Taos High team 142
Proposal, Black Mold: Supercomputing 2014-15

The Black Mold Issue:
Black Mold is a common toxic mold that has a wide range of effects, including impaired mental function. This toxic black mold, Stachybotrys Chartarum, often grows in houses and is dangerous because it grows in dark places or in areas that are not normally visible to inhabitants. This means that often the inhabitants must suffer the effects of black mold before they learn about the infestation. Preventing black mold growth is the only way to effectively stop its harm to human health. To effectively prevent black mold growth, one must understand the factors that influence growth, and how each variable affects the others.
The team will use a complex simulated environment to study the effects of temperature and moisture on the growth and spread of black mold. The team will compare results to the humidity and temperatures of various cities and population centers around the United States to gain an understanding of who is most at risk to black mold growth, and then research within those communities to design an approach to mitigate this risk or prevent it entirely.

Plan of Action:
The team will develop a model that radiates outward, at varying speeds, according to moisture and humidity concentration. The growth rate over time will be recorded with different combinations of moisture and humidity. The team will attempt to find other scientific studies complete scaling and to insure accuracy. The team will then determine the most favorable conditions and look for data from real world locations that are closest to the optimal conditions and import these measurements into the program, to simulate these environments. This will allow us to develop ideas on how to treat and prevent black mold growth or mitigate its risk to humans.

Recent Progress
So far the team have been able to isolated two main variables in mold growth: Humidity and temperature. The team has researched weather patterns related to these variable for the ten most populous cities in the USA. This is the team's first year doing supercomputing and it will be a while before it is ready to start work on the model. Currently, the team is in a research and education phase, learning how to model and what should be modeled.

Expected Results:
Black mold is one of the most stealthy health detriments in homes all across the united states. Many cities have climates that could help the spread of black mold. The black mold Netlogo model should help quickly simulate the growth of mold under several factors related to humidity and temperature, which will be extrapolated from weather data in major US cities. From the results of the study, the team will develop ideas to either combat the spread of, or help with the discover or prevention of black mold. We hope to be able to make significant improvements to the lives of many, including those who are most at risk due to location or socioeconomic status. Black mold can cause many injuries and understanding growth and spread, and generating a lot of data fast is the first step to helping those who are most at risk.

Final Report

1. Team number:
2. Taos High School
3. Area of Science: Mycology
4. The computer language used: NetLogo
5. Team Members: Sam Smith, Chandler Taylor
6. Team members Smiths4m98@gmail.com goldenxtig3r@yahoo.com

Executive Summary:

We researched the growth of black mold and modeled the effects of humidity and temperature on its growth. We took the humidity and temperature data from the top 10 cities in the United States. We took our black mold growth data from peer reviewed studies. We found that Humidity has the most effect on the growth of black mold and proposed several ways to combat growth by reducing humidity.

Introduction

We thought it better to delve into the question of what conditions does black mold spread best, what populations are most at risk, and to find out how can we prevent it from spreading.. Black mold, the silent killer, is a common household problem that people do not realize is slowly bringing them to their death. Black mold forms nearby moisture, warmth, and organic material it produces mildew in damp, warm, and poorly lit places. Black mold causes many deadly symptoms such as mental, neurological, respiratory, circulatory, vision, eye, skin, immune system, reproductive system, tiredness, and discomfort. Black mold can be killed off or prevented by bleach material, borax, vinegar, ammonia, hydrogen peroxide, baking soda, tea tree oil, and grapefruit seed extract. However, these actions are far too expensive and spot oriented to prevent black mold, and miss the key problem; that most black mold has already done its damage by the time this is an effective method. Therefore, we will determine what makes black mold grow best, and how to most effectively prevent it.

