Tree-ring based climate reconstructions in the Italian Alps

Manuela Pelfini (*) & Giovanni Leonelli speaking (°)
(*) Dipartimento di Scienze della Terra "A.Desio" – Università degli Studi di Milano
(°) Dipartimento di Scienze Ambiente e Territorio e Scienze della Terra – Università degli Studi di Milano-Bicocca

Climate variability in Italy during the last two millennia – Italy 2k
ROMA 1 - 2 DICEMBRE 2014

NextData

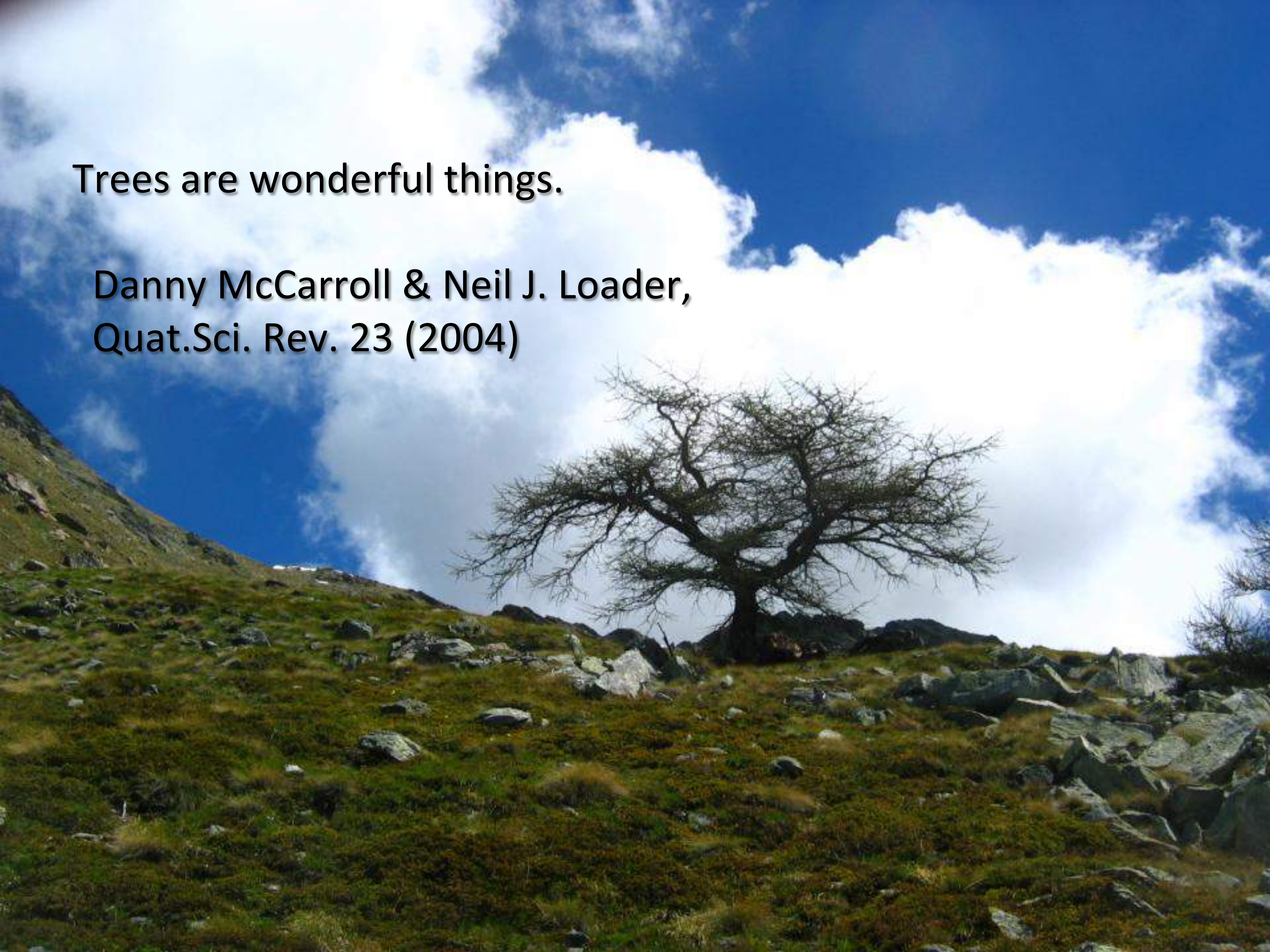
Università degli Studi di Milano

Università degli Studi di Milano Bicocca

Accademia Nazionale dei Lincei
Centro Linceo Interdisciplinare «Beniamino Segre»

Trees are wonderful things.

Danny McCarroll & Neil J. Loader,
Quat.Sci. Rev. 23 (2004)



What climate information can be derived

Past position of glaciers in key sites (in situ stumps, logs, etc.)

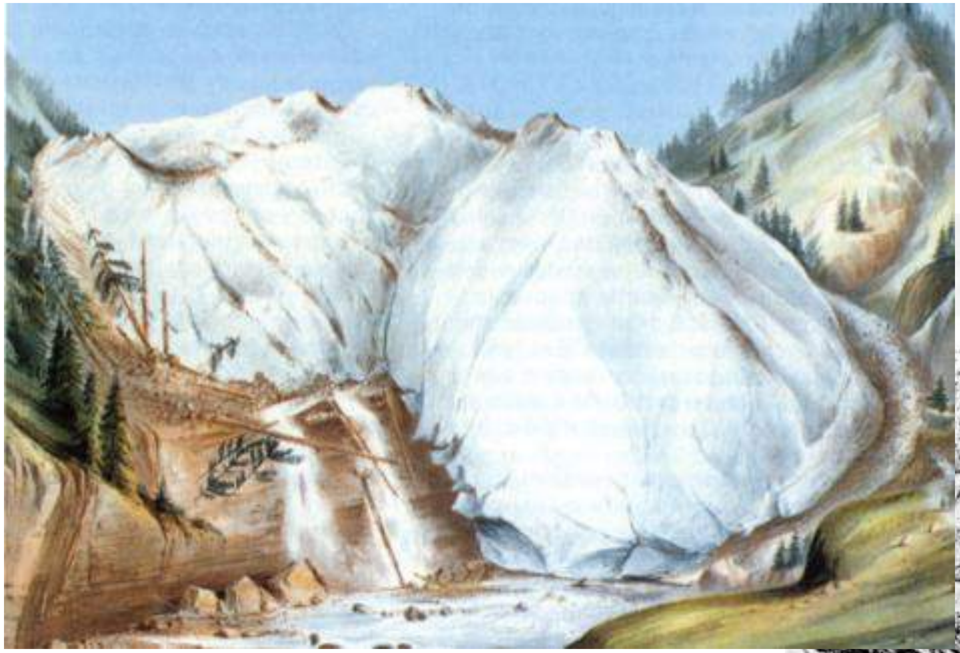
Glacio-hydrological changes through time (stable isotopes)

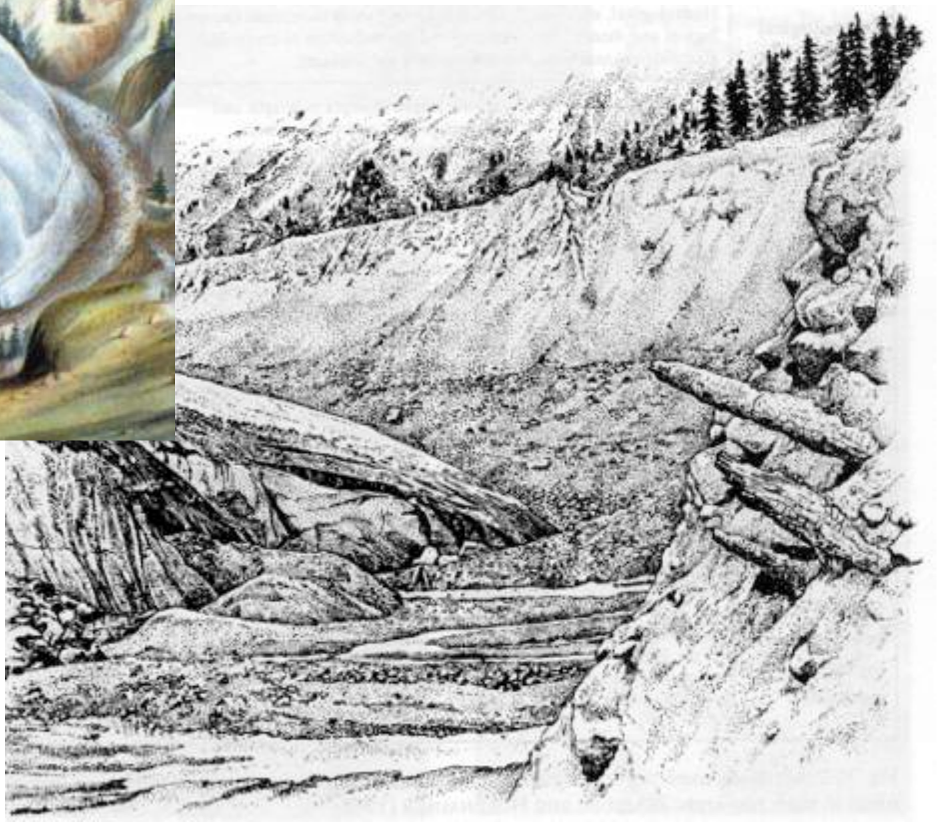
Climate signal stability through time (ring-width chronologies)

Highly-resolved climate reconstructions (TRW; MXD, stable isotopes, etc.)

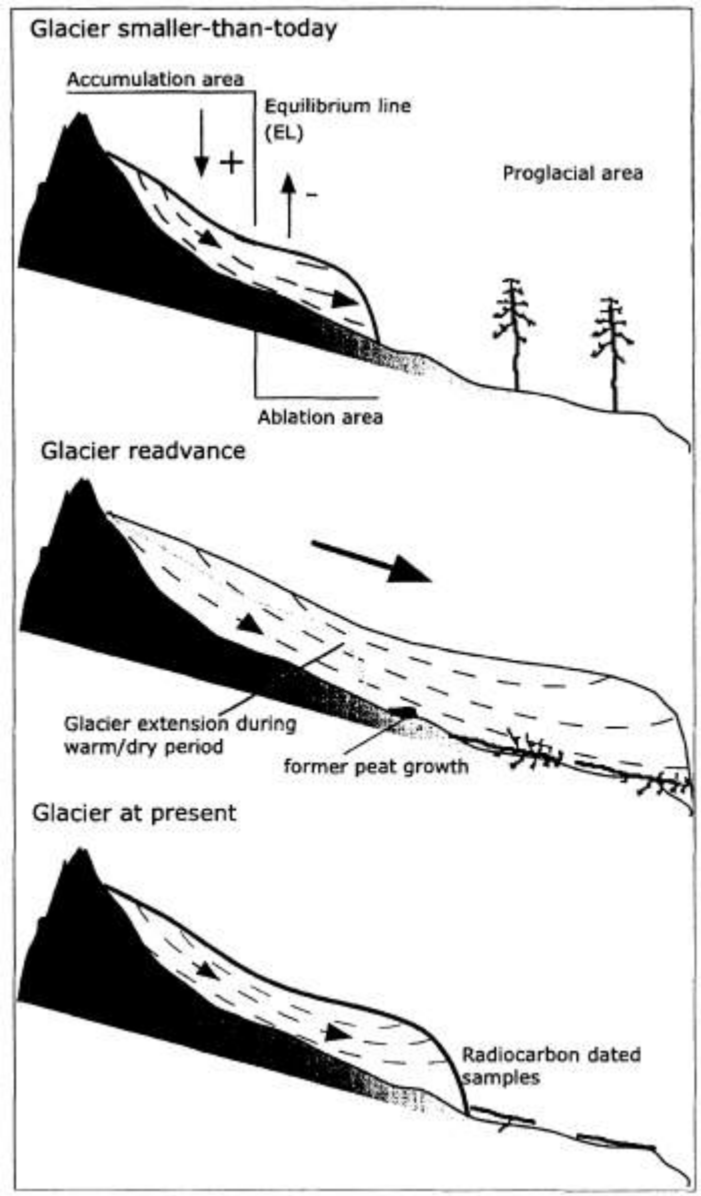
Tree-ring groups currently active in Italy and their effort for the Italy 2k objective

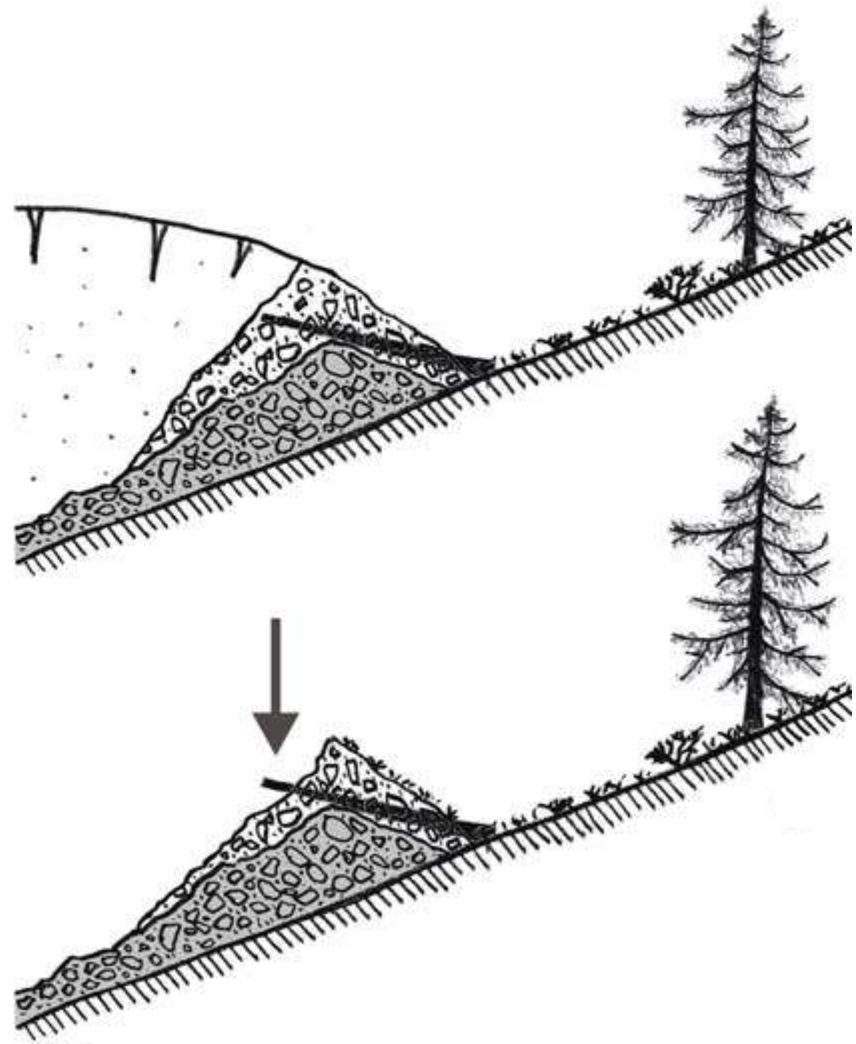
Subfossil wood stumps and logs





Subfossil wood stumps and logs



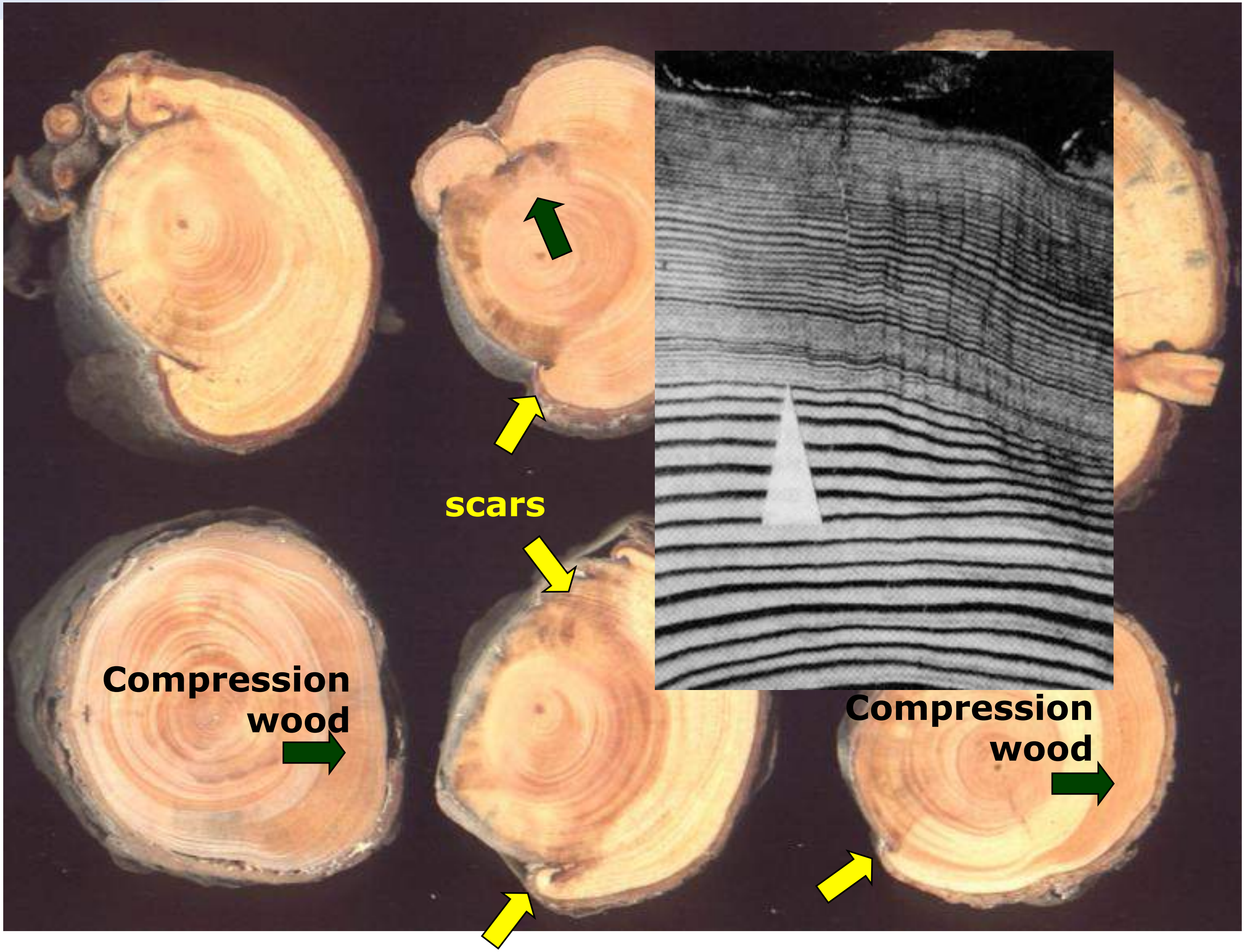


Hormes et al 2001 Holocene

Pelfini et al 2009 Mem. Descr. Carta Geol. d'It.

