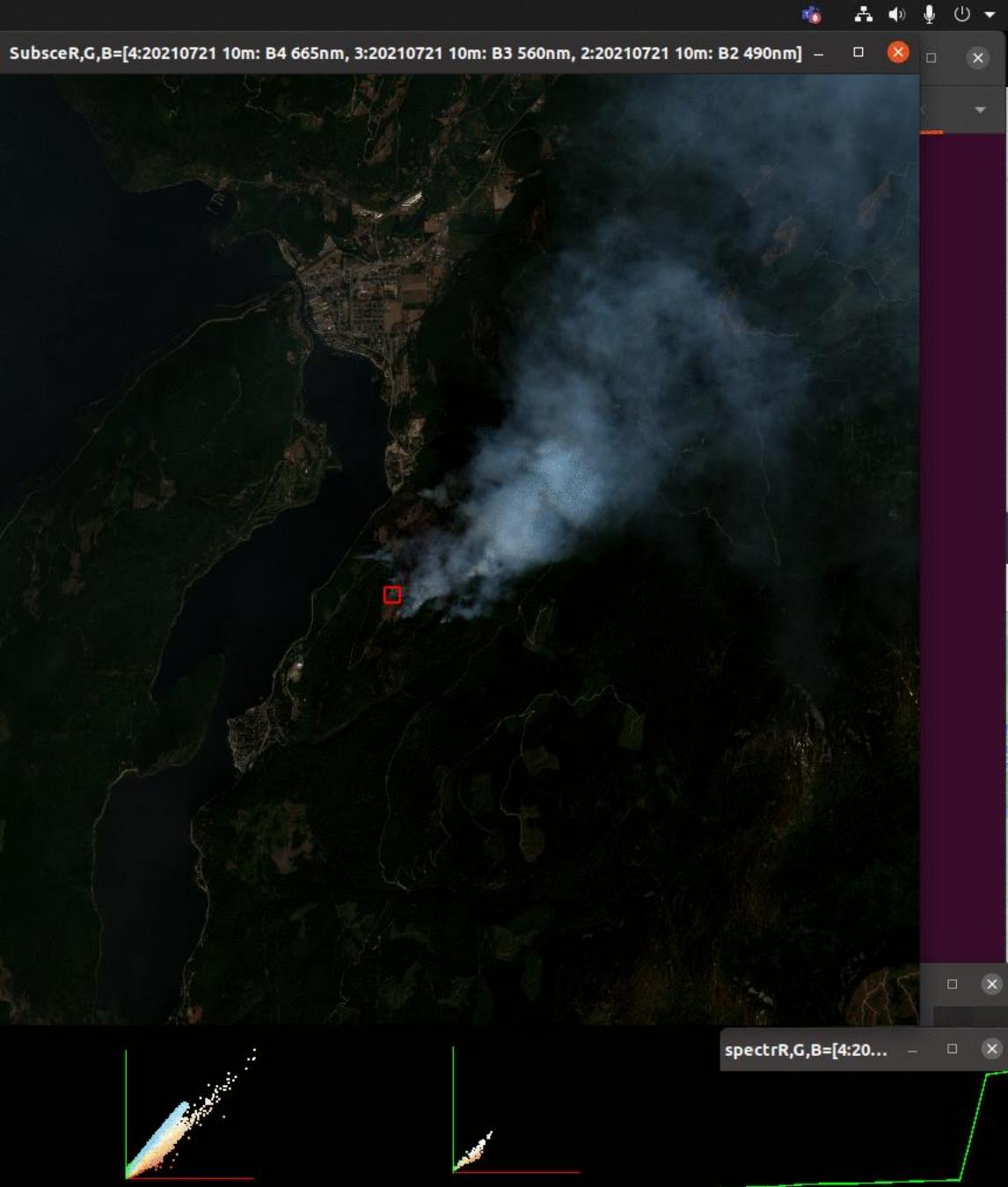


Fire mapping w Shortwave Infrared



Overview



1. Pre-process
2. Fire Detection method #1

And Perimeter recipe

3. Fire Detection method #2

Deal w clouds/ice without Level2-processing cloud mask!

4. Appendix:

Visualize results of Sen2Cor



Satellite mapping of fires



- Remote areas: less costly, safer compared to heli-GPS perimeters
- Cost effective, timely BI for fires being monitored
- Fire growth modelling & other predictive services require daily perimeter updates to reduce simulation error
- Complement other methods: airborne-GPS and IR scanning (less frequent as fires get large/ smoke conditions limit visibility)
- Provide additional info about recent fire activity along a perimeter, helping refine model inputs
- Start with Sentinel-2.. Add more?

SWIR for fire mapping?



- "Unlike TIR imaging, smoke is not transparent at these wavelengths but SWIR has somewhat better haze and smoke penetration than visible light" [1]
- Historically SWIR more popular for monitoring volcanoes than forest fires.. (DGG)
- Increasing popularity of SWIR for forest fires
 - Connected with / enhanced by Machine Learning algorithms [3]

[1] (2016) R.S Allison, J. M. Johnston, G Craig and S. Jennings, "Airborne Optical and Thermal Remote Sensing for Wildfire Detection and Monitoring

[2] (2004) Vis with fires = orange / red <https://www.youtube.com/watch?v=lp1fj2Vx6fY>

[3] (2021) Automated classification of heat sources detected using SWIR remote sensing
<https://www.sciencedirect.com/science/article/pii/S0303243421001987>



Pre-processing steps

1. Sen2cor processing (L1C --> L2A)*

2. Retain

B12 2190nm (20m), B11 1610nm (20m), B9 945nm (60m)

3. Resample to 20m

(Why? bands of interest: 20m, 20m, 60m)

4. Sort bands in order: wavelength increasing**

** Always sort data if:

1. We can
2. It makes physical sense to do so

Why?

1. Easier to follow the story
2. Sorting is the only thing computers can do
(proof by "SUBLEQ" OISC)

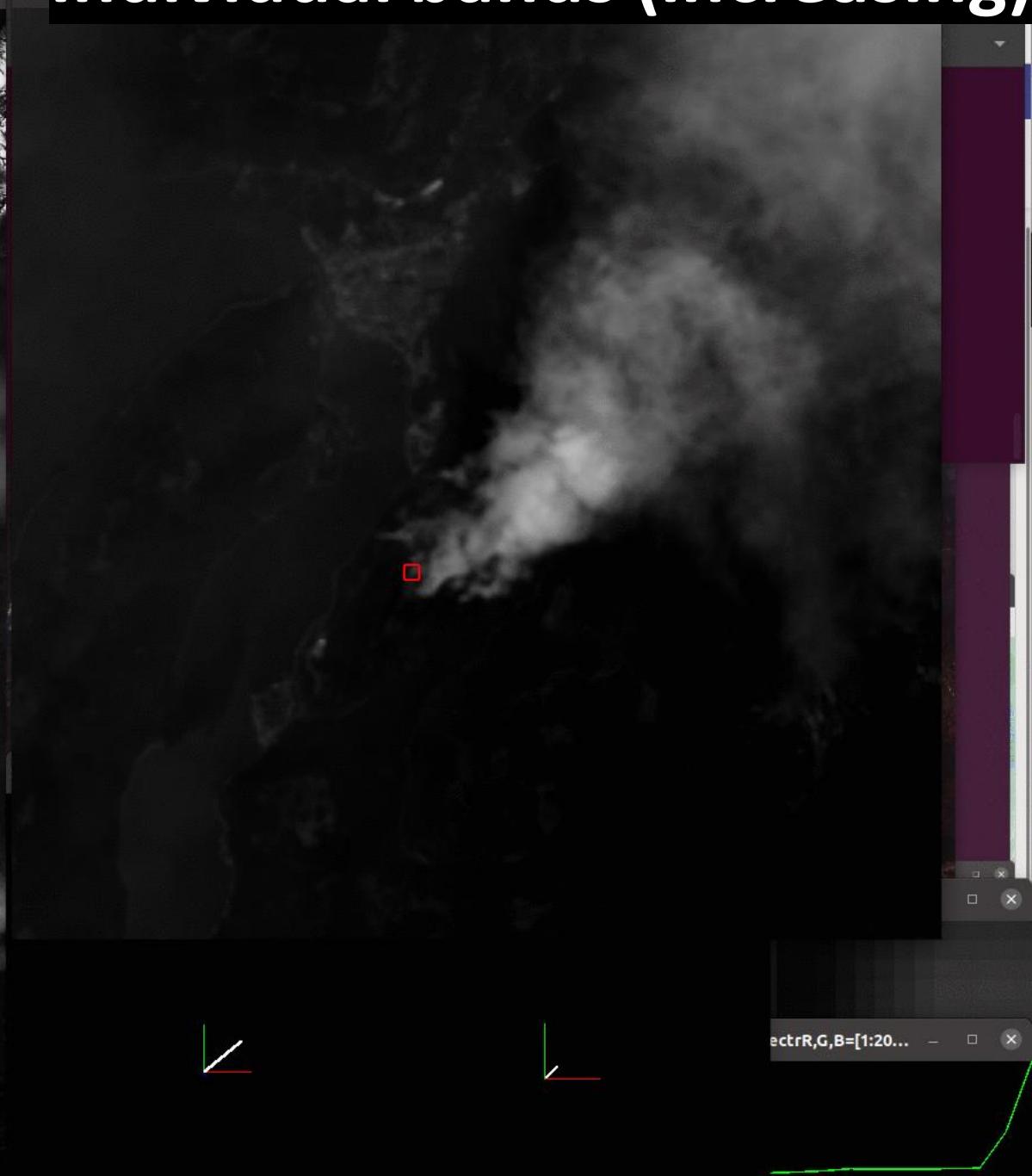
Activities

Unknown ▾

Apr 11 20:50 •

Scene R,G,B=[1:20210721 60m: B1 443nm, 1:20210721 60m: B1 443nm, 1:20210721 60m: B1 443nm]

Individual bands (increasing)



electrR,G,B=[1:20...

Satellite-based fire perimeter recipe



1. **Threshold** (create a fire mask)
2. **Flood** (identify pieces of fire)
3. **Link** (put pieces together)
4. **Trace** (a linear boundary)
 - Exclude segments less than certain size
 - Alpha hull --> geolocate the coords
 - Create KML



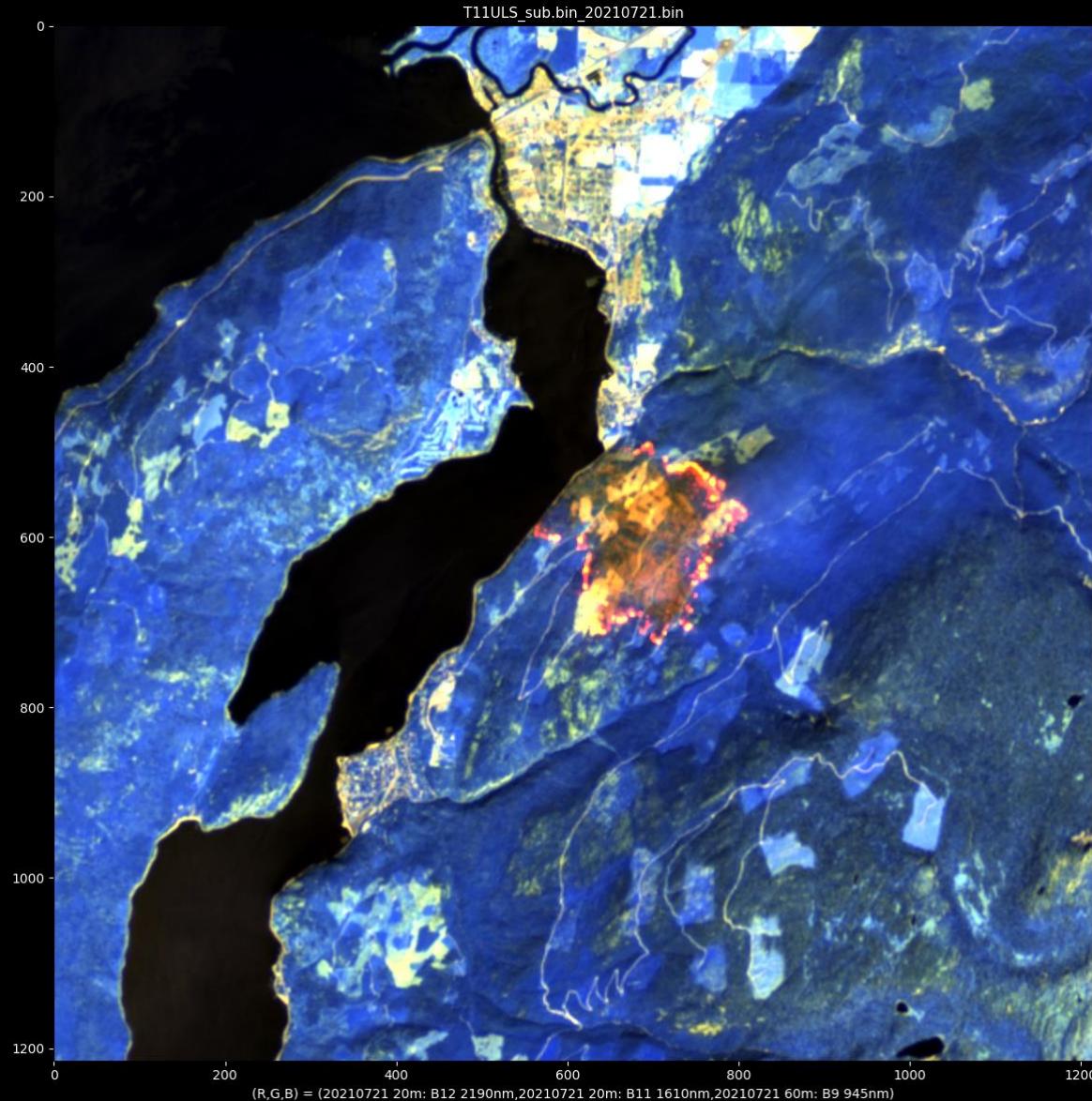
Small fire example

RGB = RGB (visible)



