

ACCADEMIA NAZIONALE DEI LINCEI

La variabilità climatica in Italia negli ultimi 2000 anni – Italy 2k
Roma, 1-2 Dicembre 2014



Mediterranean Climate Reconstructed from Ice Core

Valter Maggi, Mattia De Amicis, Matteo Mattavelli
Jacopo Gabrieli, Carlo Barbante, Giuliano Dreossi
+ more.....



EuroCold Lab



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Presentation outlines

- Brief introduction to ice core science
- Climatic and environmental reconstruction from ice core records
- Some remarks
- Perspectives



Despite the glaciers are distributed at all the Latitudes, ice core drilling will not done anywhere.

Glaciers are one of the best archives of atmospheric data, but the fragility of its environment can present troubles on data sequences.

Summer melting or winter wind erosion can reduce or cancel the informations stored in the ice.

Only glaciers (or part of them) in cold conditions, with T° below 0°C , can be useful for this kind of studies, normally located at high altitude inside the mountain chains.

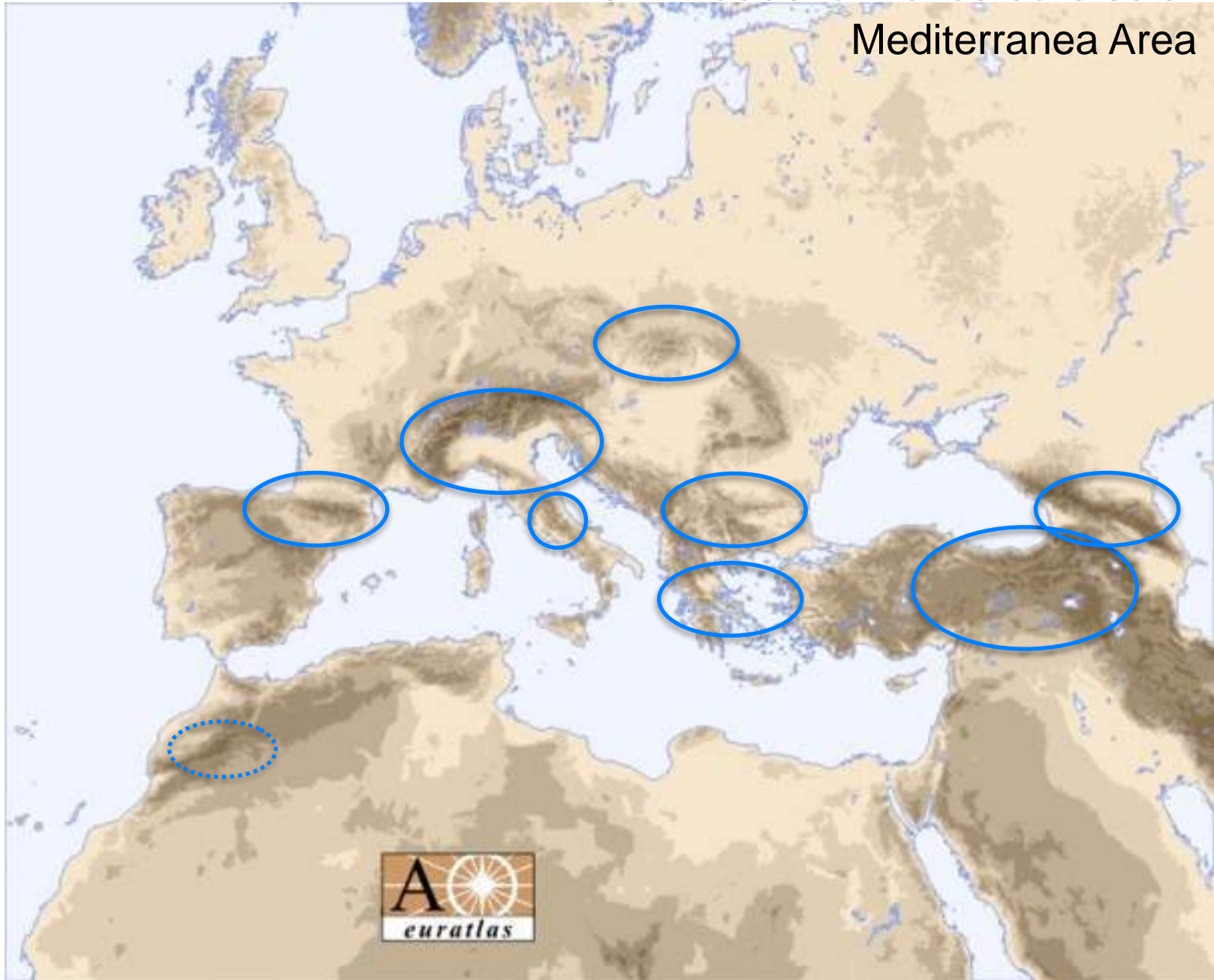
In the Alpine region, with few exceptions, 3800-4000 m as seem to be a limit for this kind of the work. In the Himalaya-Karakorum systems, need to reach 5-6000 m asl or more.



Brief introduction to ice core science



Mediterranea Area

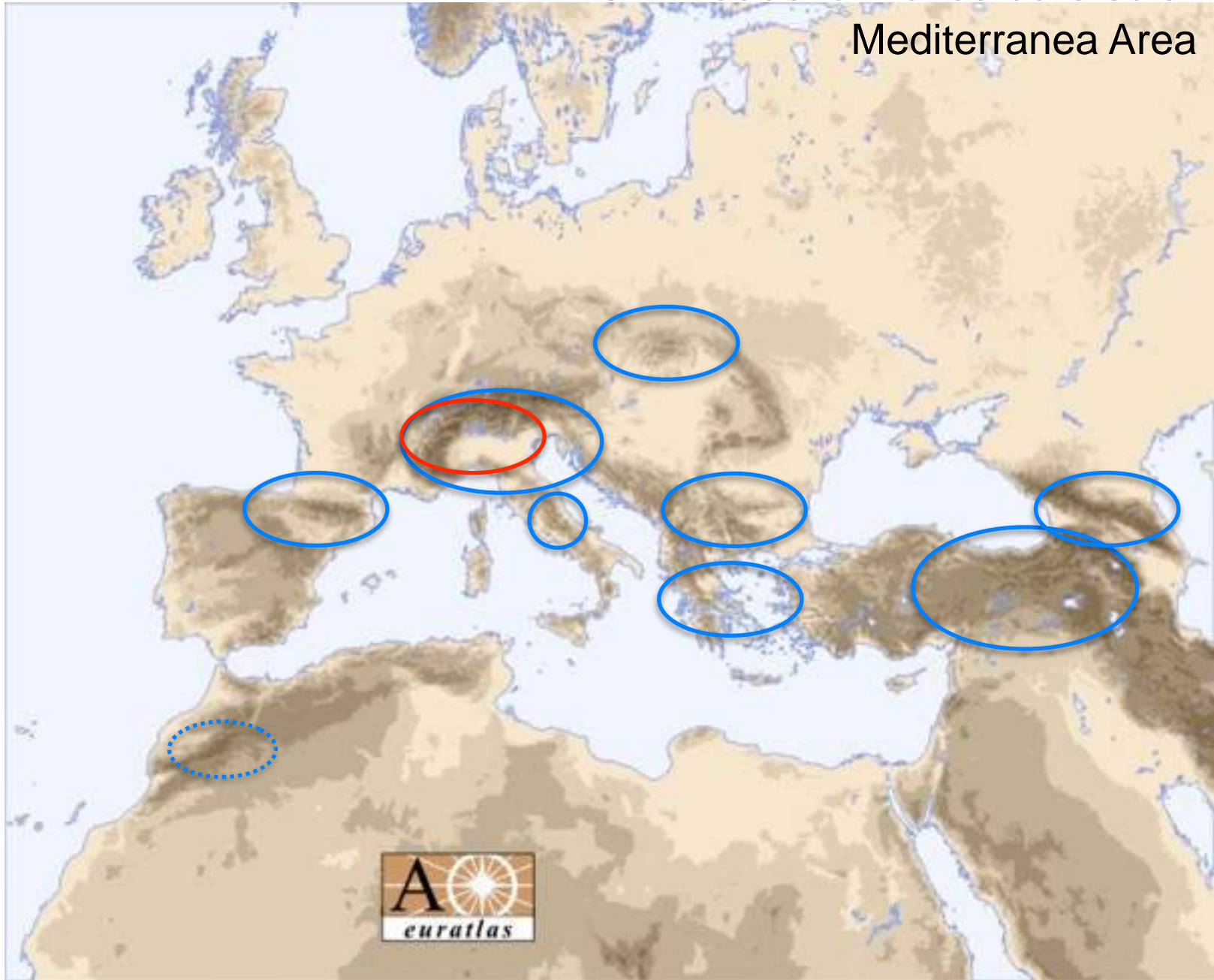
-  Glaciers
-  Glaciers?



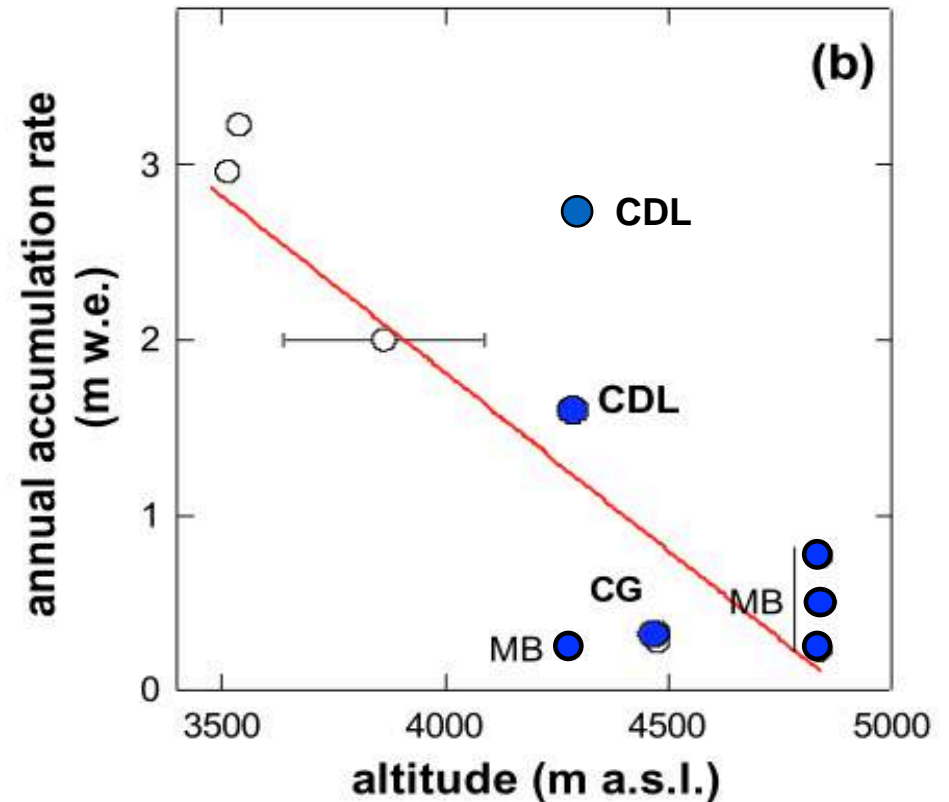
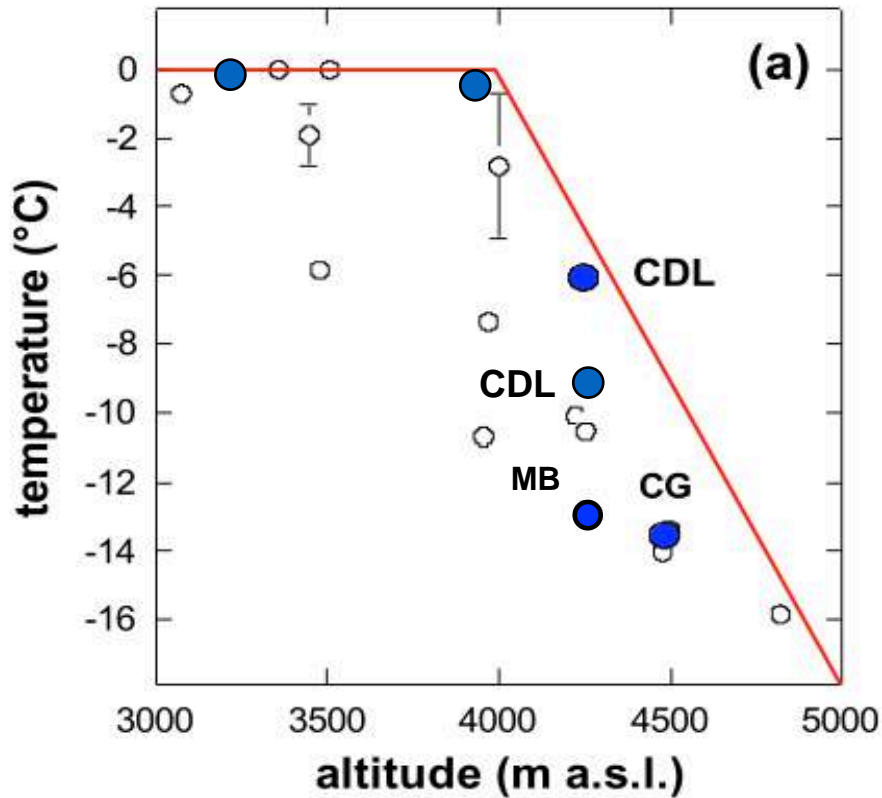
Brief introduction to ice core science

Mediterranea Area

-  Glaciers
-  Glaciers?
-  Ice Core



Brief introduction to ice core science



Relationship between altitude of the drill sites and -10 m temperature (a) and annual accumulation rate (b). CDL: Colle del Lys; CG: Colle Gnifetti; MB: Mont Blanc (from Haeberli, 1983, modify)



Home IDB - Ice Core Database v 1.0

Introduction

In this page are presented two useful tools to search in quickly and efficient way ice core data. In the page is possible find:

- a form built with drop-down menus, this is the core of the page, from there you can concretely download the data;
- a webGIS that can be use to localize and get information about name and dataprovider of the ice cores.



How to

Three drop-down menu has been built to retrieve chemical and physical ice cores data characterizations. It is possible select an ice core name, a dataprovider or a parameter name. You can start your research with any of these three variables. When a variable is selected, automatically the other two drop-down menu will be related with this choice. The downloading file format is CSV with comma separated field. To generate it just press the download button. You can download data selecting even only one of the three variables (e.g. selecting 'maggi v.' as dataprovider, you can directly download all ice cores data related to him.)

select icecore name ...

select dataprovider name ...

select parameter name ...

Download Reset

WebGIS



Brief introduction to ice core science

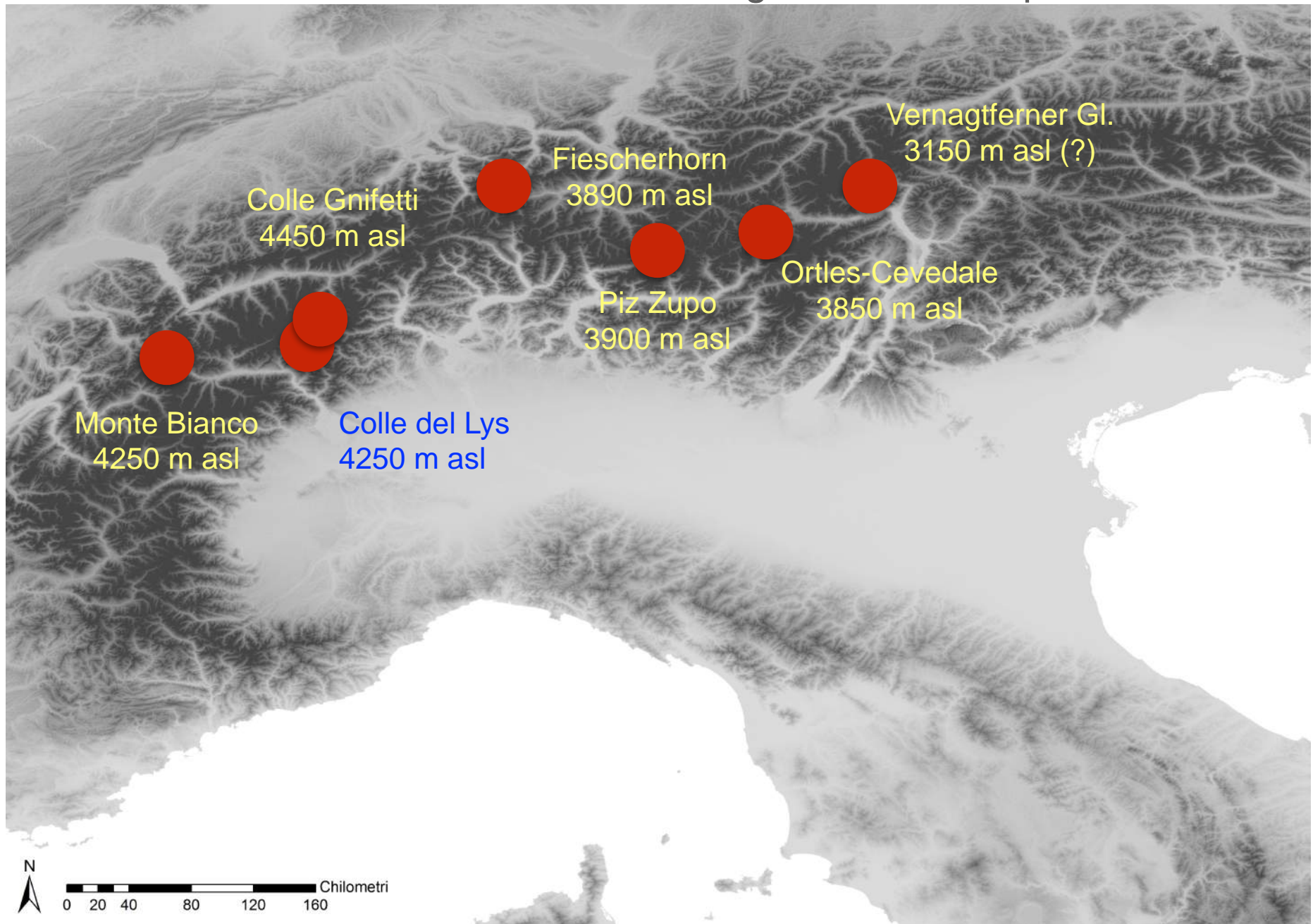
The ice core distribution around the world cover all the most high mountain chains , as Rockies, Ande, Himalaya-Karakorum, Alps and African equatorial glaciers.

