



WorldDendro 2010
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Dendrochronology

Floating millennial chronologies of *Pinus* in the Sierra de Gredos (Spain)



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Introduction

This research has been carried out by some members of the “History and Dynamics of the Vegetal Landscape” Research Group of the Technical University of Madrid (Spain). The team has been working on the flora, vegetation and dendrochronology of the Sierra de Gredos (Ávila, Spain) for the last 20 years.



Recently, we have implemented a new research field focused on the study of megafossils. All this data set has allowed us to develop an interpretation of the dynamics of mountain pine forests in this region.





Nevertheless a number of dendroecological studies on *Pinus sylvestris* and *Pinus nigra* Gredos pinewoods have been carried out over the last decades, with the aim of increasing the knowledge of tree's longevity, their patterns of growth as well as their forest dynamics, structure and origin.

LOCALIDAD	AUTOR/ES	ESPECIE	LOCALIZACIÓN GEOGRÁFICA	ALTITUD (m)	N	TIME SPAN
Navarredonda	K. Richter	<i>P.sylvestris</i>	40°20'-5°08'	1500	24	1769-1985 (217 años)
Hoyos del Espino	K. Richter	<i>P.sylvestris</i>	40°20'-5°10'	1500	21	1813-1985 (173 años)
Cuevas del Valle	D. García & M. Génova	<i>P.sylvestris</i>	40°19'-5°01'	1500/ 1700	28	1740-2003 (264 años)
Piedralaves/ Casavieja	M. Génova	<i>P.nigra</i>	40°21'-4°40'	1300/ 1500	31	1667-1991 (325 años)
El Arenal	M. Génova & D. García	<i>P.nigra</i>	40°17'-5°07'	1300/ 1600	51	1686-2002 (317 años)
Navalacruz	P. Moya & M. Génova	<i>P.nigra</i>	40°25'-4°53'	1000/ 1200	94	1809-2006 (198 años)



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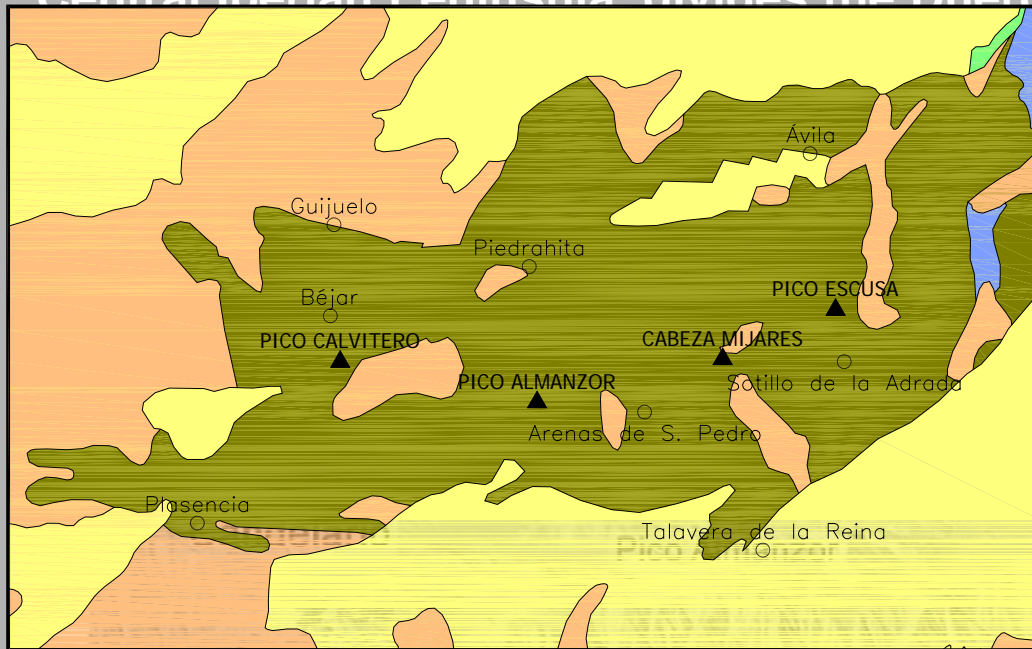
In this presentation, we expose the results of our efforts to acquire preserved sub-fossil pine material in order to increase the dendrochronological data, with the aim to develop a longer master chronology in the region.



