Planimetric Misregistration Assessment

Author(s): ***Kévin GROSS***
VisioTerra Task 5 Mission Expert
Axel CORSEAUX
VisioTerra Engineer

Approval: ***Serge RIAZANOFF***
VisioTerra Task 5 Lead

Accepted: ***Clément ALBINET***
ESA Technical Officer

EDAP.REP.054 *Issue: 1.1* *08/04/2022*

TELESPAZIO
a LEONARDO and THALES company

AMENDMENT RECORD SHEET

The Amendment Record Sheet below records the history and issue status of this document.

ISSUE	DATE	REASON
1.0	12/08/2021	First release: executive summary (section 2) and methods (section 3).
1.1	04/04/2022	Results (section 4) and conclusion (section 5).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Reference documents

The following is a list of reference documents with a direct bearing on the content of this technical note. When referenced in the text, these are identified as [RD-n], where 'n' is the number in the list below:

1.1.1 DEMIX documents

RD-1. DEMIX plenary 17/07/2020 — *CEOS - Working Group Calibration & Validation - Terrain Mapping Sub-Group (TMSG) - DEM Intercomparison eXercise DEMIX*
17 July 2020 (updated 24 July)
Peter Strobl, European Commission, Joint Research Centre (EC-JRC)
Microsoft Teams link

RD-2. P. A. Strobl & al., 2021 — *The Digital Elevation Model Intercomparison eXperiment DEMIX, a community-based approach at global DEM benchmarking*
Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLIII-B4-2021, 395–400
https://doi.org/10.5194/isprs-archives-XLIII-B4-2021-395-2021

RD-3. DEMIX 10k grid — *Proposal for creating a global tiling for DEM benchmarking based on the DGED zonation*
24 June 2021
Peter GUTH
Microsoft Teams link

RD-4. DGIWG 250 — *Defence Gridded Elevation Data - Product Implementation Profile*
edition 1.2.1, 2 October 2020
Defence Geospatial Information Working Group (DGIWG)
http://portal.dgiwg.org/files/71215

1.1.2 Copernicus DEMs

RD-5. Data access — *Data Discovery and Download*
Copernicus Space Component Data Access
https://spacedata.copernicus.eu/fr/web/cscda/data-access/discovery-and-download

RD-6. Product Handbook — *Copernicus Digital Elevation Model Product Handbook version 3.0, 9 November 2020*
Airbus
https://spacedata.copernicus.eu/documents/20126/0/GEO1988-CopernicusDEM-SPE-002_ProductHandbook_I3.0.pdf

RD-7. TD-GS-PS-0021 — *TanDEM-X - Ground Segment - DEM Products Specification Document*
issue 3.1, 05.08.2016
DLR
https://elib.dlr.de/108014/1/TD-GS-PS-0021_DEM-Product-Specification_v3.1.pdf

RD-8. *WorldDEM™ Technical Product Specification - Digital Surface Model, Digital Terrain Model*
version 2.5, April 2019 - Airbus
https://www.intelligence-airbusds.com/automne/api/docs/v1.0/document/download/ZG9jdXRoZXF1ZS1kb2N1bWVudC01NTcyOQ==/ZG9jdXRoZXF1ZS1maWxlLTU1NzI4/WorldDEM_TechnicalSpecificationss_Version2.6-202012.pdf

RD-9. P. Rizzoli & al., 2017 *Generation and performance assessment of the global TanDEM-X digital elevation model*
http://dx.doi.org/10.1016/j.isprsjprs.2017.08.008

RD-10. Validation report *Copernicus DEM Validation Report*
version 3.0, 9 November 2020 - Airbus
https://spacedata.copernicus.eu/documents/20126/0/GEO1988-CopernicusDEM-RP-001_ValidationReport_I3.0.pdf

RD-11. K. Becek & al., 2016 *Evaluation of Vertical Accuracy of the WorldDEM™ Using the Runway Method*
Remote Sens. 2016, 8(11), 934;
https://doi.org/10.3390/rs8110934

RD-12. COPE-PMAN-EOPG-TN-15-0004
Copernicus Space Component Data Access Portfolio: Data Warehouse 2014 – 2020
issue/revision 2.7, 16/12/2019 - ESRIN
https://spacedata.copernicus.eu/documents/20126/0/DAP+Document+-+current+%2810%29.pdf

1.1.3 EU-DEM

RD-13. C4EO17 *EU-DEM Upgrade - Documentation EEA User Manual*
issue 1 revision 2, 14 October 2015 - Indra Systemas
https://land.copernicus.eu/user-corner/technical-library/eu-dem-v1-1-user-guide

RD-14. EU-DEM Validation *EU-DEM Statistical Validation*
August 2014 - DHI GRAS
https://land.copernicus.eu/user-corner/technical-library/eu-dem-v1.0

RD-15. A. Mouratidis & al., 2019 *European Digital Elevation Model Validation against Extensive Global Navigation Satellite Systems Data and Comparison with SRTM DEM and ASTER GDEM in Central Macedonia (Greece)*
ISPRS Int. J. Geo-Inf. 2019, 8, 108.
https://doi.org/10.3390/ijgi8030108

RD-16. W. Augath & al., 2002 *Definition and Realization of Vertical Reference Systems -The European Solution EVRS/ EVRF 2000 -*
https://tu-dresden.de/bu/umwelt/geo/gi/gg/ressourcen/dateien/veroeffentlichungen/european_solution_evrs.pdf?lang=en

RD-17. G. Liebsch & al., 2015 *Unification of height reference frames in Europe*
http://www.euref.eu/documentation/Tutorial2015/t-04-01-Liebsch.pdf

RD-18. J. Ihde & al., 2001 — *The Vertical Reference System for Europe* upgraded version of EUREF Technical Working Group (TWG) meeting in Tromsø, 21.6.2000 http://www.euref.eu/symposia/book2000/P_99_115.pdf

1.1.4 ESA WorldCover

RD-19. WorldCover_PUM_v1.0 — *Product User Manual* version 1.0, 15 October 2020 ESA https://esaworldcover.s3.amazonaws.com/v100/2020/docs/WorldCover_PUM_V1.0.pdf

1.1.5 DEM comparison methods

RD-20. M.A. Sutton & al., 1983 — *Determination of displacements using an improved digital correlation method* Image and Vision Computing, ISSN: 0262-8856, Vol: 1, Issue: 3, Page: 133-139 https://doi.org/10.1016/0262-8856(83)90064-1

RD-21. Dematteis & al., 2021 — *Comparison of digital image correlation methods and the impact of noise in geoscience applications* MDPI, Remote Sens. 2021, 13, 327. https://doi.org/10.3390/rs13020327

RD-22. ITI — *Introduction au Traitement d'Image* Cours S. Riazanoff, University Paris-Est http://www-igm.univ-mlv.fr/~riazano/enseignement/SR-ITI-COURS-02-07.pdf

RD-23. TIG — *Télédétection et Information Géographique* Cours S. Riazanoff, University Paris-Est http://www-igm.univ-mlv.fr/~riazano/enseignement/SR-TIG-COURS-01-21.pdf

1.1.6 Other studies

RD-24. EDAP.REP.029 — *Global DEM quality assessment summary* Issue 1.2, 16/07/2020 – VisioTerra https://visioterra.fr/telechargement/P317_ESA_EDAP/EDAP.REP.029_1.2_Global_DEM_Quality_Assessment_Summary.pdf

RD-25. EDAP.REP.039 — *Copernicus DEMs Quality Assessment Summary* Issue 1.2, 29/07/2021 – VisioTerra https://visioterra.fr/telechargement/P317_ESA_EDAP/EDAP.REP.039_1.2_Copernicus_DEMs_Quality_Assessment_Summary.pdf

1.2 Glossary

The following acronyms and abbreviations have been used in this report.

CEOS	Committee on Earth Observation Satellites
CRS	Coordinate Reference System
DEM	Digital Elevation Model
DEMIX	Digital Elevation Model Intercomparison eXercise
DGED	Defense Gridded Elevation Data
DSM	Digital Surface Model
DTM	Digital Terrain Model

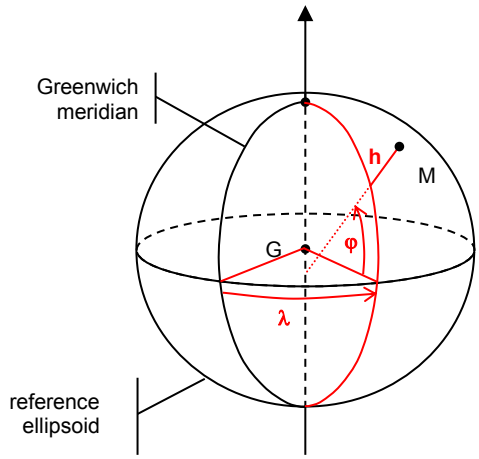
EC-JRC	European Commission Joint Research Centre
EEA	European Economic Area
EEA-10	European Economic Area DEM 0.4''arcsecond (≈10 metres)
EGG08	European Gravimetric Geoid 2008
EGM96	Earth Gravity Model 1996
EGM2008	Earth Gravity Model 2008
EPSG	European Petroleum Survey Group
ESA	European Space Agency
ETRS89	European Terrestrial Reference System 89
EU-DEM	European Digital Elevation Model
EVRS2000	European Vertical Reference System 2000
GeoTIFF	Geocoded Tagged Image File Format
GSD	Ground Sampling Distance
ILM	Inverse Location Model
LAEA	Lambert Azimuthal Equal Area
LULC	Land Use / Land Cover
SAR	Synthetic Aperture Radar
SRTM	Shuttle Radar Topography Mission
TanDEM-X	TerraSAR-X add-on for Digital Elevation Measurements
TMSG	Terrain Mapping Sub-Group
VRS	Vertical Reference System
WGS84	World Geodetic System 1984

1.3 Definitions

The following definitions have been used in this report.

coordinates reference system (CRS)

geographic

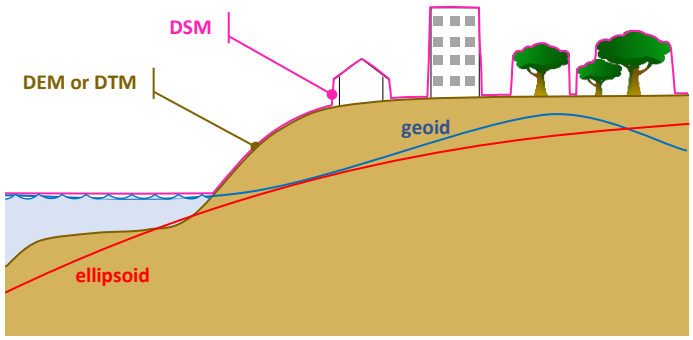


DTM
or
DEM
or
DSM

The "Digital Terrain Model" is also called "Digital Elevation Model" (DEM) or sometimes "Altimetry model". A DEM is a raster data made of a georeferenced grid in which each cell gives an altitude with regard to a geoid (most frequent case) or a height above an ellipsoid.

In maritime parts, the altitudes or elevations may give the sea level (altitude equal to 0 metres above a geoid) or may give the ocean floor (negative values also called bathymetry).

The "Digital Surface Model" (DSM) gives altitudes or heights above overground: building roofs, top of canopy, sea level...

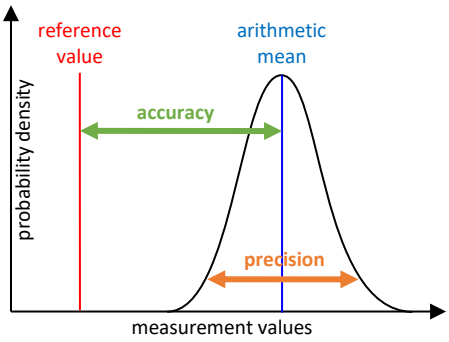


Metrology

accuracy vs. precision

Accuracy measures the closeness of agreement between a measured quantity value and a true quantity value. Distance between the arithmetic mean and the reference value is called the bias.

The precision measures the closeness of agreement between indications or measured quantity values obtained by replicate measurements on the same or similar objects under specified conditions.



See
https://www.bipm.org/utils/common/documents/jcgm/JCGM_200_2012.pdf

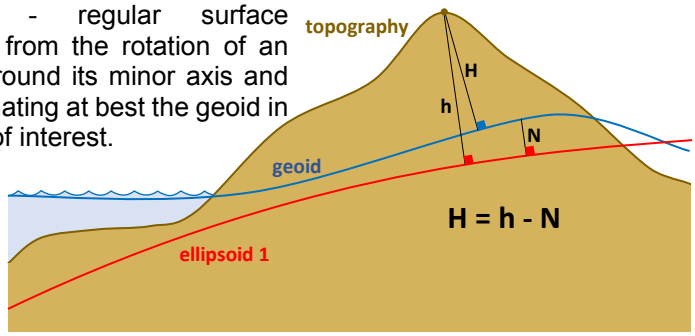
resampling

Change of the ground sampling distance (GRD) of an image by a mathematical transform modifying the size of the pixels. One call "sub-sampling" when the resolution is decreased and "over-sampling" when the resolution is increased.

vertical reference system

There are three types of reference surface:

- topography - being the site of the interface between the solid phase and the gaseous and liquid phases of terrestrial matter;
- geoid - equipotential surface of the acceleration field of gravity (gravity + centrifugal force); the geoid is close to the mean surface of the sea;
- ellipsoid - regular surface resulting from the rotation of an ellipse around its minor axis and approximating at best the geoid in an area of interest.



The heights H with respect to the geoid (also called "altitude") are reference heights for the study of physical phenomena such as runoff. The altitude 0 meters corresponds to the mean sea level.

The heights h with respect to the ellipsoid (also called "elevation") are used for terrestrial modelling and in particular for orthorectification with respect to a reference ellipsoid (often WGS84).

2. EXECUTIVE SUMMARY

This study aims to compare two European DEMS: EU-DEM v1.1 and Copernicus DEM EEA-10 release 2021_1. As these two DEMs have different CRS and sampling distances, they should be resampled in order to be overlapped correctly. These reprojections offer the opportunity to assess different sampling methods (nearest neighbour, bi-linear and bi-cubic) as well as their effect on DEM difference statistics.

This comparison exercise (study 1) is performed on 38 European countries, selecting for each country a tile of approximately 10 km x 10 km. These tiles have been chosen in a grid predefined by the DEMIX (DEM Intercomparison eXercise) group.

A first global differences study aims to compute the difference between resampled instances of EU-DEM and EEA-10. A particular attention is given to the resampling methods and their impact on the difference statistics. At the end of study 1, the bilinear resampling method appears to be the best.

This bi-linear interpolation having been chosen, the quality of DEM superimposition (planimetric accuracy) is measured performing a “disparity analysis” in study 2. This method is used in photogrammetry by searching for each point of Copernicus DEM EEA-10 a homologous point in EU-DEM. These pairings produce a field of error vectors which may depend on the land use / land cover but also on the source of the elevation values. Nominally, Copernicus DEM EEA-10 and EU-DEM have respectively been generated from TanDEM-X and SRTM data. However, most recent versions of these DEMs show areas filled with other DEMs. These other sources have an impact on statistics and on the quality of the planimetric superimposition of the two DEMs.

Study 1: The overall results of the global differences highlight **low statistics variations between the nearest neighbour, bi-linear and bi-cubic resampling methods**. However, the **best results are obtained with the bi-linear resampling method**, retrieving a mean of -0.55 m, a standard deviation of 9.02 m and a RMSE of 9.04 m. The worst results are obtained with the nearest neighbour resampling method, with a mean of -0.55 m, a standard deviation of 9.37 m and a RMSE of 9.38 m (see section 5.1.1). **As a consequence, the bilinear resampling is used to perform the disparity analysis study.**

Study 2: Considering all the DEMIX tiles, the disparity analysis shows a low displacement mean of 0.345 pixels in the x-axis, and -0.352 pixels in the y-axis. However, high standard deviations are retrieved, reaching 5.688 pixels for dX, and 5.498 pixels for dY. The norms of displacement mean reaches 6.985 pixels, with a standard deviation of 3.746 pixels. This norm shows that **high displacements are retrieved between EU-DEM and EEA-10** (see section 5.2.1). Individual DEMIX tiles highlight major uniform displacements (see section 0), dependency of displacements on land use / land cover (see section 5.2.3) and on DEM source data (see section 5.2.4).

3. STUDY METHODS

These sections describe the methods that will be applied in next section (section 4).

3.1 Study overview

EU-DEM and Copernicus DEM EEA-10 exhibit major differences in their representations:

- Coordinate Reference System:
  - **EU-DEM** - Lambert Azimuthal Equal Area - ETRS89-LAEA (EPSG:3035)
  - **Copernicus DEM EEA-10** – DGED Geographic – EPSG:4326
- Sampling distance:
  - **EU-DEM** – 25 metres
  - **Copernicus DEM EEA-10** – 0.4'' x 0.4'' ([0°,50°] in latitude), 0.6'' x 0.4'' ([50°,60°] in latitude), 0.8'' x 0.4'' ([60°,70°] in latitude), 1.2'' x 0.4'' ([70°,75°] in latitude)
- Vertical Reference System:
  - **EU-DEM** – EVRS2000 – EGG08
  - **Copernicus DEM EEA-10** – EGM2008

Each one of these differences will be taken into account to set the two DEMs in the same CRS **DGED Geographic** (EPSG:4326), at **2/3'' arcsecond** (approximately 20 metres along vertical) and with elevations given above **EGM2008**.

As shown in Figure 1, the national tiles will be reprojected in the planimetric and vertical reference system with the specified sampling distance by using three interpolation methods (see RD-22): nearest neighbour (NN) – bi-linear (BL) – bi-cubic (BC).

For each national tile, the differences between the two DEMs will be analysed by multiplexing the computation by the 3 x 3 sampling methods, i.e., by computing the 9 differences between EU-DEM-NN and EEA-10-NN, EU-DEM-NN and EEA-10-BL, EU-DEM-NN and EEA-10-BC, EU-DEM-BL and EEA-10-NN…

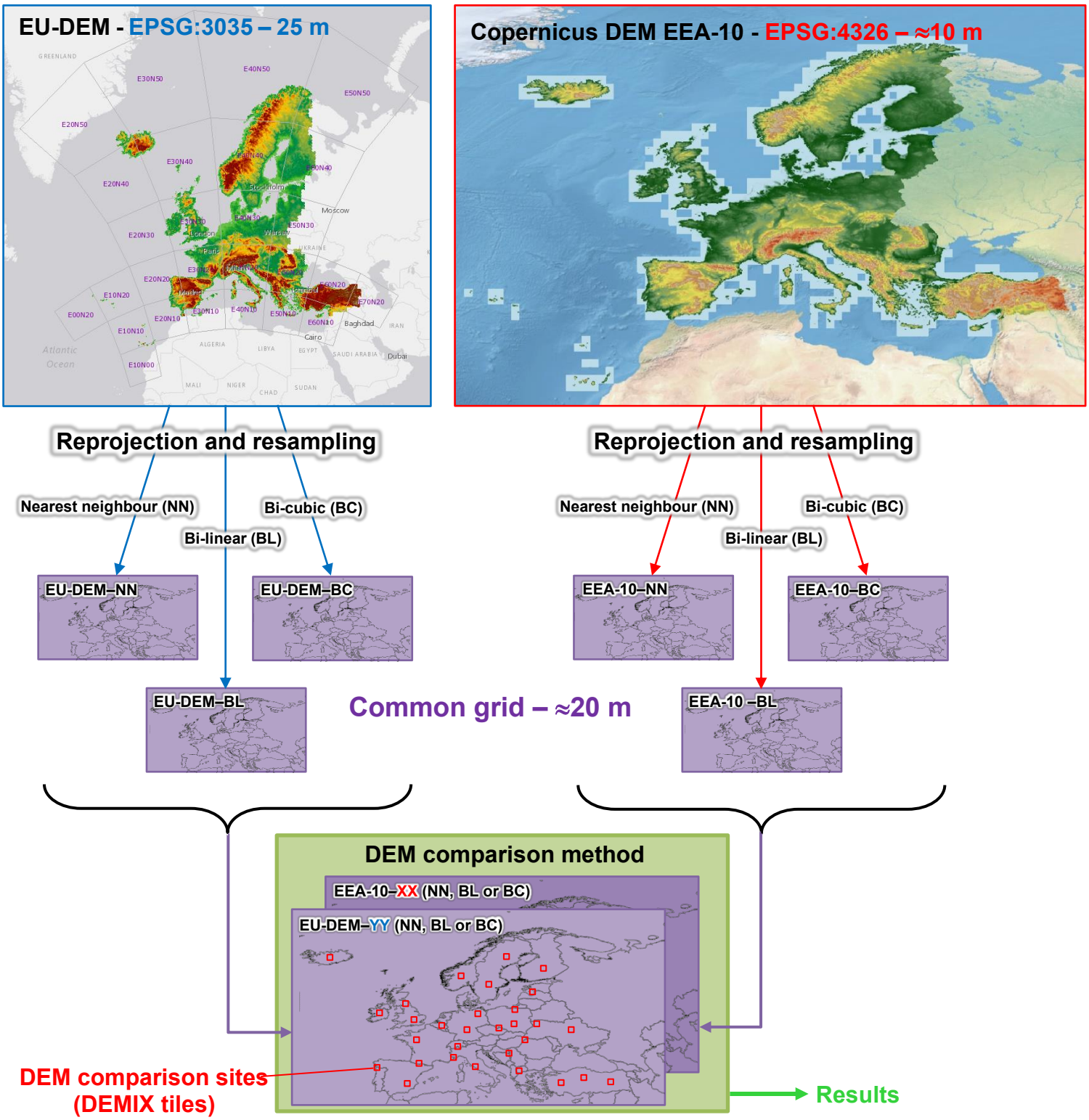


Figure 1 – Overview of the study.

3.2 Resampling methods

As illustrated in section 3.1, the compared DEMs do not share the same CRS and spatial resolution. Consequently, this section aims to present the different methods used to resample DEMs to a common grid (RD-23).

In the next subsections, the following variables are considered:

- DEM_{src} is the source DEM of width w_{src} and height h_{src}. All the resampling methods described in the following subsections rely on the heights of this source DEM,
- DEM_{dst} is the resampled destination DEM of width w_{dst} and height h_{dst}. The heights of the resampled destination DEM are retrieved using resampling methods described in the following subsections,
- (x, y) correspond to the resampling coordinates. These coordinates are **real** and contained in the source DEM image coordinates bounds (i.e., $(x, y) \in [0, w_{src} - 1] \times [0, h_{src} - 1]$),
- (i, j) correspond to the source DEM image coordinates. These coordinates are **integer** and contained in the source DEM image coordinates bounds (i.e., $(i, j) \in [\![0, w_{src} - 1]\!] \times [\![0, h_{src} - 1]\!]$).
- (I, J) correspond to the resampled destination DEM image coordinates. These coordinates are **integer** and contained in the resampled destination DEM image coordinates bounds (i.e., $(I, J) \in [\![0, w_{dst} - 1]\!] \times [\![0, h_{dst} - 1]\!]$).

The (x, y) coordinates are obtained using an **Inverse Location Model (ILM)** applied to the (I, J) coordinates, as illustrated in the following figure.

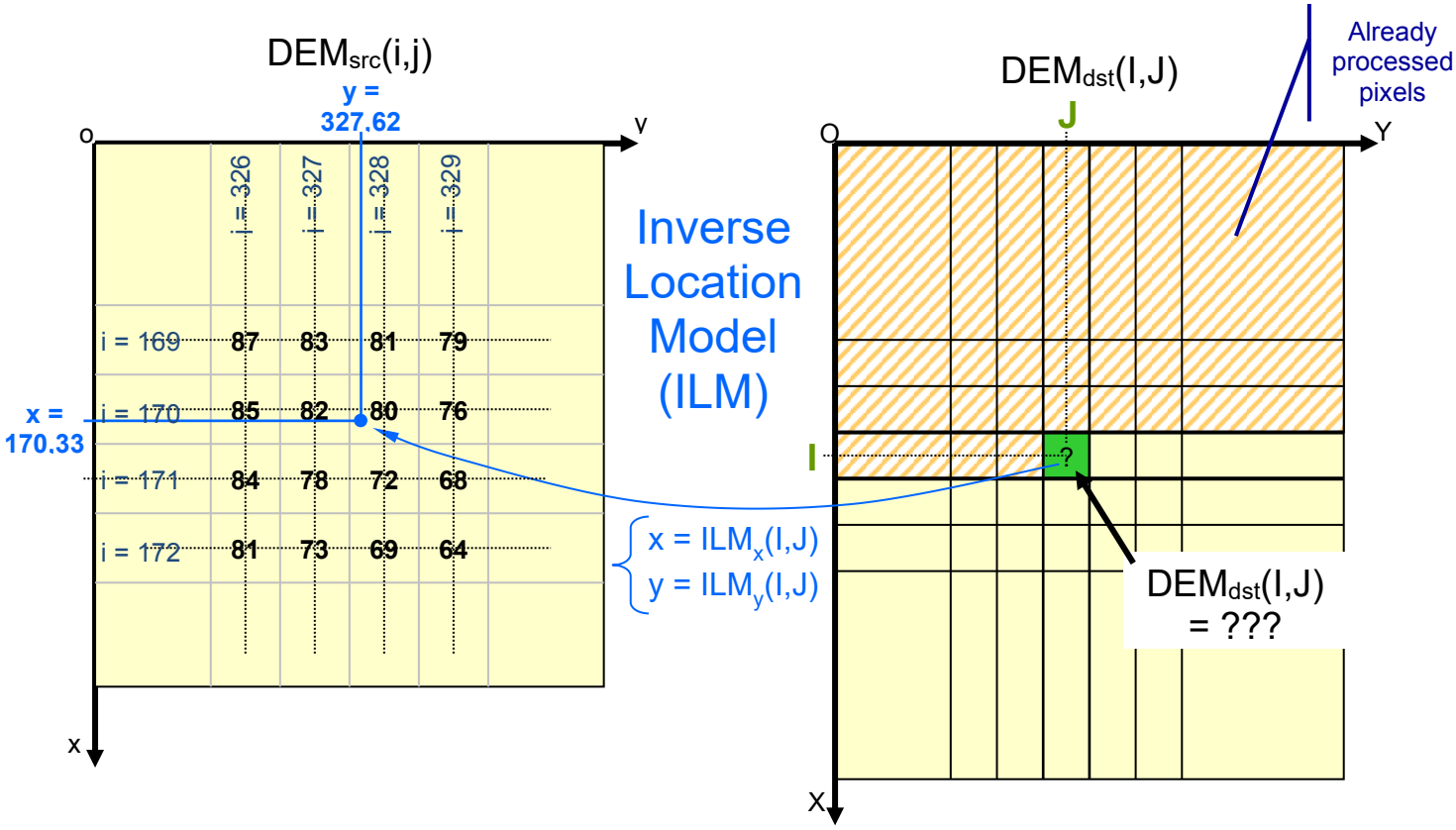
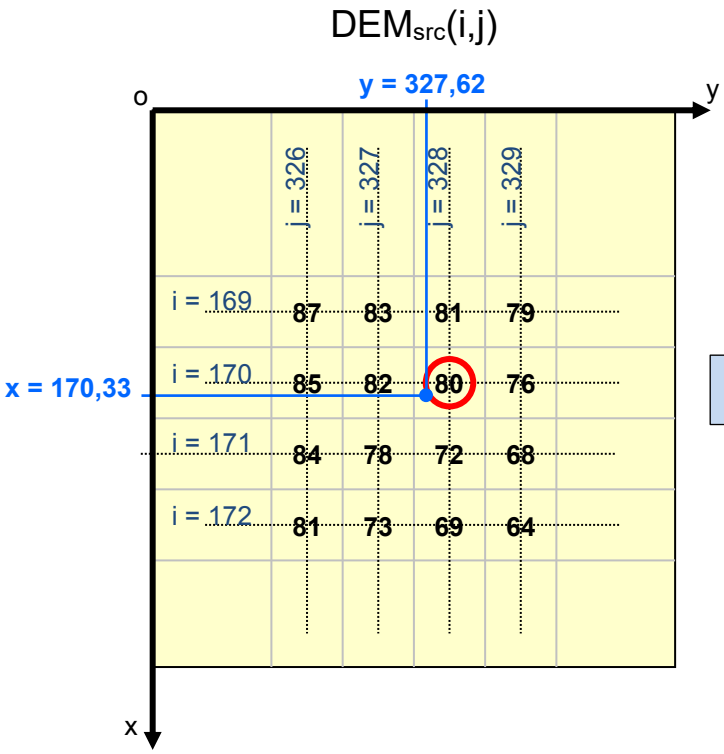


Figure 2 – Principle of the Inverse Location Model.

3.2.1 Nearest neighbour (NN)

This section presents the **nearest neighbour resampling method**.

Given (x, y) *resampling coordinates*, a *resampled destination DEM* height is retrieved considering only one *source DEM* height. For this method, the closest *source DEM* height to the (x,y) *resampling coordinates* is considered, as illustrated in the following figure.



$$DEM_{res}(I,J) \leftarrow DEM_{src}[round(x), round(y)]$$

Figure 3 – Nearest neighbour interpolation principle.

In Figure 3, a height value is sampled on a source DEM at image coordinates (x=170.33, y=327.62). The value 80 is considered for this resampling *(source DEM image coordinates* (i=170, j=328)), because it is the closest pixel to the (x=170.33, y=327.62) *resampling coordinates*.

3.2.2 Bi-linear (BL)

This section presents the **bi-linear resampling method**.

Given (x, y) *sampling coordinates*, a *resampled DEM* height is retrieved considering four *source DEM* heights. For this method, the four *source DEM* height neighbours to the (x,y) *resampling coordinates* are considered, as illustrated in the following figure.

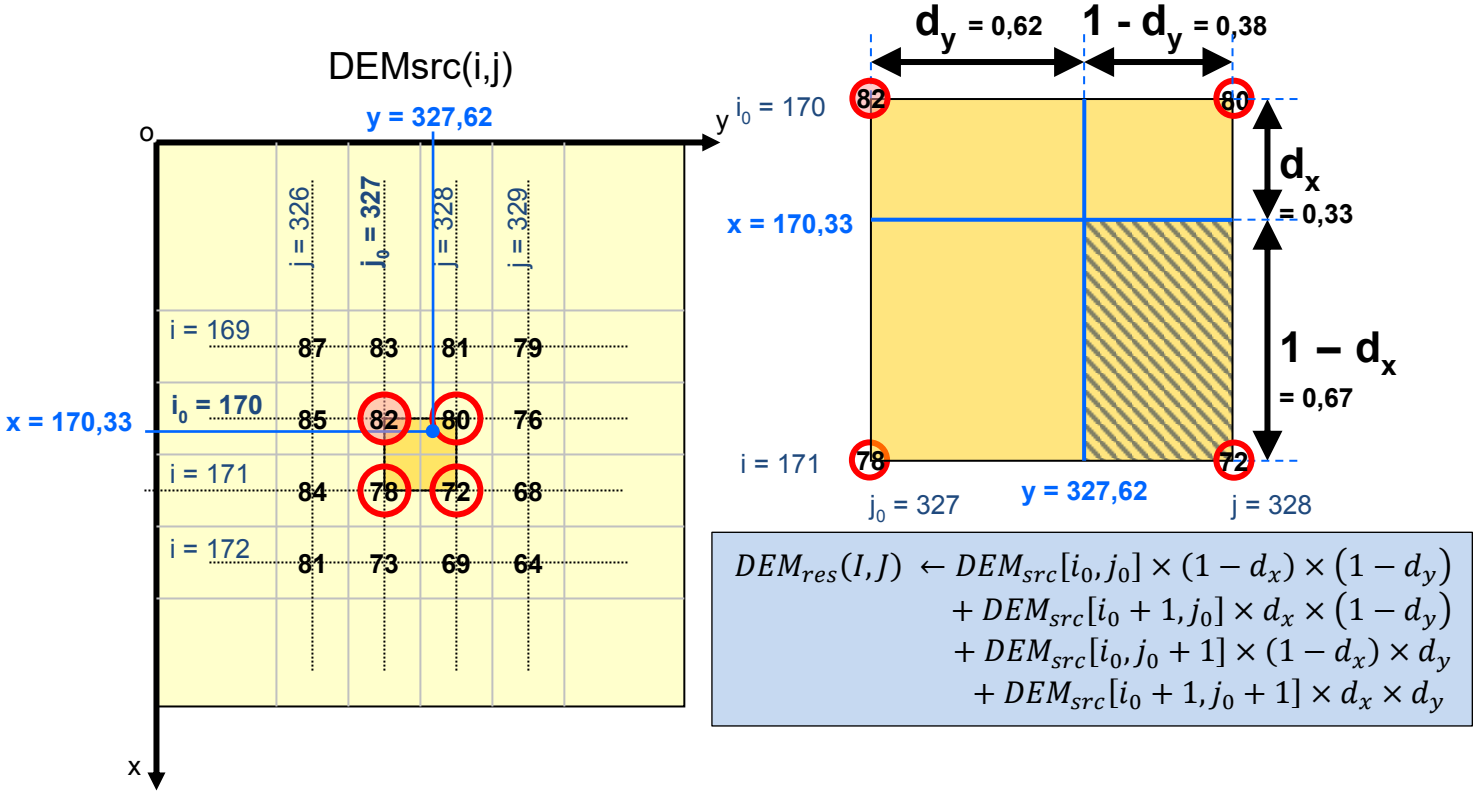


Figure 4 – Bi-linear interpolation principle.

In Figure 4, a height value is sampled on a source DEM at image coordinates (x=170.33, y=327.62). The four red encircled height values of the *source DEM* are considered for this resampling, because they are the four neighbours of the (x=170.33, y=327.62) *resampling coordinates*.

3.2.3 Bi-cubic (BC)

This section presents the **bi-cubic resampling methods**. The different bi-cubic resampling depend on the w_i functions that give the weight of the 4 x 4 nearest neighbours according to their distance d to the *resampling coordinates* (x, y). These functions are 3rd degree polynomials solutions of the equation with the following constraints:

- $w_i(0) = 1$
- $w_i(1) = 0$ and the same for the symmetry versus vertical axis $w_i(-1) = 0$
- $w_i(2) = 0$ and the same for the symmetry versus vertical axis $w_i(-2) = 0$
- $w'_i(1) = t \in]-\infty,0[$ and $w'_i(-1) = -t \in]0,+\infty[$

Parameter t discriminates between the different bi-cubic functions leading to more or less Laplacian effect. For example, $w'_1(1) = -1$ leads to edge enhancement sharper than $w'_3(1) = -1/2$.

Given (x, y) *sampling coordinates*, a *resampled DEM* height is retrieved considering sixteen *source DEM* heights. For this method, the sixteen *source DEM* height neighbours to the (x,y) *resampling coordinates* are considered, as illustrated in the following figure.

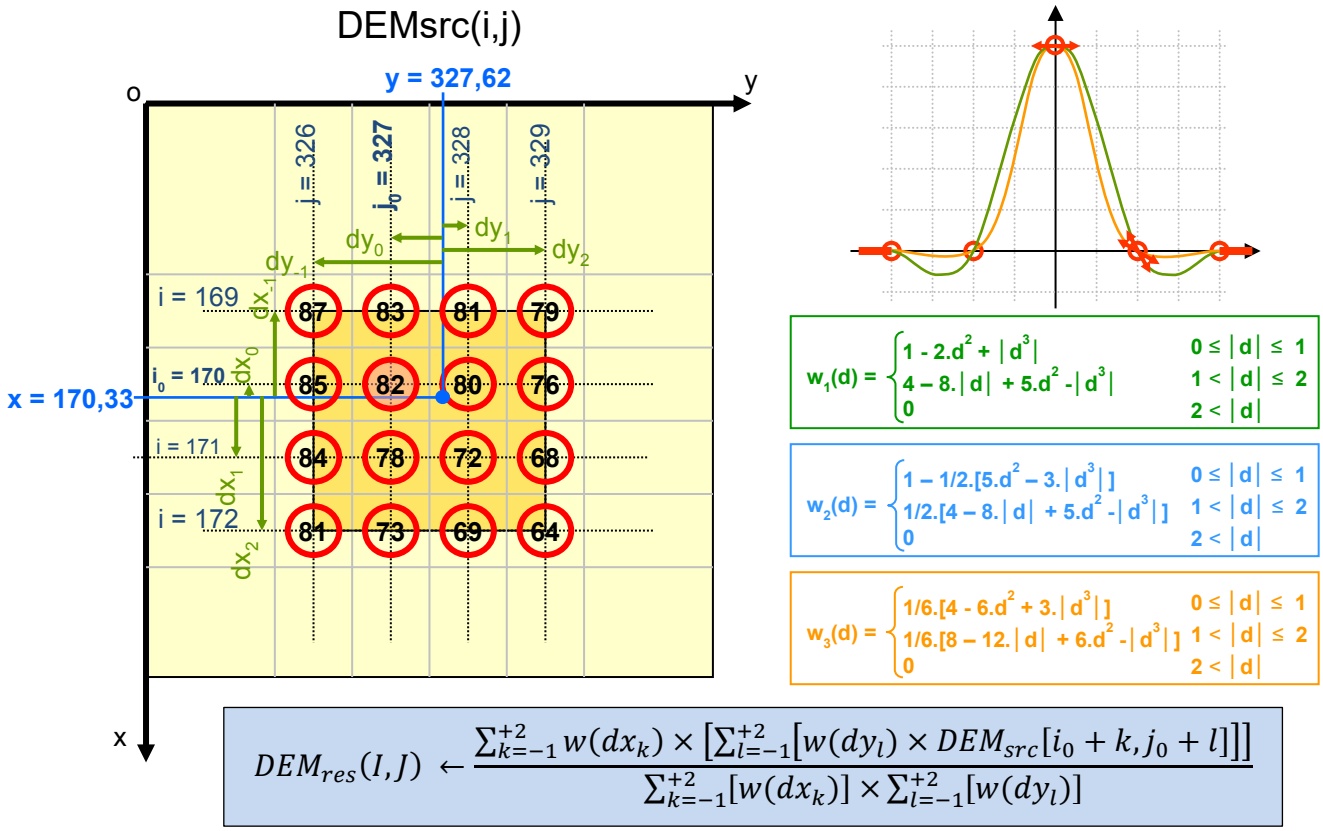


Figure 5 – Bi-cubic interpolation principle.

In Figure 5, a height value is sampled on a source DEM at image coordinates (x=170.33, y=327.62). The sixteen red encircled height values of the *source DEM* are considered for this resampling, because they are the sixteen neighbours of the (x=170.33, y=327.62) *resampling coordinates*.

3.3 Study tiles

Resampled DEMs are compared on specific areas, entitled study tiles, following the DEMIX grid and tile specifications (version 0.8). This section aims to present these specifications, as well as giving an exhaustive list of study tiles used in DEM comparisons.

3.3.1 DEMIX grid

The DEMIX grid is a tiling structure created to be suitable for DEM intercomparisons. The goal of the DEMIX grid is to provide a global division of ~10 km per 10 km tiles (entitled DEMIX tiles). The DEMIX grid is based on the DGED standard (see RD-3), which globally ensures, as much as possible, a comparable sampling distance in longitude and latitude. The spacing of the DGED grid is given in the following table.

Zone	Zone latitudes (North - South)	Latitude spacing	Longitude spacing
1	0° - 50°	r	r
2	50° - 60°	r	1.5 * r
3	60° - 70°	r	2 * r
4	70°- 80°	r	3 * r
5	80° - 85°	r	5 * r
6	85° - 90°	r	10 * r

Table 1 – DGED spacing per zone.

As illustrated in Table 1, the longitude spacing of the DGED standard depends on the latitude of each tile. Following a similar principle, the DEMIX grid specifies 1°x1° cells subdivisions, ensuring each DEMIX tile surface should approximate 100 km² (10x10 km). The exact specification of the DEMIX grid is given in the following table.

Zone	Zone latitudes (North - South)	Longitude spacing [arcmin]	Number of tiles in Lon per 1° cell	Latitude spacing [arcmin]	Number of tiles in Lat per 1° cell	max extent in x [km]	min extent in x [km]
1	0° - 50°	6	10	6	10	11,1	7,2
2	50° - 60°	10	6	6	10	12,0	9,3
3	60° - 70°	12	5	6	10	11,2	7,6
4	70°- 80°	20	3	6	10	12,7	6,5
5	80° - 85°	30	2	6	10	9,7	4,9
6	85° - 90°	60	1	6	10	9,7	0,0

Table 2 – DEMIX grid specification.

The DEMIX grid follows a specific tile naming convention, defined as the following:

[N,S]yy[M,P,Q,R,T,U,V,X,Y,Z]
[W,E]xxx[A,B,C,D,F,G,H,J,K,L]

Where:

- [N,S] corresponds to the cardinal direction in latitude,
- yy is the absolute latitude of the 1°x1° tile,
- [M,P,Q,R,T,U,V,X,Y,Z] is the y coordinate of the DEMIX tile (within the 1°x1° tile)
- [W,E] corresponds to the cardinal direction in longitude,
- xxx is the absolute longitude of the 1°x1° tile,
- [A,B,C,D,F,G,H,J,K,L] is the x coordinate of the DEMIX tile (within the 1°x1° tile)

The following figure illustrates an example of DEMIX tile naming.

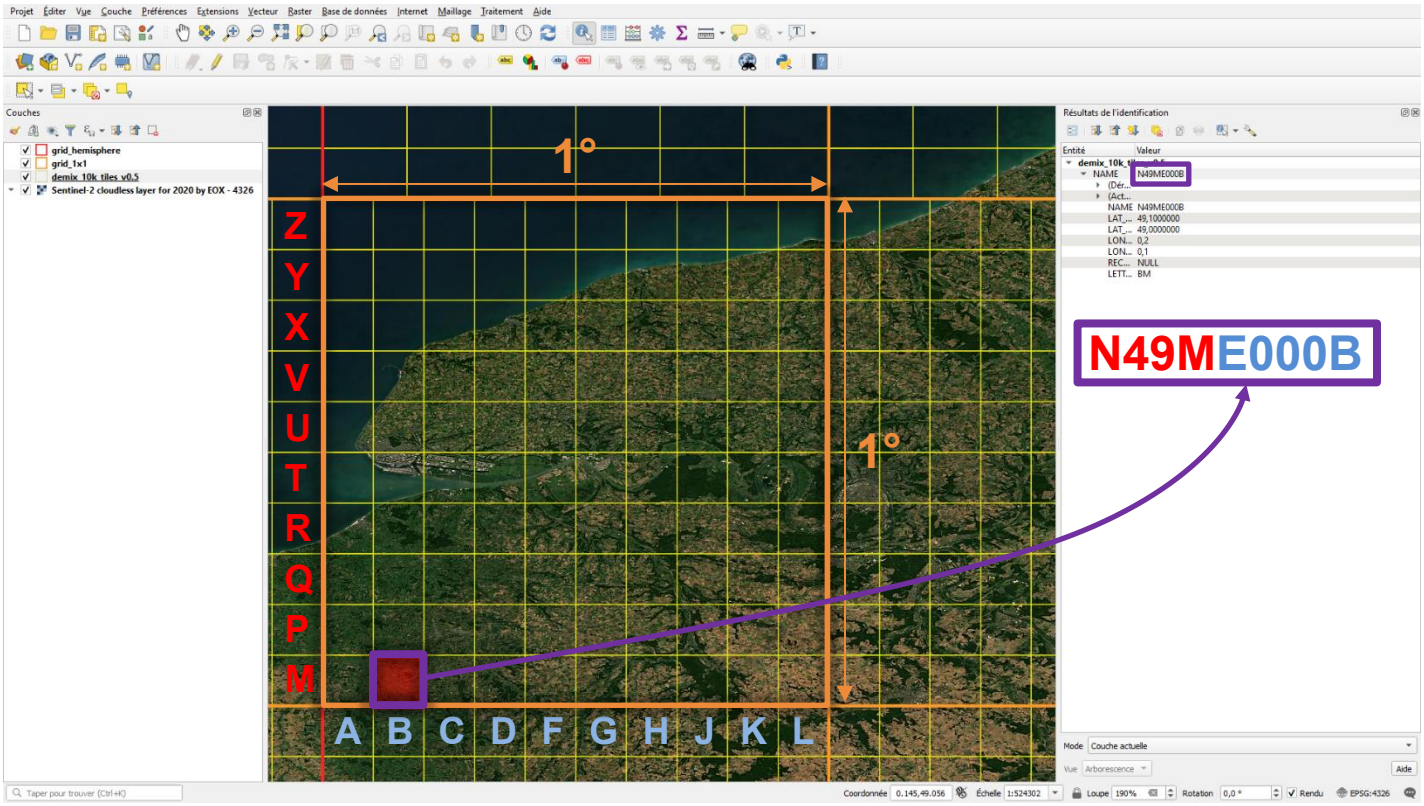


Figure 6 – Coordinates of the DEMIX grid – the N49ME000B DEMIX tile.

3.3.2 DEMIX tiles

Following the DEMIX grid coordinates, 38 DEMIX tiles have been chosen as EU-DEM/ EEA-10 comparison areas. These DEMIX tiles are identified in the following figure (entitled as "**Country – DEMIX tile**").

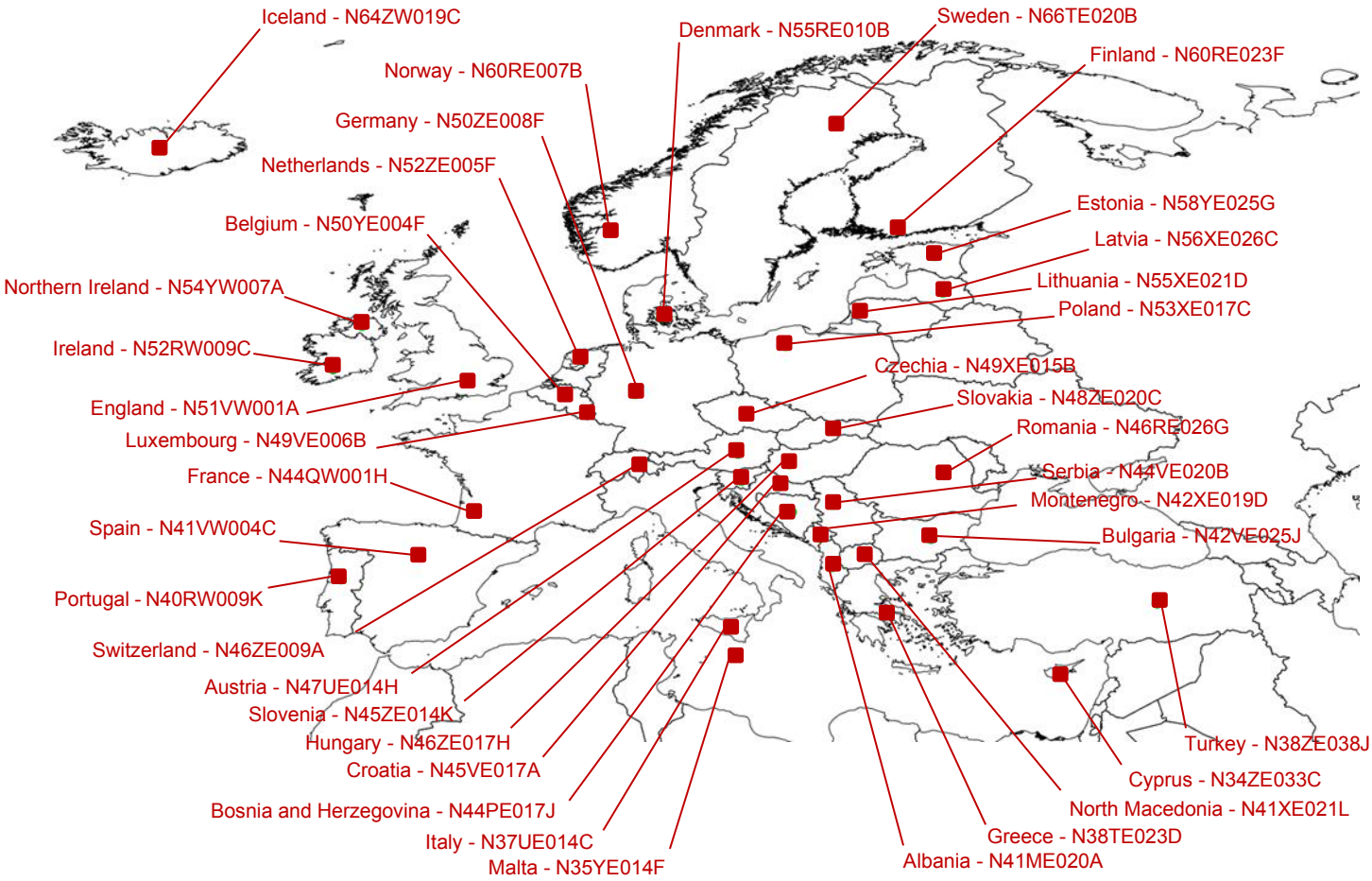


Figure 7 – 38 DEMIX tiles considered for EUDEM/EEA-10 comparisons.

The horizontal resolution (GSD_x) of these tiles varies according to the DEMIX grid. The relation between GSD_X and the zones of the DEMIX grid over Europe is summarized by the following figure.

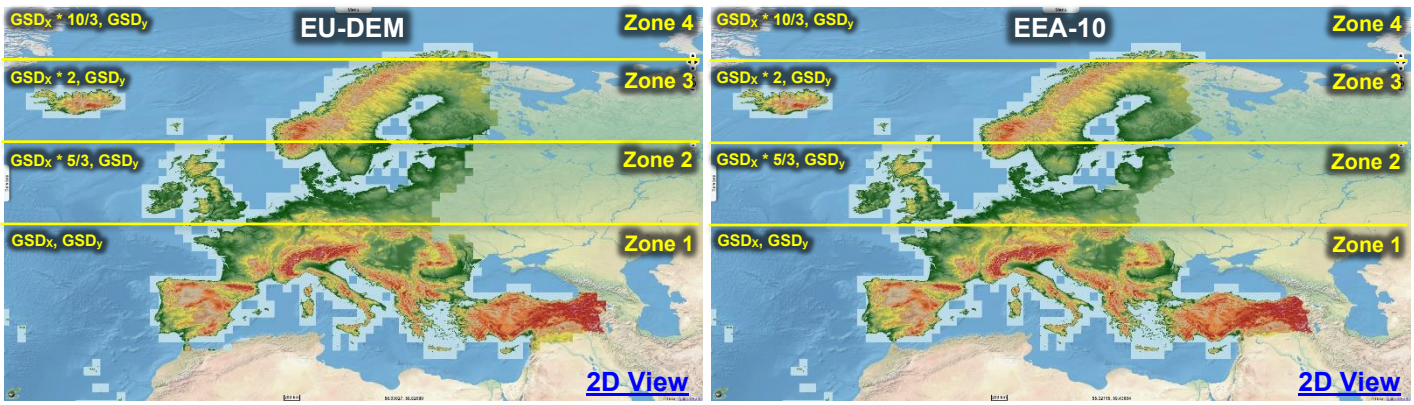


Figure 8 – DEMIX grid zones over EU-DEM (reprojected to EPSG:4326) and EEA-10.

3.4 Comparison methods

3.4.1 Method 1 – Global differences

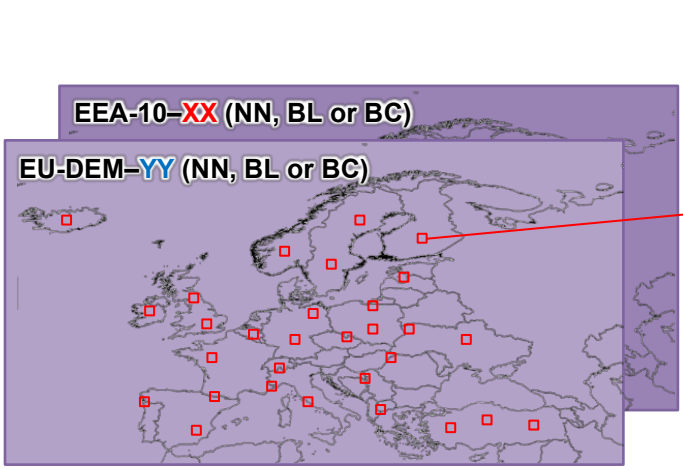
3.4.1.1 Scope

The **global differences** are the means of computing the pixelwise difference between a work image and a reference image, resulting in a differences image. From the resulting image, statistics may be computed, such as the arithmetic mean, standard deviation and RMSE of the differences.

This technique can be used to compute height difference statistics between a work DEM and a reference DEM (respectively EU-DEM and EEA-10 in this study). As explained in section 3.3.2, this DEM comparison is not performed over the spatial extent of each DEM, but over **38 DEMIX tiles**.

3.4.1.2 Principle

The work DEM and the reference DEM images are cropped over their mutual intersection area. Then, the pixelwise difference between work DEM and reference DEM is computed, retrieving a height difference for each common pixel. Finally, height difference statistics and histogram are processed.

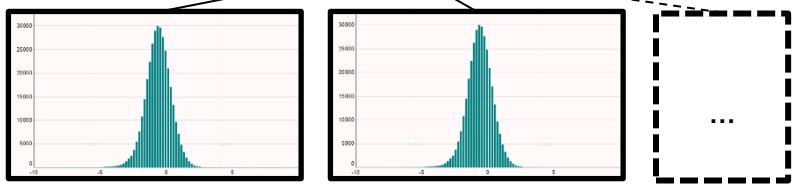


0.57 m	4.42 m	0.25 m	0.34 m	0.15 m	…
0.63 m	0.38 m	0.43 m	0.70 m	1.80 m	…
0.57 m	1.42 m	2.25 m	2.34 m	1.48 m	…
2.74 m	1.57 m	10.25 m	1.34 m	1.15 m	…
1.43 m	1.02 m	1.25 m	1.34 m	1.59 m	…
…	…	…	…	…	…

(EEA-10–XX - EU-DEM–YY) over DEMIX tile Z

EEA-10 / EU-DEM	Nearest neighbour (NN)	Bi-linear (BL)	Bi-cubic (BC)
Nearest neighbour (NN)	Mean = … RMSE = … …	Mean = … RMSE = … …	Mean = … RMSE = … …
Bi-linear (BL)	Mean = … RMSE = … …	Mean = … RMSE = … …	Mean = … RMSE = … …
Bi-cubic (BC)	Mean = … RMSE = … …	Mean = … RMSE = … …	Mean = … RMSE = … …

DEM height difference statistics over DEMIX tile Z



EEA-10-NN – EU-DEM-NN EEA-10-NN – EU-DEM-BL

DEM height difference histograms over DEMIX tile Z

Figure 9 – Global differences principle.

As illustrated in Figure 9, height difference statistics and histogram are computed between each resampled DEM instance of EU-DEM and Copernicus DEM EEA-10.

3.4.1.3 Algorithm

The algorithm described hereafter is generic, computing the difference between a work DEM and a reference DEM over their bounding box intersection. We assume that reference and work DEMs are on a common grid, i.e., in the same planimetric coordinates reference system (CRS), with the same pixel spacing and with upper-left origin being multiple of the grid sampling distance.

This algorithm is also suitable for processing the difference of DEMs over DEMIX tiles. Therefore, the input reference DEM and work DEM are respectively resampled instances of Copernicus DEM EEA-10 and EU-DEM, cropped over a specific DEMIX tile.

Input

Let	$DEM_{reference}$	be the reference DEM
	DEM_{work}	be the work DEM
	(UL_X, UL_Y, LR_X, LR_Y)	be the bounding box of the reference DEM
	(ul_X, ul_Y, lr_X, lr_Y)	be the bounding box of the work DEM
	$(grid\_size_X, grid\_size_Y)$	be the horizontal and vertical pixel size of the grid
	min_histogram	be the minimum value of the height difference histogram
	max_histogram	be the maximum value of the height difference histogram
	nb_bins	be the number of bins of the height difference histogram

Output

histogram[nb_bins]	histogram of DEM differences
count	number of DEM differences
min	minimum DEM difference value
max	maximum DEM difference value
mean	mean of DEM differences
stdev	standard deviation of DEM differences
rmse	RMSE of DEM differences

Pseudo-code

Initialise output variables
count ← +∞
min ← +∞
max ← +∞
mean ← +∞
stdev ← +∞
rmse ← +∞

Compute the bounding box of the overlay between reference and work DEM in geodetic CRS
$overlay\_UL_X \leftarrow \max(UL_X, ul_X)$
$overlay\_UL_Y \leftarrow \min(UL_Y, ul_Y)$
$overlay\_LR_X \leftarrow \min(LR_X, lr_X)$
$overlay\_LR_Y \leftarrow \max(LR_Y, lr_Y)$
if $((overlay\_UL_X > overlay\_LR_X)$ or $(overlay\_UL_Y < overlay\_LR_Y))$ then
   No overlay
   Exit
endif

Compute the bounding box of the overlay between reference and work DEM in reference image CRS
$L_{start} \leftarrow (UL_Y - overlay\_UL_Y) / grid\_size_Y$
$L_{stop} \leftarrow (UL_Y - overlay\_LR_Y) / grid\_size_Y$
$P_{start} \leftarrow (overlay\_UL_X - UL_X) / grid\_size_X$
$P_{stop} \leftarrow (overlay\_LR_X - UL_X) / grid\_size_X$

Initialise the reference to work translation in pixels
$reference\_to\_work_L \leftarrow (ul_Y - UL_Y) / grid\_size_Y$
$reference\_to\_work_P \leftarrow (ul_X - UL_X) / grid\_size_X$

Initialise statistics and histogram computation variables
difference_count ← 0

```
difference_sum ← 0
square_difference_sum ← 0
histogram_step ← nb_bins / (max_histogram - min_histogram)

Loop on lines of the overlay area
L_reference ← L_start
while (L_reference < L_stop) do
   L_work ← L_reference + reference_to_work_L

   Loop on pixels of the overlay area
   P_reference ← P_start
   while (P_reference < P_stop) do
      P_work ← P_reference + reference_to_work_P

      Check if reference and work pixels are not background or sea
      if(is_valid(P_work) and is_valid(P_reference)) then

         Add DEM difference to statistics and histogram
         DEM_difference ← DEM_work[L_work,P_work] - DEM_reference[L_reference,P_reference]
         difference_count ← difference_count + 1
         difference_sum ← difference_sum + DEM_difference
         square_difference_sum ← square_difference_sum + DEM_difference * DEM_difference
         histogram_bin ← (DEM_difference - min_histogram) / histogram_step
         histogram[histogram_bin] ← histogram[histogram_bin] + 1
      endif
      P_reference ← P_reference + 1
   enddo
   L_reference ← L_reference + 1
enddo
count ← difference_count
min ← min_tmp
max ← max_tmp
mean ← difference_sum / count
stdev ← √(square_difference_sum / count - mean * mean)
rmse ← √(square_difference_sum / count)
```

3.4.2 Method 2 – Disparity analysis

3.4.2.1 Scope

The **disparity analysis** is the means of matching two images to find for any point of a reference image the homologous point in an image to be analysed called the work image. This technique is the one used in particular to pair two stereoscopic views to compute a value in the third dimension by photogrammetry technics.

This disparity analysis can be used in quality control applications to map the deformations of a work DEM to be analysed against a reference DEM.

3.4.2.2 Principle

3.4.2.2.1 Pixel analysis

The search for the homologous points is performed for each pixel or for a series of points regularly spaced according to a hexagonal structure in the overlap zone between the two DEMs (see RD-20 and RD-21 for the basis of the disparity analysis).

For each point (L_R,P_R) to be processed in the reference image, its homologous point [$dL(L_R,P_R)$,$dP(L_R,P_R)$] is searched for in the working DEM by testing the correlation at each point within an exploration window (e_X x e_Y) centred around the position (L_W,P_W) assumed in the working image. If the two DEMs are on a common grid, the assumed position is simply predicted by transforming the coordinates from the geodetic CRS to the image CRS. If a common grid is not used, the values of the working DEM are reprojected into the grid of the reference DEM.

For each position (dL,dP) in the exploration window, the linear correlation coefficient (also called Pearson coefficient) r(dL,dP) is computed according to the following equations.

$$r(dL,dP) = \frac{Cov\left(DEM_R(L_R,P_R), DEM_W(L_W+dL, P_W+dP)\right)}{\sigma_R(L_R,P_R) \times \sigma_W(L_W+dL, P_W+dP)} \quad \text{(eq. 1)}$$

$$Cov\left(DEM_R(L_R,P_R), DEM_W(L_W+dL, P_W+dP)\right) = \sum_{k=-s_Y/2}^{+s_Y/2} \sum_{l=-s_X/2}^{+s_X/2} [DEM_R(L_R+k, P_R+l) \times DEM_W(L_W+dL+k, P_W+dP+l)] \quad \text{(eq. 2)}$$

$$\sigma_R(L_R,P_R) = \sqrt{\frac{1}{s_X \times s_Y} \sum_{k=-s_Y/2}^{+s_Y/2} \sum_{l=-s_X/2}^{+s_X/2} [DEM_R(L_R+k, P_R+l)]^2 - \left[\frac{1}{s_X \times s_Y} \sum_{k=-s_Y/2}^{+s_Y/2} \sum_{l=-s_X/2}^{+s_X/2} DEM_R(L_R+k, P_R+l)\right]^2} \quad \text{(eq. 3)}$$

$$\sigma_W(L_W+dL, P_W+dP) = \sqrt{\frac{1}{s_X \times s_Y} \sum_{k=-s_Y/2}^{+s_Y/2} \sum_{l=-s_X/2}^{+s_X/2} [DEM_W(L_R+dL+k, P_R+dP+l)]^2 - \left[\frac{1}{s_X \times s_Y} \sum_{k=-s_Y/2}^{+s_Y/2} \sum_{l=-s_X/2}^{+s_X/2} DEM_W(L_R+dL+k, P_R+dP+l)\right]^2} \quad \text{(eq. 4)}$$

Where:

- $r(dL,dP)$ is the linear regression coefficient computed at position (dL,dP) in the exploration window, i.e. between the correlation window around (L_R,P_R) of the reference DEM and the correlation window around (L_W+dL,P_W+dP) of the work DEM,
- $Cov(R,W)$ is the covariance computed around (L_R,P_R) of the reference DEM and (L_W+dL,P_W+dP) of the work DEM,
- $\sigma_R(L_R,P_R)$ is the standard deviation computed within a correlation window (s_X x s_Y) around (L_R,P_R) in the reference DEM,
- $\sigma_W(L_W+dL, P_R+dP)$ is the standard deviation computed within a correlation window (s_X x s_Y) around (L_W+dL,P_R+dP) in the work DEM.

The disparities in rows dL(L_R,P_R) and columns dP(L_R,P_R) match the maximum of correlation found in the exploration window.

$$[dL(L_R,P_R); dP(L_R,P_R)] = Arg_{\substack{dL=-\frac{e_X}{2}\ldots+\frac{e_X}{2} \\ dP=-\frac{e_Y}{2}\ldots+\frac{e_Y}{2}}} [Max\{r(dL,dP)\}] \quad \text{(eq. 5)}$$

These disparities are computed for all the points (L_R,P_R) in the overlay area of the two DEMs leading to an “error vector field” shown in blue in Figure 10. The displacement values $dL(L_R,P_R)$ and $dP(L_R,P_R)$ and the linear correlation coefficient $r(L_R,P_R) = Max\{r(dL,dP)\}$ are stored in three images in output.

A “radial error” is computed as the norm of the “displacement vector”.

$$norm(L_R,P_R) = \sqrt{[dL(L_R,P_R)]^2 + [dP(L_R,P_R)]^2} \quad \text{(eq. 6)}$$

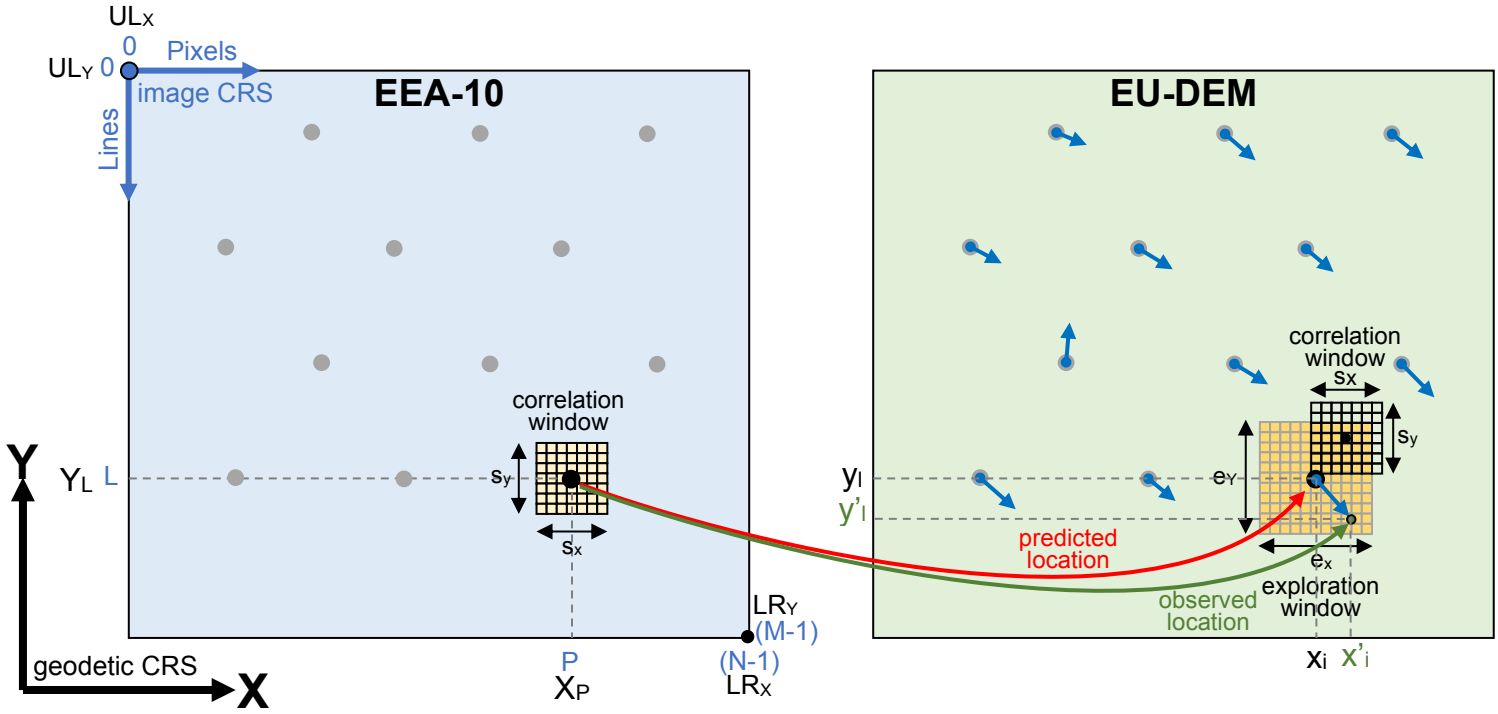


Figure 10 – Disparity analysis principle.

3.4.2.2.2 Sub-pixel analysis

The sub-pixel analysis is an additional step of the pixel analysis. This analysis is computed for each pixel of the reference and work DEM, after an integer pixel displacement has been computed (see previous section 3.4.2.2.1).

Given a reference DEM pixel $P_{ref}=(L_R,P_R)$ and its homologous work DEM pixel $P_{work} = [dL(L_R,P_R);dP(L_R,P_R)]$, a sub-pixel displacement can be estimated within the 4 facets around P_{work}. A paraboloid surface is computed (see Figure 11 below) that interpolates the 3x3 linear regression coefficients. The vertical distances between the 9 linear coefficients and this surface is minimized according to least square minimisation method.

$$r(x,y) = a.x^2 + b.y^2 + c.xy + d.x + e.y + f \qquad \text{(eq. 7)}$$

Where:

- x — is horizontal coordinate (longitude or easting) in the geodetic coordinates reference system. For geocoded images, this coordinate is given by $x = UL_X+PxGSD_w$ (pixel width).
- y — is vertical coordinate (latitude or northing) in the geodetic coordinates reference system. For geocoded images, this coordinate is given by $y = UL_Y-LxGSD_h$ (pixel height).
- r(x,y) — is the linear regression coefficient computed (for integer values as shown in previous section) or estimated using the paraboloidal interpolation (for sub-pixel floating values).
- a,b,c,d,e,f — are the 6 coefficients estimated from the 3x3 linear regression coefficients R(X,Y), $X=X_0-1,X_0,X_0+1$, $Y=Y_0-1,Y_0,Y_0+1$.

Minimizing the difference $\overline{D} = \sum_{X=X_0-1}^{X_0+1}\sum_{Y=Y_0-1}^{Y_0+1}[r(X,Y) - R(Y,Y)]^2$ leads to compute the partial derivative with regard to the unknowns a, b, c, d, e and f that should have a null value

at the best fit. The system of 6 linear equations is solved by inverting the matricial equation below.

$$\begin{bmatrix} \Sigma\Sigma X^4 & \Sigma\Sigma X^2Y^2 & \Sigma\Sigma X^3Y & \Sigma\Sigma X^3 & \Sigma\Sigma X^2Y & \Sigma\Sigma X^2 \\ \Sigma\Sigma X^2Y^2 & \Sigma\Sigma Y^4 & \Sigma\Sigma XY^3 & \Sigma\Sigma XY^2 & \Sigma\Sigma Y^3 & \Sigma\Sigma Y^2 \\ \Sigma\Sigma X^3Y & \Sigma\Sigma XY^3 & \Sigma\Sigma X^2Y^2 & \Sigma\Sigma X^2Y & \Sigma\Sigma XY^2 & \Sigma\Sigma XY \\ \Sigma\Sigma X^3 & \Sigma\Sigma XY^2 & \Sigma\Sigma X^2Y & \Sigma\Sigma X^2 & \Sigma\Sigma XY & \Sigma\Sigma X \\ \Sigma\Sigma X^2Y & \Sigma\Sigma Y^3 & \Sigma\Sigma XY^2 & \Sigma\Sigma XY & \Sigma\Sigma Y^2 & \Sigma\Sigma Y \\ \Sigma\Sigma X^2 & \Sigma\Sigma Y^2 & \Sigma\Sigma XY & \Sigma\Sigma X & \Sigma\Sigma Y & 9 \end{bmatrix} \times \begin{bmatrix} a \\ b \\ c \\ d \\ e \\ f \end{bmatrix} = \begin{bmatrix} \Sigma\Sigma X^2.R(X,Y) \\ \Sigma\Sigma Y^2.R(X,Y) \\ \Sigma\Sigma XY.R(X,Y) \\ \Sigma\Sigma X.R(X,Y) \\ \Sigma\Sigma Y.R(X,Y) \\ \Sigma\Sigma R(X,Y) \end{bmatrix} \quad \text{(eq. 8)}$$

Then, the floating coordinates (x_m,y_m) of the highest points of this surface is retrieved by deriving the surface r(x,y) and by looking for the horizontal tangent.

$$\begin{cases} \dfrac{\partial(r(x,y))}{\partial x} = 2a.x_m + c.y_m + d = 0 \\ \dfrac{\partial(r(x,y))}{\partial y} = c.x_m + 2b.y_m + e = 0 \end{cases} \quad \text{(eq. 9)}$$

The following figure illustrates the principle of the sub-pixel analysis.

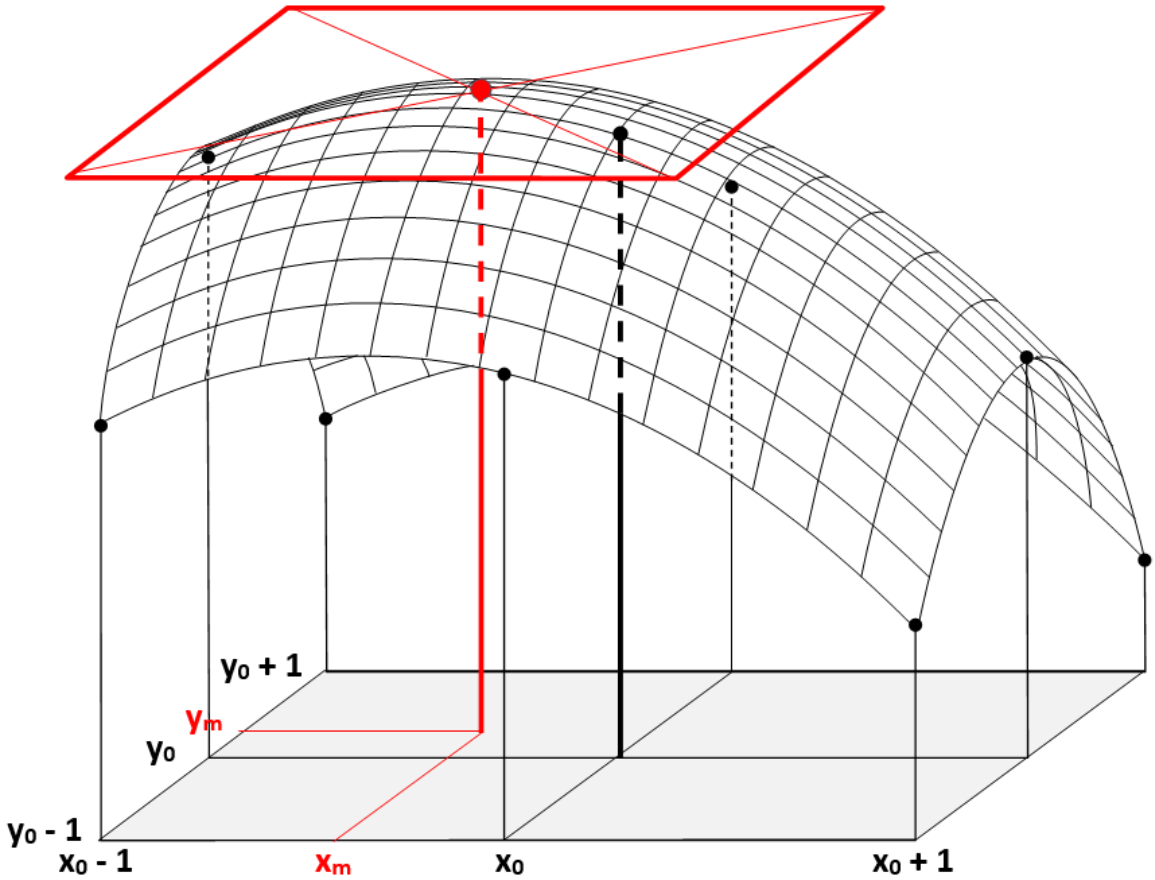


Figure 11 – Sub-pixel disparity analysis principle.

In Figure 11, a 3x3 correlation matrix is illustrated. Each vertical line corresponds to a correlation value. The maximum of correlation is located in the centre, and corresponds to the P_{work} correlation. A paraboloid surface can be seen over these correlation values. The parameters {a, b, c, d, e, f} of this surface are chosen to globally minimize the vertical

distance between each correlation value and the paraboloid surface. Using this surface, an estimation of the maximum of correlation and its coordinates can be computed.

3.4.2.3 Algorithm

In this generic algorithm, we assume that reference and work DEMs are on a common grid, i.e., in the same planimetric coordinates reference system (CRS), with the same pixel spacing and with upper-left origin being multiple of the grid sampling distance.

For better understanding, the algorithm below is limited to calculating integer values of displacement expressed in pixels. The step involving the sub-pixel algorithm is highlighted in cyan.

Input

Let $DEM_{reference}$ be the reference DEM
DEM_{work} be the work DEM
(UL_X, UL_Y, LR_X, LR_Y) be the bounding box of the reference DEM
(ul_X, ul_Y, lr_X, lr_Y) be the bounding box of the work DEM
$(grid\_size_X, grid\_size_Y)$ be the horizontal and vertical pixel size of the grid
correlation_window size (must be odd) of the correlation window in pixels (ex. 9)
exploration window size (must be odd) of the exploration window in pixels (ex. 11)
horizontal_jump be the number of pixels between successive evaluation (=0 to compute all pixels)

Output

r[L,P] image of the correlation values in the overlay area
dL[L,P] image of the line (= vertical axis Y) displacement values in the overlay area
dP[L,P] image of the pixel (= horizontal axis X) displacement values in the overlay area

Pseudo-code

Compute the bounding box of the overlay between reference and work DEM in geodetic CRS

$overlay\_UL_X \leftarrow \max(UL_X, ul_X)$
$overlay\_UL_Y \leftarrow \min(UL_Y, ul_Y)$
$overlay\_LR_X \leftarrow \min(LR_X, lr_X)$
$overlay\_LR_Y \leftarrow \max(LR_Y, lr_Y)$
if $((overlay\_UL_X > overlay\_LR_X)$ or $(overlay\_UL_Y < overlay\_LR_Y))$ then
  No overlay
  Exit
endif

Compute the bounding box of the overlay between reference and work DEM in reference image CRS

$border\_size \leftarrow exploration\_window / 2 + correlation\_window / 2$
$L_{start} \leftarrow (UL_Y - overlay\_UL_Y) / grid\_size_Y - border\_size$
$L_{stop} \leftarrow (UL_Y - overlay\_LR_Y) / grid\_size_Y - border\_size$
$P_{start} \leftarrow (overlay\_UL_X - UL_X) / grid\_size_X - border\_size$
$P_{stop} \leftarrow (overlay\_LR_X - UL_X) / grid\_size_X - border\_size$
Initialise the reference to work translation in pixels
$reference\_to\_work_L \leftarrow (ul_Y - UL_Y) / grid\_size_Y$
$reference\_to\_work_P \leftarrow (ul_X - UL_X) / grid\_size_X$

Initialise the number of lines between successive evaluations to get a hexagonal distribution

$vertical\_jump \leftarrow \sqrt{3} / 2 * horizontal\_jump$
Loop on lines
$L_{reference} \leftarrow L_{start}$
$L_{work} \leftarrow L_{reference} + reference\ to\ work_L$
while $(L_{reference} < L_{stop})$ do
  $L_{work} \leftarrow L_{reference} + reference\_to\_work_L$
  Loop on pixels
  $P_{reference} \leftarrow P_{start} + (L_{reference}$ modulo $2) * horizontal\ jump / 2$
  while $(P_{reference} < P_{stop})$ do
    $P_{work} \leftarrow P_{reference} + reference\_to\_work_P$

    Look for the pixel with the maximum correlation in the exploration window

```
    r_max ← -∞

    Loop on lines of the exploration window
    for dL← -exploration_window/2 to + exploration_window/2 do

       Loop on pixels of the exploration window
       for dP← -exploration_window/2 to + exploration_window/2 do

          Compute the correlation
          sample_number    ← 0
          sum_product      ← 0
          sum_reference    ← 0
          sum_work         ← 0
          square_sum_reference ← 0
          square_sum_rwork ← 0

          Loop on lines of the correlation window
          for k← -correlation_window/2 to + correlation_window/2 do

             Loop on pixels of the correlation window
             for l← -correlation_window/2 to + correlation_window/2 do
                value_reference ← DEM_reference[L_reference+k,P_reference+l]
                value_work      ← DEM_work[L_work+dL+k,P_work+dP+l]

                Check if work and reference pixels are not background or sea
                if (is_valid(value_reference) and is_valid(value_work)) then
                   sample_number    ← sample_number + 1
                   sum_product      ← sum_product   + value_reference * value_work
                   sum_reference    ← sum_reference + value_reference
                   sum_work         ← sum_work      + value_work
                   square_sum_reference ← square_sum_reference + (value_reference)^2
                   square_sum_work  ← square_sum_work     + (value_work)^2
                endif
             done
          done

          If non-backgroud pixels have been found in the correlation window,

          compute the linear correlation coefficient and keep it if it is the

          maximum
          if (sample_number > 0) then
             mean_product    ← sum_product   / sample_number
             mean_reference  ← sum_reference / sample_number
             mean_work       ← sum_work      / sample_number
             stdev_reference ← √(square_sum_reference / sample_number - mean_reference^2)
             stdev_work      ← √(square_sum_work     / sample_number - mean_work^2)
             covariance  ← (sum_product / sample_number) - (mean_reference * mean_work)
             correlation ← covariance / (stdev_reference * stdev_work)
             if (correlation > r_max) then
                r_max ← correlation
                dL_max ← dL
                dP_max ← dP
             endif
          endif
       done
    done

    When the maximum has been found, keep values in the arrays
    if (r_max ≥ -1) then
       Get sub-pixel dL_max, dP_max and r_max
       dL[L_reference,P_reference] ← dL_max
       dP[L_reference,P_reference] ← dP_max
       r[L_reference,P_reference]  ← r_max
    else
       dL[dL_max L_reference,P_reference] ← backgroud_value
       dP[L_reference,P_reference] ← backgroud_value
       r[L_reference,P_reference]  ← backgroud_value
    endif
    P_reference ← P_reference + 1 + horizontal_jump
 enddo
```

```
    L_reference ← L_reference + 1 + vertical_jump
Enddo
```

4. RESULTS

4.1 Study 1 – Impact of the resampling methods on the global differences

This section presents the results of the global differences per DEMIX tile (see section 3.4.1 for methods).

4.1.1 Individual DEMIX tiles

Each subsection focuses on one of the 38 DEMIX tiles defined in section 3.3.2.

For each DEMIX tile, the following views and statistics are given:

Resampling views Views of the EU-DEM and EEA-10 resamplings over the current tile. These views include **EU-DEM-NN** (Nearest Neighbour), **EU-DEM-BL** (Bilinear) and **EU-DEM-BC** (Bicubic) for EU-DEM**,** and **EEA-10-NN** (Nearest Neighbour), **EEA-10-BL** (Bilinear) and **EEA-10-BC** (Bicubic).

Differences views Views of the differences between EU-DEM and EEA-10 resamplings. These views form a 3x3 table, for which **top row** corresponds to **EU-DEM-NN**, the **middle row** corresponds to **EU-DEM-BL** and the **bottom row** corresponds to **EU-DEM-BC**. Following the same logic, the **left column** corresponds to **EEA-10-NN**, the **middle column** corresponds to **EEA-10-BL**, and the **right column** corresponds to **EEA-10-BC**. The intersection between these rows and columns correspond to the difference between EU-DEM-XX and EEA-10-YY, where XX and YY are the respective resamplings of EU-DEM and EEA-10 over the current DEMIX tile. Example: the intersection between top row and middle column corresponds to the (EU-DEM-NN – EEA-10-BL) difference.

Differences statistics Statistics of the differences between EU-DEM and EEA-10 resamplings, including the **mean**, the **standard deviation** and the **RMSE**. These statistics are directly computed from the differences views (see last point) and follow the same 3x3 table layout. For each tile, **the lowest difference mean, standard deviation and RMSE are highlighted in green**, whereas the **highest difference mean, standard deviation and RMSE** are **highlighted in red**. In the following statistics, the **best results** correspond to the (EU-DEM-XX – EEA-10-YY) comparison having the most statistics in green, whereas the **worst results** correspond to the (EU-DEM-XX – EEA-10-YY) comparison having the most statistics in red.

Differences histograms Histograms of the differences between EU-DEM and EEA-10 resamplings. These statistics are directly computed from the differences views (see the “differences views” point) and follow the same 3x3 table layout.

Overall statistics, which encompass all the 38 DEMIX tiles, are available in next section (see section 4.1.2).

4.1.1.1 01 – Iceland – N64ZW019C (zone 3)

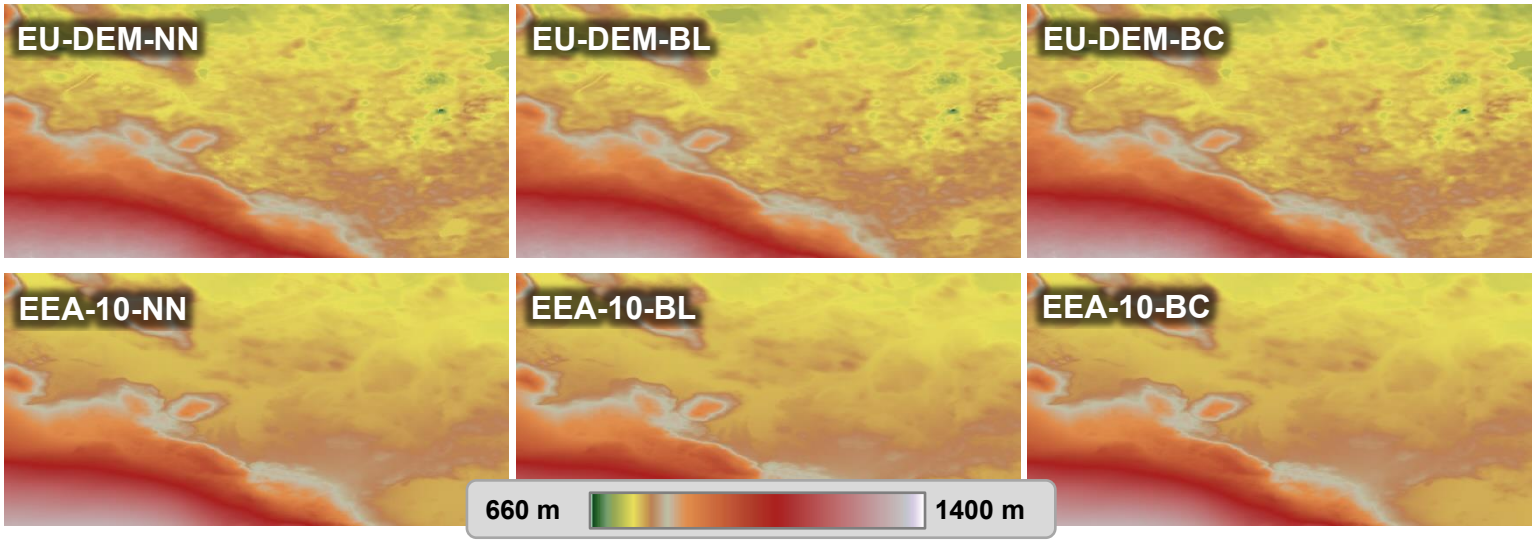


Figure 12 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N64ZW019C.

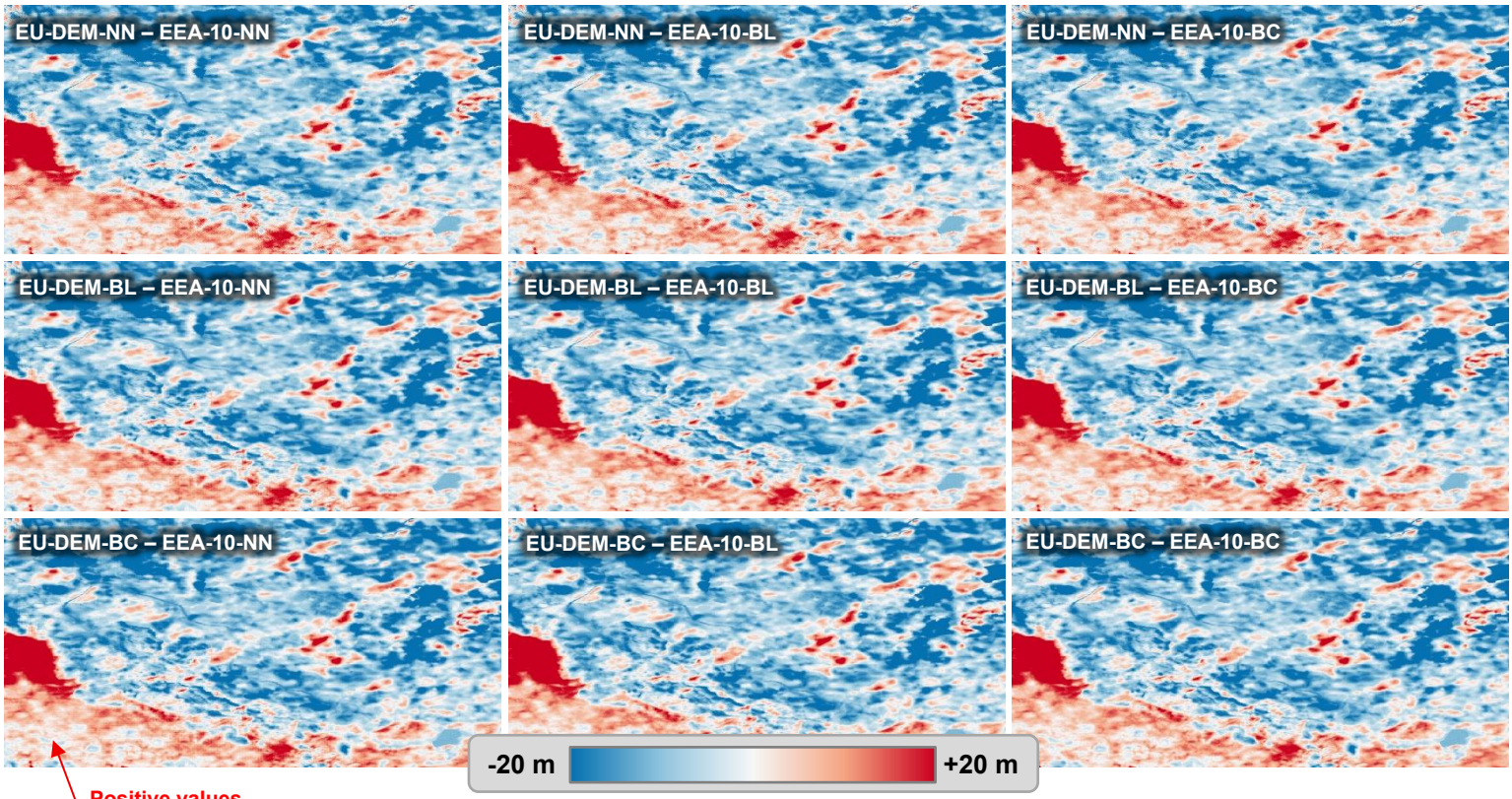
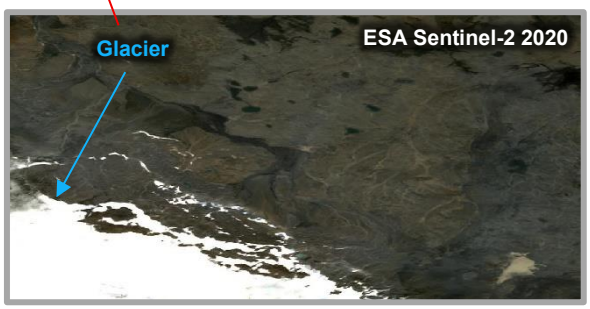


Figure 13 – Views of (EU-DEM -EEA-10) over DEMIX tile N64ZW019C.



Over this tile, the resampled instances of EU-DEM show more roughness than those of EEA-10 (see Figure 12). EU-DEM instances also highlight lower heights than EEA-10 over the North East of this tile, underlined by shades of light green.

One may note that the variation of sampling method does not seem to have an important impact on the (EU-DEM - EEA-10) views (see Figure 13). These views feature a majority of negative values, with a cluster of positive values in the South West of the tile. This cluster seems to be linked to the presence of a glacier over this tile (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -5.53 m Std Dev = 11.52 m RMSE = 12.78 m	Mean = -5.54 m Std Dev = 11.51 m RMSE = 12.77 m	Mean = -5.54 m Std Dev = 11.51 m RMSE = 12.78 m
Bilinear (BL)	Mean = -5.53 m Std Dev = 11.46 m RMSE = 12.72 m	Mean = -5.54 m Std Dev = 11.44 m RMSE = 12.71 m	Mean = -5.54 m Std Dev = 11.45 m RMSE = 12.72 m
Bicubic (BC)	Mean = -5.53 m Std Dev = 11.50 m RMSE = 12.76 m	Mean = -5.54 m Std Dev = 11.48 m RMSE = 12.75 m	Mean = -5.54 m Std Dev = 11.48 m RMSE = 12.75 m

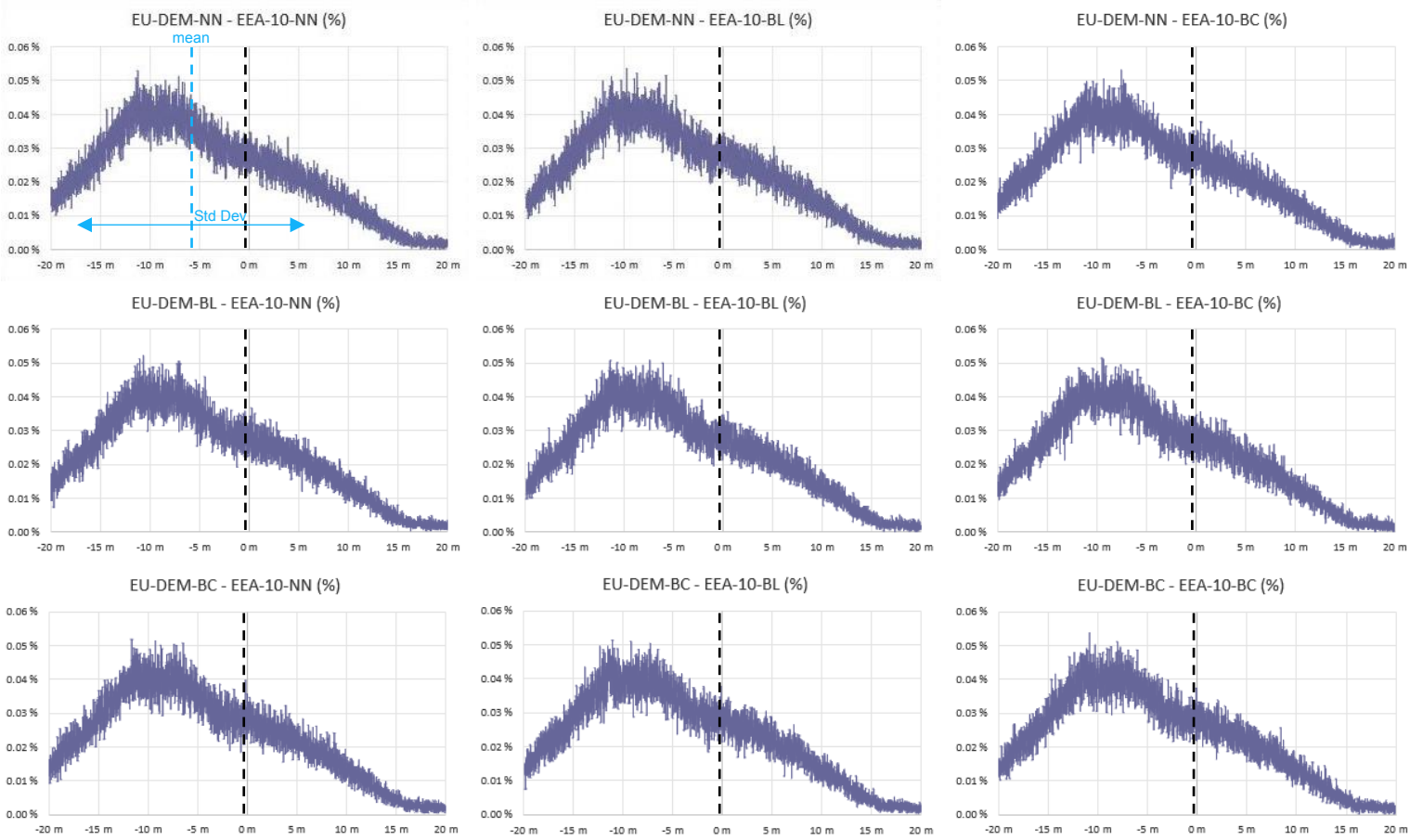


Figure 14 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N64ZW019C.

Statistically, the **best results** are obtained from the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained from the **(EU-DEM-NN – EEA-10-NN)** study. One may observe that the differences between best and worst statistics are really low, reaching **0.01 m** for mean, **0.08 m** for standard deviation and **0.07 m** for RMSE. In this case, **the sampling method does not have a significant impact on statistics**.

All the (EU-DEM – EEA-10) histograms have the same overall aspect. These histograms are composed of two gaussian curves: one centred at 0 metres, with a long tail of distribution of positive values, the other negative, with a mode approximately reaching -9.5 metres. Positive errors are linked to the presence of a glacier over the study area (see Figure 13).

4.1.1.2 02 – Norway – N60RE007B (zone 3)

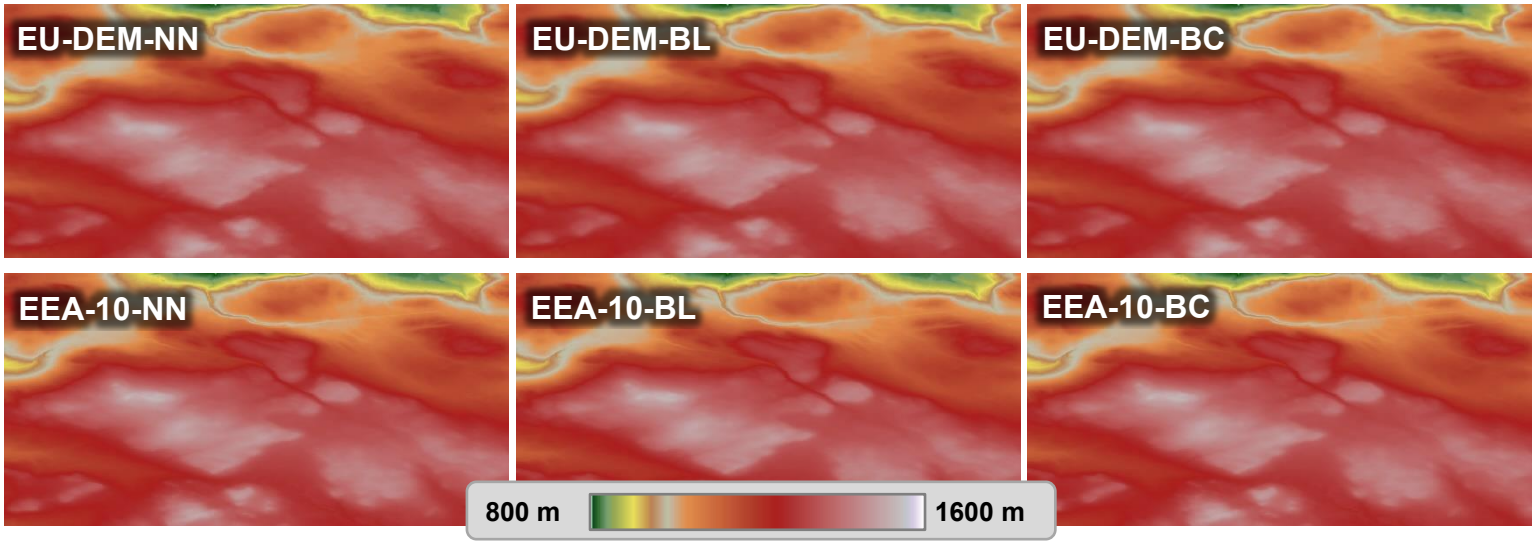


Figure 15 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N60RE007B.

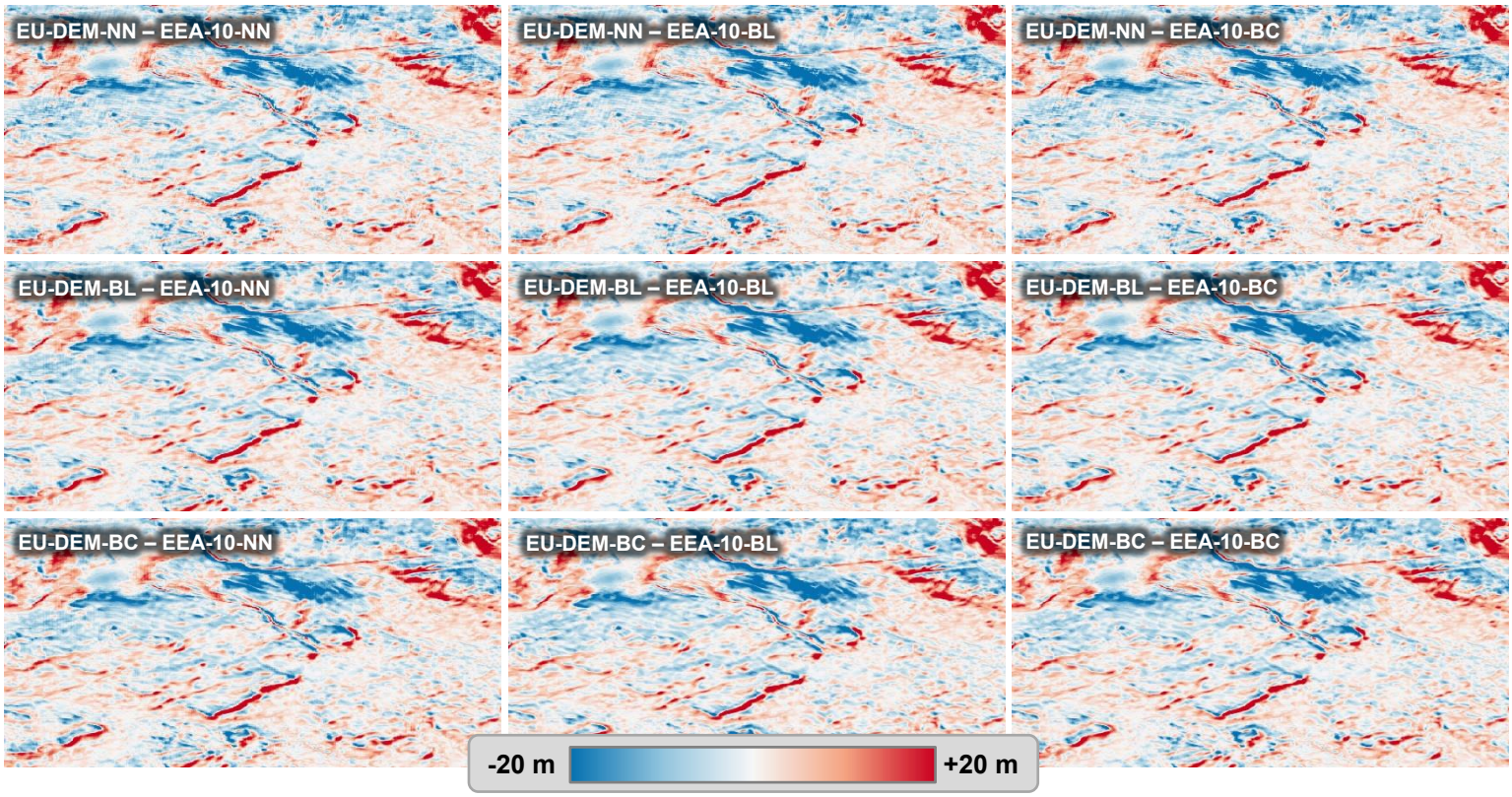
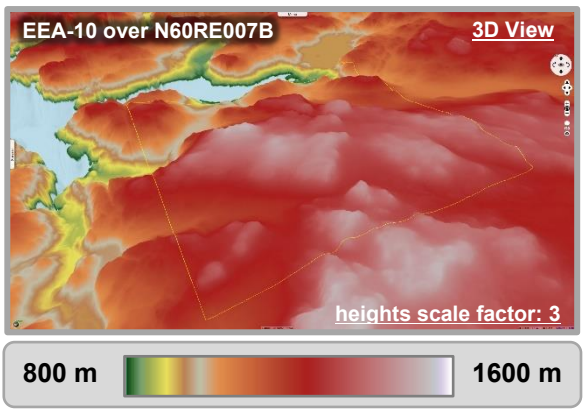


Figure 16 – Views of (EU-DEM -EEA-10) over DEMIX tile N60RE007B.



As opposed to the N64ZW019C tile of Iceland (see 4.1.1.1), the EEA-10 and EU-DEM instances seem relatively similar (see Figure 15).

As previously observed, the variation of sampling method does not seem to have an important impact on the (EU-DEM - EEA-10) views (see Figure 16). These views highlight major height differences over the North of the tile, which may be linked to the important height variation over this area (see attached figure). One may also notice lines of extreme errors, which are located over the mountain crests and mountain passes.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -0.57 m** **Std Dev = 7.86 m** **RMSE = 7.88 m**	**Mean = -0.52 m** **Std Dev = 7.74 m** **RMSE = 7.76 m**	**Mean = -0.52 m** **Std Dev = 7.77 m** **RMSE = 7.78 m**
Bilinear (BL)	**Mean = -0.57 m** **Std Dev = 7.72 m** **RMSE = 7.74 m**	**Mean = -0.52 m** **Std Dev = 7.60 m** **RMSE = 7.62 m**	**Mean = -0.52 m** **Std Dev = 7.63 m** **RMSE = 7.64 m**
Bicubic (BC)	**Mean = -0.57 m** **Std Dev = 7.75 m** **RMSE = 7.77 m**	**Mean = -0.52 m** **Std Dev = 7.63 m** **RMSE = 7.64 m**	**Mean = -0.52 m** **Std Dev = 7.65 m** **RMSE = 7.67 m**

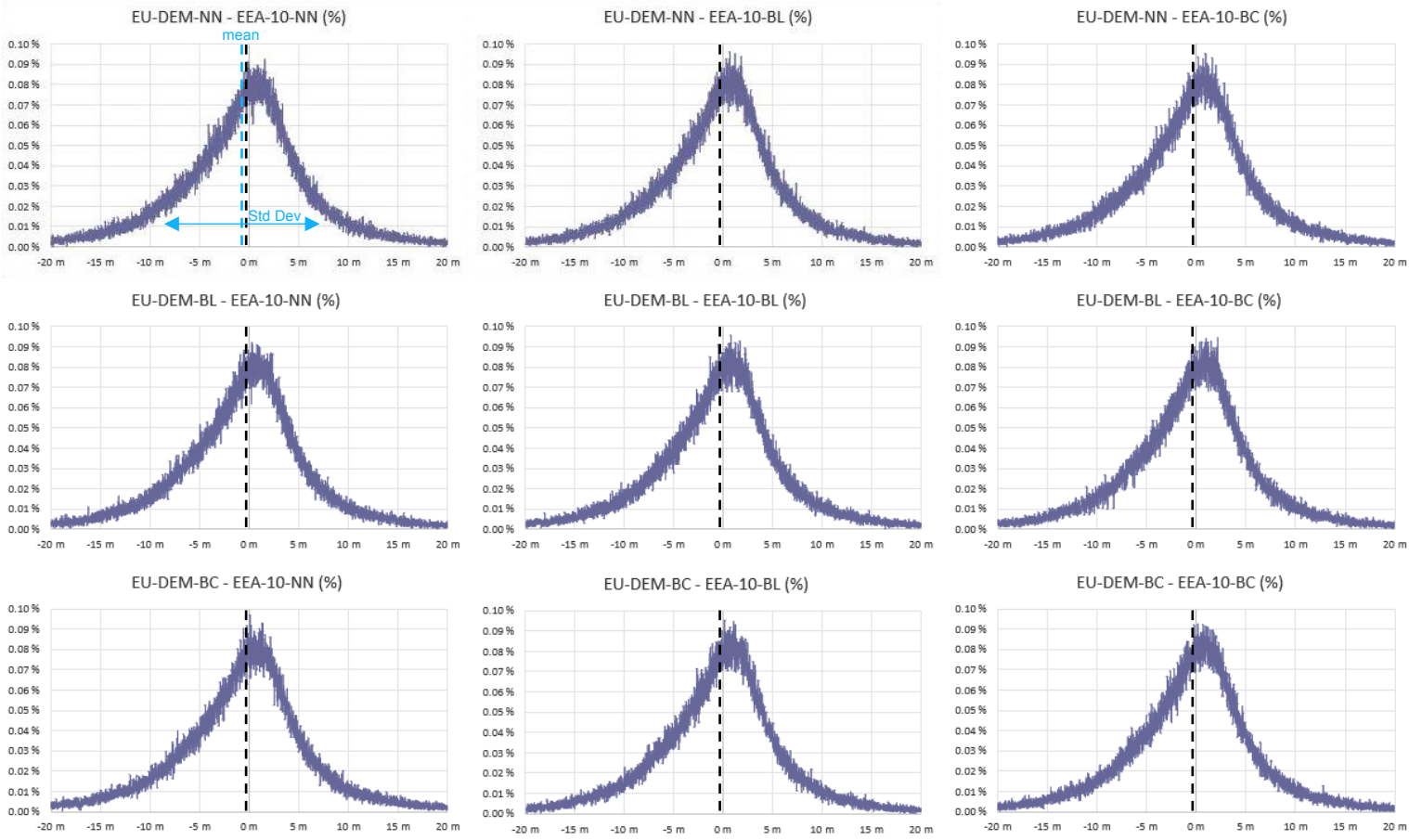


Figure 17 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N60RE007B.

As observed in previous section 4.1.1.1, the **best results** are obtained from the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained from the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics respectively reach **0.05 m** for mean, **0.26 m** for standard deviation and **0.26 m** for RMSE. These differences are higher than the ones observed over Iceland (see section 4.1.1.1), but the overall results **still show that the sampling method does not have a significant impact on the (EU-DEM – EEA-10) statistics**.

All the (EU-DEM – EEA-10) histograms show a unique gaussian curve, with a mode approximately equal to 0.5 metres. These results highlight relatively low height differences over this area (see Figure 16).

4.1.1.3 03 - Sweden - N66TE020B (zone 3)

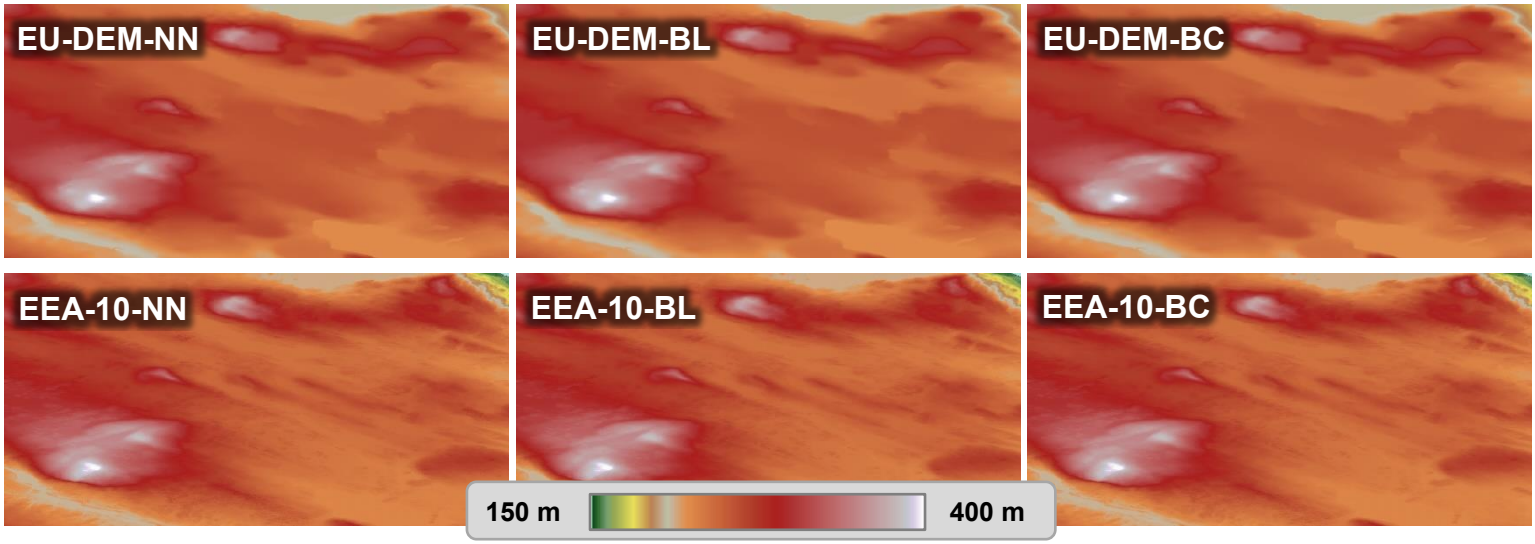


Figure 18 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N66TE020B.

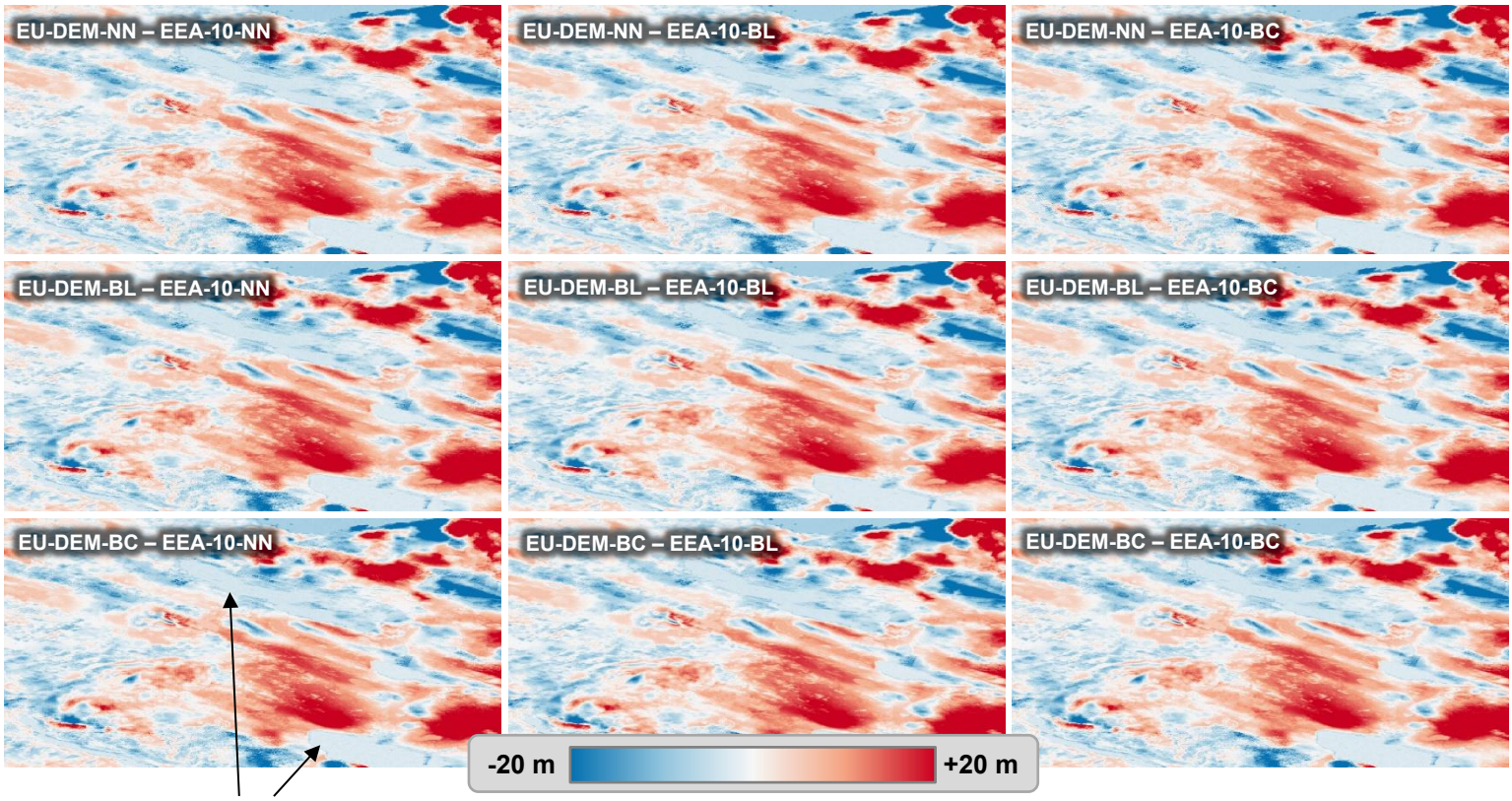
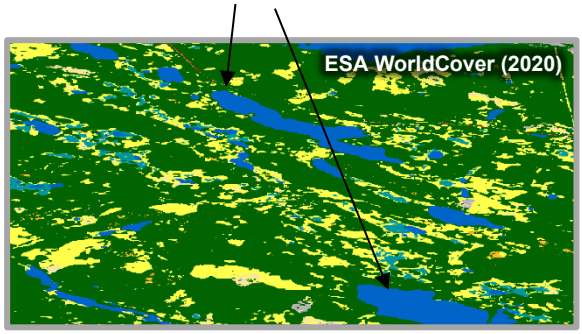


Figure 19 – Views of (EU-DEM -EEA-10) over DEMIX tile N66TE020B.



Over this tile, the resampled instances of EEA-10 show more roughness than those of EU-DEM (see Figure 18). EEA-10 instances feature multiple red clusters over the centre of the tile, whereas the EU-DEM instances stay relatively flat.

