LPVE23 - WORKSHOP ON LAND PRODUCT VALIDATION AND EVOLUTION

The Fire Radiative Power (FRP) Inter-comparison framework: an approach to identify product differences for non-simultaneous detections

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INTRODUCTION

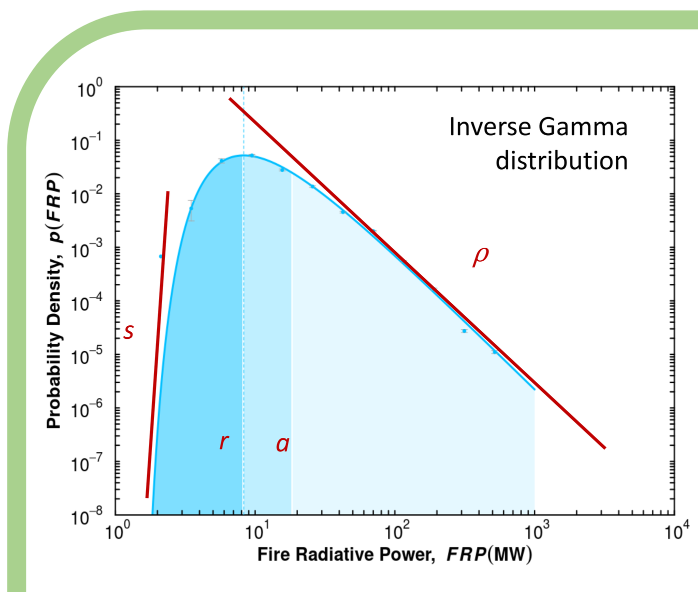
The current method to systematically validate Earth Observation (EO) based Fire Radiative Power (FRP) products relies mostly on the intercomparison between products **without clearly identifying** one as the **reference dataset**. In addition, due to the highly dynamic nature of fire, comparisons are mostly restricted to near-simultaneous detections between polar and geostationary based products. Here, we propose a new comparison framework that overcomes these limitations by comparing each product's capability in capturing the full fire event **power detection range** and its **characterized fire signature**.

DATA & METHODS

In this framework, we inter-compare eight operational remotely sensed Fire Radiative Power (FRP) products: eight polar-orbiter products derived from active fires and five geostationary products. This novel approach is based on a **robust statistical analysis of the frequency density (f-D) distributions** of each product's active fire detections, whereby an **Inverse-gamma distribution** is used to characterize the **fire statistical signature**, providing a reference baseline on to which FRP products can be compared, and their representation uncertainty assessed.

Product Name	Platform/ Sensor	Spectral channel	Spatial resolution	Temporal coverage	Spatial coverage	Units	Unc	Reference/Data provider
MSG FRPPixel	MSG/SEVIRI	3.92 [range 3.48-4.36]	3-5.3 km	2005-2021 (15 min)	Hemispheric	MW	Y	Wooster et al., 2012 LANDSAF (https://landsaf.ipma.pt/)
MSG IODC FRPPixel	MSG/SEVIRI			2017-2021 (15 min)				
KCL/IPMA_GOES17	GOES-17/ABI	3.90 [range 3.80-4.00]	2-3.5 km	2020-2021 (10 min)				
KCL/IPMA_GOES16	GOES-16/ABI			2018-2021 (10 min)				
KCL/IPMA_HMWR	HIMAWARI/ABI			2019-2021 (10 min)				
MOD14ML	TERRA/MODIS	3.95 [range 3.39 - 3.99]	1 km	2001-2021 (Daily-N/D)	Global		N	Giglio et al., 2016 NASA/UMD (fuoco.geog.umd.edu)
MYD14ML	AQUA/MODIS			20032021 (Daily-N/D)				
VNP14ML	SUOMI-NPP/VIIRS	3.74 [bw 0.38]	750 m	2012-2019 (Daily-N/D)				
VNP14IMGML	SUOMI-NPP/VIIRS	3.70 [bw 0.18]	375 m	2014-2021 (Daily-N/D)				
S3A_L2_FRP	Sentinel-3A/SLSTR	S7 or F1 at 3.74 [bw 0.38]	1 km	04/2021-06/2022 (Daily-N)	16 ROI		Y	Wooster et al., 2012 EUMETSAT (https://eoportal.eumetsat.int/cas/)
S3B_L2_FRP	Sentinel-3B/SLSTR			04/2021-06/2022 (Daily-N)				
C3S FRP V1.1	Sentinel-3A/SLSTR			03/2020-02/2021 (Daily-N)	Global			Xu et al., 2020 C3S (https://cds.climate.copernicus.eu/)
C3S FRP V1.1	Sentinel-3B/SLSTR			03/2020-12/2022 (Daily-N/D)				