BC Wildfire
Service

RGB= (B12, B11, B9) shortwave IR



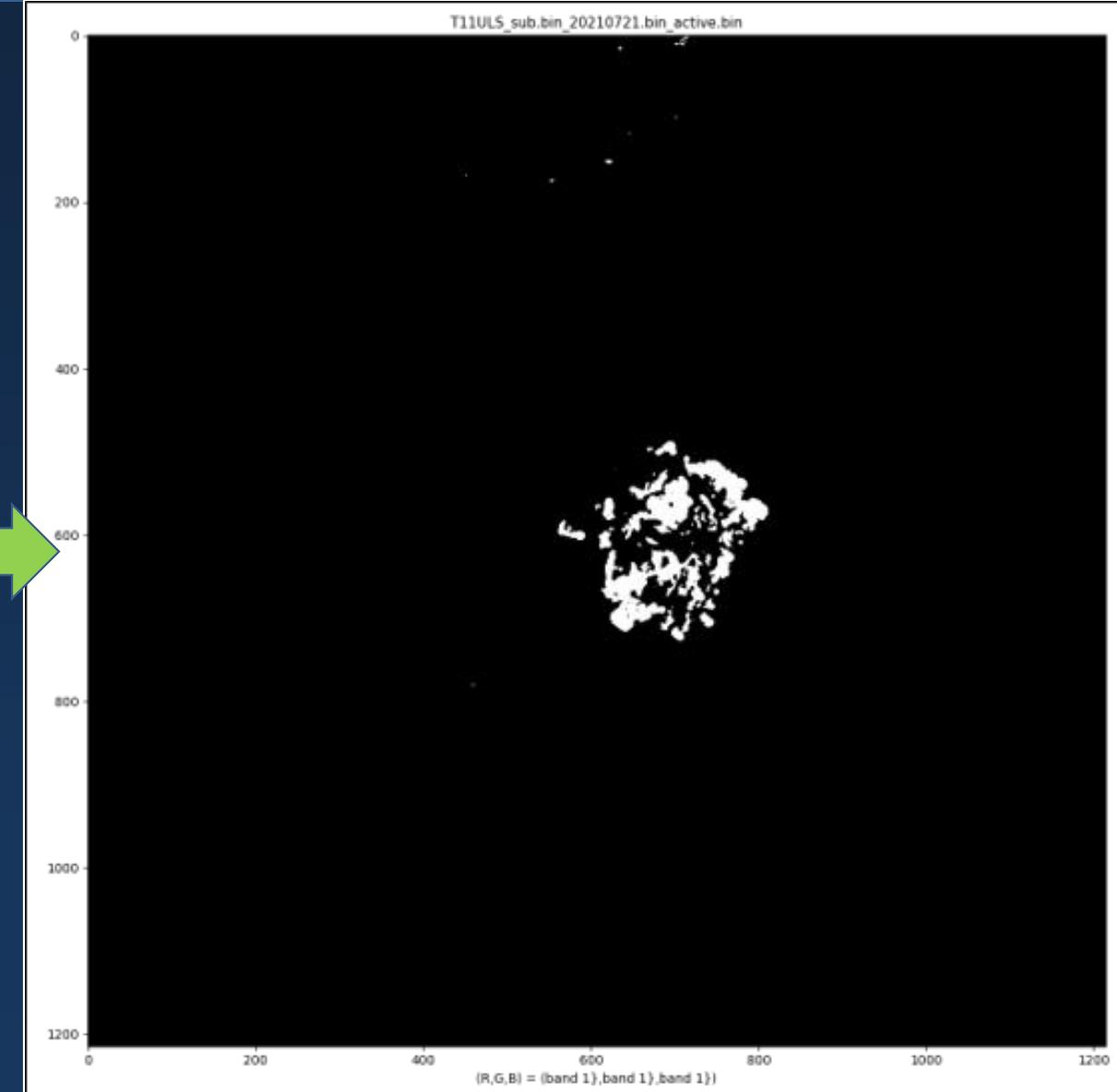
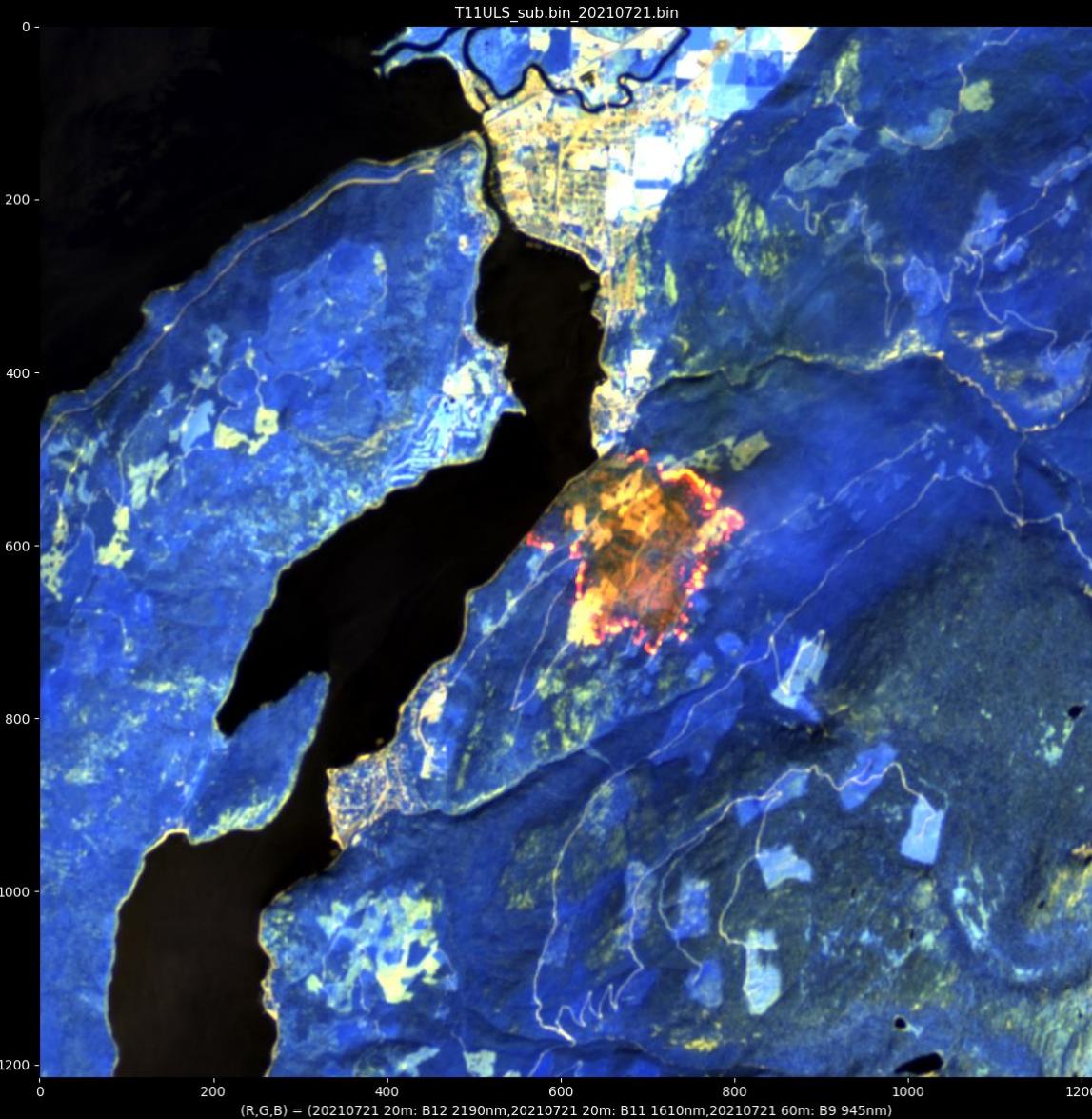
1. Threshold

RGB= (B12, B11, B9) shortwave IR

[please
click here
for source
code]



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Service

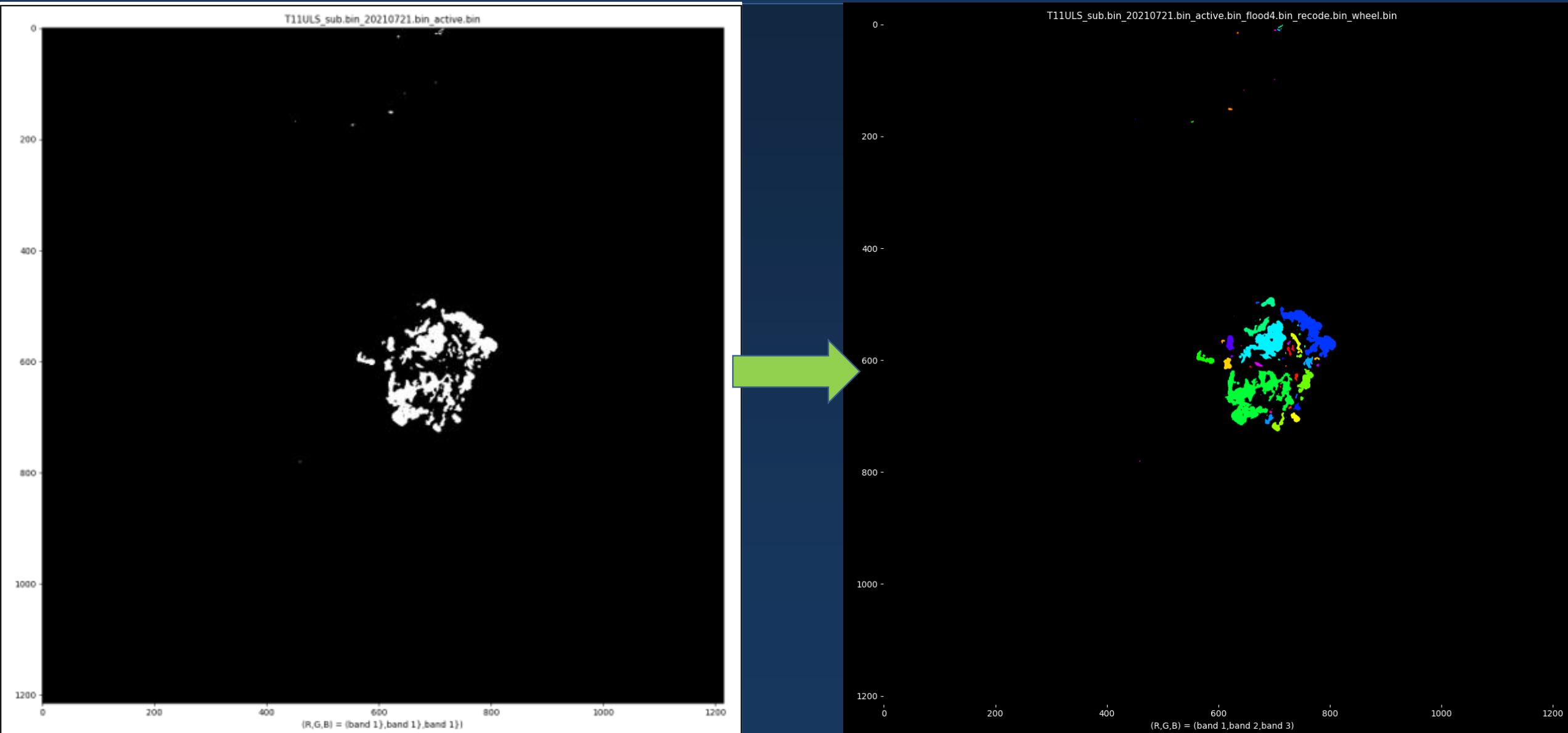


2. Flood fill

[please
click here
for source
code]



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Service



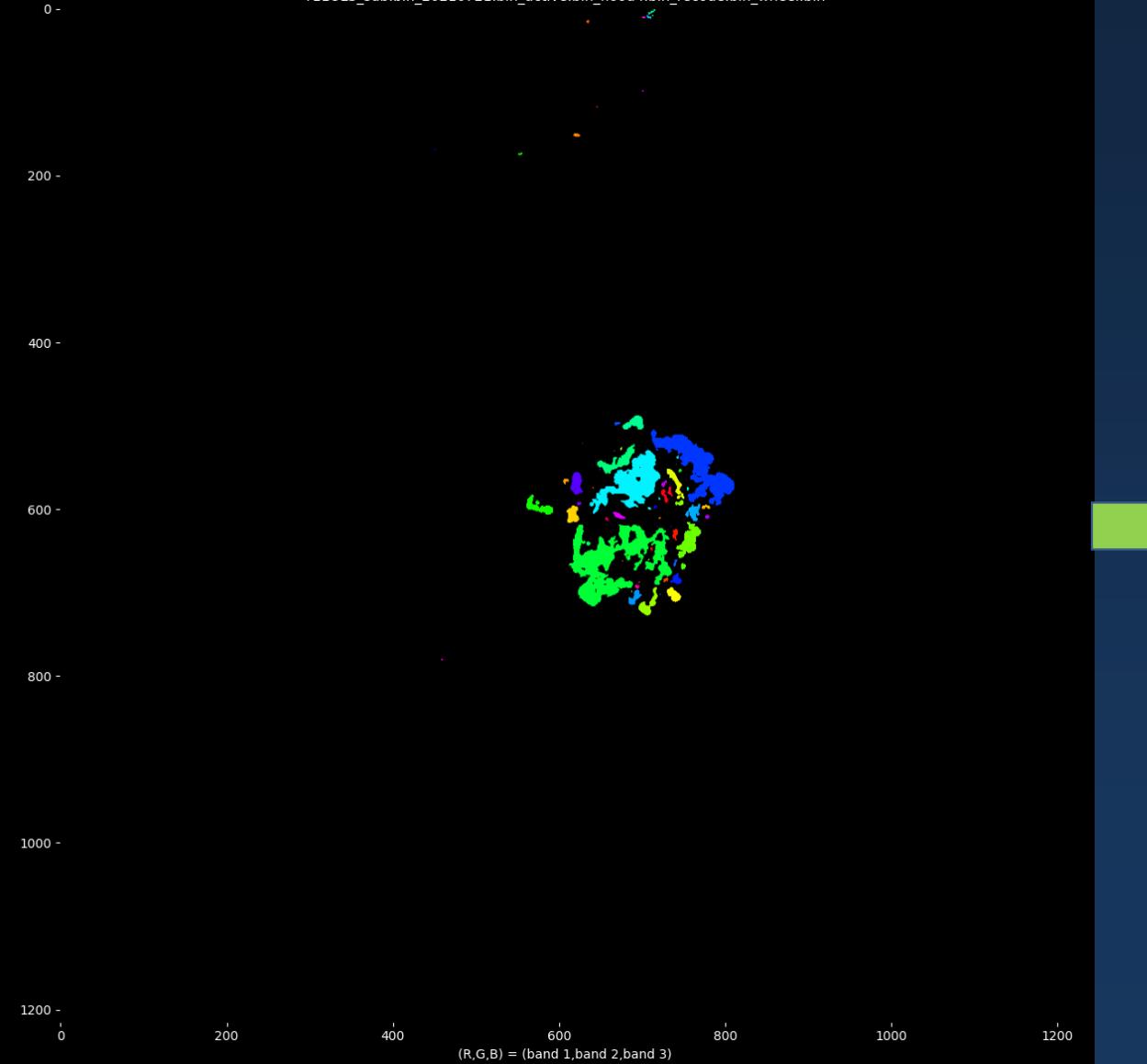
3. Link

[please
click here
for source
code]

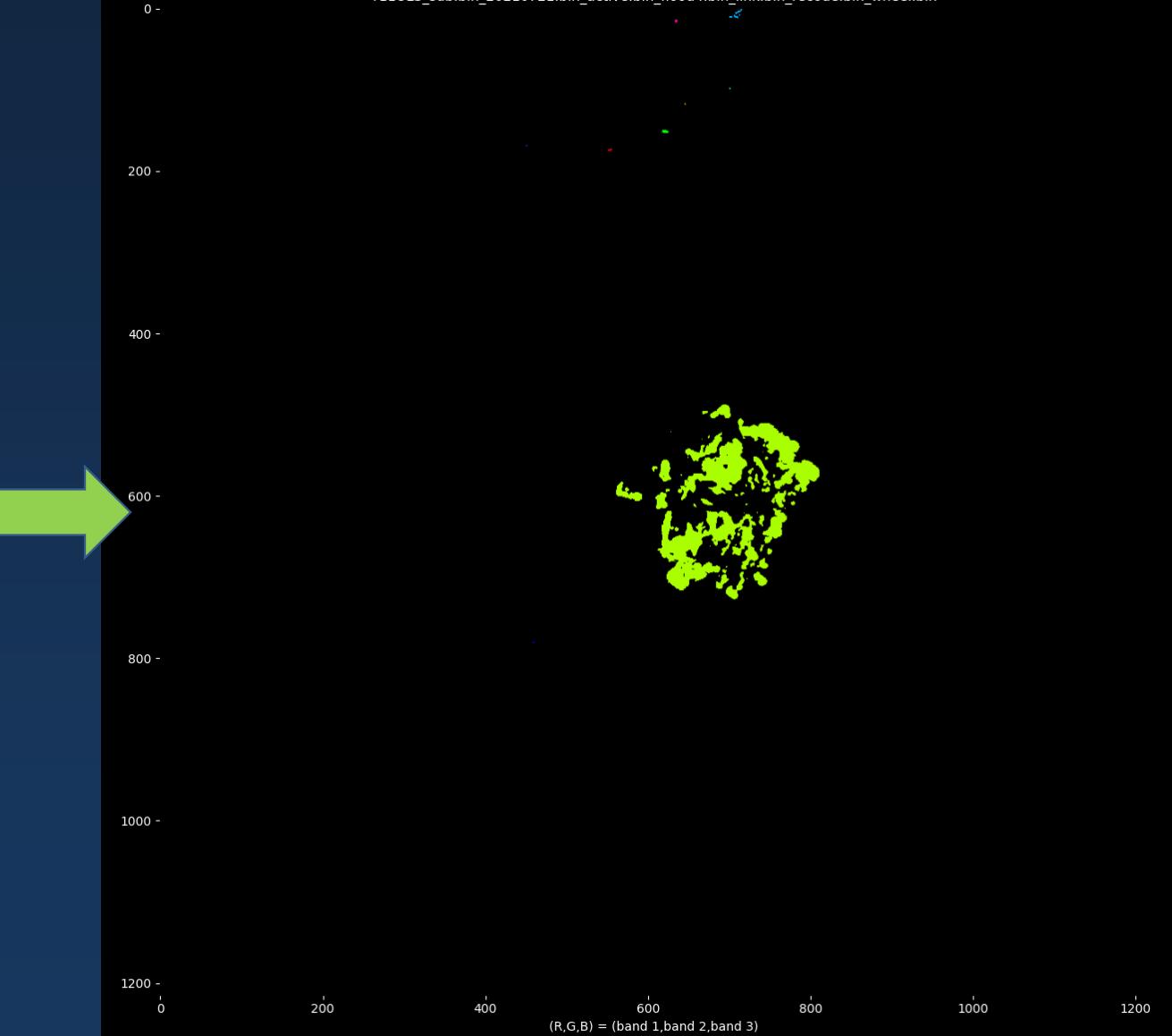


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T11ULS_sub.bin_20210721.bin_active.bin_flood4.bin_recode.bin_wheel.bin



