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

Integrating the Sentinels for novel fuel, fire and fire emission products

https://sense4fire.eu/

Living Planet Symposium, Bonn, 25th May 2022

(1) Technische Universität Dresden

(2) Cardiff University – Earth and Ocean Sciences

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

Estimating fire emissions

Sense⁴ Fire

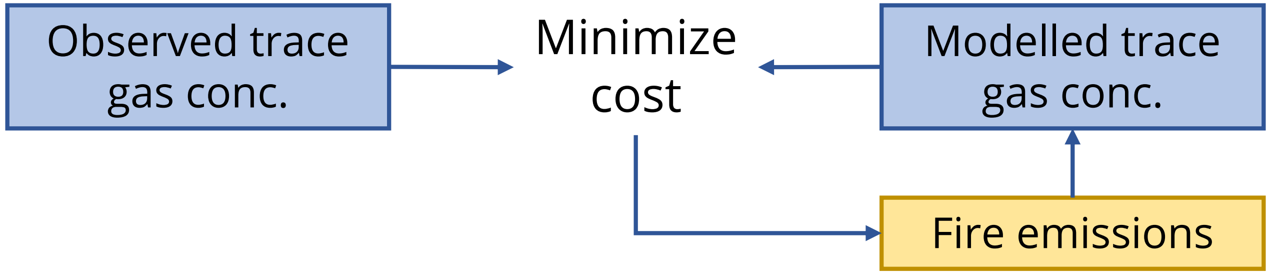
Burned area-based approach (e.g. Seiler and Crutzen 1980, van der Werf et al. 2006)

Fire emissions = Burned area x Fuel consumption x Emission factors

Fire radiative energy (FRE)-based approach (e.g. Kaiser et al. 2012)

Fire emissions = Fire radiative energy x Conversion factor

Top-down/inverse approach (e.g. Hooghiemstra et al. 2011)



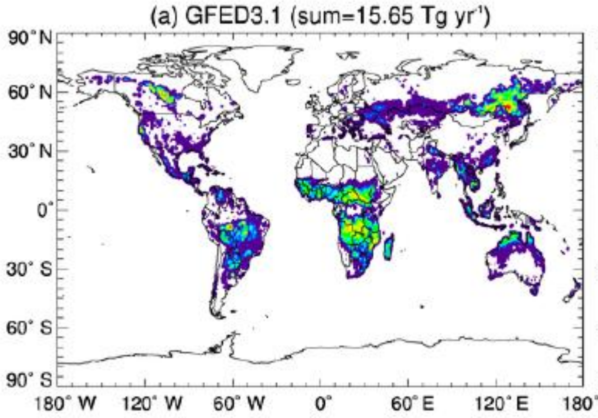
Global fire emissions

Atmos. Chem. Phys., 20, 969–994, 2020
https://doi.org/10.5194/acp-20-969-2020

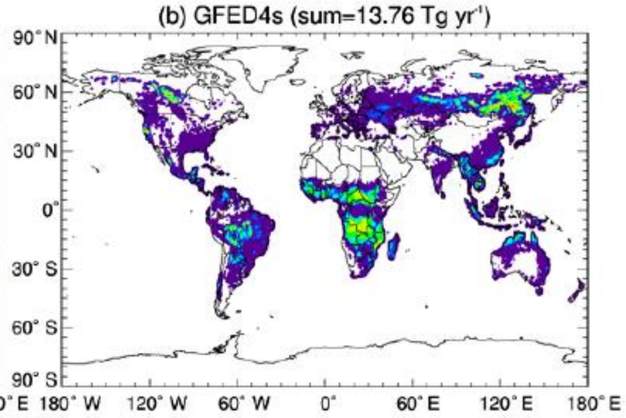
Atmospheric Chemistry and Physics
Open Access

Six global biomass burning emission datasets: intercomparison and application in one global aerosol model

Xiaohua Pan[1,2], Charles Ichoku[3], Mian Chin[2], Huisheng Bian[4,2], Anton Darmenov[2], Peter Colarco[2], Luke Ellison[5,2], Tom Kucsera[6,2], Arlindo da Silva[2], Jun Wang[7], Tomohiro Oda[6,2], and Ge Cui[7]

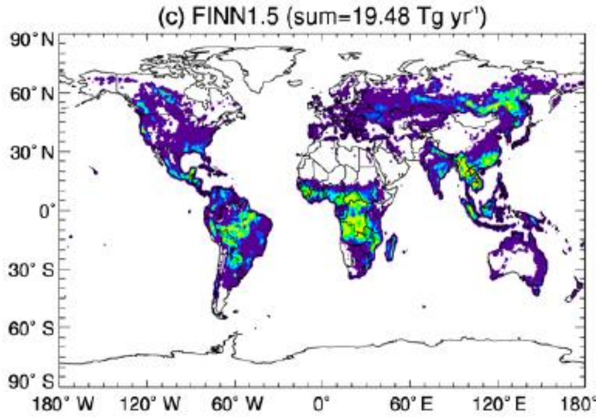


GFED3.1: MODIS burned area + CASA model

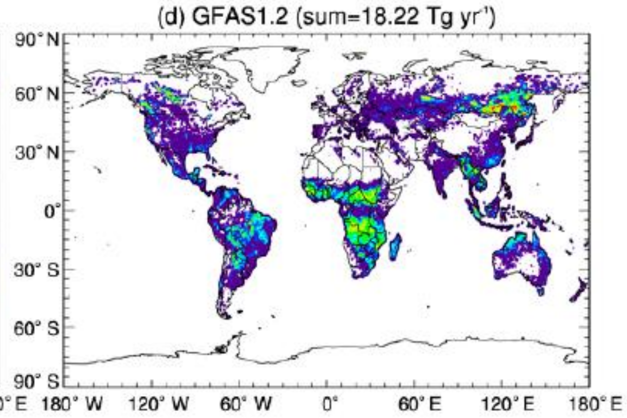


GFED4s: MODIS burned area + small fires + CASA model

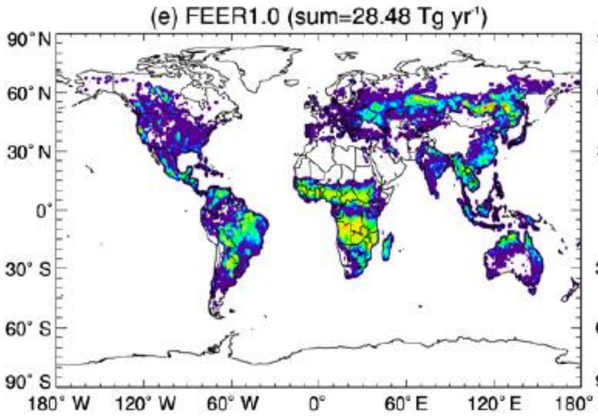
Total organic carbon emissions (2008) (g m^{-2} a^{-1})



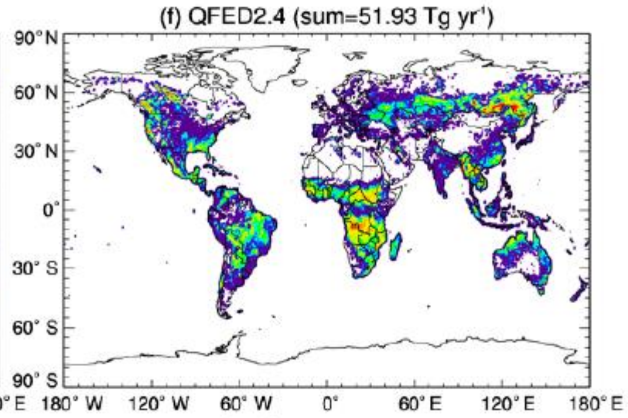
FINN1.5: MODIS active fires + fire emission model



