West Everglades National Park—East Everglades National Park Tie Analysis

Report Produced for the United States Geological Survey

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Introduction

Under the Lidar Collection West Everglades Area of Interest scope of work (contract G16PC00020), Dewberry was tasked to evaluate how well the recently produced West Everglades lidar data ties spatially to preexisting lidar data produced for the East Everglades. The East Everglades lidar data was acquired in the summer of 2017 for the United States Geological Survey (USGS). The West Everglades lidar data was acquired in the spring and summer of 2019. Dewberry has compared the new West Everglades lidar data to the previous East Everglades lidar data where the two datasets overlap.

Edge-Tie Analysis

There are 455 West Everglades tiles which overlap with the East Everglades lidar data, shown in Figure 1 below. A difference raster was produced to analyze elevation differences between the two datasets in areas of overlap. 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 no gross feature discontinuities.

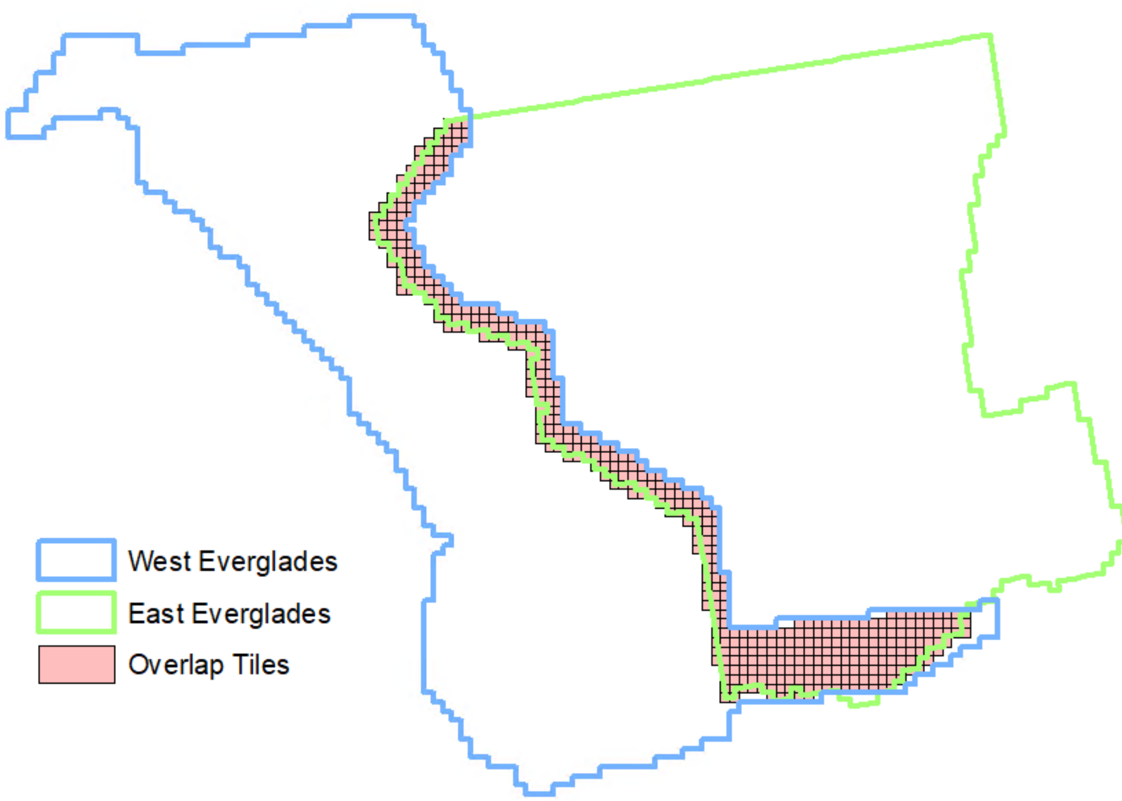

Figure 1 – Areas of overlap between the West Everglades AOI and previously collected East Everglades AOI.

