1st DESIS User Workshop

September 28th to October 1st, 2021

Utilization of hyperspectral remote sensing imagery for improving burnt area mapping accuracy

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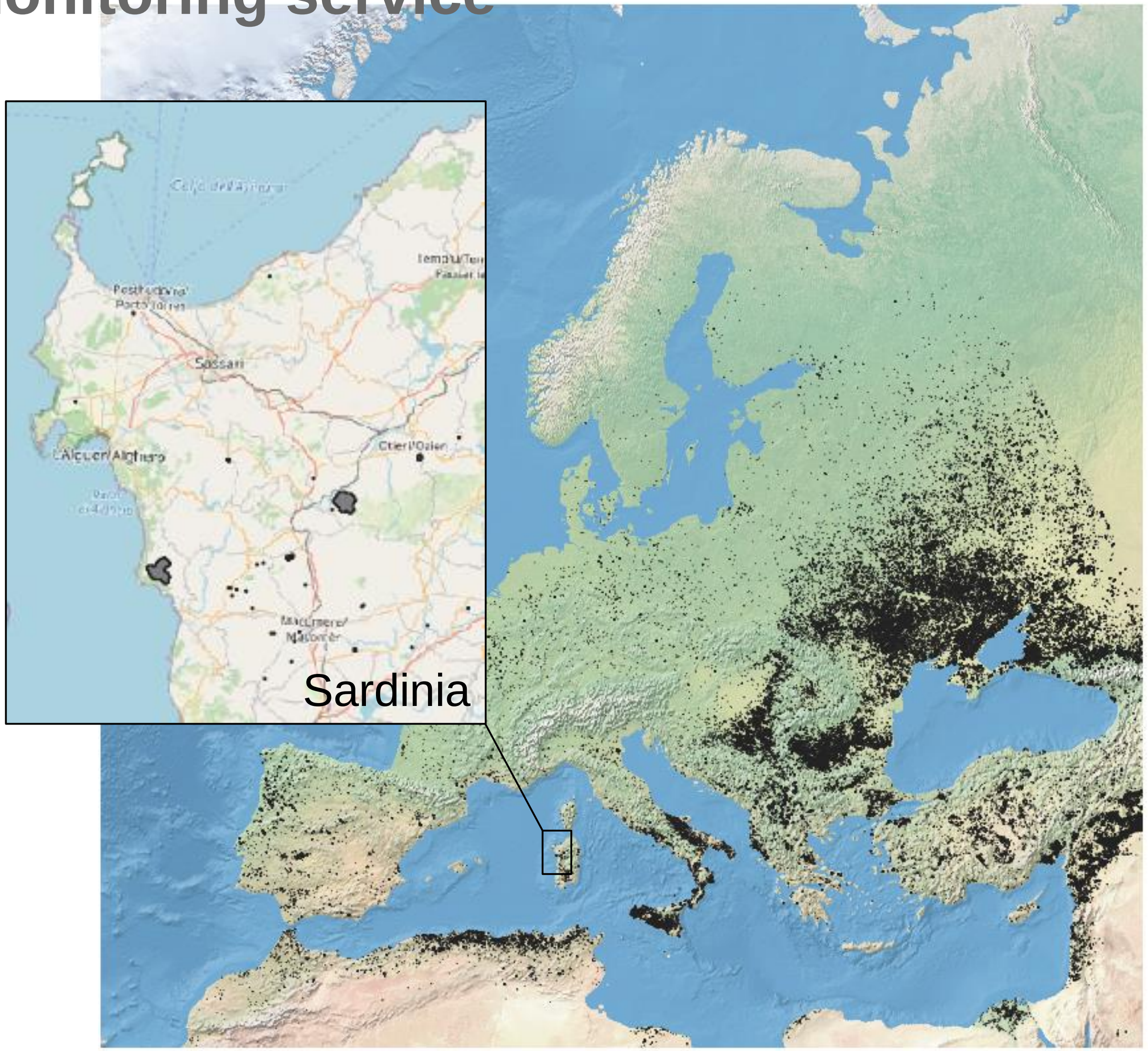
Background: The DLR-GZS wildfire monitoring service

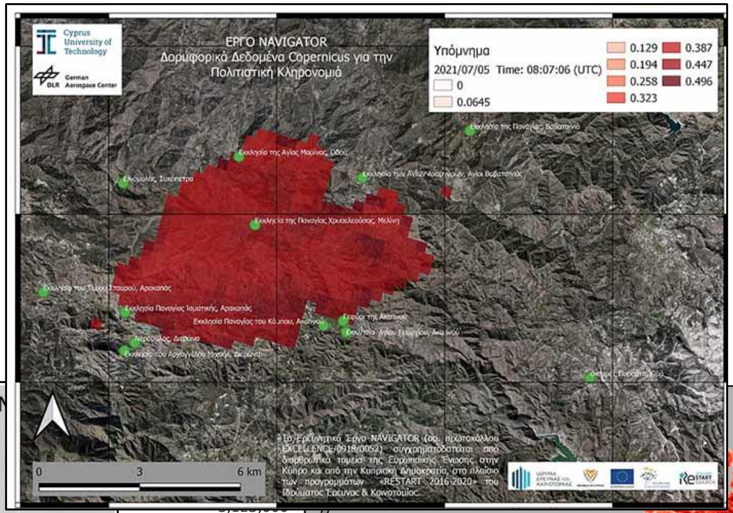
- Monitoring burnt area in Europe twice a day
- Output: fire perimeter, burn severity, fire evolution
- Products: NRT / Fusion
- Data source: Sentinel3-OLCI mid-resolution optical data, bands 8 and 17.
- Methodology: morphological snakes algorithm, based on differences in vegetation fitness
    - red/NIR information
    - Cloud information

