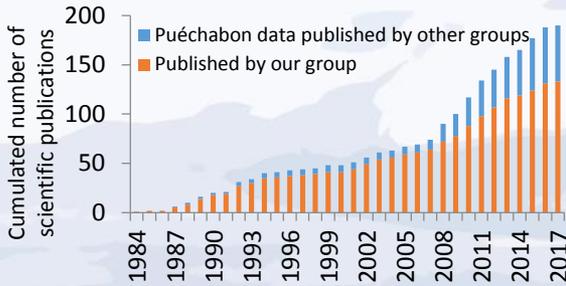


# Scientific publications



The scientific researches carried out at the Puéchabon experimental site since 1984 have contributed to 197 publications in peer-reviewed journals, 137 of which authored by researchers and students working at the CEFE.

## Selected references:

- Lempereur M *et al.* (2015) Growth duration is a better predictor of stem increment than carbon supply in a Mediterranean oak forest : implications for assessing forest productivity under climate change. *New Phytologist* 207:579-590
- Rodriguez-Calcerrada J *et al.* (2014) Stem CO2 efflux and its contribution to ecosystem CO2 efflux decrease with drought in a Mediterranean forest stand. *Agricultural and Forest Meteorology* 195-196 : 61-72
- Martin-StPaul NK *et al.* (2013) The temporal response to drought in a Mediterranean evergreen tree : comparing a regional precipitation gradient and a throughfall exclusion experiment. *Global Change Biology* 19:2413-2426
- Pérez-Ramos IM *et al.* (2013) Quercus ilex recruitment in a drier world : A multi-stage demographic approach. *Perspectives in Plant Ecology, Evolution and Systematics* 15 : 106-117
- Misson L *et al.* (2011) Phenological responses to extreme droughts in a Mediterranean forest. *Global Change Biology* 17(2):1036-1048
- Limousin JM *et al.* (2010) Do photosynthetic limitations of evergreen Quercus ilex leaves change with long-term increased drought severity ? *Plant Cell and Environment* 33 : 863-875
- Lavoit AV *et al.* (2009) Drought reduced monoterpene emission from the evergreen Mediterranean oak Quercus ilex : results from a throughfall displacement experiment. *Biogeosciences* 6 : 1167-1180
- Limousin JM *et al.* (2009) Long-term transpiration change with rainfall decline in a Mediterranean Quercus ilex forest. *Global Change Biology* 15 : 2163-2175
- Allard V *et al.* (2008) Seasonal and annual variation of carbon exchange in an evergreen Mediterranean forest in southern France. *Global Change Biology* 14:714-725
- Ciais P *et al.* (2005) Europe-wide reduction in primary productivity caused by the heat and drought in 2003. *Nature* 437:529-533
- Rambal S *et al.* (2003) Drought controls over conductance and assimilation of a Mediterranean evergreen ecosystem : scaling from leaf to canopy. *Global Change Biology* 9:1813-1824



<http://puechabon.cefe.cnrs.fr/>

## Contacts:

- Richard Joffre: richard.joffre@cefe.cnrs.fr  
 Jean-Marc Ourcival: jean-marc.ourcival@cefe.cnrs.fr  
 Jean-Marc Limousin: jean-marc.limousin@cefe.cnrs.fr

