Florida Southeast Lidar Edge-Tie Analysis with Everglades National Park and Palm Beach County Lidar

Report Produced for U.S. Geological Survey

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Introduction

Under the Florida Southeast AOI lidar collection scope of work (contract G16PC00020), Dewberry was tasked to evaluate how well the newly produced Florida Southeast lidar data (acquired in 2018) ties spatially to preexisting lidar data produced for Everglades National Park to the south and Palm Beach County to the north. The lidar data for Everglades was acquired in 2017 for the USGS under contract G10PC00020, and the lidar data for Palm Beach County was originally acquired in 2016 for the USGS under contract G16PD00020. Dewberry has compared the new Florida Southeast lidar data to the Everglades and Palm Beach lidar data where the two datasets overlap. The results are detailed in the following sections.

Florida Southeast and Everglades Edge-Tie Analysis

There are 90 Florida Southeast tiles which overlap with 69 Everglades tiles of lidar data. The area of overlap, shown in Figure 1, is approximately 27.3 km^2.

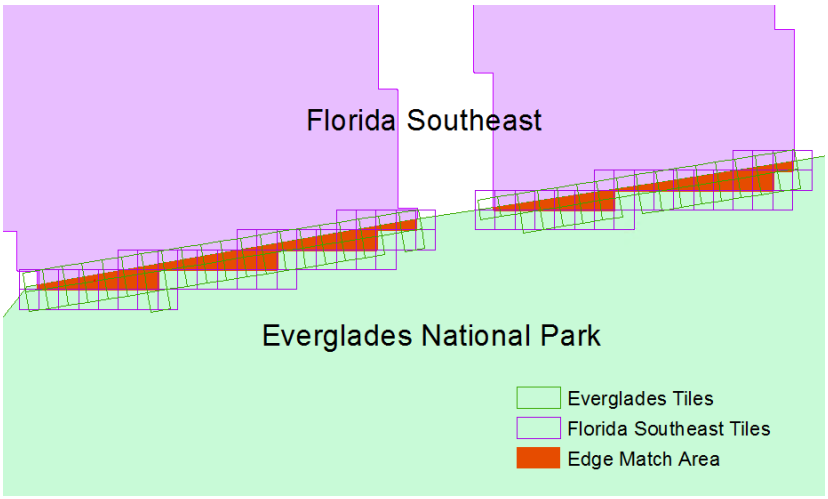

Figure 1 - Ninety tiles of Florida Southeast overlap with 69 tiles of Everglades lidar data.

Profiles and visual reviews were used to compare the two datasets where the datasets are adjacent but do not overlap. This review of the adjacent, non-overlapping areas was to ensure no obvious feature discontinuities exist between the datasets.

One breakline feature exists in the Everglades lidar within the tiles that overlap (Figure 2). The majority of the breakline feature is below specification and was not collected in the Florida Southeast lidar. Dewberry found no other gross feature discontinuities.

A difference raster was produced to analyze elevation differences between the two datasets in areas of overlap.

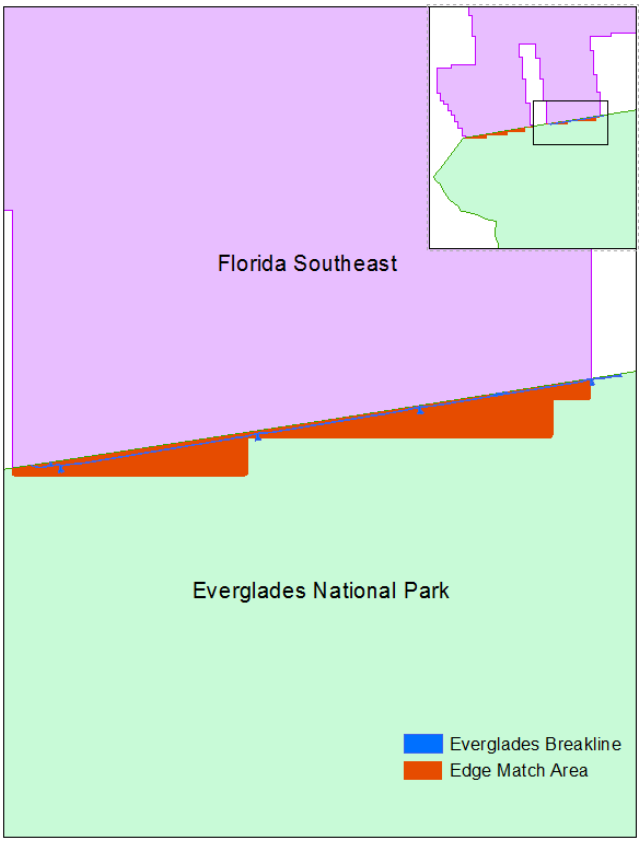

Figure 2 - One Everglades breakline exists within the overlap tiles of Florida Southeast and Everglades lidar data. Breaklined hydrographic features, shown in blue, were removed from analysis as water levels are likely to vary between acquisitions.