We focus on **annual detection periods** and perform the analysis at **0.5° grid cell** resolution (with 100 min counts), for the full time-series of each product/ The results are analysed for their **temporal and spatial consistency**, and inter-product differences are analysed in the context of its drivers.



$$p(FRP|\rho,a,s) = \frac{1}{a\Gamma(\rho)}\left[\frac{a}{FRP-s}\right]^{\rho+1}\exp\left[-\frac{a}{FRP-s}\right]$$

Shape parameter, (ρ)
Right hand side exponent associated with events. power-law relation associated with nature's self-organized critical behaviour.

Location parameter, (a)
Identifies the FRP threshold below which detection relations detach from a power-law relation

Rollover parameter, (r)
Identifies the FRP threshold below which a detection algorithm/sensors are limited

Scale parameter, (s)
Left hand size exponent associated with the rate of decay of detections

CONCLUSIONS & FUTURE WORK

This proposed framework is a useful tool to compare non-simultaneous based FRP products, contribute to identification of the main FRP product uncertainty sources, and provide a knowledge management tool for identifying where and when product inconsistencies occur. Preliminary results show that:

- **Spatial consistency** in the shape parameter between the products
- **Temporal consistency** in the rollover parameter for each product.
- Geostationary satellite based detections are **under-represented at larger VZA angles**.
- Differences can be identified between detections made by Identical sensors.
- **Large shape parameter** differences can highlight **potential algorithm/sensor issues**.

Further work should focus on assessing the impact of some of the key non-fire effects, such as: pixel size, pixel area growth off-nadir, algorithm limitations, quality information, and its uncertainty sources. Understanding each product limitations is essential for deriving higher level (L3/L4) products, in this context, this approach is a contribution for the retrieval of conversion factors for product harmonization.

REFERENCES

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Wooster, M.J., Roberts, G., Freeborn, P.H., Xu, W., Govaerts, Y., Beeby, R., He, J., Lattanzio, A., Fisher, D. and Mullen, R., 2015. LSA SAF Meteosat FRP products–Part 1: Algorithms, product contents, and analysis. *Atmospheric Chemistry and Physics*, *15*(22), pp.13217-13239.

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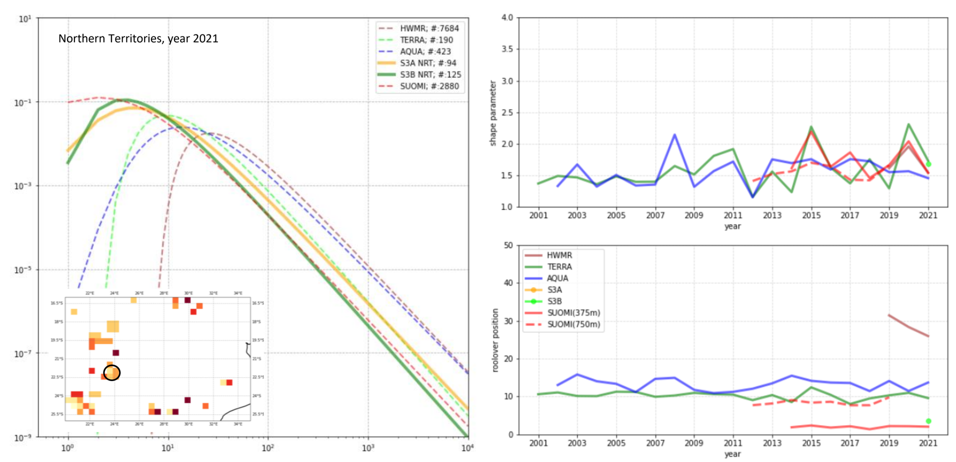
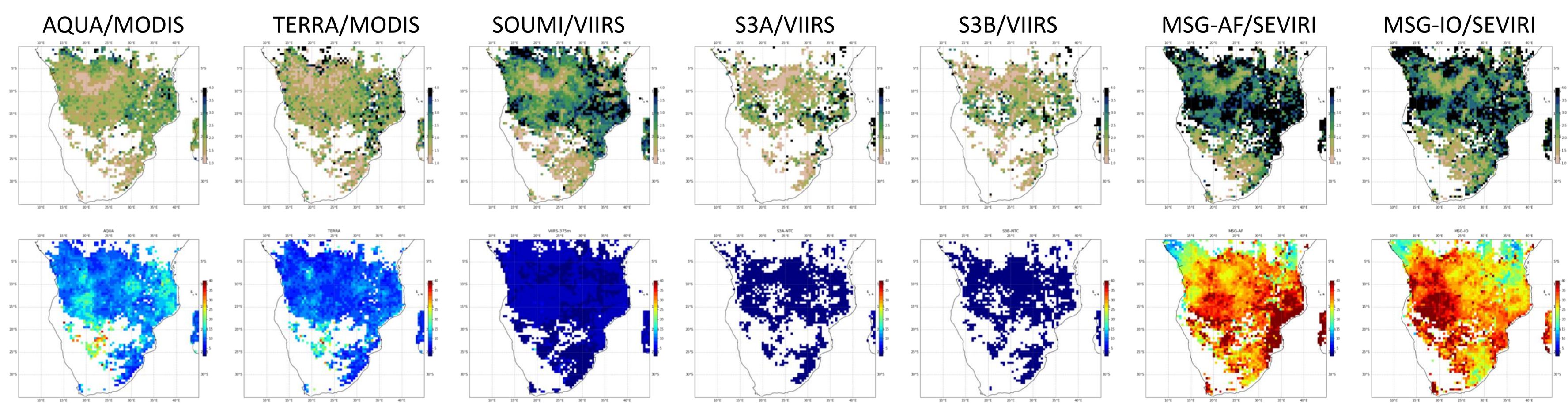
RESULTS

