OPT-MPC

Copernicus Sentinel

Optical Mission Performance Cluster

Sentinel-3 FRP product validation with Sentinel-2

Sentinel-3 Validation Team - 9th meeting

Funded by the EU and ESA

European Union

March 31st, 2026

L. Rivoire, S. Clerc, T. Miraglio

Objective & method

Objective : validate Sentinel-3 SLSTR ESA Fire Radiative Power (FRP) products (day time)

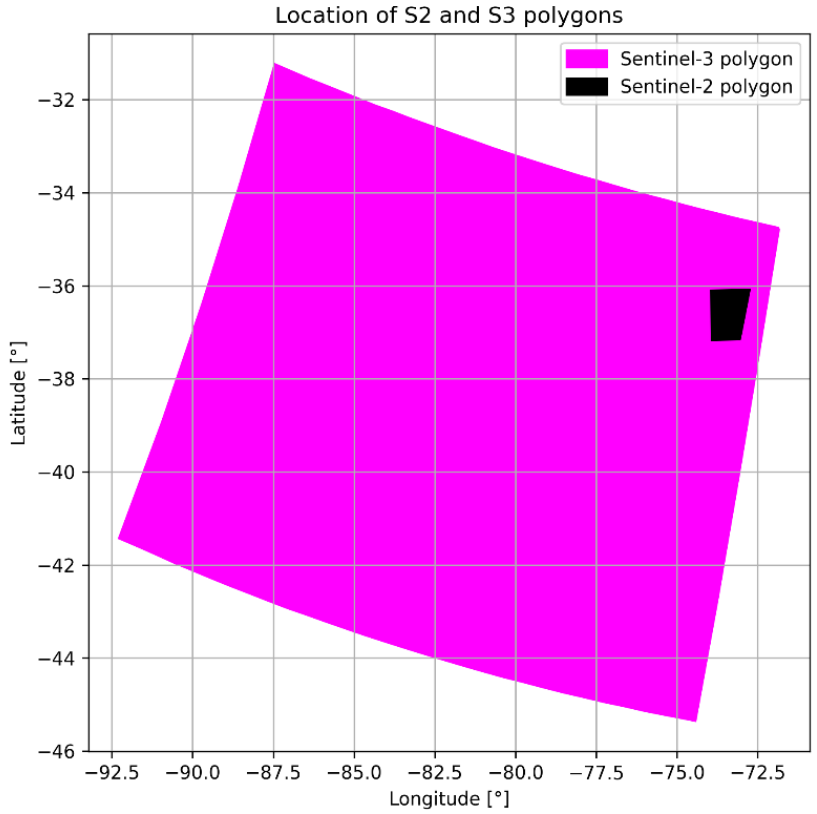
Method :

- **find matchups with a high resolution Sentinel sensor : Sentinel-2 MSI**
- **compare fires detected by Sentinel-2 MSI and Sentinel-3 SLSTR over the matchups**

Methodology

1. Detection of matchups between S2 and S3 scenes

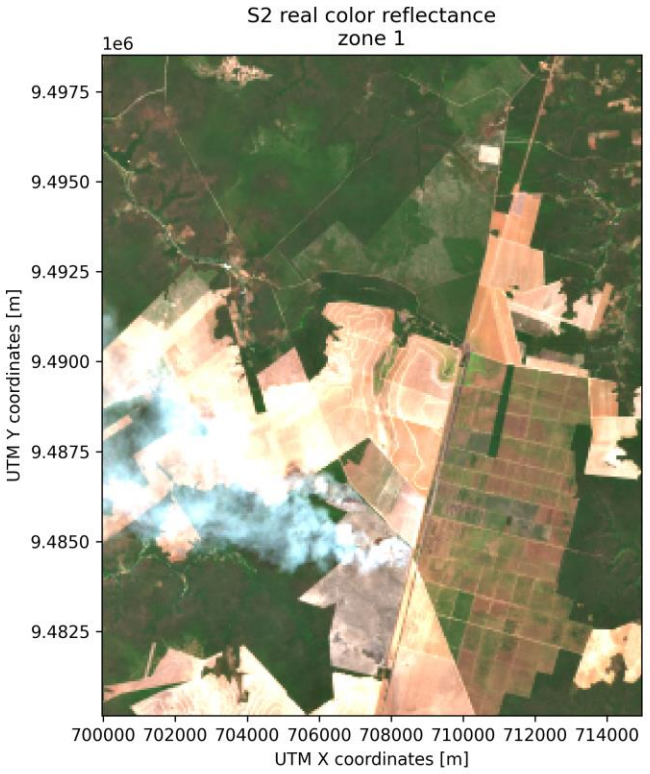
- < 30 min of temporal difference
- < 3 % of cloud cover in S2 product



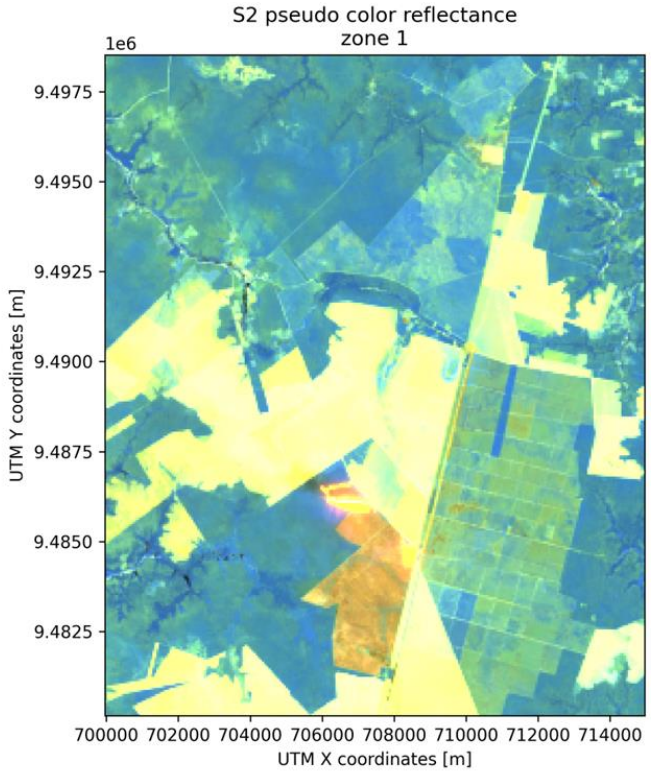
S2A_MSIL2A_20251019T144751_N0511_R139_T18HXE_20251019T205916
S3B_SL_2_FRP____20251019T144634_20251019T144934_20251020T213456_0179_112_210_3600_ESA_O_NT_004

Methodology

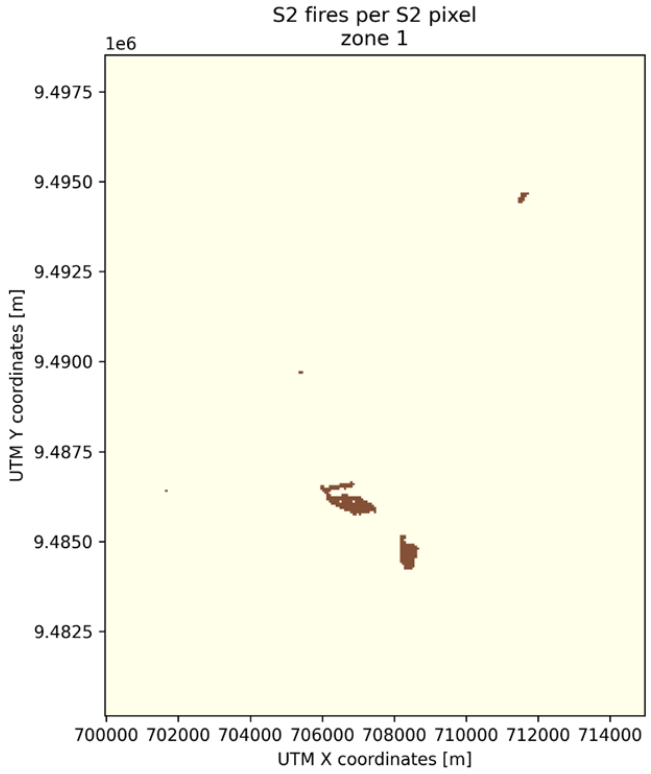
2. Detection of fires in the S2 60m L2A products using Schroeder et al. (2016) algorithm (2200 nm radiance higher than 865 nm radiance)



MSI true color image (665 nm, 560 nm and 490 nm)



MSI false color image (2200 nm, 1610 nm and 865 nm)



Pixels labelled as « fire »

S2B_MSIL2A_20251015T132229_N0511_R038_T23MQQ_20251015T151216

Methodology

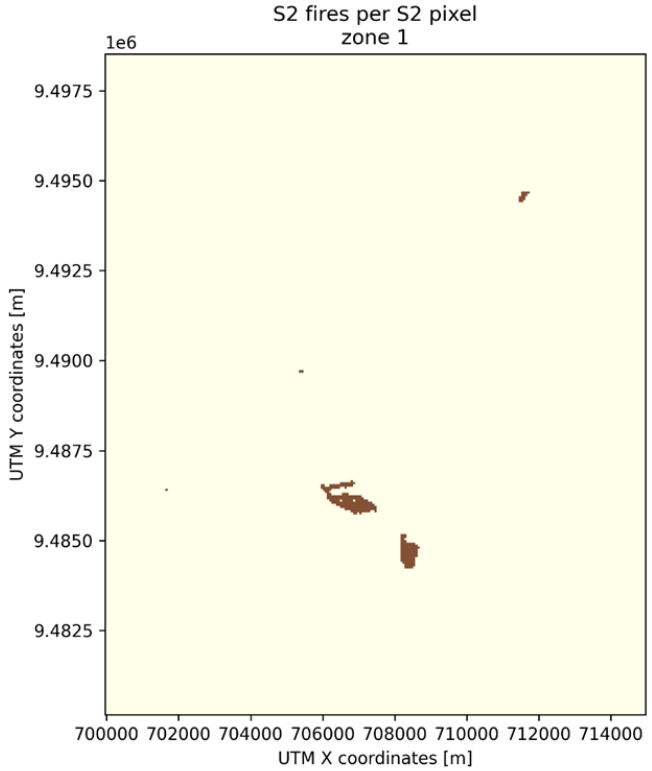
3. Number of S2 fire pixels is binned in the closest S3 pixel and counted as in Xu and Wooster (2023) ; No threshold applied on the number of S2 fire pixels per S3 pixel

