Matthias Forkel[1], Niels Andela[2], Vincent Huijnen[3], Christine Wessollek[1],
Alfred Awotwi[1], Daniel Kinalczyk[1], Christopher Marrs[1], and Jos de Laat[3]

Sense4Fire

Effects of land use, fuel loads and fuel moisture on fire intensity and fire emissions in South America derived by reconciling bottom-up and top-down satellite observations

EGU 2023, Vienna, 24. April 2023

(1) TECHNISCHE UNIVERSITÄT DRESDEN

(2) CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD solid living changing EARTH OCEAN

(3) Royal Netherlands Meteorological Institute Ministry of Infrastructure and Water Management

SCIENCE ADVANCES | RESEARCH ARTICLE

CLIMATOLOGY

Tracking and classifying Amazon fire events in near real time

Niels Andela[1,2]*, Douglas C. Morton[3], Wilfrid Schroeder[4], Yang Chen[5], Paulo M. Brando[5,6,7], James T. Randerson[5]

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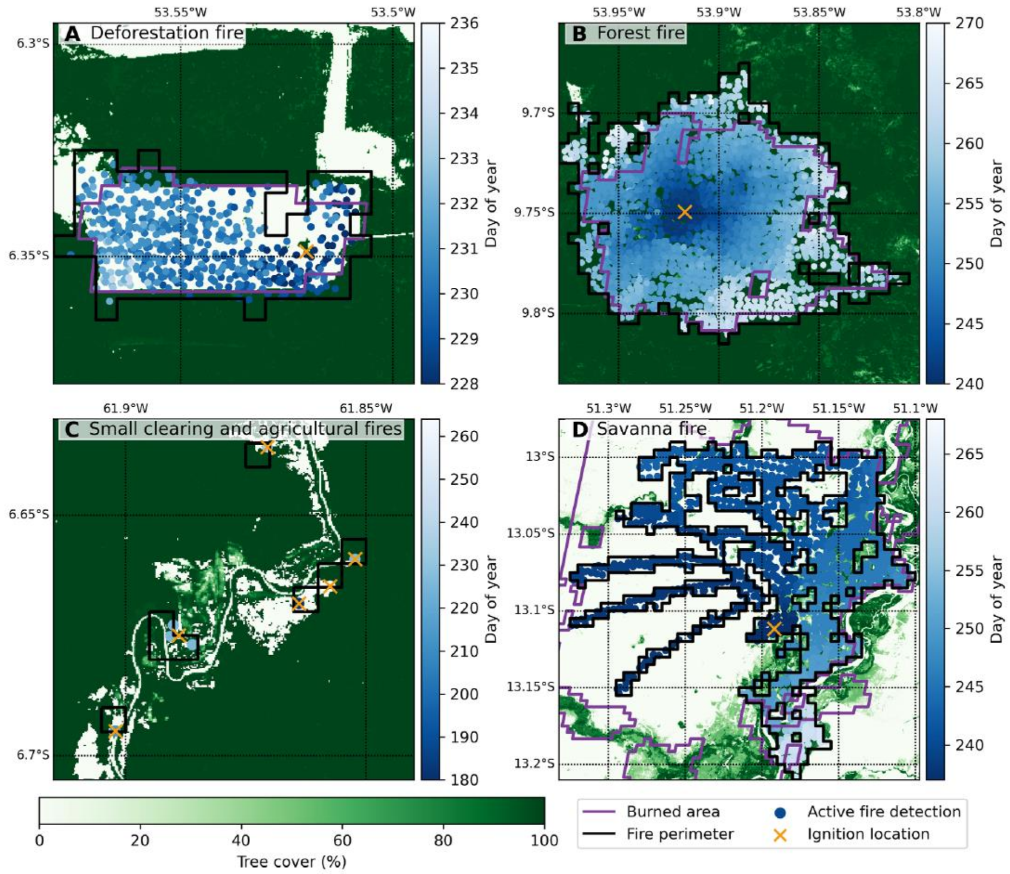
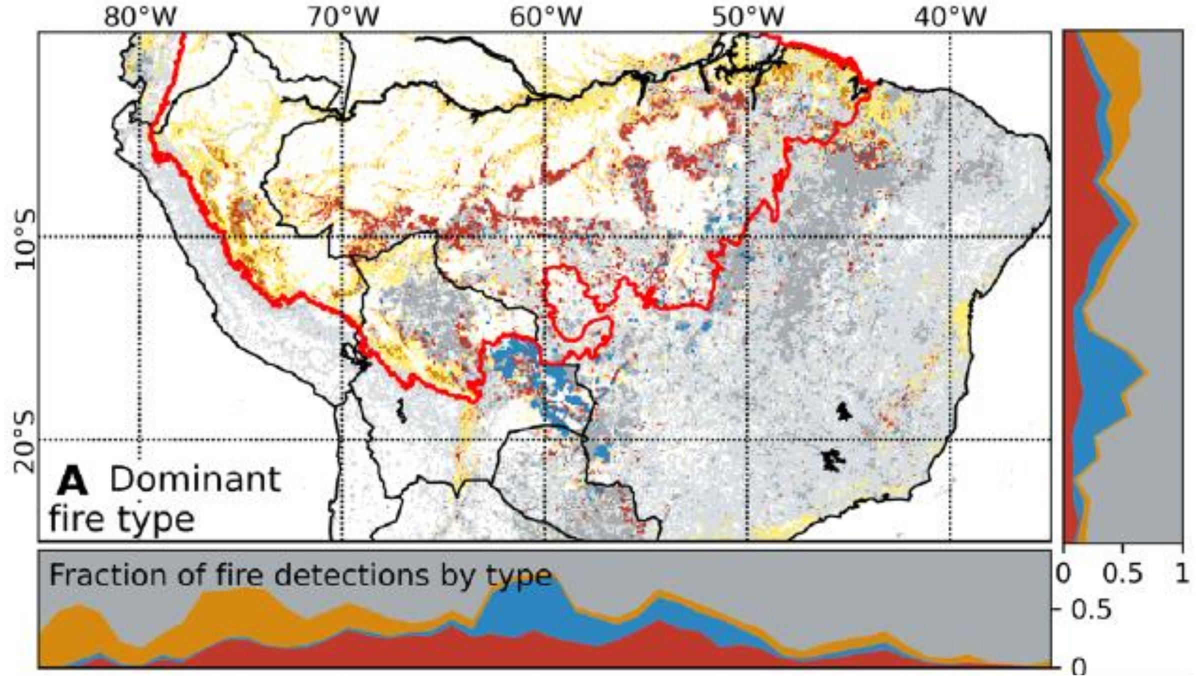
Fire types in the Amazon