Again, the variation of sampling method does not seem to have an important impact on the (EU-DEM - EEA-10) views (see Figure 19). Extreme differences can be seen over rough areas of EEA-10, which are compared to flattened areas of EU-DEM. One may see multiple areas filled with light blue, corresponding height differences over lakes (see attached LULC map).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 1.19 m** **Std Dev = 9.23 m** **RMSE = 9.31 m**	**Mean = 1.20 m** **Std Dev = 9.23 m** **RMSE = 9.31 m**	**Mean = 1.20 m** **Std Dev = 9.25 m** **RMSE = 9.32 m**
Bilinear (BL)	**Mean = 1.19 m** **Std Dev = 9.22 m** **RMSE = 9.29 m**	**Mean = 1.20 m** **Std Dev = 9.21 m** **RMSE = 9.29 m**	**Mean = 1.20 m** **Std Dev = 9.23 m** **RMSE = 9.31 m**
Bicubic (BC)	**Mean = 1.19 m** **Std Dev = 9.22 m** **RMSE = 9.30 m**	**Mean = 1.20 m** **Std Dev = 9.22 m** **RMSE = 9.30 m**	**Mean = 1.20 m** **Std Dev = 9.24 m** **RMSE = 9.31 m**

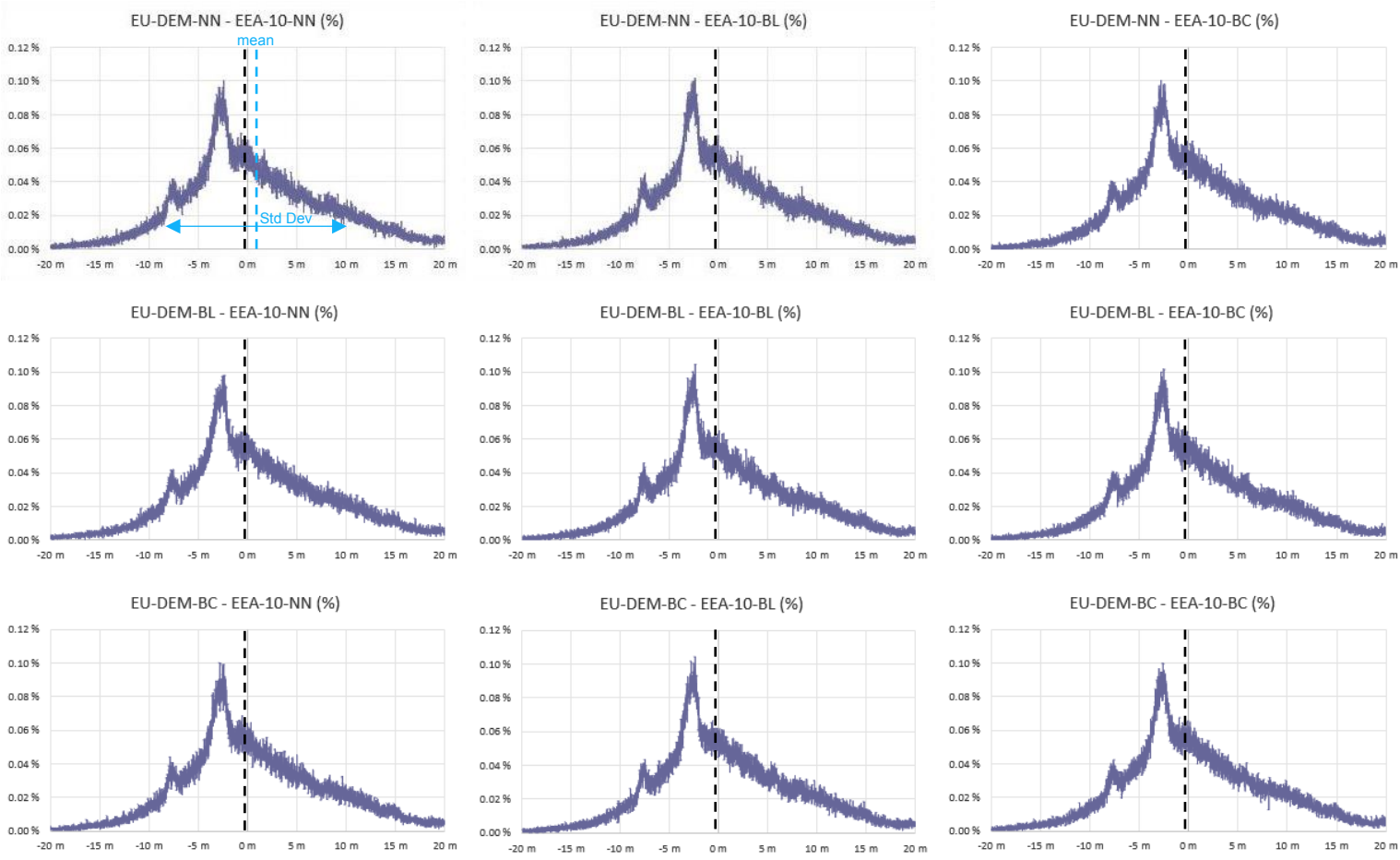


Figure 20 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N66TE020B.

In this case, the **best results** are mostly obtained with the **(EU-DEM-NN – EEA-10-BC)** and **(EU-DEM-NN – EEA-10-BC)** studies, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-BC)** study. The differences between best and worst statistics respectively reach **0.01 m** for mean, **0.04 m** for standard deviation and **0.03 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM – EEA-10) statistics.**

One may note the presence of narrow gaussian distributions over the histogram, which highlight the presence of flat areas in this tile. These flat areas have been identified as lakes (see attached figure of last page).

4.1.1.4 04 - Finland - N60RE023F (zone 3)

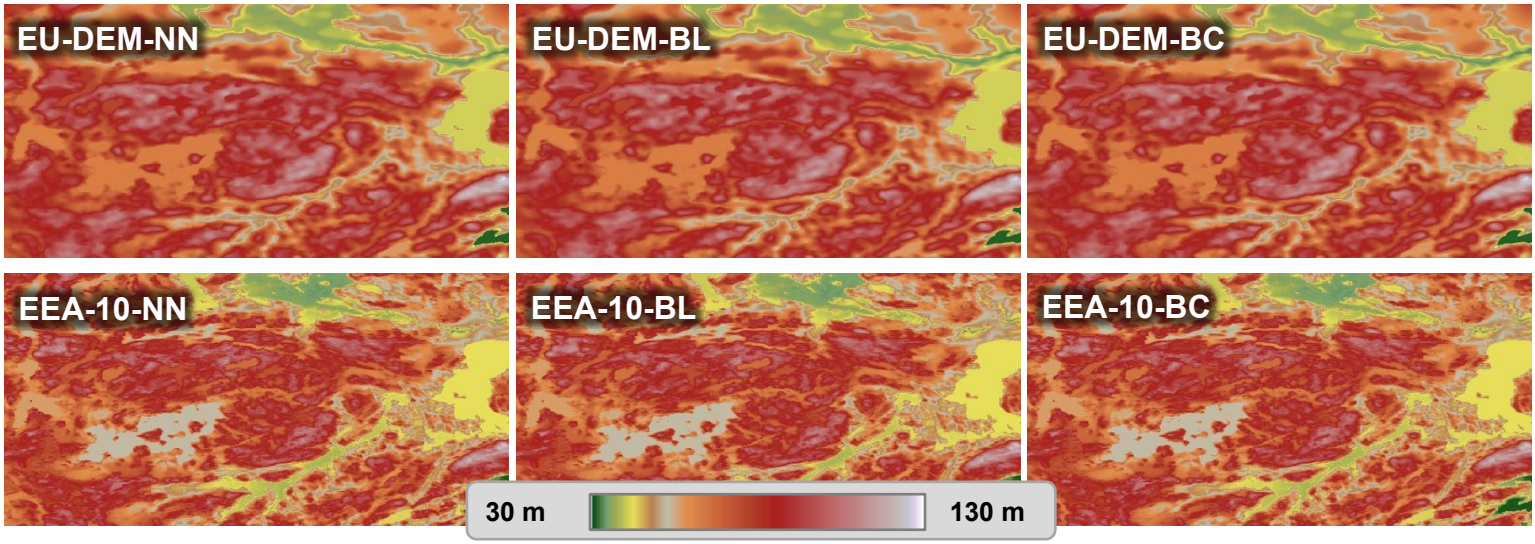


Figure 21 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N60RE023F.

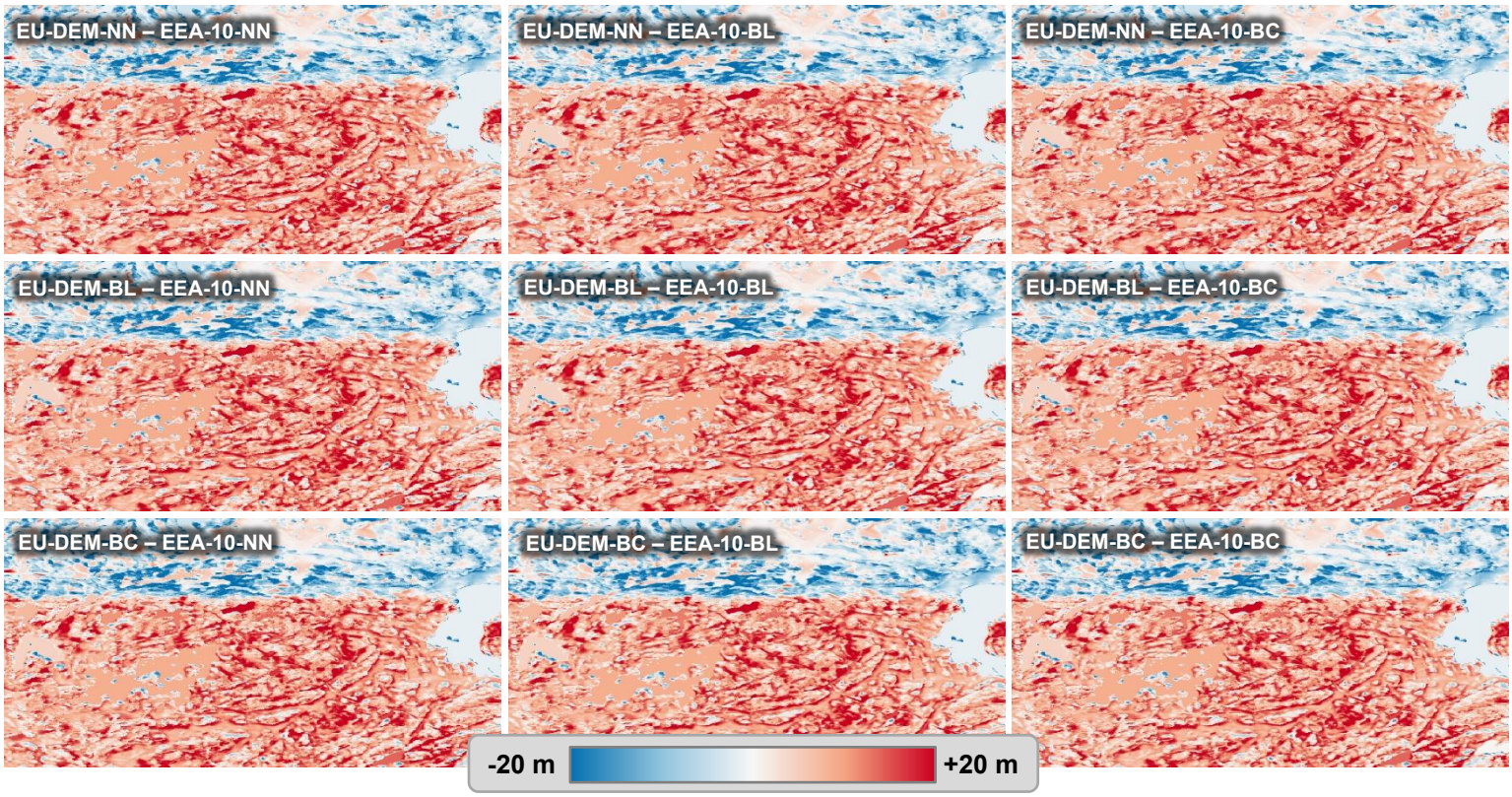
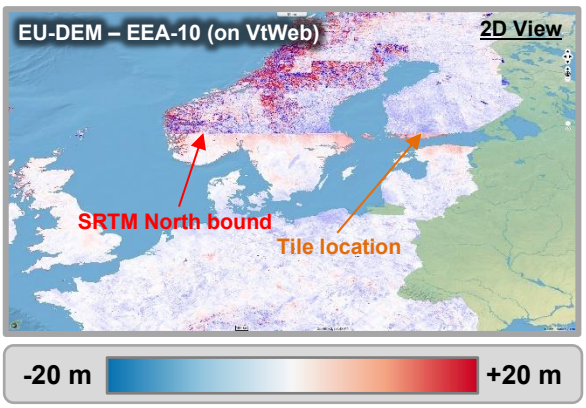


Figure 22 – Views of (EU-DEM -EEA-10) over DEMIX tile N60RE023F.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 21). One must note that the original EEA-10 DEM has a better spatial resolution than EU-DEM, which may lead to big differences over areas with such height variations.

Again, the variation of sampling method does not seem to have an important impact on the (EU-DEM - EEA-10) views (see Figure 22). The difference views highlight an abrupt change of values between the North and the South of the tile, which is due to a change of source data in EU-DEM (SRTM North bound, see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 4.43 m** **Std Dev = 9.20 m** **RMSE = 10.21 m**	**Mean = 4.43 m** **Std Dev = 9.07 m** **RMSE = 10.09 m**	**Mean = 4.43 m** **Std Dev = 9.13 m** **RMSE = 10.15 m**
Bilinear (BL)	**Mean = 4.43 m** **Std Dev = 9.17 m** **RMSE = 10.18 m**	**Mean = 4.43 m** **Std Dev = 9.04 m** **RMSE = 10.07 m**	**Mean = 4.43 m** **Std Dev = 9.10 m** **RMSE = 10.13 m**
Bicubic (BC)	**Mean = 4.43 m** **Std Dev = 9.17 m** **RMSE = 10.18 m**	**Mean = 4.43 m** **Std Dev = 9.04 m** **RMSE = 10.07 m**	**Mean = 4.43 m** **Std Dev = 9.10 m** **RMSE = 10.13 m**

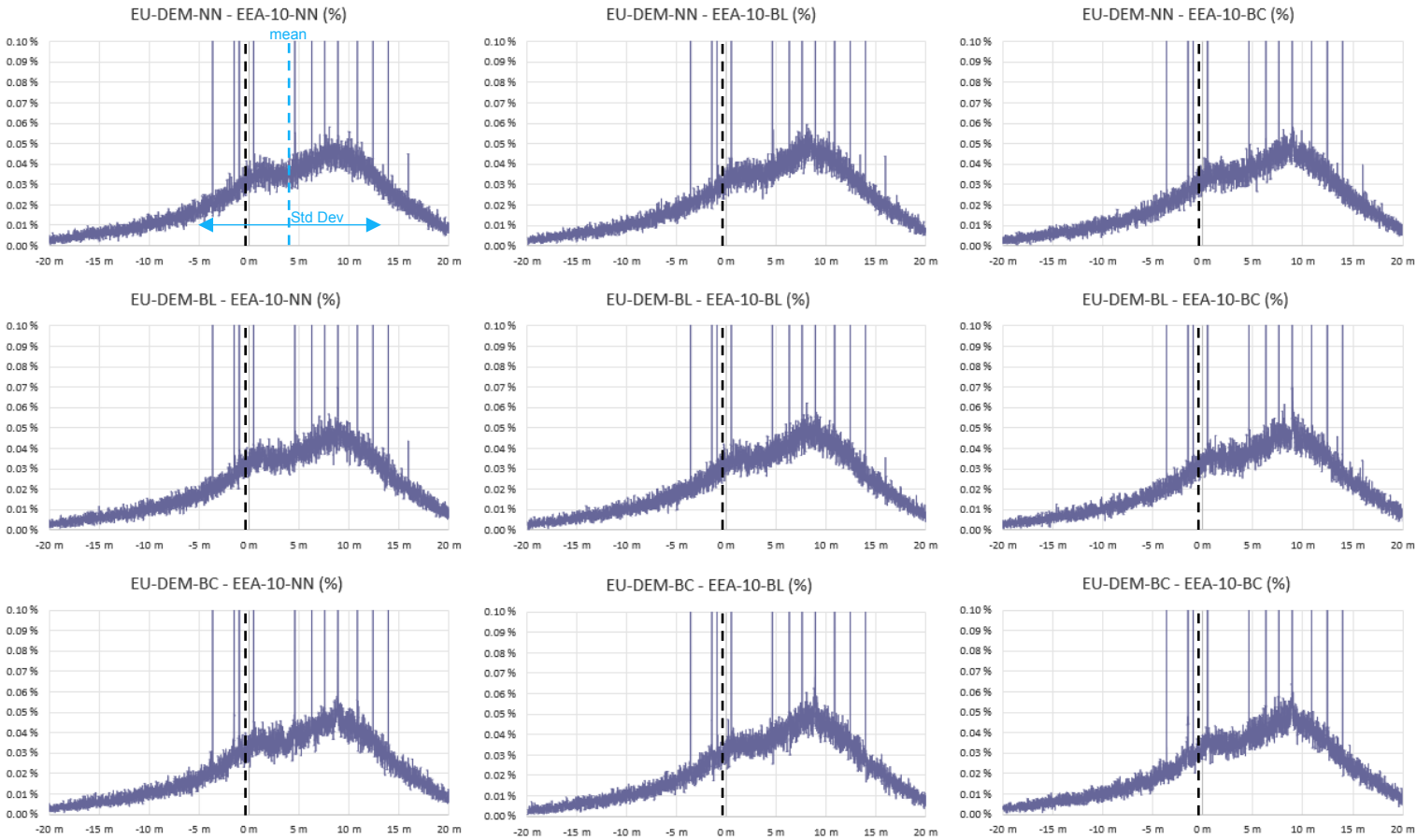


Figure 23 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N60RE023F.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** and **(EU-DEM-BC – EEA-10-BL)** studies, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.16 m** for standard deviation and **0.14 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

Histograms show particularly high peaks for some values. These values are due to the presence of flattened lakes in both DEMs. In these areas, the difference between the DEMs is equal across all pixels, leading to high peaks in the histograms.

4.1.1.5 05 - Estonia - N58YE025G (zone 2)

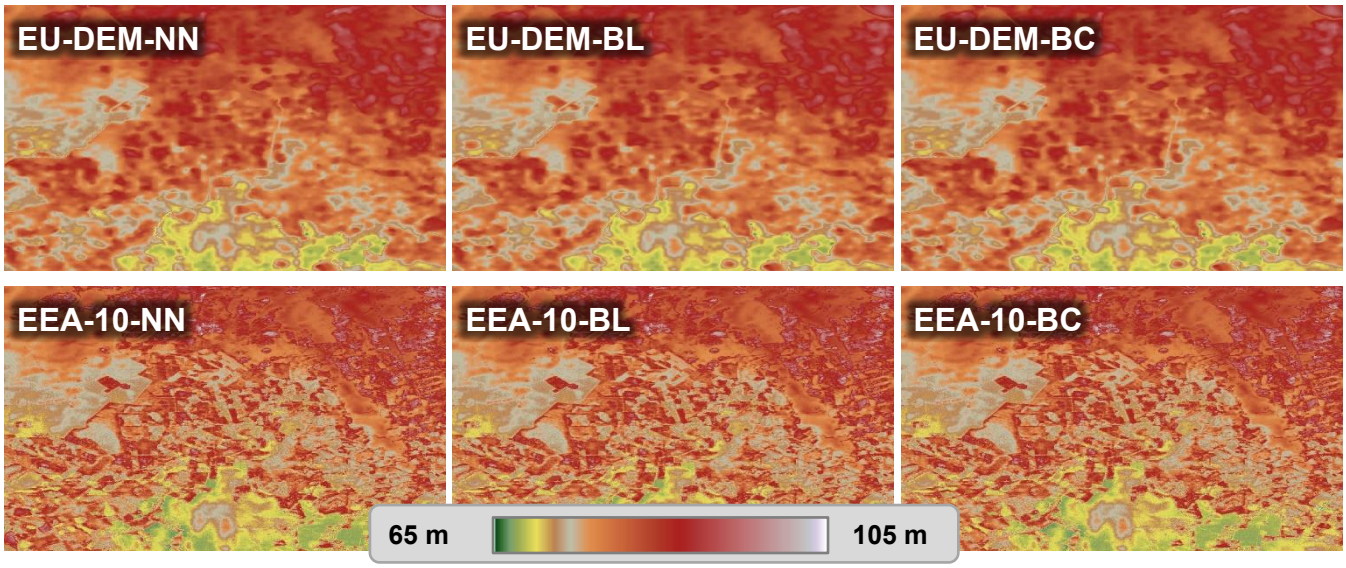


Figure 24 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N58YE025G.

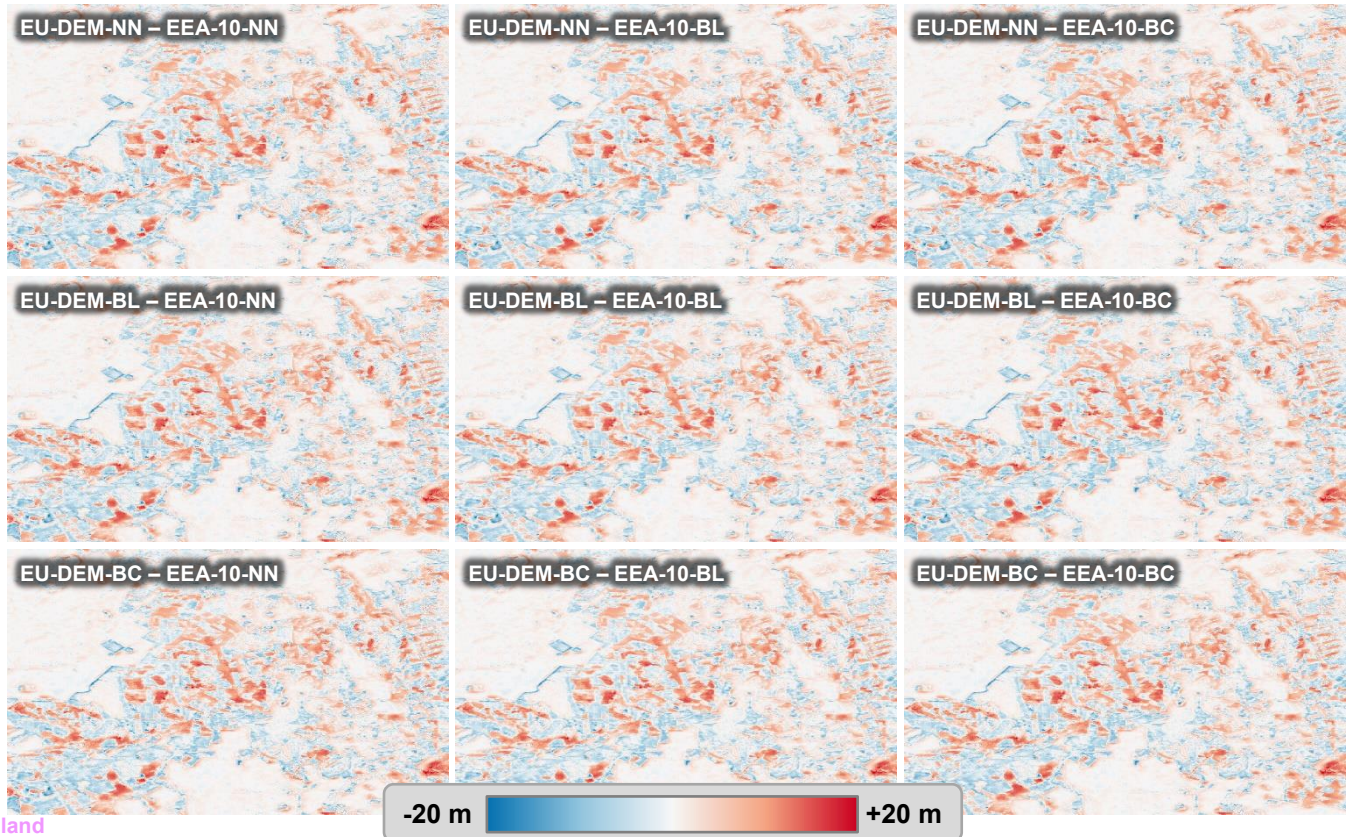
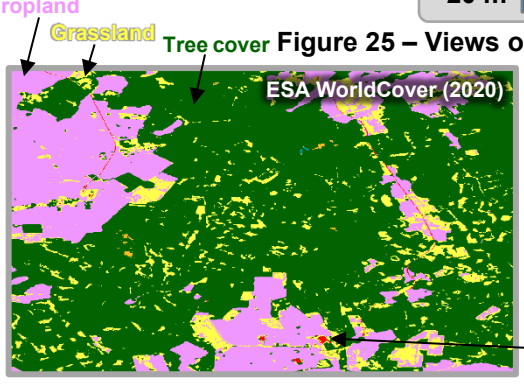


Figure 25 – Views of (EU-DEM -EEA-10) over DEMIX tile N58YE025G.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 24), which are identified as transitions between grasslands, croplands and tree cover (see attached LULC map).

One may see small height differences over grasslands and croplands, whereas the highest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 0.66 m** **Std Dev = 4.56 m** **RMSE = 4.60 m**	**Mean = 0.65 m** **Std Dev = 4.44 m** **RMSE = 4.48 m**	**Mean = 0.65 m** **Std Dev = 4.52 m** **RMSE = 4.57 m**
Bilinear (BL)	**Mean = 0.66 m** **Std Dev = 4.55 m** **RMSE = 4.59 m**	**Mean = 0.65 m** **Std Dev = 4.43 m** **RMSE = 4.47 m**	**Mean = 0.65 m** **Std Dev = 4.51 m** **RMSE = 4.56 m**
Bicubic (BC)	**Mean = 0.66 m** **Std Dev = 4.55 m** **RMSE = 4.60 m**	**Mean = 0.65 m** **Std Dev = 4.43 m** **RMSE = 4.48 m**	**Mean = 0.65 m** **Std Dev = 4.51 m** **RMSE = 4.56 m**

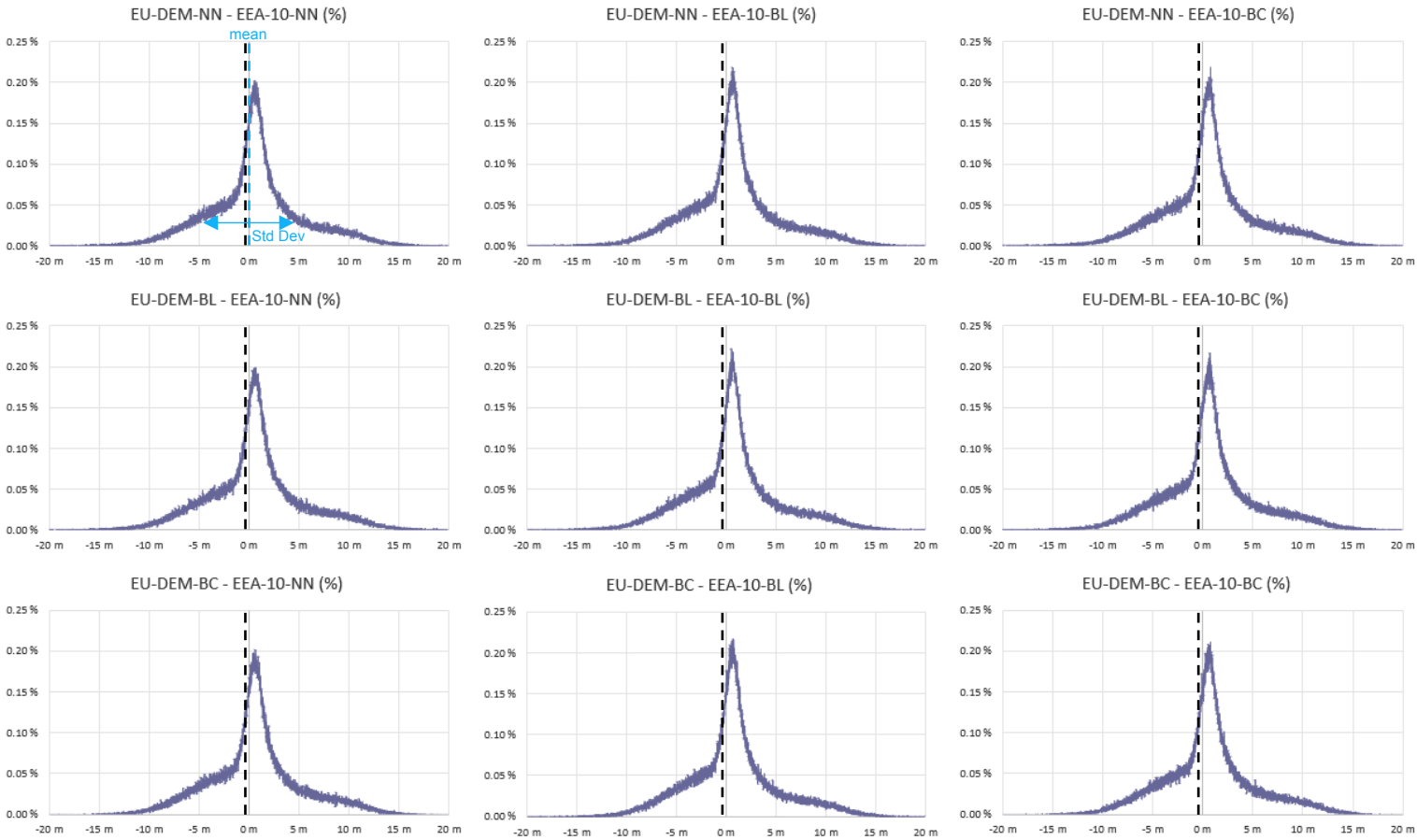


Figure 26 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N58YE025G.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for the mean, **0.13 m** for standard deviation and **0.13 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms are composed of two superimposed gaussian distributions, with modes close to 0.5 m of difference. The first gaussian is relative to croplands, with a low standard deviation. The second gaussian is due to tree cover, showing a high standard deviation (see attached figure of last page).

4.1.1.6 06 - Latvia - N56XE026C (zone 2)

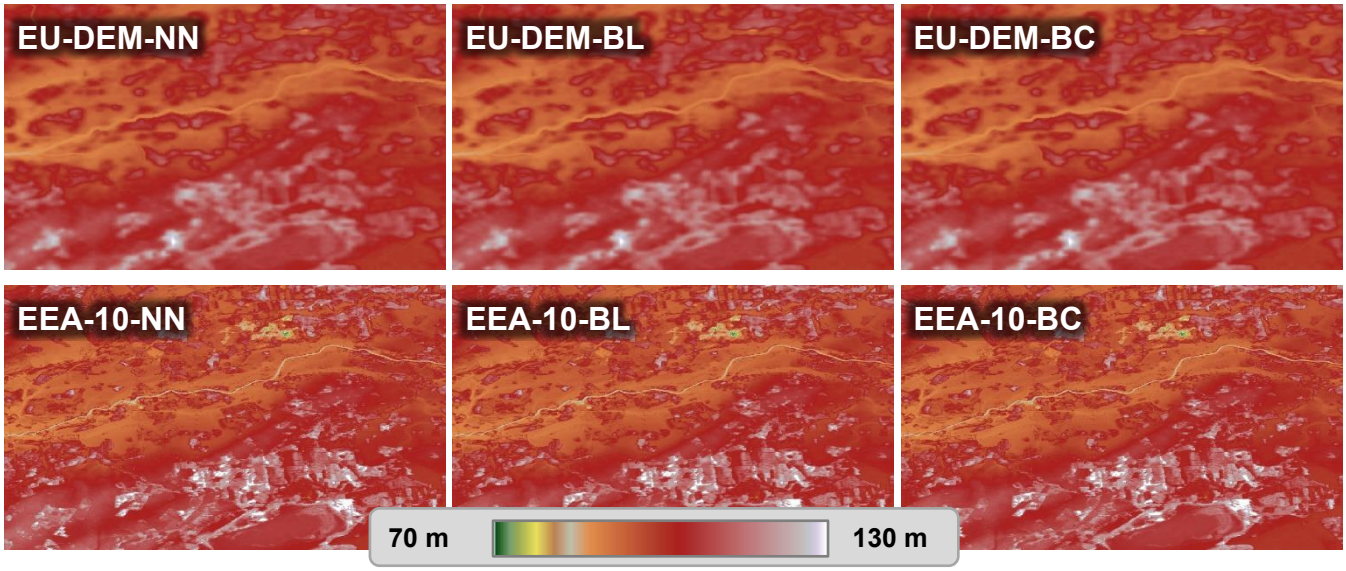


Figure 27 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N56XE026C.

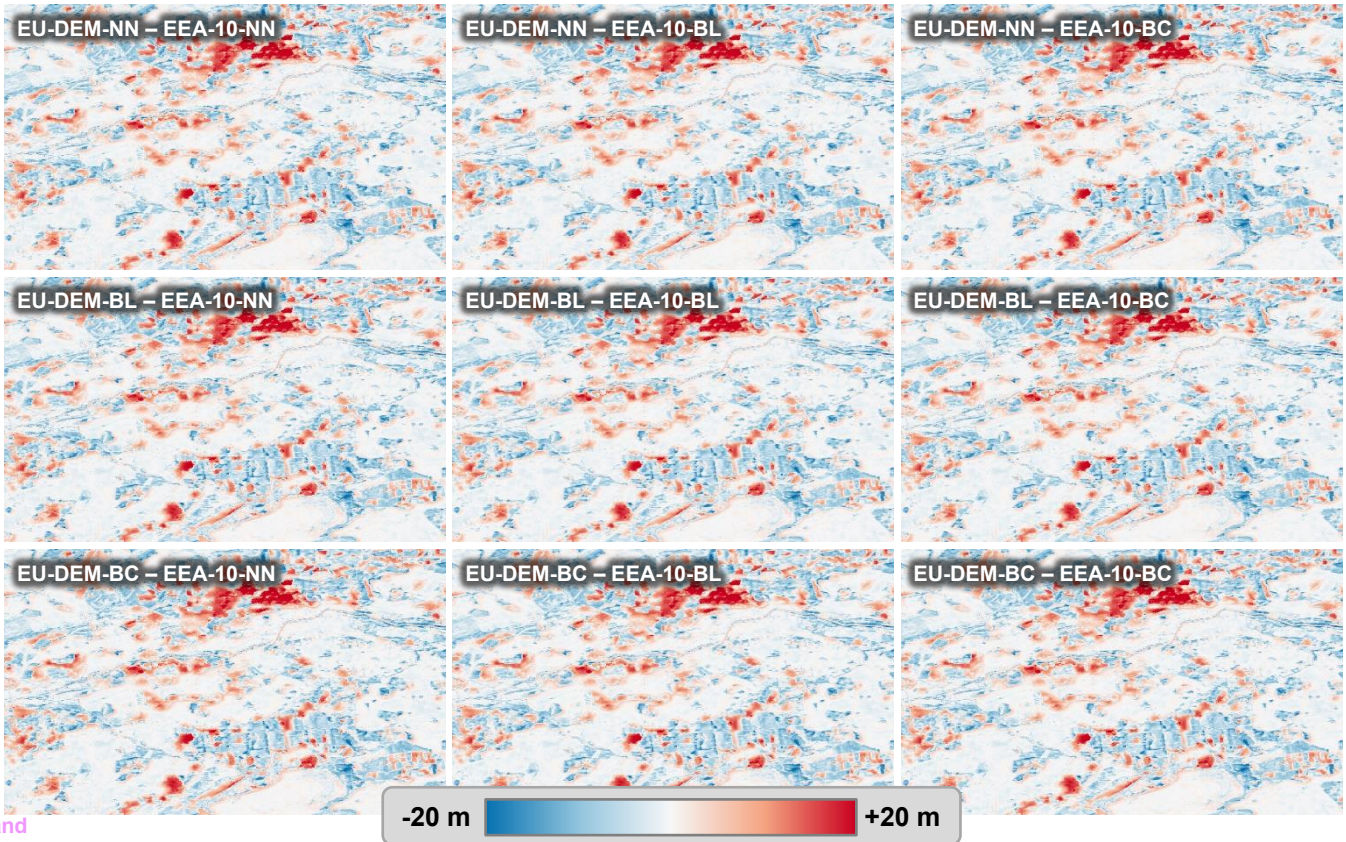
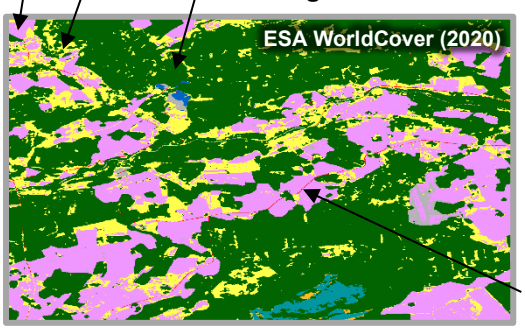


Figure 28 – Views of (EU-DEM -EEA-10) over DEMIX tile N56XE026C.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 27), which are identified as transitions between grasslands, croplands and tree cover (see attached figure).

As seen in the Estonia tile (see section 4.1.1.5), small height differences are visible over grasslands and croplands, whereas the biggest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -0.51 m** **Std Dev = 5.87 m** **RMSE = 5.90 m**	**Mean = -0.51 m** **Std Dev = 5.77 m** **RMSE = 5.79 m**	**Mean = -0.51 m** **Std Dev = 5.84 m** **RMSE = 5.87 m**
Bilinear (BL)	**Mean = -0.51 m** **Std Dev = 5.86 m** **RMSE = 5.89 m**	**Mean = -0.51 m** **Std Dev = 5.76 m** **RMSE = 5.78 m**	**Mean = -0.51 m** **Std Dev = 5.83 m** **RMSE = 5.86 m**
Bicubic (BC)	**Mean = -0.51 m** **Std Dev = 5.87 m** **RMSE = 5.89 m**	**Mean = -0.51 m** **Std Dev = 5.77 m** **RMSE = 5.79 m**	**Mean = -0.51 m** **Std Dev = 5.84 m** **RMSE = 5.86 m**

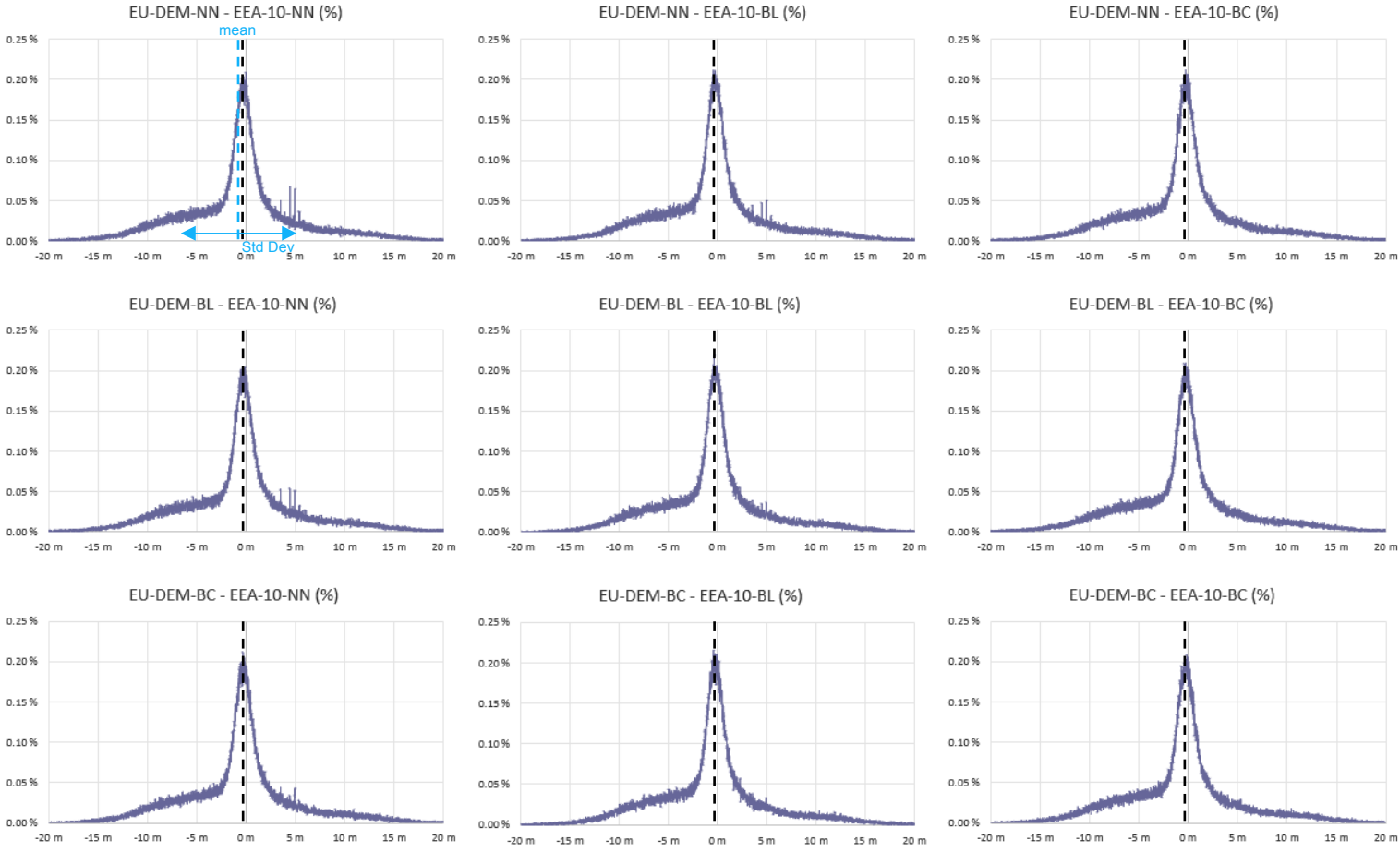


Figure 29 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N56XE026C.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.11 m** for standard deviation and **0.12 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -0.5 m of difference. This mode is linked to cropland and grassland classes. The long tails of distribution are due to the tree cover (see attached figure of last page).

4.1.1.7 07 - Lithuania - N55XE021D (zone 2)

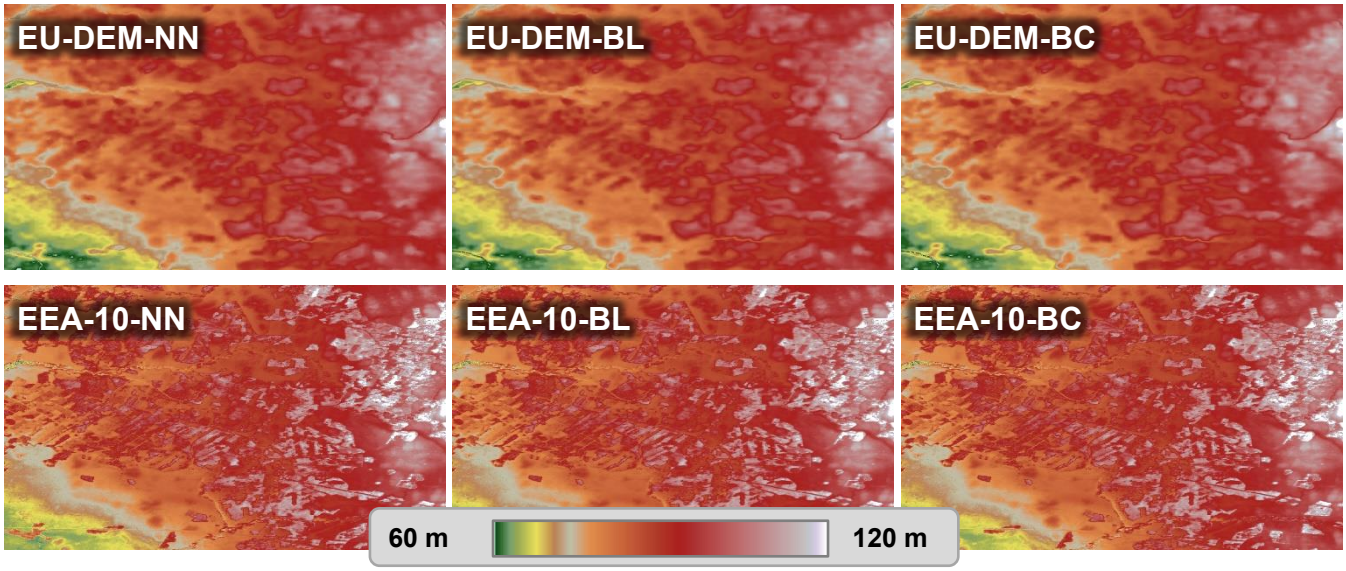


Figure 30 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N55XE021D.

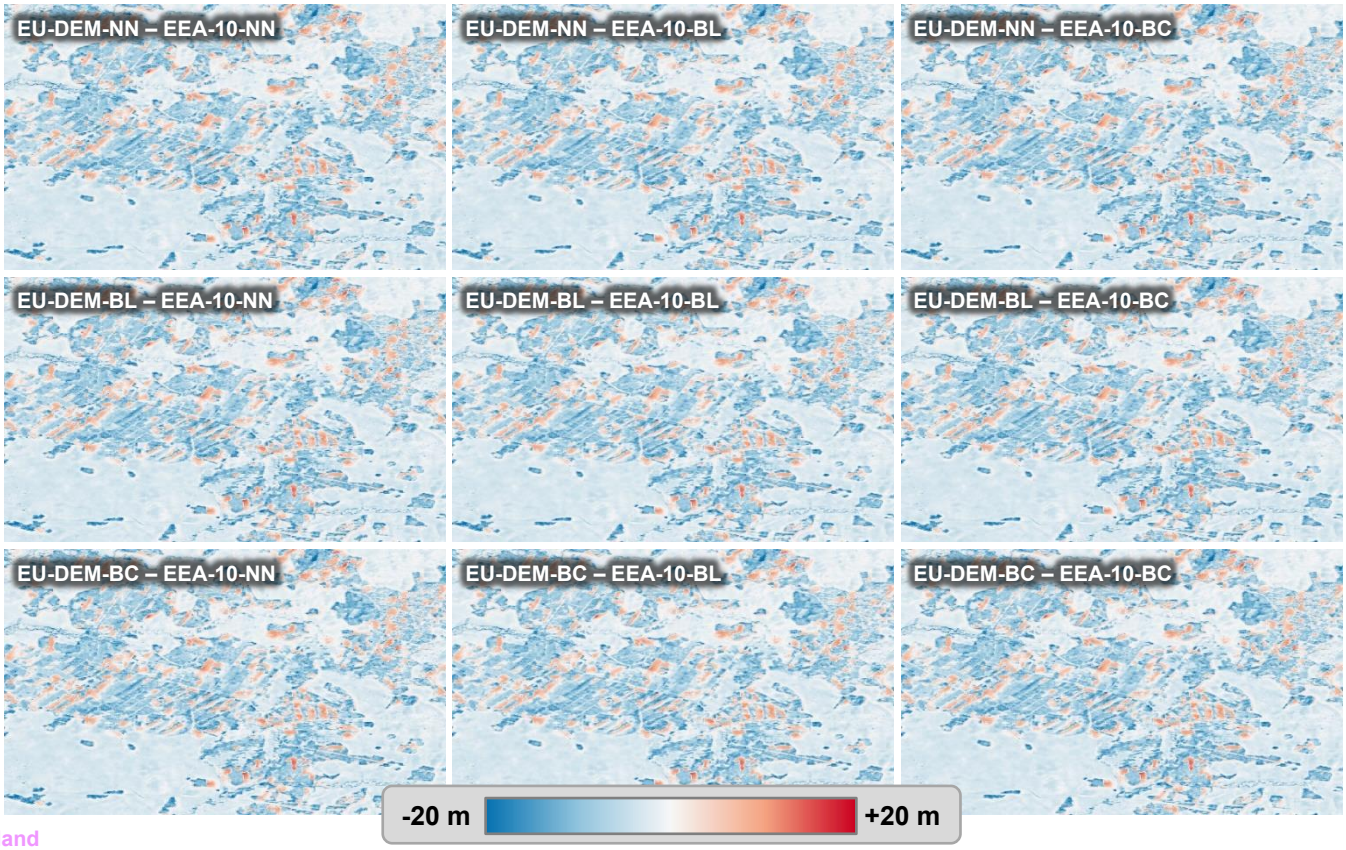
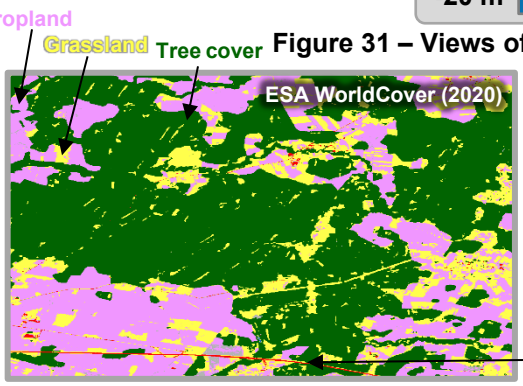


Figure 31 – Views of (EU-DEM -EEA-10) over DEMIX tile N55XE021D.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 30), which are identified as transitions between grasslands, croplands, urban areas and tree cover (see attached LULC map).

One may see small height differences over grasslands, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -3.58 m** **Std Dev = 5.08 m** **RMSE = 6.22 m**	**Mean = -3.58 m** **Std Dev = 4.94 m** **RMSE = 6.10 m**	**Mean = -3.58 m** **Std Dev = 5.04 m** **RMSE = 6.18 m**
Bilinear (BL)	**Mean = -3.58 m** **Std Dev = 5.07 m** **RMSE = 6.21 m**	**Mean = -3.58 m** **Std Dev = 4.93 m** **RMSE = 6.10 m**	**Mean = -3.58 m** **Std Dev = 5.03 m** **RMSE = 6.18 m**
Bicubic (BC)	**Mean = -3.58 m** **Std Dev = 5.07 m** **RMSE = 6.21 m**	**Mean = -3.58 m** **Std Dev = 4.93 m** **RMSE = 6.10 m**	**Mean = -3.58 m** **Std Dev = 5.03 m** **RMSE = 6.18 m**

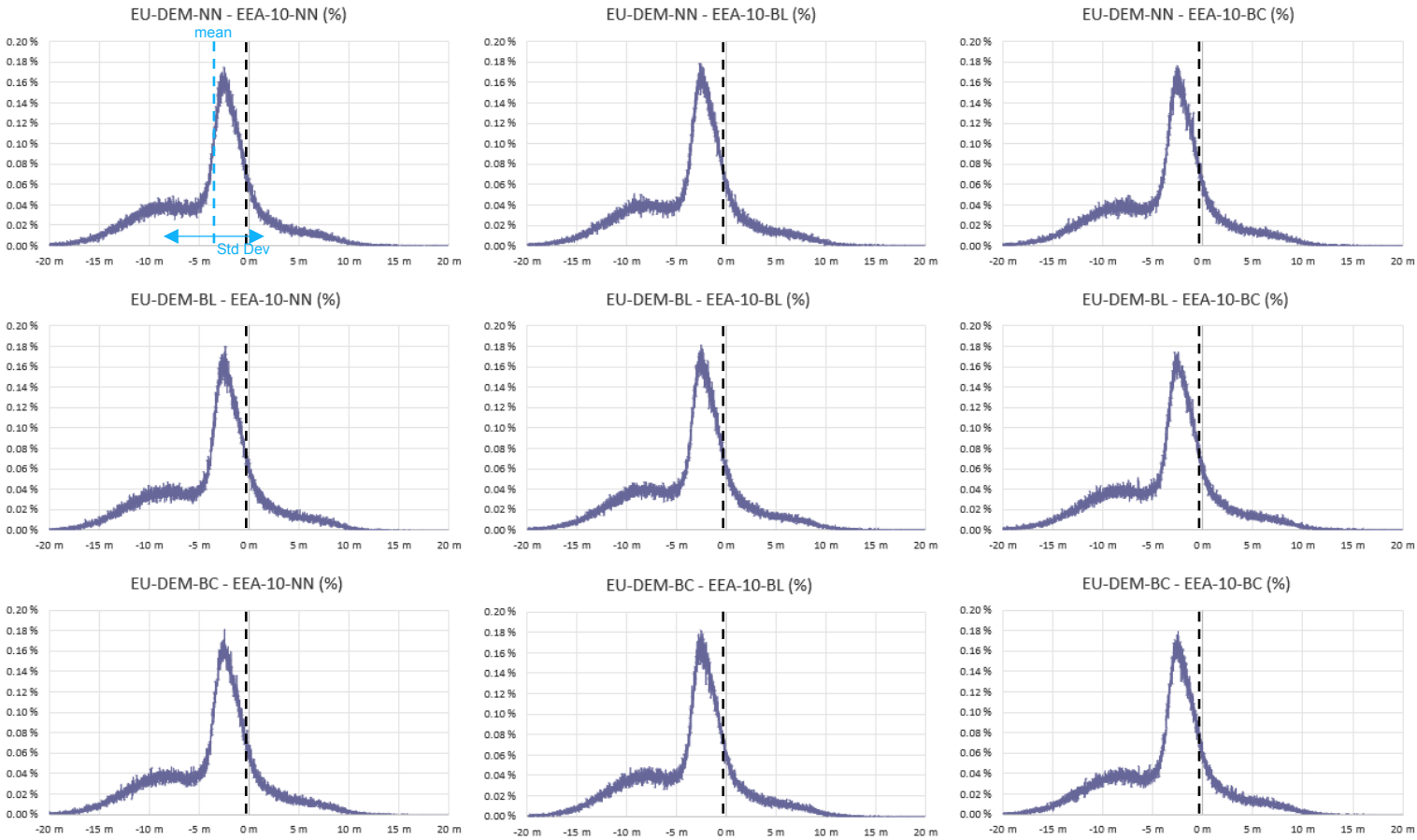


Figure 32 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N55XE021D.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** and **(EU-DEM-BC – EEA-10-BL)** studies, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.15 m** for standard deviation and **0.12 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -2.5 m of difference. This mode is linked to cropland and grassland classes. The long tails of distribution are due to the tree cover (see attached figure of last page).

4.1.1.8 08 - Poland - N53XE017C (zone 2)

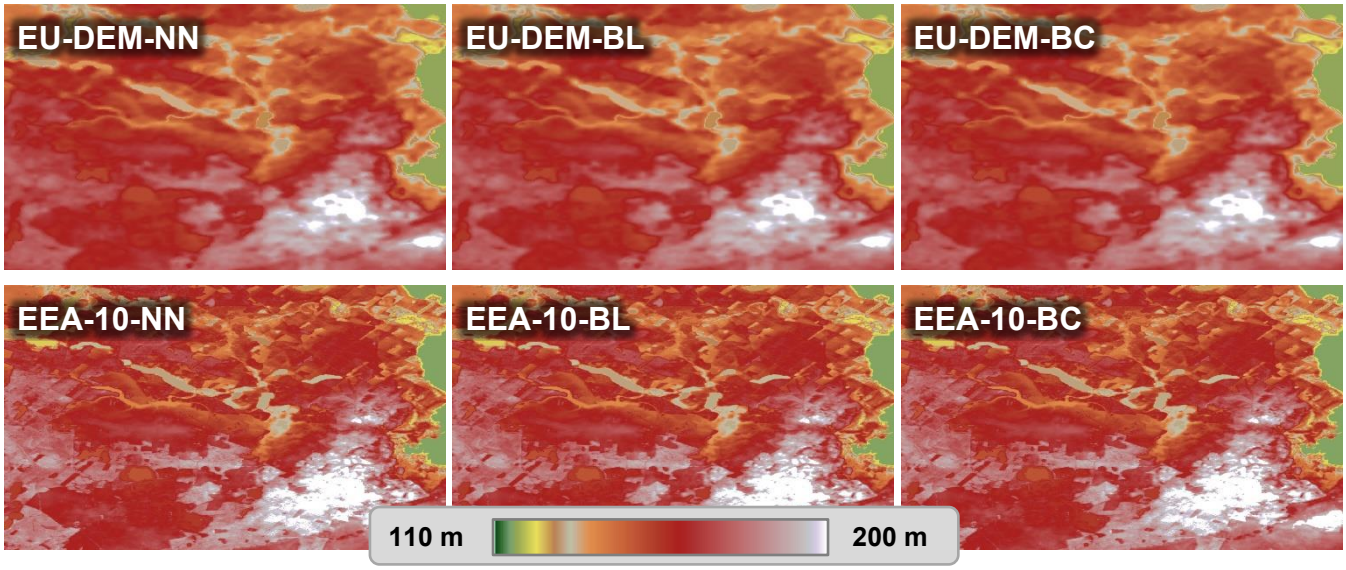


Figure 33 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N53XE017C.

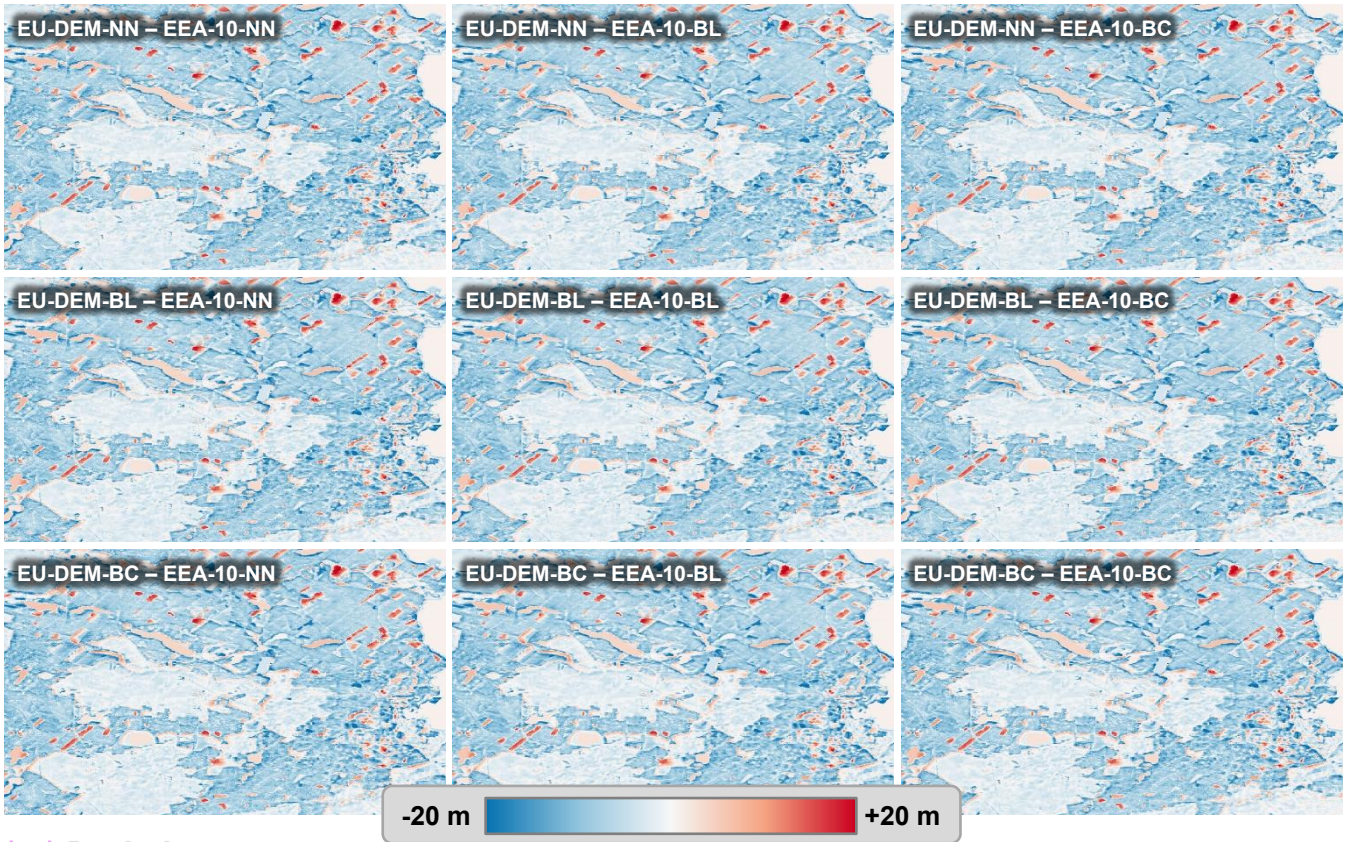
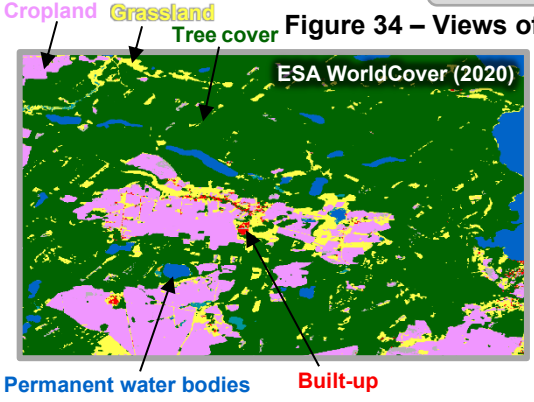


Figure 34 – Views of (EU-DEM -EEA-10) over DEMIX tile N53XE017C.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 33), which are identified as transitions between grasslands, croplands, urban areas and tree cover (see attached figure).

One may see small height differences over grasslands, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -4.83 m** **Std Dev = 5.81 m** **RMSE = 7.55 m**	**Mean = -4.83 m** **Std Dev = 5.67 m** **RMSE = 7.45 m**	**Mean = -4.83 m** **Std Dev = 5.77 m** **RMSE = 7.52 m**
Bilinear (BL)	**Mean = -4.83 m** **Std Dev = 5.79 m** **RMSE = 7.54 m**	**Mean = -4.83 m** **Std Dev = 5.66 m** **RMSE = 7.44 m**	**Mean = -4.83 m** **Std Dev = 5.75 m** **RMSE = 7.51 m**
Bicubic (BC)	**Mean = -4.83 m** **Std Dev = 5.79 m** **RMSE = 7.54 m**	**Mean = -4.82 m** **Std Dev = 5.65 m** **RMSE = 7.43 m**	**Mean = -4.83 m** **Std Dev = 5.75 m** **RMSE = 7.50 m**

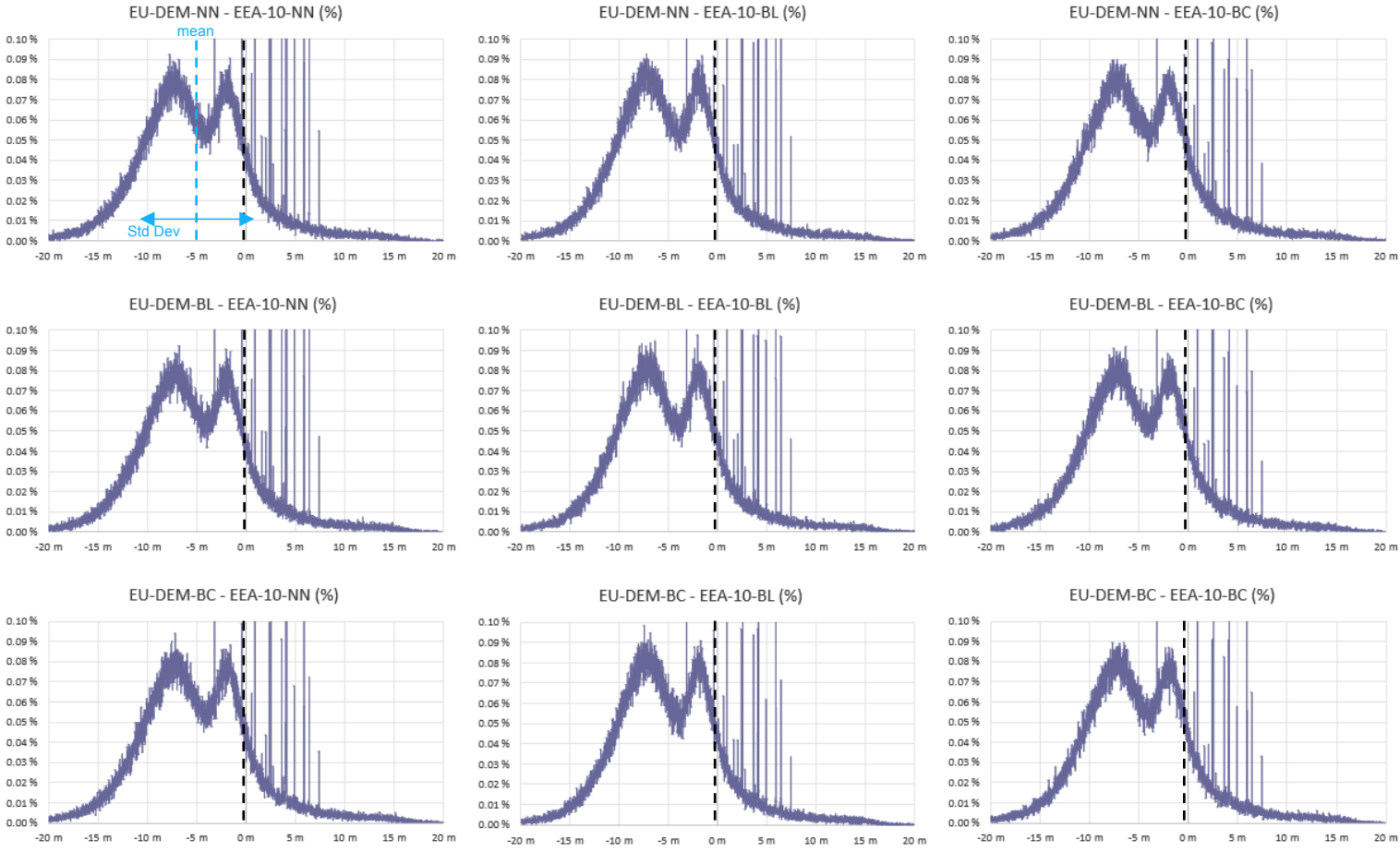


Figure 35 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N53XE017C.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for mean, **0.16 m** for standard deviation and **0.12 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

One may note the presence of two negative modes in the histograms. The first, close to -1.5 metres, is due to height comparisons over cropland and grassland. The second, close to – 7.5 metres, is due to the tree cover (see last page).

4.1.1.9 09 - Germany - N50ZE008F (zone 2)

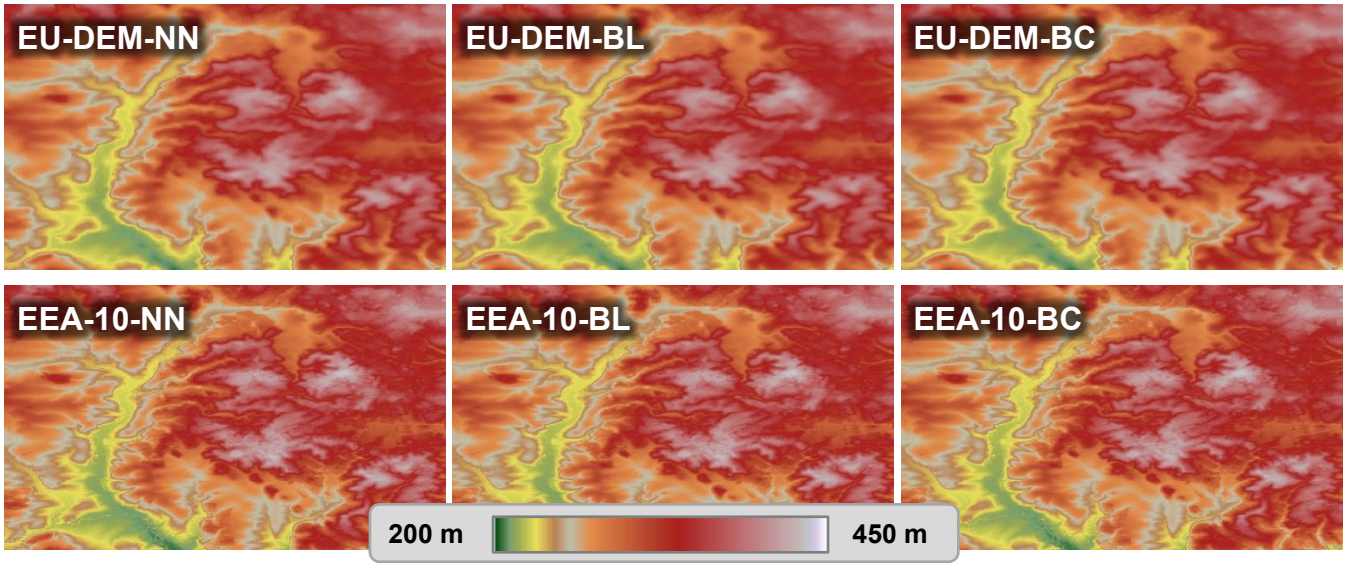


Figure 36 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N50ZE008F.

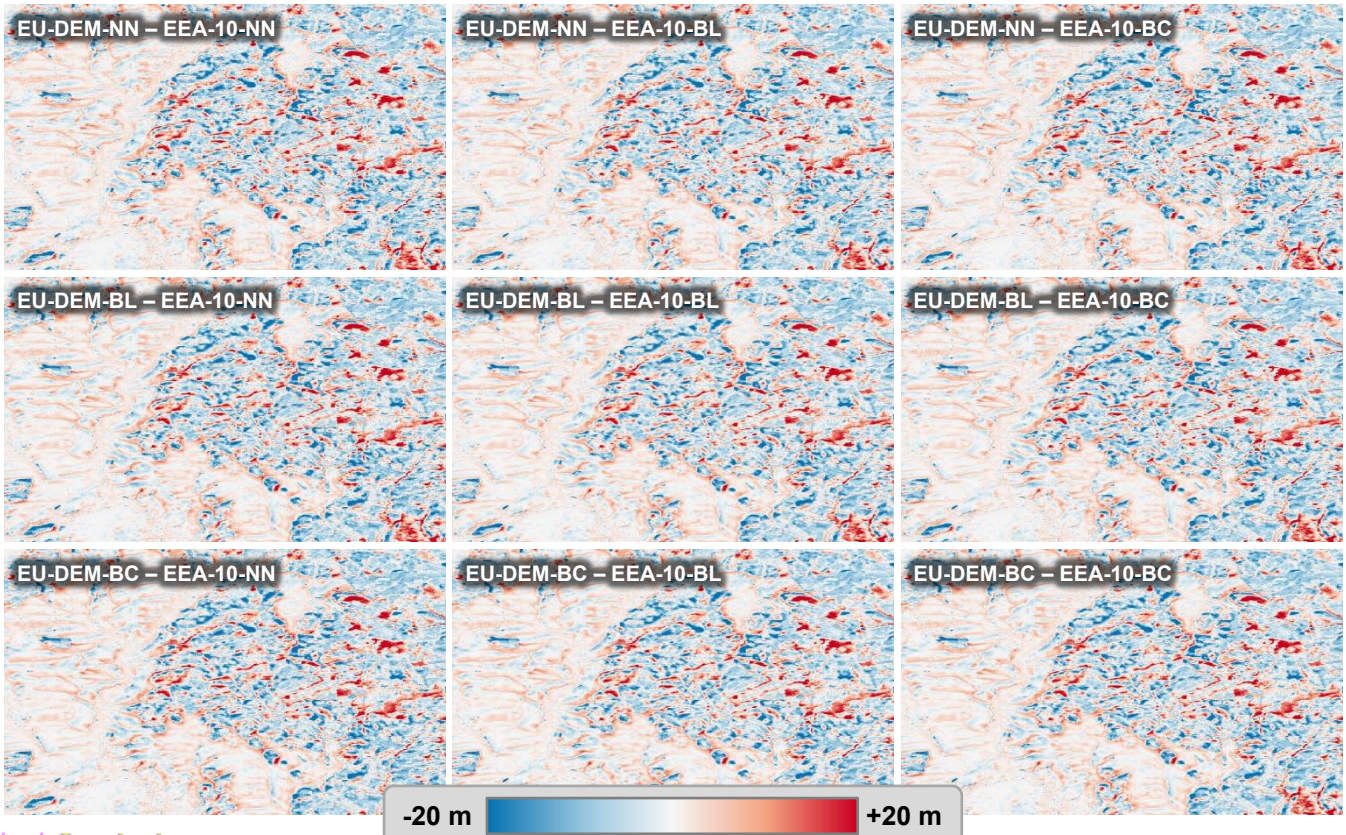
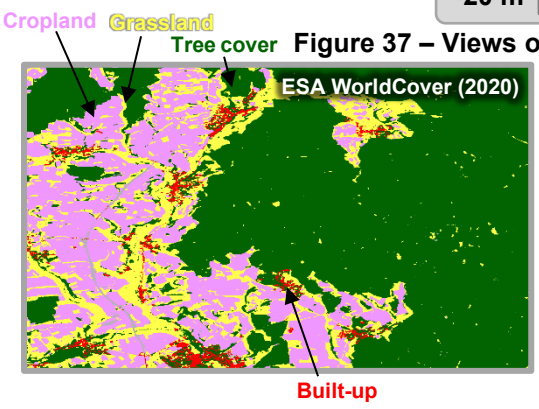


Figure 37 – Views of (EU-DEM -EEA-10) over DEMIX tile N50ZE008F.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 36), which are identified as transitions between grasslands, croplands, urban areas and tree cover (see attached figure).

One may see small height differences over grasslands, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -0.77 m Std Dev = 6.98 m RMSE = 7.02 m	Mean = -0.77 m Std Dev = 6.83 m RMSE = 6.87 m	Mean = -0.77 m Std Dev = 6.91 m RMSE = 6.95 m
Bilinear (BL)	Mean = -0.77 m Std Dev = 6.92 m RMSE = 6.96 m	Mean = -0.77 m Std Dev = 6.77 m RMSE = 6.81 m	Mean = -0.77 m Std Dev = 6.85 m RMSE = 6.89 m
Bicubic (BC)	Mean = -0.77 m Std Dev = 6.91 m RMSE = 6.96 m	Mean = -0.77 m Std Dev = 6.76 m RMSE = 6.81 m	Mean = -0.77 m Std Dev = 6.85 m RMSE = 6.89 m

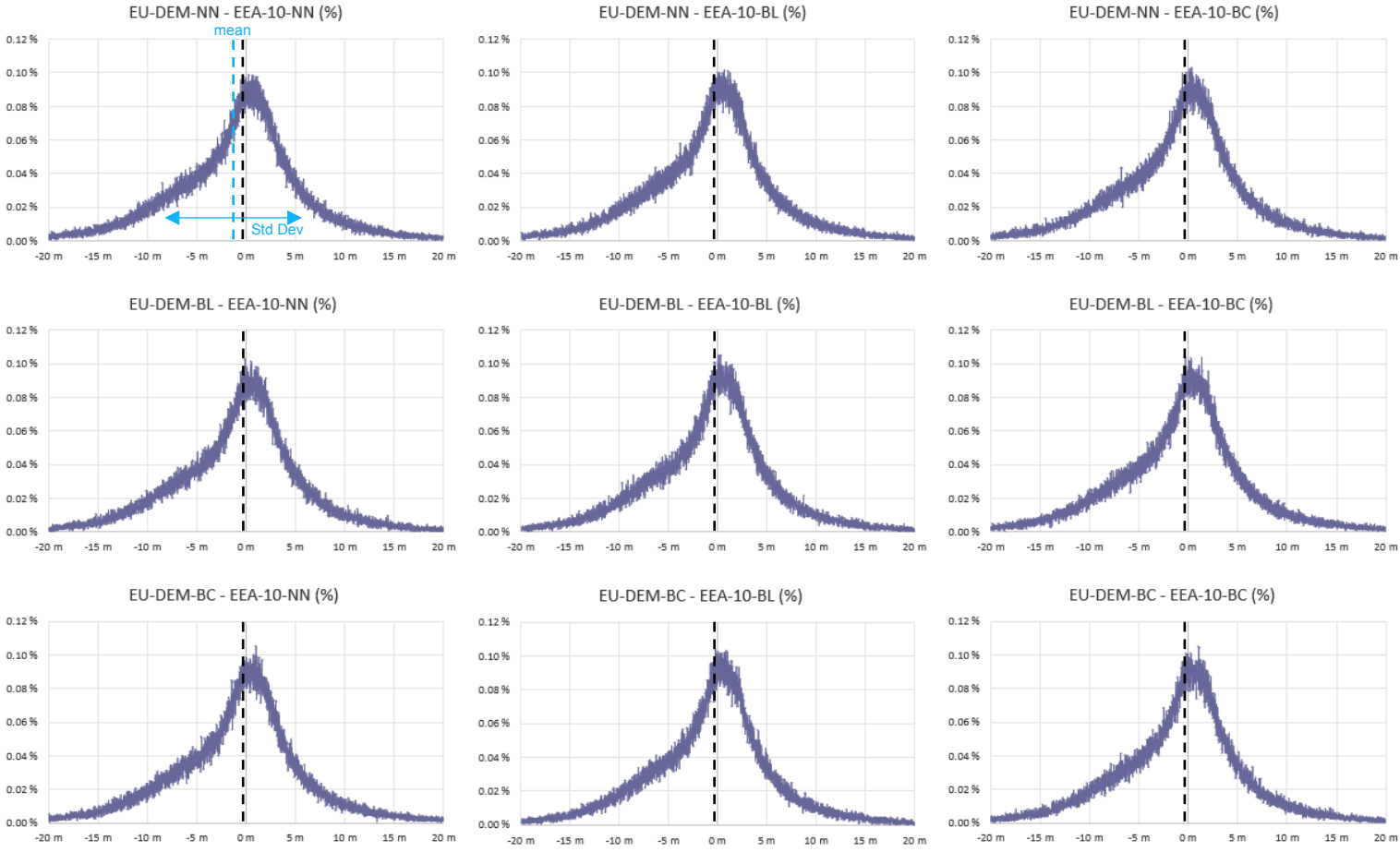


Figure 38 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N50ZE008F.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.17 m** for standard deviation and **0.21 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 0.5 m of difference. This mode is linked to cropland and grassland classes. The long tails of distribution are due to the tree cover (see attached figure of last page).

4.1.1.10 10 - Denmark - N55RE010B (zone 2)

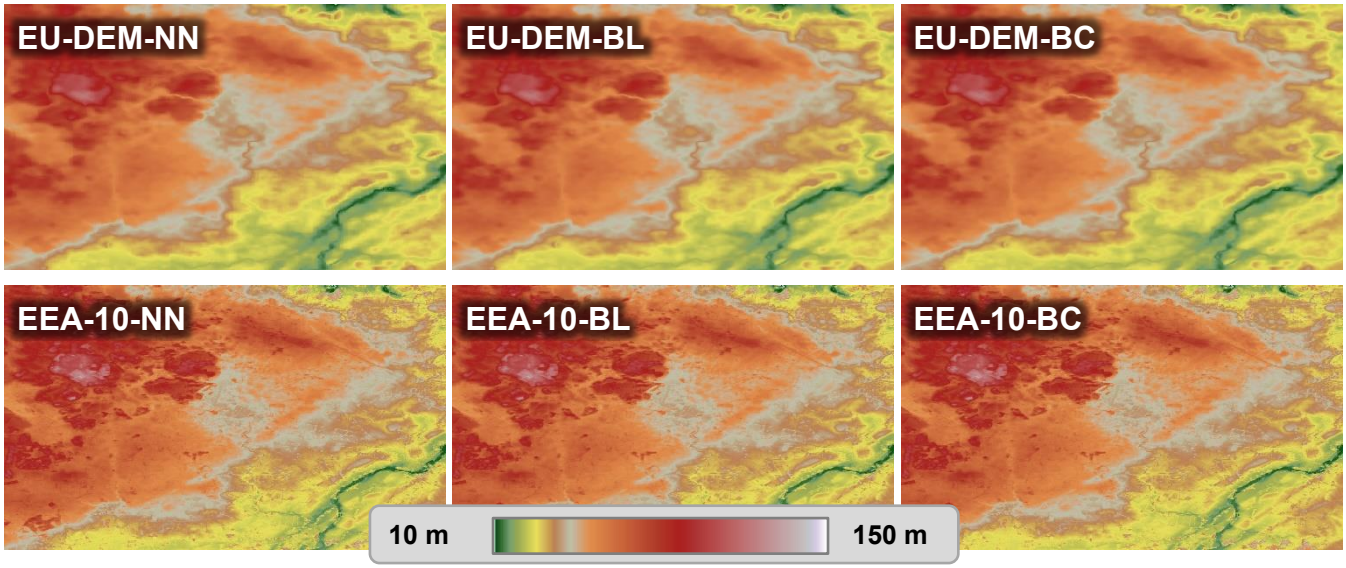


Figure 39 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N55RE010B.

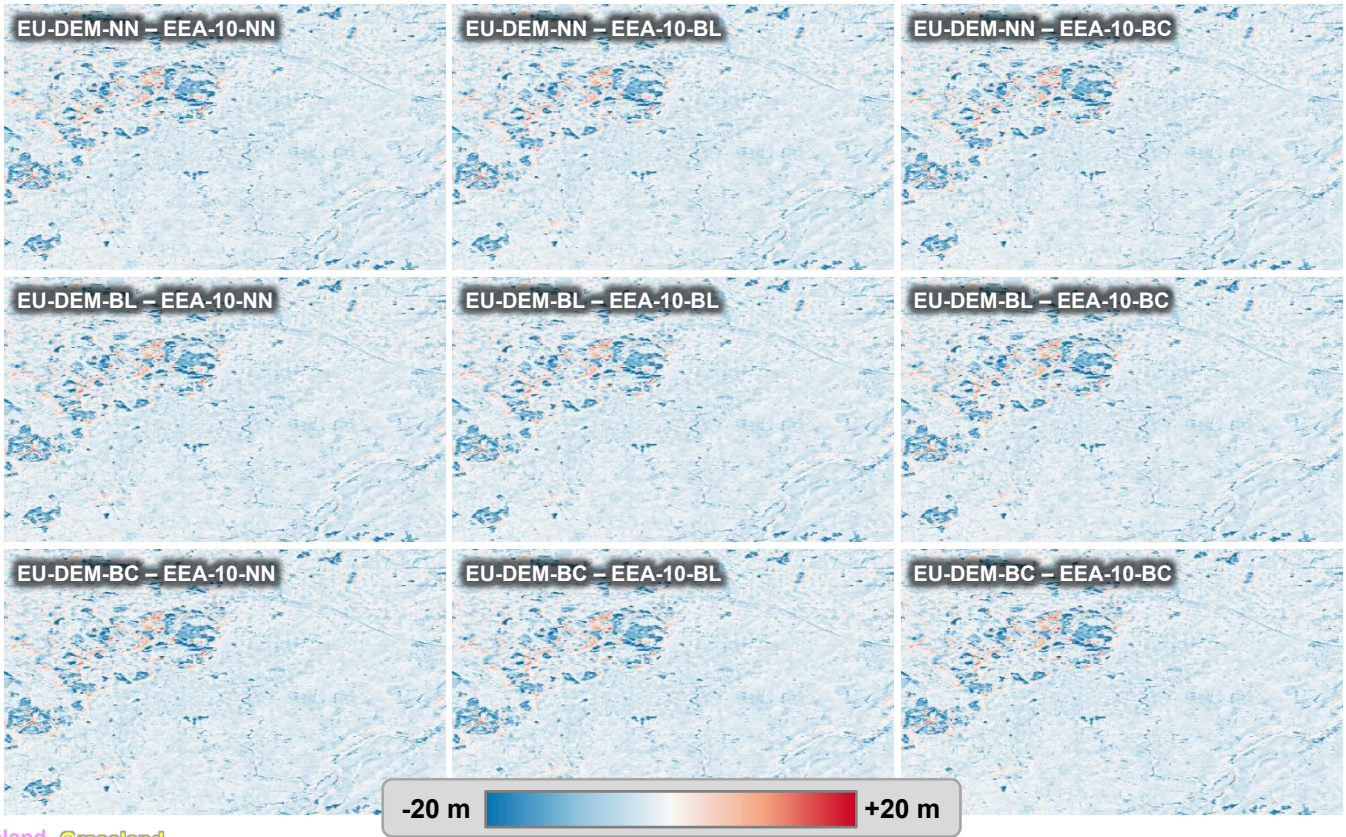
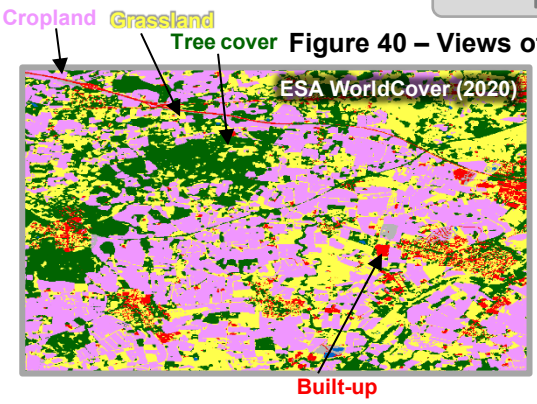


Figure 40 – Views of (EU-DEM -EEA-10) over DEMIX tile N55RE010B.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 39), which are identified as transitions between grasslands, croplands, urban areas and tree cover (see attached figure).

One may see small height differences over grasslands, urban areas and croplands. Especially high differences can be seen on the North East of this tile, which are caused by the tree cover class. On the opposite, sparse tree cover does not seem to lead to high differences.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -2.97 m** **Std Dev = 3.73 m** **RMSE = 4.76 m**	**Mean = -2.97 m** **Std Dev = 3.58 m** **RMSE = 4.66 m**	**Mean = -2.97 m** **Std Dev = 3.67 m** **RMSE = 4.73 m**
Bilinear (BL)	**Mean = -2.97 m** **Std Dev = 3.71 m** **RMSE = 4.75 m**	**Mean = -2.97 m** **Std Dev = 3.57 m** **RMSE = 4.64 m**	**Mean = -2.97 m** **Std Dev = 3.66 m** **RMSE = 4.72 m**
Bicubic (BC)	**Mean = -2.97 m** **Std Dev = 3.71 m** **RMSE = 4.75 m**	**Mean = -2.97 m** **Std Dev = 3.57 m** **RMSE = 4.64 m**	**Mean = -2.97 m** **Std Dev = 3.66 m** **RMSE = 4.71 m**

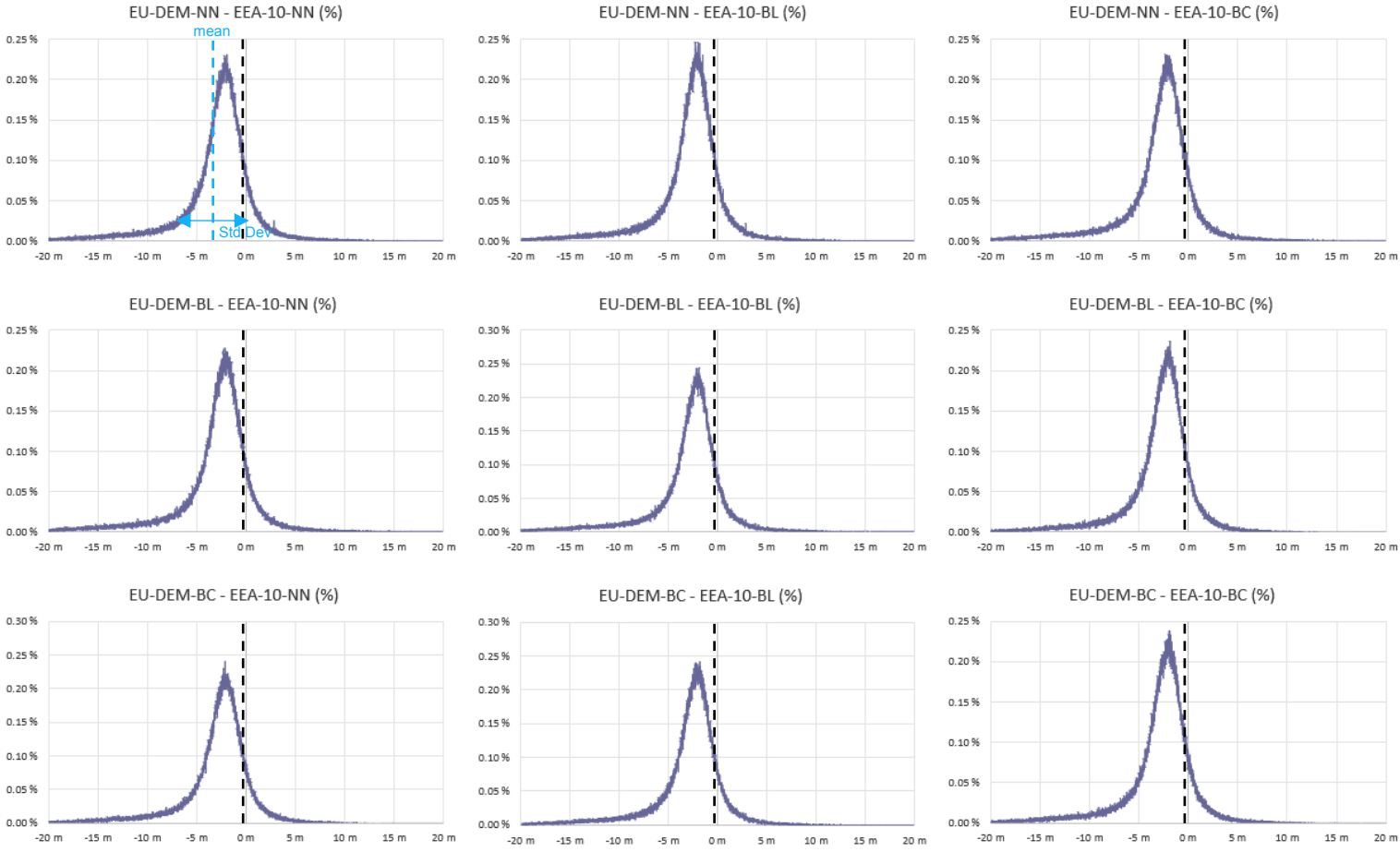


Figure 41 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N55RE010B.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** and **(EU-DEM-BC – EEA-10-BL)** studies, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.16 m** for standard deviation and **0.13 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a high mode close to -2 m of difference. This mode is linked to cropland and grassland classes. The highest positive and negative differences are due to the tree cover (see attached figure of last page).

4.1.1.11 11 - Netherlands - N52ZE005F (zone 2)

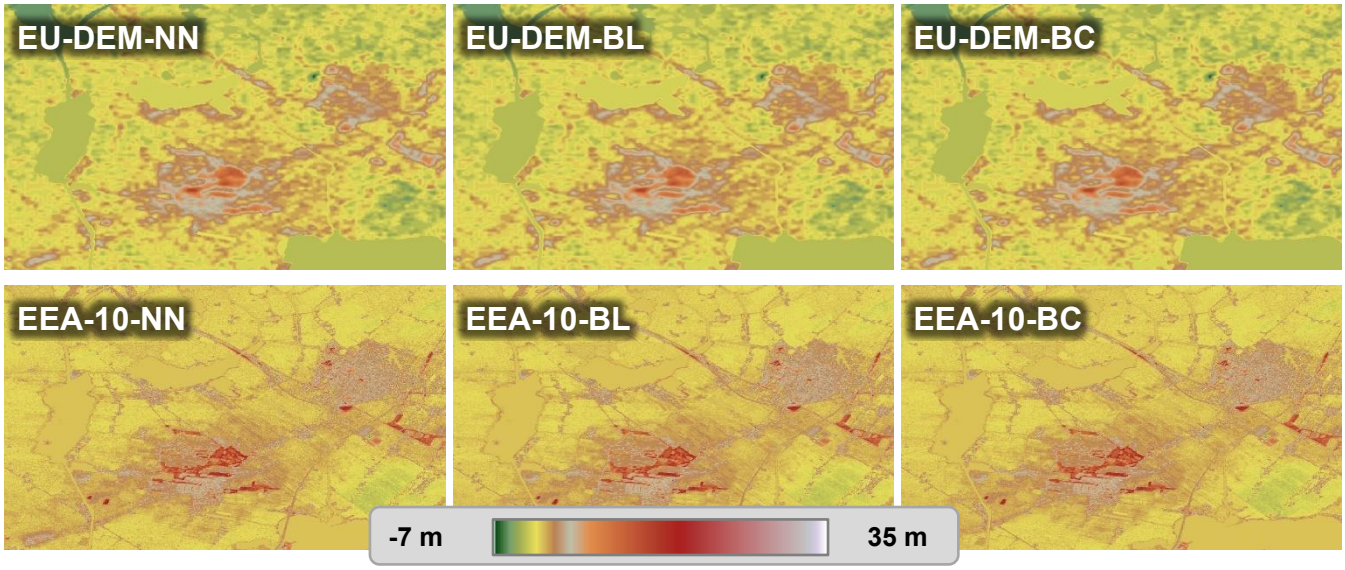


Figure 42 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N52ZE005F.

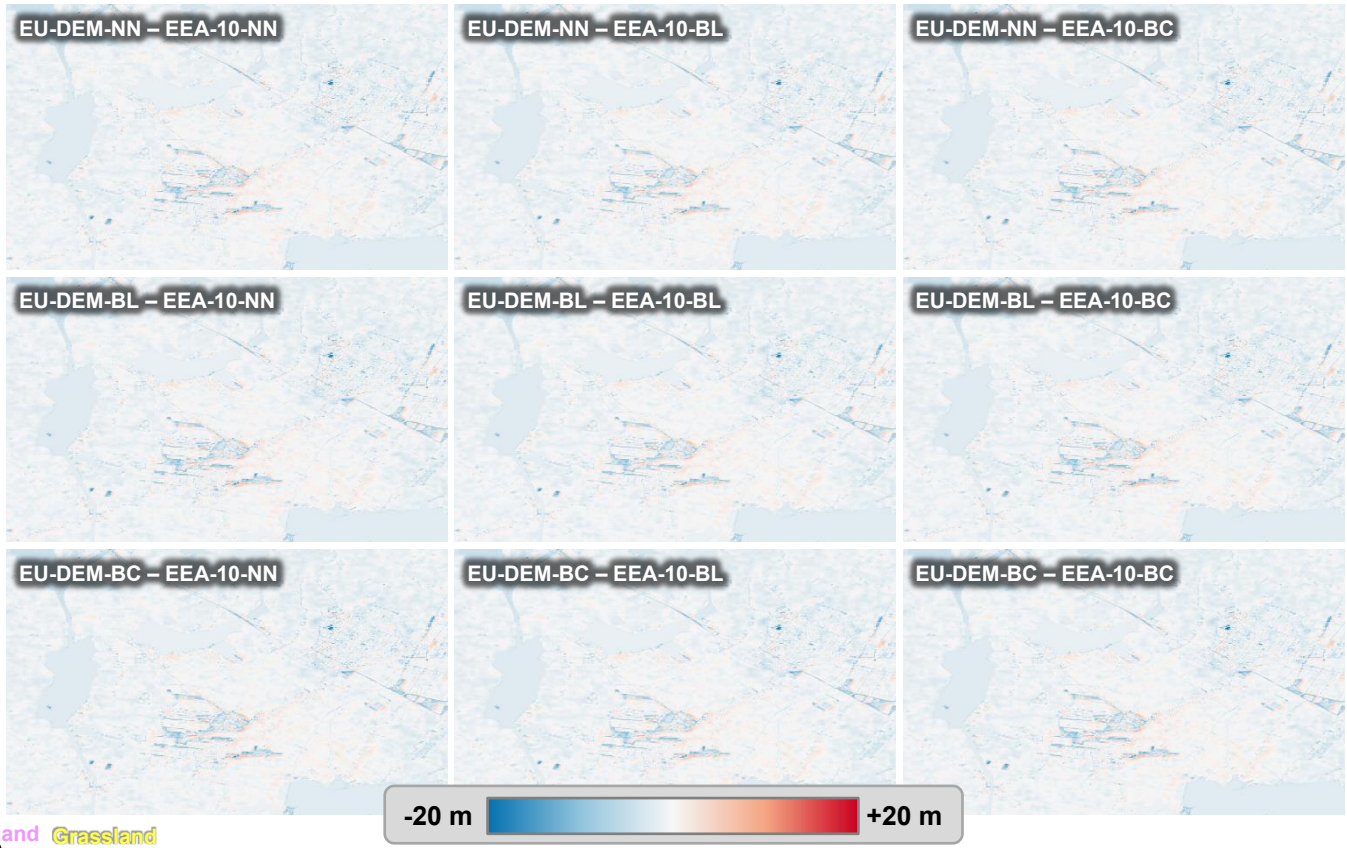
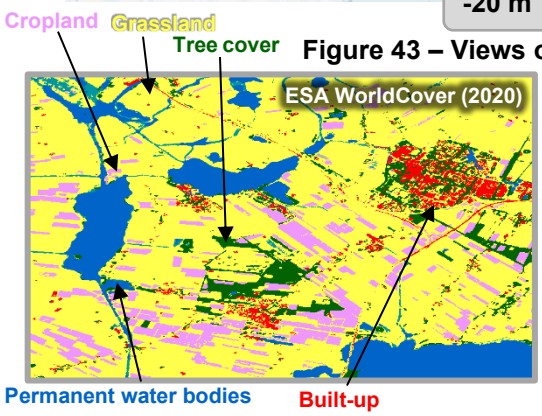


Figure 43 – Views of (EU-DEM -EEA-10) over DEMIX tile N52ZE005F.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 42). The highest points, highlighted in red, belong to the tree cover class (see attached figure).

One may see small height differences over grasslands, permanent water bodies, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -1.08 m** **Std Dev = 1.57 m** **RMSE = 1.91 m**	**Mean = -1.08 m** **Std Dev = 1.49 m** **RMSE = 1.84 m**	**Mean = -1.08 m** **Std Dev = 1.54 m** **RMSE = 1.88 m**
Bilinear (BL)	**Mean = -1.08 m** **Std Dev = 1.56 m** **RMSE = 1.90 m**	**Mean = -1.08 m** **Std Dev = 1.49 m** **RMSE = 1.84 m**	**Mean = -1.08 m** **Std Dev = 1.53 m** **RMSE = 1.88 m**
Bicubic (BC)	**Mean = -1.08 m** **Std Dev = 1.57 m** **RMSE = 1.91 m**	**Mean = -1.08 m** **Std Dev = 1.49 m** **RMSE = 1.84 m**	**Mean = -1.08 m** **Std Dev = 1.54 m** **RMSE = 1.88 m**

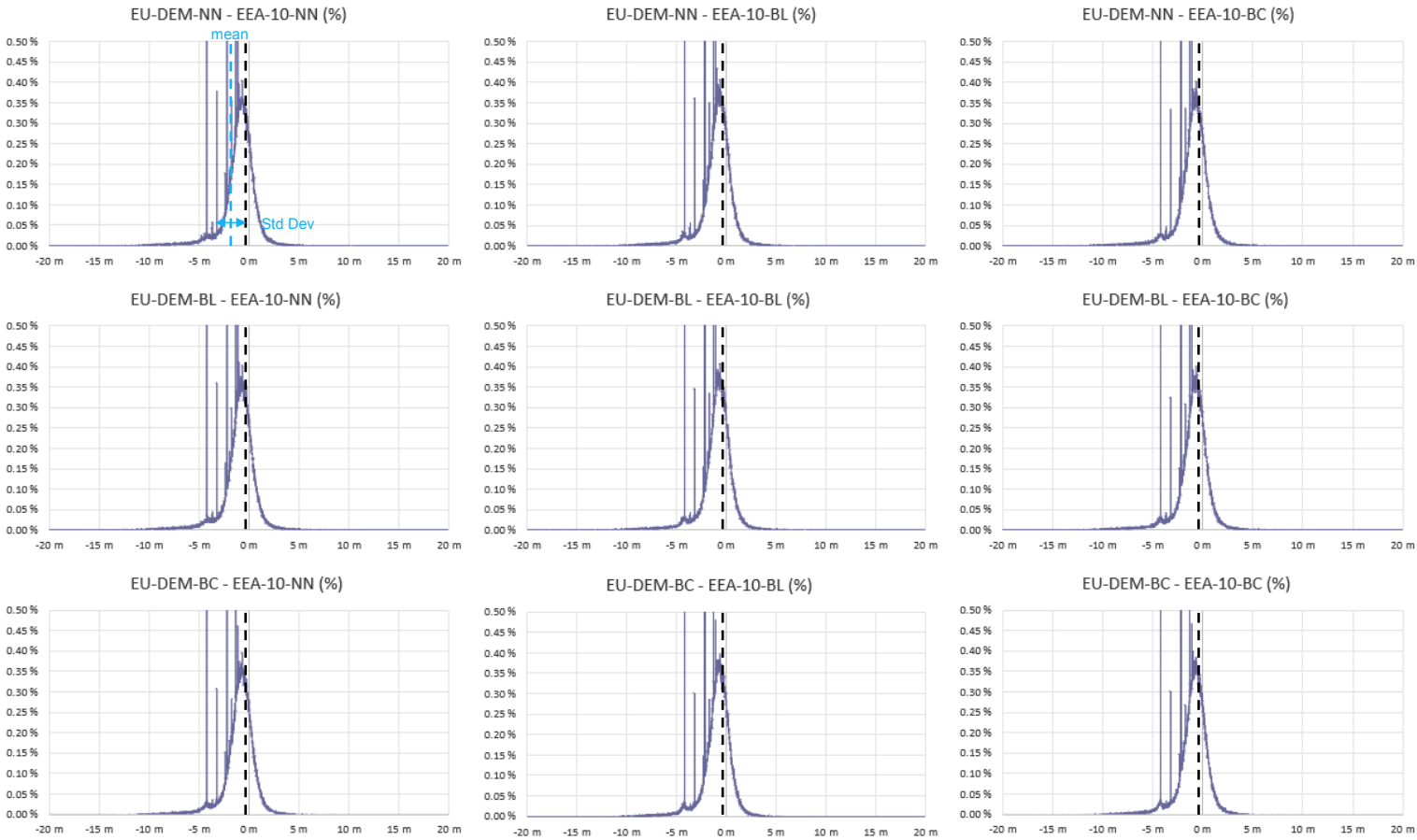


Figure 44 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N52ZE005F.

In this case, the **best results** are obtained with the **(EU-DEM-NN – EEA-10-BL), (EU-DEM-BL – EEA-10-BL) and (EU-DEM-BC - EEA-10-BL)** studies, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN) and (EU-DEM-BC - EEA-10-NN)** studies. The differences between best and worst statistics reach **0.08 m** for standard deviation and **0.07 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -0.5 m of difference. This peak is linked to cropland and grassland classes. Punctual high values in the histogram are due to flat areas, identified as lakes (see attached figure of last page).

4.1.1.12 12 - Belgium - N50YE004F (zone 2)

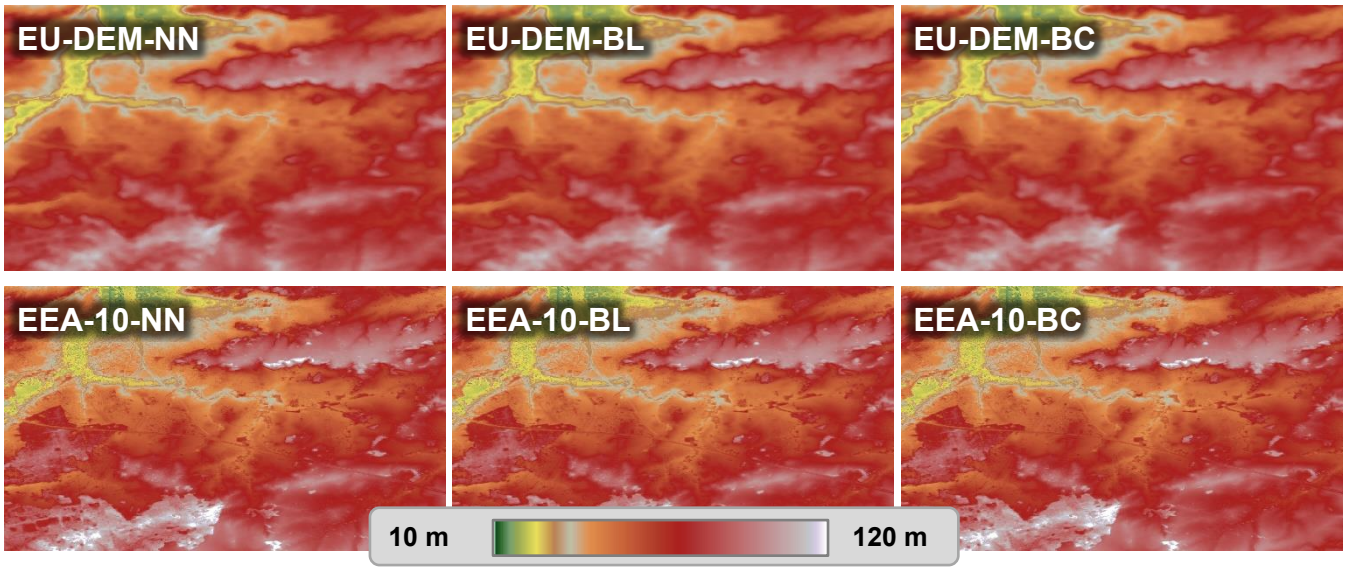


Figure 45 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N50YE004F.

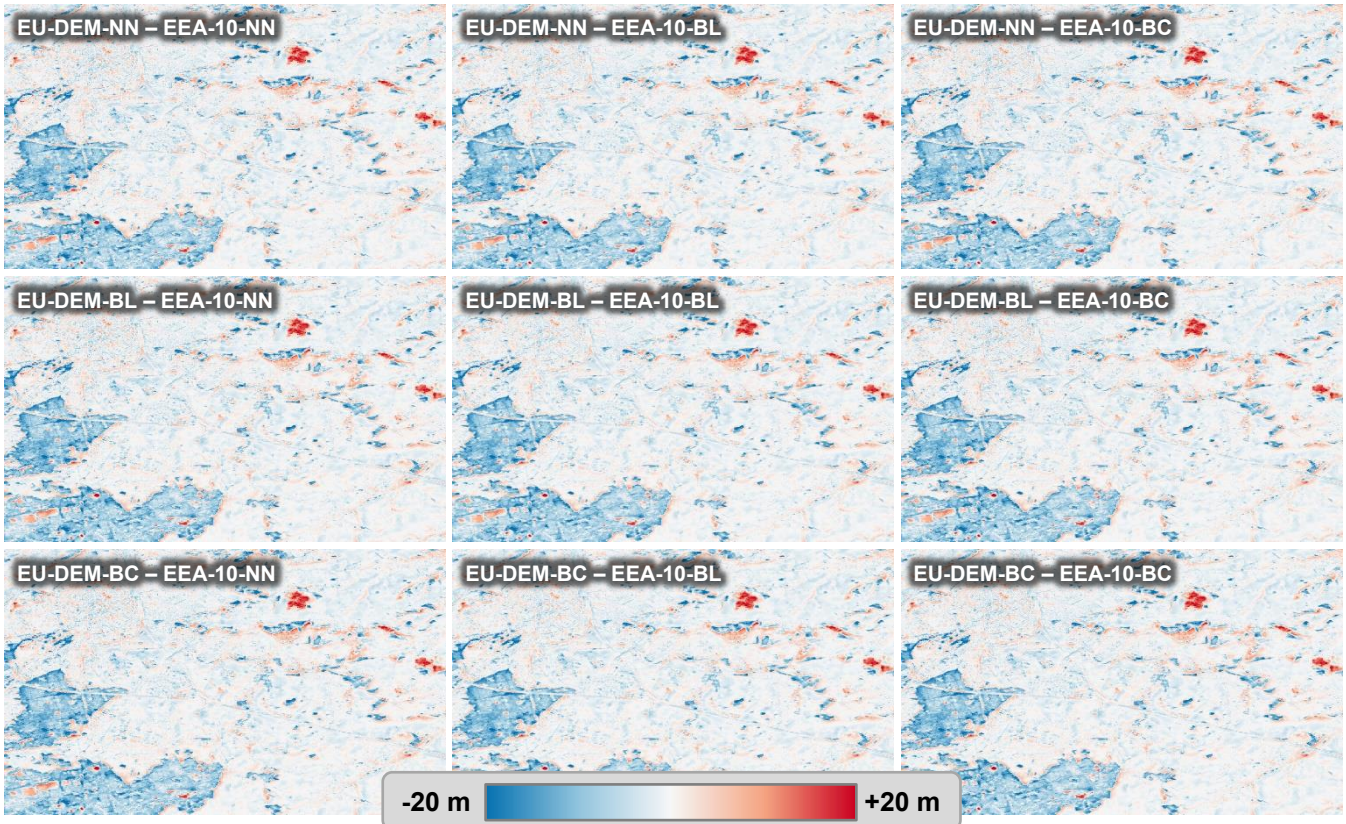
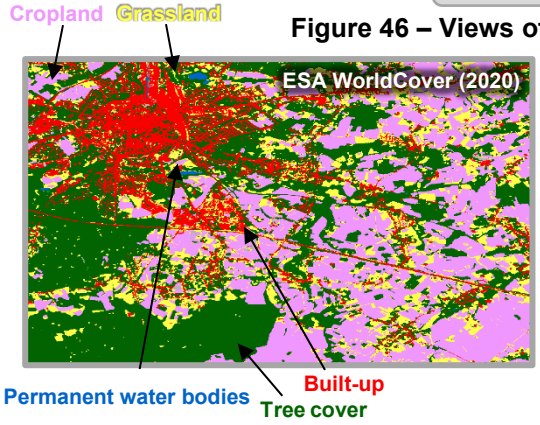


Figure 46 – Views of (EU-DEM -EEA-10) over DEMIX tile N50YE004F.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 45). Most of the height transitions are visible in an urban area located at the North West of the tile (see attached figure).

One may see that most of the high differences are located over the forests of this area. The grasslands and urban areas do not lead to high differences.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -1.72 m** **Std Dev = 4.71 m** **RMSE = 5.01 m**	**Mean = -1.71 m** **Std Dev = 4.56 m** **RMSE = 4.87 m**	**Mean = -1.71 m** **Std Dev = 4.65 m** **RMSE = 4.96 m**
Bilinear (BL)	**Mean = -1.72 m** **Std Dev = 4.70 m** **RMSE = 5.00 m**	**Mean = -1.71 m** **Std Dev = 4.55 m** **RMSE = 4.86 m**	**Mean = -1.71 m** **Std Dev = 4.64 m** **RMSE = 4.95 m**
Bicubic (BC)	**Mean = -1.72 m** **Std Dev = 4.69 m** **RMSE = 4.99 m**	**Mean = -1.71 m** **Std Dev = 4.54 m** **RMSE = 4.85 m**	**Mean = -1.71 m** **Std Dev = 4.64 m** **RMSE = 4.94 m**

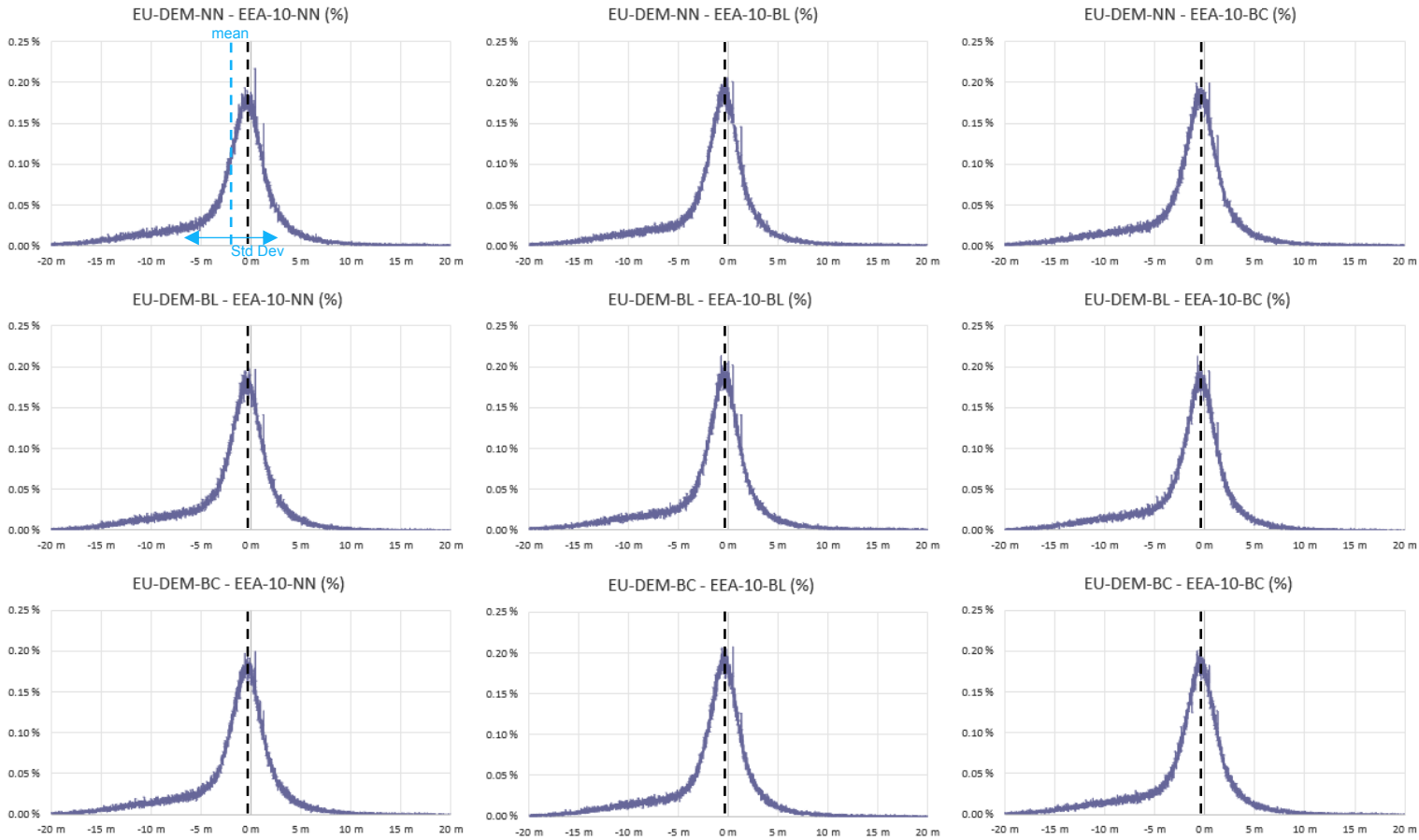


Figure 47 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N50YE004F.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for mean, **0.17 m** for standard deviation and **0.16 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -0.3 m of difference. This peak is linked to built-up, cropland and grassland classes. The highest differences are due to the tree cover (see attached figure of last page). Peaks are due to flat areas, identified as lakes.

4.1.1.13 13 - France - N44QW001H (zone 1)

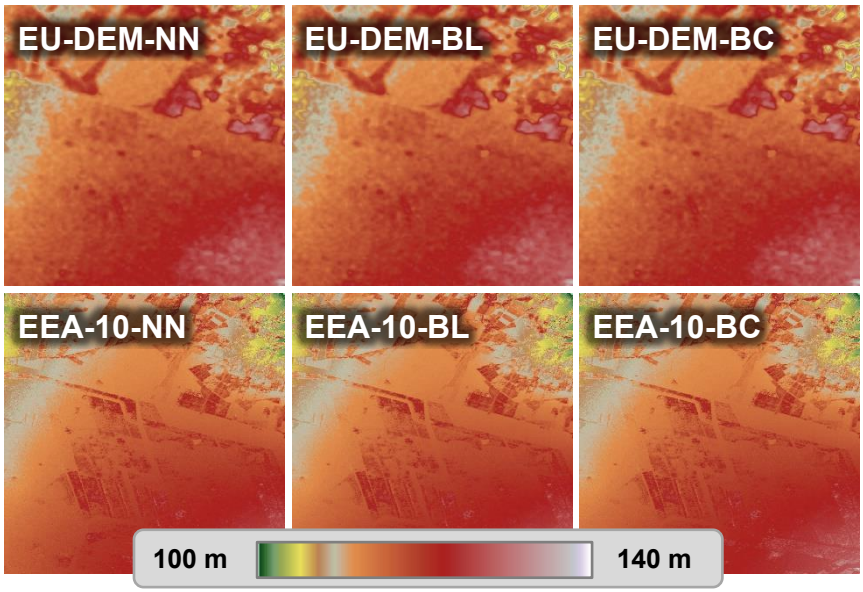
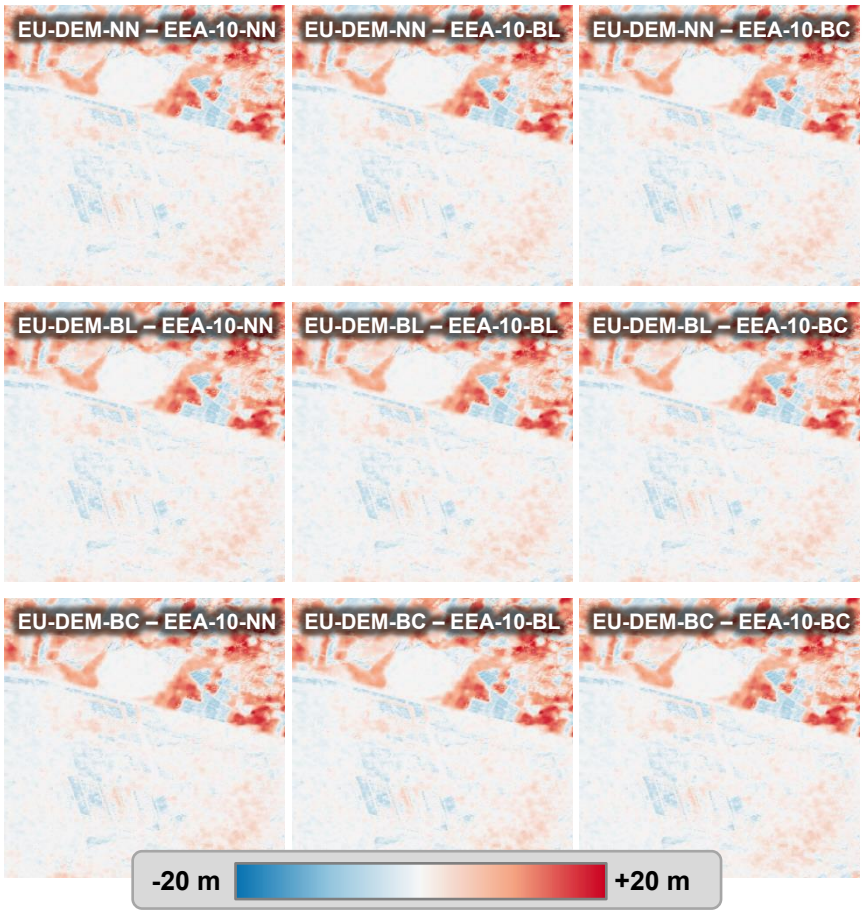


Figure 48 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N44QW001H.



