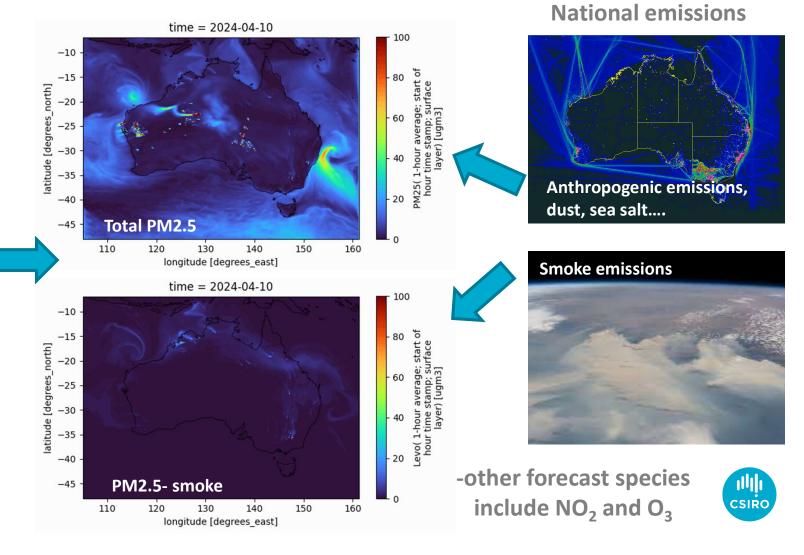
Australia's National Science Agency

How are the national forecasts generated?

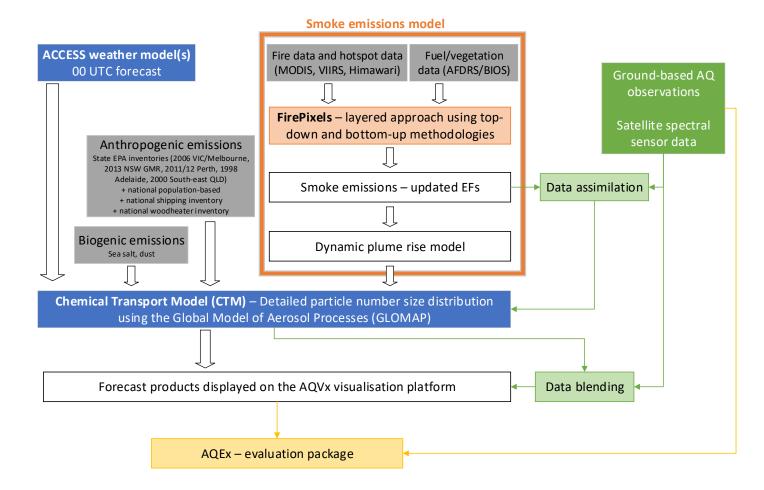
Weather forecasts (Bureau of Meteorology)



72-hour forecasts;9 km spatial (national);1.6 to 3 km spatial (regional)

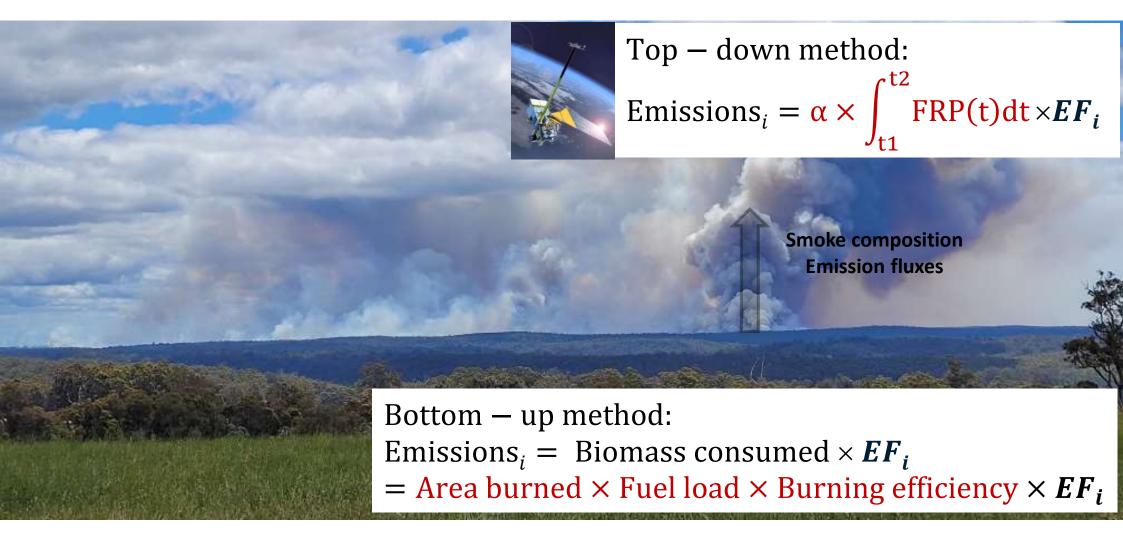


Workflow diagram of the CSIRO Prototype National Air Quality Forecast System (AQFx_p)