Belvedere Glacier *(Belò, 2002)*

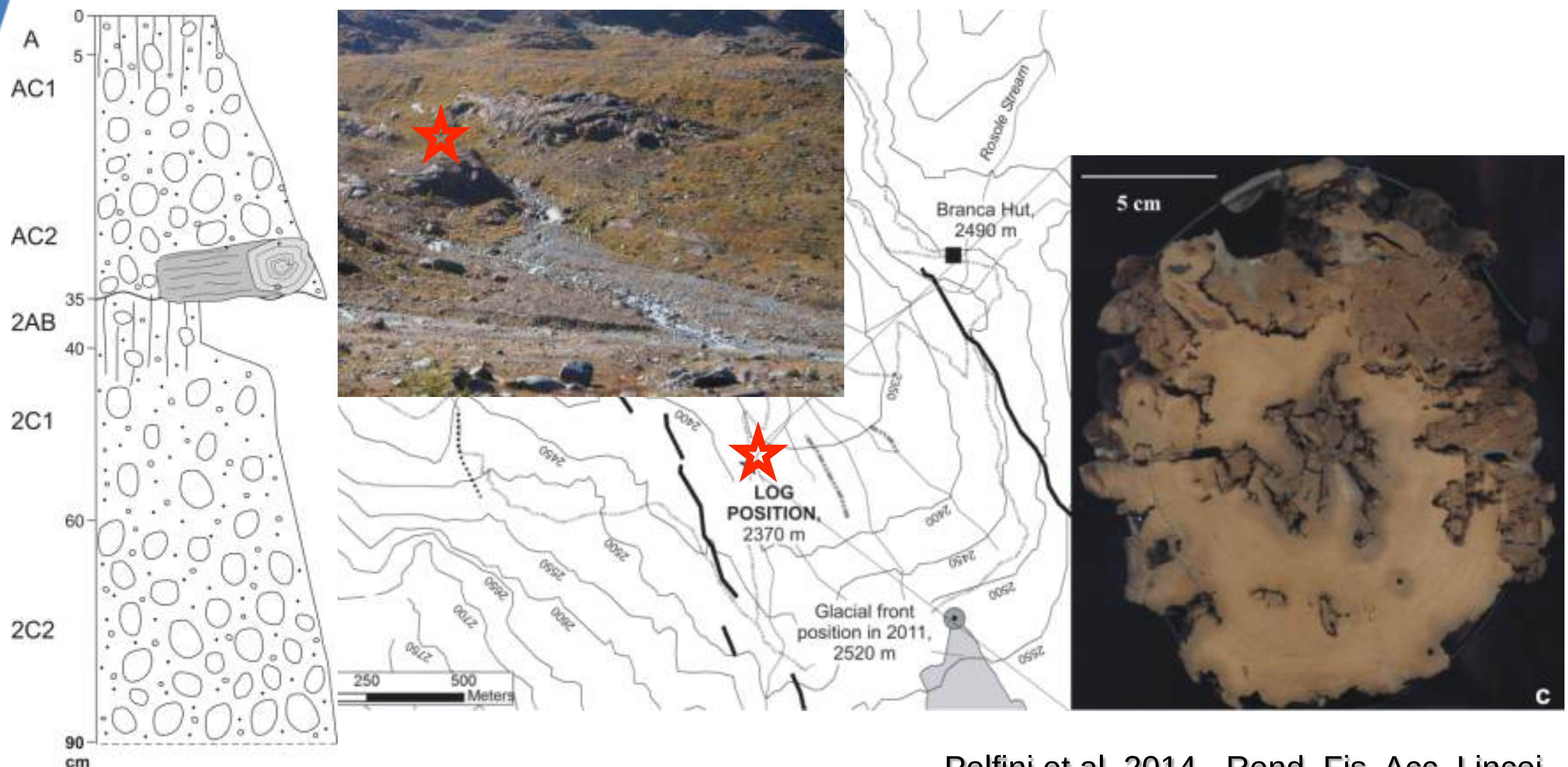
Subfossil wood stumps and logs



some spot retrievals from the IT Alps

- Forni Glacier

A buried log was found under the slope colluvium at an altitude of 2385 m a.s.l. and dating 4201-4031 cal. yr BP: this reveals that during the Sub-Boreal much older specimens of stone pine were present on the valley slopes.

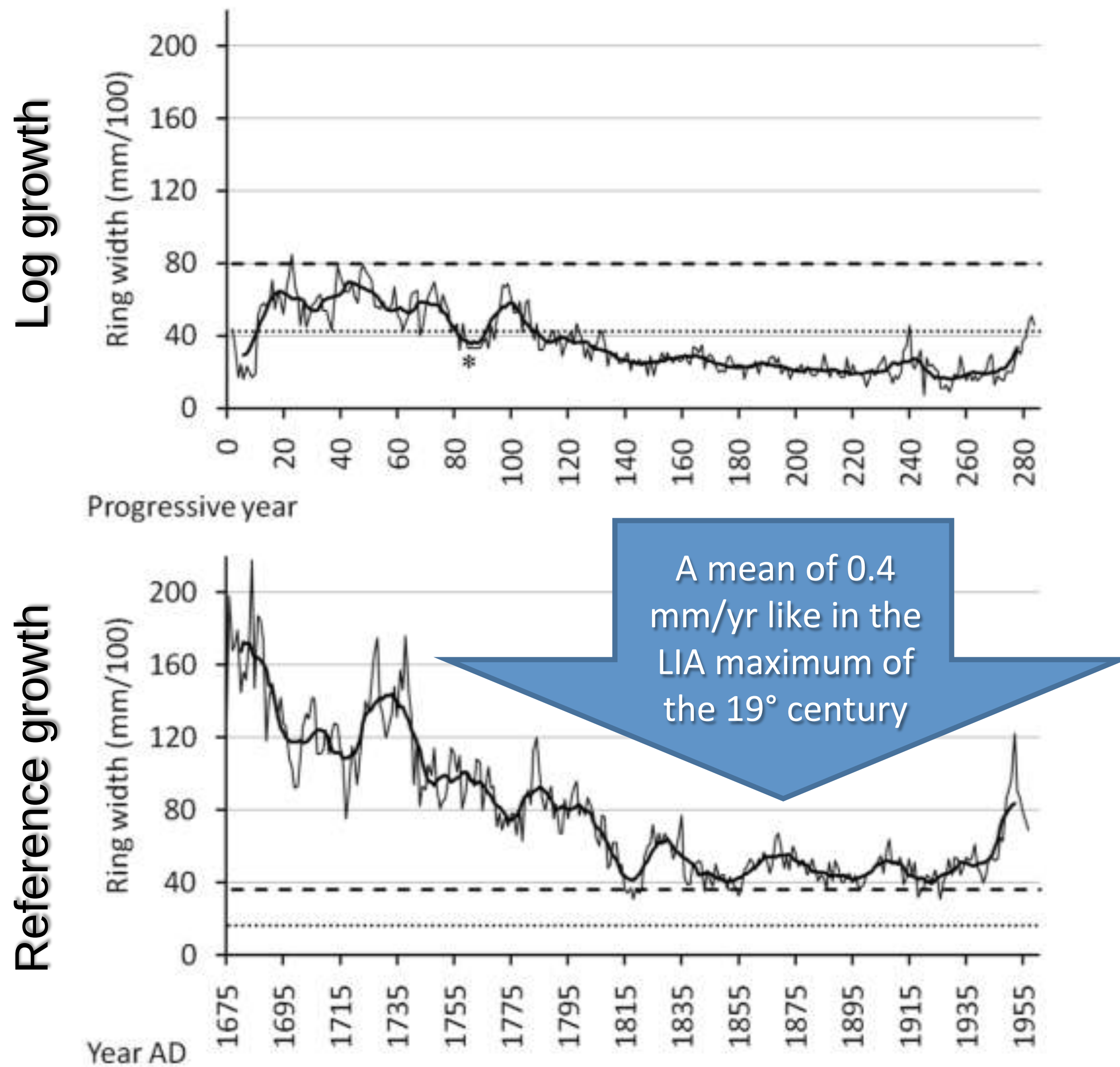


Pelfini et al. 2014 - Rend. Fis. Acc. Lincei

The log has 283 tree rings and was likely uninterruptedly buried in the deposit since the Subboreal, at least since 4201-4031 cal. yr BP, date of the outermost tree ring.

The retrieved log reveals that during the Subboreal in the Forni Valley likely much older specimens of stone pine were present on the slopes, in strong contrast to present-day conditions.

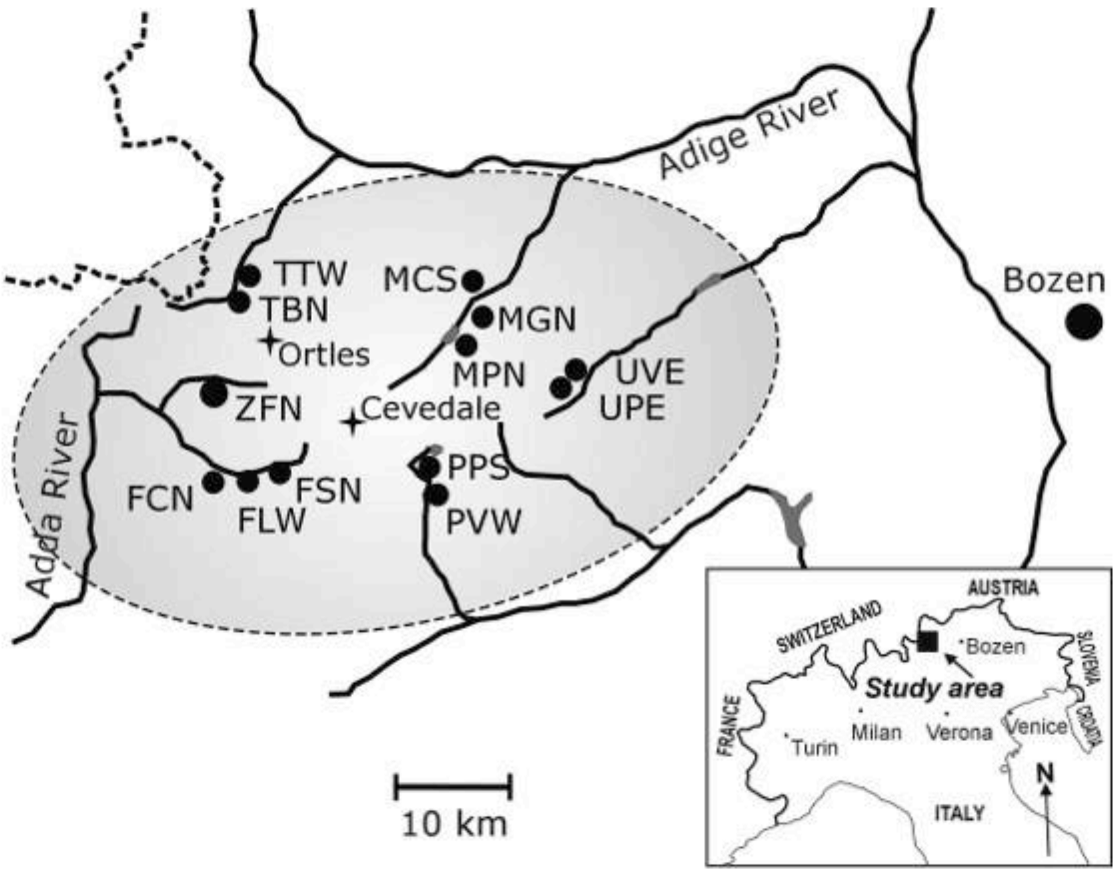
The Glacier was probably in an advancing phase



Pelfini et al. 2014 - Rend. Fis. Acc. Lincei

Climate signal stability through time

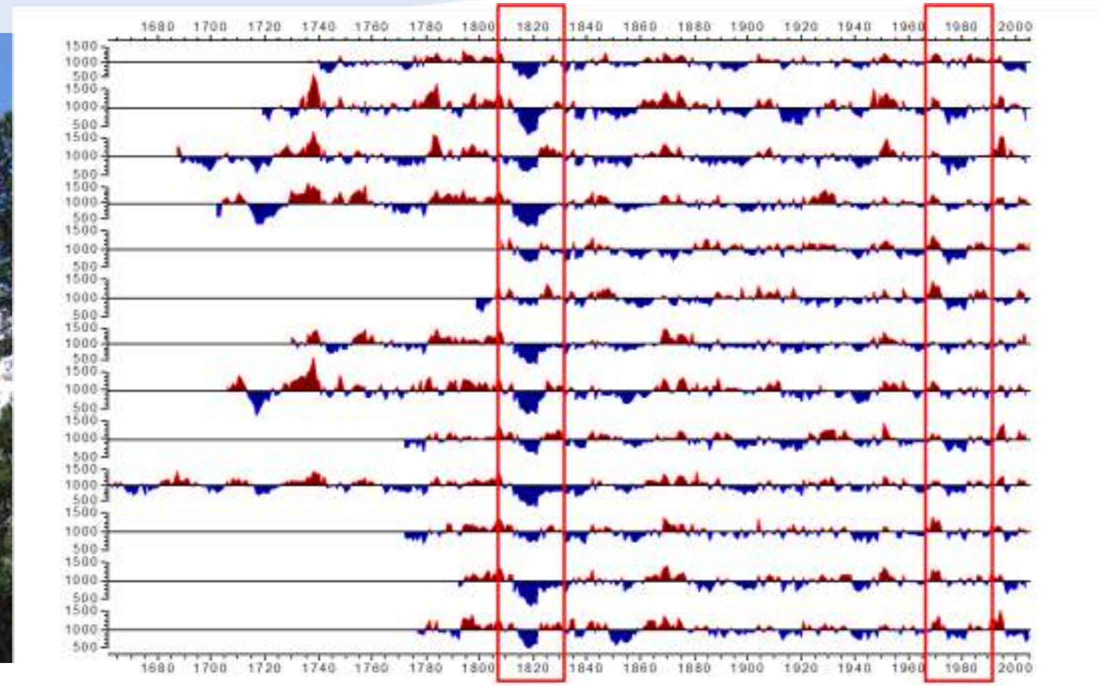
- The Ortles-Cevedale tree-ring network (*Pinus cembra* L.)