CEFE – CNRS  
 1919 Route de Mende  
 34293 Montpellier Cedex 5, France

# The experimental site of Puéchabon



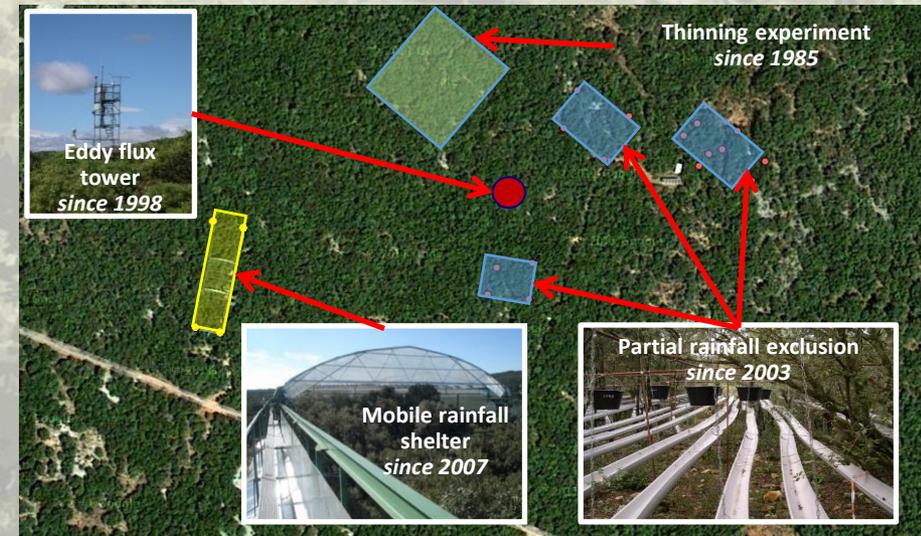
Experimental site of Puéchabon

## Studying climate change impacts on Mediterranean oak forests



The Puéchabon national forest has been studied by researchers from the CEFE-CNRS (Centre for Evolutionary and Functional Ecology) since 1984. Earlier experiments concerned forestry and management practices: clear-cutting, thinning, regeneration. Research questions evolved toward ecosystem functioning and

biogeochemical cycles with the installation of an eddy flux tower that has been continuously measuring carbon and water fluxes since 1998. Climate change related questions have then arisen with the set up of a replicated partial rainfall exclusion in 2003, which has been continuously followed since. A second rainfall manipulation experiment using a mobile rainfall shelter was latter installed in 2007. The Puéchabon experimental site is now a unique facility for studying Mediterranean forest response to climate change due to the complementarity of the existing experimental protocols and to the long data series collected at the site, some of them longer than 30 years.



## Site characteristics

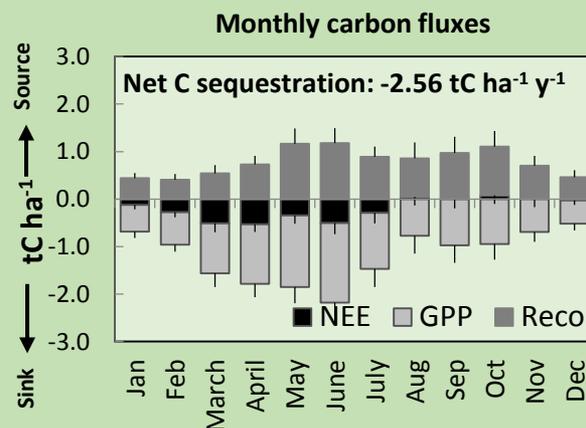
The experimental site belongs to the Puéchabon national forest. It is located near the Hérault valley, 45 km away from Montpellier. The site has a typical Mediterranean climate characterized by an important summer drought. The forest, which is strongly dominated by *Quercus ilex*, has been managed as a coppice for centuries and the last clearcut took place in 1942.

Location, Elevation 43°44'29"N, 3°35'45"E, 270 m a. s. l.  
 Mean annual temperature, precipitation 13.2 °C, 916 mm

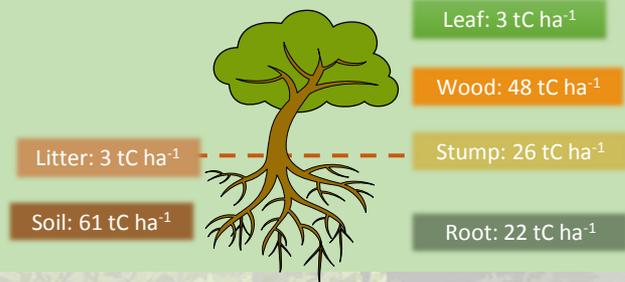
Stem density	4700 stems ha <sup>-1</sup>	Soil depth	4.5 m
Canopy height	5.5 m	Stone fraction	0.88
Basal area	29.5 m <sup>2</sup> ha <sup>-1</sup>	Soil field capacity	238mm
Leaf Area Index	2.4 m <sup>2</sup> m <sup>-2</sup>		

