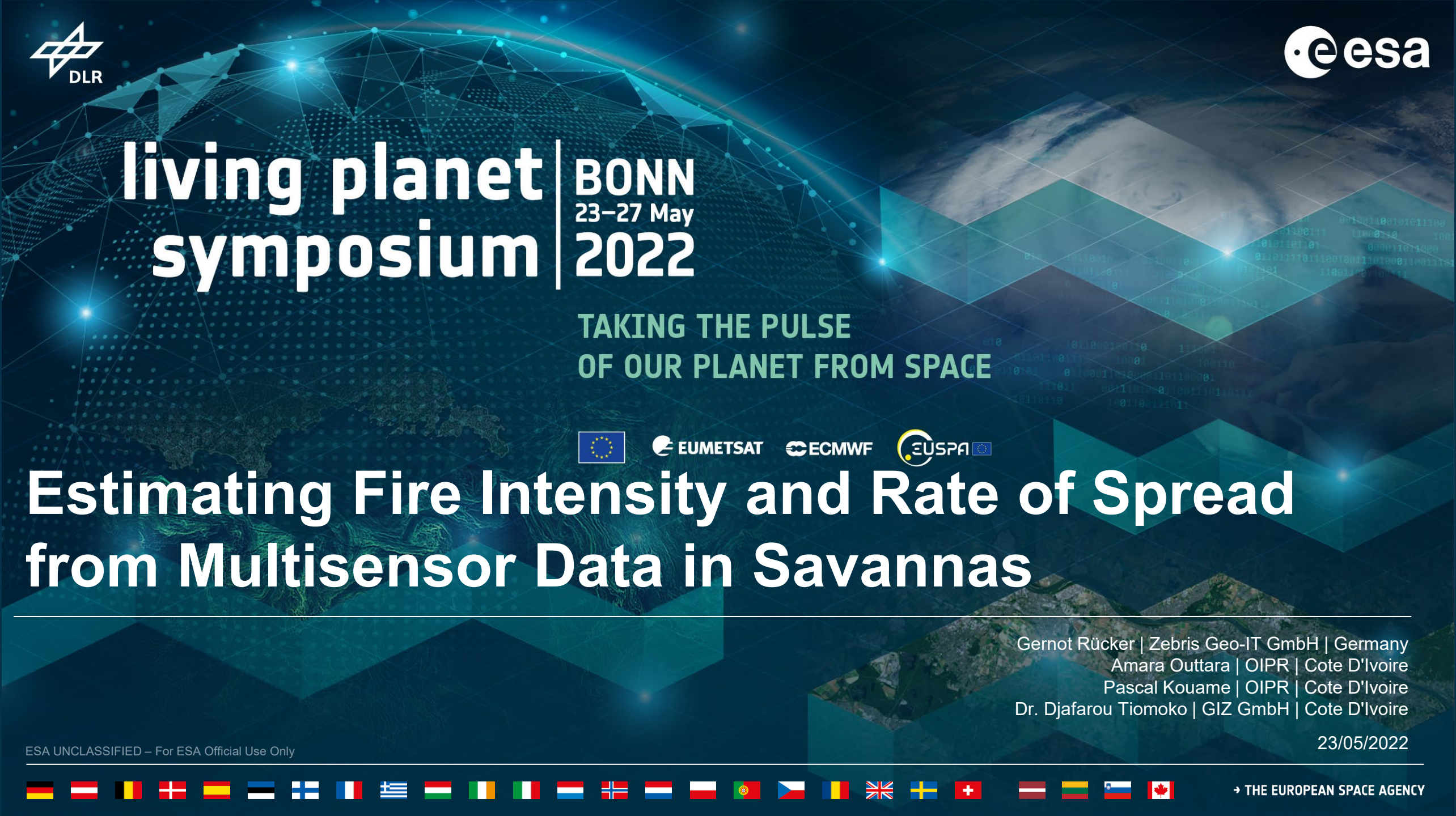


# Estimating Fire Intensity and Rate of Spread from Multisensor Data in Savannas

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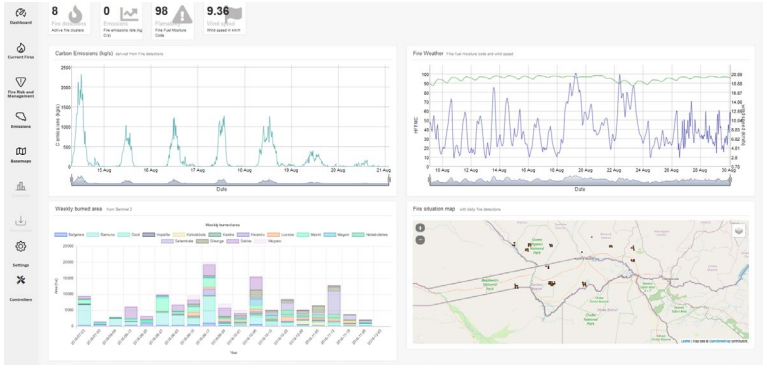
Amara Outtara | OIPR | Cote D'Ivoire
Pascal Kouame | OIPR | Cote D'Ivoire
Dr. Djafarou Tiomoko | GIZ GmbH | Cote D'Ivoire