DIFFERENCE RASTER

Dewberry created a difference raster by subtracting the Everglades DEM elevation values cell by cell from the Florida Southeast elevation data. The difference raster is shown in Figure 3.

Figure 3 - Difference raster and symbology key created for the Florida Southeast-Everglades overlap. Difference values are shown in meters.

All hydrographic features in the overlap tiles, including streams, rivers, ponds, and lakes, were excluded from analysis because water levels likely varied between the two lidar acquisitions. Hydrographic features, overlaid on the difference raster, are shown in blue in Figure 2.

ELEVATION DIFFERENCE THRESHOLDS

Per the specifications, the Florida Southeast data must meet 0. 196 m vertical accuracy at the 95% confidence level based on RMSEz (0.10 m) x 1.9600 in non-vegetated areas. After accuracy assessment testing using 69 Non-vegetated Vertical Accuracy (NVA) surveyed check points, the Florida Southeast data NVA was found to have $RMSE_z$ = 0.041 m, equating to ±0.080 m at 95% confidence level.

The Everglades lidar data tested at RMSEz = 0.035 m, equating to ±0.068m at the 95% confidence level using 61 checkpoints.

Adjacent datasets should typically match within the combined tested RMSEz values for low slope, open terrain areas. For Florida Southeast-Everglades overlap, this translates to ±0.076 m of allowable elevation differences between the two datasets in flat, open terrain.

EDGE-TIE RESULTS

When looking at all overlap areas consisting of all slopes and all land cover types, 67% (18.3 km^2) of the Florida Southeast-Everglades overlap area matches within ±0.076 m of each other. The majority of larger vertical differences between these two datasets occur within dynamic areas, including heavily vegetated wetland areas, and are largely due to the 1 year temporal difference between the two lidar acquisitions. There are visible changes in water levels, vegetation heights, and anthropogenic landscape alteration. Additionally, more stringent vegetation processing methods were implemented for the Florida Southeast lidar to remove excess vegetation. Details of these methods are included in the project report accompanying this delivery. Figures 5 and 6 show examples of these temporal and vegetation differences. The areas with greater than 2 m of offset make up less than 0.01% (244 m^2) of the overlap area.

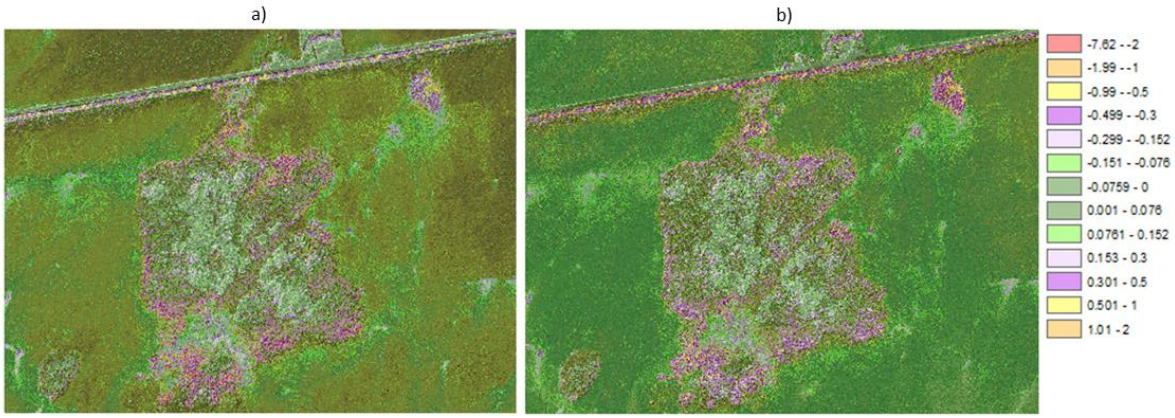

Figure 5 – a) 2017 Everglades bare earth DEM overlaid with the difference raster (partially transparent). b) 2018 Florida Southeast bare earth DEM overlaid with the difference raster (partially transparent). Elevation differences exist primarily due to temporal changes in vegetation.