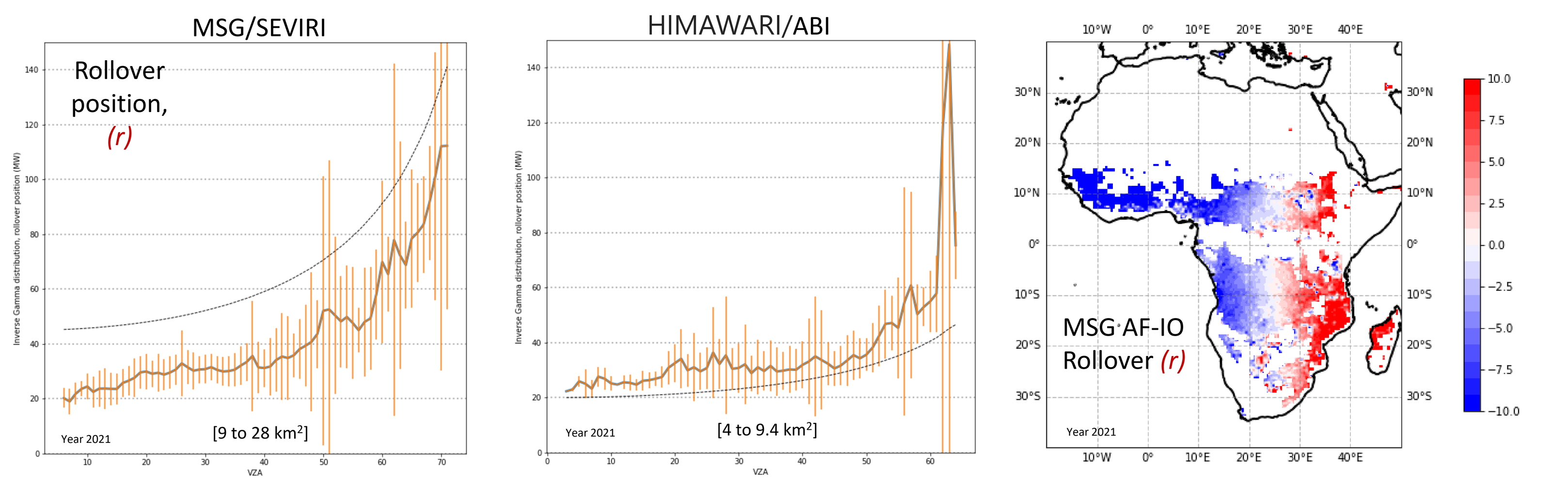
- The rollover parameter show the **degree of under-representation** of each sensor's detections, which typically precludes the detection of a proportion of the highly numerous but individually relatively small and/or low intensity fires. Shape parameter identify the relation between each detection within the same sensors.



