European Commission (EC)
GOFC GOLD Fire Implementation Team (GOFC Fire IT)

5th GWIS and GOFC-GOLD Fire IT meeting
21st-22rd June 2022

Hotel Regina Palace
Corso Umberto I, 29, 28838 Stresa VB, Italy

14.40 – 15.00 Coffee break [20 minutes]

15:00 – 16:10 Active fire detection research & products (Chair: Josh Jhonson)

…

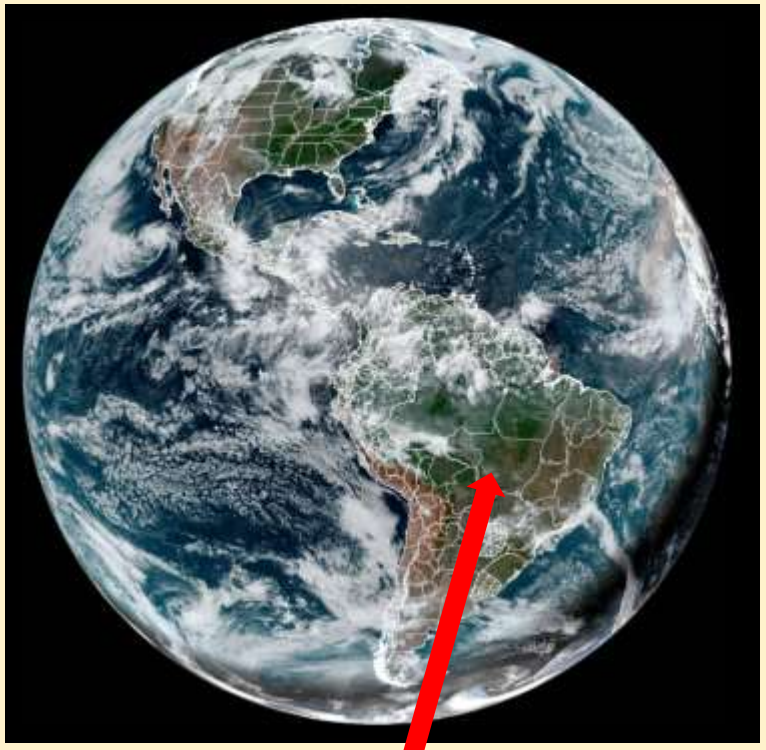
…

The current GOES & MSG INPE fire detection algorithm, Alberto Setzer, P.S.S. Victorino, M.J. Bottino and F. Morelli (Brazil) [15 minutes]

INPE - Instituto Nacional de Pesquisas Espaciais
ProgramaQueimadas
Monitoramento por Satélites

Images from two Geostationary satélites can monitor vegetation fires over Brazil
(GOES-ABI 02 km nominal spatial resolution **every 10 minutes**;
MSG-SEVIRI 03 km nominal spatial resolution **every 15 minutes**)

GOES-17 “West” ~ 137º W
(Extremely limited)



GOES-16 “East” ~ 75º W
(Very good)

MSG-11 ~ 0º
(Limited)

One of the limitations: pixel footprints can vary up to 8 times depending on the viewing angle (and there is not much you can do about it ...)