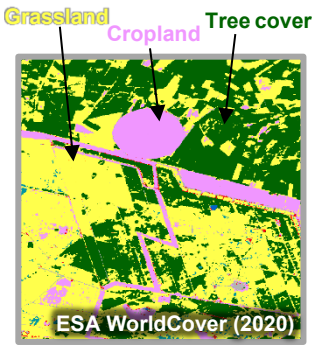


Figure 49 – Views of (EU-DEM -EEA-10) over DEMIX tile N44QW001H.

Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 48).
One may see high differences on the North of the tile, which are due to the tree cover. The smallest differences, located in the South of the tile, highlight the transition between forest / cropland and a military base (see attached figures). Sparse tree cover and grassland may explain the best results observed over the South of the tile.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 1.62 m** **Std Dev = 4.16 m** **RMSE = 4.46 m**	**Mean = 1.62 m** **Std Dev = 4.12 m** **RMSE = 4.43 m**	**Mean = 1.62 m** **Std Dev = 4.14 m** **RMSE = 4.45 m**
Bilinear (BL)	**Mean = 1.62 m** **Std Dev = 4.15 m** **RMSE = 4.45 m**	**Mean = 1.62 m** **Std Dev = 4.11 m** **RMSE = 4.42 m**	**Mean = 1.62 m** **Std Dev = 4.13 m** **RMSE = 4.44 m**
Bicubic (BC)	**Mean = 1.62 m** **Std Dev = 4.16 m** **RMSE = 4.46 m**	**Mean = 1.62 m** **Std Dev = 4.12 m** **RMSE = 4.43 m**	**Mean = 1.62 m** **Std Dev = 4.14 m** **RMSE = 4.45 m**

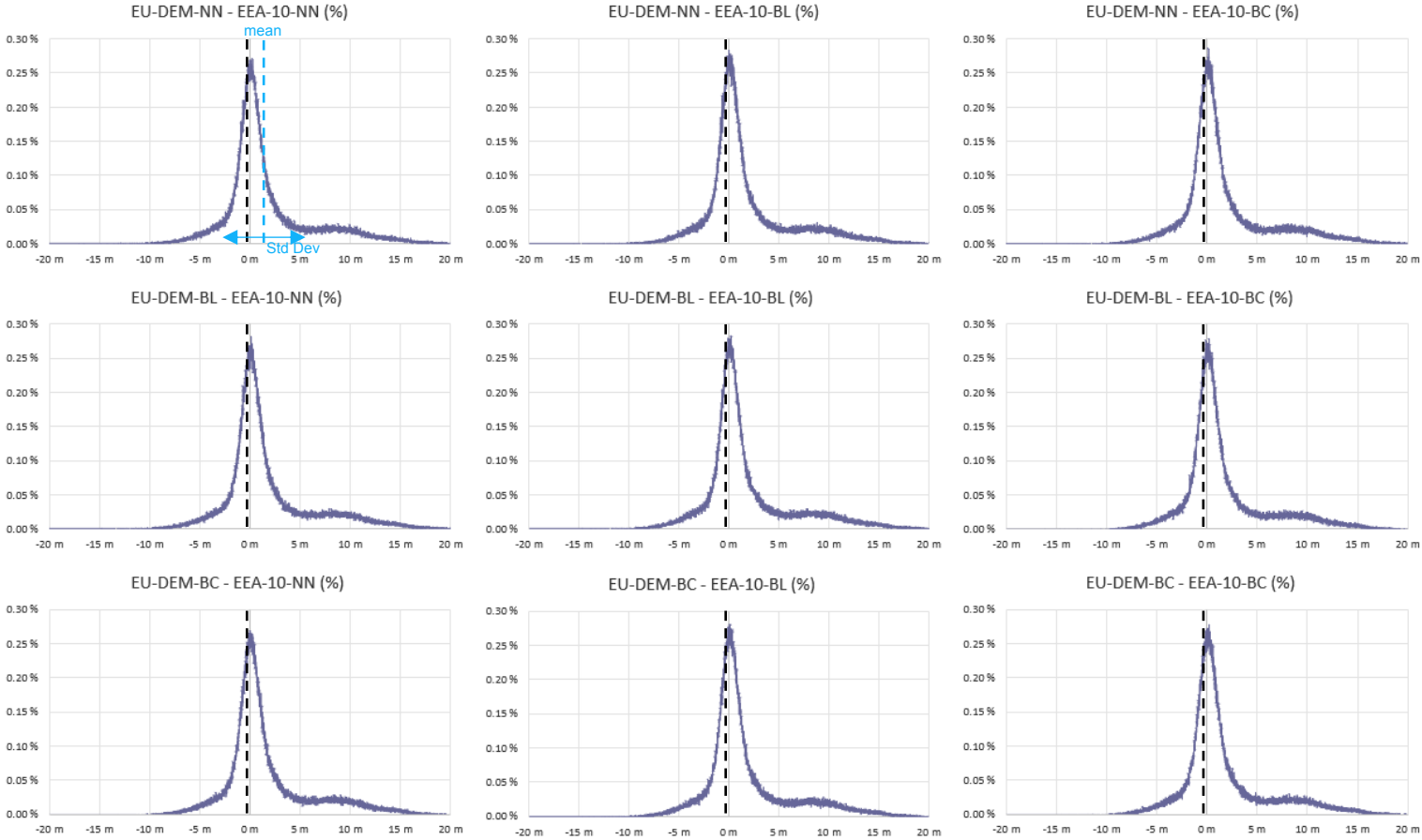


Figure 50 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N44QW001H.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN) and (EU-DEM-BC – EEA-10-NN)** studies. The differences between best and worst statistics reach **0.05 m** for standard deviation and **0.04 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a high peak close to 0 m of difference. This peak is linked to a military base at the South of the tile, showing small variations between both DEMs. The highest differences are due to the forest (see attached figure of last page).

4.1.1.14 14 - Spain - N41VW004C (zone 1)

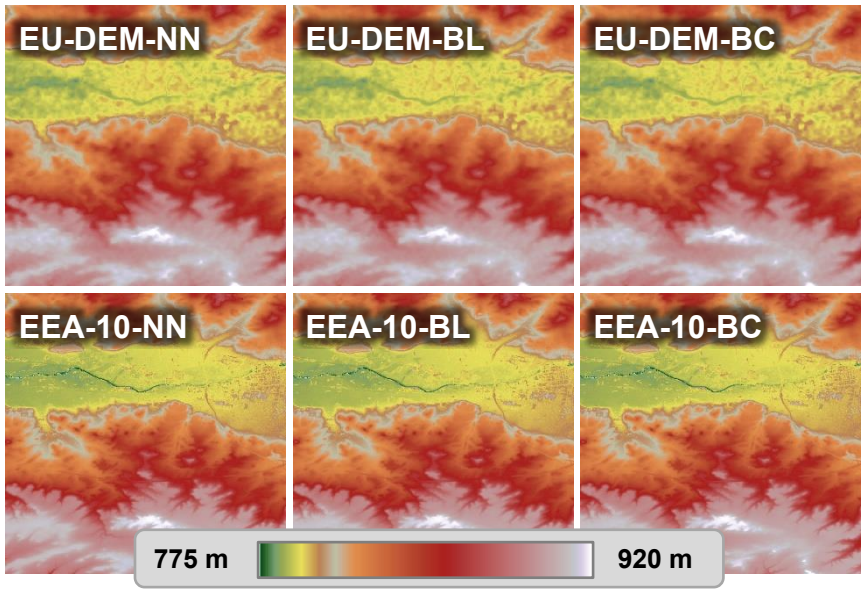


Figure 51 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N41VW004C.

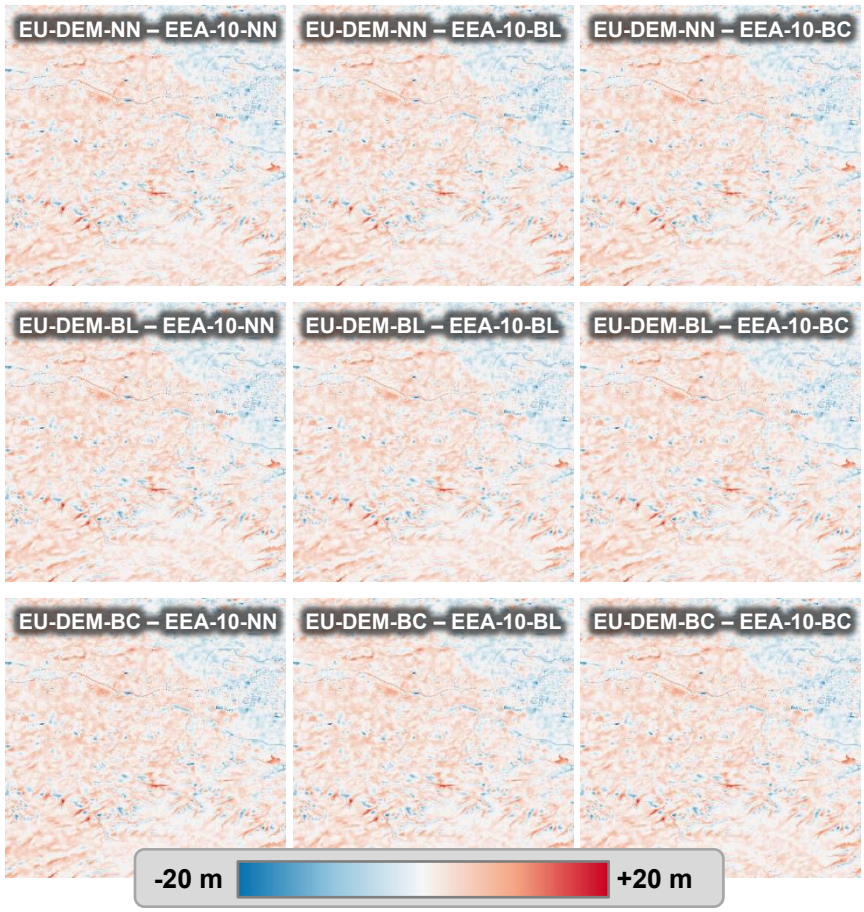
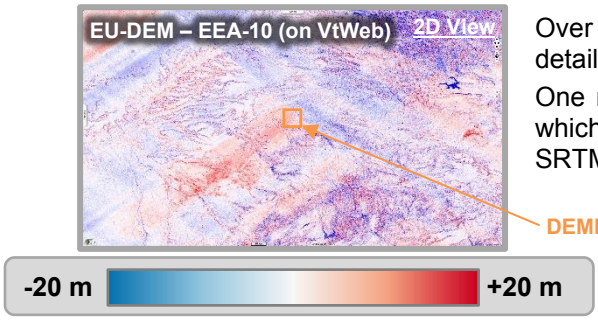


Figure 52 – Views of (EU-DEM -EEA-10) over DEMIX tile N41VW004C.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 51).

One may see negative differences on the North East of the tile, which highlights different swaths of acquisitions, identified as SRTM swaths.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 1.14 m** **Std Dev = 3.12 m** **RMSE = 3.32 m**	**Mean = 1.14 m** **Std Dev = 3.06 m** **RMSE = 3.26 m**	**Mean = 1.14 m** **Std Dev = 3.10 m** **RMSE = 3.30 m**
Bilinear (BL)	**Mean = 1.14 m** **Std Dev = 3.08 m** **RMSE = 3.28 m**	**Mean = 1.14 m** **Std Dev = 3.02 m** **RMSE = 3.23 m**	**Mean = 1.14 m** **Std Dev = 3.06 m** **RMSE = 3.26 m**
Bicubic (BC)	**Mean = 1.14 m** **Std Dev = 3.09 m** **RMSE = 3.29 m**	**Mean = 1.14 m** **Std Dev = 3.03 m** **RMSE = 3.23 m**	**Mean = 1.14 m** **Std Dev = 3.07 m** **RMSE = 3.27 m**

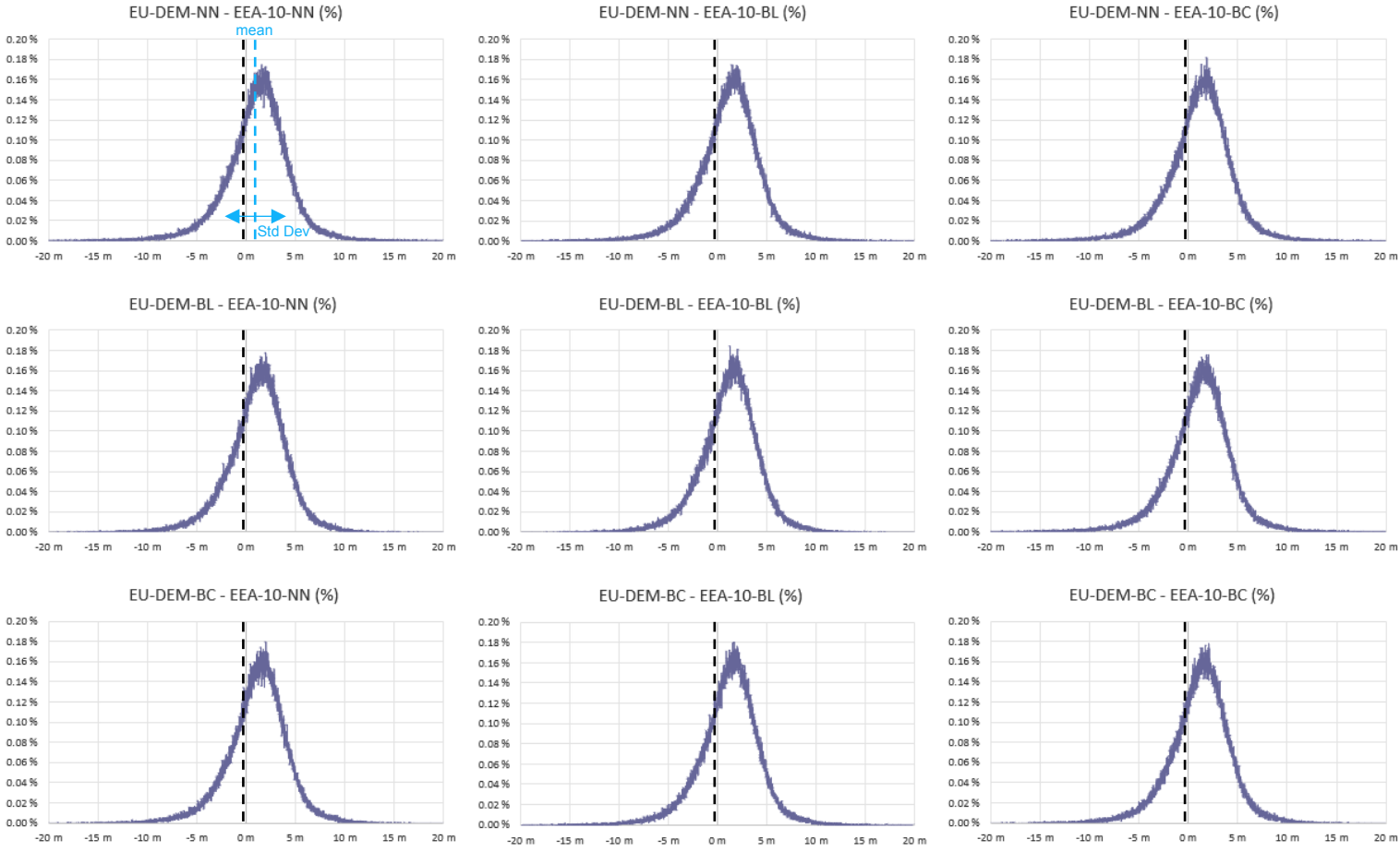


Figure 53 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N41VW004C.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.10 m** for standard deviation and **0.09 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a peak close to 1.5 m of difference. The differences over this tile are mostly constant, only showing small variations due to different SRTM swaths of acquisition (see attached figure of last page).

4.1.1.15 15 - Portugal - N40RW009K (zone 1)

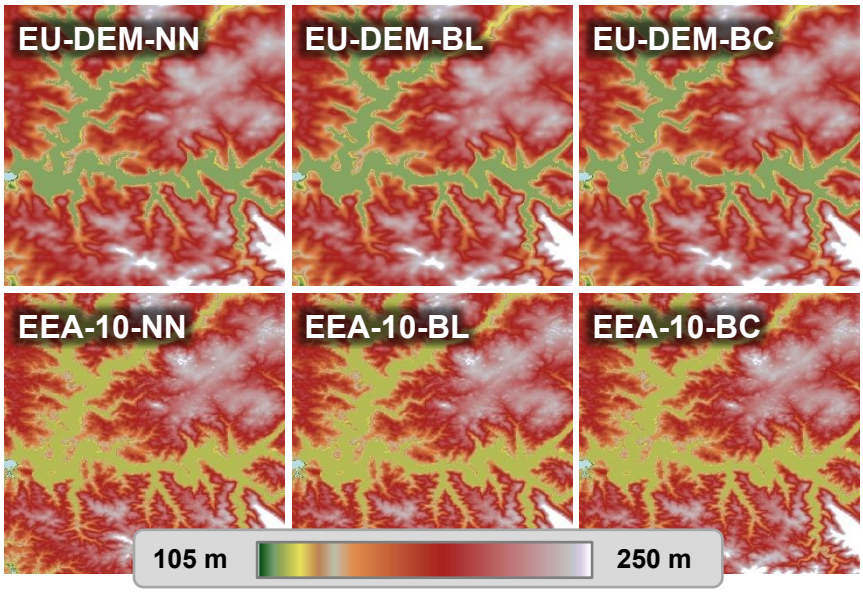


Figure 54 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N40RW009K.

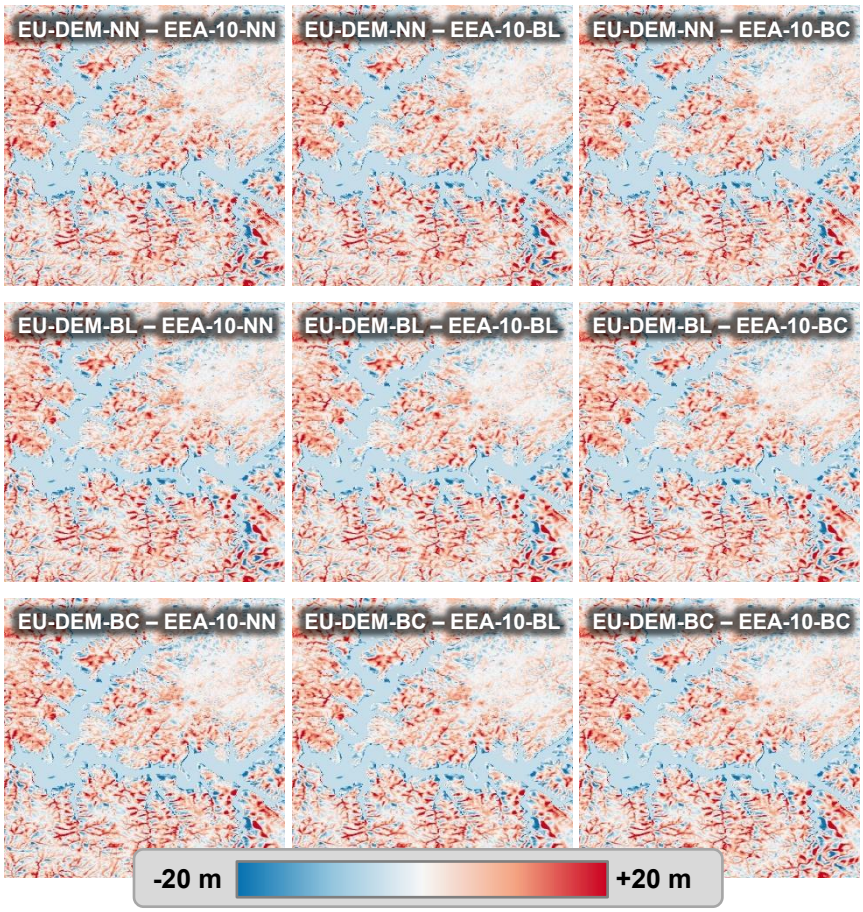
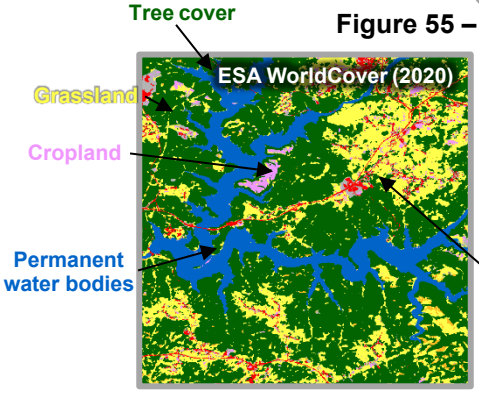


Figure 55 – Views of (EU-DEM -EEA-10) over DEMIX tile N40RW009K.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 54).

One may see small height differences over grasslands, permanent water bodies, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class. A particularly flat area, coloured in light blue, highlights the presence of the Mondego River over this tile.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 1.09 m** **Std Dev = 7.29 m** **RMSE = 7.37 m**	**Mean = 1.11 m** **Std Dev = 7.13 m** **RMSE = 7.21 m**	**Mean = 1.11 m** **Std Dev = 7.20 m** **RMSE = 7.29 m**
Bilinear (BL)	**Mean = 1.09 m** **Std Dev = 7.11 m** **RMSE = 7.19 m**	**Mean = 1.11 m** **Std Dev = 6.94 m** **RMSE = 7.03 m**	**Mean = 1.11 m** **Std Dev = 7.02 m** **RMSE = 7.10 m**
Bicubic (BC)	**Mean = 1.09 m** **Std Dev = 7.14 m** **RMSE = 7.22 m**	**Mean = 1.11 m** **Std Dev = 6.97 m** **RMSE = 7.06 m**	**Mean = 1.11 m** **Std Dev = 7.05 m** **RMSE = 7.14 m**

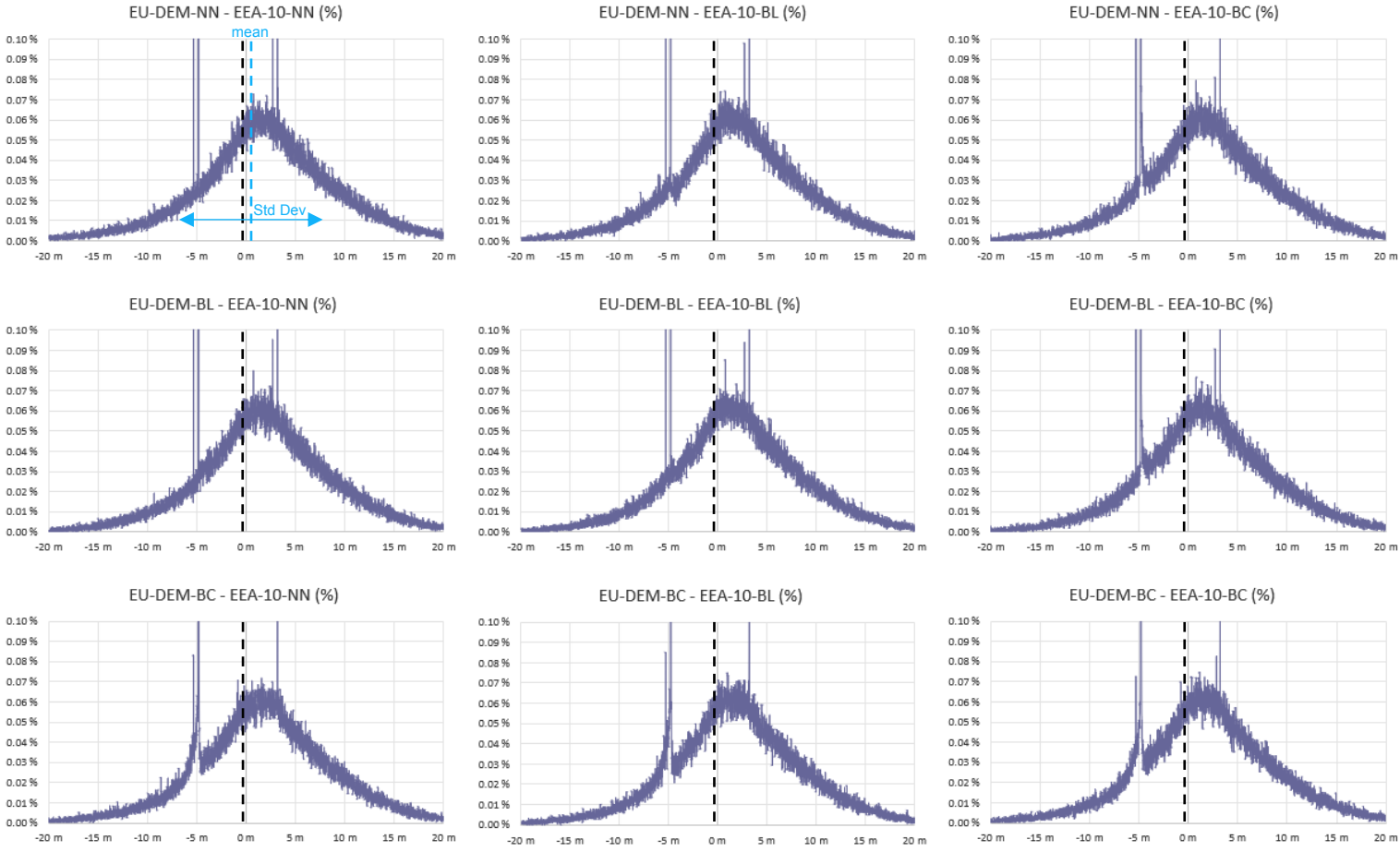


Figure 56 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N40RW009K.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.02 m** for mean, **0.35 m** for standard deviation and **0.34 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a gaussian distribution with a mode close to 1.5 m of difference. One may note a high standard deviation, caused by a high amount of land use / land cover changes (see attached figure of last page).

4.1.1.16 16 - Italy - N37UE014C (zone 1)

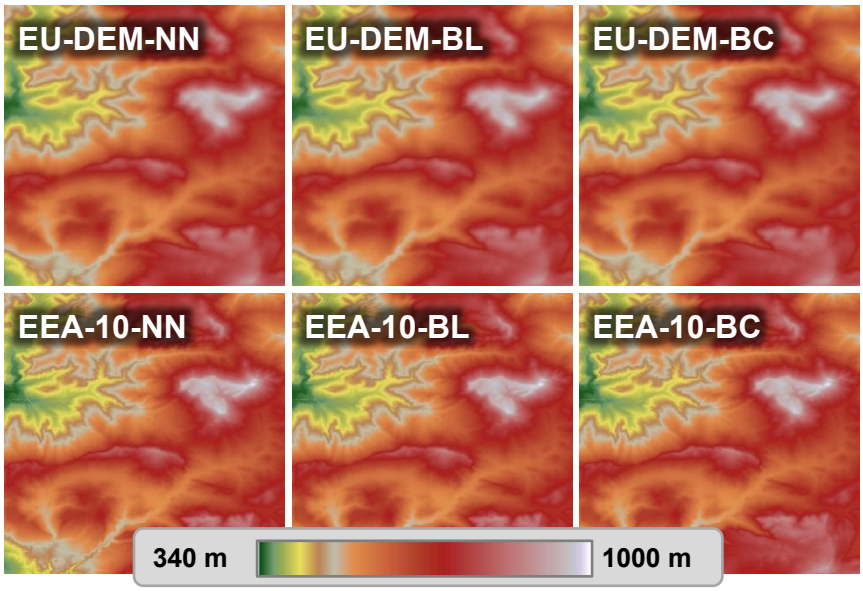


Figure 57 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N37UE014C.

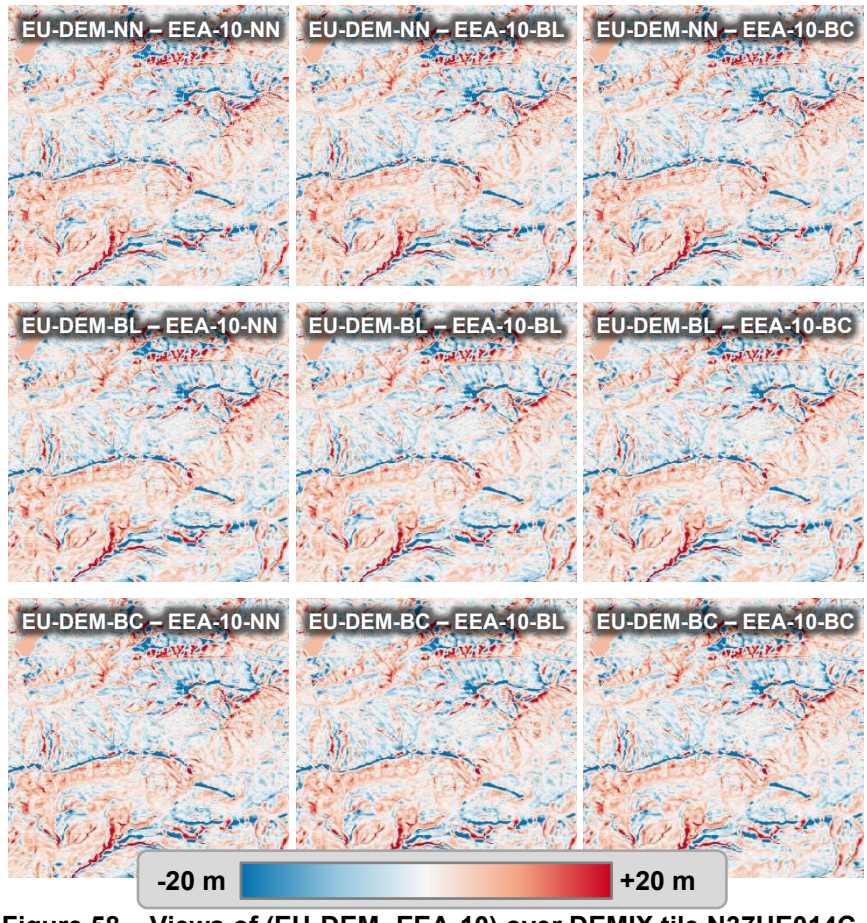
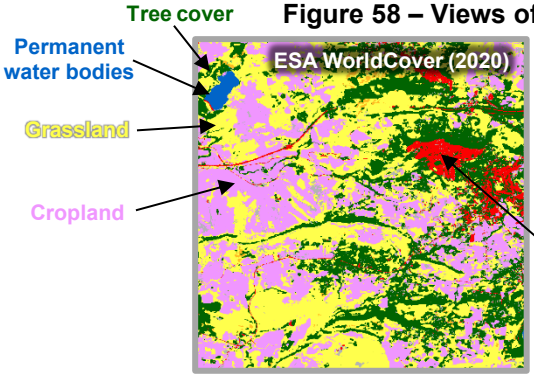


Figure 58 – Views of (EU-DEM -EEA-10) over DEMIX tile N37UE014C.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 57).

One may see important negative and positive differences over the tree cover class (see attached view).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 0.40 m** **Std Dev = 7.42 m** **RMSE = 7.43 m**	**Mean = 0.39 m** **Std Dev = 7.31 m** **RMSE = 7.32 m**	**Mean = 0.39 m** **Std Dev = 7.37 m** **RMSE = 7.38 m**
Bilinear (BL)	**Mean = 0.40 m** **Std Dev = 7.23 m** **RMSE = 7.24 m**	**Mean = 0.39 m** **Std Dev = 7.12 m** **RMSE = 7.13 m**	**Mean = 0.39 m** **Std Dev = 7.18 m** **RMSE = 7.19 m**
Bicubic (BC)	**Mean = 0.40 m** **Std Dev = 7.21 m** **RMSE = 7.22 m**	**Mean = 0.39 m** **Std Dev = 7.10 m** **RMSE = 7.11 m**	**Mean = 0.39 m** **Std Dev = 7.16 m** **RMSE = 7.17 m**

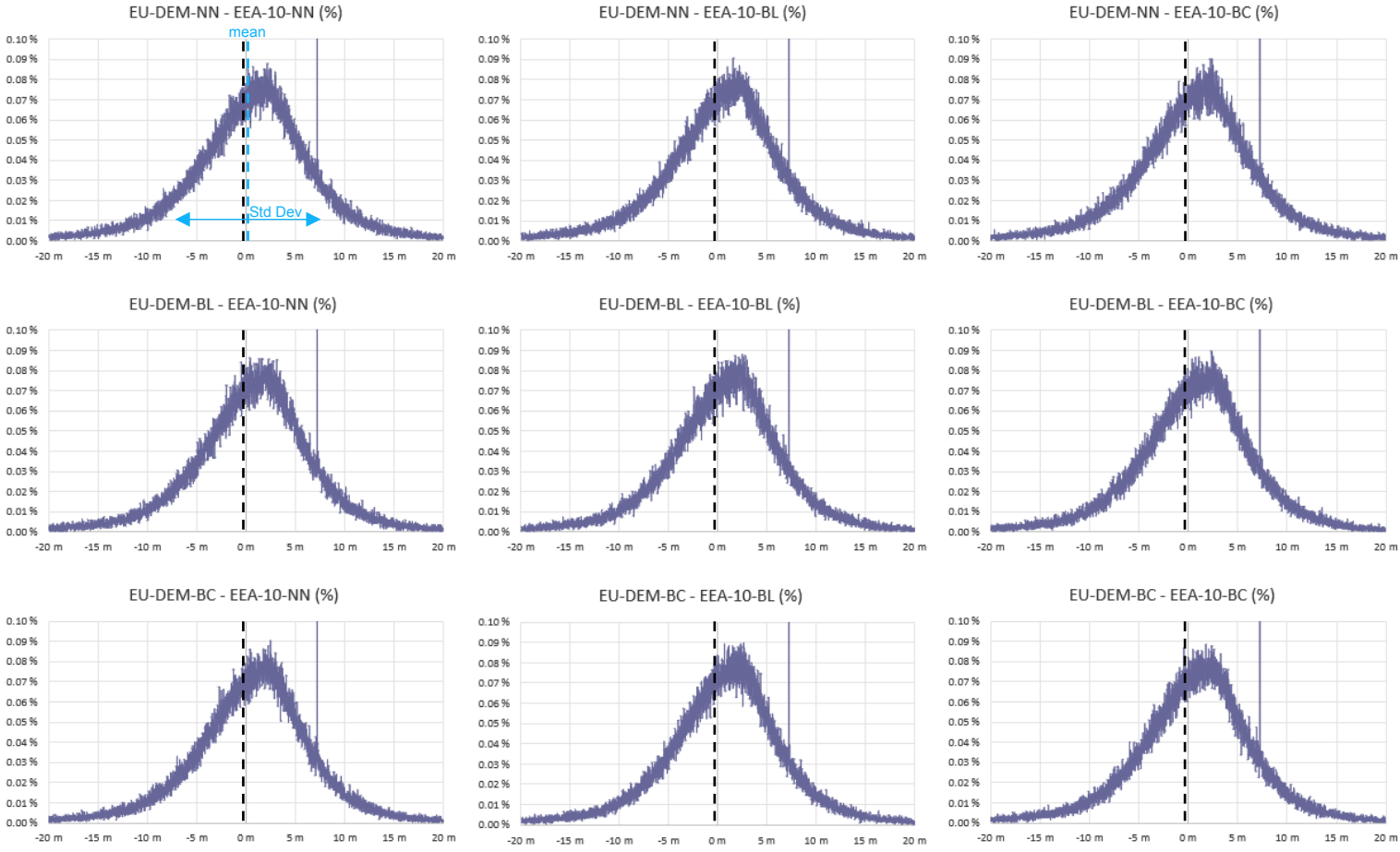


Figure 59 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N37UE014C.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for mean**, 0.32 m** for standard deviation and **0.32 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 1.5 m of difference. The highest differences are due to the tree cover (see attached figure of last page). A high peak, close to 7 m, highlights the presence of flat areas, identified as lakes.

4.1.1.17 17 - Switzerland - N46ZE009A (zone 1)

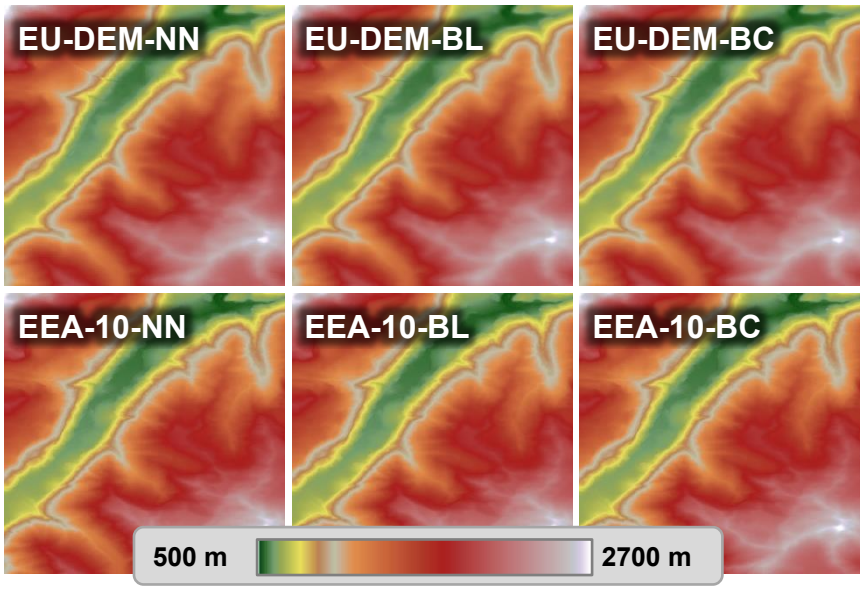


Figure 60 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N46ZE009A.

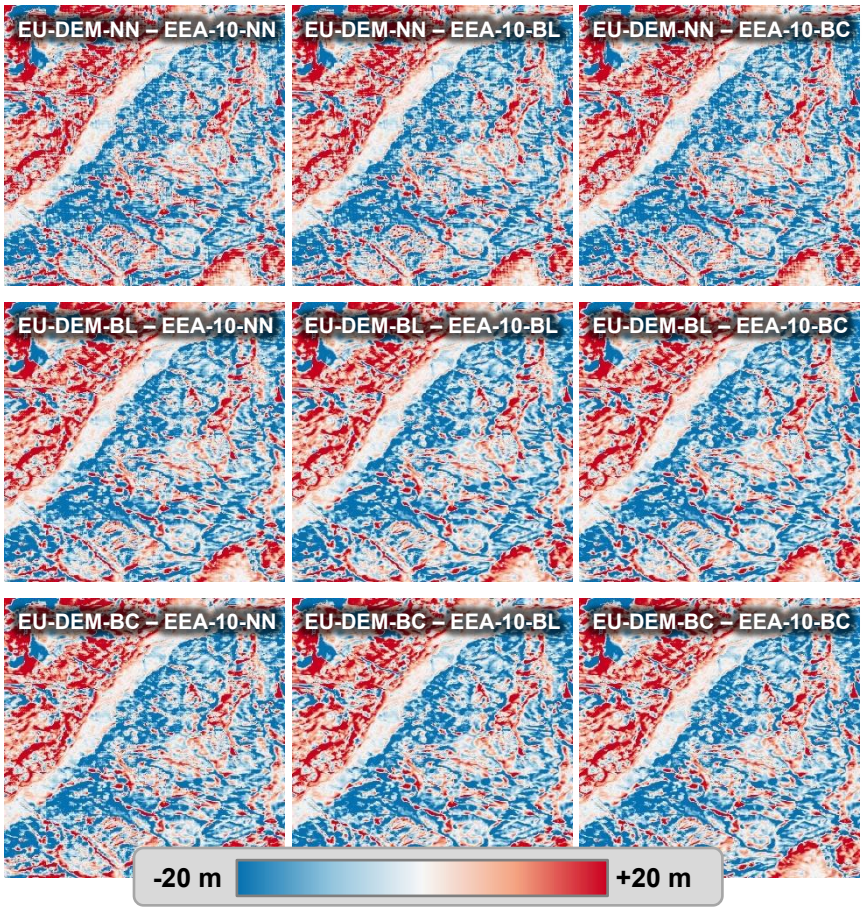
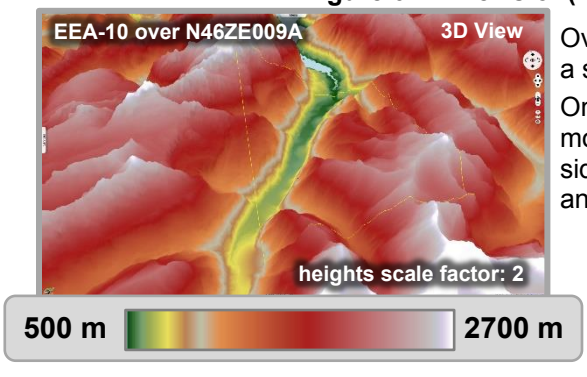


Figure 61 – Views of (EU-DEM -EEA-10) over DEMIX tile N46ZE009A.



Over this mountain pass, the resampled instances of EEA-10 have a similar aspect (see Figure 60).

One may see high positive differences on the North West of the mountain pass, whereas negative errors are present on the other side. These results are expectable, as 2.2 km separate the lowest and highest points (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -2.50 m Std Dev = 17.54 m RMSE = 17.72 m	Mean = -2.50 m Std Dev = 17.34 m RMSE = 17.51 m	Mean = -2.50 m Std Dev = 17.43 m RMSE = 17.61 m
Bilinear (BL)	Mean = -2.50 m Std Dev = 16.94 m RMSE = 17.12 m	Mean = -2.50 m Std Dev = 16.72 m RMSE = 16.91 m	Mean = -2.50 m Std Dev = 16.81 m RMSE = 17.00 m
Bicubic (BC)	Mean = -2.51 m Std Dev = 16.95 m RMSE = 17.13 m	Mean = -2.50 m Std Dev = 16.73 m RMSE = 16.92 m	Mean = -2.50 m Std Dev = 16.82 m RMSE = 17.01 m

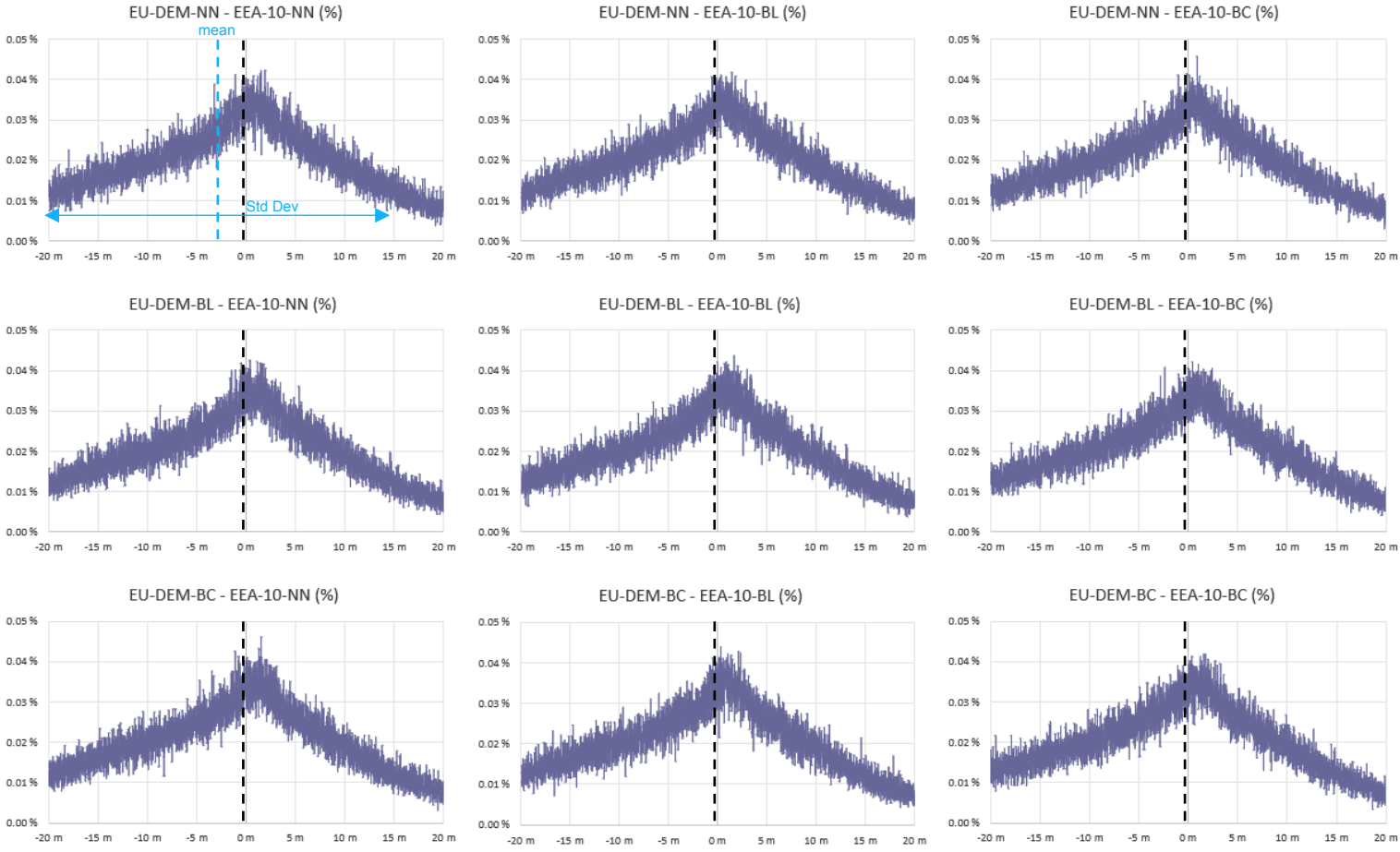


Figure 62 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N46ZE009A.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for the mean**, 0.81 m** for standard deviation and **0.81 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 1 m of difference. One must note the high standard deviation of this distribution, which is mainly due to the height variations over this area (see attached figure of last page).

4.1.1.18 18 - Austria - N47UE014H (zone 1)

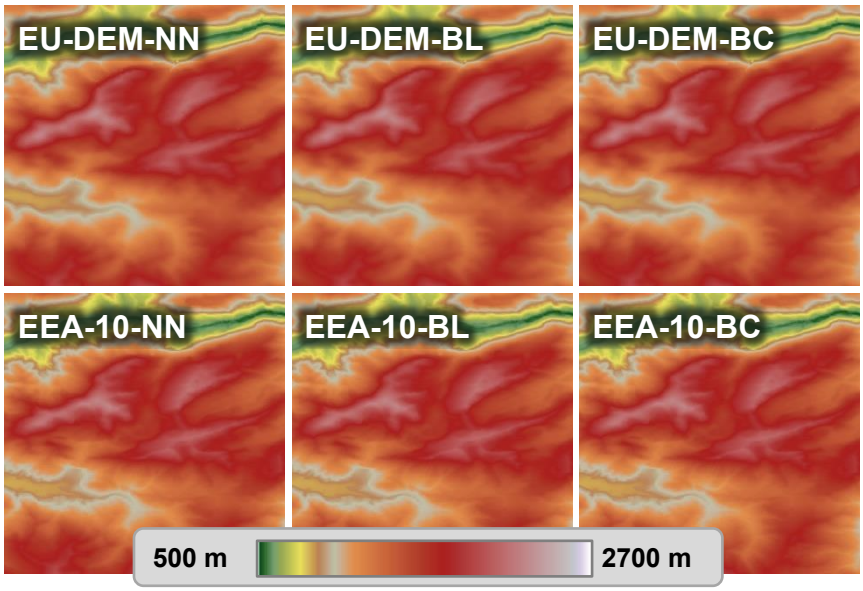


Figure 63 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N47UE014H.

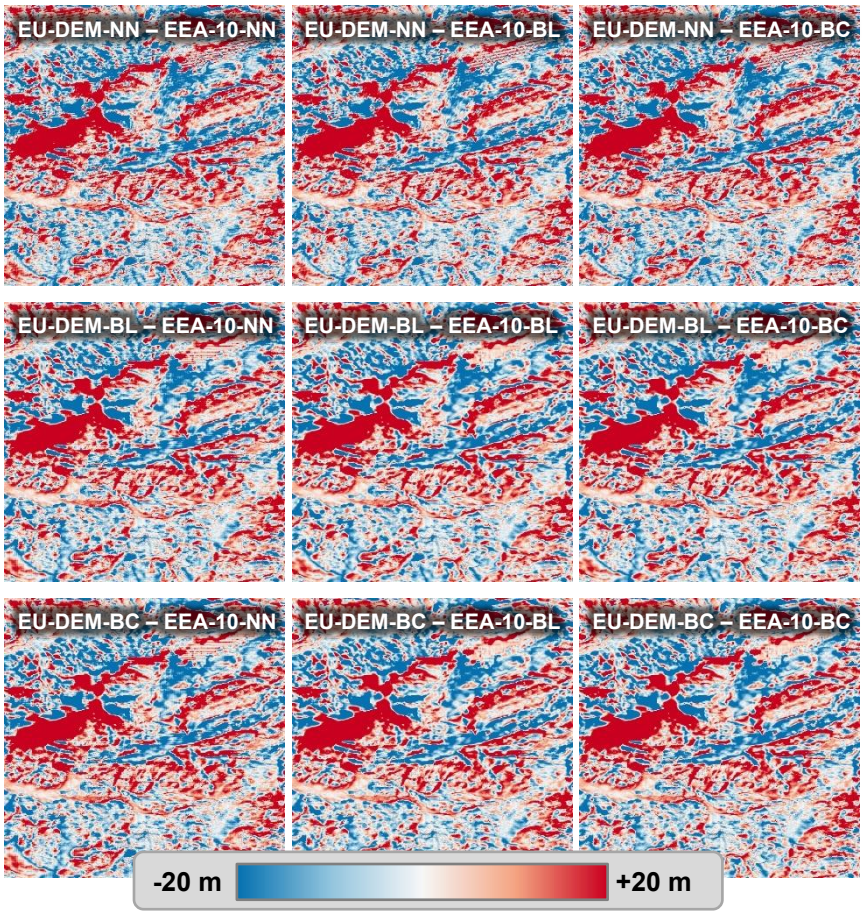
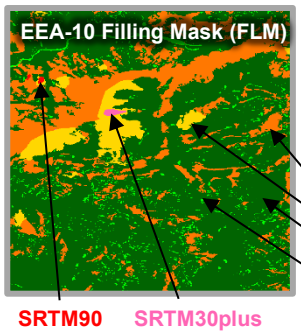


Figure 64 – Views of (EU-DEM -EEA-10) over DEMIX tile N47UE014H.



Over this tile, the resampled instances of EEA-10 and EU-DEM have a similar aspect (see Figure 63).

One may see a cluster of high positive errors over the West of this tile. One may note that these errors can be seen over filled areas of EEA-10, especially over SRTM30 and ASTER fillings (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 1.83 m** **Std Dev = 21.93 m** **RMSE = 22.01 m**	**Mean = 1.80 m** **Std Dev = 21.79 m** **RMSE = 21.87 m**	**Mean = 1.80 m** **Std Dev = 21.88 m** **RMSE = 21.95 m**
Bilinear (BL)	**Mean = 1.82 m** **Std Dev = 21.35 m** **RMSE = 21.43 m**	**Mean = 1.79 m** **Std Dev = 21.21 m** **RMSE = 21.28 m**	**Mean = 1.79 m** **Std Dev = 21.29 m** **RMSE = 21.37 m**
Bicubic (BC)	**Mean = 1.82 m** **Std Dev = 21.38 m** **RMSE = 21.46 m**	**Mean = 1.79 m** **Std Dev = 21.24 m** **RMSE = 21.31 m**	**Mean = 1.79 m** **Std Dev = 21.32 m** **RMSE = 21.40 m**

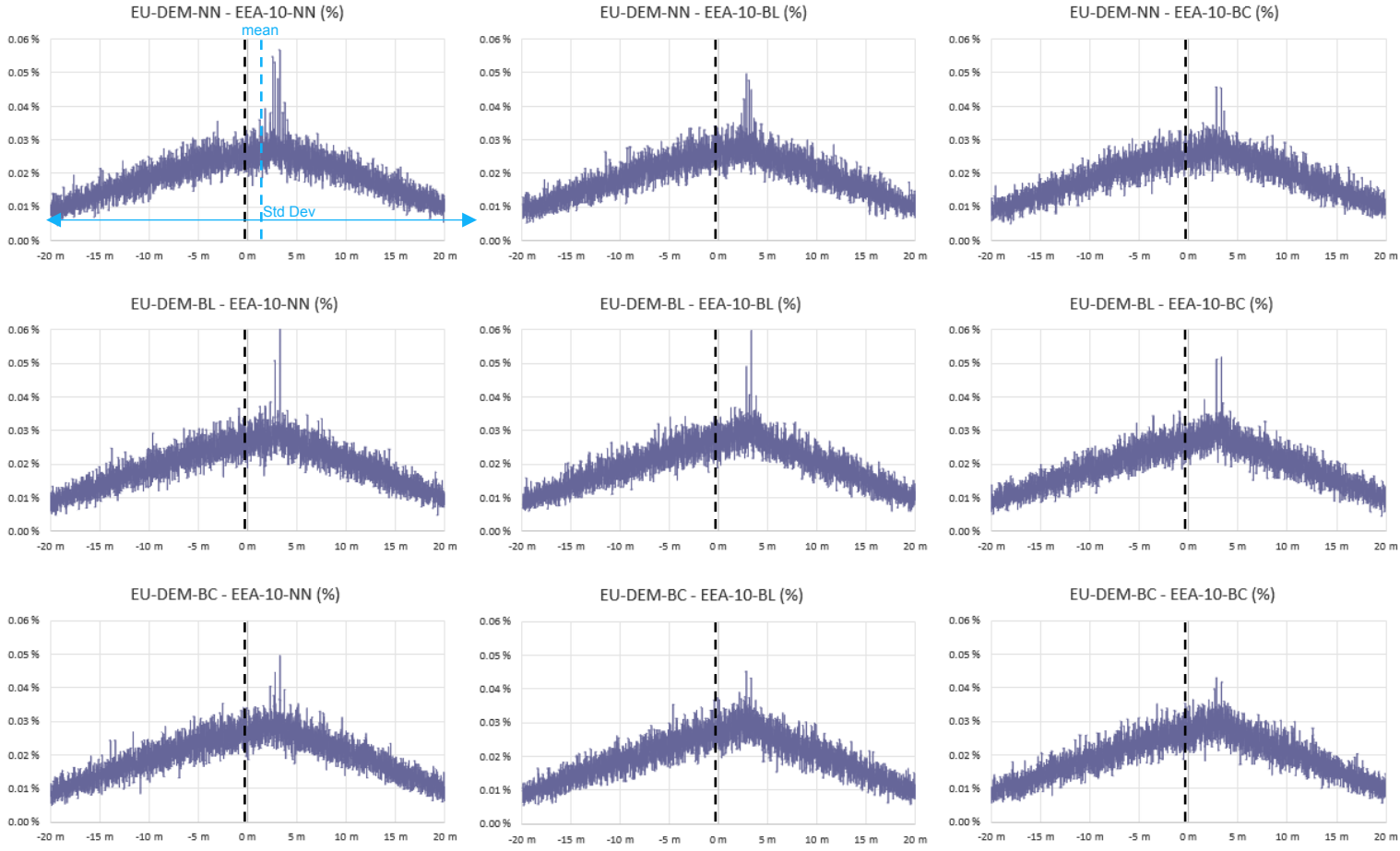


Figure 65 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N47UE014H.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.02 m** for the mean**, 0.72 m** for standard deviation and **0.73 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 2.5 m of difference. One must note the high standard deviation of this distribution, which can be linked to changes of source DEMs in EEA-10 (see attached figure of last page).

4.1.1.19 19 - Czechia - N49XE015B (zone 1)

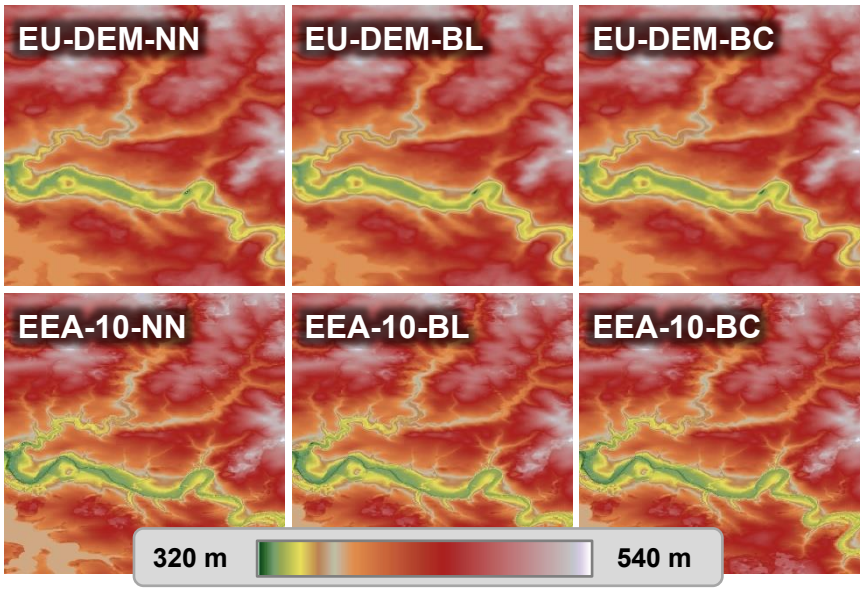


Figure 66 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N49XE015B.

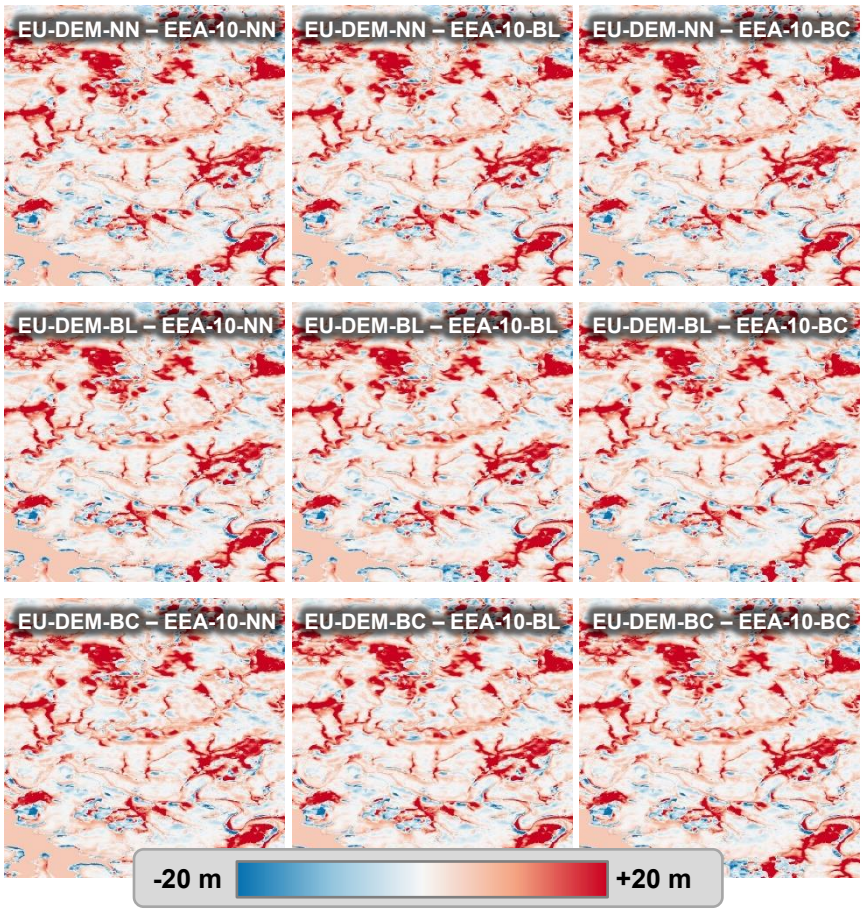
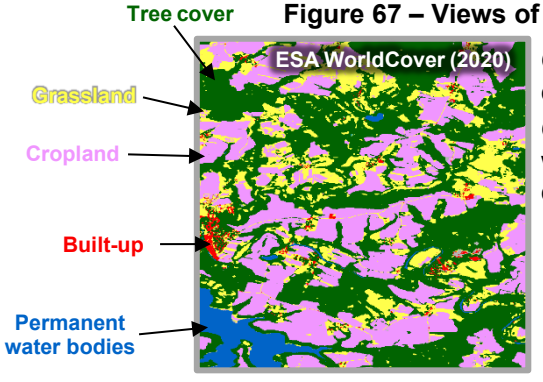


Figure 67 – Views of (EU-DEM -EEA-10) over DEMIX tile N49XE015B.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 66).

One may see small height differences over grasslands, permanent water bodies, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 4.01 m** **Std Dev = 8.17 m** **RMSE = 9.11 m**	**Mean = 4.00 m** **Std Dev = 8.08 m** **RMSE = 9.01 m**	**Mean = 4.00 m** **Std Dev = 8.14 m** **RMSE = 9.07 m**
Bilinear (BL)	**Mean = 4.01 m** **Std Dev = 8.12 m** **RMSE = 9.06 m**	**Mean = 4.00 m** **Std Dev = 8.02 m** **RMSE = 8.96 m**	**Mean = 4.00 m** **Std Dev = 8.08 m** **RMSE = 9.02 m**
Bicubic (BC)	**Mean = 4.01 m** **Std Dev = 8.12 m** **RMSE = 9.06 m**	**Mean = 4.00 m** **Std Dev = 8.02 m** **RMSE = 8.97 m**	**Mean = 4.00 m** **Std Dev = 8.08 m** **RMSE = 9.02 m**

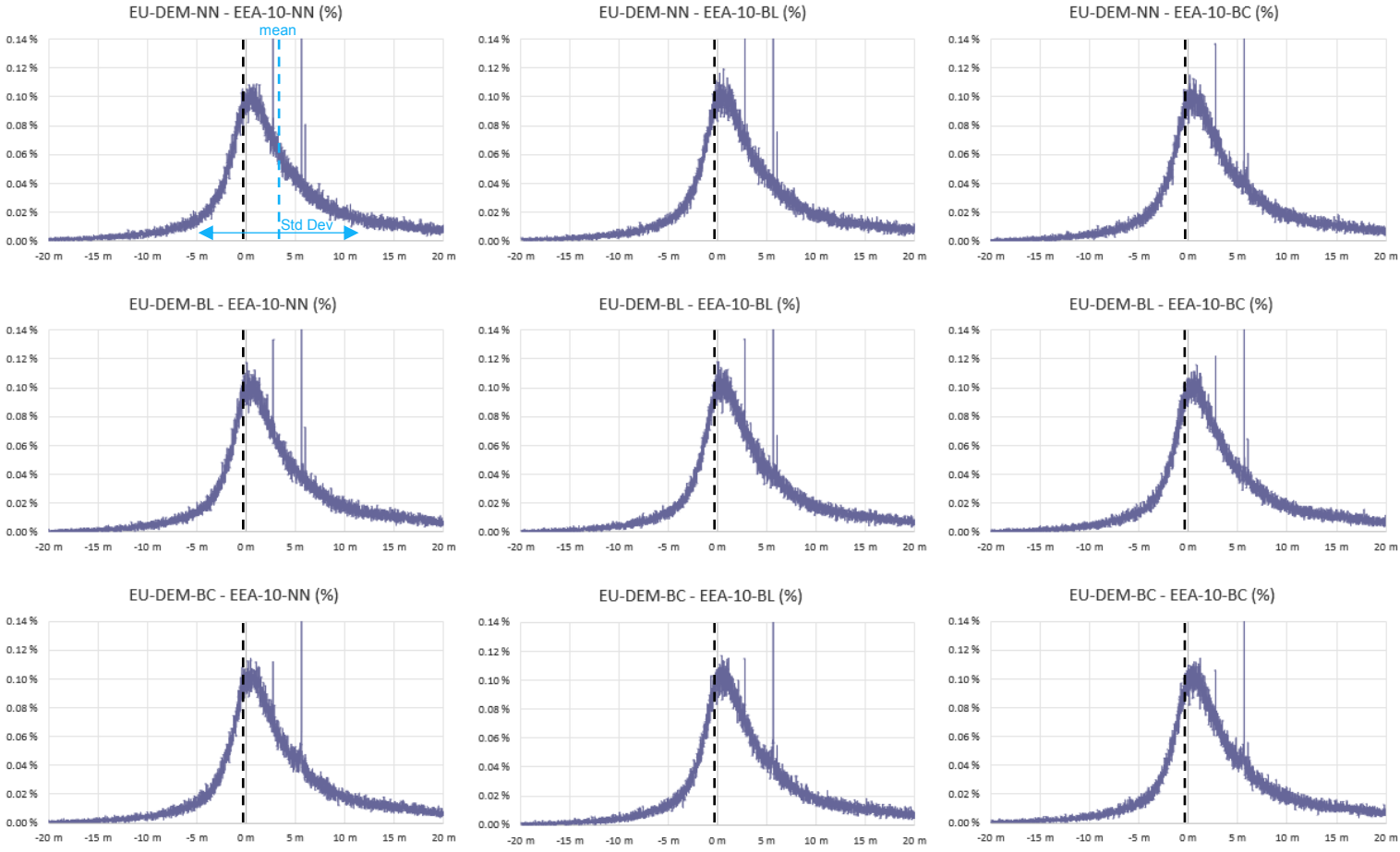


Figure 68 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N49XE015B.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for the mean**, 0.15 m** for standard deviation and **0.15 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 0.1 m of difference. The long tail of distribution of positive values is mainly caused by the tree cover (see attached figure of previous page). High peaks are due to flat areas, identified as lakes.

4.1.1.20 20 - Slovakia - N48ZE020C (zone 1)

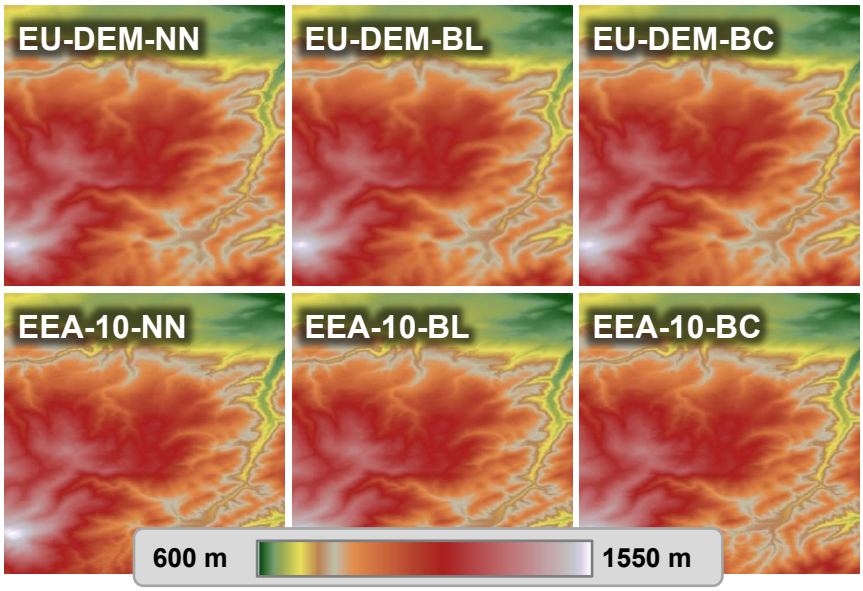


Figure 69 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N48ZE020C.

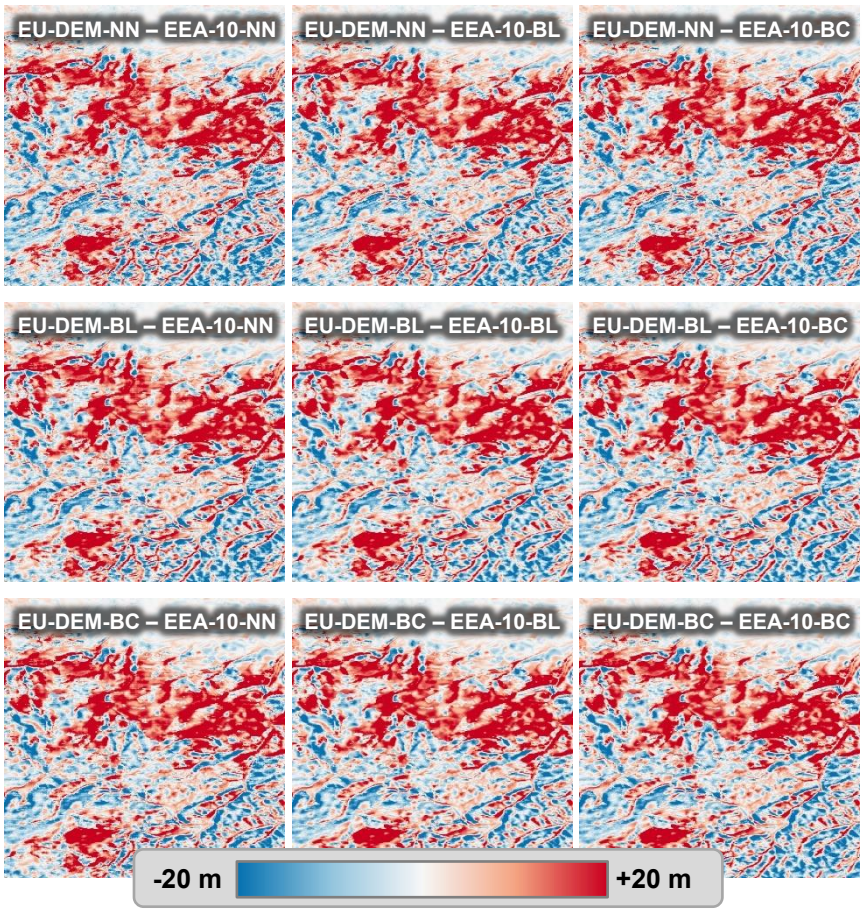
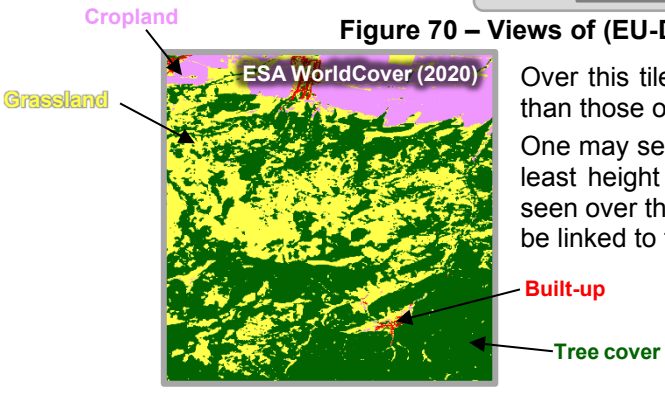


Figure 70 – Views of (EU-DEM -EEA-10) over DEMIX tile N48ZE020C.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 69).

One may see low height differences over the North of the tile, where the least height variations are seen. On the opposite, high differences are seen over the height transitions of this tile. High differences also seem to be linked to the tree cover and grassland classes (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 2.81 m** **Std Dev = 12.57 m** **RMSE = 12.88 m**	**Mean = 2.82 m** **Std Dev = 12.39 m** **RMSE = 12.71 m**	**Mean = 2.82 m** **Std Dev = 12.46 m** **RMSE = 12.78 m**
Bilinear (BL)	**Mean = 2.81 m** **Std Dev = 12.36 m** **RMSE = 12.67 m**	**Mean = 2.82 m** **Std Dev = 12.17 m** **RMSE = 12.50 m**	**Mean = 2.82 m** **Std Dev = 12.24 m** **RMSE = 12.56 m**
Bicubic (BC)	**Mean = 2.81 m** **Std Dev = 12.37 m** **RMSE = 12.69 m**	**Mean = 2.82 m** **Std Dev = 12.19 m** **RMSE = 12.51 m**	**Mean = 2.82 m** **Std Dev = 12.26 m** **RMSE = 12.58 m**

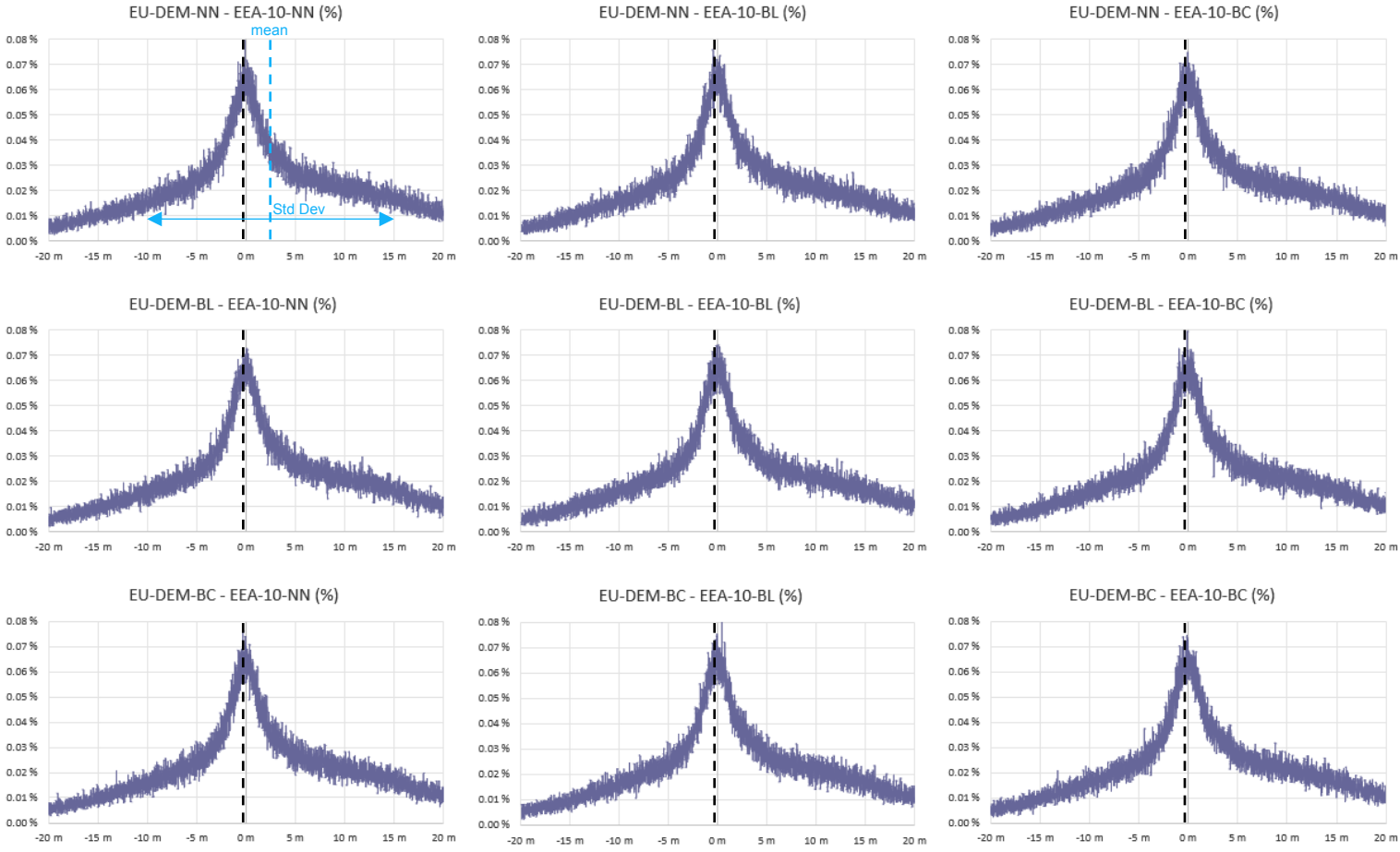


Figure 71 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N48ZE020C.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for the mean**, 0.40 m** for standard deviation and **0.38 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -0.1 m of difference. In this area, high errors both seem to be linked to height variations, and to the tree cover / grassland class variations (see attached figure of last page).

4.1.1.21 21 - Hungary - N46ZE017H (zone 1)

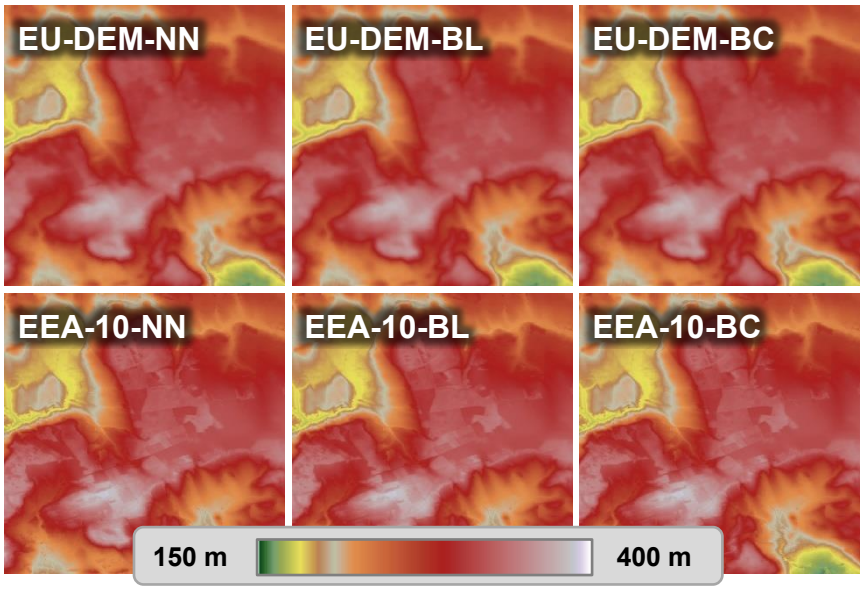


Figure 72 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N46ZE017H.

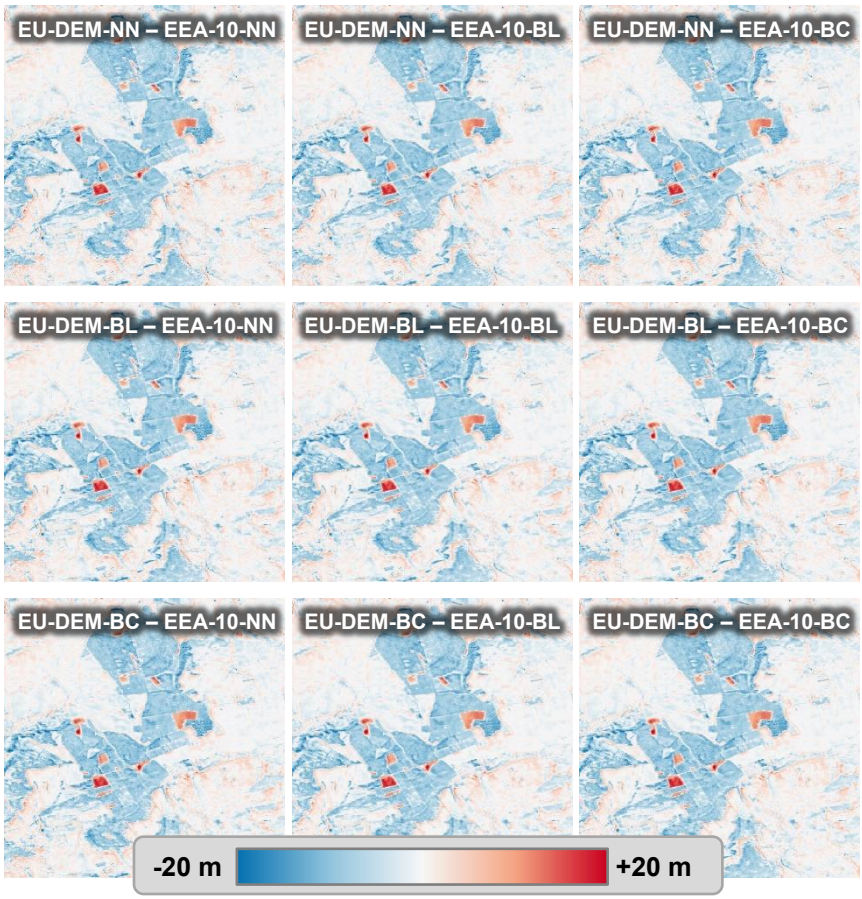
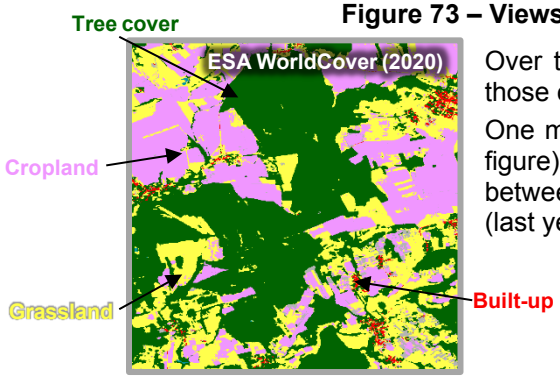


Figure 73 – Views of (EU-DEM -EEA-10) over DEMIX tile N46ZE017H.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 72).

One may see the highest differences over the tree cover class (see attached figure). Clusters of red pixels highlight deforestation in this area, which occurred between 2001 (SRTM year of acquisition, used to generate EU-DEM) and 2015 (last year of TanDEM-X acquisitions used for the generation of EEA-10).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -2.12 m Std Dev = 4.66 m RMSE = 5.12 m	Mean = -2.12 m Std Dev = 4.56 m RMSE = 5.03 m	Mean = -2.12 m Std Dev = 4.60 m RMSE = 5.07 m
Bilinear (BL)	Mean = -2.12 m Std Dev = 4.61 m RMSE = 5.07 m	Mean = -2.12 m Std Dev = 4.51 m RMSE = 4.98 m	Mean = -2.12 m Std Dev = 4.55 m RMSE = 5.02 m
Bicubic (BC)	Mean = -2.12 m Std Dev = 4.59 m RMSE = 5.06 m	Mean = -2.12 m Std Dev = 4.49 m RMSE = 4.97 m	Mean = -2.12 m Std Dev = 4.54 m RMSE = 5.01 m

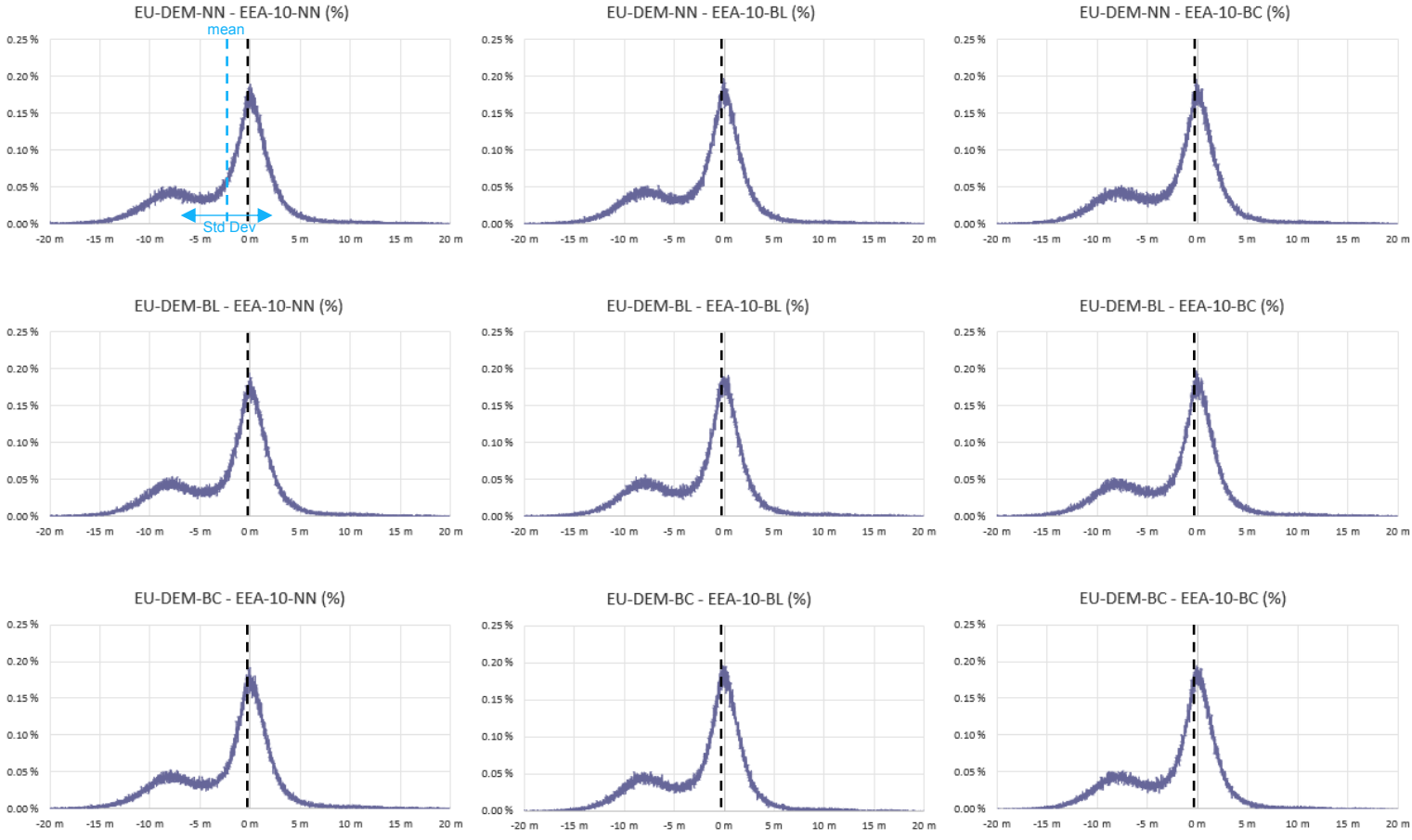


Figure 74 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N46ZE017H.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.17 m** for standard deviation and **0.15 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0 m of difference. In this area, the high number of negative differences seems to be linked to the tree cover (see attached figure of last page).

4.1.1.22 22 - Slovenia - N45ZE014K (zone 1)

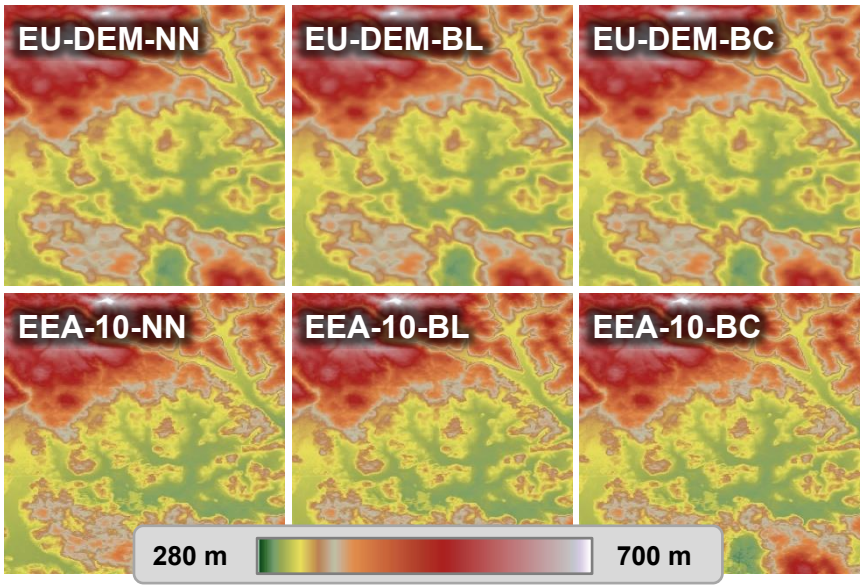


Figure 75 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N45ZE014K.

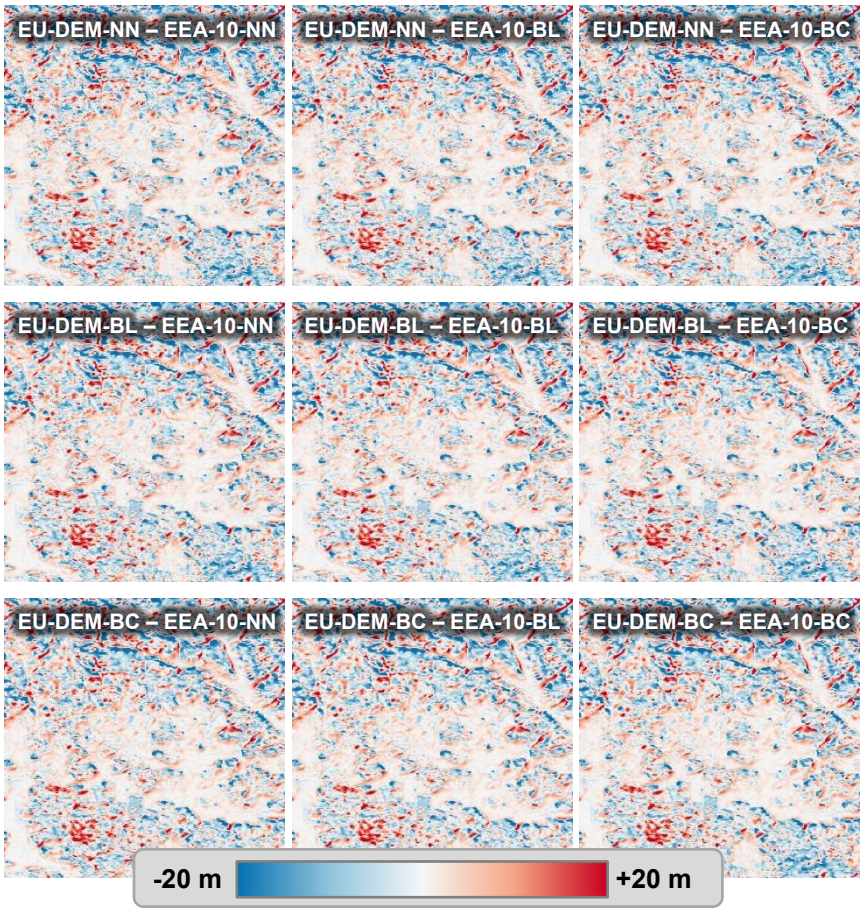
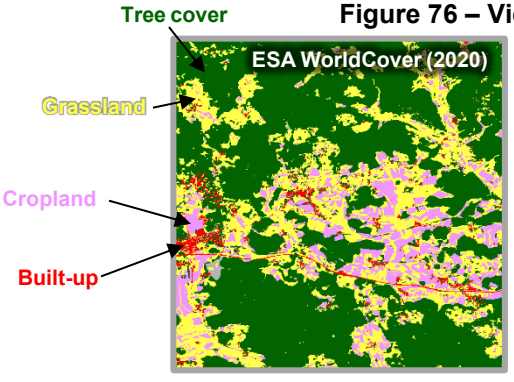


Figure 76 – Views of (EU-DEM -EEA-10) over DEMIX tile N45ZE014K.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 75).

One may see small height differences over grasslands, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -0.73 m Std Dev = 8.52 m RMSE = 8.55 m	Mean = -0.73 m Std Dev = 8.34 m RMSE = 8.37 m	Mean = -0.73 m Std Dev = 8.43 m RMSE = 8.46 m
Bilinear (BL)	Mean = -0.73 m Std Dev = 8.39 m RMSE = 8.42 m	Mean = -0.73 m Std Dev = 8.21 m RMSE = 8.24 m	Mean = -0.73 m Std Dev = 8.30 m RMSE = 8.33 m
Bicubic (BC)	Mean = -0.73 m Std Dev = 8.39 m RMSE = 8.42 m	Mean = -0.73 m Std Dev = 8.21 m RMSE = 8.24 m	Mean = -0.73 m Std Dev = 8.30 m RMSE = 8.33 m

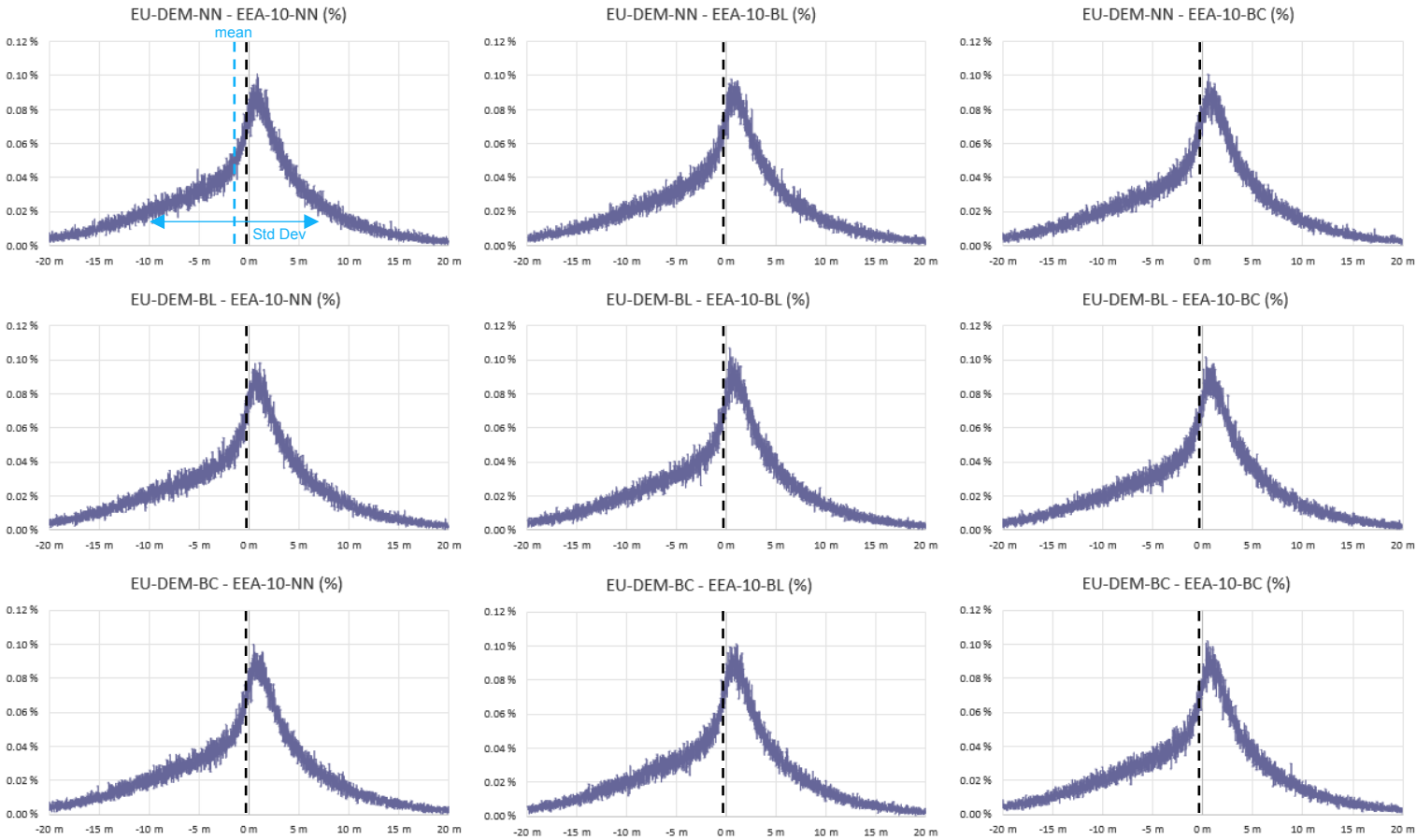


Figure 77 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N45ZE014K.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL) and (EU-DEM-BL – EEA-10-BL)** studies, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.31 m** for standard deviation and **0.31 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 0.5 m of difference. In this area, the high number of negative differences seems to be linked to the tree cover (see attached figure of last page).

4.1.1.23 23 - Croatia - N45VE017A (zone 1)

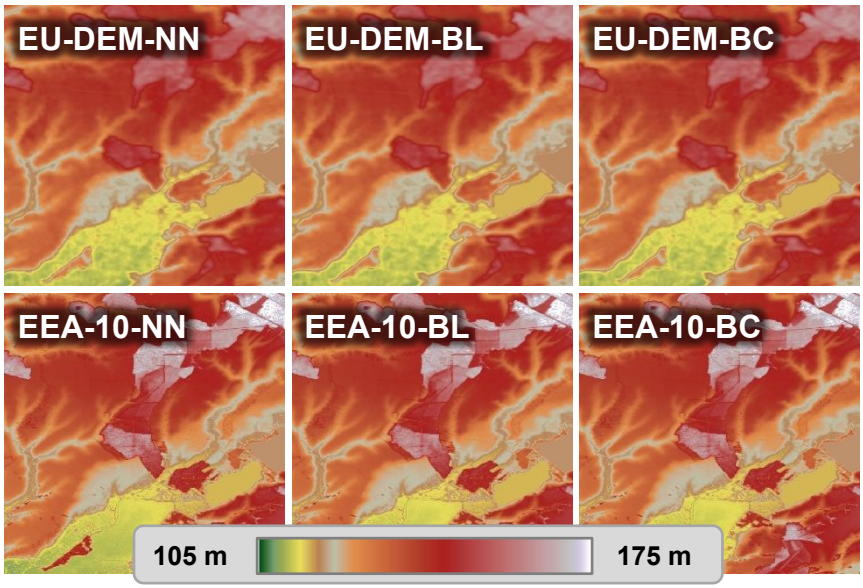


Figure 78 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N45VE017A.

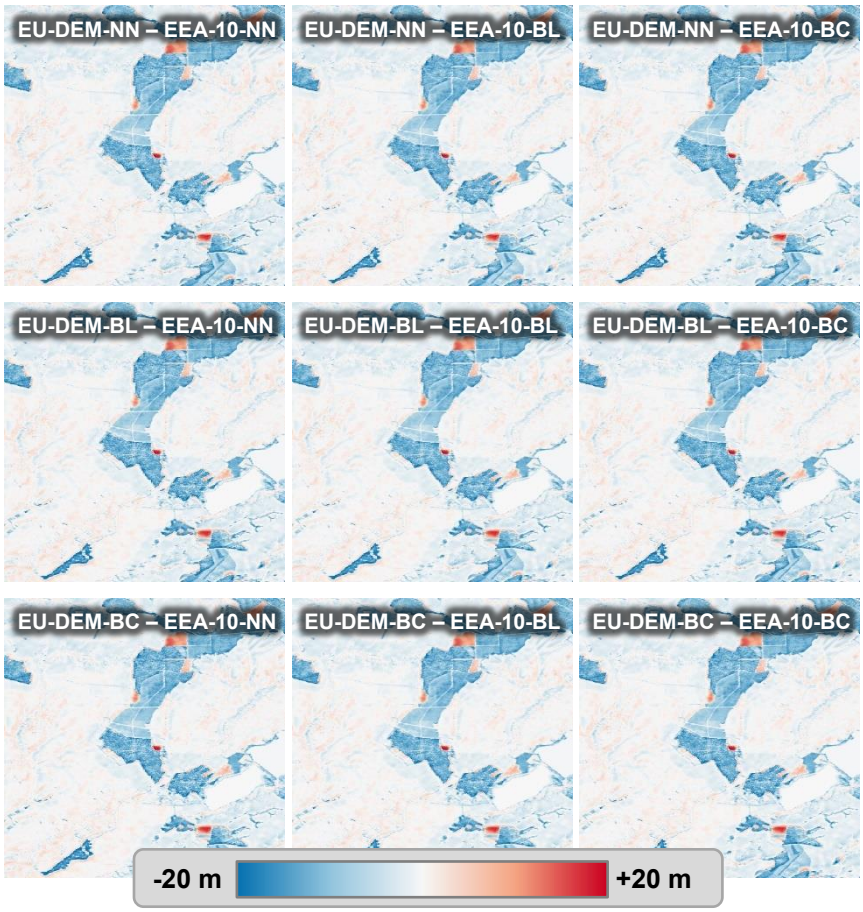
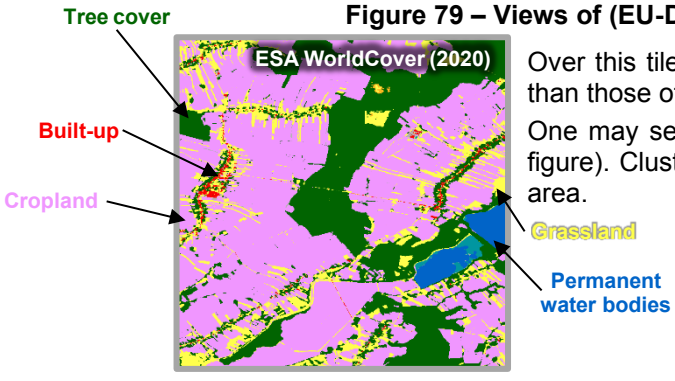


Figure 79 – Views of (EU-DEM -EEA-10) over DEMIX tile N45VE017A.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 78).

One may see high differences over the tree cover class (see attached figure). Clusters of positive differences highlight the deforestation in this area.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -2.40 m Std Dev = 4.82 m RMSE = 5.39 m	Mean = -2.40 m Std Dev = 4.75 m RMSE = 5.32 m	Mean = -2.40 m Std Dev = 4.79 m RMSE = 5.36 m
Bilinear (BL)	Mean = -2.40 m Std Dev = 4.82 m RMSE = 5.38 m	Mean = -2.40 m Std Dev = 4.75 m RMSE = 5.32 m	Mean = -2.40 m Std Dev = 4.79 m RMSE = 5.36 m
Bicubic (BC)	Mean = -2.40 m Std Dev = 4.81 m RMSE = 5.37 m	Mean = -2.40 m Std Dev = 4.74 m RMSE = 5.31 m	Mean = -2.40 m Std Dev = 4.78 m RMSE = 5.35 m

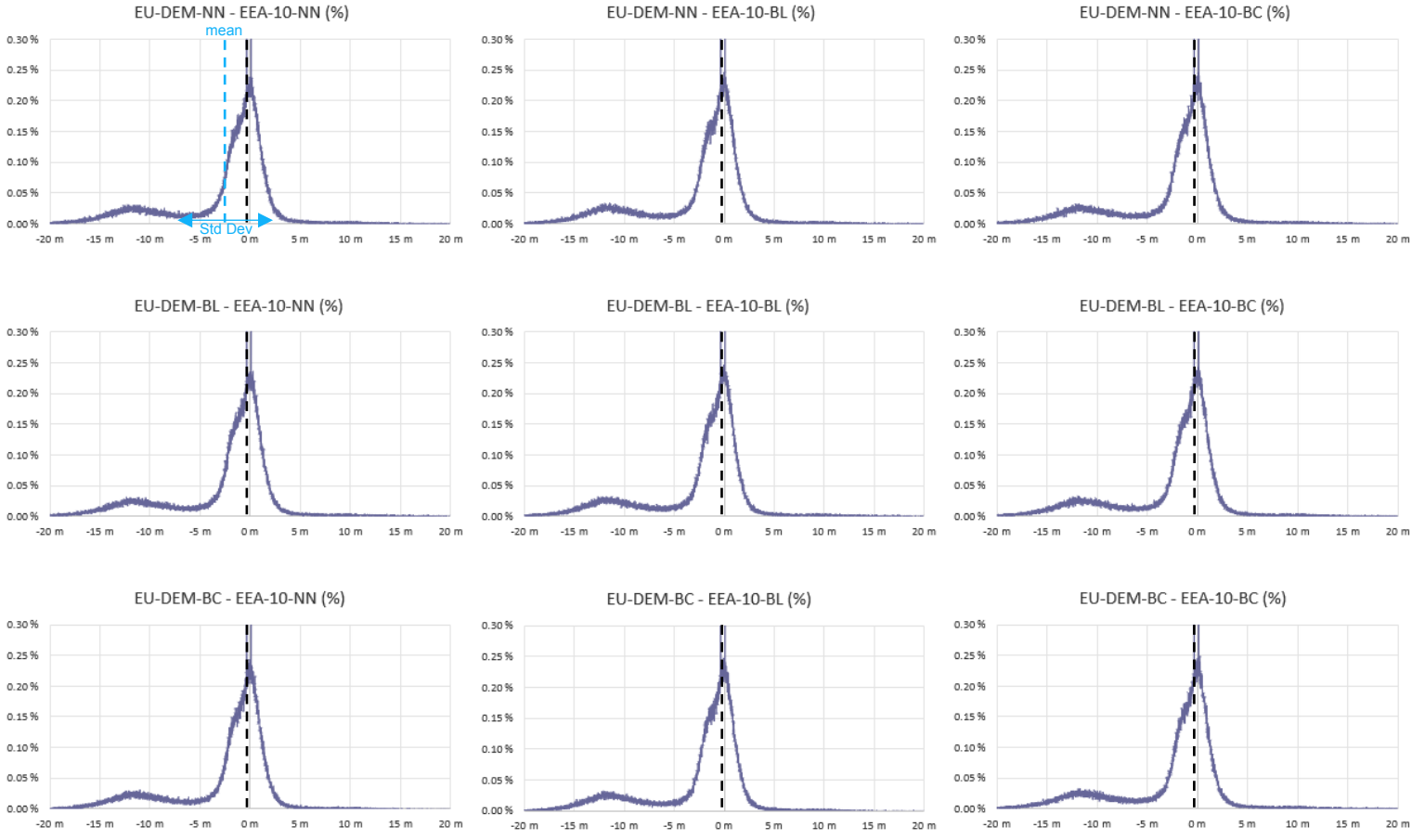


Figure 80 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N45VE017A.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.08 m** for standard deviation and **0.08 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0 m of difference. In this area, the high number of negative differences seems to be linked to the tree cover (see attached figure of last page). Peaks close to 0 m are linked to flat areas, identified as lakes.

4.1.1.24 24 - Bosnia and Herzegovina - N44PE017J (zone 1)

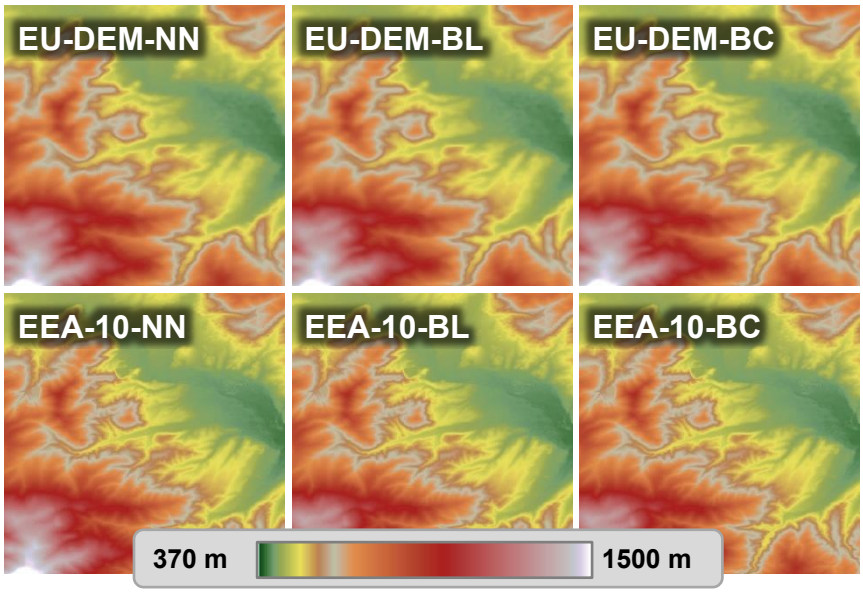


Figure 81 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N44PE017J.

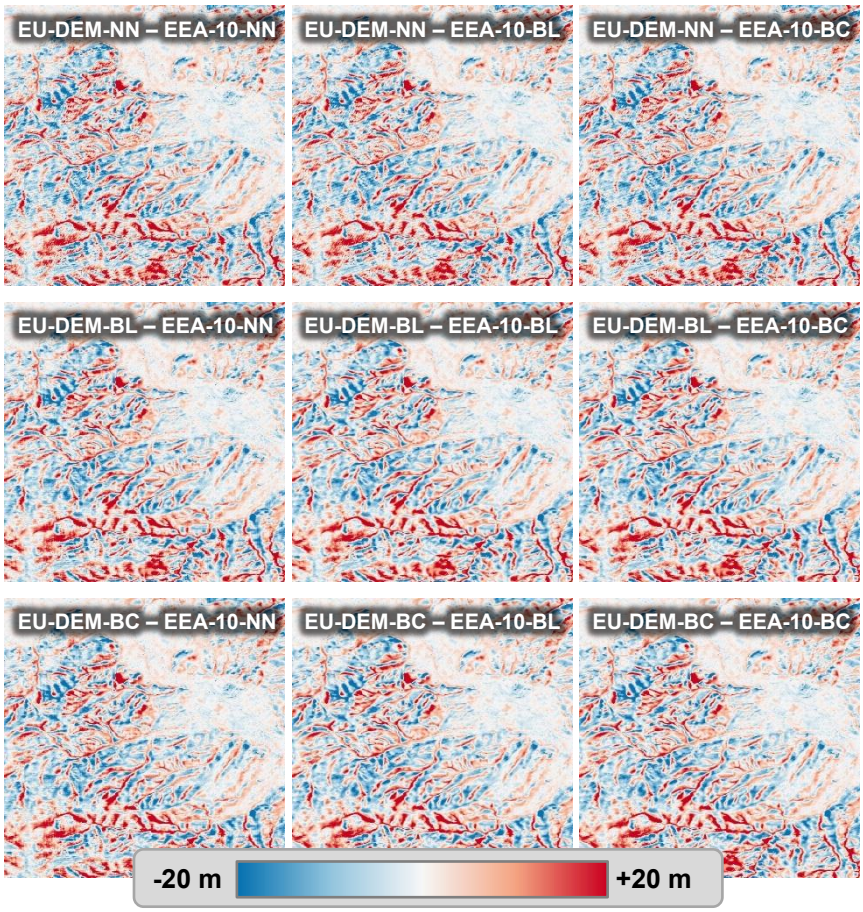
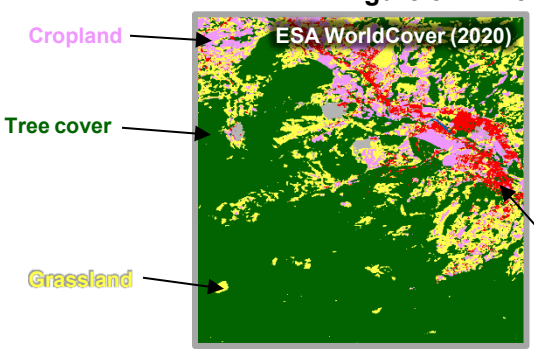


Figure 82 – Views of (EU-DEM -EEA-10) over DEMIX tile N44PE017J.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 81).

One may see small height differences over grasslands, permanent water bodies, urban areas and croplands, whereas the biggest differences can be seen over the tree cover class (see attached figure). The highest differences also seem to be linked to height variations.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 0.16 m** **Std Dev = 8.80 m** **RMSE = 8.80 m**	**Mean = 0.13 m** **Std Dev = 8.66 m** **RMSE = 8.66 m**	**Mean = 0.13 m** **Std Dev = 8.73 m** **RMSE = 8.73 m**
Bilinear (BL)	**Mean = 0.16 m** **Std Dev = 8.57 m** **RMSE = 8.57 m**	**Mean = 0.13 m** **Std Dev = 8.43 m** **RMSE = 8.43 m**	**Mean = 0.13 m** **Std Dev = 8.50 m** **RMSE = 8.50 m**
Bicubic (BC)	**Mean = 0.16 m** **Std Dev = 8.55 m** **RMSE = 8.55 m**	**Mean = 0.13 m** **Std Dev = 8.41 m** **RMSE = 8.41 m**	**Mean = 0.13 m** **Std Dev = 8.48 m** **RMSE = 8.48 m**

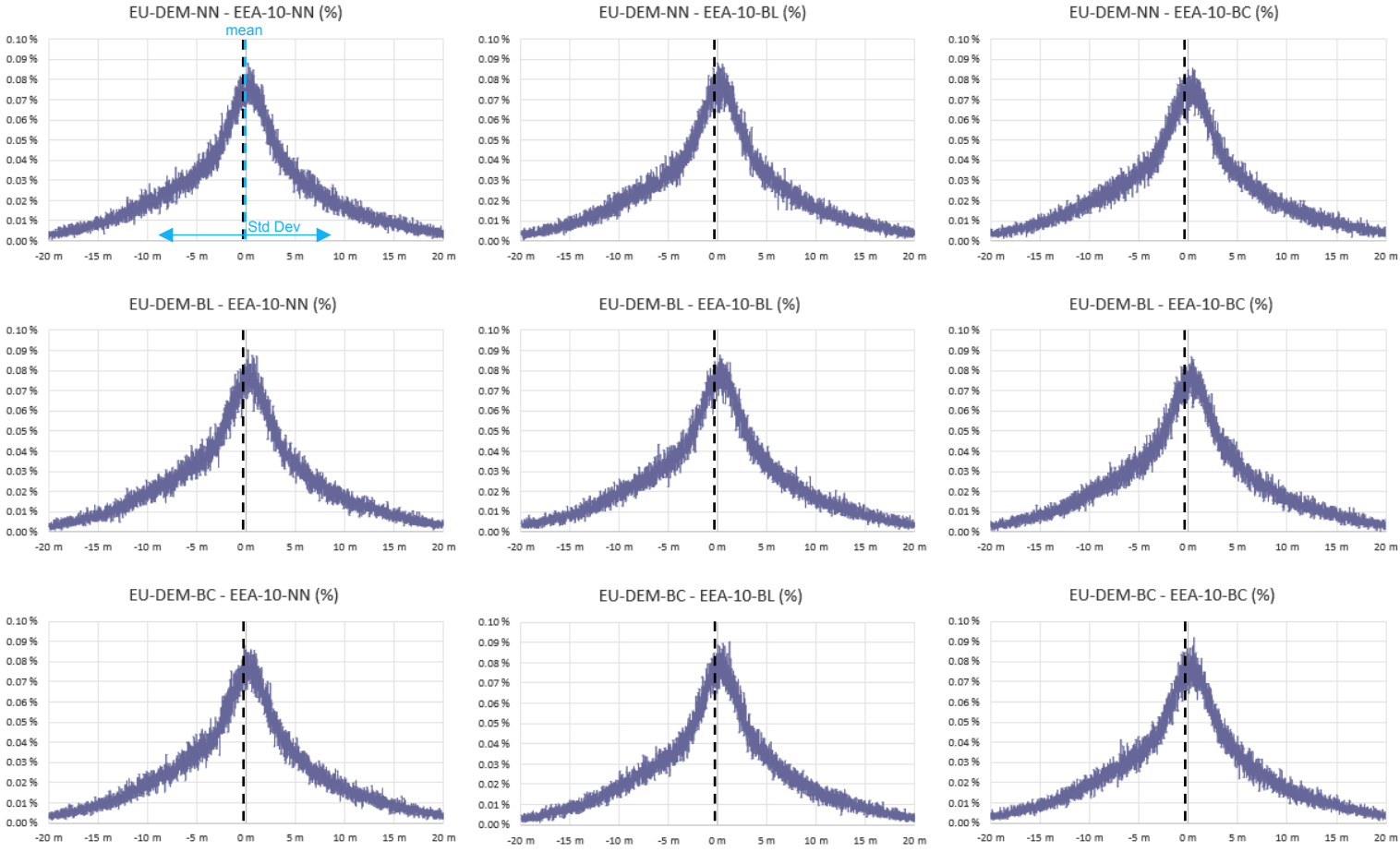


Figure 83 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N44PE017J.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.03 m** for the mean, **0.39 m** for standard deviation and **0.39 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0 m of difference. In this area, high differences seem to be linked to the height variations and tree cover (see attached figure of last page).

