4th Carbon from Space Workshop

Matthias Forkel[1], Niels Andela[2,4], Vincent Huijnen[3], Jos de Laat[3], Alfred Awotwi[2], Daniel Kinalczyk[1], Johanna Kranz[1], Christopher Marrs[1], Luisa Schmidt[1], and Christine Wessollek[1]

Quantifying Fuels, Fire Behaviour and Fire Emissions by Integrating Observations from Sentinel-1, -2, -3, -5p ++

1 TU Dresden, 2 Cardiff University, 3 KNMI, 4 BeZero Carbon

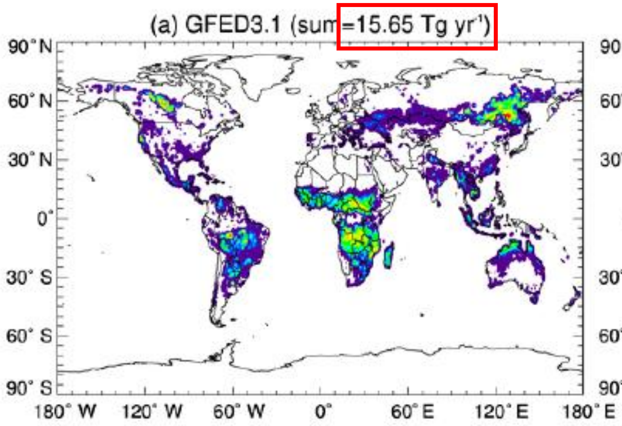
Global fire emissions

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

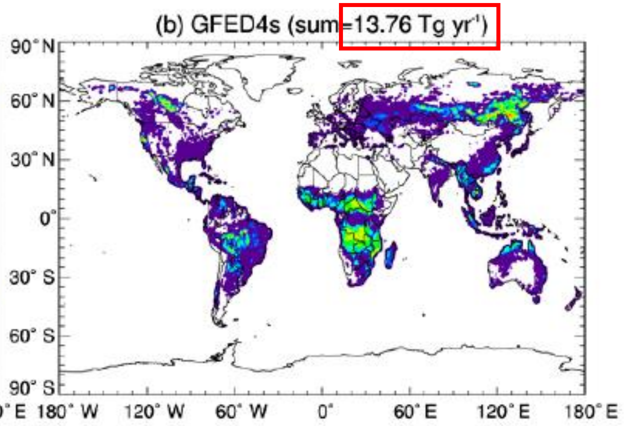
Atmospheric Chemistry and Physics
Open Access
EGU

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]

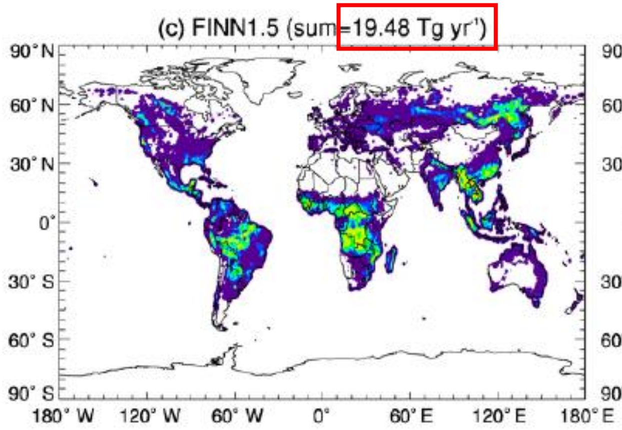


GFED3.1: MODIS burned area + CASA model

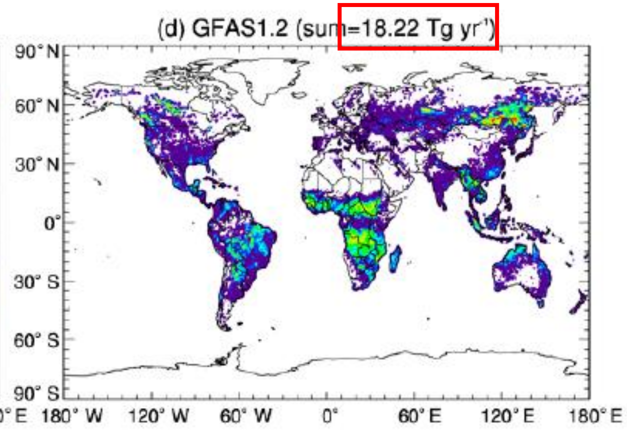


GFED4s: MODIS burned area + small fires + CASA model

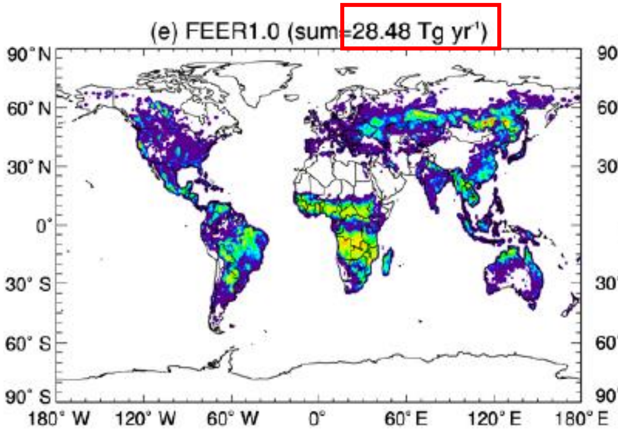
Total organic carbon emissions (2008) (g m^{-2} a^{-1})



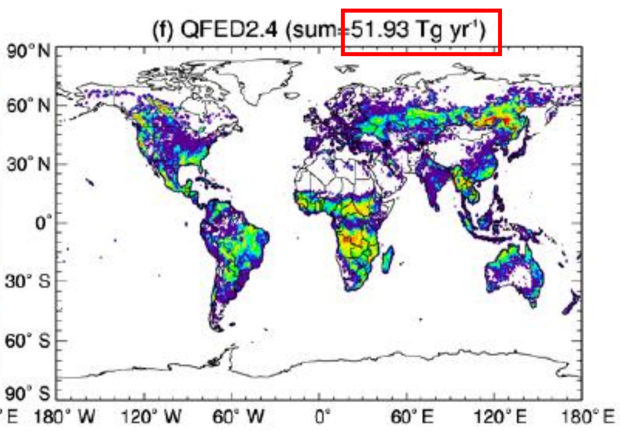
FINN1.5: MODIS active fires + fire emission model



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



FEER1.0: FRP from GFAS + MODIS AOD



QFED2.4: MODIS+GOES active fires + AOD

Satellite observations for fire emissions

Fuels loads

- Leaf area index (e.g. Proba-V, Sentinel-3)
- Land cover (change) (e.g. ESA CCI)
- Biomass (e.g. ESA CCI)
- Forest height (e.g. GEDI)
- Vegetation Optical Depth (e.g. SMOS, VODCA)

Fire dynamics

Fuel moisture

Atmospheric composition

Satellite observations for fire emissions

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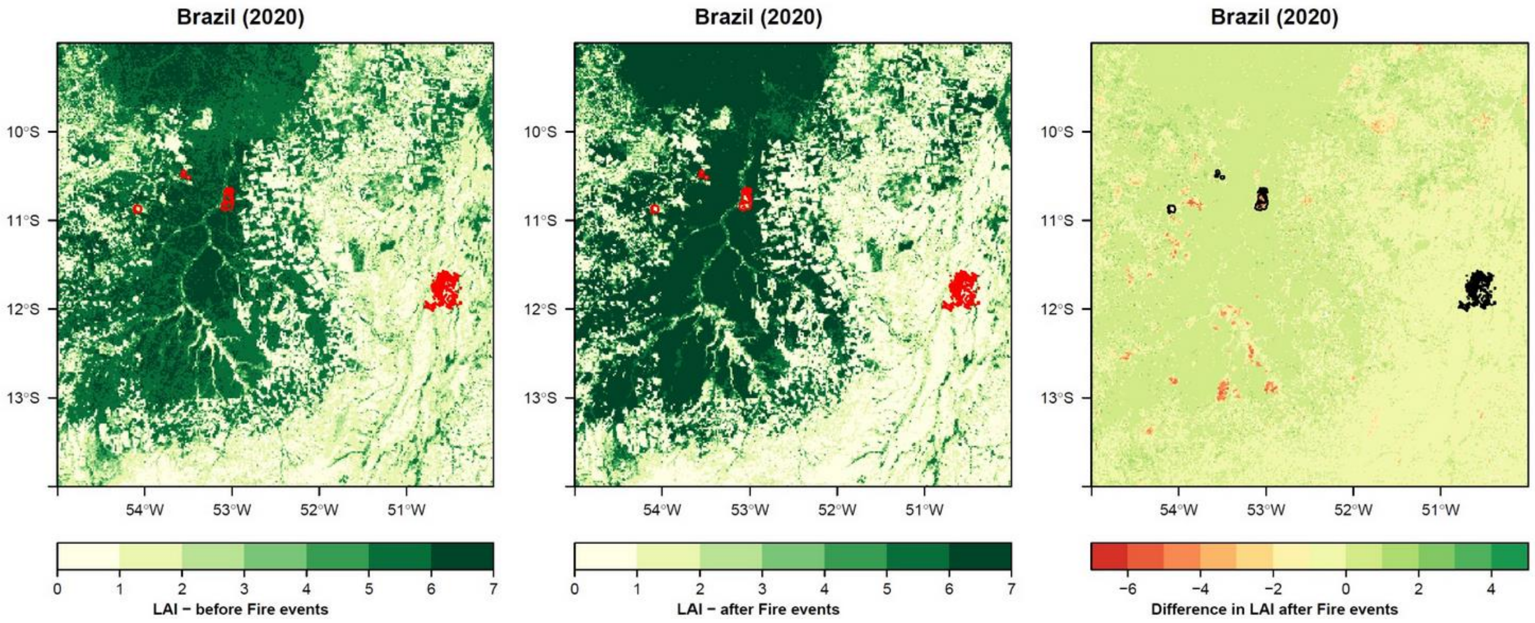
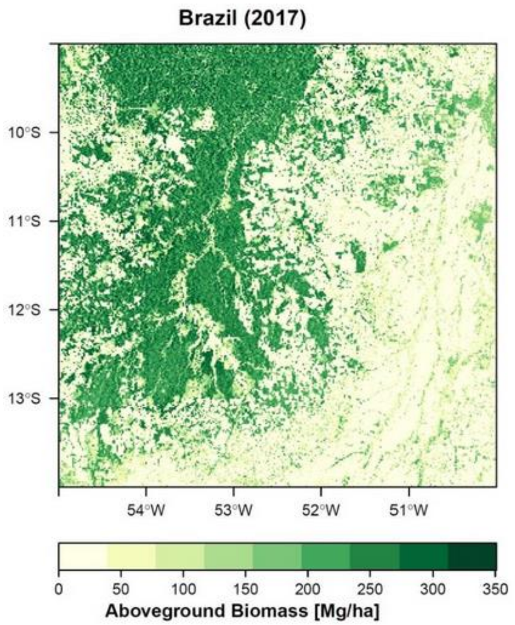
Sentinel-3 LAI (2020, Amazon study region)