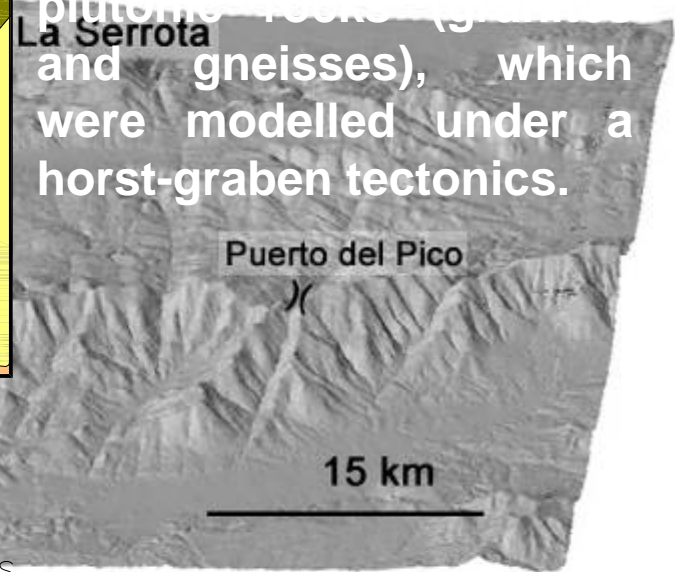


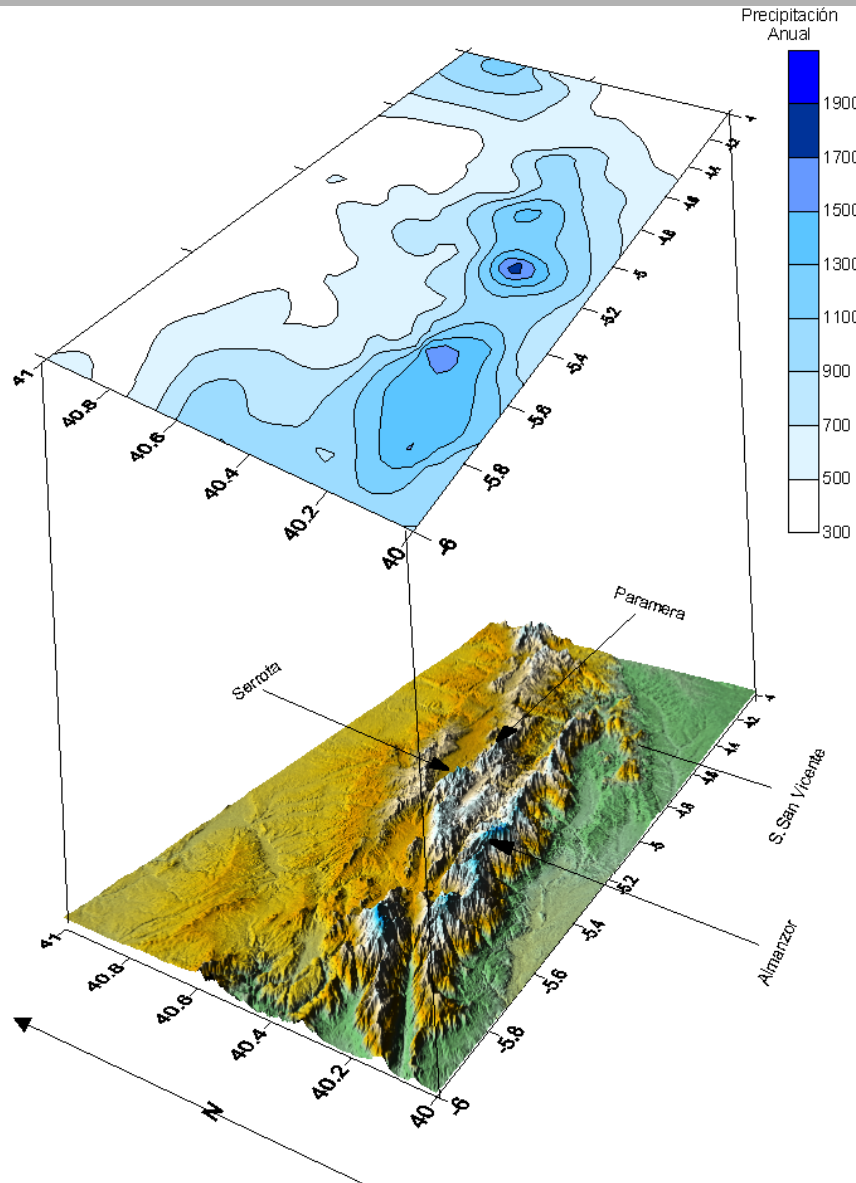
Study area

The Iberian Central range, running from west to east in the Central Iberian Peninsula, divides the Duero and Tajo basins. The Gredos stem of the Central System. It is the highest peak of Central Iberia. The continental basement is mostly composed of



plutonic rocks (granites and gneisses), which were modelled under a horst-graben tectonics.





The climate is montane Mediterranean, characterized by a strong summer drought, high seasonal temperature fluctuations and heavy orographically controlled precipitations.

Because of the influence of south-western humid winds there is a high asymmetry in the moisture gradient, the mean annual precipitation ranging from 1500–2000 mm in the southern slopes to less than 500 mm in the northern ones.

