Allergy & Asthma NETWORK

American College of Allergy, Asthma & Immunology

USAsthma SUMMIT 2024

The Impact of Climate Change on Asthma and Allergic Disease

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Allergy & Asthma NETWORK

Climate Change and Asthma

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Disclosures

- No relevant conflicts of interest.

Defining Climate Change

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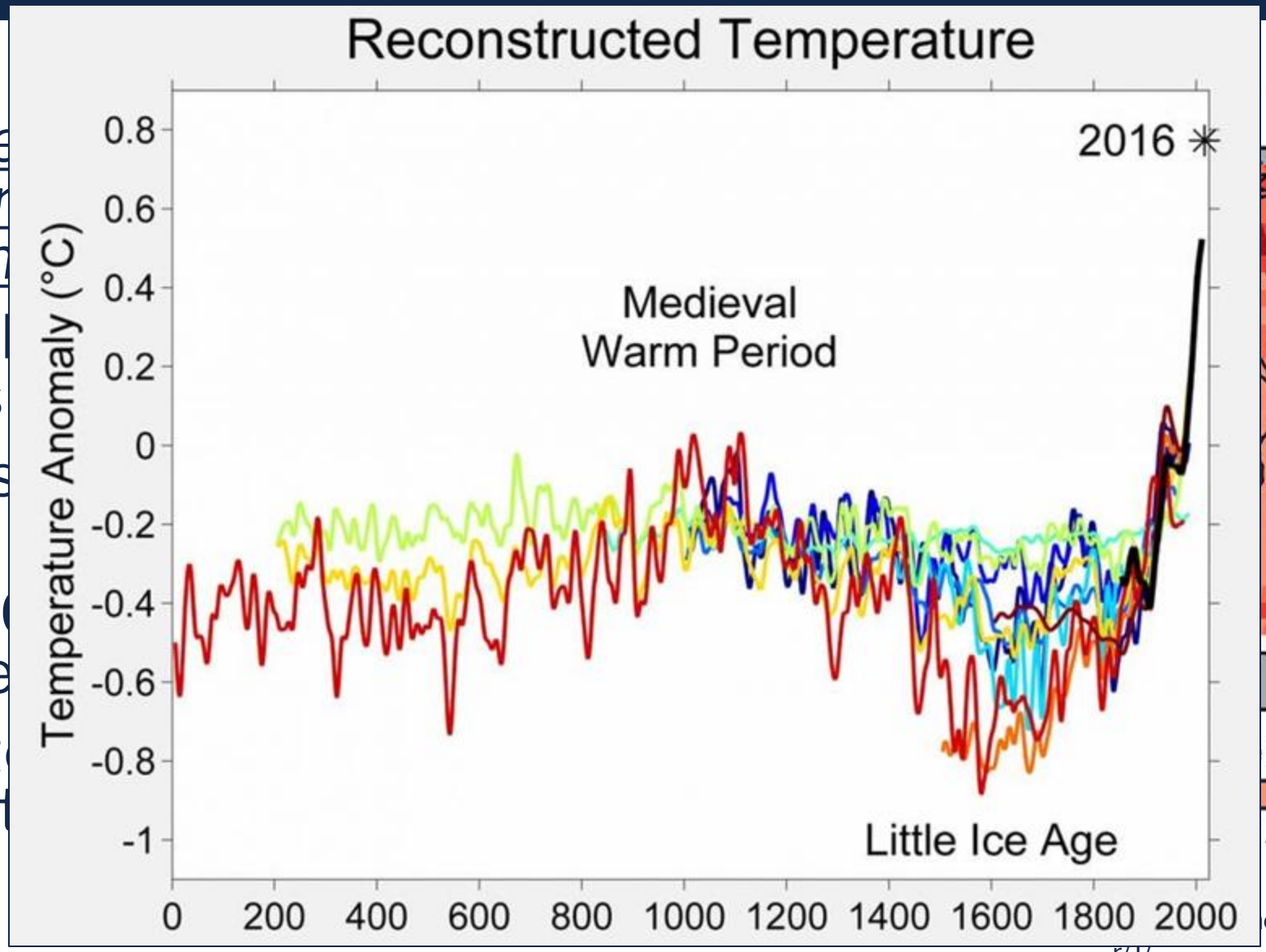

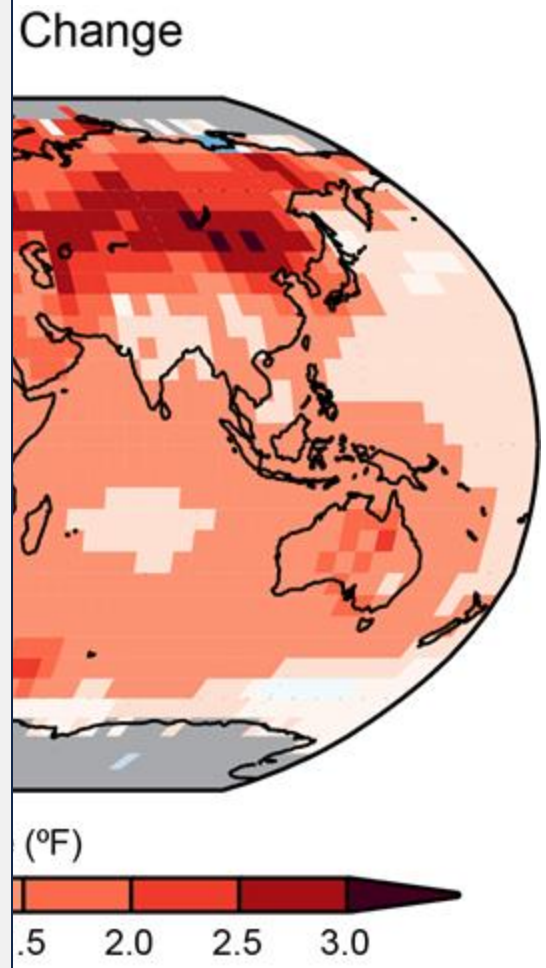

ce2017.globalchange.gov/chapte

United Nations. https://www.un.org/en/climatechange/what-is-climate-

Defining Climate Change

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Hurricane Helene Asheville, NC 2024

Lahaina Wildfires Maui, HI 2023

Enhanced Greenhouse Effect

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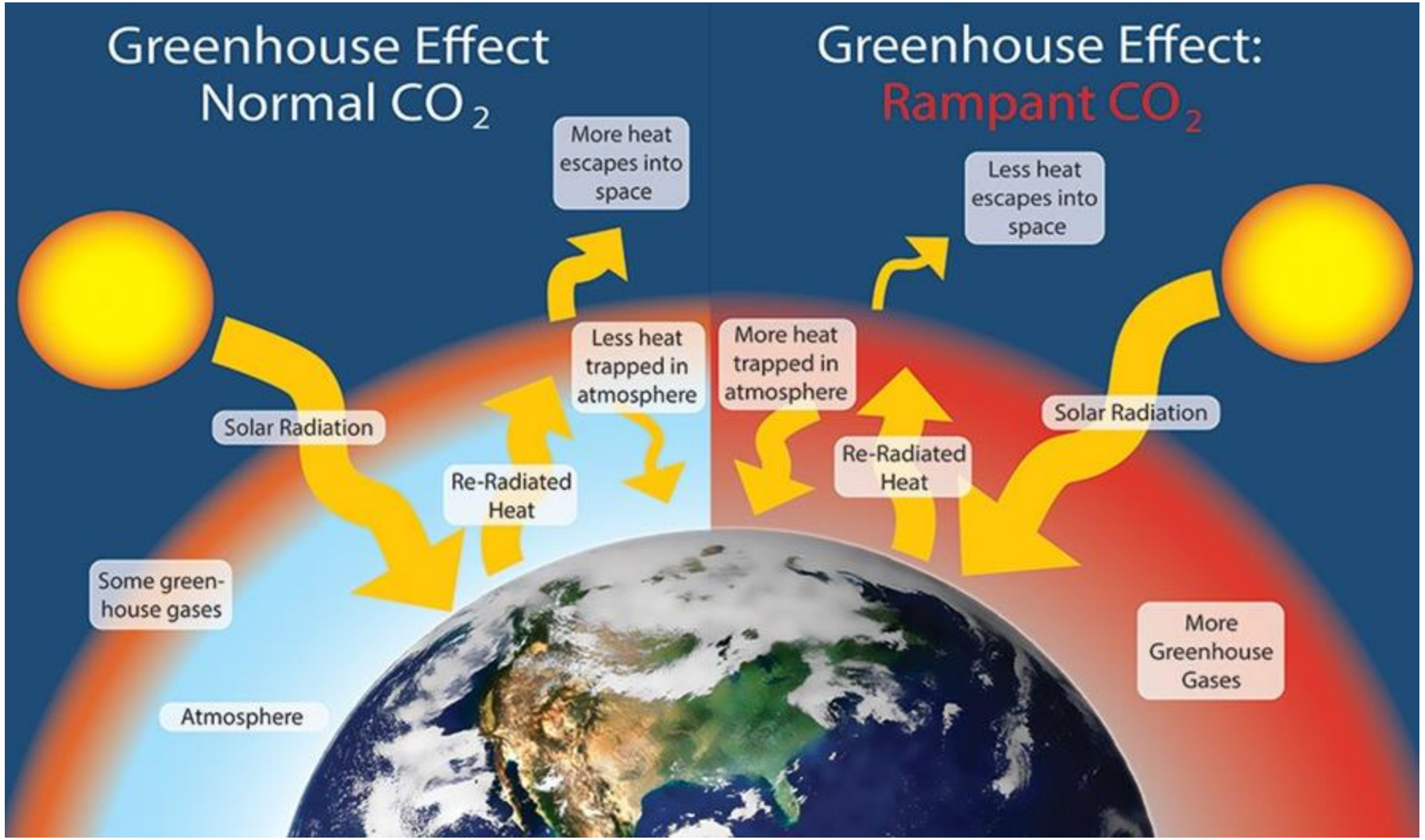
Greenhouse Gases (GHG) trap heat in the atmosphere

