climate change initiative

→ FIRE

Burned area products derived from the ESA FireCCI project and the C3S service.

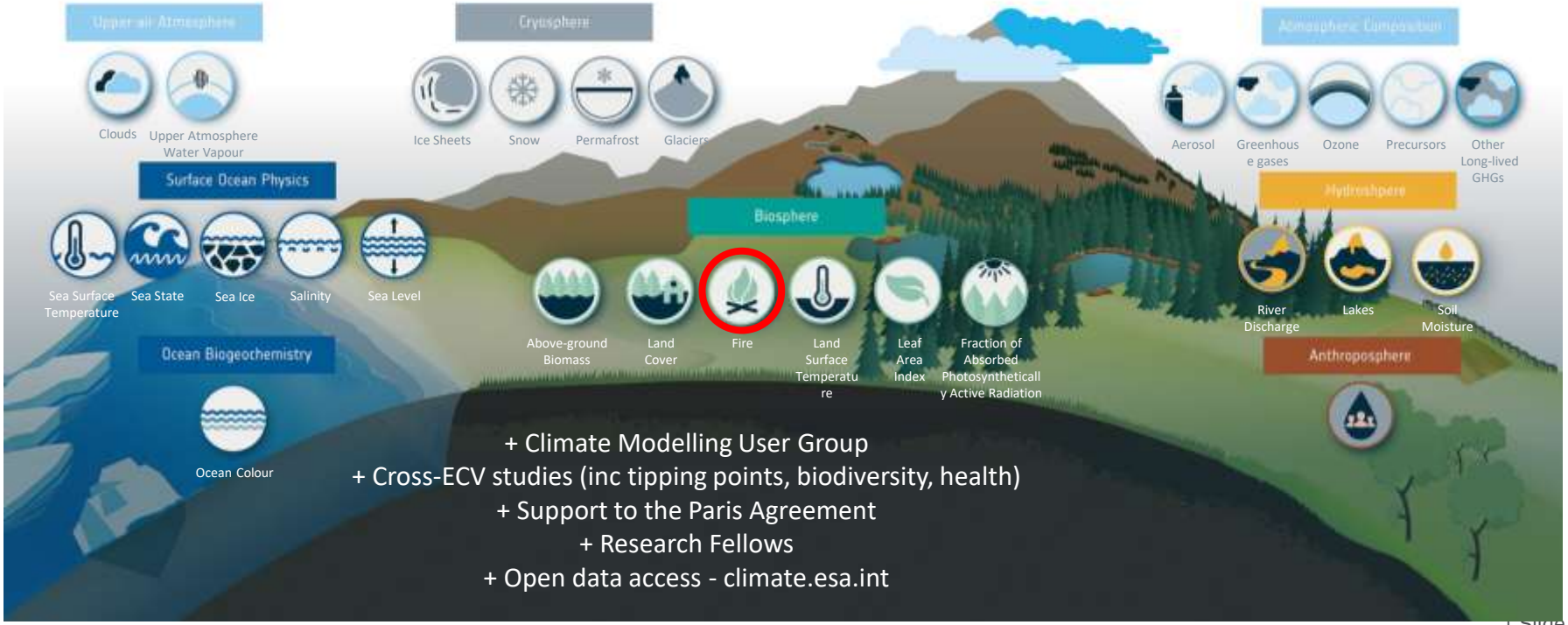
Emilio Chuvieco (on behalf of the FireCCI team)

fire cci

EUMeTrain Forest Fires training event week

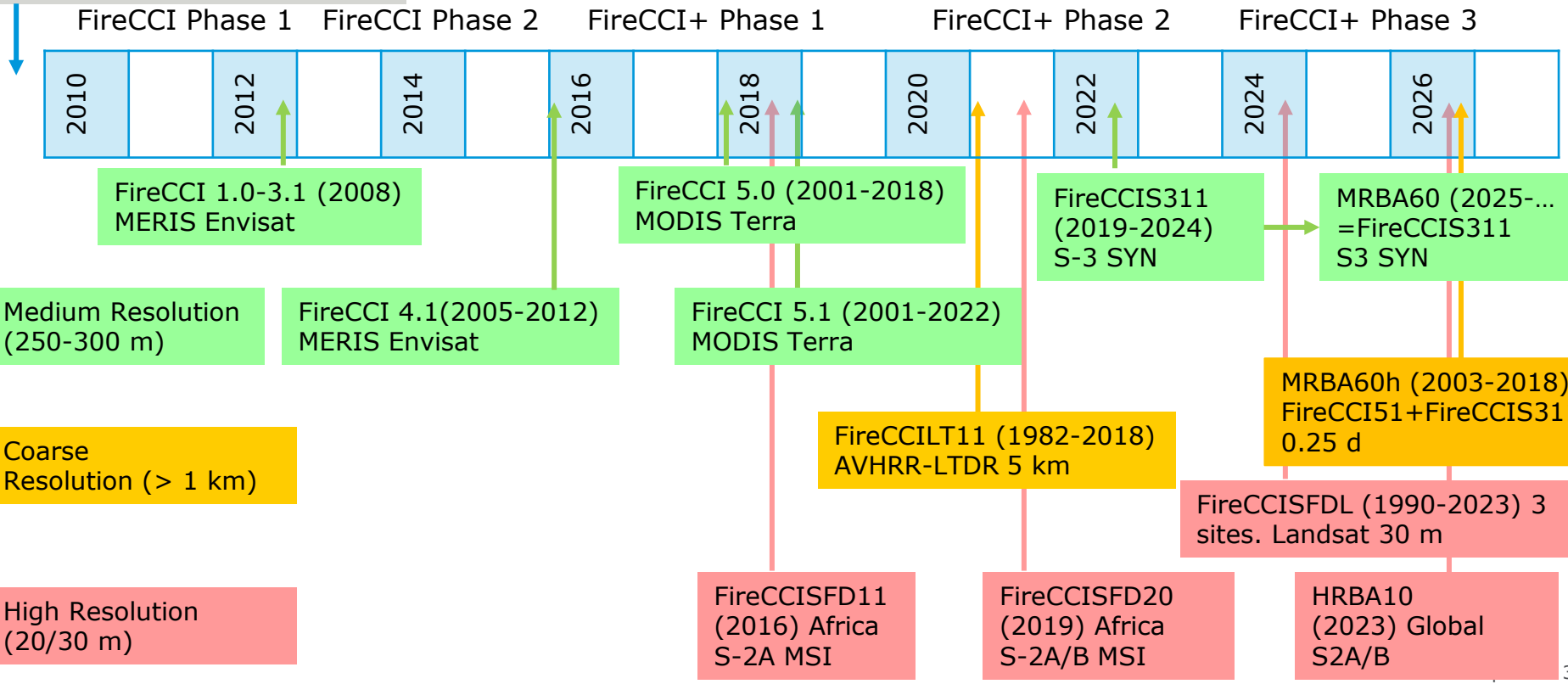
ESA Climate Change Initiative ECVs

GCOS defined **55** Essential Climate Variables | **36** benefit from space observations | **28** generated by ESA's Climate Change Initiative



FireCCI datasets' history (pixel products)