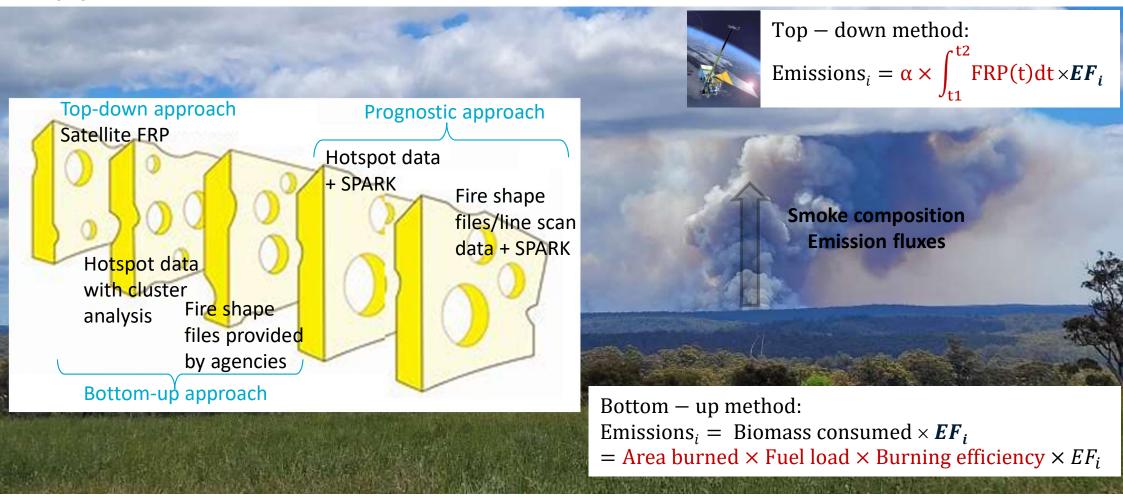




How are smoke emission fluxes derived?



Enhance smoke emissions module using a multi-layered approach



jlv_day_H8-15_LST

+ frp_p-interp

frp_b-interp fp_p-data

frp_b-data

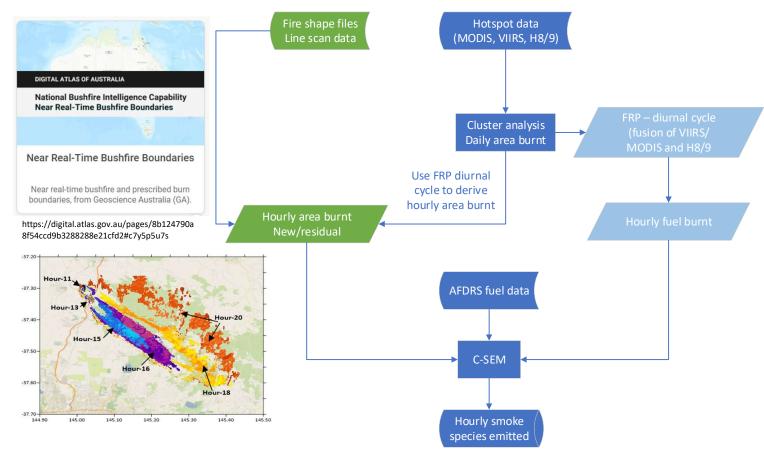
Fire pixels – a multi-layered approach **Top-down method** Hotspot data (MODIS, VIIRS, H8/9) Suomi NPP/VIIRS hotspot location. Cluster analysis Daily area burnt 3. H8/9 clusters (green) which overlap VIIRS (black) clusters **Cluster analysis** (60 fire clusters) Scaled hourly frp 16000 14000 12000 AFDRS fuel data Scaled frp (mw) 10000 8000 6000 C-SEM 4000 2000 0 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 Hourly smoke Time (hours) species emitted

1.

2.