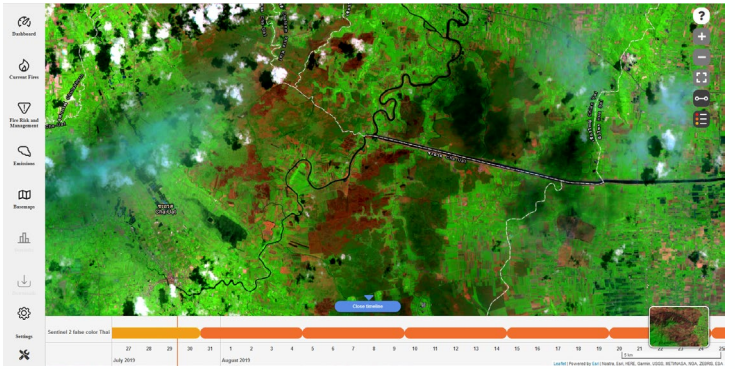
23/05/2022

# Background: firemaps.net – a fire information platform

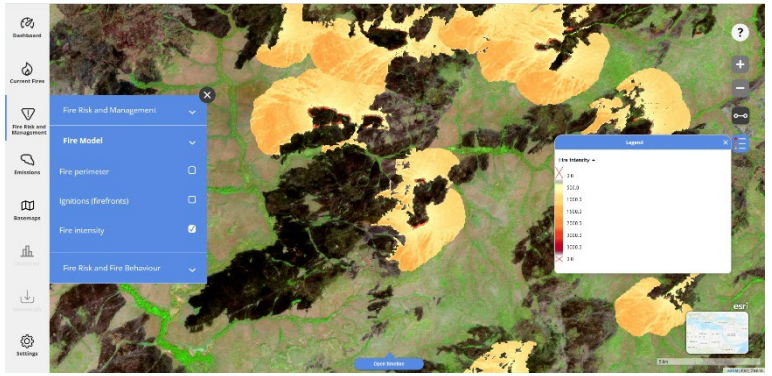
firemaps.net



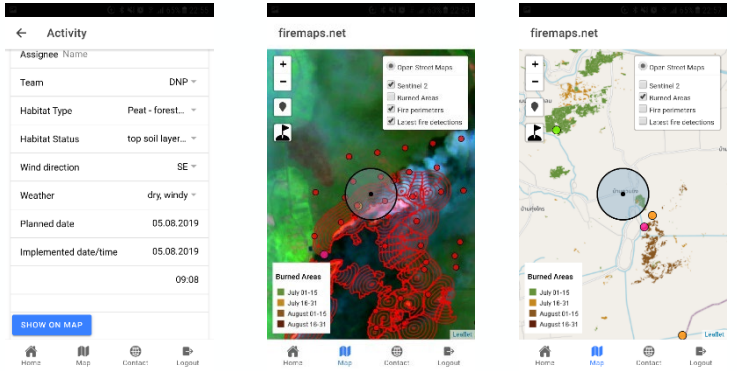
NRT Dashboard



Satellite derived burned area, GHG emissions



Online fire spread model, fire risk model




Mobile App

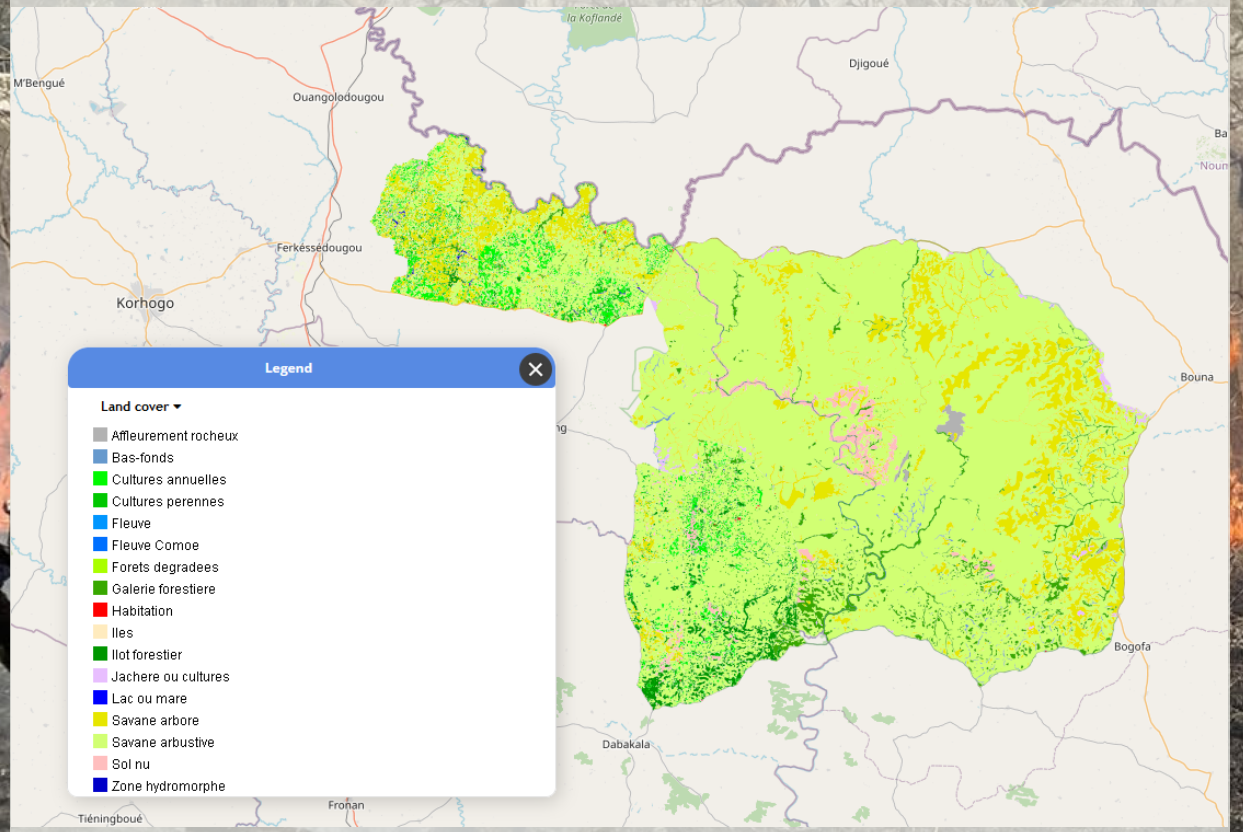
Firemaps.net is a web based information system on fires

It helps fire managers and other decision makers to asses fires in their areas of responsibility and plan, track, report and evaluate management action

Here we report on R & D results on fire intensity

ZEBRIS

# Key ecological facts and study area




In savannas, trees and grasses coexist

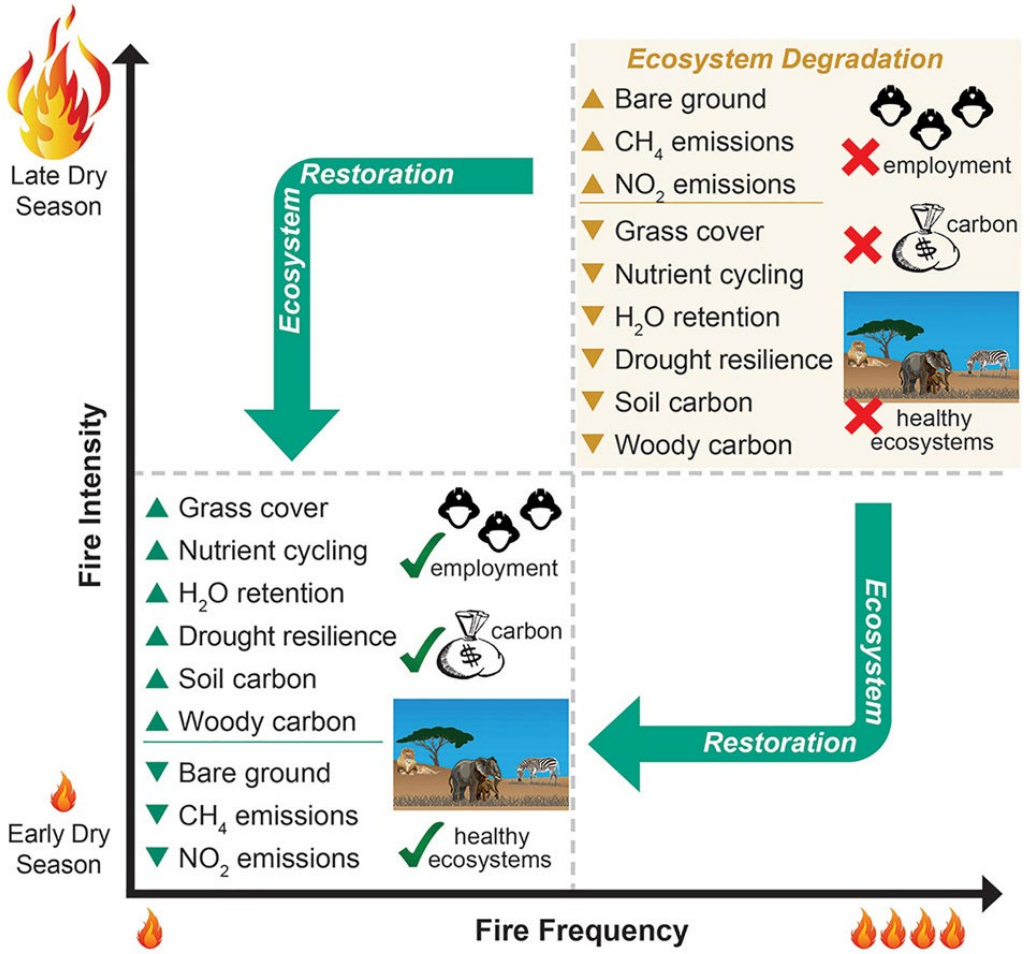
Fire and herbivory determine whether trees or grasses dominate

Depending on their influence, and climatic and soil conditions, savannas can transform to forests or grasslands

This has substantial implications on the functioning of the system: biodiversity, livelihoods, carbon stocks and fluxes….

