Monitoring of wildfire emissions using satellite and reanalysis data: A review

Lerato Shikwambana

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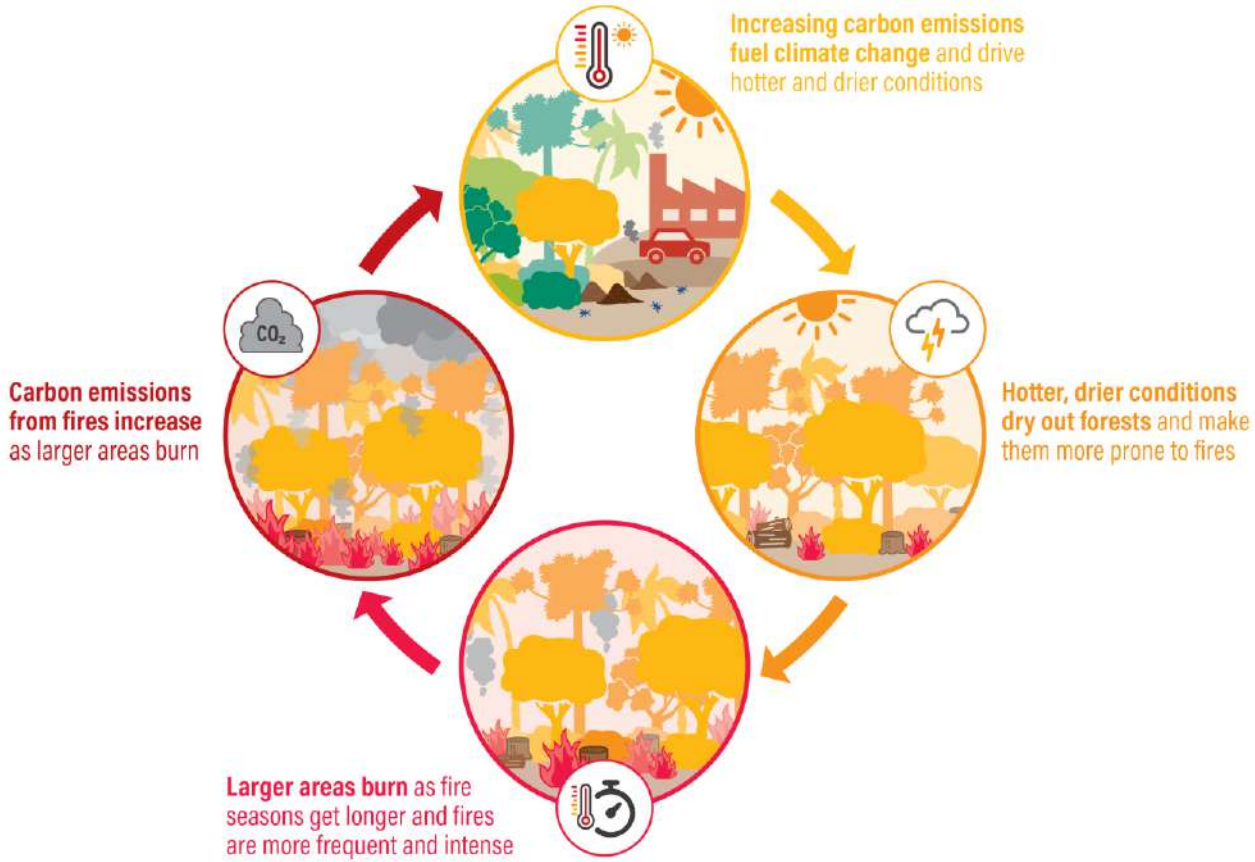
Wildfires emission and trend

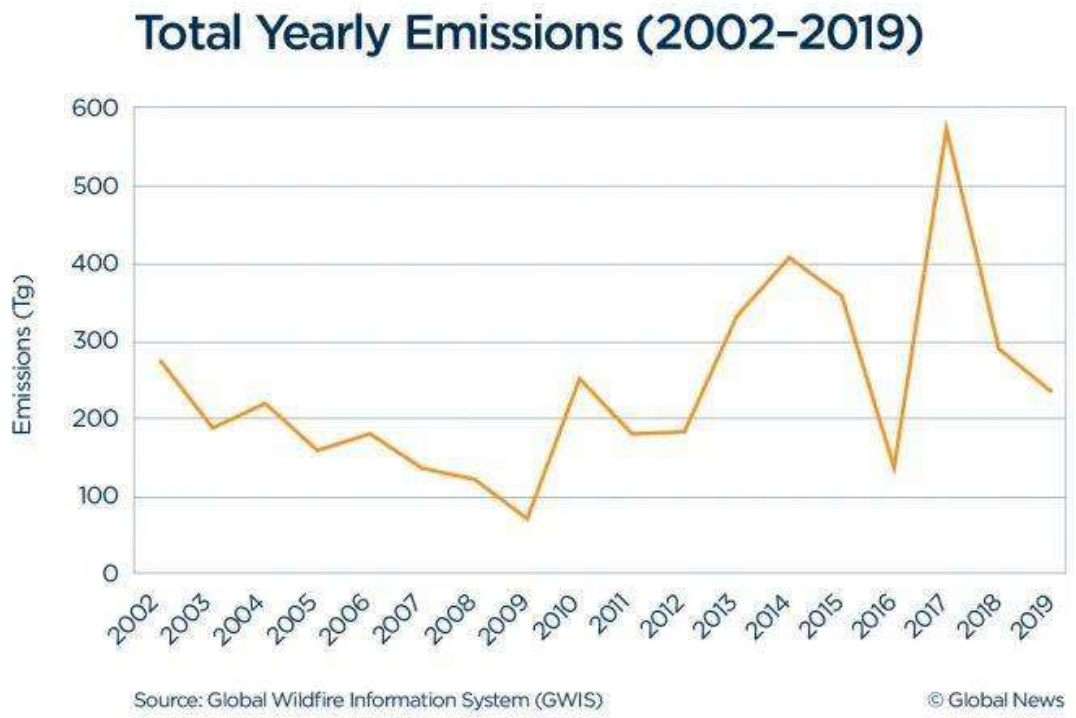
Fires and the Climate Feedback Loop



Source: Global Forest Watch.

GLOBAL FOREST WATCH

WORLD RESOURCES INSTITUTE



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Wildfire impact

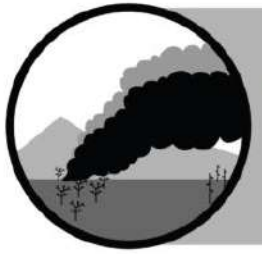
What are the Negative Effects of Wildfire?

Ecosystem Damage

Extremely hot fires can decimate even healthy ecosystems.

