Analysis of the Seasonal Variability of Atmospheric Composition using SSA, EOF, and Fourier Analysis

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Abstract

Understanding the patterns in the temporal and spatial variability of CO, NO_x, H_2O and CH_4 aids us in separating sources and sinks of these gases for the use of improving model biases in atmospheric chemistry and climate simulations. This study focuses on matrix decomposition and spectral methods to accomplish this. We use Singular Spectrum analysis and Fourier analysis to compare normal PDFs (probability density functions) of the power spectra for satellite retrieved CO from the MOPITT and IASI instrument, as well as the global CAMS reanalysis and CAM-chem simulations. By examining the mean and variance in the PDFs we show regional differences in their spatiotemporal distributions and how these differences relate to the dominant time scales for each mode. We determine that the seasonal variability from MOPITT is strongest in comparison to CAMS, IASI, and CAM-chem which we postulate is because of its near infrared enhanced retrieval. Examining the EOF patterns of MOPITT shows us that this variability is also the most localized in space. The spectral distributions of CAM-chem CO tags show that the anthropogenic signal of CO can be statistically separated from the biogenic signal in the Northern Hemisphere while the signal from fires can be separated in the Southern Hemisphere. A spatial map of the dominant time scales for monthly CO shows that long term variability corresponds to changes in the background, while seasonal modes reveal regional transport, or interhemispheric exchanges. A similar map for monthly H_2O shows that long term variability corresponds to the ITCZ (intertropical convergence zone). Maps of NOx are investigated for possible connections between long term variability and the presence of PAN (peroxyacetyl nitrate). This analysis is being extended to high resolution temporal data and additional species including CH_2O, CO_2, and AOD to determine potential relationships between chemical lifetime and the dominant time scale.

Early Career Scientist

YES, I am an early career scientist.

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