In the frame of NEXTDATA Project, a open database of all the known ice core were build up.

More than 270 ice core was drilled in more than 70 sites worldwide.



Paleoclimatic significance of Alpine ice cores



Name	Location	Place name of Drilling site	Drilled	Year top	Year bottom	coverage
CDB 6	Alps, Mont Blanc	Col de Brenva	1984	1984	1982	2
CDD 10	Alps, Mont Blanc	Col du Dome	1994	1994	1918	76
CDD 11	Alps, Mont Blanc	Col du Dome	1994	1994	1844	150
CDD 12	Alps, Mont Blanc	Col du Dome	1997	1997	1992	5
CDD 2	Alps, Mont Blanc	Col du Dome	1973	1976	1940	36
CDD 2b	Alps, Mont Blanc	Col du Dome	1976	-	-	-
CDD 3	Alps, Mont Blanc	Col du Dome	1974	1974	1948	26
CDD 5	Alps, Mont Blanc	Col du Dome	1980	1980	1971	9
CDD 7	Alps, Mont Blanc	Col du Dome	1986	1986	1955	31
CDD 8	Alps, Mont Blanc	Col du Dome	1991	1991	1984	7
CDK	Alps, Mont Blanc	Col du Dome	2004	2004	1920	84
DDG 2	Alps, Mont Blanc	Dome du Guter	1999	-	-	-
MB 73	Alps, Mont Blanc	Mont Blanc Summit	1973	1973	1970	3
MB 99	Alps, Mont Blanc	Mont Blanc	1999	-	-	-
CdL 96	Alps Monte Rosa	Colle del Lys	1996	1996	1954	42
CdL 00/1	Alps Monte Rosa	Colle del Lys	2000	2001	1999	2
CdL 03/1	Alps Monte Rosa	Colle del Lys	2003	2003	1933	70
CdL 03/2	Alps Monte Rosa	Colle del Lys	2003	2003	1933	70
CdL 03/3	Alps Monte Rosa	Colle del Lys	2003	2003	1933	70
CdL 12/1	Alps Monte Rosa	Colle del Lys	2012	2012	2002	10
CG B76	Alps Monte Rosa	Colle Gnifetti	1976	1976	1901	75
CG B77/1	Alps Monte Rosa	Colle Gnifetti	1977	1977	1778	199
CG B77/2	Alps Monte Rosa	Colle Gnifetti	1977	-	-	-
CG B82/1	Alps Monte Rosa	Colle Gnifetti	1982	1982	0	1982
CG B82/1b	Alps Monte Rosa	Colle Gnifetti	1982	-	-	-
CG CC B82/2	Alps Monte Rosa	Colle Gnifetti	1982	-	-	-
CG KCH B95/1	Alps Monte Rosa	Colle Gnifetti	1995	1995	1864	131
CG KCS B95/2	Alps Monte Rosa	Colle Gnifetti	1995	1995	1747	248
CG 03/1	Alps Monte Rosa	Colle Gnifetti	2003	2003	-8000	10003
CG 03/2	Alps Monte Rosa	Colle Gnifetti	2003	2003	550	1453
CG KCI 05	Alps Monte Rosa	Colle Gnifetti	2005	2005	1836	169
CG KCI sup	Alps Monte Rosa	Colle Gnifetti	2005	-	-	-
Ortles Ice core	Alps Ortles-Cevedale massif	Alto dell'Ortles	2009	-	-	-
Ortles 1	Alps Ortles-Cevedale massif	Alto dell'Ortles	2011	-	-	-
Ortles 2	Alps Ortles-Cevedale massif	Alto dell'Ortles	2011	-	-	-
Ortles 3	Alps Ortles-Cevedale massif	Alto dell'Ortles	2011	-	-	-
Ortles 4	Alps Ortles-Cevedale massif	Alto dell'Ortles	2011	-	-	-
Piz Zupo PZ02/1	Alps Morteratsch	Piz Zupo	2002	-	-	-
Piz Zupo PZ02/2	Alps Morteratsch	Piz Zupo	2002	-	-	-
Fiescherhorn FH89	Alps Grossfiescherhorn	Fiescherhorn Glacier	1989	1989	1946	43
Fiescherhorn FH02	Alps Grossfiescherhorn	Fiescherhorn Glacier	2002	2002	1660	342
Vernagtferner_I	Oetztal Alps	Vernagtferner	1979	1979	1896	83
Vernagtferner_II	Oetztal Alps	Vernagtferner	1979	1979	1896	83
Vernagtferner_III	Oetztal Alps	Vernagtferner	1979	-	-	-

Brief introduction to ice core science

Mont Blanc Group

Monte Rosa Group

Ortles-Cevedale

Bernina Group

Bernese Alps

Tyrol Alps



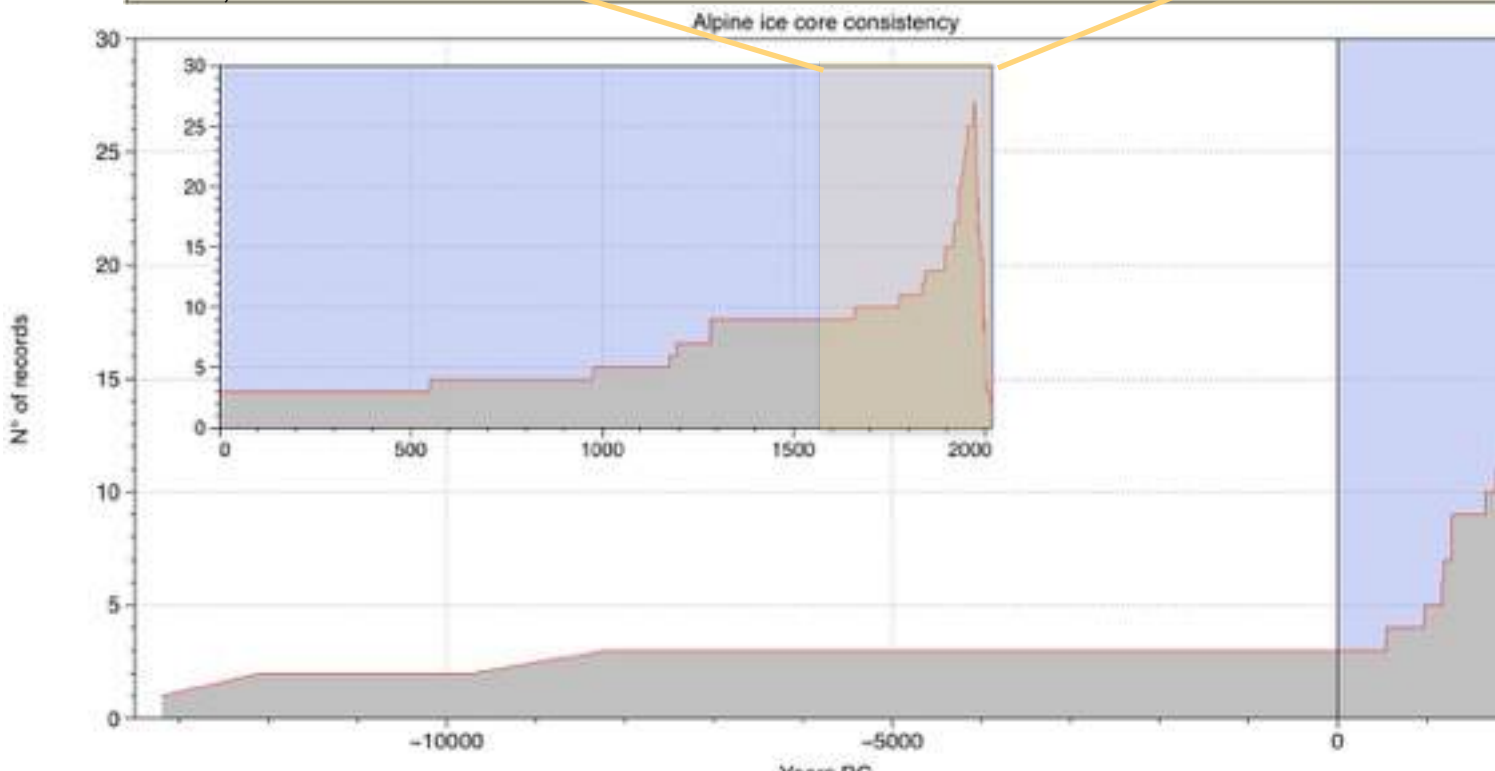
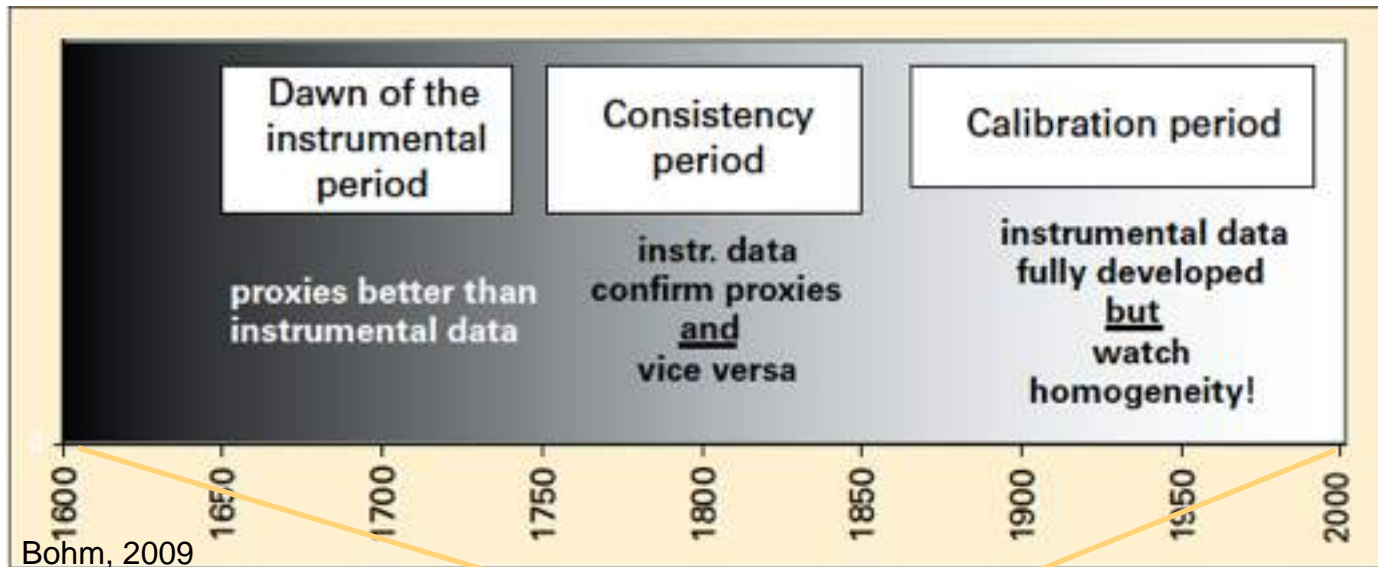
Brief introduction to ice core science

The Alpine consistency
7 Sites for 44 ice cores

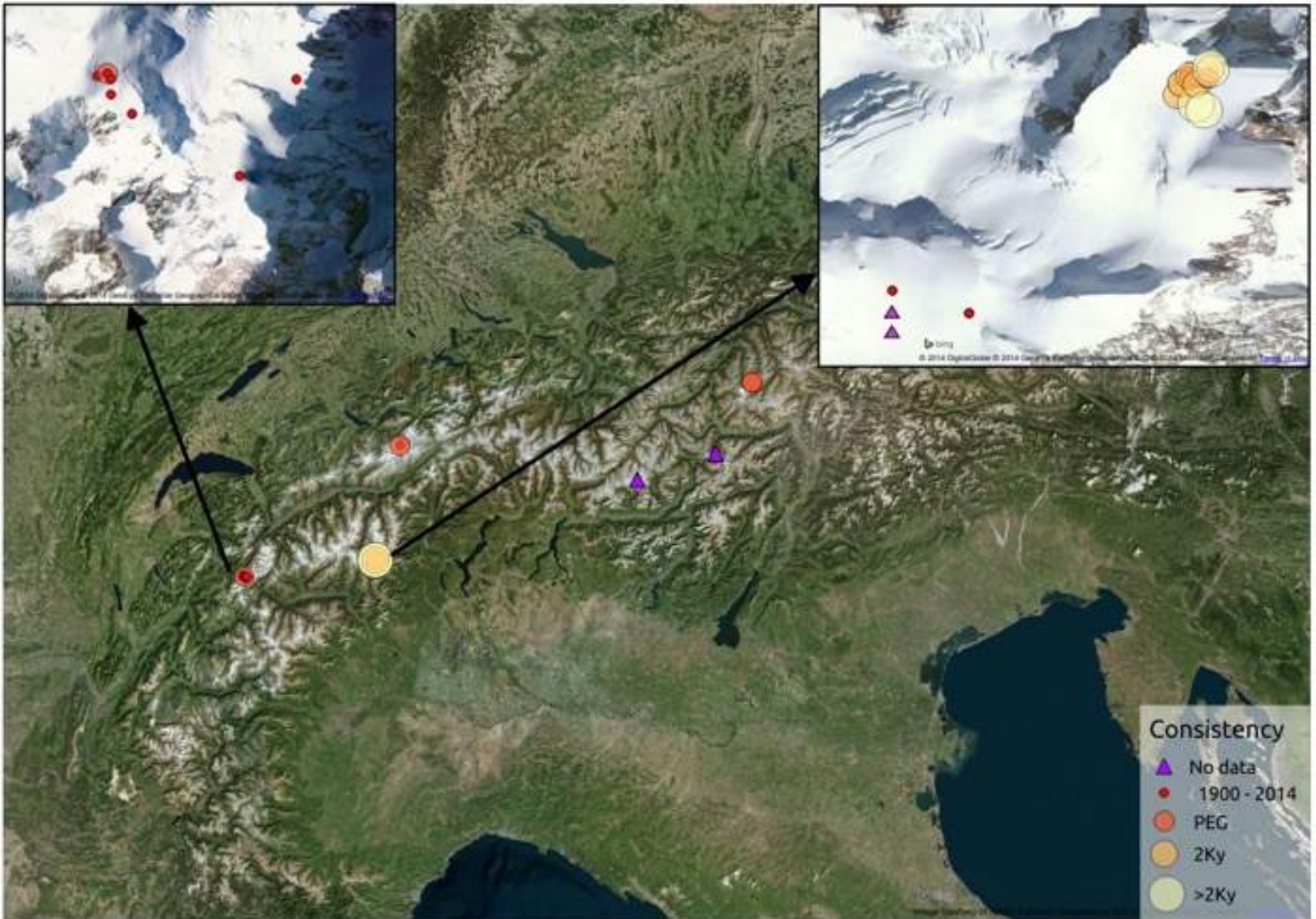
The ice core records for the Alpine area cover the entire Holocene and part of Younger Dryas (around 13.000 BC). Most of the records span the last centuries, with special emphasis the last 70-100 years.

Strong drop in the last decade.

The decrease of the length in time, increase the resolution, until the seasonality for the shorter records.



