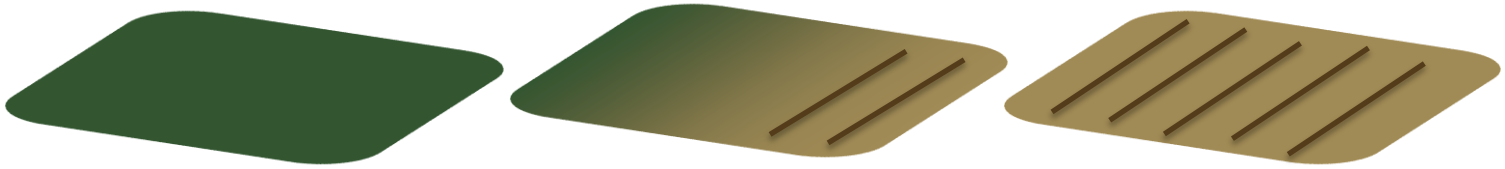
Forest Information Technology
summer semester 2017

Semi-automated Edge Detection at Landscape Level Using Sentinel 2 Satellite Images and Python



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Student research colloquium
20-21/4/2017

Mitglied der Leibniz-Gemeinschaft

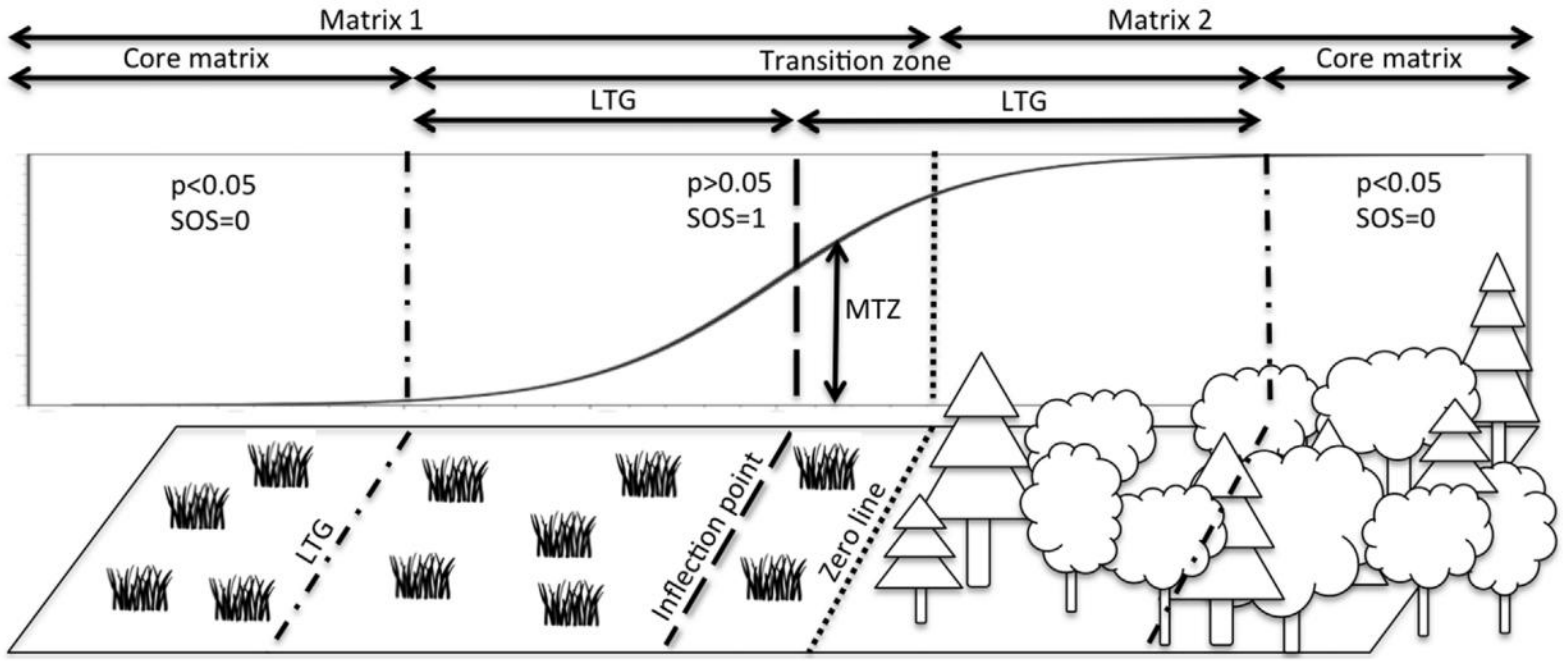
zalf

Agenda

- Introduction
- Methods
- Results
- Conclusion

Introduction - definition

- **Transition zone**: “Spatio-temporal variable entity with functional and structural gradients in between adjacent core matrices.” (SCHMIDT ET AL., 2016)
  Synonyms: Boundary, edge, corridor, ecotone…



Source: SCHMIDT ET AL. (2016)

Introduction (cont‘d)

- Impact of edge effects in landscape ecology: Interest for climate change mitigation, biodiversity research and conservation
- Edges between landcover types exposed to discontinuities in microclimate: Varying biotic/abiotic components

Introduction (cont‘d)

- Δ of concentrations of inorganic soil components at the location of the edge vs. adjacent core matrices
- Δ of plant growth patterns, biomass accumulation, carbon storage capacities (feedback loop)