GFAS1.2: MODIS FRP + calibration against GFED3.1



FEER1.0: FRP from GFAS + MODIS AOD

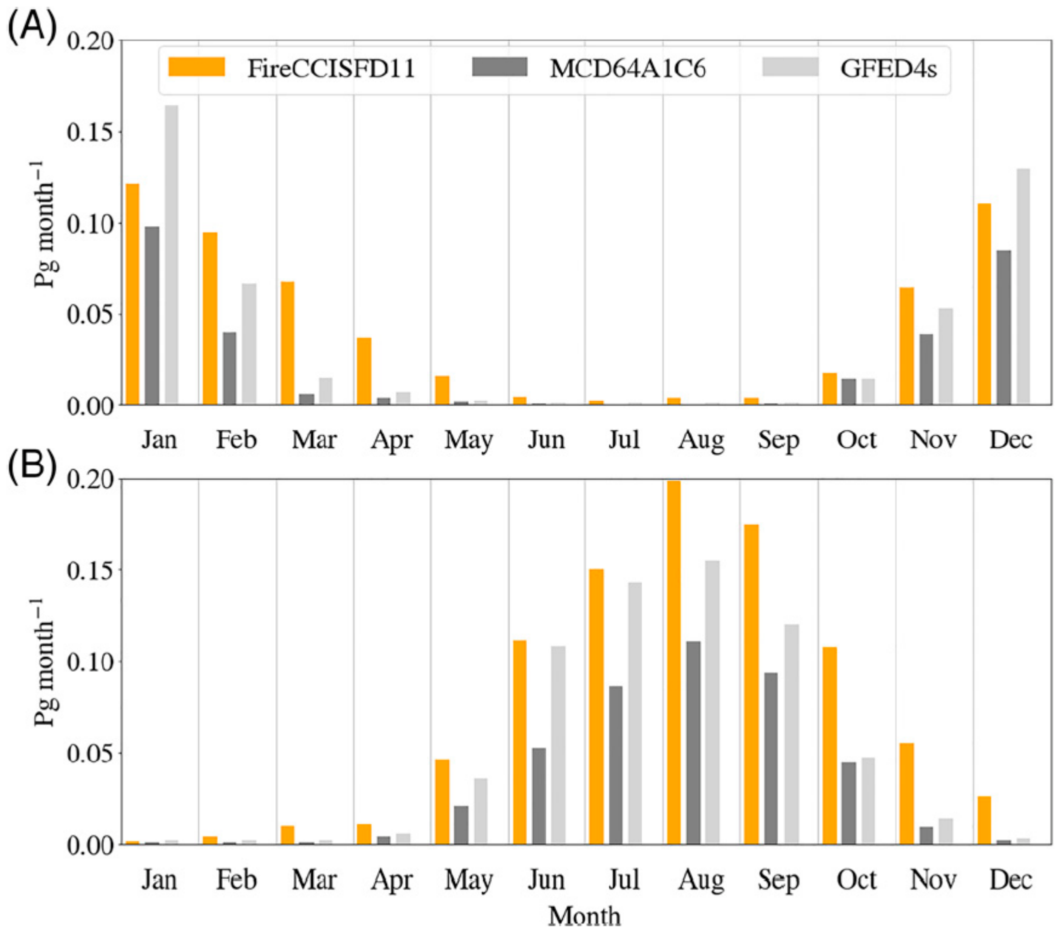


QFED2.4: MODIS+GOES active fires + AOD

Contribution of small fires to fire emissions

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

Ruben 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]



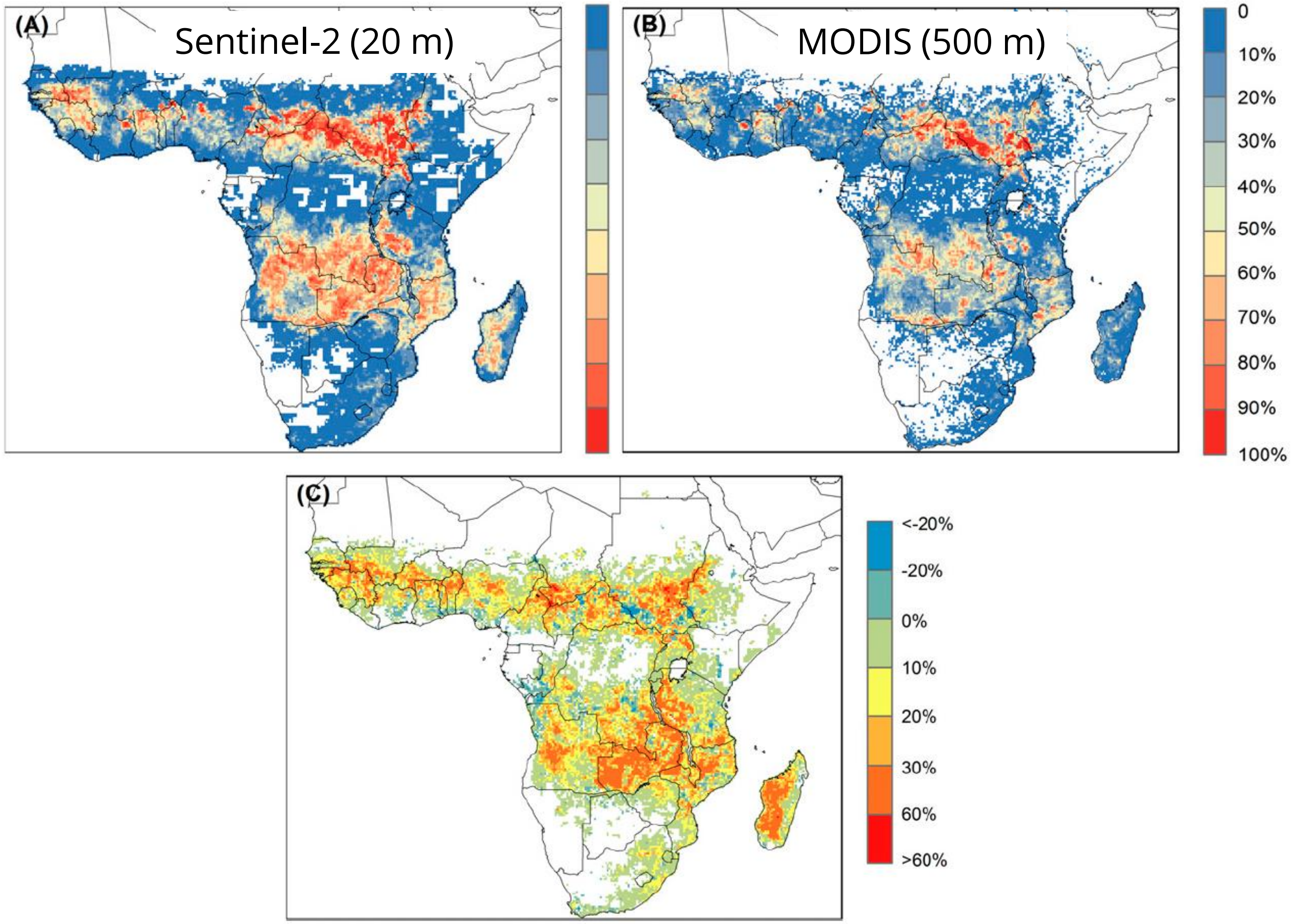
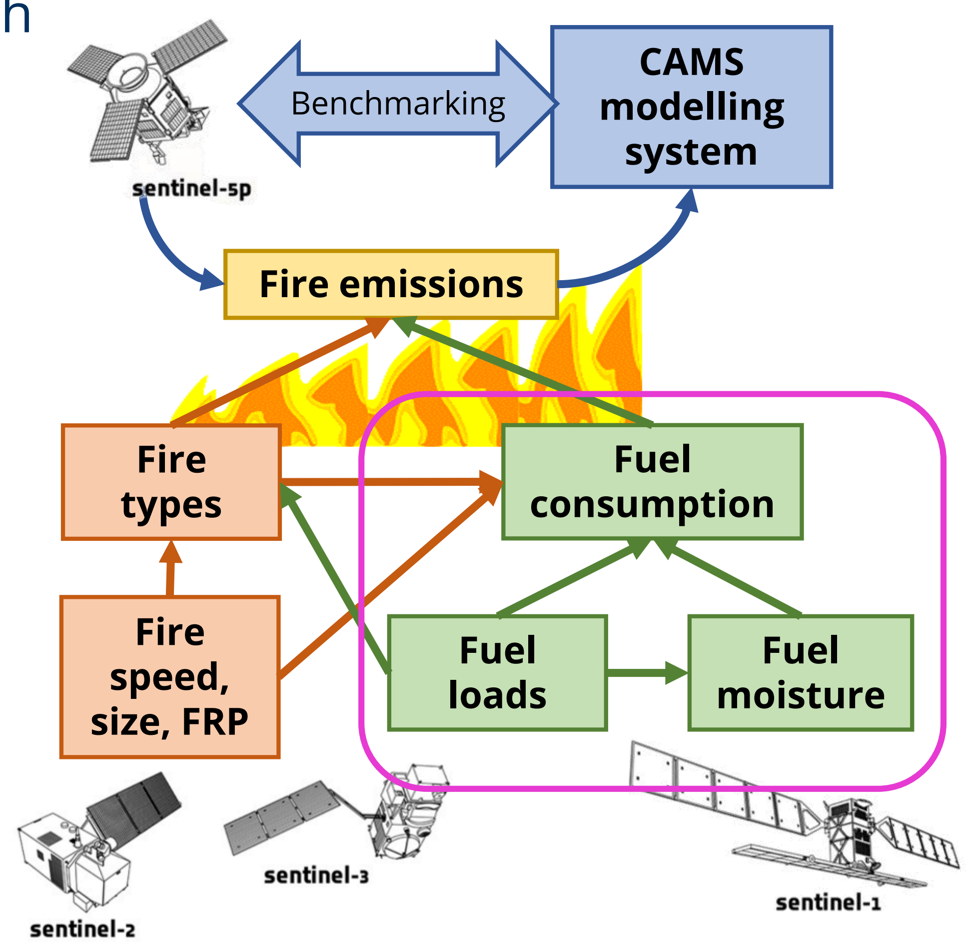


Fig. 1. Area burned in 2016, expressed as the fraction of each 0.25° grid cell according to FireCCISFD11 (*A*), GFED4s (*B*), and the difference of fractions between them (FireCCISFD11-GFED4s) (*C*). The rectangular blank grids in *A* correspond to S2 scenes where no active fires were detected by MODIS sensors in 2016. Therefore, no BA was mapped in those tiles.

