GNSS Measurements

Inuvik-Tuktoyaktuk-Highway (ITH) and Trail Valley Creek (TVC) 2018

2018-08-12 – 2018-09-03

Metadata Documentation

2020-05-20

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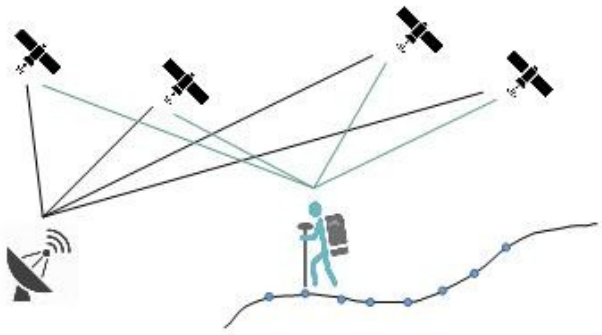

Project: MOSES - Modular Observation Solutions for Earth Systems

General Information

The main purpose of this project was to detect subsidence in the field and on and around the Inuvik-Tuktoyaktuk-Highway (ITH). Therefore, we surveyed many points around the Trail Valley Creek field camp (TVC) and several points on and close to the highway. In the field we collected data along transects and grids across valleys and hills and we installed ground control points (GCP`s) for drone surveys. The ground control points will also be used for as quality control for the overflight of the Polar5 with measurements of airborne laser scanning and high-resolution imagery. Figure 1 shows all the GNSS surveys around TVC and one of the three measurements on the ITH. The survey from the 20th August 2018 is about 10 km further north and the first measurements from the 17th August 2018 is 10 km to south.