Brief introduction to ice core science



Climatic and environmental reconstruction from ice core records

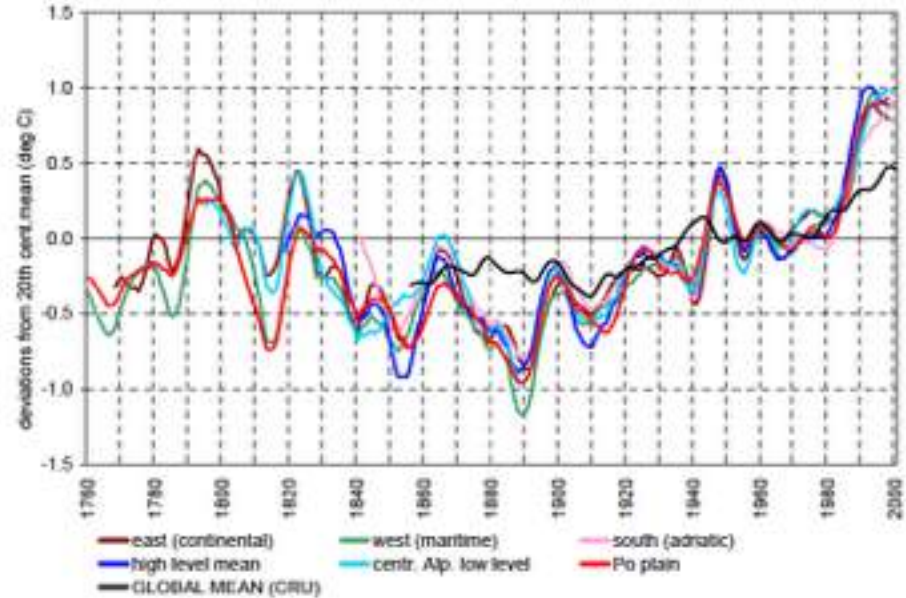
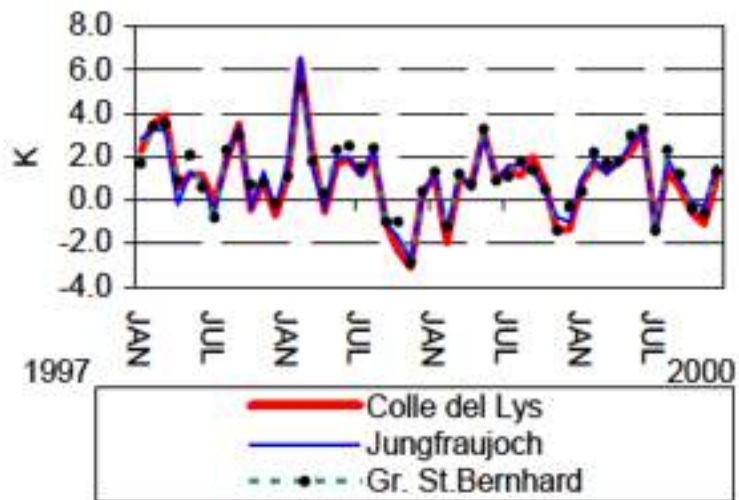
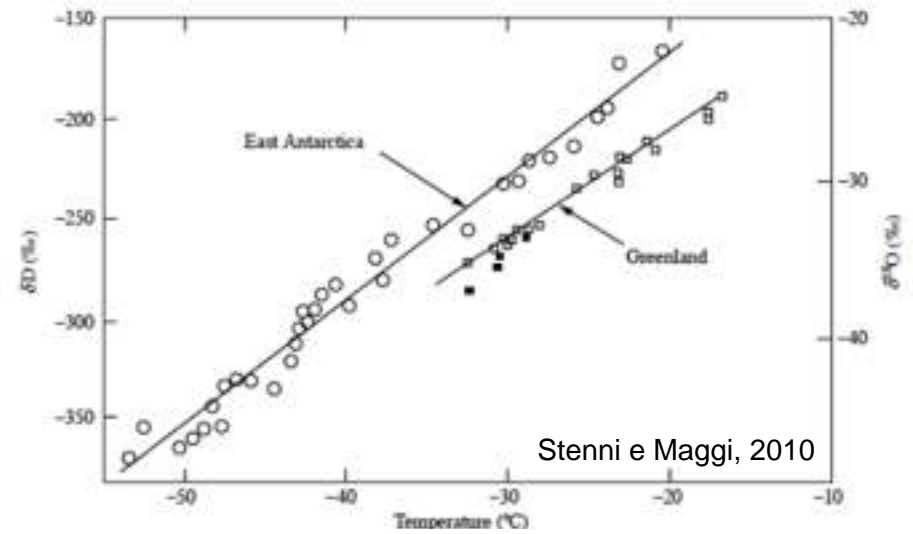
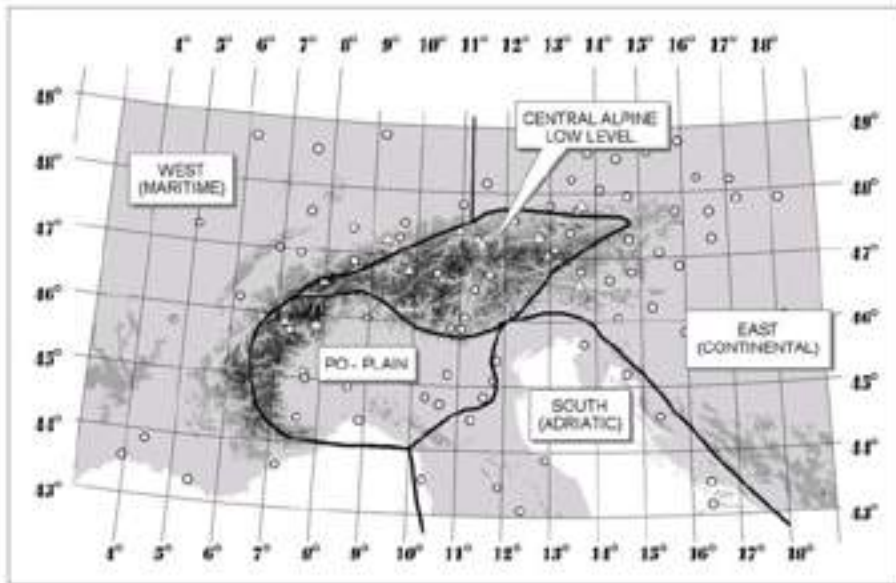


Fig. 3.2.7. Annual mean sub-regional temperature series in the greater Alpine region (GAR) (deviations in K from 20th century mean) smoothed with a 3 σ gaussian low pass filter (11 years wide running window).

Auer et al., 2001



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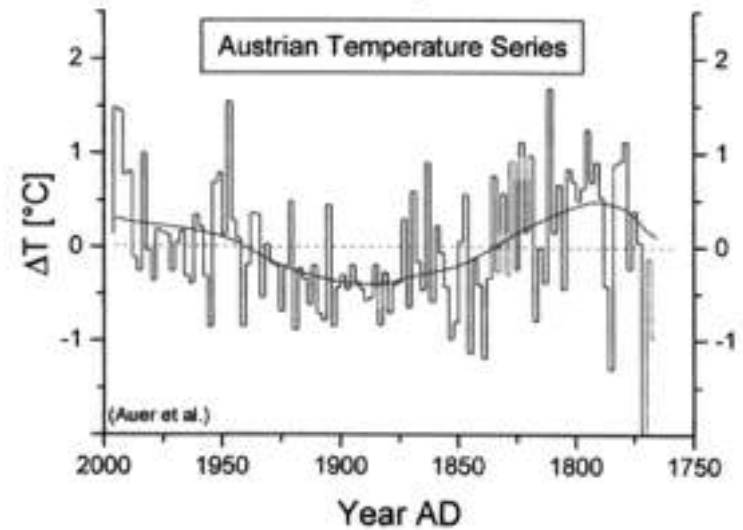
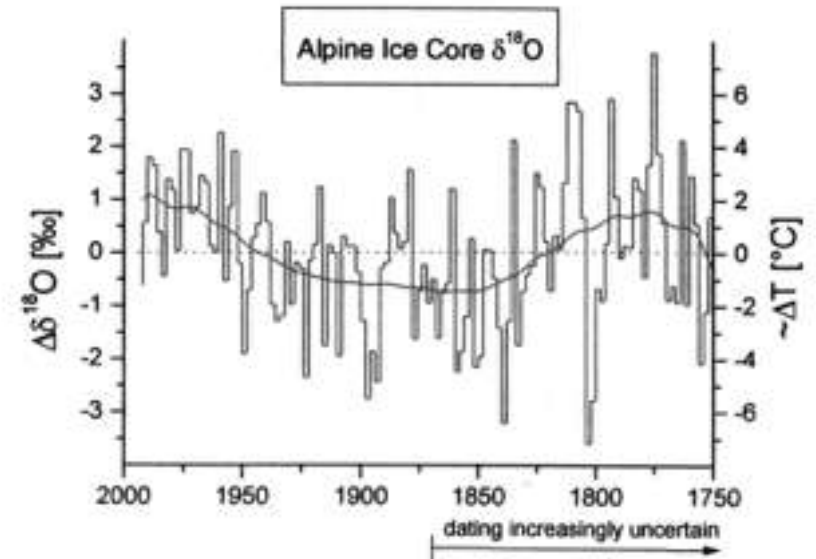
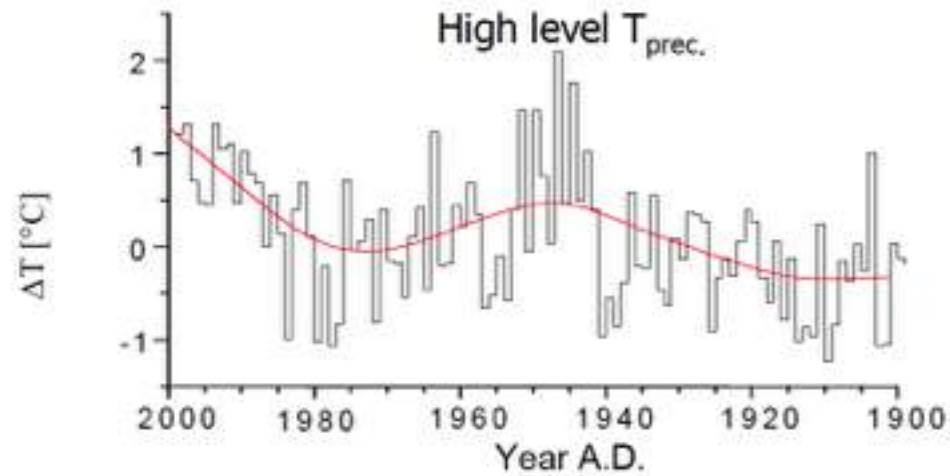
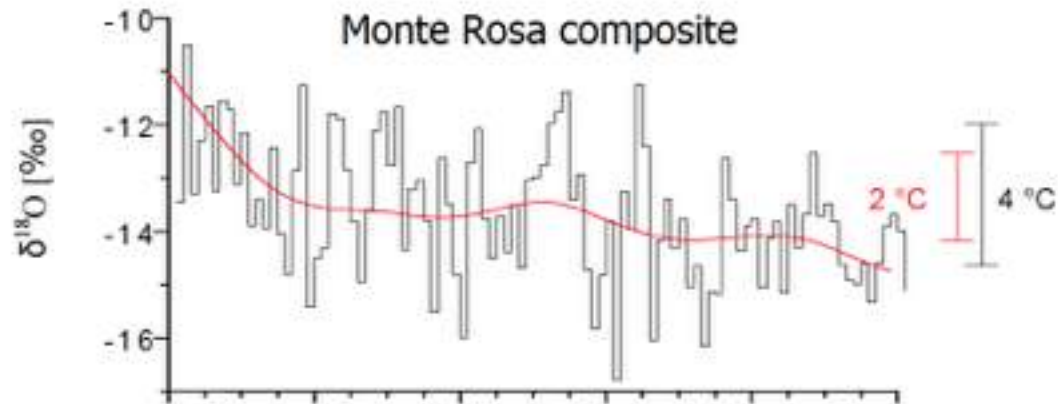


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Roma, 1-2 Dicembre 2014



Monte Rosa - Colle Gnifetti - Isotopic Temperature



Wagenbach et al., 2005; 2008, ALP-IMP

Auer et al., 2007



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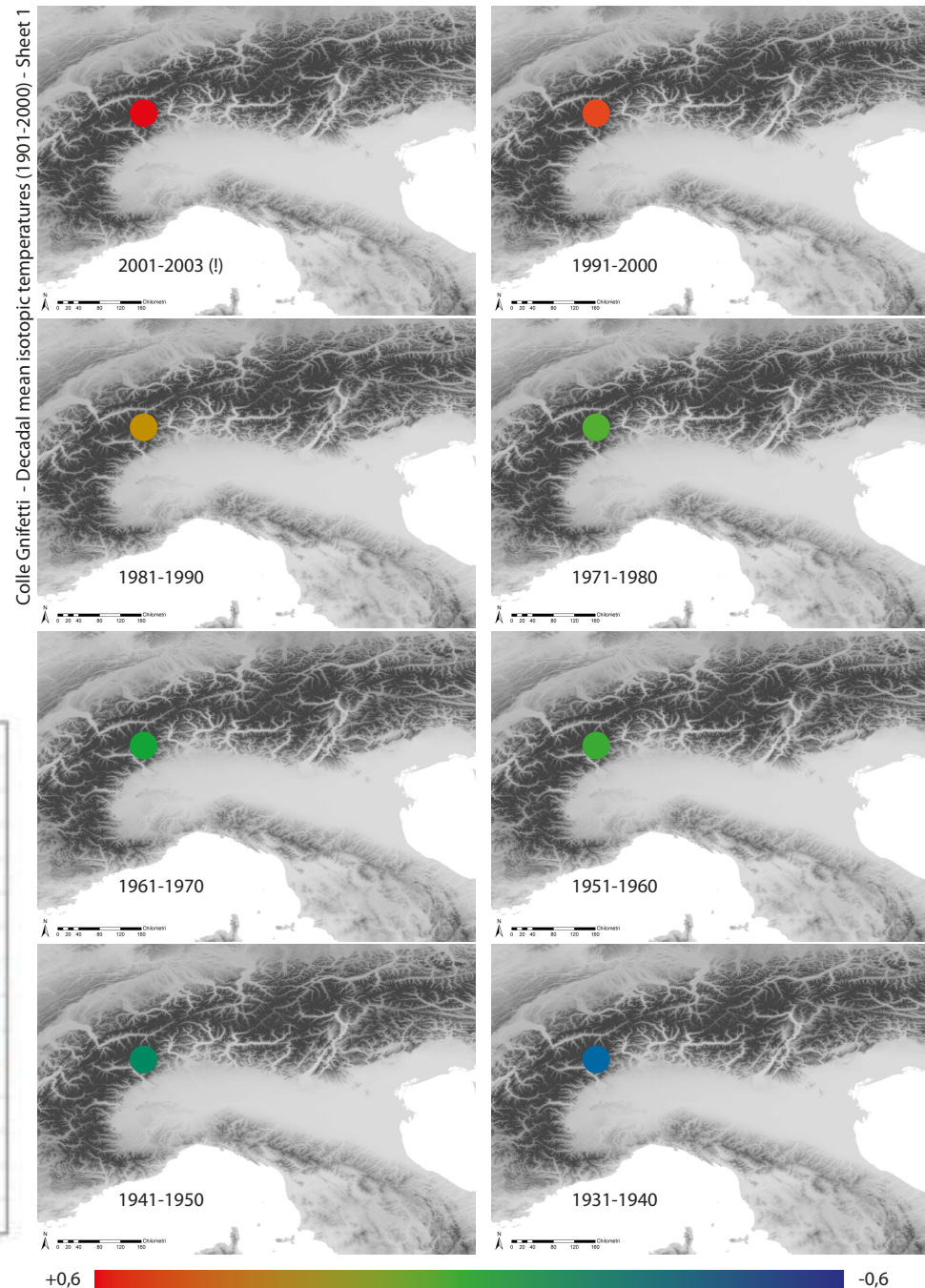
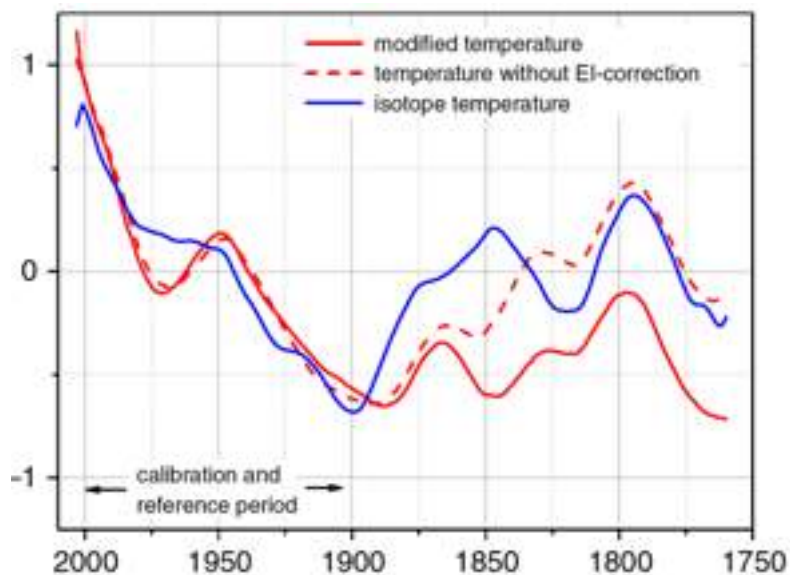


