# Seasonal allergies: pollen and mold

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## INTRODUCTION

Millions of Americans suffer from seasonal allergies each year, and climate change is making it worse.

About one-quarter of adults (26%) and 19% of children in the U.S. suffer from seasonal allergies, according to the Centers for Disease Control and Prevention. Seasonal allergies, such as "hay fever," are allergic reactions caused by airborne plant pollen and mold spores.

A growing body of research shows that warming temperatures, shifting seasonal patterns, and more carbon dioxide in the atmosphere—all linked to climate change and greenhouse gas emissions—are affecting the length and intensity of allergy season in the U.S.

Allergies are more than just inconvenient—they are expensive to manage and can have significant health implications, such as triggering or worsening asthma. But there are ways to mitigate the impact of allergies in a changing climate.

This research brief provides background information and summarizes Climate Central's relevant analyses on weather and climate trends that affect allergy season locally. These resources can help explain and report on the growing health risks of outdoor aeroallergens and their connection to climate change.

# Seasonal allergies are caused by pollen and mold spores released throughout the year.

Many plants reproduce by releasing small pollen grains. Small pollen particles can be carried by wind, making them more easily inhaled.

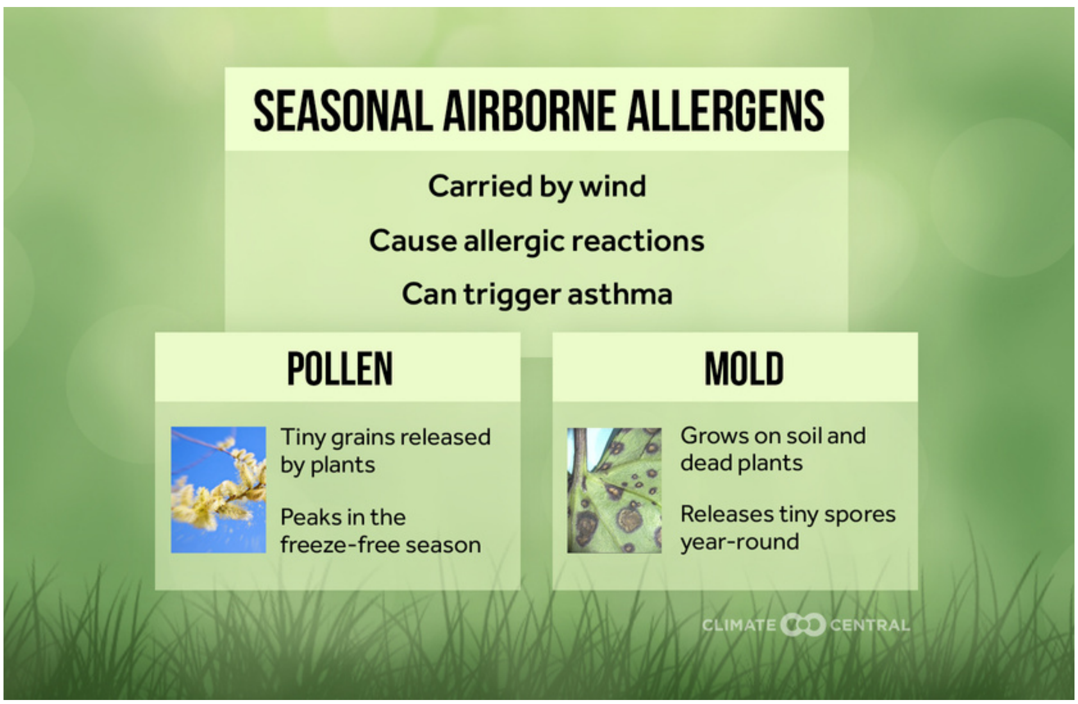
When and how pollen grains are dispersed depends on the plant species and local conditions, among other factors.

Many tree species release pollen in the spring. Grass pollen often peaks during the summer, while weeds—such as ragweed—emit pollen into the fall. This is a typical pattern of pollen release for much of the country—but in some regions, plants release pollen in the winter, too.

For example, "cedar fever" is common in the South and Southwest between December and February, when mountain cedar trees release pollen. The Allergy and Botany Research Library can help identify which plant species contribute to pollen reactions locally.

