A new database for reconstructing the spatial-temporal evolution of the glacial resource in the Italian Alps

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[2] IGG-CNR, Institute of Geosciences and Earth Resources
[3] Comitato Glaciologico Italiano, Italian Glaciological Commetee
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SISC NextData - Venezia, 17-18 ottobre 2018

NEXTDATA – Project
PNR 2011-13
WP 1.6: Mountain criospheric resources

Alpine glaciers and snow cover are sensitive indicators of climate change. Glaciers and winter snow also represent an important source of freshwater, provided as melt water during warm summer and late spring periods, that are typically characterized by low precipitation.

A reduction of these reservoirs, already ongoing since several years, can lead to severe consequences on the availability of water and on river discharge.

This WP is devoted to the implementation of a coherent information database on Italian Alpine glaciers.

WP 1.6: Risorse criosferiche montane

- *Task 1*

Monitoring and quantitative inventory of Alpine glaciers

quantitative and geo-referenced data on glaciers' areal variation, mass balances, changes in the Equilibrium Line Altitude; collection of iconographic and photographic/ photogrammetric material.

The task is performed in collaboration with the Italian Glaciological Committee.

The **Italian Glaciological Committee** (**CGI**) has been working in Italy since 1895, with the task of promoting and coordinating research in the field of glaciology.

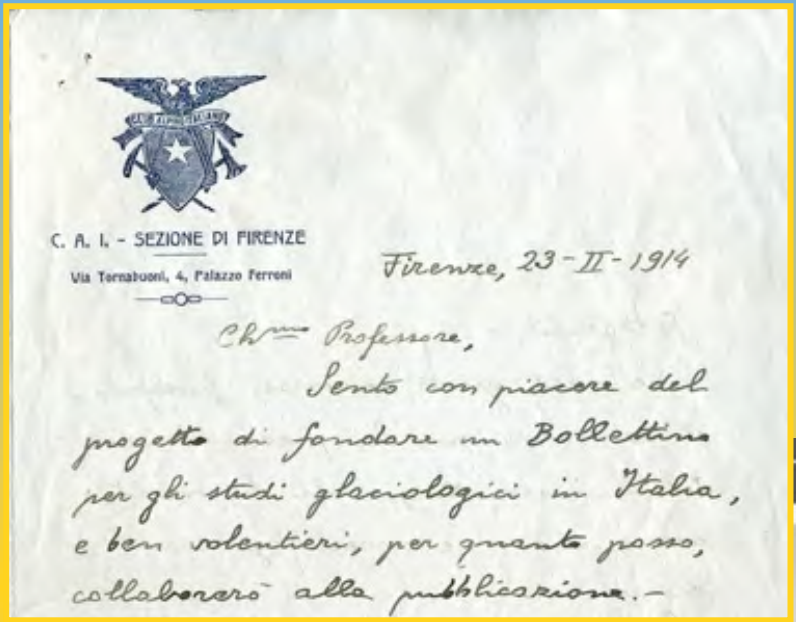
In origin, the CGI was a **commission for the study of Italian glaciers** within the Italian Alpine Club (CAI);
Since 1914, it became independent organism with the support of the National Research Council (CNR) and of other organizations and agencies interested in glaciological research

Carlo Somigliana (1860-1955)

First President of the Italian Glaciological Committee (1910-1953) after having been President of the **Italian Glaciological Commission**.

CGI 1895

Since its origin, the CGI recognized the importance of systematic monitoring of Italian glaciers and, in particular, of measurement of frontal variations.



C. A. I. - SEZIONE DI FIRENZE

Via Tornabuoni, 4, Palazzo Ferroni

Firenze, 23 - II - 1914

Ch^mo Professore,

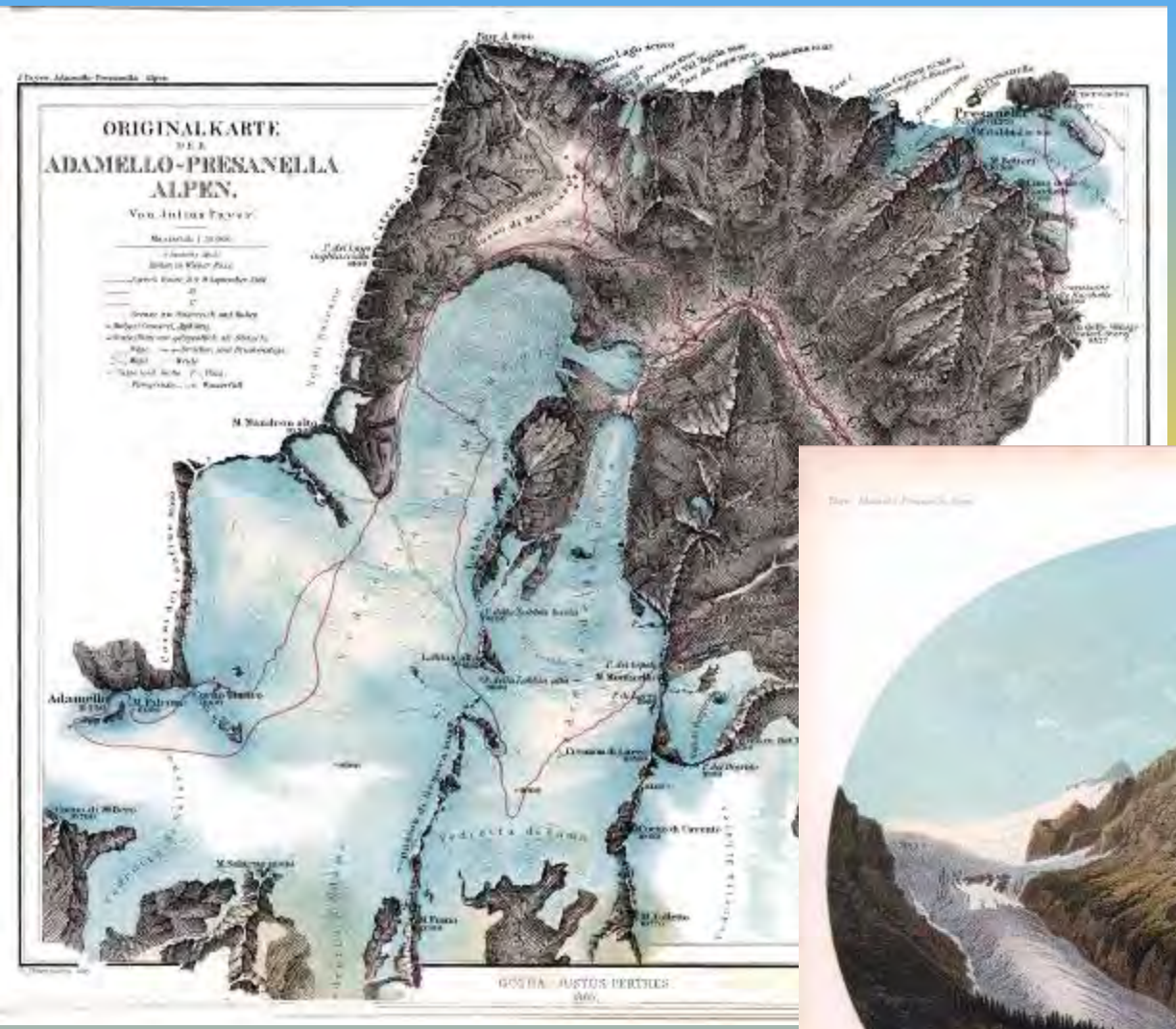
Sento con piacere del progetto di fondare un Bollettino per gli studi glaciologici in Italia, e ben volentieri, per quanto posso, collaborerò alla pubblicazione.-

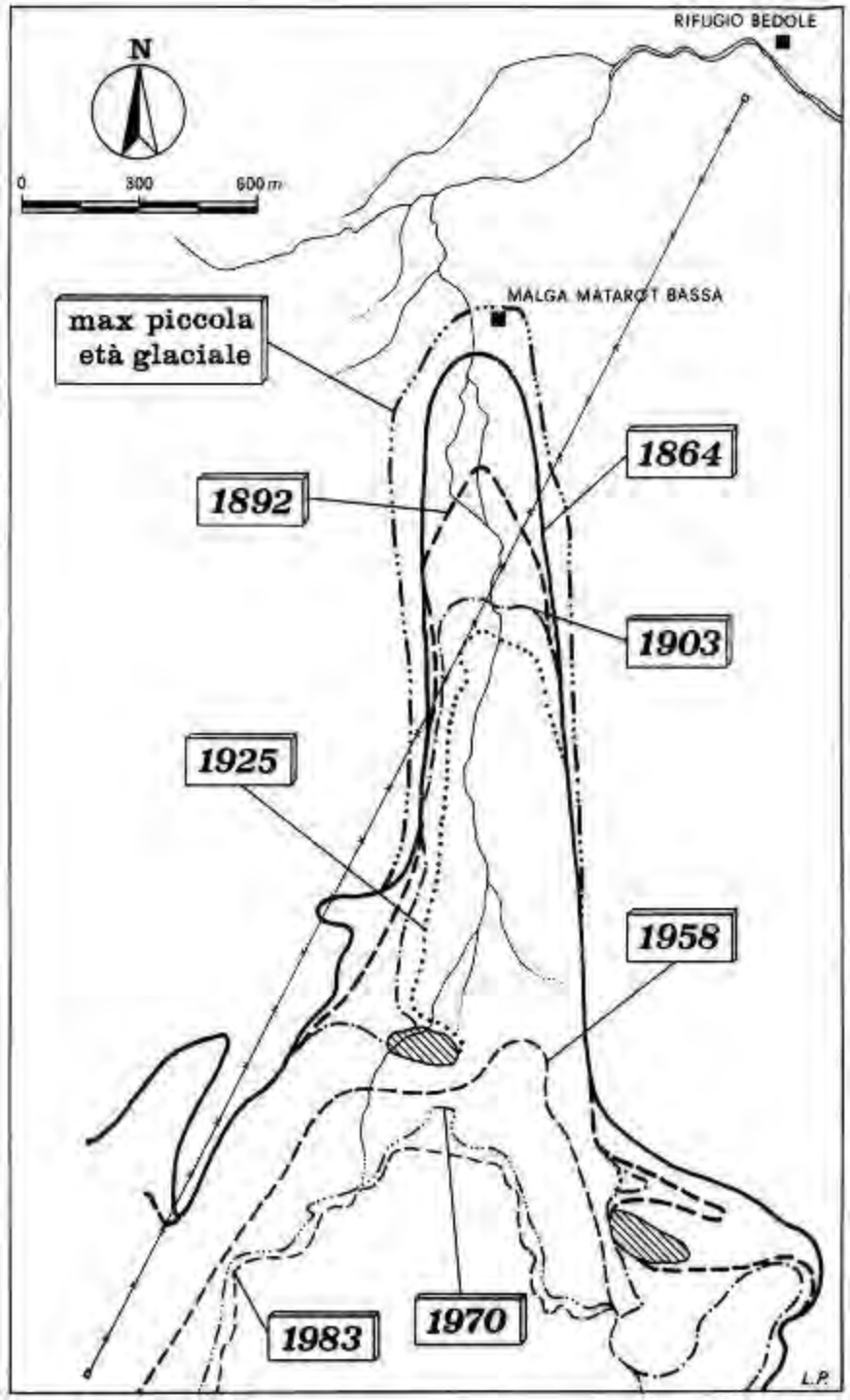
CGI 1895

This activity is regularly conducted since the end of the 19th Century, supplying therefore one of the longest observations series of glaciers frontal variations in the world.

Ghiacciai del Mandrone e della Lobbia

Originalkarte der Adamello Presanella Alpen (Payer J. 1865)





Vedretta della Lobbia (Adamello)

1864: Originalkarte der Adamello Presanella Alpen di Iulius Payer

1892: Specialkarte von Oesterreich Ungarn zone 21 coll III Tione un Monte Asdamello (K.U.K. Militaer Geographiscen Institut)

1902: Karte der Adamello und Presannella Gruppe. Deutsch un Oesterreich Alpen Verein

1925: Cima Presanella 1:25.000 IGM F. 20 IV SE (da levate austriache1907-1908)

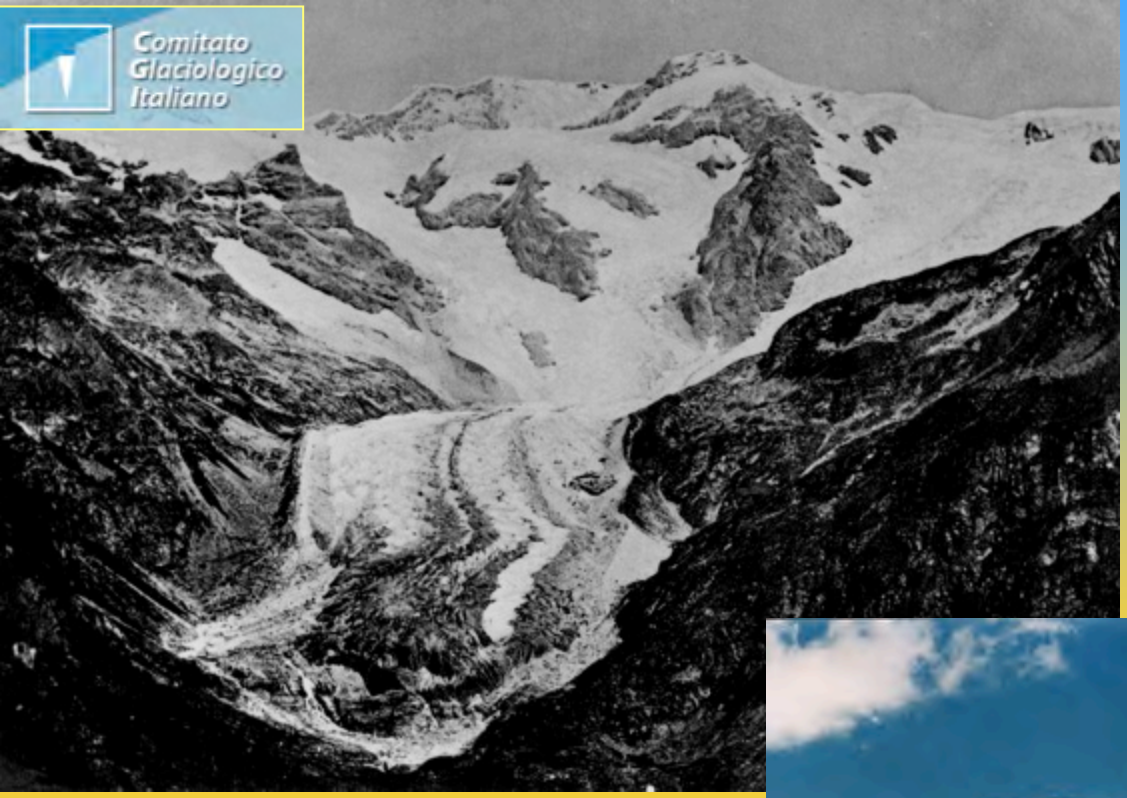
1958: Catasto dei Ghiacciai Italiani (C.G.I. 1961)

1970: Cima Presanella 1:25.000 IGM F. 20 IV SE ed 1973.