13 sites

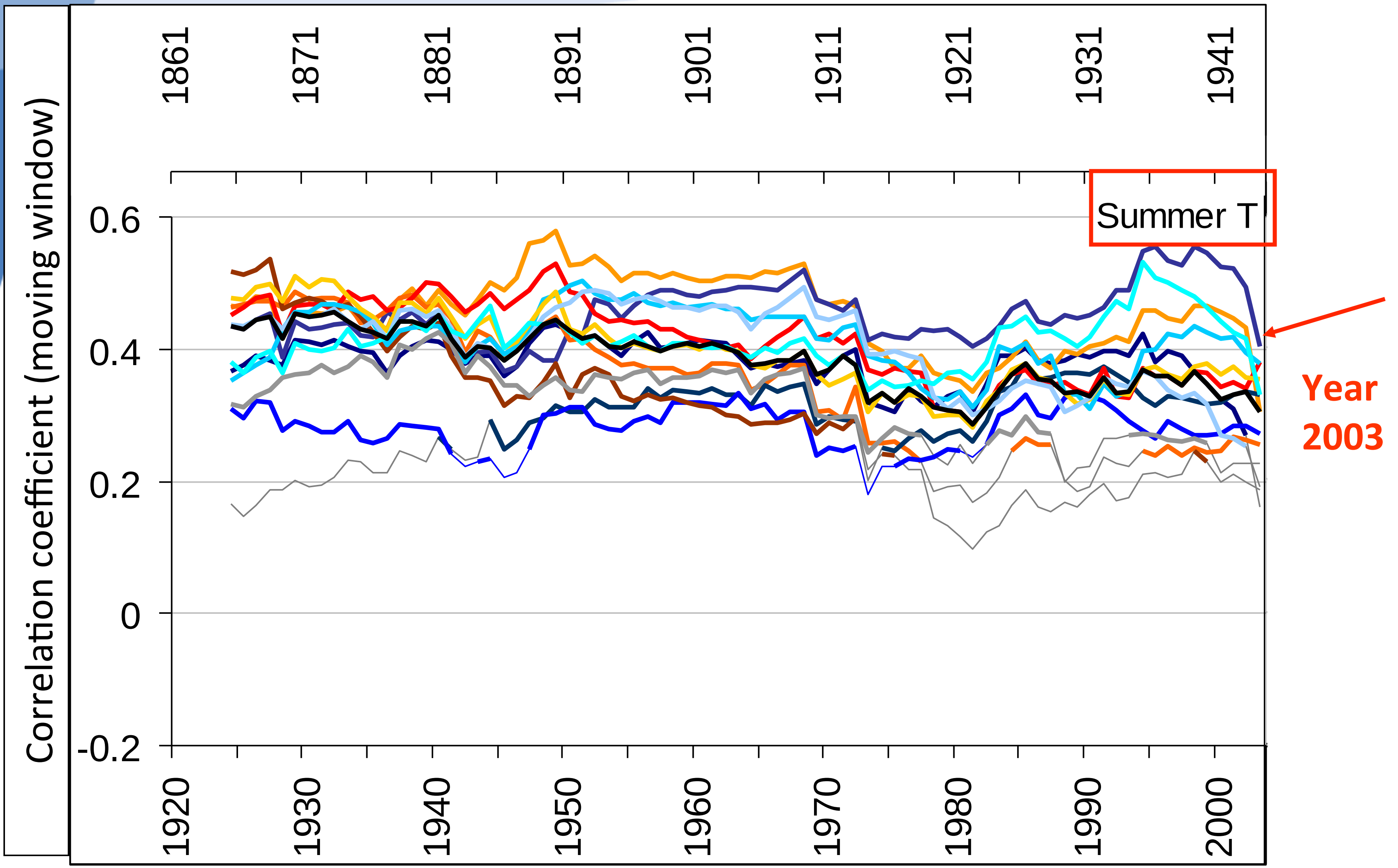
Leonelli et al., 2009 – Climatic Change

Climate signal through time

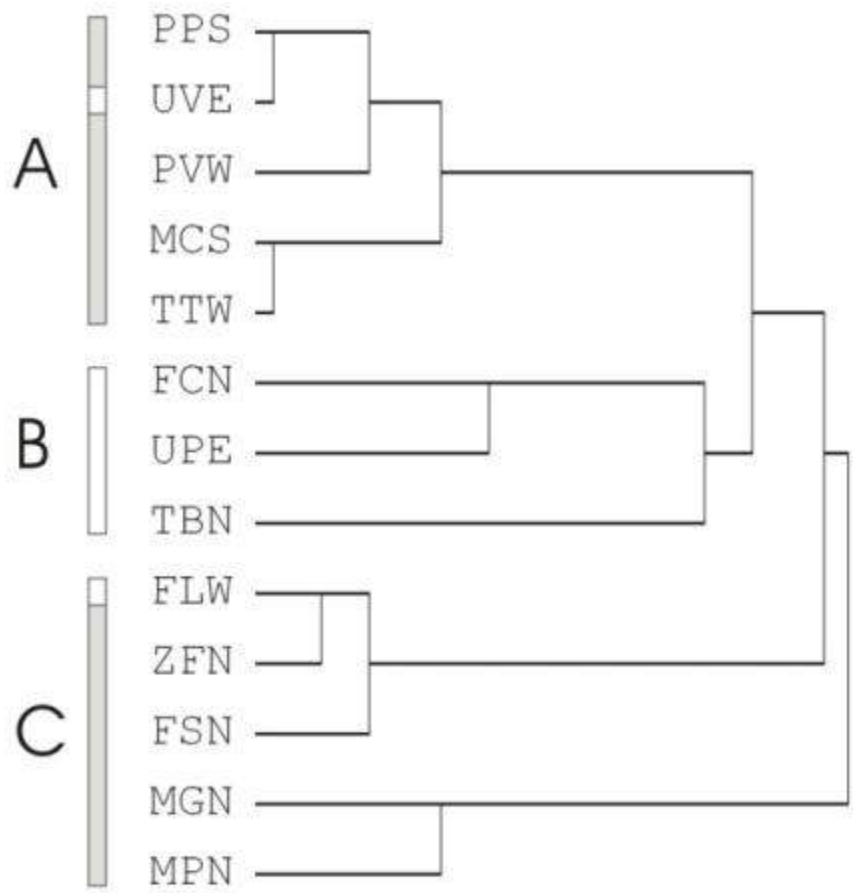


Site code	Mean Altitude	First year of chronology	Last year of chronology	Chronology length
PPS	2230	1560	2004	445
UVE	2250	1752	2004	253
PVW	2250	1593	2004	412
MCS	2230	1680	2005	326
TTW	2150	1636	2004	369
FCN	2250	1664	2004	341
UPE	2150	1751	2004	254
TBN	2100	1699	2004	306
FLW	2200	1685	2004	320
ZFN	2180	1756	2005	250
FSN	2170	1657	2004	348
MGN	2190	1760	2005	246
MPN	2110	1742	2005	264