- Carbon Dioxide
- Methane
- Nitrous oxide
- F gases
- Ozone
- Water vapor

Major Contributors:

- Burning Fossil Fuels
- Deforestation
- Agriculture



https://www.nps.gov/goga/learn/nature/climate-change-

How does climate change affect asthma?

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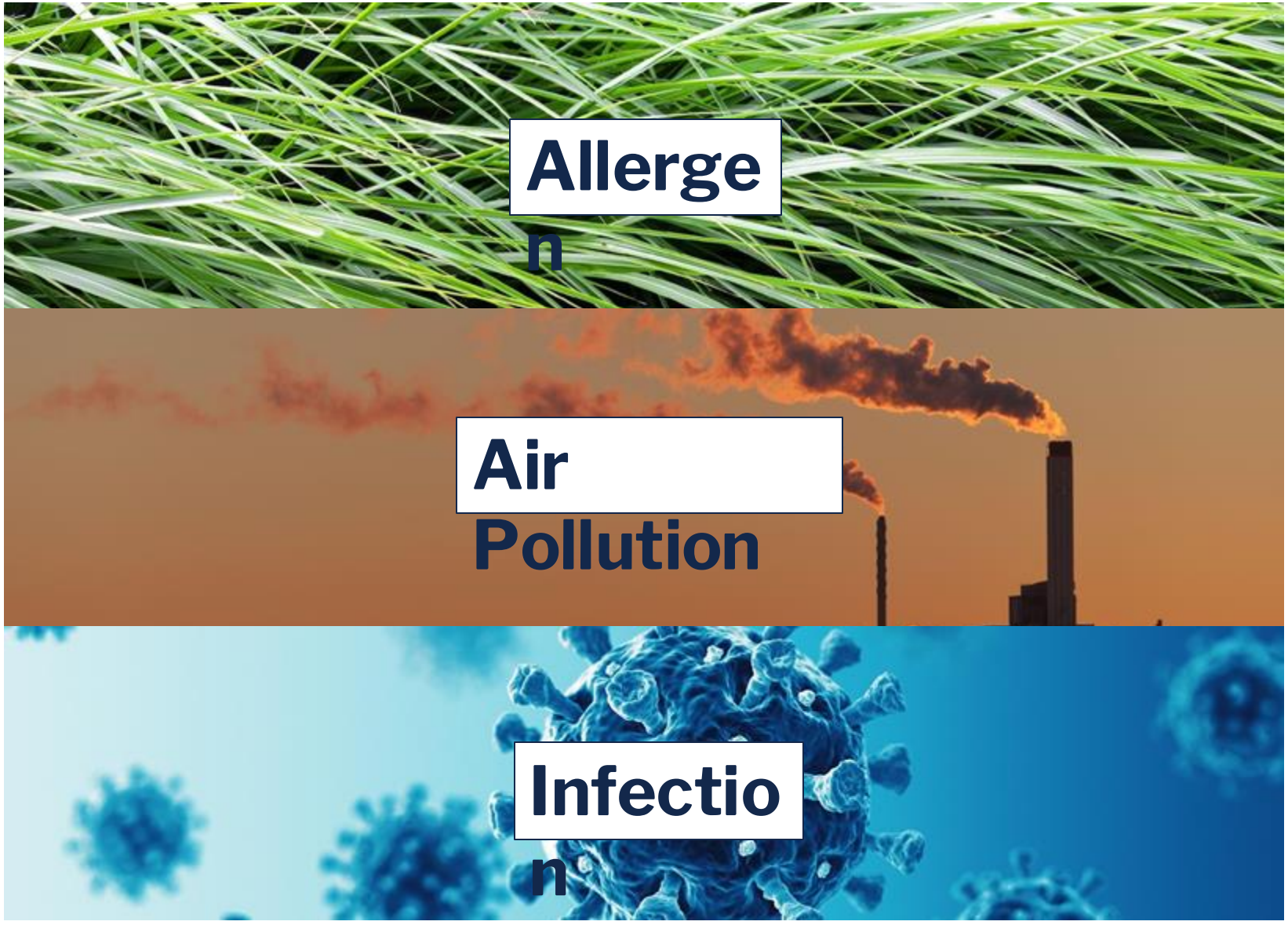

