Statistical approaches to improve paleoenvironmental reconstructions

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Over the last thirty years, advances in technical capabilities have led to a remarkable expansion of the use of geochemical indicators as proxies for terrestrial paleoclimate and paleoenvironment. A multitude of biomarkers, for example, are now commonly used to infer past changes in temperature, rainfall, and vegetation cover, yielding a wealth of new data across a variety of environments and timescales that have been used to infer fundamental aspects of the Earth System. However, the statistical methods to infer past climate states have not evolved alongside the geochemical capabilities.

This talk will explore ways in which the geochemistry field can advance towards more quantitative estimates of paleoenvironments by incorporating both established and new statistical techniques. The calibration of proxies to target environmental variables can benefit from the incorporation of forward models, which explicitly encode the science linking the proxy to target environmental parameters. Inference may then proceed by either frequentist inverse modeling or Bayesian approaches. Higher dimensional geochemical data may be amenable to the use of data mining and newer machine learning approaches. Case study applications demonstrate that these approaches can provide robust estimates of paleoenvironments with quantitative uncertainty bounds, thereby improving our understanding of past — and by analogy, future — climates.