

ANALYSIS OF PATTERNS IN PCDD, PCDF, AND PCB SOIL CONCENTRATIONS FROM A COMMUNITY IN MICHIGAN, USA

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Introduction

Objective of UMDES

- To develop statistical relationships between living on contaminated soil and increase in body burden of dioxins

Objective of Soil Dioxin Pattern Analysis

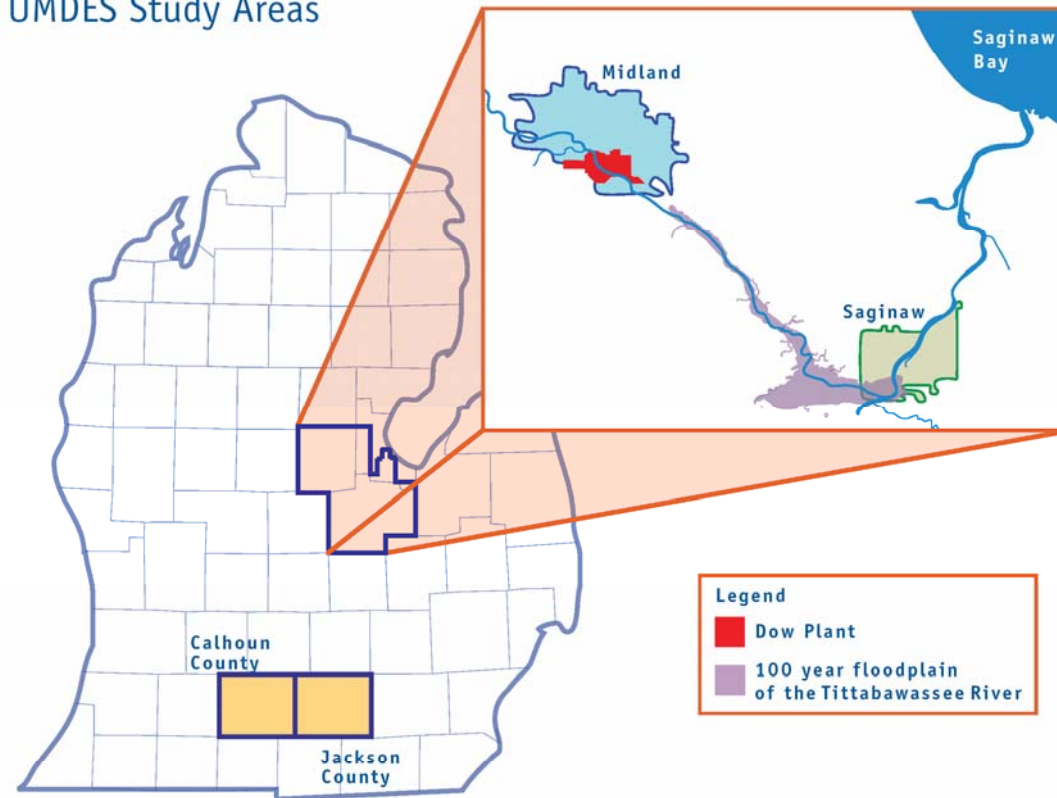
- To understand the geographic distribution of source patterns in soils across five sampled populations
- To help quantify the contributions of these sources to house dust and body burden



Geographic Sampling Regions

- Floodplain
- Near floodplain
- Midland Plume
- Other Midland/
Saginaw
- Jackson/Calhoun

