Title

In situ proglacial river ice thickness, ground penetrating radar (GPR) data and bright reflector mappings from southwest Greenland, February 2015

Authors

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Supporting Publication

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Abstract:

Meltwater export from the Greenland Ice Sheet (GrIS) is a significant contributor to sea level rise. Despite this, relatively little is known about the temporal and spatial dynamics of meltwater routing through and retention in/under the GrIS. Thus to investigate if GrIS hydrologic processes stay active year-round, we deployed to southwest Greenland during winter, approximately 4 months after summertime surface melt. We surveyed the frozen Isortoq, Sandflugtdalen, Ørkendalen, and Watson proglacial rivers, which drain all meltwater runoff from tributary Isunguata Sermia, Russell, Leverett, Ørkendalen, and Isorlersuup outlet

glaciers. At each river site, we established transects across the river ice perpendicular to summertime flow direction. We then executed ground penetrating radar (GPR) surveys along each transect and also mechanically drilled boreholes through the river ice. We discovered evidence of minimal meltwater export beneath proglacial river ice in the Isortoq River. Geochemical analysis of this water suggests that it was sourced from the GrIS. Surveys in neighboring proglacial rivers revealed no evidence of meltwater runoff. We suggest that the discovered runoff only in the Isortoq River is the result of residual meltwater storage and release enabled by a deep, spatially pervasive, subglacial trough beneath Isunguata Sermia outlet glacier. This suggests that GrIS hydrological processes can stay active year-round. The enclosed data supports these results, and includes: point locations of river ice thickness measured in mechanically drilled boreholes; GPR data and processed echograms; approximate point locations of bright reflectors mapped beneath the Isortoq River ice. This data supports the methods, results and conclusions in Pitcher et al. (2020).

Data Description:

- River ice thickness and ground penetrating radar (GPR) surveys were conducted at six proglacial river field sites in southwest Greenland during February 2015.
- At each field site, a transect was established across the frozen proglacial river orthogonal to the summertime flow directions. The start and end coordinates of each transect were recorded using a handheld GPS.
- River ice thickness measurements were tested along each orthogonal transect by mechanically drilling boreholes using a ~5 cm diameter Kovacs ice augur and/or a ~25 cm augur mounted on a Jiffy Model 30 Ice Drill. The depth from the ice surface to the bottom of the borehole and the GPS coordinates were measured at each borehole site.
- Ground penetrating radar (GPR) surveys were conducted by manually escorting a SIR-3000 Geophysical Survey Systems, Inc. (GSSI©) GPR controller and a 400-MHz antenna mounted on a 0.6 cm thick plastic Siglin© sled along each transect. The field site name, survey date, ice thickness measurements, GPS coordinates, and accompanying GPR data files are all summarized in the accompanying .csv data table. Raw *.dzt GPR data is included with accompanying *.txt header information. Processed GPR echograms and transect maps are included as *.tif files.
- At the Isortoq River site, water was found beneath the river ice. For this location, short GPR transects were performed both upstream and downstream of the primary orthogonal transect. The bright reflectors in the echograms are interpreted as likely locations of meltwater beneath proglacial Isortoq River ice. A GPS was not integrated with the GPR during these surveys, so the geolocation is best approximated from field notes, feature tracking within GPR data, and satellite imagery. Despite limitations in geolocation, the spatial pervasiveness of bright reflectors is consistent with a water filled conduit network beneath proglacial river ice. See Figure 2 in of Pitcher et al. (*2020*) and supporting information for further interpretations and description of GPR processing. The .shp file summarizing the location of these approximate bright reflectors is included here.

Data Table for in situ proglacial river ice thickness measurements and ground penetrating radar (GPR) survey locations

File Name: greenland_2015_feb_proglacial_river_surveys.csv

File Type: .csv tabular data

Description: .csv file containing latitude and longitude coordinate locations, river ice thickness measurements, GPR survey locations and accompanying GPR data file names.