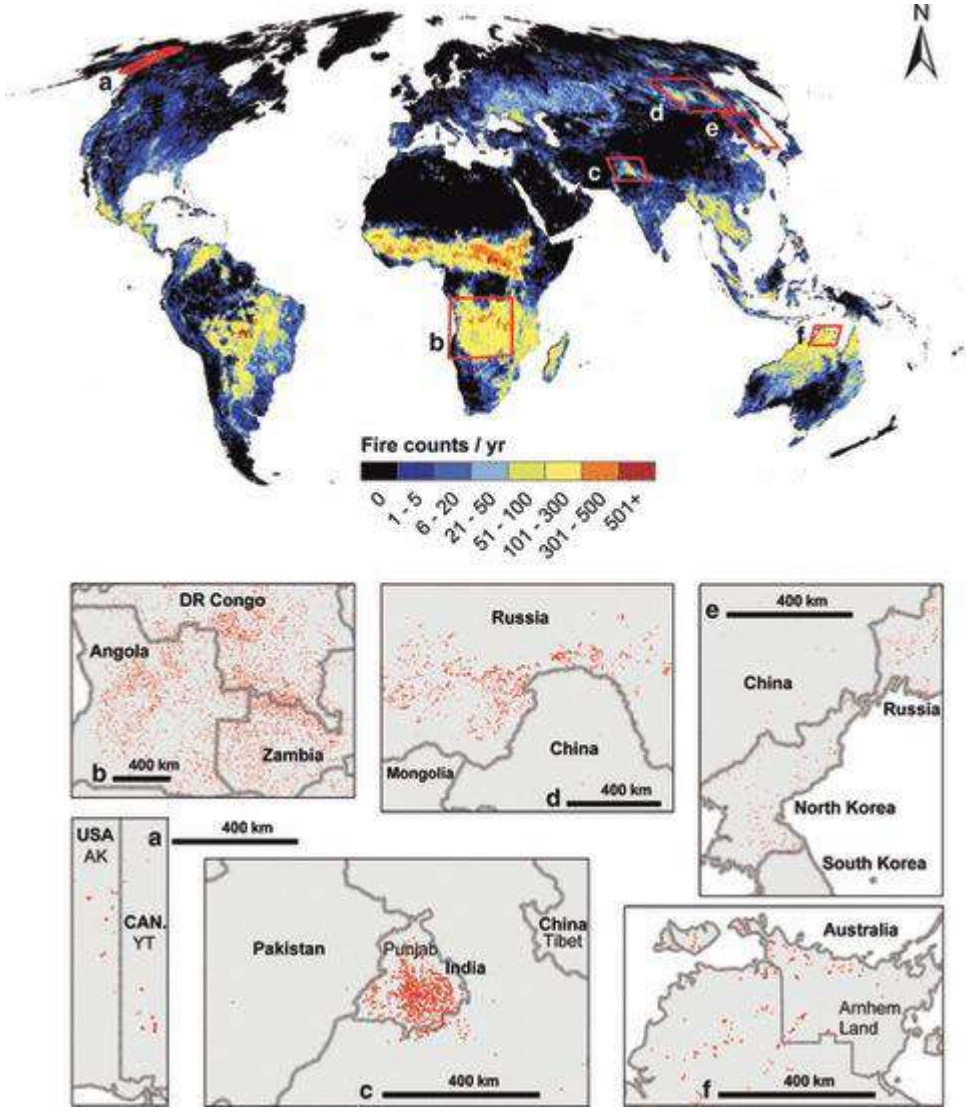
Erosion

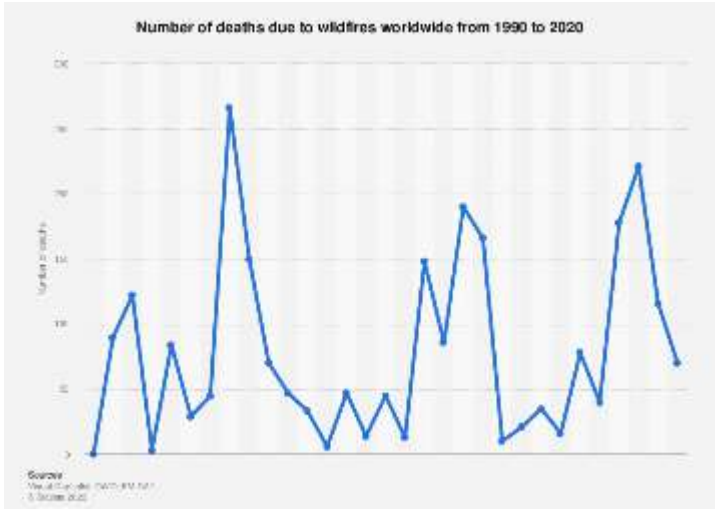
Reduced canopy and weakened roots can lead to ersion problems.



Air Pollution

Wildfires generate smoke, harmful particulates, and greenhouse gases.





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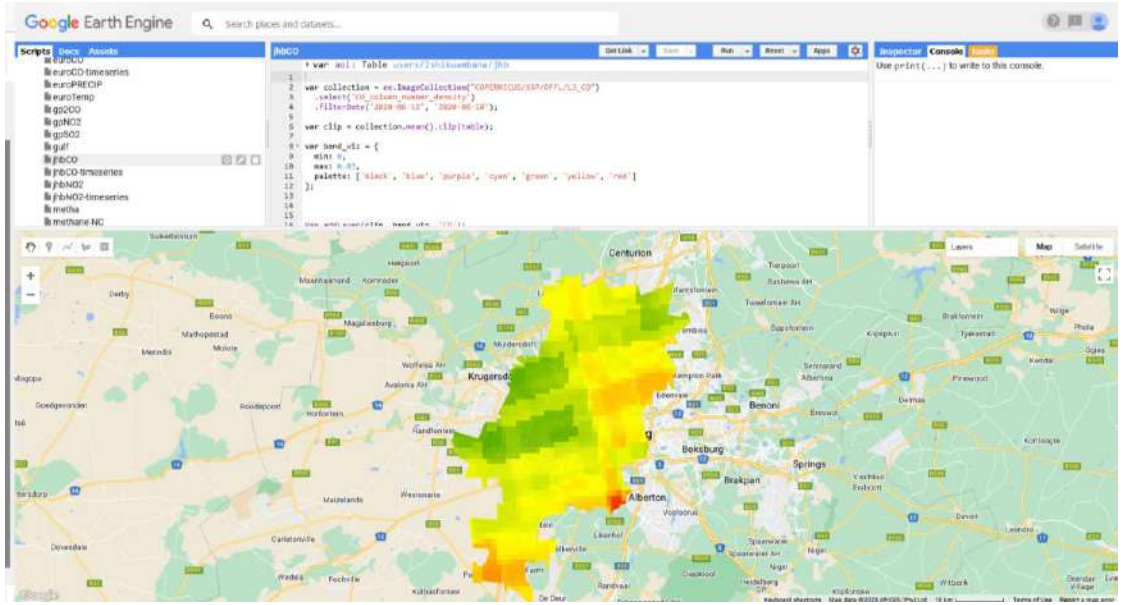
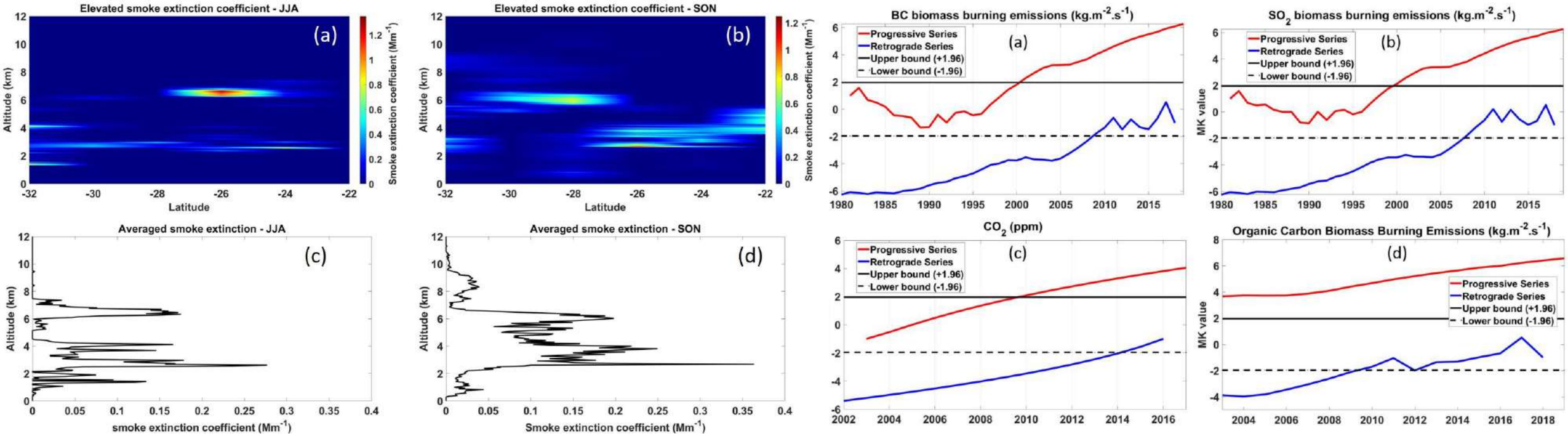
Some data for wildfire studies