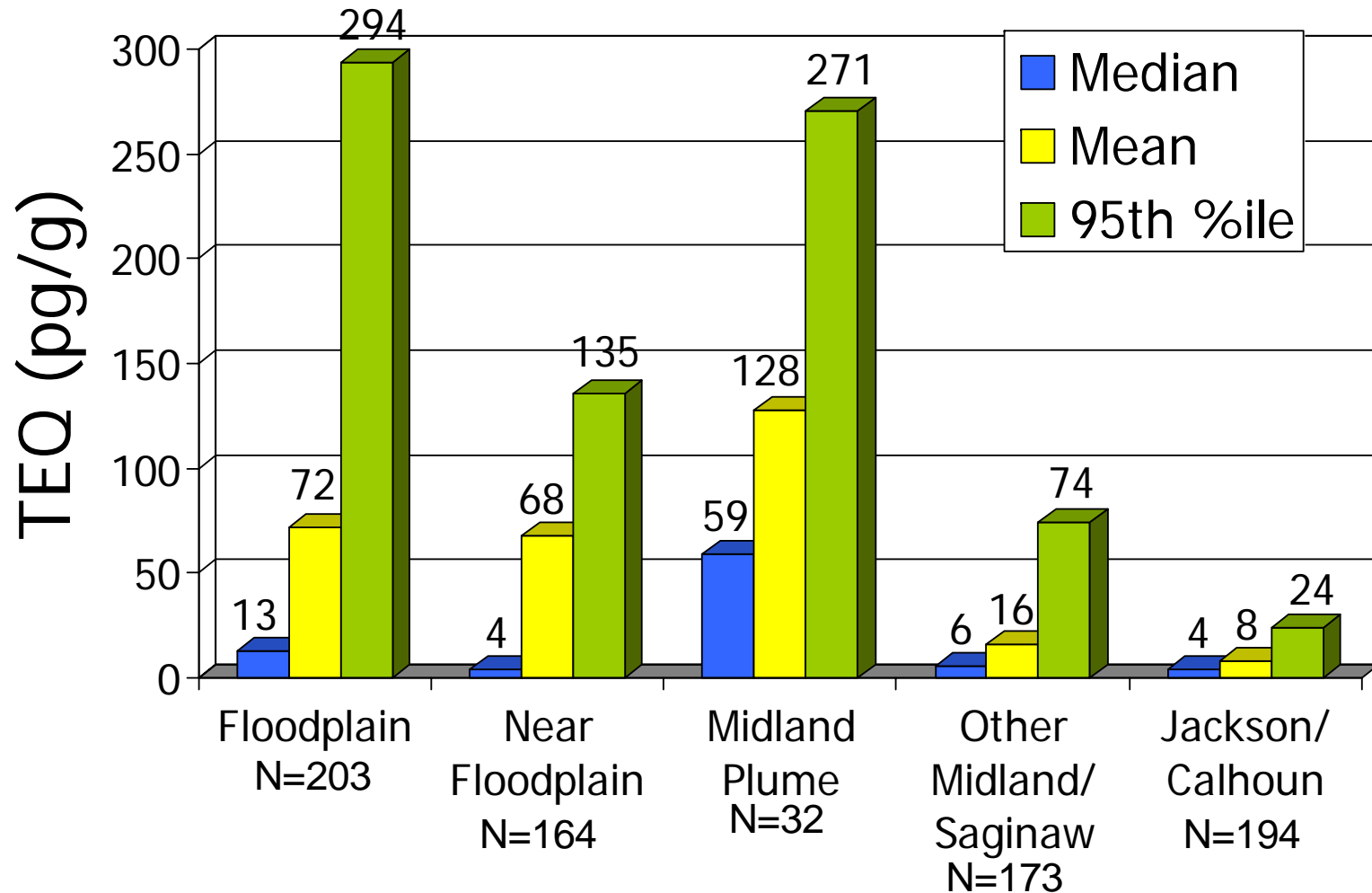
UMDES Study Areas





Comparison of TEQ for Geographic Regions

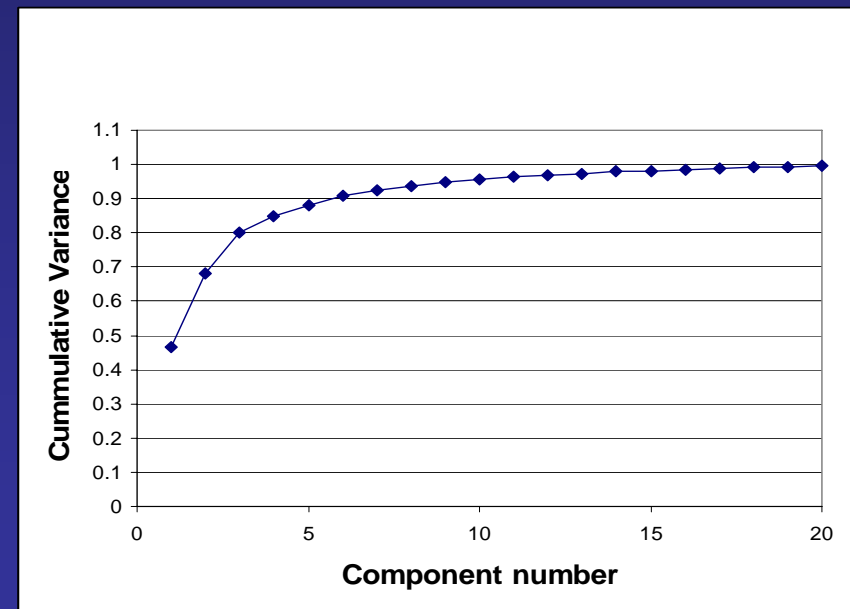
House perimeter 0-1 inch





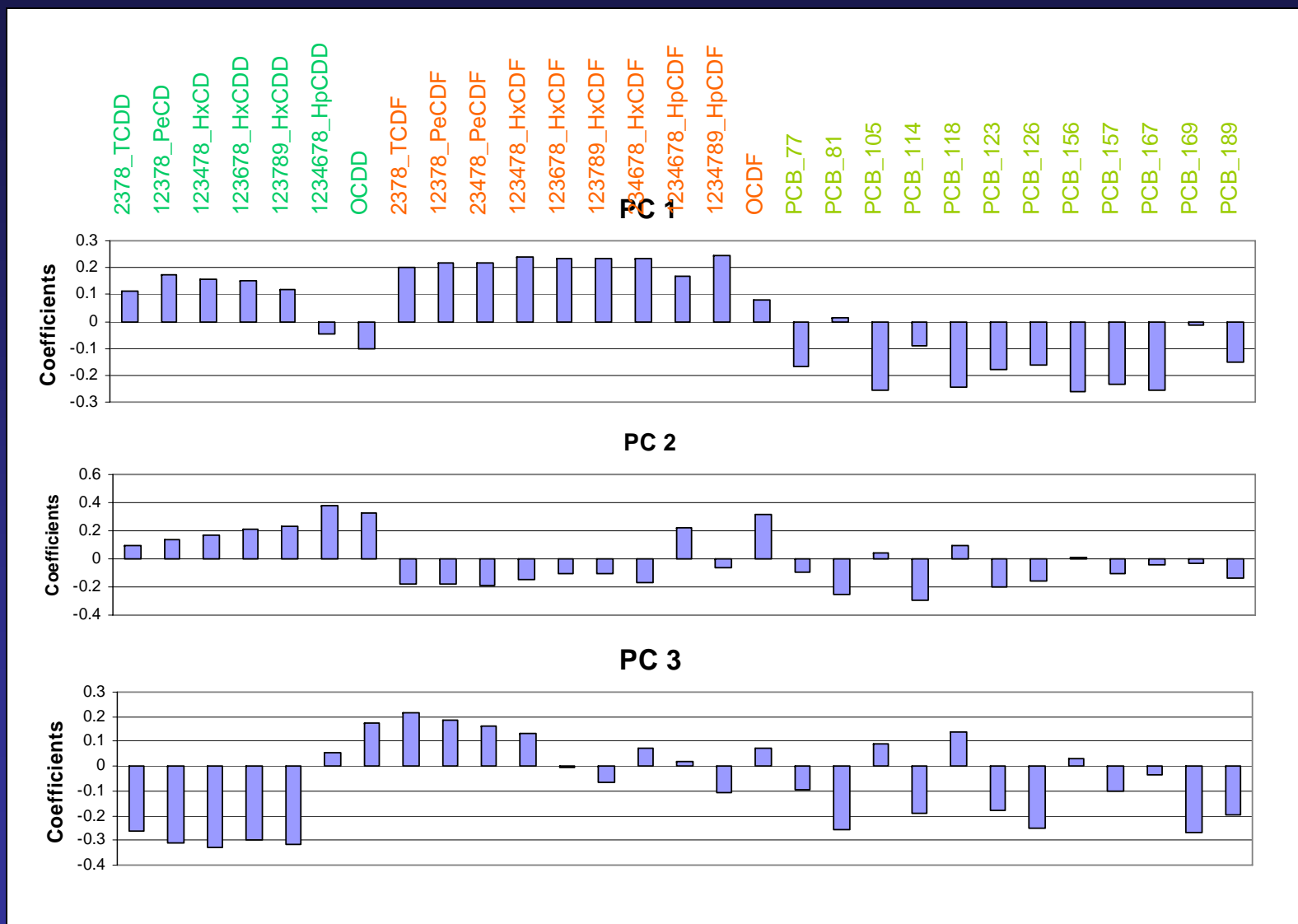
Principal Components Analysis for Soil Patterns

- Data:
 - Soil samples from all regions, stations and strata (2,081 samples)
- Data Transformations (Johnson and Ehrlich, 2002)
 - $\ln(x+1)$
 - Constant Row Sum: sum of analytes totals 100%
 - Range (min-max): homogenization of variance (minimum concentration '0'; maximum concentration '1')
- Principal Component Analysis:
 - Correlation matrix
 - 10 PCs explained 95% of the variance
 - PC scores (the contribution of each PC) were determined for each sample.