4. Comparison with the location of the fires from the S3 “FRP_in” file

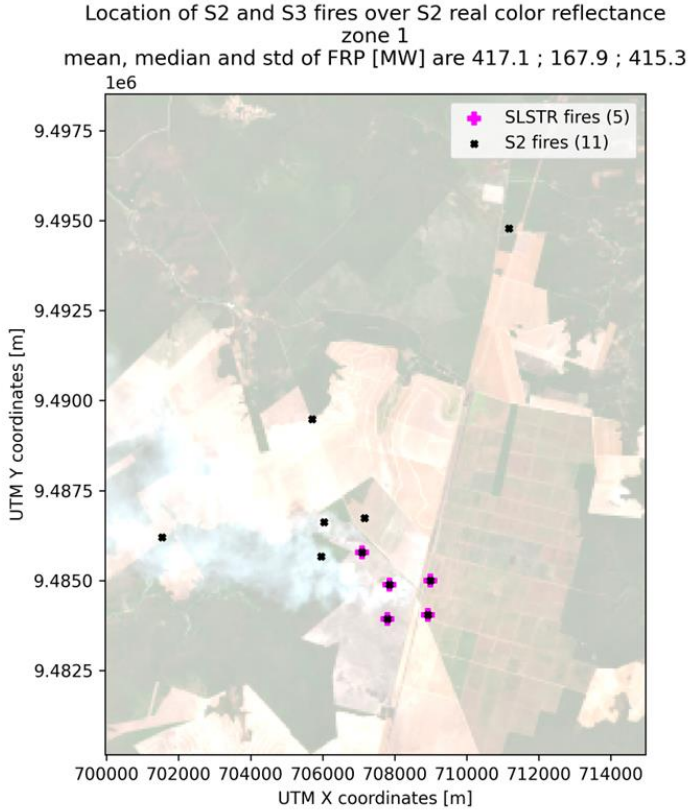
Methodology

SLSTR fire

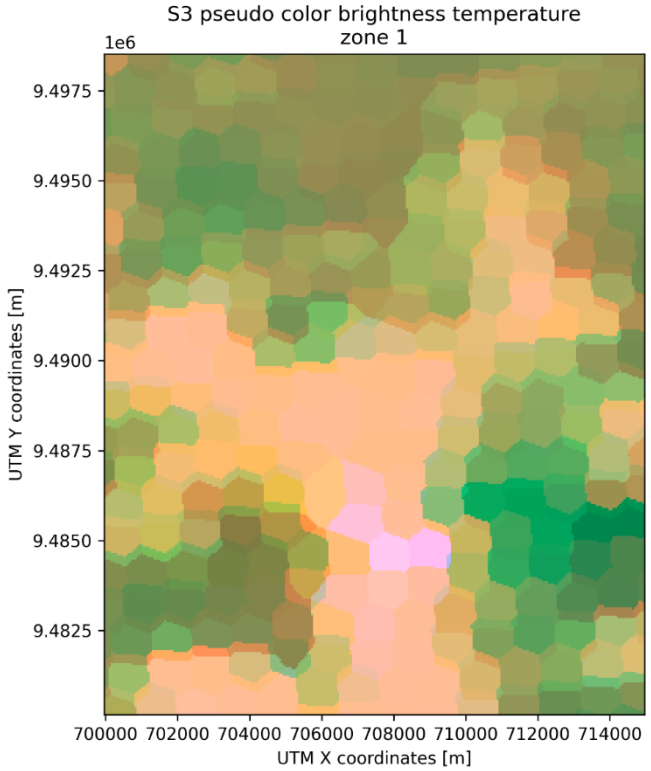
MSI fire



Pixels labelled as « fire » using MSI



MSI fire pixels on the SLSTR 1 km grid and SLSTR FRP fires



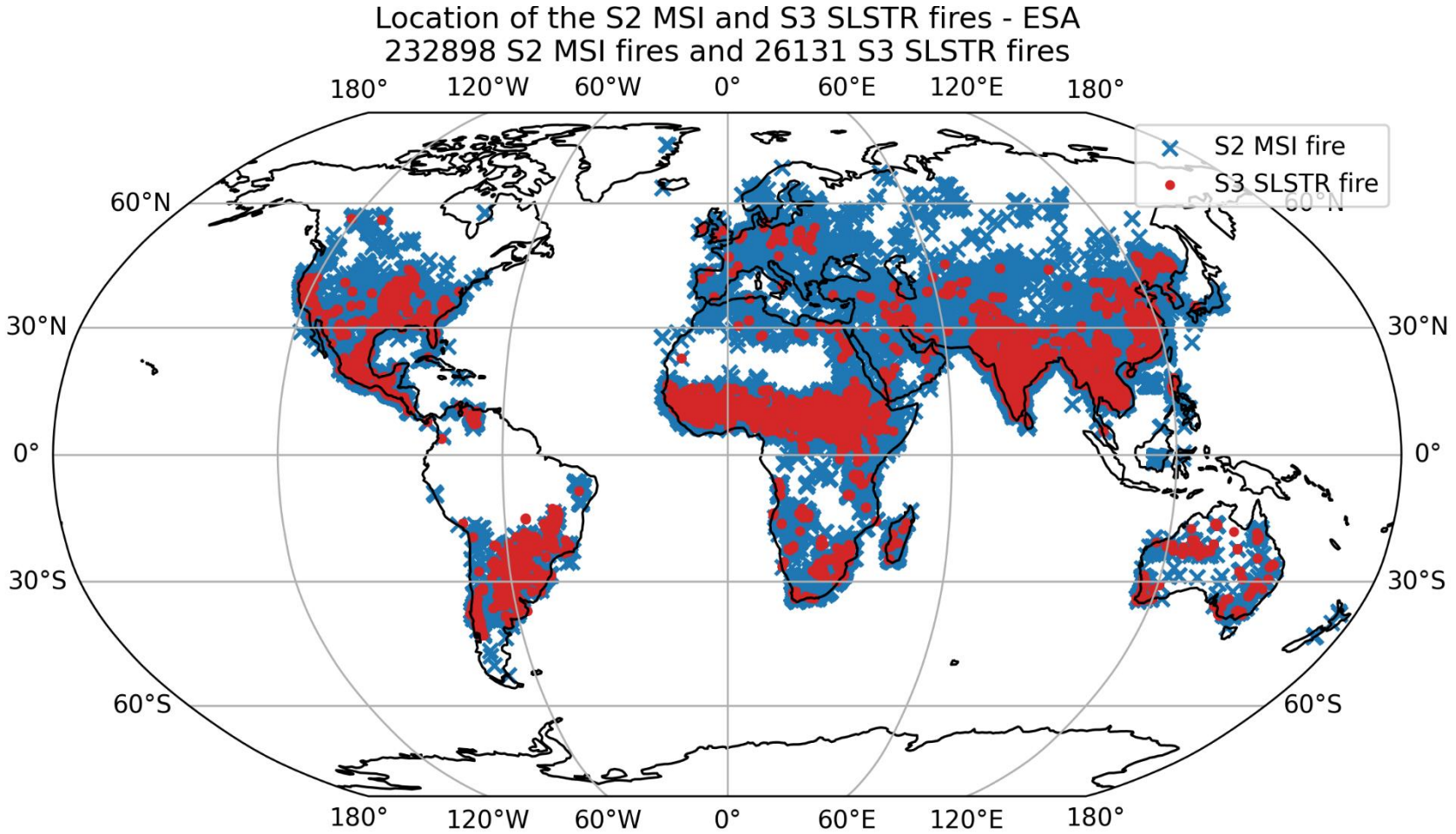
SLSTR false color image (3,7 µm (fire), 3,7 µm, 12,0 µm)

S2B_MSIL2A_**20251015T132229**_N0511_R038_T23MQQ_20251015T151216
S3B_SL_2_FRP____**20251015T130019**_20251015T130319_20251016T203838_0179_112_152_3060_ESA_O_NT_004

Methodology

5. We consider that one S2 fire matches a S3 fire if there is at least one S3 fire located within a square of 7 kilometres (= 7 SLSTR pixels) centred on the S2 fire, and reciprocally

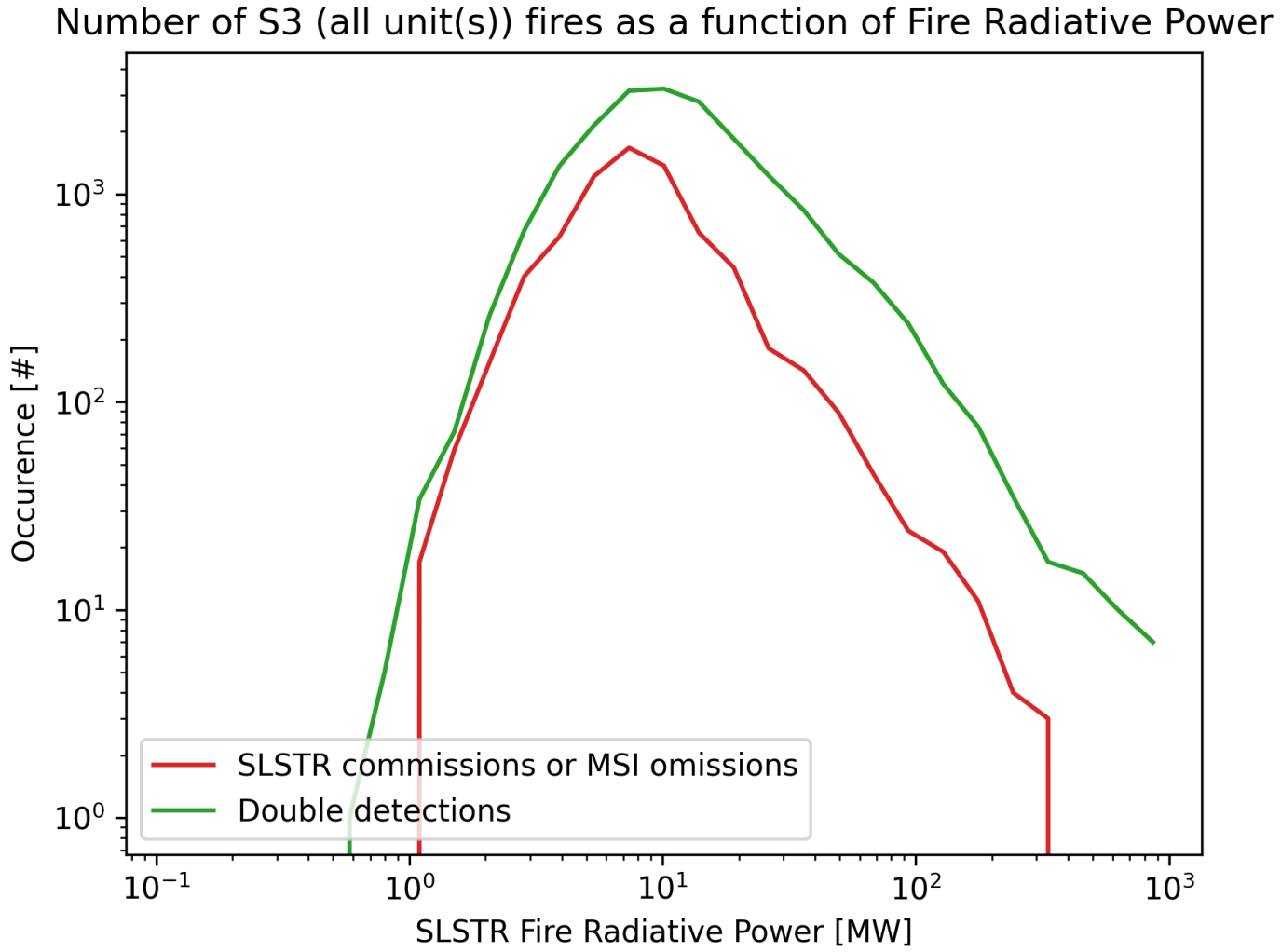
Location of the matchups



Statistical results

Double detections

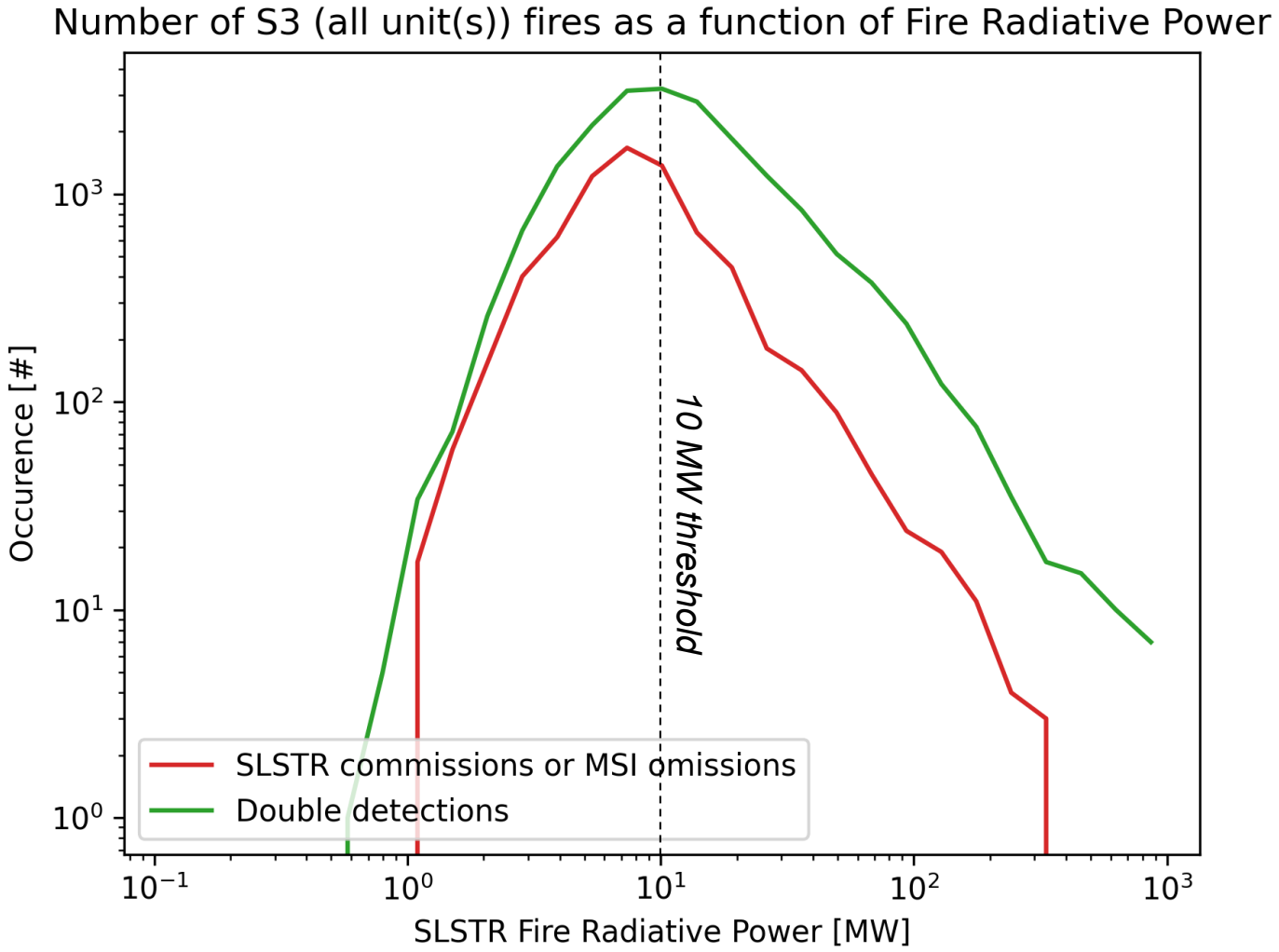
SLSTR commissions or MSI omissions



Statistical results

Double detections

SLSTR commissions or MSI omissions



Statistical results

Among the low intensity fires (FRP < 10 MW) :

