**DISCLAIMER:**

No warranty expressed or implied is made by National Park Service regarding the utility of the data on any other system nor shall the act of distribution constitute any such warranty.

**Abstract:** Ashland county LiDAR was flown during leaf-off conditions in late 2014 (November 1st and 2nd) and early 2015 (April 17th). The flight on April 17, 2015 was to re-do a flight line (49) that had been done November 2, 2014. The data delivered to the State of Wisconsin were classified LAS files with only bare earth points (class 2) classified. We took this data and after several steps to remove outliers, we produced several vegetation metrics using a free add-on tools to ENVI called BCAL LiDAR tools.

**Purpose:** To use LiDAR data to characterize and measure terrestrial vegetation characteristics such as height, density, and amount of vegetation in multiple height strata.

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1. Create a one meter bare earth raster (DEM) and associated hillshade with the classified LAS files delivered by the contractor.
2. Remove outlier points from the classified LAS files
3. Create vegetation metrics from cleaned LAS files

**Processing steps for DEM (ArcMap 10.3.1)**

1. Create LAS dataset in ArcCatalog
2. Load LAS dataset into ArcMap
3. Create a layer with only bare earth points
   1. Use ‘Make LAS Dataset Layer’ tool within ArcMap
      1. Select class 2 points
4. Create a raster from this bare earth point layer
   1. Use ‘LAS Dataset To Raster’ tool
      1. IDW cell assignment
      2. Linear void fill
      3. 1 m cell size
      4. Z factor: 0.3048 to convert raster values from feet to meters

**Processing steps for vegetation metrics**

1. Remove the outliers from the classified LAS files
   1. An image depicting all values over 1950’ (purple) present in the classified LAS dataset delivered by the contractor. Our goal was to remove or re-classify the outlier points in order to further process the LAS files for vegetation metric calculations.

