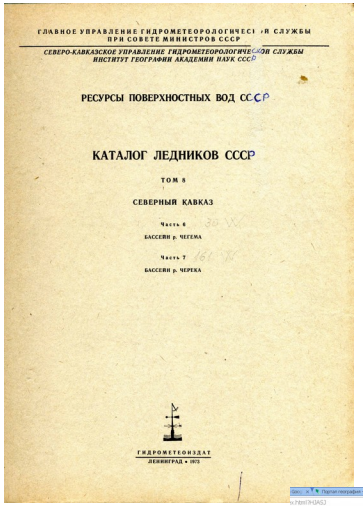
New Glacier Inventory of the Russian glaciers.

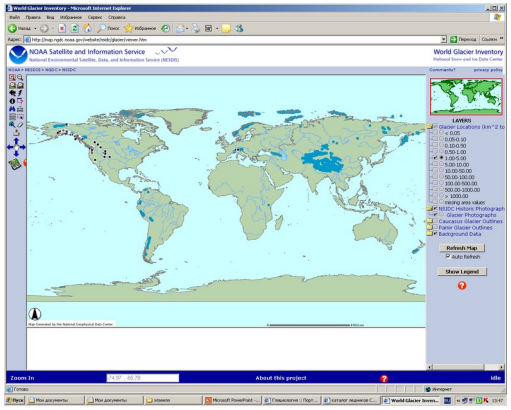
Taiana Khromova, Gennady Nosenko, Andrey Glazovsky,
Stanislav Nikitin, Anton Muraviev, Ivan Lavrentiev.

Institute of Geography RAS, Moscow, Russia

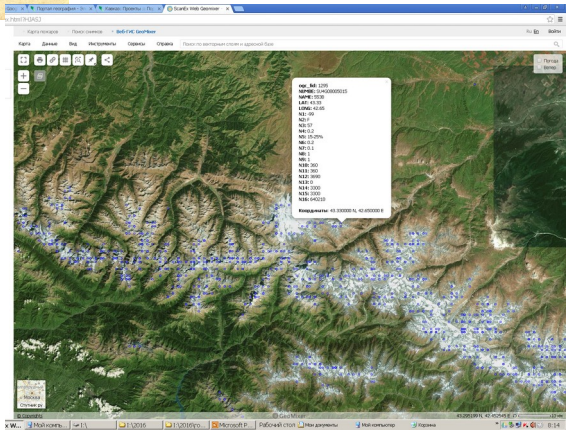
tkhromova@igras.ru

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918





WGI



- The first detailed glacier inventory of the USSR was published in 1960-1980.
- It was the only systematic assessment of the state of glacial systems in Russia for a long time
- Identification of the glaciers was based on aerial photographs as well as on topographic maps (1957).
- Glacier area was calculated by mechanically planimetering the surface.
- Now available as a part of World Glacier Inventory (WGI)
- Despite the huge amount of satellite data, there was no system information about the state of glaciers in Russia until recently.
- The results of individual studies are fragmentary and sometimes contradictory. Some of them accumulated in GLIMS and RGI

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

Project objectives

- Creation of an inventory of glaciers in Russia based on modern satellite data
- Use unified methodological approaches taking into account international standards
- The inventory must be compatible with international databases WGI, GLIMS, WGMS, RGI
- The basis for glacier monitoring
- Online access

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

Data sources

- Satellite data (Sentinel, ASTER, Landsat)
- Glacier inventory of the USSR
- Scientific publications

Methods

- Manual (expert)deliniation of glacier outlines
- Using DEM to determine ice divides and the altitude parameters of glaciers
- Uncertainty estimates using the GLIMS project methodology
- Creating a database on the ARCGIS Online platform

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

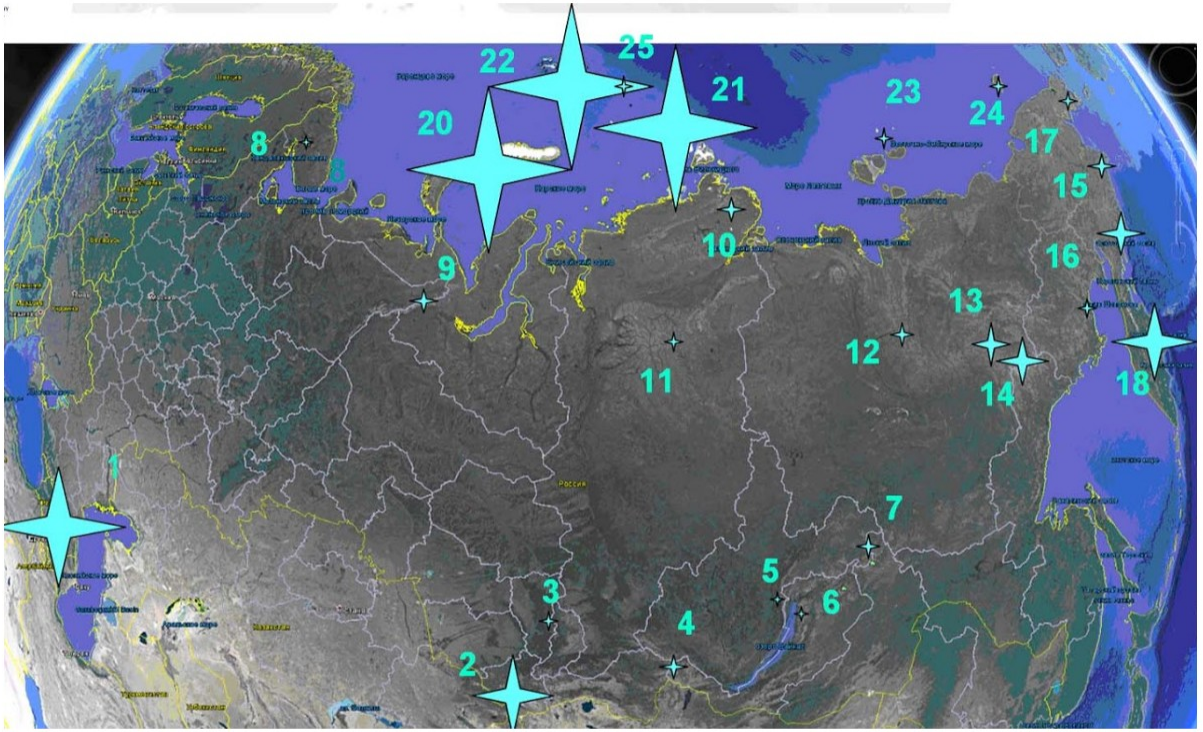
Main Page of the online Glacier Inventory

Access to regional data
Project objectives, data, methods, funding

Glaciers of Russia

- Main page
- About project
- Glacier regions
  - Caucasus
  - Altai
  - Kuznetskii Alatau
  - Eastern Sayan
  - Baikal range
  - Barguzin range
  - Kodar Range
  - Khibiny
  - Urals
  - Putorana
  - Byrranga
  - Cherskii