T11ULS_sub.bin_20210721.bin_active.bin_flood4.bin_link.bin_recode.bin_wheel.bin

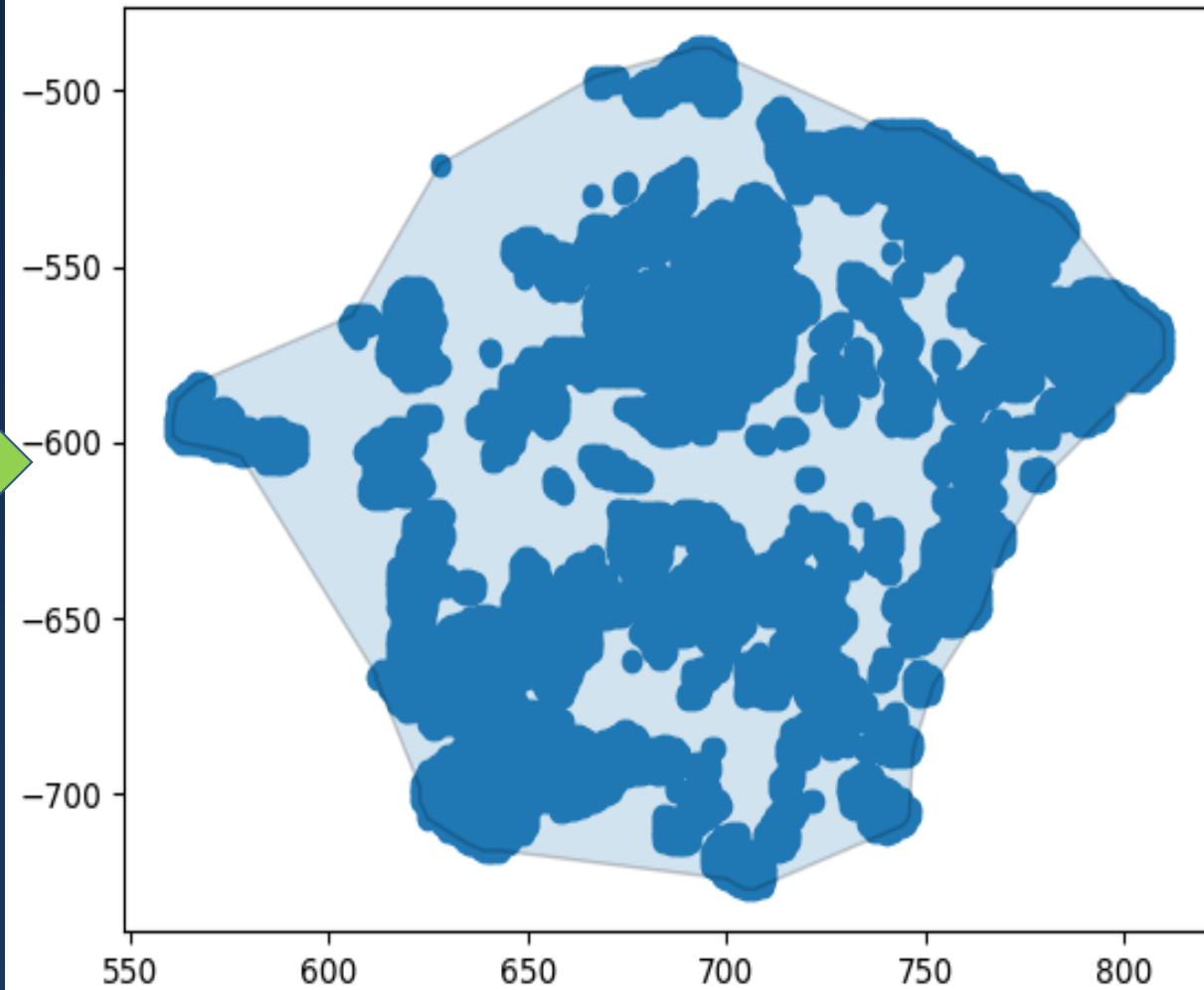
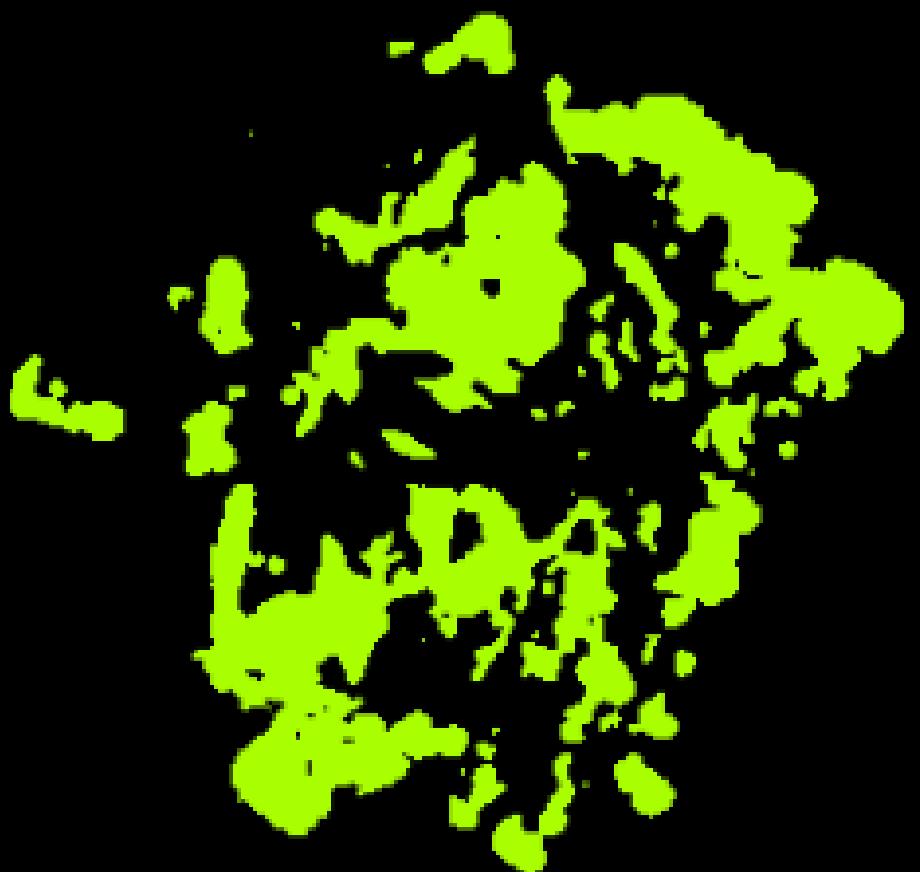


4. Trace

[please
click here
for source
code]



BC Wildfire
Service



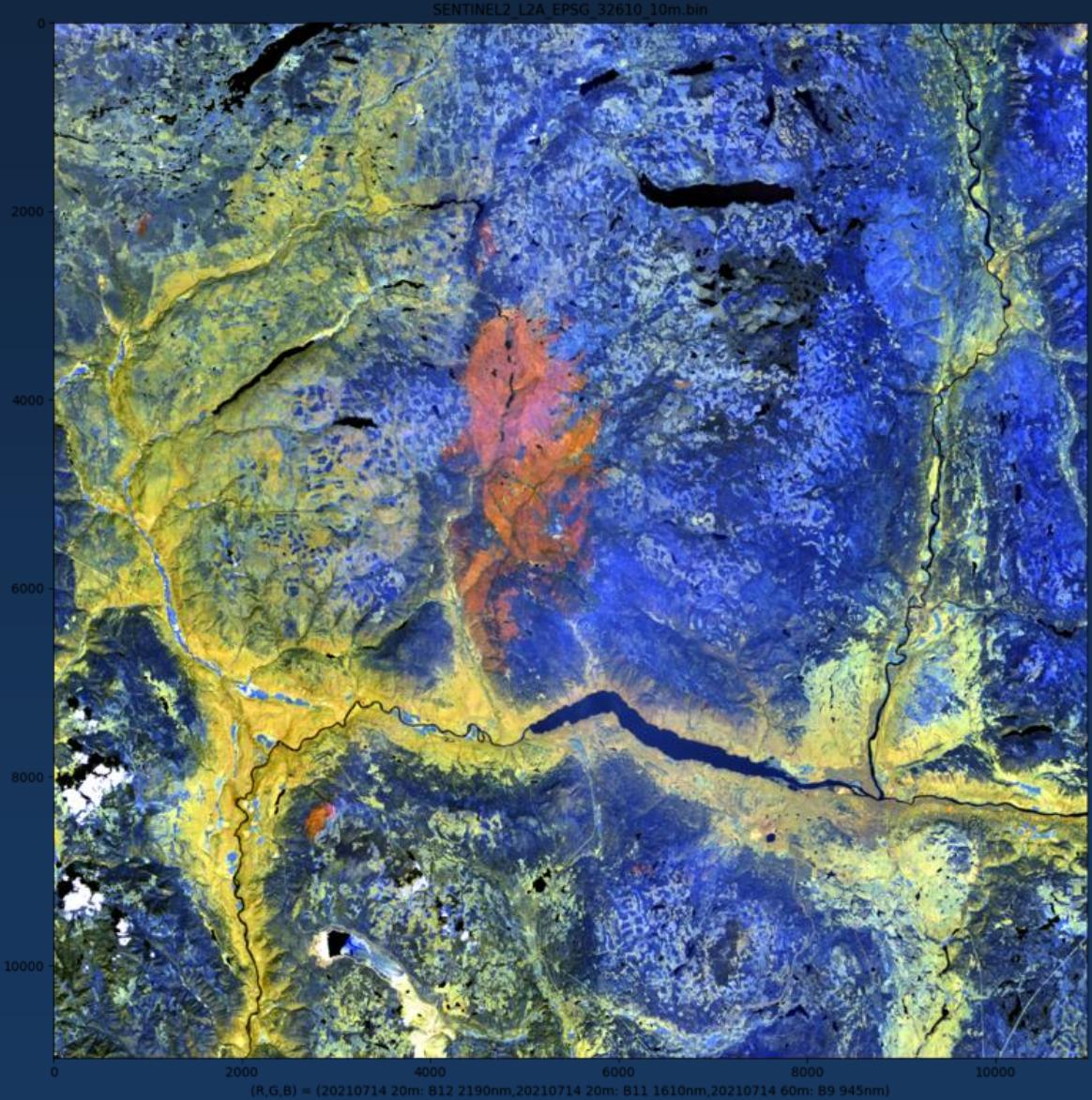
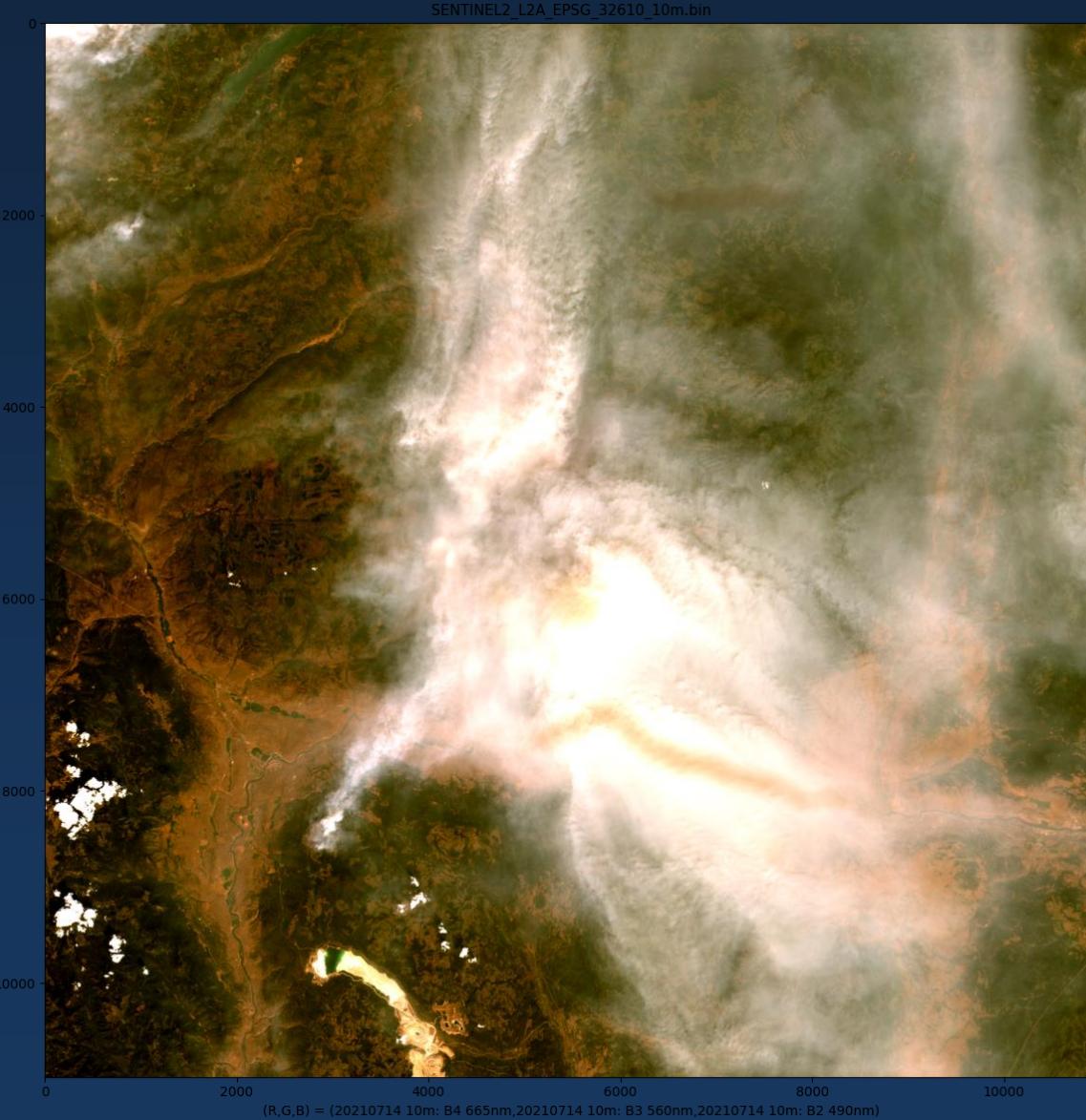
Big fire example

RGB = RGB (visible)