Biomass CCI (2017)



Satellite observations for fire emissions

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- Forest height (e.g. GEDI)
- Vegetation Optical Depth (e.g. SMOS, VODCA)

Fuel moisture

- Vegetation Optical Depth (e.g. SMOS, VODCA)
- Soil moisture (e.g. SMOS, ASCAT, Sentinel-1)
- Live fuel moisture content (e.g. MODIS, Sentinel-3, Sentinel-1, VOD-based)

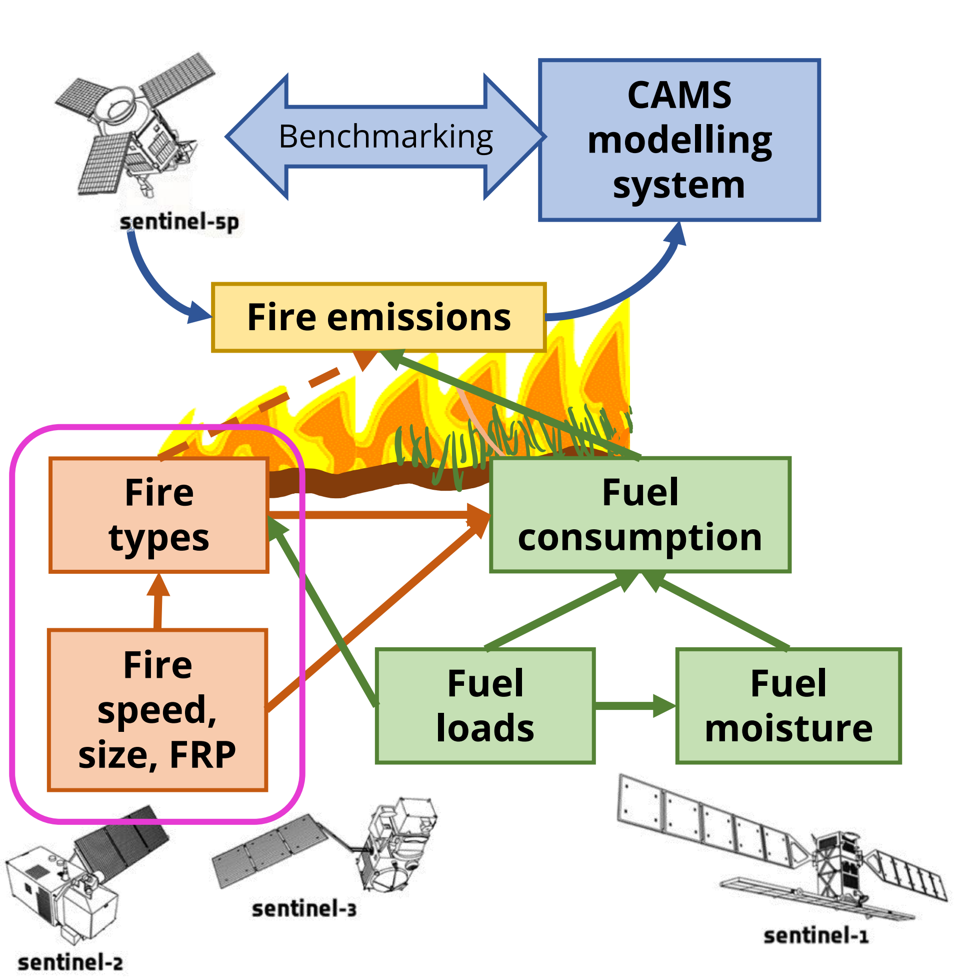
Fire dynamics

- Burned area (e.g. ESA CCI, Sentinel-2)
- Fire size, speed, duration (e.g. Fire Atlas)
- Fire radiative power (e.g. MODIS, VIIRS, Sentinel-3)

Atmospheric composition

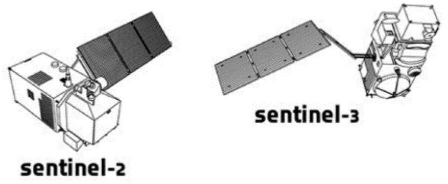
- Column-integrated CO, NOx (e.g. Sentinel-5p)
- Aerosols (e.g. Sentinel-5p)