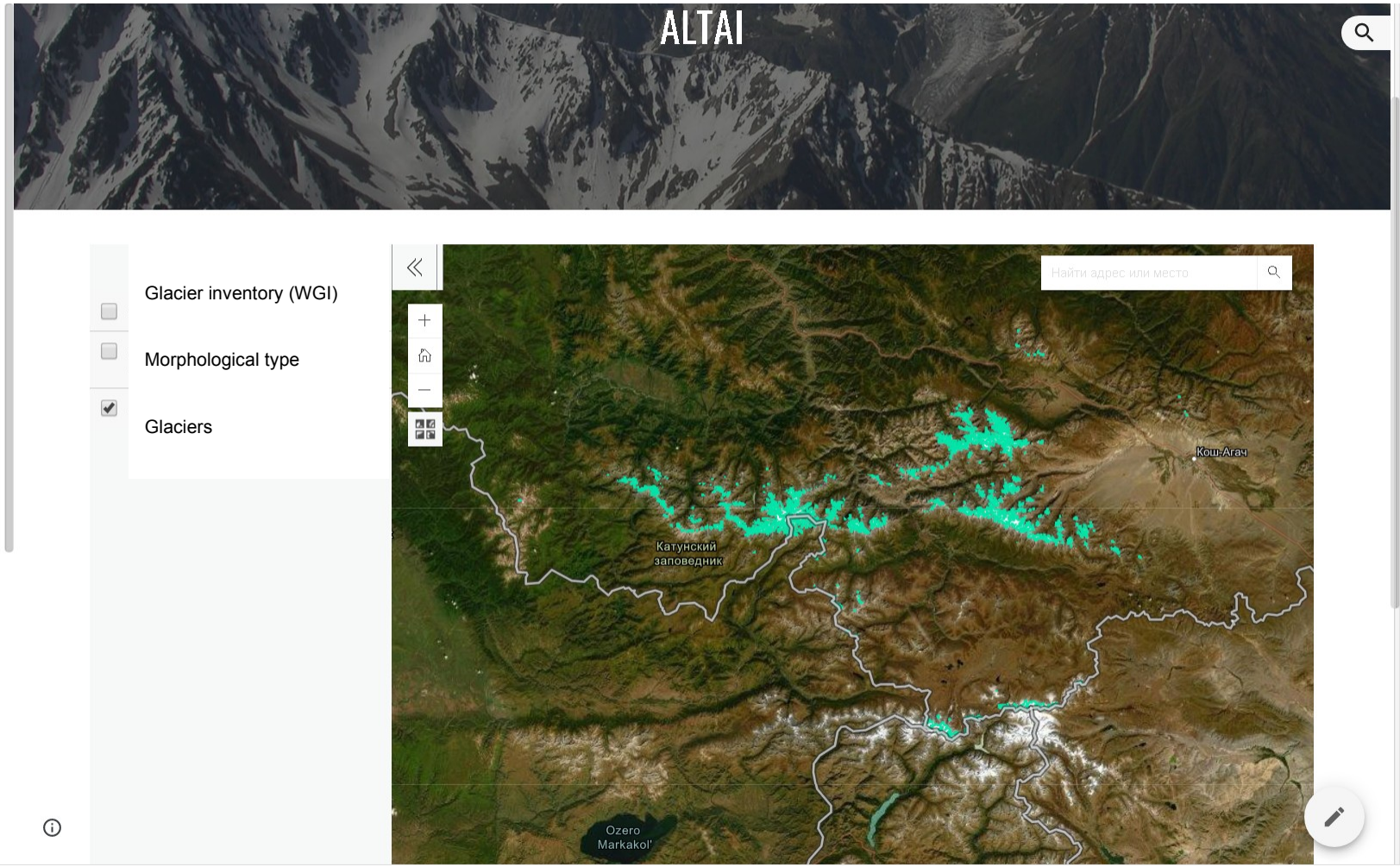
Glacier regions of Russia



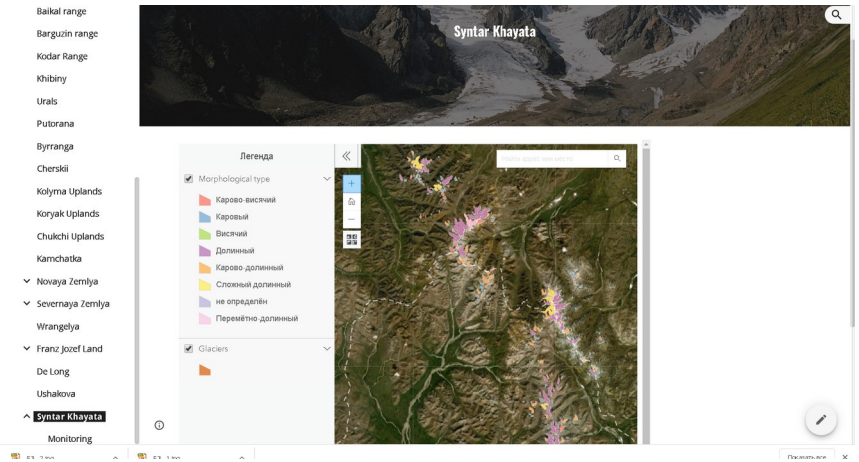
1- Northern Caucasus, 2 – Altai, 3 - Kuznetskii Alatau, 4- Eastern Sayan, 5 - Baikal range, 6 - Barguzin range , 7 - Kodar Range, 8 - Khibiny, 9 - Urals, 10- Putorana, 11Byrranga,12 - Orulgan,13 - Cherskii, 14 - Suntar Khayata, 15 - Kolyma Uplands, 16 - Koryak Uplands, 17 - Chukchi Uplands, 18 - Kamchatka, 20 Novaya Zemlya, 22.Severnaya Zemlya,23 Franz Jozef Land, 24 De Long 25 Wrangelya, 26 Ushakova

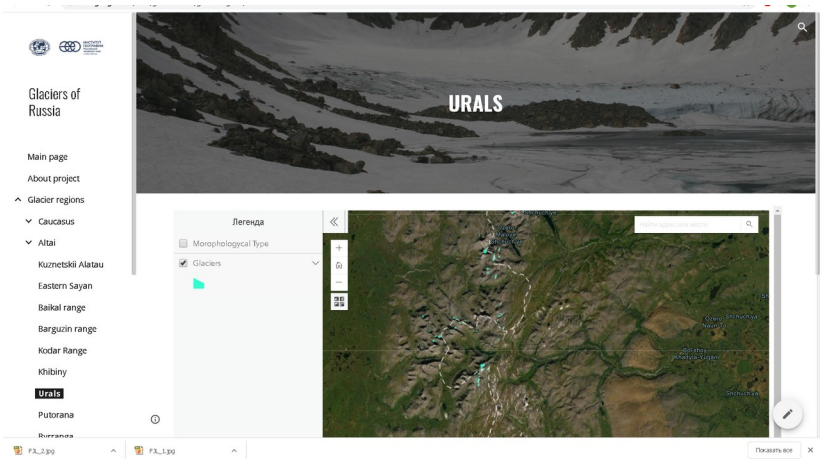
INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