4.1.1.25 25 - Montenegro - N42XE019D (zone 1)

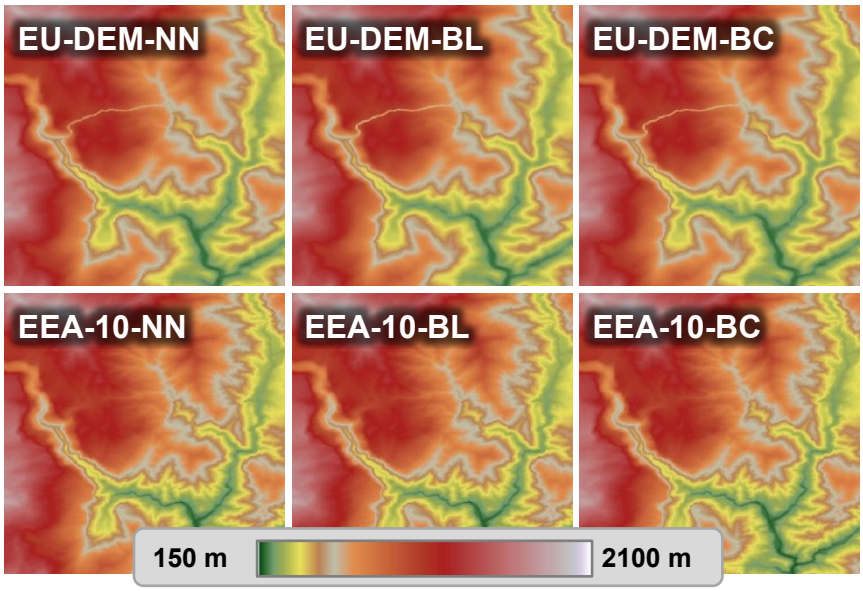
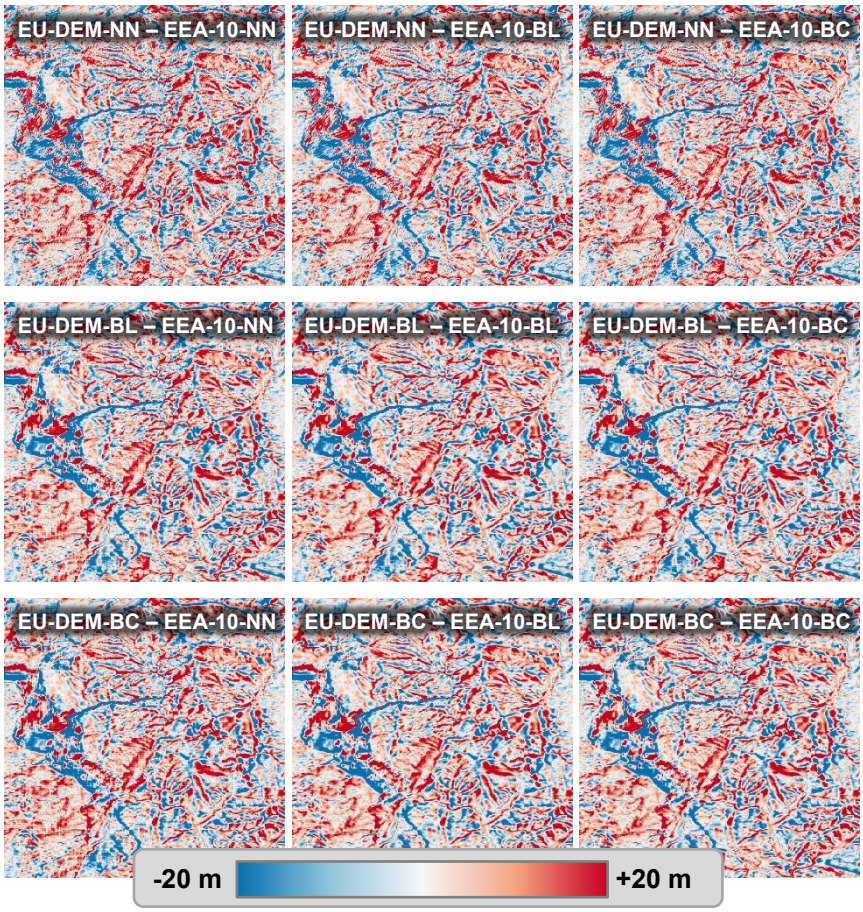


Figure 84 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N42XE019D.



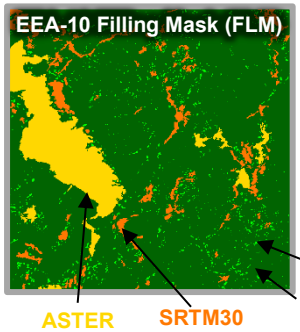


Figure 85 – Views of (EU-DEM -EEA-10) over DEMIX tile N42XE019D.

Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM However, one may note the presence of an edited area over the centre of the EU-DEM tiles (see Figure 84).

One may see high differences in this area, which can mainly be linked to the filling sources of EEA-10. One may see cluster of high differences over the East of the tile, which can be linked to ASTER data used to fill EEA-10 (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 0.27 m** **Std Dev = 22.67 m** **RMSE = 22.67 m**	**Mean = 0.20 m** **Std Dev = 22.46 m** **RMSE = 22.46 m**	**Mean = 0.20 m** **Std Dev = 22.54 m** **RMSE = 22.54 m**
Bilinear (BL)	**Mean = 0.28 m** **Std Dev = 21.34 m** **RMSE = 21.35 m**	**Mean = 0.21 m** **Std Dev = 21.12 m** **RMSE = 21.12 m**	**Mean = 0.21 m** **Std Dev = 21.20 m** **RMSE = 21.20 m**
Bicubic (BC)	**Mean = 0.28 m** **Std Dev = 21.92 m** **RMSE = 21.92 m**	**Mean = 0.21 m** **Std Dev = 21.71 m** **RMSE = 21.71 m**	**Mean = 0.21 m** **Std Dev = 21.78 m** **RMSE = 21.78 m**

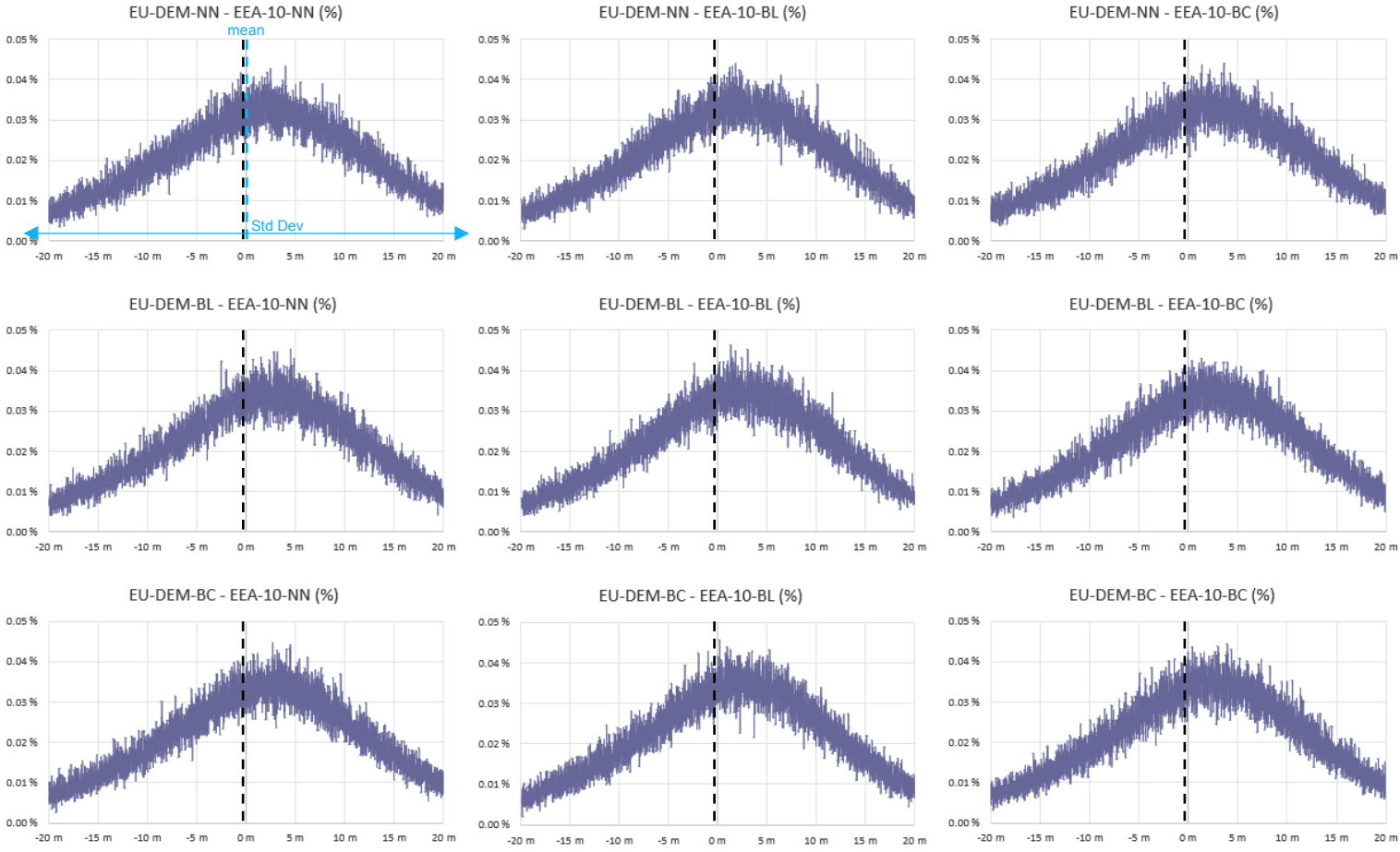


Figure 86 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N42XE019D.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.08 m** for the mean, **0.55 m** for standard deviation and **0.55 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a high standard deviation, with a mode close to 2.5 m. This high standard deviation is linked to ASTER infill of EEA-10 (see attached figure of previous page).

4.1.1.26 26 - Albania - N41ME020A (zone 1)

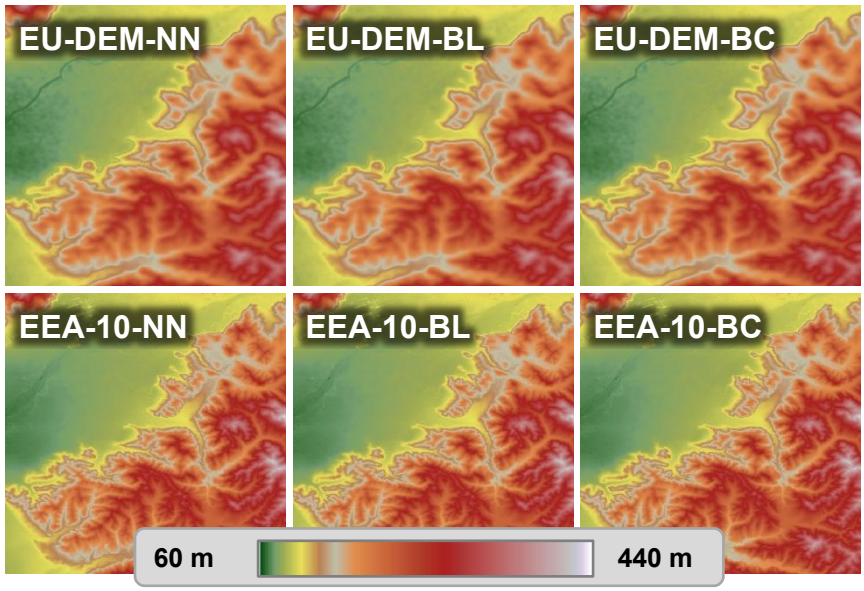


Figure 87 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N41ME020A.

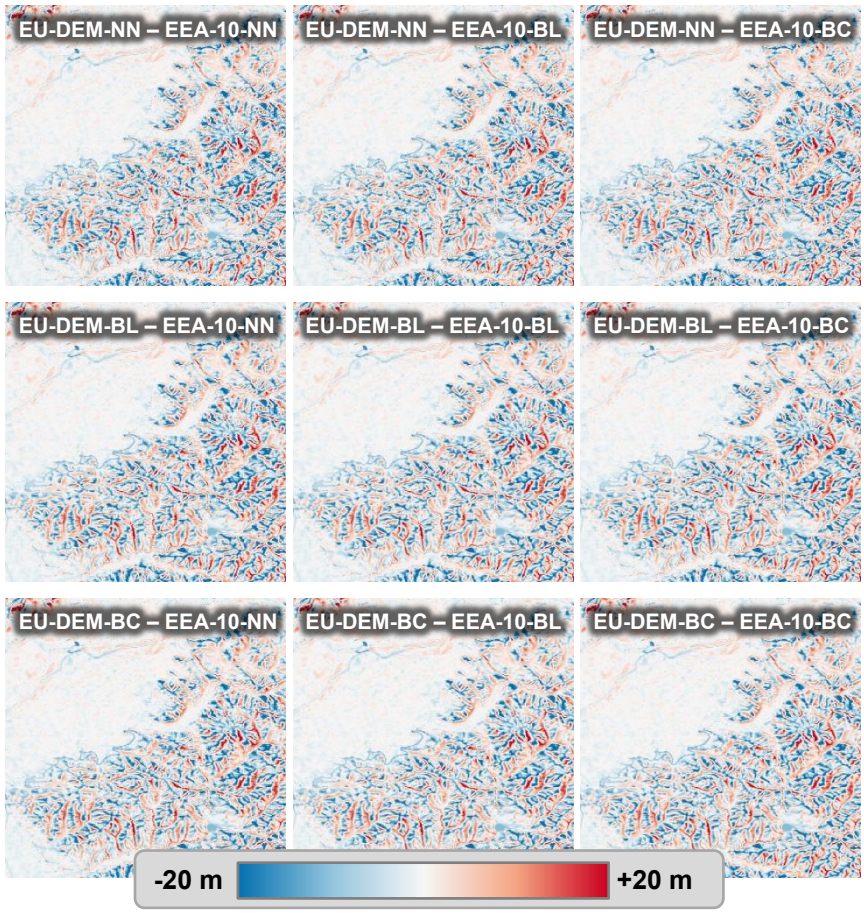
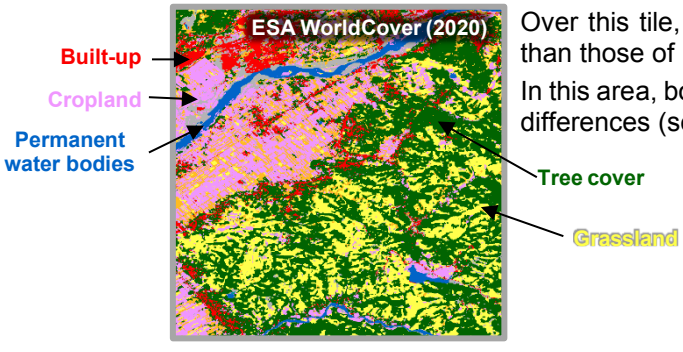


Figure 88 – Views of (EU-DEM -EEA-10) over DEMIX tile N41ME020A.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 87).

In this area, both changes in land cover and in height seem to lead to high differences (see attached figure and Figure 87).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -1.11 m** **Std Dev = 6.59 m** **RMSE = 6.69 m**	**Mean = -1.09 m** **Std Dev = 6.43 m** **RMSE = 6.52 m**	**Mean = -1.09 m** **Std Dev = 6.50 m** **RMSE = 6.59 m**
Bilinear (BL)	**Mean = -1.11 m** **Std Dev = 6.50 m** **RMSE = 6.59 m**	**Mean = -1.09 m** **Std Dev = 6.33 m** **RMSE = 6.42 m**	**Mean = -1.09 m** **Std Dev = 6.40 m** **RMSE = 6.49 m**
Bicubic (BC)	**Mean = -1.11 m** **Std Dev = 6.46 m** **RMSE = 6.55 m**	**Mean = -1.09 m** **Std Dev = 6.29 m** **RMSE = 6.38 m**	**Mean = -1.09 m** **Std Dev = 6.35 m** **RMSE = 6.45 m**

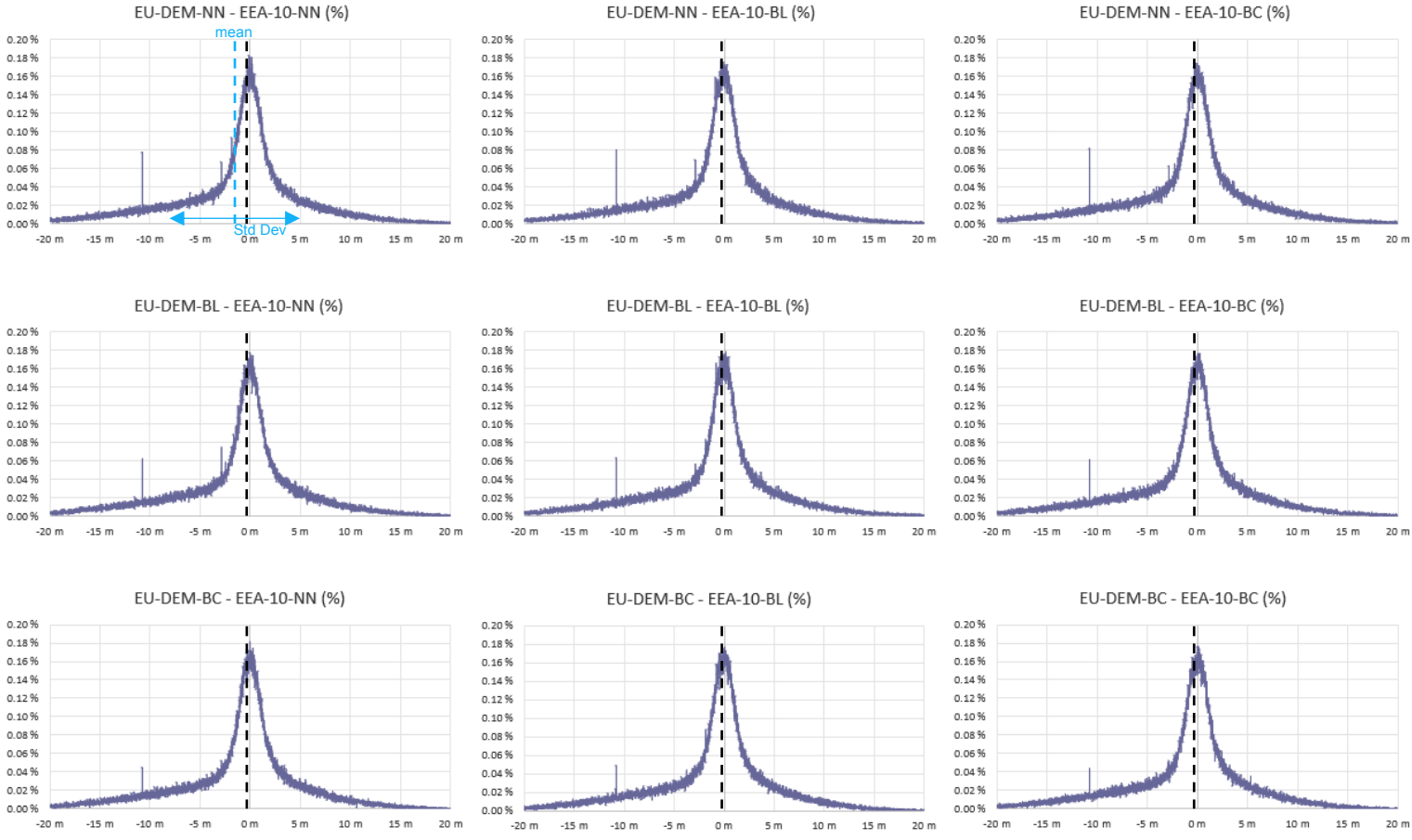


Figure 89 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N41ME020A.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.02 m** for the mean, **0.30 m** for standard deviation and **0.31 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0 m of difference. High differences are both due to the height variations and to the tree cover (see attached figure of previous page).

4.1.1.27 27 - North Macedonia - N41XE021L (zone 1)

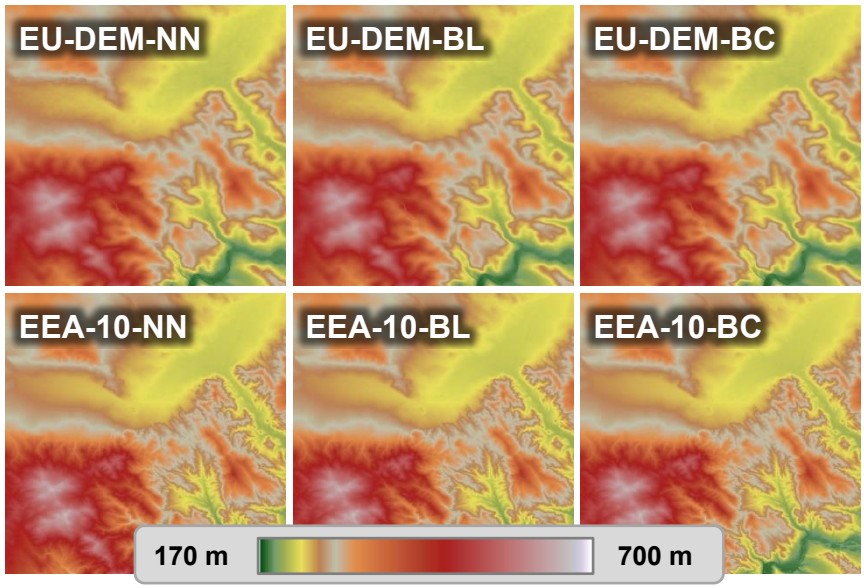


Figure 90 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N41XE021L.

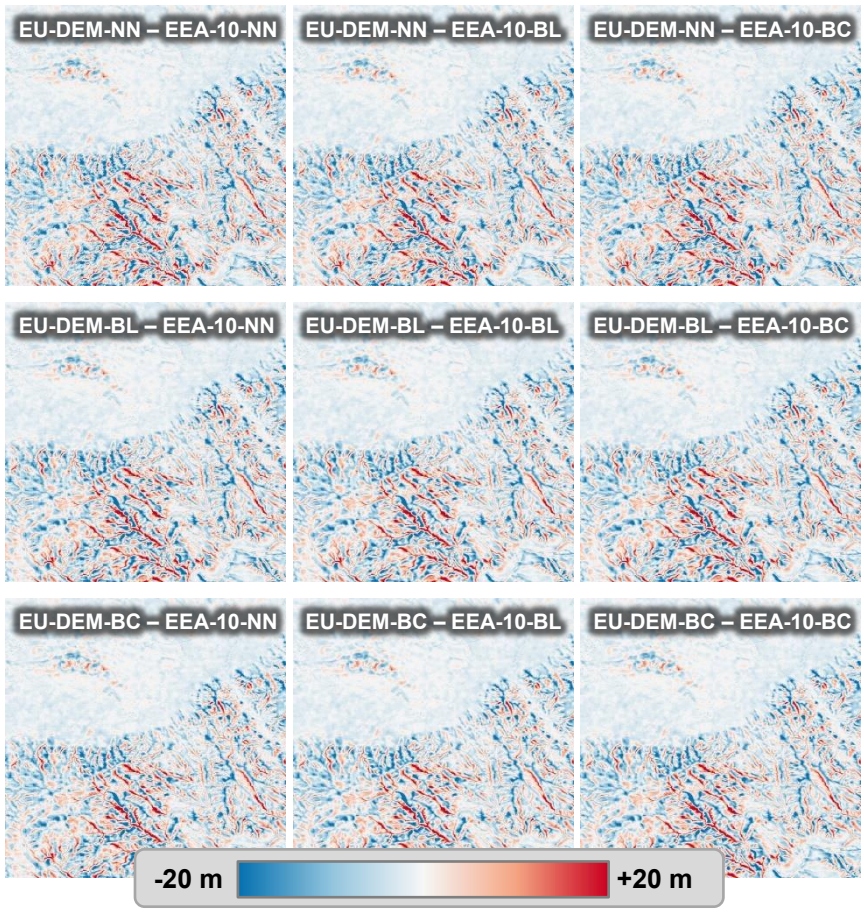
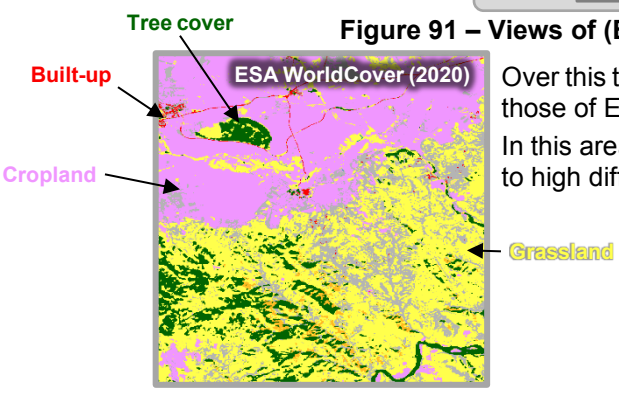


Figure 91 – Views of (EU-DEM -EEA-10) over DEMIX tile N41XE021L.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 90).

In this area, both changes in land cover and height variations seem to lead to high differences (see attached figure and Figure 90).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -1.67 m** **Std Dev = 6.03 m** **RMSE = 6.26 m**	**Mean = -1.66 m** **Std Dev = 5.95 m** **RMSE = 6.18 m**	**Mean = -1.66 m** **Std Dev = 6.01 m** **RMSE = 6.24 m**
Bilinear (BL)	**Mean = -1.67 m** **Std Dev = 5.93 m** **RMSE = 6.16 m**	**Mean = -1.66 m** **Std Dev = 5.85 m** **RMSE = 6.08 m**	**Mean = -1.66 m** **Std Dev = 5.91 m** **RMSE = 6.14 m**
Bicubic (BC)	**Mean = -1.67 m** **Std Dev = 5.91 m** **RMSE = 6.14 m**	**Mean = -1.66 m** **Std Dev = 5.83 m** **RMSE = 6.06 m**	**Mean = -1.66 m** **Std Dev = 5.89 m** **RMSE = 6.12 m**

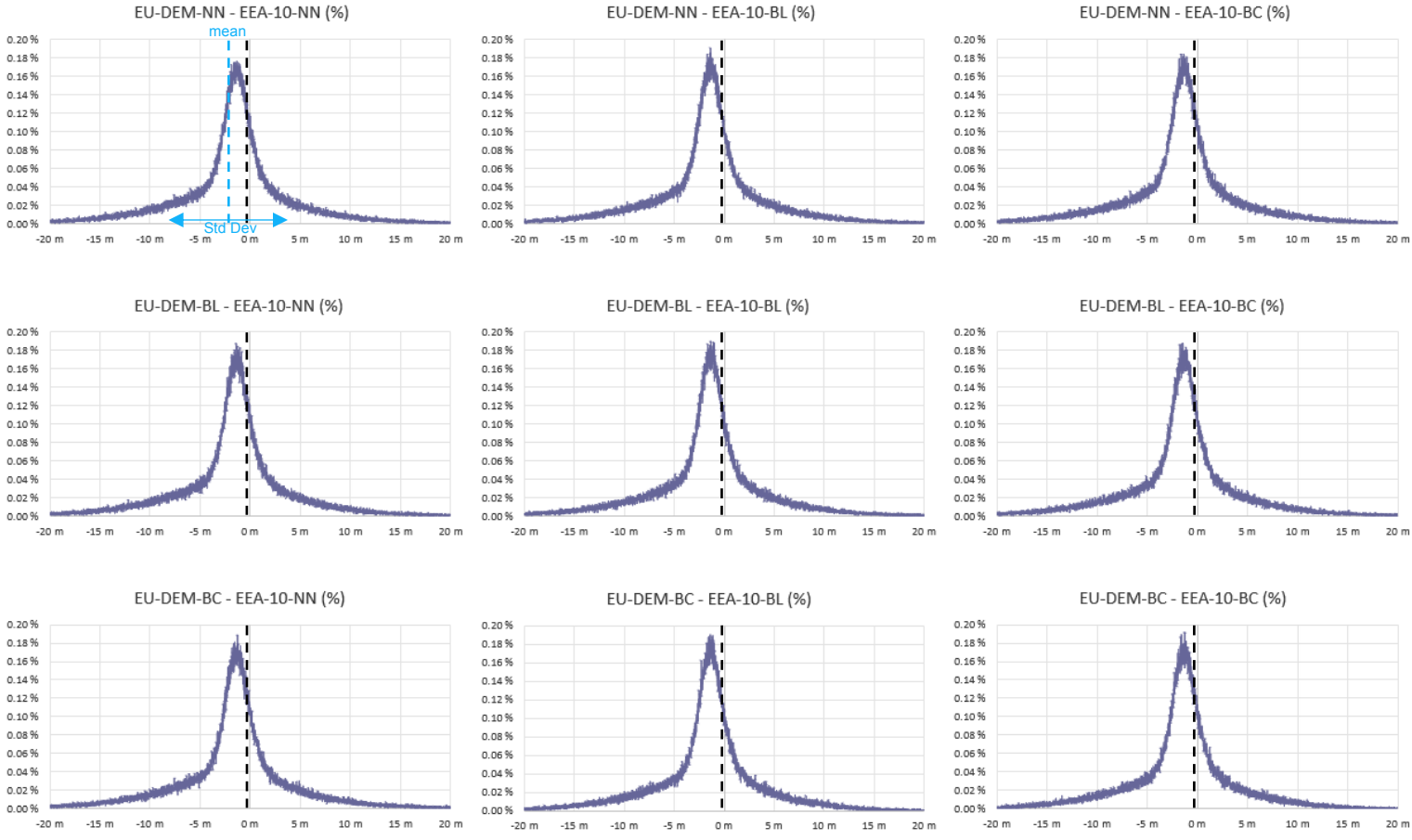


Figure 92 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N41XE021L.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for the mean, **0.20 m** for standard deviation and **0.20 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -1.5 m of difference. In this area, high differences seem to be linked to the height variations and to the grassland, tree cover classes (see attached figure of last page).

4.1.1.28 28 - Serbia - N44VE020B (zone 1)

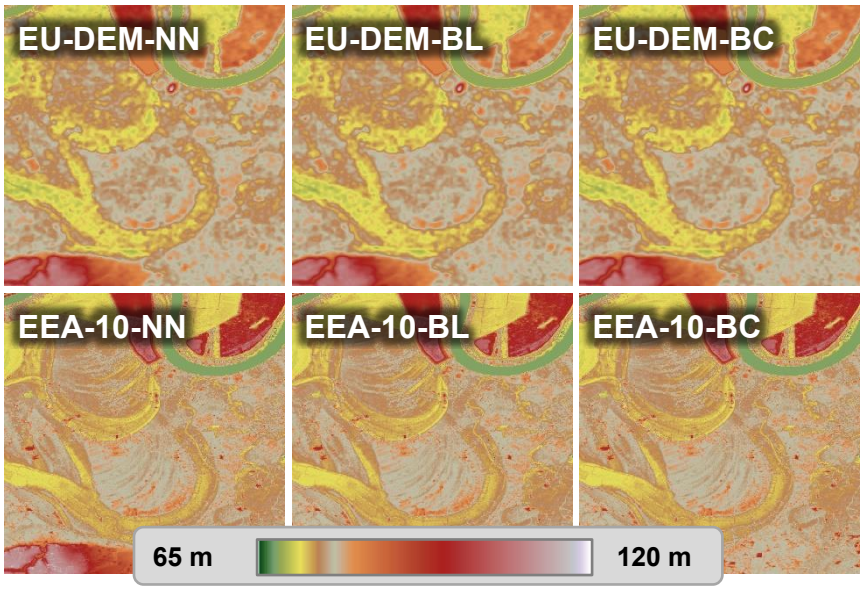


Figure 93 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N44VE020B.

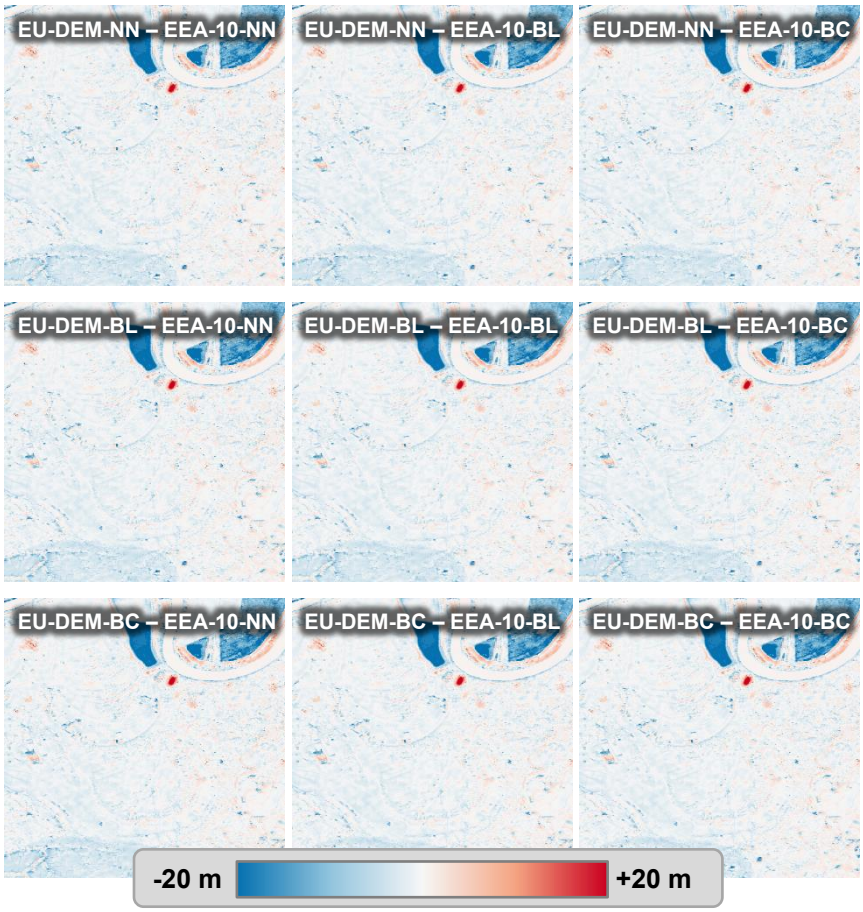
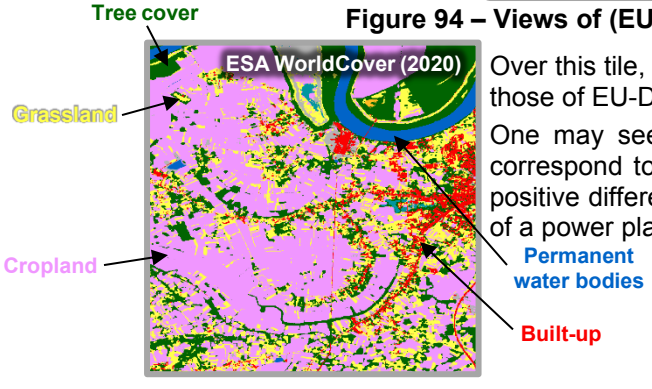


Figure 94 – Views of (EU-DEM -EEA-10) over DEMIX tile N44VE020B.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 93).

One may see high negative errors in the North East of this tile, which correspond to tree cover (see attached figure). One may see a cluster of positive differences over the North of the tile, which are linked to the height of a power plant.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -1.57 m Std Dev = 3.91 m RMSE = 4.22 m	Mean = -1.57 m Std Dev = 3.85 m RMSE = 4.16 m	Mean = -1.58 m Std Dev = 3.89 m RMSE = 4.20 m
Bilinear (BL)	Mean = -1.57 m Std Dev = 3.90 m RMSE = 4.21 m	Mean = -1.58 m Std Dev = 3.84 m RMSE = 4.15 m	Mean = -1.58 m Std Dev = 3.88 m RMSE = 4.19 m
Bicubic (BC)	Mean = -1.57 m Std Dev = 3.91 m RMSE = 4.21 m	Mean = -1.58 m Std Dev = 3.84 m RMSE = 4.15 m	Mean = -1.58 m Std Dev = 3.89 m RMSE = 4.19 m

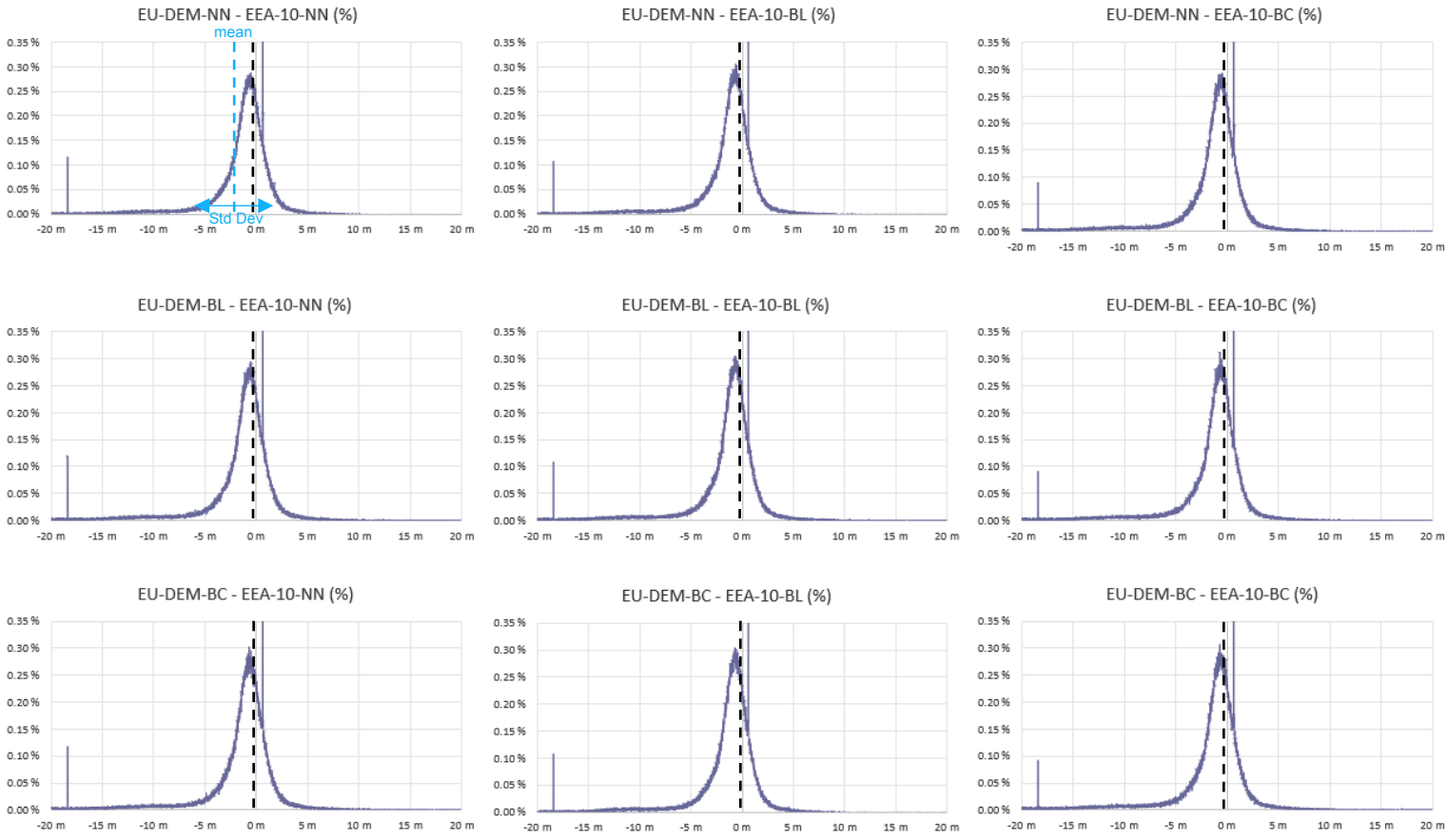


Figure 95 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N44VE020B.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL) and (EU-DEM-BL – EEA-10-BL)** studies, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for the mean, **0.07 m** for standard deviation and **0.07 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -0.5 m of difference. In this area, high differences seem to be linked to the height variations and tree cover (see attached figure of last page). High peaks, close to 0.5 m and -18.5 m, are due to flat areas, identified as lakes.

4.1.1.29 29 - Romania - N46RE026G (zone 1)

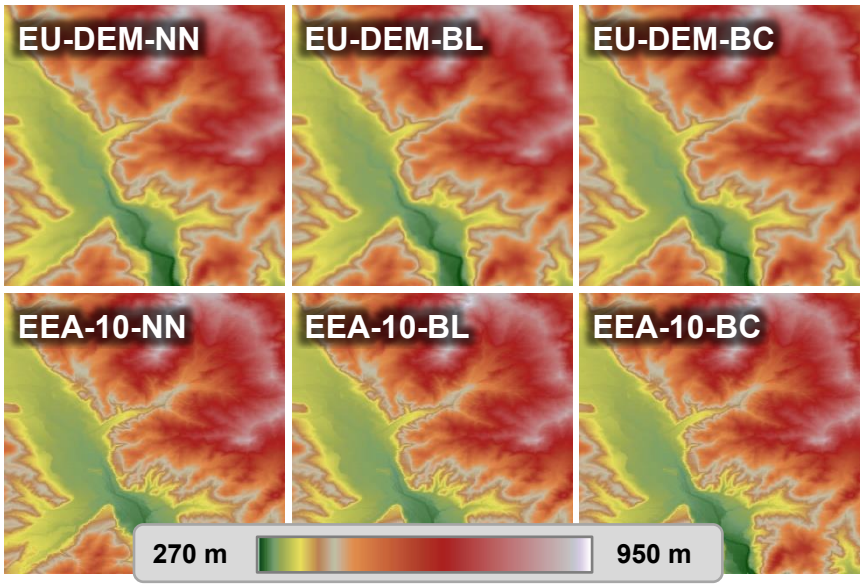


Figure 96 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N46RE026G.

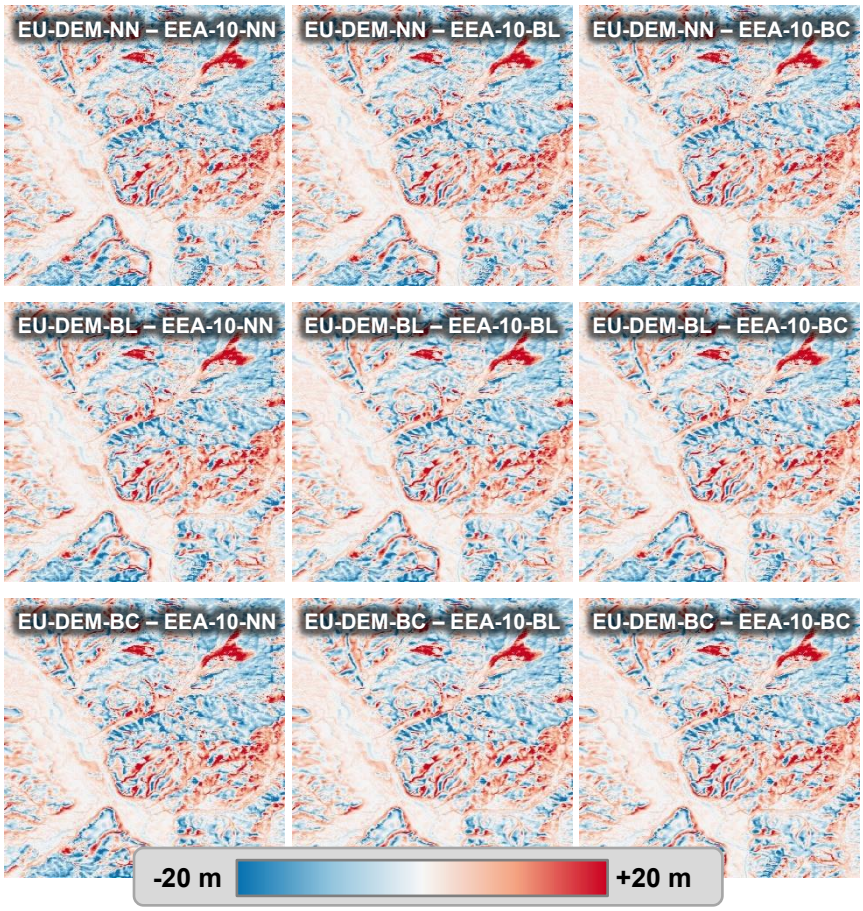
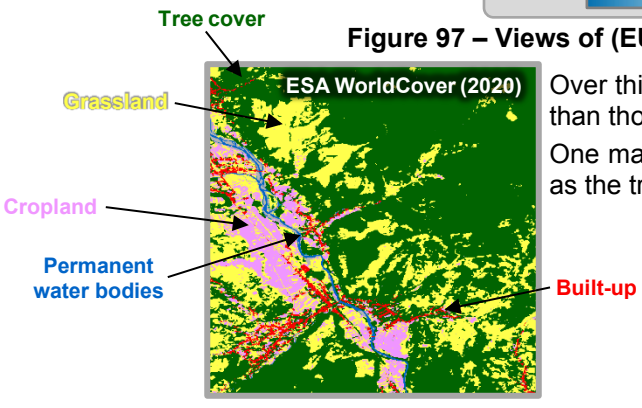


Figure 97 – Views of (EU-DEM -EEA-10) over DEMIX tile N46RE026G.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 96).

One may see height differences linked to the height variations, as well as the tree cover over this area (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -0.48 m** **Std Dev = 8.10 m** **RMSE = 8.12 m**	**Mean = -0.48 m** **Std Dev = 7.84 m** **RMSE = 7.86 m**	**Mean = -0.48 m** **Std Dev = 7.93 m** **RMSE = 7.94 m**
Bilinear (BL)	**Mean = -0.49 m** **Std Dev = 7.92 m** **RMSE = 7.94 m**	**Mean = -0.48 m** **Std Dev = 7.66 m** **RMSE = 7.68 m**	**Mean = -0.48 m** **Std Dev = 7.75 m** **RMSE = 7.76 m**
Bicubic (BC)	**Mean = -0.49 m** **Std Dev = 7.89 m** **RMSE = 7.90 m**	**Mean = -0.48 m** **Std Dev = 7.62 m** **RMSE = 7.64 m**	**Mean = -0.48 m** **Std Dev = 7.71 m** **RMSE = 7.72 m**

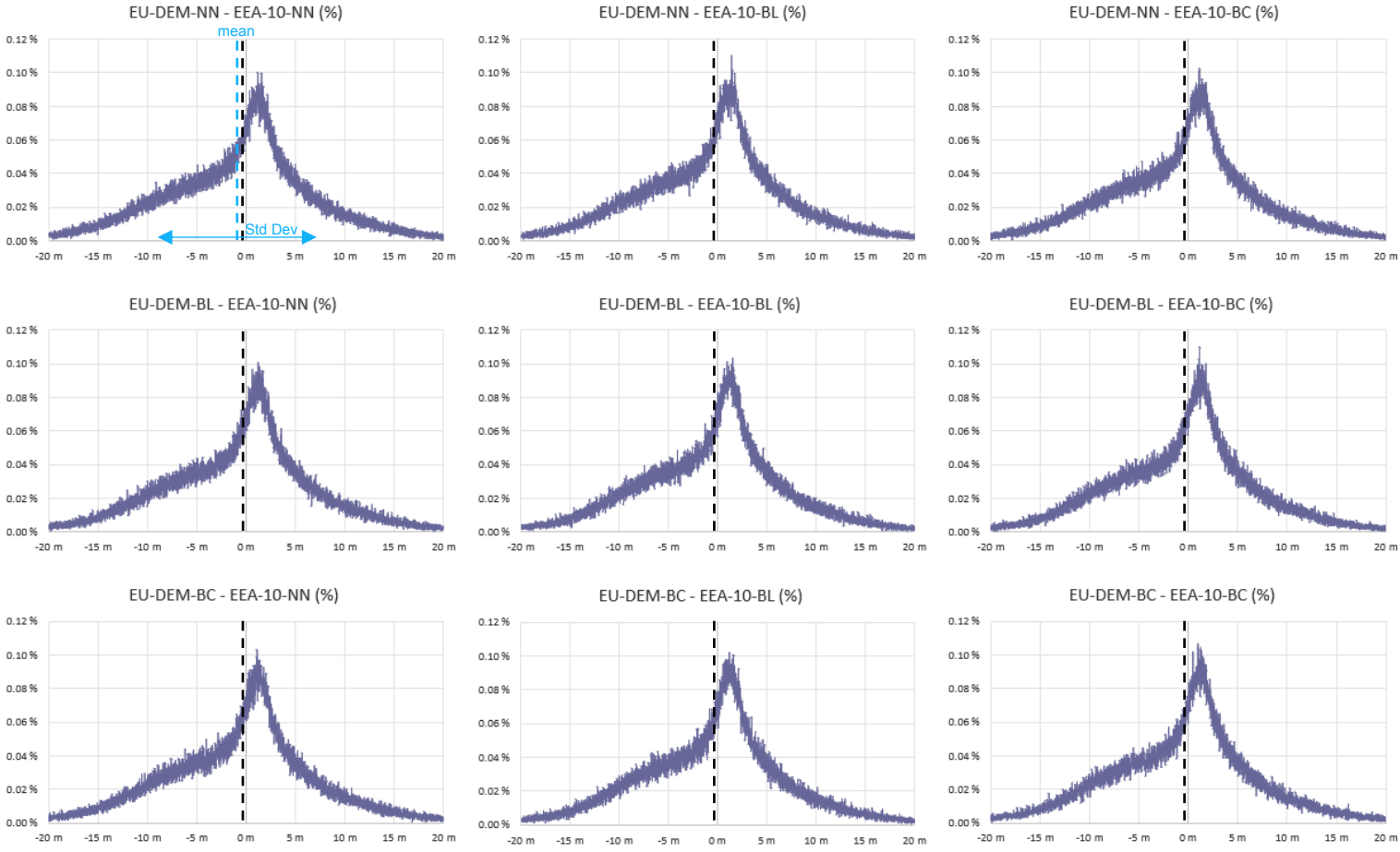


Figure 98 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N46RE026G.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.01 m** for the mean, **0.48 m** for standard deviation and **0.48 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 1 m of difference. In this area, high differences seem to be linked to the height variations and tree cover (see attached figure of last page).

4.1.1.30 30 - Bulgaria - N42VE025J (zone 1)

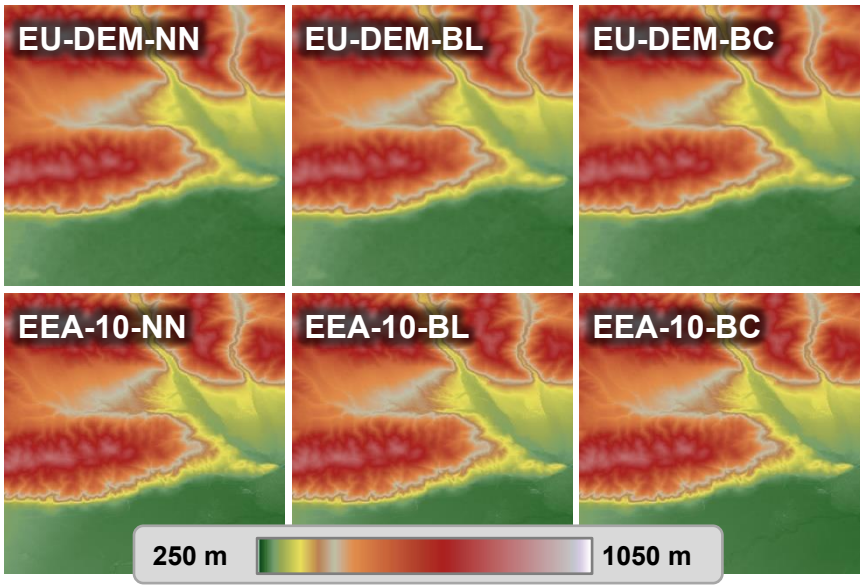


Figure 99 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N42VE025J.

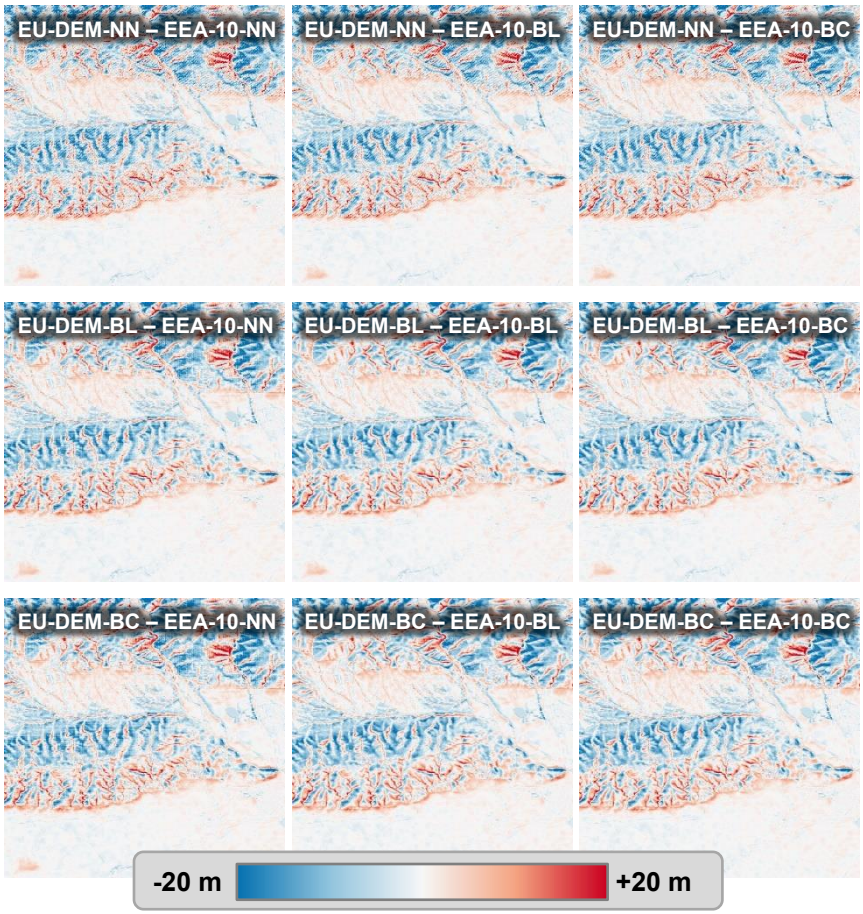
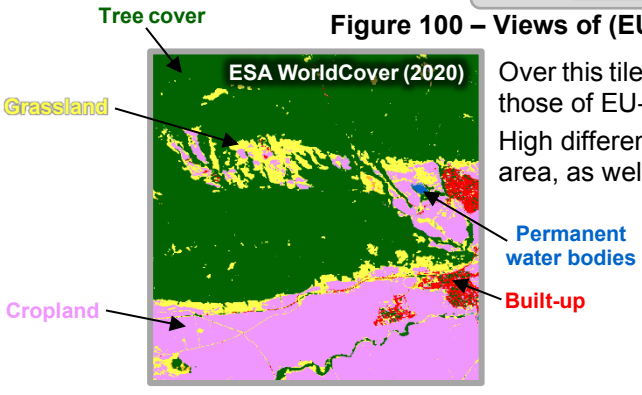


Figure 100 – Views of (EU-DEM -EEA-10) over DEMIX tile N42VE025J.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 99).

High differences mostly seem to be linked to the height variations over this area, as well as the tree cover (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -1.45 m** **Std Dev = 6.50 m** **RMSE = 6.66 m**	**Mean = -1.43 m** **Std Dev = 6.40 m** **RMSE = 6.55 m**	**Mean = -1.43 m** **Std Dev = 6.46 m** **RMSE = 6.61 m**
Bilinear (BL)	**Mean = -1.45 m** **Std Dev = 6.24 m** **RMSE = 6.40 m**	**Mean = -1.43 m** **Std Dev = 6.13 m** **RMSE = 6.29 m**	**Mean = -1.43 m** **Std Dev = 6.19 m** **RMSE = 6.35 m**
Bicubic (BC)	**Mean = -1.45 m** **Std Dev = 6.19 m** **RMSE = 6.35 m**	**Mean = -1.43 m** **Std Dev = 6.07 m** **RMSE = 6.24 m**	**Mean = -1.43 m** **Std Dev = 6.14 m** **RMSE = 6.30 m**

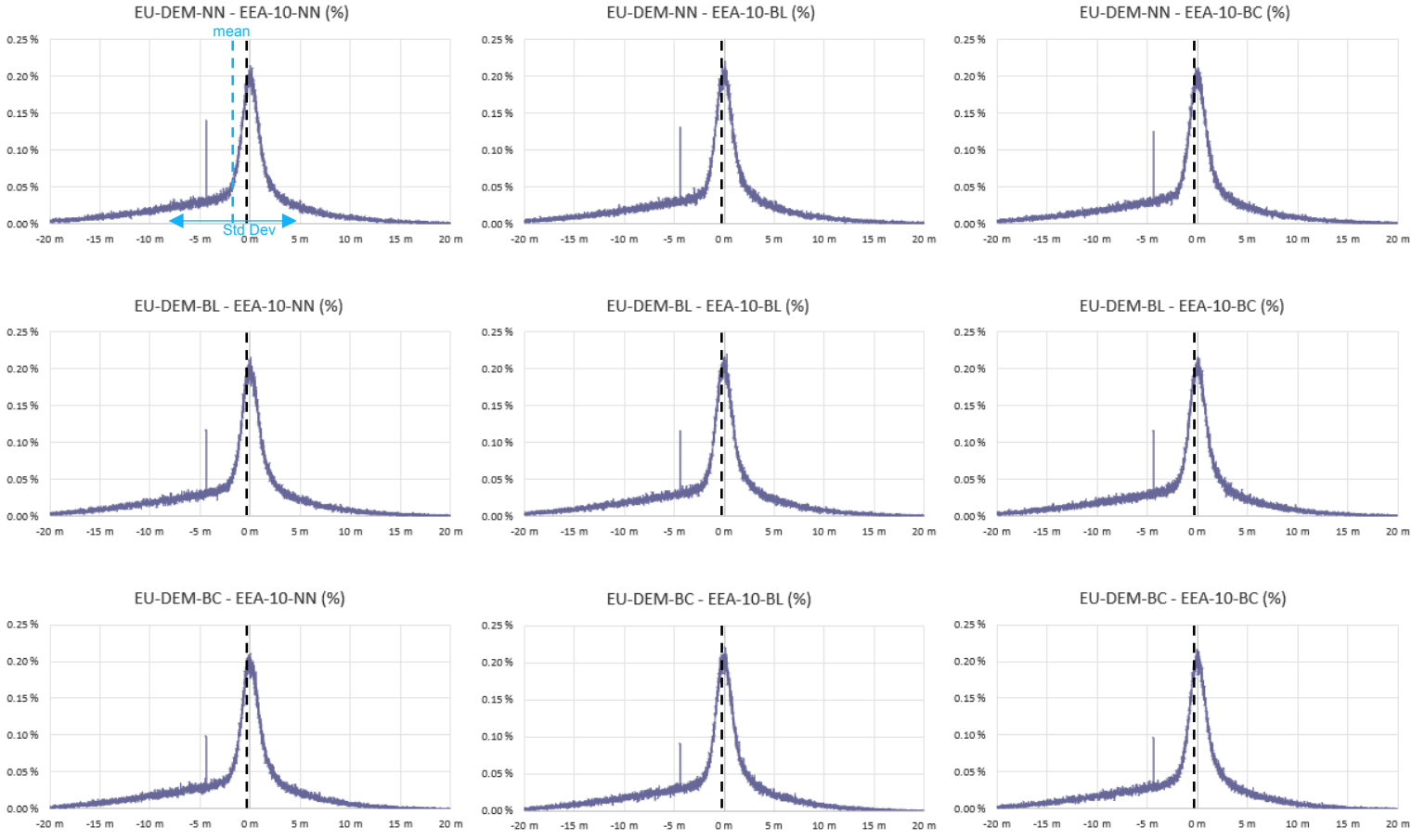


Figure 101 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N42VE025J.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.02 m** for the mean, **0.43 m** for standard deviation and **0.42 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0 m of difference. In this area, high differences seem to be linked to the height variations and tree cover (see attached figure of last page). A peak, close to -4.8 m, is due to flat areas, identified as lakes.

4.1.1.31 31 - Greece - N38TE023D (zone 1)

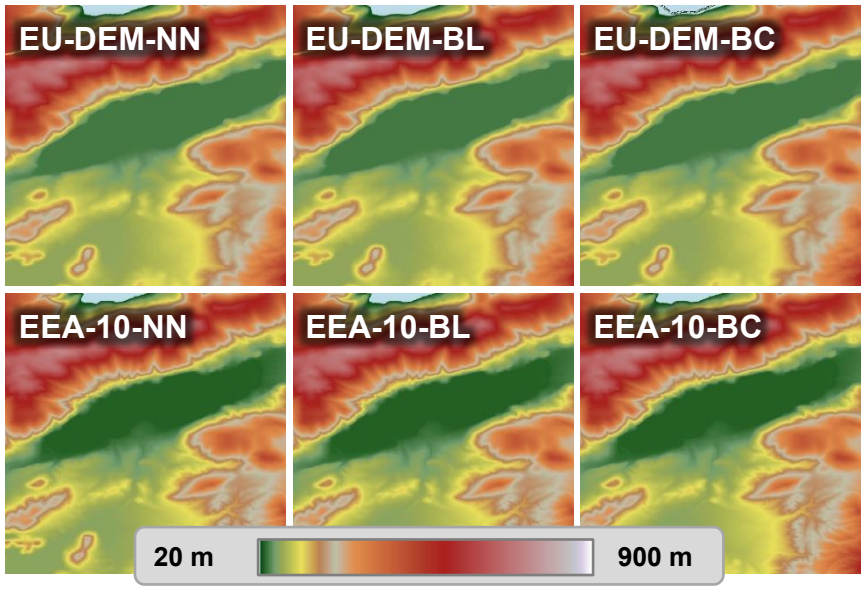


Figure 102 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N38TE023D.

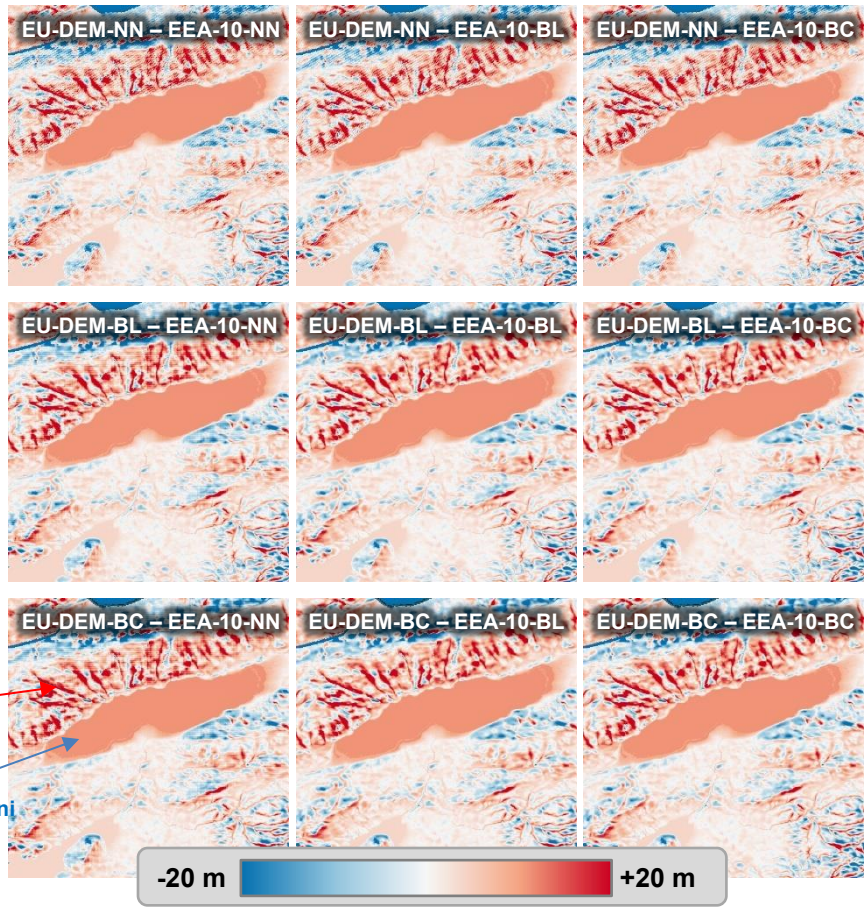
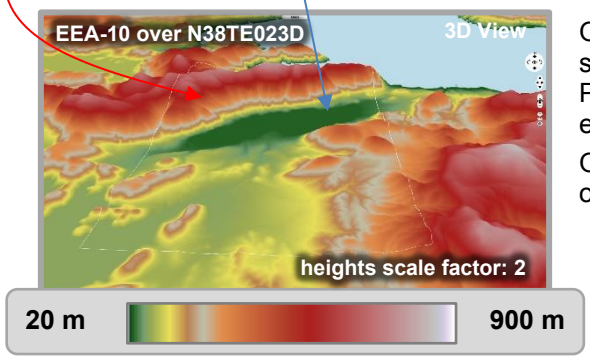


Figure 103 – Views of (EU-DEM -EEA-10) over DEMIX tile N38TE023D.



Over this tile, the resampled instances of EEA-10 and EU-DEM show similar level of details (see Figure 102). One may see that the Paralimni Lake, located at the centre of the tile, shows higher elevations in EU-DEM than in EEA-10.

One may see greater differences in height transition areas, as seen over the North shore of the Paralimni Lake (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 2.53 m** **Std Dev = 10.19 m** **RMSE = 10.50 m**	**Mean = 2.51 m** **Std Dev = 10.07 m** **RMSE = 10.38 m**	**Mean = 2.51 m** **Std Dev = 10.09 m** **RMSE = 10.39 m**
Bilinear (BL)	**Mean = 2.54 m** **Std Dev = 9.75 m** **RMSE = 10.07 m**	**Mean = 2.51 m** **Std Dev = 9.61 m** **RMSE = 9.94 m**	**Mean = 2.51 m** **Std Dev = 9.63 m** **RMSE = 9.95 m**
Bicubic (BC)	**Mean = 2.54 m** **Std Dev = 9.92 m** **RMSE = 10.24 m**	**Mean = 2.52 m** **Std Dev = 9.79 m** **RMSE = 10.11 m**	**Mean = 2.52 m** **Std Dev = 9.81 m** **RMSE = 10.13 m**

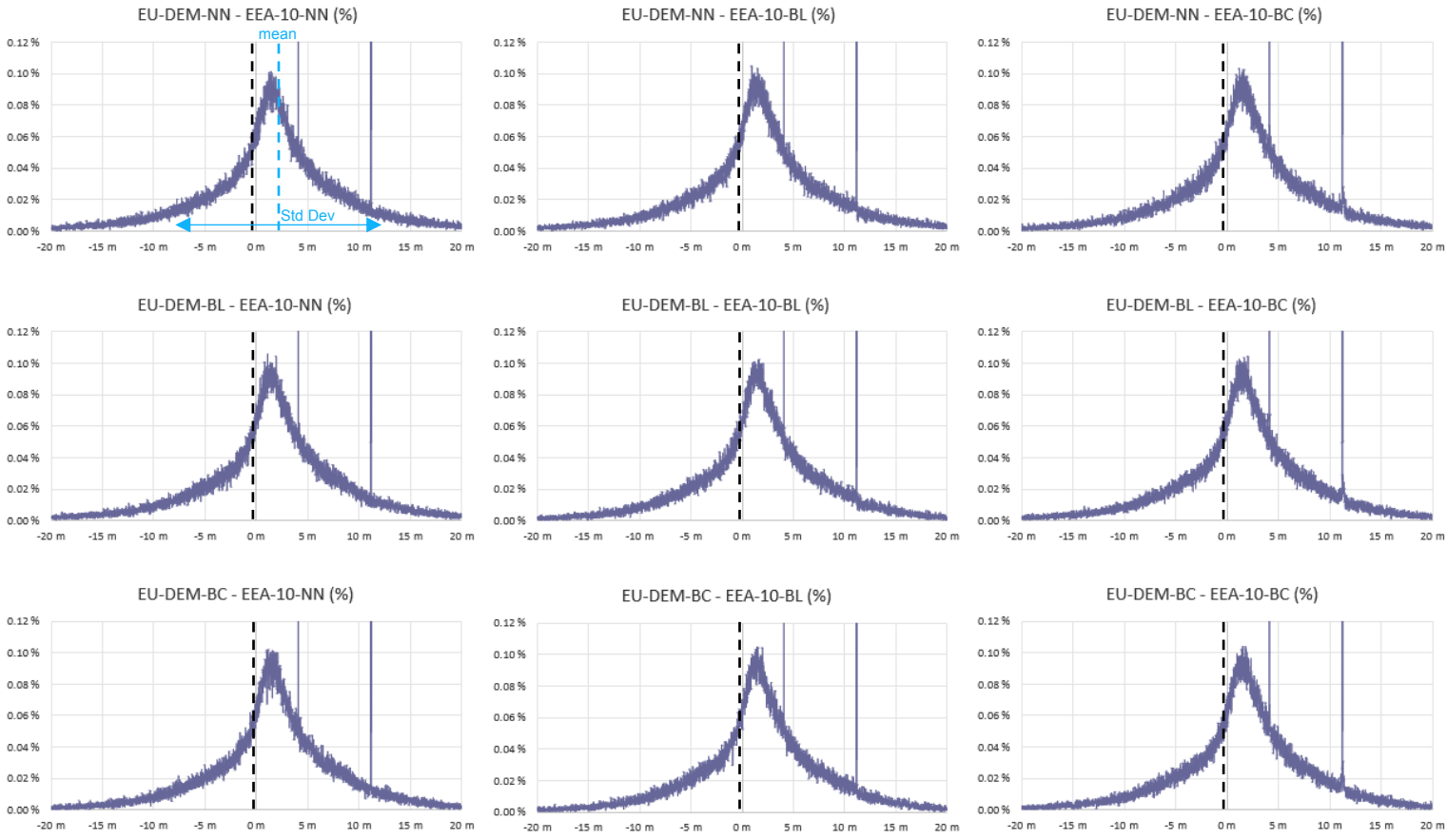


Figure 104 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N38TE023D.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.03 m** for the mean, **0.58 m** for standard deviation and **0.56 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 1.2 m of difference. In this area, high differences seem to be linked to the height variations (see attached figure of last page). Peaks, close to 4.5 m and 11 m, are due to flat areas, identified as lakes.

4.1.1.32 32 - Turkey - N38ZE038J (zone 1)

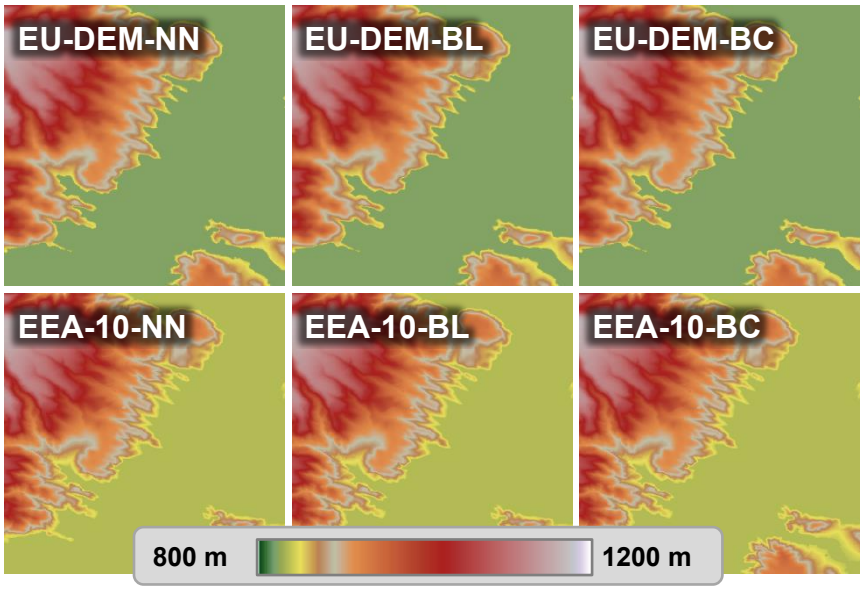


Figure 105 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N38ZE038J.

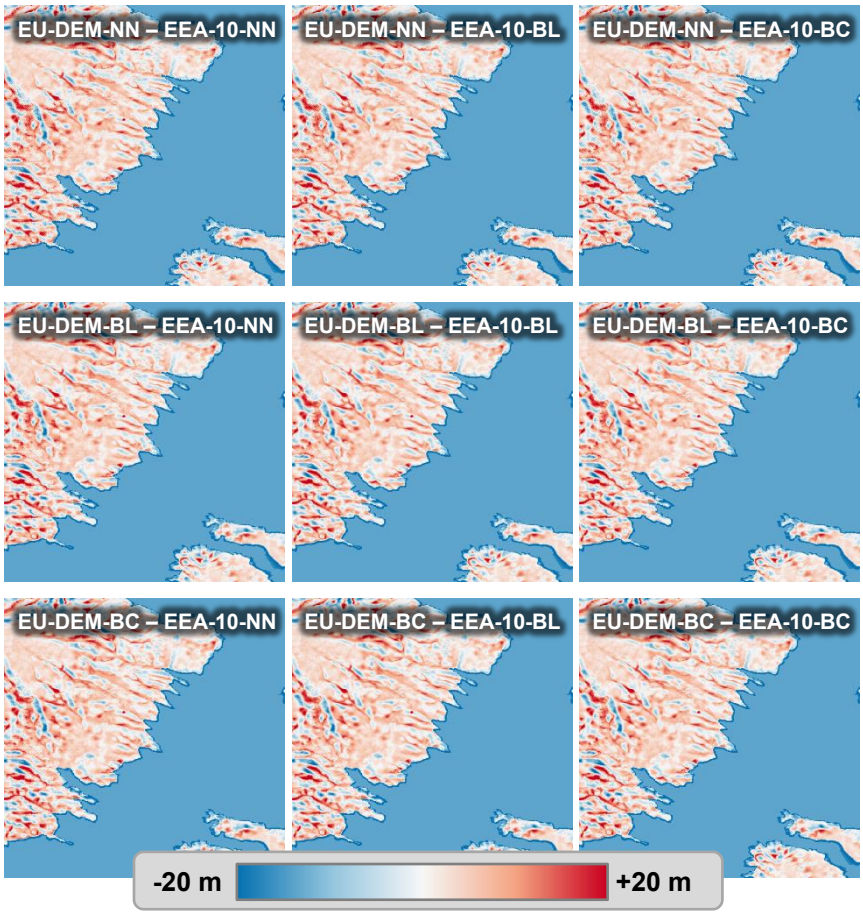
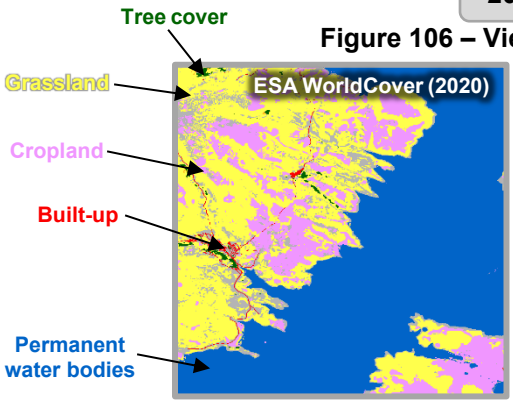


Figure 106 – Views of (EU-DEM -EEA-10) over DEMIX tile N38ZE038J.



Over this tile, the resampled instances of EEA-10 and EU-DEM show a similar level of detail (see Figure 105).

One may see that the differences are linked to height variations, but not really from the land cover over this area (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -6.13 m Std Dev = 9.46 m RMSE = 11.27 m	Mean = -6.15 m Std Dev = 9.40 m RMSE = 11.23 m	Mean = -6.15 m Std Dev = 9.41 m RMSE = 11.24 m
Bilinear (BL)	Mean = -6.13 m Std Dev = 9.37 m RMSE = 11.20 m	Mean = -6.15 m Std Dev = 9.31 m RMSE = 11.16 m	Mean = -6.15 m Std Dev = 9.32 m RMSE = 11.17 m
Bicubic (BC)	Mean = -6.13 m Std Dev = 9.40 m RMSE = 11.22 m	Mean = -6.15 m Std Dev = 9.34 m RMSE = 11.19 m	Mean = -6.15 m Std Dev = 9.35 m RMSE = 11.19 m

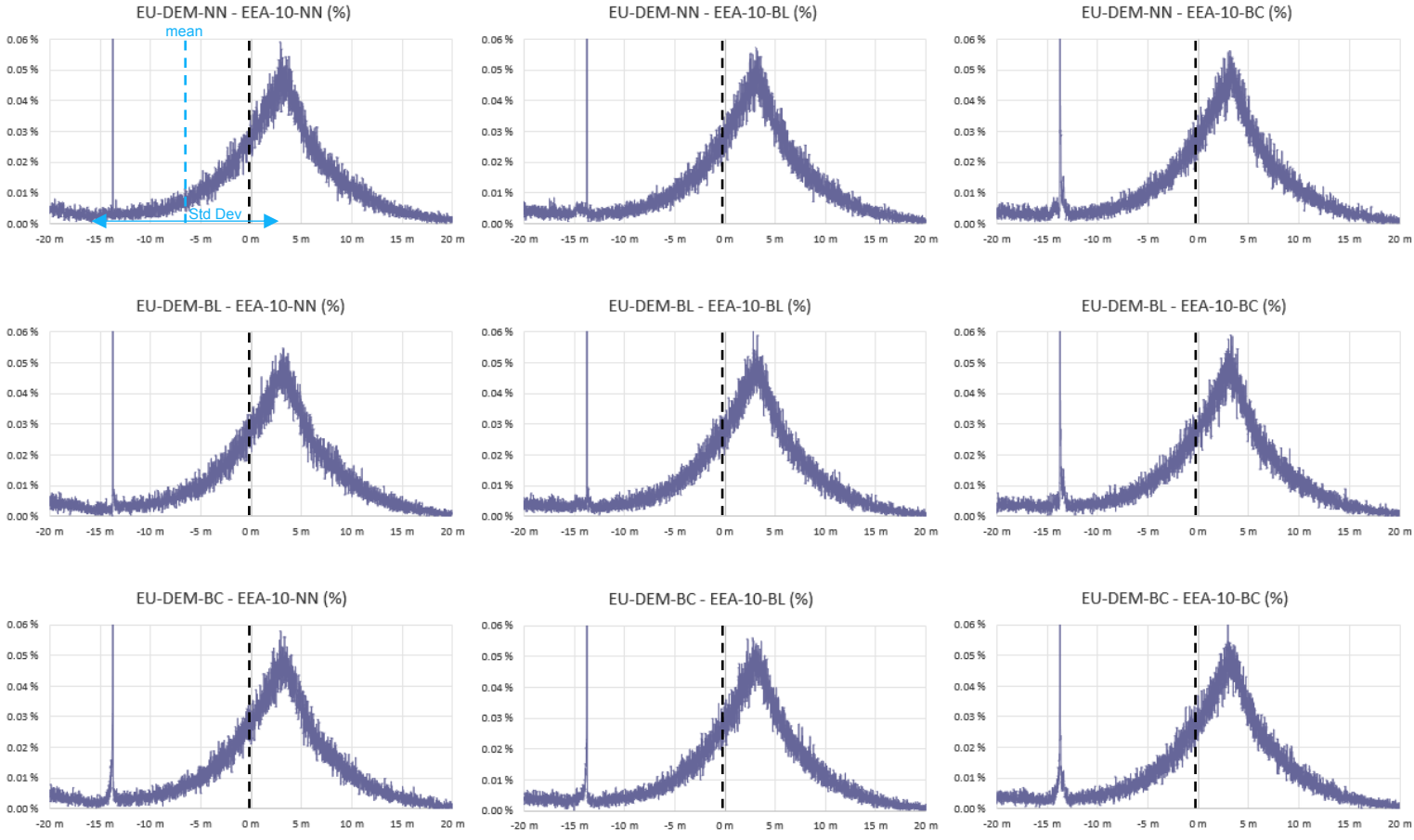


Figure 107 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N38ZE038J.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.02 m** for the mean, **0.15 m** for standard deviation and **0.11 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 3 m of difference. In this area, high differences seem to be linked to the height variations (see attached figure of last page). A peak, close to -14 m, is due to flat areas, identified as water.

4.1.1.33 33 - England - N51VW001A (zone 2)

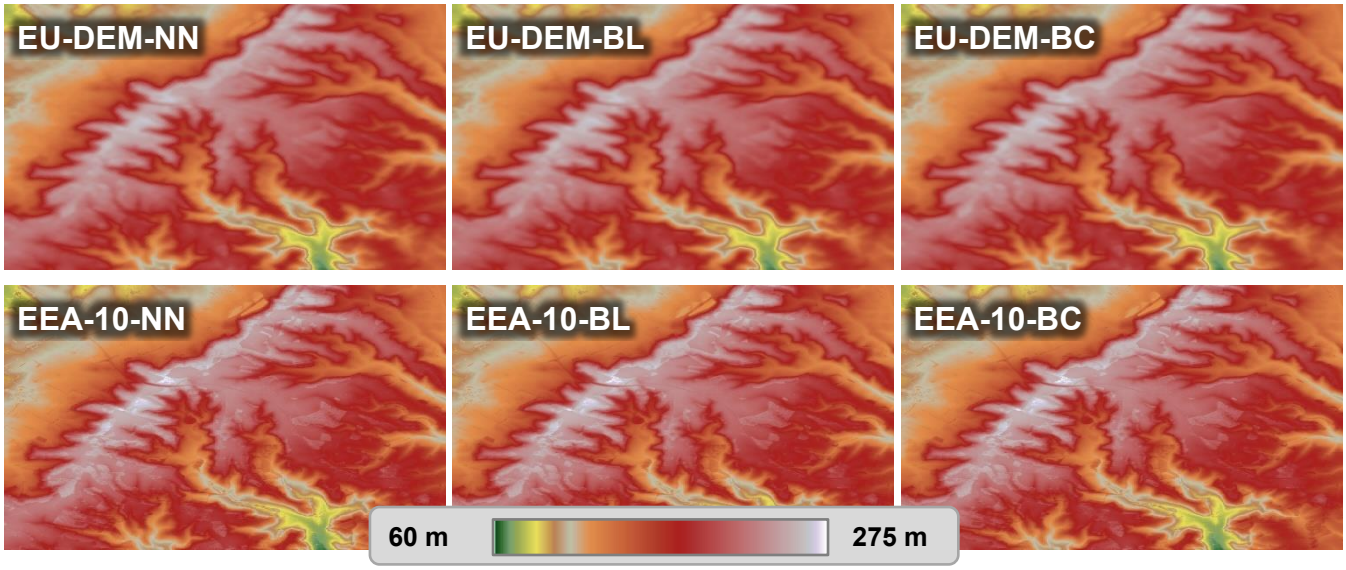


Figure 108 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N51VW001A.

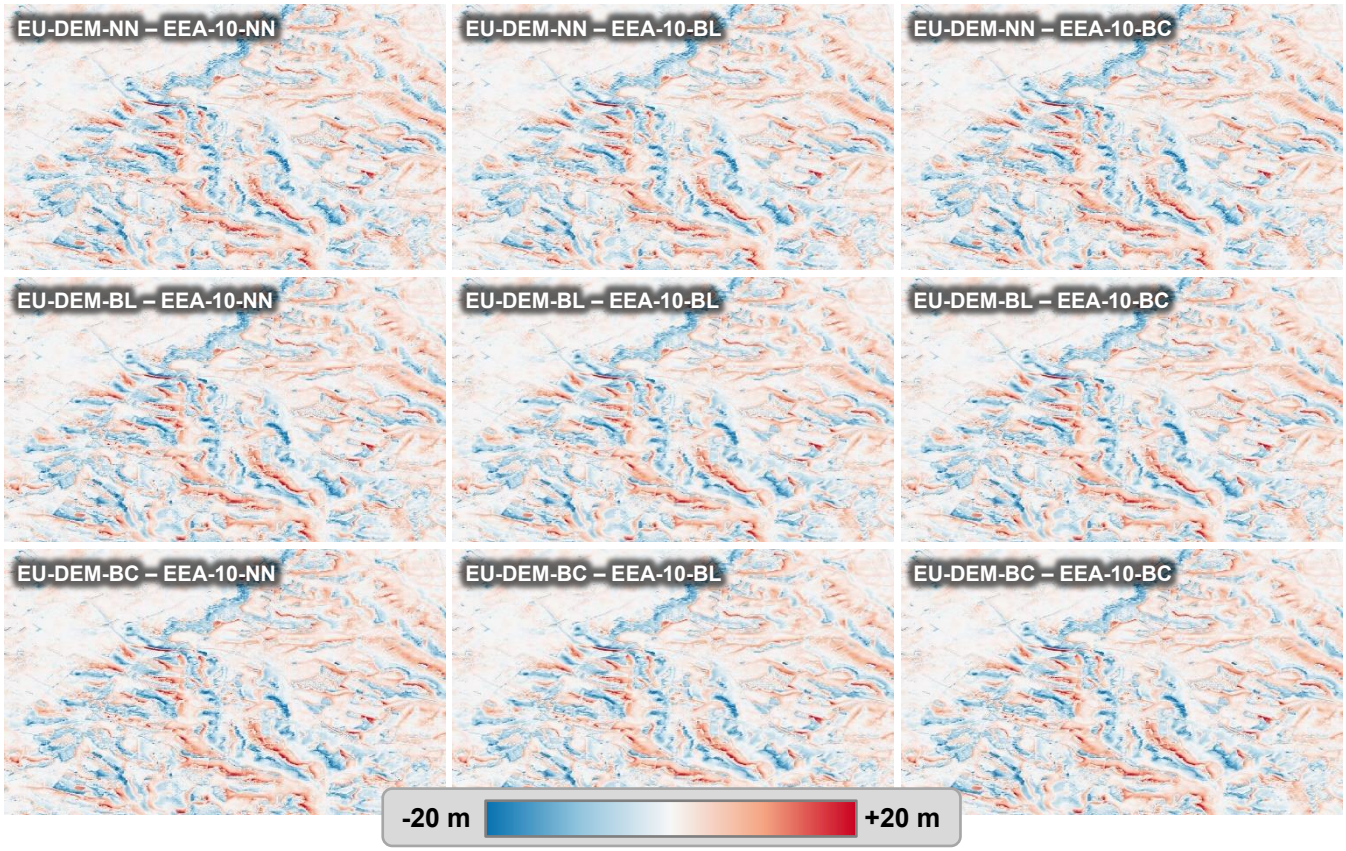
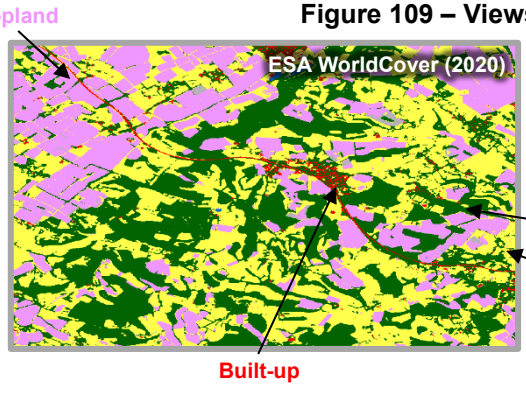


Figure 109 – Views of (EU-DEM -EEA-10) over DEMIX tile N51VW001A.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 108).

One may see more important differences over mixed tree cover and grassland than over mixed croplands and grassland (North West of the tile, see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -0.09 m** **Std Dev = 5.02 m** **RMSE = 5.02 m**	**Mean = -0.09 m** **Std Dev = 4.85 m** **RMSE = 4.85 m**	**Mean = -0.09 m** **Std Dev = 4.94 m** **RMSE = 4.94 m**
Bilinear (BL)	**Mean = -0.09 m** **Std Dev = 4.95 m** **RMSE = 4.95 m**	**Mean = -0.09 m** **Std Dev = 4.78 m** **RMSE = 4.79 m**	**Mean = -0.09 m** **Std Dev = 4.87 m** **RMSE = 4.87 m**
Bicubic (BC)	**Mean = -0.09 m** **Std Dev = 4.94 m** **RMSE = 4.94 m**	**Mean = -0.09 m** **Std Dev = 4.77 m** **RMSE = 4.77 m**	**Mean = -0.09 m** **Std Dev = 4.86 m** **RMSE = 4.86 m**

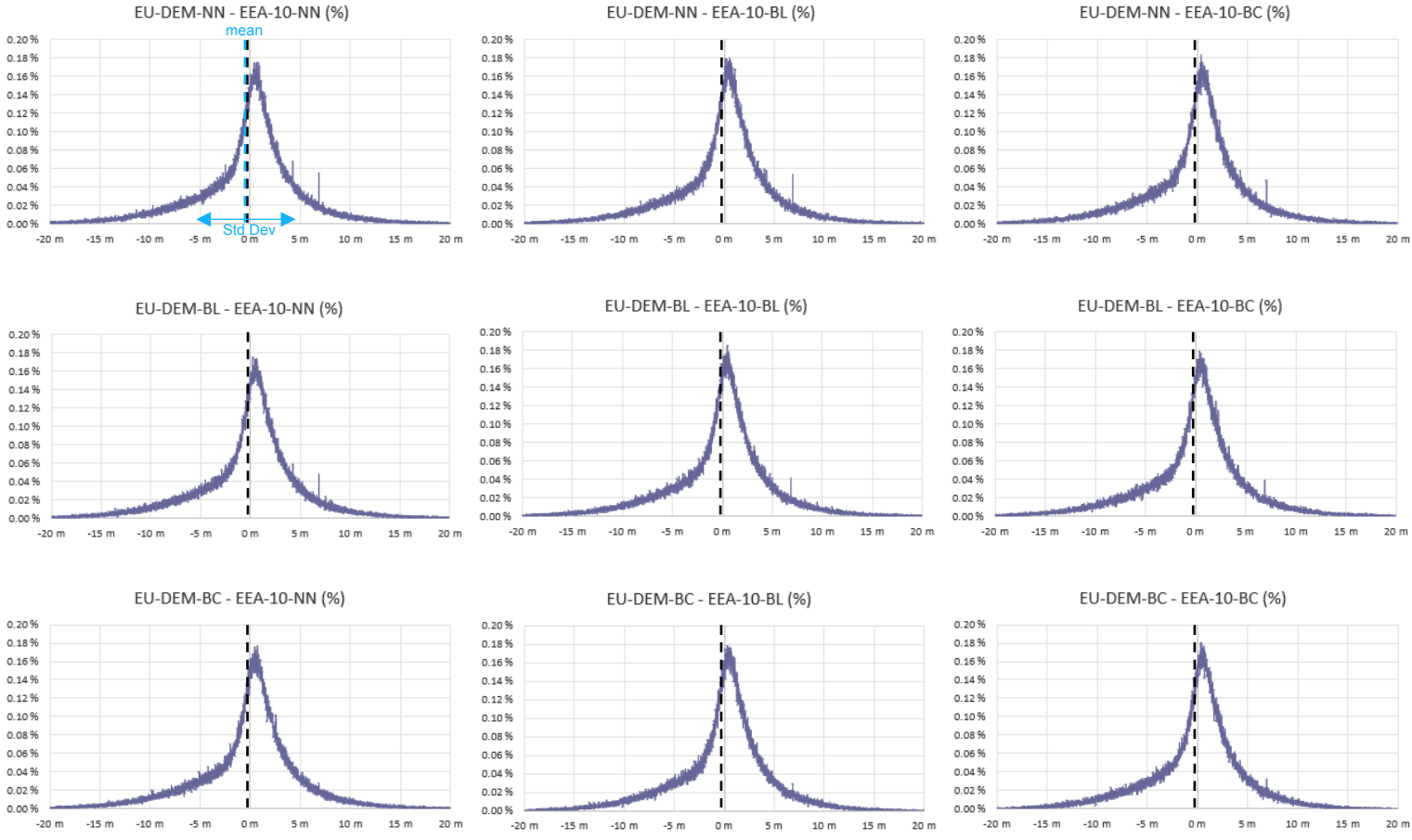


Figure 110 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N51VW001A.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.25 m** for standard deviation and **0.25 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0.8 m of difference. In this area, high differences seem to be linked to the height variations and mixed tree cover / grassland (see attached figure of last page).

4.1.1.34 34 - Ireland - N52RW009C (zone 2)

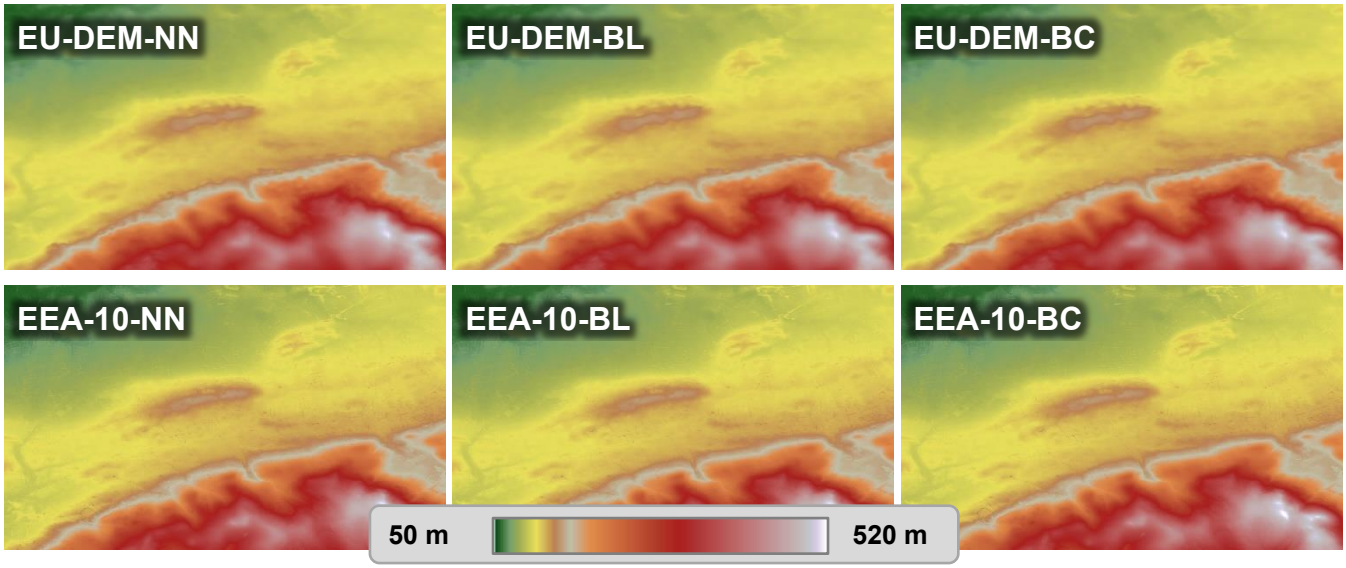


Figure 111 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N52RW009C.

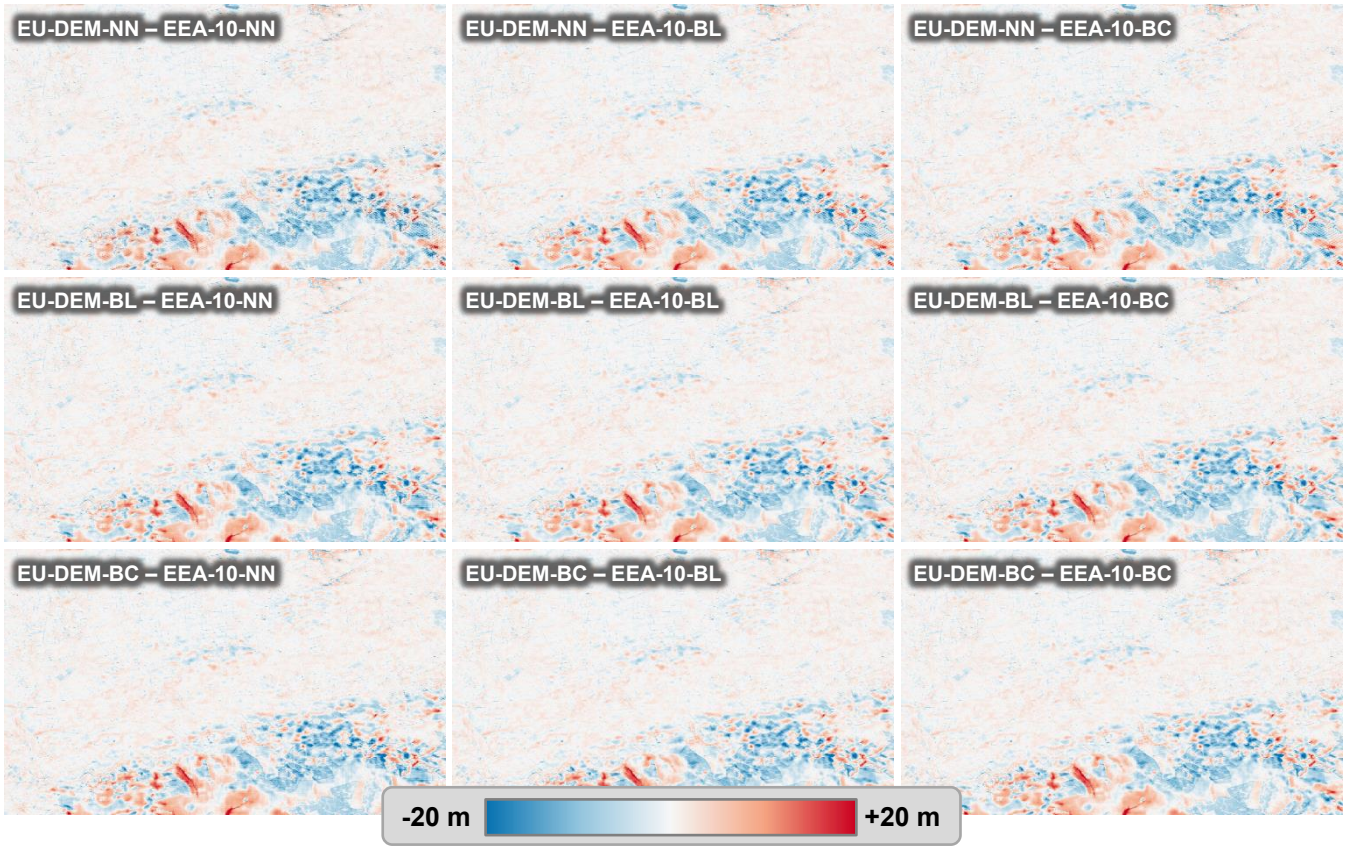
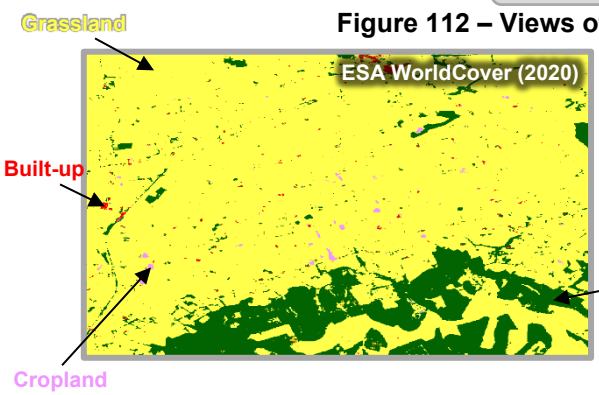


Figure 112 – Views of (EU-DEM -EEA-10) over DEMIX tile N52RW009C.



Over this tile, the resampled instances of EEA-10 and EU-DEM show a similar level of detail (see Figure 111).

One may see high differences over height transition areas, located in the South East of this tile. The flattest areas of this tile result in lower difference values. High differences are also linked to the tree cover class (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -0.20 m** **Std Dev = 3.50 m** **RMSE = 3.51 m**	**Mean = -0.16 m** **Std Dev = 3.40 m** **RMSE = 3.40 m**	**Mean = -0.16 m** **Std Dev = 3.44 m** **RMSE = 3.44 m**
Bilinear (BL)	**Mean = -0.20 m** **Std Dev = 3.43 m** **RMSE = 3.44 m**	**Mean = -0.16 m** **Std Dev = 3.32 m** **RMSE = 3.33 m**	**Mean = -0.16 m** **Std Dev = 3.36 m** **RMSE = 3.37 m**
Bicubic (BC)	**Mean = -0.20 m** **Std Dev = 3.44 m** **RMSE = 3.45 m**	**Mean = -0.16 m** **Std Dev = 3.34 m** **RMSE = 3.34 m**	**Mean = -0.16 m** **Std Dev = 3.38 m** **RMSE = 3.38 m**

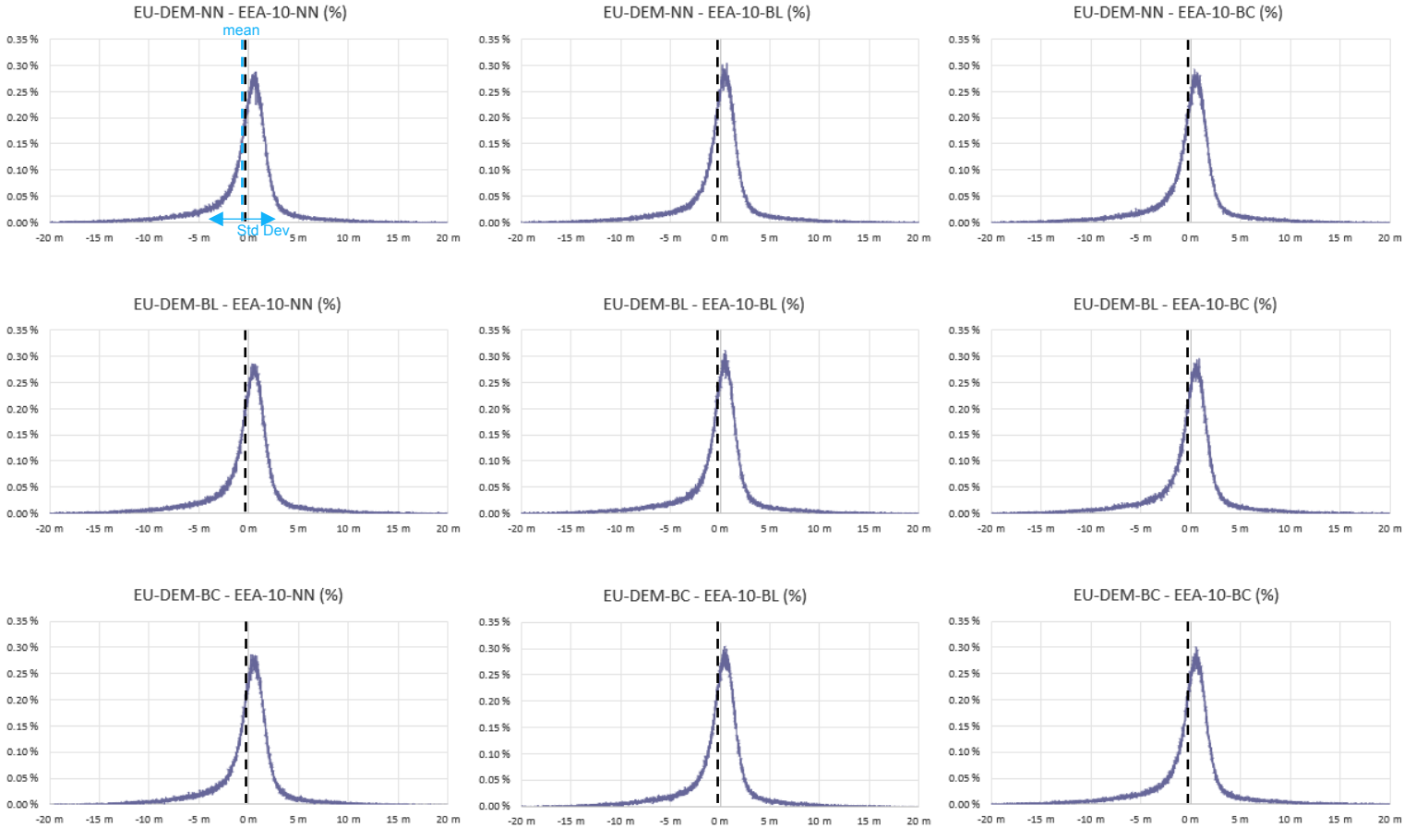


Figure 113 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N52RW009C.

In this case, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.04 m** for the mean, **0.18 m** for standard deviation and **0.18 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 0.5 m of difference. In this area, high differences seem to be linked to the height variations and tree cover (see attached figure of last page).

4.1.1.35 35 - Northern Ireland - N54YW007A (zone 2)

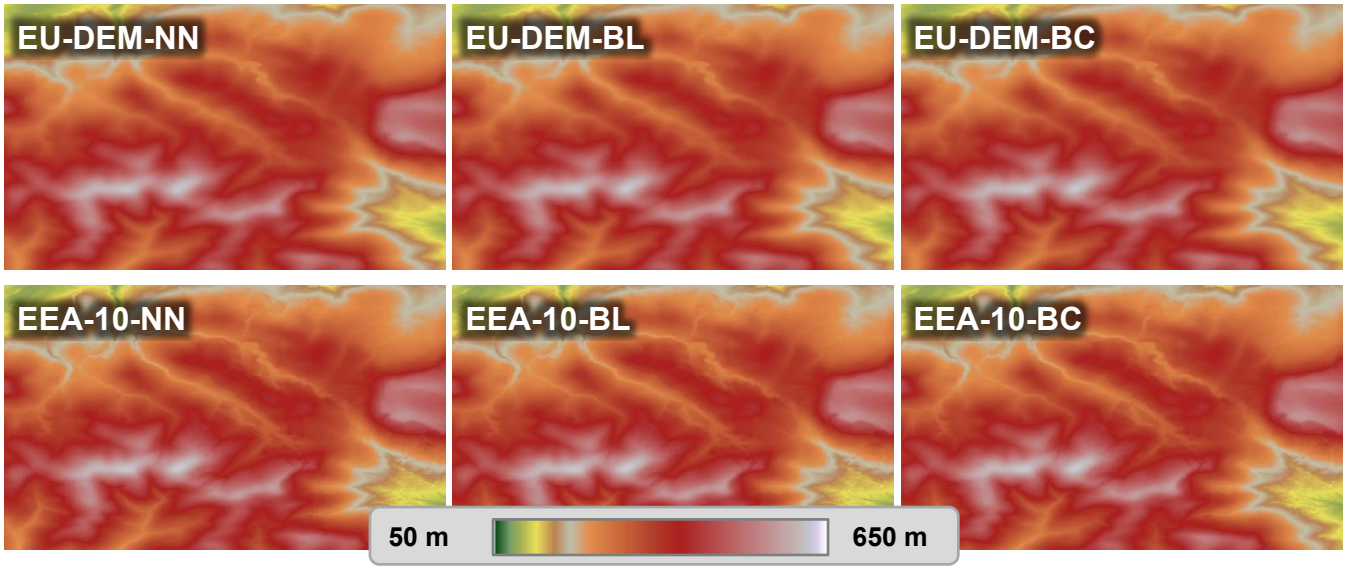


Figure 114 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N54YW007A.

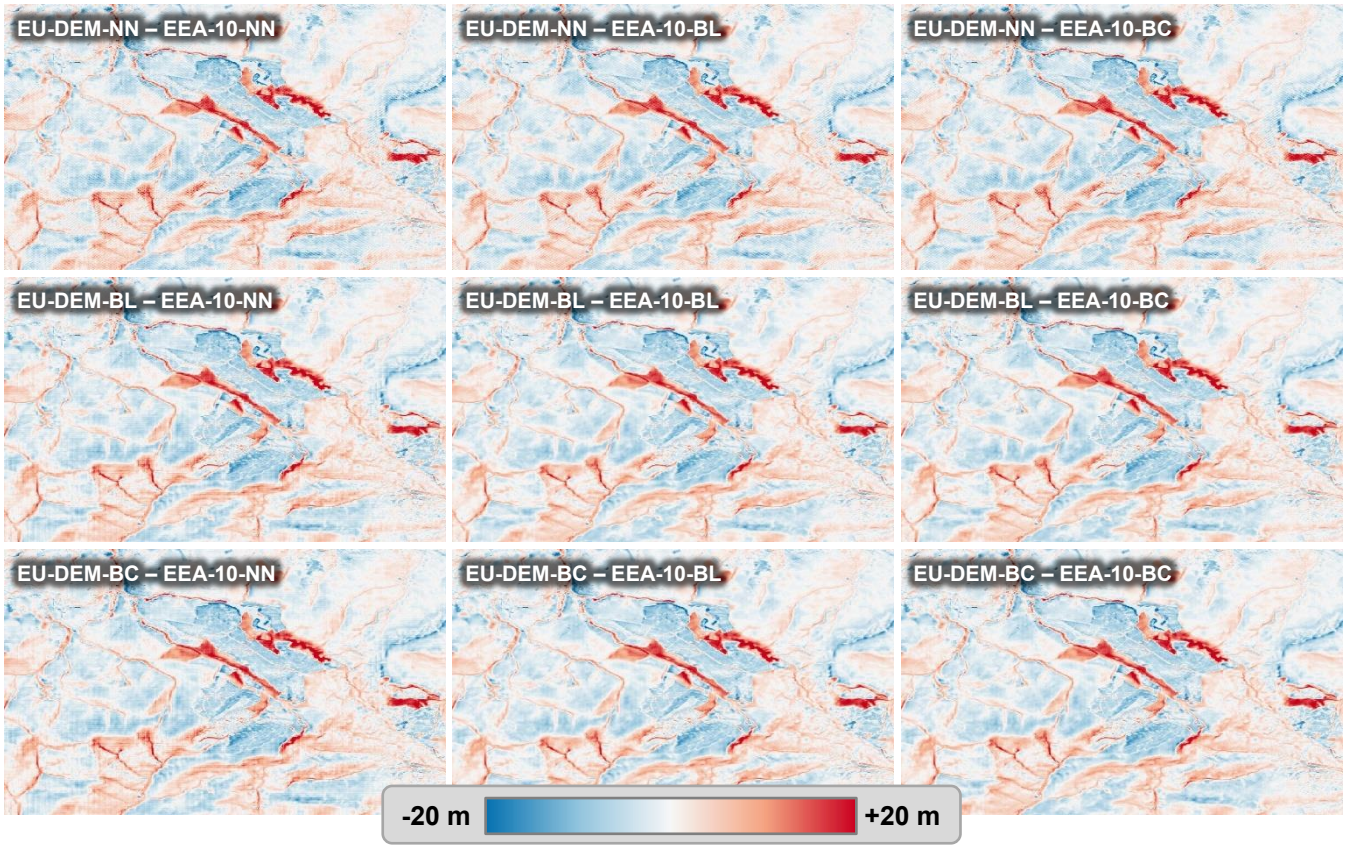
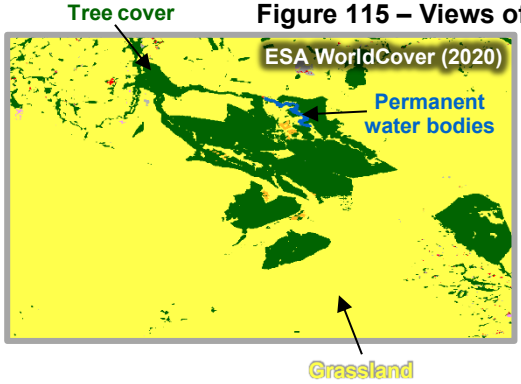


Figure 115 – Views of (EU-DEM -EEA-10) over DEMIX tile N54YW007A.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 114).

One may see the greatest height differences over the mountain passes. On the centre of the tile, negative differences are linked to tree cover (see attached figure).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -0.34 m** **Std Dev = 5.25 m** **RMSE = 5.26 m**	**Mean = -0.32 m** **Std Dev = 5.08 m** **RMSE = 5.09 m**	**Mean = -0.32 m** **Std Dev = 5.13 m** **RMSE = 5.14 m**
Bilinear (BL)	**Mean = -0.34 m** **Std Dev = 5.12 m** **RMSE = 5.13 m**	**Mean = -0.32 m** **Std Dev = 4.95 m** **RMSE = 4.96 m**	**Mean = -0.32 m** **Std Dev = 4.99 m** **RMSE = 5.00 m**
Bicubic (BC)	**Mean = -0.34 m** **Std Dev = 5.10 m** **RMSE = 5.12 m**	**Mean = -0.32 m** **Std Dev = 4.93 m** **RMSE = 4.94 m**	**Mean = -0.32 m** **Std Dev = 4.98 m** **RMSE = 4.99 m**

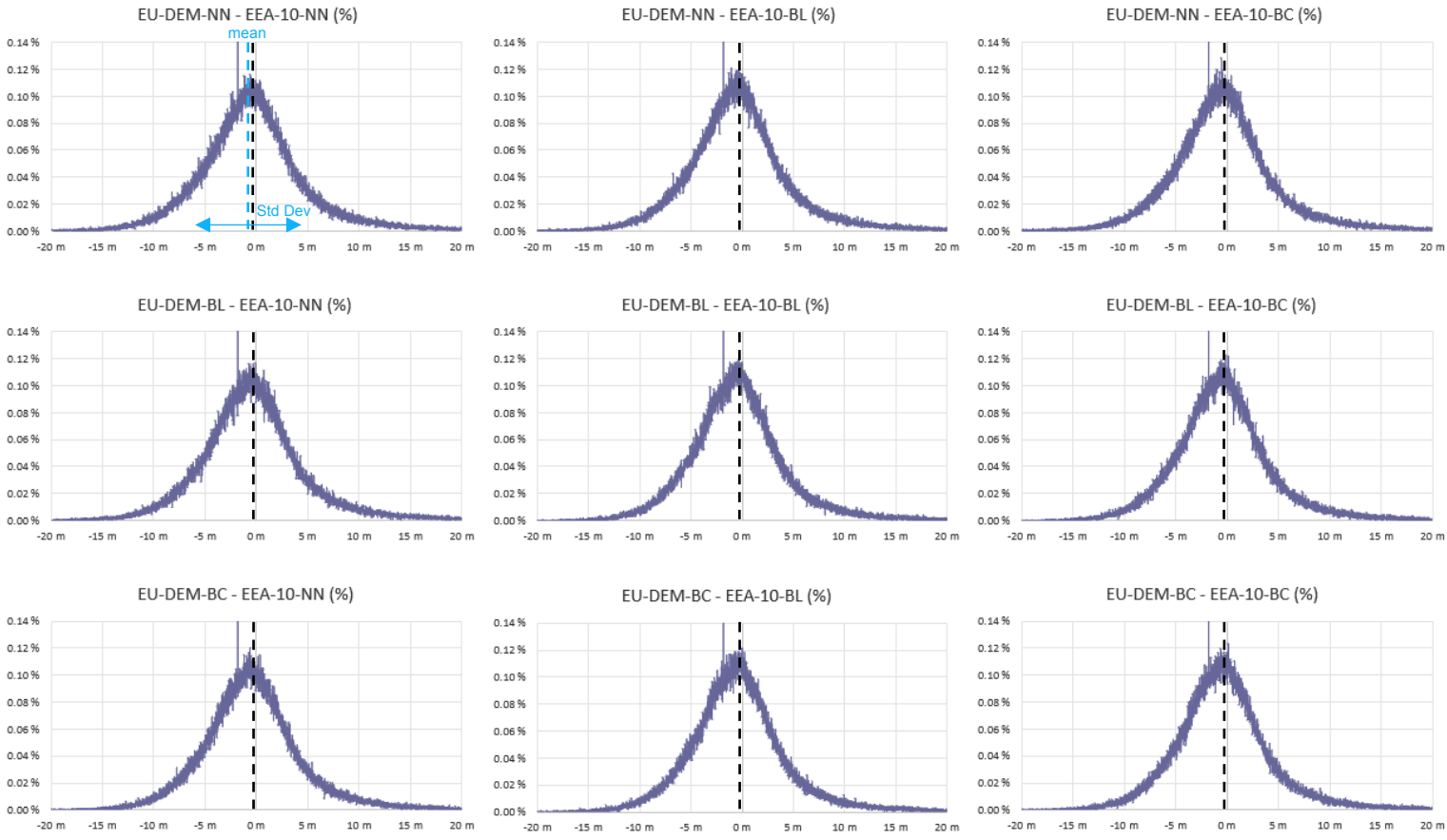


Figure 116 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N54YW007A.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.02 m** for the mean, **0.32 m** for standard deviation and **0.32 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to -0.3 m of difference. In this area, high differences seem to be linked to the height variations, especially tree cover for negative values (see attached figure of last page). A peak, close to -2 m, is due to flat areas, identified as lakes.

