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Significant Tropospheric O_3 Production from Extratropical Forest Fires: When? When Not?

R. Chatfield and the NASA ARCTAS and SEAC4RS Science Teams Team
NASA Ames, Moffett Field, CA, United States (Robert.B.Chatfield@nasa.gov)

There is significant controversy on whether extratropical fires contribute importantly to widespread ozone production absent the addition of urban pollutant nitrogen oxides (Jaffe and Widger, 2012, Singh et al., 2012,2013). We report a significant range of O_3 production early in the fire plume history and report controls on which notable O_3 production occurs. The current data set is the airborne observations made on board NASA's highly instrumented DC-8 aircraft during the ARCTAS (2008) and SEAC4RS (2013) campaigns within the Western United States. A clear analysis of fire emissions was aided considerably by MERET (a Mixed Effects Regressions Emissions Technique). This technique allows consistent emission factors and enhancement ratios for O_3 for individual aircraft samples largely free from uncertainties resulting from mixing and entrainment which plague many published estimates. (Yokelson et al, 2013, Chatfield and Andreae, 2016). We find support for the reasonable idea that the ratio of nitrogen oxides (NO_x) to volatile organic carbon (VOC) emissions controls new O_3 production. The evidence is for significant O_3 production from high-fuel-nitrogen fuels (as evidenced by acetonitrile) and extremely hot large fires (like the Yosemite Rim Fire of 2013 which we analyze), while others do not. VOC emissions factors vary significantly from fire to fire (and from different samples in the Rim Fire). Relative CO production (aka "modified combustion efficiency") is only one factor describing VOC emissions factors.

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