Distribution of total rainfall (mm) in the Gredos massif



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Below 1100 m evergreen oaks (*Quercus ilex* subsp. *ballota* and *Quercus suber* in the southern slopes) occupy the basal belt, mixed with extensive pinewoods (*Pinus pinea*) on sandy or xeric enclaves.



Deciduous Pyrenean oak (*Quercus pyrenaica*) and Cluster pine forests (*Pinus pinaster*) extend up to 1400 m.

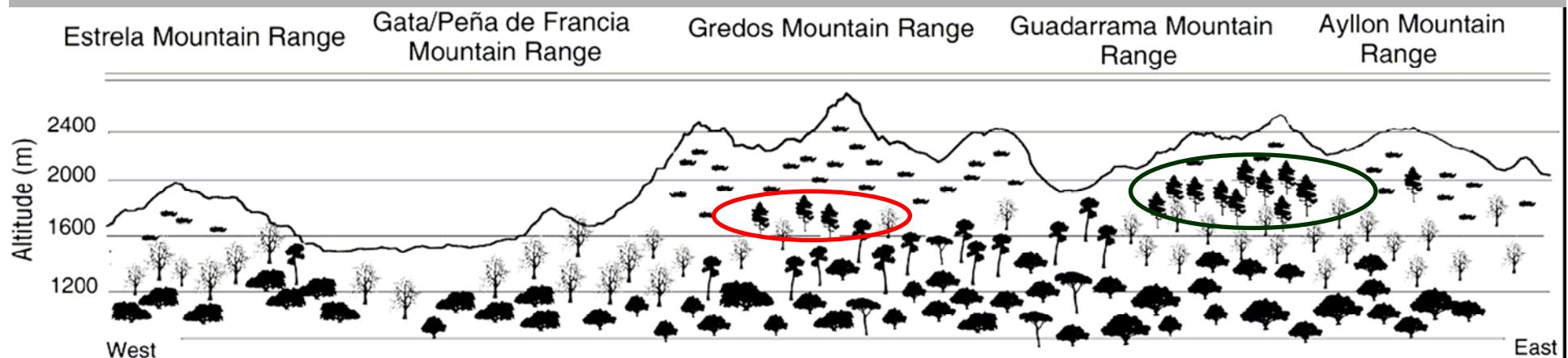




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The tree-line reaches 1800 m with isolated and dispersed stands of *Pinus nigra* subsp. *salzmannii* and *P. sylvestris*. The upper zone is a shrub-dominated community of broom (*Cytisus oromediterraneus*) and prostrate juniper (*Juniperus communis* subsp. *alpina*).





