Estimating Clinically Significant Mold Spores in Outdoor Environment

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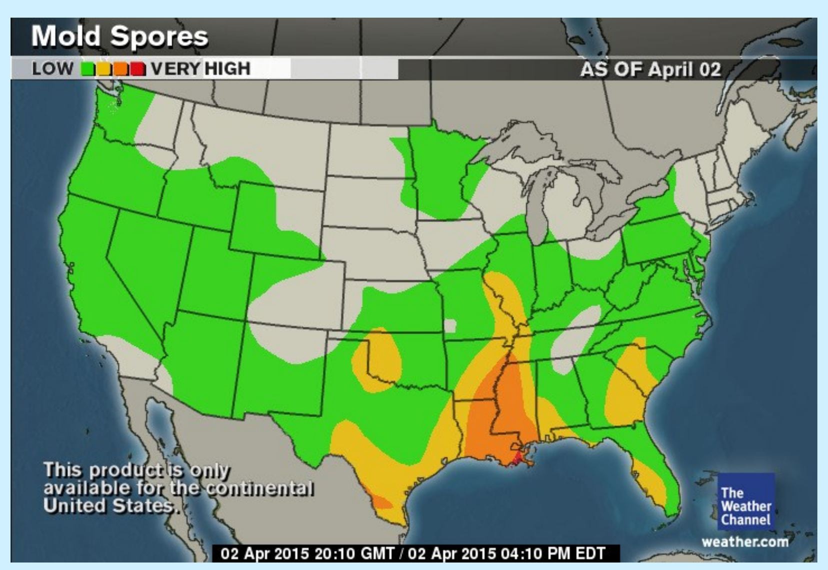
Purpose

Estimate clinically significant mold spore abundance in outdoor environment on a daily basis to reduce health burden due to exposure to Harmful Airborne Fungal Spores (HAFS) in outdoor environment.

Introduction

Exposure to airborne fungal elements has been known to associate with many adverse health outcomes including asthma severity, pneumonitis, allergic rhinitis, cardiovascular and chronic obstructive pulmonary diseases, and even death. Harmful Airborne Fungal Spores (HAFS) cause a state or condition in which an immune reaction is triggered due to foreign substance encounter, known as immunoglobulin E (IgE) sensitization. However, the severity depends on the spore type and amount in the air.



Information on the abundance of spores is not available at local scales due to a scarcity of costly in-situ monitoring sites. Current mold spore monitoring stations only total 46 nationwide and the reporting is often extrapolated to multi-state areas. Since the fungal spore abundances at any given time are significantly controlled by environment in many different ways, we attempted to estimate spatiotemporal distribution of the clinically significant mold spores using environmental data.

Outdoor mold spore abundance is critically important for health because outdoor fungal spores can: a) cause serious health problems on exposure, and b) can control the indoor spore types and amount by entering the indoor environment.

Spore	Common Health Effects
Alternaria	Highly allergic common outdoor fungal genus. Can deposit in the nose, mouth and upper respiratory tract causing an allergic response.
Aspergillus	Most are allergenic Various species can cause a serious and persistent lung infection and some are also known to produce mycotoxins.
Cladosporium	Most abundant outdoor spore type with worldwide distribution. A few species have been reported as human pathogens and are known to be allergenic; responsible to trigger for hay fever and asthma symptoms.
Penicillium	Also a common fungal genus known to be allergenic. Some species are also known to produce mycotoxins.
Stachybotrys	This less common toxic black mold that produces airborne toxins that can cause serious breathing difficulties, dizziness, flu-like symptoms and bleeding in the lungs.
Fusarium	Can produce a number of different mycotoxins. Some species can produce vomitoxin, some poses inhalation and deep skin (dermal) inoculation health risks to persons with weak immune systems.