    → pre/post: dNDVI

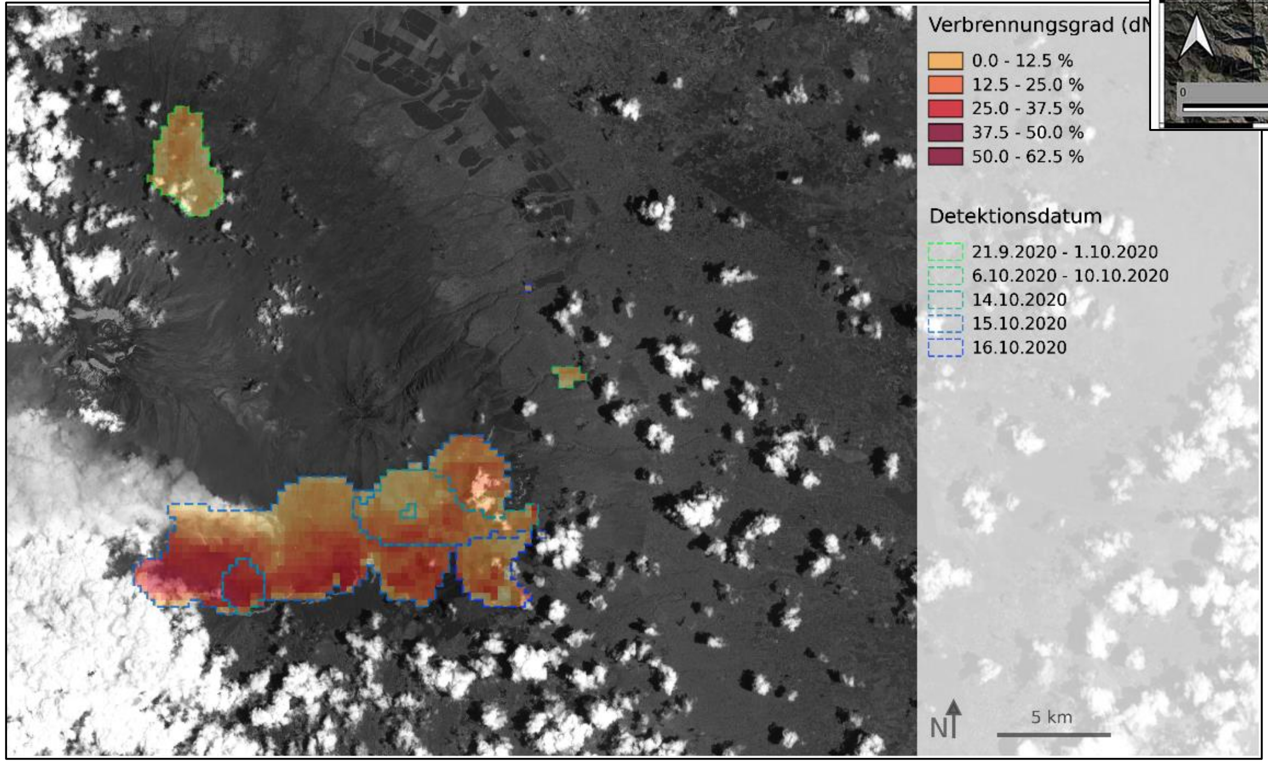


Monitoring region (with burnt areas of summer 2019)

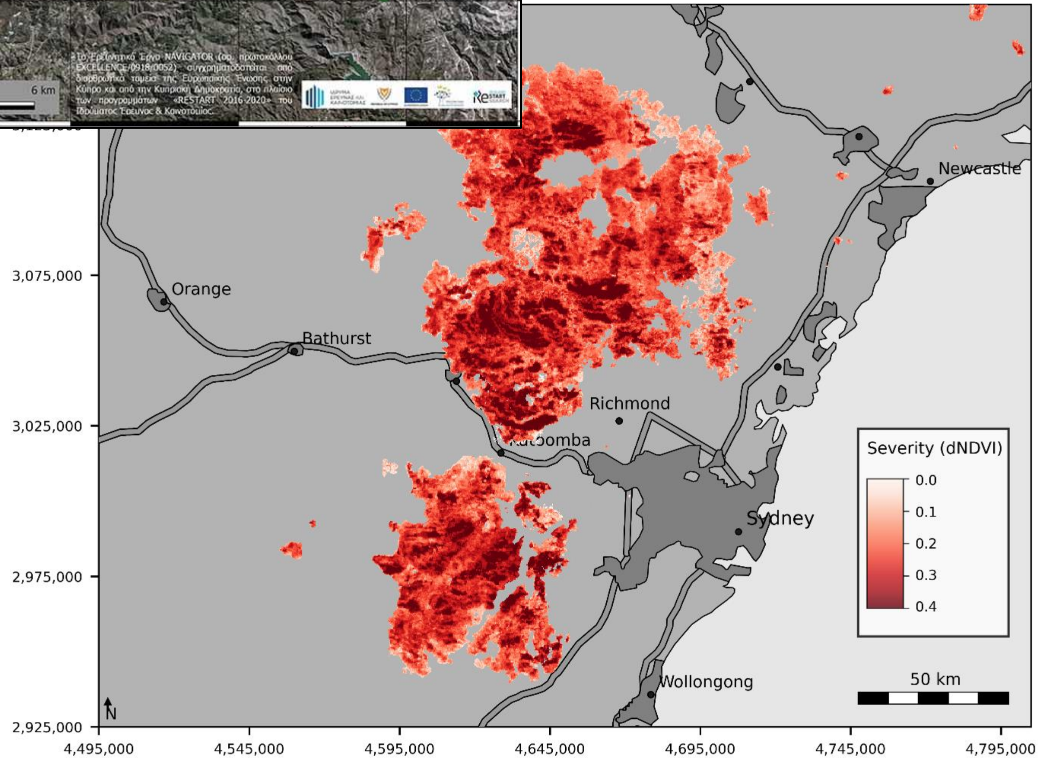
Custom burnt area study areas



Cyprus,
July 2021
(requested by Technical University of Cyprus)