Mapping of fire types and behaviour from VIIRS Fire Radiative Power (2019)





Deforestation
Forest

Small clearing/agriculture
Savannah

Quantifying fire emissions

Main approaches to quantify fire emissions

1. Burned area (BA) based approach

Emissions = burned area *x* fuel load *x* combustion completeness *x* emission factor

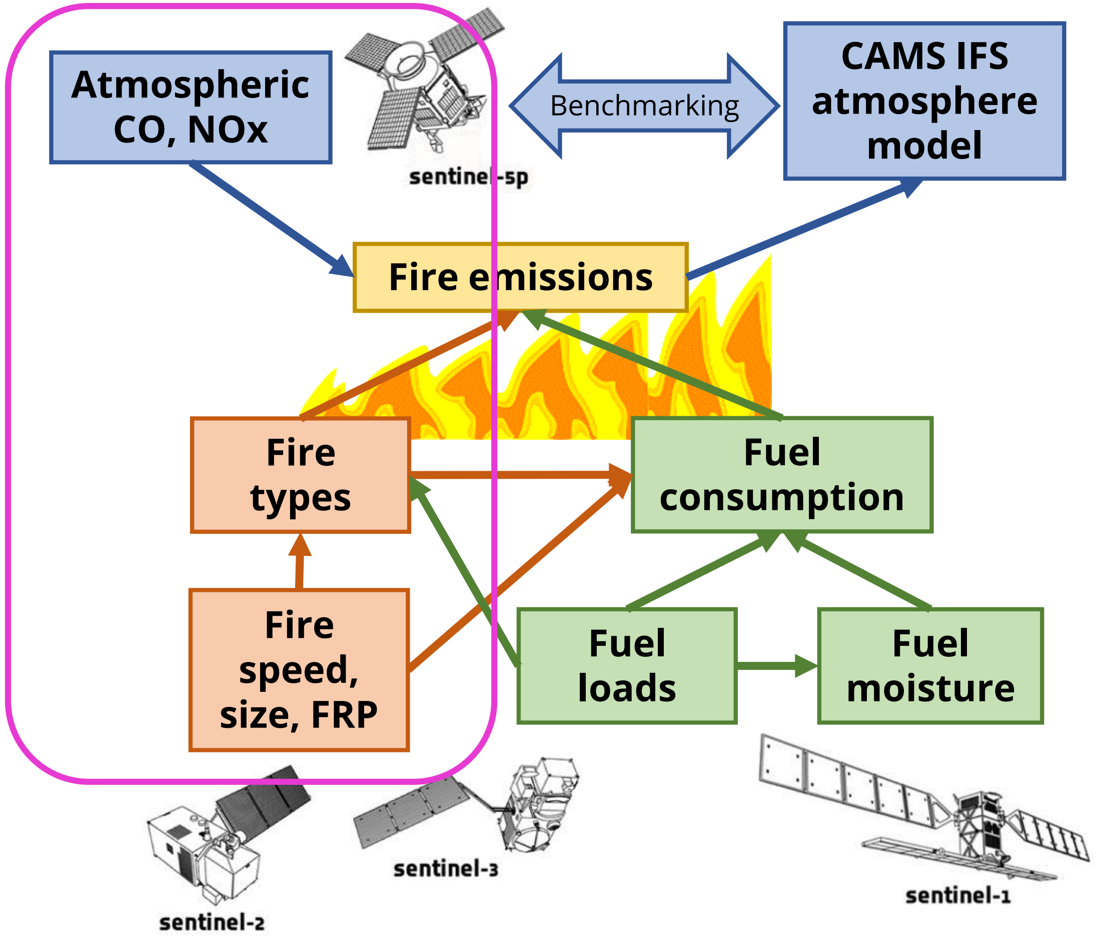
2. Fire radiative power (FRP) based approach

Emissions = fire radiative power *x* conversion factor

Emission or conversion factors are usually *average values per biome*.

→ Effects of fire types, fuel moisture, fuel types/chemistry, combustion efficiency on fire emissions?