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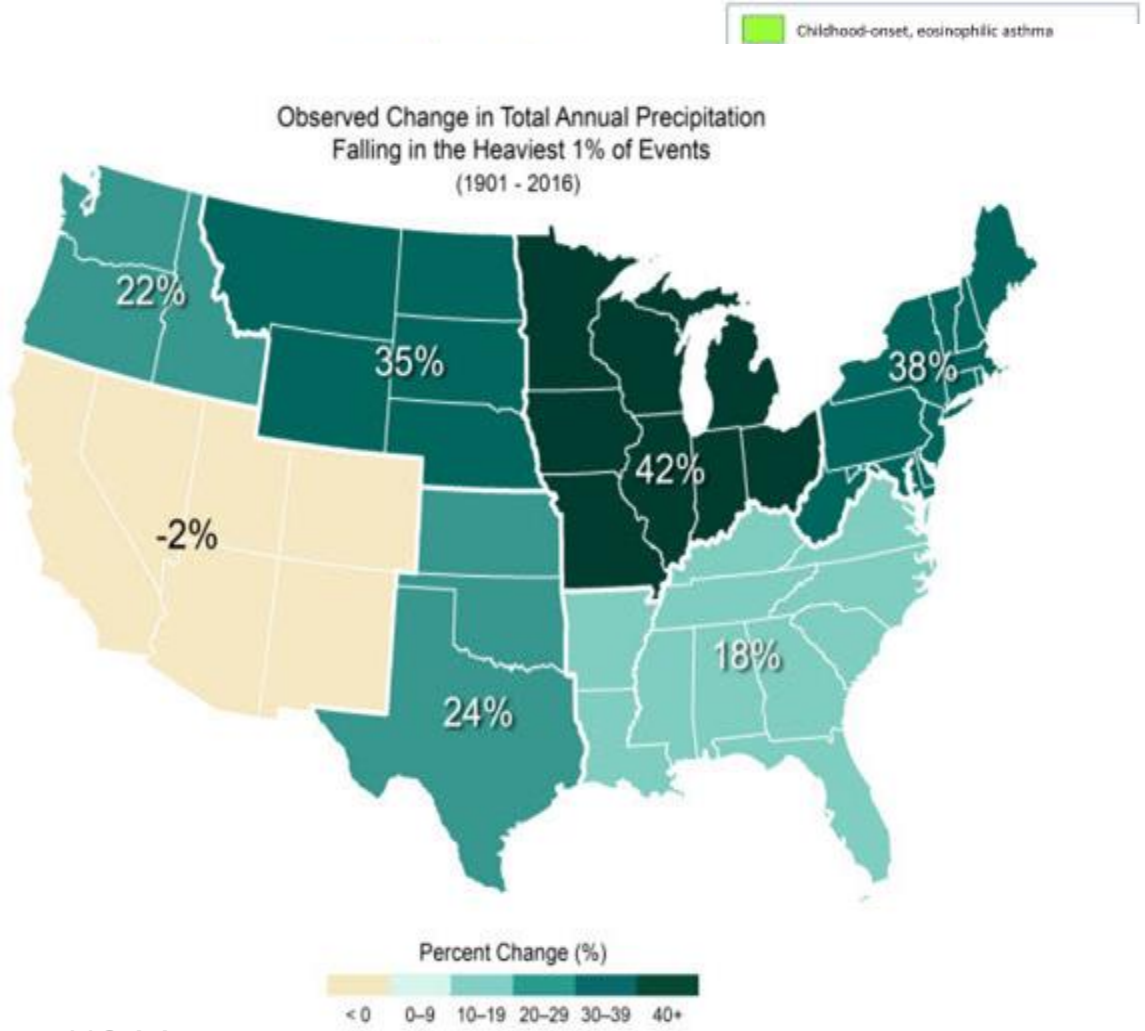
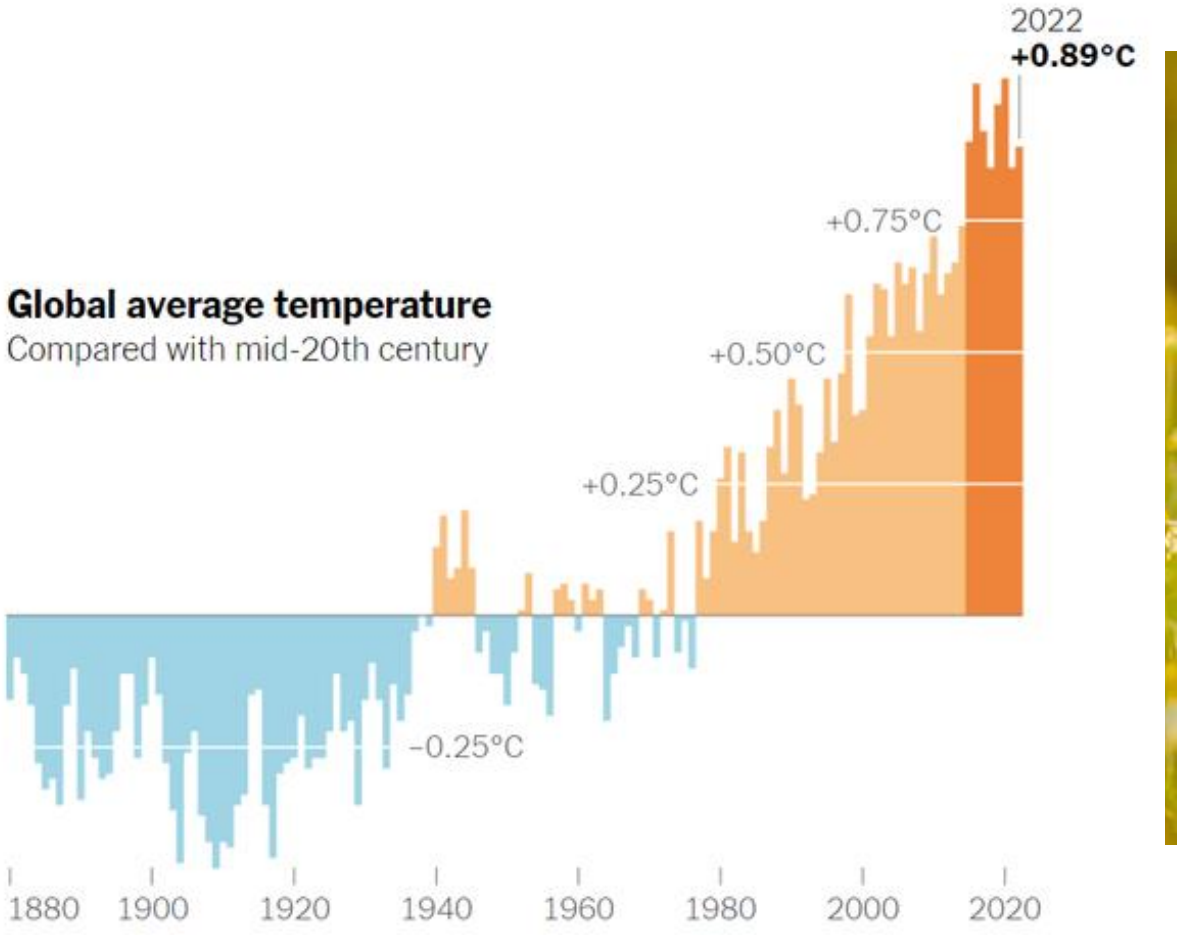
Climate Change and Allergens

Allergens and asthma



Source: NOAA Climate.gov

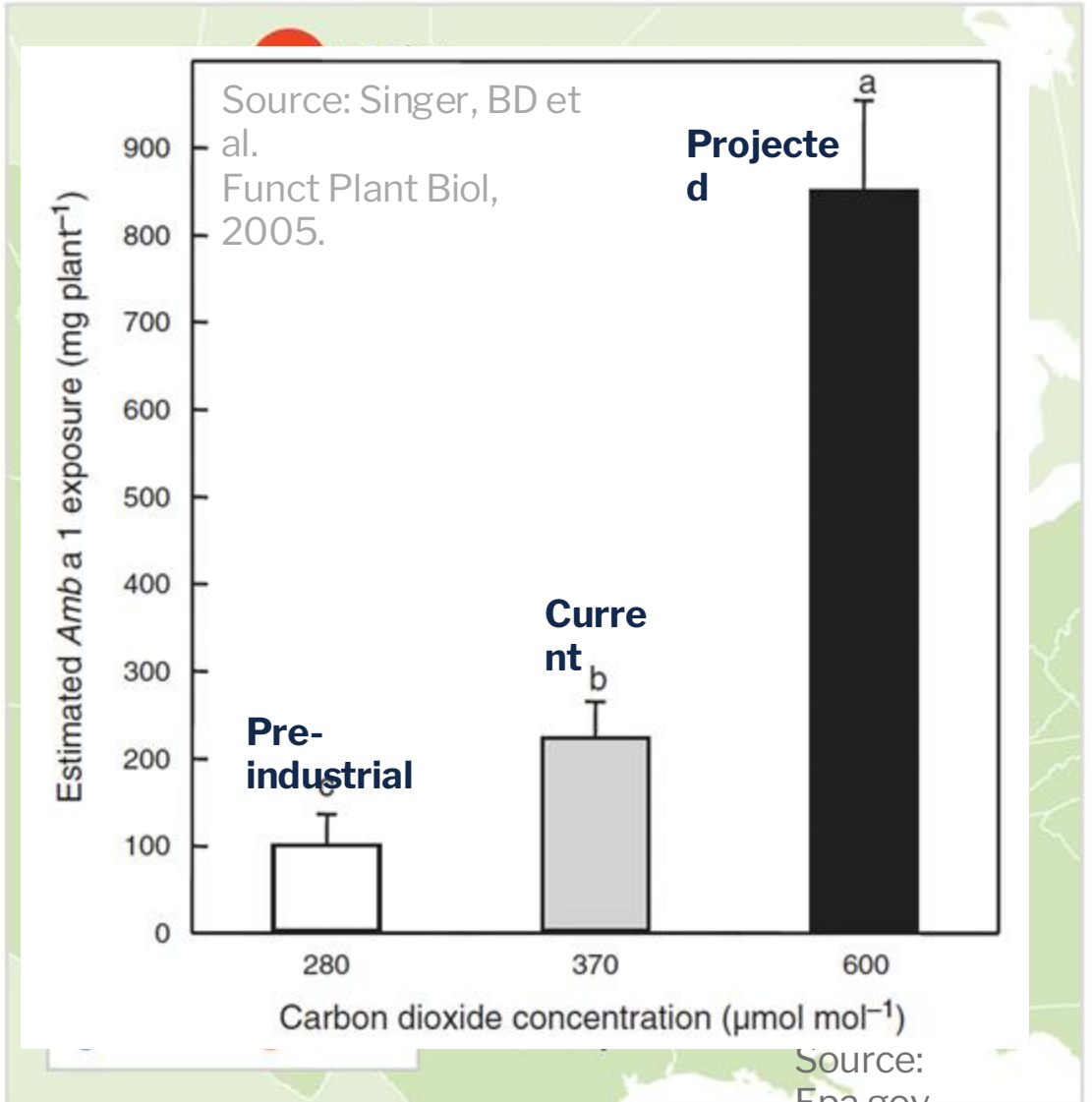


Source: NASA Goddard Institute for Space Studies

Climate change and changing allergen

- Pollen seasons starting earlier, ending later
- Higher total pollen emission and higher peak pollen emission
- Increase temperature, humidity, and precipitation altered growth and geographic distribution
- Higher CO_2
  - higher pollen production
  - greater potency – eliciting more intense allergic responses