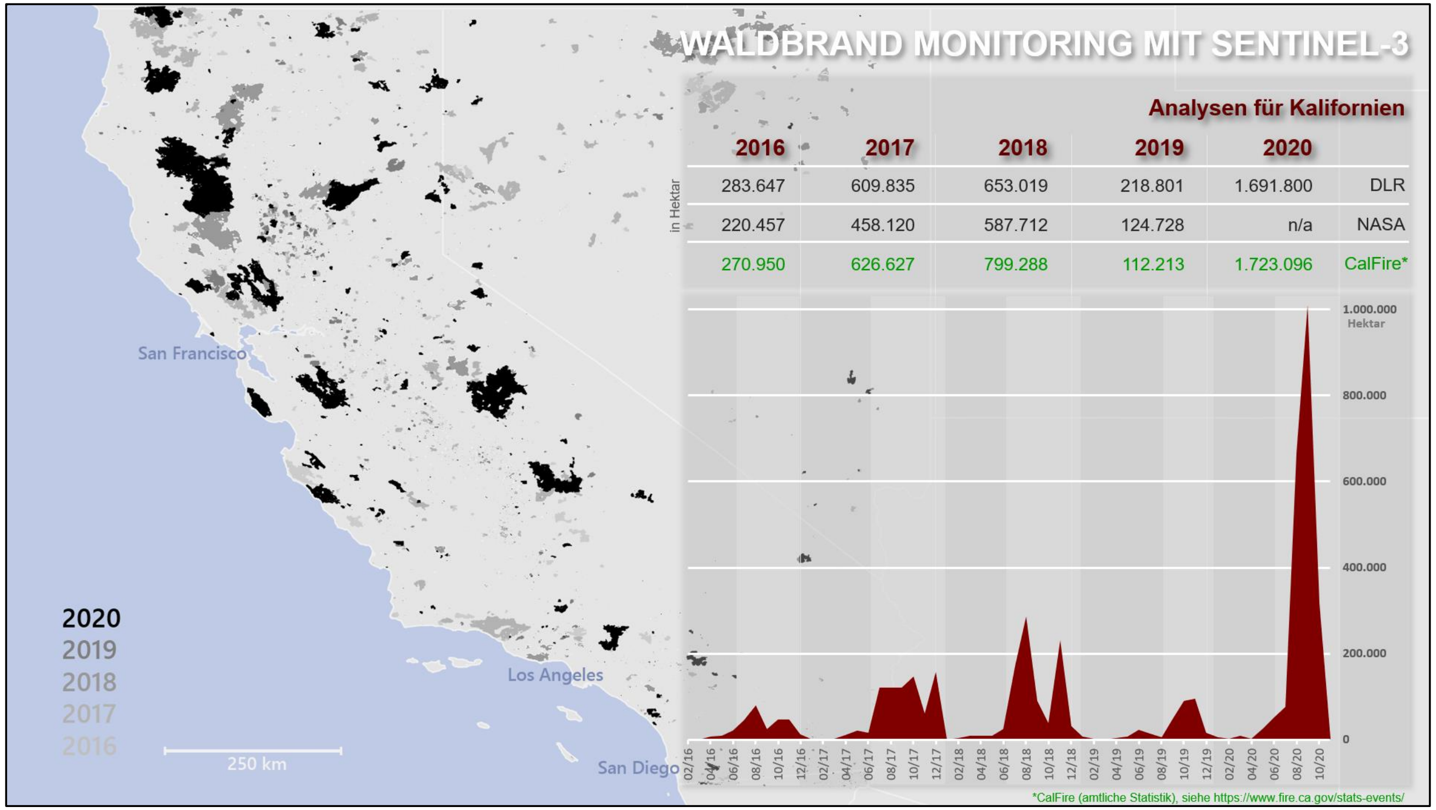


Kilimandscharo, Oct. 2020



New South Wales / Australia, Jan. 2019 / Dec 2020

Custom burnt area study areas: California / USA

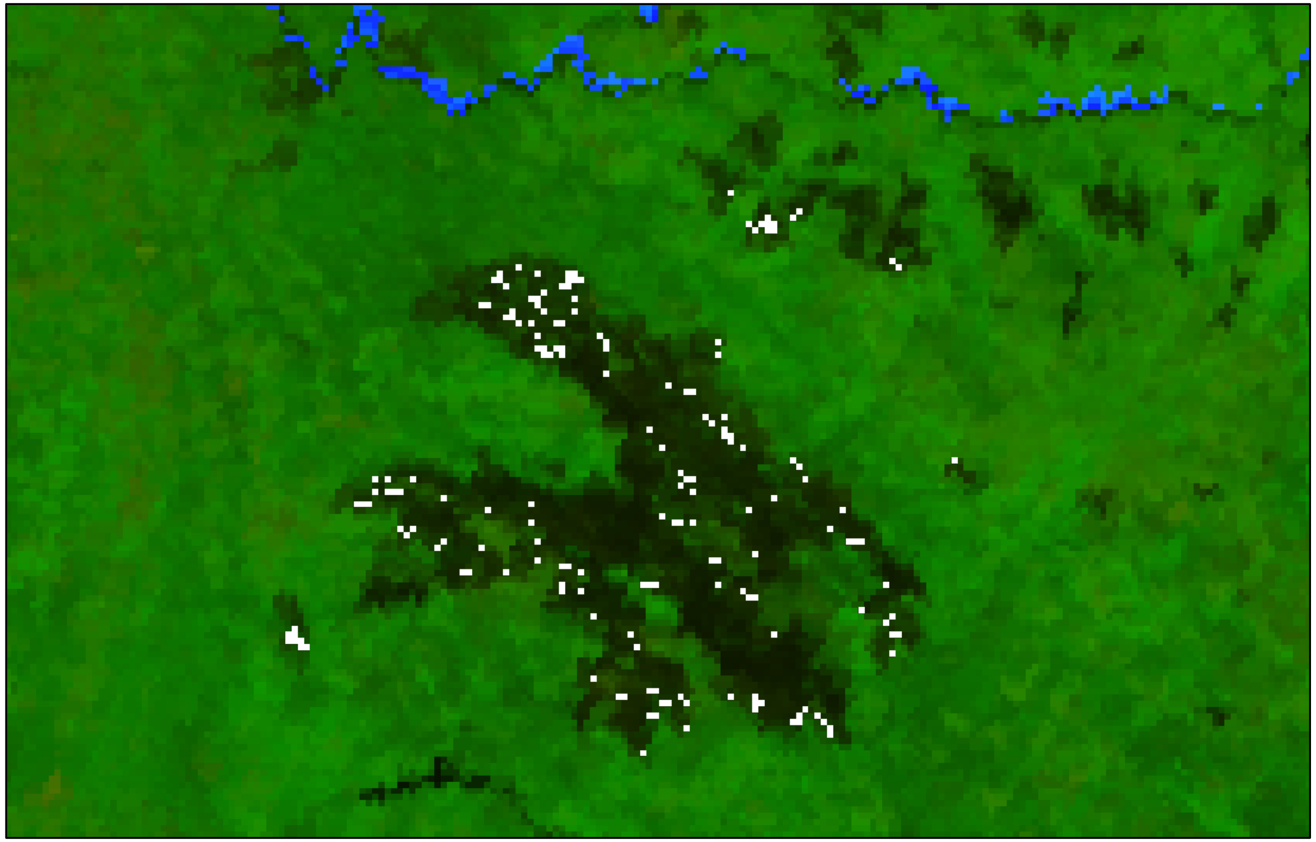


2016	2017	2018	2019	2020	
283.647	609.835	653.019	218.801	1.691.800	DLR
220.457	458.120	587.712	124.728	n/a	NASA
270.950	626.627	799.288	112.213	1.723.096	CalFire*

