Geophysical Research Abstracts
Vol. 15, EGU2013-5512, 2013
EGU General Assembly 2013

Effects of management thinning on carbon dioxide uptake by a plantation oak woodland in SE England

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Eddy covariance (EC) methods are widely used to estimate net ecosystem CO_2 exchanges from sub-hourly to inter-annual time scales. The majority of forest sites contributing to the global EC networks are located in large, unmanaged forest areas. However, managed and plantation forests have an important role in greenhouse gas emissions abatement, nationally and globally, as exemplified by LULUCF inventory reporting. In the lowland areas of the UK forestry is mainly carried out in small woodlands, heterogeneous in species and structure and with regular management interventions.

The aim of this study was to improve our understanding of the influence of management on forest CO_2 uptake during a stand-scale thinning. CO_2 fluxes have been measured using EC at the 70-80 year old, 90 ha oak-with-understorey plantation of the Straits Inclosure in the Alice Holt Research Forest since 1998. The mean annual net ecosystem productivity (NEP) from EC over 12 years was 486g C m-2 y-1, although there has been substantial inter-annual variation (95 % CI of $\pm$ 73g C m-2 y-1). This has been partitioned into a gross primary productivity (GPP) of 2034 $\pm$ 145g C m-2 y-1 and an ecosystem respiration rate (Reco) of 1548 $\pm$ 122 C m-2 y-1. In 2007 approximately 50% of the woodland area within the EC flux tower footprint was selectively thinned according to normal management prescription with mechanical harvesters. High resolution aerial LiDAR surveys of the whole woodland collected pre- (2006) and post- (2010) thin were used to characterise the canopy gap fraction and tree height changes. We then used EC footprint analysis combined with LiDAR data to quantify the effects of the management thinning and subsequent recovery on the CO_2 flux and partitioning. Following the management thinning there was an average reduction in peak midday summer uptakes of approximately 5 μmol CO_2 m-2 s-1 (20%) compared to fluxes from the un-thinned area, and a larger depression in night-time efflux. A depression in net daily CO_2 uptake was still evident in the summer of 2010, three years after the thin. The implications of such management intervention for woodland C balances are discussed.