TLS SURVEY OF WATERTRACK SITES NEAR TOOLIK LAKE, KUPARUK BASIN, ALASKA

SITE SURVEY 2014-08-06 TO 2014-08-11

Report by Brendan Hodge, Engineer, UNAVCO Inc.

Project Summary

The main goal of this project is to quantify the hydrologic conditions and flow in the subsurface at selected watertrack sites located in the Kuparuk Basin near Toolik Lake, Alaska. A TLS survey was conducted at each study site in order to produce a high-resolution surface topography map. This data will be used in hydrologic models to define the contributing area within each distinct hydrologic basin.

PROJECT PERSONNEL

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Site Description

Three survey areas were selected that encompassed a coverage area containing five watertrack basin study sites. The surveys were conducted over a period of one week in August 2014 during a period of unusually stable and mild weather. The ground cover at all the sites consisted of hummocky tussock grasses and low shrubs. Some parts of each study site had standing water visible on the surface or where saturated to ground level. The topography in general was gently sloping with few if any rock outcrops. Scientific equipment was installed at each site, which is a feature captured by each survey with the LiDAR data.

SURVEY OBJECTIVE

The primary objective of the survey was to collect a geo-referenced surface topography map of the ground surface of each watertrack basin. The desired resolution of each survey was sub-meter and typically on the order of one or two decimeters or higher.

SITE LOCATION

Latitude: N 68.6445°
Longitude: W 149.3914°
Elevation: 750 m ASL

SITE CONDITIONS

Atmospheric conditions at the sites were typically mild with calm or no winds and zero precipitation. Visibility was typically unlimited with only occasion periods of low clouds or fog. Scanning was completed during the mid-morning to late afternoon period of the day. Temperatures ranged between 10C and 20C. Mosquitos were a significant nuisance and which resulted in many areal returns in the vicinity of the scanner and at distance. These returns required extensive filtering in order to remove from the final point cloud.

Survey Results

The first survey was completed on August 6th of on a gently sloping west facing aspect of the valley. During this survey watertracks #5 and #6 were successfully surveyed in addition to large areas around each of the study zones. Retro-reflective targets were used and installed level with GPS on top for geographic registration. The second survey during August 7th was completed was completed at watertrack #1 in a slightly steeper north facing aspect in the valley. Retro-reflective targets were also used and installed level with GPS on top for geographic registration. Watertrack #2 and #4 were surveyed over a two day period starting on August 10th. Reregistration was defined by the scanner inclination and position measured with fast static GPS solutions collected over the phase-center of the scanner. This method allowed for quicker movement on the much larger study area while still maintaining sub decimeter level accuracy in point measurements.

SURVEY EQUIPMENT
- Scanner: Riegl VZ1000 w/ Nikon D800 camera and forced centering GPS mount (0.251 m to scanner phase center from bottom of antenna mount)
- Targets: Unavco CNC machined (0.108 m to center)
- GPS: 2 Trimble R7 with Zephyr Geodetic 2 antenna, one Trimble R10 GNSS w/extension
- Optical plummets and tripods for leveled targets.

GPS SOLUTIONS
All GPS solutions are referenced to the continuous reference station TOOL located at the Toolik Arctic Research Station approximately 8-11 km from the survey sites. A fixed local GPS basestation was also installed at each survey site to correct for network solution errors and provide a redundant baseline to local surveyed targets. All GPS measurements where collected on a leveled tripod over retro-reflective targets, with the exception of the static occupations of individual scanner position measurements.   Each solution was corrected to the centroid of the target or the phase center of the scanner respectively with TBC software and reported in addendum. Positioning solutions returned results with individual point position horizontal uncertainty of 8-13 mm over baseline distances up to 1100 meters. Vertical position uncertainty was reported ranging from 12-31 mm. The

coordinate precision of the fixed base station is estimated from the a posteriori position produced by an OPUS PPP solution and is assumed null.

TOOL (IGS08) – Global Reference Position

The GPS reference antenna height for this survey is 0.000 m measured to the phase center of the antenna.

- N 68 37' 39.11979"
- W 149 35' 51.932548"
- 739.984 m (WGS84 ellipsoid height, no geoid)

ALIGHNMENT/MSA RESULTS

Watertrack 1 Survey:

The scan positions are registered with target finescan coordinates in the Scanner project coordinate system (PRCS). These five PRCS coordinates are registered to geographic coordinates (GLCS) with a linear regression solution producing three dimensional RMS residual of 0.0098 m. A filter algorithm was used to eliminate large outliers, mosquitos, and otherwise reduce the excessive data density in near range around the scanner. MSA refined surface-to-surface alignments reported below.