The Comoé park in Northern Côte d'Ivoire is one of West Africa's largest protected areas - a UNESCO World-heritage site with exceptional biodiversity

# Shift fire regimes for improved carbon managment?




Source: Tear et al. One Earth, 4,12, 2021

A fire regime describes fire characteristics in a landscape: timing of fires, frequency, intensity,…

Recently, shifting fire regimes to Early Dry Season Burning in savannas has been proposed as a means to reduce emissions and create better landscapes

One assumption is that early season fires per se are less intense and emit less GHG‘s

BUT: this has been disputed on various grounds

One of them is that fire intensity is strongly influenced not only by season but also by time of day and type of fire

While fire intensity is the most widely used term to describe fires in the wildfire community, there is no EO dataset on it

This is the first derivation of (Byram‘s) fire intensity from space

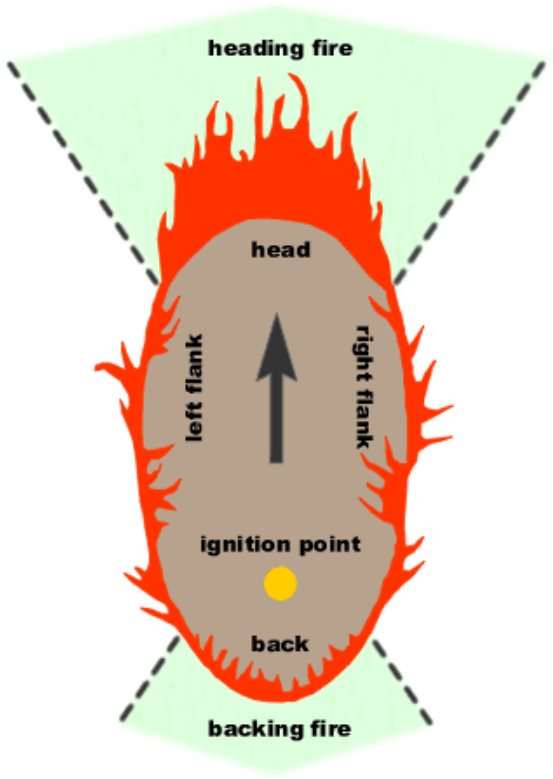
# What is fire intensity and why is it important?

*FI = h*w*r*

*h: heat content of vegetation (+/- constant)*

*w: fuel consumption in the active flaming zone*

*r: forward rate of spread*




Above:

Fuel consumption: ~ 0.35 kg/m²

Rate of spread: ~ 0.05 m/s

Heat content: 16890 kJ/kg

Fire intensity: 330 kW/m (low)

Below:

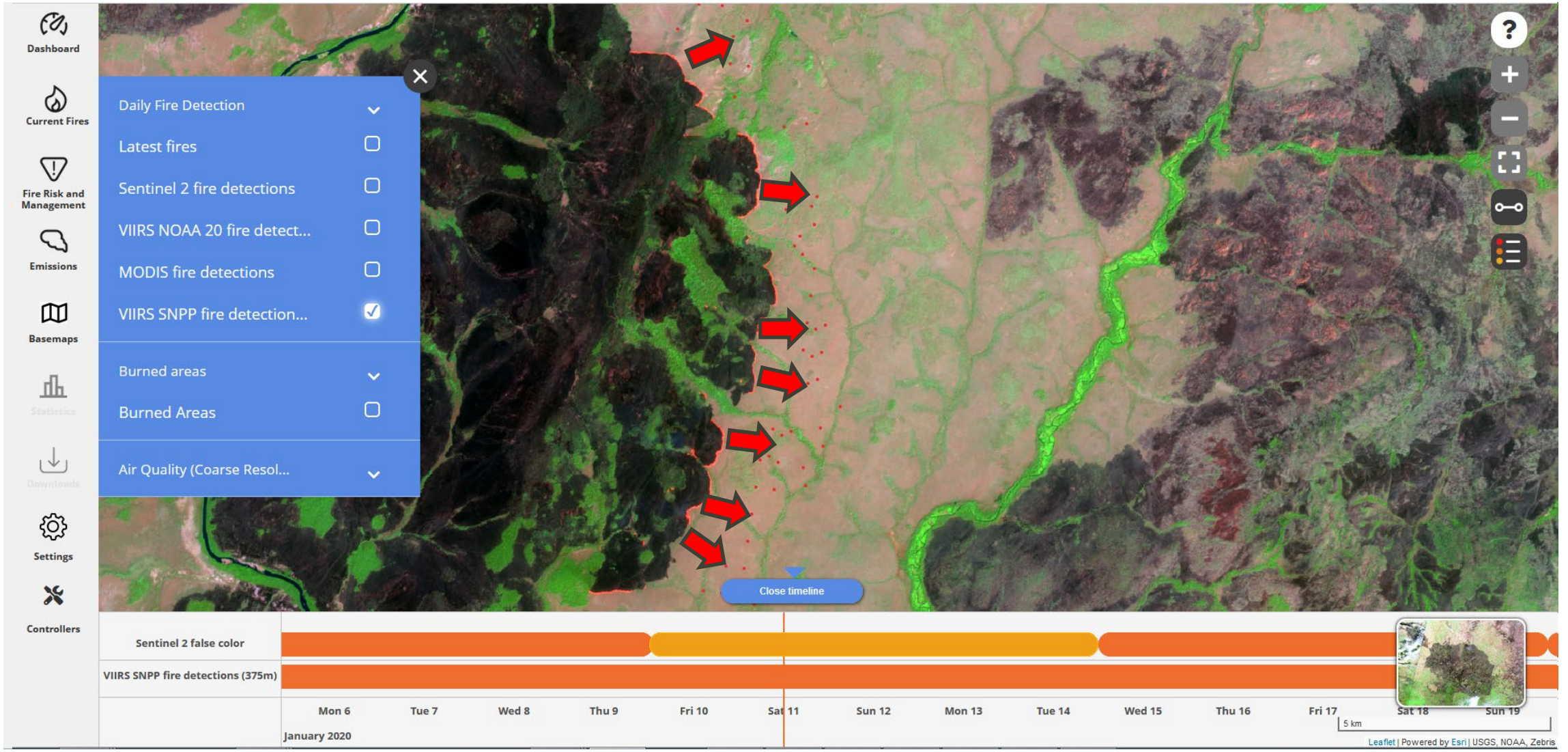
Fuel consumption: ~ 0.45 kg/m²

Rate of spread: 0.45 m/s

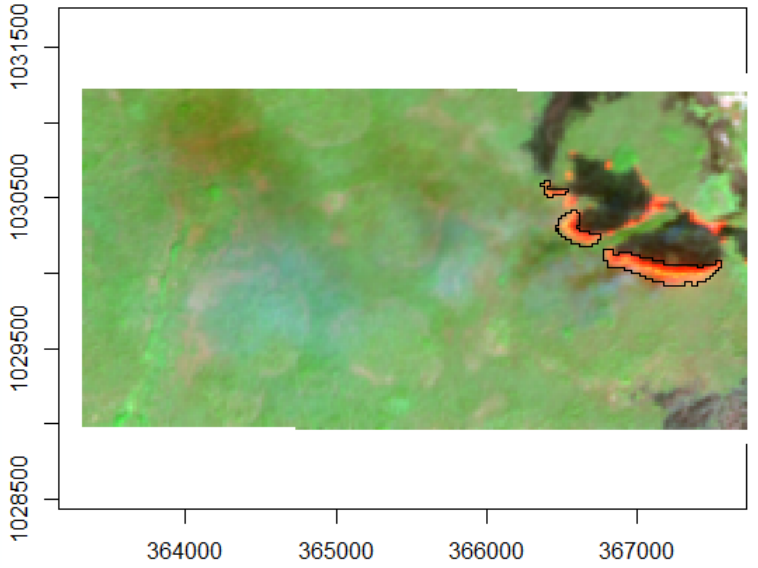
Heat content: 16890 kJ/kg

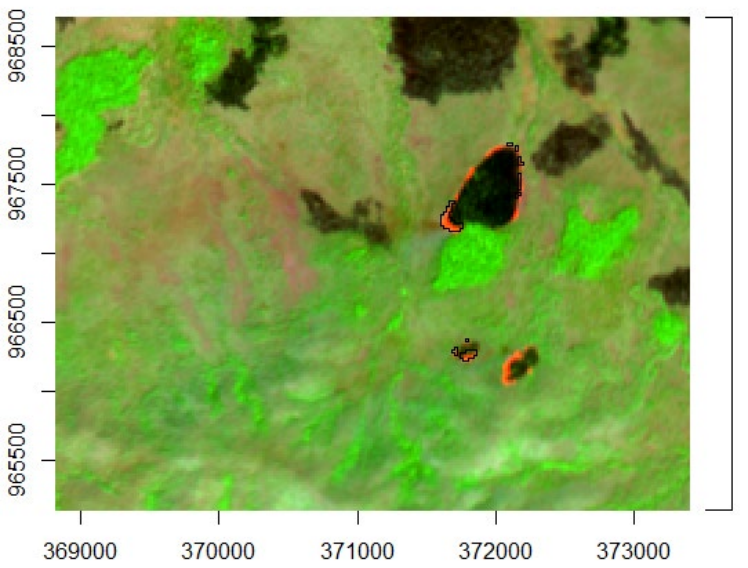
Fire intensity: 3631 kW/m (high)

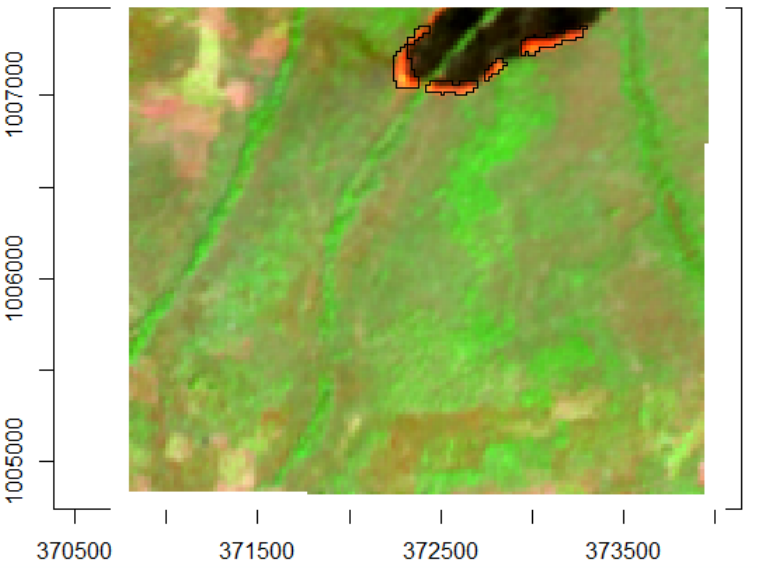
# Fire Rate of Spread seen from space (S 2 -> VIIRS)

