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Comparison of approaches for reporting forest fire-related biomass loss and greenhouse gas emissions in southern Europe

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Abstract. Wildfires are the most common disturbances in Mediterranean forest ecosystems that cause significant emissions of greenhouse gases as a result of biomass burning. Despite this, there is reasonably high uncertainty regarding the actual fraction of burnt biomass and the related CO_2 and non-CO_2 gas emissions released during forest fires. The aim of this paper is to compare existing methodologies adopted in the National Greenhouse Gas Inventory reports of five of the most fire-affected countries of southern Europe (Italy, Spain, Greece, Portugal, France) with those proposed in the literature, to operationally estimate forest fire emissions, and to discuss current perspectives on reducing uncertainties in reporting activities for the Land Use, Land Use Change and Forestry sector under the United Nations Framework Convention on Climate Change and the Kyoto Protocol. Five selected approaches have been experimentally applied for the estimation of burnt biomass in forest fire events that occurred in Italy in the period 2008–2010. Approaches based on nominal rates of biomass loss can lead to an overly conservative value or, conversely, to underestimation of the fraction of burnt biomass. Uncertainties can be greatly reduced by an operational method able to assess inter-annual and local variability of fire effects on fire-affected forest types.

Additional keywords: CO_2 and non-CO_2 gases, fire intensity, fire severity, forest type.

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Introduction

Wildfires are the most common disturbance in Mediterranean forests (Schelhaas *et al.* 2003) causing significant emissions of greenhouse gases (GHGs) from forest biomass burning (CO_2, CO, CH_4, N_2O, NO_x). In the last 30 years (1980–2010), ~50 000 forest fires occurred yearly in five of the most fire-affected countries of southern Europe (Portugal, Spain, France, Italy and Greece), burning yearly $\sim 0.5 \times 10^6$ ha. The annual forest burnt area, however, varies considerably depending on year-to-year climatological variability (European Commission 2011). When weather conditions are particularly severe (e.g. heat waves or very hot and dry summers combined with strong winds) forest fires may reach catastrophic proportions, the so-called mega-fires events, producing noteworthy GHG emissions in the atmosphere.

These extreme fire seasons usually receive world media coverage. Recent exceptional fire seasons occurred in Portugal (286 000 ha of forest burnt in 2003 and 214 000 ha in 2005), Spain (188 697 ha of forest burnt in 2005), Greece (193 268 ha of forests and other wooded land burnt in 2007), Italy (116 602 ha of forest burnt in 2007) and France (more than 70 000 ha of forest burnt in 2003) (European Commission 2011). According to the European Forest Fire Information System (http://forest.jrc.ec.europa.eu/effis/, accessed 22 February 2013) (San-Miguel-Ayanz *et al.* 2012), the CO_2 emissions during recent catastrophic fires in Greece in 2007 were ~4.5 Mt CO_2 until the end of August, equalling ~4% of the average annual CO_2 emissions of this country. Emissions from wildfires in Portugal during the 2003 fire season were estimated to have reached 7.4 Mt CO_2 (Rosa *et al.* 2011).

Fire risk in Mediterranean forests is expected to further increase over the next 100 years, as climate change is likely to result in more extended hot periods and drought, with a summer temperature increase of 4–5°C and summer rainfall decrease of up to 50% through southern Europe (Lindner *et al.* 2010).

Estimates of GHG emissions from biomass burning can be highly uncertain, because of the high spatial and temporal variability of fuel loads, combustion completeness and seasonality