WGMS Intership Report:
Growing the Glacier Photograph Collection

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Titlephoto: Ama Dablam courtesy of Ethan Welty.

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PROJECT DESCRIPTION

1.1 FRAMEWORK

This project was carried out as a collaboration between the World Glacier Monitoring Service (WGMS) in Zurich, Switzerland, and the National Snow and Ice Data Center (NSIDC), in Boulder, Colorado, USA. The NSIDC hosts the Glacier Photograph Collection (GPC), a database of glacier photographs from around the world, but with a strong focus on North American and Greenland glaciers. The WGMS works with collaborators throughout the world to collect data on glacier changes. This data is regularly published in the WGMS's Glacier Mass Balance Bulletin (GMBB) and the Fluctuations of Glaciers (FoG) series.

The aim of this project was to better represent the FoG glaciers in the GPC. Both the GPC and FoG data sets can be accessed through the Global Terrestrial Network for Glaciers (GTN-G) browsers, alongside the Randolph Glacier Inventory (RGI), the World Glacier Inventory (WGI), and the GLIMMS (Global Land Ice Measurements from Space) data. As such, the GTN-G browser represents a central data tool for scientists and the general public alike. Figure 1 and Figure 2 illustrate how badly represented most FoG glaciers are in the GPC.

This internship lasted from February through April 2015, one month was spent working at WGMS in Zurich and two months were spent in Boulder, Colorado, closely collaborating with NSIDC.

1.2 STRATEGY

A number of different sources was used to accomplish the aforementioned goal (for more details see chapter 2). On the whole, the photos were to be collected from existing digital sources, they needed to be freely available (e.g. shared under a Creative Commons license or considered public domain). They had to be digitally available (go-

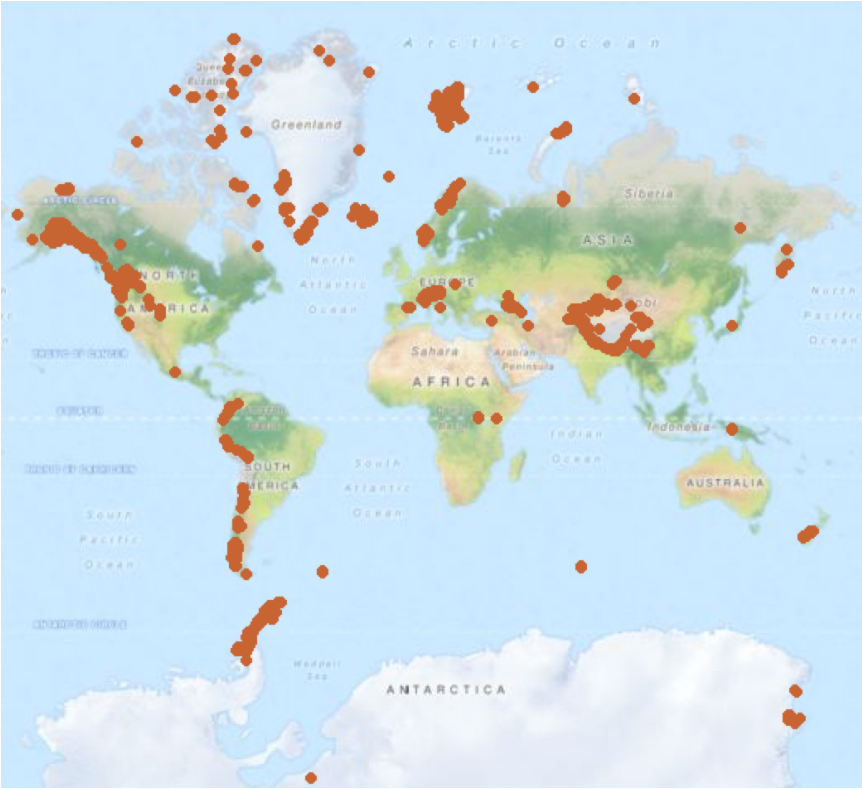

Figure 1: Spatial distribution of glaciers that make up the Fluctuations of Glaciers (FoG) database.

ing into analog archives and scanning were not an option), and they needed to be in the FoG database. However, where larger amounts of data could be obtained from one source, good photos of glaciers that are NOT in the FOG database were to be added to the database all the same. The search followed a photo priority list based on the number of change observation available for any specific glaciers. Most importantly, the 37 WGMS reference glaciers are amongst the top listed (see Table 1).

