**Understanding Wildfire Smoke**

**LaCuKnoS Language Booster**

Whether you live on the Oregon coast, mountains, or desert, you probably have experienced wildfire smoke. Oregon had an unprecedented **wildfire** season in 2020, with more than one million acres burnt. That summer, many cities and towns were blanketed with smoke resulting in hazardous air quality. As wildfires become more frequent and larger all over the world, we are starting to see the effects of wildfires from other places far from where we live. For example, in summer 2023 wildfires in Canada spread smoke all the way to Washington and Oregon. Smoke can travel very long distances, sometimes spreading all across the world!

Smoke from wildfires can have negative effects on the planet and our health. Smoke and ash contain chemicals that can irritate your eyes and throat, causing coughing and itchy eyes. Very small smoke particles can enter your lungs, and long-term **exposure** to smoke can increase the risk of lung diseases such as asthma. These health issues are more serious for some people, including children and seniors, who are more sensitive to unhealthy air. For that reason, we monitor air quality using the **Air Quality Index (AQI)** to determine whether it is safe to be outside.

Have you ever wondered where smoke goes after a wildfire? Or why smoke sometimes lasts for days in our communities? The answer to these questions involves the smoke itself as well as the air around it. For example, after smoke is no longer visible, the large particles are carried back to the surface by rain or by their own weight. Smaller particles, including gasses such as carbon dioxide, can travel higher into the upper atmosphere, where they stay in circulation. Air temperature also influences how long smoke stays in our communities. When air is cold near the earth’s surface, and warmer air moves on top of it, this creates a **temperature inversion**. The denser and colder air gets trapped near the ground level by the warm air above it. This creates stagnant air that keeps smoke from mixing and moving. In this lesson, we will learn about smoke and what makes it stay close or travel far from where we live.

**Discussion questions**

**Talk with your partner about these questions, then write your answers.**

1. Where does smoke go after a wildfire?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Why does smoke sometimes last for days in our communities?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Describe what you remember about the last time there was smoke in your community.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Understanding Wildfire Smoke**

**LaCuKnoS Activity**

One way to understand why smoke and air pollution linger around us is by studying the concept of temperature inversion. This phenomenon can be visualized using liquids at different temperatures with the following activity. What you will need:

* Hot and cold water
* A piece of ¾ inch PVC tube
* Blue and yellow food coloring
* Two 16 oz Mason jars
* A funnel
* Ice
* Large bowl/container

Step 1: Divide the class into six groups (or less based on number of students). Three groups will follow instructions for Group A, and three groups will follow instructions for Group B.

**Group A**

Step 2: Your teacher will heat water with an electric kettle. The water should be hot but not boiling.

Step 3: While the water warms, half-fill one jar with cold water. Add 10 drops of blue food coloring and stir.

Step 4: Fill the other jar half-full with the hot water, add 10 drops of yellow food coloring, and stir.

Step 5: Insert the PVC tube inside the hot, yellow water jar, making sure it touches the bottom.

Step 6: Insert the funnel in the PVC tube and slowly pour the cold, blue water into the tube. Observe carefully what is happening at the bottom of the jar!!

**Group B**

Step 2: Your teacher will heat water with an electric kettle. The water should be hot but not boiling.

Step 3: While the water warms, half-fill one jar with cold water. Add 10 drops of blue food coloring and stir.

Step 4: Fill the other jar half-full with the hot water, add 10 drops of yellow food coloring, and stir.

Step 5: Insert the PVC tube inside the cold, blue water jar, making sure it touches the bottom.

Step 6: Insert the funnel into the PVC tube and slowly pour the hot, yellow water into the tube. Observe carefully what is happening at the bottom of the jar!!

**Understanding Wildfire Smoke**

**LaCuKnoS Teacher Demonstration**

Another way of demonstrating temperature inversion is with smoke. This experiment can be demonstrated by your teacher.

Materials:

* Two Mason jars with lids
* bowl of ice
* warming plate
* two small pieces of paper
* a lighter

***Model of air on a day with a temperature inversion***

Step 1: Place one glass jar (with lid on) on a warming plate and another jar (with lid on) in a bowl with ice.

Step 2: Take the cold jar out of the ice, light a small piece of paper on fire, drop it inside the jar, and replace the lid immediately. Smoke should form inside.

Step 3: Take the warm jar and take the lid off, then quickly take the lid off the cold/smoky jar and invert the warm jar and place on top of the cold jar. Observe the smoke in the jars and describe what happens.

***Model of air on a normal day***

Step 1: Place one glass jar (with lid on) on a warming plate and another jar (with lid on) in a bowl with ice.

Step 2: Take the warm jar off of the warming plate, light a small piece of paper on fire, drop it inside the jar, and replace the lid immediately. Smoke should form inside.

Step 3: Take the cold jar and take the lid off, then quickly take the lid off the hot/smoky jar and invert the cold jar and place on top of the warm jar. Observe the smoke in the jars and describe what happens.

