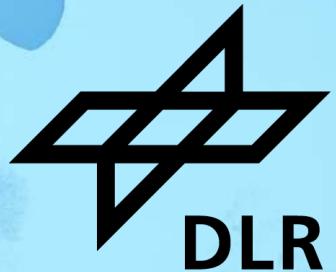


ARTIFACT DETECTION IN SAR IMAGES WITH AUTOENCODER METHODS

Kathrin Rack, Wadim Koslow, Alexander Rüttgers



Higher-level Goal

DLR-Project: RESIKOAST (Resiliente Versorgungsinfrastruktur und Warenströme im Kontext küstennaher Extremwetterereignisse)

Background:

- Increase of sea level
- More extreme weather due to climate change

Task:

- Increase resilience of coastal region
 1. Monitoring of weather and coast
 2. **AI-based algorithms to detect anomalies (Hotspot detection)** and predict trends
 3. Evaluation method of impact of events to logistic chains, harbours, infrastructure
 4. Emergency response plan and long-range adaption of region

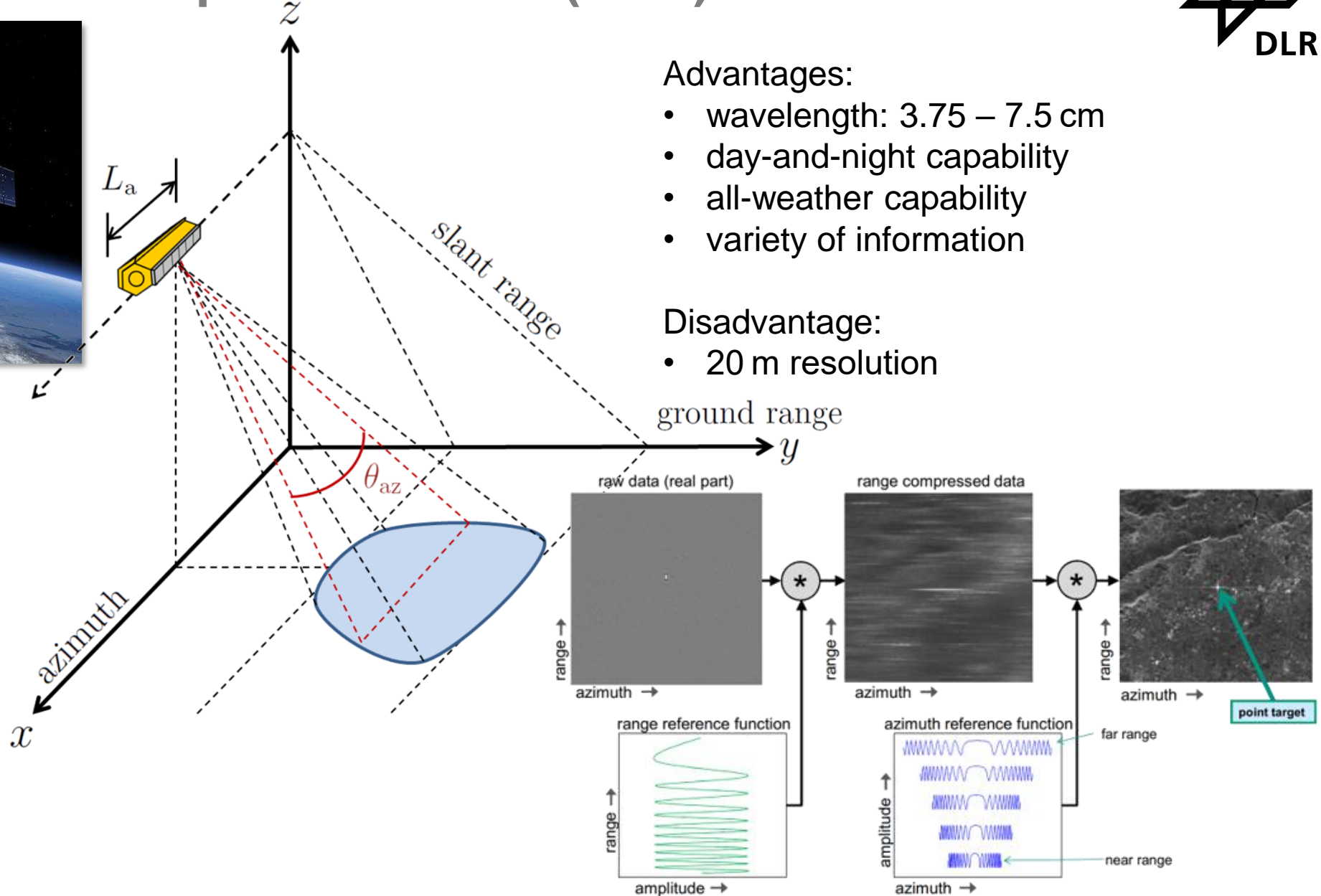
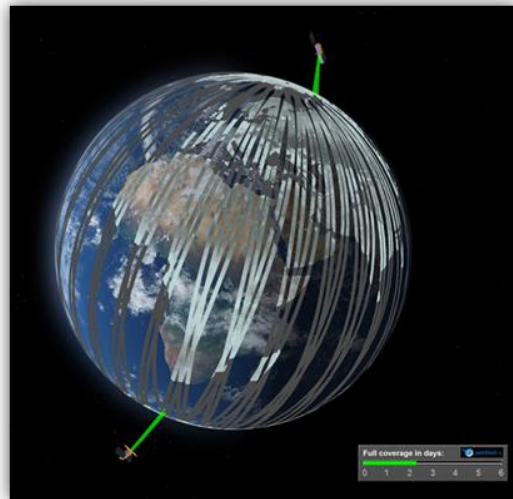