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

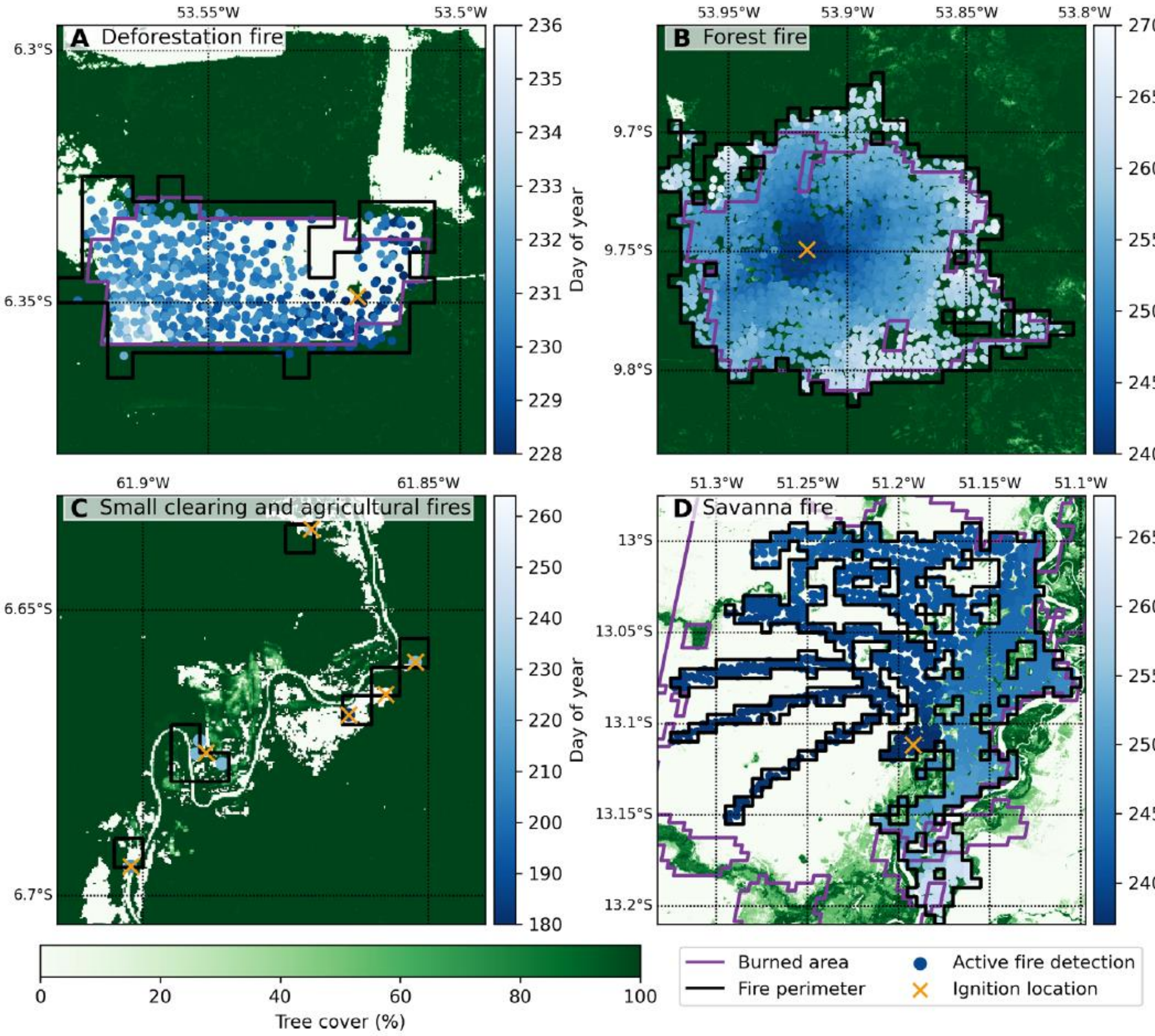


SCIENCE ADVANCES | RESEARCH ARTICLE

CLIMATOLOGY

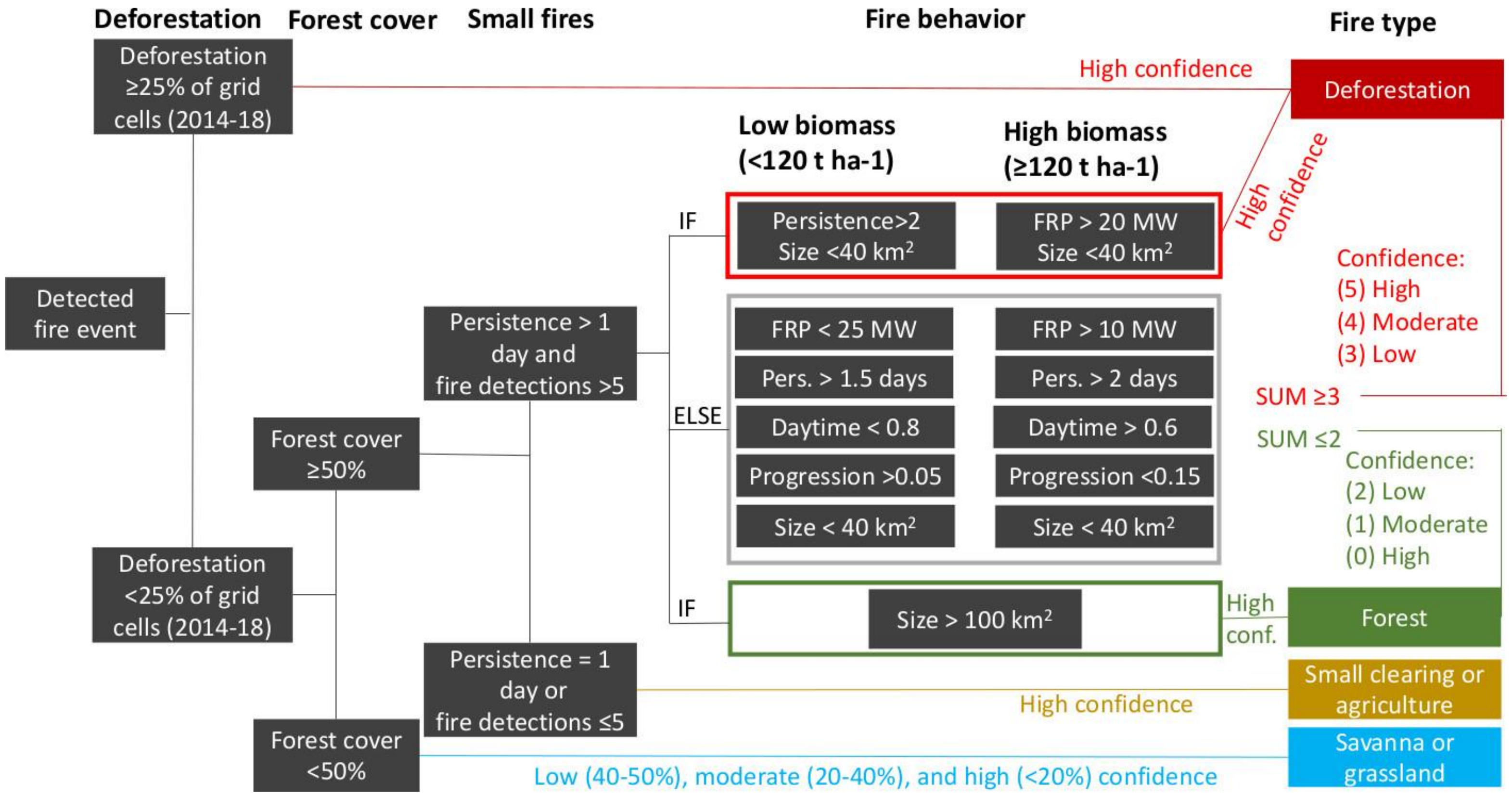
Tracking and classifying Amazon fire events in near real time

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



Mapping fire types

Mapping different fire types (for Brazil)

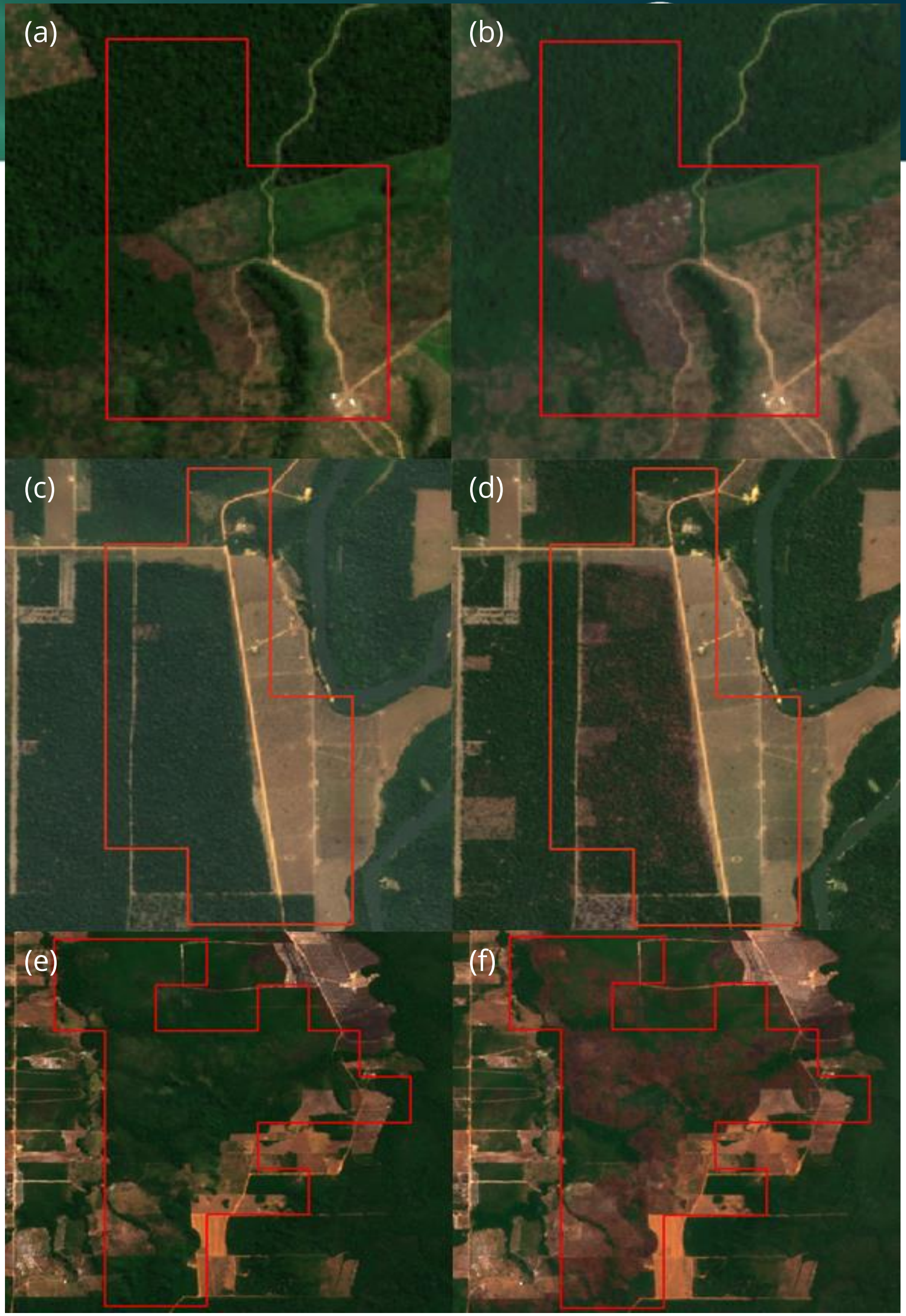


Further fire types will be defined for Africa, temperate steppes and boreal forests