Change in Ragweed Pollen Season, 1995–2015



Source:

Climate change and changing allergen

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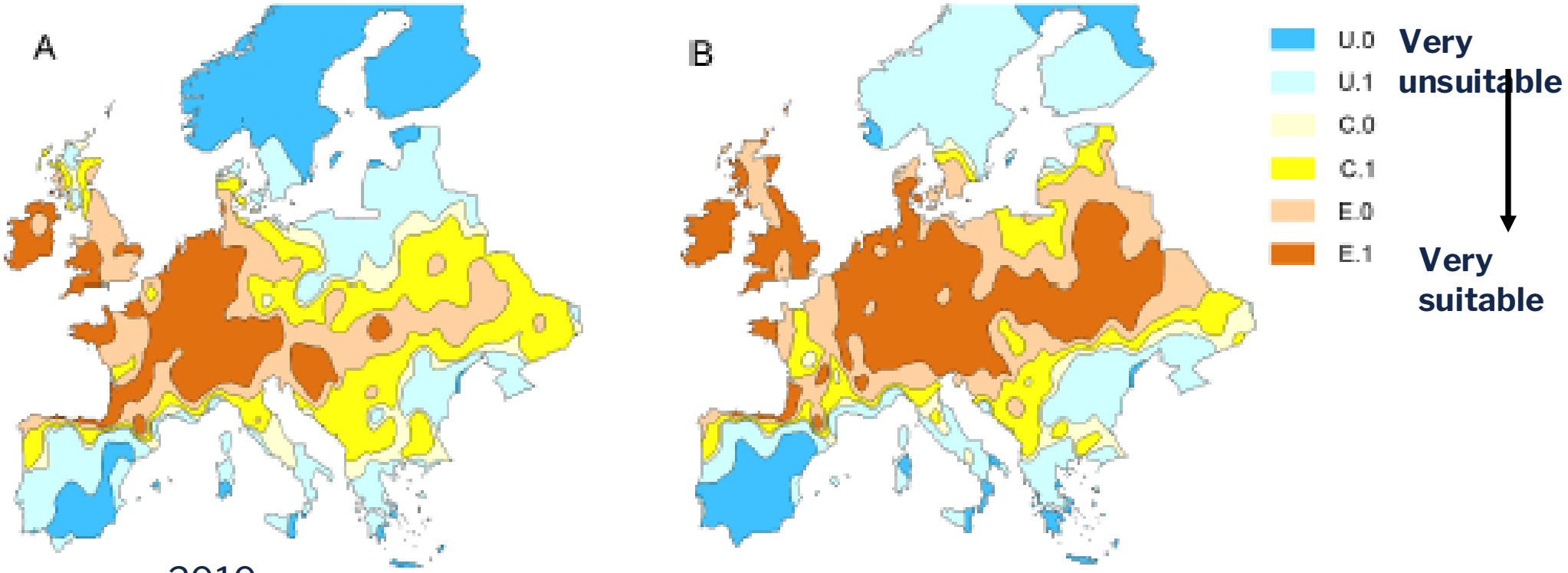
- Changing climate modified geographic distribution of allergenic plants



2010-2030

Common Ragweed

2050-2070

Source: Storkey J, et al. PLOS one, 2014

Climate change and changing allergen

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Increased

Source: NOAA Climate.gov

Source: NASA Goddard Institute for Space Studies

What does this mean for asthma?

- **Positive association between pollen counts and**:
  - Increased ED visits and hospitalizations for asthma
  - Strongest data for tree and ragweed pollen in U.S.
  - Increased risk of allergen sensitization?
- **Positive association between house dust mite exposure and asthma exacerbations**
- **Positive associations between Indoor/outdoor fungal exposure and asthma exacerbations**

What does this mean for asthma?

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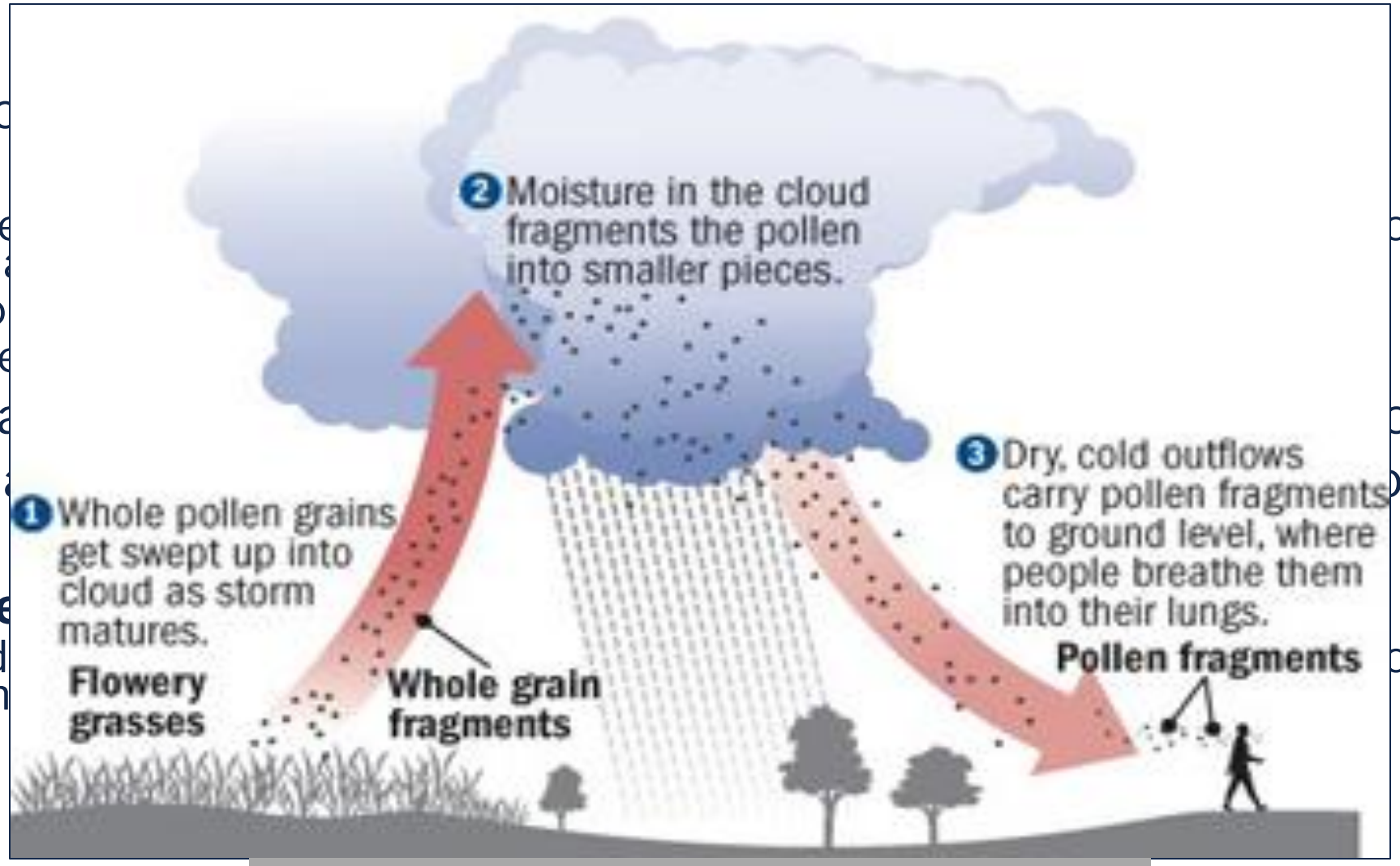

Source: Your Community Health (yourch.org/au)

