Geophysical Research Abstracts
Vol. 20, EGU2018-6050, 2018
EGU General Assembly 2018

A global dataset for pyrogenic carbon production: unifying existing research for use in global models

Matthew Jones (1,2), Cristina Santín (1), and Stefan Doerr (1)

(1) Swansea University, College of Science, Geography, United Kingdom, (2) University of Exeter, College of Life and Environmental Science, Earth System Science, United Kingdom

Open biomass burning affects 3-4.6 million km^2 globally per year, an area comparable to that of India. While the majority of the vegetation carbon stocks affected by fire are emitted as CO_2 and CO, a nontrivial fraction is converted to pyrogenic carbon (PyC) in the form of charcoal. PyC contains highly recalcitrant organic carbon forms which persist in environmental matrices for long periods, leading to its significant contribution to soil, freshwater and oceanic pools of organic carbon. This makes PyC production an important component of the global carbon cycle and a long-term mediator of atmospheric carbon concentrations, yet recent estimates of its global production range by almost an order of magnitude (56-379 million tonnes year^{-1}; Bird et al. 2015, Santín et al. 2016). Constraining the range of global production estimates is pivotal to understanding the wider importance of fires in past, present and future climates. We seek to improve global production estimates of PyC production by modifying existing models used in the atmospheric sciences.

In the current Global Fire Emissions Database (GFED) modelling framework, gas and particle–phase carbon emissions from burned areas emissions are quantified by applying factors for biomass combustion efficiency (β_E; kg C emitted kg^{-1} C exposed) and compound-specific carbon emission (ε; g C species emitted kg^{-1} C emitted) to vegetation carbon stocks exposed to fire (van der Werf et al. 2017). β_E factors are applied to individual fuel components (leaves, stems, litter and coarse woody debris) and total fuel consumption is optimised through retrospective comparison to observed values of $\beta_E$measured in ∼80 field studies (van Leeuwen et al. 2014). Meanwhile, values for ε are adopted from a dataset of observations from ∼20 field studies and applied to total fuel consumption (Akagi et al. 2010).

We propose a parallel method for modelling PyC production that includes the modification of the β term to also account for the fuel carbon fraction converted to charcoal ($\beta_+ = \beta_E + \beta_{CHAR}$; kg C affected kg^{-1} C exposed), as well as the replacement of ε with a corresponding factor for PyC production, γ (g PyC kg^{-1} C affected). Until now, the principle obstacle to performing this global modelling exercise has been the lack of a sufficiently rich and standardised dataset with which to constrain β_+ and γ. To address this, we have compiled a new database of β_+ and γ factors from a global collection of 26 field studies, which standardises the reporting of production estimates spread over 7 major fire-prone biomes. We envisage that meta-analysis of this dataset will provide representative values and uncertainty ranges for β_+ and γ for use in global models. Here, we outline the criteria used for study selection and the standardisation approaches applied during data collection. We present summary and comparative statistics for biomes and fuel components and review current data availability and limitations. Finally, the feasibility of integrating this dataset into the GFED modelling framework is evaluated.