Polytopic Vector Analysis of UMDES Soil, Dust, and Serum Samples

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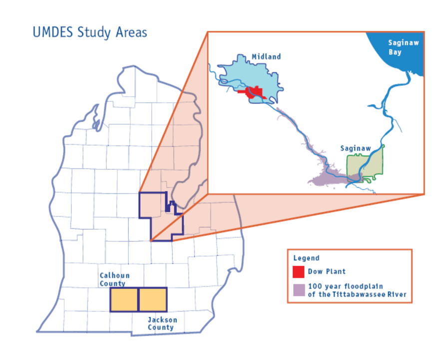
INTRODUCTION AND OBJECTIVES

- The University of Michigan Dioxin Exposure Study (UMDES) was undertaken in response to concerns among the people of Midland and Saginaw Counties related to the discharge of dioxin-like compounds from the Dow Chemical Company facilities in Midland, resulting in the contamination of soils in the Tittabawassee River floodplain and areas of the City of Midland.
- Polytopic Vector Analysis (PVA), a statistical fingerprinting technique, was used to evaluate and compare PCDD/F source contributions to each of the sample matrices collected as part of the study: soil, household dust, and serum.
- This poster is intended to:
  - Provide a brief explanation of statistical fingerprinting concepts,
  - Present the source signatures found in soil, dust, and serum samples collected as part of the UMDES, and
  - Offer interpretation of the signatures found in each matrix.

DATA COLLECTION

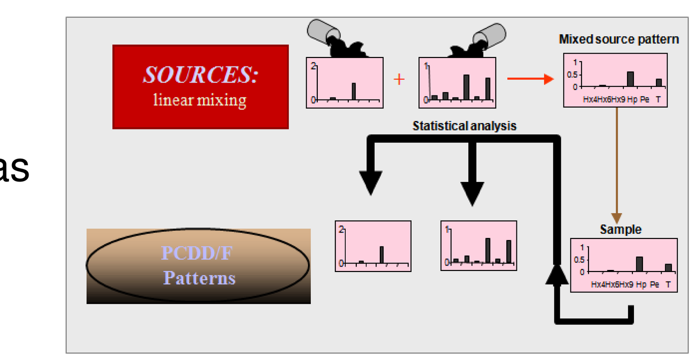
- Four of the five study populations were located in counties surrounding the Dow Chemical Plant:
  - (Tittabawassee River) Floodplain (FP)
  - Near Floodplain (NFP)
  - Other Midland/Saginaw (MS)
  - Midland Plume (PL)
- One study population, Jackson/Calhoun (JC), was far removed from the Dow Chemical Plant and served as the reference population.



- Chemical analysis was performed on:
  - 2081 soil samples from 766 properties
  - 764 household dust samples
  - 946 serum samples
- Samples were analyzed for PCDD/PCDF/PCBs. Only dioxins and furans are included in this analysis

STATISTICAL FINGERPRINTING

- Each source emits a unique composition of chemicals (dioxin and furan congeners in this case) = fingerprint
- Once emitted into environment, individual source compositions mix leading to different patterns measured in sediment samples.
- Correlations among the dioxin congeners help establish which congeners occur together in stable compositions, and each sample is decomposed into these stable patterns.
- This leads to the fingerprints that have contributed to the mix in each sample.
- PVA is a factor analysis technique with a non-negativity constraint. It has been demonstrated to be effective in"un-mixing" source fingerprints.



- A PVA model consists of the characteristic patterns of dioxins/furans (end members) into which each sample can be mathematically separated.
- Each end member can represent:
  - the congener composition of individual PCCD/F sources;
  - mixtures of sources (if, for example, the same source discharged two different sources simultaneously for some period of time);
  - phenomena responsible for altering the original signatures such as dechlorination and differential elimination; and
  - portions of a source signature that differentiate it from another source.
- Each end member can be paired with a matching fingerprint of industrial emissions. Industrial emission fingerprints for dioxins and furans are known from chemical analysis of emissions across a variety of industries (USEPA, *The Inventory of Sources of Dioxins in the United States*, 2000, 2005).

RESULTS AND DISCUSSION

Dust and Soil Results

<u>Soil 5 EM Model</u>

- Profiles show the congener composition of each EM. Congeners in each family listed in order of increasing chlorination.
- Box and whisker plots present distribution of loadings by study population – EM3 is elevated in the Floodplain and Near Floodplain.