Photo Priority	Reference Glacier Name	Country Code	Existing Photos
1	Storglaciären	SE	0
3	Storbreen	NO	0
4	Sarennes	FR	0
5	Hintereisferner	AT	0
6	Lemon Creek	US	5
7	Kesselwandferner	AT	0
8	South Cascade	US	226
9	Ts. Tusuksuyskiy	AT	0
10	Saint Sorlin	FR	0
11	Stubacher Sonnenblick Kees	AT	0
12	Meighen Ice Cap	CA	0
13	Silvretta	CH	0
14	Devon Ice Cap NW	CA	0
15	Nigardsbreen	NO	0
16	Hellstugubreen	NO	0
17	Maliy Aktru	RU	0
18	Gråsubreen	NO	0
19	Gries	CH	4
20	Rembesdalskåka	NO	0
21	White	CA	0
22	Ålfotbreen	NO	0
24	Vernagtferner	AT	0
25	Place	CA	0
26	Wolverine	US	19
27	Gulkana	US	0
28	Careser	IT	0
29	Peyto	CA	0
30	Austre Brøggerbreen	SJ	0
31	Djankuat	RU	0
32	Midtre Løvenbreen	SJ	0
34	Engabreen	NO	0
38	Urumqi Glacier No. 1	CN	0
40	Echaurren Norte	CL	0
41	Helm	CA	0
42	Argentière	FR	6
43	Leviy Aktru	RU	0
44	Vodopadniy (No. 125)	RU	0

Table 1: Reference glaciers that make up the top of the photo priority list. The column 'Existing Photos' refers to the number of images that could be found in the collection of the specific glacier at the onset of the project.

Figure 2: Spatial distribution of images in the Glacier Photo Collection.

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SOURCES

2.1 SOURCES USED

ARCHIVE WGMS This collection comprises all photos that were available at WGMS from earlier calls for data. These images were collected and cataloged by Rebecca Navarro in late 2014 / early 2015.

BAYERISCHE GLETSCHER publicizes the results of a German research project conducted at the Ludiwg-Maximilians University and the Kommission für Glaziologie der Bayerischen Akademie der Wissenschaften. Though focused on glaciers in Southern Germany, they provided long time series depicting the changes of glaciers in this particular region.

CALL FOR DATA 2015 (WGMS) Photos collected through the WGMS's regular Call for Data.

CALL FOR PHOTOS (WGMS) Additionally, a special Call for Photos was sent to all WGMS PIs, specifially requesting photos of the FoG glaciers.

CRYOSCIENCE Website of the Cryosphere Research Laboratory at the University of Nagoya, Japan. Focusing on glaciers in Asia, this source provided some valuable footage, despite the fact that some of the glaciers are not FoG glaciers (e.g. Bhutan glaciers).

ETHAN WELTY PHOTOGRAPHY Ethan Welty is a professional photographer specialized in nature and outdoor photography. He added at least one photograph of every FoG glacier that he had a picture of in his collection.

FLICKR was searched for photos that are published under Creative Commons licenses. For the first approximately 150 glaciers (according to the photo priority), the searches were conducted

manually. Experience showed that only well known glaciers are actually tagged in the photos (e.g. Franz-Josef) or their name shows up in the description. In many cases, the search had to go through names of other landmarks (summits, lakes etc.). An example for this is Garabashi Glacier, located on Mt. Elbrus. While there are plenty of photos of Mt. Elbrus, few have glacier names in their description. Using Google Earth, the WGMS Metadata Browser and the GTN-G Global Glacier Browser, other landmarks made it possible to find photos of Garabashi Glacier. Another approach was to look for photos taken from nearby peaks that would comprise the glaciers in question. These indirect approaches were significantly complicated by the fact that a large number of FoG coordinates are inaccurate (see section 2.3 for more details). Additionally, an automated Flickr search was conducted based on the entire list of glaciers. The code was provided by Ethan Welty (INSTAAR @ CU Boulder). The FoG database is badly set up for these kind of tasks, but a number of photos found through this search could be used in the process. A detailed problem description can also be found in section 2.3. All Flickr users were informed of the fact that their picture is being added to the GPC (the email template can be found in the Appendix).

GLACIERS ONLINE Jürg Alean and Micheal Hambrey's renowned collection of glacier photos is of course the ideal source for a project like this. Luckily they agreed to share high resolution photos of glaciers that could not be found elsewhere (e.g. Meighen Ice Cap).

GLETSCHERVERGLEICHE is a project conducted by Simon and Daniela Oberli who have been documenting glacier changes in the Swiss Alps for over a decade. They have generously given permission for all the images available on their site to be added to the GPC.

OTHERS A number of photos were found through normal Google searches, and were then specifically requested from the authors. For example, photos from Glaciar Pilot were found through *www.andeslimite.net*, the site of two Argentinian mountain guides who were very willing to share their photos.