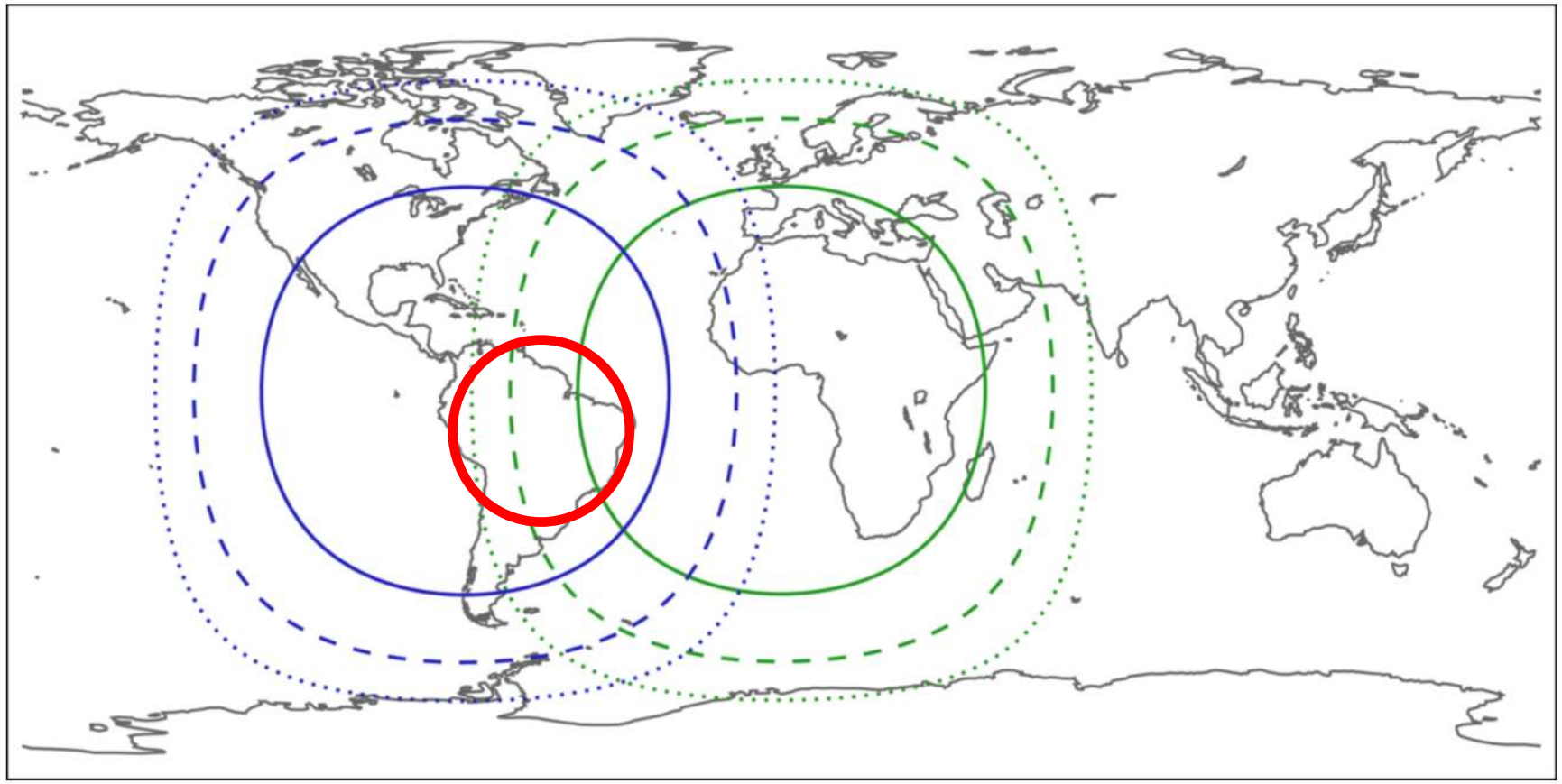


Fig. 1. Spatial coverage of geostationary fire data from the MSG SEVIRI (dark green outline) and GOES-16 ABI (blue outline) sensors used in this study. Solid, dashed, dotted lines indicate the boundaries at which the area of the pixel footprint grows to a factor of 2, 4, and 8 times larger than at the sub-satellite point. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

Validation of GOES-16 ABI and MSG SEVIRI active fire products

J.V. Hall[a,*], R. Zhang[a], W. Schroeder[b], C. Huang[a], L. Giglio[a]

Sunglint is a major fator that impairs day-time detection of vegetation fires with the 3.7–4.2 μm band, and in all satellites.

The sun light reflection is clearly seen in this picture taken by astronauts at the International Space Station with sunglint highlighting the ocean coast and the main rivers in southeast Brazil. The date was 25/August/2019, at the peak of the fire season – thus the smoke pall to the West.

Source:
https://eoportal.org/web/eoportal/satellite-missions/i/iss-sample-imagery-2019

On that ocasion (25/August/2019) uncontroled fires in Brazil, Bolivia and Paraguay were in the headlines, and even the G-7 met to discuss the Amazon situation.

earthobservatory.nasa.gov/images/145522/fire-burns-in-paraguay-bolivia-and-brazil

Images | Global Maps | Articles | Blogs

earth observatory

Fire Burns in Paraguay, Bolivia, and Brazil

Natural color — SWIR overlay

Natural color - August 25, 2019 — JPEG

SWIR overlay - August 25, 2019 — JPEG

View Both Images

Since the beginning of August 2019, NASA satellites have observed fires burning near the border of Bolivia, Paraguay, and Brazil.