Molds are types of fungi that reproduce with tiny airborne spores, which can be allergenic for some and contribute to seasonal allergies. There are many different species of molds, but not all molds cause allergic reactions. Some of the most common allergenic mold groups include *Alternaria, Aspergillus, Cladosporium,* and *Penicillium*.

Optimal growing conditions can vary across mold species—but all require air, moisture, nutrients, and organic material to germinate and grow. Because molds often grow on soil, leaf litter, and decaying plant matter, their life cycles can be closely aligned with that of local vegetation. Studies have observed a significant increase in mold spore concentrations when plants die or leaves fall. Peak spore exposure can extend from summer into fall, but may be perennial under the right conditions.




## BOX 1. Data source: pollen/spore counts and forecasts

Data on airborne biological particles like pollen and fungal spores are captured at monitoring stations across the world. Specialized devices collect air samples; the pollen and spores are counted and categorized to calculate a local pollen/spore count. Pollen forecasts are typically based on previous years' pollen count data combined with weather data.

Local allergen counts and forecasts can be found through resources such as the National Allergy Bureau. In general, count stations are not evenly distributed across the U.S. Some areas may not have a local station or may have shorter histories of available data.

# Climate change is altering allergy season—making it longer and more intense.

The connections between climate change and seasonal allergies are becoming increasingly clear. From warming temperatures and more freeze-free days to increased carbon dioxide in the atmosphere, climate change is making allergy season longer and more intense, with higher amounts of allergens in the air.

A recent study found that North American pollen seasons became longer (by 20 days on average) and more intense (21% increase in concentrations) from 1990 to 2018. Human-caused warming accounted for about half of the shift toward earlier pollen seasons and about 8% of the increase in spring pollen concentrations during this period.

Mold allergens are likely similarly affected by a changing climate, with warmer, wetter weather increasing favorable conditions for mold growth. Outdoor mold is not as well studied as pollen, however, and more research is needed to identify specific impacts of climate change on outdoor mold.

## WARMING TEMPERATURES MEAN THAT ALLERGY SEASON ARRIVES SOONER IN SPRING AND LASTS LONGER INTO FALL.

Changes in the length of the growing season—which stretches from the last freeze (32°F) of spring to the first freeze of fall—indicate how much longer plants may release allergy-inducing irritants.

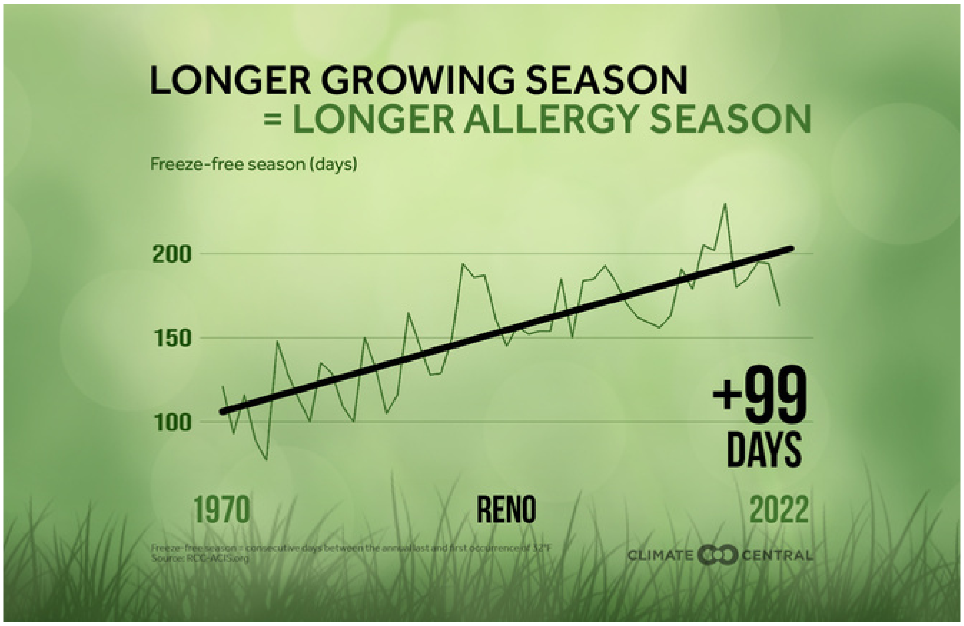
To analyze how the growing season has changed in the U.S., Climate Central assessed temperature data for 203 cities since 1970. The freeze-free season is lengthening across the country, giving plants more than two weeks (15 days) longer on average to grow, flower, and release pollen.

