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## Data Sources and Considerations

*Daily Temperature data (via [NOAA API](#)):*

- Daily minTemp data was collected for each city from 1950-2020
- Seasons were classified using the following definitions:
  - Spring = Months 3-5
  - Summer = Months 6-8
  - Fall = Months 9-11
  - Winter = Months 12-2
- “Frost season” length was calculated by determining the difference between the first day in fall and last day in spring with temperature  $\leq 32^{\circ}\text{F}$ ; “Growing season” length was calculated by subtracting “Frost Season” from 365
- 1995 Stockton, and several years in McAllen had no days in which the temperature was  $\leq 32^{\circ}\text{F}$ ; these years were given a “growing season” value of 365

*Practicing allergist data (via [Medicare Provider Utilization data](#))*

- Provider practice data filtered by whether or not provider is an allergist
- Used address to determine which county provider practices in
- CMS data was joined with census population estimates to determine number of allergists per 100k people in county

*Air pollution data (via [CACES](#))*

- particulate matter ( $\leq 2.5 \mu\text{m}$ )
- concentrations are listed as the variable "pred\_weight"; units are micrograms per cubic meter for PM2.5
- Data available from 1999-2015

*Asthma prevalence data (via [CDC](#))*

- Asthma prevalence data are self-reported by respondents to the National Health Interview Survey (NHIS).
- From 1997-2000, a redesign of the NHIS questions resulted in a break in the trend data as the new questions were not fully comparable to the previous questions. Data exists for 1980-96 and 2001-18.
- 1980-96 source: Moorman JE, Akinbami LJ, Bailey CM, et al. National Surveillance of Asthma: United States, 2001 -2010. National Center for Health Statistics. Vital Health Stat 3 (35). 2012.

- 2001-18 source: [NHIS prevalence tables](#)

*Ranking of most challenging places to live for people with allergies (via [AAFA 2020 report](#))*

1. Richmond, Virginia
2. Scranton, Pennsylvania
3. Springfield, Massachusetts
4. Hartford, Connecticut
5. McAllen, Texas
6. New Haven, CT

...

95. Milwaukee, WI
96. Stockton, California
97. Salt Lake City, Utah
98. Seattle, Washington
99. Provo, Utah
100. Durham, North Carolina

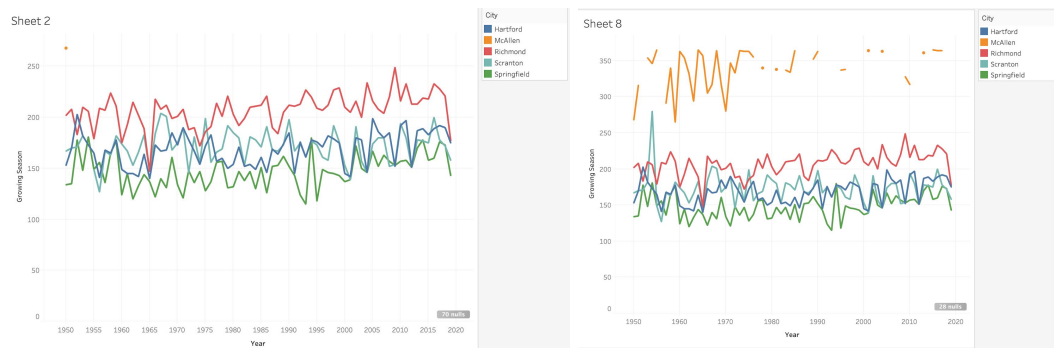
*Practicing Allergy/Immunotherapy residents (via [ACGME report](#))*

- Pg 56 of report — has data for 2014-18

## EDA + Viz Prototypes

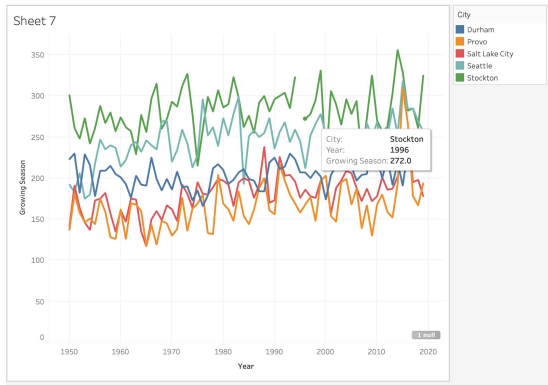
### Charting lengthening allergy seasons for cities (NOAA data)

“Worst” cities:

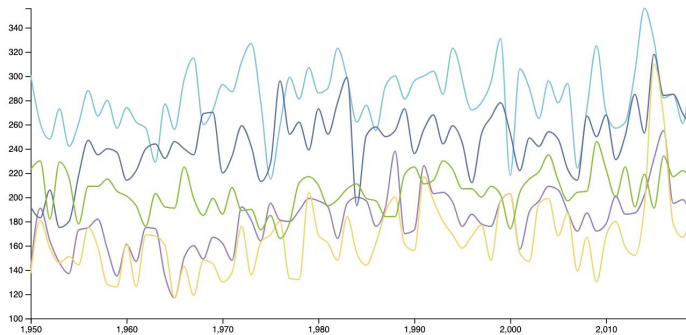


McAllen has many years w/ no temps  $\leq 32$  -- replace w/ 365.