7 684 are double detections (64.98 %)

4 142 are SLSTR-only detections (35.02 %)

Among the high intensity fires (FRP > 10 MW) :

11 319 are double detections (79.13 %)

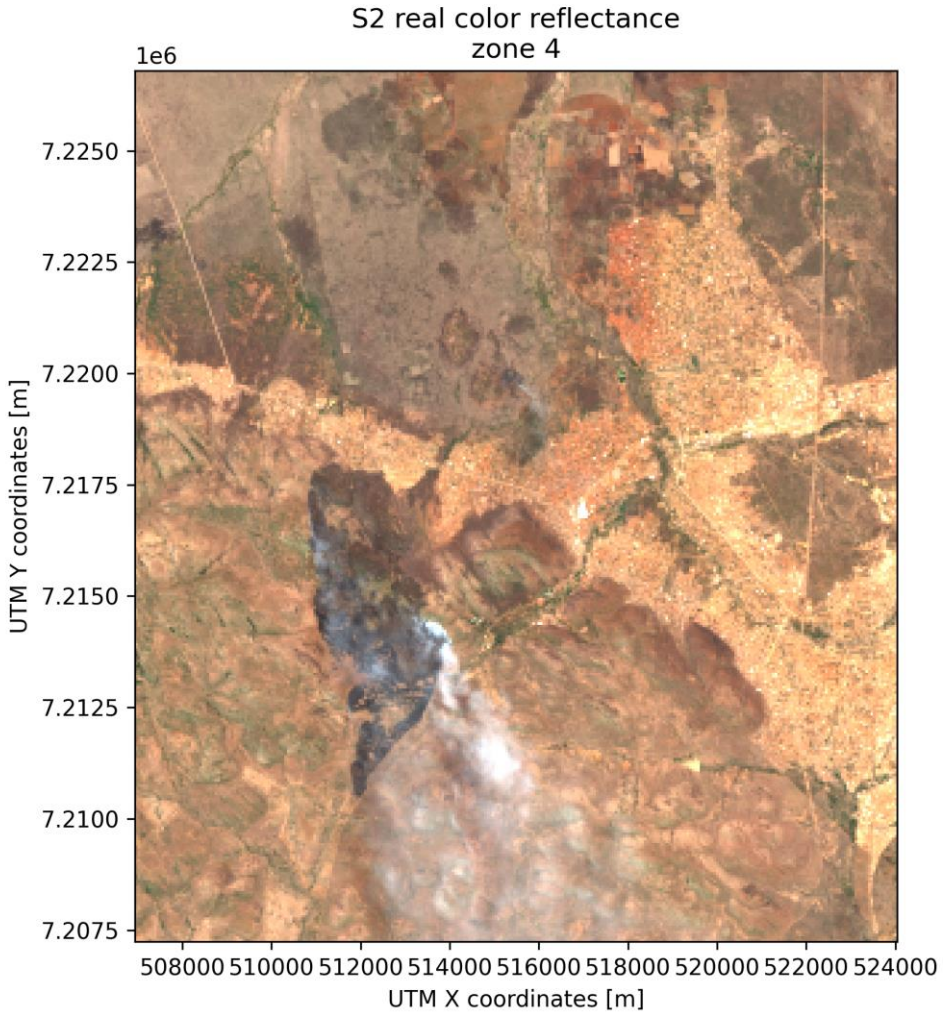
2 986 are SLSTR-only detections (20.87 %)

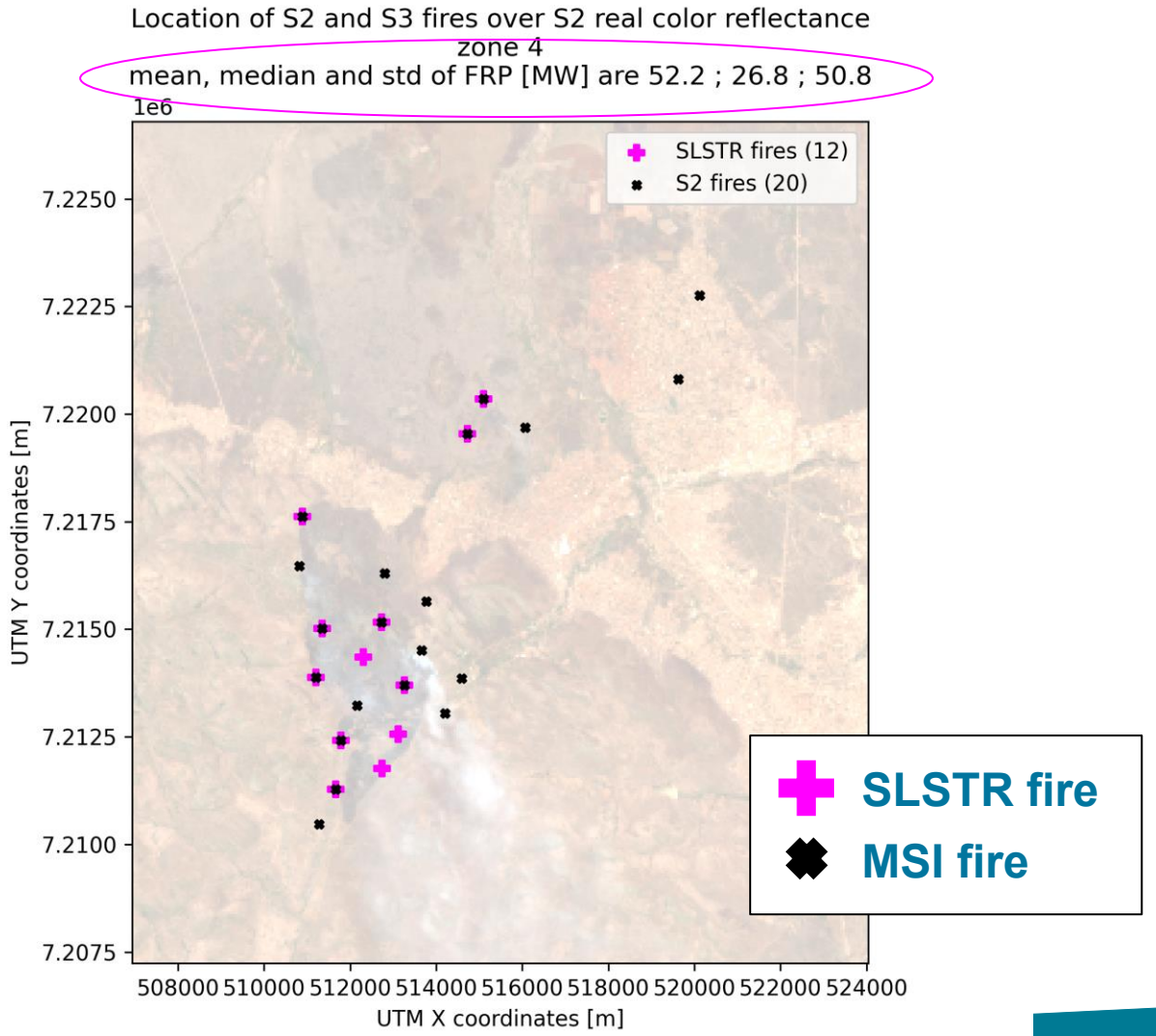
FRP-independent results are :
72.72 % of double detections
27.28 % of SLSTR-only detections

HIGH RADIATIVE POWER FIRES

Example 1 – South Africa – standard power

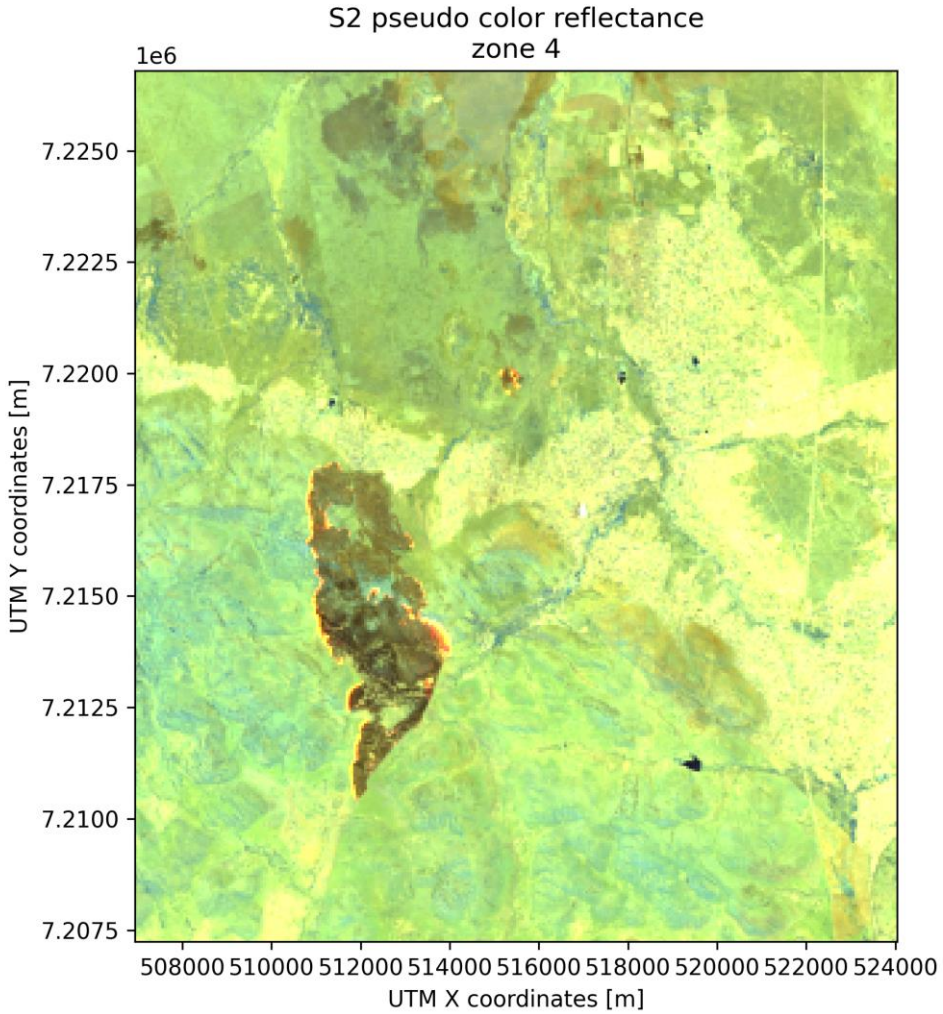
S2B_MSIL2A_20251025T075919_N0511_R035_T35JNN_20251025T104937
S3A_SL_2_FRP____20251025T074214_20251025T074514_20251027T231149_0179_132_049_3420_PS1_O_NT_004
17 min of temporal difference between acquisitions

