Exploring spatial distributions, radiative forcing and source-receptor relationships of black carbon in the Community Atmosphere Model

H. WANG[1]* , P.J. RASCH[2], R.C. EASTER[3] AND P.-L. MA[4]

[1]Pacific Northwest National Laboratory (PNNL), Richland, WA 99352, USA (*correspondence: Hailong.Wang@pnnl.gov)
[2]PNNL, Richland, WA, USA (Philip.Rasch@pnnl.gov)
[3]PNNL, Richland, WA, USA (Richard.Easter@pnnl.gov)
[4]PNNL, Richland, WA, USA (Po-Lun.Ma@pnnl.gov)

Black carbon (BC) is believed to be the second most important forcing agent after carbon dioxide in causing the climate warming. However, unlike greenhouse gases, BC has large spatio-temporal variability, and the climate impact of BC can be more rapidly communicated to the human-earth system through changing regional energy budget and water cycle. Thus it is necessary to have accurate global 3-D distribution of BC to fully assess the regional impacts using climate models. Many global aerosol-climate models, including the Community Atmosphere Model version 5 (CAM5), have large biases in the prediction of global 3-D distribution of BC, particularly over high latitudes and in the upper troposphere.

We recently improved the treatment of aerosol convective transport and wet removal processes in CAM5, which largely reduces these biases and improves the global spatial distribution of BC in the atmosphere and in snow/glacier over land surface [1]. Based on the improved model, we examined the impact of circulation features on BC transport into high latitudes by configuring the model to run in an “off-line” mode in which meteorology is constrained to agree with reanalysis products [2]. To better understand the response of climate to BC emission uncertainties, we further introduced an explicit BC source tagging technique in CAM5 to characterize the global source-receptor relationships and transport pathways of regional emissions, to attribute BC loading and radiative forcing to various regional and sectoral BC sources [3]. We found that BC lifetime, forcing-per-emission and forcing-per-loading have strong dependence on source regions. New insights from these studies, particularly the sensitivity of BC radiative impacts to relevant chemical/physical processes in the model and to change in regional emissions will be discussed.

[1] Wang *et al* (2013) *Geosci. Model Dev.*, **6**, 765-782. [2] Ma *et al* (2013) *J. Geophys. Res. Atmos.*, **118**, 4657–4669. [3] Wang *et al* (2014), submitted.