Units:, [m], [deg]

File created:, 2014-09-24 14:44:19

Error (StdDev) [m]:, 0.0350

Number of observations used for calculation:

Tiepoints:, 0

Tieobjects:, 0

Polydata:, 7849

Scan pos.s:, 1

TLS METADATA

NAME	DELTA X	DELTA Y	DELTA Z	DELTA ROLL	DELTA PITCH	DELTA YAW	DELTA SCALE	#	REMARKS
ScanPos001	0.000	0.000	0.000	0.000	0.000	0.000	0.0	3453	Position locked
ScanPos002	0.000	0.000	0.000	0.000	0.000	0.000	0.0	3326	Position locked
ScanPos003	0.000	0.000	0.000	0.000	0.000	-0.001	0.0	4186	Position locked
ScanPos004	0.000	0.000	0.000	0.000	0.000	0.000	0.0	1968	Position locked
ScanPos005	-0.014	0.027	0.000	-0.001	0.002	-0.005	0.0	775	
ScanPos006	0.026	0.001	0.006	-0.001	0.000	-0.003	0.0	1030	
ScanPos007	-0.004	0.005	-0.004	0.001	0.002	0.002	0.0	516	
ScanPos008	-0.213	0.107	-0.004	-0.002	0.002	-0.011	0.0	447	

ECEF Target Coordinates

Point ID	X (ECEF)	Y (ECEF)	Z (ECEF)
1	-2005253.048	-1183971.831	5918748.471
2	-2005219.339	-1184026.221	5918748.875
3	-2005442.748	-1184181.874	5918661.325
4	-2005600.266	-1184212.817	5918610.512
LOCAL	-2005533.864	-1184092.167	5918651.073

Watertrack 2&4 survey:

Each of eight (8) scan positions are registered to the scanner phase center in Cartesian coordinates and aligned with the scanner inclination sensor. A multi-station adjustment (MSA) was then used to produce the final alignment (adjusting for roll, pitch and yaw) and allowing for XYZ shift of up to 0.02 m in the global reference system. The procedure provided an overall improved surface alignment with every scan position reported below.

Project:, 20140809_Toolik-watertrack4_GeoRegMSA

Units:, [m], [deg]

File created:, 2014-09-25 17:38:34

TLS METADATA

Error (StdDev) [m]:, 0.0540

Number of observations used for calculation:

Tiepoints:, 0

Tieobjects:, 0

Polydata:, 21834

Scan pos.s:, 8

NAME	DELTA X	DELTA Y	DELTA Z	DELTA ROLL	DELTA PITCH	DELTA YAW	DELTA SCALE	#	REMARKS
ScanPos001	0.001	0.009	-0.088	0.000	0.000	0.000	0.0	7815	
ScanPos002	0.000	0.000	0.000	0.000	0.000	0.000	0.0	8668	
ScanPos003	0.009	-0.003	0.013	0.000	0.000	-0.008	0.0	8851	
ScanPos004	0.000	0.000	0.000	0.000	0.000	0.000	0.0	7334	Position locked
ScanPos005	0.003	-0.002	0.000	0.000	0.000	-0.012	0.0	3151	
ScanPos006	0.154	-0.002	0.000	0.000	0.000	0.000	0.0	611	
ScanPos007	0.000	0.001	0.000	0.000	0.000	0.003	0.0	3787	
ScanPos008	0.000	-0.003	0.000	0.000	0.000	0.000	0.0	3475	

ECEF Scanner Positions

Point ID	X (ECEF)	Y (ECEF)	Z (ECEF)
1	-2005260.280	-1186254.083	5918280.442
2	-2005197.040	-1186255.652	5918310.520
3	-2005137.490	-1186338.350	5918323.764
4	-2005076.807	-1186382.762	5918339.665
5	-2005080.902	-1186551.137	5918310.302
6	-2004660.824	-1187346.946	5918357.414
7	-2004572.866	-1187527.395	5918368.197
8	-2004531.047	-1187593.953	5918372.890
LOCAL	-2005160.203	-1186317.843	5918317.559

Watertrack 5&6 survey:

Each of eight (8) scan positions are first registered to the targets fine scan coordinates in PRCS. The fine scan registration is geographically registered with the GLCS in ECEF Cartesian coordinates with a standard deviation of 0.035 meters.

NAME	X[M]	Y[M]	Z[M]	SIGMA X[M]	SIGMA Y[M]	SIGMA Z[M]	DELTA X[M]	DELTA Y[M]	DELTA Z[M]
PRCS_001	-6.910	-50.903	0.400	0.005	0.001	0.004	-0.007	0.011	-0.046
PRCS_002	10.204	42.923	0.228	0.004	0.002	0.004	-0.005	0.013	-0.073
PRCS_003	-232.850	72.070	16.240	0.009	0.006	0.004	0.005	-0.003	0.062
PRCS_004	-132.864	24.460	8.589	0.004	0.002	0.004	-0.003	0.007	0.038
PRCS_005	-237.130	-31.273	16.939	0.020	0.006	0.010	0.005	-0.002	0.063
PRCS_006	-637.400	95.162	55.301	0.012	0.033	0.025	-0.015	0.002	-0.050
PRCS_007	-390.087	213.744	31.953	0.027	0.038	0.050	0.000	0.001	-0.015
PRCS_008	-159.780	235.036	12.810	0.019	0.007	0.033	0.019	-0.030	0.021

GEOREFERENCED PRODUCTS

Aligned georeferenced point-cloud data are provided in an Earth Centered Earth Fixed (ECEF) coordinate systems in ASCII CSV files located on the TLS archive. The area-of-interest (AOI) data is provided with a terrain filtered product for some study areas. The filtered data product has outliers removed and has reduced point density in areas around the scanner where density is excessive. Watertrack #5 and #6 have AOI data that has been down-sampled by a factor of 4. All project data and metadata will be archived at: **http://tls.unavco.org**