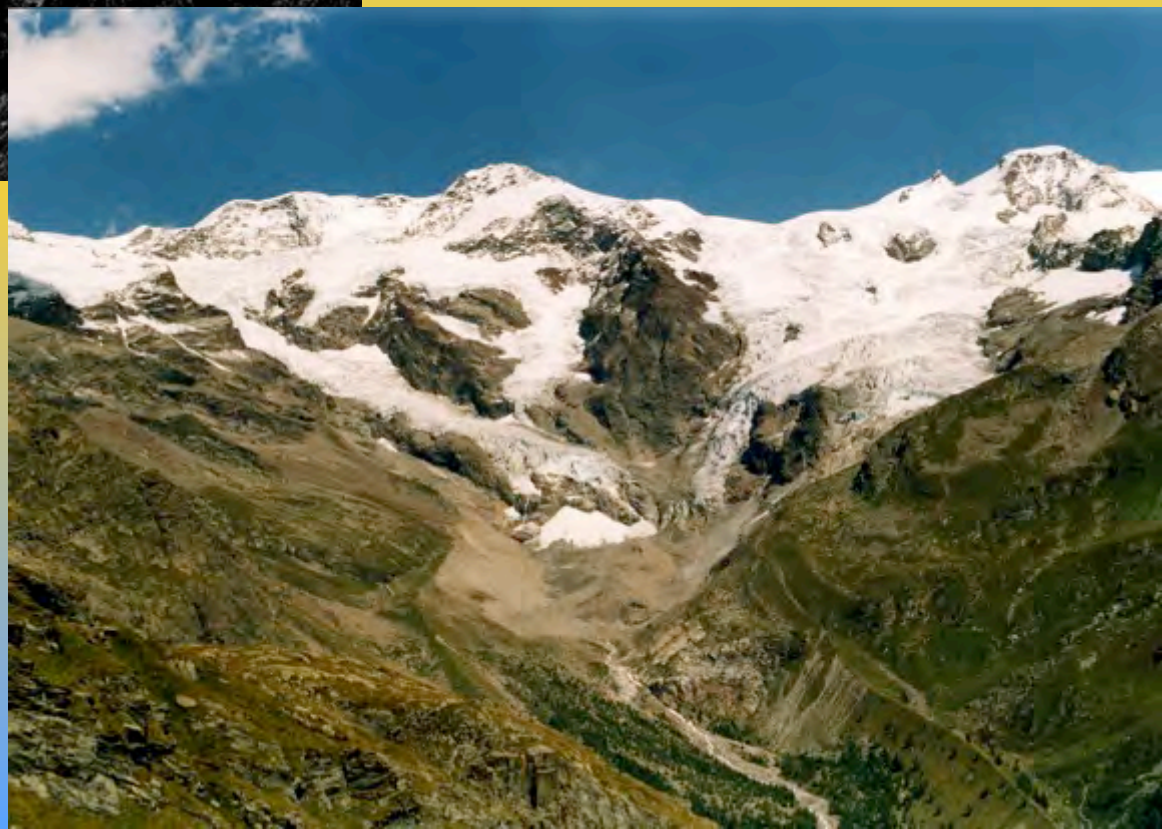
1983: sezione 058030 Cresta della Croce e 058040 Rifugio Bedole carta Topografica generale P.A.T.

Comitato Glaciologico Italiano

1868
Arh. CGI



Ghiacciaio del Lys
(V. d'Aosta)
M. Rosa

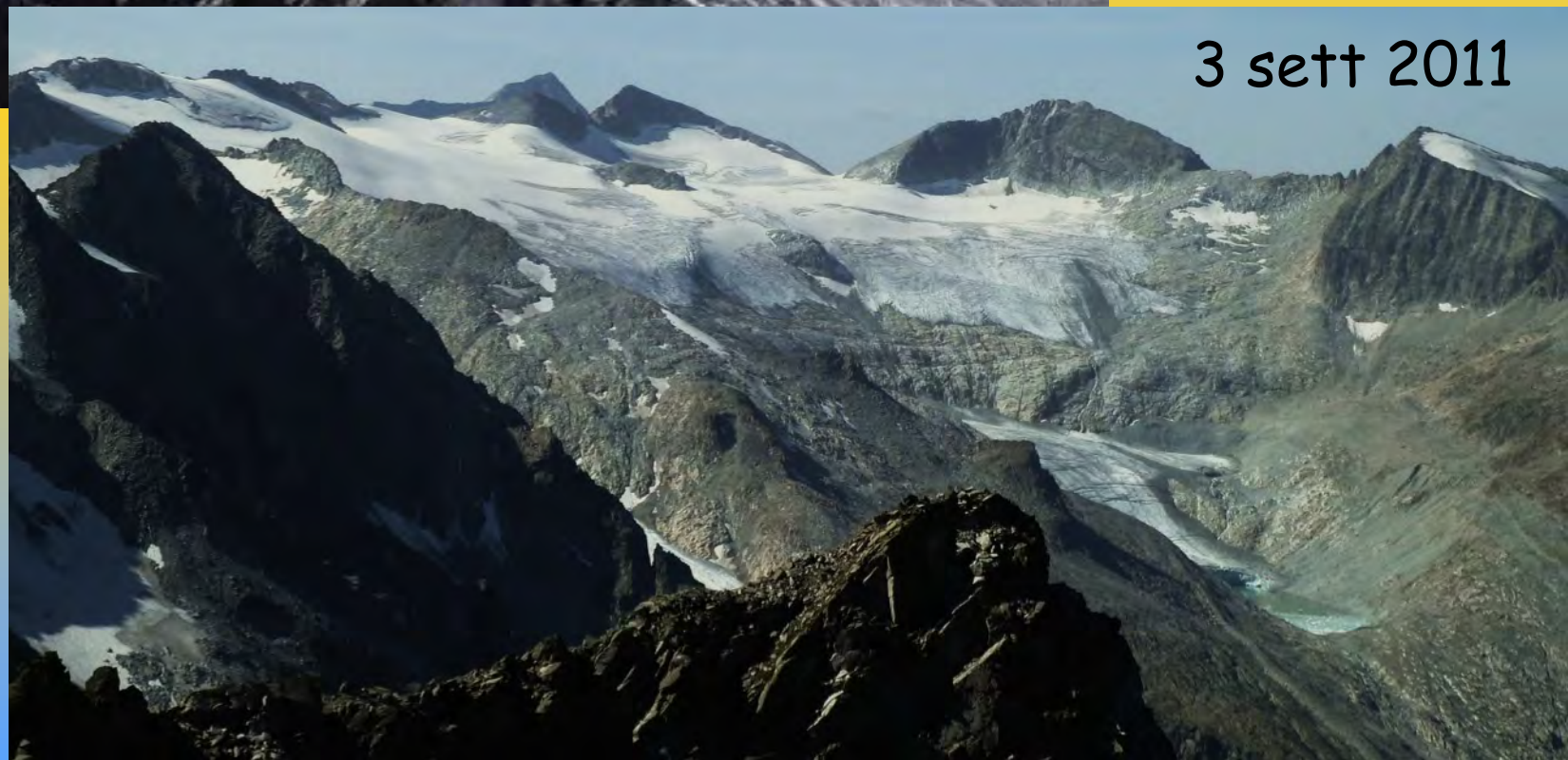


2005
Arh. CGI – W. Monterin

Ghiacciaio Occidentale di Pisgana (1918 - CGI).

sett 1997

sett 1997



3 sett 2011

IGM, 1917 – From P.zo Tresero

Forni Glacier
Ortles-Cevedale Group
about
13 km^2 in 1991,
12 km^2 in 2003

G. Cola, SGL - 2010

Comitato Glaciologico Italiano


Colucci 2012


Di Collertaldo 1948

1985
G. Potenza

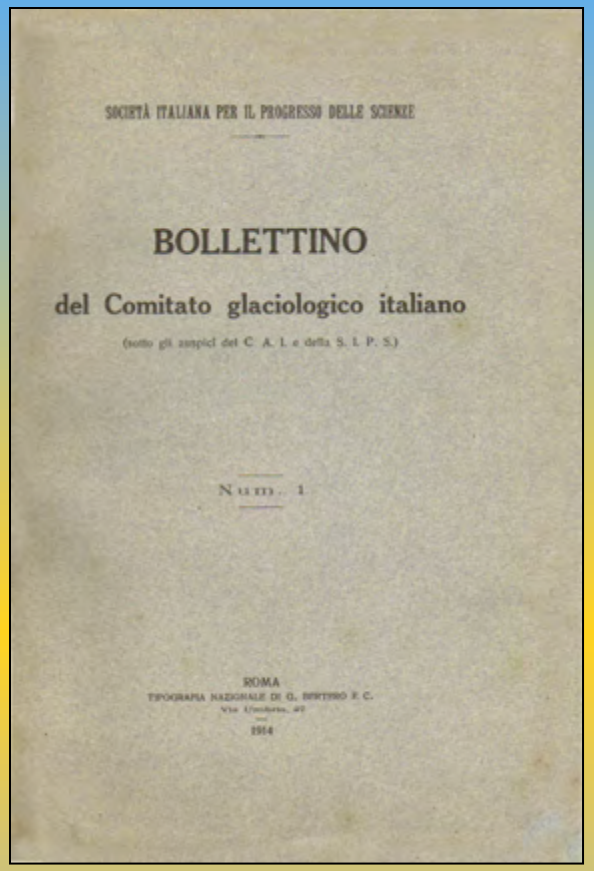
Comitato Glaciologico Italiano

Bernina Group
Western and Eastern Fellaria Glaciers

2006
M. Butti - SGL

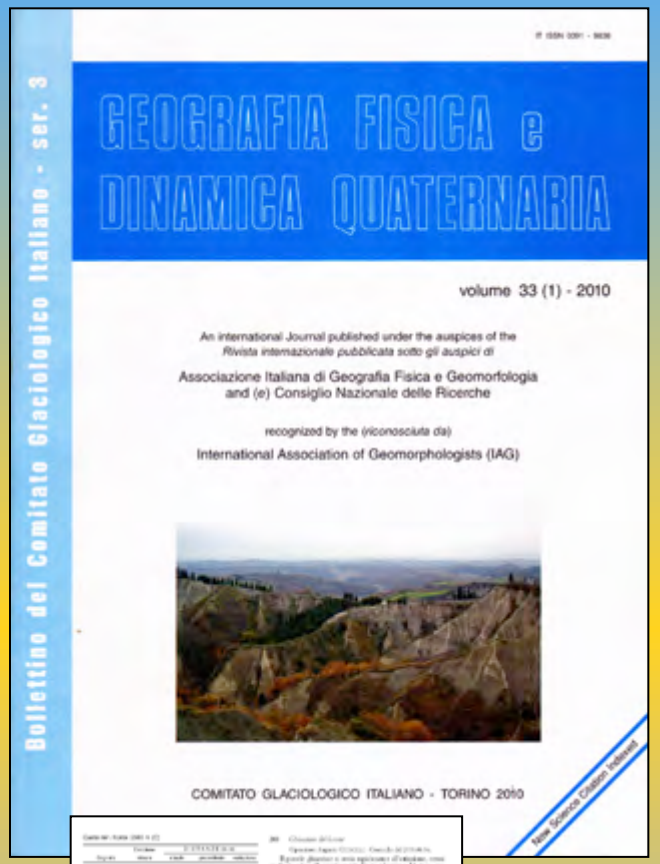
In recent years, almost 100% of the Italian glaciers are retreating;
numerous alpine glaciers have repeatedly found entirely below the snowline, recording significant frontal retreat, contractions of the accumulation basins, thinning of glacial bodies and tongues.

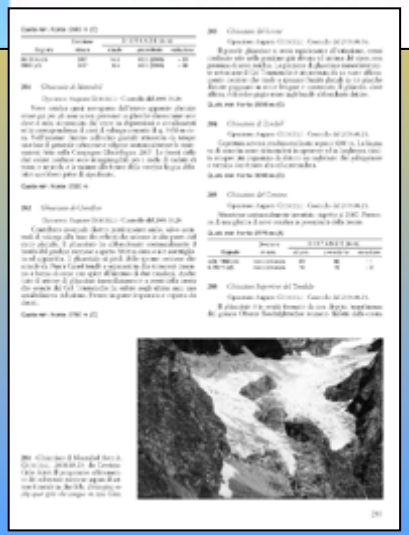
1914-1948



1950-1977

1977-2012 …





A section of the CGI Bulletin is dedicated, since 1927, to the results obtained in the framework of the annual glaciological survey (http://www.gfdq.glaciologia.it/).