DIFFERENCE RASTER

The East Everglades DEMs were delivered with a pixel resolution of 1 m x 1 m. The West Everglades DEMs are being delivered with a pixel resolution of 0.5 m x 0.5 m; however, for consistency and simplicity of comparison a 1 m x 1 m DEM for the West Everglades was produced to use in this analysis. Using the 1 meter bare-earth DEMs for each dataset, Dewberry created a difference raster by subtracting West data from East data. This difference raster is shown in Figure 2 below.

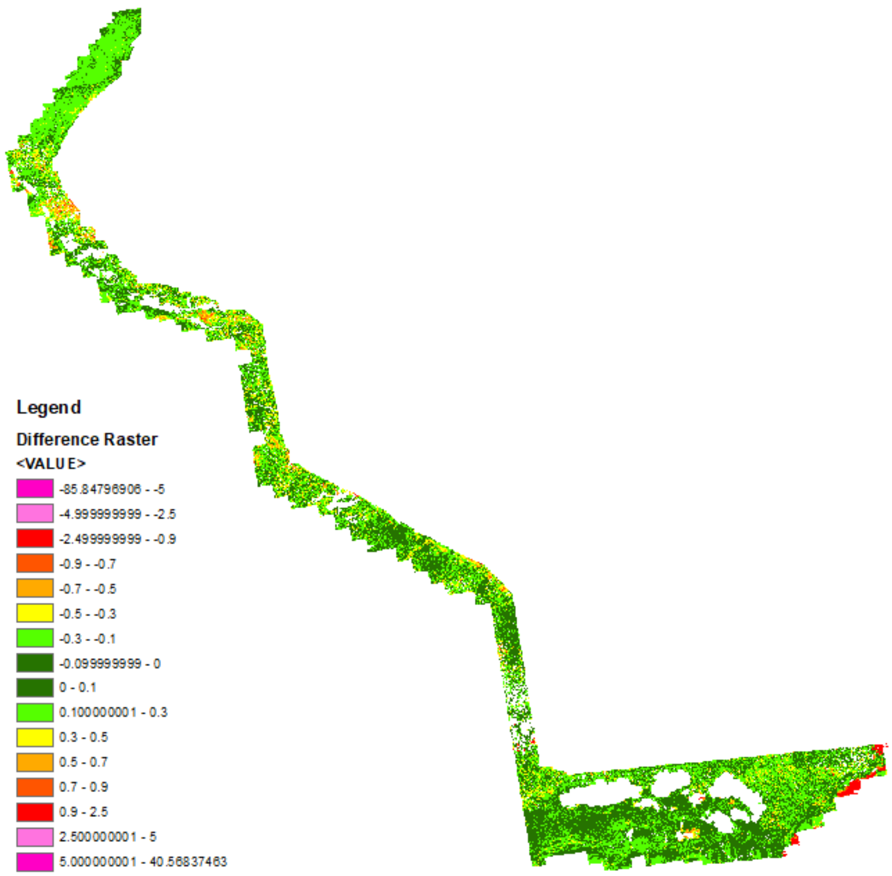

Figure 2 – Difference raster and symbology key created for the West-East Everglades overlap.

ELEVATION DIFFERENCE THRESHOLDS

Per client request, all overlapping data was analyzed to show which areas have elevations within 10 cm (RMSEz requirements for USGS QL1 and QL2 data) of each other. As such, pixels in the difference raster representing 0 to+10 cm and 0 to -10 cm of elevation change between the two datasets are binned. From these initial bins, Dewberry then used intervals of 20 cm up to ±90 cm as this allows detailed analysis of changes within ±1 m. The 20 cm bins, starting from the required ±10 cm bin also allows for analysis of change at ±30 cm, which is the required VVA for USGS QL1 and QL2 data. Larger elevations differences tend to result from similar or consistent sources, so after the ±90 cm bins, data were binned to ±2.5 m, ±5 m, and everything greater than +5 m or less than –5 m.

Dewberry symbolized the difference raster for this analysis using the binned values described above with the color schema shown below. Values are in meters.