PERSONAL COLLECTIONS This category comprises all photos that were donated to the collection by individuals based on specific

requests. Photos were shared by Mauro Fischer, Ladina Glaus, Mylène Jacquemart, Jürg Nägeli, Paribesh Pradhan, Anne-Aylin Sigg, Laura Thomson.

PROJECT PRESSURE is a glacier photography project run by photographer Klaus Thyman. Though very willing to help, collaboration proved difficult and only resulted in five photographs.

SWISS GLACIER MONITORING NETWORK The Swiss Glacier Monitoring Network comprises around 120 glaciers and is run by VAW (Labratory of Hydraulics, Hydrology and Glaciology) at ETH Zurich. Relatively small photos are available for all photos, but coverage in Switzerland is high. These photos were collected and cataloged by Julien Bodart in ealry 2015.

WIKIMEDIA Wikimedia Commons contains a large number of media files (mostly photographs, but video and audio as well) that are freely available. Wikimedia users were informed that their photo has been added to the GPC by email if possible (not all Wikimedia users have the Email option enabled). The email template can be found in the Appendix.

USED SOURCES	
Site	URL
Bayerische Gletscher	www.bayerische-gletscher.de
Cryoscience	www.cryoscience.net
Ethan Welty	www.weltyphotography.com
Flickr	www.flickr.com
Glaciers Online	www.swisseduc.ch/glaciers
Gletschervergleiche	www.gletschervergleiche.ch
Swiss Glacier Monitoring Network	glaciology.ethz.ch/swiss-glaciers/
Project Pressure	www.project-pressure.org
Wikimedia	commons.wikimedia.org
UNUSED SOURCES	
Site	URL
Enrico Rovelli Archive	www.glaciersarchive.org
Gletscherarchiv	gletscherarchiv.de
TopoSvalbard	toposvalbard.npolar.no/

Table 2: URLs for all of the used and unused sources

2.2 UNUSED SOURCES

Two of the main sources that were initially (see Table 2) identified could not be used because the owners were not willing to share any

of their data (Gletscherarchiv) or did not respond to our request at all (Enrico Rovelli, TopoSvalbard).

2.3 DIFFICULTIES

Some of the main difficulties encountered during this project are briefly outlined here. Most notably is the trouble that inaccurate coordinates within the FOG database made it hard to verify if a picture actually showed the glacier in question. This was especially problematic for smaller glaciers, where a small inaccuracy can place the FoG-dot far beside it's target. Where the GLIMMS outlines included glacier names, that proved helpuful, but this was not always the case. In some cases (e.g. Mt. Baker or Colorado Rockies), larger systematic inaccuracies were discovered. Wherever the data could be corrected without too much trouble, the new coordinates were retained for the next FoG database update.

The flickr queries provided their own challenges. Firstly, it must be noted that the date given under the 'date taken' information is not necessarily the actual shoot date. This is hard to verify in detail, but where available, the given shoot date was corroborated against the EXIF metadata on respective flickr photo page. Additionally, a rough season check was usually performed, thus a photo taken in Alaska in January should be pretty snowy, and the opposite is true for a glacier in Patagonia.

Setting up a good automated flickr query proved challenging mostly because the glacier names in the FoG list are not handled systematically. Ideally the flickr query could be fed the glacier name without the 'glacier' extension on it. I.e. Gråsu (from Gråsubreen) or Hintereis (not Hintereisferner). Many possible combinations can then be automatically queried, attaching the word 'glacier' in many languages to 'Gråsu' or 'Hintereis, thus looking for Hintereisferner, Hintereisglacier, Hintereisgletscher, Hintereisjökull etc. Additionally, the fact that Umlauts are not used in the database is a problem, since hardly anyone will tag their photo Graasubreen, but Gråsubreen. Ideally the glacier names would make use of the required UTF8 characters.

2.4 LICENSING

Photos were only used if they were licensed under a Creative Commons licensed or in public domain. The license information was re-

tained in the database, adding this information to the 'Rights' field in the GPC. The different Creative Commons licenses can be found under www.creativecommons.org. In some cases few cases (e.g. Qiyi glacier), users were contacted to ask if the fotos could be used under a Creative Commons license.

2.5 FUTURE SOURCES

A short list of sources that could yet be helpful in the future. In some cases, photographers would have to be directly contacted to ask for contributions:

1. NVE
2. flickr: automated and manual searches could certainly be continued.
3. GlacierWorks by David Breashears.
4. Jonathan Byers
5. Snows of the Nile (Photographers Neil Losin and Nate Dappen). Repeat photography project aimed at retaking photos shot by photographer Vittorio Sella in the Rwenzori Mountains.