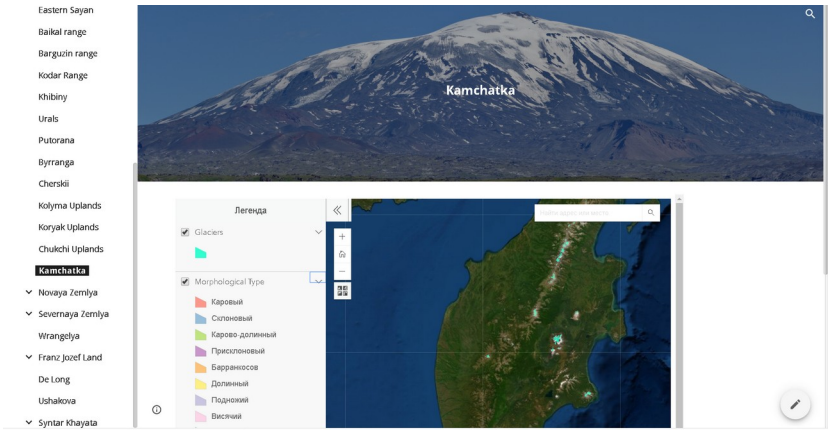
Access to regional data

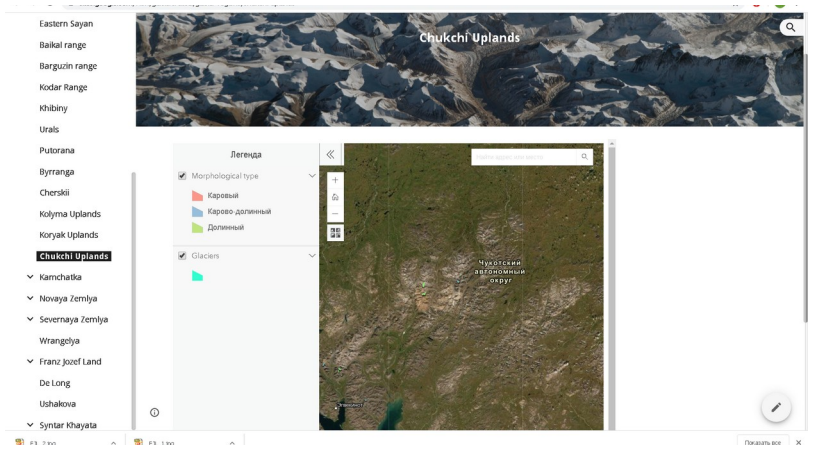


Access to regional data



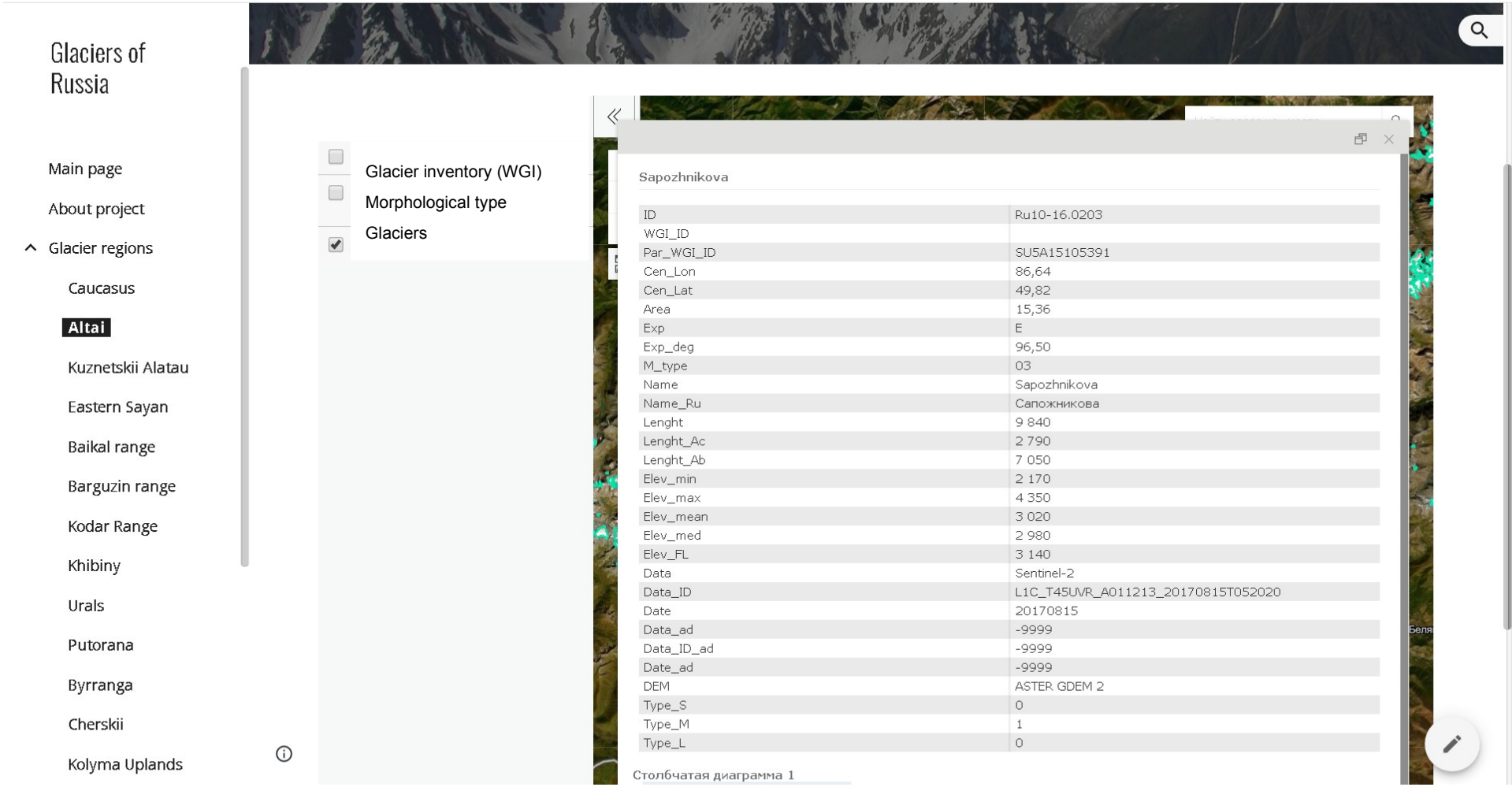






INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

Glacier inventory attribute tables



INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

Visualization of Glacier Inventory Data

The data of Glacier Inventory of USSR

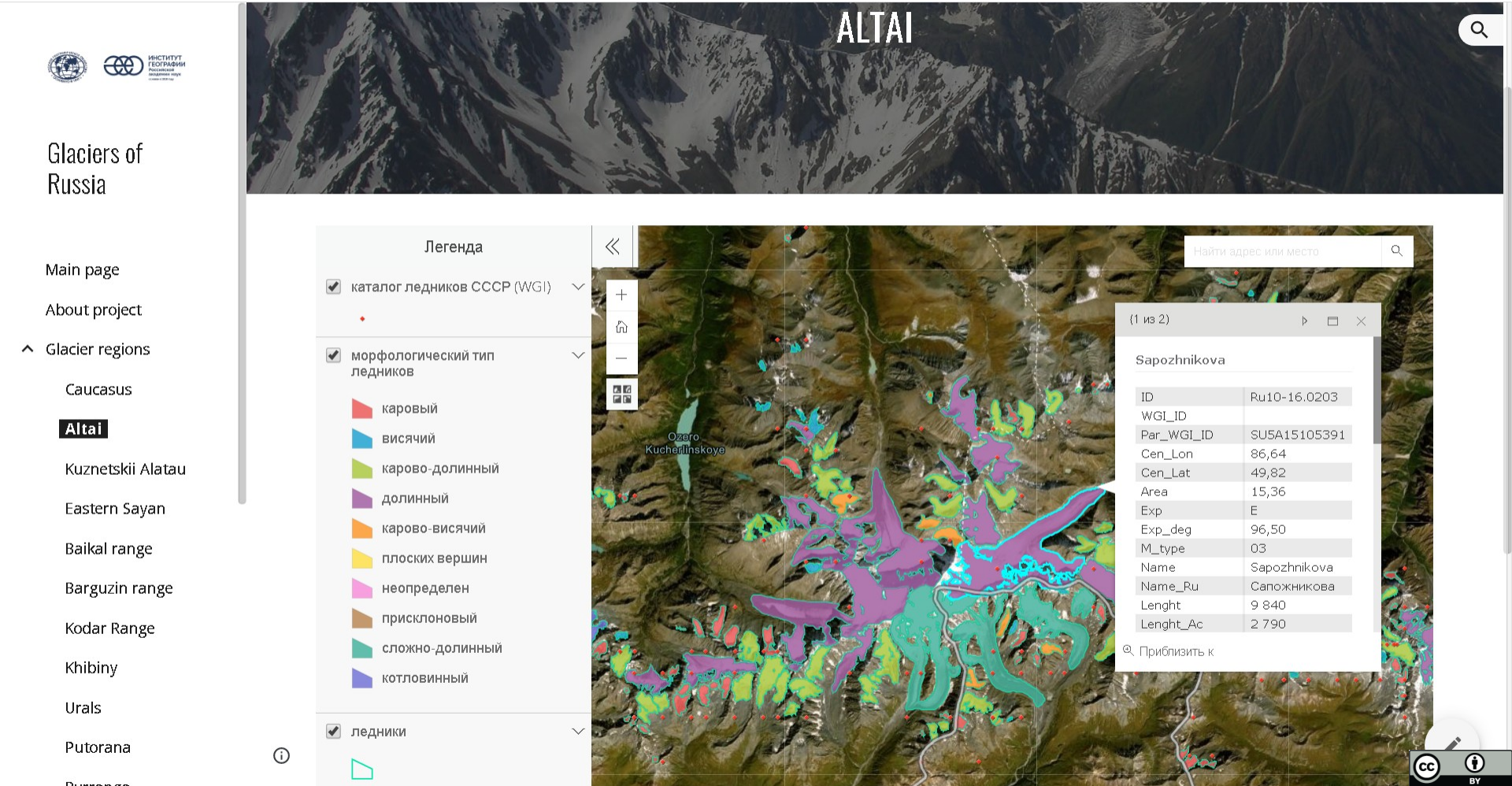
Morphological types of glaciers, Glacier outlines