Data	Spatial resolution	Temporal resolution	Products
Merra-2	0.5˚ × 0.625˚	Daily	Black Carbon concentration
TROPOMI	0.01 × 0.01 arc degrees	1-day	Cabon Monoxide
CALIPSO	0.5˚ × 0.625˚	Monthly	Smoke and Polluted dust AOD 532 nm
MODIS	500 m	Monthly	Burned Area (MCD64A1)
	1 km	Daily	AOD (550 nm)
MODIS	1 km	Daily	Fire Location (MCD14ML)
PROBA-V, Sentinel-3 OLCI	300 m	Annual	Land Cover (CCI-LC)



CALIPSO

Sugarcane burning in KZN and MP



Shikwambana, L.; Ncipha, X.; Sangeetha, S.K.; Sivakumar, V.; Mhangara, P. Qualitative Study on the Observations of Emissions, Transport, and the Influence of Climatic Factors from Sugarcane Burning: A South African Perspective. Int. J. Environ. Res. Public Health **2021**, 18, 7672. https://doi.org/10.3390/ijerph18147672

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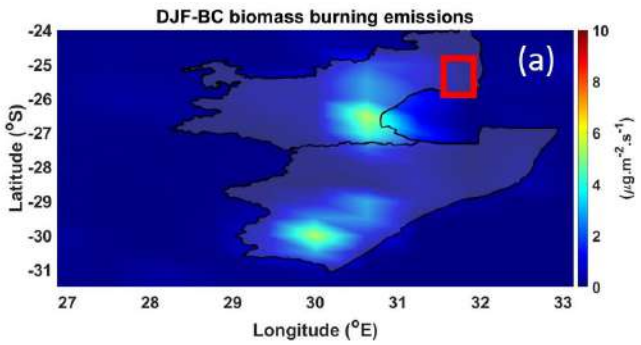
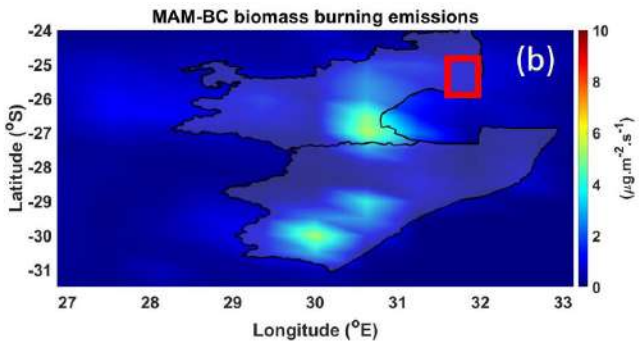
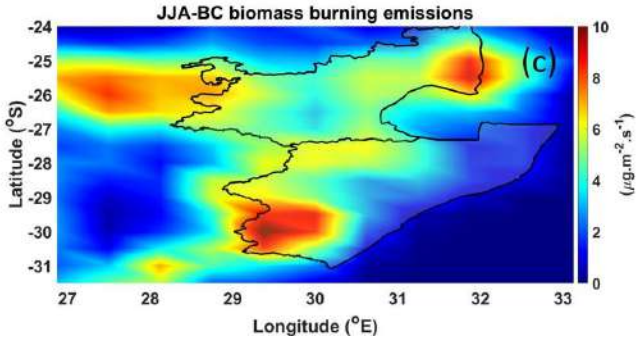
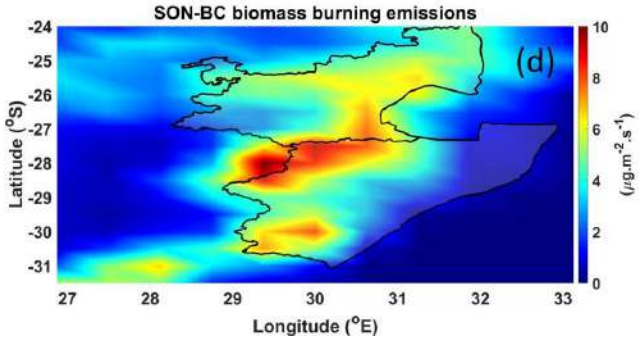
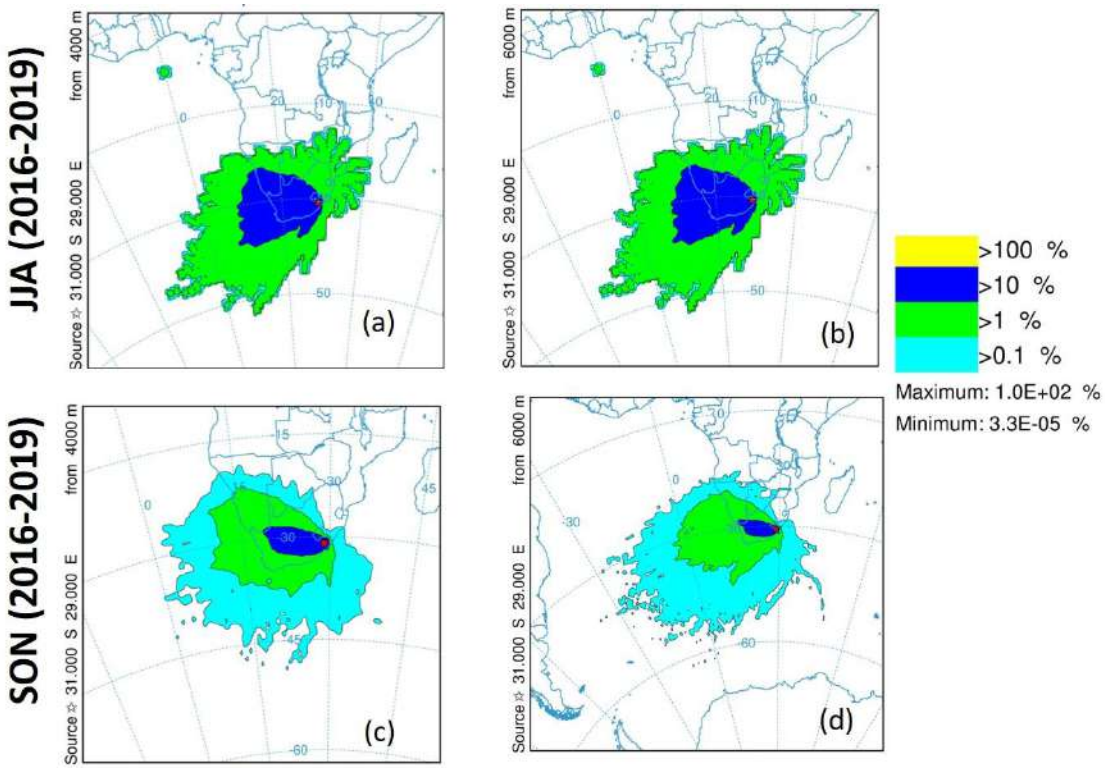
Sugarcane burning in KZN and MP cont…











