Using Machine Learning for Fire Monitoring

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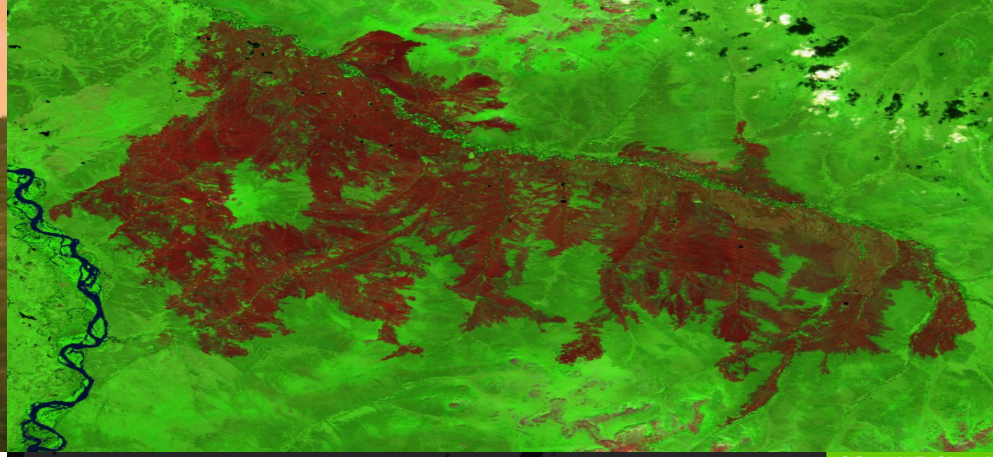
2023 January



Siberian Wildfire Could Become Biggest in Recorded History – Greenpeace

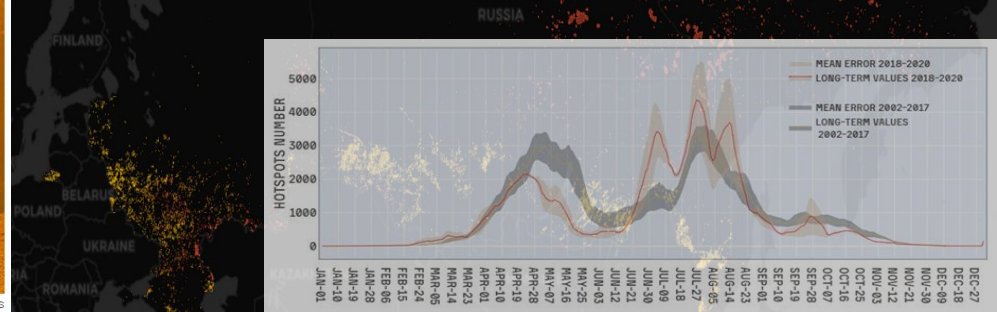
Updated: **Sep. 7, 2021**

The republic of Sakha (Yakutia), Russia's largest and coldest region, has been devastated by unprecedented wildfires this summer. Ivan Nikiforov / TASS