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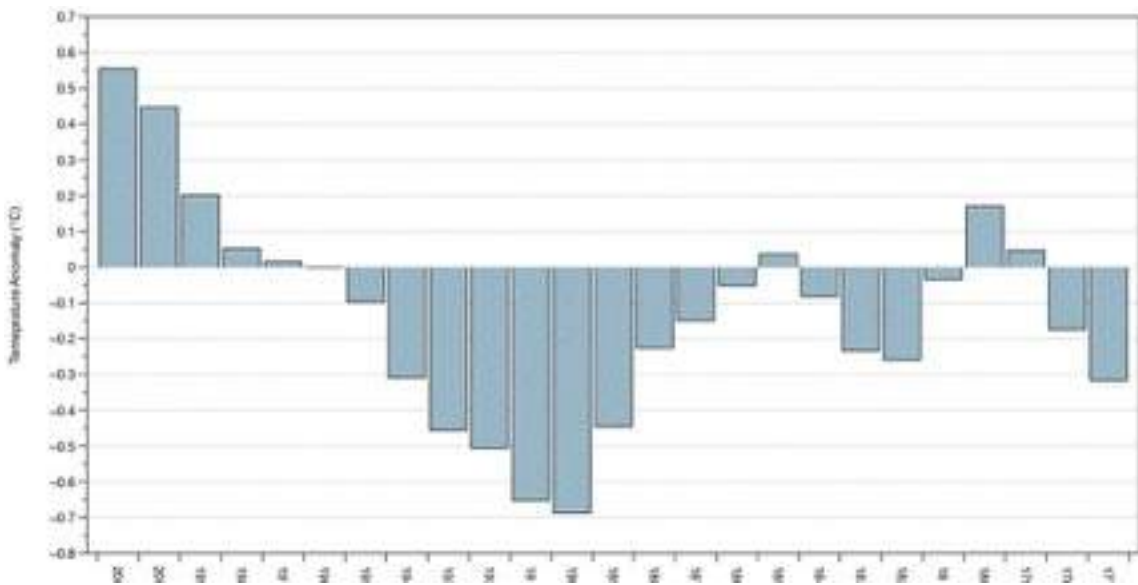
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Monte Rosa - Colle Gnifetti - Isotopic Temperature



Wagenbach et al., 2005; 2008



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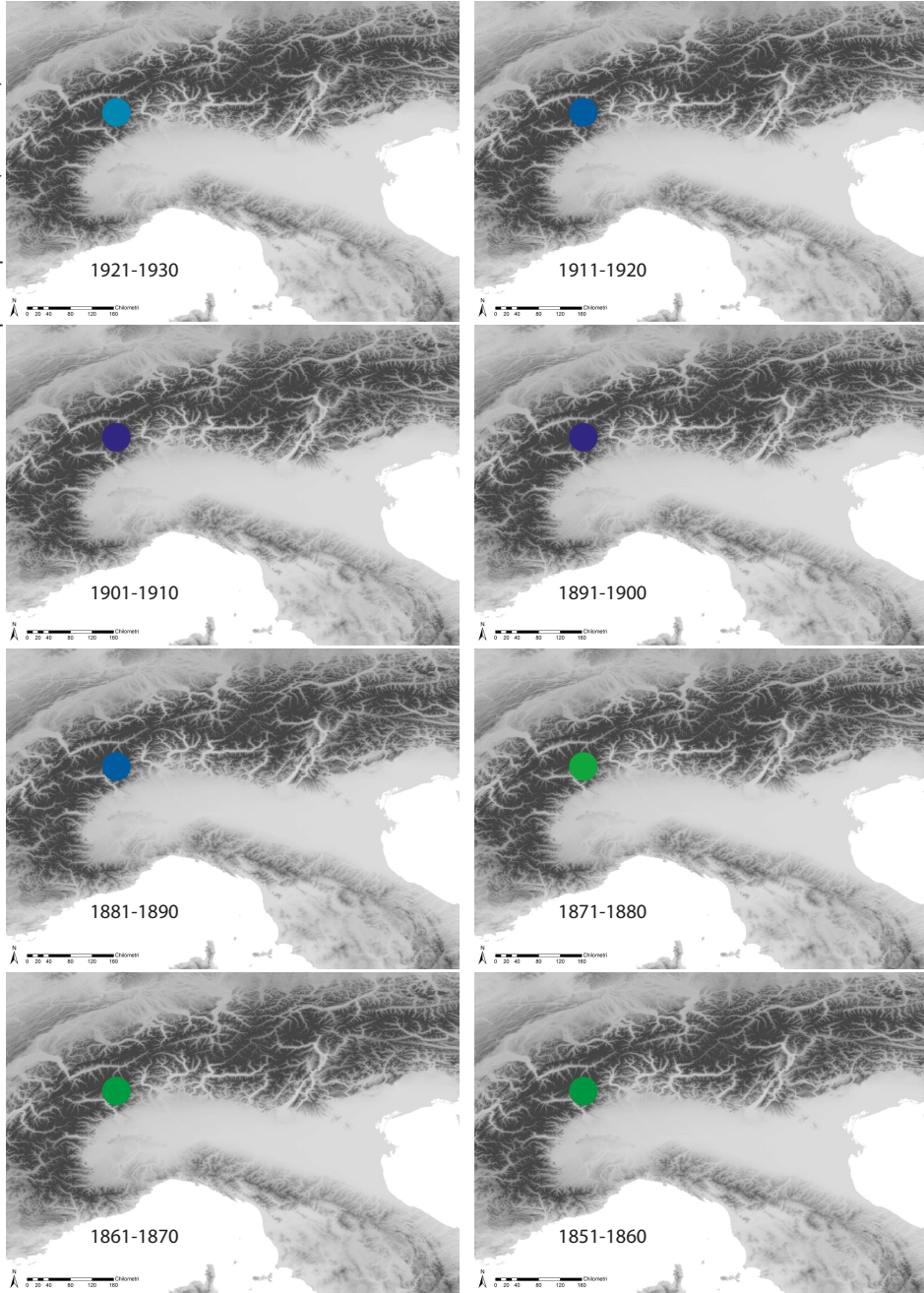


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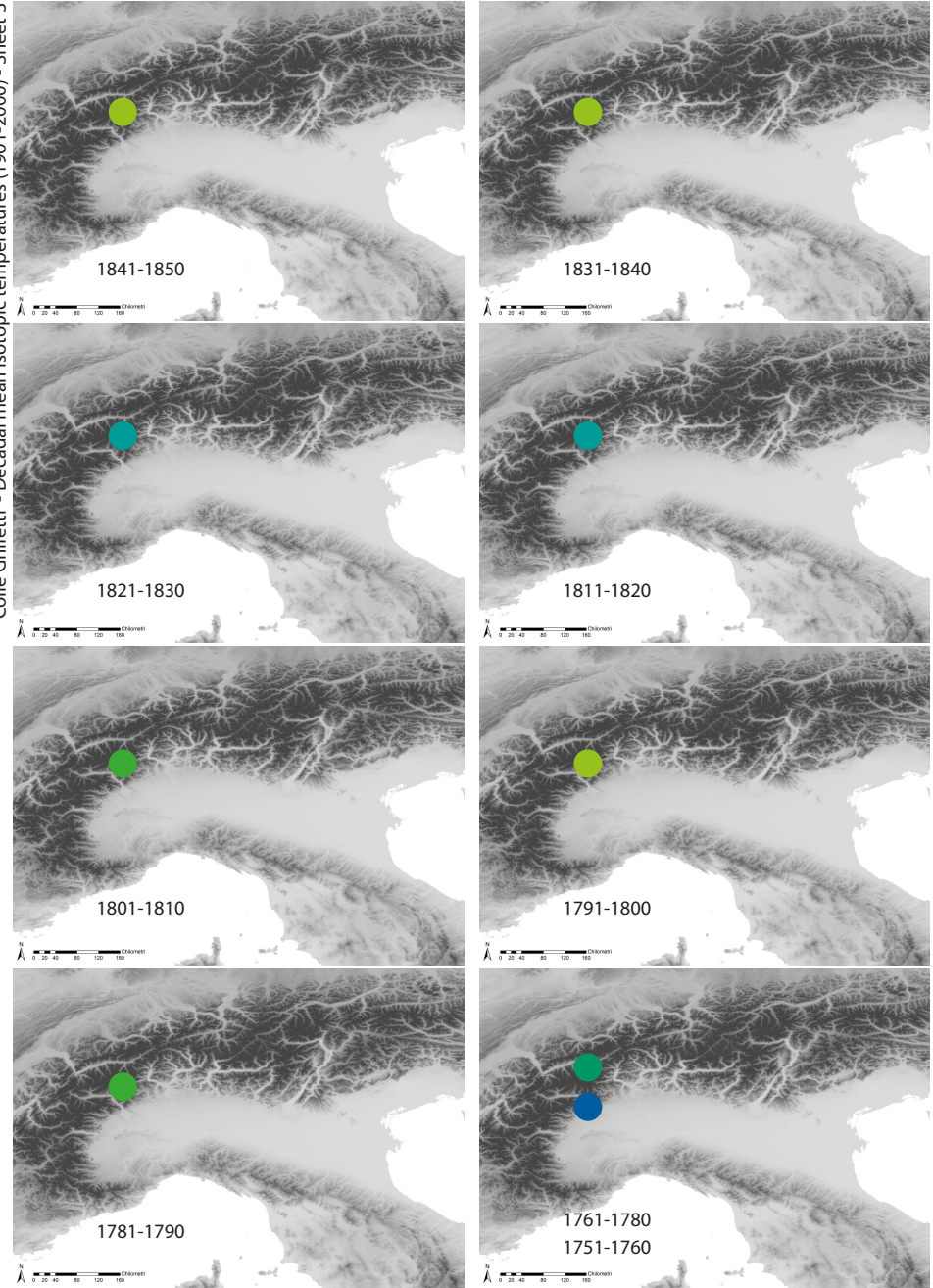


Monte Rosa - Colle Gnifetti - Isotopic Temperature

Colle Gnifetti - Decadal mean isotopic temperatures (1901-2000) - Sheet 2

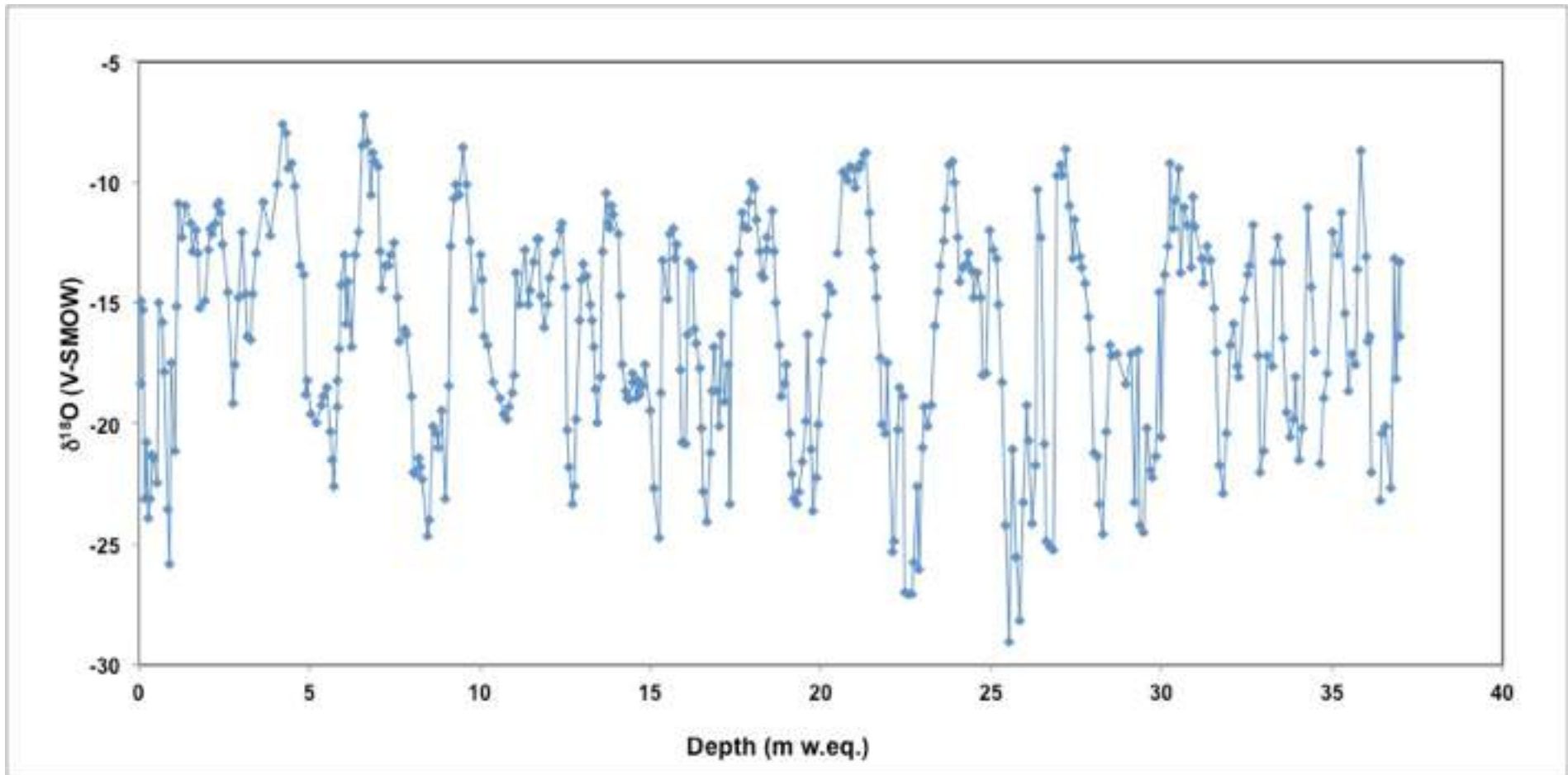


Colle Gnifetti - Decadal mean isotopic temperatures (1901-2000) - Sheet 3



Climatic and environmental reconstruction from ice core records

Colle del Lys stable isotope records, drilled in 1996, present a very high resolution (seasonal) that permit an annual counting for dating purposes



Stenni, unpublished



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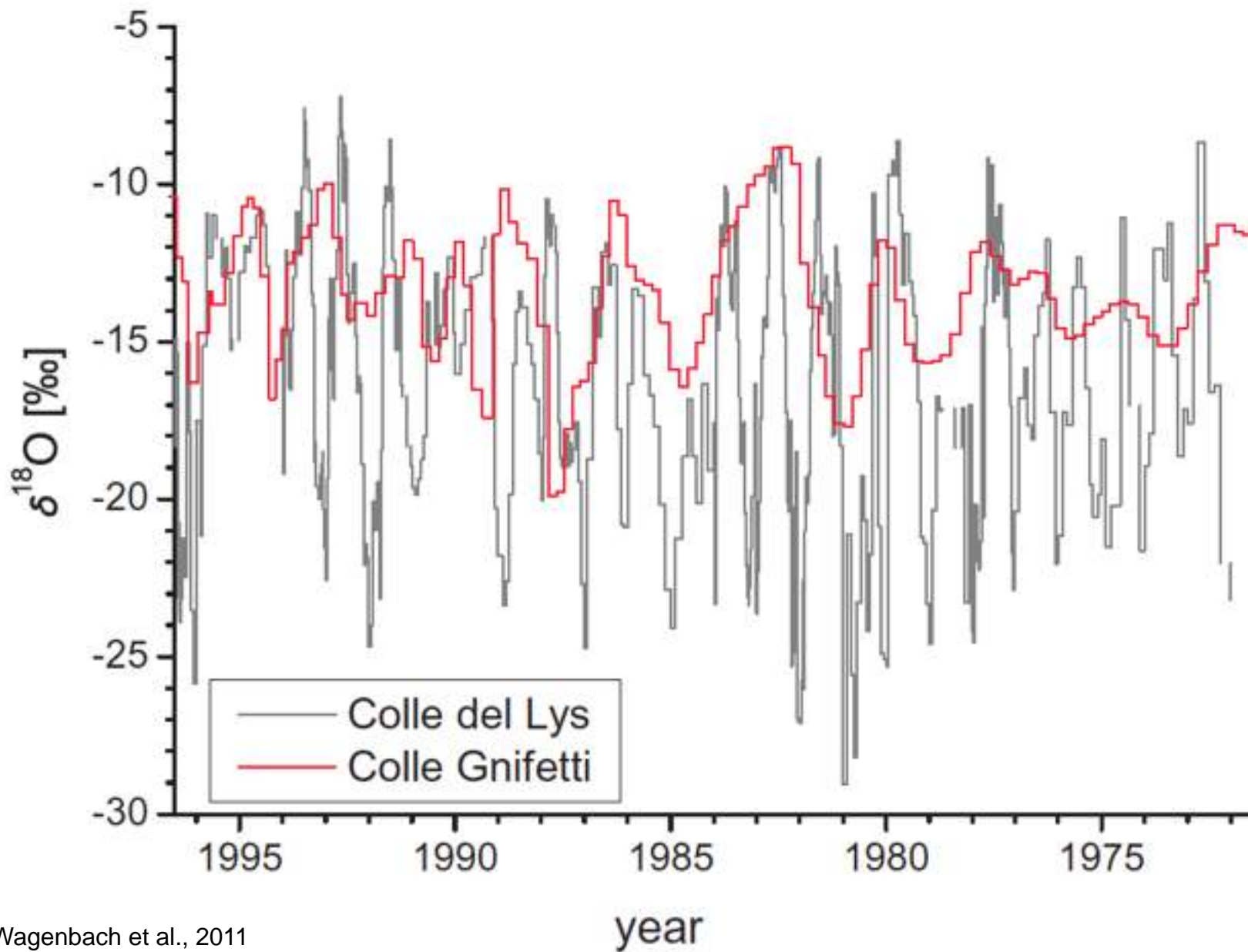


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Climatic and environmental reconstruction from ice core records



Wagenbach et al., 2011



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Monte Rosa - Colle del Lys - accumulation rate vs gridded precipitation

