Comparison of methods for biomass burning emissions. The first two are solved using mixed-effects (ME) modeling (classes) and are shown using a different color set. These processes are also described in detail in Ref. 1.

Why Sequence Analysis • Emission Factor ("NEM", "ERM") Often Fails

Mixed-Effects Regression

Separating Effects:

Examining Fire Types:

Mixed Effects Factors Vary ... by Fire Type (Affects All Methods)

Details: Bootstrapping Past The Messy Part

Details: But We Want x Intercepts Not y-Intercepts to Get C Backgrounds!

Three Interlinked Types of Variables to Solve for Simultaneously:

1. Background C (and C− or C+) 
2. The emission factor of species i, defined by fire type (NEM, ERM, etc.)... 
3. The fire type at emission (time) same for all species.

Why it’s so complicated:
The factors are solved using joint-effects (ME) modeling and each is used to solve for using data from non-negative matrix factorization (NMF). The ME step takes into account if there are single or multiple emissions and it combines multiple emissions, including differences in the relative factor loadings. This step also combines data from hour(s) at a single location in a single fire type using information about emissions and factors is possible. A complete factor analysis framework is used to resolve the relationships between the emissions and factors at a single location.

Three key concepts are used to solve for:

1. The emissions factor of species i, defined by fire type (NEM, ERM, etc.)...
2. The fire type at emission (time) same for all species.
3. Background C (and C− or C+) 

HCHO-likes or CH3-CO-likes

HCHO is likely formed both from VOC oxidation as well as from HCHO production. High [%HCHO]− in this class, including the very high [%HCHO]−, is likely due to 

CH4-likes or CH3-CO2-likes

This class was only seen in California, and not in the Sierra samples. The CH4 seems to come from high-sulfur fuels, since CH4/CN in the highest in these fires. CH4-likes (VOC) is lower than the red CH3-like class. The locations tend to be in Southern California, suggesting possibly a chapparal or other dry wood fuel type. There is no correlation with CI, CNCH or urban emission. We attempted to remove urban-dominated emissions by various techniques, though some samples were not from urban areas.

CO-likes

CO had the most similar emission factors among fire types. HCHO-likes and CH3-CO2-likes emitted slightly higher amounts of CO, but the fire type also had high CO emissions, hence the name. This fire type was common in both minimums, and distinguished from the Montana multi-stroke plane sampling.

Even-More

These samples include more aged plumes: note the progression in the fire-free plane moving north into Nevada. "Even-more" samples may be observed in the future due to the increased likelihood of samples from the high-emission areas.

Conclusions

As the abstract suggests, the combination of mixed-effects modeling and non-negative matrix factorization has solved the problem of: emission factors, and variation among different types of fires. However, this first attempt to classify fire types has led to new questions about fire chemistry. Statistics has done its work; other approaches may now be called for.