GREENPEACE

Crowdfunding mapping in 2020

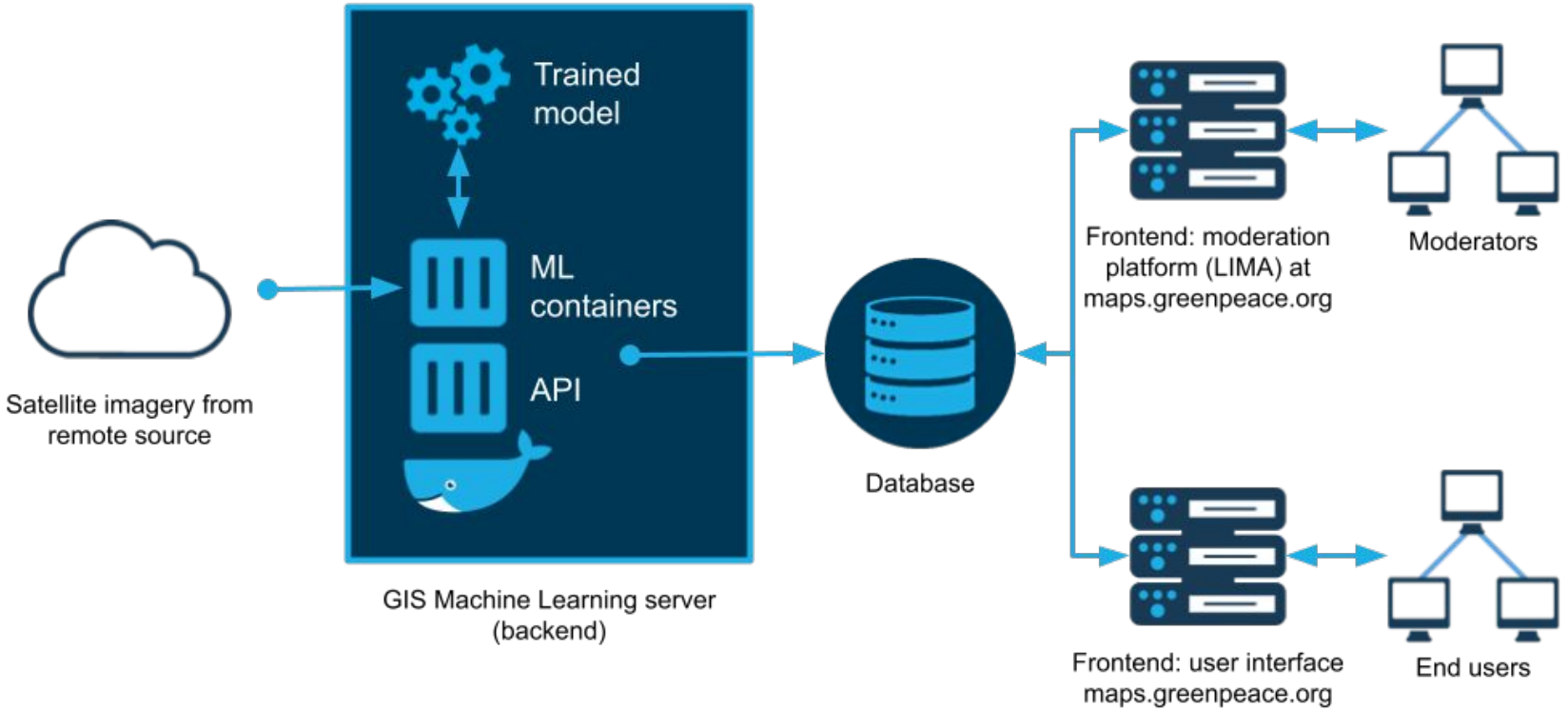
Glushkov I, Zhuravleva I, McCarty J L, Komarova A, Drozdovsky A, Drozdovskaya M, Lupachik V, Yaroshenko A, Stehman S V and Prishchepov A V 2021 Spring fires in Russia: results from participatory burned area mapping with Sentinel-2 imagery *Environ. Res. Lett.* **16** 125005



HIERARCHY OF OUR GOAL/S

1. Fires monitoring in one region where fire season 2022 start (Russian Far East)
2. Constant fires monitoring in one+ region (depending on the fires situation)
3. Constant operational fires monitoring for the whole country

PROPOSED SCHEME



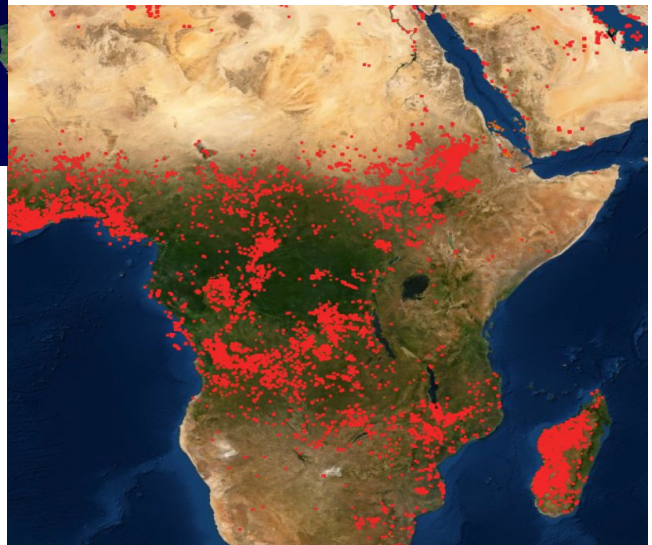
DATA

SATELLITE IMAGES

Sentinel-2 MSI
spatial resolution 10 m
time period 3-5 days

THERMAL HOTSPOTS

Active fire product detects fires in 375m-1km pixels (depending on sensor) that are burning at the time of satellite overpass using a contextual algorithm