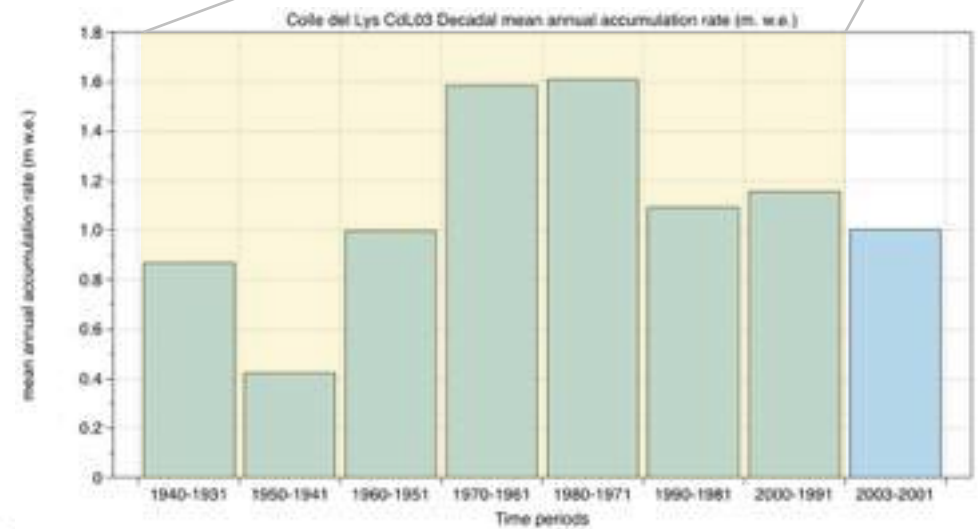
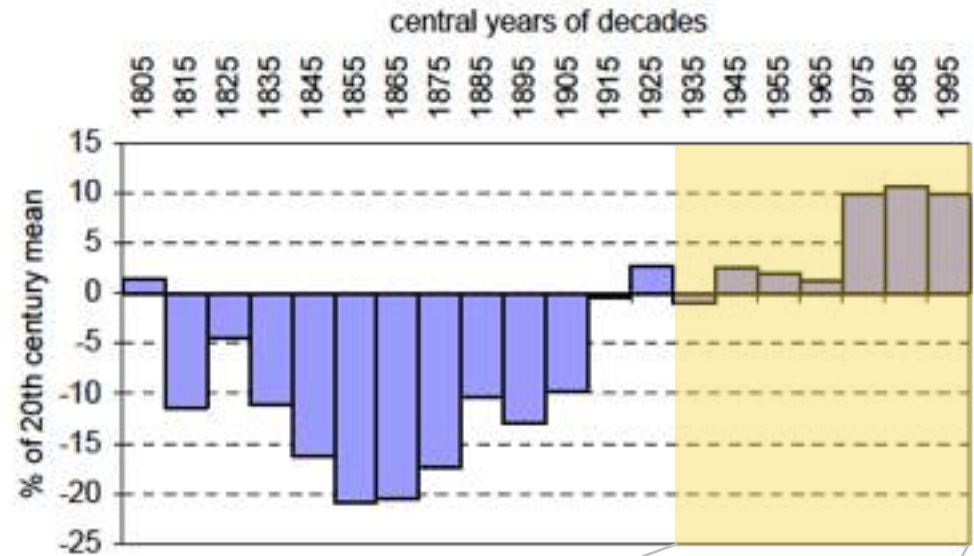
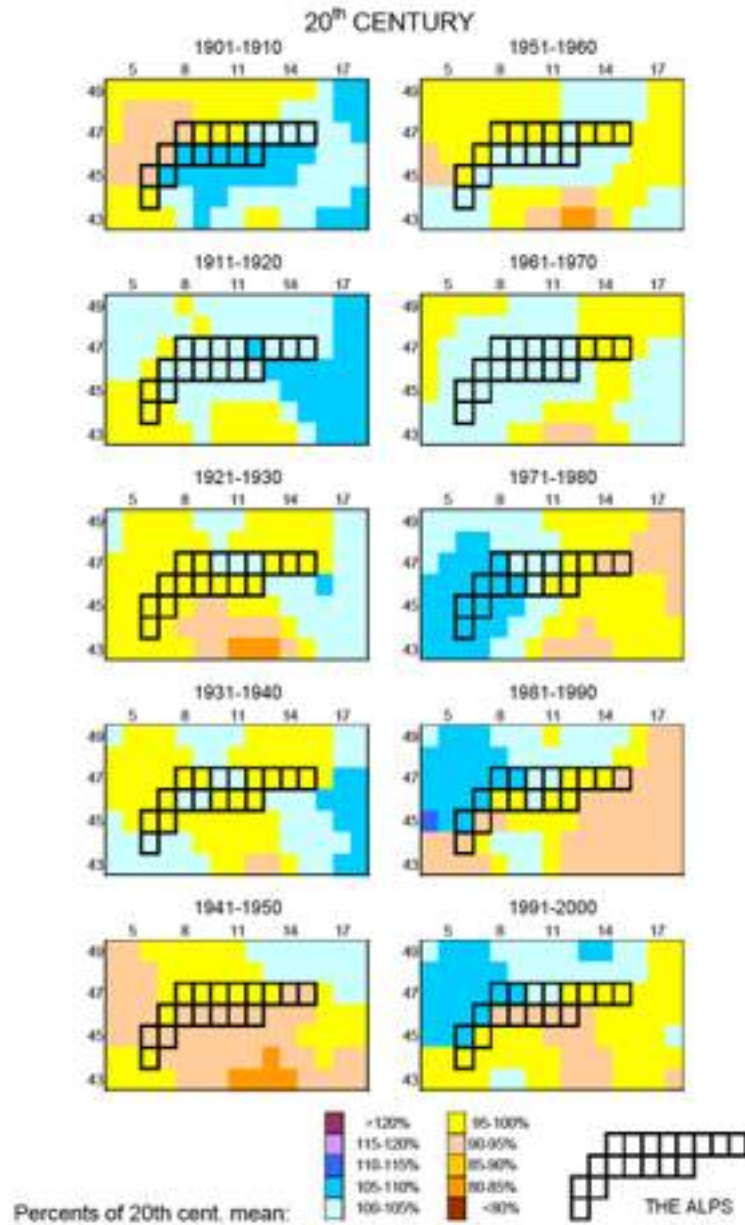


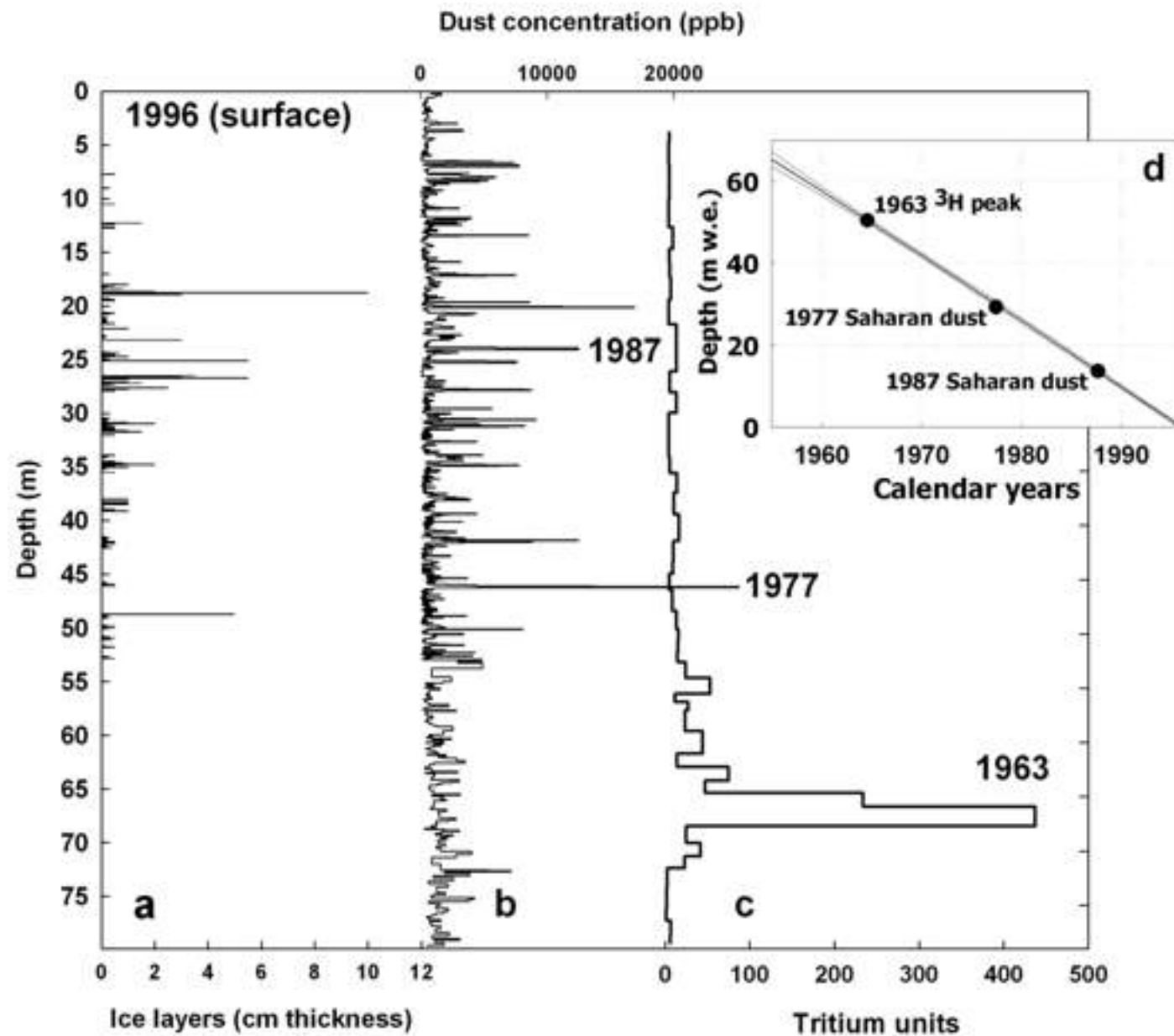
Fig. 3.2.15. Spatial patterns of decadal mean precipitation variability in the greater alpine region in the 20th century

Auer et al., 2001, Maggi, unpublished

ALPCLIM report, 2001; Maggi unpublished



Climatic and environmental reconstruction from ice core records



Maggi, unpublished



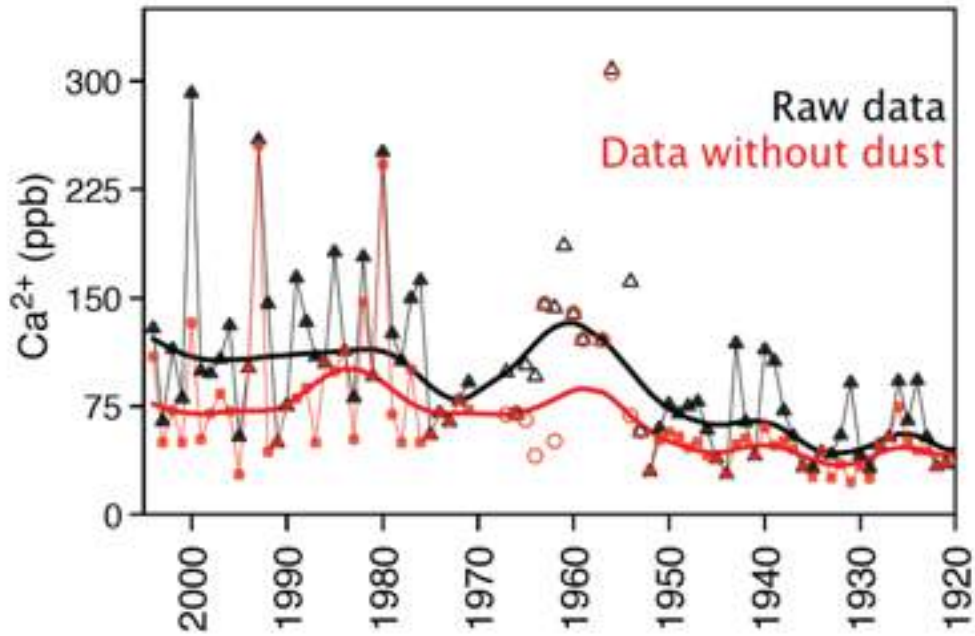
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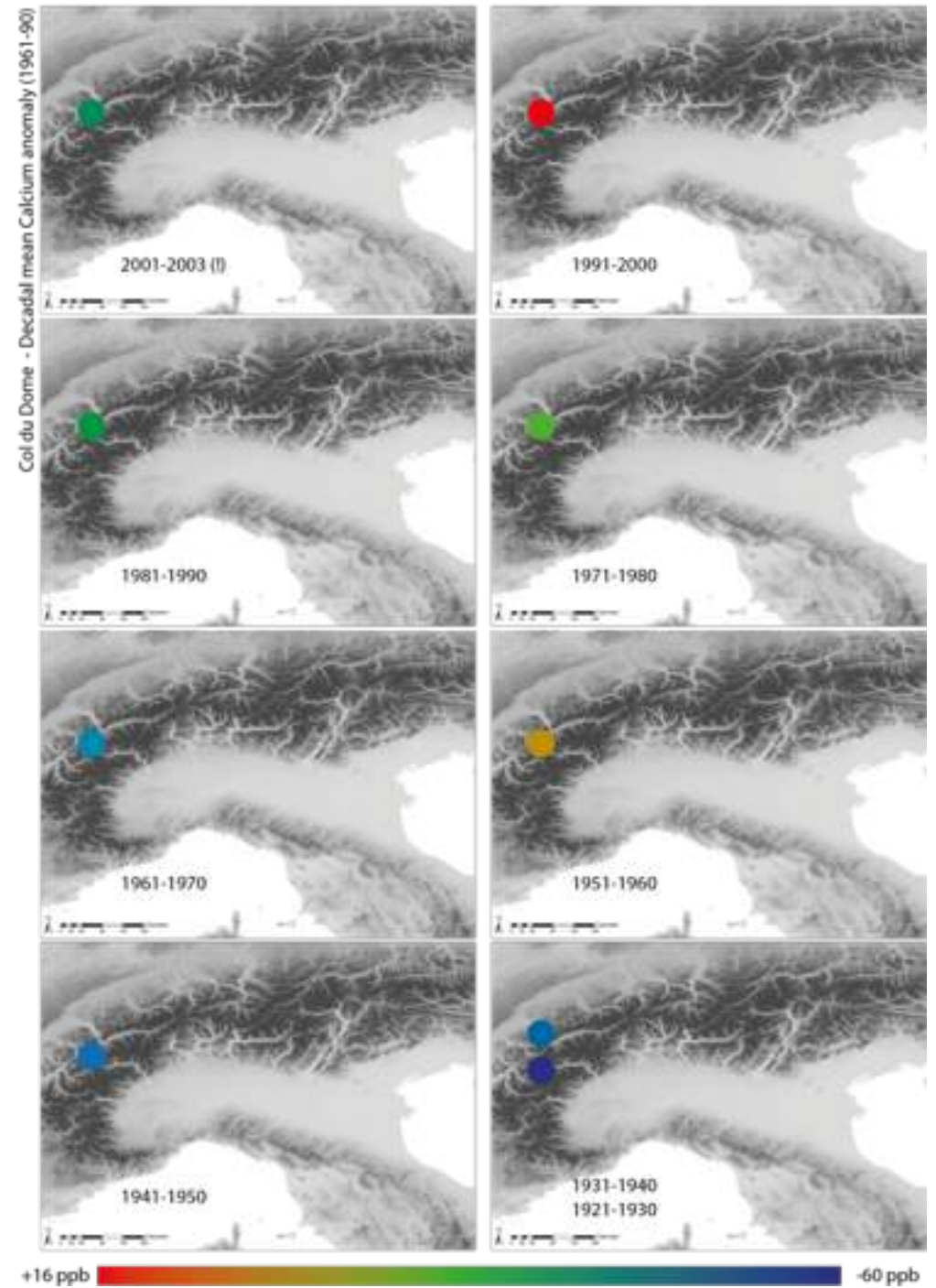
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Roma, 1-2 Dicembre 2014