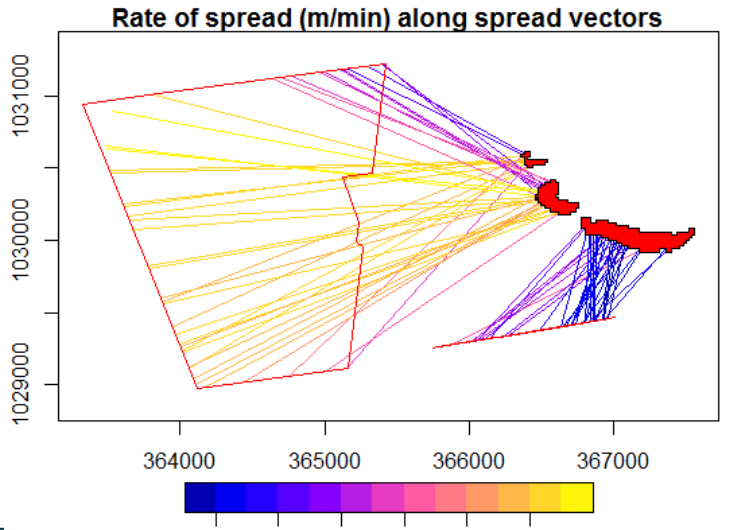


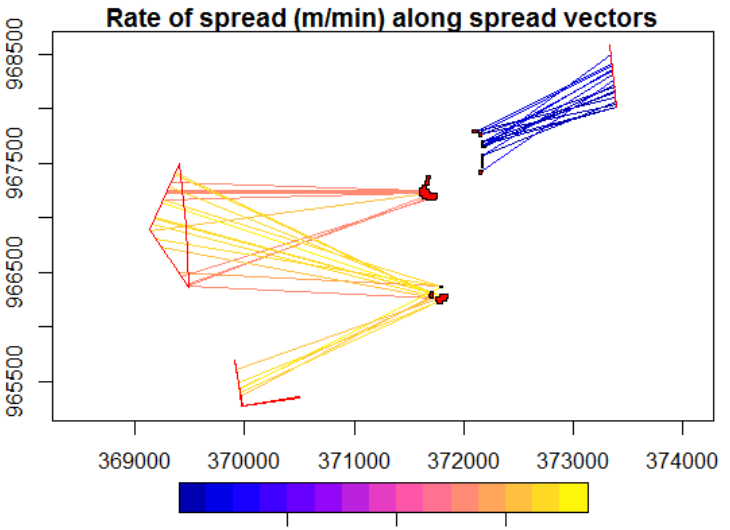
# Estimating Rate of Spread from Space

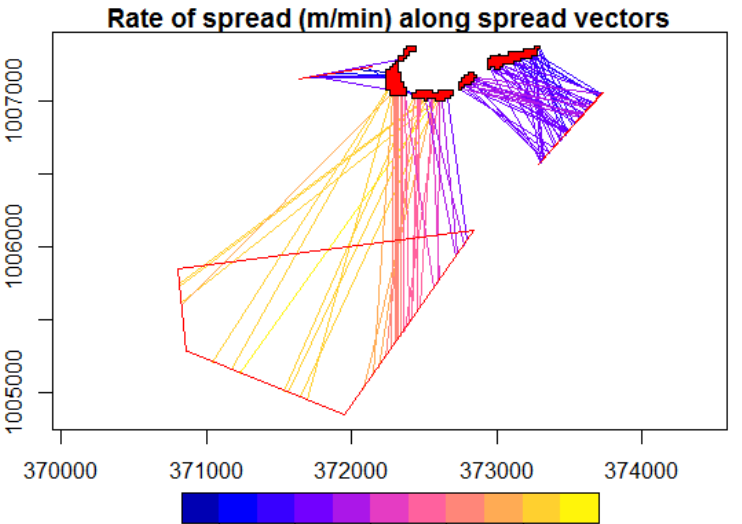


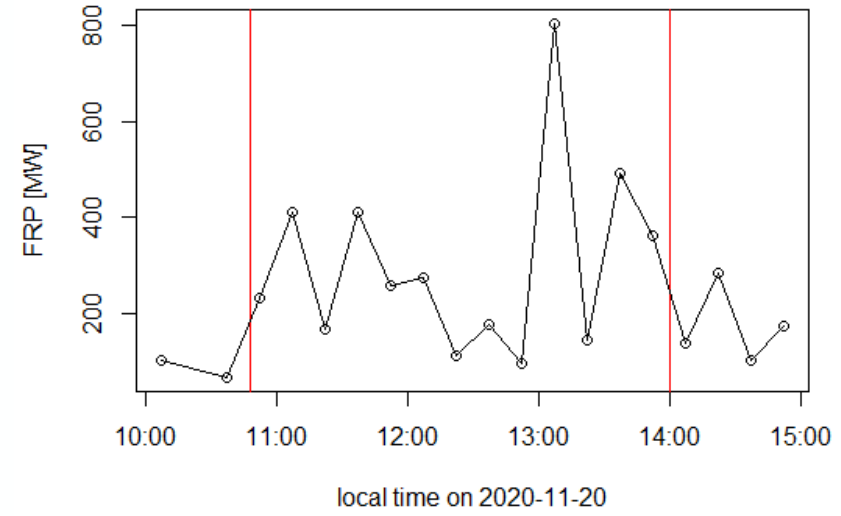



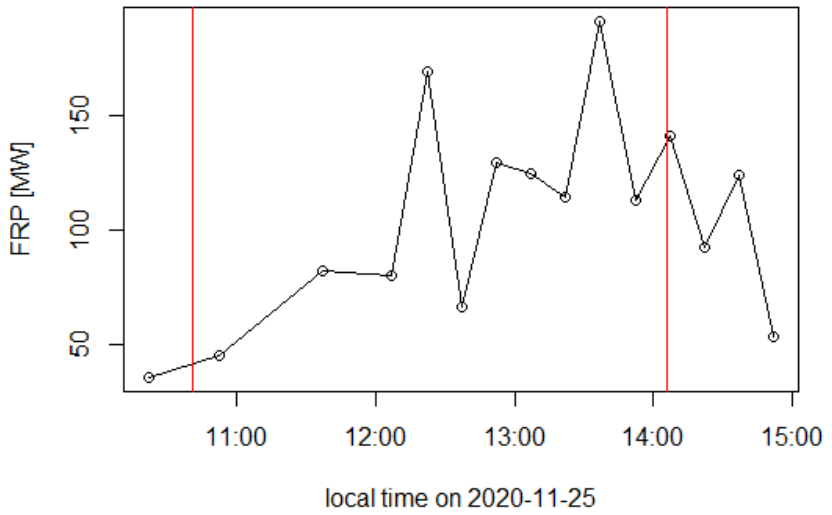



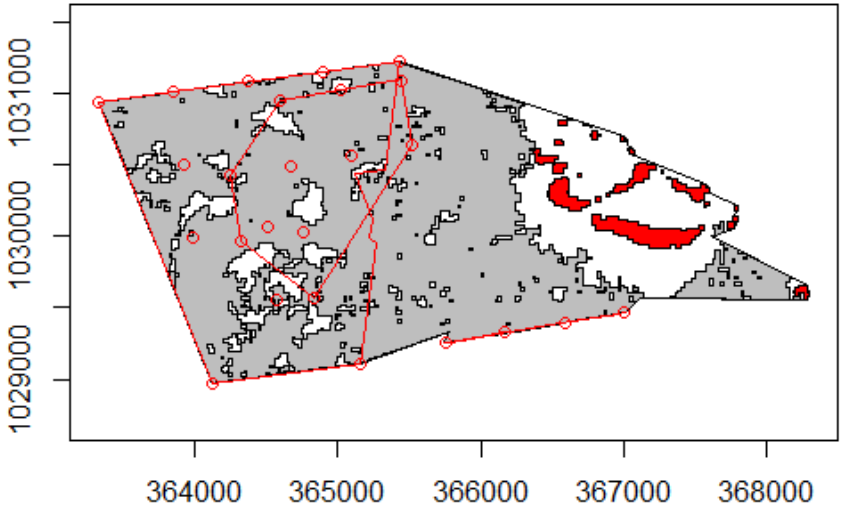
# Estimating fuel consumption: Fire Radiative Power

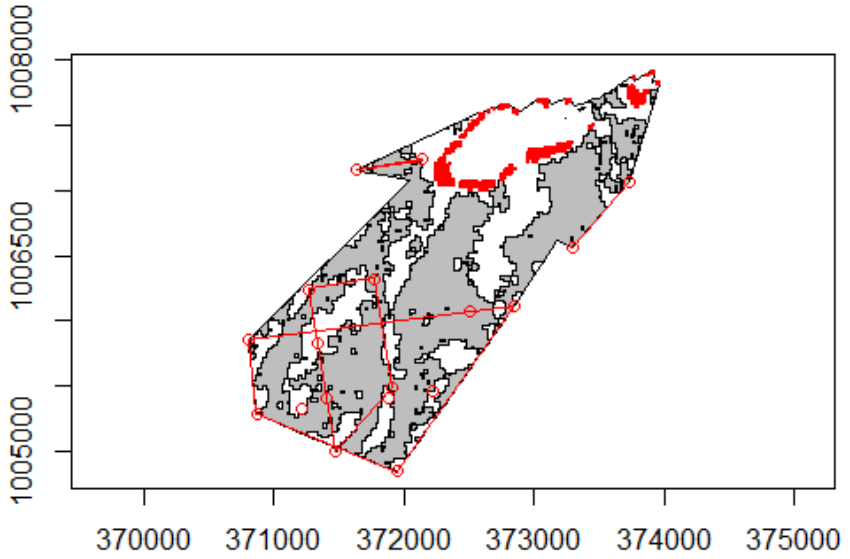



- Fire Radiative Power (FRP) measures the heat release going to radiation (units: MW)
- FRP is linearly correlated to fuel consumption rate
- FRP is assessed from Meteosat observations, available every 15 minutes
- Detections clustered over the respective Sentinel and VIIRS fire detections
- Integration of FRP over time between the Sentinel 2 and VIIRS detections gives total fuel consumption over the cluster area

