Supplementary material

The case of a southern European glacier disappearing under recent warming that survived Roman and Medieval warm periods by Ana Moreno, Miguel Bartolomé, Juan Ignacio López-Moreno et al.
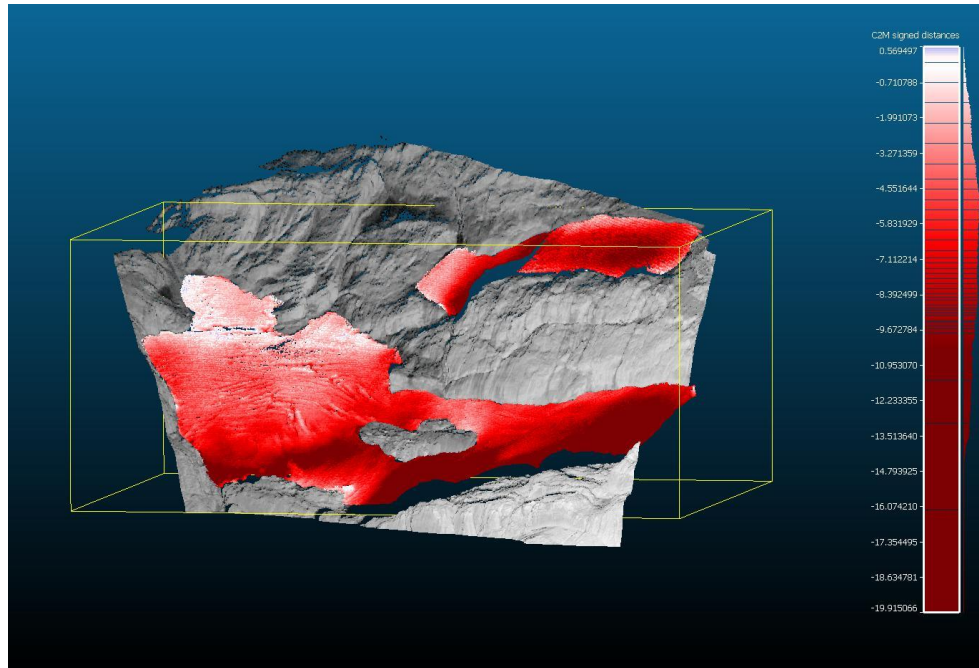

Fig. S1. Surface elevation change of the upper and lower MPG based on terrestrial laser scanning from September of 2011 to 2019.
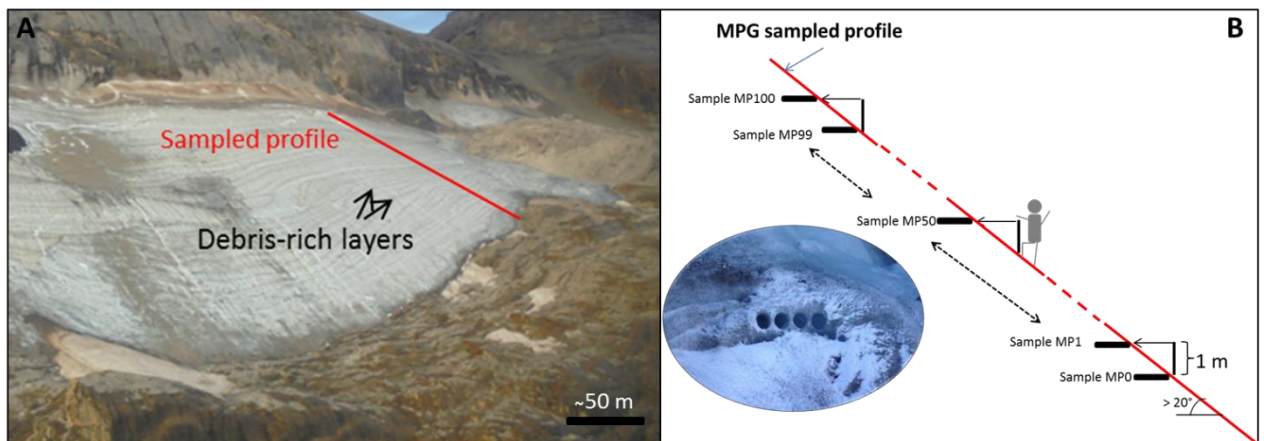

Fig. S2. **(A)**. Picture of the glacier in October 2017 where the organic and debris-rich dark layers can be observed. In red, the line where the sampling was carried out. **(B)** A scheme of the samples taken every meter in MPG using the Jacob's staff. Note only few samples in the profile are indicated. The inset picture shows four small ice cores obtained at a particular sampling site as an example of sampling procedures.

Table S1. Concentrations of ^{137}Cs in the soluble water fraction of ice from Monte Perdido samples.

Sample	Mass of ice analyzed (g)	MDA (Bq·L^{-1})
MP61	240	0.15
MP82	178	0.16
MP97	232	0.14
MP98	376	0.09
MP100	238	0.17

Table S2. Determination of ^{210}Pb activity in the soluble water fraction of 100 g of ice from Monte Perdido samples.

Sample	[210]Pb activity (Bq·L^{-1})	MDA (Bq·L^{-1})
MP73	17.4 ± 2.6	1.14
MP76	6.2 ± 1.3	0.70
MP82	<MDA	0.61
MP85	<MDA	0.84
MP88	<MDA	1.23
MP91	<MDA	1.05
MP94	<MDA	0.71
MP97	<MDA	0.77
MP98	<MDA	0.58
MP100	8.5 ± 1.5	0.71

Monte Perdido age-depth model

The depth age model was created using the package CLAM 2.2 (Blaauw, 2010; Blaauw et al., 2019) run in R (R Development Core, 2018). CLAM creates depth-age models that can be based on linear interpolation, linear or polynomial regression and cubic, smooth or locally weighted splines. CLAM enables that for each date the probability of a calendar year being sampled is proportionate to its calibrated probability (Blaauw, 2010). Uncertainty ranges as well as a most-likely age-model are produced as a CLAM output.

In order to reproduce the presented age model we provide here details on the chosen parameters.

The dataset to build this age model is available in the file *paleoice.csv* and a summary of the parameter used are in *paleoice_polyn_regr_settings.txt*. We chose to perform a linear regression (polynomial of order 1) as the more realistic option to enhance the goodness of fit of our model,with a confidence interval of 0.95 where 1000 iterations were run. The regression was weighted according to the calibrated probabilities of the dates and the age-depth model derived ages averages were weighted too. We set a hiatus at 2700 cm as explained in the text (equivalent to 73 m depth following a bottom-up sampling strategy).

The following R code lines enable creating the current age-depth model. We encourage the reader to read Blaauw (2010) and the online version of CLAM 2.2 before running this code.

```
install.packages("clam")
library(clam)
clam(core = "paleoice", type = 2, smooth =1, prob = 0.95,
     its = 1000, coredir = c(), wghts = 1, cc = 1,
     BCAD = TRUE, decimals = 0, hiatus = c(2700), revd = TRUE, revyr = TRUE,
plotname=FALSE)
```

Blaauw, M., 2010. Methods and code for 'classical' age-modelling of radiocarbon sequences. Quaternary Geochronology 5, 512–518. https://doi.org/10.1016/j.quageo.2010.01.002

Blaauw, M., Christen, J.A., Vazquez, J.E., Goring, S., 2019. clam: Classical Age-Depth Modelling of Cores from Deposits. CRAN 2019 https://CRAN.R-project.org/package=clam