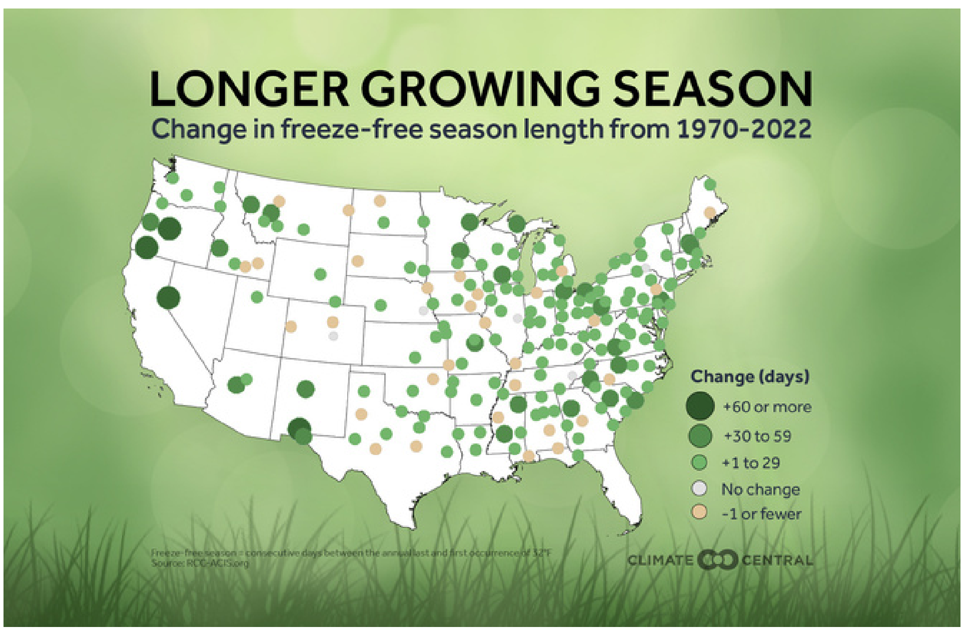
Of the cities analyzed, 85% (172) saw their freeze-free seasons lengthen during the study period. In 31 cities, the season between the last and first freeze grew by at least a month. Reno, Nevada's season increased by 99 days—among the biggest increases in the country.

### Box 2. More high mold days in Connecticut

The Climate Change and Health in Connecticut: 2020 Report, produced by the Yale Center on Climate Change and Health, included analysis of outdoor allergens from 2007 to 2019. The data showed an increased percentage of days with "high" or "very high" outdoor mold concentrations, according to the National Allergy Bureau measurement scale. The authors did not, however, observe a similar trend for tree, grass, or weed pollen counts.

Since 1970, the freeze-free season lengthened the most in the West (27 days) among the stations analyzed. The season lengthened by more than two weeks in the Southeast (16 days), Northeast (15 days), and South (14 days). The Central region saw the freeze-free season lengthen by 13 days.




## WARMING WINTERS COULD MEAN INCREASED EXPOSURE TO MOLD ALLERGENS.

Freezing temperatures don't necessarily kill mold outdoors. Instead, molds may be dormant in cold weather and can revive when acceptable conditions return.

Depending on species and location, mold can be found year-round in the atmosphere. Although spore counts are almost certainly lower in winter, increasingly mild winters could mean higher spore counts from some species—and more days with airborne mold allergens.

Winter is the fastest-warming season for 232 locations across the U.S., according to Climate Central's analysis of temperature data since 1970. About 80% (190) of those locations had at least seven more days above the 1991–2020 winter normal temperature than in 1970.

See the full winter weather trend analysis in Climate Central's 2022 Winter Package.

## CARBON POLLUTION INTENSIFIES ALLERGEN PRODUCTION.

Climate change not only lengthens allergy season—it also intensifies allergen production. Higher levels of carbon dioxide ($CO_2$) in the atmosphere can stimulate plant growth—which directly impacts pollen production and supports mold growth.