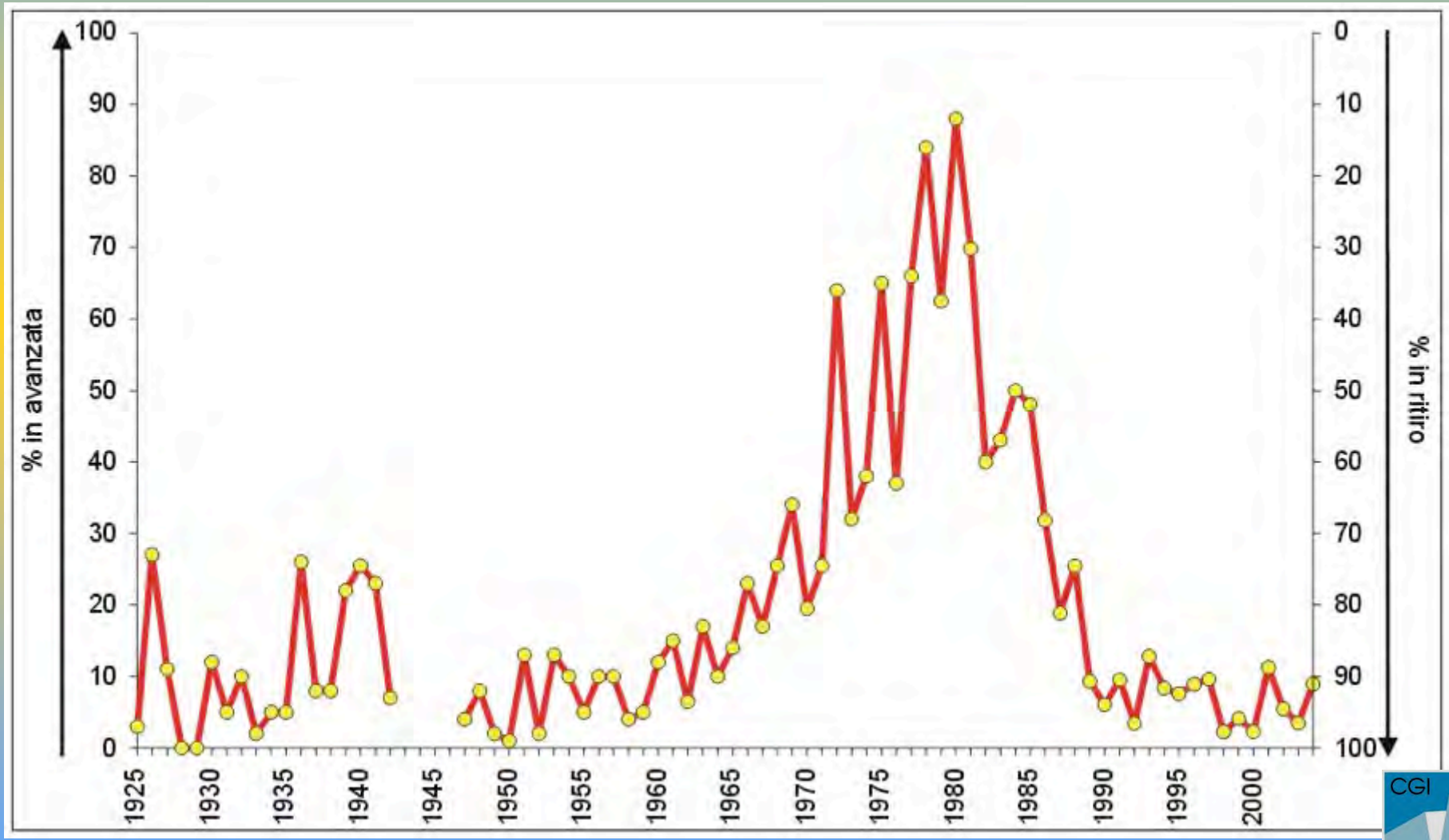
http://www.glaciologia.it/i-ghiacciai-italiani/le-campagne-glaciologiche/

Global Glacier Changes: facts and figures

WGMS glacier data.

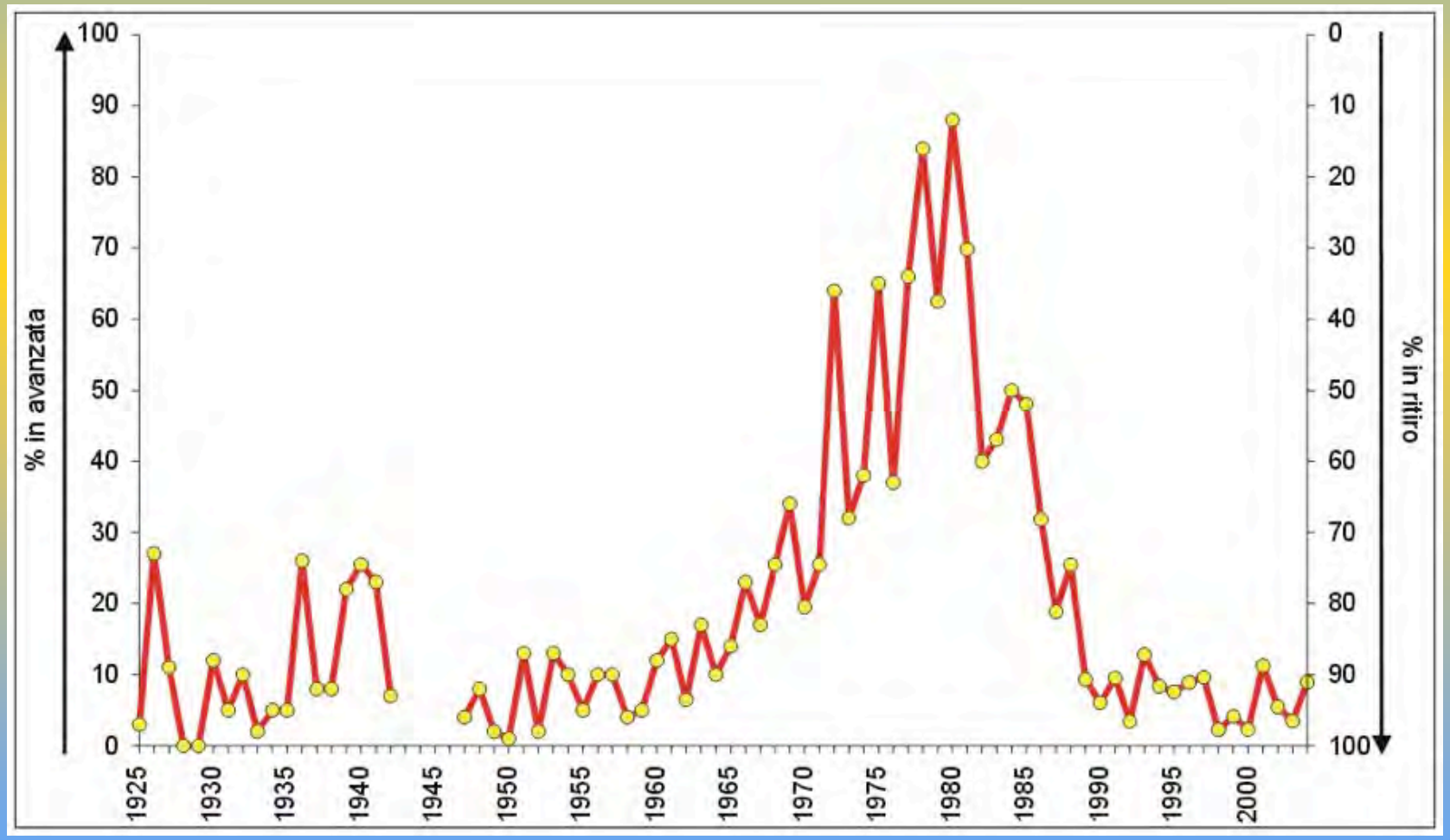
All the collected data related to the monitoring of frontal variations and annual mass balances measured in the Italian Alps contribute to the World Glacier Monitoring Service (WGSM) database (www.geo.uzh.ch/microsite/wgms/).

At present, approximately 150 glaciers are monitored every year by voluntary surveyors, also linked to regional associations
http://www.glaciologia.it/i-ghiacciai-italiani/le-campagne-glaciologiche/?lang=en



CGI
1895

Since the end of the maximum Holocene advance during the Little Ice Age, the Italian glaciers have experienced a generalized phase of retreat, which accelerated in the 50s of the 20th Century and was followed by a slight expansion culminated in the late '70s and early '80s. Since the '90s, almost all the Italian glaciers resumed their retreat.




Comitato Glaciologico Italiano
Ubicazione dei ghiacciai italiani
dati tratti dal Catasto dei ghiacciai italiani CGI-CNR, 1959-1962
Location map of the italian glaciers
data from the Inventory of
Italian Glaciers, CGI-CNR, 1959-1962
Mappa
Satellite
http://www.glaciologia.it/ghiacciai.html
Google
Immagini ©2011 TerraMetrics - Termini e condizioni d'uso

Glacier Name	Ghiacciaio della Brenva
Code	219
SubCode	0
WGI Code	IT4L01517011
Acquisition Year	2006
Acquisition Date (DD/MM /YYYY)	23/08/2006
Surface Area (km²)	6.38
Maximum Length (m)	4093
Minimum Elevation (m)	2279
Maximum Elevation (m)	4810
Mean Slope (degree)	21
Mean Aspect	SE
Latitude DD.ddd°	45.832
Longitude DD.ddd°	6.893
Group Number	2
Group Name	Monte Bianco
SuperGroup Name	Massiccio del Monte Bianco
SubSection	7.V
Section	7
Part	I

Database frontal variation

NextData

=INDICE('D:\ricerca\prova_database\[2006_2007_glaciers_PI_PD_TO.xlsx]2006-2007_glaciers_PI_PD_TO'!$X$2:$X$1369

B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	
ECTDI	NAME	GL_NAME	WGMS	CGI_	WGI_ID	Gr	ardized Mountain Sul		rdized Mountain Subdivis		LATITUDE	LONGITUDE	Year	FRONT_	Variazioni_Fror	VUOT	CI	OK	CUMULA	CHECK CI	WGI_ID_fr	CHEC
ENTALI	COL DEI BECCHI	Ghiacciaio di Colle dei Becch	1265	83.0	IT4L01451031	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.49534845	7.335427467	1975				ok				IT4L01051031	WGI_ID
CIDENTALI		Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1925		20.0	FALSO	NO	20	20	CGI_ID_corrisp	IT4L01312019	WGI_ID
CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1927	-6	-8.0	FALSO	NO	-8	12	CGI_ID_corrisp	IT4L01312019	WGI_ID
CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1928		-5.0	FALSO	NO	-5	7	CGI_ID_corrisp	IT4L01312019	WGI_ID
CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1929		0.0	VERO	ok			CGI_ID_corrisp	IT4L01312019	WGI_ID
CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1930	-20	-15.0	FALSO	NO	-15	-8	CGI_ID_corrisp	IT4L01312019	WGI_ID
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CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1956	-3	-3.5	FALSO	NO	-4	-180	CGI_ID_corrisp	IT4L01312019	WGI_ID
CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1957		0.0	VERO	ok			CGI_ID_corrisp	IT4L01312019	WGI_ID
CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1958	-11	-11.0	FALSO	ok	-11	-191	CGI_ID_corrisp	IT4L01312019	WGI_ID
CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1959	-8	-8.0	FALSO	ok	-8	-199	CGI_ID_corrisp	IT4L01312019	WGI_ID
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CIDENTAI	COUPE DE MONEY	Ghiacciaio del Coupe di Mor	1271	109.0	IT4L01512019	2	Gran Paradiso - Rocciaviva A		Catena del Gran Paradiso	7.IV	45.53116135	7.349275479	1961	-78	-8.0	FALSO	NO	-8	-207	CGI_ID_corrisp	IT4L01312019	WGI_ID

~ work version ~

Comitato Glaciologico Italiano

RELAZIONI DELLA CAMPAGNA GLACIOLOGICA 2015

REPORT OF THE GLACIOLOGICAL SURVEY 2015

Geogr. Fis. Dinam. Quat.
40 (2017). 233-319

DOI 10.4461/GFDQ 2017.40.14

RELAZIONI DELLA CAMPAGNA GLACIOLOGICA 2016

REPORT OF THE GLACIOLOGICAL SURVEY 2016

a cura di (*editors*) CARLO BARONI, ALDINO BONDESAN & MARTA CHIARLE

103 *Ghiacciaio di Valeille*

Operatori: Valerio BERTOGLIO
e Piero BORRE Controllo del 2016.09.24

Ancora potente la vasta zona con crepacciatura trasversale in zona centro-frontale. Davanti alla fronte è presente un deposito di limo glaciale misto a detriti di varia pezzatura. Il ghiacciaio risulta parzialmente coperto da detrito nel settore destro frontale.

Quota min. fronte: 2690 m

Segnale	Direzione della misura	DISTANZE (in m)		
		attuale	precedente	variazione
LP1 (cf)	190°	73	47	- 26

WGMS-FoG-2017-06-C-FRONT-VARIATION_mod_SG - Excel

File Home Inserisci Layout di pagina Formule Dati Revisione Visualizza Acrobat Che cosa si desidera fare?