Table variable names and descriptions:

variable name	description
site_name	name of field site
yyyy	year of data collection, 4 digits
mm	month of data collection, 2 digits
dd	day of data collection, 2 digits
date	date of data collection, formatted as day/month/year
id	site identifier TN end of transect on north bank of river TS end of transect on south bank of river H1-H* borehole numeric identifier
depth_m	thickness of proglacial river ice. Units: meters
latitude	coordinate location, units: decimal degrees
longitude	coordinate location, units: decimal degrees
info	description of site
echo	file name of accompanying processed GPR echogram, with site id
map	file name of accompanying processed GPR transect, with site id
GPR_file_1	file name of accompanying GPR data
GPR_file_2	file name of accompanying GPR data

Ground Penetrating Radar (GPR) data

File description:

file type	description
*.txt	header information for GPR data
*.dzt	original GPR data collected in field
*_R.dzt	GPR data restored by removing gain applied in situ
*_G5.dzt	GPR data with linear gain applied multiplying each relative-amplitude sample by 5 to enhance features
GPR data are provided in native .dzt format with .txt file header.	
GPR data are organized by survey location.	
Open-source tools to open this data type are available at: https://github.com/dlilien/ImpDAR.	

Overview of GPR instrumentation and survey techniques:

- GPR controller used: SIR-3000 Geophysical Survey Systems, Inc. (GSSI©) GPR controller
- GPR antenna used: 400-MHz antenna installed on a 0.6 cm thick plastic Siglin© sled
- Surveys were conducted on foot by establishing transects orthogonal to flow direction across frozen proglacial rivers.
- At most field sites, two GPR profiles were collected, with start and stop points on opposite banks.
- Enclosed .csv file summarizes GPR survey locations, file names, and field validation borehole information
- Pitcher et al. (*2020*) details field data collection and processing.

Ground Penetrating Radar (GPR) Echograms and Transect Maps

Description: processed echograms with borehole locations/river ice thickness and GPR profile location plot with best estimated mean travel speeds for each survey location. The echogram and location plot best matching boreholes and field notes is shown for each site.

File names and descriptions:

ØrkendalenRiverDownstream_GPR091corrected_echo.tif

- Processed echogram for Ørkendalen River, downstream site. Plotted from FILE____091_R_G5.DZT. Borehole location/ice thickness given in: greenland_2015_feb_proglacial_river_surveys.csv.

ØrkendalenRiverDownstream_GPR091corrected_map.tif

- GPR profile location plot for FILE____091_R_G5.DZT.

ØrkendalenRiverGlacierTerminus_GPR052_echo.tif

- Processed echogram for ÿrkendalen River, glacier terminus site. Plotted from FILE____052_R_G5.DZT. Borehole location/ice thickness given in: greenland_2015_feb_proglacial_river_surveys.csv.

ØrkendalenRiverGlacierTerminus_GPR052_map.tif

- GPR profile location plot for FILE____052_R_G5.DZT.

SandflugtdalenRiver_GPR060_echo.tif

- Processed echogram for Sandflugtdalen River site. Plotted from FILE____060_R_G5.DZT. Borehole location/ice thickness given in: greenland_2015_feb_proglacial_river_surveys.csv.

SandflugtdalenRiver_GPR060_map.tif

- GPR profile location plot for FILE____060_R_G5.DZT.

WatsonRiverDownstream_GPR044corrected_echo.tif

- Processed echogram for Watson River, downstream site. Plotted from FILE____044_R_G5.DZT. Borehole location/ice thickness given in: greenland_2015_feb_proglacial_river_surveys.csv.

WatsonRiverDownstream_GPR044corrected_map.tif

- GPR profile location plot for FILE____044_R_G5.DZT.

WatsonRiverUpstream_GPR055_echo.tif

- Processed echogram for Watson River, upstream site. Plotted from FILE____055_R_G5.DZT. Borehole location/ice thickness given in: greenland_2015_feb_proglacial_river_surveys.csv.

WatsonRiverUpstream_GPR055_map.tif

- GPR profile location plot for FILE____055_R_G5.DZT.

Note:
Echogram for Isortoq River GPR data is published in Figure 2 of Pitcher et al. (2020). Original GPR .dzt data from which echogram was derived is given here.

Location of GPR reflectors beneath Isortoq River proglacial river ice

Description: approximate point locations of bright reflectors found in GPR echograms. These reflectors are interpreted as likely locations of meltwater beneath proglacial Isortoq River ice. A GPS was not integrated with the GPR during these surveys. The spatial location is best approximated. See Figure 2 in Pitcher et al. (*2020*) for interpretations as well as supporting information for description of GPR processing.

File information

file name		GPR_bright_reflectors_isortoq_river.shp
File type		.shp point file
spatial reference		Geoographic Coordinate System: GCS_WGS_1984
attribute table fields	FID	unique numeric field identifier
	lat	latitude of approximate reflector location, units: decimal degrees
	lon	longitude of approximate reflector location, units: decimal degrees