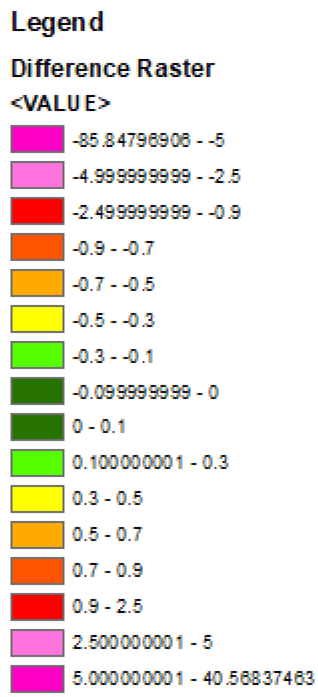

Figure 3– Raster symbology. Pixels within the 0 to ±30 cm threshold are colored as green. Dark green is used for pixels in the 0 to ±10 cm bin and light green is used for the ±10 cm to ±30 cm bin.

EDGE-TIE RESULTS

When looking at all overlap areas consisting of all slopes and all land cover types, 46% of the overlapping data is within the 0 to ±10 cm threshold. Further analysis indicates that 87% of the overlapping data is within the 0 to ±30 cm threshold, which is expected given the density of vegetation coverage across the AOI.

The remaining points that exceed ±30 cm are located in areas with temporal offsets. Temporal offsets may occur in dynamic environments, such as wetlands, marsh, or floodplains, or may occur in upland areas due to human-induced changes like new construction. Temporal differences in this overlap area are located primarily in wetland/marsh areas and are described in further detail in the sections below.

Wetland/Marsh Areas

The majority of areas of larger vertical differences between these two datasets occur within dynamic wetland areas. Hydrographic features were not hydroflattened in either Everglades AOI. Therefore they have not been removed from this difference raster analysis. These types of changes are due to the 2 year temporal difference between the two lidar acquisitions, over which time changes in ground along shorelines and within marsh/wetland areas have likely occurred. The figures below show examples of these temporal changes.