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

Visualization of Glacier Inventory Data

Morphological types of glaciers

Glacier inventory attribute tables

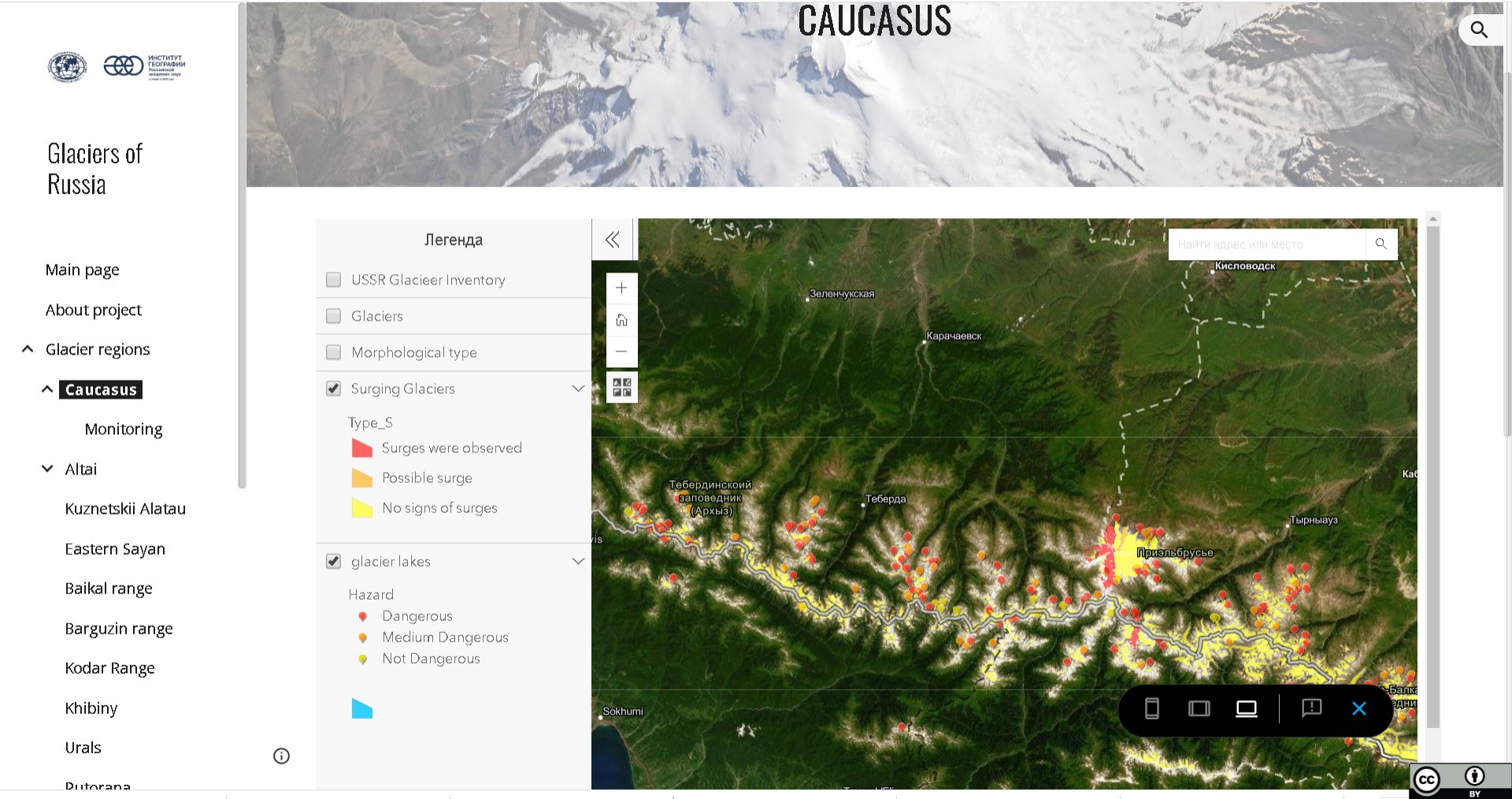


INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

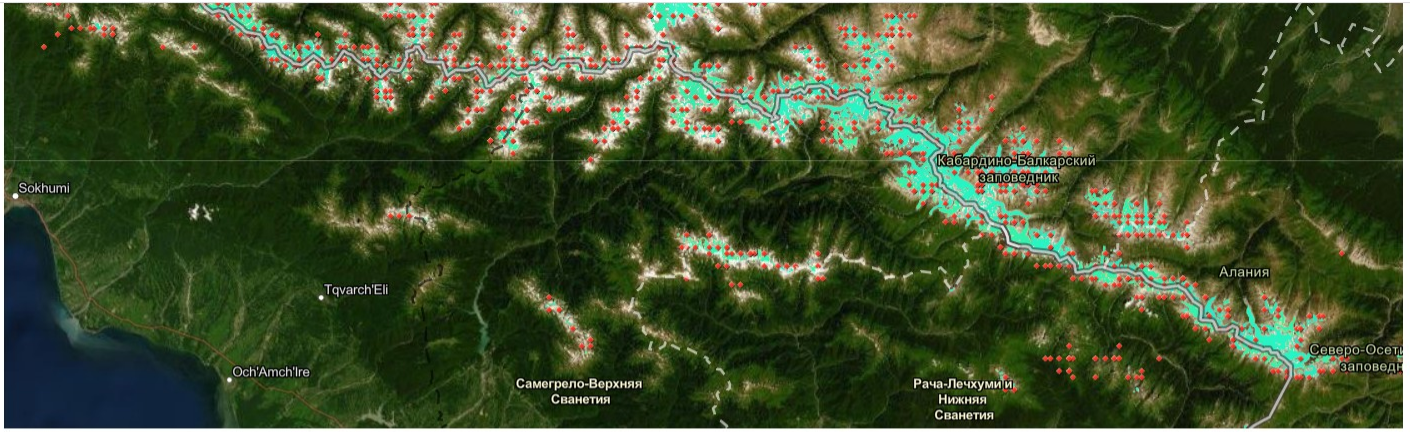
Visualization of Glacier Inventory Data

Surging Glaciers

Glacier Lakes



Statistics



Morphological type of glaciers

M-type	Morphological type	area, km²	number	Mean size, km²
02	Compound valley	180,81 ±8,64	19	9,52
03	Valley	405,47 ±25,04	256	1,58
04	Cirque - valley	159,02±11,62	198	0,80
05	Cirque	89,85±13,11	696	0,13
06	Hanging	36,37±6,13	428	0,08
28	Cirque-hanging	120,07±12,00	378	0,32
10	Flat peaks	0,27±0,03	2	0,14
08	Slope	3,80±0,70	62	0,06
29	Conical peaks	71,27±2,48	9	7,92
00	Not defined	0,14±0,05	6	0,02
	Total	**1067,07±79,80**	**2054**	**0,52**

Glacier Area

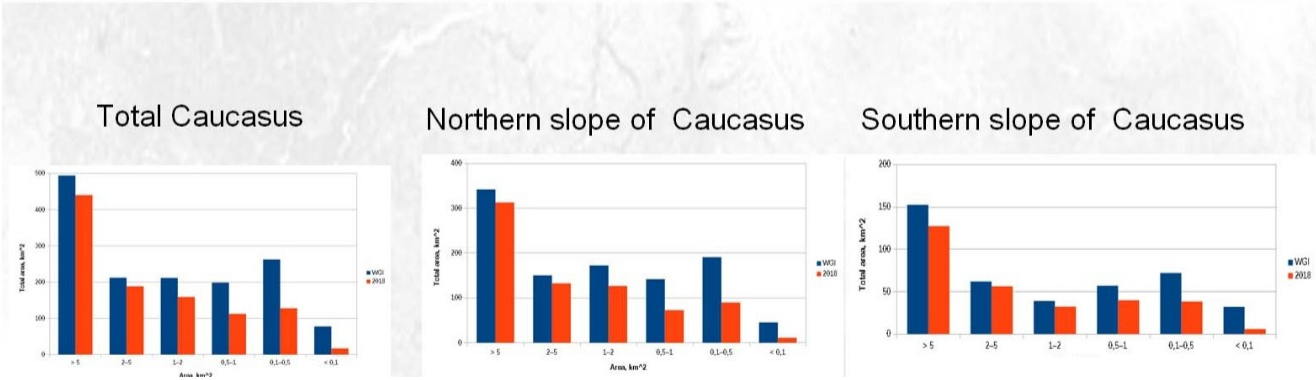
Glacier size, km²	Area, km ²	Number
>5	387,87± 16,62	38
2–5	197,88± 11,55	64
1–2	165,49± 11,67	120
0,5–1	120,30± 10,57	169
0,1–0,5	152,99± 19,58	708
<0,1	42,54± 9,81	955
Total	**1067,07± 79,80**	**2054**

Glaciers of Russia

Main page
About project
Glacier regions
Caucasus
Monitoring
Altai
