Supplementary Material

# Supplementary Data

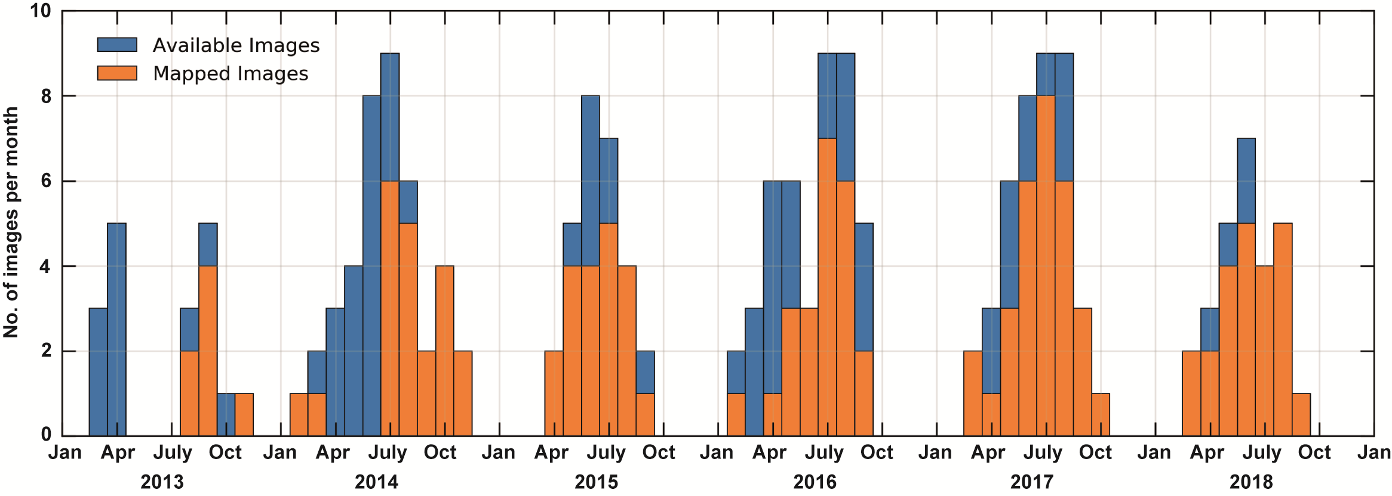
This supplementary material consists of five figures, two tables and a description of a geographic information system (GIS) ready data set of mapped terminus traces that correspond to the publication of Brough, S. et al. (2019) Exceptional Retreat of Kangerlussuaq Glacier, East Greenland, Between 2016 and 2018. Front. Earth Sci. 7:123. doi: 10.3389/feart.2019.00123.

**Figures:** ‘SF1’ presents frequency counts over time of available and mapped Landsat 8 images used in this study. ‘SF2’ presents a frequency count over time for velocity maps utilized in this study and ‘SF3’ presents the time difference between image pairs used to generate these maps. ‘SF4’ presents the data source and elevation error associated with the bed topography from the BedMachine v3 product. ‘SF5’ presents a comparison of radar derived bed geometry to bed geometry derived in BedMachine v3.

**Tables:** ‘ST1’ presentsdetails of Landsat 8 imagery used to digitize glacier termini. ‘ST2’ presents a summary of data sources used in this study.

**Data Sets:** ‘DS1.zip’ provides GIS ready shapefiles for mapped terminus traces between 2013 and 2018. Data are provided in both geographic (EPSG: 4326; WGS84) and projected (EPSG:3413; NSIDC Sea Ice Polar Stereographic North) coordinate systems. As each terminus trace has metadata appended, including the unique path identifier, it is possible to directly and easily identify the original image used in the mapping process. Both shapefiles are compatible for ingestion into the Google Earth Digitization Tool (GEEDiT) Reviewer (<https://liverpoolgee.wordpress.com/>) for reviewing and subsetting the dataset (see Lea et al., 2018).