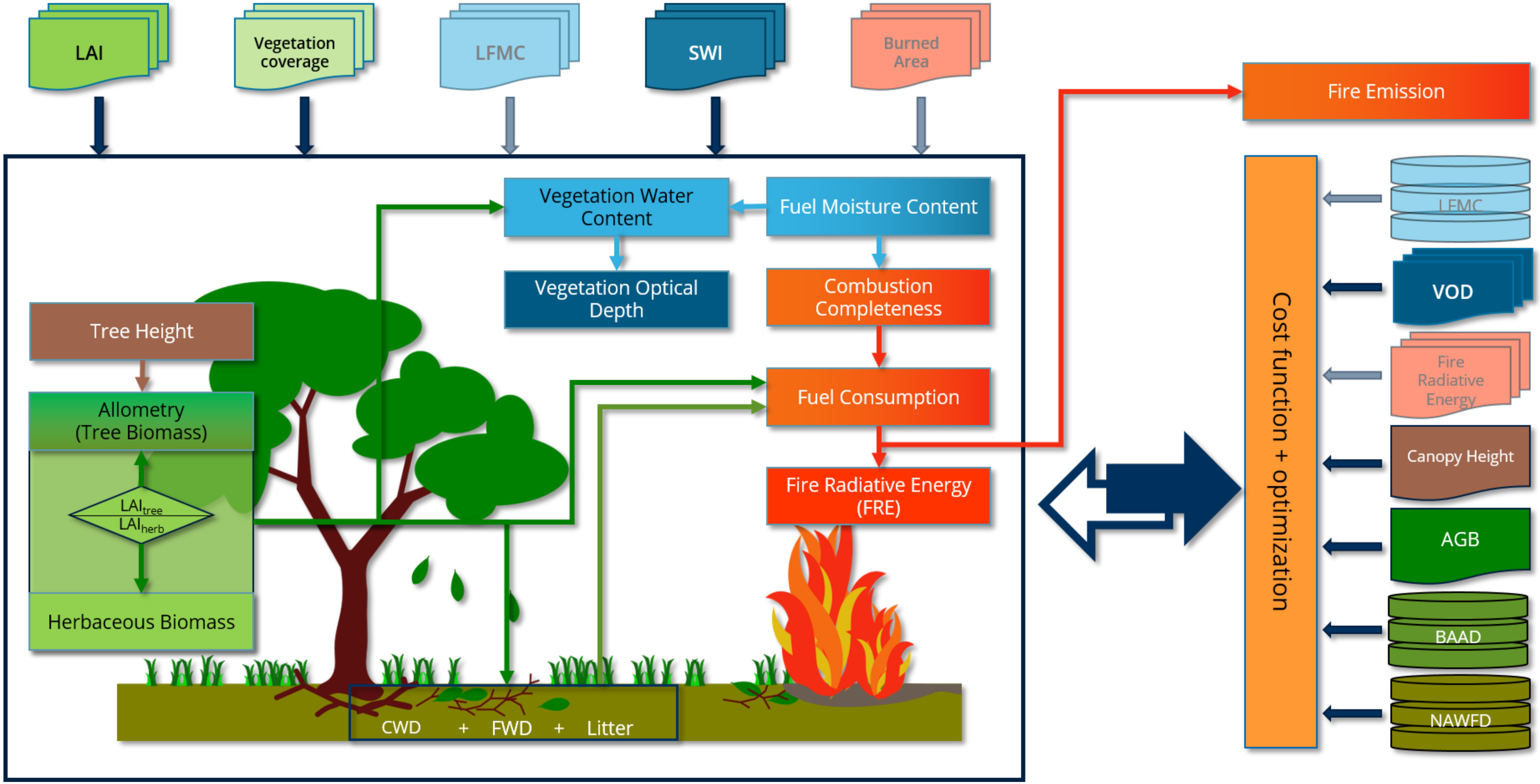
Sentinels for fire emissions

The **Sense4Fire** approach



Fuel model driven by satellite data

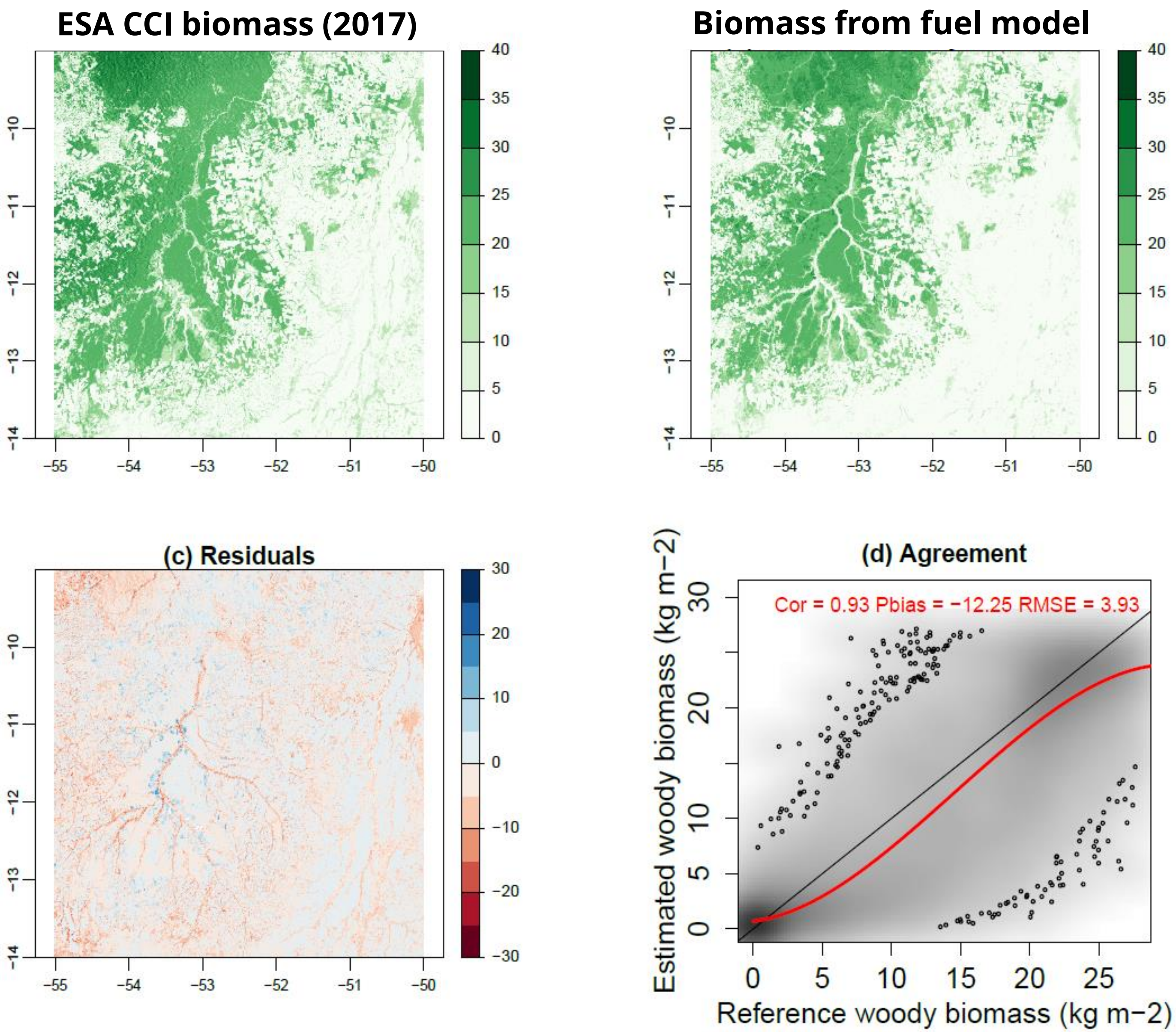
Poster
Christine Wessollek et al.
Wed, 17:20, Poster 356



