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Evaluation of factors controlling long-range transport of black carbon to the Arctic

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This study evaluates the sensitivity of long-range transport of black carbon (BC) from mid- and high-latitude source regions to the Arctic to aging, dry deposition and wet removal processes using the GFDL coupled chemistry and climate model (AM3). We derive a simple parameterization for BC aging (i.e., coating with soluble materials) which allows the rate of aging to vary diurnally and seasonally. Slow aging during winter permits BC to remain largely hydrophobic throughout transport from mid-latitude source regions to the Arctic. In addition, we apply surface-dependent dry deposition velocities and reduce the wet removal efficiency of BC in ice clouds. The inclusion of the above parameterizations significantly improves simulated magnitude, seasonal cycle and vertical profile of BC over the Arctic compared with those in the base model configuration. In particular, wintertime concentrations of BC in the Arctic are increased by a factor of 100 throughout the tropospheric column. Based on sensitivity tests involving each process, we find that the transport of BC to the Arctic is a synergistic process. A comprehensive understanding of microphysics and chemistry related to aging, dry and wet removal processes is thus essential to the simulation of BC concentrations over the Arctic.