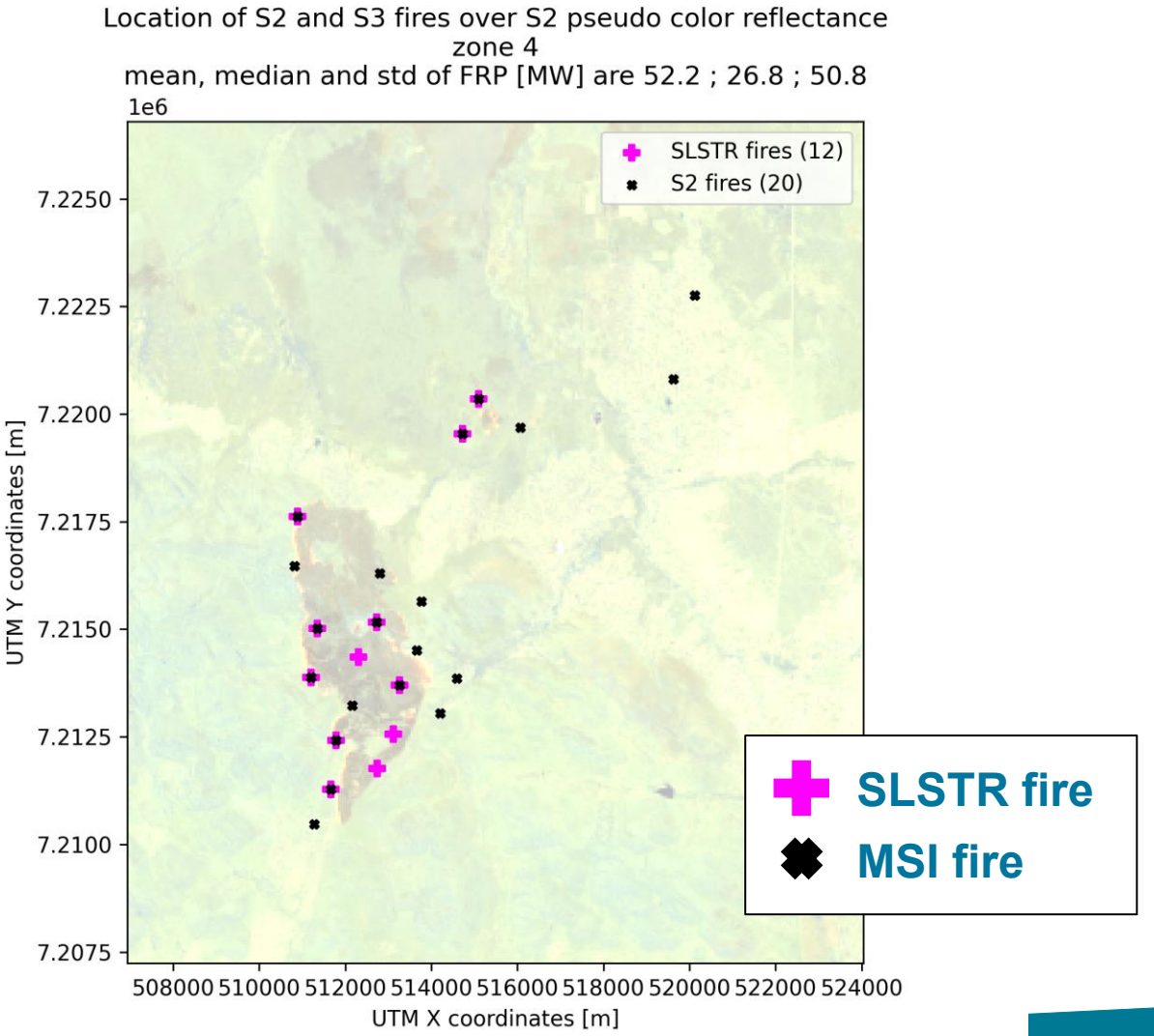




Example 1 – South Africa – standard power

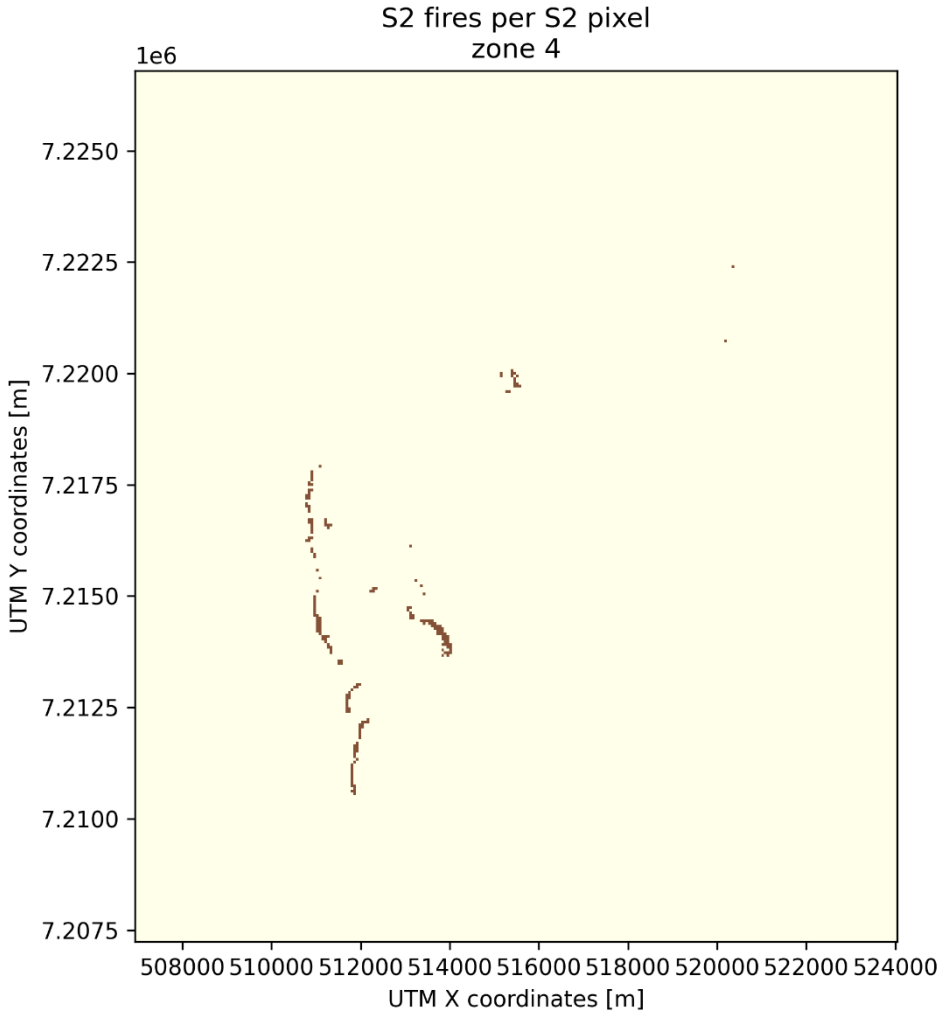
S2B_MSIL2A_20251025T075919_N0511_R035_T35JNN_20251025T104937
S3A_SL_2_FRP____20251025T074214_20251025T074514_20251027T231149_0179_132_049_3420_PS1_O_NT_004
17 min of temporal difference between acquisitions

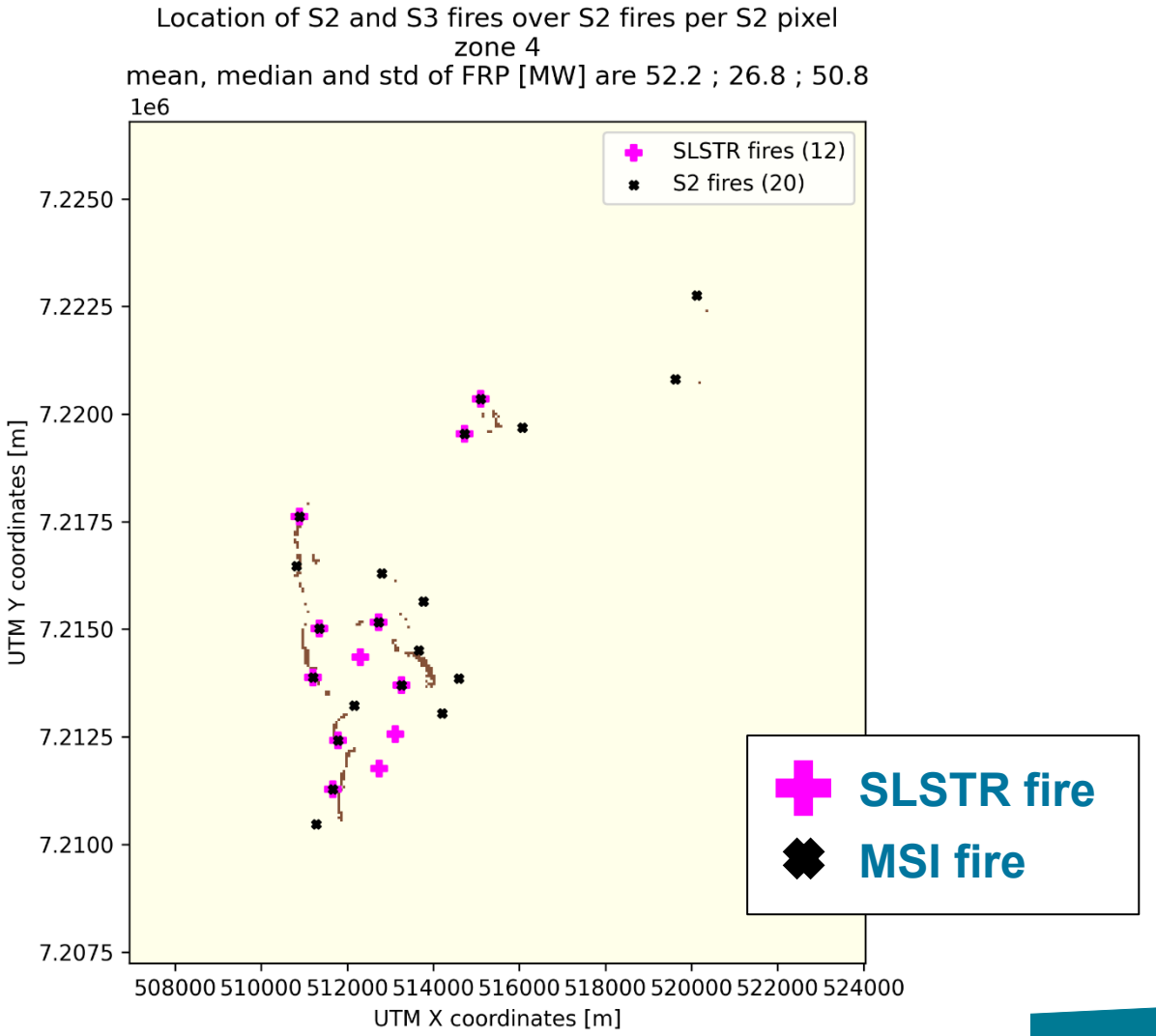




Example 1 – South Africa – standard power

S2B_MSIL2A_20251025T075919_N0511_R035_T35JNN_20251025T104937
S3A_SL_2_FRP____20251025T074214_20251025T074514_20251027T231149_0179_132_049_3420_PS1_O_NT_004
17 min of temporal difference between acquisitions