Precursors: L3JRC / Globcarbon



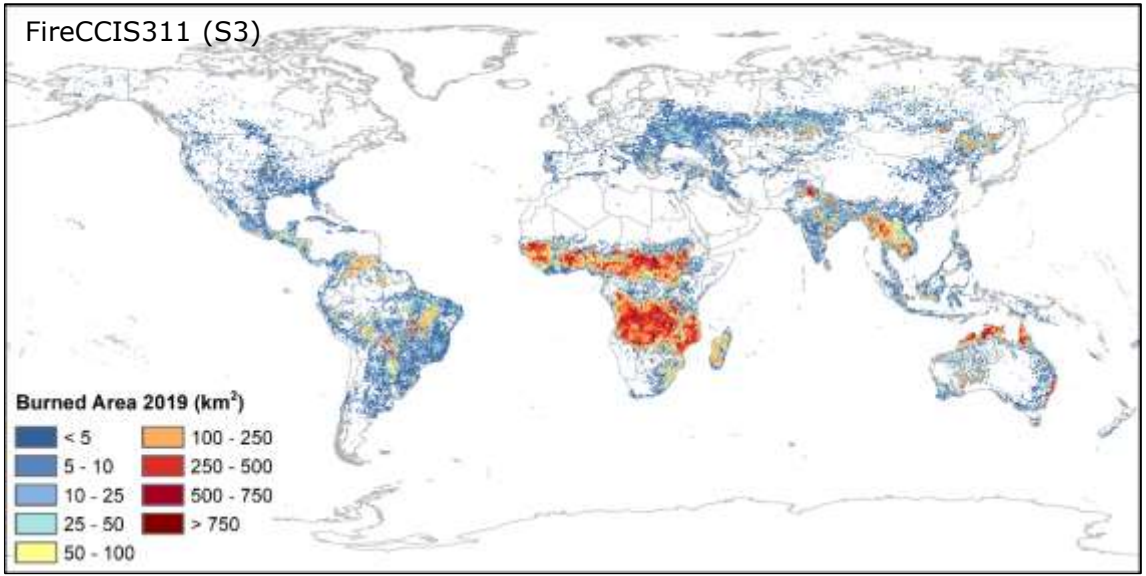
FireCCI Medium-resolution products

- Current MR products

	FireCCI51	FireCCIS311
Coverage	Global	
Time series	2001-2022	2019-…
Pixel resolution	250 m	300 m
Grid resolution	0.25 deg.	0.25 deg.
Input SR	MODIS NIR	S3 SYN SWIR
Input AF	MODIS 1 km	VIIRS 375 m

Greater detection capability of FireCCIS311:

- 26.5% > FireCCI51 (2019-2022)
- 38.8% > MCD64A1 (2019-2024)

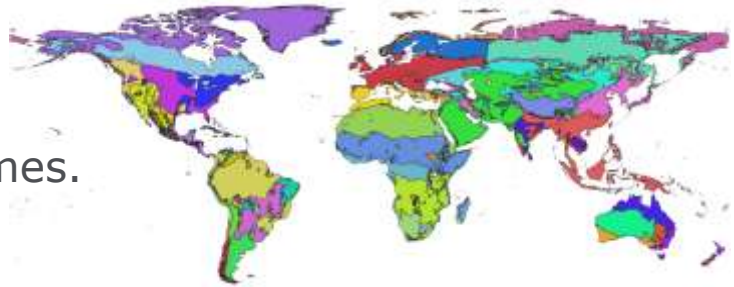


FireCCIS311/MRBA60: Production to be continued from 2025 onwards as part of C3S (Copernicus Climate Change Service)

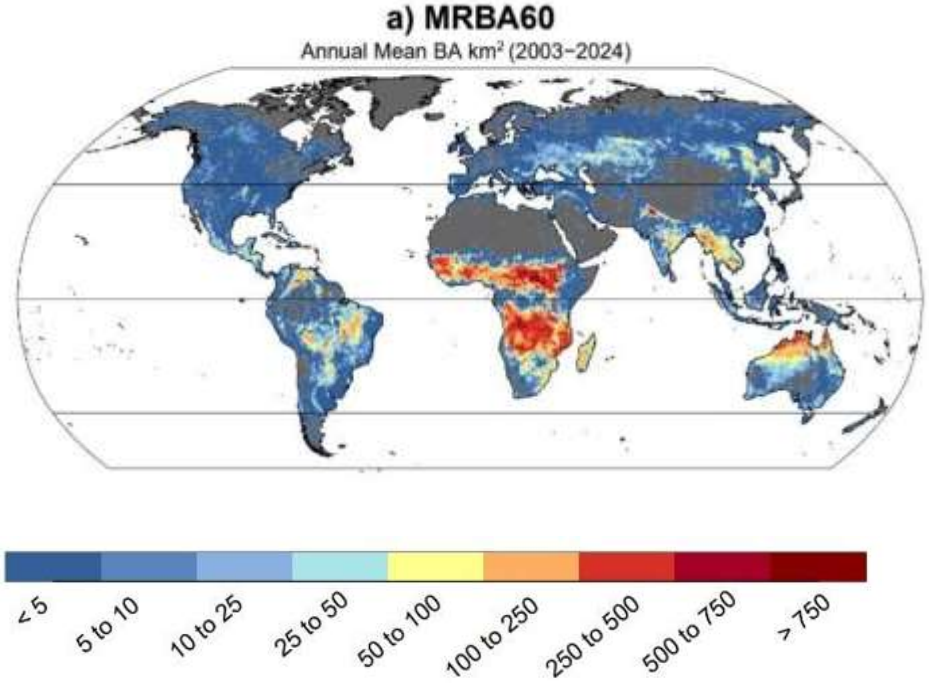
MRBA60

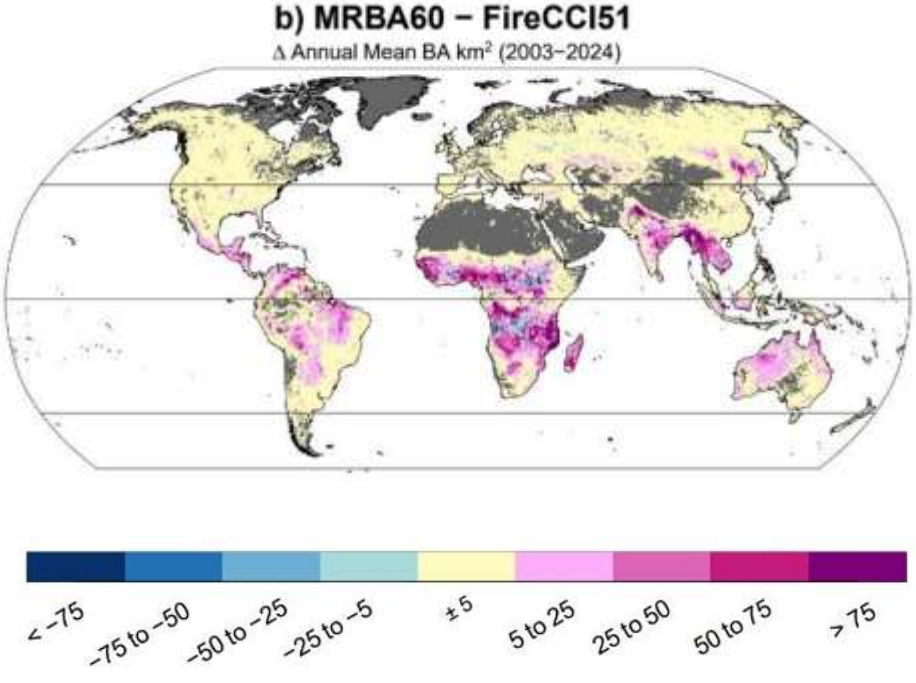
- Target:
  - MRBA60h: Harmonised (FireCCI51+FireCCI311) product at 0.25º for 2003-2018.
  - MRBA60 after 2019 (previously named FireCCIS311 2019-2024).
- Methods:
  - FireCCIS311 = f (FireCCI51, MODIS HS, Meteo data, NDVI, etc.)
  - Random Forest models based on common period: 2019-2024.
  - Biome-continent and monthly-adapted.
  - Extremes smoothed from modelling

  (average conditions), observed data for extremes.