Sense4Fire approach



Fire emissions from fire types

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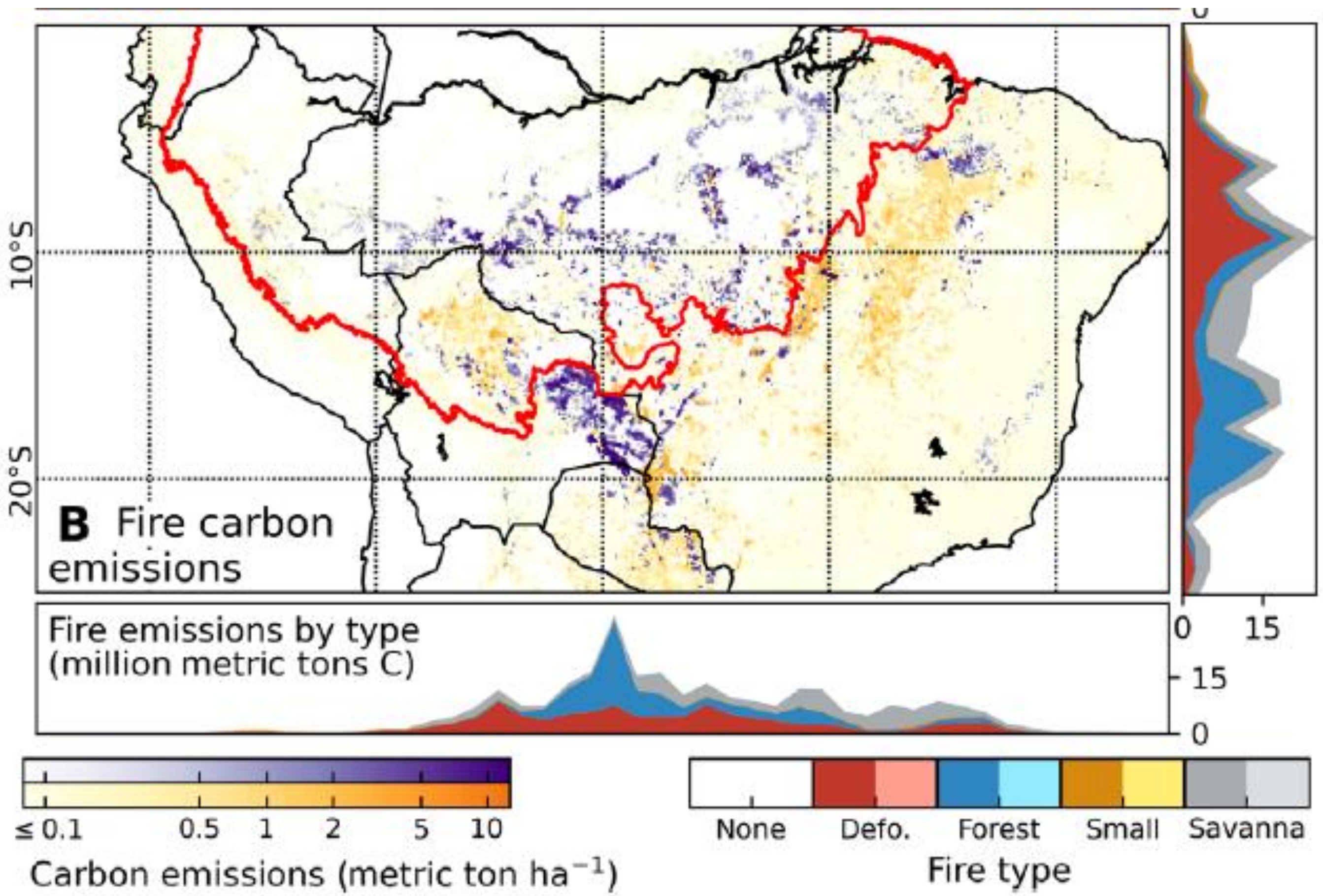
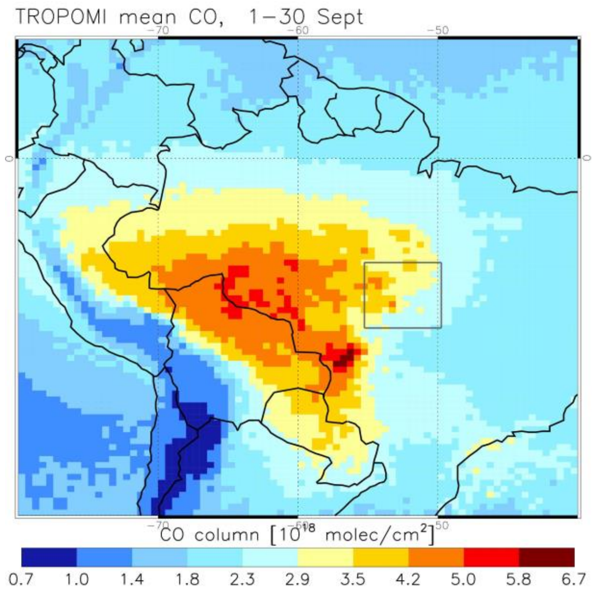
Fire emissions (2019)



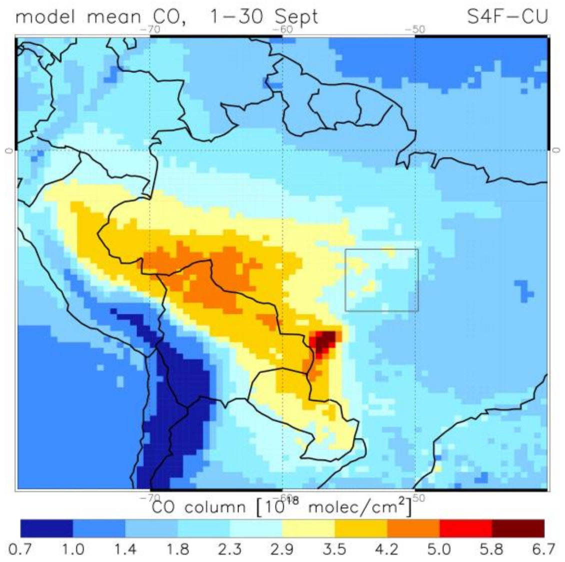
Evaluation against TROPOMI (year 2020)