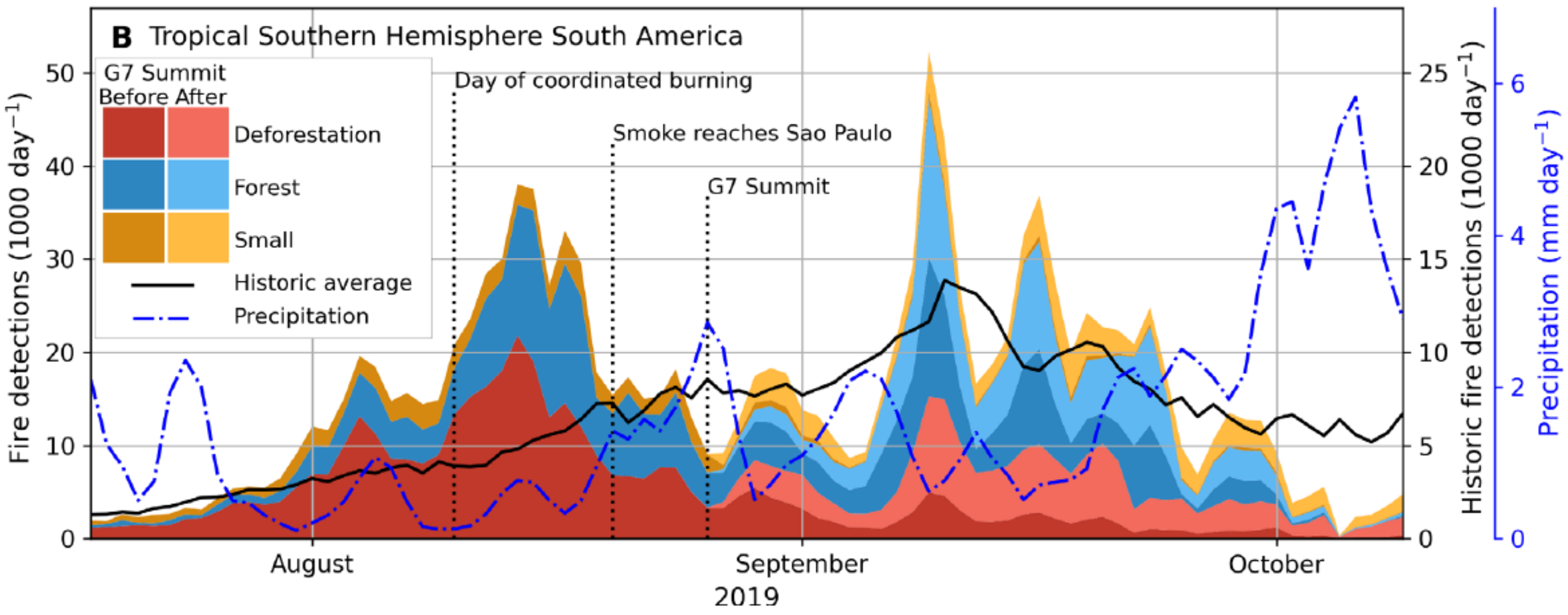
Mapping fire types

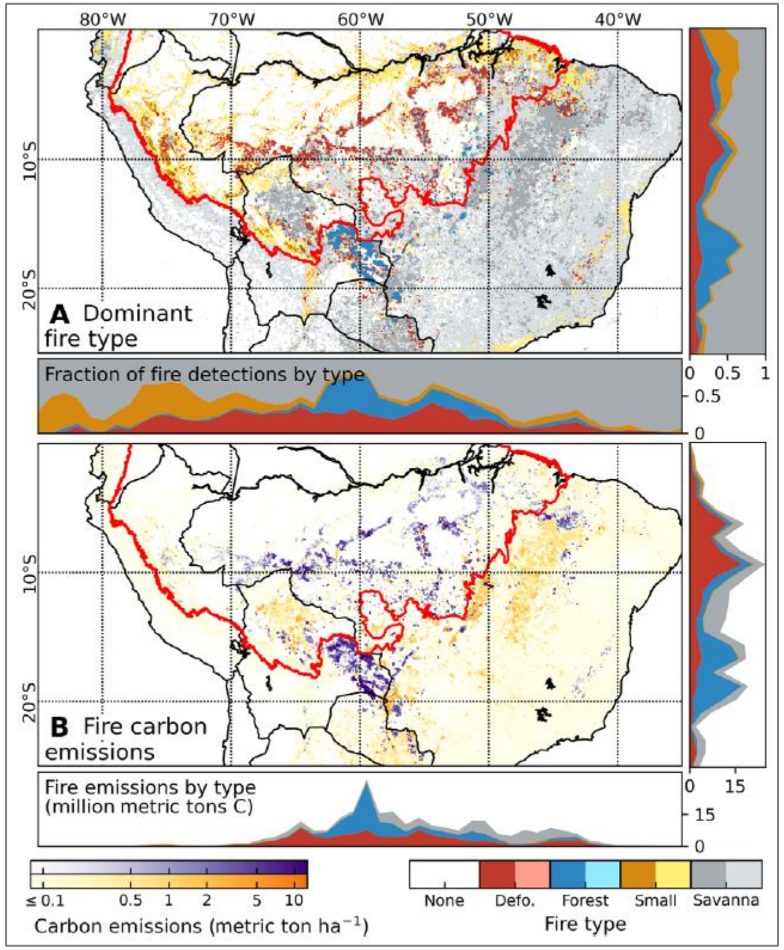
Interpretation of pre- and post fire Sentinel-2 pairs for 163 randomely sampled fires across the South American domain in 2019

a) Fire events		**Reference data**			
Classi-fication		Deforestation	Forest	Total	**User's Accuracy**
	Deforestation	64	34	98	**65%**
	Forest	19	46	65	**71%**
	Total	83	80	163	
	Producer's accuracy	**77%**	**58%**		
	Overall Accuracy = 67%				



Fire types in the Amazon in 2019





SCIENCE ADVANCES | RESEARCH ARTICLE

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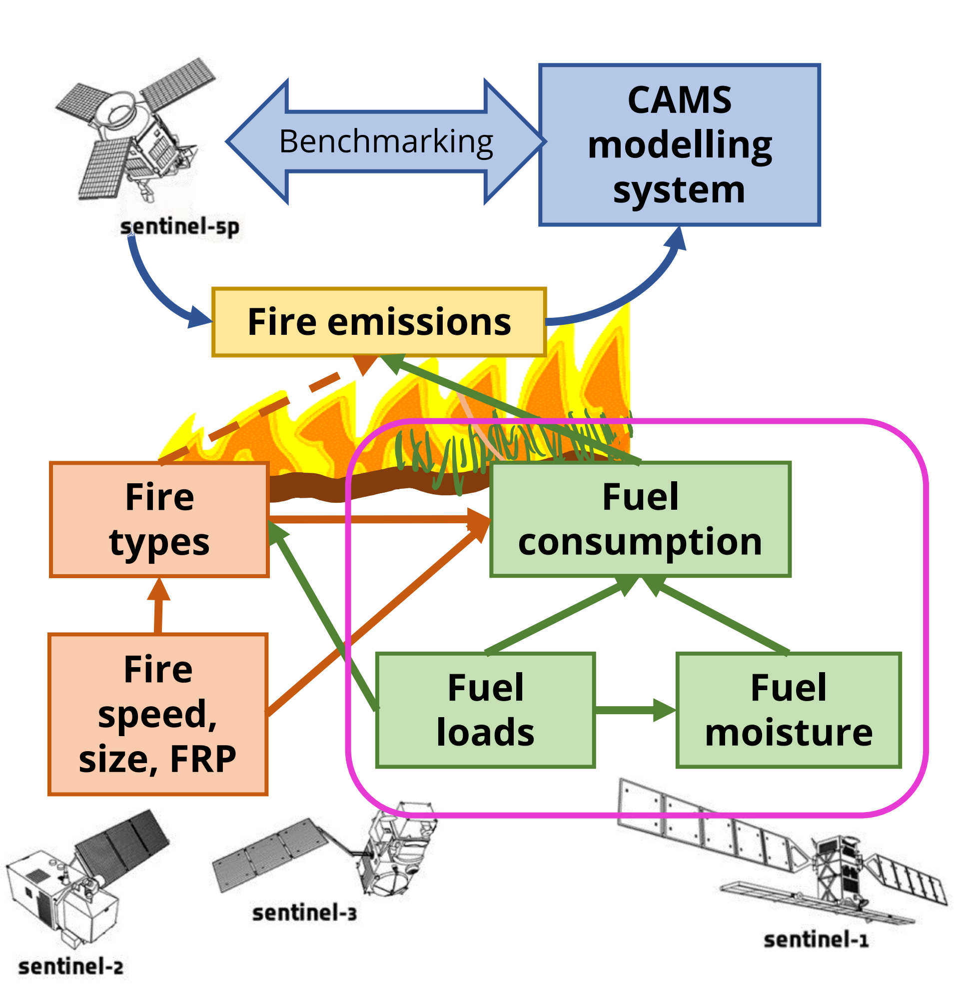
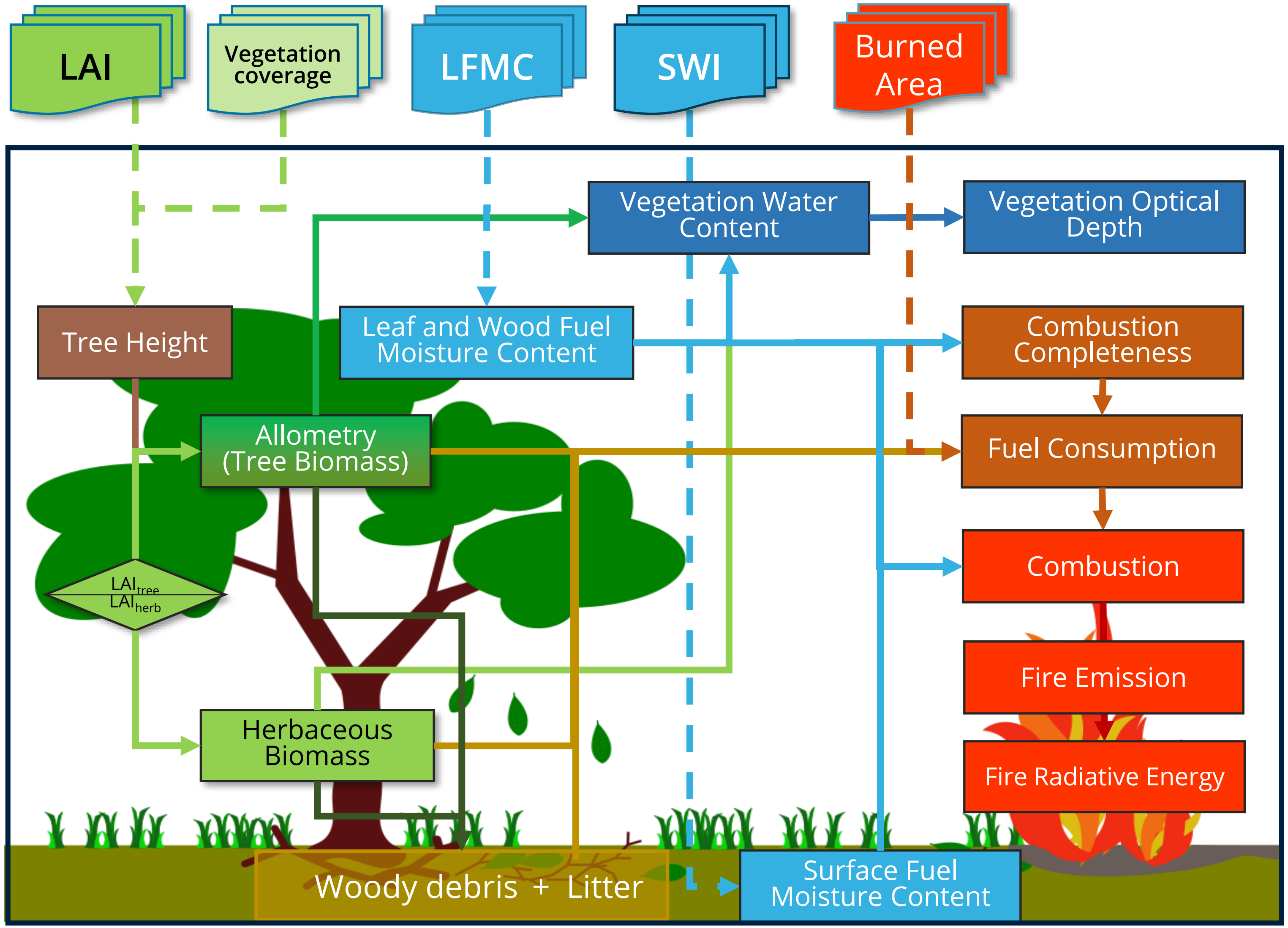
Sense4Fire approach