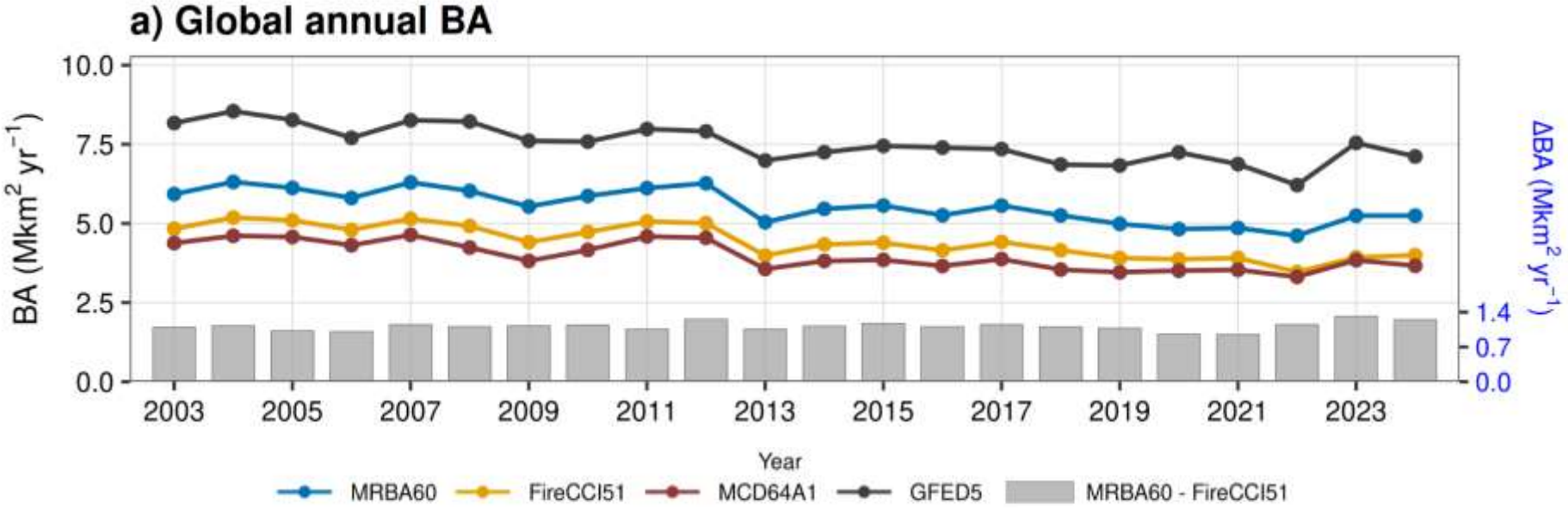


MRBA60 global analysis





Temporal trends of MRBA60: cross-comparison

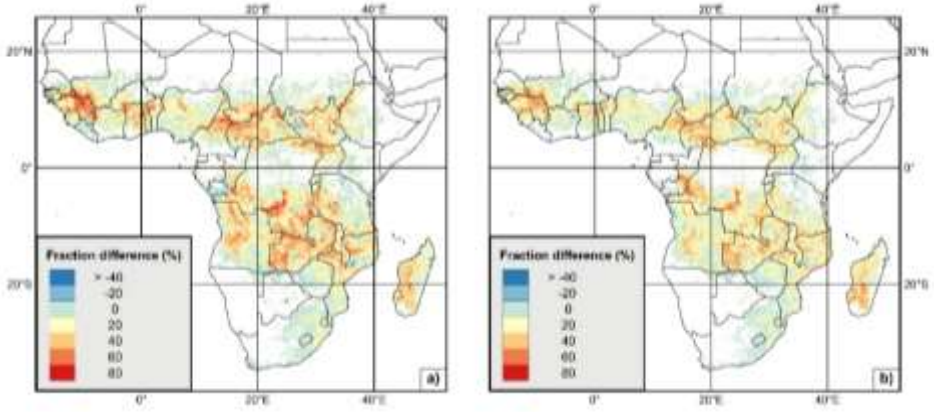


Mean MRBA60 → ~5.5 Mkm²

FireCCI HR products

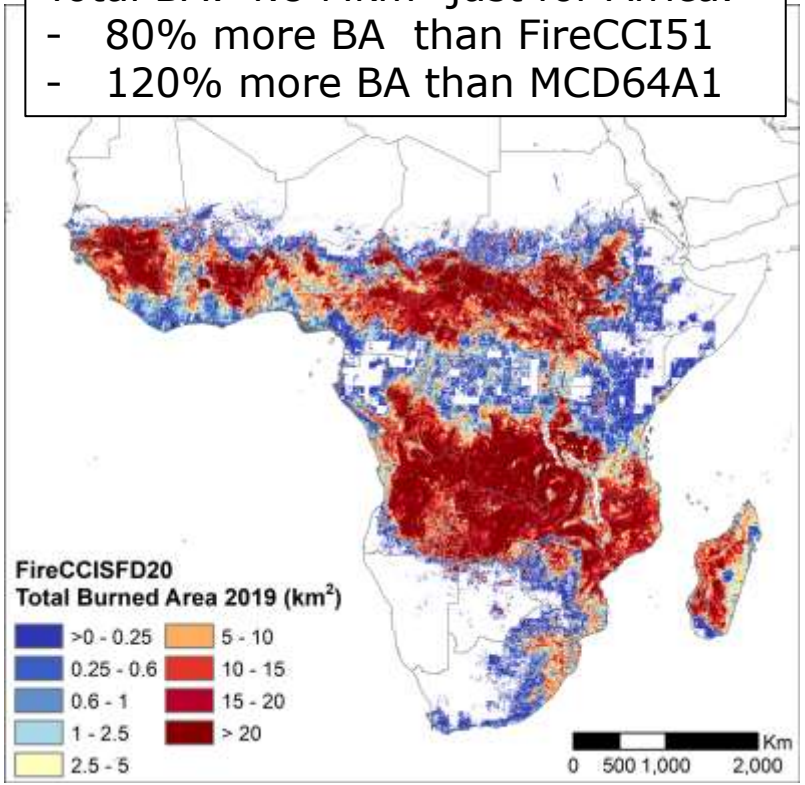
	FireCCISFD11	FireCCISFD20
Coverage	Sub-Saharan Africa	
Time series	2016	2019
Pixel resolution	20 m	20 m
Grid resolution	0.25 deg.	0.05 deg.
Input SR	S2A	S2A&B
Input AF	MODIS 1 km	VIIRS 375 m

SFD: Small Fire Dataset



Difference in BA proportion between FireCCISFD20 and a) MCD64A1 and b) FireCCI51

Total BA: 4.8 Mkm^2 just for Africa.
- 80% more BA than FireCCI51
- 120% more BA than MCD64A1

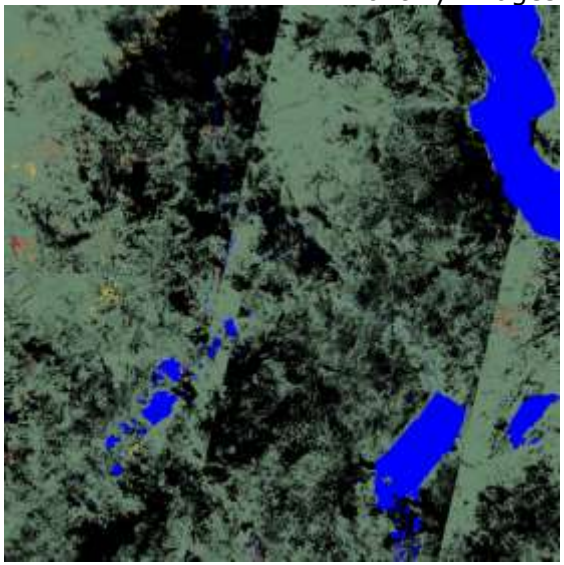


(Chuvieco et al., 2022, STOTEN)

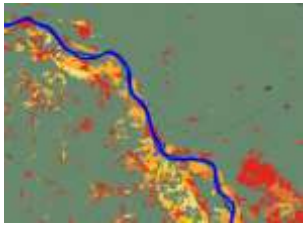
HRBA10 2023

- Global BA coverage for 2023.
- Bulk processing:
  - 3 Million granule items, 1,944,000 x 972,000 pixels (~2 PB)
- Pixel product:
  - 20m resolution, Sentinel-2 A&B + VIIRS AF
  - Tiles of 5ºx5º
- Grid product:
  - Global 0.05º / 0.25º