Instrument:
Landsat 8 — OLI

Heat | Land | Fires | Human Presence | Remote Sensing

Since the beginning of August 2019, NASA satellites have observed several fires near the border of Bolivia, Paraguay, and Brazil. (Note that this area is not in the Amazon rainforest.)

On August 25, 2019, the Operational Land Imager (OLI) on Landsat 8 acquired images of one of the larger fires, which was burning north of the Paraguay River near Puerto Busch. The first image was made using OLI bands 4-3-2 (visible light). The second image includes observations of shortwave-infrared light in order to highlight the active fire. Recently burned areas appear black.

Images from NASA's MODIS sensors indicate that this fire likely burned first in Paraguay and then spread into Bolivia and Brazil by August 19, 2019. You can view a rough time-series animation of the fires from August 1–26 by clicking here.

NASA Earth Observatory images by Joshua Stevens, using Landsat data from the U.S. Geological Survey. Caption by Adam Voiland.

South American Fires in 2019

Fire activity in the Amazon and much of South America often coincides with a dry season from July through October.

View more images like this

References & Resources

NASA (2019, August 27) FIRMS FAQ. Accessed August 27, 2019.

NASA (2019, August 27) Worldview. Accessed August 27, 2019.

NASA Earth Observatory Fire.

NASA Earth Observatory (2019, August 21) Building a Long-Term Record of Fire.

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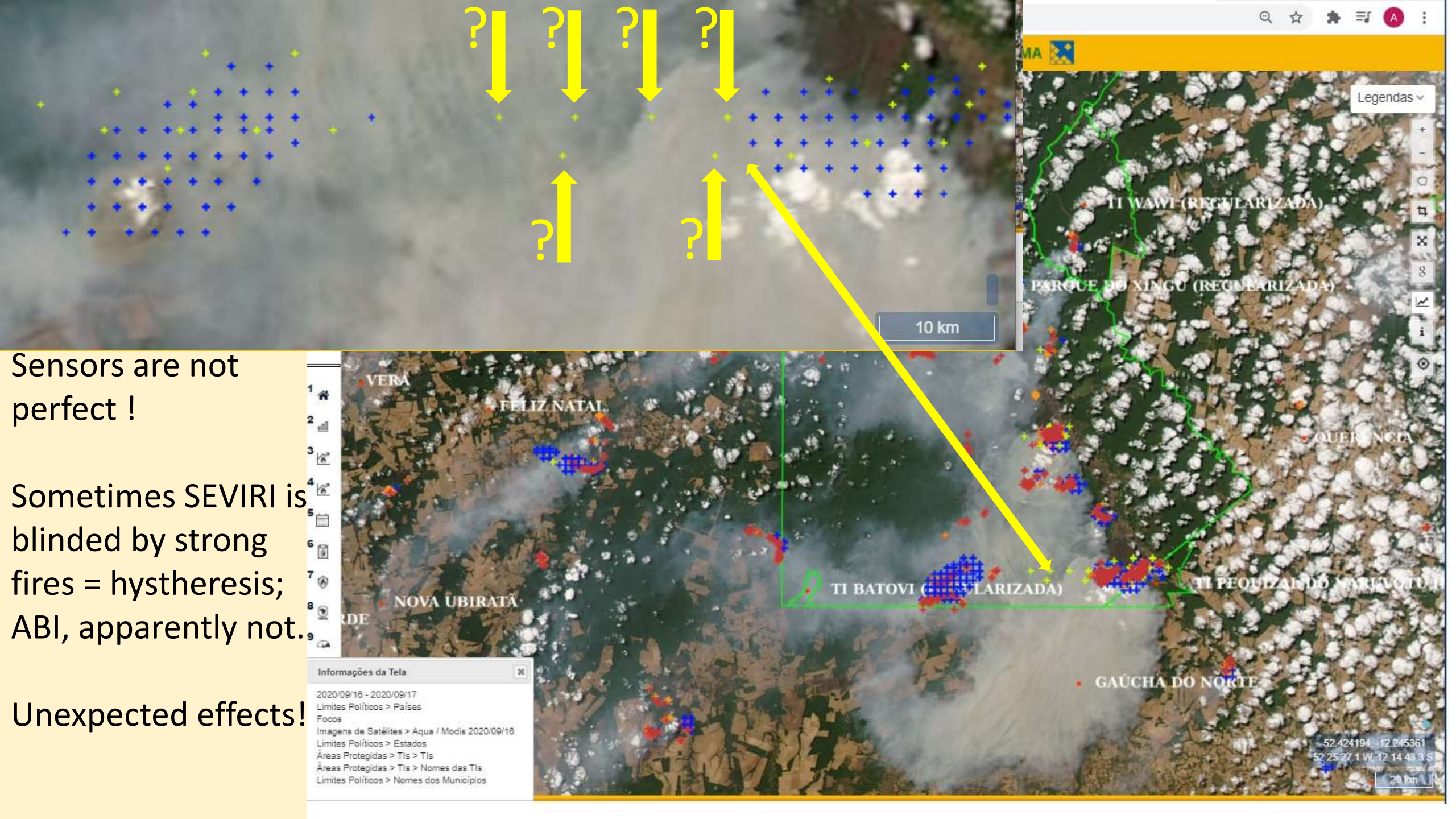
Incêndios