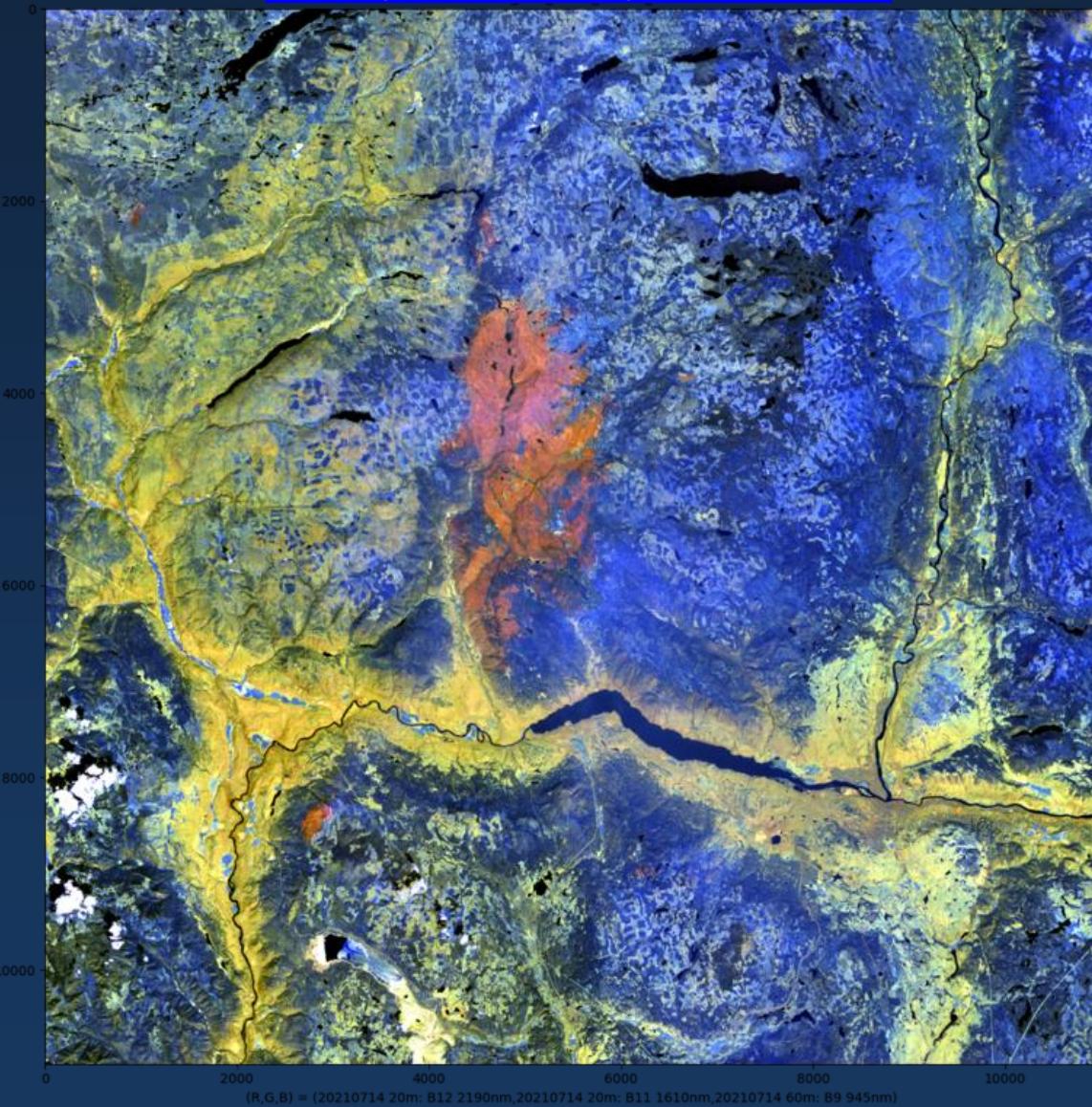
BC Wildfire
Service

RGB= (B12, B11, B9) shortwave IR

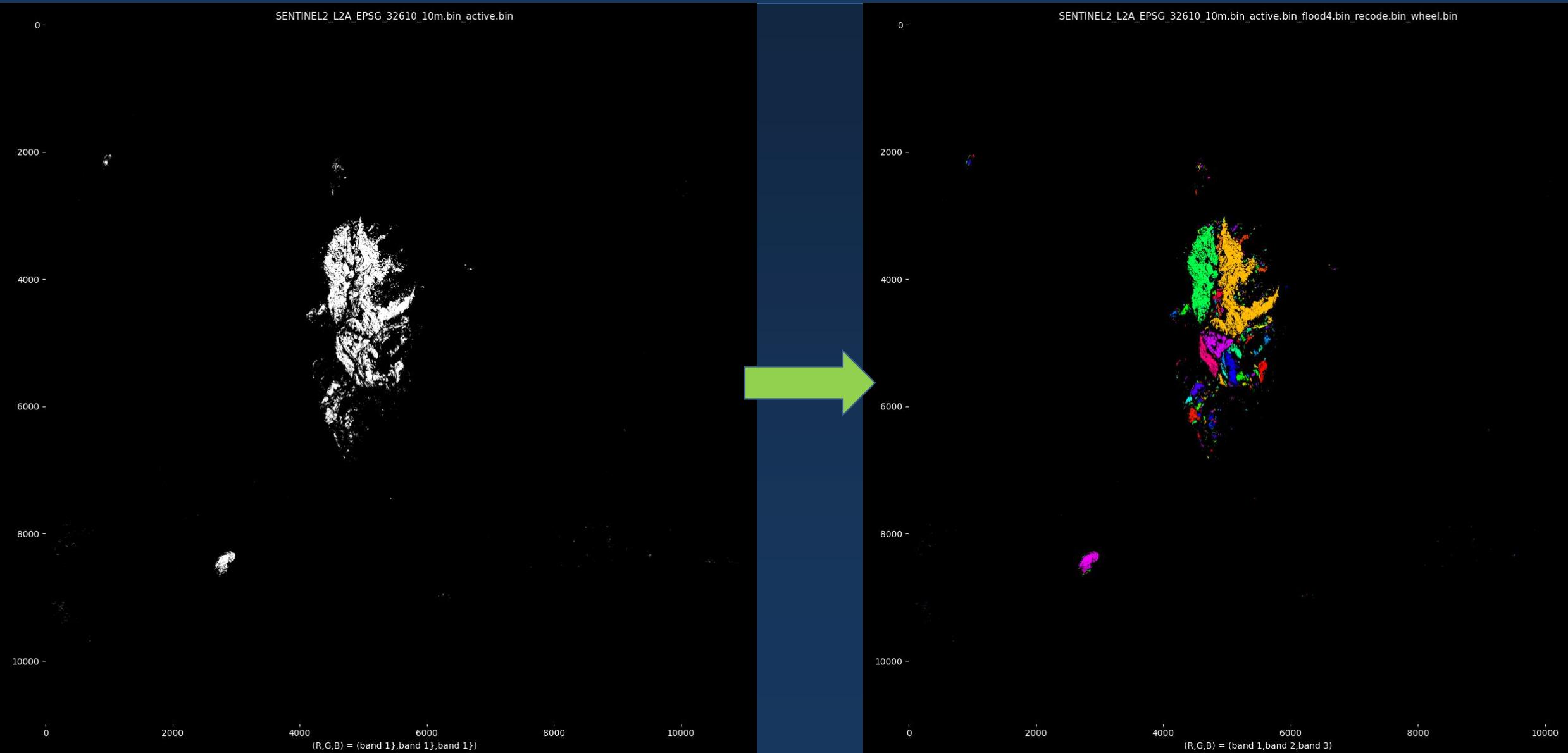


1. Threshold

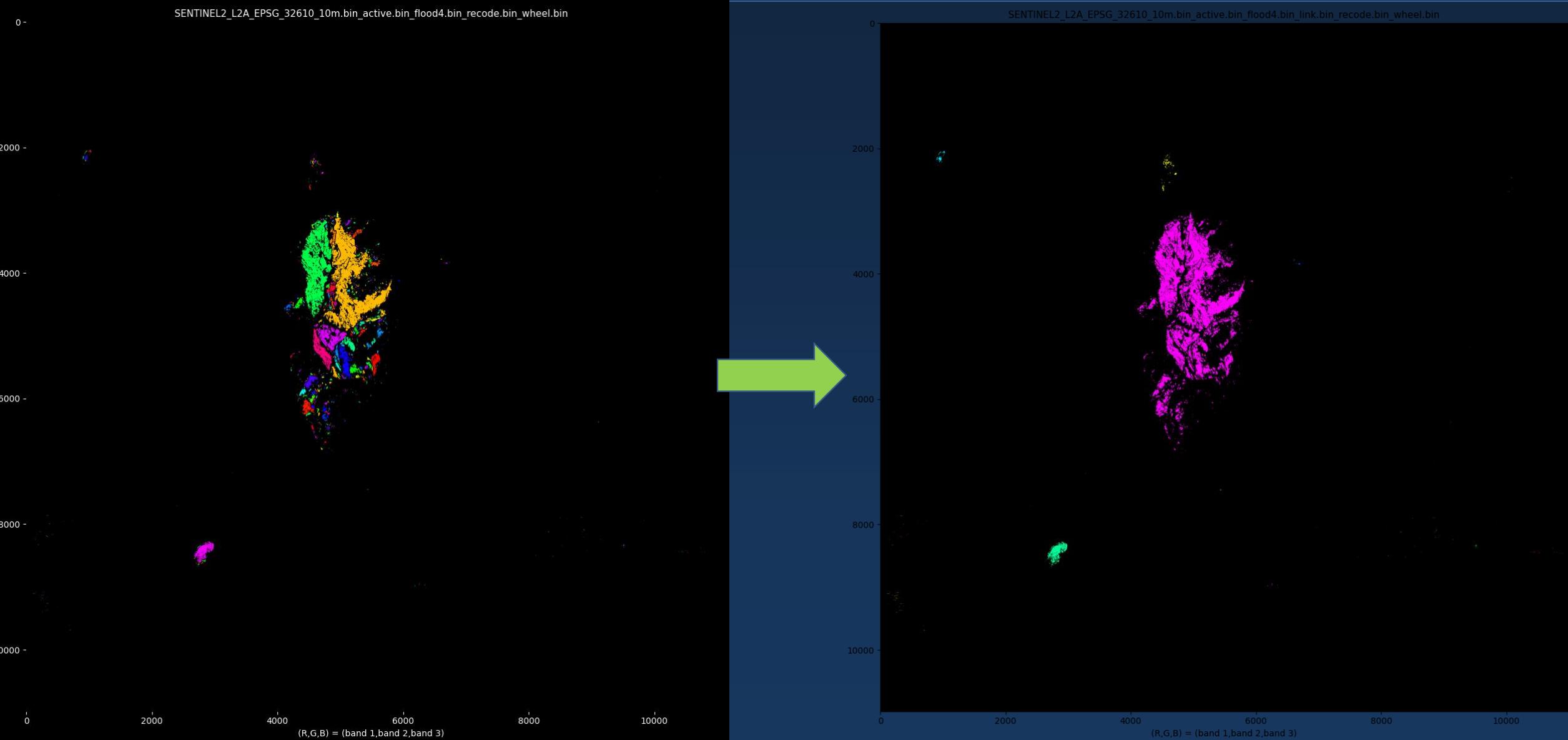
RGB= (B12, B11, B9) shortwave IR



2. Flood fill



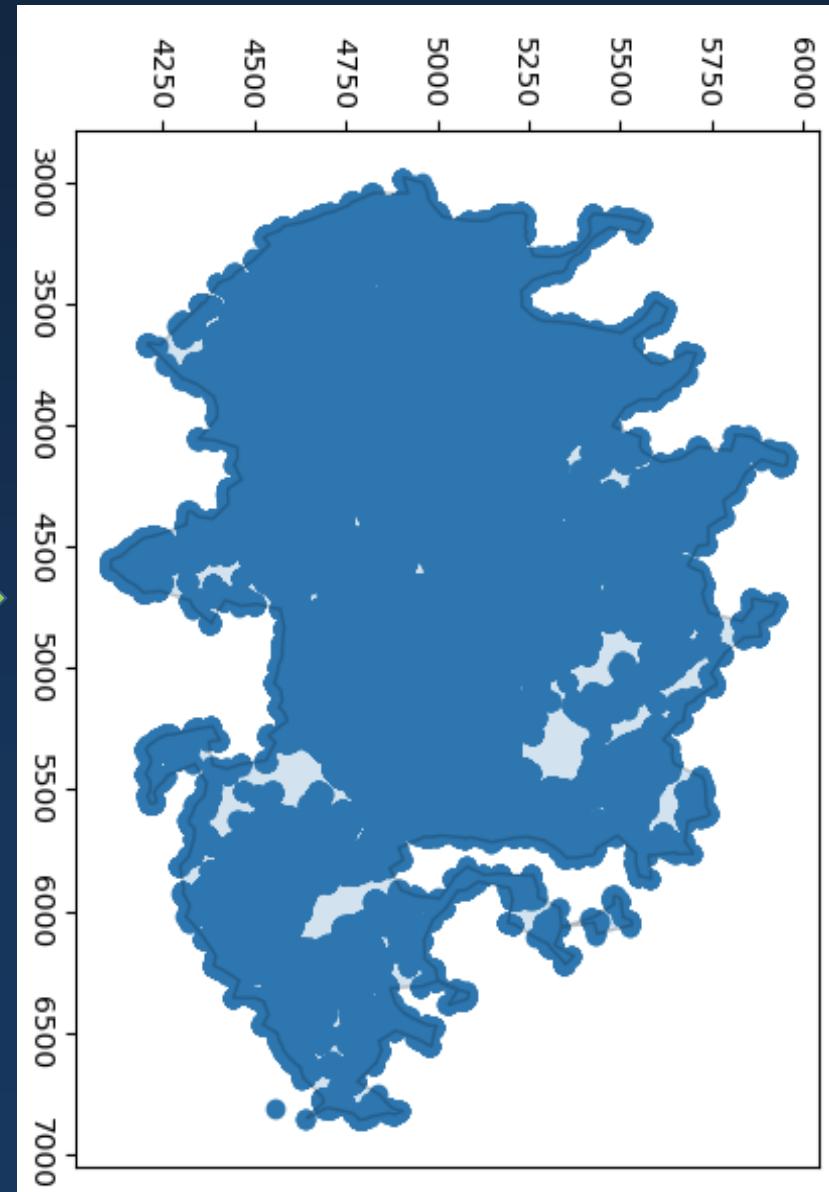
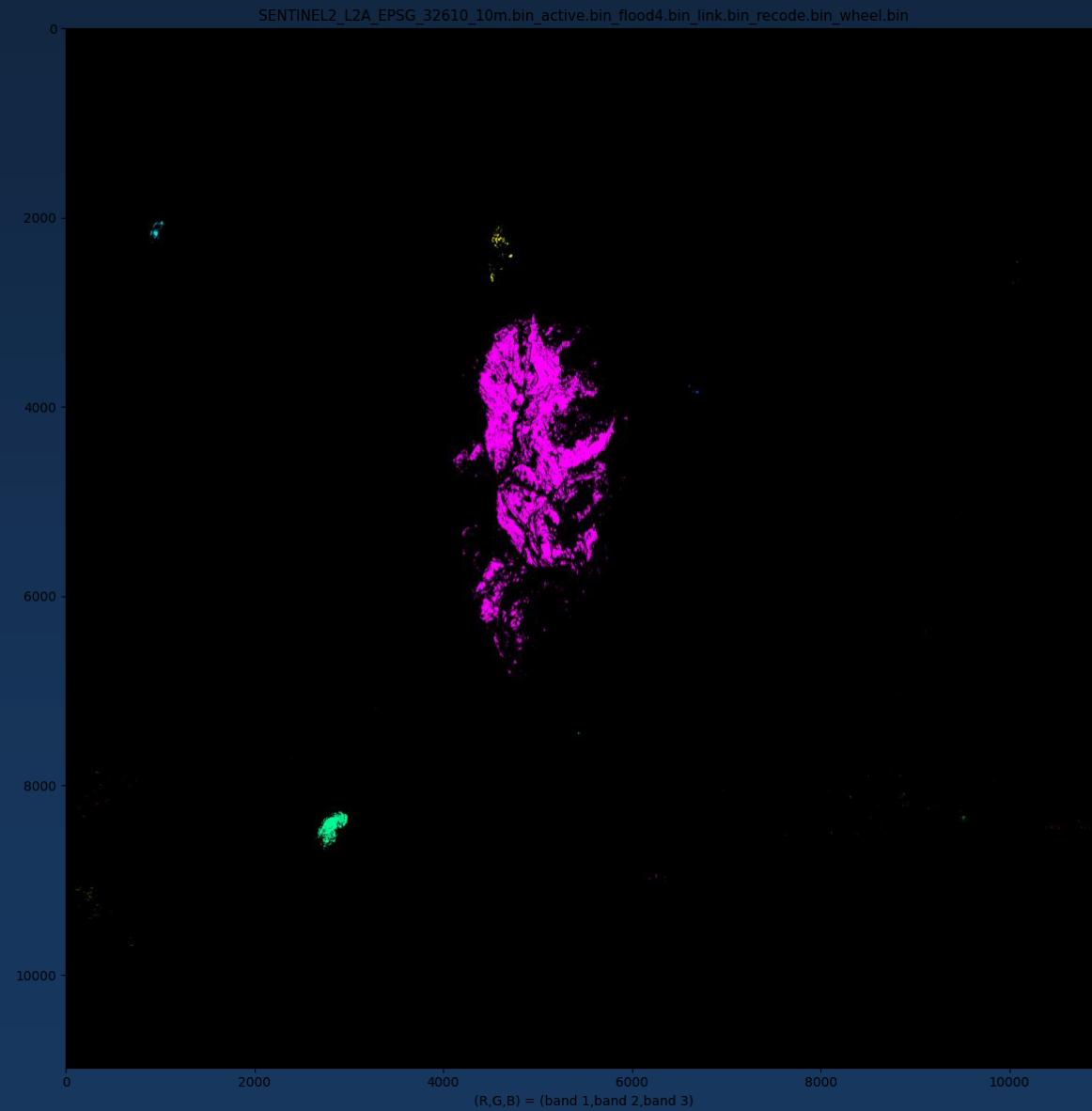
3. Link