Methods

Data Collection

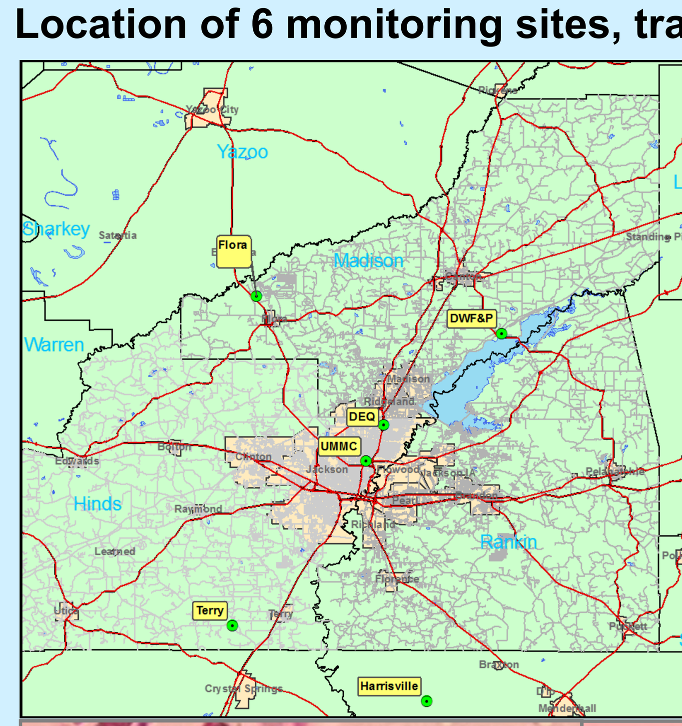
a) Environmental Data
- Meteorological
- Ground condition
- Airborne particulate

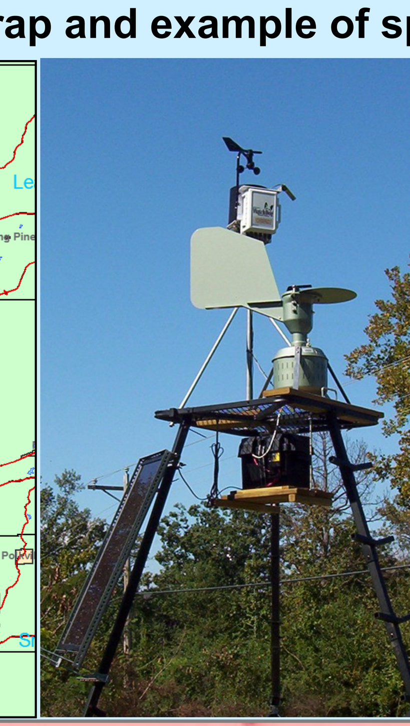
- Derived using Earth observation resources (e.g. NASA, NOAA)
- Directly available (e.g. NOAA)
- Modeled