Von Jerry Coli auf pixabay

Our Data: Synthetic Aperture Radar (SAR)



Sentinel-1



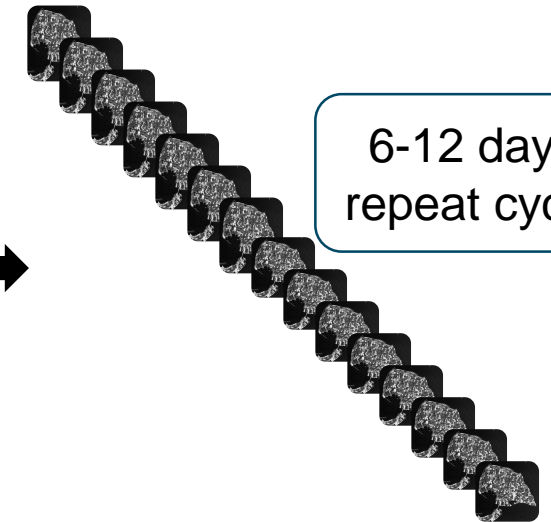
Advantages:

- wavelength: 3.75 – 7.5 cm
- day-and-night capability
- all-weather capability
- variety of information

Disadvantage:

- 20 m resolution

Future pipeline for Hotspot detection



6-12 days repeat cycle

First Steps

- Filter for interesting dates
- Detect Artifacts
- Interpret further findings

Challenges

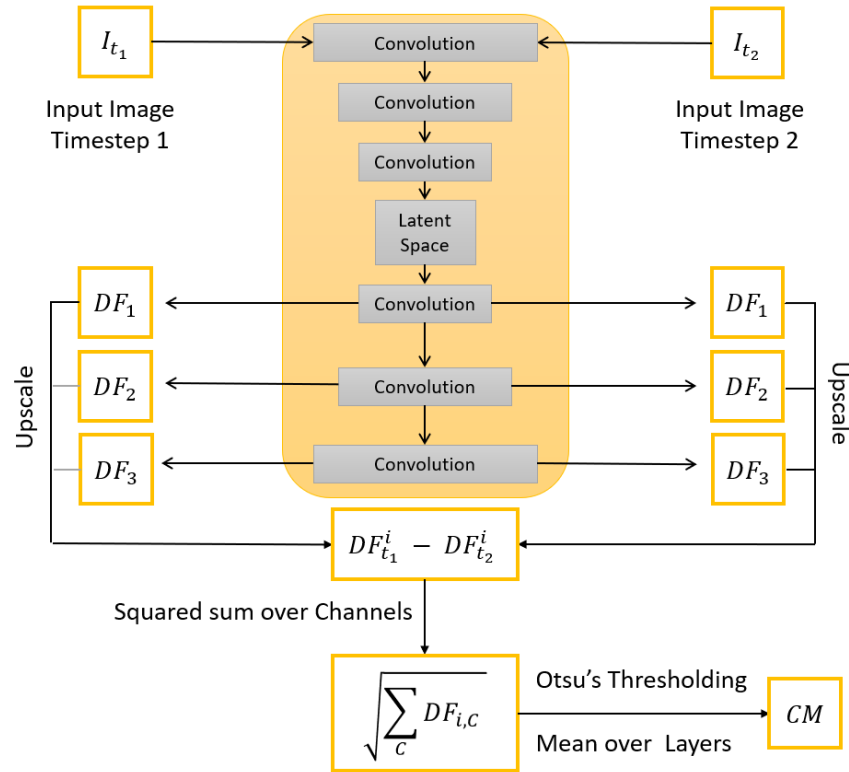
- Coastal mask
- Tides
- Missing validation (ground truth)
- Artifacts