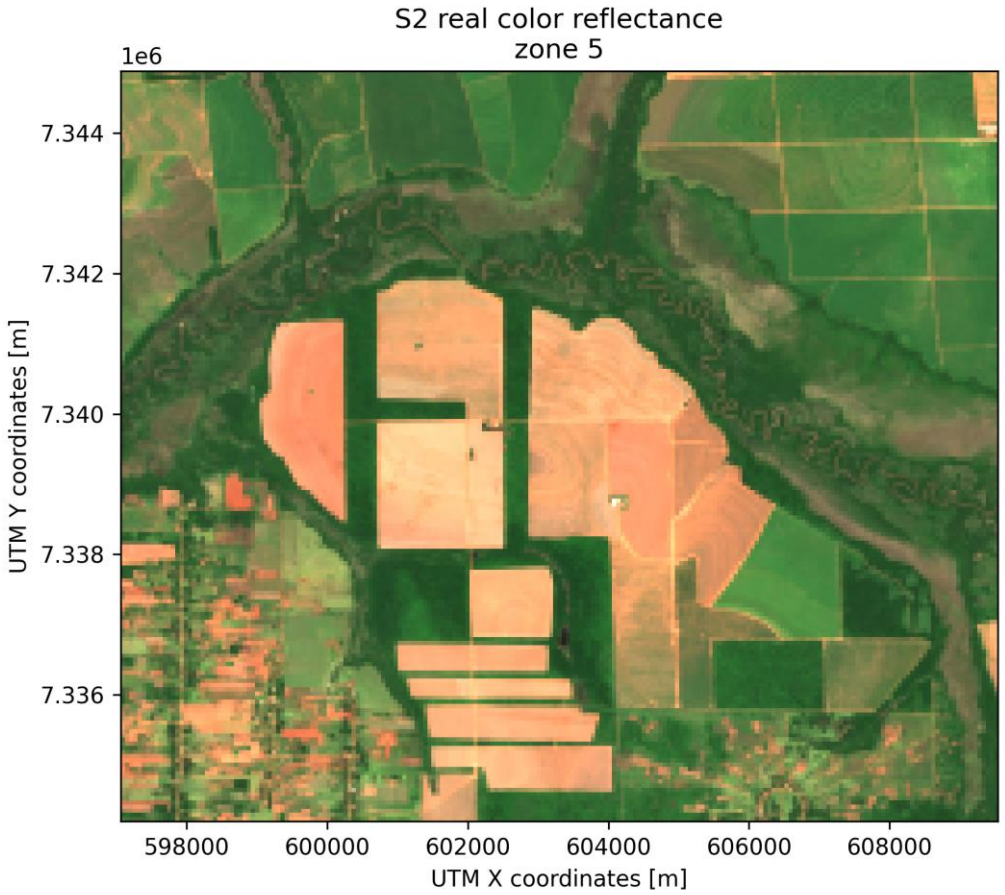


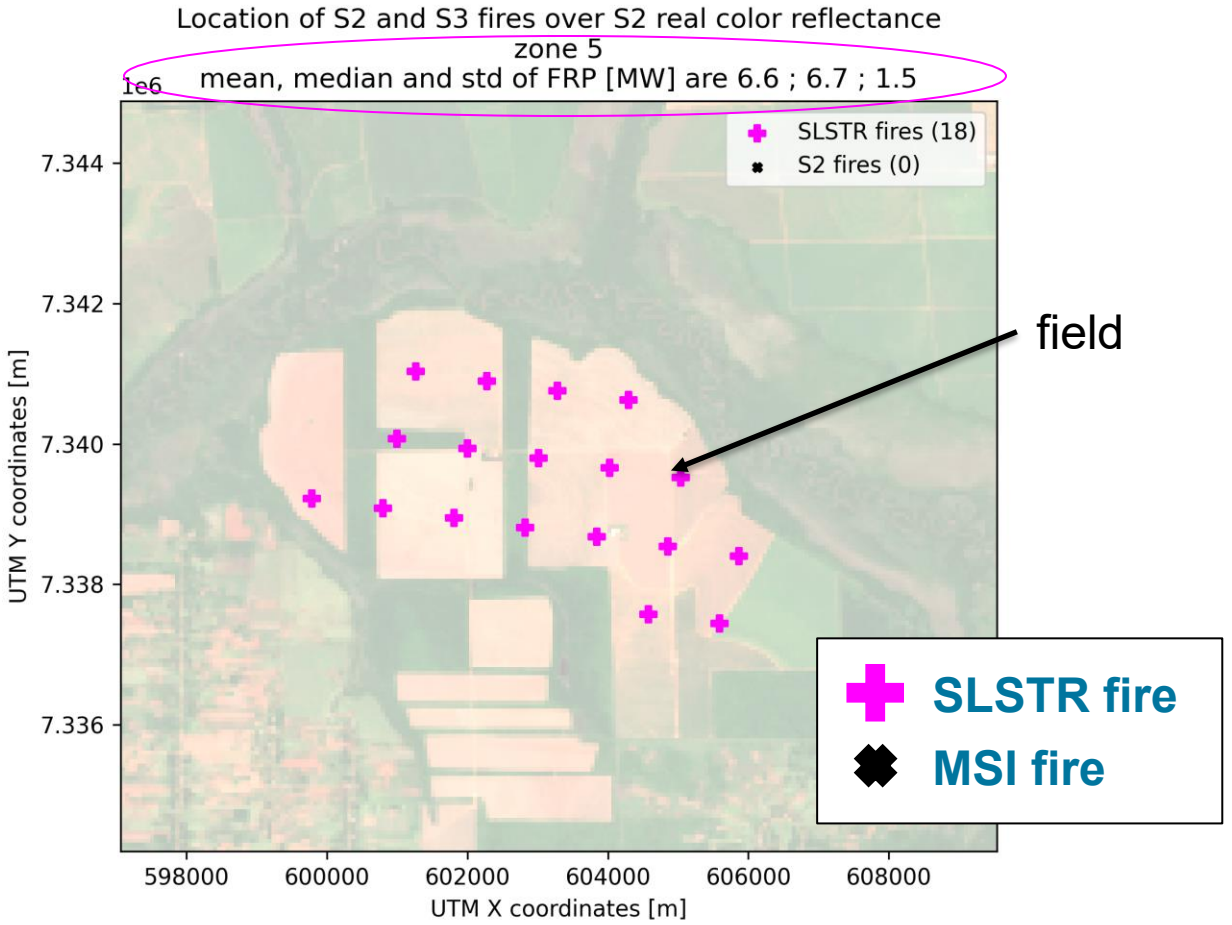


LOW RADIATIVE POWER FIRES

Example 2 – Paraguay - field

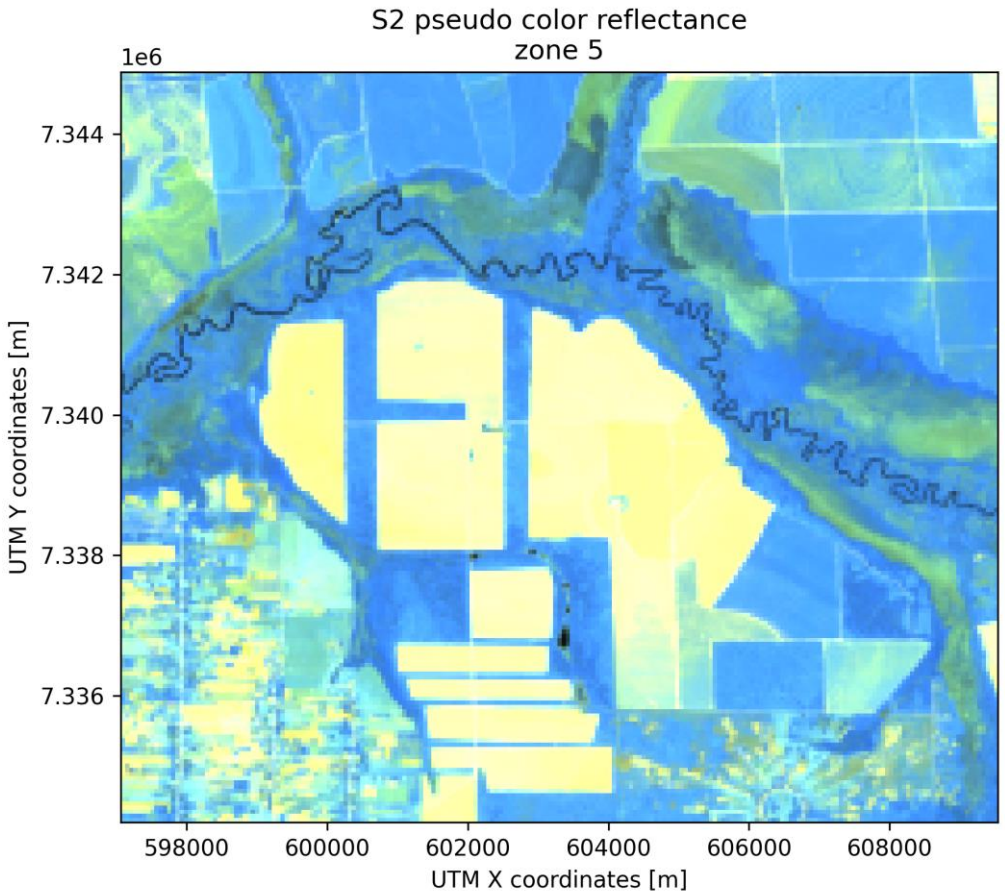
S2B_MSIL2A_20251014T134709_N0511_R024_T21KWP_20251014T185946
S3B_SL_2_FRP____20251014T133230_20251014T133530_20251015T181825_0179_112_138_3420_ESA_O_NT_004
15 min of temporal difference between acquisitions

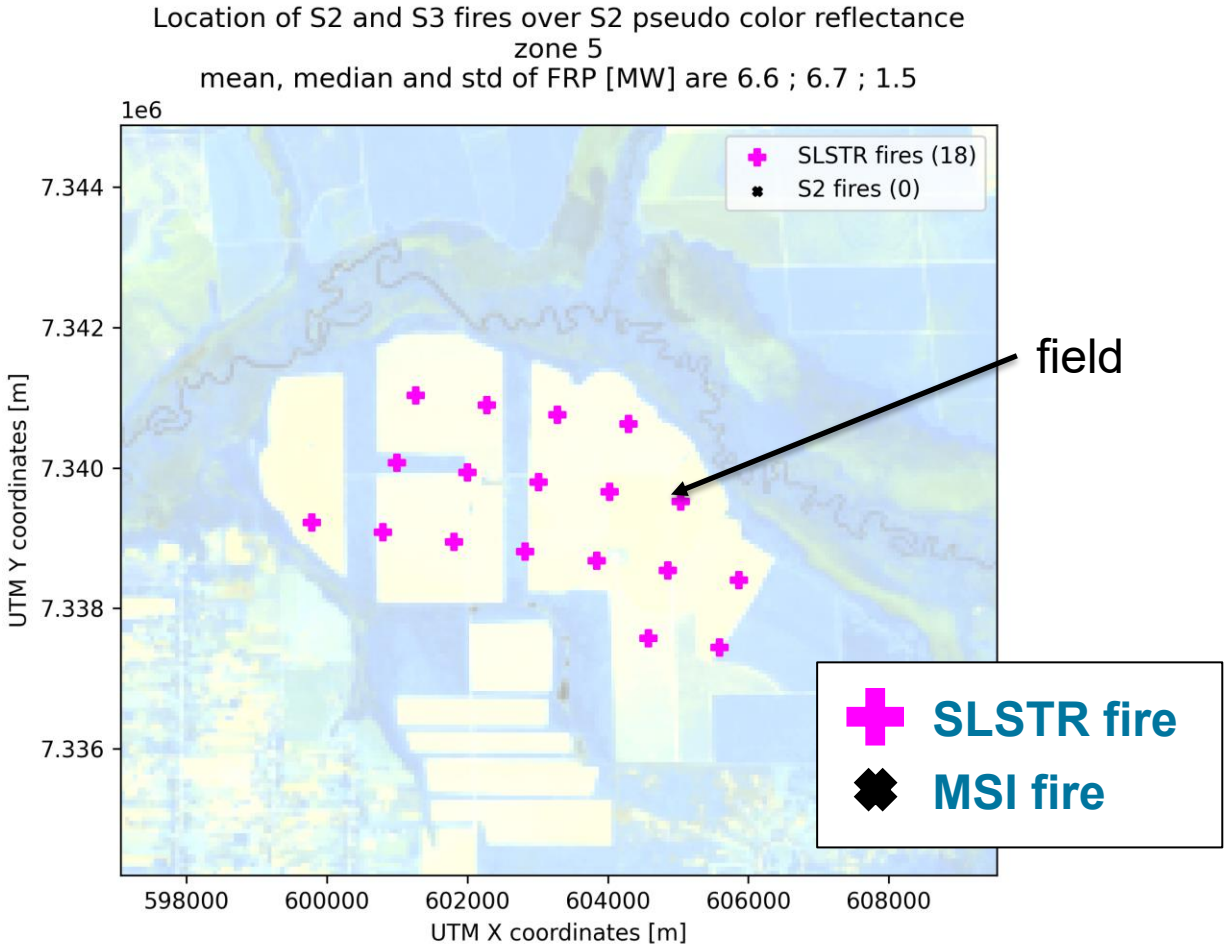




Example 2 – Paraguay - field

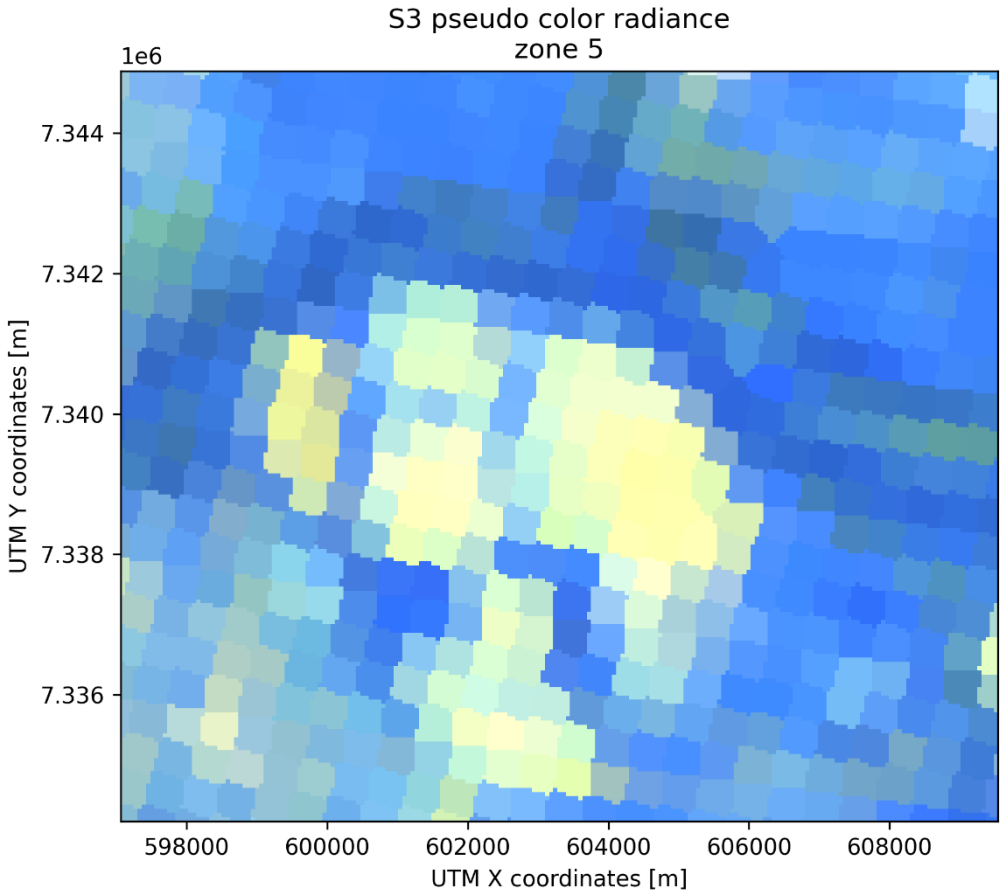
S2B_MSIL2A_20251014T134709_N0511_R024_T21KWP_20251014T185946
S3B_SL_2_FRP____20251014T133230_20251014T133530_20251015T181825_0179_112_138_3420_ESA_O_NT_004
15 min of temporal difference between acquisitions

