Introduction

Drought may induce productivity decreases in temperate forests, as was observed for ecosystem CO_2 fluxes during the drought of 2003 (Ciais et al., 2005, Granier et al., 2007, Reichstein et al., 2007). Key processes have been found to alter tree functioning immediately after a drought (such as related to crown condition declines, root mortality or cavitation) and for some years after an extreme event, which is mainly due to carbon reserve depletion (reviewed in Bréda et al., 2006). In addition to global warming, the frequency and the intensity of droughts will probably increase in central and southern Europe (IPCC, 2007). This may have future implications for species distribution areas (e.g. in France, Cheaib et al., in prep.) Understanding the vulnerability of tree species to climatic variations is therefore an essential issue. Investigation of recent past impacts of climate on tree growth provides useful information on the vulnerability of each affected species.

Dendroclimatic studies show the relationships between climatic data and standardised tree-ring width indices (Fritts, 1976). They highlight the main changes in ring widths due to extreme climatic events during pointer years and the sensitivity of each species to monthly temperatures and precipitation. Identification of each species' sensitivity to climatic variables could also provide valuable information for paleoclimatic studies. Additional physiological indices, such as related to soil water deficits (Zahner & Stage, 1966), are used rather than climatic data to allow biological interpretations of the growth response to climate. These indices could be better correlated with radial growth than monthly climatic variables (Foster & Leblanc, 1993) because soil water availability is a major limiting factor for tree growth. Trees growing on sites with a low available water capacity could be more sensitive to climatic variations compared to trees growing on other sites (Lebourgeois et al., 2005).

Dendrological studies are generally focused on species growing under extreme climatic conditions where climate-ring correlations were strong (e. g. Rigling et al., 2001, Wang et al., 2006). Fewer studies have been conducted in temperate forests, although they represent 24% of the global forest area and exhibit carbon storage equally allocated between vegetation and soil (Robert & Saugier, 2003). Our study site is a French temperate forest where we compared the tree growth response of three species (*Fagus sylvatica*, *Quercus petraea* and *Pinus sylvestris*) with contrasting wood anatomy, phenology and ecophysiology to the same climatic variations. *Q. petraea* is a ring-porous species characterised by growth beginning prior to budburst (Bréda & Granier, 1996), whereas *F. sylvatica* is a diffuse-porous species showing growth beginning after budburst (Suzuki et al., 1996). *P. sylvestris* is an evergreen species, so its needles can be photosynthetically active before and during radial growth and new needle expansion. These species are widely distributed in European temperate forests, but dendrological studies on these trees are scarce in the French plains (e.g. Lebourgeois et al., 2010, Mérian & Lebourgeois, 2011). Earlywood, latewood and total ring widths were analysed for