AI Based Software for Hotspot Detection

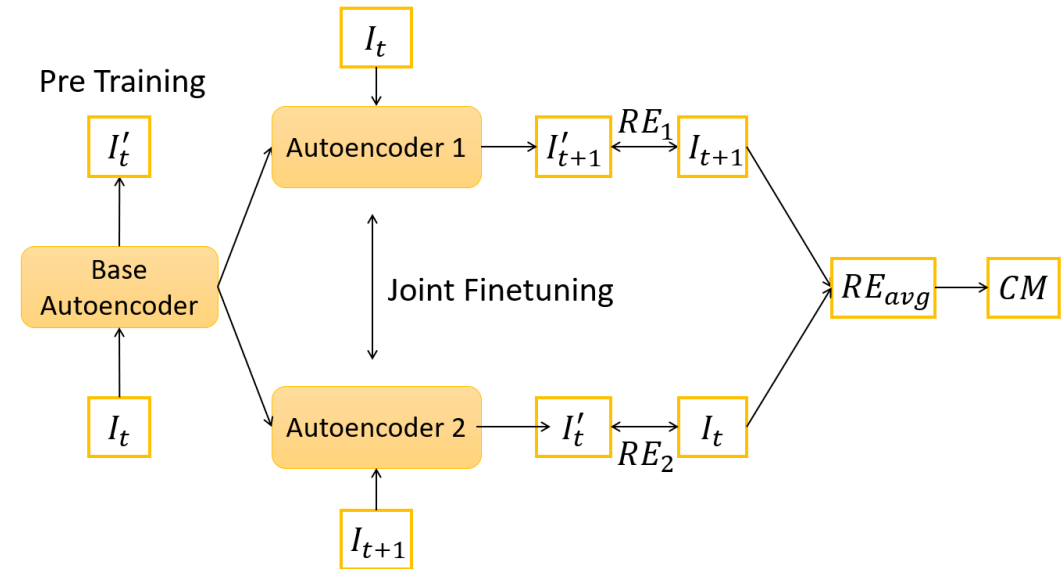
- High quality:
 - CI
 - Tests
 - Code analysis
 - User-friendly
- Different Machine Learning Algorithms



Base and Deep Extraction¹ AE



Joint² AE



Base

- Create reconstruction (FR)
- Reconstructed change:
 $RC_t = |FR_t - FR_{t-1}|$

Deep

- Extract outputs of convolutional layer
- Upscale and average outputs
- Take timewise difference

¹L. Bergamasco et al. *Image and Signal Proces. for Remote Sens. XXV. Vol. 11155. SPIE, 2019*