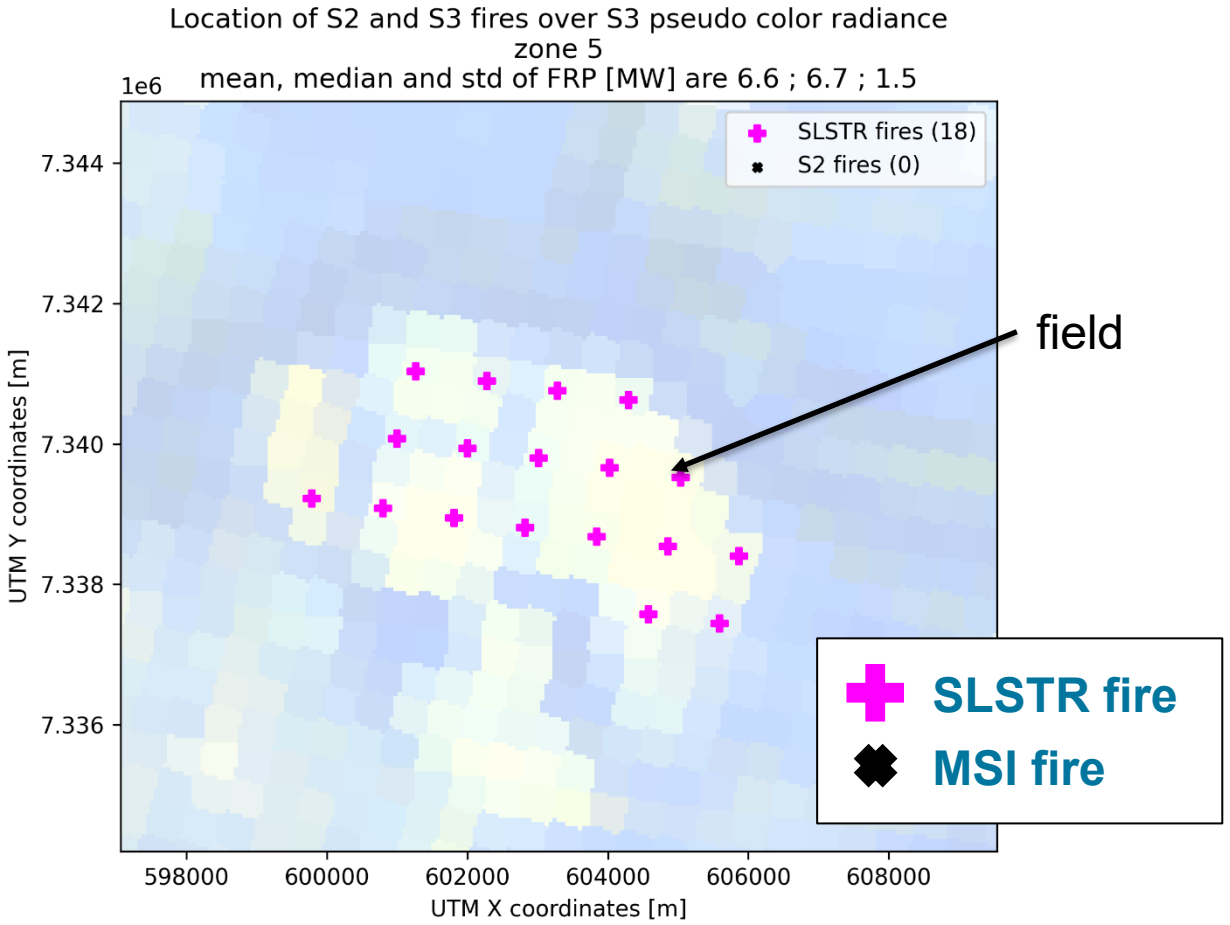




Example 2 – Paraguay - field

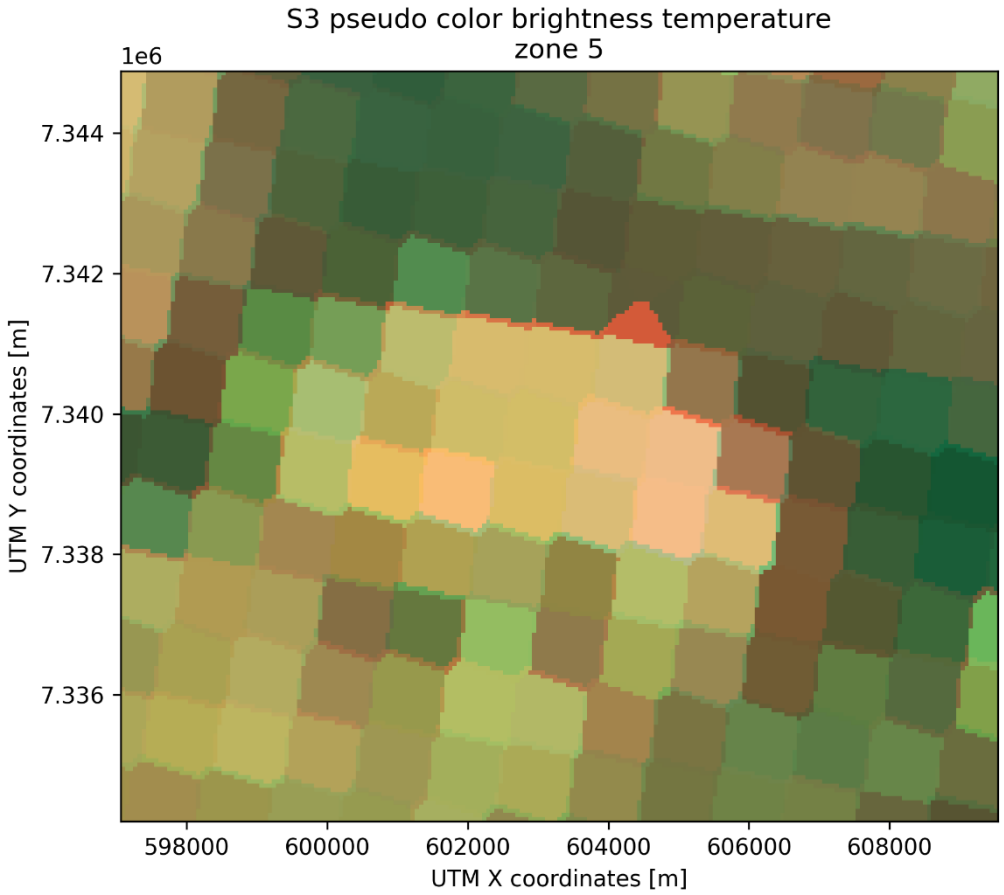
S2B_MSIL2A_20251014T134709_N0511_R024_T21KWP_20251014T185946
S3B_SL_2_FRP____20251014T133230_20251014T133530_20251015T181825_0179_112_138_3420_ESA_O_NT_004
15 min of temporal difference between acquisitions

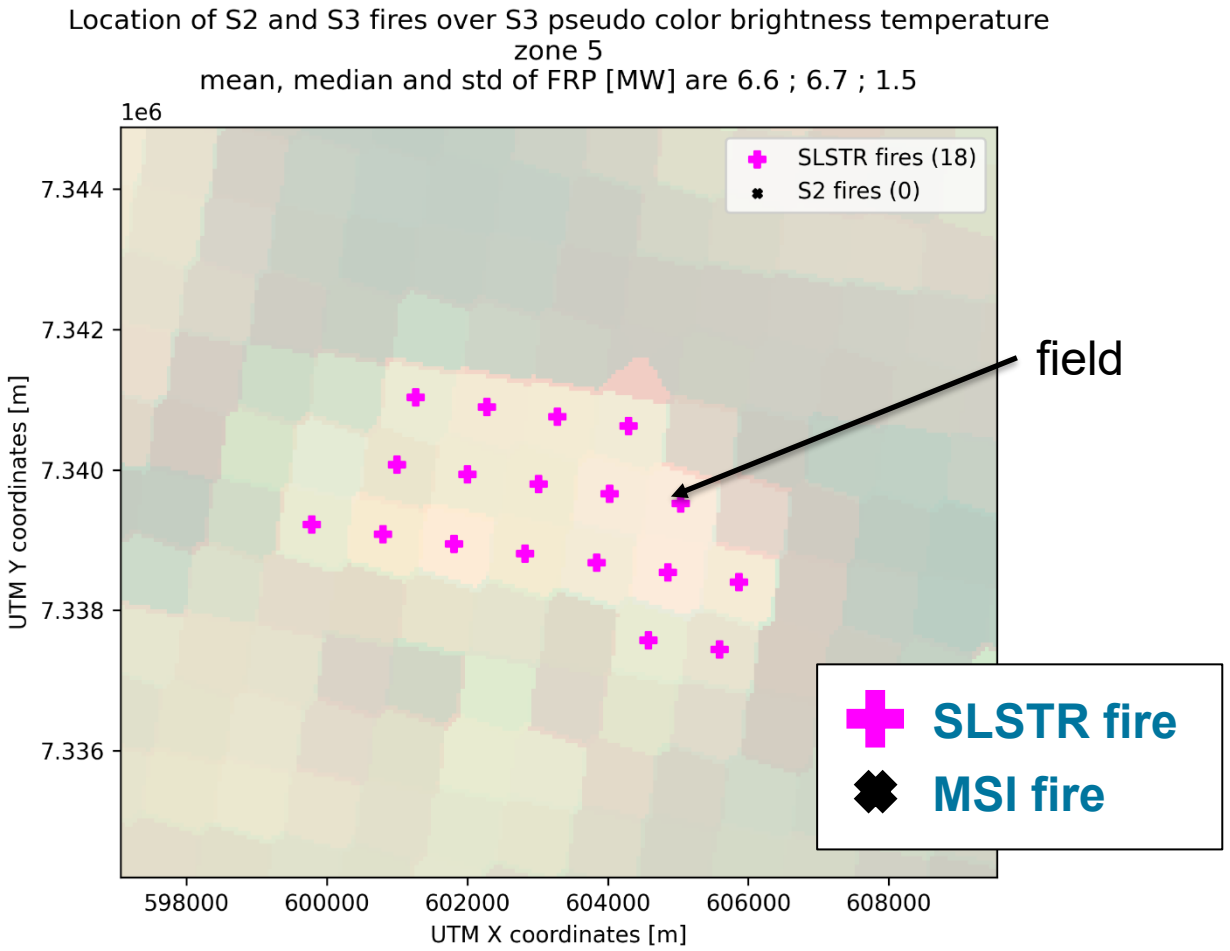




Example 2 – Paraguay - field

S2B_MSIL2A_20251014T134709_N0511_R024_T21KWP_20251014T185946
S3B_SL_2_FRP____20251014T133230_20251014T133530_20251015T181825_0179_112_138_3420_ESA_O_NT_004
15 min of temporal difference between acquisitions