Monthly Images



Detail



Day of Burn

First day of the month

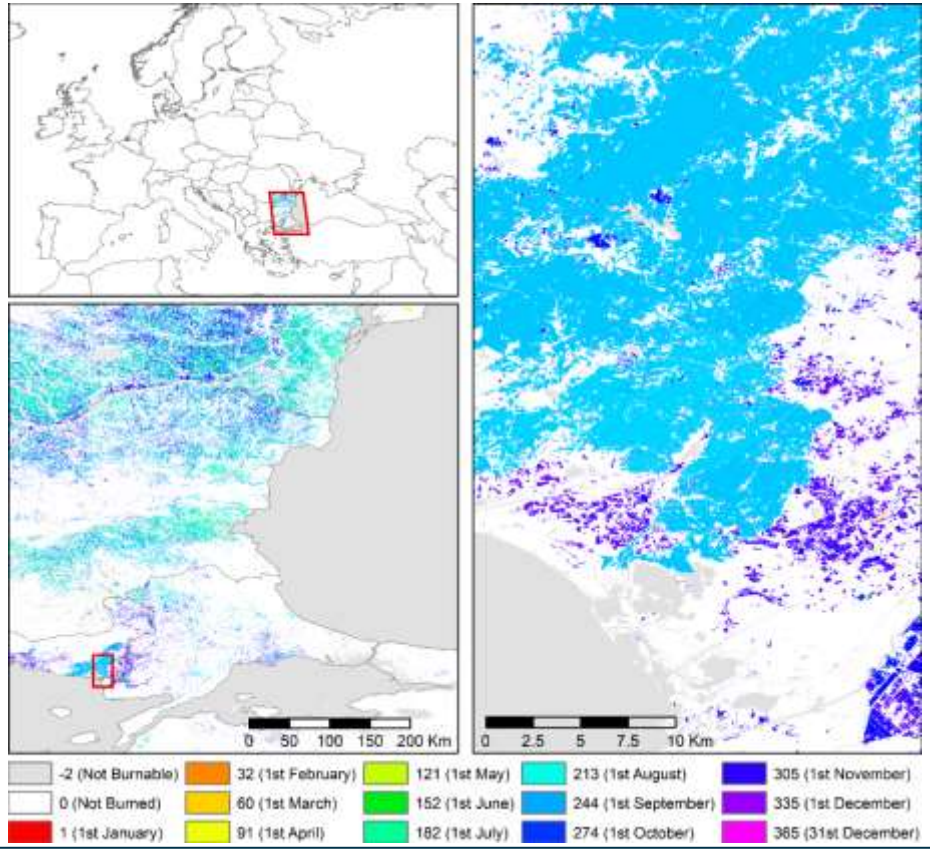
Last day of the month

Not burned

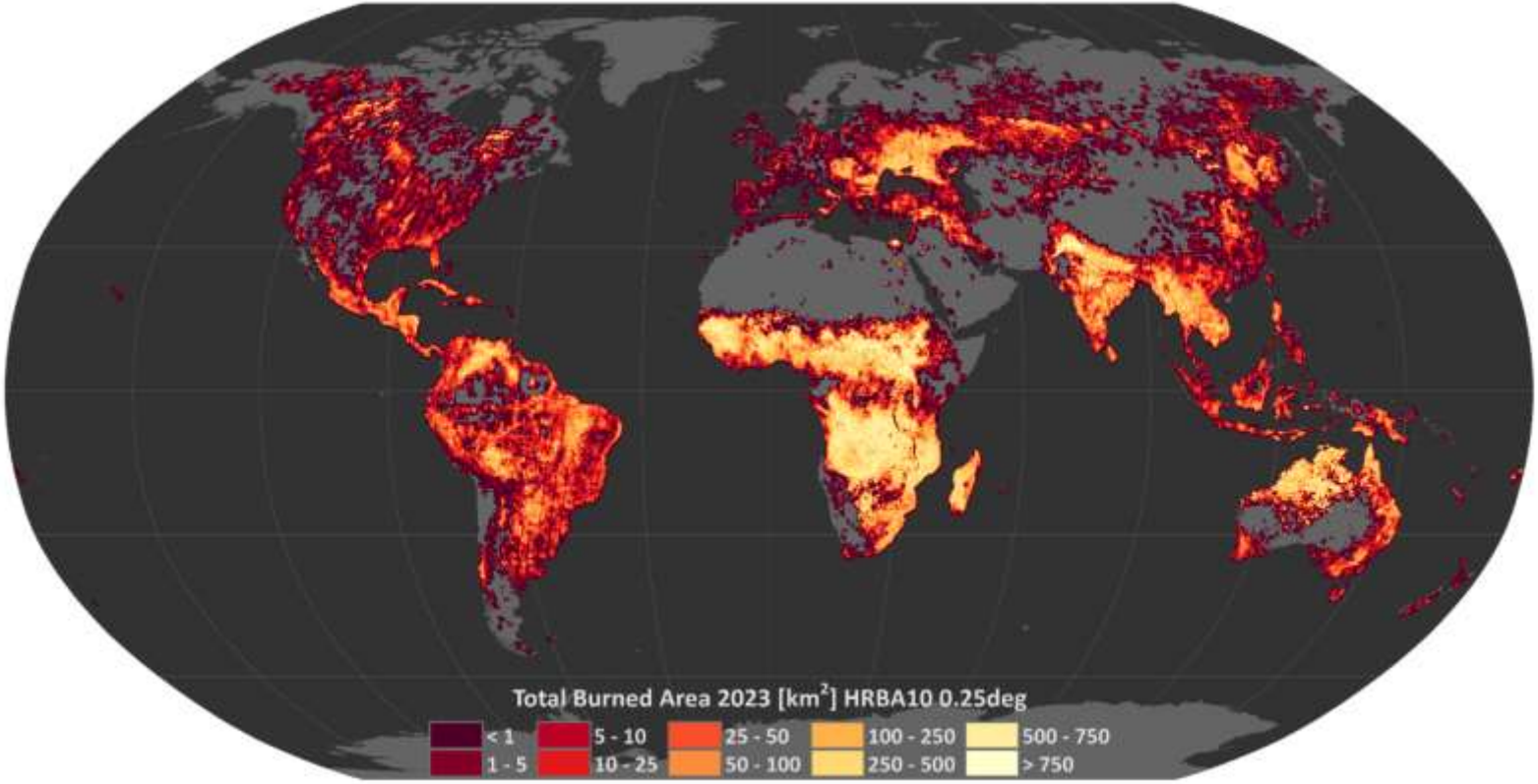
Not observed (clouds)