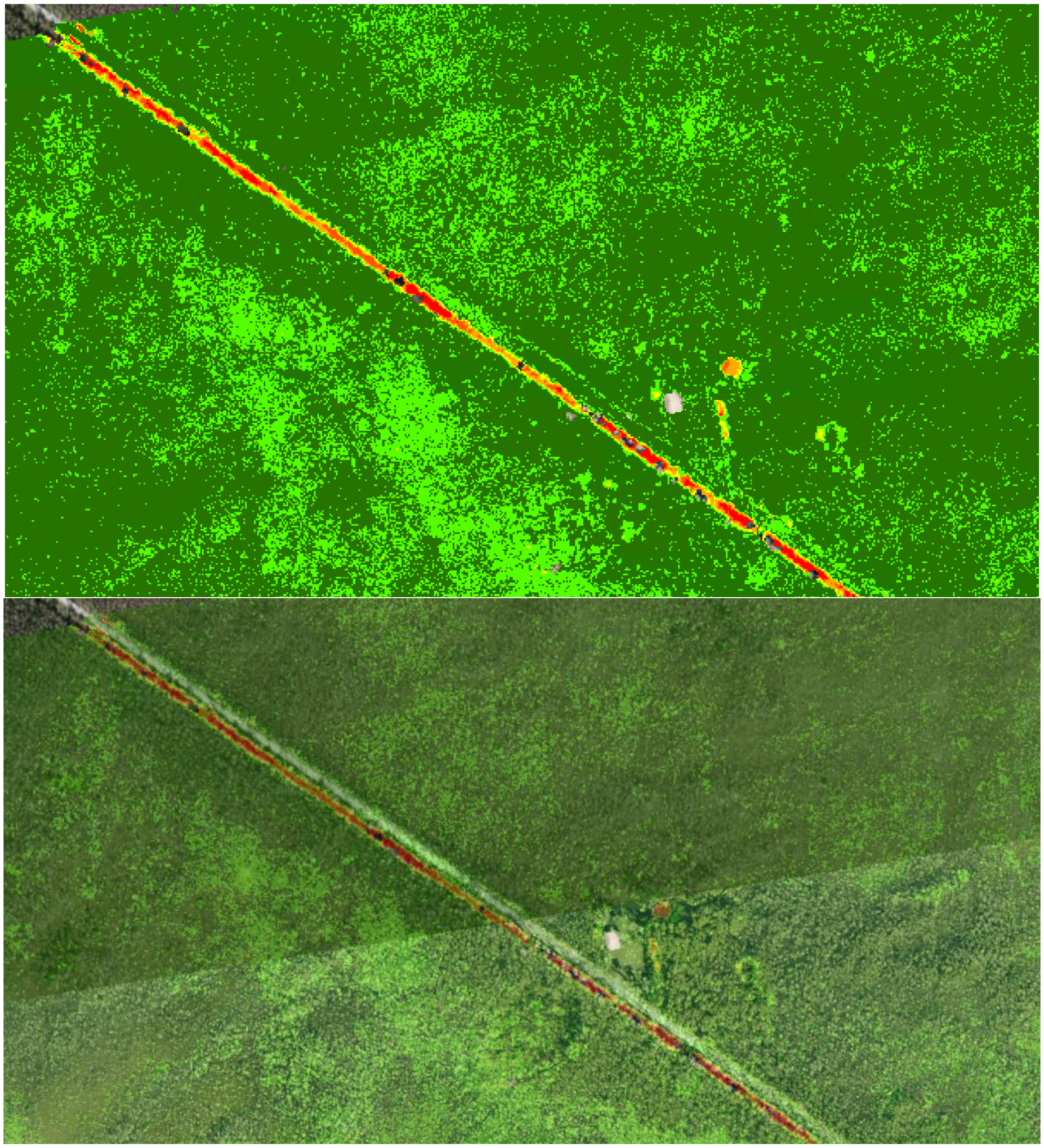

Figure 4 – The top image shows a non-transparent image of the difference raster in the northernmost section of the AOI. The road remains unchanged, but the water levels in the ditch alongside the road have changed since the East Everglades AOI was collected. The image on the bottom shows a transparent image with the basemap showing where the roadway is.