Kuznetskii Alatau
Eastern Sayan
Baikal range
Barguzin range
Kodar Range
Khibiny

Glacier changes

Glacier size km²	Total area km²						Number of glaciers						Glacier area change WGI (1960)– 2018 y.					
	2018 y.			WGI (1960)			2018 y.			WGI (1960)			km²			%		
	all	N	S	all	N	S	all	N	S	all	N	S	all	N	S	all	N	S
>5	440,45±20,41	313,07±14,04	127,38±6,37	494,4	341,9	152,5	97	52	45	39	29	10	−53,95	−28,83	−25,12	−10,9	−8,4	−16,5
2–5	188,80±11,94	132,42±8,57	56,38±3,38	212,4	150,4	62,0	108	72	36	63	45	18	−23,60	−17,98	−5,62	−11,1	−12,0	−9,1
1–2	158,23±11,66	126,99±9,42	32,24±2,24	211,7	172,8	38,9	161	125	36	115	91	24	−52,47	−45,81	−6,66	−24,8	−26,5	−17,1
0,5–1	112,54±10,49	72,74±6,61	39,80±3,89	198,8	141,8	57,0	223	134	89	159	104	55	−86,26	−69,06	−17,20	−43,4	−48,7	−30,2
0,1–0,5	128,03±16,90	89,77±11,72	38,26±5,17	262,92	190,9	72,0	674	459	215	563	393	170	−134,89	−101,13	−33,76	−53,1	−53,0	−46,9
<0,1	17,19±3,73	11,29±2,40	5,90±1,33	77,75	45,6	32,2	333	211	122	314	201	113	−60,56	−34,31	−26,25	−77,9	−75,2	−81,6
Всего	**1046,24±75,13**	**746,28±52,76**	**299,96±22,37**	**1458**	**1043,4**	**414,6**	**1596**	**1053**	**543**	**1253**	**863**	**390**	**−411,73**	**−297,12 ±52,76**	**−114,61**	**−28,2**	**−28,5**	**−27,6**



