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Transport and chemistry of anthropogenic pollution and boreal forest fire emissions to the Arctic during summer 2008

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Ozone pollution transported to the Arctic is a significant concern because of the rapid, enhanced warming in high northern latitudes, which is caused, in part, by short-lived climate forcers, such as ozone. Long-range transport of pollution contributes to background and episodic ozone levels in the Arctic. However, the extent to which plumes are photochemically active during transport, particularly during the summer, is still uncertain. Regional chemical transport model simulations are used to examine photochemical production of ozone in airmasses originating from boreal fire and anthropogenic emissions over North America and during their transport toward the Arctic during early July 2008. Model results are evaluated using POLARCAT aircraft data collected over boreal fire source regions in Canada (ARCTAS-B) and several days downwind over Greenland (POLARCAT-France and POLARCAT-GRACE) during the study period. Model results are generally in good agreement with the observations, except for certain trace gas species over boreal fire regions, in some cases indicating that the fire emissions were too low. Anthropogenic and biomass burning pollution (BB) from North America was rapidly uplifted during transport east and north to Greenland where pollution plumes were observed in the mid and upper troposphere during POLARCAT. A model sensitivity study shows that CO levels are in better agreement with POLARCAT measurements (fresh and aged fire plumes) upon doubling CO emissions from fires. Analysis of model results, using $\Delta O_3/\Delta CO$ enhancement ratios, shows that pollution plumes formed ozone during transport towards the Arctic. We show that aged anthropogenic and BB pollution together made an important contribution to ozone levels with a spatially averaged contribution for latitudes>55 ºN of up to 6.5 ppbv (18%) from anthropogenic pollution and 3 ppbv (5.2%) from fire pollution in the model domain during the study period.