**Understanding Wildfire Smoke**

**LaCuKnoS Investigation Summary**

Describe the difference between what happened in Group A and B’s experiments with the hot and cold water.

|  |
| --- |
|  |

Describe the difference between what happened with the smoke in the hot and cold jars.

|  |
| --- |
|  |

How could you explain this phenomenon to your younger sibling or cousin in a language they would understand?

|  |
| --- |
|  |

How could you explain this phenomenon to your science teacher in language they would use?

|  |
| --- |
|  |

**Understanding Wildfire Smoke**

**LaCuKnoS Concept Cards**

|  |
| --- |
| **Wildfire/**  **Incendio forestal** |
|  |
| A fire that burns rapidly and uncontrollably over a large area of wildland vegetation. |
| Un fuego que arde rápida e incontrolablemente sobre una gran área de vegetación silvestre. |
|  |
| Wildfires have become an increasing threat to people in Oregon |
| Concept Card |

|  |
| --- |
| **Exposure/**  **Exposición** |
|  |
| Experiencing something or being affected by it because of being in a particular situation or place |
| Experimentar algo o ser afectado por ello debido a estar en una situación o lugar particular |
|  |
| Sunglasses protect your eyes from exposure to sunlight. *Image:* [*www.myhealth1st.com.au*](http://www.myhealth1st.com.au) |
| Concept Card |

|  |
| --- |
| **Air Quality Index (AQI)/**  **Índice de Calidad del Aire (AQI)** |
|  |
| An index used to classify levels of air pollution. The greater the index, the greater the level of health concern for the public |
| Un índice utilizado para clasificar niveles de contaminación atmosférica. Mientras más alto el índice, mayor es la preocupación para la salud de las personas. |
|  |
| Air Quality Index (AQI) is used for reporting daily air quality. *Image: Oklahoma Department of Environmental Quality* |
| Concept Card |

|  |
| --- |
| **Temperature inversion/**  **Inversión de temperatura** |
|  |
| Is when air temperature is cooler closer to the ground and gets warmer as we go higher. |
| Es cuando la temperatura del aire es más fría cerca del suelo y está más caliente a mayor altura. |
|  |
| Normal conditions versus temperature inversion. *Image:* [*https://lotusarise.com/temperature-inversion-upsc/*](https://lotusarise.com/temperature-inversion-upsc/) |
| Concept Card |

**Understanding Wildfire Smoke**

**LaCuKnoS Extension**

Now that we have learned more about wildfire smoke, what can we do about it? One way we can be actively involved with fire prevention in our community and homes is to learn about defensible space. This is especially important for communities that live close to the forest or forested areas.

Students can learn what defensible space is, the three defensible space zones and evaluate a building in their community or where they live and whether they have adequate defensible space.

***Resources:***

Fire Science Core Curriculum. Module 5. Fire prevention for home and landscape. Oregon State University. <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9172-module5.pdf>

Ready for wildfire. Defensible Space. CAL FIRE. <https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/defensible-space/>

**References:**

***Smoke***

<https://atmosphere.copernicus.eu/cams-monitors-smoke-release-devastating-us-wildfires>

<https://www.placer.ca.gov/DocumentCenter/View/1463/Dealing-with-Smoke-Tips-for-Children-PDF>

***Forest Management***

Safford et al. 2012. Fuel treatment effectiveness in California yellow pine and mixed conifer forests. Forest Ecology and Management. <https://www.sciencedirect.com/science/article/pii/S0378112712000898>

Ager et al. 2014. Wildfire exposure and fuel management on western US national forests. Forest Ecology and Management. <https://www.sciencedirect.com/science/article/pii/S0301479714002916>

Loudermilk et al. 2014. Effectiveness of fuel treatments for mitigating wildfire risk and sequestering forest carbon: A case study in the Lake Tahoe Basin. Forest Ecology and Management. <https://www.sciencedirect.com/science/article/pii/S037811271400156X>

Mitchell et al. 2009. Forest fuel reduction alters fire severity and long-term carbon storage in three Pacific Northwest ecosystems. Ecological Applications. <https://esajournals.onlinelibrary.wiley.com/doi/full/10.1890/08-0501.1>

Adlam, C and C. Berger. 2022. Prescribed fire basics: why we burn. OSU Extension Publication. <https://extension.oregonstate.edu/sites/default/files/documents/em9339.pdf>

Kolden. 2019. We’re Not Doing Enough Prescribed Fire in the Western United States to Mitigate Wildfire Risk. Fire. <https://www.mdpi.com/2571-6255/2/2/30>

Fernandes, P.M.; Botelho, H.S. A review of prescribed burning effectiveness in fire hazard reduction. Int. J. Wildland Fire 2003, 12, 117–128. <https://www.publish.csiro.au/WF/WF02042>

Pollet, J.; Omi, P.N. Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. Int. J. Wildland Fire 2002, 11, 1–10.<https://www.publish.csiro.au/wf/WF01045>

Vaillant, N.M.; Fites-Kaufman, J.A.; Stephens, S.L. Effectiveness of prescribed fire as a fuel treatment in Californian coniferous forests. Int. J. Wildland Fire 2009, 18, 165–175. <https://www.publish.csiro.au/wf/wf06065>

USDA Climate hubs. Prescribed fire in the Pacific Northwest <https://www.climatehubs.usda.gov/hubs/northwest/topic/prescribed-fire-northwest>

Wu et al. 2023. Low-intensity fires mitigate the risk of high-intensity wildfires in California’s forests. Science Advances. <https://www.science.org/doi/10.1126/sciadv.adi4123>