Introduction (cont‘d)

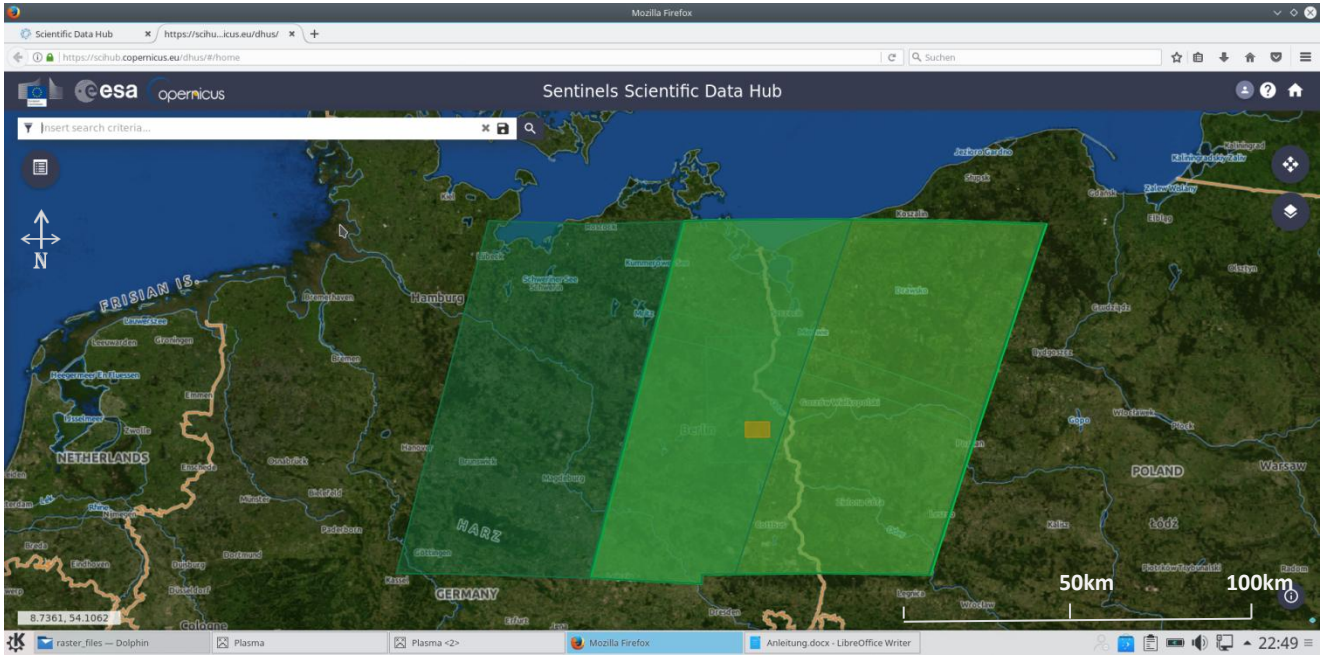
Knowing magnitude of the gradient, depth of the edge, **location** of transition zones

=>

- ✓ Estimation of share at landscape level
- ✓ Proxy for a more accurate estimation of carbon storage potential for climate change mitigation

Methods

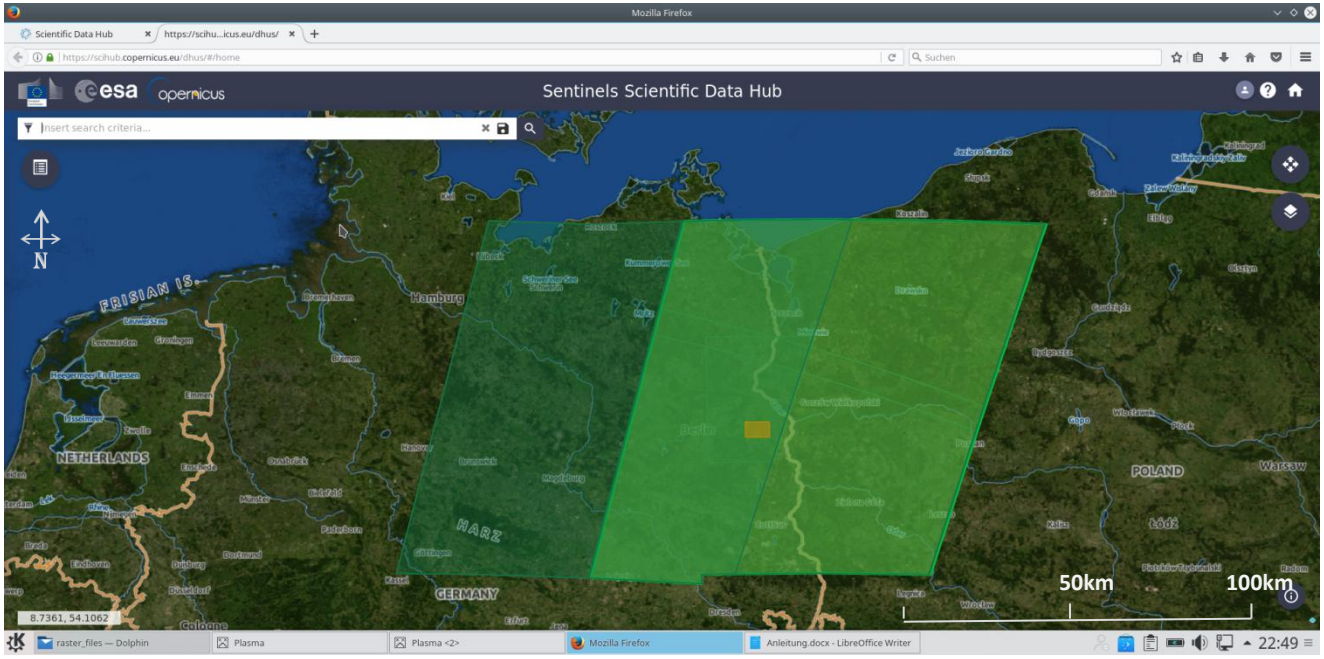
- (1) Area of interest:
- Brandenburg in general (green tiles)
- Area around Müncheberg, east of Berlin (orange area)