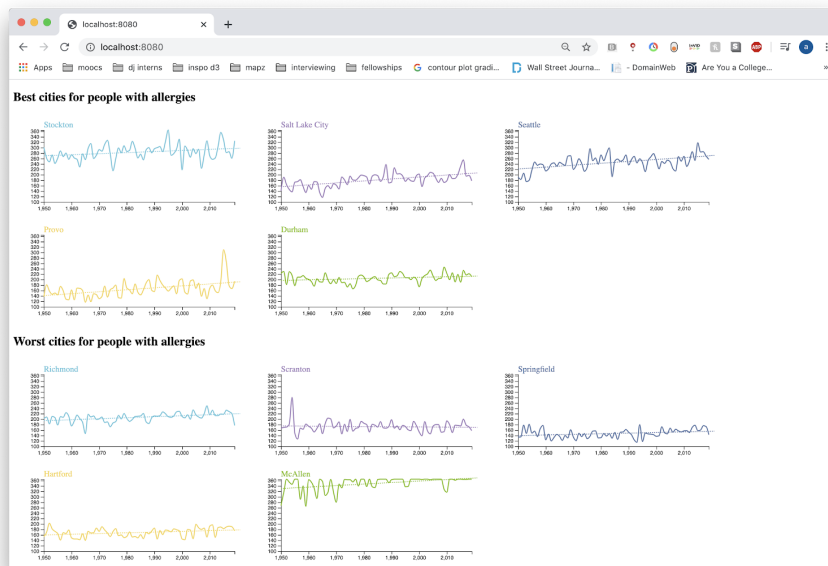
“Best” cities:



Stockton 1995 didn't have temp  $\leq 32$  -- replace w/ 365



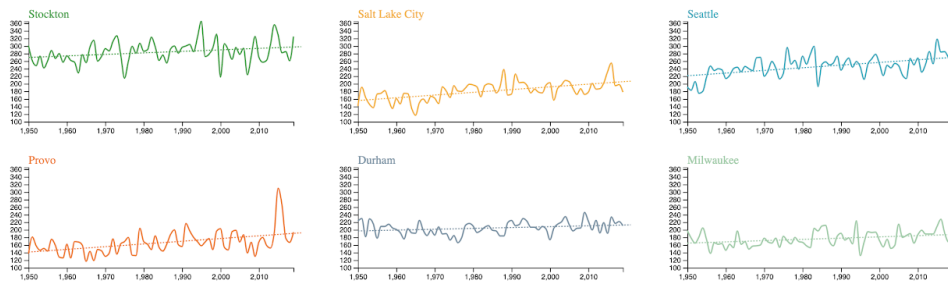
--> this isn't very legible



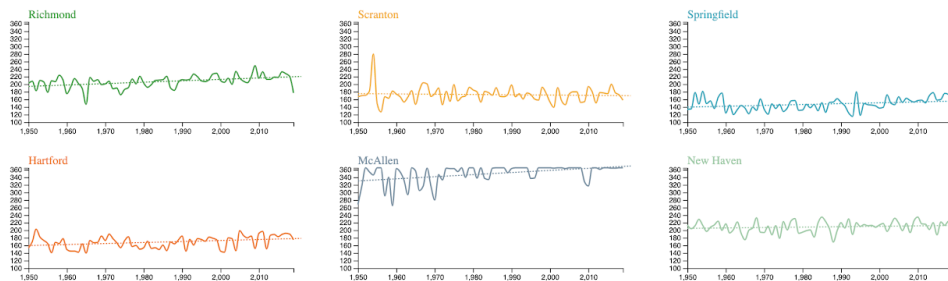
--> small multiples

instead, add sixth city to make even

### Best cities for people with allergies

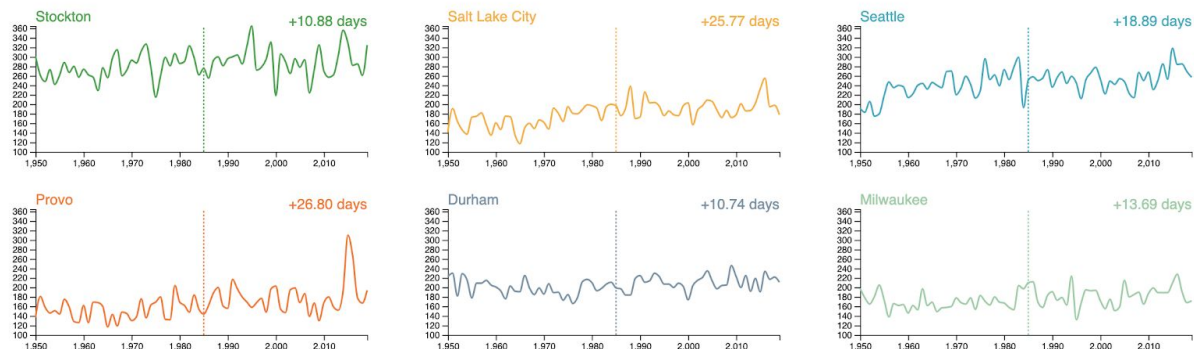


### Worst cities for people with allergies

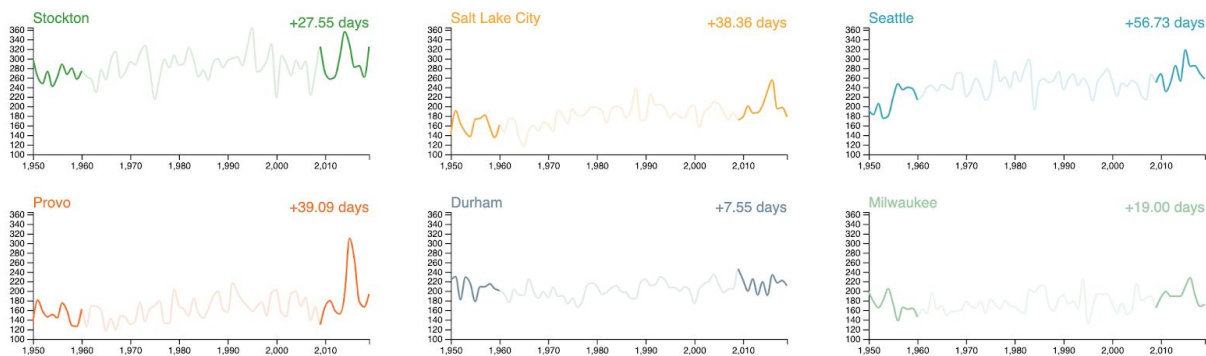


This may not look like a consistent relationship, but by comparing the average allergy season length from before 1985 and after, you can see just how much allergy season has grown in these cities.

transition to:

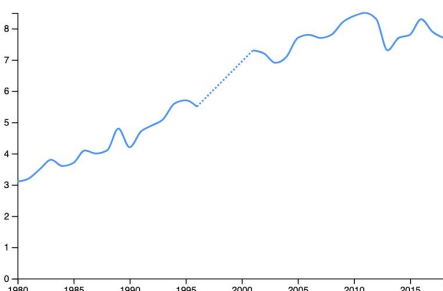


transition to:

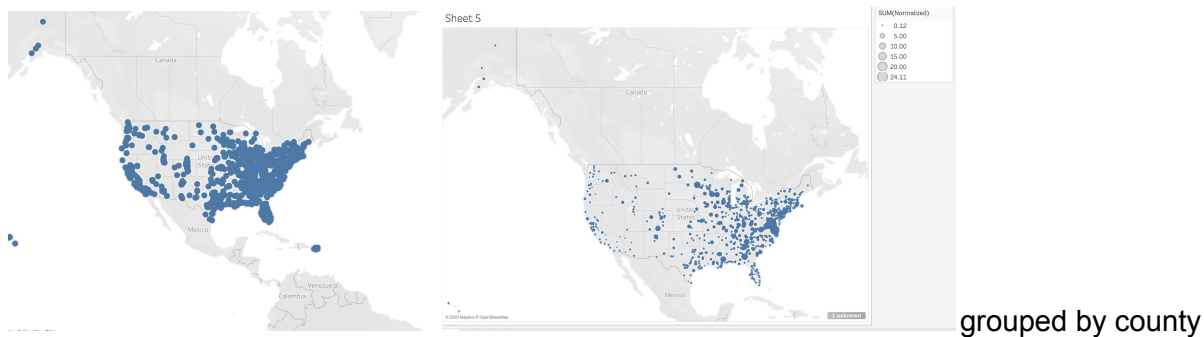


And an even more profound effect emerges by just comparing the first and last decades.

