Multivariate Receptor Modeling with Widely Dispersed Lichens as Bioindicators of Air Quality

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Introduction

Lichens are frequently used as air-quality bioindicators. Here, we investigate to what degree accumulation patterns of generic pollution sources are detectable on broad geographic and temporal scales.

Objectives

We examine whether state-of-the-art Bayesian multivariate receptor models (BMRMs) can sufficiently detect and discriminate signals of generic (rather than specific point) pollution sources with noisy elemental data from widely dispersed lichen samples. We contrast positive matrix factorization (PMF), which decomposes elemental concentration profiles from samples into contributions from estimated pollution source profiles. We contrast PMF results with those of two Bayesian multivariate receptor models (BMRM). Through informative priors, these models incorporate information about potential pollution source profiles, allowing for varying degrees of knowledge and appropriately propagating uncertainty. Because our elemental measurements represent lichen physiology in addition to accumulated pollution, we customize the models to include a pre-estimated factor (source) representing background lichen secondary chemistry.

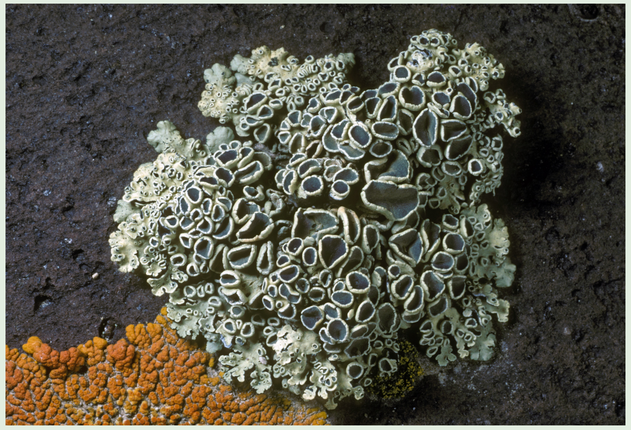
Methods

Using samples of the widespread "rock-posy" lichen sampled across the Intermountain Region of the USA, we contrast analyses of elemental concentrations employing PMF and BMRM. We extend the standard Bayesian implementation to include i) separately estimated lichen secondary chemistry as a factor, and ii) shrinkage priors to allow for sharper selection among a set of candidate sources at each site. Through regularization, the extended model is better able to maintain source identity, as specified though informative prior distributions on elemental profiles.

Conclusions

Quantitative profile matching shows that the PMF model primarily captures variations of the baseline profile. Both PMF and BMRM results suggest that the most detectable signatures relate to aeolian dust deposition, while spatial patterns hint at anthropogenic signatures near industrial activity and population centers.

Deposition patterns of **aerial pollutants are detectable** with clear spatial patterns using sensitive **indicator lichens** sampled across broad spatial and temporal scales under **limited sampling replication.**



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