Monte Bianco - Col Du Dome - Ca concentration



Preunkert & Legrand, 2013



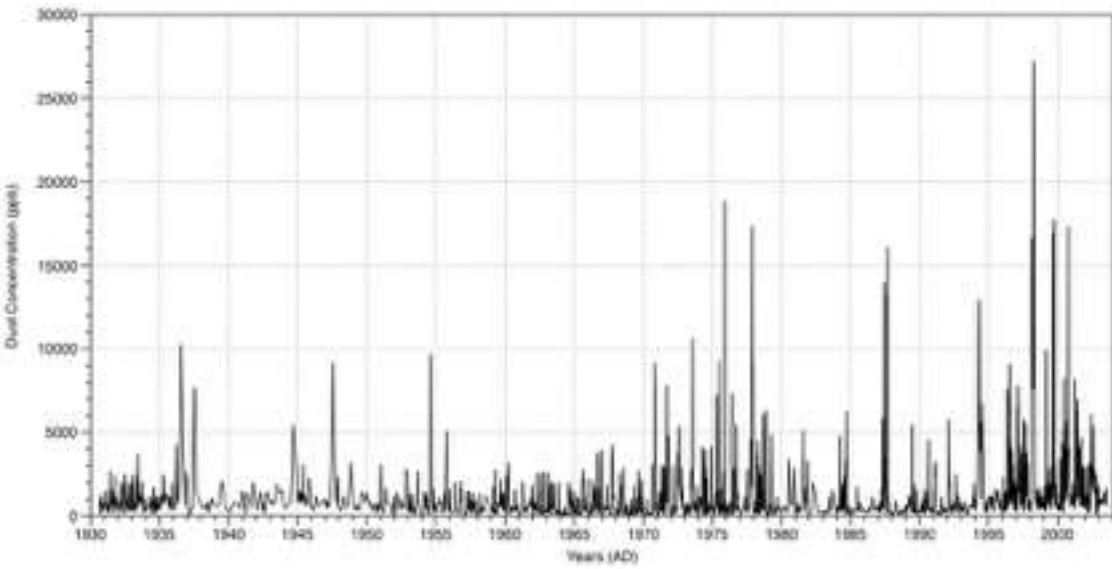
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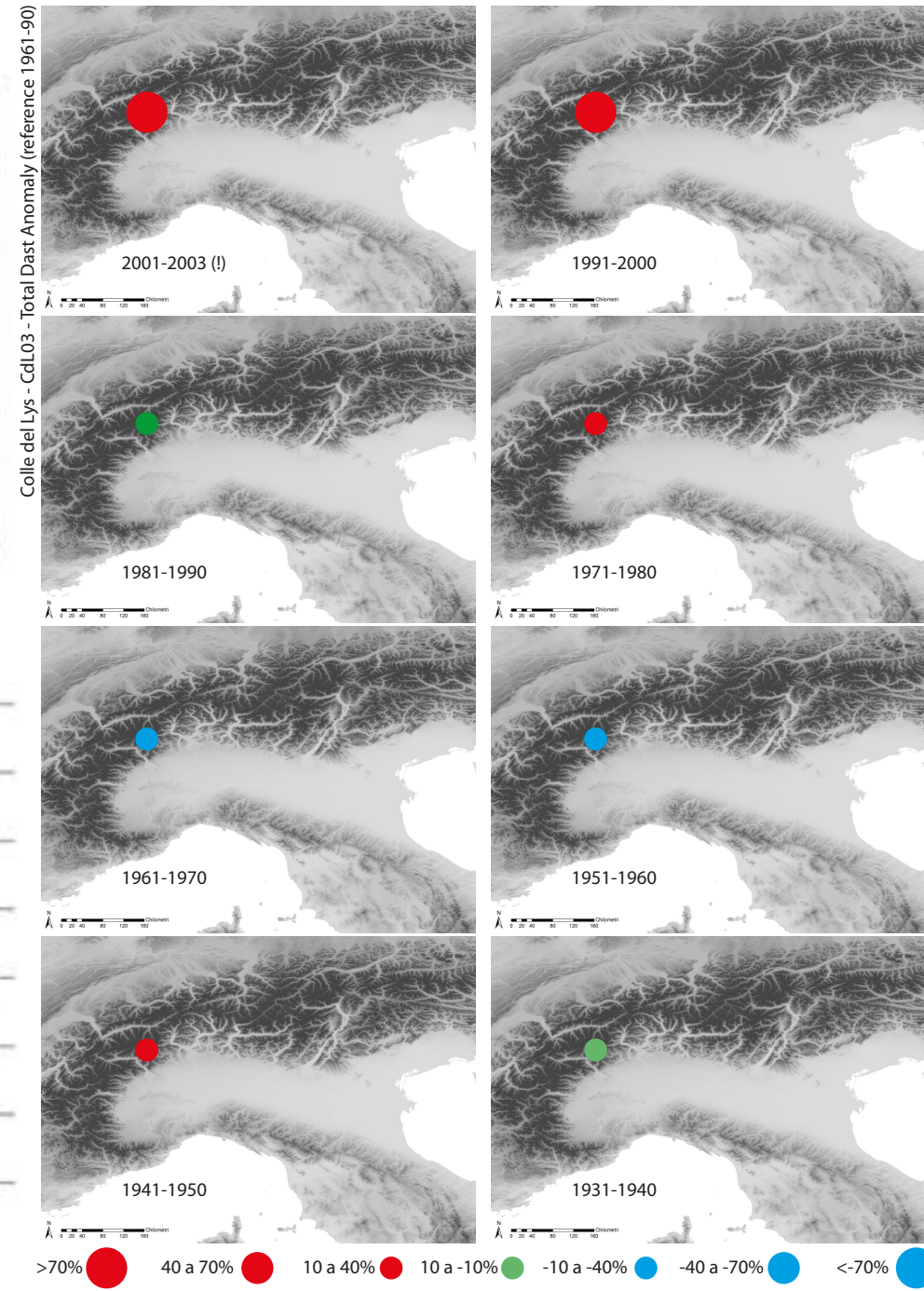
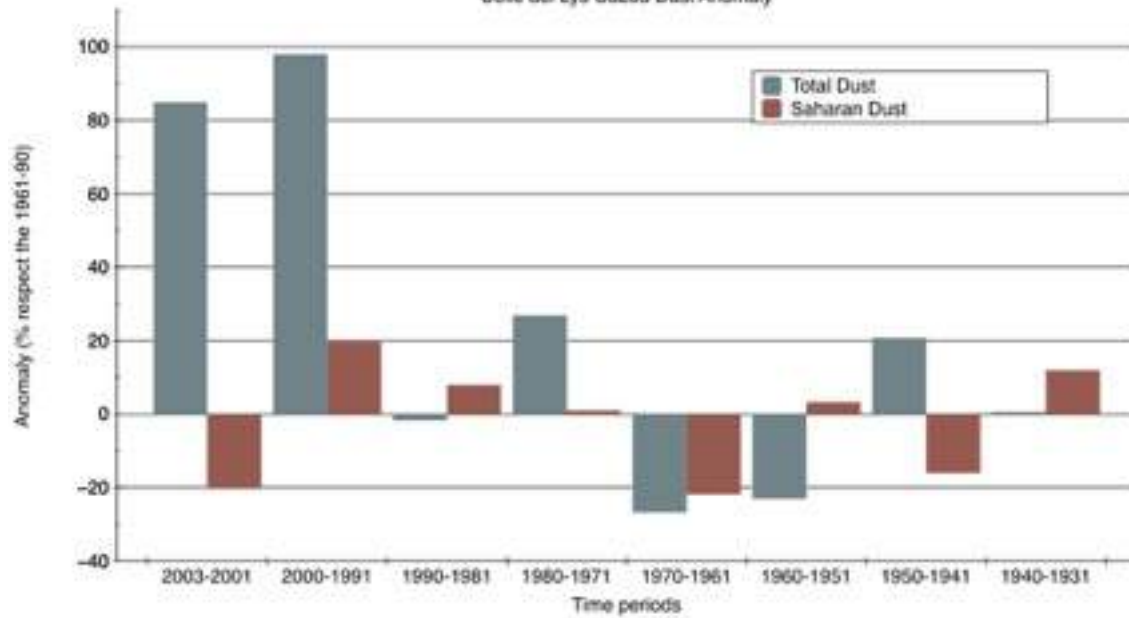
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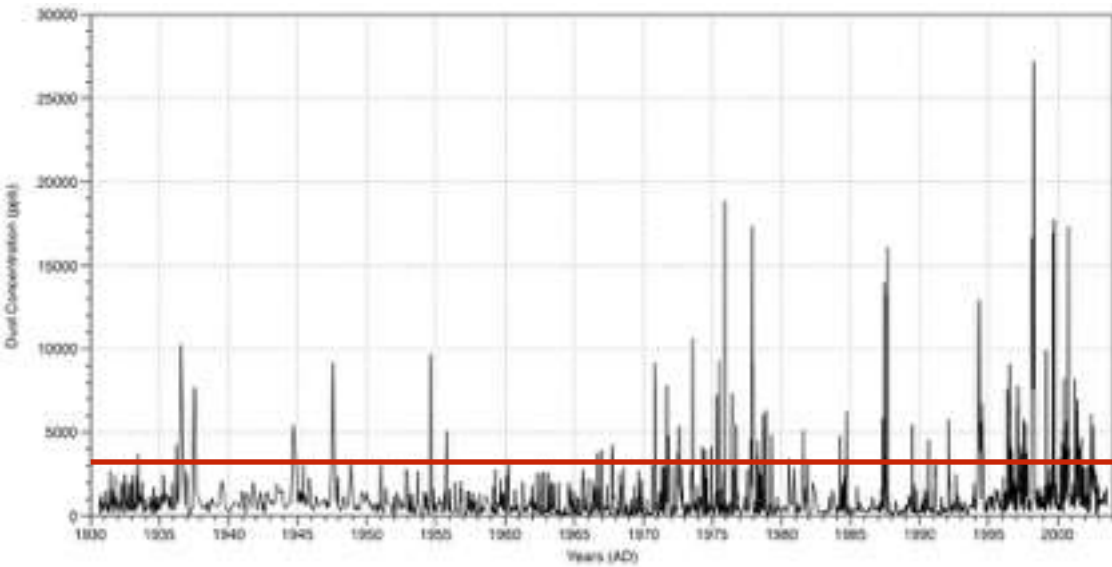
Monte Rosa - Colle del Lys - Total Dust



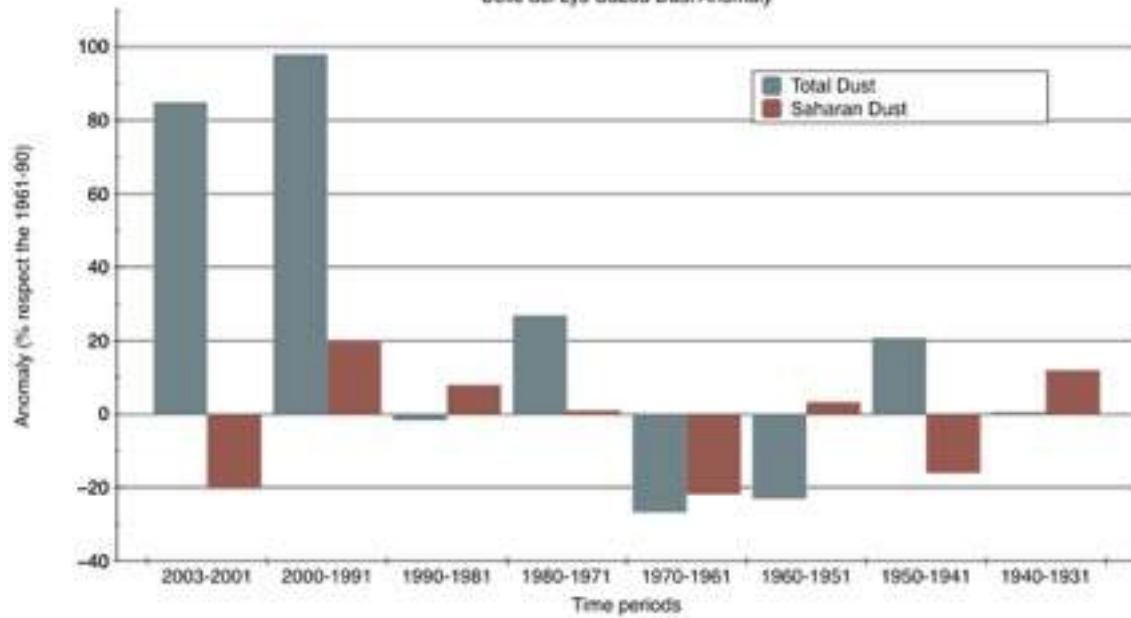
Colle del Lys CdL03 Dust Anomaly



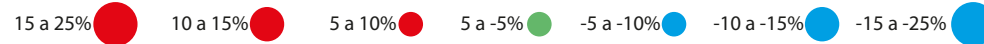
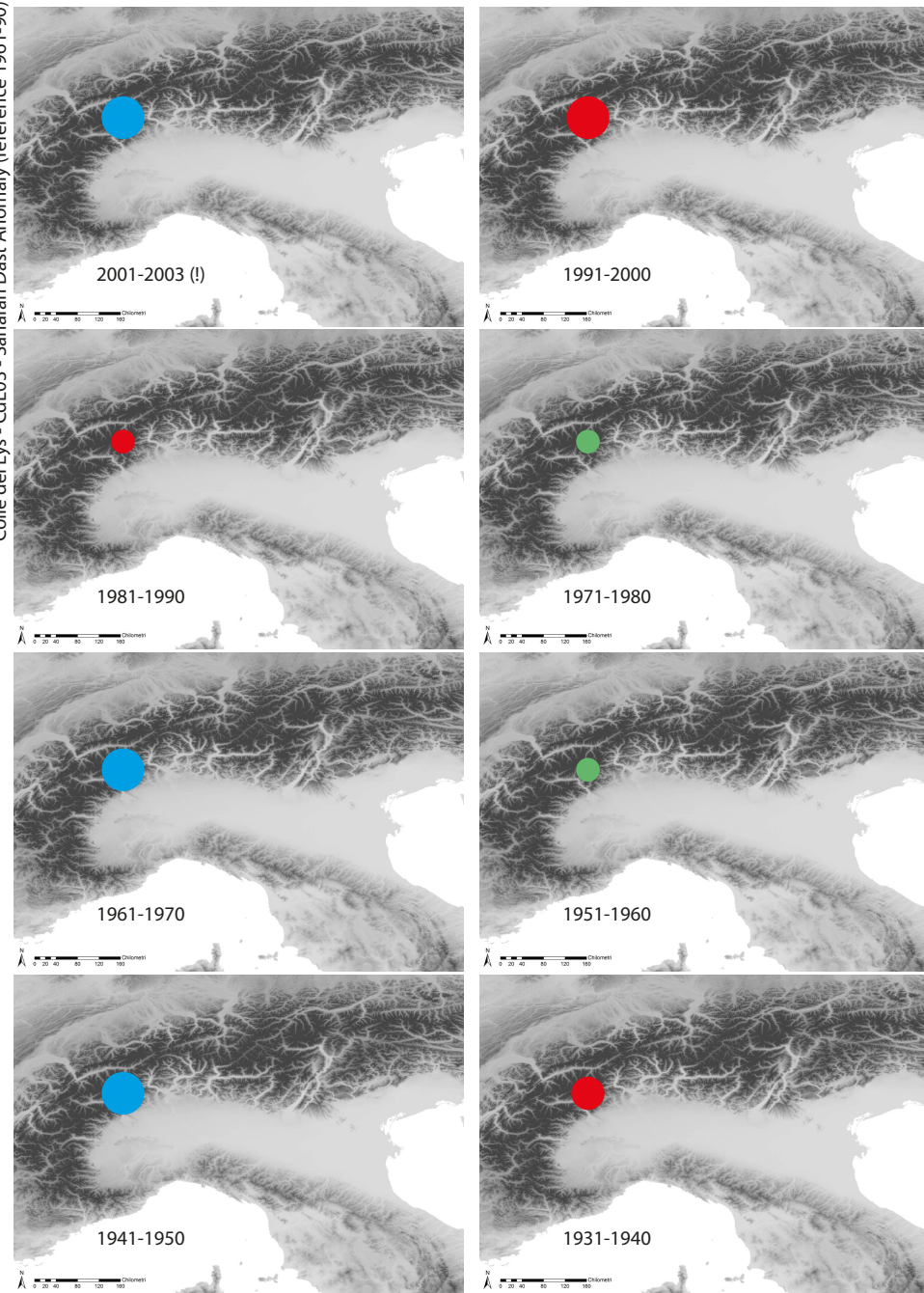
Monte Rosa - Colle del Lys - Saharan Dust