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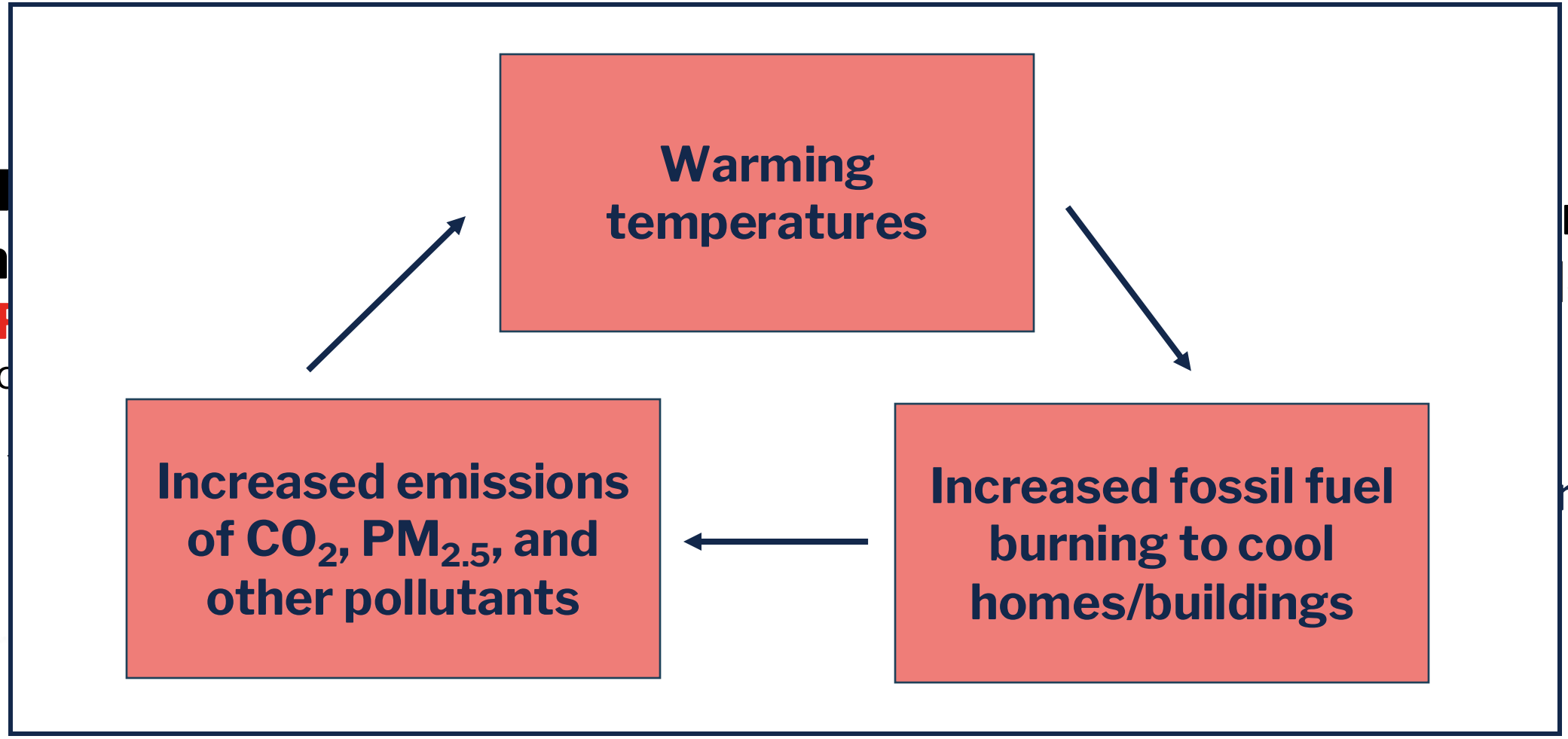
Climate Change and Air Pollution

Climate Change and Air pollution



Source: Perera F. Environ Health Perspect

Climate Change and Air Pollution

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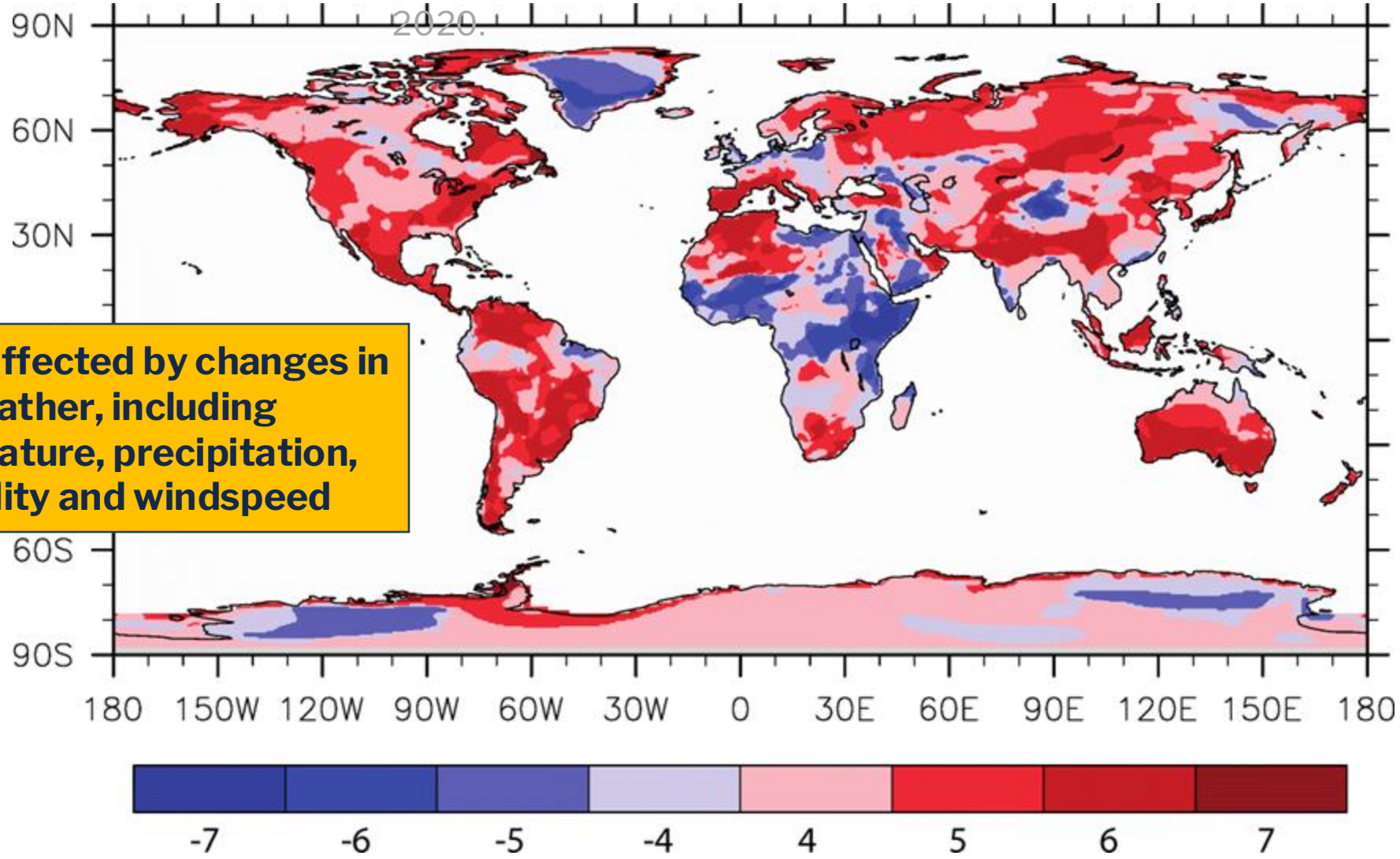
Source: Park S, et al. Air Qual Atmos Health 2020.



$PM_{2.5}$ is affected by changes in weather, including temperature, precipitation, humidity and windspeed

