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Using the Relationship between MODIS Aerosol Optical Thickness and OMI Trace Gas Columns to better understand Aerosol Formation and Chemical Composition

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Aerosols are one of the leading uncertainties in global and regional climate change. One of the most important reasons for the limited understanding of the effects of aerosols is their strong temporal and spatial variability in chemical composition and size distribution. Important anthropogenic sources for aerosols are transportation, power plants, industries and biomass burning. Natural sources include windblown desert dust, sea spray, biogenic emissions, volcanoes, and biomass burning. Together, these sources form a complex chemical mixture of desert dust, sea salt, sulfates, nitrates and organic material. To better understand the Earth's climate system, accurate knowledge is needed on the complex relation between the emissions of precursor gases and primary aerosol particles, and aerosol composition. Satellite measurements have the horizontal and temporal coverage to assess the global effect of aerosols on climate. In addition to the information on aerosols, tropospheric columns of nitrogen dioxide (NO_2), formaldehyde (HCHO) and sulfur dioxide (SO_2) can be observed from space.

In this contribution, the spatial and temporal correlations between AOT and tropospheric columns of NO_2, SO_2 and HCHO are used to derive information on the composition of the aerosols particles. Spatial correlation between AOT and NO_2 indicate that the aerosols are from combustion processes, such as fossil fuel and biomass burning. The AOT to NO_2 ratio provides zeroth order information on the combustion sources. This ratio is low for regions dominated by controlled fossil fuel combustion and high for biomass burning regions, whereas the difference of this ratio between these regions can be more than two orders of magnitude. Overall the GEOS-CHEM simulations can reproduce the observed AOT-NO_2 ratios well. Spatial correlation between AOT and NO_2 is found for many of the industrialized ad biomass burning regions in the world. Correlations with HCHO are especially important in biomass burning regions, and in industrial regions in Southeast Asia. Over the Southeastern United States and Southern China a seasonal maximum in AOT and HCHO is observed which is related to biogenic sources. We propose to use the relationship between AOT and precursor gases observed from space as an indicator for the extent of which combustion occurs in a controlled way.