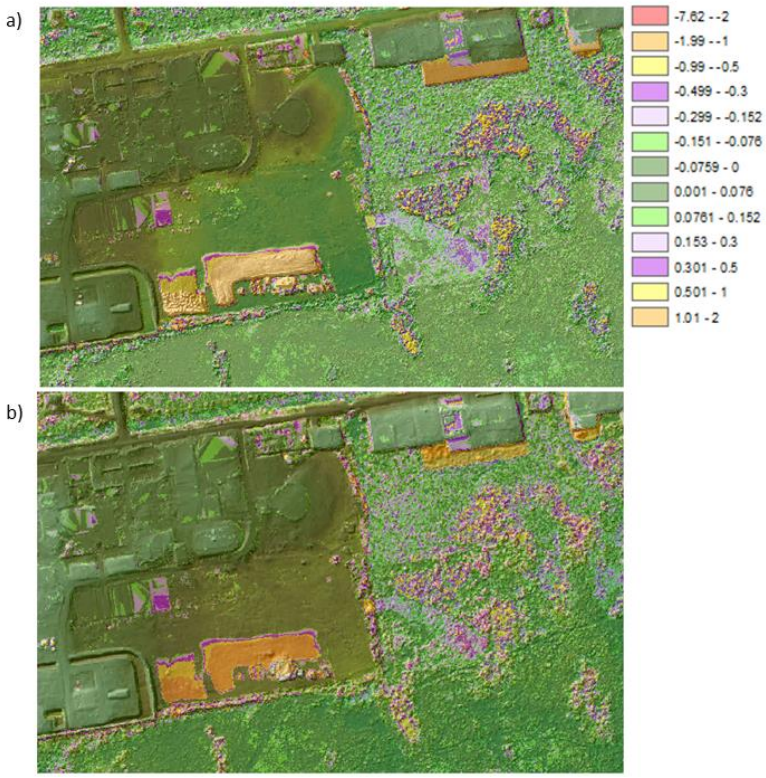

Figure 6 - a) 2017 Everglades bare earth DEM overlaid with the difference raster (partially transparent). b) 2018 Florida Southeast bare earth DEM overlaid with the difference raster (partially transparent). Elevation differences exist primarily due to temporal changes in vegetation and anthropogenic landscape alteration.

SUMMARY

Overall the Florida Southeast and Everglades lidar data match well with 67% (18.3 km^2) of the overlap data matching within ±0.076m, 86% (23.5 km^2) of the overlap data matching within ±0.152 m, and 99% (27.0 km^2) of the overlap data matching within ±0.5 m. The largest vertical elevation differences within the overlap areas occur due temporal changes (vegetation growth and anthropogenic landscape alteration), vegetation, and divots.

Florida Southeast and Palm Beach Edge-Tie Analysis

There are 187 Florida Southeast tiles which overlap with 236 Palm Beach tiles of lidar data. The area of overlap between the tiles is approximately 60.0 km² and is shown in Figure 7.