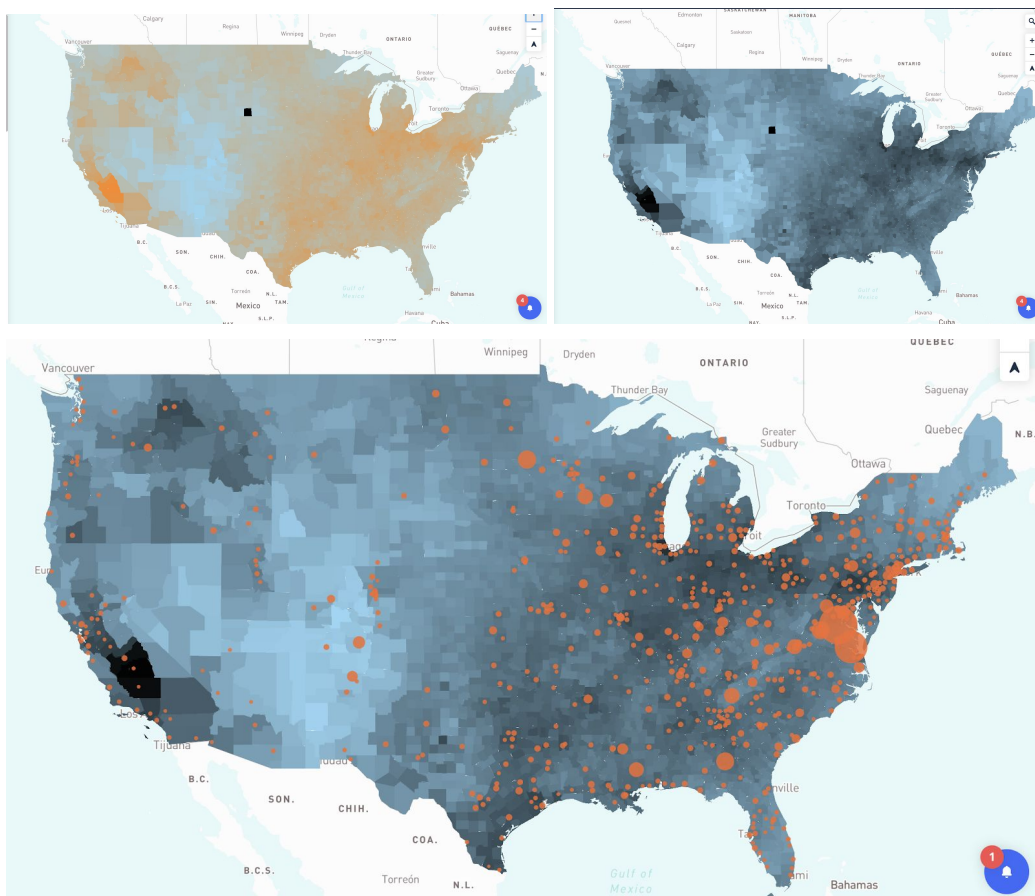
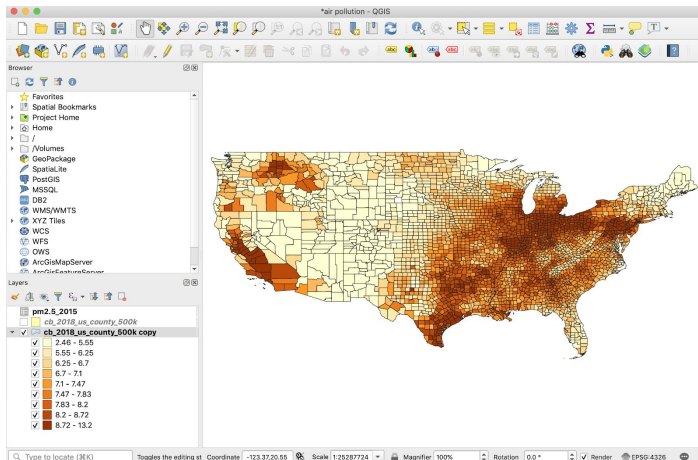
## Asthma prevalence



## Prototyping of allergist map



## Air pollution map (data = CACES)



## Data analysis of allergists

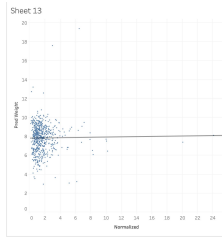
Out of counties with allergists, mean number of allergists per 100k people is 1.66

Including counties without, the average is 0.3748893987152104

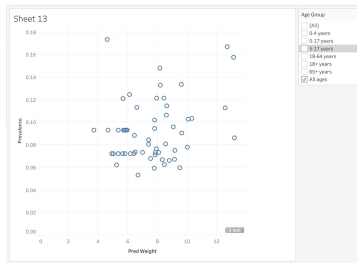
In [39]:

There are a total number of 3,265 practicing allergists.

## Correlation between air pollution and allergists?



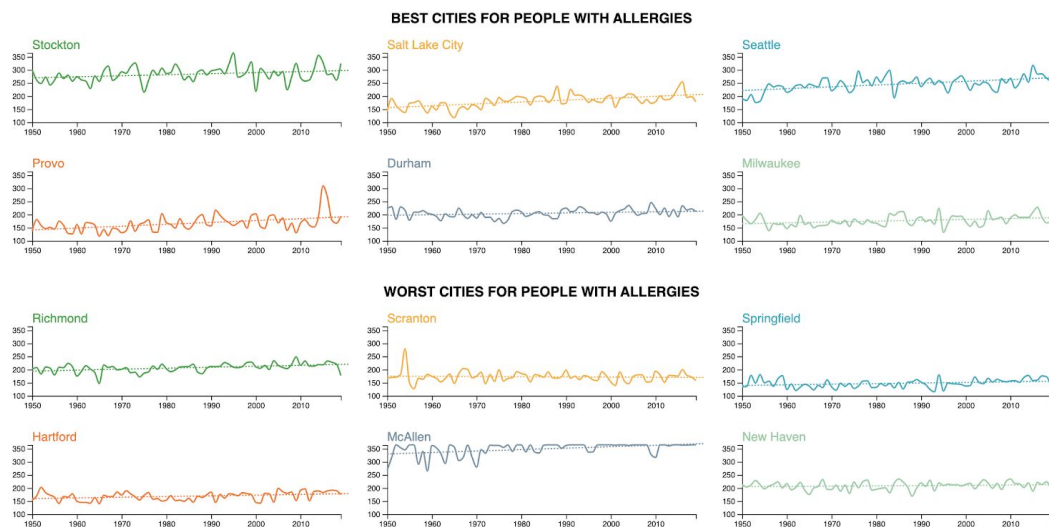
Allergists may be concentrated in more polluted areas, but nothing statistically significant.