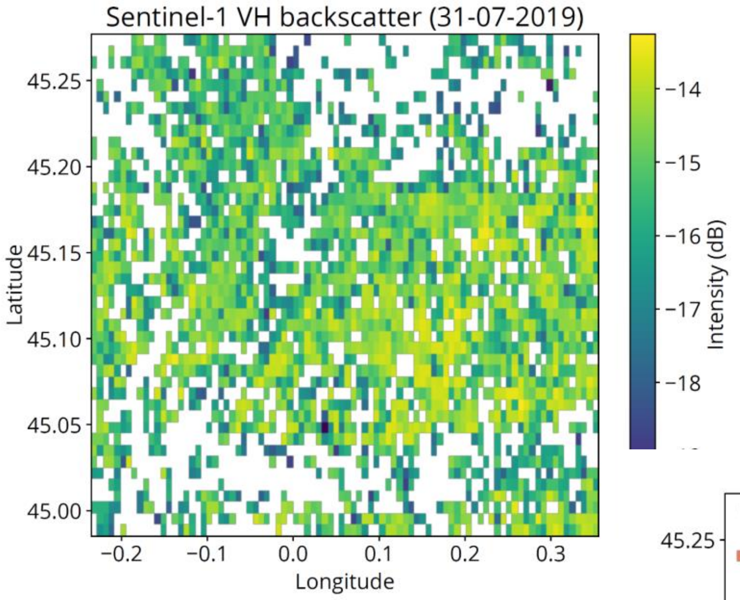
S4F Fuel and Fire Emissions Model

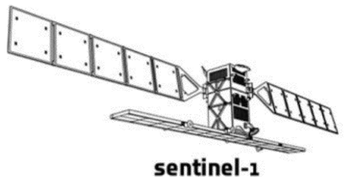


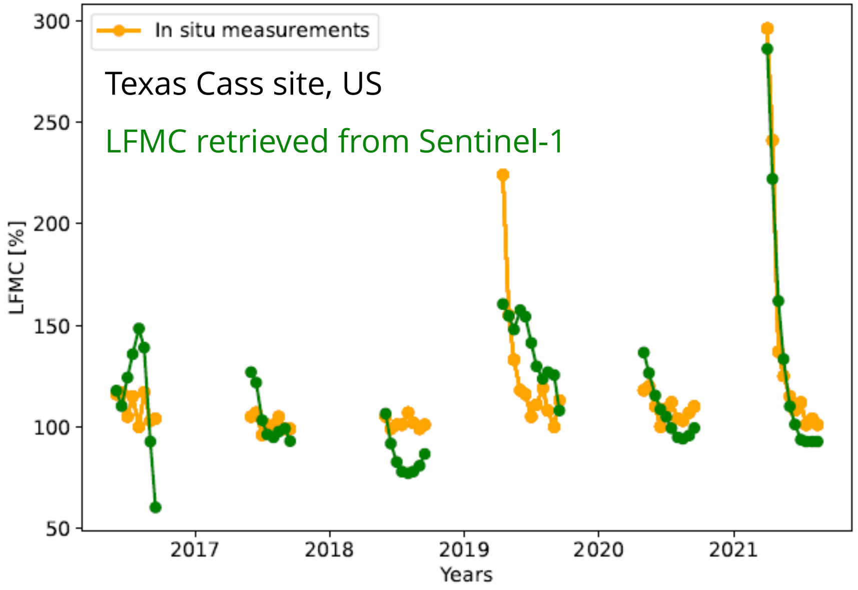
Estimating fuel moisture: #1 from Sentinel-1

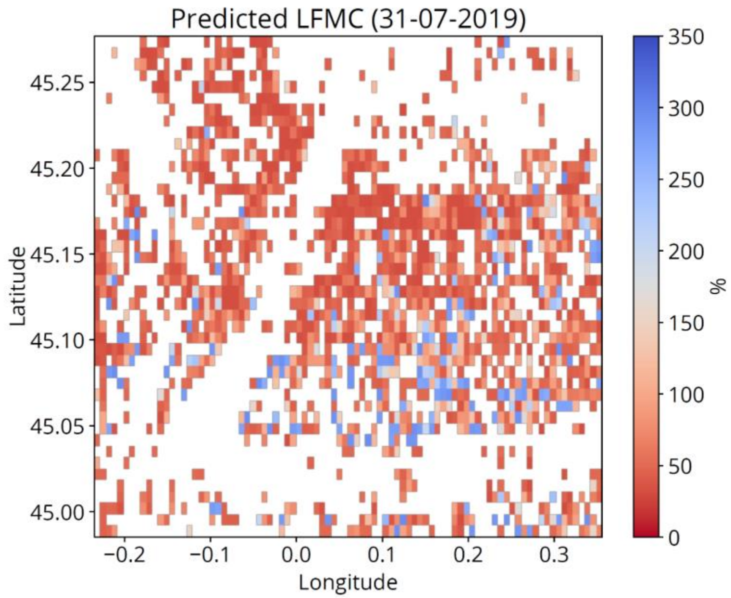
Gefördert durch DFG Deutsche Forschungsgemeinschaft
PhenoFeedBacks