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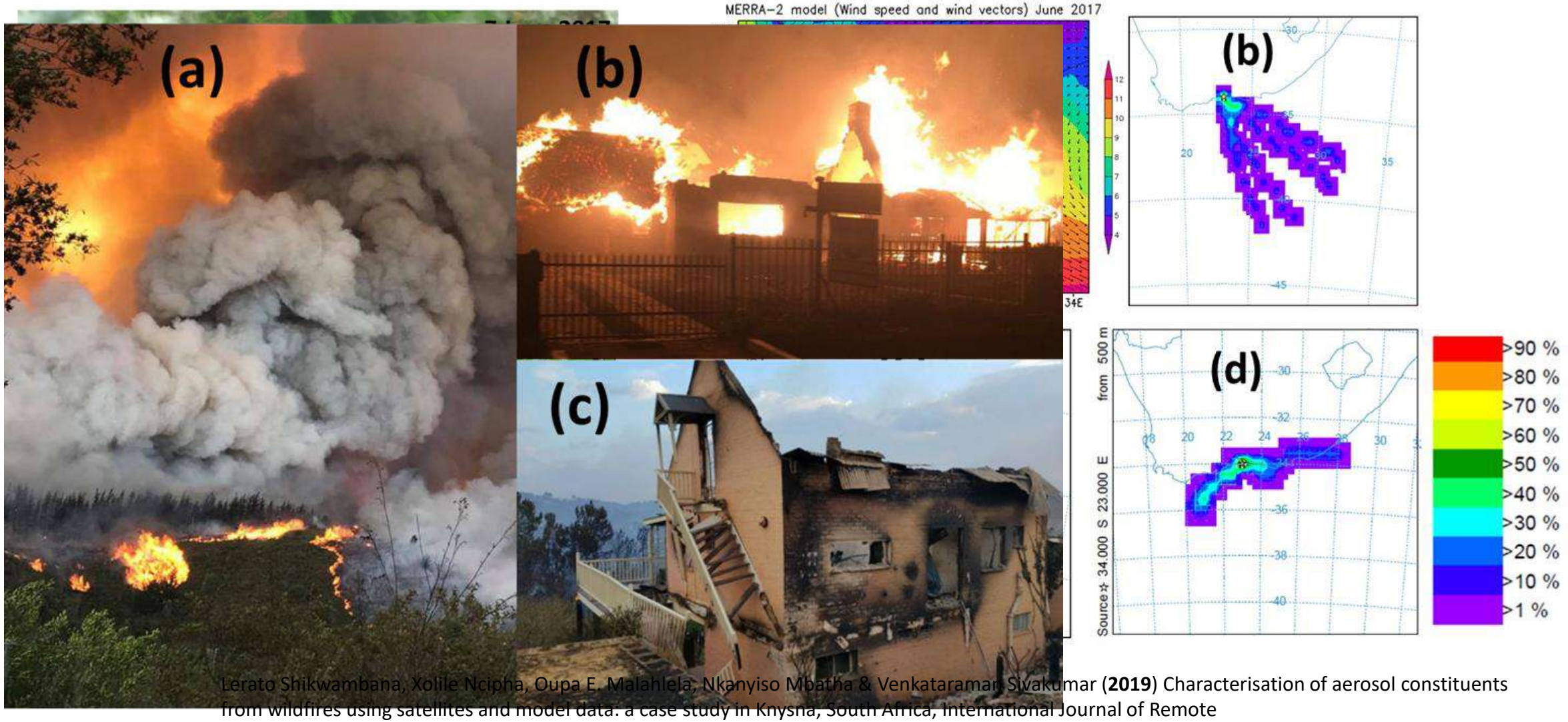
Knysa wildfires June 2017



Lerato Shikwambana, Xolile Ncipha, Oupa E. Malahlela, Nkanyiso Mbatha & Venkataraman Sivakumar (**2019**) Characterisation of aerosol constituents from wildfires using satellites and model data: a case study in Knysna, South Africa, International Journal of Remote Sensing, 40:12, 4743-4761,