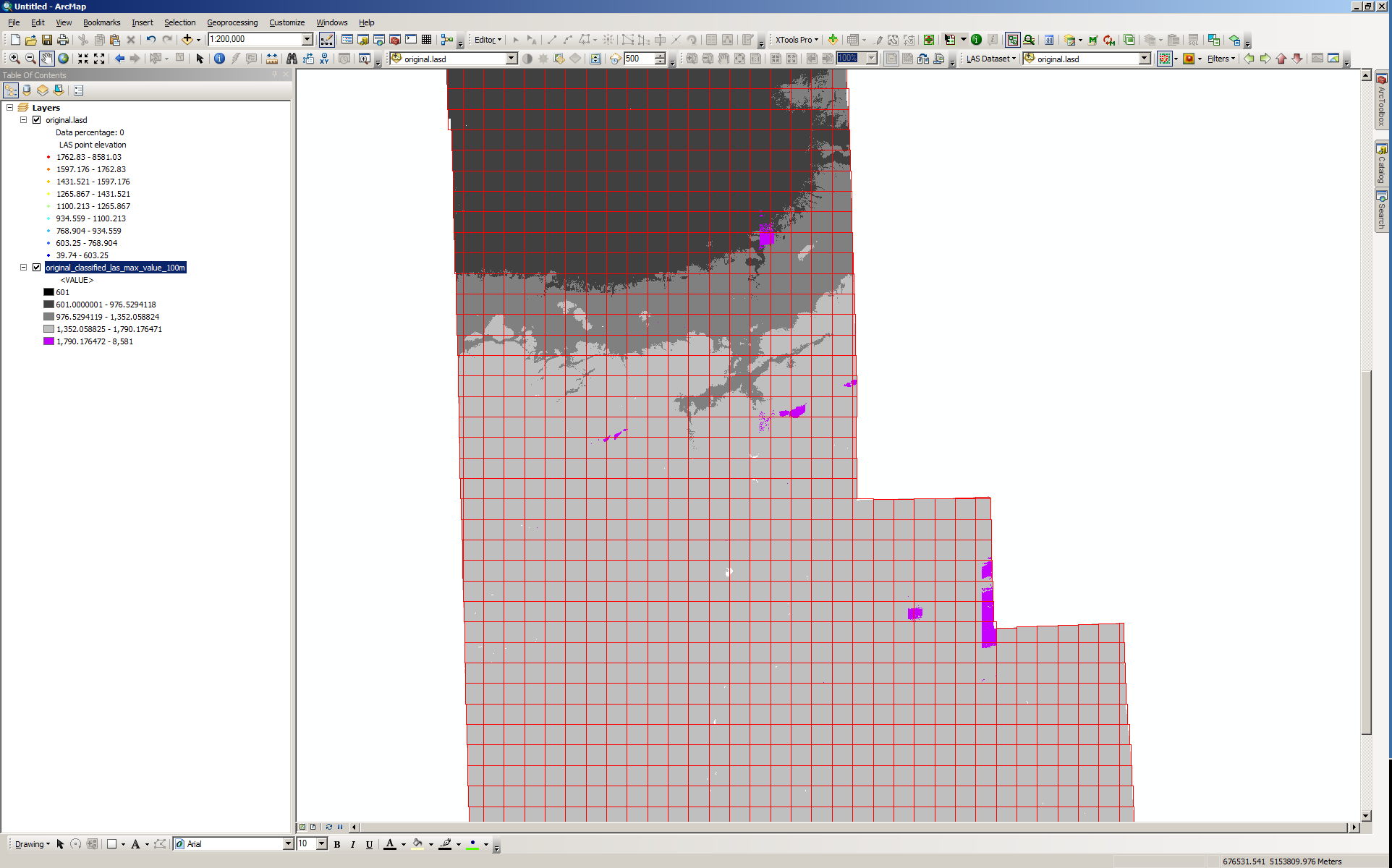


Figure 1. Overview of most tiles in Ashland county, with the purple pixels being elevation values over 1800’. These were the bulk of outliers removed from the data.

