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Technical note

Novel application of a combustion chamber for experimental assessment of biomass burning emission

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HIGHLIGHTS

- We describe a new combustion chamber for studying emission from biomass burning.
- We examine the emissions of gases and particulate matter during litter combustion.
- We highlight the potentiality of this facility to investigate emissions from fire.

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ABSTRACT

Biomass burning is an important ecological factor in the Mediterranean ecosystem and a significant source of several atmospheric gases and particles. This paper demonstrates the performance of a recently developed combustion chamber, showing its capability in estimating the emission from wildland fire through a case study with dried leaf litter of *Quercus robur*. The combustion chamber was equipped with a thermocouple, a high resolution balance, an epiradiometer, two different sampling lines to collect volatile organic compounds (VOCs) and particles, and a portable analyzer to measure carbon monoxide (CO) and carbon dioxide (CO_2) emission. VOCs were determined by gas chromatography–mass spectrometry (GC–MS) after enrichment on adsorption traps, but also monitored on-line with a proton-transfer-reaction mass spectrometer (PTR-MS). Preliminary qualitative analyses of emissions from burning dried leaf litter of *Q. robur* found CO and CO_2 as the main gaseous species emitted during the flaming and smoldering stages. Aromatic VOCs, such as benzene and toluene, were detected together with several oxygenated VOCs, like acetaldehyde and methanol. Moreover, a clear picture of the carbon balance during the biomass combustion was obtained with the chamber used. The combustion chamber will allow to distinguish the contribution of different plant tissues to the emissions occurring during different combustion phases.

1. Introduction

Vegetation fires, such as savanna and forest fires, domestic fuels and agricultural wastes burnings, release a great amount of trace gases as carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrous oxide (NO) and volatile organic compounds (VOC) annually that could affect the atmospheric chemistry (Lobert et al., 1990; Miranda et al., 1994) through the "greenhouse" effect and the photochemical ozone formation (Hegg et al., 1987; Schultz et al., 1999; Koppmann et al., 2005). Biomass burning also exacerbates atmospheric particulate matter loadings (Ward and Hardy, 1991). This in turn leads to significant health implications, particularly for the respirable fraction (fine particles less than 2.5 μm in diameter) and impact on the Earth's radiative budget. By acting as cloud condensation nuclei, fine particles increase the cloud albedo partly counteracting the greenhouse effect (Delmas et al., 1995; Scholes et al., 1996; Reid et al., 2005). Particularly, low intensity fires produce high particulate matter emissions due to the agglomeration of condensed hydrocarbon and tar material, as well as the

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