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'Siberian Express' of reactive bromine transport from the Arctic Ocean: GEM-AQ model runs

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The bromine explosion in the springtime polar boundary layer is so intense and widespread that is even evident in BrO column measurements from space. The outflow of reactive bromine to the free troposphere and to the lower latitudes also appears to occur to appreciable degrees, although its magnitude and mechanistic details are not well understood. Here we present results from model runs using the 3-D air quality model GEM-AQ to characterize general features of the Arctic bromine outflow from March to May. The model accounts for standard tropospheric chemistry with newly added gas-phase and heterogeneous bromine chemistry, the prescribed Br_2 emission from the frozen ocean, and the dry/wet deposition of HBr etc. to the ground surface. The model runs are performed with global variable-resolution horizontal grids having a high-resolution Arctic core (90 x 90 grids with 0.88 x 0.88 degree). Frontogenesis is quite active in the springtime subarctic Siberia, Pacific, and Atlantic, but the transport of bromine is simulated to be most effective in Siberia. In particular, the Eurasian source of anthropogenic sulfate aerosols helps activate bromine chemistry in the outflow. The GOME BrO column measurements often show the horizontal movement of 'BrO clouds' qualitatively consistent with the model simulations, although the model still appears to need significant improvement for better quantitative agreement. Once air mass is exported over the snow/ice free surface the BrO outflow if any is rather difficult to be detected from space, because satellite backscatter measurements are not very sensitive to target compounds in the lower troposphere over the low albedo sur-

face. Quasi-horizontal belt-conveyer type transport also takes place lifting the reactive bromine to the subarctic free troposphere, which may be detectable by ground-based MAX-DOAS measurements of BrO rather than from space. Finally, the upper tropospheric transport of BrO of stratospheric origin is noted as an additional factor for corrupting the interpretation of the horizontal movement of ‘BrO clouds’ in the satellite data, because frontal activities are associated with quasi-horizontal transport in both of the upper and lower troposphere.