Congener Loading for Top Three Components in Soil



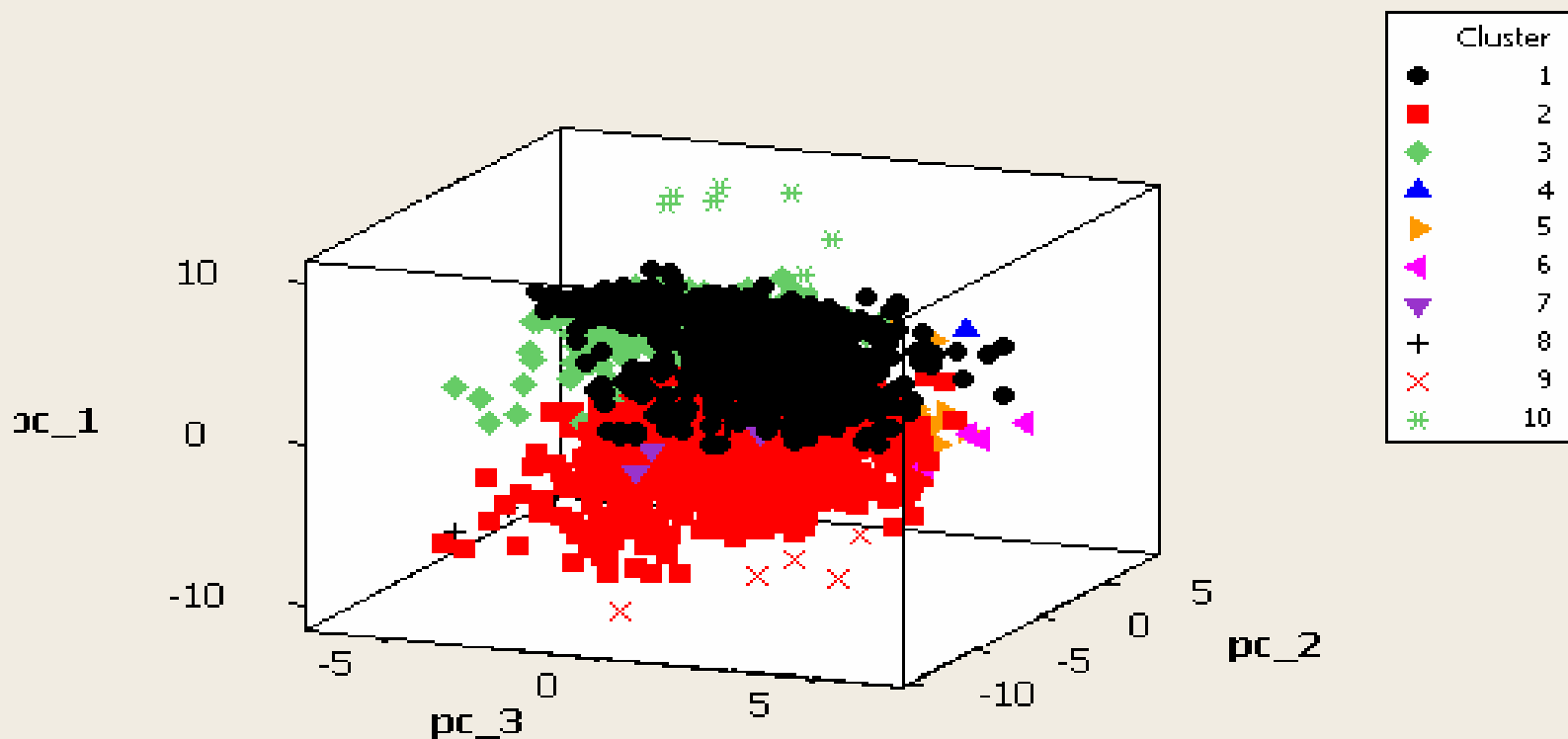


Hierarchical Cluster Analysis of Soil Patterns

- Ten clusters were selected to correspond with the number of principal components.
- Each sample was assigned a point in 10 dimensions based on each of its PC scores.
- Clusters were assigned using an iterative algorithm that groups the samples based on Euclidean distance between the points.
- Identification of centroid (center in 10-D space) as a representative pattern for each cluster