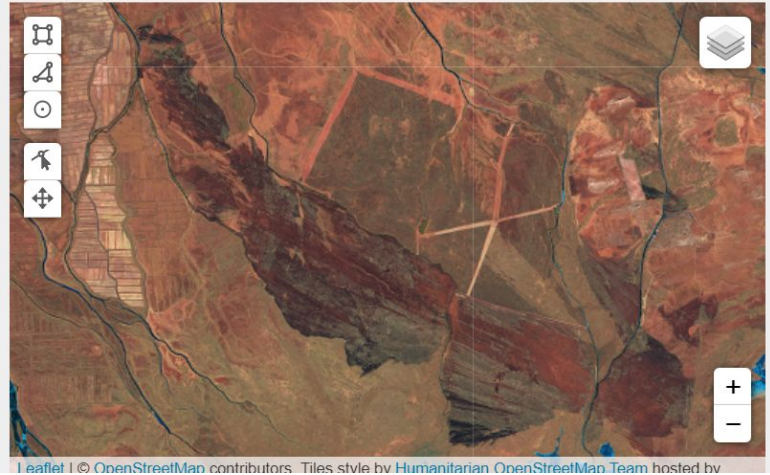
- AOI splitted by tiles with 1*1 decimal degrees extent
- Only tiles with hotspots intersection threshold for for selected time period processed

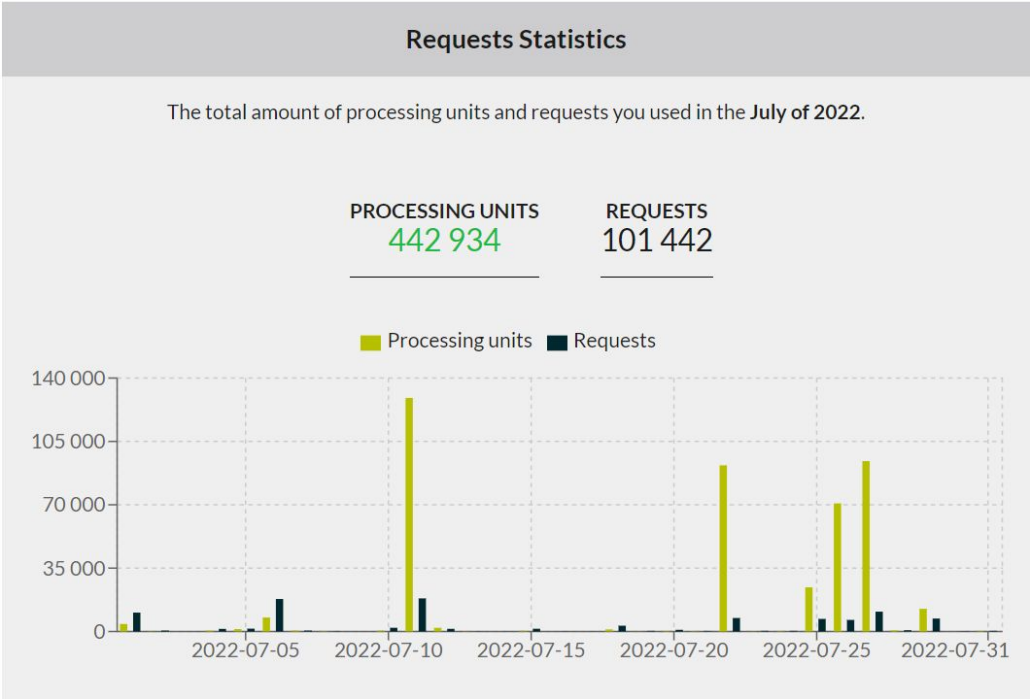
DATA SOURCE

SATELLITE IMAGES

sentinelhub by SINERGISE

Sentinel-HUb Python API



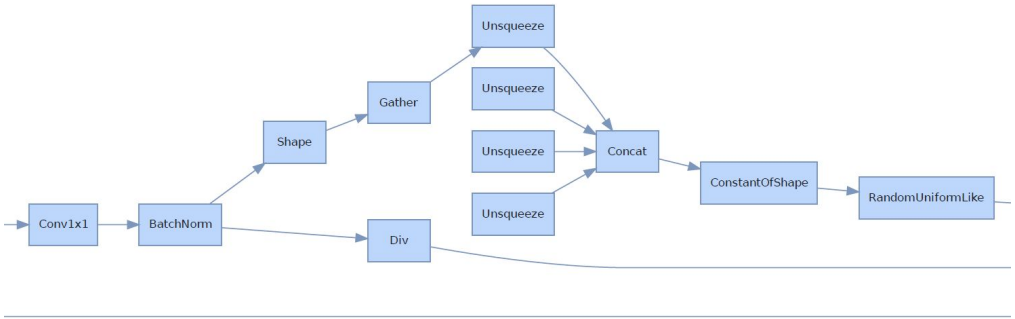


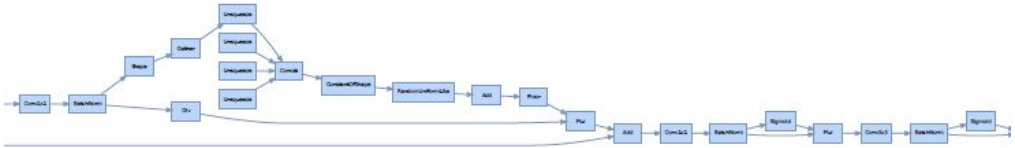
15 requests with max image size
per tile 1*1 decimal degrees for one selected date