Climate signal through time

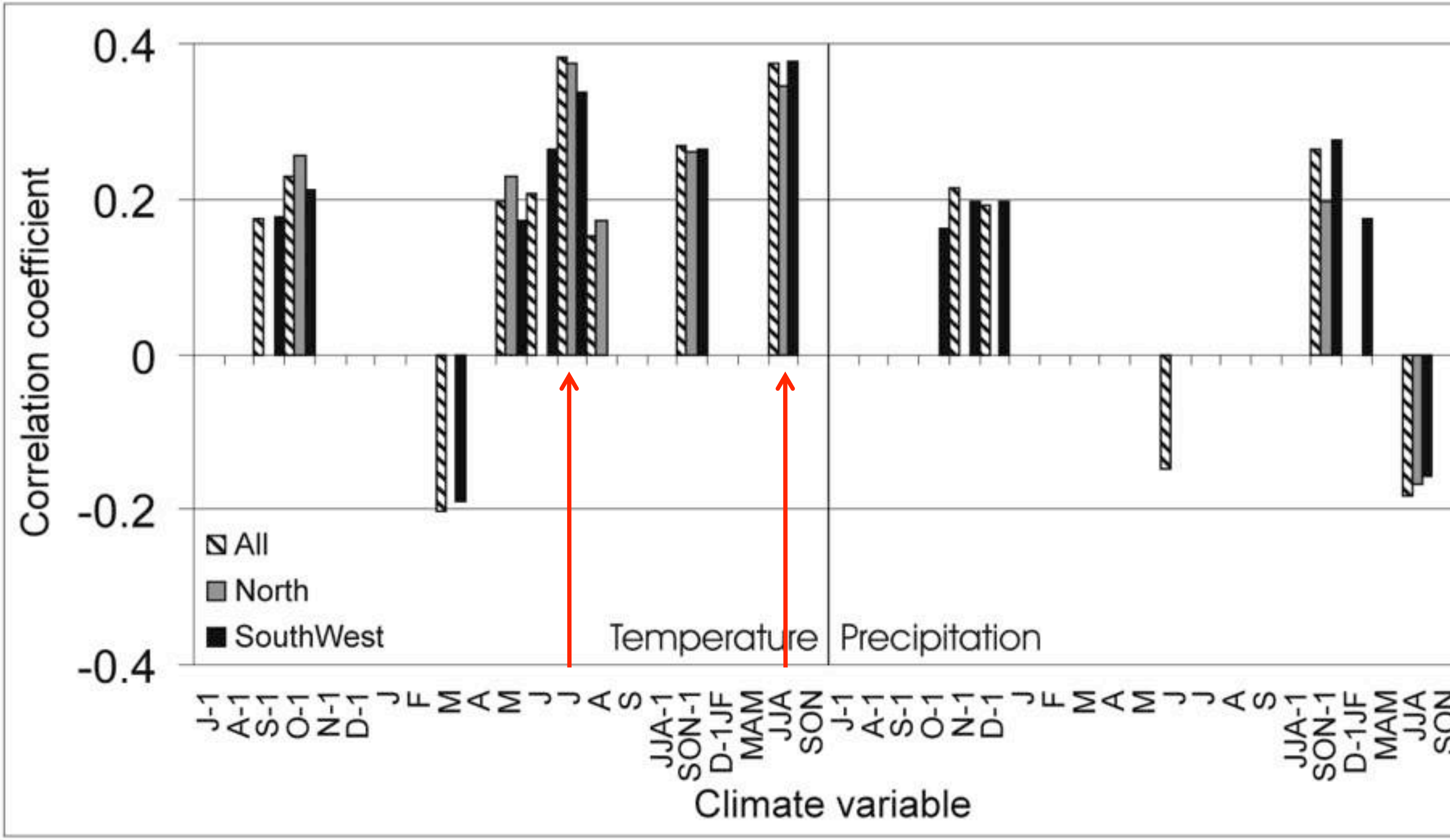


Coloured lines = p<0.05



Leonelli et al., 2009 – Climatic Change

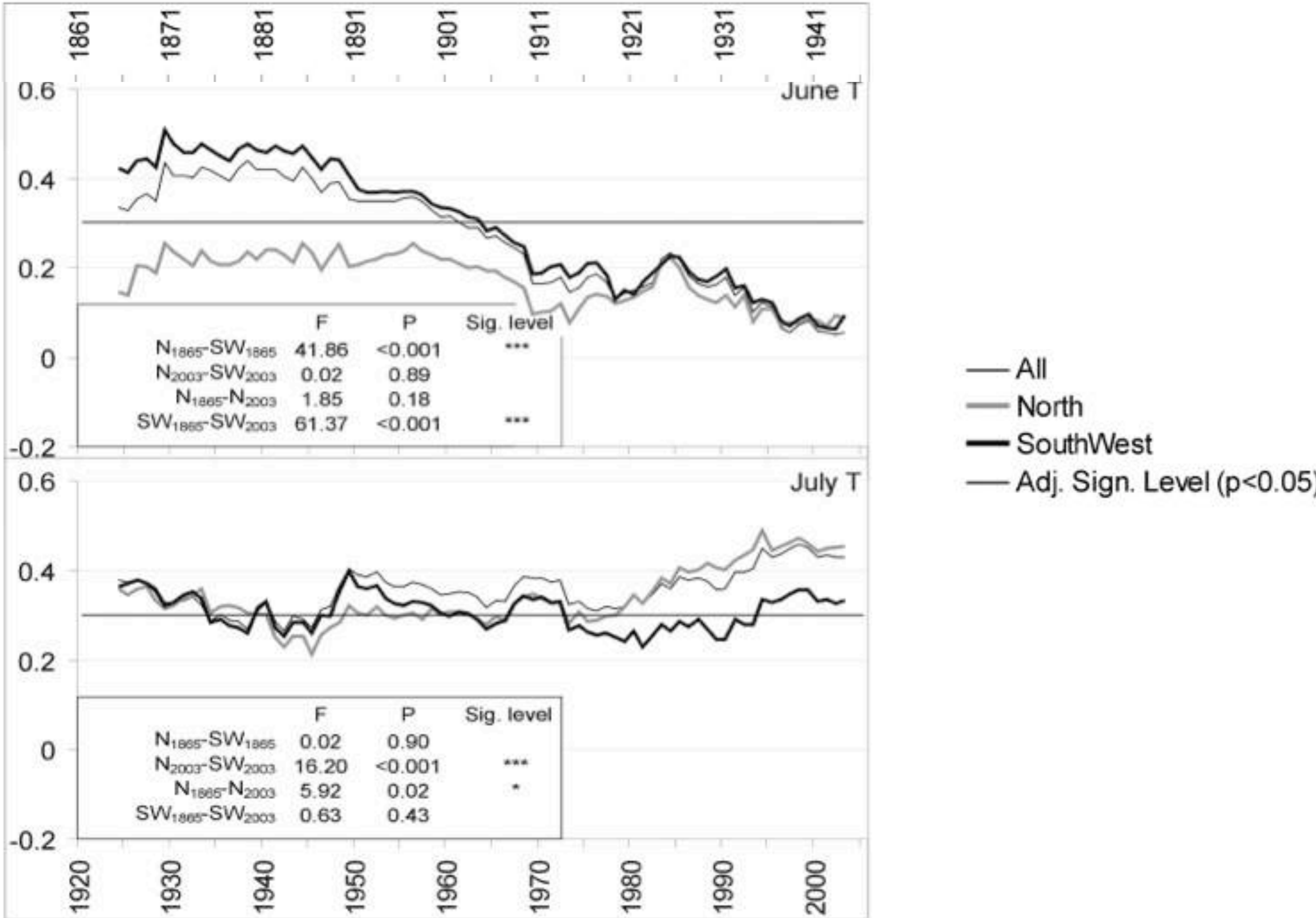
Climate signal through time



Bootstrapped Corr. Ceff., period: 1865–2003

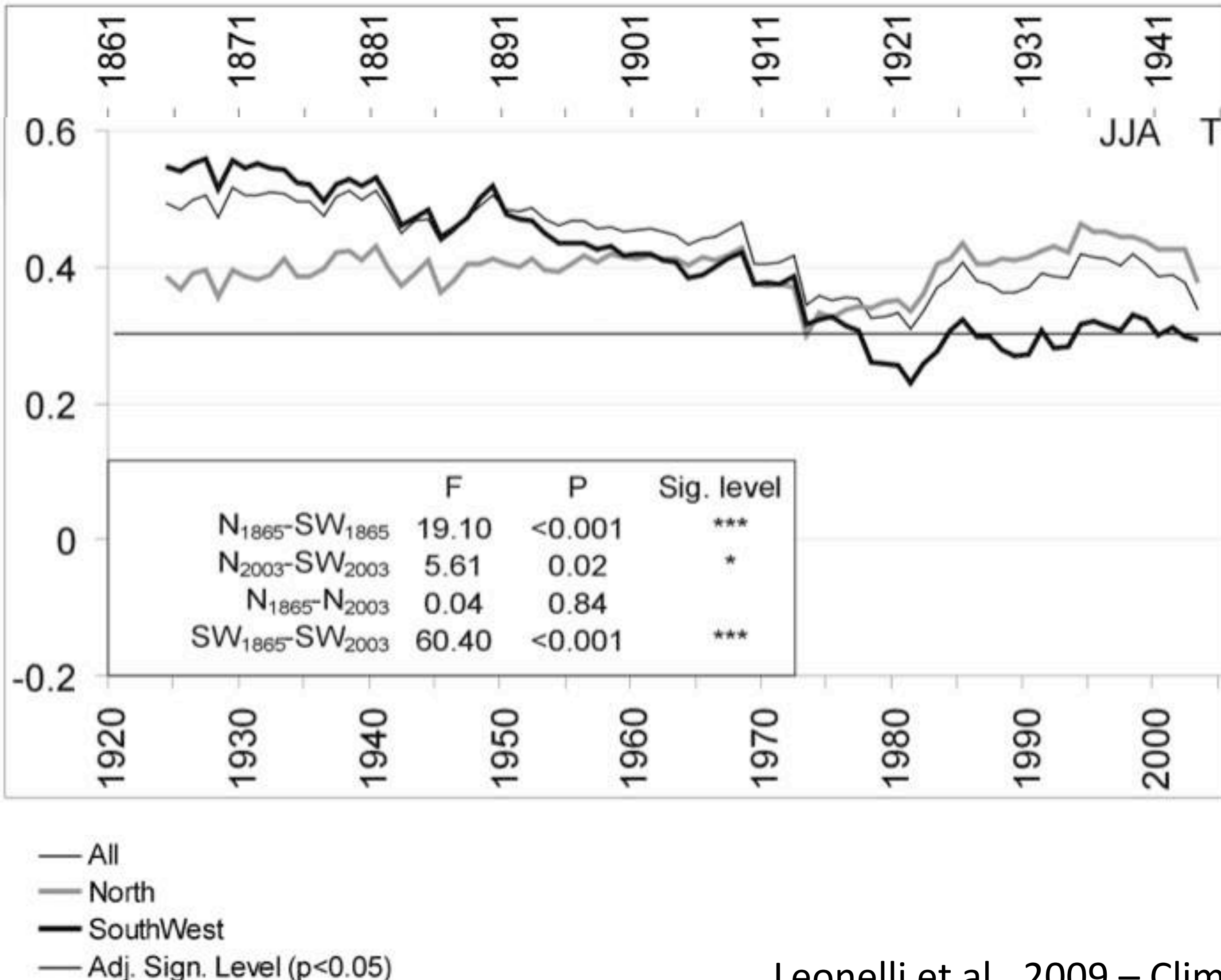
Leonelli et al., 2009 – Climatic Change

Climate signal through time

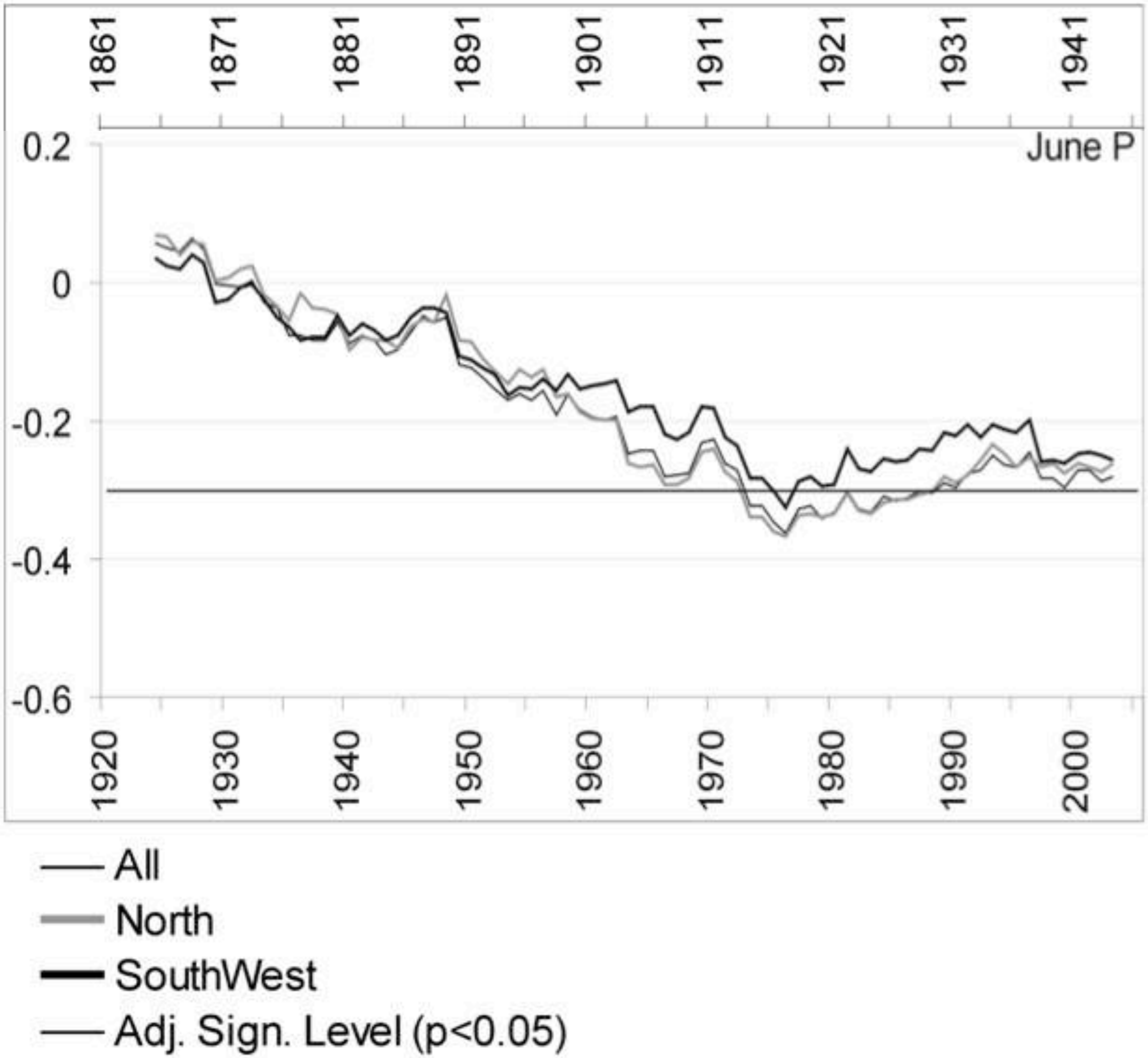


Leonelli et al., 2009 – Climatic Change

Climate signal through time

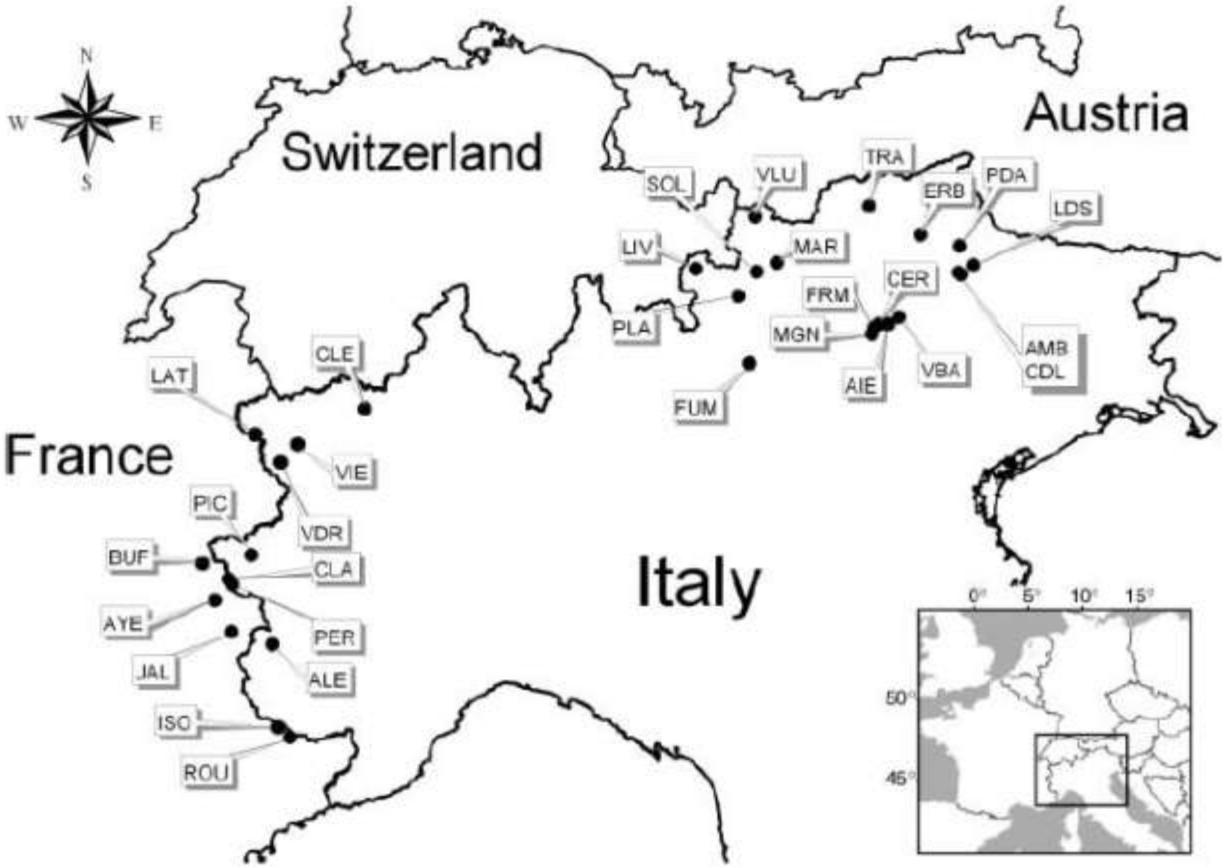


Leonelli et al., 2009 – Climatic Change



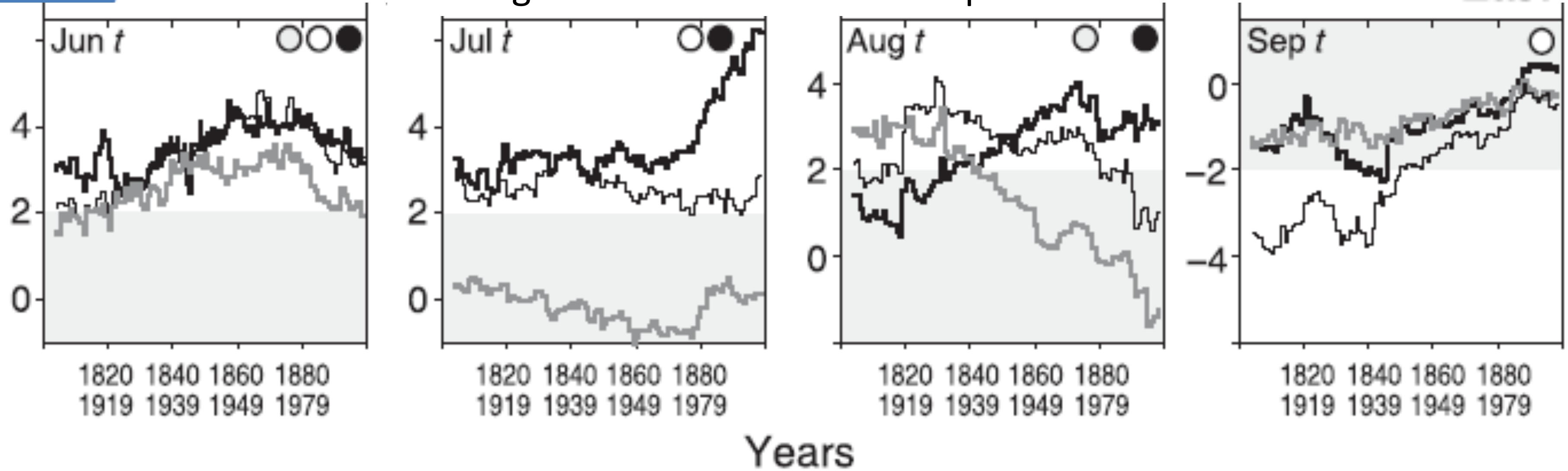
Leonelli et al., 2009 – Climatic Change

- Another *P.cembra* Alpine tree-ring network

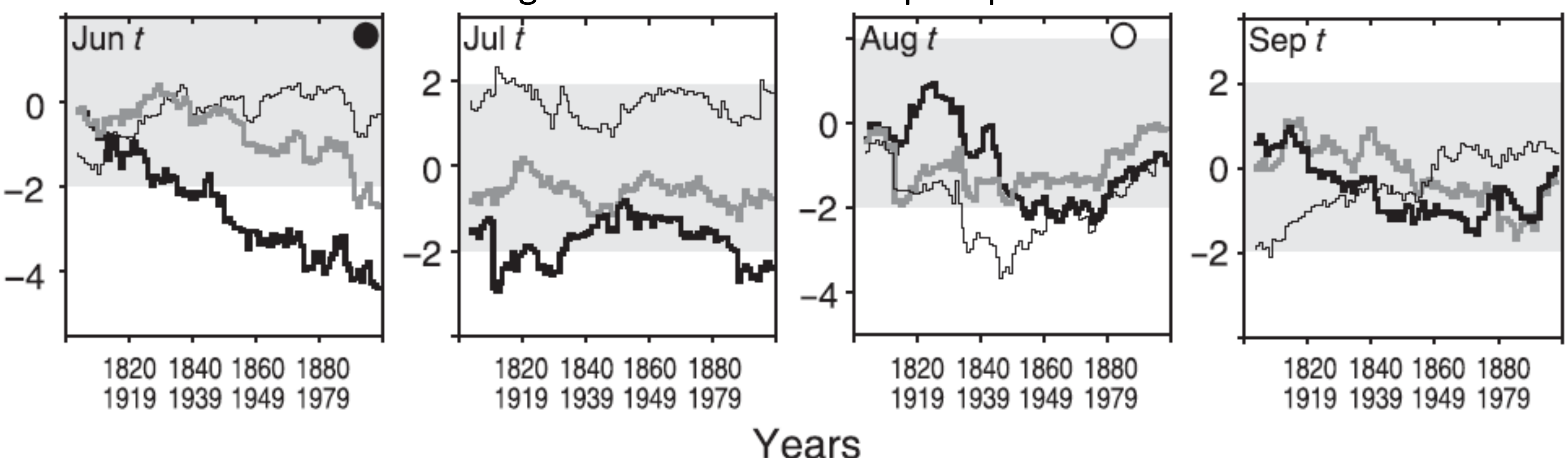


Carrer et al., 2007 – J. Ecol.

Moving correlation function: temperature

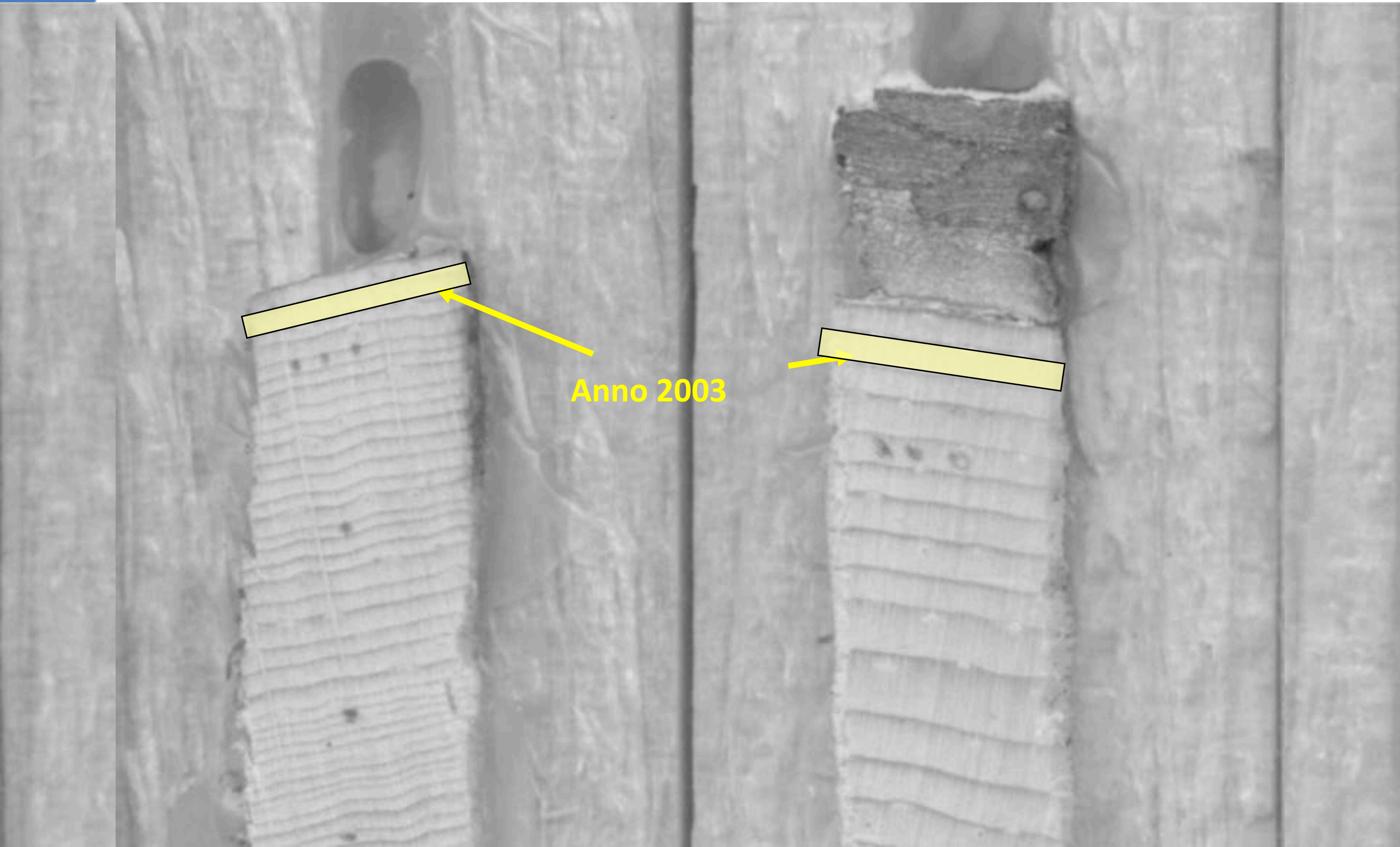


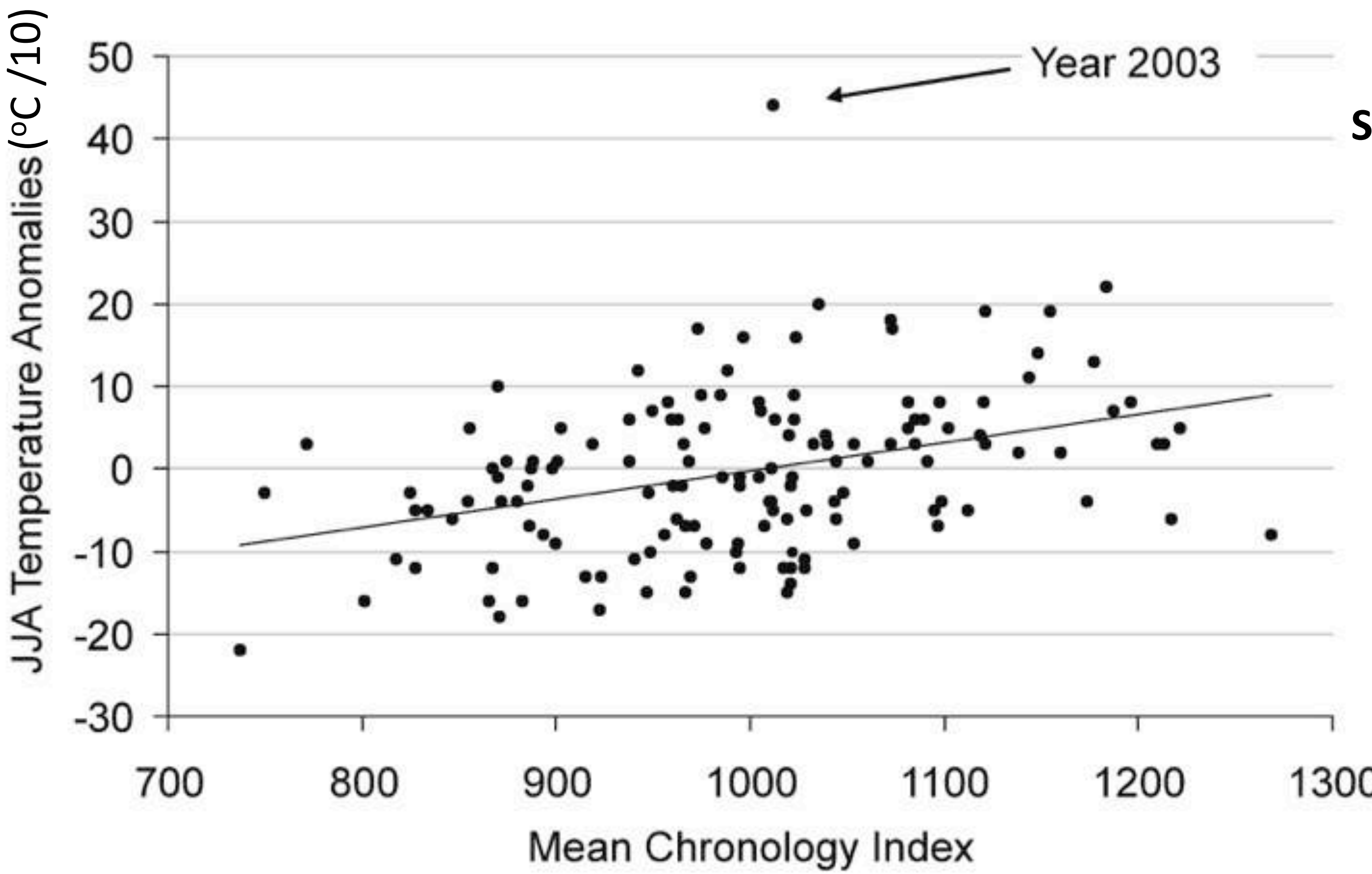
Moving correlation function: precipitation



Carrer et al., 2007 – J. Ecol.