4.1.1.36 36 - Cyprus - N34ZE033C (zone 1)

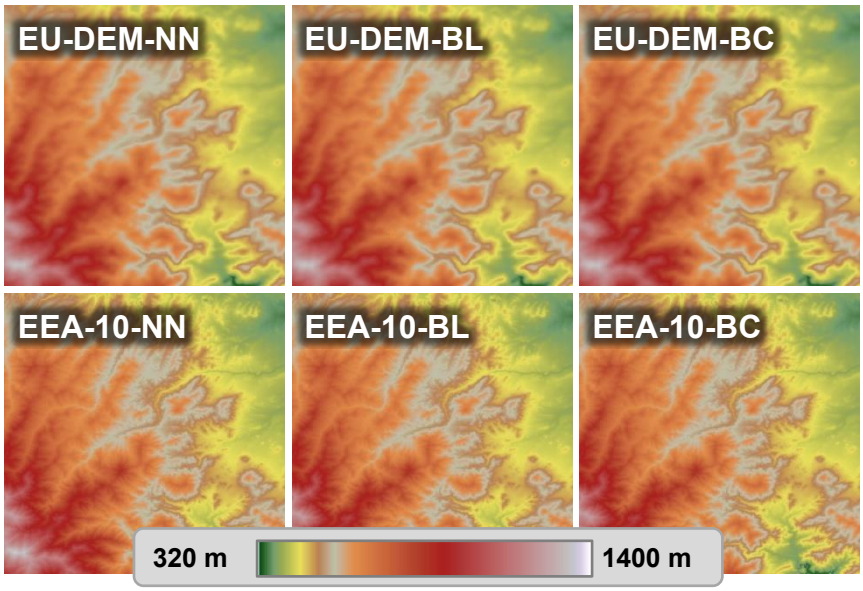


Figure 117 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N34ZE033C.

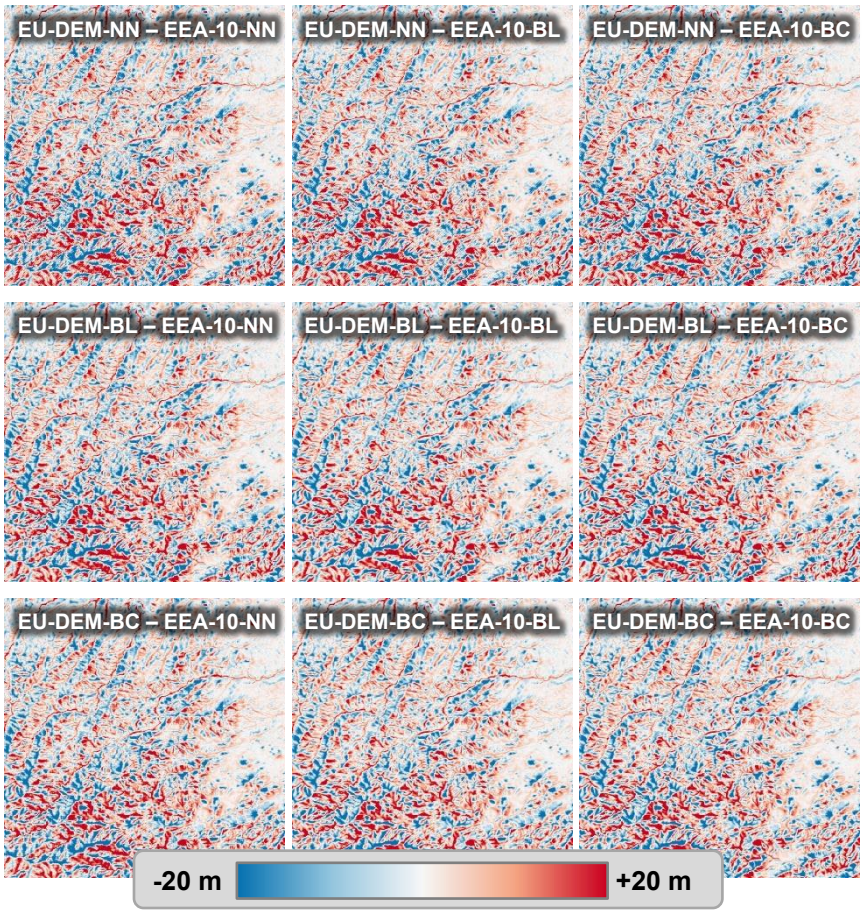
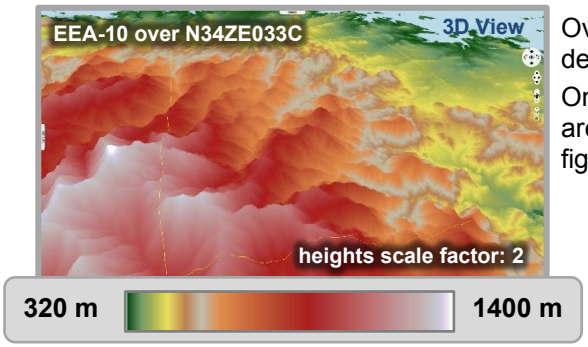


Figure 118 – Views of (EU-DEM -EEA-10) over DEMIX tile N34ZE033C.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 117).

One may see variations in the difference views. These differences are linked to the height variations over this area (see attached figures).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 0.32 m** **Std Dev = 10.26 m** **RMSE = 10.27 m**	**Mean = 0.32 m** **Std Dev = 10.02 m** **RMSE = 10.02 m**	**Mean = 0.32 m** **Std Dev = 10.11 m** **RMSE = 10.12 m**
Bilinear (BL)	**Mean = 0.32 m** **Std Dev = 10.09 m** **RMSE = 10.09 m**	**Mean = 0.32 m** **Std Dev = 9.84 m** **RMSE = 9.84 m**	**Mean = 0.32 m** **Std Dev = 9.93 m** **RMSE = 9.94 m**
Bicubic (BC)	**Mean = 0.32 m** **Std Dev = 10.07 m** **RMSE = 10.08 m**	**Mean = 0.32 m** **Std Dev = 9.82 m** **RMSE = 9.83 m**	**Mean = 0.32 m** **Std Dev = 9.92 m** **RMSE = 9.92 m**

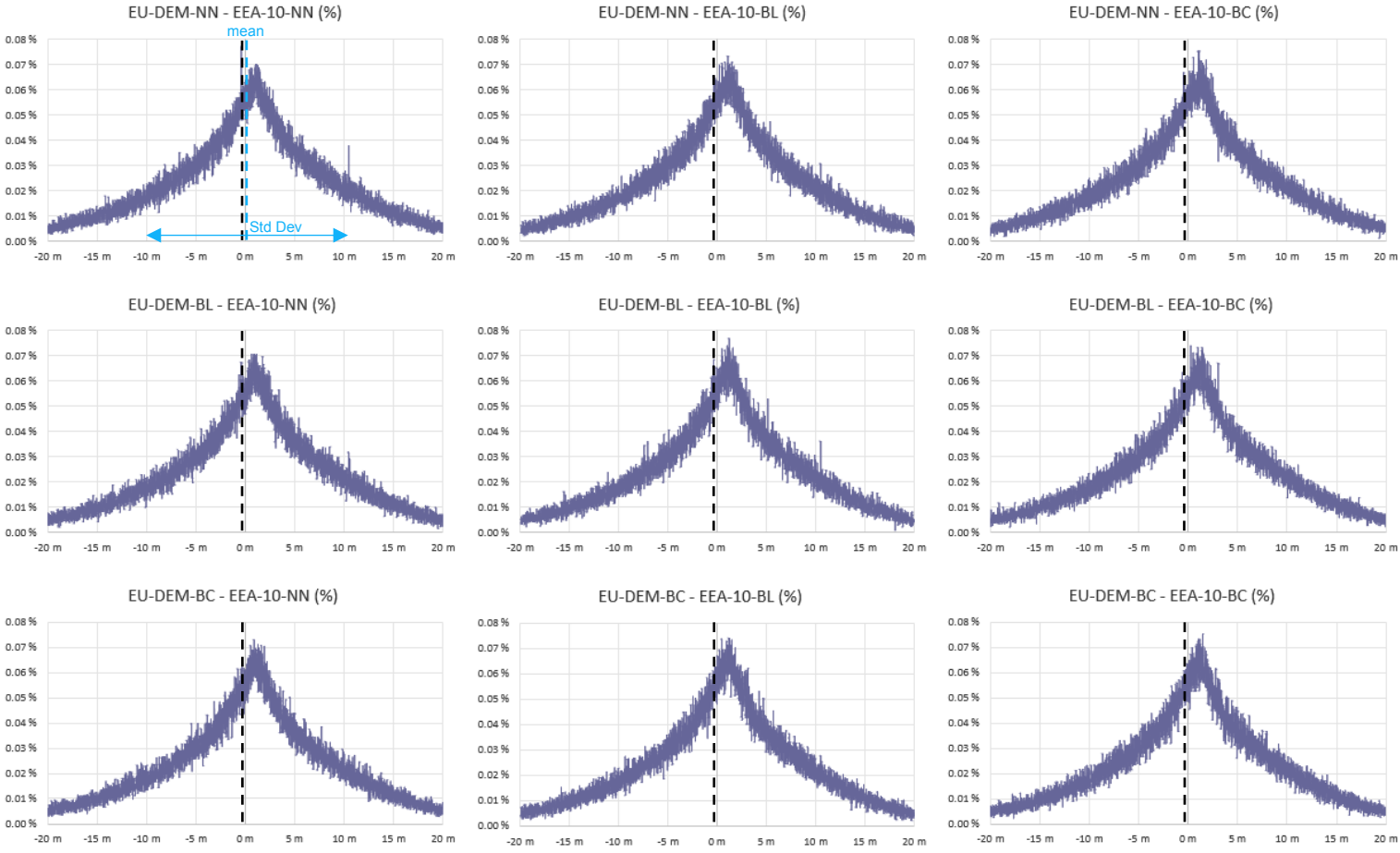


Figure 119 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N34ZE033C.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.44 m** for standard deviation and **0.44 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode close to 0.8 m of difference. In this area, high differences seem to be linked to the height variations (see attached figure of last page).

4.1.1.37 37 - Luxembourg - N49VE006B (zone 1)

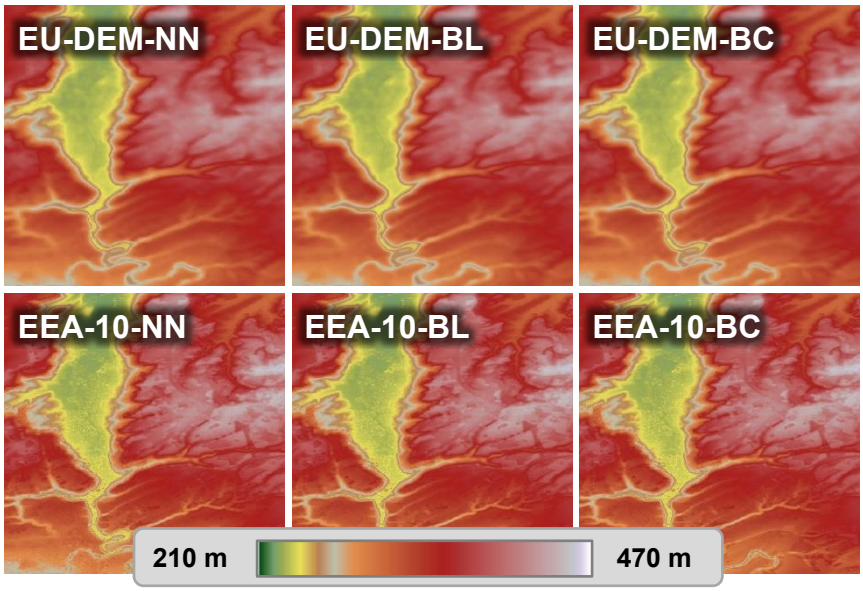


Figure 120 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N49VE006B.

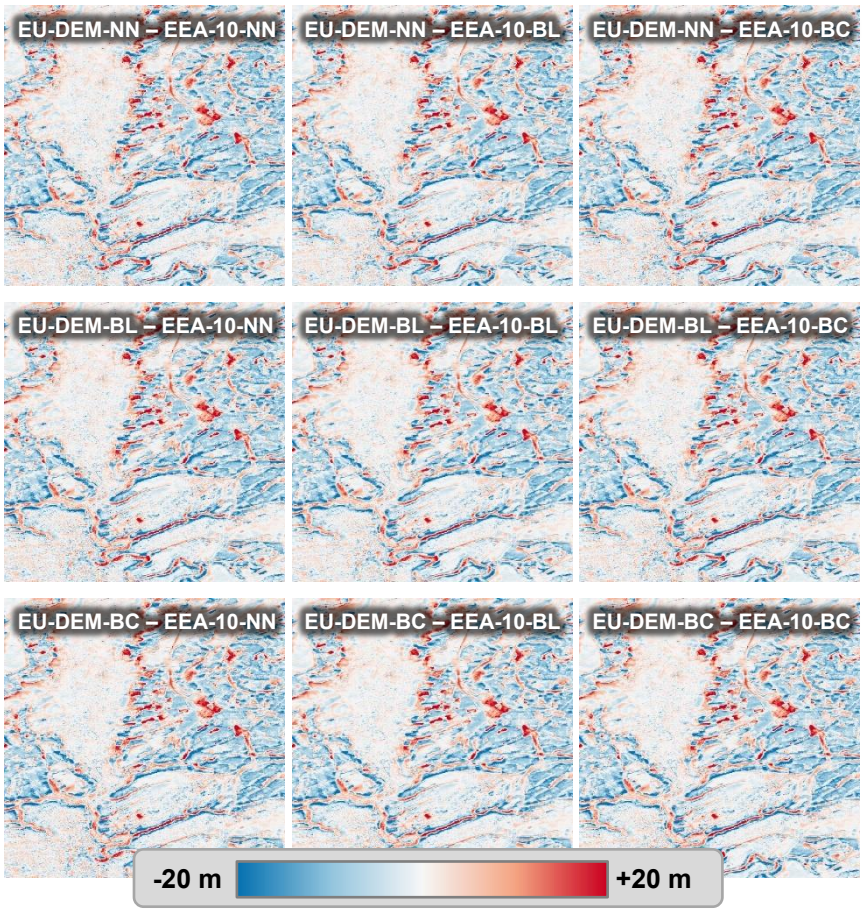
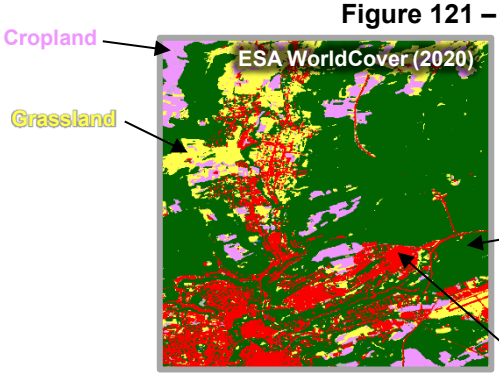


Figure 121 – Views of (EU-DEM -EEA-10) over DEMIX tile N49VE006B.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 120).

High differences can be seen over the tree cover class (see attached figure). One may also note that the more the height varies EEA-10 and EU-DEM, the higher the differences are.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -1.42 m** **Std Dev = 7.16 m** **RMSE = 7.30 m**	**Mean = -1.42 m** **Std Dev = 6.98 m** **RMSE = 7.12 m**	**Mean = -1.42 m** **Std Dev = 7.10 m** **RMSE = 7.24 m**
Bilinear (BL)	**Mean = -1.42 m** **Std Dev = 7.09 m** **RMSE = 7.23 m**	**Mean = -1.42 m** **Std Dev = 6.91 m** **RMSE = 7.06 m**	**Mean = -1.42 m** **Std Dev = 7.04 m** **RMSE = 7.18 m**
Bicubic (BC)	**Mean = -1.42 m** **Std Dev = 7.07 m** **RMSE = 7.21 m**	**Mean = -1.42 m** **Std Dev = 6.89 m** **RMSE = 7.03 m**	**Mean = -1.42 m** **Std Dev = 7.02 m** **RMSE = 7.16 m**

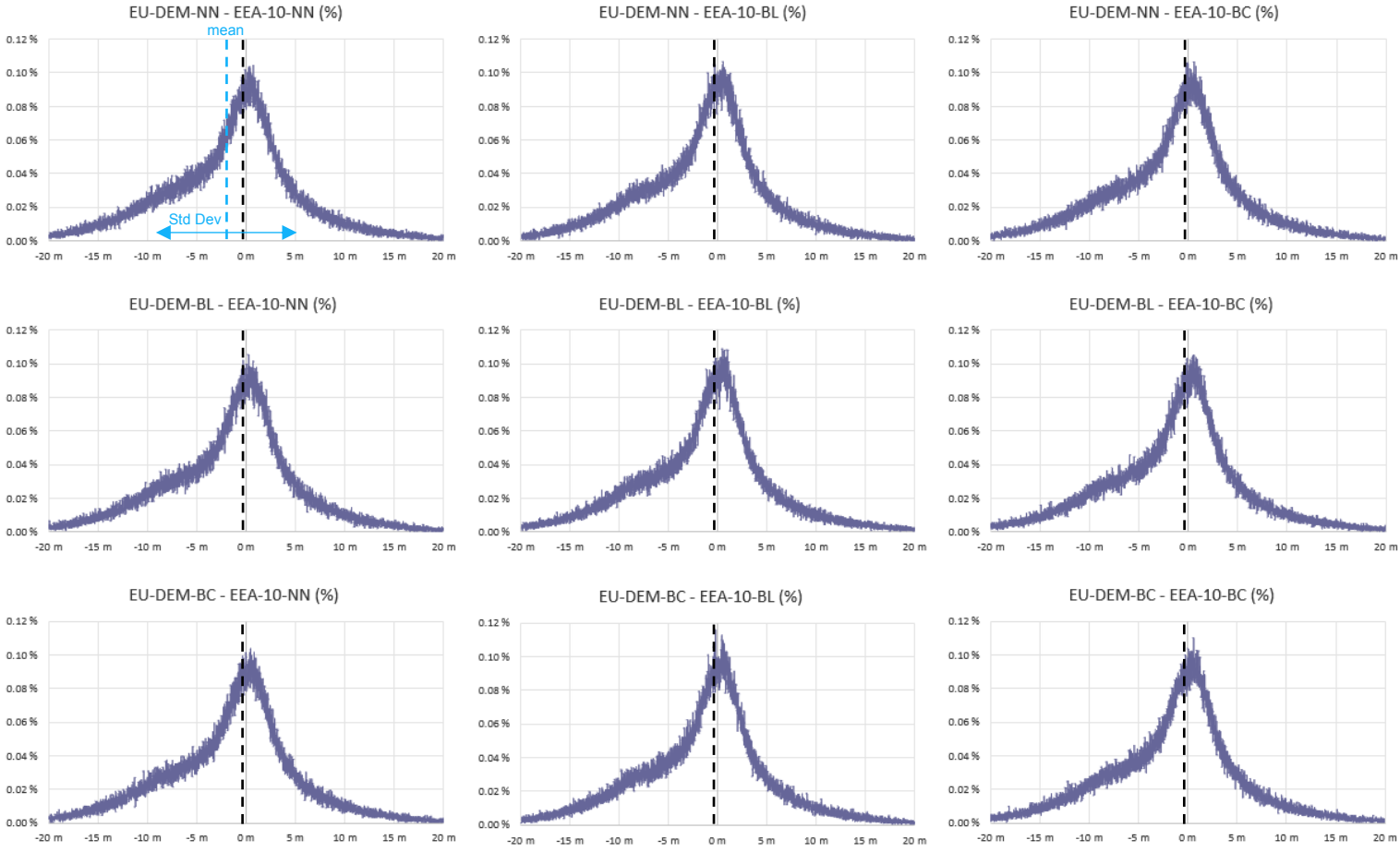


Figure 122 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N49VE006B.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.27 m** for standard deviation and **0.27 m** for RMSE. One must note **that the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0 m of difference. In this area, high differences seem to be linked to the height variations and tree cover (see attached figure of last page).

4.1.1.38 38 - Malta - N35YE014F (zone 1)

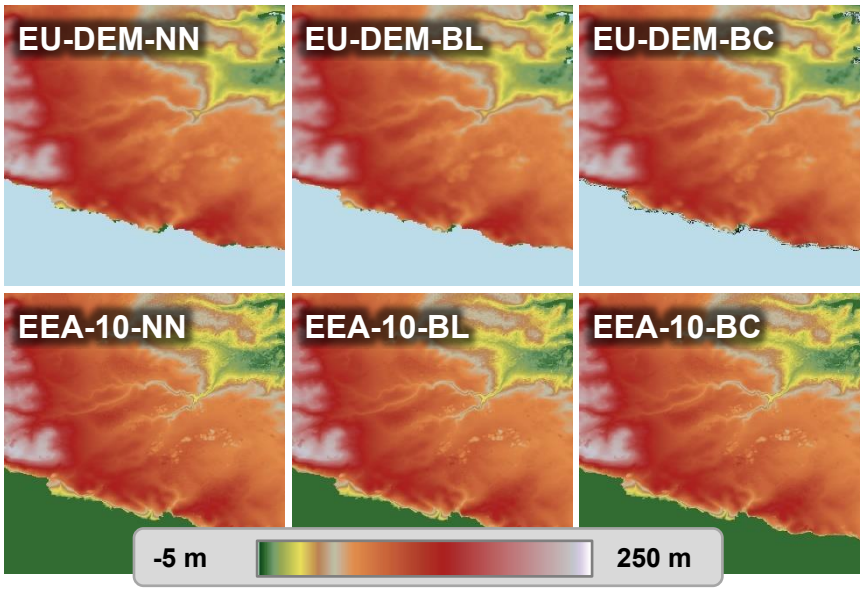


Figure 123 – Views of EU-DEM and EEA-10 resamplings over DEMIX tile N35YE014F.

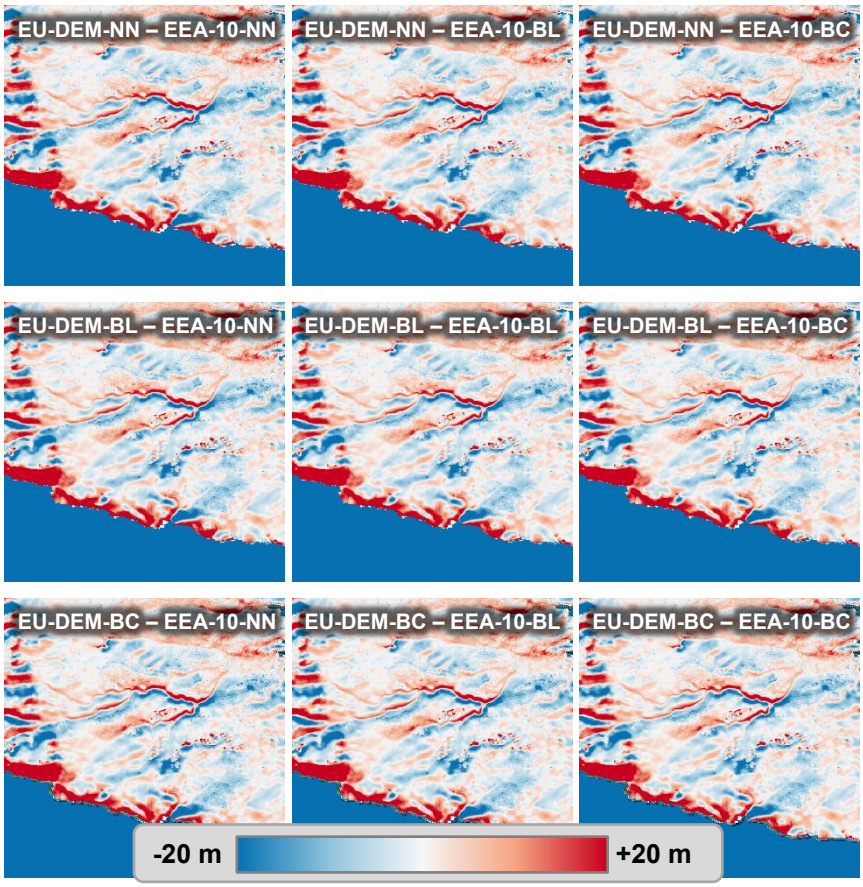
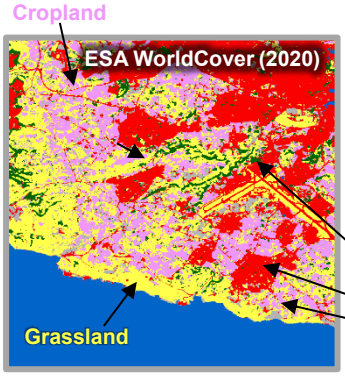


Figure 124 – Views of (EU-DEM -EEA-10) over DEMIX tile N35YE014F.



Over this tile, the resampled instances of EEA-10 show sharper details than those of EU-DEM (see Figure 123).

One may note that the height differences match the height variations of EU-DEM and EEA-10. Differences are higher over the East grasslands (see attached figure). Sea pixels, located at the South of the tile, are assigned with negative fill values in EU-DEM, whereas filled with a 0 metres height in EEA-10. These pixels are not taken into account for statistics computation.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = 0.93 m** **Std Dev = 9.86 m** **RMSE = 9.90 m**	**Mean = 0.93 m** **Std Dev = 9.74 m** **RMSE = 9.78 m**	**Mean = 0.93 m** **Std Dev = 9.77 m** **RMSE = 9.81 m**
Bilinear (BL)	**Mean = 0.89 m** **Std Dev = 9.65 m** **RMSE = 9.69 m**	**Mean = 0.89 m** **Std Dev = 9.53 m** **RMSE = 9.57 m**	**Mean = 0.89 m** **Std Dev = 9.56 m** **RMSE = 9.60 m**
Bicubic (BC)	**Mean = 0.82 m** **Std Dev = 9.48 m** **RMSE = 9.52 m**	**Mean = 0.82 m** **Std Dev = 9.37 m** **RMSE = 9.41 m**	**Mean = 0.82 m** **Std Dev = 9.40 m** **RMSE = 9.44 m**

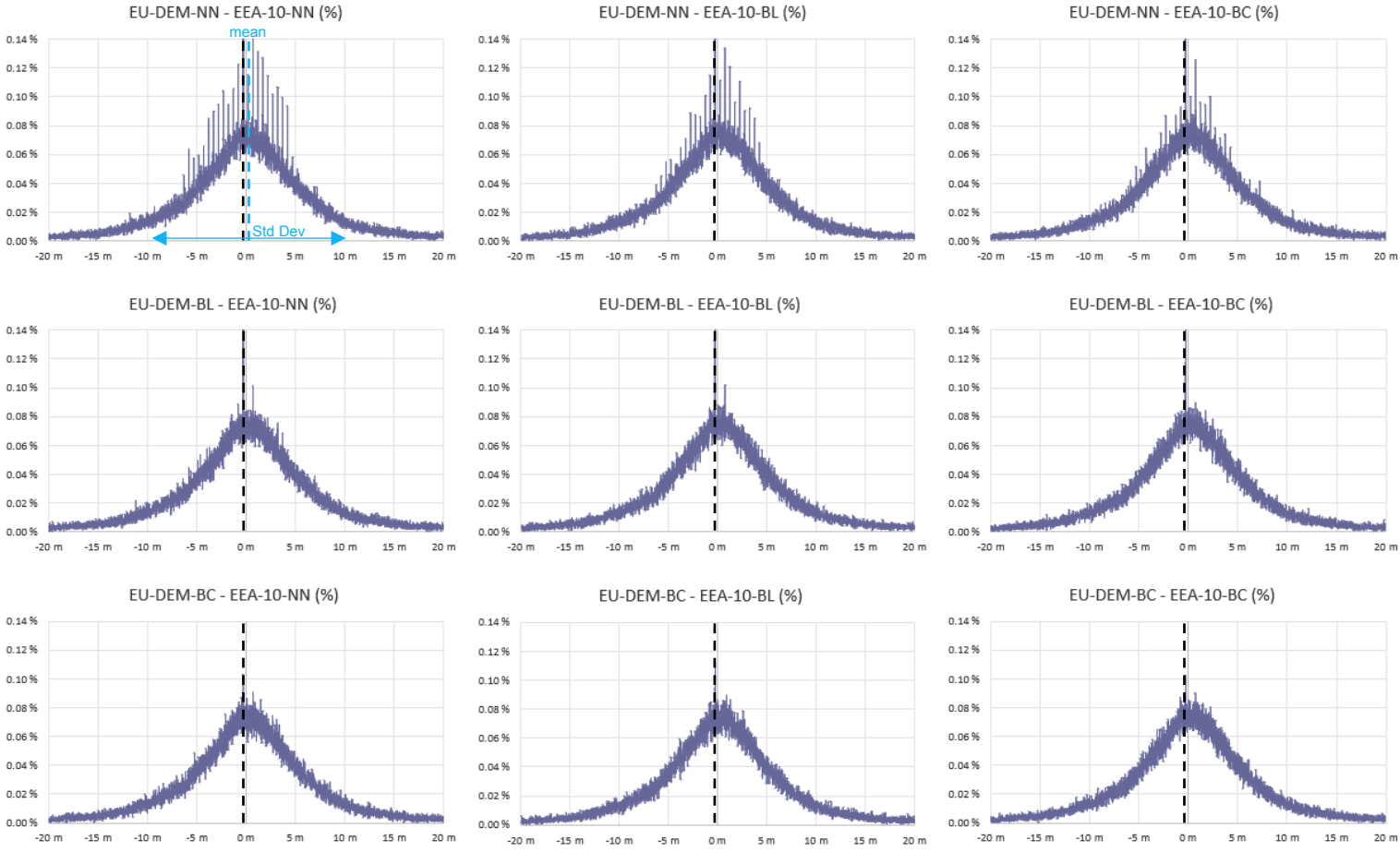


Figure 125 – Statistics of the (EU-DEM –EEA-10) differences over DEMIX tile N35YE014F.

In this case, the **best results** are obtained with the **(EU-DEM-BC – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.11 m** for the mean, **0.49 m** for standard deviation and **0.49 m** for RMSE. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

The histograms show a mode centred at 0 m of difference. In this area, high differences seem to be linked to the height variations and tree cover (see attached figure of last page). A peak, close to -4.8 m, is due to flat areas, identified as lakes.

4.1.2 Overall statistics

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	**Mean = -0.55 m** **Std Dev = 9.37 m** **RMSE = 9.38 m**	**Mean = -0.55 m** **Std Dev = 9.25 m** **RMSE = 9.27 m**	**Mean = -0.55 m** **Std Dev = 9.30 m** **RMSE = 9.32 m**
Bilinear (BL)	**Mean = -0.55 m** **Std Dev = 9.14 m** **RMSE = 9.16 m**	**Mean = -0.55 m** **Std Dev = 9.02 m** **RMSE = 9.04 m**	**Mean = -0.55 m** **Std Dev = 9.08 m** **RMSE = 9.09 m**
Bicubic (BC)	**Mean = -0.55 m** **Std Dev = 9.18 m** **RMSE = 9.19 m**	**Mean = -0.55 m** **Std Dev = 9.06 m** **RMSE = 9.08 m**	**Mean = -0.55 m** **Std Dev = 9.11 m** **RMSE = 9.13 m**

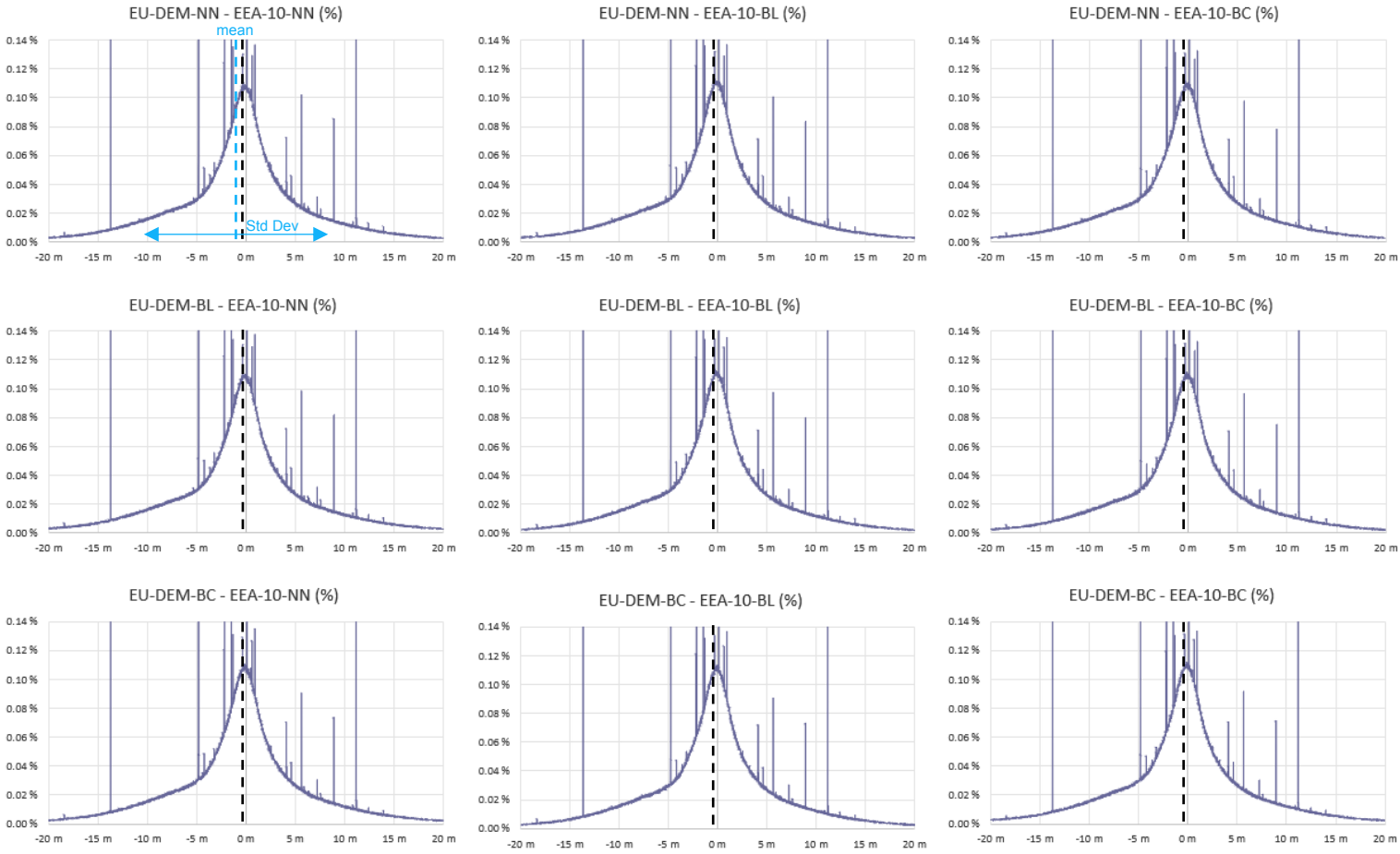


Figure 126 – Statistics of the (EU-DEM –EEA-10) differences over the 38 European DEMIX tiles.

Over all the tiles, the **best results** are obtained with the **(EU-DEM-BL – EEA-10-BL)** study, and the **worst results** are obtained with the **(EU-DEM-NN – EEA-10-NN)** study. The differences between best and worst statistics reach **0.35 m** for standard deviation and **0.34 m** for RMSE. One must note that **the mean stays equal for all the distributions**. The overall results still show that **the sampling method does not have a significant impact on the (EU-DEM - EEA-10) statistics.**

4.2 Study 2 – Disparity analysis

This section presents the results of the disparity analysis applied on each of the 38 European DEMIX tile (see section 3.4.23.4.1 for methods).

4.2.1 Individual DEMIX tiles

Each subsection focuses on one of the 38 DEMIX tiles defined in section 3.3.2.

For each DEMIX tile, the following views and statistics are given:

Resampling views	Views of the EU-DEM and EEA-10 resamplings over the current tile. These views include **EU-DEM-BL** (Bilinear) for EU-DEM**,** and **EEA-10-BL** (Bilinear) for EEA-10. Only the bilinear resamplings of the DEMs are used, as the best global differences statistics have been obtained using this resampling method (see section 4.2.2).
dX and dY views	Views of the displacement in X (dX) and displacement in Y (dY) from EEA-10 to EU-DEM. These displacements are included in the [-12, +12] pixels range. For these views, and for the correlation, displacement vectors and displacement norms views, any sub-pixel displacement not included in the]-1.0,1.0[range is excluded. For visualisation purposes, dX and dY values found on the border of the exploration window are kept. This is not the case for histograms and statistics (see paragraph below).
Correlation views	View of the linear correlation coefficient for each displacement in the dX and dY images.
Displacement vectors	View of the displacement vectors from EEA-10 to EU-DEM. These vectors are processed using the dX and dY images. For visualisation purposes, these vectors are computed at a step of 20 pixels horizontally and vertically.
Displacement norms	View of the norms of displacement vectors. These norms are computed using the dX and dY images.
ESA WorldCover 2020	View of the ESA World Cover 2020 LULC map. For each DEMIX tile, this view is used to assess the dependency of displacements on land use.
EEA-10 Filling Mask	View of the EEA-10 Filling Mask map. This mask indicates the source data used to generate EEA-10 heights. For each DEMIX tile, this view is used to assess the dependency of displacements on the source data. As no source data layer has been found for EU-DEM, the dependency of displacements on source data has only been assessed for EEA-10.
Histograms & statistics	Distributions and statistics of the dX, dY, vector norms and correlation are given. For these statistics, Any sub-pixel displacement not included in the]-1.0,1.0[range is excluded. Moreover, dX and dY values found on the border of the exploration window are excluded, as the maximum of correlation may be located outside of the window. Due to this filtering, and due to the variable resolution in longitude, an aliasing effect may be encountered in the dX and dY histograms.

Overall statistics, which encompass all the 38 DEMIX tiles, are available in next section (see section 4.2.24.1.2).

4.2.1.1 01 – Iceland – N64ZW019C (zone 3)

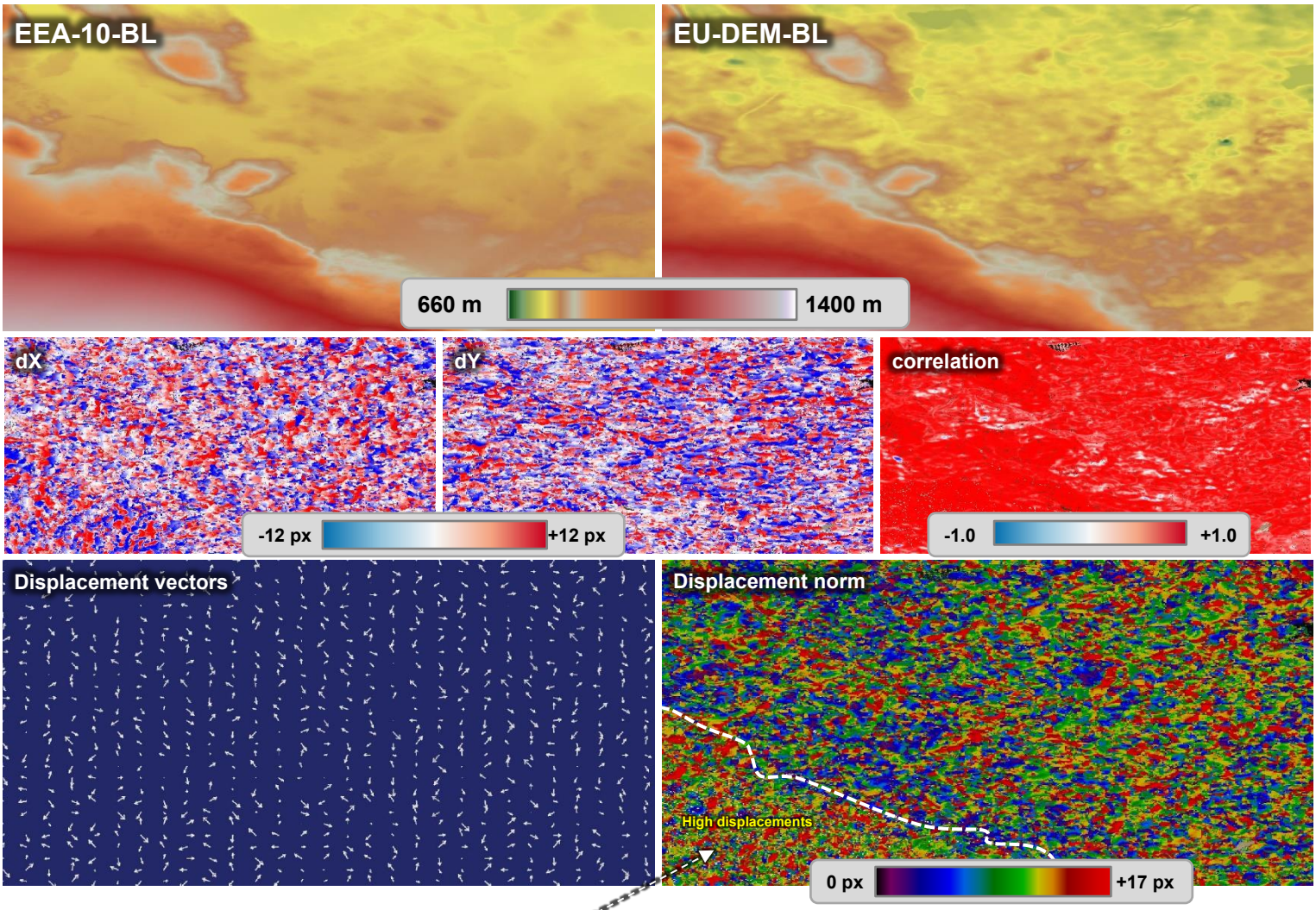
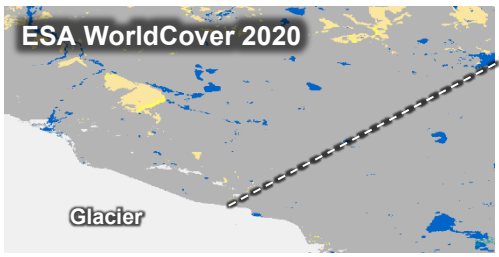


Figure 127 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N64ZW019C.

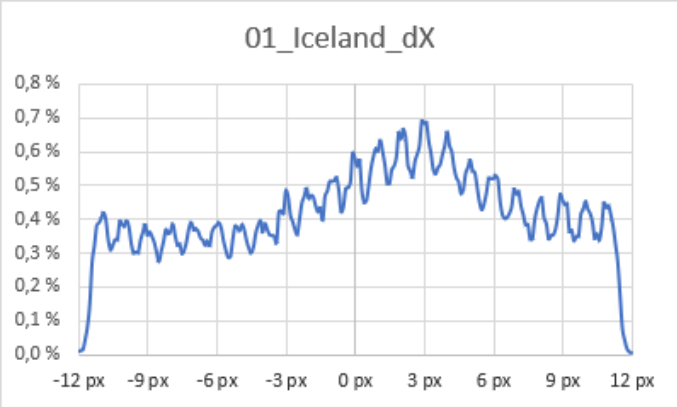


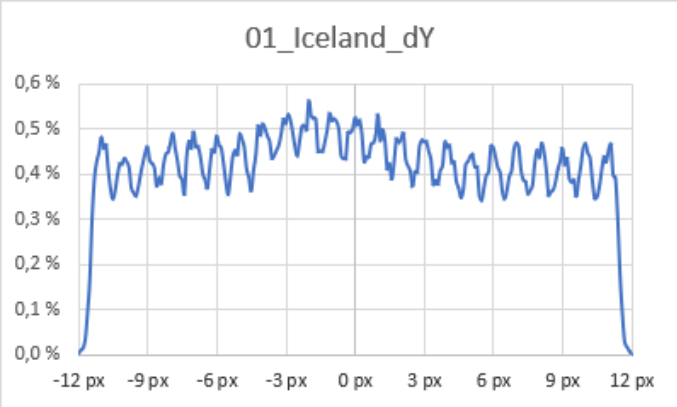
As seen in Figure 127, important height variations are visible over EU-DEM and EEA-10 (740 metres between lowest and highest points). The EEA-10 tile shows less roughness than the EU-DEM tile.

The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see important saturation on these images, which are primarily due to the difference of roughness between the two tiles.

A strong correlation can be seen over the glacier of this area (see attached LULC map). As opposed to the rest of the tile, the glacier has a similar aspect in both DEMs.

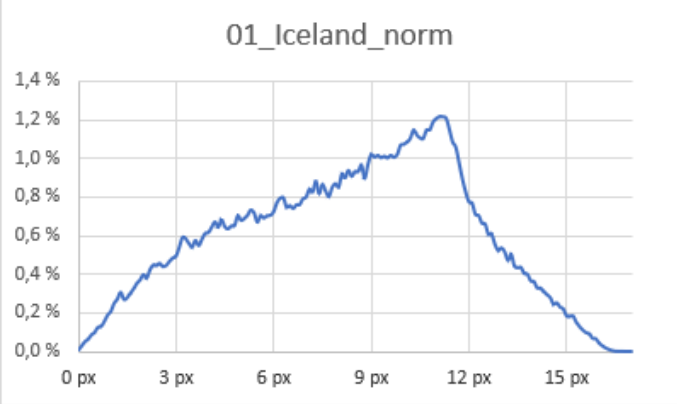
Displacements vectors highlight no uniform or local direction. One may note higher displacement norms over the glacier than over the rest of the tile.

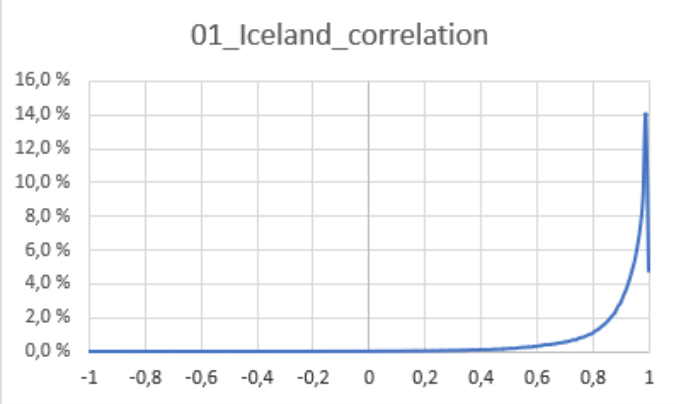




Count	Min	Max	Mean	Std Dev
204 556	-12,0 px	12,0 px	0,570 px	6,252 px

Count	Min	Max	Mean	Std Dev
204 556	-12,0 px	12,0 px	-0,123 px	6,498 px





Count	Min	Max	Mean	Std Dev
204 556	0,000 px	16,679 px	8,322 px	3,520 px

Count	Min	Max	Mean	Std Dev
204 556	-0,873	1,000	0,885	0,150

Figure 128 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N64ZW019C.

Both dX and dY distributions highlight important displacement modes (3.1 pixels and -2.0 pixels respectively), with high standard deviations (6.252 pixels for dX, 6.498 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 9 and 12 pixels. Norms greater than 12 pixels are less frequently observed.

The correlations are high, with a mean of 0.885 and a standard deviation of 0.150. One may see lower correlations (included in the [0.5, 0.8] range). These low correlations are due to a difference of roughness in both DEMs (see observations of preceding page).

4.2.1.2 02 – Norway – N60RE007B (zone 3)

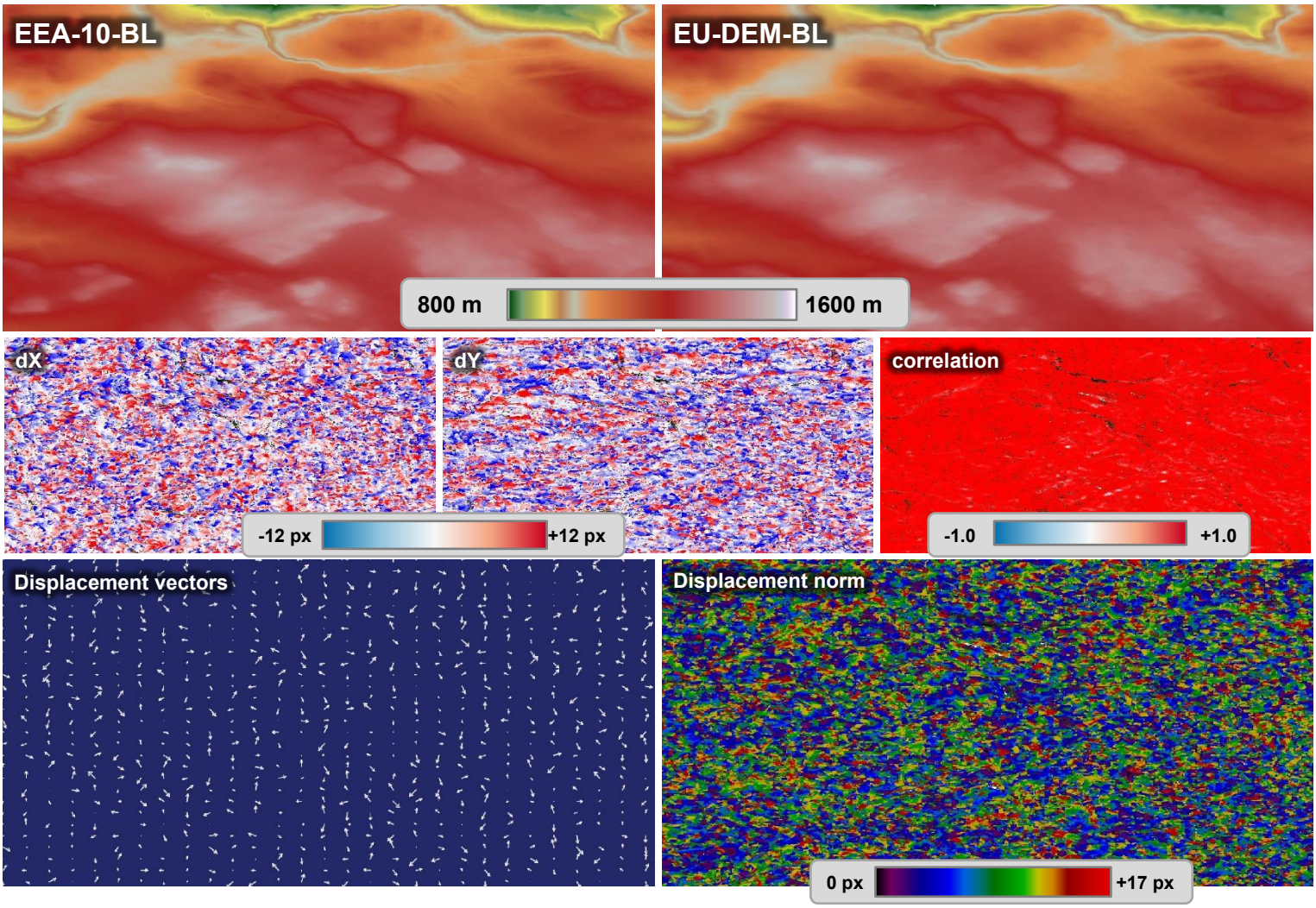
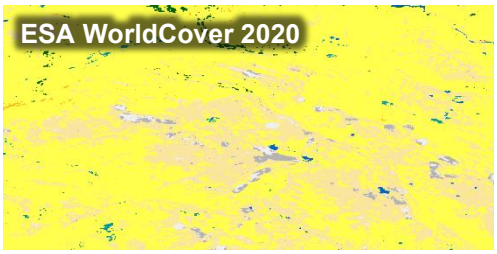
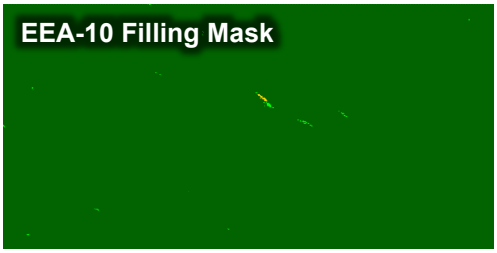


Figure 129 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N60RE007B.





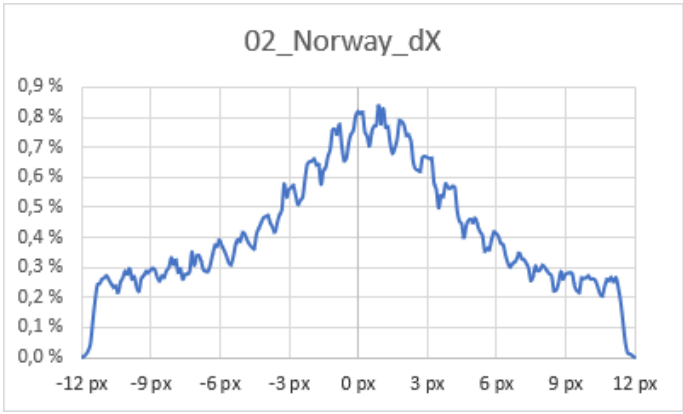
As seen in Figure 129, important height variations are visible over EU-DEM and EEA-10 (800 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, but the overall aspect of the two DEMs is similar.

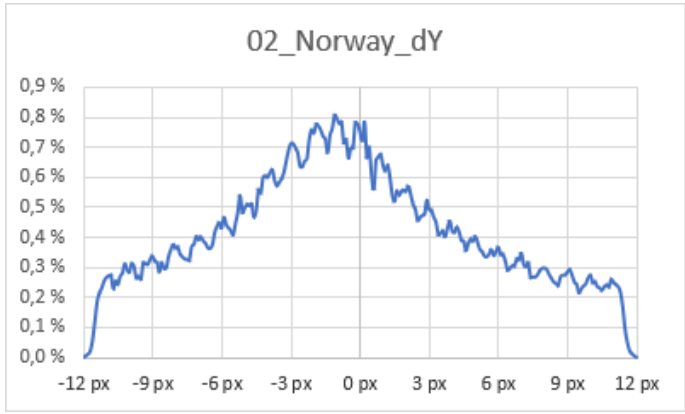
The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-3, +3[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

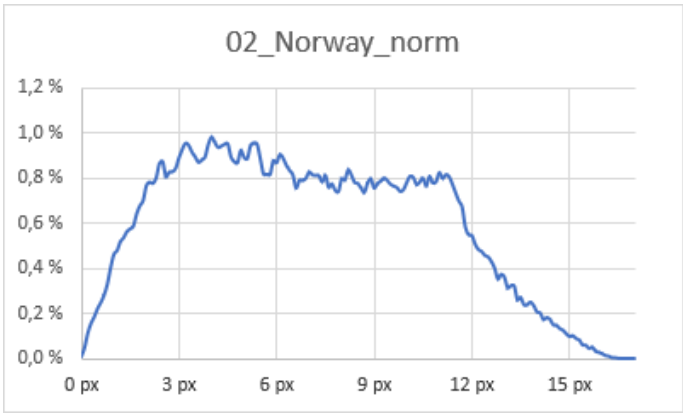
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

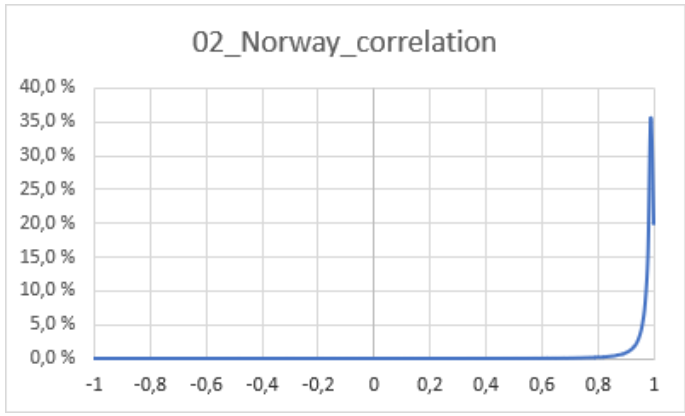




Count	Min	Max	Mean	Std Dev
236 286	-12,0 px	12,0 px	0,109 px	5,502 px

Count	Min	Max	Mean	Std Dev
236 286	-12,0 px	12,0 px	-0,480 px	5,587 px





Count	Min	Max	Mean	Std Dev
236 286	0,000 px	16,478 px	6,967 px	3,632 px

Count	Min	Max	Mean	Std Dev
236 286	-0,516	1,000	0,972	0,048

Figure 130 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N60RE007B.

Both dX and dY distributions highlight relatively low displacement modes (0.9 pixels and -1.1 pixels respectively), with high standard deviations (5.502 pixels for dX, 5.587 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 3 and 11 pixels. Norms greater than 11 pixels are less frequently observed, as seen in the norms image (see preceding page).

The correlations are strong, with a mean of 0.972 and a standard deviation of only 0.048.

4.2.1.3 03 - Sweden - N66TE020B (zone 3)

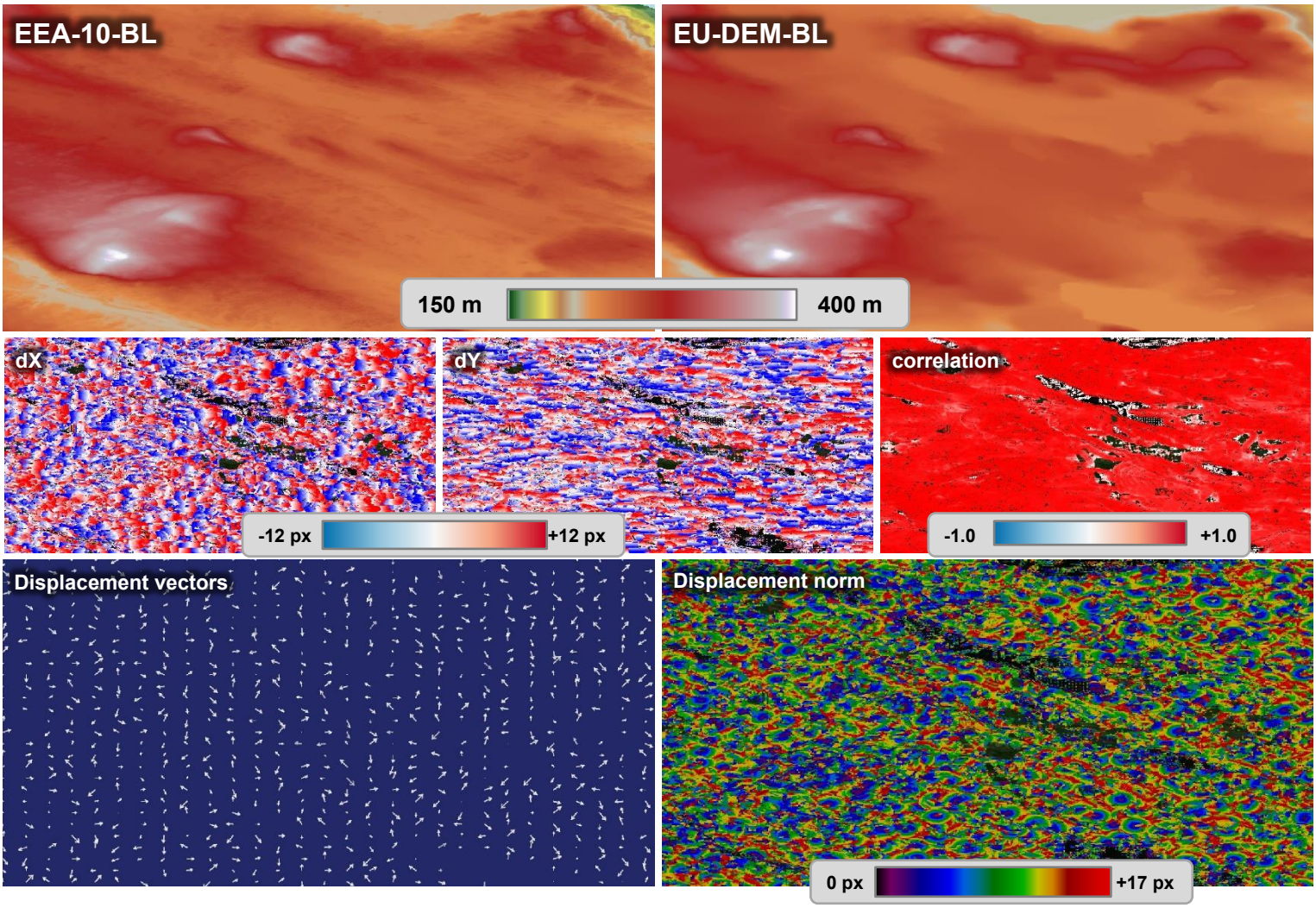
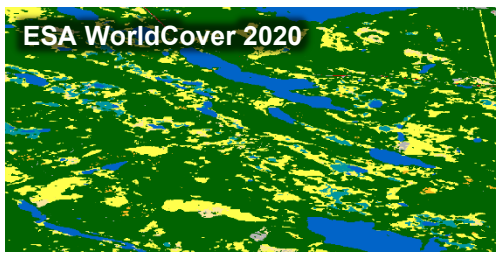
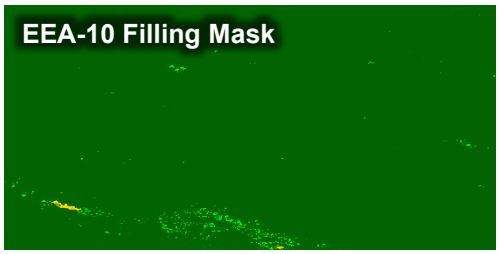


Figure 131 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N66TE020B.





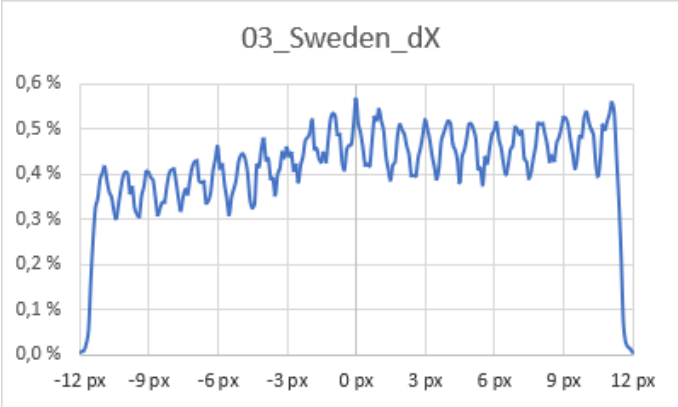
As seen in Figure 131, relatively low height variations are visible over EU-DEM and EEA-10 (250 metres between lowest and highest points).

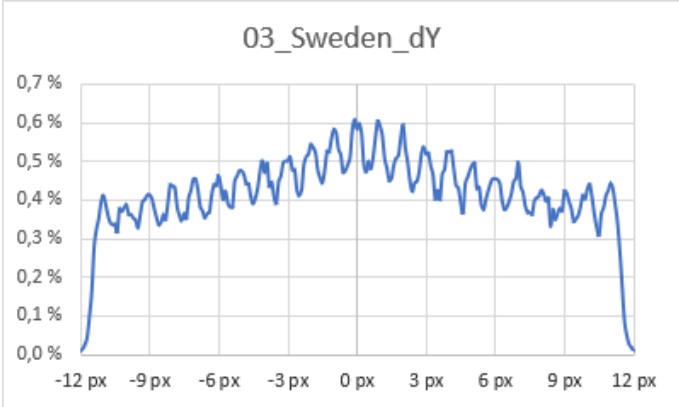
The dX and dY images show more important variations than those seen in previous tile N60RE007B of Norway.

Strong correlations can be seen over most of the tile, but some low correlation or not computed pixels can be seen over lakes (see attached LULC map).

No uniform or local direction can be seen over the displacement vectors, but at first glance, most of the vectors seem to have a relatively similar length. The displacement norm image seems mostly green, showing a large number of displacements between 9 and 12 pixels.

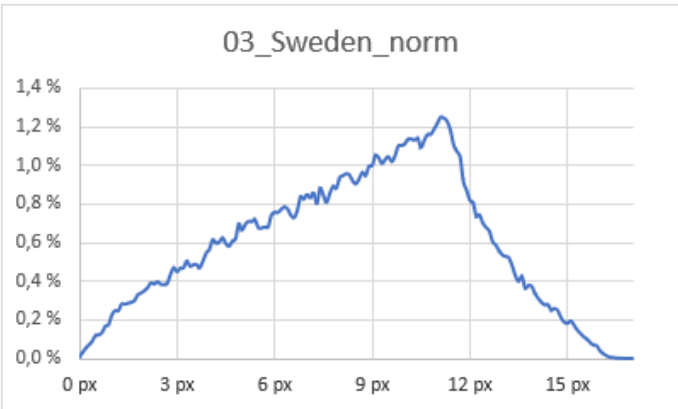
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

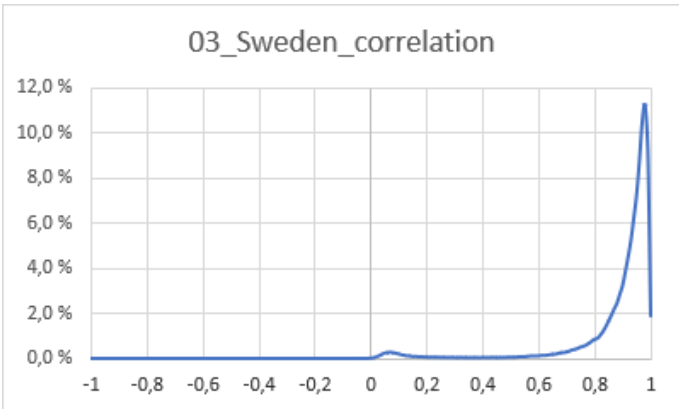




Count	Min	Max	Mean	Std Dev
200 982	-12,0 px	12,0 px	0,607 px	6,523 px

Count	Min	Max	Mean	Std Dev
200 982	-12,0 px	12,0 px	0,090 px	6,317 px





Count	Min	Max	Mean	Std Dev
200 982	0,000 px	16,739 px	8,415 px	3,465 px

Count	Min	Max	Mean	Std Dev
200 982	-0,044	1,000	0,889	0,170

Figure 132 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N66TE020B.

Both dX and dY distributions highlight a high standard deviation (6.523 pixels and 6.317 pixels respectively), which is mainly due to the flatness of the terrain and lakes of this area. Those variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 9 and 12 pixels. Norms greater than 12 pixels are less frequently observed, as seen in the norms image (see preceding page).

The correlations are relatively strong, with a mean of 0.889 and a standard deviation of 0.170. One may note some correlations between 0.0 and 0.15, which are primarily due to flat areas, such as lakes.

4.2.1.4 04 - Finland - N60RE023F (zone 3)

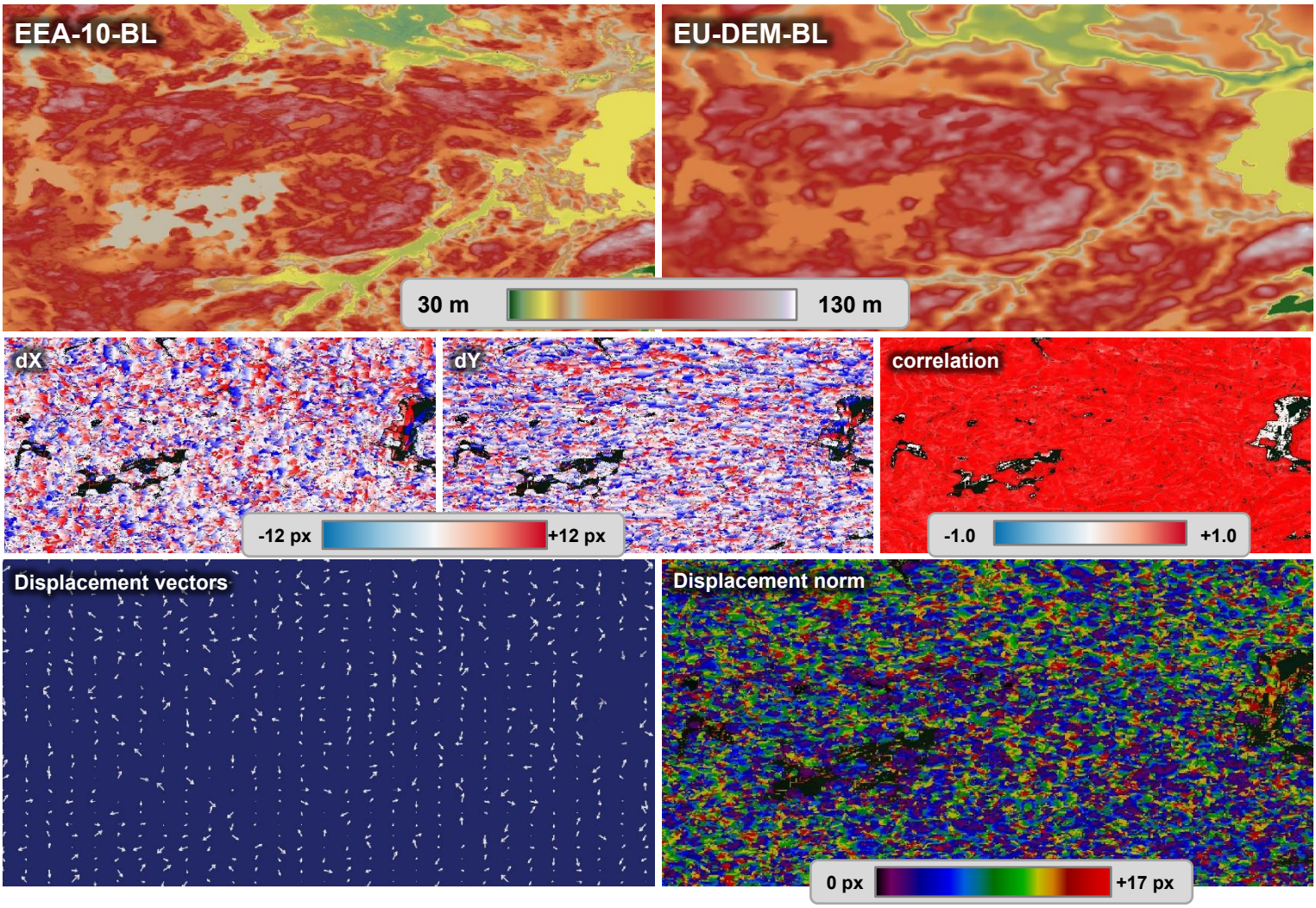
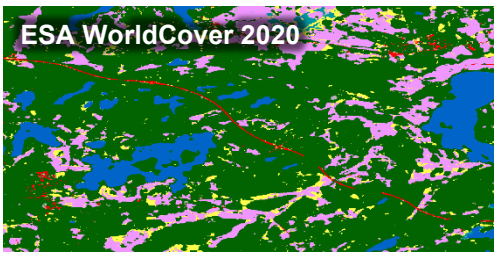
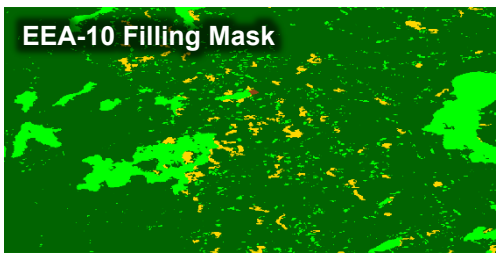


Figure 133 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N60RE023F.





As seen in Figure 133, low height variations are visible over EU-DEM and EEA-10 (100 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, with differences of heights over the lakes (see attached LULC map).

The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-3, +3[pixels interval).

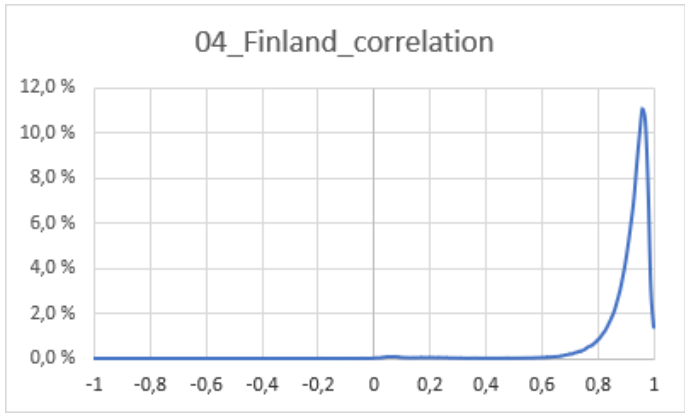
A strong correlation can be seen over this area, as most values are close to 1. One may note low correlations or not computed pixels due to the flatness of the lakes.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 7] interval (blue shades). Displacement norms above 7 pixels are more rarely observed.

No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

Count	Min	Max	Mean	Std Dev
234 328	-12,0 px	12,0 px	0,195 px	5,123 px

Count	Min	Max	Mean	Std Dev
234 328	-12,0 px	12,0 px	-0,559 px	5,337 px



Count	Min	Max	Mean	Std Dev
234 328	0,000 px	16,778 px	6,367 px	3,813 px

Count	Min	Max	Mean	Std Dev
234 328	-0,509	1,000	0,911	0,108

Figure 134 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N60RE023F.

Both dX and dY distributions highlight low displacement modes (0.1 pixels and -1.1 pixels respectively), with high standard deviations (5.123 pixels for dX, 5.337 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 3 and 11 pixels. One may note a higher number of low displacements (between 2 and 7 pixels) than high displacements (over 7 pixels).

The correlations are strong, with a mean of 0.911 and a standard deviation of only 0.108. One may note a small number of correlations between 0.0 and 0.1, due to the presence of flattened lakes on this tile.

4.2.1.5 05 - Estonia - N58YE025G (zone 2)

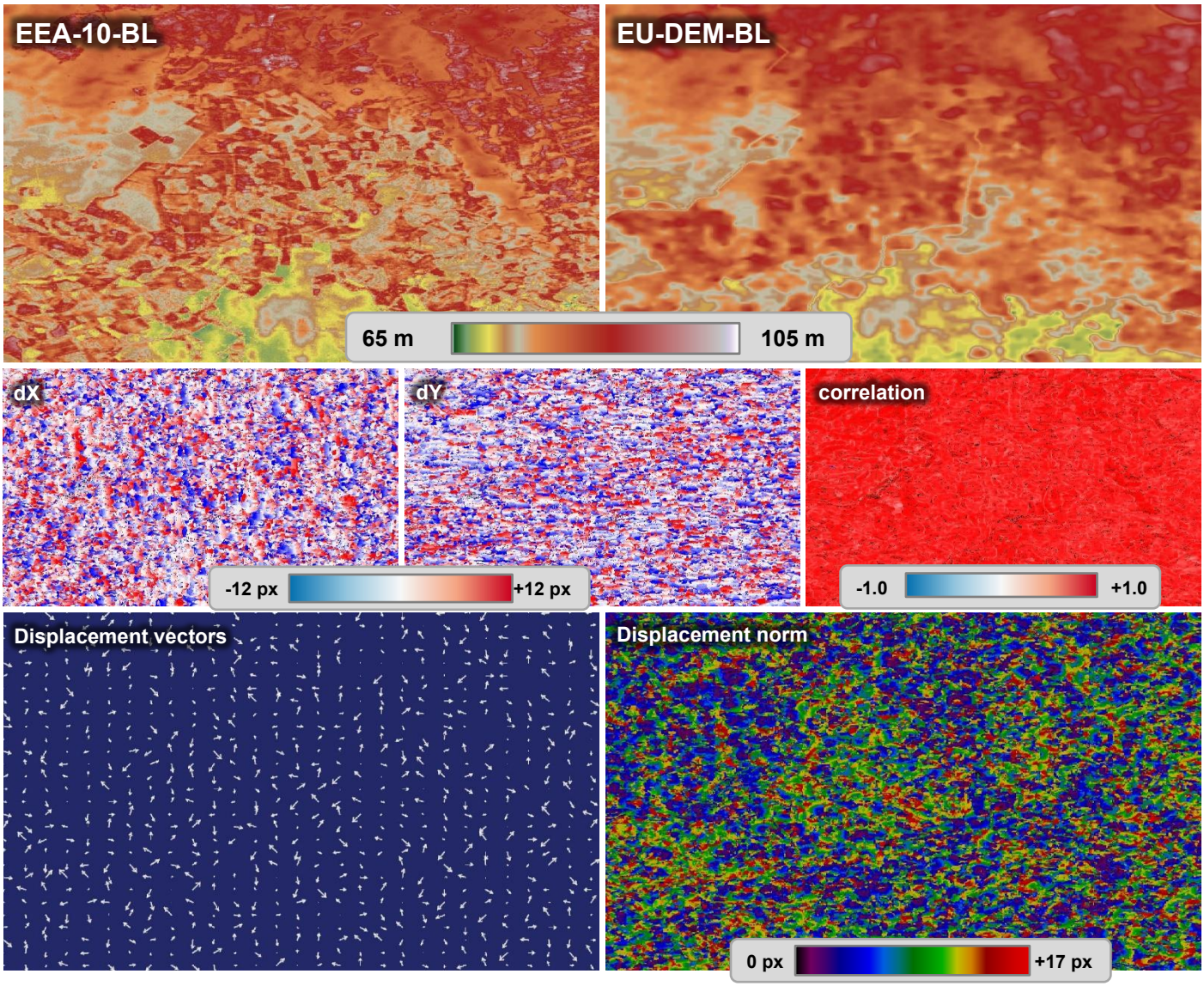
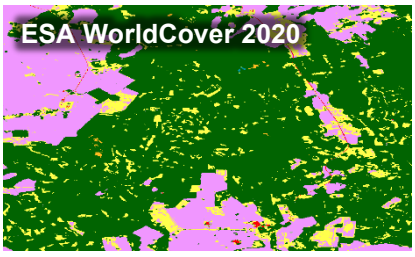
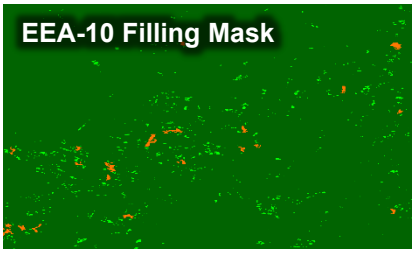


Figure 135 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N58YE025G.



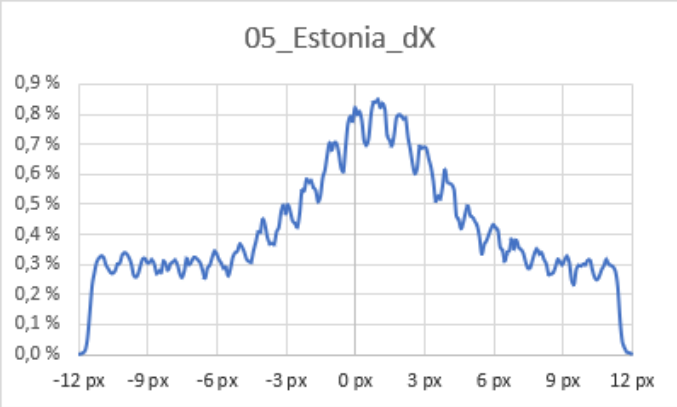


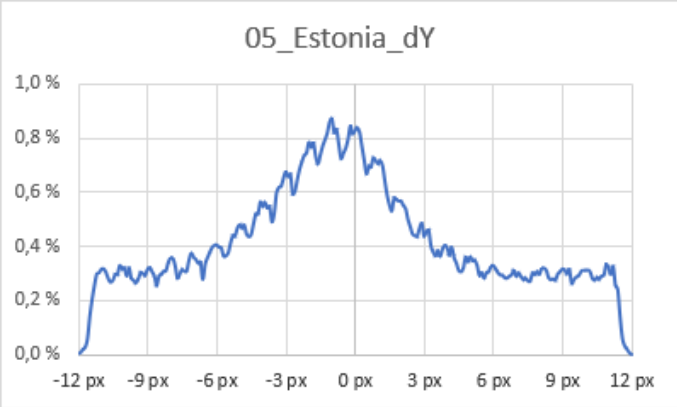
As seen in Figure 135, really low height variations are visible over EU-DEM and EEA-10 (40 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, highlighting the presence of croplands (see attached LULC map).

The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-3, +3[pixels interval) .

A high correlation can be seen over this area, as most values are close to 1.

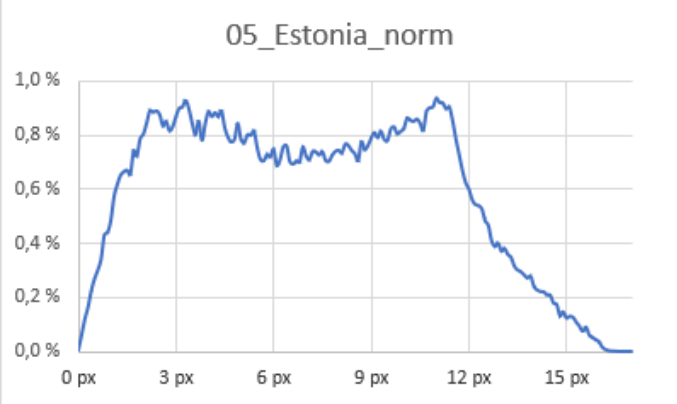
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). One may see clusters of low displacements norms (blue shades, in the [2,5] interval). These patterns are not clearly linked to the land use / land cover (see attached LULC map).

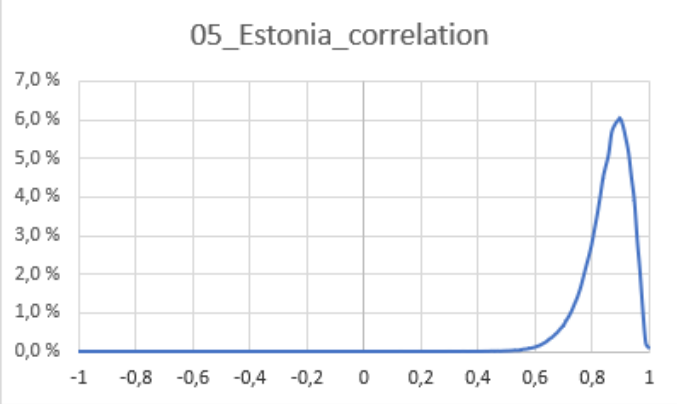




Count	Min	Max	Mean	Std Dev
230 977	-12,0 px	12,0 px	0,293 px	5,694 px

Count	Min	Max	Mean	Std Dev
230 977	-12,0 px	12,0 px	-0,314 px	5,698 px





Count	Min	Max	Mean	Std Dev
230 977	0,000 px	16,546 px	7,115 px	3,801 px

Count	Min	Max	Mean	Std Dev
230 977	0,000	1,000	0,860	0,076

Figure 136 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N58YE025G.

Both dX and dY distributions highlight low displacement modes (0.9 pixels and -1.2 pixels respectively), with high standard deviations (5.694 pixels for dX, 5.698 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 3 and 11 pixels. One may note two modes: one at 3.4 pixels and the other at 11.1 pixels.

The correlations are mainly spread over the [0.6, 1.0] range, with a mean of 0.860 and a standard deviation of only 0.076. This spread is due to the flatness of terrain over this tile.

4.2.1.6 06 - Latvia - N56XE026C (zone 2)

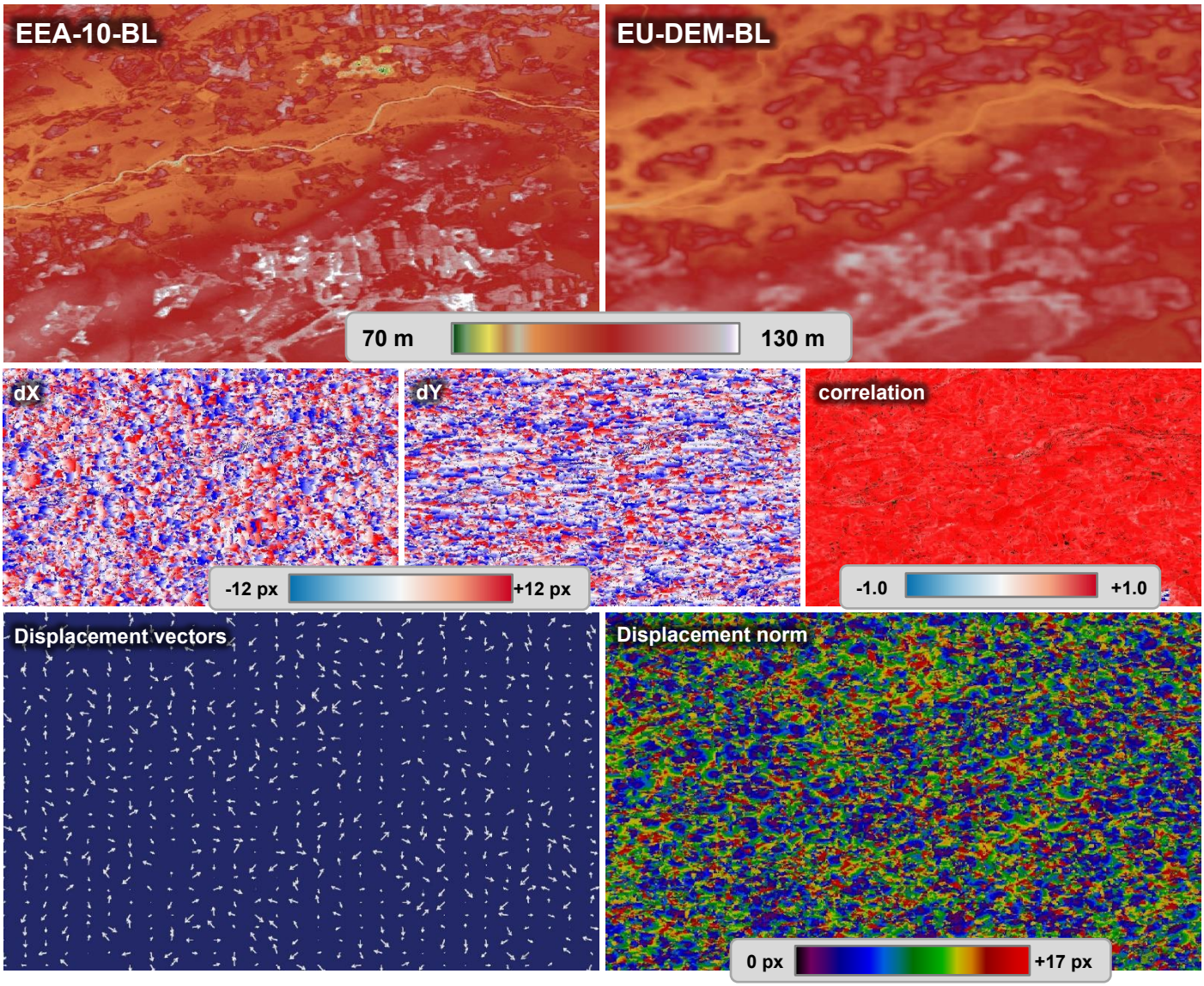
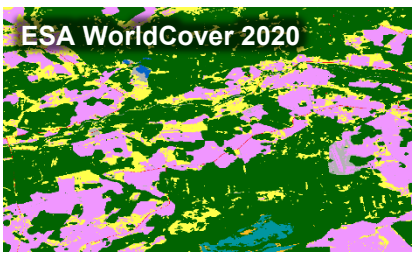
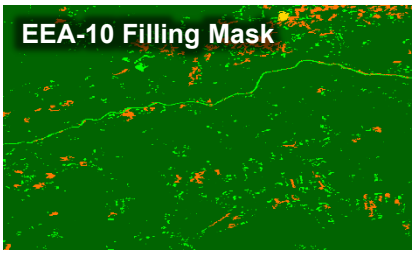


Figure 137 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N56XE026C.





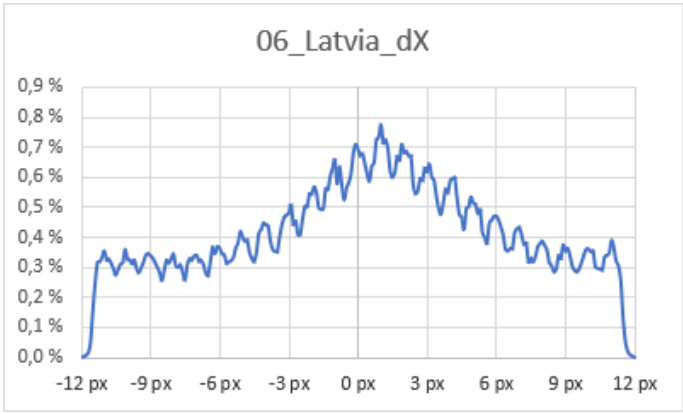
As seen in Figure 137, low height variations are visible over EU-DEM and EEA-10 (60 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile.

The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

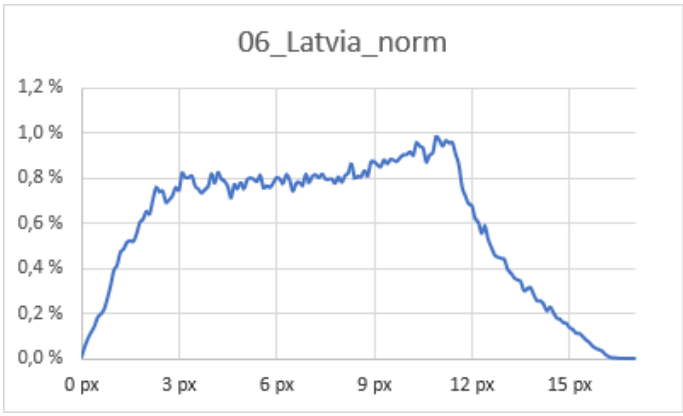
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 12] interval (from dark blue to light green). Displacement norms above 12 pixels are more rarely observed.

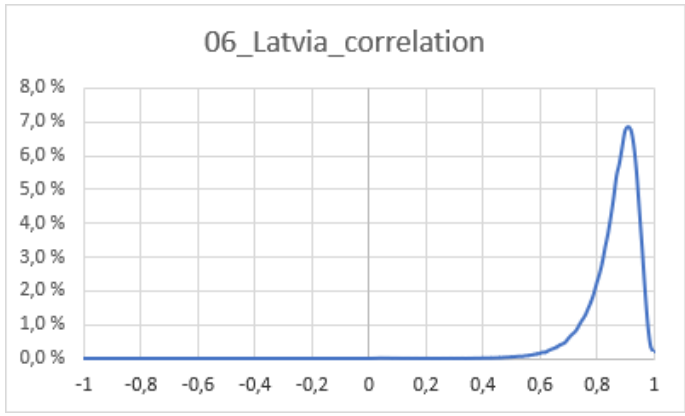
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.



Count	Min	Max	Mean	Std Dev
227 042	-12,0 px	12,0 px	0,362 px	5,931 px

Count	Min	Max	Mean	Std Dev
227 042	-12,0 px	12,0 px	-0,510 px	5,826 px





Count	Min	Max	Mean	Std Dev
227 042	0,000 px	16,595 px	7,479 px	3,683 px

Count	Min	Max	Mean	Std Dev
227 042	0,000	1,000	0,866	0,082

Figure 138 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N56XE026C.

Both dX and dY distributions highlight low displacement modes (1.0 pixels and -1.1 pixels respectively), with high standard deviations (5.931 pixels for dX, 5.826 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 3 and 11 pixels. This distribution has a single mode of 10.7 pixels.

The correlations are mainly spread over the [0.6, 1.0] range, with a mean of 0.866 and a standard deviation of only 0.082. This spread is due to the flatness of terrain over this tile.

4.2.1.7 07 - Lithuania - N55XE021D (zone 2)

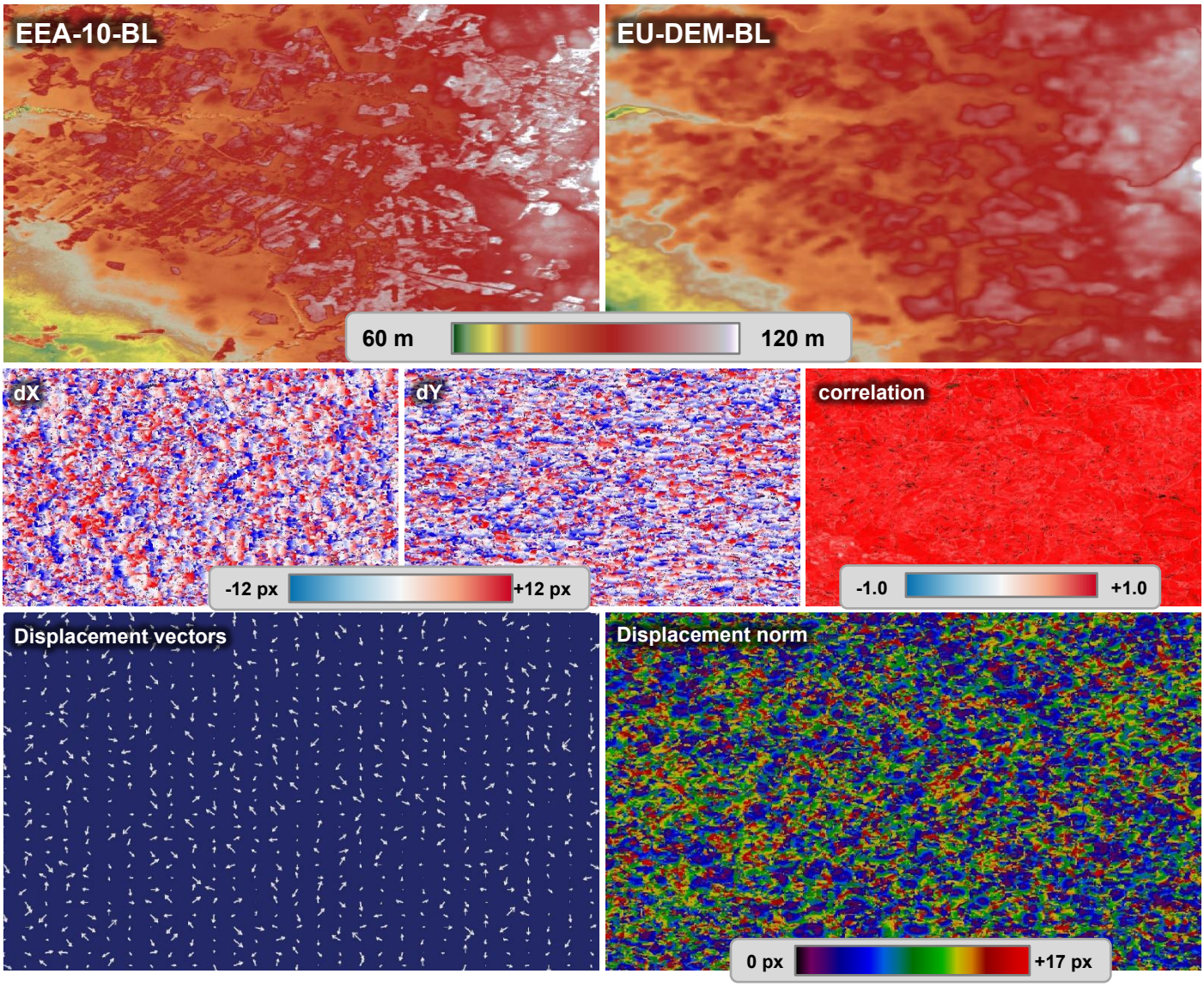
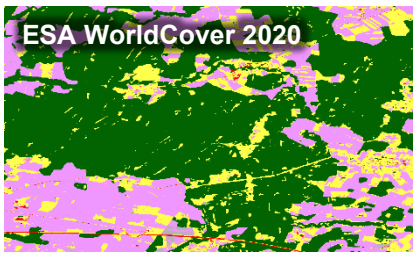
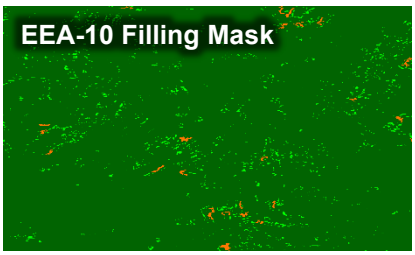


Figure 139 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N55XE021D.





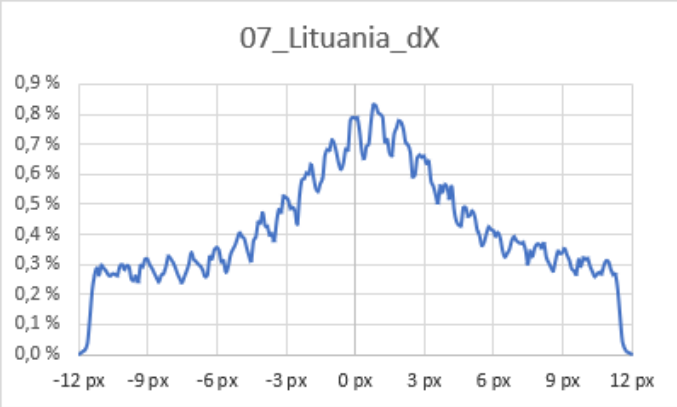
As seen in Figure 139, low height variations are visible over EU-DEM and EEA-10 (60 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, highlighting the presence of croplands and forests (see attached figure).

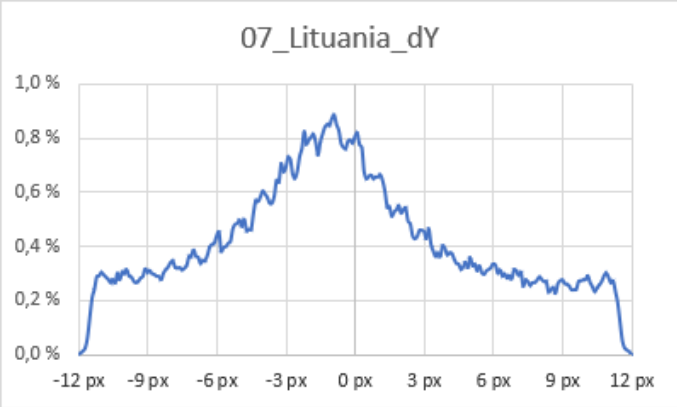
The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 12] interval (from dark blue to green). Displacement norms above 12 pixels are more rarely observed.

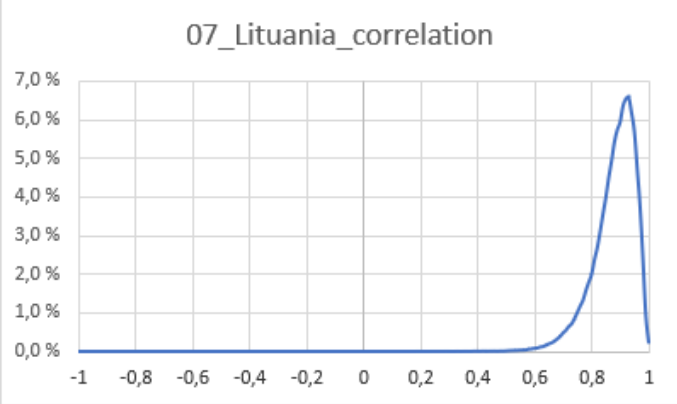
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.





Count	Min	Max	Mean	Std Dev
234 319	-12,0 px	12,0 px	0,366 px	5,674 px

Count	Min	Max	Mean	Std Dev
234 319	-12,0 px	12,0 px	-0,509 px	5,590 px



Count	Min	Max	Mean	Std Dev
234 319	0,000 px	16,646 px	7,062 px	3,737 px

Count	Min	Max	Mean	Std Dev
234 319	0,000	1,000	0,879	0,074

Figure 140 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N55XE021D.

Both dX and dY distributions highlight low displacement modes (1.1 pixels and -1.1 pixels respectively), with high standard deviations (5.674 pixels for dX, 5.590 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 3 and 11 pixels. Two modes can be seen over this distribution: a first mode of 3.1 pixels, and a second mode of 11.2 pixels.

The correlations are mainly spread over the [0.6, 1.0] range, with a mean of 0.879 and a standard deviation of only 0.074. This spread is due to the flatness of terrain over this tile.

4.2.1.8 08 - Poland - N53XE017C (zone 2)

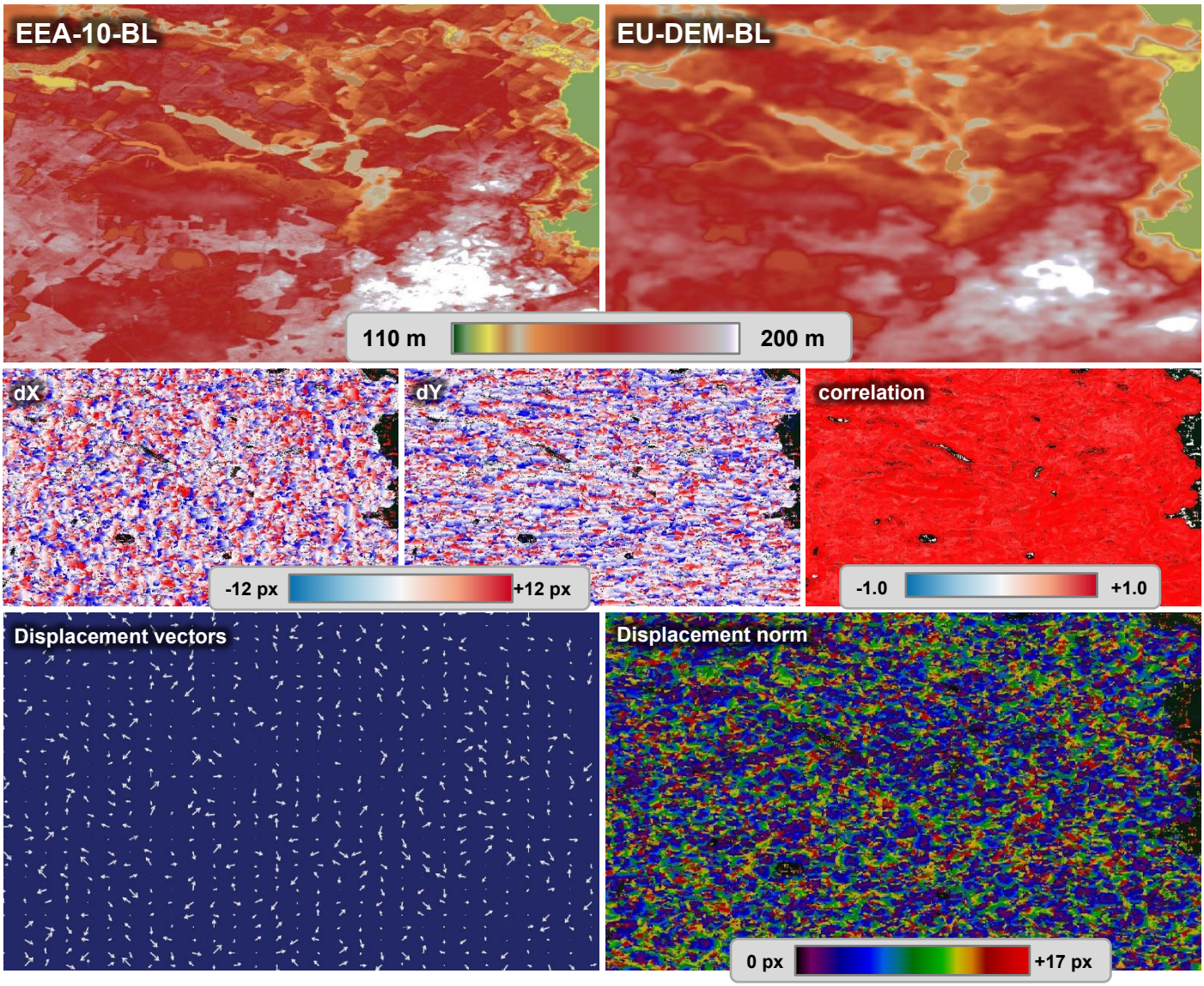
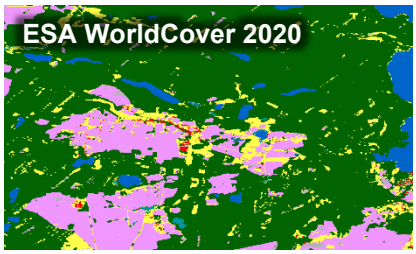
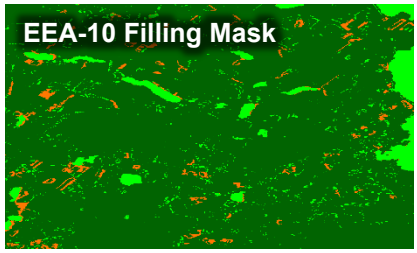


Figure 141 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N53XE017C.





As seen in Figure 141, low height variations are visible over EU-DEM and EEA-10 (90 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, highlighting the presence of croplands and forests.

The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-3, +3[pixels interval).

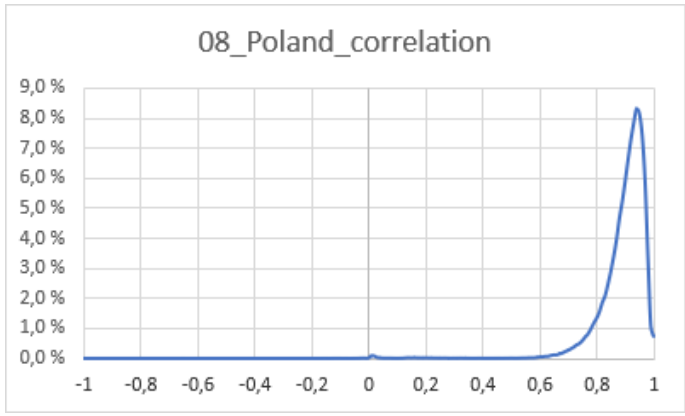
A strong correlation can be seen over this area, as most values are close to 1. One may see low correlations or not computed pixels due to the flatness of lakes (see attached LULC map).

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

Count	Min	Max	Mean	Std Dev
236 070	-12,0 px	11,9 px	0,332 px	5,334 px

Count	Min	Max	Mean	Std Dev
236 070	-12,0 px	12,0 px	-0,505 px	5,147 px



Count	Min	Max	Mean	Std Dev
236 070	0,000 px	16,517 px	6,370 px	3,838 px

Count	Min	Max	Mean	Std Dev
236 070	-0,788	1,000	0,896	0,088

Figure 142 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N53XE017C.

Both dX and dY distributions highlight low displacement modes (-0.1 pixels and 0.8 pixels respectively), with high standard deviations (5.334 pixels for dX, 5.147 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 2.4 pixels.

The correlations are mainly spread over the [0.6, 1.0] range, with a mean of 0.896 and a standard deviation of only 0.088. This spread is due to the flatness of terrain over this tile. One may see a small number of correlations close to 0, which are due to the flatness of lakes on the East of this tile (see preceding page).

4.2.1.9 09 - Germany - N50ZE008F (zone 2)

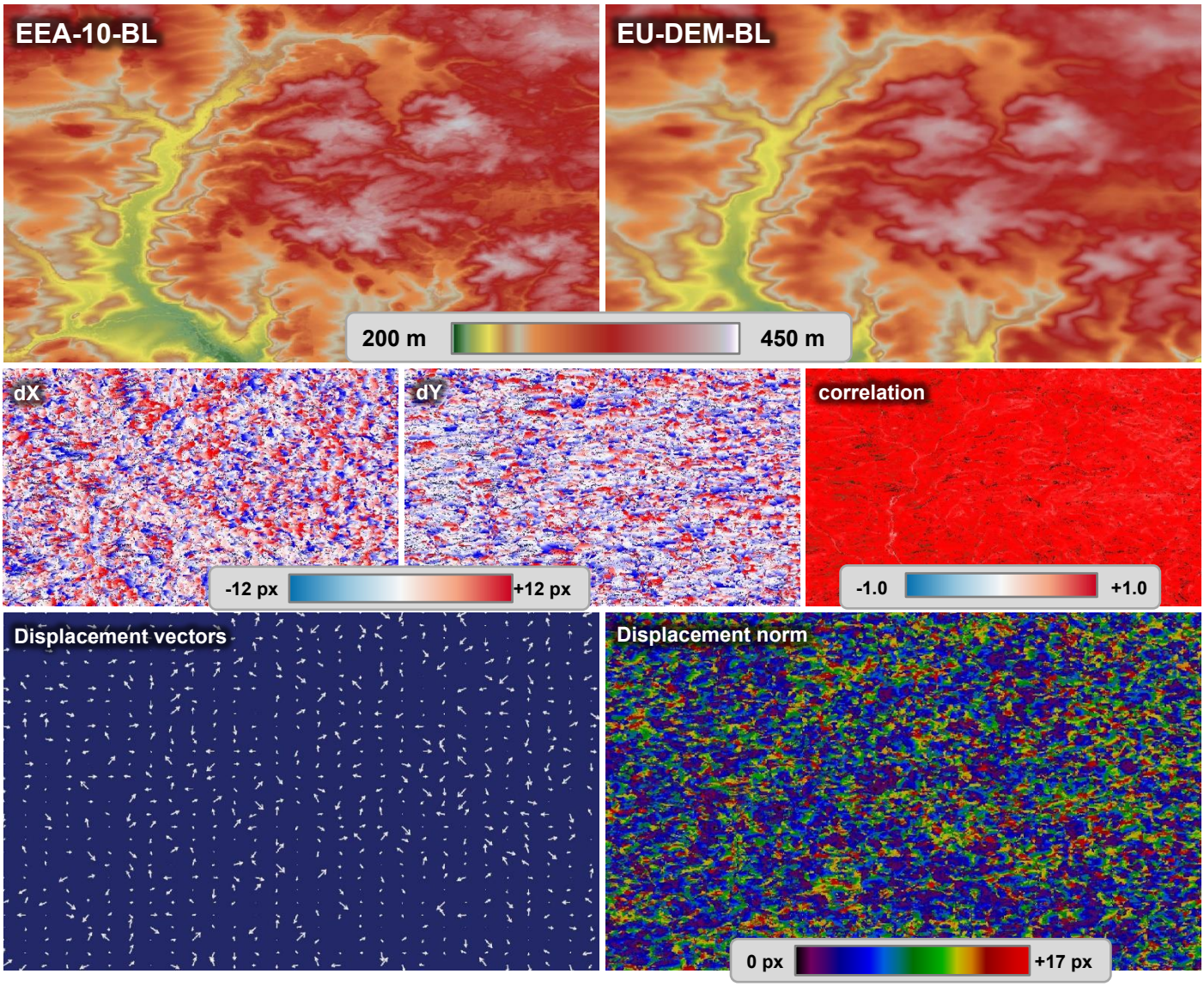
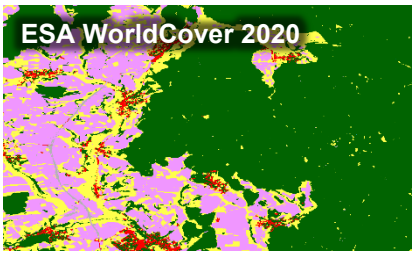
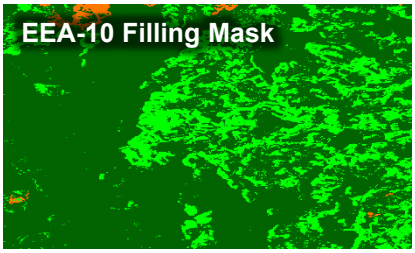


Figure 143 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N50ZE008F.





As seen in Figure 143, important height variations are visible over EU-DEM and EEA-10 (250 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, but the overall aspect of the two DEMs is similar.

The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

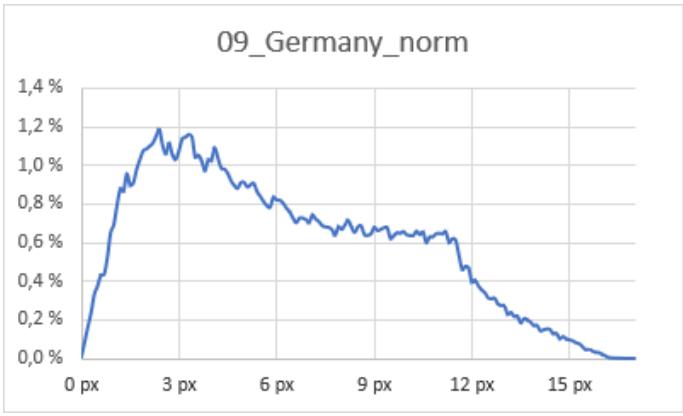
A strong correlation can be seen over this area, as most values are close to 1.

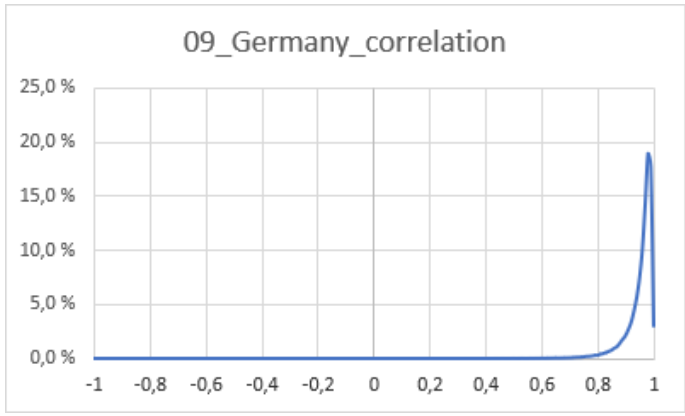
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 6] interval (blue shades). Displacement norms above 6 pixels are more rarely observed.

No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

Count	Min	Max	Mean	Std Dev
236 272	-12,0 px	11,9 px	0,521 px	5,225 px

Count	Min	Max	Mean	Std Dev
236 272	-12,0 px	12,0 px	-0,256 px	4,952 px





Count	Min	Max	Mean	Std Dev
236 272	0,000 px	16,575 px	6,212 px	3,685 px

Count	Min	Max	Mean	Std Dev
236 272	0,000	1,000	0,952	0,050

Figure 144 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N50ZE008F.

Both dX and dY distributions highlight low displacement modes (0.8 pixels and -1.0 pixels respectively), with high standard deviations (5.225 pixels for dX, 4.952 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 6 pixels. This distribution has a single mode of 2.4 pixels.

The correlations are mainly spread over the [0.8, 1.0] range, with a mean of 0.952 and a standard deviation of only 0.050.

4.2.1.10 10 - Denmark - N55RE010B (zone 2)

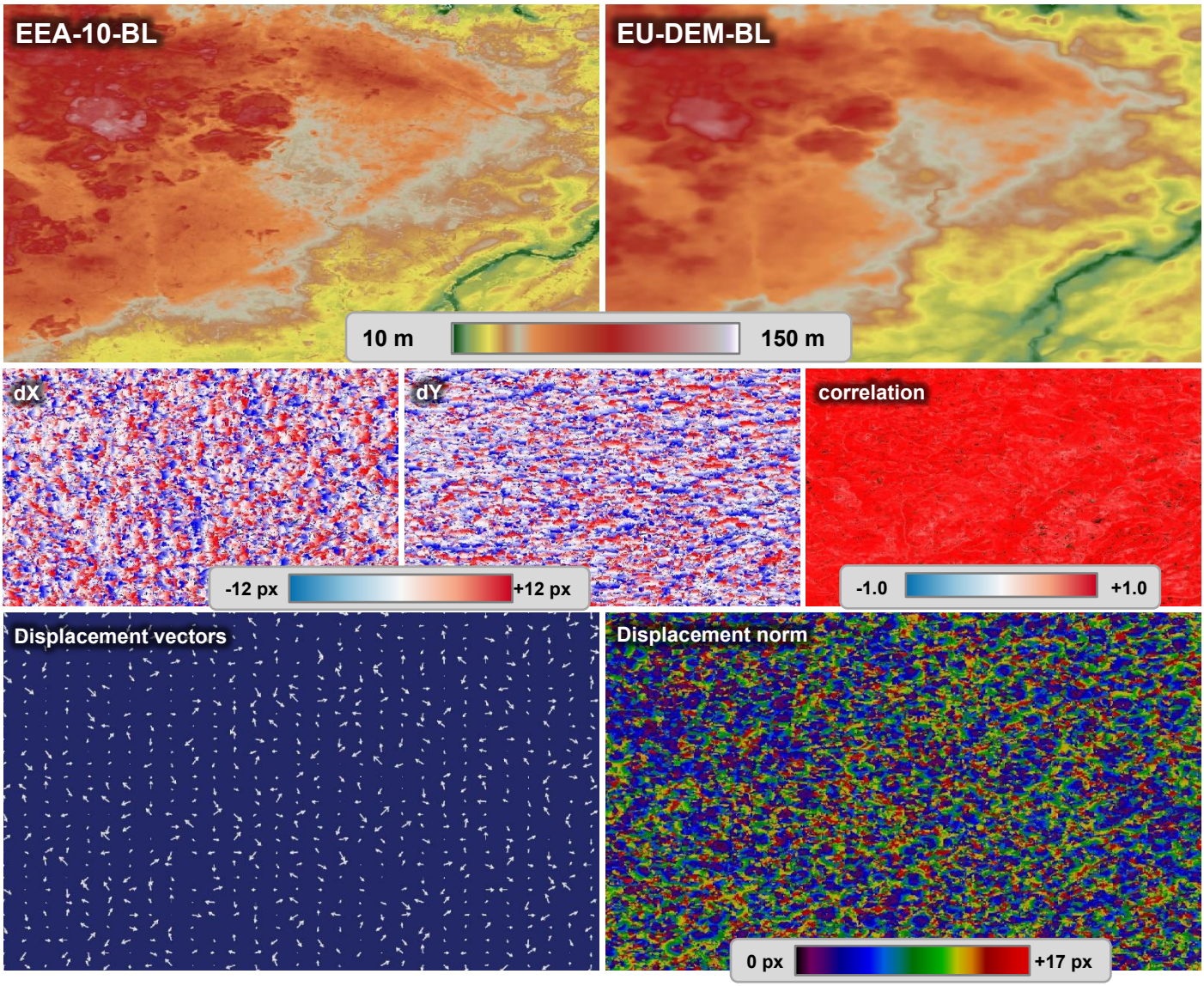
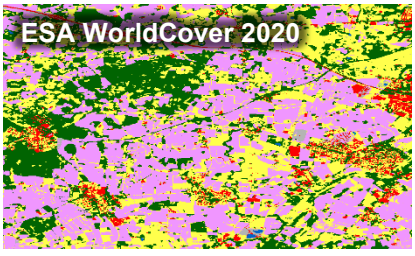
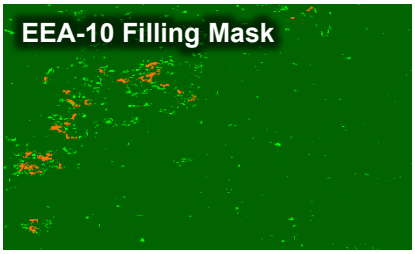


Figure 145 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N55RE010B.





