Regional Cooperation for
Limited Area Modeling in Central Europe

LACE
nwp central europe

Automated comparison of NIMBUS/OIFS products

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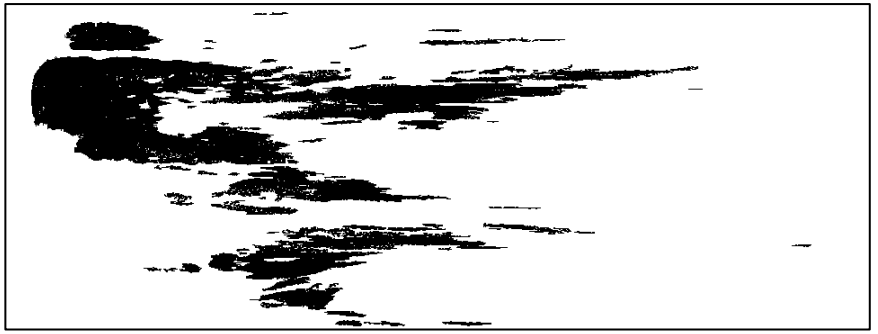
GeoSphere Austria · DHMZ · Czech Hydrometeorological Institute · OMSZ · IMGW · METEO ROMANIA · SHMÚ · ARSO METEO Slovenia

Motivation

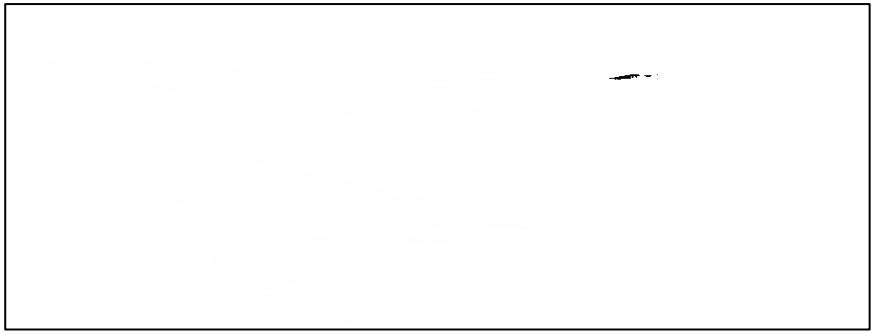
- The radar data assimilation (DA) in ALARO/AROME models utilizes OPERA OIFS HDF5 files as input data
- OPERA migrate processing hub from the OIFS HUB (located in FR) to the "NIMBUS" HUB (located in AT)
- This hub transfer has also been utilized to upgrade the current radar processing line and it was necessary to verify the content of data from the new processing line
- To better compare data from both sources was main reason to my RCLACE short term stay in CHMU in Prague

Motivation

- Given the high density of meteorological radars in Europe, I opted for an objective method over the 'eyemetric method,' which relies on visual assessment without quantifiable criteria. Therefore, I chose the Structural Similarity Index (SSIM) for a more precise and reliable analysis.



OIFS: 20240118205004_mf.satfilter_0.00



Nimbus: 20240118205004_fr.mf.satfilter_0.00

Structural similarity

skimage.metrics.structural_similarity (old name skimage.measure.compare_ssim)
(im1, im2, *, win_size=None, gradient=False, data_range=None, channel_axis=None, gaussian_weights=False, full=False, **kwargs)

Compute the mean structural similarity index between two images.

- more informations https://scikit-image.org/docs/stable/api/skimage.metrics.html
- or directly source code https://github.com/scikit-image/scikit-image/blob/v0.22.0/skimage/metrics/_structural_similarity.py#L15-L275

Coresponding papers

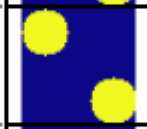
[1] Wang, Z., Bovik, A. C., Sheikh, H. R., & Simoncelli, E. P. (2004). Image quality assessment: From error visibility to structural similarity. IEEE Transactions on Image Processing, 13, 600-612.

https://ece.uwaterloo.ca/~z70wang/publications/ssim.pdf, :DOI:`10.1109/TIP.2003.819861`

[2] Avanaki, A. N. (2009). Exact global histogram specification optimized for structural similarity. Optical Review, 16, 613-621.