Joint

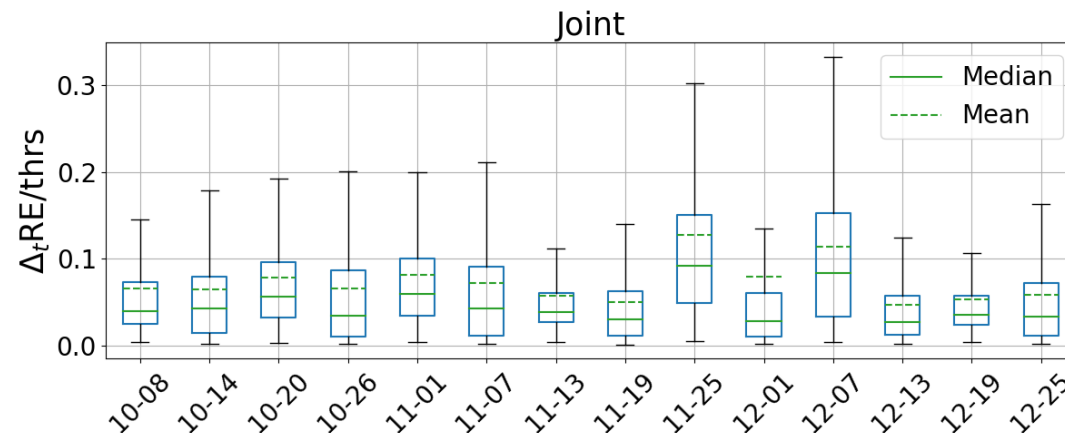
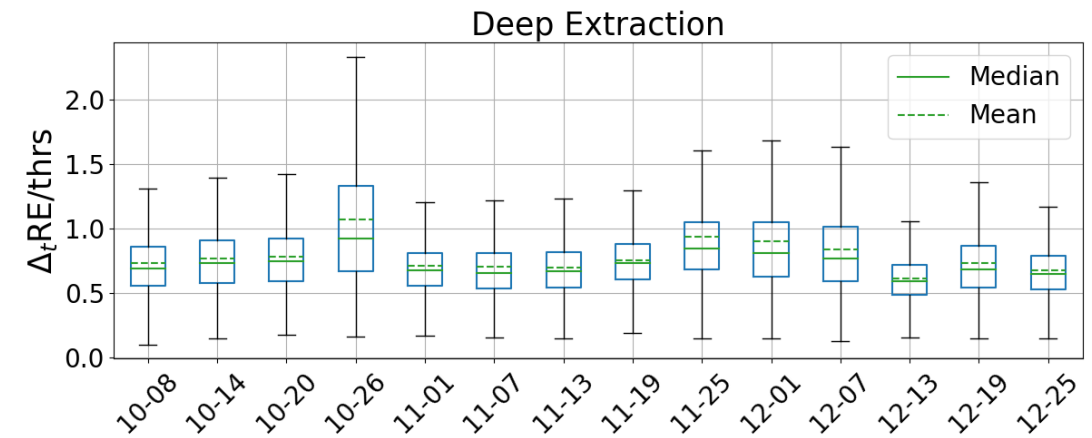
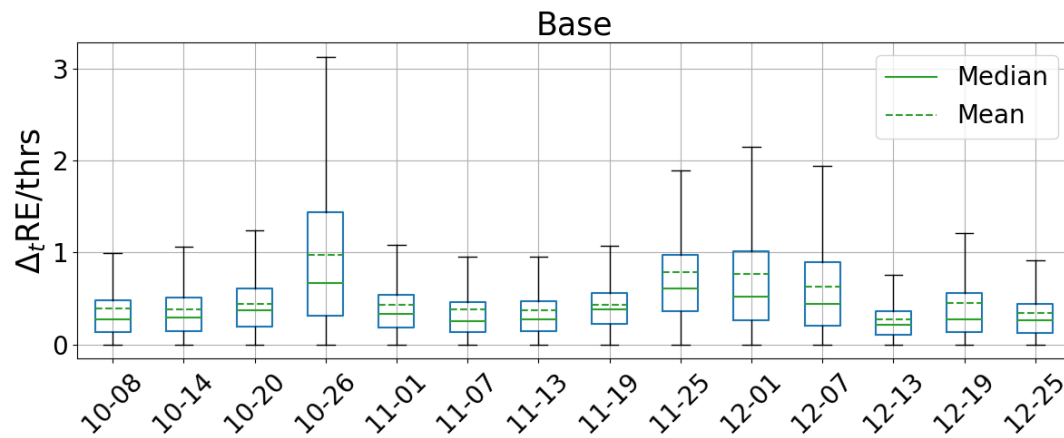
- Pretrained Base AE
- Reconstruction of image before / after
- Joint loss function ($\mathcal{L} = (\mathcal{L}_1 + \mathcal{L}_2)/2$)

²E. Kalinicheva et al., *IEEE J. of Select. Topics in Appl. Earth Observ. and Remote Sens.*, 13:1450–1466, 2020

Find interesting dates in 2020

Boxplots of

- $\Delta_t RE$ – Reconstructed change normalized by
- *thrs* – the global threshold calculated by Otsu's method.