ESA, 2017, UTM/WGS84

Methods

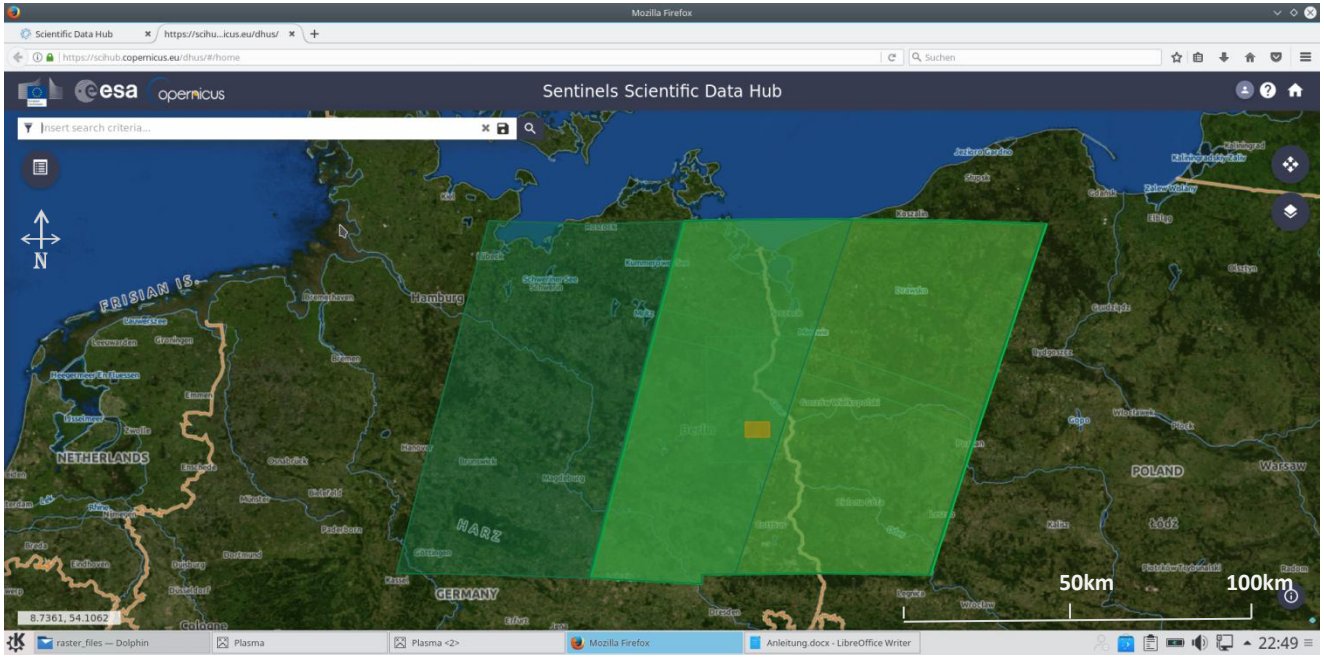
- (2) Sentinel 2 Satellite Images:
- Level-1C product, orthorectified (TOA)
- 13 bands covered (443 – 2190 nm), **10m**, 20m, 60m resolution
- Copernicus scientific data hub



ESA, 2017, UTM/WGS84

Methods

- (2) Sentinel 2 Satellite Images:
- 0-10% cc query
- 100 x 100 km tiles, UTM/WGS84 projection, jpg2000 file format