Normale | Anteprima interruzioni di pagina | Layout di pagina | Visualizzazioni personalizzate — Visualizzazioni cartella di lavoro

Righello | Barra della formula | Griglia | Intestazioni — Mostra

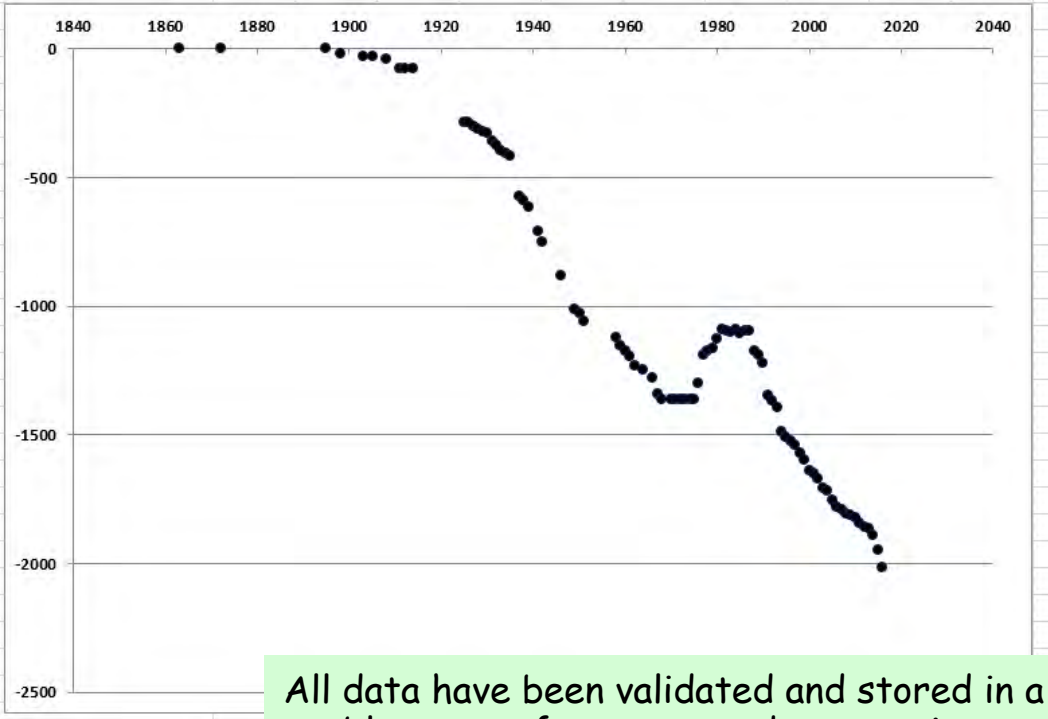
Zoom | 100% | Zoom selezione — Zoom

Nuova finestra | Disponi tutto | Blocca riquadri | Dividi | Nascondi | Scopri | Affianca | Scorrimento sincrono | Reimposta posizione finestra | Cambia finestra — Finestra

Macro — Macro

T8

	A	B
1	CGI_ID	507.1.0
2		
3	Year	Cumulative_Front_Variation
4	1863	0
5	1872	0
6	1895	0
7	1898	-20
8	1903	-30
9	1905	-30
10	1908	-42
11	1911	-77
12	1912	-77.5
13	1914	-77.5
14	1925	-287.5
15	1926	-288.7
16	1927	-303.6
17	1928	-313.1
18	1929	-324.95
19	1930	-325.4
20	1931	-357.3
21	1932	-377.25
22	1933	-395.75
23	1934	-406.35
24	1935	-416.65
25	1937	-574.65
26	1938	-586.65
27	1939	-617.25
28	1941	-710.25
29	1942	-751.25
30	1946	-881.75
31	1949	-1010.25
32	1950	-1025.75
33	1951	-1057.75
34	1958	-1120.6



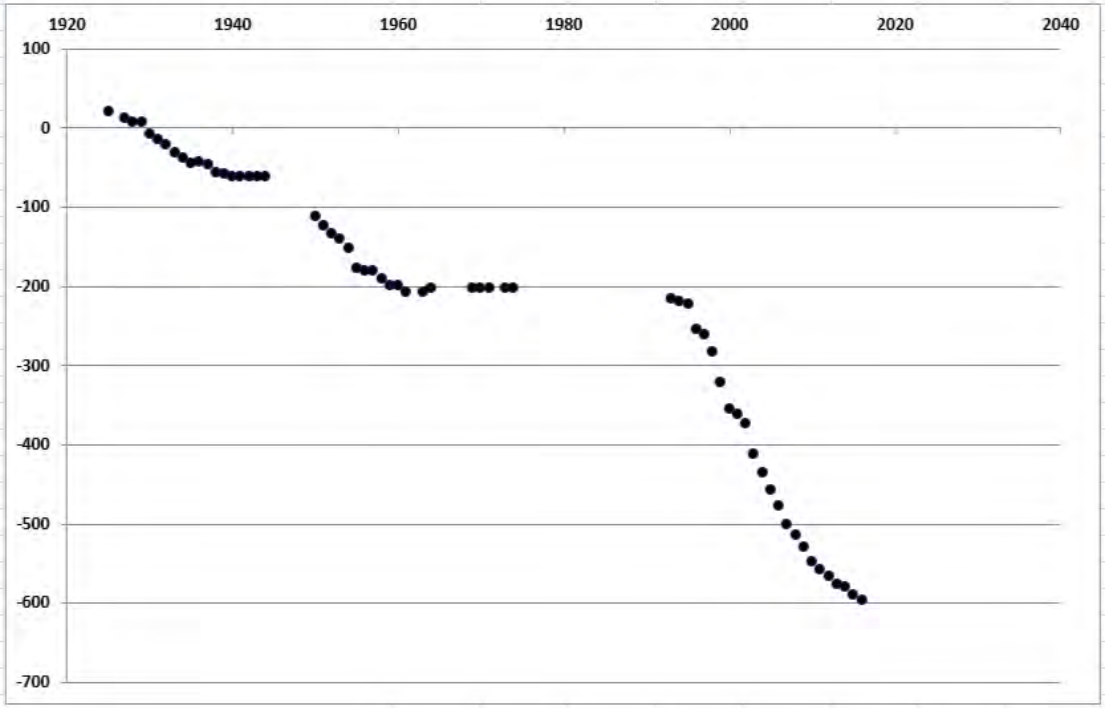
CGI_ID

106.0
107.0
108.0
109.0
110.0
111.0
112.0
113.0

All data have been validated and stored in a database, which enables to perform easy and automatic queries and analyses of the available glaciological data for the entire Italian Alps.

... | OCCIDENTALI | CENTRALI | ORIENTALI | summary | analisi_Valori_UNIVOCI_WGMS | cumulative-variation | DISTANCE-TIME_curve | da_mac-MCS

Pronto



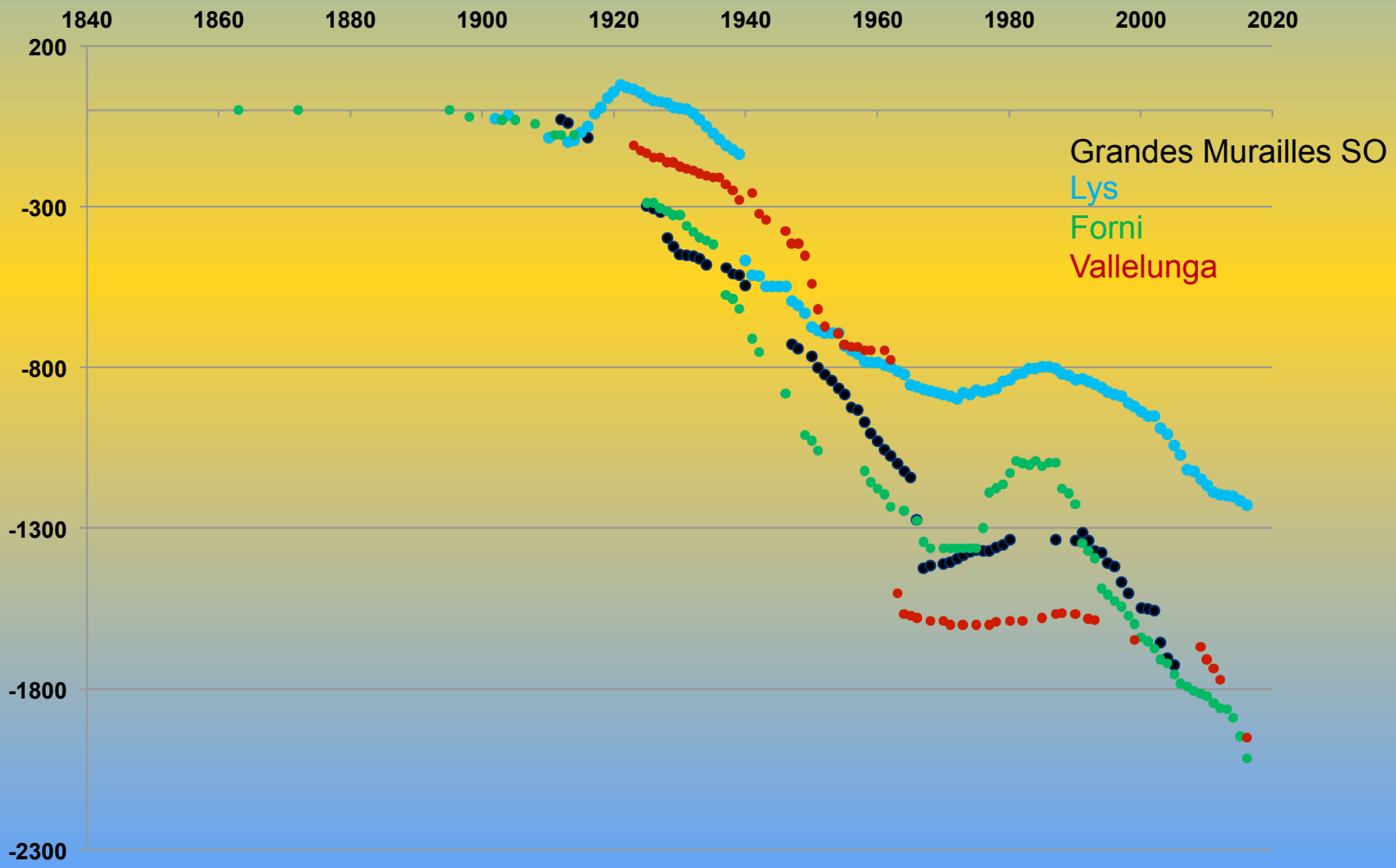
CGI_ID

106.0
107.0
108.0
109.0
110.0
111.0
112.0
113.0

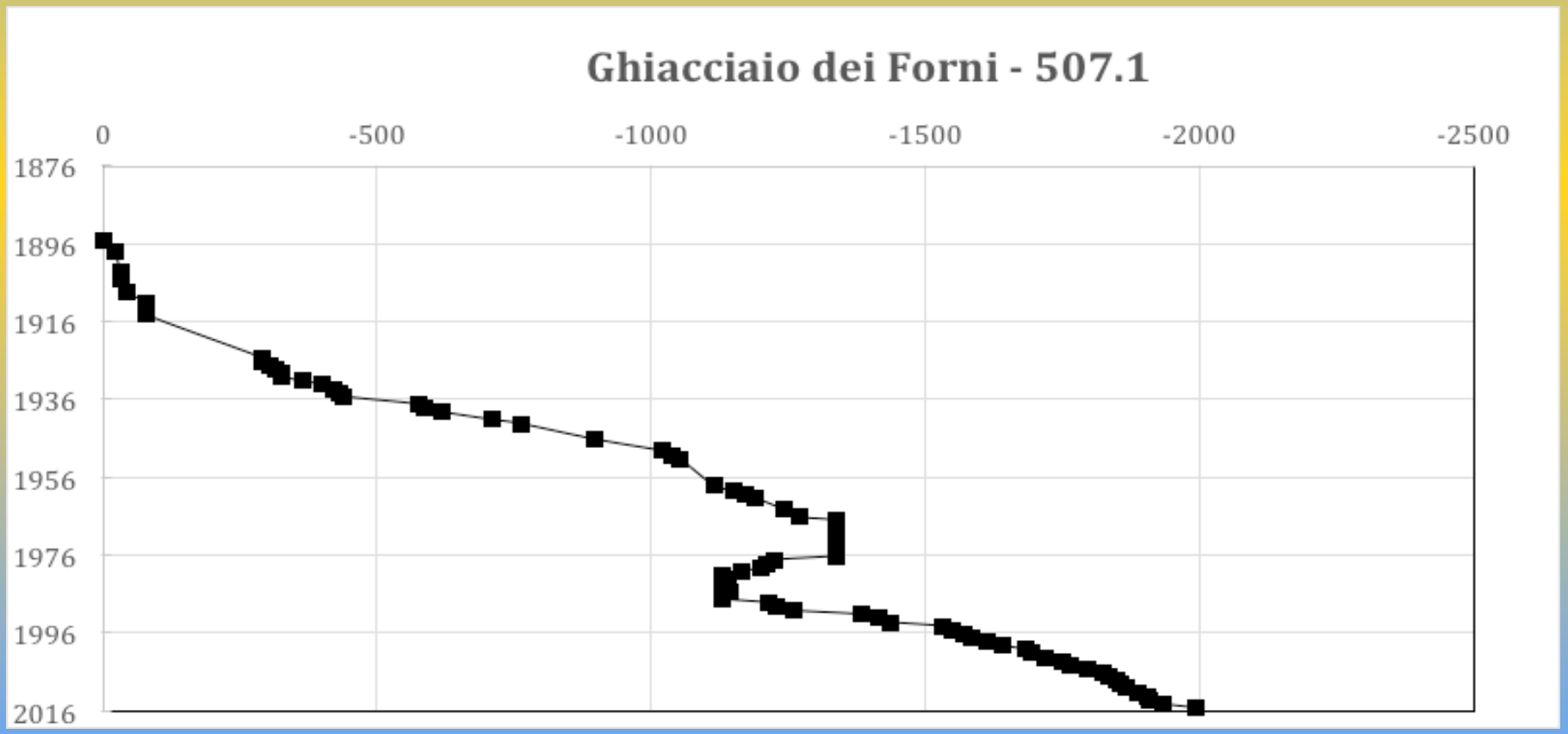
CGI_ID	109.0
Year	Cumulative_Front_Variation
1925	20
1927	12
1928	7
1929	7
1930	-8
1931	-15
1932	-21
1933	-31.5
1934	-37.5
1935	-44.5
1936	-43.5
1937	-46.5
1938	-56.5
1939	-58.5
1940	-61
1941	-62
1942	-62
1943	-62
1944	-62
1950	-112
1951	-124
1952	-133
1953	-139.5
1954	-151.5
1955	-176.5
1956	-180
1957	-180
1958	-191
1959	-199
1960	-199
1961	-207
1963	-207
1964	-202
1969	-202
1970	-202
1971	-202
1973	-202
1974	-202
1993	-215
1994	-218.5
1995	-222.5
1996	-254
1997	-260.5
1998	-282.5
1999	-321
2000	-354.5
2001	-361.5
2002	-373.5
2003	-411.5
2004	-435.5
2005	-457
2006	-477.5
2007	-501.5
2008	-513.5
2009	-530
2010	-547
2011	-557.5
2012	-566.5
2013	-575.5
2014	-579
2015	-589
2016	-596