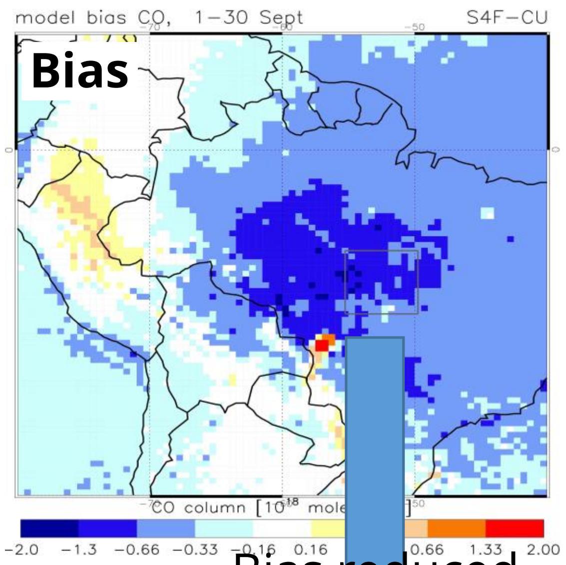
Sense[4] Fire



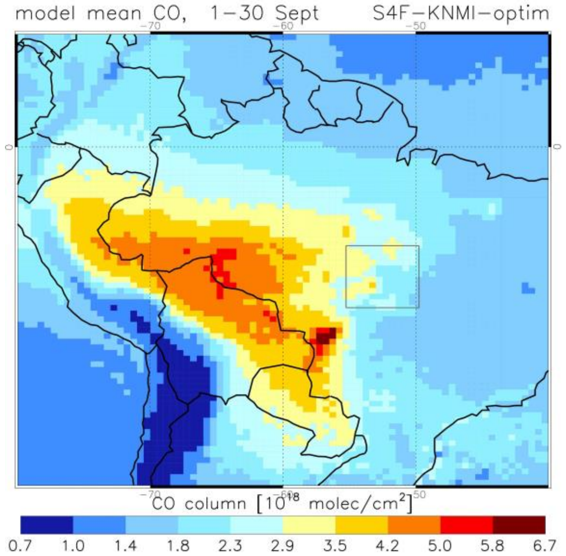
CO columns from Sentinel-5p TROPOMI

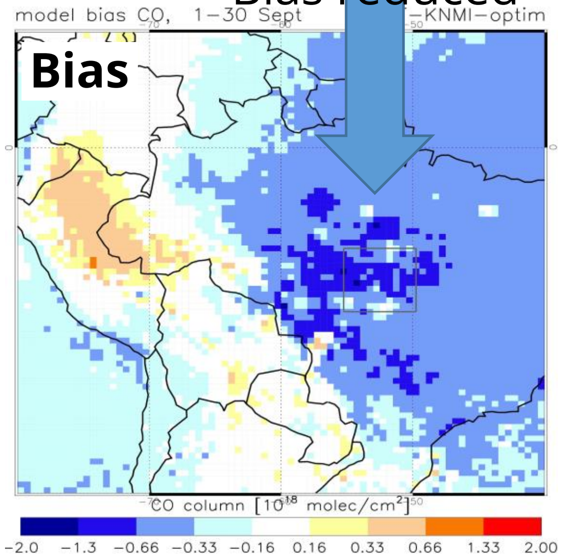
CO columns from fire type-based emissions