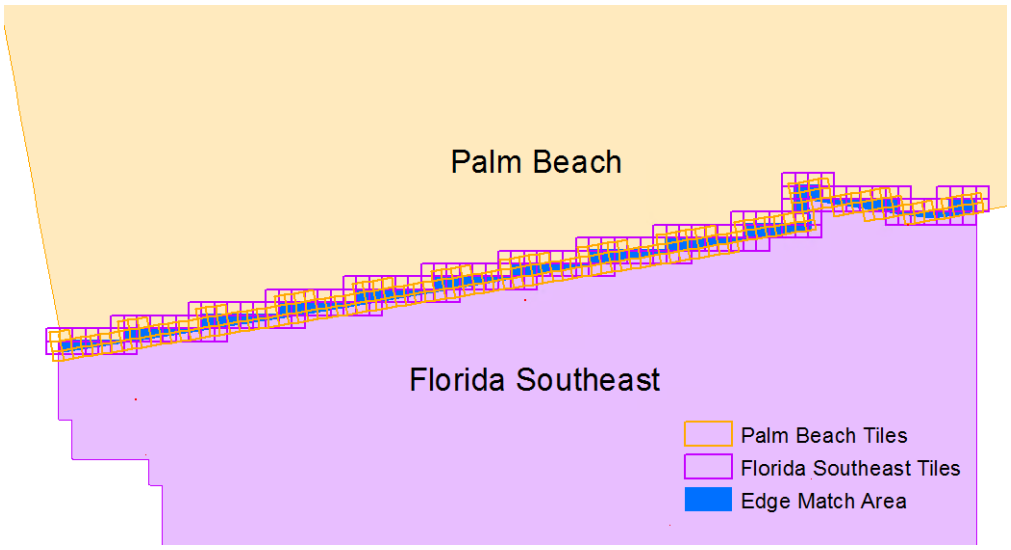

Figure 7 - 187 tiles Florida Southeast overlap with 236 tiles Palm Beach of lidar data.

Profiles and visual reviews were used to compare the two datasets where the datasets are adjacent but do not overlap. This review of the adjacent, non-overlapping areas was to ensure no obvious feature discontinuities exist between the datasets.

Dewberry identified several breakline feature discontinuities that exist within the tiles that overlap. The Palm Beach lidar dataset contains 7 river and 49 pond/lake breakline features within the overlap tiles. The Florida Southeast lidar has 9 river and 61 pond/lake breakline features. The discrepancy is likely due to temporal factors, including vegetation and changing depths and extents of water bodies. An example of breakline discrepancies between datasets is shown in Figure 8. Dewberry found no other gross feature discontinuities.

A difference raster was produced to analyze elevation differences between the two datasets in areas of overlap.

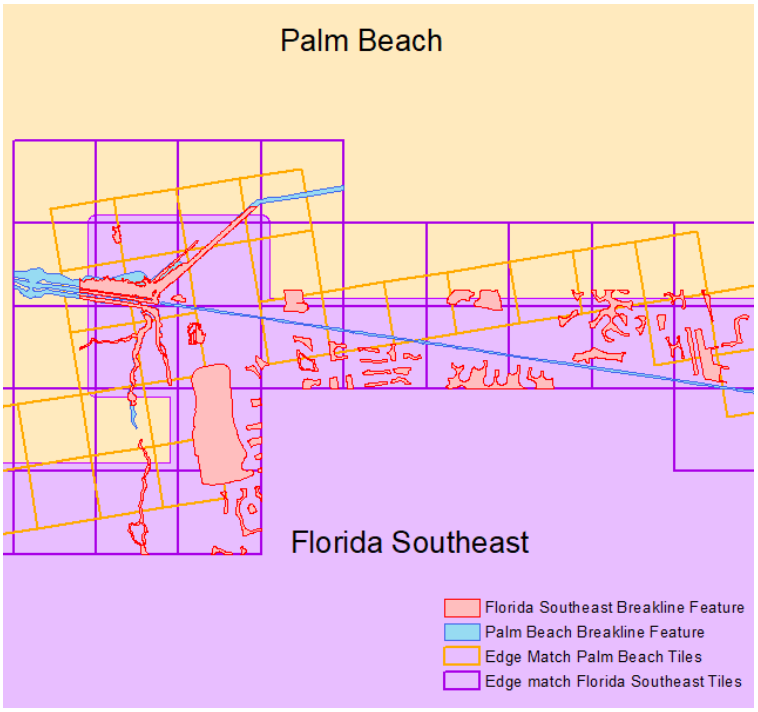

Figure 8 - An example of differences between breakline features of Florida Southeast and Palm Beach within the overlap tiles of lidar data.

DIFFERENCE RASTER

The Palm Beach DEMs, which were originally collected to QL2 specifications and modeled using a 1.0 m cell size, were re-sampled to match the 0.5 m DEM size specified for Florida Southeast. Using the 0.5 m bare-earth DEMs for each dataset, Dewberry created a difference raster by subtracting Palm Beach DEM elevation values from Florida Southeast elevation values. All hydrographic features in the overlap tiles, including streams, rivers, ponds, and lakes, were excluded from analysis because water levels likely varied between the two lidar acquisitions. This difference raster is shown in Figure 9 below.

