Last update: June 26, 2024

DGPS Measurements of Solifluction Lobe and Hillslope Creep at the Teller 47 Field Site from 2017-2019, Seward Peninsula, Alaska

NGEE Arctic Record_id: NGA254

Summary:

DGPS measurements of benchmarks locations were collected during the 2017, 2018, 2019, 2021 and 2022 summers at the NGEE Arctic Teller-47 solifluction site on the Seward Peninsula, Alaska. Benchmarks were installed in 2017 on several solifluction lobes and hillslope locations and re surveyed in 2018 and 2019 with a Trimble R10 DGPS instrument. In 2018, coincident with a UAS-based laser altimetry collection campaign, more ground control targets were installed and subsequently remeasured in 2019. Additional ground control targets were installed in 2021. Points were corrected using NOAA's Online Positioning User Software (OPUS) and Trimble Business Center (TBC) software. There are ten total *.csv files: five are data files plus one file-level metadata and five data dictionaries, two *.jpg, four shape file folders, two *.kml, one archive folder of raw data, and one *.pdf.

Please use this citation to reference the data.

Emma Lathrop, Joel Rowland, Joanmarie DelVecchio, Lauren Charsley-Groffman, Evan Thaler, Erika Swanson, Julian Dann, Nick Sutfin. 2022. DGPS measurements of solifluction and hillslopes creep at the Teller 47 field site from 2017-2019, Seward Peninsula, AK. Next Generation Ecosystem Experiments Arctic Data Collection, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, USA. Dataset accessed on [INSERT_DATE] at https://doi.org/10.5440/1881334.

Related publication

Joanmarie DelVecchio, Emma Lathrop, Julian Dann, Adam Collins, Joel Rowland. 2022. Orthoimagery and Shapefiles Documenting Pre- and Post-August 2019 Slope Disturbances, Teller Road Site, Seward Peninsula, Alaska, 2018-2019. Next Generation Ecosystem Experiments Arctic Data Collection, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, Tennessee, USA. Dataset accessed on [INSERT_DATE] at https://doi.org/10.5440/1886387.

NGEE Arctic Project Summary

The Next-Generation Ecosystem Experiments: Arctic (NGEE Arctic), was a research effort to reduce uncertainty in Earth System Models by developing a predictive understanding of carbon-rich Arctic ecosystems and feedbacks to climate. NGEE Arctic was supported by the Department of Energy's Office of Biological and Environmental Research.

The NGEE Arctic project had two field research sites: 1) located within the Arctic polygonal tundra coastal region on the Barrow Environmental Observatory (BEO) and the North Slope near Utqiagvik (Barrow), Alaska and 2) multiple areas on the discontinuous permafrost region of the Seward Peninsula north of Nome, Alaska.

Through observations, experiments, and synthesis with existing datasets, NGEE Arctic provided an enhanced knowledge base for multi-scale modeling and contributed to improved process representation at global pan-Arctic scales within the Department of Energy's Earth system Model (the Energy Exascale Earth System Model, or E3SM), and specifically within the E3SM Land Model component (ELM).

Data Characteristics

To track annual movement of solifluction lobes at the Teller mm 47 site on the Seward Peninsula, lobe markers were surveyed for three years using a Trimble dGPS system. UAV markers at the site were also surveyed for two years. Together, this dataset provides interannual displacement measurements.

- One data file provides location data for all individual points throughout the 3 years of data collection (149 points). A second data file combines matching points into single rows for determining displacement throughout the study period (65 corresponding points).
- The measurements were collected during three separate field campaigns from 2017 through 2019:
  - June 27 - June 28, 2017
  - July 10 - July 13, 2018
  - August 10 - August 16, 2019
- There are two comma-delimited data files (.csv), and 4 shapefiles (.shp) in this data set.
- An additional folder, "NGA254_Raw_Data", contains unprocessed dGPS data from 2017 through 2019 and the associated OPUS corrected base files.

Data Dictionary

Data Files

1. Target_locations_171819_all_observations.csv
2. Target_locations_171819_averages.csv

Values for these general location fields have been standardized for NGEE Arctic and are applicable for all data dictionaries that follow.