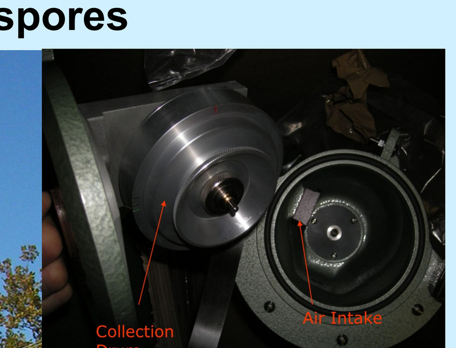
b) Mold Spore Data

- Collected using spore traps

Location of 6 monitoring sites, trap and example of spores

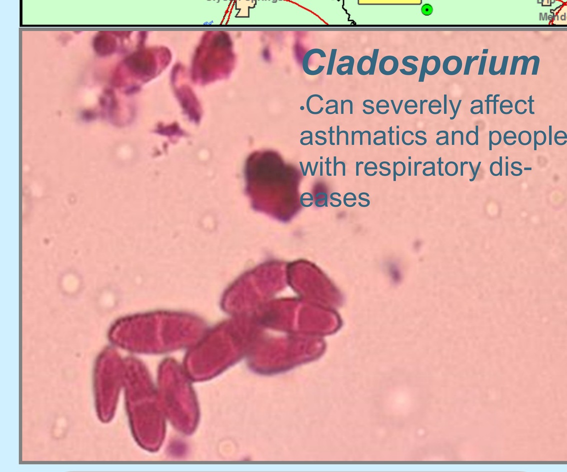


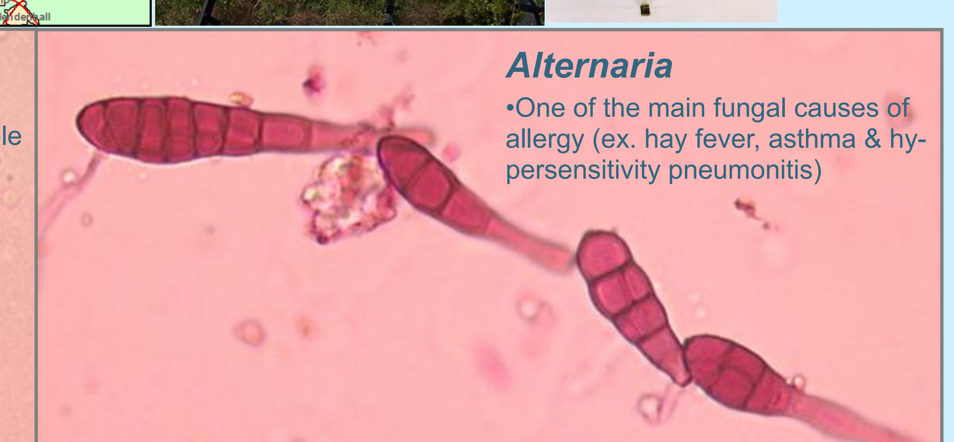




Burkard volumetric spore trap

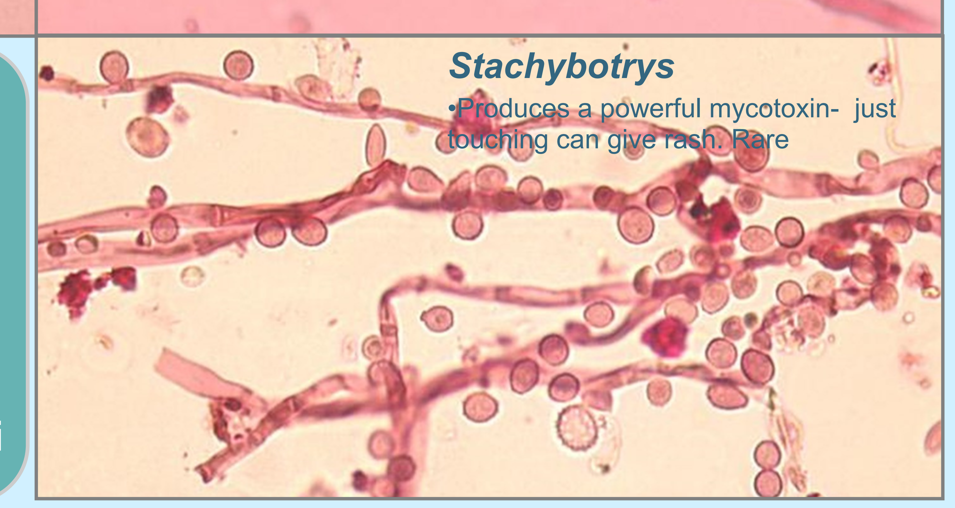
-Burkard Scientific, UK





Trapped spores are mounted on slides and manually identified and counted under microscope.