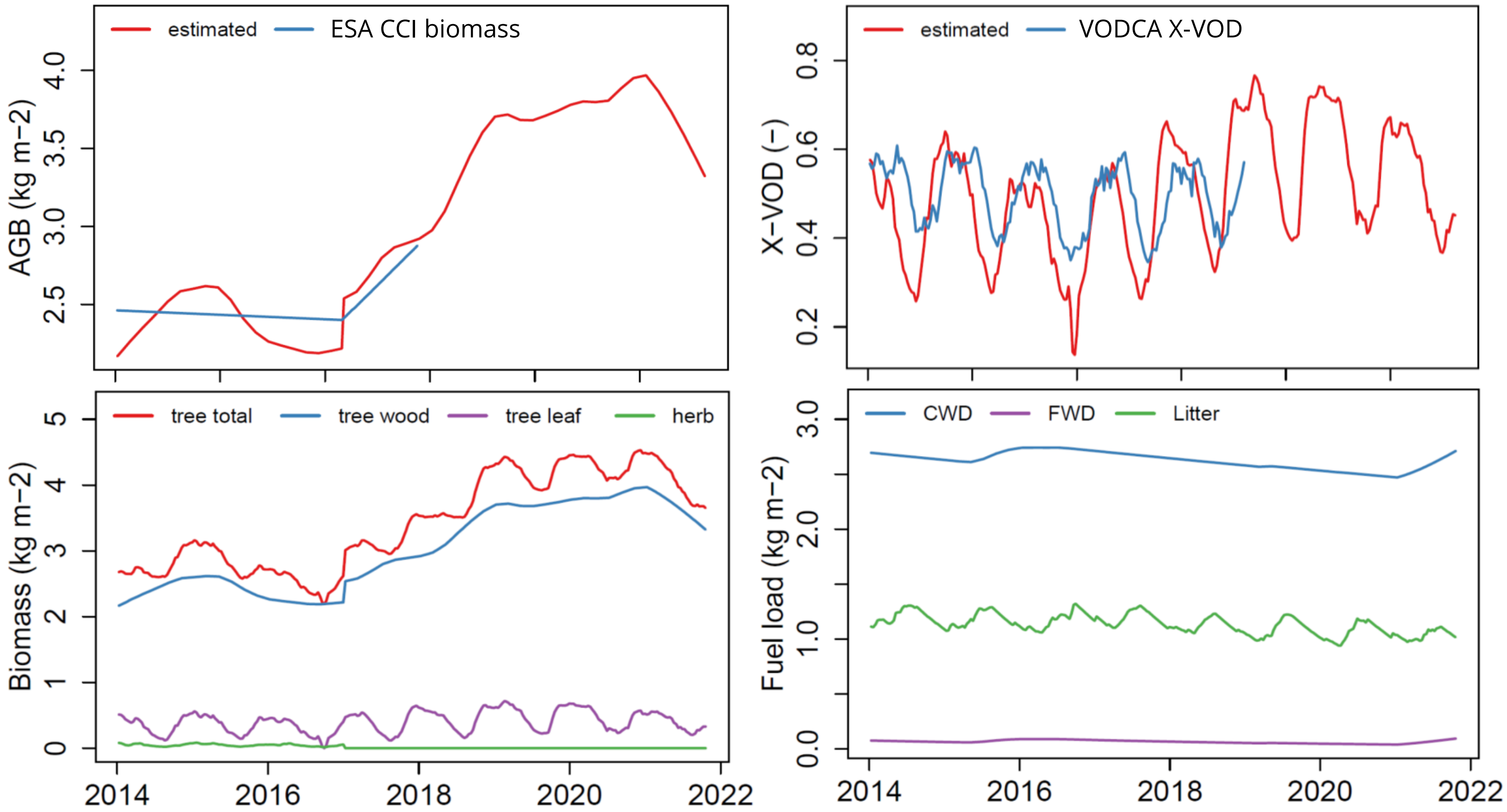
Comparison of biomass

Estimated AGB vs. ESA CCI AGB

Difference between estimated and ESA CCI woody biomass ranges between -8.5 and 3.7 kg m^{-2} in 90% of all grid cells.



Calibrating the fuel model



Model cal/val against:

- GEDI canopy height
- ESA CCI biomass
- VODCA, SMOS/SMAP VOD
- Globe-LFMC DB
- NAWFD
- DB of litter loads and fall masses

Example of the fuel model for a grid cell in the Amazon (51.64286°W, 12.071429°S)

Fuel model driven by satellite data

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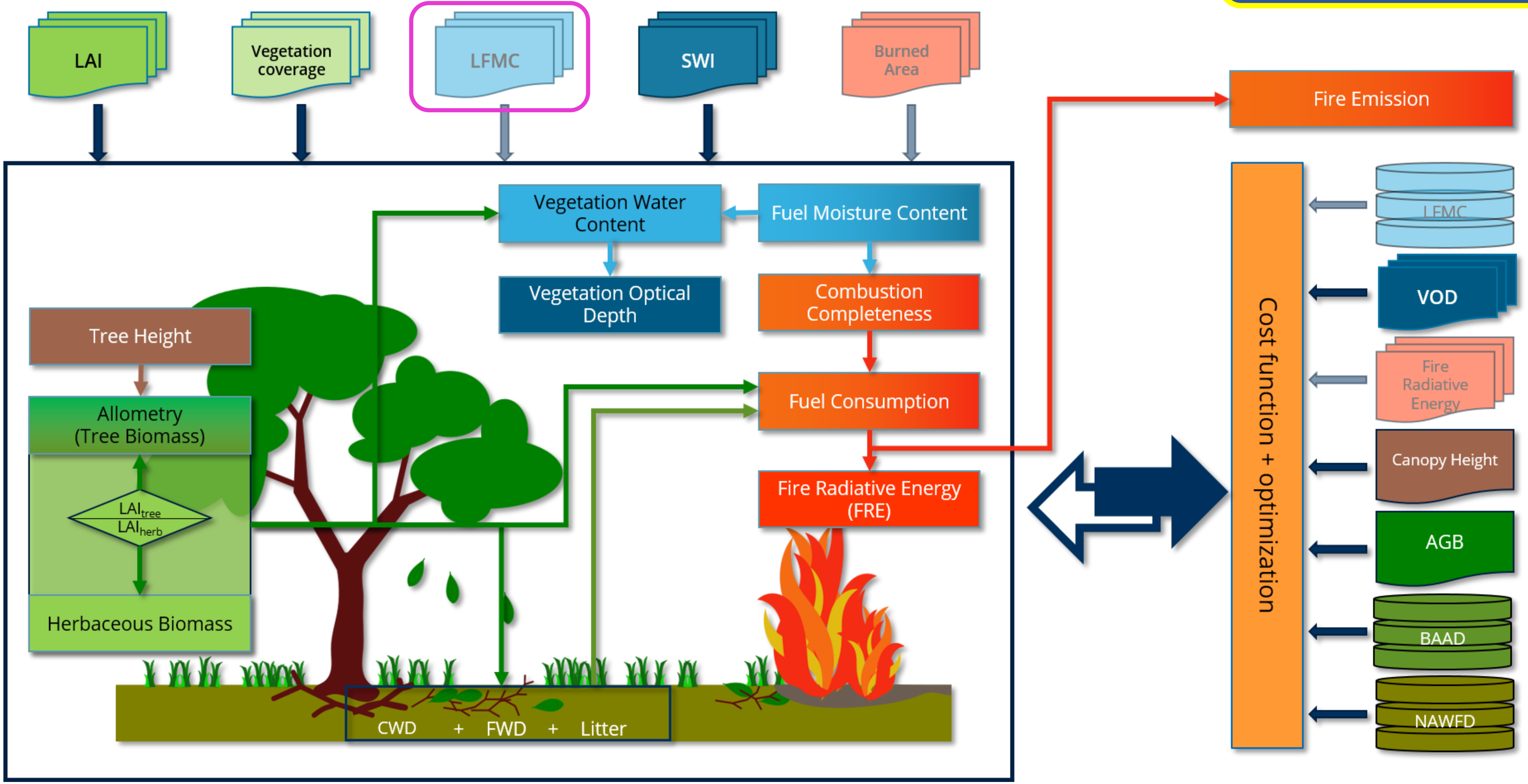
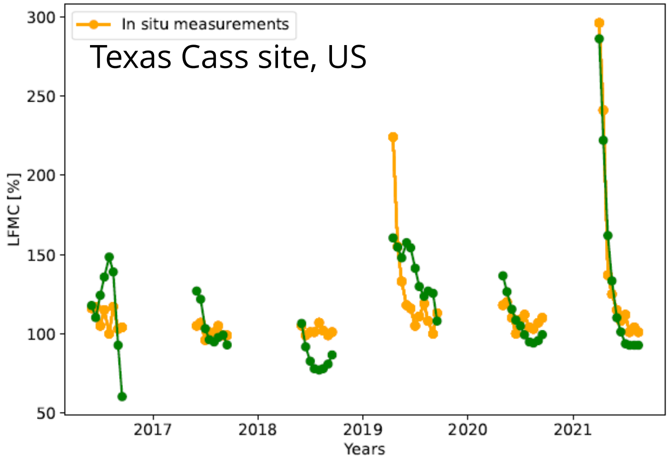
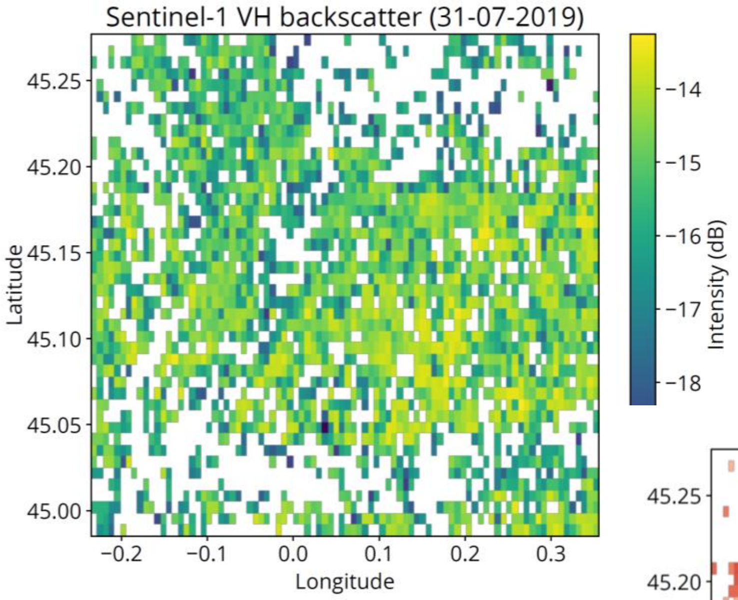
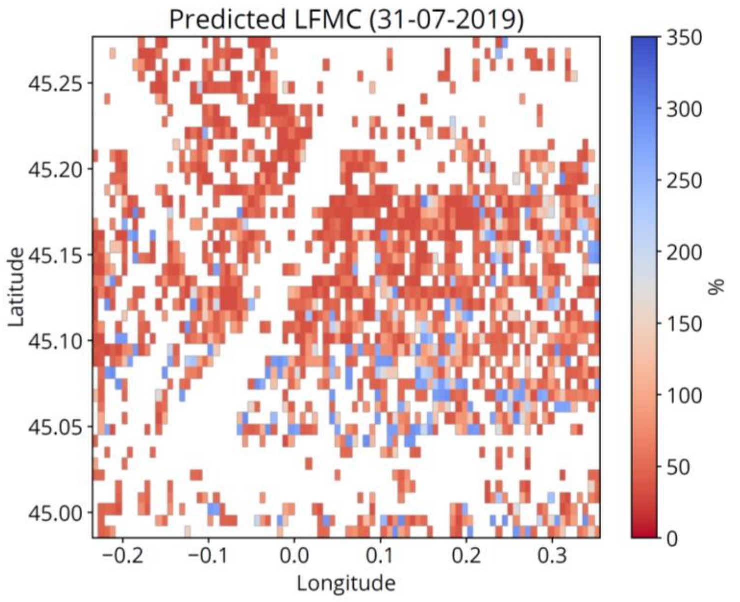