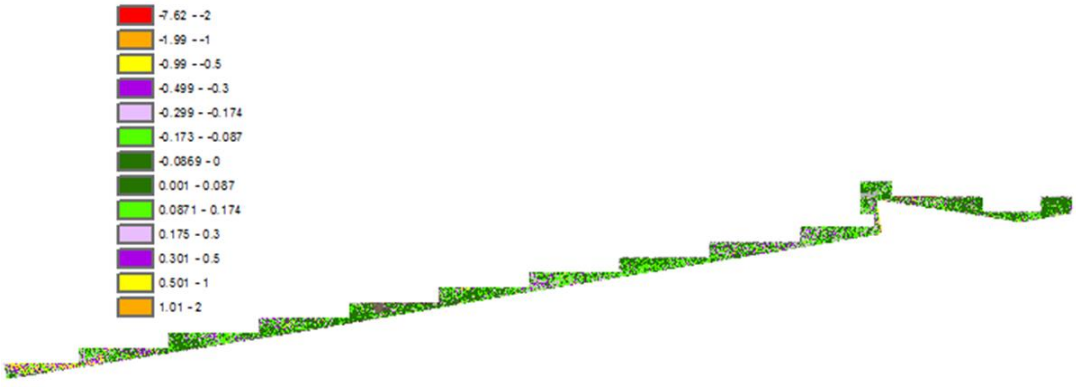

Figure 9 - Difference raster and symbology key created for the Florida Southeast-Palm Beach overlap. Difference values are shown in meters.

ELEVATION DIFFERENCE THRESHOLDS

Per the specifications, the Florida Southeast data must meet 0.196 m vertical accuracy at the 95% confidence level based on RMSEz (0.10 m) x 1.9600 in non-vegetated areas. After accuracy assessment testing using 69 Non-vegetated Vertical Accuracy (NVA) surveyed check points, the Florida Southeast data NVA was found to have $RMSE_z$ = 0.041 m, equating to ±0.080 m at 95% confidence level.

The Palm Beach lidar data tested at RMSEz=0.046 m, equating to ±0.091 m at the 95% confidence level using 79 checkpoints.

Adjacent datasets should typically match within the combined tested RMSEz values for low slope, open terrain areas. For Florida Southeast-Palm Beach overlap, this translates to ±0.087 m of allowable elevation differences between the two datasets in flat, open terrain.

EDGE-TIE RESULTS

When looking at all overlap areas consisting of all slopes and all land cover types, 47% (27.9 km²) of the Florida Southeast-Palm Beach overlap area matches within ±0.087 m. The majority of larger vertical differences between these two datasets occur within dynamic urban areas and heavily vegetated wetland areas. These changes are likely due to the 2 year temporal difference between the two lidar acquisitions. Additionally, more stringent vegetation processing methods were implemented for the Florida Southeast lidar to remove excess vegetation. These methods were not implemented in the Palm Beach data. Details of these methods are included in the project report accompanying this delivery. Figures 10 and 11 show examples of these temporal and vegetation differences. The areas with greater than 2 meters of offset make up less than 0.01% (6815 m²) of the overlap area.

