On Top of Old Smokey

Computer Wind Model for Predicting Smoke Movement

VOCABULARY
Vocabulary in article indicated in italics

Complexity
The condition of being highly complicated, a situation where many different factors are affecting what happens

Computer model
The use of a computer to simulate real life conditions

Debris
Scattered remains left after destruction

Drainage
The gradual emptying of liquid or moisture

Landscape
The visual land, such as trees, water, and sky

Nocturnal
Active or occurring at night

Prescribed Burns
Controlled fires used to improve forest habitat

Simulate
To look like or act like a natural process

Topography
Relative position or elevation of land

Wildland
Land that is not cultivated or used for civilization

Adapted from:
Achtemeier, Gary L. and James T. Paul. 1994. A computer model for predicting smoke movement. *Southern Journal of Applied Forestry*, 18:60-64.

The natural world is very complex. This makes it hard to study. In the past, scientists had to investigate only one part of nature at a time because they could not study the *complexity* and interaction of all of nature's functions at the same time. Computers are better able to handle the *complexity* of studying natural functions. Computers can be programmed in such a way that they mimic the conditions in nature. The scientists in this research are working on developing a *computer model* of how forest fire smoke moves across the land. *Computer models* may not be perfect, but they help scientists understand the interaction of many different natural functions such as the movement of air because of temperature and pressure changes.

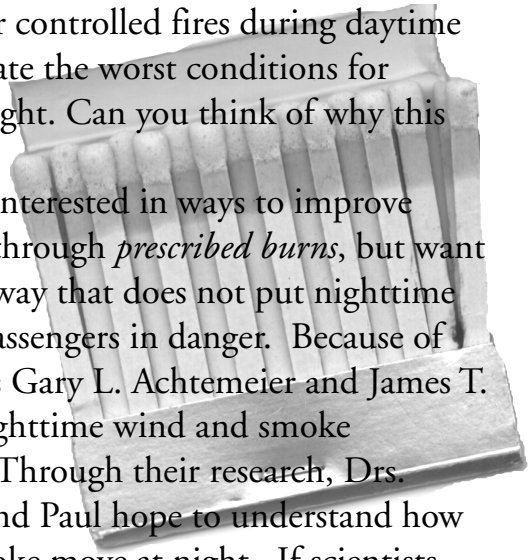
Discovery

When air cools, more molecules can be packed into the same amount of space. This gives the air more mass, and it has higher pressure. To discover whether cool air is heavier than warm air, try this experiment. Go to a refrigerator and open the door. Observe, using your sense of feeling, whether there is a difference in the temperature of the air between the top and the bottom areas of the refrigerator. Can you feel air coming out of the refrigerator? Does it come from the top or the bottom? Think about how the air moves from the refrigerator as you read about how air moves during the night in mountain valleys.

Introduction

Wildland fires occur both purposefully and by accident. Purposeful fires include fires set by individuals to remove fallen leaves or other *debris*. Often, foresters set small controlled fires on purpose called *prescribed burns*, to improve forest health and to reduce the chance of larger, uncontrolled forest fires. These kinds of fires may be helpful to some individuals and the environment, but they can also create hazardous driving conditions due to decreased

visibility. This situation is especially dangerous at night, when fog often further decreases visibility. Unfortunately, the safest weather conditions for controlled fires during daytime often also create the worst conditions for visibility at night. Can you think of why this might be so?



Foresters are interested in ways to improve forest health through *prescribed burns*, but want to do so in a way that does not put nighttime drivers and passengers in danger. Because of this, scientists Gary L. Achtemeier and James T. Paul study nighttime wind and smoke movements. Through their research, Drs. Achtemeier and Paul hope to understand how wind and smoke move at night. If scientists better understand *nocturnal* wind, they can reduce the chances of putting drivers in danger by picking safer weather conditions for *prescribed burns*.