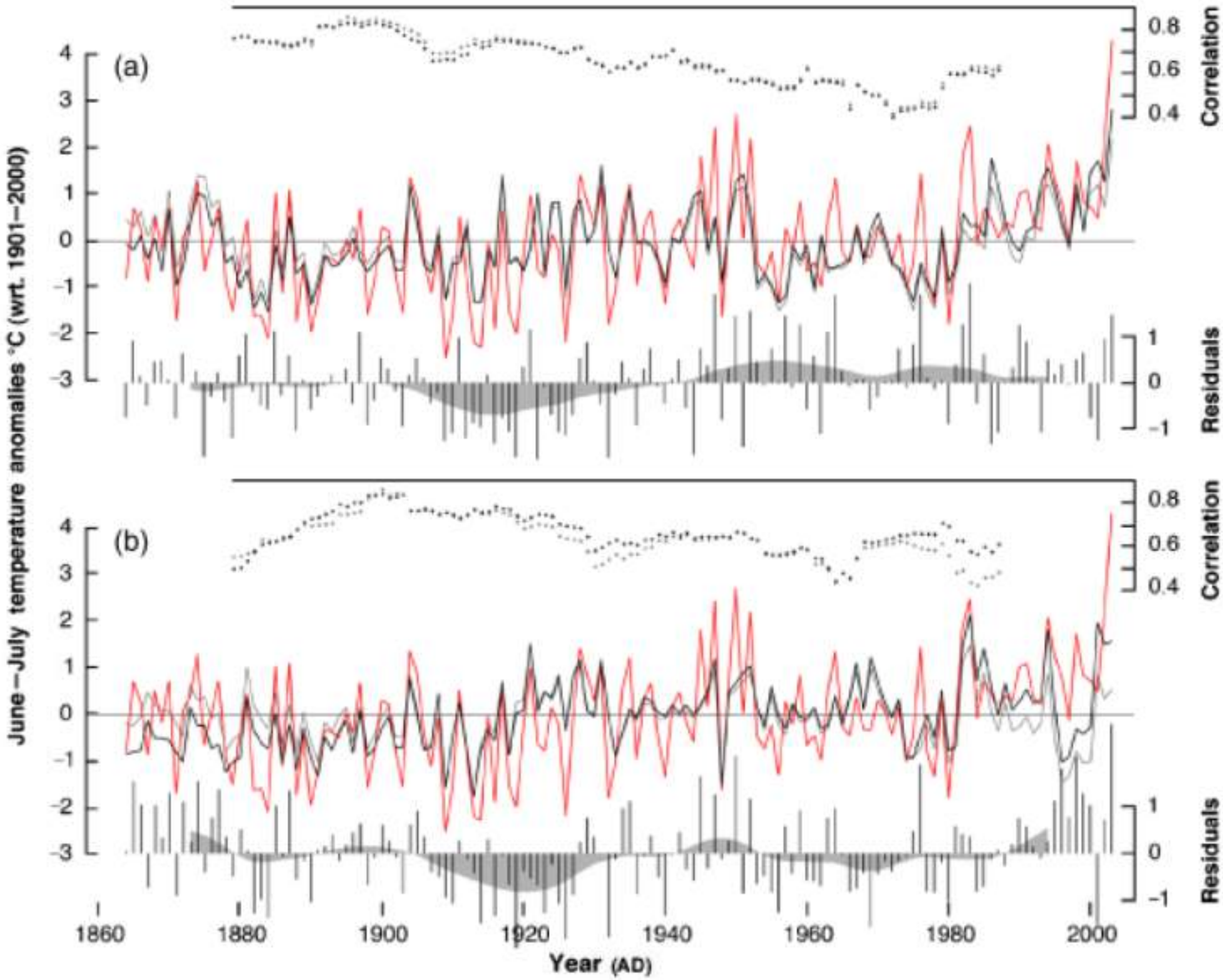
- A peculiar summer: AD 2003




Year 2003
JJA Temperature Anomalies (°C /10)
50
40
30
20
10
0
-10
-20
-30
700
800
900
1000
1100
1200
1300
Mean Chronology Index

Stone pine

Climate signal and NO divergence

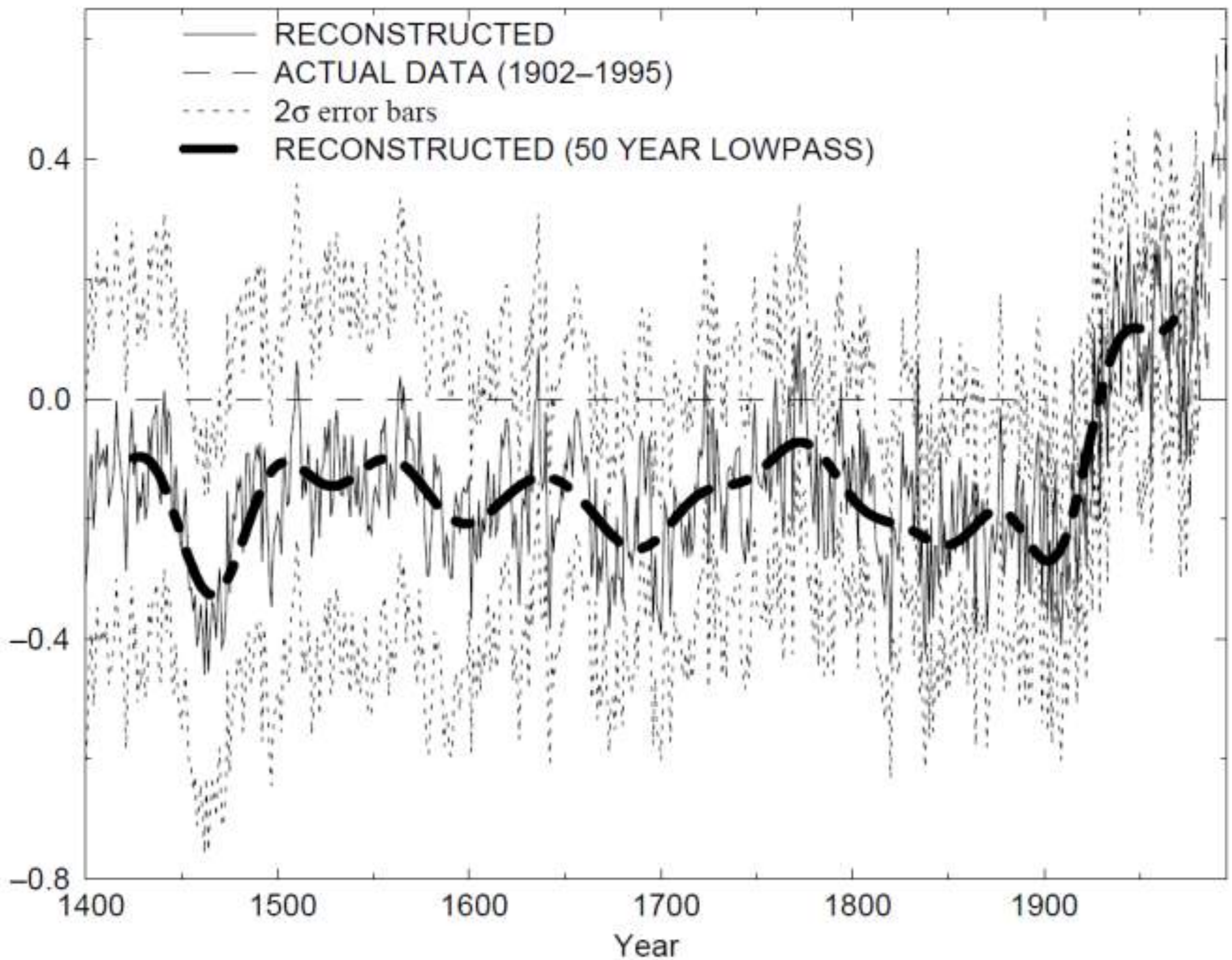


Larch

Spruce

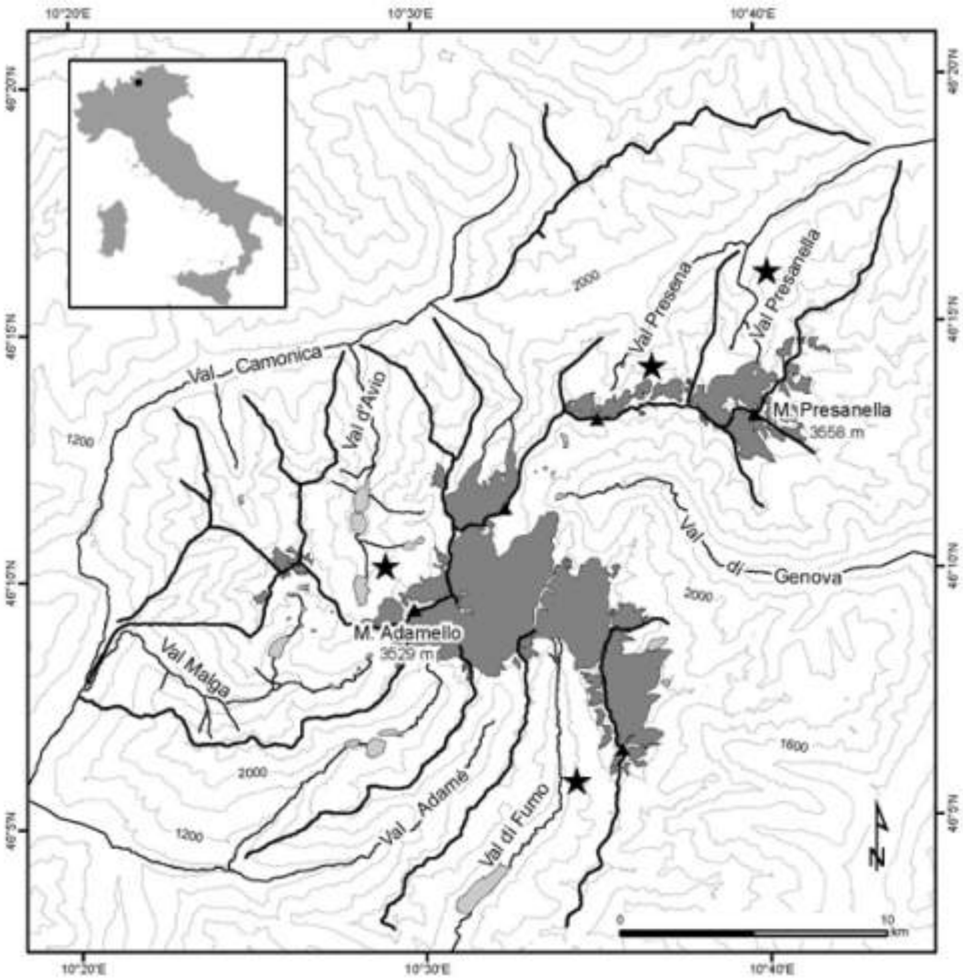
Büntgen et al, 2008 Glob. Ch. Biol.

Climate reconstructions for the past centuries



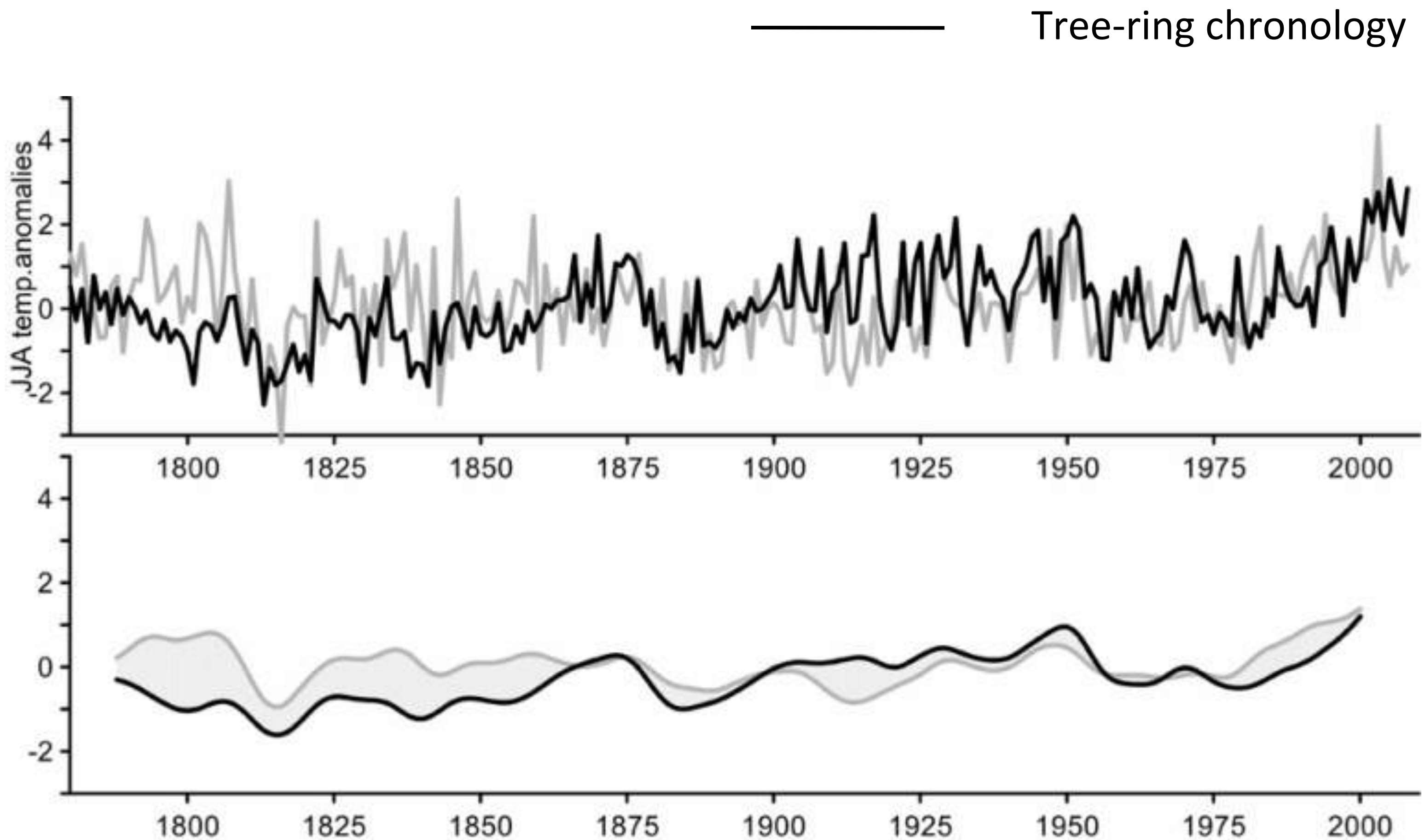
Mann, Bradley and Hughes, 1998 - Nature

- The Adamello-Presanella tree-ring network (*Larix decidua* Mill.)



Val Presena
Val Presanella
Val d'Avio
Val di Fumo

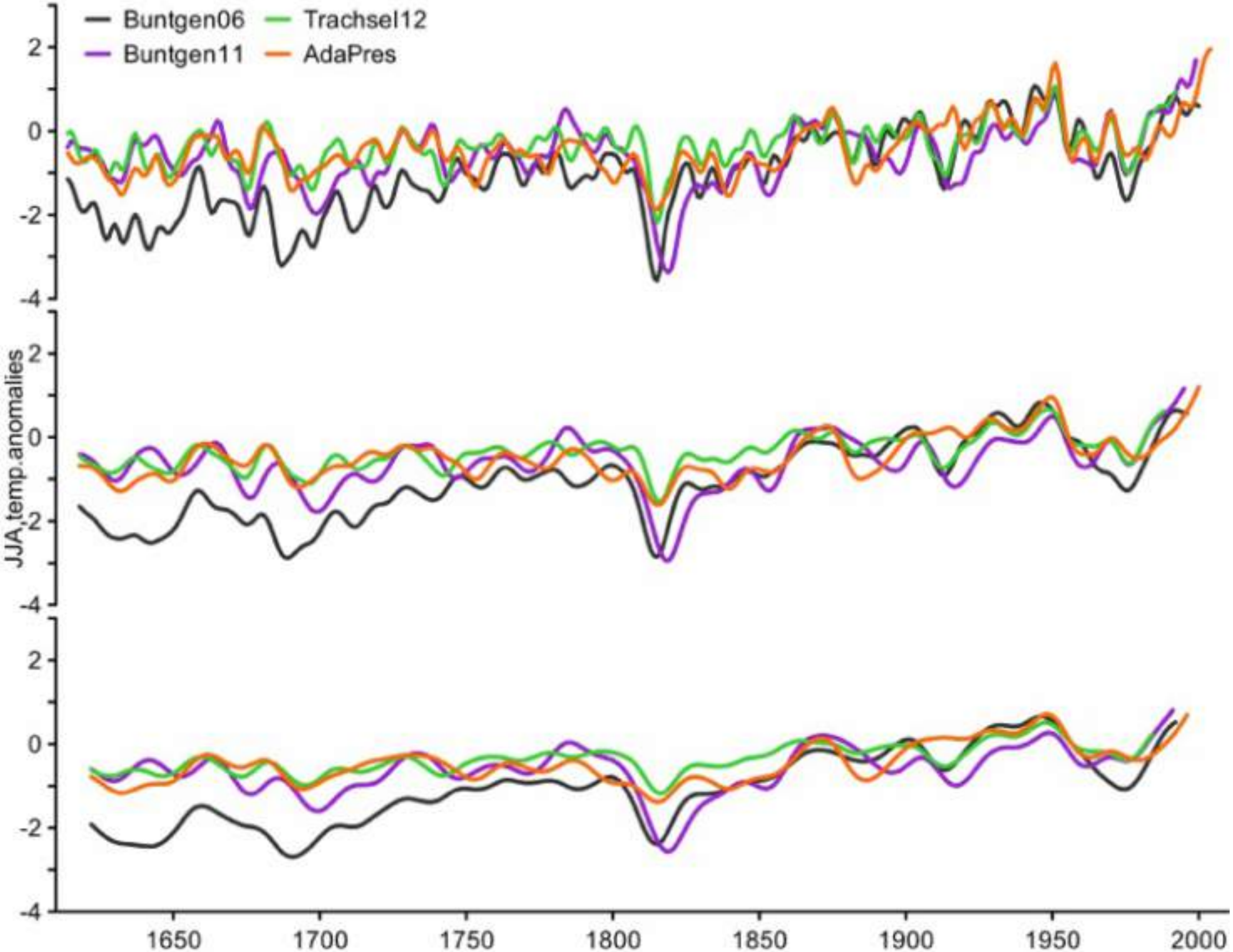
Coppola et al., 2013 - Clim. Past



Coppola et al., 2013 - Clim. Past

Calibration over the JJA temperature HISTALP dataset. Auer et al., 2007 - Int. J. Climatolgoy

