DRAFT

North Slope Alaska Coastal Lidar Survey 2010

Review of Pilot Area received on September 20, 2010

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Pilot Area Survey Extent:

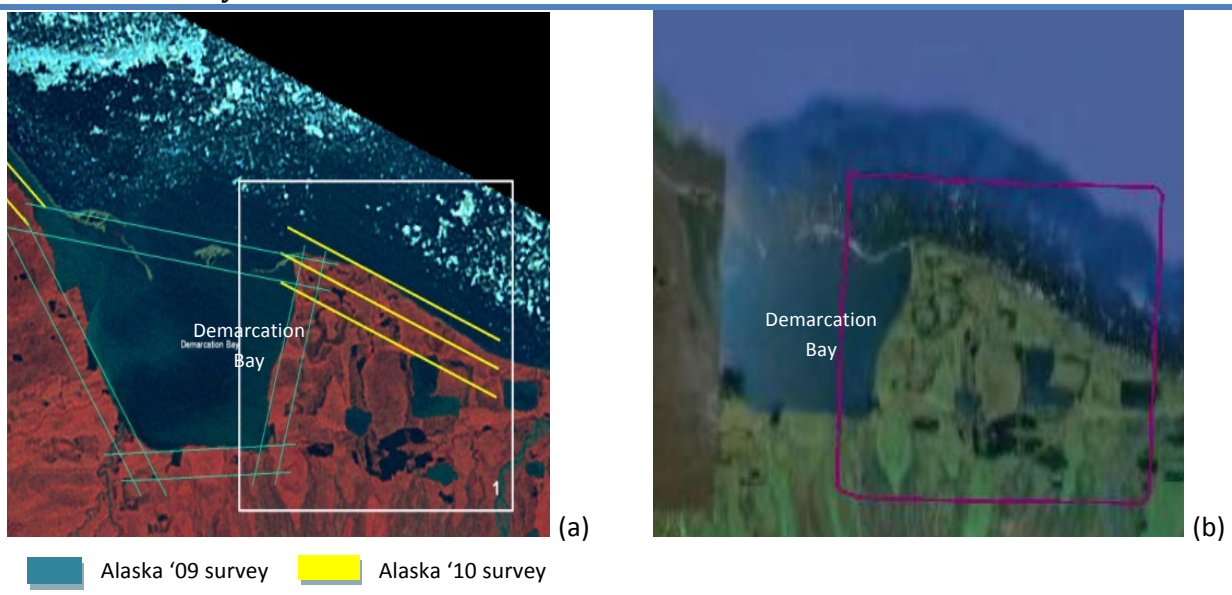


Figure1: (a) Location of pilot area overlaid on a color-infrared (CIR) image. The yellow lines indicate the flight-line extent of the pilot area surveyed in 2010. The blue-green lines indicate the flight-lines surveyed in 2009. (b) Corresponding Google Earth image showing extent of pilot area (magenta box).

DVD Contents

Each data file in the DVD represents a 2 km x 2 km region.
We received a total of 3 DVDs. Their contents are listed below:

DVD -1
Point Cloud Data – Data files containing all returns - 33 las files
First Return Data – Data files containing only first returns - 20 las and 20 ascii files

DVD -2
First Return Data – Data files containing only first returns - 14 las files **(Note: corresponding ascii files missing)**
Last Return Data – Data files containing only last returns - 33 las and 33 ascii files

DVD -3
Intensity Imagery – 33 geotiffs and 33 tif world (tfw) files

Tile index – Tile Index and Area of Interest shapefiles
Video – Video coverage of the whole survey - 2 .avi files and a readme file
Metadata – xml files for each datatype

Filetypes:
LAS – The las point cloud data is in LAS1.2 format
ASCII – The ASCII point cloud data are in the comma-delimited format: X, Y, Z, Intensity, Echo Number
GeoTIFFs –The intensity imagery are in the ESRI GeoTIFF format with 1.5 meter pixels

NOTE:
First Return file t_e494_n7730_7.las was split into two and the two parts were stored in two different DVDs. The split files were not readable and hence could not be used. The file needs to be replaced.