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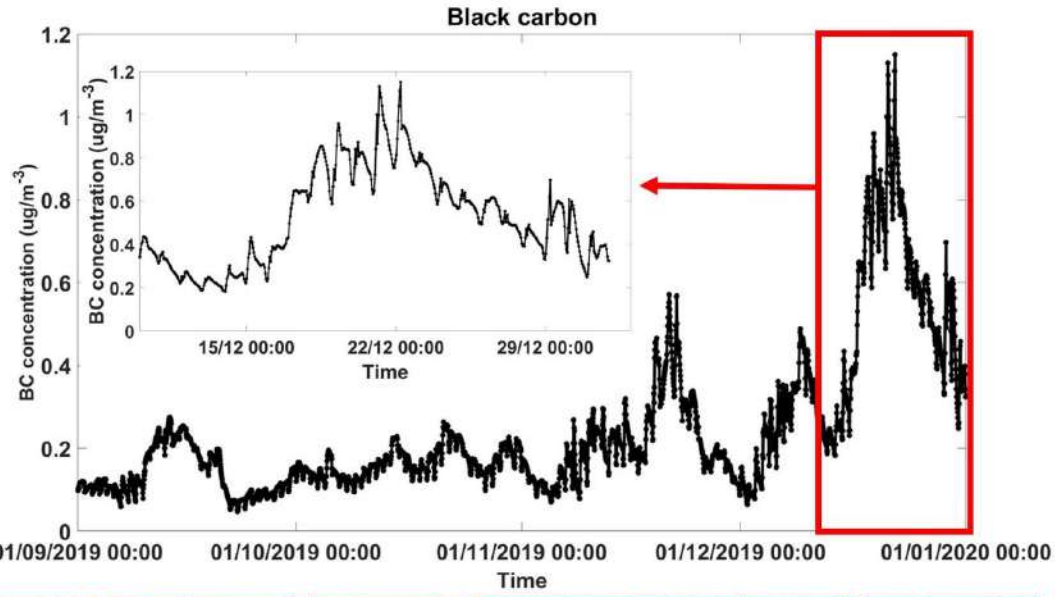
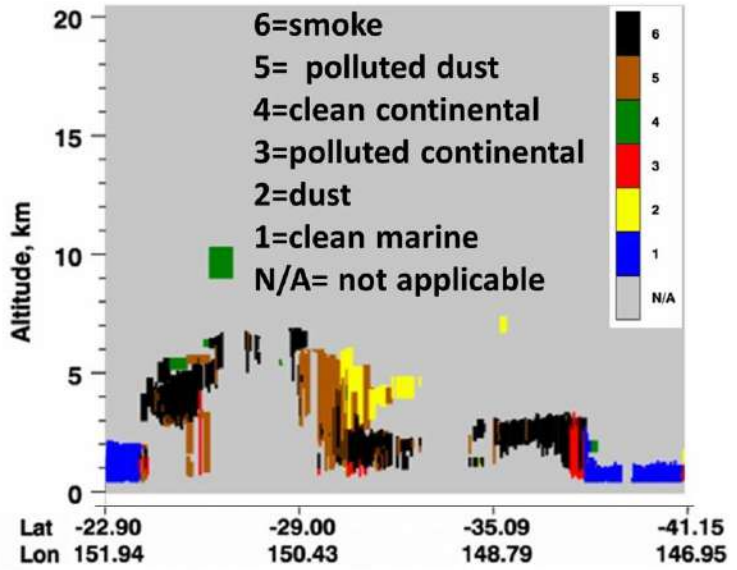
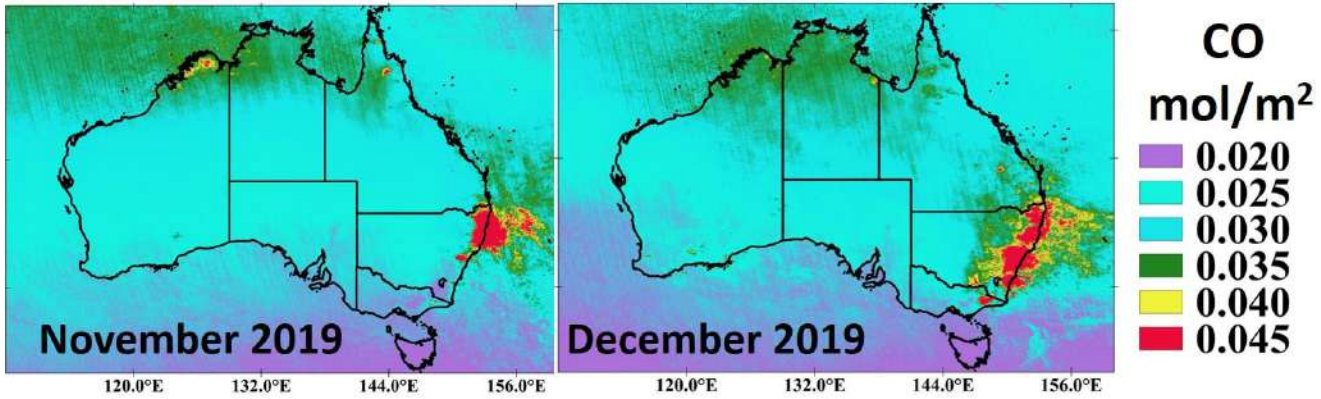
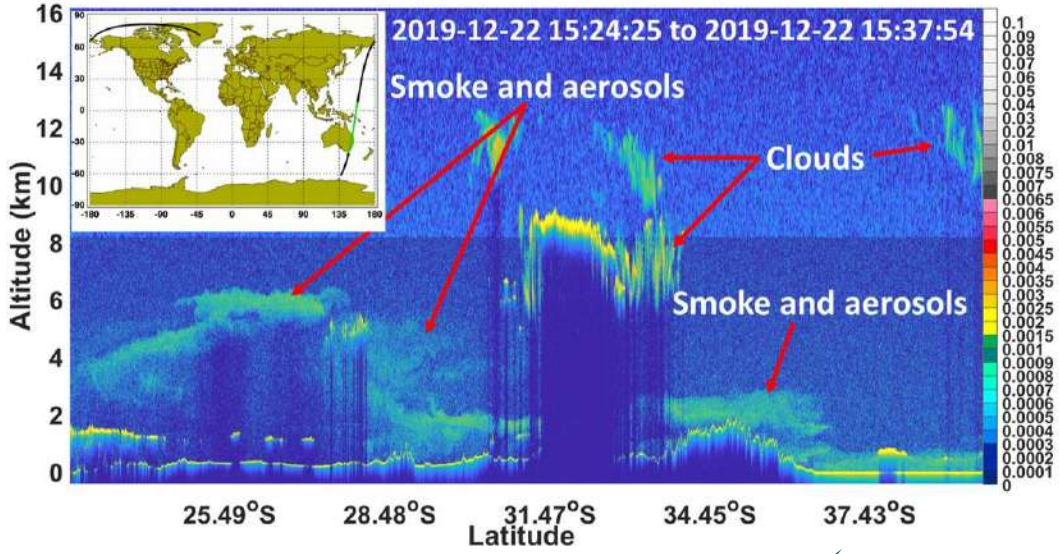
Australian Fires December 2019









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Shikwambana, L.; Kganyago, M. Observations of Emissions and the Influence of Meteorological Conditions during Wildfires: A Case Study in the USA, Brazil, and Australia during the 2018/19 Period. Atmosphere **2021**, 12,11.

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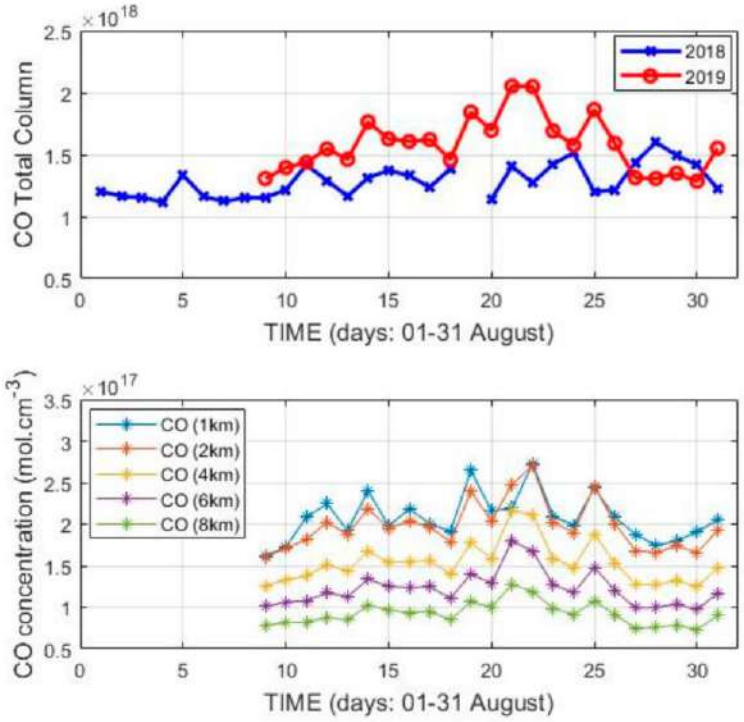
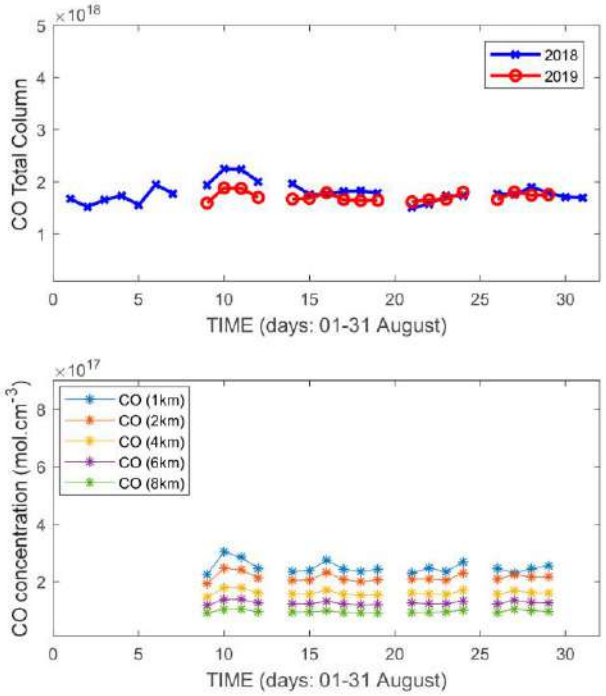
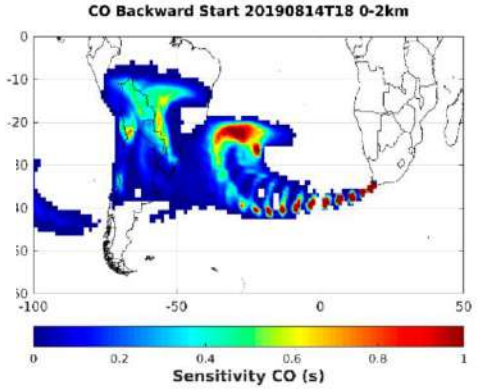
Long-Range Transport of Aerosol Plumes Following the Amazon Fires (August 2019)