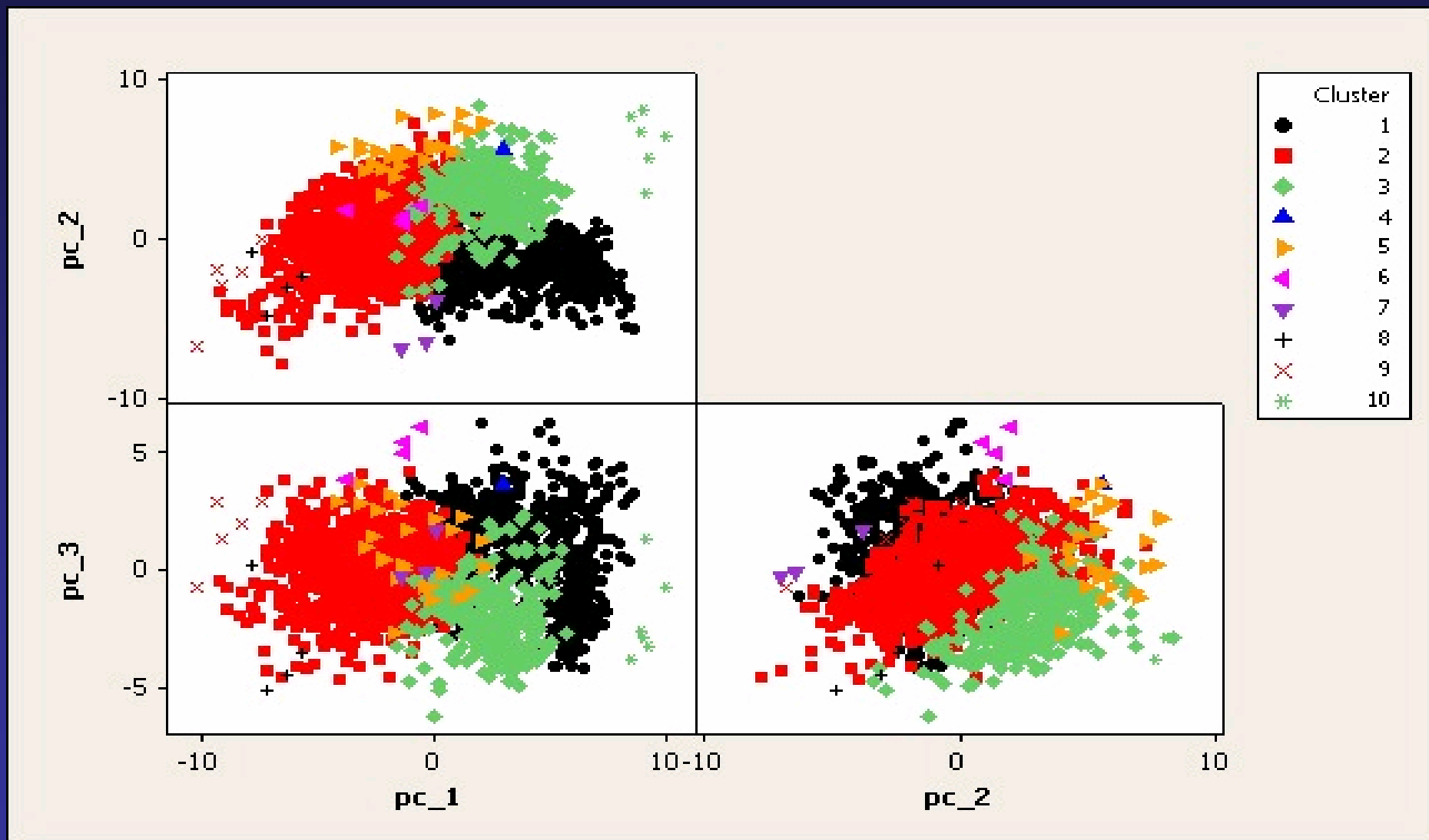


3-D Principal Component Score Plots





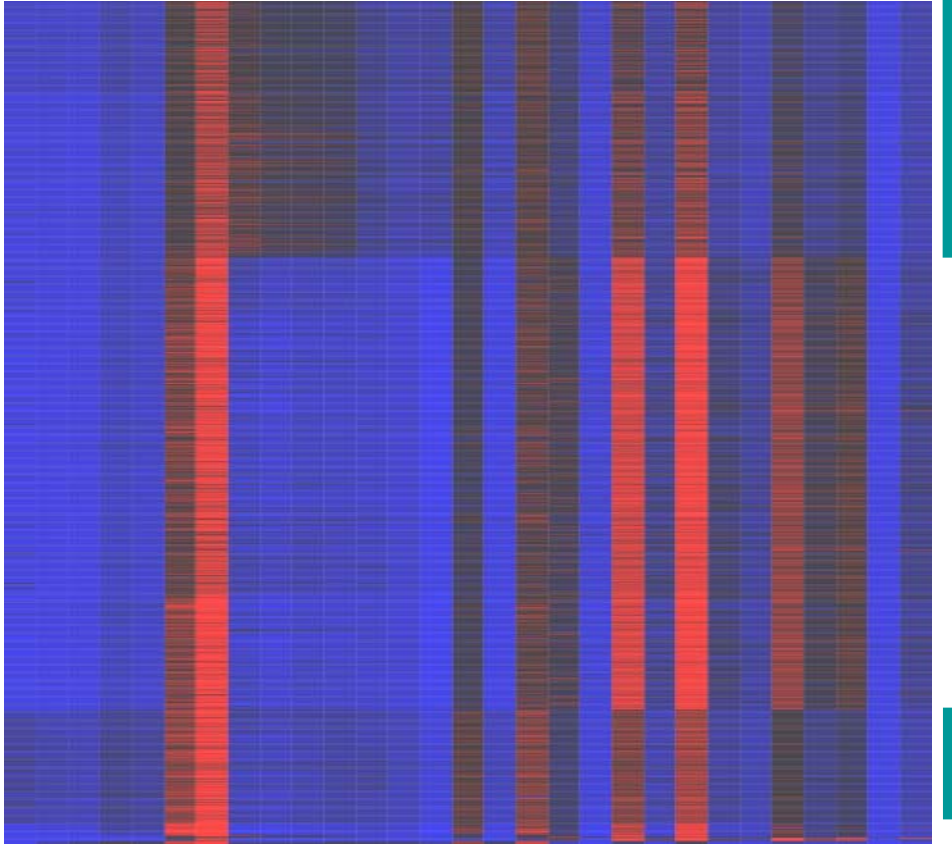
2-D Score Plots of Soil Clusters





Heatmap of Clustered Patterns in Soil

s_2378_TCDD
s_12378_PeCD
s_123478_HxCd
s_123678_HxCDD
s_123789_HxCDD
s_1234678_HpCDD
s_OCDD
s_2378_TCDF
s_12378_PeCDF
s_23478_PeCDF
s_123478_HxCDF
s_123678_HxCDF
s_123789_HxCDF
s_234678_HxCDF
s_1234678_HpCDF
s_1234789_HpCDF
s_OCDF
PCB_77_s
PCB_81_s
PCB_105_s
PCB_114_s
PCB_118_s
PCB_123_s
PCB_126_s
PCB_156_s
PCB_157_s
PCB_167_s
PCB_169_s
PCB_189_s