:arxiv:`0901.0065` :DOI:`10.1007/s10043-009-0119-z

Structural similarity

Oifs				Nimbus				Oifs	Nimbus	Difference	field [50x50]
c1x	c1y	c2x	c2y	c1x	c1y	c2x	c2y				Image similarity
14	10	40	40	15	10	40	40				0.921
10	10	40	40	15	10	40	40				0.805
40	40	40	40	15	10	40	40				0.782
10	10	0	0	15	10	40	40				0.649

Structural similarity of "randomly" generated data of size 50x50 pixels

compare_ssim_qi

- extract_unique_dates_and_elevations
- for date in unique_dates_oifs:

    for elevation in unique_elevations_oifs:

        for i, qi in enumerate(qi_name_oifs):
- if os.path.exists(image_path_oifs) and os.path.exists(image_path_nimbus):
- **(score, diff) = compare_ssim(shampoo1, shampoo2, full=True)**

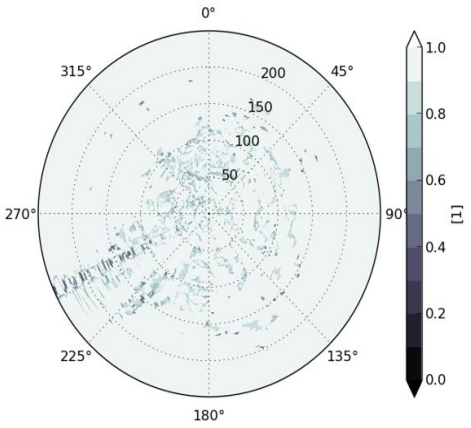
Objective Evaluation: skjav

We are interested only for Qi<1

```
Image similarity Qi
20240118205004:0.00:mf.satfilter Qi=0.748
20240118205004:0.00:se.smhi.detector.beamblockage Qi=0.997
20240118205026:0.50:mf.satfilter Qi=0.709
20240118205026:0.50:se.smhi.detector.beamblockage Qi=0.999
20240118205504:0.00:se.smhi.detector.beamblockage Qi=0.997
20240118205526:0.50:se.smhi.detector.beamblockage Qi=0.999
20240118210004:0.00:mf.satfilter Qi=0.779
20240118210004:0.00:se.smhi.detector.beamblockage Qi=0.997
20240118210026:0.50:se.smhi.detector.beamblockage Qi=0.999
```

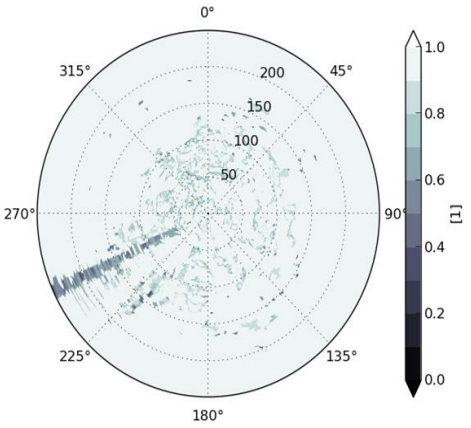
Objective Evaluation:

T_PAZZyy_C_EUON_20240115000000_plpoz_fi_fmi_ropo_detector_classification_20240115000508_0_50

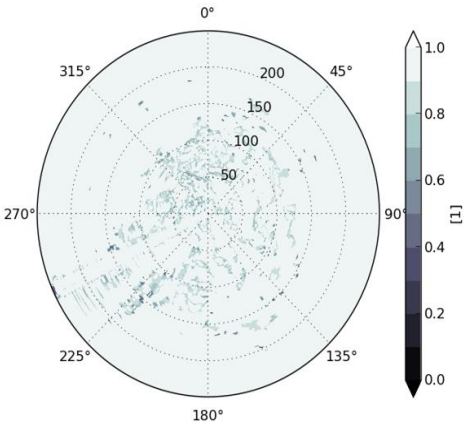


Qi=0.995741177548053

ropo detection classification



original ropo detection classification

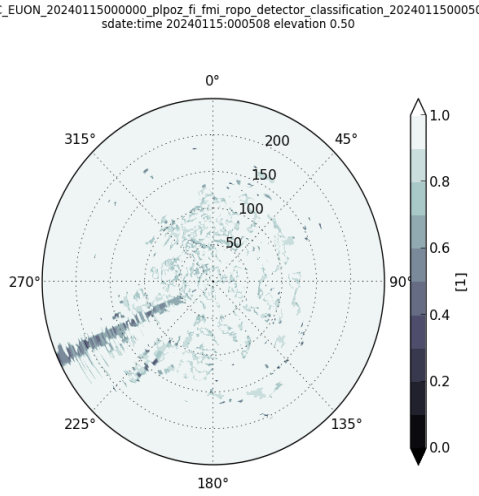


Qi=0.992959272474026

Suppression of whole noisy beams

Objective Evaluation: Is higger always diference

T_PAZZyy_C_EUON_20240115000000_plpoz_fi_fmi_ropo_detector_classification_20240115000508_0_50