Estimating fuel moisture: a) Sentinel-1

- Extending the Water Cloud Model to simulate Sentinel-1 backscatter from live-fuel moisture (LFMC), LAI and soil moisture
- Retrieval of LFMC from Sentinel-1 and LAI observations







(Johanna Kranz et al., in prep.)

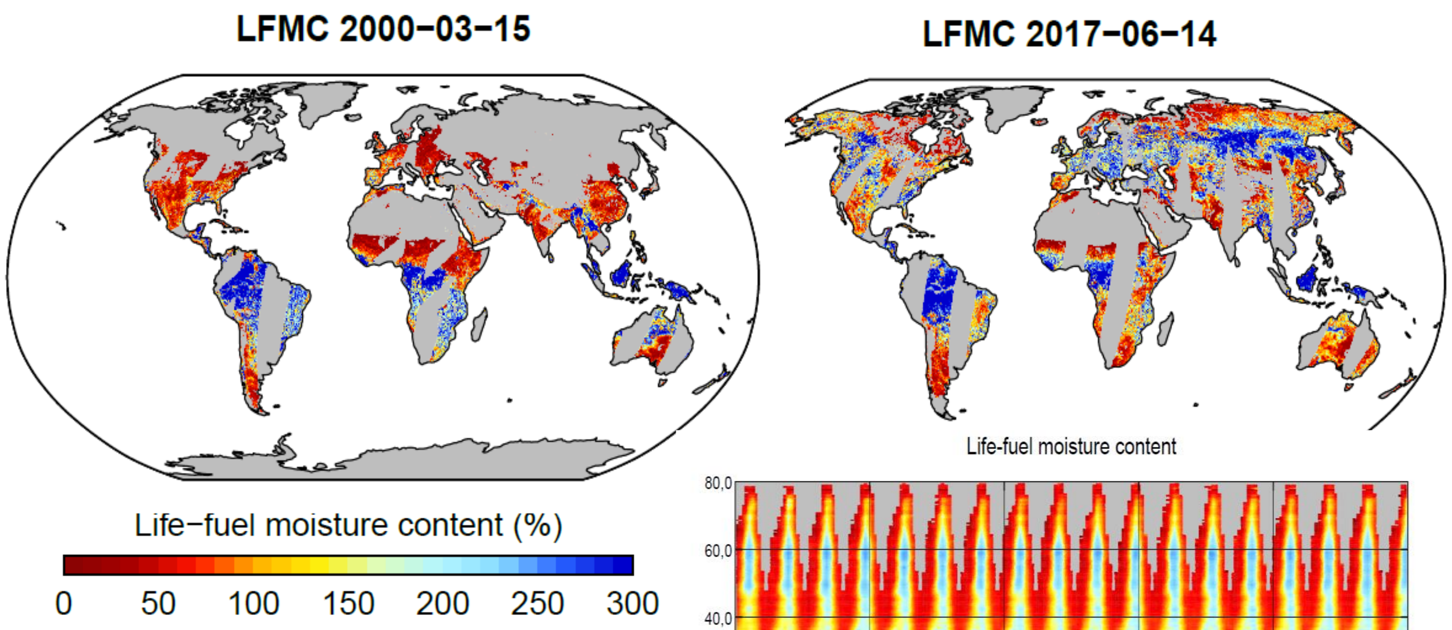
Estimating fuel moisture: b) VOD

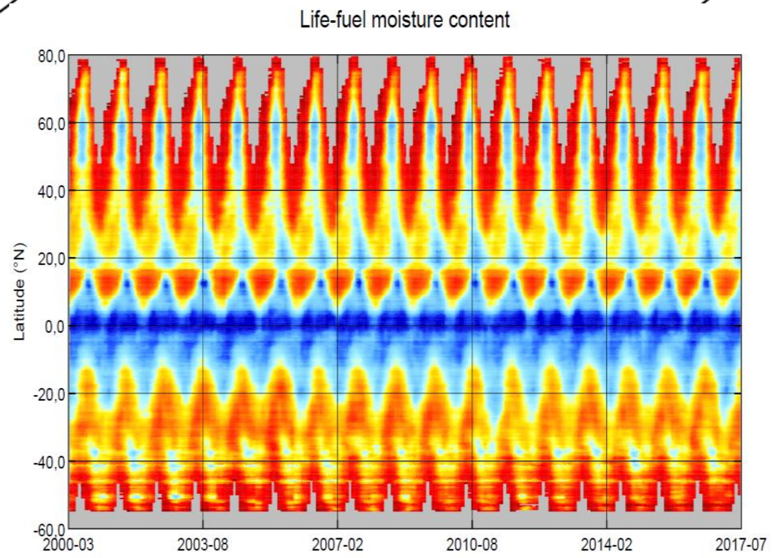
Presentation
Luisa Schmidt et al.
Friday, 11:10, Garden room

- Estimating LFMC from Ku-band Vegetation Optical Depth (VOD)
- Calibration against Globe-LFMC database
- Daily, global 2000-2017