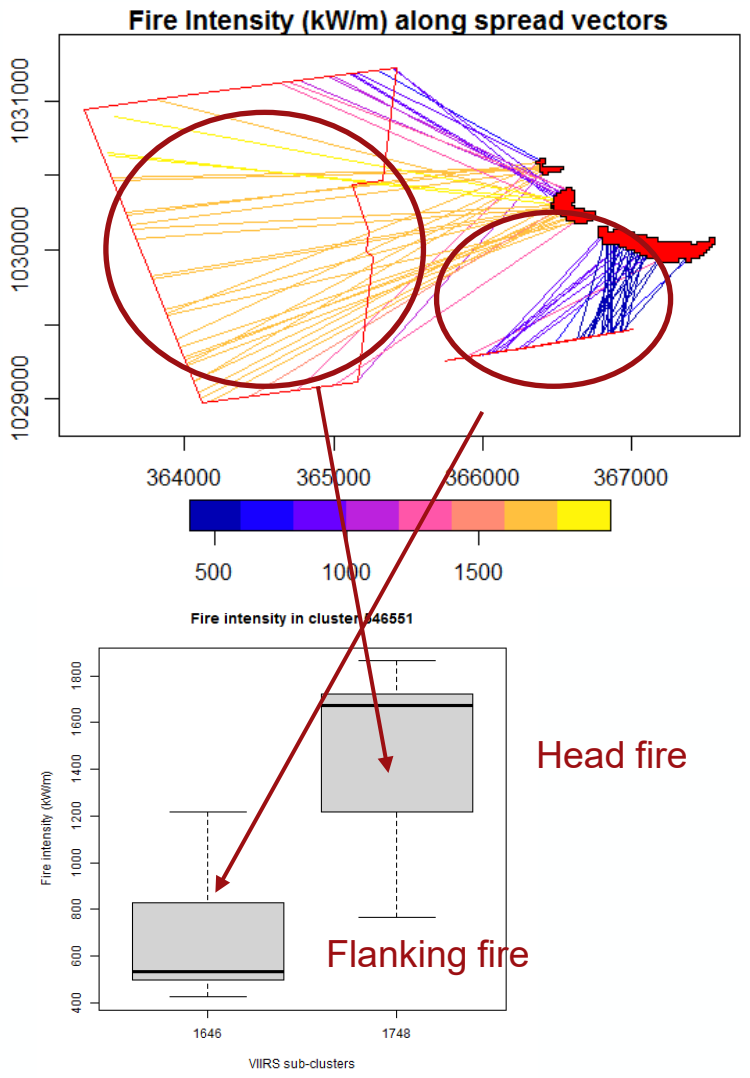
# Fuel consumption per unit area

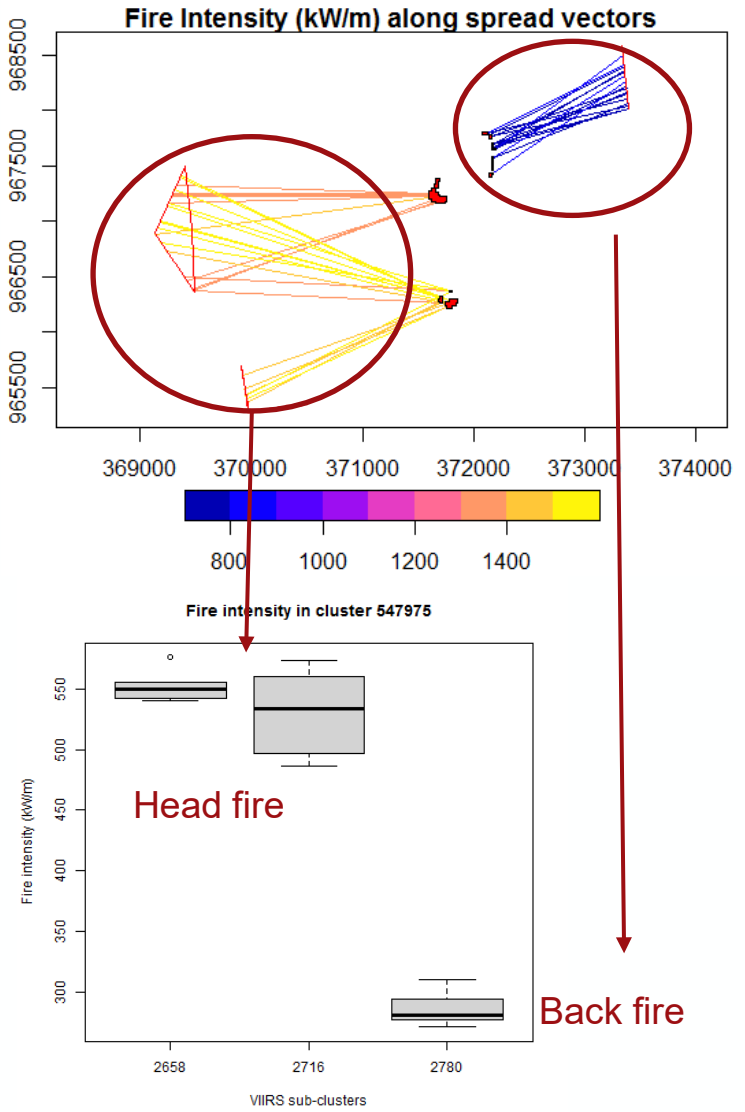


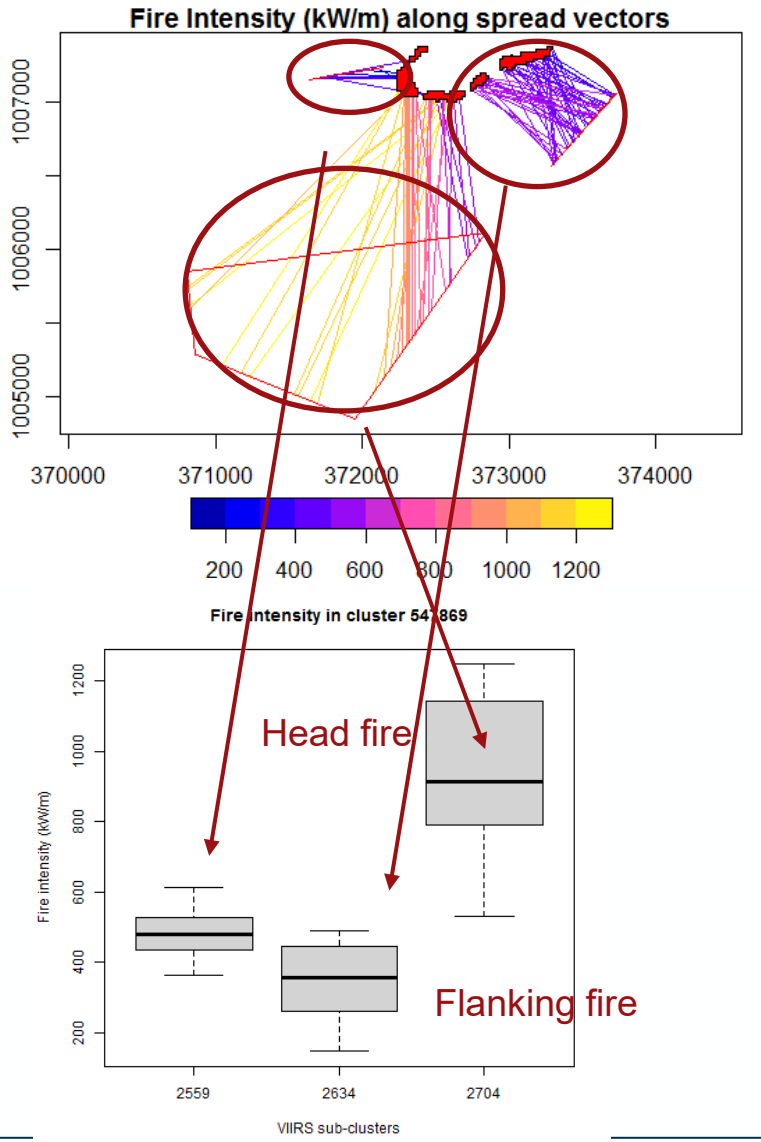




- Burned area is detected from Sentinel 2 data via change detection algorithms
- An envelope (alpha hull) is created around the area covered by the fire between Sentinel 2 and VIIRS overpasses (defined by hulls around fire pixels)
- We assume that the burned area within this hull burned between the two overpasses
- Fuel consumption per m² is calculated by dividing FRP derived cluster fuel consumption between overpasses by burned area between overpasses

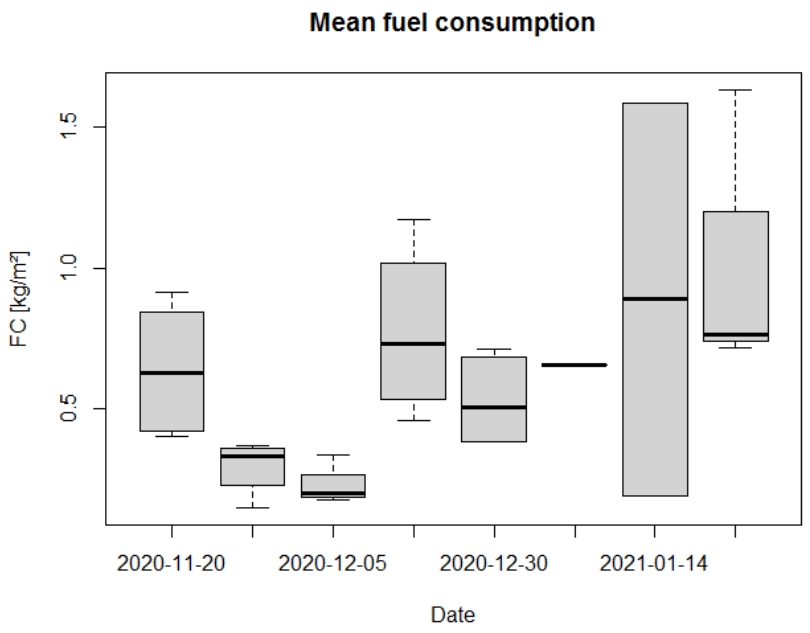
# Fire intensity along spread vectors and fire types