4. Trace



BC Wildfire
Service



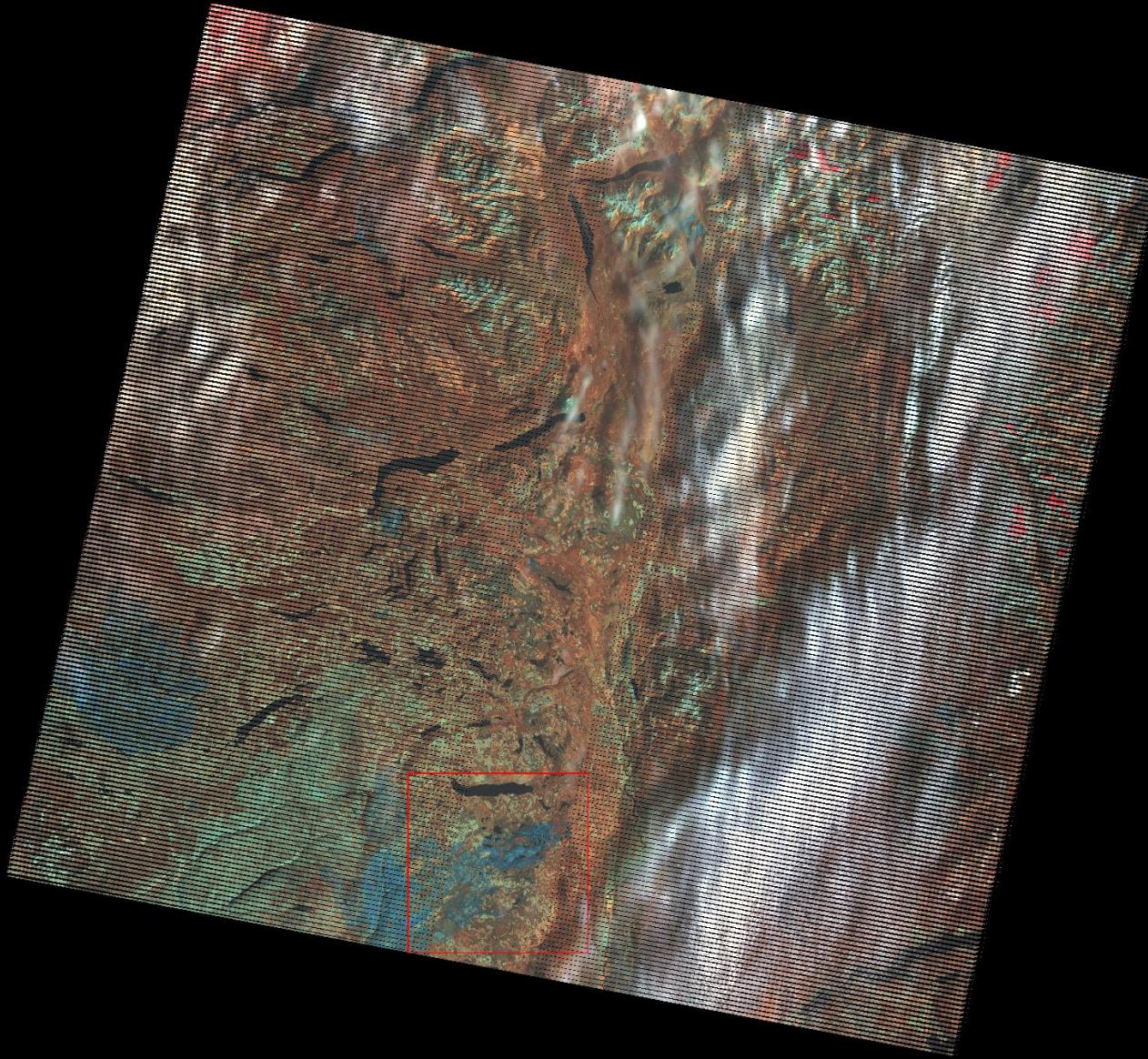
Manually select cluster
Or scrub unwanted areas

Beware the L7

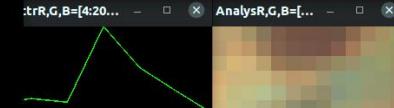
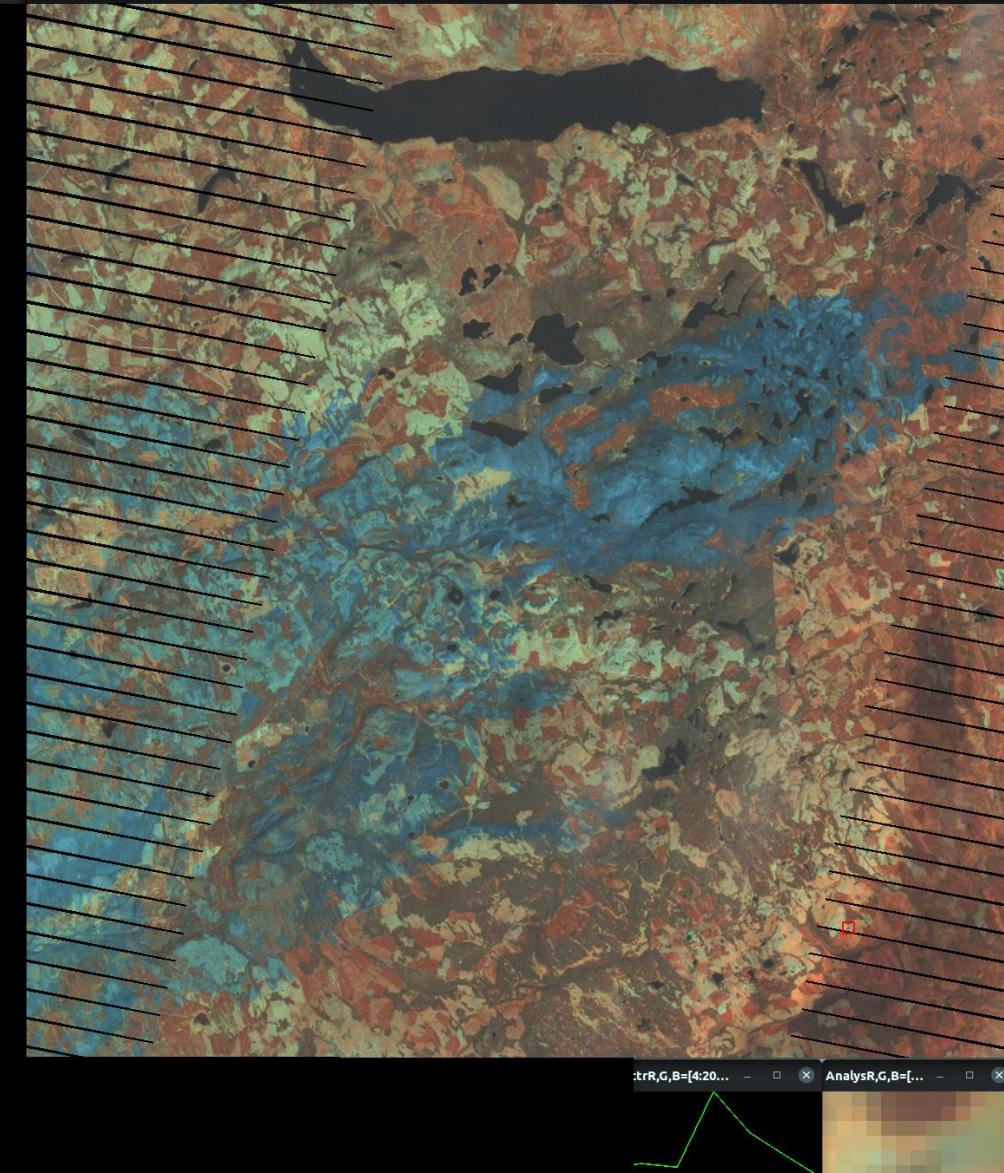


BC Wildfire
Service

Scene R,G,B=[4:20210818 30m: B4 835nm, 5:20210818 30m: B5 1650nm, 6:20210818 30m: B7 2220nm]



SubsceR,G,B=[4:20210818 30m: B4 835nm, 5:20210818 30m: B5 1650nm, 6:20210818 30m: B7 2220nm]

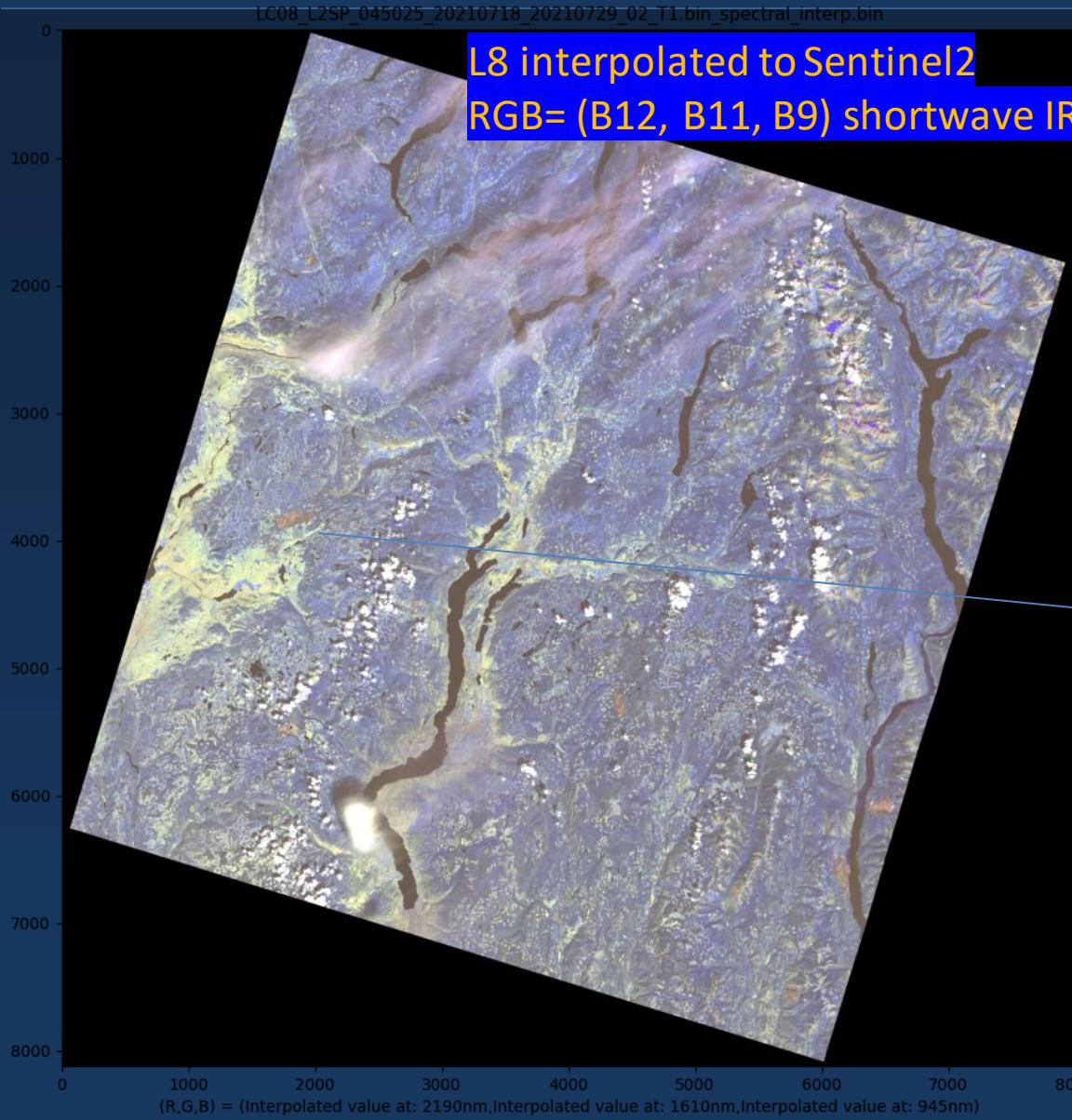


Sacrelige

Beware the L8



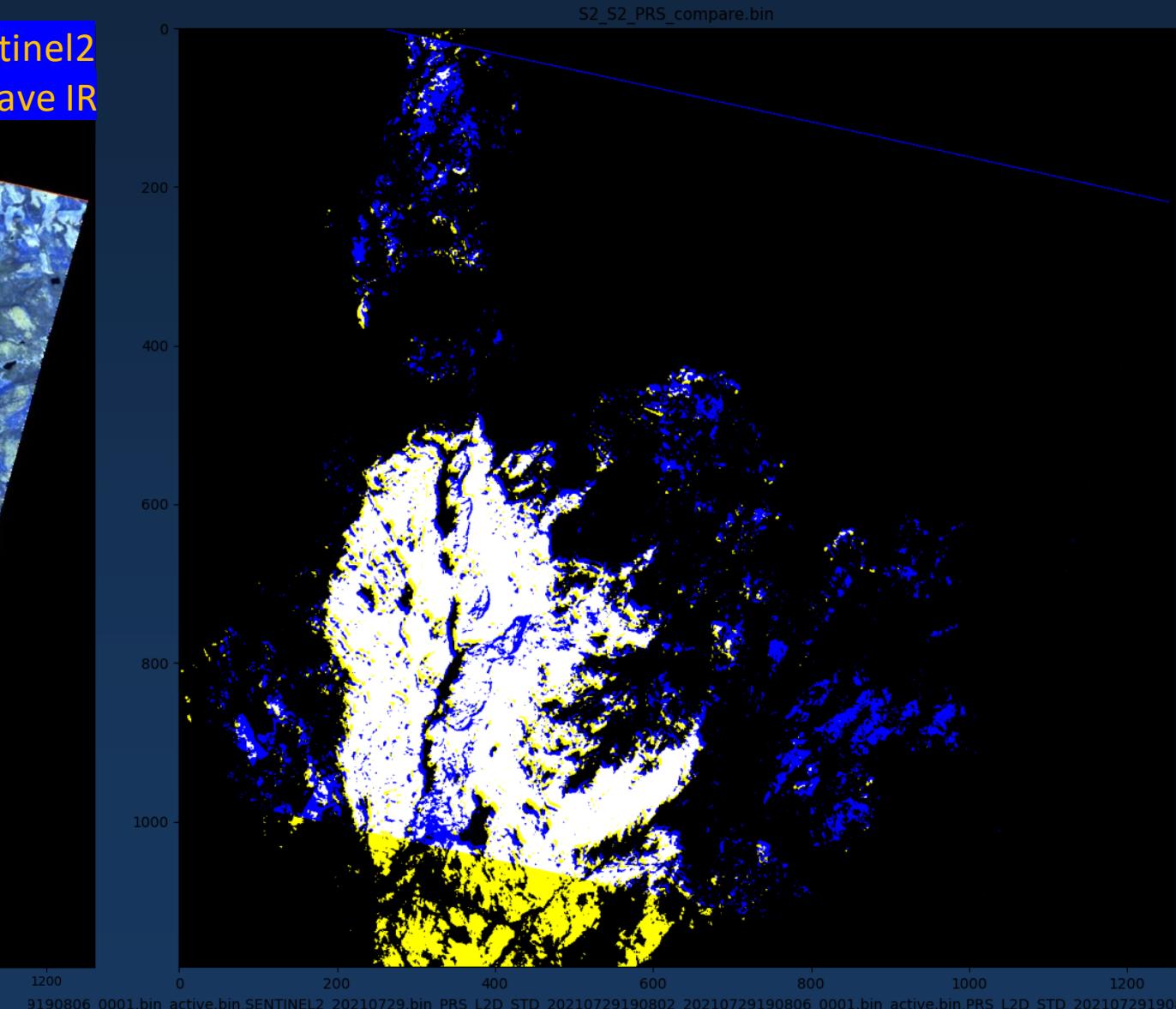
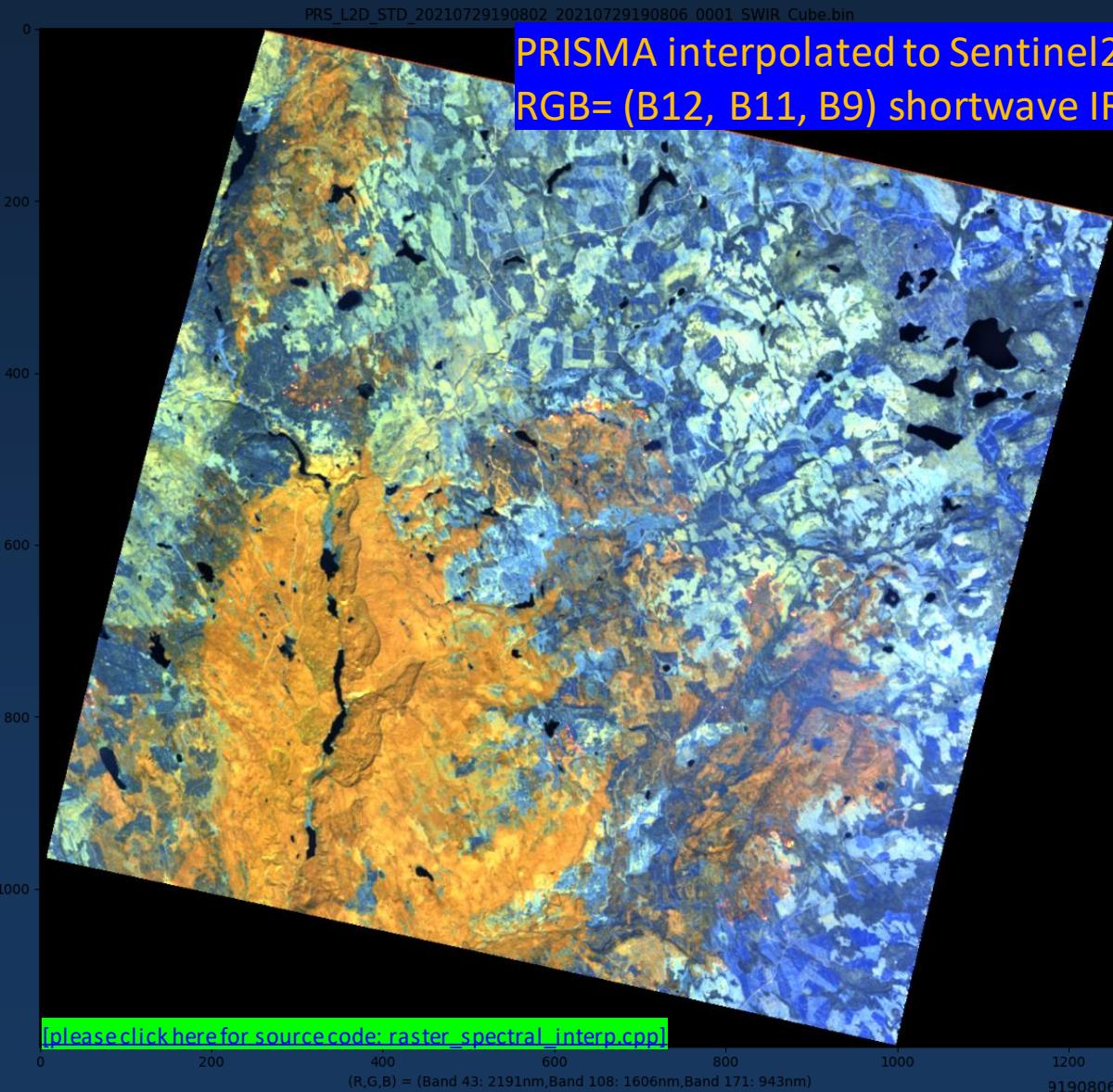
BC Wildfire
Service