General Information on data collection:

These lidar derived data products were acquired at 1800 meters above mean terrain (AMT) and they have a horizontal accuracy of 0.60 meter, with a nominal point spacing of 1.20 meter as per manufacturer's specifications. A smoothed-best estimated trajectory (SBET) of the sensor has been created at a rate of 200 Hz, by integrating the airborne GPS and IMU data The airborne GPS data was processed using TerraPos, and was referenced to WGS84 (G1150) with ellipsoidal heights. SBET and raw laser data were integrated to produce point cloud data for each flight line, using DASHMap (Optech Inc.) Data was corrected for roll, pitch, heading and mirror scale errors using TerraMatch.

Collection parameters and equipment:

Aircraft: Piper Navajo (N6GR) and Cessna 320 (N3443Q)
Lidar System: Optech ALTM Gemini (03SEN145 and 07SEN201)
Approximate Collection Altitude (Above Mean Terrain): 1800 meters
Ground Speed: 150 kts
Pulse Rate Frequency: 70 kHz
Mirror Scan Frequency: 32 Hz
Scan Angle (+/-): 20 degrees
Beam Divergence: Narrow (0.25 mrad)

Collection dates:

The lidar surveys in the pilot study area was conducted on July 16, 2010

The 2009 survey was conducted on September 3, 2009.

Tilename	Total no. of points	No. of points in First Return	No. of points in Second Return	No. of points in Third Return
t_e488_n7724_7	2248548	2248547	1	0
t_e488_n7726_7	2143195	2143195	0	0
t_e488_n7728_7	98	98	0	0
t_e488_n7730_7	262971	262967	4	0

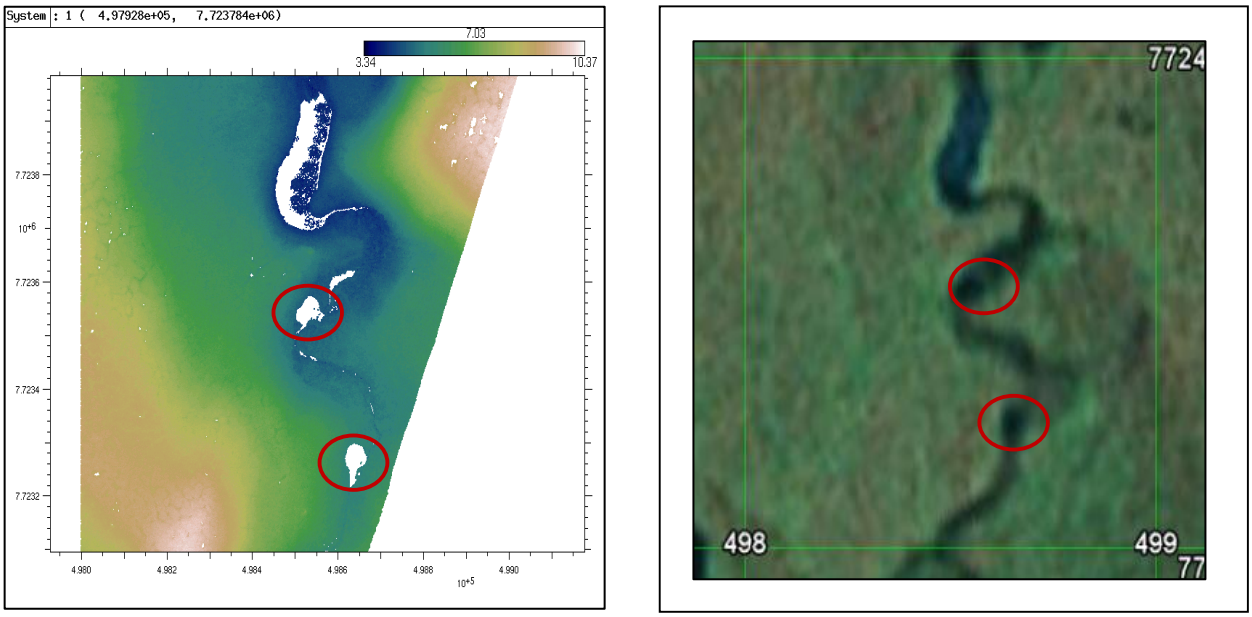
t_e488_n7732_7	2009313	2009312	1	0
t_e488_n7734_7	127	127	0	0
t_e490_n7722_7	45049	45049	0	0
t_e490_n7724_7	3159146	3159143	3	0
t_e490_n7726_7	5599762	5599665	96	1
t_e490_n7728_7	2602770	2602769	1	0
t_e490_n7730_7	1998764	1998764	0	0
t_e490_n7732_7	2145613	2145603	10	0
t_e492_n7724_7	729765	729764	1	0
t_e492_n7726_7	749020	749020	0	0
t_e492_n7728_7	2374682	2374682	0	0
t_e492_n7730_7	8142535	8142431	104	0
t_e492_n7732_7	3795627	3795615	12	0
t_e492_n7734_7	260612	260609	3	0
t_e494_n7728_7	1274141	1273717	414	10
t_e494_n7730_7	3872149	3872145	4	0
t_e494_n7732_7	397523	397523	0	0
t_e494_n7734_7	52636	52636	0	0
t_e496_n7724_7	298981	298981	0	0
t_e496_n7726_7	313520	313520	0	0
t_e496_n7728_7	2372495	2372495	0	0
t_e496_n7730_7	1043255	1043251	4	0
t_e498_n7724_7	572517	572468	49	0
t_e498_n7726_7	2793367	2793367	0	0
t_e498_n7728_7	2840594	2840594	0	0
t_e498_n7730_7	99974	99974	0	0
t_e500_n7726_7	710248	710248	0	0
t_e500_n7728_7	509109	509097	12	0
t_e500_n7730_7	293666	293666	0	0