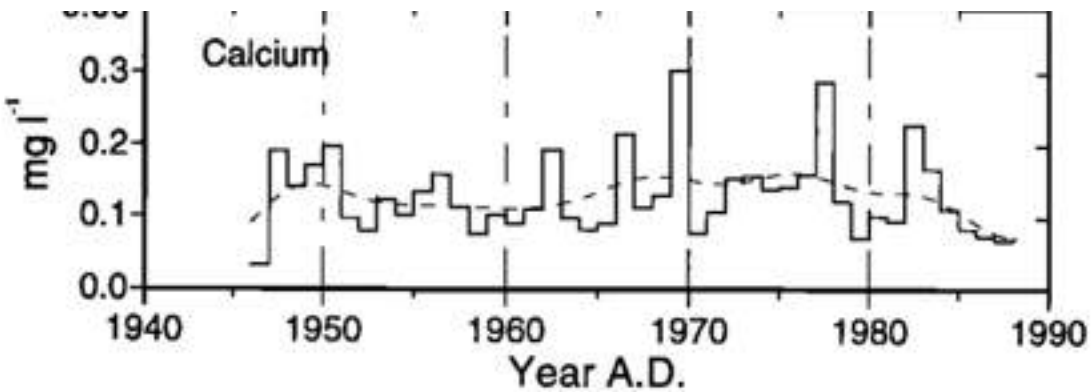
Colle del Lys CdL03 Dust Anomaly



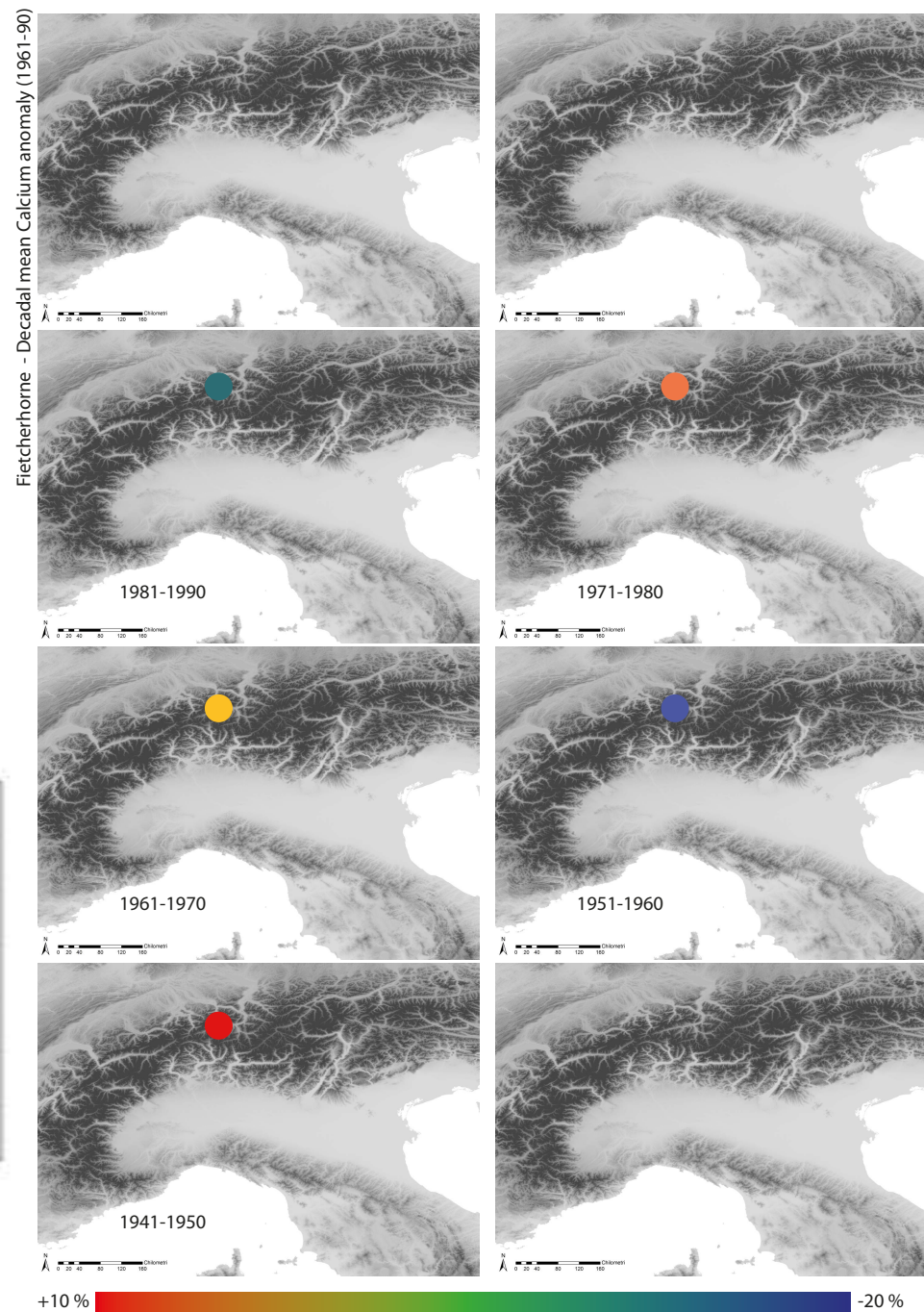
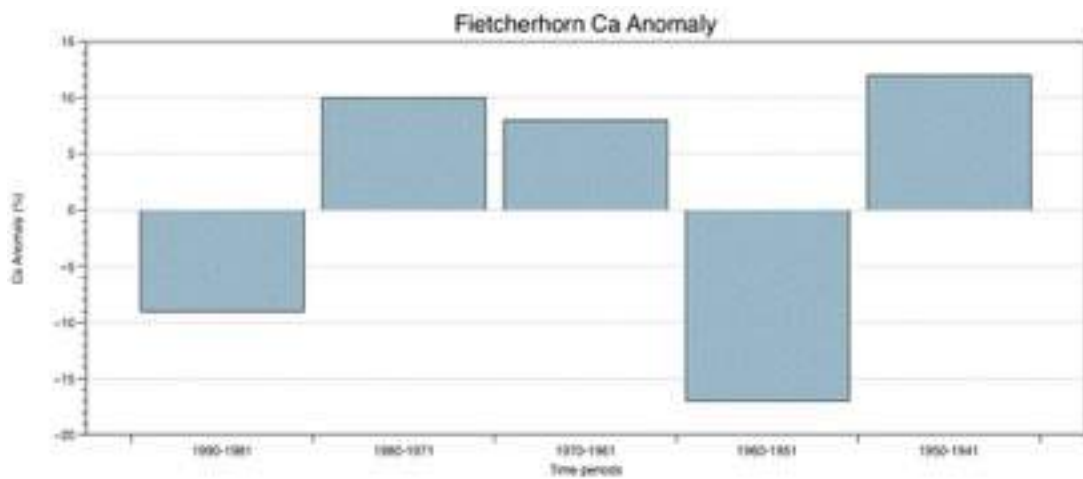
Colle del Lys - CdL03 - Saharan Dust Anomaly (reference 1961-90)



Switzerland - Fietscherhorn - Ca Anomaly



Mariani, 2013



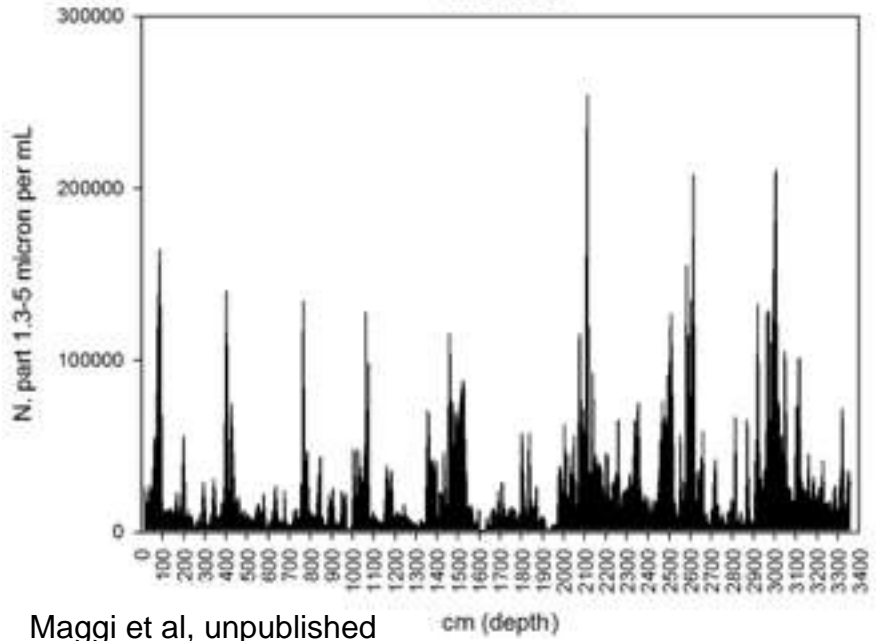
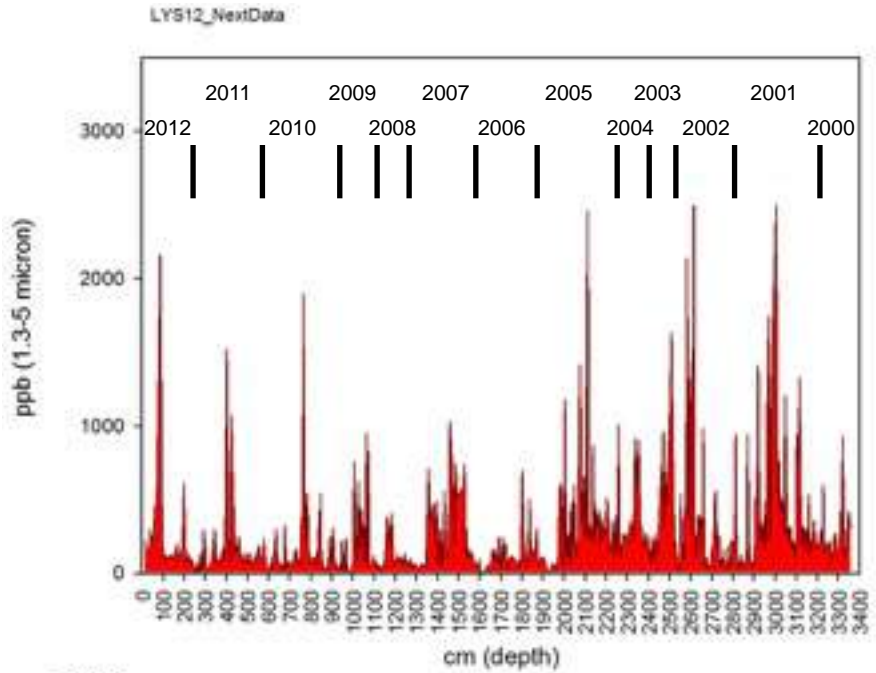
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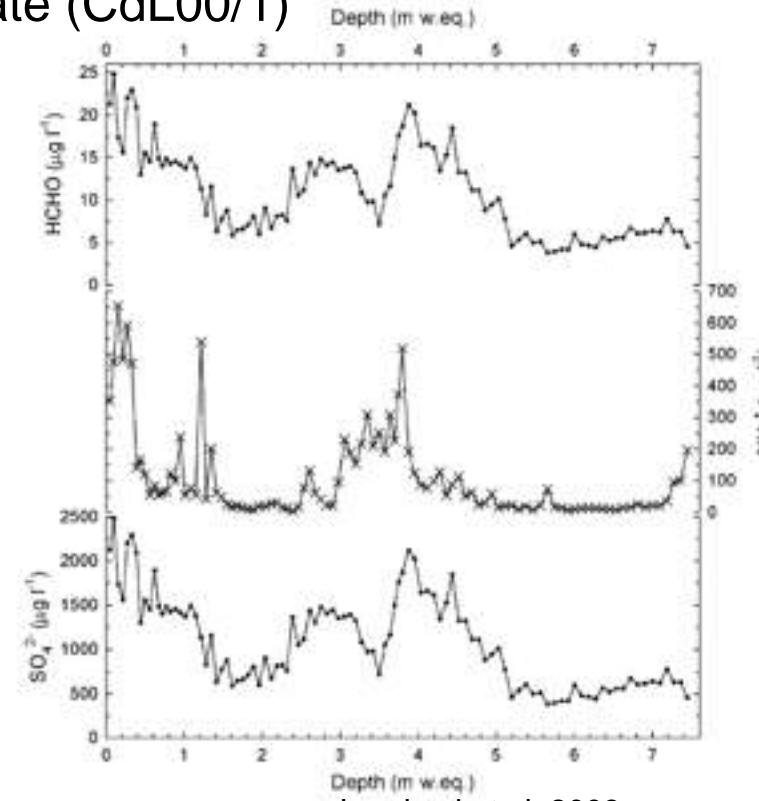


Monte Rosa - Colle del Lys - Dust concentration and Numer



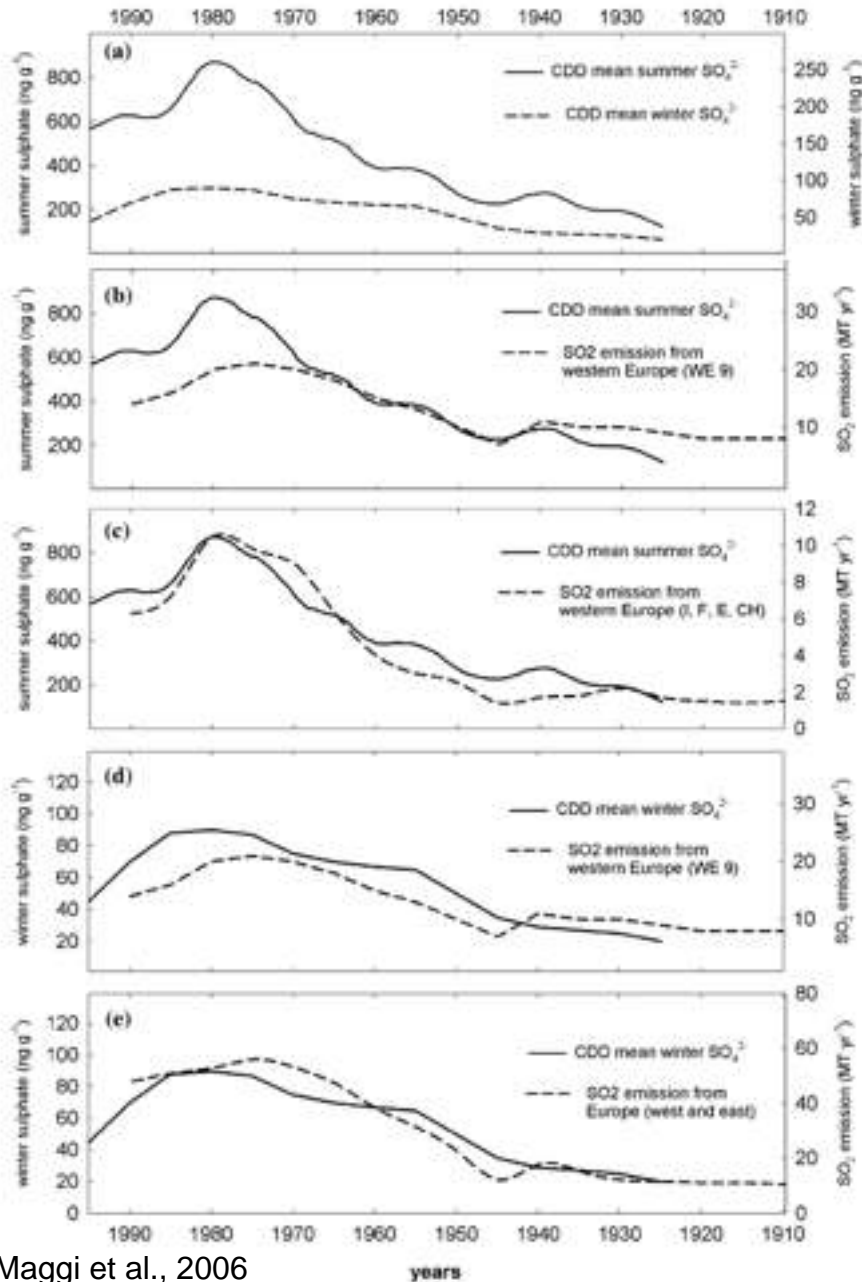
Maggi et al, unpublished

The high resolution (CdL12) permit to recognize seasonality also in other records different to the stable isotopes. As the atmospheric dust, where high concentration during the spring-to-summer periods are in opposite respect the low concentration during fall-to-winter. Or human product as ammonia or sulfate (CdL00/1)



Largiuni et al, 2003

Climatic and environmental reconstruction from ice core records



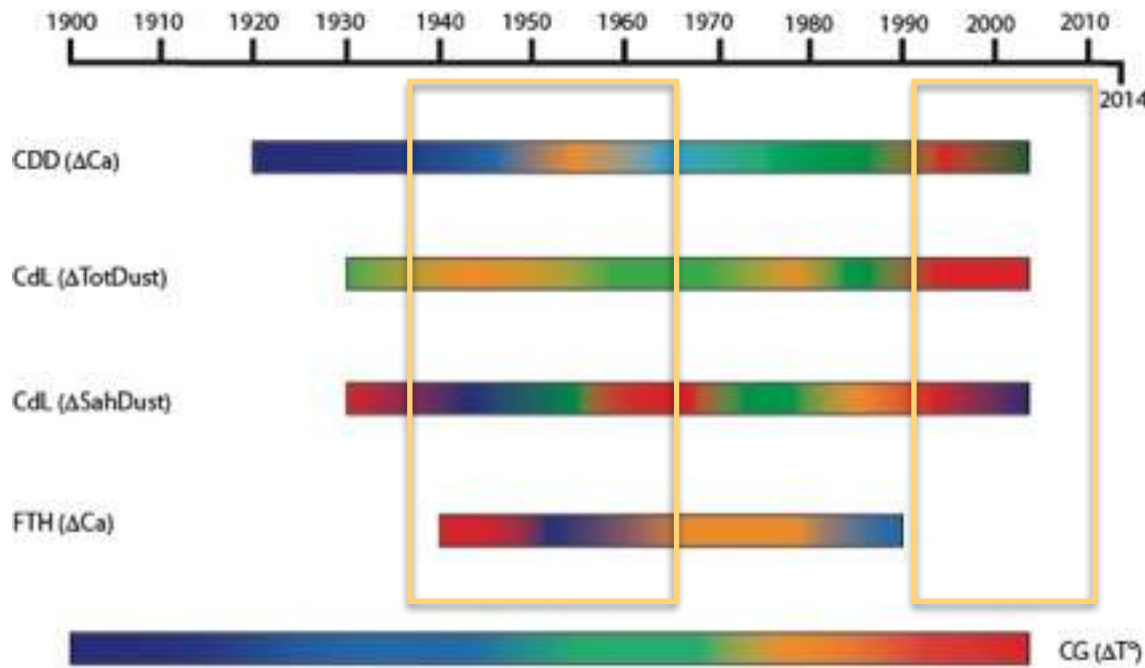
Maggi et al., 2006

Evaluation of the human impact on the Alpine system as comparison between ice core records and emission dataset for different group of countries.

This is another capability of the ice cores to provide direct information on the atmosphere.



