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A New High Frequency Multi-Satellite Constrained Approach for Understanding Global Aerosol and Trace Gas Loadings: Missing Sources, Trends, Variability, and Long-Range Transport

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Remotely sensed observations have revealed global scale changes in the magnitude, spatial, and temporal distribution of both aerosols and certain trace gasses. However, the responses over biomass burning, urban, developing, and relatively clean regions are significantly different for each other. Some regions are identified by relatively stable and obvious trends; others are dominated by variability, both inter-annual and intra-annual; and some are observed to switch from one type to another as they have evolved over the past decade.

My approach has been to produce a new top-down emissions database that accounts for all of these changes in a multi-component, and multi-spatial/temporal perspective. Trace gas and aerosol loadings are constrained from OMI, MOPITT, and MISR measurements. And initial WRF-CHEM using these constrained loadings over Asia clearly demonstrated a vastly better match in terms of both the average and variability with measurements from MODIS and AERONET.

This work expands the results globally and over the entirety of the past decade, using the CESM- CHEM modeling system. Additionally, using a MIE algorithm trained by AERONET, and a layer-approach constraining algorithm trained with CALIOP, allow for additional findings in terms of some aerosol “chemical speciation” and vertical structure of the aerosol loadings to be constrained.

There are four findings from this initial study. First, that there are significant differences in biomass burning sources, in terms of magnitude, space and time, with the overall result being an increase in biomass burning emissions. Secondly, there are significant changes in urban emissions, with a significant fractional increase throughout Asia. Thirdly, distinctly quantifying a set of regions where long-range transport provides a significant amount of the total local pollution loadings. And finally, examining the importance of emissions ratio uncertainties.