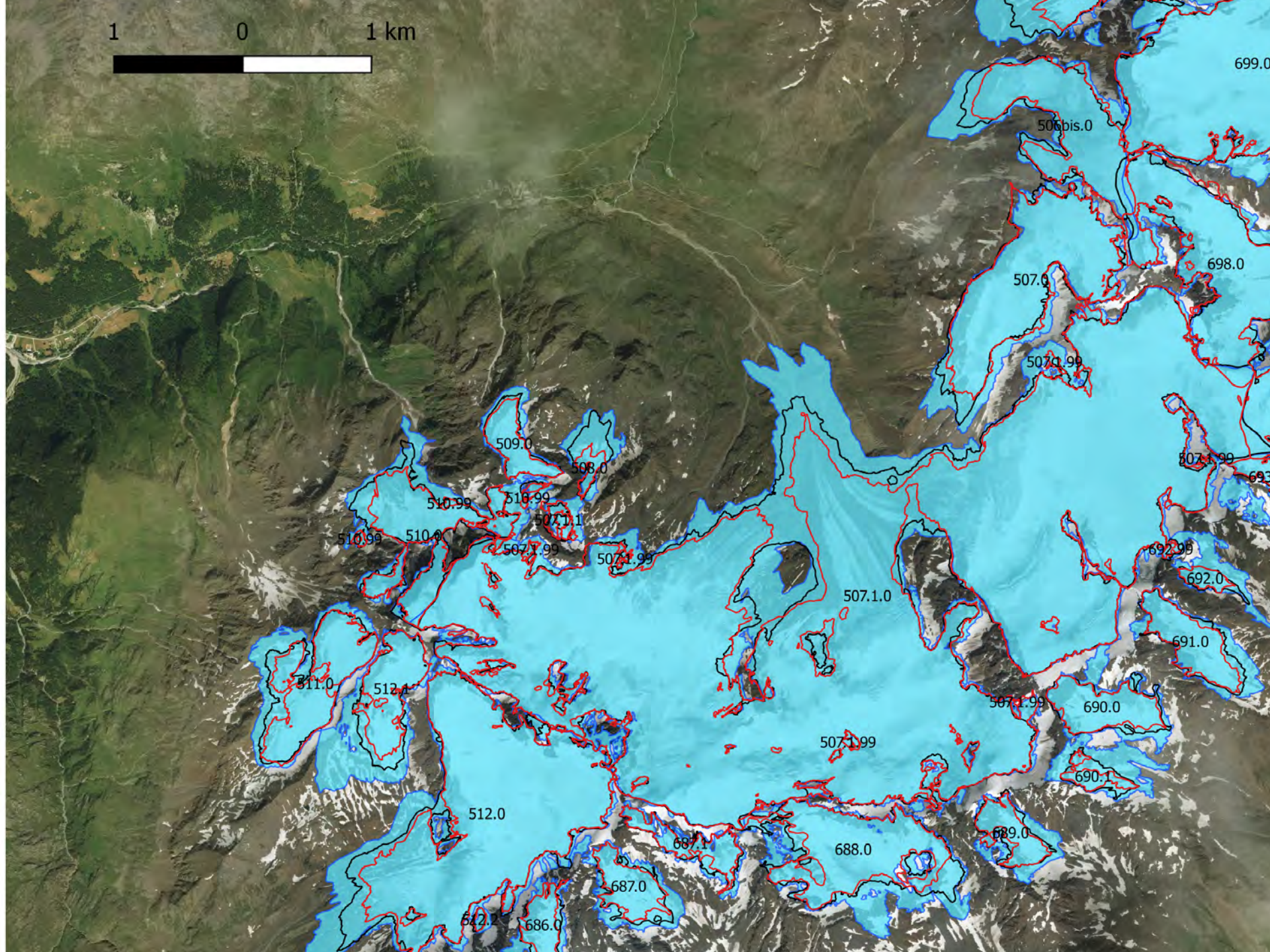
Curve T-D

	Max frontal retreat (in m)	Time interval	Glacier_name
Western Alps	-1726.5	(1912) 1925 – 2005	260.0 Ghiacciaio des Grandes Murailles SO
	-1229.4	1902 – 2016	304.0 Ghiacciaio del Lys
Central Alps	-2014.85	1895 – 2016	507.1 Ghiacciaio dei Forni
Eastern Alps	-1965.2	1899 - 2016	777.0 Vedretta di Vallelunga



Agosto 2015
G. Cola SGL




1 0 1 km
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506bis.0
698.0
507.0
507.1.99
509.0
508.0
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510.99
510.0
507.1.99
507.1.99
692.99
692.0
507.1.0
691.0
511.0
512.1
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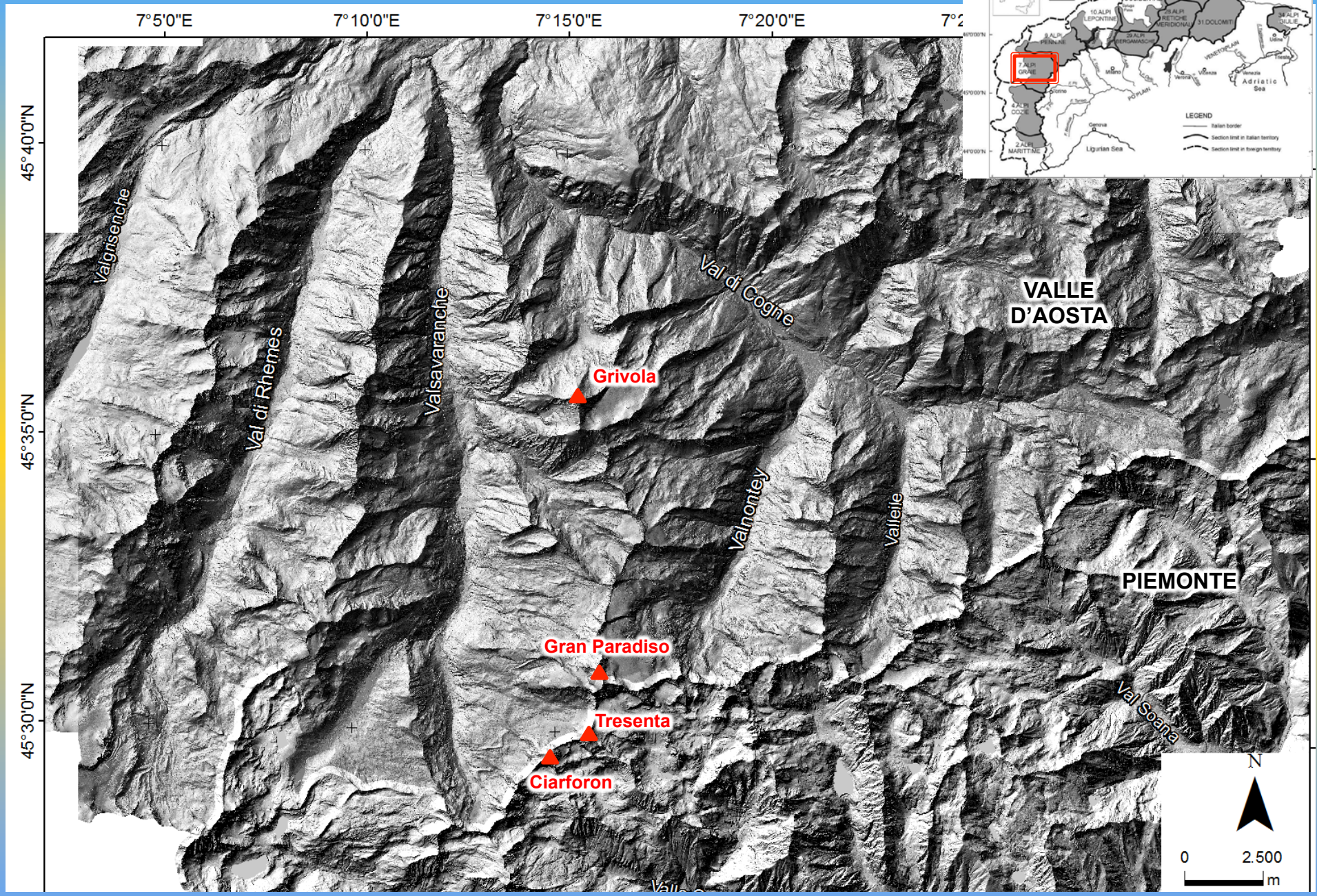
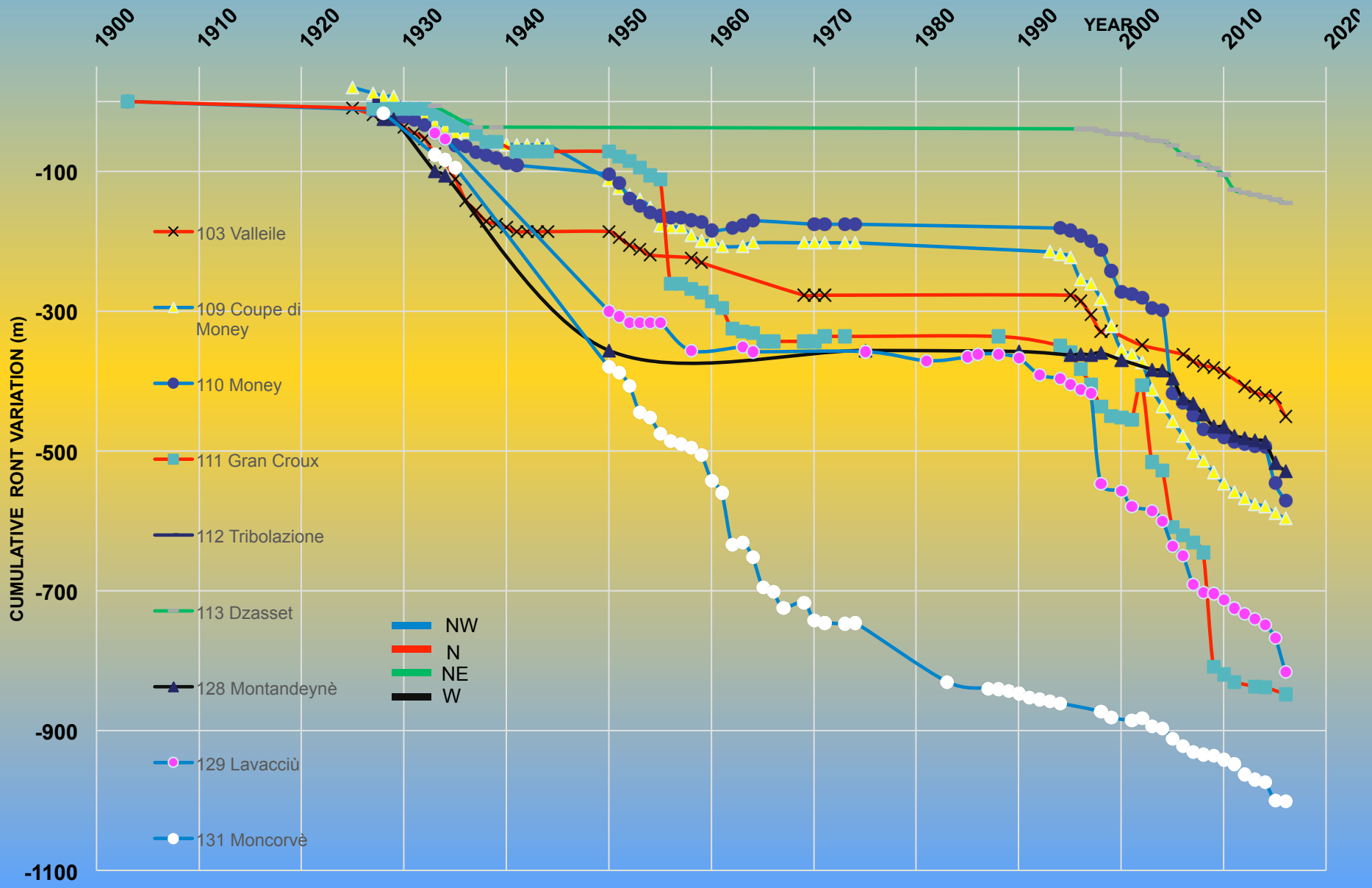
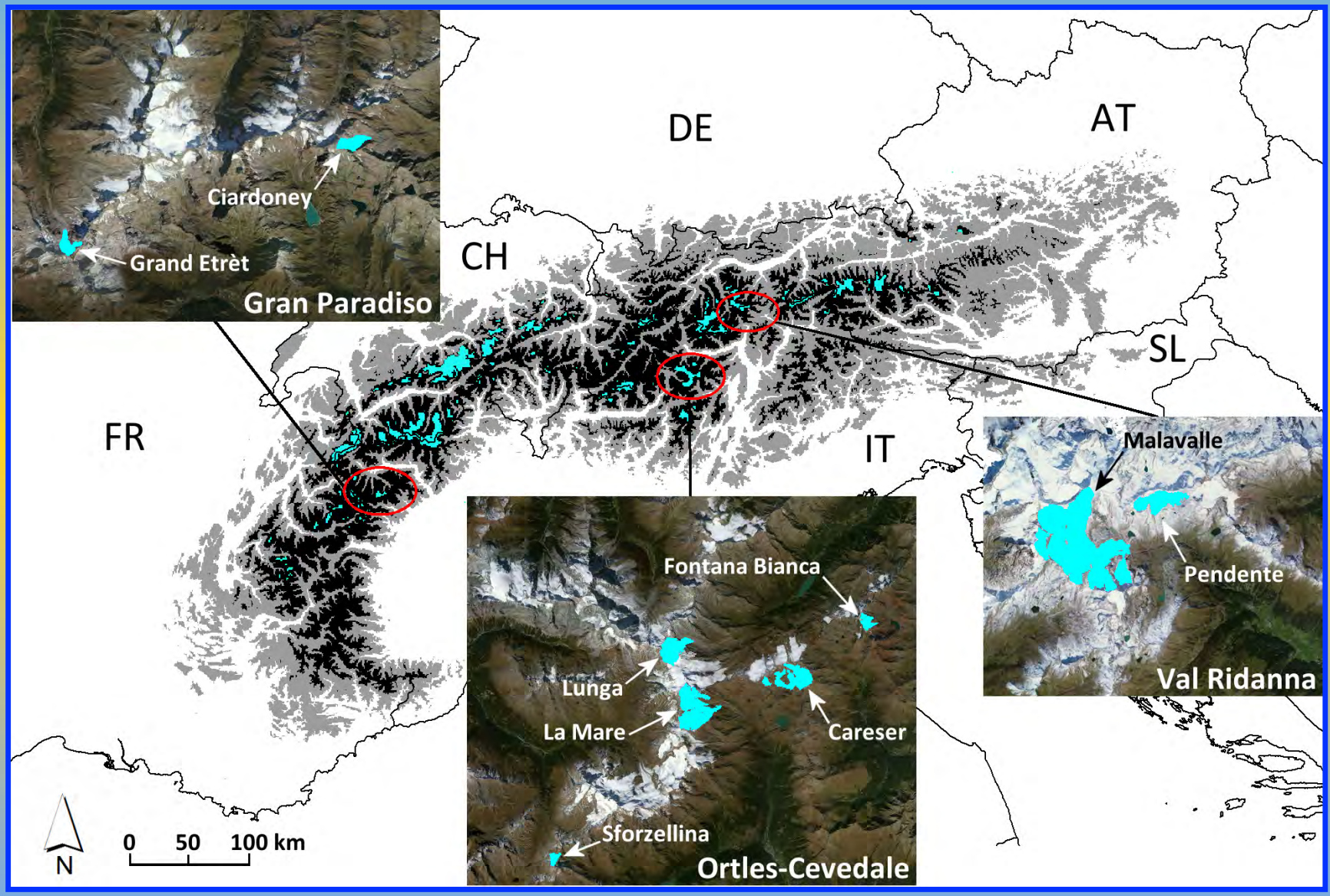
689.0
687.1
688.0
687.0
642.2
686.0


