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Upper troposphere and stratosphere distribution of hydrocarbon species in ACE-FTS measurements and GEOS-Chem simulations

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Measurements of carbon-containing species, referred to herein as “hydrocarbons”, are important components needed for describing and understanding the influence of natural and anthropogenic emissions on atmospheric chemistry. Analysis of the global pattern of hydrocarbons contributes to our understanding of the influence of regional and seasonal variation in air pollution and natural fire events. The Atmospheric Chemistry Experiment Fourier Transform Spectrometer (ACE-FTS) has monitored trace gases in the upper troposphere and stratosphere based on solar occultation measurements for more than ten years. In this study, we investigate the global pattern of seven “hydrocarbon” species (CO, C_2H_6, C_2H_2, HCN, H_2CO, CH_3OH, and HCOOH) and OCS using the ACE-FTS version 3.5 dataset from 2004 to 2013. All hydrocarbons show strong seasonal variation and regional differences, but the detailed pattern differs according to the speciation of the hydrocarbons. For example, in the Northern Hemisphere, CO, C_2H_6, and C_2H_2 show the highest mixing ratios in winter, but high CH_3OH and HCOOH appear in summer. In the Southern hemisphere, H_2CO, HCN, and HCOOH show high mixing ratios in springtime. These patterns indicate the impact of different emission sources including fuel combustion, wildfire emission, and chemical production. By calculating correlations with CO, these results can provide useful information to characterize each hydrocarbon emission. The ACE-FTS measurements have also been compared with GEOS-Chem output to examine the model performance and spatiotemporal patterns in the simulations.