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# Identifying Dust Sources by Positive Matrix Factorization (PMF)

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This presentation is on the source attribution by Positive Matrix Factorization (PMF) of aerosol samples collected in Iraq, a major source of mineral dust in the Middle East. Globally transported mineral dust from North Africa, the Middle East, China, and elsewhere are routinely being sampled at high elevation monitoring sites such as those on the Canary Islands and Hawaii, and many ambient monitoring sites worldwide. Chemical results of these filter samples reflect differences in sources impacting at each site, further complicated by the regional geomorphology and meteorology. Trace elements, isotopes, elemental ratios, and mineralogy are generally being used to pinpoint geological source regions of natural and anthropogenic dusts. A receptor site is seldom impacted by only one source at a time. Dust palls are continually being modified by added dust from soils across which they migrate, also by particle segregation in the dust plume, and precipitation of the coarser particles. The result is that dust is a mixture, with contributions from different sources, each with a different chemical and mineralogical signature.

PMF is a non-negative factorization procedure that produces only positive factor scores and loadings, in contrast to classical factor analysis (FA) and Principal Components Analysis (PCA). PMF enables us to resolve factors (chemical signatures) for source types contributing to the ambient chemical data set, and also models the source-type contributions to individual ambient samples. The latter can often be related to specific source regions. PMF was applied separately to two ambient data sets collected in Iraq in 2006, the one on Teflon membrane filters and the other on quartz fiber. Each of the filter types were previously analyzed for different chemical species: Teflon membrane for elements, by XRF and ICP-MS, while quartz fiber filters were analyzed for ions and carbon. [Engelbrecht et al. 2009]

A set of 392 Teflon filter samples analyzed for 25 elemental species was modeled by PMF. A five factor solution identified three soil factors, a silicate soil, limestone soil, and a gypsum soil, as well as a salt factor and an anthropogenic metal factor. Similarly, a set of 362 quartz filter samples analyzed for 10 selected chemical species was modeled by PMF. A five factor solution provided a limestone-gypsum soil, diesel combustion, secondary ammonium sulfate, salt and agricultural-burnpit combustion source type.

Examples of time series plots of PMF factor contributions for each of six sampling sites (Balad, Baghdad, Tallil, Tikrit, Taji, and Al Asad) will be discussed.

Engelbrecht , J. P., McDonald, E. V., Gillies, J. A., Jayanty, R. K. M., Casuccio, G., and Gertler, A. W., 2009, Characterizing mineral dusts and other aerosols from the Middle East – Part 1: Ambient sampling: Inhalation Toxicology, v. 21, p. 297-326.