7°5'0"E
7°10'0"E
7°15'0"E
7°20'0"E
45°40'0"N
45°35'0"N
45°30'0"N
Valgrisenche
Val di Rhemes
Valsavaranche
Val di Cogne
Valnontey
Valleile
Grivola
Gran Paradiso
Tresenta
Ciarforon
VALLE D'AOSTA
PIEMONTE
Val Soana
N
0
2.500
m

- Monitored glaciers > 1km2 in 2015
- (103, 112, 113, 129, 131, 109, 110; -111, 128-)

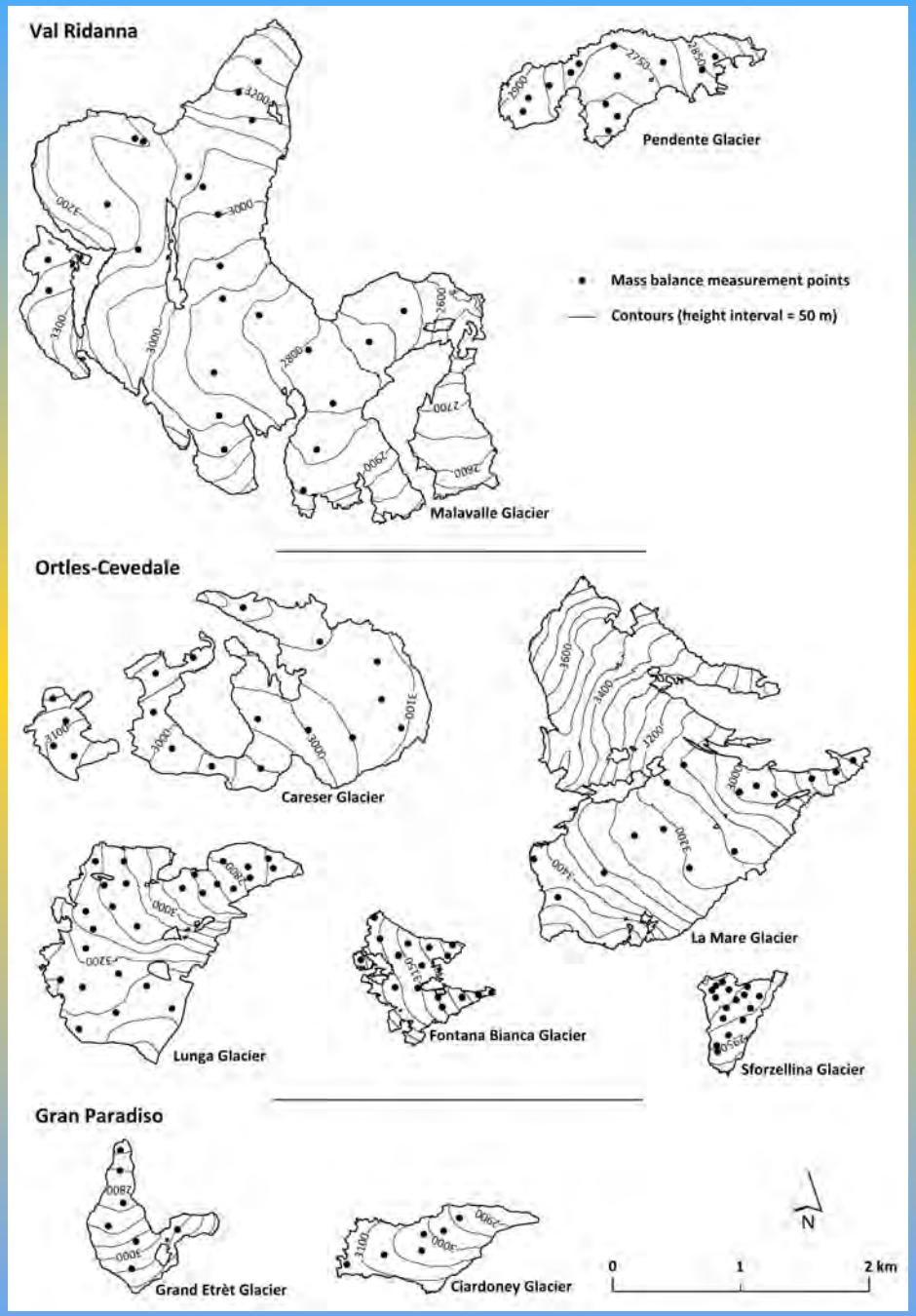


Geographic setting of the glaciers with mass balance measurements (Microsoft®Bing™ Maps)

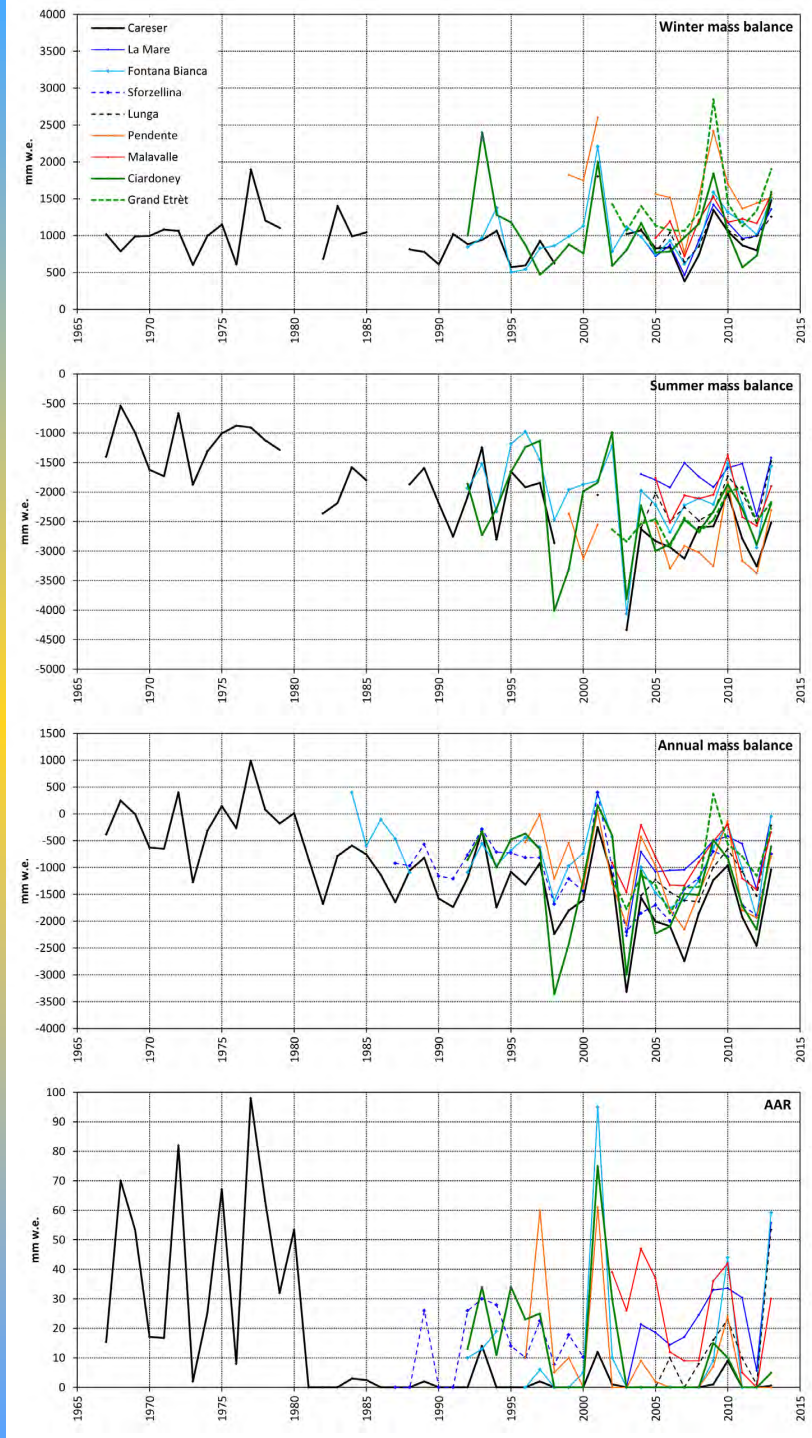


Carturan et al., 2016 (The Cryosphere)

Surface topography and measurement network of the nine glaciers analyzed



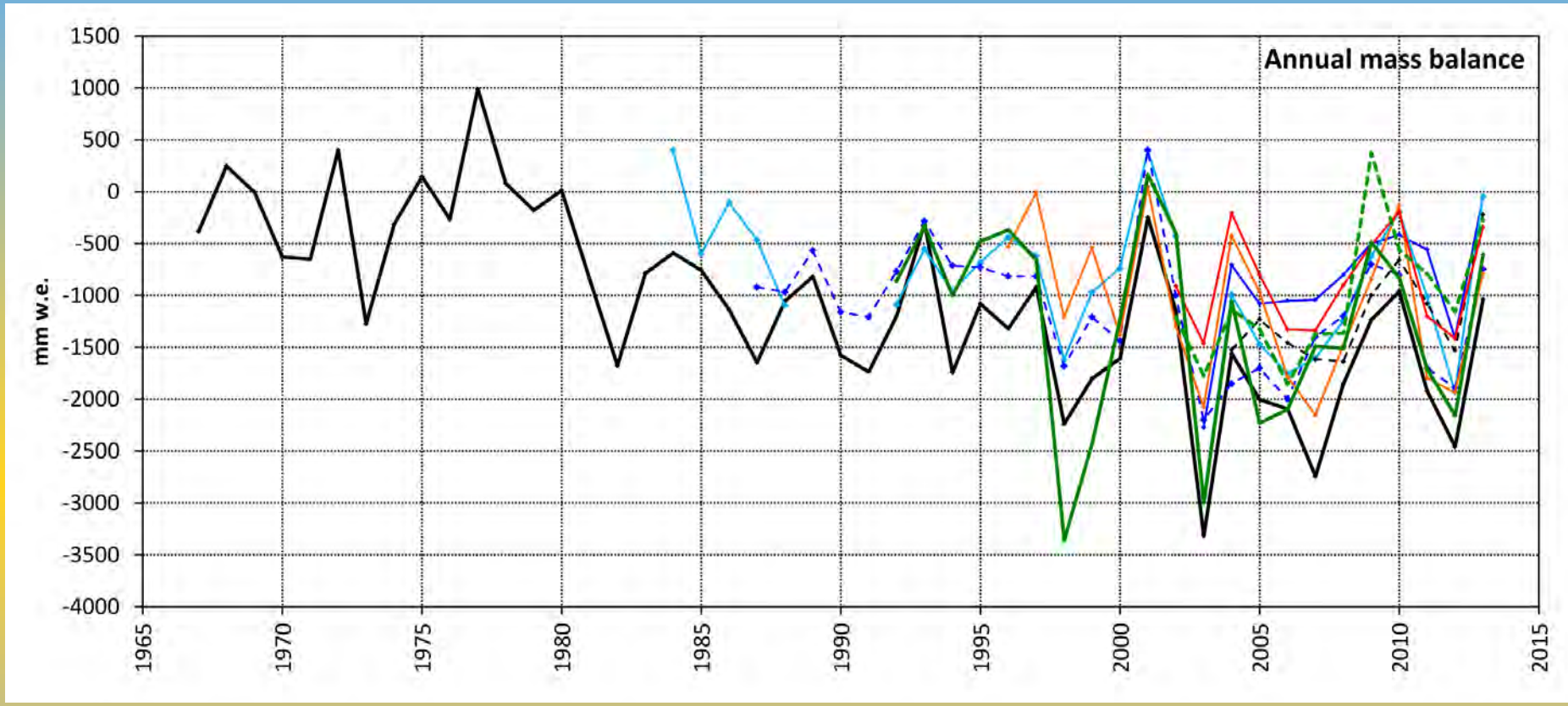
Carturan et al., 2016 (The Cryosphere)