[Now consider Reflection questions below]

Methods

Everyone knows how hard it is to predict the weather. In the same way, it is difficult to study wind and smoke movements for all the different land and climate conditions. To study a variety of weather and *landscape* conditions, Drs. Achtemeier and Paul used a computer to *simulate* the conditions associated with nighttime wind movements. These different conditions include air temperature and temperature changes, air pressure, wind speed and direction, land *topography*, and other *landscape* features such as roads, streams, rivers, and forests. All of these conditions affect the amount and direction smoke moves, even hours after a fire has stopped actively burning.

Drs. Achtemeier and Paul entered weather and *landscape* information into a computer. The weather and *landscape* information

Reflection

1 What problem are the scientists tyring to solve?

2 What are some of the barriers the scientists face when studying nighttime wind and smoke movements?

matched the conditions from a real situation. In the real situation, a forest fire had caused smoke to fill a highway at night. To test the accuracy of the *computer model*, the scientists compared the model with what actually happened.

Results

By testing the *computer model* against a real situation, Drs. Achtemeier and Paul found that the *computer model* is not yet advanced enough to determine the best weather conditions for prescribed forest fires. They found that every forest area has unique characteristics such as *topography* and weather conditions that need to be considered. The scientists found that smoke seems to follow certain patterns under certain conditions. For instance, they determined that when air cools off at night, it develops *drainage* patterns that move in different directions and follows the low areas of the *topography*, much like a stream running downhill. Even when the air feels calm and still, it is still moving in these patterns. Smoke will most often move into low places at night. If foresters burn in a valley, the smoke may stay in the valley. If they burn toward the higher mountain ridges, smoke may travel in many directions as it moves close to the earth.
This study has helped foresters to better understand the potential movement of smoke from *prescribed burns*. But although foresters have learned a lot about how smoke moves at night, they still have more to learn. What other things might affect the movement of smoke at night?

Reflection

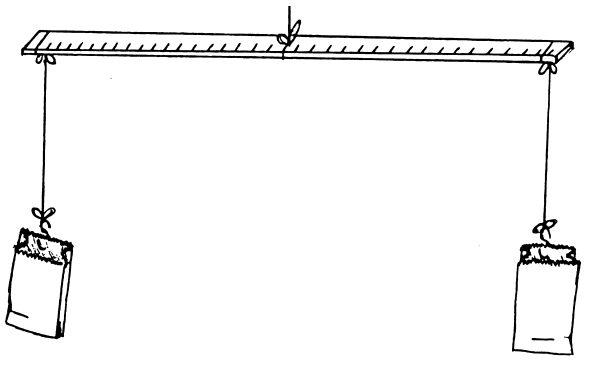
1 Why is it important to compare the computer model with a real situation?

2 What are the advantages of using computers to predict smoke movement?

3 What do you think are the disadvantages of using computers to predict smoke movement?

Further Discovery

Which is heavier--warm or cold air? To test which has a higher pressure and is therefore heavier, get two jars with lids, a yard stick, two lunch-sized paper bags, two paperclips, and three pieces of light weight string. Take the lids off of the jars. Place one in a freezer (or another cold place) and leave the other in your classroom. Tie one piece of string to the middle of the yardstick. You will use this to hang the yardstick. Tie the other two pieces of string onto each end of the yardstick, making sure that they are of equal length. Open the paperclips and tie one to the end of each of the strings. Hang the yardstick by the middle string. Open the bags and hang them on the paperclips. Make sure that everything is balanced. When everything is balanced, put the top on the jar that is in your classroom. When you have carried the jar to the bag, take the lid off and tip it over one of the bags, as if you were pouring water from the jar and into the bag. What happens to the bag? Now put the top on the jar that is in the freezer. When you have carried the jar to one of the bags, take the lid off and tip it over one of the bags, as if you were pouring water from the jar and into the bag. What happens to the bag? Now, can you answer the question about which is heavier-warm or cold air?



Write your answers and conclusions in this space.