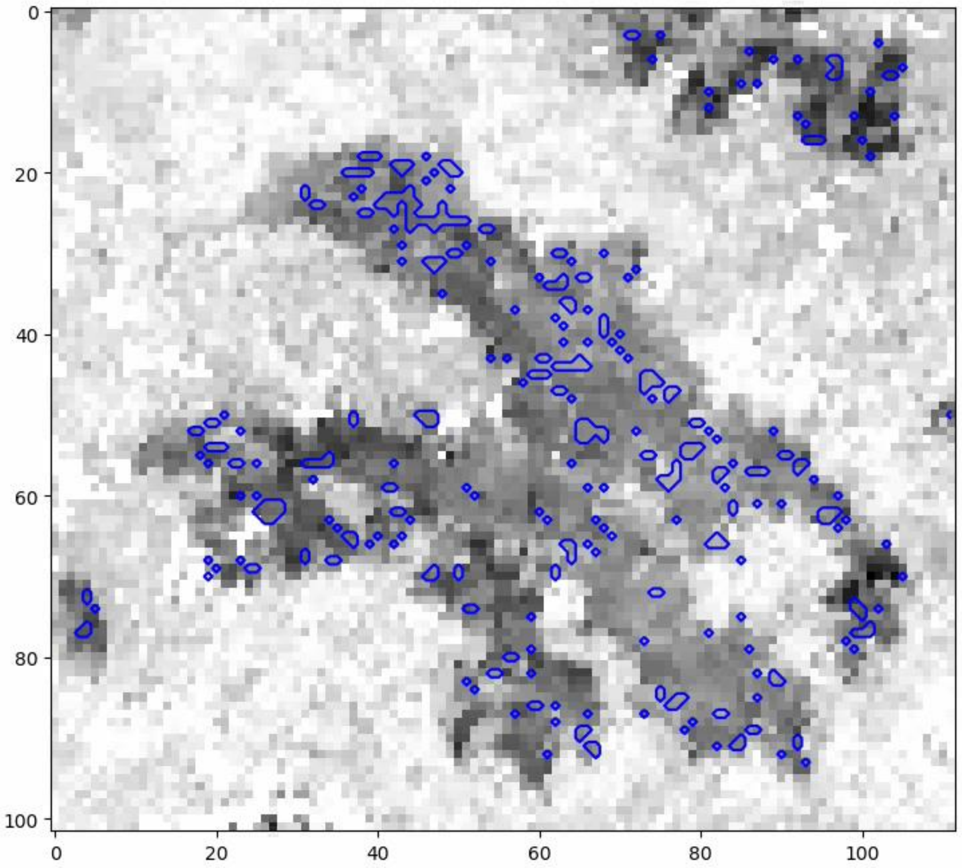
Burnt area extraction results for 2020, shown with an exemplary S3-OLCI scene

Map and statistics for burnt area extraction results from 2016 to 2020

Extraction methodology: Morphological snakes (Active Contour Level Sets)



S3-OLCI cutout showing a burnt area in northern Portugal, August 2016 (white: Active Fire locations)



Animation showing the growing of the active contour

Study design

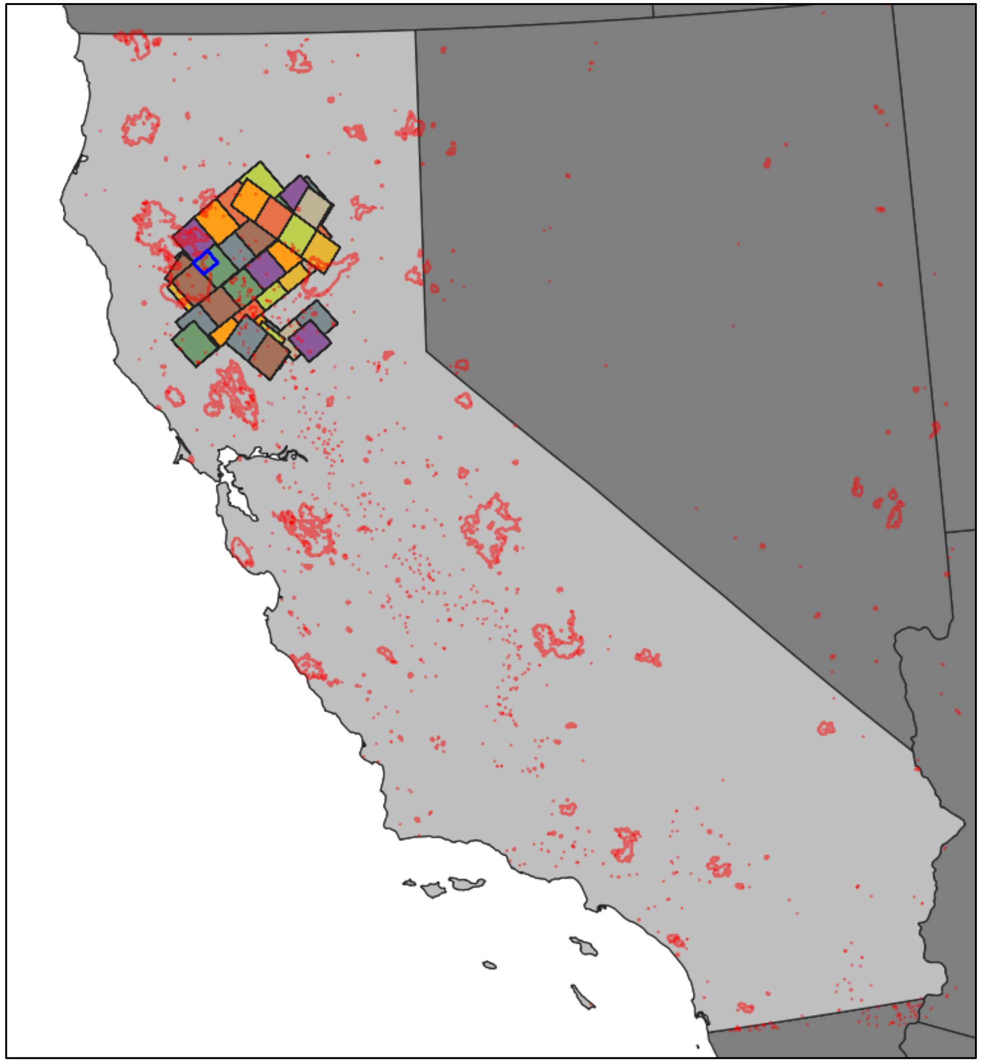
- **Goal:** Determine the most appropriate red/NIR wavelength combination for burnt area assessment (and compare with the ones from Sentinel-3 used for the GZS burnt area monitoring service)