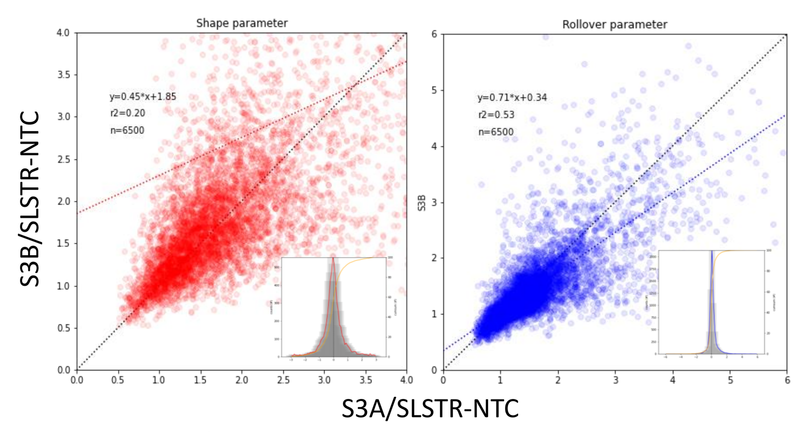
- Spatial variability of the product's **shape parameter are similar**, but can differ in magnitude. Differences are mainly driven by what each product grid-cell coverage, with SOUMI/VIIRS and MSGs having highest coverage, and characterized by higher shape parameter values. In terms of the **rollover parameter**, the products magnitudes are driven by each **sensor' spatial resolution**.

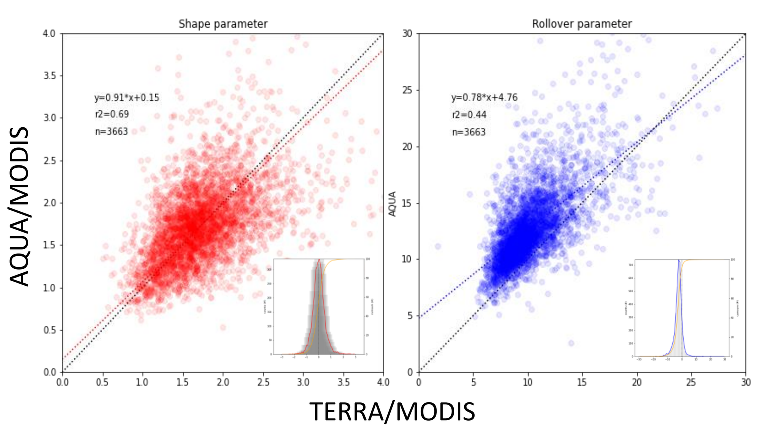


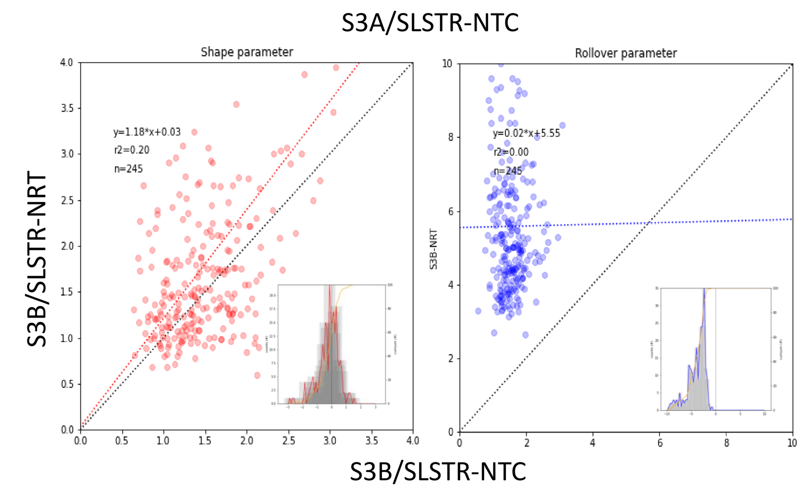
- For Geostationary-based FRP detections there is a **dependency of the pixel size** on the position of the roll-over parameter, meaning that detections below this **threshold** are **under-represented**. The pattern can be clearly seen in the mean rollover parameter by VZA bins. This means that **compatible representation** between the MSG AF and IO is only possible within a narrow longitude band.



- Differences in the fitted parameters **between identical sensors** can be identified. Although minimal compared with non-identical sensors, these need to be further investigated for their causes as they can be attributed to the **environment, sensor or algorithm**.







- Large differences in the shape parameter could **identify potential error**, either refer to false detections or due to sensor saturation. The example shows suspicious areas where the SUOMI/VIIRS – S3A/SLSTR-NTC differences are higher than 1.5