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



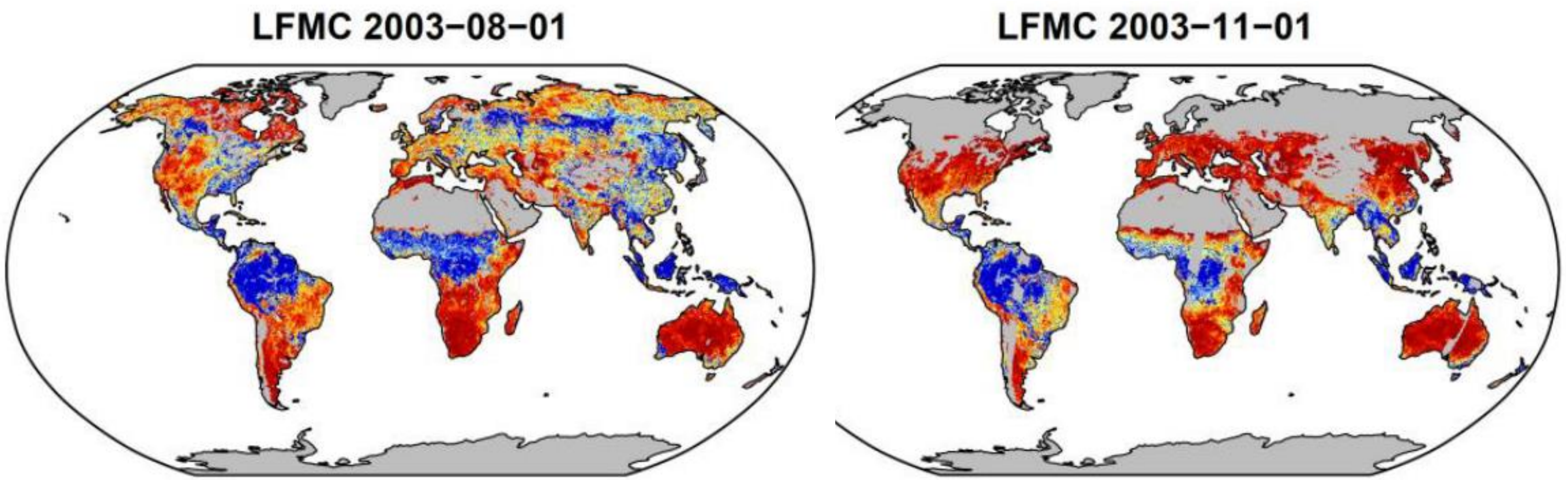


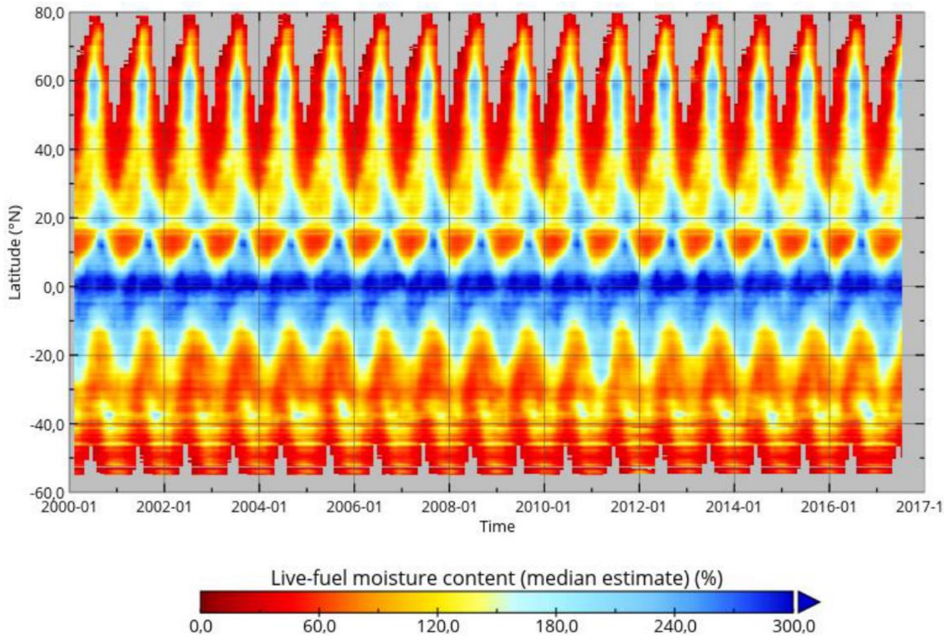




Estimating fuel moisture: #2 from Ku-VOD

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





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Hydrology and Earth System Sciences
Discussions
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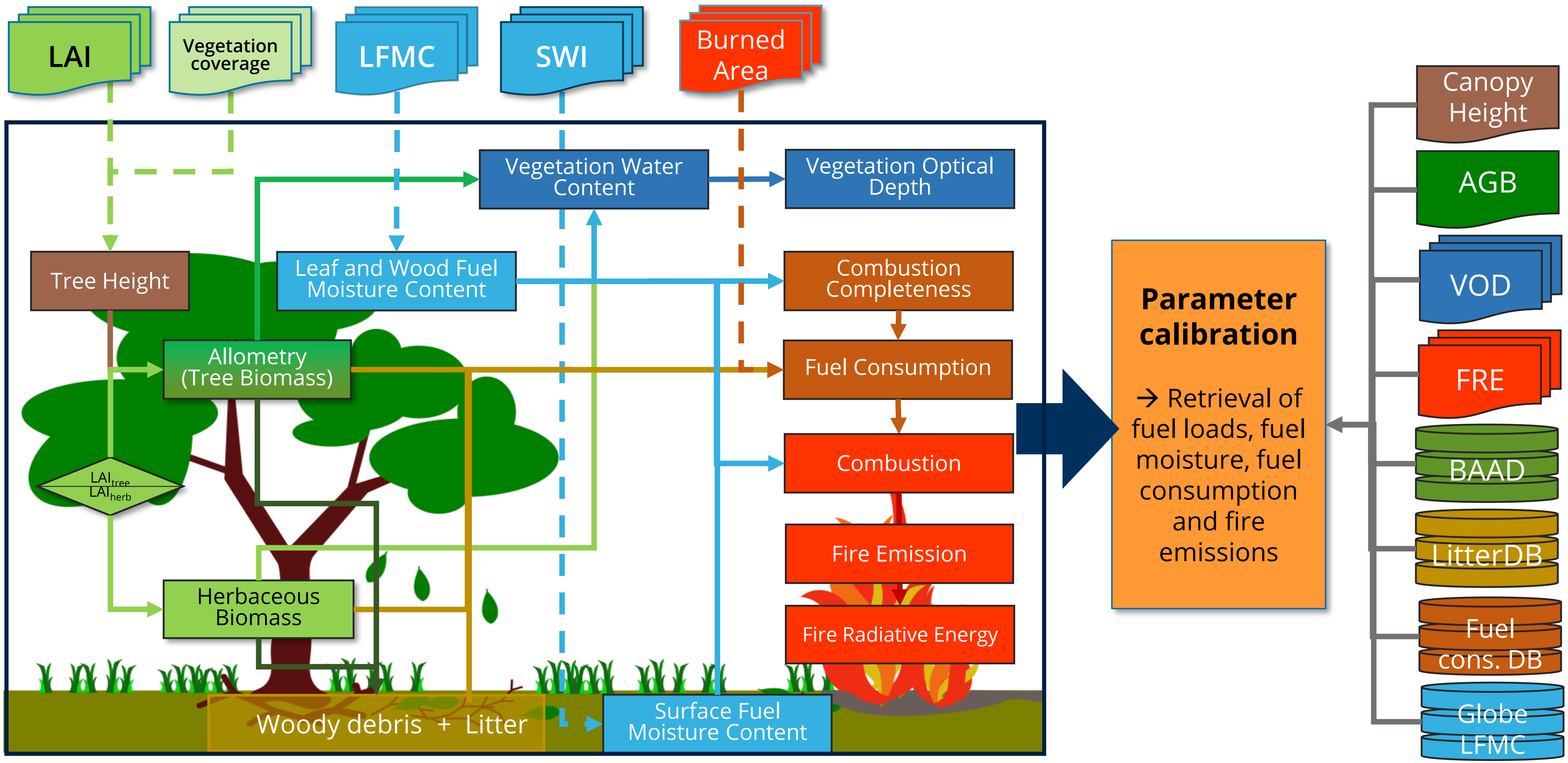
Estimating leaf moisture content at global scale from passive microwave satellite observations of vegetation optical depth

Matthias Forkel[1], Luisa Schmidt[1], Ruxandra-Maria Zotta[2], Wouter Dorigo[2], and Marta Yebra[3,4]

Data at zenodo:

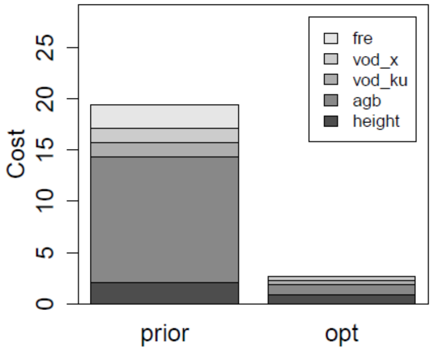
S4F Fuel and Fire Emissions Model

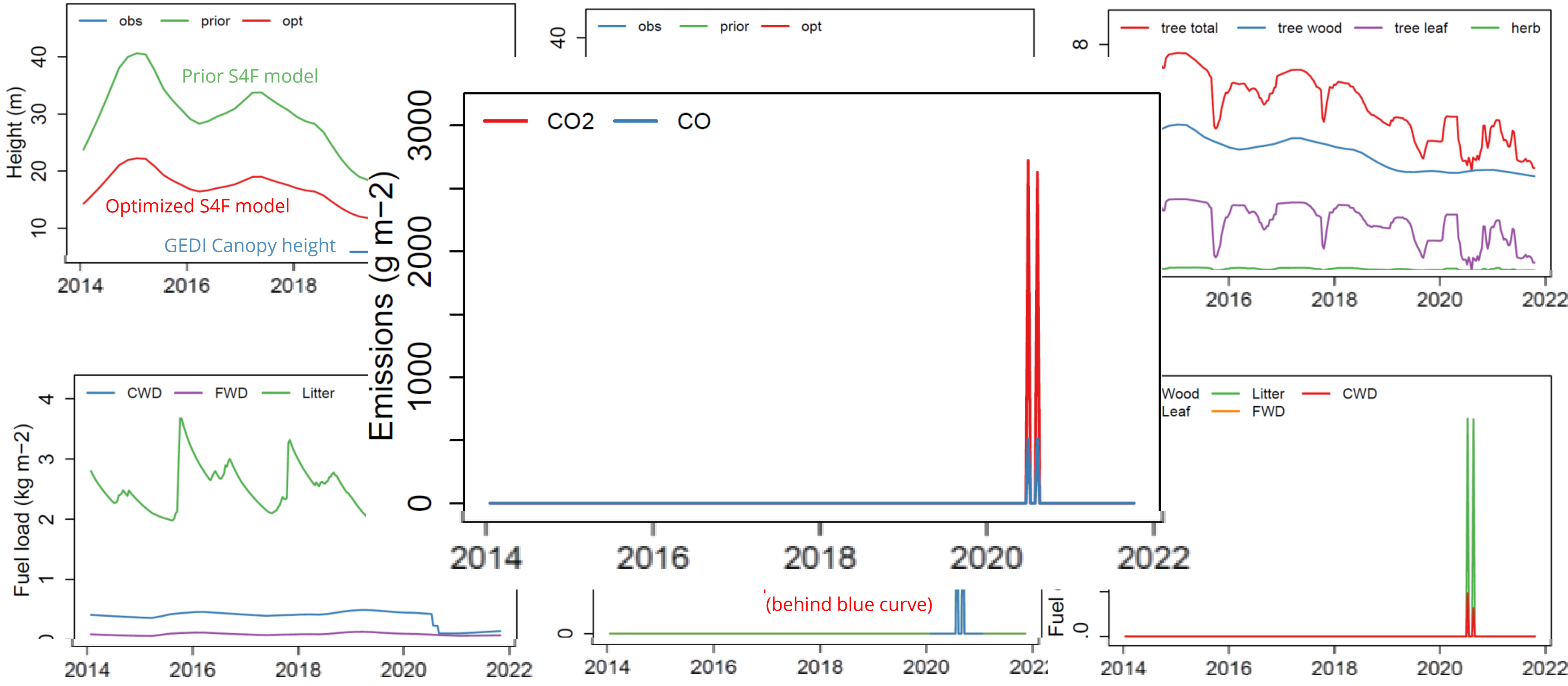


Retrieval of fuel dynamics for individual fires

Retrieval for one example fire in the Amazon in 2020

(52.42262°S, 11.845238°W)

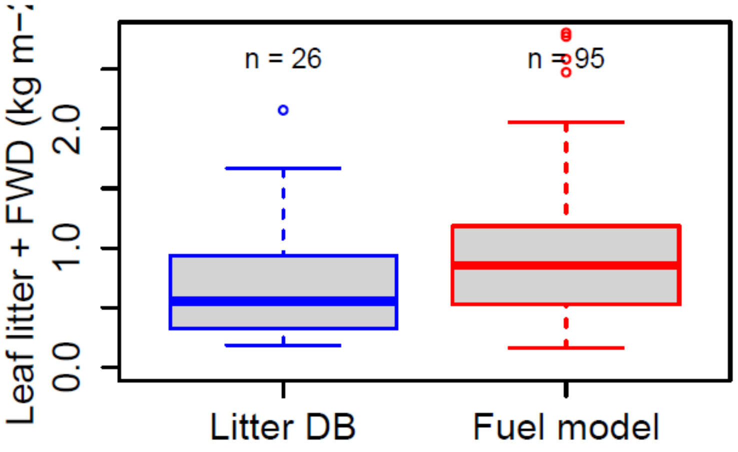




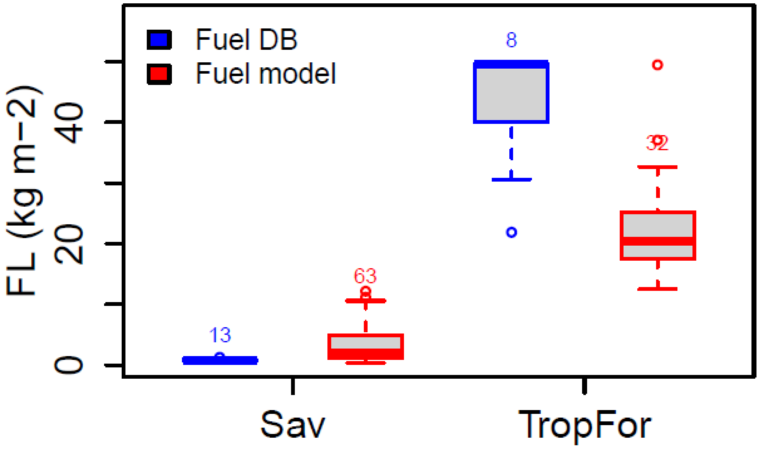
Validation against databases

Validation of statistical distributions of fuel loads and consumption and emission factors from 95 fires in the Amazon study region against databases