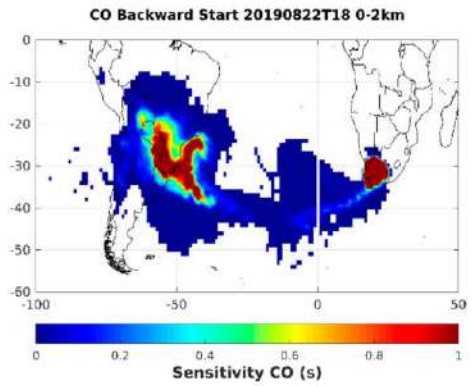
(a) Cape Point



(b) Reunion



(a)



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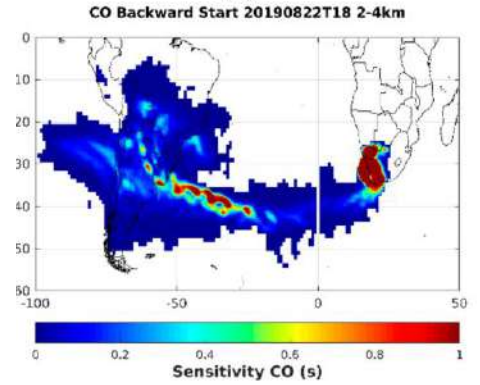

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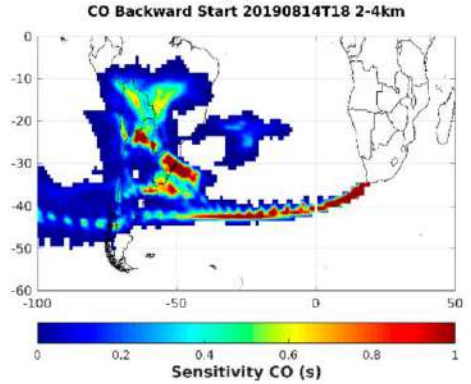

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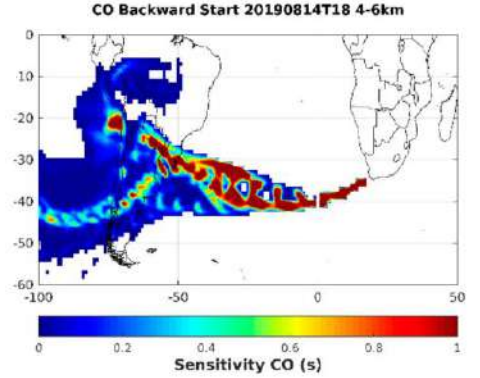

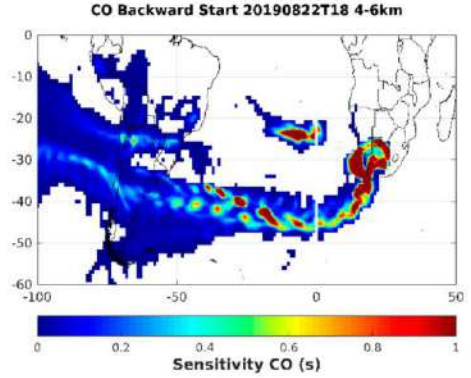

Bencherif, et al. Investigating the Long-Range Transport of Aerosol Plumes Following the Amazon Fires (August 2019): A Multi-Instrumental Approach from Ground-Based and Satellite Observations. *Remote Sens.* **2020**, *12*, 3846

