6.157 Chemical four dimensional variational data assimilation in WRFDA-Chem: Improving Black Carbon Emission Inventories during ARCTAS-CARB.

Early Career Scientist

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Abstract:

Wildfires contribute significantly to regional haze events globally, and they are potentially becoming more commonplace with increasing droughts due to climate change. PM2.5 emissions from wildfires are highly uncertain, with global annual totals varying by a factor of 2 to 3 and regional rates varying by up to a factor of 10. At the high resolution required to predict PM2.5 exposure events, this variance is attributable to differences in methodology, differing land cover datasets, spatial variation in fire locations, and limited understanding of fast transient fire behavior. Here we apply an adjoint-based online chemical inverse modeling tool, WRFDA-Chem, to constrain black carbon aerosol (BC) emissions from fires during the 2008 ARCTAS-CARB field campaign. Although BC comprises only about 5% of PM2.5 from fires during that campaign, it is one of the simpler aerosol constituents to model and measure. The constrained emission fields on June 22, 2008 are evaluated through cross validation with surface and aircraft observations on subsequent days. We find that over-predictions of BC in southern California are caused by high bias in coastal fire emissions between Los Angeles and San Francisco and also in anthropogenic inventories in both of those cities. Low emission bias exists in areas where smoke coverage might inhibit satellite detection of fire hot spots. We identify several weaknesses in the temporal distribution of emissions, including a missing early morning emission peak associated with local, persistent, large-scale forest fires. Diurnal studies of different fire types should be prioritized in future campaigns in order to improve fire inventories on the temporal and spatial scales required to predict PM2.5 exposure. WRFDA-Chem will provide insights to reduce uncertainties in aerosol and trace gas emission inventories, which feed into air quality monitoring and health and climate impact studies.