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Although pine forests are scarce nowadays, some masses and stands are still preserved with trees that can exceed 300 or 350 years (*Pinus sylvestris* and *Pinus nigra*, respectively) and have been analyzed as already mentioned.





Material and methods

Compared to northern latitudes the Iberian peninsula is not a territory suitable for the existence of environments in which fossil wood remains could be preserved properly, therefore these are scarce. In this context Gredos is an exceptional source of megafossils. We found dead pine remnants (stumps and logs) by scrutinizing the mountainous and alpine meadow zones in the study area.





Other remains were found thanks to forest works that involved the opening of trenches (drainage, water captation or forest paths).



One of the most striking trunks (nearly 2 m in circumference and 5 m in length) was the first to be found (03/07/2001).



We have found more than 140 remains from 35 different sites (in some cases only two or three in each site) from 1100 to 1800 m of altitude range.

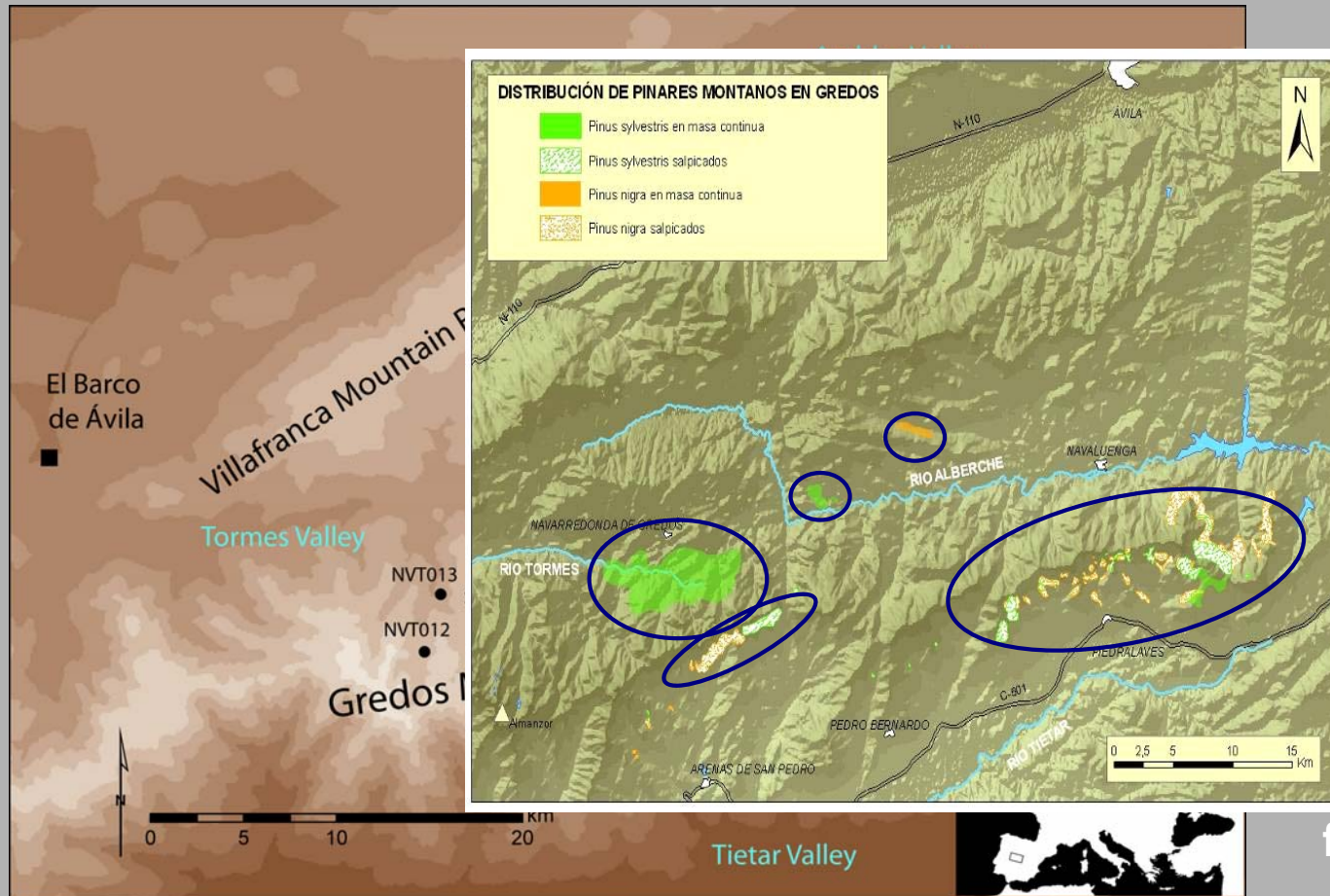
The information from the identification and ages of the fossil woods was previously used to address specific biogeographical debates, such as the naturalness of pinewoods in the mountains of Gredos.