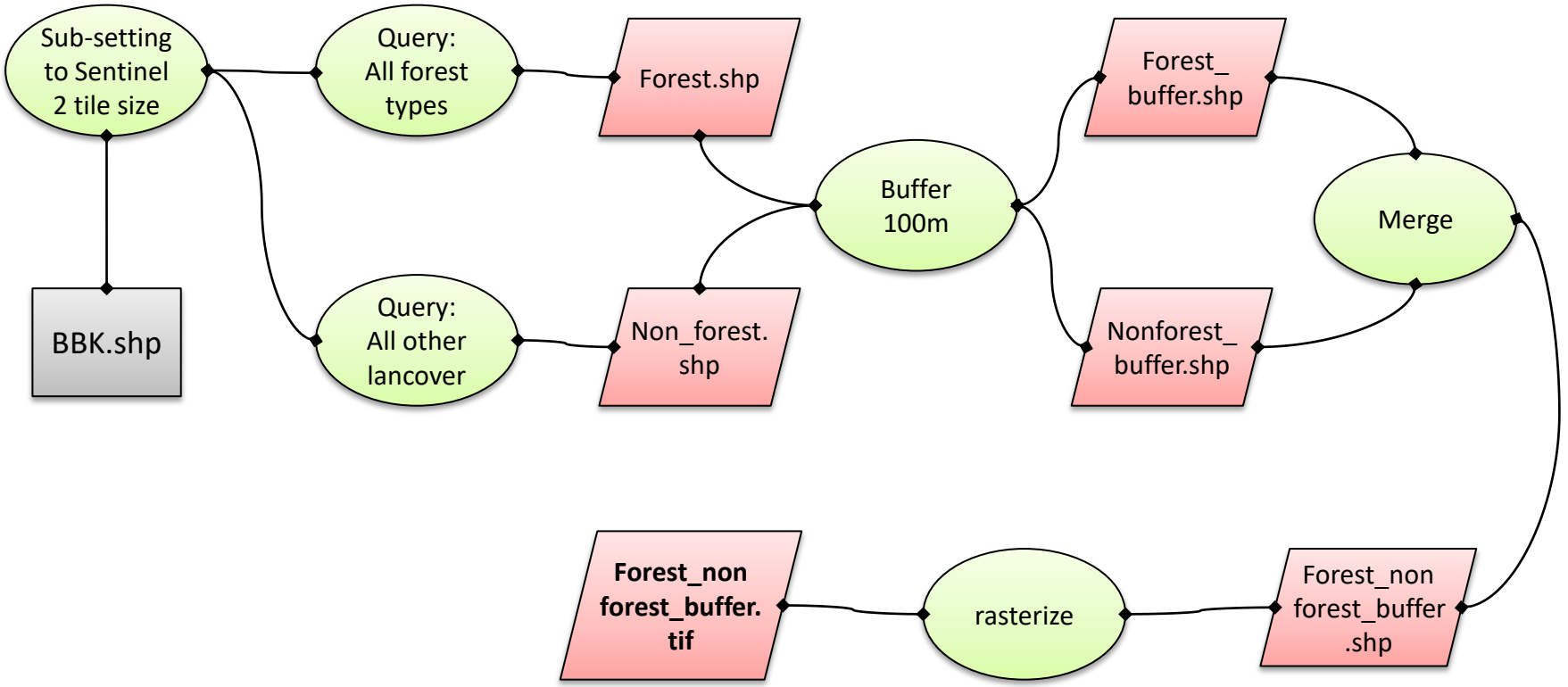


ESA, 2017, UTM/WGS84

Methods

- (3) Vector data mask for validation (BBK)

QGIS workflow

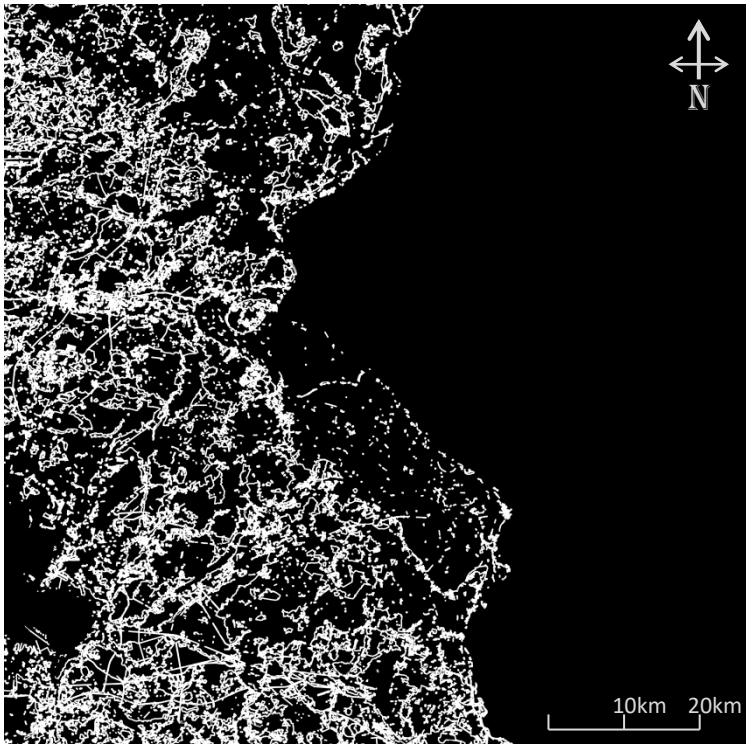


Methods

- (3) Vector data mask for validation (BBK)

Intermediate result: buffer of 200m width into forest and non-forest (100m each)