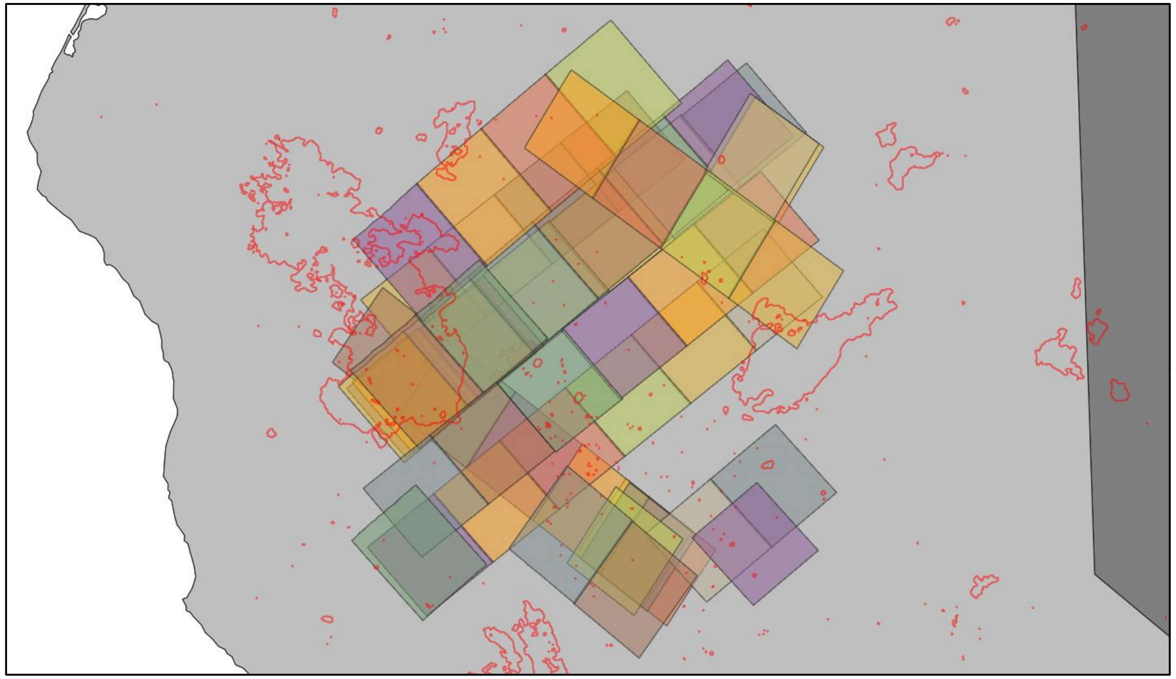
- **Problem:** Data scarcity
  - Information is required for an extended area (cluster of scenes)
    - required to derive results with statistical expressiveness
  - Information is required for different time steps for each location
    - Methodology strictly requires pre- and post information to determine the loss in vegetation fitness (intensity of change in differential NDVI)
  - Time steps most ideally be located shortly before and after a fire
    - Strongest signal when an abrupt change from healthy vegetation to burnt vegetation occurs
      - If pre-scene is too early: problems with seasonality, little chlorophyll measurement in NIR due to winter conditions
      - If post-scene is too late: Vegetation might have already recovered, also seasonality
  - Reference data based on the same methodology is required for the study area, to allow the comparison of the results

Study design

- **Approach:**
    - Search DESIS data through Teledyne Tcloud / EOWEB GeoPortal for regions regularly affected by wildfire
        - Peleponnes / Greece (☓)
        - Sicily / Italy (☓)
        - California / USA (✓)
            - -> 56 scenes between 2018 and 2021 (northern California)
    - Download all available data (L2A, bicubic) with 4-binning (reduced noise)
      → 8 bands in red domain, 29 in NIR
    - Generate 232 (29x8) variations for each of the 56 scenes with
        - a specific red / NIR band combination
        - A band for cloud pixels
      → 12992 single scenes
    - Resample the input to 300x300 m to keep processing times reasonable