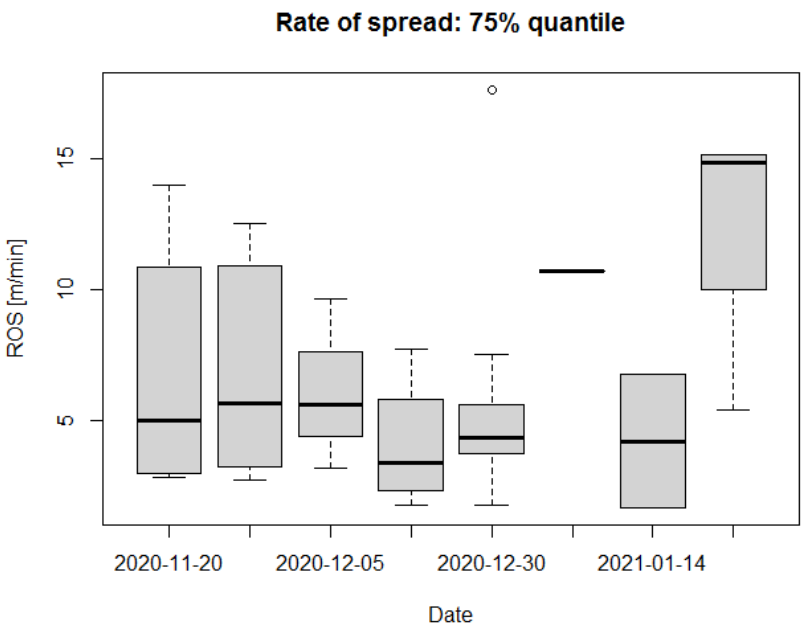


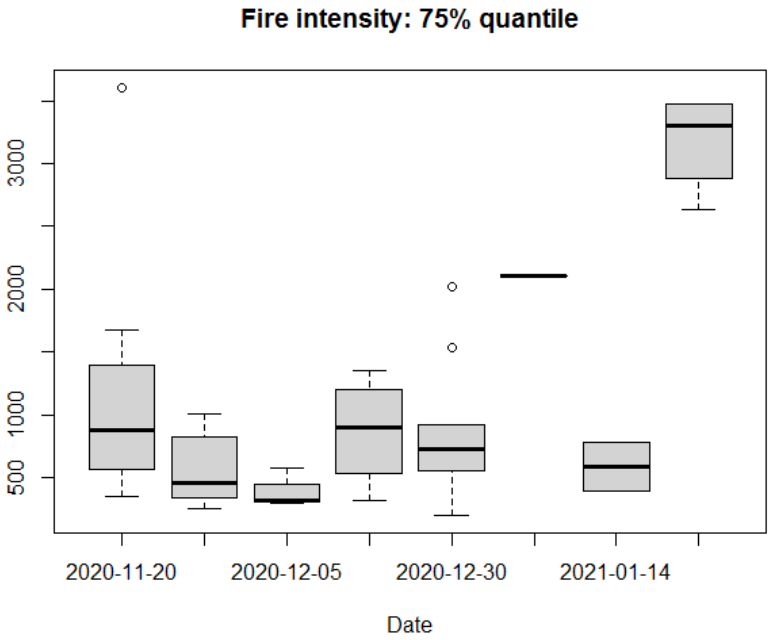



# Fire behaviour parameters for S 2 fire fronts 2020/21



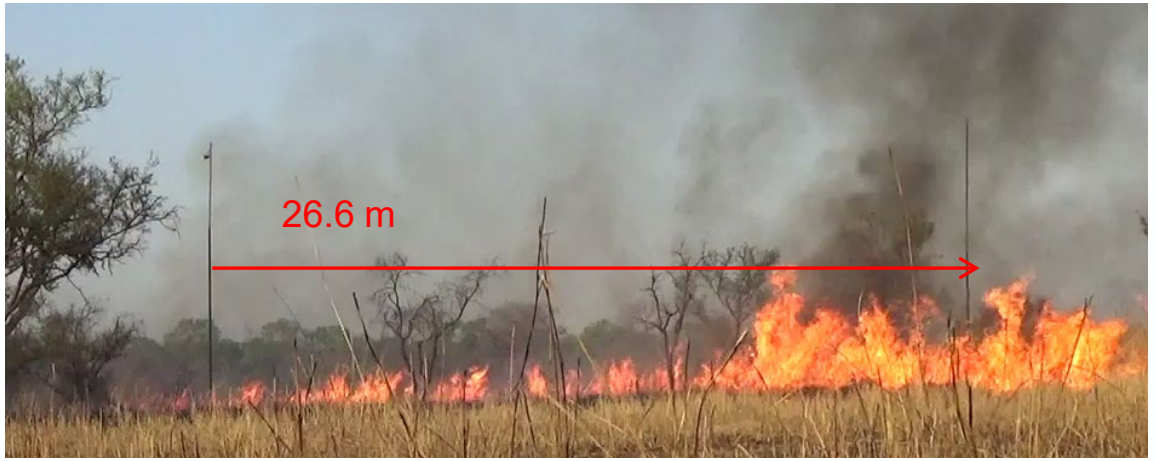



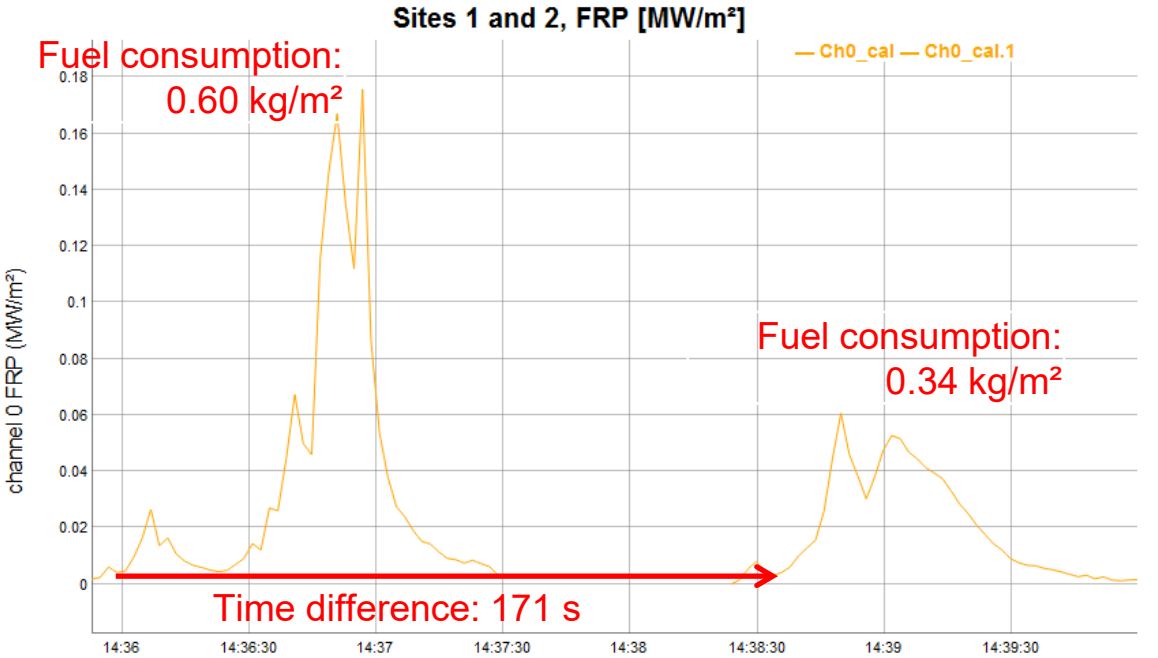




Fire behaviour parameters are within bounds obtained from literature (e.g. and own observations (next slides)

Data for one season and a limited sample indicate occurrence of high intensity fires in Late Dry Season (LDS), but this is not necessarily so, but depends on weather and fire type (i.e. how the landscape is set on fire)