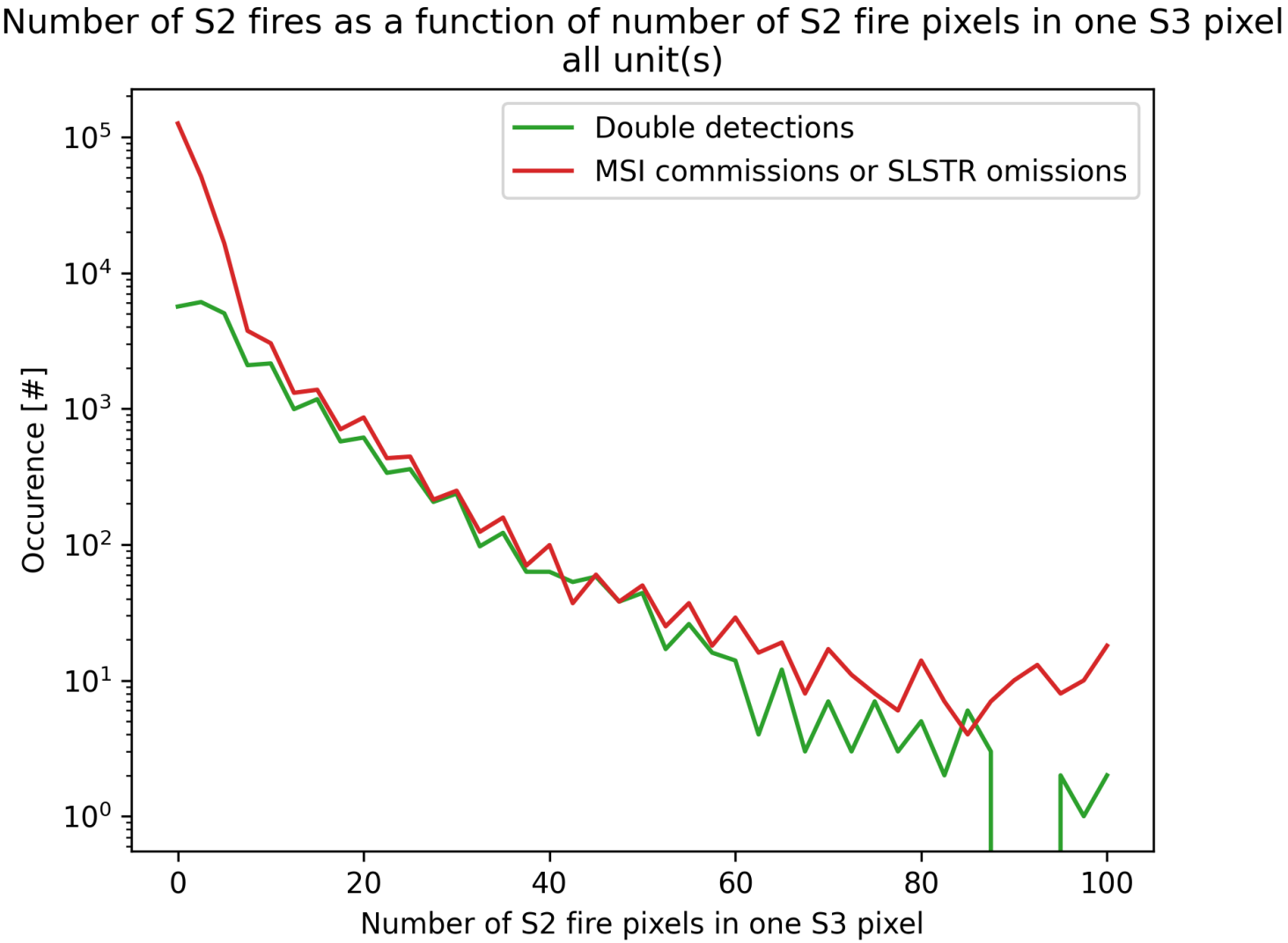


ANALYSIS OF SLSTR OMISSIONS

Statistical results

Double detections

MSI commissions or SLSTR omissions

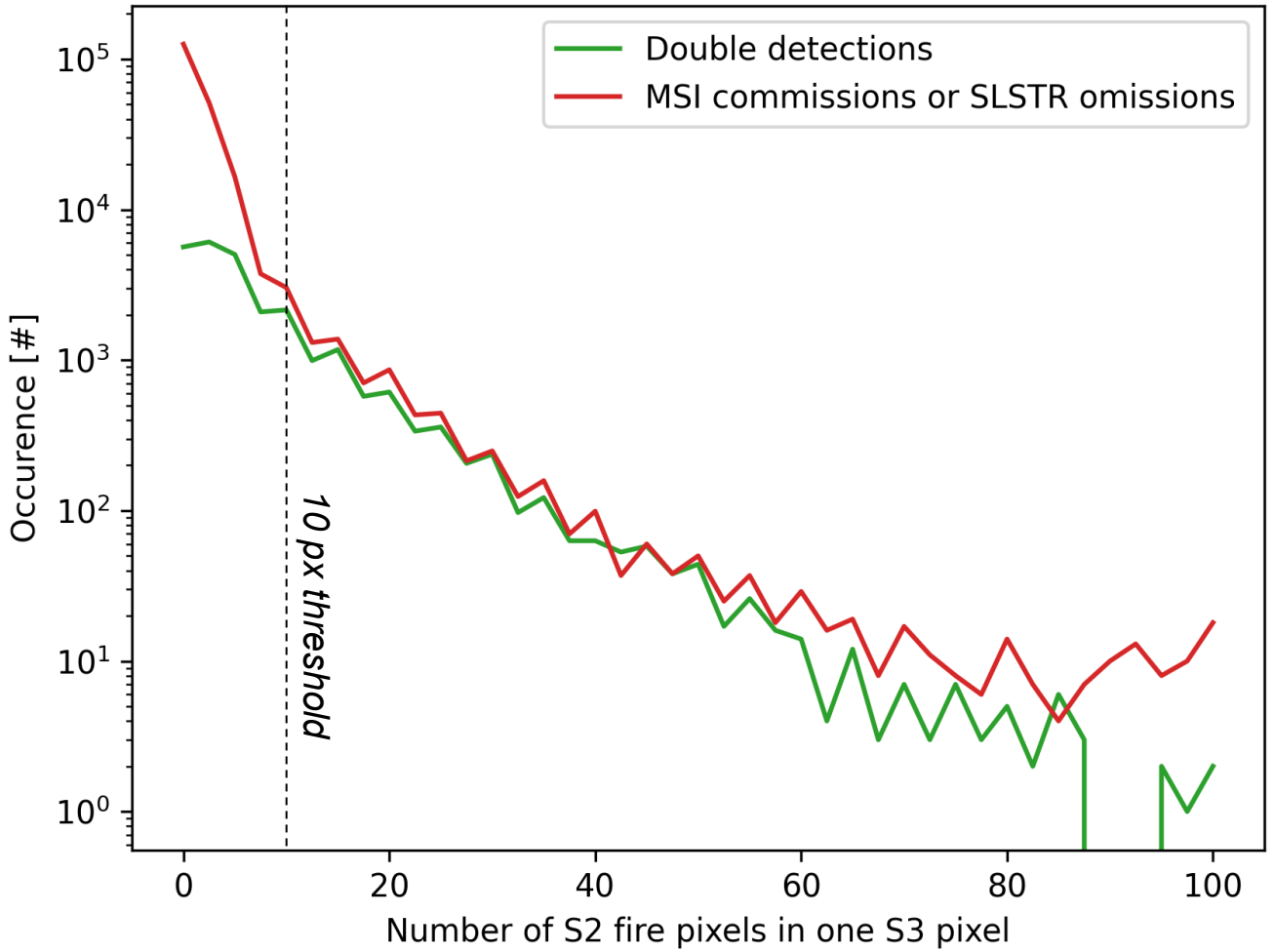


Statistical results

Double detections

MSI commissions or SLSTR omissions

Number of S2 fires as a function of number of S2 fire pixels in one S3 pixel
all unit(s)



Statistical results

Among the fires associated to a low number of S2 fire px per S3 px (nb S2 px < 10) :

18 859 are double detections (8.73 %)

197 104 are MSI-only detections (91.27 %)

Among the fires associated to a high number of S2 fire px per S3 px (nb S2 px >= 10) :

7 316 are double detections (43.40 %)

9 543 are MSI-only detections (56.60 %)

Can we find examples of important S2 fires (in terms of number of S2 fire pixels) that should be detected by S3 and that are not?

No example found yet (only S2 commission errors found : solar panels, iron mine, etc)

Conclusions

Preliminary results confirm the validity of the inter-comparison approach

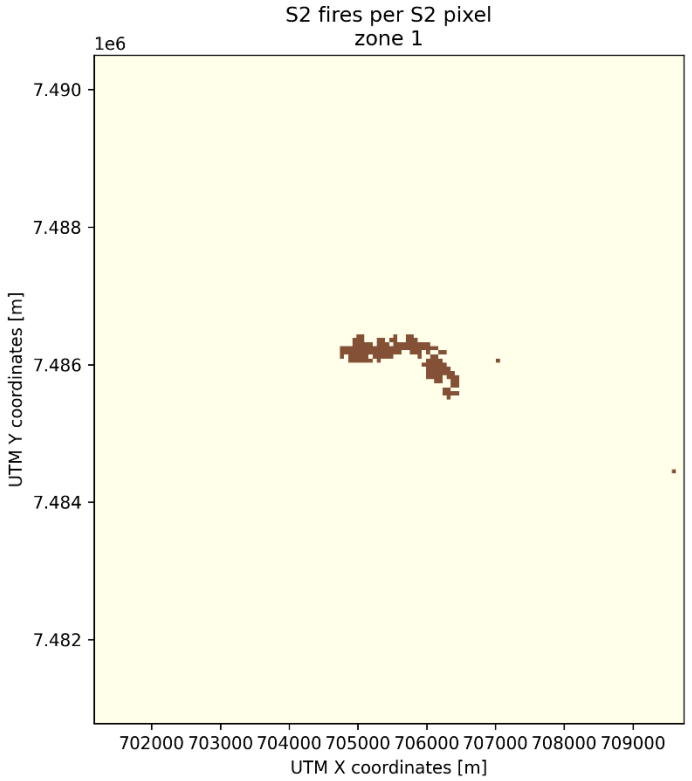
- Match-ups provide a global coverage with a good spatial sampling
- Large statistics will allow continuous monitoring and sensitivity analyses

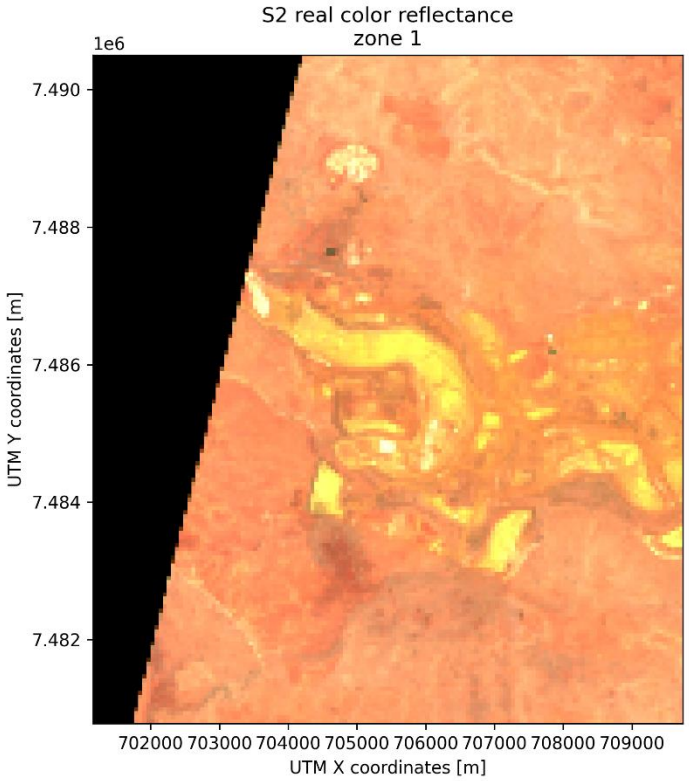
Preliminary conclusions on SLSTR NTC Fire detection performance

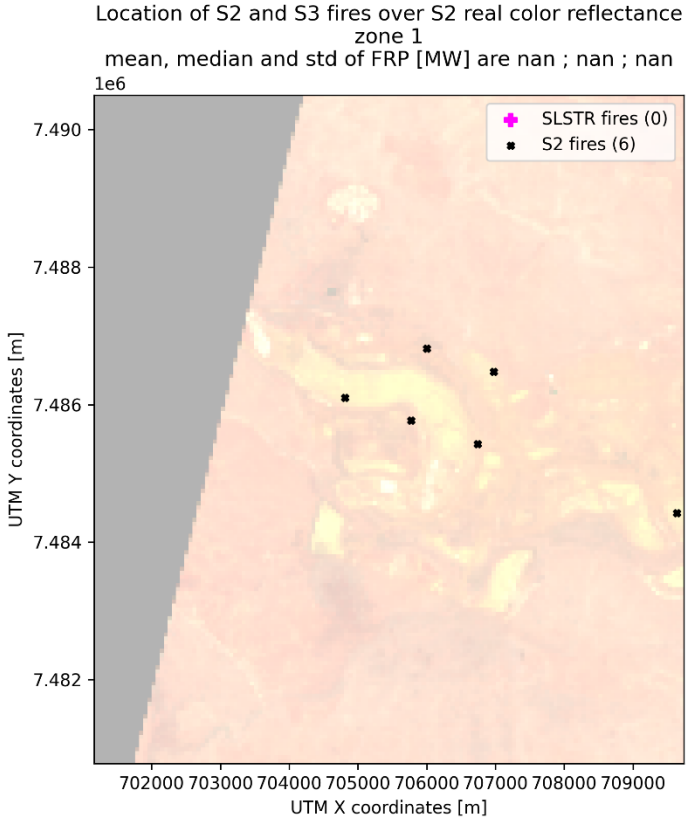
- Good consistency observed with Sentinel-2 for large fires (> 10 MW) => 80% of the fires are double detections
- SLSTR commission errors are more frequent under 10 MW => 35% of the fires are not detected by S2
- Commission error cases can be characterized using Sentinel-2 imagery (e.g. harvested fields, salt flats…), to help improve the algorithm
- No evidence yet of SLSTR omissions found. Most “S2-only” detections are probably S2 commission errors