Table 1: Table showing the total number of points, number of points in first return, number of points in second return and number of points in third return. All data shown in this table were acquired in 2010.

The highlighted file t_e494_7728_7 from Table 1 has the highest number of second returns (414). These second returns may correspond to the presence of vegetation or may be “noise” in the data.

Data Holidays:

The holiday (or gaps) in the data correspond to the water bodies. These holidays were also present in data acquired in 2009, and can be explained by the weak (or non-existent) returns from dark water surfaces.



(a) (b)

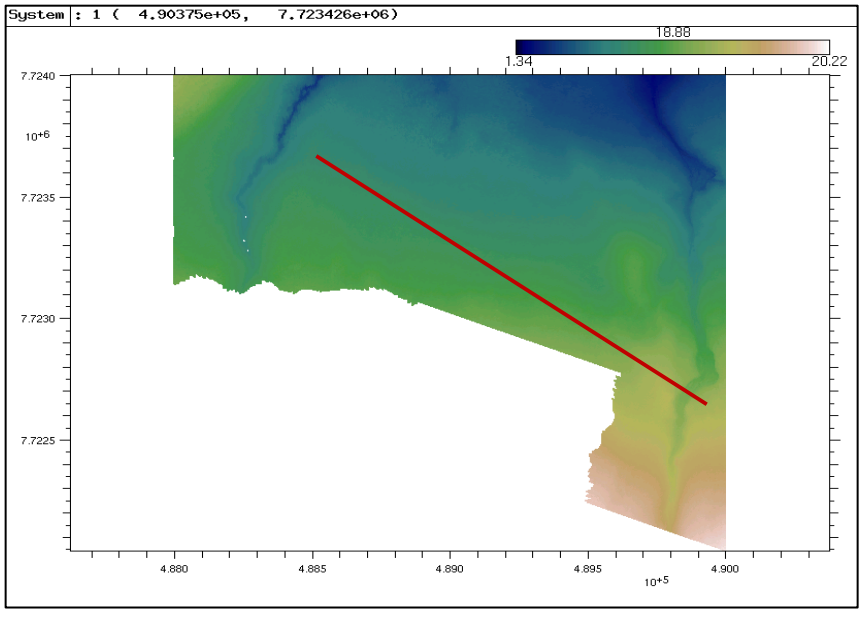
Figure 3: (a) and (b) Data holidays in tile t_e498_n7724_7 shown in ALPS and corresponding image snapshot in Google Earth

QA/QC Analysis - Transects

Using the USGS Airborne Lidar Processing Software (ALPS), overlapping data from different flightlines were evaluated along a transect to check for accuracy.

Example 1: Tile e488_n7724: The red line in Figure 4(a) shows the location of the transect. Figure 4(b) is a plot of all data within 1 m along the transect line. The data along the transect are color coded by flight line thereby illustrating any flightline-to-flightline biases. The resulting transect plot in Figure 4(b) suggests a very good match between flightlines along an 800-m-long transect with a vertical elevation change of 3 m.