Qi=0.995741177548053

Qi=0.992959272474026

Summary

- Utilizing structural similarity appears to be a valuable, efficient, and objective method, saving time and ensuring reliability
- The initial approach of comparing files with the same timestamp was quickly discarded, as their contents often originated from different data sources, leading to exaggerated and misleading results.
- In the next phase of the work, we will split each HDF5 file and compare data from the same elevation with the corresponding scan time.
- Comparison tool was tuned during ACCORD DA WD in Dublin.

Acknowledgment

- Thank you for the support of RC LACE and the CHMU NWP team.
- Specifically, I would like to extend my gratitude to Alenka Trojakova and Antonin Bucanek.

- report is here

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Thank you for your attention.

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OMSZ
IMGW
METEO ROMANIA
SHMÚ
ARSO METEO Slovenia

Qi - from my perspective - opencv

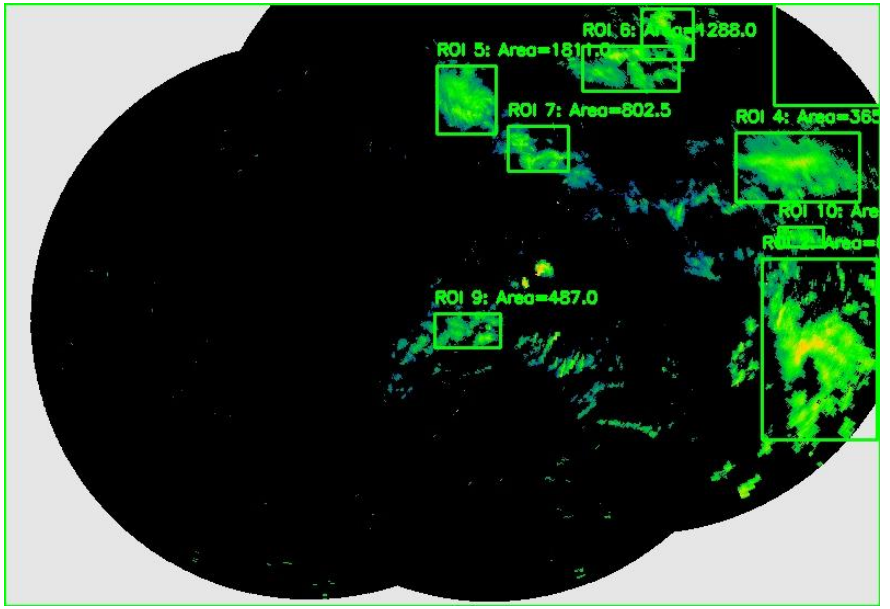
- I would like to show also my Qi from "old INCA times" which I plan to test in our SHMU RUC1 (ALARO-1 cy46 1km) on OPERA HDF5 and then use it in our radar DA
- It use opencv on three temporal consecutive radar scans and after consultation with Peter Smerkol and other colleagues I would like to extend HOOF for it

