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Land use change through afforestation has contrasting effects on net ecosystem greenhouse gas budgets.

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Forest ecosystems represent a significant carbon store and play an important role in climate change mitigation through carbon sequestration. The impacts of land use change through afforestation on net ecosystem greenhouse gas emissions was investigated using a mobile eddy covariance tower to measure net ecosystem carbon dioxide exchange (NEE) together with static chamber techniques to measure soil derived trace gas emissions of methane (CH4) and nitrous oxide (N2O). A chronosequence (age-related) approach was used to investigate the conversion of marginal and managed grasslands to Sitka spruce and Ash plantations, respectively. The net carbon sink strength of both forest chronosequences was observed to increase after land conversion and with forest age due to an increase in productivity associated with the transition from non-forest vegetation to a closed canopy forest and the greater utilisation of resources such as light, water and nutrients. In the Sitka spruce plantation the net ecosystem carbon sink for the grassland, eight and sixteen year old stands was 0.26, 2.21 and 8.52 t C ha-1 yr-1, respectively, while NEE for the Ash plantation was 0.62, 1.38 and 4.67 t C ha-1 yr-1 for the grassland, six and twelve year old stands, respectively. Trace gas emissions however, exhibited contrasting patterns for the Sitka spruce chronosequence where CH4 emissions were 7.61, 0.49 and -0.80 kg ha–1 yr–1 for the same chronosequence, while N2O emissions increased from 0.12 to 10.12 kg ha–1 yr–1, representing some of the highest N2O fluxes from unfertilised coniferous forests in Europe. Trace gas emissions from the Ash chronosequence were significantly lower in comparison to the Sitka spruce plantations and the annual N2O (0.17-0.70 kg ha–1 yr–1) and CH4 (-0.28 to -0.91 kg ha–1 yr–1) dynamics were not influenced by afforestation, indicating that generalisations about the influence of afforestation on GHG emissions is difficult. For the Sitka spruce forest the contribution of these gases to the total greenhouse gas (GHG) budget has the potential to reduce the global warming amelioration capacity by between 8-12%.