G7 acorda sobre ajuda à Amazônia "o mais rápido possível"

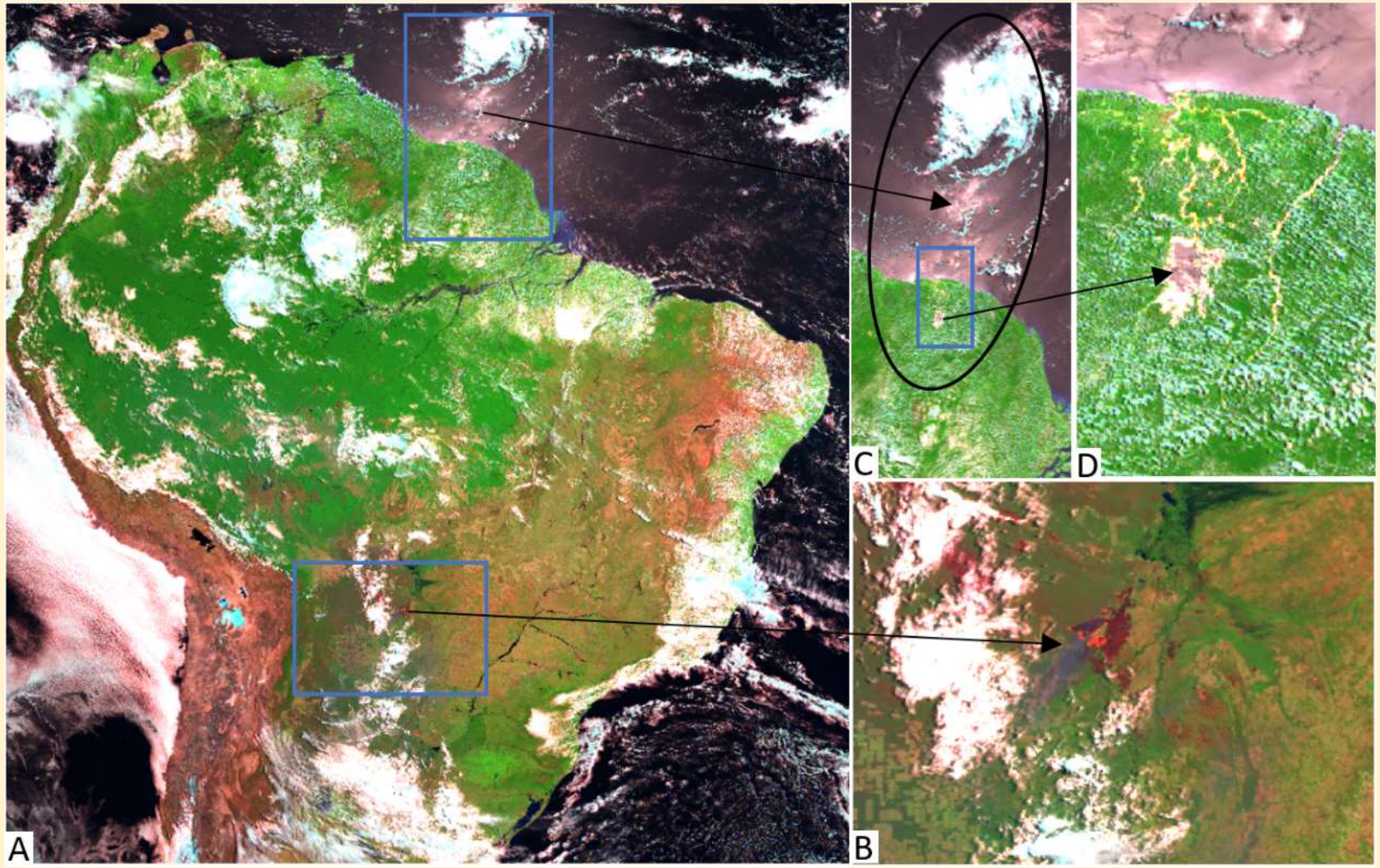
- Trump chega à França para participar da cúpula do G7
- Manifestantes vão às ruas em defesa da Amazônia
- Bolsonaro autoriza uso das Forças Armadas contra incêndios na Amazônia