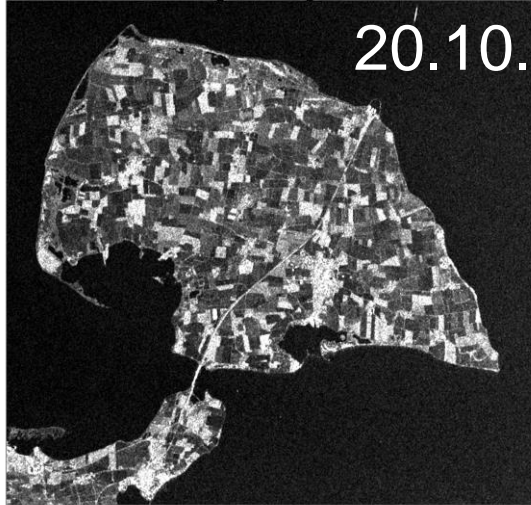


Interesting dates:

- 26.10. (base, deep)
- 25.11.
- 01.12.
- 07.12.

SAR-Data, year 2020

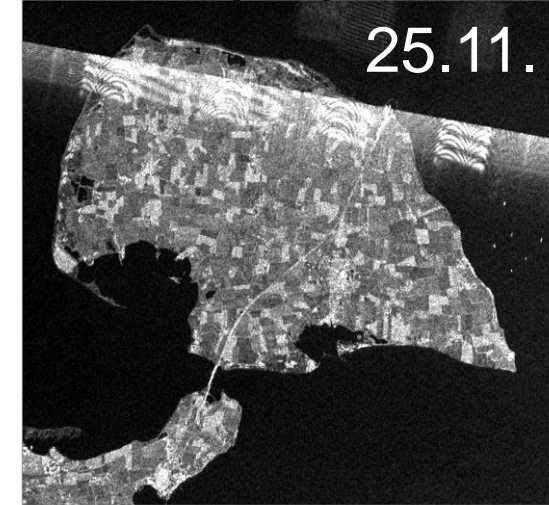
Base Full Original Image 2020-10-20



Base Full Original Image 2020-10-26



Base Full Original Image 2020-11-25



Base Full Original Image 2020-12-01



Base Full Original Image 2020-12-07



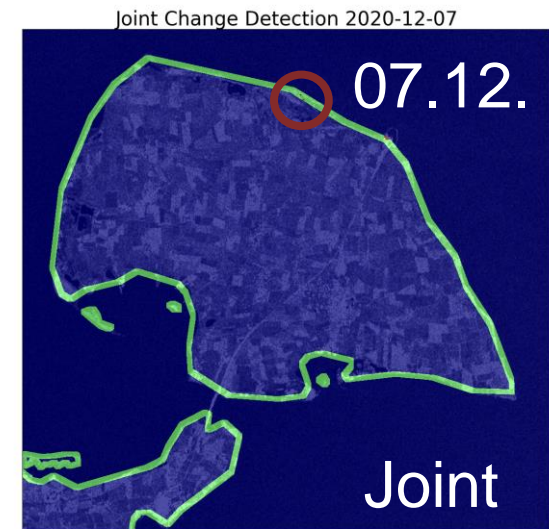