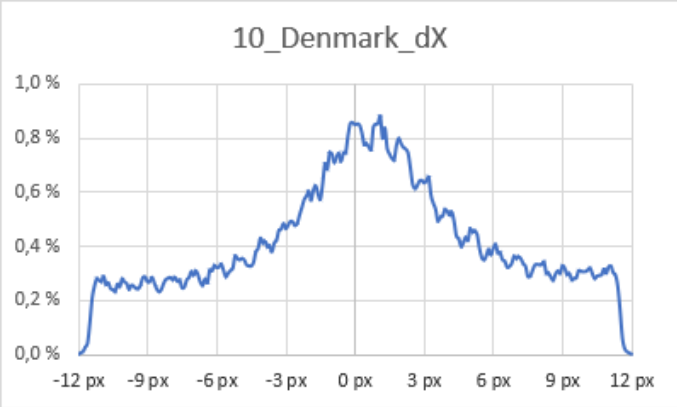
As seen in Figure 145, low height variations are visible over EU-DEM and EEA-10 (140 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, but the overall aspect of the two DEMs is similar.

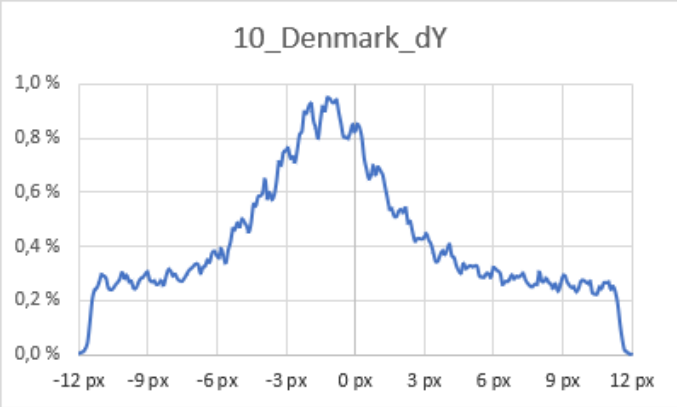
The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

High correlations can be seen over this tile, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

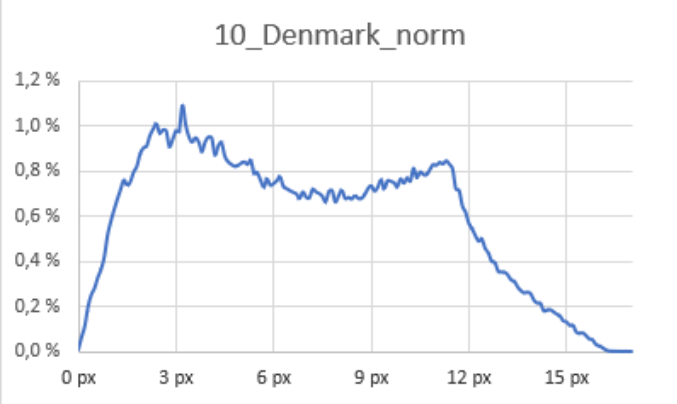
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

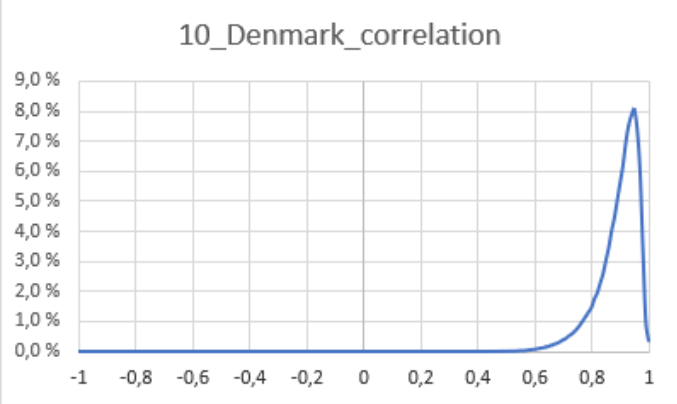




Count	Min	Max	Mean	Std Dev
233 941	-12,0 px	12,0 px	0,427 px	5,593 px

Count	Min	Max	Mean	Std Dev
233 941	-12,0 px	12,0 px	-0,465 px	5,452 px





Count	Min	Max	Mean	Std Dev
233 941	0,000 px	16,813 px	6,844 px	3,816 px

Count	Min	Max	Mean	Std Dev
233 941	0,000	1,000	0,895	0,071

Figure 146 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N55RE010B.

Both dX and dY distributions highlight low displacement modes (1.1 pixels and -1.1 pixels respectively), with high standard deviations (5.593 pixels for dX, 5.452 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 3 and 11 pixels. This distribution has two modes: one at 3.2 pixels, the other at 11.4 pixels.

The correlations are mainly spread over the [0.6, 1.0] range, with a mean of 0.895 and a standard deviation of only 0.071.

4.2.1.11 11 - Netherlands - N52ZE005F (zone 2)

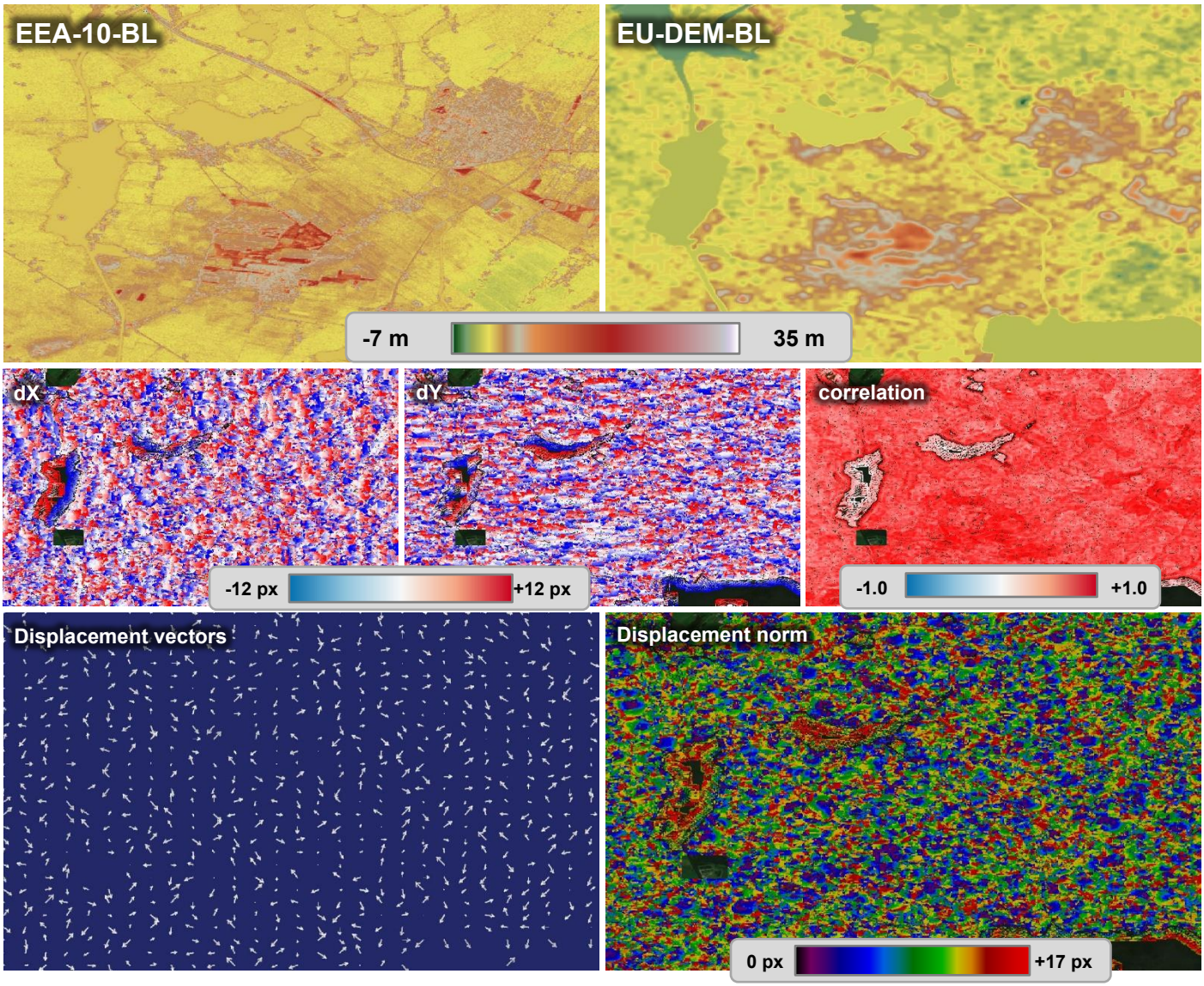
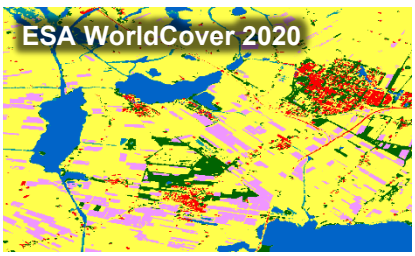


Figure 147 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N52ZE005F.



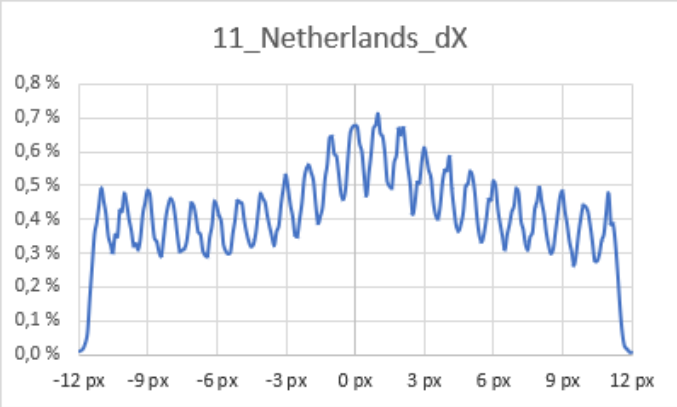
As seen in Figure 147, really low height variations are visible over EU-DEM and EEA-10 (42 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, highlighting the presence of croplands and trees (see attached LULC map).

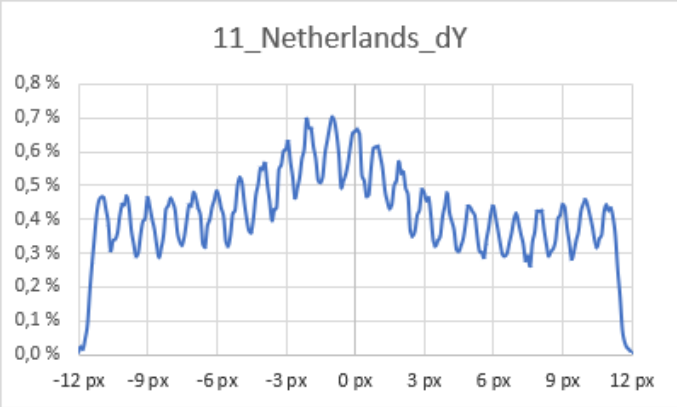
The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see important saturation over these two images.

As most of the tile is flat, lower correlations are retrieved over this area (mostly in the [0.6, 0.8] interval).

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [8, 11] interval (green shades). Displacement norms above 11 pixels and below 8 pixels are more rarely observed.

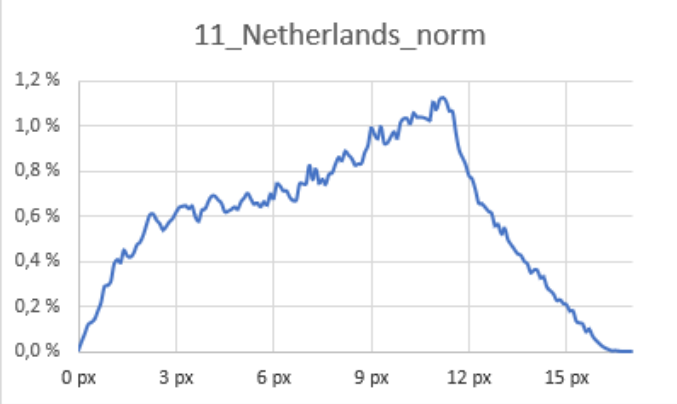
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

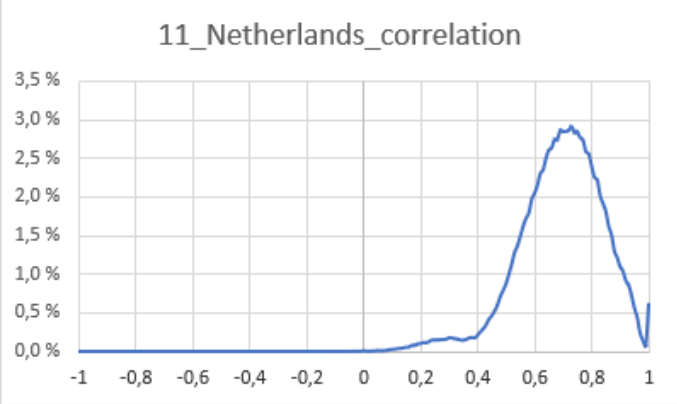




Count	Min	Max	Mean	Std Dev
210 123	-12,0 px	12,0 px	0,114 px	6,254 px

Count	Min	Max	Mean	Std Dev
210 123	-12,0 px	12,0 px	-0,271 px	6,279 px





Count	Min	Max	Mean	Std Dev
210 123	0,000 px	16,561 px	8,056 px	3,707 px

Count	Min	Max	Mean	Std Dev
210 123	-0,138	1,000	0,692	0,148

Figure 148 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N52ZE005F.

Both dX and dY distributions highlight low displacement modes (1.0 pixels and -0.9 pixels respectively), with high standard deviations (6.254 pixels for dX, 6.279 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 8 and 11 pixels. This distribution has a single mode of 11.3 pixels.

The correlations are mainly spread over the [0.4, 1.0] range, with a mean of 0.692 and a standard deviation of only 0.148. This spread is due to the flatness of terrain over this tile.

4.2.1.12 12 - Belgium - N50YE004F (zone 2)

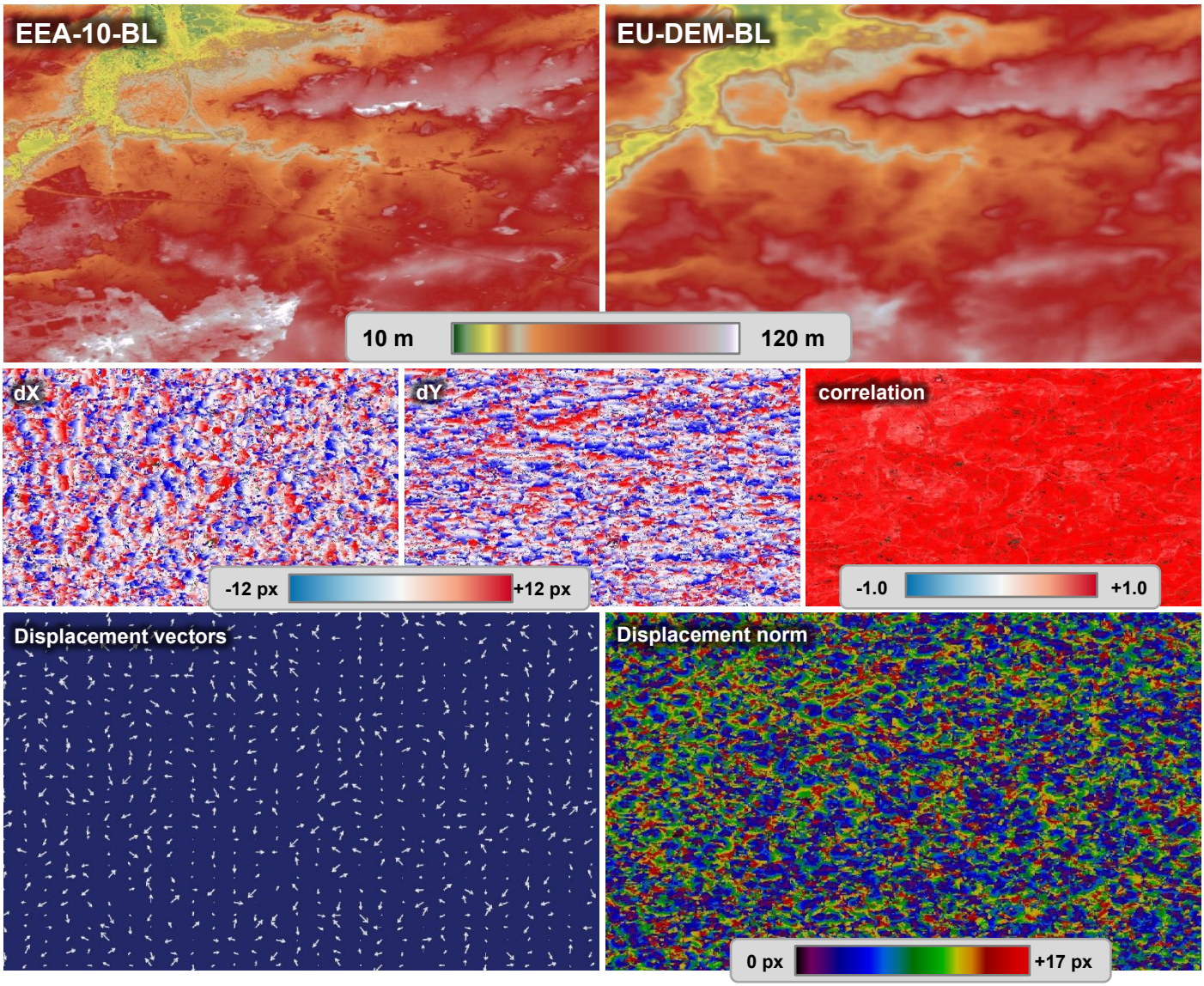
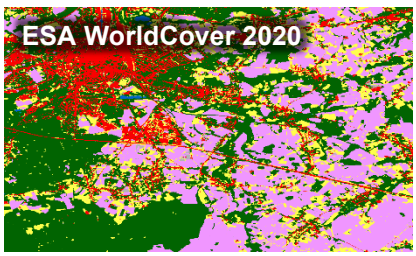
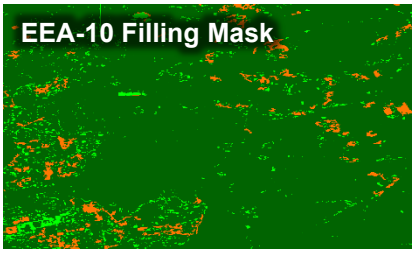


Figure 149 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N50YE004F.





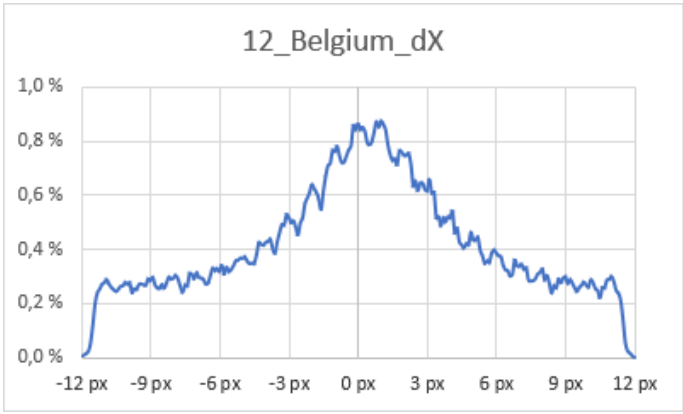
As seen in Figure 149, low height variations are visible over EU-DEM and EEA-10 (110 metres between lowest and highest points). The EEA-10 tile shows sharper details than the EU-DEM tile, but the overall aspect of the two DEMs is similar.

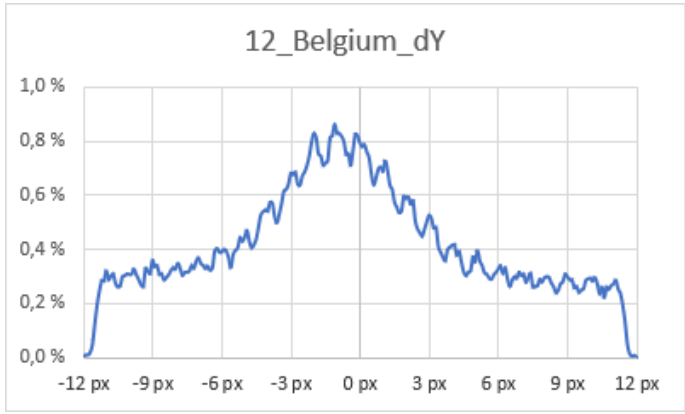
The dX and dY images show important displacement variations over all the tile. For both images, these displacements are included in the]-12, +12[pixels range. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

High correlations can be seen over this tile, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

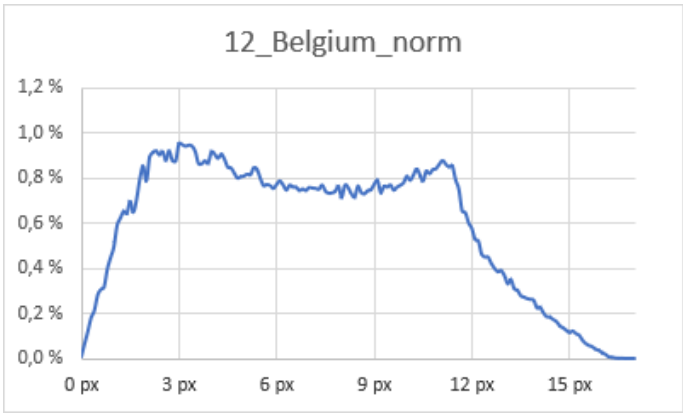
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

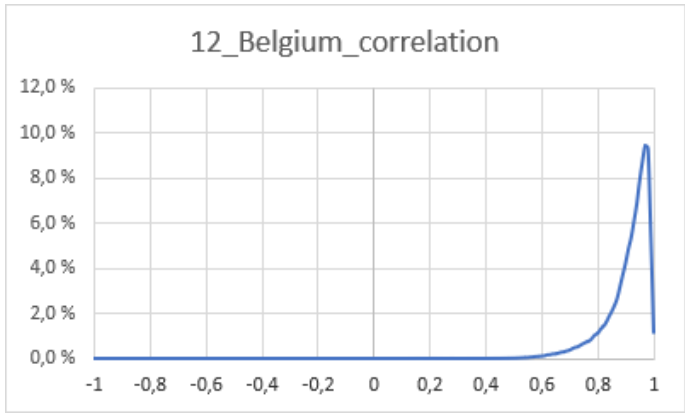




Count	Min	Max	Mean	Std Dev
229 288	-12,0 px	12,0 px	0,207 px	5,539 px

Count	Min	Max	Mean	Std Dev
229 288	-12,0 px	12,0 px	-0,395 px	5,626 px





Count	Min	Max	Mean	Std Dev
229 288	0,000 px	16,604 px	6,959 px	3,755 px

Count	Min	Max	Mean	Std Dev
229 288	0,000	1,000	0,910	0,078

Figure 150 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N50YE004F.

Both dX and dY distributions highlight low displacement modes (1.1 pixels and -1.1 pixels respectively), with high standard deviations (5.539 pixels for dX, 5.626 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has two modes: one at 3.1 pixels, the other at 11.4 pixels.

The correlations are mainly spread over the [0.6, 1.0] range, with a mean of 0.910 and a standard deviation of only 0.078.

4.2.1.13 13 - France - N44QW001H (zone 1)

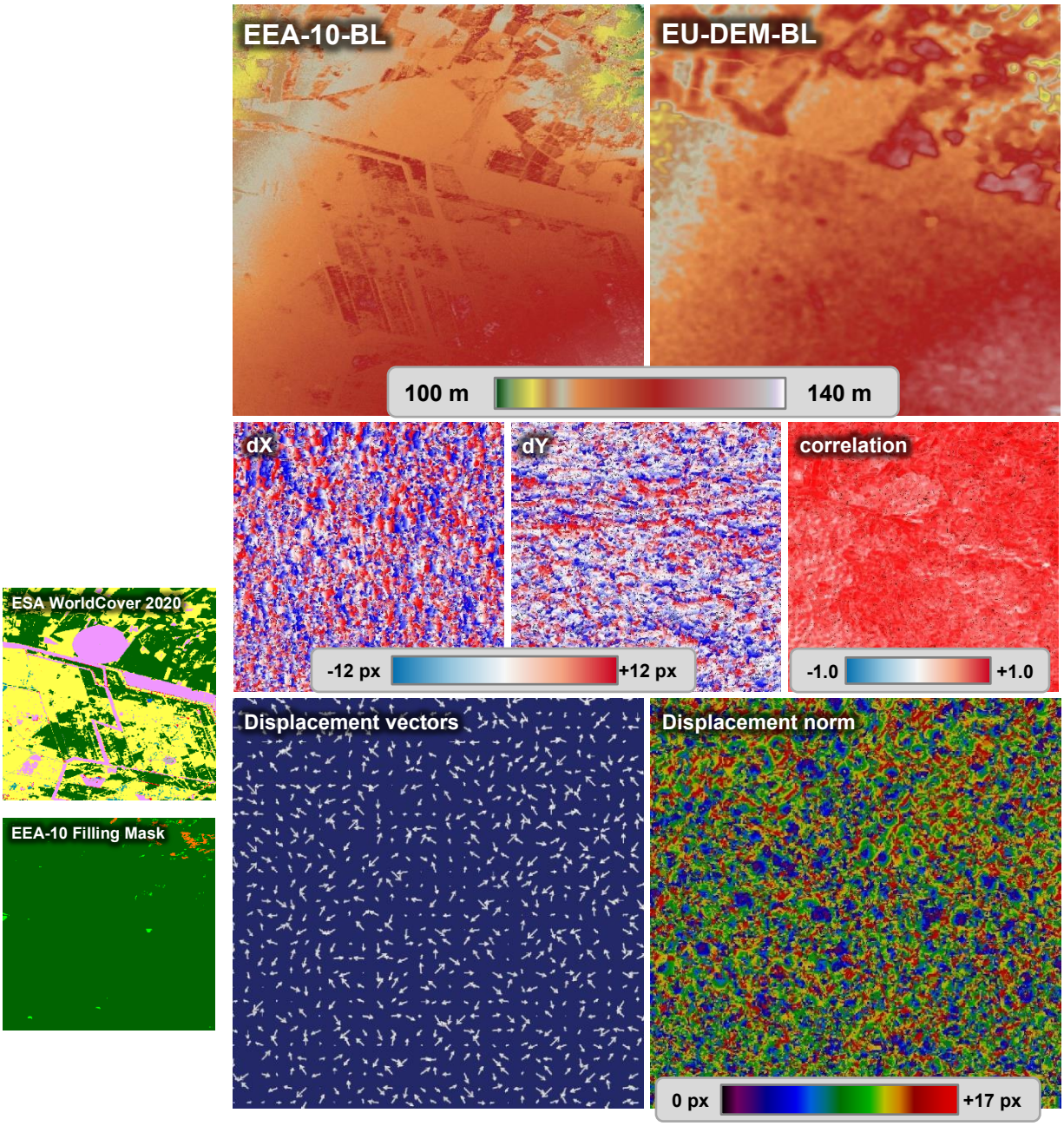


Figure 151 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N44QW001H.

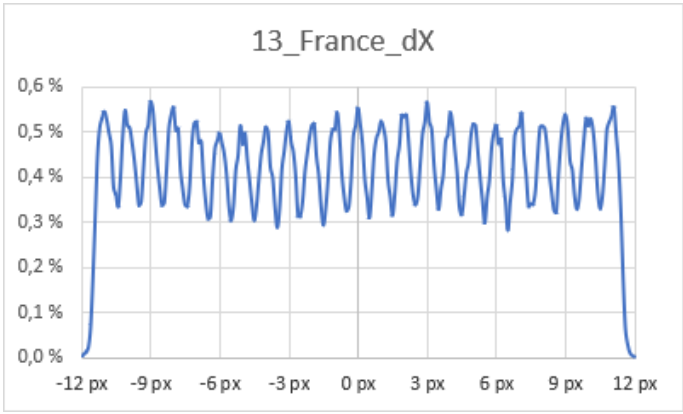
As seen in Figure 151, really low height variations are visible over EU-DEM and EEA-10 (40 metres between lowest and highest points).

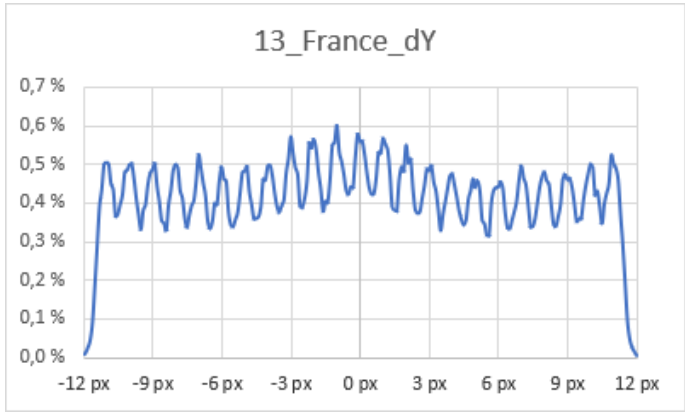
The dX and dY images show important displacement variations over all the tile. One may see both low and high displacements in this tile, which is due to its flatness.

Lower correlations are seen over this tile (mostly included in the [0.6, 0.8] interval), as this area is particularly flat.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [9, 12] range (green shades). Displacement norms out of this range are more rarely observed.

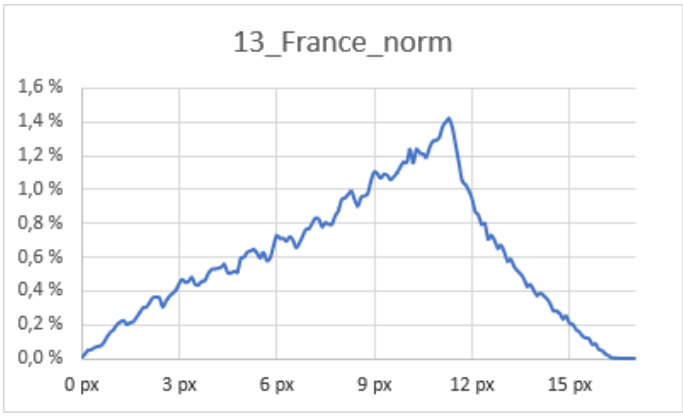
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

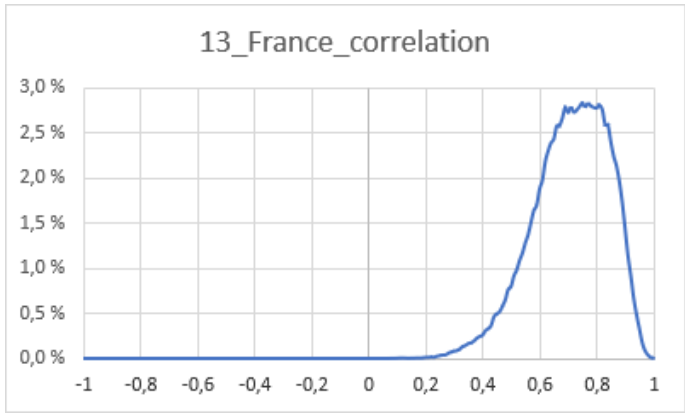




Count	Min	Max	Mean	Std Dev
211 830	-12,0 px	12,0 px	-0,004 px	6,700 px

Count	Min	Max	Mean	Std Dev
211 830	-12,0 px	12,0 px	-0,057 px	6,570 px





Count	Min	Max	Mean	Std Dev
211 830	0,000 px	16,471 px	8,743 px	3,408 px

Count	Min	Max	Mean	Std Dev
211 830	0,000	1,000	0,709	0,132

Figure 152 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N44QW001H.

Both dX and dY distributions highlight really high standard deviations (6.700 pixels for dX, 6.570 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 9 and 12 pixels. This distribution has a single mode of 11.3 pixels.

The correlations are mainly spread over the [0.4, 1.0] range, with a mean of 0.709 and a standard deviation of 0.132. This spread is due to the flatness of terrain over this tile.

4.2.1.14 14 - Spain - N41VW004C (zone 1)

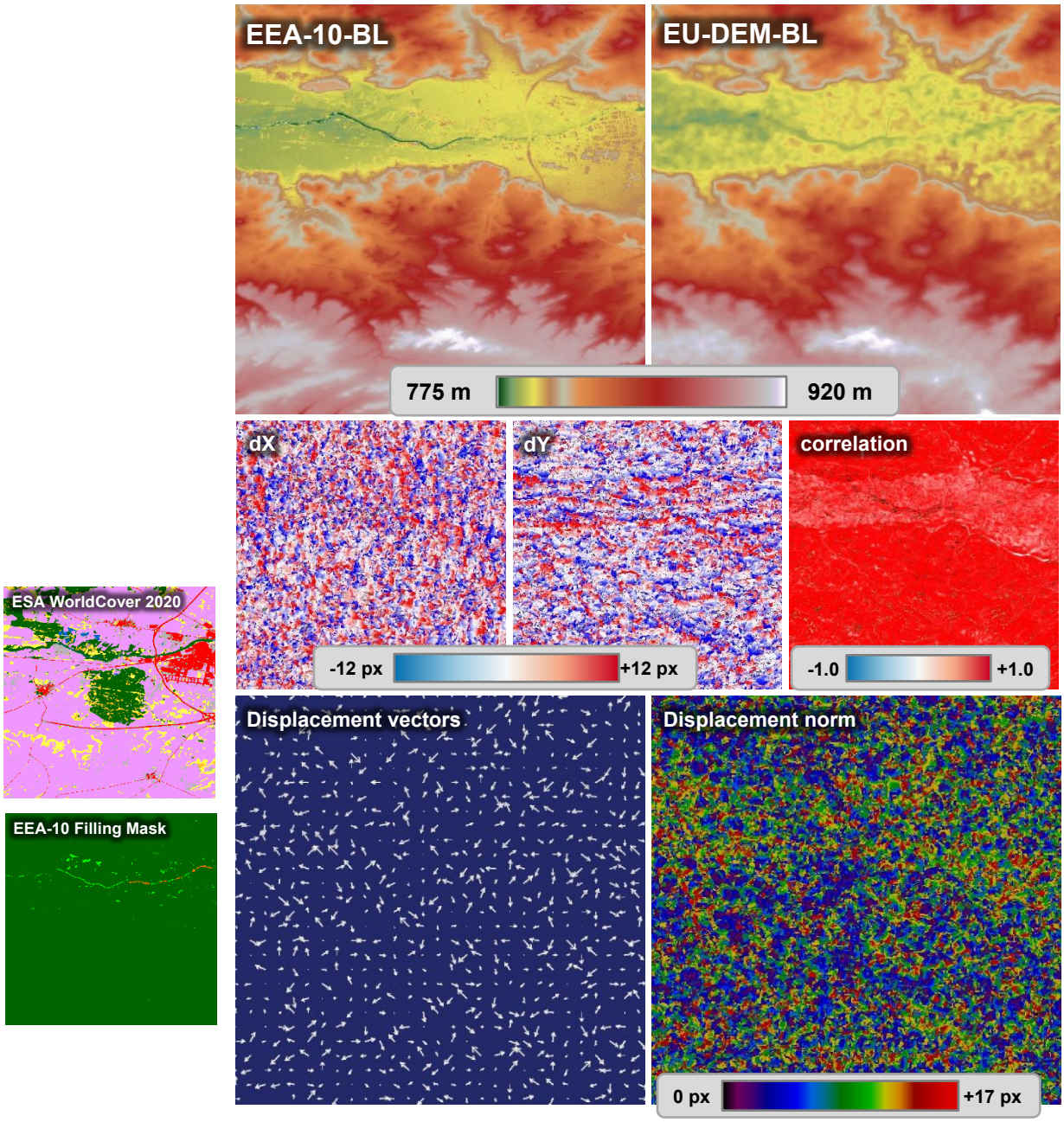


Figure 153 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N41VW004C.

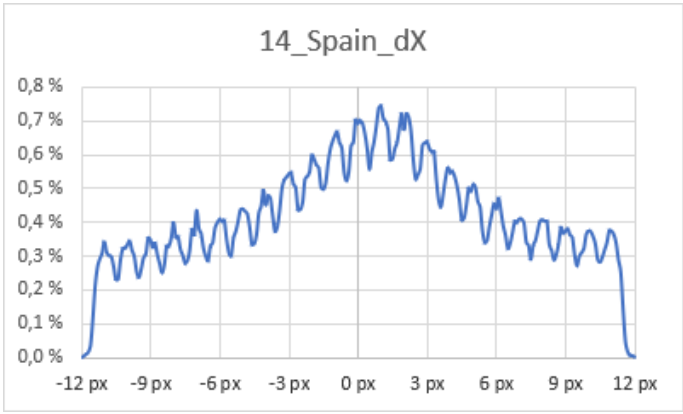
As seen in Figure 153, relatively low height variations are visible over EU-DEM and EEA-10 (145 metres between lowest and highest points).

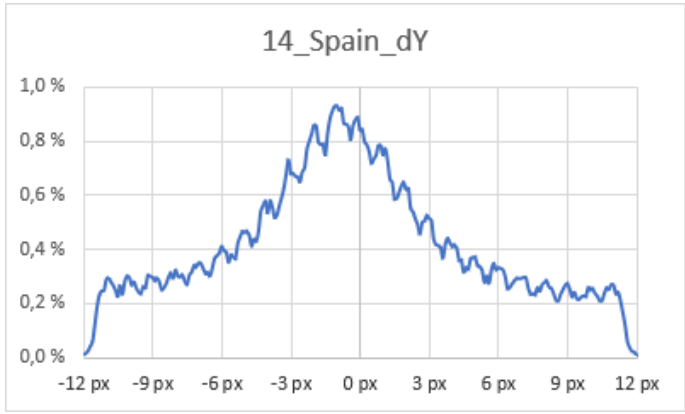
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1. Lower correlations are seen over the flattest areas of this tile.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [3, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

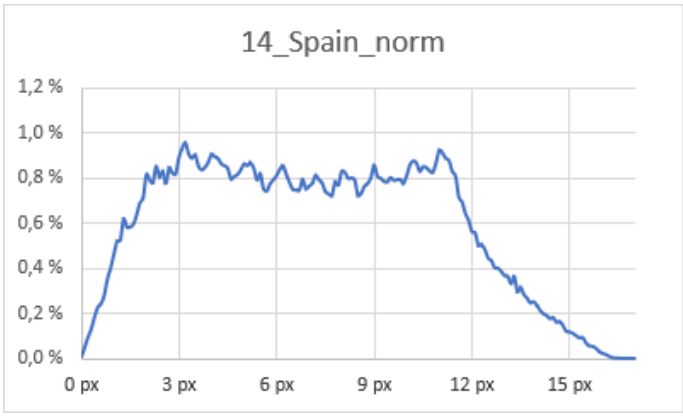
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

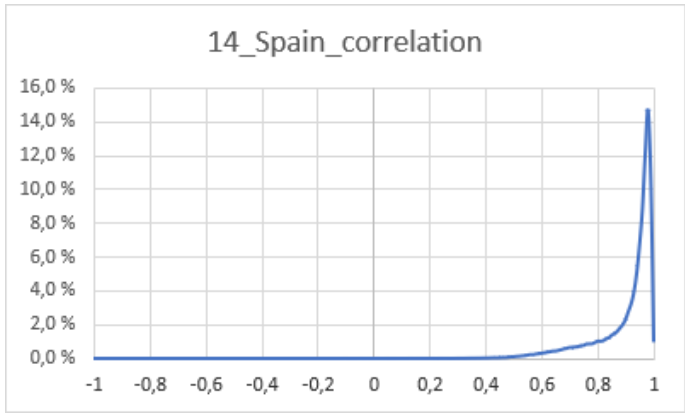




Count	Min	Max	Mean	Std Dev
224 676	-12,0 px	12,0 px	0,309 px	5,897 px

Count	Min	Max	Mean	Std Dev
224 676	-12,0 px	12,0 px	-0,412 px	5,406 px





Count	Min	Max	Mean	Std Dev
224 676	0,000 px	16,675 px	7,111 px	3,702 px

Count	Min	Max	Mean	Std Dev
224 676	-0,130	1,000	0,905	0,109

Figure 154 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N41VW004C.

Both dX and dY distributions highlight low displacement modes (0.9 pixels and -1.0 pixels respectively), with high standard deviations (5.897 pixels for dX, 5.406 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 3 and 11 pixels. This distribution has two modes: one at 3.2 pixels, the other at 11.2 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.905 and a standard deviation of only 0.109. One may note a tail of distribution between 0.4 and 0.8 pixels. This tail of distribution is due to the flatness of terrain over the North of this tile.

4.2.1.15 15 - Portugal - N40RW009K (zone 1)

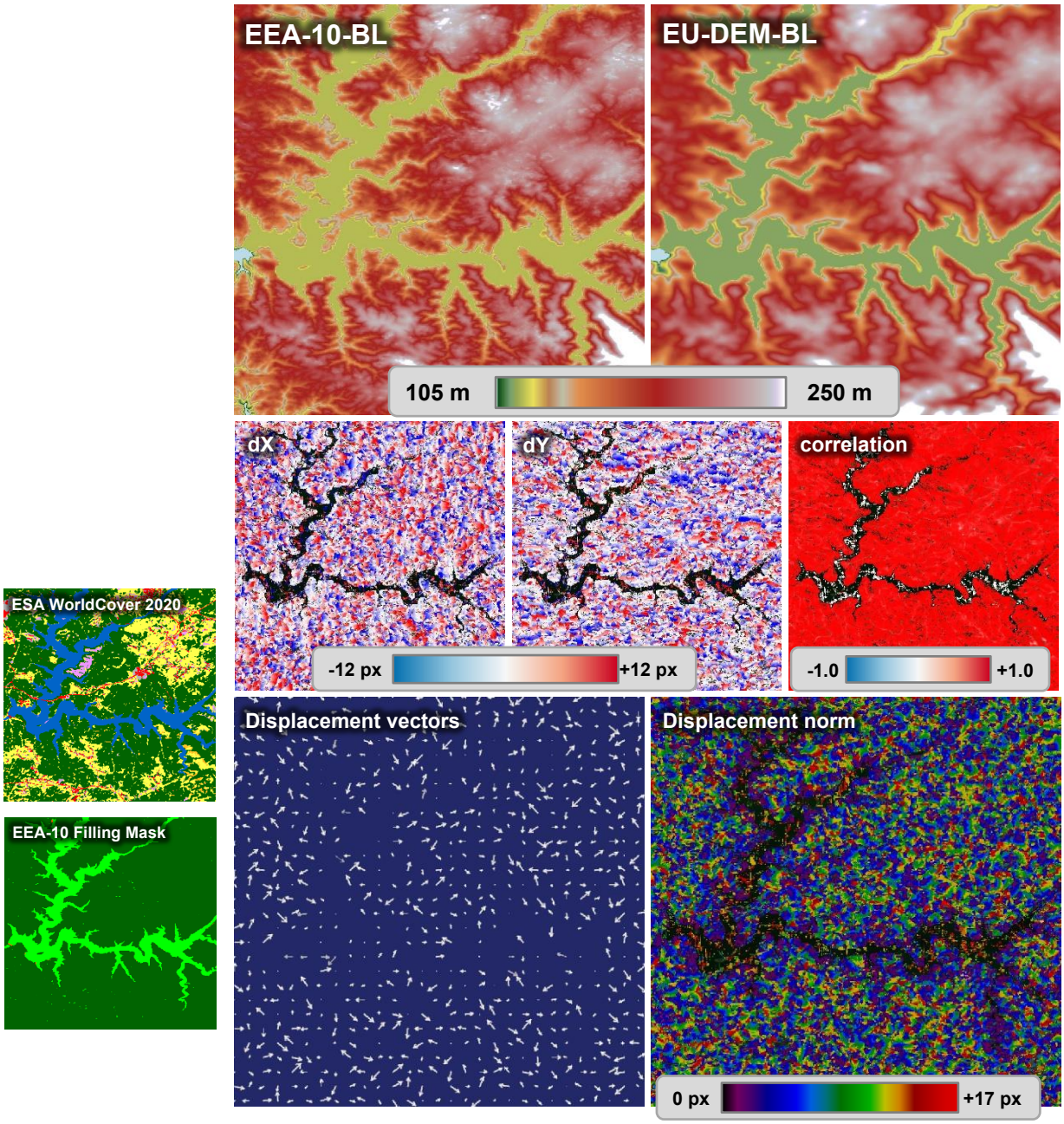


Figure 155 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N40RW009K.

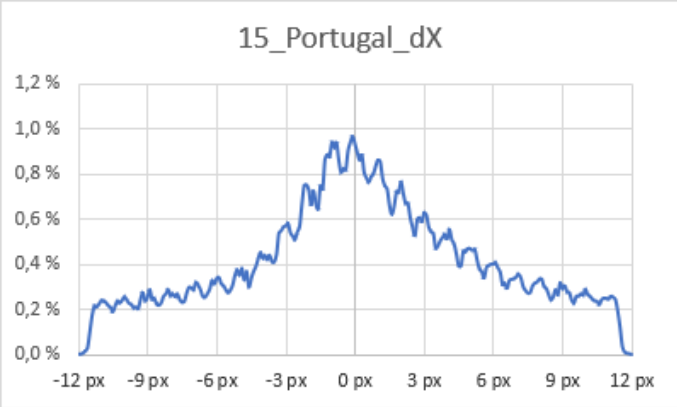
As seen in Figure 155, relatively low height variations are visible over EU-DEM and EEA-10 (145 metres between lowest and highest points).

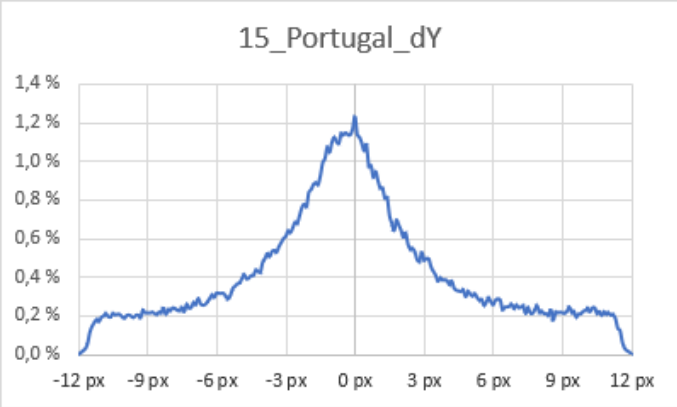
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1. Low correlation or not computed pixels are seen due to the flatness of the lakes.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [1, 4] interval (from purple to dark blue). Displacement norms above 4 pixels are more rarely observed.

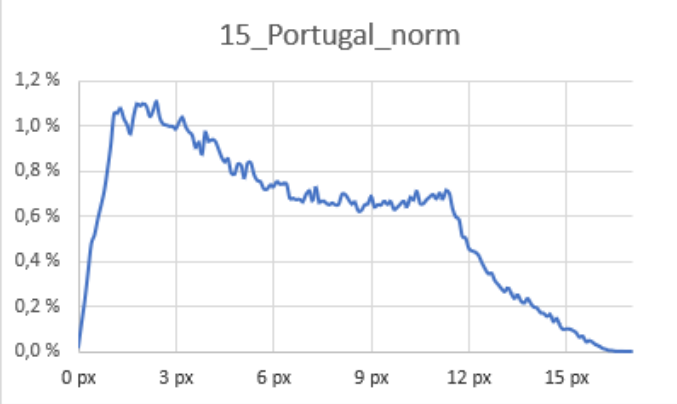
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

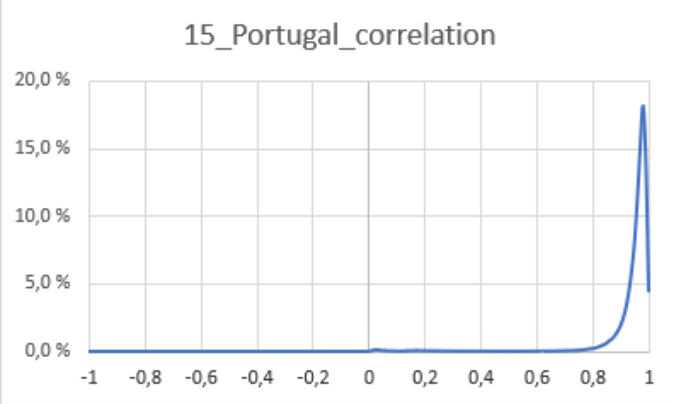




Count	Min	Max	Mean	Std Dev
224 020	-12,0 px	12,0 px	0,277 px	5,366 px

Count	Min	Max	Mean	Std Dev
224 020	-12,0 px	12,0 px	-0,146 px	5,025 px





Count	Min	Max	Mean	Std Dev
224 020	0,000 px	16,679 px	6,271 px	3,849 px

Count	Min	Max	Mean	Std Dev
224 020	-0,771	1,000	0,941	0,113

Figure 156 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N40RW009K.

Both dX and dY distributions highlight low displacement modes (-0.2 pixels and 0.0 pixels respectively), with high standard deviations (5.336 pixels for dX, 5.025 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 1 and 4 pixels. This distribution has a single mode of 2.4 pixels.

The correlations are mainly spread over the [0.8, 1.0] range, with a mean of 0.941 and a standard deviation of only 0.113.

4.2.1.16 16 - Italy - N37UE014C (zone 1)

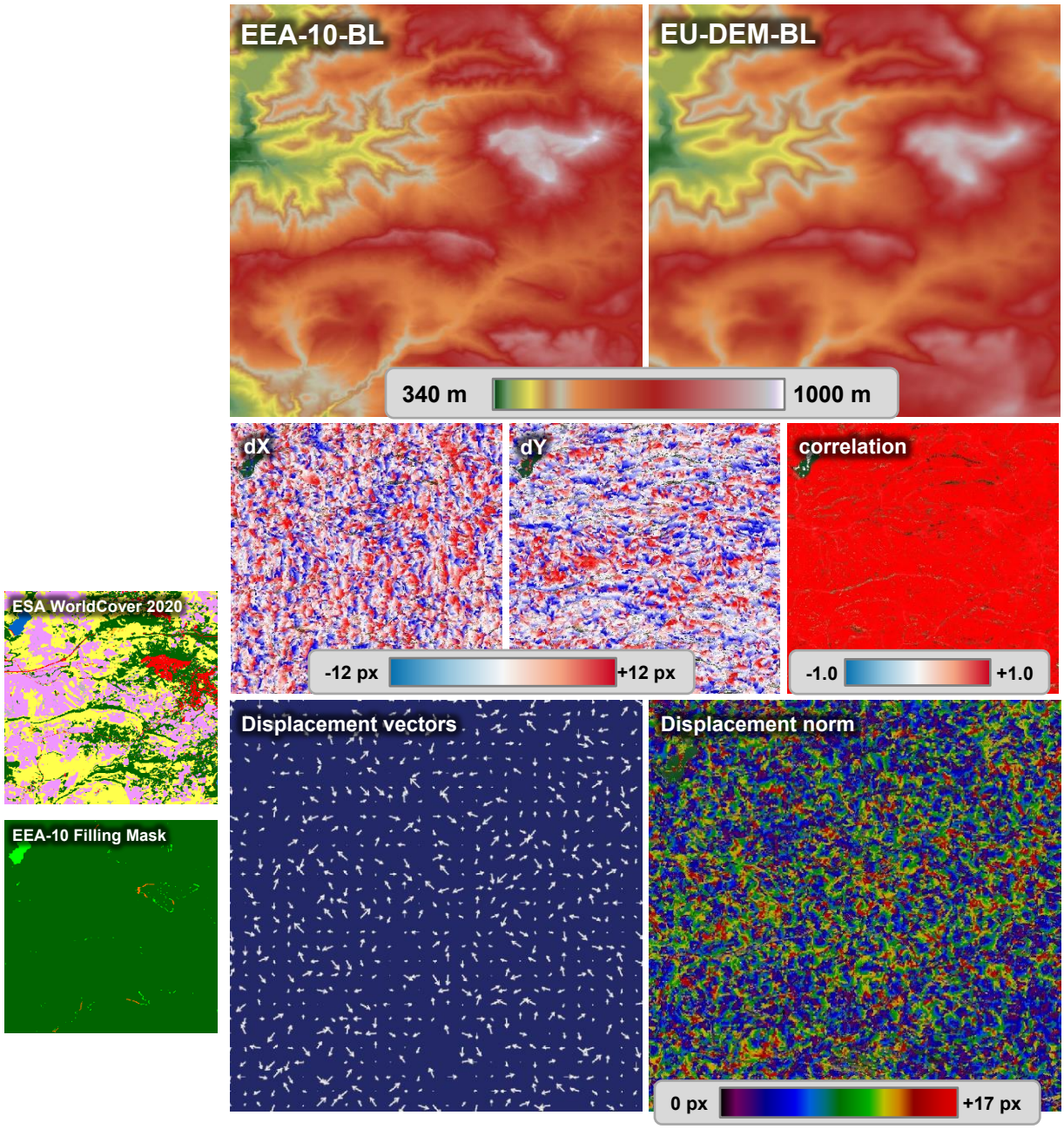


Figure 157 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N37UE014C.

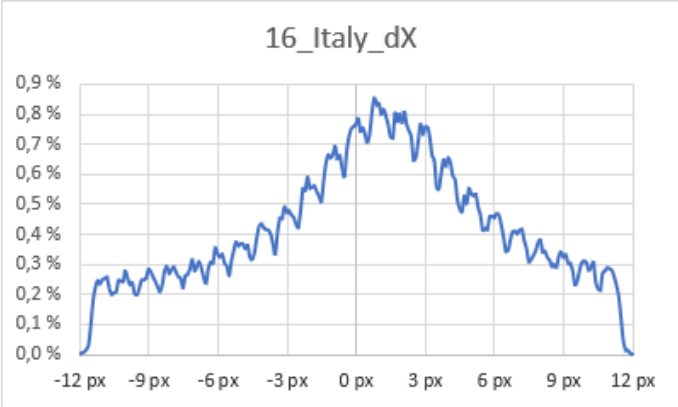
As seen in Figure 157, important height variations are visible over EU-DEM and EEA-10 (660 metres between lowest and highest points).

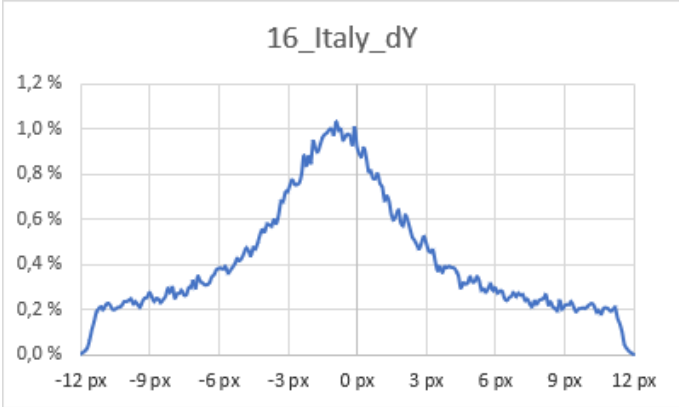
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 8] interval (from dark blue to green). Displacement norms above 8 pixels are more rarely observed.

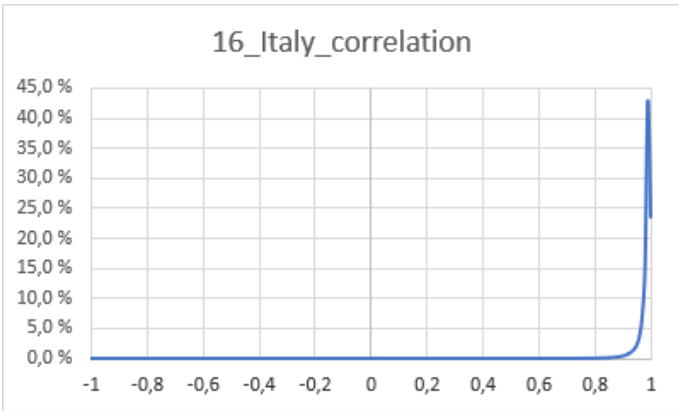
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.





Count	Min	Max	Mean	Std Dev
227 915	-12,0 px	12,0 px	0,630 px	5,510 px

Count	Min	Max	Mean	Std Dev
227 915	-12,0 px	12,0 px	-0,452 px	5,142 px



Count	Min	Max	Mean	Std Dev
227 915	0,000 px	16,809 px	6,627 px	3,673 px

Count	Min	Max	Mean	Std Dev
227 915	-0,739	1,000	0,981	0,041

Figure 158 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N64ZW019C.

Both dX and dY distributions highlight low displacement modes (0.8 pixels and -0.9 pixels respectively), with high standard deviations (5.510 pixels for dX, 5.142 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 5 pixels. This distribution has a single mode of 3.3 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.981 and a standard deviation of only 0.041. This spread is due to the flatness of terrain over this tile.

4.2.1.17 17 - Switzerland - N46ZE009A (zone 1)

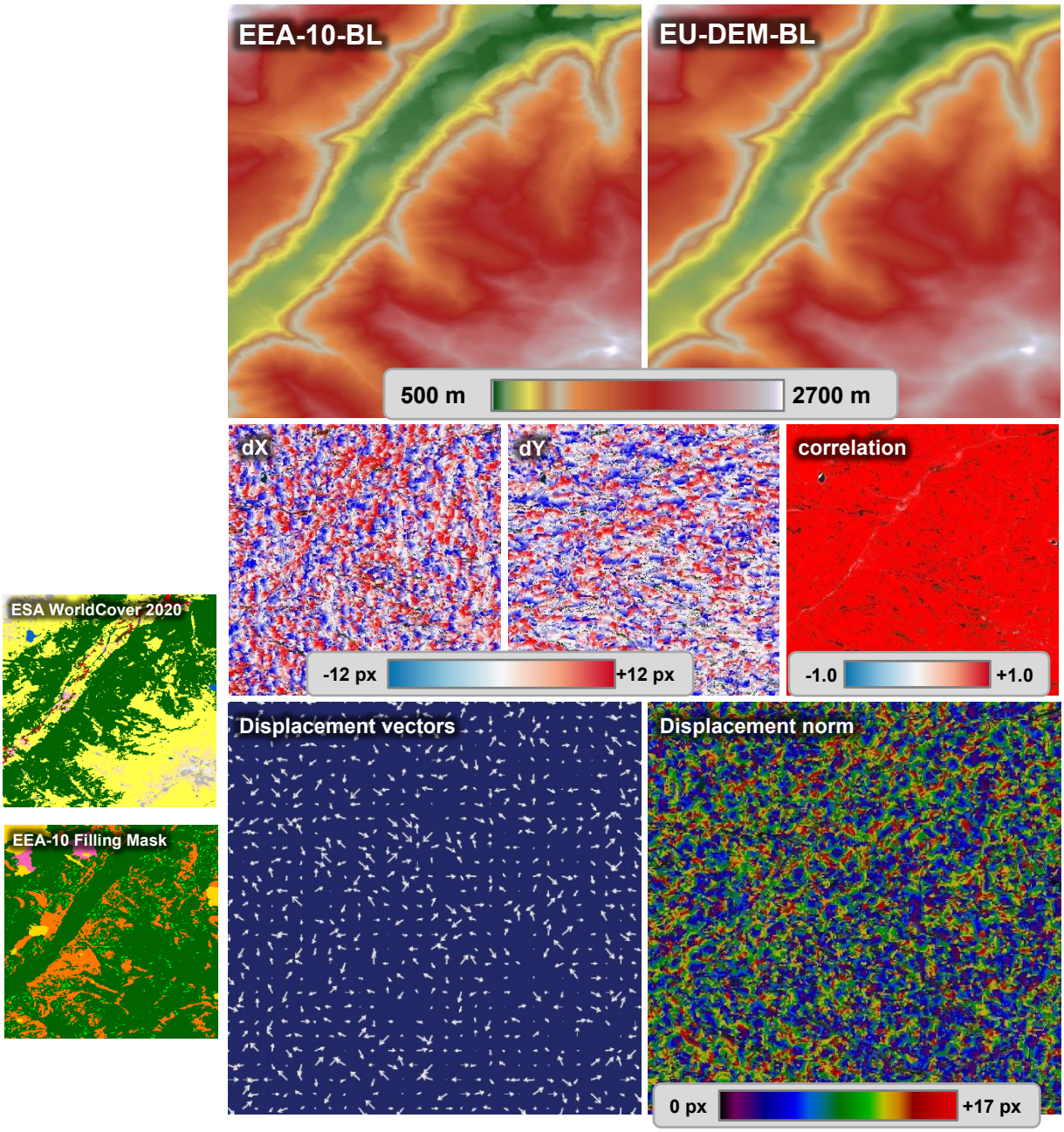


Figure 159 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N46ZE009A.

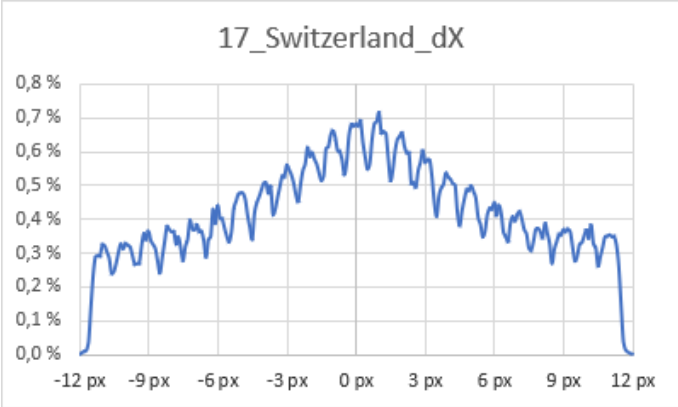
As seen in Figure 159, very important height variations are visible over EU-DEM and EEA-10 (2200 metres between lowest and highest points).

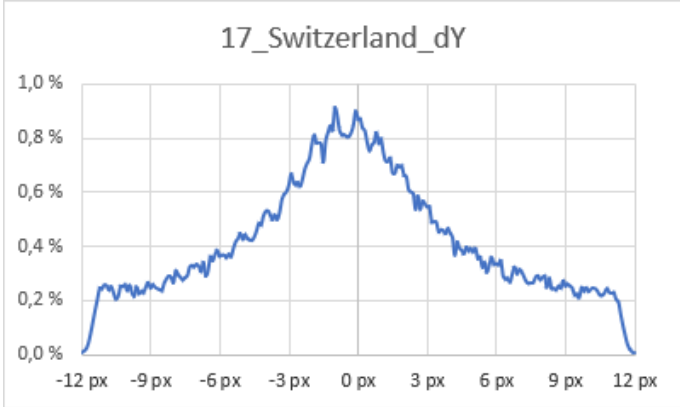
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to light green). Displacement norms above 11 pixels are more rarely observed.

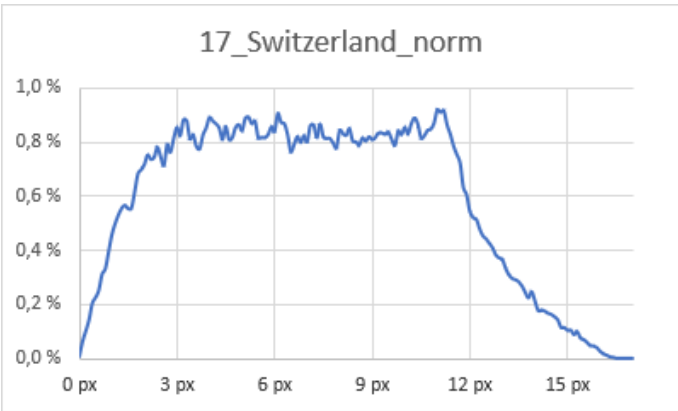
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

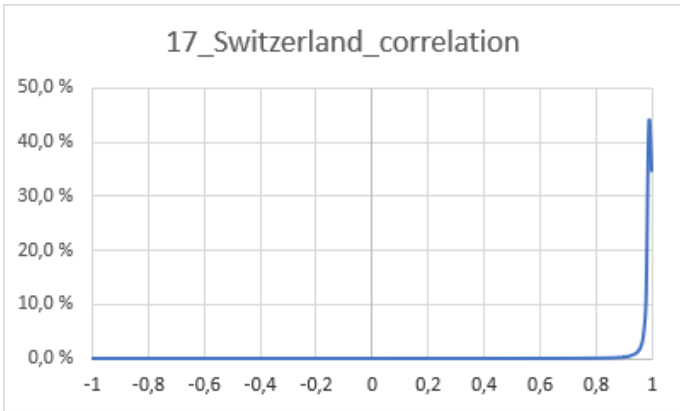




Count	Min	Max	Mean	Std Dev
223 791	-12,0 px	12,0 px	0,182 px	5,932 px

Count	Min	Max	Mean	Std Dev
223 791	-12,0 px	12,0 px	-0,171 px	5,374 px





Count	Min	Max	Mean	Std Dev
223791	0,000 px	16,434 px	7,135 px	3,637 px

Count	Min	Max	Mean	Std Dev
223791	0,000	1,000	0,986	0,031

Figure 160 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N46ZE009A.

Both dX and dY distributions highlight low displacement modes (1.1 pixels and -0.9 pixels respectively), with high standard deviations (5.932 pixels for dX, 5.374 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 11.2 pixels.

The correlations are mainly spread over the [0.95, 1.0] range, with a mean of 0.986 and a standard deviation of only 0.031.

4.2.1.18 18 - Austria - N47UE014H (zone 1)

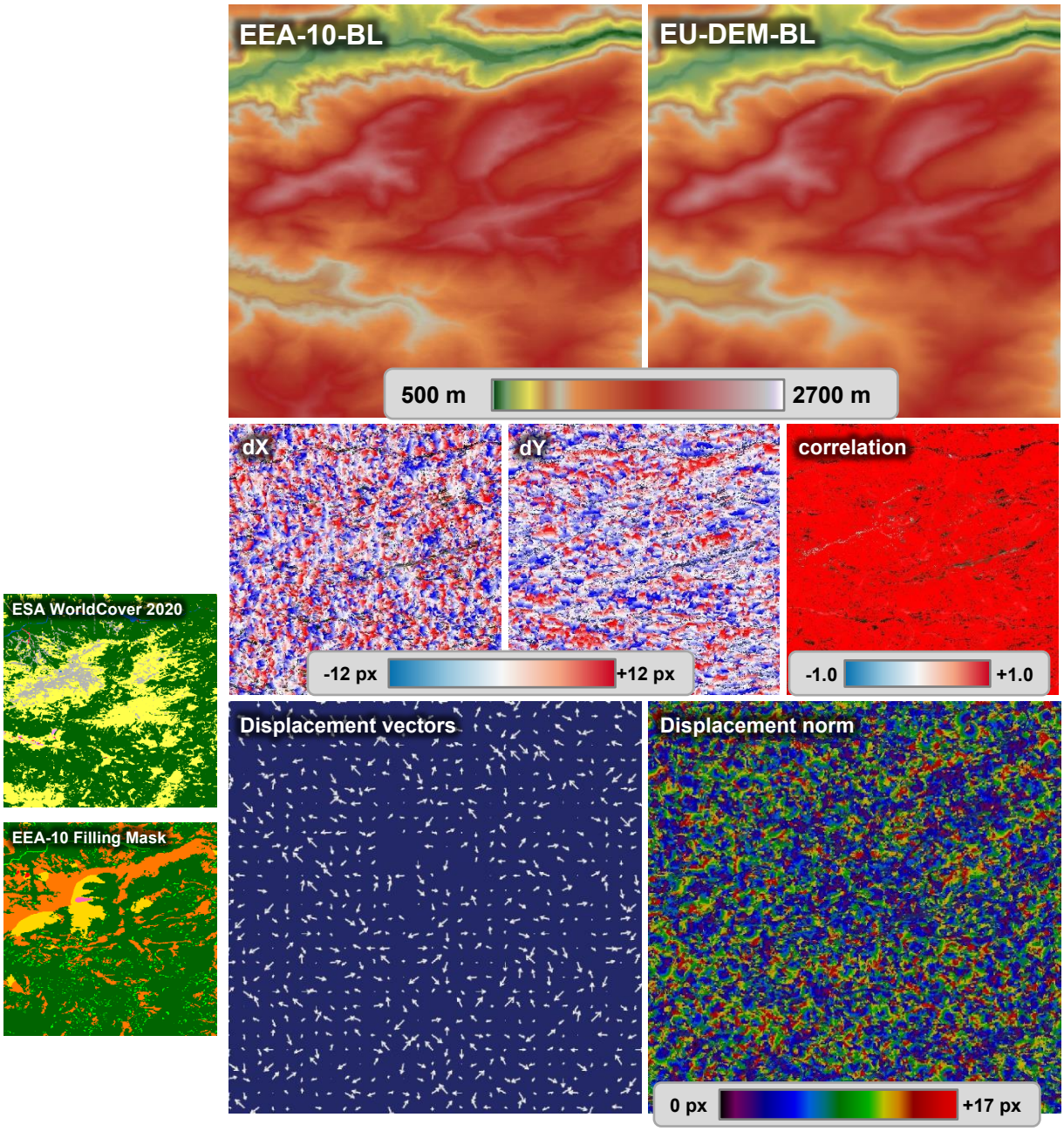


Figure 161 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N47UE014H.

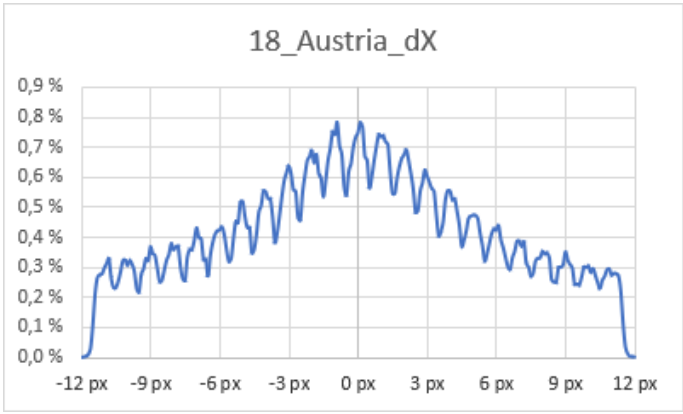
As seen in Figure 161, very important height variations are visible over EU-DEM and EEA-10 (2200 metres between lowest and highest points).

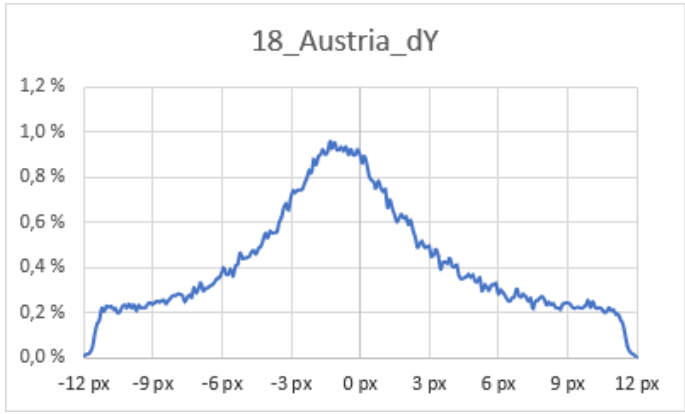
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

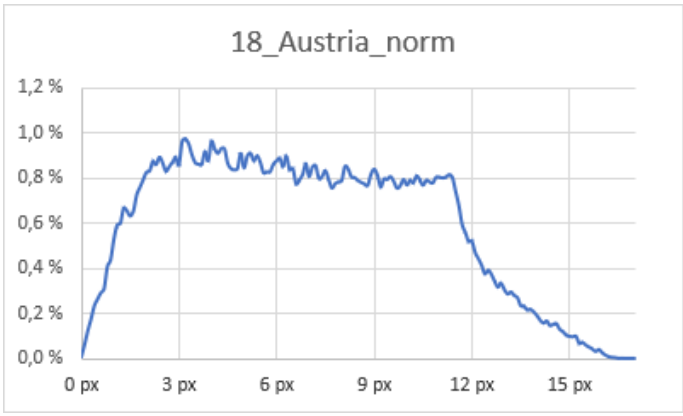
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

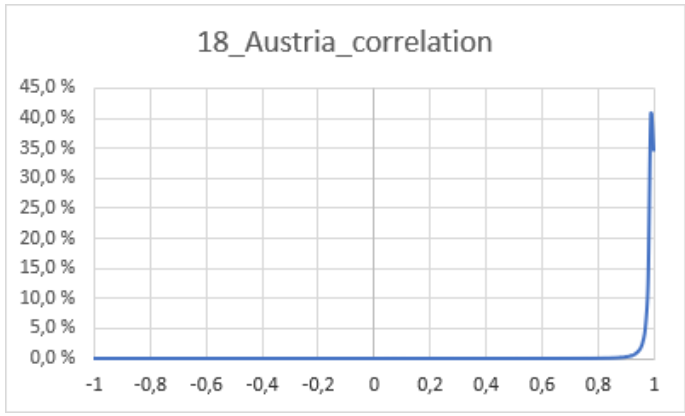




Count	Min	Max	Mean	Std Dev
224 026	-12,0 px	11,9 px	-0,042 px	5,721 px

Count	Min	Max	Mean	Std Dev
224 026	-12,0 px	12,0 px	-0,330 px	5,215 px





Count	Min	Max	Mean	Std Dev
224 026	0,000 px	16,561 px	6,843 px	3,634 px

Count	Min	Max	Mean	Std Dev
224 026	0,000	1,000	0,987	0,022

Figure 162 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N47UE014H.

Both dX and dY distributions highlight low displacement modes (-0.9 pixels and -1.1 pixels respectively), with high standard deviations (5.721 pixels for dX, 5.215 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 3.3 pixels.

The correlations are mainly spread over the [0.95, 1.0] range, with a mean of 0.987 and a standard deviation of only 0.022.

4.2.1.19 19 - Czechia - N49XE015B (zone 1)

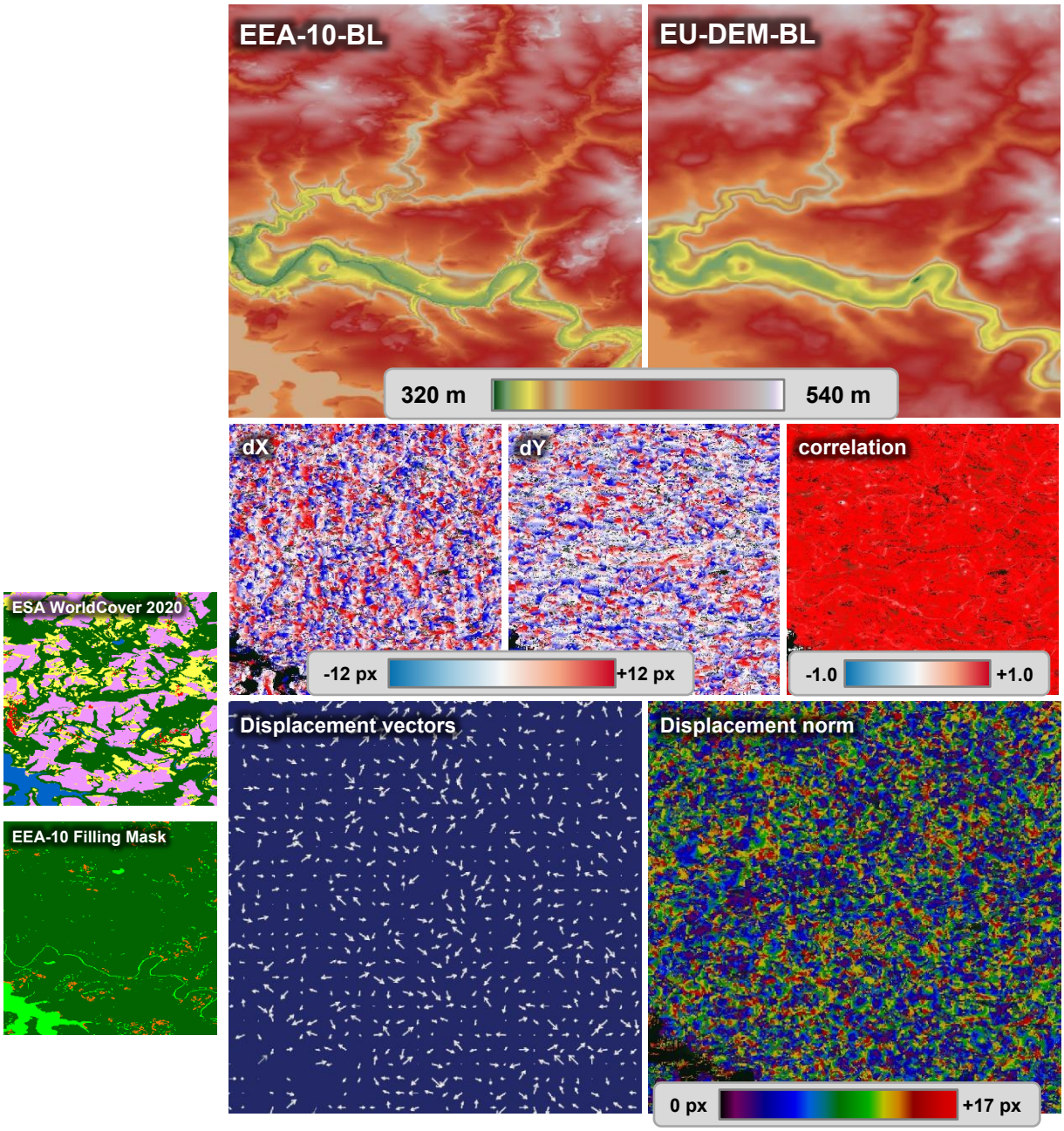


Figure 163 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N49XE015B.

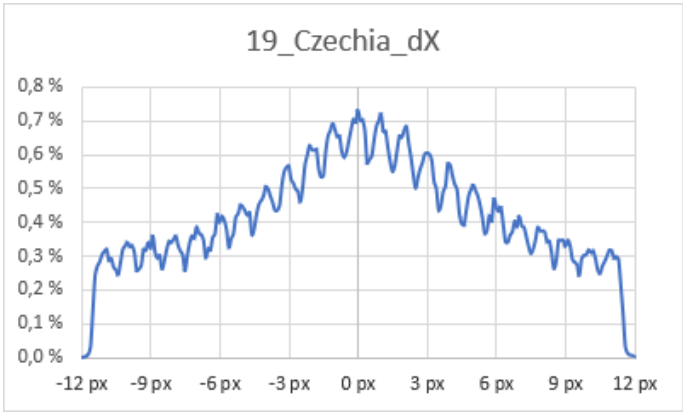
As seen in Figure 163, relatively important height variations are visible over EU-DEM and EEA-10 (220 metres between lowest and highest points).

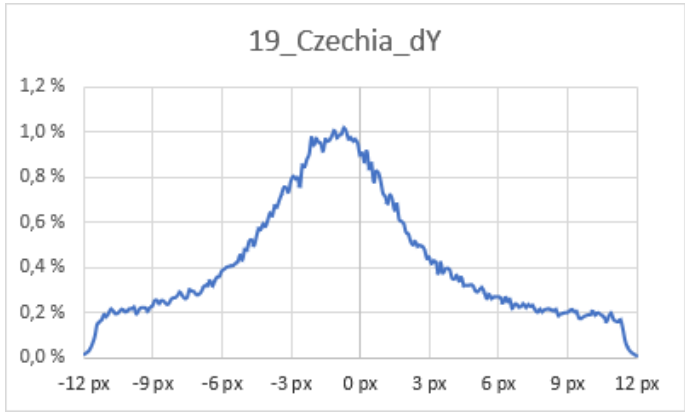
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

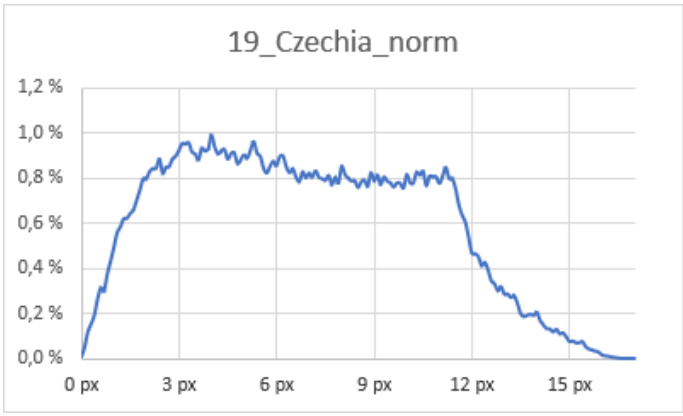
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

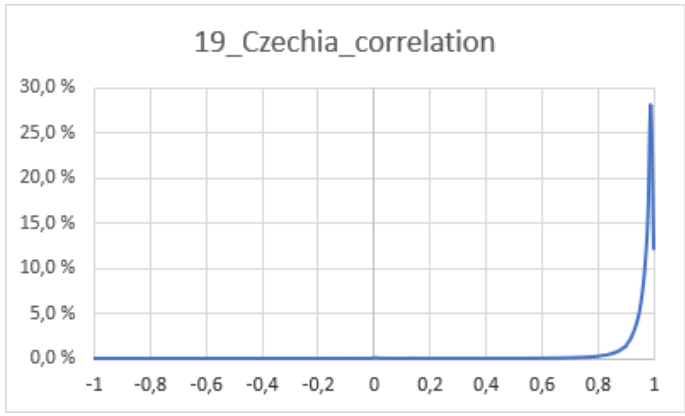




Count	Min	Max	Mean	Std Dev
211 923	-12,0 px	12,0 px	0,117 px	5,827 px

Count	Min	Max	Mean	Std Dev
211 923	-12,0 px	12,0 px	-0,605 px	5,010 px





Count	Min	Max	Mean	Std Dev
211 923	0,000 px	16,468 px	6,820 px	3,595 px

Count	Min	Max	Mean	Std Dev
211 923	-0,260	1,000	0,958	0,077

Figure 164 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N49XE015B.

Both dX and dY distributions highlight low displacement modes (0.0 pixels and -0.7 pixels respectively), with high standard deviations (5.827 pixels for dX, 5.010 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 4.0 pixels.

The correlations are mainly spread over the [0.8, 1.0] range, with a mean of 0.958 and a standard deviation of only 0.077.

4.2.1.20 20 - Slovakia - N48ZE020C (zone 1)

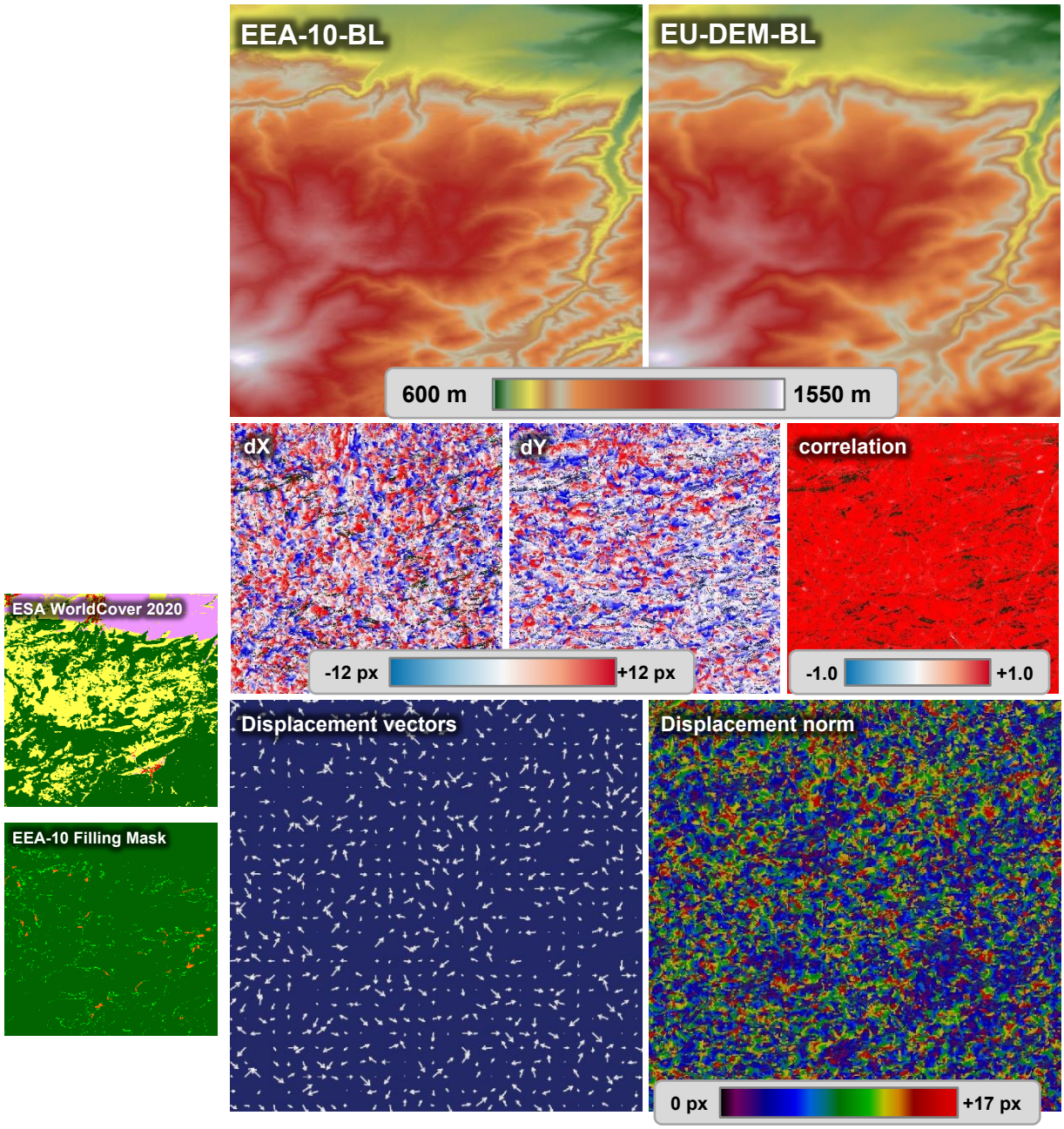


Figure 165 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N48ZE020C.

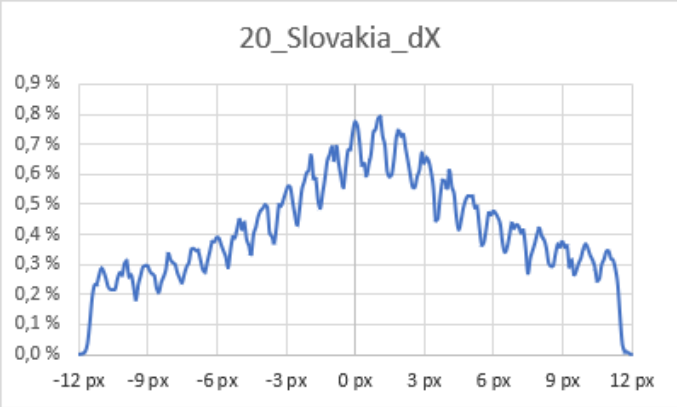
As seen in Figure 165, important height variations are visible over EU-DEM and EEA-10 (950 metres between lowest and highest points).

The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

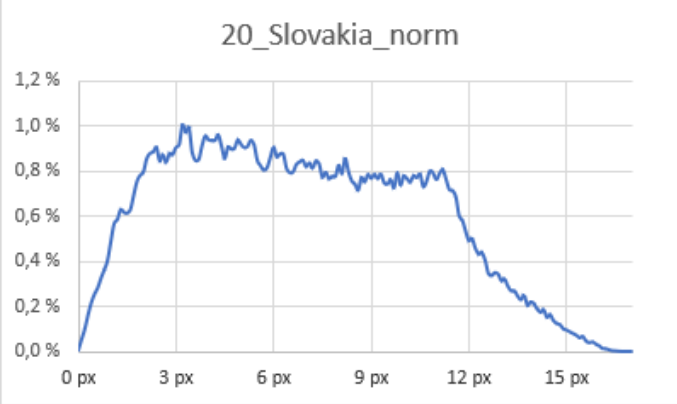
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

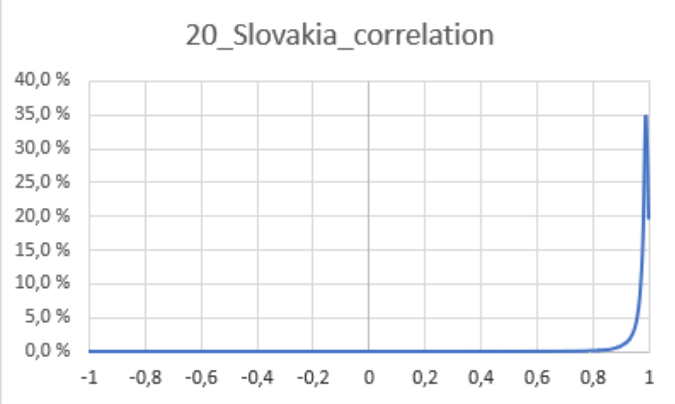
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.



Count	Min	Max	Mean	Std Dev
215 881	-12,0 px	12,0 px	0,502 px	5,712 px

Count	Min	Max	Mean	Std Dev
215 881	-12,0 px	12,0 px	-0,387 px	5,193 px





Count	Min	Max	Mean	Std Dev
215 881	0,000 px	16,582 px	6,841 px	3,633 px

Count	Min	Max	Mean	Std Dev
215 881	-0,127	1,000	0,975	0,037

Figure 166 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N48ZE020C.

Both dX and dY distributions highlight low displacement modes (1.1 pixels and -0.7 pixels respectively), with high standard deviations (5.712 pixels for dX, 5.193 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 3.3 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.975 and a standard deviation of only 0.037. This spread is due to the flatness of terrain over this tile.

4.2.1.21 21 - Hungary - N46ZE017H (zone 1)

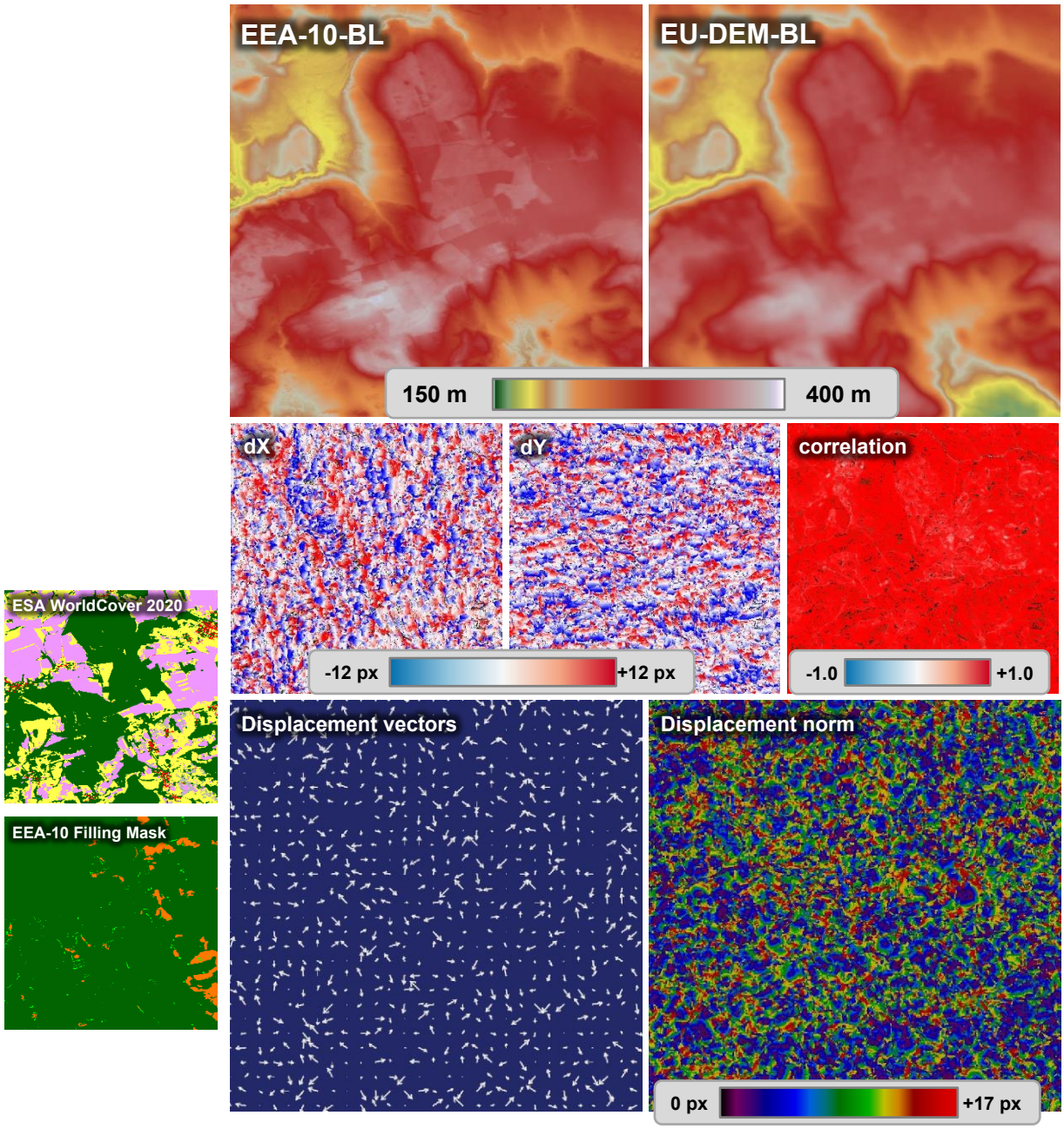


Figure 167 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N46ZE017H.

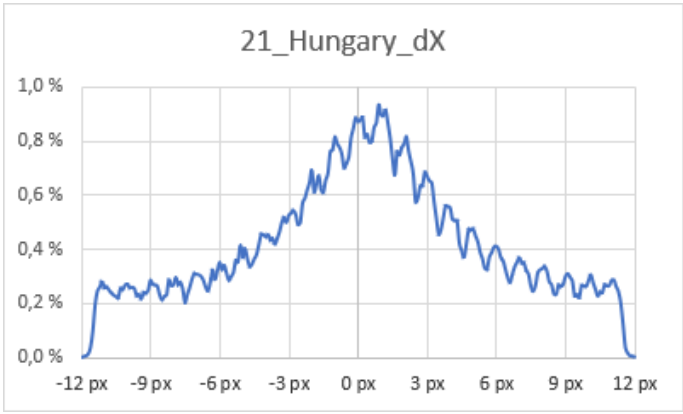
As seen in Figure 167, relatively important height variations are visible over EU-DEM and EEA-10 (250 metres between lowest and highest points).

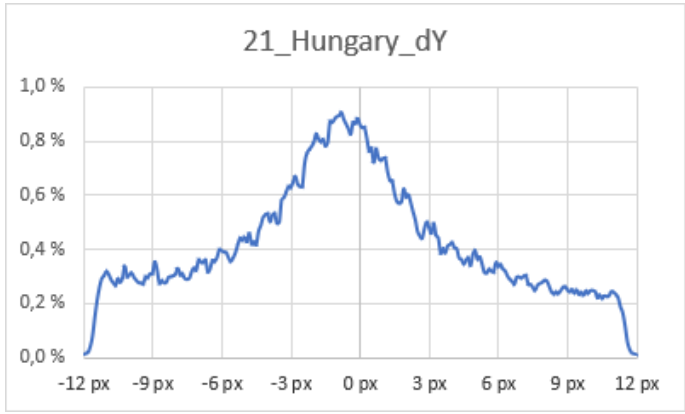
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

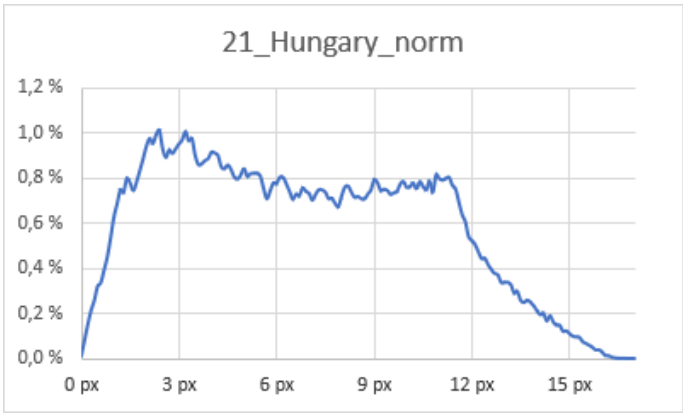
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

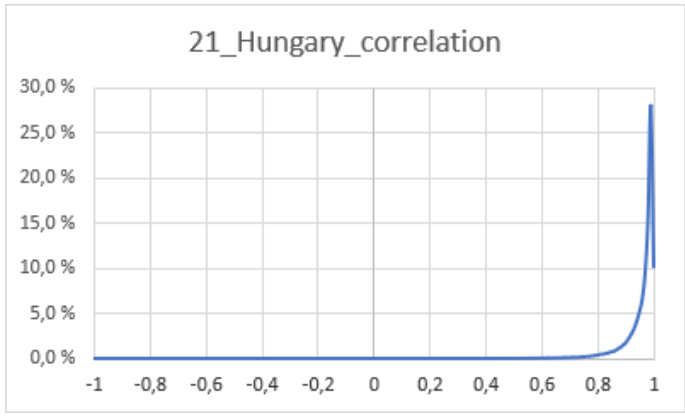




Count	Min	Max	Mean	Std Dev
227 834	-12,0 px	12,0 px	0,266 px	5,445 px

Count	Min	Max	Mean	Std Dev
227 834	-12,0 px	12,0 px	-0,453 px	5,489 px





Count	Min	Max	Mean	Std Dev
227 834	0,000 px	16,703 px	6,766 px	3,778 px

Count	Min	Max	Mean	Std Dev
227 834	0,000	1,000	0,957	0,058

Figure 168 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N46ZE017H.

Both dX and dY distributions highlight low displacement modes (0.9 pixels and -0.8 pixels respectively), with high standard deviations (5.445 pixels for dX, 5.489 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 2.4 pixels.

The correlations are mainly spread over the [0.8, 1.0] range, with a mean of 0.957 and a standard deviation of only 0.058.

4.2.1.22 22 - Slovenia - N45ZE014K (zone 1)

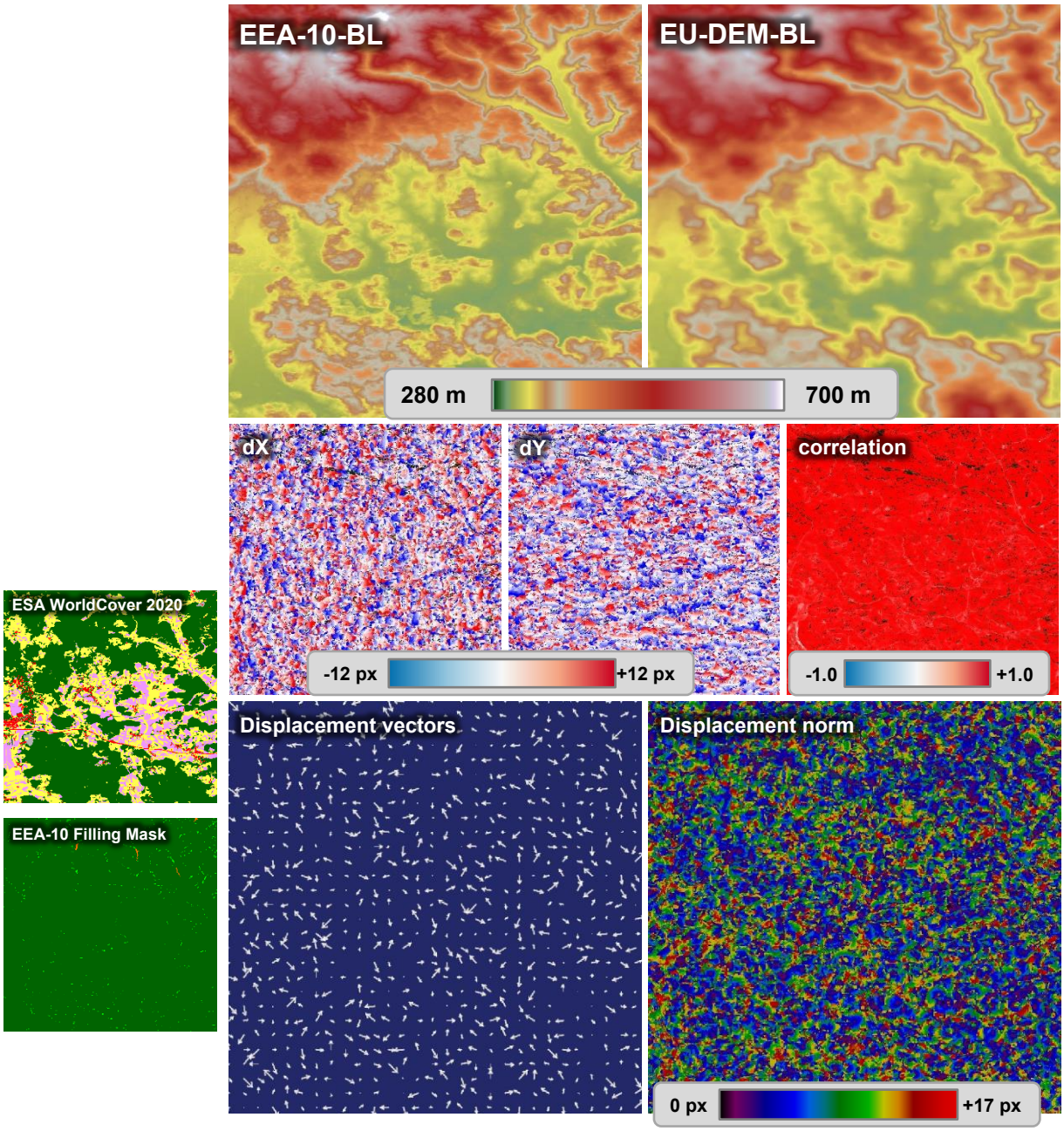


Figure 169 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N45ZE014K.

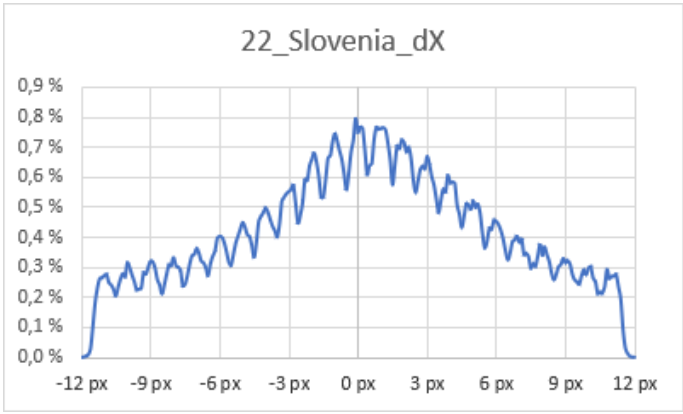
As seen in Figure 169, important height variations are visible over EU-DEM and EEA-10 (420 metres between lowest and highest points).

The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

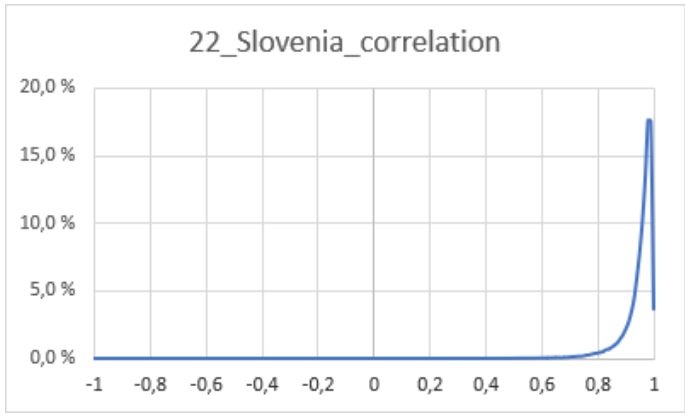
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.



Count	Min	Max	Mean	Std Dev
234 141	-12,0 px	12,0 px	0,255 px	5,601 px

Count	Min	Max	Mean	Std Dev
234 141	-12,0 px	12,0 px	-0,527 px	5,267 px



Count	Min	Max	Mean	Std Dev
234 141	0,000 px	16,561 px	6,819 px	3,599 px

Count	Min	Max	Mean	Std Dev
234 141	0,000	1,000	0,949	0,057

Figure 170 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N45ZE014K.

Both dX and dY distributions highlight low displacement modes (-0.1 pixels and -0.9 pixels respectively), with high standard deviations (5.601 pixels for dX, 5.267 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 3.4 pixels.

The correlations are mainly spread over the [0.8, 1.0] range, with a mean of 0.949 and a standard deviation of only 0.057.

4.2.1.23 23 - Croatia - N45VE017A (zone 1)

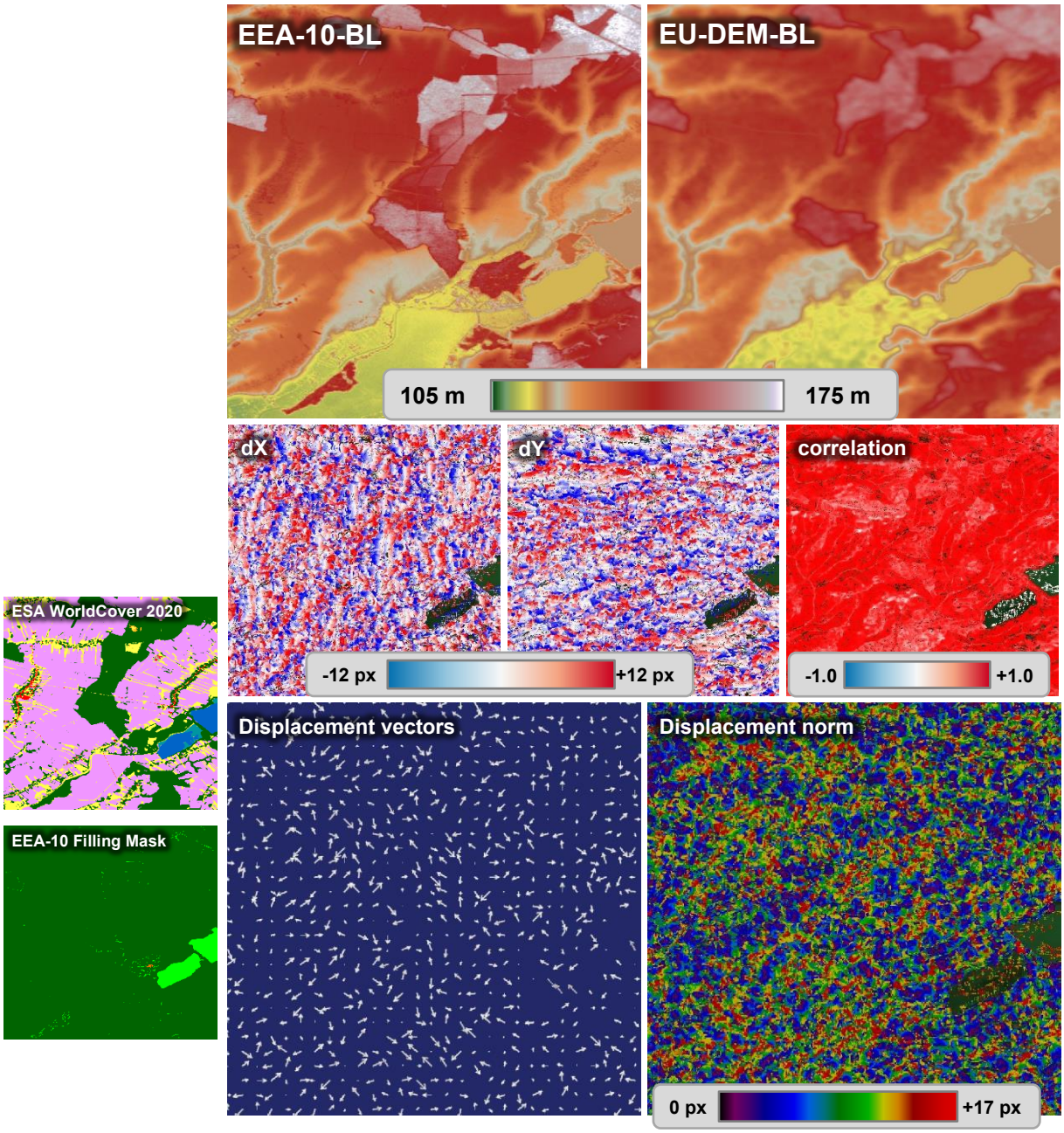


Figure 171 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N45VE017A.

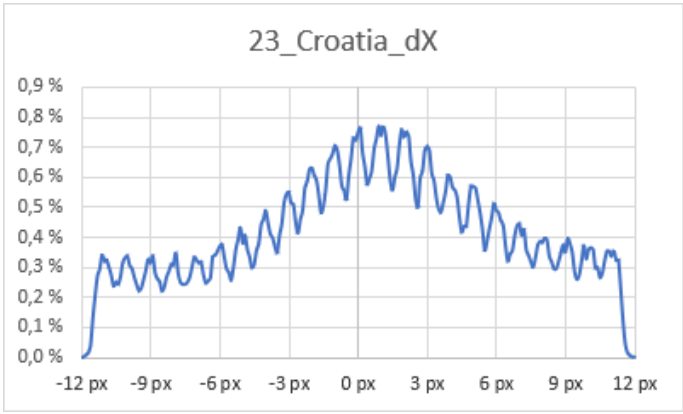
As seen in Figure 171, low height variations are visible over EU-DEM and EEA-10 (70 metres between lowest and highest points).

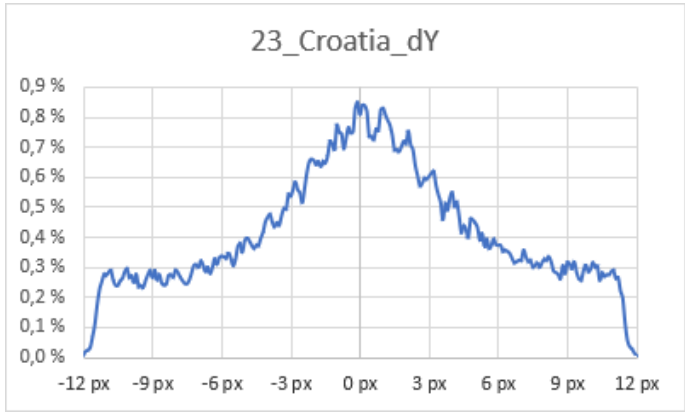
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-5, +5[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1. Lower correlations or not computed pixels can be seen due to the flatness of lakes in this area.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

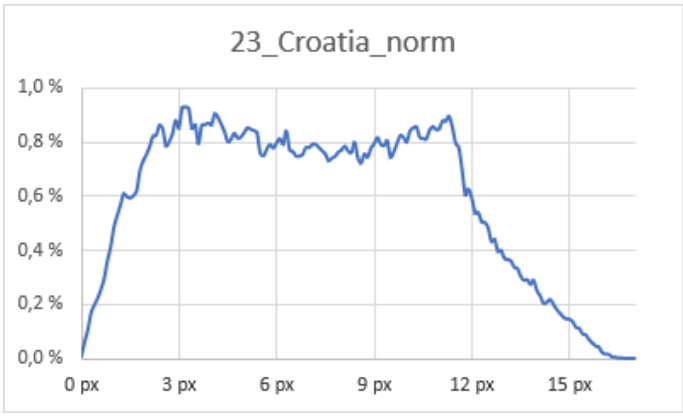
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

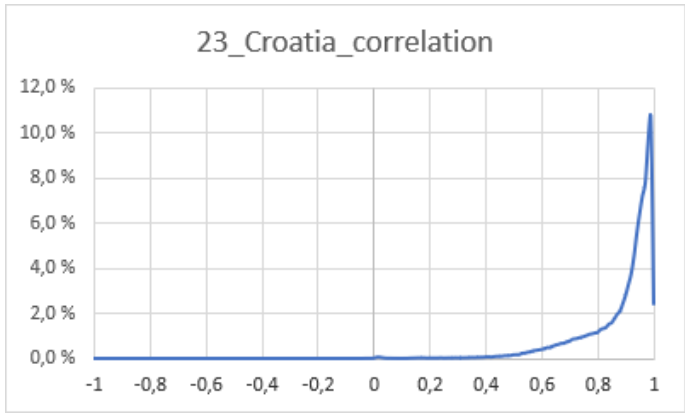




Count	Min	Max	Mean	Std Dev
217 711	-12,0 px	12,0 px	0,510 px	5,804 px

Count	Min	Max	Mean	Std Dev
217 711	-12,0 px	12,0 px	0,238 px	5,561 px





Count	Min	Max	Mean	Std Dev
217 711	0,000 px	16,628 px	7,135 px	3,745 px

Count	Min	Max	Mean	Std Dev
217 711	-0,159	1,000	0,881	0,134

Figure 172 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N45VE017A.

Both dX and dY distributions highlight low displacement modes (1.2 pixels and 0.2 pixels respectively), with high standard deviations (5.804 pixels for dX, 5.561 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has two modes: the first at 3.3 pixels and the second at 11.3 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.881 and a standard deviation of only 0.134. One may see a tail of distribution in the [0.4, 0.85] range. These low correlations are due to flat lakes in this tile.

4.2.1.24 24 - Bosnia and Herzegovina - N44PE017J (zone 1)

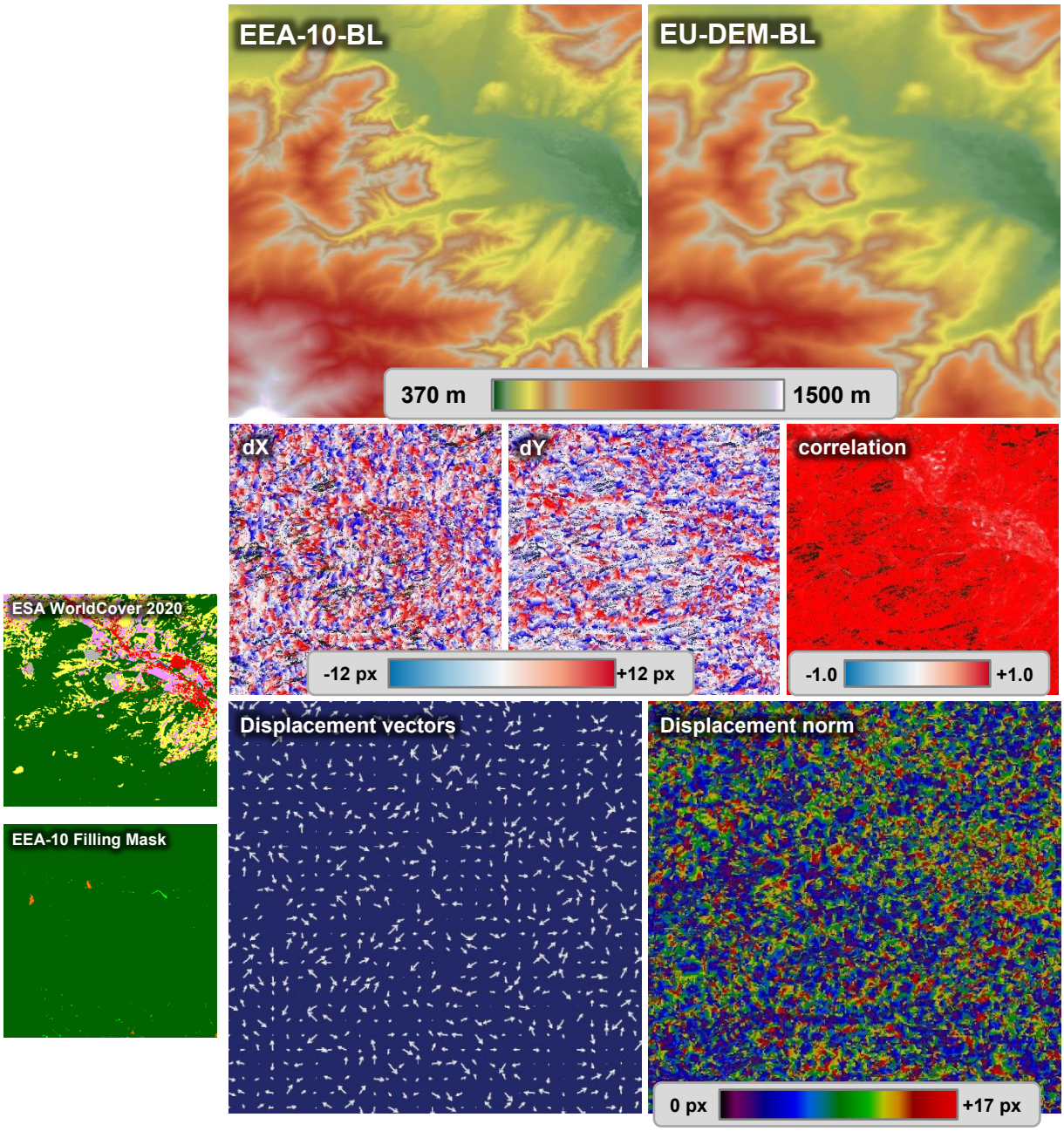


Figure 173 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N44PE017J.