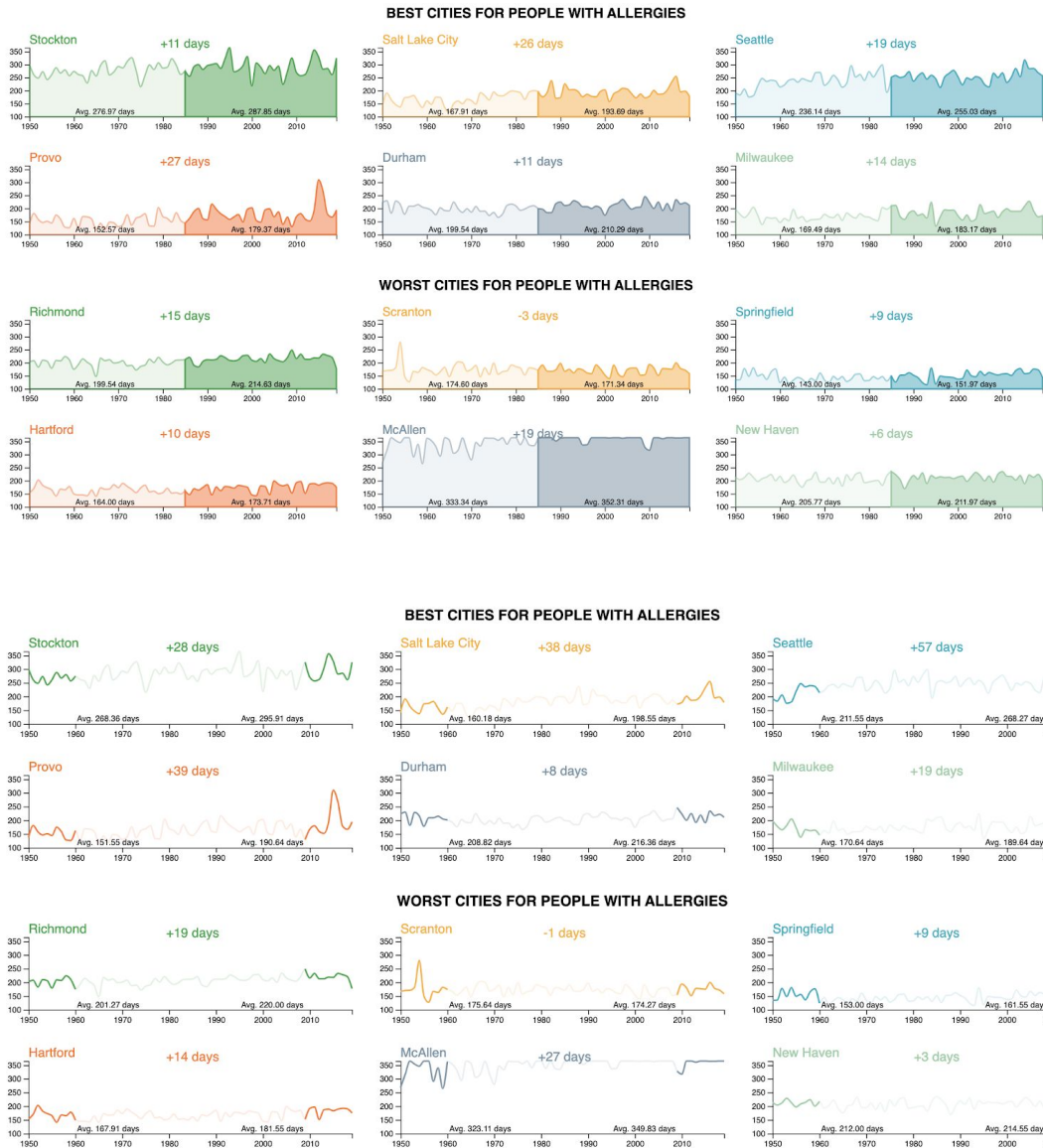
no clear correlation between pm2.5 levels and asthma prevalence