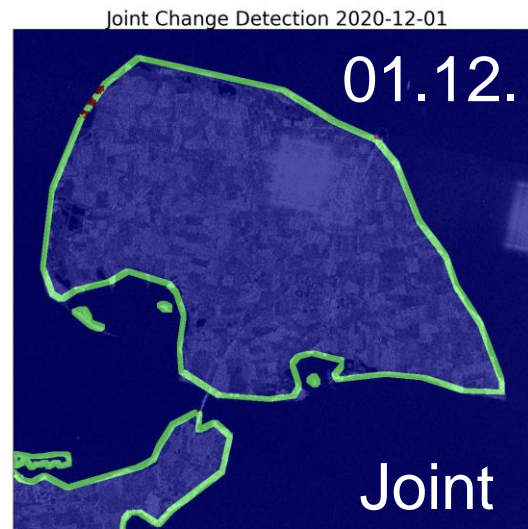
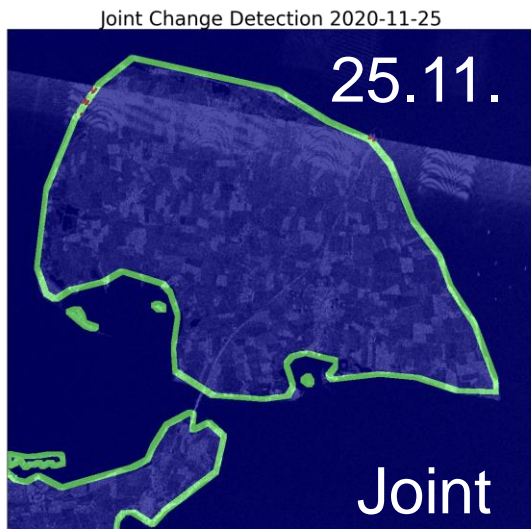
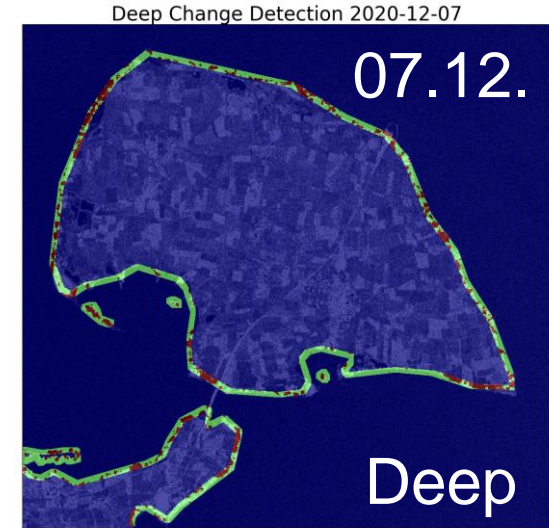
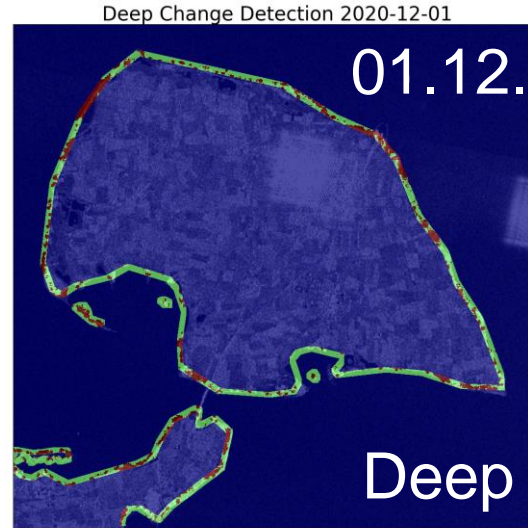
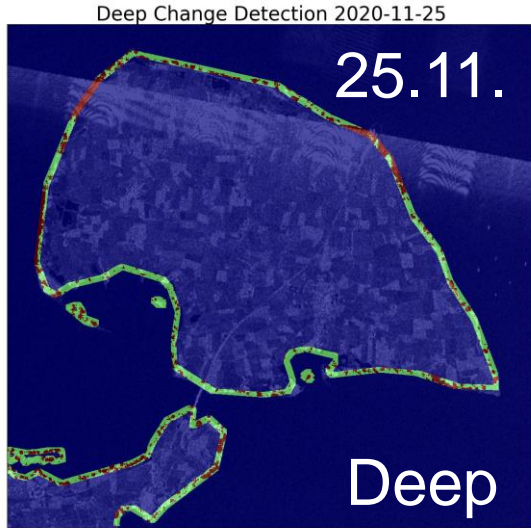
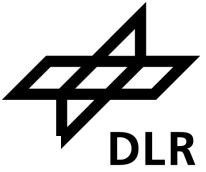
20.10. → 26.10.
Large differences
in brightness

25.11. & 01.12.
Artifacts

Change Detection Results

Green: coastline mask

Red: Change Map ($\Delta_t RE > thrs$)