<u>Dust 6 EM Model</u>

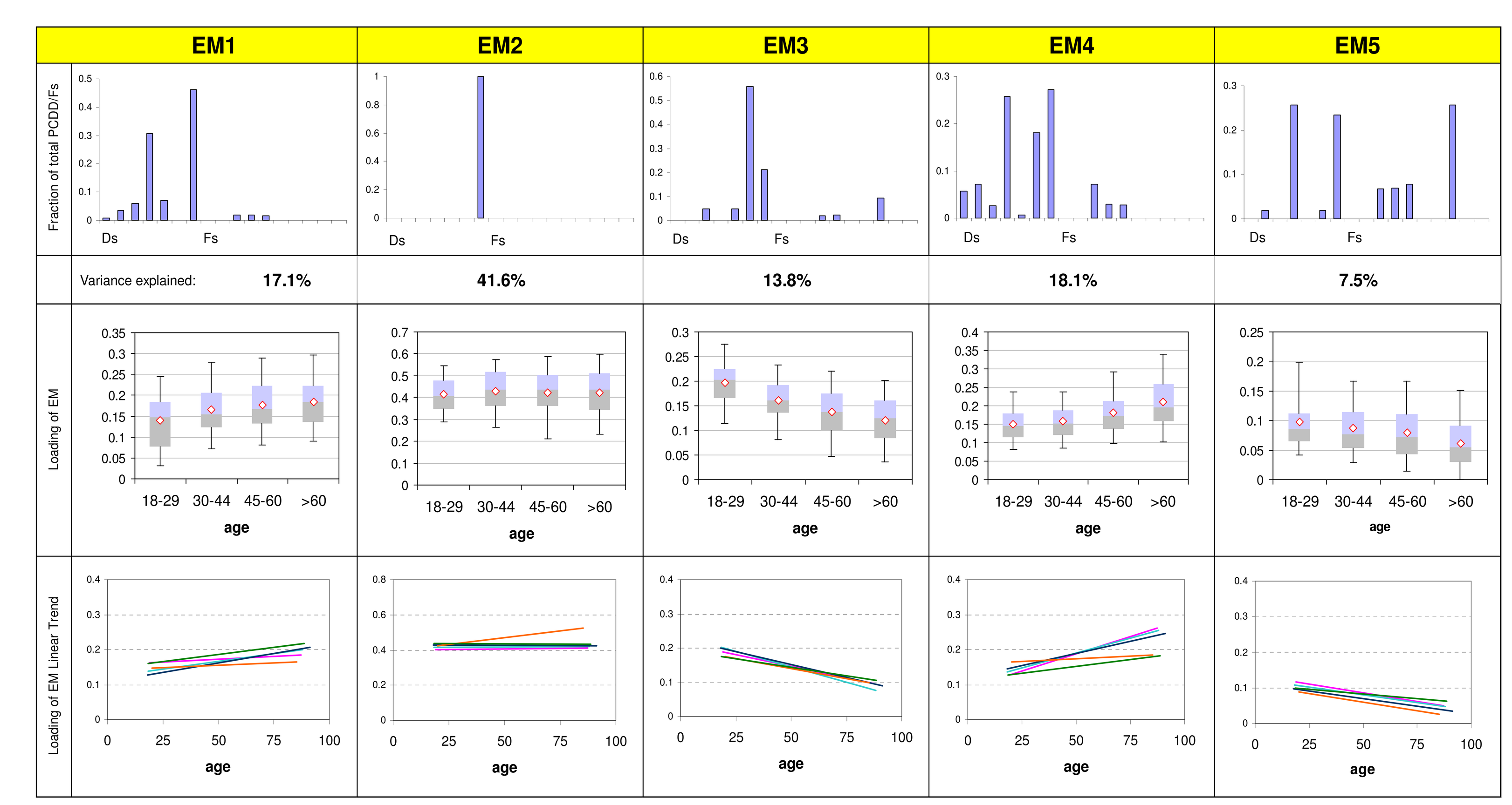
- Dust EM profiles are similar to soil profiles, with the exception of one pattern dominated by HpCDD.
- As was the case for soil, the loadings of EM3 are elevated in the Floodplain and Near Floodplain.

<u>Emission Source Profiles</u>

- Potential matching industrial emission profiles from USEPA Source Inventory.
- Graphite electrodes are thought to have been used in early 20th century processes at Dow. The profile matches EM3 with a few congeners from EM4.

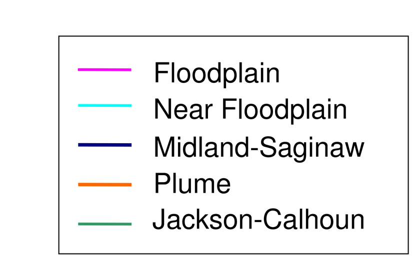
Conclusion: Soil and dust end members are similar, and they are interpretable as fingerprints from both background and local sources.

Serum Results



<u>Serum 5 EM Model</u>

- Serum EMs are distinct from those found in soil and dust.
- Box and whisker plots present distribution of serum EM loadings by age category.
- Clear increases or decreases in loading with age are evident in all but one of the serum EMs.
- These trends correspond reasonably well with known elimination rates of the various congeners (i.e, congeners with slow elimination increase with age).



- Lower plots present linear trend-lines of end member loading as a function of age for each of the study populations.
- EM2 and EM4 (and possibly EM1) exhibit regional differences:
  - The Plume shows an increase in EM2 loading (OCDD) with age.
  - The Floodplain, Near Floodplain, and the Other Midland/Saginaw populations show a larger increase in loading of EM4 with age than do the Plume and Jackson/Calhoun populations.

Conclusions

- Serum end members are age-correlated and may be more representative of differential elimination, rather than exposure source signatures.
- Some serum end members do vary by study population.
- Correlations of serum EMs blood with exposure source signatures (food, environmental) will need to be informed by pharmaco-kinetic modeling.

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