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The improved Global Fire Emissions Database (GFED) version 3: contribution of savanna, forest, deforestation, and peat fires to the global fire emissions budget

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Global fire activity is an important contributor to the atmospheric trace gas and aerosol burdens. New burned area datasets and top-down constraints from atmospheric concentration measurements of pyrogenic gases have decreased the large uncertainty in fire emissions estimates, but little is known about the contribution of deforestation, agricultural waste, peat, forest, and savanna fires to total global fire emissions. Here we used a revised version of the CASA biogeochemical model and improved satellite-derived estimates of area burned, fire activity, and plant productivity to calculate fire emissions for the 1997-2008 period on a $0.5^\circ \times 0.5^\circ$ spatial resolution with a monthly time step.

For November 2000 onwards, estimates were based on burned area, active fire detections, and plant productivity from the MODIS sensor. For this time period we also calculated the breakdown of emissions into different sources. We used TRMM-VIRS and ATSR data to extend our fire time series back in time, combined with AVHRR-derived plant productivity in the pre-MODIS era. Average global fire carbon emissions were 1.9 Pg C / year with significant interannual variability over 1997-2001 (2.6 Pg C / year in 1998 and 1.5 Pg C / year in 2001) while emissions over 2002-2007 were relatively constant (varying between 1.9 and 2.0 Pg C / year), before declining in 2008 (1.6 Pg C / year). Over 2002-2007, interannual variability was still large on regional scales but on a global scale high fire years in some regions were balanced by low fire years in other regions.

In the MODIS era (2001 onwards), most carbon losses were the result of fires in (wooded) savannas (68%) with lower contributions from deforestation (13%), forest (12%), agricultural waste (4%), and tropical peat fires (3%). On regional scales, these contributions vary to a large degree, and the contribution of peat fires would increase when including the 1997/1998 El Niño period with record-high fire emissions in Equatorial Asia. For reduced trace gases such as CO and CH4, deforestation and peat fires were the largest contributors due to higher emissions of reduced trace gases per unit carbon combusted compared to savanna fires. Net fire carbon losses (tropical deforestation and peat fires) were on average 0.3 Pg C / year, which is likely a conservative estimate because our deforestation rates were lower than reported. Our results provide the first global assessment of the contribution of different sources to total global fire emissions for the past 13 years, and provide the community with more reliable fire emissions estimates that will be updated frequently.