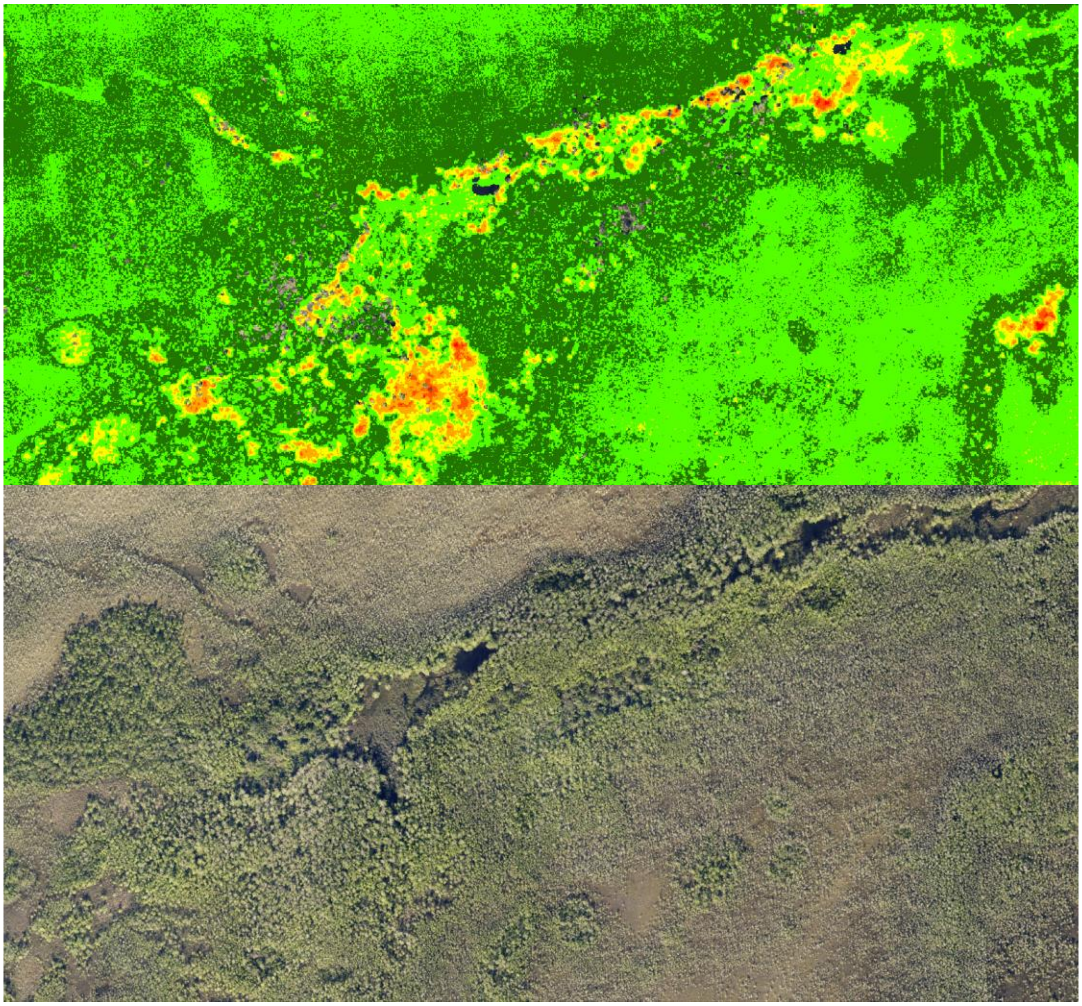

Figure 5 – The top image shows a non-transparent image of the difference raster. The vegetation has changed since the East Everglades AOI was collected. Differences in vegetation density mean different degrees of lidar penetration, which can affect consistent classification of the ground surface. Dynamic eroson and deposition in coastal wetlands may also result in changes to ground over time. The bottom image shows basemap imagery of the same area.

Upland Areas

Upland areas are expected to remain more stable over time. This land cover type provides more consistent analysis between temporally different lidar datasets. There are only two roadways within the overlapping datasets. Examples of each road are shown in Figure 6 below. The northern roadway is within the original AOI and differences between the two datasets are generally less than 10 cm (the NVA RMSEz requirement of each respective dataset). Maximum elevation differences along the northern roadway are approximately 12-13 cm.

The southern roadway transverses both the original AOI and the eastern add-on portion of the AOI. The portion of the southern roadway within the original AOI shows differences between the two datasets of less than 10 cm. The portion of the southern roadway within the eastern add-on portion shows higher differences between the two datasets, with maximum elevation differences of approximately 25 cm.

The eastern add-on portion of the FL West Everglades NP project area was particularly difficult to align due to relatively few hard surfaces present which could reliably be used during the alignment process.

Only one road is present in this add-on area. Due to the nature of relative swath alignment being based off the "ground" surface within each swath (which in reality is just the lowest plane of points), the process of using the lowest points can introduce some discrepancies due to these assumptions. In some areas one sensor may penetrate the vegetation to a greater extent, resulting in a lower last return surface. The alignment process bases the corrections from the statistical trends found in these offsets. This means that if there is a much greater coverage of vegetated areas than hard surfaces, those vegetated areas can have a much larger impact on the relative alignment of the data. In the case of this area the discrepancy resulted in a misalignment along a portion of the roadway while the vegetated areas nearby show no misalignment. Examining the park road in the east of the project shows that several of the swaths have some bias between the NIR and green swaths (approx. 7-11 cm), but there are 3-4 flightlines with larger offsets approaching 15 cm. Areas along the road exhibiting the most measureable offsets are identified in the provided shapefile, named "W_Everglades_NP_Lidar_Interswath_Issues".

The challenges posed during the alignment process of the eastern add-on portion of this AOI contribute to the higher than normal differences observed in the overlap between these two datasets for a section of hard, non-vegetated road surface.