Forest_non-forest_buffer.tif

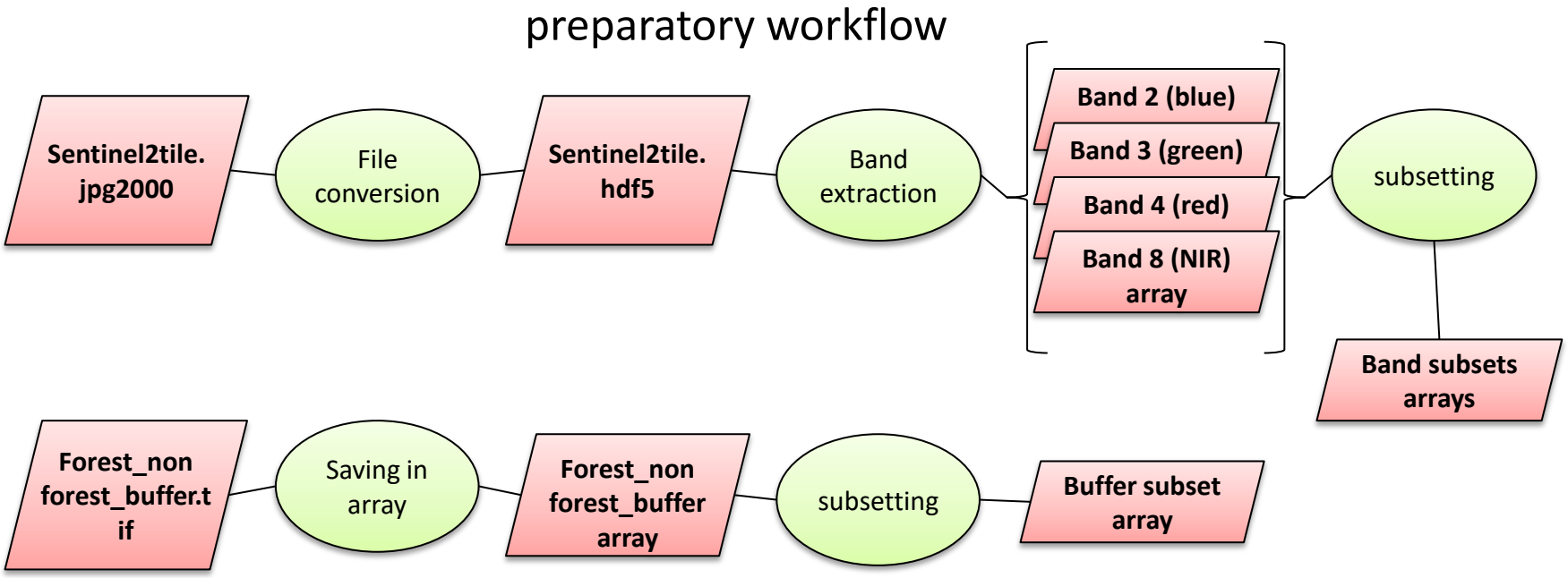


Own creation, UTM/WGS84

10 x 10 m cell size grid

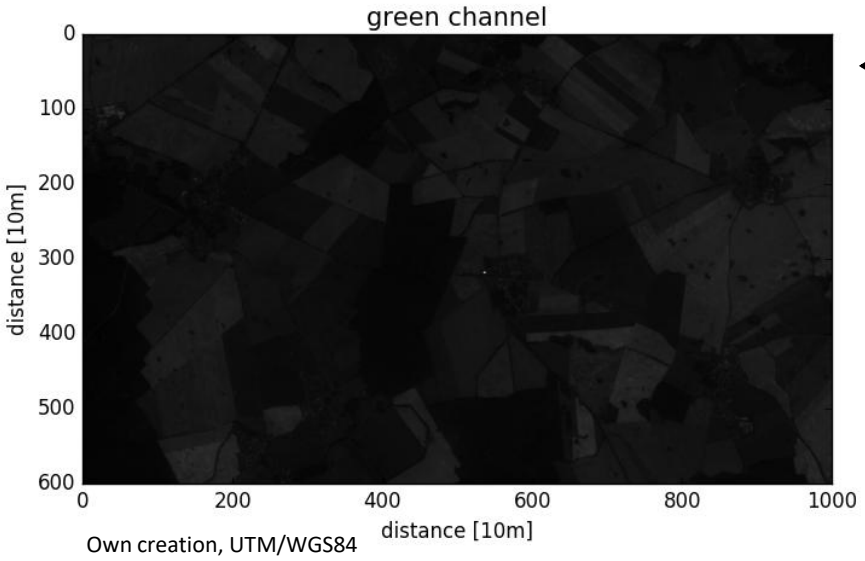
Methods

- (4) Automatization with python
- Packages: numpy, cv2, pylab, tables, gdal



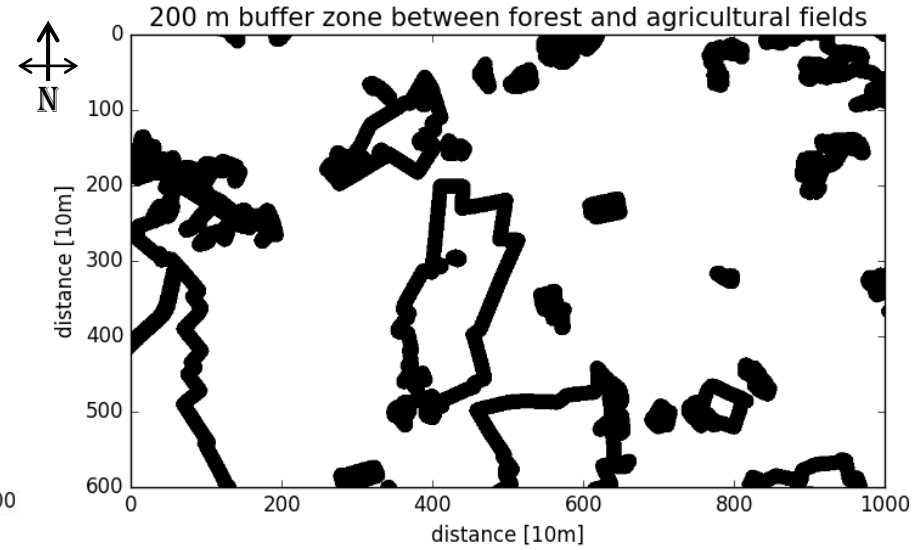
Methods

Band subset array



Own creation, UTM/WGS84

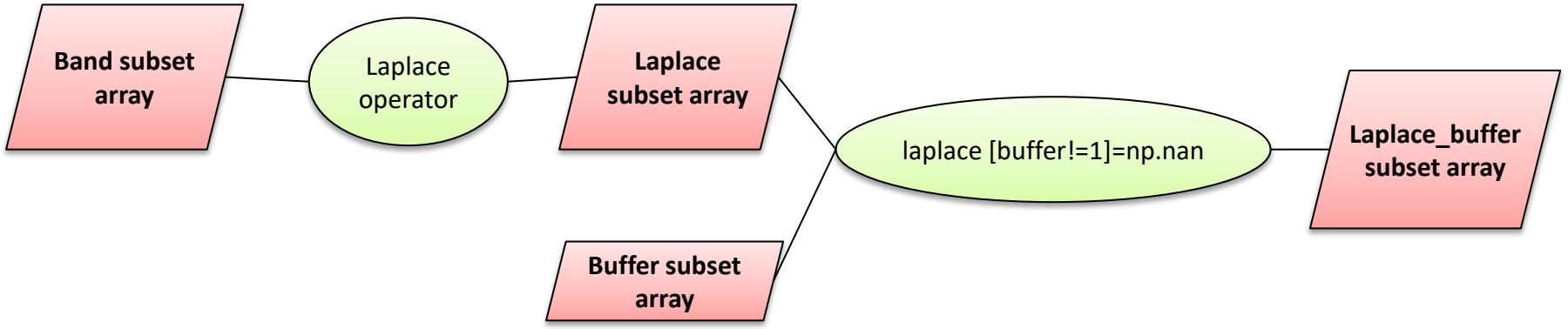
Buffer subset array



Methods

- (4) Automatization with python (cont‘d)

Image filtering and transformation workflow



Methods

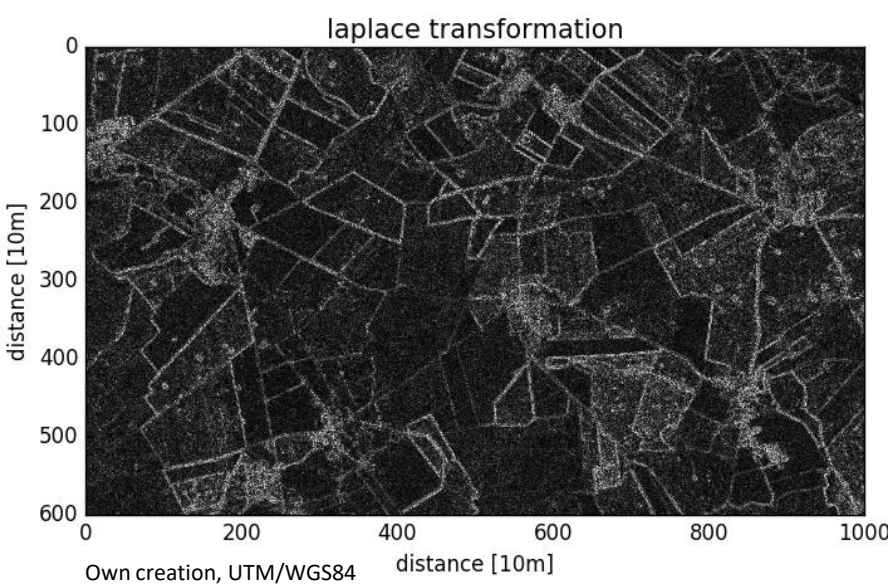
- (4) Automatization with python – code piece

```
B12 = h5.root.B10.data.read()[6624:7224,3149:4149]
B8A = h5.root.B8A.data.read()[6624:7224,3149:4149]

#For further processing, we are using a mask which was created previously using QGIS from Brandenburg biotope mapping vector
#file, using only a query of buffers 100m into the forest and 100m outside of the forest from all available land use types
buffer_extent = gdal.Open(buffer_name, gdalconst.GA_ReadOnly)
#We are storing the file in an array