Column_name	Units/format	Description
region		Seward Peninsula
locale		Teller
site		Teller Road Mile Marker 47 (TL_MM47)

File 1: Target_locations_171819_all_observations.csv

Column_name	Units/format	Description
Name_Common		Common name of point
Target_Name		Name of associated target
Point_Type		Type of point (lobe or ground control point)
Name_Common_Year	name_yyyy	Point name followed by year
Name_2018		Point name used in 2018 (bl = bottom left, br = bottom right, tl = top left, tr = top right)
Name_2019_x		Point name used in 2019 (lr = lower right, ur = upper right, ll = lower left, lr = lower right)
Easting_2018_y	m	Easting distance of 2018 dGPS point
Northing_2018_y	m	Northing distance of 2018 dGPS point
Elevation_2018_y	m	Elevation of 2018 dGPS point
H_Prec_Obs_2018_y	m	Horizontal precision of 2018 observation
V_Prec_Obs_2018_y	m	Vertical precision of 2018 observation
Date_Obs_2018_y	yyyy-mm-dd	Date of data collection
Time_Obs_2018_y	hh:mm:ss	Time of data collection
Name_2019_y		Point name used in 2019
Layer_2019		Type of layer
Rebar_Height_2019	m	Height of rebar in 2019
Easting_2019_y	m	Easting distance of 2019 dGPS point
Northing_2019_y	m	Northing distance of 2019 dGPS point
Elevation_2019_y	m	Elevation of 2019 dGPS point
Elevation_Minus_Rebar_2019	m	Ground surface height
Global_Lat_2019	Decimal degrees	Location coordinate for 2019 point
Global_Long_2019	Decimal degrees	Location coordinate for 2019 point
Global_Elli_2019	m	Elevation of 2019 dGPS point
Elli_Height_Minus_Rebar_2019	m	Ground surface height
Local_Lat_2019_y	Decimal degrees	Location coordinate for 2019 point
Local_Long_2019_y	Decimal degrees	Location coordinate for 2019 point
Local_Elli_2019_y	m	Elevation of 2019 dGPS point
Local_Elli_Height_Minus_Rebar_2019	m	Ground surface height
H_Prec_Obs_2019_y	m	Horizontal precision of 2019 observation
V_Prec_Obs_2019_y	m	Vertical precision of 2019 observation
Date_Obs_2019_y	yyyy-mm-dd	Date of data collection
Time_Obs_2019_y	hh:mm:ss	Time of data collection

Easting_2017	m	Easting distance of 2017 dGPS point
Northing_2017	m	Northing distance of 2017 dGPS point

Column_name	Units/format	Description
Elevation_2017	m	Elevation of 2017 dGPS point
Local_Lat_2017	Decimal degrees	Location coordinate for 2017 point
Local_Long_2017	Decimal degrees	Location coordinate for 2017 point
Local_Elli_2017	m	Elevation data for 2017 point
H_Prec_Obs_2017	m	Horizontal precision of 2017 observation
V_Prec_Obs_2017	m	Vertical precision of 2017 observation
Date_Obs_2017	yyyy-mm-dd	Date of data collection
Time_Obs_2017	hh:mm:ss	Time of data collection
Name_2017		Point name used in 2017

File 2: Target_locations_171819_averages.csv

Column_name	Units/format	Description
Target_Name		Name of point
Easting_2018	m	Easting distance of 2018 dGPS point
Northing_2018	m	Northing distance of 2018 dGPS point
Elevation_2018	m	Elevation of 2018 dGPS point
H_Prec_Obs_2018	m	Horizontal precision of 2018 observation
V_Prec_Obs_2018	m	Vertical precision of 2018 observation
Rebar_Height_2019	m	Height of rebar in 2019
Easting_2019	m	Easting distance of 2019 dGPS point
Northing_2019	m	Northing distance of 2019 dGPS point
Elevation_2019	m	Elevation of 2019 dGPS point
Elevation_Minus_Rebar_2019	m	Elevation of 2019 point minus height of rebar in 2019
Global_Lat_2019	Decimal degrees	Location coordinate for 2019 point
Global_Long_2019	Decimal degrees	Location coordinate for 2019 point
Global_Elli_2019	m	Elevation data for 2019 point
Elli_Height_Minus_Rebar_2019	m	Elevation of 2019 point minus height of rebar in 2019
Local_Lat_2019	Decimal degrees	Location coordinate for 2019 point
Local_Long_2019	Decimal degrees	Location coordinate for 2019 point
Local_Elli_2019	m	Elevation data for 2019 point
Local_Elli_Height_Minus_Rebar_2019	m	Ground surface height
H_Prec_Obs_2019		Horizontal precision of 2019 point