Water

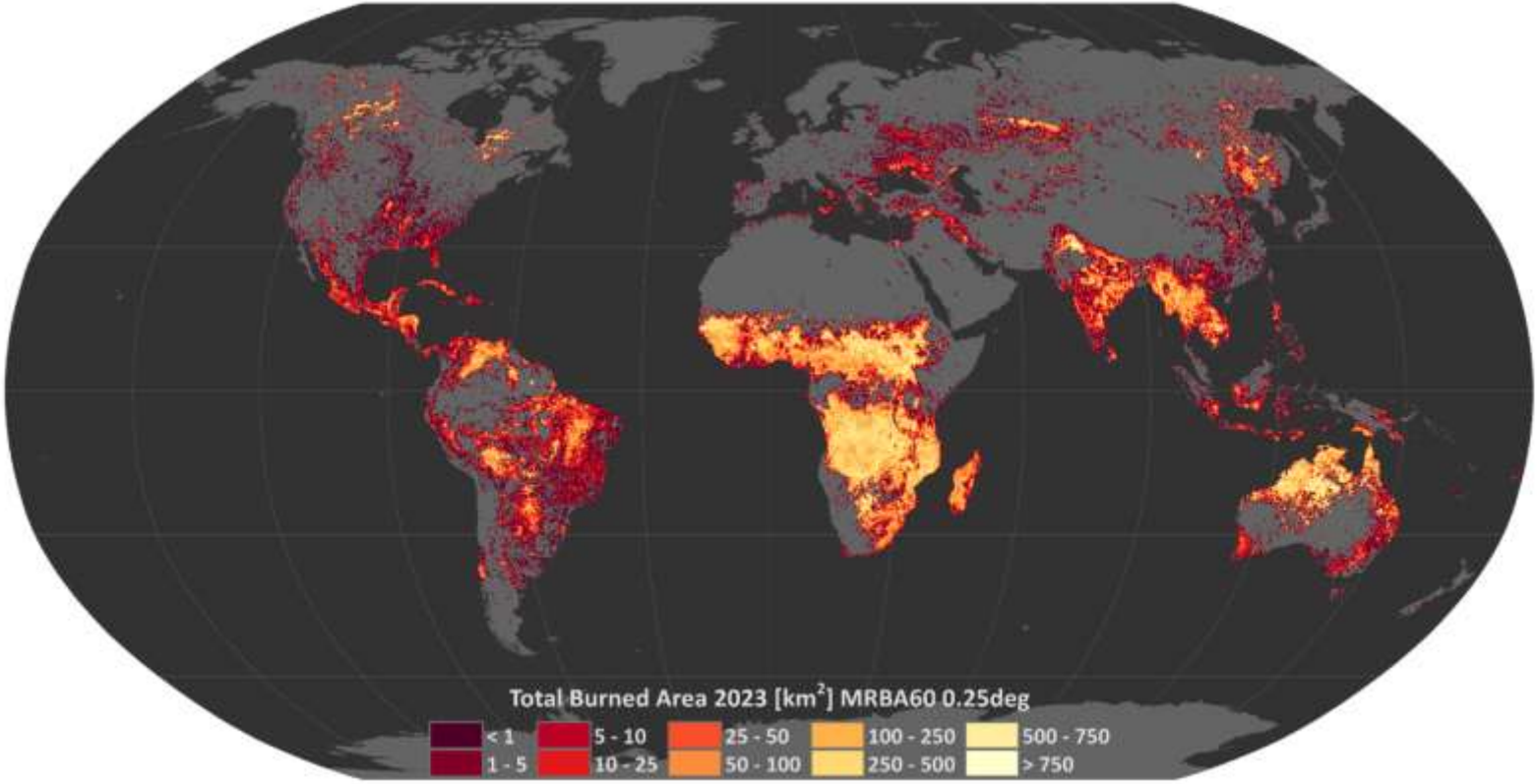
HRBA10 2023 – Pixel product



HRBA10 2023 – 0.25 deg



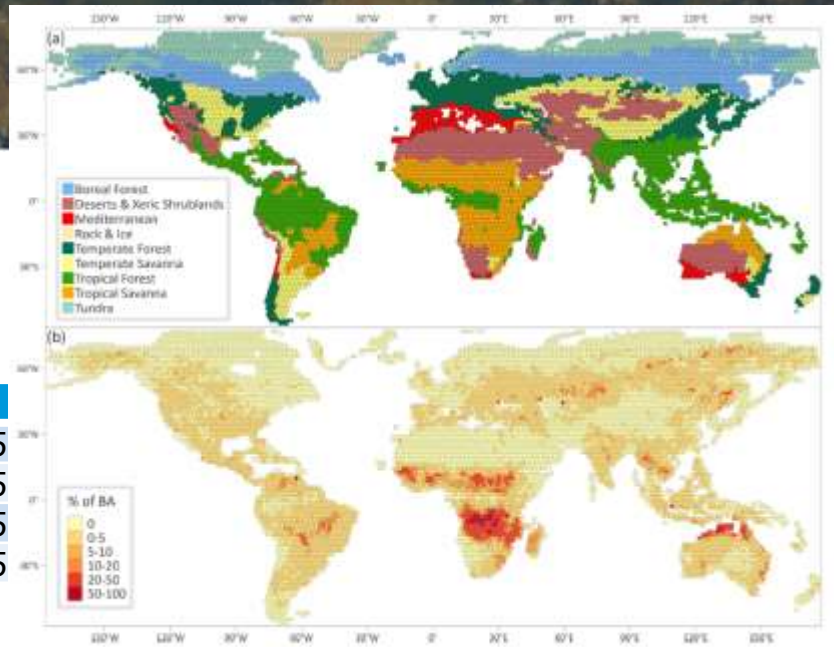
MRBA60 2023 – 0.25 deg (grid product)



Validation

- Random stratified sampling of TSA (2017-2024):
  - Long-term sampling scenes
  - Average values for the common years (2019-2022)

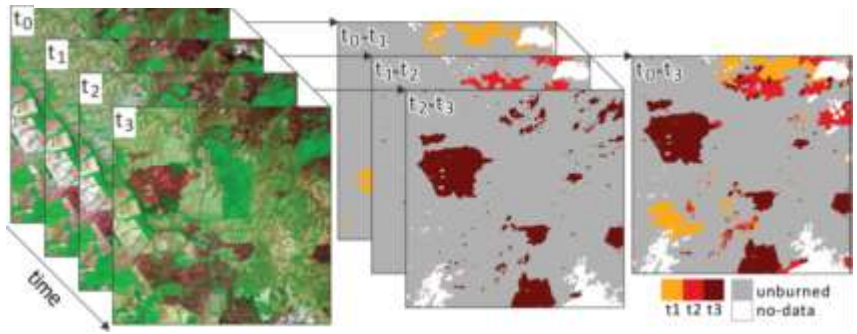
	FireCCI51	FireCCIS311	MCD64A1	C3BA11
DC	55.342	60.625	50.55	50.55
CE	20.735	19.350	18.55	18.55
OE	57.086	51.150	62.85	62.85
relB	-45.943	-39.400	-54.075	-54.075



- Africa (2019):

	FireCCI51	FireCCISFD20	MCD64A1
DC	52.2	87.7	56.5
CE	25.1	15.0	21.1
OE	58.4	8.5	56.0
relB	-36.2	8.4	-44.9

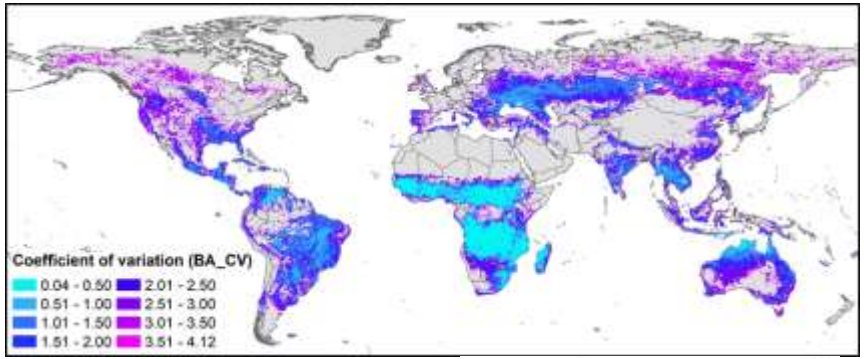
Stroppiana et al., 2022 IJPRS.

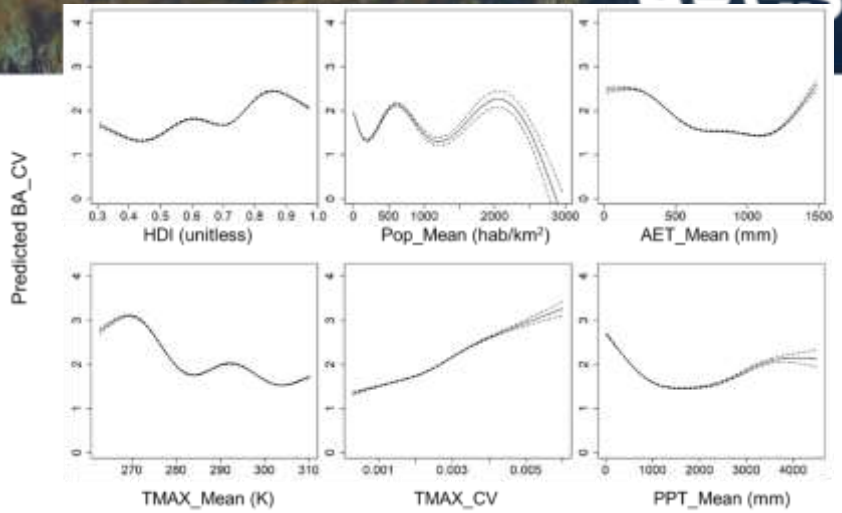


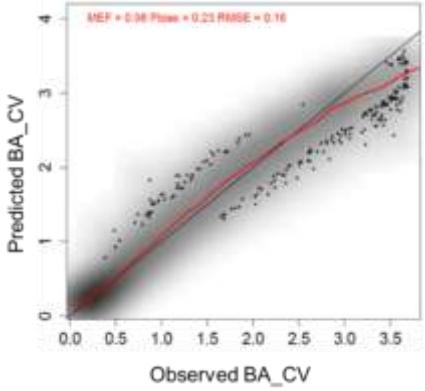
Analysis of fire impacts

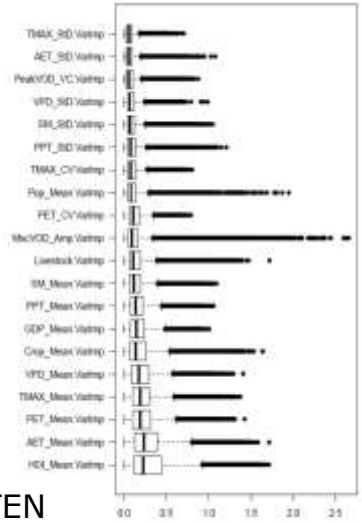
- Global:
  - Fire regimes characterization.
  - Extreme events.
- Regional:
  - Emissions from fires (Africa)
  - Fire and deforestation (Africa and Amazonia).
  - Peat fires (Siberia).

