Summary

Rates of ozone decomposition on aluminum oxide (alumina) particles were measured in a flow tube reactor equipped with molecular beam sampling mass spectrometry and ultraviolet absorption spectroscopy, and in a static reaction cell equipped with ultraviolet absorption spectroscopy. Reaction probabilities η are reported for ozone on α-alumina, γ-alumina, and chromatographic alumina (hydroxylated alumina), respectively, over the temperature range –60 to 200°C. This work addresses the potential for stratospheric ozone depletion by launch vehicle solid rocket motor exhaust. Considering best estimates of plume particle size distributions and dispersion rates, we calculate ozone depletion profiles, for direct decomposition on alumina only. The calculated ozone holes are rather narrow. In the worst case, ozone levels are within 5×10^{-5} of ambient in the center of the plume. A simple analysis of the global impact of alumina particles on ozone decomposition indicates a potential steady-state daytime depletion of $<3\times10^{-9}$ at present launch rates.

The laboratory measurements presented here support atmospheric modeling efforts to understand rocket plume / stratosphere interactions. The laboratory and modeling work in turn is used to define design parameters for the HIgh Resolution Ozone ImaGing (HIROIG) spectrometer to be used to monitor ozone and chemical composition of solid rocket motor plumes.