Methodology: Area of interest

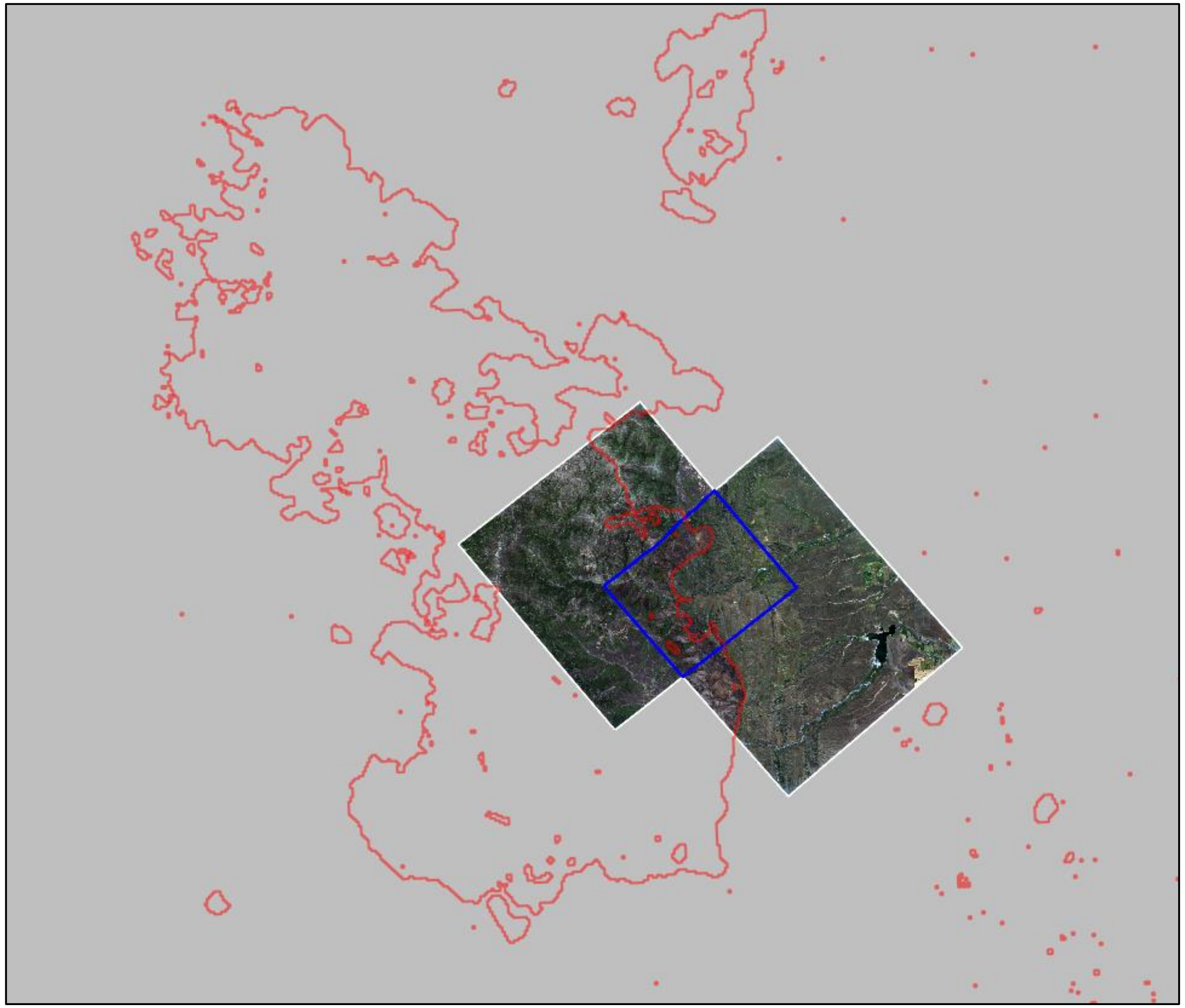




Available DESIS scenes 2018 - 2021

Burnt area detected with S3 OLCI in 2020

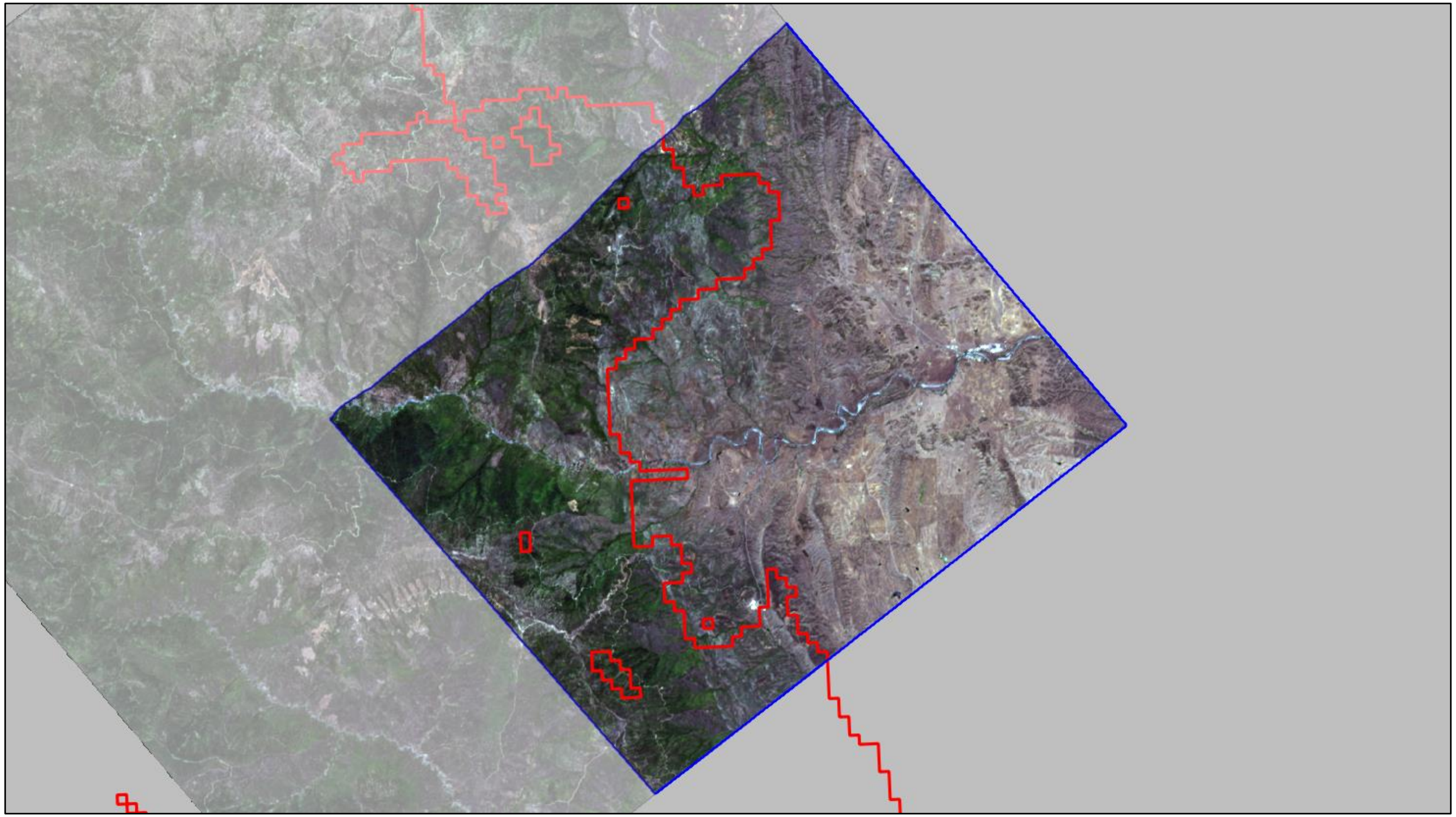
Methodology: example pre/post scenes (2020-06-09 / 2021-04-08)