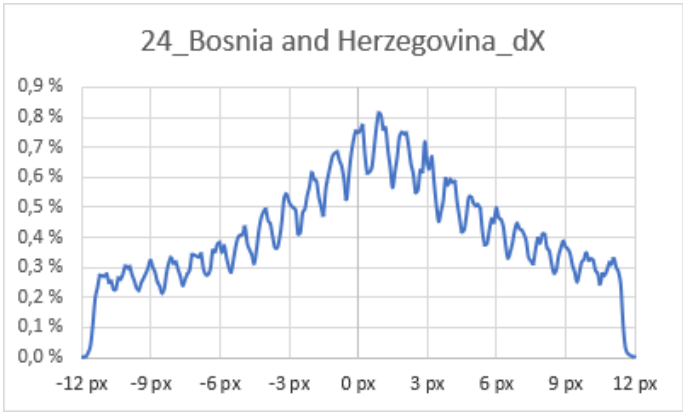
As seen in Figure 173, important height variations are visible over EU-DEM and EEA-10 (1130 metres between lowest and highest points).

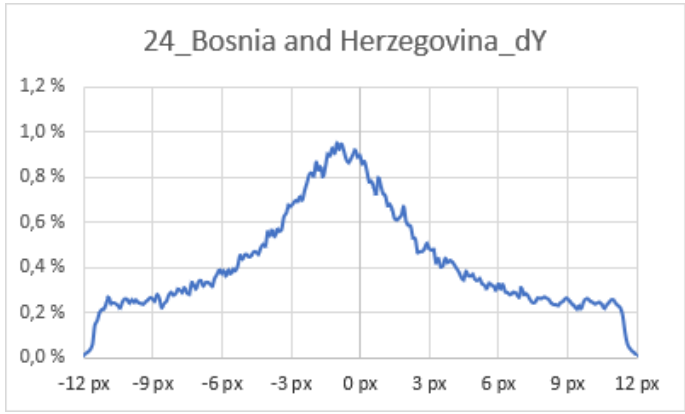
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

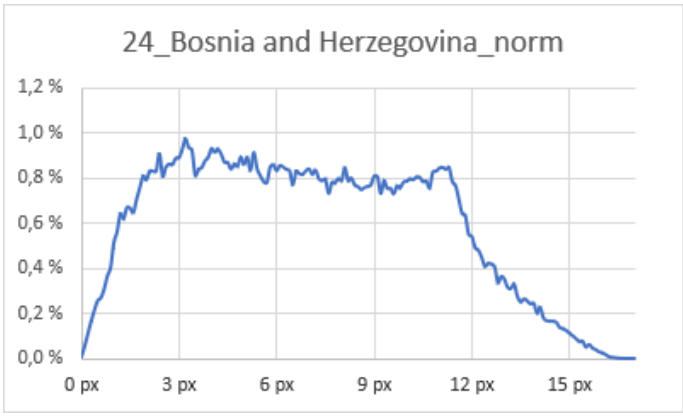
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

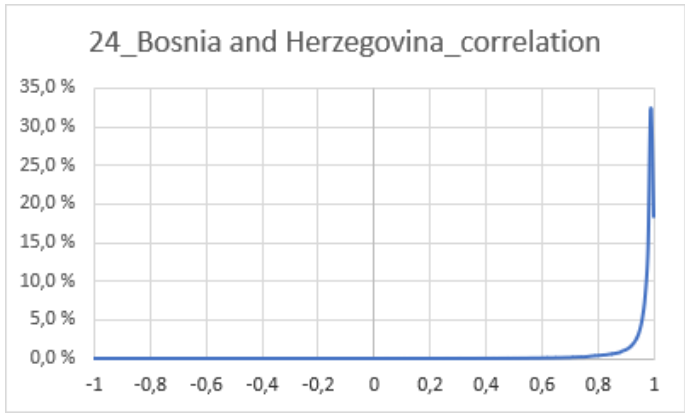




Count	Min	Max	Mean	Std Dev
219 576	-12,0 px	11,9 px	0,486 px	5,722 px

Count	Min	Max	Mean	Std Dev
219 576	-12,0 px	12,0 px	-0,311 px	5,343 px





Count	Min	Max	Mean	Std Dev
219 576	0,000 px	16,622 px	6,935 px	3,678 px

Count	Min	Max	Mean	Std Dev
219 576	0,000	1,000	0,962	0,065

Figure 174 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N44PE017J.

Both dX and dY distributions highlight low displacement modes (1.0 pixels and -0.7 pixels respectively), with high standard deviations (5.722 pixels for dX, 5.343 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 3.3 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.962 and a standard deviation of only 0.065.

4.2.1.25 25 - Montenegro - N42XE019D (zone 1)

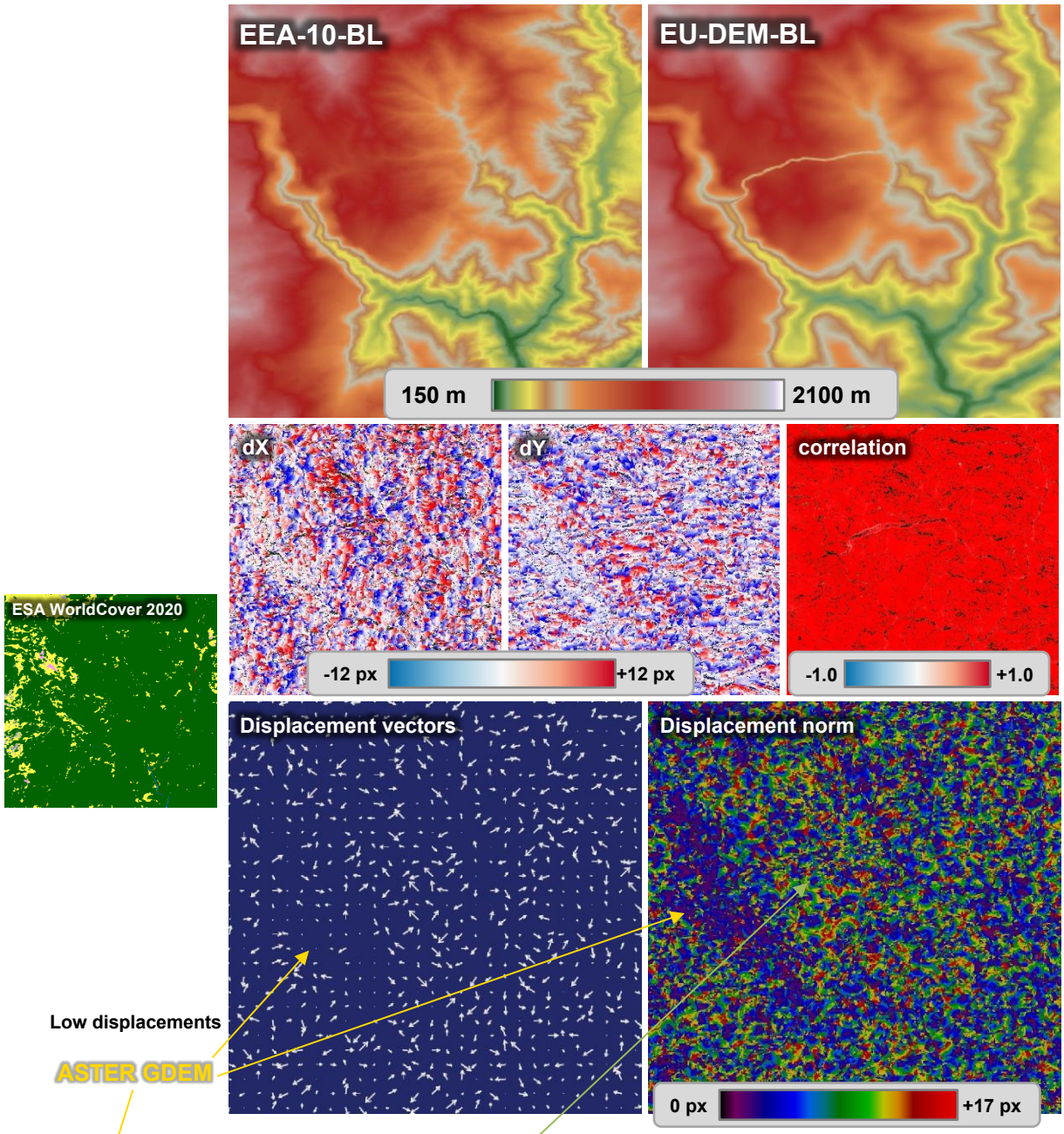
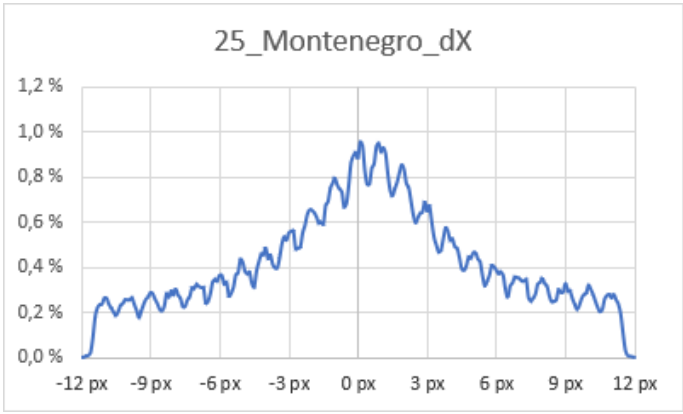


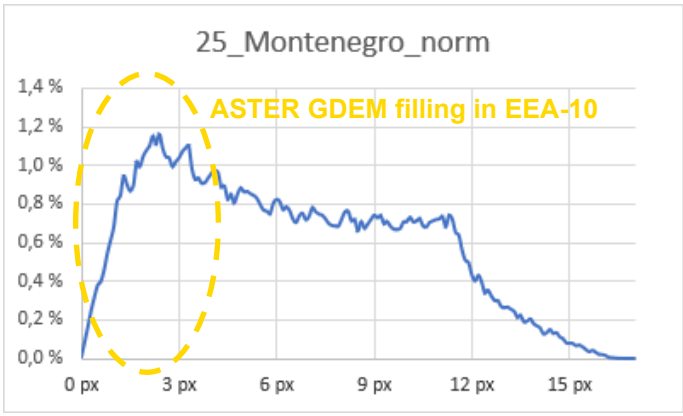
Figure 175 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N42XE019D.

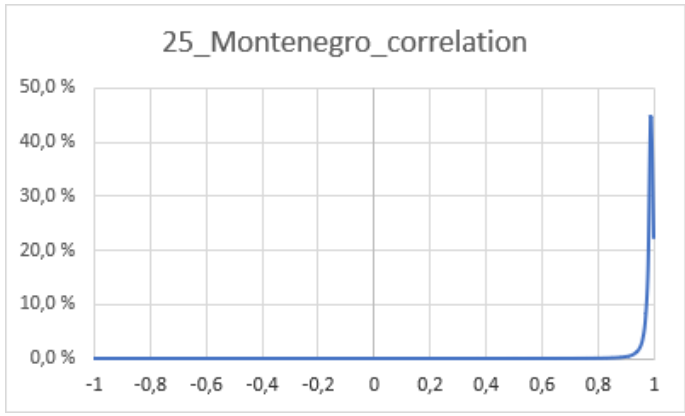
As seen in Figure 175, a cluster of low displacements (between 1 and 3 pixels) is visible on the West of this DEMIX tile. The shape of this cluster can be linked to the filling mask of EEA-10, in which an ASTER GDEM filling can be seen over the same area. As EU-DEM is derived from SRTM and ASTER GDEM data, these low displacements may be due to the same source data used in both EEA-10 and EU-DEM. Other areas of this tile, in which TanDEM-X data has been used to generate EEA-10, highlight important variations of displacement norms (between 1 and 16 pixels). No matching has been found between SRTM fillings, edited pixels of EEA-10 and displacements, as the filling areas are too small to be analysed.



Count	Min	Max	Mean	Std Dev
230 344	-12,0 px	12,0 px	0,290 px	5,405 px

Count	Min	Max	Mean	Std Dev
230 344	-12,0 px	12,0 px	-0,589 px	4,971 px





Count	Min	Max	Mean	Std Dev
230 344	0,000 px	16,594 px	6,370 px	3,712 px

Count	Min	Max	Mean	Std Dev
230 344	0,000	1,000	0,983	0,024

Figure 176 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N42XE019D.

As seen in histograms of Figure 176, low means are retrieved over the dX and dY distributions (0.290 pixels and -0.589 pixels of mean, respectively).

The mode of the norm distribution is located at 2.4 pixels, which is linked to the ASTER GDEM filling of EEA-10 (see preceding page). Norm values over 3 pixels are mainly seen over TanDEM-X derived heights. No assumption can be made over SRTM data and edited pixels, as the areas of filling and editing are too small to be representative in the distribution.

The correlation histogram highlights a strong correlation over all this tile, with a mean of 0.983 and a standard deviation of 0.024.

4.2.1.26 26 - Albania - N41ME020A (zone 1)

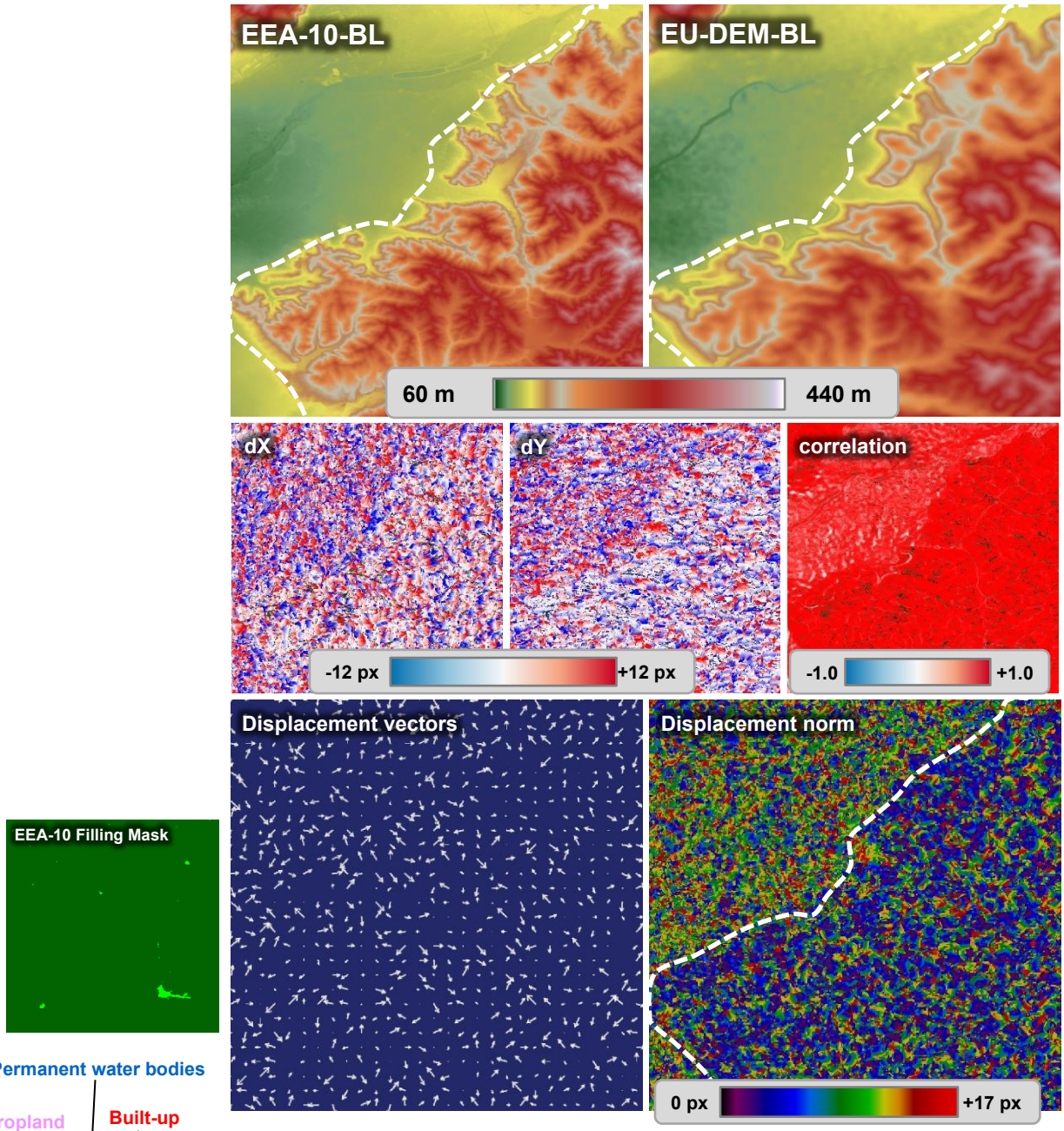


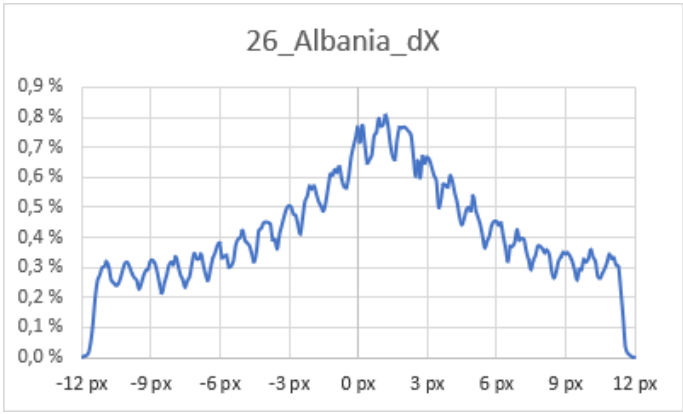
Figure 177 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N41ME020A.

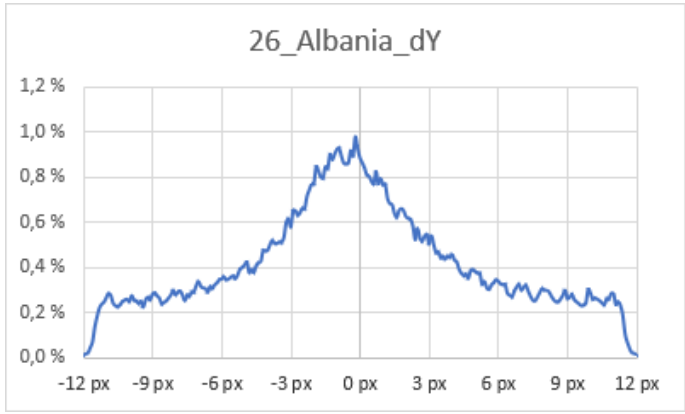
As seen in Figure 177, important height variations are visible over EU-DEM and EEA-10 (380 metres between lowest and highest points).

The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1. Lower correlations can be seen over the North-West part of the tile, which corresponds to a flat area.

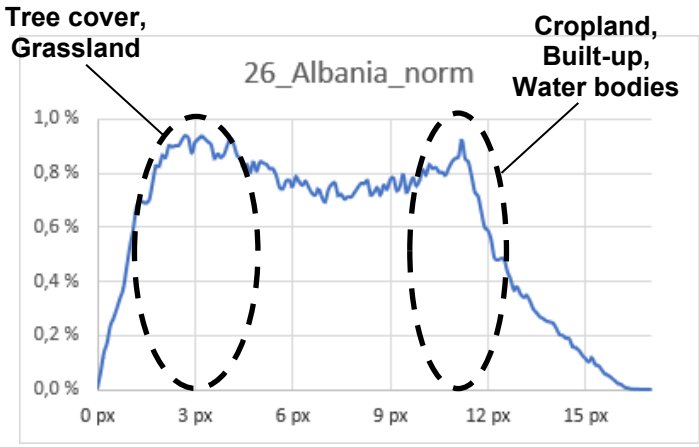
One may see low displacement norms over the South East of the tile, contrasting with high displacement norms over the North West. These displacements may both be linked to the land use and to the height variations (see white dot line on DEMs and attached LULC map).

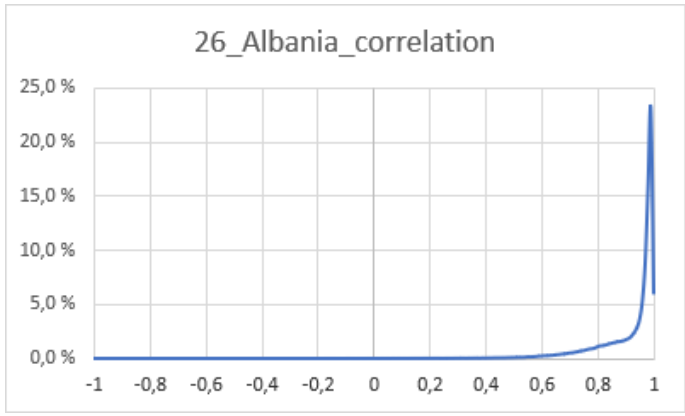




Count	Min	Max	Mean	Std Dev
226 163	-12,0 px	12,0 px	0,452 px	5,744 px

Count	Min	Max	Mean	Std Dev
226 163	-12,0 px	12,0 px	-0,106 px	5,421 px





Count	Min	Max	Mean	Std Dev
226 163	0,000 px	16,645 px	6,954 px	3,774 px

Count	Min	Max	Mean	Std Dev
226 163	-0,173	1,000	0,918	0,112

Figure 178 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N41ME020A.

Both dX and dY distributions highlight low displacement modes (1.2 pixels and -0.2 pixels respectively), with high standard deviations (5.744 pixels for dX, 5.421 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has two modes: a first mode at 2.8 pixels, identified as “Grassland” and “Tree cover” classes, and a second mode at 11.2 pixels, identified as “Cropland”, “Built-up” and “Permanent water bodies” classes (see LULC map of preceding page).

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.918 and a standard deviation of only 0.112. One may see the presence of a tail of distribution in the [0.6, 0.9] range. This tail is due to the flatness of terrain over the North West of this tile.

4.2.1.27 27 - North Macedonia - N41XE021L (zone 1)

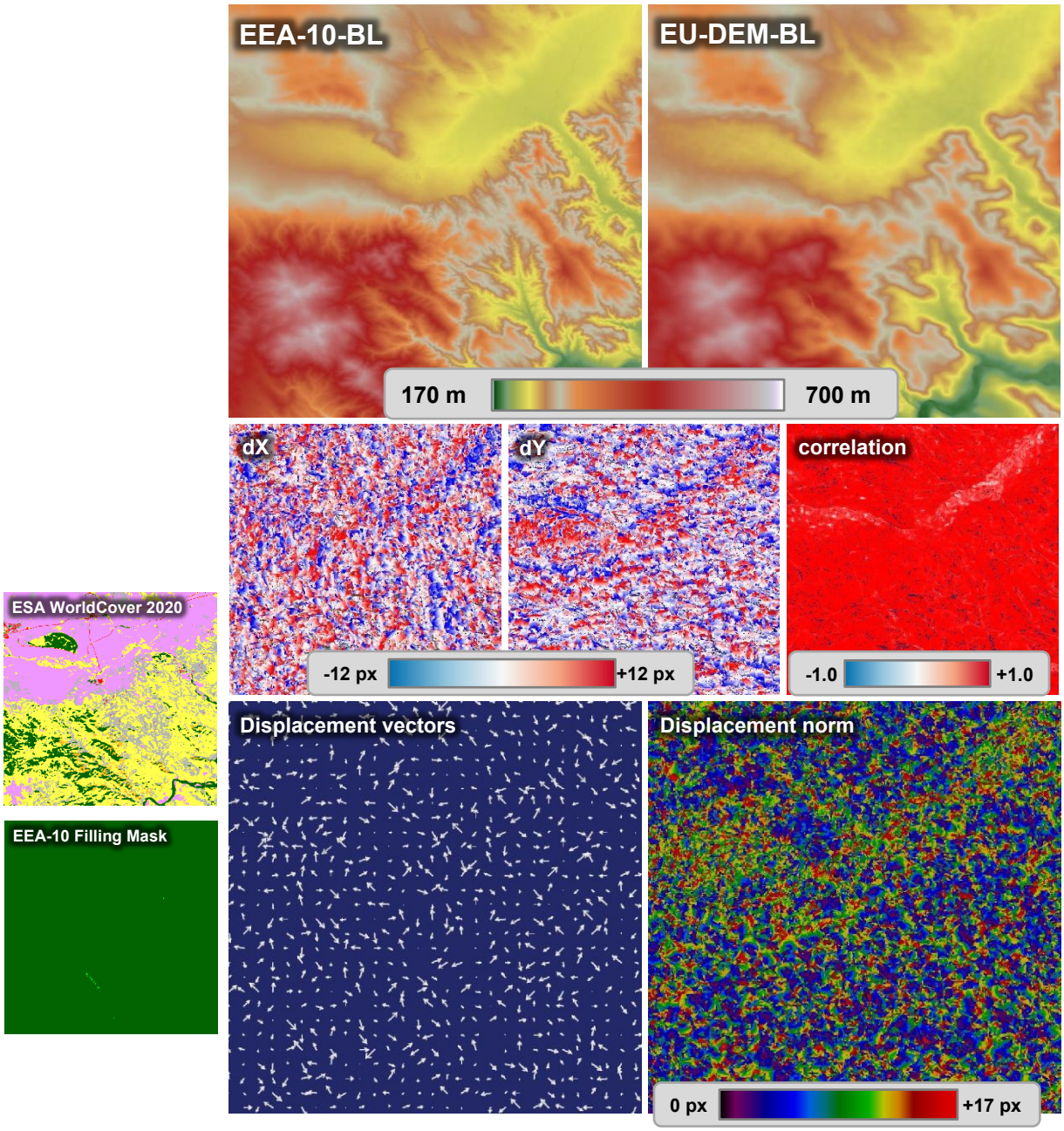


Figure 179 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N41XE021L.

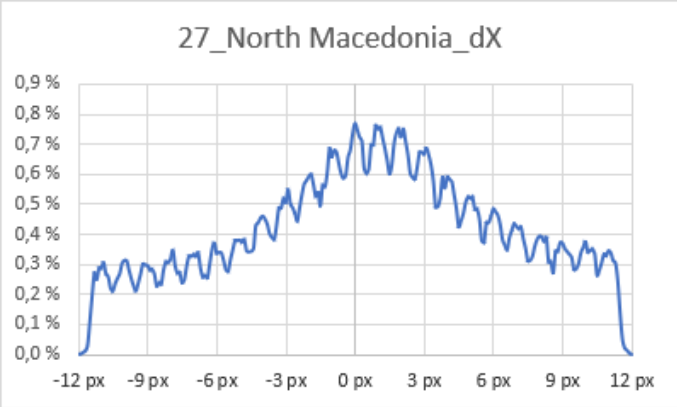
As seen in Figure 179, important height variations are visible over EU-DEM and EEA-10 (530 metres between lowest and highest points).

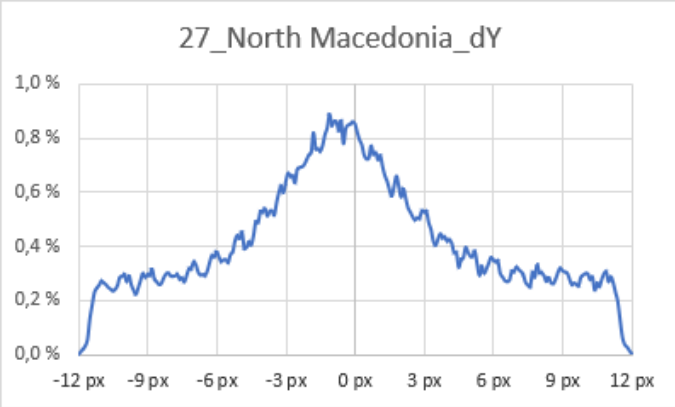
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

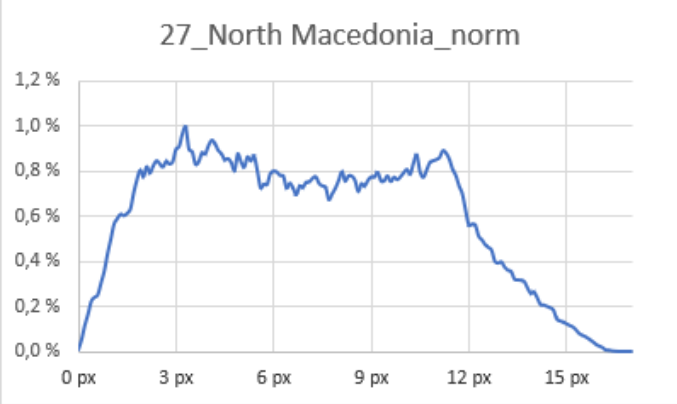
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

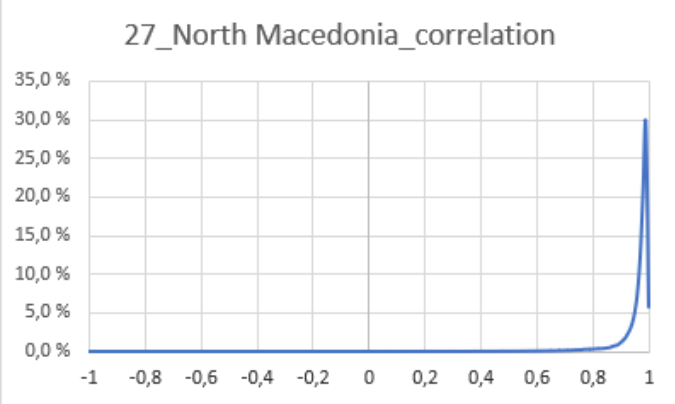




Count	Min	Max	Mean	Std Dev
226 406	-12,0 px	12,0 px	0,566 px	5,754 px

Count	Min	Max	Mean	Std Dev
226 406	-12,0 px	12,0 px	-0,124 px	5,548 px





Count	Min	Max	Mean	Std Dev
226 406	0,000 px	16,514 px	7,077 px	3,760 px

Count	Min	Max	Mean	Std Dev
226 406	-0,256	1,000	0,957	0,068

Figure 180 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N41XE021L.

Both dX and dY distributions highlight low displacement modes (1.1 pixels and -1.1 pixels respectively), with high standard deviations (5.754 pixels for dX, 5.548 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 3.3 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.957 and a standard deviation of only 0.068.

4.2.1.28 28 - Serbia - N44VE020B (zone 1)

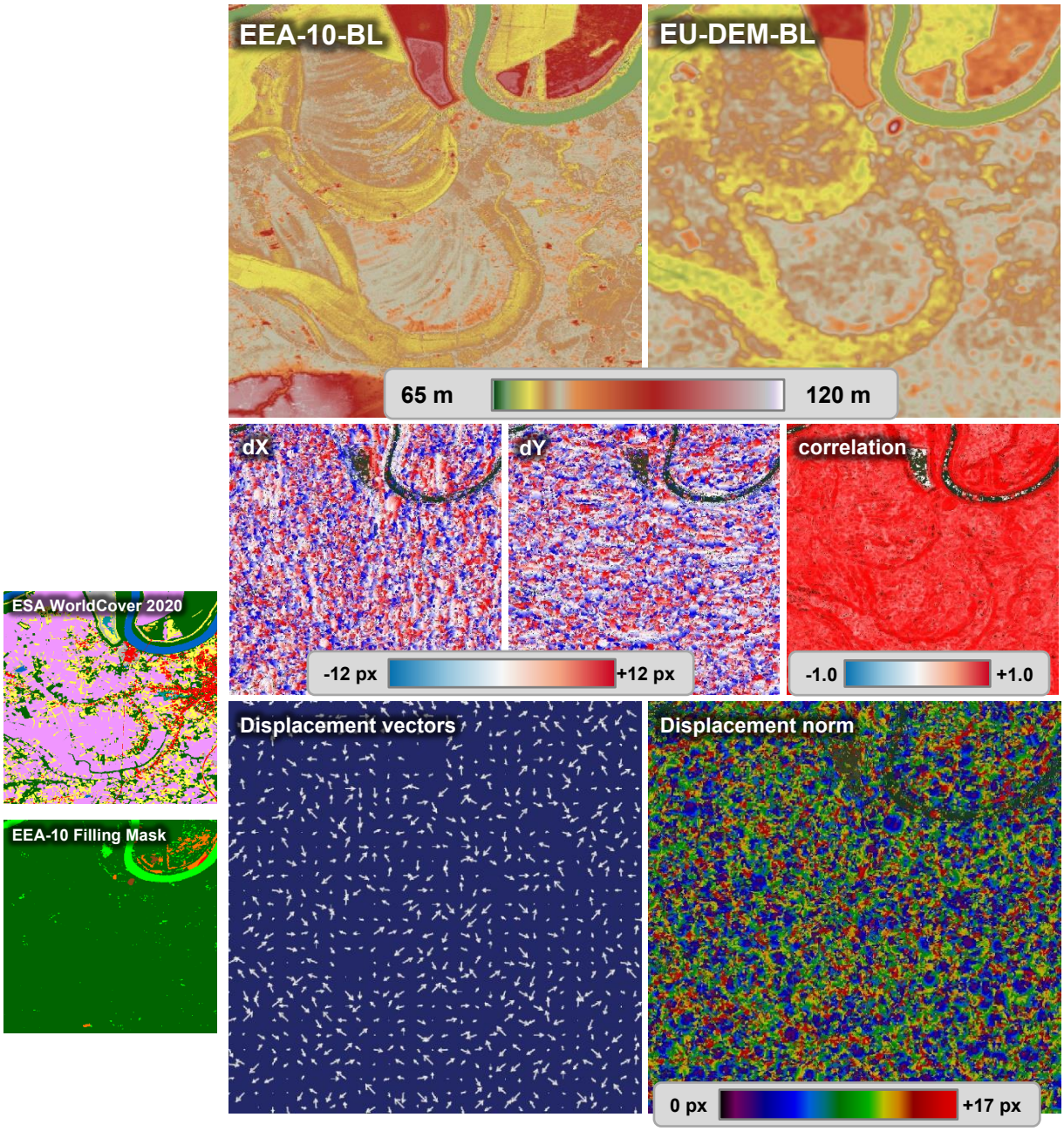


Figure 181 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N44VE020B.

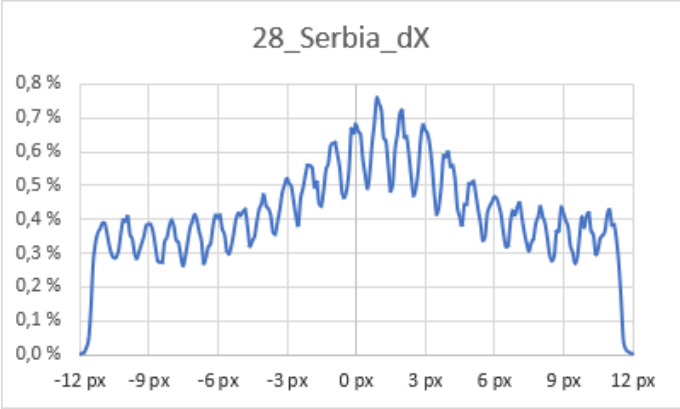
As seen in Figure 181, low height variations are visible over EU-DEM and EEA-10 (55 metres between lowest and highest points).

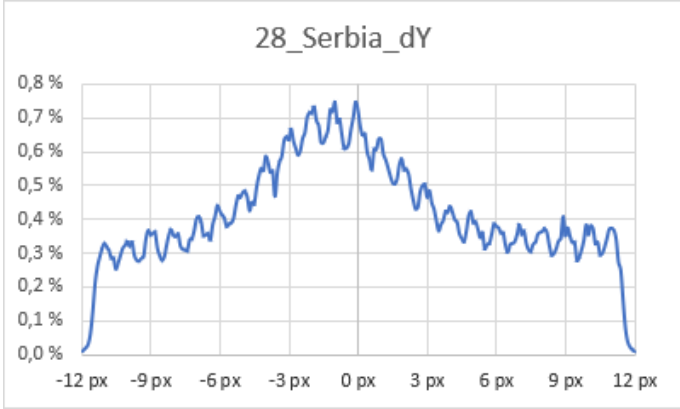
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1. Low correlations or not computed pixels can be seen due to the flatness of the water bodies in both DEMs.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [6, 11] interval (from light blue to green). Displacement norms above 11 pixels are more rarely observed.

No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.





Count	Min	Max	Mean	Std Dev
220 934	-12,0 px	12,0 px	0,283 px	6,094 px

Count	Min	Max	Mean	Std Dev
220 934	-12,0 px	12,0 px	-0,119 px	5,922 px

Count	Min	Max	Mean	Std Dev
220 934	0,000 px	16,753 px	7,669 px	3,671 px

Count	Min	Max	Mean	Std Dev
220 934	-0,604	1,000	0,811	0,119

Figure 182 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N44VE020B.

Both dX and dY distributions highlight low displacement modes (1.1 pixels and -0.9 pixels respectively), with high standard deviations (5.931 pixels for dX, 5.826 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 9 and 11 pixels. This distribution has a single mode of 11.4 pixels.

The correlations are mainly spread over the [0.6, 1.0] range, with a mean of 0.811 and a standard deviation of only 0.119. This spread is due to the flatness of terrain over this tile. One may see a small number of correlations included in the [0.0, 0.1] range. These low correlations are due to the flatness of water bodies in both DEMs.

4.2.1.29 29 - Romania - N46RE026G (zone 1)

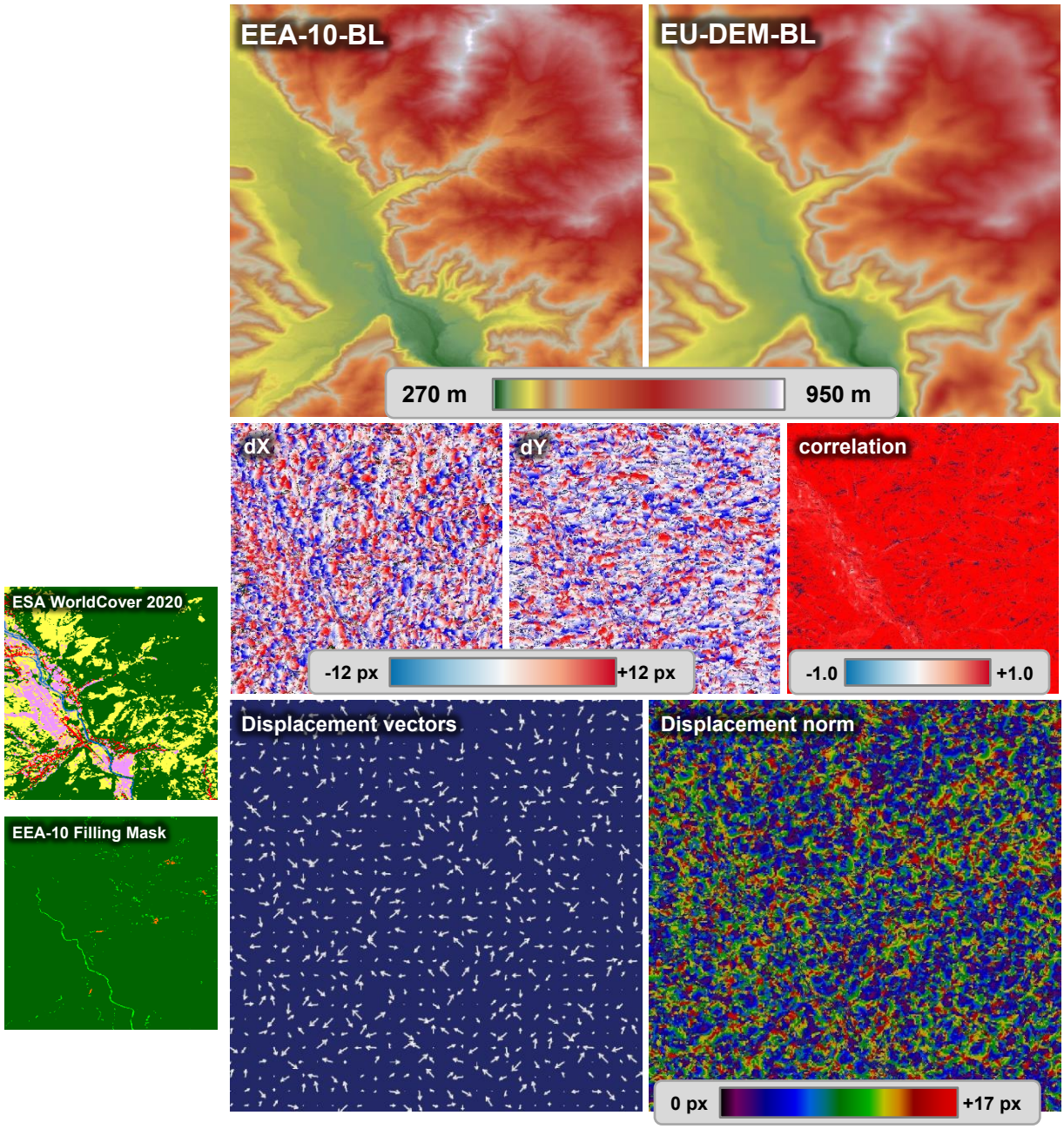


Figure 183 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N46RE026G.

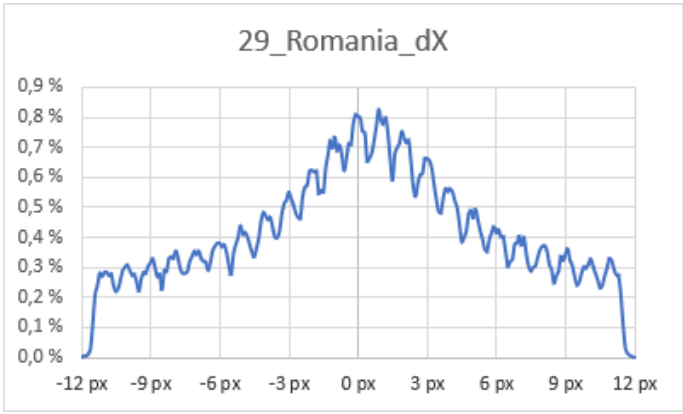
As seen in Figure 183, important height variations are visible over EU-DEM and EEA-10 (680 metres between lowest and highest points).

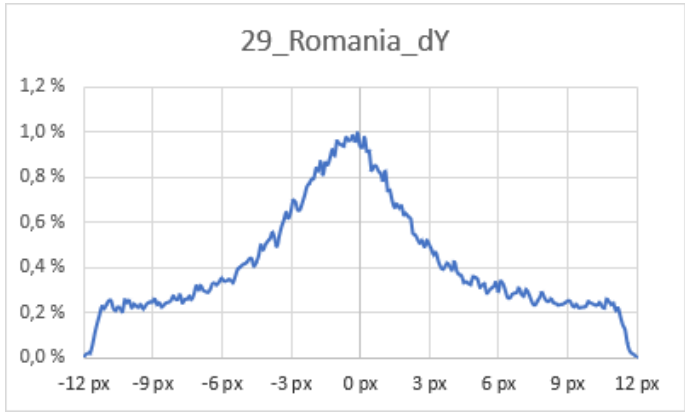
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

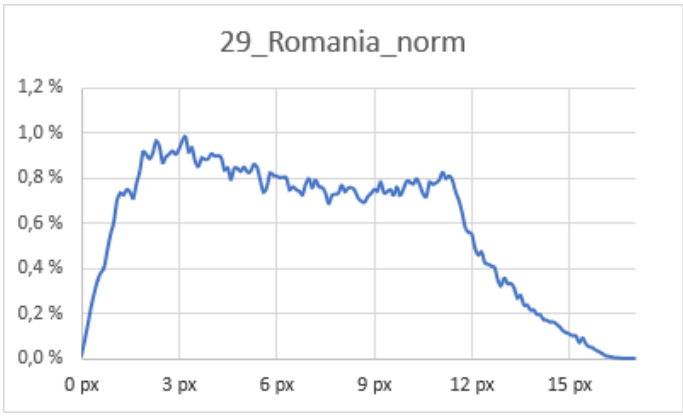
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

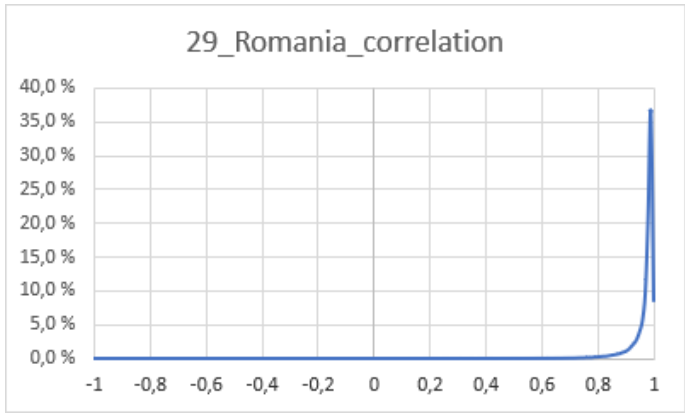




Count	Min	Max	Mean	Std Dev
226 522	-12,0 px	12,0 px	0,236 px	5,668 px

Count	Min	Max	Mean	Std Dev
226 522	-12,0 px	12,0 px	-0,196 px	5,263 px





Count	Min	Max	Mean	Std Dev
226 522	0,000 px	16,549 px	6,768 px	3,756 px

Count	Min	Max	Mean	Std Dev
226 522	0,000	1,000	0,968	0,046

Figure 184 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N46RE026G.

Both dX and dY distributions highlight low displacement modes (1.2 pixels and -0.1 pixels respectively), with high standard deviations (5.931 pixels for dX, 5.826 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 3.2 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.968 and a standard deviation of only 0.046. This spread is due to the flatness of terrain over this tile.

4.2.1.30 30 - Bulgaria - N42VE025J (zone 1)

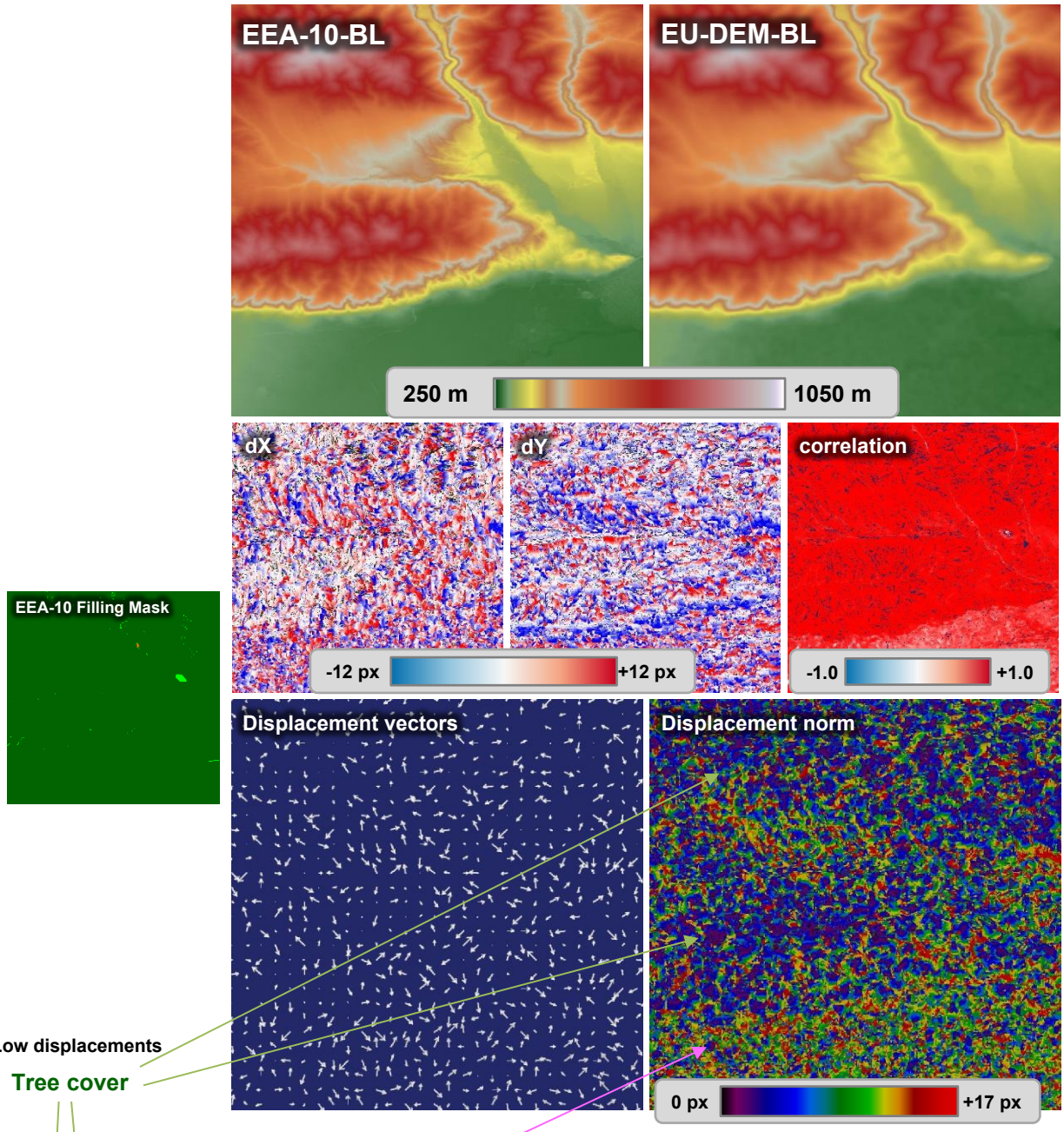
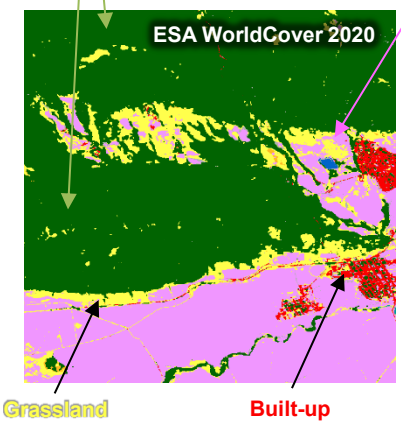
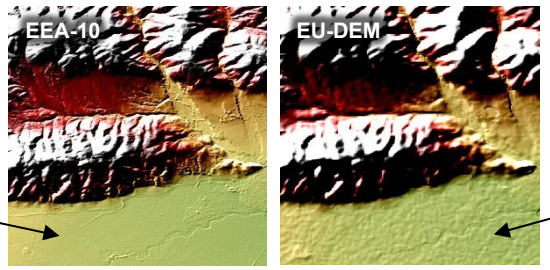


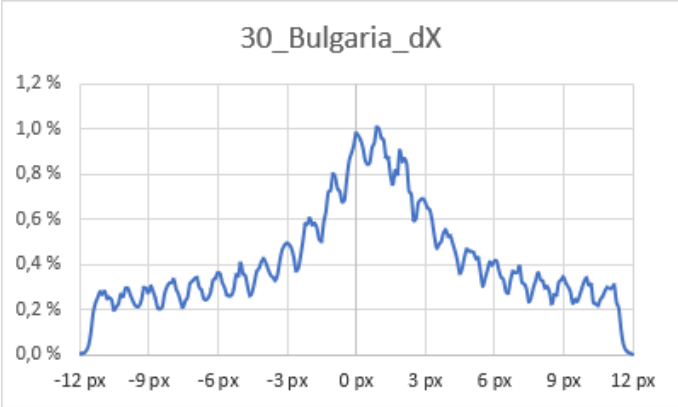
Figure 185 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N42VE025J.

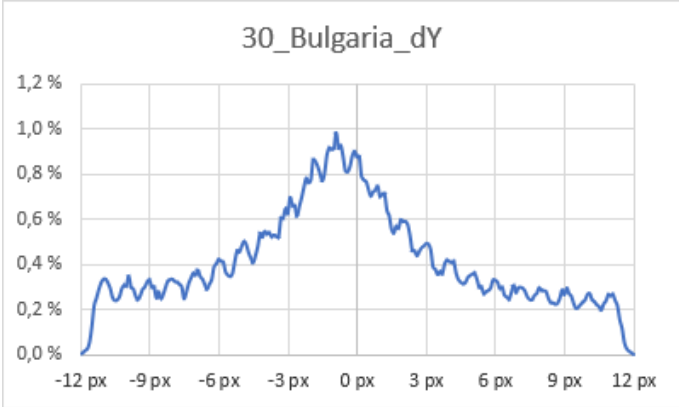


As seen in Figure 185, clusters of low displacements (between 1 and 3 pixels) can be seen over the North and the centre of this DEMIX tile. The shapes of these clusters can be linked to the tree cover (see tree cover class of attached LULC map). On the opposite, high displacement variations can be seen mainly over the croplands, but also over the built-up areas and grasslands. One may note the loss of correlation in the South of the tile, which is due to flat areas in EEA-10 being compared to rough areas in EU-DEM (see shadowed DEMs below).



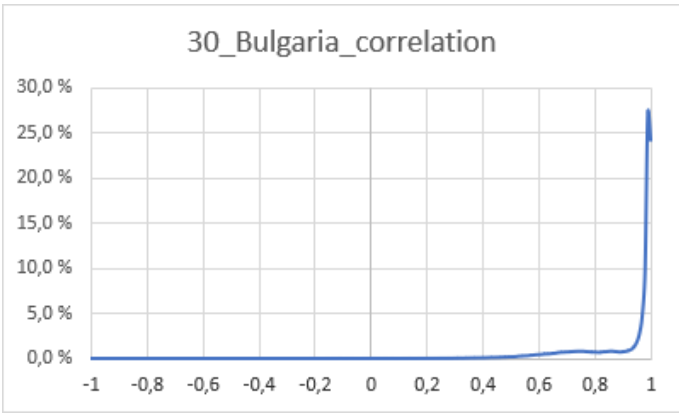
2D animation





Count	Min	Max	Mean	Std Dev
223 723	-12,0 px	12,0 px	0,398 px	5,478 px

Count	Min	Max	Mean	Std Dev
223 723	-12,0 px	12,0 px	-0,485 px	5,501 px



Count	Min	Max	Mean	Std Dev
223 723	0,000 px	16,550 px	6,776 px	3,841 px

Count	Min	Max	Mean	Std Dev
223 723	-0,212	1,000	0,915	0,138

Figure 186 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N42VE025J.

As seen in histograms of Figure 186, low means are retrieved over the dX and dY distributions (0.398 pixels and -0.485 pixels of mean, respectively).

The mode of the norm distribution is located at 2.2 pixels, which is linked to the tree cover (see preceding page). Norm values over 3 pixels are mainly seen over croplands, but also over grasslands and built-up areas.

The correlation histogram highlights a strong mean of 0.915. One may see an important tail of distribution, due to a loss of correlation over the south of this DEMIX tile. This loss of correlation is commonly due to flat areas, where the disparity analysis cannot find a relevant homologous pixel. Despite of this loss, the correlations are still relatively high in this area.

4.2.1.31 31 - Greece - N38TE023D (zone 1)

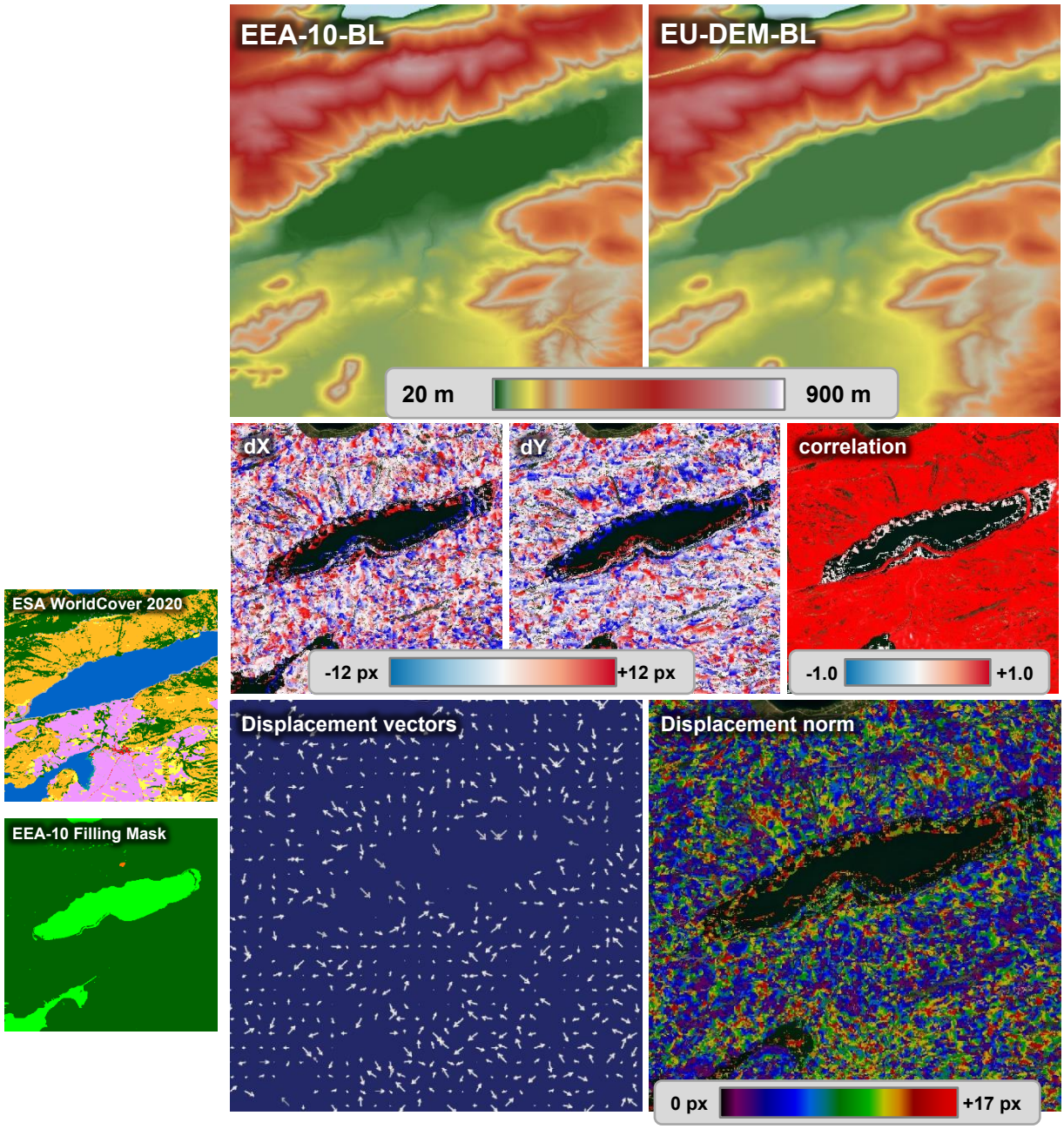


Figure 187 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N38TE023D.

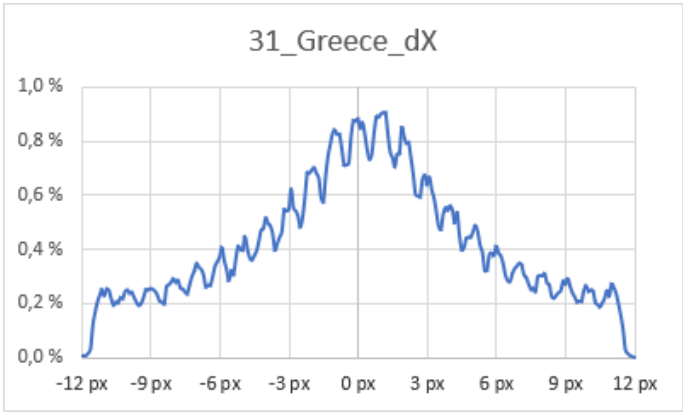
As seen in Figure 187, important height variations are visible over EU-DEM and EEA-10 (880 metres between lowest and highest points).

The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1. Low correlation or not computed pixels are due to the flatness of the lakes in both DEMs.

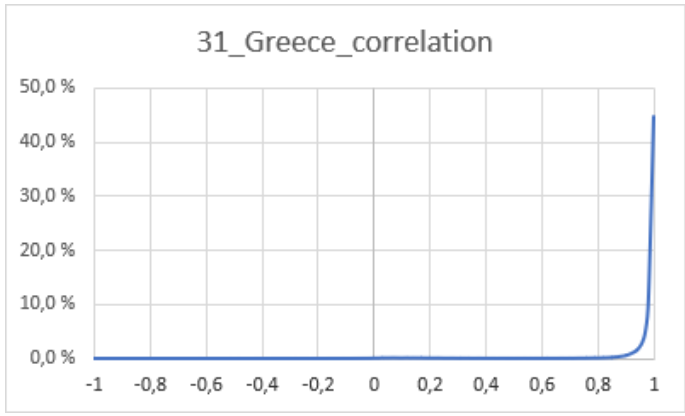
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 5] interval (from dark blue to light blue). Displacement norms above 5 pixels are more rarely observed.

No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.



Count	Min	Max	Mean	Std Dev
194 935	-12,0 px	12,0 px	0,166 px	5,323 px

Count	Min	Max	Mean	Std Dev
194 935	-12,0 px	12,0 px	-0,445 px	5,050 px



Count	Min	Max	Mean	Std Dev
194 935	0,000 px	16,547 px	6,357 px	3,694 px

Count	Min	Max	Mean	Std Dev
194 935	-0,616	1,000	0,959	0,141

Figure 188 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N38TE023D.

Both dX and dY distributions highlight low displacement modes (1.2 pixels and -0.9 pixels respectively), with high standard deviations (5.323 pixels for dX, 5.050 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 5 pixels. This distribution has a single mode of 2.4 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.959 and a standard deviation of only 0.141. This spread is due to the flatness of terrain over this tile.

4.2.1.32 32 - Turkey - N38ZE038J (zone 1)

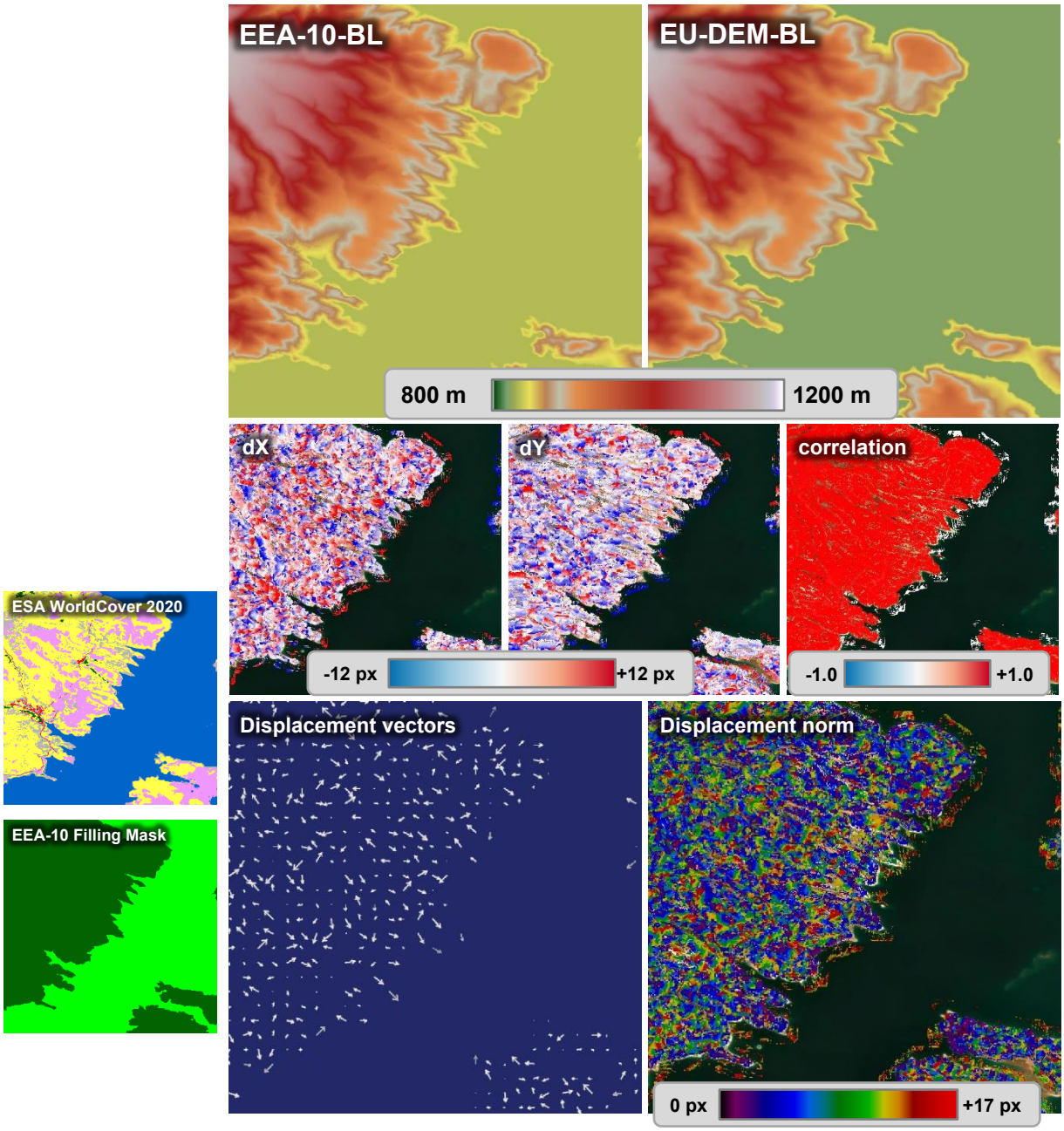


Figure 189 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N38ZE038J.

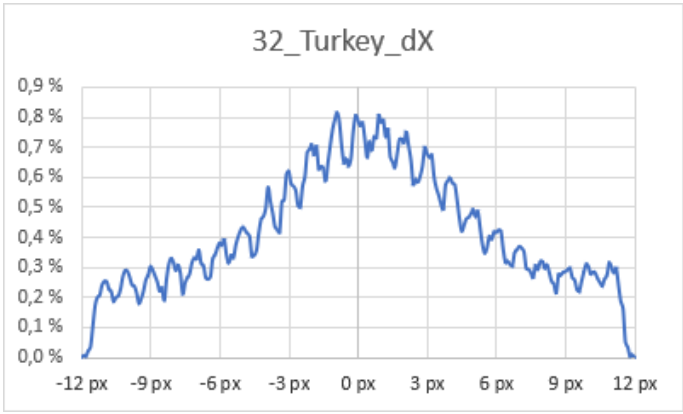
As seen in Figure 189, important height variations are visible over EU-DEM and EEA-10 (400 metres between lowest and highest points).

The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-5, +5[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1. Low correlation or not computed pixels are due to the flatness of lakes in both DEMs.

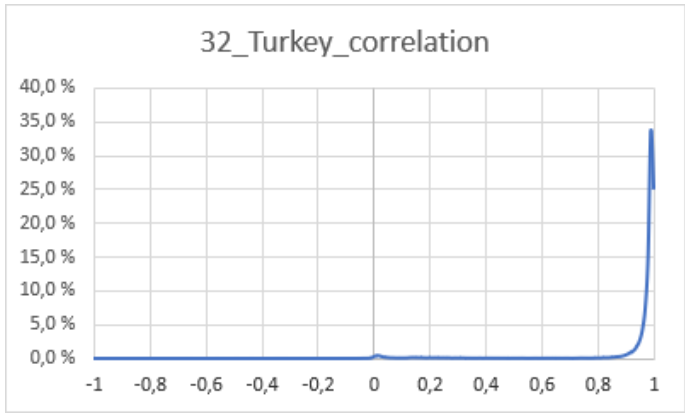
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 5] interval (from dark blue to light blue). Displacement norms above 5 pixels are more rarely observed.

No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.



Count	Min	Max	Mean	Std Dev
123 908	-12,0 px	12,0 px	0,268 px	5,513 px

Count	Min	Max	Mean	Std Dev
123 908	-12,0 px	12,0 px	-0,605 px	4,872 px



Count	Min	Max	Mean	Std Dev
123 908	0,000 px	16,668 px	6,415 px	3,662 px

Count	Min	Max	Mean	Std Dev
123 908	-0,917	1,000	0,940	0,180

Figure 190 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N38ZE038J.

Both dX and dY distributions highlight low displacement modes (-0.9 pixels and -1.2 pixels respectively), with high standard deviations (5.513 pixels for dX, 4.872 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 5 pixels. This distribution has a single mode of 3.3 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.940 and a standard deviation of only 0.180. One may note a small number of correlations in the [0.0, 0.1] range. These low correlations are due to the flattened water bodies in both DEMs.

4.2.1.33 33 - England - N51VW001A (zone 2)

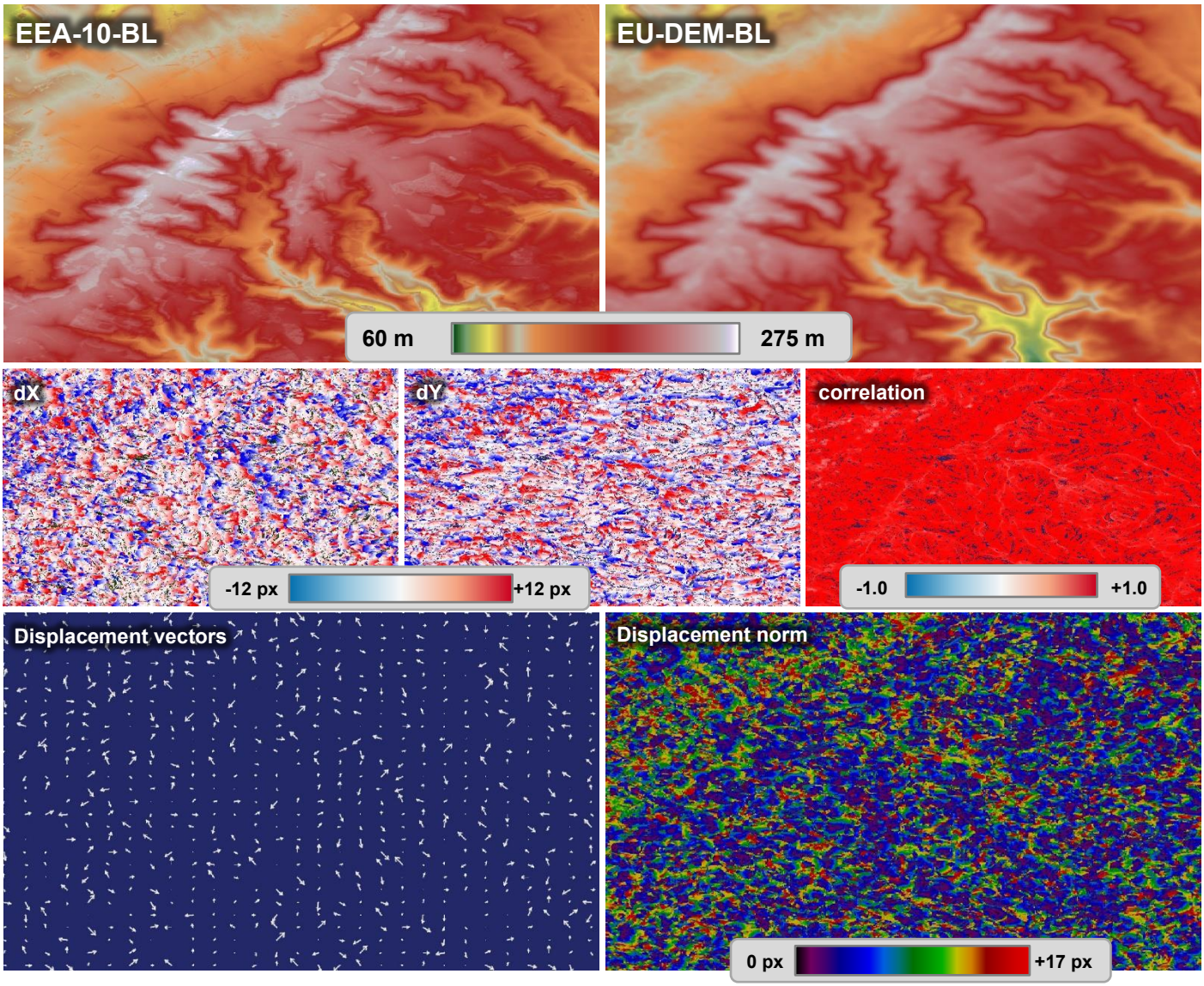
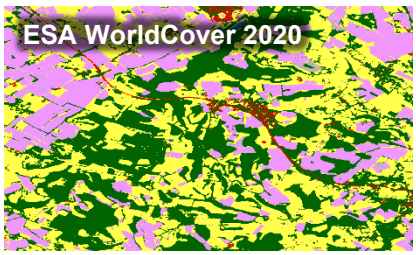
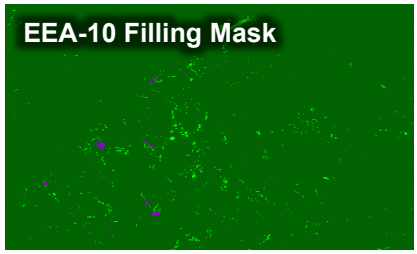


Figure 191 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N51VW001A.



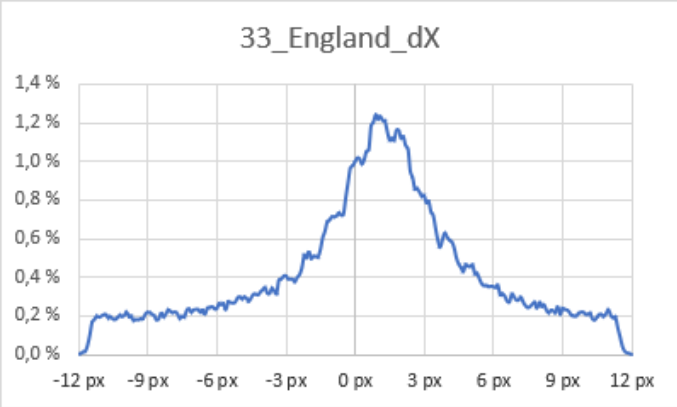


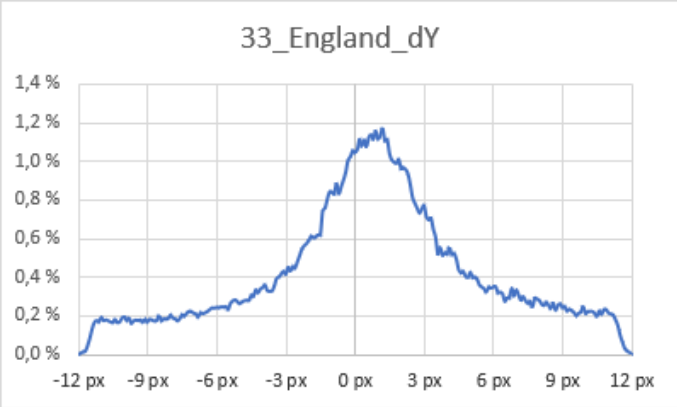
As seen in Figure 191, relatively important height variations are visible over EU-DEM and EEA-10 (215 metres between lowest and highest points).

The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-3, +3[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

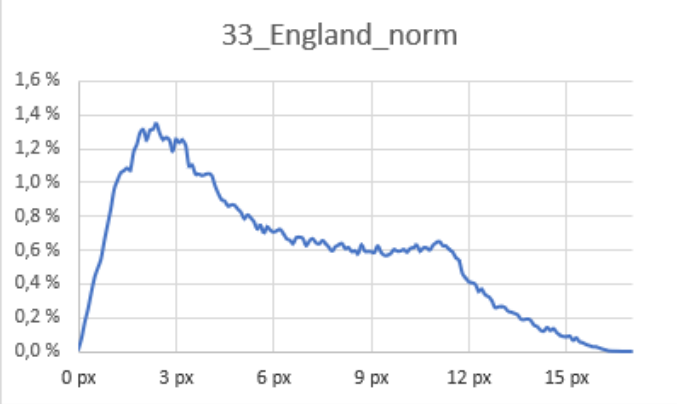
Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 6] interval (blue shades). Displacement norms above 6 pixels are more rarely observed. One may note the highest displacements observed in the North West of the tile. These displacements seem to be linked to flat areas in both DEMs.

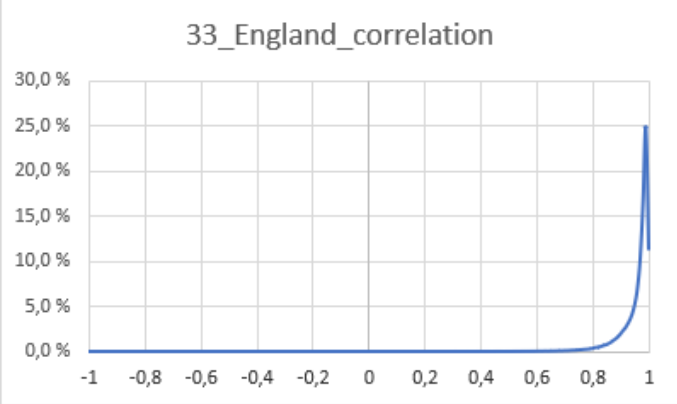




Count	Min	Max	Mean	Std Dev
228 121	-12,0 px	12,0 px	0,638 px	4,971 px

Count	Min	Max	Mean	Std Dev
228 121	-12,0 px	12,0 px	0,669 px	4,925 px





Count	Min	Max	Mean	Std Dev
228 121	0,000 px	16,641 px	5,975 px	3,757 px

Count	Min	Max	Mean	Std Dev
228 121	0,000	1,000	0,957	0,054

Figure 192 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N51VW001A.

Both dX and dY distributions highlight low displacement modes (0.8 pixels and 1.3 pixels respectively), with high standard deviations (4.971 pixels for dX, 4.925 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 4 pixels. This distribution has a single mode of 2.4 pixels.

The correlations are mainly spread over the [0.85, 1.0] range, with a mean of 0.957 and a standard deviation of only 0.054.

4.2.1.34 34 - Ireland - N52RW009C (zone 2)

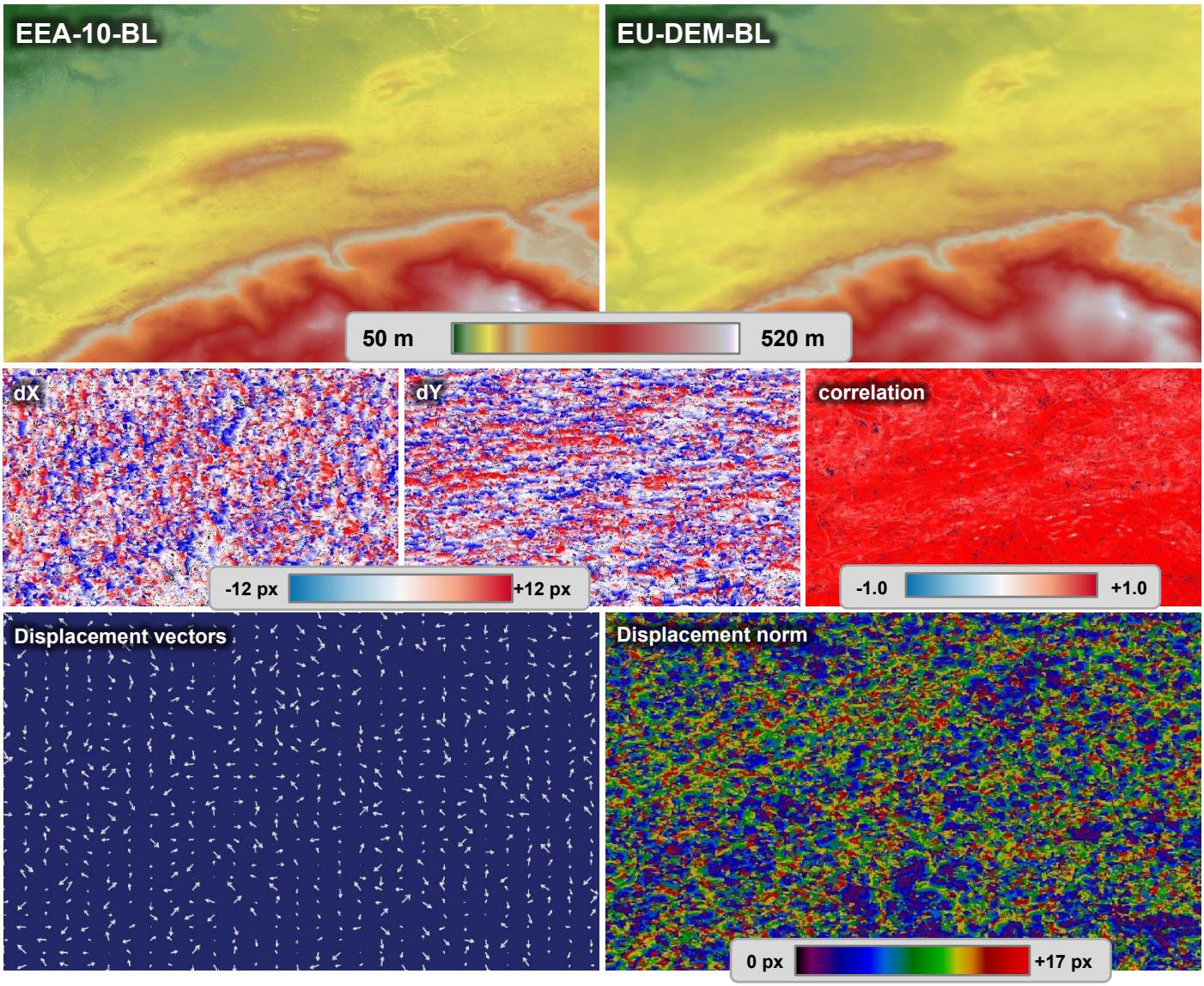
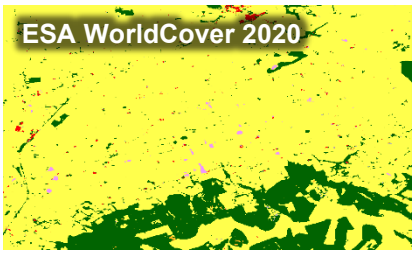


Figure 193 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N52RW009C.



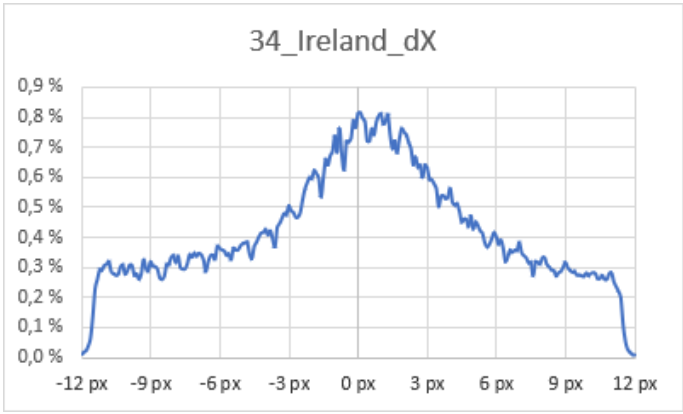
As seen in Figure 193, important height variations are visible over EU-DEM and EEA-10 (470 metres between lowest and highest points).

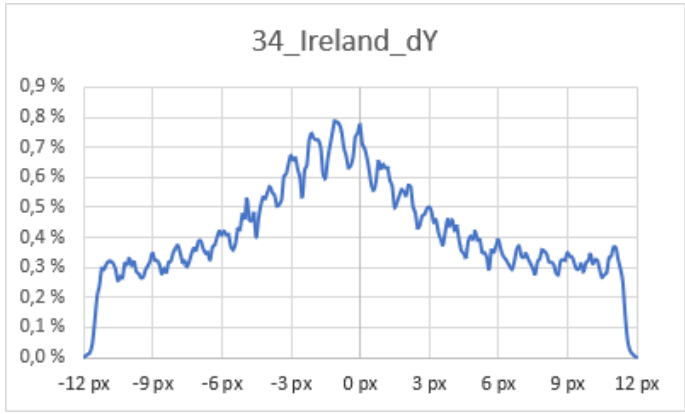
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-5, +5[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

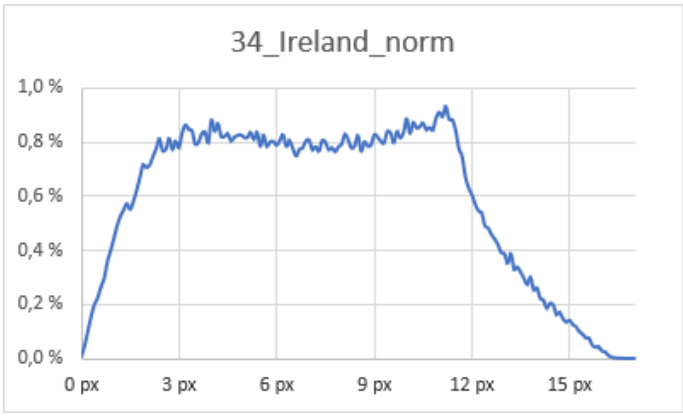
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

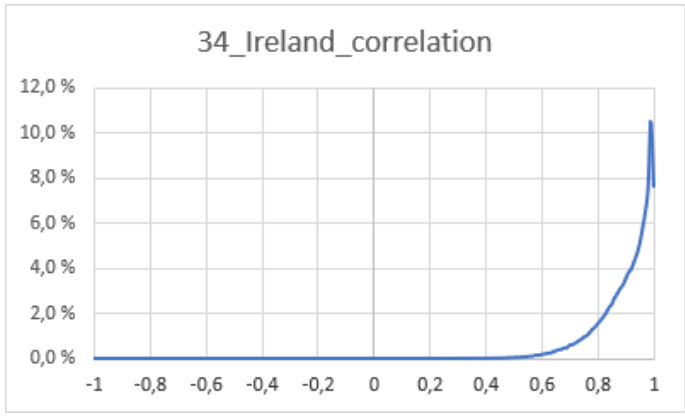




Count	Min	Max	Mean	Std Dev
225 603	-12,0 px	12,0 px	0,133 px	5,655 px

Count	Min	Max	Mean	Std Dev
225 603	-12,0 px	12,0 px	-0,155 px	5,839 px





Count	Min	Max	Mean	Std Dev
225 603	0,000 px	16,576 px	7,235 px	3,711 px

Count	Min	Max	Mean	Std Dev
225 603	-0,020	1,000	0,901	0,095

Figure 194 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N52RW009C.

Both dX and dY distributions highlight low displacement modes (1.3 pixels and -0.9 pixels respectively), with high standard deviations (5.655 pixels for dX, 5.839 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 11.2 pixels.

The correlations are mainly spread over the [0.65, 1.0] range, with a mean of 0.901 and a standard deviation of 0.095.

4.2.1.35 35 - Northern Ireland - N54YW007A (zone 2)

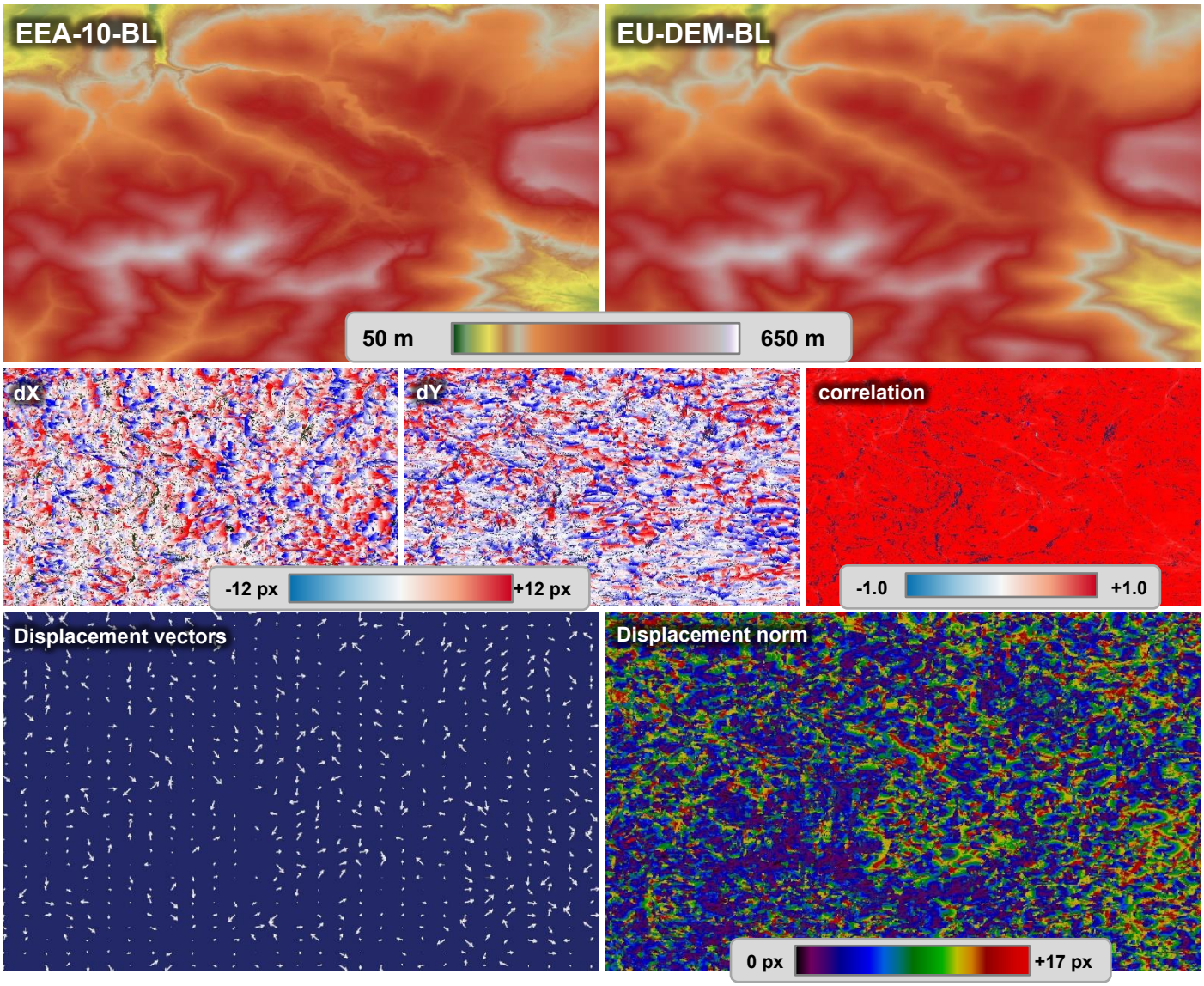
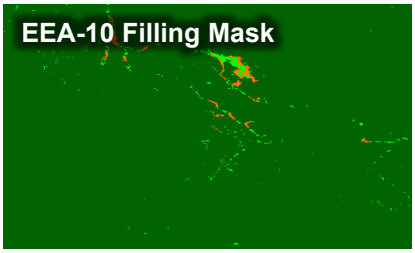


Figure 195 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N54YW007A.

As seen in Figure 195, important height variations are visible over EU-DEM and EEA-10 (600 metres between lowest and highest points).

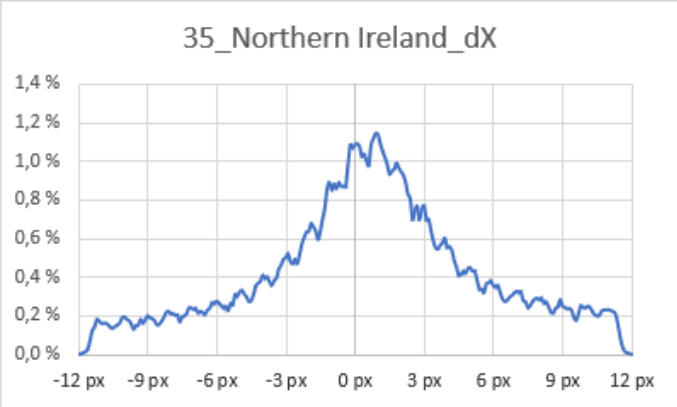
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

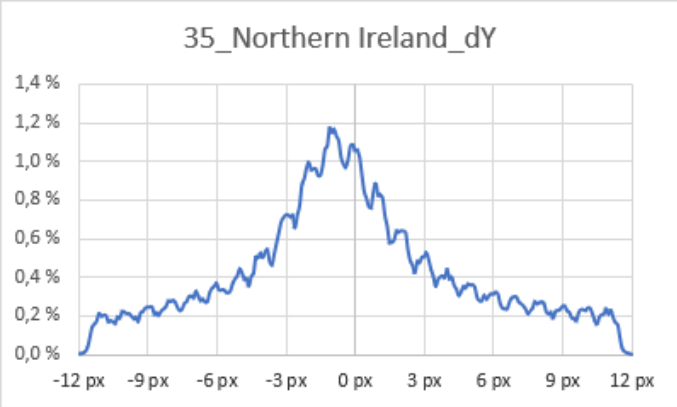
A strong correlation can be seen over this area, as most values are close to 1.



Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 8] interval (from dark blue to dark green). Displacement norms above 8 pixels are more rarely observed. One may see that the lowest displacements seem to be linked to the highest elevations in the tile.

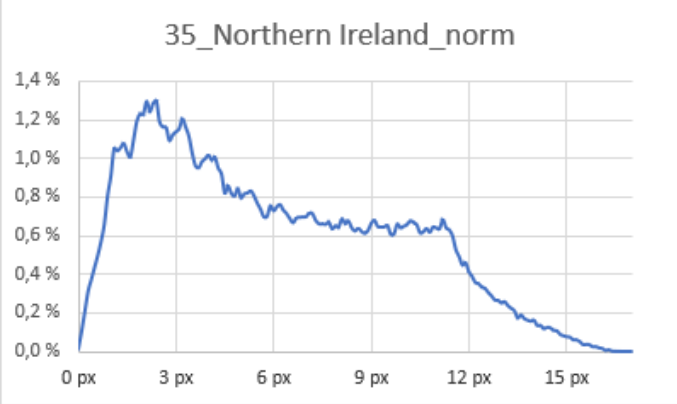
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

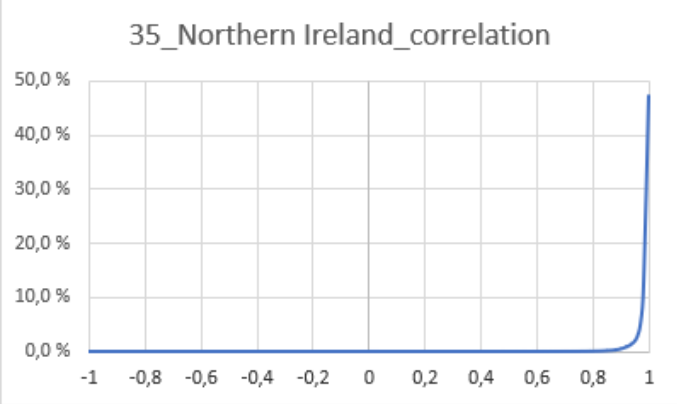




Count	Min	Max	Mean	Std Dev
234 583	-12,0 px	12,0 px	0,631 px	4,931 px

Count	Min	Max	Mean	Std Dev
234 583	-12,0 px	12,0 px	-0,241 px	5,046 px





Count	Min	Max	Mean	Std Dev
234 583	0,000 px	16,558 px	6,027 px	3,731 px

Count	Min	Max	Mean	Std Dev
234 583	0,000	1,000	0,985	0,027

Figure 196 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N54YW007A.

Both dX and dY distributions highlight low displacement modes (1.0 pixels and -1.1 pixels respectively), with high standard deviations (4.931 pixels for dX, 5.046 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 4 pixels. This distribution has a single mode of 2.4 pixels.

The correlations are mainly spread over the [0.95, 1.0] range, with a mean of 0.985 and a standard deviation of only 0.027.

4.2.1.36 36 - Cyprus - N34ZE033C (zone 1)

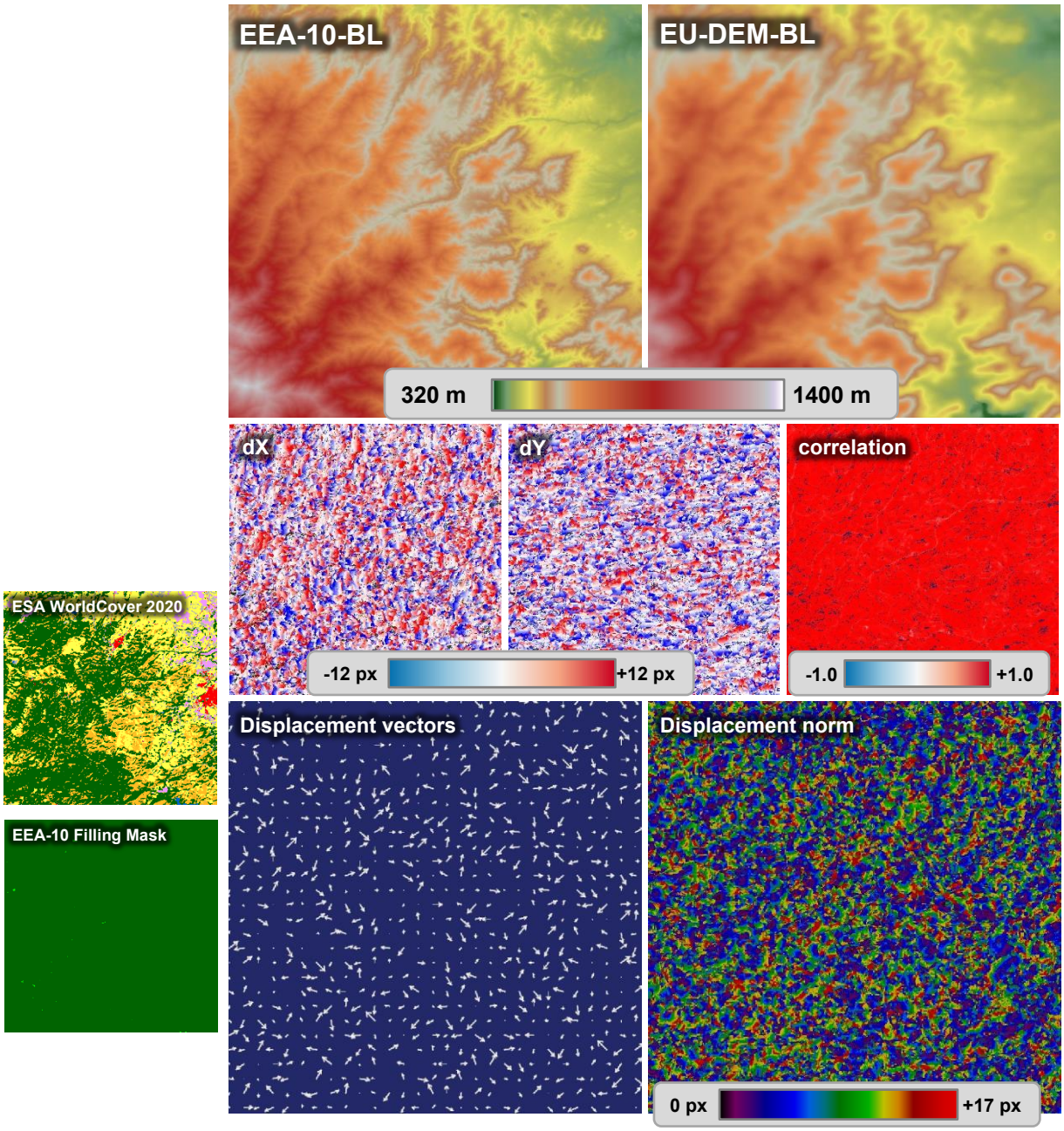


Figure 197 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N34ZE033C.

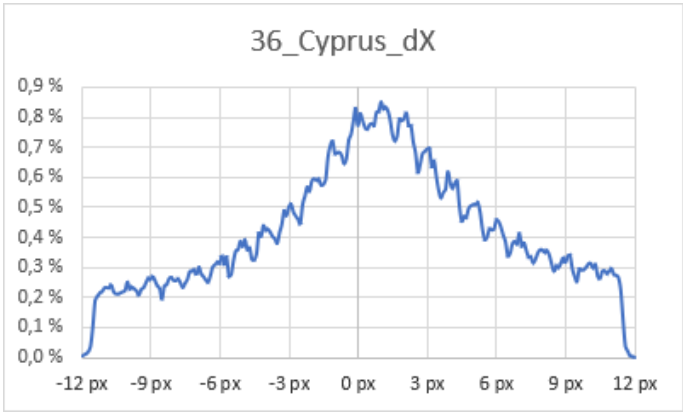
As seen in Figure 197, important height variations are visible over EU-DEM and EEA-10 (1080 metres between lowest and highest points).

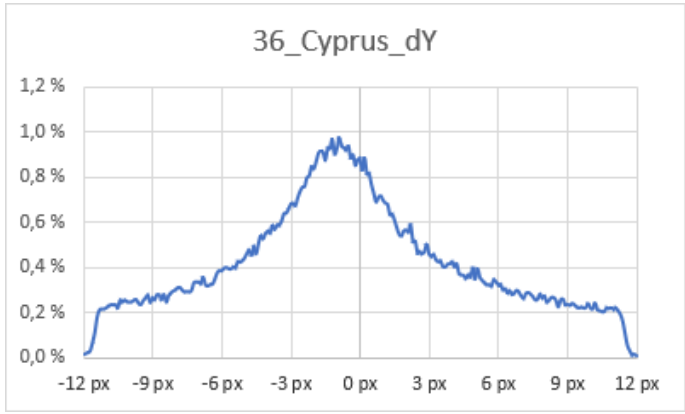
The dX and dY images show important displacement variations over all the tile. One may see that most of the pixels are not saturated, meaning that low displacements are the most common (included in the]-4, +4[pixels interval).

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

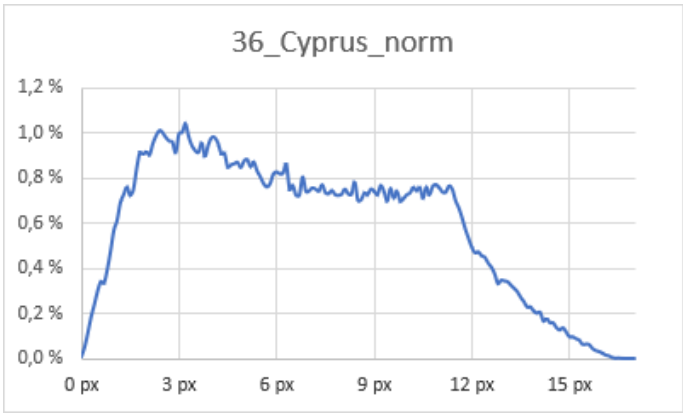
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

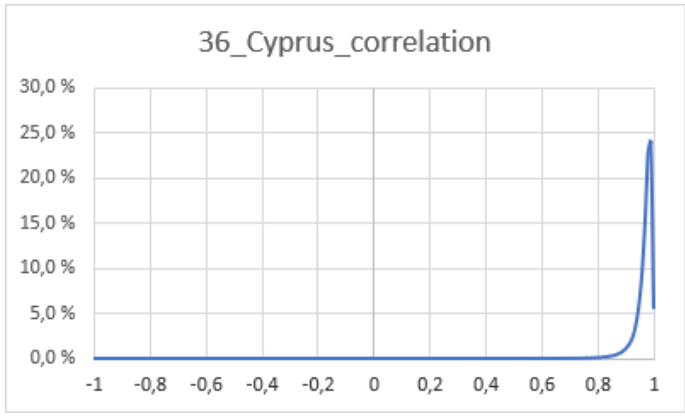




Count	Min	Max	Mean	Std Dev
233 459	-12,0 px	12,0 px	0,628 px	5,503 px

Count	Min	Max	Mean	Std Dev
233 459	-12,0 px	12,0 px	-0,402 px	5,301 px





Count	Min	Max	Mean	Std Dev
233 459	0,000 px	16,600 px	6,712 px	3,727 px

Count	Min	Max	Mean	Std Dev
233 459	0,000	1,000	0,967	0,032

Figure 198 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N34ZE033C.

Both dX and dY distributions highlight low displacement modes (1.2 pixels and -0.9 pixels respectively), with high standard deviations (5.503 pixels for dX, 5.301 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 3.2 pixels.

The correlations are mainly spread over the [0.9, 1.0] range, with a mean of 0.967 and a standard deviation of only 0.032. This spread is due to the flatness of terrain over this tile.

4.2.1.37 37 - Luxembourg - N49VE006B (zone 1)

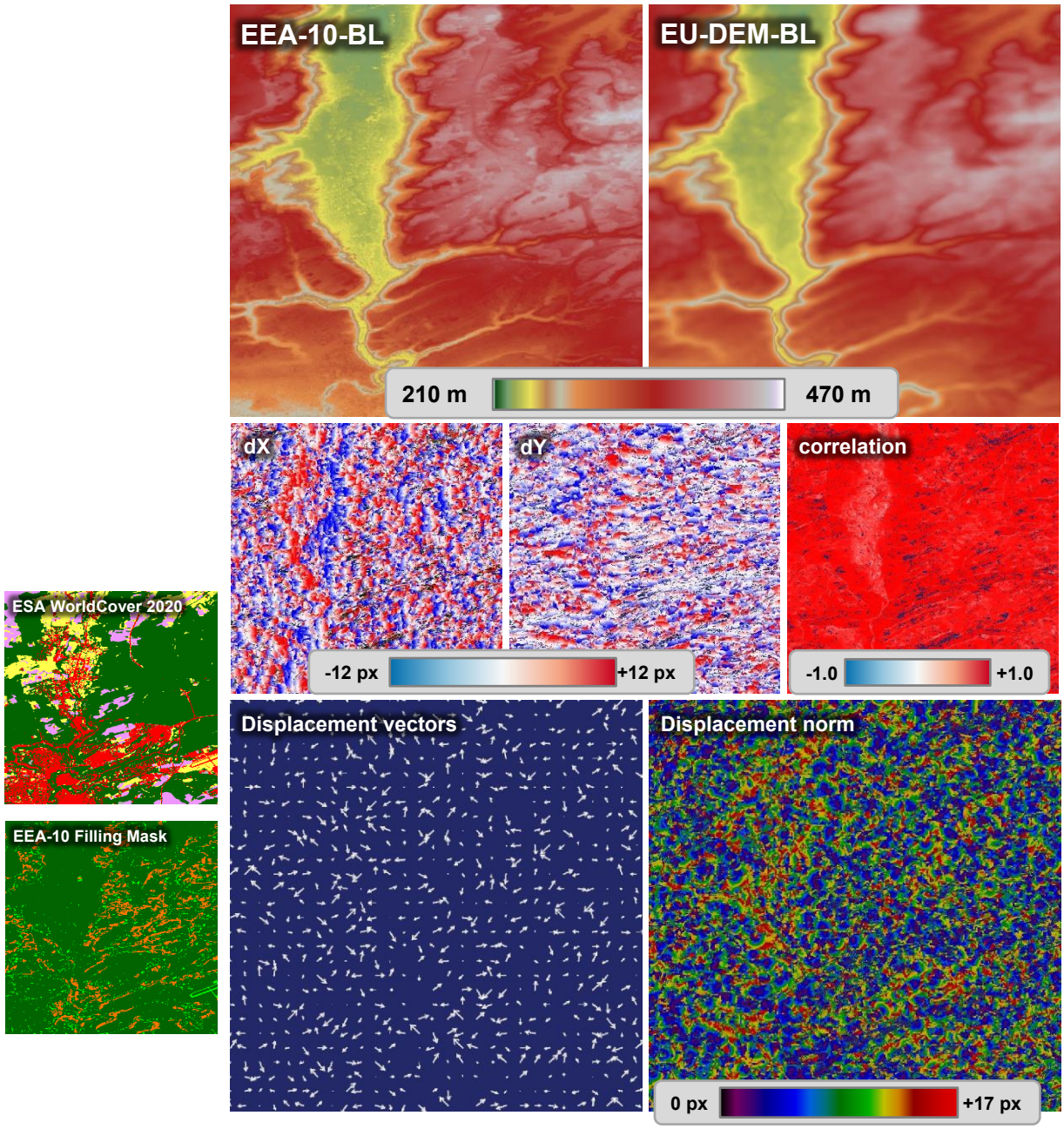


Figure 199 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N49VE006B.

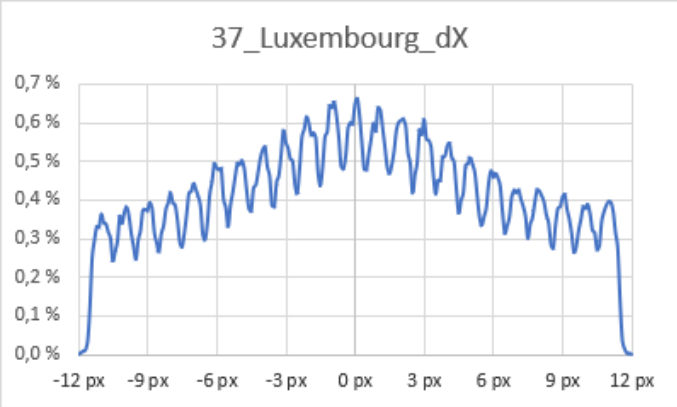
As seen in Figure 199, relatively important height variations are visible over EU-DEM and EEA-10 (260 metres between lowest and highest points).

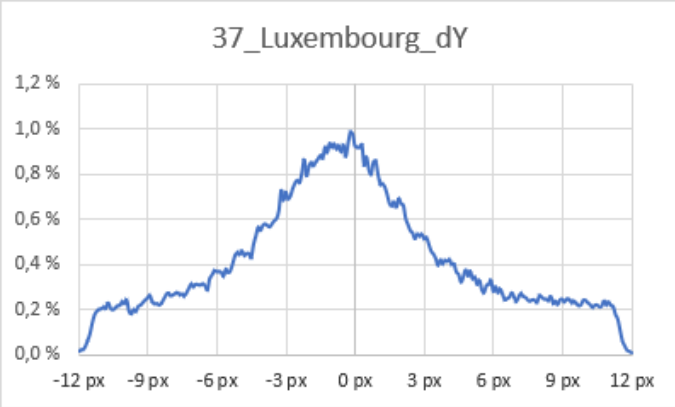
The dX and dY images show important displacement variations over all the tile. However, more important displacements can be seen over dX than over dY.

A strong correlation can be seen over this area, as most values are close to 1.

Displacements vectors highlight no uniform or local direction. The displacement norms are mainly included in the [2, 11] interval (from dark blue to green). Displacement norms above 11 pixels are more rarely observed.

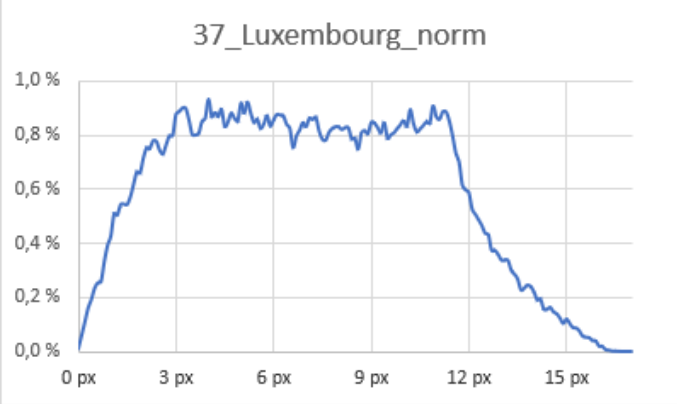
No clear matching has been found between the disparity analysis results and LULC maps or source data of both DEMs.

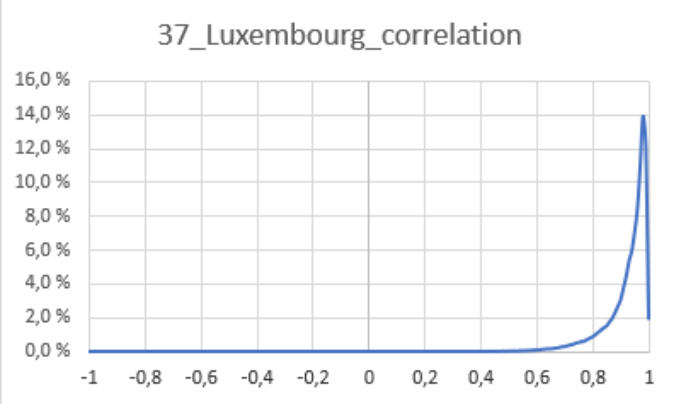




Count	Min	Max	Mean	Std Dev
217 378	-12,0 px	11,9 px	0,096 px	6,074 px

Count	Min	Max	Mean	Std Dev
217 378	-12,0 px	12,0 px	-0,254 px	5,168 px





Count	Min	Max	Mean	Std Dev
217 378	0,000 px	16,647 px	7,109 px	3,624 px

Count	Min	Max	Mean	Std Dev
217 378	0,000	1,000	0,925	0,076

Figure 200 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N49VE006B.

Both dX and dY distributions highlight low displacement modes (0.0 pixels and -0.1 pixels respectively), with high standard deviations (5.931 pixels for dX, 5.826 pixels for dY). These variations can be seen over the dX and dY images (see preceding page).

Most of the displacement norms range between 2 and 11 pixels. This distribution has a single mode of 4.0 pixels, but displacements in the [3, 11] pixels range have a similar frequency.

The correlations are mainly spread over the [0.8, 1.0] range, with a mean of 0.925 and a standard deviation of 0.076.

4.2.1.38 38 - Malta - N35YE014F (zone 1)

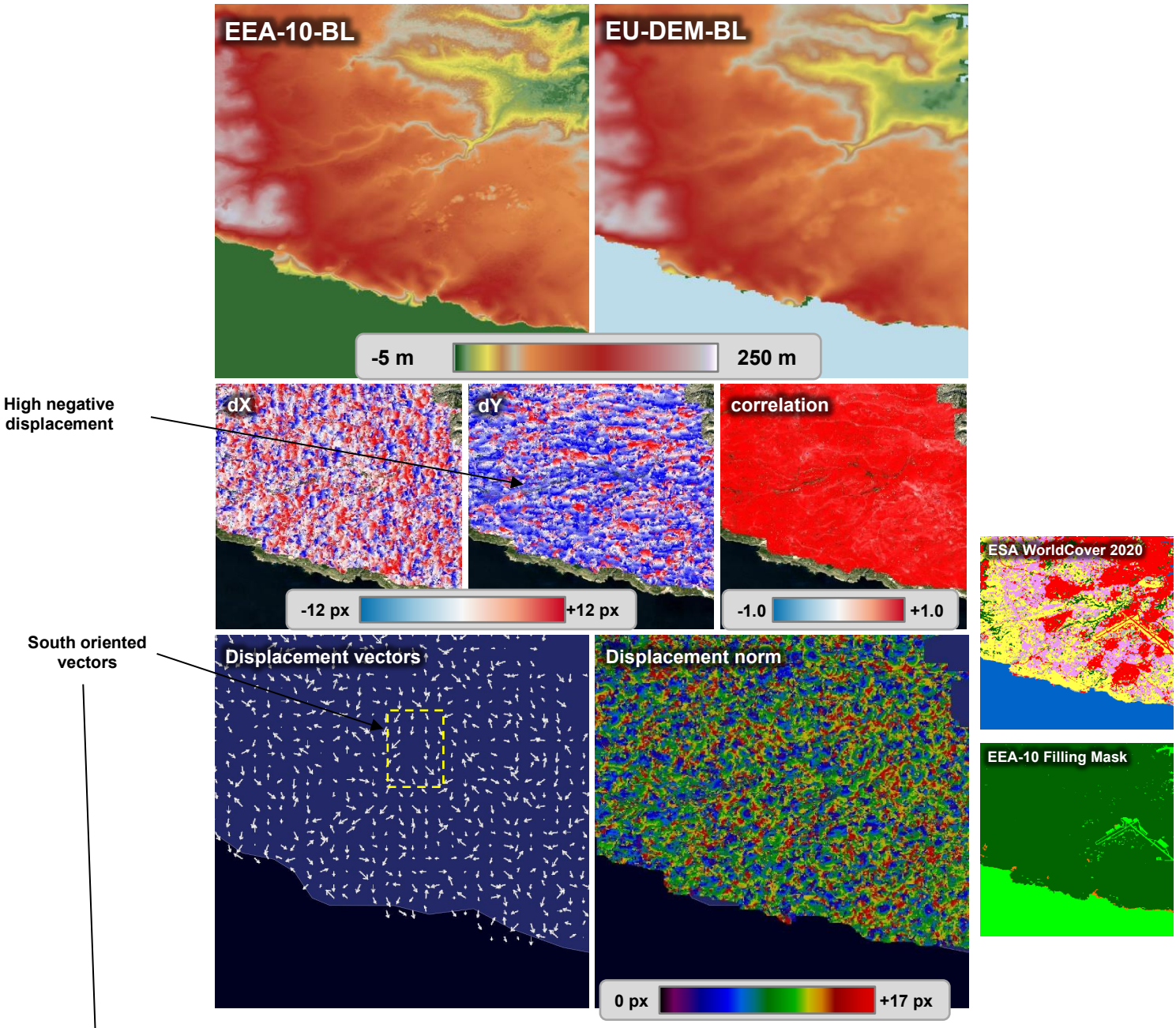
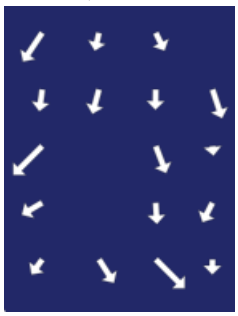
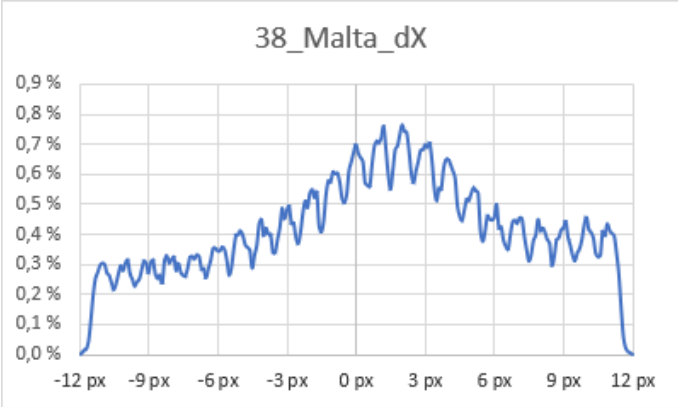


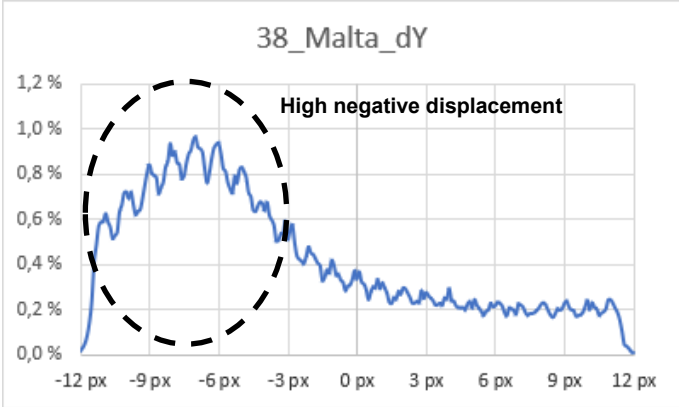
Figure 201 – Disparity analysis between EU-DEM and EEA-10 over DEMIX tile N35YE014F.