BACKUP SLIDES

Examples of potential S3 omissions

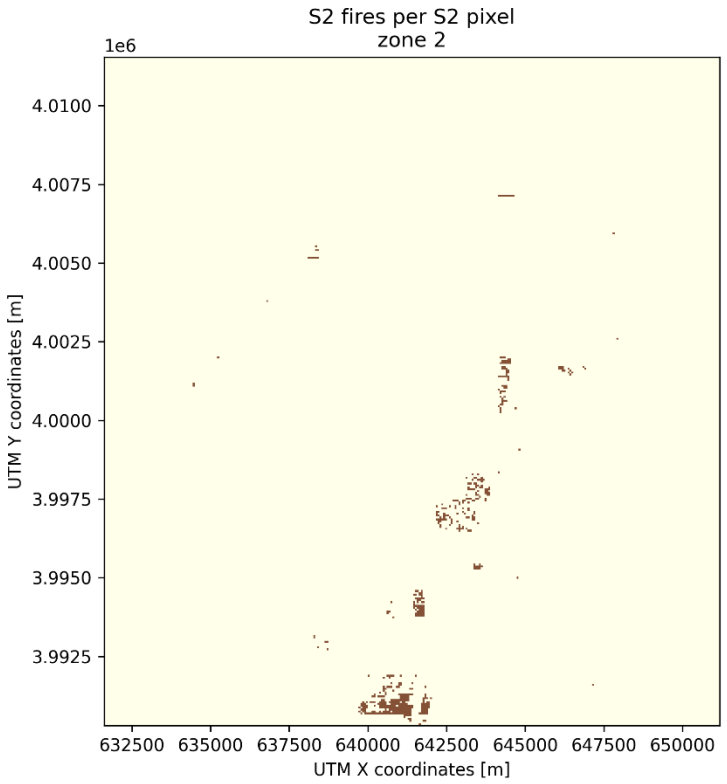


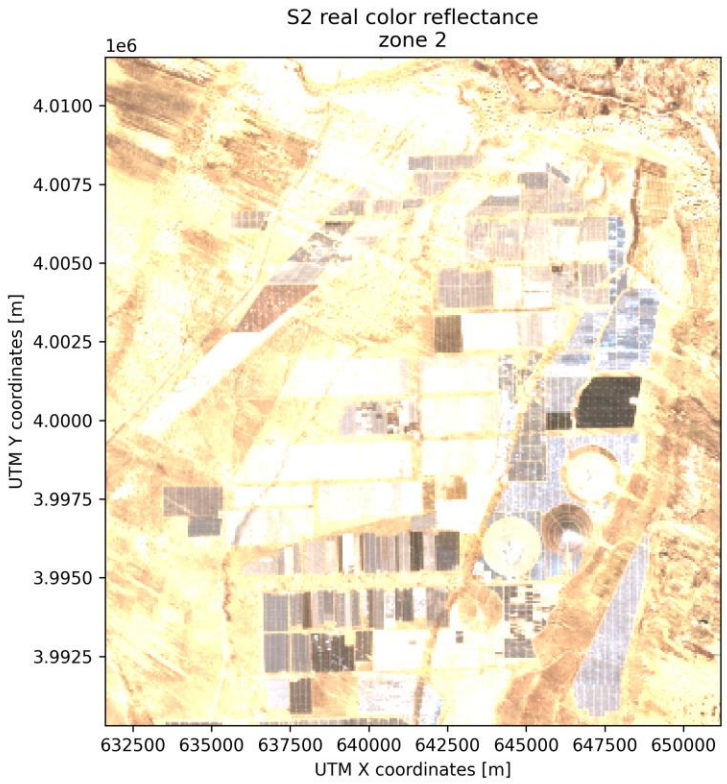


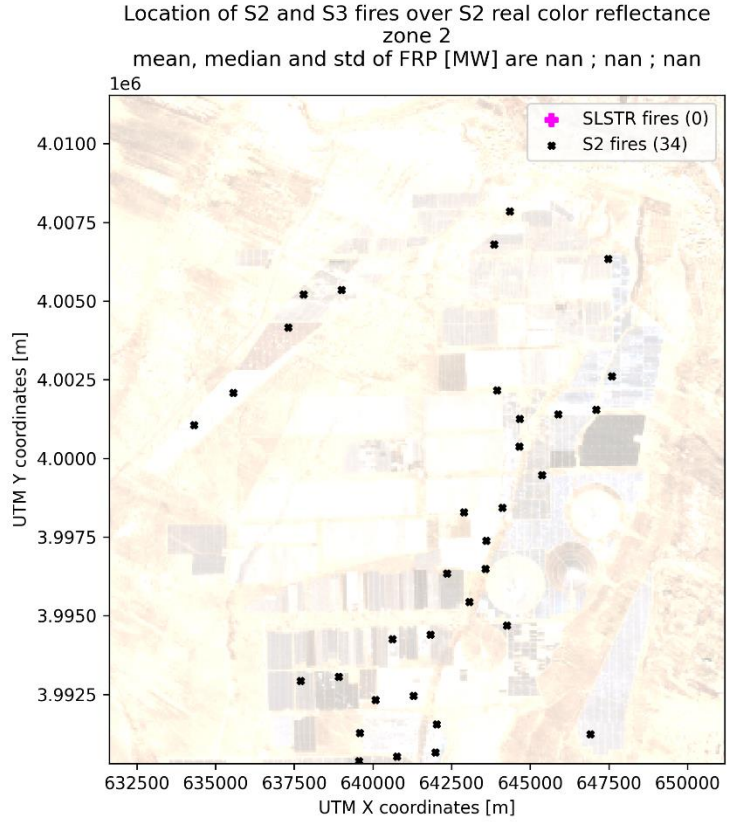


Iron mine in desertic Australia : fire probability seems low at first sight, likely to be a S2 commission error

Examples of potential S3 omissions

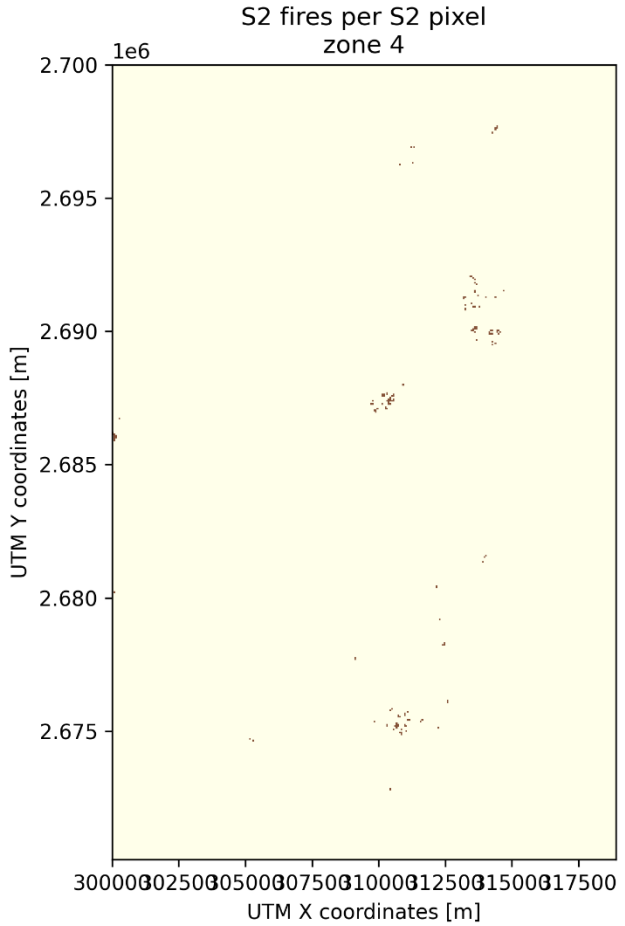


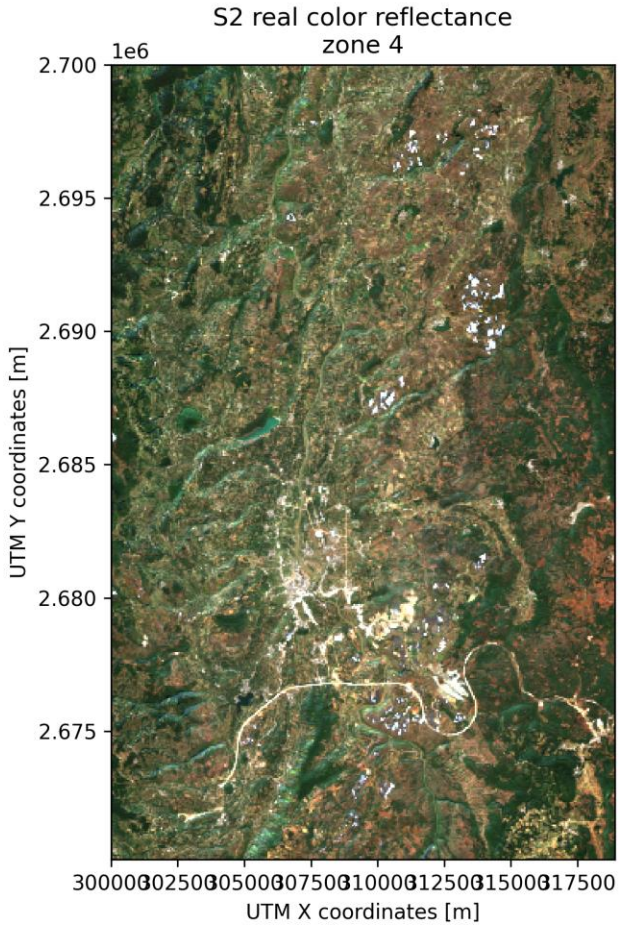


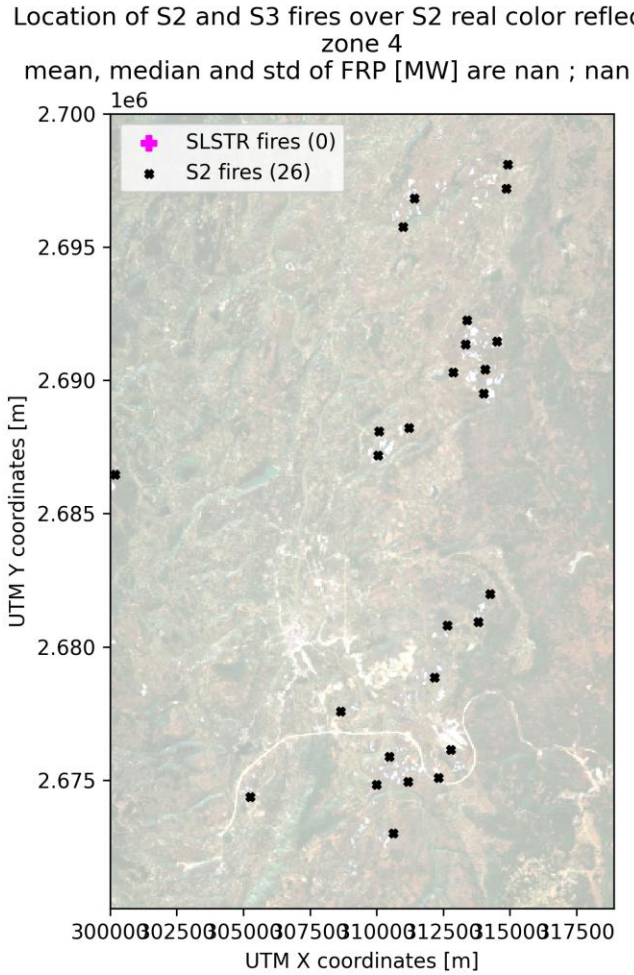


Solar panels in desertic China : fire probability seems low at first sight, likely to be a S2 commission error

Examples of potential S3 omissions







Not identified (snow, plastic?) in China : fire probability seems low at first sight, likely to be a S2 commission error