## Carbon balance and stock

The Puéchabon *Q. ilex* forest is a net sink of carbon with an average Net Ecosystem Exchange (NEE) of -2.6 tC ha<sup>-1</sup> y<sup>-1</sup>. The Gross Primary Productivity (GPP) is on average 11.6 tC ha<sup>-1</sup> y<sup>-1</sup> and the Respiration of the ecosystem (Reco) is 9.1 tC ha<sup>-1</sup> y<sup>-1</sup> on average. The NEE ranged from 1.4 to 4.5 tC ha<sup>-1</sup> y<sup>-1</sup> between 2001 and 2014 due to the climate variability. Although *Q. ilex* is an evergreen species, 75% of annual carbon sequestration occurs in Spring, and both GPP and Reco are reduced by drought during the summer months.



### Estimated carbon stocks



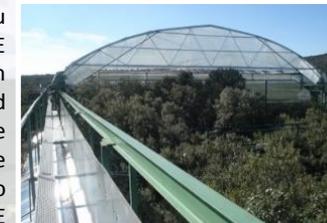
The eddy covariance fluxes measured continuously in Puéchabon since 1998 contribute to the French network of forest sites SOERE FORET, to the European ERIC observatory ICOS and to the international network of micrometeorological towers FLUXNET.

## Rainfall exclusion experiments

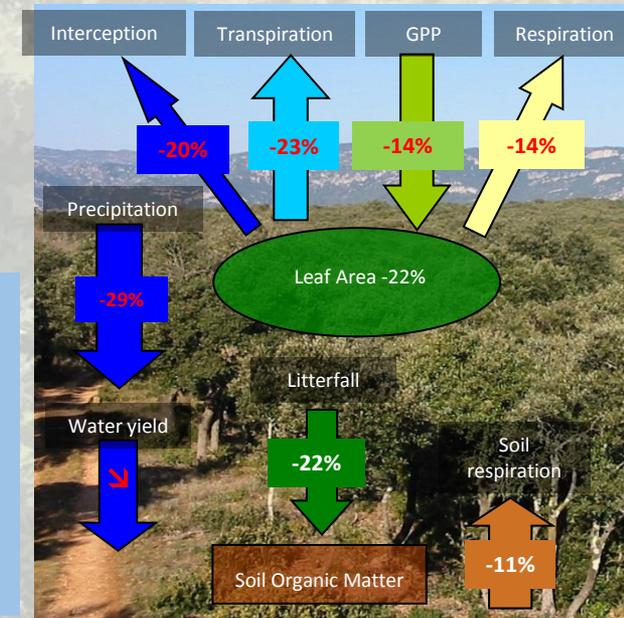


A Throughfall Exclusion Experiment (TEE) has been set up in Puéchabon in 2003 and continuously monitored since. The TEE, replicated three times in the forest, has an ambient treatment which receives the natural precipitation, a dry treatment where the precipitation is reduced by approximately 29% by PVC gutters hang under the canopy, a thinned treatment where the tree basal area has been reduced by 30% in 2003, and a dry and thinned treatment (-30% of basal area and -29% of precipitation).

One of the experimental plots is further equipped with a two-level scaffolding walkway that allows access to the tree canopy for in situ measurements on branches and leaves. Measurements in the TEE concern tree growth and mortality, leaf and acorn production, stem sapflow, leaf ecophysiology and biochemistry, soil water content and water potential. Data records obtained since 2003 make the Puéchabon experiment **one of the world's longest** and an invaluable research tool to understand Mediterranean forest response to increasing drought at different time scales from days to years. The TEE is completed by a rainfall manipulation experiment using a mobile rainout shelter that can simulate more extreme drought events.



### Summary of responses to drought after 12 years of -30% rainfall exclusion



### Water balance (mm)

Rainfall	932 ± 213
Transpiration (sapflow)	347 ± 39
Evapotranspiration (eddy)	400 ± 62
PET Potential	
EvapoTranspiration	1320 ± 57