(Forkel et al. 2022, HESSD)

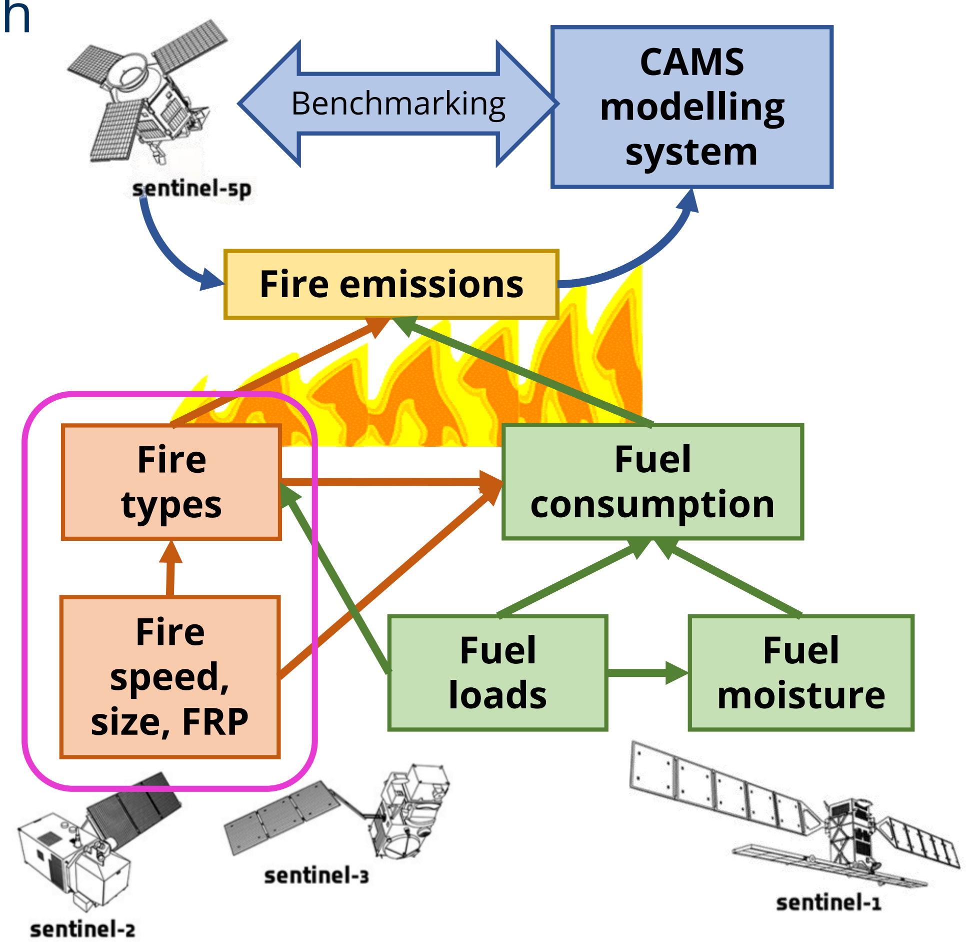
Data at zenodo:





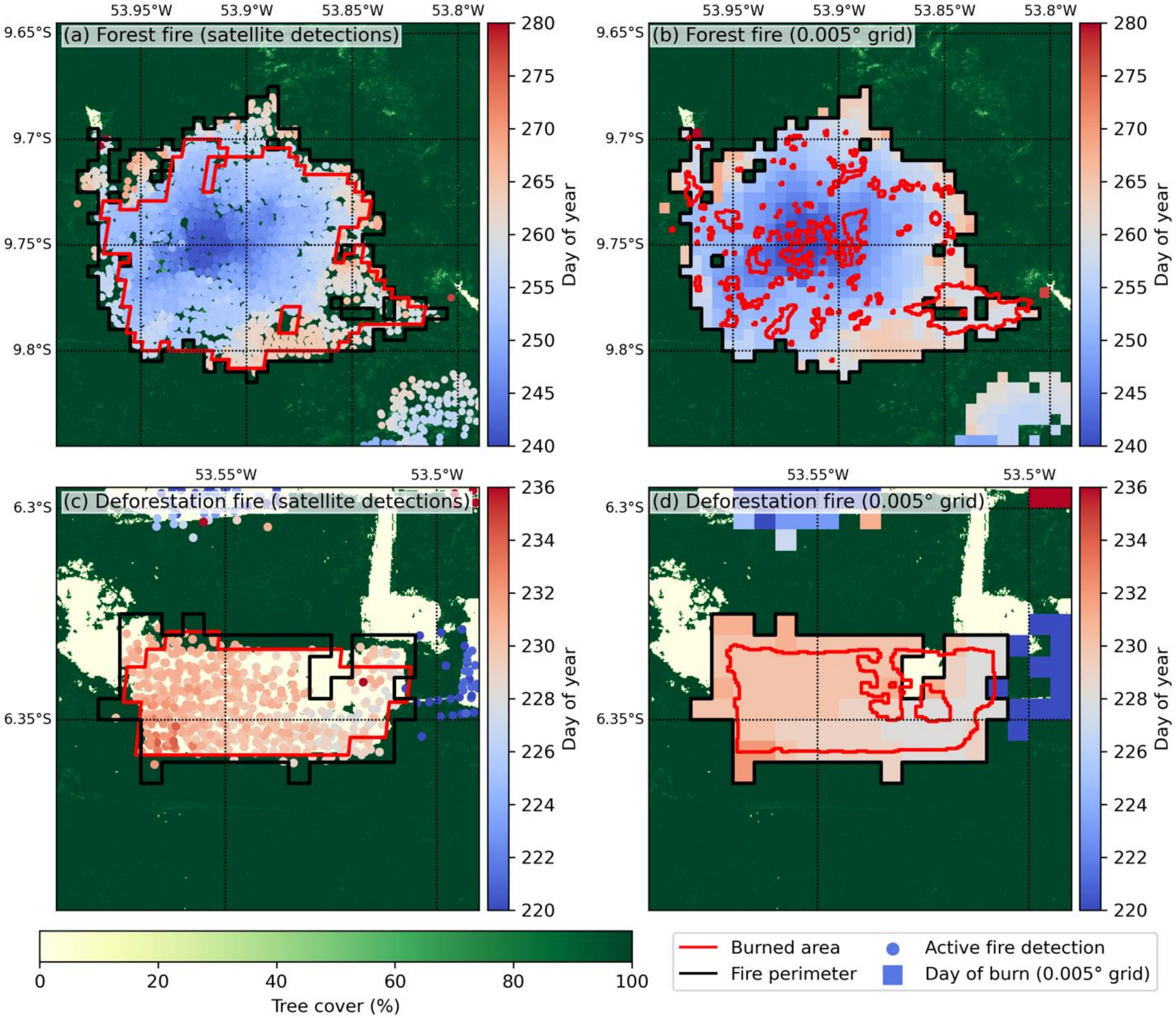
Sentinels for fire emissions

The **Sense4Fire** approach



Fire behaviour

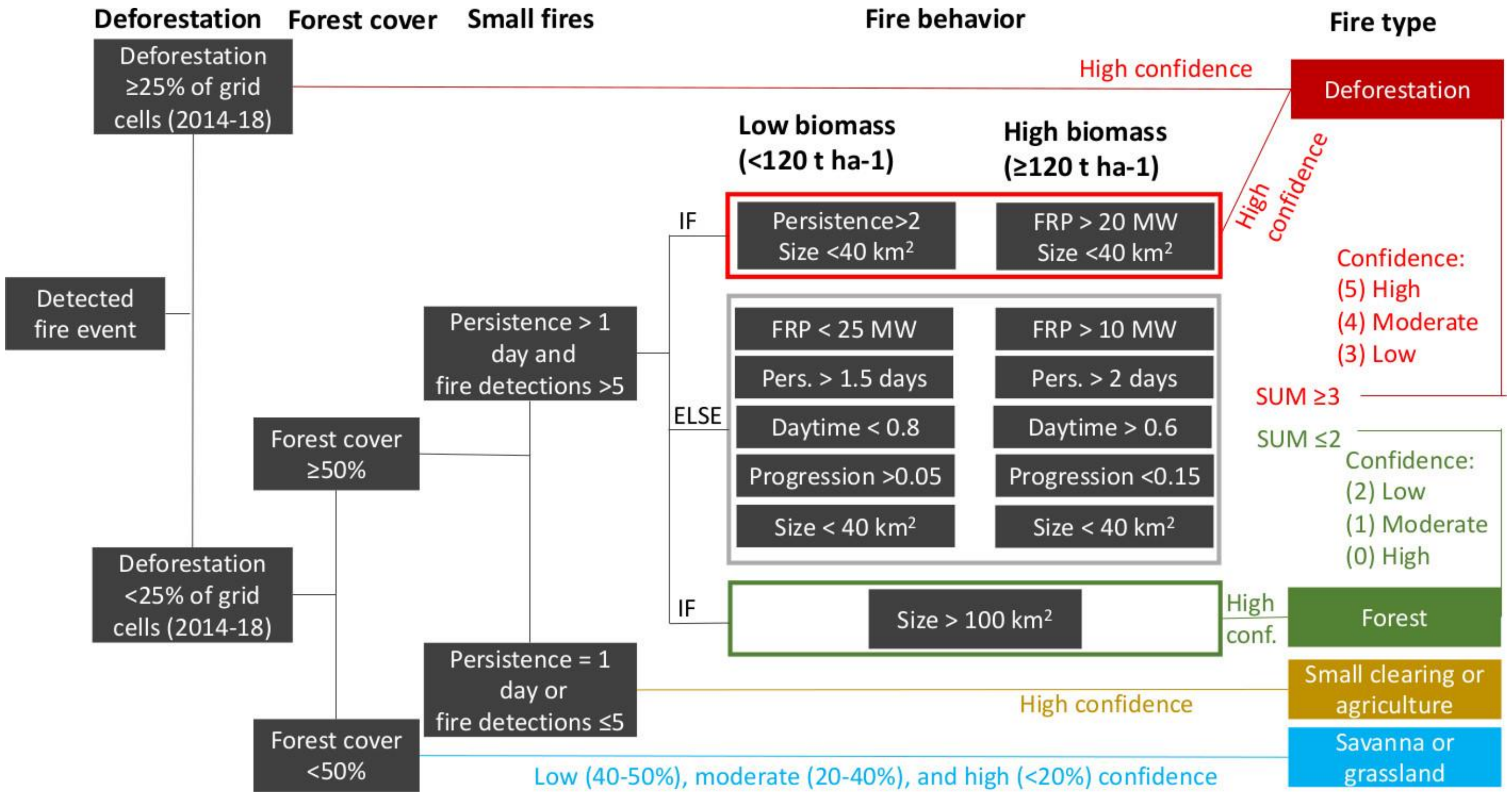
- Sentinel-3 SLSTR and Suomi-NPP VIIRS: temporal development of individual fires
- Sentinel-2: mapping burned area using FireCCI BAMT tool
- Quantification of fire persistence, progression, size, and fire radiative power



Presentation
Niels Andela et al.
Friday, 14:30, Genf

Mapping fire types

Mapping different fire types (for Brazil):



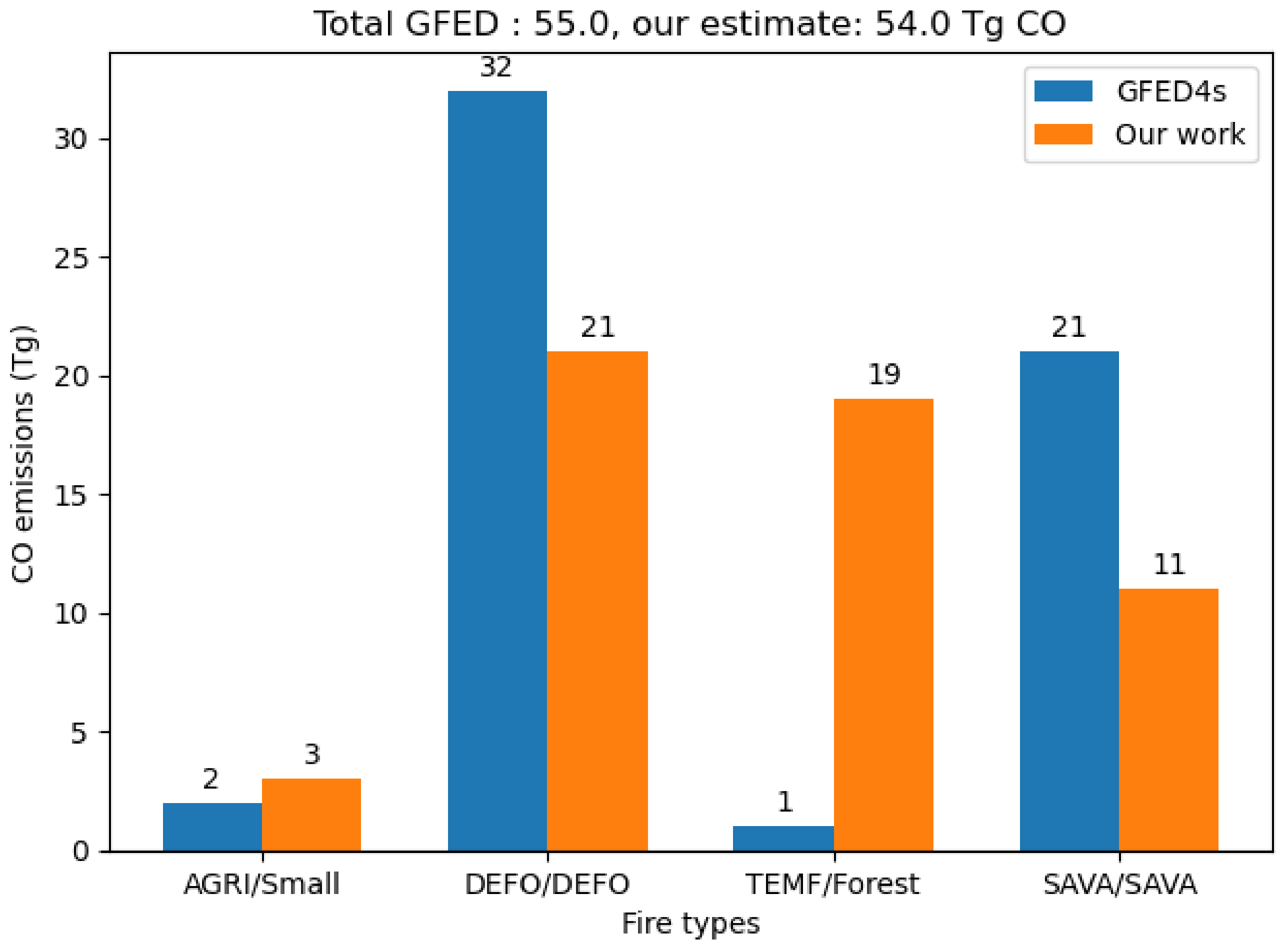
Further fire types will be defined for Africa, temperate steppes and boreal forests

Comparing fire emissions

Sense⁴ Fire

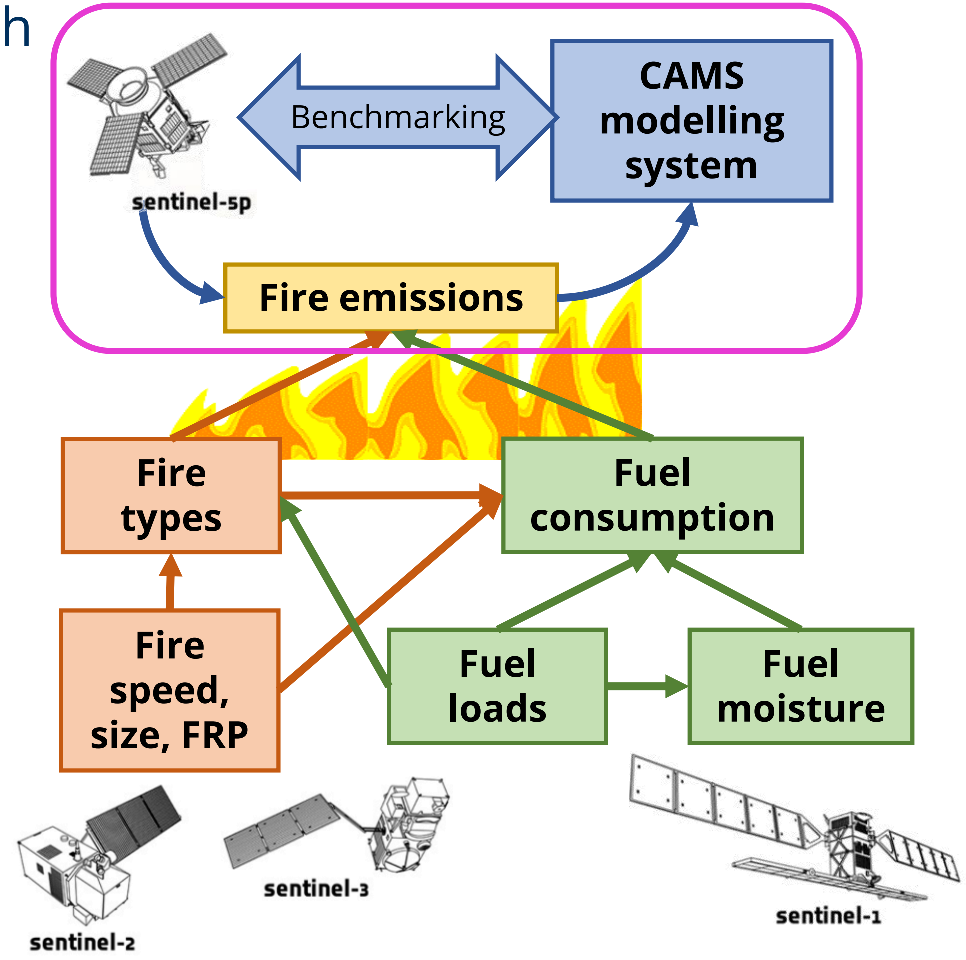
Initial fire emission estimates for southern-hemisphere South America