Climate change and Wildfires

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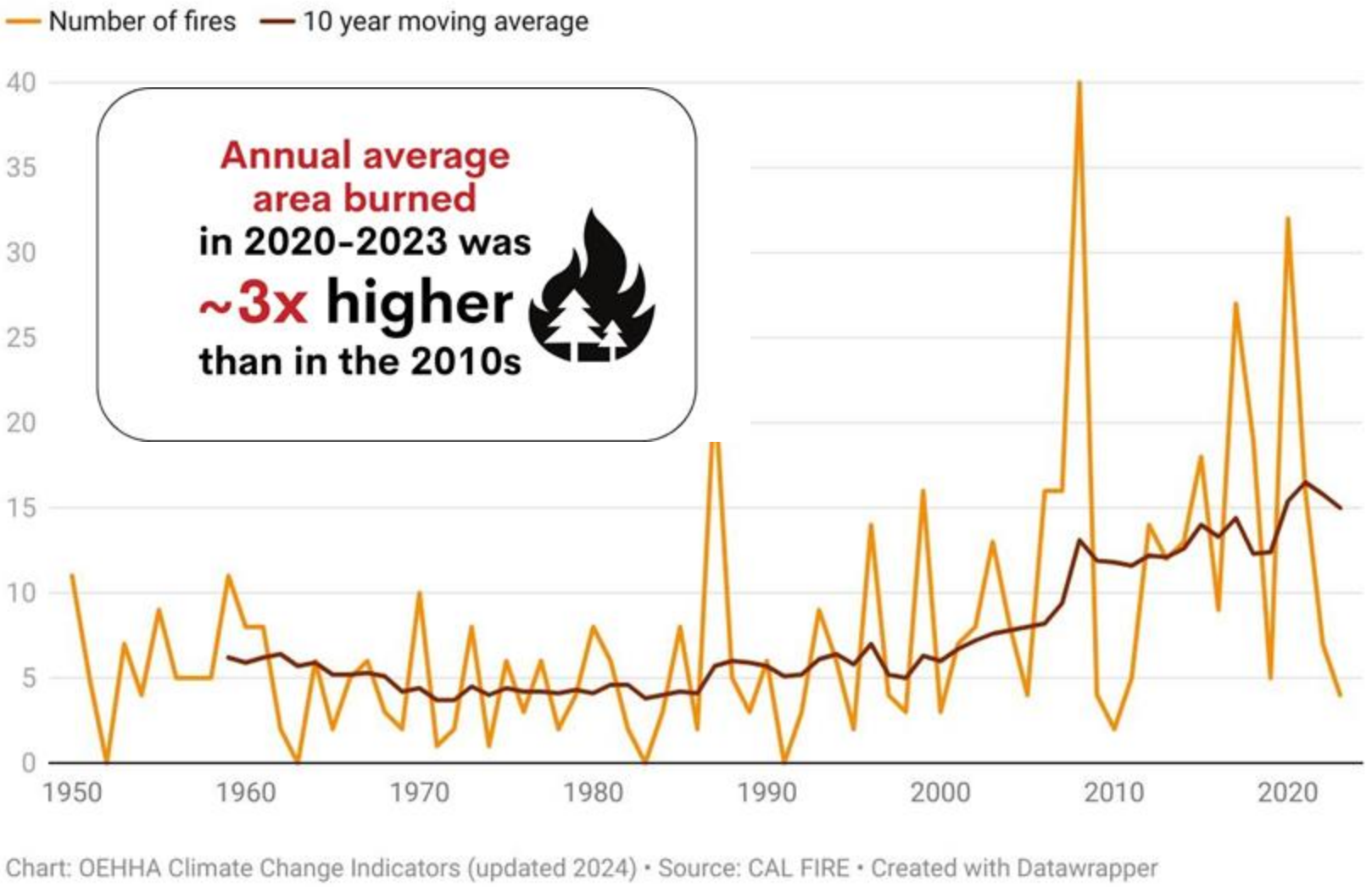

What are the expected short-term effects on asthma?

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Short-term increases in pollutant exposure:

- Increase respiratory symptoms
- Increase medication use
- Increase emergency healthcare use
- Increase airway inflammation and hyperresponsiveness
- Decrease lung function
- Increase frequency of respiratory tract infections including pneumonia and bronchiolitis
- Increase hospital admissions for respiratory tract infections
- Increase asthma mortality

How will this affect asthma incidence and prevalence?

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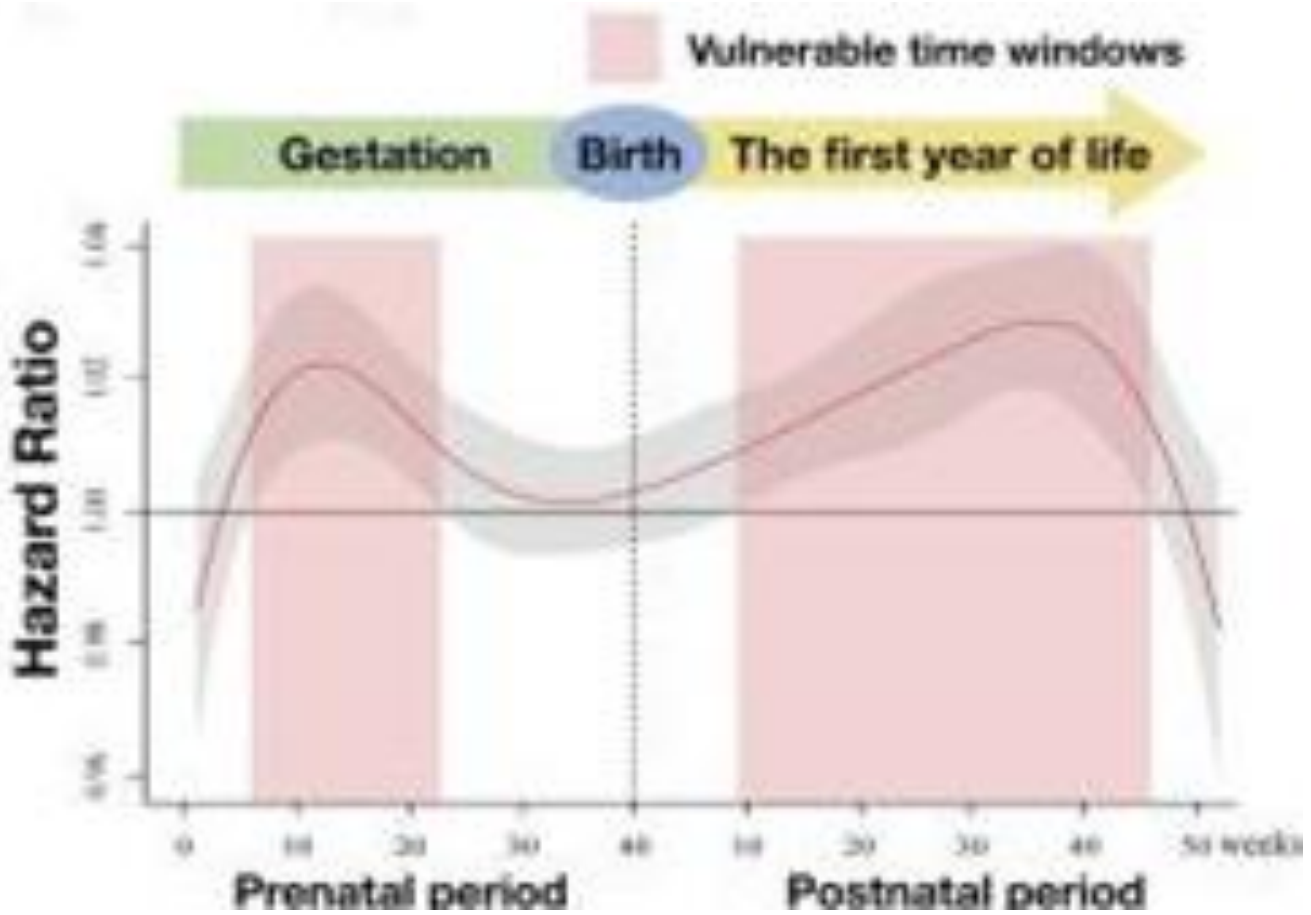
- Children are particularly susceptible to air pollution
- Exposure during critical windows in lung development may lead to altered growth, airway remodeling
- Early life exposure to traffic-related air pollution associated with reduced lung function in later childhood
- Distance-dependent relationship between residential proximity to major roadways in early childhood and asthma risk