Sensors are not perfect !

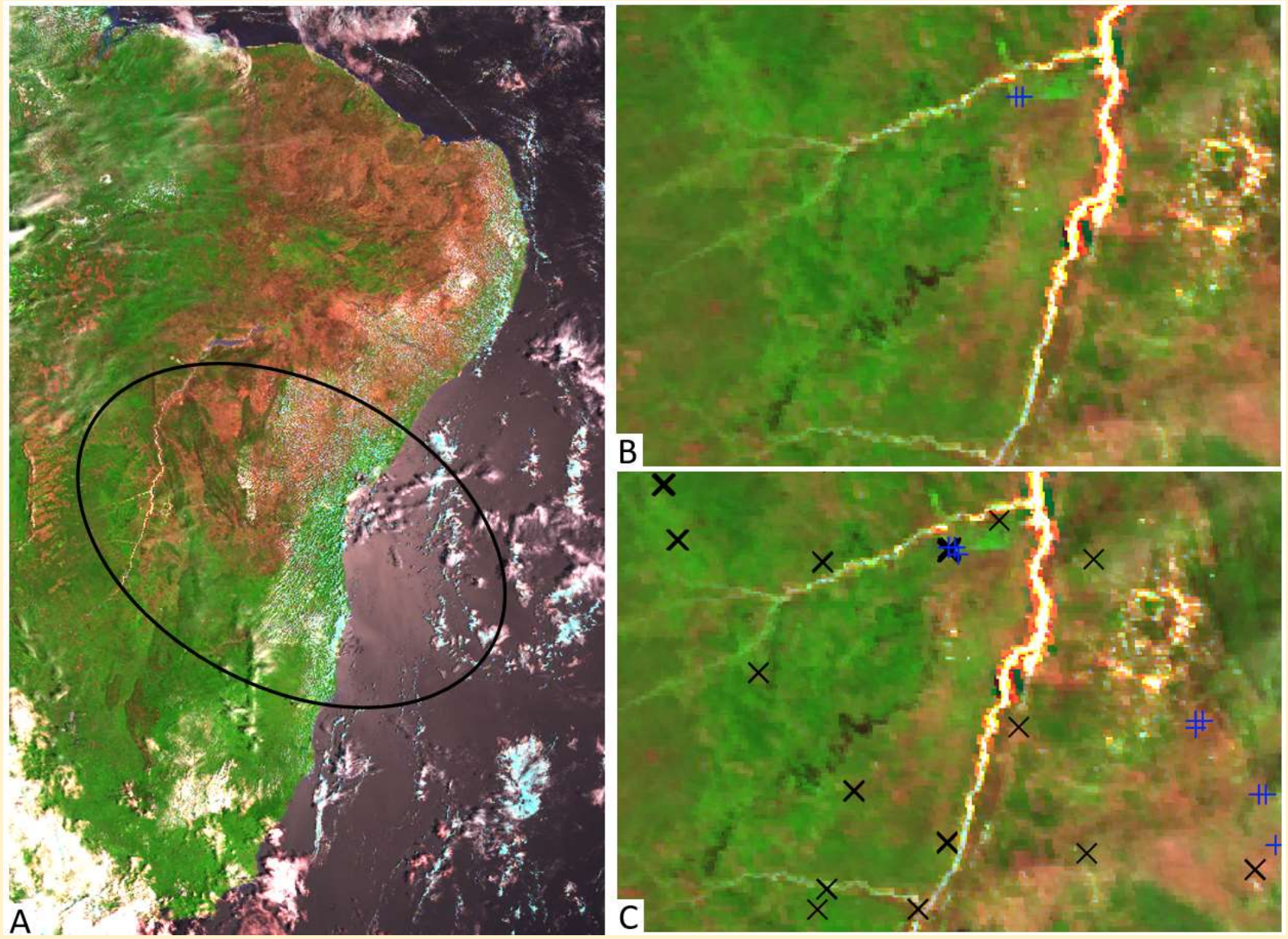
Sometimes SEVIRI is blinded by strong fires = hystheresis; ABI, apparently not.