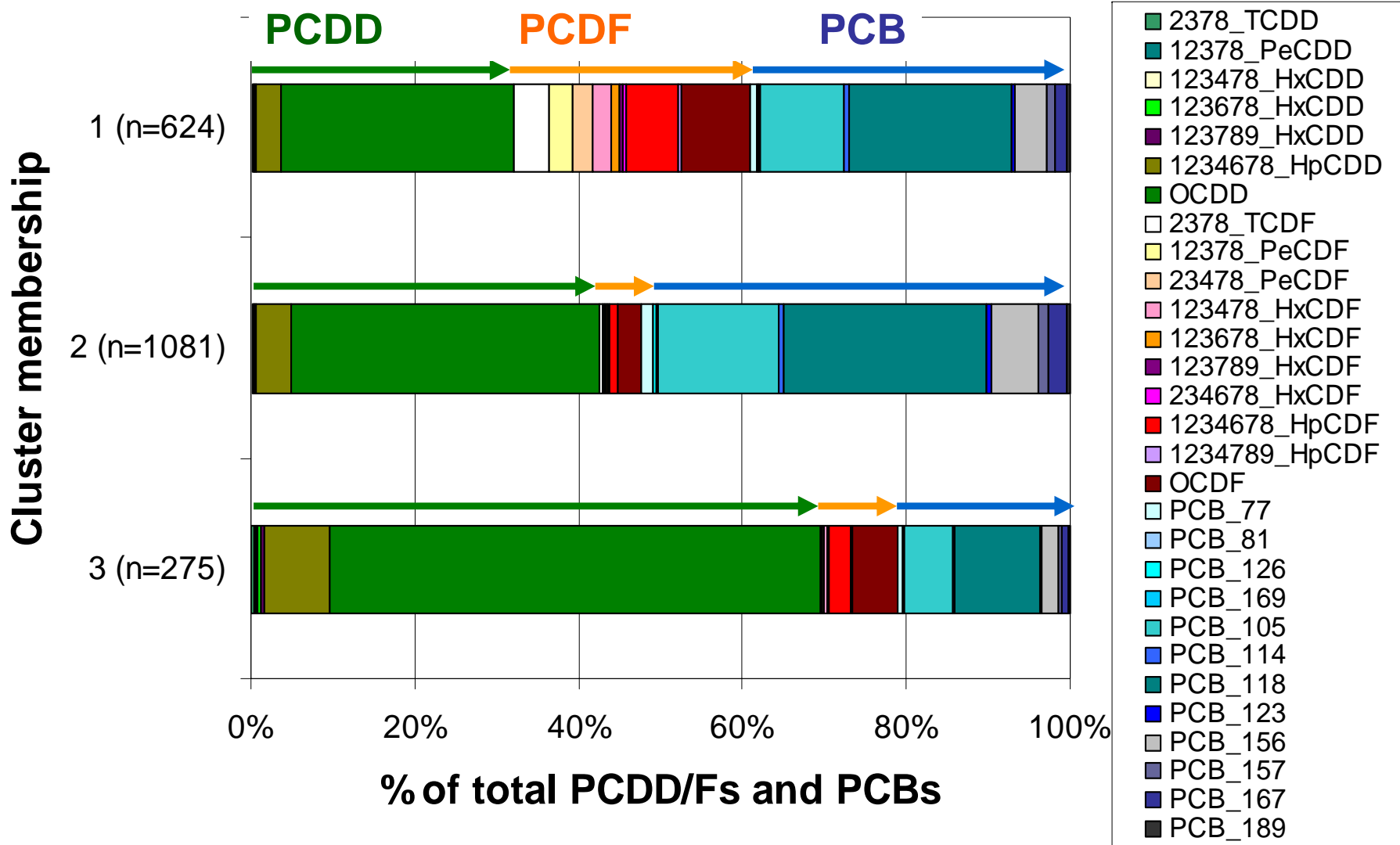
TEQ > 90 ppt
TEQ > 200ppt



- Heat map : value-coded colors.
- The brightest blue color indicates the minimum values in the whole data set and the brightest red the maximum. Black color represents middle values.
- The data are sorted by cluster membership.
- The transfer of clustered congener concentrations to a color-coded maps confirms the presence of three dominant clusters.
- High TEQ floodplain patterns are contained within cluster 1