(a)



(b)

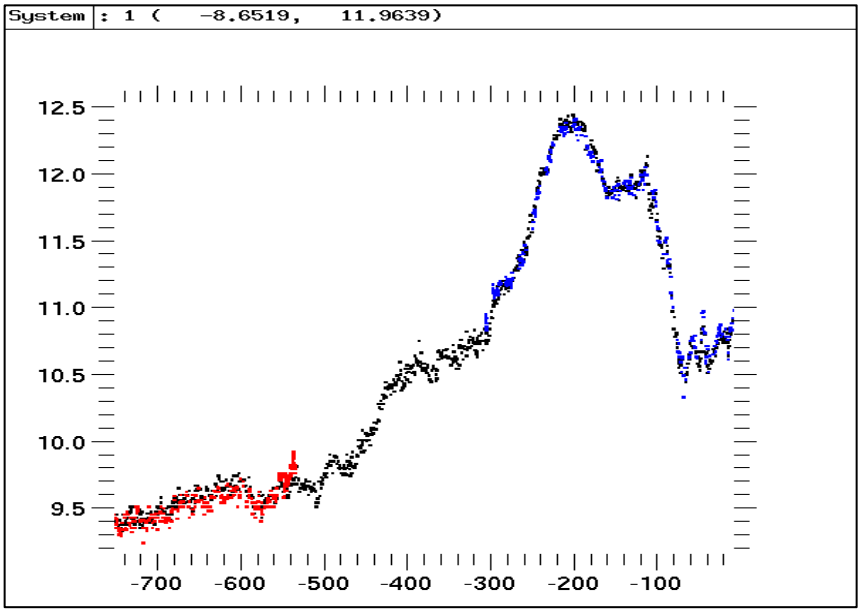
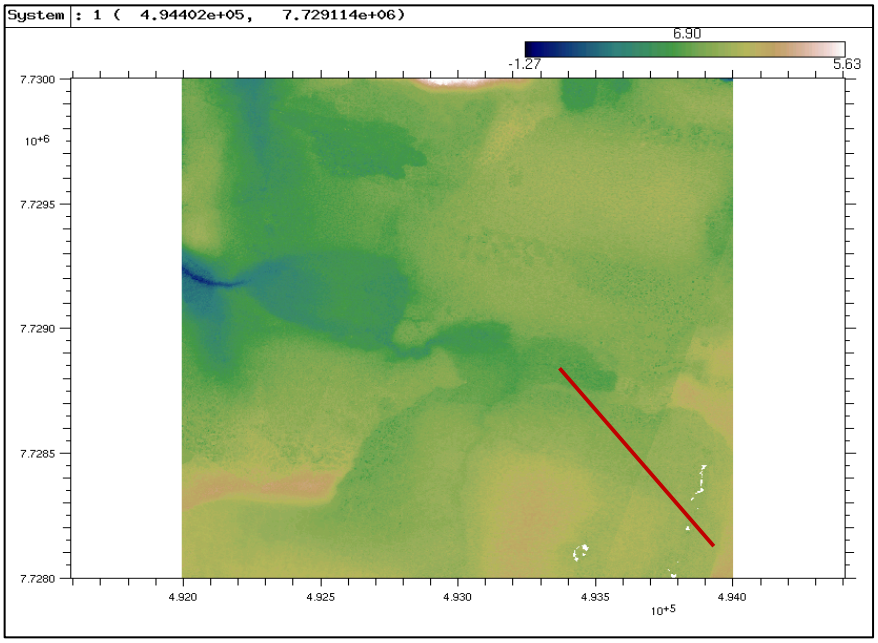


Figure 4: Transcect analysis of data tile e488_n7724

Example 2: Tile e492_n7730: The red line in Figure 5(a) shows the location of the transect. Figure 5(b) is a plot of all data within 1 m along the transect line. The data along the transect are color coded by flight line thereby illustrating any flightline-to-flightline biases. There appears to be a greater mismatch between data along overlapping flight lines along a transect when compared with Example 1. The transect is plotted over a relatively flat terrain where the elevation change is less than 1 m along a 600-m-long transect. The flightline denoted by the "red" dots appear to be lower than the flightlined denoted by the "blue" and "black" dots. The overall spread of points along the transect is ~70cm.