As seen in Figure 201, an important negative displacement is visible over the dY raster. This phenomenon is also highlighted in the displacement vectors, which are mostly directed to the South (see close view on attached figure).

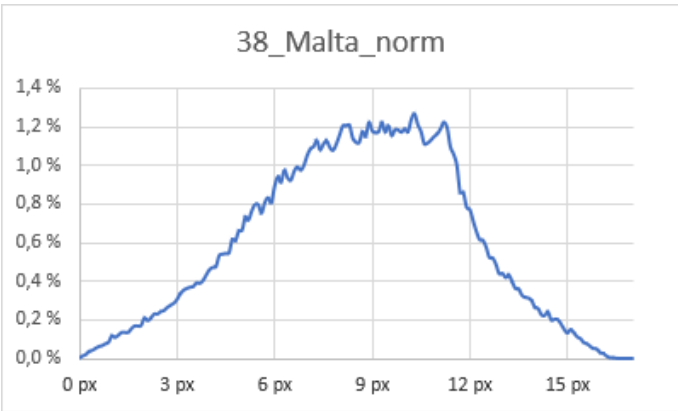
As opposed to the other DEMIX tiles, the displacement over Malta is almost uniform. This displacement does not seem to be linked to source data or to the land use (see attached figures).

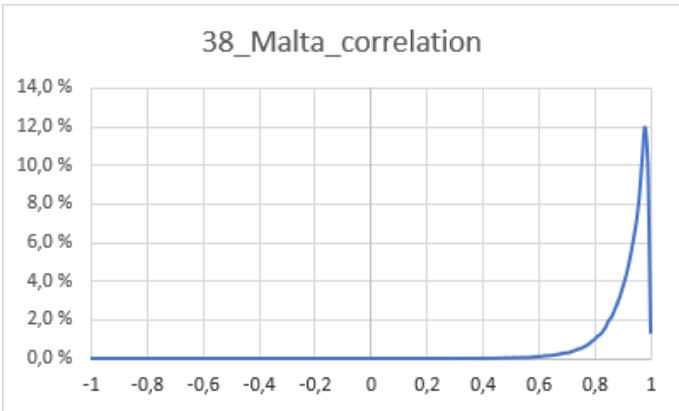




Count	Min	Max	Mean	Std Dev
158 716	-12,0 px	12,0 px	0,794 px	5,912 px

Count	Min	Max	Mean	Std Dev
158 716	-12,0 px	12,0 px	-3,299 px	5,962 px





Count	Min	Max	Mean	Std Dev
158 716	0,000 px	16,491 px	8,521 px	3,068 px

Count	Min	Max	Mean	Std Dev
158 716	0,000	1,000	0,919	0,078

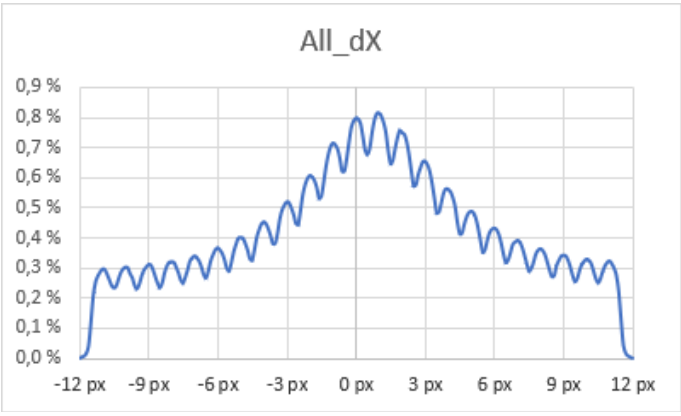
Figure 202 – Statistics of disparity analysis between EU-DEM and EEA-10 over DEMIX tile N35YE014F.

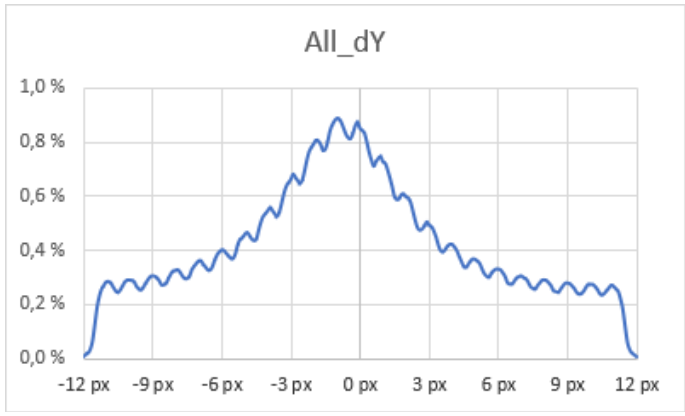
As seen in histograms of Figure 202, a low mean is retrieved for dX (0.794 pixels) but a high mean can be seen over dY (-3.299 pixels). One may also note that the mode of this distribution is high (-6.9 pixels).

A majority of norm values are seen between 6 and 11 pixels over this tile. This phenomenon is due to the high negative displacements seen over the dY distribution.

The correlation histogram highlights a strong correlation over all this tile, with a mean of 0.919 and a low standard deviation of 0.078.

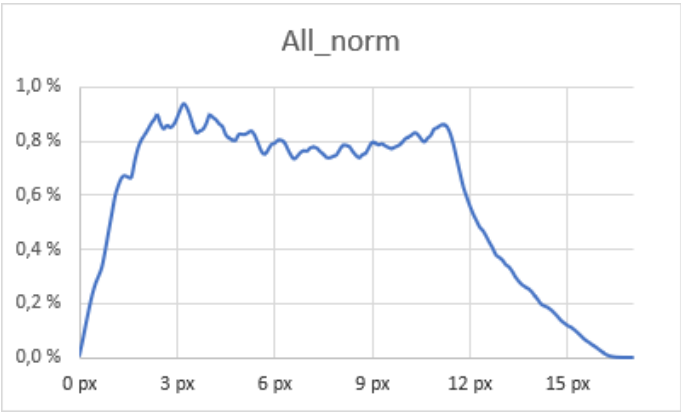
4.2.2 Overall statistics

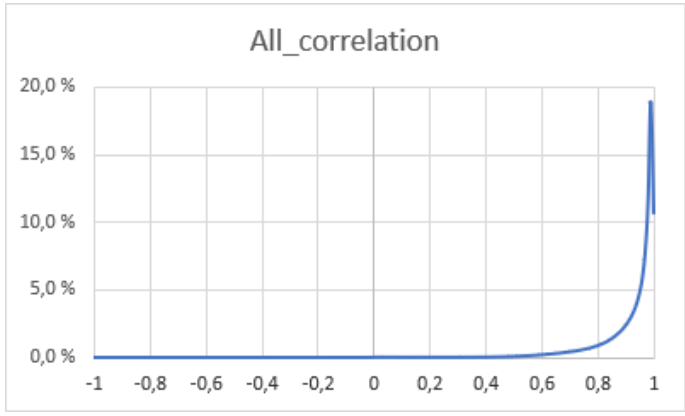




Count	Min	Max	Mean	Std Dev
8 348 303	-12,0 px	12,0 px	0,345 px	5,688 px

Count	Min	Max	Mean	Std Dev
8 348 303	-12,0 px	12,0 px	-0,352 px	5,498 px





Count	Min	Max	Mean	Std Dev
8 348 303	0,000 px	16,813 px	6,985 px	3,746 px

Count	Min	Max	Mean	Std Dev
8 348 303	-0,917	1,000	0,919	0,113

Figure 203 – Statistics of disparity analysis between EU-DEM and EEA-10 over all 38 European DEMIX Tiles

As seen in Figure 203, **the dX and dY displacement means are low** (0.345 px for dX, -0.352 px for dY), but **the standard deviations are high** (5.688 px for dX, and 5.498 px for dY). Both dX and dY look like gaussian distributions, with an aliasing effect every 1 pixel. This effect is further explained in beginning of section 4.2.1 (see paragraph “Histograms and statistics”).

The norms histogram highlights two modes: a first low mode of 3.2 pixels, and a second high mode of 11.3 pixels. The mean mode is high (6.985 pixels) meaning that **important displacements are observed from EEA-10 to EU-DEM**.

The overall correlation is really high, with a mean value of 0.919. One may see a tail of distribution in the [0.5, 0.8] correlation range. These lower correlation values are due to flat areas.

5. CONCLUSION

5.1 Study 1 - Global differences

5.1.1 Overall results

In section 4.1, a study of the differences between resampled instances of EEA-10 and EU-DEM is carried. A particular attention is given to the sampling methods and their effect on the differences results. This study shows that **the different sampling methods have a low impact over the (EU-DEM - EEA-10) statistics** (nearest neighbour, bilinear and bicubic). The following table highlights the statistics variations over the 38 DEMIX tiles of this study (as observed in each subsection of section 4.1).

ID	Study	DEMIX tile	Mean variation	Std Dev variation	RMSE variation
01	Iceland	N64ZW019C	0.01 m	0.08 m	0.07 m
02	Norway	N60RE007B	0.05 m	0.26 m	0.26 m
03	Sweden	N66TE020B	0.01 m	**0.04 m**	**0.03 m**
04	Finland	N60RE023F	**0.00 m**	0.16 m	0.14 m
05	Estonia	N58YE025G	0.01 m	0.13 m	0.13 m
06	Latvia	N56XE026C	**0.00 m**	0.11 m	0.12 m
07	Lithuania	N55XE021D	**0.00 m**	0.15 m	0.12 m
08	Poland	N53XE017C	0.01 m	0.16 m	0.12 m
09	Germany	N50ZE008F	**0.00 m**	0.17 m	0.21 m
10	Denmark	N55RE010B	**0.00 m**	0.16 m	0.13 m
11	Netherlands	N52ZE005F	**0.00 m**	0.08 m	0.07 m
12	Belgium	N50YE004F	0.01 m	0.17 m	0.16 m
13	France	N44QW001H	**0.00 m**	0.05 m	0.04 m
14	Spain	N41VW004C	**0.00 m**	0.10 m	0.09 m
15	Portugal	N40RW009K	0.02 m	0.35 m	0.34 m
16	Italy	N37UE014C	0.01 m	0.32 m	0.32 m
17	Switzerland	N46ZE009A	0.01 m	**0.81 m**	**0.81 m**
18	Austria	N47UE014H	0.02 m	0.72 m	0.73 m
19	Czechia	N49XE015B	0.01 m	0.15 m	0.15 m
20	Slovakia	N48ZE020C	0.01 m	0.40 m	0.38 m
21	Hungary	N46ZE017H	**0.00 m**	0.17 m	0.15 m
22	Slovenia	N45ZE014K	**0.00 m**	0.31 m	0.31 m
23	Croatia	N45VE017A	**0.00 m**	0.08 m	0.08 m
24	Bosnia and Herzegovina	N44PE017J	0.03 m	0.39 m	0.39 m
25	Montenegro	N42XE019D	0.08 m	0.55 m	0.55 m
26	Albania	N41ME020A	0.02 m	0.30 m	0.31 m
27	North Macedonia	N41XE021L	0.01 m	0.20 m	0.20 m
28	Serbia	N44VE020B	0.01 m	0.07 m	0.07 m
29	Romania	N46RE026G	0.01 m	0.48 m	0.48 m
30	Bulgaria	N42VE025J	0.02 m	0.43 m	0.42 m
31	Greece	N38TE023D	0.03 m	0.58 m	0.56 m
32	Turkey	N38ZE038J	0.02 m	0.15 m	0.11 m
33	England	N51VW001A	**0.00 m**	0.25 m	0.25 m
34	Ireland	N52RW009C	0.04 m	0.18 m	0.18 m
35	Northern Ireland	N54YW007A	0.02 m	0.32 m	0.32 m
36	Cyprus	N34ZE033C	**0.00 m**	0.44 m	0.44 m
37	Luxembourg	N49VE006B	**0.00 m**	0.27 m	0.27 m
38	Malta	N35YE014F	**0.11 m**	0.49 m	0.49 m
All	**-**	**-**	**0.00 m**	**0.35 m**	**0.34 m**

Figure 204 – Mean, Std Dev and RMSE variations over all 38 European DEMIX tiles.

5.1.2 Influence of the sampling method

5.1.2.1 Highest variations between sampling methods, case of Switzerland

As seen in the results of section 4.1.1, views of the differences between {EU-DEM-NN, EU-DEM-BL, EU-DEM-BC} and {EEA-10-NN, EEA-10-BL, EEA-10-BC} share the same overall features.

In this section, differences of the differences between EU-DEM and EEA-10 resamplings are compared. The (EU-DEM-BL – EEA-10-BL) study is taken as reference, as this study obtained the best overall results in the global differences study (see section 4.1.2).

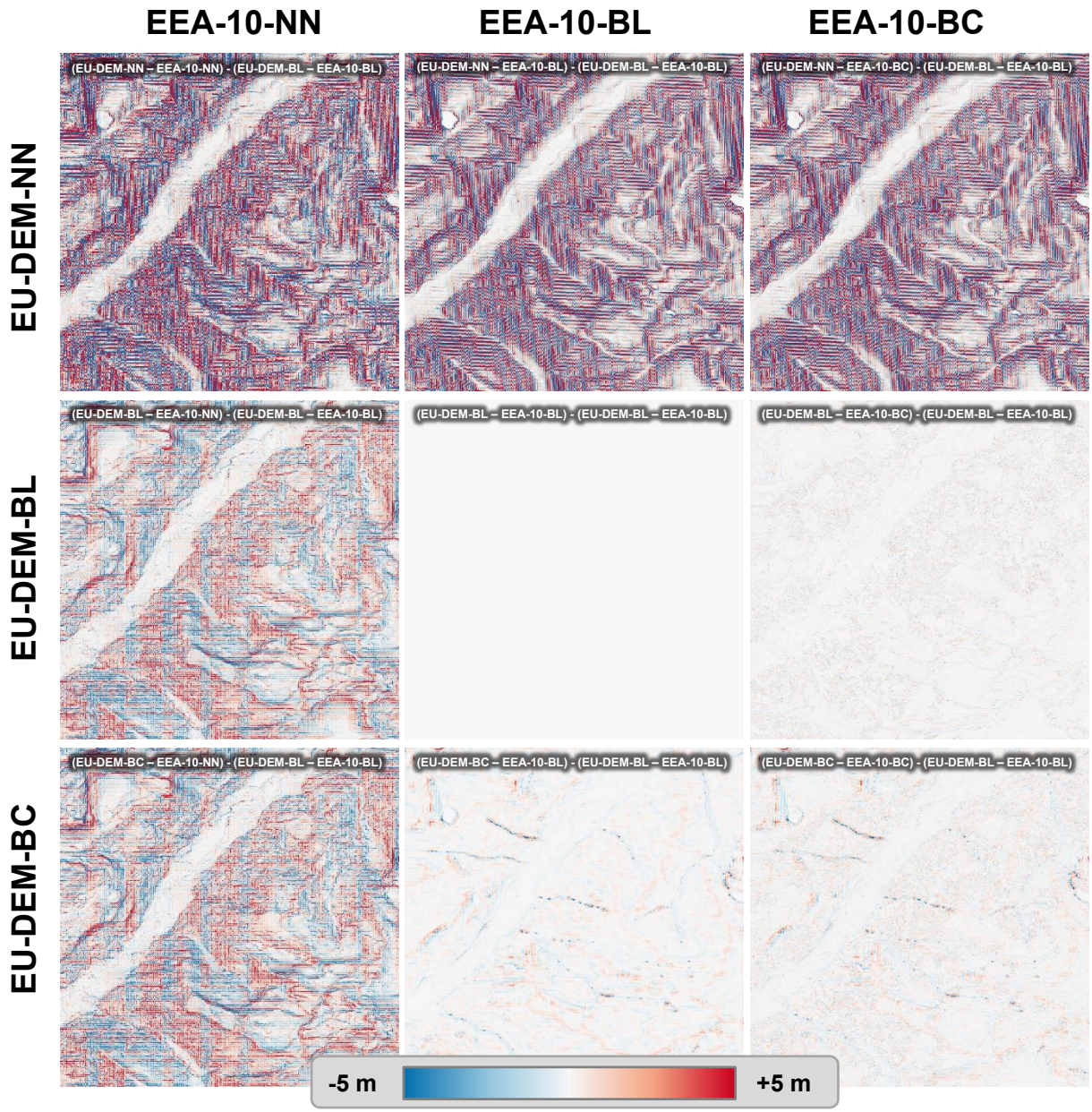


Figure 205 – Differences of differences over DEMIX tile N46ZE009A (Switzerland).

Over all 38 European DEMIX tiles, the most important statistics variation has been seen over the case of Switzerland (DEMIX tile N46ZE009A, see section 4.1.1.17 for statistics). In Figure 205, differences of the differences are given for this DEMIX tile. One may note that the differences involving the nearest neighbour sampling method really differ from the reference (EU-DEM-BL – EEA-10-BL) study. On the opposite, only small variations can be seen over the differences involving the bilinear and bicubic sampling methods.

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -0.001 149 064 m Std Dev = 5.212 m RMSE = 5.212 m	Mean = 0.001 601 026 m Std Dev = 4.562 m RMSE = 4.562 m	Mean = 0.001 746 360 m Std Dev = 4.577 m RMSE = 4.577 m
Bilinear (BL)	Mean = -0.002 750 090 m Std Dev = 2.550 m RMSE = 2.550 m		Mean = 0.000 145 335 m Std Dev = 0.362 m RMSE = 0.362 m
Bicubic (BC)	Mean = -0.004 563 137 m Std Dev = 2.574 m RMSE = 2.574 m	Mean = -0.001 813 047 m Std Dev = 0.373 m RMSE = 0.373 m	Mean = -0.001 667 712 m Std Dev = 0.497 m RMSE = 0.497 m

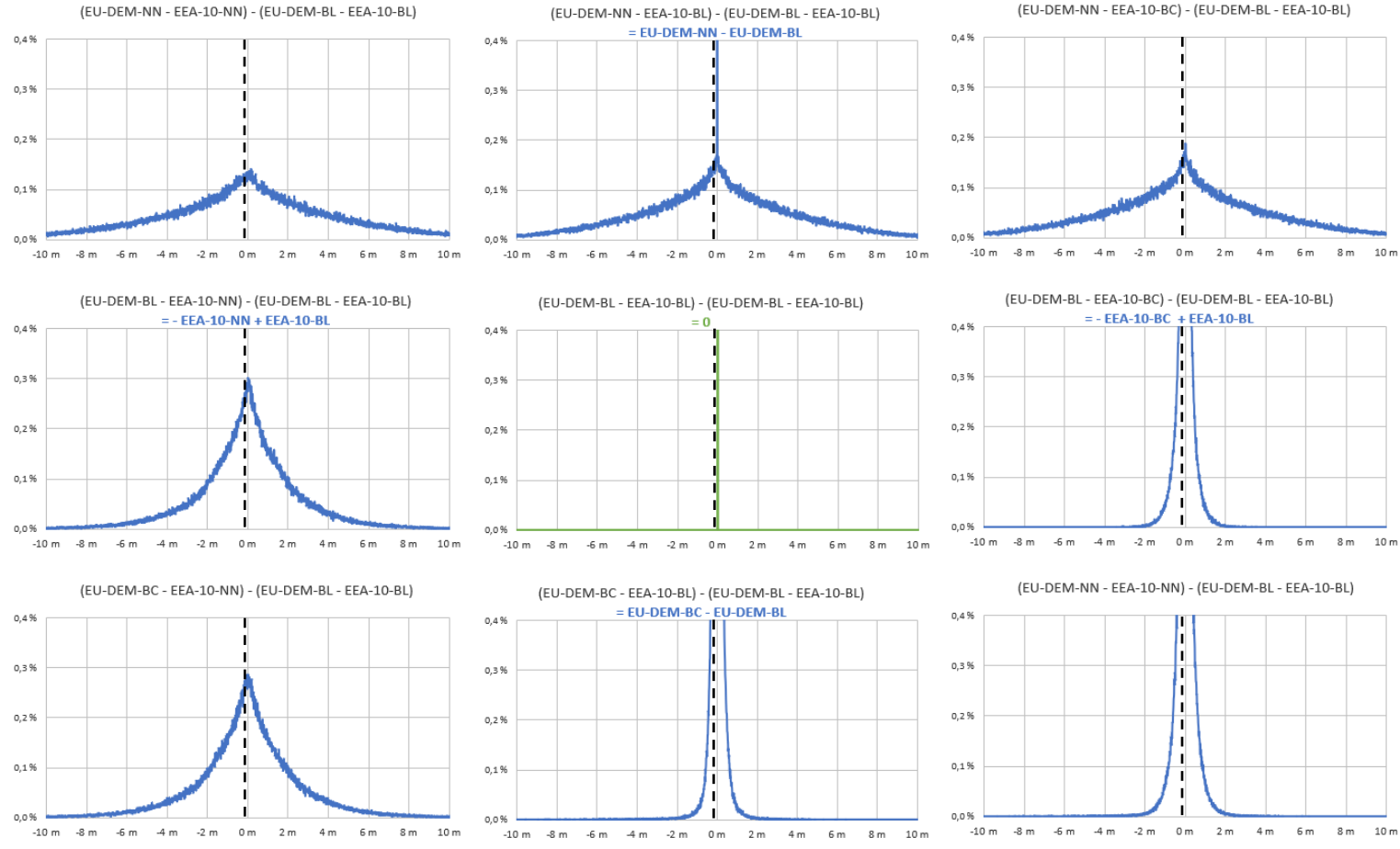


Figure 206 – Statistics of the differences of differences over DEMIX tile N46ZE009A (Switzerland).

One may see the highest standard deviation among distributions involving EU-DEM-NN (first line). Similar distributions can be observed for EEA-10-NN (first column), but with a lower standard deviation when compared to EU-DEM-BL and EU-DEM-BC. The best results are obtained comparing {EU-DEM-BL, EU-DEM-BC} to {EEA-10-BL, EEA-10-BC}. Overall, **the bilinear and bicubic sampling methods lead to similar results**. On the opposite, **significant differences can be seen between the nearest neighbour and bilinear sampling methods**.

5.1.2.2 Lowest variations between sampling methods, case of Sweden

In this section, as explained in previous section, differences of the differences between EU-DEM and EEA-10 resamplings are compared. The (EU-DEM-BL – EEA-10-BL) study is taken as reference, as this study obtained the best overall results in the global differences study (see section 4.1.2).

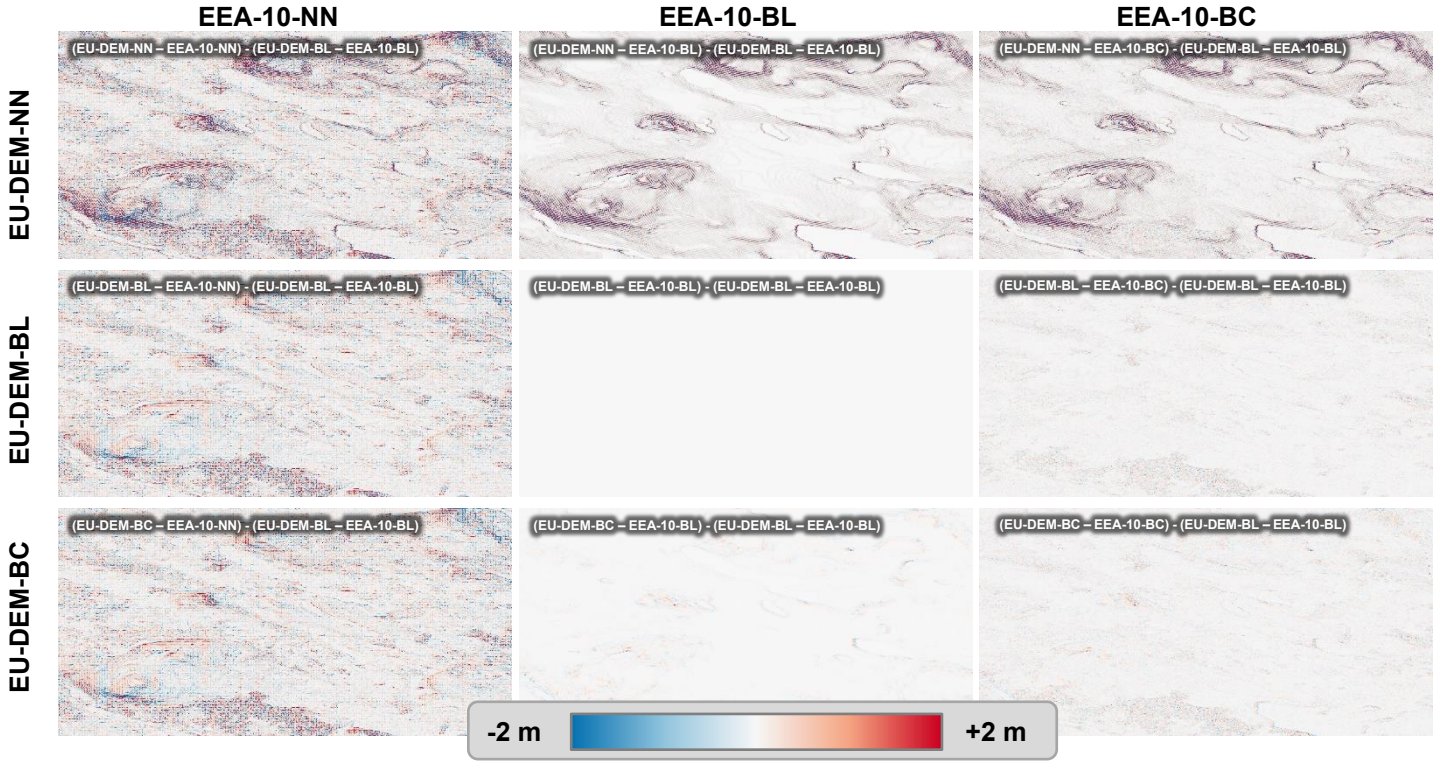


Figure 207 – Differences of differences over DEMIX tile N66TE020B (Sweden).

Over all 38 European DEMIX tiles, the least important statistics variation has been seen over the case of Sweden (DEMIX tile N66TE020B, see section 4.1.1.3 for statistics). In Figure 207, differences of the differences are given for this DEMIX tile. As seen for the Switzerland tile (see previous section 5.1.2), differences involving the nearest neighbour sampling method really differ from the reference (EU-DEM-BL – EEA-10-BL) study.

On the opposite, only small variations can be seen over the differences involving the bilinear and bicubic sampling methods. As expected, the differences variations observed for this tile are significantly lower than those observed for the Switzerland tile (see previous section 5.1.2).

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = -0.010 213 071 m Std Dev = 0.735 m RMSE = 0.735 m	Mean = 0.000 078 918 m Std Dev = 0.496 m RMSE = 0.496 m	Mean = 0.000 080 495 m Std Dev = 0.515 m RMSE = 0.515 m
Bilinear (BL)	Mean = -0.010 291 989 m Std Dev = 0.544 m RMSE = 0.544 m		Mean = 0.000 001 578 m Std Dev = 0.142 m RMSE = 0.142 m
Bicubic (BC)	Mean = -0.010 230 581 m Std Dev = 0.547 m RMSE = 0.547 m	Mean = 0.000 061 408 m Std Dev = 0.061 m RMSE = 0.061 m	Mean = 0.000 062 986 m Std Dev = 0.154 m RMSE = 0.154 m

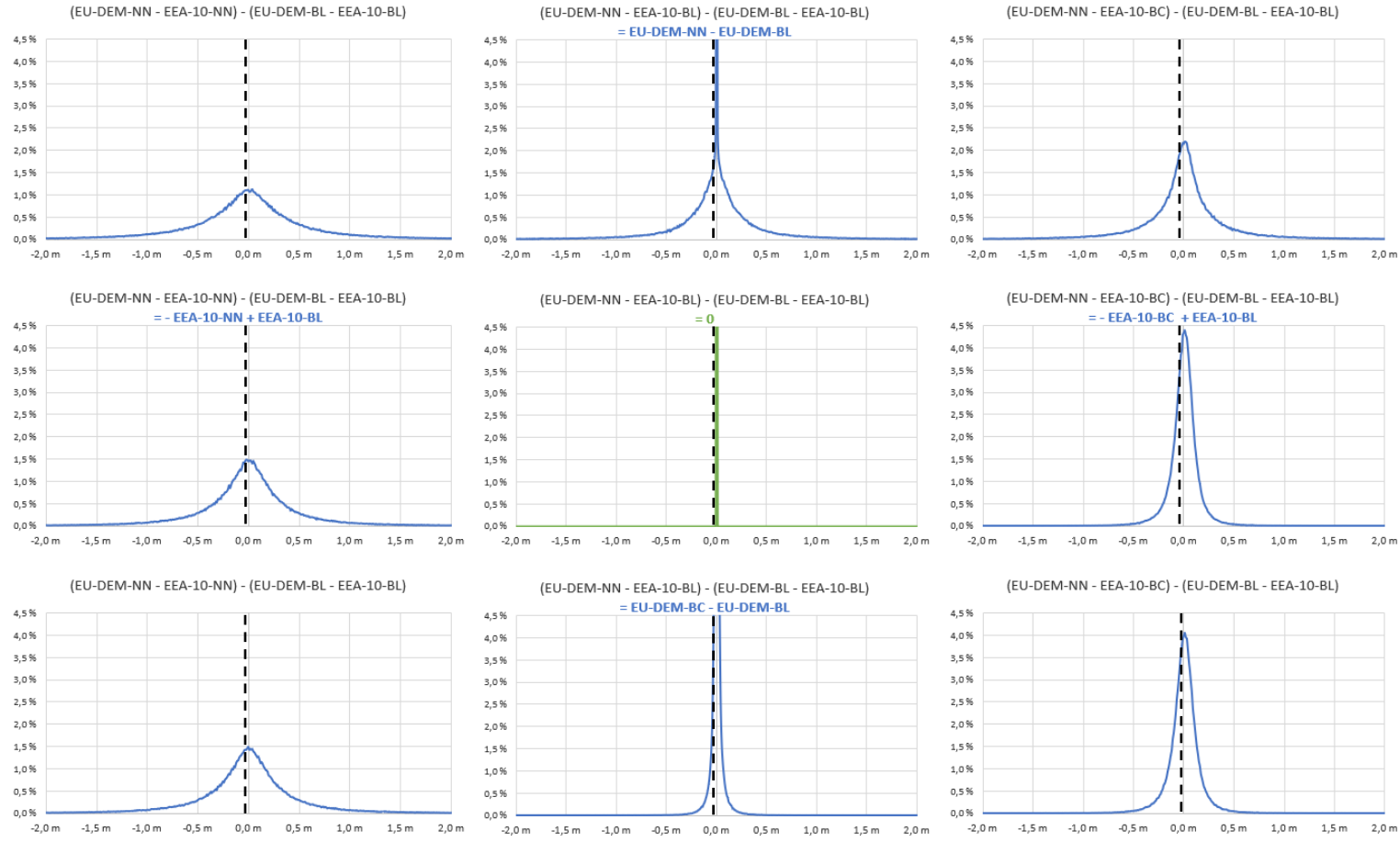


Figure 208 – Statistics of the differences of differences over DEMIX tile N66TE020B (Sweden).

As opposed to the Switzerland case, one may see the highest standard deviation among distributions involving EEA-10-NN (first column). Lower standard deviations can be observed over differences involving EU-DEM-NN (first line), as lakes have been flattened in EU-DEM over this tile, but not in EEA-10. Again, the best results are obtained comparing {EU-DEM-BL, EU-DEM-BC} to {EEA-10-BL, EEA-10-BC}. Overall, **the bilinear and bicubic sampling methods lead to similar results**. On the opposite, **significant differences can be seen between the nearest neighbour and bilinear sampling methods**.

5.1.2.3 Overall variations between sampling methods

EU-DEM \ EEA-10	Nearest neighbour (NN)	Bilinear (BL)	Bicubic (BC)
Nearest neighbour (NN)	Mean = 0.000 065 500 m Std Dev = 2.212 m RMSE = 2.212 m	Mean = 0.000 086 900 m Std Dev = 1.866 m RMSE = 1.866 m	Mean = 0.000 061 800 m Std Dev = 1.877 m RMSE = 1.877 m
Bilinear (BL)	Mean = -0.000 021 400 m Std Dev = 1.191 m RMSE = 1.191 m		Mean = -0.000 025 000 m Std Dev = 0.216 m RMSE = 0.216 m
Bicubic (BC)	Mean = 0.000 031 900 m Std Dev = 1.223 m RMSE = 1.223 m	Mean = 0.000 102 000 m Std Dev = 0.278 m RMSE = 0.278 m	Mean = 0.000 078 300 m Std Dev = 0.344 m RMSE = 0.344 m

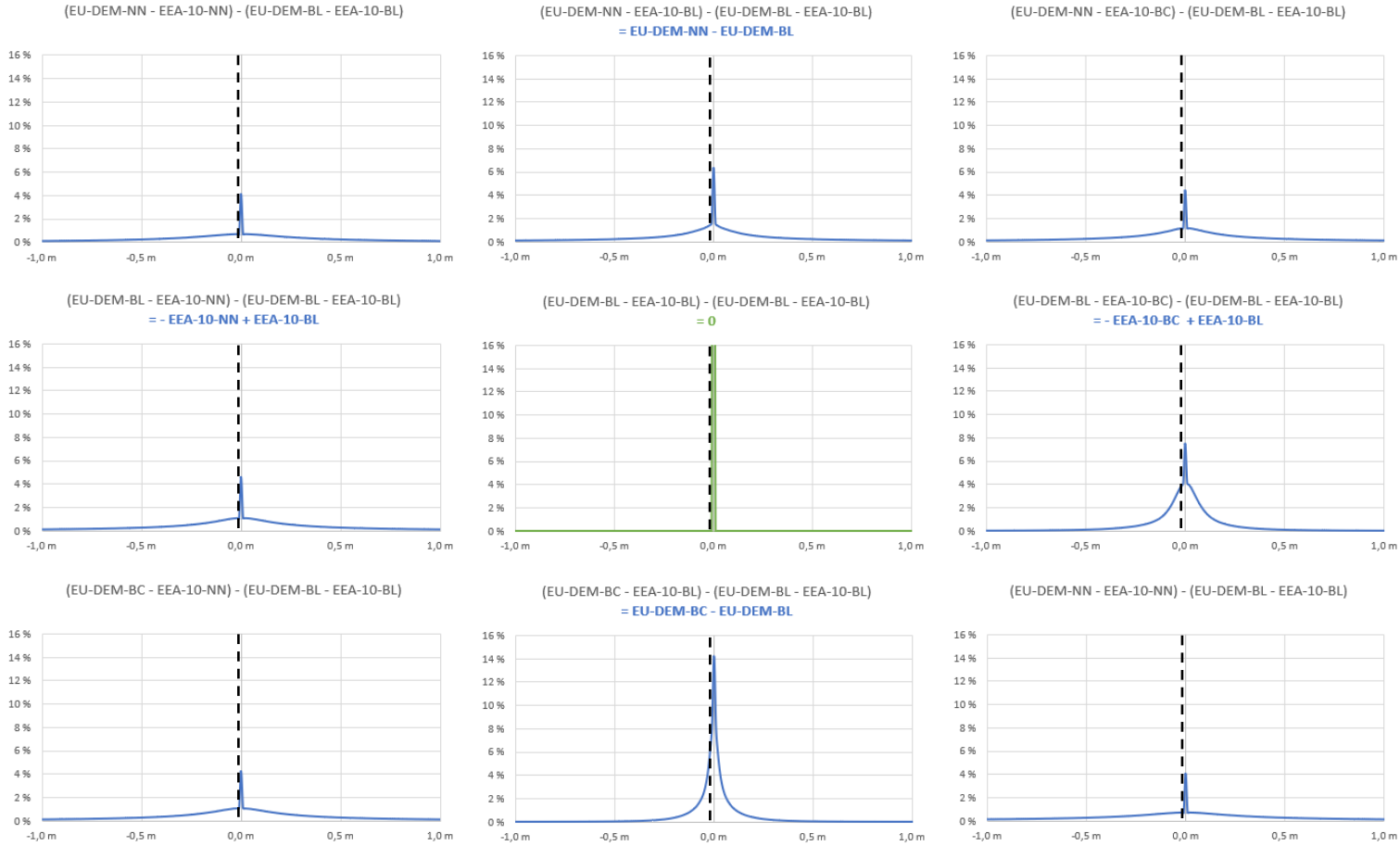


Figure 209 – Statistics of the differences of differences over the 38 European DEMIX tiles.

One may see the highest standard deviation among distributions involving EU-DEM-NN (first line). Similar distributions can be observed for EEA-10-NN (first column), but with a lower standard deviation when compared to EU-DEM-BL and EU-DEM-BC. The best results are obtained comparing {EU-DEM-BL, EU-DEM-BC} to {EEA-10-BL, EEA-10-BC}. Overall, **the bilinear and bicubic sampling methods lead to similar results**. On the opposite, **significant differences can be seen between the nearest neighbour and bilinear sampling methods**.

5.1.3 Influence of the lakes, case of Sweden

Flattened areas, such as lakes, can lead to singularities in the (EU-DEM – EEA-10) difference histograms, which are illustrated in the following figure.

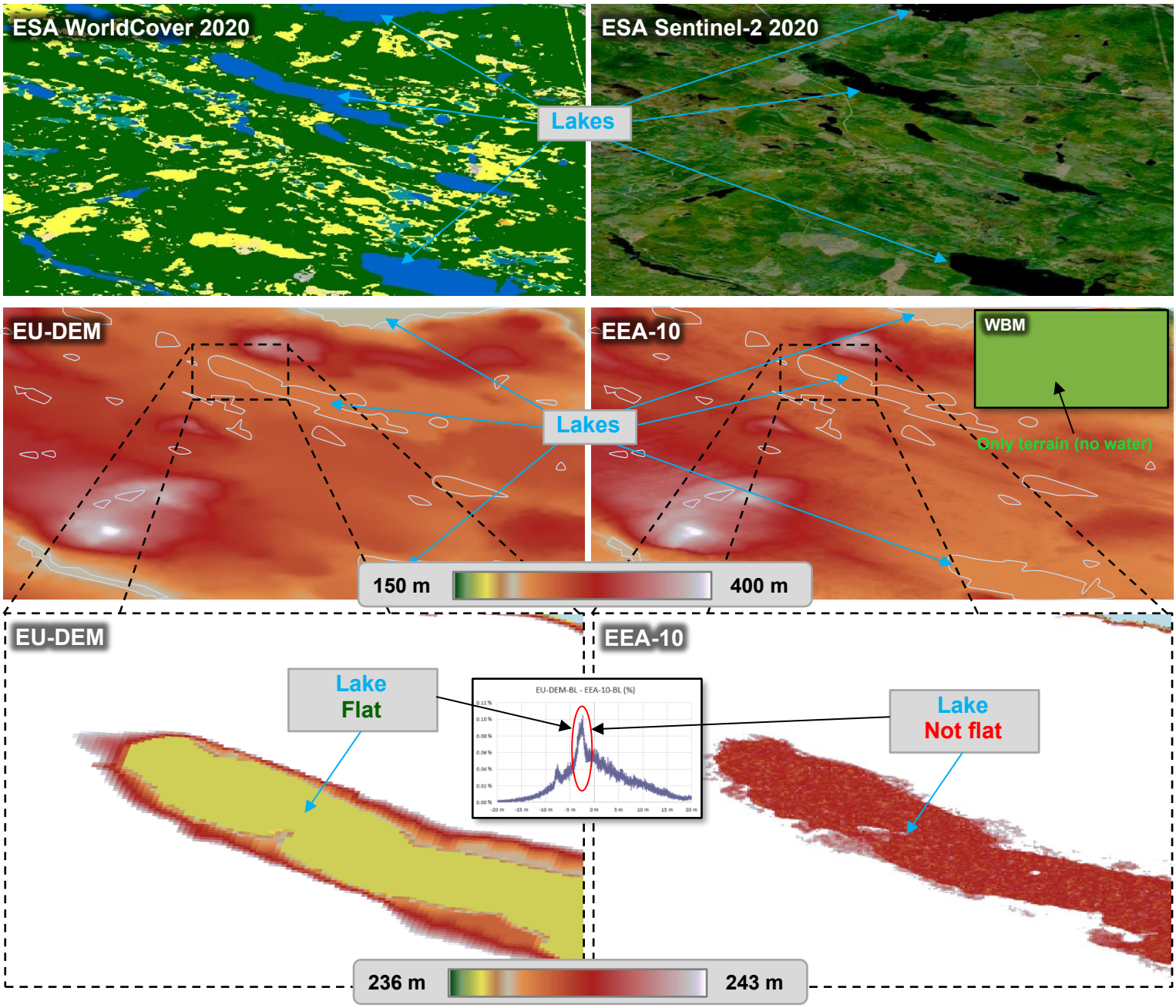


Figure 210 – Flatness of lakes, comparison between EU-DEM and EEA-10 (Sweden, DEMIX tile N66TE020B).

In Figure 210, EU-DEM and EEA-10 are compared over the DEMIX tile N66TE020B (Sweden). Reference images from Sentinel-2 and the ESA WorldCover 2020 classification map clearly show the presence of water bodies over this area (first line of images). An overview of the two DEMs shows flattened areas over lakes for EU-DEM, whereas height variations can be seen for EEA-10 (second line of images). This fact is highlighted in the close views of each DEM over the lakes, for which EU-DEM shows a solid colour and variations can be seen over EEA-10 (third line of images). These facts are underlined by the presence of gaussian distributions with low standard deviations in the difference histograms.

5.1.4 Influence of the tree cover

In this section, (EU-DEM – EEA-10) differences are compared over two land use / land cover classes, respectively named “tree cover” and “no tree cover”. This classification is based-on the ESA WorldCover 2020 map, illustrated in the following figure.

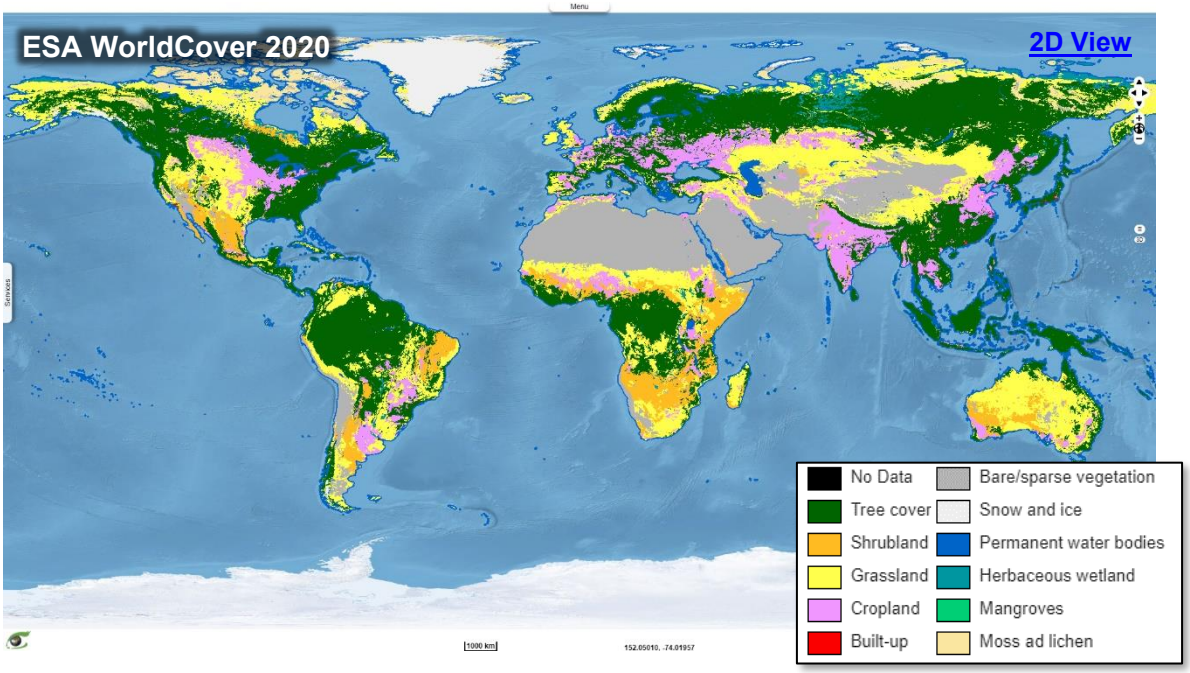


Figure 211 – Overview of the ESA WorldCover 2020 map.

Based on the ESA WorldCover map, the “tree cover” and the “no tree cover” classes of this study consist of the following class remapping.

ESA WorldCover 2020 class	Study class
Tree cover	Tree cover
Shrubland	No tree cover
Grassland	
Cropland	
Built-up	
Bare/sparse vegetation	
Snow and ice	
Permanent water bodies	
Herbaceous wetland	
Mangroves	
Moss ad lichen	

Figure 212 – Tree cover / No tree cover remapping of the ESA WorldCover 2020 map.

For this study, the **(EU-DEM-BL – EEA-10-BL)** difference is chosen, as it obtained the best results in the global differences study (see section 4.1.2).

5.1.4.1 Best overall results with no tree cover

Overall, the best results are obtained over the “no tree cover” class, as illustrated in the following table.

	Tree cover					No tree cover				
	Count	Count (%)	Mean	Std Dev	RMSE	Count	Count (%)	Mean	Std Dev	RMSE
01_Iceland	0	0.0 %	-	-	-	291 600	100.0 %	-5.541 m	11.440 m	12.711 m
02_Norway	1 360	0.5 %	-2.156 m	11.029 m	11.238 m	290 240	99.5 %	-0.513 m	7.581 m	7.599 m
03_Sweden	209 581	71.9 %	1.024 m	9.639 m	9.693 m	82 019	28.1 %	1.653 m	8.007 m	8.175 m
04_Finland	202 782	69.5 %	3.952 m	9.835 m	10.599 m	88 818	30.5 %	5.529 m	6.751 m	8.726 m
05_Estonia	193 277	66.3 %	0.599 m	5.121 m	5.156 m	98 323	33.7 %	0.759 m	2.559 m	2.669 m
06_Latvia	170 438	58.4 %	-0.956 m	7.167 m	7.230 m	121 162	41.6 %	0.112 m	2.630 m	2.632 m
07_Lithuania	164 762	56.5 %	-4.686 m	6.055 m	7.657 m	126 838	43.5 %	-2.141 m	2.165 m	3.045 m
08_Poland	204 187	70.0 %	-6.351 m	5.698 m	8.532 m	87 413	30.0 %	-1.261 m	3.589 m	3.805 m
09_Germany	172 890	59.3 %	-2.200 m	8.045 m	8.340 m	118 710	40.7 %	1.304 m	3.305 m	3.553 m
10_Denmark	74 876	25.7 %	-5.491 m	5.409 m	7.708 m	216 724	74.3 %	-2.099 m	2.022 m	2.915 m
11_Netherlands	19 636	6.7 %	-2.991 m	2.940 m	4.193 m	271 964	93.3 %	-0.945 m	1.209 m	1.534 m
12_Belgium	119 111	40.8 %	-3.744 m	6.004 m	7.076 m	172 489	59.2 %	-0.307 m	2.285 m	2.306 m
13_France	115 068	39.5 %	2.047 m	5.092 m	5.488 m	176 532	60.5 %	1.346 m	3.284 m	3.549 m
14_Spain	32 548	11.2 %	1.215 m	3.061 m	3.294 m	259 052	88.8 %	1.128 m	3.012 m	3.217 m
15_Portugal	167 126	57.3 %	1.811 m	7.579 m	7.792 m	124 474	42.7 %	0.158 m	5.841 m	5.843 m
16_Italy	71 399	24.5 %	-0.468 m	8.341 m	8.354 m	220 201	75.5 %	0.664 m	6.655 m	6.688 m
17_Switzerland	149 128	51.1 %	-4.819 m	16.354 m	17.049 m	142 472	48.9 %	-0.075 m	16.753 m	16.753 m
18_Austria	188 652	64.7 %	-1.409 m	15.451 m	15.515 m	102 948	35.3 %	7.653 m	27.987 m	29.015 m
19_Czechia	135 532	46.5 %	6.428 m	10.442 m	12.262 m	156 068	53.5 %	1.896 m	3.988 m	4.416 m
20_Slovakia	158 357	54.3 %	1.021 m	12.686 m	12.727 m	133 243	45.7 %	4.957 m	11.168 m	12.219 m
21_Hungary	130 948	44.9 %	-5.082 m	5.019 m	7.142 m	160 652	55.1 %	0.291 m	1.841 m	1.864 m
22_Slovenia	170 527	58.5 %	-2.790 m	9.416 m	9.821 m	121 073	41.5 %	2.163 m	4.802 m	5.266 m
23_Croatia	82 393	28.3 %	-7.289 m	6.190 m	9.562 m	209 207	71.7 %	-0.471 m	1.779 m	1.840 m
24_Bosnia and Herzegovina	195 944	67.2 %	-0.441 m	9.510 m	9.520 m	95 656	32.8 %	1.302 m	5.400 m	5.554 m
25_Montenegro	260 526	89.3 %	0.085 m	20.413 m	20.413 m	31 074	10.7 %	1.253 m	26.309 m	26.339 m
26_Albania	117 820	40.4 %	-2.086 m	7.686 m	7.963 m	173 780	59.6 %	-0.411 m	5.099 m	5.116 m
27_North Macedonia	26 675	9.1 %	-2.613 m	7.135 m	7.598 m	264 925	90.9 %	-1.566 m	5.693 m	5.904 m
28_Serbia	61 494	21.1 %	-3.537 m	5.191 m	6.282 m	230 106	78.9 %	-1.051 m	3.194 m	3.362 m
29_Romania	186 413	63.9 %	-1.655 m	8.567 m	8.726 m	105 187	36.1 %	1.599 m	5.086 m	5.331 m
30_Bulgaria	172 719	59.2 %	-2.667 m	7.569 m	8.025 m	118 881	40.8 %	0.360 m	1.844 m	1.879 m
31_Greece	72 505	25.0 %	-1.827 m	13.775 m	13.896 m	217 930	75.0 %	3.960 m	7.188 m	8.206 m
32_Turkey	1 242	0.4 %	5.391 m	5.587 m	7.764 m	290 358	99.6 %	-6.204 m	9.296 m	11.176 m
33_England	101 432	34.8 %	-2.624 m	5.794 m	6.361 m	190 168	65.2 %	1.260 m	3.457 m	3.679 m
34_Ireland	45 493	15.6 %	-1.580 m	6.113 m	6.314 m	246 107	84.4 %	0.105 m	2.395 m	2.398 m
35_Northern Ireland	44 024	15.1 %	-2.046 m	7.495 m	7.769 m	247 576	84.9 %	-0.014 m	4.270 m	4.270 m
36_Cyprus	143 834	49.3 %	-0.055 m	10.736 m	10.736 m	147 766	50.7 %	0.686 m	8.858 m	8.885 m
37_Luxembourg	179 198	61.5 %	-2.833 m	7.841 m	8.337 m	112 402	38.5 %	0.844 m	4.197 m	4.281 m
38_Malta	12 738	5.7 %	0.317 m	12.826 m	12.830 m	212 456	94.3 %	0.922 m	9.290 m	9.336 m
All	4 556 635	41,4 %	-1,312 m	10,448 m	10,530 m	6 456 594	58,6 %	-0,006 m	7,814 m	7,814 m

Figure 213 – Statistics of the (EU-DEM-BL - EEA-10-BL) study, classified by tree cover / no tree cover.

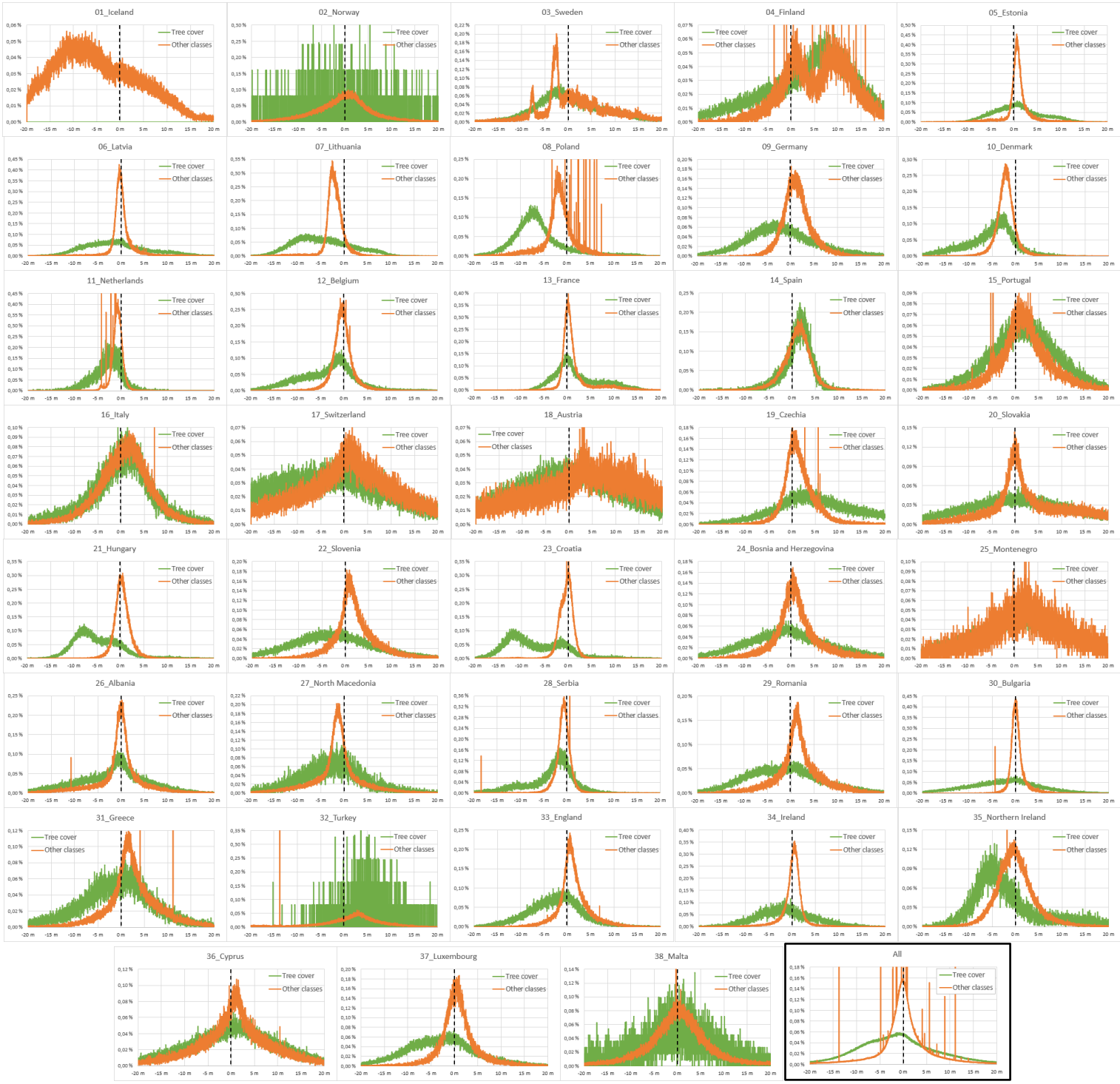


Figure 214 – Histograms of the (EU-DEM-BL - EEA-10-BL) study, classified by tree cover / no tree cover.

As illustrated in Figure 214, different “tree cover” and “no tree cover” distributions can be seen over the 38 DEMIX tiles of this study. In these histograms, both “tree cover” and “no tree cover” are **normalized by their respective number of samples**, allowing to compare the shapes of each distribution. The last histogram, in which all the 38 tiles are considered, shows a zero-centred gaussian distribution for the ‘no tree cover” classes, with a low standard deviation. On the opposite, the “tree cover” class clearly highlights two gaussian distributions with high standard deviations. The first gaussian distribution, with a bias of -5.95 metres, can be linked to the high vegetations (see next section 5.1.4.2). The second gaussian distribution, with a bias of -1.04 metres, can be linked to low / sparse vegetation (see section 5.1.4.3).

5.1.4.2 Effect of high trees on differences

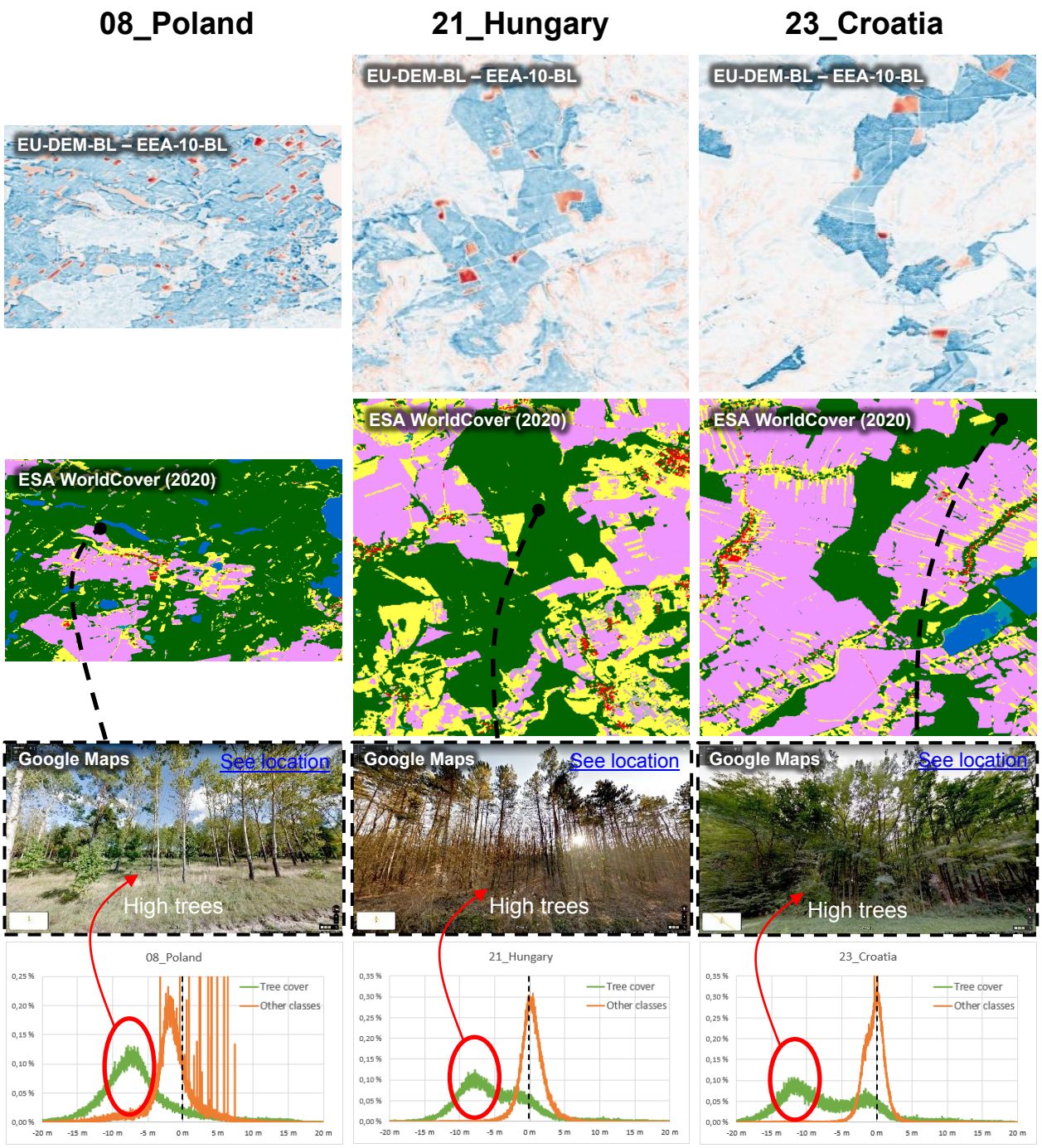


Figure 215 – Effect of high trees on (EEA-10 – EU-DEM) differences - case of Poland, Hungary and Croatia.

As illustrated in Figure 215, negative (EEA-10 – EU-DEM) differences can be seen over the tree cover distribution of Poland, Hungary and Croatia. These gaussian distributions, circled in red, are caused by the presence of high trees in the three study areas. One may note a second gaussian distribution over Hungary and Croatia, with modes of -1.81 metres and -1.23 metres respectively. These gaussian distributions may be due to low or sparse vegetation (see next section 5.1.4.3).

5.1.4.3 Effect of low and sparse vegetation on differences

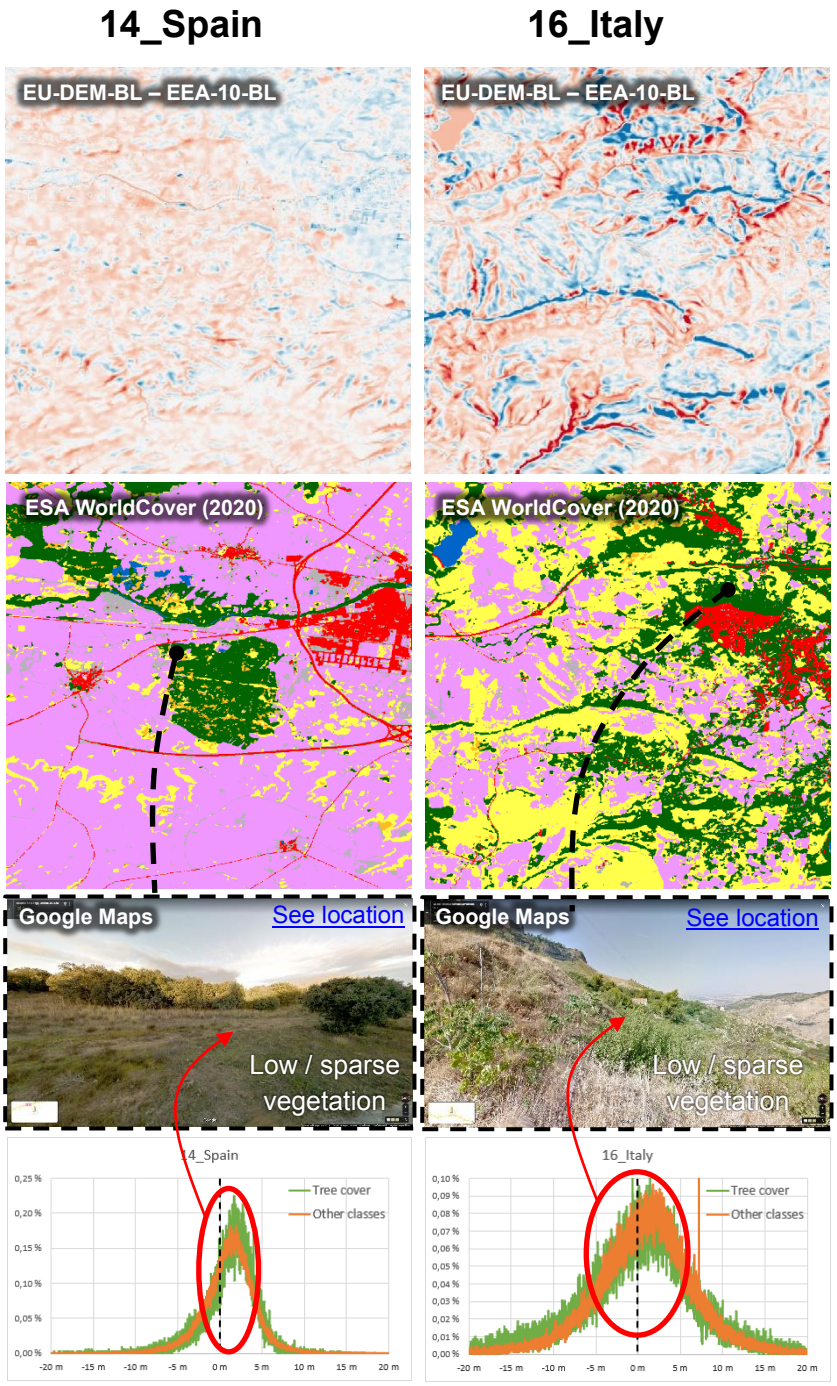
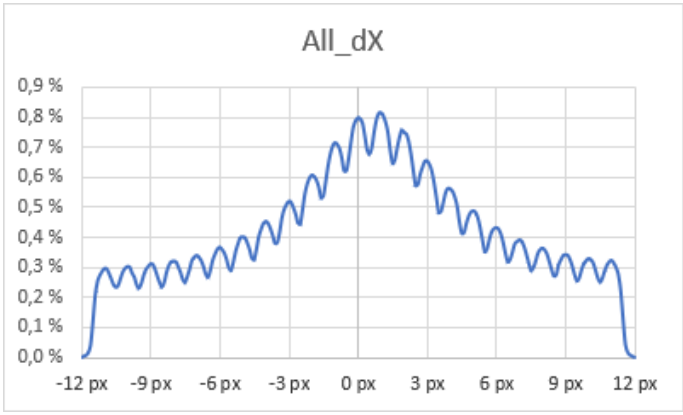


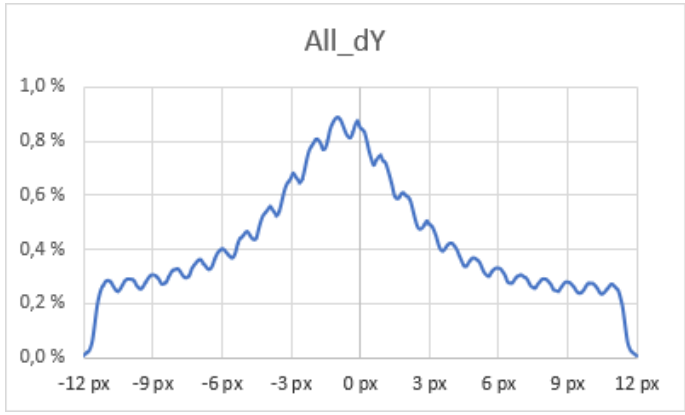
Figure 216 – Effect of low / sparse vegetation on (EEA-10 – EU-DEM) differences - case of Spain and Italy.

As illustrated in Figure 216, (EEA-10 – EU-DEM) differences show similar distributions over tree cover and other classes. This low variation between the “tree cover” and “no tree cover” classes is caused by low and sparse vegetation in the two study areas. These low vegetation areas are identified as the “Tree cover” class in the original ESA WorldCover classification.

5.2 Study 2 - Disparity analysis

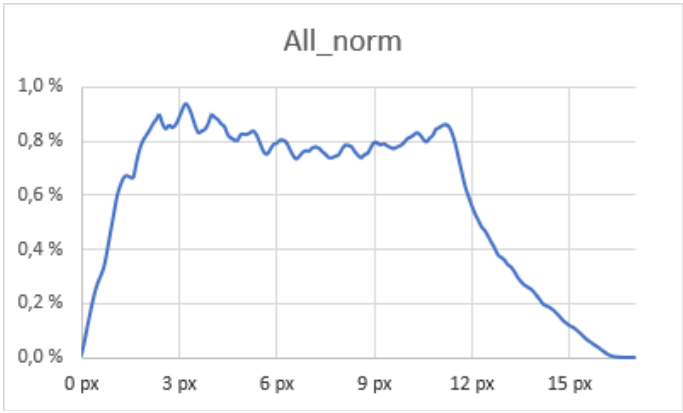
5.2.1 Overall displacements

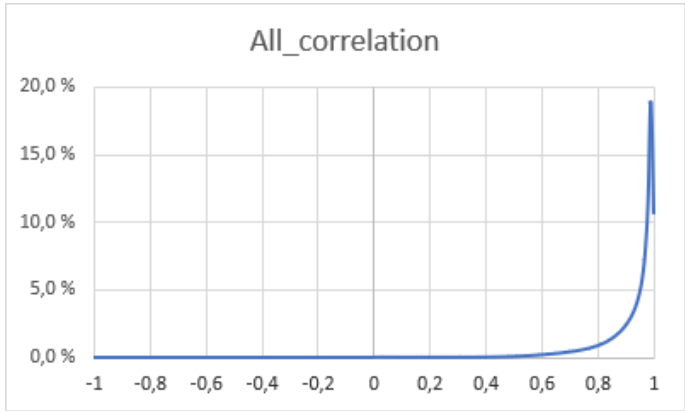




Count	Min	Max	Mean	Std Dev
8 348 303	-12,0 px	12,0 px	0,345 px	5,688 px

Count	Min	Max	Mean	Std Dev
8 348 303	-12,0 px	12,0 px	-0,352 px	5,498 px





Count	Min	Max	Mean	Std Dev
8 348 303	0,000 px	16,813 px	6,985 px	3,746 px

Count	Min	Max	Mean	Std Dev
8 348 303	-0,917	1,000	0,919	0,113

Figure 217 – Statistics of disparity analysis between EU-DEM and EEA-10 over all 38 European DEMIX Tiles

As shown in section 4.2.2, **Over the 38 DEMIX tiles, the mean dX and dY displacement from EEA-10 to EU-DEM is low** (0.345 px for dX, -0.352 px for dY). However, **the standard deviation of the dX and dY displacements is high** (5.688 px for dX, and 5.498 px for dY). Both dX and dY look like gaussian distributions, with an aliasing effect every 1 pixel. This effect is further explained in beginning of section 4.2.1 (see paragraph “Histograms and statistics”).

The mean mode is high (6.985 pixels) meaning that **important displacements are observed from EEA-10 to EU-DEM**.

The overall correlation is really high, with a mean value of 0.919. One may see a tail of distribution in the [0.5, 0.8] correlation range. These lower correlation values are due to flat areas.

5.2.2 Uniform displacements, case of Malta

In this DEMIX tile of Malta, an important uniform displacement between EU-DEM and EEA-10 is visible on the Y-axis.

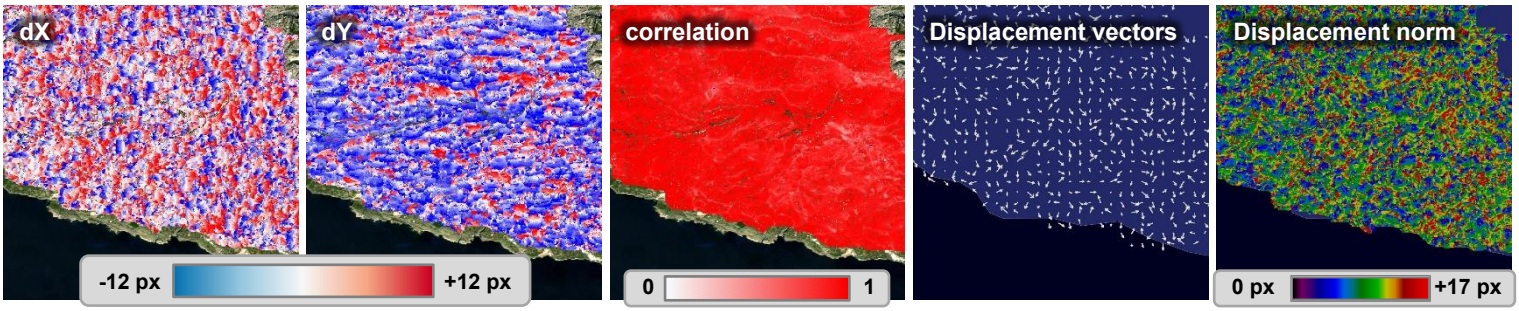


Figure 218 – EEA-10 vs. EU-DEM disparity analysis – Overview of results in Malta.

Figure 218 is an overview of the images produced by the disparity analysis over Malta (see section 4.2.1.38 for full results). One may note a high number of negative displacements over the dY image, which is magnified in the following figure. In other words, for most of the EEA-10 reference pixels, homologous pixels are found in more southern areas of EU-DEM.

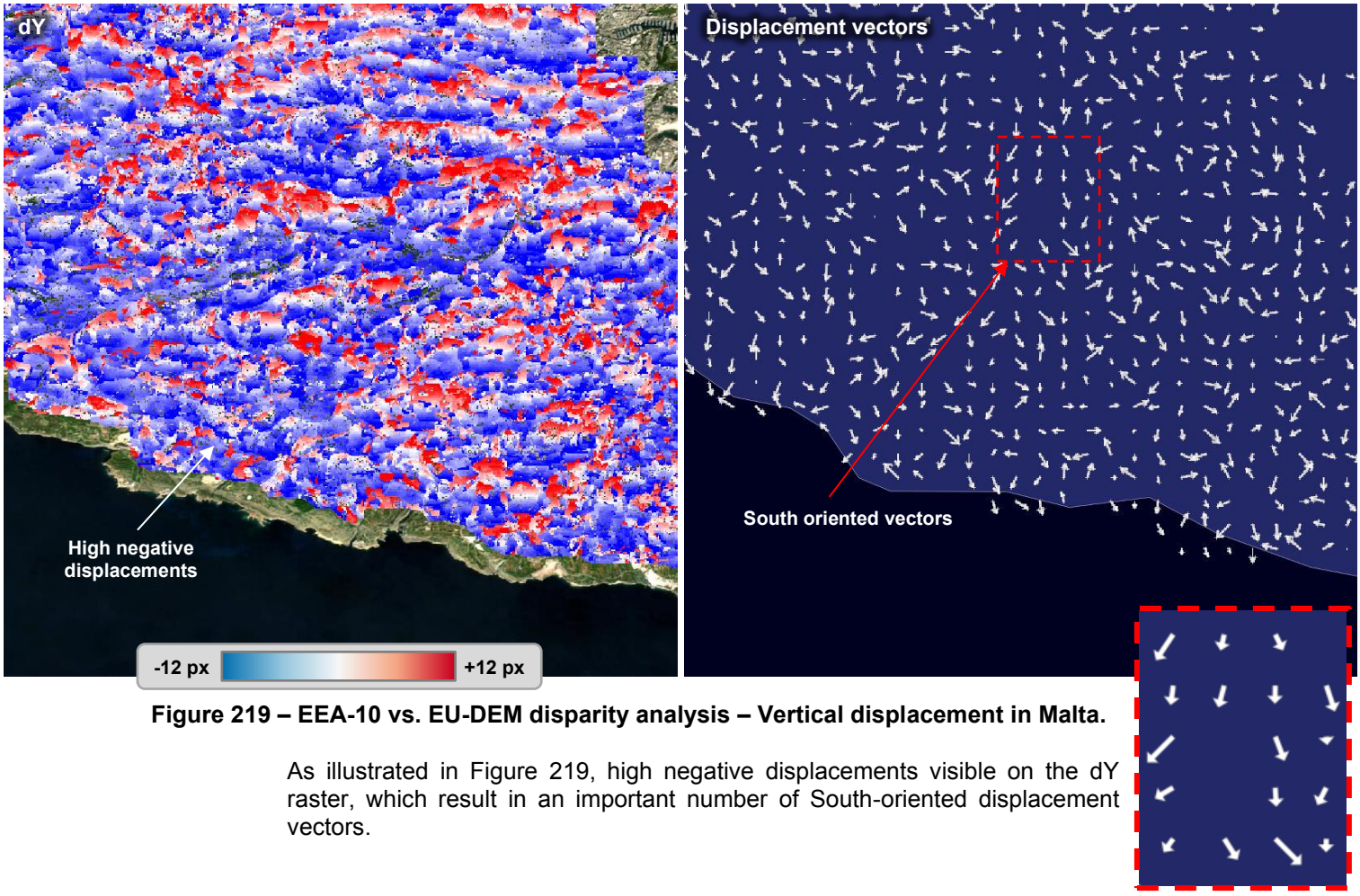
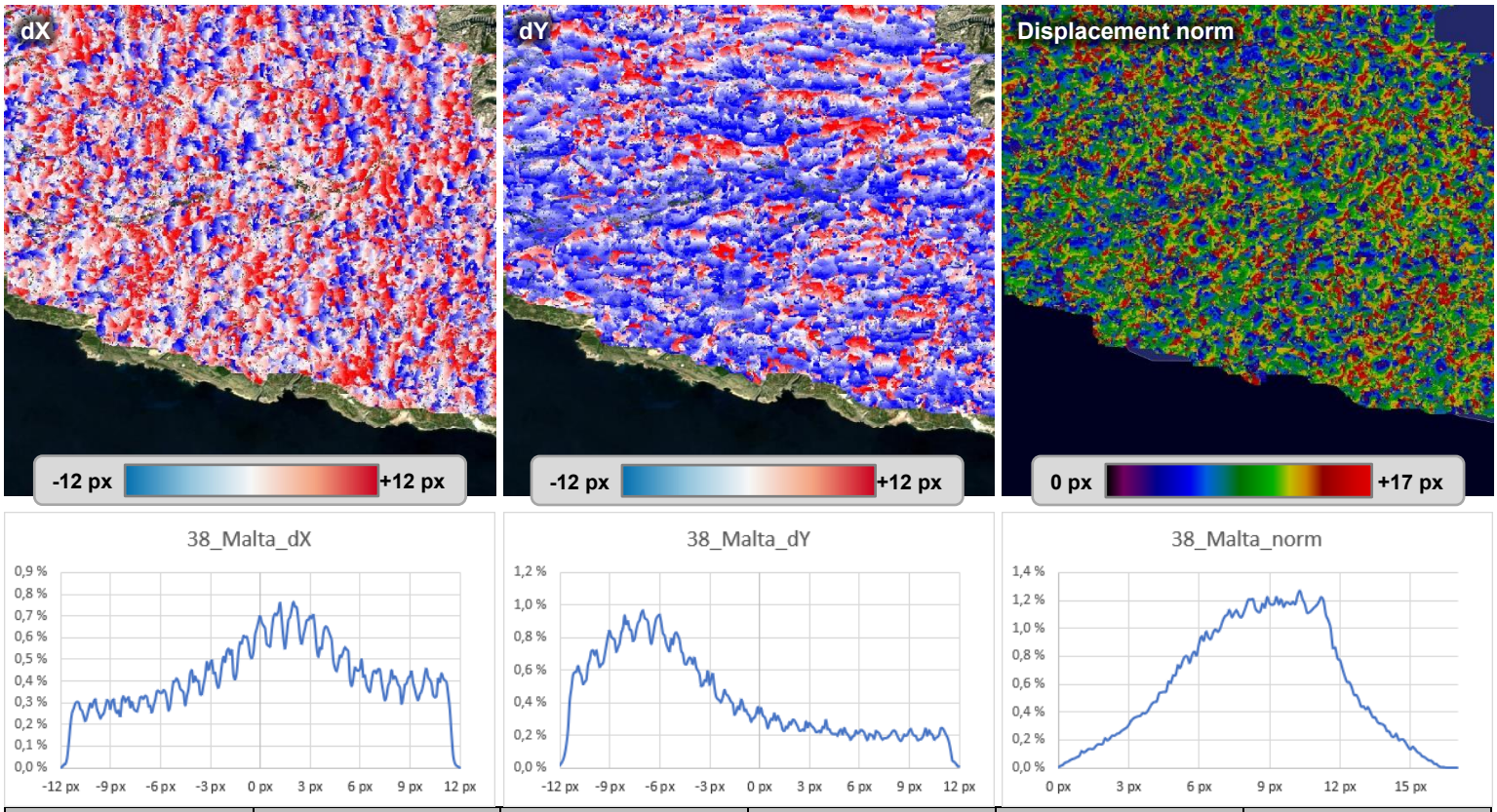


Figure 219 – EEA-10 vs. EU-DEM disparity analysis – Vertical displacement in Malta.

As illustrated in Figure 219, high negative displacements visible on the dY raster, which result in an important number of South-oriented displacement vectors.



Study	Count	Min	Max	Mean	Std Dev
dX	158716	-12,0 px	12,0 px	0,794 px	5,912 px
dY	158716	-12,0 px	12,0 px	**-3,299 px**	5,962 px
norm	158716	0,000 px	16,491 px	**8,521 px**	3,068 px

Figure 220 – EEA-10 vs. EU-DEM disparity analysis statistics - Vertical displacement in Malta.

As shown in Figure 220, the dY distribution shows a high number of negative values. The dY distribution looks gaussian, with a negative mode of -7.1 pixels, a mean of -3.299 pixels and a standard deviation of 5.962 pixels.

The displacement norm mean reaches 8.521 pixels, mainly caused by the high displacements observed on the Y-axis.

No correlation between these displacements and land use / land cover or source data has been found (see section 4.2.1.38).

5.2.3 Influence of the land use, case of Bulgaria

In this DEMIX tile of Bulgaria, multiple clusters of low displacements are observed. For this case study, the displacements between EU-DEM and EEA-10 seem linked to the land use.

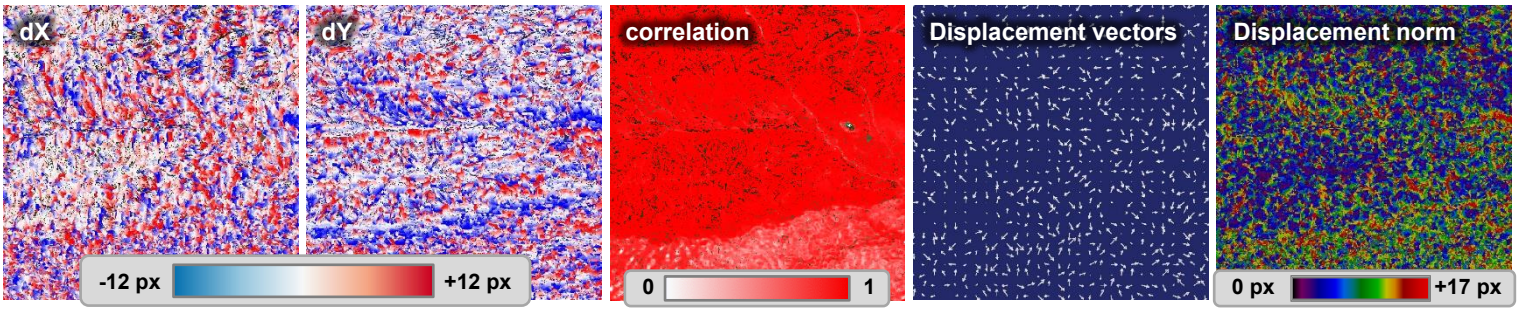


Figure 221 – EEA-10 vs. EU-DEM disparity analysis – Overview of results in Bulgaria.

Figure 221 is an overview of the images produced by the disparity analysis over Bulgaria (see section 4.2.1.30 for full results). One may see clusters of low displacement norms in the North of this tile; which is magnified in the following figure.

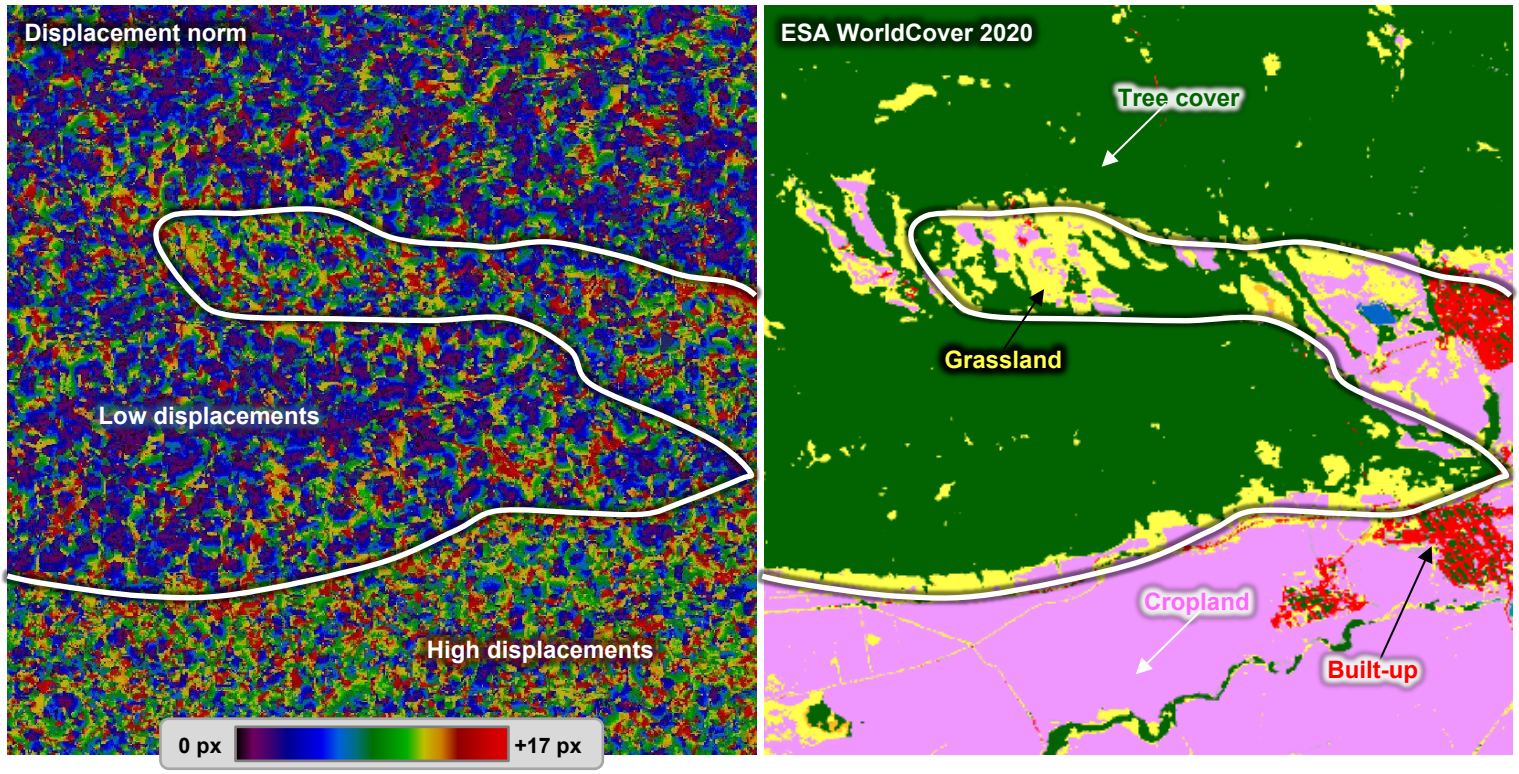
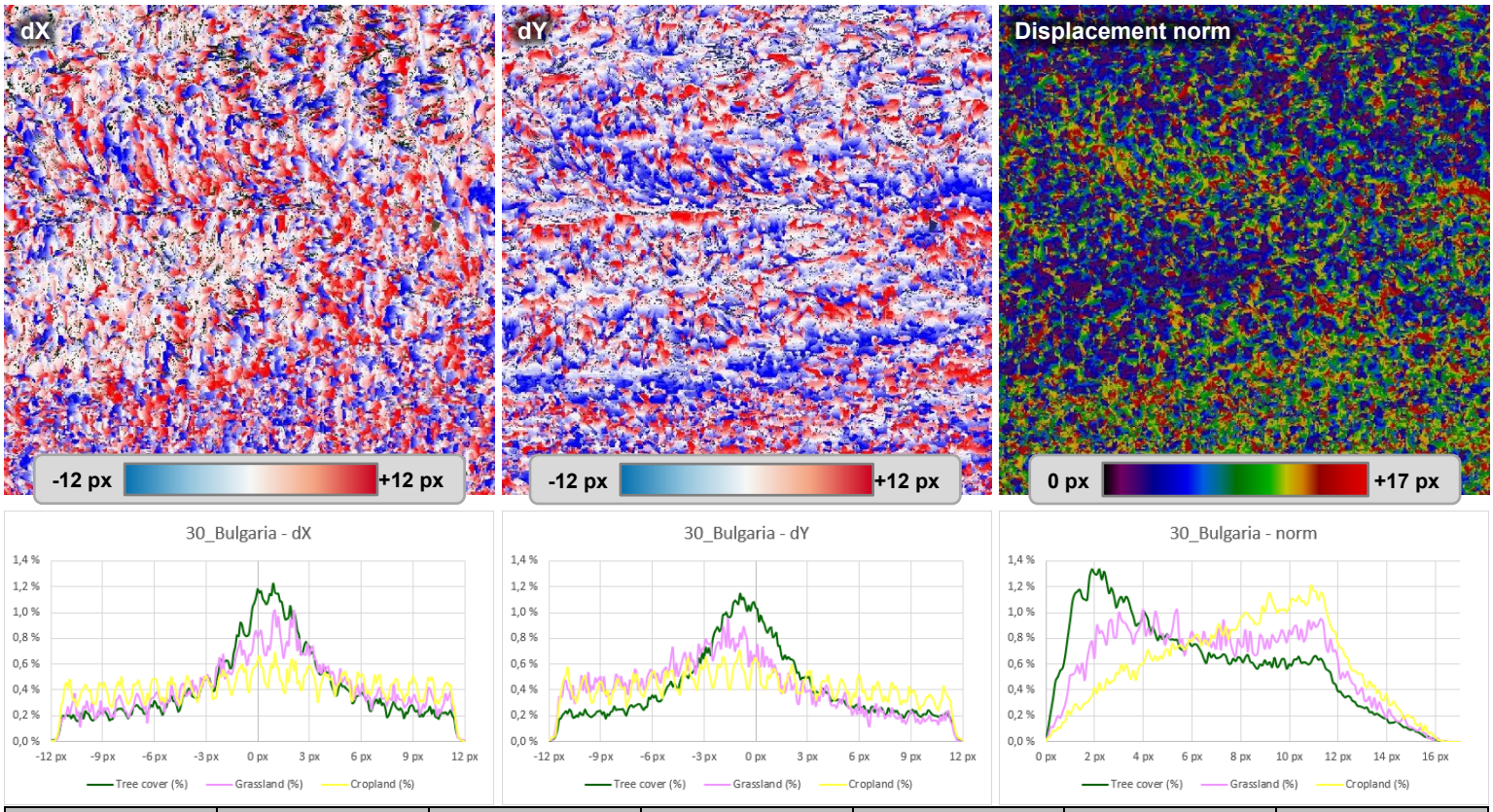


Figure 222 – EEA-10 vs. EU-DEM disparity analysis - Influence of land use / land cover in Bulgaria.

As illustrated in Figure 222Figure 219, low displacements norms are observed on the North and centre of the tile, whereas high displacements are seen over the South. One may see a vast majority of low displacements matching the “Tree cover” class of the ESA WorldCover 2020 map. Higher displacements seem to be linked to the “Cropland”, “Grassland” and Built-up classes.



Study	Class	Count	Min	Max	Mean	Std Dev
dX	Tree cover	134 656	-11,996 px	11,966 px	0,466 px	4,990 px
	Grassland	22 022	-11,962 px	11,989 px	0,604 px	5,519 px
	Cropland	60 607	-11,996 px	11,924 px	0,239 px	6,356 px
dY	Tree cover	134 656	-11,987 px	11,989 px	-0,314 px	5,036 px
	Grassland	22 022	-11,983 px	11,990 px	-1,655 px	5,556 px
	Cropland	60 607	-11,988 px	11,989 px	-0,435 px	6,263 px
norm	Tree cover	134 656	0,000 px	16,550 px	6,006 px	3,810 px
	Grassland	22 022	0,000 px	16,360 px	7,125 px	3,697 px
	Cropland	60 607	0,000 px	16,458 px	8,231 px	3,481 px

Figure 223 – EEA-10 vs. EU-DEM disparity analysis statistics - Influence of land use / land cover in Bulgaria.

In Figure 202, distributions of the dX, dY and displacement norms are given. The samples of each histogram are classified using the ESA WorldCover 2020 map. Only the “Tree cover”, “Grassland” and “Cropland” classes are used, as they are the most represented classes in this tile (see LULC map on preceding page). Each class distribution is normalized by its number of samples. This normalization allows to directly compare the shapes of the distributions between classes.

The dX statistics and histograms highlight the lowest mean for “Cropland” (0.239 pixels), followed by “Tree cover” (0.466 pixels) and “Grassland” (0.604 pixels). However, a lower standard deviation is retrieved for the “Tree cover” class (4.990 pixels) than for the “Grassland” (5.519 pixels) and “Cropland” (6.356 pixels) classes.

The dY statistics and histograms highlight low means for “Tree cover” and “Cropland” classes (-0.314 and -0.435 pixels, respectively), but a high mean for “Grassland” (-1.655 pixels) due to a left skew over the distribution. Once again, a lower standard deviation is retrieved for the “Tree cover” class (5.036 pixels) than for the “Grassland” (5.556 pixels) and “Cropland” (6.263 pixels) classes.

The norm statistics and histograms show a **lower mean displacement for “Tree cover”** (6.006 pixels) **than for “Grassland”** (7.125 pixels) **and “Cropland”** (8.231 pixels). One may see the high number of low displacements in the “Tree cover” histogram (between 1 and 3 pixels) as opposed to the “Grassland” and “Cropland” classes.

5.2.4 Influence of the source data, case of Montenegro

In this DEMIX tile of Montenegro, multiple clusters of low displacements are observed. For this case study, the displacements between EU-DEM and EEA-10 seem linked to the source data used to generate both DEMs.

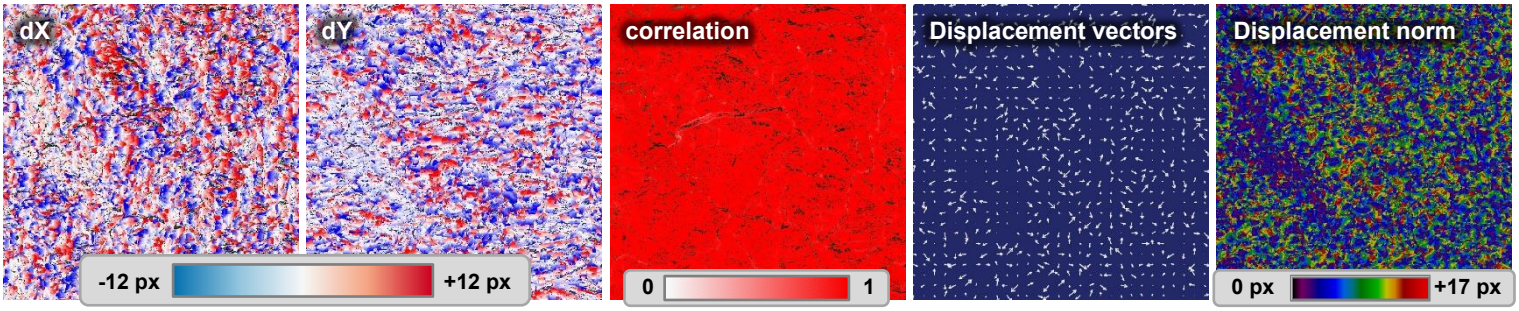


Figure 224 – EEA-10 vs. EU-DEM disparity analysis – Overview of results in Montenegro.

Figure 224 is an overview of the images produced by the disparity analysis over Montenegro (see section 4.1.1.25 for full results). One may see clusters of low displacement norms in the West of this tile; which is magnified in the following figure.

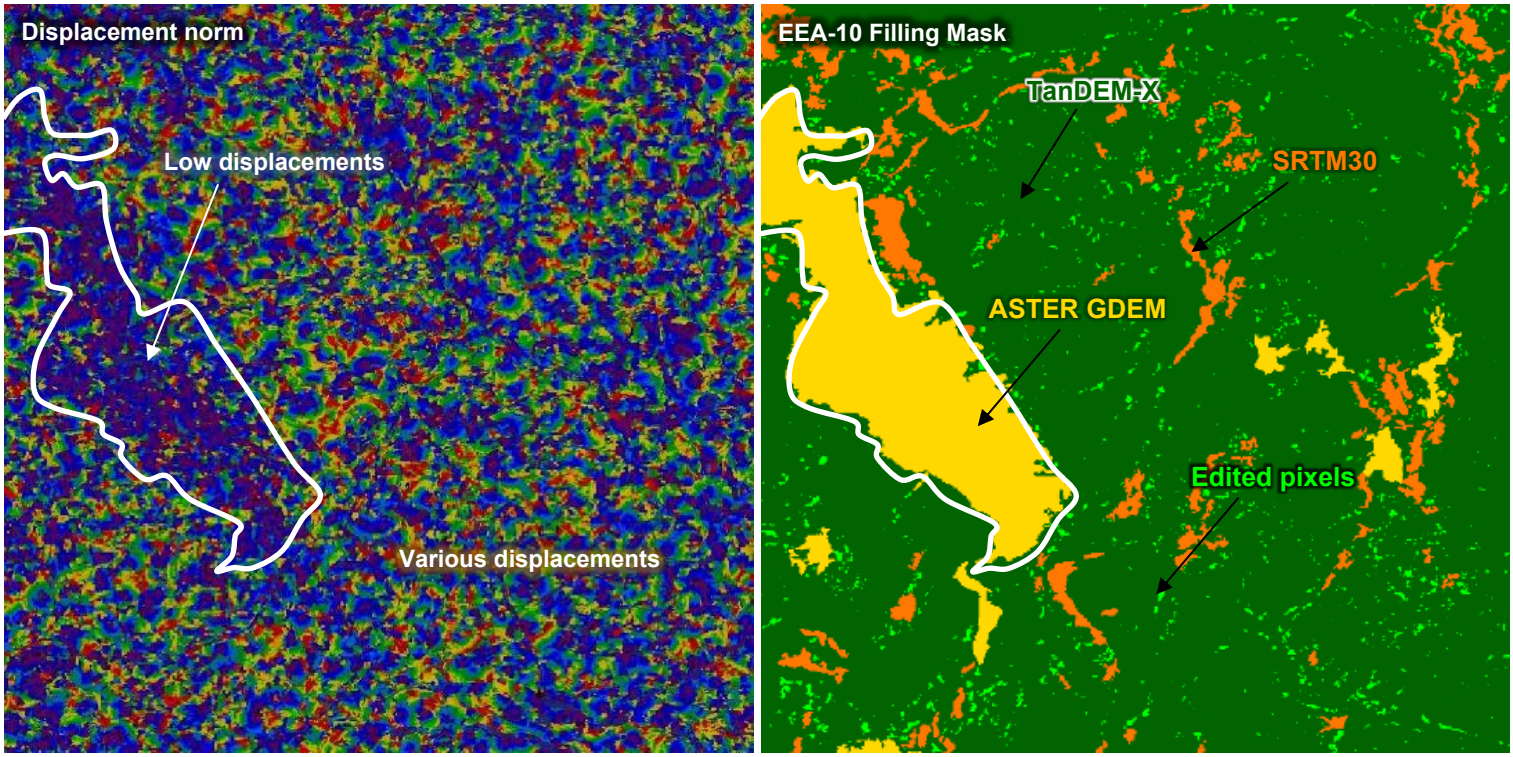
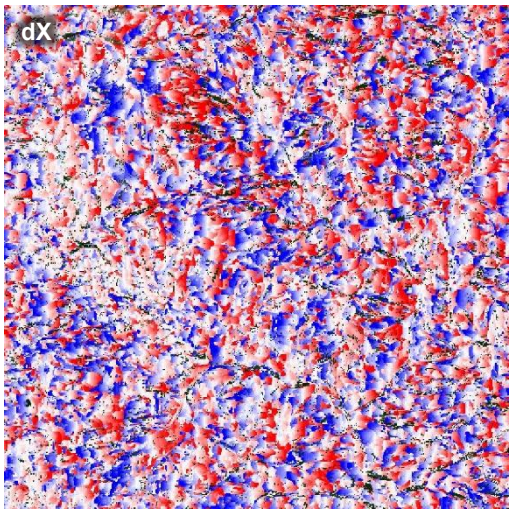
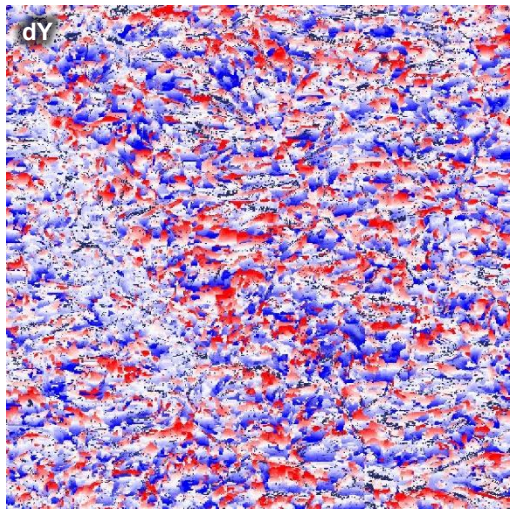
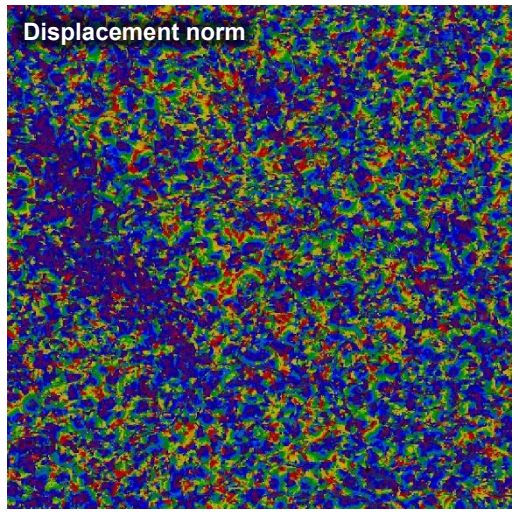


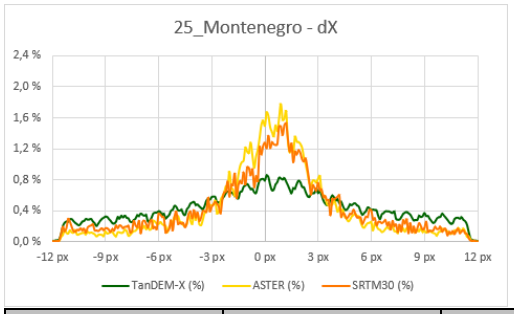
Figure 225 – EEA-10 vs. EU-DEM disparity analysis - Influence of source data in Montenegro.

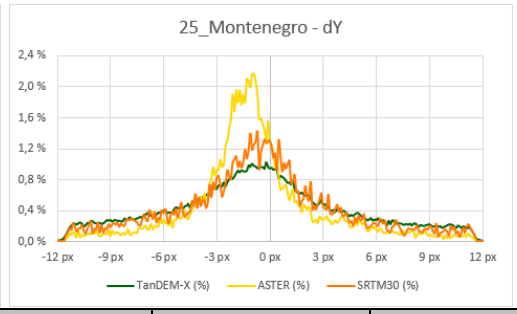
As illustrated in Figure 225Figure 219, low displacements norms are observed on the West of the tile, whereas various displacements can be seen over the other areas. One may see a vast majority of low displacements matching the “ASTER” data of the EEA-10 Filling Mask.

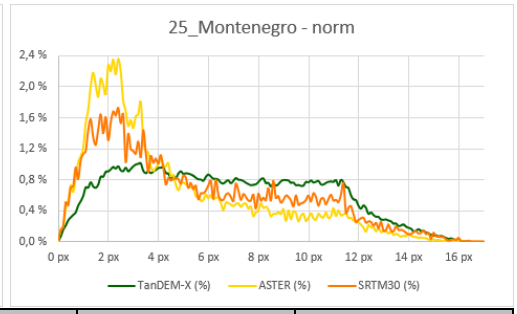












Study	Class	Count	Min	Max	Mean	Std Dev
dX	TanDEM-X	194 067	-11,984 px	11,990 px	0,277 px	5,597 px
	ASTER	25 209	-11,737 px	11,911 px	0,394 px	4,065 px
	SRTM30	10 812	-11,950 px	11,998 px	0,289 px	4,593 px
dY	TanDEM-X	194 067	-11,998 px	11,995 px	-0,553 px	5,125 px
	ASTER	25 209	-11,978 px	11,989 px	-0,871 px	3,743 px
	SRTM30	10 812	-11,903 px	11,988 px	-0,589 px	4,644 px
norm	TanDEM-X	194 067	0,000 px	16,594 px	6,667 px	3,678 px
	ASTER	25 209	0,000 px	16,375 px	4,500 px	3,347 px
	SRTM30	10 812	0,000 px	16,376 px	5,424 px	3,698 px

Figure 226 – EEA-10 vs. EU-DEM disparity analysis statistics - Influence of source data in Montenegro.

In Figure 226, distributions of the dX, dY and displacement norms are given. The samples of each histogram are classified using the EEA-10 Filling Mask (FLM). Only the "TanDEM-X", "ASTER" and "SRTM30" data sources are used, as they are the most represented data sources in this tile (see EEA-10 Filling Mask on preceding page). Each data source distribution is normalized by its number of samples. This normalization allows to directly compare the shapes of the distributions between data sources.

The dX statistics and histograms highlight the lowest mean for "TanDEM-X" (0.277 pixels), followed by "SRTM30" (0.289 pixels) and "ASTER" (0.394 pixels). However, a lower standard deviation is retrieved for "ASTER" (4.065 pixels) than for the "SRTM30" (4.593 pixels) and "TanDEM-X" (5.597 pixels) data sources.

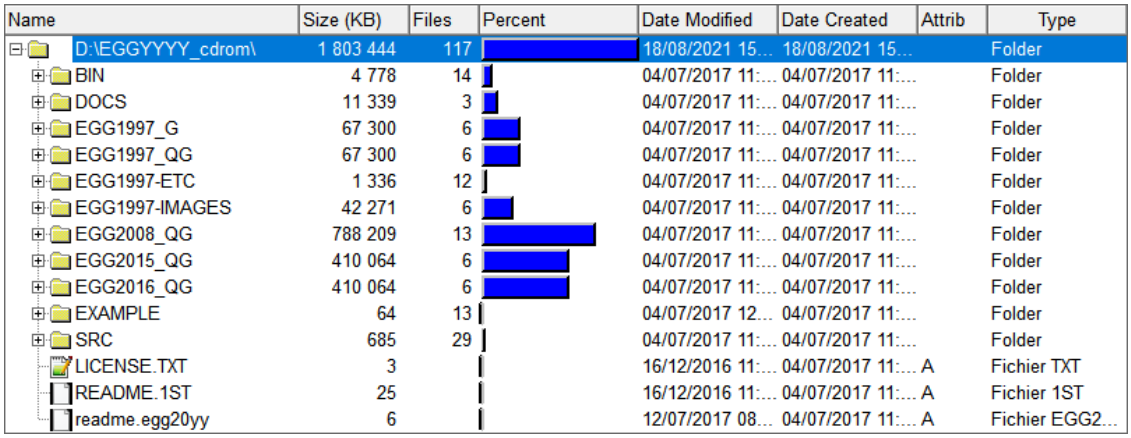
The dY statistics and histograms highlight low means for "TanDEM-X" and "SRTM30" data sources (-0.553 and -0.589 pixels, respectively), but a higher mean for "ASTER" (-0.871 pixels). Once again, a lower standard deviation is retrieved for the "ASTER" data source (3.743 pixels) than for the "SRTM30" (4.644 pixels) and "TanDEM-X" (5.125 pixels) data sources.

The norm statistics and histograms show a **lower mean displacement for "ASTER" data** (3.347 pixels) **than for "SRTM30"** (3.698 pixels) **and "TanDEM-X"** (3.678 pixels) **data**.

ANNEX A VERTICAL DATUM EGG2008

As stated in section 3.1, EU-DEM vertical datum is the EVRS2000 – EGG08. This geoid has been provided by Heiner DENKER (denker@ife.uni-hannover.de) with the following download URL https://dl.uni-h.de/?t=1044b5fb55a36832942a0294e5712a64.

The downloaded file is a ZIP archive containing several EGG versions including the EGG2008 as shown here after.



Name	Size (KB)	Files	Percent	Date Modified	Date Created	Attrib	Type
D:\EGGYYYY_cdrom\	1 803 444	117		18/08/2021 15...	18/08/2021 15...		Folder
BIN	4 778	14		04/07/2017 11:...	04/07/2017 11:...		Folder
DOCS	11 339	3		04/07/2017 11:...	04/07/2017 11:...		Folder
EGG1997_G	67 300	6		04/07/2017 11:...	04/07/2017 11:...		Folder
EGG1997_QG	67 300	6		04/07/2017 11:...	04/07/2017 11:...		Folder
EGG1997-ETC	1 336	12		04/07/2017 11:...	04/07/2017 11:...		Folder
EGG1997-IMAGES	42 271	6		04/07/2017 11:...	04/07/2017 11:...		Folder
EGG2008_QG	788 209	13		04/07/2017 11:...	04/07/2017 11:...		Folder
EGG2015_QG	410 064	6		04/07/2017 11:...	04/07/2017 11:...		Folder
EGG2016_QG	410 064	6		04/07/2017 11:...	04/07/2017 11:...		Folder
EXAMPLE	64	13		04/07/2017 12...	04/07/2017 11:...		Folder
SRC	685	29		04/07/2017 11:...	04/07/2017 11:...		Folder
LICENSE.TXT	3			16/12/2016 11:...	04/07/2017 11:...	A	Fichier TXT
README.1ST	25			16/12/2016 11:...	04/07/2017 11:...	A	Fichier 1ST
readme.egg20yy	6			12/07/2017 08...	04/07/2017 11:...	A	Fichier EGG2...

Figure 227 – EGGYYYY folder content.

The EGG2008 in the folder "EGG2008_QG" is available in three formats:

- ASCII format – EGG2008_QG/ASCII/egg2008_evrs2007_fmt
- DOS format – EGG2008_QG/DOS/egg2008.bin
- UNIX format – EGG2008_QG/UNIX/egg2008.bin

To ingest this geoid in VtWeb, we use the **DOS format** which is a raw binary format encoded in little endian. The table here after shows the structure of the DOS file. The geoid heights are stored in rows from West to East, the first row corresponding to the North and the last row to the South. There are 3 600 rows per 7 200 columns of elevation data.

Offset	Size	Type	Description
0	4	Integer (4 bytes)	Min latitude degree
4	4	Integer (4 bytes)	Min latitude minute
8	4	Integer (4 bytes)	Min latitude seconds (x 10 000)
12	4	Integer (4 bytes)	Max latitude degree
16	4	Integer (4 bytes)	Max latitude minute
20	4	Integer (4 bytes)	Max latitude seconds (x 10 000)
24	4	Integer (4 bytes)	Min longitude degree
28	4	Integer (4 bytes)	Min longitude minute
32	4	Integer (4 bytes)	Min longitude seconds (x 10 000)
36	4	Integer (4 bytes)	Max longitude degree
40	4	Integer (4 bytes)	Max longitude minute
44	4	Integer (4 bytes)	Max longitude seconds (x 10 000)
48	4	Integer (4 bytes)	Latitude spacing degree
52	4	Integer (4 bytes)	Latitude spacing minute
56	4	Integer (4 bytes)	Latitude spacing seconds (x 10 000)
60	4	Integer (4 bytes)	Longitude spacing degree
64	4	Integer (4 bytes)	Longitude spacing minute

Offset	Size	Type	Description
68	4	Integer (4 bytes)	Longitude spacing seconds (x 10 000)
72	4	Integer (4 bytes)	First geoid height in millimetres
72+4*n	4	Integer (4 bytes)	N^{th} geoid height in millimetres

Table 3 – EGG2008 DOS file format.

After ingestion in VtWeb, the geoid is displayable, and can be compared to other geoids and be added to EU-DEM to retrieve elevation above ellipsoid.

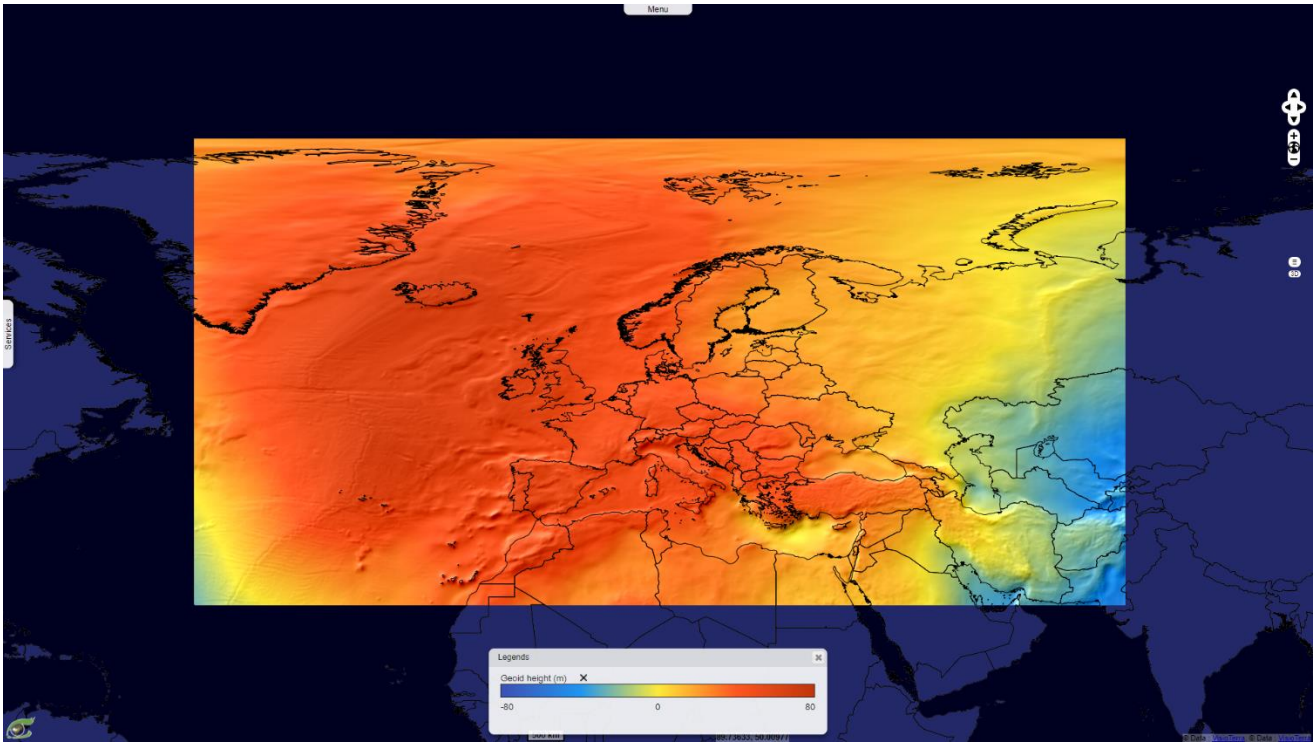


Figure 228 – View of the EGG2008 geoid between -/+ 80 metres.