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First multi-year occultation observations of CO_2 in the MLT by ACE satellite: observations and analysis using the extended CMAM

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Abstract. This paper presents the first global set of observations of CO_2 in the mesosphere and lower thermosphere (MLT) obtained by the ACE-FTS instrument on SCISAT-I, a small Canadian satellite launched in 2003. The observations use the solar occultation technique and document the fall-off in the mixing ratio of CO_2 in the MLT region. The beginning of the fall-off of the CO_2, or "knee" occurs at about 78 km and lies higher than in the CRISTA-1 measurements (~70 km) but lower than in the SABER 1.06 (~80 km) and much lower than in rocket measurements. We also present the measurements of CO obtained concurrently which provide important constraints for analysis. We have compared the ACE measurements with simulations of the CO_2 and CO distributions in the vertically extended version of the Canadian Middle Atmosphere Model (CMAM). Applying standard chemistry we find that we cannot get agreement between the model and ACE CO_2 observations although the CO observations are adequately reproduced. There appears to be about a 10 km offset compared to the observed ACE CO_2, with the model "knee" occurring too high. In analyzing the disagreement, we have investigated the variation of several parameters of interest (photolysis rates, formation rate for CO_2, and the impact of uncertainty in turbulent eddy diffusion) in order to explore parameter space for this problem. Our conclusions are that there must be a loss process for CO_2, about 2–4~times faster than photolysis that will sequester the carbon in some form other than CO and we have speculated on the role of meteoritic dust as a possible candidate. In addition, from this study we have highlighted a possible important role for unresolved vertical eddy diffusion in 3-D models in determining the distribution of candidate species in the mesosphere which requires further study.

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