Column_name	Units/format	Description
V_Prec_Obs_2019		Vertical precision of 2019 point
Easting_2017	m	Easting distance of 2017 dGPS point
Northing_2017	m	Northing distance of 2017 dGPS point
Elevation_2017	m	Elevation of 2017 dGPS point
Local_Lat_2017	Decimal degrees	Location coordinate for 2017 point
Local_Long_2017	Decimal degrees	Location coordinate for 2017 point
Local_Elli_2017	m	Elevation data for 2017 point
H_Prec_Obs_2017	m	Horizontal precision of 2017 point
V_Prec_Obs_2017	m	Vertical precision of 2017 point
Type		Type of point, either lobe or ground control point
Geometry		Type of point with precise northing and easting values

Data Acquisition Materials and Methods

In June 2017, 20 survey markers were placed in 4 clusters on lobate features to track their annual movement (Fig 1). The markers measured 40 x 70 cm and were secured with two rebar rods in the center of the marker and hammered up to 50 cm below the ground surface. On the northernmost, south facing slope, targets were distributed across three of what appear to be solifluction lobes with dimensions of ~40 m in the upslope direction and ~20 m in the cross slope. On the east facing hillslope located between the two tributary branches of the main drainage we placed a fourth cluster of ten targets across a series of arcuate features with torn vegetation and exposed soils upslope and apparent bunching of tundra and soils downslope. We used a Trimble dGPS system to survey the four corners and tops of the two rebar poles for all survey markers. We surveyed the lobe markers for three years: when the targets were first deployed June 2017, July 2018, and August 2019. This produced two years' worth of interannual displacement measurements. We also surveyed the gridded UAV markers in July 2018 and August 2019, rendering only a single interannual displacement measurement. To compare interannual movement we averaged the six XY positions at each marker to produce a single coordinate for a target in a given year. For all years we performed an OPUS correction for the survey.

Post-Processing Workflow

After raw dGPS points are collected in the field, they need to be corrected. While in the field, the base station logs where satellites are supposed to be located. Two weeks after points are collected, OPUS knows exactly where the satellites went and the position of the base station can then be corrected. By correcting the base station position, the rest of the points connected to the base station will be corrected too. Only base station files are submitted to OPUS, and there will be one base station file for each day that survey points are taken in the field. Because of the methods used to measure displacement of points during the three years of surveys, some extra processing steps were required for this dGPS dataset. See NGA254_Raw_Data.zip for unprocessed dGPS files.

Data Processing Steps

1. Raw data was extracted from the controller via a Trimble thumb drive.
2. Base files were submitted to OPUS for correction: https://gnss-processor.trimbleaccess.com/gnssprocessor
    a. OPUS files from all years (2017-2019) were corrected on the same day.
3. Base heights were entered as follows:

Date	Location	Base Height	File #	T02 File Name	Notes
6/25/17	2017 Teller 47 Base	*	79091761	79091761.T02	*Height entered in controller only
6/27/17	2017 Teller 47 Base	*	79091781	79091781.T02	*Height entered in controller only
7/10/18	2018 Teller 47 Base	1.43 m	79091920	79091920.T02	
7/11/18	2018 Teller 47 Base	1.43 m	79091921	79091921.T02	
7/12/18	2018 Teller 47 Base	1.43 m	79091931	79091931.T02	
7/13/18	2018 Base over T2_17	*	79091940	79091940.T02	*Height entered in controller only
8/10/19	2019 Teller 47 Base	1.545 m	79092220	79092220.T02	
8/11/19	2019 Teller 47 Base	1.545 m	79092230	79092230.T02	
8/14/19	2019 Teller 47 Base	1.545 m	79092260	79092260.T02	
8/15/19	2019 Teller 47 Base	1.545 m	79092273	79092273.T02	
8/16/19	2019 Teller 47 Drone Target 18	1.358 m	79092280	79092280.T02	Height from R10 extension to the ground

Table 1. Base heights* and file names for dGPS base data and corrections.