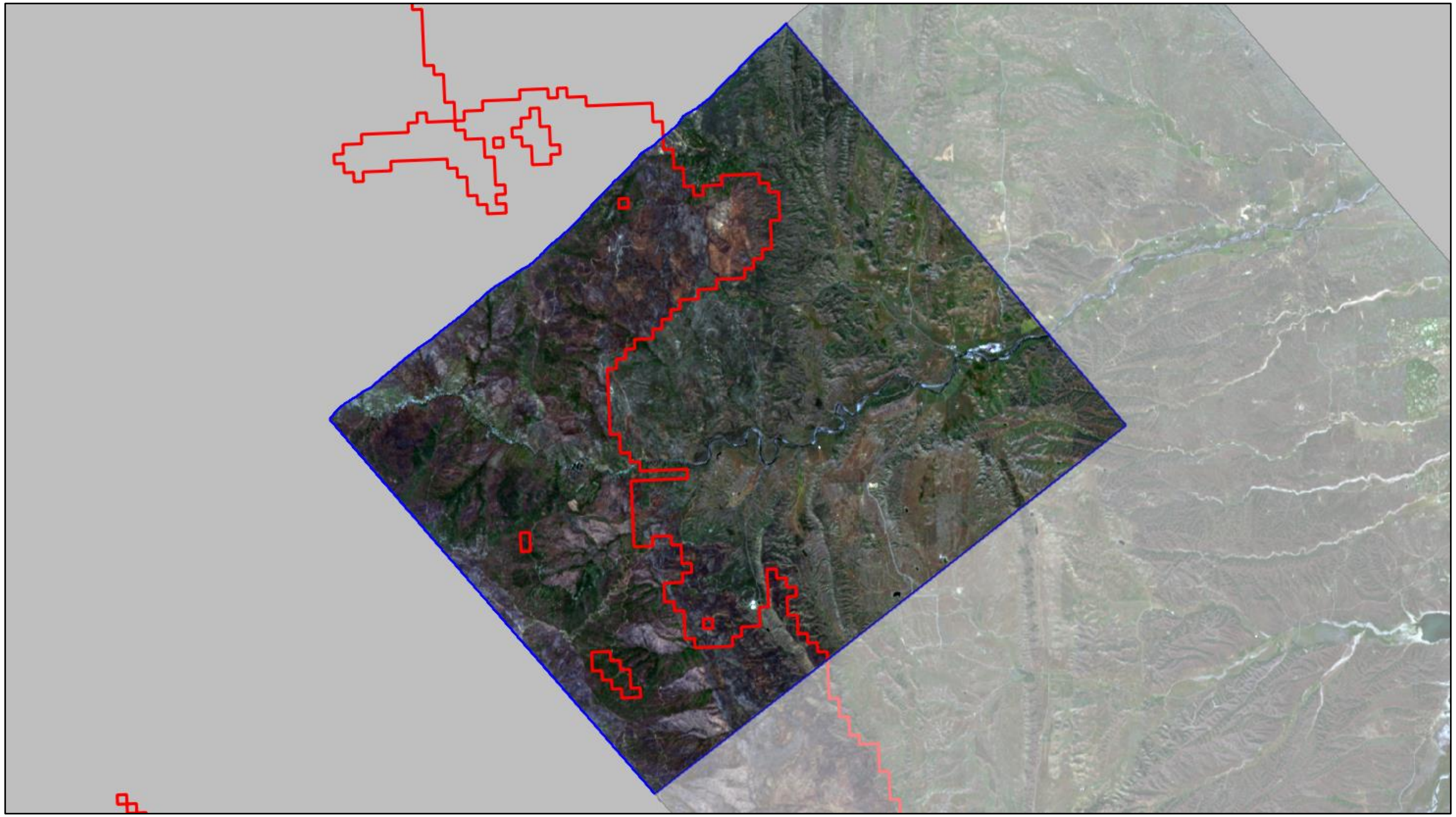
Overlapping (-> analyzable) area

Burnt area detected with S3 OLCI in 08/2020

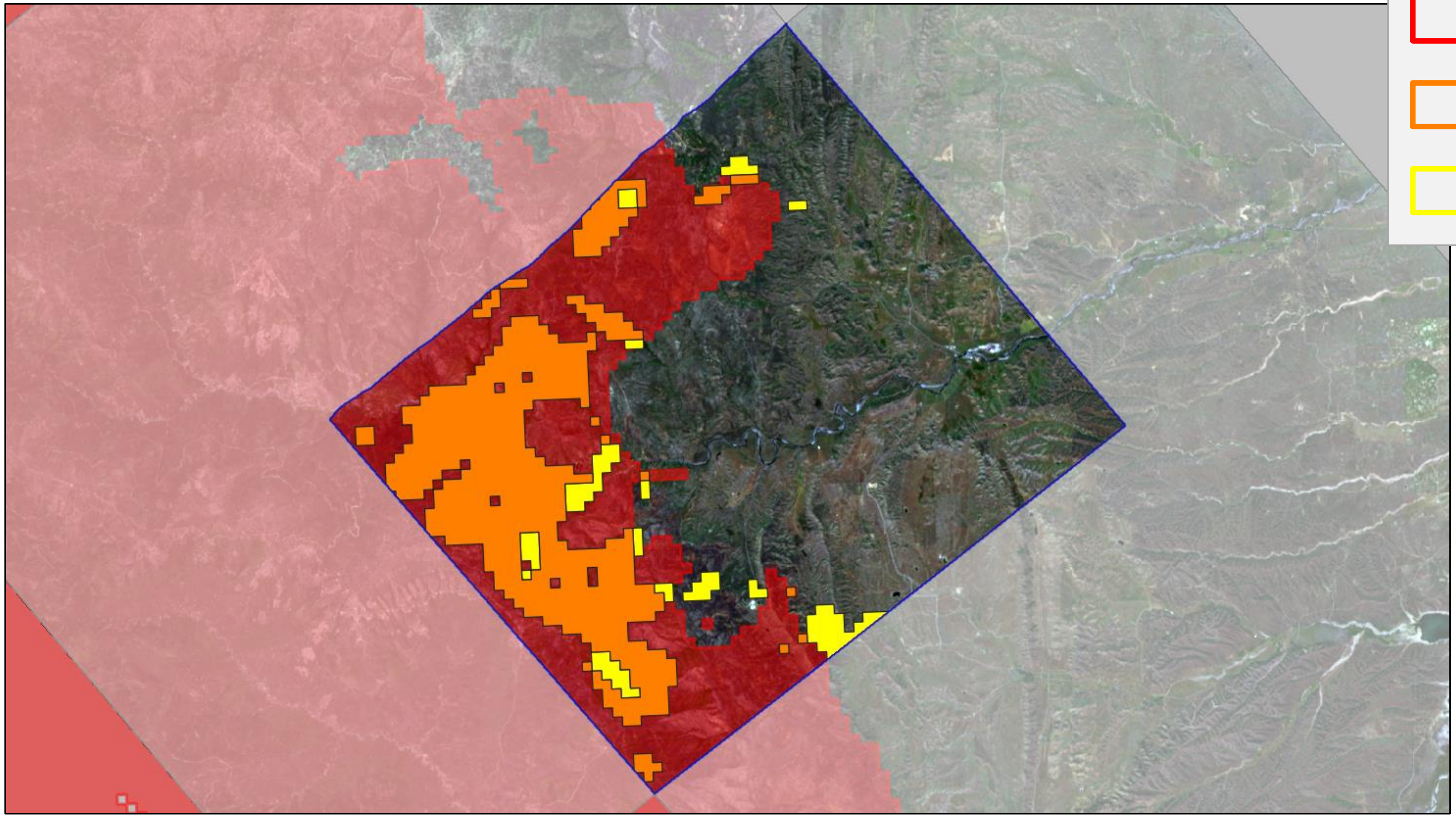
Methodology: example pre scene (2020-06-09)



Methodology: example post scene (2021-04-08)



Results: Example scene pre/post, band combination 22/30



Reference data (S3)