Prisma (ASI). SpecInterp to S2, apply Method #1 and compare w S2:



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Service

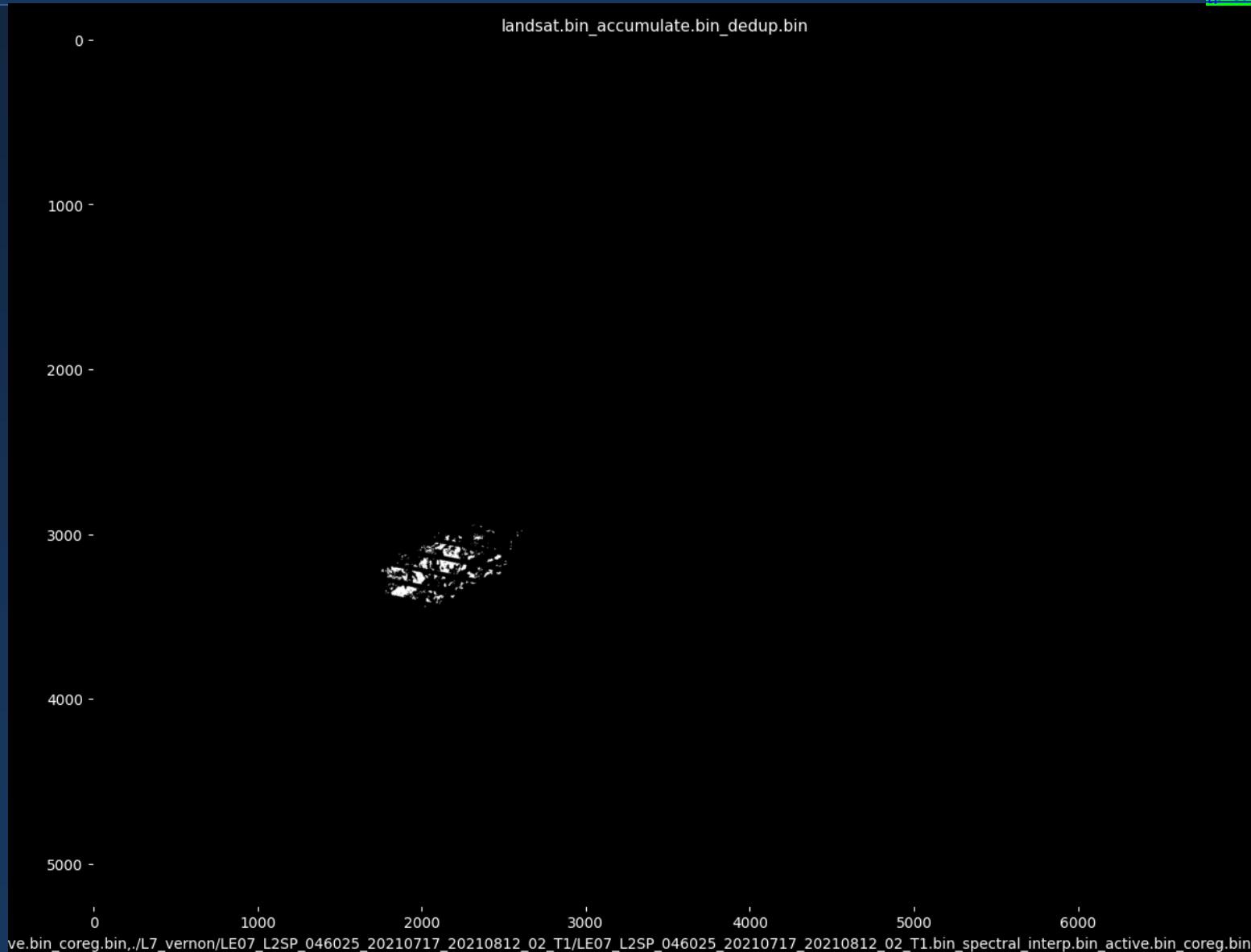


White Rock Lake Fire L7/8 included

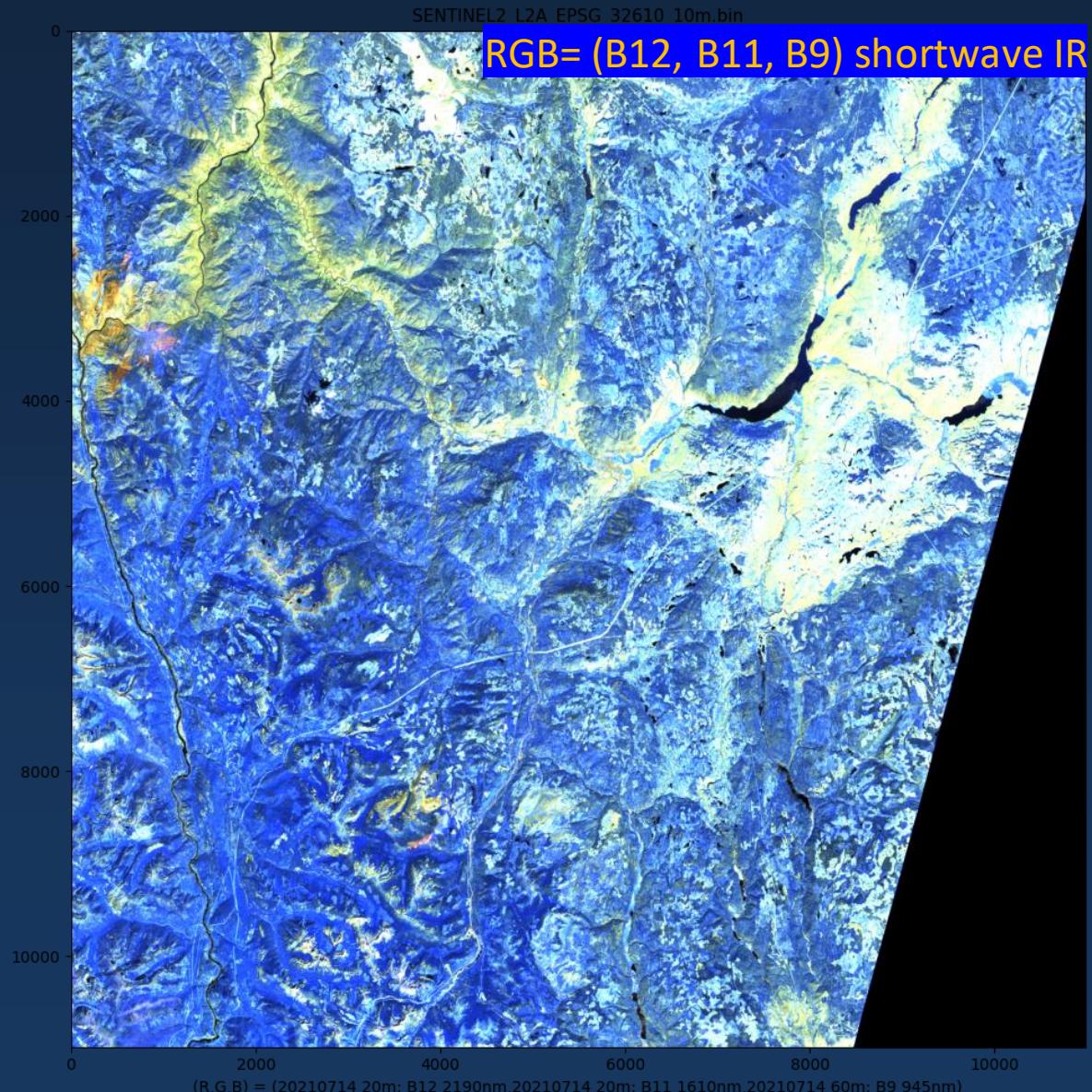
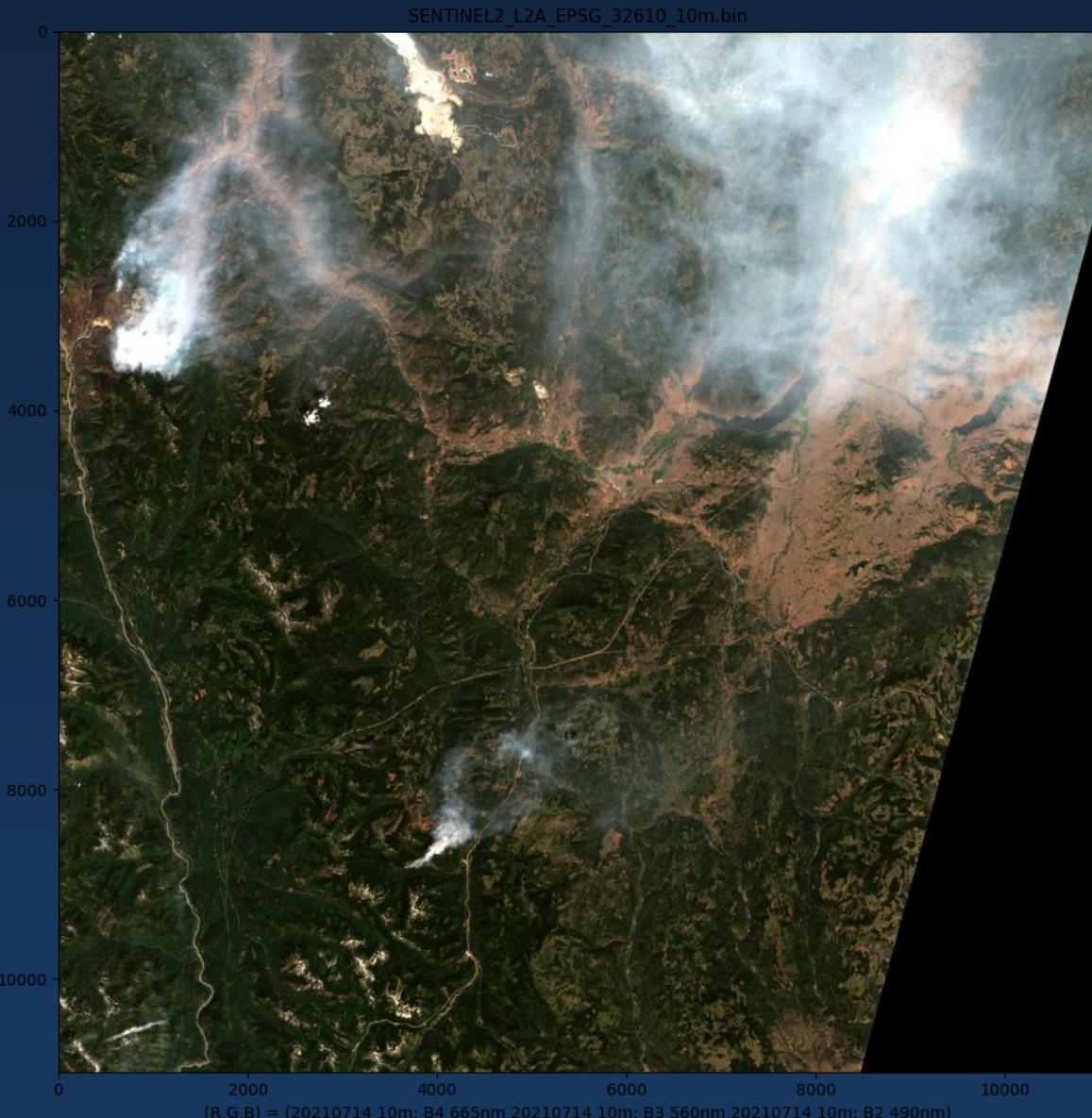