CO columns from optimized emissions



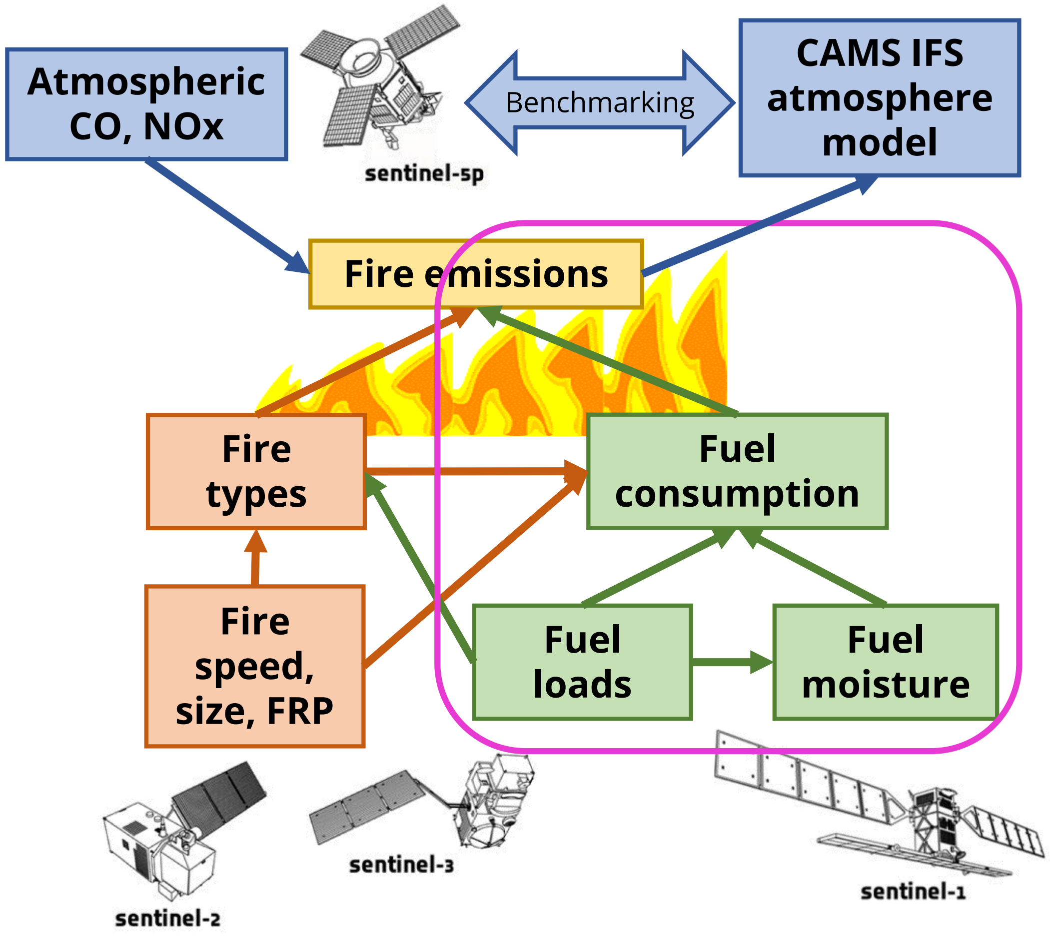


Estimating optimized emissions *E* from TROPOMI column observations *X* (CO or NO_x):

$$E_{opt} = E_{prior} \times \beta \times \frac{X_{sat} - X_{IFS}}{X_{IFS}}$$

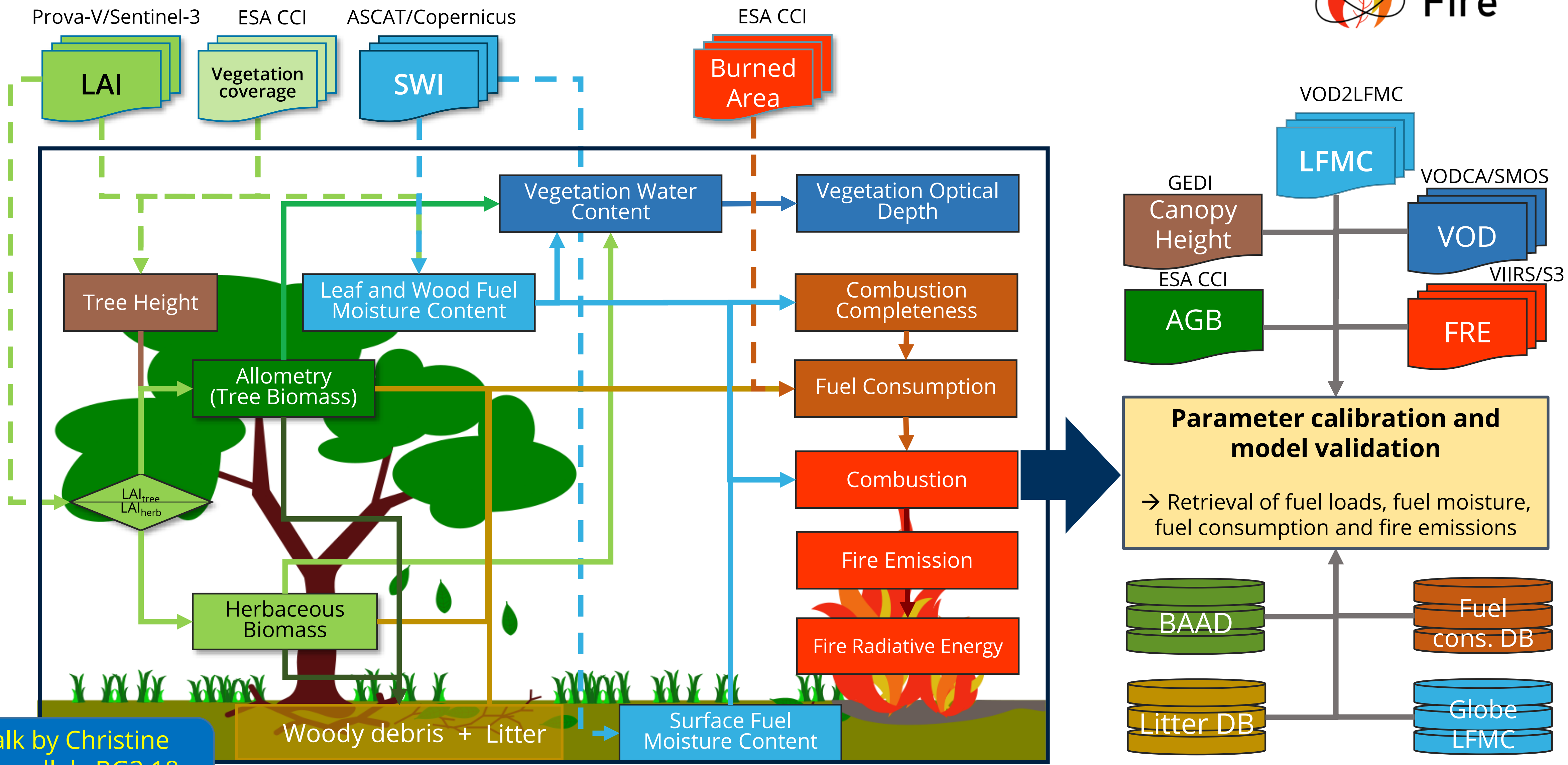
(following Lamsal et al. 2011 and Castellanos et al. 2014)