CV2 - Searching for contours … findContours

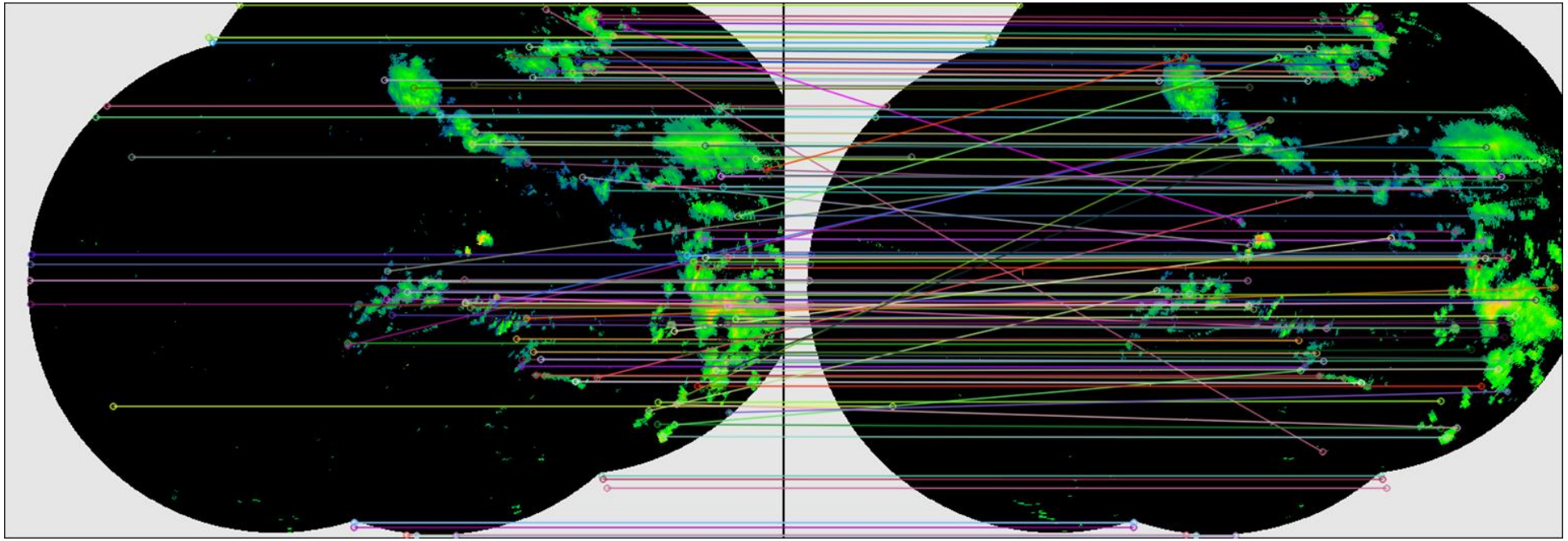
contours1, _ = **cv2.findContours(thresh1, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)**

cv2.RETR_EXTERNAL: This parameter specifies the contour retrieval mode. RETR_EXTERNAL retrieves only the external contours, ignoring any contours inside objects.

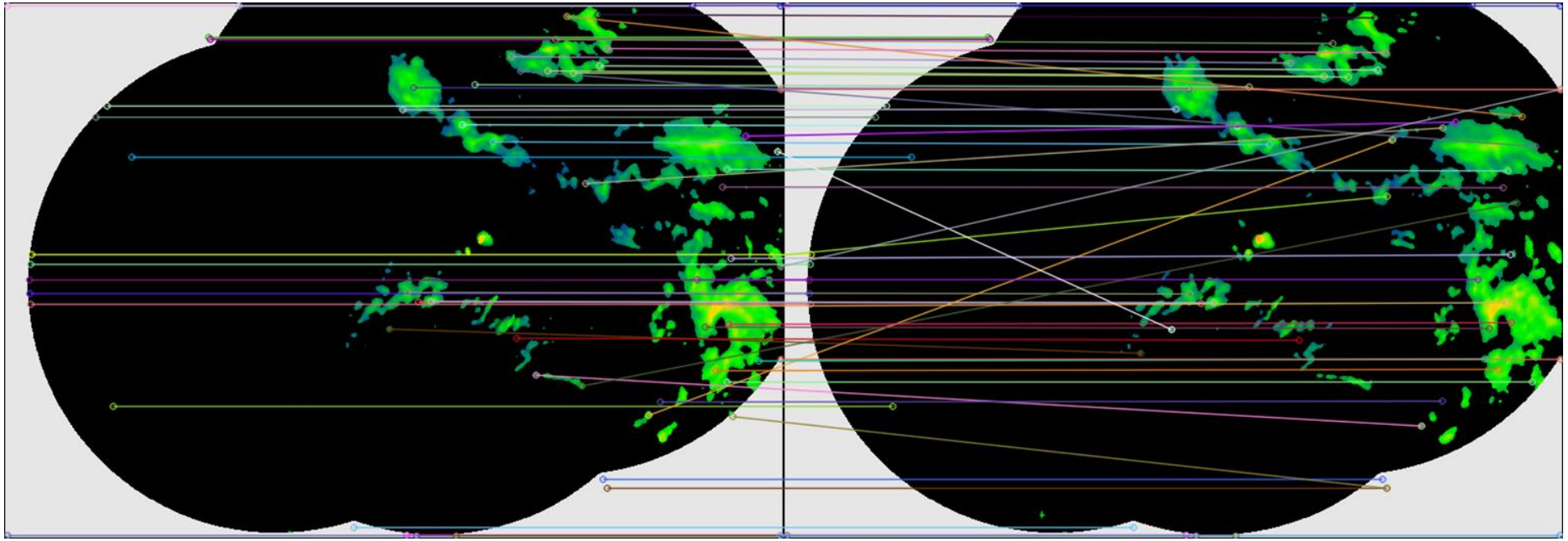
cv2.CHAIN_APPROX_SIMPLE: compresses horizontal, vertical, and diagonal segments and leaves only their end points.