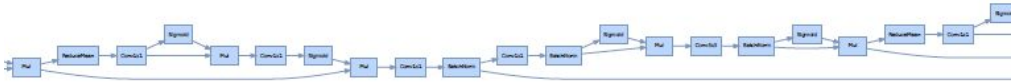
SERVER

- MSI GeForce RTX 3090
- AMD Ryzen Threadripper 3960X
- ASUS ROG ZENITH II EXTREME ALPHA
- 256 GB Kingston Renegade RGB DDR4-3600
- 1TB HYPERPC PRO M.2
- 10TB Seagate (IronWolf)
- Super Flower Leadex Titanium 1600W

MODEL







- CNN for Semantic Segmentation based on DeepLab structure

- Different size input (384,512,1024 px square tiles) from Sentinel-2 imageries (B11-B8-B2)

- 7 pretrained models

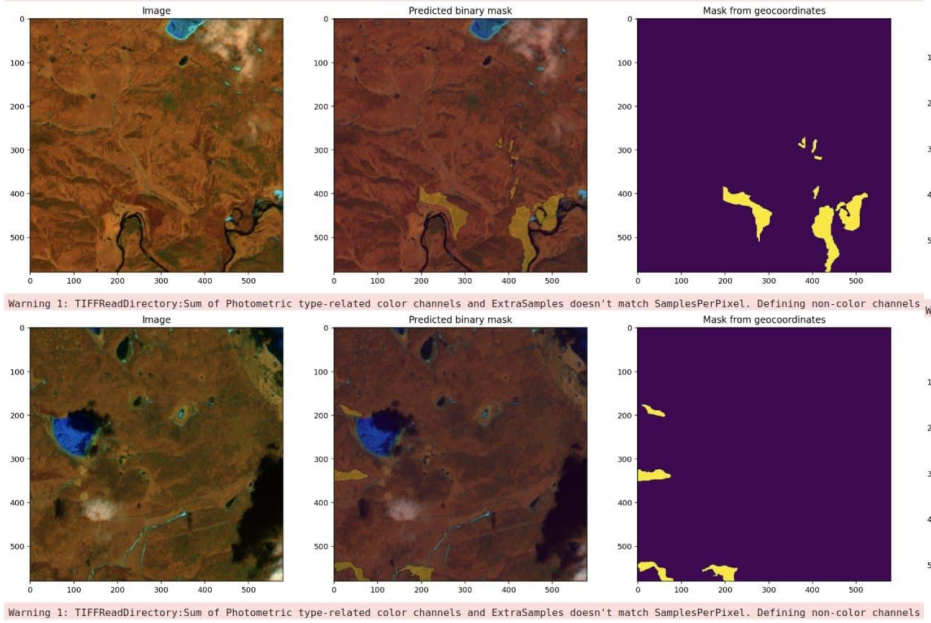
- Single-model or ensemble predictions

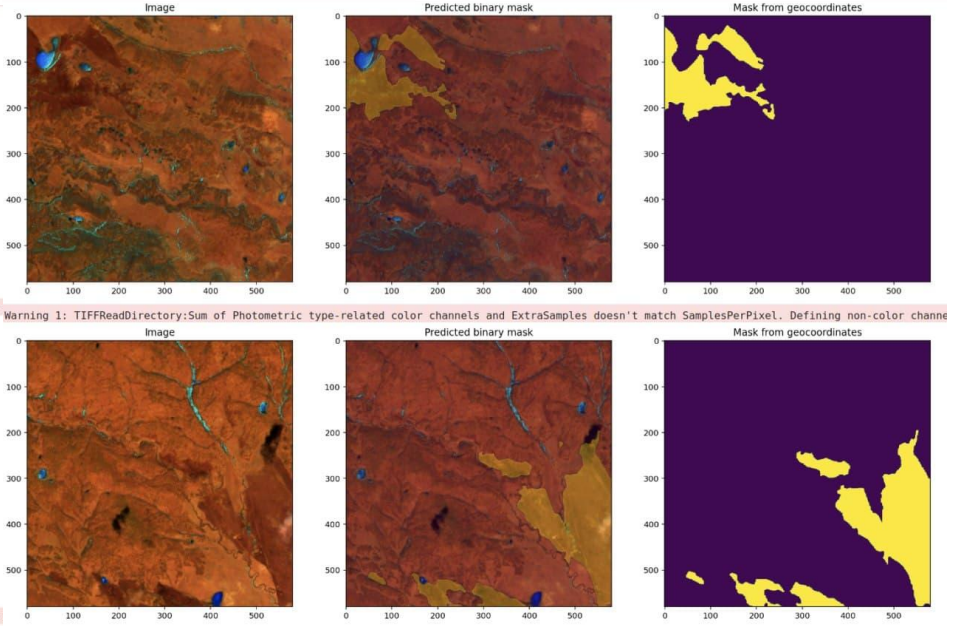
- NVIDIA Triton server for models handling