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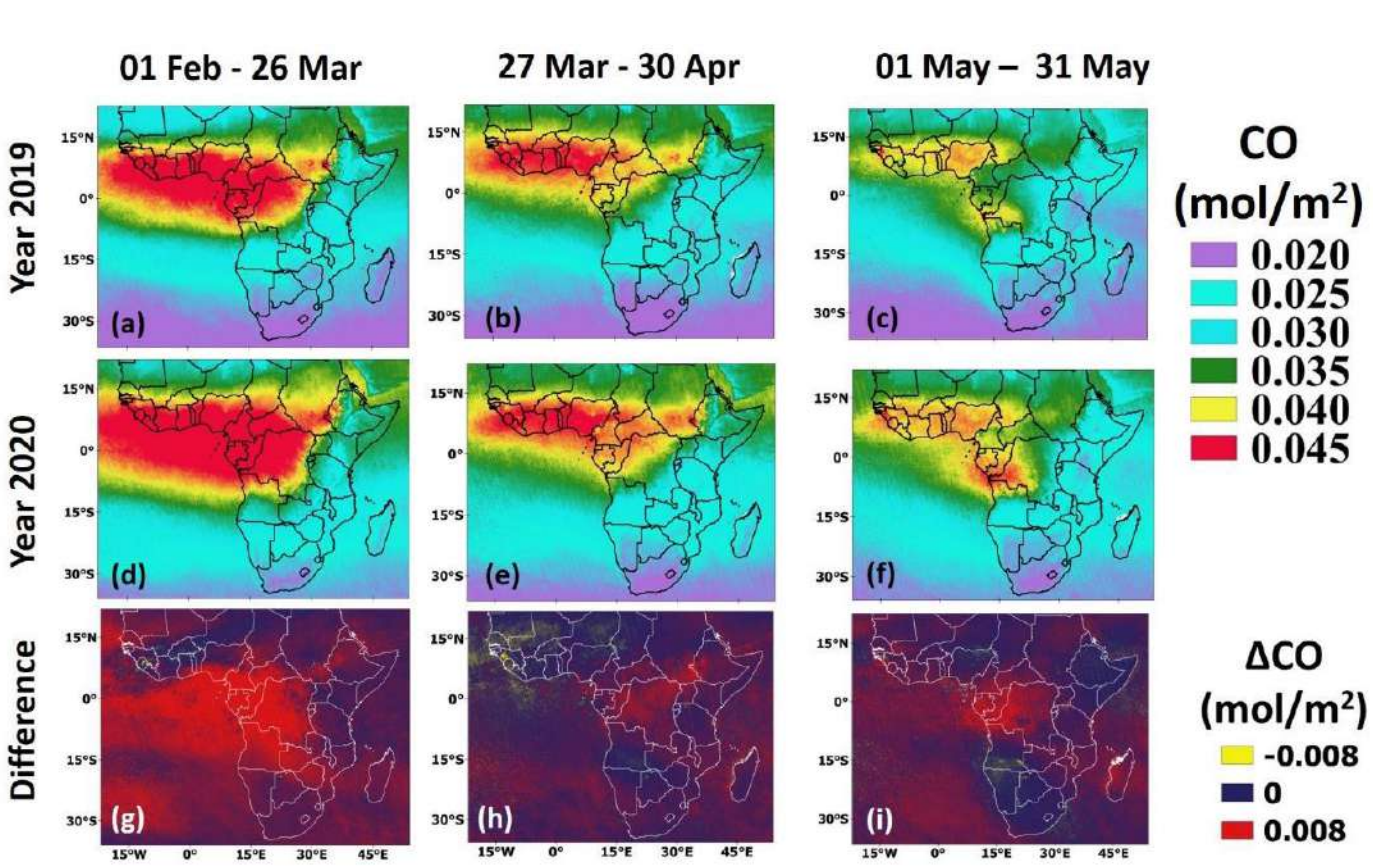
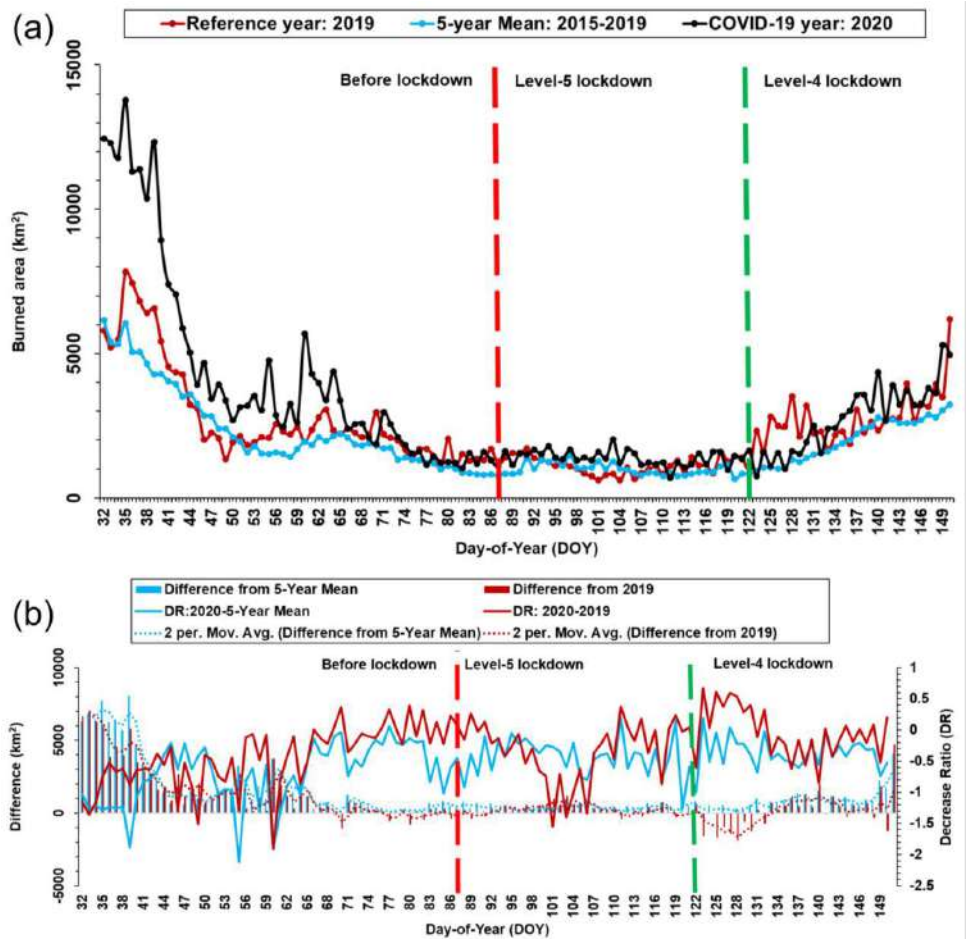
Changes in Biomass Burning Emissions during COVID-19 Lockdown?





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Kganyago and Shikwambana (**2020**). Did COVID-19 Lockdown Restrictions have an Impact on Biomass Burning Emissions in Sub-Saharan Africa? Aerosol and Air Quality Research.

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Wildfire Risk mitigation

Ignition-Resistant Homes

Use wildfire-resistant building materials and landscaping.

READ MORE

Land Use Planning

Direct how communities develop in wildfire-prone areas with plans and regulations.

READ MORE>>

Evacuation & Readiness

Be ready for wildfires with community alerts, evacuation routes, and family plans.

READ MORE>>

Equitable Risk Reduction

Address the social and economic vulnerabilities of people in the community.

READ MORE>>

Smoke Ready

Prepare for the health impacts of wildfire smoke in the community.

READ MORE>>

Prevent Ignitions

Reduce ignitions from campfires, debris burning, vehicles, and other sources.

READ MORE>>

Response

Manage and fight wildfires to protect lives, communities, and resources.

READ MORE>>

Hazardous Fuels Management

Cut, thin, burn, or otherwise reduce flammable vegetation on the landscape.

READ MORE>>

Recovery and Rebuilding

Restore the landscape and community following a wildfire.

READ MORE>>

Major findings

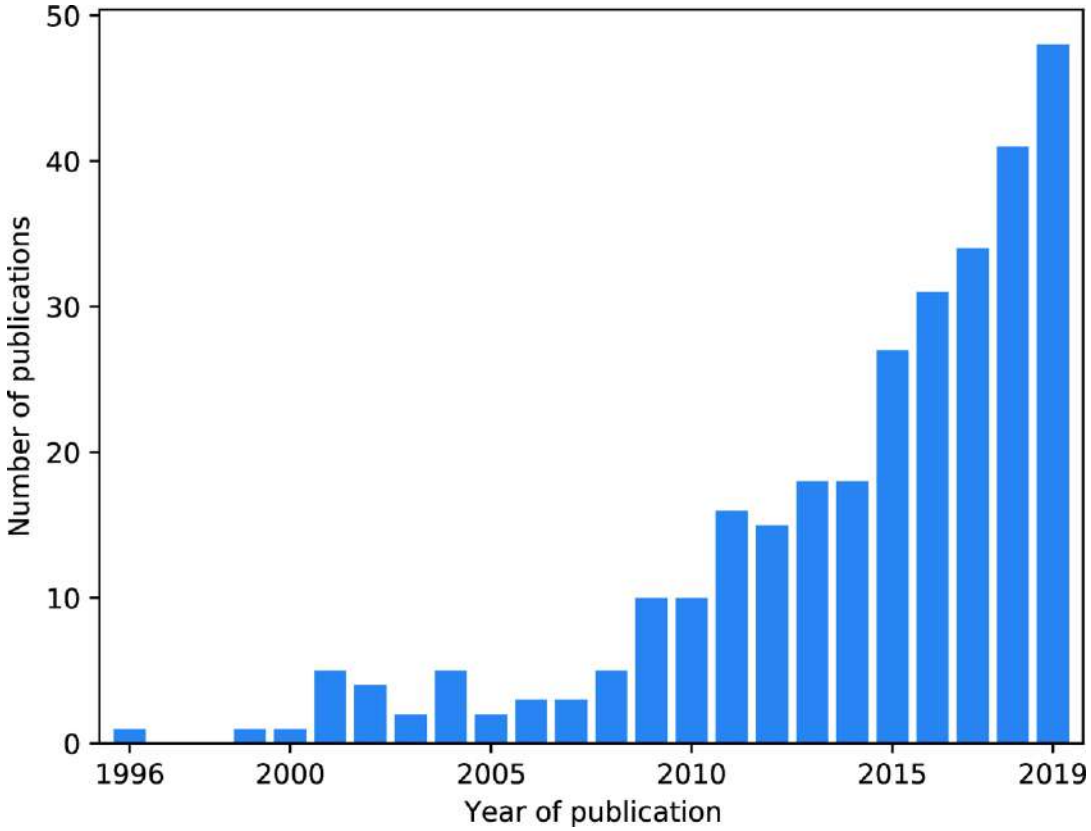
- Satellite data are the best instruments to use to study wildfires and their impact in the atmosphere
- Emissions from wildfires can travel long distances and impact faraway places
- Increased emissions during the COVID-19 lockdown period
- Smoke plumes were observed at heights of 4, 6, and 9 km