Hotspot Detection

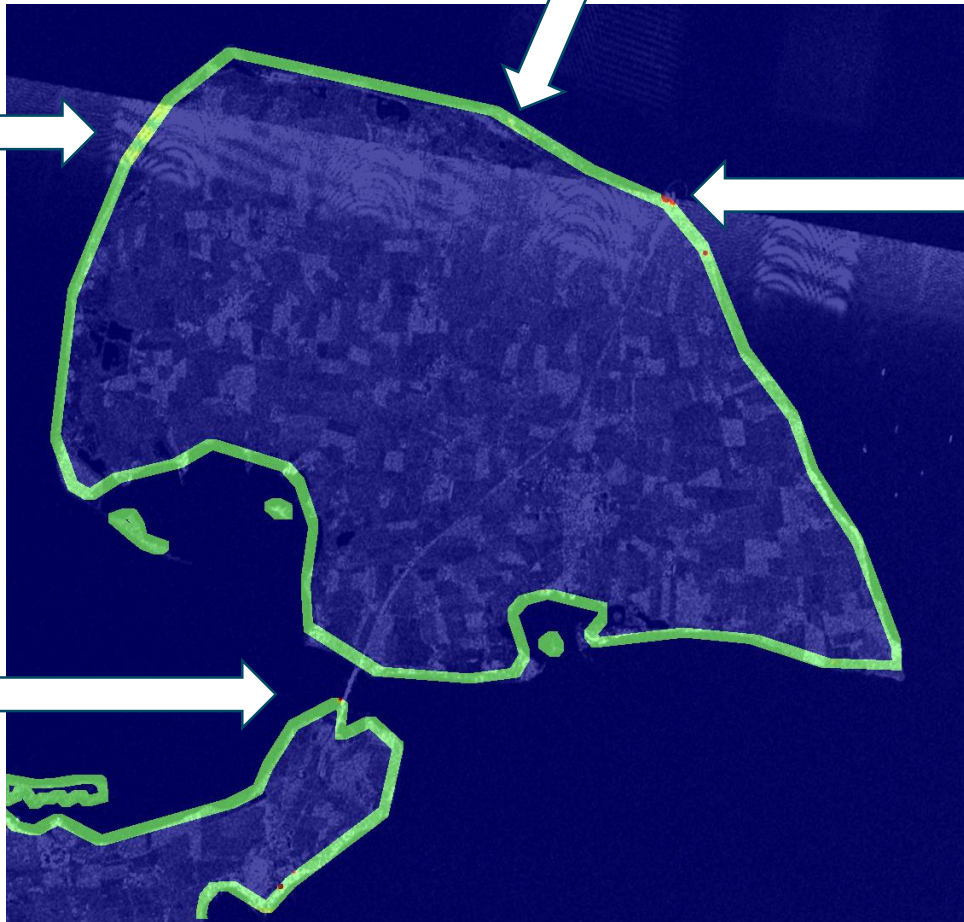


Artifacts are visible but not standing out

Nature reserve

Noticeable region: harbor

Noticeable region: harbor

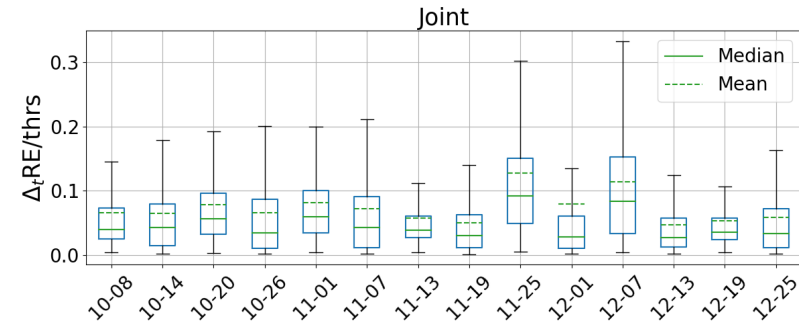


Hotspot detection – averaged change detection of all times

Conclusion & Outlook

Conclusion

- Boxplots can filter dates
- Artifacts successfully identified
- Joint Autoencoder best suited for hotspot detection
- Joint AE detects busy regions



Outlook

- Check events in nature reserve
- Check Baltic and North Sea for prominent events
- Compare to classical method as local outlier factor



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