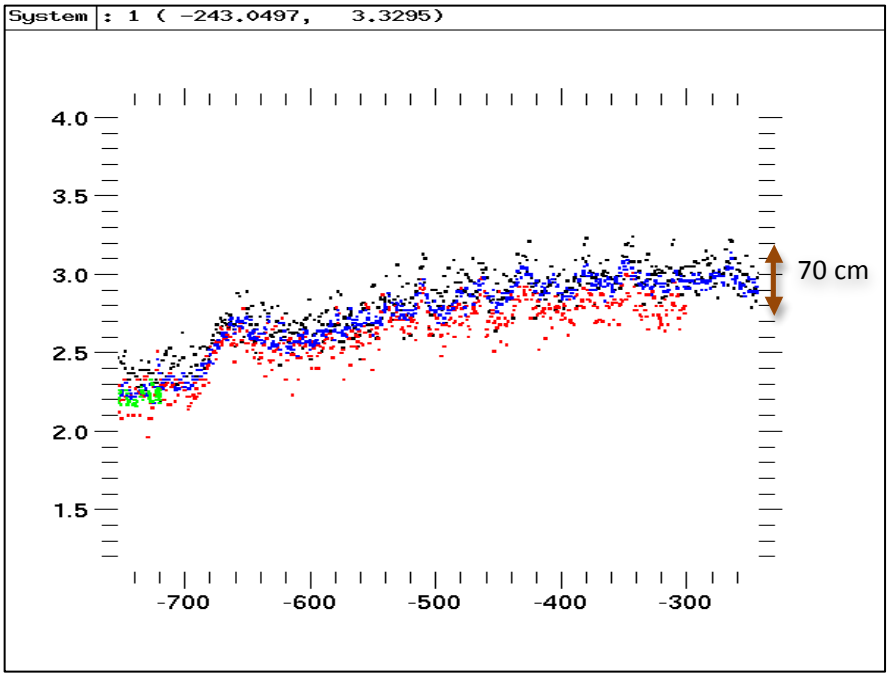


Figure 5: Transect and Flightlines of data tile e492_n7730

Comparison of Alaska_09 and Alaska_10 acquired data:

A comparison between 2009 and 2010 acquired Alaska survey data was done by drawing transects (red lines) over areas common to both surveys. The results show that the 2009 data are consistently lower in elevation when compared to the 2010 data. However, the average difference between them is only ~10-15cm.

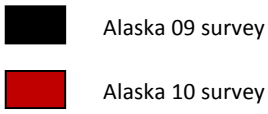
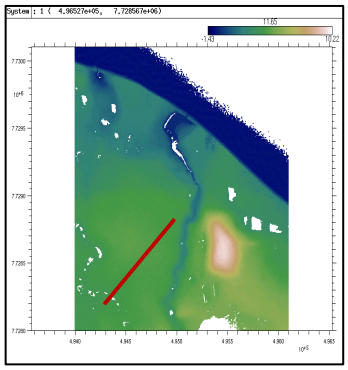
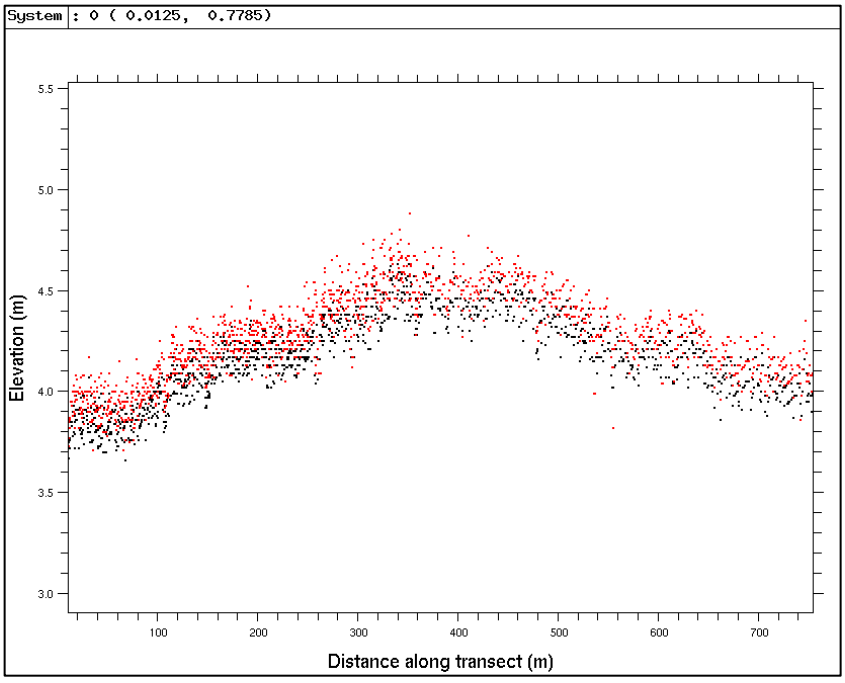