Temperature reconstructions



Coppola et al., 2013 - Clim. Past

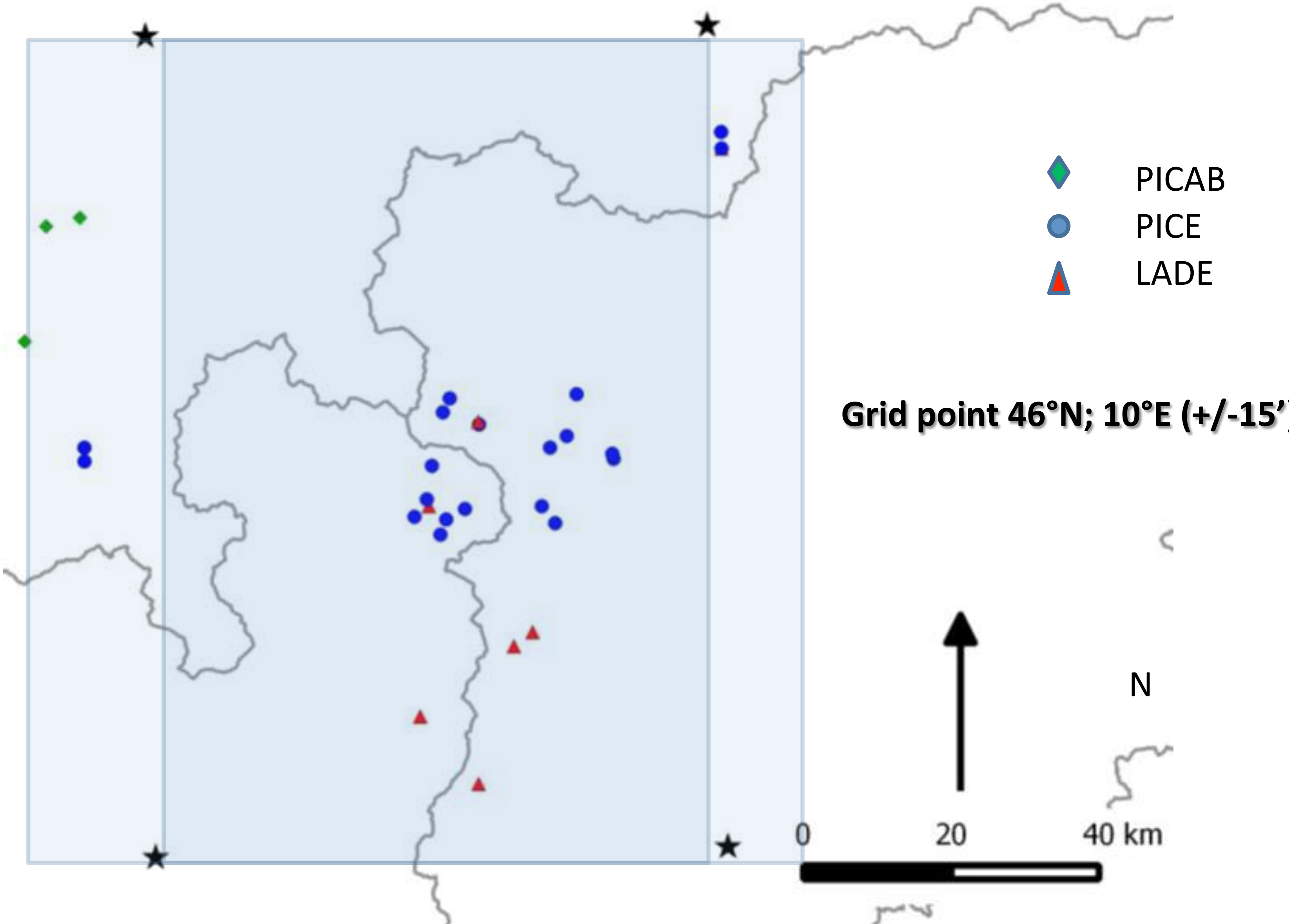
Main points

• The temperature variations characterizing the LIA are well evident also in the reconstructed data, particularly the coldest years of the 19th century (e.g. 1813, 1816 and 1821 AD).

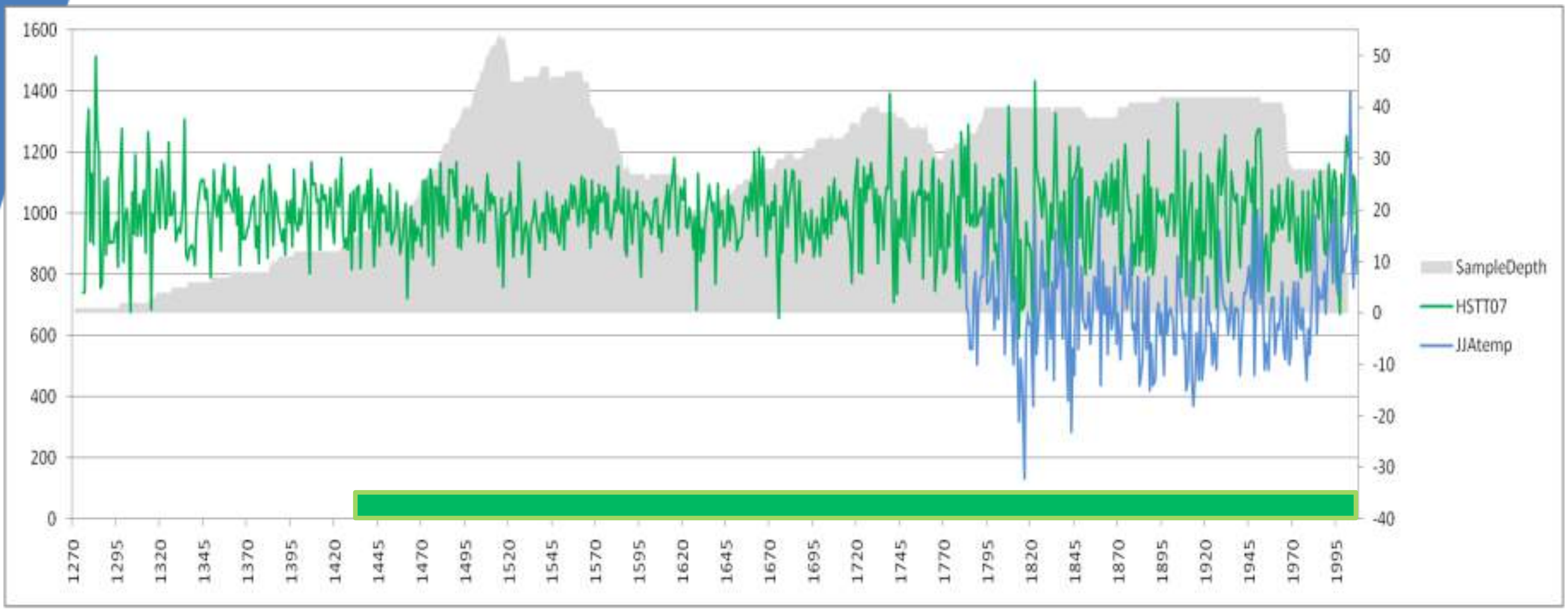
• The reconstructed temperature dataset records the recent warming trend of summer conditions starting from about 1970, mostly following the measured instrumental trends

• Our results encourages an extension of the tree-ring record further back in time, we underline also the importance of climate reconstructions related to single mountain groups for a better assessment of climate variability and the related glacier dynamics of specific regions

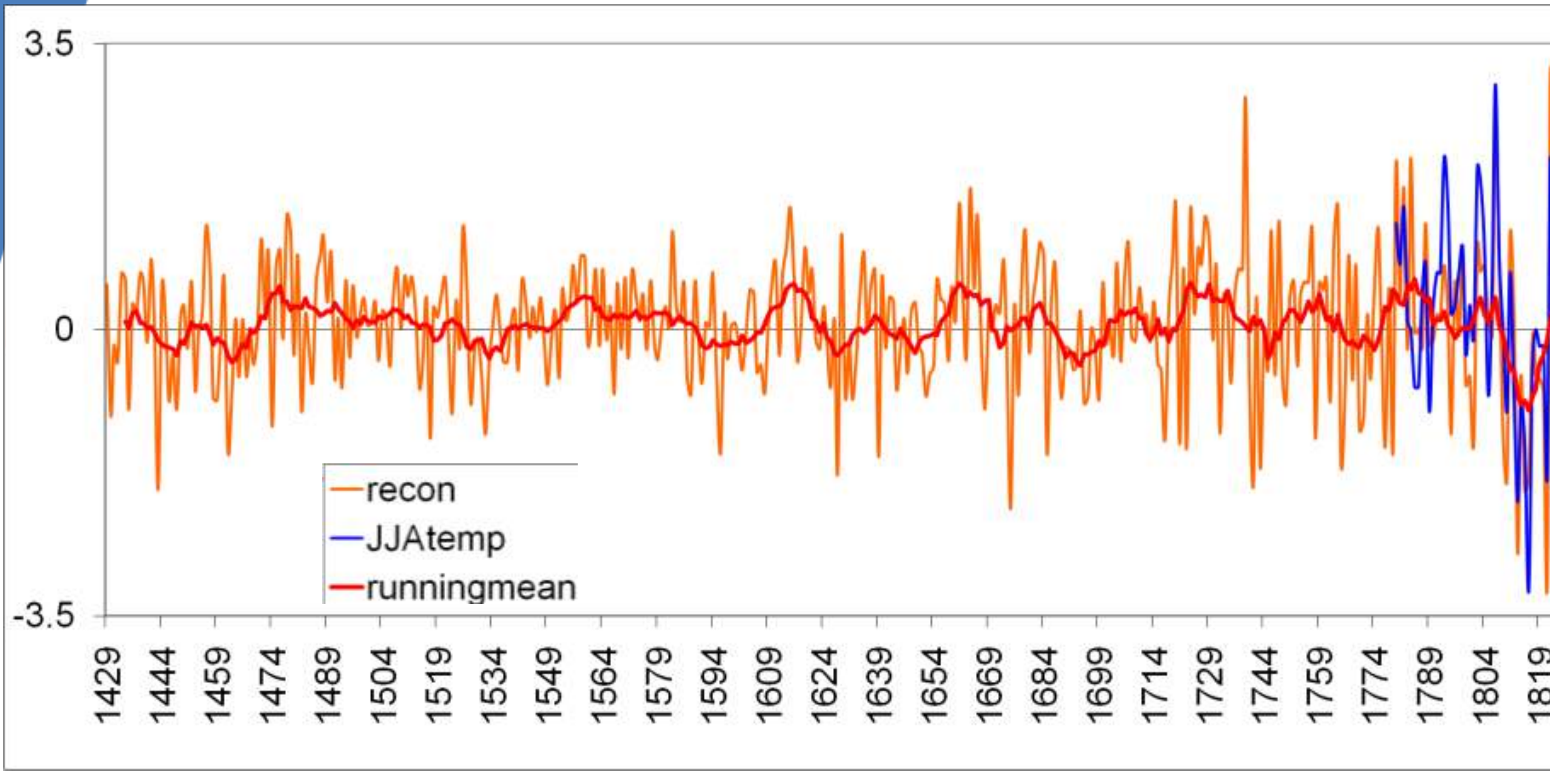
- The 46N 10E tree-ring network (*multi species approach*)



Temperature reconstructions



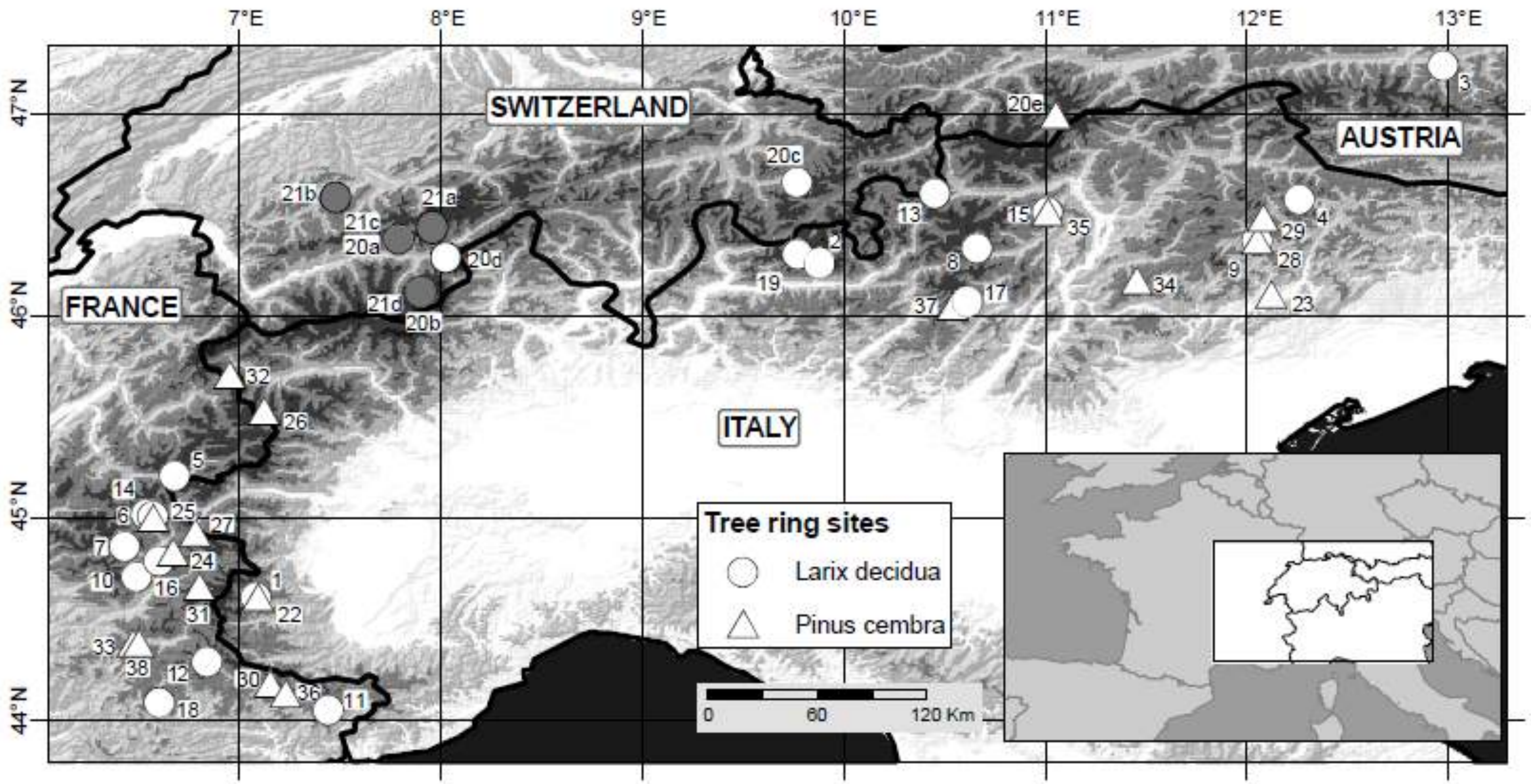
Chronology time span 1276-2008 (732 yr)
Period with EPS>85% 1430-2005 (576 yr)



Summer temperature reconstruction for the pre-instrumental period

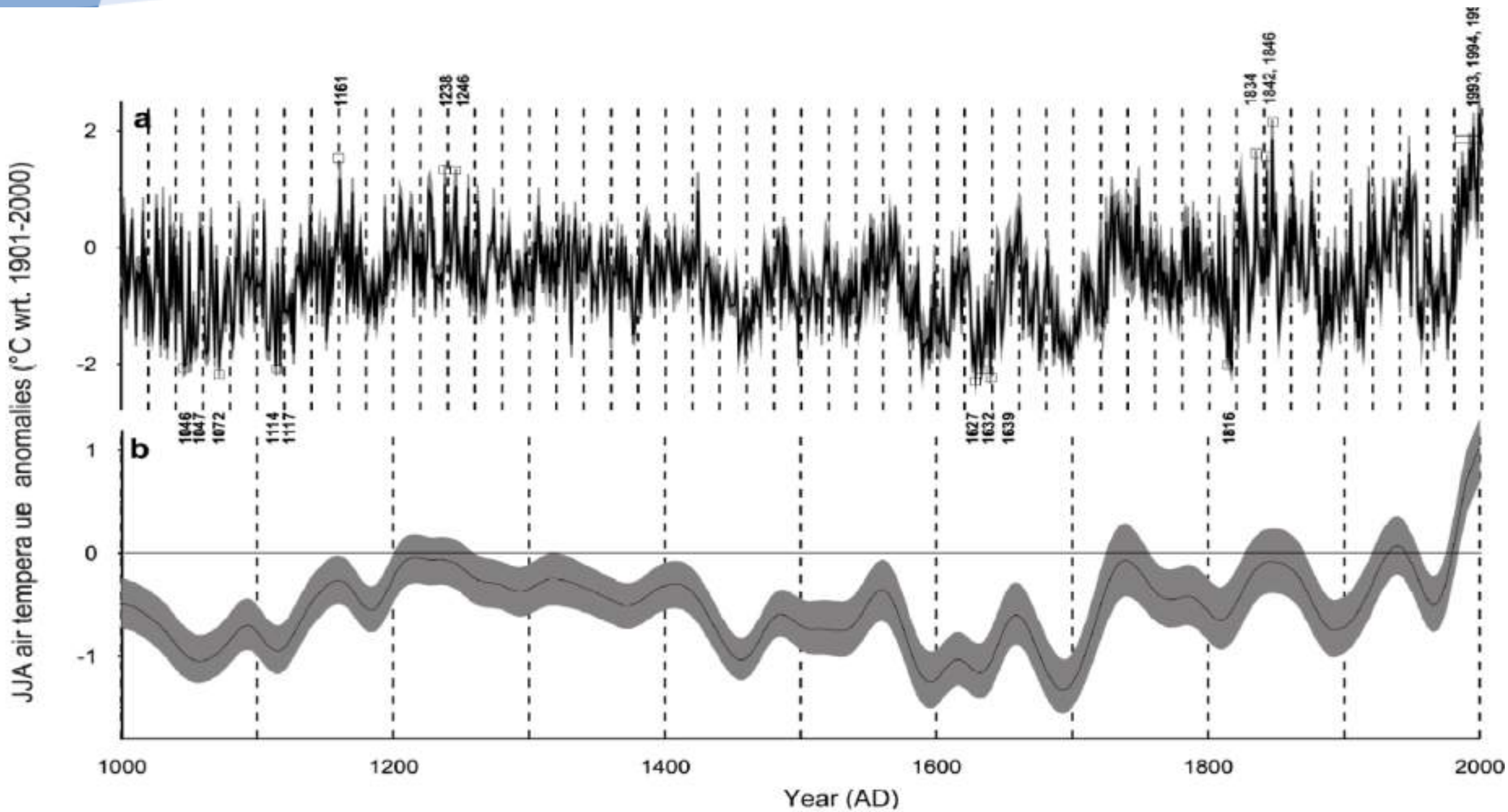
Modeling JJA temperature by scaling

- An Alpine tree-ring network (*larch and stone pine species*)