Acceleration of glacier decrease rate

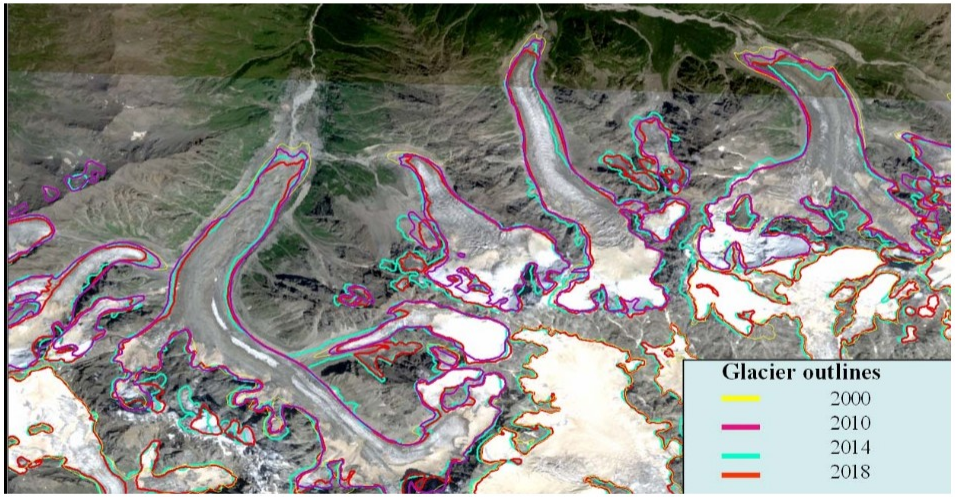
	number	area, km²	decrease , km²	%	decrease rate , %/year
2018 *(IGRAN)*	2048	1066,9	126,3	10,6	2,6
2014 *(Telidze Wheate, 2018)*	2020	1193,2	288.9 ± 12.8	19.5 ± 4.6	0.69
1986*(Telidze Wheate, 2018)*	2209	1482,1	192.8 ± 8.4	11.5 ± 4.4	0.44
1960*(Telidze Wheate, 2018)*	2349	1674,9			

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

Area change of individual Caucasus glaciers 2000-2010-2014-2018yy

Glaciers of Russia

Main page
About project
Glacier regions
Caucasus
Monitoring
Altai
Kuznetskii Alatau
Eastern Sayan
Baikal range
Barguzin range
Kodar Range



Glacier area change, km2

	Shkhelda	Bashkara	Kashkatash
2000	7,7	4,1	3,1
2010	7,3	3,7	3,0
2014	8,3	4,0	3,1
2018	6,8	3,4	2,5

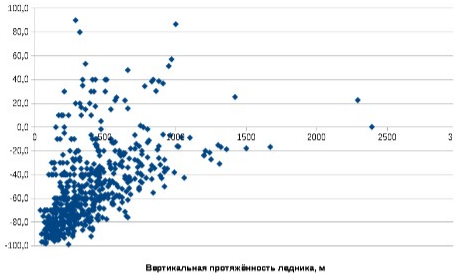
Glacier Change

Altai

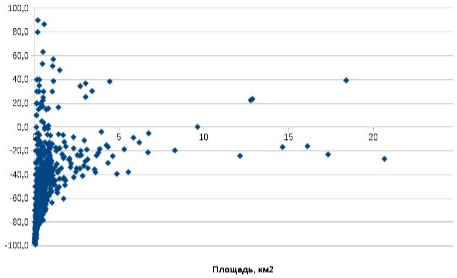
Glaciers of Russia

Main page
About project
Glacier regions
Caucasus
Altai
Monitoring
Kuznetskii Alatau
Eastern Sayan
Baikal range
Barguzin range
Kodar Range
Khibiny
Urals

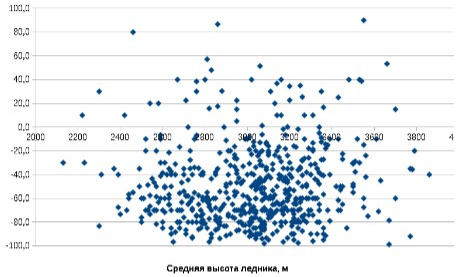
1952(Glacier inventory of the USSR) - 2017



Change (%) in the area of Altai glaciers depending on their vertical extent



Change (%) in the area of Altai glaciers depending on their size

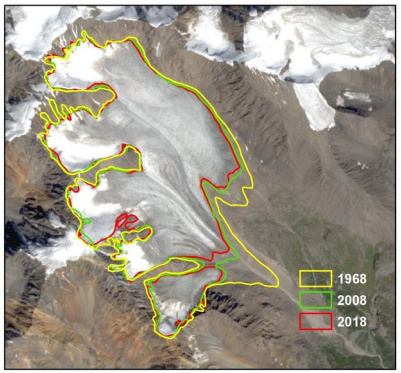


Change (%) in the area of Altai glaciers depending on their average altitude

Glacier change 1850-1952-1968-2008-2018

data source	Reconstruction of Narozhny and Okishev	Glacier INventtttory of USSR	CORONA	ALOS PRISM	Sentinel 2	Glacier decrease %						
							Glacier decrease rate , %/year			Glacier decrease rate , %/year		
год	1850	1952	1968	2008	2018	1952-2018	1952-1968	1952-2008	1952-2018	1952-1968	1968-2008	2008-2018
Range												
Katunsky	376,09	292,2	263,2	210,2	199	**31,9**	0,62	0,50	0,48	0,62	0,50	0,53
South Chuisky	255,59	220,7	165,2	130,5	118,1	**46,5**	1,57	0,73	0,70	1,57	0,53	0,95
North Chuisky	192,18	177,1	149,81	127,04	112,75	**36,3**	0,96	0,50	0,55	0,96	0,38	1,12
Altai.	823,86	690	578,21	467,74	429,85	**37,7**	1,01	0,58	0,57	1,01	0,48	0,81

