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CH4 and N2O fluxes in undisturbed and burned Quercus ilex, Quercus pyrenaica and Pinus sylvestris forests in Madrid, Spain

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Fire is among the most relevant form of ecosystem disturbance affecting nutrient cycling in Mediterranean forest ecosystems. Over the last few decades, the number of wildfires has increased in this region destroying thousands of hectares every year. Interest in the effects of fire on forest soil fertility and soil-atmosphere exchange of CH4 and N2O has recently heightened due to the concern that climate change may increase fire frequency and intensity. The short term effects of fires on forest soils have been widely studied. However, less information is available on the long-term effects of wildfires. The aim of this work was to study the long-term effect of wildfires on N2O and CH4 soil-atmosphere exchange in three typical Mediterranean type forest ecosystems in the surrounding area of Madrid (Spain). We investigated N2O and CH4 fluxes from soils of Quercus ilex, Quercus pyrenaica and Pinus sylvestris stands. The fluxes were measured for 18 months from both mature stands and post fire stands using the static chamber technique. Simultaneously with gas fluxes, soil temperature, soil water content, soil C and soil N were measured in the stands. Nitrous oxide fluxes ranged from -11.43 to 8.34 μg N2O–N m-2 h-1 in Q.ilex, -7.74 to 13.52 μg N2O–N m-2 h-1 in Q.pyrenaica and -28.17 to 21.89 μg N2O–N m-2 h-1 in P. sylvestris. Fluxes of CH4 ranged from -8.12 to 4.11 μg CH4–C m-2 h-1 in Q.ilex,-7.74 to 3.0 μg CH4–C m-2 h-1 in Q. pyrenaica and -24.46 to 6.07 μg CH4–C m-2 h-1 in P. sylvestris.

The forest soils in the surrounding area of Madrid were mostly weak N2O emitters and significant sinks for atmospheric CH4. The nutrient status in forest soils had an effect on the fluxes of N2O and CH4.
Mean fluxes of N2O and CH4 were highest in P. sylvestris and Q.pyrenaica stands. A weak N2O uptake from the atmosphere into the soil was observed in fall and summer. The shift from CH4 sink to CH4 source was observed in wet months. N2O and CH4 seasonal variation were mainly related to soil water availability. The impact of fire on the fluxes of N2O and CH4 differed from one ecosystem to another and from one season to another. The burned sites showed higher CH4 oxidation in Q.ilex stands, and lower oxidation rates in P. sylvestris stands. Fire decreases N2O fluxes in Q. pyrenaica stands. The data suggest that the impact of fire on CH4 and N2O flux might strongly depend on the climatic seasonal patterns, ecosystem type and main soil characteristics. Due to the lack of information on fluxes in Mediterranean ecosystems, it is difficult to compare their contribution to the local, regional and global flux of N2O and CH4. This emphasizes the necessity for better estimates of atmospheric CH4 and N2O fluxes, which can only be achieved through an improved understanding of the underlying processes and supplementary field data.