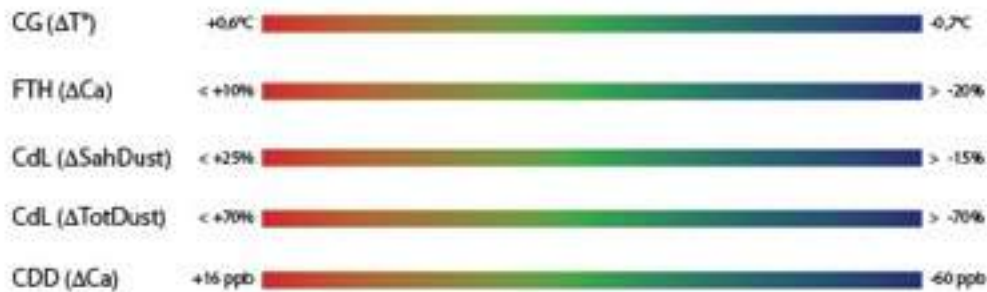
Some remarks



The dust concentration (both, microparticles and Calcium records) as multiproxy system, mainly related to the transport from North Africa seem to have a some general features along the Alpine area.

The last 2 decades seem to be related to high concentration, despite the middle of XX century the level seem to be lower.

In reality exists some difficult to interpret these data, because the transport from North Africa across the Mediterranean use different baric mechanisms.



Colle Gnifetti isotopic Temperature Anomaly

Fietscherhorn Calcium % Anomaly

Colle del Lys Saharan Dust % Anomaly

Colle del Lys Total Dust % Anomaly

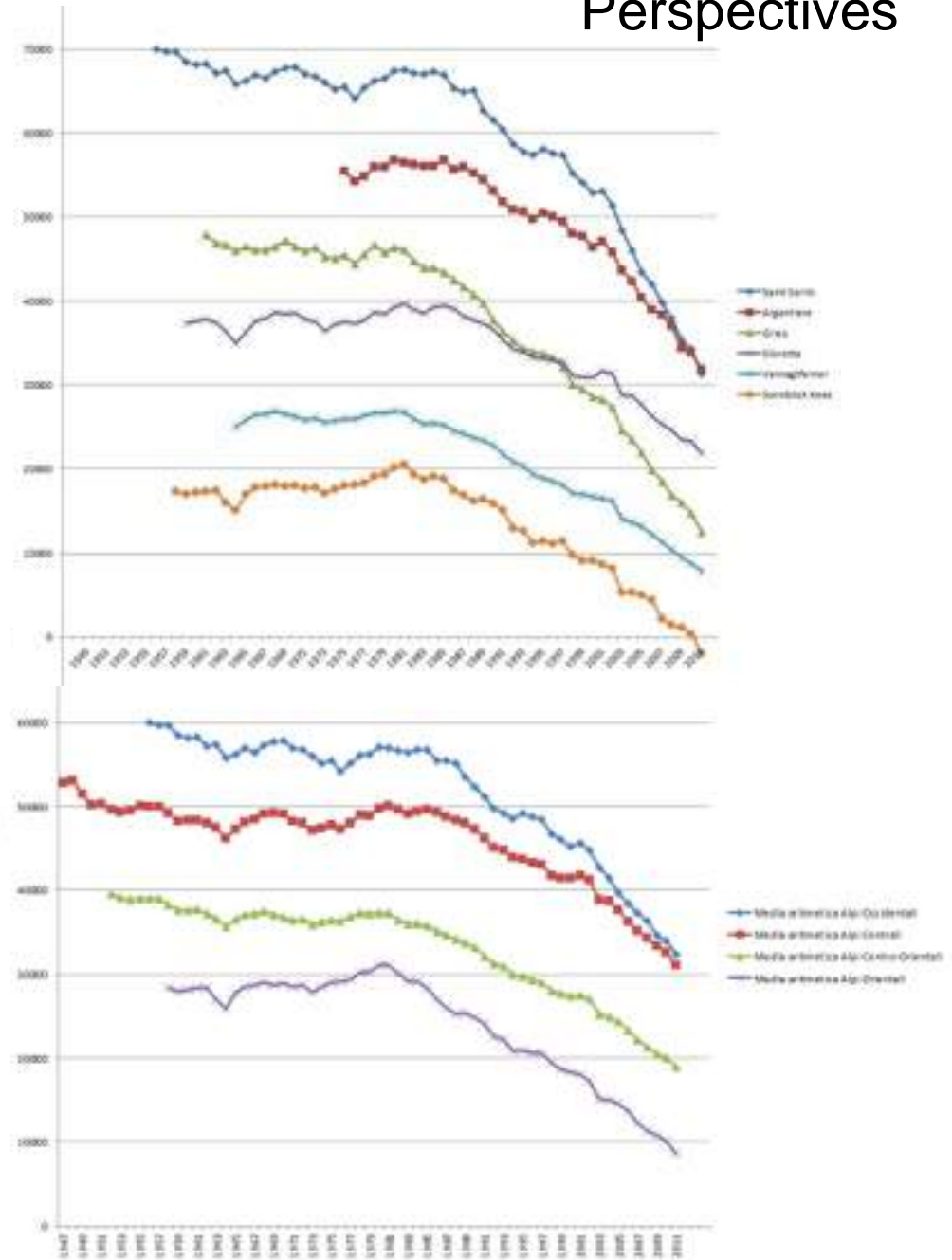
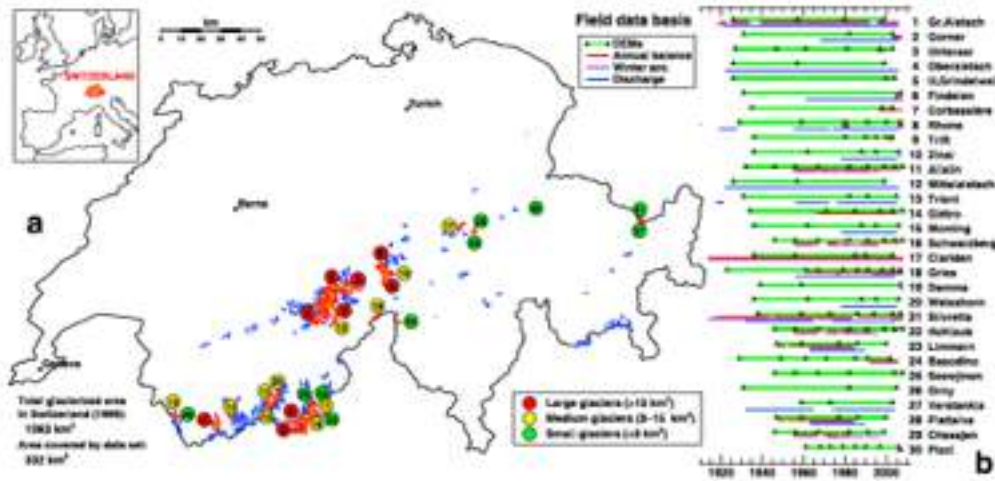
Col du Dome Calcium % Anomaly

Maggi et al, unpublished



Glaciers at glance!

Improving the proxy dataset, for the last 1-2 centuries will be important to use both, ice core data and glacier data, that permit to increase the dataset for climatic interpretation and future modeling.

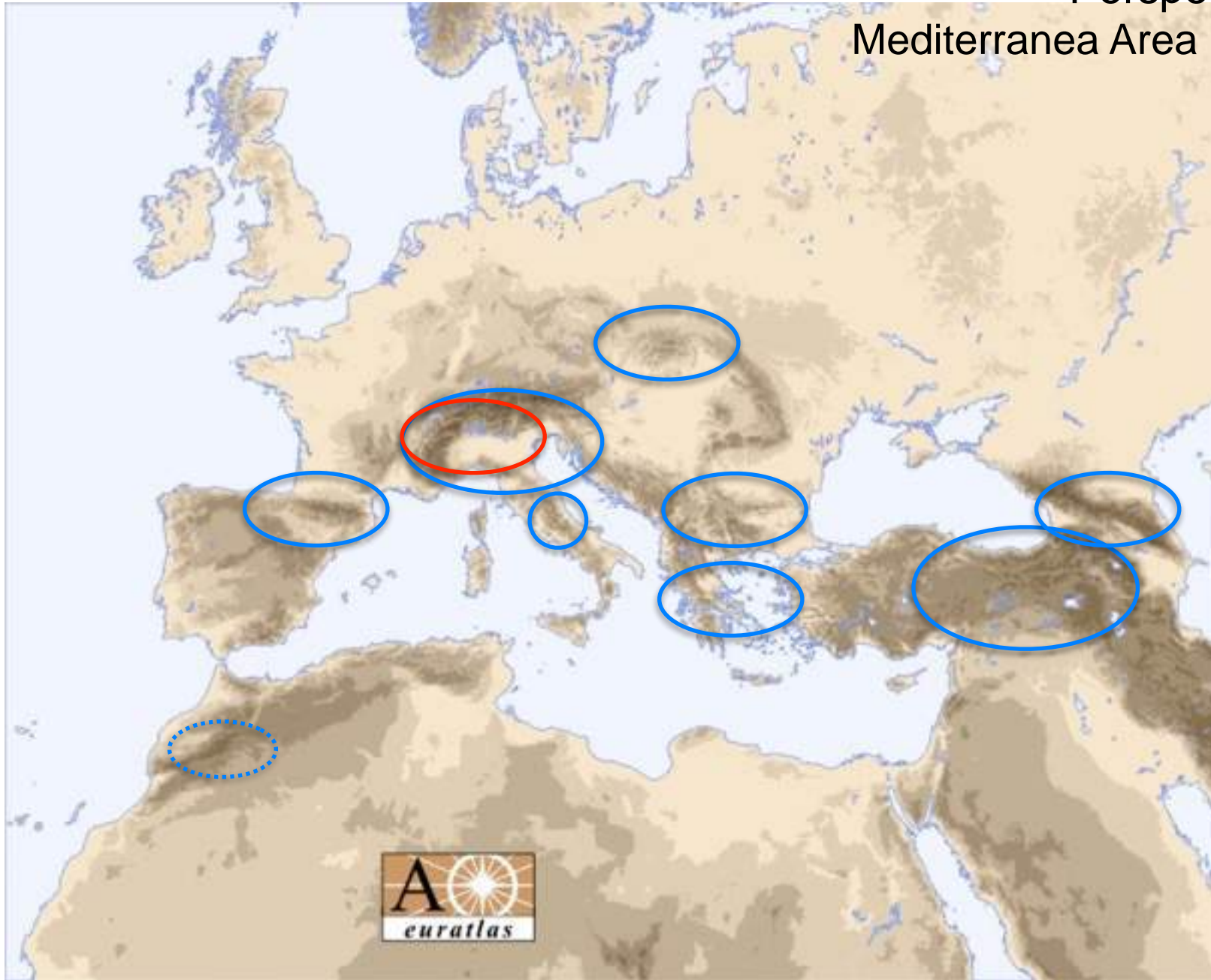


Huss et al., 2010

Maggi et al., unpublished

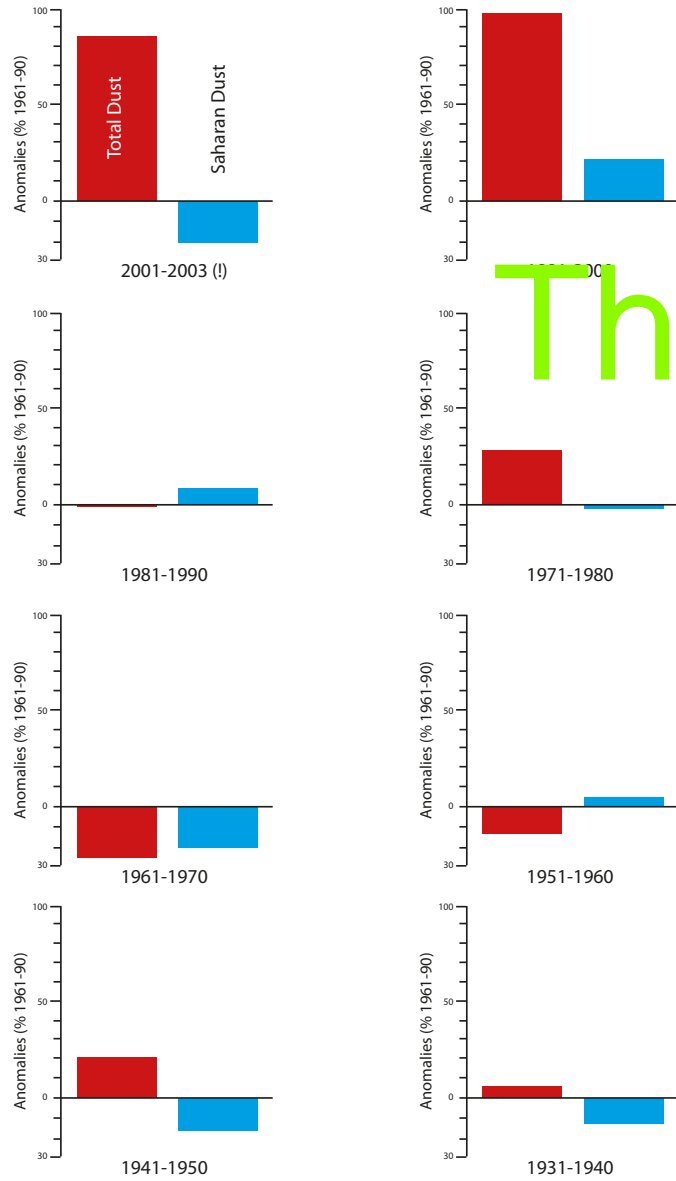
Mediterranea Area

- Glaciers
- Glaciers?
- Ice Core

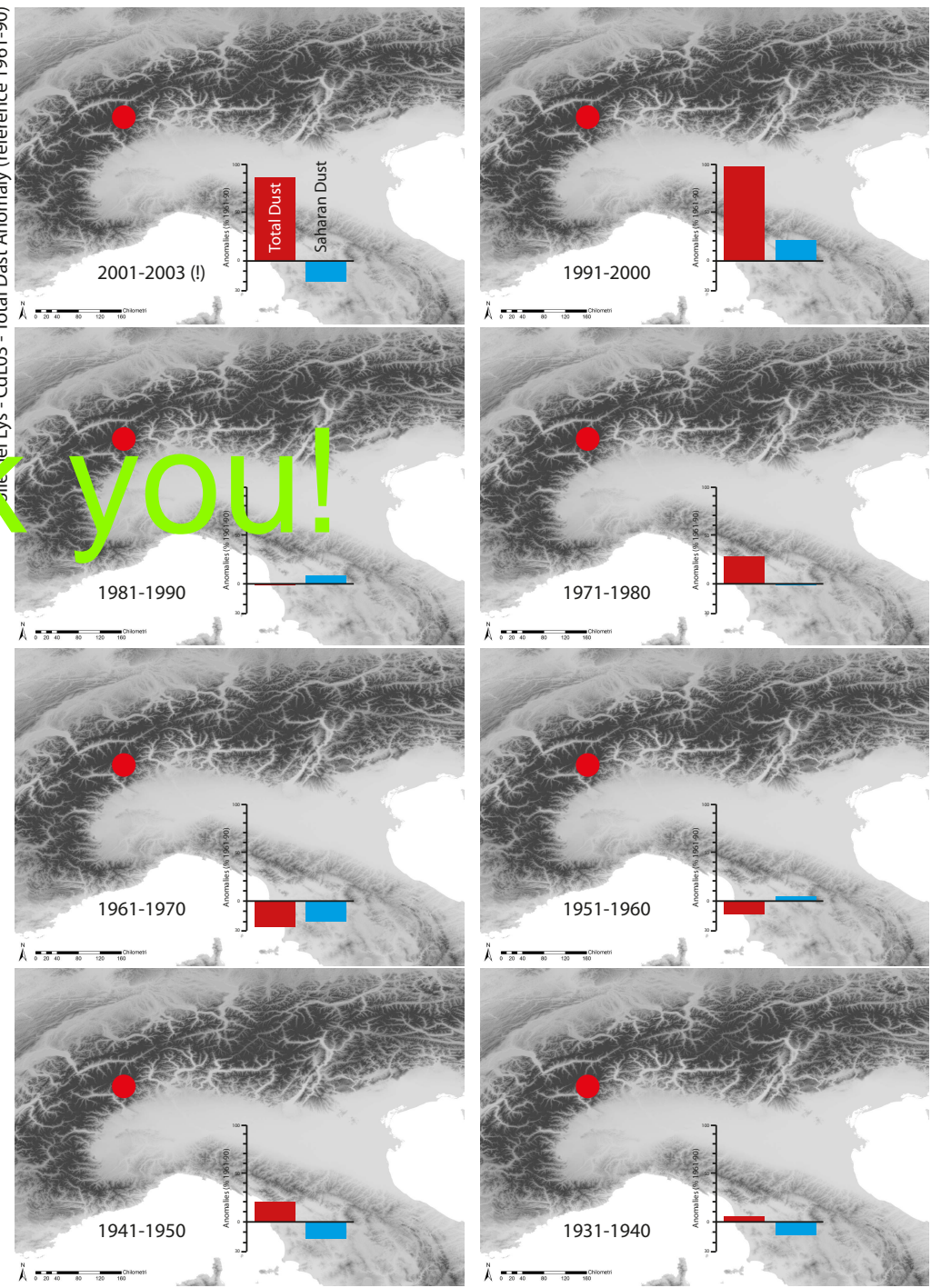


Monte Rosa - Colle del Lys - Dust Summary

Colle del Lys dust anomalies (CdL03)



Colle del Lys - Total Dast Anomaly (reference 1961-90)



Thank you!

Maggi et al. unpublished