A number of laboratory-based studies show that increased atmospheric $CO_2$ could boost pollen and spore production—and in some cases, how allergenic they are—in certain species, including grasses, ragweed, oak trees, and common allergenic fungi such as *Alternaria alternata* and *Aspergillus fumigatus*.

One study modeled pollen emissions for multiple species across the U.S. under continuing high rates of greenhouse gas emissions. Results suggest that in these scenarios, the increase in atmospheric $CO_2$ could double pollen production by the end of the century. Other findings from the study study show that pollen season could start up to 40 days earlier and last up to 19 days longer.

### Box 3. Longer ragweed pollen season in parts of the U.S.

As the freeze-free season has lengthened, so has the pollen season of ragweed—one of the most commonly allergenic plants in the U.S. For instance, research showed that ragweed pollen season lengthened by about three weeks between 1995 and 2015 in parts of the Midwest.

See Climate Central's analysis on carbon dioxide and pollen concentrations.

## THUNDERSTORMS MAY INCREASE THE RISKS OF ALLERGIC ASTHMA.

A number of studies have shown associations between thunderstorms and asthma attacks or asthma-related hospitalizations—a phenomenon known as "thunderstorm asthma." The exact science behind these events isn't yet fully understood, but research shows that pollen and mold spores almost certainly play a role.

Thunderstorms bring pressure changes and winds that blow around pollen and mold spores—breaking them into smaller, more easily inhaled particles and transporting them through the air. Studies have shown high pollen and mold counts around thunderstorms correlate with increased asthma symptoms and hospital admissions.

Cases of thunderstorm asthma have been reported across the globe for decades. Right before or during a thunderstorm, people with asthma experience exacerbated symptoms or difficulty breathing. In some instances, local emergency rooms have been overwhelmed with patients admitted with asthma attacks—as was the case in Melbourne in 2016.

Because researchers are still learning about this meteorological health risk, it's difficult to predict who might be affected or where another thunderstorm asthma event might occur. There is enough evidence for some health professionals and researchers to caution people with asthma or seasonal allergies to be alert for symptoms when thunderstorms are approaching.

Public alerts for predicted thunderstorms could help people with asthma prepare and take precautions.

See Climate Central's analysis on thunderstorm potential to understand how the risks of severe storms might be increasing locally.

## Longer, more intense allergy seasons are a significant threat to human health.

It can be difficult to distinguish between a pollen or mold allergy without specific tests because symptoms are similar for both.

Typically, symptoms of seasonal allergies (namely, allergic rhinitis) include nasal congestion, irritated eyes, sneezing, and itchy nose or throat.

### Box 4. Longer pollen and mold season linked to climate change in San Francisco Bay Area

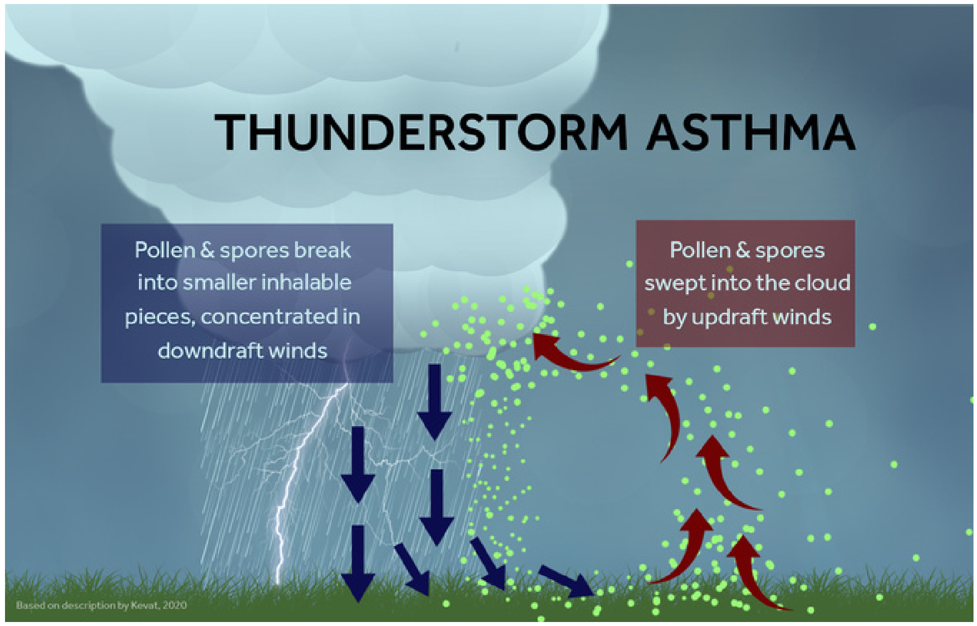
Analysis suggests that climate change is linked to a longer allergy season in the San Francisco Bay Area. Researchers analyzed pollen and mold data collected at an area monitoring station from 2002 to 2019, focusing on the 20 most common species. The data show that over the 18-year period, pollen and mold season lengthened by around eight and nine weeks, respectively. When compared to weather data, the researchers observed associations between changing climate conditions (namely temperature and precipitation) and spikes in allergen levels. But overall, annual counts of pollen and mold decreased during the study period—which the researchers attribute possibly to urbanization and land use changes in the area.