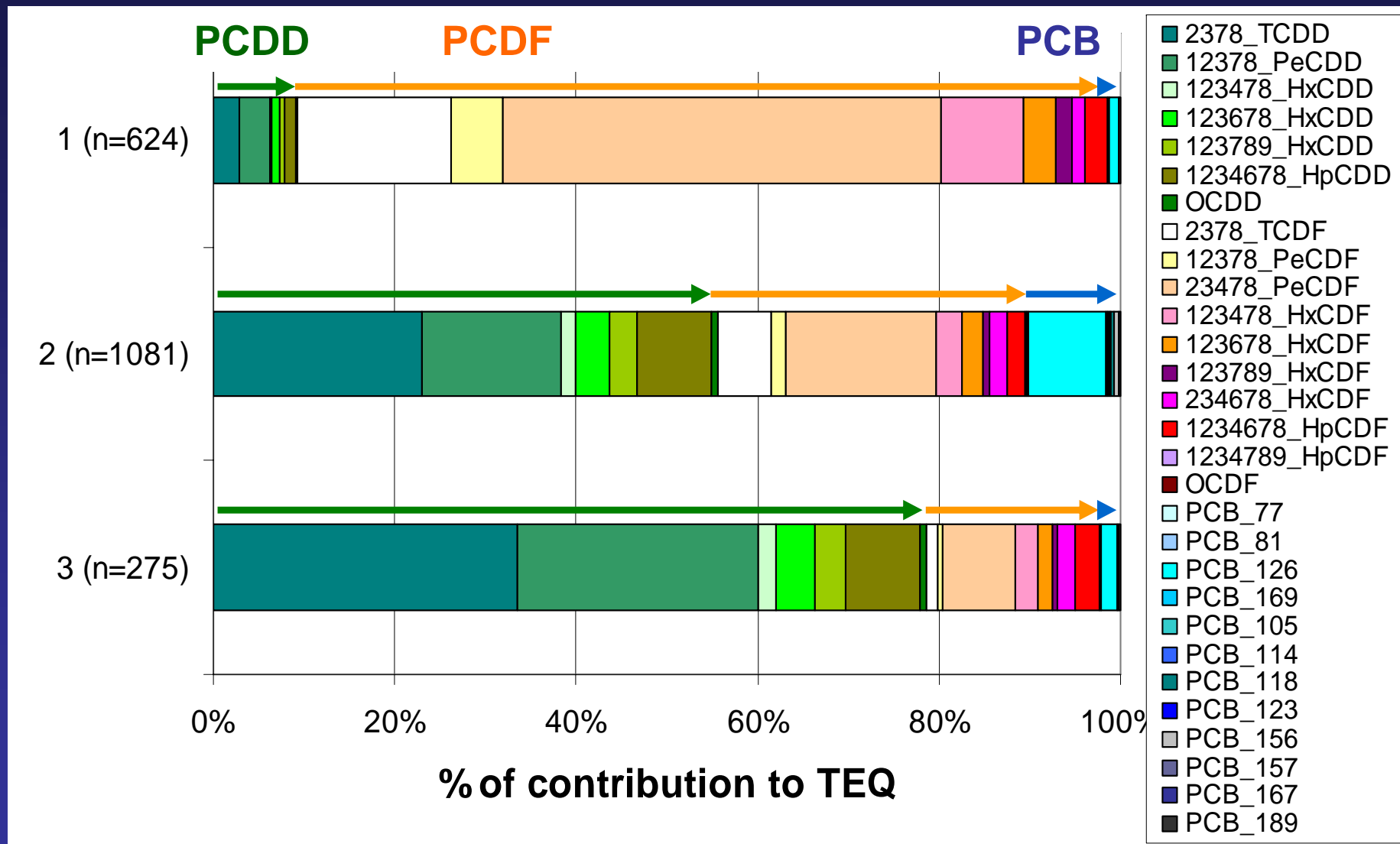


Unweighted Centroid Patterns of Dominant Clusters



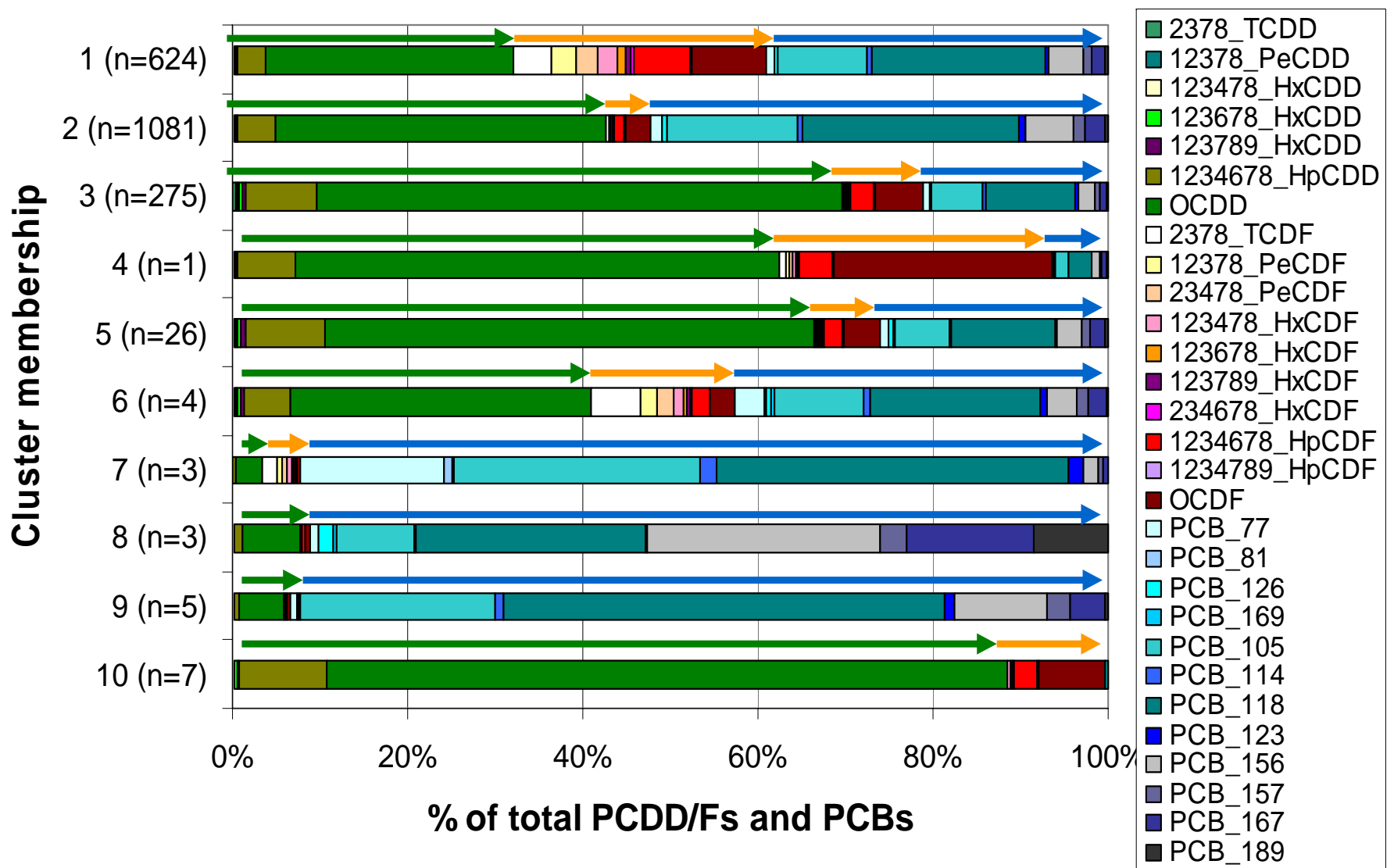


TEF-Weighted Centroid Patterns of Dominant Clusters



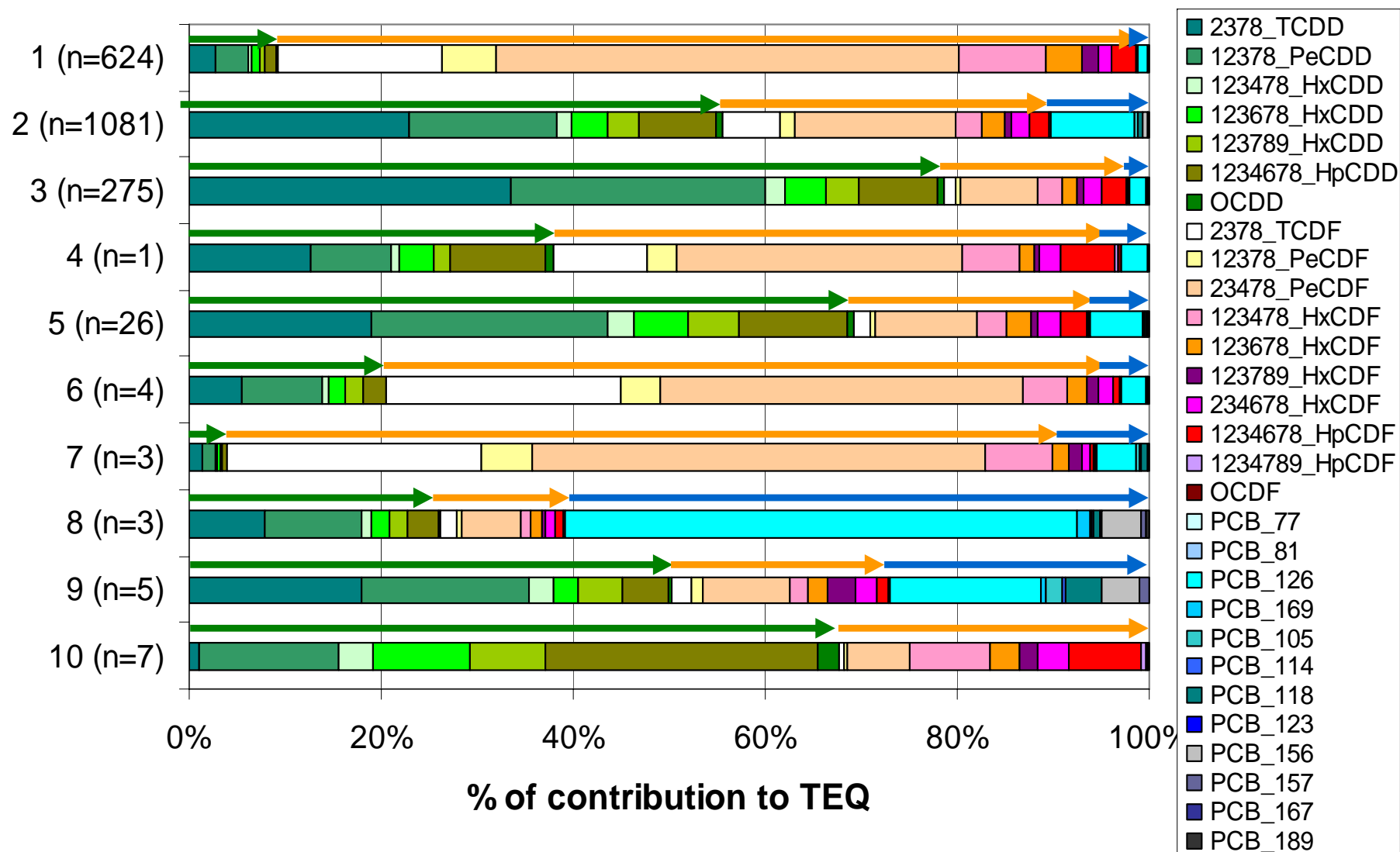


Unweighted Centroid Patterns - All





TEF Weighted Centroid Patterns - All





Geographic Distribution of Observed Patterns

Note: Due to confidentiality constraints, actual maps depicting the distribution cannot be shown in public

1. The most common pattern, characterized by **elevated HpCDD, OCDD and PCBs**, believed to be due to combustion, was found in soils throughout Jackson/Calhoun and Midland/Saginaw.
2. The next most common pattern, characterized by **elevated TCDF and 4-PCDF** was found mainly in the Floodplain and Near Floodplain. We believe this pattern is the result of Dow's historic discharges into the river.
3. The Midland Plume region, downwind of the Dow plant in Midland, is related **to the combustion pattern. The magnitude of the combustion pattern was higher, and 2,3,7,8-TCDD and 1,2,3,7,8-PeCDD were elevated.** We believe this pattern is a result of Dow's historic airborne discharges.
4. The Jackson-Calhoun region is similar to other Midland-Saginaw. The highest TEQ values in J-C were due to contributions of PCBs. The source of this/these pattern(s) is undetermined at this time



Conclusions

- PCA analysis of WHO-29 congeners in >2,000 soil samples resulted in the resolution of 10 clusters explaining 95% of sample variance.
- The fingerprints, based on cluster centroids, resolved incineration, chloralkali, and Aroclor sources contributing to soil patterns. Other cluster centroids indicate combustion patterns mixed with unknown sources.
- The geographic distribution of the incineration and chloralkali patterns are indicative of Dow's historical airborne and aquatic emissions to soils and the Tittabawassee River floodplain.
- Region-specific fingerprinting and application of other chemometric mixing models (e.g. polytopic vector analysis, or confirmatory factor analysis) will be required to quantitatively resolve mixed patterns.



Related Presentations

- Oral presentation 63
Analysis of Patterns in Soil Concentrations
- Poster 84
Methods for Sampling and Analyzing Soil Samples
- Poster 98
Spatial Analysis of Soil Concentrations
- Poster 100
Analysis of Vegetation Concentrations

All posters in Poster Session A