Source: Jung CR et al. J Allergy Clin Immunol 2019 Jun;143(6):2254-

What

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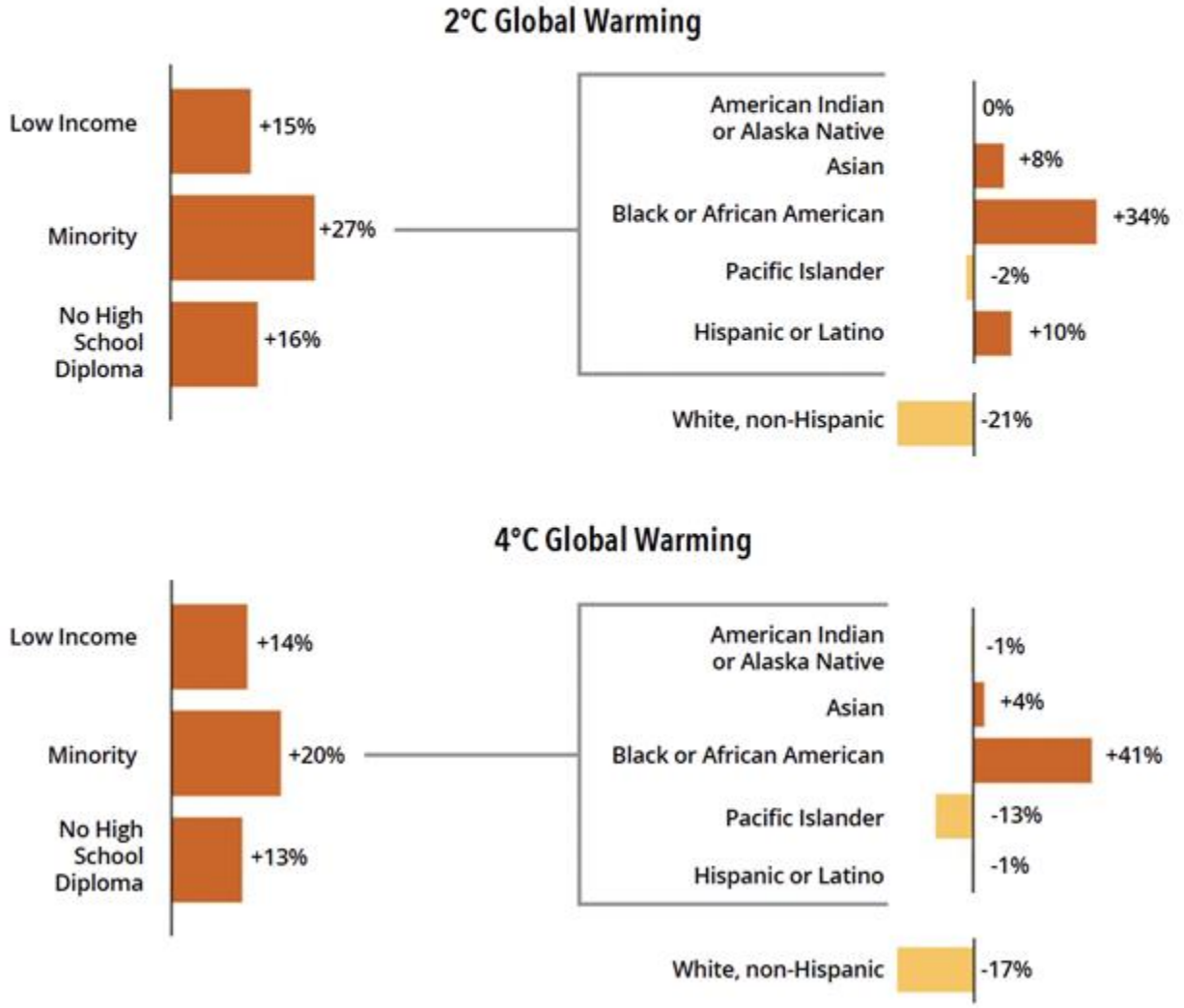
Figure 3.4 – Likelihood that Those in Socially Vulnerable Groups Currently Live in Areas with the Highest Projected Increases in Annual Childhood Asthma Diagnoses due to Climate-Driven Effects on $PM_{2.5}$

The bar charts present the relative likelihood that individuals in each socially vulnerable group (e.g., low income) currently live in areas with the highest projected increases in asthma diagnoses in children ages 0 to 17 relative to their reference populations (e.g., non-low income). Positive percentages indicate higher comparative risk, and negative percentages indicate lower comparative risk. Levels of global warming are relative to the 1986-2005 average.



Source: EPA. 202 otection Agency, EPA 430-R-21-0

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Climate Change and Respiratory Infections

POLL QUESTION

What percentage of asthma exacerbations in adults are caused by respiratory viruses?

A) 30%
B) 40%
C) 50%
D) 60%

Respiratory Viral infection and Asthma

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- Respiratory viruses responsible for at **least 40% of asthma exacerbations in adults and 90% of exacerbations in children**!

- Viral respiratory infection in early life is associated with development of asthma (rhinovirus, RSV).

Respiratory Viruses and Climate

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- Acute viral respiratory infections are the most common diseases globally (RSV, influenza, rhinovirus); LRTI the #1 cause of death in children <5 years.
- Viruses are “climate sensitive” - influenced by temperature, humidity, and precipitation.
- Air pollution exposure was associated with increased susceptibility to viral infections.

Weather and Respiratory Viruses

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- **Temperature** – surges during cold months; pattern shifts during years with “warmer” winters
- **Humidity** – higher humidity associated with reduced seasonal transmission (but could result in more persistent epidemics – outside of “normal” season)
- **Precipitation** – more precipitation linked with more severe epidemics

Respiratory Viruses and Extreme Climate

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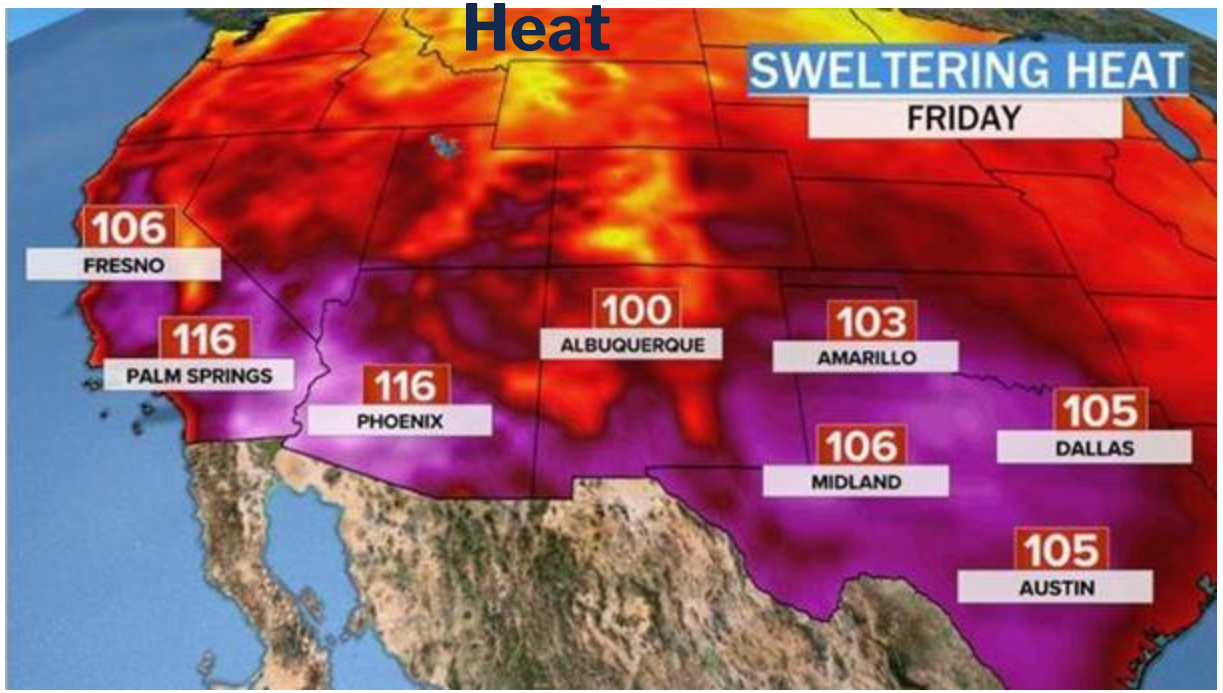
Extreme Rainfall, Flooding

- Flooding associated with higher admissions for acute LRTI in children in Mekong River Delta.
- Extreme rainfall and flooding were associated with ED visits for influenza in children 5-18 yrs in the Northeastern US.

Extreme Heat



- CA heat waves = ED visits for acute resp infection increased in preschool-aged children, after controlling for air pollution levels.

Reviewed by Di Cicco et al. Int J Environ Res Public Health 2020;17: 5244

How does air pollution increase susceptibility to viruses?