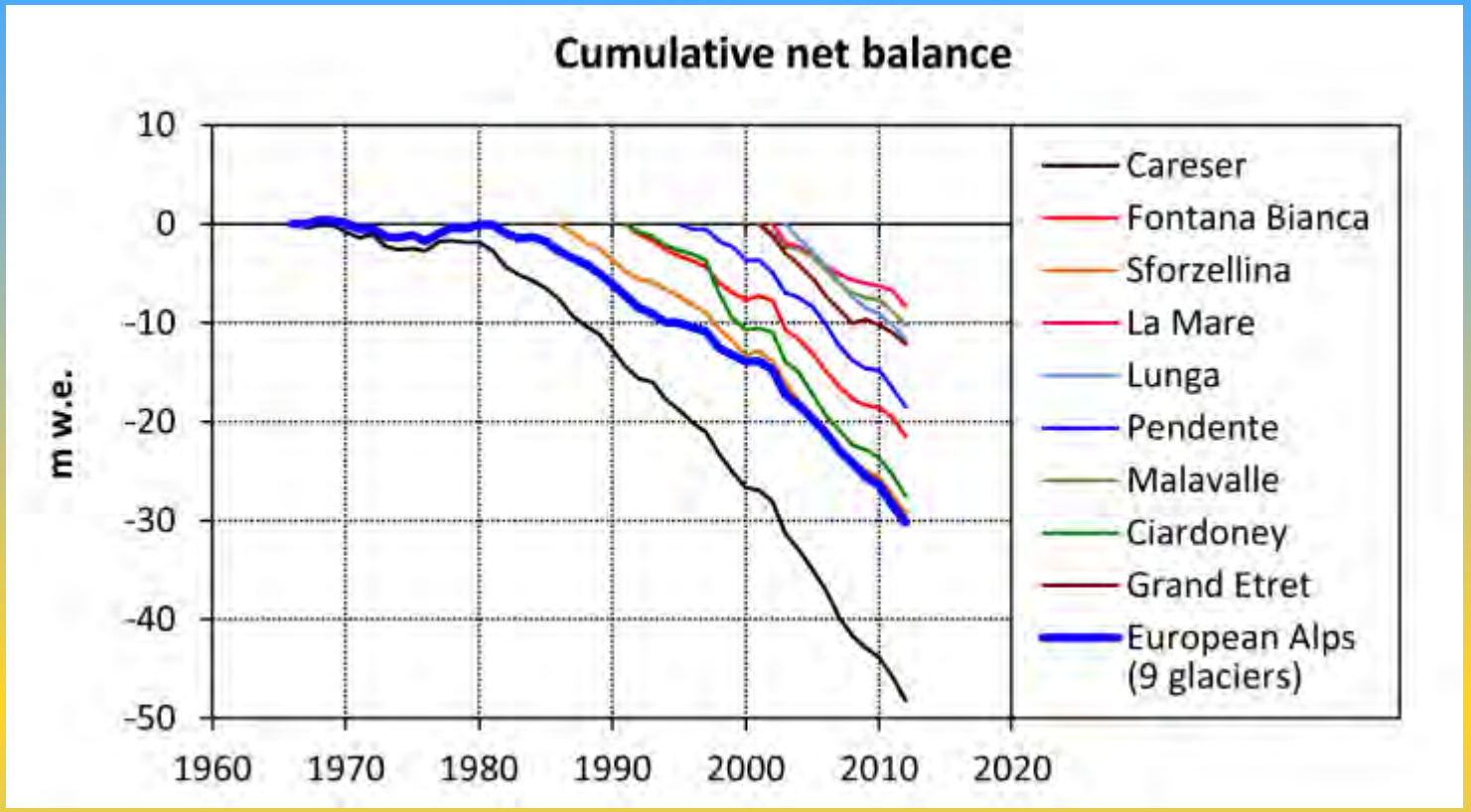
Time series of **B**w, **B**s, **B**a and AAR for the nine Italian glaciers analyzed

Carturan et al., 2016 (The Cryosphere)

Time series **B**a for the nine Italian glaciers analyzed

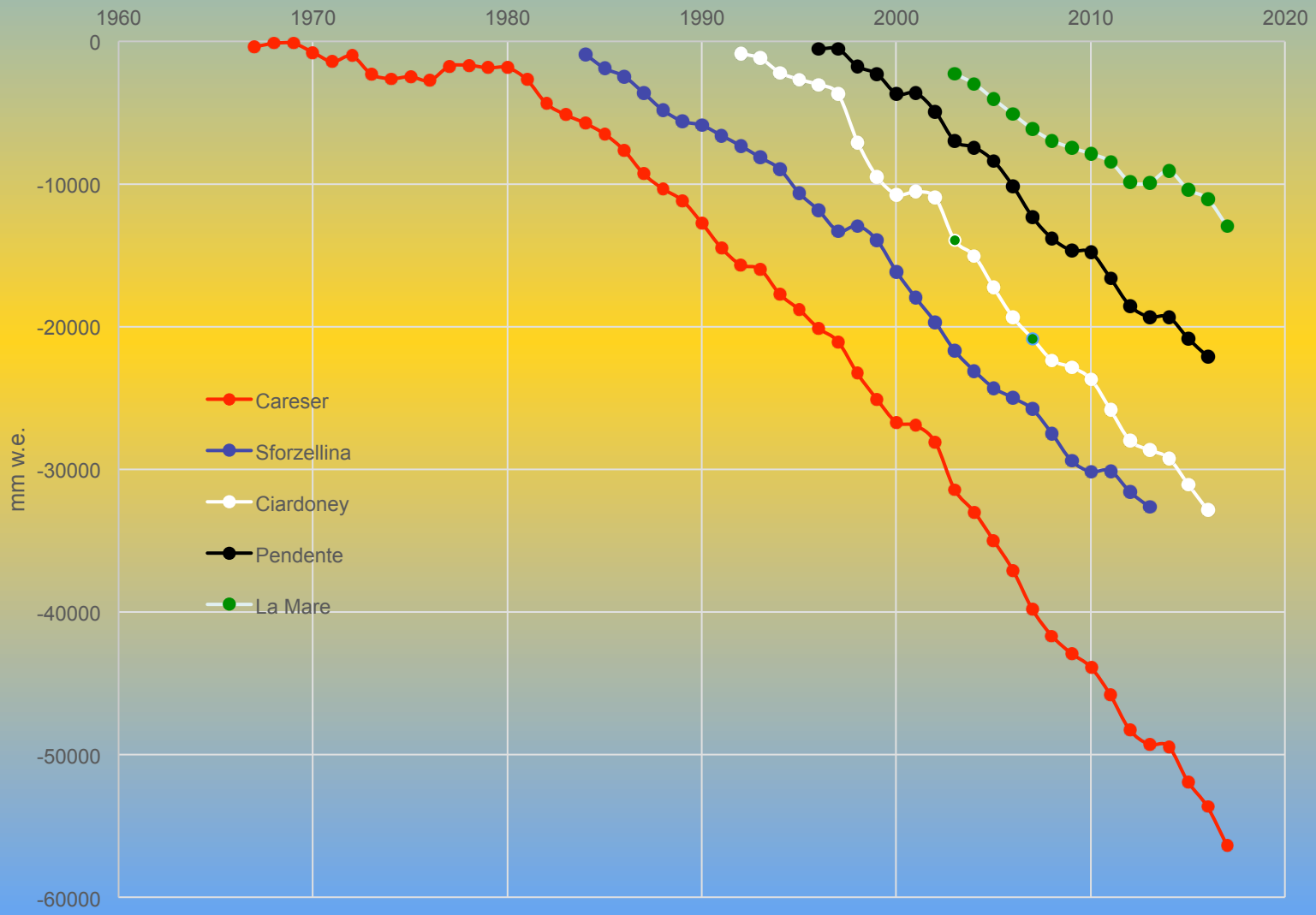


Carturan et al., 2016 (The Cryosphere)



	Glaciers in the Italian Alps		Glaciers in the European Alps	
Period	Number	Mean annual net balance	Number	Mean annual net balance
1967-1982	1	-273	9	-62
1983-1992	1-4	-984	9	-752
1993-2002	4-7	-897	9	-623
2003-2012	8-9	-1358	9	-1545

Careser 1967-2017 ca. -56311 mm w.e.
Ciardoney 1992-2016 ca -32840 mm w.e.
Sforzellina 1987-2016 ca. -32627 mm w.e.
Pendente 1996-2016 ca. -22084 mm w.e.
La Mare 2003-2017 ca. -12949 mm w.e.



	Car	Mar	FB	Sfo	Lun	Pen	Mal	Cia	GE
B_w	927	989	1085	–	991	1537	1194	1052	1472
(9 years)	(330)	(301)	(338)		(222)	(425)	(256)	(421)	(578)
B_s	−2740	−1758	−2183	–	−2151	−2857	−2087	−2510	−2396
(9 years)	(368)	(303)	(457)		(368)	(525)	(386)	(378)	(321)
B_a	−1788	−763	−1088	−1399	−1195	−1231	−825	−1419	−946
(10 years)	(590)	(395)	(642)	(505)	(466)	(692)	(484)	(646)	(648)
AAR	1	25	11	–	12	4	23	3	–
(10 years)	(3)	(14)	(22)		(16)	(8)	(17)	(5)	

Mean values (and standard deviation in brackets) of **Bw**, **Bs**, **Ba** and AAR for nine Italian glaciers in the period from 2004 to 2013 (Car is Careser, FB is Fontana Bianca, Pen is Pendente, Cia is Ciardoney, Sfo is Sforzellina, GE is Grand Etrèt, Lun is Lunga, Mar is La Mare, Mal is Malavalle).
Values are expressed in mmw.e. except for AAR, which is in percent.

Carturan et al., 2016 (The Cryosphere)

	Car	Mar	FB	Sfo	Lun	Pen	Mal	Cia	GE
B_w (9 years)	927 (330)	989 (301)	1085 (338)	–	991 (222)	1537 (425)	1194 (256)	1052 (421)	1472 (578)
B_s (9 years)	−2740 (368)	−1758 (303)	−2183 (457)	–	−2151 (368)	−2857 (525)	−2087 (386)	−2510 (378)	−2396 (321)
B_a (10 years)	−1788 (590)	−763 (395)	−1088 (642)	−1399 (505)	−1195 (466)	−1231 (692)	−825 (484)	−1419 (646)	−946 (648)
AAR (10 years)	1 (3)	25 (14)	11 (22)	–	12 (16)	4 (8)	23 (17)	3 (5)	–

A common characteristic for all glaciers analyzed is their very low mean AAR in the last decade.

Accumulation areas were almost nonexistent in most glaciers, indicating that they will soon disappear, even without additional warming.

Some glaciers are displaying morphological changes that indicate their impending extinction, such as rapid disintegration

Carturan et al., 2016 (The Cryosphere)

- All examined glaciers are experiencing imbalanced conditions, and the longer series show sustained negative trends of **B**a .

- The observed behavior was mainly caused by **increased ablation**, led by warmer temperature and related feedbacks, such as the **lengthening of the ablation season**.

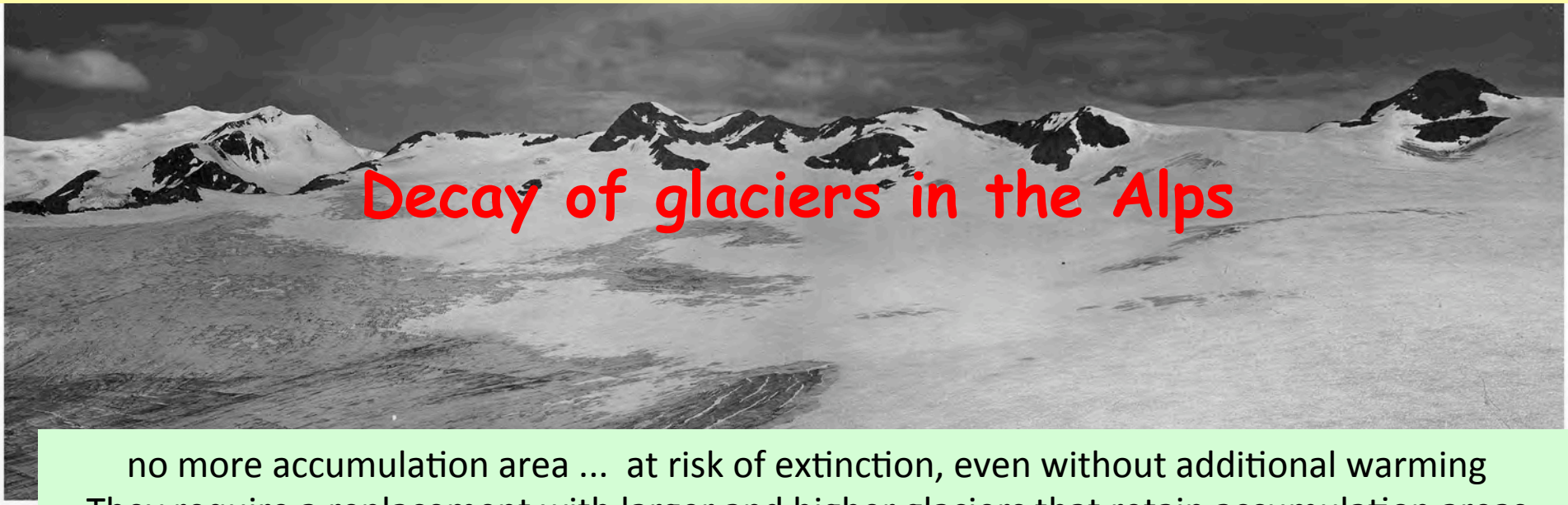
- The total precipitation does not show any significant trend, but the fraction of solid precipitation decreased as a consequence of the warmer temperature.