Emission factors vary with fire types



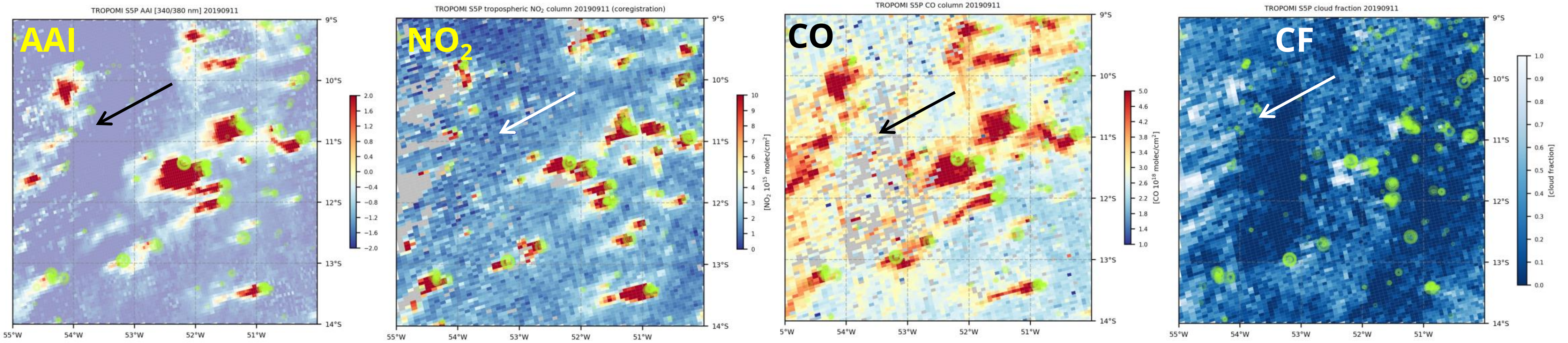
Sentinels for fire emissions

The **Sense4Fire** approach



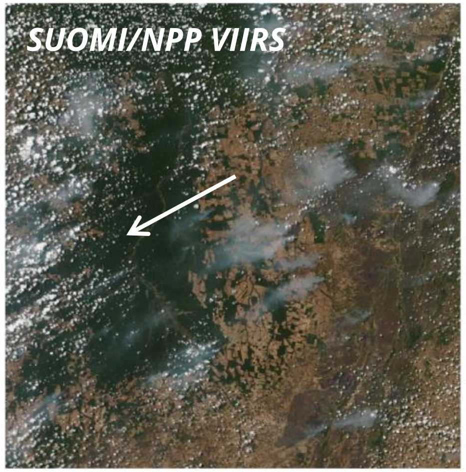
Sentinel-5p observations of fire plumes

Sense⁴ Fire



green circles = SUOMI/NPP VIIRS FRP

SUOMI-NPP VIIRS RGB 20190911 source © NASA EARTHDATA

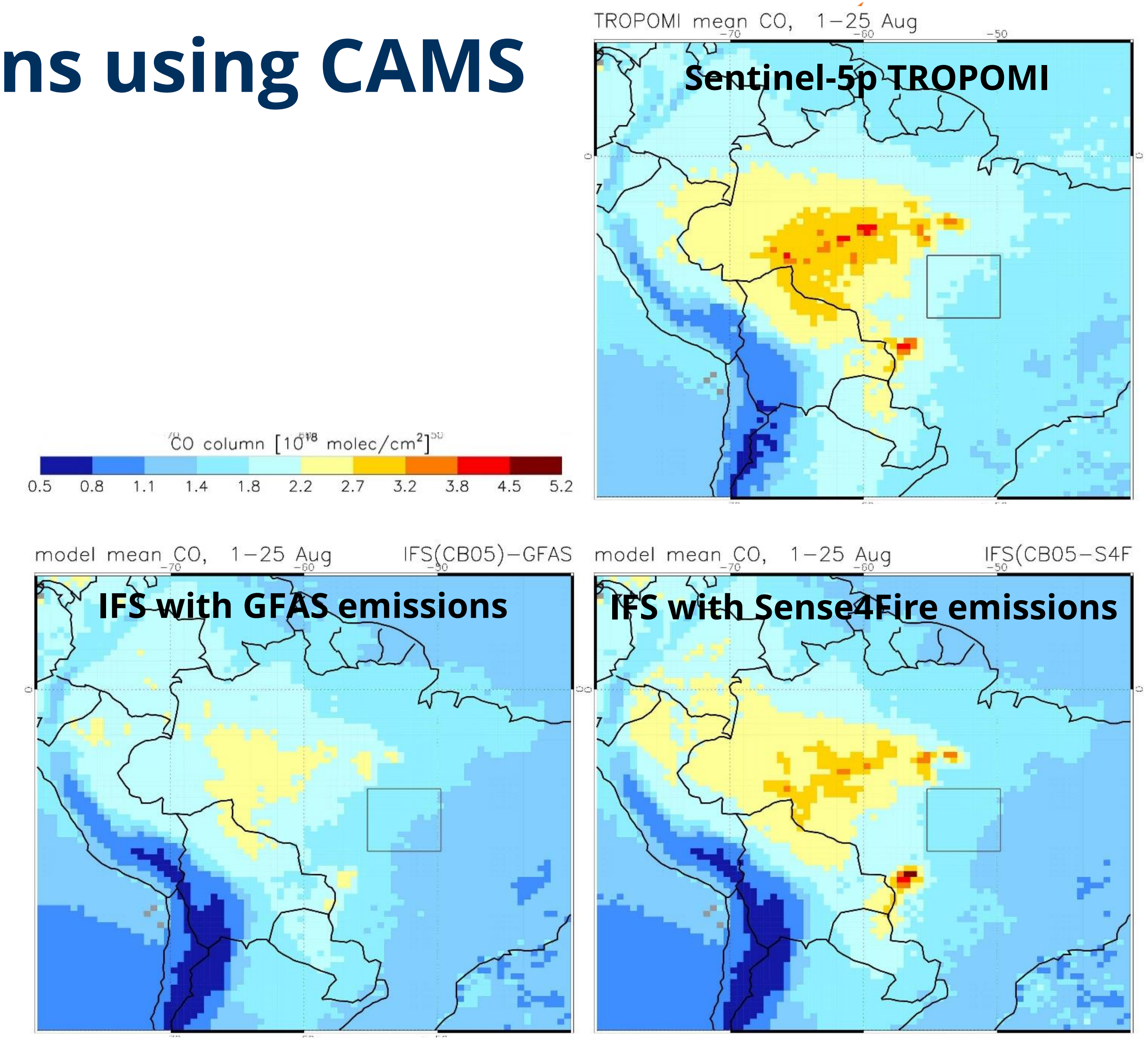


AMAZON **11 September 2019**

- enhanced AAI, NO_2, CO, cloud fraction
- differences: NO_2 more localized than CO, AAI
- CO, AAI lifetime (days-weeks) time longer than NO_2 (hours)

Benchmarking emissions using CAMS

- Prescribing fire emissions to the CAMS Integrated Forecasting System (IFS)
- Comparison of IFS with Sentinel-5p TROPOMI
- Identification of model biases and constraint on fire emissions and emission factors



Copernicus
Europe's eyes on Earth

Sense4Fire

Poster
Matthias Forkel et al.
Wed, 17:20, Poster 355

Developments

New datasets of fuel loads, fuel moisture, fire behaviour, fire types and fire emissions based on Sentinels and other European Earth observation data

- Oct 2022: Completion of methods and validation and first initial datasets on request
- Mar 2023: Release of datasets

matthias.forkel@tu-dresden.de

https://sense4fire.eu/