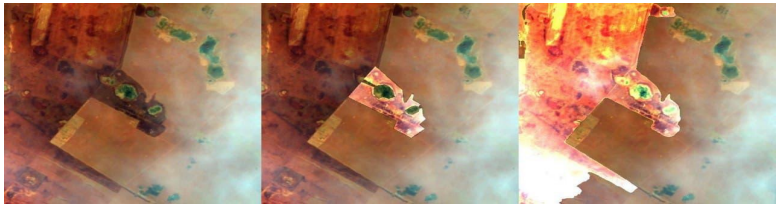
https://github.com/waleedka/hiddenlayer

Natalia Yurasova -
Mikhail yurasov - NVIDIA

MODEL RESULTS







MODEL PROS AND CONS

(+)

- Precise mapping
- Automated monitoring for large areas
- Consistency of results
- Fast working
- Could be extrapolated to the past

(-)

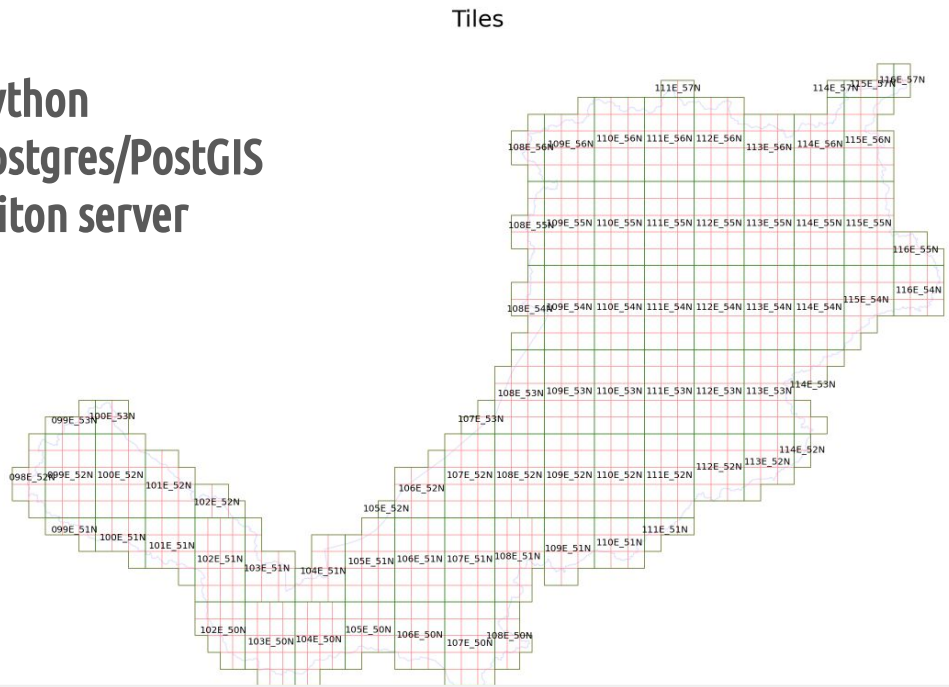
- Not all types of burned areas recognized well
- Errors on wetlands and treeless areas (tundra, north mountains)
- Additional postselection needed for Siberian regions (NBR threshold,hotspot intersection)

BACKEND

```
7]: %%time
    #select with aoi
    selected_tiles,one_region = select_tiles_by_aoi(REGIONS_PATH,'Республика Бурятия','SubjectNam',TILES_PATH)

    /usr/local/lib/python3.9/site-packages/IPython/core/magics/execution.py:1335: FutureWarning: The `op` parameter is deprecated and will be removed in a fu
    ease use the `predicate` parameter instead.
      exec(code, glob, local_ns)
    CPU times: user 2.91 s, sys: 25.6 ms, total: 2.94 s
    Wall time: 2.93 s

8]: grid_plot(selected_tiles,one_region)
```