Figure 6: Comparison of 2009 and 2010 acquired Alaska survey data





QA/QC: Uniqueness and Correctness Checks

Using ALPS, the uniqueness and correctness of the data were verified.

Timestamp Uniqueness:

The uniqueness is determined by verifying that each laser return has a unique time stamp. The Seconds of the Epoch (SOE) values are sorted and the difference between the adjacent values is determined. If the minimum difference is zero, then they are NOT unique (i.e., if two more returns have the same SOE value). In this case, the minimum difference was 0.000013828 seconds, which is the expected time gap between adjacent laser returns. Hence, the timestamps are unique.

```
> e488_n7724_7 = e488_n7724_7(sort(e488_n7724_7.soe))
> e488_n7724_7.soe(dif)(min)
1.38283e-05
```

Figure 7: (a) Uniqueness check – difference between timestamps not equal to 0

Timestamp Correctness:

The correctness is determined by verifying the timestamp range of each flightline segment in the study area. The sequence of the timestamps must appear logical and in the correct order. The data are segemented by flightline as shown in Figure 8 in order to check the correctness. Here, the sequence appears correct.

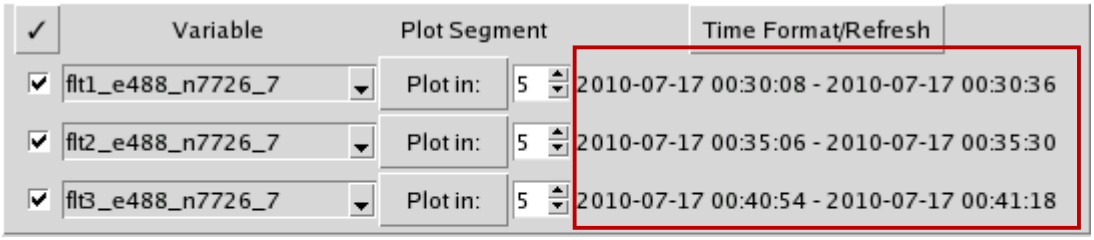
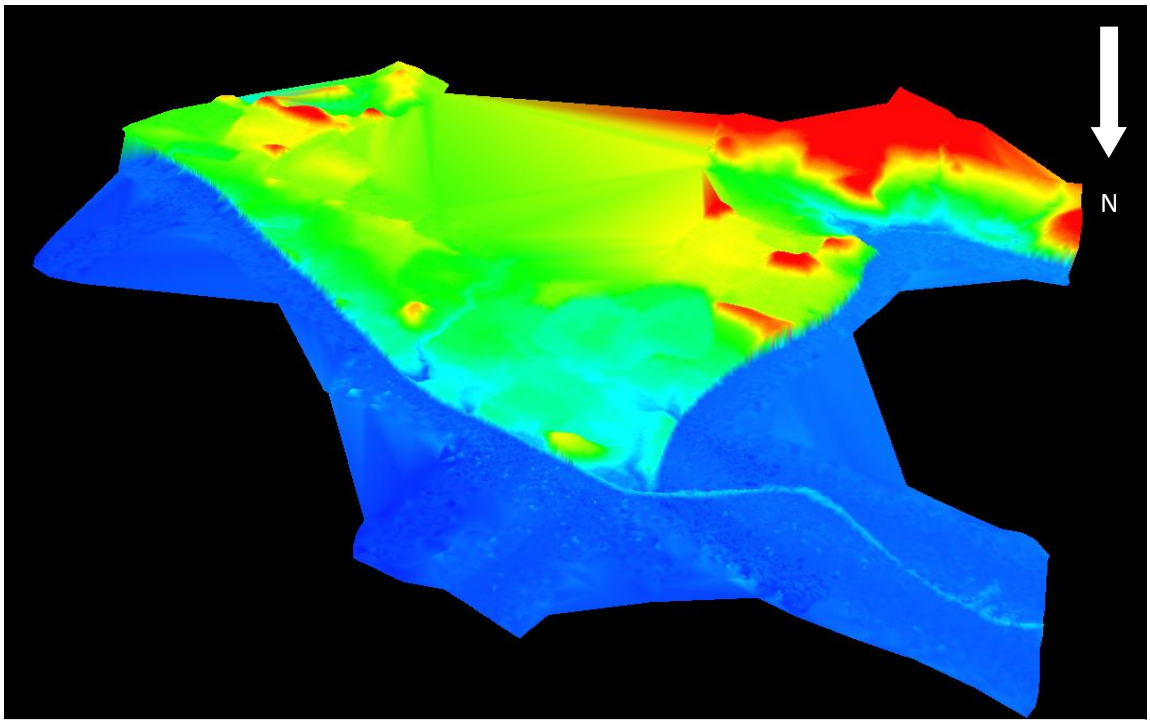


