Re-assessment of pre-industrial fires in CMIP6 models and the implications for radiative forcing

EGU2020-18190 Session BG3.17/AS4.26/CL2.24/NH7.3

Ken Carslaw, Cat Scott, Masaru Yoshioka (University of Leeds, UK), Douglas Hamilton (Cornell University, USA), Fiona O’Connor, Gerd Folberth, Mohit Dalvi, Jane Mulcahy (UK Met Office), Yves Balkanski, Ramiro Checa-Garcia (LSCE-IPSL, France), Dirk Olivie, Michael Schulz (MetNo, Norway), Martine Michou, Pierre Nabat (CNRM, France), Lars Nieradzik (Lund University, Sweden), Twan van Noije (KNMI, Netherlands) Tommi Bergman (Finnish Meteorological Institute, Finland)
Summary

• Natural emissions are an important contributor to variance in the first aerosol indirect radiative forcing (slide 3)

• Pre-industrial fire emissions have a substantial impact on the strength of the first aerosol indirect radiative forcing in an offline global aerosol model (slide 4)

• When AeroCom or CMIP6 PI fire emissions are used, the model over-predicts the PD / PI black carbon ratio when compared to ice core observations - are the PI fire emissions “too low”? (slide 5)

• What do we see in Earth System Models (slide 6) being used in CMIP6?
Natural emissions are an important contributor to variance in the first aerosol indirect radiative forcing (Carslaw et al., 2013; link)
First aerosol indirect radiative forcing strongly affected by pre-industrial fire emissions

Annual mean first aerosol indirect radiative forcing using GLOMAP-mode aerosol model with **CMIP6 pre-industrial fire emissions** (van Marle et al., 2017):

Global annual mean: **-1.1 W m\(^{-2}\)**

Strength of first aerosol indirect radiative forcing reduces when emissions from **two alternative pre-industrial fire models** are used:

- **SIMFIRE-BLAZE**
  - Global annual mean:
  - G: -0.7 N: -1.2 S: -0.3 Wm\(^{-2}\)

- **LMfire**
  - Global annual mean:
  - G: 0.1 N: -0.5 S: +0.3 Wm\(^{-2}\)

(Hamilton et al., 2018; link)
How well do models capture the impact of fire emissions on the pre-industrial atmosphere?

Present day (PD) to pre-industrial (PI) ratio of black carbon (BC) concentration at surface is over-predicted by GLOMAP-mode aerosol model using the AeroCom or CMIP6 emissions, when compared to ice cores from the northern hemisphere. ‘Real’ PI concentrations of BC were likely higher than the model simulates.

Using emissions from SIMFIRE-BLAZE and LMfire reduces the overestimate.

(Hamilton et al., 2018; link)
The CRESCENDO Earth System Models

Models being used for CMIP6 (AerChemMIP)