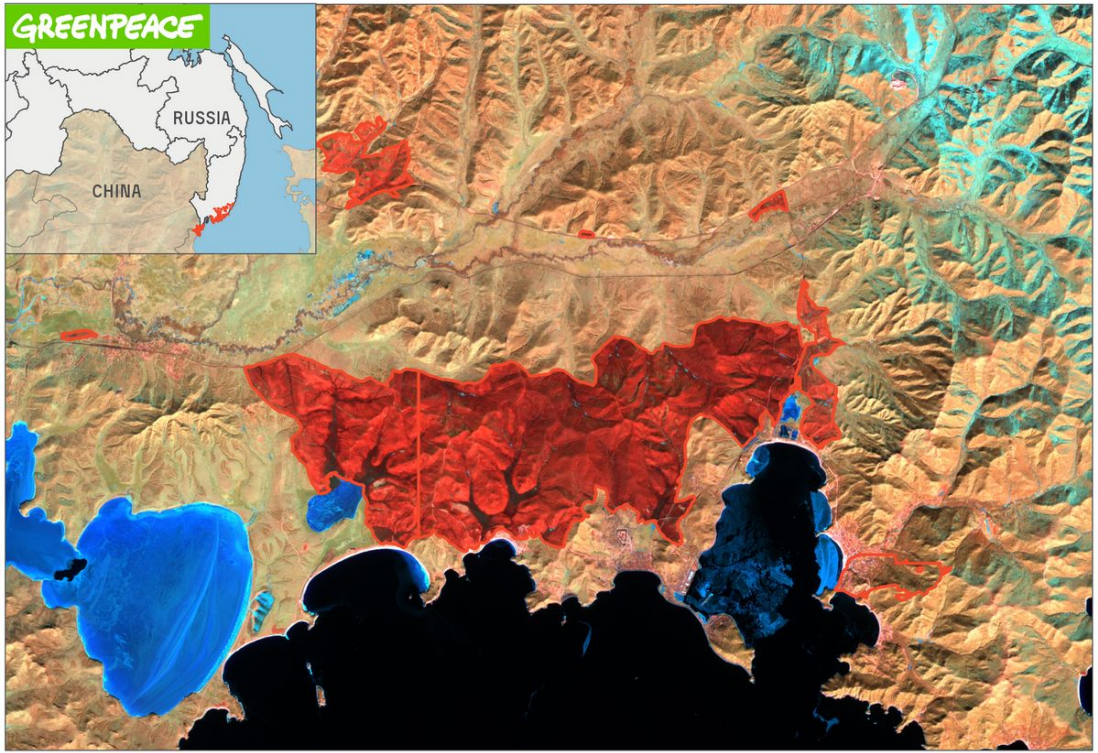


Python
Postgres/PostGIS
Triton server

```
*[14]: TRITON = True
       TRITON_HTTP_SERVICE_URL = "172.17.0.1:18000"
       CHANELS = ["B11", "B08", "B02"]
       DEVICE = "cuda"
       TEST_REGION_PATH = glob.glob("%s/*/*"%FOLDER_TO_SAVE)
       MAX_BATCH_SIZE = 8
       TRITON_MODEL_NAME = "model1"
       TORCH_MODEL_PATH="/app/models/model1.pth"
       MODEL_PATHS = sorted(glob.glob("/app/models/*.pth"))
       PATH_RES = '/app/geojson_results'
       COLS = ['path','date','geometry']
       MODEL_NUMBERS = [1, 2, 3, 4, 5, 6, 7]
       ENSEMBLE_THRESHOLD = 12
       INTERSECTION = 0.2
       INTERSECTIONS = [0.2, 0.15, 0.1]
       IMG_SIZE = 384
       IMG_SIZES = [384, 512, 1024]

[16]: triton_client = httpclient.InferenceServerClient(
          url=TRITON_HTTP_SERVICE_URL,
          verbose=False,
          connection_timeout=600,  # may be needed to wait for tensorrt to run
          network_timeout=600,
          concurrency=1,
      )
      triton_client.get_model_repository_index()
```

