EGU21-7286
https://doi.org/10.5194/egusphere-egu21-7286
EGU General Assembly 2021

Direct radiative effects of smoke aerosol during the extreme 2019/2020 Australian wildfire season

Bernd Heinold[1], Holger Baars[1], Matthew Christensen[2,3], Anne Kubin[1], Kevin Ohneiser[1], Kerstin Schepanski[1], Roland Schrödner[1], Fabian Senf[1], and Ina Tegen[1]

[1]Leibniz Institute for Tropospheric Research, Modelling Department, Leipzig, Germany (heinold@tropos.de)

[2]Oceanic and Planetary Physics, University of Oxford, Oxford, United Kingdom

[3]Now at Atmospheric Sciences and Global Change Division, Pacific Northwest National Laboratory, Richland, WA, USA

Record wildfires affected Australia from December 2019 to early 2020. Massive plumes of fire pollutants were lifted into the upper troposphere and even into the stratosphere by pyro-convection triggered by the intense heat of the fires. Subsequently the smoke aerosol was transported over thousands of kilometres eastwards at above 20 km altitude as Lidar observations in South America and satellite imagery show. Space and ground-based remote sensing of aerosol optical thickness indicate a temporary substantial increase in aerosol loading over large parts of the Southern Hemisphere, which offset the usual hemispheric contrast in aerosol. In addition to the massive impact on air quality at Australia's east coast, this had important effects on the hemisphere-wide radiation budget.

We investigate the dispersal of the fire smoke aerosol and its radiative effects with the global aerosol-climate model ECHAM6.3-HAM2.3. Biomass burning emissions are prescribed by daily satellite-based estimates from the Global Fire Assimilation System (GFAS). As the horizontal model resolution is too coarse to explicitly resolve convection, the injection height of Australian fire smoke is set to heights between 5 and 15 km and varied in terms of sensitivity studies. The model results for late 2019 and early 2020 are evaluated with ground and satellite remote sensing measurements, as well as contrasted with smoke results for years with low Australian wildfire emissions. The sensitivity results show how the fire injection heights affect the evolution of the smoke plume but also what role radiatively induced self-lifting plays. According to the model, the 2019/20 Australian wildfires considerably perturbed the radiation budget of the Southern Hemisphere. Due to large transport heights relative to clouds and a long lifetime of smoke particles in the stratosphere, the solar irradiance at ground averaged from January to March 2020 decreased by more than 1 W m^{-2} for the Southern Hemisphere, which corresponds roughly to the short-term cooling caused by a large volcanic eruption, while the elevated smoke layers experienced significant absorptive heating.

Considering the recent series of extreme wildfires globally and their probably further increasing occurance in a changing climate, these results indicate a need for larger attention to pyro-convection in global climate modelling.