Seasonal allergens such as pollen and mold can also trigger or aggravate asthma, which affects nearly 8% of Americans. In the 25 million Americans with asthma, "allergic asthma" occurs for 50% of adults and nearly 90% of children. Mold spore exposure is associated with an increase in asthma exacerbation and hospital visits for children, making them an especially vulnerable group to mold allergies.

These aeroallergens can put some people at risk for other health problems. One study suggests that pollen exposure can increase susceptibility to respiratory viral infections, including COVID-19. And the health effects from allergies and asthma can be compounded by other environmental pollutants linked to our warming climate, including ozone and diesel fuel pollution.

## Box 5. Does rainfall make allergies better or worse?

The associations between rainfall and allergies are complicated. Rainfall can wash away allergenic particles in the air, minimizing symptoms in the immediate aftermath. And pollen tends to travel better in hot, dry, windy conditions. Some species of mold have shown increased spore concentrations with dry weather and intermittent rainfall—while others release more spores shortly after rain, likely because of increased moisture in the environment.



Thunderstorms may increase asthma risks during allergy season; this illustrates how whole pollen and spores may be broken into smaller, more easily-inhaled pieces. Based on description by Kevat, 2020.

### ALLERGY AND ASTHMA REACTIONS CAN BE EXPENSIVE TO TREAT.

Over-the-counter or prescribed medications may relieve symptoms. But in some cases of severe allergies, doctors may prescribe immunotherapy, or allergy shots, which can be expensive. In the U.S., the total cost of allergies is more than $18 billion a year; and during 2008–2013, the annual medical cost of asthma was just over $3,200 per person.

Effective medications and therapy to manage symptoms can be a burden on low-income families, especially since asthma is more prevalent in families living below the poverty line. Currently, the highest asthma diagnoses, hospitalizations, and deaths are disproportionately found in minority communities (Black, Hispanic, and American Native/Alaskan Native) due to a combination of determinants.

# Managing seasonal allergies

Cutting greenhouse gas emissions is ultimately the most meaningful action to slow the rate of warming, curb the expanding allergy season, and limit CO2 influence on allergen production.

As research advances, so will the ability to predict when and where allergy season changes will occur

—which can help people prepare for and manage the health effects.

Seasonal allergies may be unavoidable for most people, but there are ways to minimize their effects. When pollen and mold peak outdoors, families can take action to reduce exposure and make the indoors safer and more comfortable for allergy and asthma sufferers.

- Check local air quality reports and allergen forecasts before heading outside.
- Close windows and doors to limit pollen and spores from entering the home.
- Maintain indoor humidity between 30% and 50% to minimize mold growth.

Use adequately-sized portable high-efficiency particulate air (HEPA) filters in living spaces and (especially) bedrooms to remove allergenic particles from the air.

## METHODOLOGY

The growing season is the difference between the last day below 32°F from January through July and the first day below 32°F from July through December. Years with growing seasons of less than two weeks were dropped from the analysis (e.g., beginning June 30, ending July 3). This condition only impacted a handful of years in Bend, Ore. and Butte, Mont. Forty-four stations that did not have a regular growing season and were on average frost-free for most of the year were excluded completely.