buffer = np.array(buffer_extent.GetRasterBand(1).ReadAsArray())[6624:7224,3149:4149]

#rgb composite of the three band arrays r,g,b
sc=np.dstack((B04,B03,B02))
sc=sc.astype('float')
# the image viewer can only display so many colors, so the color gradient is cut down to fit real colors
sc[sc>2000]=2000
sc=sc/sc.max()

# laplace transformation of the single bands and transfer to 8bit integer for visibility
l02 = cv2.Laplacian(B02,cv2.CV_64F)
l02 = np.absolute(l02)
l02 = np.uint8(l02)
l03 = cv2.Laplacian(B03,cv2.CV_64F)
l03 = np.absolute(l03)
l03 = np.uint8(l03)
l04 = cv2.Laplacian(B04,cv2.CV_64F)
l04 = np.absolute(l04)
l04 = np.uint8(l04)
l08 = cv2.Laplacian(B08,cv2.CV_64F)
l08 = np.absolute(l08)
l08 = np.uint8(l08)
lsc = l02+l03+l04
#lsc = cv2.Laplacian(sc,cv2.CV_64F)
lsc = np.absolute(lsc)
lsc = np.uint8(lsc)
#print(lsc.shape)

#B02=B02.astype('float')
#B02[buffer!=1]=np.nan
#B03=B03.astype('float')
#B03[buffer!=1]=np.nan
#B04=B04.astype('float')
#B04[buffer!=1]=np.nan
#B08=B08.astype('float')
#B08[buffer!=1]=0
```