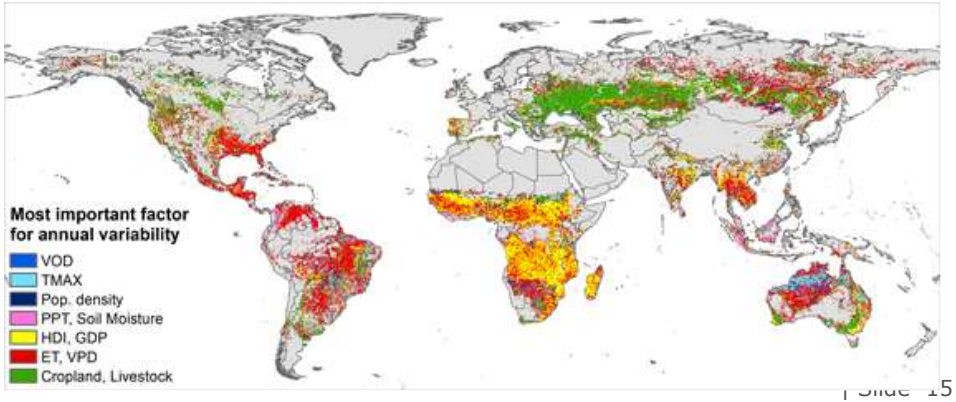
Persistence factors











Chuvieco et al., 2021, STOTEN

Fire impacts on emission estimations

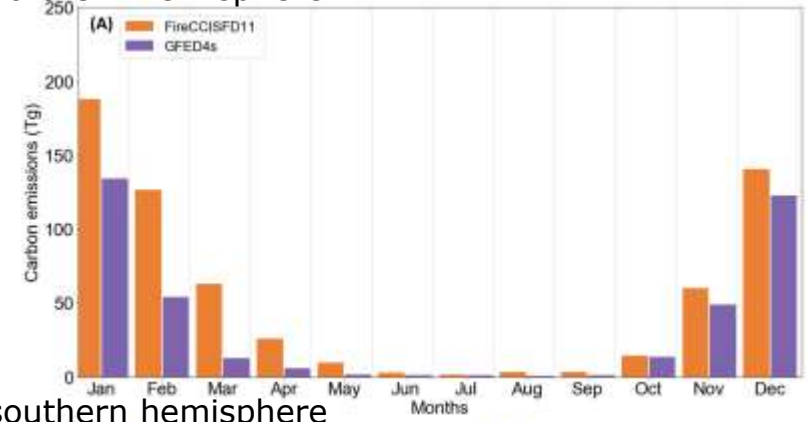
- GFED framework
  - 1.7 Pg C for SFD.
  - 67% more than GFED4s
- Land-cover specific estimates of biomass fuel consumption per BA unit.
  - 1.3 Pg C for SFD.
  - 61% more than GFED4s

African burned area and fire carbon emissions are strongly impacted by small fires undetected by coarse resolution satellite data

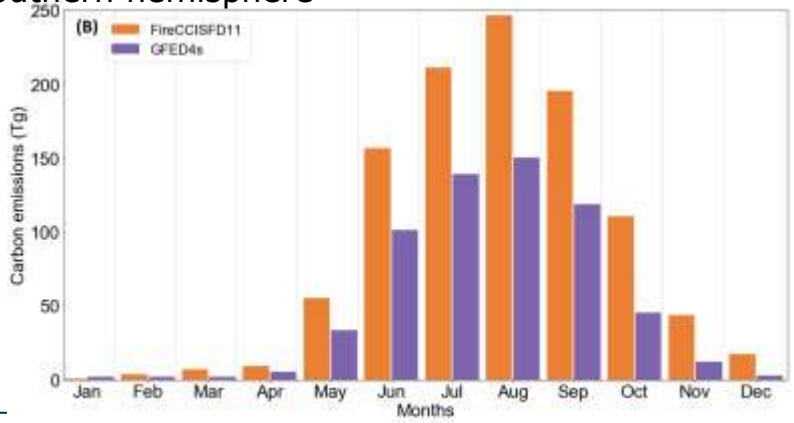
Rubén Ramo[a,b,1], Ekhi Roteta[c], Ioannis Bistinas[d,e], Dave van Wees[d], Aitor Bastarrika[c], Emilio Chuvieco[b], and Guido R. van der Werf[d]

PNAS 2021 Vol. 118 No. 9 e2011160118

(A) northern hemisphere

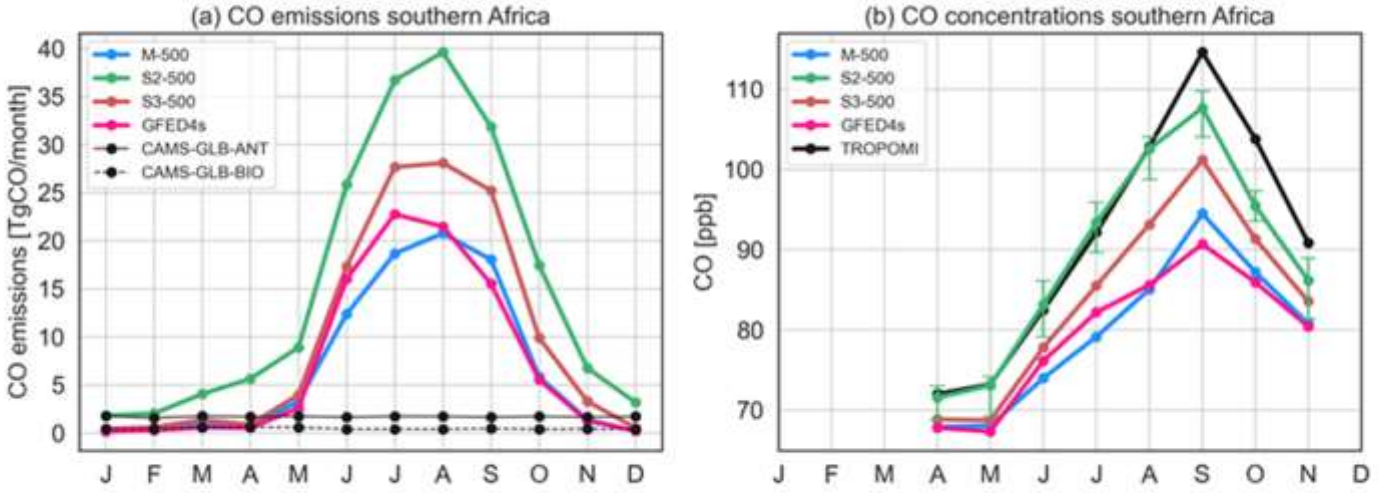


(B) southern hemisphere



Fire impacts on emission estimations

- Impact for Climate Modelling:
  - BA datasets based on Sentinel-2 data show much more BA than medium-resolution products.
  - Obtaining emissions data from these products are closer to observations.