# Fire intensity in field experiment



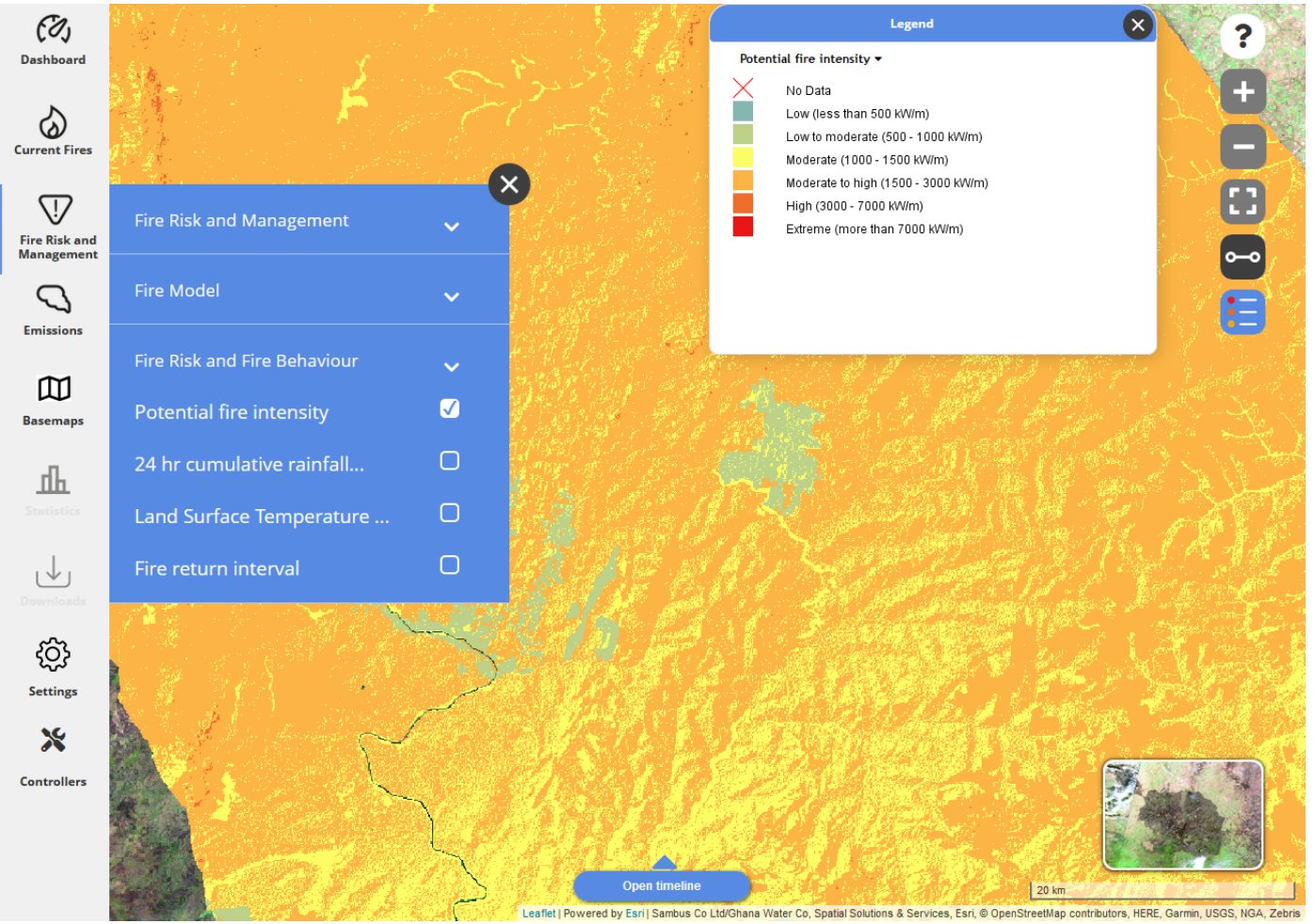



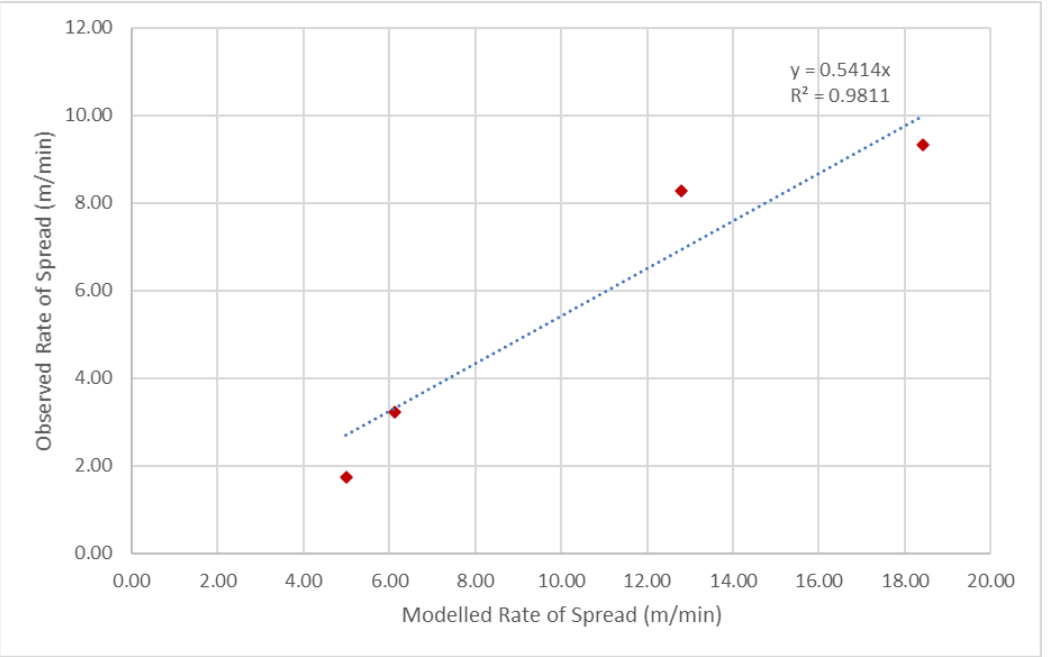

Radiometers mounted on 6 m poles of the fire for FRP

Fuel consumption derived from FRP and sampling

Rate of spread measured by arrival times at radiometer

# Fire intensity: Model versus observations




In firemaps.net, potential fire behaviour (intensity, rate of spread..) is estimated daily based on fuel, terrain and weather (Based on Canadian Fire Behaviour Model)

Experiments and space observations enable better calibration/validation

# Conclusions – Take away

We have – for the first time - demonstrated the feasibility of directly deriving Byram‘s fire intensity through multi-sensor remote sensing

The results shown are a Proof of Concept over a large, frequently burning savanna landscape

A larger multi-year dataset over a larger sub-continental to continental area may have the potential for previously unattainable insight into fire regimes in savannas, thus serving climate mitigation and conservation efforts

The approach is portable to other continents and sensors that can retrieve FRP and / or fire fronts

Errors on the individual components can be constrained (FC, ROS) and thus an error budget established

As this is a POC the product is far from mature, and further research and improvement of methods needed

We are seeking partners for funding and cooperation in developing a mature product

# Thank you

www.firemaps.net info@firemaps.net
www.zebris.com gruecker@zebris.com

Paper: Ruecker et al., Estimation of Byram's fire intensity and rate of spread from spaceborne remote sensing data in a savanna Landscape. *Fire* 2021, 4, 65.

## Acknowledgments

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ZIM Zentrales Innovationsprogramm Mittelstand

OIPR Office Ivoirien des Parcs et Réserves

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

## Awards

Copernicus masters FINALIST 2016 T-SYSTEMS OPEN TELEKOM CLOUD CHALLENGE

Copernicus masters Winner The DLR Environment, Energy and Health Challenge