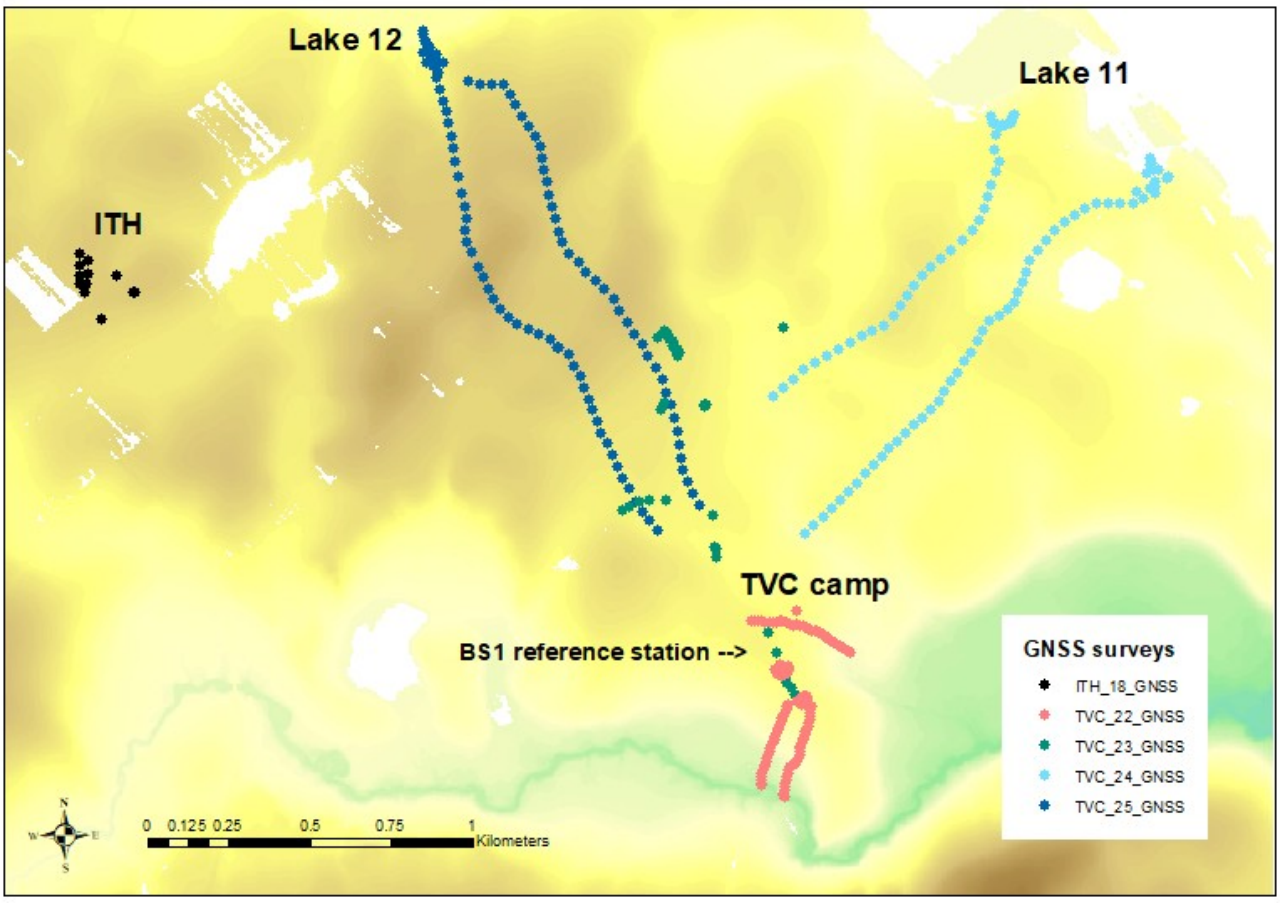

Figure 1: Overview of the measurement area, transects and grids around Trail Valley Creek (TVC).

GNSS setup

The first three days we measured along the ITH, therefore we setup our reference station close to the highway. There were several markers along the road, from the time of the construction (Fig. 3). We used these points, with the “over known point” option and a RTK-mode (Real-Time-Kinematic) for the rover. The Precise Point Positioning (PPP)-corrected (Canadian Geodetic Survey, 2017) positions for these reference points are in table 3.

On the last four days, we used the same setup, but always with the same position for the reference station. This position was also used on prior expeditions in 2015 and 2016 (Anders et al, 2018). The rover setup consists of a 1.8 m pole, with a GS18 antenna (Leica Geosystems, 2017), with a 20 cm diameter PVC-plate at the bottom of the pole (see Fig. 2 and 4). The PVC-plate is needed to keep the tip of the pole from sinking into the wet or moist soil conditions at Trail Valley Creek.

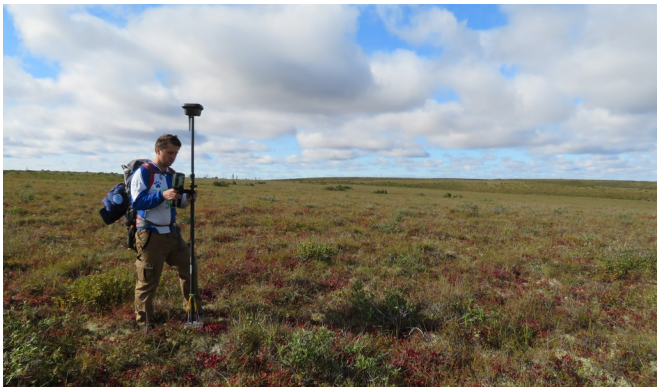

Figure 2: GNSS RTK-Measurements in field

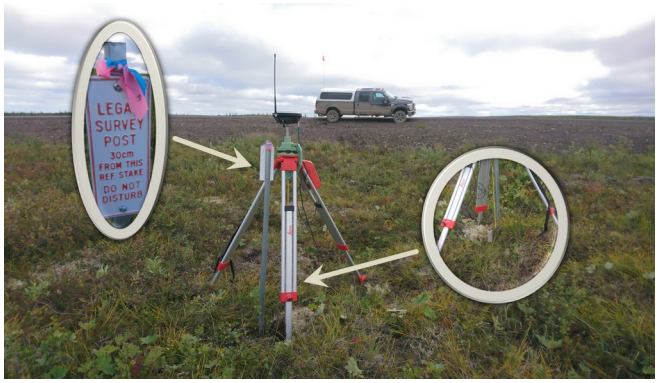

Figure 3: Reference station GS16 installed over a known point, close to the highway

Figure 4: left: reference station close to Trail Valley Creek installed over stick, which was installed in 2016, right: Rover pole with 20 cm diameter PVC-plate

Figure 5: Ground control points (40 x 40 cm black/white rubber mat) around a thaw slump.