QUALITY CONTROL AND MODEL ENHANCEMENT



- Burn Ratio Index calculation

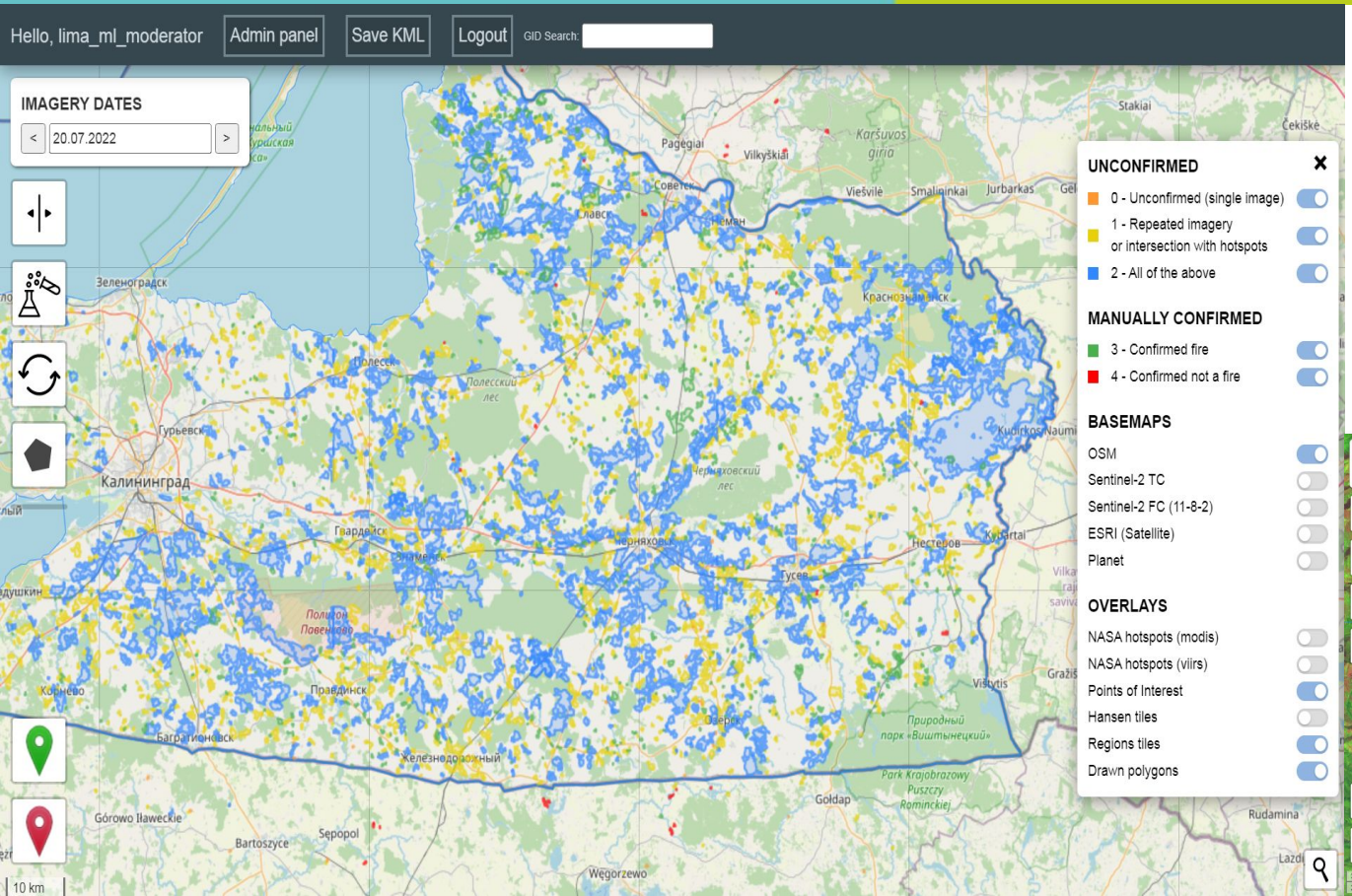
- Hotspot intersection

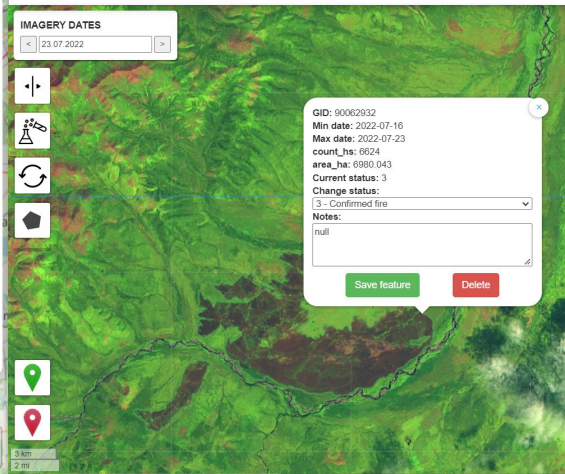
- Time-series analysis for features

- Expert verification (on web platform)