Estimated hourly FRP using 10-4. min H8 data

Fire pixels – a multi-layered approach Bottom-up method



Daily area burnt:

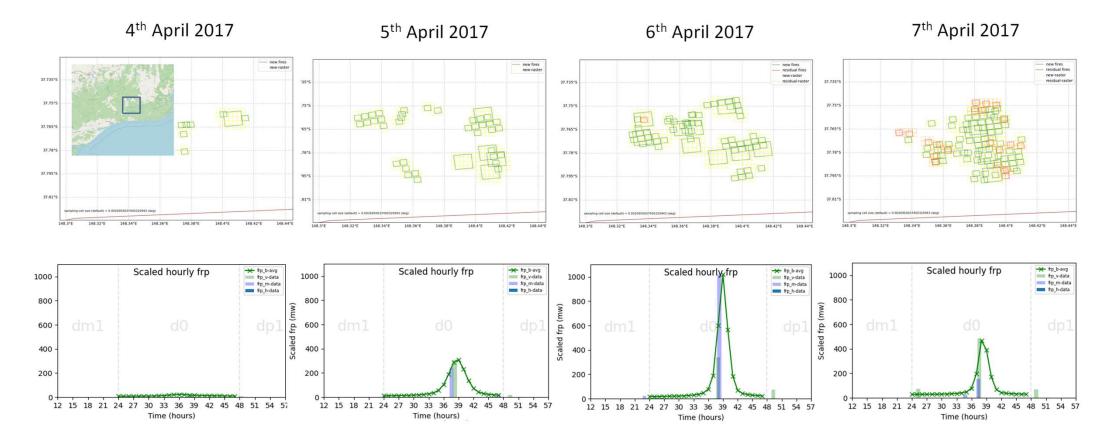
- Provided by fire shape files
- Calculated from satellite hotspot density, and empirical relationships between land category and area burnt.

Daily fuel burnt:

 Calculated from fine and coarse woody fuel load and burning efficiency.



Distinguishing between new and residual fires



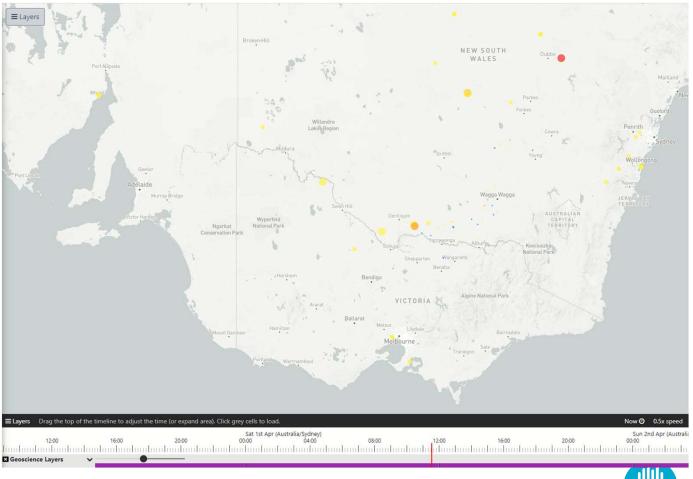


Hotspot detection- agricultural burning

Significant hotspot activity over central VIC/NSW captured by the MODIS/VIIRS satellite overpass at ~1pm each day. This is primarily due to agricultural burning.

The hotspot activity is significantly lower overnight (as captured by the 1am VIIRS satellite overpass).

This may be due to short-lived fast-moving burns (e.g., agricultural burns) or undercanopy smouldering fires not well captured by MODIS/VIIRS.

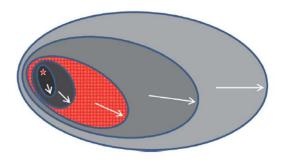


Active fire hotspot locations using MODIS and VIIRS satellite observations between 1-5 April 2023

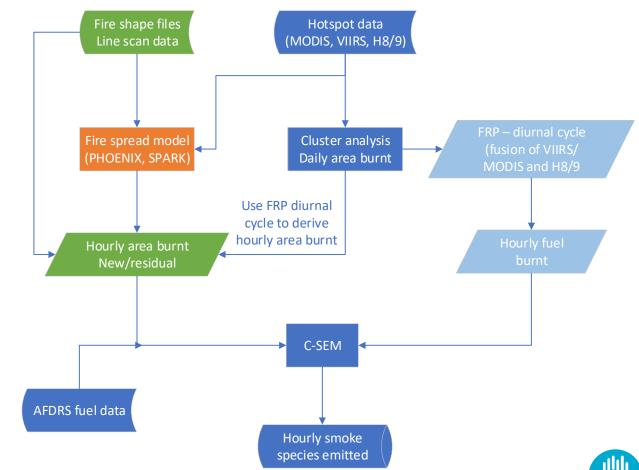
CSIRO

Fire pixels – a multi-layered approach Prognostic method

 Area burnt is derived from Phoenix Rapid Fire/SPARK fire spread modelling



PHOENIX FireFlux bushfire simulator with modifications - at the end of a time step the area burnt is identified as a polygon and the total amount of fuel consumed is calculated

