Intercomparisons of Aura MLS, ACE, and HALOE Tracers using the LaRC Lagrangian Chemistry and Transport Model

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Introduction:
• We use the LaRC Lagrangian Chemistry and Transport Model (LCTM) [Considine et al., 2007; Pierce et al., 2003] to intercompare ACE, Aura, and HALOE observations of long-lived trace gases.
• The LCTM calculates the transport, mixing, and photochemical evolution of an ensemble of parcels that have been initialized from ACE-FTS measurements.
• Here we focus on late November, 2004 comparisons, due to the previous 3-week period of continuous HALOE observations and MLS v2.2 data on November 29, 2004.
• DAS-driven transport and relatively short trajectory lifetime promotes strong influence of initializing observations on subsequent LCTM constituent distributions.
• Large number of model parcels produces more coincident measurements for intercomparisons and allows comparison of meridional and longitudinal variations.

LaRC-LCTM Model Description:
• Model tracks transport, mixing, and photochemical evolution of parcels initialized from observations.
• NASA GEOS-4 DAS meteorological data.
• 12.5° lat × 12.5° long × 5 km levels, 33 hPa top.
• 6-hour average horizontal winds and vertical pressure velocity from DAS to kinematically advect parcels.
• Parcels initialized from ACE observations.
• Other species in standard stratospheric chemical mechanism initialized using parcel 0, CH4, and model climatology mapped to θ and CH4.
• Overhead column O3 calculated from DAS and Aura MLS O3 mapping for each run day.
• Parcels only initialized when at-observed species have signal maxima > 0.1.
• Parcels diagnostics output every 6 hours.
• LCTM output compared to v2 ACE, v2.5 Aura MLS observations and v19 HALOE observations.

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Conclusions:
• Excellent agreement of ACE-FTS tracer observations, demonstrating capability of model to follow the evolution of ACE-observed air parcels.
• 50% deficits in LCTM-predicted NH upper stratospheric N2O and ~25% deficits in CH4 suggest GEOS 4 DAS met data have excessive vertical descent in the NH upper stratosphere during November, 2004.
• Upper stratosphere low biases in LCTM with high NH CH4 high bias at 46.4 hPa.
• Otherwise relatively low uncertainties and high correlations.
• Comparisons of ACE-initialized LCTM with HALOE observations show ACE/BALESO biases consistent with published results (HALOE HCl and HDO are low-biased relative to LCTM). LCTM HDO uncertainty is ~25% higher than with ACE HDO measurements.

Horizontal distributions of MLS and ACE LCTM O3 at 3.21, 25, and 46.4 hPa. The LCTM represents MLS horizontal distributions at 3, 21.5, and 46.4 hPa. The low slope of the HCl correlation plot indicates a low bias of LCTM Cly in the upper stratosphere.

Horizontal distributions of MLS and ACE LCTM N2O at 3, 21.5, and 46.4 hPa. The LCTM profiles agree well with observations in the SH and in the NH between 100 hPa - 1 hPa. Percent diffs at ~3 hPa in the NH exceed -50%, indicating a problem with LCTM transport or previous ACE observations used to initialize LCTM.

Horizontal distributions of MLS and ACE LCTM O3 at 3, 21.5, and 46.4 hPa. Very good correspondence of LCTM with previous ACE observations at 3, 21.5, and 46.4 hPa. LCTM profile agreement in SH with observations is excellent. In the NH between ~5 hPa and 1 hPa, LCTM profiles are initialized with observations in previous ACE observations. The low slope of the HCl correlation plot indicates a low bias of LCTM Cly in the upper stratosphere.

Horizontal distributions of MLS and ACE LCTM CH4 at 3, 21.5, and 46.4 hPa. ACE LCTM compared to MLS observations of O3, N2O, HCl, and H2O. Note the 3 hPa deficit of N2O in the NH and high NH HCl high bias at 46.4 hPa.