Sense4Fire approach



S4F Fuel and Fire Emissions Data-Model Fusion

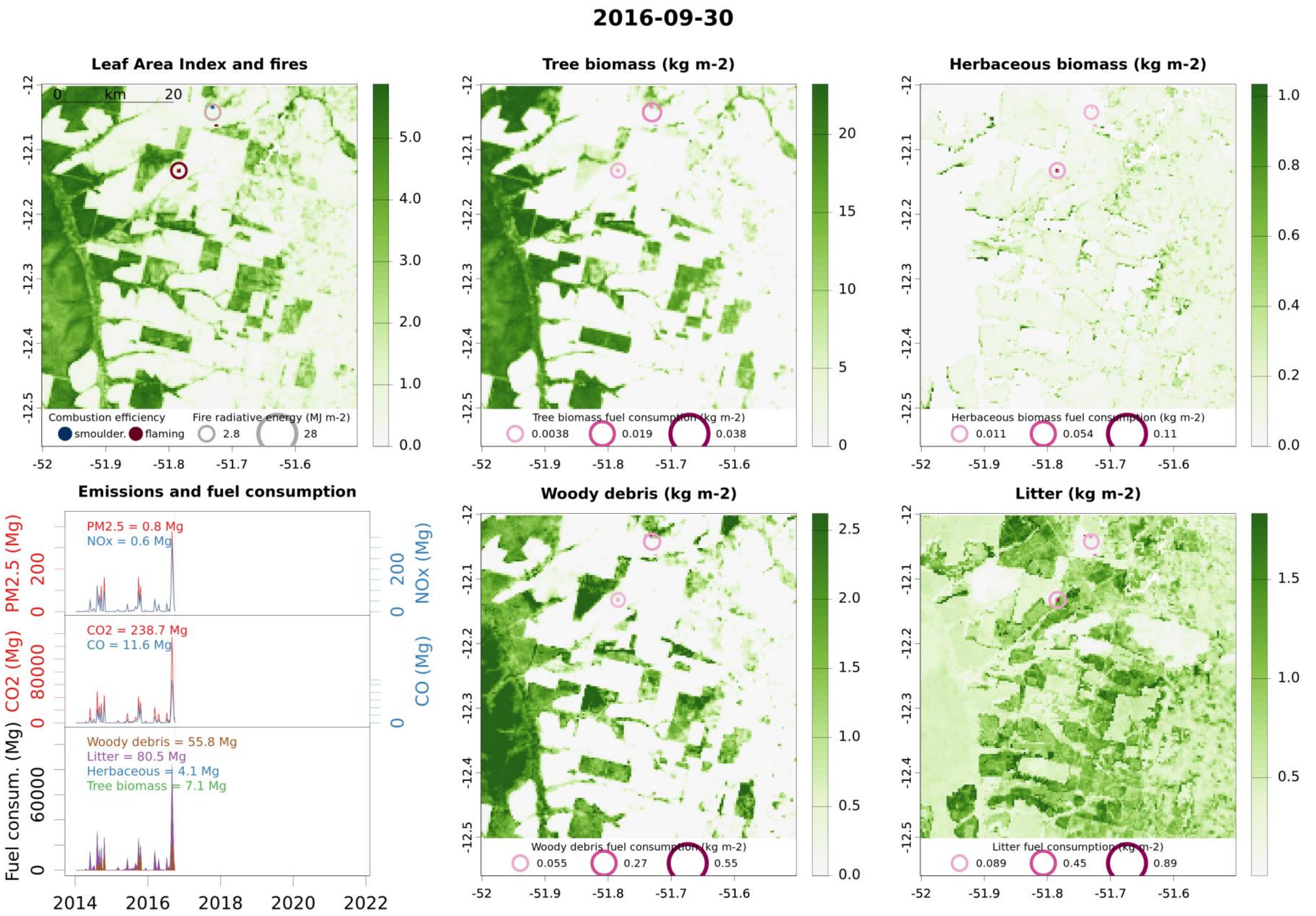
Sense[4] Fire



talk by Christine Wessollek, BG3.18, Thu, 17:05, N2

S4F Fuel and Fire Emissions Data-Model Fusion

Sense[4] Fire



Full video online:

esa

S4F Fuel and Fire Emissions Data-Model Fusion

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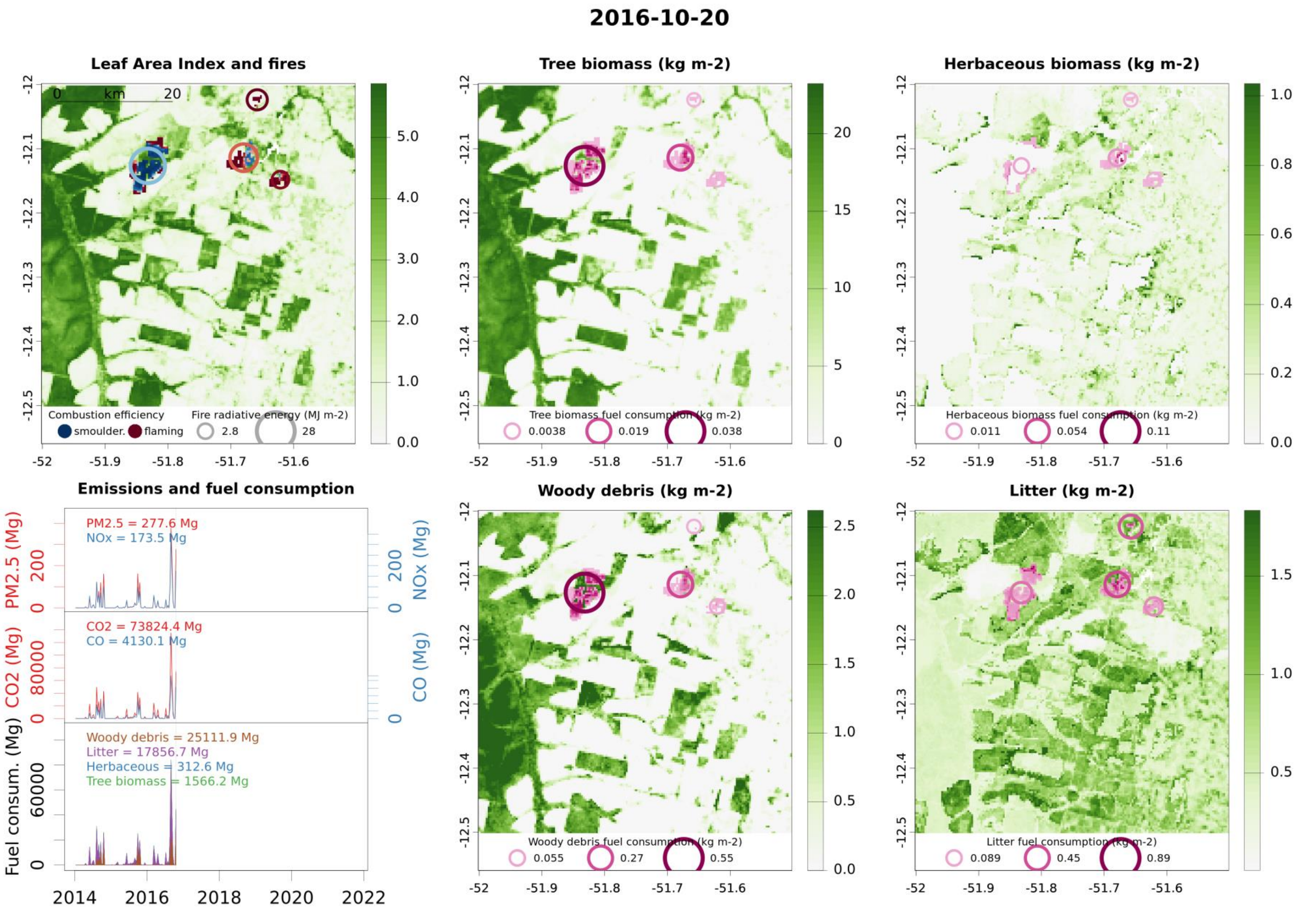

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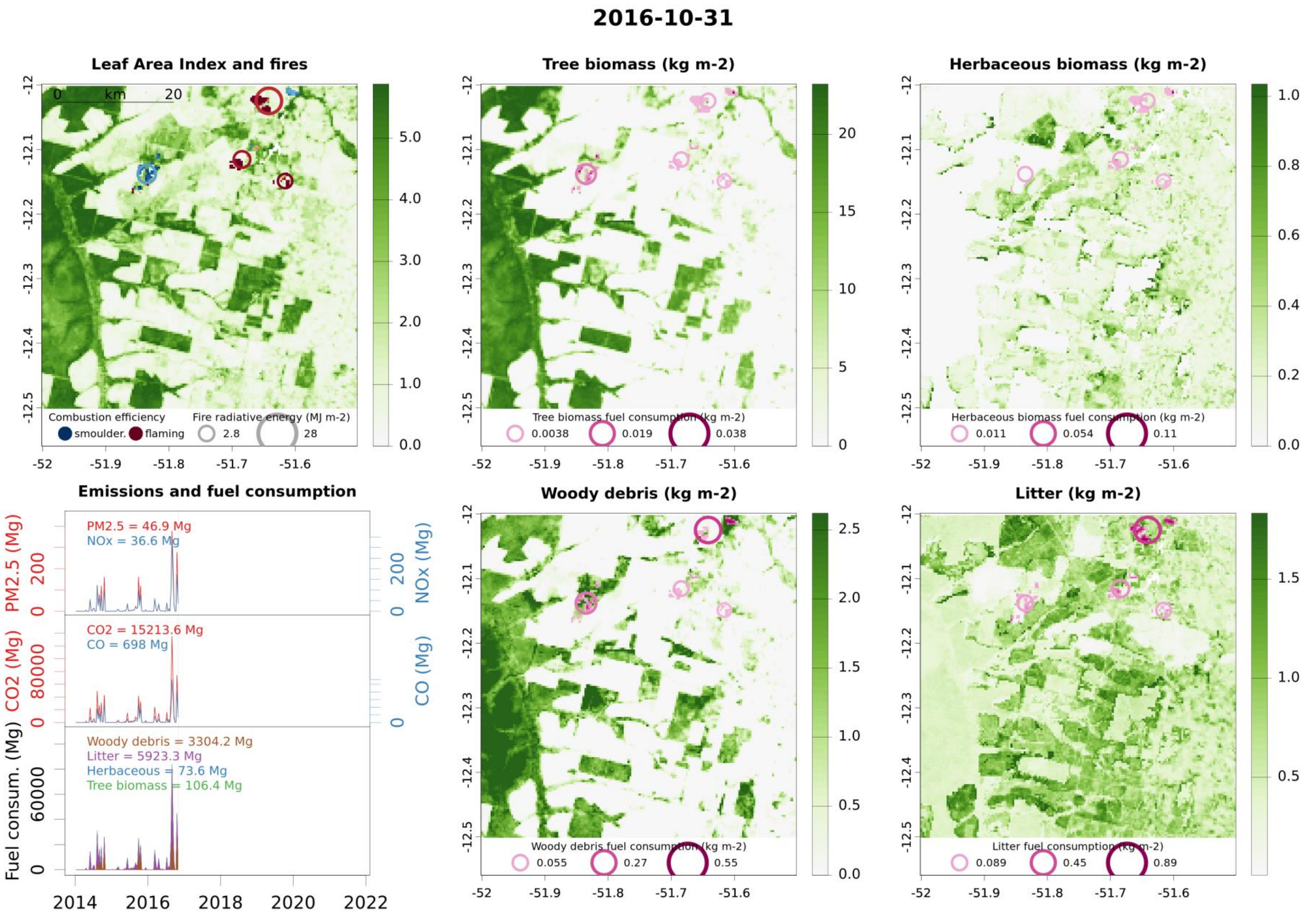