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Altogether, 22 megafossils (mainly stumps and logs) and some sections of archaeological wood from ancient structures were recovered in an area of 750 km², radiocarbon dated and analyzed for dendrochronological purposes.



Most of these remains were recovered on the southern slopes of the central part of Gredos, nowadays treeless area.

They have been identified to the group or species level, based on its wood anatomical features.



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At least one section was obtained from each specimen. In each sample a minimum of two or three radios were measured and crossdated (with the equipment and application LINTAB Win and TSAP).



Radiocarbon dates were obtained from samples of wood taken from the outer heartwood rings (aprox 20) of the logs.

Dates were calibrated using the CALIB 6.0.1 software with the last dataset available (INTCAL 09).

Dates are presented as calibrated years BP or BC/AD and the dated parts of each measured floating series are approximately located in the most probable year to which the part corresponds, following the median of probability as suggested by Telford et al.

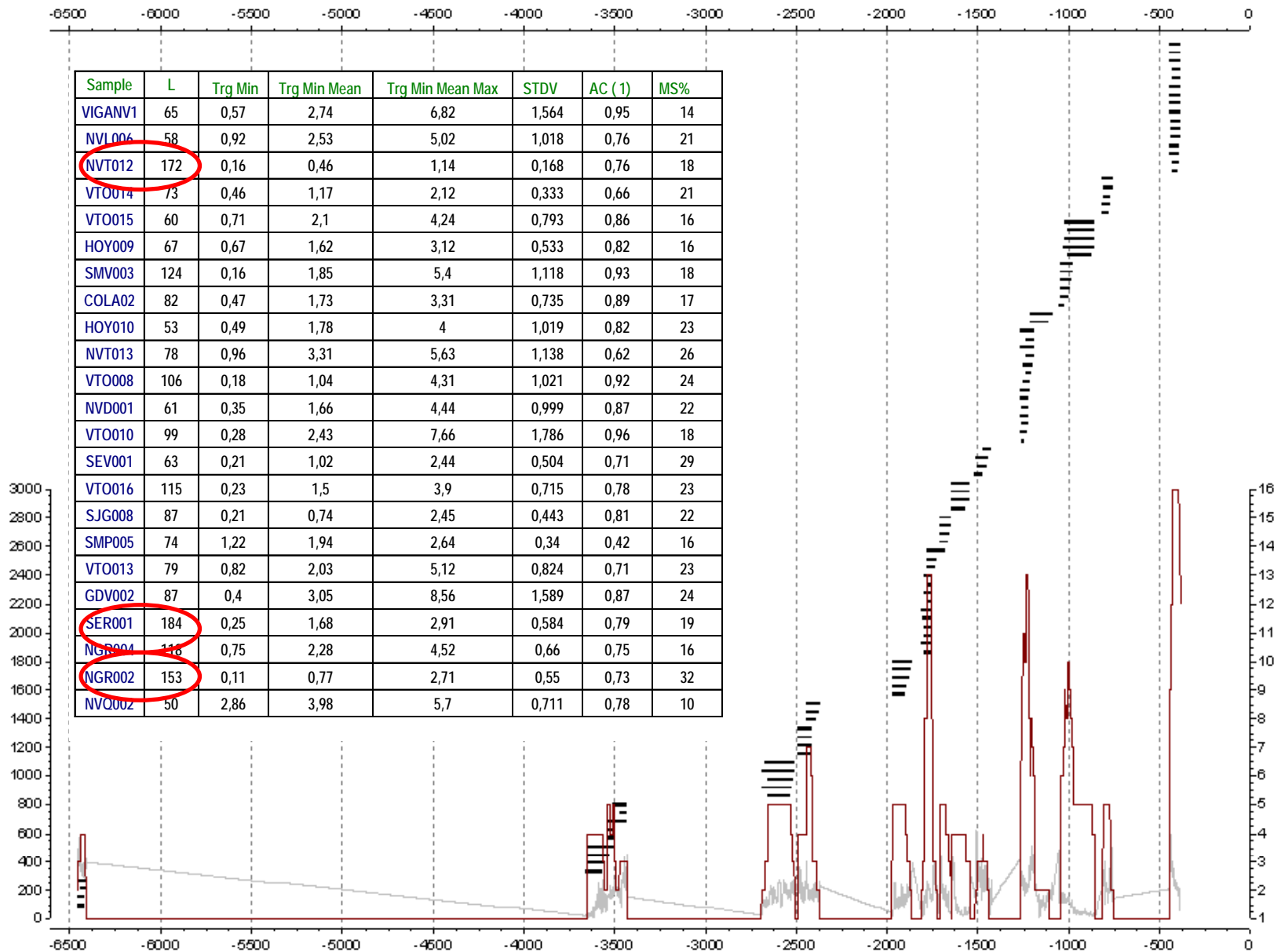


Results and Discussion

The 23 radiocarbon dated samples of *P. sylvestris* group extent from **315-456 cal BP** (archaeological wood) to **6318-6477 cal BP** (subfossil stumps, some in life position)