calculate motion vector

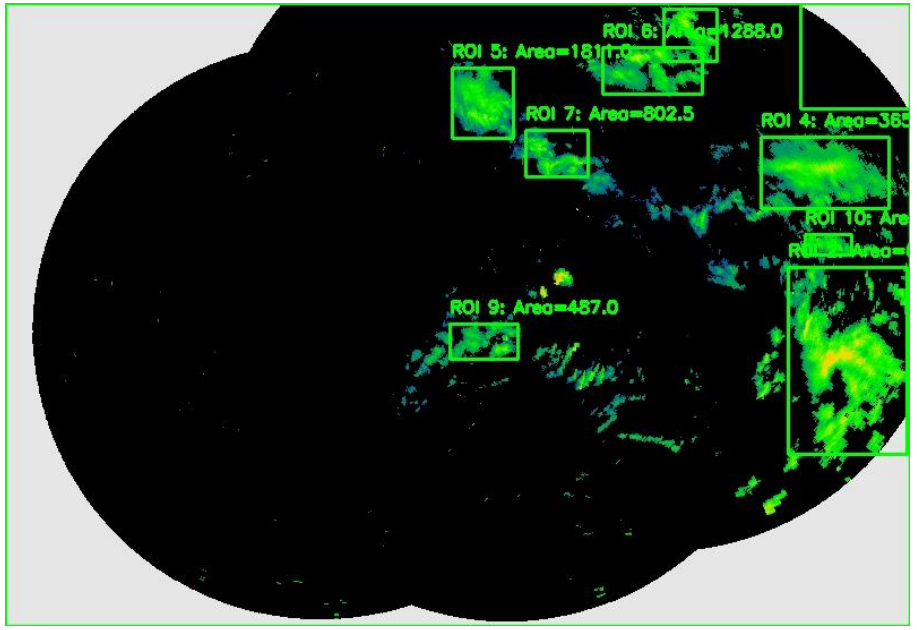


Apply Gaussian blur to reduce noise

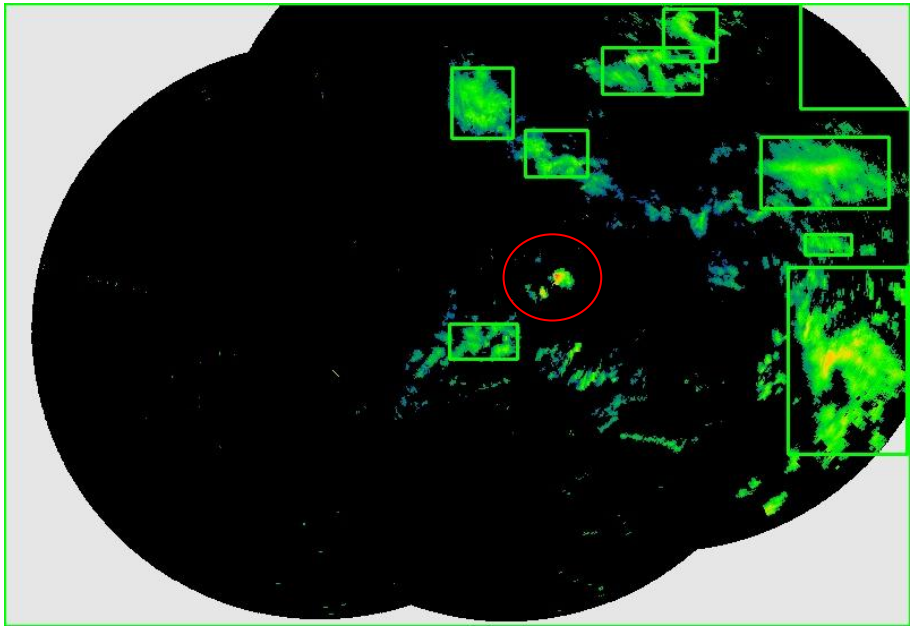


cv2.GaussianBlur(gray1, (5, 5), 0)