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- Pollutants act synergistically with virus to cause more severe airway inflammation
- Together amplify allergic airway inflammation
- Alter epithelial barrier function
- Modify viral entry into cells
- Impaired immune response to virus

Respiratory Infections and Air Pollution

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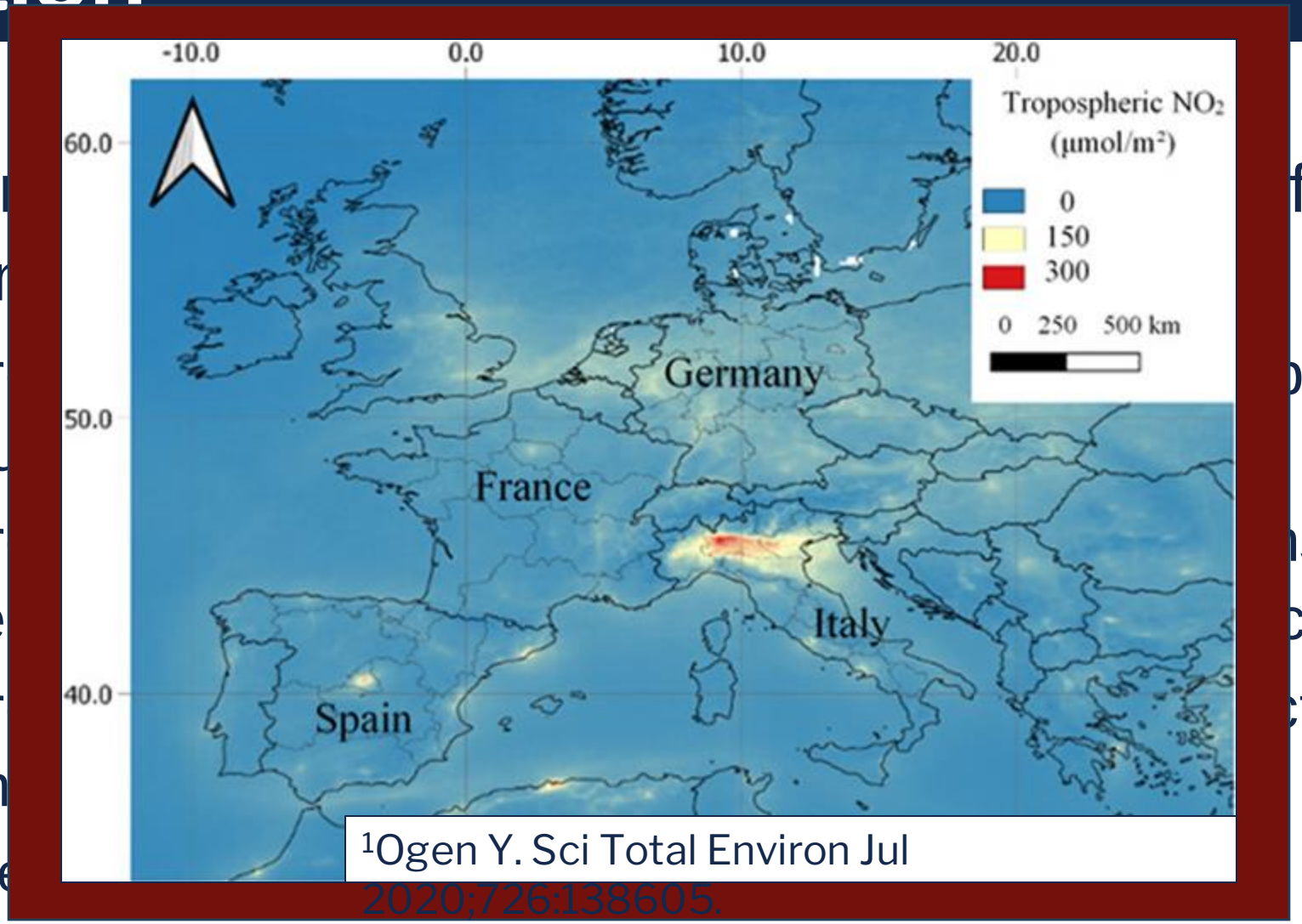
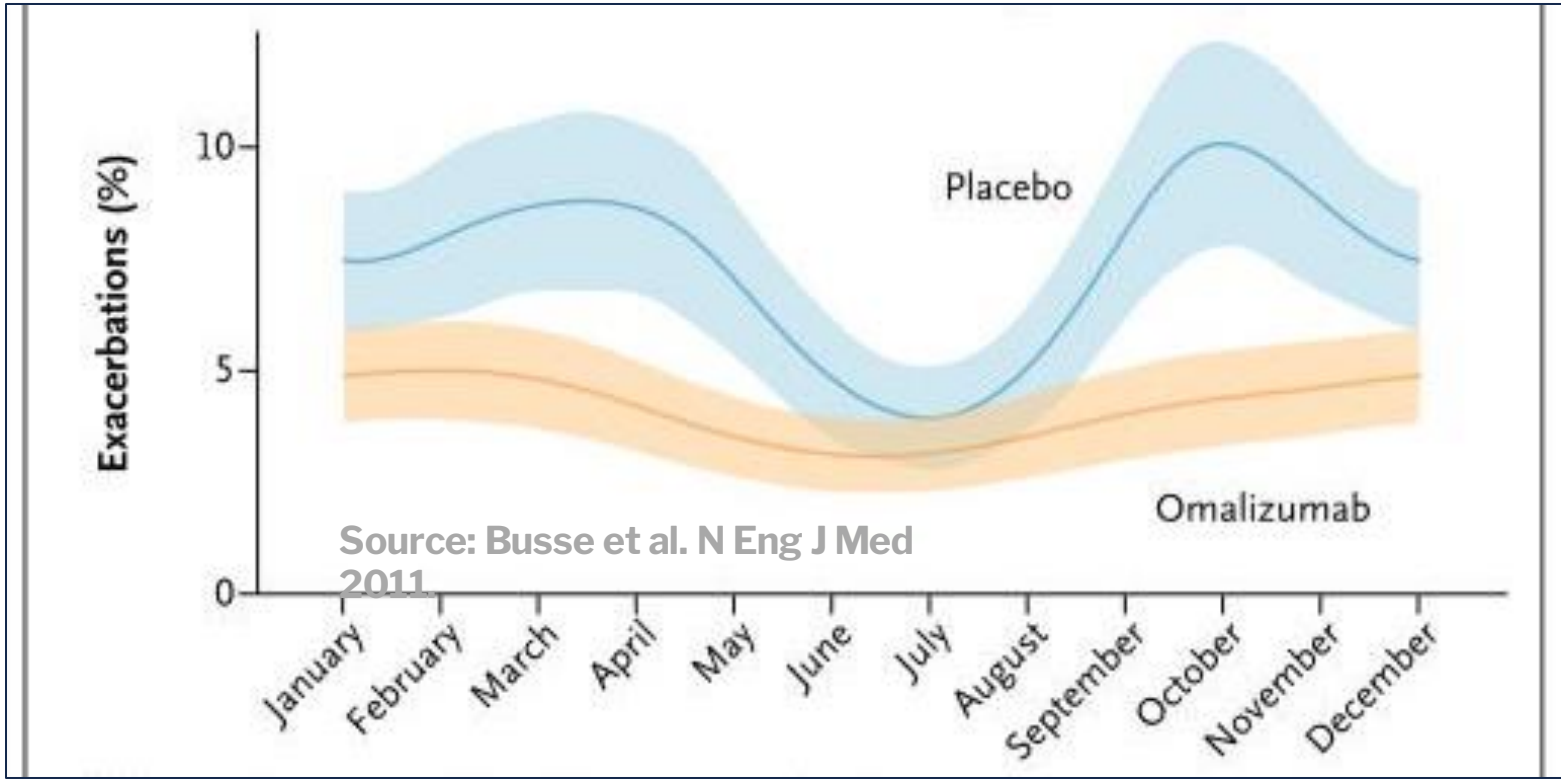


[1]Ogen Y. Sci Total Environ Jul 2020;726:138605.

What does this mean for asthma?

- Effects on established asthma
  - Altered seasonal patterns of asthma exacerbations
  - Increased susceptibility to infection
  - more frequent or intense exacerbations?
- Effects on asthma incidence
  - Persistent exposure to virus more early life infections greater risk of asthma development?



Source: Busse et al. N Eng J Med 2011

Climate Change Vulnerability

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- Intentional siting of polluting facilities in low-income communities of color
- Red-lining, residential segregation
- Residential proximity to major roadways

- Disproportionate exposure to pollutants and toxicants
- Community disinvestment crumbling infrastructure, poor housing, low access to healthcare

Community and neighborhood-level disparities in extreme climate exposure

- Communities of color disproportionately affected
  - Extreme heat urban heat island effect
  - More likely to live in flood-prone areas
  - Fewer resources to adapt, evacuate or rebuild
  - Largest spikes in morbidity and mortality following extreme weather events

Summary

- Climate change influences 3 of the most common drivers of asthma morbidity: allergen, air pollution, and respiratory viruses.
- The impact of outdoor allergens such as pollens is expected to increase as pollen seasons lengthen in duration and intensity.
- Climate change and air pollution are tightly linked; O_3 and PM exposure are projected to increase due to climate change.
- Viral respiratory infection patterns are influenced by climate and by extreme weather events.
- Air pollution may increase susceptibility to respiratory viral infection and may induce more severe illness.
- Some groups are more vulnerable to the consequences of climate change than others.


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