## Finalized Visualizations

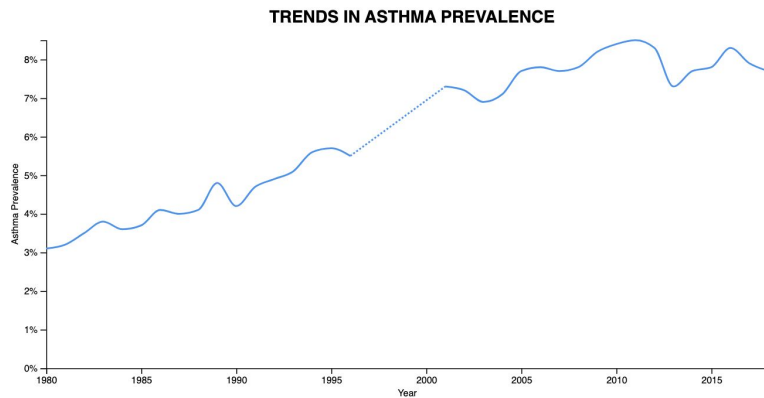
### 1. Charting the change in allergy season length



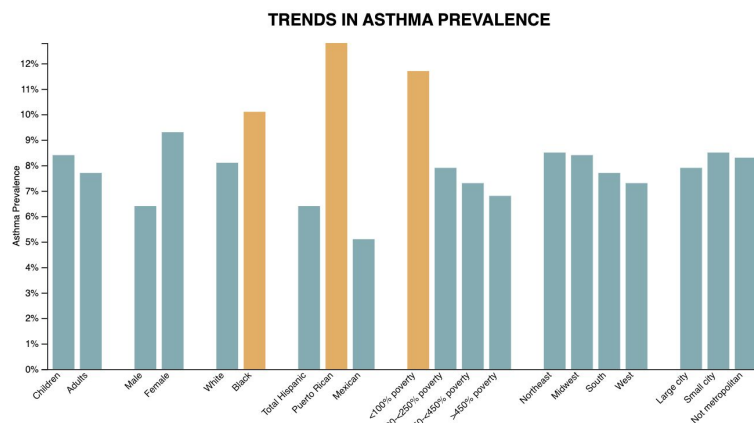
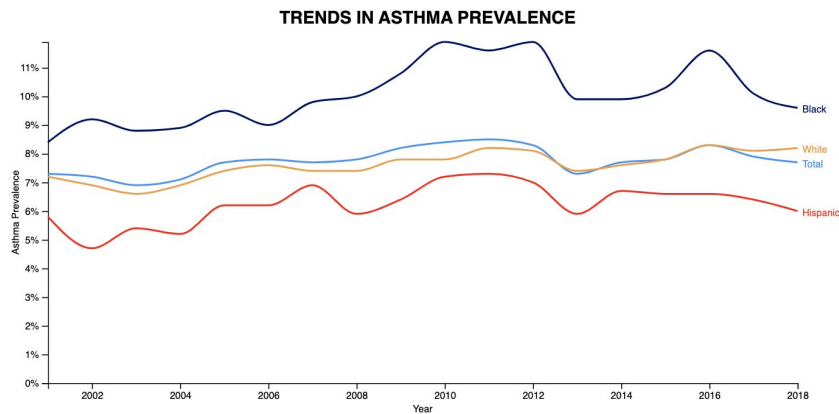




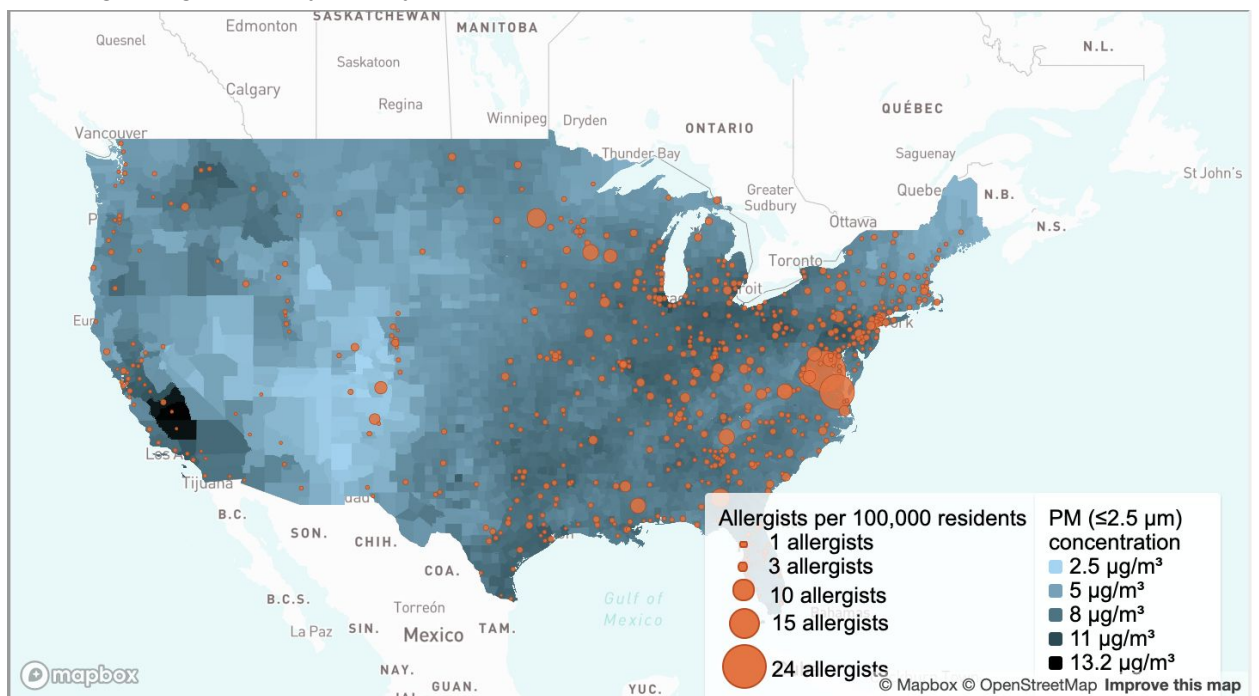
## 2. Charting trends in asthma prevalence







