Previous studies of emission factors from biomass burning are prone to large errors since they ignore the interplay of mixing and varying pre-fire background CO_2 levels. Such complications severely affected our studies of 446 forest fire plume samples measured in the Western US by the science teams of NASA's SEAC4RS and ARCTAS airborne missions. Consequently we propose a Mixed Effects Regression Emission Technique (MERET) to check techniques like the Normalized Emission Ratio Method (NERM), where use of sequential observations cannot disentangle emissions and mixing. We also evaluate a simpler "consensus" technique. All techniques relate emissions to fuel burned using $C_{burn} = \Delta C_{tot}$ added to the fire plume, where $C_{tot} \approx (CO_2 + CO)$. Mixed-effects regression can estimate pre-fire background values of C_{tot} (indexed by observation j) simultaneously with emissions factors indexed by individual species i, $\delta\epsilon\lambda\tau\alpha - x_i / (C_{burn})_{i,j}$., MERET and "consensus" require more than two emissions indicators. Our studies excluded samples where exogenous CO or CH_4 might have been fed into a fire plume, mimicking emission.

We sought to let the data on 13 gases and particulate properties suggest clusters of variables and plume types, using non-negative matrix factorization (NMF). While samples were mixtures, the NMF unmixing suggested purer burn types. Particulate properties (b_{scat}, b_{abs}, SSA, AÅE) and gas-phase emissions were interrelated. Finally, we sought a simple categorization useful for modeling ozone production in plumes. Two kinds of fires produced high ozone: those with large fuel nitrogen as evidenced by remnant CH3CN in the plumes, and also those from very intense large burns. Fire types with optimal ratios of delta-NOy/delta-HCHO associate with the highest additional ozone per unit Cburn, Perhaps these plumes exhibit limited NOx binding to reactive organics. Perhaps these plumes exhibit limited NOx binding to reactive organics.