*Note that base heights at TL_47 are the height from the R10 lever extension to top of the rebar cap. In past years, the height was measured from the lever of the R10 extension to the ground. In 2019 it was measured from the R10 extension to the top of the rebar cap. The height of the rebar was also measured and the base height is the height from the R10 extension plus the height of the rebar. If compared to the calculated geometry to match the way the previous year bases were measured, this would not make more than 1/10 of an inch difference.

4. A new project was created in TBC (Trimble Business Center) and project settings were defined as follows:
    a. Coordinate system group: World wide/UTM
    b. Zone: 3North

   c. Datum Transformation: WGS 1984
   d. Geoid model: GEOID03 (Alaska)
   e. Geoid quality: unknown
5. All T02 files from the main TL-47 base were added into TBC. All OPUS files were copied into the same source folder as the T02 files.
6. All 4 OPUS points were added to TBC, then averaged to create a new point, called "TL_47_OPUS_all".
7. **Correcting data to base:** To correct data for each year to the base from that survey (i.e. to correct all 2019 data to 2019 base). For the TL47 2019 Base:
   a. Data was imported and project settings were automatically filled from the rover files.
   b. T02 files for each day of data from that year were added to TBC (see Table 1 for file names).
   c. Points were recomputed using the F4 button.
   d. All OPUS xml files were added to TBC.
   e. All OPUS solutions for that year were added together by selecting all, right clicking, and selecting "Average Points."
   f. After naming this new point and clicking "Compute", the new averaged point showed up in the list of points.
   g. In the list of points, the point options drop down for the base point was selected. This was done so that a new coordinate could be made under the original base to reflect the coordinates of the average OPUS solution.
   h. "Add coordinate" was selected by right clicking on the base point. In the banner on the right side, coordinate type was set as Global.
   i. The Latitude box was highlighted and the point next to the years averaged OPUS point was selected so that the latitude would auto-fill and the two points would be the same. The same was done for the height box.
   j. The icon to the right of the input boxes was selected to make both the latitude and the height control quality.
   k. Points were recomputed using F4.
   l. Steps h through k were repeated separately for the drone target base point in 2019.
   m. All points for that year had then been corrected to the OPUS solutions.
   n. To export points for comparison, all points were highlighted. Under the Home tab, the export tab was selected. They were then exported as a shapefile.
   o. These steps were repeated for each year of surveys.
8. Excel files were created from the shapefiles to use for point comparisons between years.
   a. ArcGIS was used to convert shapefile attribute tables to excel files. These new files were saved.
9. **To remove rebar heights from 2019 points:**
   a. During the 2019 survey, points on rebar were measured from the top of the rebar instead of from the base of the rebar as was done in 2017 and 2018.

b. To correct these points and make the measurement method consistent, the height of the rebar (measured after surveying the point) was subtracted from the elevation (from both the Elevation columns and the Local Elli columns in the excel files).
c. The height of the rebar that was below the base was then subtracted to get the true ground distance. Base heights had to be corrected both when they were OPUS submitted and in all of the RTK connections between points and the base.
    i. In TBC, the project was opened.
    ii. In the Home tab under the Data section, Vector was selected. This opened a spreadsheet of all vectors in the project, organized by base point and height.
    iii. The box with the arrow on the left hand side next to the Vector ID column was selected. To edit the antenna heights, the desired vectors were selected by the base.
    iv. The side box was clicked and properties were selected.
    v. The heights were then corrected, as well as the method for where measurements were taken from (lever of the R10 extension).
    vi. Points were recomputed using F4. This was done for all bases needing height corrections.
d. After correcting these points, the uncorrected columns were deleted

10. **To rename all points and make a combined file for comparisons and velocity vectors:**
    a. Point names were reviewed to ensure that all points had a consistent name relative to their 2017 name for easy comparison. (See Fig. 2 for example of TL47 benchmarks where names differed between years)
    b. For all years, the average of all OPUS points (used for the base) was called base_avg_OPUS.
    c. Repeated data and error files were removed. If repeat files were present for one point, the data collected earliest was deleted.
    d. A new file called "TL47_targets_20172019" was created, starting with points from the 2019 file with renamed and corrected points.
    e. A VLOOKUP from the 2018 and 2017 files were used to fill in the rest of the missing data.
11. **To create shapefiles from the new combined Excel file:**
    a. Multiple versions of shapefiles were created in ArcGIS. To create shapefiles, XY data was added to ArcGIS and then exported as shapefiles.
    b. A shapefile was created for each year (named by year: "TL47_yyyy.shp").
    c. An additional combined shapefile was created with all points from all years ("TL47_20172019.shp").
12. **To compare differences in point locations between all years:**

a. Differences were calculated as newer year minus older year. A positive difference is equal to downslope movement.
b. Points that were only collected in 2019 were removed from the data.
c. The magnitude of displacement was calculated for each point to determine which points moved the most.