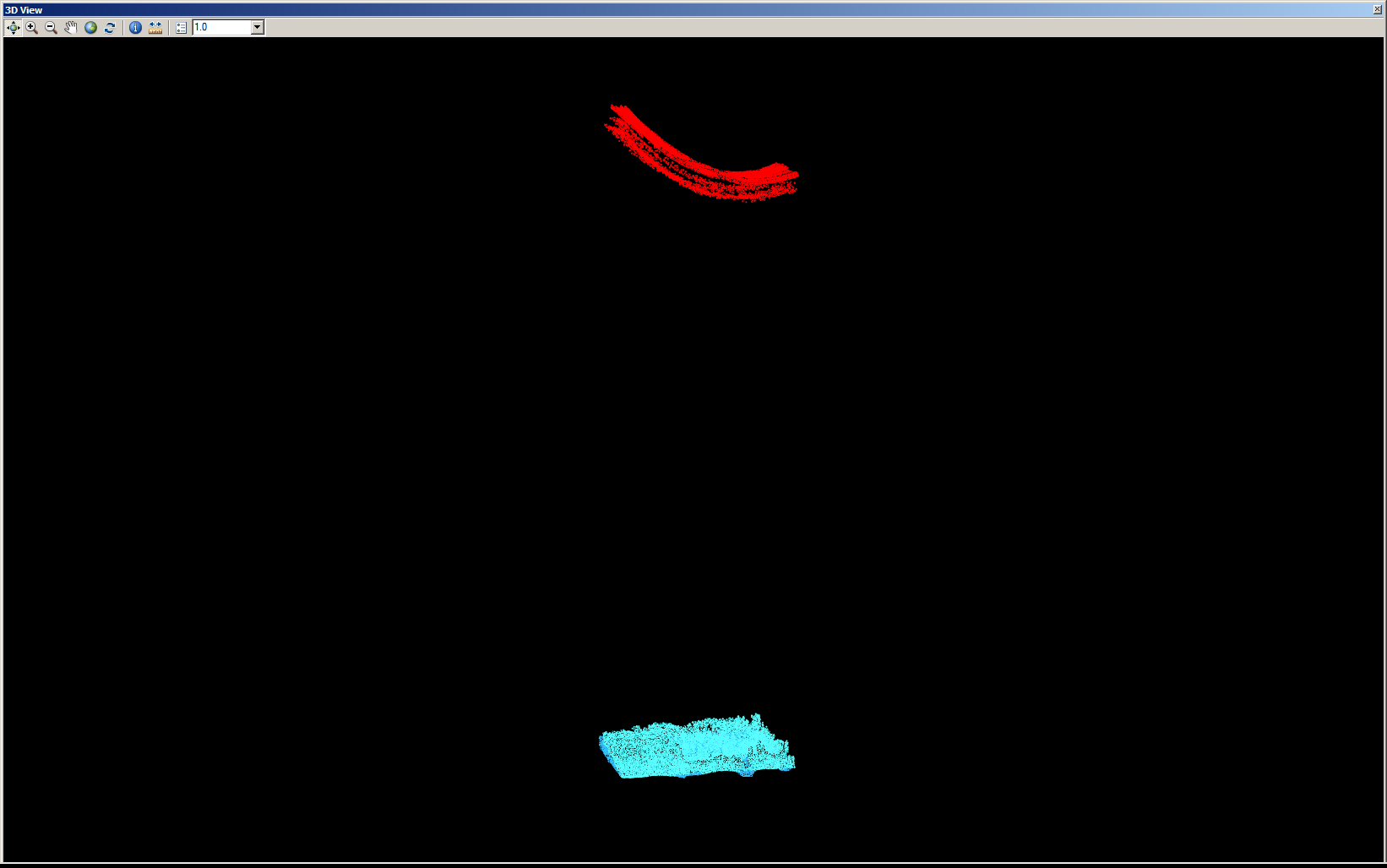
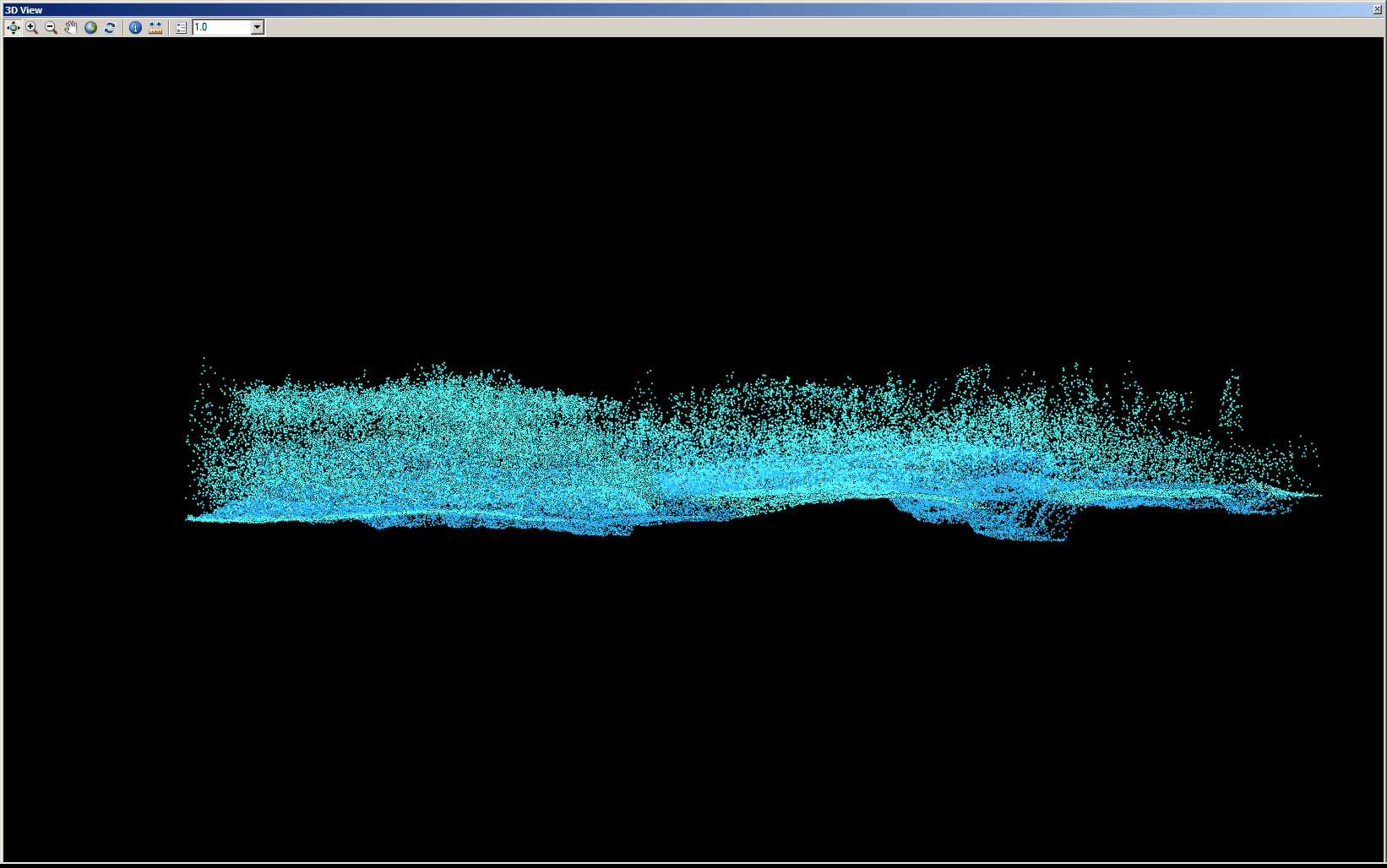