Figure 8: Correctness check – sequence of the timestamps appears correct

Result: The pilot data passed both the uniqueness and correctness checks.

Data and Intensity Plots:

Sample perspective view of the pilot study area (2010 data):



(a)

(b)

Figure 9: (a) 3D perspective view of the gridded pilot area data using MARS software (b) Corresponding view in Google Earth

Intensity Image

Below is the intensity image of the entire pilot data. Tile e494_n7730 has been zoomed in to show the variation in intensity between different flightlines.

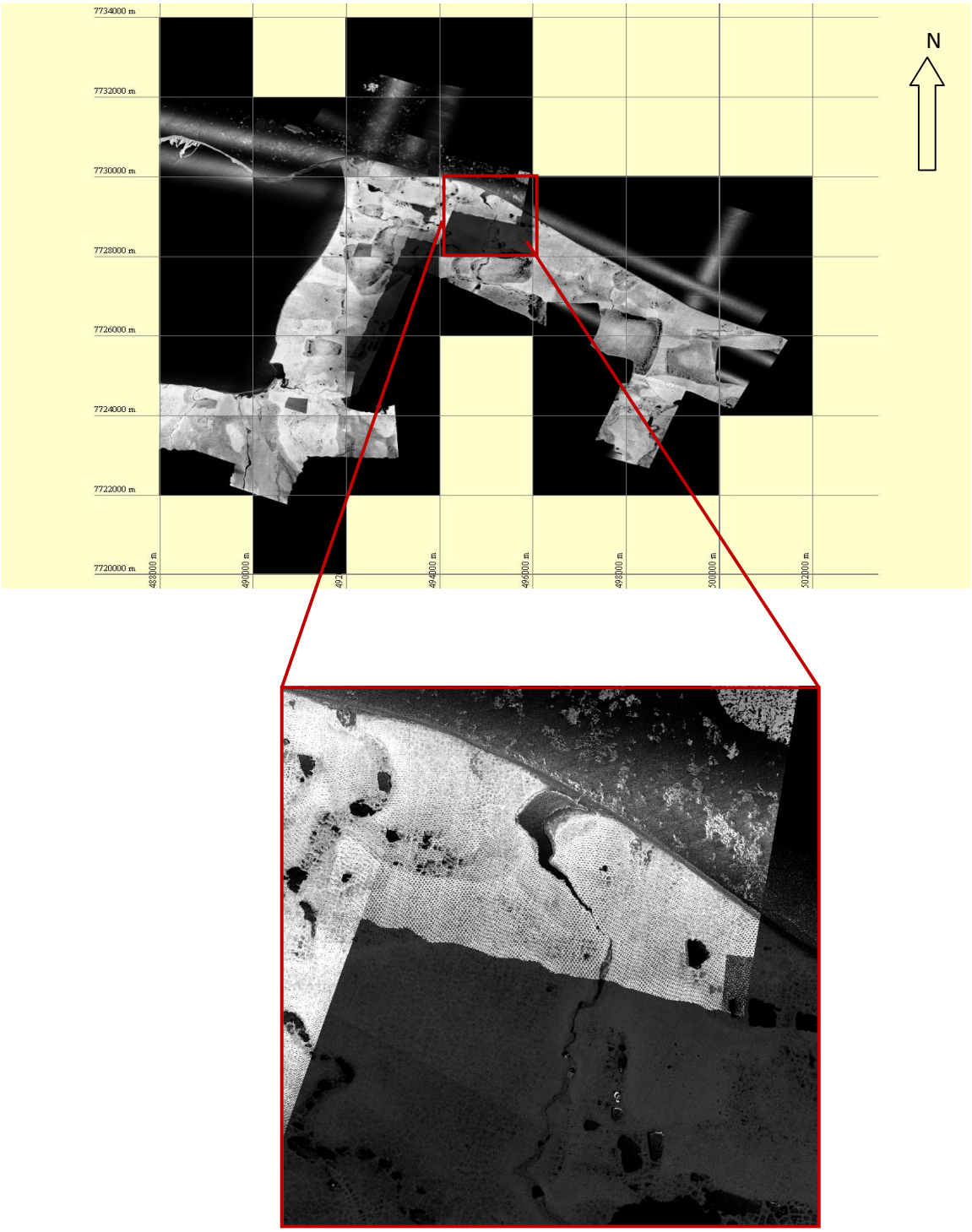


Figure 11: Intensity GeoTIFF image of pilot area and tile e494_n7730 showing intensity mismatch between flightlines.

Tile Index

The tile index shapefile and pilot area boundary shapefile were plotted in ArcMap with labels denoting the tile names.

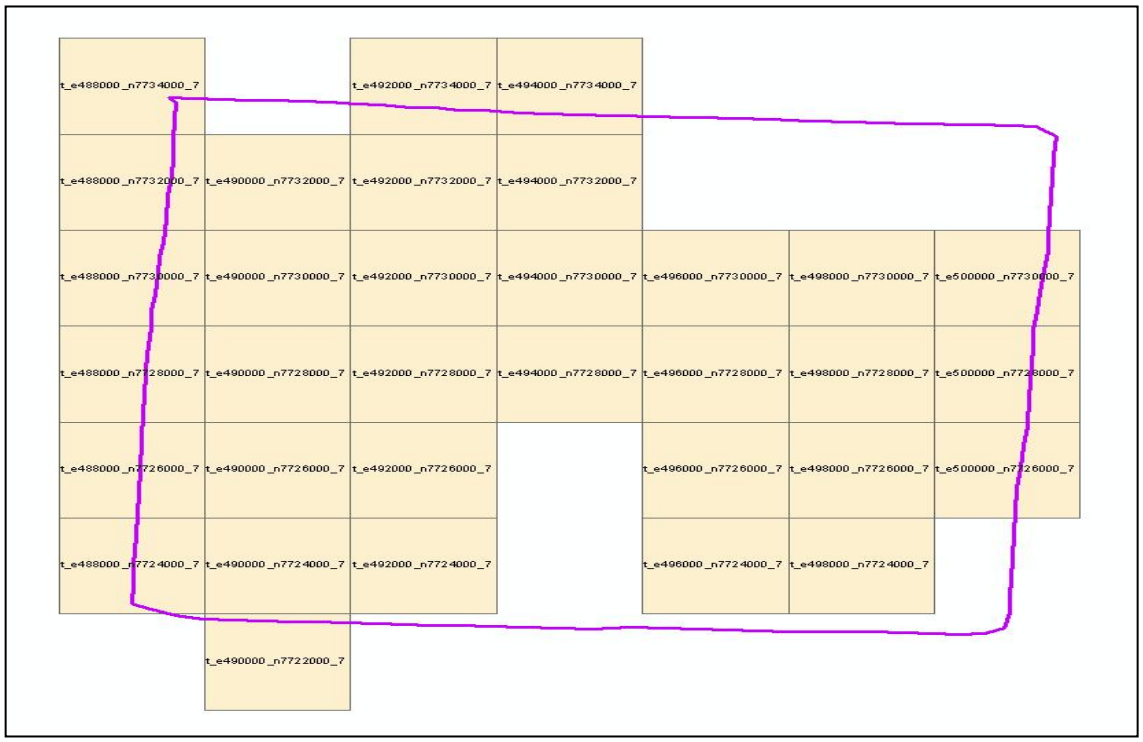


Figure 12: Labeled tile index shapefile for pilot area with data boundary (magenta)