13. **To estimate error from DGPS points:**
    a. To estimate year-to-year error, R10 RTK <30km specs were used:
        i. Calculate vertical error: 8 mm + 1 ppm
        ii. Calculate horizontal error: 15 mm + 1 ppm
            1. 1 ppm = greatest distance from a point to the base /1,000,000 then converted to mm.
        iii. Using HDOP and VDOP gives the epoch to epoch residual (error) and not the year-to year variation.
    b. Ex: Used T2_18 base to T2_ex_6, the vector distance in TBC was 924.647 m. This meant adding 0.925 mm to the 8/15 mm.

Supplemental Files

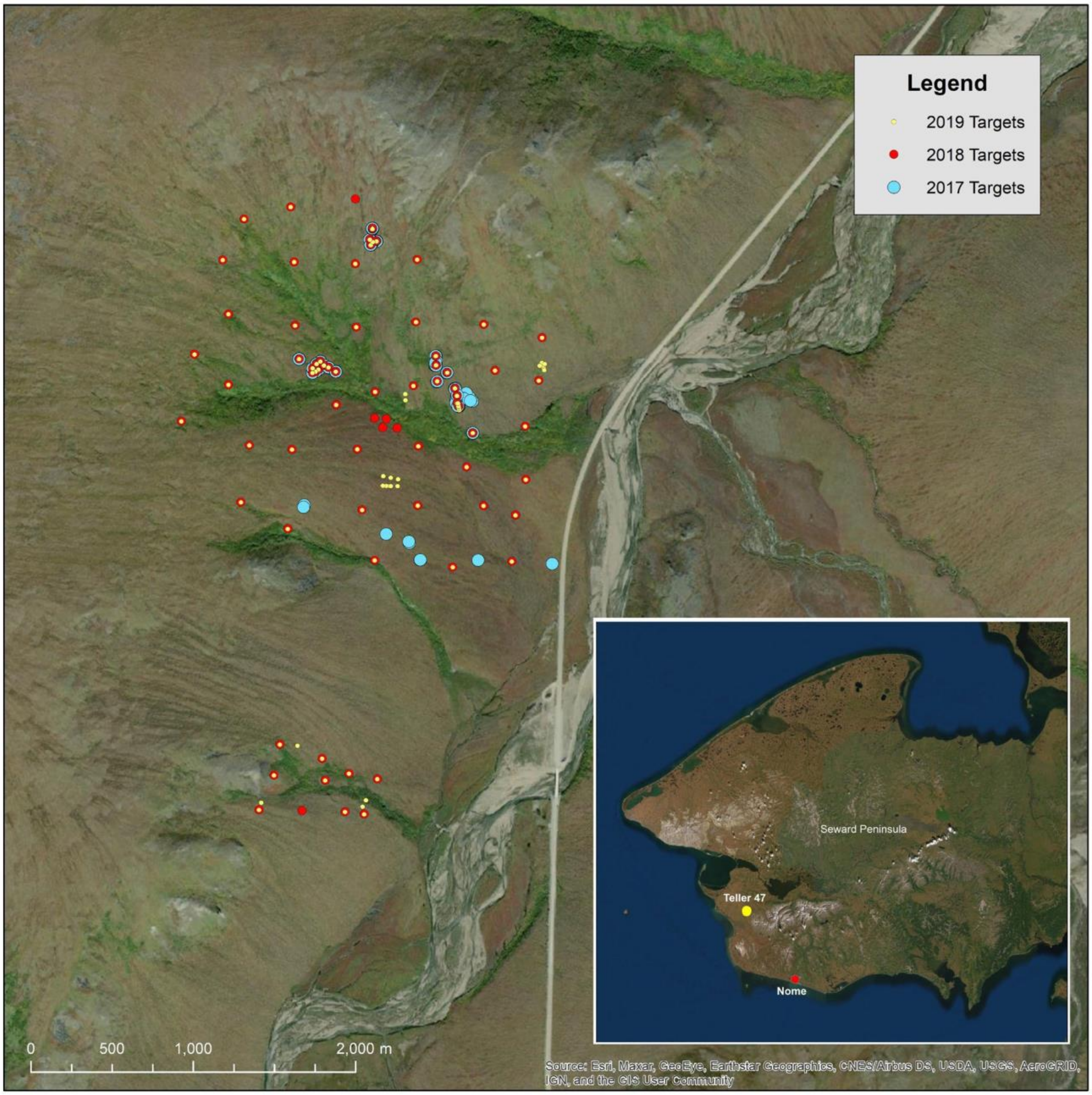

Figure 1. Teller 47 site location and DGPS target locations in 2017, 2018, and 2019

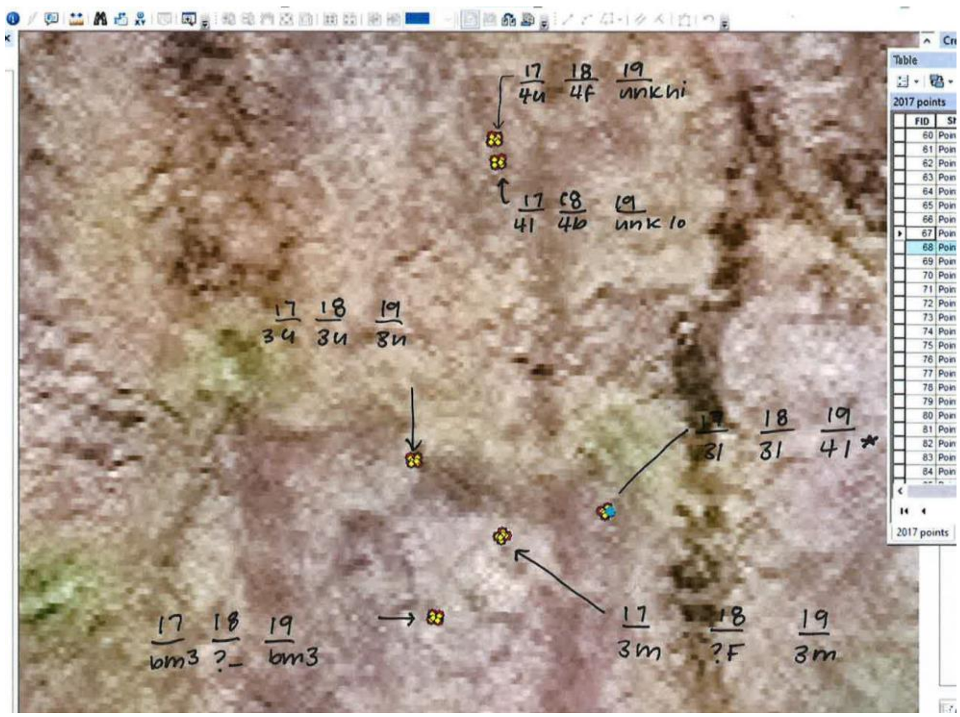

Figure 2. Example photo from post-processing work where the names of upper Teller 47 benchmarks differed between years.

Addendum to NGA254

DGPS measurements at Teller 47 Field Site from 2021 and 2022, Seward Peninsula, Alaska

Summary:

Benchmarks installed in 2017 and 2018 were re-surveyed in 2021 and 2022 with a Trimble R10 dGPS instrument. Additional ground control targets were installed in 2021. Following the same processing protocol, points were corrected using NOAA's Online Positioning User Software (OPUS) and Trimble Business Center (TBC) software.

Data Characteristics:

- A comma-delimited data file (.csv) provides target locations for all points surveyed in 2021.
- A comma-delimited data file (.csv) provides target locations for all points surveyed in 2022.
- An additional comma-delimited data file (.csv) includes post-processing calculation of surface movement between 2019 and 2021.
- Data dictionary files are provided for all new .csv files.

Post-Processing Calculations:

Surface movement in horizontal and vertical displacement was calculated between the 2019 and 2021 dGPS data. Displacement values can be found in the Displacement_20192021.csv.