- The **B**a of the analyzed glaciers is mainly correlated to **B**s , except for two glaciers where wind-borne snow enhances the importance of **B**w .

For most glaciers, approximately two-thirds of the **B**a variance can be explained by multiple linear regression, using the Oct–May precipitation and Jun–Sep temperature as independent variables.

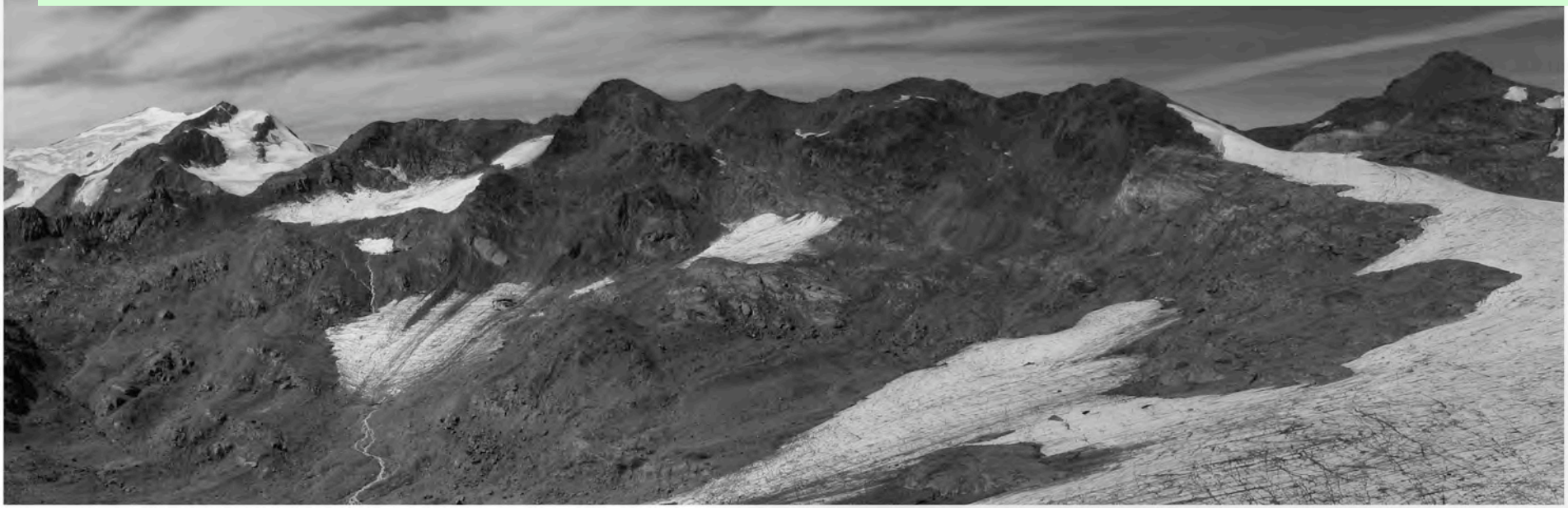
Carturan et al., 2016 (The Cryosphere)

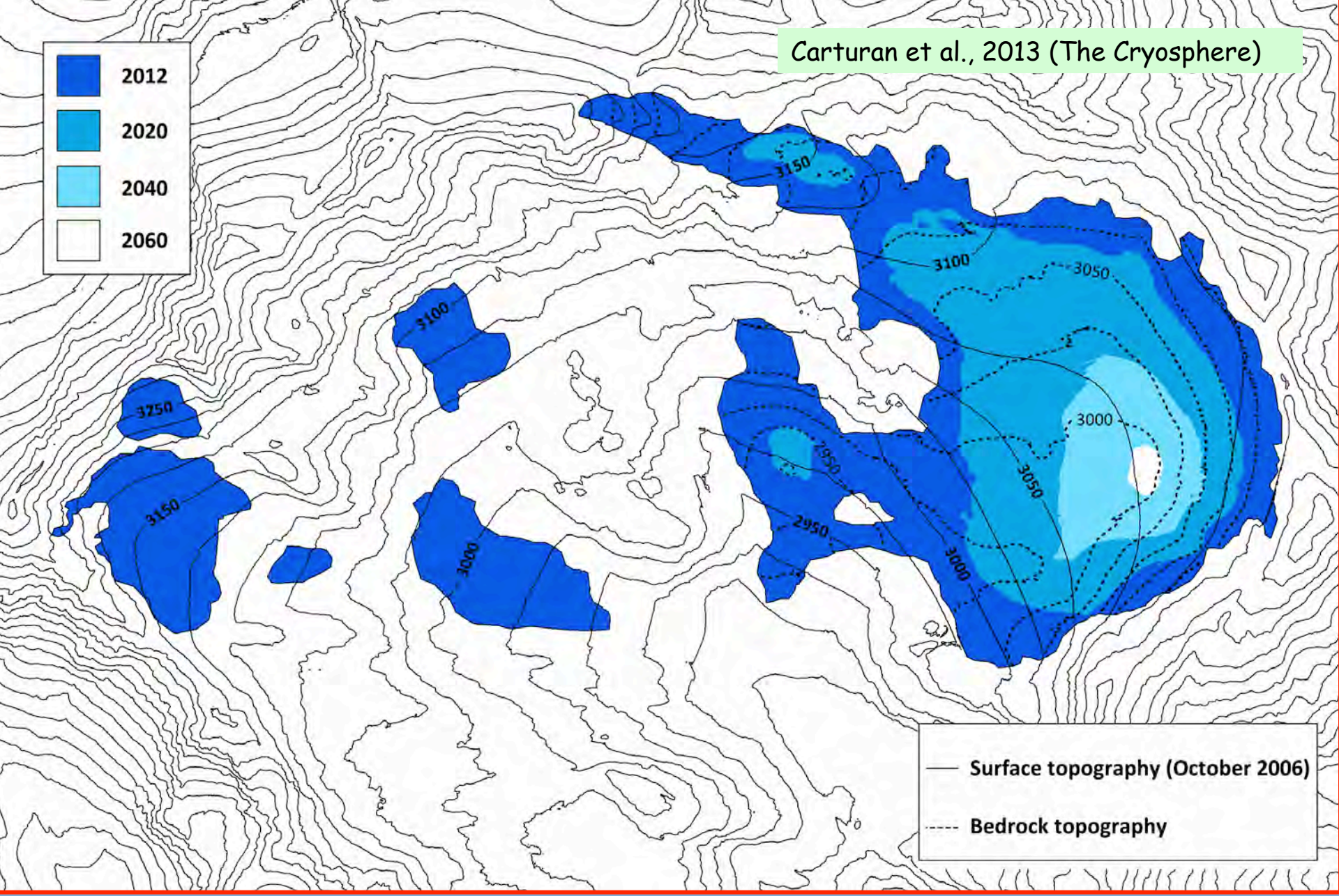
Photographic comparison of the Careser glacier in August 1933 (above, courtesy of Comitato Glaciologico Italiano) and on 28 August 2012 (below, photo L. Carturan).



Decay of glaciers in the Alps

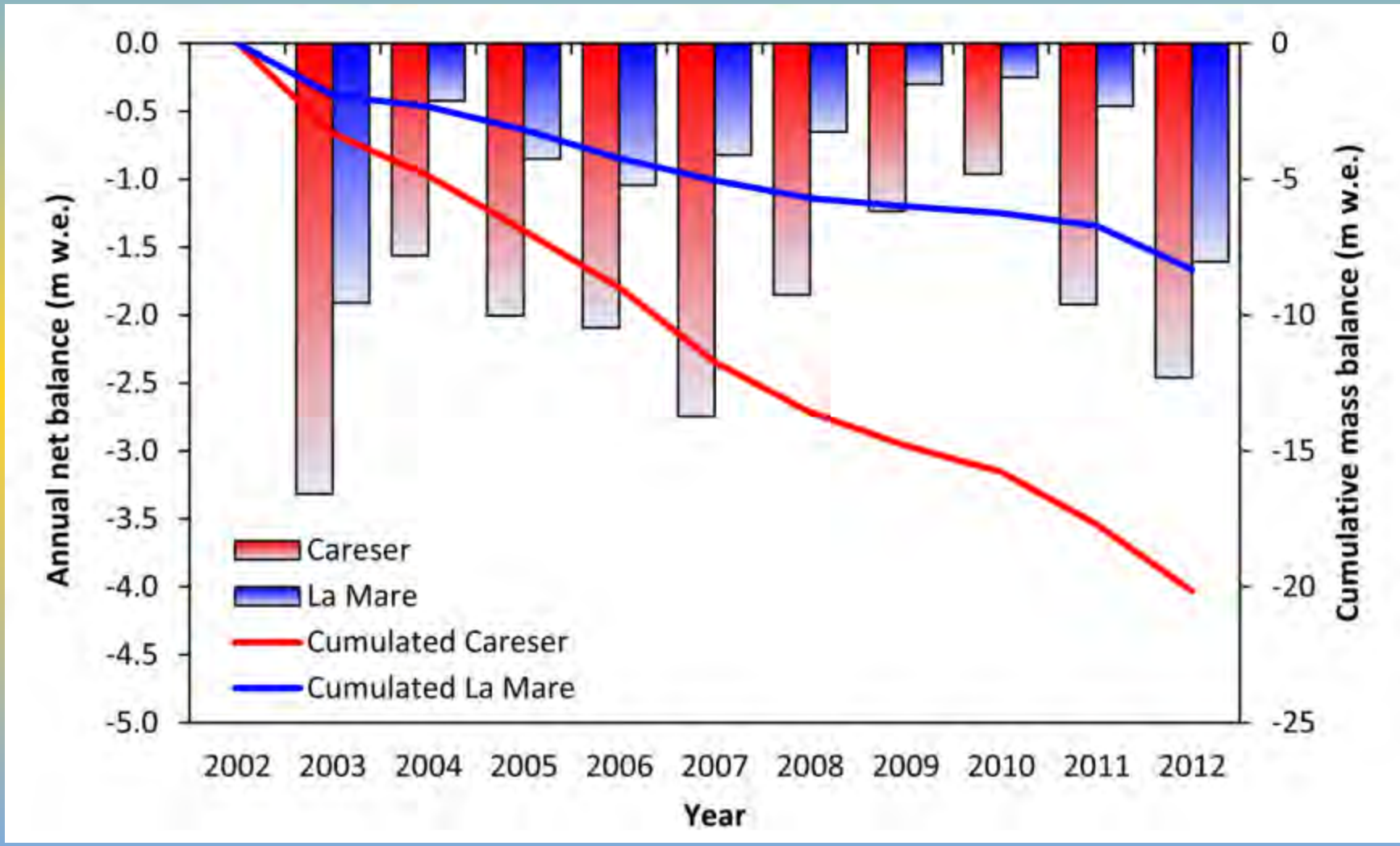
no more accumulation area ... at risk of extinction, even without additional warming
They require a replacement with larger and higher glaciers that retain accumulation areas



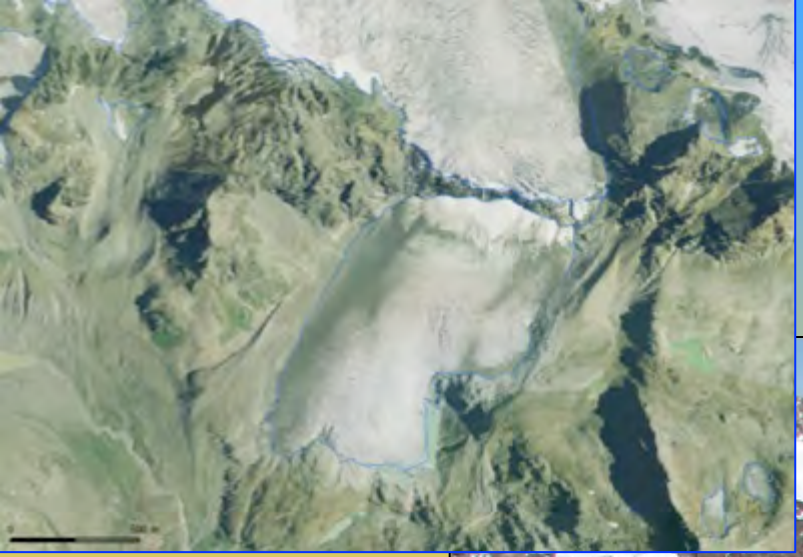


Current (2012) and future extent of the Careser Gl., assuming unchanged spatial distribution of the mean annual mass balance compared to the decade from 2003-2012

Carrying out parallel observations for future replacement



Regional assessments of the mass loss rates using the geodetic method are required to identify possible replacing glaciers, evaluate their spatial representativeness and enable the transitions from replaced to replacing glaciers, as suggested by Haeberli et al. (2013).



Grazie....

Ghiacciaio Orientale di Fellaria
(G. Kappenberger, 5 Sett. 2006)