Unexpected effects!



RGB GOES-16 ABI image combining channels 6, 3 and 2 on 25/Aug/2019, 14h UTC, where [B] shows a large fire in the Pantanal, [C] a sunglint from the ocean, and [D] from lake Brokopondo (D) in the Guyanas.

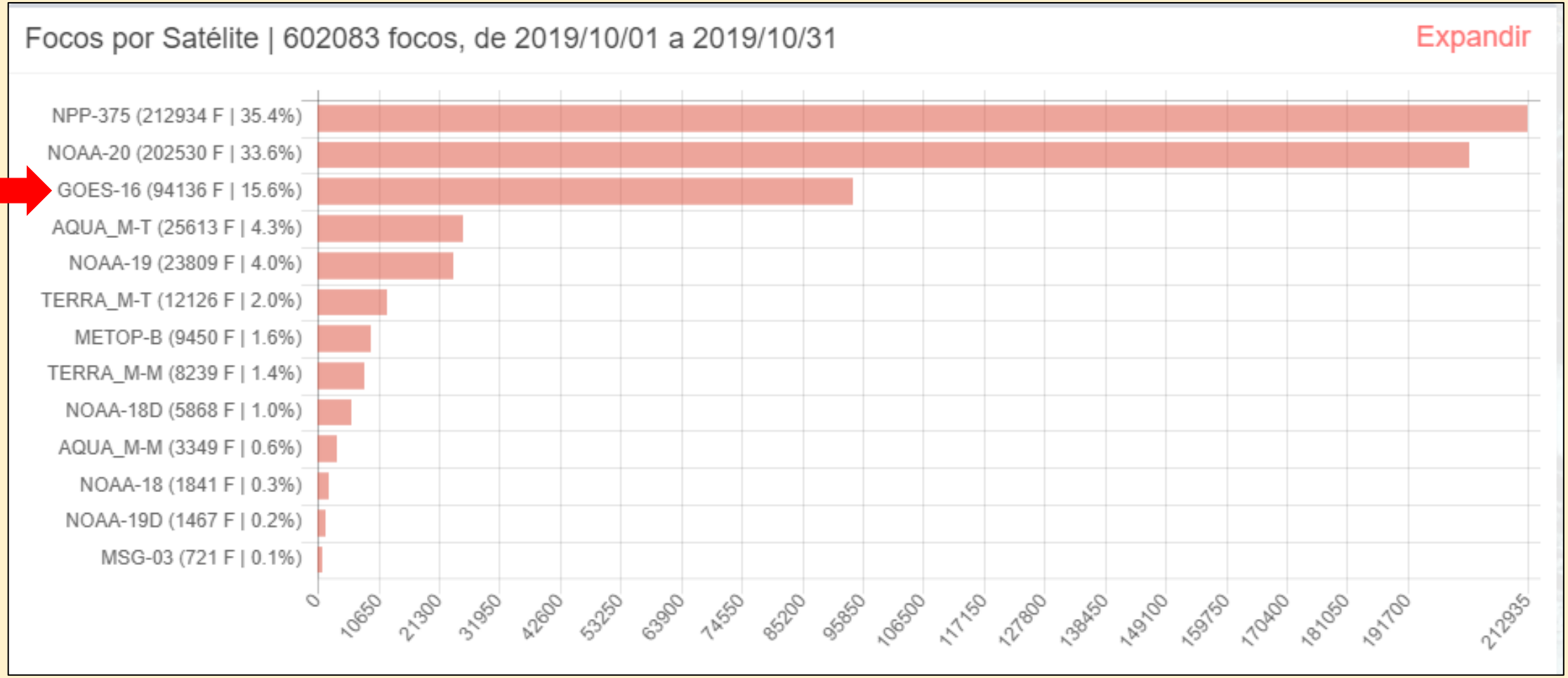
Algorithms must differentiate between active fires and sun glint in the same image, both with similar signals in the 3.7-4.2 μm band.