### 3. Mapping allergist rate by county



## Background research

### *Allergies + climate change*

[Climate change will make allergy sufferers suffer a little bit longer each year](#) (via Massive Science)

- Cited [2019 study](#) from Dept. of Agriculture; study found that 71% of the locations analyzed had significant increases in pollen production + 65% of the locations had a significant increase in the length of the pollen producing season
- “this study was unique in that it provides evidence for large-scale shifts in pollen loads and seasonal duration over a much longer time scale, across multiple allergenic plant species and locations.”
- “scientists can predict pollen counts.” — 1991 [study](#)
- 2016 [study](#) explores allergies in a changing climate
- No interviews.

[Get Ready for the Worst Allergy Season We've Ever Had](#) (via Elemental)

- Interviews w/ director of Allergy and Asthma Care of New York; VP of AAFA; director of Center for Climate, Health, and the Global Environment @ Harvard;
- Same 2019 study: in areas where the onset of spring came weeks earlier than average, measured by visible greening of the landscape captured by satellite images, there was a 14% higher prevalence of hay fever (NHIS data).
- Confluence of longer pollen seasons, and more CO<sub>2</sub>; UMass study [found](#) plants growing in environments with CO<sub>2</sub> levels of 800 ppm produced twice as much pollen

[It's not your imagination. Allergy season gets worse every year.](#) (via Vox)

- Interviews w/ director of Allergy, Asthma, and Immunology Center of Alaska;
- COVID-19 symptoms overlap w/ allergy symptoms.
- “Forecasters expect 2020 to be yet another above-average year for allergies, if not the worst year ever. Just like [2019](#), the [year before](#) that, the [year before](#) that, and the [year before](#) that.”
- [Estimates](#) that pollen production to double by 2040

[Climate Change Is Making Your Allergies Even Worse](#) (via NatGeo)

- Interview w/ Leonard Bielory ([study](#) ACAAI press release)
- “Reports of pollen allergies first appeared around the time of the industrial revolution.”
- People who have pollen allergies may experience intensified symptoms, and people who don't normally have pollen allergies may start to.

[Your seasonal allergies are getting worse because of high levels of carbon dioxide — here's why](#) (via Business Insider)

- children in low- and middle-income countries are disproportionately affected by consequences of warming, Annesi-Maesano said.
- “Age matters in climate change, with children and elderly suffering more from the effects of climate change than the rest of the population,” she added.

### *Asthma + air pollution*

#### [Why Are Asthma Rates Soaring?](#) (via Scientific American)

- “Hygiene hypothesis” was upheld for awhile, until a study found that asthma rates were also skyrocketing in more urban areas
- Only half of asthma cases have an allergic component
- Piece doesn't link or otherwise cite research.

#### [Climate Change and Asthma](#) (via Harvard's SPH)

- Burning fossil fuels (for example, from power plants, cars, and trucks) produces carbon pollution that drives climate change and creates conventional air pollution, including particulate matter or PM, that can be harmful to health.
- Boston [study](#) found that lifetime exposure to black carbon (or soot) and microscopic air particles, known as particulate matter or PM, was linked to asthma in early childhood (3-5 years old)
- Higher temperatures → more ground-level ozone pollution, which can trigger asthma attacks; also wildfire smoke.

#### [Asthma and Allergies on the Rise in the U.S.](#) (via Healthline)

- Interviews w/ Clifford W. Bassett, M.D., also an ACAAI fellow
- Asthma most commonly starts in childhood
- “The rise in allergies and asthma may also be due to an increase in airborne pollens, climate changes that trigger a rise in pollen levels, the energy-proofing of indoor home and work spaces, urban air pollution, or the overuse of antibiotics.”
- Indoor and outdoor triggers include: smoke pollution and strong odors, pet dander, mold, pollen, dust mites, exercise, pests like roaches and mice, colds and flus, certain foods, and changes in the weather.

