4.130 Development of the MRI-ESM2 and evaluations of spatial distributions and radiative effects of black carbon.

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Abstract:

The Meteorological Research Institute earth system model (MRI-ESM2) has recently been developed and the model participates in the Coupled Model Intercomparison Project Phase 6 (CMIP6). In this study, we perform the MRI-ESM2 calculations for the years 2008-2015 with nudging towards the meteorological data and prescribed sea surface temperatures and evaluate the spatial distributions of black carbon (BC) and its radiative effects. The MRI-ESM2 simulation with a new microphysical BC aging parametrization successfully reproduces the seasonal variations of BC observed by the surface measurements over the Arctic, although our previous approach with a constant conversion rate from hydrophobic BC to hydrophilic BC largely underestimates the BC mass concentrations throughout the years. Vertical profiles of BC observed by the aircraft measurements (e.g., A-FORCE, ARCTAS, and HIPPO) are successfully reproduced by the MRI-ESM2 simulation with a new consistent treatment of wet removal and vertical transport of aerosols in the spectral cumulus parameterization, although our previous wet removal approach largely overestimates BC mass concentrations particularly in the upper and middle troposphere over the tropical Pacific. These results suggest that the seasonal variations of BC over the Arctic are primarily controlled by the aging processes and the wet removal associated with cumulus convection plays an important role for the spatial distributions of BC in the upper and middle troposphere. The MRI-ESM2 simulation

underestimates the aerosol optical depths (AODs) and absorbing aerosol optical depths (AAODs) obtained from the Aerosol Robotic Network by 23% and 30%, respectively, on a global basis. The annually and globally averaged direct radiative forcing by BC at the top of atmosphere is estimated to be approximately 0.2 W m^{-2} for the global BC emission of 7.0 Tg $year^{-1}$ in the simulation.