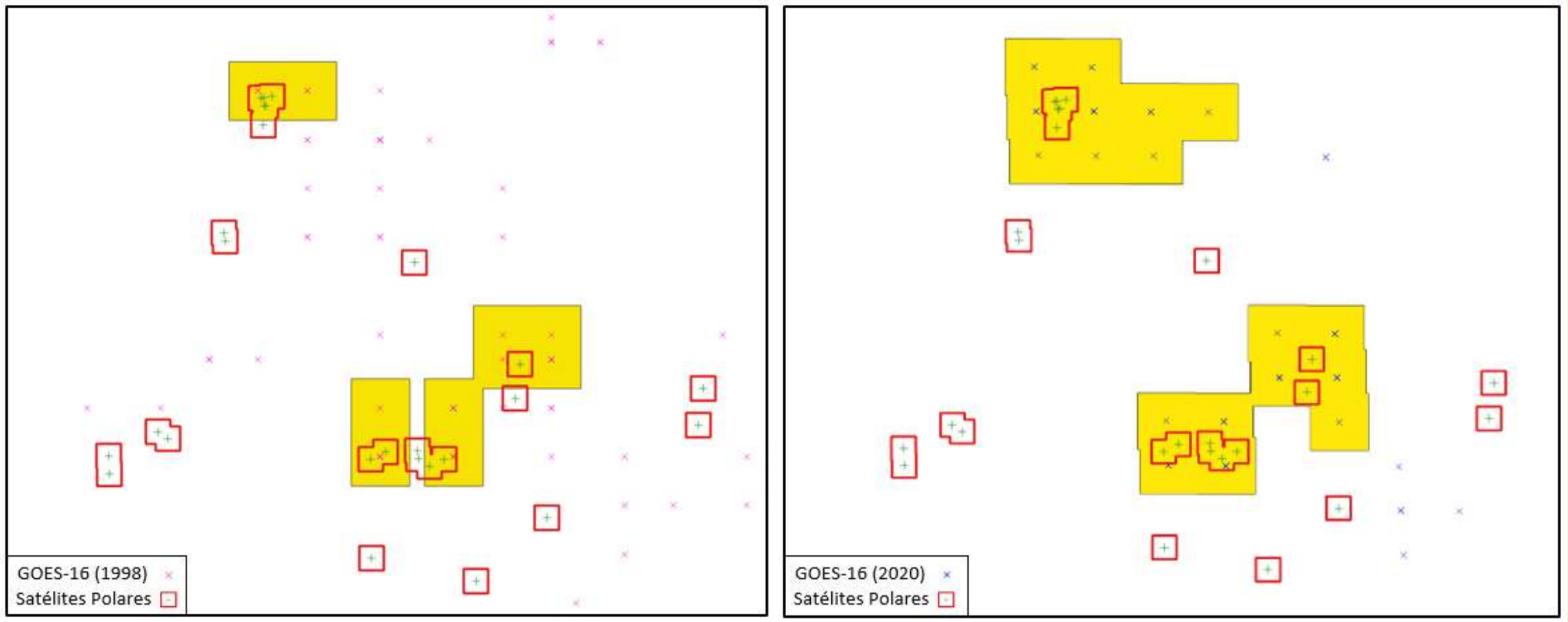
RGB GOES-16 ABI imagefor East Brazil, combining channels 6, 3 and 2 on 22/December/2019, 12h UTC, depicting sunglint conditions in [A] at the Atlantic Ocean and in [B] for the San Francisco River, where two fire pixels were detected at the two blue “+” in the upper part, close to the river.

[C] shows all fire pixels detected by GOES-16 in the same área (blue “+”s) with the fire pixels(black “x”s) from Polar Orbiters AQUA, TERRA, S-NPP and NOAA-20 in the same period. Note the validation of the GOES-16 detections in [B].

Pixels with active fires and sun glint can be very close spatially and the algorithm should be able to select only the valid detections of fires.



Comparison of the number of fire pixels detected by the 10 diferente satelites used at INPE's wildfire monitoring program during October 2019. GOES-16, with images every 10 minutes, detected 15.6% of the pixels.