Methods and Materials

We decided to research the growth of black mold and work with it in a agent based model to determine how the environmental factors of humidity and temperature effect black mold growth, based on data reported from major cities. We decided to use agent based modeling because we know that temperature and humidity are not constant on the microscopic level, and to account for that we developed our model accordingly. The model uses “hotspots” to simulate fluctuations in temperature and humidity. Our mold is set to behave exactly like black mold. S. Chartarum, Black Mold, is part of a family of molds that asexually reproduces from the top of its hypha. The hypha may be thought of as the stalk of the mold. It is important to remember that mold is not one organism, but instead a group of hundreds of thousands of individual, living, organisms. The hypha is the stalk of this individual, with a spore sack on top and “roots” on the bottom. We simulated the hypha by using individual turtles for each hypha. Due to this we could end up with hundreds of thousands of turtles in less than four generations. We simulated a black mold that reproduces with 44 spores to each hyphal sack. This is not the true number of spores that black mold can release, which can reach over one thousand. The average number of released CFU’s -that is, colony forming units, those spores which are viable for reproduction - is about 441. We set our black mold to produce one tenth of that number because of our hardware limitations.

The following are some other notable points about our program.

The program is designed to note both the number of black mold hypha in the world and also record a toxicity variable for each patch. This is because while the black mold hypha is the living organism, even dead spores and the hyphal fragments that they float along with are toxic.

Our black mold is sensitive to humidity and temperature and will only “root” at specific conditions. All of these conditions were taken from peer reviewed articles on S. Chartarum or other Stachybotrys molds, its closest neighbors.

Some of our Constants:

S. Chartarum will only “root” if the patch has greater than 78% RH (humidity) and 20 degrees celsius.

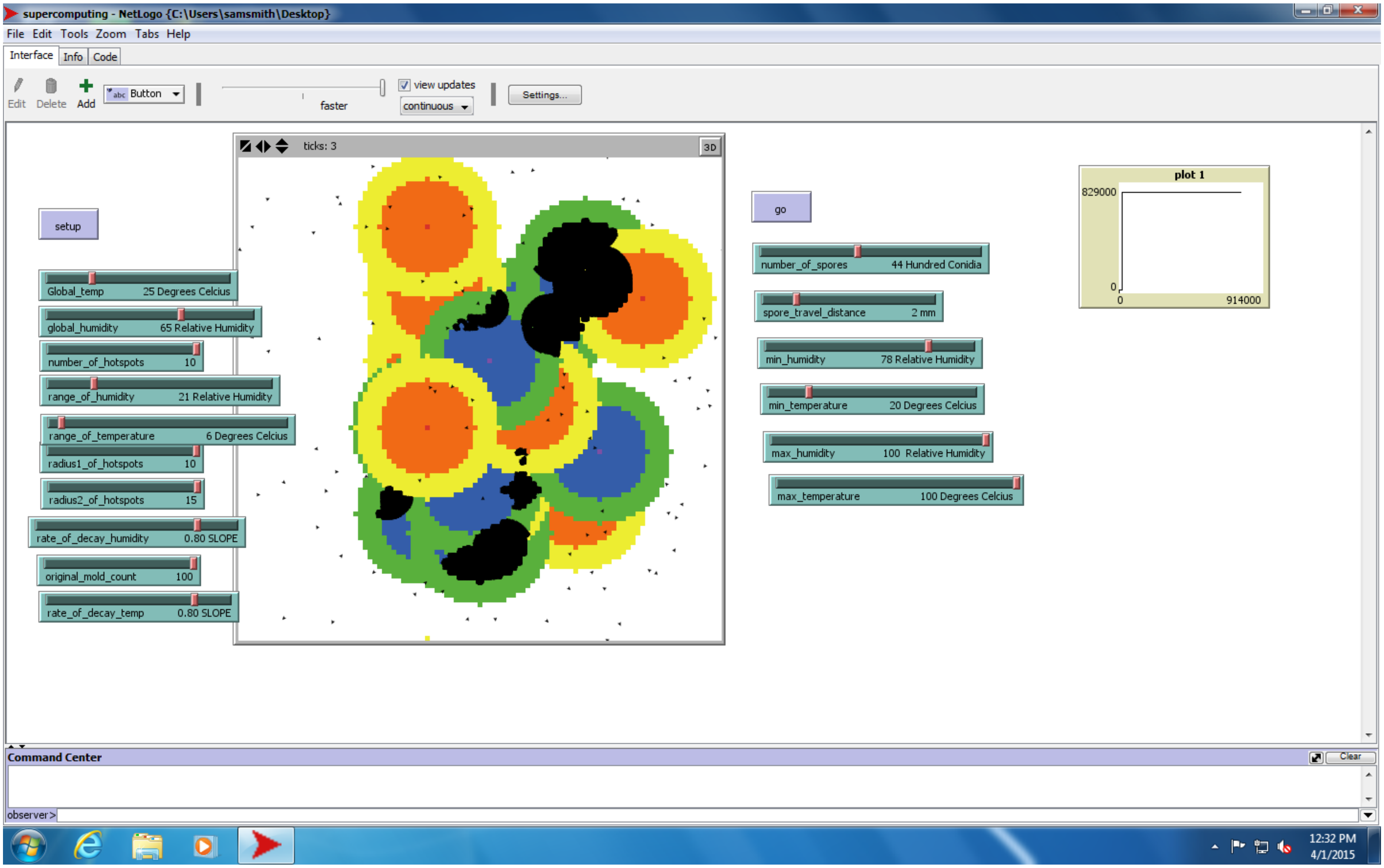
It will not root if either condition is over 100%.

