Development of Rapid Prototyping Capability to Evaluate Potential Uses of NASA Research Products and Technologies to Estimate Distribution of Mold Spore Levels over Space and Time
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PROJECT OVERVIEW
The goal of this project is to develop Rapid Prototyping Capability (RPC) to evaluate potential uses of NASA research products and technologies to estimate mold levels through experiments. The University of Mississippi Medical Center (UMMC) has teamed with Goddard Space Flight Center (GSFC), Science Systems & Applications, Inc. (SSAI), Mississippi State University, Mississippi Department of Health, American Lung Association of Mississippi, and Mississippi Asthma Coalition to achieve this goal by forming an effective team composed of data providers, prototype developers and user communities. Estimation of mold spore distribution is currently conducted based on very sporadic ground monitoring facilities. It is known that meteorological conditions influence mold growth and distribution. Our objective is to estimate mold spore level using NASA and NOAA data so that no ground monitoring stations are required and estimation can be made wherever NASA/NOAA data are available.

DATA
This study involves analyzing three sets of data:
1. Meteorological data from ground monitoring stations
2. Meteorological data from NASA and NOAA
3. Mold spore data from ground monitoring stations

NASA Data:
a) Vegetation Moisture Index (NPP VIIRS)
b) Precipitation (GPM DPR)
c) Humidity (NPP CrIS and ATMS)
d) Soil moisture (AMSR-e)

NOAA Data:
a) Relative humidity
b) Temperature
c) Wind speed and direction

Ground Meteorological Data:
a) Precipitation/Rainfall
b) Temperature (air)
c) Humidity (relative)
d) Soil moisture
e) Leaf wetness
f) Wind direction and speed

Ground Mold Data:
a) Mold spore count

Fig. 1. Data relationship diagram for mold spore distribution estimation
Fig. 2. RPC product development flow diagram
Fig. 3. Burkard Pollen and Mold trap: a) left: assembled, b) below: collection drum
MODELING APPROACH
Outdoor mold spore distributions are known to be dependent on local climate variables including temperature, moisture and wind conditions. The interrelationships may be complicated. For example, mold levels are usually positively correlated with relative humidity, but negatively correlated with precipitation. There is, however, a positive correlation between precipitation and relative humidity. Usually, the precipitation physically removes the mold spores from the air with no lag time, but the effect is only transient. The effects of humidity may have a long lag time but are of longer duration. The model, therefore, must be able to take into account the variable lag periods and may include duration effects via integration over time. There are clearly both spatial and temporal correlation effects to be expected. But because of our relatively small study area and short duration of the study, our ability to take these effects into account is limited. However, with the advantage of a finer resolution of the VIIRS normalized difference moisture index (NDMI), a modeling approach that adds a spatial component to account for scale may be possible. Even though the other satellite datasets (rainfall, humidity, soil moisture, etc.) are somewhat coarser, similar methods may be beneficial with these data as well. We will use multivariable regression between the mold spore counts and the independent meteorological variables. An autoregression (ARMA and ARIMA), with a spatial component to account for the scale, will be performed using the lag variables and the best fit will be determined using maximum likelihood estimation. Additionally, spatial cross-correlation will be conducted to reveal possible directional trends between the climate and mold data. We will also look at the cross correlation of variables both within and between these data sources (NASA/NOAA, ground station) to evaluate the consistency of the data sets with each other.

PROGRESS STATUS
A kick-off meeting with team members was held in March to discuss approaches of achieving the goals of this project. Evaluation and review of RPC system requirements were carried out. We have acquired ground monitoring equipment and accessories for collecting mold spore and weather data. Training on mold spore count was also completed. Final arrangements for ground sample monitoring sites and maintenance agreements have been made. We are currently installing the ground sampling facilities. An agreement with SSAI, who will provide the VIIRS data set, has been signed. The agreement with GSFC, who will provide GPM DPR, NPP CrIS and ATMS, and AMSR-e data, is progressing. The mechanism for accessing to the required weather model and data from NOAA has been reviewed. Ground data collection has begun on a test basis. A quarterly meeting with the sponsoring agency took place in July.

Fig. 4. Study area map with eight ground monitoring station locations (4 in suburban/rural areas, 3 in urban areas and 1 on UMMC campus)