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Understanding ozone (O3) in the Arctic: Comparison between model and satellite observations using Geos-CHEM and TES O3 and carbon monoxide (CO) products

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Arctic tropospheric ozone is difficult to model because of uncertainties in the transport of ozone and ozone pre-cursors from lower latitudes into the Arctic and uncertainties in the distribution of chemical processes controlling Arctic ozone (e.g., Walker et al., AGU 2009; Emmons et al, AGU 2009, Hair et al., AGU 2009). Recent validation of TES tropospheric ozone profiles at Arctic latitudes shows promise for placing constraints on Arctic ozone amount and assessing the transport of ozone and its pre-cursors from source regions into the Arctic.
Our primary objectives for this analysis are to understand the flux of ozone into the arctic and the distribution of processes controlling this ozone. A necessary first step is to compare the ozone and carbon monoxide distributions from the GEOS-Chem model (version 8-02-01) to the TES O3 and CO profiles to help characterize the ozone produced from combustion sources versus lightning, strat/trop exchange and transport (e.g., Verma et al., 2009 JGR, Alvarado et al., 2010 JGR, Dupont et al., 2010 ACPD). A subsequent step is to use the observed Arctic and higher latitude ozone and CO distributions, along with the GEOS-Chem adjoint to understand the ozone distribution; this study differs from previous studies in that we will use the recently validated TES arctic ozone measurements.
Despite good overall agreement between TES and GEOS-Chem, we observe significant differences between TES measurements and the GEOS-Chem ozone and CO estimates over the Arctic. GEOS-Chem CO concentrations are larger than TES by more than 20 ppbv in the lower troposphere and 50 ppbv in the upper troposphere. GEOS-Chem O3 concentrations are also larger than TES O3 measurement in the lower troposphere by up to 50 ppbv. However, in the upper troposphere, simulated O3 concentrations are significantly lower than TES by up to 70 ppbv.
In our ongoing study, we will use GEOS-Chem and its adjoint constrained by TES O3 and CO measurements to understand the major chemical nd dynamical factors that drive O3 concentrations in the Arctic.