# Supplementary Figures



**SF1:** Landsat 8 available images and mapping frequency between March 2013 and September 2018 for Kangerlussuaq.



**SF2:** Velocity map frequency between February 2009 and November 2018 for Kangerlussuaq.



**SF3:** Time difference between image pairs used to calculate velocity. Data are plotted based on the mid-date of the image pair.



**SF4:** Overview of bed topography data for Kangerlussuaq for: (a) data source and (b) bed elevation error associated with the BedMachine v3 product (Morlighem et al., 2017). White line indicates the center line profile and black line corresponds to the glacier’s most retreated ice front (16 May 2018).



**SF5:** Comparison of radar derived bed geometry from CReSIS (CReSIS, 2018) to bed geometry derived in BedMachine v3 (Morlighem et al., 2017). (a) Location of radar derived point measurements (red circles) within 150 m of center line profile (white line). Black line corresponds to the glaciers most retreated ice front (16 May 2018). (b) Close up of (a) showing only the region that has radar measurements. (c) Bed and surface profiles along the center line. Grey line and shading correspond to the bed profile and spatially varying error obtained from BedMachine v3 (Figure SF4). Red pluses correspond to radar derived bed-elevation point measurements from CReSIS. Surface elevation data is contained within the BedMachine v3 product and is obtained from the Greenland Ice Mapping Project (GIMP) surface digital elevation model, and has a nominal date of 2007 (Howat et al., 2014).

# Supplementary Tables

**ST1:** Details of Landsat 8 imagery used to digitize glacier termini. Path and Row correspond to the World Reference System 2.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Path** | **Row** | **Date** | **Path** | **Row** | **Date** | **Path** | **Row** | **Date** | **Path** | **Row** | **Date** | **Path** | **Row** | **Date** |
| 229 | 012 | 20130822 | 230 | 012 | 20130930 | 231 | 012 | 20130820 | 232 | 11 | 20140713 | 232 | 012 | 20130928 |
|  |  | 20130923 |  |  | 20131101 |  |  | 20130905 |  |  | 20140729 |  |  | 20141017 |
|  |  | 20140214 |  |  | 20140731 |  |  | 20140706 |  |  | 20140814 |  |  | 20150427 |
|  |  | 20140302 |  |  | 20140816 |  |  | 20140722 |  |  | 20141102 |  |  | 20150513 |
|  |  | 20140724 |  |  | 20140917 |  |  | 20140807 |  |  | 20150614 |  |  | 20160819 |
|  |  | 20140809 |  |  | 20141104 |  |  | 20140823 |  |  | 20150716 |  |  | 20160904 |
|  |  | 20140910 |  |  | 20150429 |  |  | 20141026 |  |  | 20160702 |  |  | 20170619 |
|  |  | 20141012 |  |  | 20150531 |  |  | 20150506 |  |  | 20160718 |  |  | 20170721 |
|  |  | 20141028 |  |  | 20150702 |  |  | 20150607 |  |  | 20170518 |  |  | 20170907 |
|  |  | 20150508 |  |  | 20150718 |  |  | 20150623 |  |  | 20170603 |  |  |  |
|  |  | 20150625 |  |  | 20150819 |  |  | 20150709 |  |  | 20170705 |  |  |  |
|  |  | 20150727 |  |  | 20160517 |  |  | 20150810 |  |  | 20170721 |  |  |  |
|  |  | 20150812 |  |  | 20160618 |  |  | 20160508 |  |  | 20170806 |  |  |  |
|  |  | 20150828 |  |  | 20160704 |  |  | 20160609 |  |  | 20180505 |  |  |  |
|  |  | 20150929 |  |  | 20160720 |  |  | 20160625 |  |  | 20180606 |  |  |  |
|  |  | 20160220 |  |  | 20160805 |  |  | 20160727 |  |  | 20180622 |  |  |  |
|  |  | 20160424 |  |  | 20160821 |  |  | 20160828 |  |  | 20180724 |  |  |  |
|  |  | 20160526 |  |  | 20160906 |  |  | 20170511 |  |  | 20180809 |  |  |  |
|  |  | 20160713 |  |  | 20170317 |  |  | 20170612 |  |  |  |  |  |  |
|  |  | 20160729 |  |  | 20170520 |  |  | 20170628 |  |  |  |  |  |  |
|  |  | 20160814 |  |  | 20170605 |  |  | 20170714 |  |  |  |  |  |  |
|  |  | 20160830 |  |  | 20170707 |  |  | 20170730 |  |  |  |  |  |  |
|  |  | 20170310 |  |  | 20170723 |  |  | 20170815 |  |  |  |  |  |  |
|  |  | 20170411 |  |  | 20170824 |  |  | 20170831 |  |  |  |  |  |  |
|  |  | 20170614 |  |  | 20180421 |  |  | 20180530 |  |  |  |  |  |  |