Therefore they lie in an interval of more than 6000 years

Sample	Lab code	Coordinates	Site	Radiocarbon date (14C BP)	Calibrated date (years BP)	Median (years BP)
VIGANV1	Beta-27851	30TVK1870 1500	Navarredonda de Gredos	330±50	315-456	393
NVL006	Pta-9240	30TUK3079 1500	Navalacruz	860±20	739-779	762
NVT012	Beta-18734	30TUK0660 1750	Navalperal de Tormes, Garganta de Gredos	970±60	795-933	866
VT0014	Beta-27851	30TVK1688 1500	Puerto de Villatoro	1070±40	933-1051	981
VT0015	Beta-27851	30TVK1688 1500	Puerto de Villatoro	1080±50	935-1052	995
HOY009	Pta- 9249	30TUK3163 1750	Hoyos del Espino	1090±30	961-1052	998
SMV003	Beta-21565	30TUK1575 1650	San Martín de la Vega del Alberche	1170±40	1014-1171	1094
COLA02	Beta-27850	30TUK3168 1500	El Colmenar	1250±40	1143-1266	1196
HOY010	Pta- 9261	30TUK3164 1850	Hoyos del Espino	1300±60	1178-1289	1224
NVT013	Pta-9243	30TVK0763 1570	Navalperal de Tormes (Roncesvalles)	1560±35	1407-1516	1460
VT0008	Beta-27851	30TVK1688 1500	Puerto de Villatoro	1650±40	1446-1612	1551
NVD001	Pta-9231	30TUK2476 1600	Navadijos	1750±45	1573-1715	1660
VT0010	Beta-27851	30TVK1688 1500	Puerto de Villatoro	1770±40	1613-1733	1687
SEV001	Pta-9235	30TUK3315 1550	San Esteban del Valle	1815±25	1713-1811	1759
VT0016	Beta-27851	30TVK1688 1500	Puerto de Villatoro	1920±40	1822-1920	1868
SJG008	Pta-9247	30TUK1162 1560	Navacepeda de Tormes	2085±25	2003-2107	2056
SMP005	Beta-21565	30TUK2670 1300	San Martín del Pimpollar	2350±40	2333-2455	2376
VT0013	Beta-27851	30TVK1688 1500	Puerto de Villatoro	2380±40	2346-2459	2420
GDV002	Pta-9253	30TUK2081 1600	Garganta del Villar	2430±15	2363-2470	2437
SER001	Beta-18734	30TUK3666, 1500	Puerto de Serranillos	2440±60	2358-2695	2515
NGR004	Beta-27851	30TVK1870 1500	Navarredonda de Gredos	3220±40	3391-3469	3437
NGR002	Beta-27851	30TVK1870 1500	Navarredonda de Gredos	3280±40	3463-3558	3510
NVQ002	Beta-20882	30TUK3276 1750	Navalosa	5630±70	6318-6477	6415





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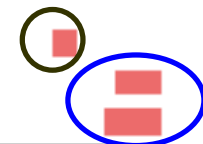


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Floating millennial chronologies of
Pinus in the Sierra de Gredos and
the nearer living chronologies of
Pinus sylvestris (Richter, 1988):

