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Temporal variability and drivers of net ecosystem production of a Turkey oak forest in Italy under coppice management

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The progress in the understanding of the carbon exchange between forests and the atmosphere has been dramatic over the last few years, yet largely based on observations of middle-aged or mature stands in the temperate and boreal region while quite a few studies report on the temporal dynamics of carbon balance in forest stand chronosequences taking into account the effect of forest management (Law et al., 2003; Kowalski et al., 2003; Kolari et al, 2004; Zha et al., 2009).

In order to quantify the temporal variability of CO_2 fluxes at ecosystem level following coppicing, we analyze eddy covariance data of a deciduous oak (*Quercus cerris* L.) coppice forest in central Italy (Roccarespampani, VT) collected over two differently aged forest stands in the period 2000-2006 and covering most of the rotation period (0-6; 11-15 years).

Data processing was performed evenly for whole data-set according to the CarboEurope database standard (Papale et al., 2006). The inter-annual variability and seasonal dynamics of net ecosystem exchange (*NEE*), partitioned into ecosystem respiration (R_{eco}) and gross primary production (*GPP*), were analyzed looking at the relationships with the main structural (biomass) and environmental drivers (air and soil temperature, precipitation, soil water content, vapour pressure deficit, global radiation) to understand which factors control the carbon dynamics of these intensively managed forests

After harvesting the forest acted as a carbon source of 69 gC m^{-2}, while in the following years NEE ranged from -18.9 (stand age: 2 years) to -1077.9 g C $m^{-2}yr^{-1}$ (stand age: 15 years). Evidently the ecosystem promptly recovers its carbon sink capacity already in the years shortly after the harvest and increases its carbon sequestration capacity with stand age (R^2= 0.75, P <0.003). Stand age was also the best predictor of annual *GPP* (R^2=0.64, P <0.001) which varied between 1293.8 and 1933.6 gC $m^{-2}yr^{-1}$and scaled with the fast growing leaf area of the coppice shoots. In contrast, annual R_{eco} did not show a clear trend with stand age, ranged between 784.6 and 1404.6 gC $m^{-2}yr^{-1}$ and responded mostly to mean annual soil temperature variations (R^2= 0.66; P <0.05), indicating that soil respiration was the main contributor to ecosystem respiration. Right after coppicing, the ecosystem stand structure, soil microclimate and processes are profoundly disturbed: particularly the increase of soil temperature in the absence of canopy cover but also the large inputs of coarse woody debris together with dead fine roots into the soil contribute to enhance soil respiration. By integrating NEE over the time frame of 16 years and subtracting the harvestable biomass produced, we assess a long term carbon sink of 2.7 tC ha^{-1} yr^{-1}.

The large variation in the carbon exchange observed during the rotation period shows that these forests under intensive management are highly dynamic and thus, points out the importance to include forest management and site history in our current estimates of continental carbon balances.