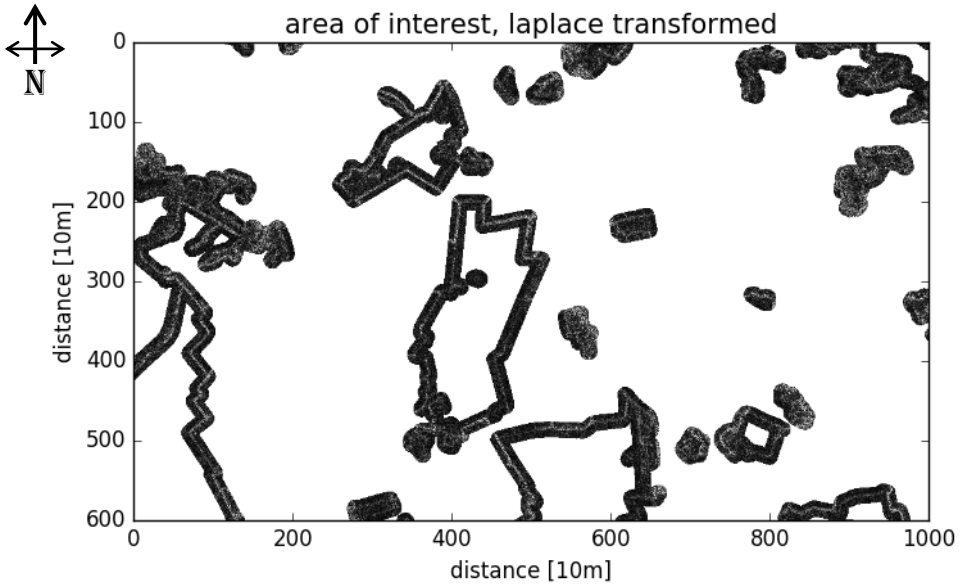
Results

Laplace subset array

Laplace_buffer subset array

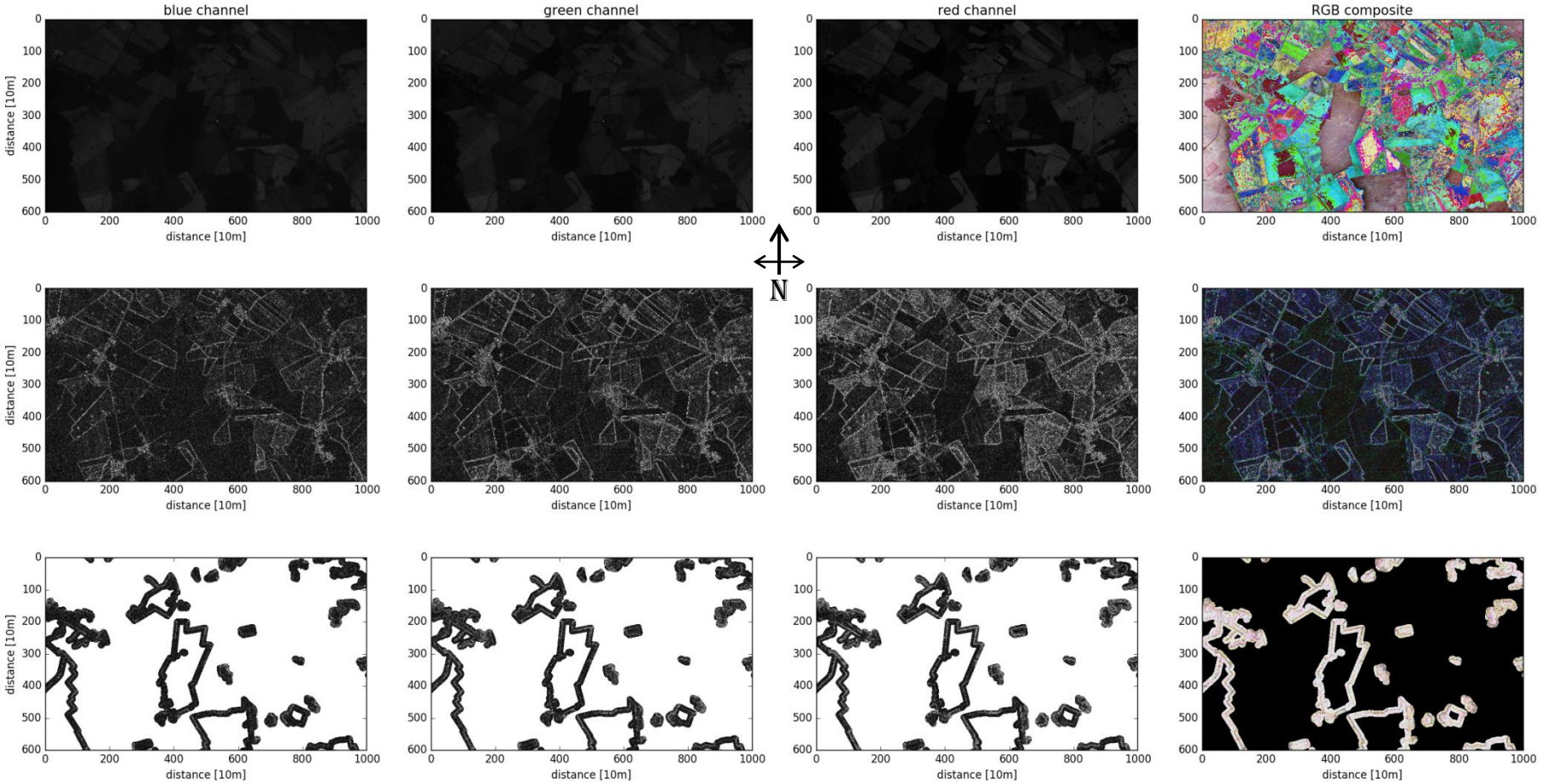


Own creation, UTM/WGS84



Results

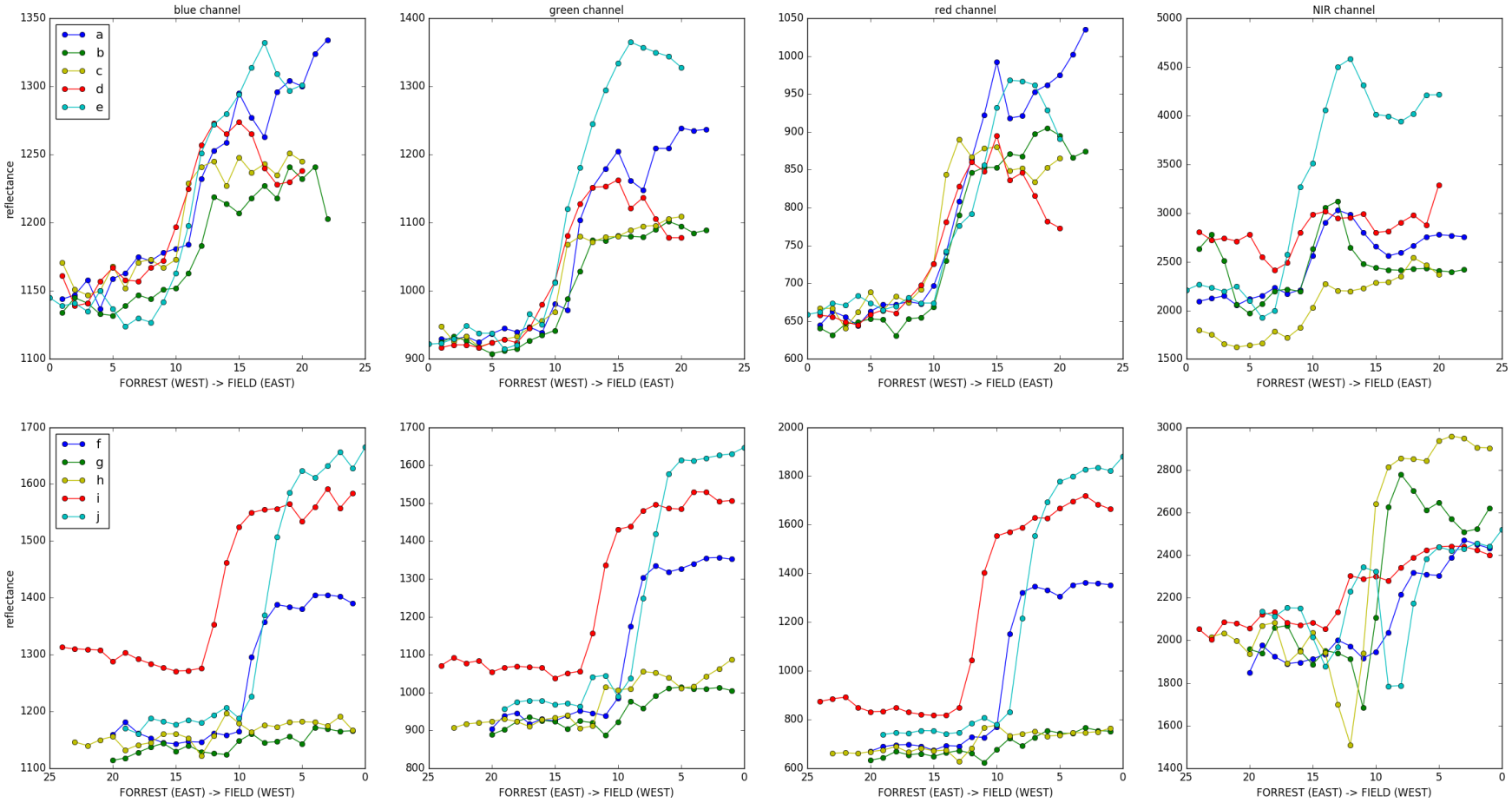
Results – different bands and intermediate results



Own creation, UTM/WGS84

Results

Results – transects over edges and reflectances



Own creation

Conclusion

- ✓ Reasonable results without atmospherical correction
- ✓ Validation „mask“ prove that algorithm is functional

- **Improvements:** Regression analysis of best detection results for different bands/combinations/edge detection algorithms and parameter fine tuning; image preprocessing; gaussian filtering

- **Future research:** Upscaling to larger areas such as Brandenburg to estimate the distribution of transition zones as share of other landuse types + understand magnitude and length of edges between different landcover types and thus determine carbon storage potentials.

Thank you

so much

for your attention!

Bibliography

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