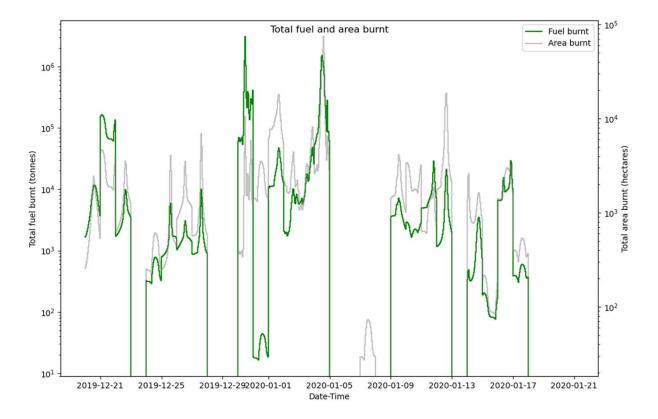


CSIR

Total fuel and area burnt using satellite data

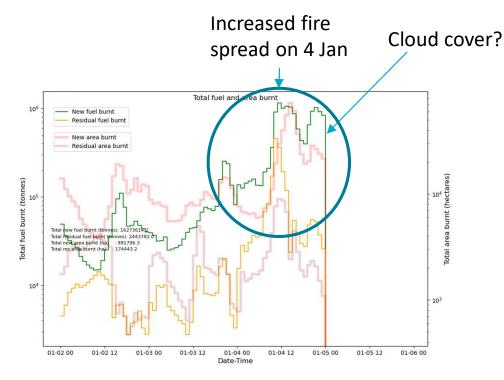
The data gaps correspond to days with significant cloud cover or smoke cover when thermal anomalies are not detected.

Data gaps are filled using a persistence assumption or prognostic modelling (Phoenix or SPARK).

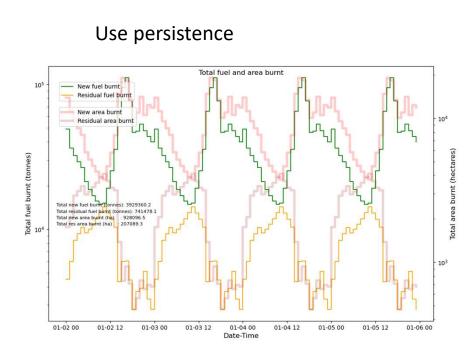




The use of historical vs forecast mode for estimating smoke emissions



Historical mode – an increase in fire activity and smoke emissions on 4 January 2020, followed by no emissions due to missed fire detections because of dense cloud cover.



Forecast mode – assume persistence of fire activity for the forecast days until new satellite data becomes available. The increased fire activity and smoke emissions on 4 January 2020 was not captured, but smoke emissions did not cease due to cloud cover.

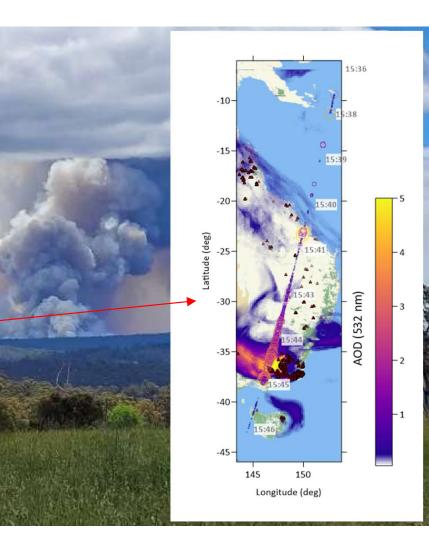


Derive emissions from satellite AOD or CO observations

Altitude: 10.5

Top – down approach:

- 1. Derive emissions using FRP, which is related to the rate of biomass combustion
- 2. Derive particle emissions using satellite AOD observations (MODIS, Himawari)
- Derive emission rates of trace gases (e.g. CO, NO₂) using the TROPOspheric Monitoring Instrument (TROPOMI) observations.





Thank you

Environment

Fabienne Reisen **Principal Research** Scientist

+61 3 9239 4435 fabienne.reisen@csiro.au

Environment

Martin Cope **Principal Research** Scientist

+61 3 9239 4647 martin.cope@csiro.au

Air Quality Forecasting

About 🗸 Latest 🗸 🛛 AQFx features 🗸 Portal Login 👻

AOVx access

National AQFx prototype system

A tool for assessing smoke impacts from bushfires and planned burns

The extent of the 2019/2020 bushfires highlighted the urgent need for a national smoke forecasting system to protect the health of Australians. In response, the Australian Government provided funding in 2021 to develop a national prototype smoke forecasting system. The project tested potential extensions to the operational AQEx system that has been running by the Bureau of Meteorology in Victoria for the Department of Energy, Environment and Climate Action (DEECA) (formerly Department of Environment, Land, Water and Planning (DELWP)), and in NSW for the Rural Fire Service (RFS).

The prototype system was developed through a research collaboration between CSIRO, Bureau of Meteorology, the University of Tasmania, the University of Sydney, the University of Melbourne and DEECA.



https://research.csiro.au/aqfx/

Australia's National Science Agency

CSIRO.AU

Q