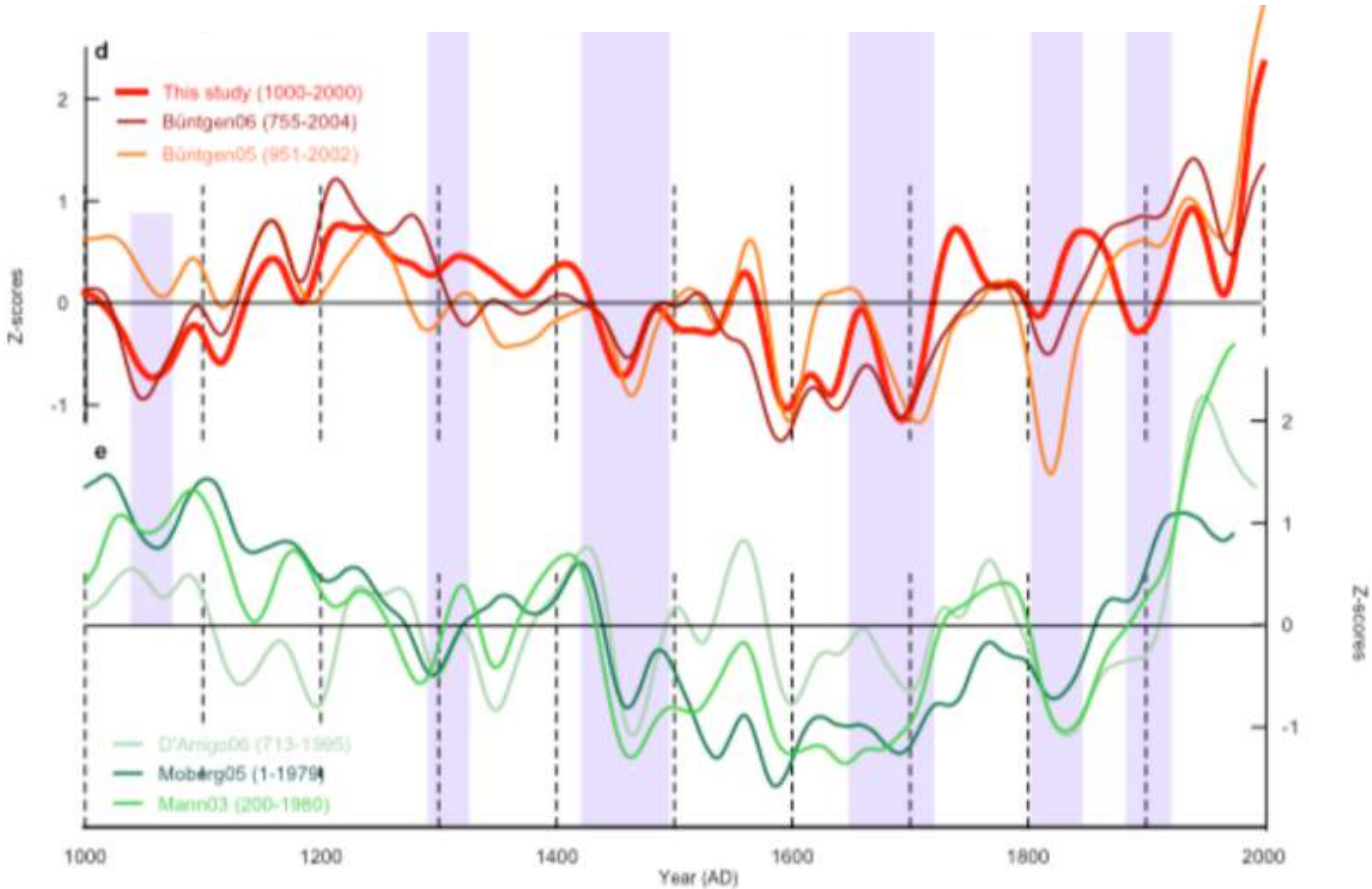


Corona et al., 2010 - Clim. Past

Temperature reconstructions



Corona et al., 2010 - Clim. Past



Corona et al., 2010 - Clim. Past

CLIMATE reconstructions

Tree-ring based climate reconstructions may be performed also by using

Tree-ring maximum latewood density
Tree-ring stable isotopes

as witnessed by many researchers carried out in Europe and the Mediterranean area with century-long chronologies

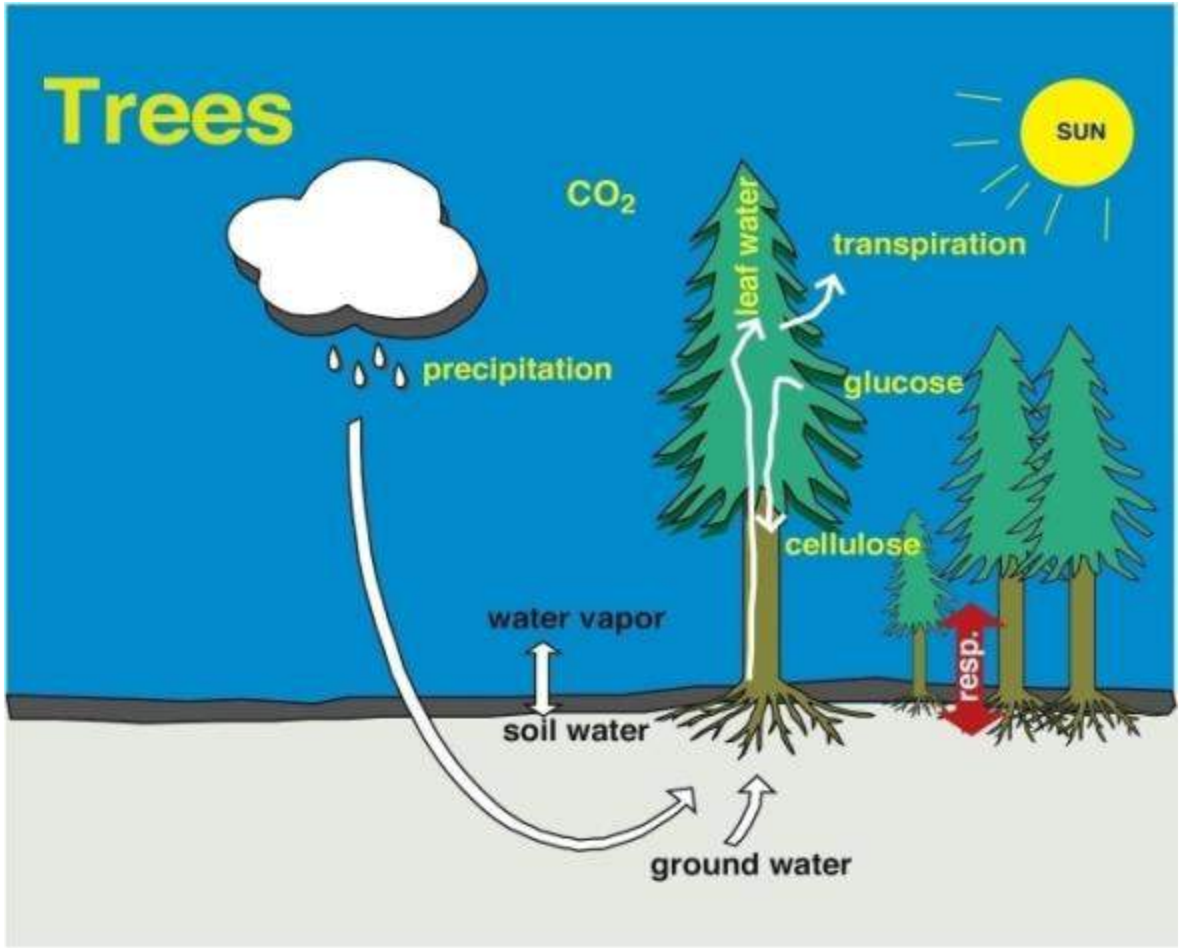
Temperature, Precipitation, Drought Events. etc-

Tree-ring stable isotopes

Controls on the isotopic signature in trees

Oxygen

- Precipitation
- Temp.
- humidity
- transpiration
- source water



Carbon

- CO_2 source
- water stress
- Temp.
- humidity
- transpiration

(Anderson et al. 2003)

- $\delta^{13}C$ and temperatures

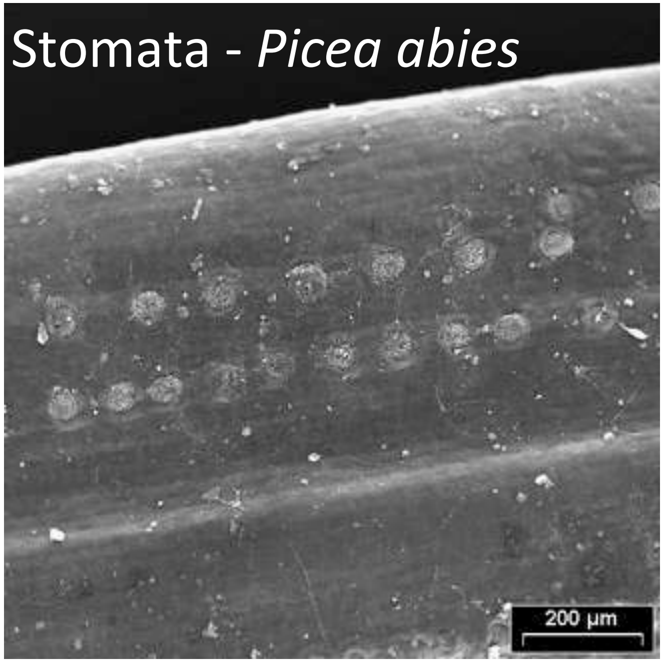
During the photosynthetic process the rubisco enzyme discriminates against the ^{13}C (fact that leads to a depleted cellulose)

But: with high photosynthetic rates (e.g. optimal conditions of temperatures and traspiration, light and general conditions of the tree)
or: when stomata are closed but the phtosynthetic processes is still working, then more ^{13}C enters into the processes (fact that leads to cellulose enrichments)

The $\delta^{13}C$ largely depends on the stomatal conductance which is modulated by:

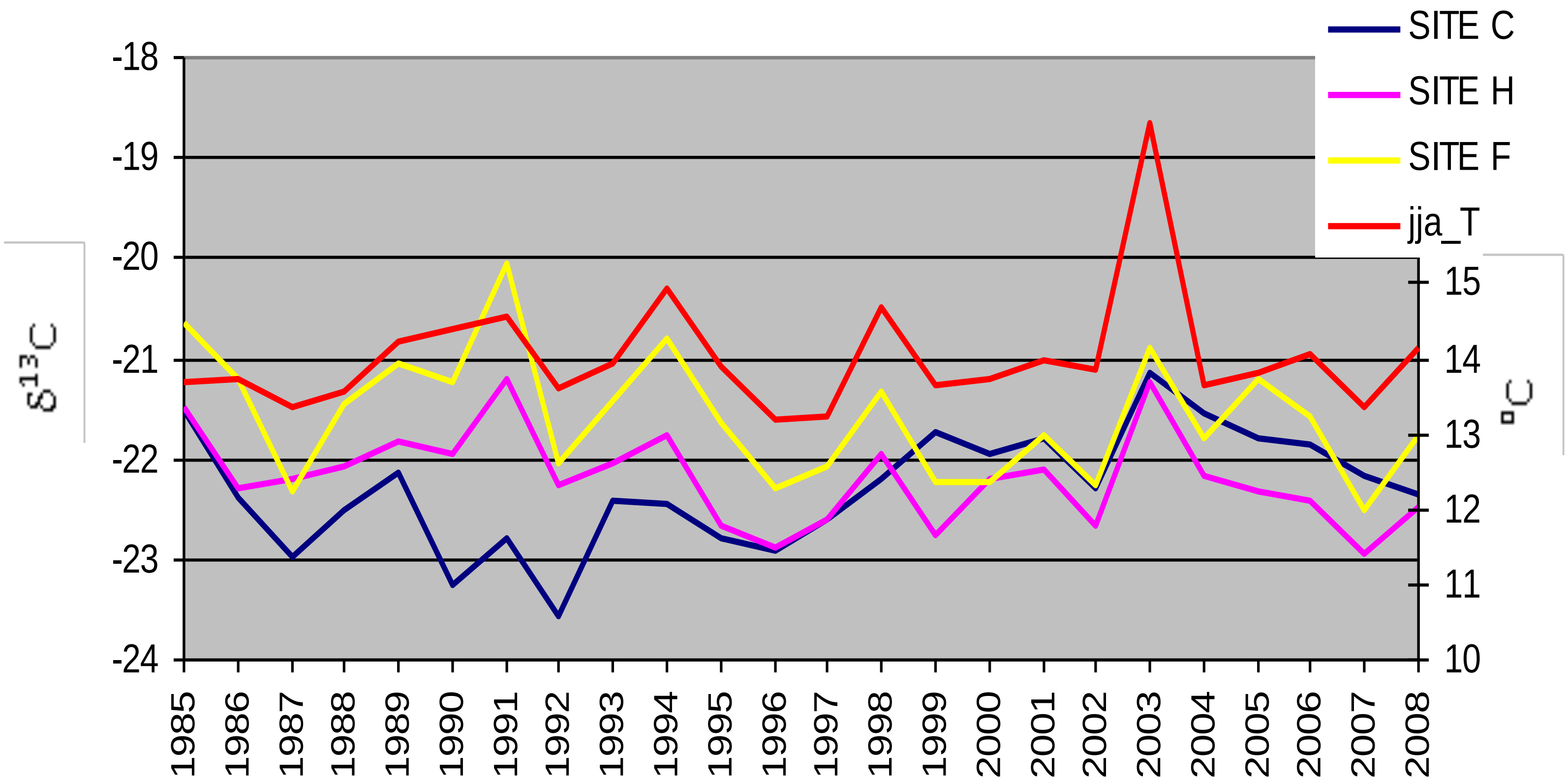
- Relative humidity of the atmosphere

- Temperature of the growing season



(Anderson et al. 2003)

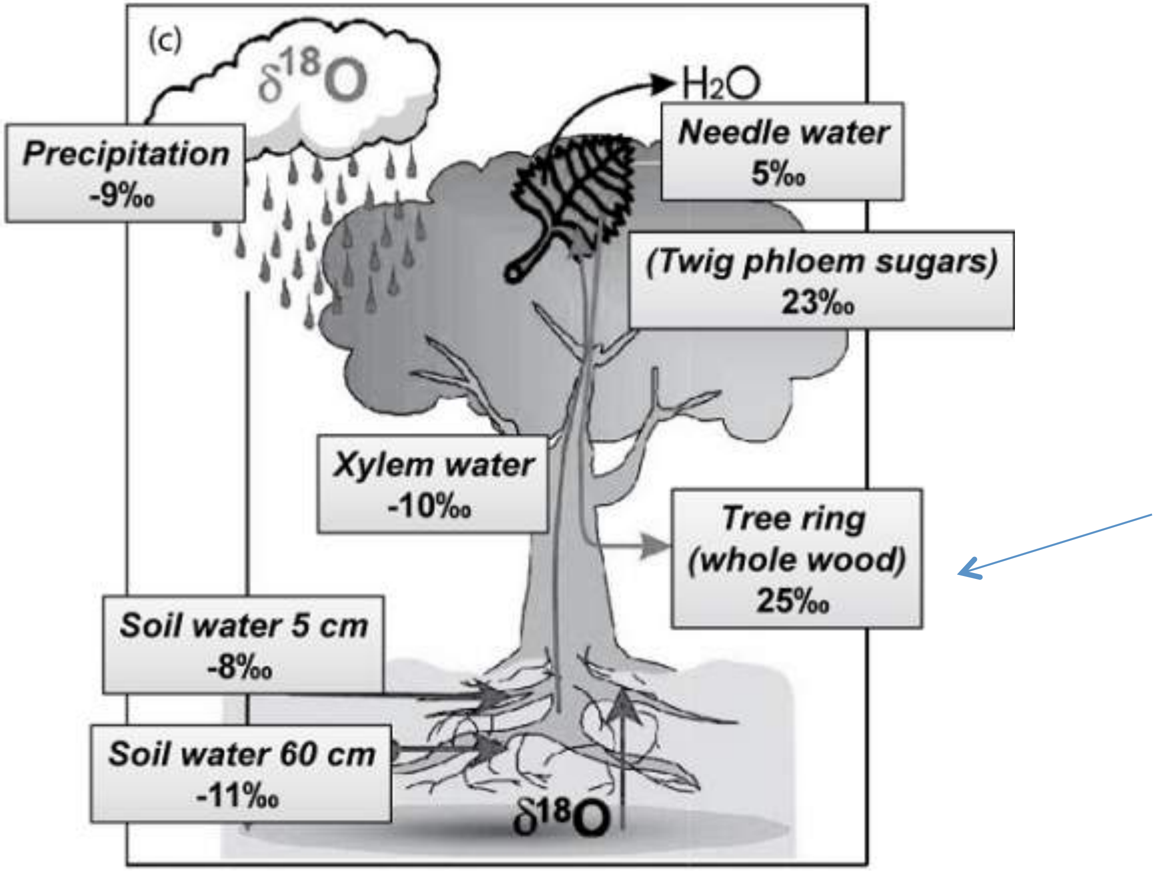
High dependence of $\delta^{13}C$ from summer temperatures also in non-extreme sites*: high potential for climate reconstructions



* Mt. Blanc area sites, Italy: ~1400 m a.s.l.

Leonelli et al., 2012 - Atm. Env.