Glacier Gelo change



1968- 8,05km2
2008- 7,07km2
2018- 6,69km2

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

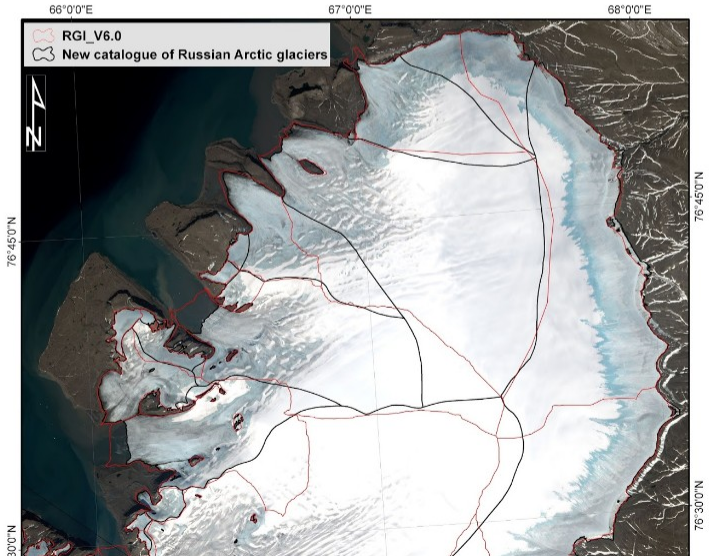
ИНСТИТУТ ГЕОГРАФИИ Российской академии наук

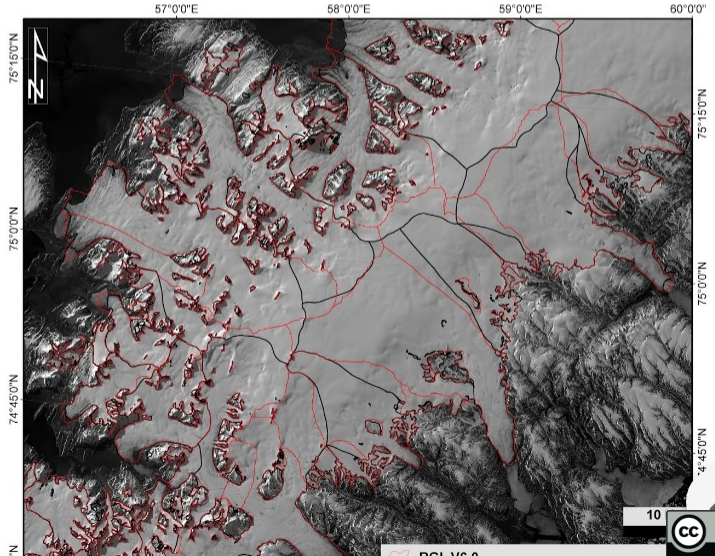
Monitoring

Change of Glacier outlines location 2000/2008(RGI)-2019
Correction of Glacier ice divides location

Novaya Zemlya

Glacier Change 2000/2003/2008(RGI) - 2019



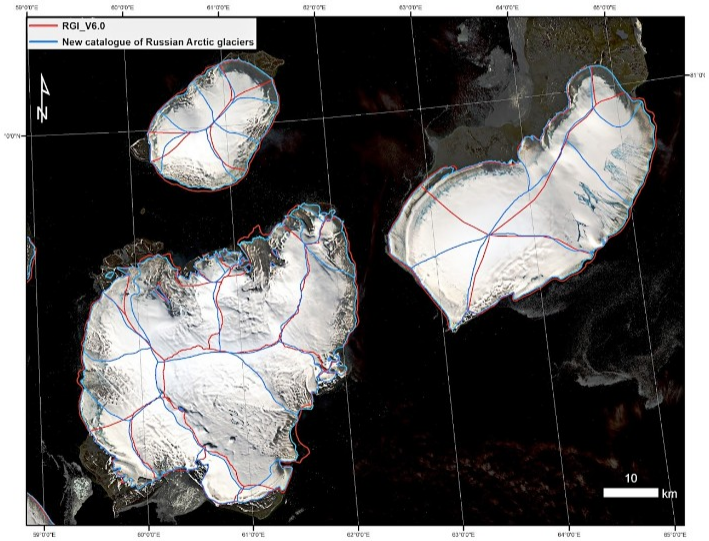


Change of Glacier outlines location 2001(RGI)-2016

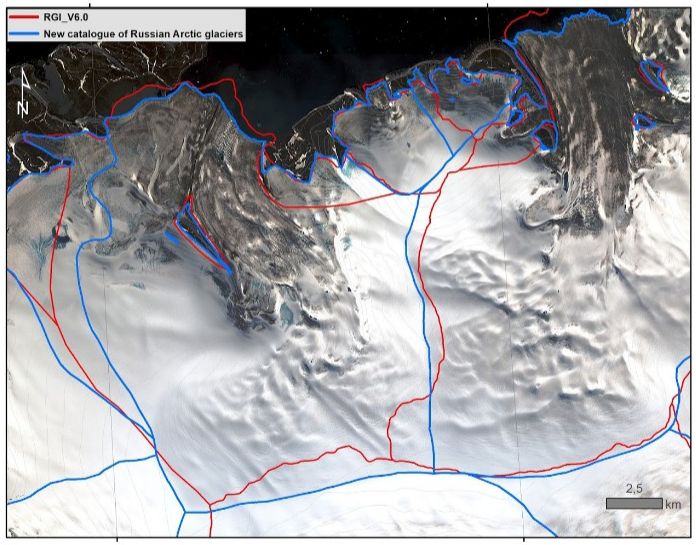
Correction of Glacier ice divides location

Franz Jozef Land

Glacier change 2001(RGIv6) - 2016



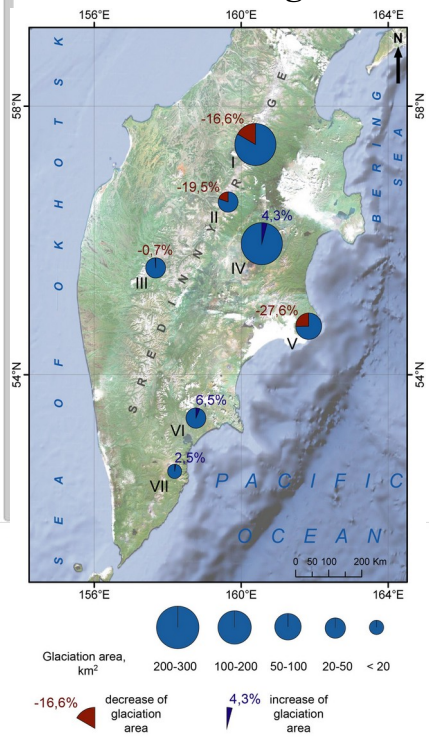
Graham Bell Island, Wilzhek Land Island, La Ronciere Island