All major clinically significant spore types were found in Central Mississippi



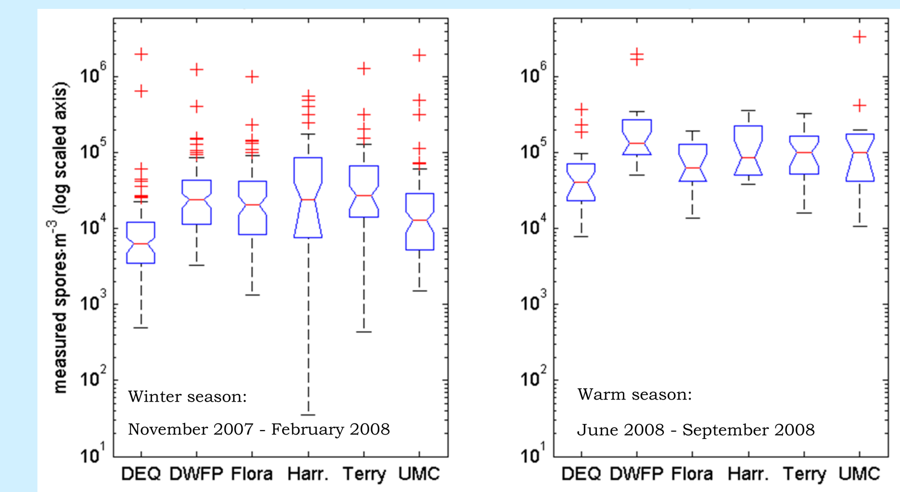
Three types of measurements

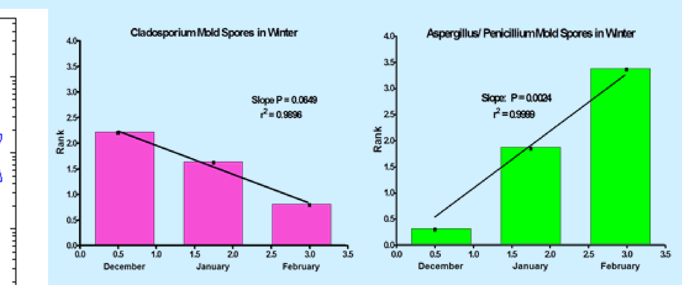
1.**Concentration** (number / m^3) of air per day

2.**Burst Event**
An event in which spore count of one genera in one microscopic field (longitudinally across the slide) is >50% of the field

3.**Spike Event**
A daily mold spore count for a specific genus or total count larger or equal to 75th percentile of their corresponding annual daily spore counts

Results

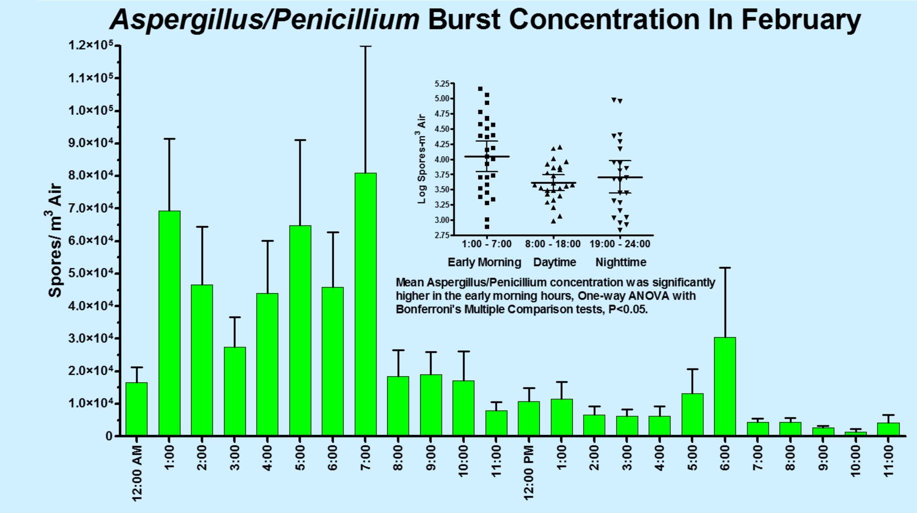




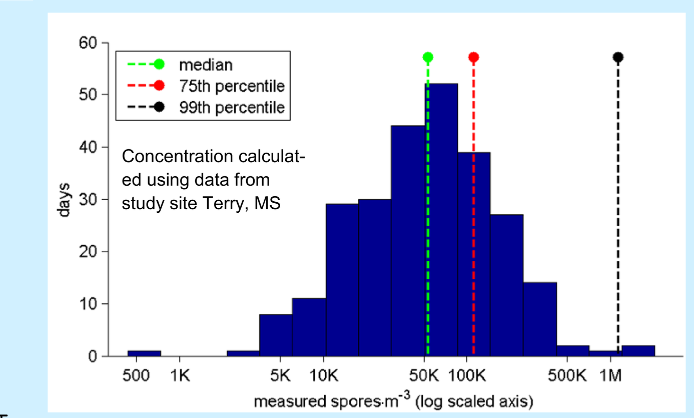
TOP: All spore types DO NOT respond to environment equally. *Cladosporium* and *Aspergillus/Penicillium* inversely respond to cold

LEFT: Spore count distribution comparison among six sites and seasons

***Aspergillus/Penicillium* Burst Concentration In February**



Changes in environmental conditions by the hours drastically impact Burst measurements. (Kruskal-Wallis and Dunn's Multiple Comparison tests)