Table 1: Instrument specification for Leica GNSS

Parameter	Specification
Mode	Real-time kinematic (RTK)
Accuracy	Horizontal: 8 mm + 1 ppm (rms) Vertical: 15 mm + 1 ppm (rms)

The following adjustments are obligatory:

- coordinate system: WGS 84 / UTM zone 8N
- epsg-code: 32608
- ellipsoid: WGS 84
- projection: UTM 8N
- epoch: ITRS14
- antenna typ: GS18 Lotstab
- antenna height: 1.80 m (changeable individually for specific measurements)

Data Information

Rover data

The collected data were stored in daily projects (see Table 2). We measured during seven days on this expedition. For selected points, we took pictures (not provided here) for interpretation and/or to find the points again. The processing steps are as follows: First export uncorrected data to results (only for the 4 days at TVC, point class 1, see Table 1). Second, project the data using the PPP-corrected reference stations (eg. TVC_22_ppp-project, point class 1). The accuracy is still same for each point; therefore, the point class does not change. The movement of the projection is approximately 82 cm towards north-east and 15 cm upwards (see Table 3 last row). Finally, the recalculation of the inaccurate positions (loss of RTK connection), with GNSS post-processing of the RAW-data (see Table 5). This results in two point classes (2 & 3); point class 2 is of higher accuracy, because of the longer measurement time. Point class 3 is of lower accuracy, but still much higher than without correction.

Table 2: Project overview, with different names and amount of measurements.

date	project name collecting	reference data name ppp-tool	project rtk	project rtk ppp corrected	nr of points
2018-08-17	ITH-20180817_2210_0817_230747	ITH-2291.pos	-	ITH_17_ppp	67
2018-08-18	ITH-20180818_2210_0818_175230	ITH-2300.pos	-	ITH_18_ppp	15
2018-08-20	ETH-20180820_2210_0820_193115	66432320.pos	-	ITH_20_ppp	26
2018-08-22	TVC-20180822_2210_0822_180230	BS1_2341.pos	TVC_22_rtk	TVC_22_ppp	163
2018-08-23	TVC-20180823_2210_0823_184833	BS1_2350.pos	TVC_23_rtk	TVC_23_ppp	50
2018-08-24	TVC-20180824_2210_0824_180927	BS1_2360.pos	TVC_24_rtk	TVC_24_ppp	100
2018-08-25	TVC-20180825_2210_0825_193235	BS1_2370.pos	TVC_25_rtk	TVC_25_ppp	103

Reference data

All GNSS-data were measured in RTK-mode over a known point. Additionally, we saved all raw data from each measurement. In the field camp of Trail Valley Creek (TVC) we used the same reference point and coordinates as in previous campaigns (Anders et al, 2018) to find specific points of interest and to compare the results. To verify the results with data from outside this local system, we corrected the data using the Precise Point Positioning tool of the Canadian Government (Canadian Geodetic Survey, 2017). Our Measurements along the ITH were done with the same setup, but processed data are only available in the global system with PPP-correction.

Table 3: PPP-Coordinates for all reference stations.

UTM north Zone 8	E [m]	N [m]	Ell. Height [m]
2018-08-17	552562.297	7609103.977	90.805
2018-08-18	558794.923	7627324.181	92.575
2018-08-20	569630.099	7658017.778	18.108
Reference Station BS1			
2018-08-22	560814.732	7626307.290	80.019
2018-08-23	560814.736	7626307.285	80.017
2018-08-24	560814.730	7626307.287	80.015
2018-08-25	560814.734	7626307.283	80.017
BS1 mean	560814.733	7626307.286	80.017
BS1 sd	+/-0.003	+/-0.004	+/-0.002
BS1 RTK (2015,2016)	560814.045	7626306.838	79.8708
Offset BS1 RTK to mean	0.688	0.448	0.1462

Validation

Precise Point Positioning Tool

The installation over the fixed point at TVC (see Fig. 4) was permanent for the 4 days we made measurements. Any movements or mistakes, or little inaccuracy in the setup can be ruled out. The post-processed positions for the four days are very high accuracy in all dimensions. Especially for height, the values are extremely good (+/- 0.002 m).