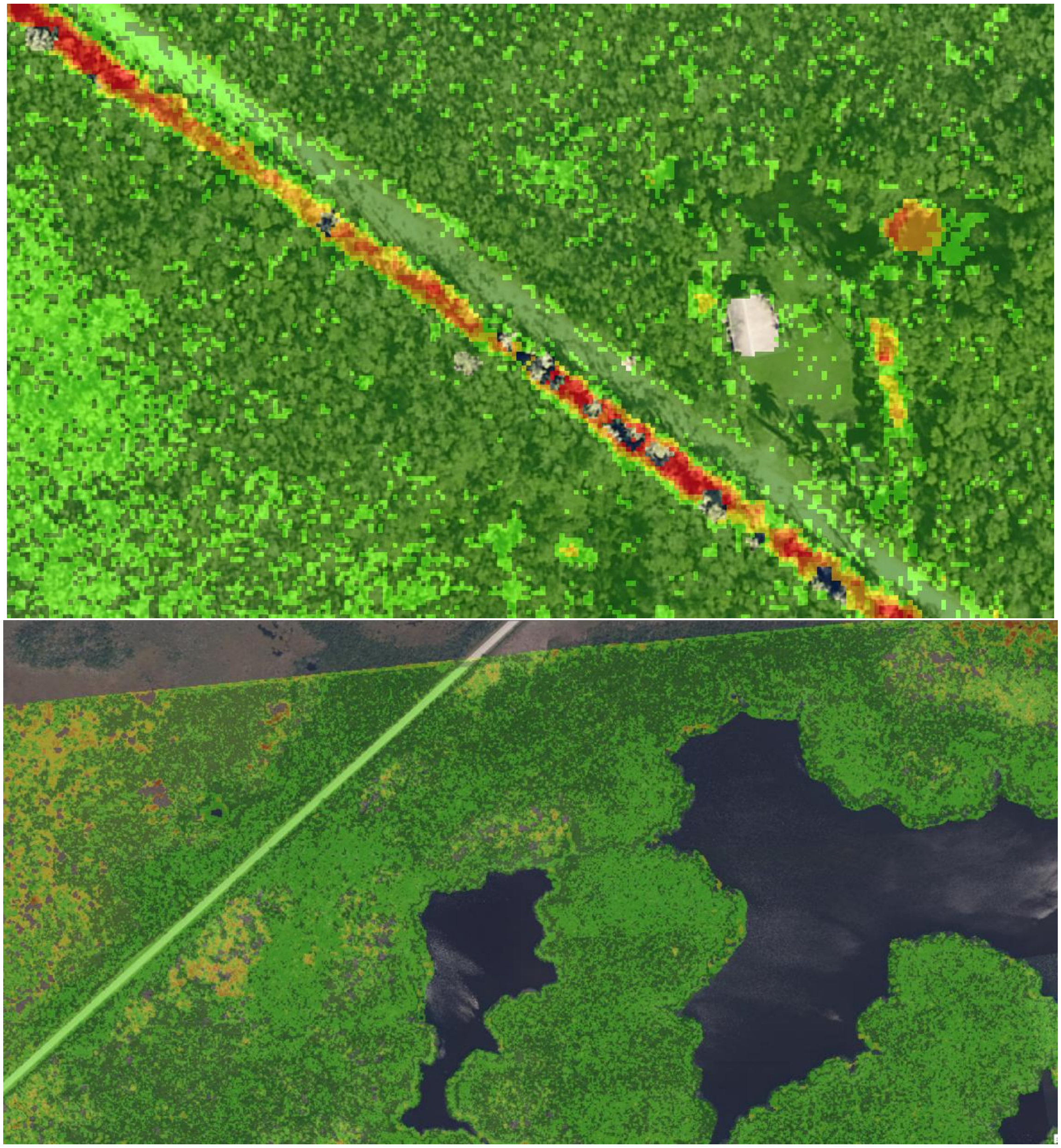

Figure 6- The top image shows the difference raster for the northern road (the red and yellow pixels next to the road represent the ditch highlighted in Figure 4 due to temporally different water levels between the two datasets). This northern road displays elevation differences generally less than 10 cm. The bottom image shows the park roadway in the southeast of the difference raster. While portions of this southern roadway display differences less than 10 cm, portions of this roadway also display elevation differences up to 25 cm. The higher than normal elevation diffierences along this roadway are due to challenges in the alignment process of this eastern add-on section of the AOI.

Summary

The East and West Everglades lidar data match well with 46% of the overlap data matching within ±10 cm and 87% of the overlap data matching within ±30 cm. The areas of largest vertical elevation discrepancies occur due to temporal differences and include varying levels of water in hydrographic features, and changes in wetlands/marsh areas. Cultural or man-made changes did not contribute to larger elevation differences due to the lack of those man-made items in the Everglades National Park.