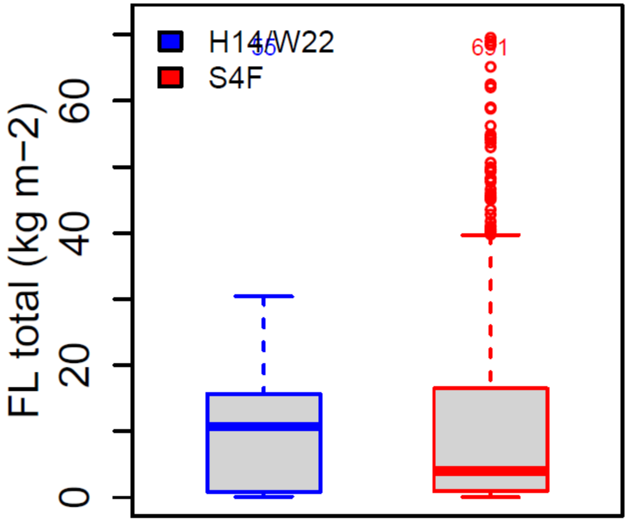
Full video online:

Validation against databases

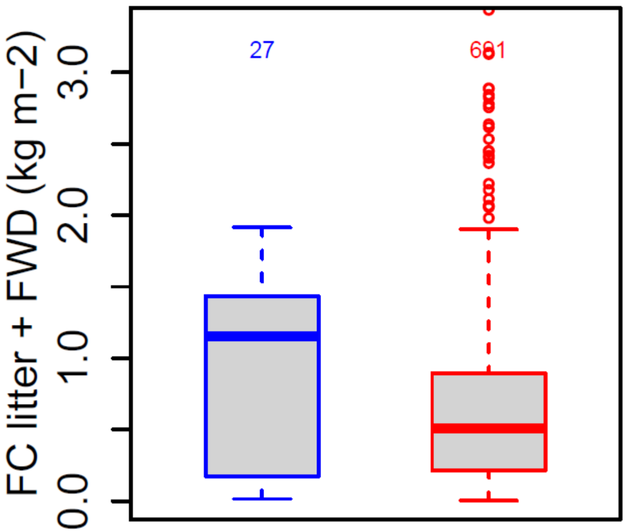
Sense4 Fire

Validation of fuel loads, fuel consumption, combustion completness and emission factors against databases

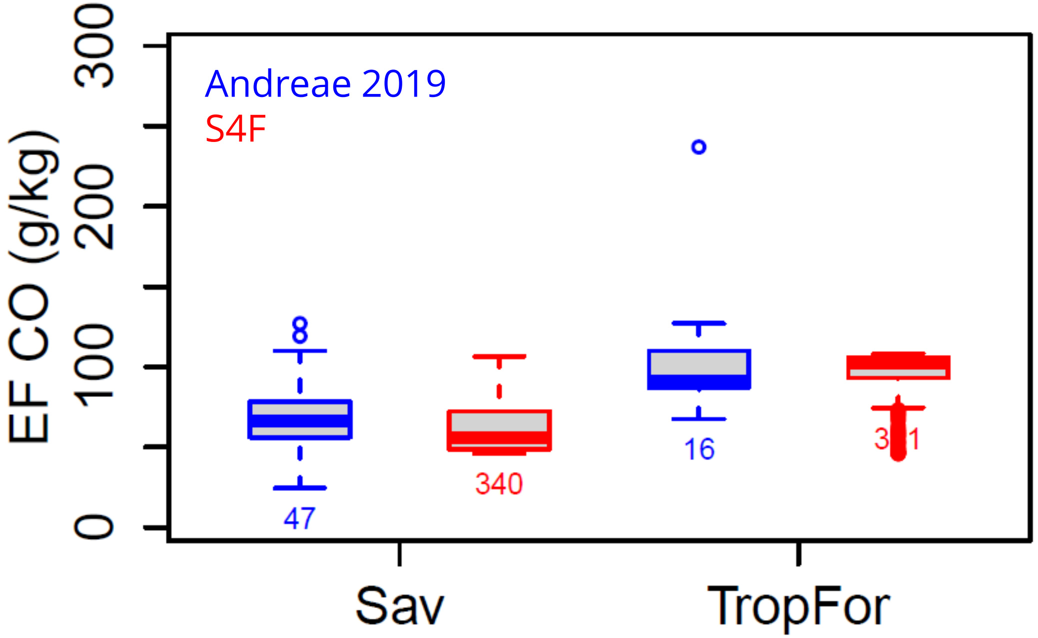
Fuel loads
(Holland et al. 2014, van Wees et al. 2022)



Fuel consumption
(van Wees et al. 2022)



Emission factors and combustion efficiency
(Andreae 2019)



Conclusions

- Three new emission estimates based on complementary approaches
- Outperform GFAS in comparison to Sentinel-5p (evaluated for CO and NOx)
- Allows investigating fire dynamics and composition of fire emissions for individual fires
- Tropical deforestation fires:
  - Higher burning of wood and woody debris
  - Lower combustion efficiency (smouldering)
  - Higher emissions of CO than in savannah fires
- Algorithm descriptions, validation report and experimental database available in May 2023 at **sense4fire.eu**