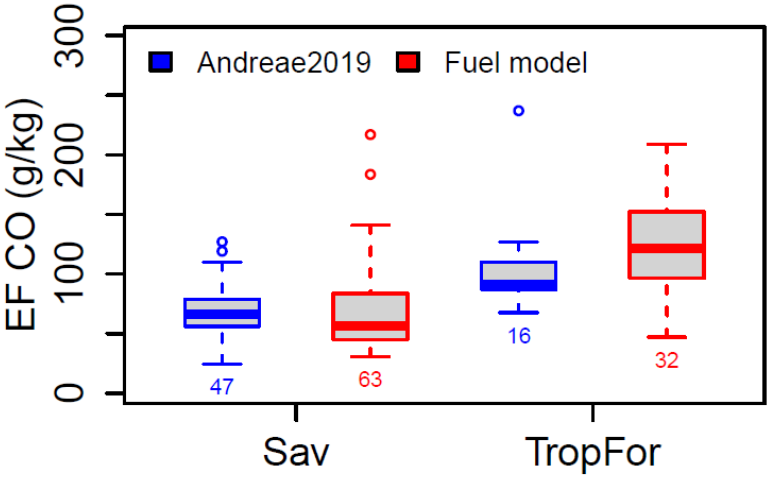
Litter and woody debris
(Global database of litter fall masses and litter pool carbon, Holland et al. 2014)



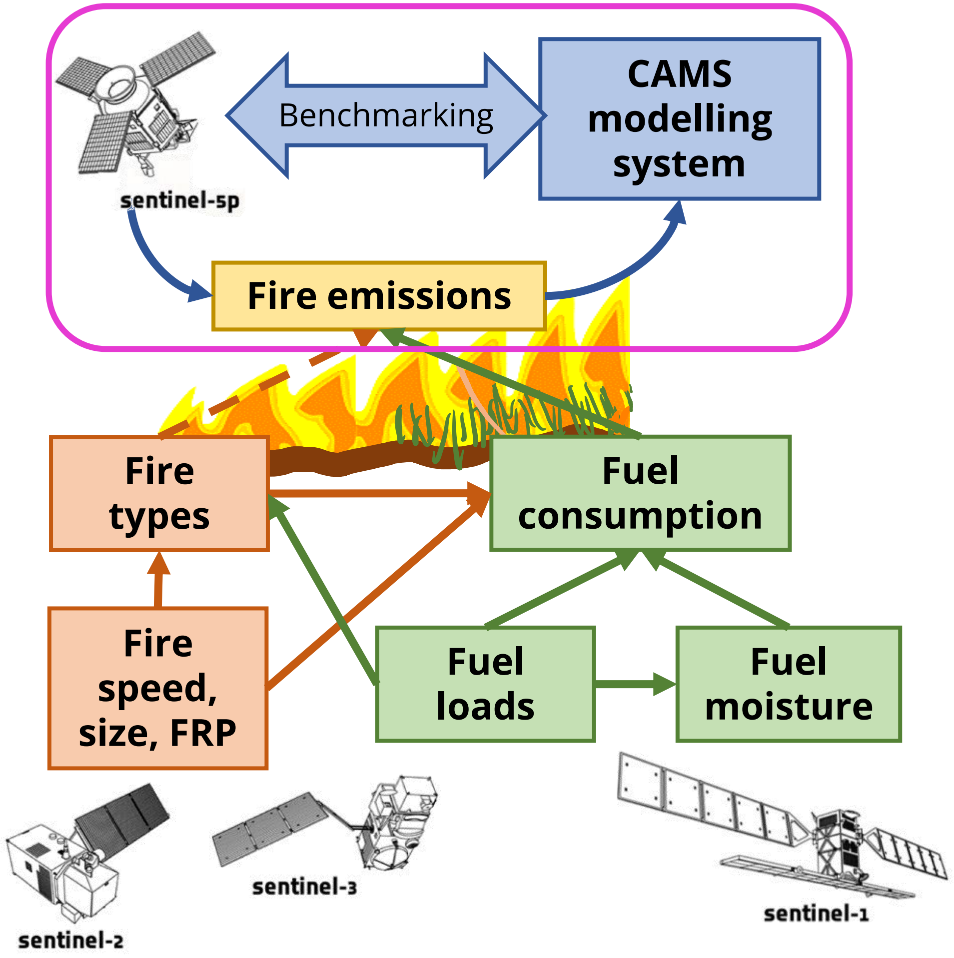
Fuel load and combustion completeness
(Fuel database, van Leeuwen et al. 2014)



Emission factors and combustion efficiency
(Database from Andreae 2019)



Sense4Fire approach

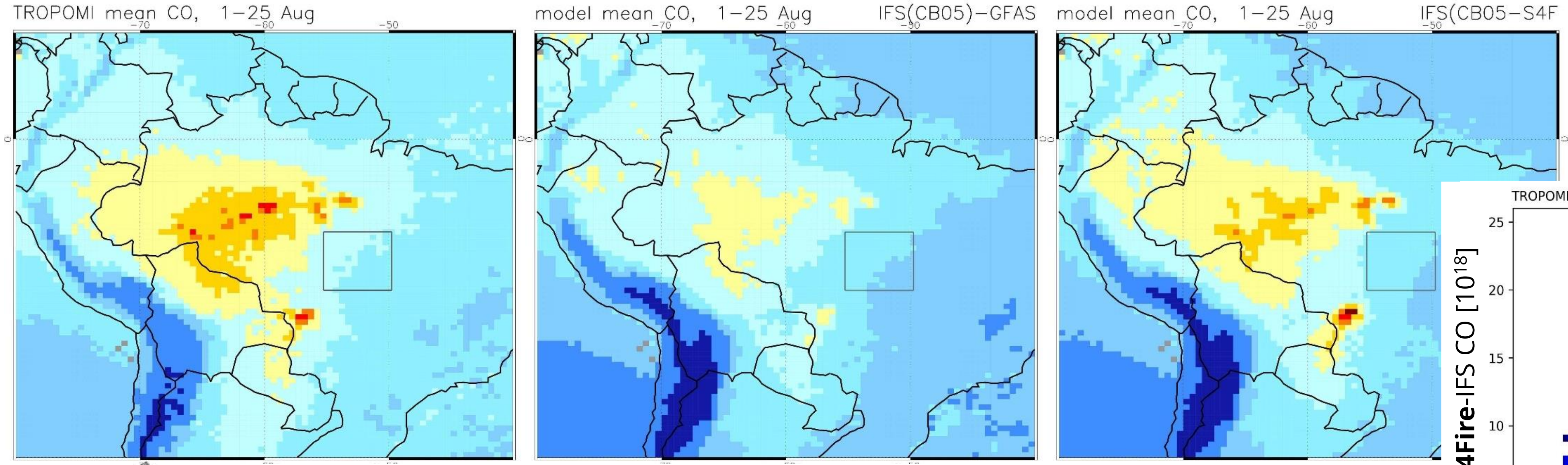


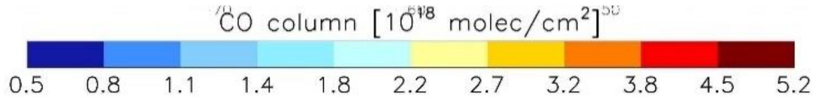
Sense4 Fire

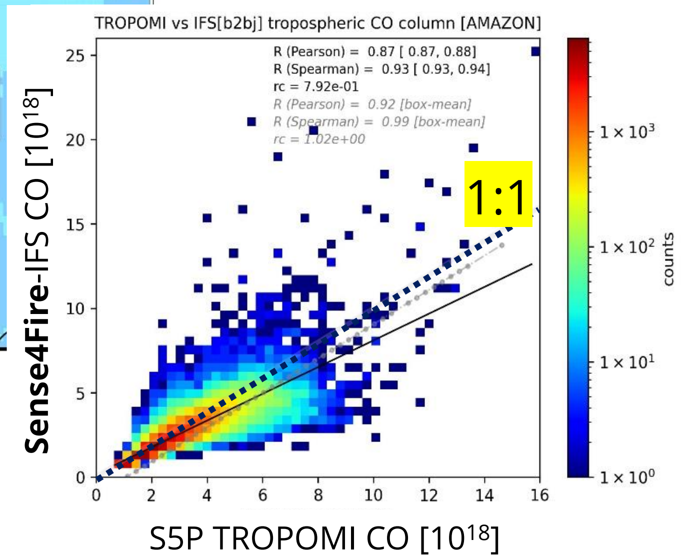
Benchmarking emissions against TROPOMI

Integration of emissions in CAMS IFS and comparison of column CO with S5p TROPOMI (August-September 2020, Amazon 70W-50W/25S-5S

Sentinel-5p TROPOMI | **IFS with GFAS emissions** | **IFS with Sense4Fire v0.1 emissions**