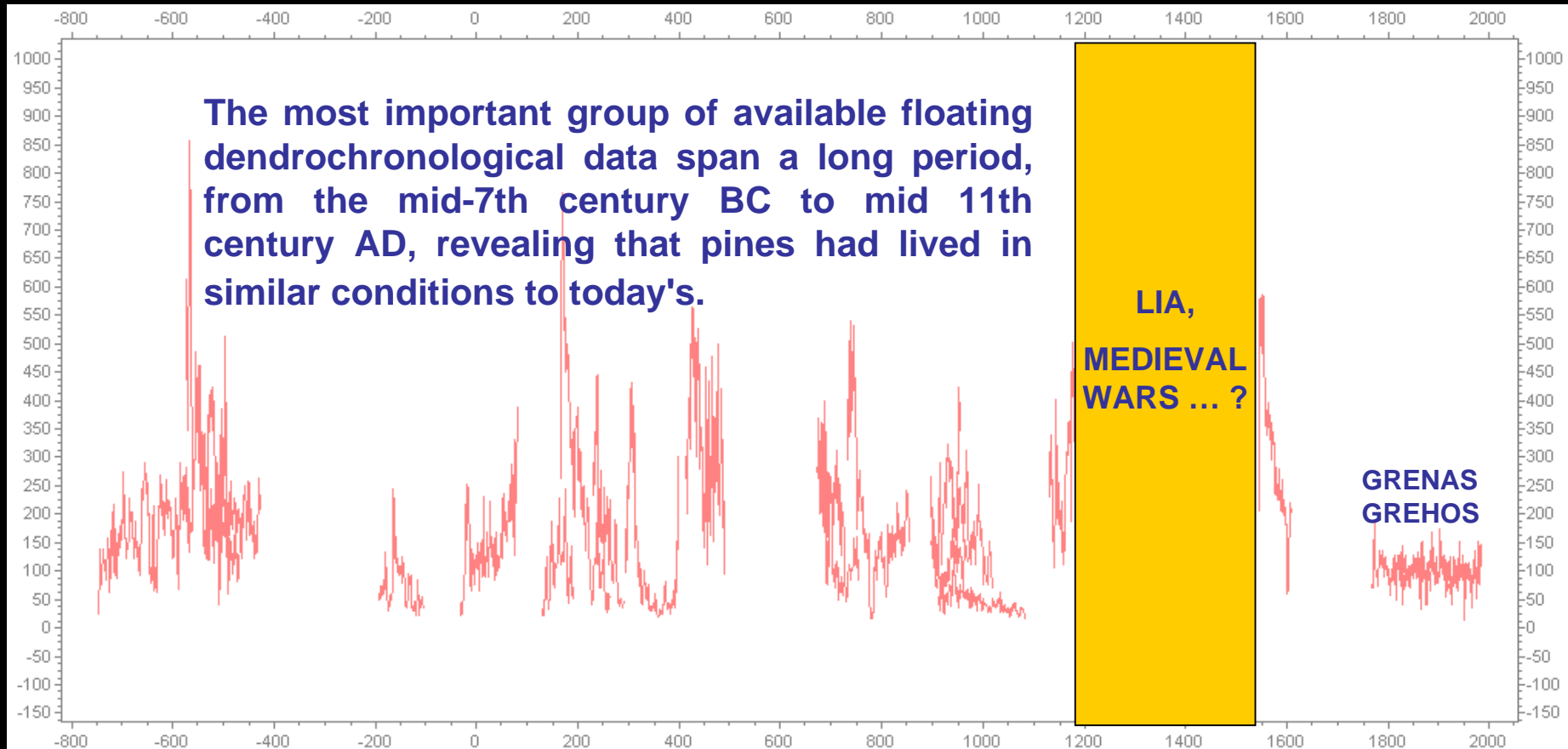
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GRENAS (1770-1985) and GREHOS (1813-1985)





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However, no living trees or fossil remains have been found during the following 350 years, perhaps due to climatic influences and/or the increase of anthropogenic activities.



We are aware about the sparse number of remain and about the difficulty of extending, significantly, these chronologies.



But our ambitious aim is both to improve the living chronologies and complete the gaps between the floating chronologies.

For example, we are beginning to extend the living chronologies with data from stumps belonging to trees cut for management purposes and to crossdate these with the regional master chronology published by Génova (2000).

Seq	Series	Time_span	1800	1825	1850	1875	1900	1925	1950	1975
			1849	1874	1899	1924	1949	1974	1999	2024
1	COTORR	1808 1910	.14B	.45	.52	.50				
2	GREHOS	1813 1985	.11B	.40	.65	.79	.77	.46	.48	
3	GRENAS	1769 1985	.03B	.29A	.61	.69	.61	.68	.73	
4	RODADC	1838 2004		.65	.68	.77	.76	.46	.51	.57
5	TOCON3	1824 2004	.07B	.21B	.49	.68	.69	.48	.53	.60
Av segment correlation			.09	.40	.59	.69	.71	.52	.56	.58



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The study of the taphonomic processes suffered by megafossils, as well as their abundance and distribution, has allowed us to suppose that they were not isolated trees in a marginal area different from a forested one. Then our work in Gredos has proved the existence of a pine's belt during the last 6500 years, clarifying its altitudinal range, surface extension, and its stability.

Pine forests in Gredos maintained their hegemony during the Holocene, but experienced a progressive decline as times went by and these forests are disappearing. Probably there is a relationship between the deforestations of the last millennia, linked with climatic changes, and the anthropogenic disturbances that occurred during the Lateglacial and Holocene.

This is the first time that a Project like this has been done in Spain and it is the southernmost among Europeans.



Acknowledgments

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We collectively thank the colleagues and friends who have accompanied us in fieldwork leading to this report.

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