Gaps and Future work

Use machine learning in

- fire occurrence prediction
- fire detection
- burned-area prediction
- Emission patterns prediction

Number of publications by year for 300 publications on topic of machine learning and wildfire science and management



Collaborators

Dr Mahlatse Kganyago – University of Johannesburg

Prof Paida Mhangara- University of the Witwatersrand

Dr Nkanyiso Mbatha- University of Zululand

Dr Oupa Malahlela – University of Venda

Dr Xolile Ncipha - South African Weather Service

Prof Venkataraman Sivakumar – University of KwaZulu Natal

Prof Hassan Bencherif - Université de la Réunion

Dr Nelson Bègue - Université de la Réunion

Biomass Burning Aerosol Campaign - BiBAC

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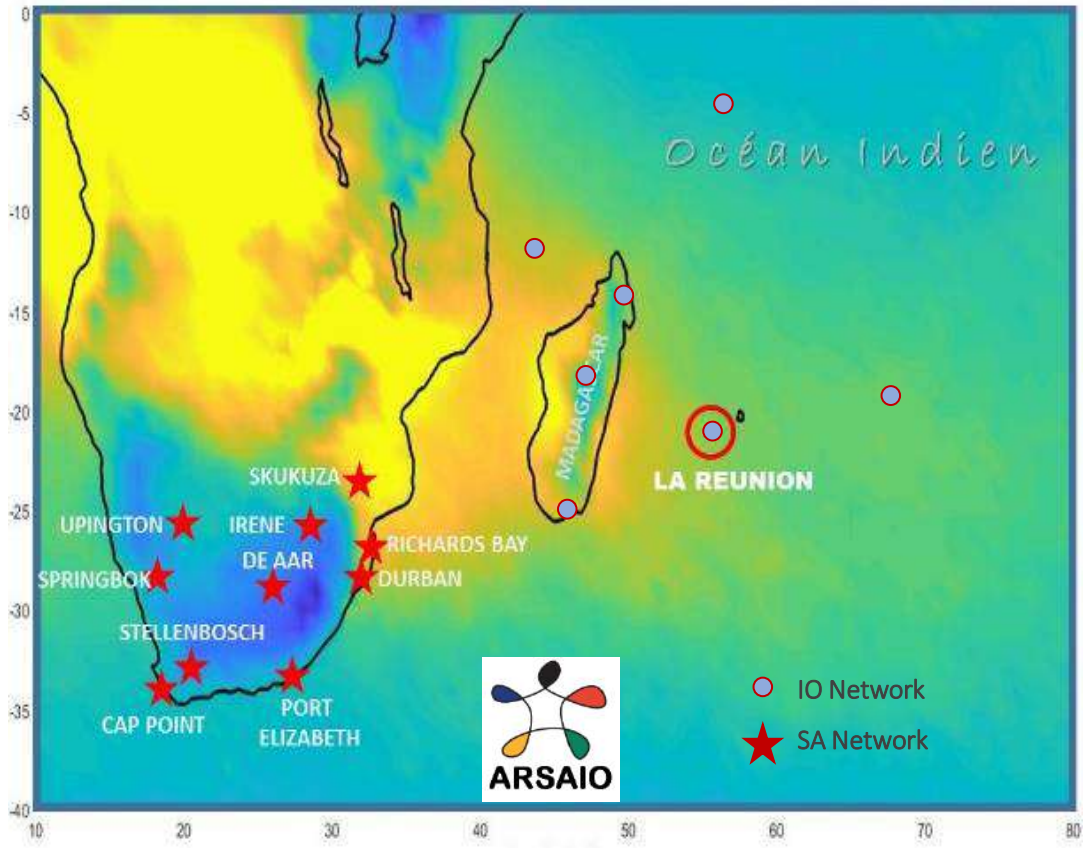
Biomass Burning Aerosol Campaign - BiBAC

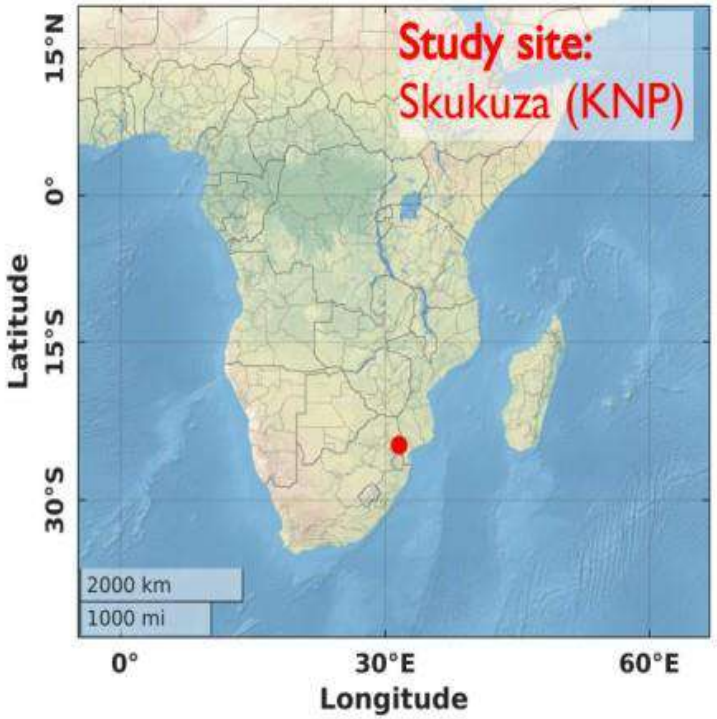
a multi-instrumental campaign in southern Africa and Indian Ocean (August-November, 2022)



- **LiDAR systems**
  - Réunion (OPAR)
  - Skukuza (UKZN mobile): Aero + wind
- **Ozonesondes (SHADOZ)**
  - Réunion (OPAR, SHADOZ)
  - Irene (SAWS, SHADOZ)
- **Dobson and SAOZ Spectrometers**
  - **Irene (SAWS)**
  - Springbok (SAWS)
  - Stellenbosch (SAWS)
  - **Réunion (OPAR)**
- **Sun-photometers**
  - Skukuza
  - Durban (UKZN)
  - Reunion
  - Pretoria
  - Other stations (Maputo and Maune)
- LOAC sonde (LPC2E-LACy)
- Static LOAC (LPC2E-LACy)

- **UV stations**
  - SAWS network (Irene, Durban, Port Elisabeth, De Aar, Cape Town, Cape Point)
  - UV-indien network (Réunion, Madagascar, Seychelles, Comoros, Rodrigues)

In addition to satellite obs. (Fire, AOD, Aero profiles, O_3, CO, …): MODIS, CALIOP, OMI, MLS, IASI, …



Mobile lidar

Sun-photometer

LOAC

UV station

AQMS (NWU)

PM2.5, PM10, Nephelometer
Meteorology, O3, SO2, NO2

THANK YOU

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