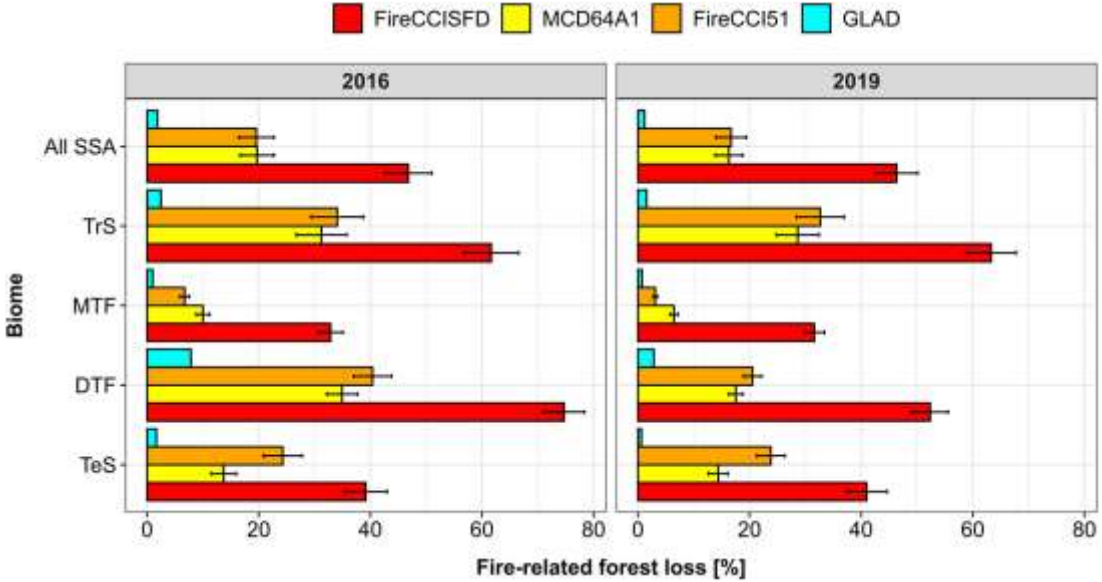


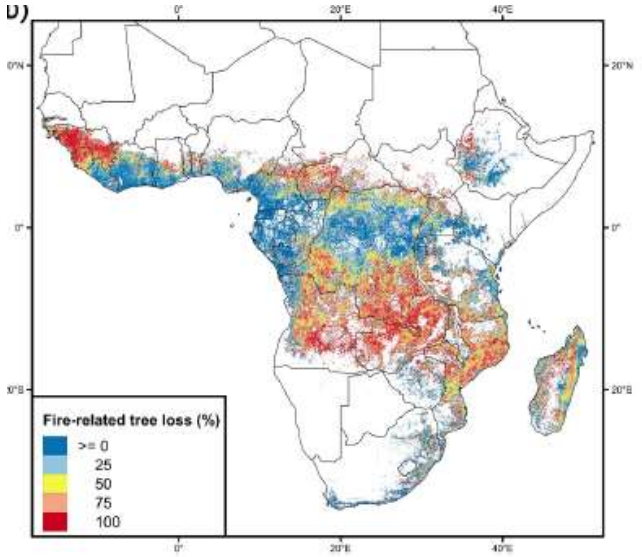
M-500: emissions derived from MCD64A1C6. S2-500: emissions derived from FireCCISFD20. S3-500: emissions derived from FireCCIS311.

Van der Welde et al. (2024), https://doi.org/10.1029/2023GL106122

Fire and deforestation in Africa (2019)

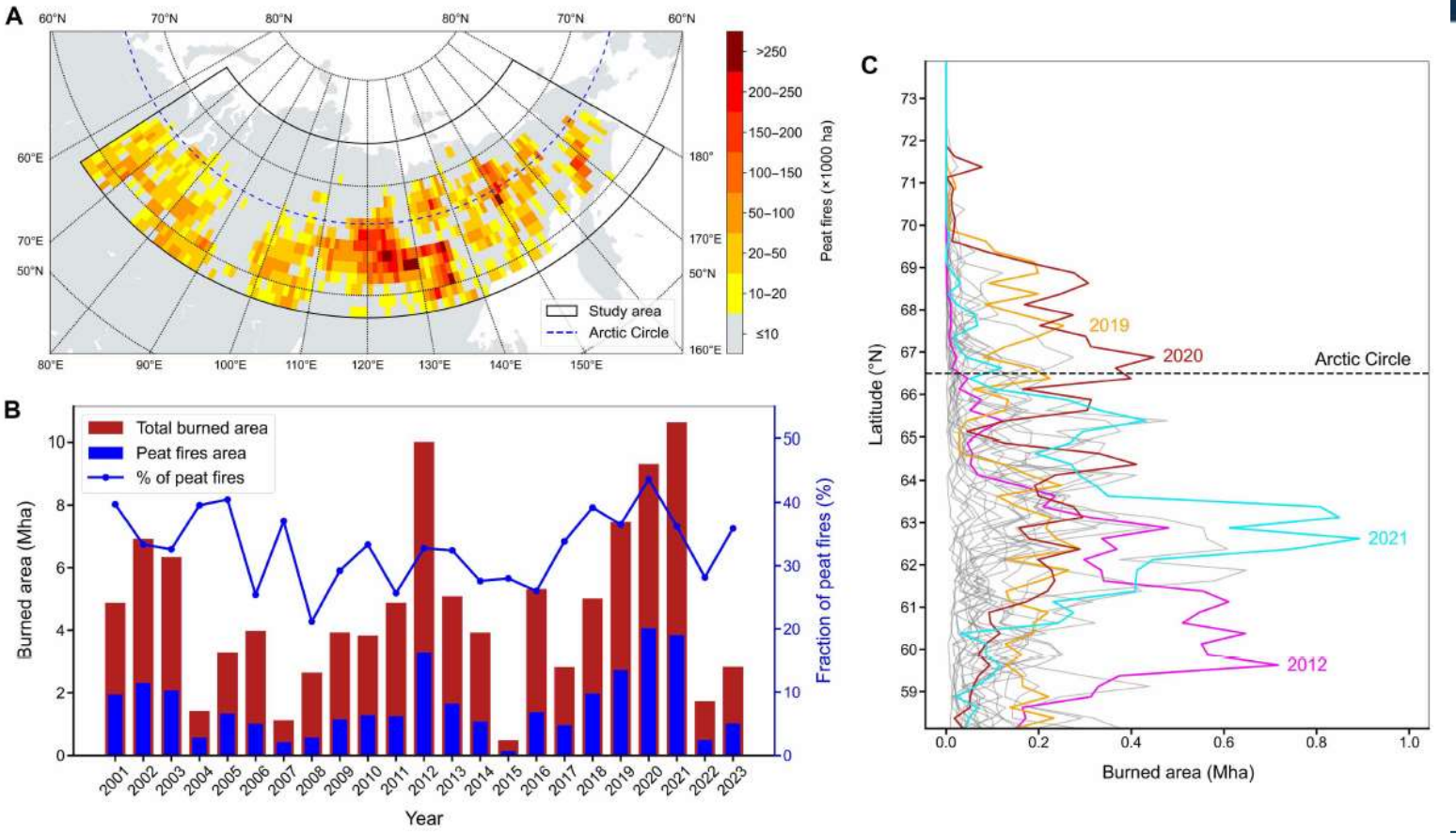
- Fires contribute to >46 % of total forest losses over SSA (double than previous estimates).
- BA showed more than twofold likelihood of subsequent loss compared to unburned ones.





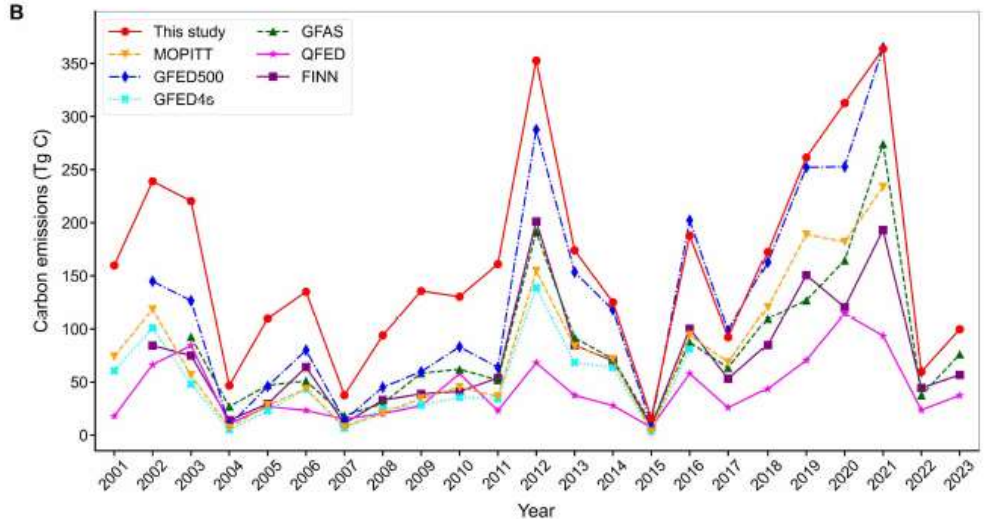
Khairoun et al, 2024 STOTEN

Peat fires (2001-2023)