**ST1 continued**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Path** | **Row** | **Date** | **Path** | **Row** | **Date** | **Path** | **Row** | **Date** | **Path** | **Row** | **Date** | **Path** | **Row** | **Date** |
| 229 | 012 | 20170716 | 230 | 012 | 20180507 | 231 | 012 | 20180615 |  |  |  |  |  |  |
|  |  | 20170801 |  |  | 20180726 |  |  | 20180717 |  |  |  |  |  |  |
|  |  | 20170817 |  |  | 20180827 |  |  | 20180802 |  |  |  |  |  |  |
|  |  | 20170902 |  |  |  |  |  | 20180818 |  |  |  |  |  |  |
|  |  | 20170918 |  |  |  |  |  | 20180903 |  |  |  |  |  |  |
|  |  | 20171004 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180313 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180329 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180430 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180516 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180601 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180617 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180719 |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | 20180804 |  |  |  |  |  |  |  |  |  |  |  |  |

**ST2:** Summary of data sources used in this study.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data Type** | **Product** | **Date Range** | **DOI/Link** | **Reference** |
| Terminus traces | Sub-annual terminus position | 2013-2018 |  | This study |
|  | Sub-annual terminus position | 2000-2010 | https://doi.org/10.1657/AAAR0014-049 | Murray et al., (2015) |
|  | Annual terminus position | Little Ice Age,  1932, 1966, 1972, 1981, 1985, 1991,  1999-2012 | <http://doi.org/10.5194/tc-8-1497-2014> | Khan et al. (2014) |
| Ice velocity | MEaSUREs Greenland Ice Velocity: Selected Glacier Site Velocity Maps from InSAR, Version 1.2 | 2009-2018 | <https://doi.org/10.5067/MEASURES/CRYOSPHERE/nsidc-0481.001> | Joughin et al. (2010) |
| Surface elevation change | IceBridge ATM L4 Surface Elevation Rate of Change, Version 1. Annual. | 2001-2002,  2002-2003,  2005-2006,  2007-2008,  2010-2011,  2011-2012,  2012-2013,  2013-2014,  2014-2015,  2015-2016,  2016-2017,  2017-2018 | <https://doi.org/10.5067/BCW6CI3TXOCY> | Studinger (2014) |
|  | IceBridge ATM L4 Surface Elevation Rate of Change, Version 1. Cumulative. | 2001-2002,  2001-2003,  2001-2005,  2001-2006,  2001-2007,  2001-2008,  2001-2010,  2001-2011,  2001-2012,  2001-2013,  2001-2014,  2001-2015,  2001-2016,  2001-2017,  2001-2018 | <https://doi.org/10.5067/BCW6CI3TXOCY> | Studinger (2014) |

**ST2 continued**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data Type** | **Product** | **Date Range** | **DOI/Link** | **Reference** |
| Ice Surface and bed topography | IceBridge BedMachine Greenland, Version 3. | 1993-2016 (with a nominal date of 2007) | <https://doi.org/10.5067/2CIX82HUV88Y> | Morlighem et al. (2017) |
|  | CReSIS Kangerdlugssuaq 2006-2014 composite v3 | 2006-2014 | <https://data.cresis.ku.edu/data/grids/> | CReSIS (2018) |

# References

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