DESIS True Positives

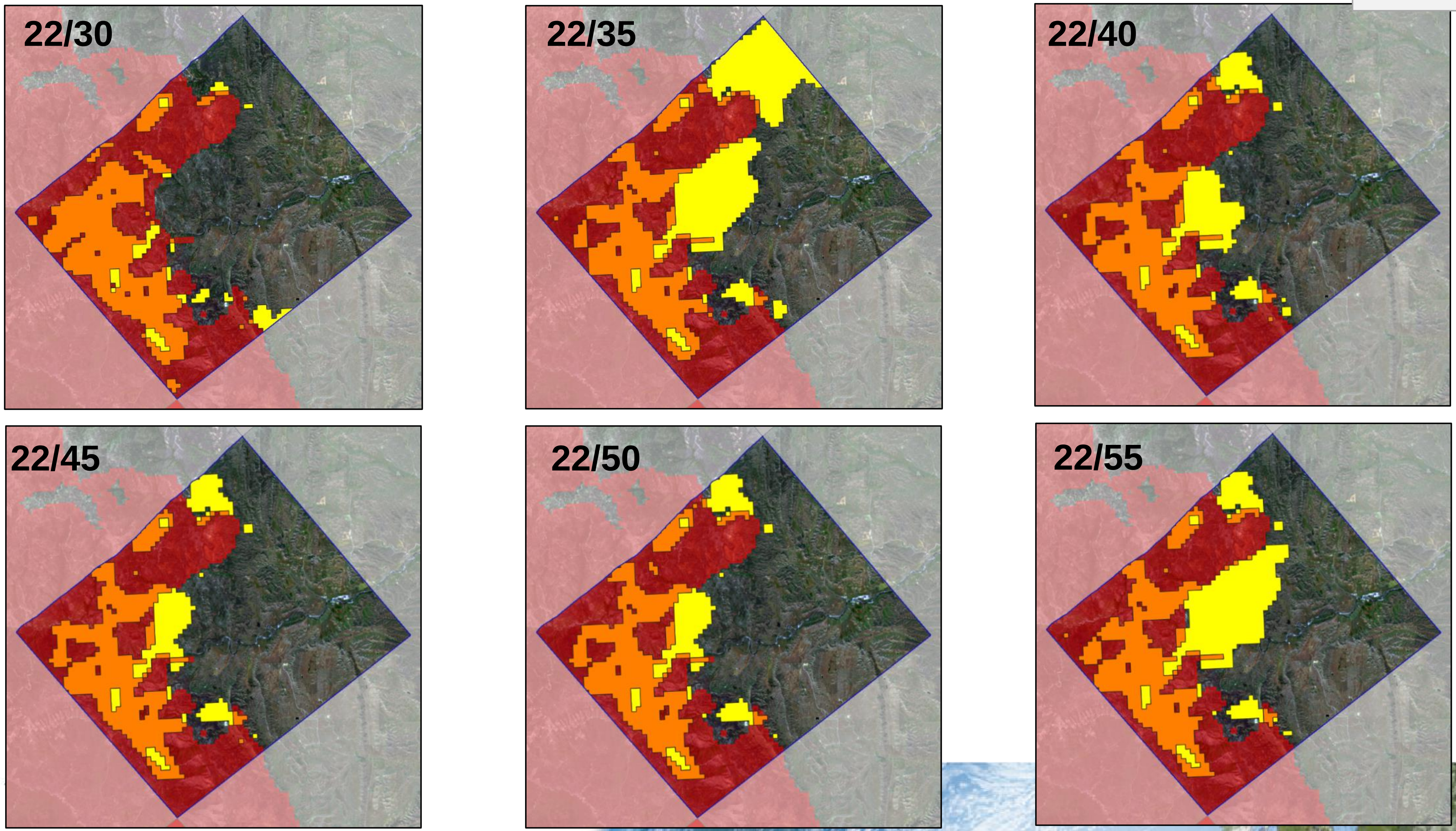
DESIS False Positives

Results: Example scene (pre/post) red band 22 / different NIR bands

Reference data (S3)

DESIS True Positives

DESIS False Positives



Results

- Validation:
  - TP: Areas detected with DESIS and also with S3, in relation to S3 total area
  - FP: Areas detected with DESIS but not with S3 in relation to S3 total area subtracted from 1
  - Result: (TP + (1-FP)) / 2

- Each cell represents the mean result – values of all 56 scenes for the given band combination

- Comparison of wavelenght combinations:
  - S3-OLCI red/NIR: 0.65 avg.
  - DESIS proposed combination: 0.67 avg.

red 4-bins (with wavelenghts)

NIR 4-bins (with wavelenghts)

	22 (629.5)	23 (639.7)	24 (649.9)	25 (660.1)	26 (670.3)	27 (680.5)	28 (690.7)	29 (700.9)
30 (711.1)	0.63	0.61	0.63	0.65	0.66	0.68	0.64	0.6
31 (721.3)	0.66	0.69	0.68	0.64	0.59	0.62	0.66	0.67
32 (731.5)	0.65	0.63	0.63	0.61	0.63	0.66	0.62	0.61
33 (741.7)	0.63	0.65	0.66	0.64	0.65	0.64	0.62	0.64
34 (751.9)	0.67	0.69	0.65	0.67	0.68	0.66	0.63	0.65
35 (762.1)	0.68	0.68	0.66	0.68	0.65	0.66	0.65	0.66
36 (772.3)	0.66	0.65	0.63	0.65	0.62	0.63	0.66	0.62
37 (782.5)	0.69	0.65	0.65	0.64	0.64	0.64	0.66	0.63
38 (792.7)	0.65	0.67	0.66	0.67	0.63	0.65	0.66	0.63
39 (802.9)	0.68	0.65	0.65	0.66	0.69	0.66	0.67	0.66
40 (813.1)	0.66	0.66	0.64	0.67	0.67	0.66	0.67	0.65
41 (823.3)	0.64	0.66	0.64	0.67	0.69	0.67	0.67	0.65
42 (833.5)	0.67	0.65	0.64	0.65	0.65	0.63	0.68	0.62
43 (843.7)	0.69	0.66	0.64	0.64	0.65	0.67	0.65	0.62
44 (853.9)	0.67	0.65	0.61	0.64	0.67	0.66	0.65	0.64
45 (864.1)	0.62	0.66	0.66	0.67	0.63	0.63	0.62	0.63
46 (874.3)	0.62	0.66	0.69	0.67	0.66	0.64	0.65	0.63
47 (884.5)	0.65	0.65	0.66	0.64	0.65	0.63	0.64	0.62
48 (894.7)	0.65	0.65	0.68	0.67	0.65	0.64	0.66	0.63
49 (904.9)	0.66	0.67	0.68	0.66	0.66	0.64	0.62	0.65
50 (915.1)	0.62	0.63	0.65	0.66	0.64	0.65	0.63	0.63
51 (925.3)	0.67	0.64	0.63	0.65	0.68	0.61	0.63	0.62
52 (935.5)	0.64	0.62	0.61	0.63	0.62	0.62	0.63	0.65
53 (945.7)	0.68	0.68	0.66	0.67	0.69	0.65	0.68	0.65
54 (955.9)	0.67	0.66	0.61	0.67	0.68	0.68	0.68	0.68
55 (966.1)	0.68	0.64	0.68	0.67	0.69	0.67	0.67	0.65
56 (976.3)	0.64	0.66	0.64	0.65	0.66	0.65	0.62	0.62
57 (986.5)	0.66	0.64	0.64	0.67	0.7	0.64	0.64	0.65
58 (996.7)	0.62	0.6	0.64	0.63	0.66	0.66	0.63	0.65

Conclusions

- Detection accuracy increases with higher NIR wavelengths
- Detection accuracy differs around 11% (59% to 70%) for the various band combinations
- Sentinel-3 Red / NIR (8/17) bands currently used for the GZS wildfire service are well suited for burnt area detection, but are not optimal. Replacing band 17 by band 20 would likely increase the detection accuracy.