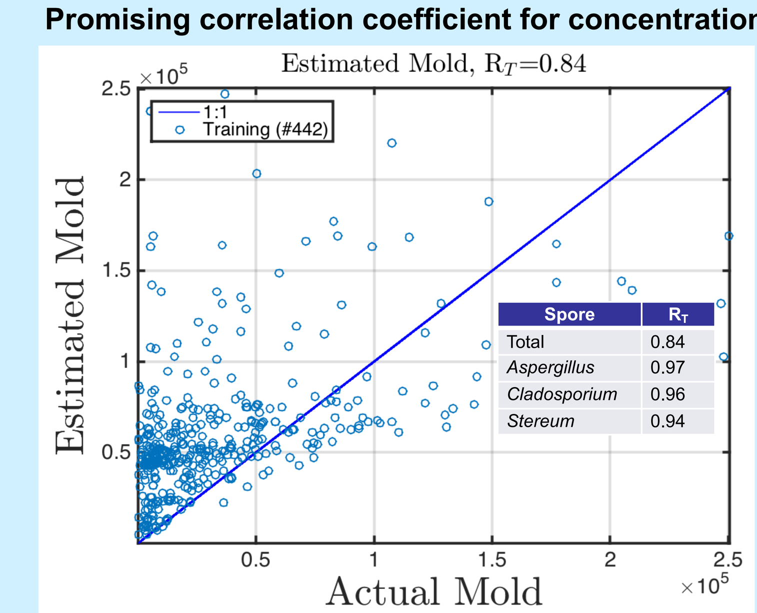
Threshold Statistic	National Allergy Bureau	Our Study Values
Median	6,500	54,000
75th percentile	13,000	110,000
99th percentile	50,000	1100,000

Because of the complex biological behaviors of mold spores we explored multiple approaches to estimate their abundance:

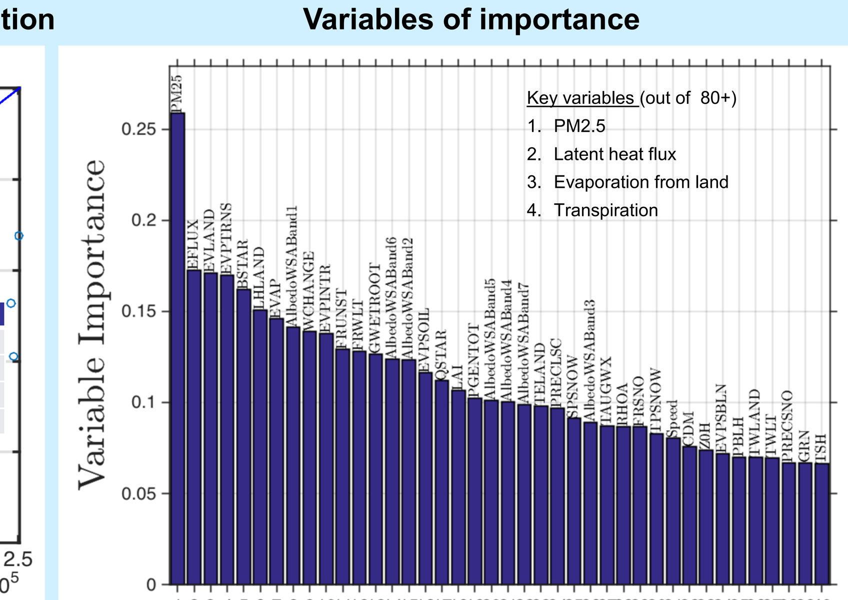
1. Linear Regression using Ground Meteorological Variables for Estimating Spore Burst
   can be useful predicting only specific types of spore bursts
2. Multiple Regression Model for Estimating Total Spore Count
   shows promise of using NASA and NOAA data without in predicting spore abundance in warm season
3. Logistic Regression Model for Estimating Mold Spore Spike
   shows promise for predicting only *Cladosporium* spike events (with sensitivity >63% and specificity >92%)
4. Machine Learning Approach for Estimating Spore Count and Burst
   So far shows the best promise

Machine Learning Approach

Promising correlation coefficient for concentration



Variables of importance



Conclusions

- Machine Learning approach is promising in estimating outdoor mold spore abundance
- More training data are required to validate this approach