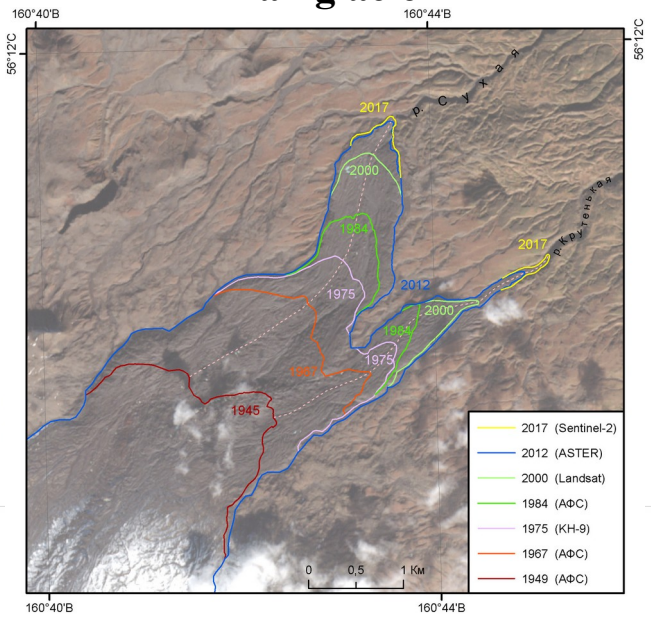
Northeastern part of Wilzhek Land Island

Kamchatka

Glacier Change 1952-2015



Erman glacier



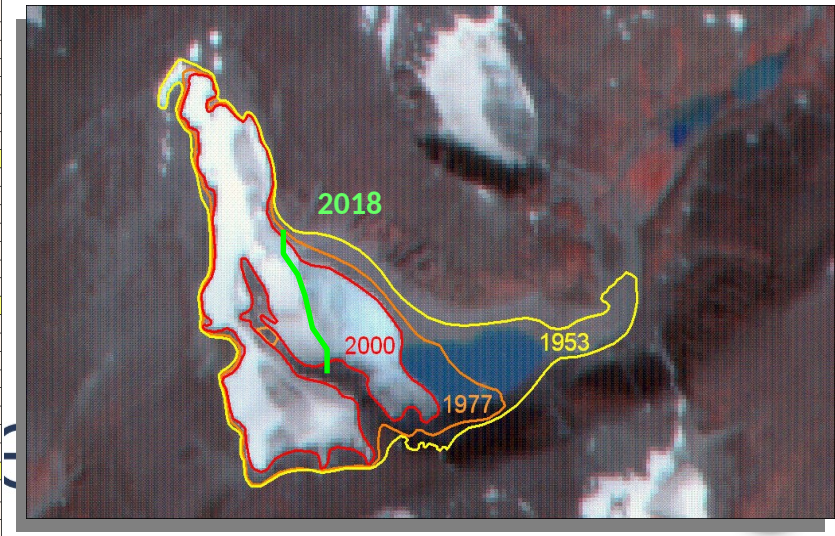
Advance of the glacier front 1949–2017 гг.

Glaciers of Russia

Main page
About project
Glacier regions
Caucasus
Altai
Kuznetskii Alatau
Eastern Sayan
Baikal range
Barguzin range
Kodar Range
Khibiny
Urals
Monitoring
Putorana

	ID	Name	S (1953), км2	S (2000) км2	S (2018) км2	ΔS(2000-2018) км2	ΔS(2000-2018), %
1	1	KARSKYJ_S	0.80	0.506	0.424	0.082	16
2	1	KARSKYJ_N		0.113	0.062	0.051	45
3	2	TROITSKOGO	0.12	0.052	0.016	0.037	70
4	3	ODINOKIJ	0.06	0.062	0.029	0.032	52
5	5	TERENTIEVA	0.30	0.191	0.146	0.046	24
6	6	MGG	0.63	0.429	0.312	0.117	27
7	7	MIIGAIK	0.50	0.293	0.152	0.141	48
8	8	DOLGUSHINA	0.92	0.505	0.399	0.106	21
9	9	BOCHA	0.22	0.212	0.159	0.052	25
10	10	PARUS	0.09	0.056	0.041	0.015	26
11	11	ALESHKOVA	0.53	0.309	0.217	0.092	30
12	13	KHOOTINSKY	0.18	0.177	0.098	0.079	45
13	14	STCHUCHIJ	0.70	0.361	0.307	0.054	15
14	15	TRONOVA	0.23	0.210	0.181	0.029	14
15	17	SYNOK	0.25	0.192	0.137	0.055	29
16	18	MGU	1.16	0.606	0.260	0.346	57
17	19	OLENIJ	0.12	0.086	0.039	0.047	55
18	20	STANTSYONNYJ	0.07	0.046	0.019	0.027	59
19	21	ANUCHINA	0.17	0.116	0.051	0.065	56
20	22	SKRYTYJ	0.13	0.117	0.029	0.088	75
21	23	AVGEVICHA	0.15	0.089	0.040	0.050	56
22	24	AVSYUKA	0.18	0.152	0.071	0.081	53
23	25	SHUMSKOGO	0.25	0.153	0.085	0.069	45
24	26	OBRUCHEVA	0.40	0.310	0.222	0.088	28
25	27	IGAN	1.25	1.025	0.604	0.421	41
26	28	FOTOGEODEZISTOV	0.06	0.058	0.016	0.041	72
27	127	BAKLUNDA	0.24	0.093	0.056	0.037	40
28	128	KULIKA	0.22	0.125	0.062	0.063	51
29	129	BOL'SHOI USINSKY	0.70	0.629	0.343	0.287	46
30	131	CHERNOVA	0.27	0.190	0.092	0.097	51
31	133	BERGA	0.42	0.225	0.182	0.043	19
32	134	KOVAL'SKOGO	0.21	0.152	0.084	0.067	44
33	135	LEPIOKHINA	0.10	0.102	0.052	0.050	49
34	136	KALESNIKA	0.30	0.196	0.121	0.075	38
35	137	KHABAKOVA	0.35	0.109	0.033	0.076	70
36	138	PRILIEPYSH	0.16	0.140	0.061	0.079	56
37	142	MALYSH	0.14	0.125	0.083	0.042	34
38	143	MARKOVA	0.30	0.159	0.143	0.016	10
		Итого:	12.88	8.669	5.426	3.243	37

Reduction of glaciers area of the Polar Urals from 2000 to 2018



years	1953	1960	1968	1974	1977	2000	2018
area, км2	0,98	0,93	0,86	0,79	0,76	0,53	0,26

Change in the area of the MGU glacier from 1953 to 2018

INSTITUTE OF GEOGRAPHY
Russian Academy of Sciences
Founded in 1918

Conclusion

- The new glacier inventory of Russia is being created
- It is mostly based on the latest remote sensing data
- An unified methodology is used
- The inventory is compatible with international databases WGI, GLIMS, WGMS, RGI
- An online access is arranged using ARCGIS online
- Data will be provided in GLIMS and RGI
- Analysis of glacier changes based on the data of the new glacier inventory shows :
  - the generally reduction of glaciers continues
  - an acceleration of glacier decrease rate in some regions during last decades
  - a large variability in the regions as well as in the behavior of individual glaciers very much depending on the orographic factors, the morphology, size, local meteorological conditions and natural

Acknowledgements.

The presentation includes the results obtained in the framework of the following research projects:

№ 0148-2019-0004 of the Research Plan of the Institute of Geography of the Russian Academy of Sciences,

№ 05/2019/RGS-RFBR supported by the Russian Geographical Society

№ 18-05-60067 supported by RFBR.