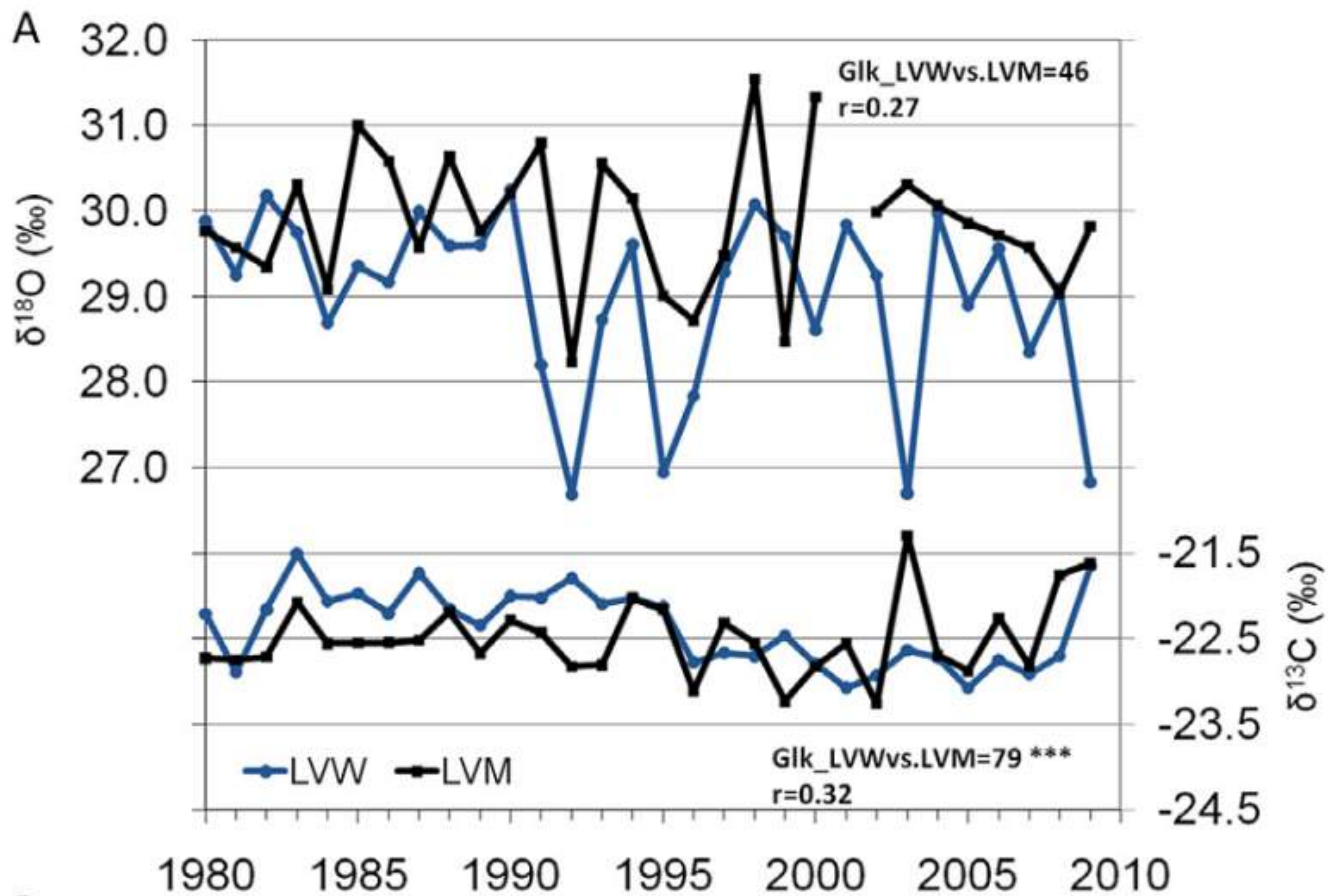
- $\delta^{18}O$ and the source water



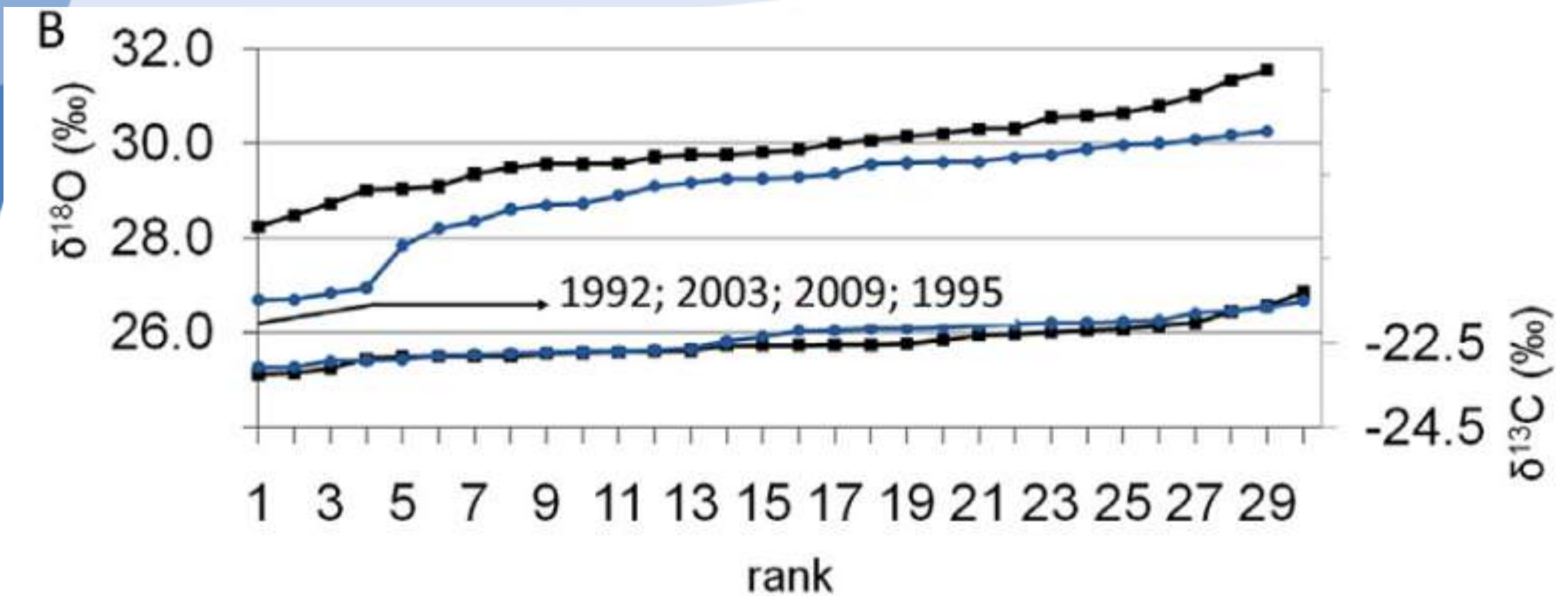
complex interplay between signals carried
-in the source water taken up by the roots and those produced
-by evaporative enrichment and
- (post-) photosynthetic processes at the leaf level and during downstream metabolism.

Leonelli et al., 2014 - Boreas

Tree-ring stable isotopes and glacio-hydrological reconstructions

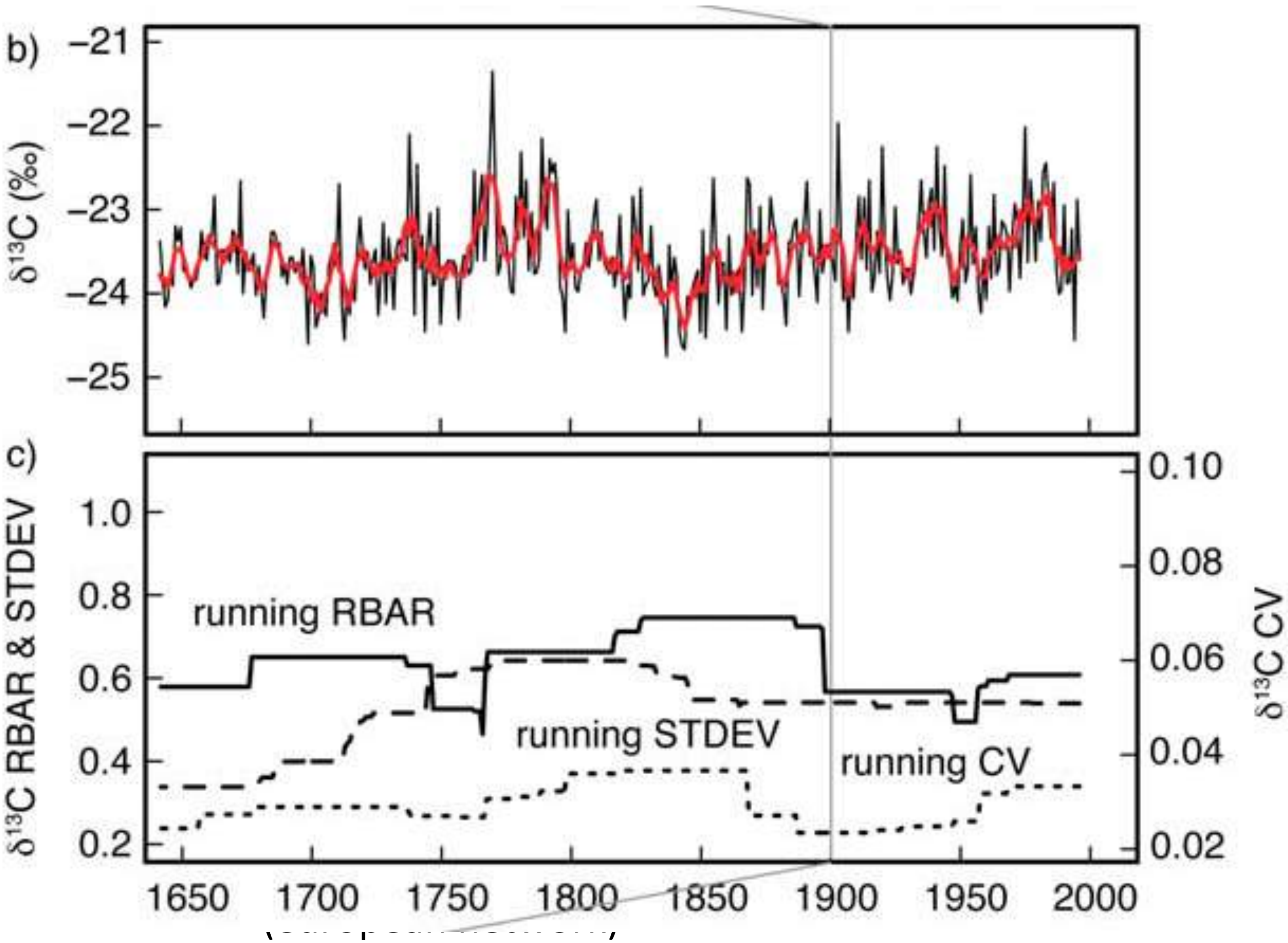


Leonelli et al., 2014 - Boreas



	Average (‰)	Standard deviation
Glacial meltwater (n=4)	–15.71	0.61
Lake water (n=3)	–15.16	0.36
Annual precipitation	–10.64	2.29
JJA precipitation	–7.80	0.87
Mid-June precipitation	–8.05	–

Leonelli et al., 2014 - Boreas

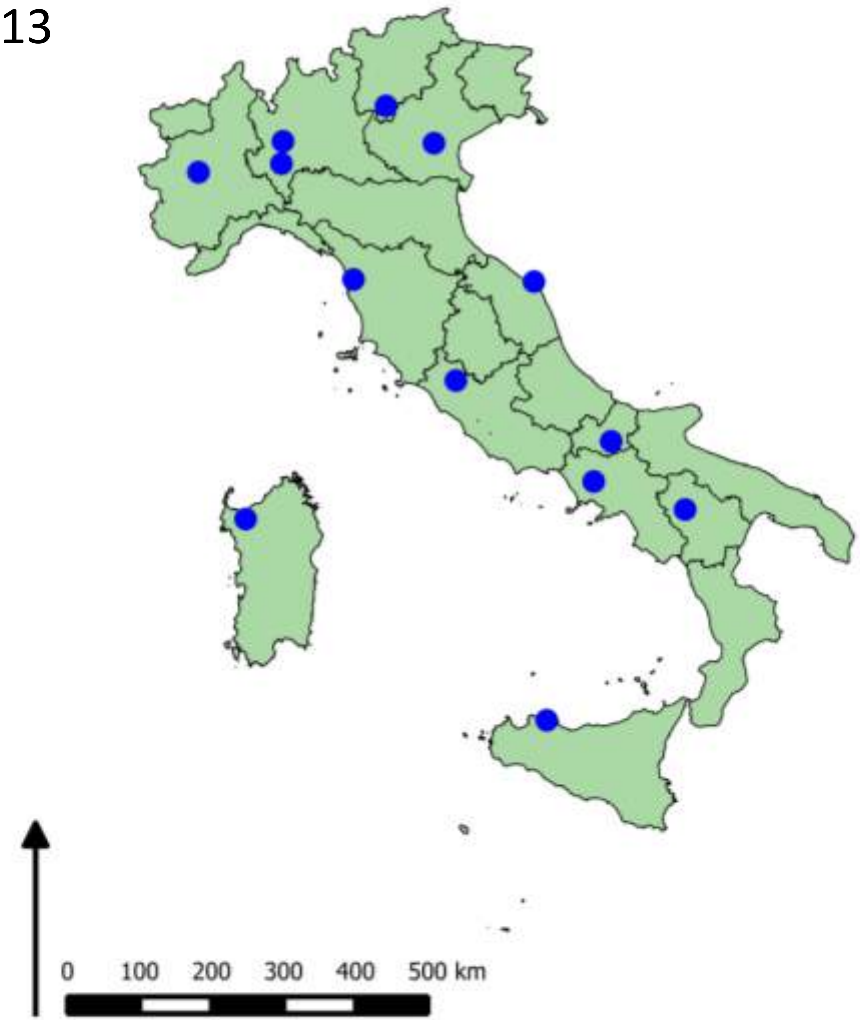


Kress et al. 2010 - Glob. Biogeochem. Cycles

Tree-ring groups currently active in Italy

A first census has allowed to identify 13 major research groups owning dendrochronological data potentially useful for climate reconstructions

Museo Civico di ROVERETO (ex IID)
Università del MOLISE
Università della BASILICATA
Università della TUSCIA
Università delle MARCHE
Università di MILANO
Università di PADOVA
Università di PALERMO
Università di PAVIA
Università di PISA
Università di SASSARI
Università di TORINO
Università Seconda di NAPOLI



Tree-ring data for Italy

Available tree-ring sites in Italy via ITRDB

44 sites (IT territory)
201 sites (IT+ 50 km)

+
~ 60 sites from IT and nearby countries potentially available from the contacted groups

NOAA

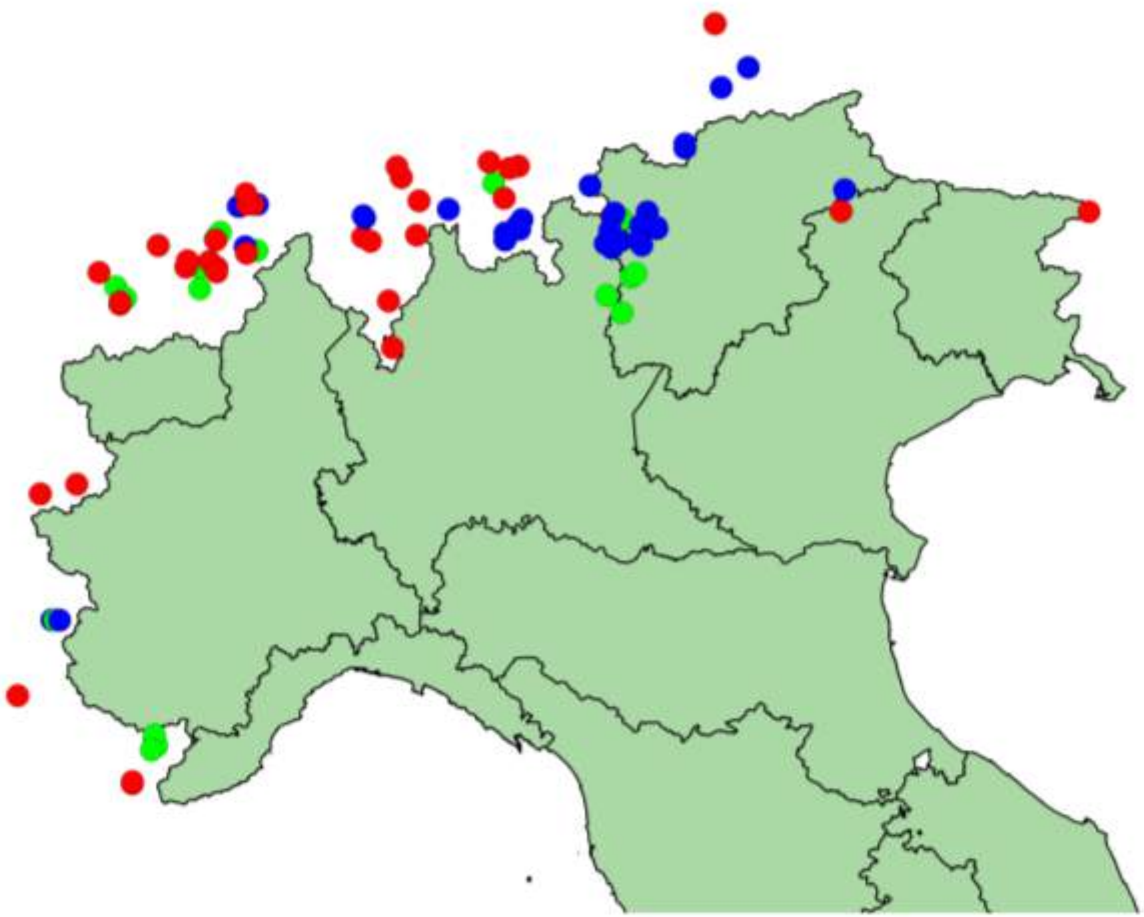
The International Tree-Ring Data Bank

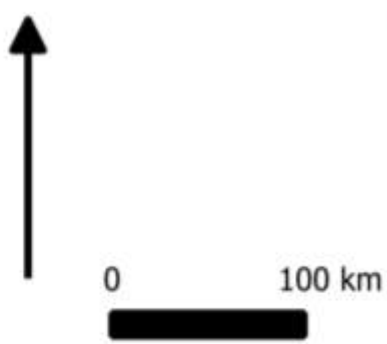
- *Picea abies* Karst. (51 sites)
- *Larix decidua* Mill. (39 sites)
- *Pinus cembra* L. (39 sites)

IT Alps +50 km: 129 sites (ITRDB + UniMilano +UniPisa)

The importance of open data access

A new way for acknowledging the chronologies' authors





Thank you for your attention !

giovanni.leonelli@unimib.it

NextData

Università degli Studi di Milano

Università degli Studi di Milano Bicocca

Accademia Nazionale dei Lincei
Centro Linceo Interdisciplinare «Beniamino Segre»