Figure 2. A 3D view of the outliers delivered in the classified LAS files by the contractor.

* 1. A three-step approach was used in order to remove all outliers.
     1. Delete any values >1800’ in elevation (las2las—keep\_z)
        1. This removed the bulk of outliers



* 1. Next we only kept points with scan angles between -20 and 20 (las2las—keep\_scan\_angle)
     1. Used [las2las](https://www.cs.unc.edu/~isenburg/lastools/download/las2las_README.txt) tool to delete any points below -20° and above 20°
  2. Remove remaining outliers (FUSION—filterdata)
     1. For this step we used a tool (FUSION – filterdata) that calculates the standard deviation of a given window size, then removes any points within N standard deviations of the mean. The software we used was called [FUSION](http://forsys.cfr.washington.edu/fusion/FUSION_manual.pdf) which has a function called ‘filterdata’ that will accomplish this task.
        1. Window size: 1000 meters
        2. Standard deviations: 5

1. Convert z from feet to meters (las2las –scale\_z)
   1. The [BCAL](https://code.google.com/archive/p/bcal-lidar-tools) tools need to have the z values in meters
   2. Used las2las tool to ‘scale\_z’ by 0.3048
2. Buffer each LAS tile (BCAL- Buffer LAS files)
   1. The BCAL tools need to have each tile buffered by at least 2x the canopy spacing
      1. Buffer value chosen: 20 m
3. Perform height filtering (BCAL-Perform Height Filtering)
   1. Canopy spacing: 10
   2. Threshold value: 0.10
   3. Interpolation method: Natural Neighbor
   4. Maximum allowed height: 100
   5. Maximum iteration: 30
4. Create vegetation metrics (BCAL-Vegetation Products)
   1. Return numbers: All returns
   2. Raster spacing: 3, 5, and 10m rasters were produced
   3. Value for no data: -1
   4. Ground threshold: 0.15
   5. Crown threshold: 1.37
   6. Interpolate empty pixels: yes
   7. Mosaic: yes
   8. Ignore outliers: yes
   9. Select all products (n=33)