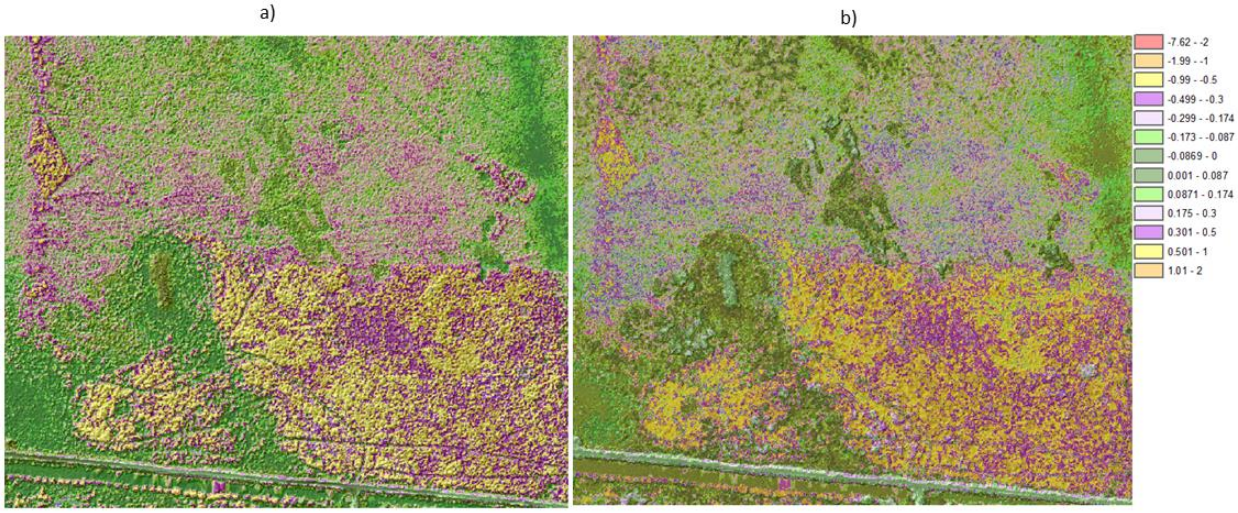

Figure 10 - a) 2016 Palm Beach bare earth DEM overlaid with the difference raster (partially transparent). b) 2018 Florida Southeast bare earth DEM overlaid with the difference raster (partially transparent). Elevation differences exist primarily due to temporal changes in vegetation and the built environment.

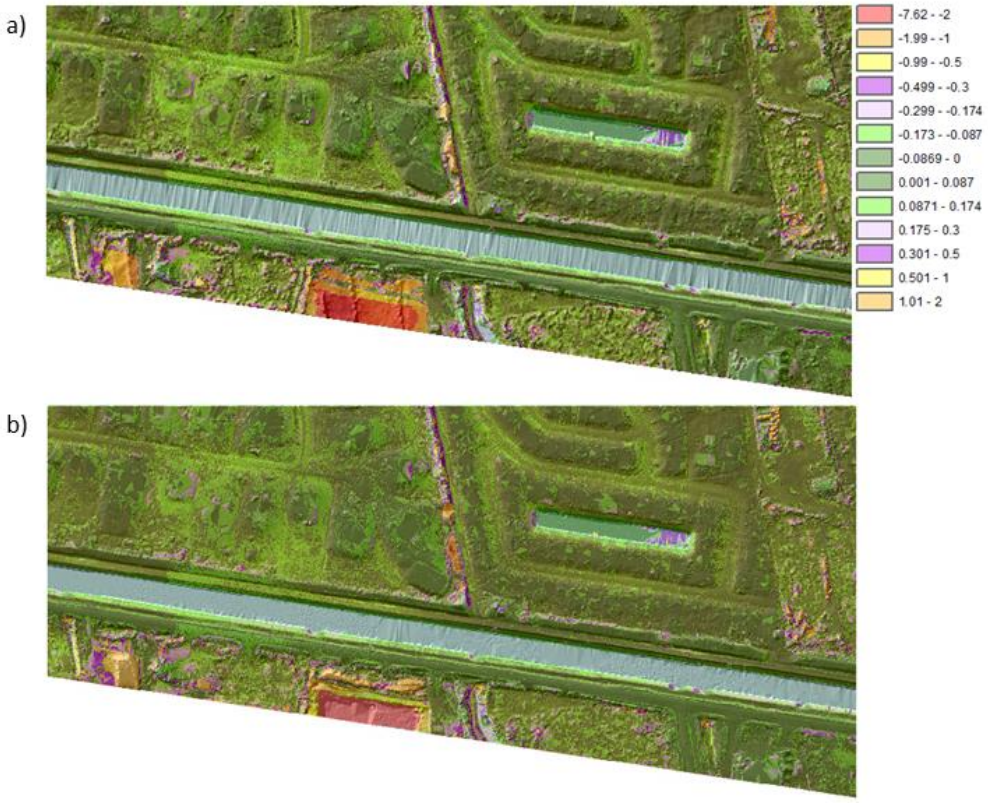

Figure 11 - a) 2016 Palm Beach bare earth DEM overlaid with the difference raster (partially transparent). b) 2018 Florida Southeast bare earth DEM overlaid with the difference raster (partially transparent). Elevation differences exist primarily due to temporal changes in vegetation and the built environment.

SUMMARY

Overall the Florida Southeast and Palm Beach lidar data match well with 47% (27.9 km^2) of the overlap data matching within ±0.087 m, 74% (44.6 km^2) of the overlap data matching within ±0.174 m, and 97% (58.1 km^2) of the overlap data matching within ±0.5 m. The largest vertical elevation differences within the overlap areas occur due temporal changes (vegetation growth and anthropogenic landscape alteration) and vegetation.