Example of congruence analysis for fire pixels detected by GOES-16 (“x”) and by Polar Orbiters (“+” with red contour), where the yellow polygons mark the cases coinciding spatially and temporarilly during October/2019 in an area of 900 km2 at the border of the MA and PI states in northeast Brazil. The left figure presentes results for the previous 1998 algorithm and the right one for the 2020 current algorithm

Main points of the **INPE empirical algorithm** to detect vegetation fires in GOES-ABI and MSG-SEVIRI images.

- Data source: https://www.goes-r.gov/spacesegment/abi.html NetCDF format and https://docs.opendata.aws/noaa-goes16/cics-readme.html . Georeferncing with https://cimss.ssec.wisc.edu/csppgeo/

- Sun-Pixel-Satellite geometry filter based on azimuth and elevation empirical limits: solar reflection angle > 20^{o} and azimutal sun and satellite diferences beyond $180^{o} \pm 15^{o}$.

- Detection thresholds for five ABI bands with basic detection in channel 7 (4µm) followed by quality control using empirical equations for channels 2 (0.64 µm), 3 (0.86 µm), 10 (7.3 µm) and 14 (11.2 µm).

- Additionasl details: SETZER, A.; VICTORINO, P.S.S.; BOTTINO, M.J. Detecção de queimadas por satélites geoestacionários e seu uso no Programa Queimadas do INPE. Cap. 04, Queimadas e Incêndios Florestais: Mediante Monitoramento Orbital. Livro, Editora Oficina de Textos, ISBN 978-85-7975-318-3, pp. 99-121, 2021.

1998 Algorithm	**2021 New Algorithm**	Differ.(2021-1998)
22h to 10h UTC, night	22h to 10h UTC, **night**	night
# PolarOrb. events 117,392	**# PolarOrb. events** 117,392	
# GOES-16 events 24,107	**# GOES-16 events** 56,000	31.893 ⇒ **132%**
# hits 20,726 ⇒ 86%	**# hits** 49,118 ⇒ **88%**	2%
# omissions 19,603 ⇒ 17%	**# omissions** 24,060 ⇒ **20%**	3%
# commissions! 3,381 ⇒ 14%	**# commissions!** 6,882 ⇒ **12%**	**-2%**
10h to 22h UTC, day	10h to 22h UTC, day	day
# PolarOrb. events 346,776	# PolarOrb. events 346,776	
# GOES-16 events 68,723	# GOES-16 events 326,124	257.419 ⇒ **375%**
# hits 29,200 ⇒ 42%	# hits 194,719 ⇒ 60%	18%
# omissions 94,564 ⇒ 27%	# omissions 103,519 ⇒ 30%	3%
# commissions! 39,523 ⇒ 58%	# commissions! 131,405 ⇒ 40%	**-18%**
day + night	day + night	day + night
# PolarOrb. events 467,233	# PolarOrb. events 467,233	
# GOES-16 events 94,168	# GOES-16 events 384,182	290.013 ⇒ **308%**
# hits 50,073 ⇒ 53%	# hits 245,538 ⇒ 64%	11%
# omissions 119,338 ⇒ 26%	# omissions 118,206 ⇒ 25%	-1%
# commissions! 44,095 ⇒ 47%	# commissions! 138,644 ⇒ 36%	**-11%**

Fire pixels over Brazil: comparison of detections of events with GOES-16 and Polar Orbiters (TERRA + AQUA + NPP-S + NOAA-20 from NASA & UMD, Collection 6) for October/2019 using the previous and current INPE algorithm for geostationary imagers.

Note: In October the Sun is in the Southern Hemisphere, when sun glint is more frequent for GOES-16.

- **Contribution** of this work: a comparison of fire pixels from GOES-16 and from Polar Orbiters (AQUA, TERRA, S-NPP and NOAA-20)

	Night = best case	Day = worst case
GOES-16 fire events confirmed by Polar Orbiters	88 %	60 %
GOES-16 fire events without confirmation	12 %	40 %
Polar Obiter fire events not detected by GOES-16	20 %	30 %

- **Suggestion** (once again) : a contest/competition of GOES and MSG fire detection algorithms to select the best one or, to combine the best parts of diferent algorithms, so a consistent method for global spatial and temporal analyses of geostationary fire monitoring is accepted by GWIS and used by our community. A protocol to compare the detections of the algorithms is also needed.