Comment: We used the mean of the corrected coordinates, to have the same base for each measurement day. This allows us to compare the results.

Table 4: Mean quality in three dimensions by point classes. Point class 1 is RTK quality, point class 2 & 3 is after post-processing of raw data, point class 3 is calculated with lower solutions. Very high accuracy in light blue (<0.01 m), high accuracy in yellow (0.01-0.02 m), lower accuracy in orange (0.02-0.1 m), and very low in red (>0.1 m).

ID	amount	Q3D [m]	Q2D [m]	Q1D [m]
Point class 1				
2018-08-17	64	0.0113	0.0051	0.0101
2018-08-18	15	0.0095	0.0038	0.0087
2018-08-20	26	0.0094	0.0039	0.0085
2018-08-22	163	0.0079	0.0034	0.0071
2018-08-23	50	0.0082	0.0038	0.0073
2018-08-24	93	0.0086	0.0039	0.0077
2018-08-25	77	0.0092	0.0042	0.0082
Mean		0.0092	0.0040	0.0082
Mean weighted		0.0088	0.0039	0.0079
Point class 2				
2018-08-17	1	0.0720	0.0321	0.0644
2018-08-24	4	0.0025	0.0012	0.0022
2018-08-25	25	0.0013	0.0006	0.0012
Mean		0.0253	0.0113	0.0226
Mean weighted		0.0117	0.0053	0.0105
Point class 3				
2018-08-24	3	0.0676	0.0377	0.0555
2018-08-25	1	0.0243	0.0050	0.0238
Mean		0.0460	0.0213	0.0397
Mean weighted		0.0568	0.0295	0.0476

Table data description

Table 5: Export table description, with column names, units and value explanation. The three light grey columns are only available in the TVC-data.

column name	unit	description
pointID	-	point name
date/time(UTC)	-	date and time, Format (YYYY-mm-dd HH:MM:SS)
lat(wgs)	decimal degree	latitude
lon(wgs)	decimal degree	longitude
alt(wgs)	m	ellipsoid height
east(utm)	m	easting UTM zone 8 North
north(utm)	m	northing UTM zone 8 North
Q3D	m	quality in three dimensions (XYZ)
Q2D	m	quality in horizontal dimension (XY)
Q1D	m	quality in vertical dimension (Z)
east(local)	m	local coordinates, based on reference station, (uncorrected)
north(local)	m	local coordinates, based on reference station, (uncorrected)
alt(local)	m	local coordinates, based on reference station, (uncorrected)
point class	-	classification; 1-fixed, 2- averaged, 3-code

References

Anders, Katharina; Antonova, Sofia; Beck, Inga; Boike, Julia; Höfle, Bernhard; Langer, Moritz; Marsh, Philip; Marx, Sabrina (2018): Multisensor ground-based measurements of the permafrost thaw subsidence in the Trail Valley Creek, NWT, Canada, 2015-2016. Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research, Bremerhaven, PANGAEA, https://doi.org/10.1594/PANGAEA.888566.

Canadian Geodetic Survey (2017). Canadian Spatial Reference System (CSRS) Precise Point Positioning (PPP) tool. Natural Resources Canada. URL: http://www.nrcan.gc.ca/earth-sciences/geomatics/geodetic-reference-systems/tools-applications/10925#ppp (2020-02-20).

Leica Geosystems (2017), Leica GNSS GS18 receiver: Datasheet. URL: https://leica-geosystems.com/-/media/files/leicageosystems/products/datasheets/leica_gs18_t_ds.ashx (2020-02-20).

Leica Geosystems (2016), Leica Viva Smart Antenna GS16 : Datasheet. URL: https://leica-geosystems.com/-/media/files/leicageosystems/products/datasheets/leica_viva_GS16_GNSS_smart_antenna_ds.ashx (2020-02-20).