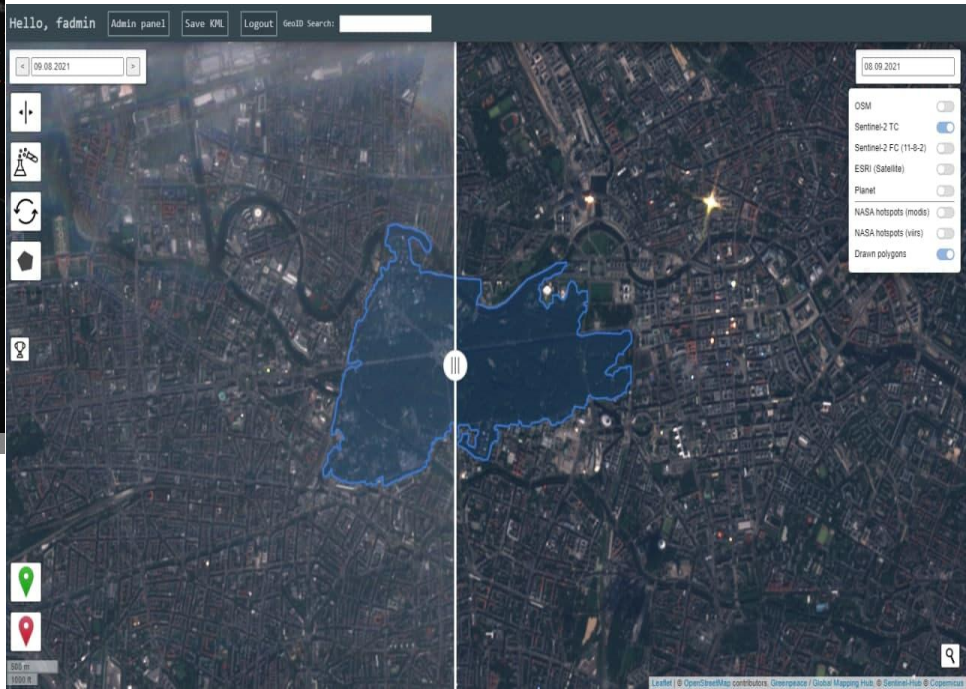
- Expert verification result back to training - > new iterations

INTERNAL PLATFORM

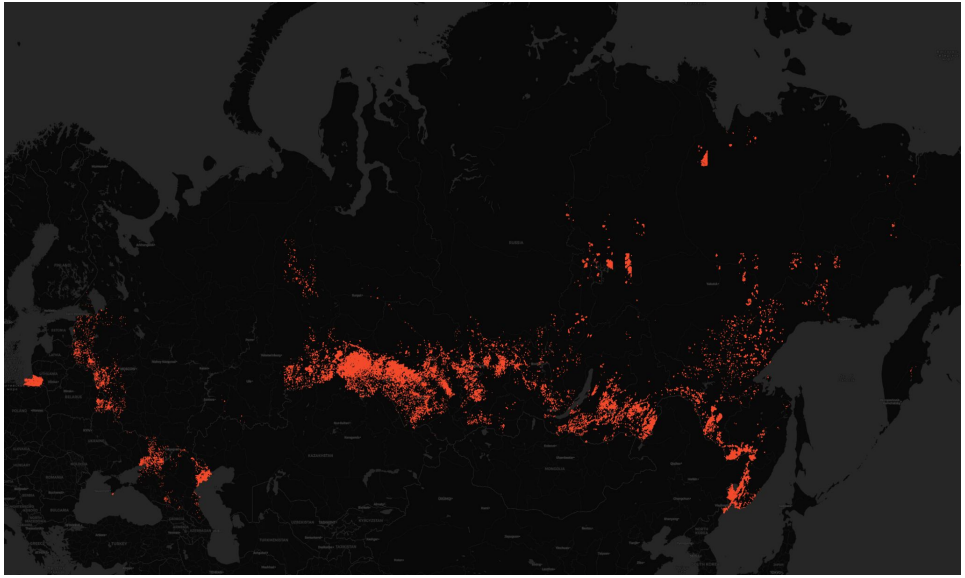




FRONTEND PRODUCT EXAMPLES



CURRENT RESULTS



Preliminary results for Jan-July 2022:

1. 70K polygons; 1/3 area of Russia under monitoring
2. Area of burned areas at this point is about 15 Mha (2 times more official statements)
3. At least 2 regions checked for errors and uncertainties in method
4. Post-processing workflow adjusted according to new knowledge
5. Method limitations was investigated and we working on improving models quality and useability

PROPOSED DEADLINES