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COLLECTION OVERVIEW

Table 3 shows the number of photos collected from the different sources and Table 4 shows how many photos of the reference glaciers were collected.

Source	Number of Photos
Archive WGMS	151
Bayerische Gletscher	44
Call for Data 2015 (WGMS)	22
Call for Photos (WGMS)	101
Cryolist Call	42*
Cryoscience	13
Ethan Welty Photography	52
Flickr (manual search)	40
Flickr (automated search)	186 (28,189**)
Glaciers Online / J. Alean & M. Hambrey	23
Glaciers of Georgia (Levan Tielidze)	31***
Glaciers of Kazakhstan (Viktor Blagov-echshenskiy)	26***
Gletschervergleiche / Simon Oberli	62
Others 85	
Private contributions	159
North Cascades Climate Project	6
Swiss Glacier Monitoring Network	107
Wikimedia	42
Total	

Table 3: Number of photos collected from different sources. *Personal contributions by Individuals **Total number of photos found through automated search. *** Contributions of collections based on Cryolist call.

3.1 WGMS SELECTION

For the WGMS, one photo of each glacier was selected. Where multiple photos of the same glacier were available, the following guidelines (in more or less this order) were used to decide which photo to use:

1. Recent photos were preferred over older photos.

Photo Priority	Reference Glacier Name	Country Code	Existing Photos	Added photos
1	Storglaciären	SE	0	6
3	Storbreen	NO	0	3
4	Sarennes	FR	0	1
5	Hintereisferner	AT	0	3
6	Lemon Creek	US	5	2
7	Kesselwandferner	AT	0	2
8	South Cascade	US	226	6
9	Ts. Tusuksuyskiy	AT	0	15
10	Saint Sorlin	FR	0	1
11	Stubacher Sonnenblick Kees	AT	0	4
12	Meighen Ice Cap	CA	0	1
13	Silvretta	CH	0	1
14	Devon Ice Cap NW	CA	0	0
15	Nigardsbreen	NO	0	4
16	Hellstugubreen	NO	0	6
17	Maliy Aktru	RU	0	6
18	Gråsubreen	NO	0	7
19	Gries	CH	4	2
20	Rembesdalskåka	NO	0	1
21	White	CA	0	7
22	Ålfotbreen	NO	0	2
24	Vernagtferner	AT	0	5
25	Place	CA	0	1
26	Wolverine	US	19	3
27	Gulkana	US	0	2
28	Careser	IT	0	5
29	Peyto	CA	0	3
30	Austre Brøggerbreen	SJ	0	1
31	Djankuat	RU	0	5
32	Midtre Løvenbreen	SJ	0	2
34	Engabreen	NO	0	2
38	Urumqi Glacier No. 1	CN	0	9
40	Echaurren Norte	CL	0	1
41	Helm	CA	0	2
42	Argentière	FR	6	2
43	Leviy Aktru	RU	0	0
44	Vodopadniy (No. 125)	RU	0	0

Table 4: Reference glaciers that make up the top of the photo priority list. The column 'Existing Photos' refers to the number of images that could be found in the collection of the specific glacier at the onset of the project. The column 'Added Photos' shows how many photos were found during this project.

2. (Aerial) overview photos were preferred over close-ups of details.
3. Photos of ablation areas were preferred over photos of the accumulation area if no general overview was available.
4. Late summer photos with reduced snow cover were preferred over early summer photos.
5. High resolution files were preferred over low resolution files.
6. Color photographs were preferred over black and white images.

3.2 COP21 EXHIBITION SELECTION

A number of photos were chosen as possible candidates for the COP21 collection. The basic requirement for this collection was image size, and only photos that were larger than 3000-4000 px by 4000-5000px. Regarding the photos contributed by Klaus Thymann / Project Pressure, the versions that are in the database are smaller, and the larger files would have to be requested.

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APPENDIX

WIKIMEDIA / FLICKR INFO MAIL

Hi!
Your photo from [GLACIER NAME] has been integrated into the Glacier Photograph Collection, hosted by the National Snow and Ice Data Center, in Boulder, CO, USA. This database provides scientists and the general public with an easy access to glacier photos from around the globe, some dating back to the late 19th century.
Your [flickr][wikimedia] username will be used in the citation, unless you feel like communicating your real name to us by just answering this email (or mylene.jacquemart@geo.uzh.ch). Please include your [flickr][wikimedia] username and your real name in the email.

Thanks for sharing your photos!

for the World Glacier Monitoring Service,
Mylène Jacquemart

find more infos at:
www.wgms.ch (World Glacier Monitoring Service)
nsidc.org (National Snow and Ice Data Center)
nsidc.org/data/glacier_photo (Glacier Photo Collection)