Geophysical Research Abstracts
Vol. 19, EGU2017-10034, 2017
EGU General Assembly 2017

Developing and diagnosing climate change indictors of regional aerosol optical properties

Ryan C. Sullivan (1), Robert C. Levy (2), Arlindo M. da Silva (2), and Sara C. Pryor (1)

(1) Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, NY, USA, (2) NASA Goddard Space Flight Center, Greenbelt, MD, USA

The US Global Change Research Program has developed climate indicators (CIs) to track changes in the physical, chemical, biological, and societal components of the climate system. Given the importance of atmospheric aerosol particles to clouds and radiative forcing, human mortality and morbidity, and biogeochemical cycles, we propose new aerosol particle CIs applicable to the US National Climate Assessment (NCA). Here we define these aerosol CIs and use them to quantify temporal trends in each NCA region. Furthermore, we use a synoptic classification (e.g., meteorological variables), and gas and particle emissions inventories to diagnose and attribute causes of observed changes.

Our CIs are derived using output from the satellite-constrained Modern-Era Retrospective Analysis for Research and Application, Version 2 (MERRA-2) reanalysis. MERRA-2 provides estimates of column-integrated aerosol optical properties at 0.625° by 0.5° resolution, including aerosol optical depth (AOD), Ångström exponent (AE), and single scattering albedo (SSA), which are related to aerosol loading, relative particle size, and chemical composition, respectively. For each NCA region, and for each aerosol variable, we derive statistics that describe mean and extreme values, as well as two metrics (spatial autocorrelation and coherence) that describe the spatial scales of aerosol variability.

Consistent with previous analyses of aerosol precursor emissions and near-surface fine aerosol mass concentrations in the US, analyses of our aerosol CIs show that since 2000, both mean and extreme AOD have decreased over most NCA regions. There are significant (α = 0.05, using the non-parametric Kendall's tau) decreases in AOD for the Northeast (NE), Southeast (SE), Midwest (MW), and lower Great Plains (GPl) regions, and notable but not significant decreases in the Southwest (SW). AOD has increased for the Northwest (NW; significant) and upper Great Plains (GPu; not significant). Over all regions, there is a significant positive trend in AE (relative decrease in aerosol size) along with significant negative trend in SSA (relative decrease in scattering versus absorption extinction). Negative trends in AOD and SSA are consistent with documented decreases in sulfur dioxide emissions. Conversely, increased AOD in NW and GPu may reflect a lower impact of emissions standards in more remote regions, and/or that other aerosol and precursor sources (e.g., gas and oil extraction, wildfire frequency, long-range transport) may be increasing. Low AOD days are associated with dry, cool synoptic conditions. Since 2000, the structure of the aerosol field has changed. Using the Moran's I test, all regions exhibit declining spatial autocorrelation, suggesting AOD has become less uniform. At the same time, semivariogram models show that in many regions (NW, GPl, MW, SE) spatial coherence is increasing, and is consistent with an increase in the intensity of certain synoptic conditions. These results suggest that it is the variability in local emissions that accounts for the spatial structure of the AOD fields. However, more intense synoptic features are associated with more intense regional aerosol events.