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Black Carbon Radiative Forcing over the Arctic

Ulas Im (1,2), Kostas Tsigaridis (3,4), Jesper H. Christensen (1,2), Kaj M. Hansen (1,2), Jacob K. Nøjgaard (1,2), Andreas Massling (1,2), Henrik Skov (1,2)

(1) Department of Environmental Science, Aarhus University, Frederiksborgvej 399, 4000, Roskilde, Denmark, (2) Aarhus University Interdisciplinary Centre of Climate Change, Frederiksborgvej 399, 4000, Roskilde, Denmark, (3) NASA Goddard Institute for Space Studies, 2880 Broadway, New York, NY 10025 USA, (4) Center for Climate Systems Research, Columbia University, New York, NY 10025 USA

The surface temperatures in the Arctic are warming at about twice the rate of the global average, referred as the Arctic Amplification. Short lived climate forcers (SLCF), including aerosol particles can contribute to the Arctic Amplification by direct and indirect radiative effects. In particular black carbon (BC) in the atmosphere, as well as when deposited on snow and sea ice, has a positive impact on the top of atmosphere (TOA) radiation. In this study, we use the GISS modelE2.1 to simulate the change of TOA radiative forcing due to BC (rfBC) over the Arctic (north of 67 °) from 1850 to 2015. We use the non-interactive tracers (NINT) version of the model, fully coupled with the ocean, land and sea-ice in order to investigate the changes in the radiative forcing as well as the sea-ice and snow properties (sea-ice cover and thickness, snow thickness and melt) over the Arctic. Aerosol concentrations are prescribed using the Atmospheric Model Intercomparison Project (AMIP) simulation conducted by the same model version. Therefore, tracers can impact the climate but not the opposite. In addition to the control run, we made sensitivity simulations from 1950 onwards where we changed the BC concentrations by a factor of 10. Preliminary results show that the TOA radiative forcing due to BC over the Arctic is calculated to increase from 0.11 Wm^{-2} in 1951 to 0.22 Wm^{-2} in 2015 (increase by 94%) in the Control simulation. The net radiative forcing due to anthropogenic aerosols increased from -0.02 Wm^{-2} in 1951 to 0.05 Wm^{-2} in 2015. The 10xBC scenario leads the rfBC to increase linearly by a factor of 10 to 2.1 Wm^{-2} in 2015. The 10 times increase in BC concentrations leads to the surface temperature anomaly in 2015 relative to the 1951-1980 mean temperatures to increase from 2.31 ˚C to 3.3 ˚C. The global surface temperature anomaly is much smaller than that in the Arctic in both scenarios, increasing from 0.96 ˚C to 1.12 ˚C. Additional simulations will be performed where we use active tracers in order to simulate the climate-SLCF interactions over the Arctic.