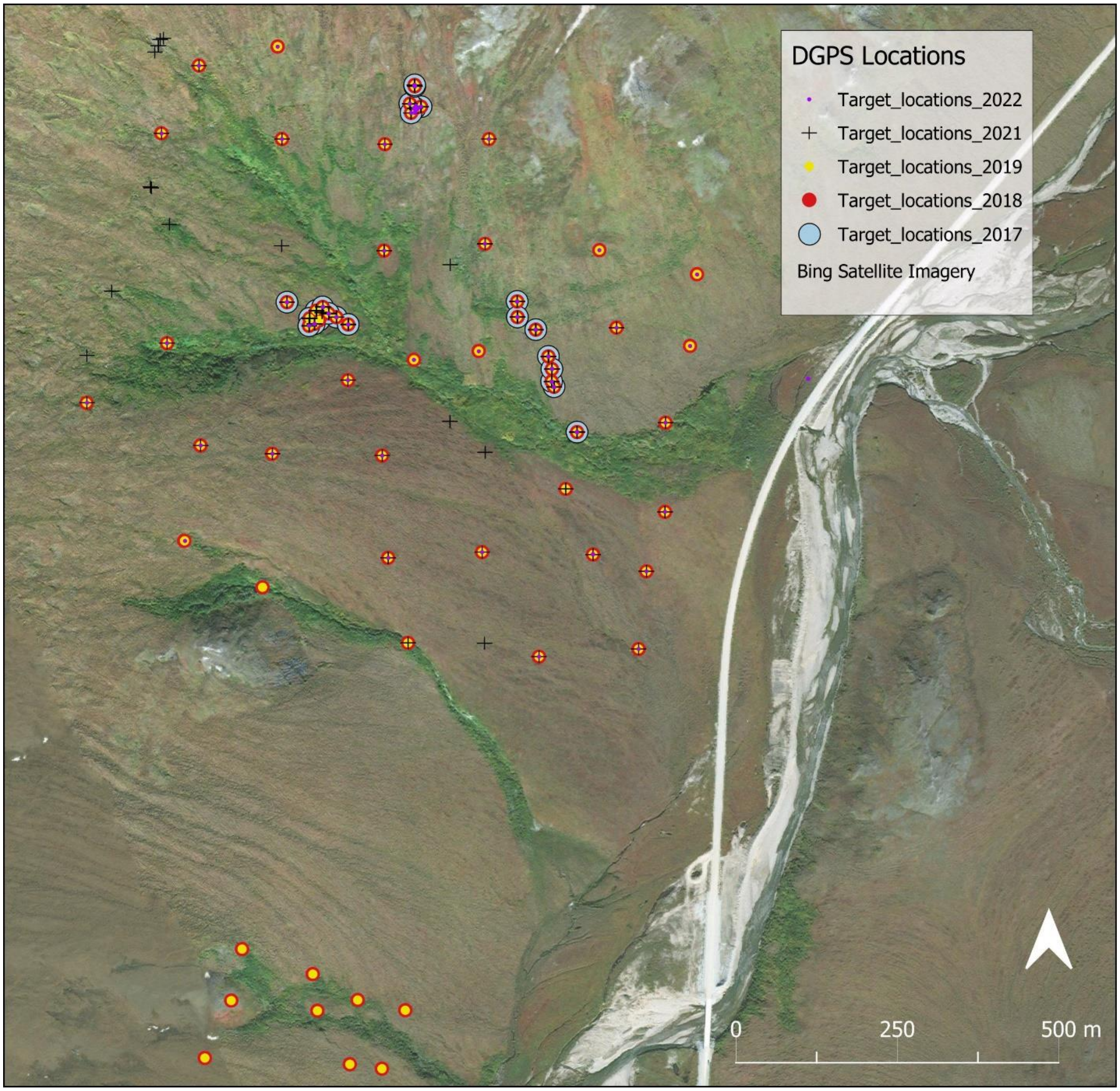

Figure 1. Updated map of the Teller 47 dGPS target locations in 2017, 2018, 2019, 2021, and 2022.

Data Access

Data Center Contact
support-ngee-arctic@ornl.gov

Disclaimer of Liability
Data and documents available from the NGEE Arctic web site (http://ngee.ornl.gov/) were prepared as an account of work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, or any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Further, Oak Ridge National Laboratory is not responsible for the contents of any off-site pages referenced.

The complete ORNL disclaimer can be viewed at http://www.ornl.gov/ornlhome/disclaimers.shtml.