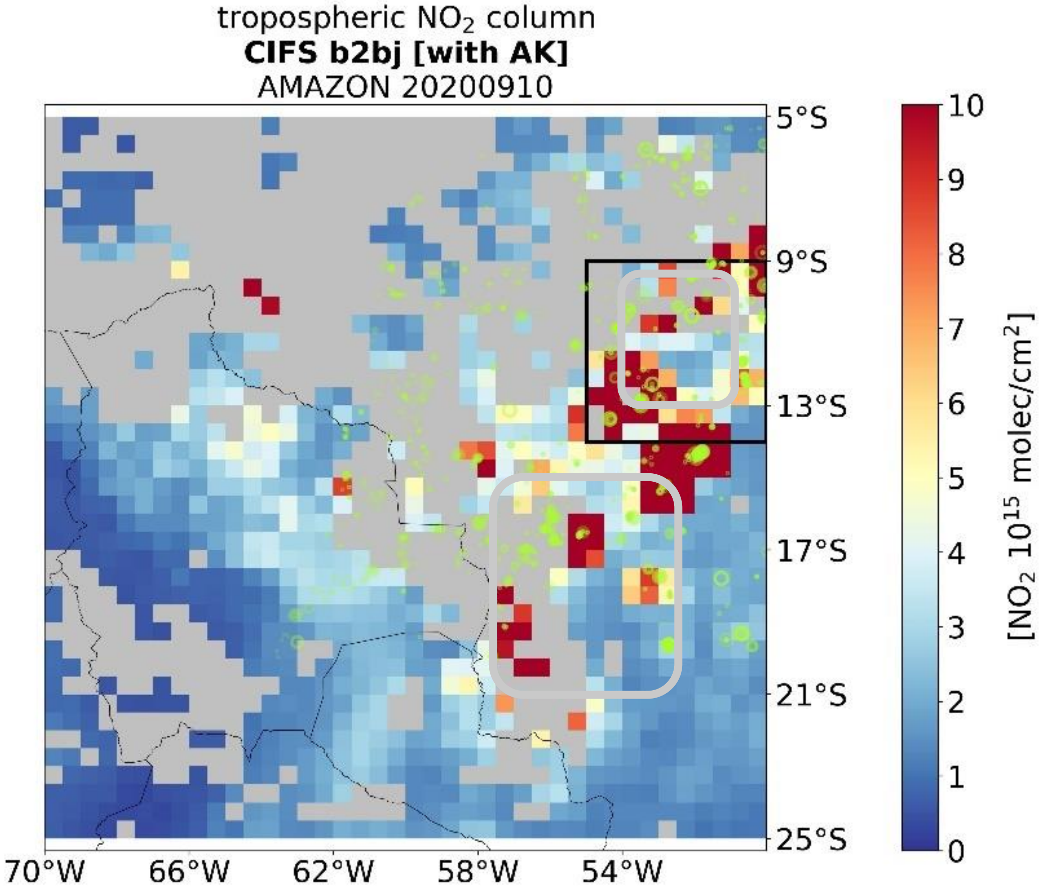


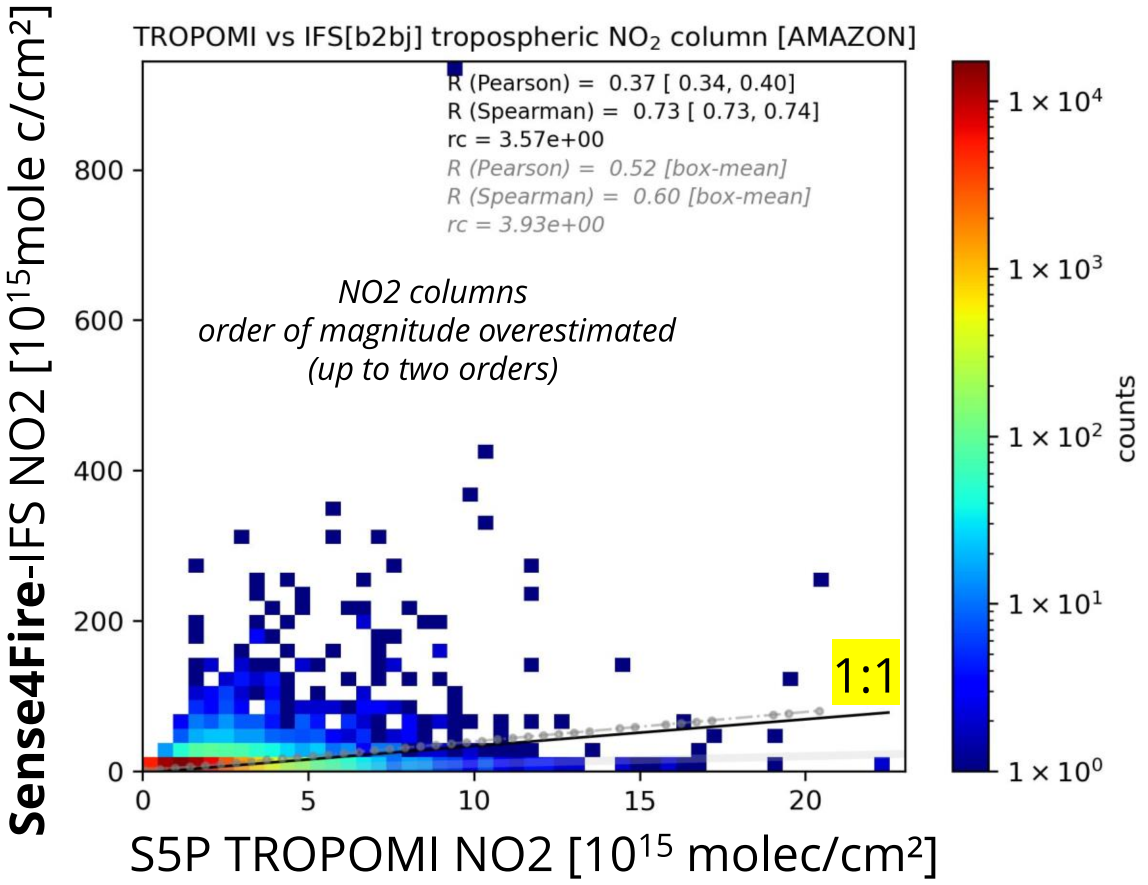




Benchmarking emissions against TROPOMI

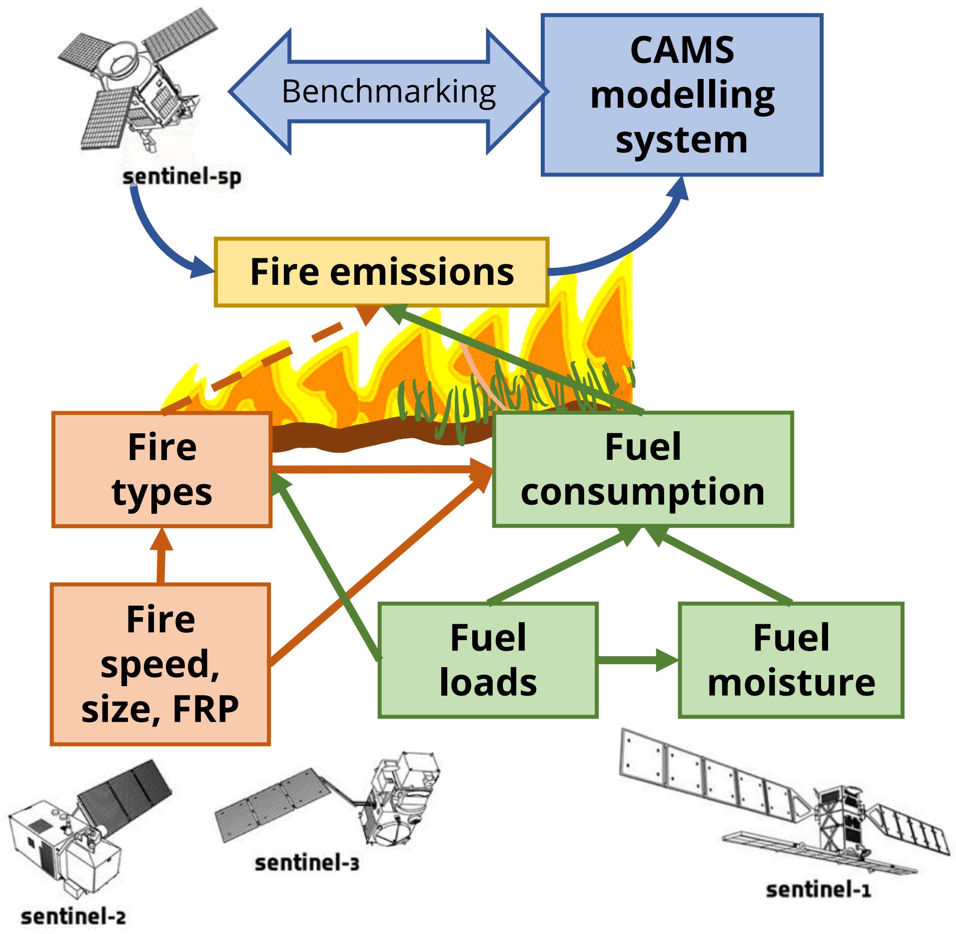
Comparison with TROPOMI NO_2





Summary

- Classification of fire types shows what is burning
- Estimation of fuel loads, fuel moisture, fuel consumption and fire emissions for individual fires
- Emission factors depend on fire type, fuel type, and moisture
- S4F improves over GFAS for CO
- GFAS and S4F reveal large NO_2 biases (over certain fires)



Knowledge gaps and research priorities

Fire dynamics and emissions

- Harmonizing datasets + uncertainties (e.g. height + biomass + land cover + VOD)
- Understanding individual fires, rather than gridded pixels or fire counts
- Assessing fire emissions from multiple perspectives (vegetation + emissions modeling + atmospheric constraints + field databases)
- Quantify climate-vegetation-fire interactions to predict feedbacks and trends

3-dimensional vegetation structure

- LAI and fAPAR should separate between trees + grass + shrubs per pixel
- Leaf + woody biomass + woody debris from optical + (Tomo)SAR + Lidar

Future land carbon sink? → carbon turnover, mortality and disturbance!

- Focus on litter production/stocks, disturbances, forest mortality, dead wood, forest structure changes, decomposition …