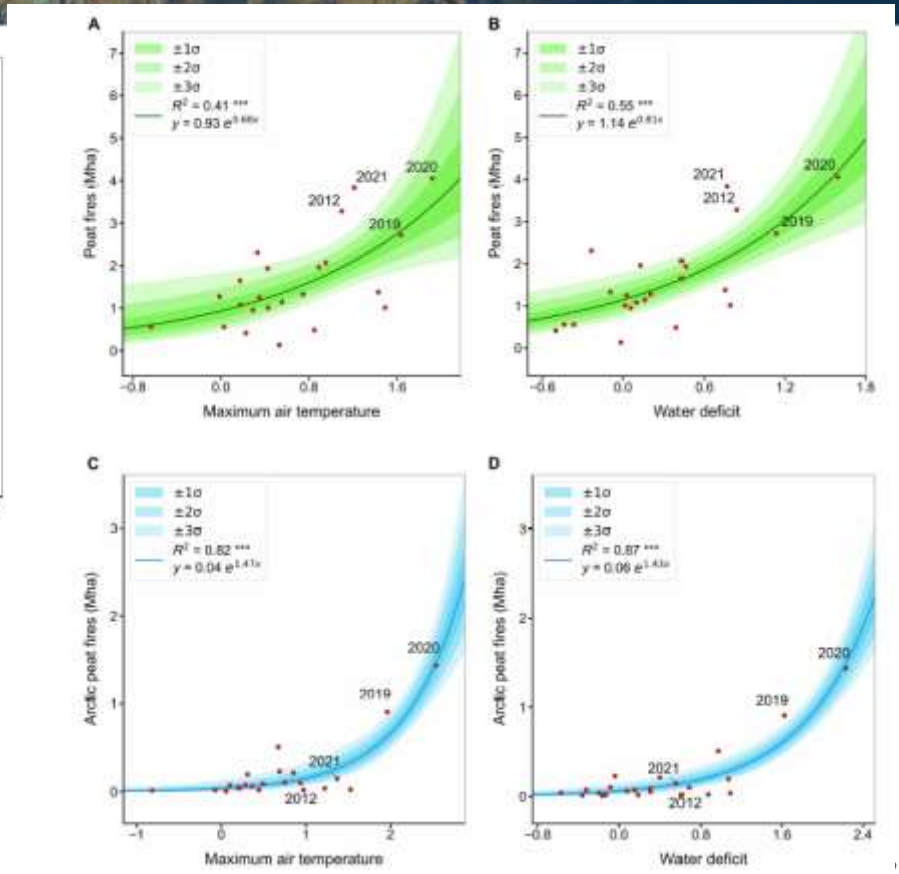


(Khairoun et al, 2026, Science advances)

Explanation factors of peat fires



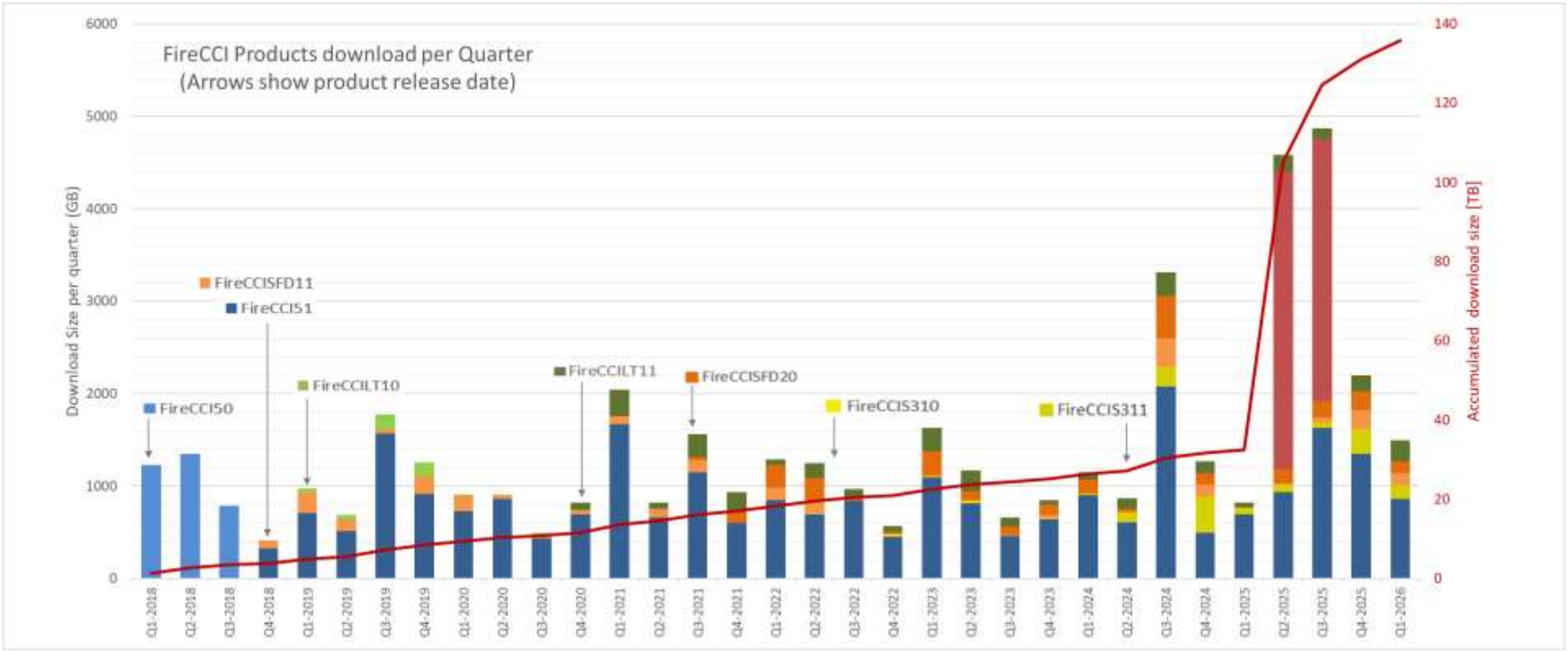
BA Trends from different sources



Relation to meteorological drought indices

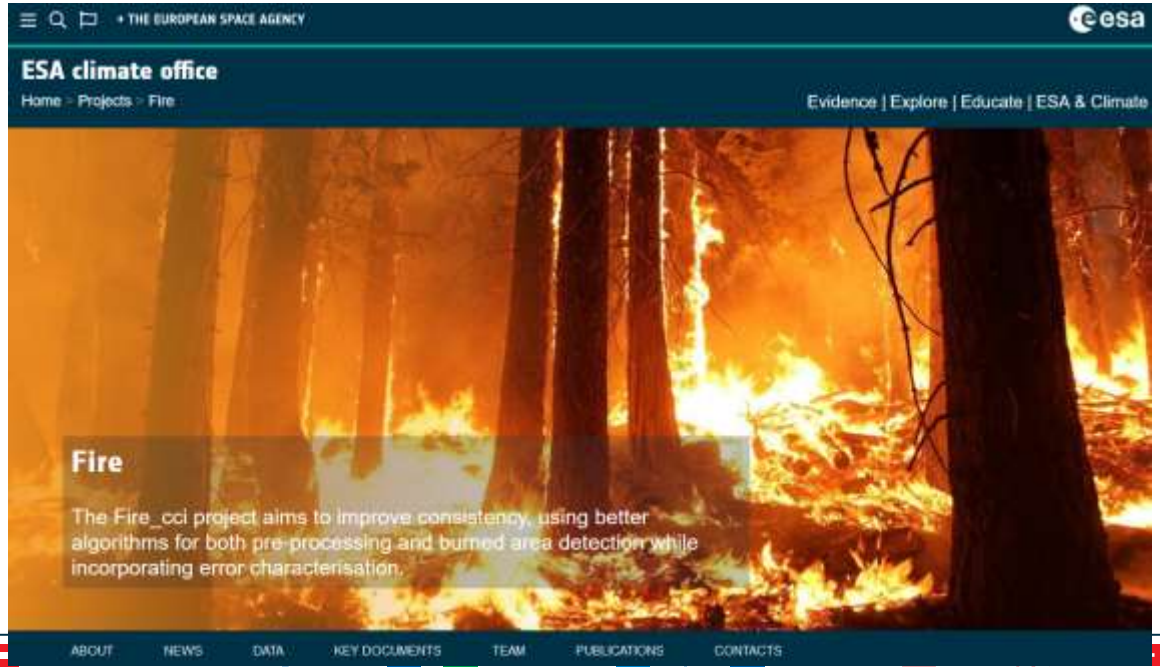
(Khairoun et al, 2026, Science advances)

FireCCI project outputs: downloads



FireCCI project outputs:

- European BA datasets are now distributed and used widely.
- The provide an alternative approach to understand fire occurrence.
- HR products estimate significantly more BA than MR products.



https://climate.esa.int/en/projects/fire/about/

Thanks
emilio.chuvieco@uah.es