ROI - adapt for temporal consecutive radar scans

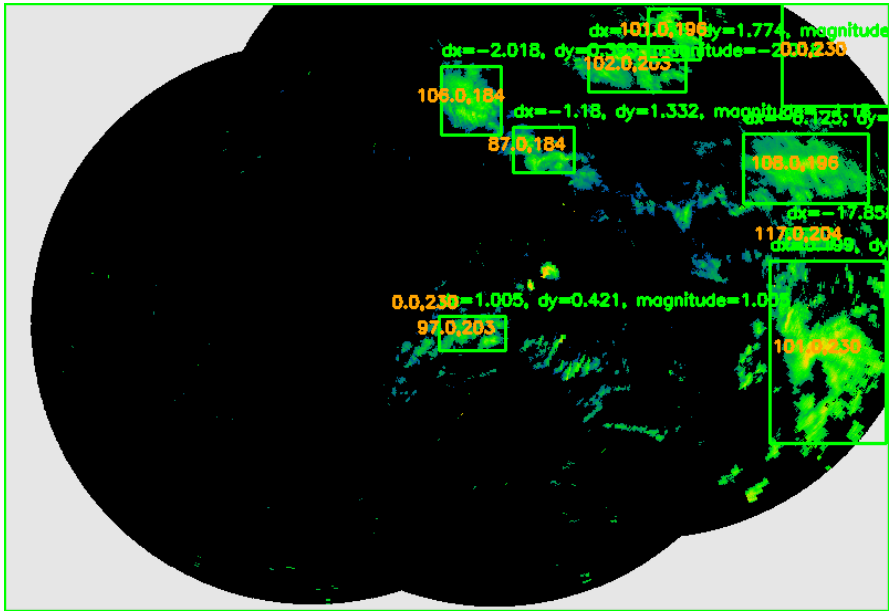


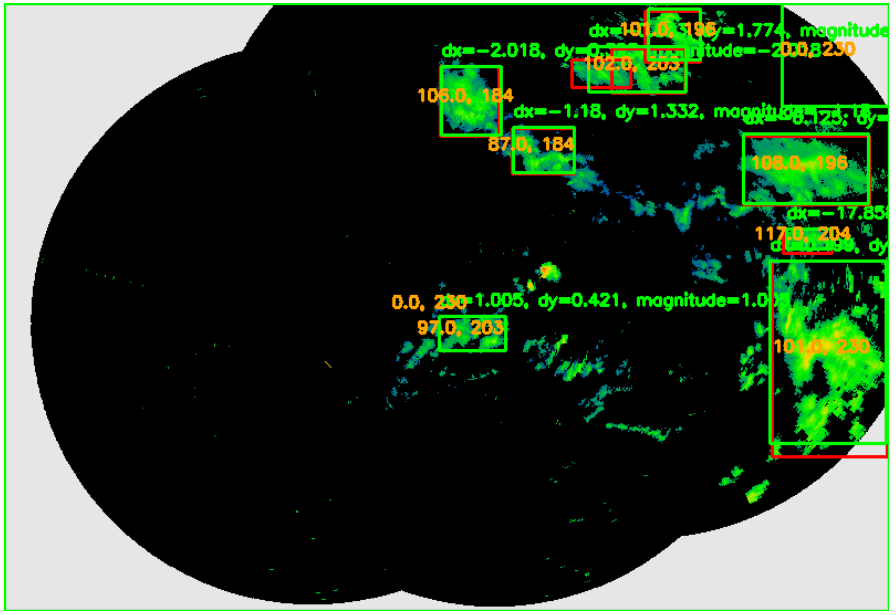
Extract top 10 ROIs from data



Apply 10 ROIs to next and previous timestep

ROI - adapt for temporal consecutive radar scans





T-1: top **10 ROI1**

T0: **10 ROI_1** green **10 ROI_2** red
Median and Max ROI_1

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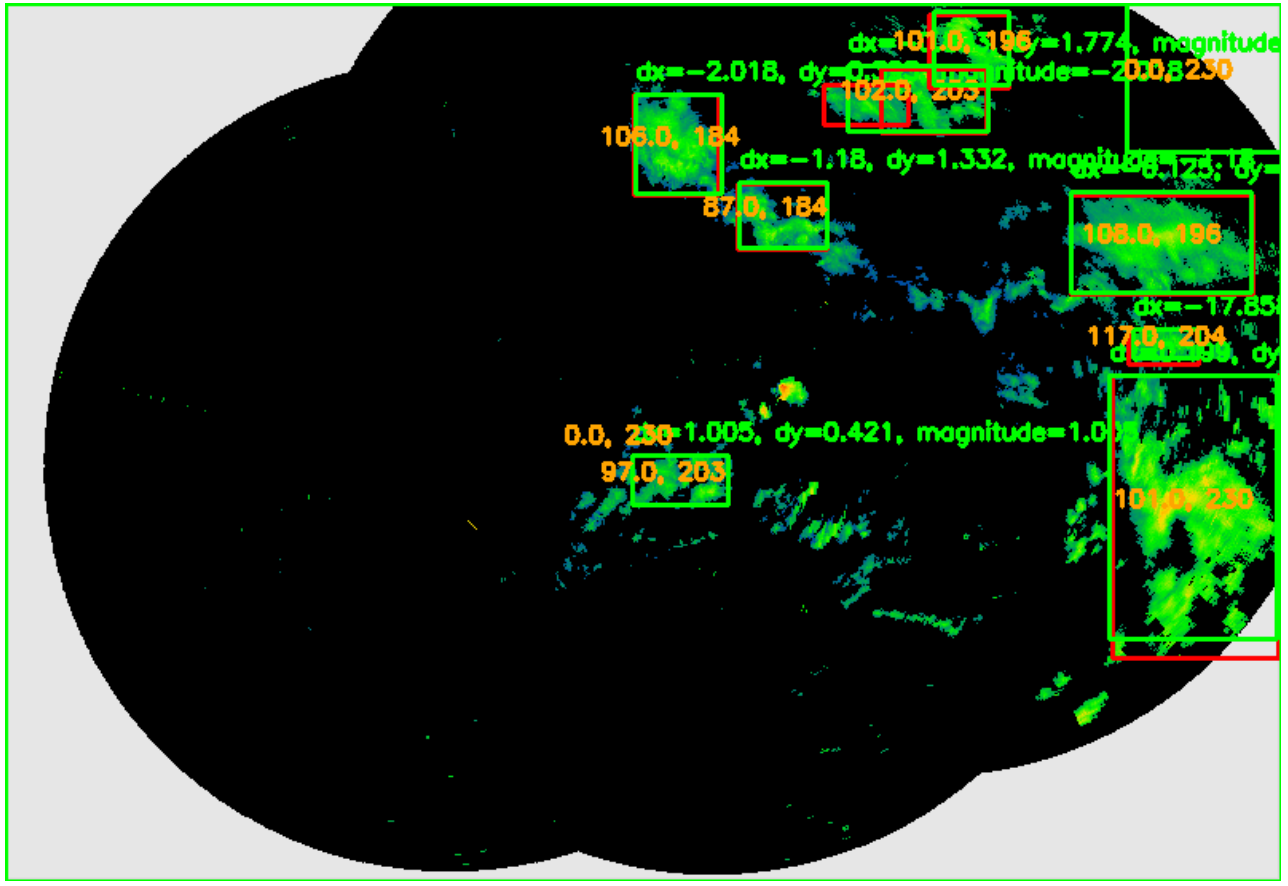
['ROI', 'dx', 'dy', 'magnitude']



ROI1

ROI1

Median, Max

ML - sklearn.ensemble - RandomForestClassifier

- radar data (control = period/all)
  - T_PAGZ41_C_LZIB/png/ (all data)
  - T_PAGZ41_C_LZIB/png/arte (data which was labeled as with artefact)
- Train a classifier (Random Forest)
  - classifier = RandomForestClassifier
- Evaluate the classifier on the validation set
  - calculate classifier.predict, accuracy_score
- Testing radar period
  - T_PAGZ41_C_LZIB/png/arte_con (put data with artefact)
  - prepare csv with labels