BC Wildfire
Service

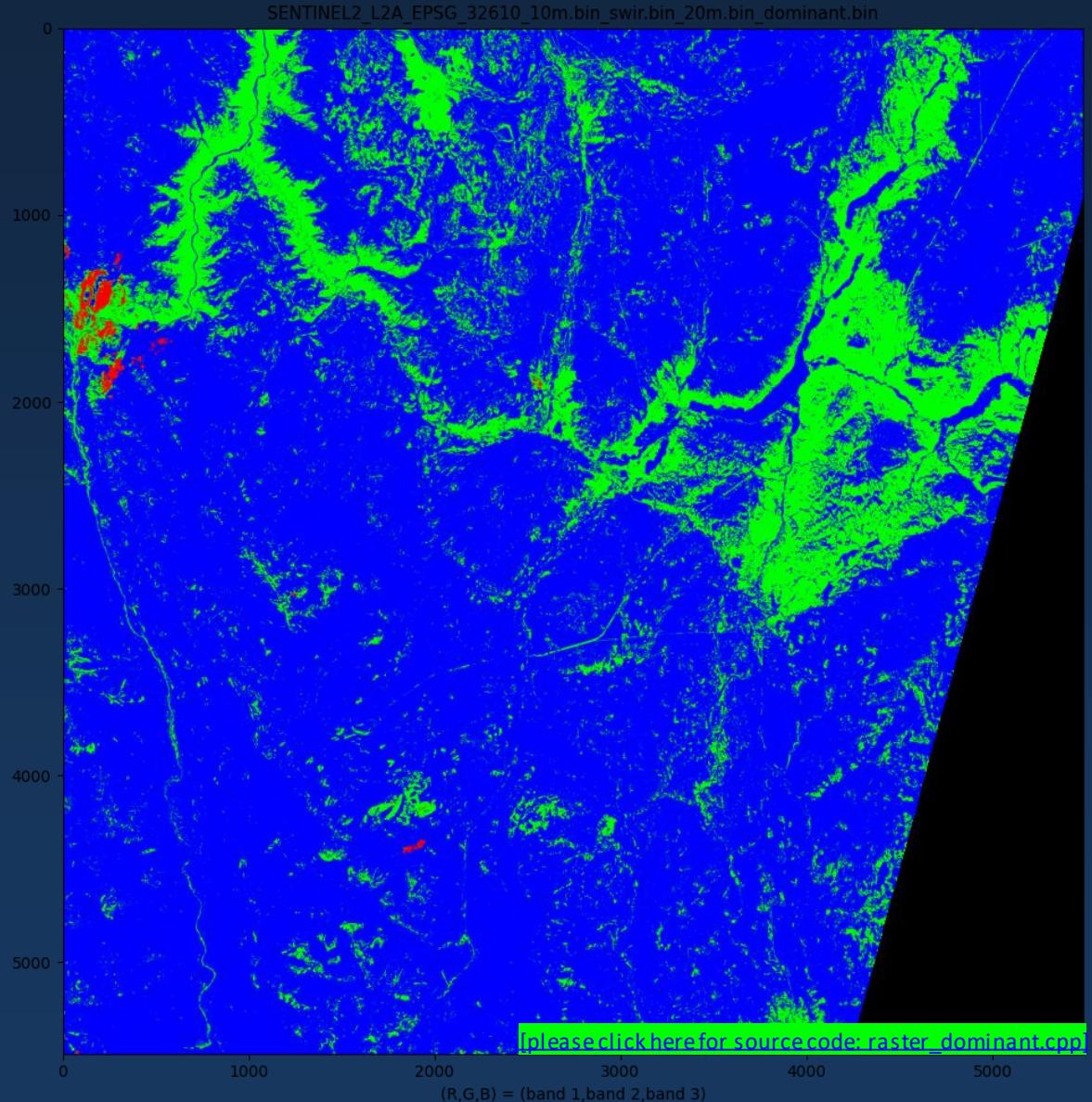
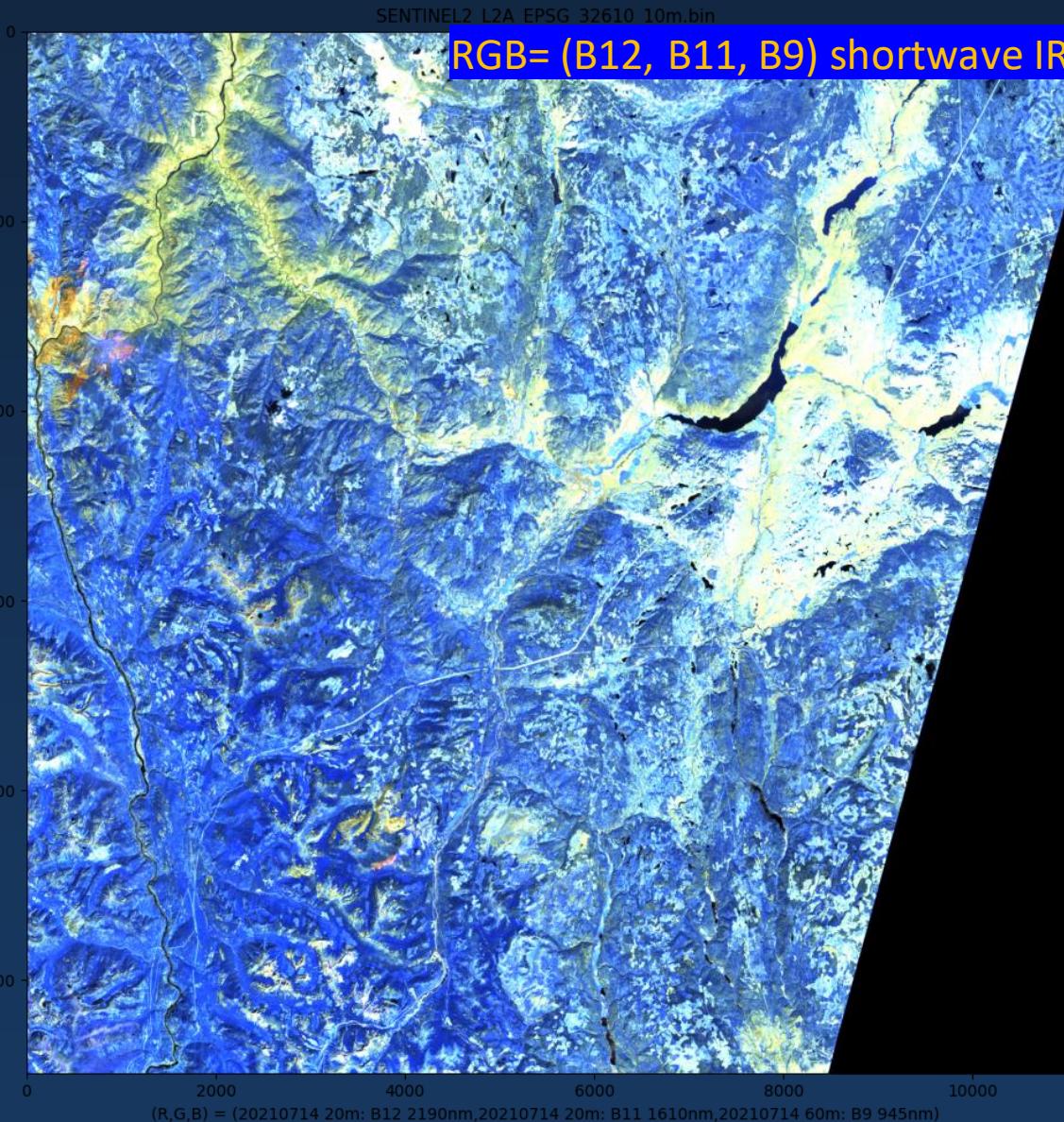
[please click here for source code: [raster_accumulate.cpp](#)]



Method 2: dominant band (Lytton, 2021)

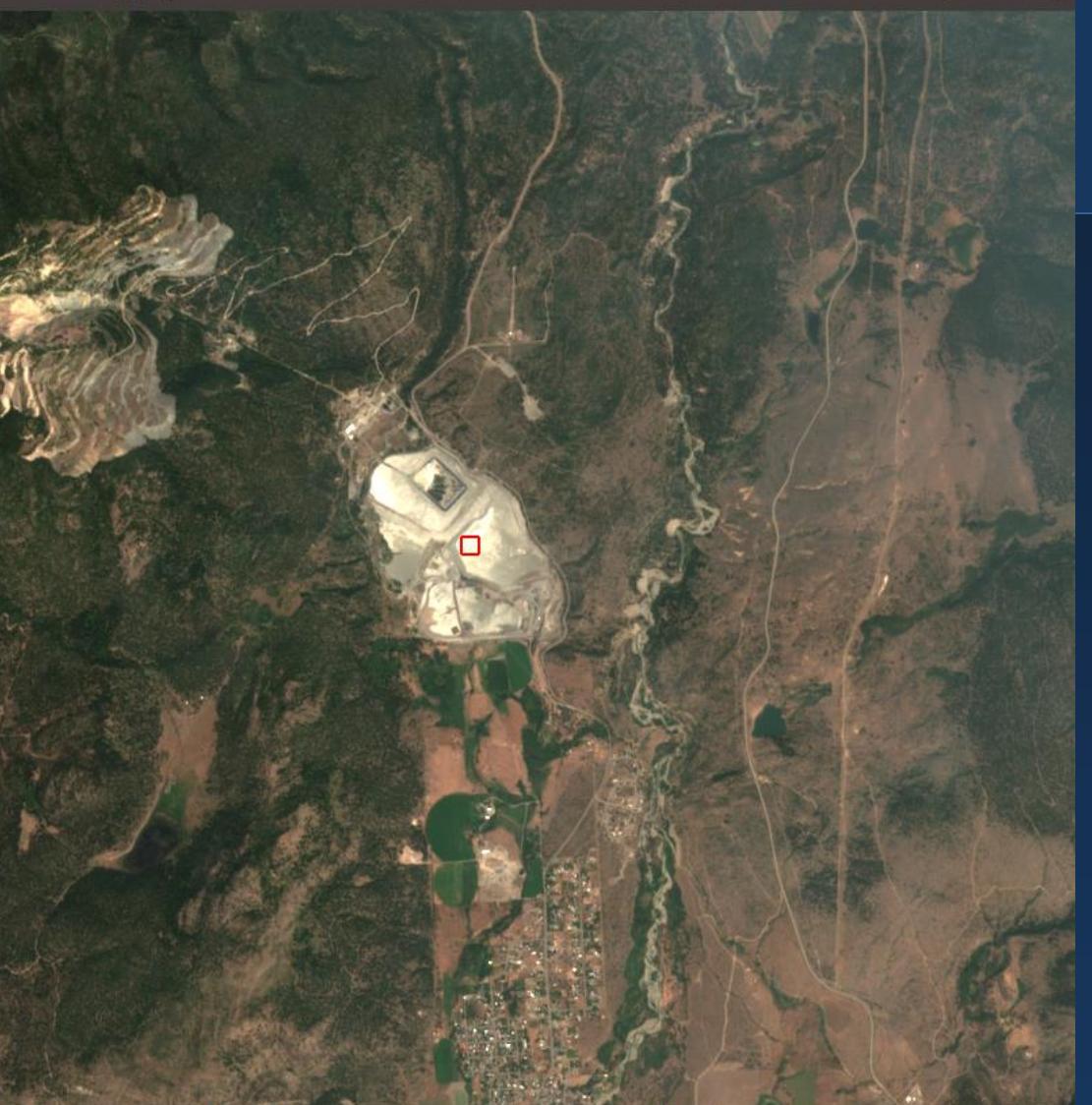


Method 2: dominant band (Lytton, 2021)



Scene R,G,B=[4:20210714 10m: B4 665nm, 3:20210714 10m: B3 560nm, 2:20210714 10m: B2 490nm]

SubsceR,G,B=[4:20210714 10m: B4 665nm, 3:20210714 10m: B3 560nm, 2:20210714 10m: B2 490nm]



False positive: urban target

Can we use L2 class map?

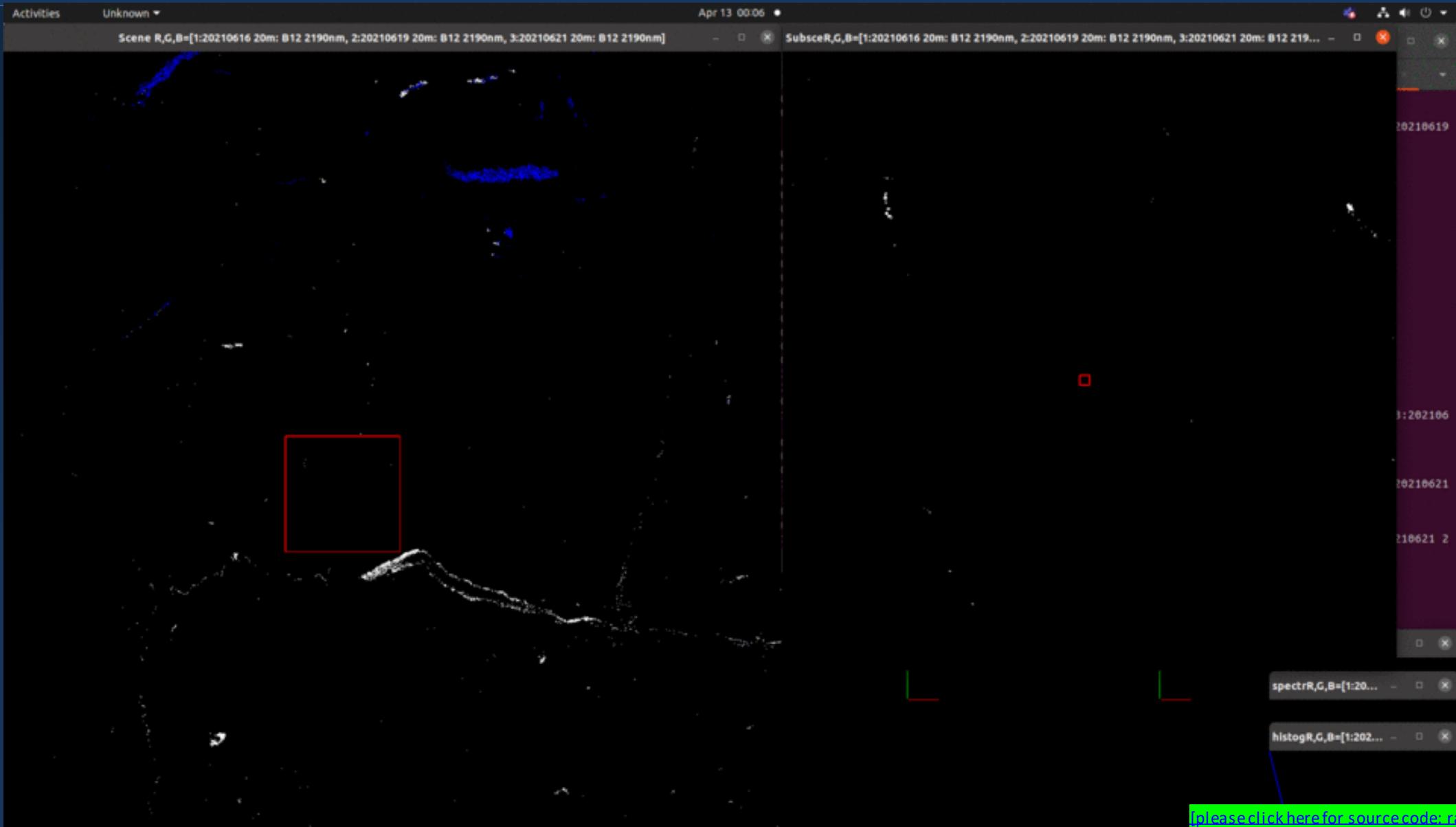
- From Sen2Cor (ESA)
 - Results don't look great!
 - Check snow class (value 11)
 - Smoke gets marked as snow
-
- Need ML for more reliable/ Contextual land cover
 - ML can respond to new training and compensate for lack of calibration



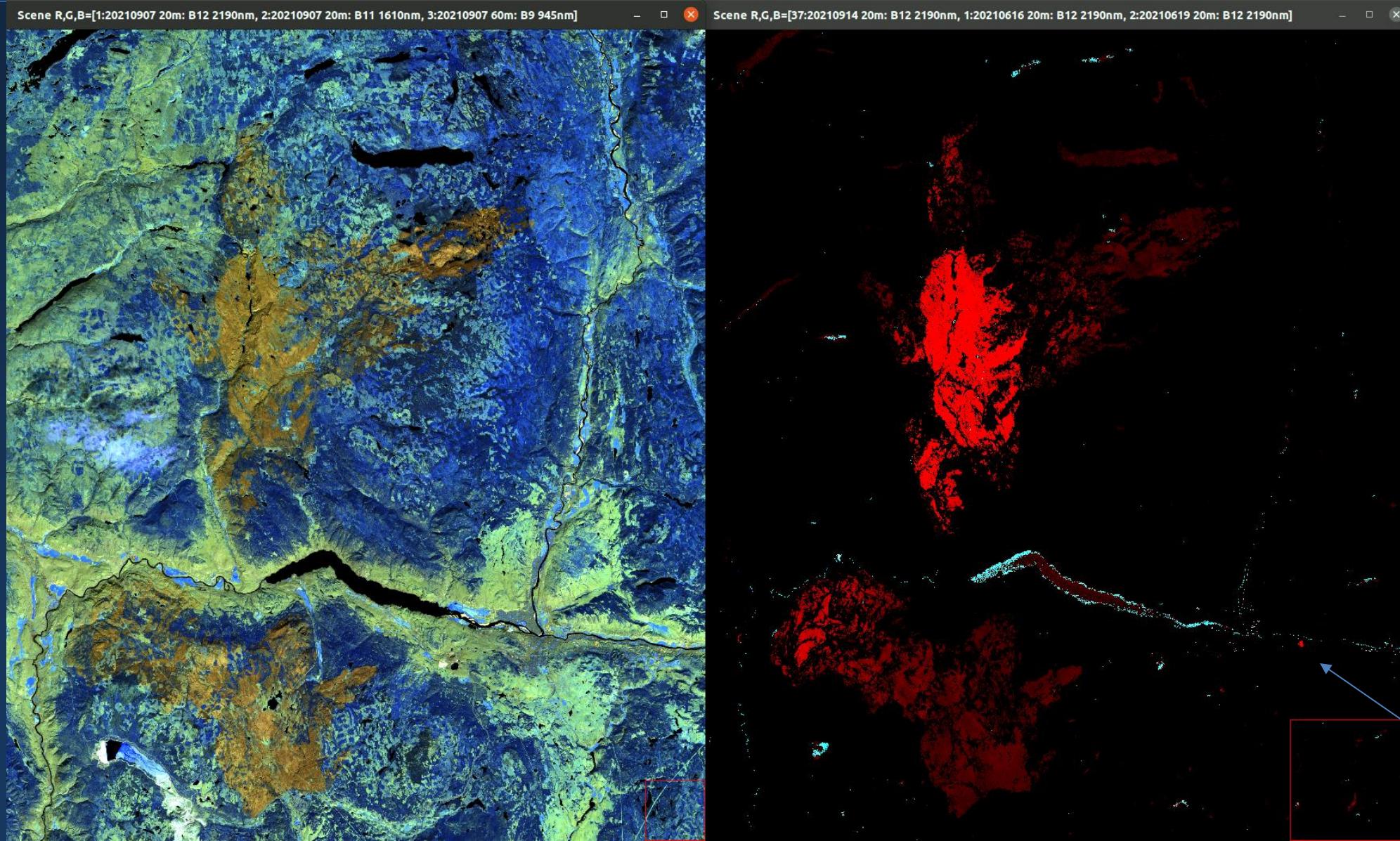
Method 2: dominant band (Sparks 2021)



BC Wildfire
Service



Method 2: dominant band (Sparks 2021)





Summary / next steps

- Accessible baseline to study actual Machine Learning
 - Get people on board with the potential of Remote Sensing
 - Start without math / computing requirements and bring people along!
- Work w Devona & team to meet BCWS standards
- Work w Ben & Neal to support fire simulations
- Automate addition of Landsat 7/8/9
- Remove nonveg/urban/water
- *Recency of detection*
- Work w Agile team
- More satellites

Possibilities:

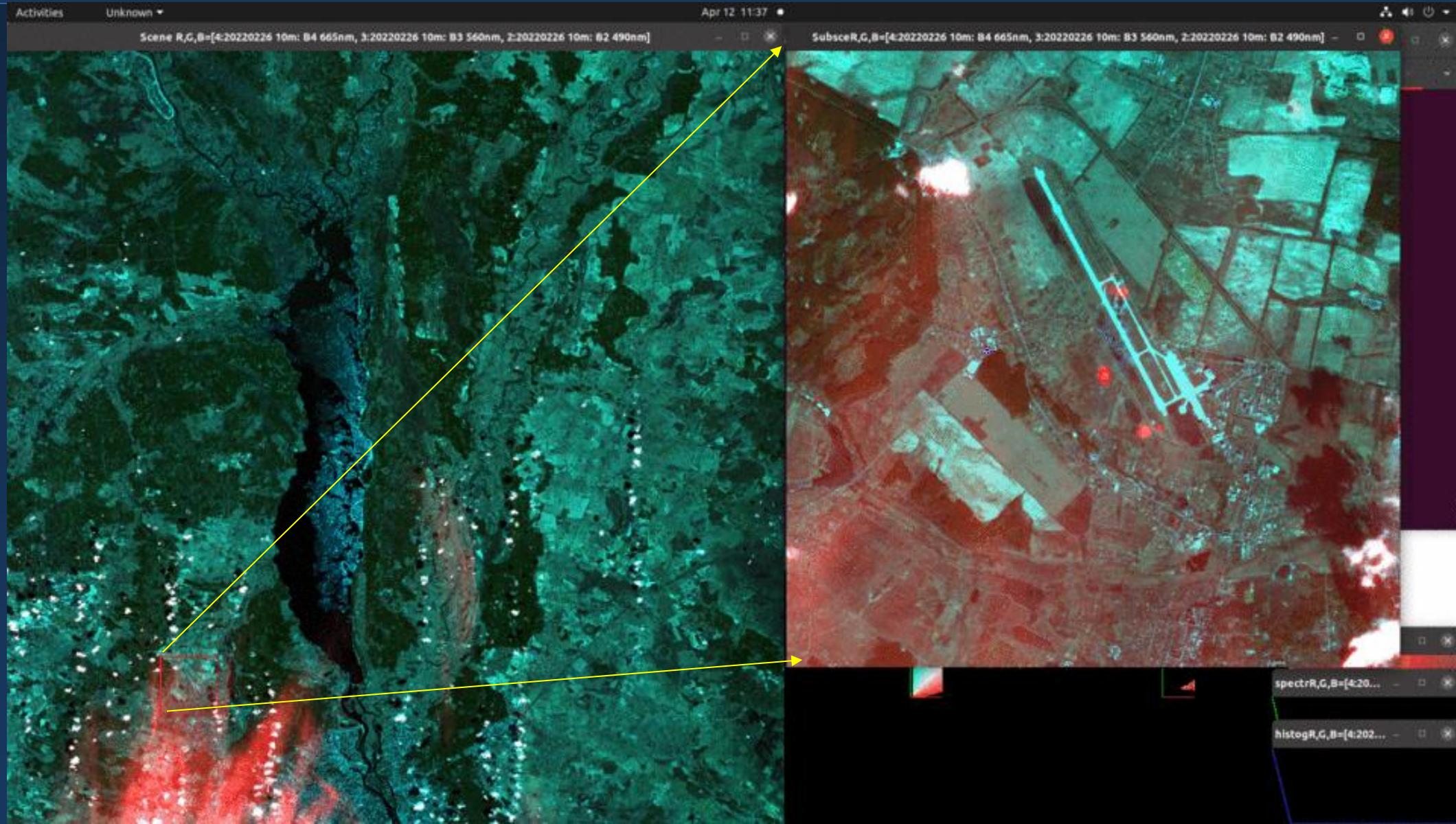
- Combine immediate info with before/after info
- First-principles physics modelling to derive spectra

L1 Sentinel-2.. Sen2Cor not applied

GML (аэропорт Гостомель)



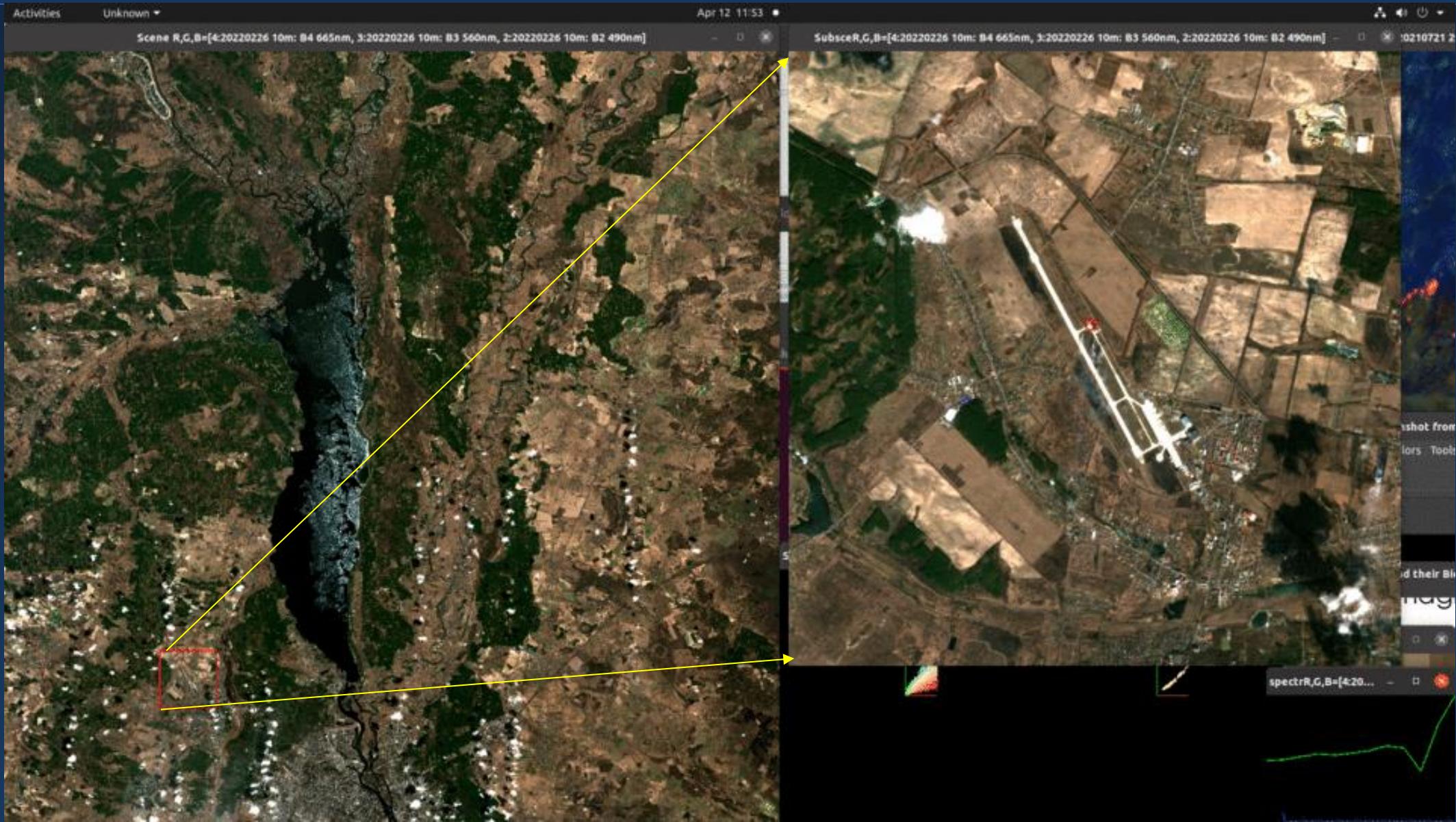
BC Wildfire
Service



L2 Sentinel-2.. Sen2Cor applied GML (аэропорт Гостомель)



BC Wildfire
Service



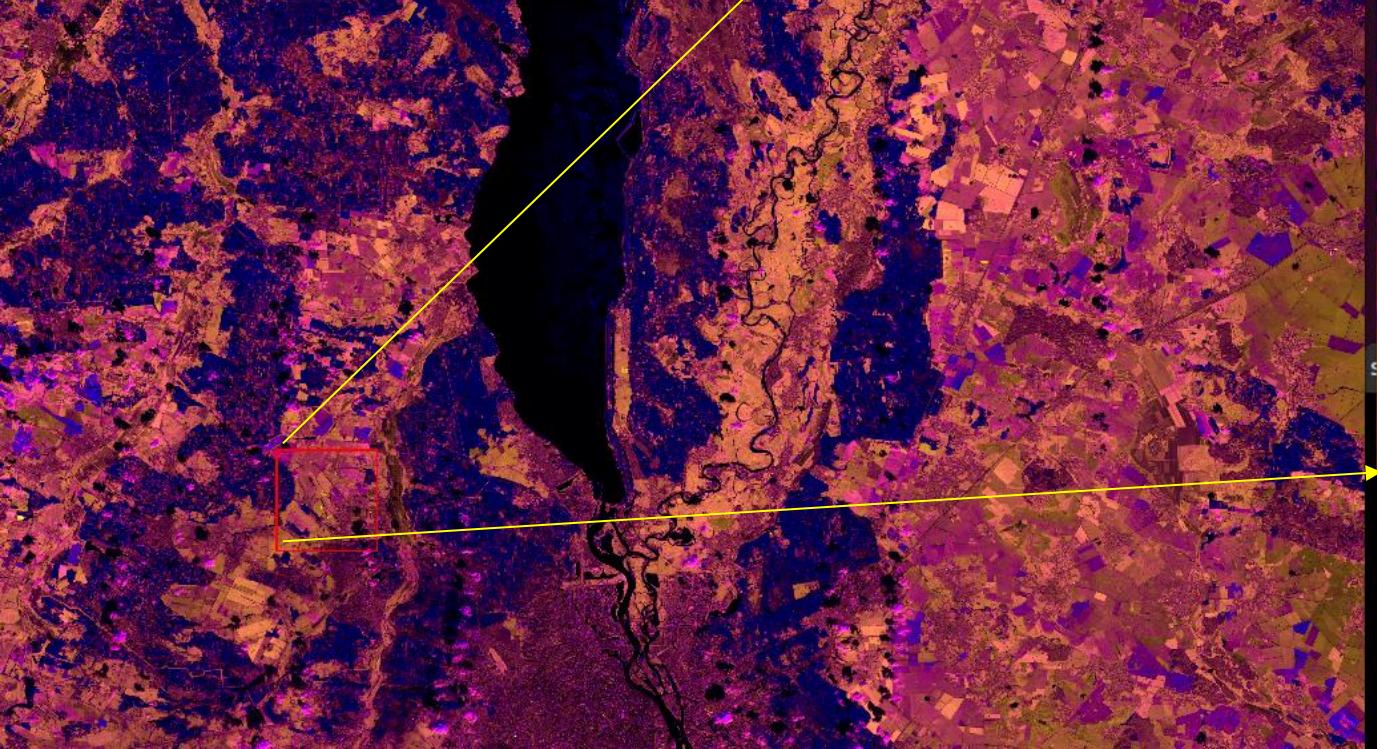
1) Subselect SWIR from L1 (4 bands)

2) perform combinatorial differencing 3) select b 14, 13, 10

ENVI
samples = 10980
lines = 10980
bands = 4
header offset = 0
filetype = ENVI Standard
data type = 4
interleave = bsq
byte order = 0
band names = {20220226 60m: B9 945nm,
20220226 60m: B10 1375nm,
20220226 20m: B11 1610nm,
20220226 20m: B12 2190nm}

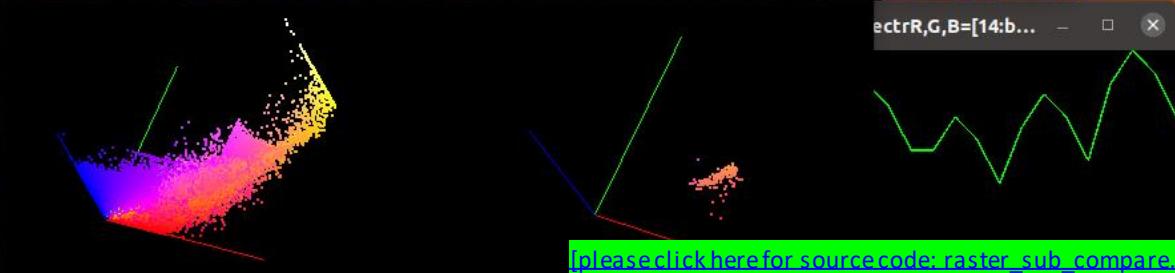
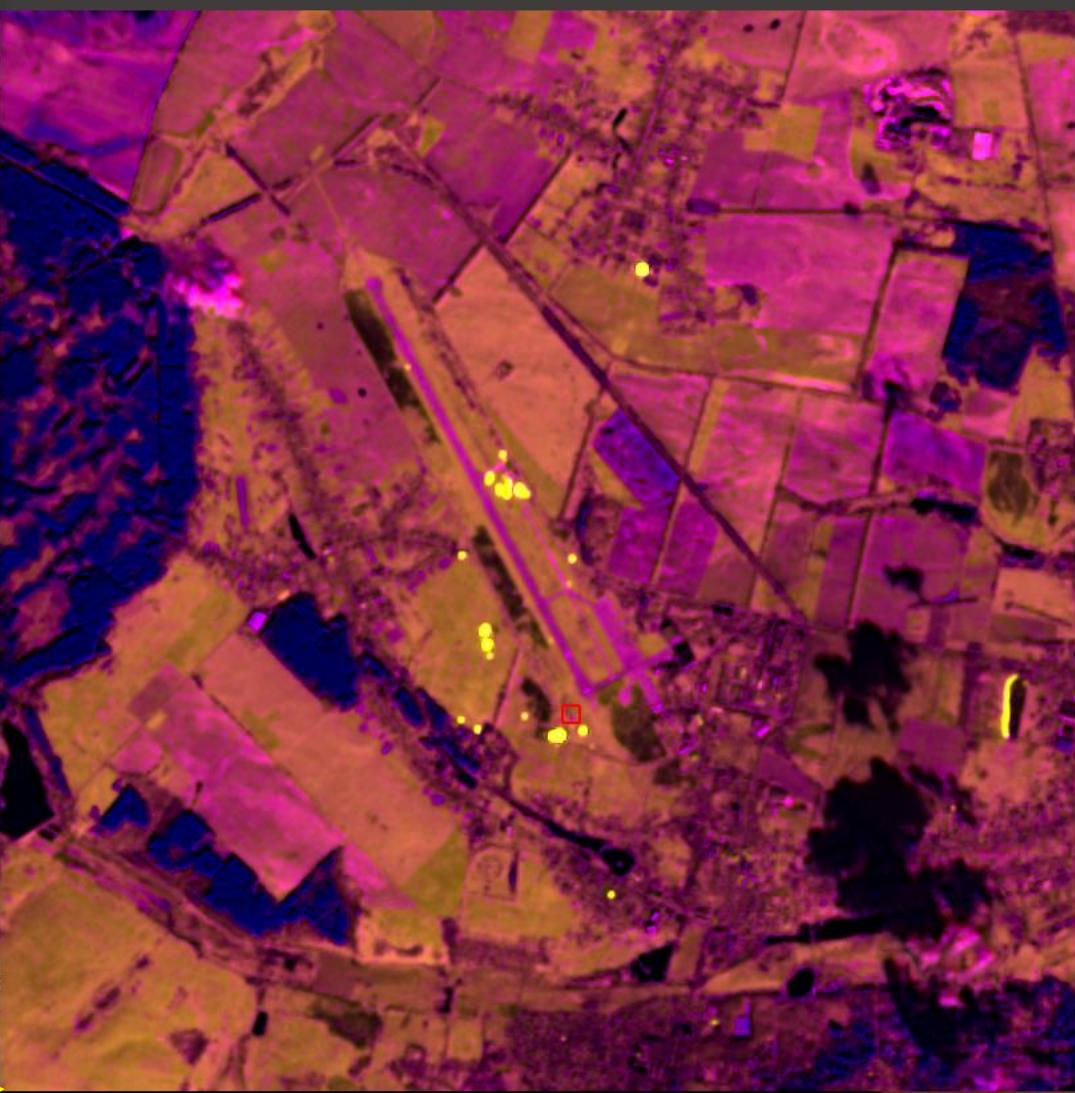
"swir.hdr" 13L, 251C

Then raster_sub_compare.cpp



Apr 11 23:09

Subscr,G,B=[14:band 14, 13:band 13, 10:band 10]



[please click here for source code: raster_sub_compare.cpp]