### *General notes on demographics*

- Children and the elderly are particularly vulnerable to asthma and allergy attacks, as their respiratory systems are more susceptible to environmental pollutants.
- African American and Hispanic families have higher rates of respiratory illness
- A [2011 report](#) found that PM 2.5-attributable asthma emergency department visit rates were more than three times higher among children in high poverty neighborhoods. -- air pollution will continue to exacerbate inequality
- Racial [inequities](#) have meant that Black Americans and Hispanics of Puerto Rican origin have the highest rates of asthma in the U.S., as well as the highest asthma death rates. They also have the highest number of emergency room visits and hospital stays due to asthma. Black Americans and Puerto Ricans are three times more likely to die from asthma than whites.

### *Data visualizations + maps*

#### [Frost-free season](#) (via National Climate Assessment)

[Climate Change Indicators: Length of Growing Season](#) (via EPA)

*Allergist Shortage*

[Allergist Report](#) (via ACAAI)

[Addressing the shortage of qualified allergists](#) (via Barton Associates)

## **Summarized Research**

Research shows that climate change is [worsening](#) allergies. As yearly frost seasons get shorter and shorter, pollen-producing plants — including grasses and weeds — have more time to grow. Essentially, spring is starting earlier and lasting longer.

At the same time, rising CO2 levels mean that plants have a [higher](#) capacity to produce pollen.

Pollen counts dramatically [drop](#) after the first freeze, research has shown. This means that we can chart the change in allergy season length by determining the first and last days with temperatures below freezing each year.

Air pollution is also a culprit of [worsening](#) allergies and asthma. [Research](#) has shown that communities of color and low income neighborhoods are more likely to live in polluted areas.

Asthma and allergy rates have exploded in recent years, for unclear reasons. About 25 million, 8%, of the population had asthma in 2018, compared to 20 million, or 7.3%, who had asthma in 2001. 60 million individuals in the U.S. [suffer](#) from allergic rhinitis.

According to my analysis, there are just 3,265 allergists who accept Medicare. 80 percent of counties in the U.S. do not have a practicing allergist. Alongside growing rates of asthma and allergies and worsening symptoms, the lack of access to necessary specialty care is concerning, especially as [demand](#) is expected to increase.

## **Extra notes**

Researchers are [predicting](#) 2020 to perhaps be the worst year yet for those with allergies. Similar forecasts were made [last year](#), and the [year](#) before that, and the [year](#) before that and even the [year](#) before that.

The culprit of worsening allergies, like many public health crises in recent years, is climate change. The threat is multi-pronged — earlier and longer springs mean that pollen-producing plants have more time to grow, and rising CO2 levels lead to plants having higher capacity pollen production.

Researchers have been pointing to this relationship for decades. A [study](#) from 2000 under lead researcher Lewis Ziska found that rising carbon dioxide levels led to a corresponding doubling in pollen production of ragweed.

The evidence has grown stronger with each year. Numerous studies have corroborated Ziska's initial findings, and Ziska himself published an update in 2016 with more recent data that reconfirmed his earlier findings.

Alongside worsening symptoms, the rates of allergies and asthma are increasing. The incidence rate of asthma in particular has been increasing since the 1980s in all age, sex and racial groups.

About 25 million, 8%, of the population had asthma in 2018, compared to 20 million, or 7.3%, who had asthma in 2001.

The relationship between air pollution and asthma is well-established, and recent studies are finding that historically underserved communities face more air pollution on average. Specifically, Asian American, African American, and Latino residents in the Northeast and Mid-Atlantic regions of the U.S. are likelier to live in polluted areas — in sum, these communities breathe 66 percent more air pollution from vehicles than white residents, according to a [study](#) from the Union of Concerned Scientists.

Not only do Black Americans and Hispanics of Puerto Rican origin have the highest rates of asthma, but also the highest death rates due to asthma. They also have the highest number of emergency room visits and hospital stays due to asthma, and are three times more likely to die from asthma than White Americans.

Lacking access to care is perhaps experienced by Black and Hispanic patients most acutely, but the shortage of practicing allergists is felt almost everywhere.

In a country where an estimated 50 million people suffer from allergic rhinitis, and 25 million people suffer from asthma, there are only 3,265 practicing allergists, according to Medicare Provider Utilization data. Primary care physicians and other specialists can treat these patients and help close specialty care access gaps, but many who have chronic or severe allergies likely do not live near someone who can provide the care they need.

According to our analysis, 80 percent of U.S. counties do not have a practicing allergist — of the counties with allergists, the average number of allergists per 100,000 county residents is 1.66. Including counties with zero allergists means that the average number of allergists is a mere 0.37 per 100,000 residents.

The dovetailing threats of climate change, air pollution and allergist shortages will only serve to exacerbate inequality among those with allergies and asthma, and further worsen symptoms.

Upon first glance, it may seem that allergists are concentrated in more polluted areas. Our analysis, however, found no statistical correlation between air pollution and the number of allergists by county.

The broader point is that allergy-specific treatment is inaccessible for most in America. And as environmental factors worsen both the symptoms and prevalence of allergies and asthma, the demand for practicing allergists will only grow.