Our hotspots add a random value that decreases as it moves away from the center. This value is a maximum of 20% RH and a maximum of 6 degrees celsius. The humidity is derived from average daily fluctuations in US cities and the heat is derived from the heat that the most common household appliance that covers up water damage, the refrigerator.

Results

Due to the limitations of our computer and some significant setbacks in programming as well as general unhelpfulness and non-participation from most of our group members, we only ran the program once without it freezing out computer.

The following is a screenshot of that result, from our New York Dataset.



Discussion

The Black blobs are black turtles, each representing 44 hypha from spore that have taken root.

The colorful circles are hotspots and wet spots. Hotspots are in bright colors. Wetspots are in darker colors.

The black mold behaved as we thought it would. It formed along the areas which were most hospitable, being in the golden zone on the edge of several humidity spots. The humidity in New

York was too low normally for black mold to form, but along several hotspots, it did reach the needed levels. Basically, more humidity and more heat made more black mold.

Conclusions

Based on the different elements to prevent black mold, we have concluded that if an area is infected by the mold, there are many ways to limit the growth, but the most effective are ways that limit humidity, as black mold has a much wider range of temperature tolerance than humidity tolerance.

Dehumidifiers can prevent the spread of black mold but can't remove it, because it has already formed.

To be fully be rid of the mold and its spores two actions must be actions must be taken. Evacuate the infected area and use a negative air machine. A dehumidifier will remove any moisture in the air for the time being, but once the dehumidifier is removed, moisture can reenter the area and the spores will begin to attach and grow. The negative air machine removes all spores from the air, and the infected areas have to be cleaned.

Personal Statement

Our team feels that the most significant original achievement on the project is the code. The code that we have worked on not only gives a visual representation of how black mold grows, it also illustrates how the mold can be removed and prevented from growing. To create the code it was time consuming and required a brief understanding of the growth cycle of black mold, and how to use the program to effectively demonstrate the possibilities of removal.

Acknowledgments

We would like to acknowledge our teacher Mrs. Tracy Galligan for helping us with the program and for trying, as hard as she might, to keep us on track. We would also like to acknowledge Mr. Gilroy for giving us a brief outline of how we might abstract the problem into Netlogo and giving us information on black mold. We would like to acknowledge supercomputing for teaching us the basics of Netlogo.